MECHANICAL

ME(H6DO)

1. General Description

A: SPECIFICATIONS

Engine	Type			Horizontally opposed, liquid cooled, 6-cylinder, 4-stroke gasoline engine
	Valve arrangement			Chain driven, double over-head camshaft, 4-valve/cylinder
	Bore x Stroke		mm (in)	89.2 x 80 (3.512 x 3.150)
	Displacement		cm^3 (cu in)	3,000 (183)
	Compression ratio			10.7
	Compression pressure (350 rpm and fully open throttle)		kPa (kg/cm^2, psi)	1,275 — 1,471 (13.0 — 15.0, 185 — 213)
	Number of piston rings			Pressure ring: 2, Oil ring: 1
	Intake valve timing	Opening		5° BTDC
		Closing		55° ABDC
	Exhaust valve timing	Opening		52° BBDC
		Closing		0° ATDC
	Valve clearance	Intake	mm (in)	$0.20^{+0.04}_{-0.06}$ ($0.0079^{+0.0016}_{-0.0024}$)
		Exhaust	mm (in)	0.25±0.05 (0.0098±0.0020)
	Idle speed [At “P” or “N” position]		rpm	600±50 (No load) 700±50 (A/C switch ON)
	Firing order			1 → 6 → 3 → 2 → 5 → 4
	Ignition timing		BTDC/rpm	10°±8°/600

NOTE:
STD: Standard I.D.: Inner Diameter O.D.: Outer Diameter US: Undersize OS: Oversize

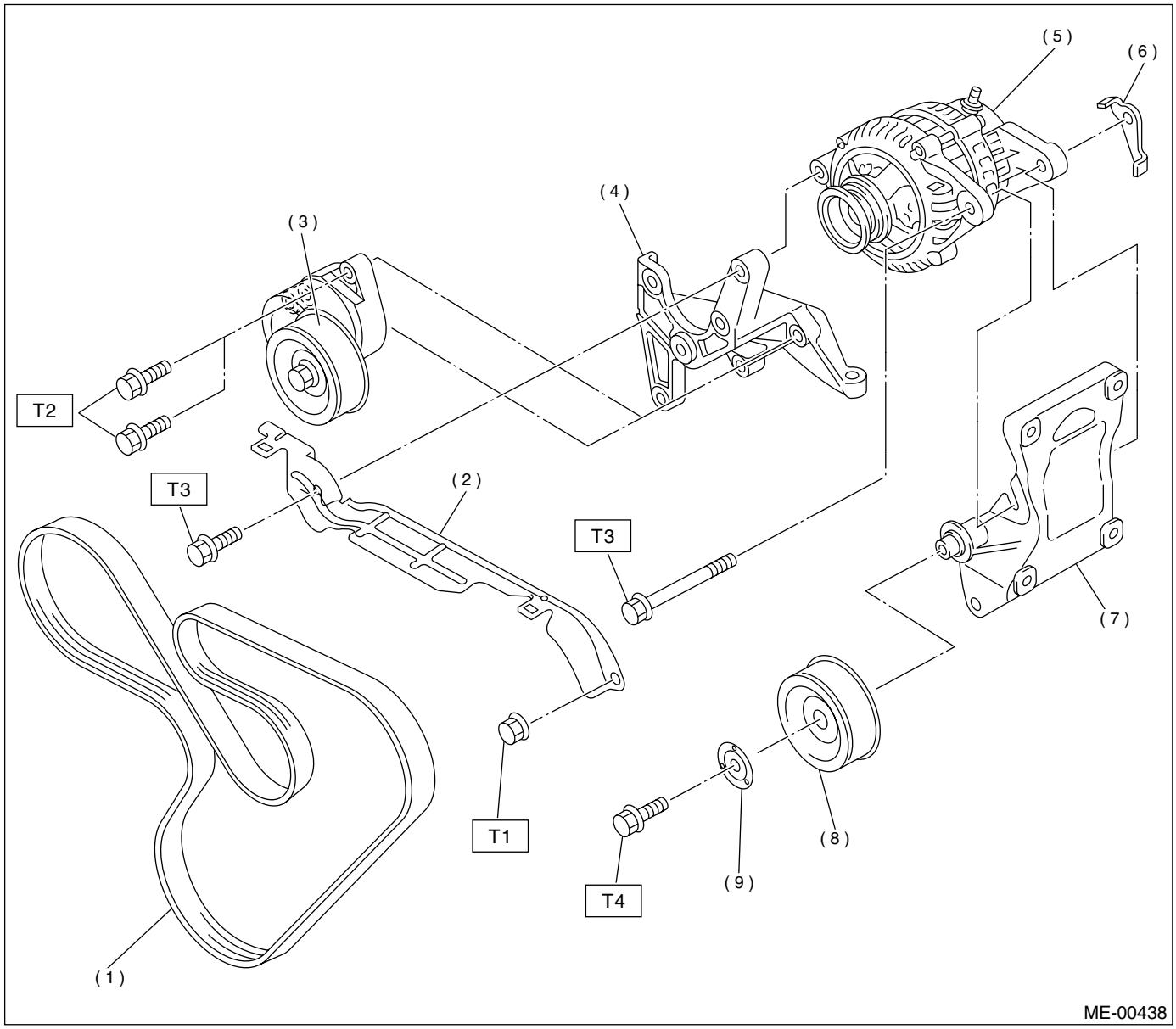
Camshaft	Bend limit			0.020 mm (0.0008 in)
	Thrust clearance	Intake	STD	0.075 — 0.135 mm (0.0030 — 0.0053 in)
		Exhaust	STD	0.048 — 0.108 mm (0.0019 — 0.0043 in)
	Cam lobe height	Intake	STD	45.75 — 45.85 mm (1.8012 — 1.8051 in)
		Exhaust	STD	45.25 — 45.35 mm (1.7815 — 1.7854 in)
	Camshaft journal O.D.	Front		37.946 — 37.963 mm (1.4939 — 1.4946 in)
		Center & Rear		27.946 — 27.963 mm (1.1002 — 1.1009 in)
	Camshaft journal hole I.D.	Front		38.000 — 38.018 mm (1.4961 — 1.4968 in)
		Center & Rear		28.000 — 28.018 mm (1.1024 — 1.1031 in)
	Oil clearance		STD	0.037 — 0.072 mm (0.0015 — 0.0028 in)
Cylinder head	Warping limit (Mating with cylinder block)			0.02 mm (0.0008 in)
	Inner diameter of valve lifter hole			34.006 — 34.016 mm (1.3388 — 1.3392 in)
	Standard height			124 mm (4.88 in)
Valve seat	Refacing angle			90°
	Contacting width	Intake	STD	1.0 mm (0.039 in)
			Limit	1.7 mm (0.067 in)
		Exhaust	STD	1.5 mm (0.059 in)
			Limit	2.2 mm (0.087 in)
Valve guide	Inner diameter			5.500 — 5.512 mm (0.2165 — 0.2170 in)
	Protrusion above head		Intake	12.3 — 12.7 mm (0.484 — 0.500 in)

Valve	Head edge thickness		Intake	STD	1.0 mm (0.039 in)
				Limit	0.8 mm (0.031 in)
			Exhaust	STD	1.2 mm (0.047 in)
				Limit	1.0 mm (0.039 in)
	Stem diameter			Intake	5.455 — 5.470 mm (0.2148 — 0.2154 in)
				Exhaust	5.445 — 5.460 mm (0.2144 — 0.2150 in)
	Stem oil clearance		STD	Intake	0.030 — 0.057 mm (0.0012 — 0.0022 in)
				Exhaust	0.040 — 0.067 mm (0.0016 — 0.0026 in)
	Overall length			Intake	103.5 mm (4.07 in)
				Exhaust	103.2 mm (4.06 in)
	Outer diameter of valve lifter				33.959 — 33.975 mm (1.3370 — 1.3376 in)
Valve spring	Free length				46.79 mm (1.8421 in)
	Squareness				2.5°, 2.0 mm (0.079 in)
Cylinder block	Standard height				202 mm (7.951 in)
	Warping limit (Mating with cylinder head)				0.02 mm (0.0008 in)
	Cylinder bore		STD	A	89.205 — 89.215 mm (3.5120 — 3.5124 in)
				B	89.195 — 89.205 mm (3.5116 — 3.5120 in)
	Taper				0.03 mm (0.0012 in)
	Out-of-roundness				0.01 mm (0.0004 in)
	Piston clearance			STD	0.010 — 0.030 mm (0.0004 — 0.0012 in)
	Enlarging (boring) limit				0.5 mm (0.020 in)
Piston	Outer diameter		STD	A	89.185 — 89.195 mm (3.5112 — 3.5116 in)
				B	89.175 — 89.185 mm (3.5108 — 3.5112 in)
			0.25 mm (0.0098 in) OS		89.425 — 89.435 mm (3.5207 — 3.5211 in)
			0.50 mm (0.0197 in) OS		89.675 — 89.685 mm (3.5305 — 3.5309 in)
	Standard inner diameter of piston pin hole				22.000 — 22.006 mm (0.8661 — 0.8664 in)
Piston pin	Outer diameter				21.994 — 22.000 mm (0.8659 — 0.8661 in)
	Standard clearance between piston pin and hole in piston				0.004 — 0.008 mm (0.0002 — 0.0003 in)
	Degree of fit				Piston pin must be fitted into position with thumb at 20°C (68°F).
Piston ring	Piston ring gap	Top ring	STD		0.20 — 0.35 mm (0.0079 — 0.0138 in)
		Second ring	STD		0.35 — 0.50 mm (0.0138 — 0.0197 in)
		Oil ring	STD		0.20 — 0.60 mm (0.0079 — 0.0236 in)
	Clearance between piston ring and piston ring groove	Top ring	STD		0.040 — 0.080 mm (0.0016 — 0.0031 in)
		Second ring	STD		0.030 — 0.070 mm (0.0012 — 0.0028 in)
Connecting rod	Bend twist per 100 mm (3.94 in) in length		Limit		0.10 mm (0.0039 in)
	Side clearance		STD		0.070 — 0.330 mm (0.0028 — 0.0130 in)
Connecting rod bearing	Oil clearance		STD		0.022 — 0.052 mm (0.0009 — 0.0020 in)
	Thickness at center portion		STD		1.490 — 1.502 mm (0.0587 — 0.0591 in)
			0.03 mm (0.0012 in) US		1.510 — 1.513 mm (0.0594 — 0.0596 in)
			0.05 mm (0.0020 in) US		1.520 — 1.523 mm (0.0598 — 0.0600 in)
			0.25 mm (0.0098 in) US		1.620 — 1.623 mm (0.0638 — 0.0639 in)
Connecting rod bushing	Clearance between piston pin and bushing		STD		0 — 0.022 mm (0 — 0.0009 in)

Crankshaft	Bend limit			0.035 mm (0.0014 in)
	Crank pin and crank journal	Out-of-roundness		0.020 mm (0.0008 in) or less
		Grinding limit		0.250 mm (0.0098 in)
	Crank pin outer diameter		STD	51.984 — 52.000 mm (2.0466 — 2.0472 in)
			0.03 mm (0.0012 in) US	51.954 — 51.970 mm (2.0454 — 2.0461 in)
			0.05 mm (0.0020 in) US	51.934 — 51.950 mm (2.0446 — 2.0453 in)
			0.25 mm (0.0098 in) US	51.734 — 51.750 mm (2.0368 — 2.0374 in)
	Crank journal outer diameter	#1, #3, #5, #7	STD	63.992 — 64.008 mm (2.5194 — 2.5200 in)
			0.03 mm (0.0012 in) US	63.962 — 63.978 mm (2.5182 — 2.5188 in)
			0.05 mm (0.0020 in) US	63.942 — 63.958 mm (2.5174 — 2.5180 in)
			0.25 mm (0.0098 in) US	63.742 — 63.758 mm (2.5095 — 2.5102 in)
		#2, #4, #6	STD	63.992 — 64.008 mm (2.5194 — 2.5200 in)
			0.03 mm (0.0012 in) US	63.962 — 63.978 mm (2.5182 — 2.5188 in)
			0.05 mm (0.0020 in) US	63.942 — 63.958 mm (2.5174 — 2.5180 in)
			0.25 mm (0.0098 in) US	63.742 — 63.758 mm (2.5095 — 2.5102 in)
	Thrust clearance		STD	0.030 — 0.115 mm (0.0012 — 0.0045 in)
	Oil clearance		STD	0.015 — 0.030 mm (0.0006 — 0.0012 in)
Crankshaft bearing	Crankshaft bearing thickness	#1, #3, #5, #7	STD	1.992 — 2.005 mm (0.0784 — 0.0789 in)
			0.03 mm (0.0012 in) US	2.017 — 2.020 mm (0.0794 — 0.0795 in)
			0.05 mm (0.0020 in) US	2.027 — 2.030 mm (0.0798 — 0.0799 in)
			0.25 mm (0.0098 in) US	2.127 — 2.130 mm (0.0837 — 0.0839 in)
		#2, #4, #5	STD	1.996 — 2.000 mm (0.0786 — 0.0787 in)
			0.03 mm (0.0012 in) US	2.019 — 2.020 mm (0.0795 — 0.0795 in)
			0.05 mm (0.0020 in) US	2.029 — 2.032 mm (0.0799 — 0.0800 in)
			0.25 mm (0.0098 in) US	2.129 — 2.132 mm (0.0838 — 0.0839 in)

B: COMPONENT

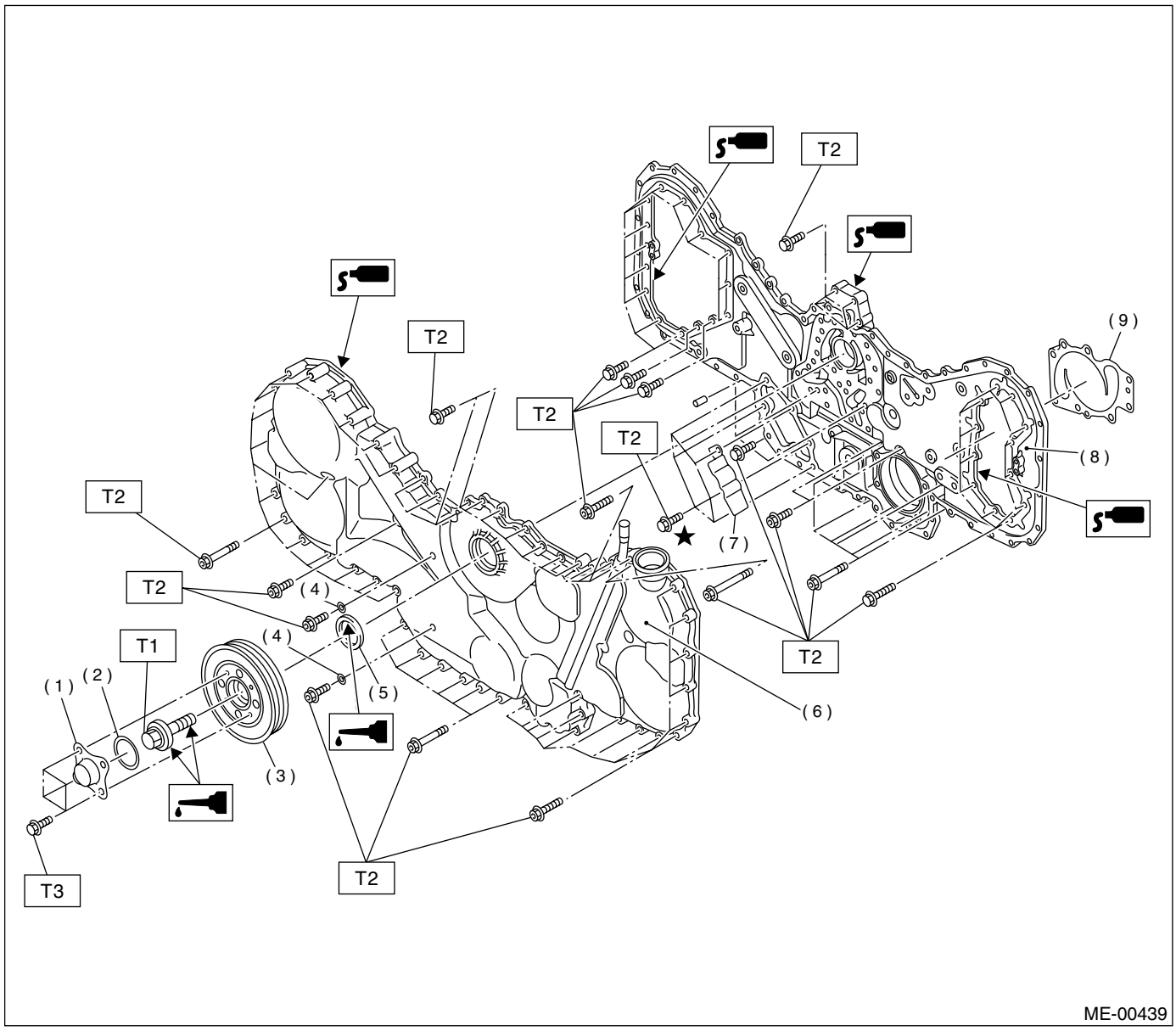
1. V-BELT



(1) V-belt
(2) Belt cover
(3) Belt tensioner
(4) Power steering pump bracket
(5) Generator
(6) Generator plate
(7) A/C compressor stay
(8) Idler pulley
(9) Idler pulley cover

Tightening torque: N·m (kgf-m, ft-lb)
T1: 6.4 (0.65, 4.7)
T2: 20 (2.0, 14)
T3: 25 (2.5, 18)
T4: 33 (3.4, 25)

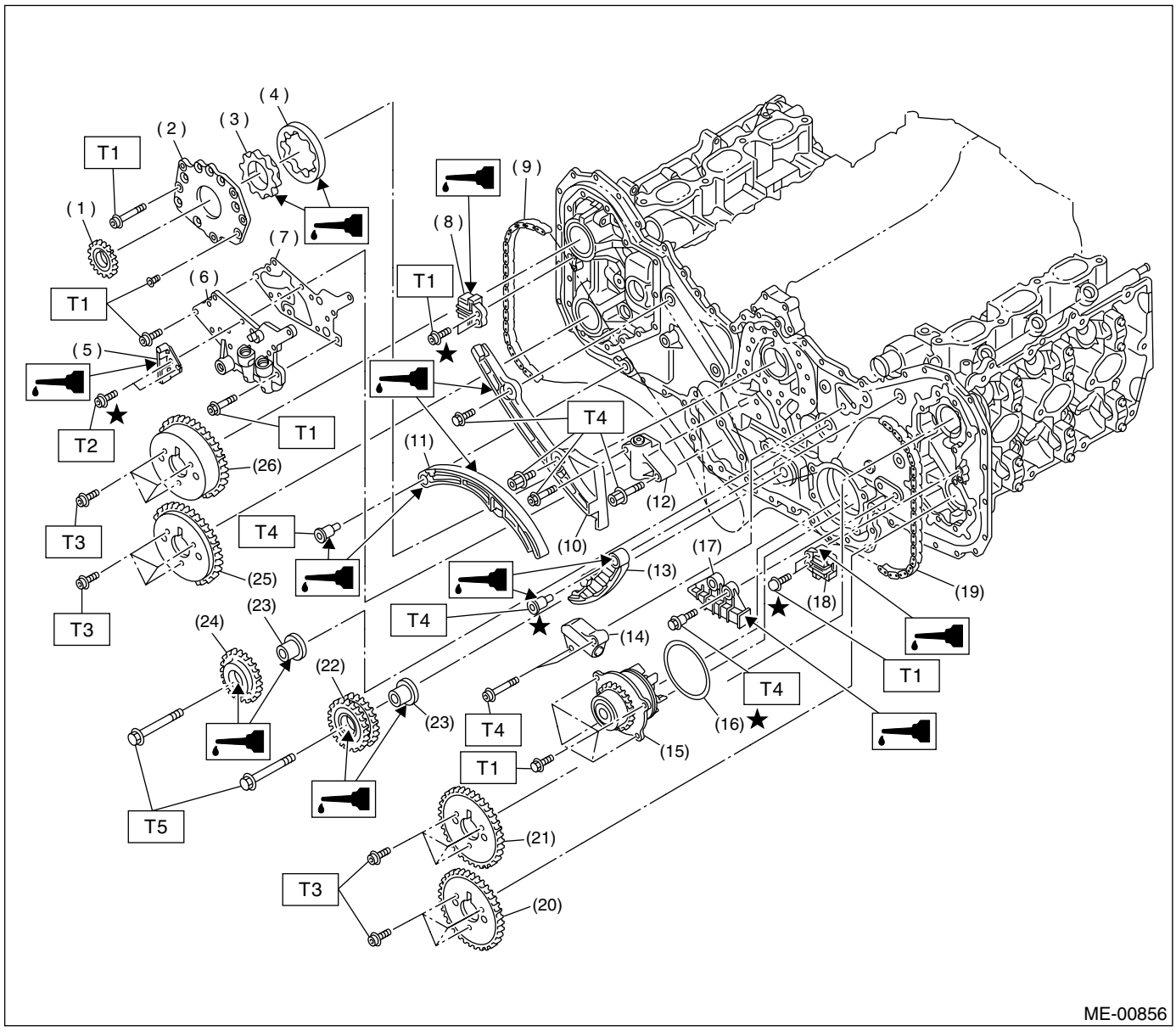
2. TIMING CHAIN COVER



(1) Crank pulley cover
(2) O-ring
(3) Crank pulley
(4) Sealing washer
(5) Oil seal
(6) Front chain cover
(7) Baffle
(8) Rear chain cover
(9) Water pump gasket

Tightening torque: N·m (kgf-m, ft-lb)
T1: <Ref. to ME(H6DO)-38, Crankshaft Pulley.>
T2: <Ref. to ME(H6DO)-39, Front Chain Cover.>
T3: 6.4 (0.65, 4.7)

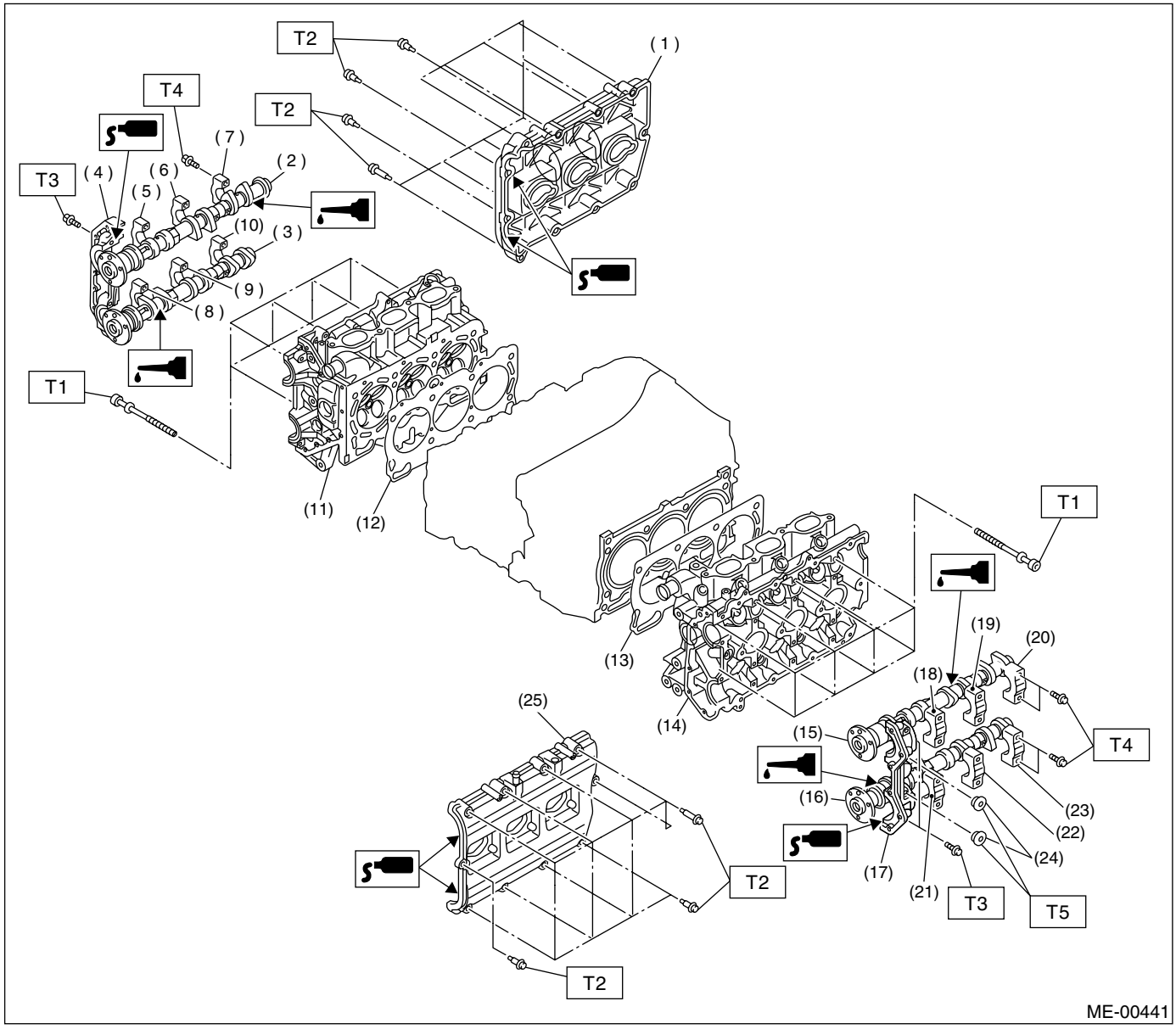
3. TIMING CHAIN



(1) Crank sprocket
(2) Oil pump cover
(3) Inner rotor
(4) Outer rotor
(5) Chain guide (Center)
(6) Relief valve case
(7) Relief valve case gasket
(8) Chain guide (Right-hand between cams)
(9) Timing chain (RH)
(10) Chain guide (RH)
(11) Chain tensioner lever (RH)
(12) Chain tensioner (RH)
(13) Chain tensioner lever (LH)
(14) Chain tensioner (LH)
(15) Water pump
(16) O-ring
(17) Chain guide (LH)
(18) Chain guide (Left-hand between cams)
(19) Timing chain (LH)
(20) Exhaust cam sprocket (LH)
(21) Intake cam sprocket (LH)
(22) Idler sprocket (Lower)
(23) Idler sprocket color
(24) Idler sprocket (Upper)
(25) Exhaust cam sprocket (RH)
(26) Intake cam sprocket (RH)

Tightening torque: N·m (kgf-m, ft-lb)
T1: 6.4 (0.64, 4.7)
T2: 7.8 (0.80, 5.8)
T3: 13 (1.3, 9.4)
T4: 16 (1.6, 11.6)
T5: 69 (7.0, 50.6)

4. CYLINDER HEAD AND CAMSHAFT

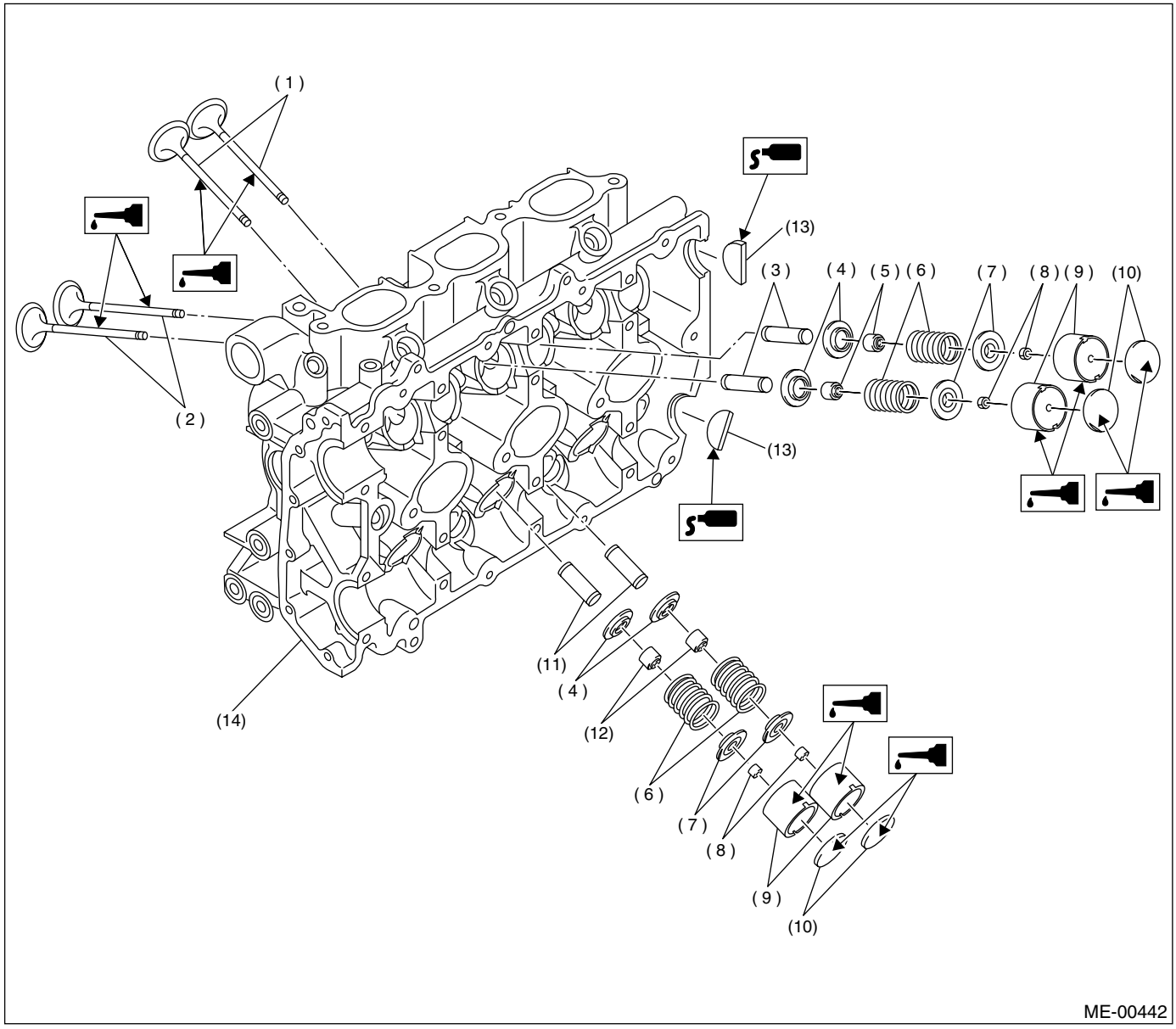


(1) Rocker cover (RH)
(2) Intake camshaft (RH)
(3) Exhaust camshaft (RH)
(4) Front camshaft cap (RH)
(5) Intake camshaft cap (Front RH)
(6) Intake camshaft cap (Center RH)
(7) Intake camshaft cap (Rear RH)
(8) Exhaust camshaft cap (Front RH)
(9) Exhaust camshaft cap (Center RH)
(10) Exhaust camshaft cap (Rear RH)
(11) Cylinder head (RH)
(12) Cylinder head gasket (RH)
(13) Cylinder head gasket (LH)
(14) Cylinder head (LH)
(15) Intake camshaft (LH)
(16) Exhaust camshaft (LH)
(17) Front camshaft cap (LH)
(18) Intake camshaft cap (Front LH)
(19) Intake camshaft cap (Center LH)
(20) Intake camshaft cap (Rear LH)
(21) Exhaust camshaft cap (Front LH)
(22) Exhaust camshaft cap (Center LH)
(23) Exhaust camshaft cap (Rear LH)
(24) Plug
(25) Rocker cover (LH)

Tightening torque: N·m (kgf-m, ft-lb)

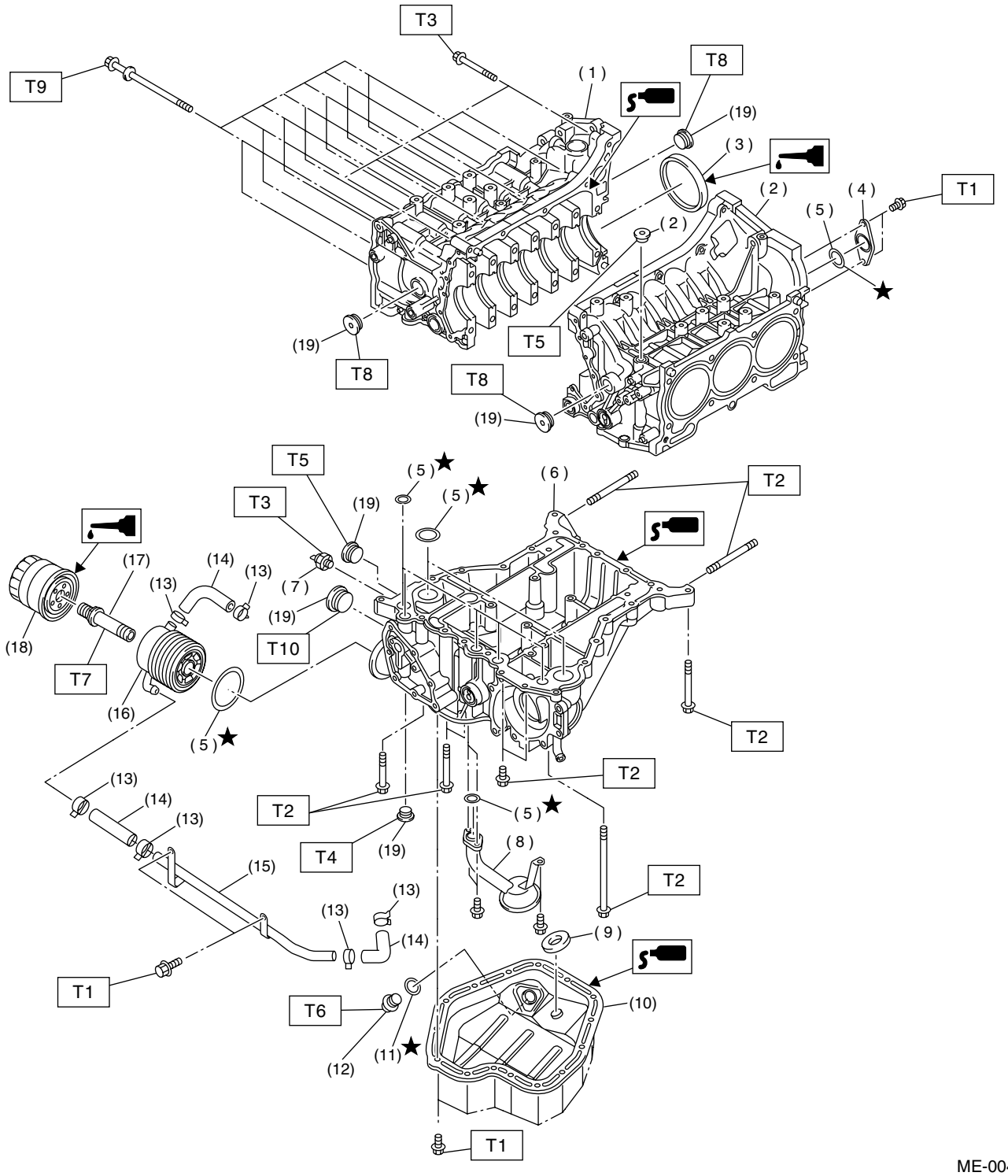
T1: <Ref. to ME(H6DO)-54, Cylinder Head Assembly.>
T2: <Ref. to ME(H6DO)-50, Camshaft.>
T3: <Ref. to ME(H6DO)-50, Camshaft.>
T4: <Ref. to ME(H6DO)-50, Camshaft.>
T5: 59 (6.0, 43)

5. CYLINDER HEAD AND VALVE ASSEMBLY



(1) Exhaust valve
(2) Intake valve
(3) Intake valve guide
(4) Valve spring seat
(5) Intake valve stem seal
(6) Valve spring
(7) Retainer
(8) Retainer key
(9) Valve lifter
(10) Shim
(11) Exhaust valve guide
(12) Exhaust valve stem seal
(13) Cylinder head plug
(14) Cylinder head

6. CYLINDER BLOCK

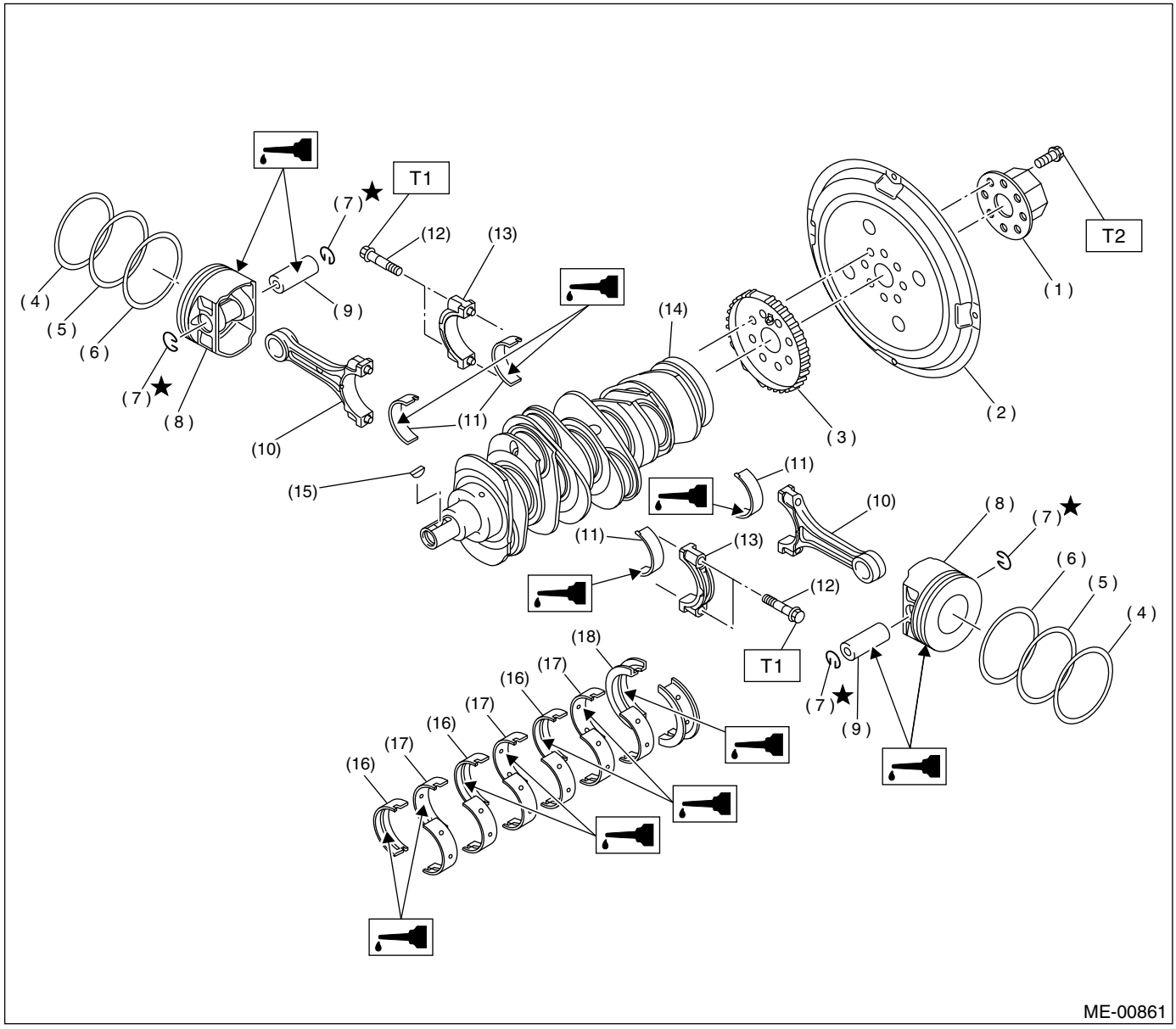


ME-00443

(1) Cylinder block (RH)
(2) Cylinder block (LH)
(3) Rear oil seal
(4) Service hole cover
(5) O-ring
(6) Oil pan upper
(7) Oil pressure switch
(8) Oil strainer
(9) Magnet
(10) Oil pan
(11) Metal gasket
(12) Drain plug
(13) Clamp
(14) Hose
(15) Oil cooler pipe
(16) Oil cooler
(17) Connector
(18) Oil filter
(19) Plug

Tightening torque: N·m (kgf-m, ft-lb)
T1: 6.4 (0.65, 4.7)
T2: 18 (1.8, 13.0)
T3: 25 (2.5, 18)
T4: 34 (3.5, 25)
T5: 37 (3.8, 27)
T6: 44 (4.5, 33)
T7: 54 (5.5, 40)
T8: 69 (7.0, 51)
T9: <Ref. to ME(H6DO)-60, Cylinder Block.>
T10: 90 (9.2, 67)

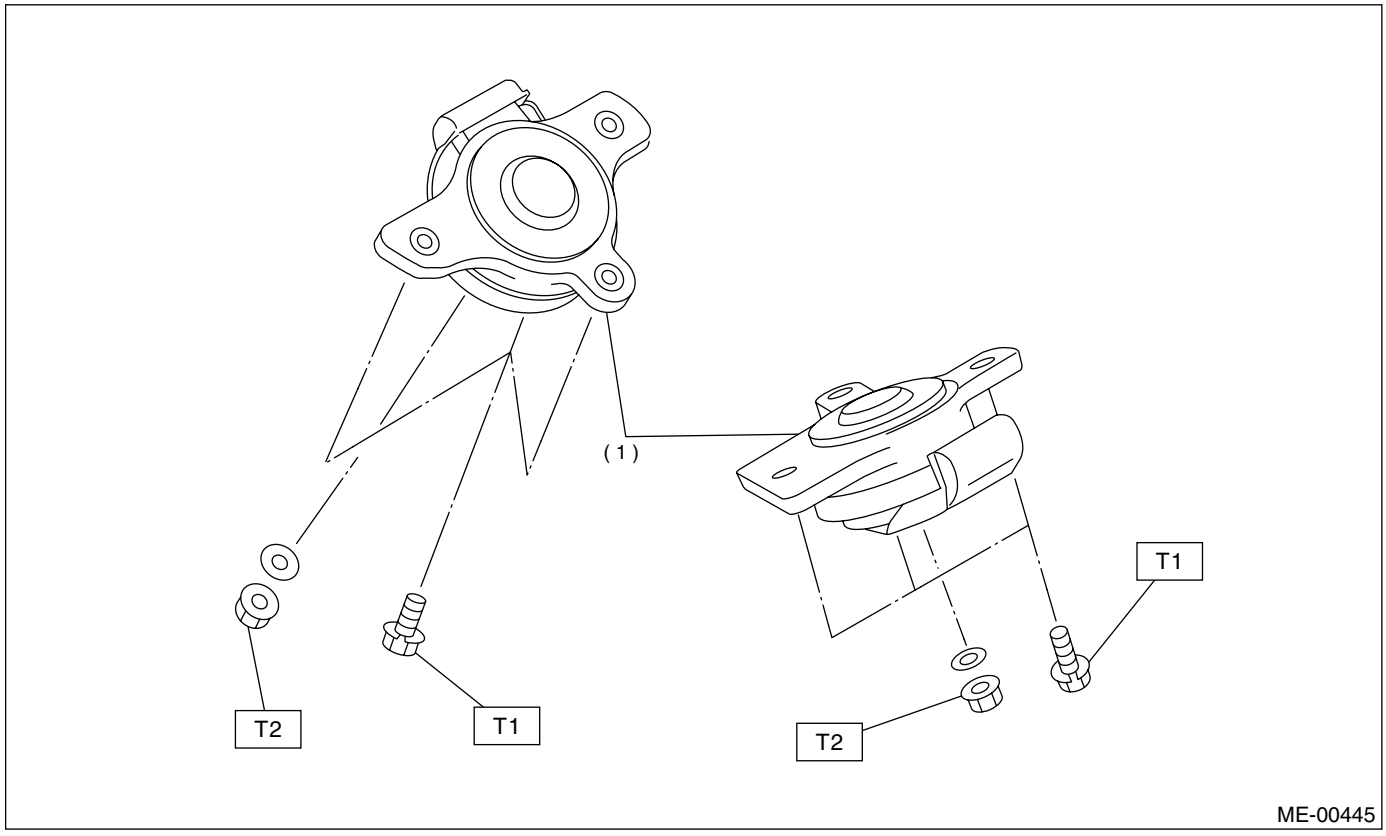
7. CRANKSHAFT AND PISTON



(1) Reinforcement
(2) Drive plate
(3) Crankshaft sensor plate
(4) Top ring
(5) Second ring
(6) Oil ring
(7) Circlip
(8) Piston
(9) Piston pin
(10) Connecting rod
(11) Connecting rod bearing
(12) Connecting rod bolt
(13) Connecting rod cap
(14) Crankshaft
(15) Woodruff key
(16) Crankshaft bearing #1, #3, #5
(17) Crankshaft bearing #2, #4, #6
(18) Crankshaft bearing #7

Tightening torque: N·m (kgf-m, ft-lb)
T1: 53 (5.4, 39)
T2: 81 (8.3, 60)

8. ENGINE MOUNTING



(1) Front cushion rubber

Tightening torque: N·m (kgf-m, ft-lb)
T1: 34 (3.5, 25.3)
T2: 74 (7.5, 54)

C: CAUTION

• Wear working clothing, including a cap, protective goggles, and protective shoes during operation.
• Remove contamination including dirt and corrosion before removal, installation or disassembly.
• Keep the disassembled parts in order and protect them from dust or dirt.
• Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly, and replacement.
• Be careful not to burn your hands, because each part in the vehicle is hot after running.
• Be sure to tighten fasteners including bolts and nuts to the specified torque.
• Place shop jacks or safety stands at the specified points.
• Before disconnecting electrical connectors of sensors or units, be sure to disconnect ground cable from battery.
• All parts should be thoroughly cleaned, paying special attention to the engine oil passages, pistons and bearings.
• Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.
• Be careful not to let oil, grease or coolant contact the clutch disc and flywheel.
• All removed parts, if to be reused, should be reinstalled in the original positions and directions.
• Bolts, nuts and washers should be replaced with new ones as required.
• Even if necessary inspections have been made in advance, proceed with assembly work while making rechecks.
• Remove or install engine in an area where chain hoists, lifting devices, etc. are available for ready use.
• Be sure not to damage coated surfaces of body panels with tools or stain seats and windows with coolant or oil. Place a cover over fenders, as required, for protection.
• Prior to starting work, prepare the following:
Service tools, clean cloth, containers to catch coolant and oil, wire ropes, chain hoist, transmission jacks, etc.
• Lift-up or lower the vehicle when necessary. Make sure to support the correct positions.

D: PREPARATION TOOL

1. SPECIAL TOOLS

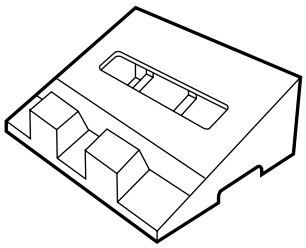
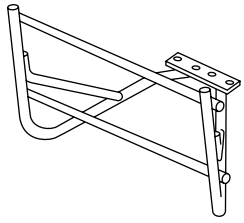
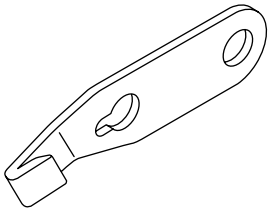
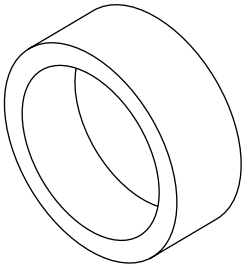
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18250AA000	18250AA000	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve springs.
 ST18232AA000	18232AA000	ENGINE STAND	Used for engine disassembly and assembly.
 ST-498497100	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of flywheel when loosening and tightening crankshaft pulley bolt, etc.
 ST18254AA000	18254AA000	PISTON GUIDE	Used for installing piston in cylinder.

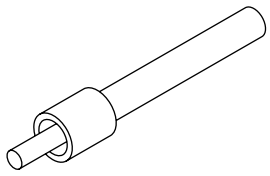
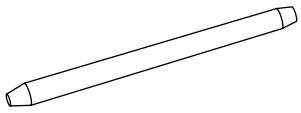
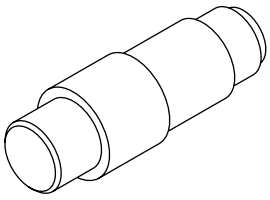
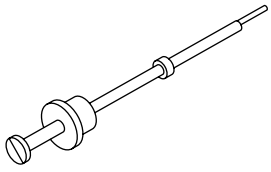
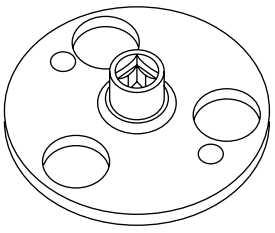
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499585500	499585500	VALVE STEM SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide stem seals.
 ST18253AA000	18253AA000	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST18350AA000	18350AA000	CONNECTING ROD BUSHING REMOVER & INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499097500	499097500	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST18231AA000	18231AA000	CAMSHAFT SPROCKET WRENCH	Used for removing and installing camshaft sprocket.

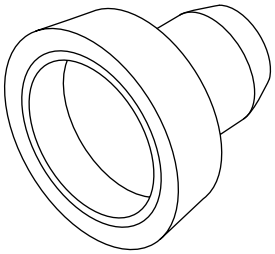
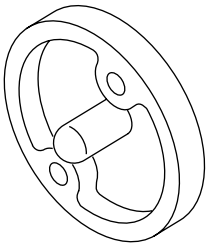
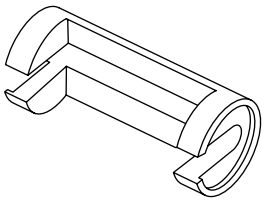
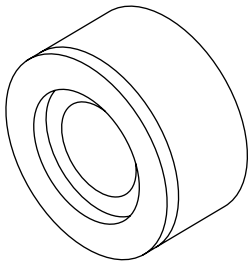
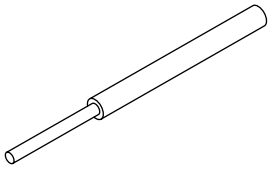
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499718000	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST18251AA000	18251AA000	VALVE GUIDE ADJUSTER	Used for installing valve guides.
 ST-499765700	499765700	VALVE GUIDE REMOVER	Used for removing valve guides.

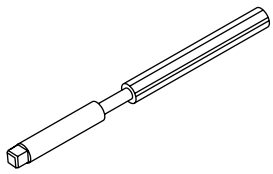
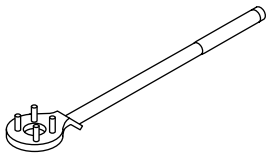
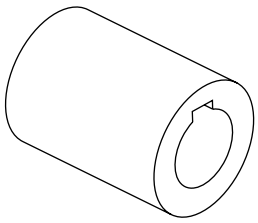
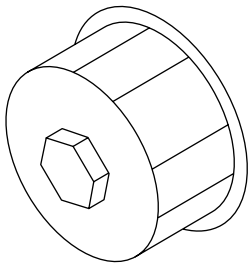
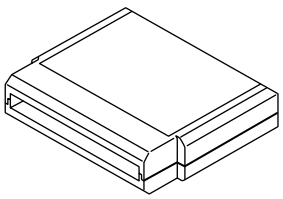
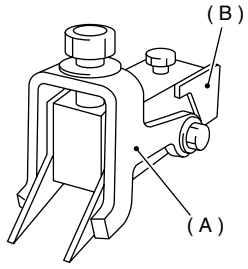
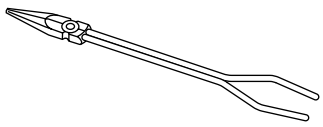
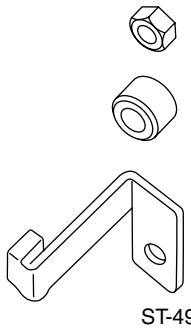
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499765900	499765900	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499977100	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crankshaft pulley when loosening and tightening crankshaft pulley bolts.
 ST18252AA000	18252AA000	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST-498547000	498547000	OIL FILTER WRENCH	Used for removing and installing oil filter.
 ST24082AA230	24082AA230	CARTRIDGE	Troubleshooting for electrical systems.

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST22771AA020	22771AA020	SELECT MONITOR KIT	Troubleshooting for electrical systems.
 ST18329AA000	18329AA000	SHIM REPLACER ASSY	Used for correct valve clearance.
	A: 18330AA010	LIFTER	If 498187200 SHIM REPLACER ASSY (H4) tool is available, it is commonly used for H6 by partially replacing the following parts: • LIFTER (H4) → LIFTER (H6) A: 18330AA010 • SLIDER (H4) → SLIDER (H6) B: 18351AA000
	B: 18351AA000	SLIDER	
 ST18233AA000	18233AA000	PISTON PIN CIRCLIP PLIERS	Used for removing piston pin circlip.
 ST-498277200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.

2. GENERAL PURPOSE TOOLS

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.

E: PROCEDURE

It is possible to conduct the following service procedures with engine on the vehicle, however, the procedures described in this section are based on the condition that the engine is removed from the vehicle.

- Camshaft
- Cylinder Head

2. Compression

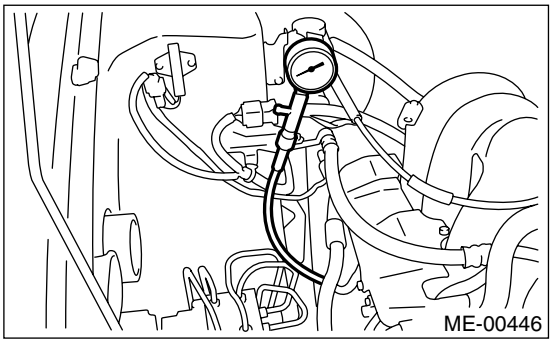
A: INSPECTION

CAUTION:
After warming-up, engine becomes very hot. Be careful not to burn yourself during measurement.

1) After warming-up the engine, turn ignition switch to OFF.
2) Make sure that the battery is fully charged.
3) Release fuel pressure. <Ref. to FU(H6DO)-50, RELEASING OF FUEL PRESSURE, OPERATION, Fuel.>
4) Remove all the spark plugs. <Ref. to IG(H6DO)-4, REMOVAL, Spark Plug.>
5) Check the starter motor for satisfactory performance and operation.
6) Hold the compression gauge tight against the spark plug hole.

CAUTION:
When using a screw-in type compression gauge, the screw (put into cylinder head spark plug hole) should be less than 18 mm (0.71 in) long.

7) Fully open throttle valve.
8) Crank the engine by means of the starter motor, and read the maximum value on the gauge when the pointer is steady.



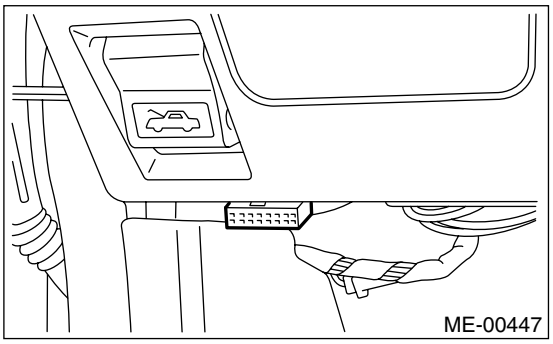
9) Perform at least two measurements per cylinder, and make sure that the values are correct.

Compression (350 rpm and fully open throttle):
Standard;
1,275 — 1,471 kPa (13.0 — 15.0 kg/cm^2, 185 — 213 psi)
Limit;
1,128 kPa (11.5 kg/cm^2, 164 psi)

3. Idle Speed

A: INSPECTION

1) Before checking idle speed, check the following:
   (1) Ensure that air cleaner element is free from clogging, ignition timing is correct, spark plugs are in good condition, and that hoses are connected properly.
   (2) Ensure that malfunction indicator light (CHECK ENGINE light) does not illuminate.
2) Warm-up the engine.
3) Stop the engine, and turn ignition switch to OFF.
4) When using SUBARU SELECT MONITOR <Ref. to ME(H6DO)-14, SPECIAL TOOLS, PREPARATION TOOL, General Description.>
   (1) Insert the cartridge to SUBARU SELECT MONITOR.
   (2) Connect SUBARU SELECT MONITOR to the data link connector.



   (3) Turn ignition switch to ON, and SUBARU SELECT MONITOR switch to ON.
   (4) Select {2. Each System Check} in Main Menu.
   (5) Select {Engine Control System} in Selection Menu.
   (6) Select {1. Current Data Display & Save} in Engine Control System Diagnosis.
   (7) Select {1.12 Data Display} in Data Display Menu.
   (8) Start the engine, and read engine idle speed.

NOTE:
• When using the OBD-II general scan tool, carefully read its operation manual.

5) Check idle speed when unloaded. (With headlights, heater fan, rear defroster, radiator fan, air conditioning, etc. OFF)

Idle speed (No load and gears in N or P position):
600±50 rpm

6) Check idle speed when loaded. (Turn air conditioning switch to "ON" and operate compressor for at least one minute before measurement.)

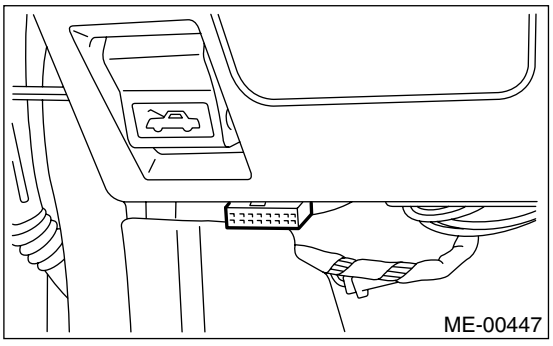
Idle speed [A/C "ON", no load and gears in N or P position]:
700±50 rpm

CAUTION:
Idle speed cannot be adjusted manually because it is controlled automatically. If idle speed is out of specifications, refer to General On-board Diagnosis Table under "Engine Control System". <Ref. to EN(H6DO)-2, Basic Diagnostic Procedure.>

4. Ignition Timing

A: INSPECTION

1) Before checking ignition timing, check the following:
   (1) Ensure that air cleaner element is free from clogging, spark plugs are in good condition, and that hoses are connected properly.
   (2) Ensure that malfunction indicator light (CHECK ENGINE light) does not illuminate.
2) Warm-up the engine.
3) Stop the engine, and turn ignition switch to OFF.
4) When using SUBARU SELECT MONITOR <Ref. to ME(H6DO)-14, SPECIAL TOOLS, PREPARATION TOOL, General Description.>
   (1) Insert the cartridge to SUBARU SELECT MONITOR.
   (2) Connect SUBARU SELECT MONITOR to the data link connector.



   (3) Turn ignition switch to ON, and SUBARU SELECT MONITOR switch to ON.
   (4) Select {2. Each System Check} in Main Menu.
   (5) Select {Engine Control System} in Selection Menu.
   (6) Select {1. Current Data Display & Save} in Engine Control System Diagnosis.
   (7) Select {1.12 Data Display} in Data Display Menu.
   (8) Start engine at idle speed and check the ignition timing.

Ignition timing [BTDC/rpm]:
10°±3°/600±50

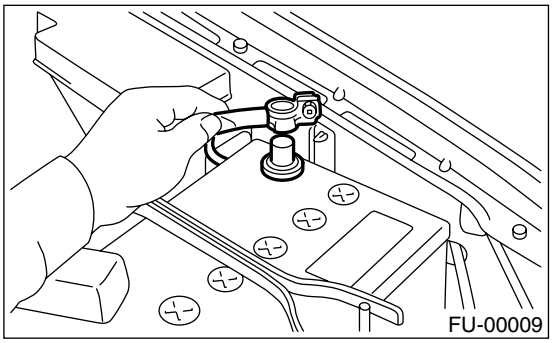
If the timing is not correct, check the ignition control system.
Refer to EN(H6) Engine Control System. <Ref. to EN(H6DO)-2, Basic Diagnostic Procedure.>

5. Valve Clearance

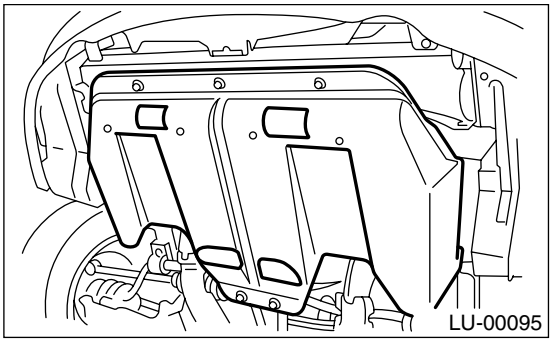
A: INSPECTION

CAUTION:
Inspection and adjustment of valve clearance should be performed while engine is cold.

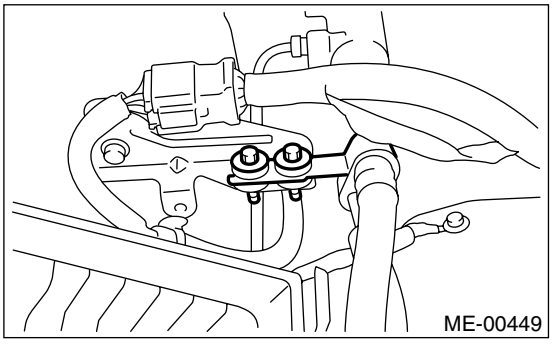
1) Set the vehicle on the lift.
2) Disconnect battery ground cable.



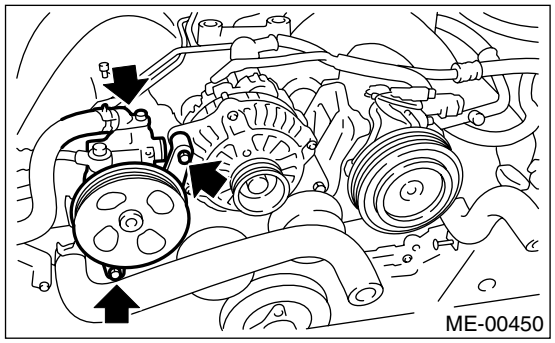
3) Lift up the vehicle.
4) Remove under cover.



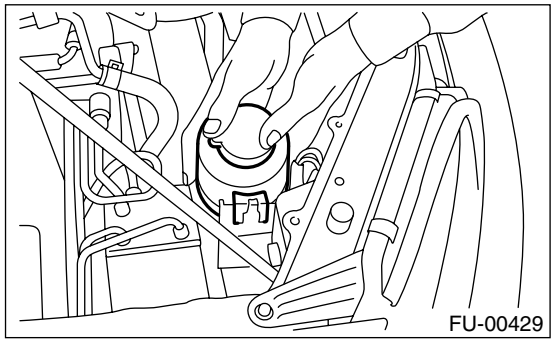
5) Lower the vehicle.
6) Place suitable container under the vehicle.
7) When inspecting RH side cylinder.
   (1) Remove air intake duct and air cleaner case. <Ref. to IN(H6DO)-7, REMOVAL, Air Intake Duct.> and <Ref. to IN(H6DO)-5, REMOVAL, Air Cleaner.>
   (2) Remove V-belt. <Ref. to ME(H6DO)-28, REMOVAL, V-belt.>
   (3) Remove power steering hose from bracket.



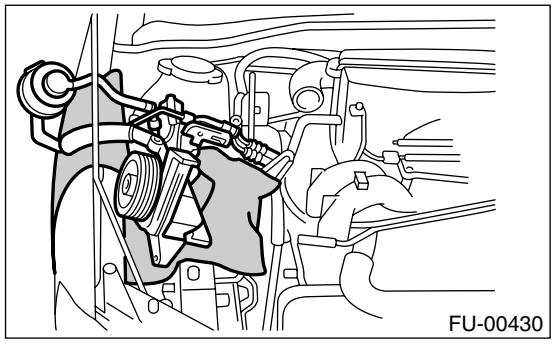
(4) Remove bolts which install power steering pump bracket.



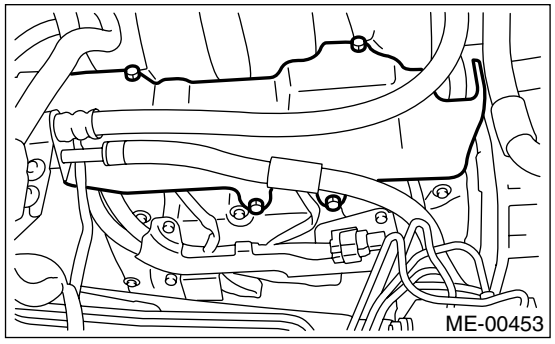
(5) Remove power steering tank from the bracket by pulling it upward.



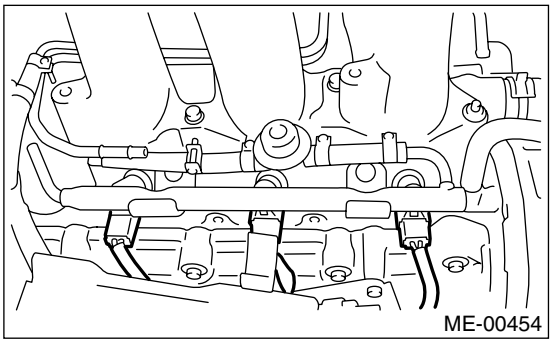
(6) Place power steering pump on the right side wheel apron.



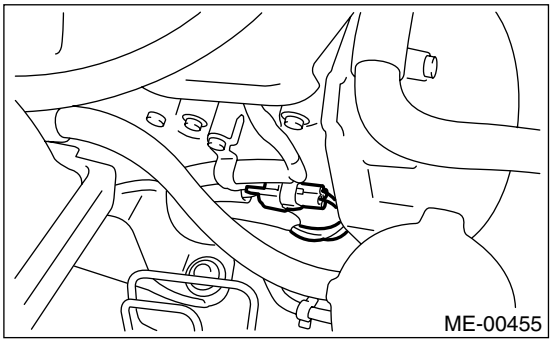
(7) Remove fuel pipe protector RH.



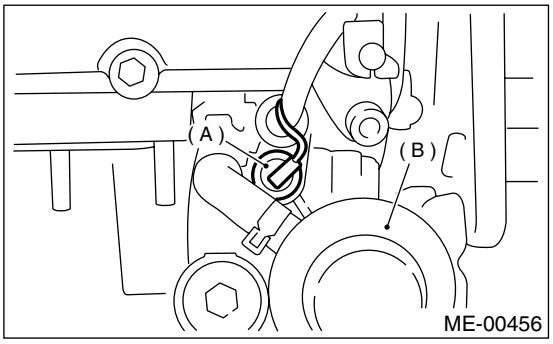
(8) Disconnect fuel injector connectors.



(9) Disconnect front oxygen (A/F) sensor connector.



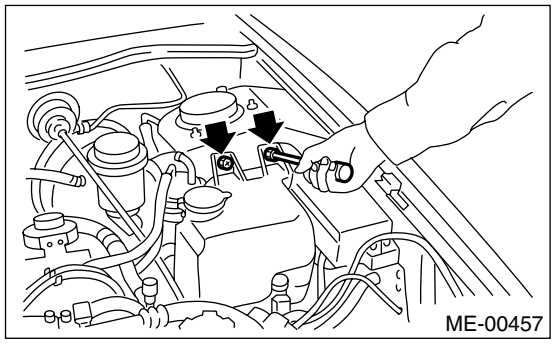
(10) Disconnect oil pressure switch connector.



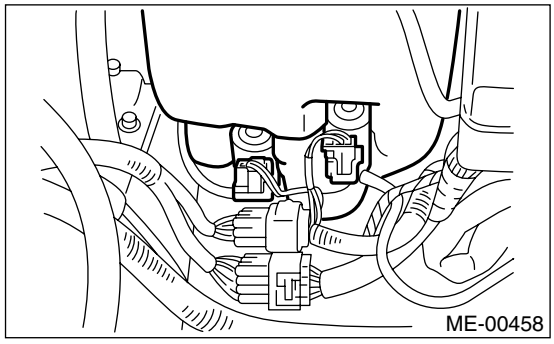
(A) Oil pressure switch
(B) Oil filter

(11)Remove ignition coils. <Ref. to IG(H6DO)-7, REMOVAL, Ignition Coil and Ignitor Assembly.>
(12)Remove rocker cover RH. <Ref. to ME(H6DO)-50, REMOVAL, Camshaft.>

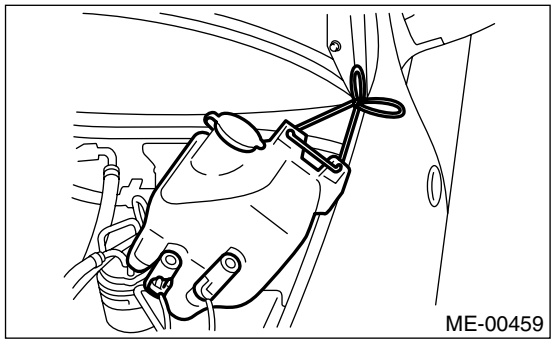
8) When inspecting LH side cylinder.
(1) Set the vehicle on the lift.
(2) Remove battery.
(3) Remove washer tank mounting bolts.



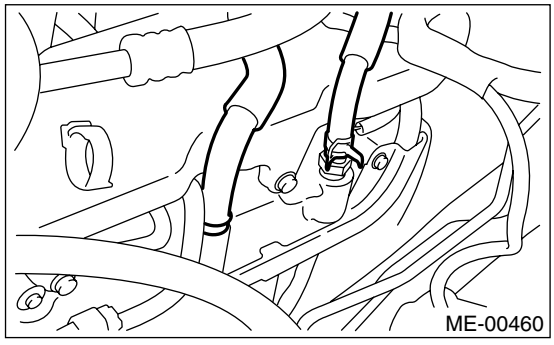
(4) Disconnect washer motor connectors.



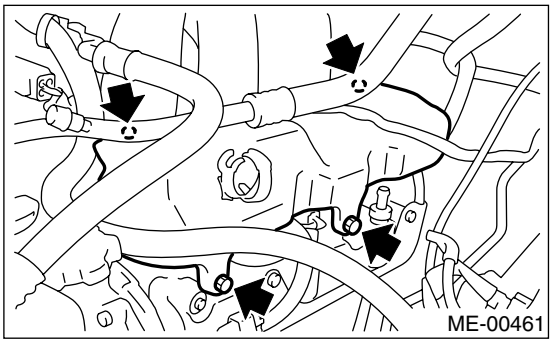
(5) Move washer tank upward.



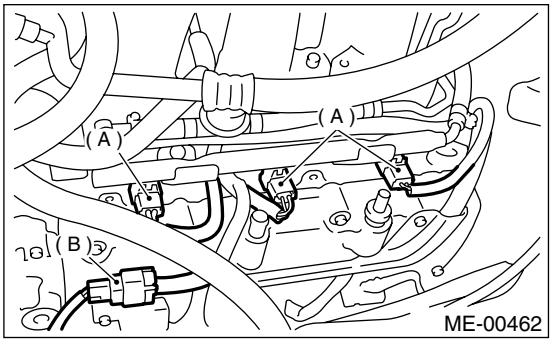
(6) Disconnect PCV hose and blow-by hose from rocker cover LH.



(7) Remove fuel pipe protector LH.

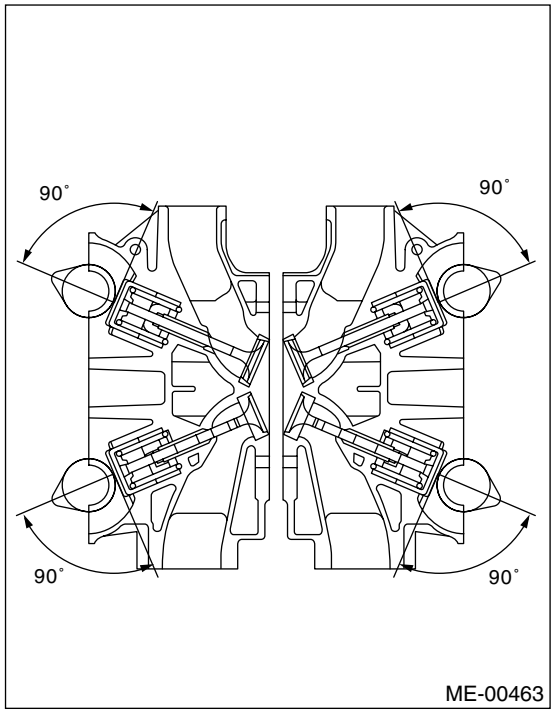


(8) Disconnect fuel injector connectors. (A)
(9) Disconnect front oxygen (A/F) sensor connector. (B)



(10)Remove ignition coils. <Ref. to IG(H6DO)-7, REMOVAL, Ignition Coil and Ignitor Assembly.>
(11)Remove rocker cover LH. <Ref. to ME(H6DO)-50, REMOVAL, Camshaft.>

9) Turn the crankshaft clockwise using the ST. Move the camshaft position so that the adjusting cam is perpendicular to the shim as shown in the figure.
ST 18252AA000 CRANKSHAFT SOCKET

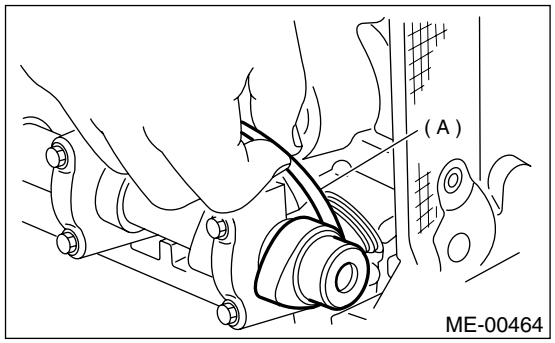


10) Measure intake valve and exhaust valve clearances by using thickness gauge (A).

CAUTION:
Insert the thickness gauge in as horizontal a direction as possible with respect to the shim.

Valve clearance:
Intake: $0.20^{+0.04}_{-0.06}$ mm ($0.0079^{+0.0016}_{-0.0024}$ in)
Exhaust: 0.25±0.05 mm (0.0098±0.0020 in)

NOTE:
If the measured value is not within specification, take notes of the value in order to adjust the valve clearance later on.



11) If necessary, adjust the valve clearance. <Ref. to ME(H6DO)-25, ADJUSTMENT, Valve Clearance.>

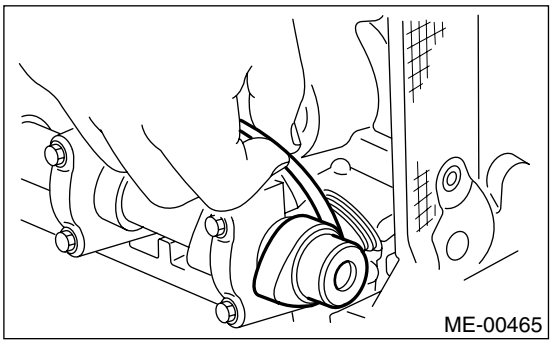
12) Further turn crankshaft pulley clockwise. Using the same procedure described previously, then measure valve clearances again.
13) After inspection, install the related parts in the reverse order of removal.

B: ADJUSTMENT

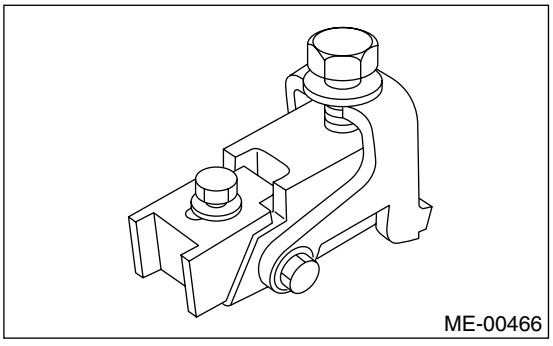
CAUTION:
Adjustment of valve clearance should be performed while engine is cold.

1) Measure all valve clearances. <Ref. to ME(H6DO)-22, INSPECTION, Valve Clearance.>

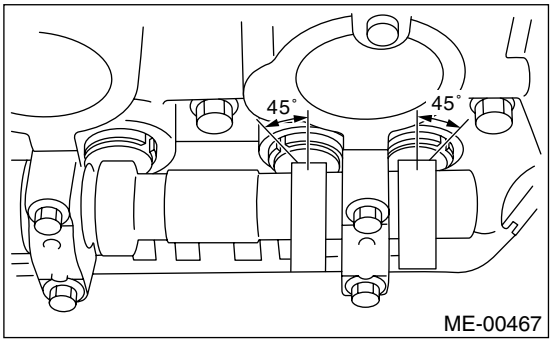
NOTE:
Record each valve clearance after it has been measured.



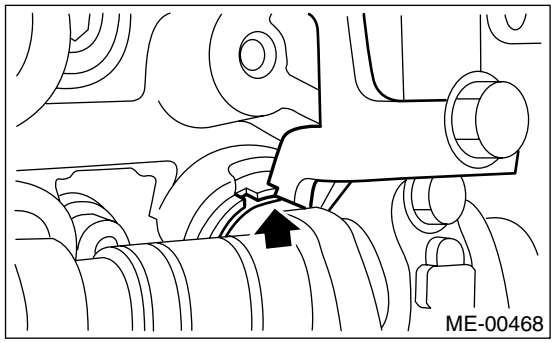
2) Remove shim from valve lifter.
(1) Prepare the ST.
ST 18329AA000 SHIM REPLACER
<Ref. to ME(H6DO)-14, PREPARATION TOOL, General Description.>



(2) Rotate the notch of the valve lifter outward by 45°.

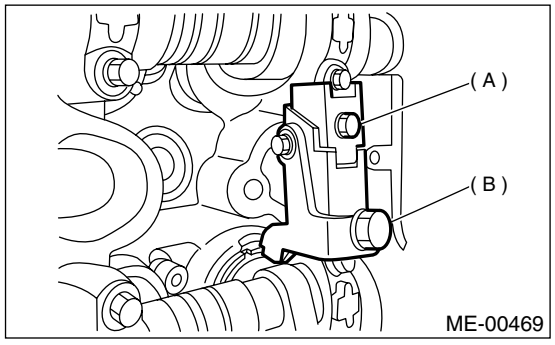


(3) Adjust SHIM REPLACER notch to valve lifter and set it.

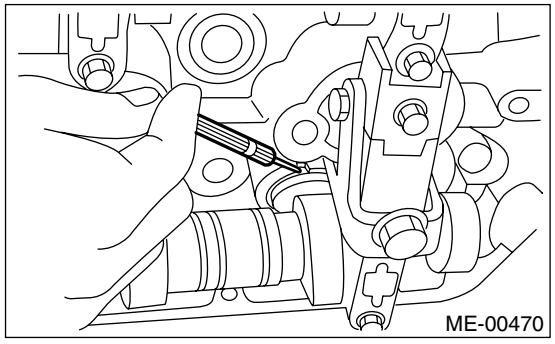


NOTE:
When setting, be careful SHIM REPLACER edge does not touch shim.

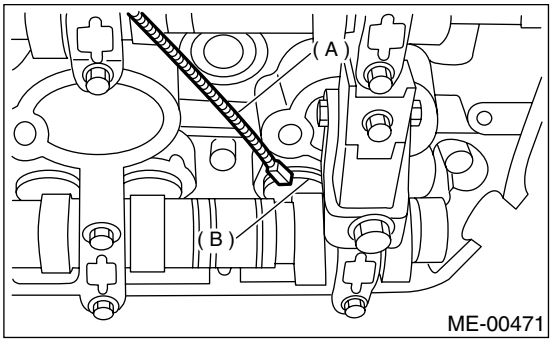
(4) Tighten bolt (A) and install it to the cylinder head.
(5) Tighten bolt (B) and insert the valve lifter.



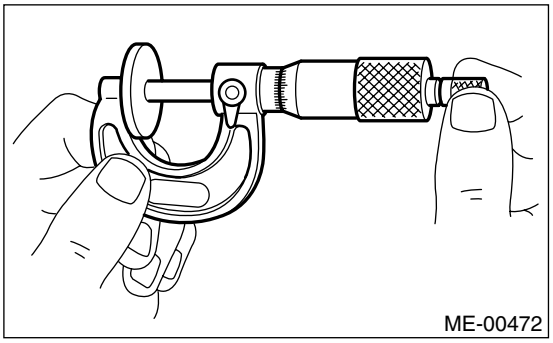
(6) Insert tweezers into the notch of the valve lifter, and take the shim out.



NOTE:
By using a magnet (A), the shim (B) can be taken out without dropping it.



3) Measure thickness of shim with micrometer.



4) Select a shim of suitable thickness using measured valve clearance and shim thickness, by referring to the following table.
5) Set suitable shim selected in step 4) to valve lifter.

Unit: mm
Intake valve: S = (V + T) − 0.20 Exhaust valve: S = (V + T) − 0.25
S: Shim thickness to be used V: Measured valve clearance T: Shim thickness required

Part No.	Thickness mm (in)
13218 AK010	2.00 (0.0787)
13218 AK020	2.02 (0.0795)
13218 AK030	2.04 (0.0803)
13218 AK040	2.06 (0.0811)
13218 AK050	2.08 (0.0819)
13218 AK060	2.10 (0.0827)
13218 AK070	2.12 (0.0835)
13218 AK080	2.14 (0.0843)
13218 AK090	2.16 (0.0850)
13218 AK100	2.18 (0.0858)
13218 AK110	2.20 (0.0866)
13218 AE710	2.22 (0.0874)
13218 AE720	2.23 (0.0878)
13218 AE730	2.24 (0.0882)
13218 AE740	2.25 (0.0886)
13218 AE750	2.26 (0.0890)
13218 AE760	2.27 (0.0894)
13218 AE770	2.28 (0.0898)
13218 AE780	2.29 (0.0902)
13218 AE790	2.30 (0.0906)
13218 AE800	2.31 (0.0909)
13218 AE810	2.32 (0.0913)
13218 AE820	2.33 (0.0917)
13218 AE830	2.34 (0.0921)
13218 AE840	2.35 (0.0925)
13218 AE850	2.36 (0.0929)
13218 AE860	2.37 (0.0933)
13218 AE870	2.38 (0.0937)
13218 AE880	2.39 (0.0941)
13218 AE890	2.40 (0.0945)
13218 AE900	2.41 (0.0949)
13218 AE910	2.42 (0.0953)
13218 AE920	2.43 (0.0957)
13218 AE930	2.44 (0.0961)
13218 AE940	2.45 (0.0965)
13218 AE950	2.46 (0.0969)
13218 AE960	2.47 (0.0972)
13218 AE970	2.48 (0.0976)
13218 AE980	2.49 (0.0980)
13218 AE990	2.50 (0.0984)
13218 AF000	2.51 (0.0988)
13218 AF010	2.52 (0.0992)
13218 AF020	2.53 (0.0996)
13218 AF030	2.54 (0.1000)
13218 AF040	2.55 (0.1004)
13218 AF050	2.56 (0.1008)
13218 AF060	2.57 (0.1012)
13218 AF070	2.58 (0.1016)
13218 AF090	2.60 (0.1024)
13218 AF100	2.61 (0.1028)
13218 AF110	2.62 (0.1031)
13218 AF120	2.63 (0.1035)
13218 AF130	2.64 (0.1039)
13218 AF140	2.65 (0.1043)
13218 AF150	2.66 (0.1047)
13218 AF160	2.67 (0.1051)
13218 AF170	2.68 (0.1055)
13218 AF180	2.69 (0.1059)
13218 AF190	2.70 (0.1063)
13218 AF200	2.71 (0.1067)
13218 AF210	2.72 (0.1071)
13218 AF220	2.73 (0.1075)
13218 AF230	2.74 (0.1079)
13218 AF240	2.75 (0.1083)
13218 AF250	2.76 (0.1087)
13218 AF260	2.77 (0.1091)

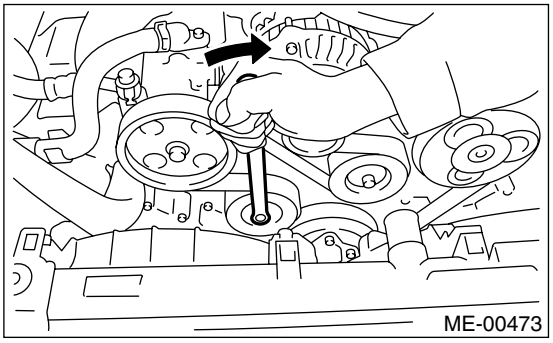
Part No.	Thickness mm (in)
13218 AF270	2.78 (0.1094)
13218 AF280	2.79 (0.1098)
13218 AF290	2.80 (0.1102)
13218 AF300	2.81 (0.1106)

6) Inspect all valves for clearance again at this stage. If the valve clearance is not correct, repeat the procedure over again from the first step.
7) After inspection, install the related parts in the reverse order of removal.

6. V-belt

A: REMOVAL

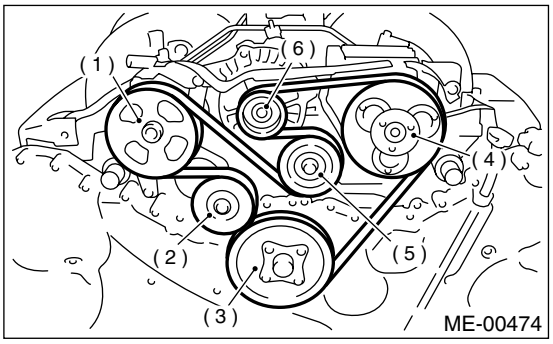
1) Fit the tool to the belt tensioner mounting bolt.
2) Turn the tool clockwise, and loosen the V-belt to remove.



3) Remove the V-belt cover.

B: INSTALLATION

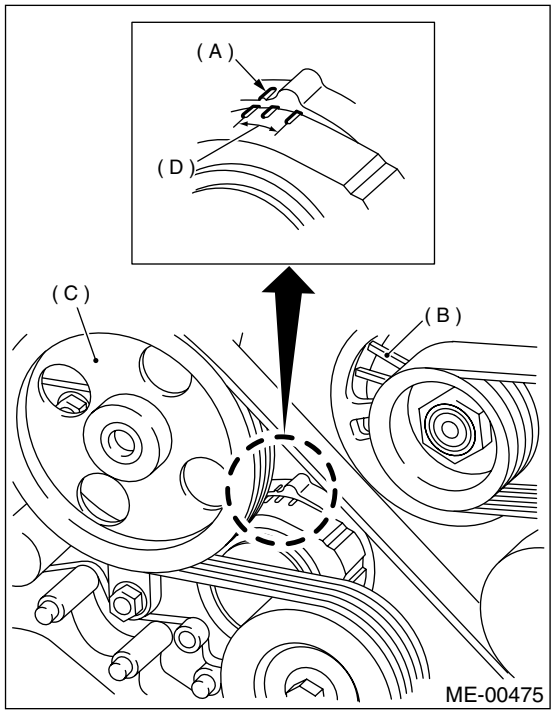
1) Install in the reverse order of removal.



(1) Power steering oil pump
(2) Belt tension adjuster
(3) Crankshaft pulley
(4) A/C compressor
(5) Belt idler
(6) Generator

C: INSPECTION

1) Replace belts, if cracks, fraying or wear is found.
2) Check that the V-belt automatic tensioner indicator (A) is within the range (D).

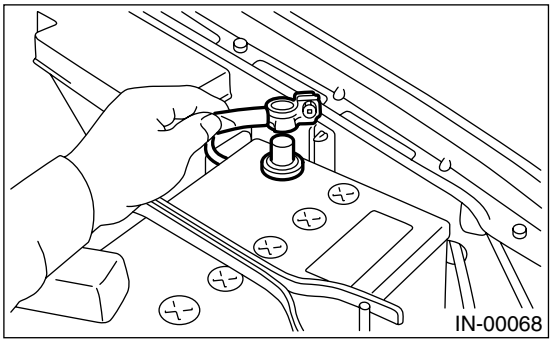


(A) Indicator
(B) Generator
(C) Power steering oil pump
(D) Service limit

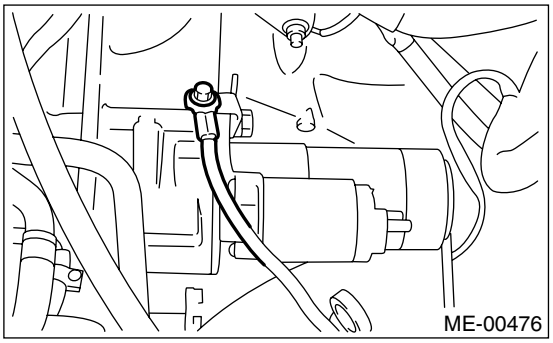
7. Engine Assembly

A: REMOVAL

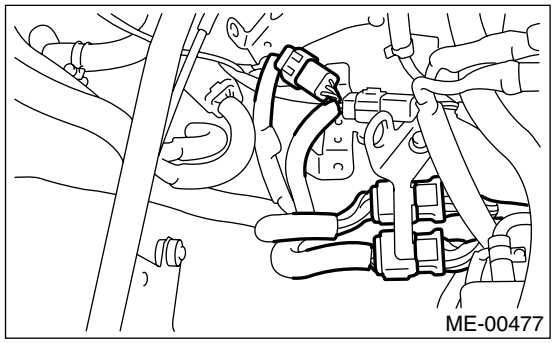
1) Set the vehicle on lift arms.
2) Open front hood fully and support with stay.
3) Raise rear seat, and turn floor mat up.
4) Release fuel pressure. <Ref. to FU(H6DO)-50, RELEASING OF FUEL PRESSURE, OPERATION, Fuel.>
5) Remove filler cap.
6) Disconnect battery ground cable.



7) Remove air intake duct, air cleaner case and air intake chamber.
<Ref. to IN(H6DO)-7, REMOVAL, Air Intake Duct.>, <Ref. to IN(H6DO)-6, REMOVAL, Air Intake Chamber.> and <Ref. to IN(H6DO)-5, REMOVAL, Air Cleaner.>
8) Lift up the vehicle.
9) Remove under cover.
10) Remove radiator from vehicle. <Ref. to CO(H6DO)-23, REMOVAL, Radiator.>
11) Remove V-belt. <Ref. to ME(H6DO)-28, REMOVAL, V-belt.>
12) Disconnect A/C pressure hoses from A/C compressor. <Ref. to AC-38, REMOVAL, Flexible Hose.>
13) Disconnect the following connectors and cables.
(1) Engine ground terminal



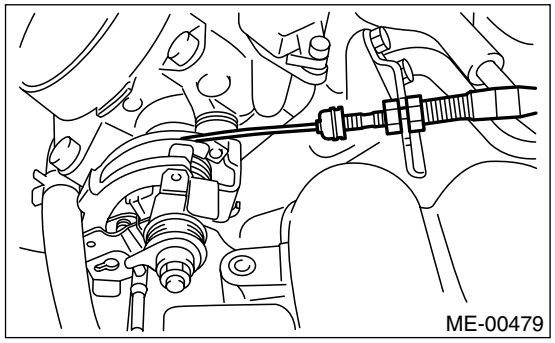
(2) Engine harness connectors



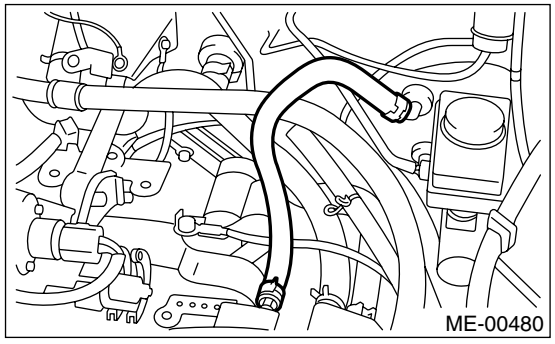
(3) Generator connector, terminal and A/C compressor connector

(A) Generator connector and terminal
(B) A/C compressor connector

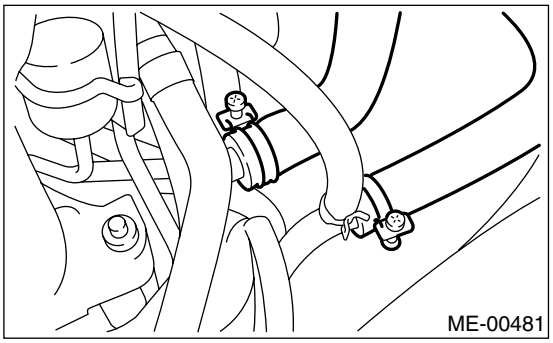
(4) Accelerator cable



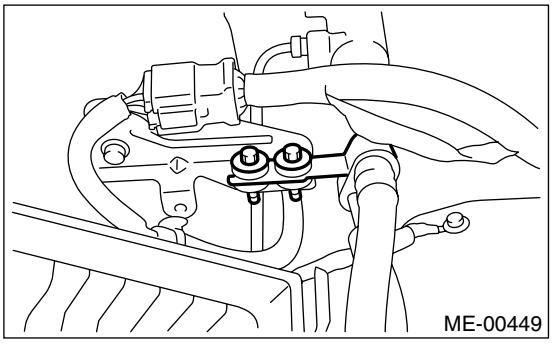
14) Disconnect the following hoses.
(1) Brake booster vacuum hose



(2) Heater inlet outlet hose

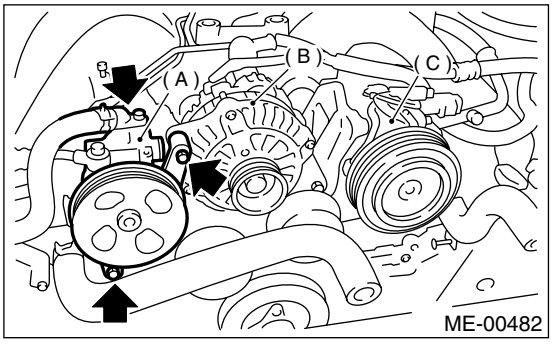


15) Remove power steering pump from bracket.
(1) Remove pipe with bracket.



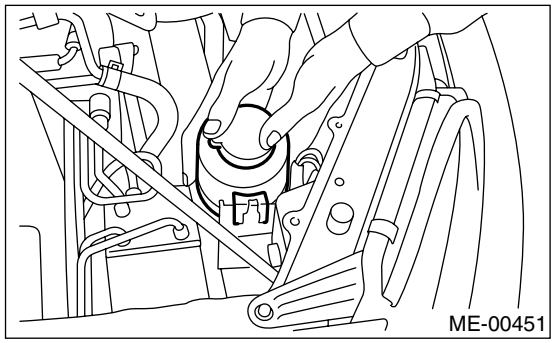
(2) Remove bolts which install power steering pump bracket.

CAUTION:
Do not separate the hose and the pipe from the pump body.

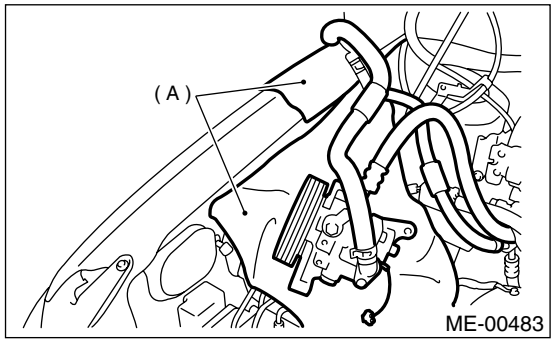


(A) Power steering pump
(B) Generator
(C) A/C compressor

(3) Remove power steering tank from the bracket by pulling it upward.

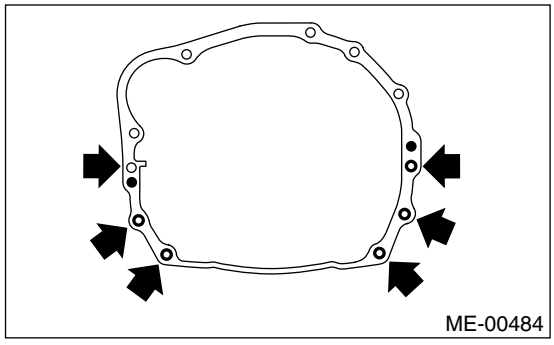


(4) Place power steering pump on the right side wheel apron.

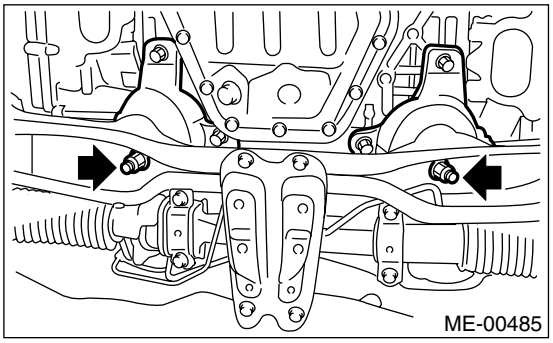


(A) Cloth

16) Remove front exhaust pipe.
<Ref. to EX(H6DO)-5, REMOVAL, Front Exhaust Pipe.>
17) Remove nuts which hold lower side of transmission to engine.

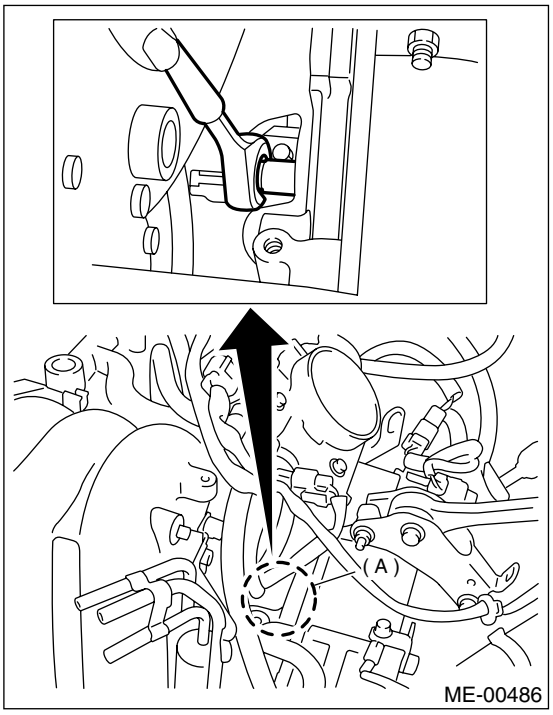


18) Remove nuts which install front cushion rubber onto front crossmember.

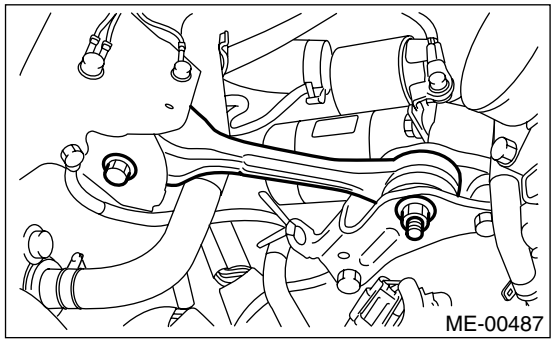


19) Separate torque converter clutch from drive plate.
(1) Lower the vehicle.
(2) Remove service hole plug (A).
(3) Remove bolts which hold torque converter clutch to drive plate.
(4) Remove other bolts while rotating the engine using ST.

ST 499977100 CRANK PULLEY WRENCH

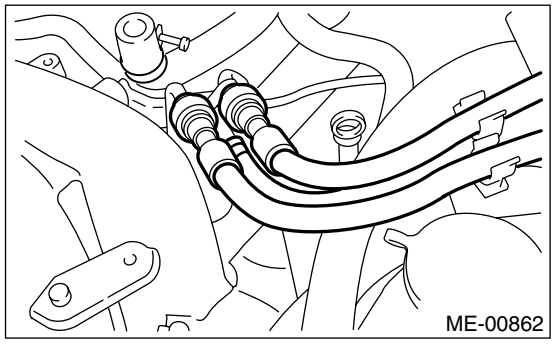


20) Remove pitching stopper.

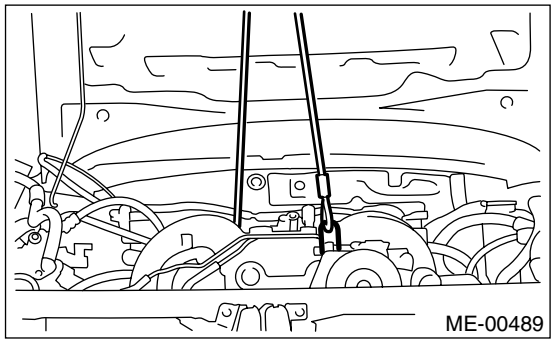


21) Disconnect fuel delivery hose, return hose and evaporation hose.
<Ref. to FU(H6DO)-75, REMOVAL, Fuel Delivery, Return and Evaporation Lines.>

CAUTION:
• Disconnect hose with its end wrapped with cloth to prevent fuel from splashing.
• Catch fuel from hose into container.

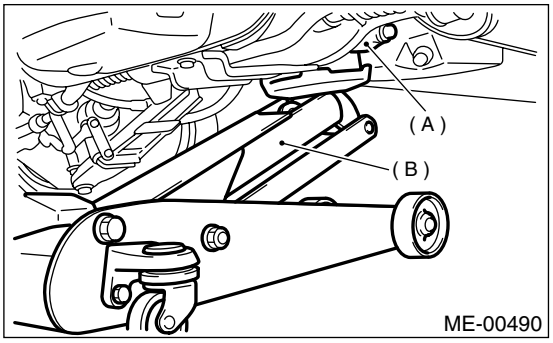


22) Support engine with a lifting device and wire ropes.



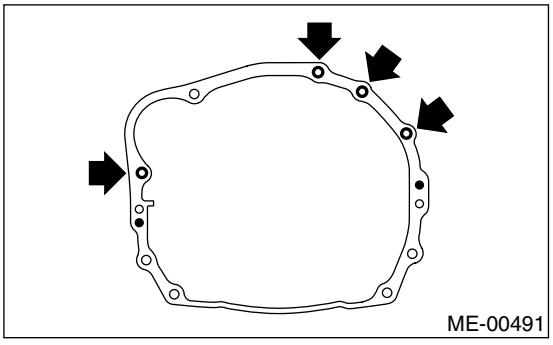
23) Support transmission with a garage jack.

CAUTION:
Before moving engine away from transmission, check to be sure no work has been overlooked. Doing this is very important in order to facilitate re-installation and because transmission lowers under its own weight.

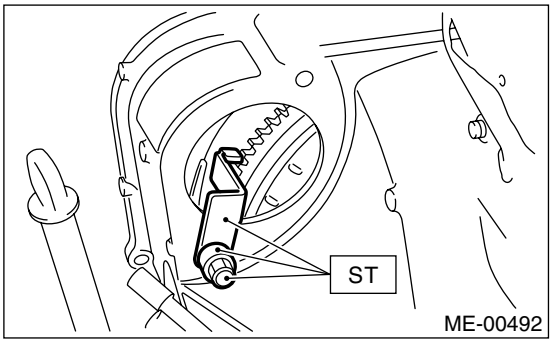


(A) Transmission
(B) Garage jack

24) Separation of engine and transmission.
(1) Remove starter. <Ref. to SC(H6DO)-6, REMOVAL, Starter.>
(2) Remove bolts which hold upper side of transmission to engine.

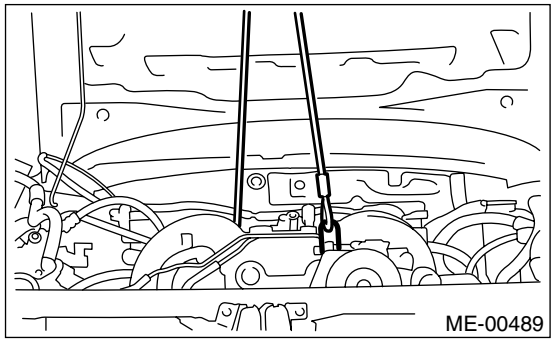


25) Install ST to torque converter clutch case.
ST 498277200 STOPPER SET



26) Remove engine from vehicle.
(1) Slightly raise engine.
(2) Raise transmission with garage jack.
(3) Move engine horizontally until main shaft is withdrawn from clutch cover.
(4) Slowly move engine away from engine compartment.

CAUTION:
Be careful not to damage adjacent parts or body panels with crank pulley, oil level gauge, etc.



27) Remove front cushion rubbers.

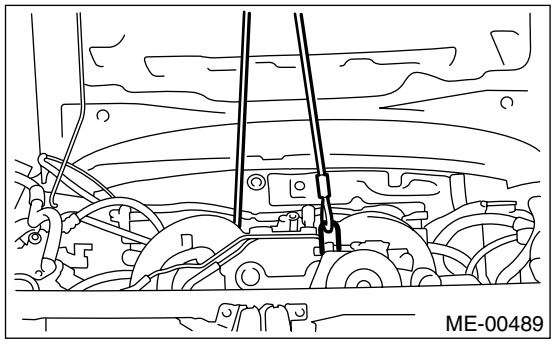
B: INSTALLATION

1) Install front cushion rubbers.

Tightening torque:
34 N·m (3.5 kgf-m, 25.3 ft-lb)

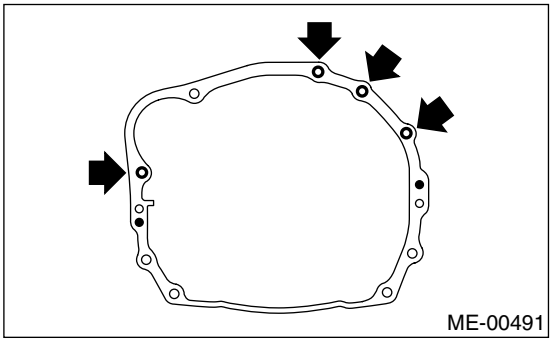
2) Position engine in engine compartment and align it with transmission.

CAUTION:
Be careful not to damage adjacent parts or body panels with crank pulley, oil level gauge, etc.

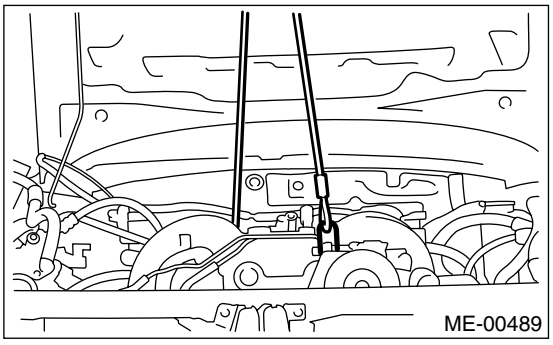


3) Tighten bolts which hold upper side of transmission to engine.

Tightening torque:
50 N·m (5.1 kgf-m, 36.9 ft-lb)

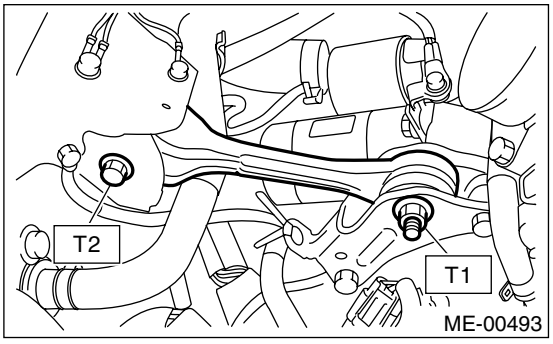


4) Remove lifting device and wire ropes.



5) Remove garage jack.
6) Install pitching stopper.

Tightening torque:
T1: 49 N·m (5.0 kgf-m, 36.2 ft-lb)
T2: 57 N·m (5.8 kgf-m, 42 ft-lb)



7) Remove ST from torque converter clutch case.

NOTE:
Be careful not to drop the ST into the torque converter clutch case when removing ST.

ST 498277200 STOPPER SET

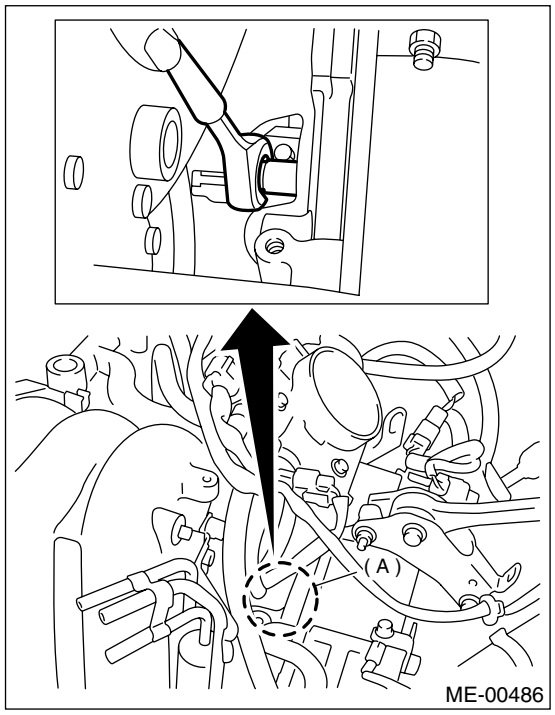
8) Install starter. <Ref. to SC(H6DO)-6, INSTALLATION, Starter.>

9) Install torque converter clutch onto drive plate.
(1) Tighten bolts which hold torque converter clutch to drive plate.
(2) Tighten other bolts while rotating the engine by using ST.

CAUTION:
Be careful not to drop bolts into torque converter clutch housing.

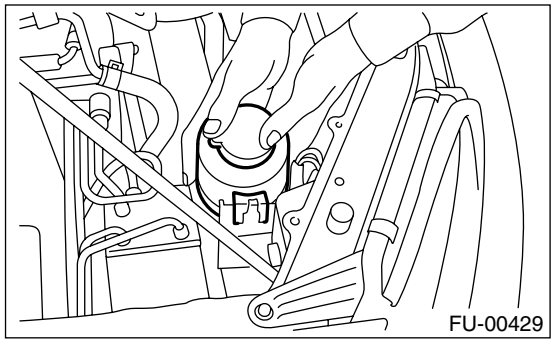
ST 499977100 CRANK PULLEY WRENCH

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



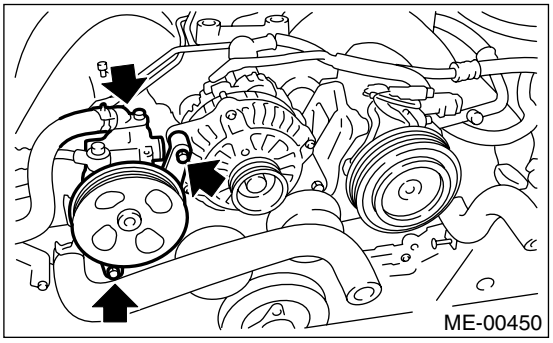
(3) Clog plug (A) onto service hole.

10) Install power steering pump on bracket.
(1) Install power steering tank on bracket.

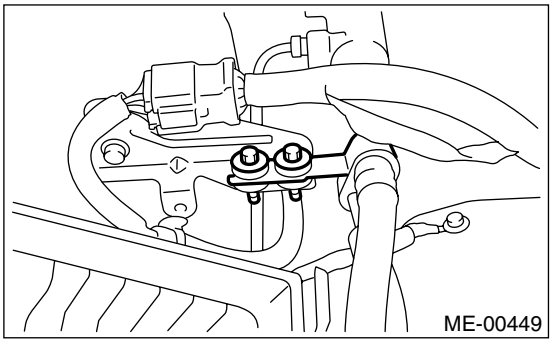


(2) Install power steering pump on bracket, and tighten bolts.

Tightening torque:
20.1 N·m (2.05 kgf-m, 14.8 ft-lb)

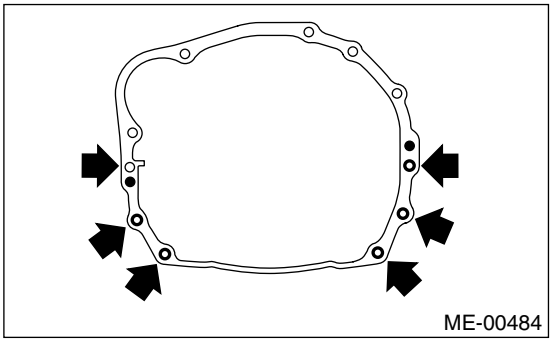


(3) Tighten bolt which installs power steering pipe bracket.



11) Tighten nuts which hold lower side of transmission to engine.

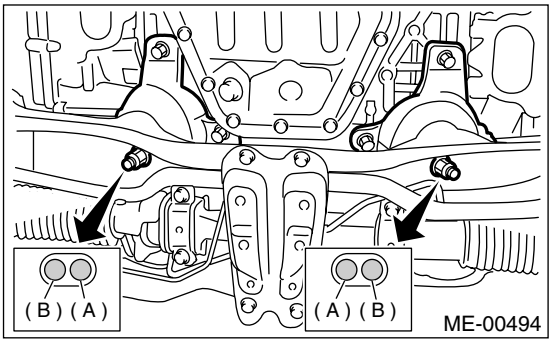
Tightening torque:
50 N·m (5.1 kgf-m, 36.9 ft-lb)



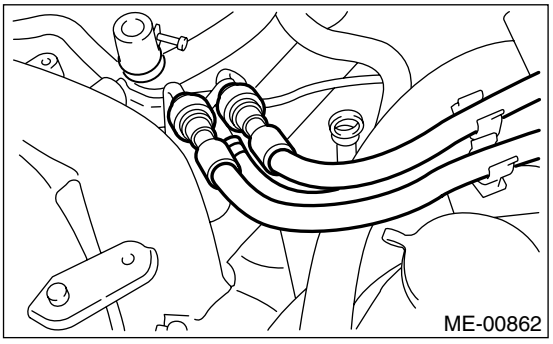
12) Tighten nuts which install front cushion rubber onto crossmember.

Tightening torque:
74 N·m (7.5 kgf-m, 54 ft-lb)

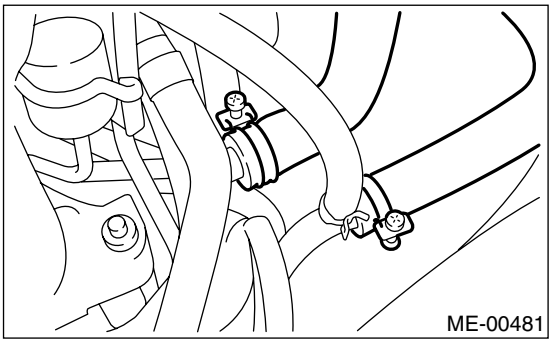
CAUTION:
Make sure the front cushion rubber mounting bolts (A) and locator (B) are securely installed.



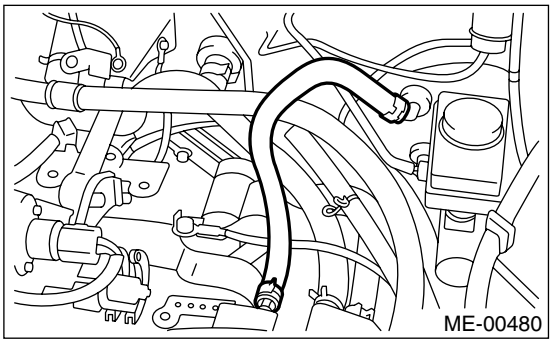
13) Install front exhaust pipe.
<Ref. to EX(H6DO)-6, INSTALLATION, Front Exhaust Pipe.>
14) Connect the following hoses.
(1) Fuel delivery hose, return hose and evaporation hose.
<Ref. to EX(H6DO)-6, INSTALLATION, Front Exhaust Pipe.>



(2) Heater inlet and outlet hoses

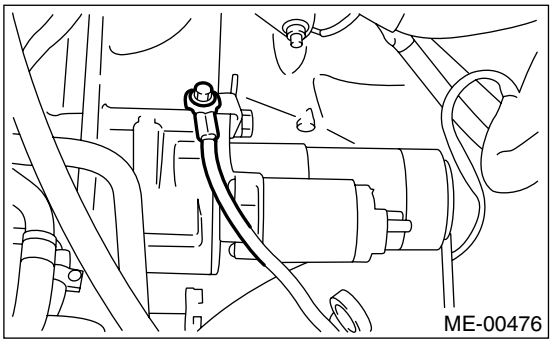


(3) Brake booster vacuum hose

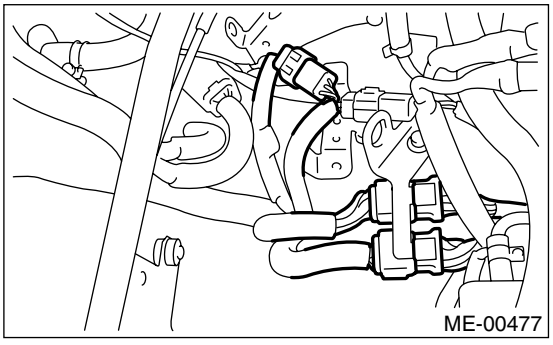


15) Connect the following connectors.
(1) Engine ground terminals

Tightening torque:
14 N·m (1.4 kgf-m, 10.1 ft-lb)

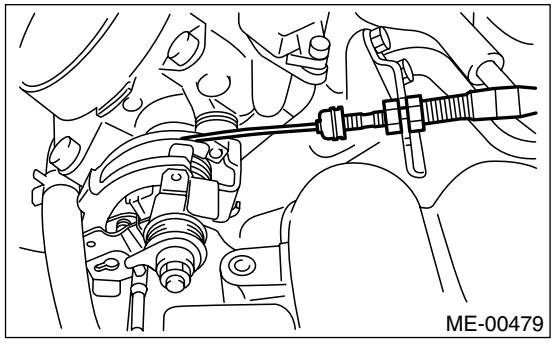


(2) Engine harness connectors



(3) Alternator connector and terminal (A)
(4) A/C compressor connectors (B)

16) Connect the following cables.
(1) Accelerator cable



CAUTION:
After connecting each cable, adjust them.

17) Install A/C pressure hoses.
<Ref. to AC-38, INSTALLATION, Flexible Hose.>
18) Install V-belt. <Ref. to ME(H6DO)-28, INSTALLATION, V-belt.>
19) Install radiator to vehicle. <Ref. to CO(H6DO)-24, INSTALLATION, Radiator.>
20) Install air intake duct, cleaner case and air intake chamber.
<Ref. to IN(H6DO)-2, General Description.>
21) Install under cover.
22) Install battery in the vehicle, and connect cables.
23) Fill coolant.
<Ref. to CO(H6DO)-18, FILLING OF ENGINE COOLANT, REPLACEMENT, Engine Coolant.>
24) Check ATF level and correct if necessary.
<Ref. to 4AT-31, Automatic Transmission Fluid.>
25) Charge A/C system with refrigerant.
<Ref. to AC-21, Refrigerant Charging Procedure.>
26) Remove front hood stay, and close front hood.
27) Take off the vehicle from lift arms.

C: INSPECTION

1) Make sure pipes and hoses are installed correctly.
2) Make sure the engine coolant and ATF are at specified levels.

8. Engine Mounting

A: REMOVAL

1) Remove engine assembly. <Ref. to ME(H6DO)-29, REMOVAL, Engine Assembly.>
2) Remove engine mounting from engine assembly.

B: INSTALLATION

Install in the reverse order of removal.

Tightening torque:
Engine mounting;
34 N·m (3.5 kgf-m, 25.3 ft-lb)

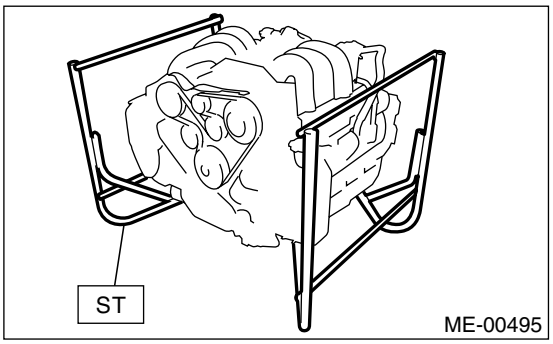
C: INSPECTION

Make sure there are no cracks or other damage.

9. Preparation for Overhaul

A: REMOVAL

1) Remove engine from body. <Ref. to ME(H6DO)-29, REMOVAL, Engine Assembly.>
2) Drain engine oil. <Ref. to LU(H6DO)-10, REPLACEMENT, Engine Oil.>
3) After removing engine from body, install ST onto engine.
ST 18232AA000 ENGINE STAND

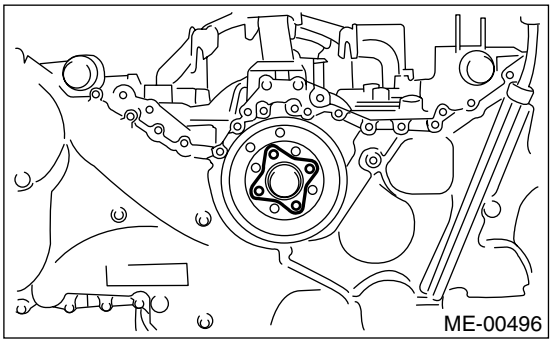


4) Remove sensors, pipes, and hoses installed on engine before starting overhaul.
(1) Remove intake manifold. <Ref. to FU(H6DO)-17, REMOVAL, Intake Manifold.>
(2) Remove generator. <Ref. to SC(H6DO)-14, REMOVAL, Generator.>
(3) Remove A/C compressor. <Ref. to AC-32, REMOVAL, Compressor.>
(4) Remove EGR pipe. <Ref. to EC(H6DO)-10, REMOVAL, EGR Valve.>
(5) Remove water pipe and hoses.
(6) Remove engine harness.
(7) Remove spark plugs. <Ref. to IG(H6DO)-4, REMOVAL, Spark Plug.>
(8) Remove camshaft position sensor. <Ref. to FU(H6DO)-31, REMOVAL, Camshaft Position Sensor.>
(9) Remove crankshaft position sensor. <Ref. to FU(H6DO)-30, REMOVAL, Crankshaft Position Sensor.>
(10)Remove knock sensor. <Ref. to FU(H6DO)-32, REMOVAL, Knock Sensor.>
(11)Remove engine coolant temperature sensor. <Ref. to FU(H6DO)-29, REMOVAL, Engine Coolant Temperature Sensor.>
(12)Remove oil pressure switch. <Ref. to LU(H6DO)-17, REMOVAL, Oil Pressure Switch.>
(13)Remove oil filter. <Ref. to LU(H6DO)-18, REMOVAL, Engine Oil Filter.>
(14)Remove oil cooler. <Ref. to LU(H6DO)-19, REMOVAL, Oil Cooler.>

10.Crankshaft Pulley

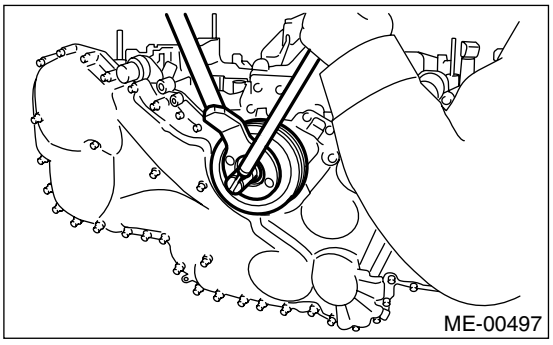
A: REMOVAL

1) Remove crankshaft pulley cover.



2) Remove crankshaft pulley bolt. To lock crankshaft, use ST.

ST 499977100 CRANKSHAFT PULLEY WRENCH



3) Remove crankshaft pulley.

B: INSTALLATION

1) Install crankshaft pulley.

2) Install crankshaft pulley bolt. To lock crankshaft, use ST.

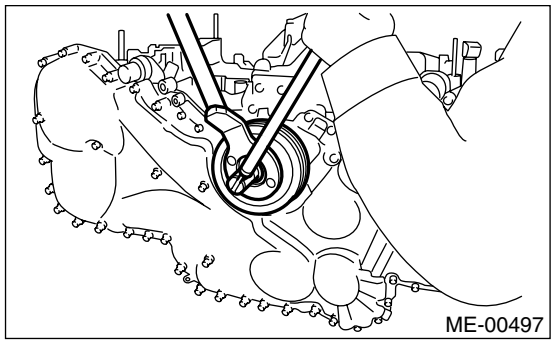
ST 499977100 CRANKSHAFT PULLEY WRENCH

(1) Clean the crankshaft pulley thread using an air gun.

(2) Apply engine oil to the crankshaft pulley bolt seat and thread.

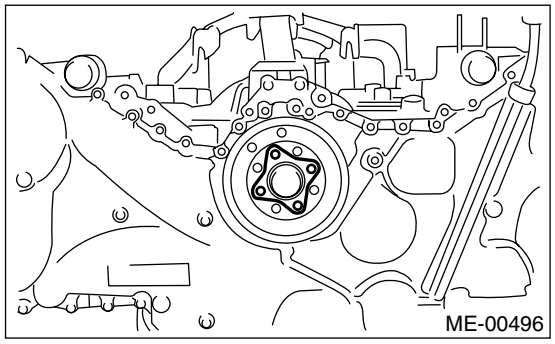
(3) Tighten the crankshaft pulley bolts.

Tightening torque:
178 N·m (18.1 kgf-m, 131 ft-lb)



3) Install the crankshaft pulley cover.

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



C: INSPECTION

1) Check crankshaft pulley cover for oil leaks and bleeding.

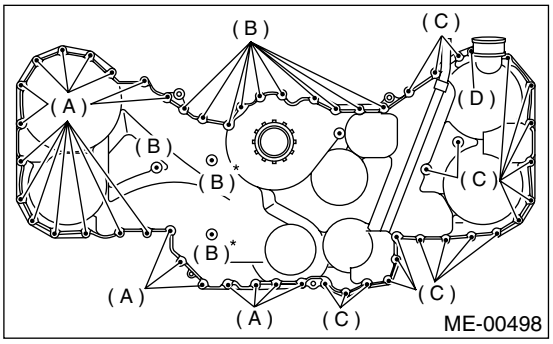
2) Check crankshaft pulley for looseness.

11.Front Chain Cover

A: REMOVAL

1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover.

NOTE:
There are four different types of chain cover mounting bolts. Sort them into separate containers to avoid confusion at installation.



Bolt dimension:

(A) 6 × 45
(B) 6 × 16
(C) 6 × 30
(D) 6 × 50

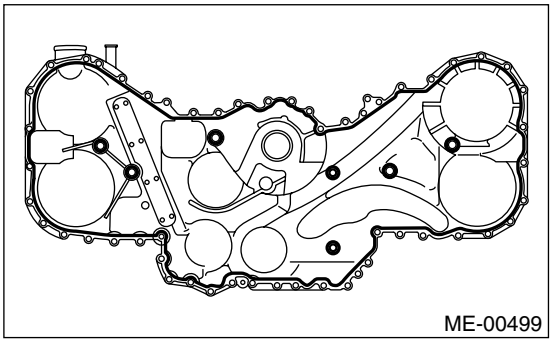
*: Sealing washer

B: INSTALLATION

1) Remove old fluid gasket on the matching surface, and degrease it.
2) Apply fluid gasket to the mating surface of front chain cover.

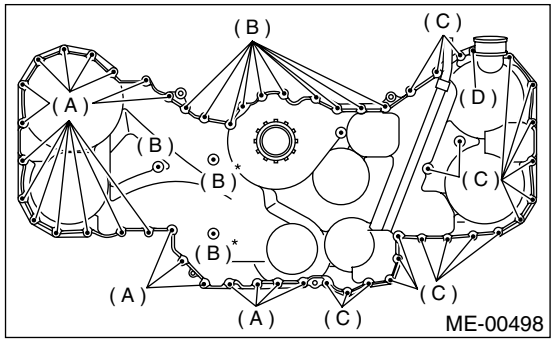
Fluid gasket:
THREE BOND 1280B

Fluid gasket application diameter:
2.5±0.5 mm (0.098±0.020 in)



3) Install front chain cover. Temporarily tighten the bolts.

CAUTION:
Do not confuse the mounting positions of the bolts.



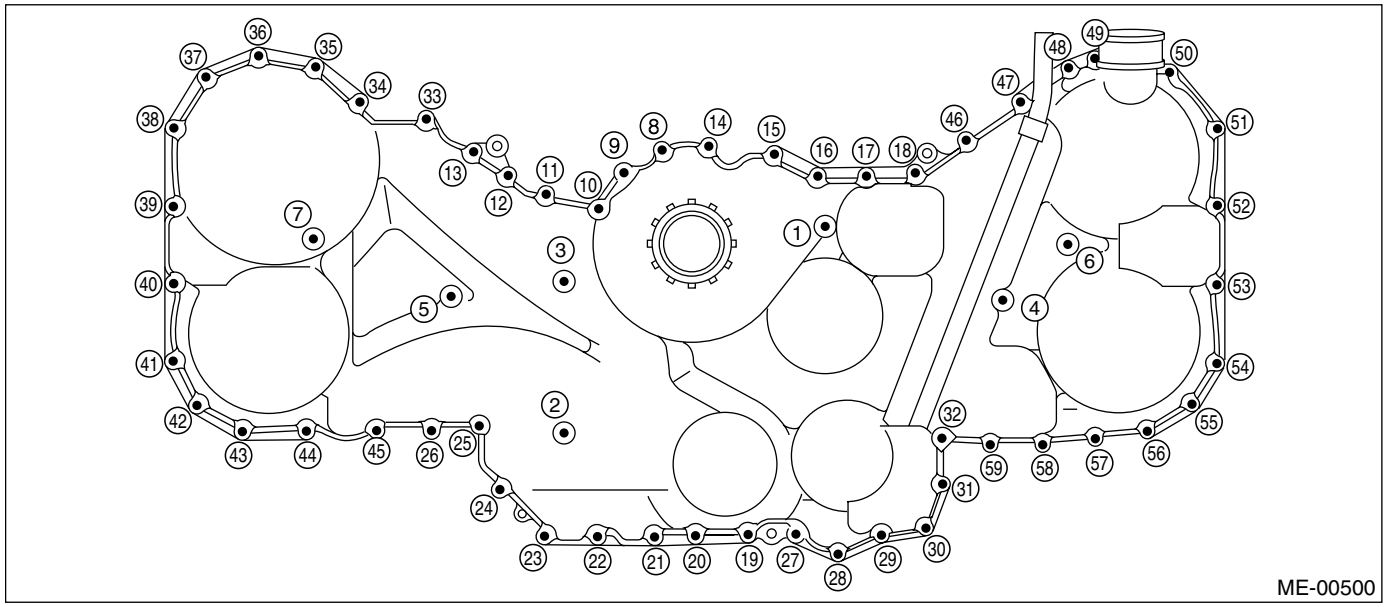
Bolt dimension:

(A) 6 × 45
(B) 6 × 16
(C) 6 × 30
(D) 6 × 50

*: Sealing washer

4) Tighten the bolts in the numerical sequence shown in figure.

Tightening torque:
6.6 N·m (0.67 kgf-m, 4.8 ft-lb)



5) Install crankshaft pulley. <Ref. to ME(H6DO)-38, INSTALLATION, Crankshaft Pulley.>

C: INSPECTION

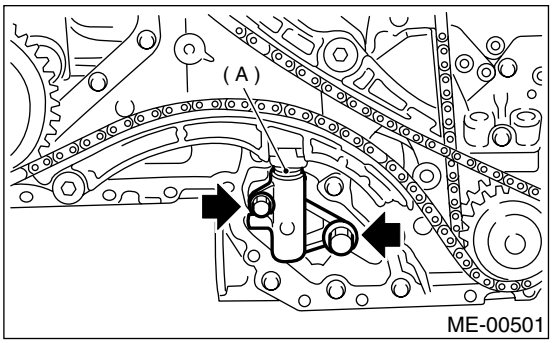
Check the cover surface for flaws and dents.
Check the cover mating surface and the mounting point of crankshaft pulley for oil leaks.

12.Timing Chain Assembly

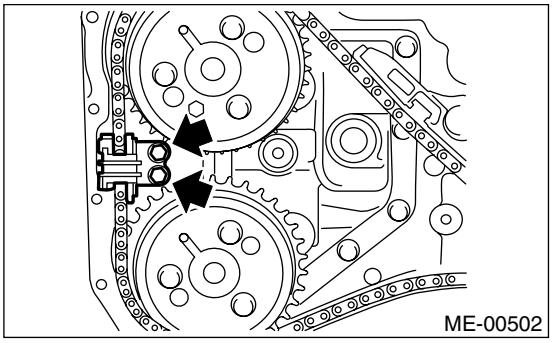
A: REMOVAL

1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover. <Ref. to ME(H6DO)-39, REMOVAL, Front Chain Cover.>
3) Remove chain tensioner (RH).

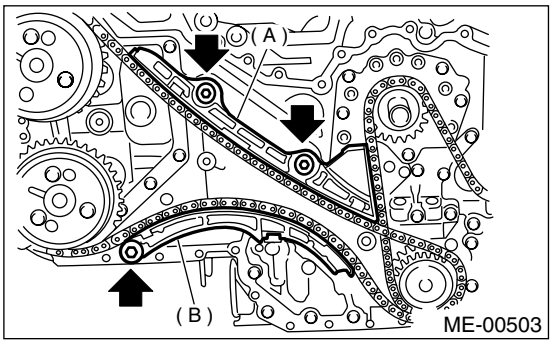
NOTE:
Make sure plunger (A) does not come out.



4) Remove chain guide. (Right-hand between cams)



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

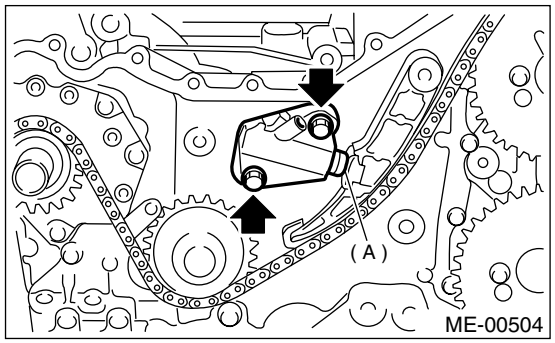


(A) Chain guide (RH)
(B) Chain tensioner lever (RH)

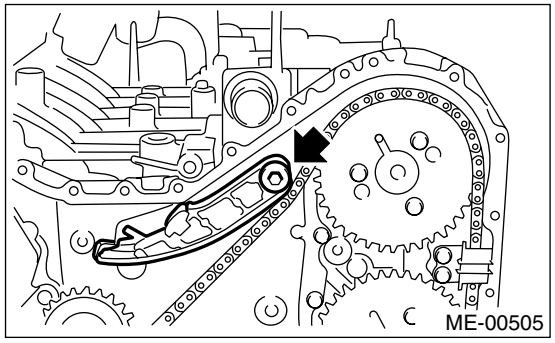
7) Remove timing chain (RH).

8) Remove chain tensioner (LH).

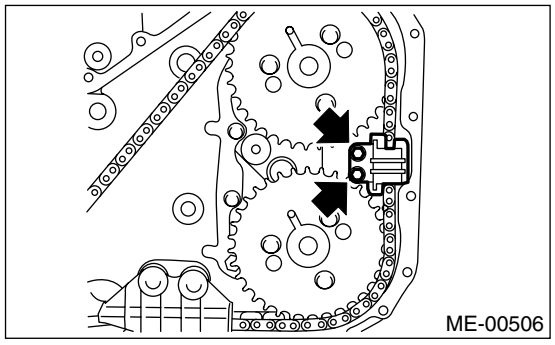
NOTE:
Make sure plunger (A) does not come out.



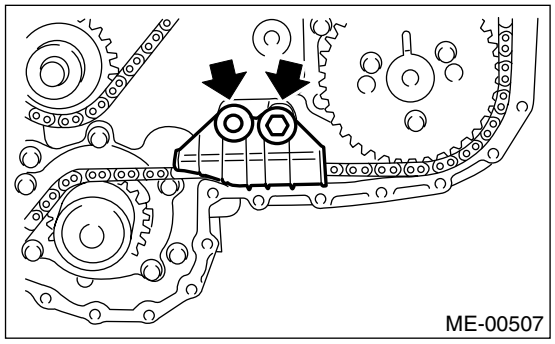
9) Remove chain tensioner lever (LH).



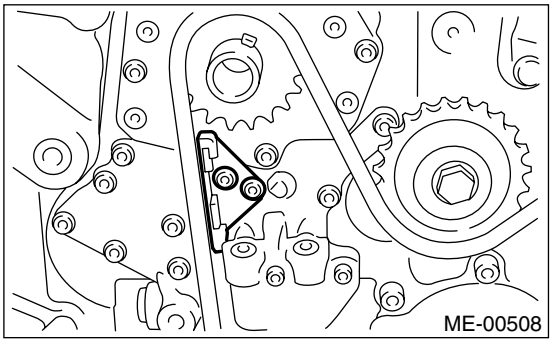
Remove chain guide. (Left-hand between cams)



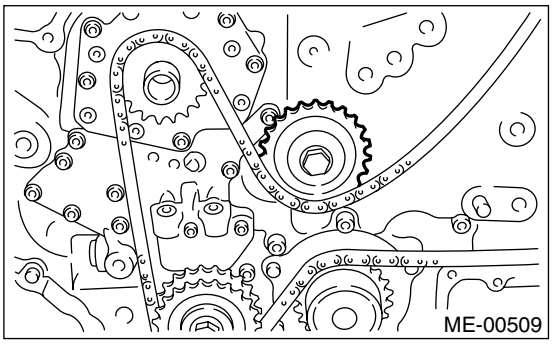
10) Remove chain guide (LH).



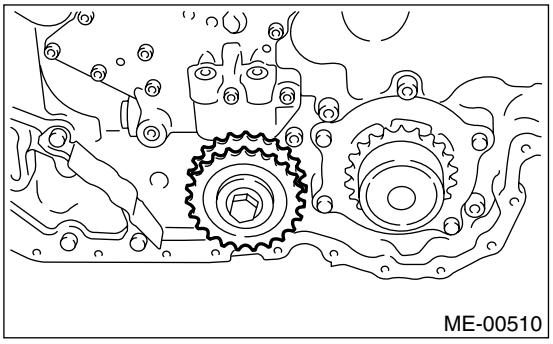
11) Remove chain guide. (Center)



12) Remove idler sprocket. (Upper)



13) Remove timing chain (LH).
14) Remove idler sprocket. (Lower)

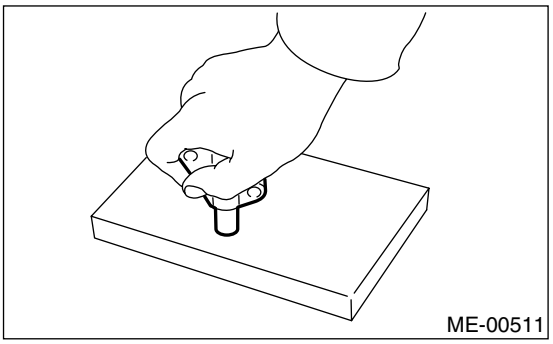


B: INSTALLATION

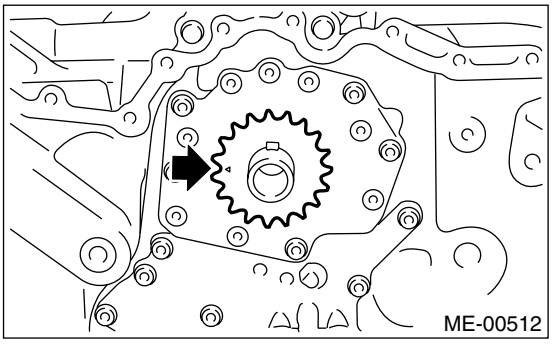
CAUTION:
• During installation, be careful to prevent foreign objects from attaching to or mixing with assembled components.
• Apply engine oil to chain guide, chain tensioner lever, and idler sprocket during installation.

1) Preparation for installation of chain tensioner.
   (1) Put the screw, spring, pin and tension rod into the tensioner body.
   (2) While pressing tensioner onto rubber mat, twist it left and right to shorten tension rod. Then set a thin pin into the holes between tension rod and tensioner body to hold it.

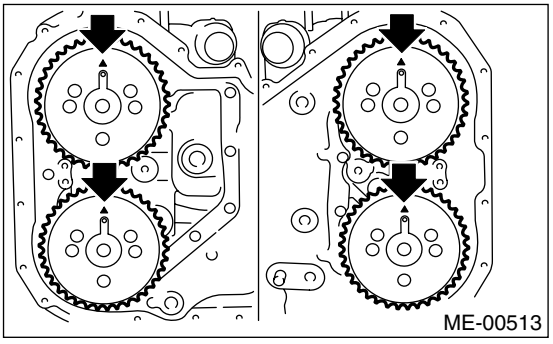
NOTE:
Carry out the work on rubber mat or other nonslip material.



2) Using ST, align “top mark” on crankshaft sprocket at 9 o'clock position as shown in the figure.
ST 18252AA000 CRANKSHAFT SOCKET

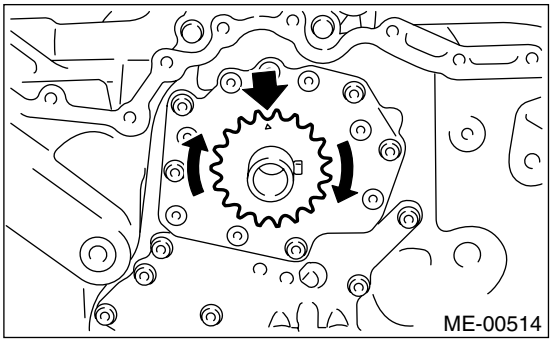


3) Using ST, align four key grooves on camshaft sprocket at 12 o'clock position as shown in the figure.
ST 18231AA000 CAMSHAFT SPROCKET WRENCH



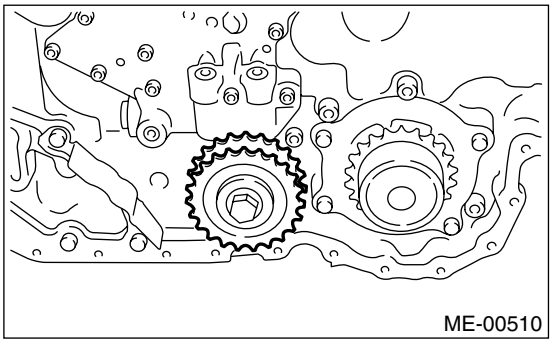
4) Rotate crankshaft sprocket clockwise to align "top mark" at 12 o'clock position as shown in the figure. (Piston # 1 is at TDC.)

CAUTION:
Do not rotate crankshaft and camshaft sprockets until timing chain is completely routed.

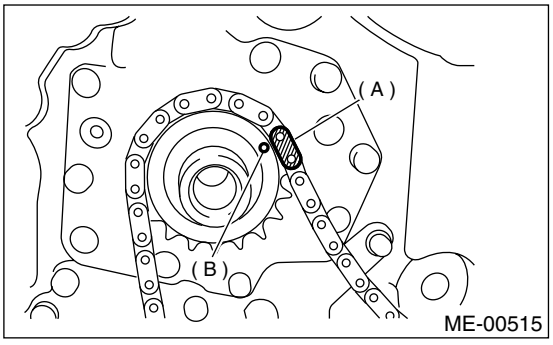


5) Install the idler sprocket. (Lower)

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



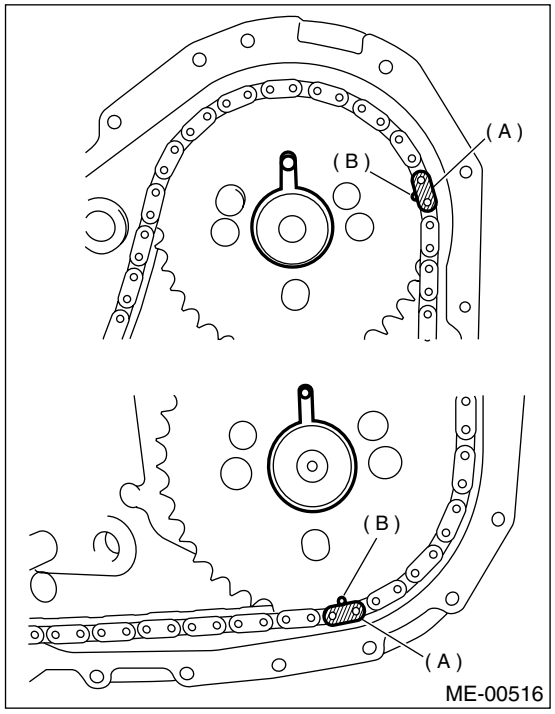
6) Install timing chain LH.
(1) Align the timing mark (B) on crankshaft sprocket with the matching mark (A) on timing chain LH.



(A) Gold
(B) Mark

(2) Route timing chain LH on idler sprocket (Lower), water pump, exhaust cam sprocket, and intake cam sprocket in order.

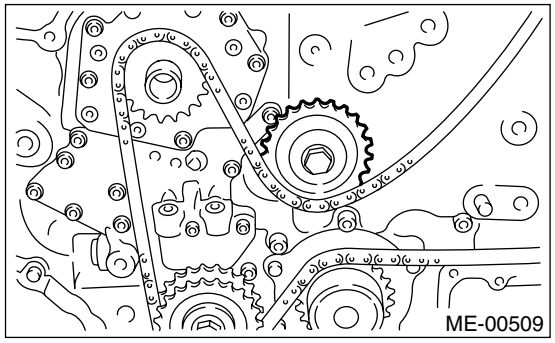
CAUTION:
Make sure that matching marks on the timing chain (A) and camshaft sprocket (B) are aligned the same way as the one on crankshaft sprocket.



(A) Dark blue
(B) Mark

(3) Install chain idler. (Upper)

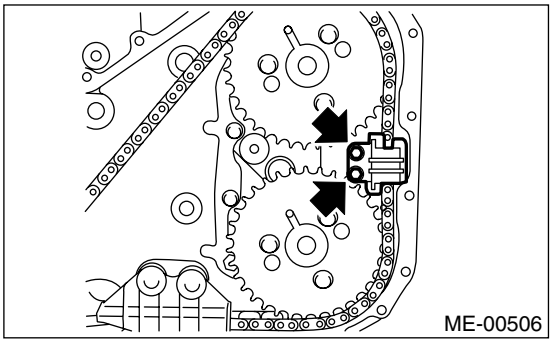
Tightening torque:
69 N·m (7.0 kgf-m, 50.6 ft-lb)



(4) Install chain guide. (Left-hand between cams)

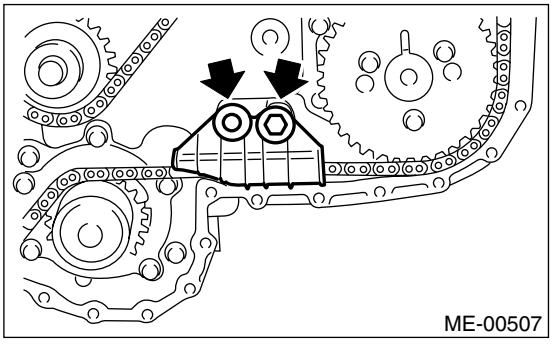
Tightening torque:
6.3N·m (0.64 kgf-m, 4.6 ft-lb)

NOTE:
Replace mounting bolt with a new one.



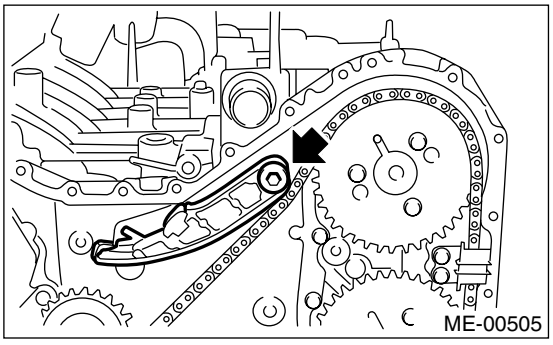
(5) Install chain guide (LH).

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



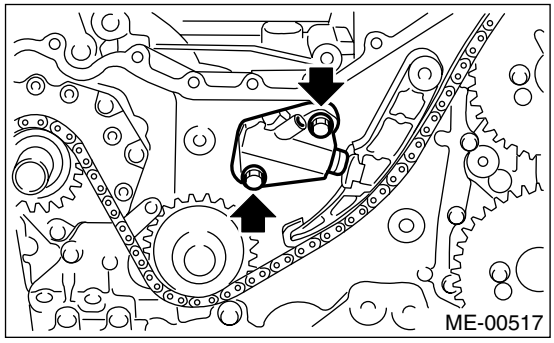
(6) Install chain tensioner lever LH.

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

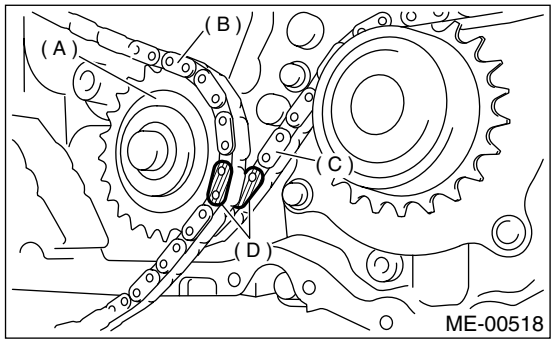


(7) Install chain tensioner LH.

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



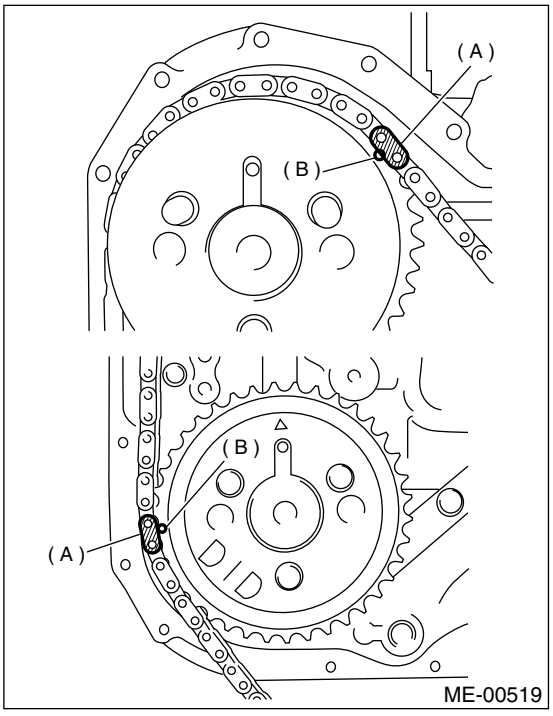
7) Install timing chain RH.
(1) On idler sprocket (Lower) , align matching marks on timing chains LH and RH.



(A) Lower idler sprocket
(B) Timing chain RH
(C) Timing chain LH
(D) Dark gray

(2) Route timing chain RH on intake cam sprocket and then exhaust cam sprocket.

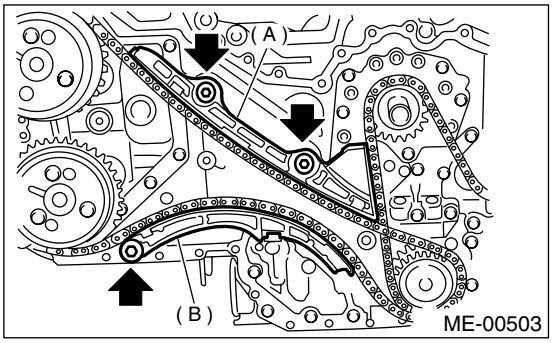
CAUTION:
Make sure that matching marks on the timing chain (A) and camshaft sprocket (B) are aligned the same way as the one on crankshaft sprocket.



(A) Gold
(B) Mark

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

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

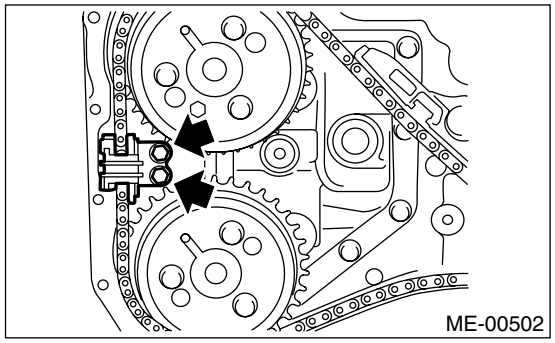


(A) Chain guide (RH)
(B) Chain tensioner lever (RH)

(5) Install timing chain guide RH No. 1.

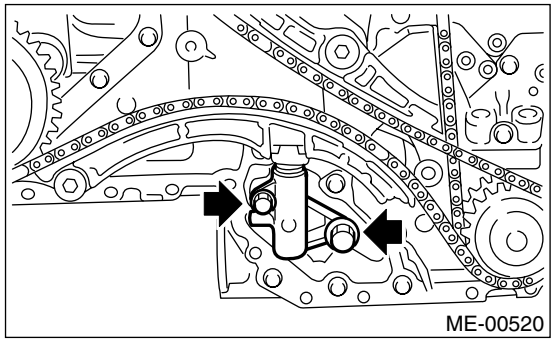
Tightening torque:
6.3 N·m (0.64 kgf-m, 4.6 ft-lb)

NOTE:
Replace mounting bolt with a new one.



(6) Install the chain tensioner (RH).

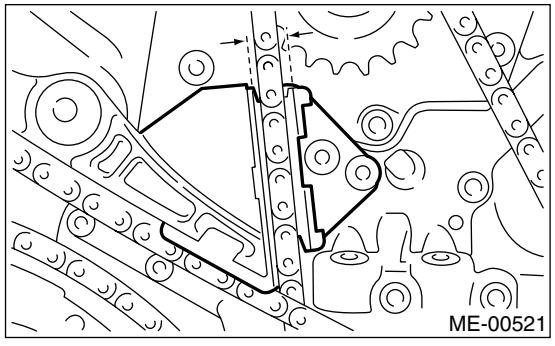
Tightening torque:
16 N·m (1.6 kgf-m, 11.6 ft-lb)



(7) Adjust the clearance between chain guide (RH) and chain guide (Center) to the range between 8.4 mm (0.331 in) to 8.6 mm (0.339 in). And install chain guide (Center).

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

NOTE:
Replace mounting bolt with a new one.



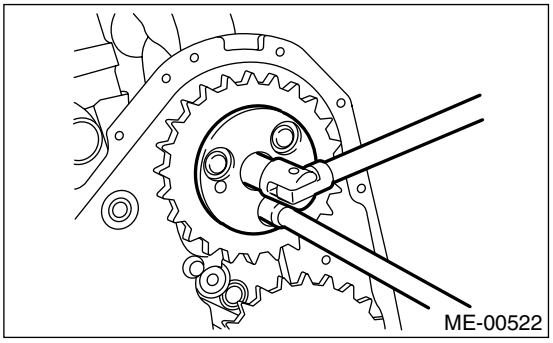
(8) After checking the matching marks on each sprocket and corresponding timing chain are aligned, pull stopper pin out of chain tensioner.

13.Camshaft Sprocket

A: REMOVAL

1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover. <Ref. to ME(H6DO)-39, REMOVAL, Front Chain Cover.>
3) Remove timing chain assembly. <Ref. to ME(H6DO)-41, REMOVAL, Timing Chain Assembly.>
4) Remove camshaft sprocket. To lock camshaft, use ST.

ST 18231AA000 CAMSHAFT SPROCKET WRENCH

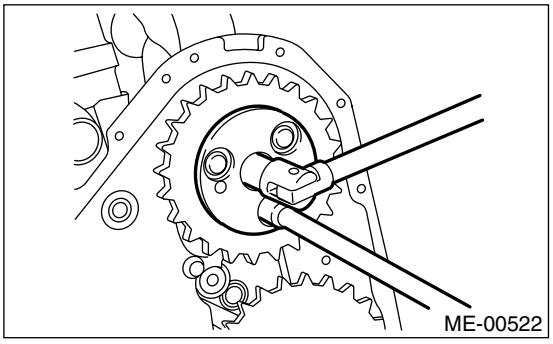


B: INSTALLATION

1) Install camshaft sprocket. To lock camshaft, use ST.

ST 18231AA000 CAMSHAFT SPROCKET WRENCH

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



2) Install timing chain assembly. <Ref. to ME(H6DO)-42, INSTALLATION, Timing Chain Assembly.>
3) Install front chain cover. <Ref. to ME(H6DO)-39, INSTALLATION, Front Chain Cover.>
4) Install crankshaft pulley. <Ref. to ME(H6DO)-38, INSTALLATION, Crankshaft Pulley.>

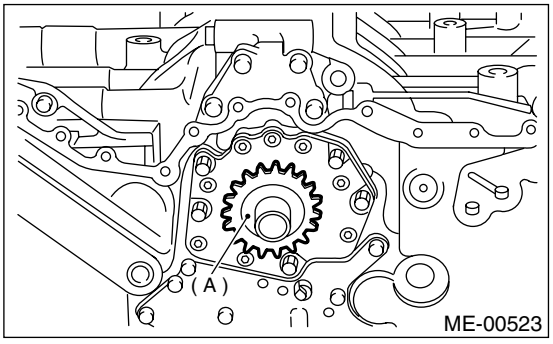
C: INSPECTION

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

14.Crankshaft Sprocket

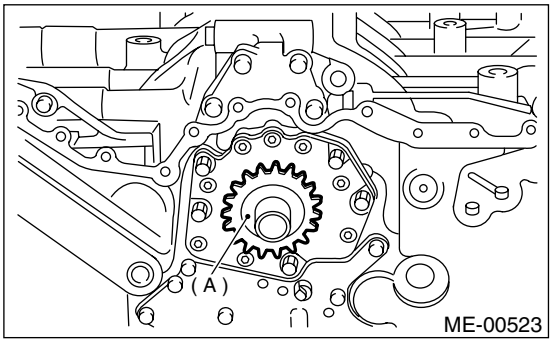
A: REMOVAL

1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover. <Ref. to ME(H6DO)-39, REMOVAL, Front Chain Cover.>
3) Remove timing chain assembly. <Ref. to ME(H6DO)-41, REMOVAL, Timing Chain Assembly.>
4) Remove camshaft sprocket. <Ref. to ME(H6DO)-46, REMOVAL, Camshaft Sprocket.>
5) Remove crankshaft sprocket (A).



B: INSTALLATION

1) Install crankshaft sprocket (A).



2) Install camshaft sprocket. <Ref. to ME(H6DO)-46, INSTALLATION, Camshaft Sprocket.>
3) Install timing chain assembly. <Ref. to ME(H6DO)-42, INSTALLATION, Timing Chain Assembly.>
4) Install front chain cover. <Ref. to ME(H6DO)-39, INSTALLATION, Front Chain Cover.>
5) Install crankshaft pulley. <Ref. to ME(H6DO)-38, INSTALLATION, Crankshaft Pulley.>

C: INSPECTION

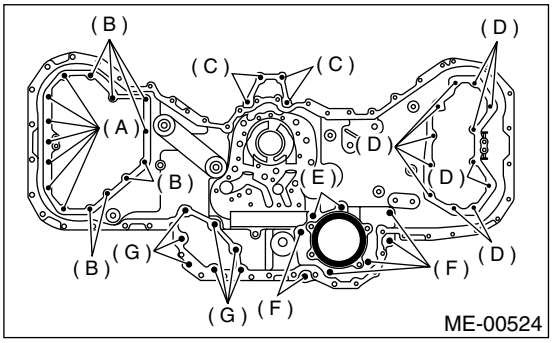
1) Check sprocket teeth for abnormal wear and scratches.
2) Make sure there is no free play between sprocket and key.

15.Rear Chain Cover

A: REMOVAL

1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover. <Ref. to ME(H6DO)-39, REMOVAL, Front Chain Cover.>
3) Remove timing chain. <Ref. to ME(H6DO)-41, REMOVAL, Timing Chain Assembly.>
4) Remove camshaft sprocket. <Ref. to ME(H6DO)-46, REMOVAL, Camshaft Sprocket.>
5) Remove crankshaft sprocket.
6) Remove oil pump. <Ref. to LU(H6DO)-12, REMOVAL, Oil Pump.>
7) Remove oil pump relief valve. <Ref. to LU(H6DO)-14, REMOVAL, Oil Pump Relief Valve.>
8) Remove water pump. <Ref. to CO(H6DO)-20, REMOVAL, Water Pump.>
9) Remove rear chain cover.

NOTE:
There are seven different types of mounting bolts. Sort them into separate containers to avoid confusion at installation.



Bolt dimension:

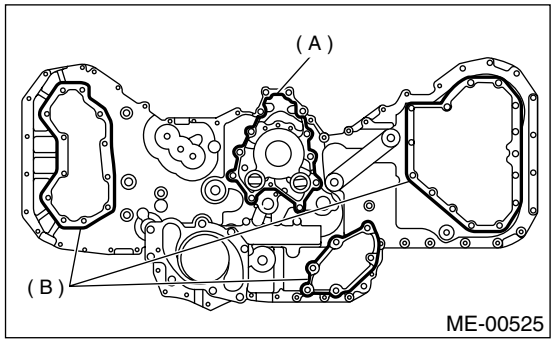
(A) 6 × 14
(B) 6 × 18 (Silver)
(C) 6 × 30
(D) 6 × 18
(E) 6 × 40
(F) 6 × 30
(G) 6 × 22

B: INSTALLATION

1) Remove old fluid gasket on the matching surface, and degrease it.
2) Apply fluid gasket to the mating surface of rear chain cover.

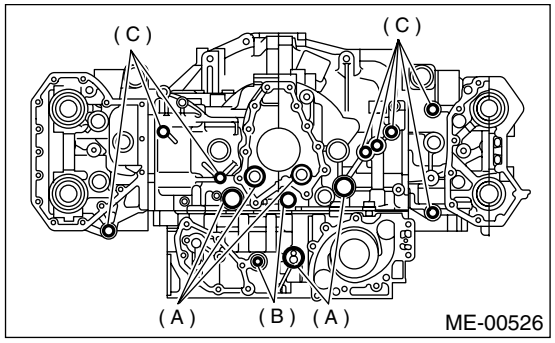
Fluid gasket:
THREE BOND 1280B

Fluid gasket application 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 O-ring.

NOTE:
Do not reuse the O-ring.

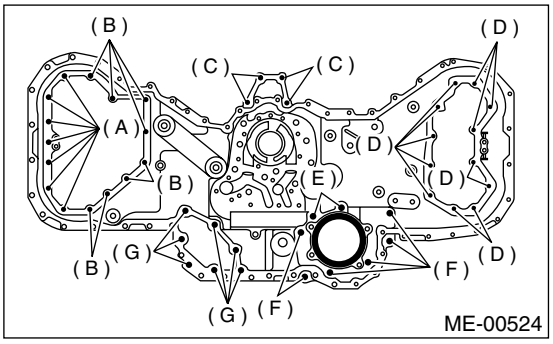


(A) O-ring (Large)
(B) O-ring (Medium)
(C) O-ring (Small)

4) Temporarily tighten rear chain cover.

CAUTION:
Do not confuse the mounting positions of the bolts.

NOTE:
Replace mounting bolts (G) with new ones.



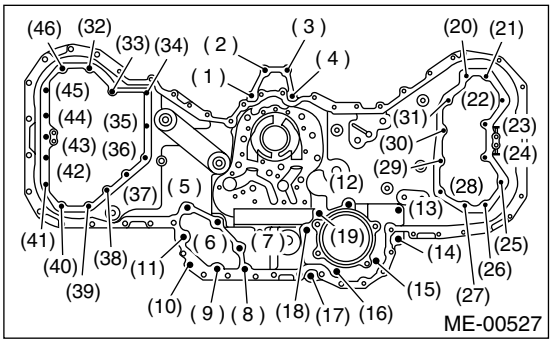
Bolt dimension:

(A) 6 × 14
(B) 6 × 18 (Silver)
(C) 6 × 30
(D) 6 × 18
(E) 8 × 40
(F) 8 × 30
(G) 6 × 22

5) Tighten the bolts in the numerical sequence shown in figure.

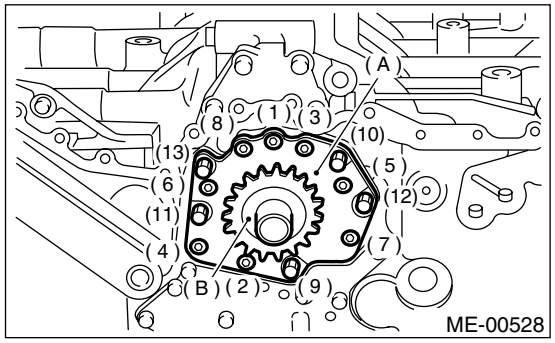
Tightening torque:

(1) to (11)	9 N·m (0.9 kgf-m, 6.5 ft-lb)
(12) to (19)	20 N·m (2.0 kgf-m, 14 ft-lb)
(20) to (31)	9 N·m (0.9 kgf-m, 6.5 ft-lb)
(32) to (39)	12 N·m (1.2 kgf-m, 8.7 ft-lb)
(40) to (46)	9 N·m (0.9 kgf-m, 6.5 ft-lb)



6) Install water pump. <Ref. to CO(H6DO)-20, REMOVAL, Water Pump.>
7) Install oil pump relief valve. <Ref. to LU(H6DO)-14, INSTALLATION, Oil Pump Relief Valve.>
8) Install oil pump. <Ref. to LU(H6DO)-12, INSTALLATION, Oil Pump.>

9) Install crankshaft sprocket.

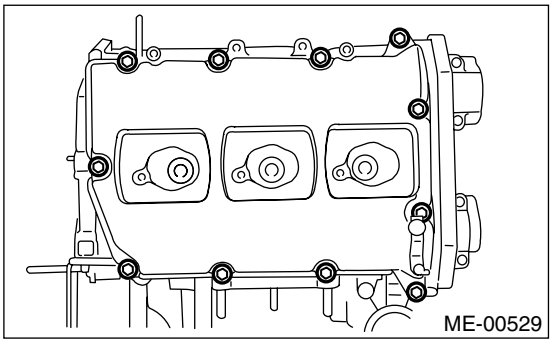


10) Install camshaft sprocket. <Ref. to ME(H6DO)-46, INSTALLATION, Camshaft Sprocket.>
11) Install timing chain. <Ref. to ME(H6DO)-42, INSTALLATION, Timing Chain Assembly.>
12) Install front chain cover. <Ref. to ME(H6DO)-39, INSTALLATION, Front Chain Cover.>
13) Install crankshaft pulley. <Ref. to ME(H6DO)-38, INSTALLATION, Crankshaft Pulley.>

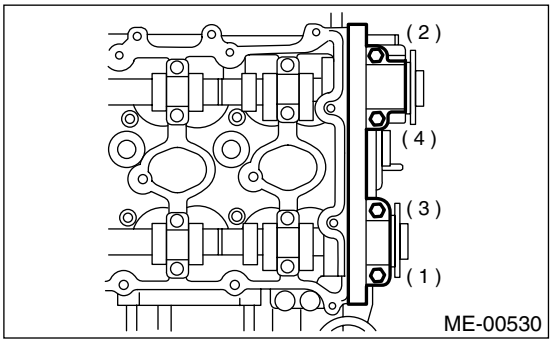
16.Camshaft

A: REMOVAL

1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover. <Ref. to ME(H6DO)-39, REMOVAL, Front Chain Cover.>
3) Remove timing chain assembly. <Ref. to ME(H6DO)-41, REMOVAL, Timing Chain Assembly.>
4) Remove camshaft sprockets. <Ref. to ME(H6DO)-46, REMOVAL, Camshaft Sprocket.>
5) Remove crankshaft sprocket. <Ref. to ME(H6DO)-47, REMOVAL, Crankshaft Sprocket.>
6) Remove rear chain cover. <Ref. to ME(H6DO)-48, REMOVAL, Rear Chain Cover.>
7) Remove rocker cover (RH).

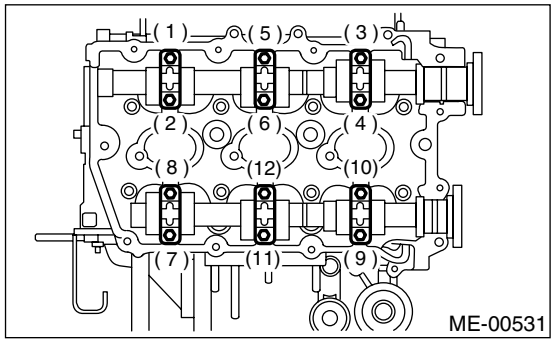


8) Loosen front camshaft cap bolts equally, a little at a time in numerical sequence shown in the figure (RH).



9) Remove camshaft cap and intake camshaft (RH).

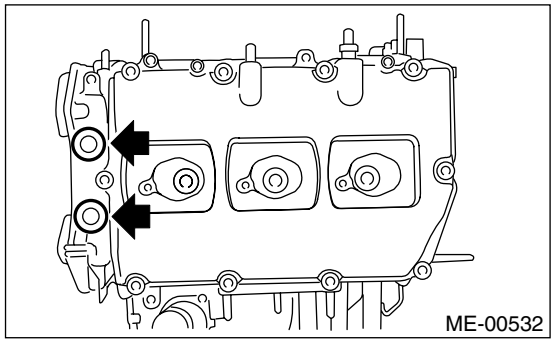
10) Loosen camshaft cap bolts equally, a little at a time in the numerical sequence shown in the figure.



11) Remove camshaft cap and exhaust camshaft (RH).

CAUTION:
Arrange camshaft caps in order so that they can be installed in their original position.

12) Remove plug (LH).

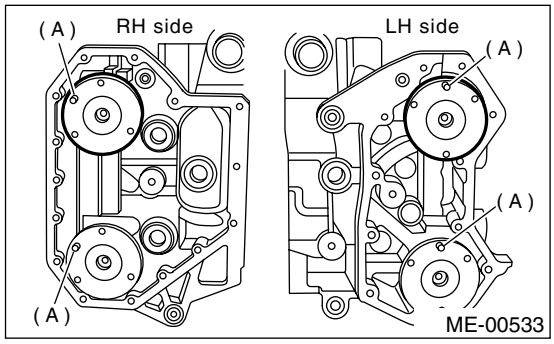


13) Similarly, remove left-hand camshafts and related parts.

B: INSTALLATION

1) Apply a coat of engine oil to camshaft journals and install camshaft.

CAUTION:
When installing camshaft, adjust camshaft front flange knock pin (A) position as follows:
LH side: 12 o'clock
RH side: 10 o'clock

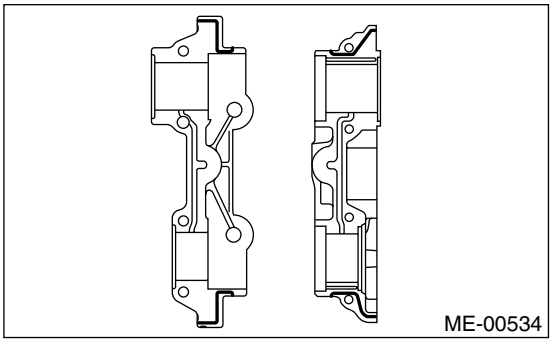


2) Install camshaft cap.
(1) Apply fluid packing sparingly to back of front camshaft cap shown in the figure.

CAUTION:
Do not apply fluid gasket excessively. Failure to do so may cause excess fluid gasket to come out and flow toward camshaft journal, resulting burning stuck of engine.

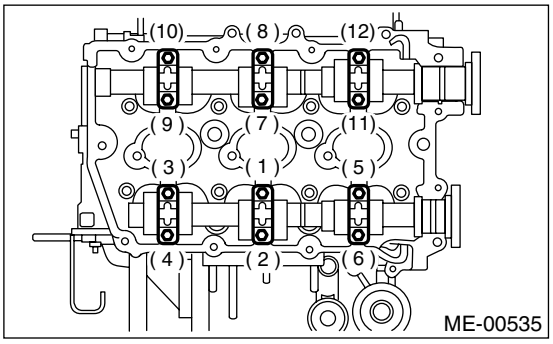
Fluid gasket:
THREE BOND 1280B

Fluid gasket application diameter:
2.0±0.5 mm (0.079±0.020 in)



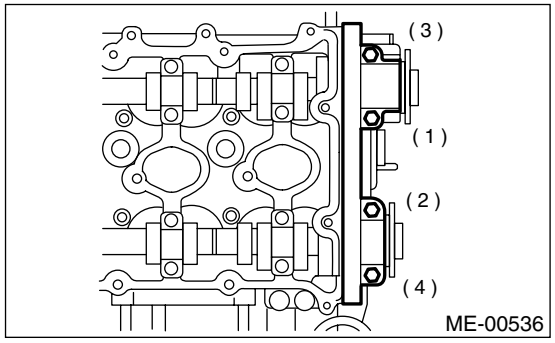
(2) Apply engine oil to cap bearing surface and install cap on camshaft.
(3) Tighten the camshaft cap bolts in the numerical sequence shown in the figure.

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



(4) Tighten the front camshaft cap bolts in the numerical sequence shown in the figure.

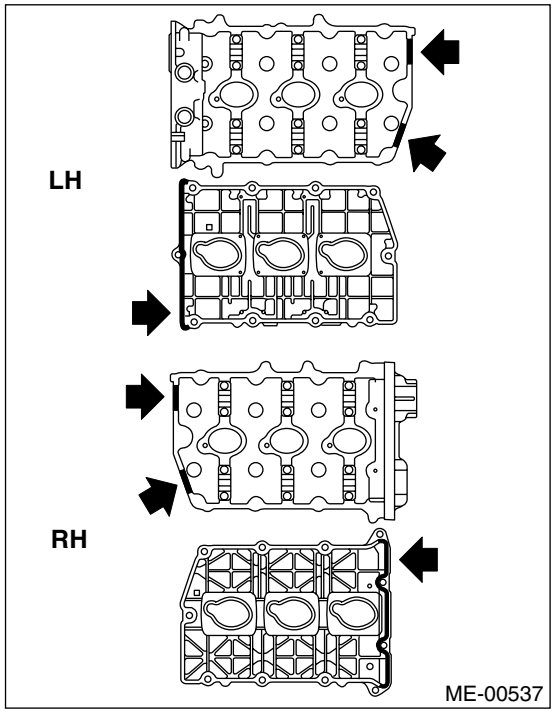
Tightening torque:
9.8 N·m (1.0 kgf-m, 7.2 ft-lb)



3) Install rocker cover.
(1) Apply fluid gasket sparingly to matching surface of cylinder heads and rocker covers shown in the figure.

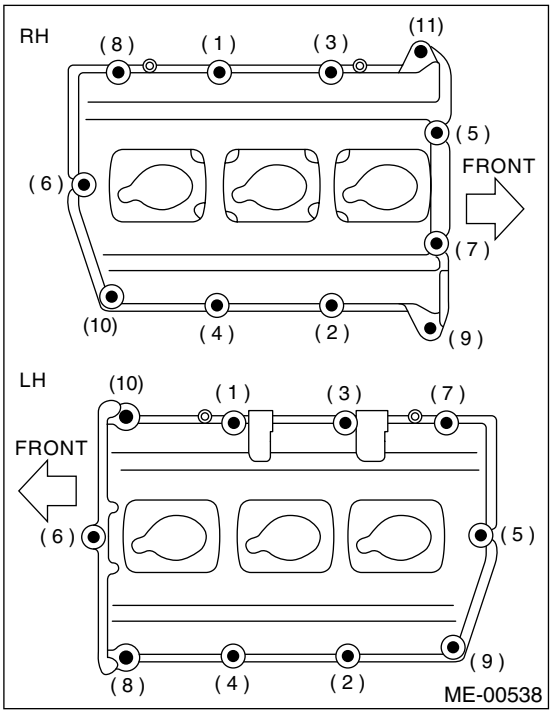
CAUTION:
Do not apply fluid gasket excessively. Doing so may cause excess fluid gasket to come out and flow toward camshaft journal, resulting burning stuck of engine.

Fluid gasket:
THREE BOND 1280B



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

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



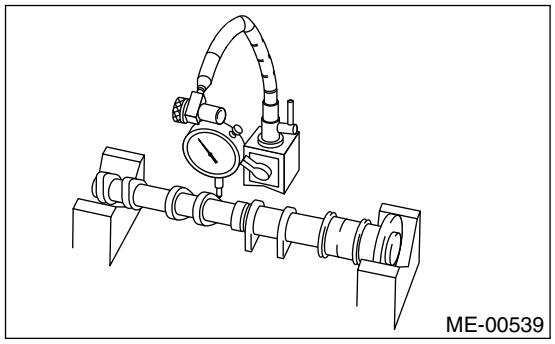
4) Install rear chain cover. <Ref. to ME(H6DO)-48, INSTALLATION, Rear Chain Cover.>
5) Install crankshaft sprocket. <Ref. to ME(H6DO)-47, INSTALLATION, Crankshaft Sprocket.>
6) Install camshaft sprockets. <Ref. to ME(H6DO)-46, INSTALLATION, Camshaft Sprocket.>
7) Install timing chain assembly. <Ref. to ME(H6DO)-42, INSTALLATION, Timing Chain Assembly.>
8) Install front chain cover. <Ref. to ME(H6DO)-39, INSTALLATION, Front Chain Cover.>
9) Install crankshaft pulley. <Ref. to ME(H6DO)-38, INSTALLATION, Crankshaft Pulley.>

C: INSPECTION

1. CAMSHAFT

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

Limit:
0.020 mm (0.0008 in)



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

	Camshaft journal	
	Front	Center, rear
Standard	37.946 — 37.963 mm (1.4939 — 1.4946 in)	27.946 — 27.963 mm (1.1002 — 1.1009 in)

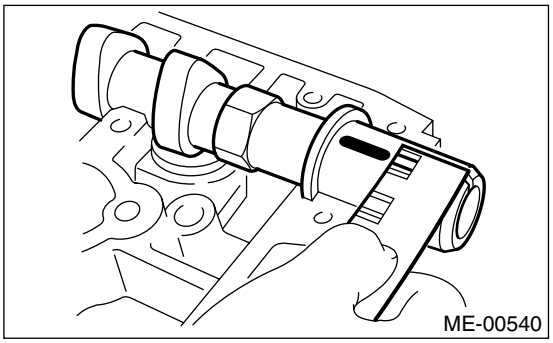
4) Measurement of the camshaft journal oil clearance
(1) Clean the bearing caps and camshaft journals.
(2) Place the camshafts on the cylinder head.
(3) Place plastigauge across each of the camshaft journals.
(4) Install the bearing caps.

CAUTION:
Do not turn the camshaft.

(5) Remove the bearing caps.

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

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



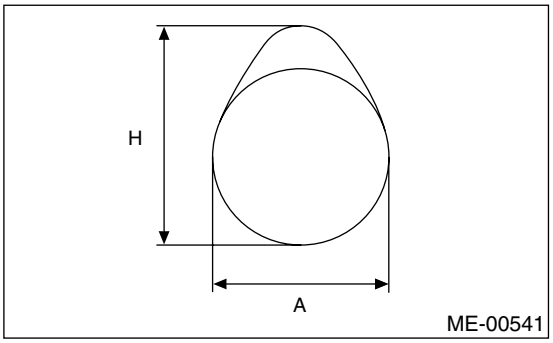
(7) Completely remove the plastigauge.

5) Check cam face condition; remove minor faults by grinding with oil stone. Measure the cam height H; replace if the limit has been exceeded.

Cam height: H

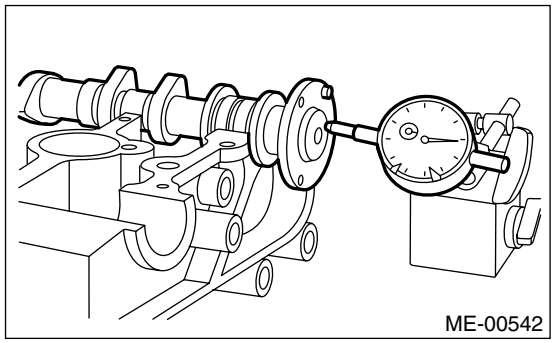
Standard:
Intake:
45.75 — 45.85 mm (1.8012 — 1.8051 in)
Exhaust:
45.25 — 45.35 mm (1.7815 — 1.7854 in)

Cam base circle diameter A:
36.0 mm (1.4173 in)



6) Measure the thrust clearance of camshaft with dial gauge. If the clearance exceeds the limit, replace caps and cylinder head as a set. If necessary replace camshaft.

Standard:
Intake:
0.075 — 0.135 mm (0.0030 — 0.0053 in)
Exhaust:
0.048 — 0.108 mm (0.0019 — 0.0043 in)

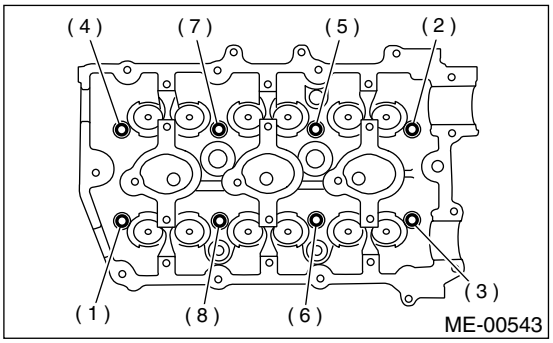


17.Cylinder Head Assembly

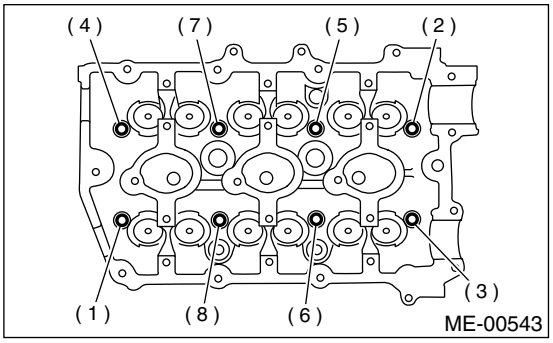
A: REMOVAL

1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover. <Ref. to ME(H6DO)-39, REMOVAL, Front Chain Cover.>
3) Remove timing chain assembly. <Ref. to ME(H6DO)-41, REMOVAL, Timing Chain Assembly.>
4) Remove camshaft sprockets. <Ref. to ME(H6DO)-46, REMOVAL, Camshaft Sprocket.>
5) Remove crankshaft sprocket. <Ref. to ME(H6DO)-47, REMOVAL, Crankshaft Sprocket.>
6) Remove rear chain cover. <Ref. to ME(H6DO)-48, REMOVAL, Rear Chain Cover.>
7) Remove camshafts. <Ref. to ME(H6DO)-50, REMOVAL, Camshaft.>
8) Remove cylinder head bolts in numerical sequence shown in figure.

CAUTION:
Leave bolts (2) and (4) engaged by three or four threads to prevent cylinder head from falling.



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



11) Remove cylinder head gasket.

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

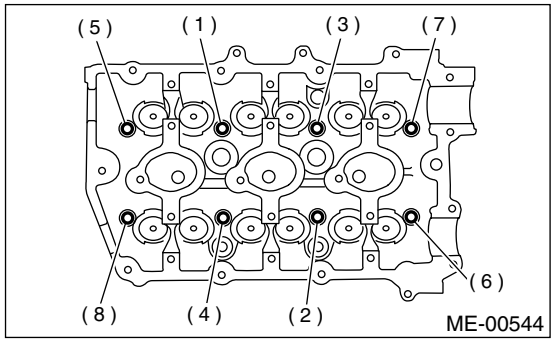
12) Similarly, remove right side cylinder head.

B: INSTALLATION

1) Install cylinder head and gaskets on cylinder block.

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

2) Tighten cylinder head bolts.
(1) Coat the washers and threaded parts of the cylinder head bolts with engine oil.
(2) Install the cylinder head on the cylinder block and tighten the bolts in the numerical order shown in the figure to a tightening torque of 20 N·m (2.0 kgf-m, 14 ft-lb).
(3) Tighten the bolts in the numerical order shown in the figure to a tightening torque of 50 N·m (5.1 kgf-m, 37 ft-lb).
(4) Loosen all the bolts in 2 stages, 180° at a time, in the reverse order of tightening.
(5) Tighten the bolts in the numerical order shown in the figure to a tightening torque of 25 N·m (2.5 kgf-m, 18 ft-lb).
(6) Tighten the bolts in the numerical order shown in the figure to a tightening torque of 25 N·m (2.5 kgf-m, 18 ft-lb).
(7) Tighten all the bolts 90° in the numerical order shown in the figure.
(8) Tighten the (1) to (4) bolts 90° again in the numerical order shown in the figure.
(9) Tighten the (5) to (8) bolts 45° again in the numerical order shown in the figure.



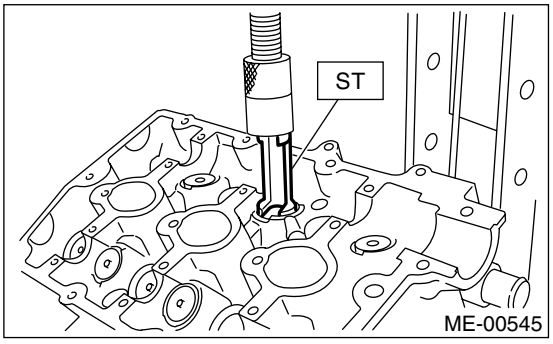
3) Install camshafts. <Ref. to ME(H6DO)-50, INSTALLATION, Camshaft.>
4) Install rear chain cover. <Ref. to ME(H6DO)-48, INSTALLATION, Rear Chain Cover.>
5) Install crankshaft sprocket. <Ref. to ME(H6DO)-47, INSTALLATION, Crankshaft Sprocket.>
6) Install camshaft sprockets. <Ref. to ME(H6DO)-46, INSTALLATION, Camshaft Sprocket.>
7) Install timing chain assembly. <Ref. to ME(H6DO)-42, INSTALLATION, Timing Chain Assembly.>
8) Install front chain cover. <Ref. to ME(H6DO)-39, INSTALLATION, Front Chain Cover.>

9) Install crankshaft pulley. <Ref. to ME(H6DO)-38, INSTALLATION, Crankshaft Pulley.>

C: DISASSEMBLY

1) Place cylinder head on ST.
ST 18250AA000 CYLINDER HEAD TABLE
2) Remove valve shims and valve lifters.
3) Set ST on valve spring retainer. Compress valve spring and remove the valve spring retainer key. Remove each valve and valve spring.
ST 499718000 VALVE SPRING REMOVER

CAUTION:
• For correct re-installation, keep removed parts in order in their original positions.
• Mark each valve to prevent confusion.
• Use extreme care not to damage the lips of the intake valve oil seals and exhaust valve stem seals.



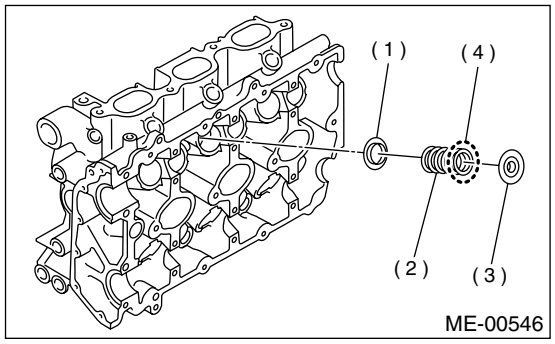
D: ASSEMBLY

1) Installation of valve spring and valve
(1) Place cylinder head on ST.
ST 18250AA000 CYLINDER HEAD TABLE
(2) Coat stem of each valve with engine oil and insert valve into valve guide.

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

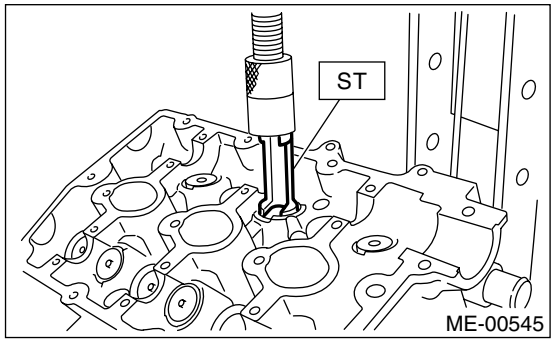
(3) Install valve spring and retainer.

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



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

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



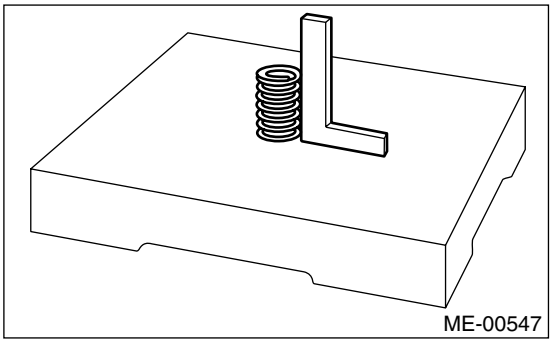
(5) Compress valve spring and fit valve spring retainer key.
(6) After installing, tap valve spring retainers lightly with wooden hammer for better seating.
2) Apply oil to the surface of the valve lifter and valve shim.
3) Install valve lifter and valve shim.

E: INSPECTION

1. VALVE SPRING

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

Free length	46.79 mm (1.8421 in)
Squareness	2.5°, 2.0 mm (0.079 in)

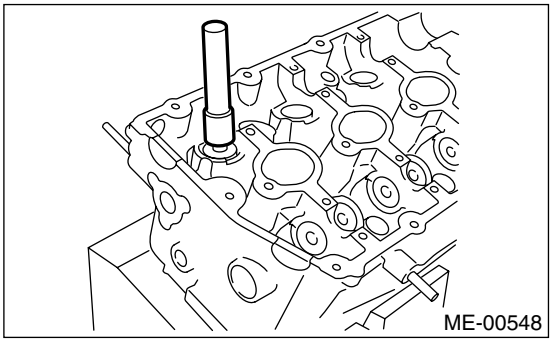


2. INTAKE AND EXHAUST VALVE STEM SEAL

Replace oil seal with new one, if lip is damaged or spring out of place, or when the surfaces of intake valve and valve seat are reconditioned or intake valve guide is replaced. Use pliers to pinch and remove oil seal from valve.
1) Place cylinder head on ST1.
2) Press-fit oil seal to the specified dimension indicated in the figure using ST2.

CAUTION:
• Apply engine oil to stem seal before press-fitting.
• When press-fitting stem seal, do not use hammer or strike in.

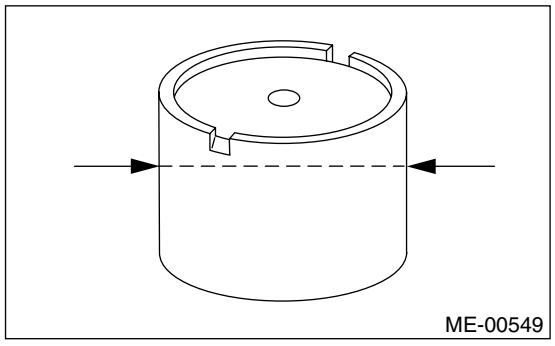
ST1 18250AA000 CYLINDER HEAD TABLE
ST2 499585500 VALVE OIL SEAL GUIDE



3. VALVE LIFTER

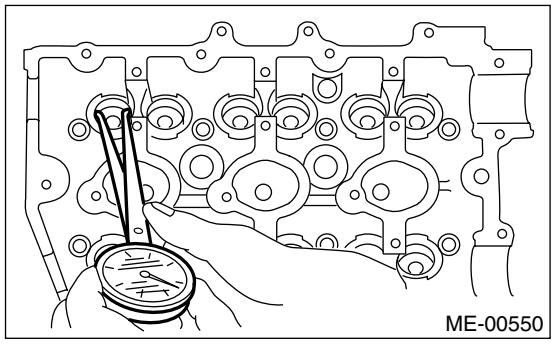
1) Check valve lifter visually.
2) Measure outer diameter of valve lifter.

Outer diameter:
33.959 — 33.975 mm (1.3370 — 1.3376 in)



3) Measure inner diameter of valve lifter mating part on cylinder head.

Inner diameter:
34.006 — 34.016 mm (1.3388 — 1.3392 in)



CAUTION:
If difference between outer diameter of valve lifter and inner diameter of valve lifter mating part is over the limit, replace cylinder head.

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

F: ADJUSTMENT

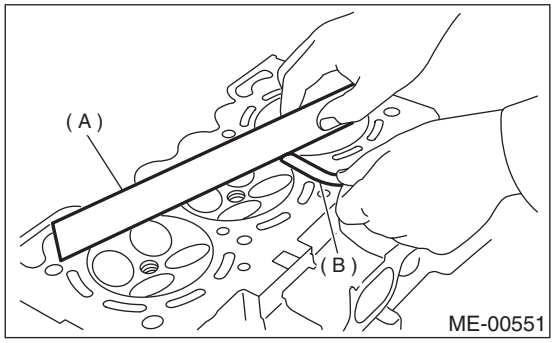
1. CYLINDER HEAD

1) Make sure that no crack or other damage exists. In addition to visual inspection, inspect important areas by means of red lead check.
Also make sure that gasket installing surface shows no trace of gas and water leaks.
2) Place cylinder head on ST.
ST 18250AA000 CYLINDER HEAD TABLE
3) Inspect the cylinder head surface that mates with cylinder block for warping by using a straight edge (A) and thickness gauge (B). If the warping exceeds the limit, replace the cylinder head.

Warping limit value:
0.02 mm (0.0008 in)

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

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



(A) Straight edge
(B) Thickness gauge

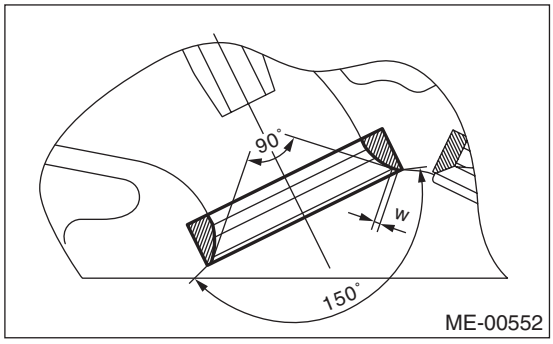
2. VALVE SEAT

Inspect intake and exhaust valve seats, and correct the contact surfaces with 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)
Limit
1.7 mm (0.067 in)

Exhaust
Standard
1.5 mm (0.059 in)
Limit
2.2 mm (0.087 in)



3. VALVE GUIDE

1) Check the clearance between valve guide and stem. The clearance can be checked by measuring the outside diameter of valve stem and the inside diameter of valve guide with outside and inside micrometers respectively.

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)

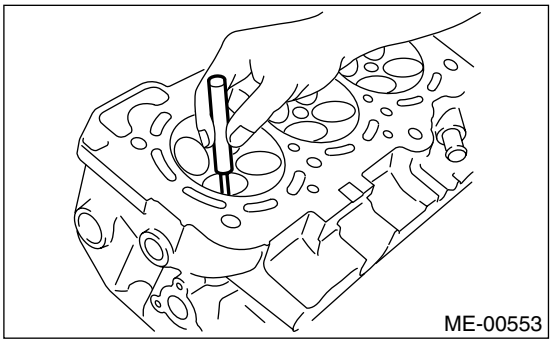
2) If the clearance between valve guide and stem exceeds the limit, replace valve guide or valve itself whichever shows greater amount of wear. See following procedure for valve guide replacement.

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

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

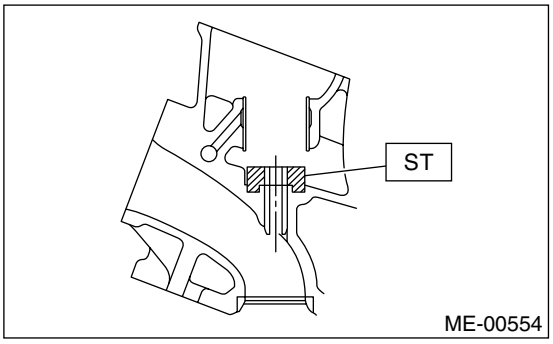
(1) Place cylinder head on ST1 with the combustion chamber upward so that valve guides enter the holes in ST1.
(2) Insert ST2 into valve guide and press it down to remove valve guide.

ST1 18250AA000 CYLINDER HEAD TABLE
ST2 499765700 VALVE GUIDE REMOVER


ME-00553

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

ST 18251AA000 VALVE GUIDE ADJUSTER

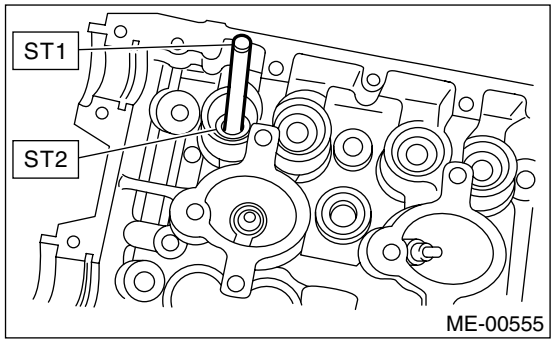


ME-00554

(4) Before installing 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 new valve guide in cylinder, and insert 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 18251AA000 VALVE GUIDE ADJUSTER



ME-00555

(6) Check the valve guide protrusion.

Valve guide protrusion: L
12.3 — 12.7 mm (0.484 — 0.500 in)

(7) Ream the inside of valve guide with ST. Gently rotate the reamer clockwise while pressing it lightly into valve guide, and return it also rotating clockwise. After reaming, clean valve guide to remove chips.

ST 499765900 VALVE GUIDE REAMER

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

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

4. INTAKE AND EXHAUST VALVE

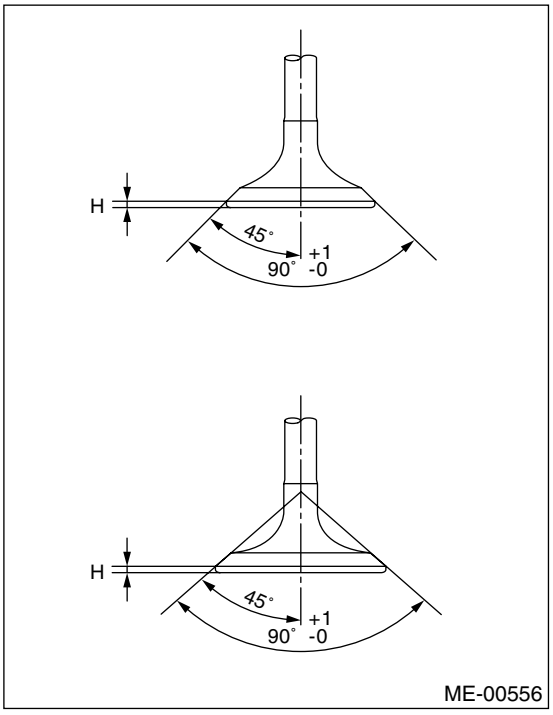
1) Inspect the flange and stem of valve, and replace if damaged, worn, or deformed, or if “H” is less than the specified limit.

H:

Intake
Standard
1.0 mm (0.039 in)
Limit
0.8 mm (0.031 in)

Exhaust
Standard
1.2 mm (0.047 in)
Limit
1.0 mm (0.039 in)

Valve overall length:
Intake
103.5 mm (4.075 in)
Exhaust
103.2 mm (4.063 in)

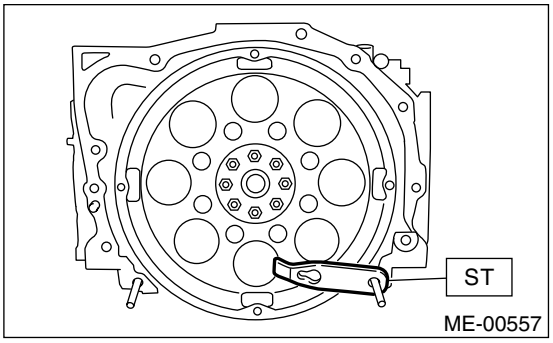


2) Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. Install a new intake valve oil seal after lapping.

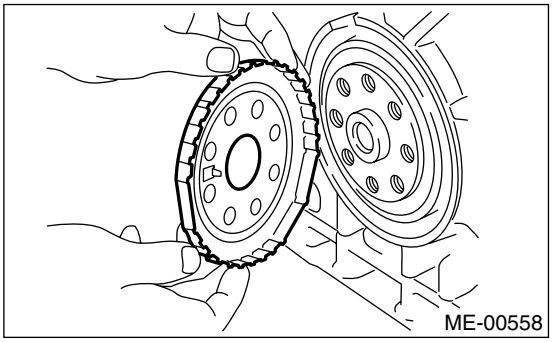
18.Cylinder Block

A: REMOVAL

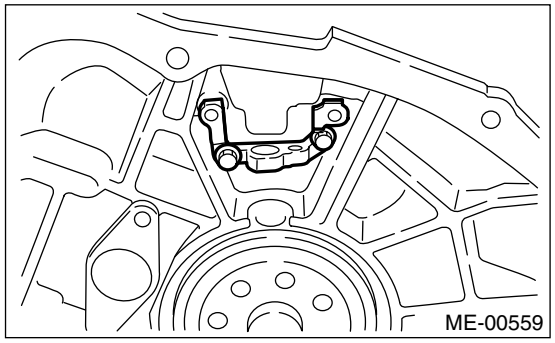
1) Remove crankshaft pulley. <Ref. to ME(H6DO)-38, REMOVAL, Crankshaft Pulley.>
2) Remove front chain cover. <Ref. to ME(H6DO)-39, REMOVAL, Front Chain Cover.>
3) Remove timing chain assembly. <Ref. to ME(H6DO)-41, REMOVAL, Timing Chain Assembly.>
4) Remove camshaft sprockets. <Ref. to ME(H6DO)-46, REMOVAL, Camshaft Sprocket.>
5) Remove crankshaft sprocket. <Ref. to ME(H6DO)-47, REMOVAL, Crankshaft Sprocket.>
6) Remove rear chain cover. <Ref. to ME(H6DO)-48, REMOVAL, Rear Chain Cover.>
7) Remove camshafts. <Ref. to ME(H6DO)-50, REMOVAL, Camshaft.>
8) Remove cylinder head assembly. <Ref. to ME(H6DO)-54, REMOVAL, Cylinder Head Assembly.>
9) Remove drive plate.
Using ST, lock crankshaft.
ST 498497100 CRANKSHAFT STOPPER



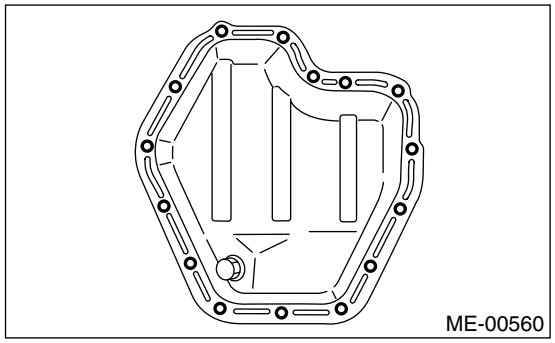
10) Remove crankshaft position sensor plate.



11) Remove crankshaft position sensor bracket.



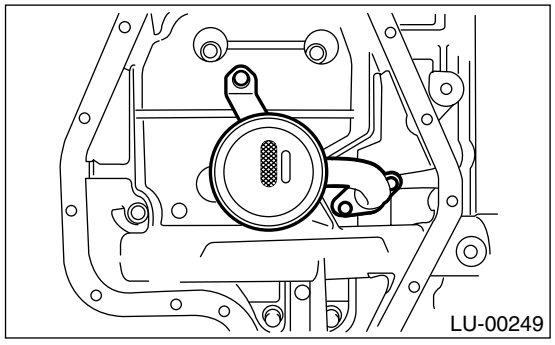
12) Rotate engine until oil pan comes to the top.
13) Remove bolts which secure lower oil pan to upper oil pan.



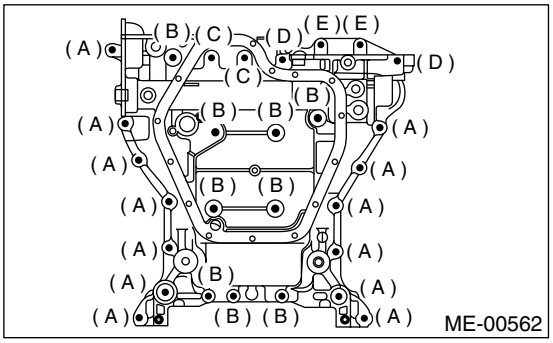
14) Insert an oil pan cutter blade between cylinder block-to-oil pan clearance and remove oil pan.

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

15) Remove oil strainer.



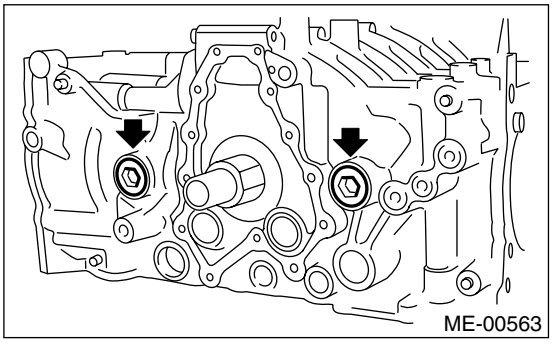
16) Remove bolts which secure upper oil pan to cylinder block.



Bolt dimension:

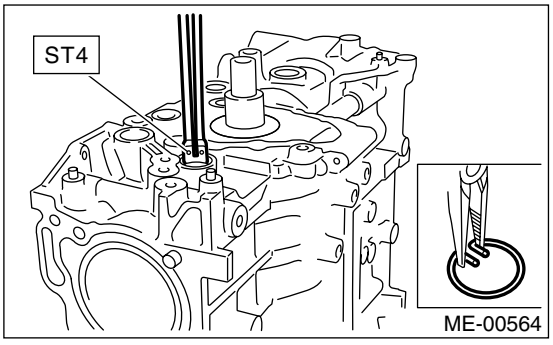
(A) 8 × 40
(B) 8 × 65
(C) 8 × 85
(D) 8 × 130
(E) 8 × 24

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



18) Rotate crankshaft to bring #1 and #2 pistons to bottom dead center position, then remove piston circlip through service hole of #1 and #2 cylinders by using ST.

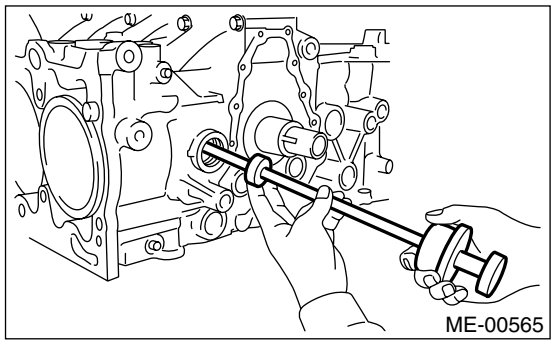
ST 18233AA000 PISTON PIN CIRCLIP PLIER



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

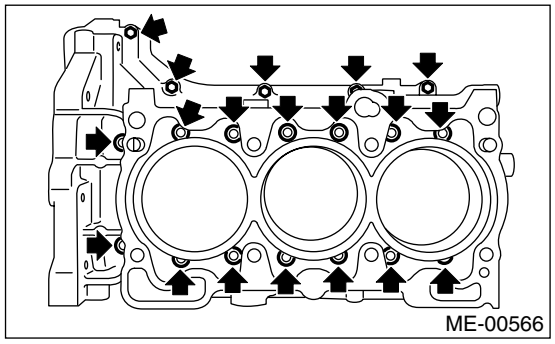
ST 499097500 PISTON PIN REMOVER

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



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

21) Remove bolts which connect cylinder block.



22) Separate left-hand and right-hand cylinder blocks.

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

23) Remove rear oil seal.

24) Remove crankshaft together with connecting rod.

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

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

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

CAUTION:
Do not confuse combination of piston, piston pin and cylinder.

B: INSTALLATION

1) Install ST to cylinder block, then install crankshaft bearing.
ST 18232AA000 ENGINE STAND

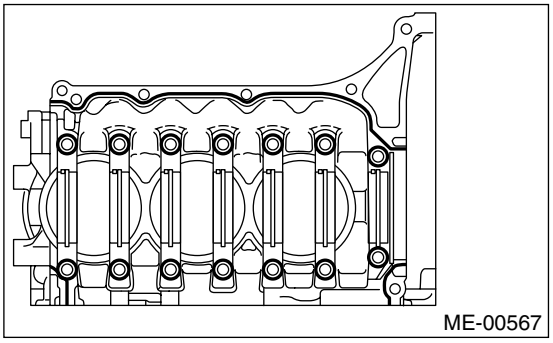
CAUTION:
Remove oil in the mating surface of bearing and cylinder block before installation. Also apply a coat of engine oil to crankshaft pins.

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

Fluid gasket:
THREE BOND 1215B or equivalent

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

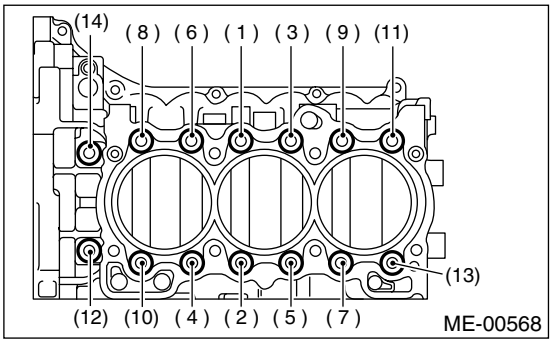
Fluid gasket application diameter:
1.0±0.2 mm (0.039±0.008 in)


ME-00567

4) Apply engine oil to washers and threads of cylinder block connecting bolts. Tighten the bolts following the steps below.
(1) Tighten all the bolts in the numerical order shown in the figure.

Tightening torque:

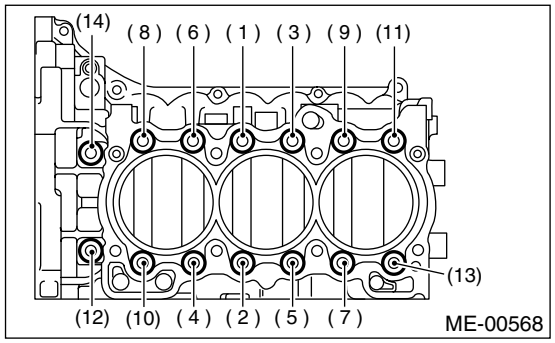
(1) to (11)	25 N·m (2.5 kgf-m, 18 ft-lb)
(12)	20 N·m (2.0 kgf-m, 14 ft-lb)
(13)	25 N·m (2.5 kgf-m, 18 ft-lb)
(14)	20 N·m (2.0 kgf-m, 14 ft-lb)



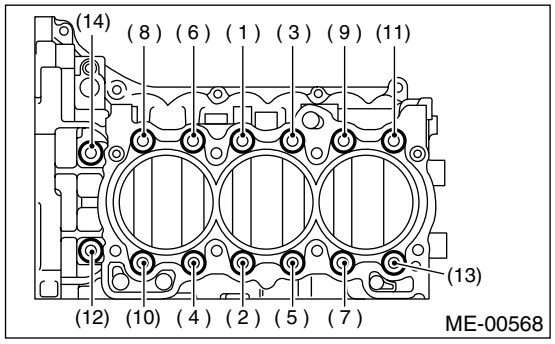
(2) Tighten all the bolts again in the order shown in the figure.

Tightening torque:

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

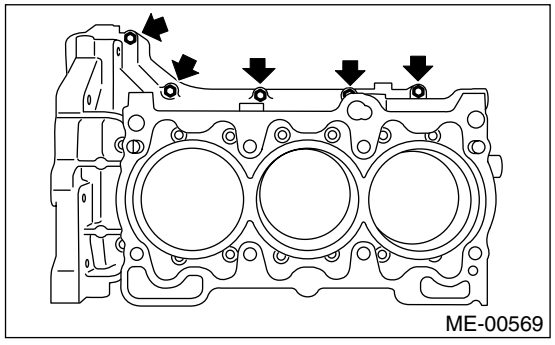


5) Tighten all the bolts by 90° in the order shown in the figure.



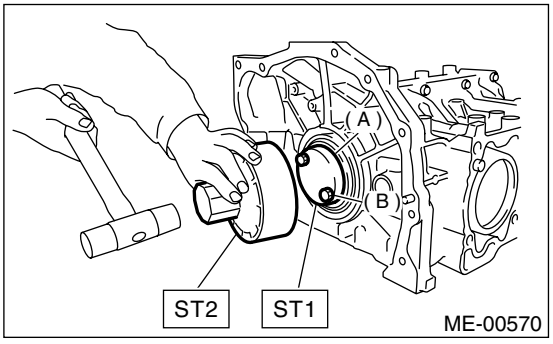
6) Install upper bolts on cylinder block.

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


ME-00569

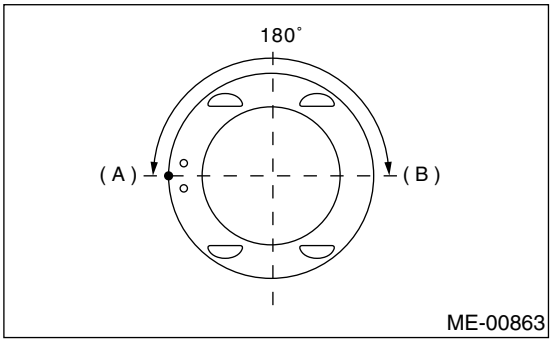
7) Install rear oil seal using ST1 and ST2.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE
ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER

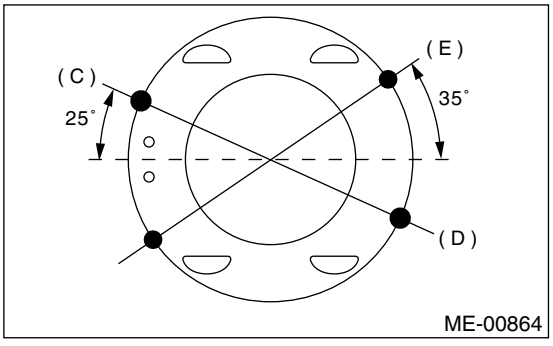


(A) Rear oil seal
(B) Drive plate attaching bolt

8) Positioning of piston ring.
(1) Position the top ring gap at (A) in the figure.
(2) Position the second ring gap at (B) in the figure.



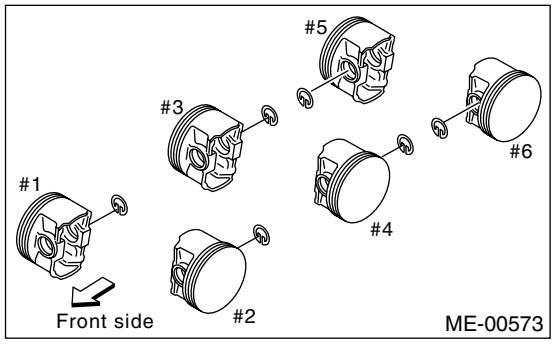
(3) Position the upper rail gap at (C) in the figure.
(4) Position the expander gap at (D) in the figure.
(5) Position the lower rail gap at (E) in the figure.



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

(6) Install circlip.
Install circlips in piston holes located opposite service holes in cylinder block, when positioning all pistons in the corresponding cylinders.

NOTE:
Use new circlips.

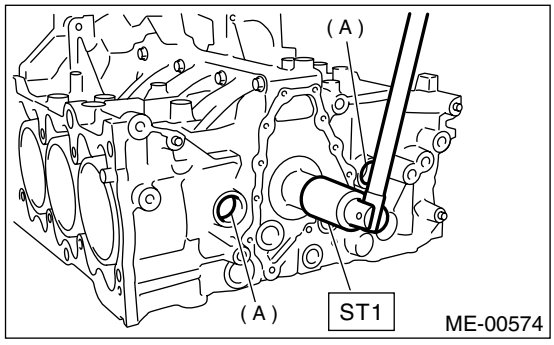


9) Installing piston.

CAUTION:
Install piston and piston pin to the same cylinder they were installed before overhaul.

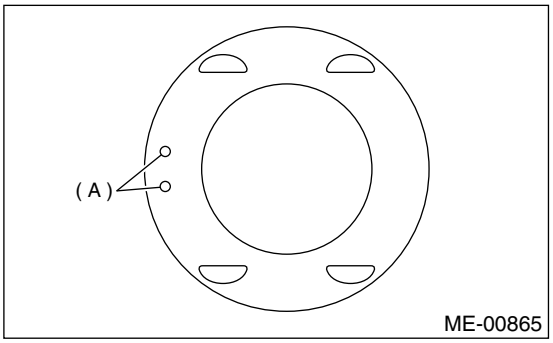
(1) Using ST1, rotate crankshaft until each small end of connecting rods #3 and #4 is aligned over service hole (A).

ST1 18252AA000 CRANKSHAFT SOCKET



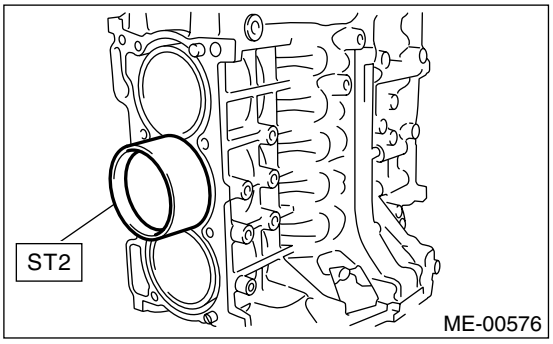
(2) Apply a coat of engine oil to piston and cylinders.

(3) Install pistons with their front marks (A) facing the front of engine.



(4) Insert pistons in their cylinders using ST2.

ST2 18254AA000 PISTON GUIDE

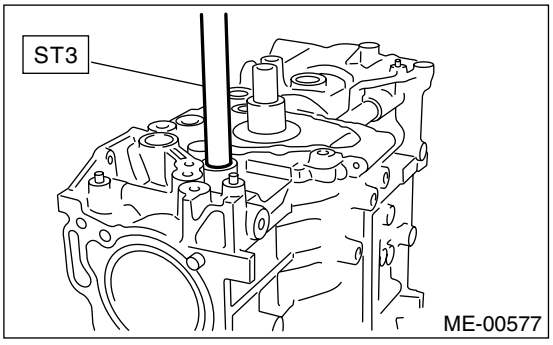


10) Installing piston pin.

(1) Apply a coat of engine oil to ST3.

ST3 18253AA000 PISTON PIN GUIDE

(2) Insert ST3 into service hole to align piston pin hole with connecting rod small end.

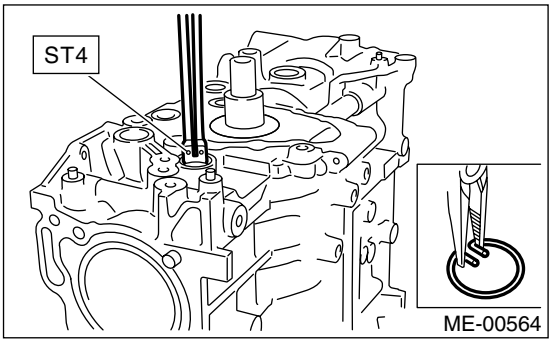


(3) Apply a coat of engine oil to piston pin and insert piston pin into piston and connecting rod small end through service hole.

(4) Using ST4, install circlip.

ST4 18233AA000 PISTON PIN CIRCLIP PLIER

NOTE:
Use a new circlip.



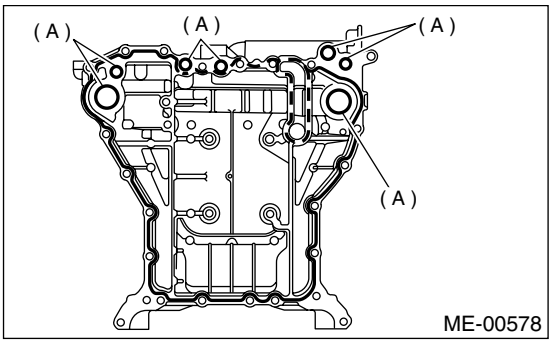
11) Repeat the same steps for pistons #1 and #2, #5 and #6.

12) Install service hole plug and cover.

13) Apply fluid gasket to mating surface of upper oil pan.

14) Install O-ring.

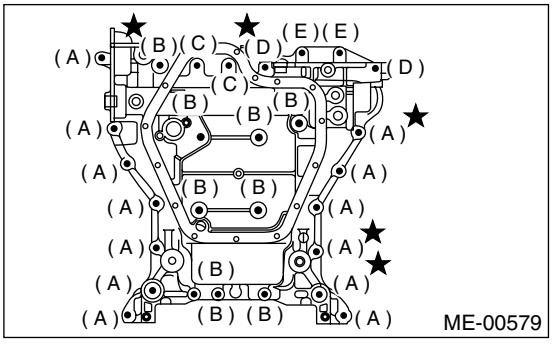
Fluid gasket:
THREE BOND 1280B



(A) O-ring

15) Temporarily tighten the upper oil pan.

CAUTION:
Do not confuse the mounting positions of the bolts.

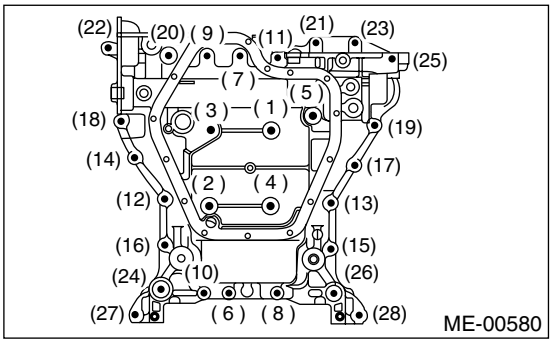


Bolt dimension:

(A) 8 × 40
(B) 8 × 65
(C) 8 × 85
(D) 8 × 130
(E) 8 × 20

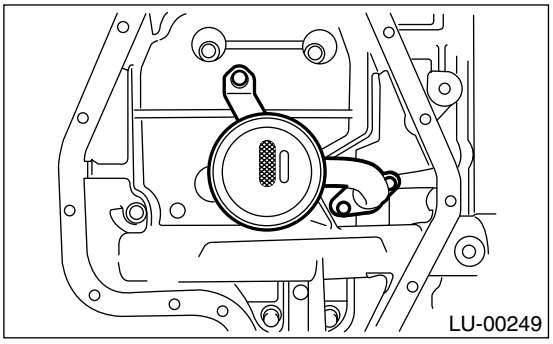
16) Tighten the upper oil pan mounting bolts in the numerical sequence shown in the figure.

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



17) Install oil strainer.

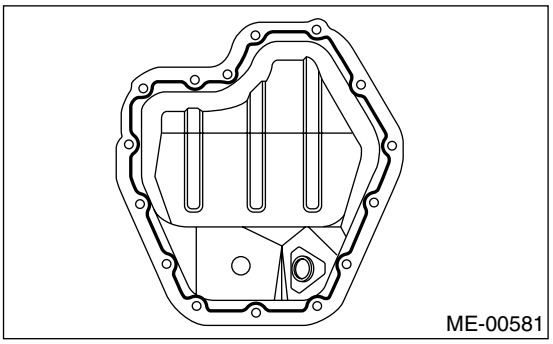
NOTE:
Use a new O-ring.



18) Apply fluid gasket to mating surface of lower oil pan.

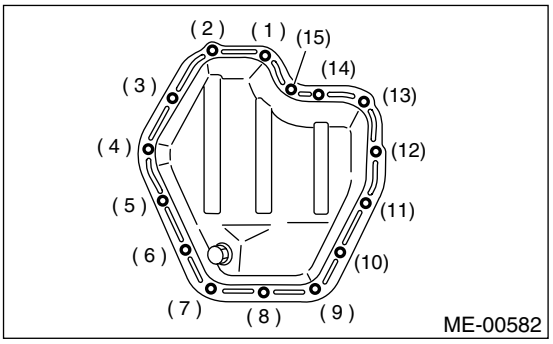
Fluid gasket:
THREE BOND 1280B

Fluid gasket application diameter:
5.0±1.0 mm (0.097±0.039 in)



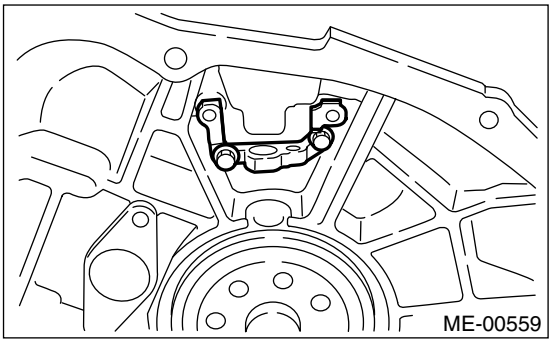
19) Tighten the lower oil pan mounting bolts in the numerical sequence shown in the figure.

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

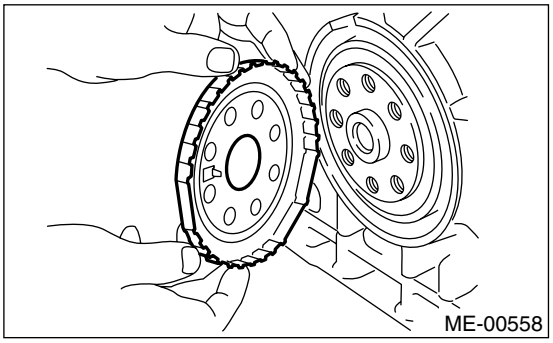


20) Install crankshaft position sensor bracket.

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

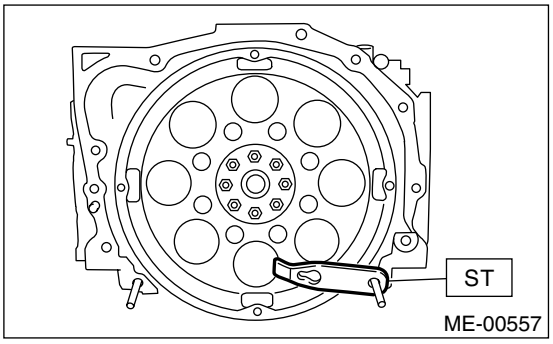


21) Install crankshaft position sensor plate.



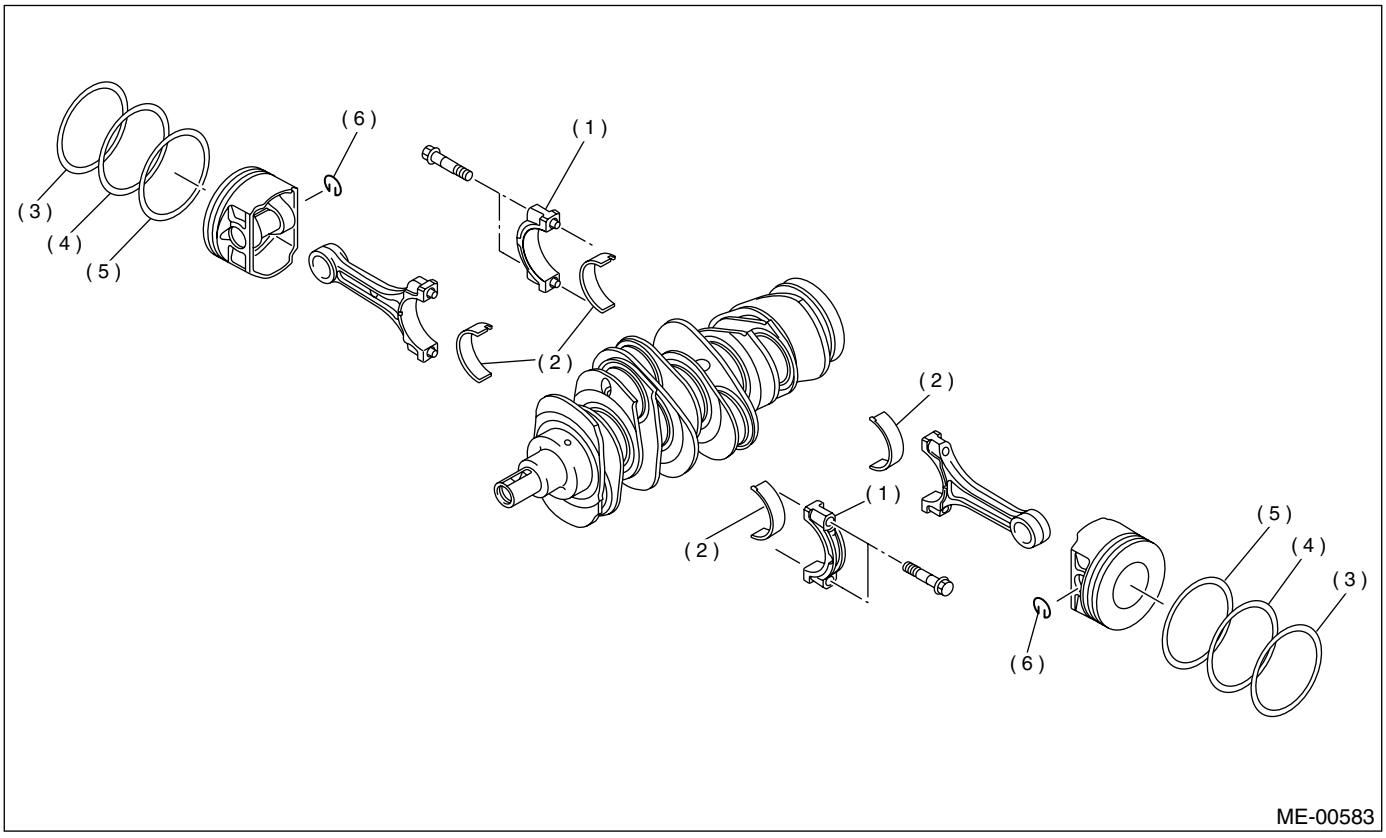
22) Install drive plate.
Using ST, lock crankshaft.
ST 498497100 CRANKSHAFT STOPPER

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



23) Install cylinder head assembly. <Ref. to ME(H6DO)-54, INSTALLATION, Cylinder Head Assembly.>
24) Install camshafts. <Ref. to ME(H6DO)-50, INSTALLATION, Camshaft.>
25) Install rear chain cover. <Ref. to ME(H6DO)-48, INSTALLATION, Rear Chain Cover.>
26) Install crankshaft sprocket. <Ref. to ME(H6DO)-47, INSTALLATION, Crankshaft Sprocket.>
27) Install camshaft sprockets. <Ref. to ME(H6DO)-46, INSTALLATION, Camshaft Sprocket.>
28) Install timing chain assembly. <Ref. to ME(H6DO)-42, INSTALLATION, Timing Chain Assembly.>
29) Install front chain cover. <Ref. to ME(H6DO)-39, INSTALLATION, Front Chain Cover.>
30) Install crankshaft pulley. <Ref. to ME(H6DO)-38, INSTALLATION, Crankshaft Pulley.>

C: DISASSEMBLY



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

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

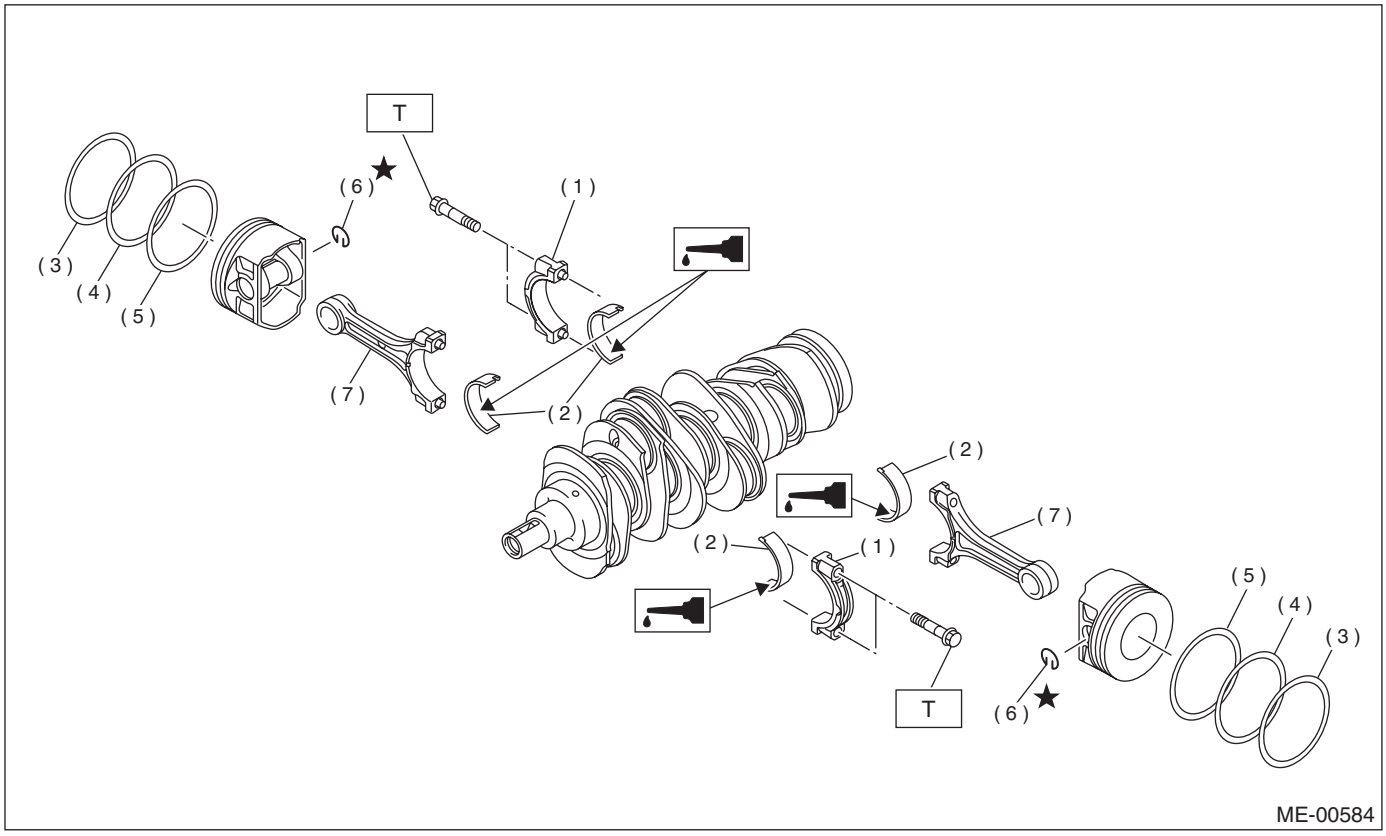
CAUTION:
Arrange removed connecting rod, connecting rod cap and bearing in order to prevent confusion.

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

CAUTION:
Arrange the removed piston rings in good order to prevent confusion.

5) Remove circlip.

D: ASSEMBLY



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

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

1) Install connecting rod bearings on connecting rods and connecting rod caps.

CAUTION:
Apply oil to the surfaces of the connecting rod bearings.

2) Install connecting rod on crankshaft.

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

3) Install connecting rod cap with connecting rod nut.
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) Installation of piston rings and oil ring

E: INSPECTION

1. CYLINDER BLOCK

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

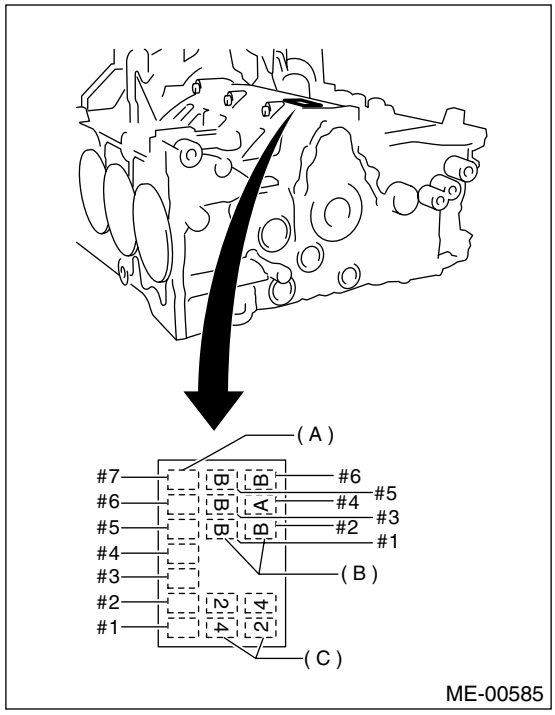
2. CYLINDER AND PISTON

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

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

NOTE:
Standard sized pistons are classified into two grades, “A” and “B”. These grades should be used as a guide line 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)



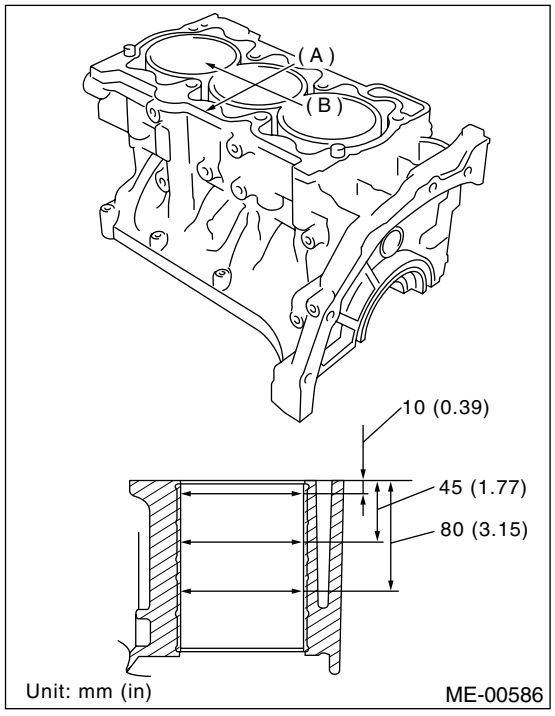
(A) Main journal size mark
(B) Cylinder bore size mark
(C) Cylinder block RH-LH combination mark

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 shown in the figure, using a cylinder bore gauge.

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

Taper:
Limit
0.030 mm (0.0012 in)

Out-of-roundness:
Limit
0.01 mm (0.0004 in)



(A) Thrust direction
(B) Piston pin direction

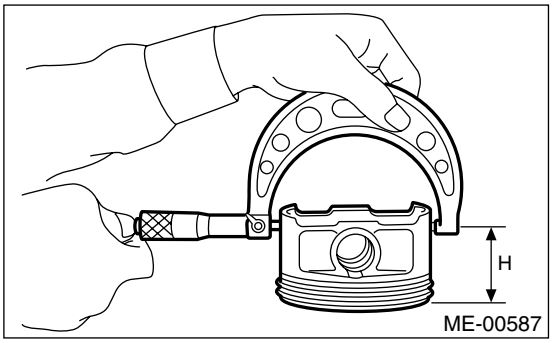
3) When piston is to be replaced due to general or cylinder wear, determine a suitable sized piston by measuring the piston clearance.

4) How to measure the outer diameter of each piston
Measure the outer diameter of each piston at the height shown in the figure. (Thrust direction)

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

Piston grade point H:
39.0 mm (1.535 in)

Piston outer diameter:
Standard
A: 89.185 — 89.195 mm
(3.5112 — 3.5116 in)
B: 89.175 — 89.185 mm
(3.5108 — 3.5112 in)
0.25 mm (0.0098 in) oversize
89.425 — 89.435 mm
(3.5207 — 3.5211 in)
0.50 mm (0.0197 in) oversize
89.675 — 89.685 mm
(3.5305 — 3.5309 in)



5) Calculate the clearance between cylinder and piston.

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

Cylinder to piston clearance at 20°C (68°F):
Standard
0.010 — 0.030 mm (0.0004 — 0.0012 in)

6) Boring and honing
(1) If the value of taper, out-of-roundness, or cylinder-to-piston clearance measured exceeds the specified limit 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 the limit after boring and honing, replace the crankcase.

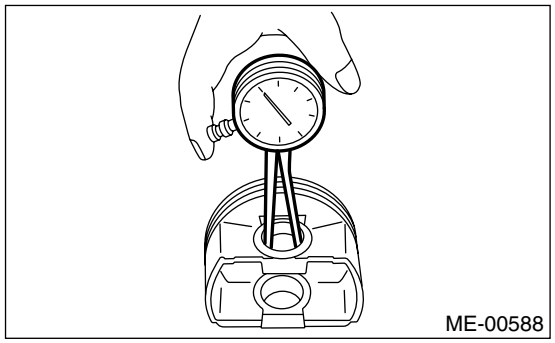
CAUTION:
Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, pay attention to this when measuring the cylinder diameter.

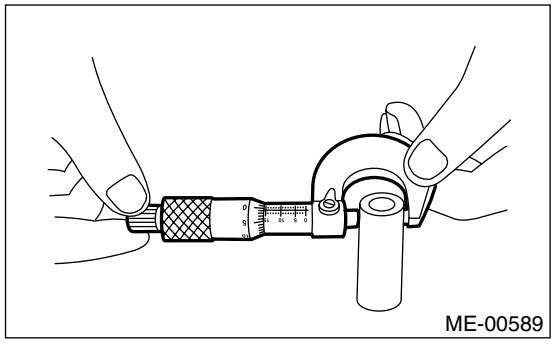
Limit of cylinder enlarging (boring):
0.5 mm (0.020 in)

3. PISTON AND PISTON PIN

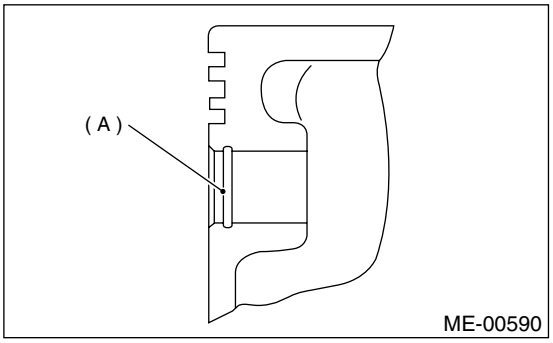
1) Check pistons and piston pins for damage, cracks, and wear and the piston ring grooves for wear and damage. Replace if defective.
2) Measure the piston-to-cylinder clearance at each cylinder. <Ref. to ME(H6DO)-68, CYLINDER AND PISTON, INSPECTION, Cylinder Block.> If any of the clearances is not to specification, replace the piston or bore the cylinder to use an oversize piston.
3) Make sure that 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 circlip installation groove on the piston for burr. If necessary, remove burr (A) from the groove so that piston pin can lightly move.

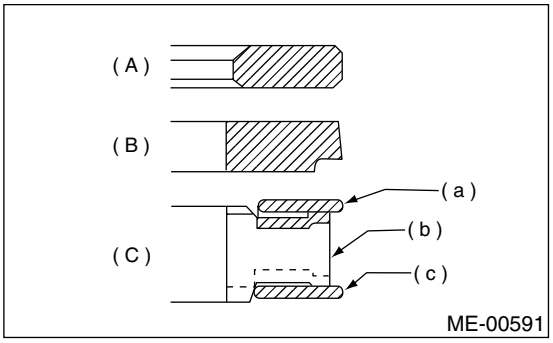


5) Check piston pin circlip for distortion, cracks and wear.

4. PISTON RING

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

CAUTION:
• Marks are shown on the end of the top and second rings. When installing the rings to the piston, face this mark upward.
• The oil ring is a combined ring consisting of two rails and a spacer in between. When installing, be careful to assemble correctly.

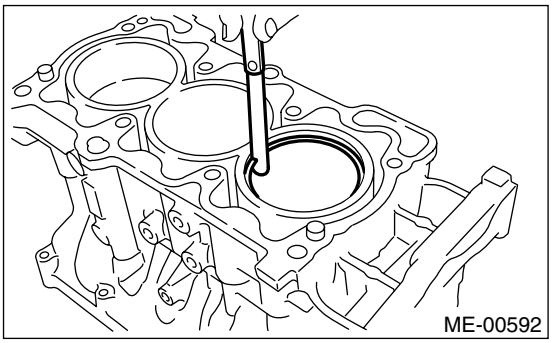


(A) Top ring
(B) Second ring
(C) Oil ring
(a) Upper rail
(b) Expander
(c) Lower rail

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

Unit: mm (in)

		Standard
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 rail	0.20 — 0.60 (0.0079 — 0.0236)

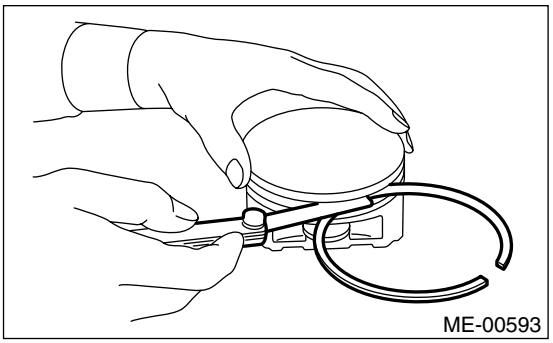


3) Measure the clearance between piston ring and piston ring groove with a thickness gauge.

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

Unit: mm (in)

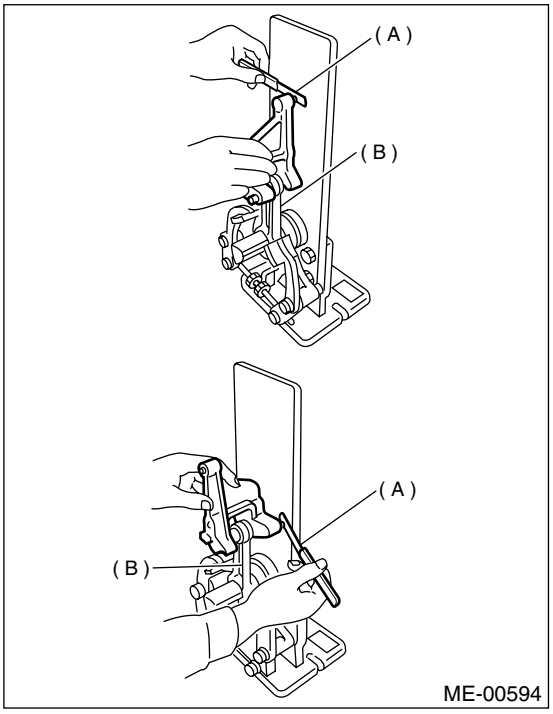
		Standard
Clearance between piston ring and piston ring groove	Top ring	0.040 — 0.080 (0.0016 — 0.0031)
	Second ring	0.030 — 0.070 (0.0012 — 0.0028)
Clearance between oil ring and oil ring groove		0.065 — 0.155 (0.0026 — 0.0061)



5. CONNECTING ROD

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

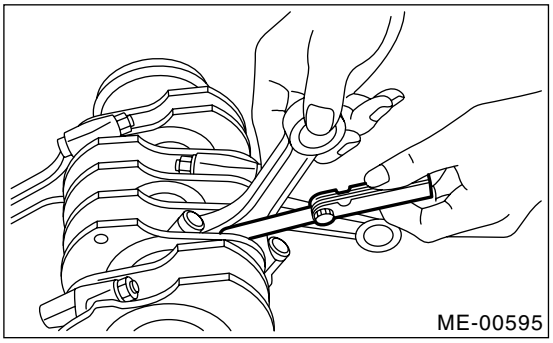
Limit of bend or twist per 100 mm (3.94 in) in length:
0.10 mm (0.0039 in)



(A) Thickness gauge
(B) Connecting rod

3) Install connecting rod fitted with bearing to crankshaft and measure the side clearance (thrust clearance). Replace connecting rod if the side clearance exceeds the specified limit.

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



4) Inspect 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 specification, replace the defective bearing with a new one of standard size or undersize as necessary. (See the table below.)

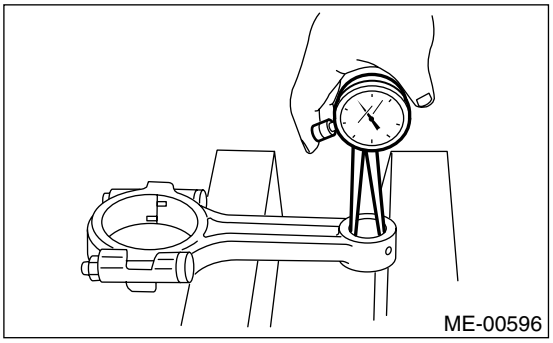
Connecting rod oil clearance:
Standard
0.022 — 0.052 mm (0.0009 — 0.0020 in)

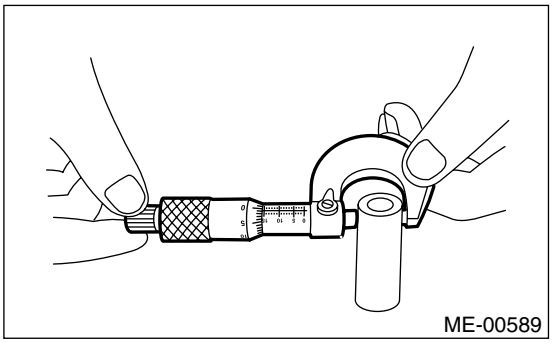
Unit: mm (in)

Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.490 — 1.502 (0.0587 — 0.0591)	51.984 — 52.000 (2.0466 — 2.0472)
0.03 (0.0012) undersize	1.510 — 1.513 (0.0594 — 0.0596)	51.954 — 51.970 (2.0454 — 2.0461)
0.05 (0.0020) undersize	1.520 — 1.523 (0.0598 — 0.0600)	51.934 — 51.950 (2.0446 — 2.0453)
0.25 (0.0098) undersize	1.620 — 1.623 (0.0638 — 0.0639)	51.734 — 51.750 (2.0368 — 2.0374)

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

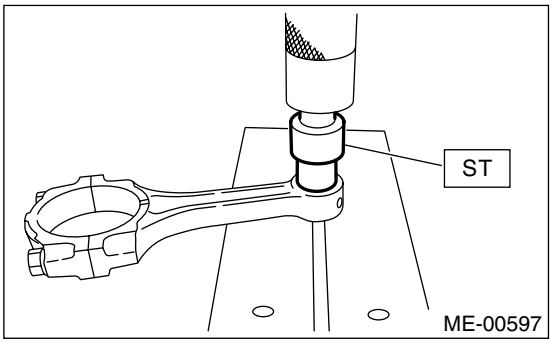
Clearance between piston pin and bushing:
Standard
0 — 0.022 mm (0 — 0.0009 in)


ME-00596


ME-00589

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

ST 18350AA000 CONNECTING ROD BUSHING REMOVER AND INSTALLER



ME-00597

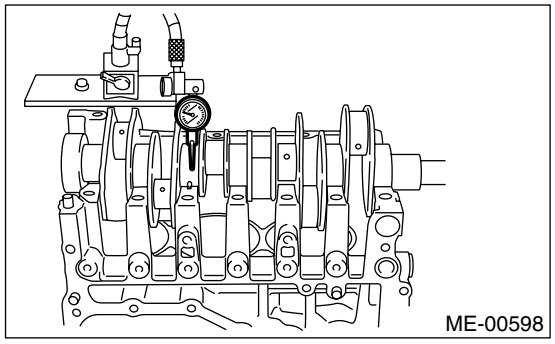
(3) Make two 3 mm (0.12 in) holes in bushing. Ream the inside of bushing.
(4) After completion of reaming, clean bushing to remove chips.

6. CRANKSHAFT AND CRANKSHAFT BEARING

1) Clean crankshaft completely and check for cracks by means of red lead check etc., and replace if defective.
2) Measure the crankshaft bend, and correct or replace if it exceeds the limit.

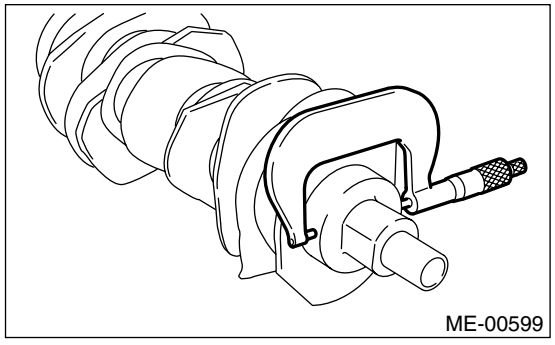
CAUTION:
If a suitable V-block is not available, install #1 and #5 crankshaft bearing on cylinder block, position crankshaft on these bearings and measure crankshaft bend using a dial gauge.

Crankshaft bend limit:
0.035 mm (0.0014 in)


ME-00598

3) Inspect the crank journal and crank pin for wear. If they are not within the specifications, replace bearing with a suitable (undersize) one, and replace or recondition crankshaft as necessary. When grinding 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
0.020 mm (0.0008 in) or less
Grinding limit
0.250 mm (0.0098 in)


ME-00599

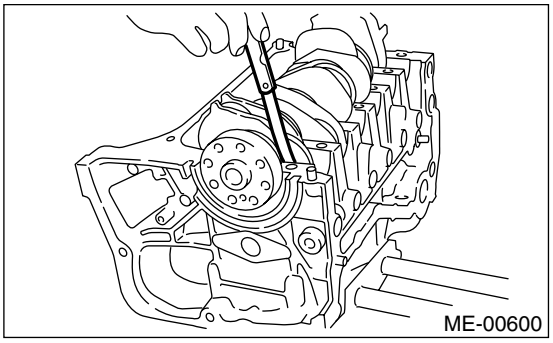
Unit: mm (in)

		Crank journal diameter		Crank pin 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 — 2.000 (0.0786 — 0.0787)	1.490 — 1.502 (0.0587 — 0.0591)
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)	2.017 — 2.020 (0.0794 — 0.0795)	2.019 — 2.020 (0.0795 — 0.0795)	1.510 — 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)	2.027 — 2.030 (0.0798 — 0.0799)	2.029 — 2.032 (0.0799 — 0.0800)	1.520 — 1.523 (0.0598 — 0.0600)
0.25 (0.0098) undersize	Journal O.D.	63.742 — 63.758 (2.5095 — 2.5102)		51.734 — 51.750 (2.0368 — 2.0374)
	Bearing size (Thickness at center)	2.127 — 2.130 (0.0837 — 0.0839)	2.129 — 2.132 (0.0838 — 0.0839)	1.620 — 1.623 (0.0638 — 0.0639)

O.D. ... Outer Diameter

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

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


ME-00600

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 defective bearing with an undersize one, and replace or recondition crankshaft as necessary.

Unit: mm (in)

Crankshaft oil clearance	
Standard	0.010 — 0.030 (0.0004 — 0.0012)

19.Engine Trouble in General

A: INSPECTION

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

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
1. Engine will not start.			
1) Starter does not turn.	• Starter	• Defective battery-to-starter harness	B
		• Defective 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)-2, Basic Diagnostic Procedure.>		A
	• Fuel line	• Defective fuel pump and relay	A
		• Lack of or insufficient fuel	B
	• Chain	• Defective	B
		• Defective timing	B
	• Compression	• Incorrect valve clearance	C
		• Loosened spark plugs or defective gasket	C
		• Loosened cylinder head bolts or defective gasket	C
		• Improper valve seat	C
		• Defective valve stem	C
		• Worn or broken valve spring	B
		• Worn or stuck piston rings, cylinder and piston	C
		• Incorrect valve timing	B
		• Improper engine oil (low viscosity)	B
3) Initial combustion occur.	• Engine control system <Ref. to EN(H6DO)-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	• Defective	B
		• Defective timing	B
	• Compression	• Incorrect valve clearance	C
		• Loosened spark plugs or defective gasket	C
		• Loosened cylinder head bolts or defective gasket	C
		• Improper valve seating	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	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
4) Engine stalls after initial combustion.	• Engine control system <Ref. to EN(H6DO)-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	• Defective	B
		• Defective timing	B
	• Compression	• Incorrect valve clearance	C
		• Loosened spark plugs or defective gasket	C
		• Loosened cylinder head bolts or defective gasket	C
		• Improper valve seating	C
		• Defective valve stem	C
		• Worn or broken valve spring	B
		• Worn or stuck piston rings, cylinder and piston	C
		• Incorrect valve timing	B
		• Improper engine oil (low viscosity)	B
2. Rough idle and engine stall	• Engine control system <Ref. to EN(H6DO)-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 plugs or defective gasket	B
		• Loosened cylinder head bolts or defective gasket	B
		• Improper valve seating	B
		• Defective valve stem	C
		• Worn or broken valve spring	B
		• Worn or stuck piston rings, cylinder and piston	B
		• Incorrect valve timing	A
		• Improper engine oil (low viscosity)	B
	• Lubrication system	• Incorrect oil pressure	B
		• Defective rocker cover gasket	C
	• Cooling system	• Overheating	C
	• Others	• Malfunction of evaporative emission control system	A
		• Stuck or damaged throttle valve	B
		• Improper adjustment of accelerator cable	C

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
3. Low output, hesitation and poor acceleration	• Engine control system <Ref. to EN(H6DO)-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 plugs or defective gasket	B
		• Loosened cylinder head bolts or defective gasket	B
		• Improper valve seat	B
		• Defective valve stem	C
		• Worn or broken valve spring	B
		• Worn or stuck piston rings, cylinder and piston	C
		• Incorrect valve timing	A
		• Improper engine oil (low viscosity)	B
	• Lubrication system	• Incorrect oil pressure	B
	• Cooling system	• Overheating	C
		• Over cooling	C
	• Others	• Malfunction of evaporative emission control system	A
4. Surging	• Engine control system <Ref. to EN(H6DO)-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 plugs or defective gasket	C
		• Loosened cylinder head bolts or defective gasket	C
		• Improper valve seat	C
		• Defective valve stem	C
		• Worn or broken valve spring	C
		• Worn or stuck piston rings, cylinder and piston	C
		• Incorrect valve timing	A
		• Improper engine oil (low viscosity)	B
	• Cooling system	• Overheating	B
	• Others	• Malfunction of evaporative emission control system	C

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
5. Engine does not return to idle.	• Engine control system <Ref. to EN(H6DO)-2, Basic Diagnostic Procedure.>		A
	• Intake system	• Loosened or cracked vacuum hose	A
	• Others	• Stuck or damaged throttle valve	A
		• Improper adjustment of accelerator cable	B
6. Dieseling (Run-on)	• Engine control system <Ref. to EN(H6DO)-2, Basic Diagnostic Procedure.>		A
	• Cooling system	• Overheating	B
	• Others	• Malfunction of evaporative emission control system	B
7. After fire in exhaust system	• Engine control system <Ref. to EN(H6DO)-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 plugs or defective gasket	C
		• Loosened cylinder head bolts or defective gasket	C
		• Improper valve seat	B
		• Defective valve stem	C
		• Worn or broken valve spring	C
		• Worn or stuck piston rings, cylinder and piston	C
		• Incorrect valve timing	A
	• Lubrication system	• Incorrect oil pressure	C
	• Cooling system	• Over cooling	C
	• Others	• Malfunction of evaporative emission control system	C
8. Knocking	• Engine control system <Ref. to EN(H6DO)-2, Basic Diagnostic Procedure.>		A
	• Intake system	• Loosened oil filter cap	B
	• Chain	• Defective timing	B
	• Compression	• Incorrect valve clearance	C
		• Incorrect valve timing	B
	• Cooling system	• Overheating	A
9. Excessive engine oil consumption	• Intake system	• Loosened or cracked PCV hose	A
		• Defective PCV valve	B
		• Loosened oil filler cap	C
	• Compression	• Defective valve stem	A
		• Worn or stuck piston rings, cylinder and piston	A
	• Lubrication system	• Loosened oil pump attaching bolts and defective gasket	B
		• Defective oil filter seal	B
		• Defective crankshaft oil seal	B
		• Defective rocker cover gasket	B
		• Loosened oil drain plug or defective gasket	B
		• Loosened oil pan fitting bolts or defective oil pan	B

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
10. Excessive fuel consumption	• Engine control system <Ref. to EN(H6DO)-2, Basic Diagnostic Procedure.>		A
	• Intake system	• Dirty air cleaner element	A
	• Chain	• Defective timing	B
	• Compression	• Incorrect valve clearance	B
		• Loosened spark plugs or defective gasket	C
		• Loosened cylinder head bolts or defective gasket	C
		• Improper valve seat	B
		• Defective valve stem	C
		• Worn or broken valve spring	C
		• Worn or stuck piston rings, cylinder and piston	B
		• Incorrect valve timing	B
	• Lubrication system	• Incorrect oil pressure	C
	• Cooling system	• Over cooling	C
	• Others	• Improper adjustment of accelerator cable	B

20.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 camshaft • Broken valve spring
Heavy and dull clank	Oil pressure is low.	• Worn crankshaft main bearing • Worn connecting rod bearing (big end)
	Oil pressure is normal.	• Loose flywheel mounting bolts • Damaged engine mounting
High-pitched clank (Spark knock)	Sound is noticeable when accelerating with an overload.	• Ignition timing advanced • Accumulation of carbon inside combustion chamber • Wrong spark plug • Improper gasoline
Clank when engine speed is medium (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 chain noise	—	• Loose timing chain • Chain contacting case/adjacent part
Valve tappet noise	—	• Incorrect valve clearance

NOTE*:
When disconnecting fuel injector connector, Malfunction Indicator Light (CHECK ENGINE light) illuminates and trouble code is stored in ECM memory.
Therefore, carry out the CLEAR MEMORY MODE <Ref. to EN(H6DO)-58, Clear Memory Mode.> and INSPECTION MODE <Ref. to EN(H6DO)-51, Inspection Mode.> after connecting fuel injector connector.