

21. Cylinder Block

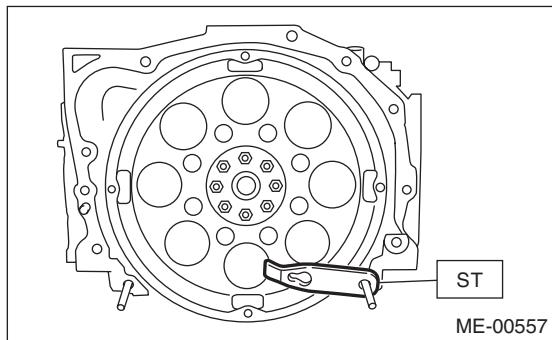
A: REMOVAL

NOTE:

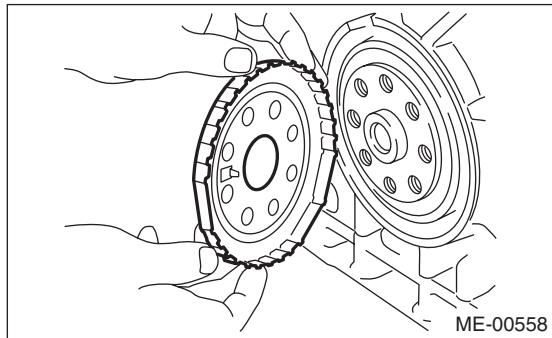
Before conducting this procedure, drain the engine oil completely.

- 1) Remove the V-belts. <Ref. to ME(H6DO)-38, REMOVAL, V-belt.>
- 2) Remove the crank pulley. <Ref. to ME(H6DO)-39, REMOVAL, Crank Pulley.>
- 3) Remove the front chain cover. <Ref. to ME(H6DO)-40, REMOVAL, Front Chain Cover.>
- 4) Remove the timing chain assembly. <Ref. to ME(H6DO)-42, REMOVAL, Timing Chain Assembly.>
- 5) Remove the cam sprocket. <Ref. to ME(H6DO)-47, REMOVAL, Cam Sprocket.>
- 6) Remove the crank sprocket. <Ref. to ME(H6DO)-48, REMOVAL, Crank Sprocket.>
- 7) Remove the rear chain cover. <Ref. to ME(H6DO)-49, REMOVAL, Rear Chain Cover.>
- 8) Remove the camshaft. <Ref. to ME(H6DO)-51, REMOVAL, Camshaft.>
- 9) Remove the cylinder head. <Ref. to ME(H6DO)-55, REMOVAL, Cylinder Head.>
- 10) Using ST, remove the drive plate.

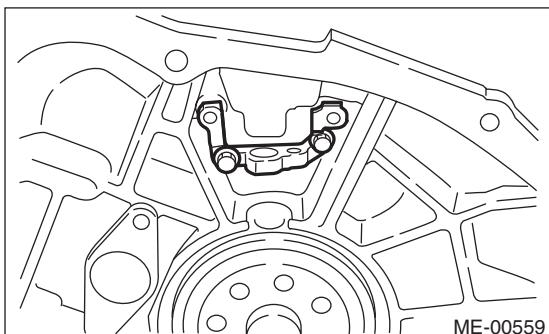
ST1 498497100 CRANKSHAFT STOPPER
ST2 499057000 TORX PLUS®



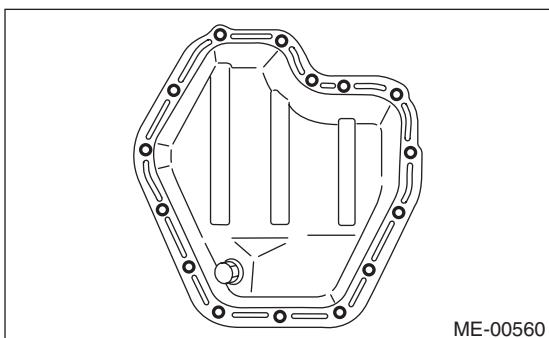
- 11) Remove the crankshaft position sensor plate.



- 12) Remove the crankshaft position sensor bracket.



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

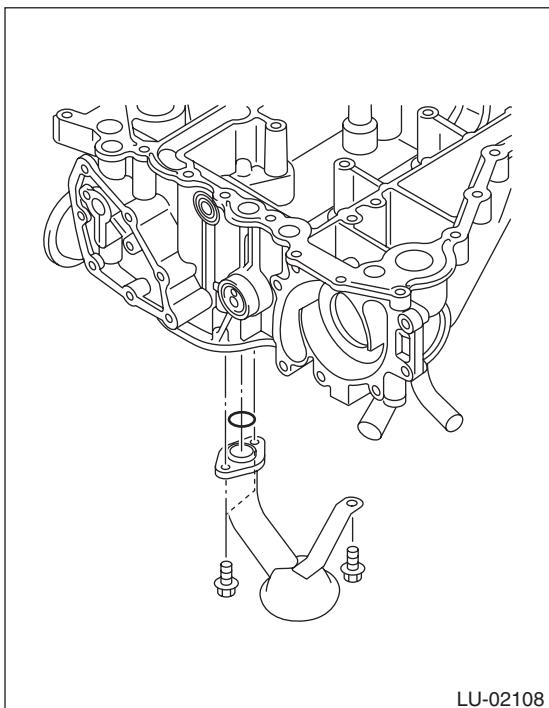


- 15) Insert an oil pan cutter blade between cylinder block-to-oil pan clearance and remove the oil pan.

CAUTION:

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

- 16) Remove the oil strainer.



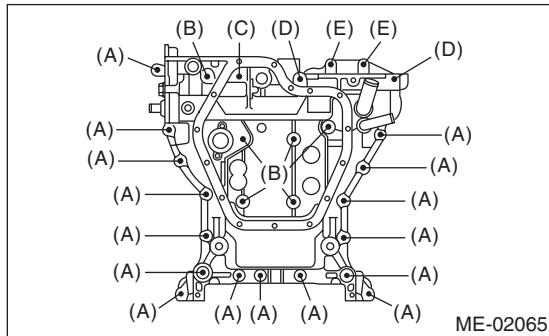
Cylinder Block

MECHANICAL

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

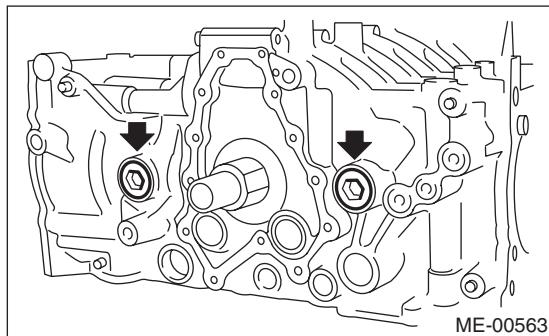
NOTE:

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



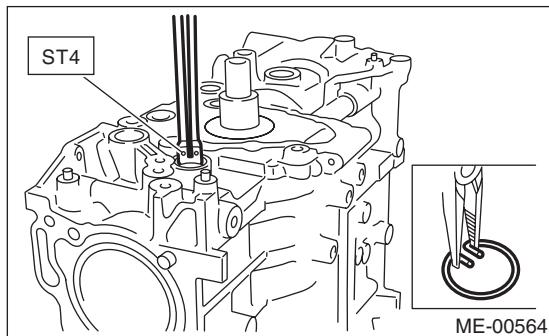
- (A) M8 x 40
- (B) M8 x 65
- (C) M8 x 85
- (D) M8 x 130.5
- (E) M8 x 24

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



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

ST 18233AA000 PISTON PIN SNAP RING PLIERS

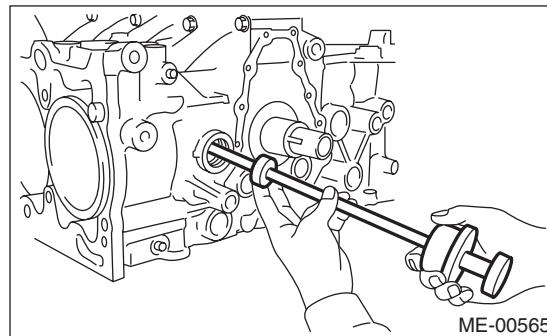


20) Draw out the piston pin from #1 and #2 pistons using ST.

ST 499097700 PISTON PIN REMOVER

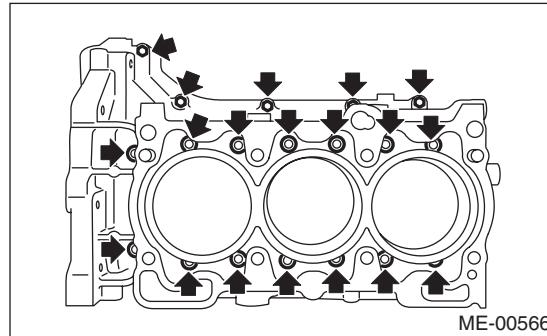
NOTE:

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



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

22) Remove the cylinder block connecting bolts.



23) 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.

24) Remove the rear oil seal.

25) Remove the crankshaft together with connecting rod.

26) 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.

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

NOTE:

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

Cylinder Block

MECHANICAL

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 cylinder block before installation. Apply a coat of engine oil to the bearing and crankshaft journal.

2) Position the crankshaft on the cylinder block (RH).

3) Apply liquid gasket to the mating surfaces of cylinder block (RH), and position the cylinder block (LH).

Liquid gasket:

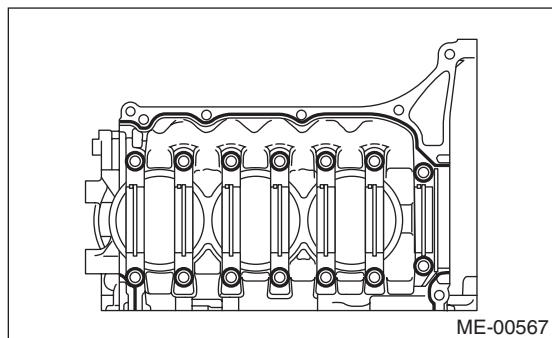
THREE BOND 1215B (Part No. 004403007)

NOTE:

Do not allow liquid gasket to run over to oil passages, bearing grooves, etc.

Applying liquid gasket diameter:

$1.0 \pm 0.2 \text{ mm (0.039} \pm 0.008 \text{ in)}$



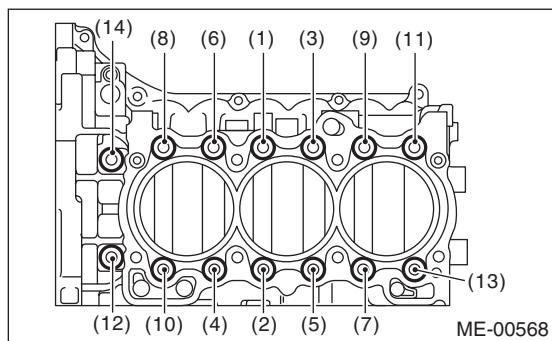
4) Apply a coat of engine oil to the washer and bolt thread.

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, 18.4 ft-lb)

(12), (14): 20 N·m (2.0 kgf-m, 14 ft-lb)

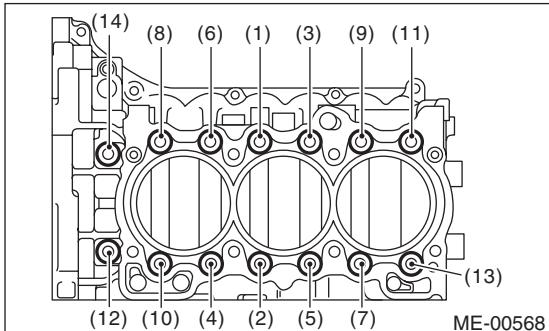


6) Retighten all bolts in the numerical order as shown in the figure.

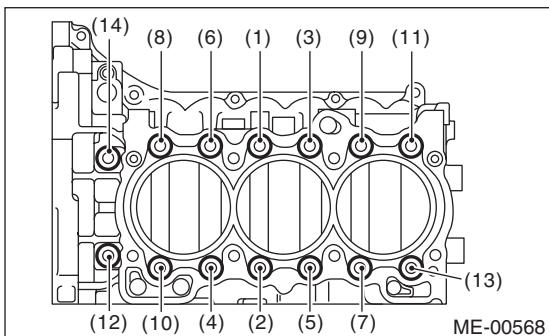
Tightening torque:

(1) — (11), (13): 25 N·m (2.5 kgf-m, 18.4 ft-lb)

(12), (14): 20 N·m (2.0 kgf-m, 14 ft-lb)



7) Tighten all bolts 90° — 110° in the numerical order as shown in the figure.



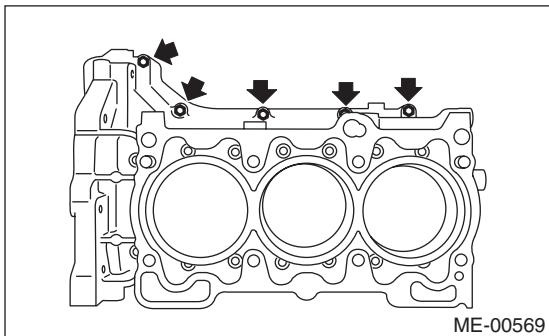
8) Install the upper bolt to cylinder block.

Tightening torque:

25 N·m (2.5 kgf-m, 18.4 ft-lb)

NOTE:

After tightening the cylinder block connecting bolts, remove the liquid gasket which is running over to the sealing surface for rear chain cover and oil pan upper.



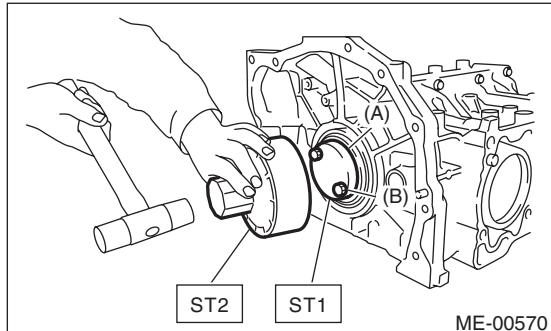
9) Apply a coat of engine oil to the oil seal periphery, then install the rear oil seal using ST1 and ST2.

NOTE:

Use a new rear oil seal.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER

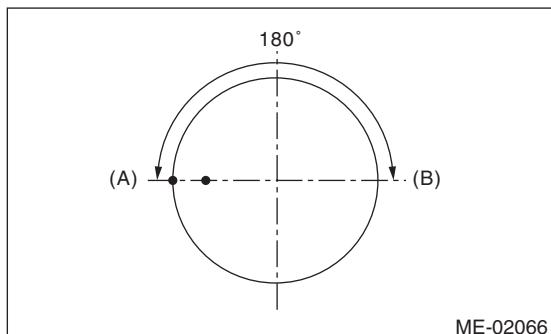


(A) Rear oil seal

(B) Drive plate installation bolt

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

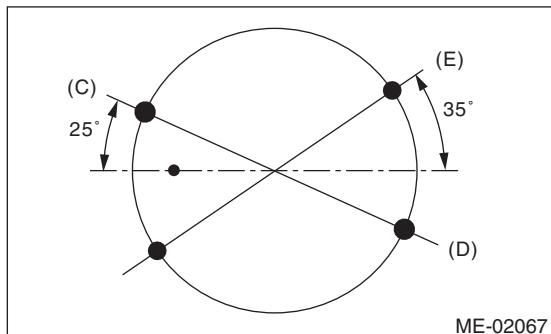
11) Position the second ring gap at (B).



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:

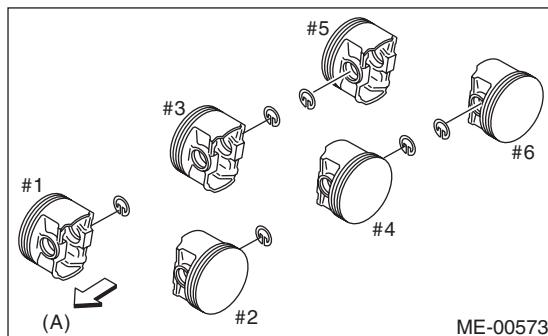
- Make sure ring gaps do not face the same direction.
- Make sure ring gaps are not within the piston skirt area.
- Assemble it so that R mark faces to top side of piston.

15) Install the snap ring.

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

NOTE:

Use new snap rings.

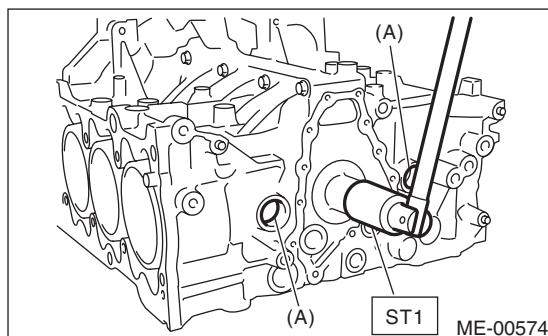


(A) Front side of vehicle

16) Installing piston:

(1) Using the ST1, turn the crankshaft so that #3 and #4 connecting rod small ends are set on the service hole (A).

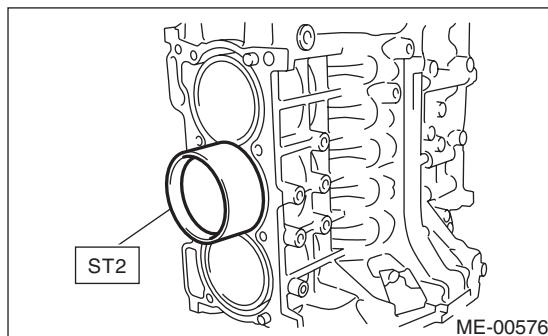
ST1 18252AA000 CRANKSHAFT SOCKET



(2) Apply a thin coat of engine oil to piston and cylinder.

(3) Using the ST2, press-fit the piston into cylinder.

ST2 18254AA000 PISTON GUIDE

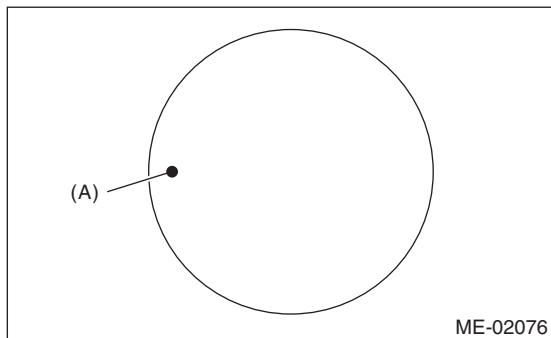


Cylinder Block

MECHANICAL

NOTE:

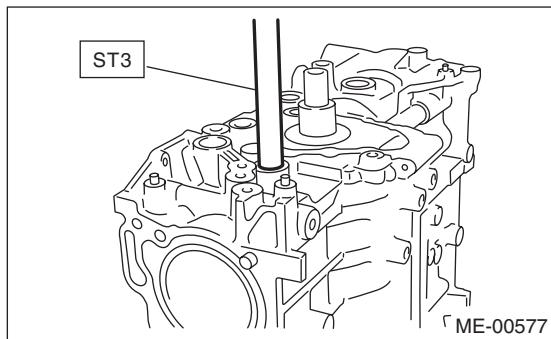
Let the piston front mark (A) face towards the front of engine.



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 PIN GUIDE



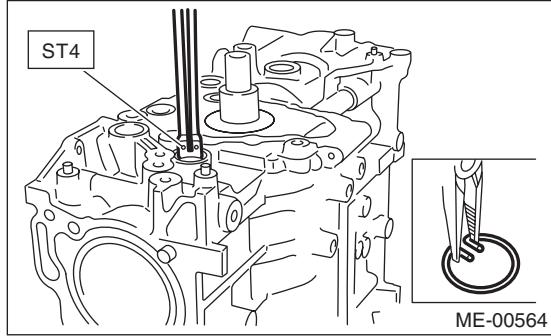
(2) Apply a coat of engine oil to piston pin, and insert the piston pin into piston and connecting rod through service hole.

(3) Using the ST4, install the snap ring.

ST4 18233AA000 PISTON PIN SNAP RING PLIERS

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 new O-rings.

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

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

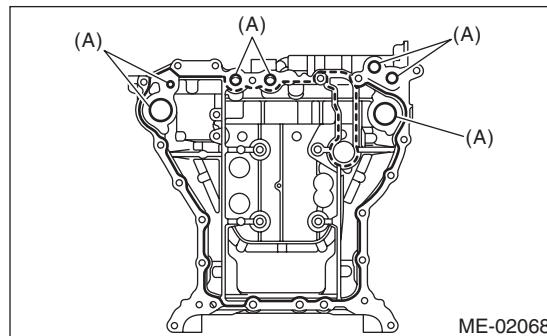
Applying liquid gasket diameter:

Full line part

3.0 ± 1.0 mm (0.12 \pm 0.04 in)

Broken line part

1.0 mm (0.04 in)



(A) O-ring

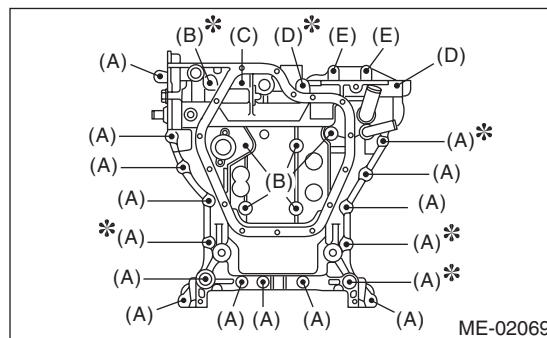
NOTE:

Use new O-rings.

20) Temporarily tighten the oil pan upper.

NOTE:

Do not install the bolts in wrong place.



(A) M8 \times 40

(B) M8 \times 65

(C) M8 \times 85

(D) M8 \times 130.5

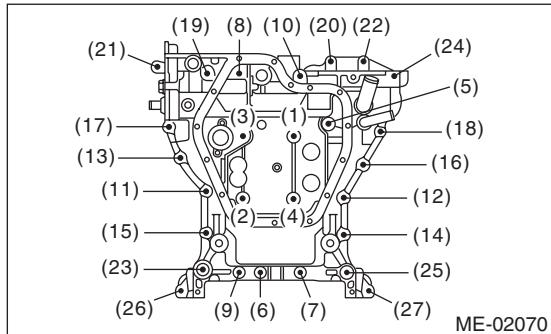
(E) M8 \times 24

*: 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, 13.3 ft-lb)



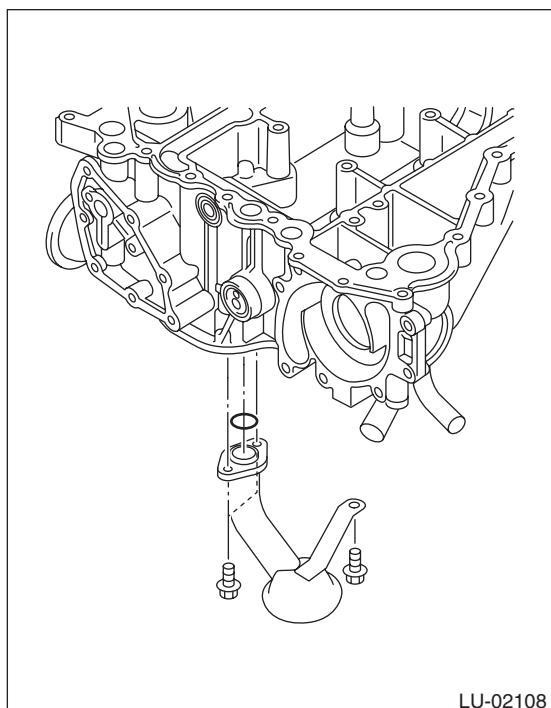
22) Install the oil strainer.

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.

NOTE:

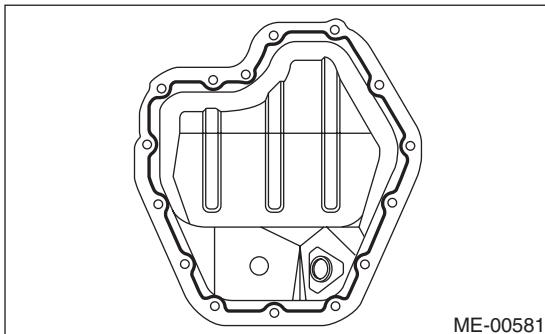
Install within 5 min. after applying liquid gasket.

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

Applying liquid gasket diameter:

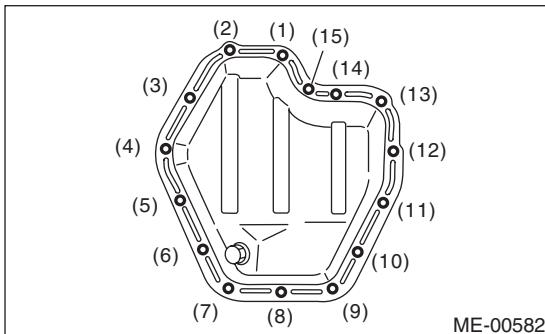
5.0 ± 1.0 mm (0.20 \pm 0.04 in)



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

Tightening torque:

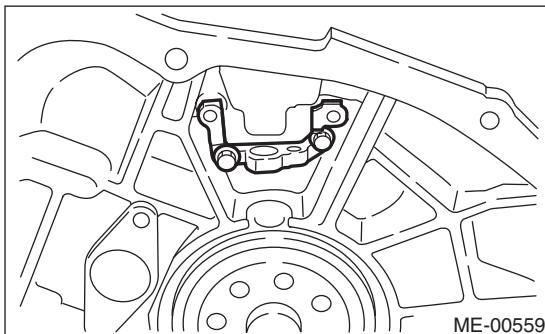
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)



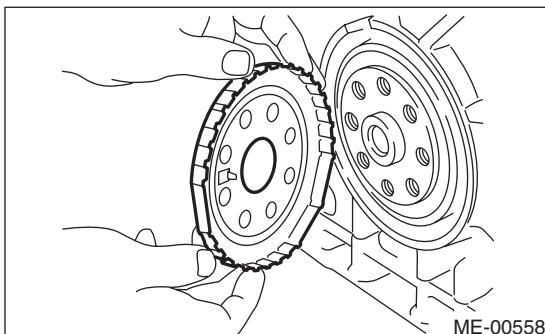
25) Install the crankshaft sensor bracket.

Tightening torque:

6.4 N·m (0.65 kgf-m, 4.7 ft-lb)



26) Install the crankshaft sensor plate.



Cylinder Block

MECHANICAL

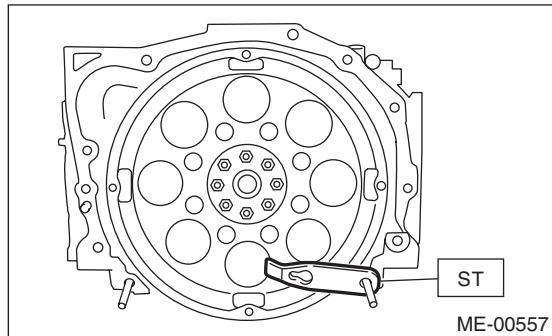
27) Using ST, install the drive plate.

ST1 498497100 CRANKSHAFT STOPPER

ST2 499057000 TORX PLUS®

Tightening torque:

81 N·m (8.3 kgf·m, 60 ft·lb)



28) Install the cylinder head. <Ref. to ME(H6DO)-55, INSTALLATION, Cylinder Head.>

29) Install the camshaft. <Ref. to ME(H6DO)-52, INSTALLATION, Camshaft.>

30) Install the rear chain cover. <Ref. to ME(H6DO)-49, INSTALLATION, Rear Chain Cover.>

31) Install the crank sprocket. <Ref. to ME(H6DO)-48, INSTALLATION, Crank Sprocket.>

32) Install the cam sprocket. <Ref. to ME(H6DO)-47, INSTALLATION, Cam Sprocket.>

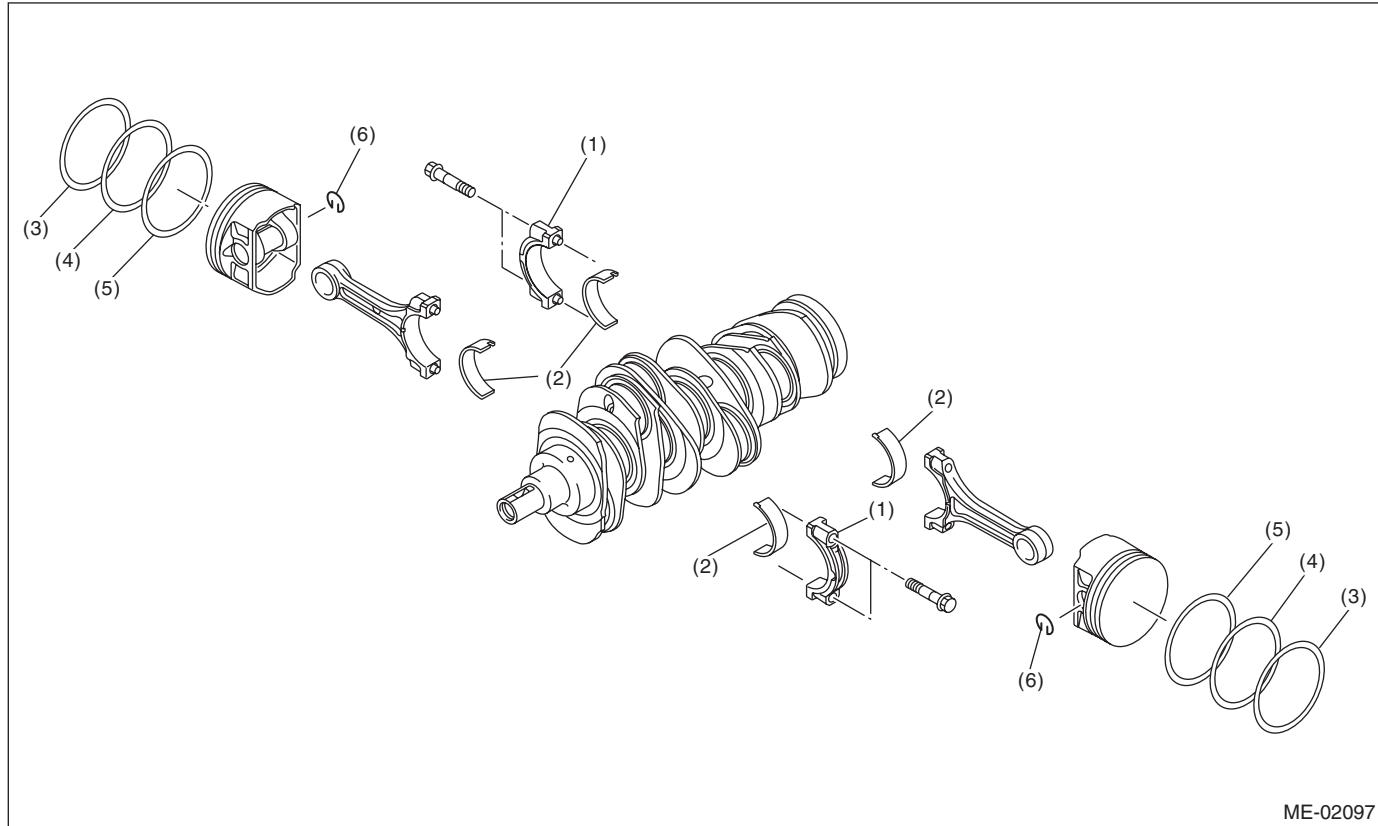
33) Install the timing chain assembly. <Ref. to ME(H6DO)-43, INSTALLATION, Timing Chain Assembly.>

34) Install the front chain cover. <Ref. to ME(H6DO)-40, INSTALLATION, Front Chain Cover.>

35) Install the crank pulley. <Ref. to ME(H6DO)-39, INSTALLATION, Crank Pulley.>

36) Install the V-belts. <Ref. to ME(H6DO)-38, INSTALLATION, V-belt.>

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.

4) Remove the oil ring by hand.

NOTE:

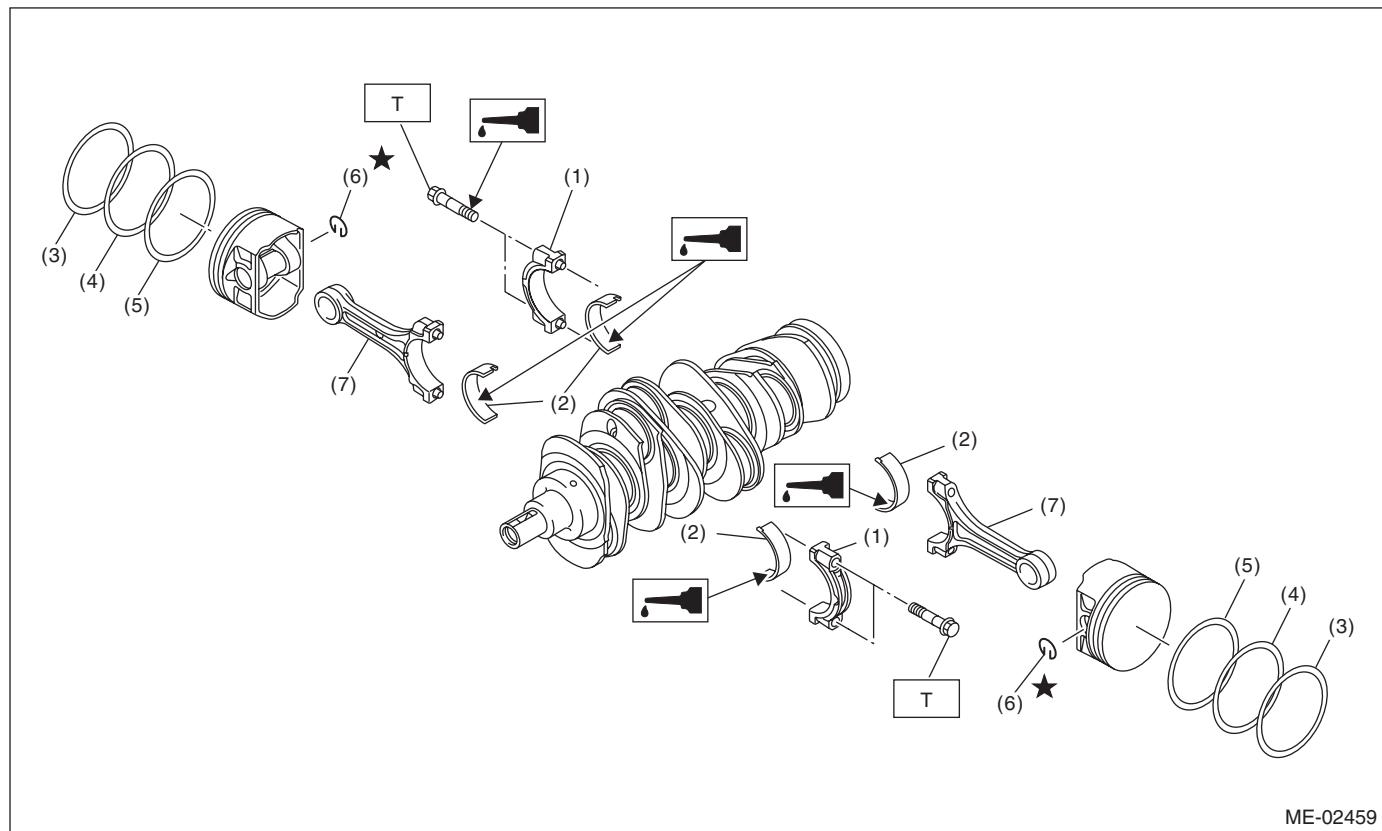
Arrange the removed piston rings in proper order, to prevent confusion.

5) Remove the snap ring.

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

3) Remove the piston rings using piston ring expander.

D: ASSEMBLY



ME-02459

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

Tightening torque: N·m (kgf·m, ft-lb)

T: 53 (5.4, 39)

- 1) Apply oil to the surface of the connecting rod bearings, and install the connecting rod bearings on connecting rods and connecting rod caps.
- 2) Position each connecting rod with the marking side facing forward.
- 3) Install the connecting rod cap. Make sure the arrow mark on connecting rod cap facing front during installation.

NOTE:

- 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 bolts, apply oil on the threads and flange end.

Tightening torque:

53 N·m (5.4 kgf·m, 39 ft-lb)

- 4) Install the oil ring spacer, upper rail and lower rail by hand.
- 5) Install the second ring and top ring using piston ring expander.

E: INSPECTION

1. CYLINDER BLOCK

- 1) Check for cracks or damage. Use liquid penetrant tester on the important sections to check for fissures. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
- 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. If the warping exceeds the limit, replace the cylinder block.

Warping limit:

0.02 mm (0.0008 in)

Standard height of cylinder block:

202 mm (7.95 in)

Cylinder Block

MECHANICAL

2. CYLINDER AND PISTON

1) The cylinder bore size is stamped on the front upper face of the cylinder block.

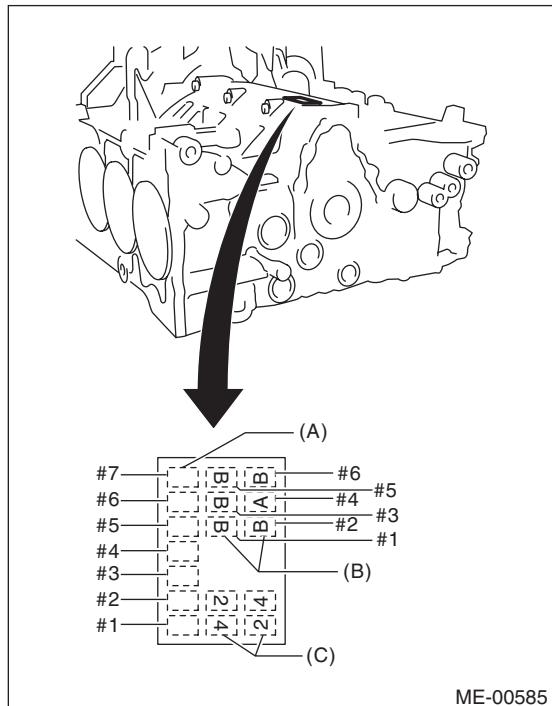
NOTE:

- 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:

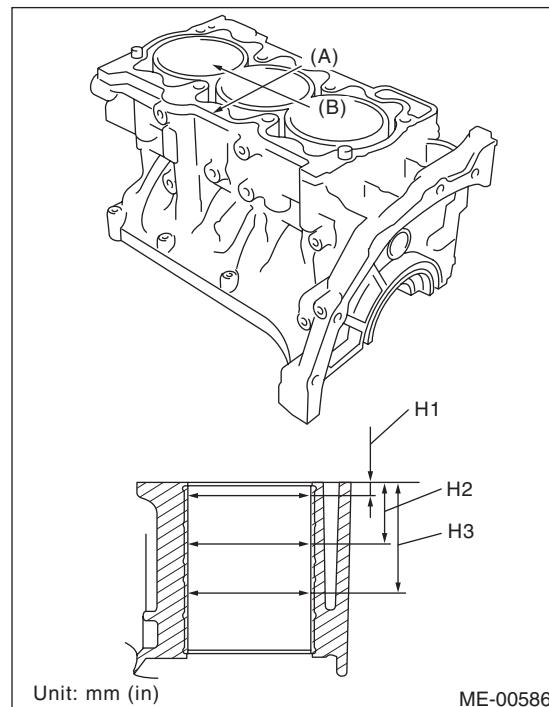
Standard

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)

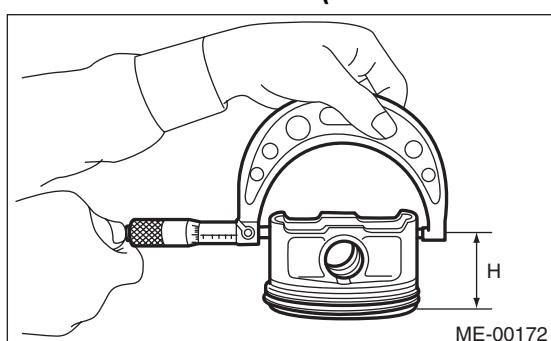
B: 89.195 — 89.205 mm (3.5116 — 3.5120 in)

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 (-0.0004 — 0.0004 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, reboore it to use an oversize piston.

CAUTION:

- When any of the cylinders needs reboring, other cylinders must be bored at the same time, and replaced with oversize pistons.**
- Do not perform boring on one cylinder only. Do not replace only a single cylinder for an oversize piston.**

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

Cylinder inner diameter boring limit (diameter):
To 89.715 mm (3.5321 in)

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 piston and piston pin for breaks, cracks or wear. Replace if faulty.

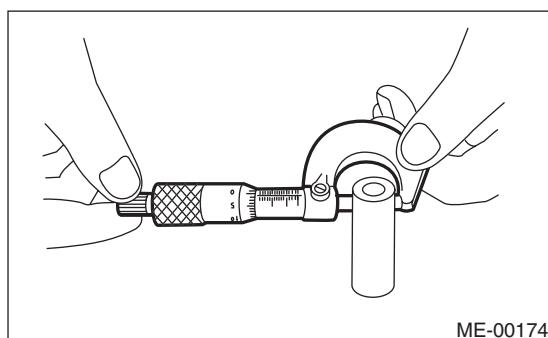
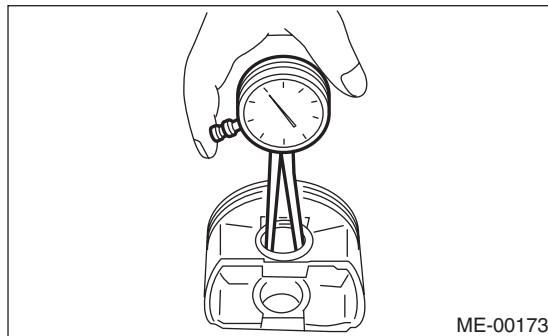
2) Check the piston ring groove for wear or damage. Replace if faulty.

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 faulty.

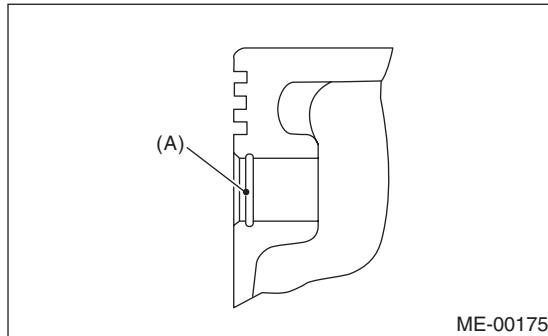
Standard clearance between piston pin and hole in piston:

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.

Cylinder Block

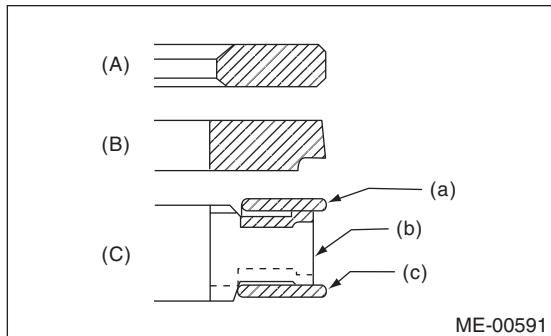
MECHANICAL

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 part of the same size as piston.

NOTE:

- The top ring and second ring have the mark to determine the direction to install on them. When installing the ring to piston, face this mark to the top side.
- Oil ring consists of the upper rail, expander and lower rail. When installing on the piston, be careful of the direction of each rail.

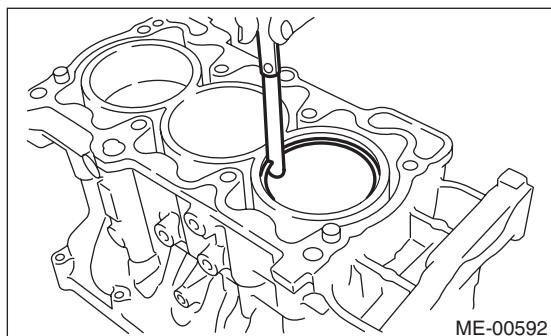


ME-00591

- (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)



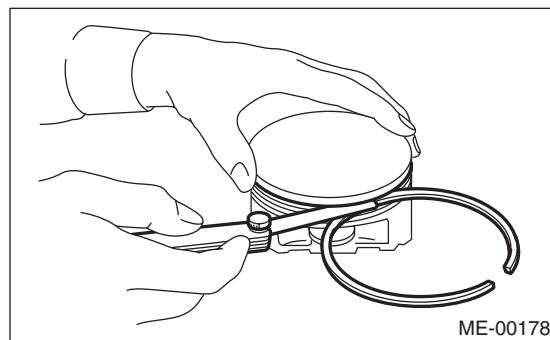
ME-00592

3) Fit the piston ring straight into the piston ring groove, then 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.

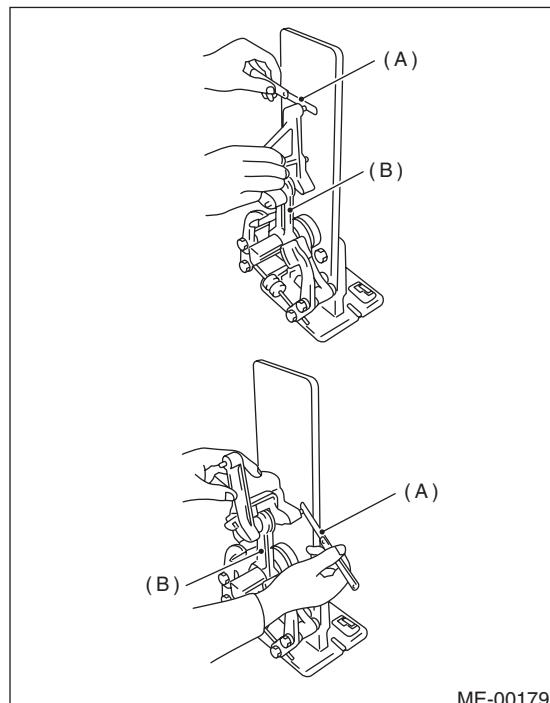
		Standard mm (in)
Clearance between piston ring and piston ring groove	Top ring	0.040 — 0.080 (0.0016 — 0.0031)
	Second ring	0.030 — 0.070 (0.0012 — 0.0028)
Clearance between oil ring and oil ring groove		0.045 — 0.125 (0.0018 — 0.0049)



ME-00178

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.



ME-00179

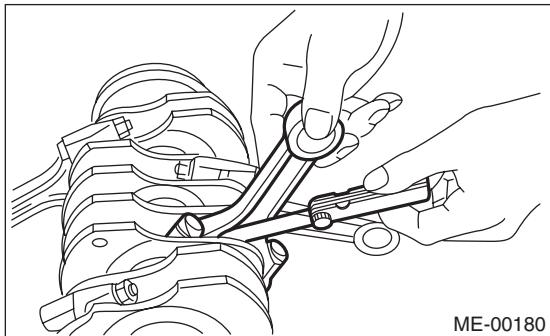
- (A) Thickness gauge
- (B) Connecting rod

3) Install the connecting rod fitted with bearing to crankshaft and measure the thrust clearance. If the thrust clearance exceeds the standard or uneven wear is found, replace the connecting rod.

Connecting rod thrust clearance:

Standard

0.070 — 0.330 mm (0.0028 — 0.0130 in)



ME-00180

4) Inspect the connecting rod bearing for scar, peeling, seizure, melting, wear, etc.

5) Measure the oil clearance on each connecting rod bearing using plastigauge. If any oil clearance is not within the standard, replace the defective bearing with a new part 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)

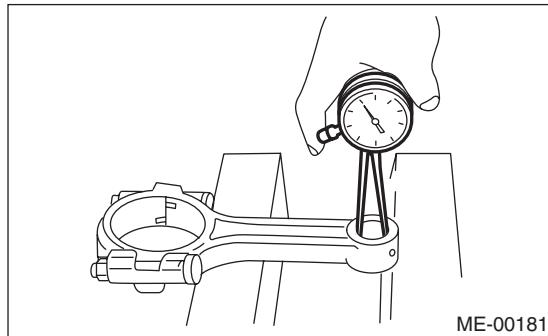
Unit: mm (in)		
Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.490 — 1.506 (0.0587 — 0.0593)	51.984 — 52.000 (2.0466 — 2.0472)
0.03 (0.0012) undersize	1.509 — 1.513 (0.0594 — 0.0596)	51.954 — 51.970 (2.0454 — 2.0461)
0.05 (0.0020) undersize	1.519 — 1.523 (0.0598 — 0.0600)	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.

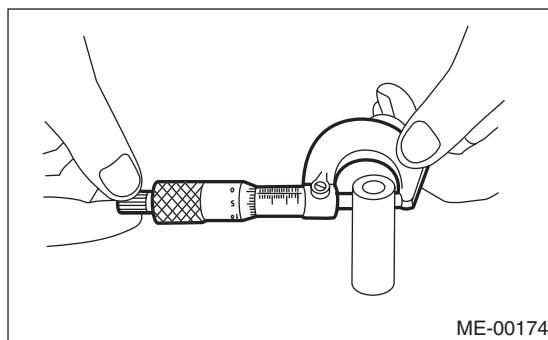
7) Measure the piston pin clearance at connecting rod small end. If the measured value is not within the standard, replace it with a new part.

Clearance between piston pin and bushing: Standard

0 — 0.022 mm (0 — 0.0009 in)



ME-00181



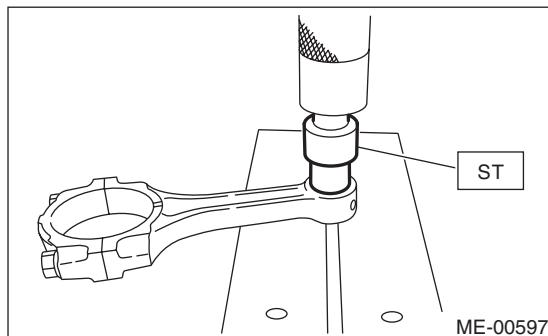
ME-00174

8) The replacement procedure for the connecting rod small end bushing 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



ME-00597

(3) Make two 3 mm (0.12 in) holes in the pressed bushing by aligning with the pre-manufactured holes on the connecting rod, and ream the inside of the bushing.

(4) After completion of reaming, clean the bushing to remove chips.

Cylinder Block

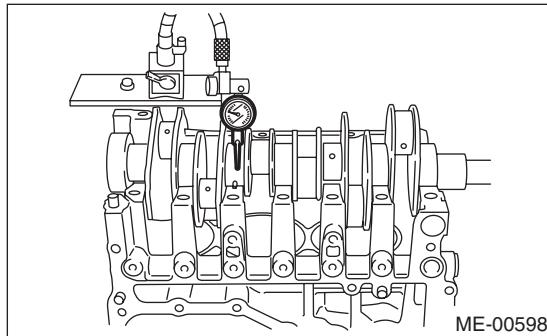
MECHANICAL

6. CRANKSHAFT AND CRANKSHAFT BEARING

- 1) Clean the crankshaft completely, and check it for cracks using liquid penetrant tester. Replace if defective.
- 2) Check the crankshaft for bend, and repair or replace if needed. Repair or replace if bended.

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 bend using a dial gauge.



- 3) Inspect the crank journal and crank pin for wear. If they are not within the specification, replace the bearing with a suitable (undersize) one, and replace or readjust 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.

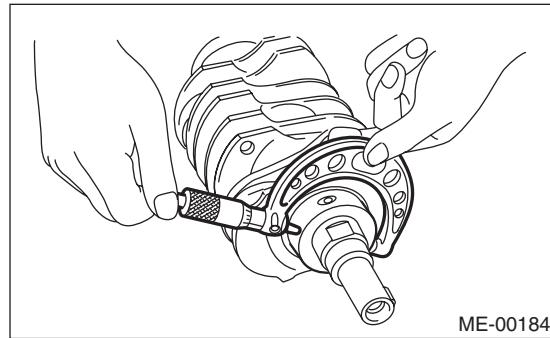
Crank pin and crank journal:

Out-of-roundness

0.005 mm (0.0002 in)

Cylindricality

0.006 mm (0.0002 in)



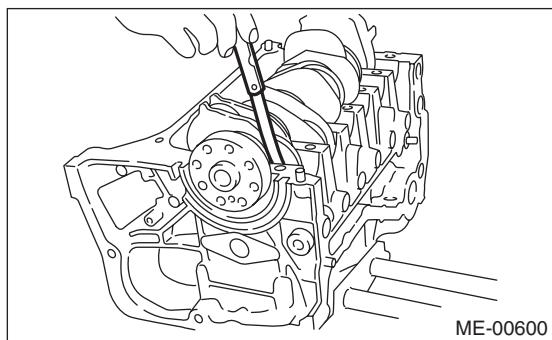
		Crank journal diameter		Unit: mm (in)
		#1, #3, #5, #7	#2, #4, #6	Crank pin outer diameter
Standard	Journal O.D.	63.992 — 64.008 (2.5194 — 2.5200)		51.984 — 52.000 (2.0466 — 2.0472)
	Bearing size (Thickness at center)	1.992 — 2.005 (0.0784 — 0.0789)	1.996 — 2.009 (0.0786 — 0.0791)	1.490 — 1.506 (0.0587 — 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 by using thickness gauge. If the thrust clearance is not within the standard, replace the bearing.

Crankshaft thrust 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 using plastigauge. If the measured value is out of standard, 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)