ENGINE SECTION 3

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.

MECHANICAL

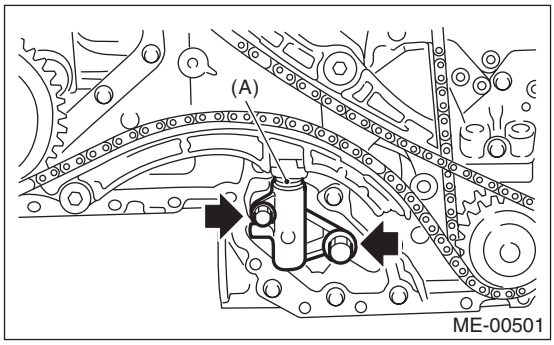
ME(H6DO)

15.Timing Chain Assembly

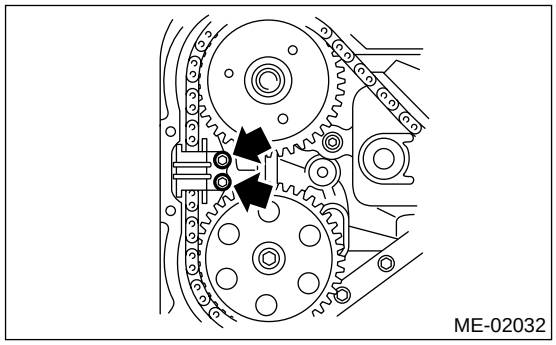
A: REMOVAL

1) Remove the crank pulley. <Ref. to ME(H6DO)-42, REMOVAL, CRANK PULLEY.>
2) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, FRONT CHAIN COVER.>
3) Remove the chain tensioner (RH).

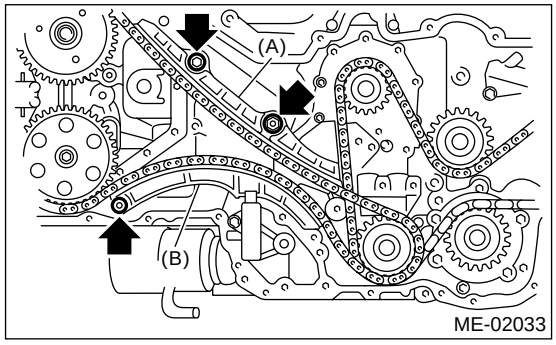
NOTE:
Be careful not to come out the plunger (A).



4) Remove the chain guide (RH: between cams).



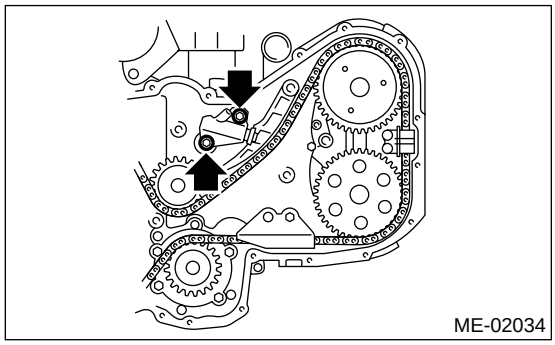
5) Remove the chain guide (RH).
6) Remove the chain tensioner lever (RH).



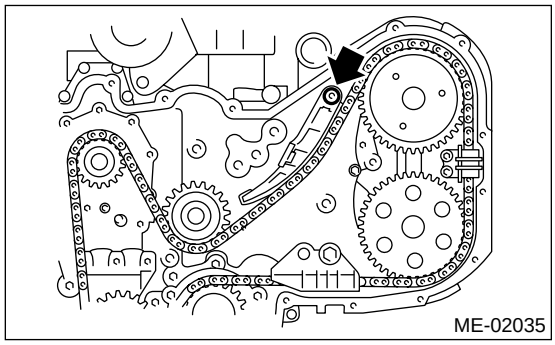
(A) Chain guide (RH)
(B) Chain tensioner lever (RH)

7) Remove the timing chain (RH).
8) Remove the chain tensioner (LH).

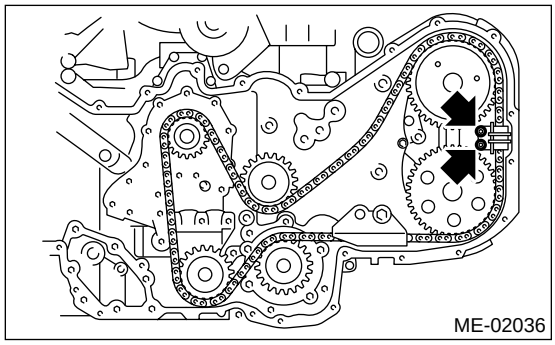
NOTE:
Be careful not to come out the plunger.



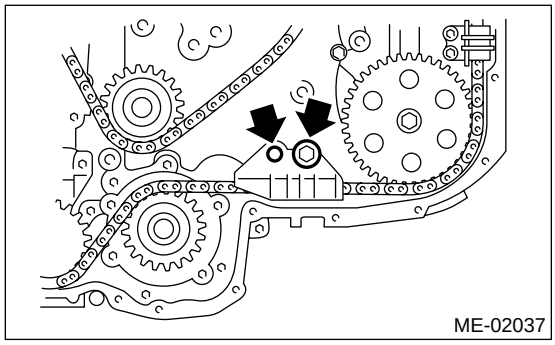
9) Remove the chain tensioner lever (LH).



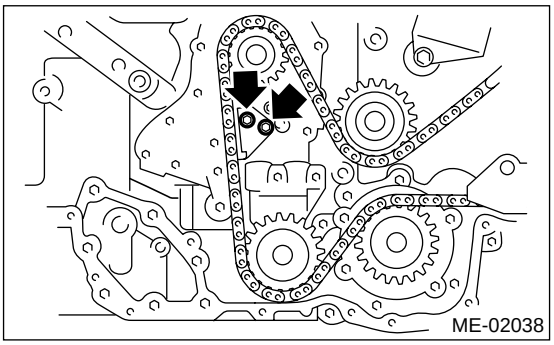
10) Remove the chain guide (LH: between cams).



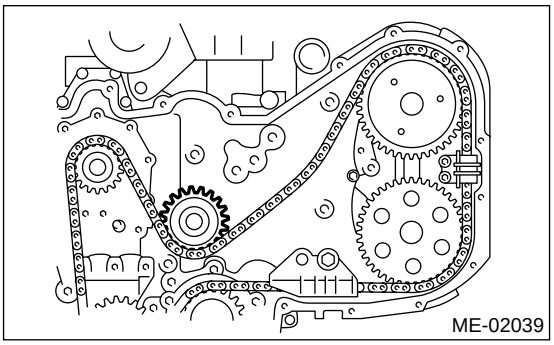
11) Remove the chain guide (LH).



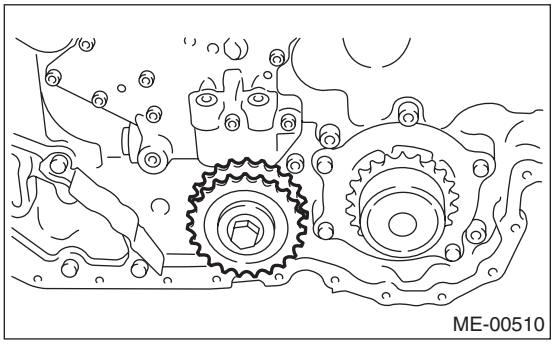
12) Remove the chain guide (CTR).



13) Remove the idler sprocket (upper).



14) Remove the timing chain (LH).
15) Remove the idler sprocket (lower).

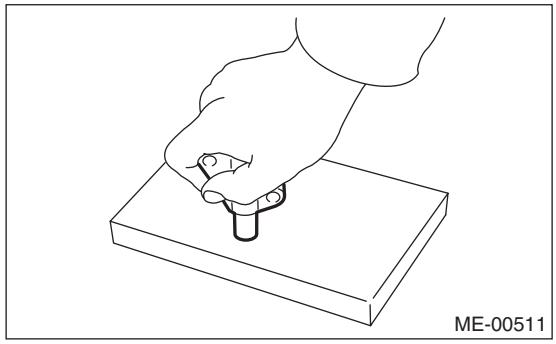


B: INSTALLATION

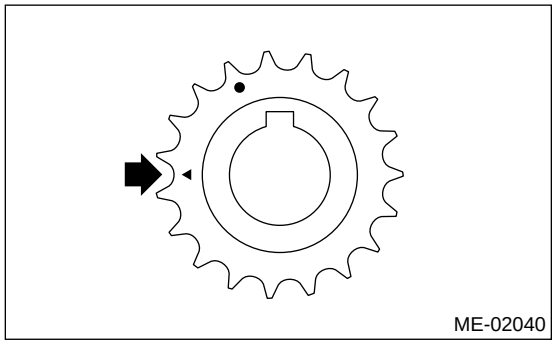
NOTE:
• Be careful that the foreign matter is not into or onto assembled component during installation.
• Apply engine oil to the chain guide, chain tensioner lever and idler sprocket when installing.

1) Preparation for chain tensioner installation
   (1) Insert the screw, spring pin and tension rod into tensioner body.
   (2) While depressing the tensioner onto rubber mat, twist it to shorten tension rod. Then insert the thin pin into the hole between tension rod and tension body to keep shortened.

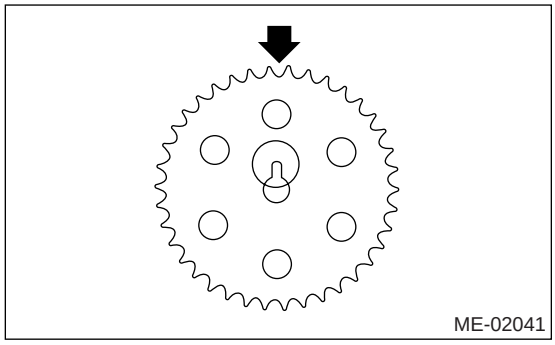
NOTE:
Work on the rubber mat or other anti-skid materials.



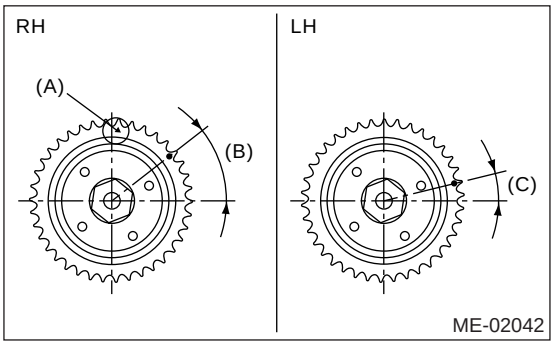
2) Using ST, align the “Top mark” on crank sprocket to 9 o’clock position as shown in the figure
ST 18252AA000 CRANKSHAFT SOCKET



3) Using ST, align the key groove on exhaust cam sprocket to 12 o’clock position as shown in the figure



4) Align the intake cam sprocket as shown in the figure.



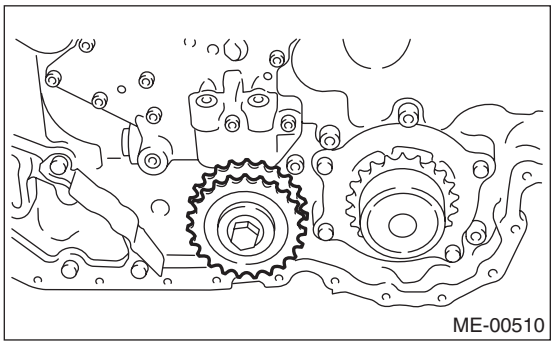
(A) Top mark
(B) 40°
(C) 15°

5) Turn the crank sprocket clockwise, align the "Top mark" to 12 o'clock position (Piston #1 is in TDC position)

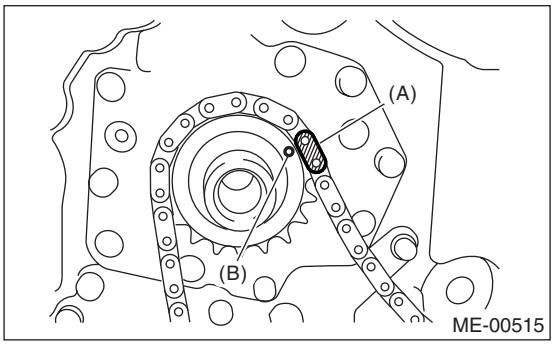
NOTE:
Do not rotate the crank shaft and cam sprocket until the timing chain routing was completed.

6) Install the idler sprocket (lower).

Tightening torque:
69 N·m (7.0 kgf-m, 50.6 ft-lb)



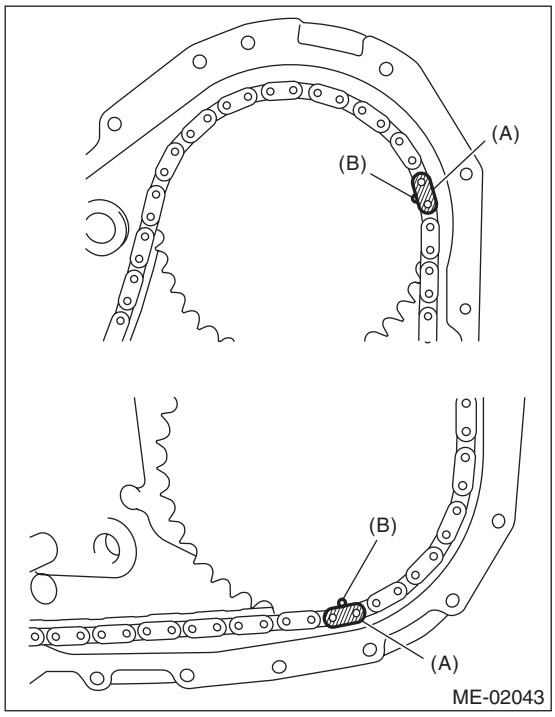
7) Install the timing chain (LH).
(1) Align the timing mark (B) on the crank sprocket with mark (A) on the timing chain (LH).



(A) Gold
(B) Mark

(2) Set the routing of timing chain (LH) on idler sprocket (lower), water pump, exhaust cam sprocket (LH) and intake cam sprocket (LH).

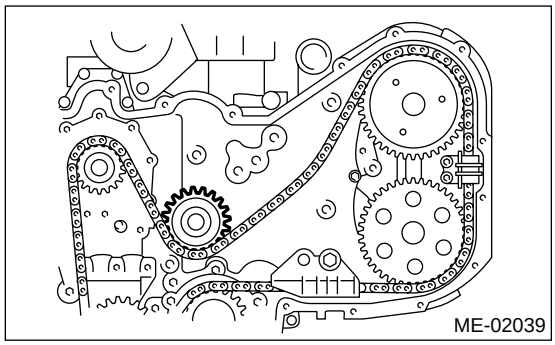
NOTE:
Check that the mark on timing chain (A) and cam sprocket (B) is aligned as same as aligned on crank sprocket.



(A) Dark blue
(B) Mark

(3) Install the chain idler (upper).

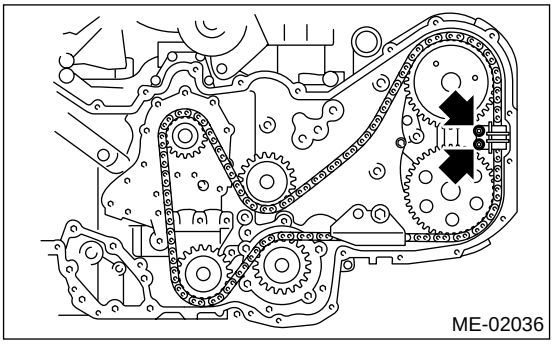
Tightening torque:
69 N·m (7.0 kgf-m, 50.6 ft-lb)



(4) Install the chain guide (LH: between cams).

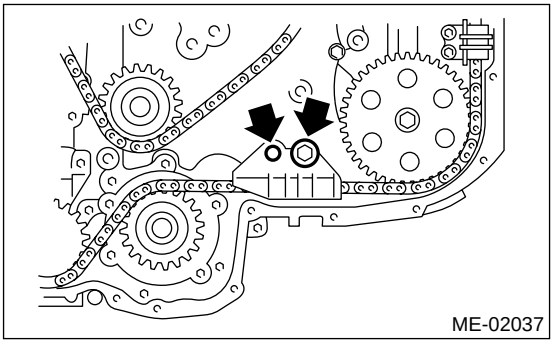
Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

NOTE:
Use a new installing bolt.



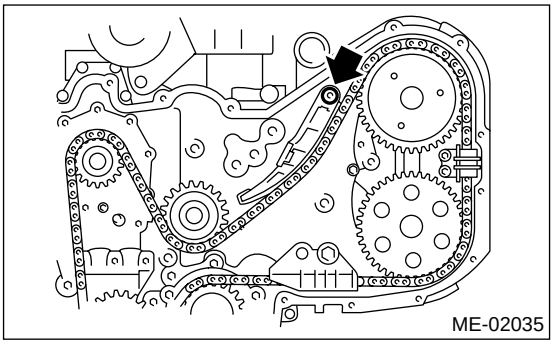
(5) Install the chain guide (LH).

Tightening torque:
16 N·m (1.6 kgf-m, 11.6 ft-lb)



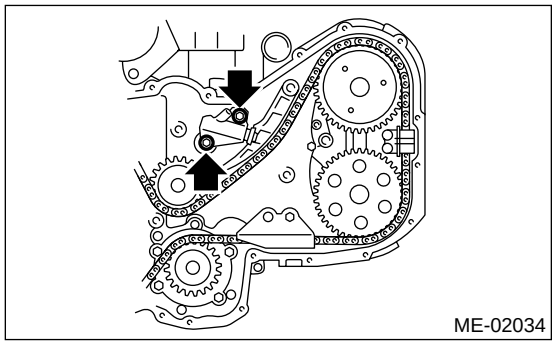
(6) Install the chain tensioner lever (LH).

Tightening torque:
16 N·m (1.6 kgf-m, 11.6 ft-lb)

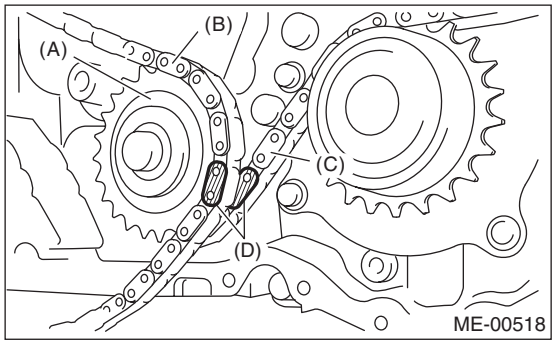


(7) Install the chain tensioner (LH).

Tightening torque:
16 N·m (1.6 kgf-m, 11.6 ft-lb)



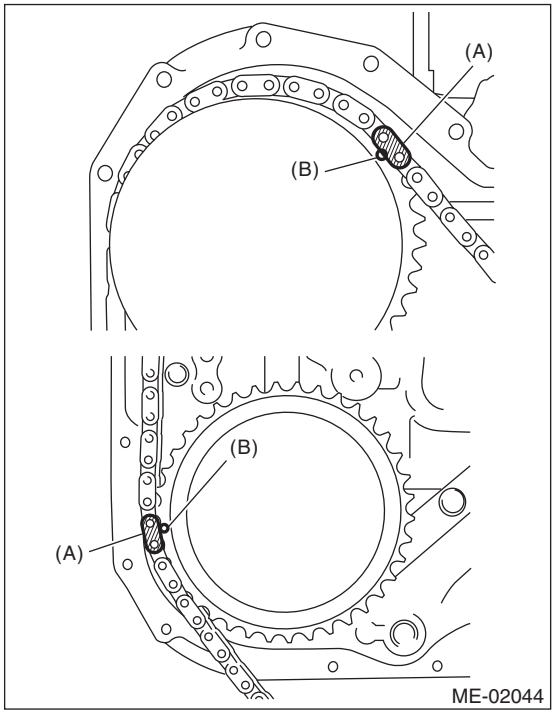
8) Install the timing chain (RH).
(1) Align the marks of timing chain LH and RH on the idler sprocket (lower).



(A) Idler sprocket (lower)
(B) Timing chain (RH)
(C) Timing chain (LH)
(D) Dark blue

(2) Set the routing of timing chain (RH) on intake cam sprocket, and then set the routing on exhaust cam sprocket.

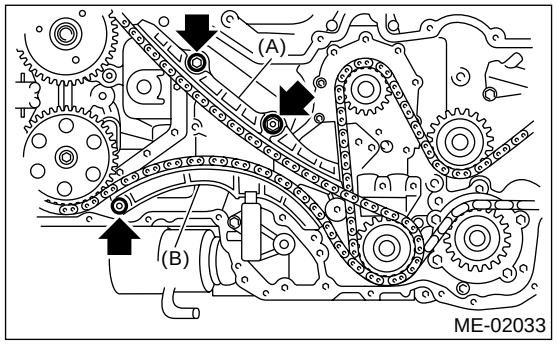
NOTE:
Check that the mark on timing chain (A) and cam sprocket (B) is aligned as same as aligned on crank sprocket.



(A) Gold
(B) Mark

(3) Install the chain guide (RH).
(4) Install the chain tensioner lever (RH).

Tightening torque:
16 N·m (1.6 kgf-m, 11.6 ft-lb)

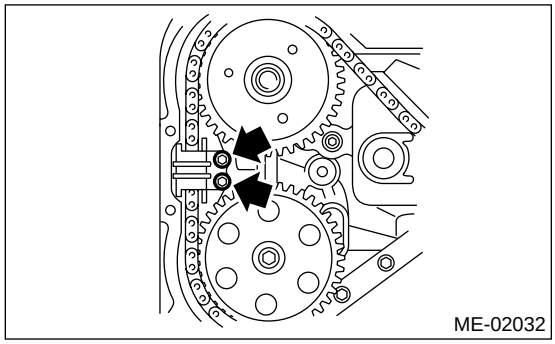


(A) Chain guide (RH)
(B) Chain tensioner lever (RH)

(5) Install the chain guide (RH: between cams).

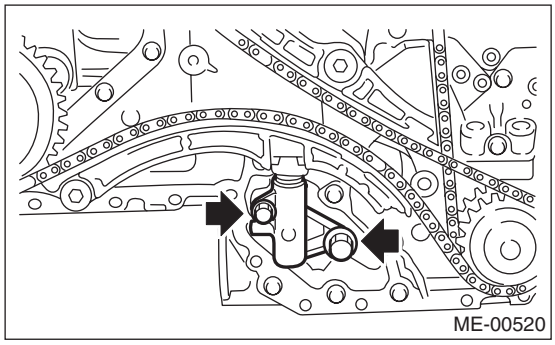
Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

NOTE:
Use a new installing bolt.



(6) Install the chain tensioner (RH).

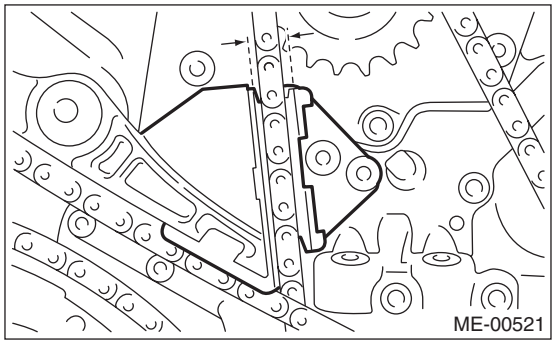
Tightening torque:
16 N·m (1.6 kgf-m, 11.6 ft-lb)



(7) Adjust the clearance between chain guide (RH) and chain guide (CTR) within 8.4 — 8.6 mm (0.331 — 0.339 in). Install the chain guide (CTR).

Tightening torque:
7.8 N·m (0.8 kgf-m, 5.8 ft-lb)

NOTE:
Use a new installing bolt.



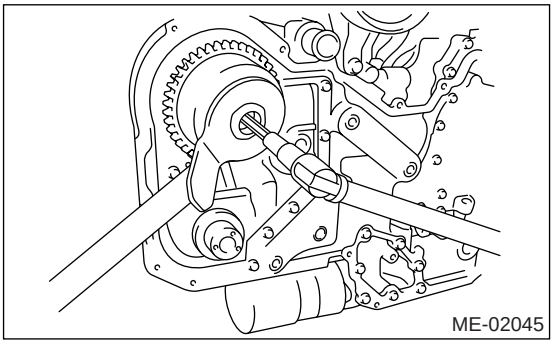
(8) Check that each mark on the sprocket and timing chain is matched, and then draw out the stopper pin from chain tensioner.

16.Cam Sprocket

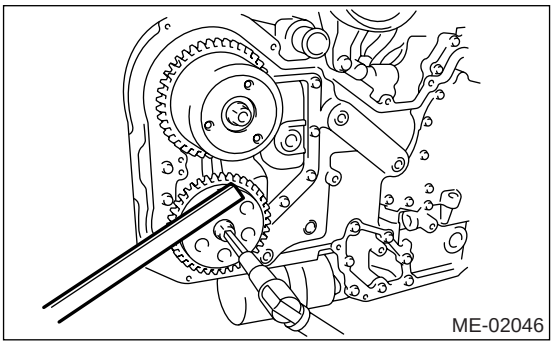
A: REMOVAL

1) Remove the crank pulley. <Ref. to ME(H6DO)-42, REMOVAL, CRANK PULLEY.>
2) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, FRONT CHAIN COVER.>
3) Remove the timing chain assembly.
<Ref. to ME(H6DO)-45, REMOVAL, TIMING CHAIN ASSEMBLY.>
4) Remove the cam sprocket. To lock the crankshaft, use the ST.

ST 499977500 CAM SPROCKET WRENCH



ST 18231AA020 CAM SPROCKET WRENCH



B: INSTALLATION

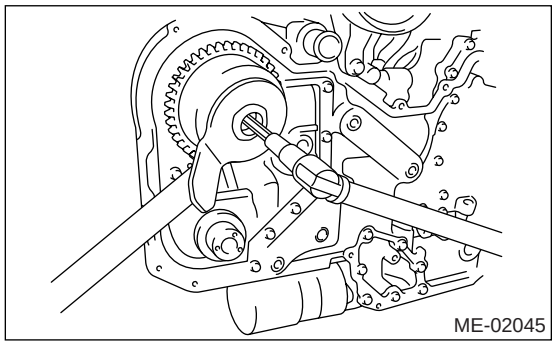
1) Install the cam sprocket. To lock the crankshaft, use the ST.

Tightening torque:
29.5 N·m (3.0 kgf-m, 21.8 ft-lb)

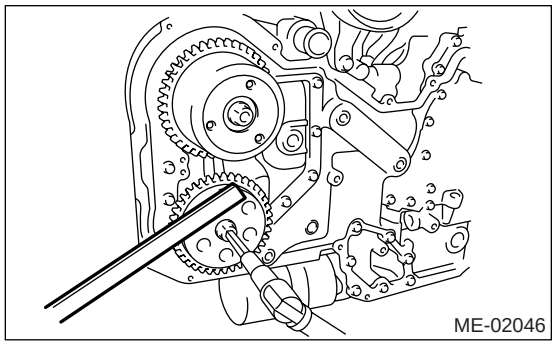
2) Further tighten the bolt.

Tightening angle:
Intake
45°±5°
Exhaust
25°±5°

ST 499977500 CAM SPROCKET WRENCH



ST 18231AA020 CAM SPROCKET WRENCH



3) Install the timing chain assembly.
<Ref. to ME(H6DO)-46, INSTALLATION, TIMING CHAIN ASSEMBLY.>
4) Install the front chain cover.
<Ref. to ME(H6DO)-43, INSTALLATION, FRONT CHAIN COVER.>
5) Install the crank pulley. <Ref. to ME(H6DO)-42, INSTALLATION, CRANK PULLEY.>

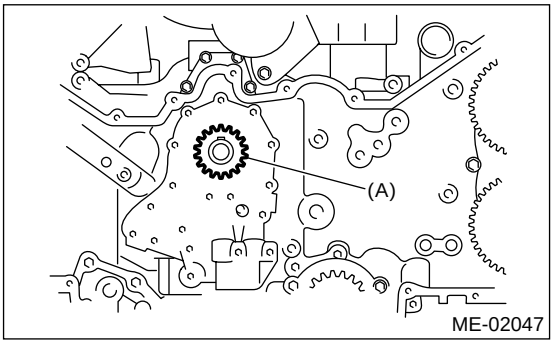
C: INSPECTION

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

17.Crank Sprocket

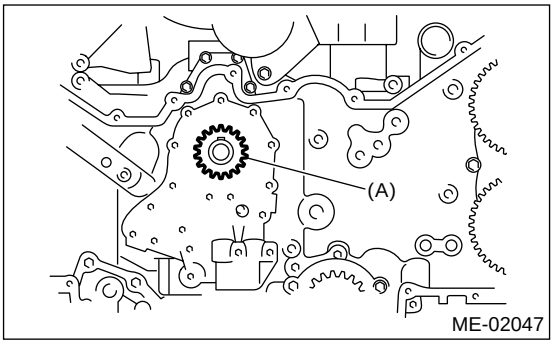
A: REMOVAL

1) Remove the crank pulley. <Ref. to ME(H6DO)-42, REMOVAL, CRANK PULLEY.>
2) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, FRONT CHAIN COVER.>
3) Remove the timing chain assembly.
<Ref. to ME(H6DO)-45, REMOVAL, TIMING CHAIN ASSEMBLY.>
4) Remove the cam sprocket. <Ref. to ME(H6DO)-50, REMOVAL, CAM SPROCKET.>
5) Remove the crank sprocket (A).



B: INSTALLATION

1) Install the crank sprocket (A).



2) Install the cam sprocket. <Ref. to ME(H6DO)-50, INSTALLATION, CAM SPROCKET.>
3) Install the timing chain assembly.
<Ref. to ME(H6DO)-46, INSTALLATION, TIMING CHAIN ASSEMBLY.>
4) Install the front chain cover.
<Ref. to ME(H6DO)-43, INSTALLATION, FRONT CHAIN COVER.>
5) Install the crank pulley. <Ref. to ME(H6DO)-42, INSTALLATION, CRANK PULLEY.>

C: INSPECTION

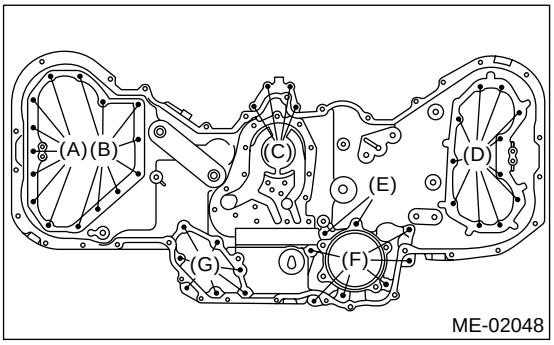
1) Check the crank sprocket teeth for abnormal wear and scratches.
2) Make sure there is no free play between crank sprocket and key.

18.Rear Chain Cover

A: REMOVAL

1) Remove the crank pulley. <Ref. to ME(H6DO)-42, REMOVAL, CRANK PULLEY.>
2) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, FRONT CHAIN COVER.>
3) Remove the timing chain. <Ref. to ME(H6DO)-45, REMOVAL, TIMING CHAIN ASSEMBLY.>
4) Remove the cam sprocket. <Ref. to ME(H6DO)-50, REMOVAL, CAM SPROCKET.>
5) Remove the crank sprocket.
6) Remove the oil pump. <Ref. to LU(H6DO)-8, REMOVAL, Oil Pump.>
7) Remove the water pump. <Ref. to CO(H6DO)-11, REMOVAL, Water Pump.>
8) Remove the rear chain cover.

NOTE:
Installation bolt has seven different sizes. To prevent the confusion in installation, keep these bolts on container individually.



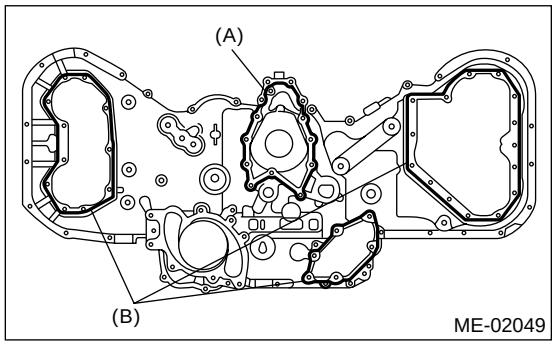
(A) M6 × 14
(B) M6 × 18 (Silver)
(C) M6 × 30
(D) M6 × 18
(E) M8 × 40
(F) M8 × 30
(G) M6 × 22

B: INSTALLATION

1) Remove the used liquid gasket from mating surface, and degrease it.
2) Apply liquid gasket to the matching surface of rear chain cover.

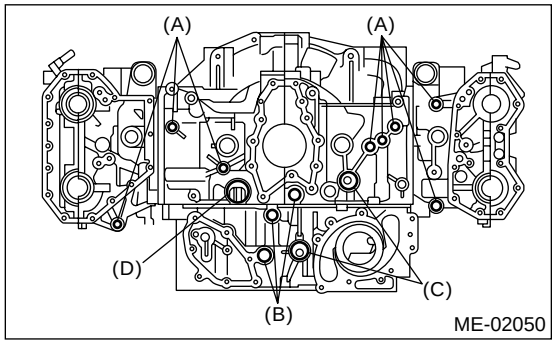
Liquid gasket
THREE BOND 1280B (Part No. K0877A018)

Applying liquid gasket diameter
(A) 1.0±0.5 mm (0.039±0.020 in)
(B) 3.0±1.0 mm (0.118±0.039 in)



3) Install the O-ring.

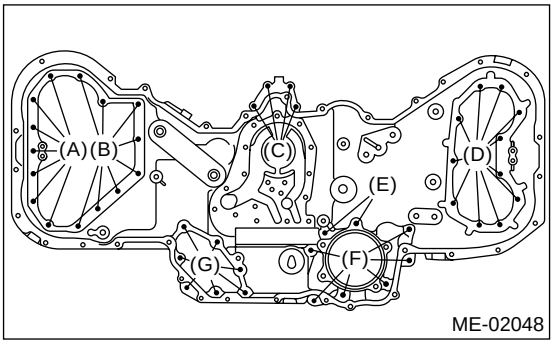
NOTE:
- Do not reuse the O-ring.
- Do not install the O-ring in wrong place.



(A) 14.2 × 1.9
(B) 19.2 × 2.4
(C) 25 × 2
(D) 31.2 × 1.9

4) Temporarily tighten the rear chain cover.

NOTE:
Do not install the bolts in wrong place.

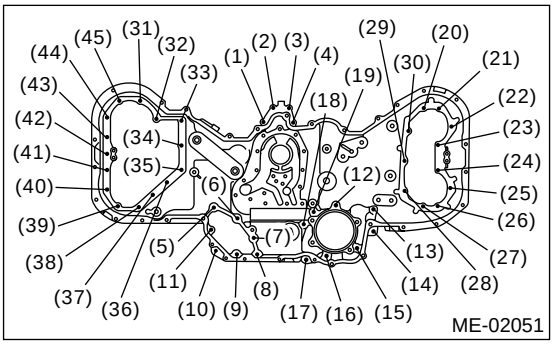


(A) M6 × 14
(B) M6 × 18 (Silver)
(C) M6 × 30
(D) M6 × 18
(E) M8 × 40
(F) M8 × 30
(G) M6 × 22

5) Tighten the bolts in the numerical order as shown in the figure.

Tightening torque:

(1) — (11)	9 N·m (0.9 kgf-m, 6.5 ft-lb)
(12) — (19)	20 N·m (2.0 kgf-m, 14 ft-lb)
(20) — (30)	9 N·m (0.9 kgf-m, 6.5 ft-lb)
(31) — (38)	12 N·m (1.2 kgf-m, 8.7 ft-lb)
(39) — (45)	9 N·m (0.9 kgf-m, 6.5 ft-lb)

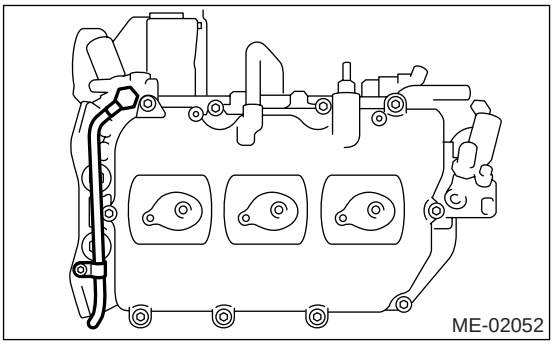


6) Install the water pump. <Ref. to CO(H6DO)-11, INSTALLATION, Water Pump.>
7) Install the oil pump. <Ref. to LU(H6DO)-8, INSTALLATION, Oil Pump.>
8) Install the crank sprocket.
9) Install the cam sprocket. <Ref. to ME(H6DO)-50, INSTALLATION, CAM SPROCKET.>
10) Install the timing chain. <Ref. to ME(H6DO)-46, INSTALLATION, TIMING CHAIN ASSEMBLY.>
11) Install the front chain cover.
<Ref. to ME(H6DO)-43, INSTALLATION, FRONT CHAIN COVER.>
12) Install the crank pulley. <Ref. to ME(H6DO)-42, INSTALLATION, CRANK PULLEY.>

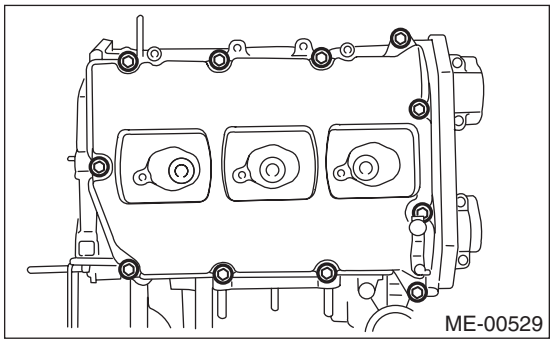
19.Camshaft

A: REMOVAL

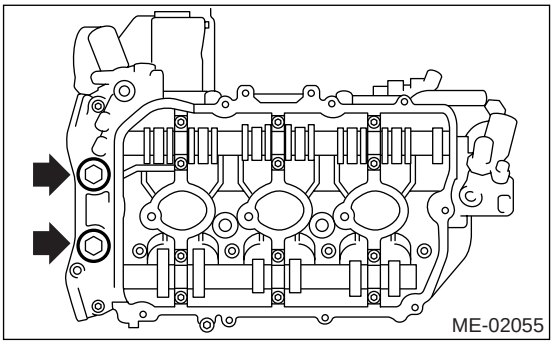
1) Remove the crank pulley. <Ref. to ME(H6DO)-42, REMOVAL, Crank Pulley.>
2) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, FRONT CHAIN COVER.>
3) Remove the timing chain assembly.
<Ref. to ME(H6DO)-45, REMOVAL, TIMING CHAIN ASSEMBLY.>
4) Remove the cam sprocket.
<Ref. to ME(H6DO)-50, REMOVAL, Cam Sprocket.>
5) Remove the crank sprocket.
<Ref. to ME(H6DO)-51, REMOVAL, Crank Sprocket.>
6) Remove the rear chain cover.
<Ref. to ME(H6DO)-52, REMOVAL, Rear Chain Cover.>
7) Disconnect the oil valve.



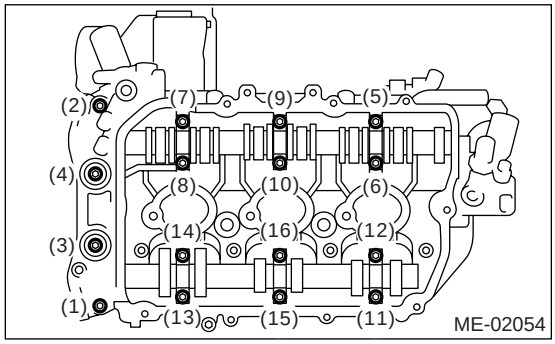
8) Remove the rocker cover (LH).



9) Remove the plugs (LH).



10) Loosen the camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the figure.



11) Remove the camshaft caps and camshaft (LH).

NOTE:
Arrange camshaft caps in order so that they can be installed in their original positions.

12) Similarly, remove the camshafts (RH) and related parts.

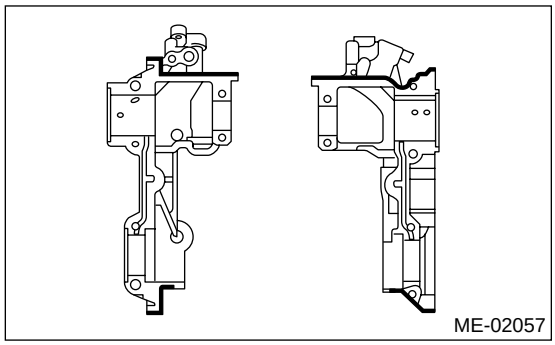
B: INSTALLATION

1) Apply engine oil to camshaft journals, and install the camshaft.
2) Install the camshaft cap.
   (1) Apply liquid gasket sparingly to back side of front camshaft cap as shown in the figure.

CAUTION:
Do not apply fluid packing excessively. Failure to do so may cause excess gasket to come out and flow toward cam journal, resulting in engine burnt.

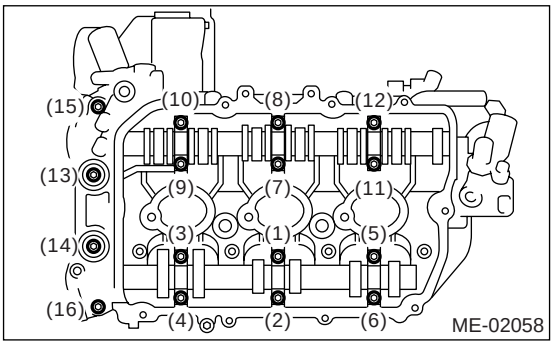
Liquid gasket
THREE BOND 1280B (Part No. K0877YA018)

Applying liquid gasket diameter:
2.0±0.5 mm (0.079±0.020 in)



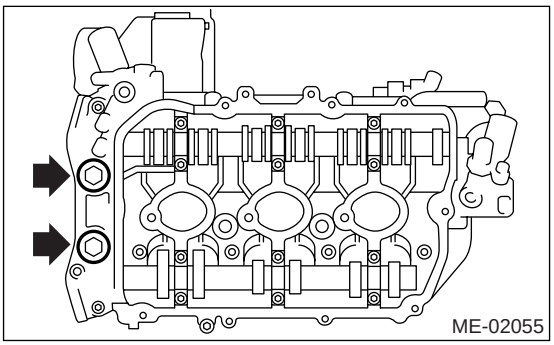
   (2) Apply engine oil to cap bearing surface, and install the cap to camshaft.
   (3) Tighten the rocker cover bolts in the numerical order as shown in the figure.

Tightening torque:
(1) — (12): 16 N·m (1.6 kgf-m, 11.6 ft-lb)
(13) — (16): 9.75 N·m (1.0 kgf-m, 7.2 ft-lb)



3) Install the plugs.

Tightening torque:
6.0 N·m (6.1 kgf-m, 44.3 ft-lb)

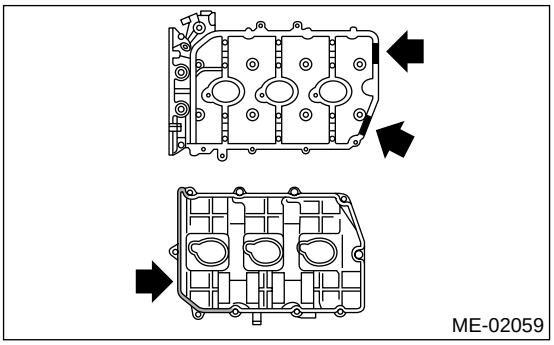


4) Install the rocker cover.
(1) Apply liquid gasket sparingly to the mating surface of cylinder head and rocker cover as shown in the figure.

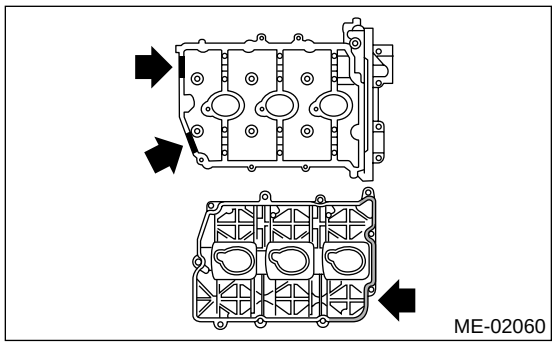
CAUTION:
Do not apply fluid packing excessively. Failure to do so may cause excess gasket to come out and flow toward cam journal, resulting in engine burnt.

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

- LH side



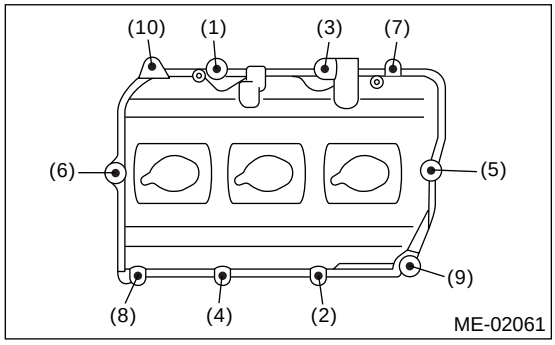
- RH side



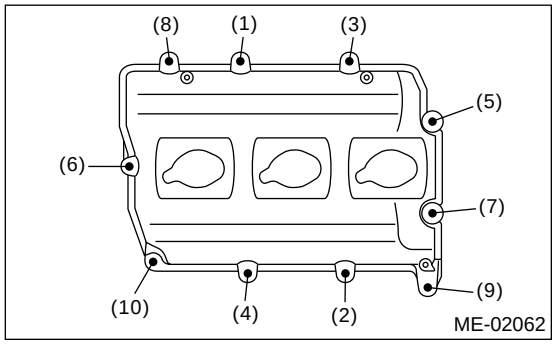
(2) Tighten the rocker cover bolts in the numerical order as shown in the figure.

Tightening torque:
6.4 N·m (0.64 kgf-m, 4.6 ft-lb)

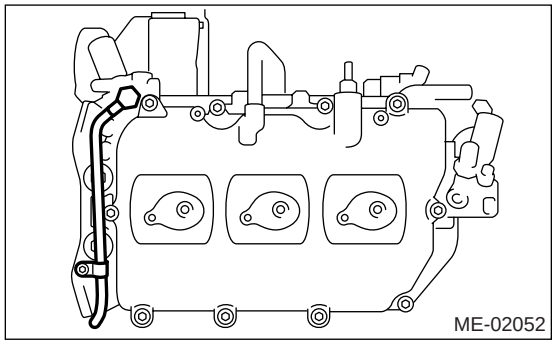
- LH side



- RH side



5) Connect the oil pipe.

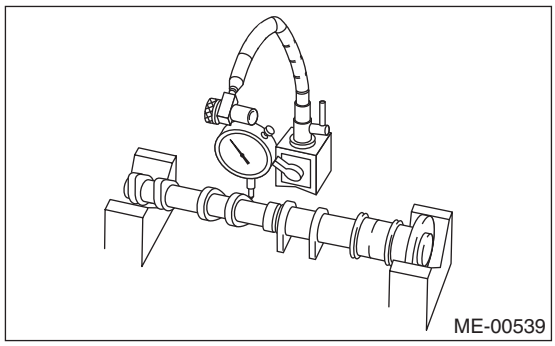


6) Install the rear chain cover. <Ref. to ME(H6DO)-52, INSTALLATION, Rear Chain Cover.>

7) Install the crank sprocket.
<Ref. to ME(H6DO)-51, INSTALLATION, Crank Sprocket.>
8) Install the cam sprocket.
<Ref. to ME(H6DO)-50, INSTALLATION, Cam Sprocket.>
9) Install the timing chain assembly.
<Ref. to ME(H6DO)-46, INSTALLATION, TIMING CHAIN ASSEMBLY.>
10) Install the front chain cover.
<Ref. to ME(H6DO)-43, INSTALLATION, FRONT CHAIN COVER.>
11) Install the crank pulley.
<Ref. to ME(H6DO)-42, INSTALLATION, Crank Pulley.>

C: INSPECTION

1) Check the camshaft for bend, and repair or replace if necessary.



2) Check the journal for damage and wear. Replace if faulty.
3) Measure the outside diameter of camshaft journal. If the journal diameter is not within specifications, check the oil clearance.

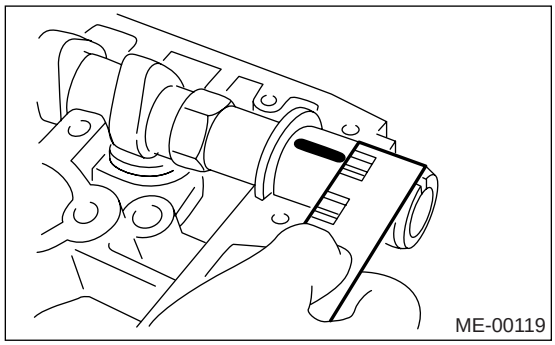
	Camshaft journal	
	Front	Except for front
Standard value mm (in)	37.946 — 37.963 (1.4939 — 1.4946)	25.946 — 25.963 (1.0215 — 1.0222)

4) Measurement of the camshaft journal oil clearance:
(1) Clean the bearing caps and camshaft journals.
(2) Place the camshafts on the cylinder head. (Without installing the valve rocker.)
(3) Place a plastigauge across each of the camshaft journals.
(4) Install the bearing cap.

NOTE:
Do not turn the camshaft.

(5) Remove the bearing caps.
(6) Measure the widest point of the plastigauge on each journal. If oil clearance exceeds the limit, replace the camshaft. If necessary, replace the camshaft caps and cylinder head as a set.

Standard:
0.037 — 0.072 mm (0.0015 — 0.0028 in)

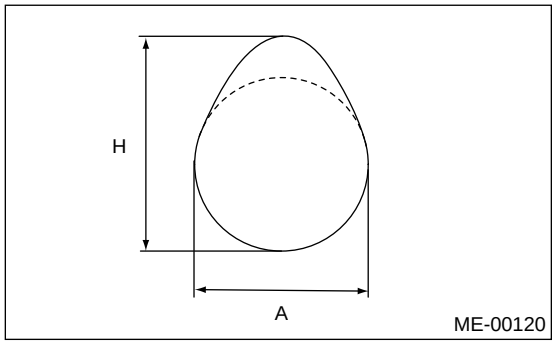


(7) Completely remove the plastigauge.
5) Check the cam face condition; remove the minor faults by grinding with oil stone. Measure the cam height H. If it exceeds the limit, replace it.

Cam height: H:

Standard:
Intake
HIGH: 42.09 — 42.19 mm (1.6571 — 1.6610 in)
LOW1: 38.14 — 38.24 mm (1.5016 — 1.5055 in)
LOW2: 34.94 — 35.04 mm (1.3756 — 1.3795 in)
Exhaust
41.65 — 41.75 mm (1.6398 — 1.6437 in)

Cam base circle diameter A:
Intake
HIGH: 32.0 mm (1.2598 in)
LOW1: 31.84 mm (1.2535 in)
LOW2: 31.84 mm (1.2535 in)
Exhaust
32.0 mm (1.2598 in)



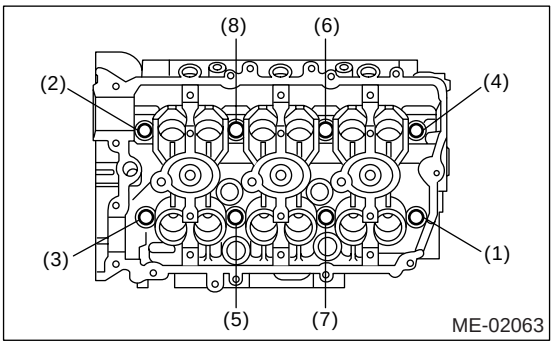
6) Measure the side clearance of camshaft with dial gauge. If the side clearance exceeds the limit or offset wearing is emitted, replace the caps and cylinder head as a set. If necessary, replace the camshaft.

Standard:
Intake
0.075 — 0.135 mm (0.0030 — 0.0053 in)
Exhaust
0.030 — 0.090 mm (0.0012 — 0.0035 in)

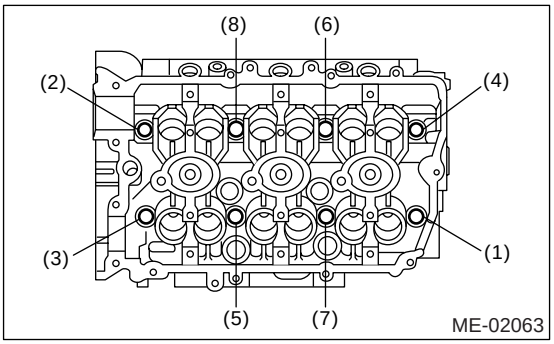
20.Cylinder Head

A: REMOVAL

1) Remove the crank pulley. <Ref. to ME(H6DO)-42, REMOVAL, Crank Pulley.>
2) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, FRONT CHAIN COVER.>
3) Remove the timing chain assembly.
<Ref. to ME(H6DO)-45, REMOVAL, TIMING CHAIN ASSEMBLY.>
4) Remove the cam sprocket.
<Ref. to ME(H6DO)-50, REMOVAL, Cam Sprocket.>
5) Remove the crank sprocket.
<Ref. to ME(H6DO)-51, REMOVAL, Crank Sprocket.>
6) Remove the rear chain cover.
<Ref. to ME(H6DO)-52, REMOVAL, Rear Chain Cover.>
7) Remove the camshaft. <Ref. to ME(H6DO)-54, REMOVAL, Camshaft.>
8) Tighten the cylinder head bolts in the numerical order as shown in the figure.
Leave bolts (2) and (4) engaged by three or four threads to prevent the cylinder head from falling.



9) While tapping the cylinder head with a plastic hammer, separate it from cylinder block.
10) Remove the bolts (2) and (4) to remove the cylinder head.



11) Remove the cylinder head gasket.

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

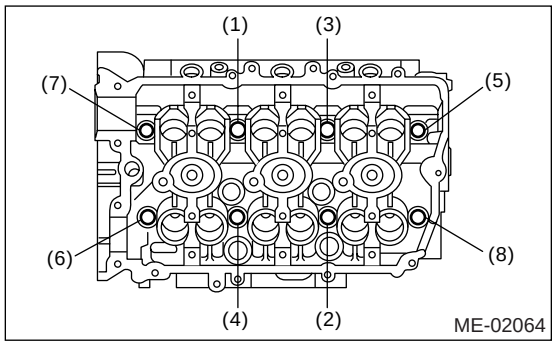
12) Similarly, remove the cylinder head (RH).

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 head and cylinder block.**

2) Tighten the cylinder head bolts.
(1) Apply a coat of engine oil to washers and cylinder head bolt threads.
(2) Install the cylinder head to cylinder block, and then tighten the bolts with torque of 20 N·m (2.0 kgf-m, 14 ft-lb) in numerical sequence as shown in the figure.
(3) Tighten the bolts with torque of 50 N·m (3.0 kgf-m, 37 ft-lb) in numerical sequence as shown in the figure.
(4) Back off all bolts by 180° in reverse order of installation, and back them off again by 180°.
(5) Tighten the bolts with torque of 20 N·m (2.0 kgf-m, 14 ft-lb) in numerical sequence as shown in the figure.
(6) Tighten the bolts (1) and (4) with torque of 48 N·m (3.5 kgf-m, 35.4 ft-lb) in numerical sequence.
(7) Tighten the bolts (5) and (8) with torque of 44 N·m (4.5 kgf-m, 32.5 ft-lb) in numerical sequence.
(8) Tighten the bolts 90° in the numerical order as shown in the figure.
(9) Tighten the bolt (1) — (4) 45° in the numerical order.



3) Install the camshaft. <Ref. to ME(H6DO)-54, INSTALLATION, CAMSHAFT.>
4) Install the rear chain cover. <Ref. to ME(H6DO)-52, INSTALLATION, Rear Chain Cover.>
5) Install the crank sprocket.
<Ref. to ME(H6DO)-51, INSTALLATION, Crank Sprocket.>
6) Install the cam sprocket.
<Ref. to ME(H6DO)-50, INSTALLATION, Cam Sprocket.>

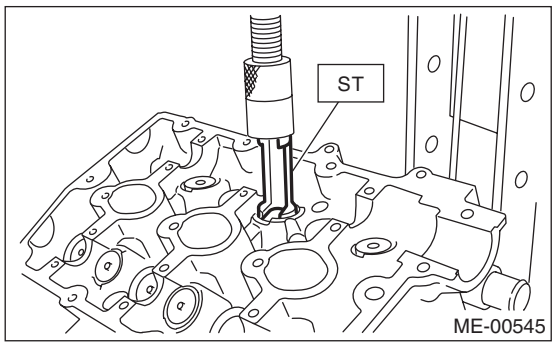
7) Install the timing chain assembly.
<Ref. to ME(H6DO)-46, INSTALLATION, TIMING CHAIN ASSEMBLY.>
8) Install the front chain cover.
<Ref. to ME(H6DO)-43, INSTALLATION, FRONT CHAIN COVER.>
9) Install the crank pulley.
<Ref. to ME(H6DO)-42, INSTALLATION, Crank Pulley.>

C: DISASSEMBLY

1) Set the cylinder head on ST.
ST 18250AA010 CYLINDER HEAD TABLE
2) Remove the valve lifter.
3) Set the ST on valve spring retainer. 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.



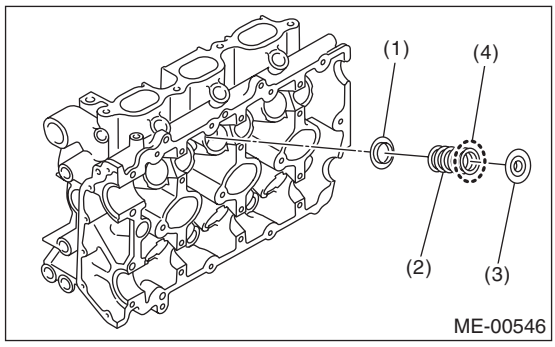
D: ASSEMBLY

1) Installation of valve spring and valve:
(1) Set the cylinder head on ST.
ST 18250AA010 CYLINDER HEAD TABLE
(2) Coat the stem of each valve with engine oil and insert the valve into valve guide.

NOTE:
When inserting the valve into valve guide, use special care not to damage the oil seal lip.

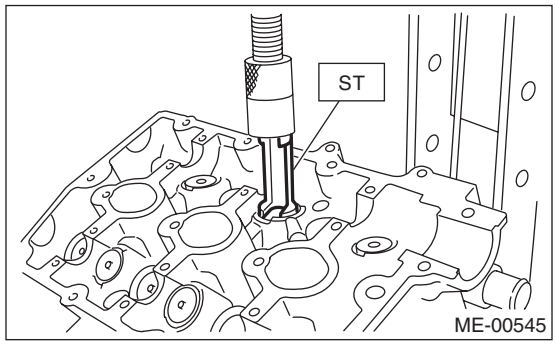
(3) Install the valve spring and retainer.

NOTE:
• Be sure to install the valve springs with their close-coiled end facing the seat on the cylinder head.
• Install the valve spring with the painted side facing to retainer.



(1) Seat
(2) Valve spring
(3) Retainer
(4) Painted face

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



(5) Compress the valve spring and fit the valve spring retainer key.
(6) After installing, tap the valve spring retainers lightly with a wooden hammer for better seating.
2) Apply oil to the surface of the valve lifter and valve shim.
3) Install the valve lifter and valve shim.

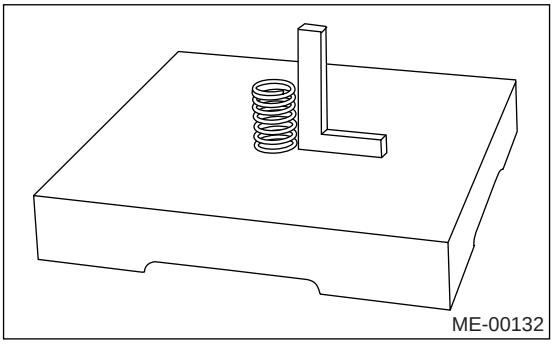
E: INSPECTION

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.

Free length mm (in)	Intake	Inner	39.55 (1.5571)
		Outer	41.18 (1.6213)
	Exhaust		46.32 (1.8236)
Squareness	Intake	Inner	2.5°, 1.7 mm (0.067 in)
		Outer	2.5°, 1.8 mm (0.071 in)
	Exhaust		2.5°, 2.0 mm (0.079 in)

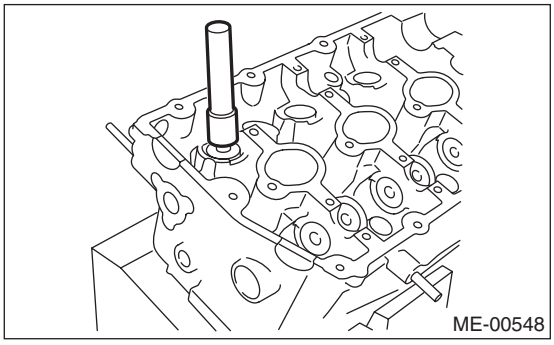
2) To measure the squareness of the valve spring, stand the spring on a surface plate and measure its deflection at the top of spring using a try square.


ME-00132

2. INTAKE AND EXHAUST VALVE OIL SEAL

Replace the oil seal with a new one, if the lip is damaged or spring is out of place, or when the surfaces of intake valve and valve seat are reconditioned or intake valve guide is replaced.
1) Set the cylinder head on ST1.
2) Press-fit the oil seal to the specified dimension indicated in the figure using ST2.
ST1 18250AA010 CYLINDER HEAD TABLE
ST2 499585500 VALVE OIL SEAL GUIDE

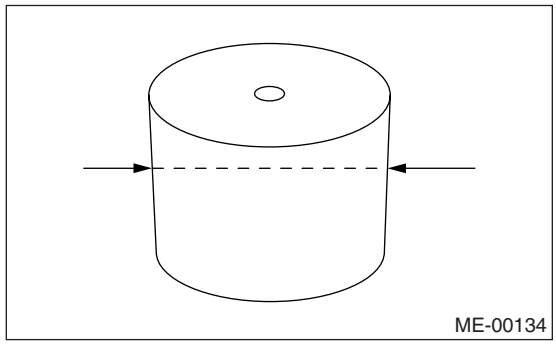
NOTE:
- Apply engine oil to oil seal before force-fitting.
- When press-fitting the oil seal, do not use a hammer or strike in.


ME-00548

3. VALVE LIFTER

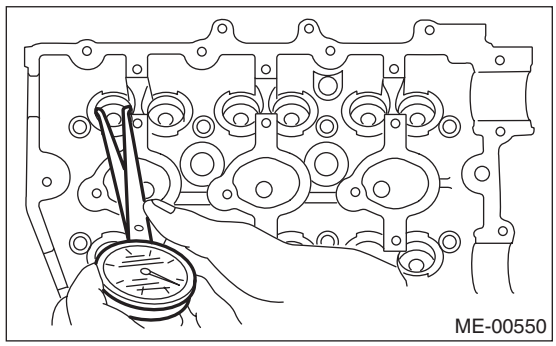
1) Check the valve lifter visually.
2) Measure the outer diameter of valve lifter.

Outer diameter:
32.959 — 32.975 mm (1.2976 — 1.2982 in)


ME-00134

3) Measure the inner diameter of valve lifter hole of cylinder head.

Inner diameter:
32.994 — 33.016 mm (1.2990 — 1.2998 in)


ME-00550

NOTE:
If difference between outer diameter of valve lifter and inner diameter of valve lifter hole is out of the standard or offset wearing is emitted, replace the cylinder head.

Standard:
0.019 — 0.057 mm (0.0007 — 0.0022 in)

F: ADJUSTMENT

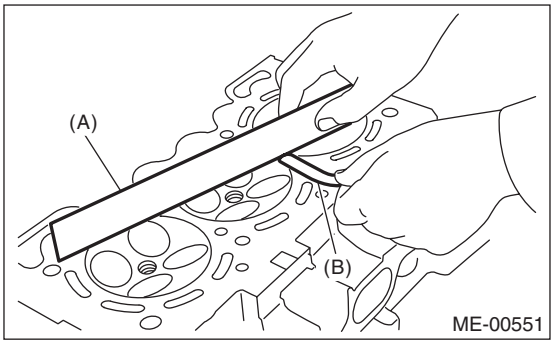
1. CYLINDER HEAD

1) Make sure that no crack or other damages do not exist. In addition to visual inspection, inspect important areas by means of red lead check. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2) Set the cylinder head on ST.
ST 18250AA010 CYLINDER HEAD TABLE
3) Measure the flatness of the cylinder head surface that mates with crankcase using a straight edge (A) and thickness gauge (B).

Flatness:
Standard
0.02 mm (0.0008 in)

Standard height of cylinder head:
124±0.05 mm (4.88±0.0020 in)

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



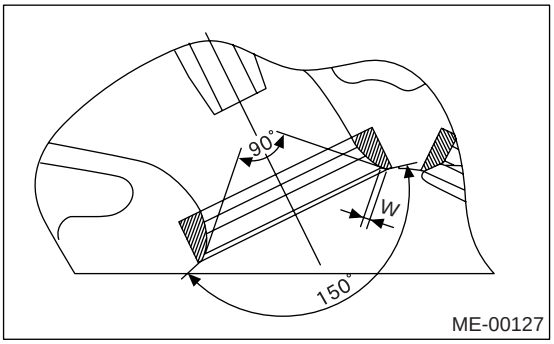
2. VALVE SEAT

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:

Intake
Standard
1.0 mm (0.039 in)

Exhaust
Standard
1.5 mm (0.059 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
0.030 — 0.057 mm (0.0012 — 0.0022 in)
Exhaust
0.040 — 0.067 mm (0.0016 — 0.0026 in)

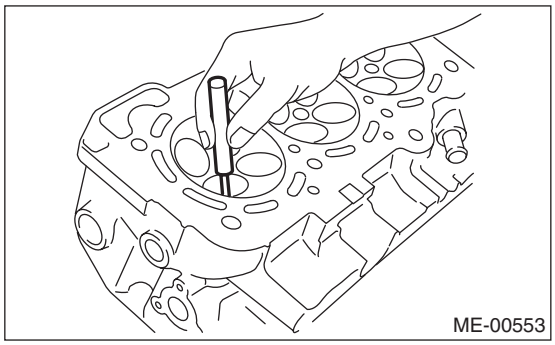
2) If the clearance between valve guide and stem is out of standard, replace the valve guide or valve itself whichever shows greater amount of wear or damaged and etc. See the following procedure for valve guide replacement.

Valve guide inner diameter:
5.500 — 5.512 mm (0.2165 — 0.2170 in)

Valve stem outer diameters:
Intake
5.445 — 5.470 mm (0.2144 — 0.2154 in)
Exhaust
5.455 — 5.460 mm (0.2148 — 0.2150 in)

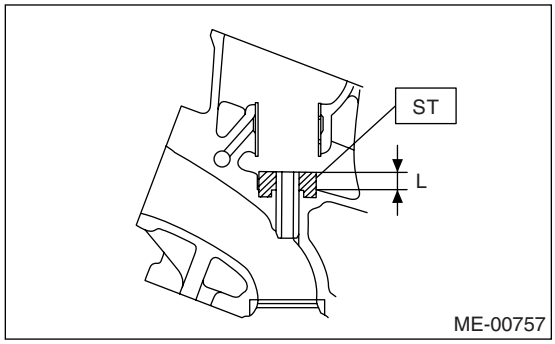
(1) Place the cylinder head on ST1 with the combustion chamber upward so that valve guides enter the holes in ST1.
(2) Insert ST2 into the valve guide and press it down to remove the valve guide.

ST1 18250AA010 CYLINDER HEAD TABLE
ST2 499765700 VALVE GUIDE REMOVER



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

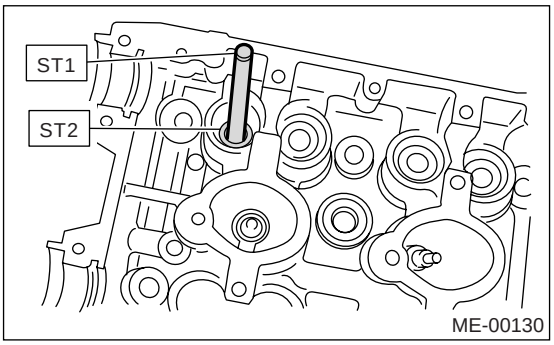
ST 18251AA040 VALVE GUIDE ADJUSTER



(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 499765700 VALVE GUIDE REMOVER

ST2 18251AA040 VALVE GUIDE ADJUSTER



(6) Check the valve guide protrusion.

Valve guide protrusion L:
11.4 — 11.8 mm (0.449 — 0.465 in)

(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.

ST 499765900 VALVE GUIDE REAMER

NOTE:
• 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.

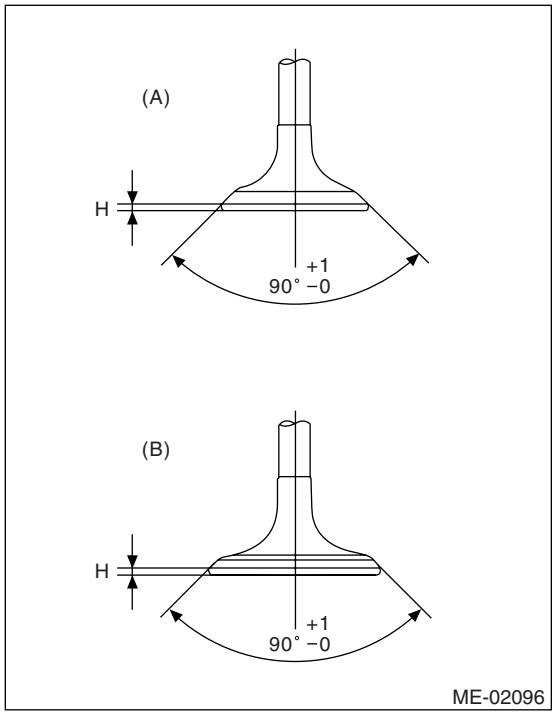
(8) Recheck the contact condition between valve and valve seat after replacing the valve guide.

4. INTAKE AND EXHAUST VALVE

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

H:
Intake (A)
Standard
1.0 mm (0.039 in)
Exhaust (B)
Standard
1.2 mm (0.047 in)

Valve overall length:
Intake (A)
99.7 mm (3.925 in)
Exhaust (B)
105.2 mm (4.142 in)



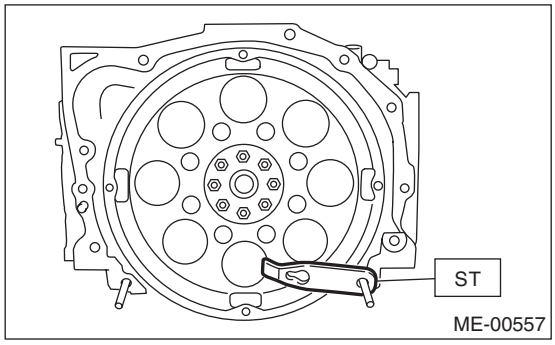
2) Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. Install a new intake valve oil seal after lapping.

21.Cylinder Block

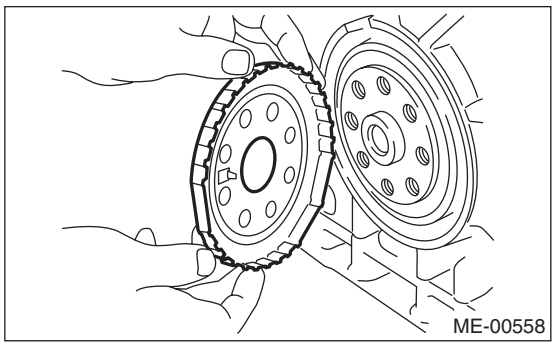
A: REMOVAL

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

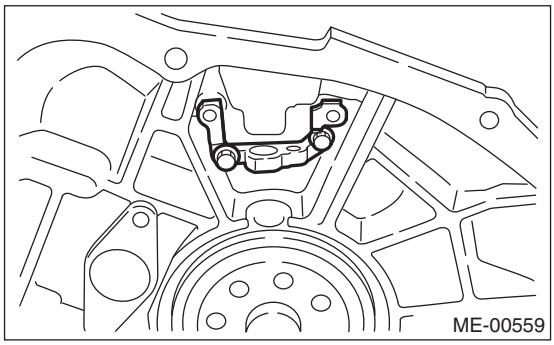
1) Remove the crank pulley. <Ref. to ME(H6DO)-42, REMOVAL, Crank Pulley.>
2) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, FRONT CHAIN COVER.>
3) Remove the timing chain assembly.
<Ref. to ME(H6DO)-45, REMOVAL, TIMING CHAIN ASSEMBLY.>
4) Remove the cam sprocket.
<Ref. to ME(H6DO)-50, REMOVAL, Cam Sprocket.>
5) Remove the crank sprocket.
<Ref. to ME(H6DO)-51, REMOVAL, Crank Sprocket.>
6) Remove the rear chain cover.
<Ref. to ME(H6DO)-52, REMOVAL, Rear Chain Cover.>
7) Remove the camshaft. <Ref. to ME(H6DO)-54, REMOVAL, Camshaft.>
8) Remove the cylinder head. <Ref. to ME(H6DO)-58, REMOVAL, CYLINDER HEAD.>
9) Remove the drive plate.
Lock the crankshaft using ST.
ST 498497100 CRANKSHAFT STOPPER



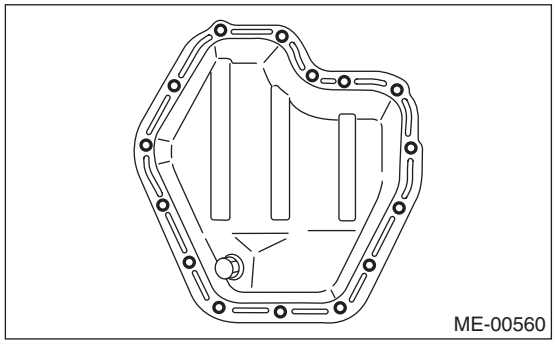
10) Remove the crankshaft position sensor plate.



11) Remove the crankshaft position sensor bracket.



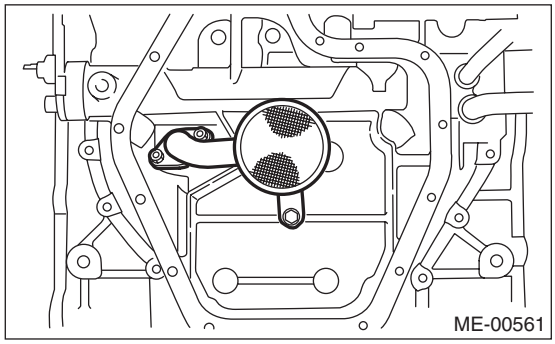
12) Rotate the engine to set oil pan upper.
13) Remove the bolts which secure oil pan lower to oil pan upper.



14) Insert a oil pan cutter blade between cylinder block-to-oil pan clearance and remove the oil pan.

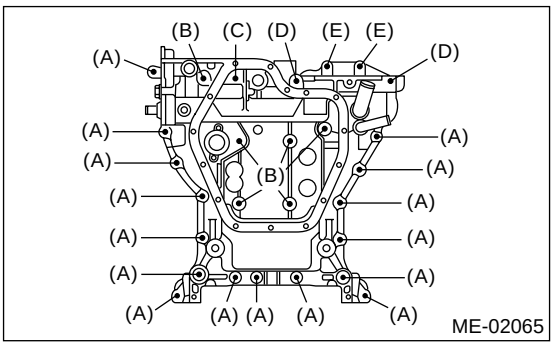
CAUTION:
Do not use a screwdriver or similar tools in place of oil pan cutter.

15) Remove the oil strainer.



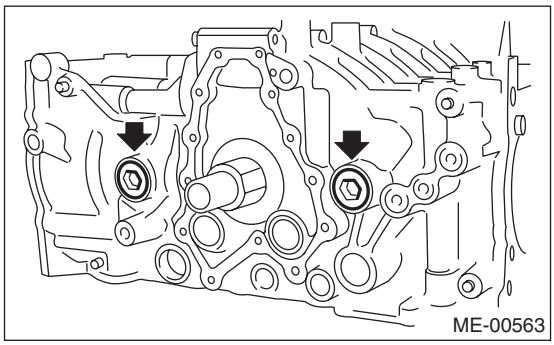
16) Remove the bolts which install oil pan upper onto cylinder block.

NOTE:
Installation bolts have five different sizes. To prevent the confusion in installation, keep these bolts on container individually.



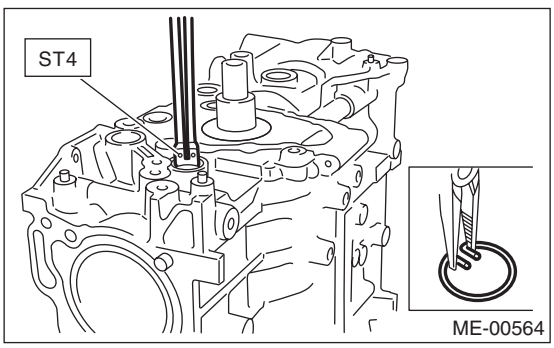
(A) M8 × 40
(B) M8 × 65
(C) M8 × 85
(D) M8 × 130
(E) M8 × 24

17) Remove the service hole cover and service hole plugs using a hexagon wrench.



18) 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 using ST.

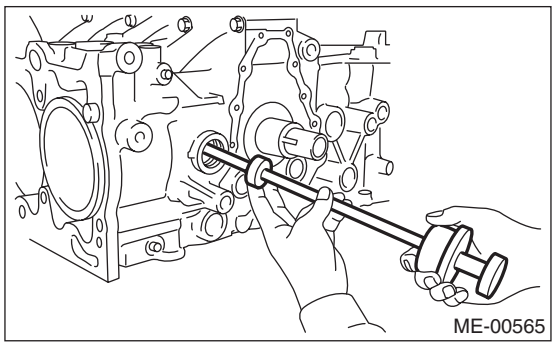
ST 18233AA000 PISTON PIN SNAP RING PRIERS



19) Draw out the piston pin from #1 and #2 pistons using ST.

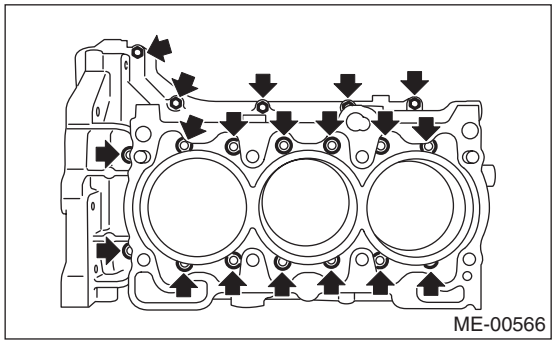
ST 499097500 PISTON PIN REMOVER

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



20) Similarly remove the piston pins from #3, #4, #5 and #6 pistons.

21) Remove the bolts which secure the cylinder block.



22) Separate the cylinder block (LH) and (RH).

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

23) Remove the rear oil seal.

24) Remove the crankshaft together with connecting rod.

25) Remove the crankshaft bearings from cylinder block using a hammer handle.

NOTE:
• Do not confuse the combination of crankshaft bearings.
• Press the bearing at the end opposite to locking lip.

26) 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) After setting the cylinder block to ST, install the crankshaft bearing.
ST 18232AA000 ENGINE STAND

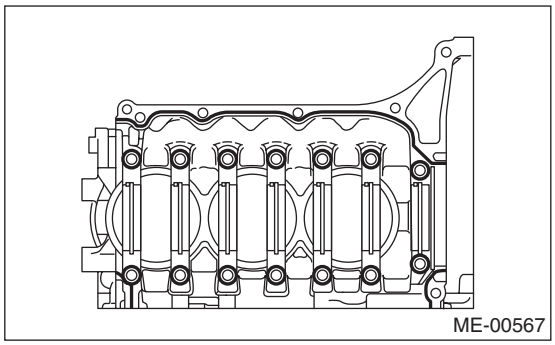
NOTE:
Remove oil on the mating surface of bearing and cylinder block before installation. Apply a coat of engine oil to crankshaft pins.

2) Position the crankshaft and connecting rod on the #2, #4 and #6 cylinder block.
3) Apply liquid gasket to the mating surface of #1, #3 and #5 cylinder block, and position it on #2, #4 and #6 cylinder block.

Liquid gasket
THREE BOND 1215B (Part No. 004403007)

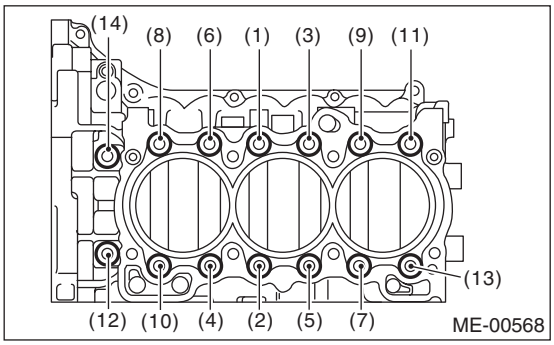
NOTE:
Do not allow liquid gasket to jut into O-ring grooves, oil passages, bearing grooves, etc.

Applying liquid gasket diameter:
1.0±0.2 mm (0.039±0.008 in)



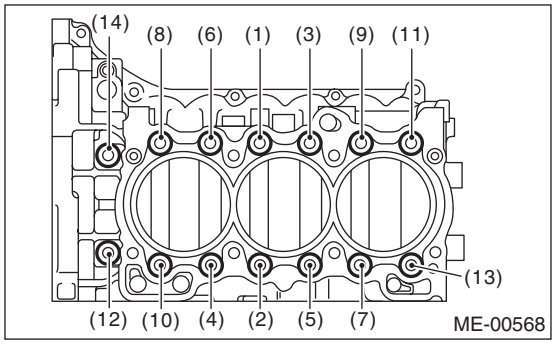
4) Apply a coat of engine oil to washers and bolt threads.
5) Tighten all bolts in the numerical order as shown in the figure.

Tightening torque:
(1) — (11), (13): 25 N·m (2.5 kgf-m, 18 ft-lb)
(12), (14): 20 N·m (2.0 kgf-m, 14 ft-lb)

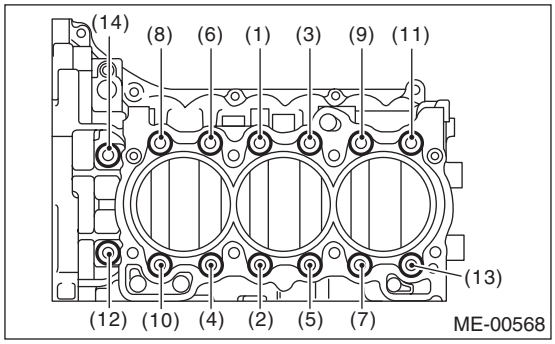


6) Retighten all bolts in the numerical order as shown in the figure.

Tightening torque:
(1) — (11), (13): 25 N·m (2.5 kgf-m, 18 ft-lb)
(12), (14): 20 N·m (2.0 kgf-m, 14 ft-lb)



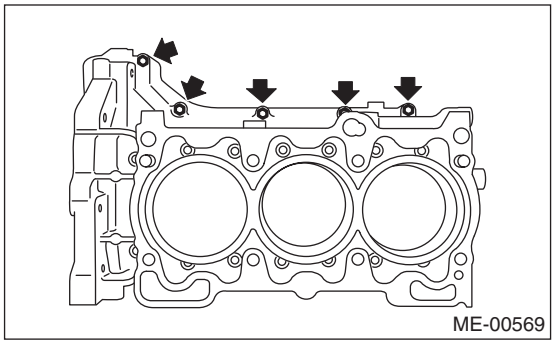
7) Tighten all bolts 90° in the numerical order as shown in the figure.



8) Install the upper bolt to cylinder block.

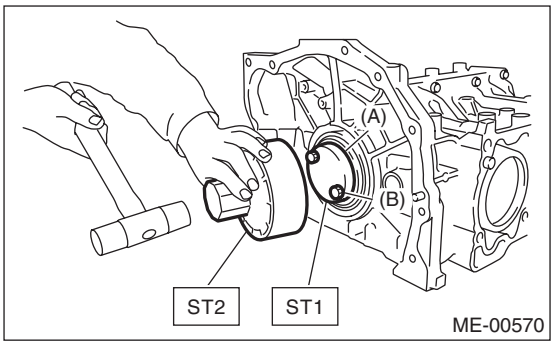
Tightening torque:
25 N·m (2.5 kgf-m, 18 ft-lb)

NOTE:
Remove the liquid gasket which is running over to sealing surface between cylinder block and rear chain cover, cylinder block and oil pan upper, after tightening the bolts which combine the cylinder block.



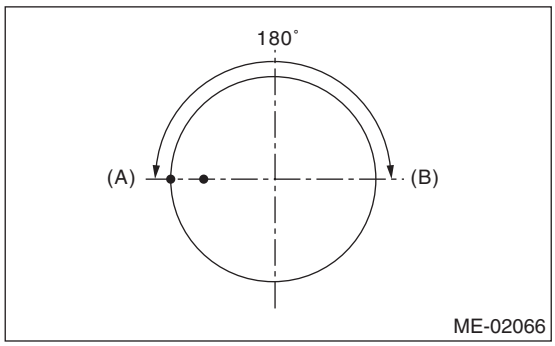
9) Install the rear oil seal using ST1 and ST2.
ST1 499597100 CRANKSHAFT OIL SEAL GUIDE
ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER

NOTE:
Apply engine oil to the pressing-in portion.

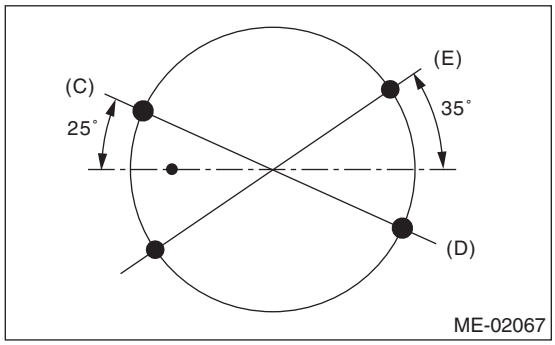


(A) Rear oil seal
(B) Drive plate installation bolt

10) Position the top ring gap at (A) in the figure.
11) Position the second ring gap at (B).



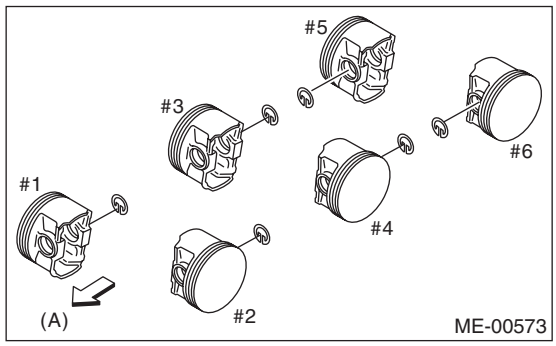
12) Position the upper rail gap at (C) in the figure.
13) Position the expander gap at (D) in the figure.
14) Position the lower rail gap at (E) in the figure.



CAUTION:
• Ensure ring gaps do not face the same direction.
• Ensure ring gaps are not within the piston skirt area.
• Ensure R mark faces to top side of piston.

15) 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.

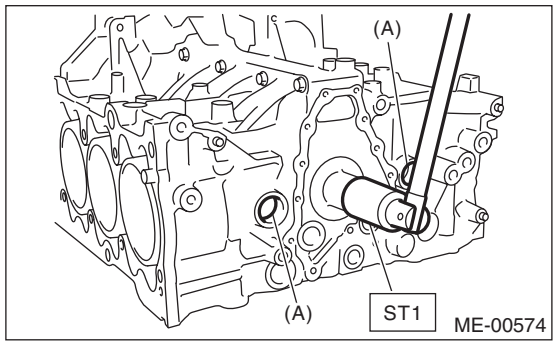
NOTE:
Use new snap rings.



(A) Front side of vehicle

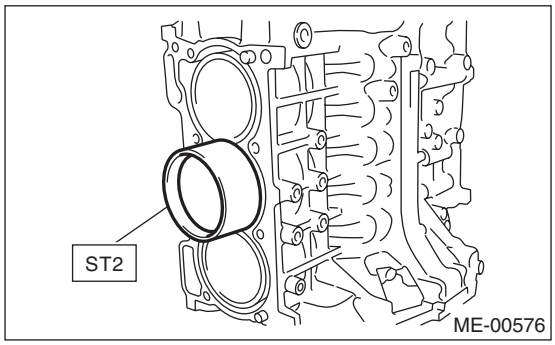
16) Installing the piston:
(1) Using ST1, turn the crankshaft so that #3 and #4 connecting rods small end are set on the service hole (A).

ST1 18252AA000 CRANKSHAFT SOCKET

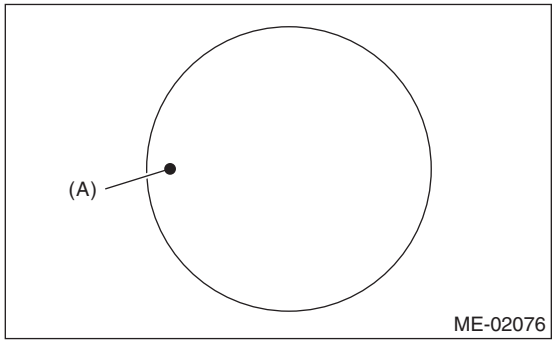


(2) Apply a thin coat of engine oil to piston and cylinder.
(3) Using ST2, press-fit the piston into cylinder.

ST2 18254AA000 PISTON GUIDE

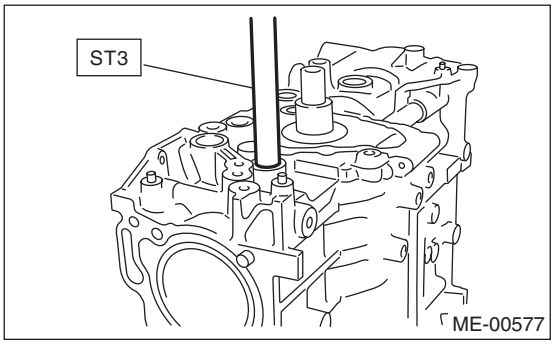


NOTE:
Piston front mark (A) faces towards the front of engine.



17) Installing piston pin:
(1) Apply a coat of engine oil to ST3 before insertion, and then insert it into the service hole to align piston pin hole with connecting rod small end.

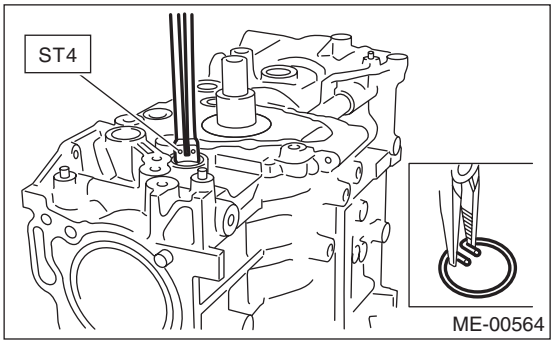
ST3 18253AA000 PISTON GUIDE



(2) Apply a coat of engine oil to piston pin, and insert the piston pin into piston and connecting rod through service hole.
(3) Using the ST4, install the snap ring.

ST4 18233AA000 PISTON PIN SNAP RING PRIERS

NOTE:
Use new snap rings.



(4) Similarly install the #1, #2, #5 and #6 pistons.

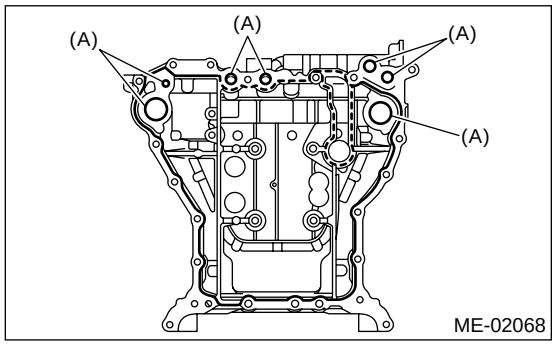
18) Install the service hole plug and O-ring.

NOTE:
Use a new O-ring.

19) Apply liquid gasket to the matching surface of oil pan upper.

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

Applying liquid gasket diameter:
Full line part
3.0±1.0 mm (0.12±0.04 in)
Broken line part
1.0 mm (0.04 in)

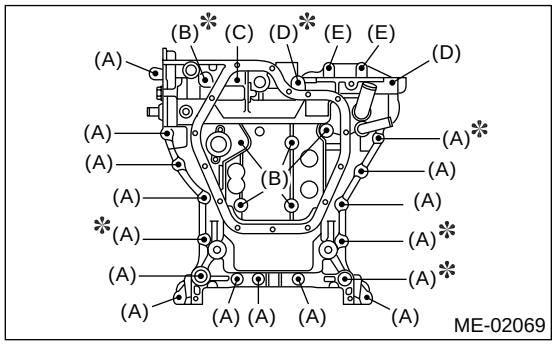


(A) O-ring

NOTE:
Use new O-rings.

20) Temporarily tighten the oil pan upper.

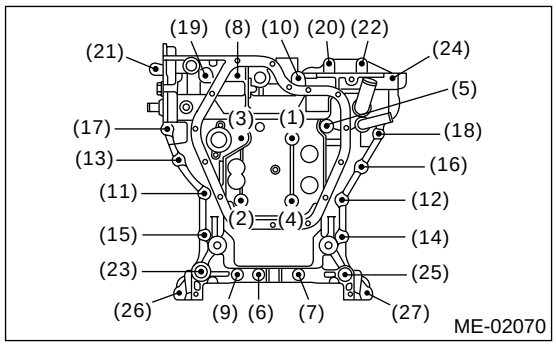
NOTE:
Do not install the bolts in wrong place.



(A) M8 × 40
(B) M8 × 65
(C) M8 × 85
(D) M8 × 130
(E) M8 × 24
*: Coating

21) Tighten the oil pan upper installing bolts in the numerical order as shown in the figure.

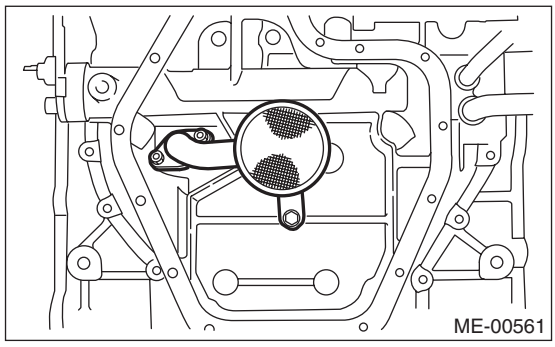
Tightening torque:
18 N·m (1.8 kgf-m, 13.0 ft-lb)



22) Install the oil strainer.

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

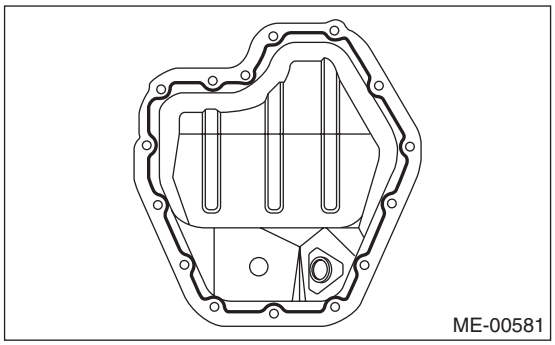
NOTE:
Use new O-rings.



23) Apply liquid gasket to the matching surface of oil pan lower.

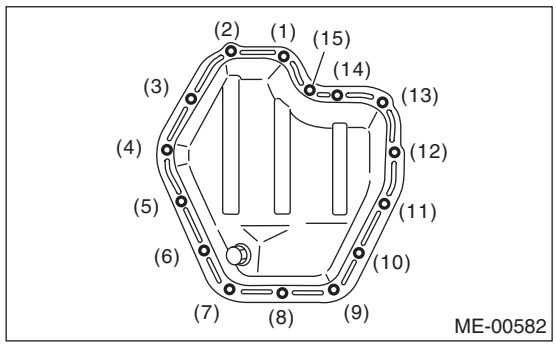
Liquid gasket
THREE BOND 1280B (Part No. K0877YA018)

Applying liquid gasket diameter:
5.0±1.0 mm (0.20±0.04 in)



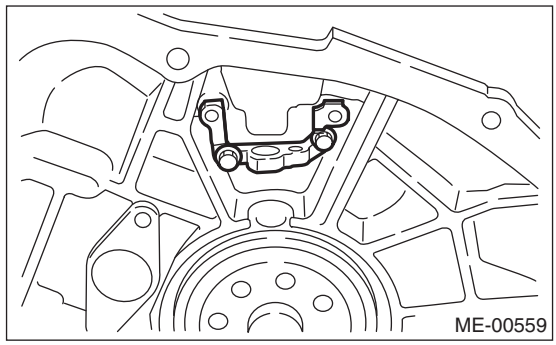
24) Tighten the oil pan lower installing bolts in the numerical order as shown in the figure.

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

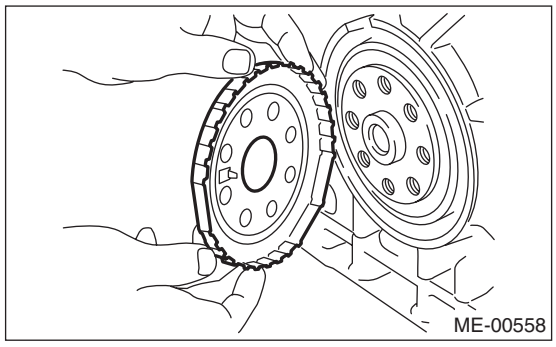


25) Install the crankshaft sensor bracket.

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

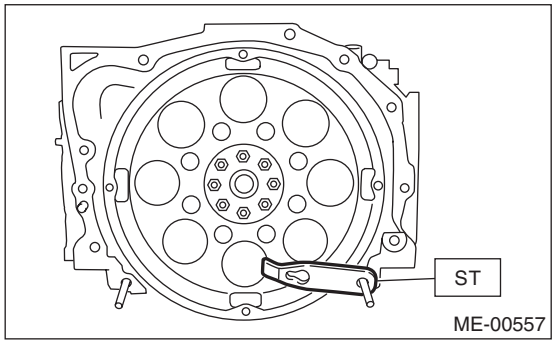


26) Install the crankshaft sensor plate.



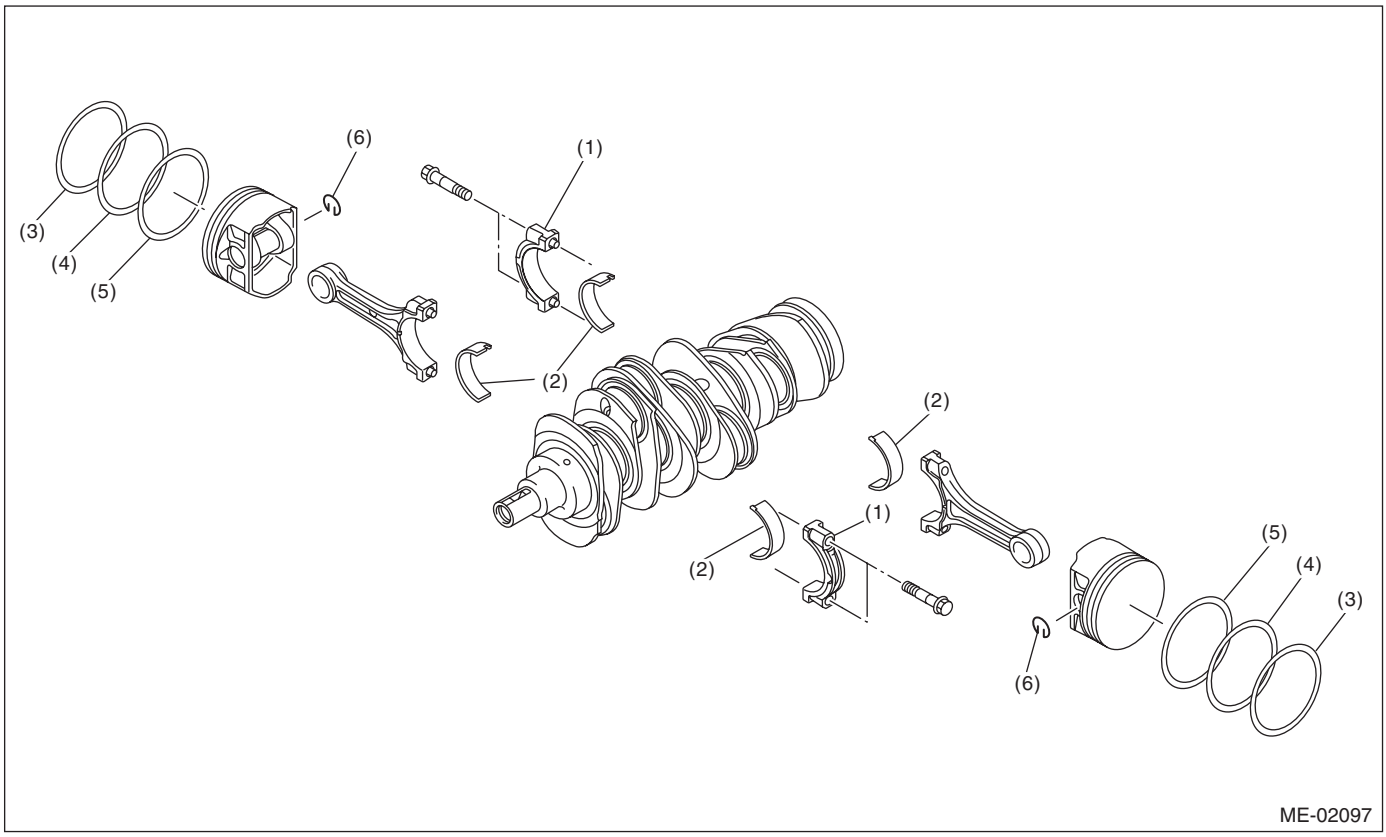
27) Install the drive plate.
To lock the crankshaft, use ST.
ST 498497100 CRANKSHAFT STOPPER

Tightening torque:
81 N·m (8.3 kgf-m, 60 ft-lb)



28) Install the cylinder head. <Ref. to ME(H6DO)-58, INSTALLATION, CYLINDER HEAD.>
29) Install the camshaft. <Ref. to ME(H6DO)-54, INSTALLATION, CAMSHAFT.>
30) Install the rear chain cover. <Ref. to ME(H6DO)-52, INSTALLATION, Rear Chain Cover.>
31) Install the crank sprocket.
<Ref. to ME(H6DO)-51, INSTALLATION, Crank Sprocket.>
32) Install the cam sprocket. <Ref. to ME(H6DO)-50, INSTALLATION, Cam Sprocket.>
33) Install the timing chain assembly.
<Ref. to ME(H6DO)-46, INSTALLATION, TIMING CHAIN ASSEMBLY.>
34) Install the front chain cover.
<Ref. to ME(H6DO)-43, INSTALLATION, FRONT CHAIN COVER.>
35) Install the crank pulley.
<Ref. to ME(H6DO)-42, INSTALLATION, Crank Pulley.>

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.

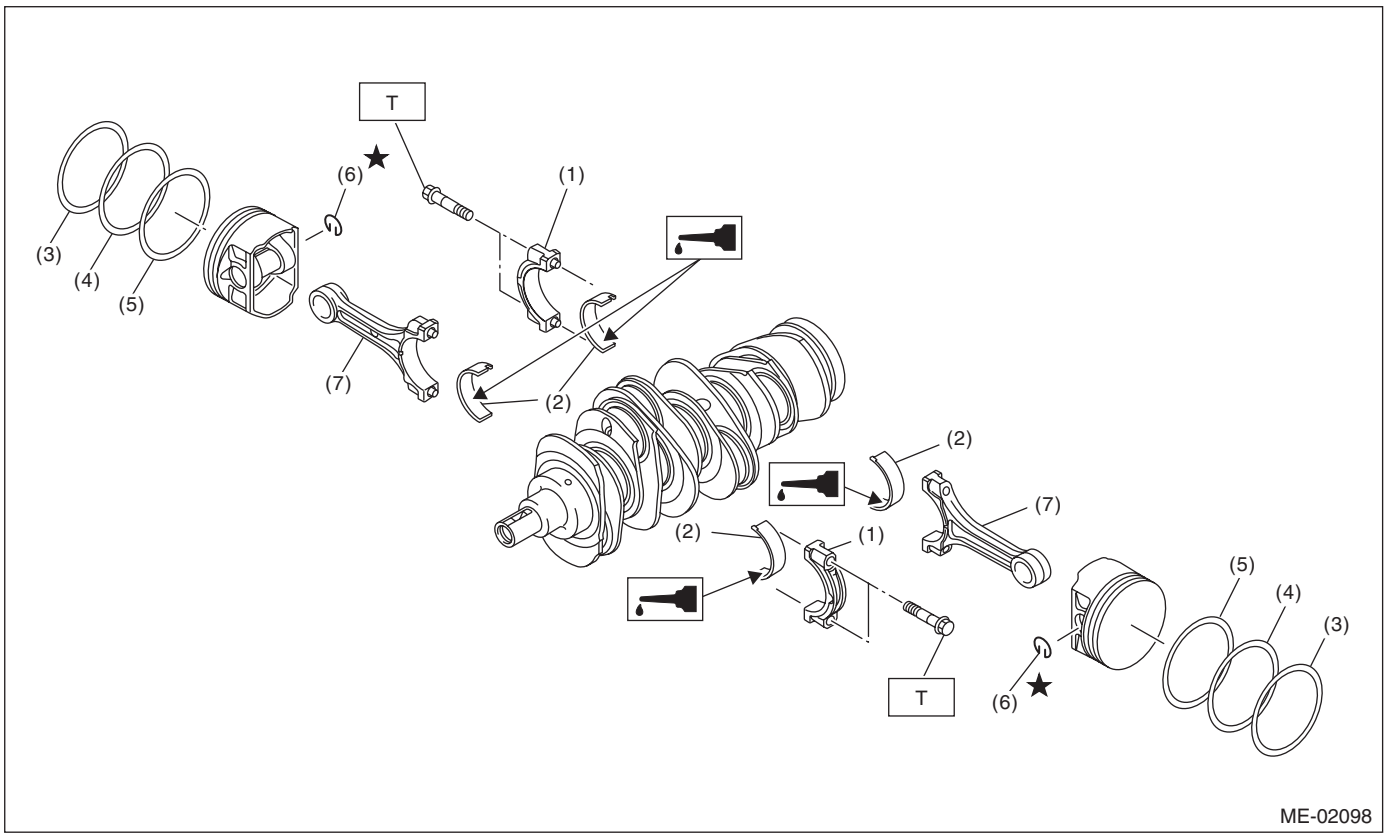
NOTE:
Arrange the removed connecting rod, connecting rod cap and bearing in order, to prevent confusion.

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

Tightening torque: N·m (kgf-m, ft-lb)
T: 53 (5.4, 39)

1) Apply oil to the surfaces of the connecting rod bearings. Install the connecting rod bearings on connecting rods and connecting rod caps.
2) Install the connecting rod on crankshaft.

NOTE:
Position each connecting rod with the side marked facing forward.

3) Install the connecting rod cap.
Ensure the arrow on connecting rod cap faces the 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.

4) Install the oil ring spacer, upper rail and lower rail in this order by hand. Then 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 crankcase surface that mates with cylinder head for warping by using a straight edge.

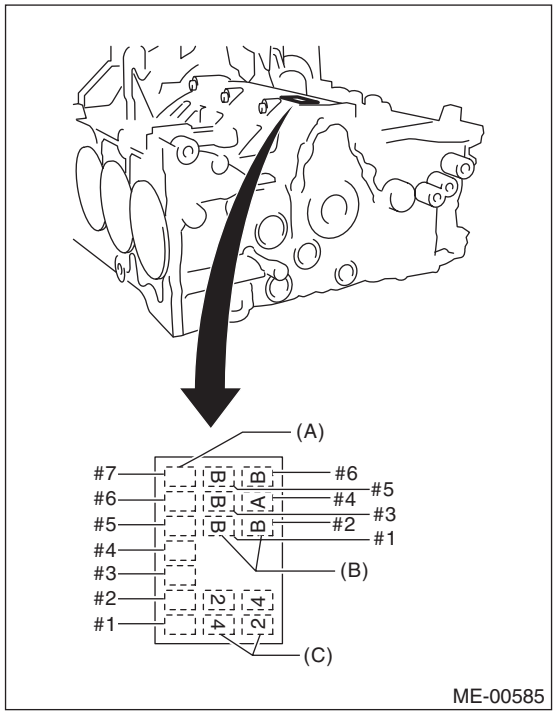
Standard height of cylinder block:
202 mm (7.95 in)

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:
A: 89.205 — 89.215 mm (3.5120 — 3.5124 in)
B: 89.195 — 89.205 mm (3.5116 — 3.5120 in)



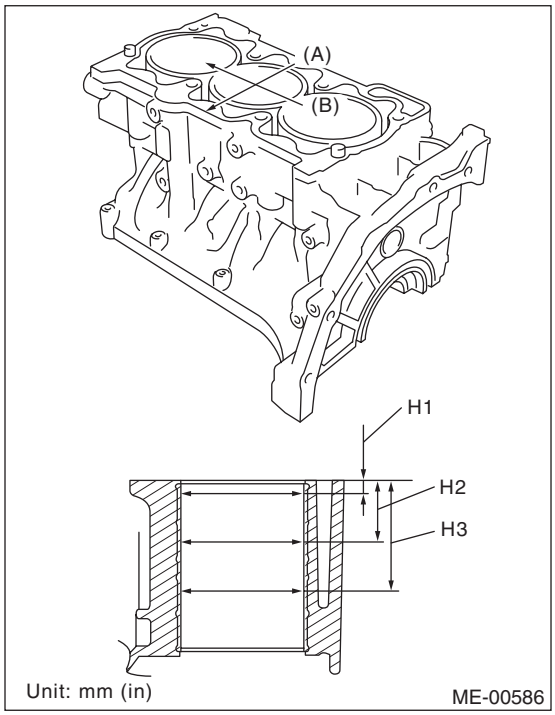
(A) Main journal size mark
(B) Cylinder bore size mark
(C) Cylinder block (RH) – (LH) combination mark

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).

Cylindricality:
Standard
0.030 mm (0.0012 in)

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



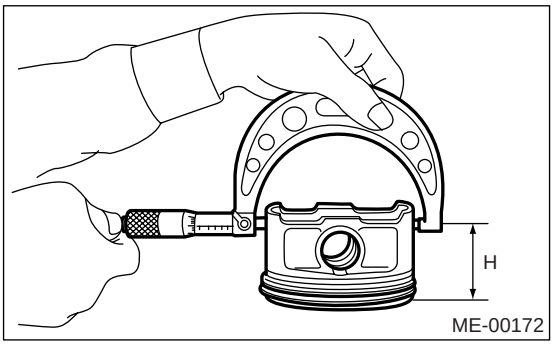
(A) Piston pin direction
(B) Thrust direction
H1: 10 mm (0.39 in)
H2: 45 mm (1.77 in)
H3: 80 mm (3.15 in)

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:
37.3 mm (1.4685 in)

Piston outer diameter:
Standard
A: 89.205 — 89.215 mm (3.5120 — 3.5124 in)
B: 89.195 — 89.205 mm (3.5116 — 3.5220 in)
0.25 mm (0.0098 in) oversize
89.445 — 89.465 mm (3.5215 — 3.5222 in)
0.50 mm (0.0197 in) oversize
89.695 — 89.715 mm (3.5313 — 3.5321 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 cylindricality, out-of-roundness, or cylinder-to-piston clearance measured is out of standard 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.

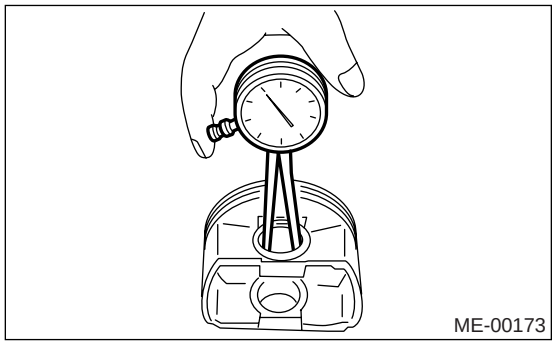
(2) If the cylinder inner diameter exceeds 89.715 mm (3.5321 in) after boring and honing, replace the crankcase.

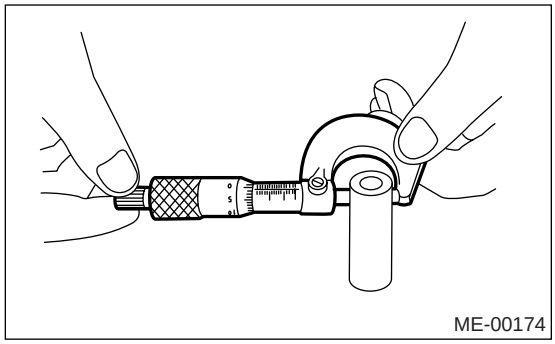
NOTE:
Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, pay attention to this when measuring the cylinder diameter.

3. PISTON AND PISTON PIN

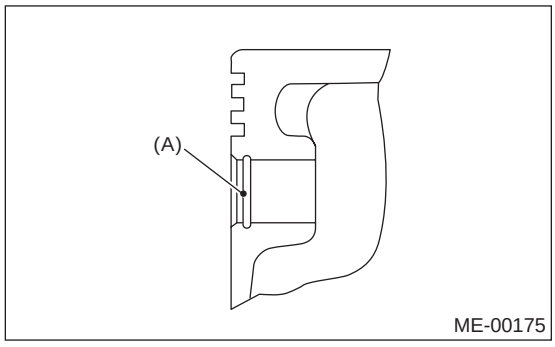
1) Check the pistons and piston pins for damage, cracks and wear, and the piston ring grooves for wear and damage. Replace if defective.
2) Measure the piston-to-cylinder clearance at each cylinder. <Ref. to ME(H6DO)-71, CYLINDER AND PISTON, INSPECTION, CYLINDER BLOCK.> If any of the clearances is not within specification, 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.

Standard clearance between piston pin and hole in piston:
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.

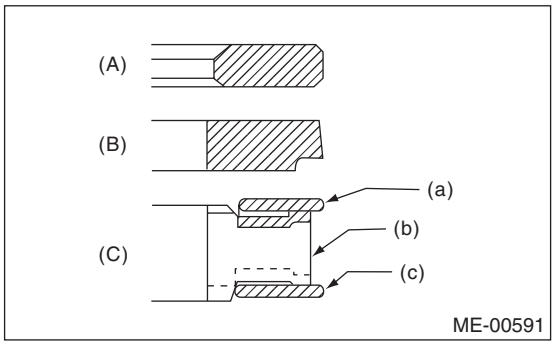


5) Check the piston pin snap ring for distortion, cracks and wear.

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.

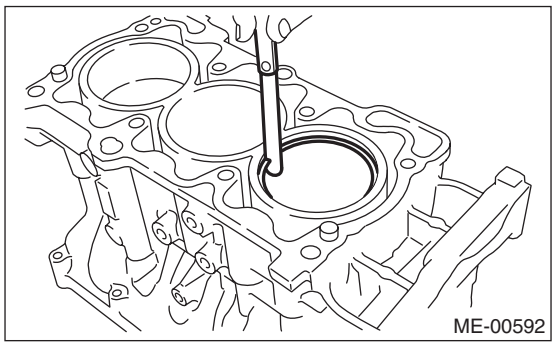
CAUTION:
• Mark is displayed on the end of top and second rings. When installing the rings to the piston, face this mark upward.
• Oil ring consists of the upper rail, expander and lower rail. When installing on piston, be careful of each rail's direction.



(A) Top ring
(B) Second ring
(C) Oil ring
(a) Upper rail
(b) Expander
(c) Lower rail

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

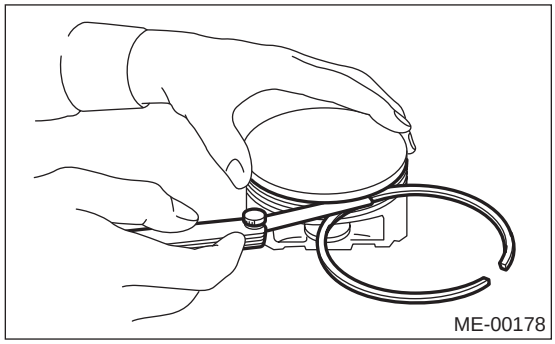
		Standard mm (in)
Piston ring gap	Top ring	0.20 — 0.35 (0.0079 — 0.0138)
	Second ring	0.35 — 0.50 (0.0138 — 0.0197)
	Oil ring	0.20 — 0.60 (0.0079 — 0.0236)



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

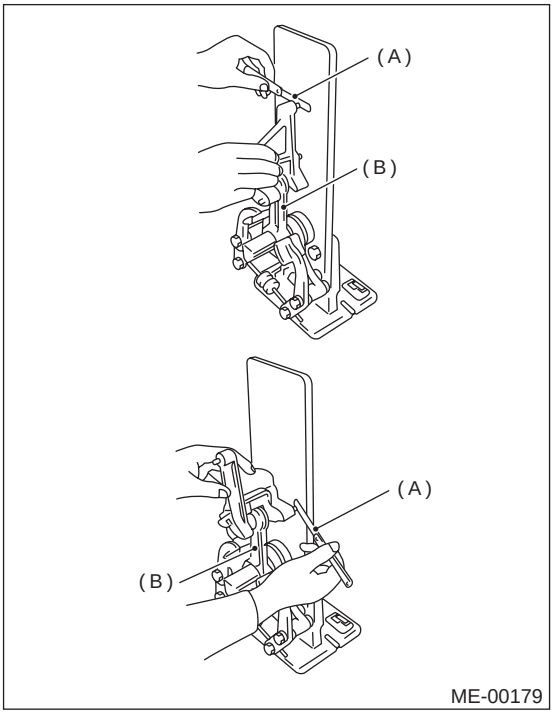
NOTE:
Before measuring the clearance, clean the piston ring groove and piston ring.

		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)
Clearance between oil ring and oil ring groove		0.045 — 0.125 (0.0018 — 0.0049)



5. CONNECTING ROD

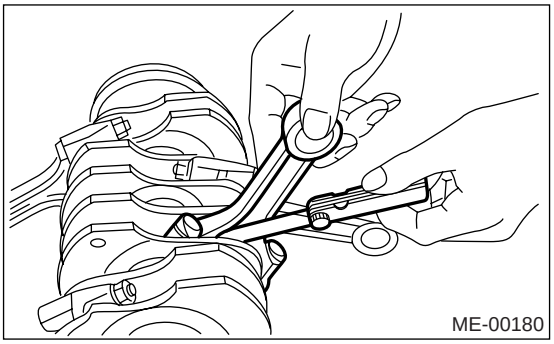
1) Replace the connecting rod, if the large or small end thrust surface is damaged.
2) Check for bend or twist using a connecting rod aligner. Replace the connecting rod if it has the bend or twist.



(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 or offset wearing is emitted, 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.)

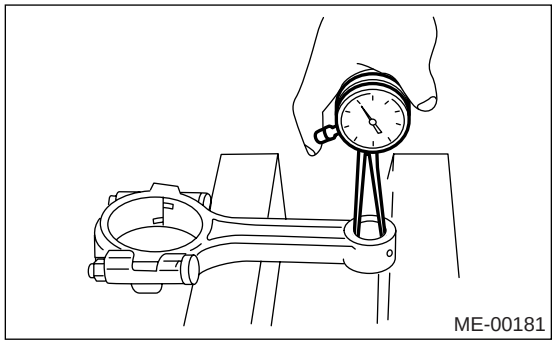
Connecting rod oil clearance:
Standard
0.016 — 0.043 mm (0.0006 — 0.0017 in)

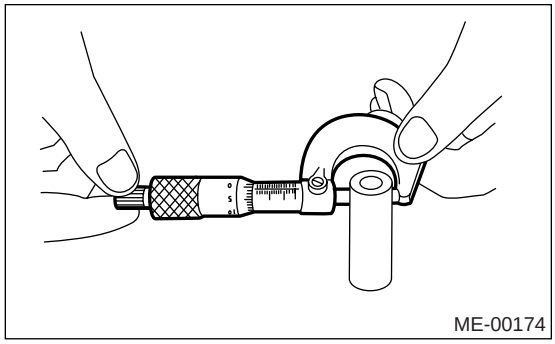
Unit: mm (in)

Bearings	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.490 — 1.506 (0.0587 — 0.0593)	51.984 — 52.000 (2.0466 — 2.0472)
0.03 (0.0012) undersize	1.509 — 1.513 (0.0594 — 0.0596)	51.954 — 51.970 (2.0454 — 2.0461)
0.05 (0.0020) undersize	1.519 — 1.523 (0.0598 — 0.0600)	51.934 — 51.950 (2.0446 — 2.0453)
0.25 (0.0098) undersize	1.619 — 1.623 (0.0637 — 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.

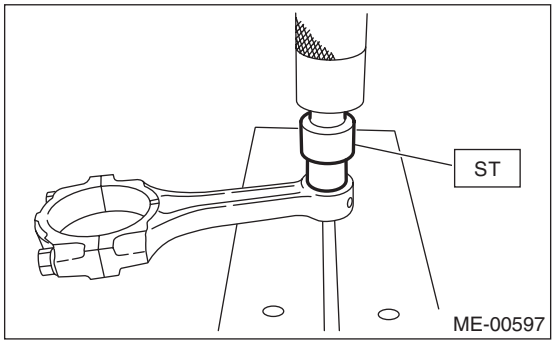
Clearance between piston pin and bushing:
Standard
0 — 0.022 mm (0 — 0.0009 in)





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 18350AA000 CONNECTING ROD BUSHING REMOVER AND INSTALLER

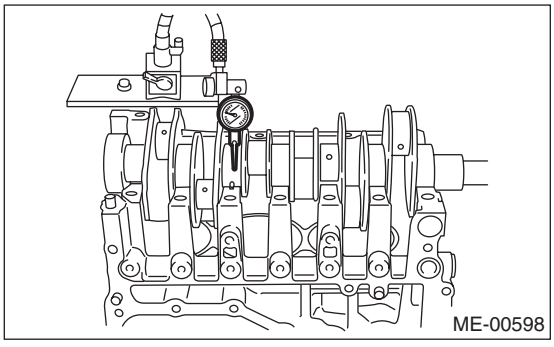


(3) Make two 3 mm (0.12 in) holes in bushing. Ream the inside of bushing.
(4) After completion of reaming, clean the bushing to remove chips.

6. CRANKSHAFT AND CRANKSHAFT BEARING

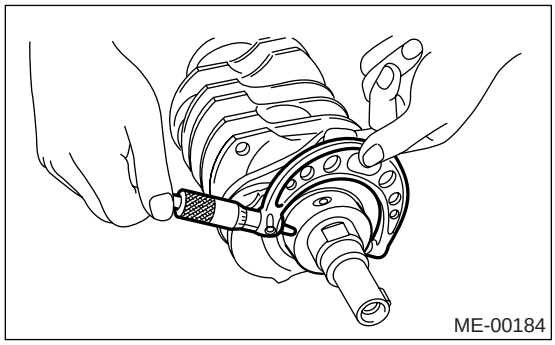
1) Clean the crankshaft completely, and check it for cracks using red lead. Replace if defective.
2) Check the crankshaft for bend, and repair or replace if needed.

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 check the crankshaft for bend using a dial gauge.



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 and crank journal:
Out-of-roundness
0.005 mm (0.0002 in)
Cylindricality
0.006 mm (0.0002 in)



Unit: mm (in)

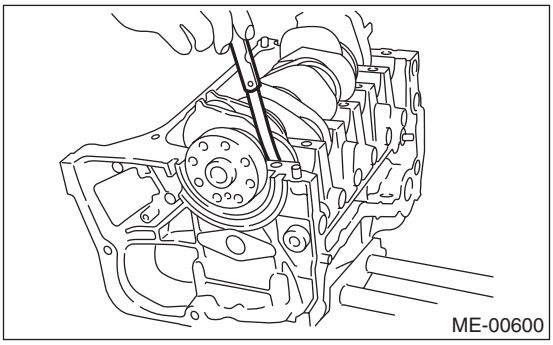
		Crank journal diameter		Crank pin outer diameter
		#1, #3, #5, #7	#2, #4, #6	
Standard:	Journal O.D.	63.992 — 64.008 (2.5194 — 2.5200)		51.984 — 52.000 (2.0466 — 2.0472)
	Bearing size (Thickness at center)	1.992 — 2.005 (0.0784 — 0.0789)	1.996 — 2.009 (0.0786 — 0.0791)	1.490 — 1.506 (0.0587 — 0.0593)
0.03 (0.0012) undersize	Journal O.D.	63.962 — 63.978 (2.5182 — 2.5188)		51.954 — 51.970 (2.0454 — 2.0461)
	Bearing size (Thickness at center)	2.011 — 2.014 (0.0792 — 0.0793)	2.015 — 2.018 (0.0793 — 0.0794)	1.509 — 1.513 (0.0594 — 0.0596)
0.05 (0.0020) undersize	Journal O.D.	63.942 — 63.958 (2.5174 — 2.5180)		51.934 — 51.950 (2.0446 — 2.0453)
	Bearing size (Thickness at center)	2.021 — 2.024 (0.0796 — 0.0797)	2.025 — 2.028 (0.0797 — 0.0798)	1.519 — 1.523 (0.0598 — 0.0600)
0.25 (0.0098) undersize	Journal O.D.	63.742 — 63.758 (2.5095 — 2.5102)		51.734 — 51.750 (2.0368 — 2.0374)
	Bearing size (Thickness at center)	2.121 — 2.124 (0.0835 — 0.0836)	2.125 — 2.128 (0.0837 — 0.0838)	1.619 — 1.623 (0.0637 — 0.0639)

4) Measure the thrust 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)



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.Oil Flow Control Solenoid Valve

A: REMOVAL

Oil flow control solenoid valve is a unit with camshaft cap.
Refer to “Camshaft” for removal. <Ref. to ME(H6DO)-54, REMOVAL, Camshaft.>

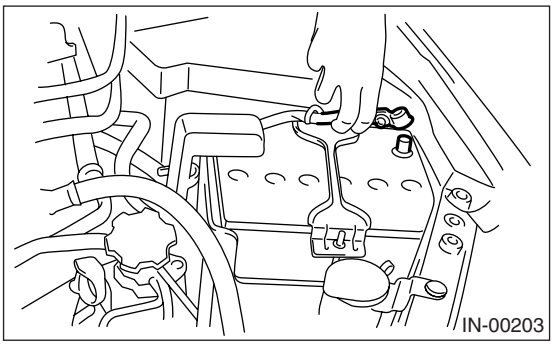
B: INSTALLATION

Install in the reverse order of removal.

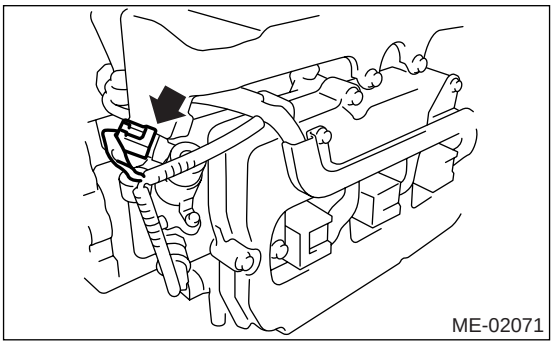
23.Oil Switching Solenoid Valve

A: REMOVAL

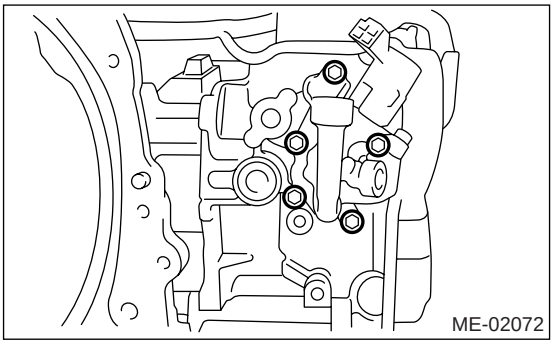
1) Disconnect the ground cable from battery.



2) Remove the air intake chamber.
<Ref. to IN(H6DO)-7, REMOVAL, Air Intake Chamber.>
3) Disconnect the connector from oil switching solenoid valve.



4) Remove the oil switching solenoid valve.
5) Remove the variable valve lift diagnosis oil pressure switch.
<Ref. to FU(H6DO)-28, REMOVAL, Variable Valve Lift Diagnosis Oil Pressure Switch.>
6) Remove the oil temperature sensor.
<Ref. to FU(H6DO)-29, REMOVAL, Oil Temperature Sensor.>
7) Remove the oil flow control solenoid valve holder from cylinder head.

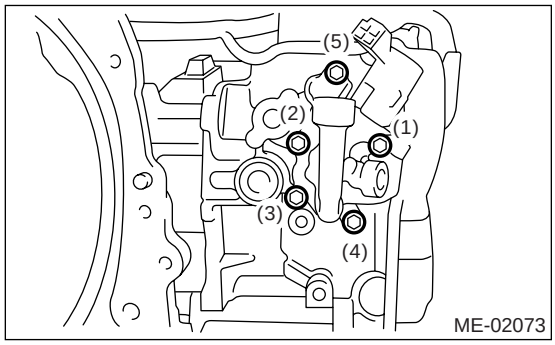


B: INSTALLATION

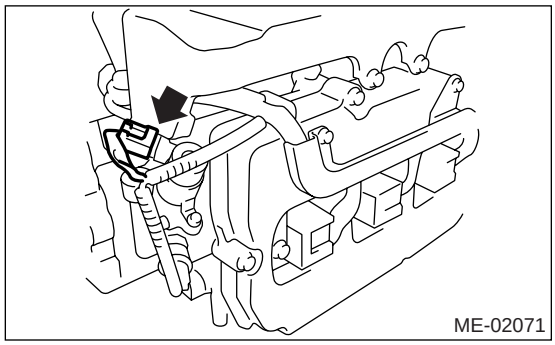
1) Install the oil switching solenoid valve holder.

NOTE:
Always use new gasket.

(1) Temporarily tighten the bolts by tightening torque of 5 — 10 N·m (0.5 — 1.0 kgf-m, 3.7 — 7.4 ft-lb) in order indicated in the figure.
(2) Tighten the bolts by tightening torque of 10±0.5 N·m (1.0±0.05 kgf-m, 7.4±0.37 ft-lb).



2) Install the oil temperature sensor.
<Ref. to FU(H6DO)-29, INSTALLATION, Oil Temperature Sensor.>
3) Install the variable valve lift diagnosis oil pressure switch.
<Ref. to FU(H6DO)-28, INSTALLATION, Variable Valve Lift Diagnosis Oil Pressure Switch.>
4) Install the oil switching solenoid valve.
5) Connect the connector to oil switching solenoid valve.

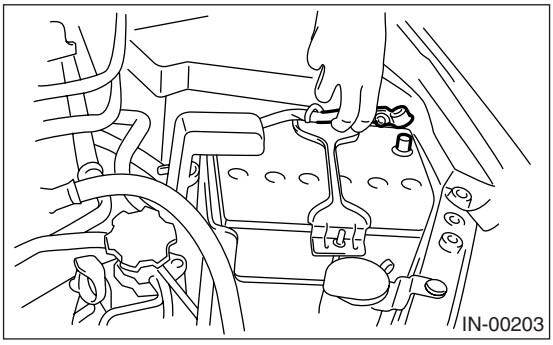


6) Install the air intake chamber.
<Ref. to IN(H6DO)-7, INSTALLATION, Air Intake Chamber.>

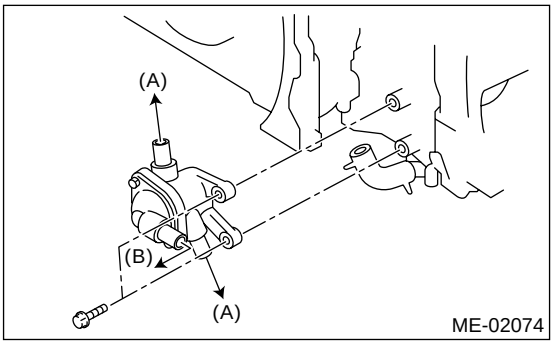
24.ATF Warmer Cock

A: REMOVAL

1) Set the vehicle on a lift.
2) Remove the collector cover.
3) Disconnect the ground cable from battery.



4) Lift-up the vehicle.
5) Remove the under cover.
6) Remove the front exhaust pipe.
<Ref. to EX(H6DO)-5, REMOVAL, Front Exhaust Pipe.>
7) Disconnect the water hose from ATF warmer cock.
8) Remove the ATF warmer cock from cylinder head.

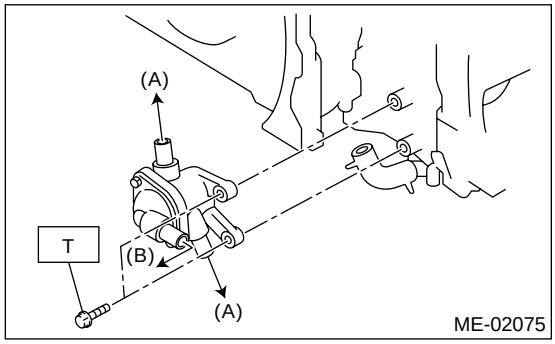


(A) Water pipe
(B) ATF warmer

B: INSTALLATION

Install in the reverse order of removal.

Tightening torque:
16 N·m (1.6 kgf-m, 11.8 ft-lb)



(A) Water pipe
(B) ATF warmer

25.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 ignition starter switch	C
		Defective inhibitor switch or neutral 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(H6DO)(diag)-2, Basic Diagnostic Procedure.>		A
	Fuel line	Defective fuel pump and relay	A
		Lack of or insufficient fuel	B
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	B

Symptom	Problem parts, etc.	Possible cause	RANK
3) Initial combustion occurs.	Engine control system <Ref. to EN(H6DO)(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
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	B
4) Engine stalls after initial combustion.	Engine control system <Ref. to EN(H6DO)(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
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	B

Symptom	Problem parts, etc.	Possible cause	RANK
2. Rough idle and engine stall	Engine control system <Ref. to EN(H6DO)(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
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	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(H6DO)(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
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	B
	Lubrication system	Incorrect oil pressure	B
	Cooling system	Over-heating	C
		Over-cooling	C
	Other	Evaporative emission control system malfunction	A

Symptom	Problem parts, etc.	Possible cause	RANK
4. Surging	Engine control system <Ref. to EN(H6DO)(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
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	B
	Cooling system	Over-heating	B
	Other	Evaporative emission control system malfunction	C
5. Engine does not return to idle.	Engine control system <Ref. to EN(H6DO)(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(H6DO)(diag)-2, Basic Diagnostic Procedure.>		A
	Cooling system	Over-heating	B
	Other	Evaporative emission control system malfunction	B

Symptom	Problem parts, etc.	Possible cause	RANK
7. After burning in exhaust system	Engine control system <Ref. to EN(H6DO)(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
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	B
	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(H6DO)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened oil filler cap	B
	Chain	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	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 o-ring	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(H6DO)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Dirty air cleaner element	A
	Chain	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
		Trouble of tappet	C
		Trouble of tappet (In case noise occurs with valve moving or harness trouble involved to variable valve lift occurred in past time.)	B
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C

26.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	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 crankshaft 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 • Trouble of tappet

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(H6DO)(diag)-40, OPERATION, Clear Memory Mode.> and inspection mode <Ref. to EN(H6DO)(diag)-33, PROCEDURE, Inspection Mode.> after connecting the fuel injector connector.