# MECHANICAL

# 1. General Description

## A: SPECIFICATIONS

| | | | | |
|---|---|---|---|---|
| Engine | Model | | | 2.5 L |
| | Type | | | Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine |
| | Valve arrangement | | | Belt driven, single over-head camshaft, 4-valve/cylinder |
| | Bore × Stroke | | mm (in) | 99.5 × 79.0 (3.917 × 3.110) |
| | Displacement | | $cm^3$ (cu in) | 2,457 (150) |
| | Compression ratio | | | 10.0 |
| | Compression pressure (at 350 rpm) | | kPa (kg/$cm^2$, psi) | 1,020 — 1,275 (10.4 — 13.0, 148 — 185) |
| | Number of piston rings | | | Pressure ring: 2, Oil ring: 1 |
| | Intake valve timing | Opening | | 1° BTDC |
| | | Closing | | 51° ABDC |
| | Exhaust valve timing | Opening | | 50° BBDC |
| | | Closing | | 6° ATDC |
| | Valve clearance | STD | Intake mm (in) | 0.20±0.02 (0.0079±0.0008) |
| | | | Exhaust mm (in) | 0.25±0.02 (0.0098±0.0008) |
| | | Limit | Intake mm (in) | 0.20±0.04 (0.0079±0.0016) |
| | | | Exhaust mm (in) | 0.25±0.04 (0.0098±0.0016) |
| | Idling speed [At neutral position on MT, or "P" or "N" position on AT] | | rpm | No load: 650±100 (MT model) 700±100 (AT model)<br>A/C ON: 850±100 |
| | Firing order | | | 1 → 3 → 2 → 4 |
| | Ignition timing | | BTDC/rpm | 10°±8°/650 (MT model)<br>15°±8°/700 (AT model) |

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

| | | | | |
|---|---|---|---|---|
| Belt tensioner adjuster | Protrusion of adjuster rod | | | 5.2 — 6.2 mm (0.205 — 0.244 in) |
| Belt tensioner | Spacer O.D. | | | 17.955 — 17.975 mm (0.7069 — 0.7077 in) |
| | Tensioner bush I.D. | | | 18.00 — 18.08 mm (0.7087 — 0.7118 in) |
| | Clearance between spacer and bush | | STD | 0.025 — 0.125 mm (0.0010 — 0.0049 in) |
| | | | Limit | 0.175 mm (0.0069 in) |
| | Side clearance of spacer | | STD | 0.20 — 0.55 mm (0.0079 — 0.0217 in) |
| | | | Limit | 0.81 mm (0.0319 in) |
| Valve rocker arm | Clearance between shaft and arm | | STD | 0.020 — 0.054 mm (0.0008 — 0.0021 in) |
| | | | Limit | 0.10 mm (0.0039 in) |
| Camshaft | Bend limit | | | 0.025 mm (0.0010 in) |
| | Thrust clearance | | STD | 0.030 — 0.090 mm (0.0012 — 0.0035 in) |
| | | | Limit | 0.10 mm (0.0039 in) |
| | Cam lobe height | Intake | STD | 39.485 — 39.585 mm (1.5545 — 1.5585 in) |
| | | | Limit | 39.385 mm (1.5506 in) |
| | | Exhaust | STD | 39.257 — 39.357 mm (1.5455 — 1.5495 in) |
| | | | Limit | 39.157 mm (1.5416 in) |
| | Camshaft journal O.D. | | | 31.928 — 31.945 mm (1.2570 — 1.2577 in) |
| | Camshaft journal hole I.D. | | | 32.000 — 32.018 mm (1.2598 — 1.2605 in) |
| | Oil clearance | | STD | 0.055 — 0.090 mm (0.0022 — 0.0035 in) |
| | | | Limit | 0.10 mm (0.0039 in) |

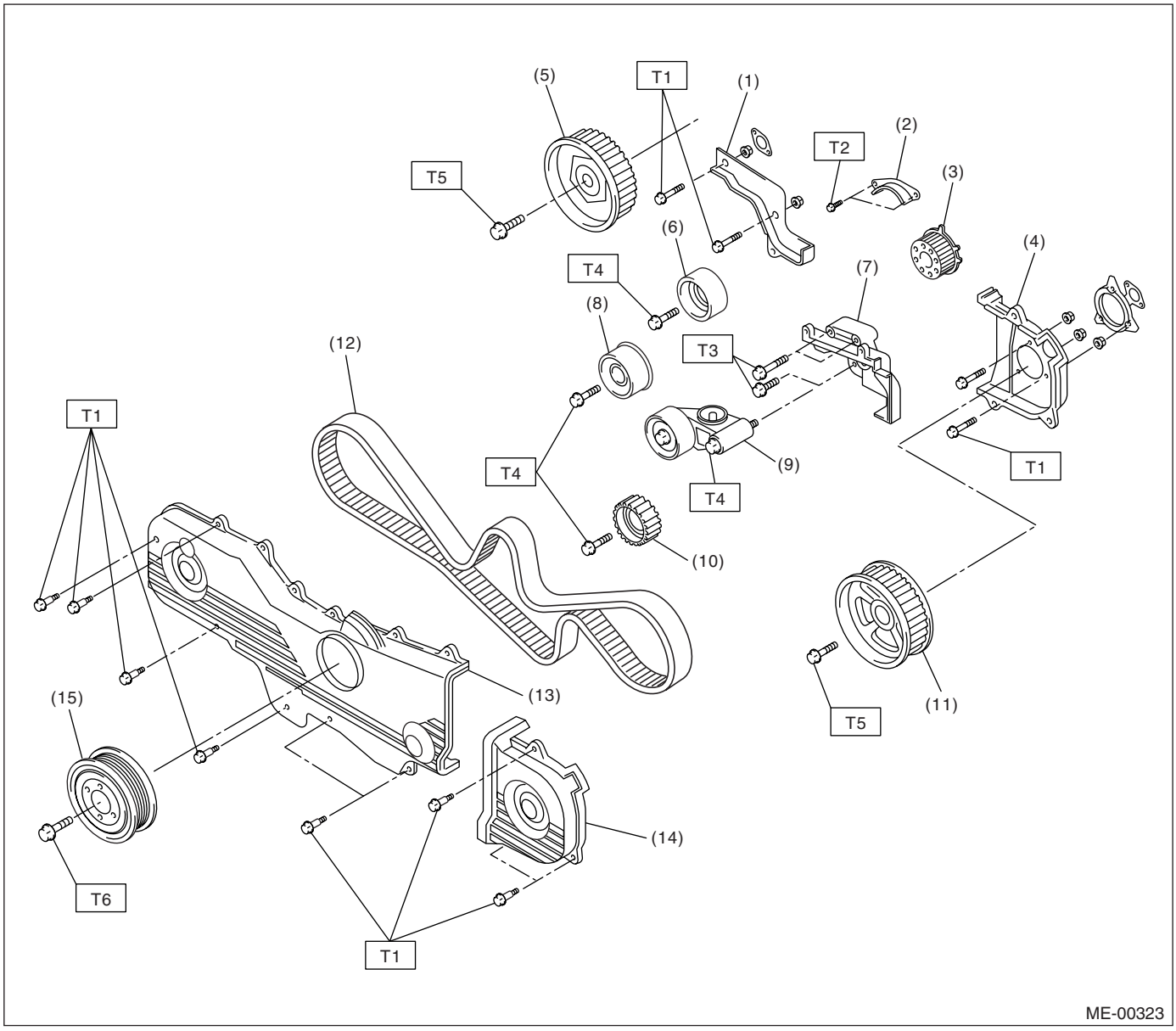
| | | | | |
|---|---|---|---|---|
| Cylinder head | Surface warpage limit | | | 0.05 mm (0.0020 in) |
| | Surface grinding limit | | | 0.1 mm (0.004 in) |
| | Standard height | | | 97.5 mm (3.84 in) |
| Valve seat | Refacing angle | | | 90° |
| | Contacting width | Intake | STD | 1.0 mm (0.039 in) |
| | | | 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 | | | 6.000 — 6.012 mm (0.2362 — 0.2367 in) |
| | Protrusion above head | | Intake | 20.0 — 20.5 mm (0.787 — 0.807 in) |
| | | | Exhaust | 16.5 — 17.0 mm (0.650 — 0.669 in) |
| Valve | Head edge thickness | Intake | STD | 1.0 mm (0.039 in) |
| | | | Limit | 0.6 mm (0.024 in) |
| | | Exhaust | STD | 1.2 mm (0.047 in) |
| | | | Limit | 0.6 mm (0.024 in) |
| | Stem diameter | | Intake | 5.950 — 5.965 mm (0.2343 — 0.2348 in) |
| | | | Exhaust | 5.945 — 5.960 mm (0.2341 — 0.2346 in) |
| | Stem oil clearance | STD | Intake | 0.035 — 0.062 mm (0.0014 — 0.0024 in) |
| | | | Exhaust | 0.040 — 0.067 mm (0.0016 — 0.0026 in) |
| | | Limit | — | 0.15 mm (0.0059 in) |
| | Overall length | | Intake | 120.6 mm (4.75 in) |
| | | | Exhaust | 121.7 mm (4.79 in) |
| Valve spring | Free length | | | 54.30 mm (2.1378 in) |
| | Squareness | | | 2.5°, 2.4 mm (0.094 in) |
| | Tension/spring height | | Set | 214 — 246 N (22 — 25 kgf, 48 — 55 lb)/ 45.0 mm (1.772 in) |
| | | | Lift | 526 — 582 N (54 — 59 kgf, 119 — 130 lb)/ 34.7 mm (1.366 in) |
| Cylinder block | Surface warpage limit (mating with cylinder head) | | | 0.05 mm (0.0020 in) |
| | Surface grinding limit | | | 0.1 mm (0.004 in) |
| | Standard height | | | 201.0 mm (7.91 in) |
| | Cylinder bore | STD | A | 99.505 — 99.515 mm (3.9175 — 3.9179 in) |
| | | | B | 99.495 — 99.505 mm (3.9171 — 3.9175 in) |
| | Taper | | STD | 0.015 mm (0.0006 in) |
| | | | Limit | 0.050 mm (0.0020 in) |
| | Out-of-roundness | | STD | 0.010 mm (0.0004 in) |
| | | | Limit | 0.050 mm (0.0020 in) |
| | Piston clearance | | STD | 0.010 — 0.030 mm (0.0004 — 0.0012 in) |
| | | | Limit | 0.050 mm (0.0020 in) |
| | Enlarging (boring) limit | | | 0.5 mm (0.020 in) |
| Piston | Outer diameter | STD | A | 99.485 — 99.495 mm (3.9167 — 3.9171 in) |
| | | | B | 99.475 — 99.485 mm (3.9163 — 3.9167 in) |
| | | 0.25 mm (0.0098 in) OS | | 99.725 — 99.735 mm (3.9262 — 3.9266 in) |
| | | 0.50 mm (0.0197 in) OS | | 99.975 — 99.985 mm (3.9360 — 3.9364 in) |
| | Standard inner diameter of piston pin hole | | | 23.000 — 23.006 mm (0.9055 — 0.9057 in) |
| Piston pin | Outer diameter | | | 22.994 — 23.000 mm (0.9053 — 0.9055 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) |
| | | | Limit | 1.0 mm (0.039 in) |
| | | Second ring | STD | 0.35 — 0.50 mm (0.0138 — 0.0197 in) |
| | | | Limit | 1.0 mm (0.039 in) |
| | | Oil ring | STD | 0.20 — 0.50 mm (0.0079 — 0.0197 in) |
| | | | Limit | 1.5 mm (0.059 in) |
| | Clearance between piston ring and piston ring groove | Top ring | STD | 0.040 — 0.080 mm (0.0016 — 0.0031 in) |
| | | | Limit | 0.15 mm (0.0059 in) |
| | | Second ring | STD | 0.030 — 0.070 mm (0.0012 — 0.0028 in) |
| | | | Limit | 0.15 mm (0.0059 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) |
| | | | Limit | 0.4 mm (0.016 in) |
| Connecting rod bearing | Oil clearance | | STD | 0.012 — 0.038 mm (0.0005 — 0.0014 in) |
| | | | Limit | 0.05 mm (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 | 1.504 — 1.512 mm (0.0592 — 0.0595 in) |
| | | | 0.05 mm (0.0020 in) US | 1.514 — 1.522 mm (0.0596 — 0.0599 in) |
| | | | 0.25 mm (0.0098 in) US | 1.614 — 1.622 mm (0.0635 — 0.0639 in) |
| Connecting rod bushing | Clearance between piston pin and bushing | | STD | 0 — 0.022 mm (0 — 0.0009 in) |
| | | | Limit | 0.030 mm (0.0012 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 | STD | 59.992 — 60.008 mm (2.3619 — 2.3625 in) |
| | | | 0.03 mm (0.0012 in) US | 59.962 — 59.978 mm (2.3607 — 2.3613 in) |
| | | | 0.05 mm (0.0020 in) US | 59.942 — 59.958 mm (2.3599 — 2.3605 in) |
| | | | 0.25 mm (0.0098 in) US | 59.742 — 59.758 mm (2.3520 — 2.3527 in) |
| | | #2, #4, #5 | STD | 59.992 — 60.008 mm (2.3619 — 2.3625 in) |
| | | | 0.03 mm (0.0012 in) US | 59.962 — 59.978 mm (2.3607 — 2.3613 in) |
| | | | 0.05 mm (0.0020 in) US | 59.942 — 59.958 mm (2.3599 — 2.3605 in) |
| | | | 0.25 mm (0.0098 in) US | 59.742 — 59.758 mm (2.3520 — 2.3527 in) |
| | Thrust clearance | | STD | 0.030 — 0.115 mm (0.0012 — 0.0045 in) |
| | | | Limit | 0.25 mm (0.0098 in) |
| | Oil clearance | #1 | STD | 0.010 — 0.030 mm (0.0004 — 0.0012 in) |
| | | | Limit | 0.040 mm (0.0016 in) |
| | | #2 | STD | 0.010 — 0.030 mm (0.0004 — 0.0012 in) |
| | | | Limit | 0.045 mm (0.0018 in) |
| | | #3 | STD | 0.010 — 0.030 mm (0.0004 — 0.0012 in) |
| | | | Limit | 0.040 mm (0.0016 in) |
| | | #4 | STD | 0.010 — 0.030 mm (0.0004 — 0.0012 in) |
| | | | Limit | 0.045 mm (0.0018 in) |
| | | #5 | STD | 0.010 — 0.030 mm (0.0004 — 0.0012 in) |
| | | | Limit | 0.040 mm (0.0016 in) |
| Crankshaft bearing | Crankshaft bearing thickness | #1, #3 | STD | 1.998 — 2.011 mm (0.0787 — 0.0792 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 | 2.000 — 2.013 mm (0.0787 — 0.0793 in) |
| | | | 0.03 mm (0.0012 in) US | 2.019 — 2.022 mm (0.0795 — 0.0796 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

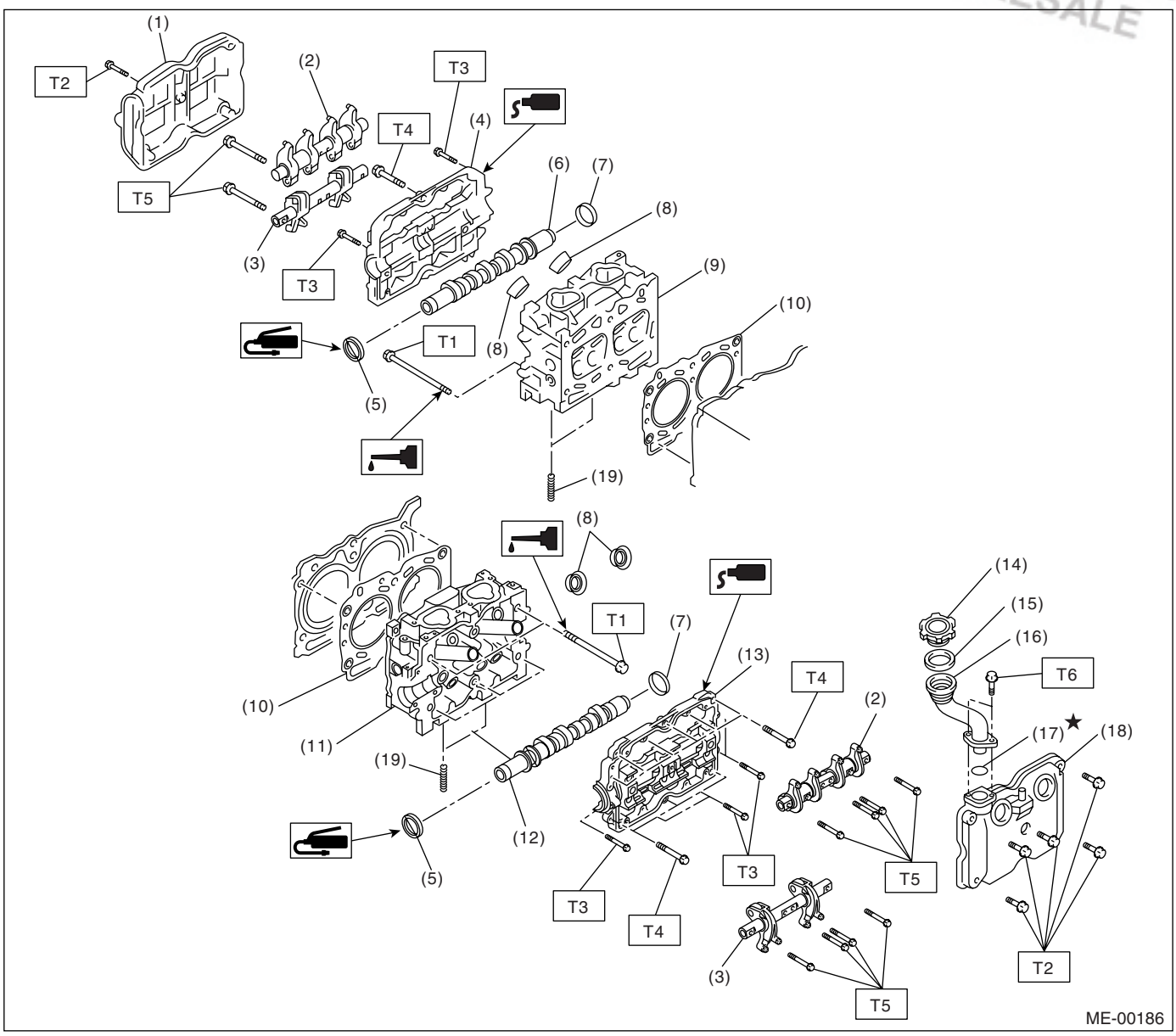
### 1. TIMING BELT




(1) Timing belt cover No. 2 (RH)
(2) Timing belt guide (MT model)
(3) Crankshaft sprocket
(4) Timing belt cover No. 2 (LH)
(5) Camshaft sprocket No. 1
(6) Belt idler (No. 1)
(7) Tensioner bracket
(8) Belt idler (No. 2)
(9) Automatic belt tension adjuster ASSY
(10) Belt idler No. 2
(11) Camshaft sprocket No. 2
(12) Timing belt
(13) Front timing belt cover
(14) Timing belt cover (LH)
(15) Crankshaft pulley

***Tightening torque: N·m (kgf-m, ft-lb)***
***T1: 5 (0.5, 3.6)***
***T2: 10 (1.0, 7.2)***
***T3: 25 (2.5, 18.1)***
***T4: 39 (4.0, 28.9)***
***T5: 78 (8.0, 57.9)***
***T6: <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>***

## 2. CYLINDER HEAD AND CAMSHAFT

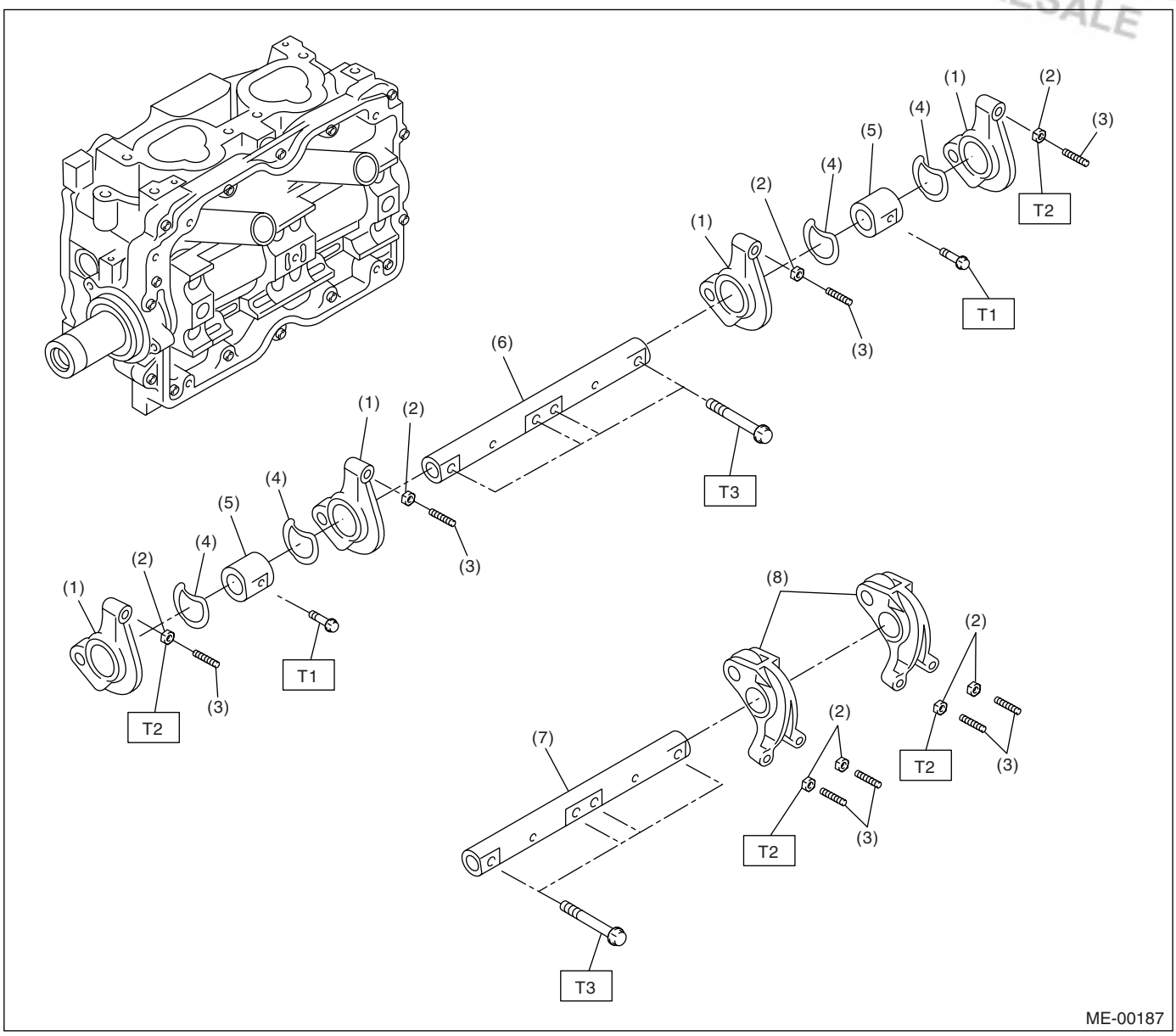



(1) Rocker cover (RH)
(2) Intake valve rocker ASSY
(3) Exhaust valve rocker ASSY
(4) Camshaft cap (RH)
(5) Oil seal
(6) Camshaft (RH)
(7) Plug
(8) Spark plug pipe gasket
(9) Cylinder head (RH)
(10) Cylinder head gasket
(11) Cylinder head (LH)
(12) Camshaft (LH)
(13) Camshaft cap (LH)
(14) Oil filler cap
(15) Gasket
(16) Oil filler duct
(17) O-ring
(18) Rocker cover (LH)
(19) Stud bolt

***Tightening torque: N·m (kgf-m, ft-lb)***

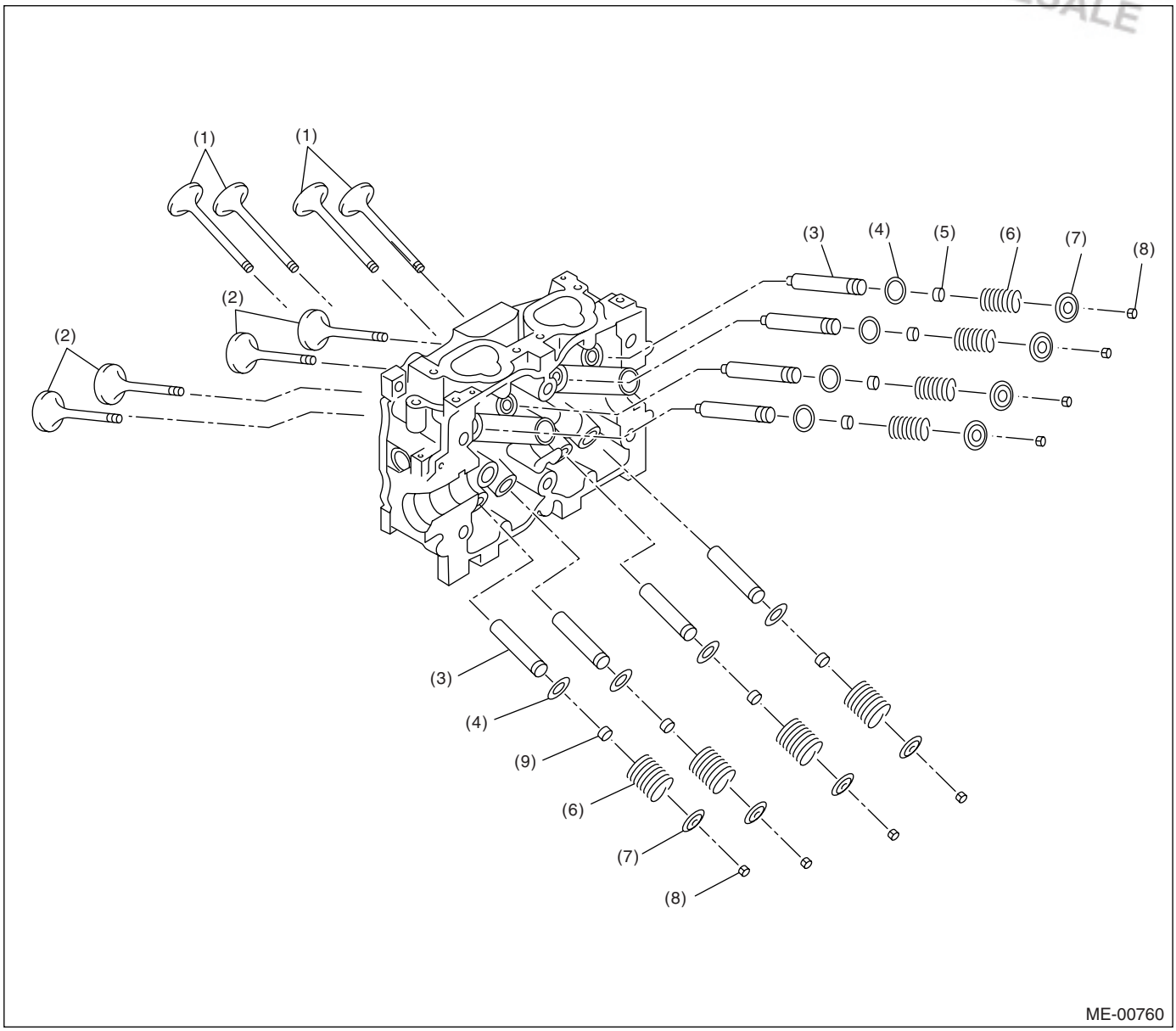
***T1: <Ref. to ME(H4SO)-58, INSTALLATION, Cylinder Head Assembly.>***
***T2: 5 (0.5, 3.6)***
***T3: 10 (1.0, 7.2)***
***T4: 18 (1.8, 13.0)***
***T5: 25 (2.5, 18.1)***
***T6: 6.4 (0.65, 4.7)***

## 3. VALVE ROCKER ASSEMBLY



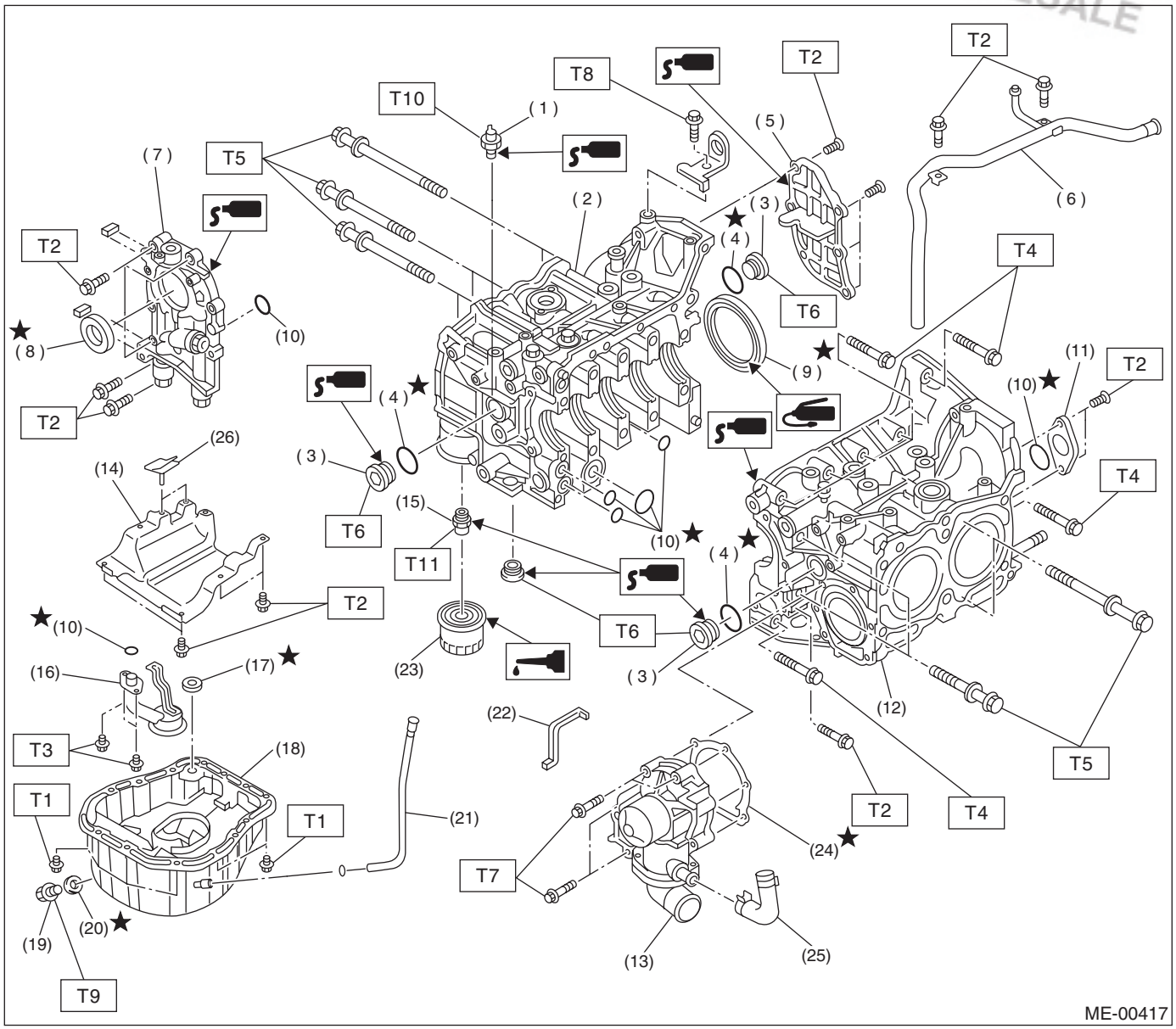

| | | | | |
|---|---|---|---|---|
| (1) | Intake valve rocker arm | (5) | Rocker shaft support | ***Tightening torque: N·m (kgf-m, ft-lb)*** |
| (2) | Valve rocker nut | (6) | Intake rocker shaft | ***T1: 5 (0.5, 3.6)*** |
| (3) | Valve rocker adjust screw | (7) | Exhaust rocker shaft | ***T2: 10 (1.0, 7.2)*** |
| (4) | Spring | (8) | Exhaust valve rocker arm | ***T3: 25 (2.5, 18.1)*** |

## 4. CYLINDER HEAD AND VALVE ASSEMBLY




(1) Exhaust valve
(2) Intake valve
(3) Valve guide
(4) Valve spring seat
(5) Intake valve oil seal
(6) Valve spring
(7) Retainer
(8) Retainer key
(9) Exhaust valve oil seal

## 5. CYLINDER BLOCK

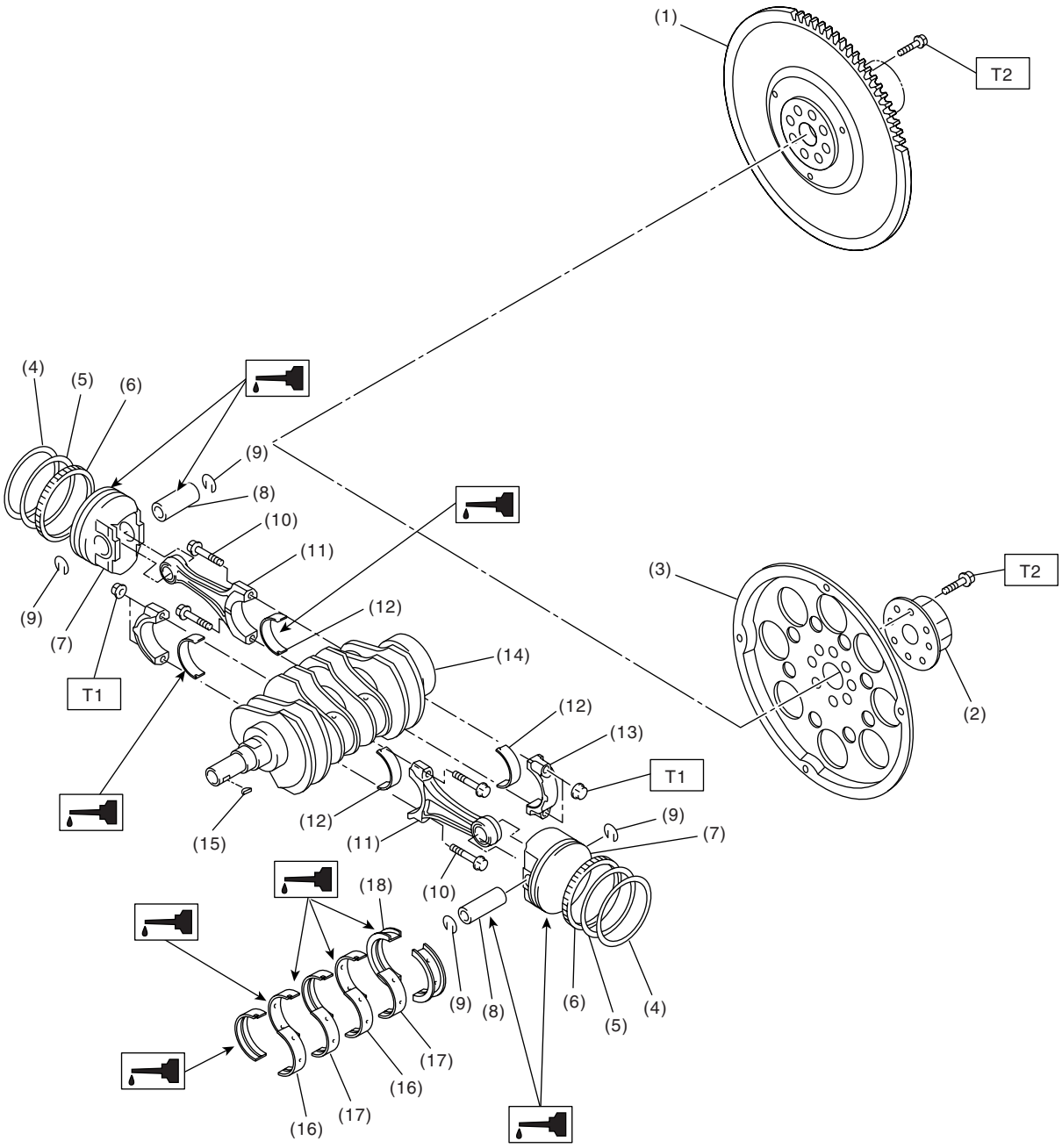



(1) Oil pressure switch
(2) Cylinder block (RH)
(3) Service hole plug
(4) Gasket
(5) Oil separator cover
(6) Water by-pass pipe
(7) Oil pump
(8) Front oil seal
(9) Rear oil seal
(10) O-ring
(11) Service hole cover
(12) Cylinder block (LH)
(13) Water pump
(14) Baffle plate
(15) Oil filter connector
(16) Oil strainer
(17) Gasket
(18) Oil pan
(19) Drain plug
(20) Metal gasket
(21) Oil level gauge guide
(22) Water pump sealing
(23) Oil filter
(24) Gasket
(25) Water pump hose
(26) Seal

***Tightening torque: N·m (kgf-m, ft-lb)***

***T1: 5 (0.5, 3.6)***
***T2: 6.4 (0.65, 4.7)***
***T3: 10 (1.0, 7.2)***
***T4: 25 (2.5, 18.1)***
***T5: <Ref. to ME(H4SO)-68, INSTALLATION, Cylinder Block.>***
***T6: 70 (7.1, 50.6)***
***T7: First 12 (1.2, 8.7)***
***Second 12 (1.2, 8.7)***
***T8: 16 (1.6, 11.6)***
***T9: 44 (4.5, 33)***
***T10: 25 (2.5, 18.1)***
***T11: 45 (4.6, 33.3)***

## 6. CRANKSHAFT AND PISTON

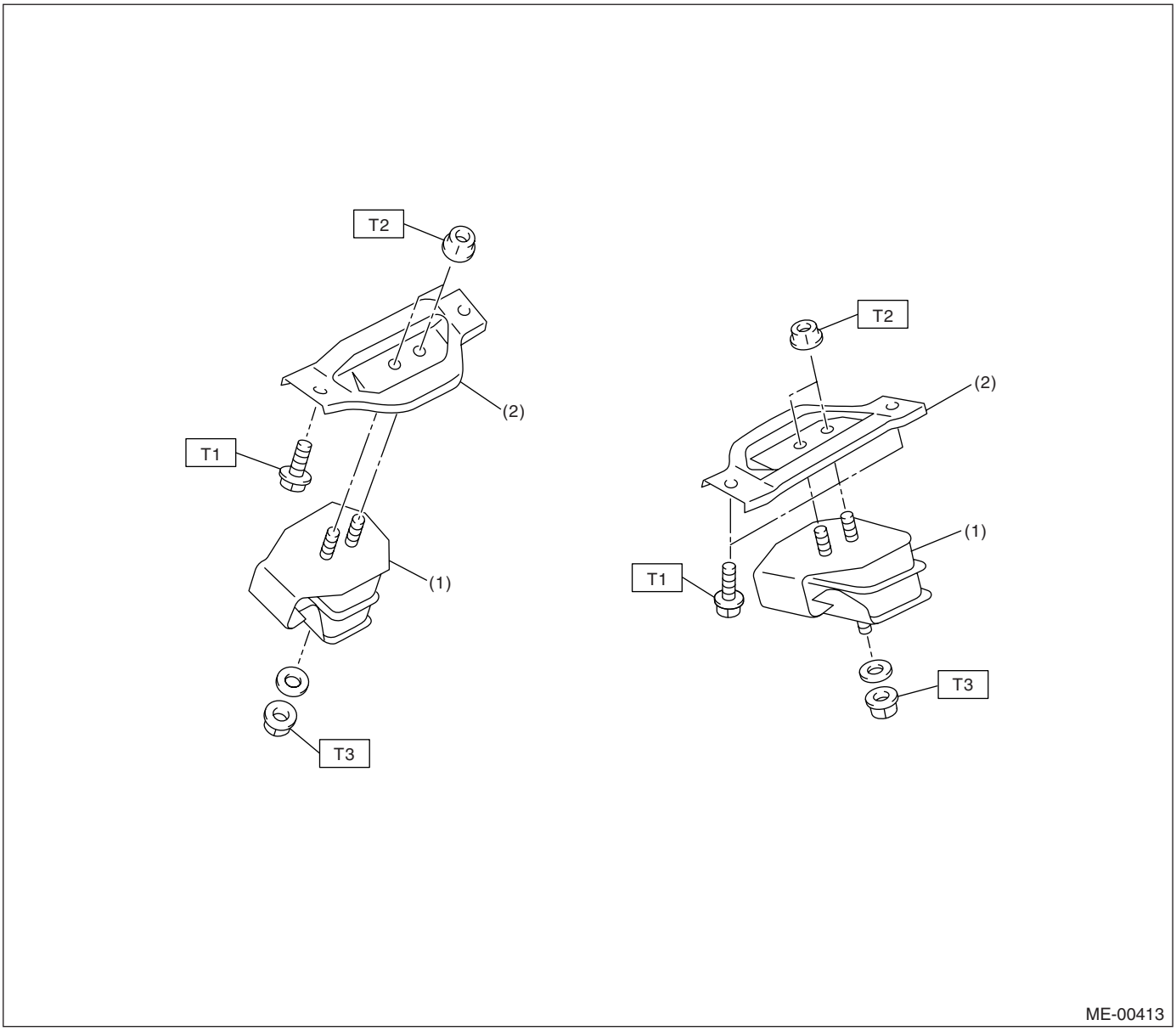



ME-00190

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

***Tightening torque: N·m (kgf-m, ft-lb)***
***T1: 45 (4.6, 33.3)***
***T2: 72 (7.3, 52.8)***

## 7. ENGINE MOUNTING




(1) Front cushion rubber
(2) Front engine mounting bracket

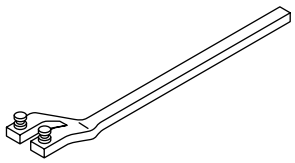
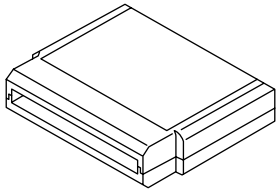
***Tightening torque: N·m (kgf-m, ft-lb)***
***T1: 35 (3.6, 25.8)***
***T2: 42 (4.3, 31.0)***
***T3: 85 (8.7, 63)***

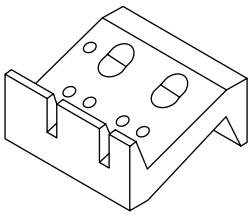
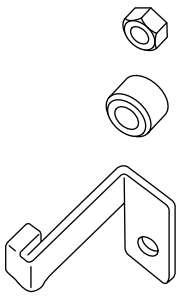
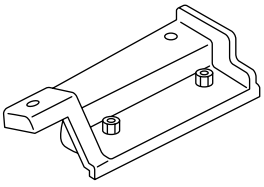
## C: CAUTION

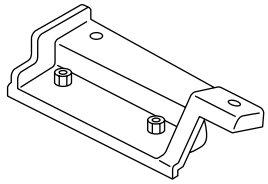
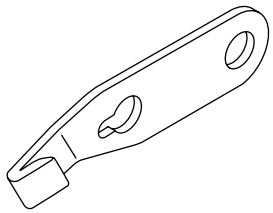
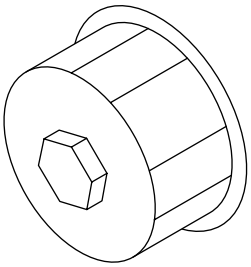
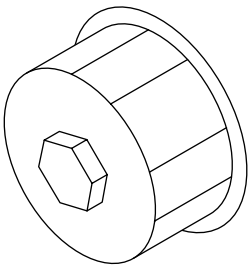
• Wear working clothing, including a cap, protective goggles, and protective shoes during operation.
• Remove contamination including dirt and corrosion before removal, installation or disassembly.
• Keep the disassembled parts in order and protect them from dust or dirt.
• Before removal, installation 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 the 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 timing belt, 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.

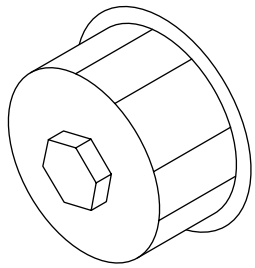
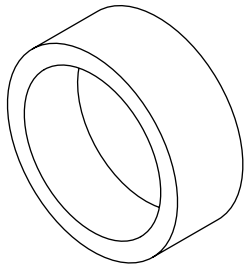
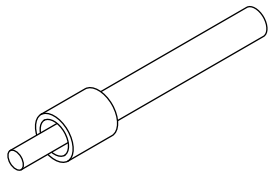
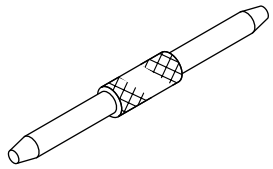
## D: PREPARATION TOOL

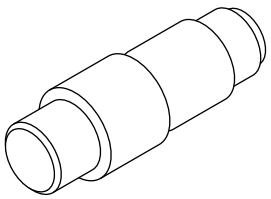
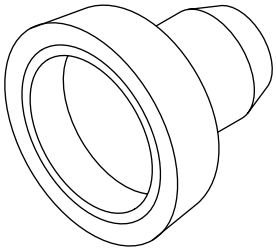
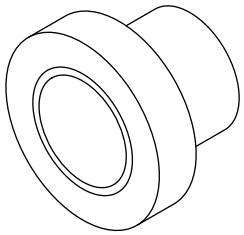
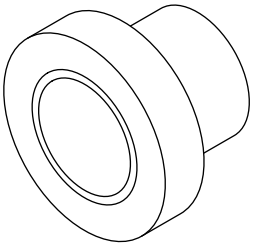
### 1. SPECIAL TOOLS

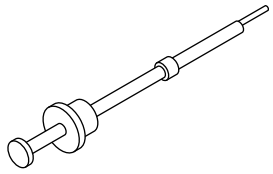
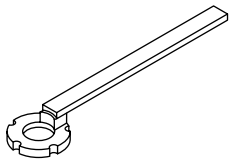
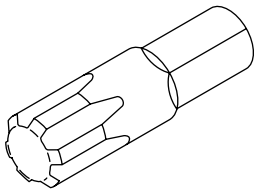
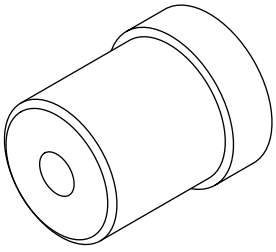
| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST18231AA010 | 18231AA010 | CAMSHAFT SPROCKET WRENCH | • Used for removing and installing camshaft sprocket. (LH side)<br>• Also the CAMSHAFT SPROCKET WRENCH (499207100) can be used. |
|  ST24082AA230 | 24082AA230 | CARTRIDGE | Troubleshooting for electrical systems. |

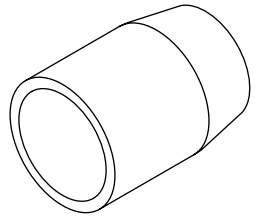
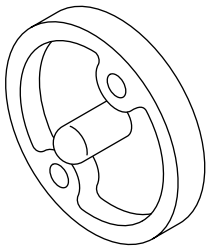
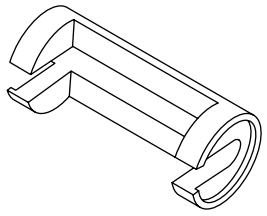
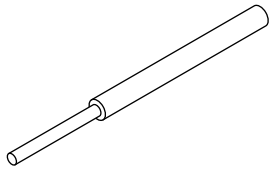
| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST22771AA030 | 22771AA030 | SUBARU SELECT MONITOR KIT | Troubleshooting for electrical systems. |
|  ST-498267800 | 498267800 | CYLINDER HEAD TABLE | • Used for replacing valve guides.<br>• Used for removing and installing valve springs. |
|  ST-498277200 | 498277200 | STOPPER SET | Used for installing automatic transmission assembly to engine. |
|  ST-498457000 | 498457000 | ENGINE STAND ADAPTER RH | Used with ENGINE STAND (499817100). |

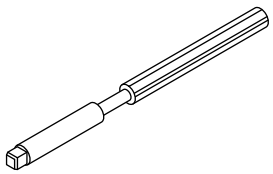
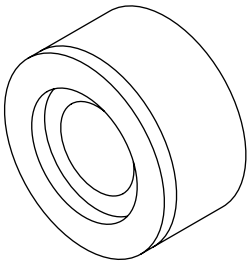
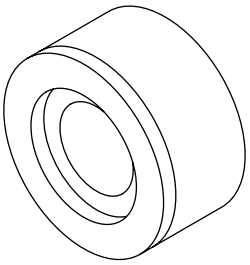
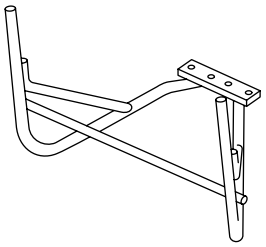
| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST-498457100 | 498457100 | ENGINE STAND ADAPTER LH | Used with ENGINE STAND (499817100). |
|  ST-498497100 | 498497100 | CRANKSHAFT STOPPER | Used for stopping rotation of flywheel when loosening and tightening crankshaft pulley bolt, etc. |
|  ST-498547000 | 498547000 | OIL FILTER WRENCH | Used for removing and installing oil filter. (Outer diameter: 80 mm (3.15 in)) |
|  ST18332AA000 | 18332AA000 | OIL FILTER WRENCH | Used for removing and installing oil filter. (Outer diameter: 68 mm (2.68 in)) |

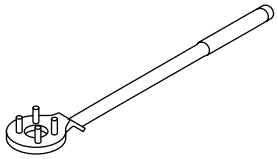
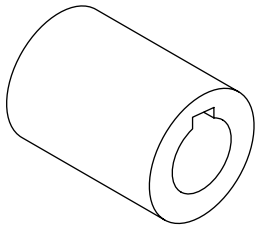
| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST18332AA010 | 18332AA010 | OIL FILTER WRENCH | Used for removing and installing oil filter. (Outer diameter: 65 mm (2.56 in)) |
|  ST-498747300 | 498747300 | PISTON GUIDE | Used for installing piston in cylinder. (2.5 L model) |
|  ST-498857100 | 498857100 | VALVE OIL SEAL GUIDE | Used for press-fitting of intake and exhaust valve guide oil seals. |
|  ST-499017100 | 499017100 | PISTON PIN GUIDE | Used for installing piston pin, piston and connecting rod. |

| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST-499037100 | 499037100 | CONNECTING ROD BUSHING REMOVER & INSTALLER | Used for removing and installing connecting rod bushing. |
|  ST-499587200 | 499587200 | CRANKSHAFT OIL SEAL INSTALLER | • Used for installing crankshaft oil seal.<br>• Used with CRANKSHAFT OIL SEAL GUIDE (499597100). |
|  ST-499587500 | 499587500 | OIL SEAL INSTALLER | • Used for installing camshaft oil seal.<br>• Used with OIL SEAL GUIDE (499597000). |
|  ST-499587700 | 499587700 | CAMSHAFT OIL SEAL INSTALLER | Used for installing cylinder head plug. |

| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST-499097700 | 499097700 | PISTON PIN REMOVER ASSY | Used for removing piston pin. |
|  ST-499207400 | 499207400 | CAMSHAFT SPROCKET WRENCH | Used for removing and installing camshaft sprocket. (RH side) |
|  ST-499497000 | 499497000 | TORX® PLUS | Used for removing and installing camshaft cap. |
|  ST-499587100 | 499587100 | OIL SEAL INSTALLER | Used for installing oil pump oil seal. |

| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST-499597000 | 499597000 | OIL SEAL GUIDE | • Used for installing camshaft oil seal.<br>• Used with CAMSHAFT OIL SEAL INSTALLER (499587500). |
|  ST-499597100 | 499597100 | CRANKSHAFT OIL SEAL GUIDE | • Used for installing crankshaft oil seal.<br>• Used with CRANKSHAFT OIL SEAL INSTALLER (499587200). |
|  ST-499718000 | 499718000 | VALVE SPRING REMOVER | Used for removing and installing valve spring. |
|  ST-499767200 | 499767200 | VALVE GUIDE REMOVER | Used for removing valve guides. |

| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST-499767400 | 499767400 | VALVE GUIDE REAMER | Used for reaming valve guides. |
|  ST-499767700 | 499767700 | VALVE GUIDE ADJUSTER | Used for installing valve guide. (Intake side) |
|  ST-499767800 | 499767800 | VALVE GUIDE ADJUSTER | Used for installing valve guide. (Exhaust side) |
|  ST-499817100 | 499817100 | ENGINE STAND | • Stand used for engine disassembly and assembly.<br>• Used with ENGINE STAND ADAPTER RH (498457000) & LH (498457100). |

| ILLUSTRATION | TOOL NUMBER | DESCRIPTION | REMARKS |
|---|---|---|---|
|  ST-499977100 | 499977100 | CRANKSHAFT PULLEY WRENCH | Used for stopping rotation of crankshaft pulley when loosening and tightening crankshaft pulley bolts. (2.5 L model) |
|  ST-499987500 | 499987500 | CRANKSHAFT SOCKET | Used for rotating crankshaft. |

### 2. GENERAL PURPOSE TOOLS

| TOOL NAME | REMARKS |
|---|---|
| Compression Gauge | Used for measuring compression. |
| Tachometer (Secondary pick-up type) | Used for measuring idle speed. |
| Timing Light | Used for measuring ignition timing. |

## 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.

- V-belt
- Timing Belt
- Valve Rocker Assembly
- Camshaft
- Cylinder Head

# 2. Compression

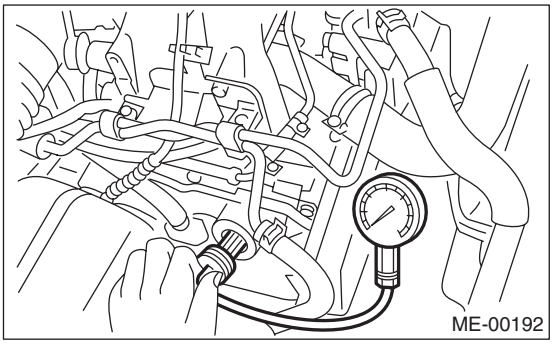
## A: INSPECTION

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

1) After warming up the engine, turn the ignition switch to OFF.
2) Make sure that the battery is fully charged.
3) Release the fuel pressure. <Ref. to FU(H4SO)-47, RELEASING OF FUEL PRESSURE, PROCEDURE, Fuel.>
4) Remove all the spark plugs. <Ref. to IG(H4SO)-4, REMOVAL, Spark Plug.>
5) Fully open the throttle valve.
6) Check the starter motor for satisfactory performance and operation.
7) Hold the compression gauge tight against spark plug hole.

NOTE:
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.

8) Crank the engine by means of starter motor, and then read the maximum value on the gauge when the pointer is steady.



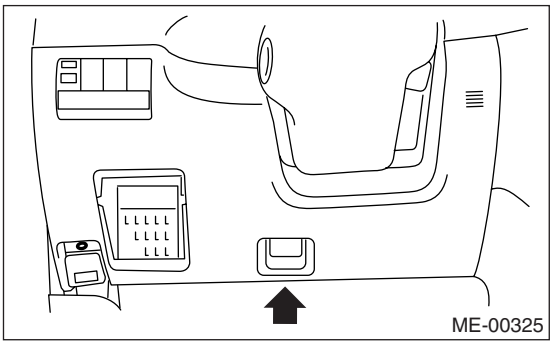

9) Perform at least two measurements per cylinder, and make sure that the values are correct.

***Compression (350 rpm and fully open throttle):***
***Standard;***
***1,275 kPa (13.0 kgf/cm$^2$, 185 psi)***
***Limit;***
***1,020 kPa (10.4 kgf/cm$^2$, 148 psi)***
***Difference between cylinders;***
***49 kPa (0.5 kgf/cm$^2$, 7 psi), or less***

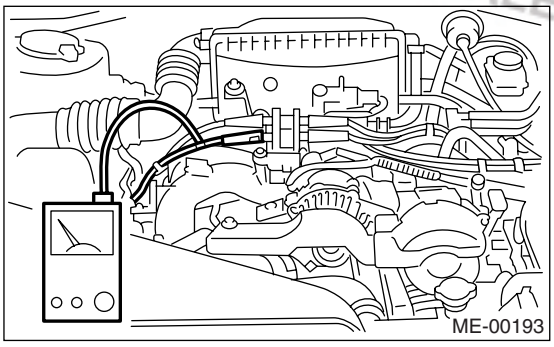
# 3. Idle Speed

## A: INSPECTION

1) Before checking idle speed, check the following:
   (1) Ensure the air cleaner element is free from clogging, ignition timing is correct, spark plugs are in good condition, and the hoses are connected properly.
   (2) Ensure the malfunction indicator light does not illuminate.
2) Warm up the engine.
3) Stop the engine, and then turn the ignition switch to OFF.
4) When using the SUBARU SELECT MONITOR, refer to the following. <Ref. to ME(H4SO)-13, SPECIAL TOOLS, PREPARATION TOOL, General Description.>
   (1) Insert the cartridge to SUBARU SELECT MONITOR.
   (2) Connect the SUBARU SELECT MONITOR to data link connector.




   (3) Turn the ignition switch to ON, and turn the SUBARU SELECT MONITOR switch to ON.
   (4) Select the {2. Each System Check} in Main Menu.
   (5) Select the {Engine Control System} in Selection Menu.
   (6) Select the {1. Current Data Display & Save} in Engine Control System Diagnosis.
   (7) Select the {1.12 Data Display} in Data Display Menu.
   (8) Start the engine, and then read the engine idle speed.
5) When using the tachometer (Secondary pick-up type).
   (1) Attach the pick-up clip to No. 1 cylinder spark plug cord.
   (2) Start the engine, and then read the engine idle speed.




NOTE:
• When using the OBD-II general scan tool, carefully read its operation manual.
• This ignition system provides simultaneous ignition for #1 and #2 plugs. It must be noted that some tachometers may register twice that of actual engine speed.

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

***Idle speed [No load and gears in neutral (MT model), or N or P (AT model) range]:***
***650±100 rpm (MT model)***
***700±100 rpm (AT model)***

7) Check the idle speed when loaded. (Turn the air conditioning switch to “ON” and operate the compressor for at least 1 minute before measurement.)

***Idle speed [A/C “ON” and gears in neutral (MT model) or N or P (AT model) range]:***
***850±100 rpm***

NOTE:
Idle speed can not be adjusted manually, because the idle speed is automatically adjusted.
If the specified idle speed can not be maintained, refer to General On-board Diagnosis Table under “Engine Control System”. <Ref. to EN(H4SO)(diag)-2, Basic Diagnostic Procedure.>

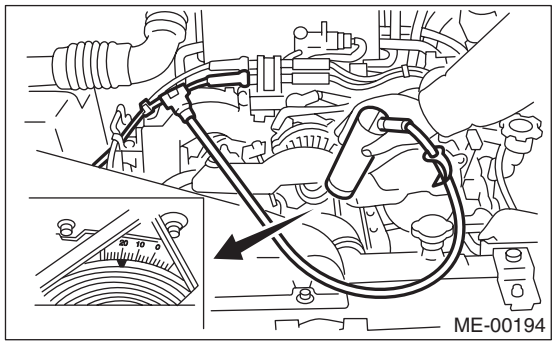
# 4. Ignition Timing

## A: INSPECTION

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

1) Warm up the engine.
2) To check the ignition timing, connect a timing light to #1 cylinder spark plug cord, and illuminate the timing mark with timing light.
3) Start the engine at idle speed and check the ignition timing.

***Ignition timing [BTDC/rpm]:***
***10°±8°/650 (MT model)***
***15°±8°/700 (AT model)***



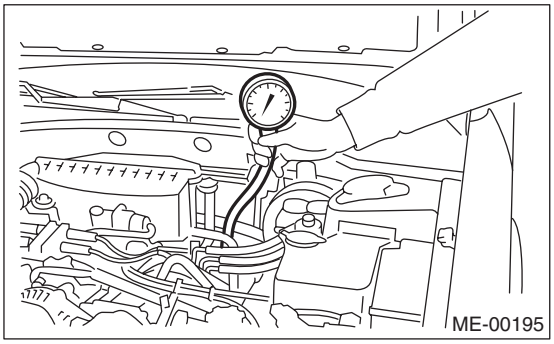

If the timing is not correct, check the ignition control system.
Refer to Engine Control System. <Ref. to EN(H4SO)(diag)-2, Basic Diagnostic Procedure.>

# 5. Intake Manifold Vacuum

## A: INSPECTION

1) Warm up the engine.
2) Disconnect the brake vacuum hose from manifold, and then install the vacuum gauge to the hose fitting on manifold.
3) Keep the engine at idle speed, and then read the vacuum gauge indication.

By observing the gauge needle movement, the internal condition of engine can be diagnosed as described below.



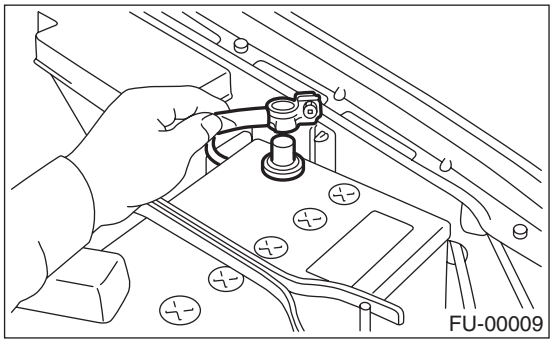

***Vacuum pressure (at idling, A/C "OFF"):***
***Less than −60.0 kPa (−450 mmHg, −17.72 in-Hg)***

| Diagnosis of engine condition by measurement of manifold vacuum | |
|---|---|
| Vacuum gauge indication | Possible engine condition |
| 1. Needle is steady but lower than normal position. This tendency becomes more evident as engine temperature rises. | Leakage around intake manifold gasket or disconnection or damaged vacuum hose |
| 2. When engine speed is reduced slowly from higher speed, needle stops temporarily when it is lowering or becomes steady above normal position. | Back pressure too high, or exhaust system clogged |
| 3. Needle intermittently drops to position lower than normal position. | Leakage around cylinder |
| 4. Needle drops suddenly and intermittently from normal position. | Sticky valves |
| 5. When engine speed is gradually increased, needle begins to vibrate rapidly at certain speed, and then vibration increases as engine speed increases. | Weak or broken valve springs |
| 6. Needle vibrates above and below normal position in narrow range. | Defective ignition system |

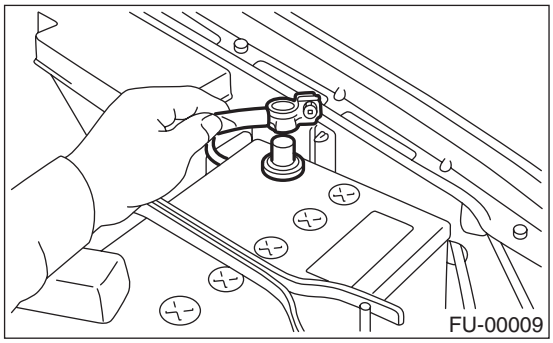
# 6. Engine Oil Pressure

## A: INSPECTION

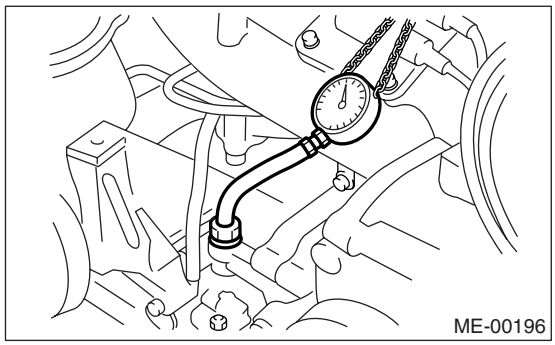
1) Disconnect the ground cable from battery.




2) Remove the generator from bracket. <Ref. to SC(H4SO)-14, REMOVAL, Generator.>
3) Disconnect the connector from oil pressure switch.
4) Remove the oil pressure switch from engine cylinder block. <Ref. to LU(H4SO)-17, REMOVAL, Oil Pressure Switch.>
5) Connect the oil pressure gauge hose to cylinder block.
6) Connect the battery ground cable to battery.




7) Start the engine, and then measure the oil pressure.




***Oil pressure:***
***88 kPa (0.9 kg/cm$^2$, 13 psi) or more at 800 rpm***
***294 kPa (3.0 kg/cm$^2$, 43 psi) or more at 5,000 rpm***

**CAUTION:**
**• If the oil pressure is out of specification, check the oil pump, oil filter and lubrication line. <Ref. to LU(H4SO)-19, INSPECTION, Engine Lubrication System Trouble in General.>**
**• If the oil pressure warning light is turned ON and oil pressure is in specification, replace the oil pressure switch. <Ref. to LU(H4SO)-19, INSPECTION, Engine Lubrication System Trouble in General.>**

NOTE:
The specified data is based on an engine oil temperature of 80°C (176°F).

8) After measuring the oil pressure, install the oil pressure switch. <Ref. to LU(H4SO)-17, INSTALLATION, Oil Pressure Switch.>

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

9) Install the generator and V-belt in the reverse order of removal, and then adjust the V-belt deflection. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

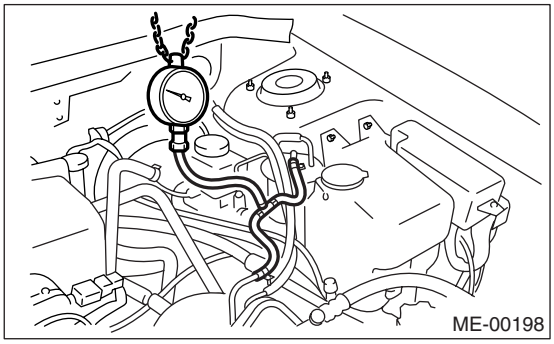
# 7. Fuel Pressure

## A: INSPECTION

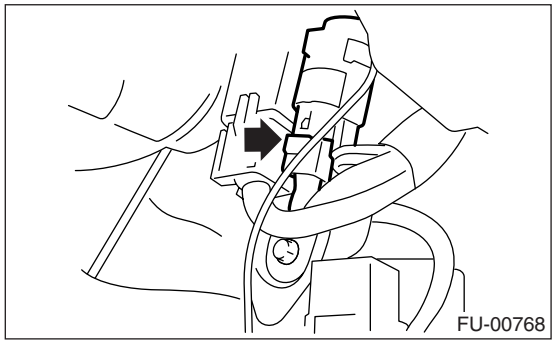
**WARNING:**
**Before removing the fuel pressure gauge, lower the fuel pressure.**

NOTE:
If out of specification, check or replace the pressure regulator and pressure regulator vacuum hose.

1) Release the fuel pressure. <Ref. to FU(H4SO)-47, RELEASING OF FUEL PRESSURE, PROCEDURE, Fuel.>
2) Open the fuel flap lid, and then remove the fuel filler cap.
3) Disconnect the fuel delivery hoses from fuel damper, and then connect the fuel pressure gauge.




4) Connect the connector of fuel pump relay.




5) Start the engine.
6) Measure the fuel pressure while disconnecting the pressure regulator vacuum hose from intake manifold.

***Fuel pressure:***
***Standard; 284 — 314 kPa (2.9 — 3.2 kg/cm$^2$, 41 — 46 psi)***

7) After connecting the pressure regulator vacuum hose, measure the fuel pressure.

***Fuel pressure:***
***Standard; 206 — 235 kPa (2.1 — 2.4 kg/cm$^2$, 30 — 34 psi)***

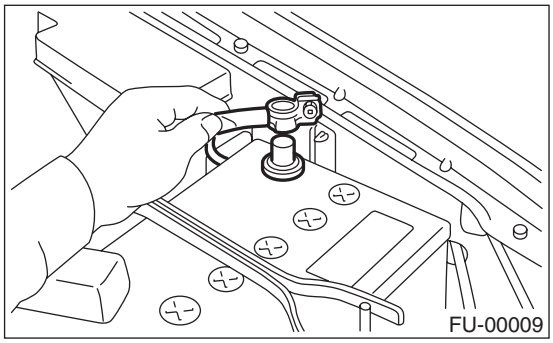
NOTE:
The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kg/cm$^2$, 1 to 3 psi) higher than standard values during high-altitude operations.

# 8. Valve Clearance

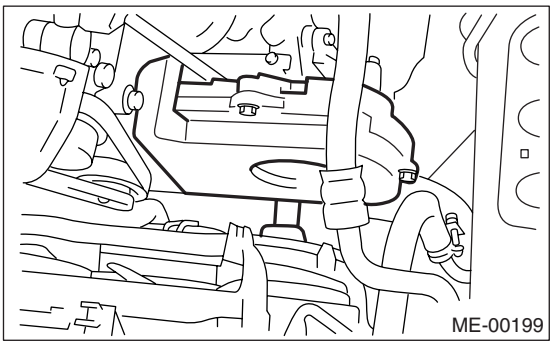
## A: INSPECTION

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

1) Set the vehicle on a lift.
2) Lift-up the vehicle.
3) Remove the under cover.
4) Lower the vehicle.
5) Disconnect the ground cable from battery.

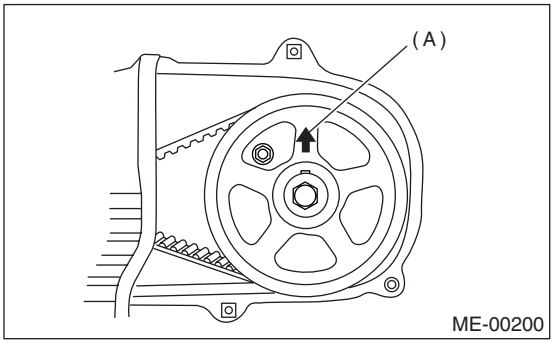



6) Remove the timing belt cover (LH).




7) When inspecting the #1 and #3 cylinders;
   (1) Disconnect the spark plug cords from spark plugs RH side. <Ref. to IG(H4SO)-4, RH SIDE, REMOVAL, Spark Plug.>
   (2) Disconnect the PCV hose from rocker cover (RH).
   (3) Remove the bolts, and then remove the rocker cover (RH).
8) When inspecting the #2 and #4 cylinders;
   (1) Disconnect the spark plug cords from spark plugs (LH Side). <Ref. to IG(H4SO)-4, LH SIDE, REMOVAL, Spark Plug.>
   (2) Disconnect the PCV hose from rocker cover (LH).
   (3) Remove the bolts, and then remove the rocker cover (LH).
9) Set the #1 cylinder piston to top dead center of compression stroke by rotating crankshaft pulley clockwise using a socket wrench.

NOTE:
When arrow mark (A) on the camshaft sprocket (LH) comes exactly to the top, #1 cylinder piston is brought to the top dead center of compression stroke.

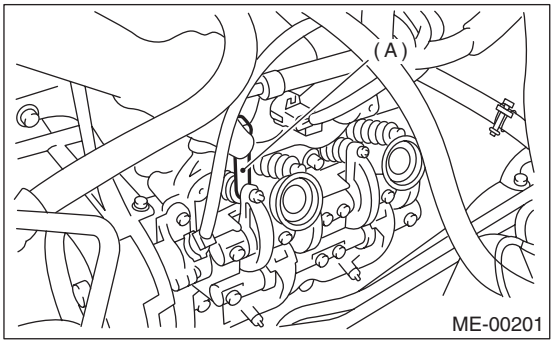



10) Measure the #1 cylinder valve clearance by using thickness gauge.

**CAUTION:**
**• Insert the thickness gauge (A) in as horizontal a direction as possible with respect to the valve stem end face.**
**• Measure the exhaust valve clearances while lifting up the vehicle.**

***Valve clearance (Standard):***
***Intake:***
***0.20±0.02 mm (0.0079±0.0008 in)***
***Exhaust:***
***0.25±0.02 mm (0.0098±0.0008 in)***

***Valve clearance (Limit):***
***Intake:***
***0.20±0.04 mm (0.0079±0.0016 in)***
***Exhaust:***
***0.25±0.04 mm (0.0098±0.0016 in)***




11) If necessary, adjust the valve clearance. <Ref. to ME(H4SO)-29, ADJUSTMENT, Valve Clearance.>
12) Similar to measurement procedures used for #1 cylinder, measure the cylinder valve clearances in the following sequence: #3, #2 and #4 cylinder.

NOTE:
• Be sure to set the cylinder pistons to their respective top dead centers on compression stroke before measuring valve clearances.
• To set each cylinder piston to its top dead center on compression stroke in the following sequence: #3, #2 and #4 cylinder, turn the crankshaft pulley clockwise by every 180° at starting with #1 cylinder piston being on top dead center on compression stroke.

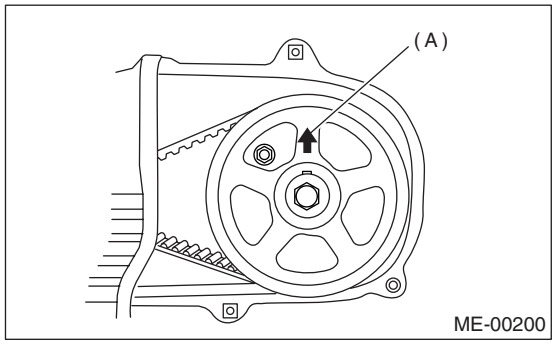
13) After inspection, install the related parts in the reverse order of removal.

## B: ADJUSTMENT

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

1) Set the #1 cylinder piston to top dead center of compression stroke by rotating crankshaft pulley clockwise using socket wrench.

NOTE:
When arrow mark (A) on the camshaft sprocket (LH) comes exactly to the top, #1 cylinder piston is brought to the top dead center of compression stroke.

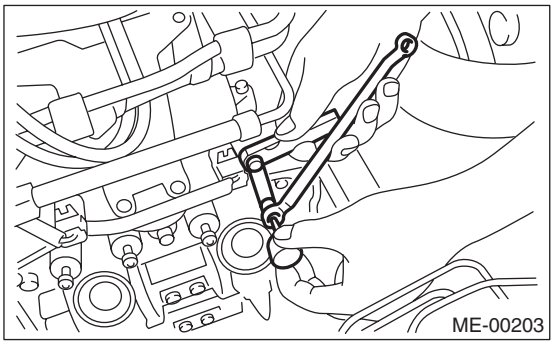



2) Adjust the #1 cylinder valve clearance.
(1) Loosen the valve rocker nut and screw.
(2) Place suitable thickness gauge.
(3) While noting the valve clearance, tighten the valve rocker adjust screw.
(4) When specified valve clearance is obtained, tighten the valve rocker nut.

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

**CAUTION:**
**• Insert the thickness gauge in as horizontal a direction as possible with respect to the valve stem end face.**
**• Adjust the exhaust valve clearances while lifting up the vehicle.**

***Valve clearance:***
***Intake;***
***0.20±0.02 mm (0.0079±0.0008 in)***
***Exhaust;***
***0.25±0.02 mm (0.0098±0.0008 in)***



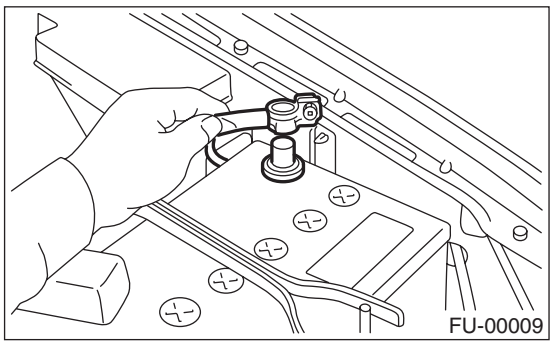

3) Ensure the valve clearances are within specifications.
4) Turn the crankshaft two complete rotations until #1 cylinder piston is again set to the top dead center on compression stroke.
5) Ensure the valve clearances are within specifications. If necessary, readjust the valve clearances.
6) Similar to adjustment procedures used for #1 cylinder, adjust the #2, #3 and #4 cylinder valve clearances.

NOTE:
• Be sure to set the cylinder pistons to their respective top dead centers on compression stroke before adjusting valve clearances.
• To set each cylinder piston to its top dead center on compression stroke in the following sequence: #3, #2 and #4 cylinder, turn the crankshaft pulley clockwise by every 180° at starting with #1 cylinder piston being on top dead center on compression stroke.

# 9. Engine Assembly

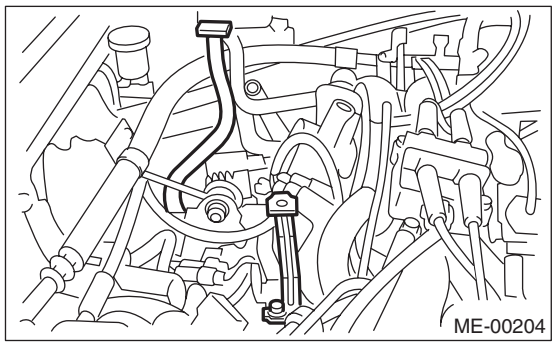
## A: REMOVAL

1) Set the vehicle on a lift.
2) Open the front hood fully, and then support with the hood stay.
3) Using the refrigerant recovery system, discharge refrigerant. <Ref. to AC-20, PROCEDURE, Refrigerant Recovery Procedure.>
4) Release the fuel pressure. <Ref. to FU(H4SO)-47, RELEASING OF FUEL PRESSURE, PROCEDURE, Fuel.>
5) Remove the fuel filler cap.
6) Disconnect the ground cable from battery.

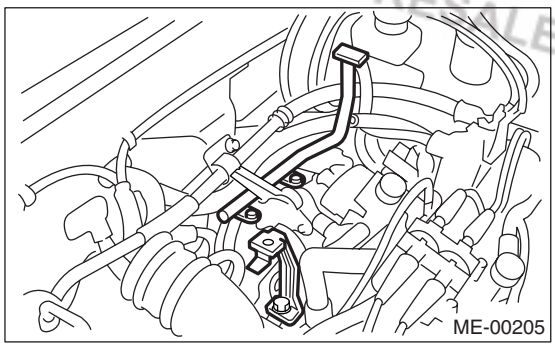

FU-00009

7) Remove the air intake duct and air cleaner case. <Ref. to IN(H4SO)-6, REMOVAL, Air Intake Duct.> and <Ref. to IN(H4SO)-5, REMOVAL, Air Cleaner Case.>
8) Remove the under cover.
9) Remove the radiator from vehicle. <Ref. to CO(H4SO)-18, REMOVAL, Radiator.>
10) Disconnect the A/C pressure hoses from A/C compressor.
11) Remove the air intake chamber stay.

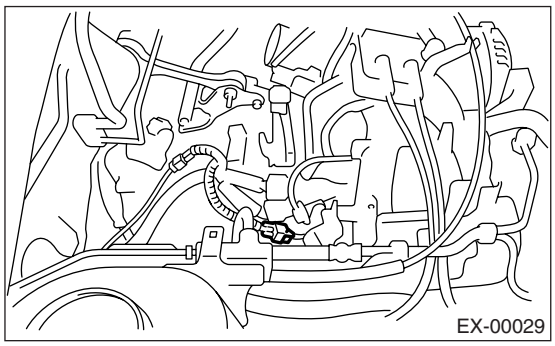
- MT MODEL


ME-00204

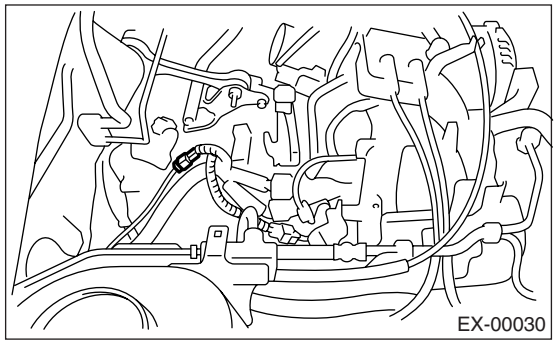
- AT MODEL


ME-00205

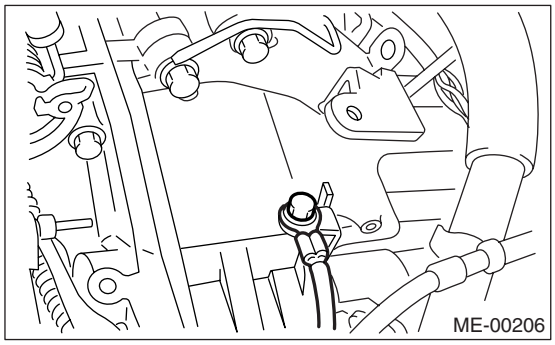
12) Disconnect the following connectors and cables.
(1) Front oxygen (A/F) sensor connector


EX-00029

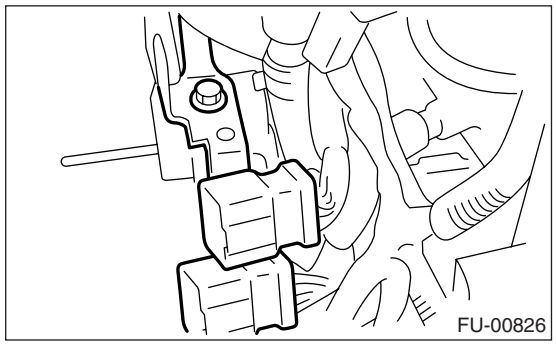
(2) Rear oxygen sensor connector


EX-00030

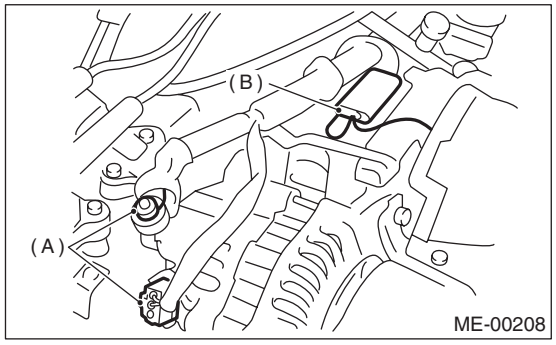
(3) Engine ground cable


ME-00206

(4) Engine harness connectors

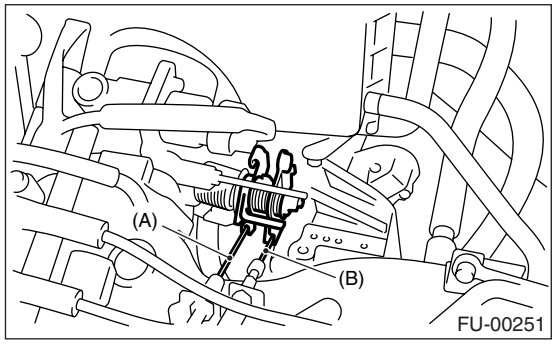



(5) Generator connector, terminal and A/C compressor connector

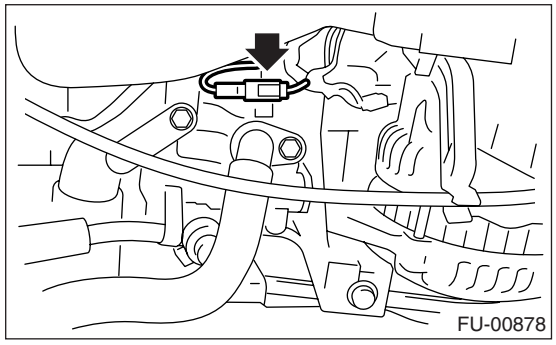



(A) Generator connector and terminal
(B) A/C compressor connector

(6) Accelerator cable (A) and cruise control cable (B) (Model with cruise control)

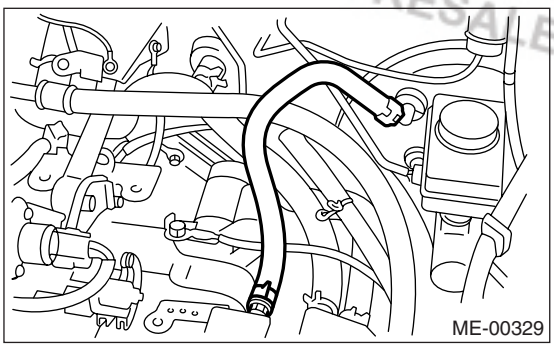



(7) Power steering switch connector

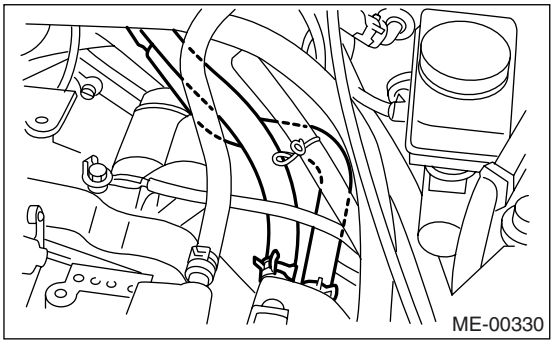



13) Disconnect the following hoses.

(1) Brake booster vacuum hose

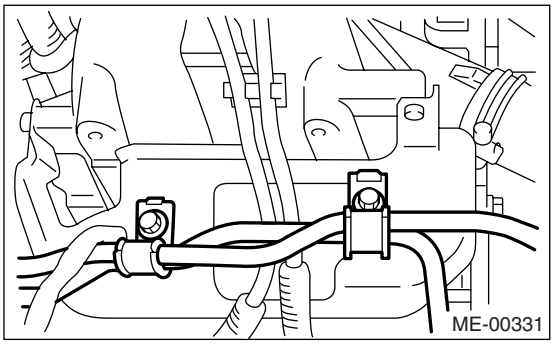



(2) Heater inlet outlet hose

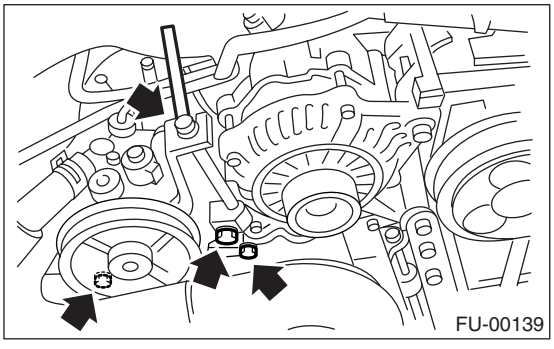



14) Remove the power steering pump from bracket.

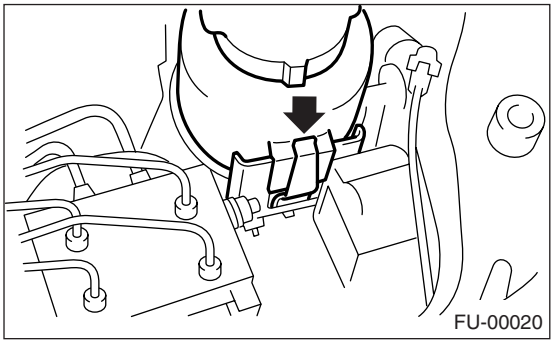
(1) Remove the resonator chamber.
(2) Loosen the lock bolt and slider bolt, and then remove the front side V-belt. <Ref. to ME(H4SO)-39, FRONT SIDE BELT, REMOVAL, V-belt.>
(3) Remove the pipe with bracket.



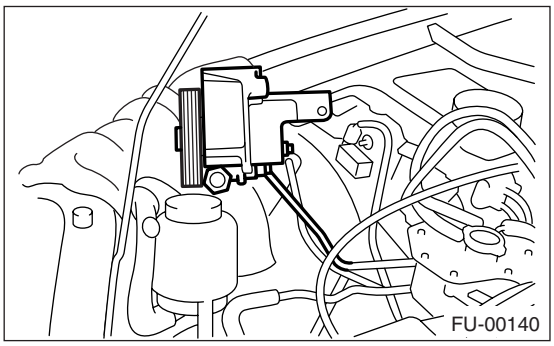

(4) Remove the bolts which install the power steering pump bracket.



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

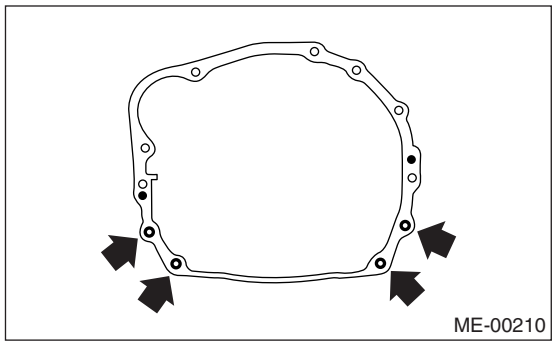



(6) Place the power steering pump on right side wheel apron.

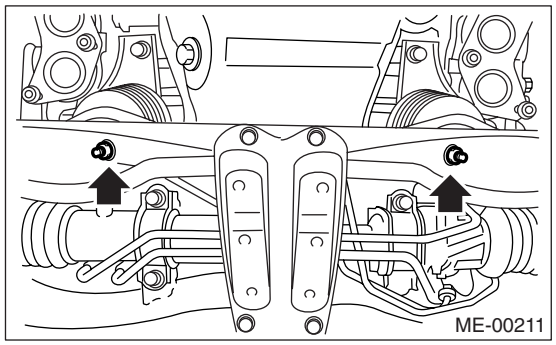



15) Remove the front and center exhaust pipe. <Ref. to EX(H4SO)-4, REMOVAL, Front Exhaust Pipe.>

16) Remove the nuts which hold the lower side of transmission to engine.




17) Remove the nuts which install the front cushion rubber onto front crossmember.



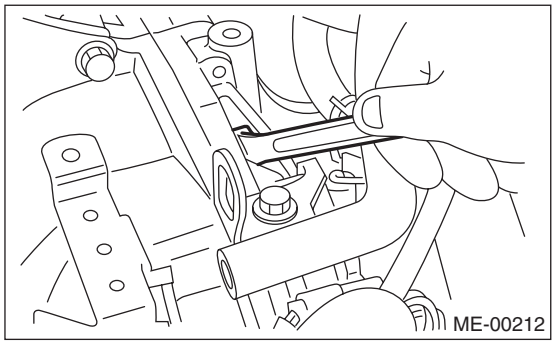

18) Separate the torque converter clutch from drive plate. (AT model)

(1) Lower the vehicle.

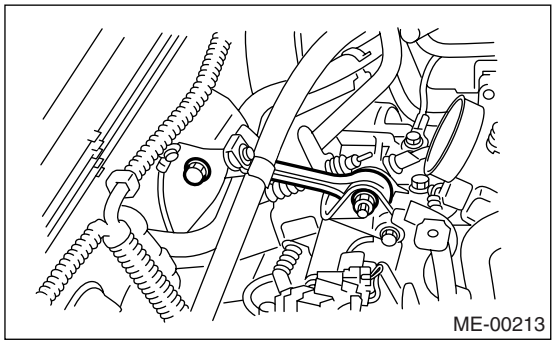
(2) Remove the service hole plug.

(3) Remove the bolts which hold the torque converter clutch to drive plate.

(4) Remove other bolts while rotating the engine using socket wrench.




19) Remove the pitching stopper.

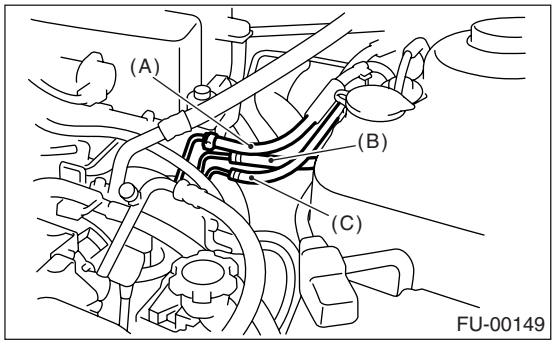



20) Disconnect the fuel delivery hose (A), return hose (B) and evaporation hose (C).

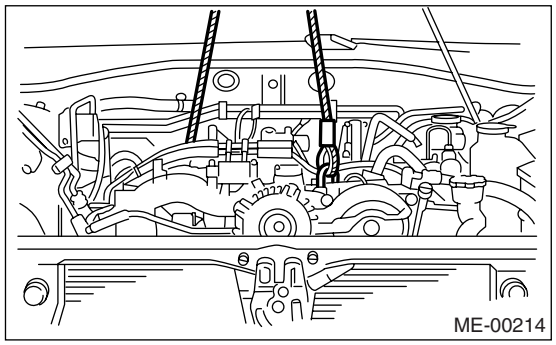
**CAUTION:**

**• Disconnect the hose with its end wrapped with cloth to prevent fuel from splashing.**

**• Catch fuel from the hose into container.**

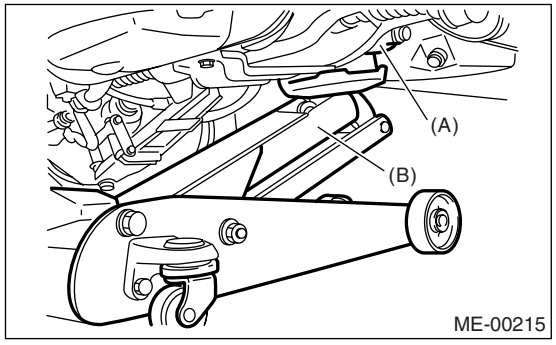


21) Support the engine with a lifting device and wire ropes.



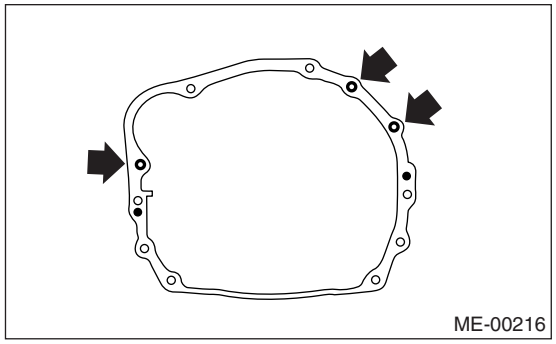

22) Support the transmission with a garage jack.

**CAUTION:**
**Before moving the 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 the transmission lowers under its own weight.**



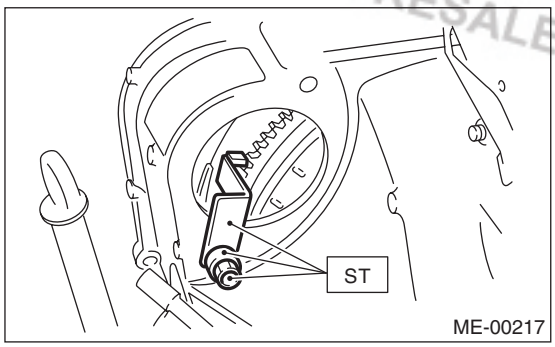

(A) Transmission
(B) Garage jack

23) Separation of the engine and transmission.
(1) Remove the starter. <Ref. to SC(H4SO)-7, REMOVAL, Starter.>
(2) Remove the bolts which hold the upper side of transmission to engine.



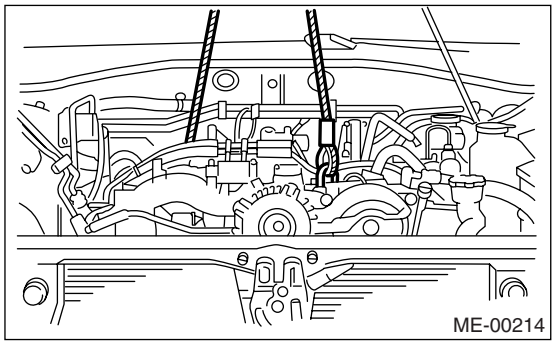

24) Install the ST to torque converter clutch case. (AT model)

ST 498277200 STOPPER SET




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

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




26) Remove the front cushion rubbers.

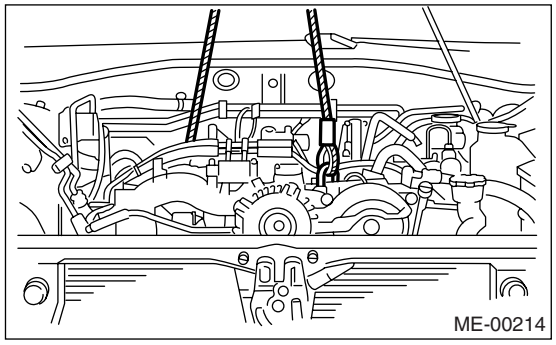
## B: INSTALLATION

1) Install the front cushion rubbers.

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

2) Install the engine onto transmission.
(1) Position the engine in engine compartment and align it with transmission.

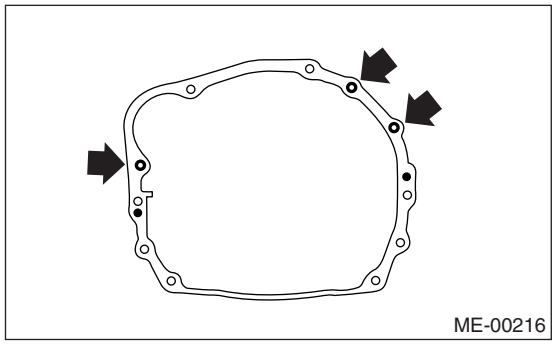
NOTE:
Be careful not to damage the adjacent parts or body panels with crank pulley, oil level gauge, etc.



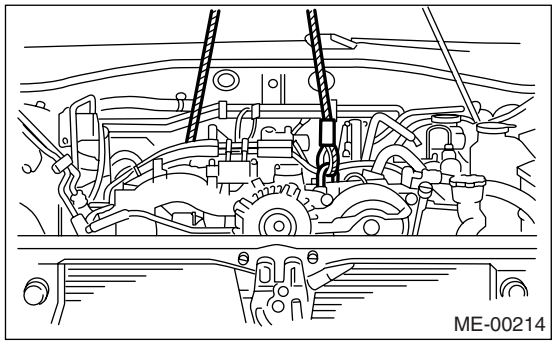

(2) Apply a small amount of grease to the spline of main shaft. (MT model)

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

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

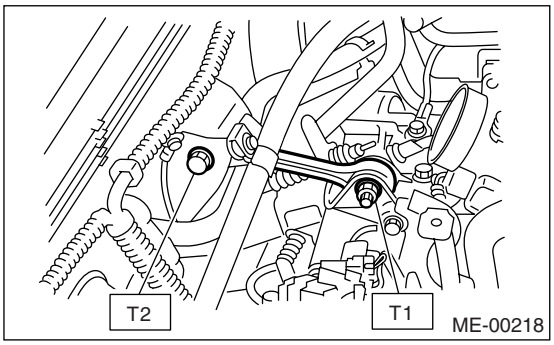



4) Remove the lifting device and wire ropes.




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

***Tightening torque:***
***T1: 50 N·m (5.1 kgf-m, 37 ft-lb)***
***T2: 58 N·m (5.9 kgf-m, 43 ft-lb)***




7) Remove the ST from torque converter clutch case. (AT model)

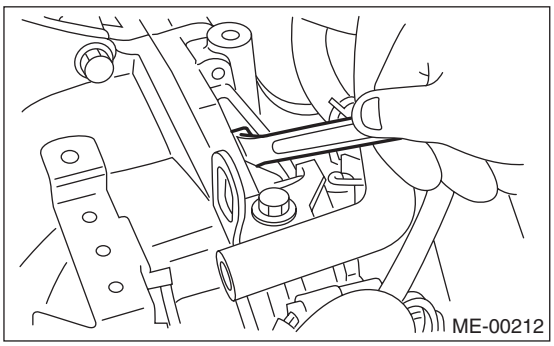
NOTE:
Be careful not to drop the ST into torque converter clutch case when removing ST.

ST 498277200 STOPPER SET

8) Install the starter. <Ref. to SC(H4SO)-7, INSTALLATION, Starter.>
9) Install the torque converter clutch onto drive plate. (AT model)
(1) Tighten the bolts which hold the torque converter clutch to drive plate.
(2) Tighten other bolts while rotating the engine by using a socket wrench.

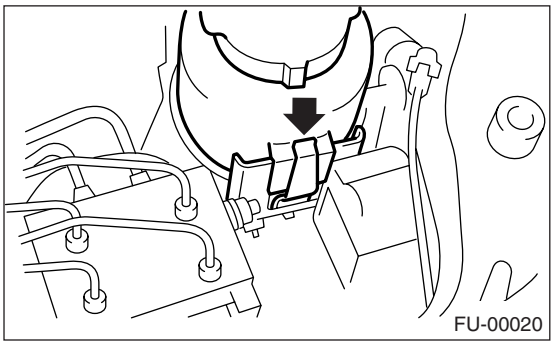
NOTE:
Be careful not to drop the bolts into torque converter clutch housing.

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



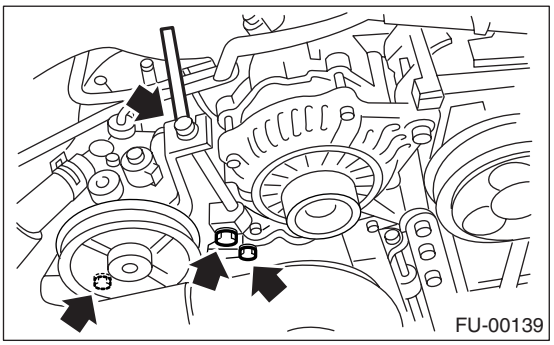

(3) Clog the plug onto service hole.

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

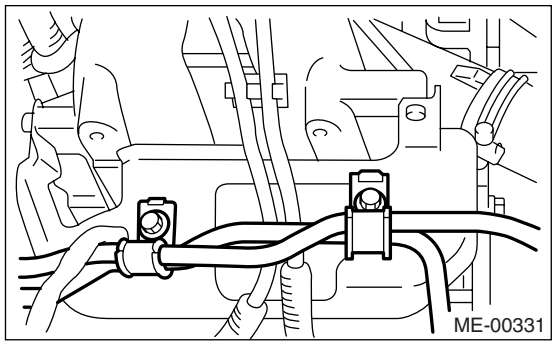



(2) Install the power steering pump on bracket, and then tighten the bolts.

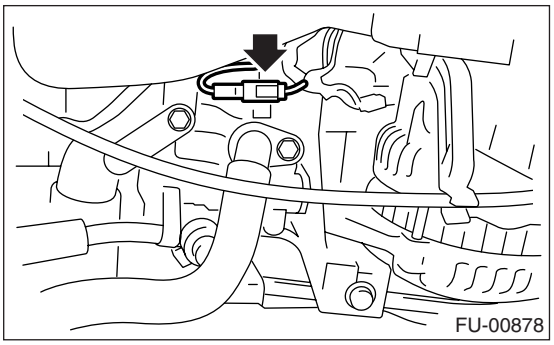
***Tightening torque:***
***20.1 N·m (2.05 kgf-m, 14.8 ft-lb)***




(3) Tighten the bolts which install the power steering pipe bracket, and then install the spark plug cords.

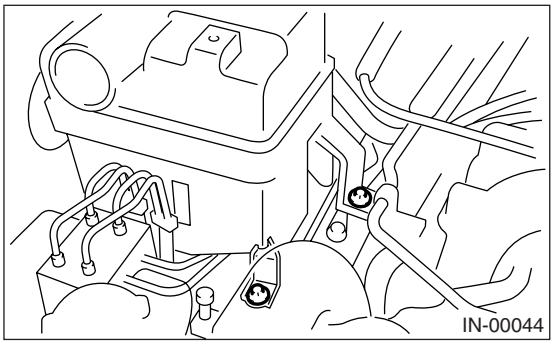



(4) Connect the power steering switch connector.



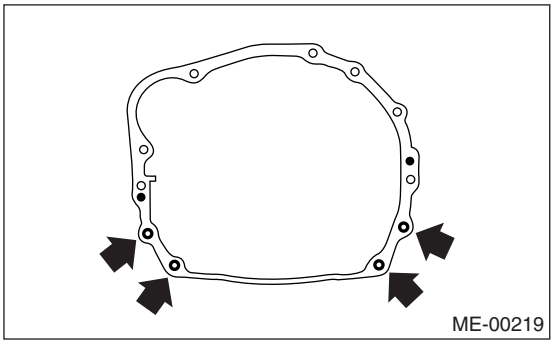

(5) Install the front side V-belt, and adjust it. <Ref. to ME(H4SO)-39, FRONT SIDE BELT, INSTALLATION, V-belt.>
(6) Install the resonator chamber.

***Tightening torque:***
***33 N·m (3.4 kgf-m, 24.6 ft-lb)***




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

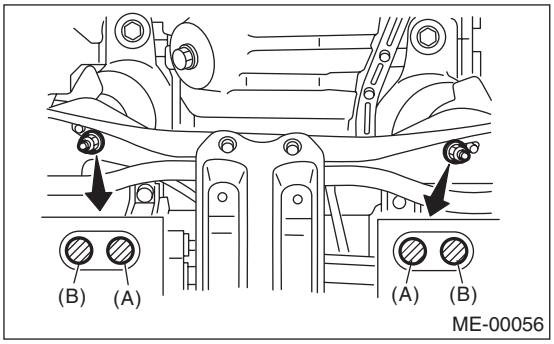
***Tightening torque:***
***50 N·m (5.1 kgf-m, 36.9 ft-lb)***




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

***Tightening torque:***
***85 N·m (8.7 kgf-m, 63 ft-lb)***

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




13) Install the front and center exhaust pipe. <Ref. to EX(H4SO)-5, INSTALLATION, Front Exhaust Pipe.>

14) Connect the following hoses.
(1) Fuel delivery hose, return hose and evaporation hose
(2) Heater inlet and outlet hoses
(3) Brake booster vacuum hose
15) Connect the following connectors.
(1) Engine ground cables

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

(2) Engine harness connectors
(3) Generator connector and terminal
(4) A/C compressor connectors
16) Connect the following cables.
(1) Accelerator cable
(2) Cruise control cable (Model with cruise control)
17) Adjust each connected cable.
18) Install the air cleaner case stay.

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

19) Install the A/C pressure hoses. <Ref. to AC-36, INSTALLATION, Hose and Tube.>
20) Install the radiator to vehicle. <Ref. to CO(H4SO)-19, INSTALLATION, Radiator.>
21) Install the air intake duct and air cleaner case. <Ref. to IN(H4SO)-6, INSTALLATION, Air Intake Duct.> and <Ref. to IN(H4SO)-5, INSTALLATION, Air Cleaner Case.>
22) Install the under cover.
23) Install battery in the vehicle, and then connect the cables.
24) Fill engine coolant.
<Ref. to CO(H4SO)-12, FILLING OF ENGINE COOLANT, REPLACEMENT, Engine Coolant.>
25) Check the ATF level and correct if necessary. (AT model)
<Ref. to 4AT-30, INSPECTION, Automatic Transmission Fluid.>
26) Charge the A/C system with refrigerant.
<Ref. to AC-21, PROCEDURE, Refrigerant Charging Procedure.>
27) Remove the front hood stay, and then close the front hood.
28) Take off the vehicle from lift arms.

## C: INSPECTION

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

# 10.Engine Mounting

## A: REMOVAL

1) Remove the engine assembly. <Ref. to ME(H4SO)-30, REMOVAL, Engine Assembly.>
2) Remove the engine mounting from engine assembly.

## B: INSTALLATION

Install in the reverse order of removal.

***Tightening torque:***
***Engine mounting;***
***35 N·m (3.6 kgf-m, 25.8 ft-lb)***

## C: INSPECTION

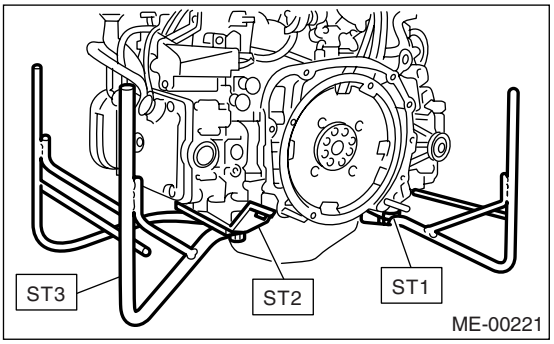
Make sure there are no cracks or other damage.

# 11.Preparation for Overhaul

## A: PROCEDURE

1) After removing the engine from body, secure it in the ST shown below.

| | | |
|---|---|---|
| ST1 | 498457000 | ENGINE STAND ADAPTER RH |
| ST2 | 498457100 | ENGINE STAND ADAPTER LH |
| ST3 | 4998171 00 | ENGINE STAND |




2) In this section the procedures described under each index are all connected and stated in order. It will be the complete procedure for overhauling of the engine itself when you go through all steps in the process.
Therefore, in this section, to conduct the particular procedure within the flow of a section, you need to go back and conduct the procedure described previously in order to do that particular procedure.

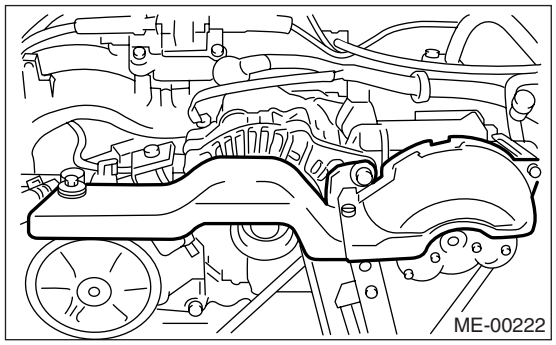
# 12.V-belt

## A: REMOVAL

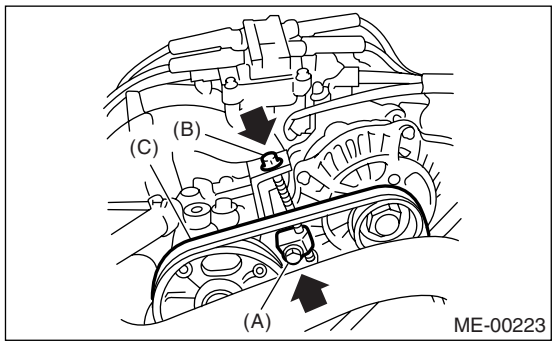
### 1. FRONT SIDE BELT

NOTE:
Perform the following procedures 1) to 4) with the engine installed to body.

1) Remove the V-belt cover.

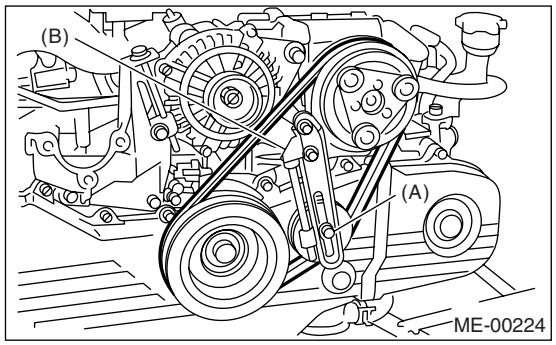



2) Loosen the lock bolt (A).
3) Loosen the slider bolt (B).
4) Remove the front side belt (C).

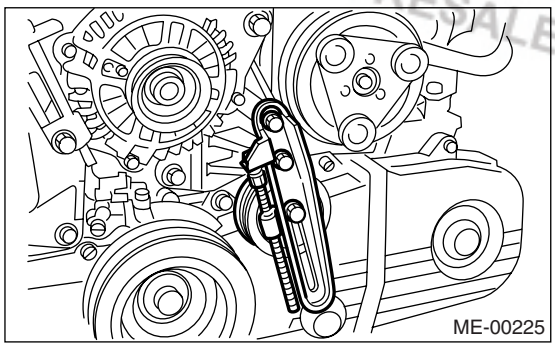



### 2. REAR SIDE BELT

1) Loosen the lock nut (A).
2) Loosen the slider bolt (B).




3) Remove the rear side belt.
4) Remove the belt tensioner.



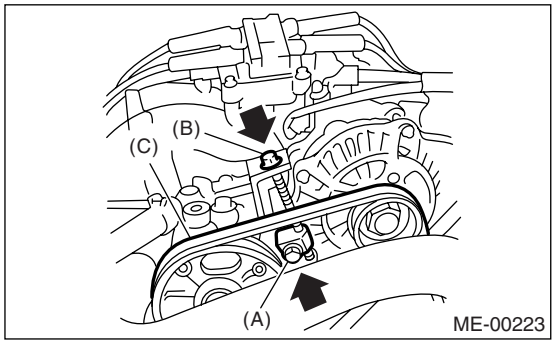

## B: INSTALLATION

NOTE:
Wipe off any oil or water on the belt and pulley.

### 1. FRONT SIDE BELT

1) Install the belt (C), and tighten the slider bolt so as to obtain the specified belt tension. <Ref. to ME(H4SO)-40, INSPECTION, V-belt.>
2) Tighten the lock bolt (A).
3) Tighten the slider bolt (B).

***Tightening torque:***
***Lock bolt (A):***
***25 N·m (2.5 kgf-m, 18.1 ft-lb)***
***Slider bolt (B):***
***8 N·m (0.8 kgf-m, 5.5 ft-lb)***

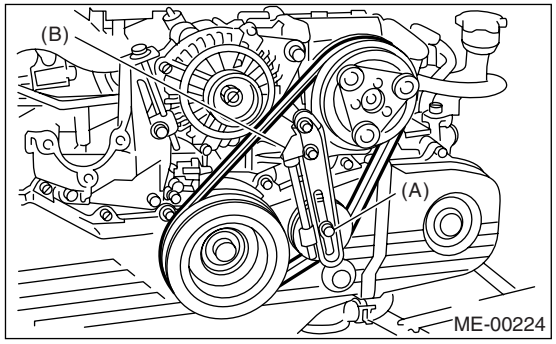



4) Idle the engine for approx. 5 min. to normalize the V-belt. (With using tension gauge)
5) Stop the engine, and then check the belt tension and adjust it. (With using tension gauge)
6) Idle the engine for approx. 1 min. to normalize the V-belt. (With using tension gauge)
7) Stop the engine, and then check the belt tension is within specified value. (With using tension gauge)
8) Adjust the belt tension until the value within specification. (With using tension gauge)

### 2. REAR SIDE BELT

1) Install the belt tensioner.
2) Install the belt, and tighten the slider bolt (B) so as to obtain the specified belt tension. <Ref. to ME(H4SO)-40, INSPECTION, V-belt.>
3) Tighten the lock nut (A).

***Tightening torque:***
***Lock nut (A);***
***23 N·m (2.3 kgf-m, 17.0 ft-lb)***



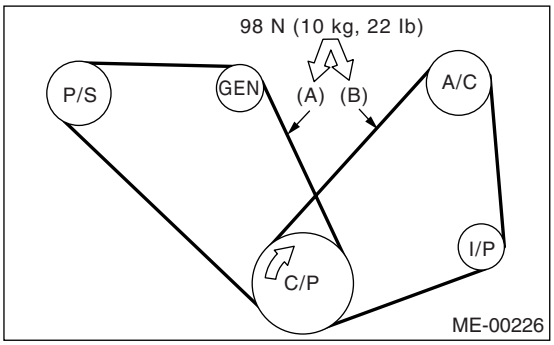

4) Idle the engine for approx. 5 min. to normalize the V-belt. (With using tension gauge)
5) Stop the engine, and then check the belt tension and adjust it. (With using tension gauge)
6) Idle the engine for approx. 1 min. to normalize the V-belt. (With using tension gauge)
7) Stop the engine, and then check the belt tension is within specified value. (With using tension gauge)
8) Adjust the belt tension until the value within specification. (With using tension gauge)

## C: INSPECTION

### 1. PROCEDURES WITHOUT BELT TENSION GAUGE

1) Replace the belts; if cracks, fraying or wear is found.
2) Check the drive belt tension and adjust it if necessary by changing the generator installing position and/or idler pulley installing position.

***Belt tension***
***(A)***
***replaced: 7 — 9 mm (0.276 — 0.354 in)***
***reused: 9 — 11 mm (0.354 — 0.433 in)***
***(B)***
***replaced: 7.5 — 8.5 mm (0.295 — 0.335 in)***
***reused: 9.0 — 10.0 mm (0.354 — 0.394 in)***

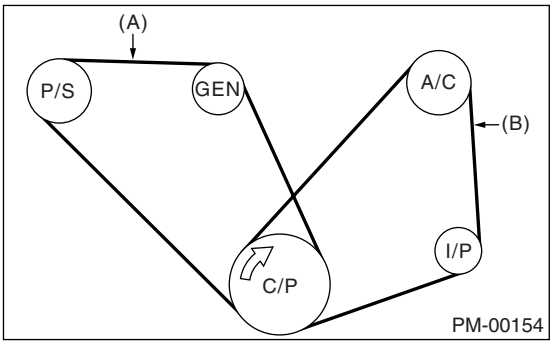



| | |
|---|---|
| C/P | Crankshaft pulley |
| GEN | Generator |
| P/S | Power steering oil pump pulley |
| A/C | Air conditioning compressor pulley |
| I/P | Idler pulley |

### 2. PROCEDURES WITH BELT TENSION GAUGE

1) Replace the belts; if cracks, fraying or wear is found.
2) Remove the V-belt cover and reservoir tank.
3) Check the V-belt tension using belt tension gauge and adjust it if necessary by changing the generator installing position and/or idler pulley installing position.

***Belt tension***
***(A)***
***490 — 640 N (50.0 — 65.3 kgf, 110.2 — 143.9 lb)***
***(B)***
***350 — 450 N (35.7 — 45.9 kgf, 78.7 — 101.2 lb)***



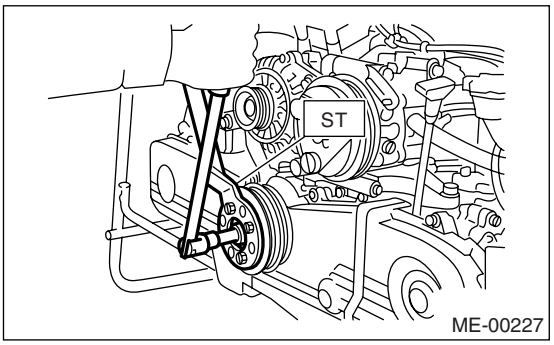

| | |
|---|---|
| C/P | Crankshaft pulley |
| GEN | Generator |
| P/S | Power steering oil pump pulley |
| A/C | Air conditioning compressor pulley |
| I/P | Idler pulley |

# 13.Crankshaft Pulley

## A: REMOVAL

1) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
2) Remove the crankshaft pulley bolt. To lock the crankshaft, use ST.

ST 499977100 CRANKSHAFT PULLEY WRENCH




3) Remove the crankshaft pulley.

## B: INSTALLATION

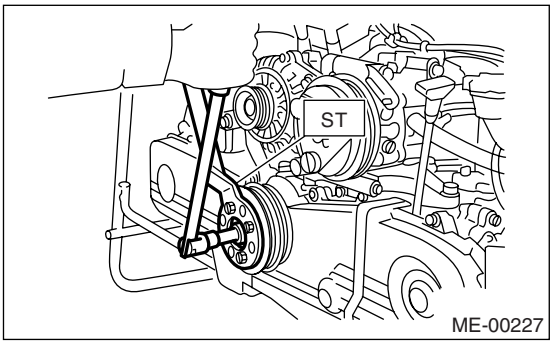
1) Install the crankshaft pulley.
2) Install the pulley bolt.

To lock the 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 bolts temporarily with tightening torque of 44 N·m (4.5 kgf-m, 33 ft-lb).
(4) Tighten the crankshaft pulley bolts.

***Tightening torque:***
***177 N·m (18.0 kgf-m, 130.2 ft-lb)***




3) Confirm that the tightening angle of crankshaft pulley bolt is 65 degrees or more. If the tightening angle of crankshaft pulley bolt is less than 65 degrees, conduct the following procedures.

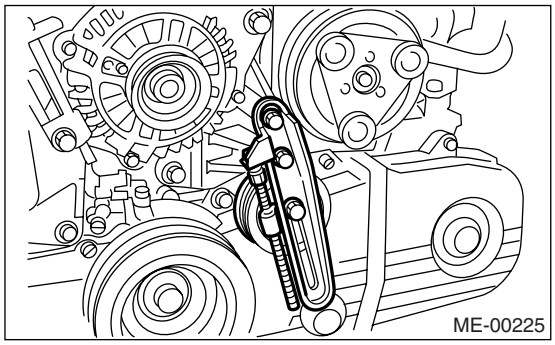
(1) Replace the crankshaft pulley bolts and clean them.

***Crankshaft pulley bolt:***
***12369AA011***

(2) Clean the crankshaft thread using an air gun.
(3) Apply engine oil to the crankshaft pulley bolt seal and thread.
(4) Tighten the bolts temporarily with tightening torque of 44 N·m (4.5 kgf-m, 33 ft-lb).
(5) Tighten the crankshaft pulley bolts keeping them in an angle between 65 degrees and 75 degrees.

NOTE:
Conduct the tightening procedures by confirming the turning angle of crankshaft pulley bolt referring to the gauge indicated on timing belt cover.

4) Install the A/C belt tensioner.




5) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

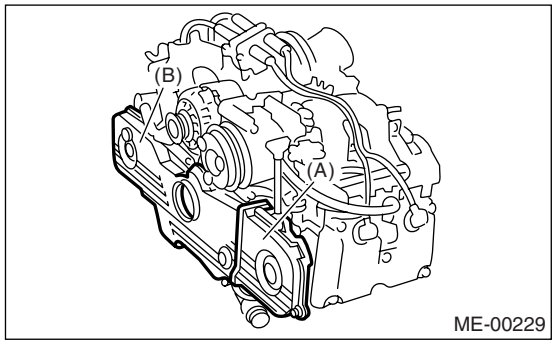
## C: INSPECTION

1) Make sure the V-belt is not worn or otherwise damaged.
2) Check the tension of the belt. <Ref. to ME(H4SO)-40, INSPECTION, V-belt.>

# 14.Timing Belt Cover

## A: REMOVAL

1) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
2) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
3) Remove the timing belt cover (LH).
4) Remove the front timing belt cover.




(A) Timing belt cover (LH)
(B) Front timing belt cover

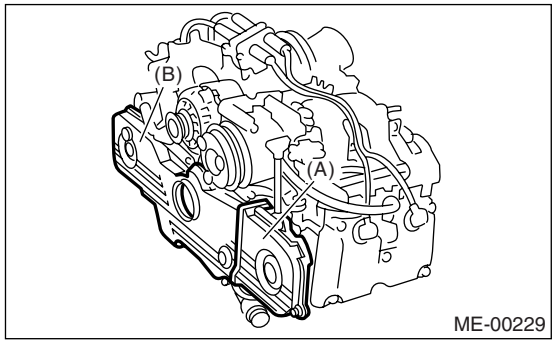
## B: INSTALLATION

1) Install the front timing belt cover.

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

2) Install the timing belt cover (LH).

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




(A) Timing belt cover (LH)
(B) Front timing belt cover

3) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>
4) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

## C: INSPECTION

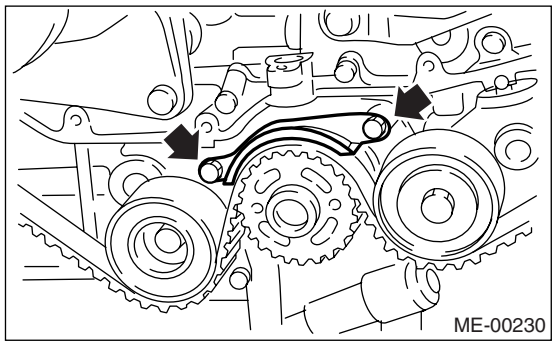
Make sure the cover is not damaged.

# 15.Timing Belt Assembly

## A: REMOVAL

### 1. TIMING BELT

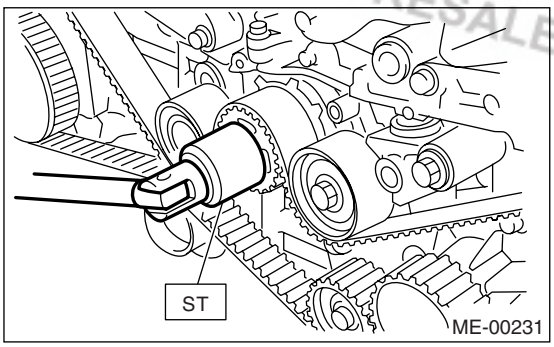
1) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
2) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO)-43, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt guide. (MT model)

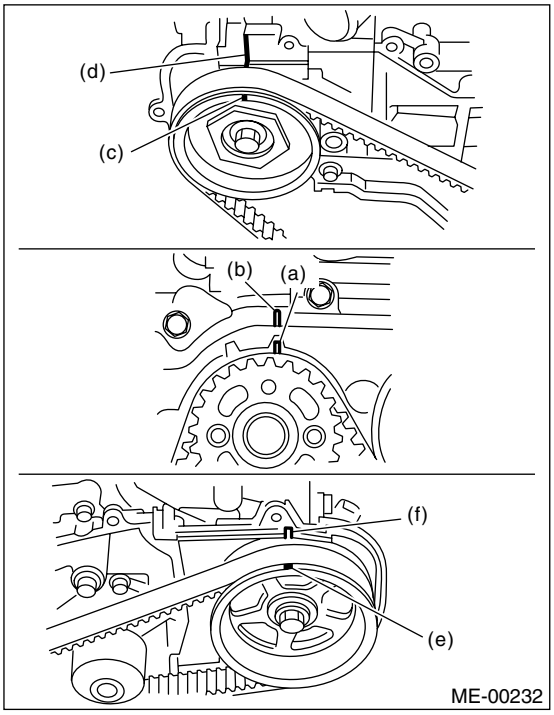



5) If the alignment mark (a) and/or arrow mark (which indicates rotation direction) on timing belt fade away, put new marks before removing the timing belt as shown in procedures below.

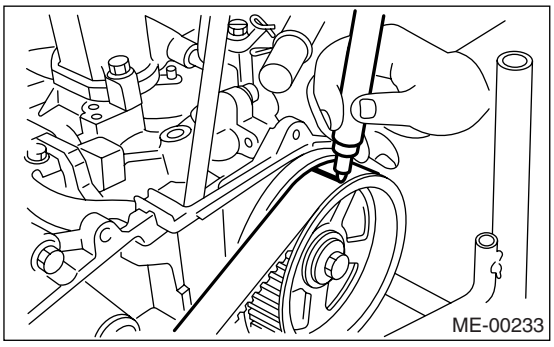
(1) Turn the crankshaft using ST. Align the mark (a) of sprocket to cylinder block notch (b) and ensure the right side cam sprocket mark (c), cam cap and cylinder head matching surface (d) and/or left side cam sprocket mark (e) and timing belt cover notch (f) are properly adjusted.

ST 499987500 CRANKSHAFT SOCKET

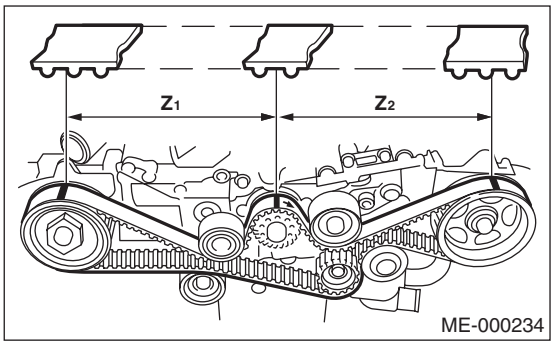


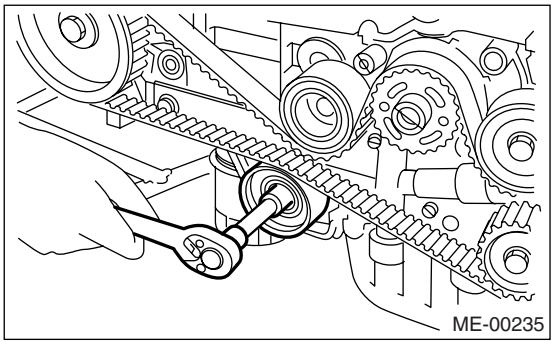

(2) Using white paint, put alignment and/or arrow marks on the timing belts in relation to crank sprocket and cam sprockets.



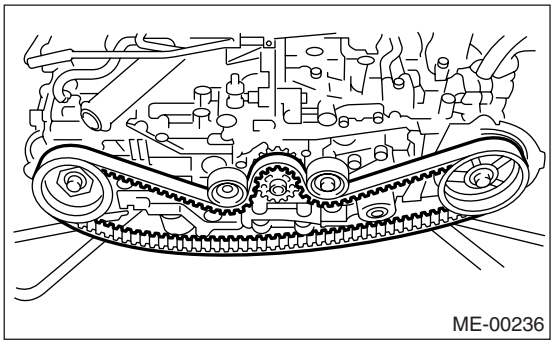
***Specified data:***
***$Z_1$: 46.8 tooth length***
***$Z_2$: 43.7 tooth length***




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

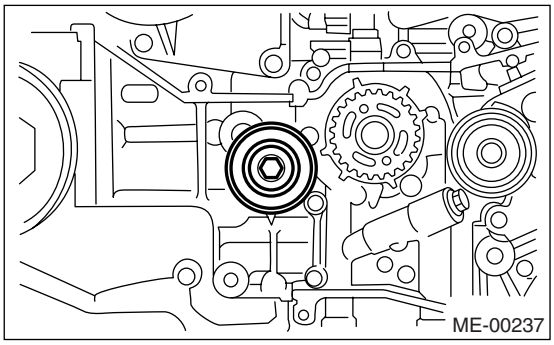



8) Remove the timing belt.

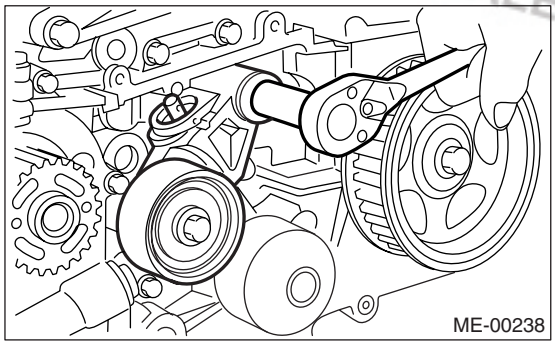



### 2. BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY

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




2) Remove the automatic belt tension adjuster assembly.



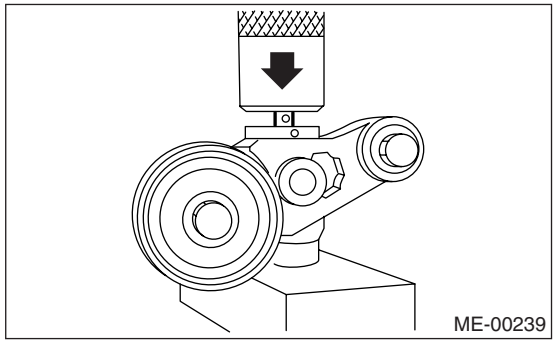

## B: INSTALLATION

### 1. AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

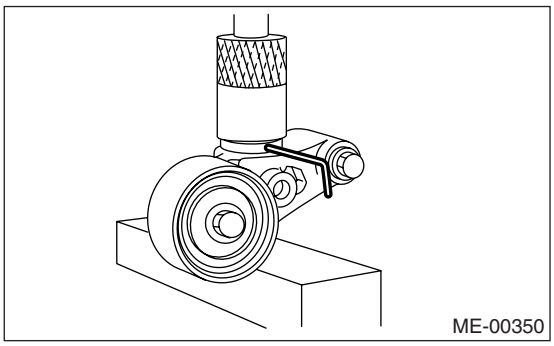
1) Preparation for installation of automatic belt tension adjuster assembly;

**CAUTION:**
**• Always use a vertical type pressing tool to move the adjuster rod down.**
**• Do not use a lateral type vise.**
**• Push the adjuster rod vertically.**
**• Press-in the push adjuster rod gradually taking more than 3 minutes.**
**• Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).**
**• Press the adjuster rod as far as the end surface of cylinder. Do not press the adjuster rod into the cylinder. Doing so may damage the cylinder.**
**• Do not release the press pressure until stopper pin is completely inserted.**

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

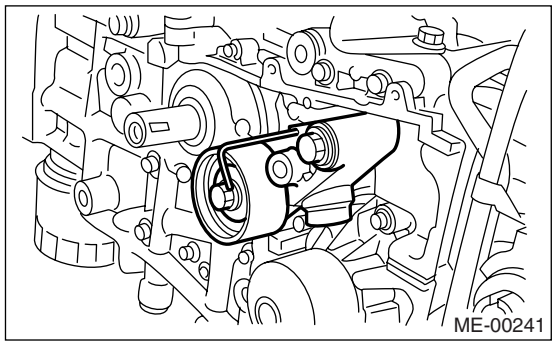


(3) With a 2 mm (0.08 in) dia. stopper pin or a 2 mm (0.08 in) (nominal) dia. hex bar wrench inserted into the stopper pin hole in the cylinder, secure the adjuster rod.


ME-00350

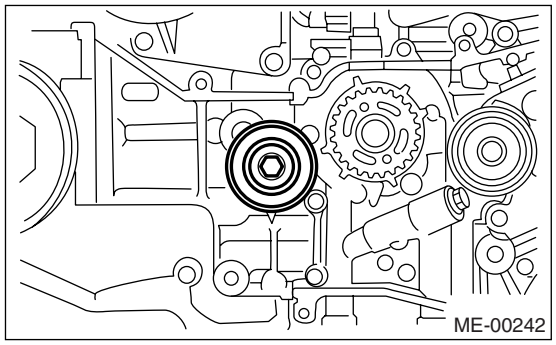
2) Install the automatic belt tension adjuster assembly.

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


ME-00241

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

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


ME-00242

## 2. TIMING BELT

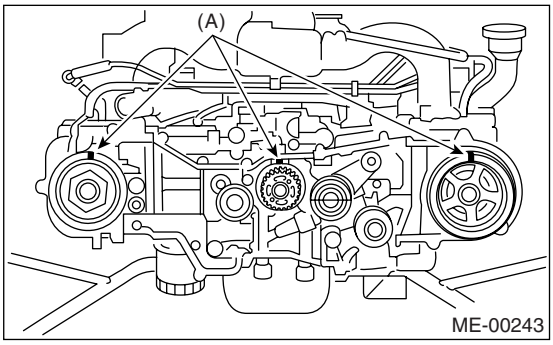
1) Preparation for the installation of automatic belt tension adjuster assembly. <Ref. to ME(H4SO)-45, AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER, INSTALLATION, Timing Belt Assembly.>

2) Installation of timing belt
(1) Turn the camshaft sprocket No. 2 using ST1, and then turn the camshaft sprocket No. 1 using ST2 so that their alignment marks (A) come to top positions.

ST1 18231AA010 CAMSHAFT SPROCKET WRENCH

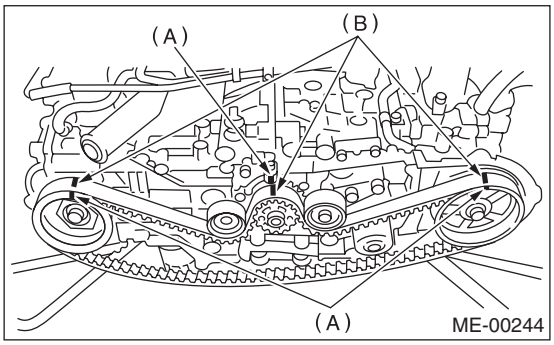
NOTE:
Also the CAMSHAFT SPROCKET WRENCH (499207100) can be used.

ST2 499207400 CAMSHAFT SPROCKET WRENCH



ME-00243

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



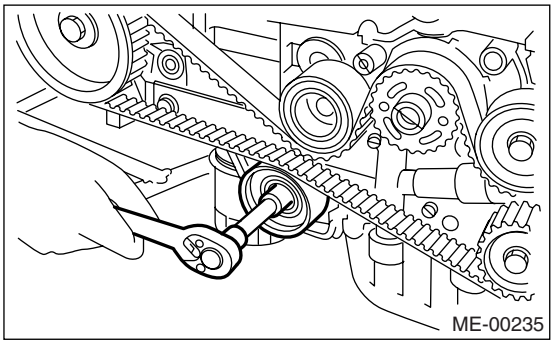
ME-00244

3) Install the belt idler No. 2.

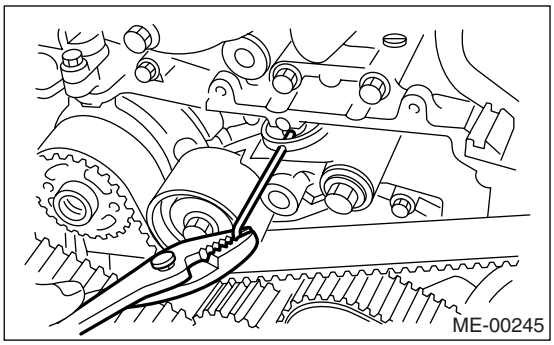
***Tightening torque:***
***39 N·m (4.0 kgf-m, 28.9 ft-lb)***

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

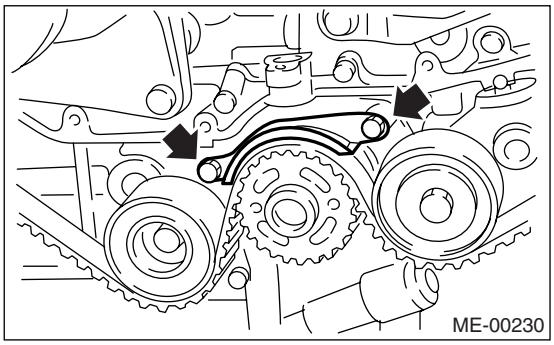
***Tightening torque:***
***39 N·m (4.0 kgf-m, 28.9 ft-lb)***


ME-00235

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

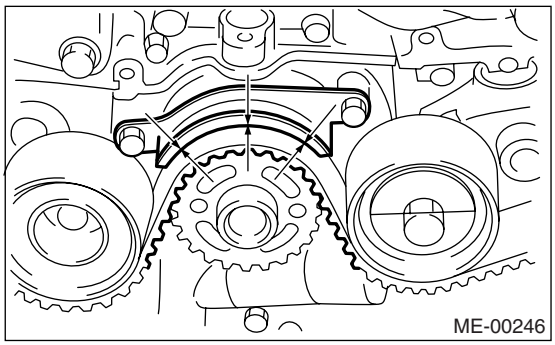

ME-00245

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


ME-00230

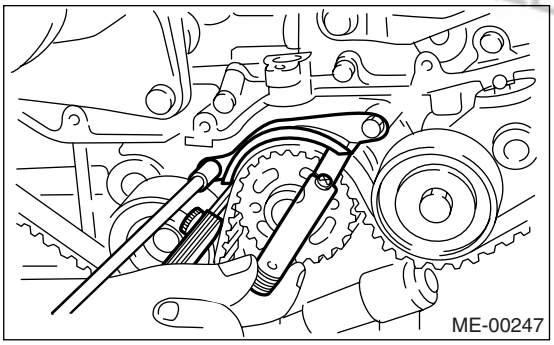
(2) Check and adjust the clearance between timing belt and timing belt guide by using thickness gauge.

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


ME-00246

(3) Tighten the timing belt guide mounting bolts.

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


ME-00247

7) Install the timing belt cover. <Ref. to ME(H4SO)-43, INSTALLATION, Timing Belt Cover.>
8) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
9) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

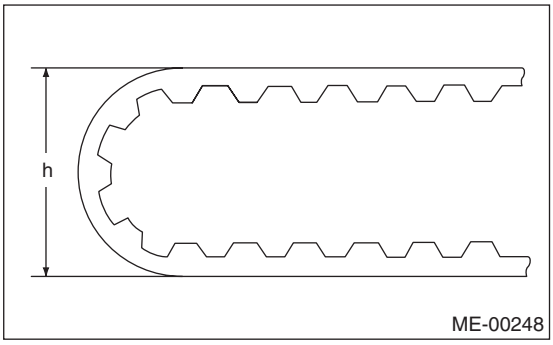
## C: INSPECTION

### 1. TIMING BELT

1) Check the timing belt teeth for breaks, cracks, and wear. If any fault is found, replace the belt.
2) Check the condition of back side of belt; if any crack is found, replace the belt.

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

***Bending radius: h***
***60 mm (2.36 in) or more***



ME-00248

### 2. AUTOMATIC BELT TENSION ADJUSTER

1) Visually check oil seals for leaks, and rod ends for abnormal wear or scratches. If necessary, replace faulty parts.
2) Check that the adjuster rod does not move when a pressure of 294 N (30 kgf, 66 lb) is applied to it. This is to check adjuster rod stiffness.

3) If the adjuster rod is not stiff and moves freely when applying 294 N (30 kgf, 66 lb), check it using the following procedures:

(1) Slowly press the adjuster rod down to the end surface of the cylinder. Repeat this motion 2 or 3 times.

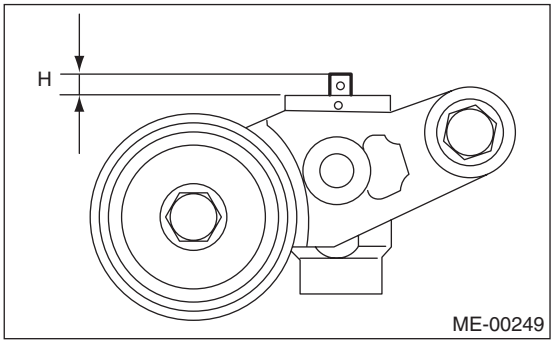
(2) With the adjuster rod moved all the way up, apply a pressure of 294 N (30 kgf, 66 lb) to it. Check adjuster rod stiffness.

(3) If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new one.

**CAUTION:**
**• Always use a vertical type pressing tool to move the adjuster rod down.**
**• Do not use a lateral type vise.**
**• Push the adjuster rod vertically.**
**• Press-in the adjuster rod gradually taking more than 3 minutes.**
**• Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).**
**• Press the adjuster rod as far as the end surface of the cylinder. Do not press the adjuster rod into the cylinder. Doing so may damage the cylinder.**

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

***Rod extension: H***
***5.7±0.5 mm (0.224±0.020 in)***




## 3. BELT TENSION PULLEY

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

## 4. BELT IDLER

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

# 16.Camshaft Sprocket

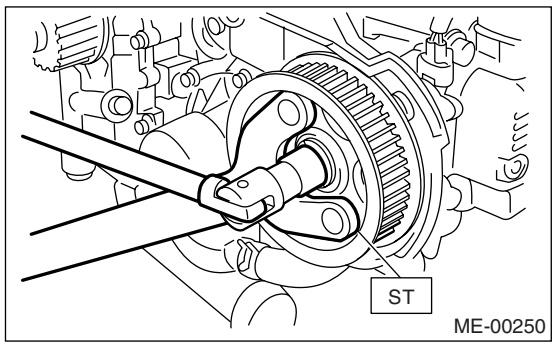
## A: REMOVAL

### 1. REMOVAL

1) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
2) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO)-43, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt assembly. <Ref. to ME(H4SO)-44, REMOVAL, Timing Belt Assembly.>
5) Remove the camshaft position sensor. <Ref. to FU(H4SO)-26, REMOVAL, Camshaft Position Sensor.>
6) Remove the camshaft sprocket No. 2. To lock the camshaft, use ST.

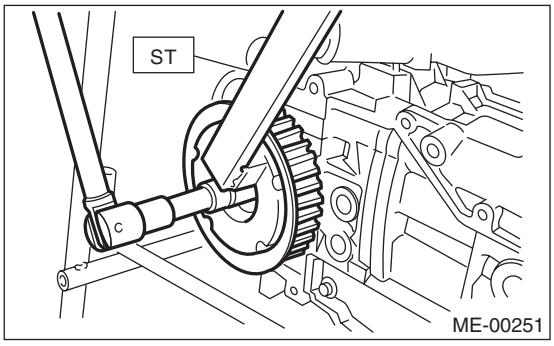
ST 18231AA010 CAMSHAFT SPROCKET WRENCH

NOTE:
Also the CAMSHAFT SPROCKET WRENCH (499207100) can be used.




7) Remove the camshaft sprocket No. 1. To lock the camshaft, use ST.

ST 499207400 CAMSHAFT SPROCKET WRENCH



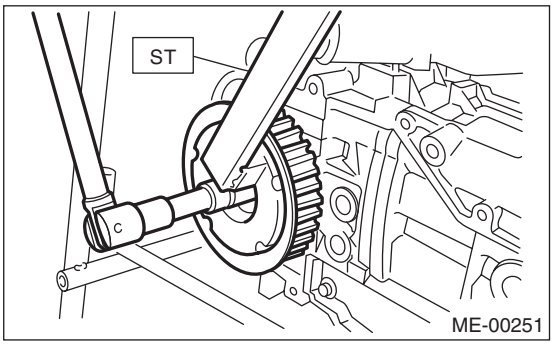

## B: INSTALLATION

1) Install the camshaft sprocket No. 1. To lock the camshaft, use ST.

ST 499207400 CAMSHAFT SPROCKET WRENCH

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

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

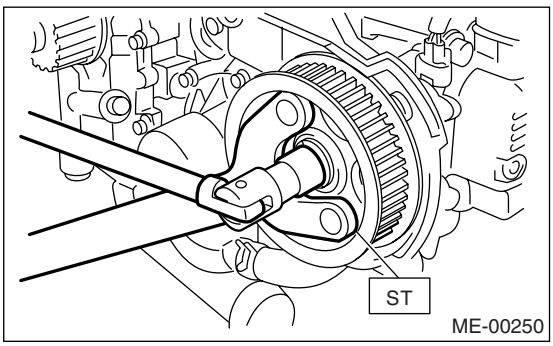



2) Install the camshaft sprocket No. 2. To lock camshaft, use ST.

ST 18231AA010 CAMSHAFT SPROCKET WRENCH

NOTE:
Also the CAMSHAFT SPROCKET WRENCH (499207100) can be used.

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




3) Install the camshaft position sensor. <Ref. to FU(H4SO)-26, INSTALLATION, Camshaft Position Sensor.>
4) Install the timing belt assembly. <Ref. to ME(H4SO)-45, INSTALLATION, Timing Belt Assembly.>
5) Install the timing belt cover. <Ref. to ME(H4SO)-43, INSTALLATION, Timing Belt Cover.>
6) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>

7) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

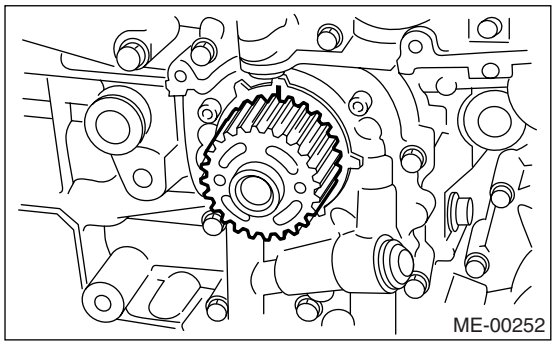
## C: INSPECTION

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

# 17.Crankshaft Sprocket

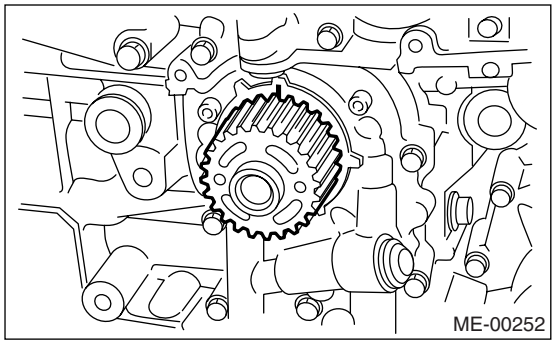
## A: REMOVAL

1) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
2) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO)-43, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt assembly. <Ref. to ME(H4SO)-44, REMOVAL, Timing Belt Assembly.>
5) Remove the camshaft sprocket. <Ref. to ME(H4SO)-49, REMOVAL, Camshaft Sprocket.>
6) Remove the crankshaft sprocket.




## B: INSTALLATION

1) Install the crankshaft sprocket.




2) Install the camshaft sprocket. <Ref. to ME(H4SO)-49, INSTALLATION, Camshaft Sprocket.>
3) Install the timing belt assembly. <Ref. to ME(H4SO)-45, INSTALLATION, Timing Belt Assembly.>
4) Install the timing belt cover. <Ref. to ME(H4SO)-43, INSTALLATION, Timing Belt Cover.>
5) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>
6) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

## C: INSPECTION

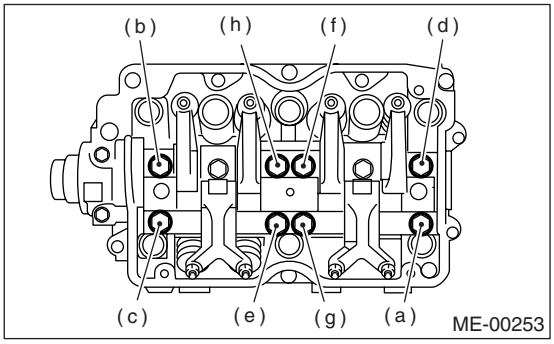
1) Check the sprocket teeth for abnormal wear and scratches.
2) Make sure there is no free play between sprocket and key.
3) Check the crankshaft sprocket notch for sensor for damage and contamination of foreign matter.

# 18.Valve Rocker Assembly

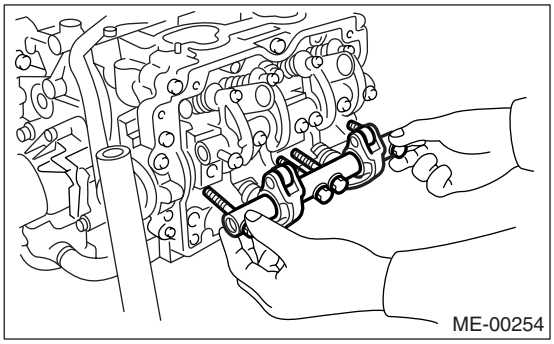
## A: REMOVAL

1) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
2) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO)-43, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt assembly. <Ref. to ME(H4SO)-44, REMOVAL, Timing Belt Assembly.>
5) Remove the camshaft sprocket. <Ref. to ME(H4SO)-49, REMOVAL, Camshaft Sprocket.>
6) Disconnect the PCV hose and remove rocker cover.
7) Removal of valve rocker assembly
   (1) Remove the bolts (a) through (h) in alphabetical sequence.

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




   (2) Remove the valve rocker assembly.



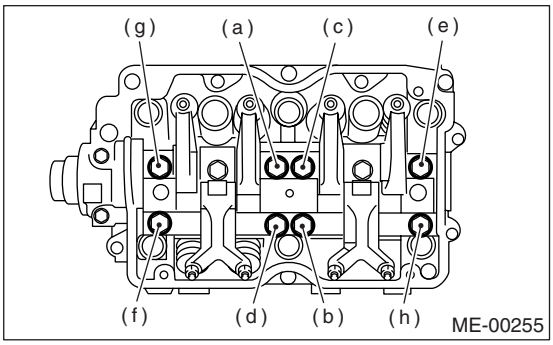

## B: INSTALLATION

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

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

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

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




2) Adjust the valve clearances. <Ref. to ME(H4SO)-29, ADJUSTMENT, Valve Clearance.>
3) Install the rocker cover and connect PCV hose.
4) Install the camshaft sprocket. <Ref. to ME(H4SO)-49, INSTALLATION, Camshaft Sprocket.>
5) Install the timing belt assembly. <Ref. to ME(H4SO)-45, INSTALLATION, Timing Belt Assembly.>
6) Install the timing belt cover. <Ref. to ME(H4SO)-43, INSTALLATION, Timing Belt Cover.>
7) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>
8) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

## C: DISASSEMBLY

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

NOTE:
Arrange all removed parts in order so that they can be installed in their original positions.

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

## D: ASSEMBLY

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

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

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

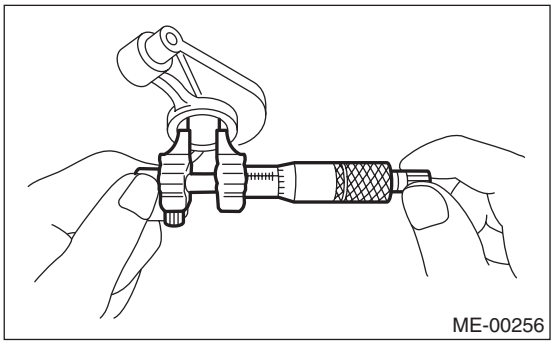
3) Install the valve rocker shaft securing bolts.

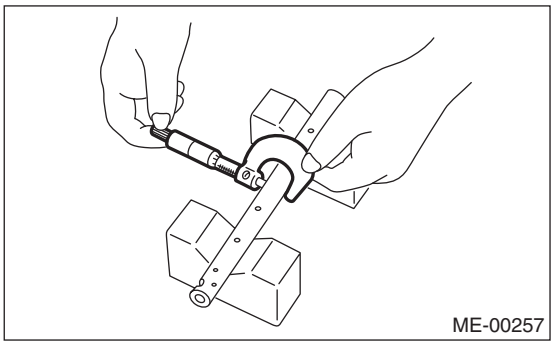
## E: INSPECTION

### 1. VALVE ROCKER ARM AND ROCKER SHAFT

1) Measure the inside diameter of valve rocker arm and outside diameter of valve rocker shaft, and determine the difference between the two (= oil clearance).

***Clearance between arm and shaft:***
***Standard***
***0.020 — 0.054 mm (0.0008 — 0.0021 in)***
***Limit***
***0.10 mm (0.0039 in)***


ME-00256


ME-00257

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

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

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

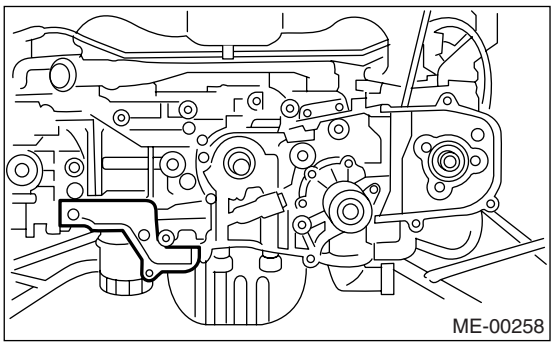
3) If cam or valve contact surface of valve rocker arm is worn or dented excessively, replace the valve rocker arm.
4) Check that the valve rocker arm roller rotates smoothly. If not, replace the valve rocker arm.

# 19.Camshaft

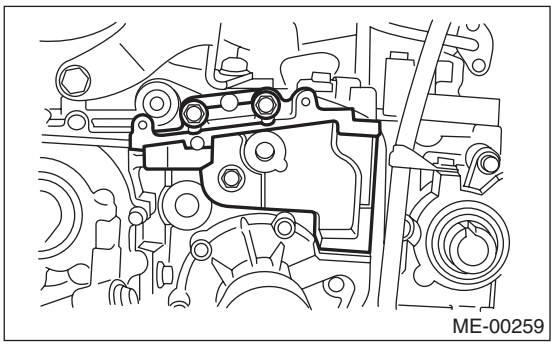
## A: REMOVAL

1) Remove the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>
2) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO)-43, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt assembly. <Ref. to ME(H4SO)-44, REMOVAL, Timing Belt Assembly.>
5) Remove the camshaft sprocket. <Ref. to ME(H4SO)-49, REMOVAL, Camshaft Sprocket.>
6) Remove the crankshaft sprocket. <Ref. to ME(H4SO)-51, REMOVAL, Crankshaft Sprocket.>
7) Remove the timing belt cover No. 2 (LH).
8) Remove the timing belt cover No. 2 (RH).

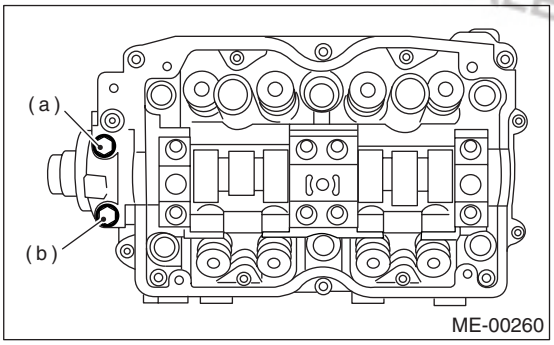
NOTE:
Do not damage or lose the seal rubber when removing the timing belt covers.


ME-00258

9) Remove the tensioner bracket.

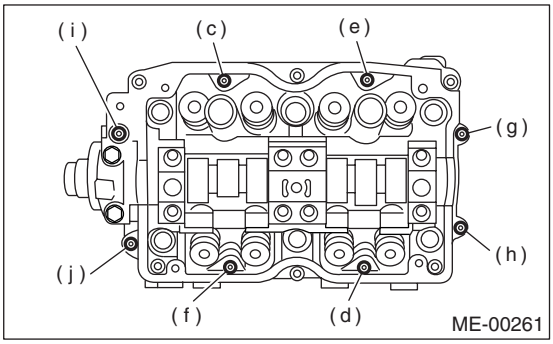

ME-00259

10) Remove the camshaft position sensor support. (LH side only)
11) Remove the oil level gauge guide. (LH side only)
12) Remove the valve rocker assembly. <Ref. to ME(H4SO)-52, REMOVAL, Valve Rocker Assembly.>
13) Remove the camshaft cap.
(1) Remove the bolts (a) through (b) in alphabetical sequence.



ME-00260

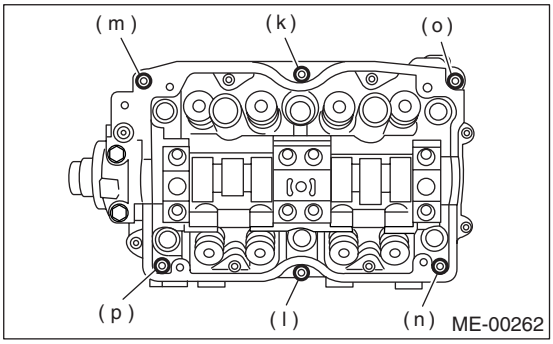
(2) Equally loosen the bolts (c) through (j) all the way in alphabetical sequence.



ME-00261

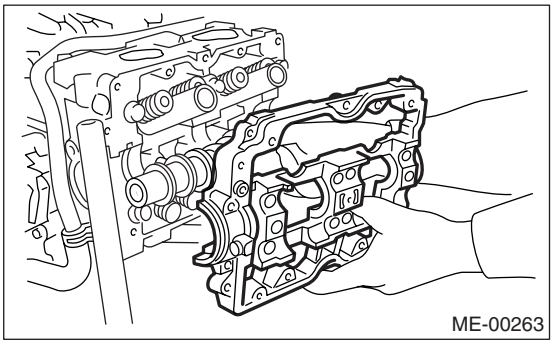
(3) Remove the bolts (k) through (p) in alphabetical sequence using ST.

ST 499497000 TORX® PLUS



ME-00262

(4) Remove the camshaft cap.


ME-00263

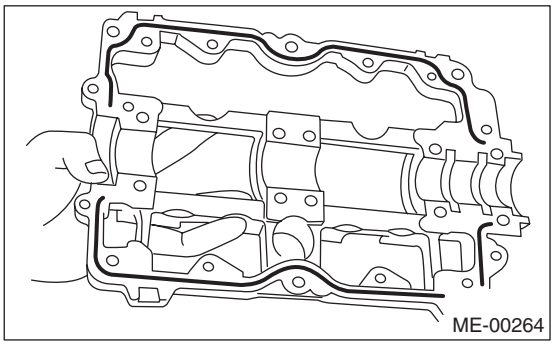
14) Remove the camshaft.
15) Remove the oil seal.
16) Remove the plug from rear side of camshaft.

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

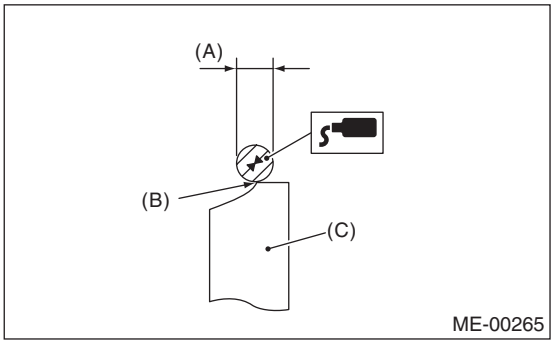
## B: INSTALLATION

1) Apply a coat of engine oil to the camshaft journals, and then install the camshaft.
2) Install the camshaft cap.
   (1) Apply liquid gasket on the around of camshaft cap.

***Liquid gasket:***
***THREE BOND 1280B***
***Part No. K0877YA018***

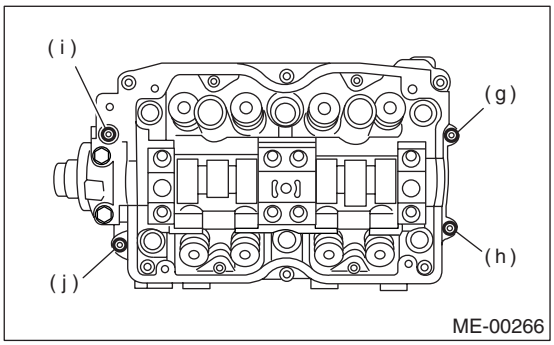

ME-00264

NOTE:
Apply a coat of 3 mm (0.12 in) dia. (A) liquid gasket along edge (B) of the camshaft cap (C) mating surface.



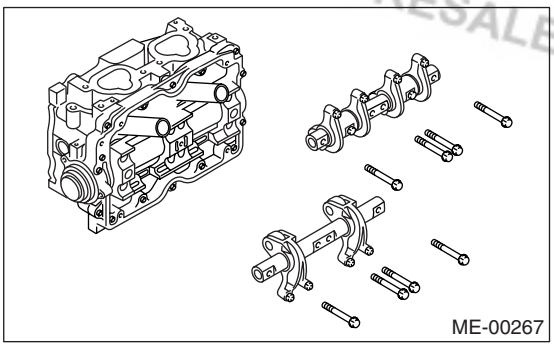
ME-00265

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



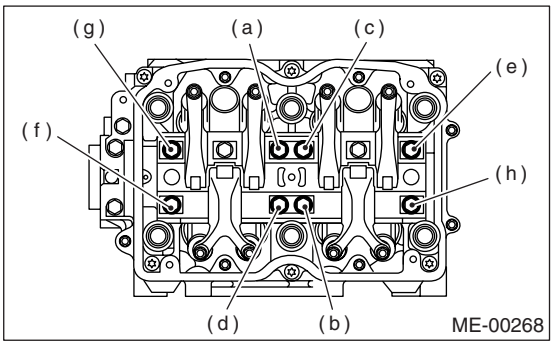
ME-00266

(3) Install the valve rocker assembly.


ME-00267

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

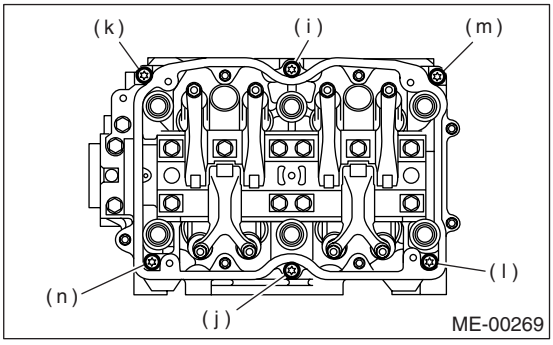
***Tightening torque:***
***25 N·m (2.5 kgf-m, 18.1 ft-lb)***



ME-00268

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

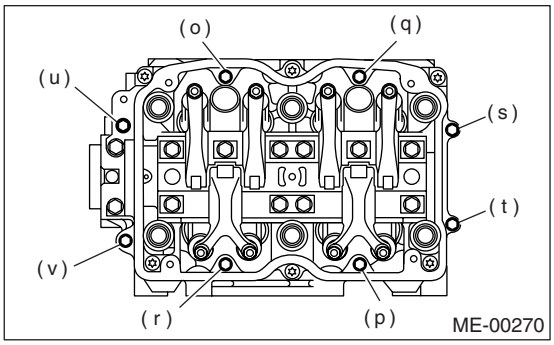
***Tightening torque:***
***18 N·m (1.8 kgf-m, 13.0 ft-lb)***



ME-00269

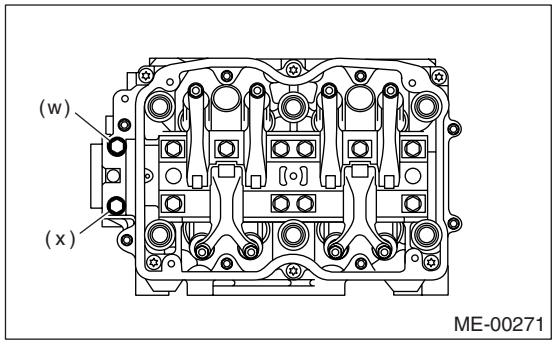
(6) Tighten the bolts (o) through (v) in alphabetical sequence.

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




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

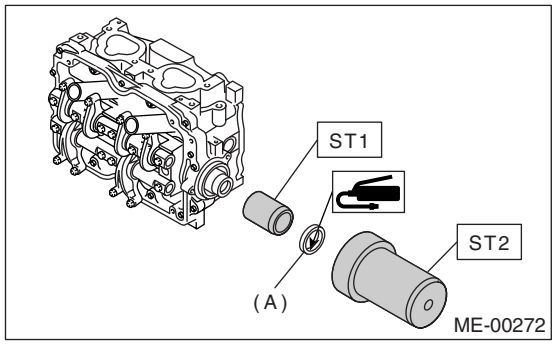
***Tightening torque:***
***10 N·m (1.0 kgf-m, 7.2 ft-lb)***




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

NOTE:
Use a new oil seal.

ST1 499597000 OIL SEAL GUIDE
ST2 499587500 OIL SEAL INSTALLER

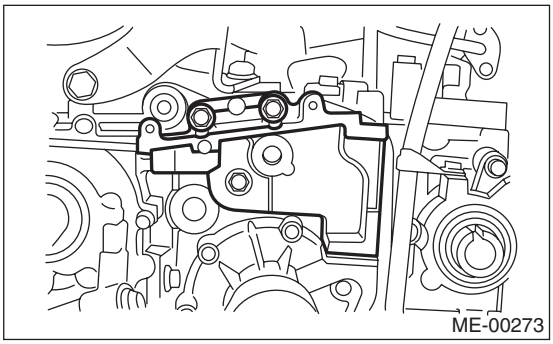



4) Install the plug using ST.

ST 499587700 CAMSHAFT OIL SEAL INSTALLER

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

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

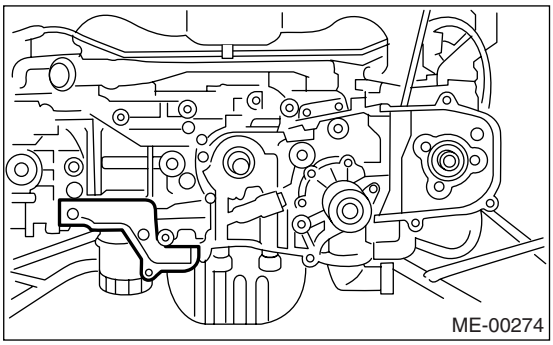



10) Install the timing belt cover No. 2 (RH).

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

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

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



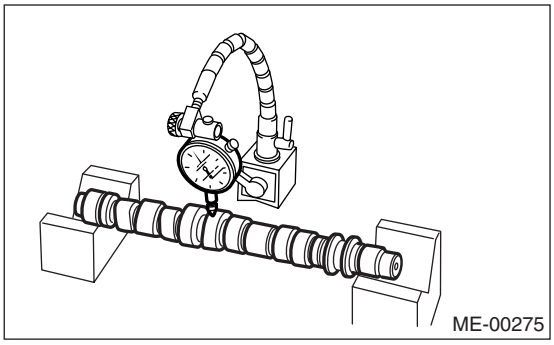

12) Install the crankshaft sprocket. <Ref. to ME(H4SO)-51, INSTALLATION, Crankshaft Sprocket.>
13) Install the camshaft sprocket. <Ref. to ME(H4SO)-49, INSTALLATION, Camshaft Sprocket.>
14) Install the timing belt assembly. <Ref. to ME(H4SO)-45, INSTALLATION, Timing Belt Assembly.>
15) Install the timing belt cover. <Ref. to ME(H4SO)-43, INSTALLATION, Timing Belt Cover.>
16) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>
17) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

# C: INSPECTION

## 1. CAMSHAFT

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

***Limit:***
***0.025 mm (0.0010 in)***




2) Check the journal for damage and wear. Replace if faulty.
3) Measure the outside diameter of camshaft journal and inside diameter of cylinder head journal, and determine the difference between two (= oil clearance). If the oil clearance exceeds specifications, replace the camshaft or cylinder head as necessary.

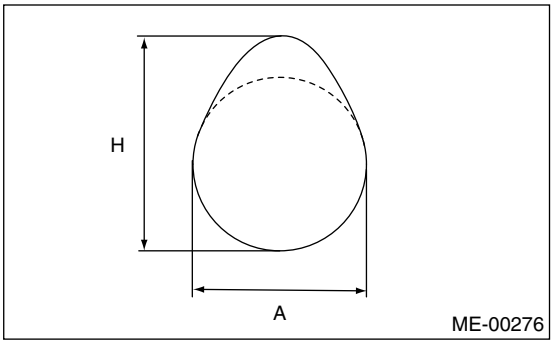
| | | Unit: mm (in) |
|---|---|---|
| Clearance at journal | Standard | 0.055 — 0.090 (0.0022 — 0.0035) |
| | Limit | 0.10 (0.0039) |
| Camshaft journal O.D. | | 31.928 — 31.945 (1.2570 — 1.2577) |
| Journal hole I.D. | | 32.000 — 32.018 (1.2598 — 1.2605) |

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

***Cam height: H***

| Item | | Unit: mm (in) |
|---|---|---|
| Intake | STD | 39.485 — 39.585 (1.5545 — 1.5585) |
| | Limit | 39.385 (1.5506) |
| Exhaust | STD | 39.257 — 39.357 (1.5455 — 1.5495) |
| | Limit | 39.157 (1.5416) |

***Cam base circle diameter A:***
***IN: 34.00 mm (1.3386 in)***
***EX: 34.00 mm (1.3386 in)***

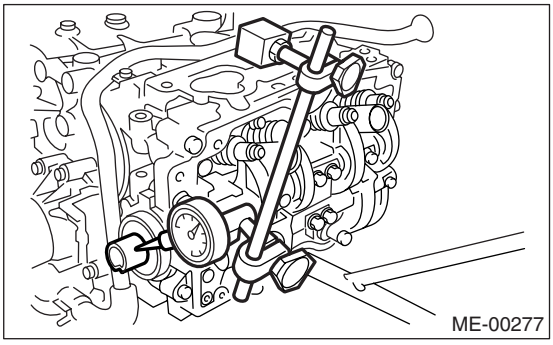



## 2. CAMSHAFT SUPPORT

Measure the thrust clearance of camshaft with dial gauge. If the clearance exceeds the limit, replace the camshaft support.

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

***Limit:***
***0.10 mm (0.0039 in)***

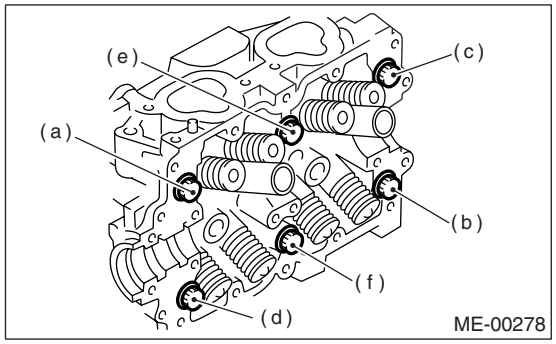


# 20.Cylinder Head Assembly

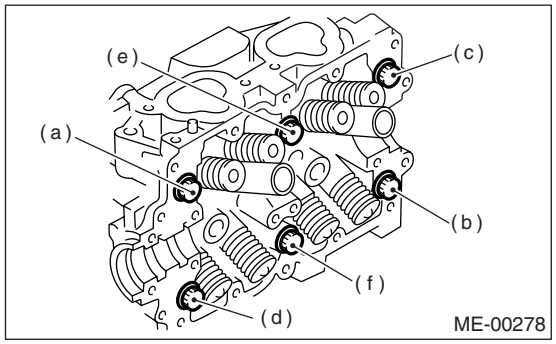
## A: REMOVAL

1) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
2) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO)-43, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt assembly. <Ref. to ME(H4SO)-44, REMOVAL, Timing Belt Assembly.>
5) Remove the camshaft sprocket. <Ref. to ME(H4SO)-49, REMOVAL, Camshaft Sprocket.>
6) Remove the intake manifold. <Ref. to FU(H4SO)-13, REMOVAL, Intake Manifold.>
7) Remove the bolt which installs the A/C compressor bracket on cylinder head.
8) Remove the valve rocker assembly. <Ref. to ME(H4SO)-52, REMOVAL, Valve Rocker Assembly.>
9) Remove the camshaft. <Ref. to ME(H4SO)-54, REMOVAL, Camshaft.>
10) Remove the cylinder head bolts in alphabetical sequence shown in the figure.

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




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




13) Remove the cylinder head gasket.

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

14) Similarly, remove the right side cylinder head.

## B: INSTALLATION

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

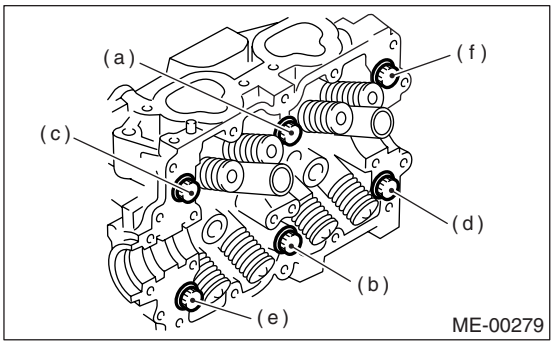
**CAUTION:**
- **Use new cylinder head gaskets.**
- **Be careful not to scratch the mating surface of cylinder block and cylinder head.**

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

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

(7) Further tighten all bolts by 80° to 90° in alphabetical sequence shown in figure below.

**CAUTION:**
**Ensure that the total "re-tightening angle" [in the former two steps], do not exceed 180°.**




3) Install the camshaft. <Ref. to ME(H4SO)-55, INSTALLATION, Camshaft.>
4) Install the valve rocker assembly. <Ref. to ME(H4SO)-52, INSTALLATION, Valve Rocker Assembly.>
5) Install the A/C compressor bracket on cylinder head.
6) Install the intake manifold. <Ref. to FU(H4SO)-15, INSTALLATION, Intake Manifold.>

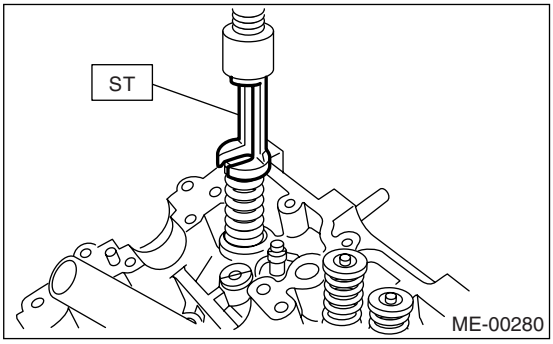
7) Install the camshaft sprocket. <Ref. to ME(H4SO)-49, INSTALLATION, Camshaft Sprocket.>
8) Install the timing belt assembly. <Ref. to ME(H4SO)-45, INSTALLATION, Timing Belt Assembly.>
9) Install the timing belt cover. <Ref. to ME(H4SO)-43, INSTALLATION, Timing Belt Cover.>
10) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>
11) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>

## C: DISASSEMBLY

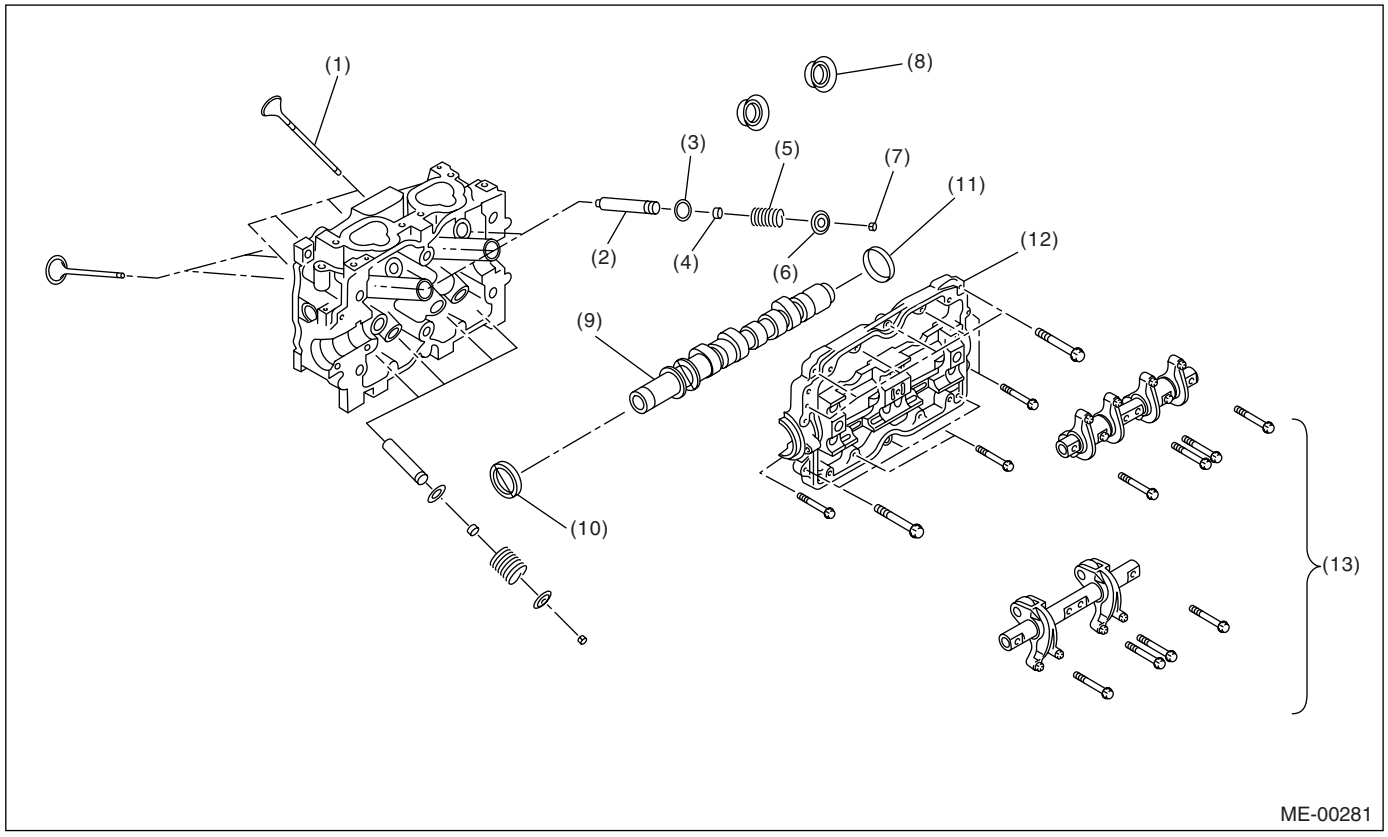
1) Place the cylinder head on ST.
ST 498267800 CYLINDER HEAD TABLE

2) Set the ST on valve spring. Compress the valve spring, and then remove the valve spring retainer key. Remove each valve and valve spring.
ST 499718000 VALVE SPRING REMOVER

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




## D: ASSEMBLY




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

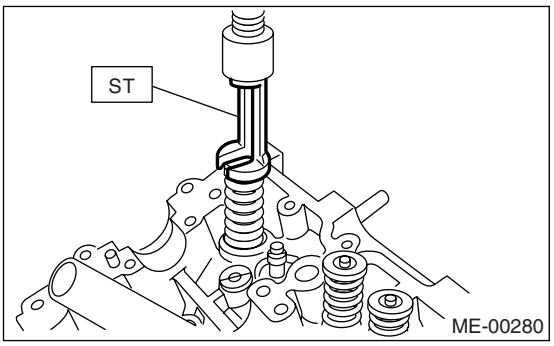
1) Installation of valve spring and valve
(1) Place the cylinder head on ST.
ST 4982678 00 CYLINDER HEAD TABLE
(2) Coat the stem of each valve with engine oil and insert valve into valve guide.

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

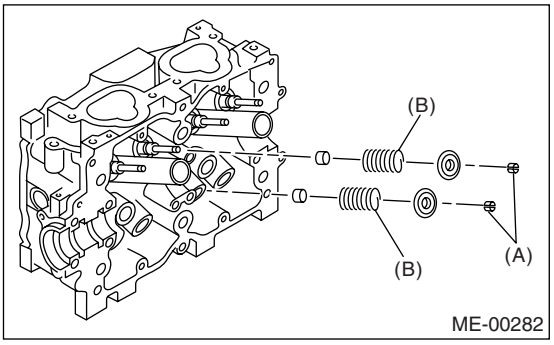
(3) Install the valve spring and retainer.

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

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




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




(A) Retainer key
(B) Valve spring

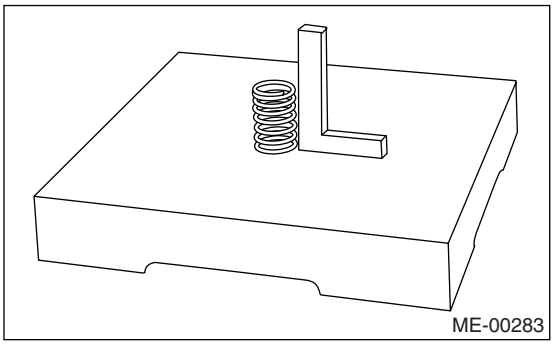
(6) After installing, tap the valve spring retainers lightly with plastic hammer for better seating.

# E: INSPECTION

## 1. VALVE SPRING

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

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




## 2. INTAKE AND EXHAUST VALVE OIL SEAL

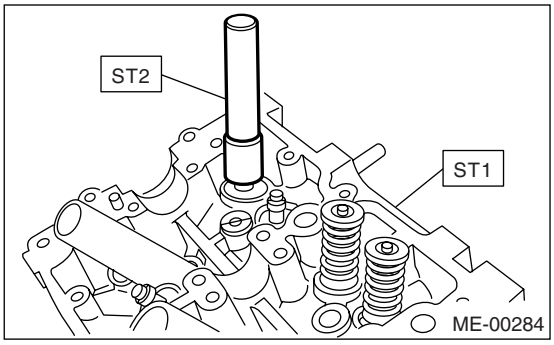
Replace the oil seal with new one, if lip is damaged or spring out of place, or when the surfaces of intake valve and valve seat are reconditioned or intake valve guide is replaced. Use pliers to pinch and remove oil seal from valve.
1) Place the cylinder head on ST1.
2) Press-fit oil seal using ST2.

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

ST1 498267800 CYLINDER HEAD TABLE
ST2 498857100 VALVE OIL SEAL GUIDE

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

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




# F: ADJUSTMENT

## 1. CYLINDER HEAD

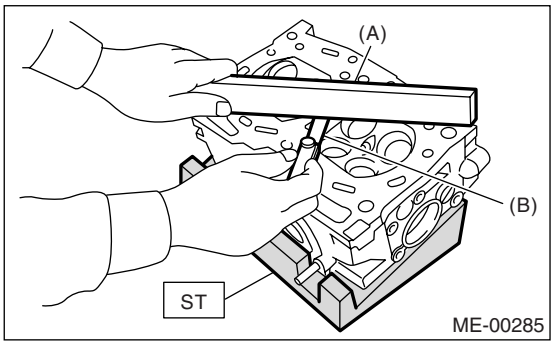
1) Make sure that no crack or other damage exists. In addition to visual inspection, inspect important areas by means of red lead check.
Also make sure that gasket installing surface shows no trace of gas and water leaks.
2) Place the cylinder head on ST.
ST 498267800 CYLINDER HEAD TABLE
3) Measure the warping of the cylinder head surface that mates with crankcase using a straight edge and thickness gauge.
If the warping exceeds 0.05 mm (0.0020 in), regrind the surface with a surface grinder.

***Warping limit:***
***0.05 mm (0.0020 in)***

***Grinding limit:***
***0.1 mm (0.004 in)***

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

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

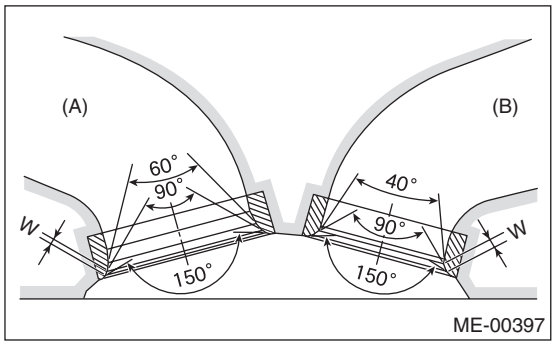


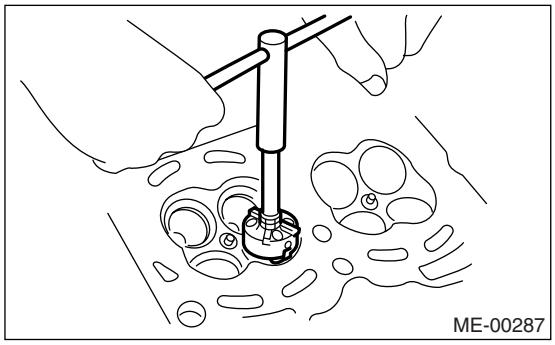

(A) Straight edge
(B) Thickness gauge

## 2. VALVE SEAT

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

***Valve seat width: W***
***Intake (A)***
***Standard 1.0 mm (0.039 in)***
***Limit 1.7 mm (0.067 in)***
***Exhaust (B)***
***Standard 1.5 mm (0.059 in)***
***Limit 2.2 mm (0.087 in)***

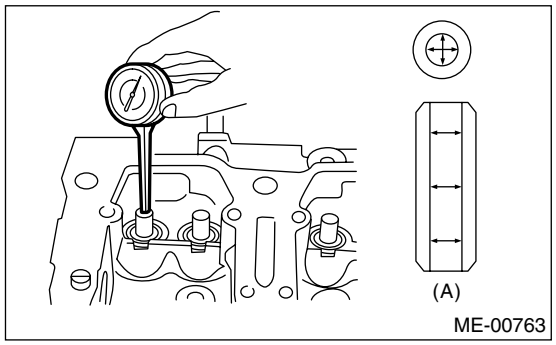


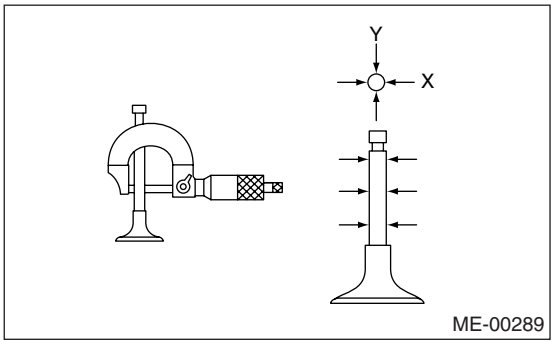

## 3. VALVE GUIDE

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 0.035 — 0.062 mm (0.0014 — 0.0024 in)***
***Exhaust 0.040 — 0.067 mm (0.0016 — 0.0026 in)***
***Limit***
***0.15 mm (0.0059 in)***




(A) Valve guide

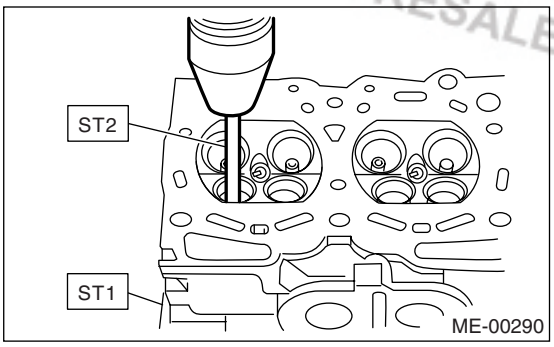



2) If the clearance between valve guide and stem exceeds the limit, replace the valve guide or valve itself whichever shows greater amount of wear. See the following procedure for valve guide replacement.

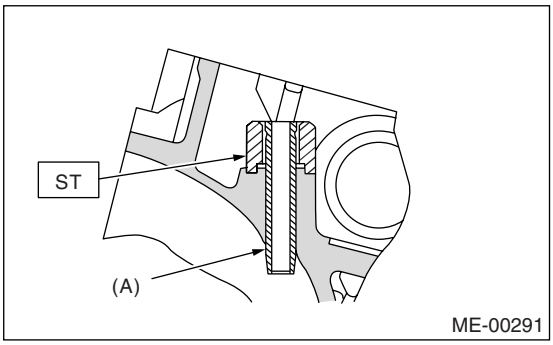
***Valve guide inner diameter:***
***6.000 — 6.012 mm (0.2362 — 0.2367 in)***

***Valve stem outer diameters:***
***Intake***
***5.950 — 5.965 mm (0.2343 — 0.2348 in)***
***Exhaust***
***5.945 — 5.960 mm (0.2341 — 0.2346 in)***

(1) Place the cylinder head on ST1 with the combustion chamber upward so that valve guides enter the holes in ST1.
(2) Insert the ST2 into valve guide and press it down to remove valve guide.
ST1 498267800 CYLINDER HEAD TABLE
ST2 499767200 VALVE GUIDE REMOVER

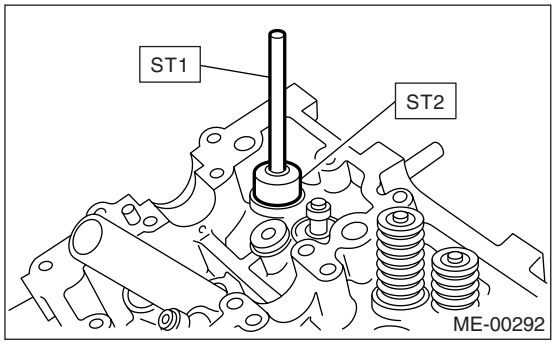



(3) Turn the cylinder head upside down and place ST as shown in the figure.
Intake side:
ST 499767700 VALVE GUIDE ADJUSTER
Exhaust side:
ST 499767800 VALVE GUIDE ADJUSTER



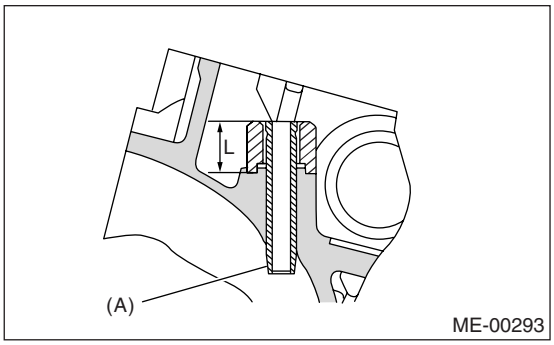

(A) Valve guide

(4) Before installing new oversize valve guide, make sure that neither scratches nor damages exist on the inside surface of valve guide holes in cylinder head.
(5) Put new valve guide, coated with sufficient oil, in the cylinder, and then insert the ST1 into valve guide. Press in until the valve guide upper end is flush with the upper surface of ST2.
ST1 499767200 VALVE GUIDE REMOVER
Intake side:
ST2 499767700 VALVE GUIDE ADJUSTER
Exhaust side:
ST2 499767800 VALVE GUIDE ADJUSTER



(6) Check the valve guide protrusion.

***Valve guide protrusion: L***
***Intake***
***20.0 — 20.5 mm (0.787 — 0.807 in)***
***Exhaust***
***16.5 — 17.0 mm (0.650 — 0.669 in)***

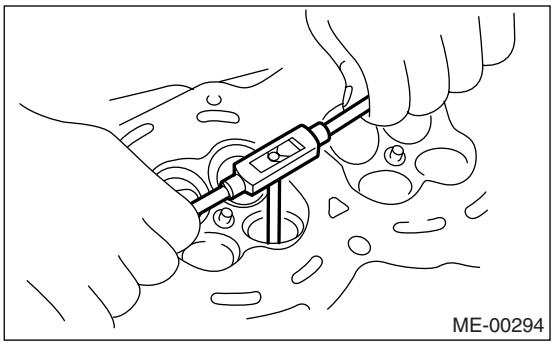



(A) Valve guide

(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 the valve guide to remove chips.

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

ST 499767400 VALVE GUIDE REAMER



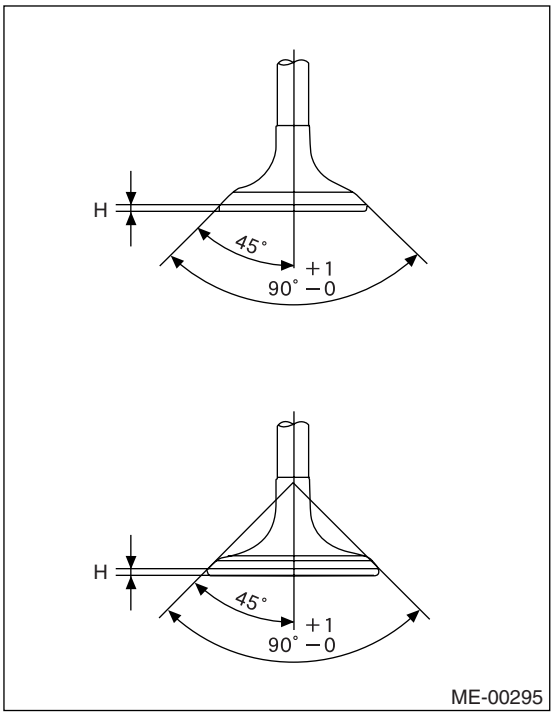

(8) Recheck the contact condition between valve and valve seat after replacing valve guide.

## 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 0.6 mm (0.024 in)***
***Exhaust***
***Standard 1.2 mm (0.047 in)***
***Limit 0.6 mm (0.024 in)***

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




2) Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. <Ref. to ME(H4SO)-61, VALVE SEAT, ADJUSTMENT, Cylinder Head Assembly.> Install a new intake valve oil seal after lapping.

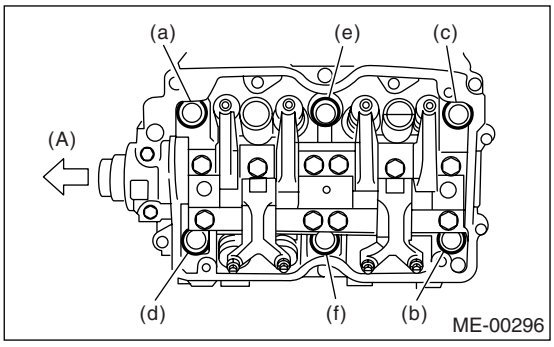
# 21.Cylinder Block

## A: REMOVAL

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

1) Remove the intake manifold. <Ref. to FU(H4SO)-13, REMOVAL, Intake Manifold.>
2) Remove the V-belt. <Ref. to ME(H4SO)-39, REMOVAL, V-belt.>
3) Remove the crankshaft pulley. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
4) Remove the timing belt cover. <Ref. to ME(H4SO)-43, REMOVAL, Timing Belt Cover.>
5) Remove the timing belt assembly. <Ref. to ME(H4SO)-44, REMOVAL, Timing Belt Assembly.>
6) Remove the camshaft sprocket. <Ref. to ME(H4SO)-49, REMOVAL, Camshaft Sprocket.>
7) Remove the crankshaft sprocket. <Ref. to ME(H4SO)-42, REMOVAL, Crankshaft Pulley.>
8) Remove the generator and A/C compressor with their brackets.
9) Remove the rocker cover.
10) Remove the cylinder head bolts in alphabetical sequence shown in the figure.

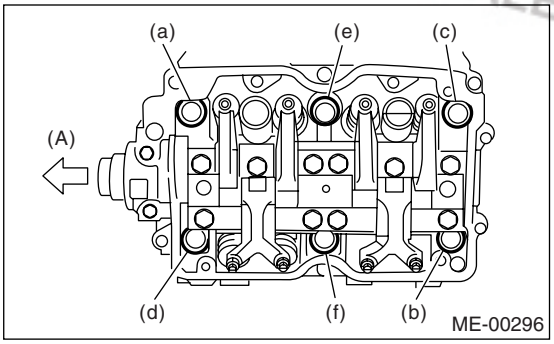
NOTE:
Leave bolts (a) and (c) engaged by three or four threads to prevent cylinder head from falling.




(A) Front

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

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



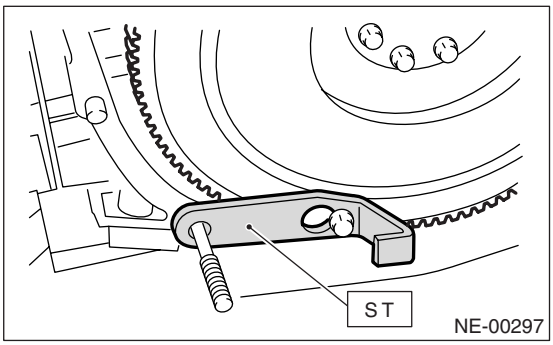

(A) Front

13) Remove the cylinder head gasket.

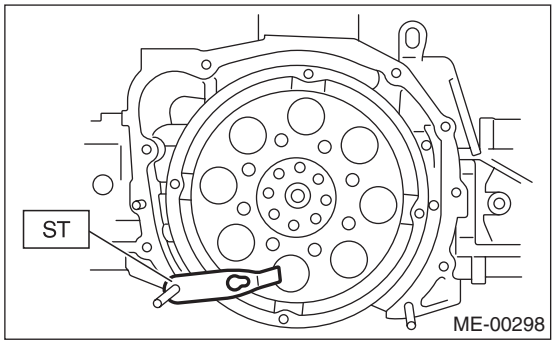
NOTE:
Do not scratch the mating surface of cylinder head and cylinder block.

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

- MT MODEL

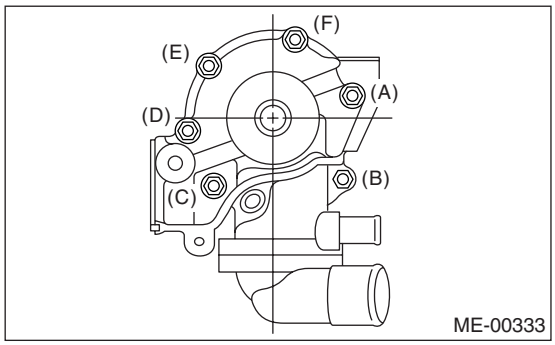



- AT MODEL



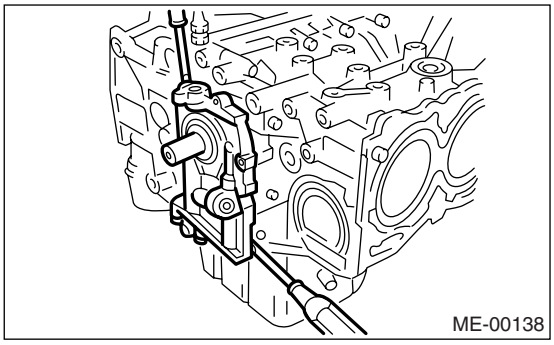

17) Remove the oil separator cover.
18) Remove the water by-pass pipe for heater.

19) Loosen the bolts in alphabetical sequence as shown in the figure, and then remove the water pump.



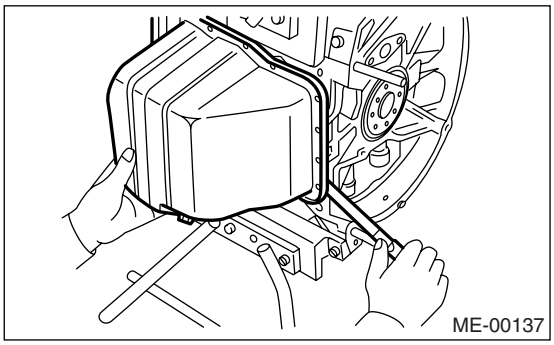

20) Remove the oil pump from cylinder block.
Use a flat-bladed screwdriver as shown in the figure when removing oil pump.

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



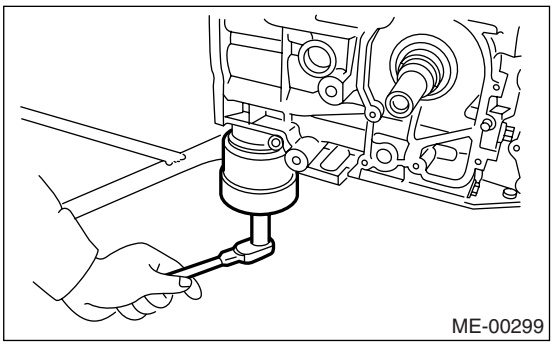

21) Removal of oil pan
(1) Turn the cylinder block to face the #2 and #4 piston sides upward.
(2) Remove the bolts which secure the oil pan to cylinder block.
(3) Insert a oil pan cutter blade between cylinder block-to-oil pan clearance, and then remove the oil pan.

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

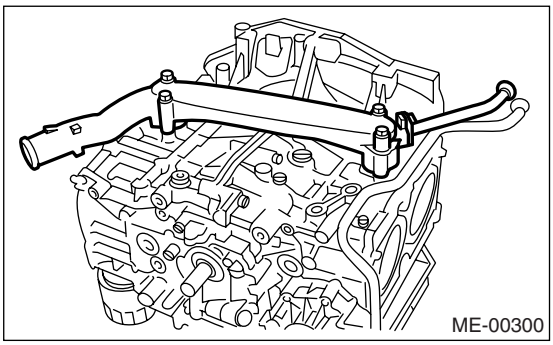


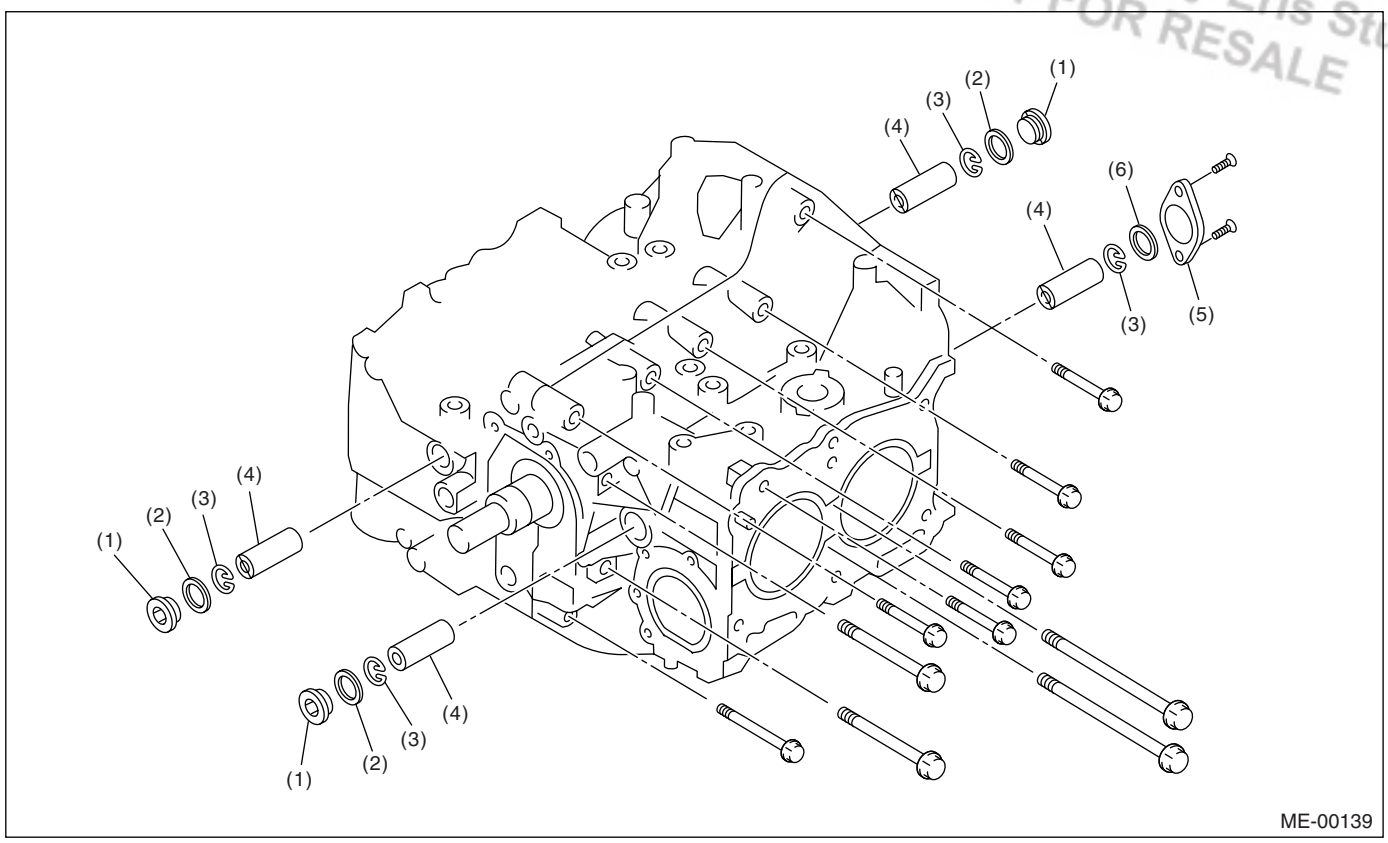

22) Remove the oil strainer stay.
23) Remove the oil strainer.
24) Remove the baffle plate.
25) Remove the oil filter using ST.

| | | |
|---|---|---|
| ST | 498547000 | OIL FILTER WRENCH (Outer diameter: 80 mm (3.15 in)) |
| ST | 18332AA000 | OIL FILTER WRENCH (Outer diameter: 68 mm (2.68 in)) |
| ST | 18332AA010 | OIL FILTER WRENCH (Outer diameter: 65 mm (2.56 in)) |



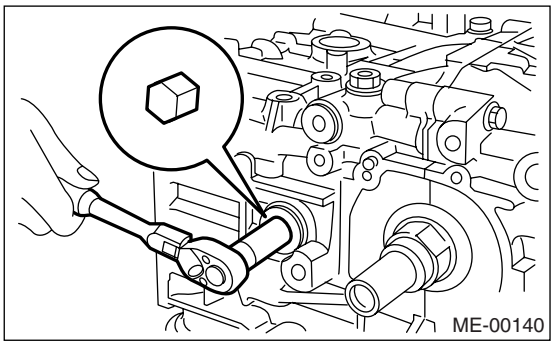

26) Remove the water pipe.



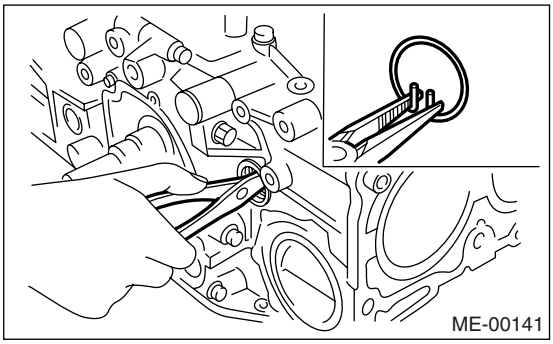



(1) Service hole plug
(2) Gasket
(3) Circlip
(4) Piston pin
(5) Service hole cover
(6) O-ring

27) Remove the service hole cover and service hole plugs using hexagon wrench [14 mm (0.55 in)].

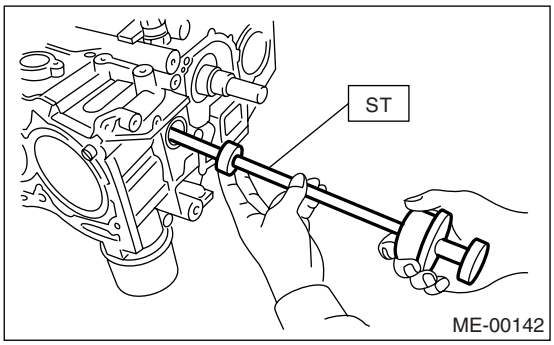



28) Rotate the crankshaft to bring #1 and #2 pistons to bottom dead center position, and then remove the piston circlip through service hole of #1 and #2 cylinders.



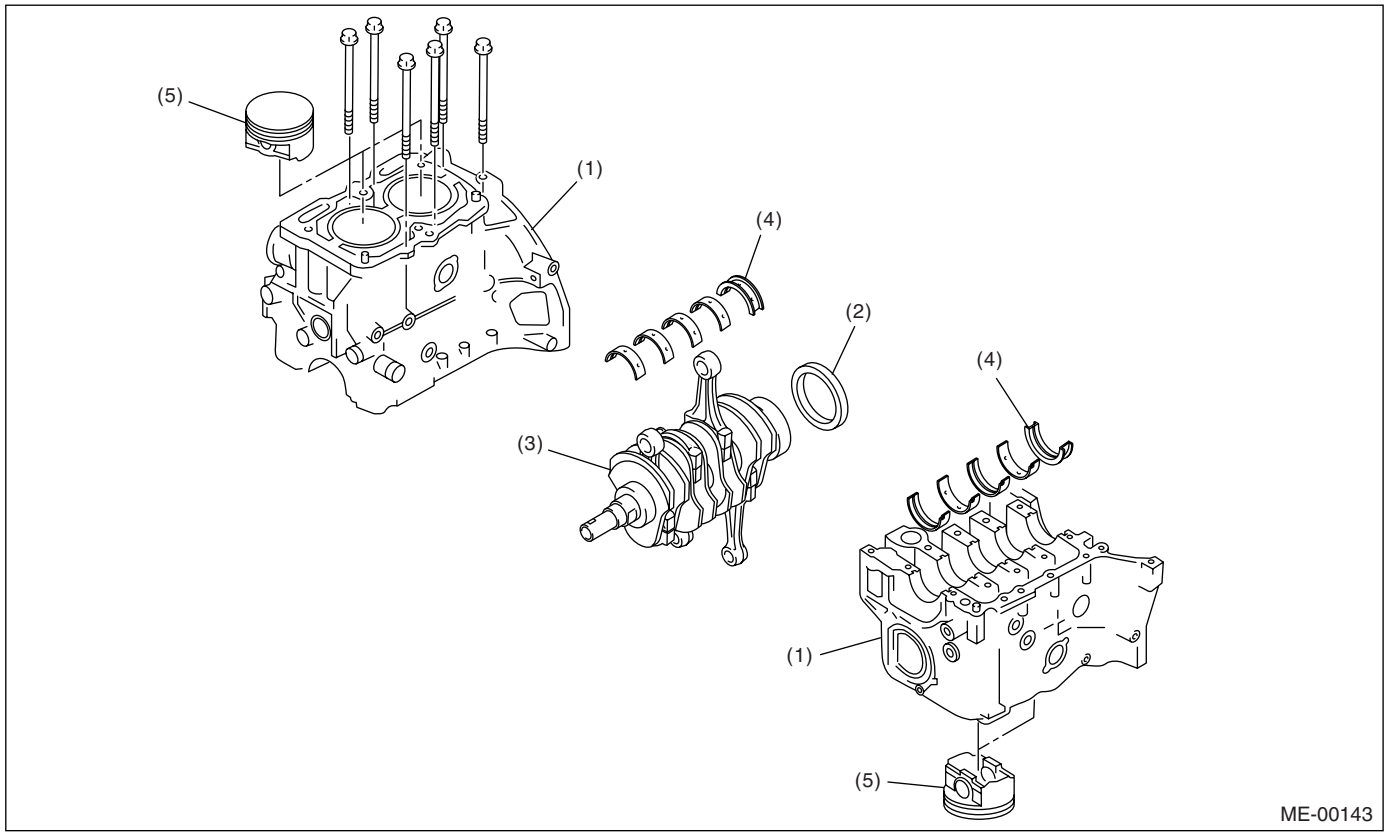

29) Draw out the piston pin from #1 and #2 pistons using ST.
ST 499097700 PISTON PIN REMOVER

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




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

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




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

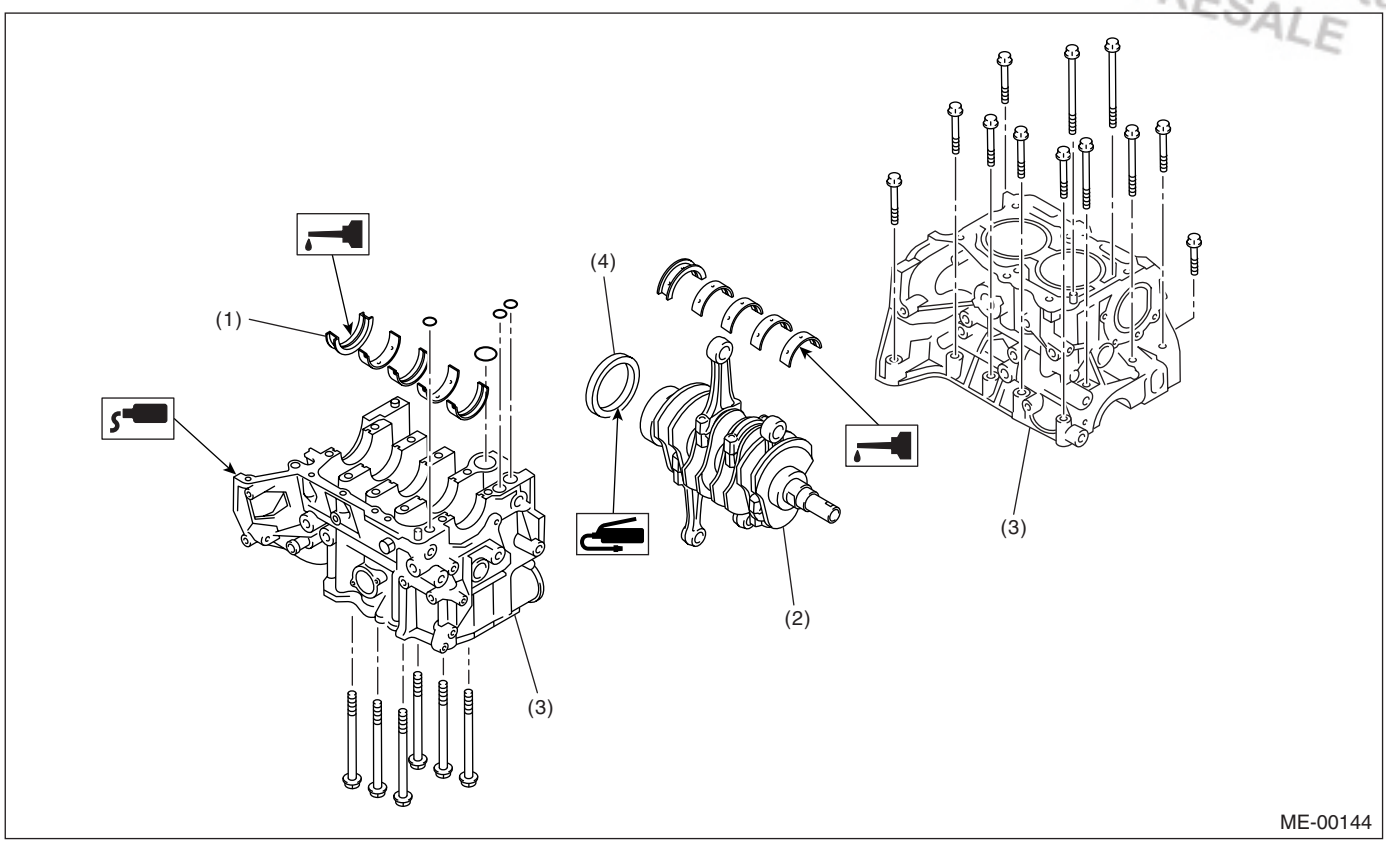
35) Remove the rear oil seal.
36) Remove the crankshaft together with connecting rod.
37) Remove the crankshaft bearings from cylinder block using hammer handle.

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

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

NOTE:
Do not confuse the combination of piston and cylinder.

## B: INSTALLATION



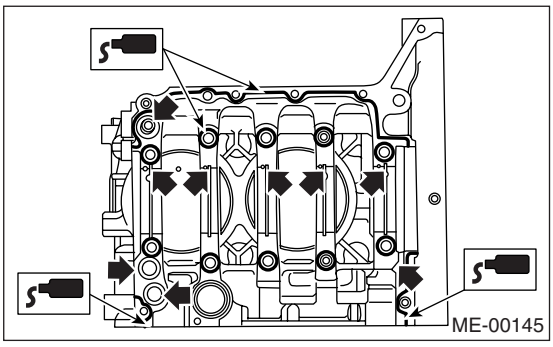

(1) Crankshaft bearing
(2) Crankshaft
(3) Cylinder block
(4) Rear oil seal

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

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

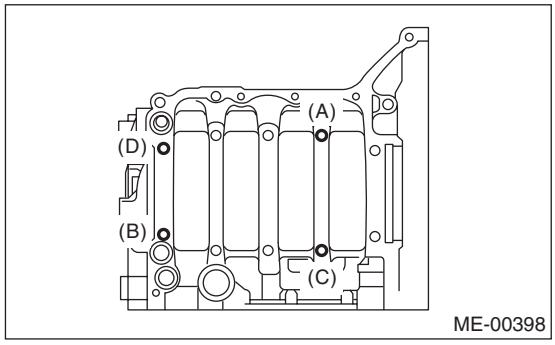
***Fluid packing:***
***Part No. 004403007***
***THREE BOND 1215 or equivalent***

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



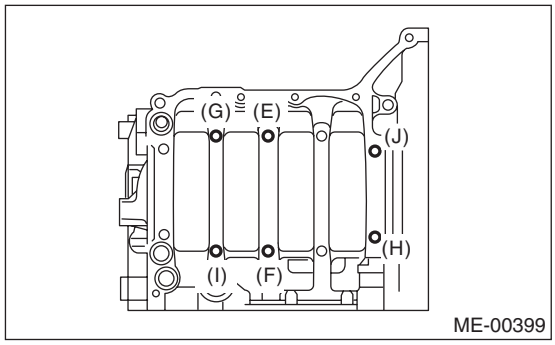

3) Tighten the 10 mm cylinder block connecting bolts in alphabetical sequence shown in the figure. (LH side)

***Tightening torque:***
***15 N·m (1.5 kgf-m, 10.8 ft-lb)***

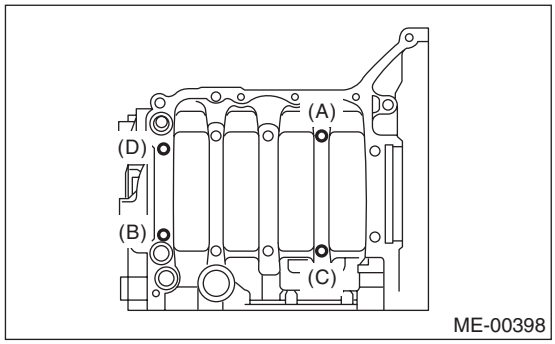



4) Tighten the 10 mm cylinder block connecting bolts in alphabetical sequence shown in the figure. (RH side)

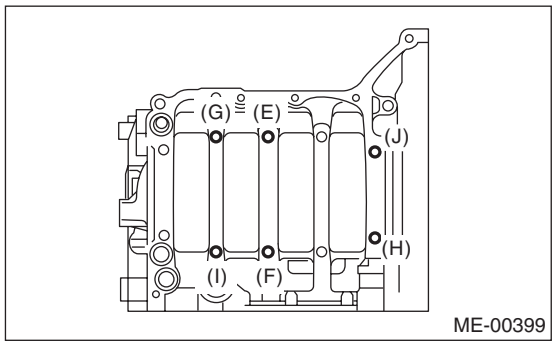
***Tightening torque:***
***15 N·m (1.5 kgf-m, 10.8 ft-lb)***




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

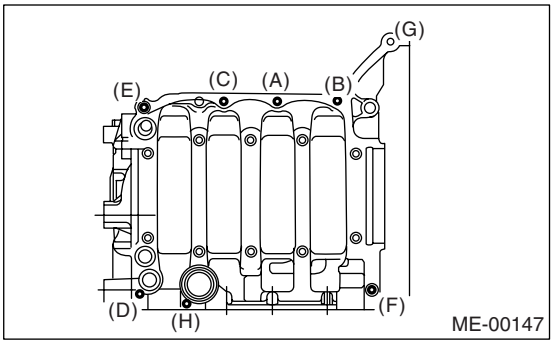



6) Further tighten the RH side bolts (E — J) to 90° in alphabetical sequence.

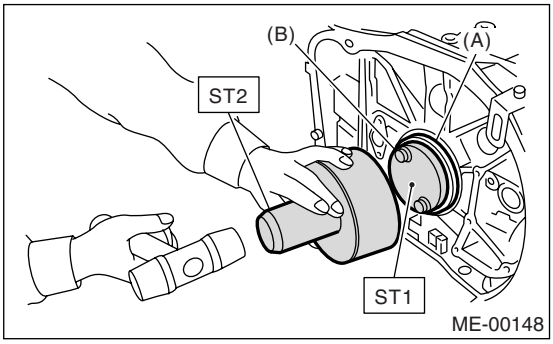



7) Tighten the 8 mm and 6 mm cylinder block connecting bolts in alphabetical sequence shown in the figure.

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

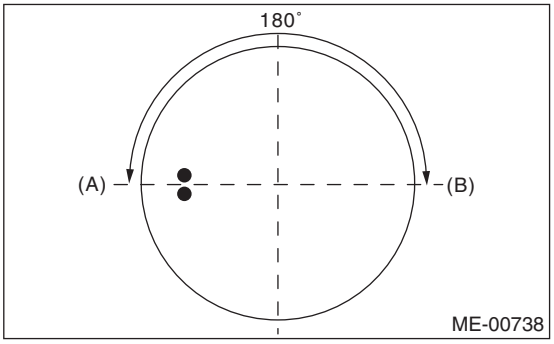



8) Install the rear oil seal using ST1 and ST2.
ST1 499597100 OIL SEAL GUIDE
ST2 499587200 OIL SEAL INSTALLER

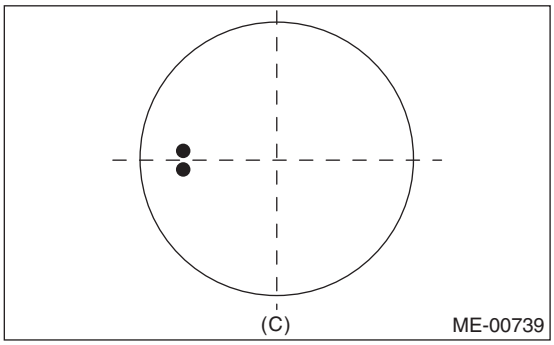



(A) Rear oil seal
(B) Flywheel attaching bolt

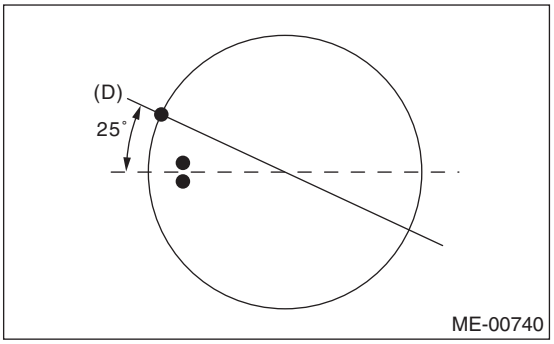
9) Position the top ring gap at (A) or (B) in the figure.
10) Position the second ring gap at 180° on the reverse side for top ring gap.



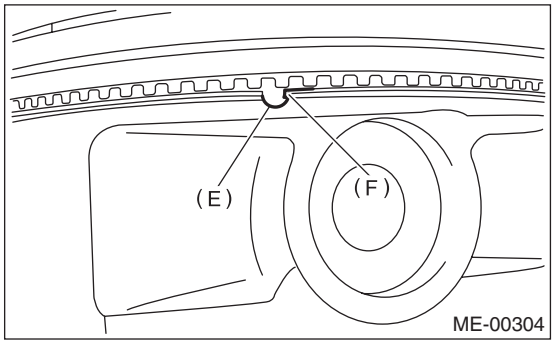
11) Position the expander gap at (C) in the figure.



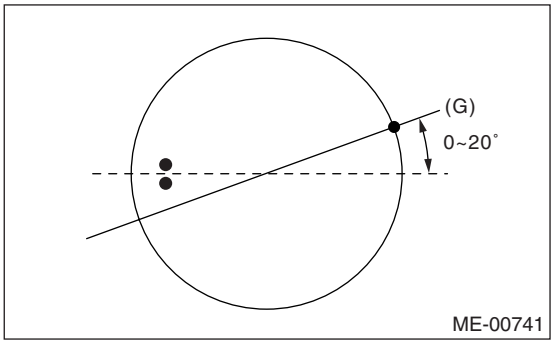

12) Position the lower rail gap at (D) in the figure.




NOTE:
Align the lower rail stopper (F) to the lateral hole (E) on the piston.



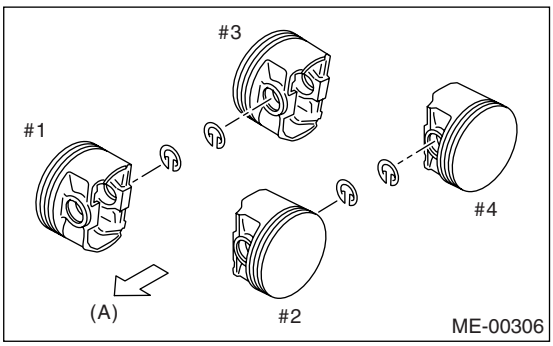

13) Position the upper rail gap at (G) in the figure.




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

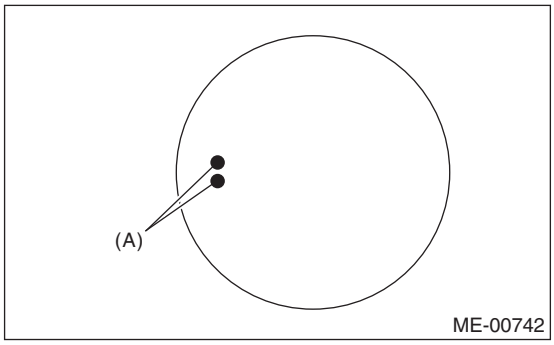
14) Install the circlip.
Install circlips in the piston holes located opposite service holes in cylinder block, when positioning all pistons in the corresponding cylinders.

NOTE:
Use new circlips.

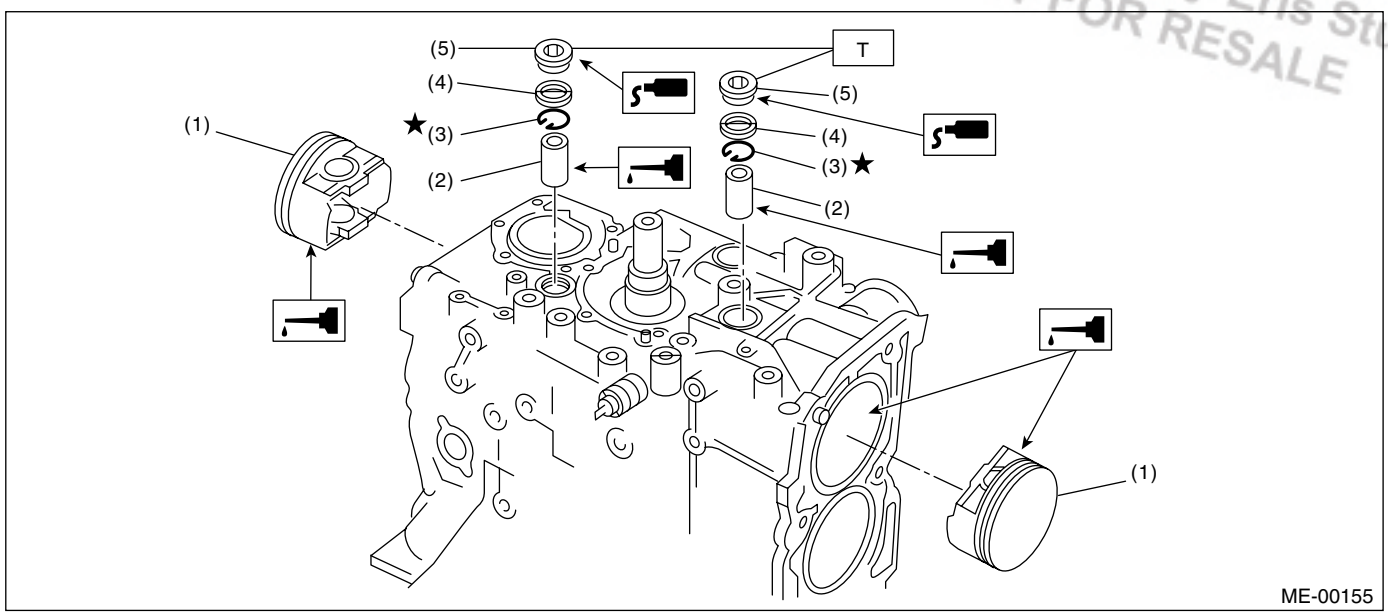



(A) Front side

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




(A) Front mark




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

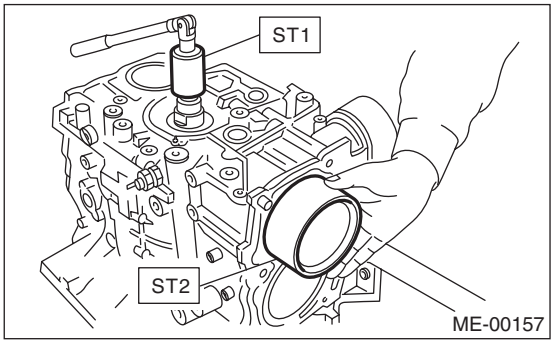
***Tightening torque: N·m (kgf-m, ft-lb)***
***T: 70 (7.0, 50.6)***

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

ST1 499987500 CRANKSHAFT SOCKET

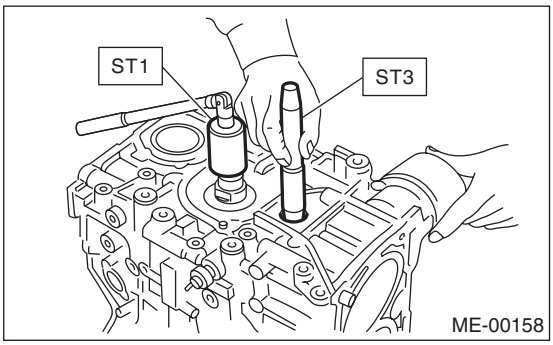
(3) Apply a coat of engine oil to pistons and cylinders, and then insert the pistons in their cylinders using ST2.

ST2 498747300 PISTON GUIDE



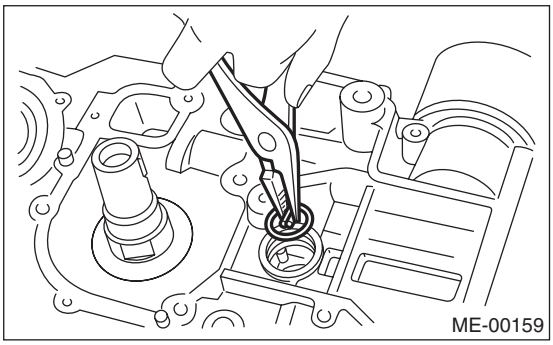

16) Installing piston pin
(1) Apply a coat of engine oil to the ST3 before insertion.
(2) Insert the ST3 into service hole to align piston pin hole with connecting rod small end.

ST3 499017100 PISTON PIN GUIDE



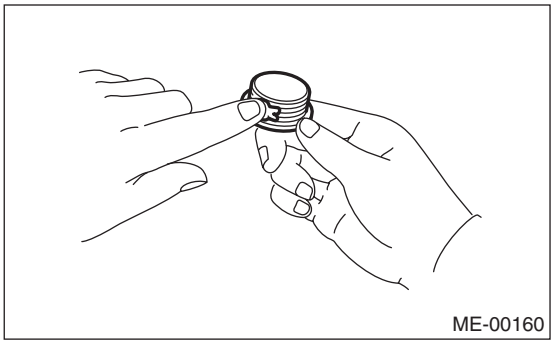

(3) Apply a coat of engine oil to the piston pin, and then insert the piston pin into piston and connecting rod through service hole.
(4) Install the circlip.

NOTE:
Use new circlips.



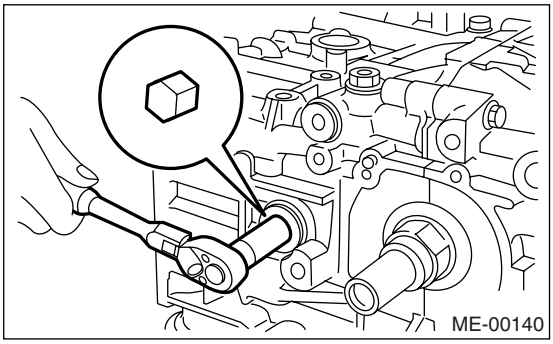
(5) Apply fluid packing around the service hole plug.

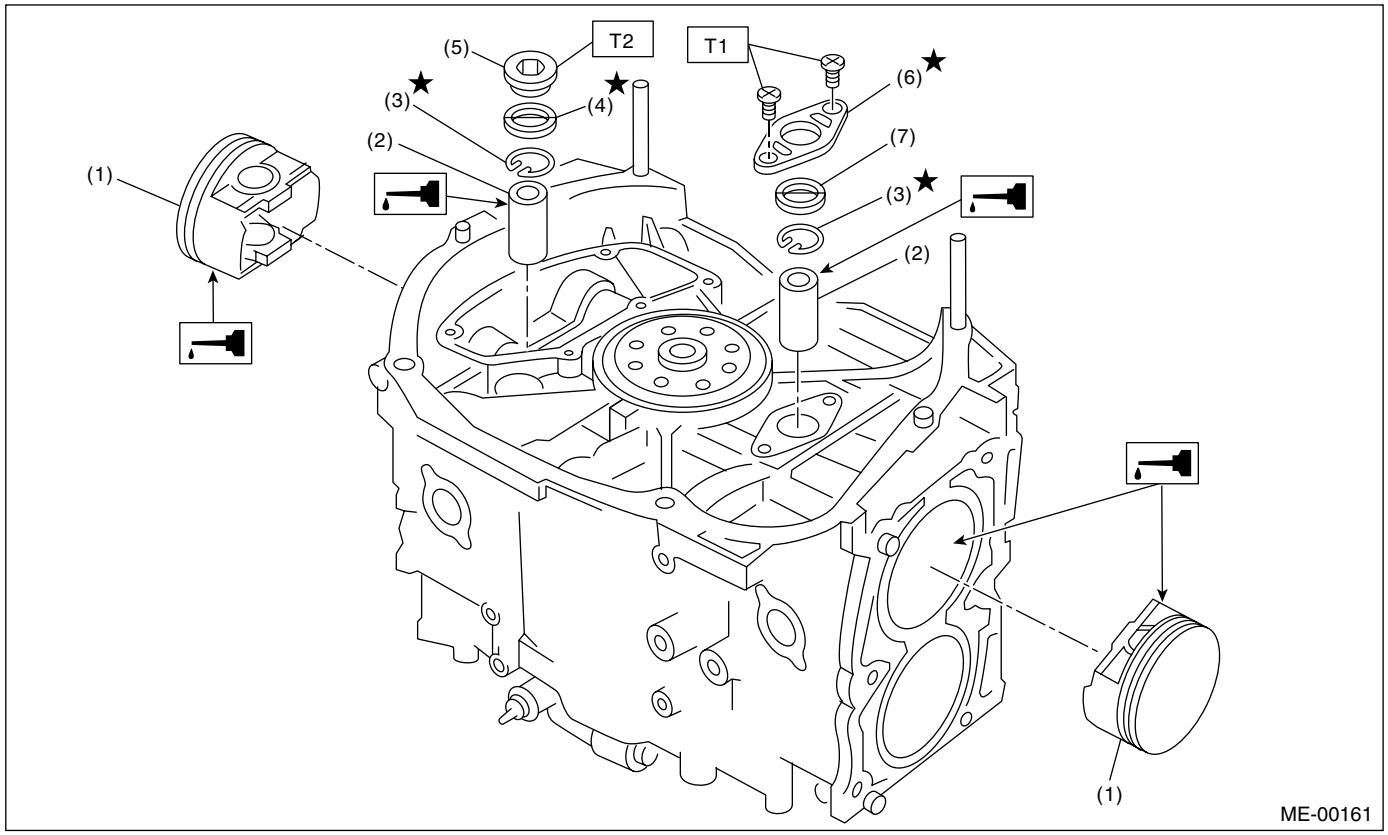
***Fluid packing:***
***Part No. 004403007***
***THREE BOND 1215 or equivalent***




(6) Install the service hole plug and gasket.

NOTE:
Use a new gasket.



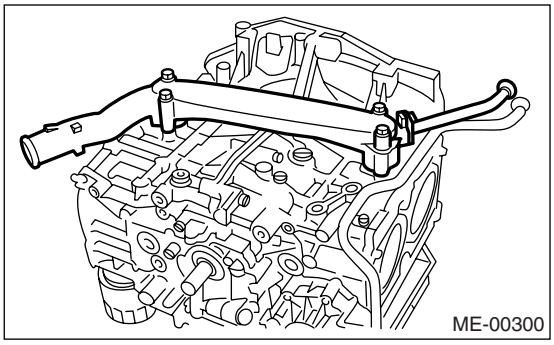




(1) Piston
(2) Piston pin
(3) Circlip
(4) Gasket
(5) Service hole plug
(6) Service hole cover
(7) O-ring

| ***Tightening torque: N·m (kgf-m, ft-lb)*** |
|---|
| ***T1: 6.4 (0.65, 4.7)*** |
| ***T2: 70 (7.1, 51.4)*** |

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

17) Install the water pipe.




18) Install the baffle plate.

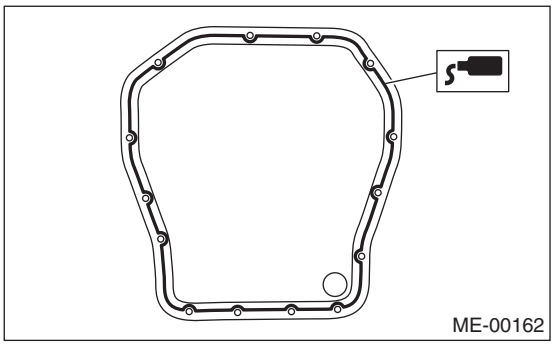
***Tightening torque:***
***6.4 N·m (0.65 kgf-m, 4.7 ft-lb)***

19) Install the oil strainer and O-ring.

***Tightening torque:***
***10 N·m (1.0 kgf-m, 7 ft-lb)***

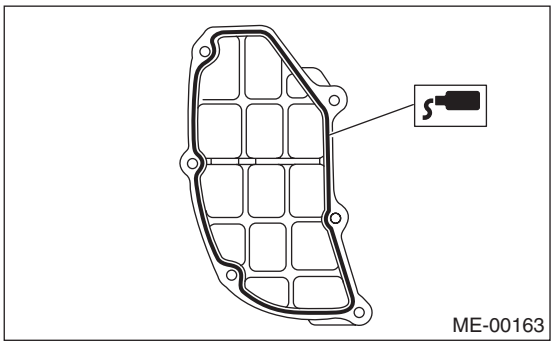
20) Install the oil strainer stay.
21) Apply fluid packing to the matching surfaces, and then install the oil pan.

***Fluid packing:***
***Part No. 004403007***
***THREE BOND 1215 or equivalent***




22) Apply fluid packing to the matching surfaces, and then install the oil separator cover.

***Fluid packing:***
***Part No. 004403007***
***THREE BOND 1215 or equivalent***

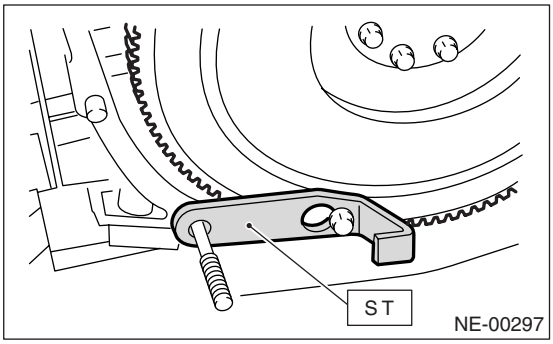



23) Install the flywheel or drive plate.
To lock the crankshaft, use ST.

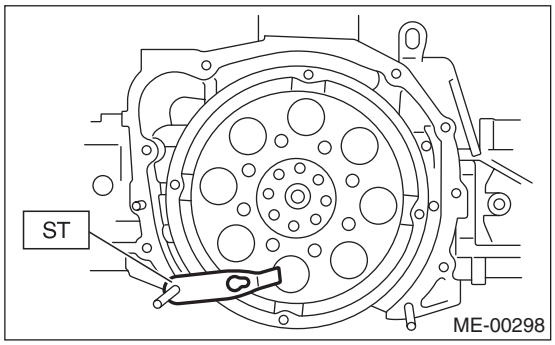
ST 498497100 CRANKSHAFT STOPPER

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

- MT MODEL

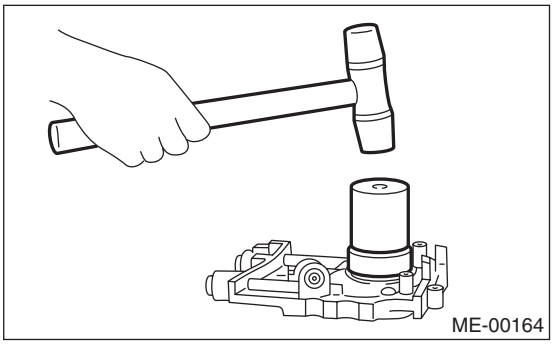



- AT MODEL



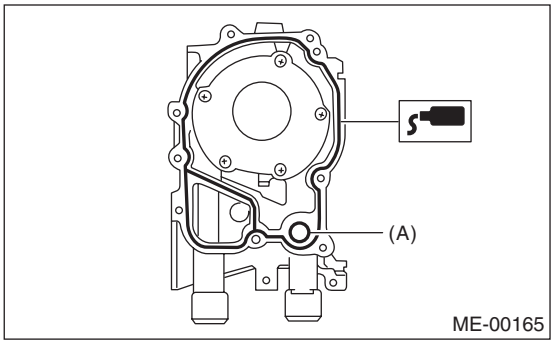

24) Install the housing cover.
25) Installation of oil pump
(1) Discard the front oil seal after removal. Replace with a new one using the ST.

ST 499587100 OIL SEAL INSTALLER



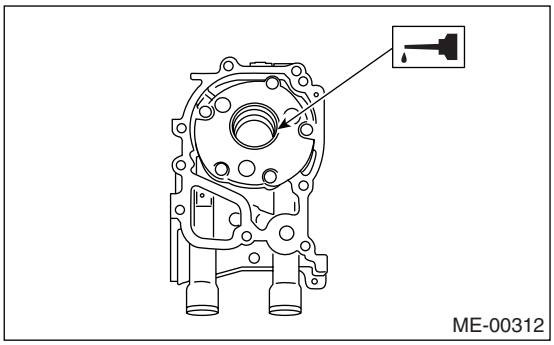

(2) Apply fluid packing to the matching surface of oil pump.

***Fluid packing:***
***Part No. 004403007***
***THREE BOND 1215 or equivalent***




(A) O-ring

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




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

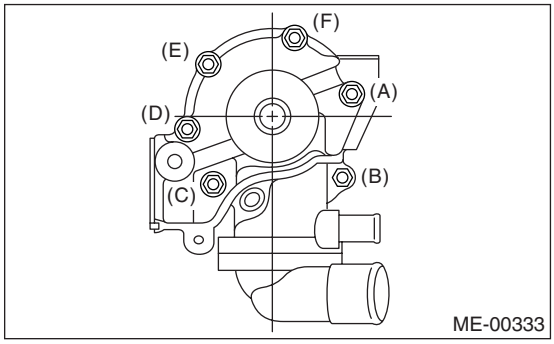
***Tightening torque:***
***6.4 N·m (0.65 kgf-m, 4.7 ft-lb)***

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

26) Install the water pump and gasket.

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

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




27) Install the water by-pass pipe for heater.
28) Install the oil filter using ST.

| | | |
|---|---|---|
| ST | 498547000 | OIL FILTER WRENCH (Outer diameter: 80 mm (3.15 in)) |
| ST | 18332AA000 | OIL FILTER WRENCH (Outer diameter: 68 mm (2.68 in)) |
| ST | 18332AA010 | OIL FILTER WRENCH (Outer diameter: 65 mm (2.56 in)) |

Install the oil filter by turning it by hand, being careful not to damage the seal rubber.
• Tighten the oil filter 80 mm (3.15 in) or 65 mm (2.56 in) in diameter by approx. 2/3 - 3/4 rotation more after the seal rubber of oil filter comes in contact with cylinder block or oil cooler.
• Tighten the oil filter 68 mm (2.68 in) in diameter by approx. 1 rotation more after the seal rubber of oil filter comes in contact with cylinder block or oil cooler.

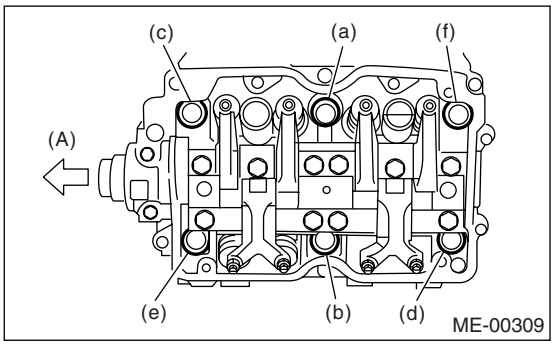
**CAUTION:**
**Do not tighten excessively, or oil may leak.**

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

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

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

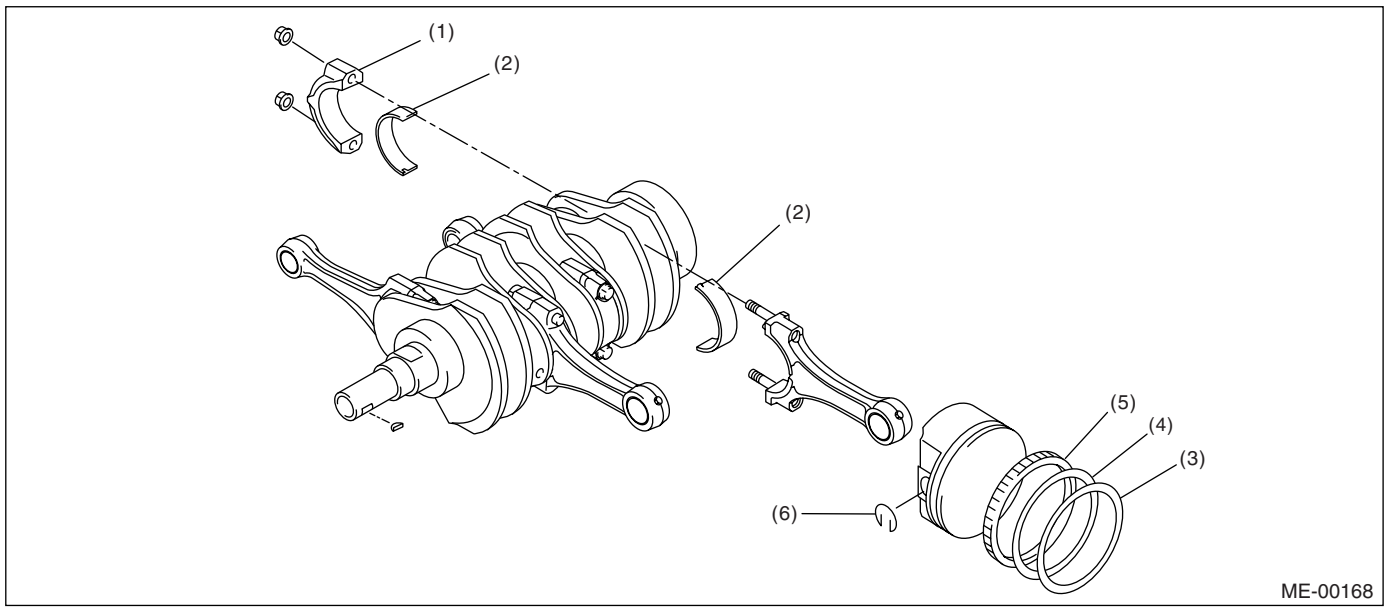
**CAUTION:**
**Ensure that the total "re-tightening angle" [in the former two steps], do not exceed 180°.**




(A) Front

30) Install the oil level gauge guide, and then tighten the attaching bolt (left side only).
31) Install the rocker cover.
32) Install the crankshaft sprocket. <Ref. to ME(H4SO)-51, INSTALLATION, Crankshaft Sprocket.>
33) Install the camshaft sprocket. <Ref. to ME(H4SO)-49, INSTALLATION, Camshaft Sprocket.>
34) Install the timing belt assembly. <Ref. to ME(H4SO)-45, INSTALLATION, Timing Belt Assembly.>
35) Install the timing belt cover. <Ref. to ME(H4SO)-43, INSTALLATION, Timing Belt Cover.>
36) Install the crankshaft pulley. <Ref. to ME(H4SO)-42, INSTALLATION, Crankshaft Pulley.>
37) Install the generator and A/C compressor brackets on cylinder head.
38) Install the V-belt. <Ref. to ME(H4SO)-39, INSTALLATION, V-belt.>
39) Install the intake manifold. <Ref. to FU(H4SO)-15, INSTALLATION, Intake Manifold.>

## C: DISASSEMBLY




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

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

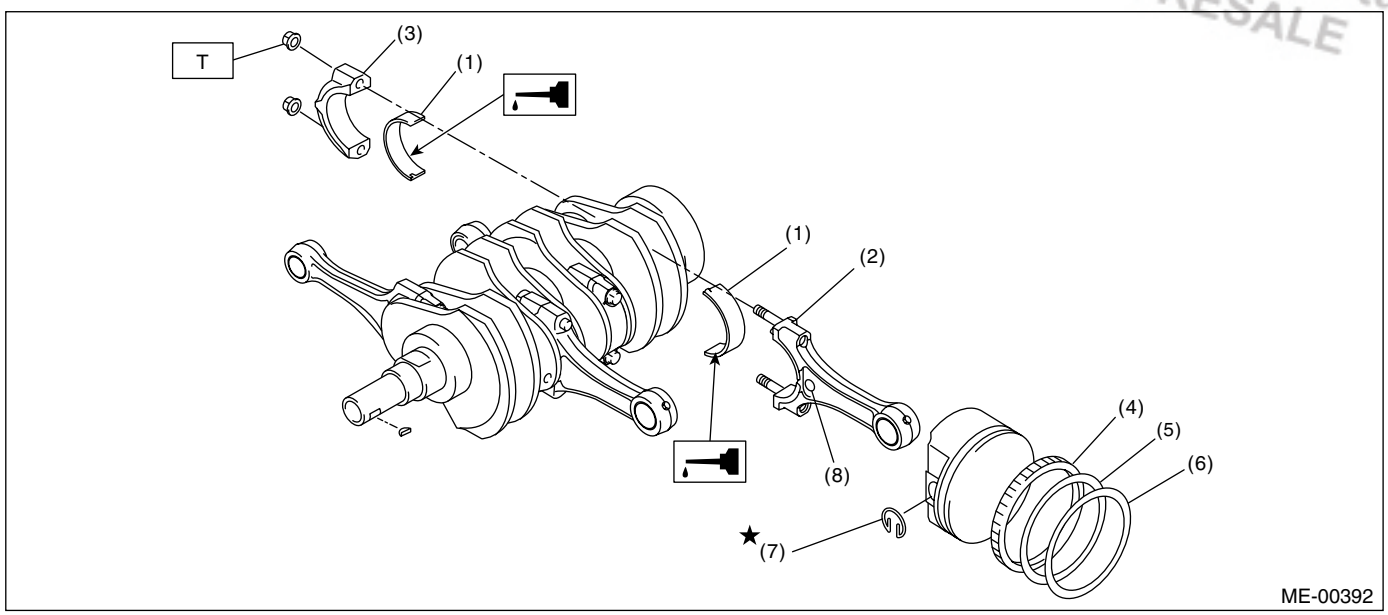
NOTE:
Arrange the removed connecting rod, connecting rod cap and bearing in order to prevent confusion.

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

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

5) Remove the circlip.

## D: ASSEMBLY




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

***Tightening torque: N·m (kgf-m, ft-lb)***
***T: 45 (4.6, 33)***

1) Apply oil to the surfaces of the connecting rod bearings.
2) Install the connecting rod bearings on connecting rods and connecting rod caps.
3) Position each connecting rod with the marked side facing forward, and then install them.
4) Install the 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.**

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

## E: INSPECTION

### 1. CYLINDER BLOCK

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

***Warping limit:***
***0.05 mm (0.0020 in)***

***Grinding limit:***
***0.1 mm (0.004 in)***

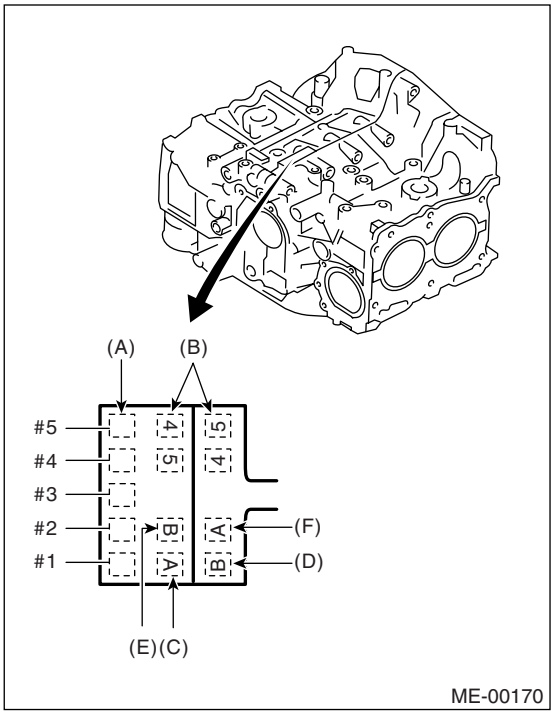
***Standard height of cylinder block:***
***201.0 mm (7.91 in)***

### 2. CYLINDER AND PISTON

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

NOTE:
• Measurement should be performed at a temperature 20°C (68°F).
• 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: 99.505 — 99.515 mm (3.9175 — 3.9179 in)***
***B: 99.495 — 99.505 mm (3.9171 — 3.9175 in)***



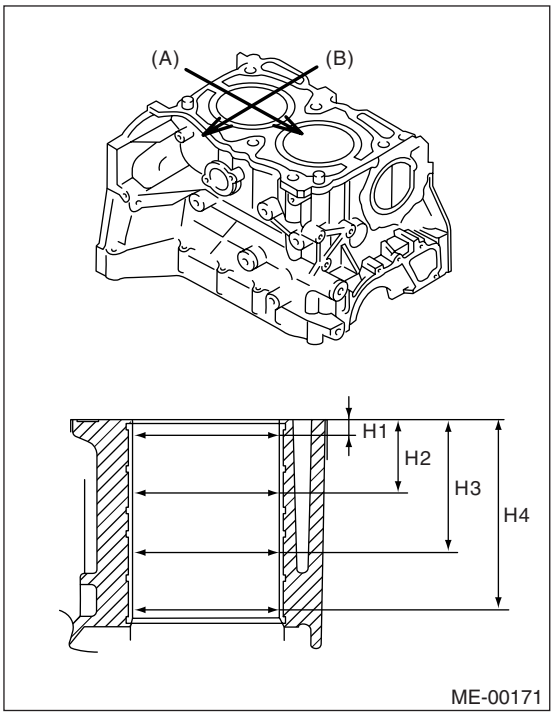

(A) Main journal size mark
(B) Cylinder block RH-LH combination mark
(C) #1 cylinder bore size mark
(D) #2 cylinder bore size mark
(E) #3 cylinder bore size mark
(F) #4 cylinder bore size mark

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

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

***Taper:***
***Standard***
***0.015 mm (0.0006 in)***
***Limit***
***0.050 mm (0.0020 in)***

***Out-of-roundness:***
***Standard***
***0.010 mm (0.0004 in)***
***Limit***
***0.050 mm (0.0020 in)***



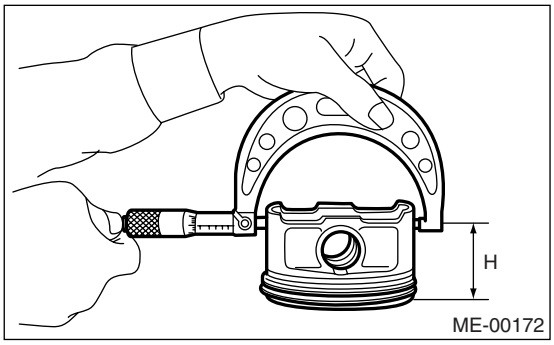

(A) Piston pin direction
(B) Thrust direction
H1 10 mm (0.39 in)
H2 45 mm (1.77 in)
H3 80 mm (3.15 in)
H4 115 mm (4.35 in)

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

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

***Piston grade point H:***
***37.0 mm (1.457 in)***

***Standard***
***A: 99.485 — 99.495 mm (3.9167 — 3.9171 in)***
***B: 99.475 — 99.485 mm (3.9163 — 3.9167 in)***
***0.25 mm (0.0098 in) oversize***
***99.725 — 99.735 mm (3.9262 — 3.9266 in)***
***0.50 mm (0.0197 in) oversize***
***99.975 — 99.985 mm (3.9360 — 3.9364 in)***




5) Calculate the clearance between cylinder and piston.

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

***Cylinder to piston clearance at 20°C (68°F):***
***Standard***
***0.010 — 0.030 mm (0.0004 — 0.0012 in)***
***Limit***
***0.050 mm (0.0020 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, reboring 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.

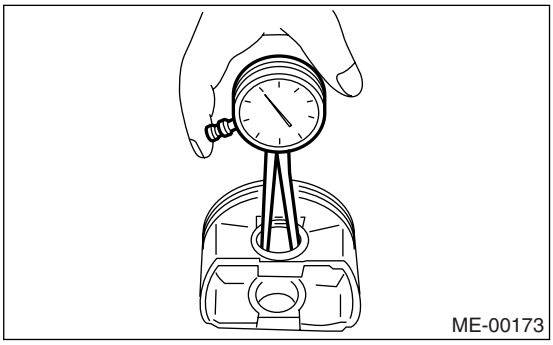
NOTE:
Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, pay attention to this when measuring the cylinder diameter.

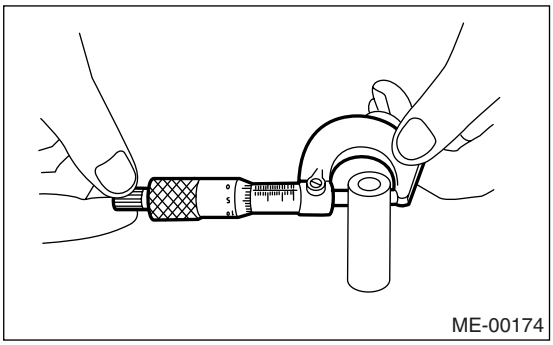
***Limit of cylinder enlarging (boring):***
***0.5 mm (0.020 in)***

## 3. PISTON AND PISTON PIN

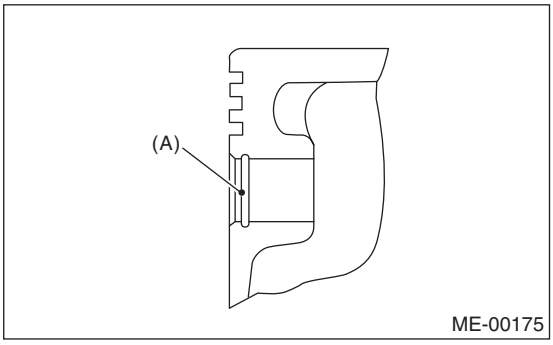
1) Check the pistons and piston pins for damage, cracks, and wear and the piston ring grooves for wear and damage. Replace if defective.
2) Measure the piston-to-cylinder clearance at each cylinder. <Ref. to ME(H4SO)-76, CYLINDER AND PISTON, INSPECTION, Cylinder Block.> If any of the clearances is not to specification, replace the piston or bore the cylinder to use an oversize piston.
3) Make the sure that piston pin can be inserted into 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)***
***Limit***
***0.020 mm (0.0008 in)***




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

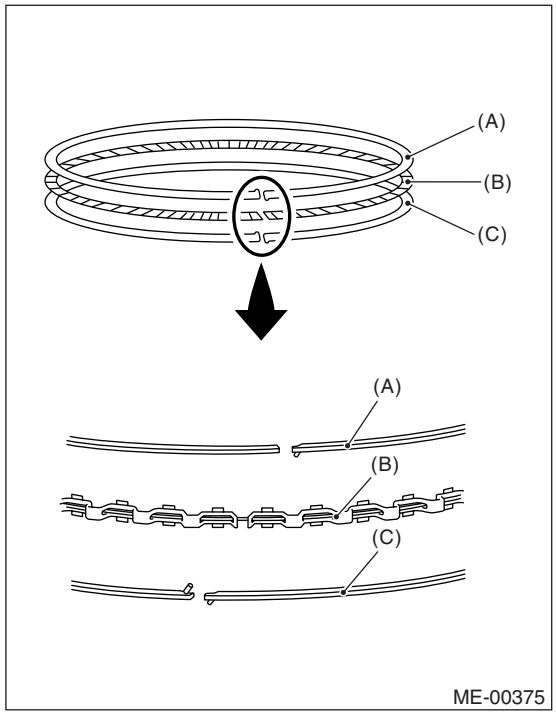


5) Check the piston pin circlip for distortion, cracks and wear.

## 4. PISTON RING

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

**CAUTION:**
**• Marks are shown on the end of top and second rings. When installing the rings to piston, face these marks upward.**
**• Oil ring is composed of upper rail, expander and lower rail. Be careful of the rail direction when installing oil ring to the piston.**

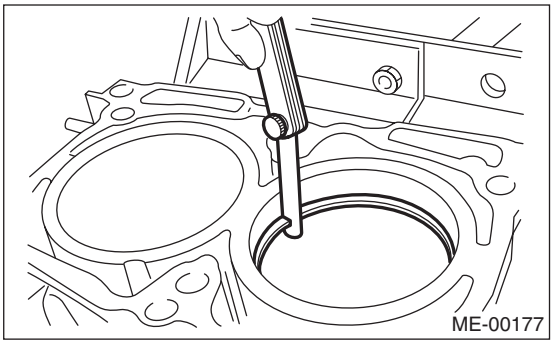



(A) Upper rail
(B) Expander
(C) Lower rail

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

Unit: mm (in)

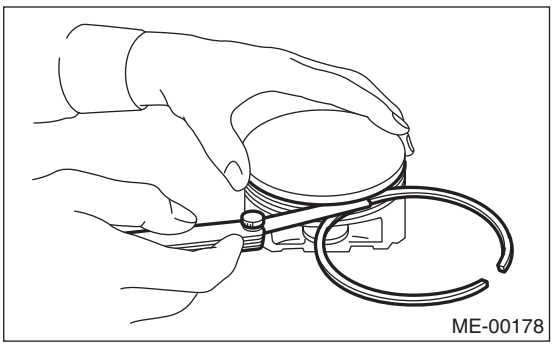
| | | Standard | Limit |
|---|---|---|---|
| Piston ring gap | Top ring | 0.20 — 0.35 (0.0079 — 0.0138) | 1.0 (0.039) |
| | Second ring | 0.35 — 0.50 (0.0138 — 0.0197) | 1.0 (0.039) |
| | Oil ring rail | 0.20 — 0.50 (0.0079 — 0.0197) | 1.5 (0.059) |




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

Unit: mm (in)

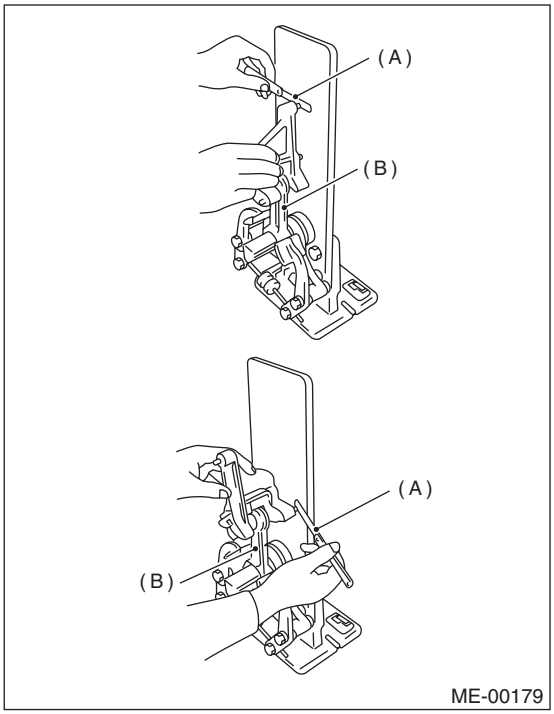
| | | Standard | Limit |
|---|---|---|---|
| Clearance between piston ring and piston ring groove | Top ring | 0.040 — 0.080 (0.0016 — 0.0031) | 0.15 (0.0059) |
| | Second ring | 0.030 — 0.070 (0.0012 — 0.0028) | 0.15 (0.0059) |



## 5. CONNECTING ROD

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

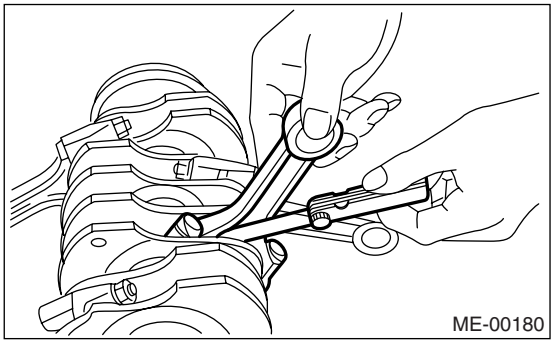
***Limit of bend or twist per 100 mm (3.94 in) in length:***
***0.10 mm (0.0039 in)***




(A) Thickness gauge
(B) Connecting rod

3) Install the connecting rod fitted with bearing to crankshaft, and then measure the side clearance (thrust clearance). Replace the 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)***
***Limit***
***0.4 mm (0.016 in)***




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

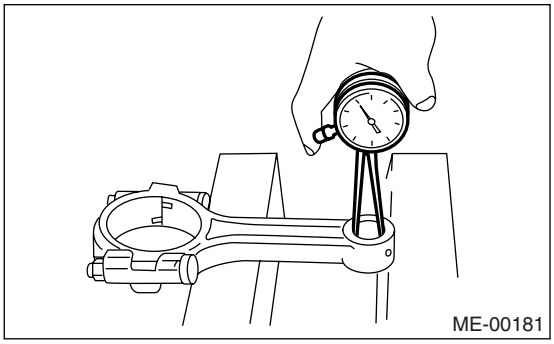
***Connecting rod oil clearance:***
***Standard***
***0.012 — 0.038 mm (0.0005 — 0.0014 in)***
***Limit***
***0.05 mm (0.0020 in)***

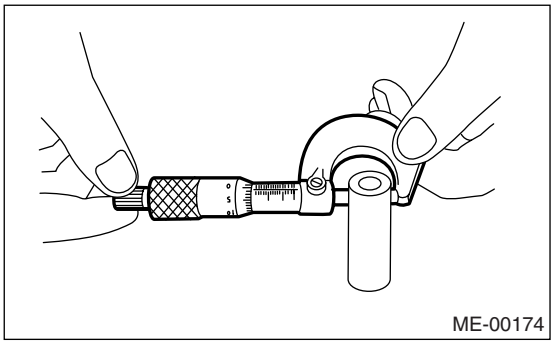
Unit: mm (in)

| 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 | 1.504 — 1.512 (0.0592 — 0.0595) | 51.954 — 51.970 (2.0454 — 2.0461) |
| 0.05 (0.0020) undersize | 1.514 — 1.522 (0.0596 — 0.0599) | 51.934 — 51.950 (2.0446 — 2.0453) |
| 0.25 (0.0098) undersize | 1.614 — 1.622 (0.0635 — 0.0639) | 51.734 — 51.750 (2.0368 — 2.0374) |

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

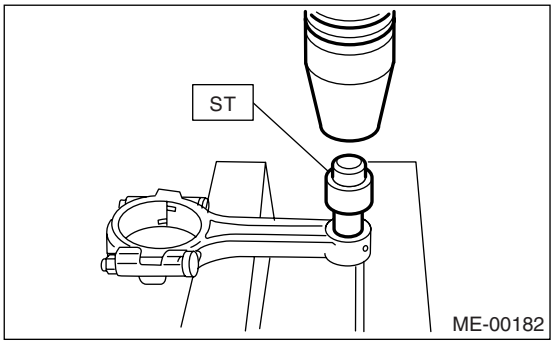
***Clearance between piston pin and bushing:***
***Standard***
***0 — 0.022 mm (0 — 0.0009 in)***
***Limit***
***0.030 mm (0.0012 in)***




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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER



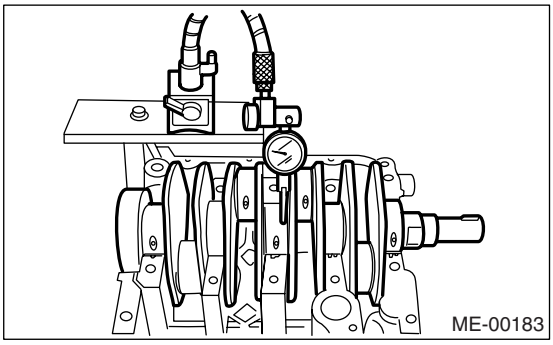

(3) Make two 3 mm (0.12 in) holes in bushing. Ream the inside of bushing.
(4) After the completion of reaming, clean the bushing to remove chips.

## 6. CRANKSHAFT AND CRANKSHAFT BEARING

1) Clean the 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.

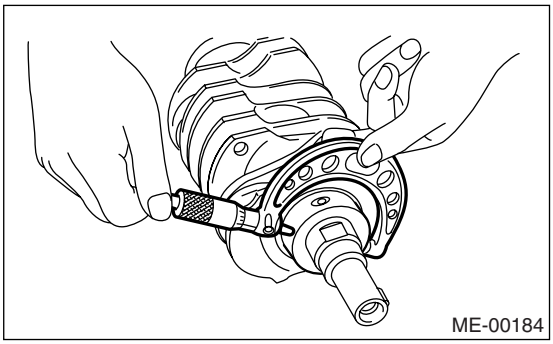
NOTE:
If a suitable V-block is not available, install the #1 and #5 crankshaft bearing on cylinder block, position the crankshaft on these bearings and measure the crankshaft bend using a dial gauge.

***Crankshaft bend limit:***
***0.035 mm (0.0014 in)***




3) Inspect the crank journal and crank pin for wear. If they are not within the specifications, replace the bearing with a suitable (undersize) one, and then replace or recondition the crankshaft as necessary. When grinding the crank journal or crank pin, finish them to 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***
***Taper limit***
***0.07 mm (0.0028 in)***
***Grinding limit***
***0.250 mm (0.0098 in)***



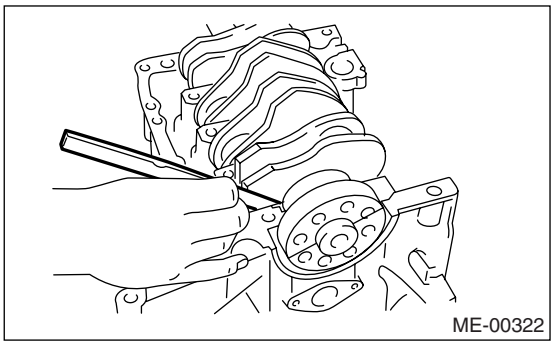
Unit: mm (in)

| | | Crank journal diameter | | Crank pin diameter |
|---|---|---|---|---|
| | | #1, #3 | #2, #4, #5 | 2.5 L |
| Standard | Journal O.D. | 59.992 — 60.008<br>(2.3619 — 2.3625) | 59.992 — 60.008<br>(2.3619 — 2.3625) | 51.984 — 52.000<br>(2.0466 — 2.0472) |
| | Bearing size (Thickness at center) | 1.998 — 2.011<br>(0.0787 — 0.0792) | 2.000 — 2.013<br>(0.0787 — 0.0793) | 1.490 — 1.502<br>(0.0587 — 0.0591) |
| 0.03 (0.0012) undersize | Journal O.D. | 59.962 — 59.978<br>(2.3607 — 2.3613) | 59.962 — 59.978<br>(2.3607 — 2.3613) | 51.954 — 51.970<br>(2.0454 — 2.0461) |
| | Bearing size (Thickness at center) | 2.017 — 2.020<br>(0.0794 — 0.0795) | 2.019 — 2.022<br>(0.0795 — 0.0796) | 1.504 — 1.512<br>(0.0592 — 0.0595) |
| 0.05 (0.0020) undersize | Journal O.D. | 59.942 — 59.958<br>(2.3599 — 2.3605) | 59.942 — 59.958<br>(2.3599 — 2.3605) | 51.934 — 51.950<br>(2.0446 — 2.0453) |
| | Bearing size (Thickness at center) | 2.027 — 2.030<br>(0.0798 — 0.0799) | 2.029 — 2.032<br>(0.0799 — 0.0800) | 1.514 — 1.522<br>(0.0596 — 0.0599) |
| 0.25 (0.0098) undersize | Journal O.D. | 59.742 — 59.758<br>(2.3520 — 2.3527) | 59.742 — 59.758<br>(2.3520 — 2.3527) | 51.734 — 51.750<br>(2.0368 — 2.0374) |
| | Bearing size (Thickness at center) | 2.127 — 2.130<br>(0.0837 — 0.0839) | 2.129 — 2.132<br>(0.0838 — 0.0839) | 1.614 — 1.622<br>(0.0635 — 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)***
***Limit***
***0.25 mm (0.0098 in)***


ME-00322

5) Inspect the individual crankshaft bearings for signs of flaking, seizure, melting, and wear.

6) Measure the oil clearance on each crankshaft bearing by means of plastigauge. If the measurement is not within the specification, replace the defective bearing with an undersize one, and then replace or recondition the crankshaft as necessary.

Unit: mm (in)

| Crankshaft oil clearance | | |
|---|---|---|
| #1 | Standard | 0.010 — 0.030 (0.0004 — 0.0012) |
| | Limit | 0.040 (0.0016) |
| #2 | Standard | 0.010 — 0.030 (0.0004 — 0.0012) |
| | Limit | 0.045 (0.0018) |
| #3 | Standard | 0.010 — 0.030 (0.0004 — 0.0012) |
| | Limit | 0.040 (0.0016) |
| #4 | Standard | 0.010 — 0.030 (0.0004 — 0.0012) |
| | Limit | 0.045 (0.0018) |
| #5 | Standard | 0.010 — 0.030 (0.0004 — 0.0012) |
| | Limit | 0.040 (0.0016) |

# 22.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(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Fuel line | • Defective fuel pump and relay | A |
| | | • Lack of or insufficient fuel | B |
| | • Belt | • 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 |
| 3) Initial combustion occurs. | • Engine control system <Ref. to EN(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Defective intake manifold gasket | B |
| | | • Defective throttle body gasket | B |
| | • Fuel line | • Defective fuel pump and relay | C |
| | | • Clogged fuel line | C |
| | | • Lack of or insufficient fuel | B |
| | • Belt | • 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(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Loosened or cracked intake duct | B |
| | | • Loosened or cracked PCV hose | C |
| | | • Loosened or cracked vacuum hose | C |
| | | • Defective intake manifold gasket | B |
| | | • Defective throttle body gasket | B |
| | | • Dirty air cleaner element | C |
| | • Fuel line | • Clogged fuel line | C |
| | | • Lack of or insufficient fuel | B |
| | • Belt | • 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(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Loosened or cracked intake duct | A |
| | | • Loosened or cracked PCV hose | A |
| | | • Loosened or cracked vacuum hose | A |
| | | • Defective intake manifold gasket | B |
| | | • Defective throttle body gasket | B |
| | | • Defective PCV valve | C |
| | | • Loosened oil filler cap | B |
| | | • Dirty air cleaner element | C |
| | • Fuel line | • Defective fuel pump and relay | C |
| | | • Clogged fuel line | C |
| | | • Lack of or insufficient fuel | B |
| | • Belt | • Defective timing | C |
| | • Compression | • Incorrect valve clearance | B |
| | | • Loosened spark 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 |
| | | • Accelerator cable out of adjustment | C |

| TROUBLE | PROBLEM PARTS, ETC. | POSSIBLE CAUSE | RANK |
|---|---|---|---|
| 3. Low output, hesitation and poor acceleration | • Engine control system <Ref. to EN(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Loosened or cracked intake duct | A |
| | | • Loosened or cracked PCV hose | A |
| | | • Loosened or cracked vacuum hose | B |
| | | • Defective intake manifold gasket | B |
| | | • Defective throttle body gasket | B |
| | | • Defective PCV valve | B |
| | | • Loosened oil filler cap | B |
| | | • Dirty air cleaner element | A |
| | • Fuel line | • Defective fuel pump and relay | B |
| | | • Clogged fuel line | B |
| | | • Lack of or insufficient fuel | C |
| | • Belt | • Defective timing | B |
| | • Compression | • Incorrect valve clearance | B |
| | | • Loosened spark 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 | 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(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Loosened or cracked intake duct | A |
| | | • Loosened or cracked PCV hose | A |
| | | • Loosened or cracked vacuum hose | A |
| | | • Defective intake manifold gasket | B |
| | | • Defective throttle body gasket | B |
| | | • Defective PCV valve | B |
| | | • Loosened oil filler cap | B |
| | | • Dirty air cleaner element | B |
| | • Fuel line | • Defective fuel pump and relay | B |
| | | • Clogged fuel line | B |
| | | • Lack of or insufficient fuel | C |
| | • Belt | • Defective timing | B |
| | • Compression | • Incorrect valve clearance | B |
| | | • Loosened spark 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 | 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(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Loosened or cracked vacuum hose | A |
| | • Others | • Stuck or damaged throttle valve | A |
| | | • Accelerator cable out of adjustment | B |
| 6. Dieseling (Run-on) | • Engine control system <Ref. to EN(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Cooling system | • Overheating | B |
| | • Others | • Malfunction of evaporative emission control system | B |
| 7. After burning in exhaust system | • Engine control system <Ref. to EN(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Loosened or cracked intake duct | C |
| | | • Loosened or cracked PCV hose | C |
| | | • Loosened or cracked vacuum hose | B |
| | | • Defective PCV valve | B |
| | | • Loosened oil filler cap | C |
| | • Belt | • Defective timing | B |
| | • Compression | • Incorrect valve clearance | B |
| | | • Loosened spark plugs or defective gasket | C |
| | | • Loosened cylinder head bolts or defective gasket | C |
| | | • Improper valve seating | 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(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Loosened oil filler cap | B |
| | • Belt | • Defective timing | B |
| | • Compression | • Incorrect valve clearance | C |
| | | • Incorrect valve timing | B |
| | • Cooling system | • 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(H4SO)(diag)-2, Basic Diagnostic Procedure.> | | A |
| | • Intake system | • Dirty air cleaner element | A |
| | • Belt | • 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 seating | 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 | • Accelerator cable out of adjustment | B |

# 23.Engine Noise

## A: INSPECTION

| Type of sound | Condition | Possible cause |
|---|---|---|
| Regular clicking sound | Sound increases as engine speed increases. | • Valve mechanism is defective.<br>• Incorrect valve clearance<br>• Worn valve rocker<br>• Worn camshaft<br>• Broken valve spring |
| Heavy and dull clank | Oil pressure is low. | • Worn crankshaft main bearing<br>• Worn connecting rod bearing (big end) |
| | Oil pressure is normal. | • Loose flywheel mounting bolts<br>• Damaged engine mounting |
| High-pitched clank (Spark knock) | Sound is noticeable when accelerating with an overload. | • Ignition timing advanced<br>• Accumulation of carbon inside combustion chamber<br>• Wrong spark plug<br>• 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<br>• 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<br>• Broken or stuck piston ring<br>• 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<br>• Worn cam gear<br>• 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<br>• Worn gear and starter pinion |
| Sound like polishing glass with a dry cloth | — | • Loose drive belt<br>• Defective water pump shaft |
| Hissing sound | — | • Loss of compression<br>• Air leakage in air intake system, hoses, connections or manifolds |
| Timing belt noise | — | • Loose timing belt<br>• Belt contacting case/adjacent part |
| Valve tappet noise | — | • Incorrect valve clearance |

NOTE*:
When disconnecting the fuel injector connector, Malfunction Indicator Light illuminates and DTC is stored in ECM memory. Therefore, carry out the CLEAR MEMORY MODE <Ref. to EN(H4SO)(diag)-44, OPERATION, Clear Memory Mode.> and INSPECTION MODE <Ref. to EN(H4SO)(diag)-37, OPERATION, Inspection Mode.> after connecting fuel injector connector.