

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

2008 ENGINE**Mechanical (H4DOTC) - Forester****GENERAL DESCRIPTION****SPECIFICATION****GENERAL SPECIFICATION**

Engine	Model			2.5 L		
	Cylinder arrangement			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine		
	Valve system mechanism			Belt driven, double overhead camshaft, 4-valve/cylinder		
	Bore x Stroke			mm (in)	99.5x79.0 (3.92x3.11)	
	Piston displacement			cm ³ (cu in)	2,457 (149.94)	
	Compression ratio			8.4		
	Compression pressure (at 200-300 rpm)			kPa (kgf/cm ² psi)	981 - 1,177 (10-12, 142-171)	
	Number of piston rings			Pressure ring: 2, Oil ring: 1		
	Intake valve timing	Open	Max. retard		5° ATDC	
			Min. advance		35° BTDC	
		Close	Max. retard		65° ABDC	
			Min. advance		25° ABDC	
	Exhaust valve timing	Open		55° BBDC		
		Close		5° ATDC		
	Valve clearance	Intake		mm (in)	0.20 ± 0.02 (0.0079 ± 0.0008)	
		Exhaust		mm (in)	0.35 ± 0.02 (0.0138 ± 0.0008)	
	Idle speed [At neutral position on MT, or "P" or "N" range on AT]		rpm	No Load	700 ± 100	
A/C ON				A/C refrigerant pressure is low	MT: 725 ± 100 AT: 750 ± 100	
				A/C refrigerant pressure is high	MT: 800 ± 100 AT: 825 ± 100	
Ignition order			1 --> 3 --> 2 --> 4			
Ignition timing			BTDC/rpm		17° ± 10°/700	

PROTRUSION OF ADJUSTER ROD

Belt tension adjuster	Protrusion of adjuster rod	5.2 - 6.2 mm (0.204 - 0.244 in)
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2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

Belt tensioner	Spacer O.D.			17.955 - 17.975 mm (0.7069 - 0.7077 in)
	Tensioner bushing I.D.			18.00 - 18.08 mm (0.7087 - 0.7118 in)
	Clearance between spacer and bushing		Standard	0.025 - 0.125 mm (0.0010 - 0.0049 in)
			Limit	0.175 mm (0.069 in)
	Side clearance of spacer		Standard	0.20 - 0.55 mm (0.0079 - 0.0217 in)
			Limit	0.81 mm (0.0319 in)
Camshaft	Bend limit			0.020 mm (0.0079 in)
	Thrust clearance		Standard	0.068 - 0.116 mm (0.0027 - 0.0046 in)
			Limit	0.14 mm (0.0055 in)
	Cam lobe height	Intake	Standard	46.55 - 46.65 mm (1.833 - 1.837 in)
			Limit	46.45 mm (1.829 in)
		Exhaust	Standard	46.75 - 46.85 mm (1.841 - 1.844 in)
			Limit	46.65 mm (1.837 in)
	Camshaft journal O.D.	Standard	Front	37.946 - 37.963 mm (1.4939 - 1.4946 in)
			Center rear	29.946 - 29.963 mm (1.1790 - 1.1796 in)
	Oil clearance		Standard	0.037 - 0.072 mm (0.0015 - 0.0028 in)
			Limit	0.1 mm (0.0039 in)
Cylinder head	Surface warpage limit (Mating surface with cylinder block)			0.035 mm (0.0014 in)
	Grinding limit			0.3 mm (0.012 in)
	Standard height			127.5 mm (5.02 in)
Valve seat	Seating angle			90°
	Contacting width	Intake	Standard	0.6 - 1.4 mm (0.024 - 0.055 in)
			Limit	1.7 mm (0.067 in)
		Exhaust	Standard	1.2 - 1.8 mm (0.047 - 0.071 in)
Limit			2.2 mm (0.087 in)	
Valve guide	Inside diameter			6.000 - 6.012 mm (0.2362 - 0.2367 in)
	Protrusion above head			15.8 - 16.2 mm (0.622 - 0.638 in)
	Head edge thickness	Intake	Standard	1.0 - 1.4 mm (0.039 - 0.055 in)
			Limit	0.8 mm (0.031 in)
		Exhaust	Standard	1.3 - 1.7 mm (0.051 - 0.067 in)
			Limit	0.8 mm (0.031 in)
	Stem outer diameter		Intake	5.955 - 5.970 mm (0.2344 - 0.2350 in)
				5.945 - 5.960 mm (0.2341 - 0.2346 in)

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

Valve			Exhaust	in)
	Valve stem gap	Standard	Intake	0.030 - 0.057 mm (0.0012 - 0.0022 in)
			Exhaust	0.040 - 0.067 mm (0.0016 - 0.0026 in)
		Limit	-	0.15 mm (0.0059 in)
	Overall length		Intake	104.4 mm (4.110 in)
		Exhaust	104.65 mm (4.120 in)	
Valve spring	Free length			47.32 mm (1.863 in)
	Squareness			2.5°, 2.1 mm (0.083 in) or less
	Tension/spring height	Set	205 - 235 N (20.9 - 24.0 kgf, 46.1 - 52.8 lb) / 36.0 mm (1.417 in)	
		Lift	426 - 490 N (43.4 - 50.0 kgf, 95.8 - 110 lb) / 26.50 mm (1.043 in)	
Valve lifter	Outer diameter			34.959 - 34.975 mm (1.3763 - 1.3770 in)
	Inner diameter (cylinder head)			34.994 - 35.016 mm (1.3777 - 1.3786 in)
	Valve lifter clearance	Standard	0.019 - 0.057 mm (0.0007 - 0.0022 in)	
		Limit	0.100 mm (0.0039 in)	
Cylinder block	Surface warpage limit (Mating surface with cylinder head)			0.025 mm (0.0098 in)
	Grinding limit			0.1 mm (0.004 in)
	Standard height			201.0 mm (7.91 in)
	Cylinder inner diameter	Standard	A	99.505 - 99.515 mm (3.9175 - 3.9179 in)
			B	99.495 - 99.505 mm (3.9171 - 3.9175 in)
	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)	
	Piston clearance	Standard	-0.010 - 0.010 mm (-0.0004 - 0.0004 in)	
		Limit	0.030 mm (0.0012 in)	
	Cylinder inner boring limit (diameter)			100.005 mm (3.9372 in)
Piston	Outer diameter	Standard	A	99.505 - 99.515 mm (3.9175 - 3.9179 in)
			B	99.495 - 99.505 mm (3.9171 - 3.9175 in)
		0.25 mm (0.0098 in) OS		99.745 - 99.765 mm (3.9270 - 3.9278 in)

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

		0.50 mm (0.0197 in) OS		99.995 - 100.015 mm (3.9368 - 3.9376 in)
Piston pin	Standard clearance between piston and piston pin		Standard	0.004 - 0.008 mm (0.0002 - 0.0003 in)
			Limit	0.020 mm (0.0008 in)
	Degree of fit			Piston pin can be fitted into position with thumb at 20°C (68°F).
Piston ring	Ring closed gap	Top ring	Standard	0.20 - 0.25 mm (0.0079 - 0.0098 in)
			Limit	1.0 mm (0.039 in)
		Second ring	Standard	0.37 - 0.52 mm (0.015 - 0.020 in)
			Limit	1.0 mm (0.039 in)
		Oil ring	Standard	0.20 - 0.50 mm (0.0079 - 0.0197 in)
			Limit	1.5 mm (0.059 in)
	Ring groove gap	Top ring	Standard	0.040 - 0.080 mm (0.0016 - 0.0031 in)
			Limit	0.15 mm (0.0059 in)
		Second ring	Standard	0.030 - 0.070 mm (0.0012 - 0.0028 in)
			Limit	0.15 mm (0.0059 in)
Connecting rod	Bend or twist per 100 mm (3.94 in) in length		Limit	0.10 mm (0.0039 in)
	Thrust clearance		Standard	0.070 - 0.330 mm (0.0028 - 0.0130 in)
			Limit	0.4 mm (0.016 in)
Bearing of large end	Oil clearance		Standard	0.017 - 0.045 mm (0.0007 - 0.0018 in)
			Limit	0.05 mm (0.0020 in)
	Thickness at center portion		Standard	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)
Bushing of small end	Clearance between piston pin and bushing		Standard	0 - 0.022 mm (0 - 0.0009 in)
			Limit	0.030 mm (0.0012 in)
	Bending limit			0.035 mm (0.0014 in)
	Crank pin	Out-of-roundness		0.003 mm (0.0001 in)
		Cylindricality		0.004 mm (0.0002 in)
		Grinding limit (dia.)		To 51.750 mm (2.0374 in)
		Crank journal	Out-of-roundness	
	Cylindricality		0.006 mm (0.0002 in)	

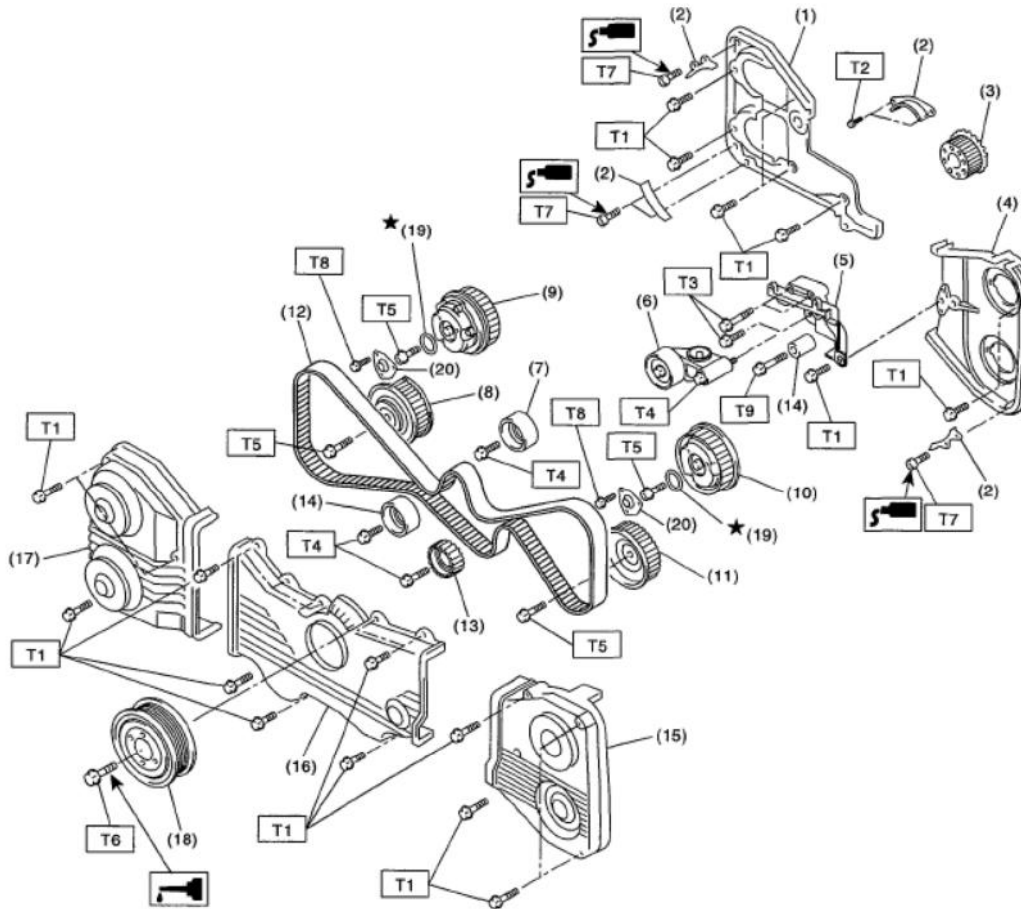
2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

Crankshaft			Grinding limit (dia.)	To 59.758 mm (2.3527 in)
	Crank pin outer diameter		Standard	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 (2.0447 - 2.0453 in)
			0.25 mm (0.0098 in) US	51.734 - 51.750 mm (2.0368 - 2.0374 in)
	Crank journal outer diameter		Standard	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		Standard	0.030 - 0.115 mm (0.0012 - 0.0045 in)
			Limit	0.25 mm (0.0098 in)
	Oil clearance		Standard	0.010 - 0.030 mm (0.0004 - 0.0012 in)
		Limit	0.040 mm (0.0016 in)	
Main bearing	Thickness of main bearing	#1,#3	Standard	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	Standard	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)
NOTE: OS: Oversize US: Undersize				

COMPONENT

TIMING BELT



ME-03315

- | | |
|--|-----------------------------|
| (1) Timing belt cover No. 2 (RH) | (13) Belt idler No. 2 |
| (2) Timing belt guide (MT model) | (14) Belt idler |
| (3) Crank sprocket | (15) Timing belt cover (LH) |
| (4) Timing belt cover No. 2 (LH) | (16) Front belt cover |
| (5) Tensioner bracket | (17) Timing belt cover (RH) |
| (6) Automatic belt tension adjuster ASSY | (18) Crank pulley |
| (7) Belt idler | (19) O-ring |
| (8) Exhaust cam sprocket (RH) | (20) Actuator cover |
| (9) Intake cam sprocket (RH) | |
| (10) Intake cam sprocket (LH) | |
| (11) Exhaust cam sprocket (LH) | |
| (12) Timing belt | |

Tightening torque: N·m (kgf-m, ft-lb)

T1: 5 (0.5, 3.7)

T2: 9.75 (1.0, 7.2)

T3: 24.5 (2.5, 18.1)

T4: 39 (4.0, 28.8)

T5:
INSTALLATION, Cam Sprocket.

T6:
INSTALLATION, Crank Pulley.

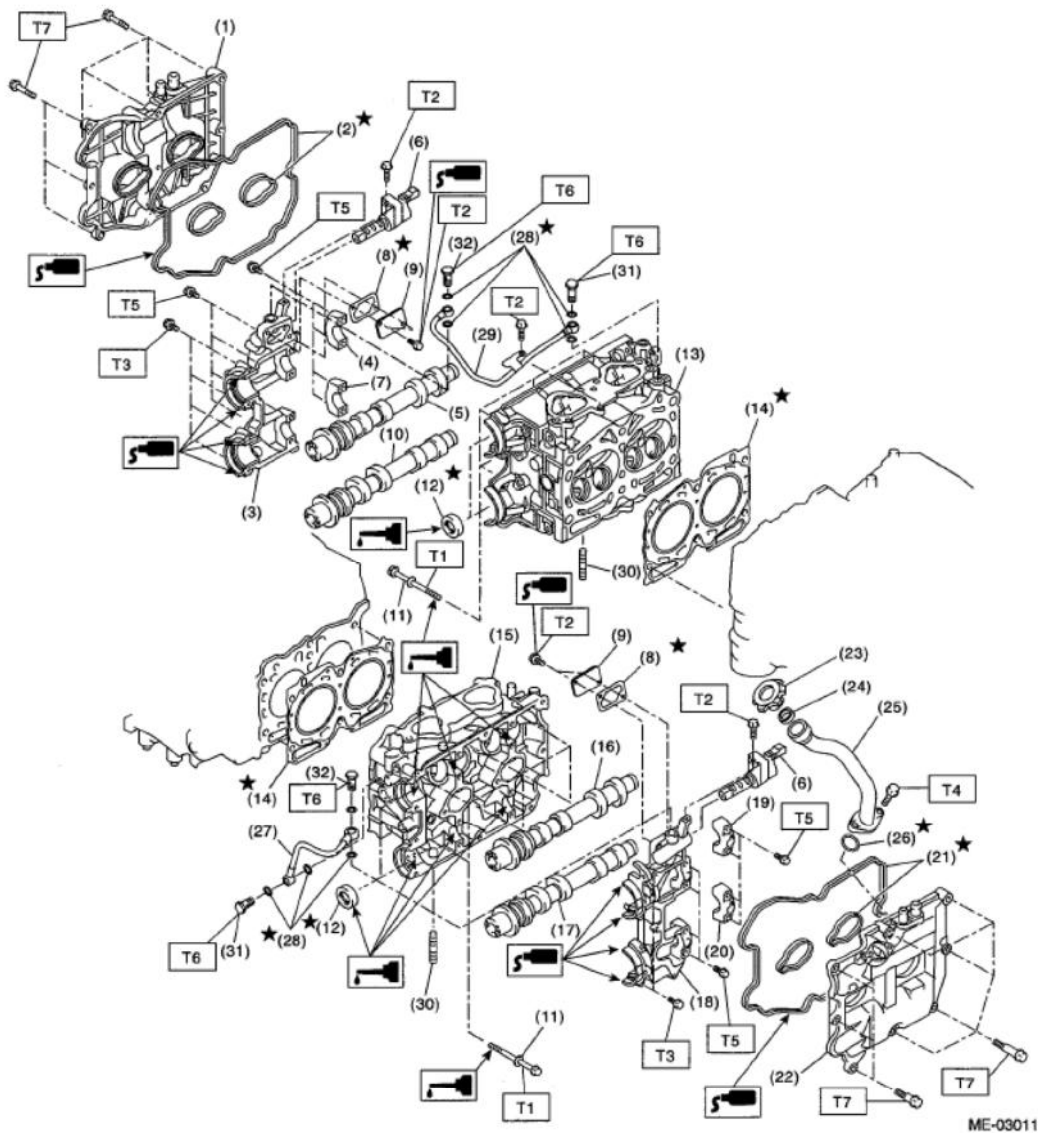
T7: 6.4 (0.65, 4.7)

T8: 3.4 (0.35, 2.5)

T9: 25 (2.5, 18.4)

Fig. 1: Identifying Timing Belt Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD AND CAMSHAFT



ME-03011

- | | | |
|-------------------------------------|--|--|
| (1) Rocker cover (RH) | (17) Exhaust camshaft (LH) | (32) Union screw without filter (Without protrusion) |
| (2) Rocker cover gasket (RH) | (18) Camshaft cap (Front LH) | |
| (3) Camshaft cap (Front RH) | (19) Intake camshaft cap (Rear LH) | |
| (4) Intake camshaft cap (Rear RH) | (20) Exhaust camshaft cap (Rear LH) | |
| (5) Intake camshaft (RH) | (21) Rocker cover gasket (LH) | |
| (6) Oil flow control solenoid valve | (22) Rocker cover (LH) | |
| (7) Exhaust camshaft cap (Rear RH) | (23) Oil filler cap | |
| (8) Gasket | (24) Gasket | |
| (9) Oil return cover | (25) Oil filler duct | |
| (10) Exhaust camshaft (RH) | (26) O-ring | |
| (11) Cylinder head bolt | (27) Oil pipe (LH) | |
| (12) Oil seal | (28) Gasket | |
| (13) Cylinder head (RH) | (29) Oil pipe (RH) | |
| (14) Cylinder head gasket | (30) Stud bolt | |
| (15) Cylinder head (LH) | (31) Union screw with filter (With protrusion) | |
| (16) Intake camshaft (LH) | | |

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

T1:

INSTALLATION, Cylinder Head.

T2: 8 (0.8, 5.9)

T3: 9.75 (1.0, 7.2)

T4: 6.4 (0.65, 4.7)

T5: 20 (2.0, 14.8)

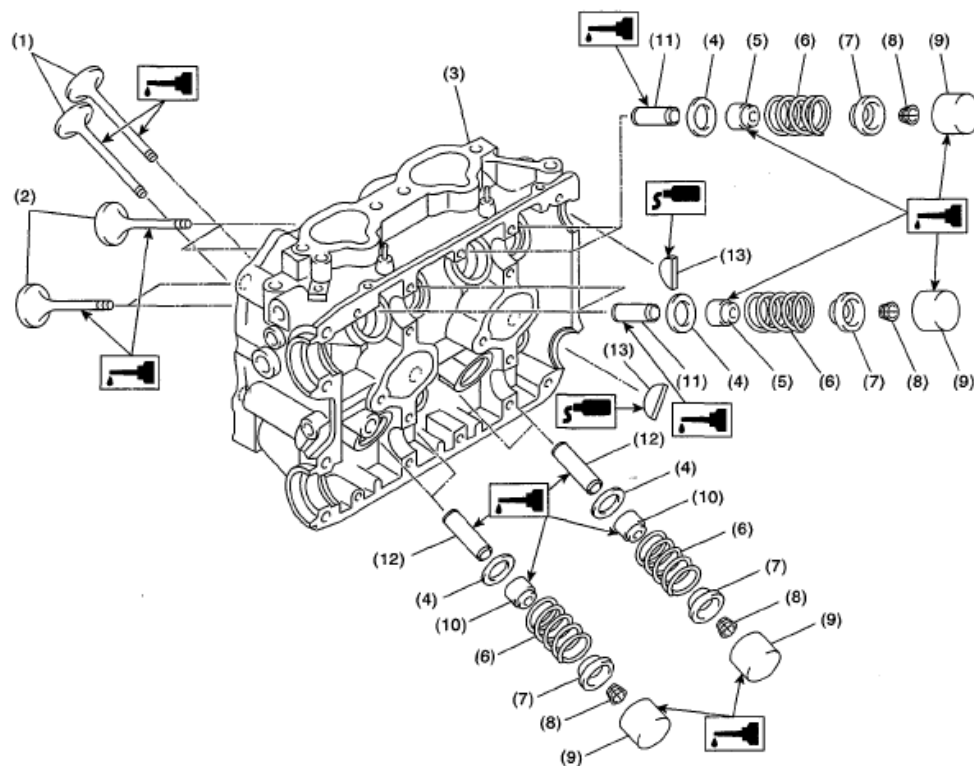
T6: 29 (3.0, 21.4)

T7:

INSTALLATION, Camshaft.

Fig. 2: Identifying Cylinder Head And Camshaft Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD AND VALVE ASSEMBLY

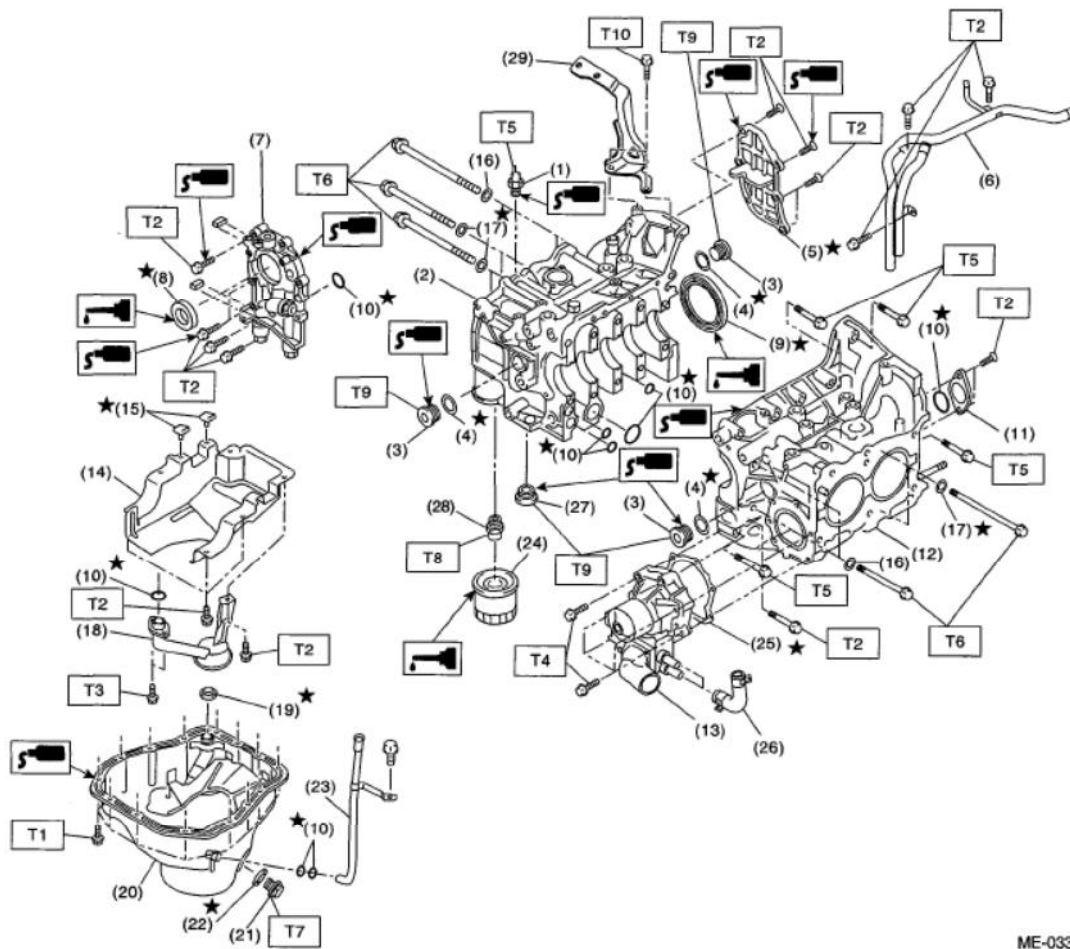


ME-03117

- | | | |
|---------------------------|------------------|-----------------------------|
| (1) Exhaust valve | (6) Valve spring | (10) Exhaust valve oil seal |
| (2) Intake valve | (7) Retainer | (11) Intake valve guide |
| (3) Cylinder head | (8) Retainer key | (12) Exhaust valve guide |
| (4) Valve spring seat | (9) Valve lifter | (13) Plug |
| (5) Intake valve oil seal | | |

Fig. 3: Identifying Cylinder Head And Valve Assembly Components
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK



ME-03316

- | | |
|--------------------------|----------------------------|
| (1) Oil pressure switch | (16) Washer |
| (2) Cylinder block (RH) | (17) Seal washer |
| (3) Service hole plug | (18) Oil strainer |
| (4) Gasket | (19) Gasket |
| (5) Oil separator cover | (20) Oil pan |
| (6) Water by-pass pipe | (21) Drain plug |
| (7) Oil pump | (22) Drain plug gasket |
| (8) Front oil seal | (23) Oil level gauge guide |
| (9) Rear oil seal | (24) Oil filter |
| (10) O-ring | (25) Gasket |
| (11) Service hole cover | (26) Water pump hose |
| (12) Cylinder block (LH) | (27) Plug |
| (13) Water pump | (28) Connector |
| (14) Baffle plate | (29) Intercooler bracket |
| (15) Seal | |

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

T1: 5 (0.5, 3.7)

T2: 6.4 (0.65, 4.7)

T3: 10 (1.0, 7.4)

T4: First 12 (1.2, 8.9)

Second 12 (1.2, 8.9)

T5: 25 (2.5, 18.4)

T6: INSTALLATION, Cylinder Block.

T7: 44 (4.5, 32.5)

T8: 45 (4.6, 33.2)

T9: 70 (7.1, 51.6)

T10: 16 (1.6, 11.8)

Fig. 4: Identifying Cylinder Block Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

CRANKSHAFT AND PISTON

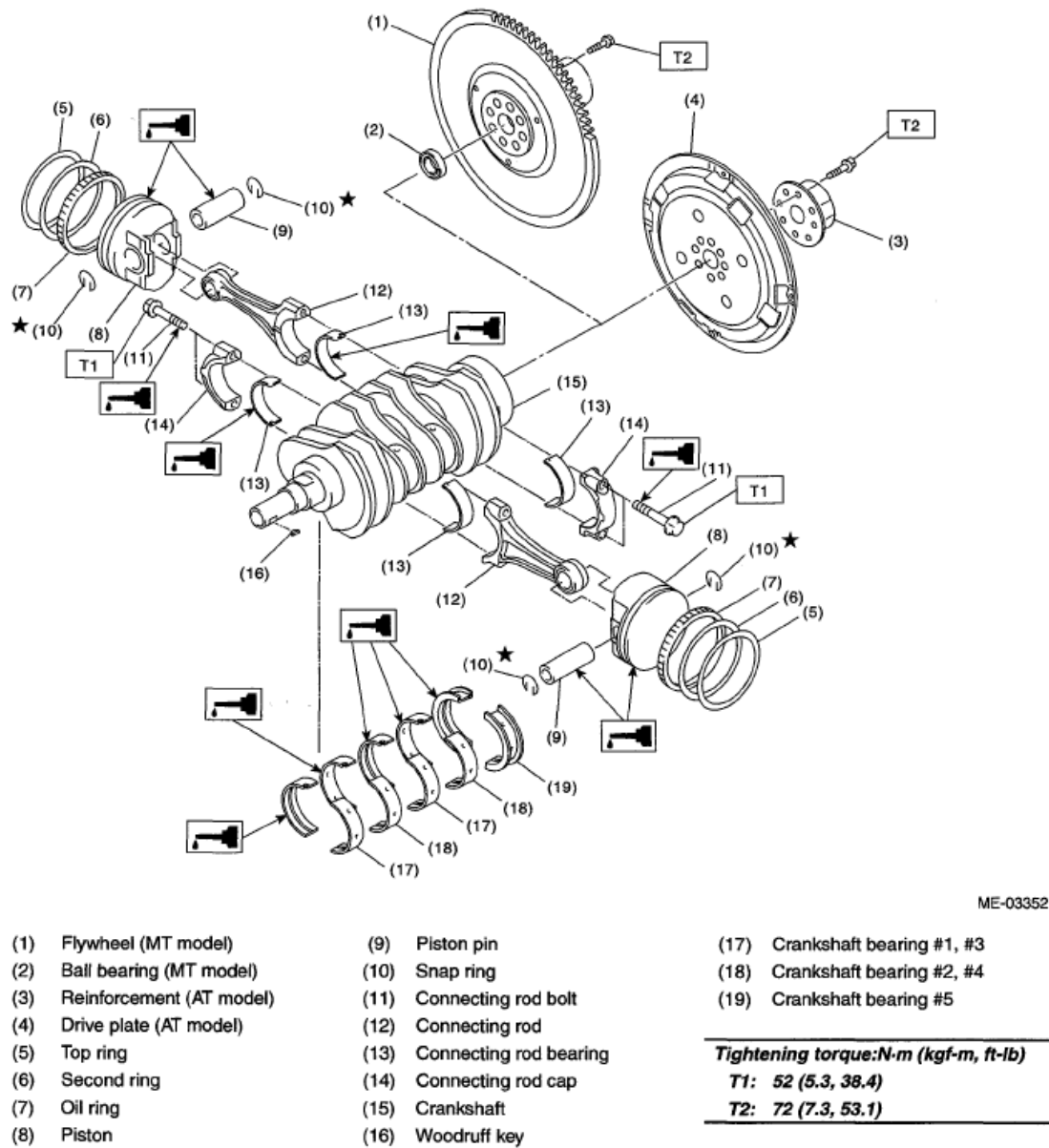
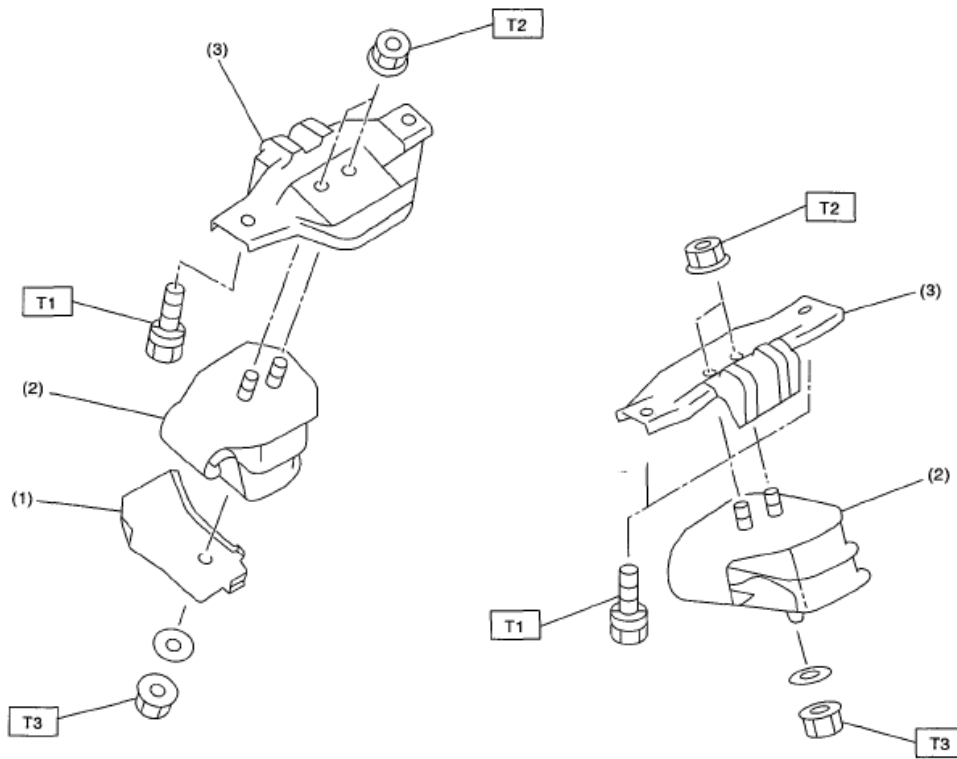


Fig. 5: Identifying Crankshaft And Piston Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

ENGINE MOUNTING



ME-00706

- (1) Heat shield cover
- (2) Front cushion rubber

- (3) 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, 62.7)

Fig. 6: Identifying Engine Mounting Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

CAUTION

- Wear appropriate work clothing, including a cap, protective goggles and protective shoes when performing any work.
- Remove contamination including dirt and corrosion before removal, installation or disassembly.
- Keep the disassembled parts in order and protect them from dust and dirt.
- Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly and replacement.
- Vehicle components are extremely hot after driving. Be wary of receiving burns from heated parts.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or rigid racks 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 engine oil passages, pistons and

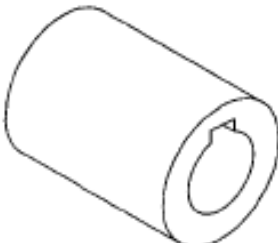
bearings.

- 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 engine 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 parts as required.
- Even if necessary inspections have been made in advance, proceed with assembly work while making rechecks.
- Remove or install the 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 fender, 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.

PREPARATION TOOL

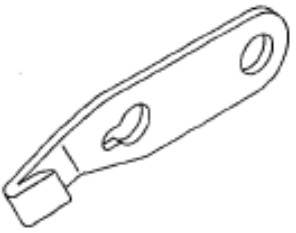
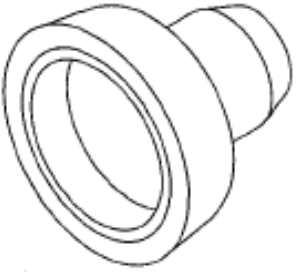
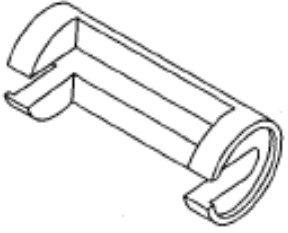
SPECIAL TOOL

SPECIAL TOOL DESCRIPTION

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499987500	498267600	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498277200	498457000	ENGINE STAND ADAPTER RH	Used with ENGINE STAND (499817100).

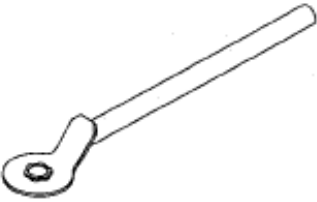
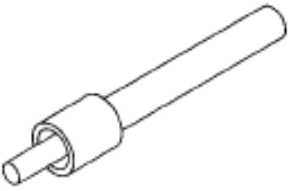
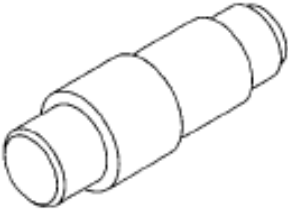
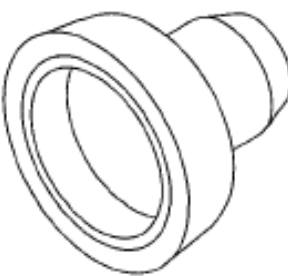
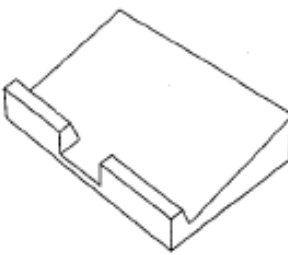
2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

 ST-498497100	498457100	ENGINE STAND ADAPTER LH	Used with ENGINE STAND (499817100).
 ST-499587200	498497100	CRANKSHAFT STOPPER	Used for removing and installing the flywheel and the drive plate.
 ST-499597100	498747300	PISTON GUIDE	Used for installing piston in cylinder for 2.5 L model.
 ST-499718000	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.

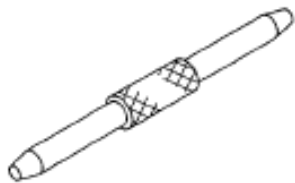
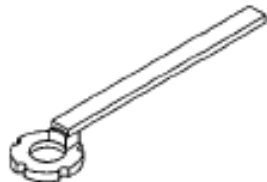
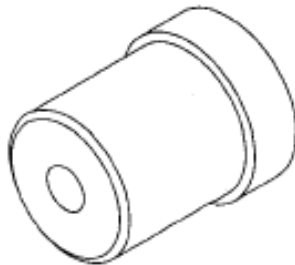
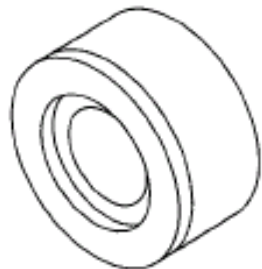
2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

 ST-499977500			
 ST-498857100	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499037100	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499587200	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (Exhaust side)
 ST-498267600	499977500	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (Intake side)

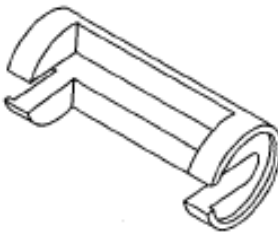
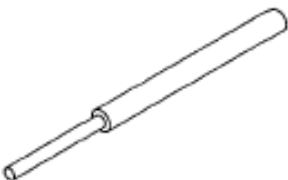
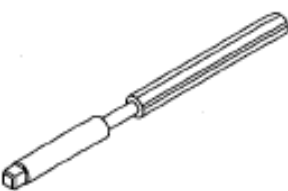
2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

 ST-499017100	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499207400	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499587100	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST18251AA020	18251AA020	VALVE GUIDE ADJUSTER	Used for installing intake and exhaust valve guides.
	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.

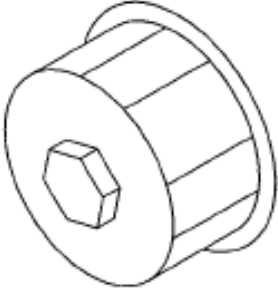
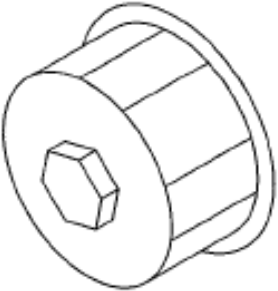
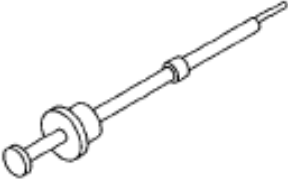
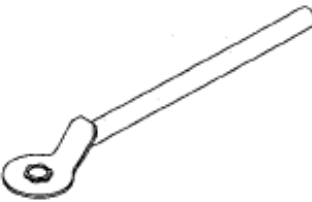
2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

 ST-499597100			
 ST-499718000	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499767200	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used with ENGINE STAND ADAPTER RH (498457000) & LH (498457100).
 ST-499767400	499977100	CRANK PULLEY WRENCH	Used to stop rotation of the crank pulley when loosening or tightening crank pulley bolts.
 ST-499817100	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.

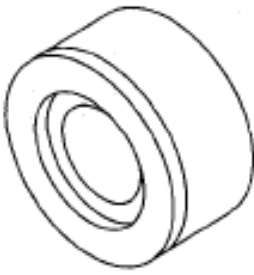
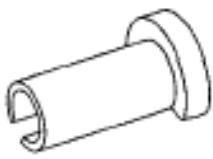
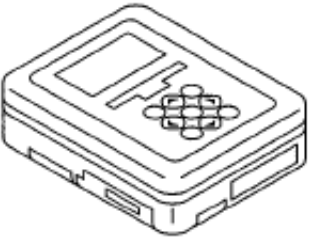
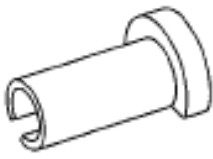
2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

 ST18332AA000	18332AA000	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 68 mm (2.68 in))
 ST18332AA010	18332AA010	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 65 mm (2.56 in))
 ST-499097700	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499977500	499587600	OIL SEAL INSTALLER	Used for installing camshaft oil seal for DOHC engine.
	499597200	OIL SEAL GUIDE	• Used for installing camshaft oil seal for DOHC engine. • Used with OIL SEAL INSTALLER (499587600).

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

 ST18251AA020			
 ST42099AE000	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST1B021XU0	1B021XU0	SUBARU SELECT MONITOR III KIT	Used for troubleshooting the electrical system.
 ST42099AE000	42099AE000	CONNECTOR REMOVER	Used for removing the quick connector in engine compartment.

GENERAL TOOL

GENERAL TOOL DESCRIPTION

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
Vacuum gauge	Used for measuring negative pressure.
Oil pressure gauge	Used for measuring oil pressure.

Fuel pressure gauge	Used for measuring fuel pressure.
Timing light	Used for measuring ignition timing.

PROCEDURE

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

- V-belt
- Timing belt
- Camshaft
- Cylinder head

COMPRESSION

INSPECTION

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

1. Remove the collector cover.
2. After warming-up the engine, turn the ignition switch to OFF.
3. Make sure that the battery is fully charged.
4. Release the fuel pressure. < Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel .>
5. Remove all the spark plugs.

< Ref. to **REMOVAL** , Spark Plug .>

6. Fully open the throttle valve.
7. Check the starter motor for satisfactory performance and operation.
8. Hold the compression gauge tightly against the spark plug hole.

NOTE: The screw of a screw-in type compression gauge should be less than 18 mm (0.71 in) in length.

9. Crank the engine by the starter motor, and read the maximum value on the gauge when the needle of gauge is steady.



Fig. 7: Identifying Compression Gauge
Courtesy of SUBARU OF AMERICA, INC.

10. Perform at least two measurements per cylinder, and check that the values are correct.

Compression (fully open throttle):

Standard

981 - 1,177 kPa

(10 - 12 kgf/cm² , 142 - 171 psi)

Limit

882 kPa (9.0 kgf/cm² , 128 psi)

Difference between cylinders

49 kPa (0.5 kgf/cm² , 7 psi), or less

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

IDLE SPEED

INSPECTION

1. Before checking the idle speed, check the following item:
 1. Check the air cleaner element is free from clogging, ignition timing is correct, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. Read the engine idle speed using Subaru Select Monitor. < Ref. to **READ CURRENT DATA FOR ENGINE (NORMAL MODE)** , OPERATION, Subaru Select Monitors.>
4. Check the idle speed when no-loaded. (Headlight, heater fan, rear defroster, radiator fan, A/C and etc. are

OFF)

Idle speed [No load and gears in neutral, "P" or "N" range]:

700 ± 100 rpm

5. Check the idle speed when loaded. (Turn the A/C switch to "ON" and operate the compressor for at least one minute before measurement.)

Idle speed [A/C ON and gears in neutral, "P" or "N" range]:

When A/C refrigerant pressure is low.

MT: 725 ± 100 rpm

AT: 750 ± 100 rpm

When A/C refrigerant pressure is high.

MT: 800 ± 100 rpm

AT: 825 ± 100 rpm

NOTE: Idle speed cannot be adjusted manually, because the idle speed is automatically adjusted. If the prescribed idle speed cannot be maintained, refer to the General On-board Diagnosis Table under "Engine Control System". < Ref. to BASIC DIAGNOSTIC PROCEDURE .>

IGNITION TIMING

INSPECTION

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

METHOD WITH SUBARU SELECT MONITOR

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. Read the ignition timing using Subaru Select Monitor. < Ref. to READ CURRENT DATA FOR ENGINE (NORMAL MODE) , OPERATION, Subaru Select Monitors.>

Ignition timing [BTDC/rpm]:***17° ± 10°/700***

If the timing is not correct, check the ignition control system. Refer to "Engine Control System". < Ref. to **BASIC DIAGNOSTIC PROCEDURE** .>

METHOD WITH TIMING LIGHT

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Remove the air intake duct.
5. Disconnect the connectors of the mass air flow and intake air temperature sensor.
6. Remove the air cleaner cover and element.
7. Connect the timing light to the power wire of #1 ignition coil.
8. Connect the connectors of air cleaner cover, element, and the mass airflow and intake air temperature sensor.
9. Start the engine, turn the timing light to the crank pulley, and check the ignition timing by means of crank pulley indicator.

Ignition timing [BTDC/rpm]:***17° ± 10°/700***

If the timing is not correct, check the ignition control system. Refer to "Engine Control System". < Ref. to **BASIC DIAGNOSTIC PROCEDURES** .>

INTAKE MANIFOLD VACUUM**INSPECTION**

1. Remove the collector cover.
2. Warm up the engine.
3. Disconnect the brake vacuum hose from intake manifold, and then install the vacuum gauge.
4. Keep the engine at idle speed and read the vacuum gauge indication.

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

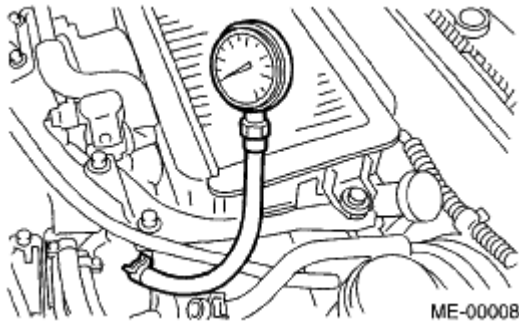


Fig. 8: Identifying Vacuum Gauge
 Courtesy of SUBARU OF AMERICA, INC.

Vacuum pressure (at idling, A/C "OFF"):

-60.0 kPa (-450 mmHg, -17.72 inHg) or less

VACUUM GAUGE INDICATION AND POSSIBLE ENGINE CONDITION

Diagnosis of engine condition by measurement of intake 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 disconnected or damaged vacuum hose
2. Needle intermittently drops to position lower than normal position.	Leakage around cylinder
3. Needle drops suddenly and intermittently from normal position.	Sticky valve
4. 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
5. Needle vibrates above and below normal position in narrow range.	Defective ignition system or throttle chamber idle adjustment

ENGINE OIL PRESSURE

INSPECTION

1. Remove the collector cover.
2. Disconnect the ground cable from the battery.

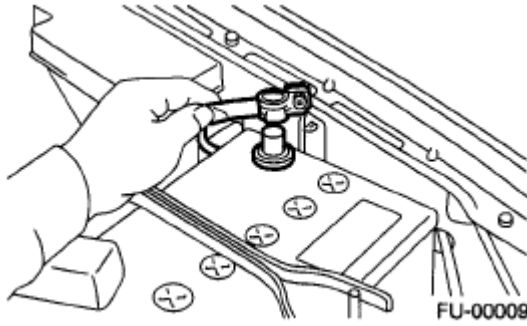


Fig. 9: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the oil pressure switch. < Ref. to **REMOVAL** , Oil Pressure Switch.>
4. Connect the oil pressure gauge hose to cylinder block.
5. Connect the ground cable to the battery.

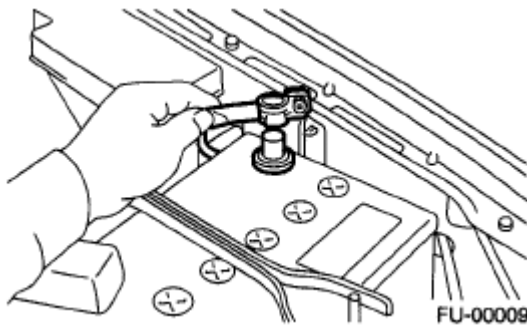


Fig. 10: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

6. Start the engine, and measure the oil pressure.

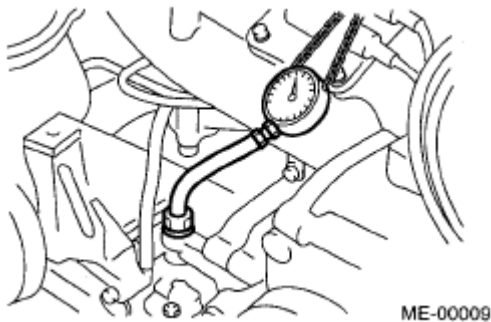


Fig. 11: Measuring Oil Pressure
Courtesy of SUBARU OF AMERICA, INC.

Oil pressure:

Standard 98 kPa (1.0 kgf/cm² , 14 psi) or more (at 600 rpm)

294 kPa (3.0 kgf/cm² , 43 psi) or more (at 5,000 rpm)

- If the oil pressure is out of specification, check the oil pump, oil filter and lubrication line. < Ref. to **INSPECTION** , Engine Lubrication System Trouble in General .>
- If the oil pressure warning light is ON and oil pressure is within specification, check the oil pressure switch. < Ref. to If the oil pressure is out of specification, check the oil pump, oil filter and lubrication line. < Ref. to **INSPECTION** , Engine Lubrication System Trouble in General .>

NOTE: **Standard value is based on an engine oil temperature of 80°C (176°F).**

7. After measuring the oil pressure, install the oil pressure switch. < Ref. to **INSTALLATION** , Oil Pressure Switch .>

Tightening torque:

25 N.m (2.5 kgf-m, 18.4 ft-lb)

FUEL PRESSURE

INSPECTION

- CAUTION:**
- Before removing the fuel pressure gauge, release the fuel pressure.
 - Be careful not to spill fuel.
 - Catch the fuel from hoses using a container or cloth.

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

1. Release the fuel pressure. < Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel .>
2. Disconnect the fuel delivery hose from fuel damper, and connect fuel pressure gauge.

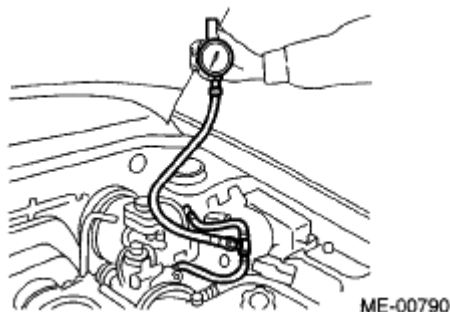


Fig. 12: Connecting Fuel Pressure Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the connector of fuel pump relay.

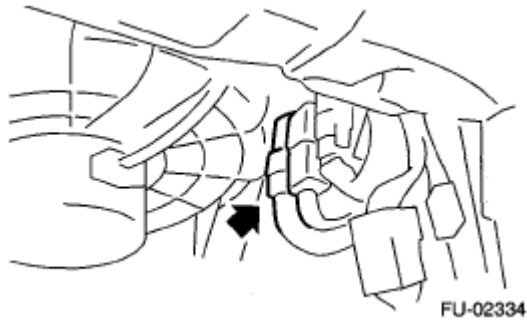


Fig. 13: Locating Fuel Pump Relay
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kgf/cm², 1 to 3 psi) higher than standard values during high-altitude operations.

Fuel pressure:

Standard

284 - 314 kPa

(2.9 - 3.2 kgf/cm², 41 - 46 psi)

6. Connect the pressure regulator vacuum hose and measure the fuel pressure.

NOTE: The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kgf/cm², 1 to 3 psi) higher than standard values during high-altitude operations.

Fuel pressure:

Standard

230 - 260 kPa (2.35 - 2.65 kgf/cm², 33 - 38 psi)

VALVE CLEARANCE

INSPECTION

NOTE: Inspection and adjustment of valve clearance should be performed while engine

is cold.

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

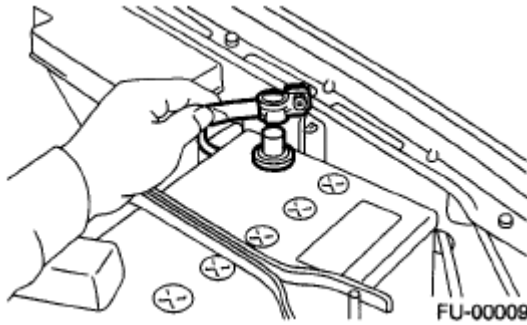


Fig. 14: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the air intake duct. < Ref. to **REMOVAL** , Air Intake Duct .>
5. Remove a bolt which secures timing belt cover (RH).
6. Lift up the vehicle.
7. Remove the under cover.
8. Loosen the remaining bolts which secure timing belt cover (RH), then remove the timing belt cover.
9. Lower the vehicle.
10. When inspecting #1 and #3 cylinders
 1. Remove the air cleaner case. < Ref. to **REMOVAL** , Air Cleaner Case .>
 2. Disconnect the connector of ignition coil.
 3. Remove the ignition coil.
 4. Place a suitable container under the vehicle.
 5. Disconnect the PCV hose from the rocker cover (RH).
 6. Remove the bolts, then remove the rocker cover (RH).
11. When inspecting #2 and #4 cylinders
 1. Disconnect the battery cable, and then remove the battery and battery carrier.

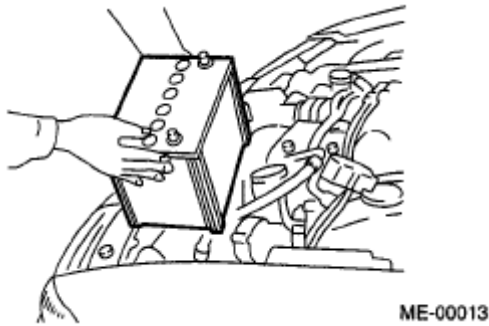


Fig. 15: Removing Battery And Battery Carrier
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the bolt which holds the engine harness bracket on the body.

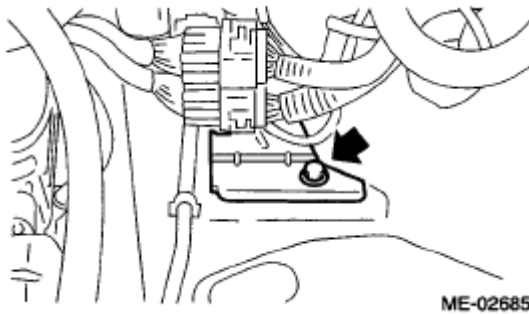


Fig. 16: Locating Engine Harness Bracket Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the secondary air pump. < Ref. to **REMOVAL** , Secondary Air Pump .>
4. Disconnect the connector of ignition coil.
5. Remove the ignition coil.
6. Place a suitable container under the vehicle.
7. Disconnect the PCV hose from the rocker cover (LH).
8. Remove the bolts, then remove the rocker cover (LH).
12. Turn the crank pulley clockwise until the round mark and arrow mark on the camshaft sprocket are set to position shown in the illustration.

NOTE: Turn the crankshaft using socket wrench.

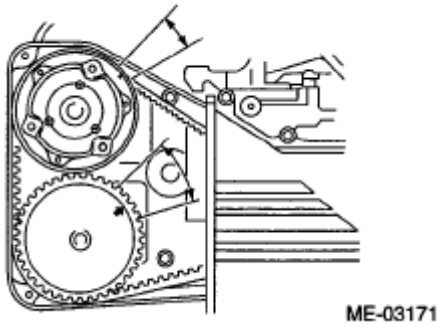


Fig. 17: Identifying Camshaft Sprocket Mark Position
 Courtesy of SUBARU OF AMERICA, INC.

13. Measure the #1 cylinder intake valve and #3 cylinder exhaust valve clearance by using thickness gauge (A).

NOTE:

- Insert a thickness gauge in a direction as horizontal as possible with respect to the valve lifter.
- Lift up the vehicle and measure the exhaust valve clearance.
- If the measured value is not within specification, take notes of the value in order to adjust the valve clearance later on.

Valve clearance:

Intake

$0.20 \pm 0.02 \text{ mm } (0.0079 \pm 0.0008 \text{ in})$

Exhaust

$0.35 \pm 0.02 \text{ mm } (0.0138 \pm 0.0008 \text{ in})$

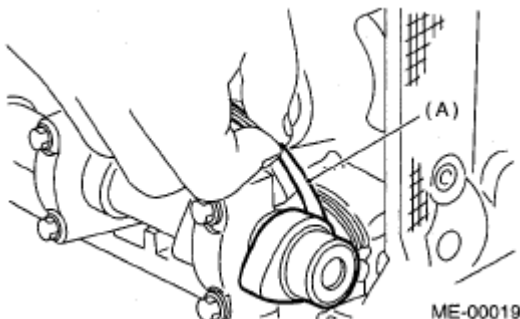


Fig. 18: Measuring Cylinder Intake Valve And Cylinder Exhaust Valve Clearance
 Courtesy of SUBARU OF AMERICA, INC.

14. If necessary, adjust the valve clearance. < Ref. to ADJUSTMENT, Valve Clearances.>

15. Further turn the crank pulley clockwise and then measure the valve clearances again.
 1. Set the round mark and arrow mark on cam sprocket to the position shown in the illustration, and measure the #2 cylinder exhaust valve and #3 cylinder intake valve clearances.

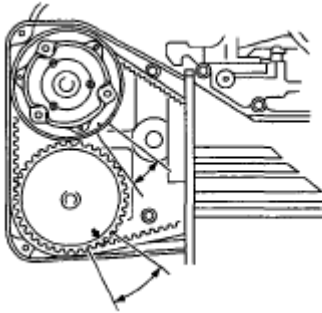


Fig. 19: Identifying Cam Sprocket Mark Position
Courtesy of SUBARU OF AMERICA, INC.

2. Set the round mark and arrow mark on cam sprocket to the position shown in the illustration, and measure the #2 cylinder intake valve and #4 cylinder exhaust valve clearances.

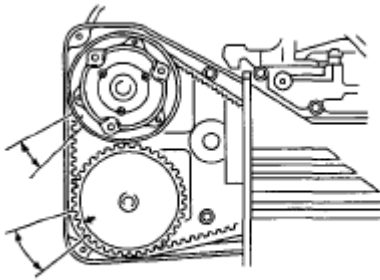


Fig. 20: Measuring #2 Cylinder Intake Valve And #4 Cylinder Exhaust Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

3. Set the round mark and arrow mark on cam sprocket to the position shown in the illustration, and measure the #1 cylinder exhaust valve and #4 cylinder intake valve clearances.

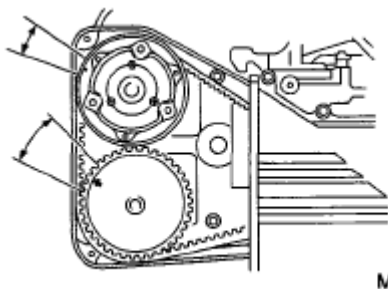


Fig. 21: Measuring #1 Cylinder Exhaust Valve And #4 Cylinder Intake Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

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

ADJUSTMENT

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

1. Measure all the valve clearances. < Ref. to **INSPECTION**, Valve Clearances.>

NOTE: Record each valve clearance after measurement.



Fig. 22: Measuring Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the camshaft. < Ref. to **REMOVAL**, Camshaft.>
3. Remove the valve lifter.
4. Measure the thickness of valve lifter using micrometer.

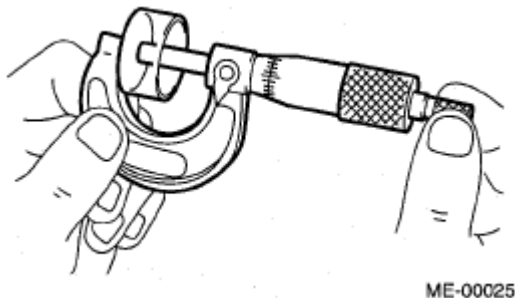


Fig. 23: Measuring Thickness Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

5. Select a valve lifter of suitable thickness from the following table using the measured valve clearance and valve lifter thickness.

VALVE LIFTER THICKNESS

Unit: (mm)
Intake valve: $S = (V \pm T) - 0.20$

Exhaust valve: $S = (V \pm T) - 0.35$

S: Required thickness of valve lifter

V: Measured valve clearance

T: Used valve lifter thickness

THICKNESS SPECIFICATION

Part No.	Thickness mm (in)
13228 AB102	4.68 (0.1843)
13228 AB112	4.69 (0.1846)
13228 AB122	4.70 (0.1850)
13228 AB132	4.71 (0.1854)
13228 AB142	4.72 (0.1858)
13228 AB152	4.73 (0.1862)
13228 AB162	4.74 (0.1866)
13228 AB172	4.75 (0.1870)
13228 AB182	4.76 (0.1874)
13228 AB192	4.77 (0.1878)
13228 AB202	4.78 (0.1882)
13228 AB212	4.79 (0.1886)
13228 AB222	4.80 (0.1890)
13228 AB232	4.81 (0.1894)
13228 AB242	4.82 (0.1898)
13228 AB252	4.83 (0.1902)
13228 AB262	4.84 (0.1906)
13228 AB272	4.85 (0.1909)
13228 AB282	4.86 (0.1913)
13228 AB292	4.87 (0.1917)
13228 AB302	4.88 (0.1921)
13228 AB312	4.89 (0.1925)
13228 AB322	4.90 (0.1929)
13228 AB332	4.91 (0.1933)
13228 AB342	4.92 (0.1937)
13228 AB352	4.93 (0.1941)
13228 AB362	4.94 (0.1945)
13228 AB372	4.95 (0.1949)
13228 AB382	4.96 (0.1953)
13228 AB392	4.97 (0.1957)
13228 AB402	4.98 (0.1961)
13228 AB412	4.99 (0.1965)
13228 AB422	5.00 (0.1969)
13228 AB432	5.01 (0.1972)

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

13228 AB442	5.02 (0.1976)
13228 AB452	5.03 (0.1980)
13228 AB462	5.04 (0.1984)
13228 AB472	5.05 (0.1988)
13228 AB482	5.06 (0.1992)
13228 AB492	5.07 (0.1996)
13228 AB502	5.08 (0.2000)
13228 AB512	5.09 (0.2004)
13228 AB522	5.10 (0.2008)
13228 AB532	5.11 (0.2012)
13228 AB542	5.12 (0.2016)
13228 AB552	5.13 (0.2020)
13228 AB562	5.14 (0.2024)
13228 AB572	5.15 (0.2028)
13228 AB582	5.16 (0.2031)
13228 AB592	5.17 (0.2035)
13228 AB602	5.18 (0.2039)
13228 AB612	5.19 (0.2043)
13228 AB622	5.20 (0.2047)
13228 AB632	5.21 (0.2051)
13228 AB642	5.22 (0.2055)
13228 AB652	5.23 (0.2059)
13228 AB662	5.24 (0.2063)
13228 AB672	5.25 (0.2067)
13228 AB682	5.26 (0.2071)
13228 AB692	5.27 (0.2075)
13228 AB702	4.38 (0.1724)
13228 AB712	4.40 (0.1732)
13228 AB722	4.42 (0.1740)
13228 AB732	4.44 (0.1748)
13228 AB742	4.46 (0.1756)
13228 AB752	4.48 (0.1764)
13228 AB762	4.50 (0.1771)
13228 AB772	4.52 (0.1780)
13228 AB782	4.54 (0.1787)
13228 AB792	4.56 (0.1795)
13228 AB802	4.58 (0.1803)
13228 AB812	4.60 (0.1811)
13228 AB822	4.62 (0.1819)
13228 AB832	4.64 (0.1827)
13228 AB842	4.66 (0.1835)

	5.29 (0.2083)
13228 AB862	5.31 (0.2091)
13228 AB872	5.33 (0.2098)
13228 AB882	5.35 (0.2106)
13228 AB892	5.37 (0.2114)
13228 AB902	5.39 (0.2122)
13228 AB912	5.41 (0.2123)
13228 AB922	5.43 (0.2138)
13228 AB932	5.45 (0.2146)
13228 AB942	5.47 (0.2154)
13228 AB952	5.49 (0.2161)
13228 AB962	5.51 (0.2169)
13228 AB972	5.53 (0.2177)
13228 AB982	5.55 (0.2185)
13228 AB992	5.57 (0.2193)
13228 AC002	5.59 (0.2201)
13228 AC012	5.61 (0.2209)
13228 AC022	5.63 (0.2217)
13228 AC032	5.65 (0.2224)

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

ENGINE ASSEMBLY

REMOVAL

1. Set the vehicle on a lift.
2. Open the front hood fully and support with the front hood stay.
3. Remove the collector cover.
4. Collect the refrigerant from A/C system. < Ref. to **REFRIGERANT RECOVERY PROCEDURE** .>
5. Release the fuel pressure. < Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel .>
6. Disconnect the battery cable, and remove the battery from the vehicle.
7. Open the fuel filler flap lid, and remove the fuel filler cap.
8. Remove the air cleaner case and air intake boot. < Ref. to **REMOVAL** , Air Cleaner Case .>
9. Remove the under cover.
10. Remove the radiator from the vehicle. < Ref. to **REMOVAL** , Radiator .>
11. Remove the coolant filler tank. < Ref. to **REMOVAL** , Coolant Filler Tank .>
12. Remove the secondary air pump. < Ref. to **INSPECTION** , Secondary Air Pump .>
13. Disconnect the A/C pressure hoses from A/C compressor.

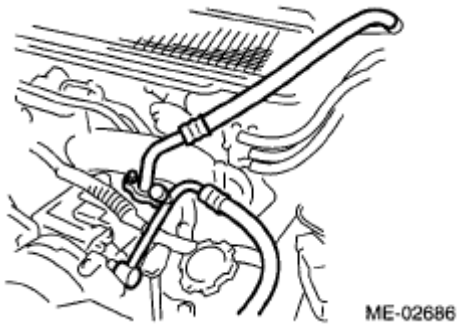


Fig. 24: Identifying A/C Pressure Hoses From A/C Compressor
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the intercooler. < Ref. to **REMOVAL** , Intercooler .>
15. Disconnect the following connectors and cables.
 1. Engine harness connectors

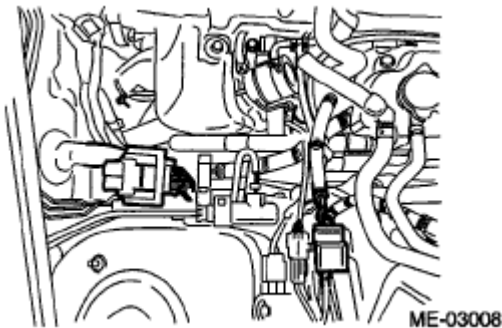


Fig. 25: Identifying Engine Harness Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Engine ground terminal

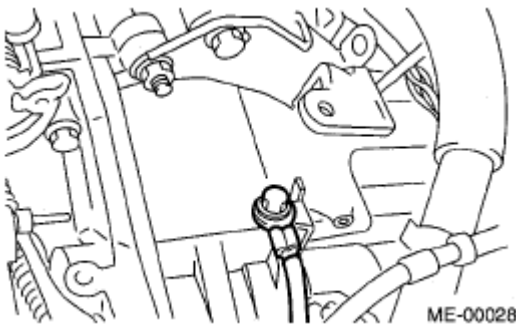


Fig. 26: Identifying Engine Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

3. Right and left engine ground cables

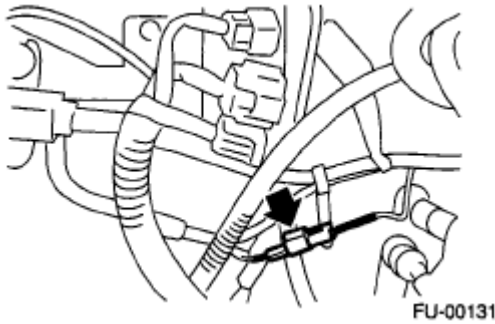


Fig. 27: Identifying Right Engine Ground Cables
Courtesy of SUBARU OF AMERICA, INC.

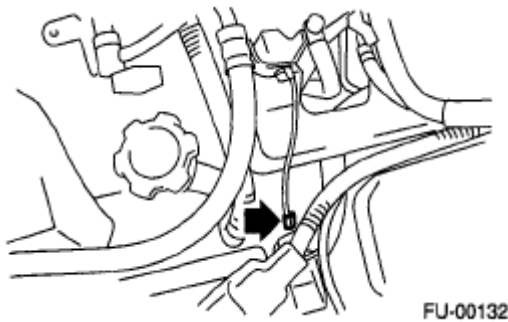
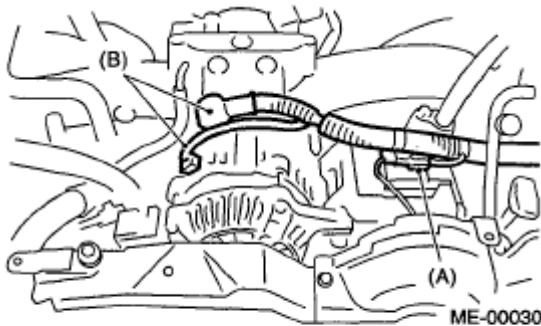


Fig. 28: Identifying Left Engine Ground Cables
Courtesy of SUBARU OF AMERICA, INC.

4. Generator connector, terminal and A/C compressor connector



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

Fig. 29: Identifying Generator Connector, Terminal And A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Power steering switch connector

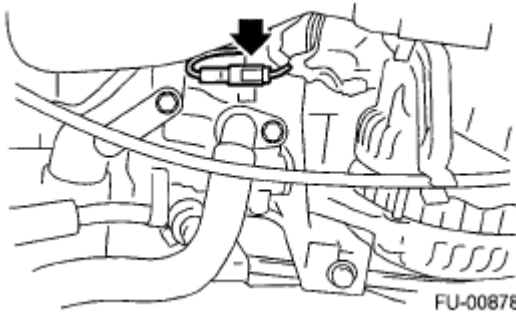


Fig. 30: Identifying Power Steering Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

16. Disconnect the following hoses.
 1. Brake booster vacuum hose

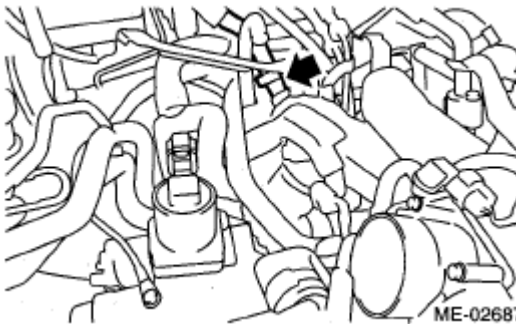


Fig. 31: Locating Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

2. Heater inlet and outlet hoses
17. Remove the power steering pump.
 1. Remove the front side belts. < Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt.>
 2. Remove the power steering pipe from the fuel pip protector RH along with the bracket.

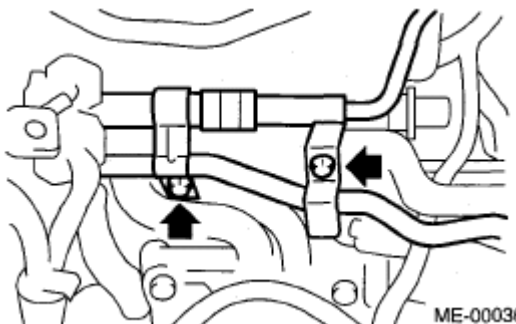


Fig. 32: Identifying Power Steering Pump Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the power steering pump from the engine.

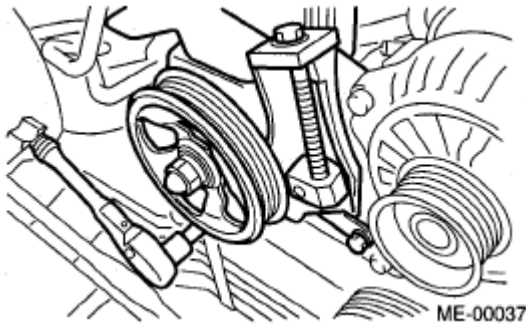


Fig. 33: Identifying Power Steering Pump From Engine
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the power steering reservoir tank from the bracket by pulling it upwards.

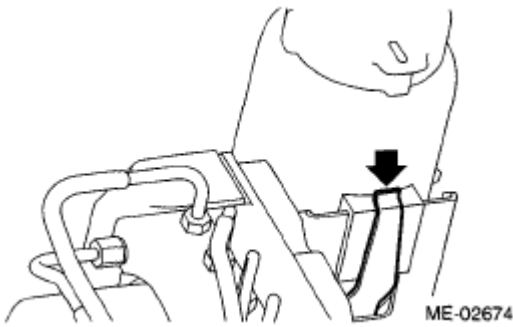


Fig. 34: Locating Power Steering Reservoir Tank Bracket
Courtesy of SUBARU OF AMERICA, INC.

5. Place the power steering pump on the right side wheel apron.

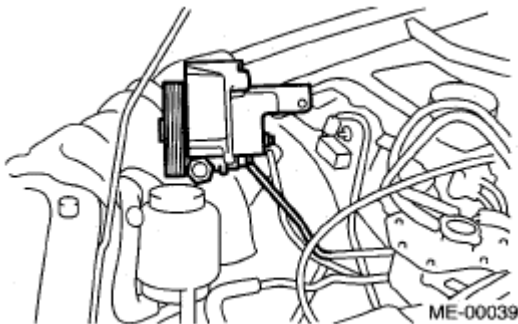


Fig. 35: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

18. Lift up the vehicle.
19. Remove the front and center exhaust pipes. < Ref. to **REMOVAL** , Center Exhaust Pipe .> < Ref. to

REMOVAL , Front Exhaust Pipe .>

20. Remove the bolts and nuts which hold lower side of transmission to engine.

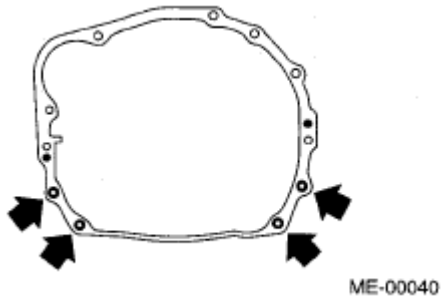


Fig. 36: Locating Bolts And Nuts
Courtesy of SUBARU OF AMERICA, INC.

21. Remove the nuts which install front cushion rubber onto front crossmember.

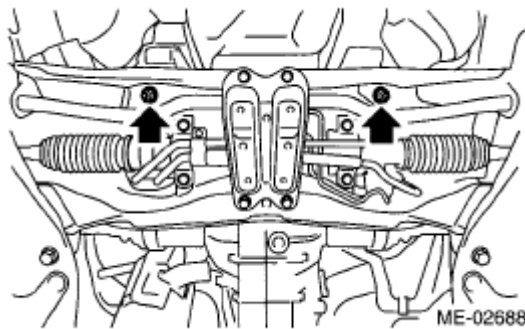


Fig. 37: Locating Front Cushion Rubber
Courtesy of SUBARU OF AMERICA, INC.

22. 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 torque converter clutch to drive plate.
 4. Remove other bolts while rotating the crankshaft using socket wrench.

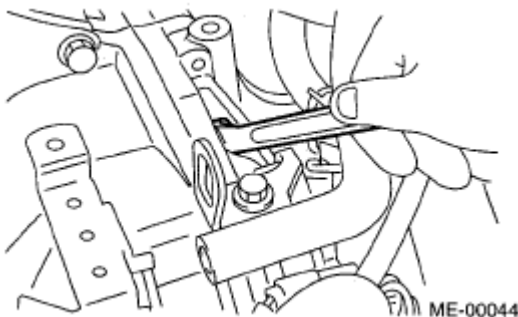


Fig. 38: Rotating Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

23. Remove the pitching stopper.

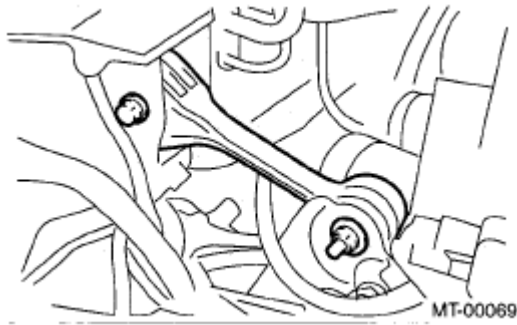
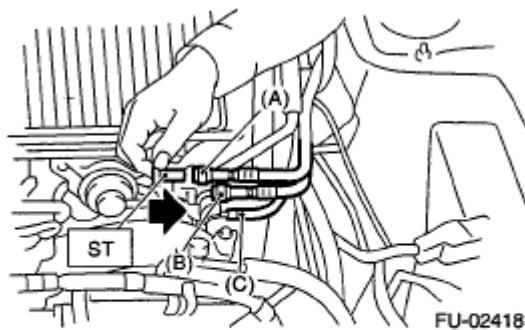


Fig. 39: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

24. Using the ST to remove the fuel hose from each fuel pipe. < Ref. to **REMOVAL** , Fuel Delivery, Return and Evaporation Lines .>

- CAUTION:**
- Be careful not to spill fuel.
 - Catch the fuel from hoses using a container or cloth.

ST 42099AE000 CONNECTOR REMOVER



- (A) Fuel delivery hose
(B) Return hose
(C) Evaporation hose

Fig. 40: Identifying Fuel Delivery, Return And Evaporation Lines
Courtesy of SUBARU OF AMERICA, INC.

25. Support the engine with a lifting device and wire ropes.

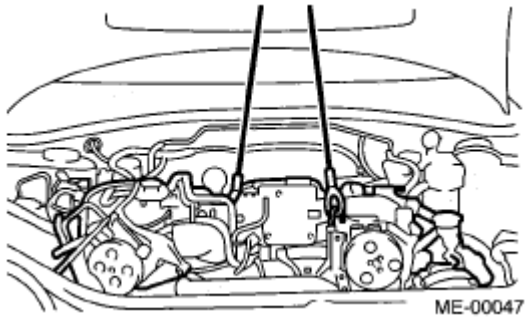
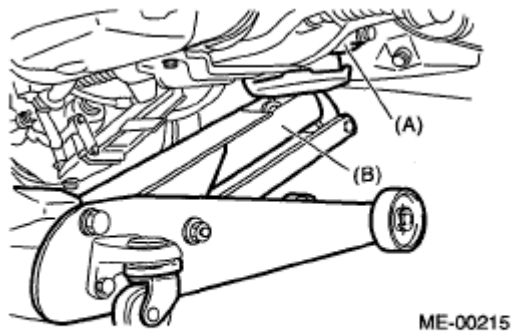


Fig. 41: Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

26. Support the transmission with a garage jack.

CAUTION: Be sure to always perform this work, in order to prevent the transmission from lowering for its own weight.



- (A) Transmission
(B) Garage jack

Fig. 42: Identifying Transmission With Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

27. Separation of engine and transmission.

CAUTION: Before removing the engine away from transmission, check to be sure no work has been overlooked.

1. Remove the starter. < Ref. to **REMOVAL** , Starter .>
2. Set the ST to torque converter clutch case. (AT model)

ST 498277200 STOPPER SET

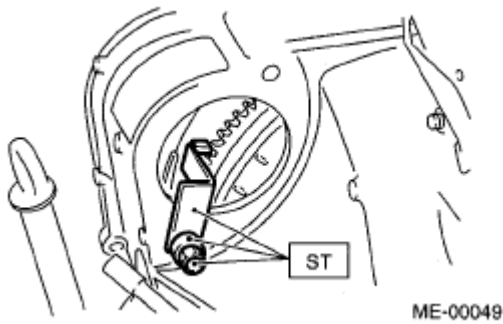


Fig. 43: Identifying ST To Torque Converter Clutch Case
 Courtesy of SUBARU OF AMERICA, INC.

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

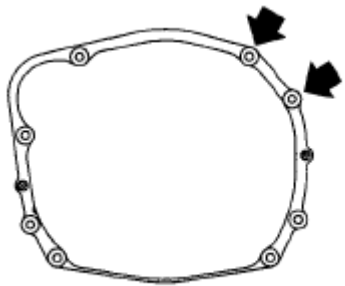


Fig. 44: Locating Transmission Bolts
 Courtesy of SUBARU OF AMERICA, INC.

28. 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 adjacent parts or body panels with crank pulley, oil level gauge, etc.

29. Remove the front cushion rubbers.

INSTALLATION

1. Install the front cushion rubbers.

Tightening torque:

35 N.m (3.6 kgf-m, 25.8 ft-lb)

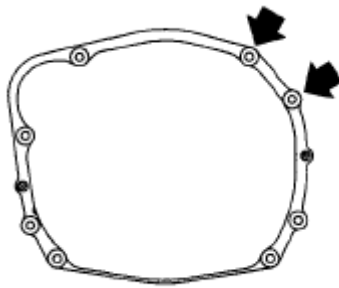
2. Apply a small amount of grease to splines of mainshaft. (MT model)
3. Position the engine in engine compartment and connect the engine to the transmission.

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

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

Tightening torque:

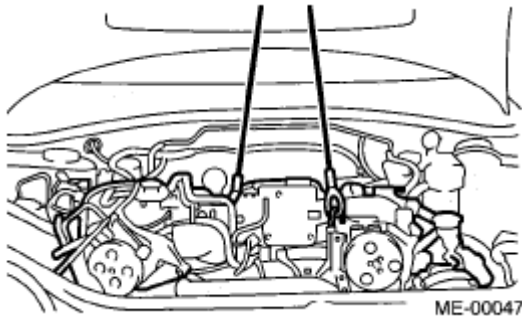
50 N.m (5.1 kgf-m, 36.9 ft-lb)



MT-01524

Fig. 45: Locating Transmission Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.



ME-00047

Fig. 46: Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the garage jack.
7. Install the pitching stopper.

Tightening torque:

T1: 50 N.m (5.1 kgf-m, 36.9 ft-lb)

T2: 58 N.m (5.9 kgf-m, 42.8 ft-lb)

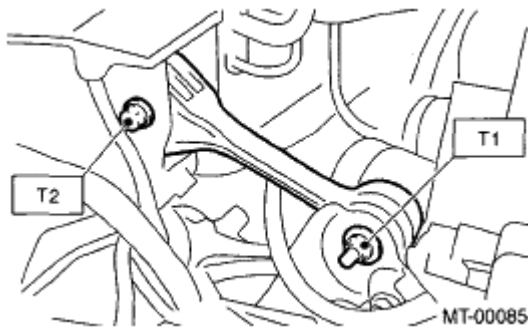


Fig. 47: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the ST from converter case. (AT model)

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

ST 498277200 STOPPER SET

9. Install the starter. < Ref. to **INSTALLATION** , Starter .>
10. Install the torque converter clutch to drive plate. (AT model)
 1. Tighten the bolts which hold torque converter clutch to drive plate.
 2. Tighten other bolts while rotating the crankshaft using socket wrench.

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

Tightening torque:

25 N.m (2.5 kgf-m, 18.4 ft-lb)

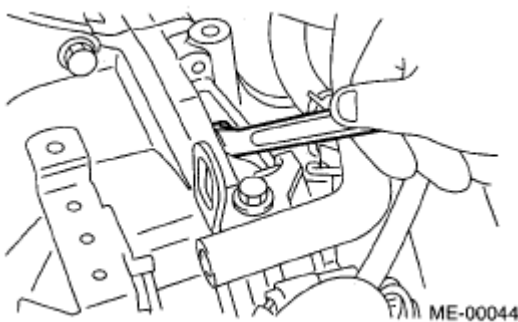


Fig. 48: Rotating Crankshaft Using Socket Wrench
Courtesy of SUBARU OF AMERICA, INC.

3. Install the service hole plug.
11. Install the power steering pump.
 1. Install the power steering reservoir tank to the bracket.

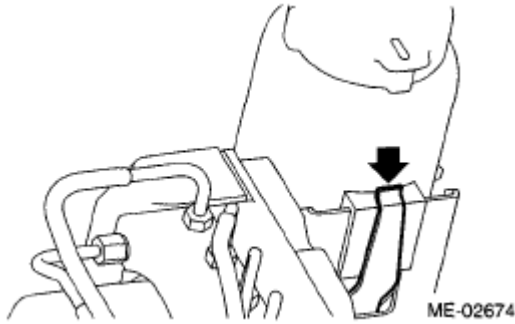


Fig. 49: Locating Power Steering Reservoir Tank Bracket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the power steering pump.

Tightening torque:

Refer to "**COMPONENTS**" of "Power Steering" information for the tightening torque.

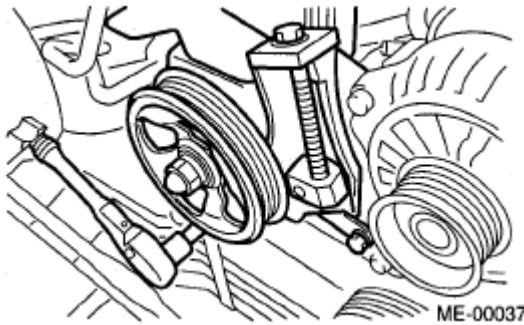


Fig. 50: Identifying Power Steering Pump From Engine
Courtesy of SUBARU OF AMERICA, INC.

3. Install the power steering pipes onto the fuel pipe protector RH.

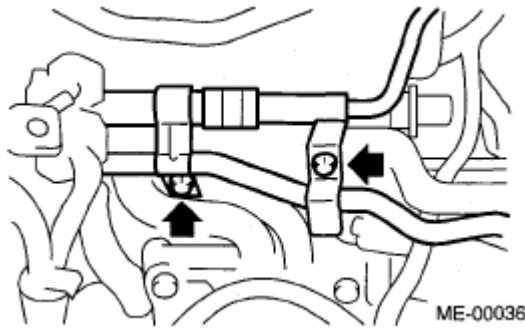


Fig. 51: Identifying Power Steering Pump Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Install and adjust the front side belt. < Ref. to **FRONT SIDE BELT**, INSTALLATION, V-belt.>
12. Lift up the vehicle.
13. Tighten the nuts and bolts which hold lower side of transmission to engine.

Tightening torque:

50 N.m (5.1 kgf-m, 36.9 ft-lb)

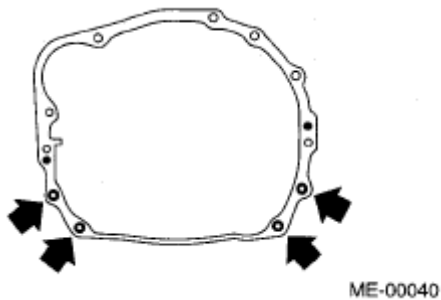


Fig. 52: Locating Bolts And Nuts
Courtesy of SUBARU OF AMERICA, INC.

14. Tighten the nuts which install the front cushion rubber onto crossmember.

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

Tightening torque:

85 N.m (8.7 kgf-m, 62.7 ft-lb)

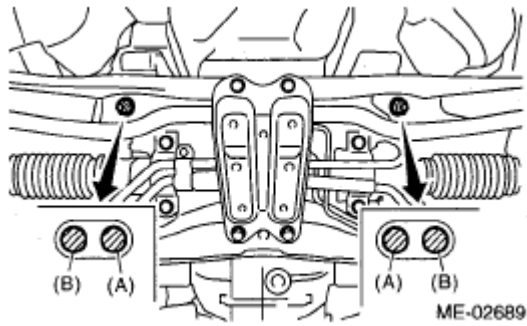


Fig. 53: Identifying Front Cushion Rubber Mounting Bolts And Locator
Courtesy of SUBARU OF AMERICA, INC.

15. Install the front and center exhaust pipe.

< Ref. to **INSTALLATION** , Front Exhaust Pipe .> < Ref. to **INSTALLATION** , Center Exhaust Pipe .>

16. Lower the vehicle.

17. Connect the following hoses.

1. Fuel delivery hose, return hose and evaporation hose
2. Heater inlet and outlet hoses
3. Brake booster vacuum hose

18. Connect the following connectors and terminals.

1. Engine ground terminal

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 connector
5. Power steering switch connector

19. Install the intercooler. < Ref. to **INSTALLATION** , Intercooler .>

20. Install the air cleaner case and air intake boot. < Ref. to **INSTALLATION** , Air Cleaner Case .>

21. Install the A/C pressure hoses. < Ref. to **INSTALLATION** , Hose and Tube .>

22. Install the radiator. < Ref. to **INSTALLATION** , Radiator .>

23. Install the under cover.

24. Install the coolant filler tank.

< Ref. to **INSTALLATION** , Coolant Filler Tank .>

25. Install the secondary air pump. < Ref. to **INSTALLATION** , Secondary Air Pump .>

26. Install the battery in the vehicle, and connect cables.
27. Fill engine coolant.

< Ref. to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant .>

28. Check the ATF level and replenish it if necessary. (AT model) < Ref. to **INSPECTION** , Automatic Transmission Fluid.>
29. Charge the A/C system with refrigerant. < Ref. to **PROCEDURE** , Refrigerant Charging Procedures .>
30. Install the collector cover.
31. Remove the front hood stay, and close the front hood.
32. Lower the vehicle from lift.

INSPECTION

1. Check that pipes, hoses, connectors and clamps are installed firmly.
2. Check that the engine coolant is at specified level.
3. Check that the ATF is at specified level. (AT model)
4. Start the engine and check for exhaust gas, engine coolant, leaks of fuel, etc. Also check for noise and vibrations.

ENGINE MOUNTING

REMOVAL

1. Remove the engine unit. < Ref. to **REMOVAL**, Engine Assembly.>
2. Remove the engine mounting from engine assembly.

INSTALLATION

Install in the reverse order of removal.

Tightening torque:

35 N.m (3.6 kgf-m, 25.8 ft-lb)

INSPECTION

Make sure that no crack or other damages do not exist.

PREPARATION FOR OVERHAUL

PROCEDURE

1. After removing the engine from body, secure it to ST in the following procedure.

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 499817100 ENGINE STAND

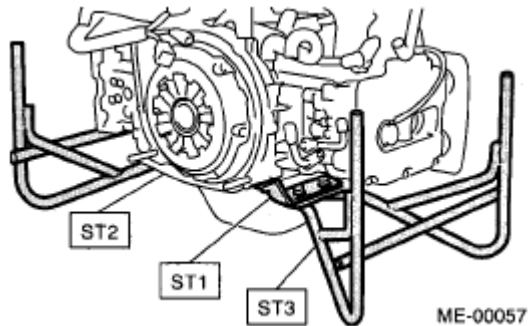


Fig. 54: Identifying Engine Stand Adapters And Engine Stand
Courtesy of SUBARU OF AMERICA, INC.

2. In this section the procedures described under each index are all connected and stated in order. The procedure for overhauling of the engine will be completed 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.

V-BELT

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part.

FRONT SIDE BELT

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

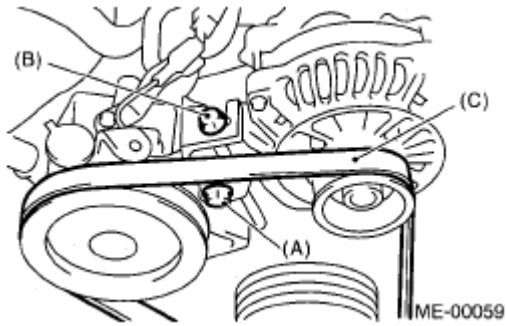


Fig. 55: Identifying Front Side Belt
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

1. Remove the front side belts. < Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt.>
2. Loosen the lock nut (A).
3. Loosen the slider bolt (B).

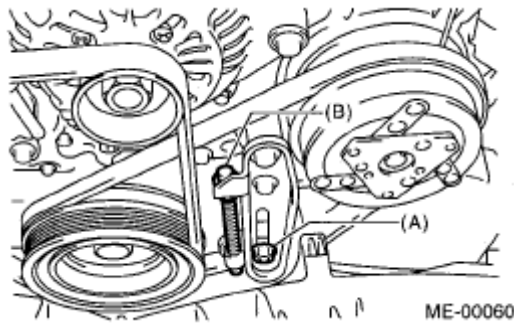


Fig. 56: Identifying Lock Nut And Slider Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the rear side belt.
5. Remove the belt tensioner.

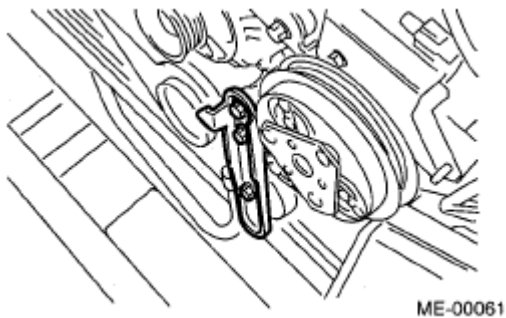


Fig. 57: Identifying Rear Side Belt And Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

FRONT SIDE BELT

1. Install the front side belt (C), and tighten the slider bolt so as to obtain the specified belt tension. < Ref. to **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, 18.4 ft-lb)

Slider bolt (B)

8 N.m (0.8 kgf-m, 5.9 ft-lb)

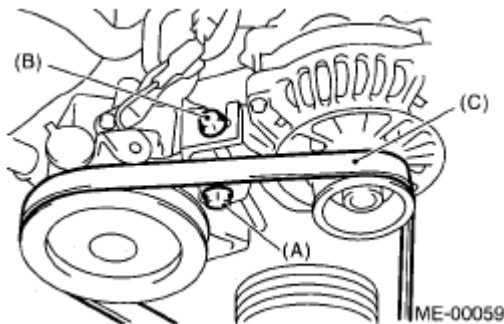


Fig. 58: Identifying Lock Nut And Slider Bolt
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

1. Install the belt tensioner.
2. Install a rear side belt, and tighten the slider bolt (B) so as to obtain the specified belt tension. < Ref. to **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)

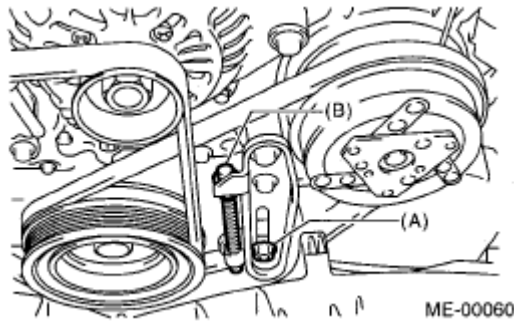


Fig. 59: Identifying Lock Nut And Slider Bolt
 Courtesy of SUBARU OF AMERICA, INC.

4. Install the front side belt. < Ref. to **FRONT SIDE BELT**, INSTALLATION, V-belt.>

INSPECTION

1. Replace the belts, if crack, fraying or wear is found.
2. Check the V-belt tension and adjust it if necessary by changing the generator installing position or idler pulley installing position.

Belt tension (with belt tension gauge):

(A)

When installing new parts

640 - 780 N (65 - 80 kgf, 144 - 175 lbf)

At inspection:

490 - 640 N (50 - 65 kgf, 110 - 144 lbf)

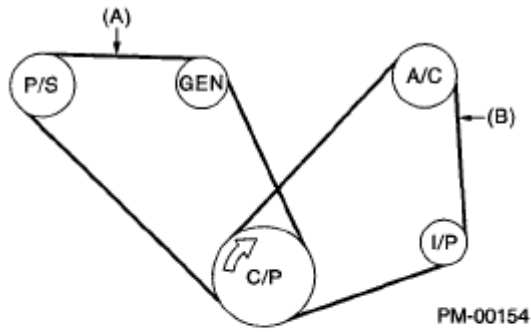
(B)

When installing new parts

650 - 750 N (66 - 76 kgf, 146 - 169 lbf)

At inspection

350 - 450 N (36 - 46 kgf, 78 - 101 lbf)



- (A) Front side belt
- (B) Rear side belt
- C/P Crank pulley
- GEN Generator
- P/S Power steering oil pump pulley
- A/C A/C compressor pulley
- I/P Idler pulley

Fig. 60: Inspecting Belt Tension
 Courtesy of SUBARU OF AMERICA, INC.

Belt tension (without belt tension gauge):

(A)

When installing new parts

7 - 9 mm (0.276 - 0.354 in)

At inspection

9 - 11 mm (0.354 - 0.433 in)

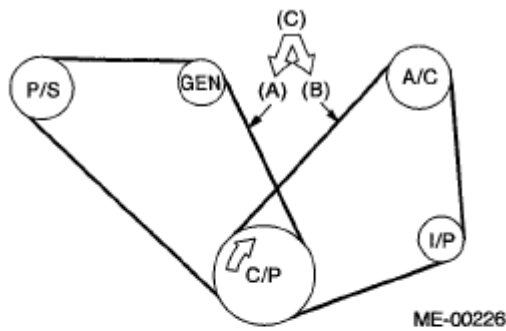
(B)

When installing new parts

7.5 - 8.5 mm (0.295 - 0.335 in)

At inspection

9.0 - 10.0 mm (0.354 - 0.394 in)



- (A) Front side belt
- (B) Rear side belt
- (C) 98 N (10 kgf, 22 lbf)
- C/P Crank pulley
- GEN Generator
- P/S Power steering oil pump pulley
- A/C Air conditioning compressor pulley
- I/P Idler pulley

Fig. 61: Inspecting Belt Tension (Without Belt Tension Gauge)
Courtesy of SUBARU OF AMERICA, INC.

CRANK PULLEY

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part.

1. Remove the V-belts. < Ref. to **REMOVAL**, V-belt.>
2. Remove the crank pulley bolt. To lock the crankshaft, use ST.

ST 499977100 CRANK PULLEY WRENCH

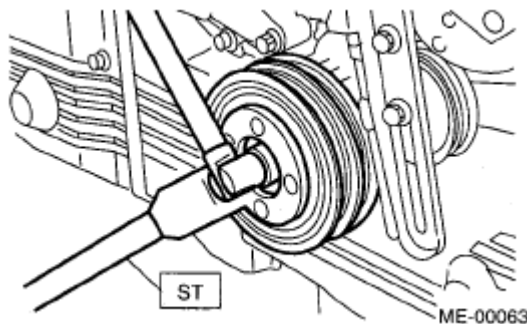


Fig. 62: Removing/Installing Crank Pulley Bolt Using Crank Pulley Wrench ST 499977100
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION

1. Install the crank pulley.
2. Install the pulley bolt.

To lock the crankshaft, use ST.

ST 499977100 CRANK PULLEY WRENCH

1. Clean the crank pulley thread using compressed air.
2. Apply engine oil to the crank pulley bolt seat and thread.
3. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 32.5 ft-lb).
4. Tighten the crank pulley bolts.

Tightening torque:

180 N.m (18.3 kgf-m, 132.7 ft-lb)

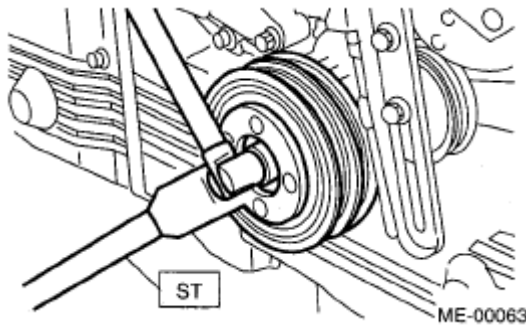


Fig. 63: Removing/Installing Crank Pulley Bolt Using Crank Pulley Wrench ST 499977100
Courtesy of SUBARU OF AMERICA, INC.

3. Check that the tightening angle of the crank pulley bolt is a minimum of 65°. Perform the following procedure when less than 65°.

CAUTION: If the tightening angle of crank pulley bolt is less than 65°, the bolt is damaged. In this case, the bolt must be replaced.

1. Replace the crank pulley bolts and clean them.

Crank pulley bolt:

Part No. 12369AA011

2. Clean the crankshaft thread using compressed air.
3. Apply engine oil to the crank pulley bolt seat and thread.

4. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 32.5 ft-lb).
5. Tighten the crank pulley bolts 65° to 75°.

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

4. Install the V-belts. < Ref. to **INSTALLATION**, V-belt.>

INSPECTION

1. Check the V-belt is not worn or otherwise damaged.
2. Check the tension of the belt. < Ref. to **INSPECTION**, V-belt.>

TIMING BELT COVER

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part.

1. Remove the V-belts. < Ref. to **REMOVAL**, V-belt.>
2. Remove the crank pulley.

< Ref. to **REMOVAL**, Crank Pulley.>

3. Remove the timing belt cover (LH) (A).
4. Remove the timing belt cover (RH) (B).
5. Remove the front timing belt cover (C).

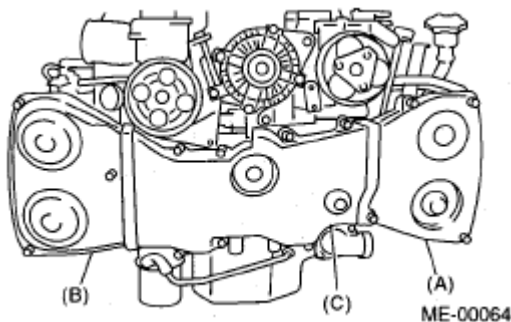


Fig. 64: Identifying Front Timing Belt Covers
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the front timing belt cover (C).

Tightening torque:***5 N.m (0.5 kgf-m, 3.7 ft-lb)***

2. Install the timing belt cover (RH) (B).

Tightening torque:***5 N.m (0.5 kgf-m, 3.7 ft-lb)***

3. Install the timing belt cover (LH) (A).

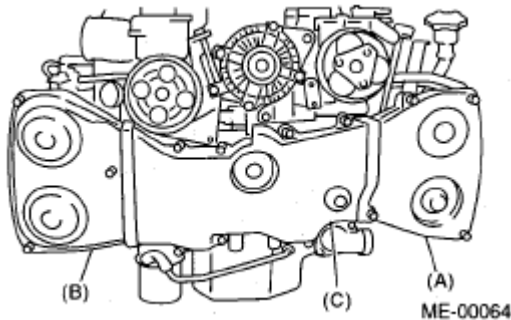
Tightening torque:***5 N.m (0.5 kgf-m, 3.7 ft-lb)***

Fig. 65: Identifying Front Timing Belt Covers
Courtesy of SUBARU OF AMERICA, INC.

4. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley.>
5. Install the V-belts. < Ref. to **INSTALLATION**, V-belt.>

INSPECTION

Check the cover for damage.

TIMING BELT**REMOVAL**

NOTE: Perform the work with the engine installed to body when replacing a single part. For operation procedures, refer to 'Timing Belt' of the PM section. < Ref. to .>

TIMING BELT

1. Remove the V-belts. < Ref. to **REMOVAL**, V-belt.>

2. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley.>
3. Remove the timing belt cover.

< Ref. to **REMOVAL**, Timing Belt Cover.>

4. Remove the timing belt guide. (MT model)

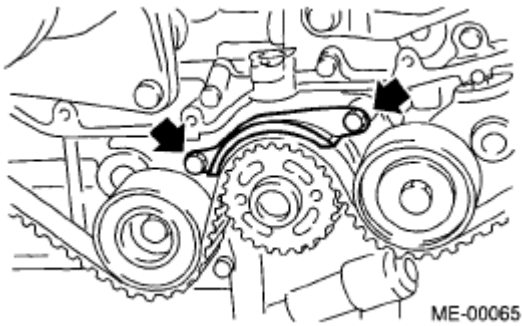


Fig. 66: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

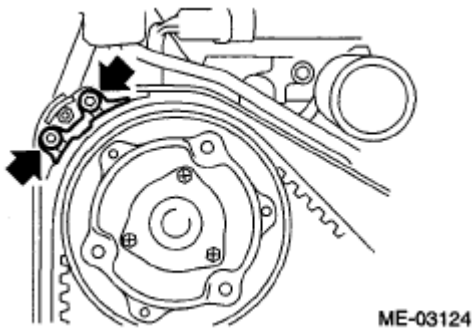


Fig. 67: Locating Timing Belt Guides (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

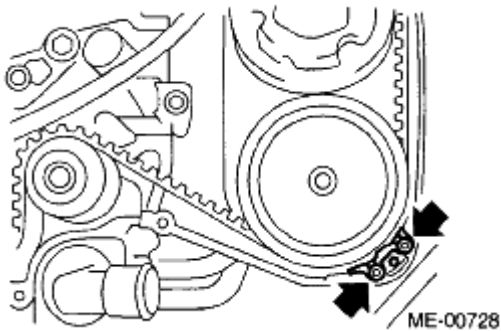


Fig. 68: Locating Timing Belt Guides
Courtesy of SUBARU OF AMERICA, INC.

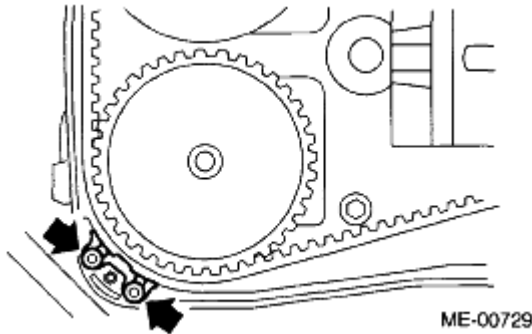


Fig. 69: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. If the alignment mark or arrow mark (which indicates the direction of rotation) on timing belt fade away, put new marks before removing the timing belt as shown in procedures below.
 1. Turn the crankshaft using ST, and align the alignment marks on crank sprocket, intake cam sprocket (LH), exhaust cam sprocket (LH), intake cam sprocket (RH) and exhaust cam sprocket (RH) with notches of timing belt cover and cylinder block.

ST 499987500 CRANKSHAFT SOCKET

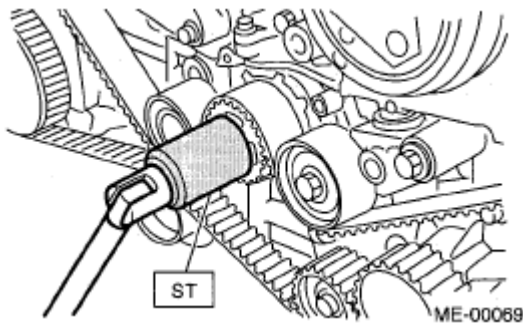


Fig. 70: Aligning Alignment Marks On Crank Sprocket Using Crankshaft Socket ST 499987500
Courtesy of SUBARU OF AMERICA, INC.

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

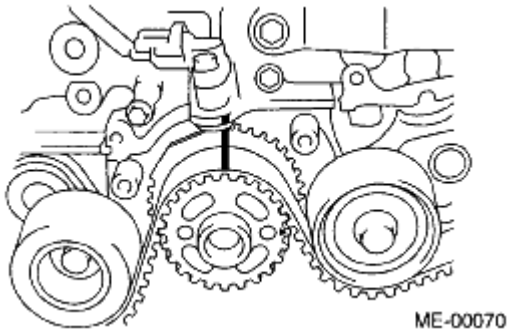


Fig. 71: Identifying Alignment Marks On Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

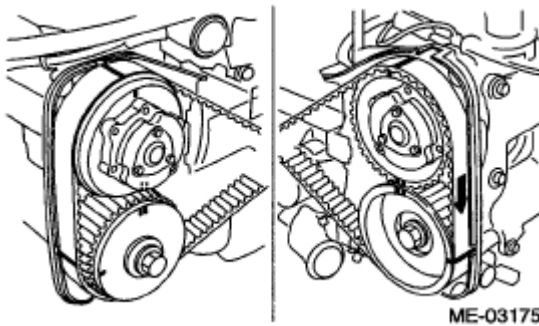


Fig. 72: Locating Alignment Marks On Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 54.5-teeth length

Z_2 : 51-teeth length

Z_3 : 28-teeth length

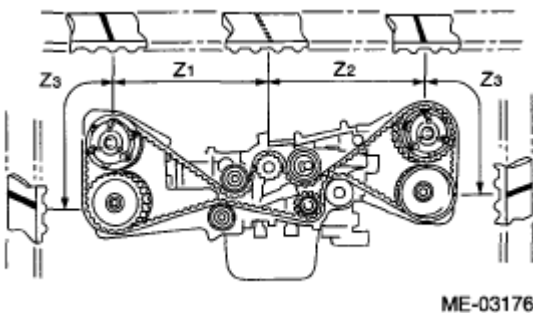


Fig. 73: Identifying Teeth Length
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the belt idler (A).

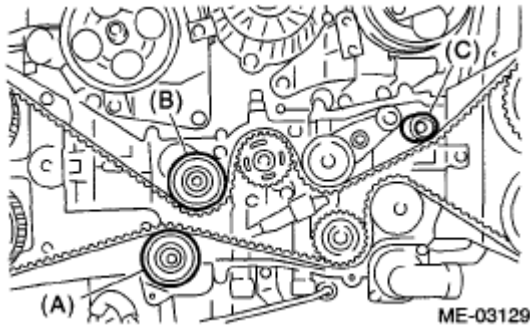


Fig. 74: Identifying Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

7. Remove the timing belt.

CAUTION: After the timing belt has been removed, never rotate the intake and exhaust sprocket. If the cam sprocket is rotated, the intake and exhaust valve heads strike together and valve stems are bent.

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

1. Remove the belt idler (B) and (C).

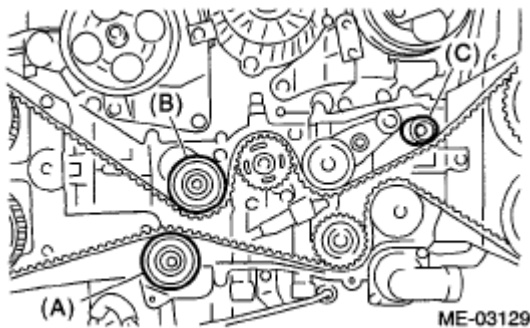


Fig. 75: Identifying Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the belt idler No. 2.

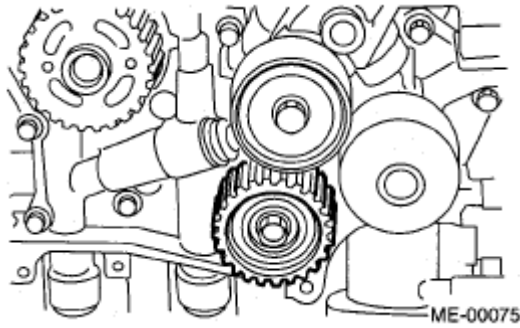


Fig. 76: Identifying Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the automatic belt tension adjuster assembly.

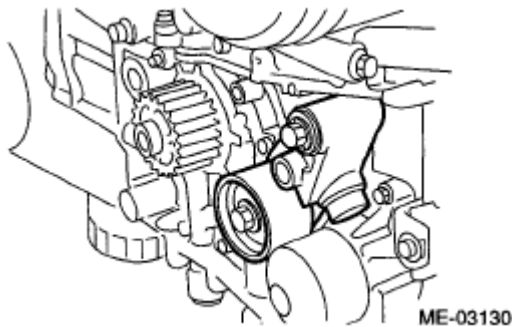


Fig. 77: Identifying Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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 three minutes or more.
- Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lbf).
- Press the adjuster rod to the end surface of the cylinder. However, do not press the adjuster rod below the end face of 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 vertical pressing tool.
2. Slowly move the adjuster rod down with a pressure of 165 N (16.8 kgf, 37.1 lbf) or more until the adjuster rod is aligned with the stopper pin hole in the cylinder.

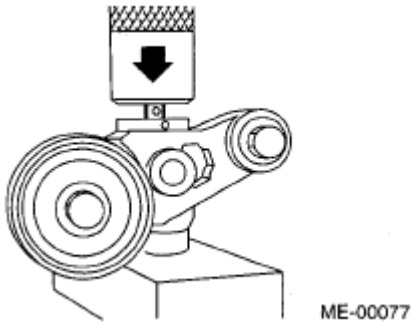


Fig. 78: Aligning Adjuster Rod With Stopper Pin Hole
Courtesy of SUBARU OF AMERICA, INC.

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

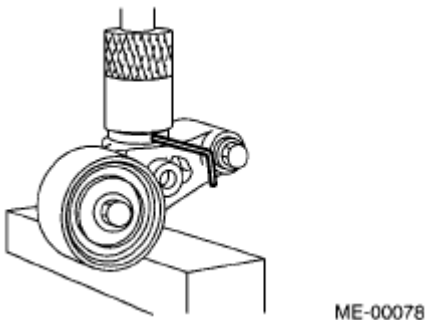
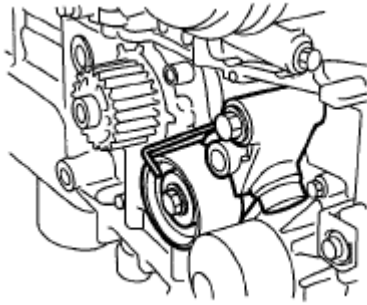


Fig. 79: Identifying Stopper Pin Hole In Cylinder
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)



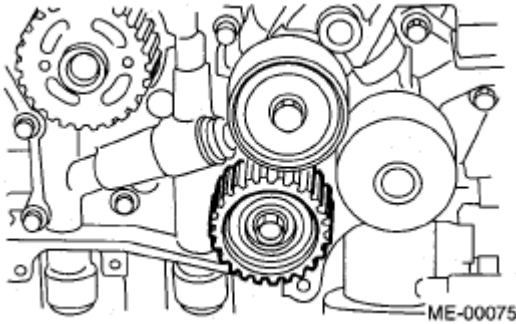
ME-03131

Fig. 80: Installing Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idler No. 2.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)



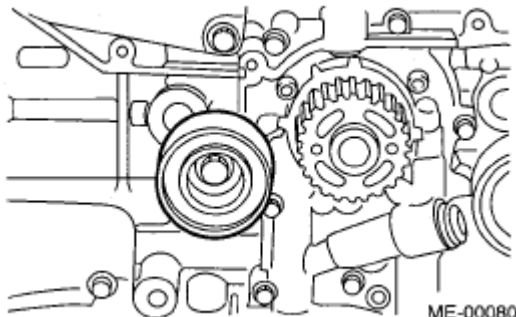
ME-00075

Fig. 81: Identifying Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

4. Install the belt idlers.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)



ME-00080

Fig. 82: Identifying Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

1. Prepare for installation of the automatic belt tension adjuster assembly. < Ref. to **AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER**, INSTALLATION, Timing Belt.>
2. Align the mark (A) on crank sprocket with the mark on oil pump cover at cylinder block.

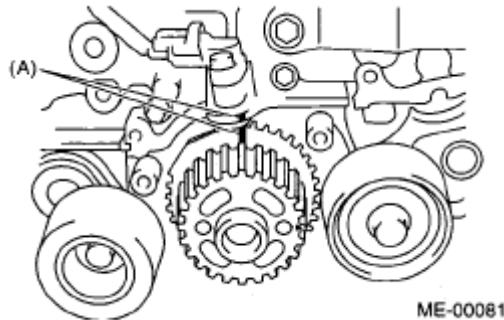


Fig. 83: Aligning Mark On Crank Sprocket With Mark On Oil Pump Cover Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

3. Align single line mark (A) on the exhaust cam sprocket (RH) with notch (B) on timing belt cover.

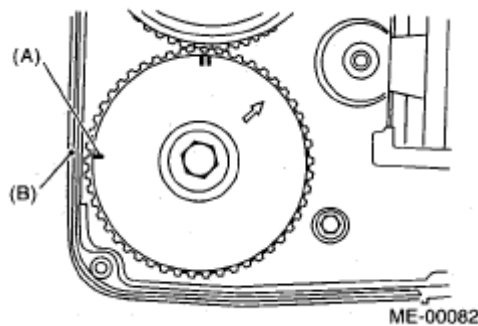


Fig. 84: Aligning Single Line Mark On Exhaust Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

4. Align single line mark (A) on the intake cam sprocket (RH) with notch (B) on timing belt cover. (Ensure double lines (C) on intake and exhaust camshaft sprockets are aligned.)

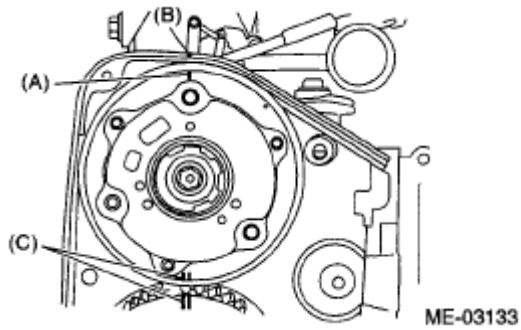


Fig. 85: Aligning Single Line Mark On Intake Cam Sprocket (RH) With Notch (B) On Timing Belt Cover

Courtesy of SUBARU OF AMERICA, INC.

5. Align the single line mark (A) on exhaust cam sprocket (LH) with notch (B) on timing belt cover by turning the sprocket counterclockwise (as viewed from front of engine).

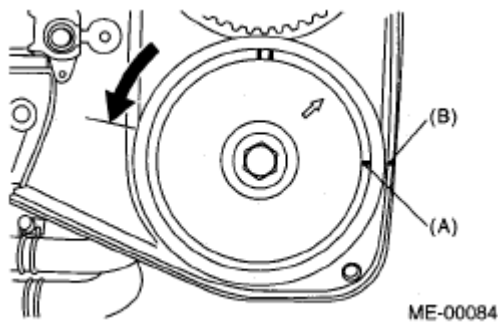


Fig. 86: Aligning Single Line Mark On Exhaust Cam Sprocket

Courtesy of SUBARU OF AMERICA, INC.

6. Align the single line mark (A) on intake cam sprocket (LH) with notch (B) on timing belt cover by turning the sprocket clockwise (as viewed from front of engine). (Make sure the double line marks (C) on intake and exhaust cam sprockets are aligned.)

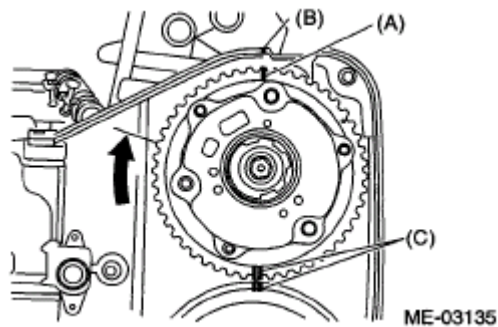


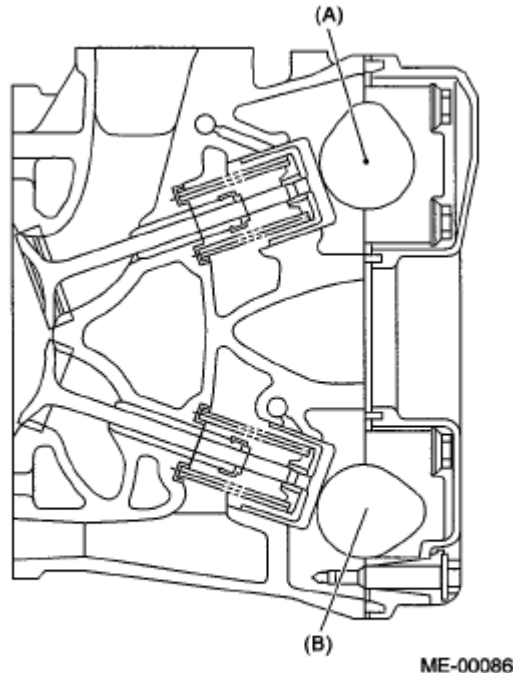
Fig. 87: Aligning Single Line Mark On Intake Cam Sprocket (LH) With Notch On Timing Belt Cover

Courtesy of SUBARU OF AMERICA, INC.

7. Make sure that the cam and crank sprockets are positioned properly.

CAUTION:

- Intake and exhaust camshafts for this DOHC engine can be independently rotated with the timing belts removed. As can be seen from the illustration, if the intake and exhaust valves are lifted simultaneously, the valve heads will interfere with each other, resulting in bent valves.

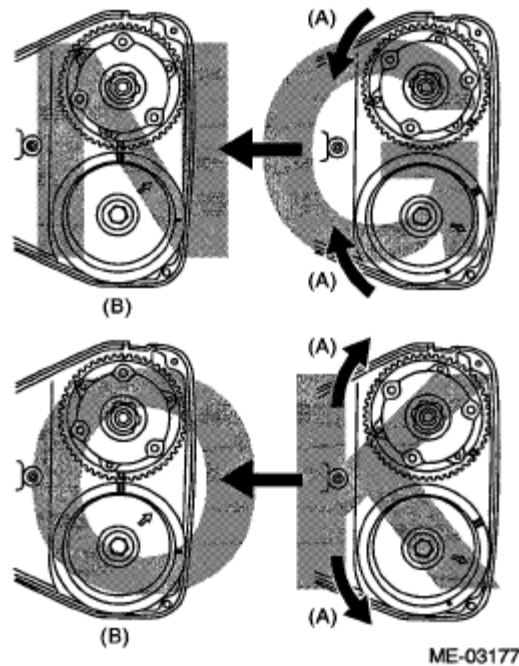


- (A) Intake camshaft
(B) Exhaust camshaft

Fig. 88: Identifying Intake And Exhaust Camshafts
Courtesy of SUBARU OF AMERICA, INC.

- When the timing belts are not installed, four camshafts are held at the "zero-lift" position, where all cams on camshafts do not push the intake and exhaust valves down. (Under this condition, all valves remain unlifted.)
- When the camshafts are rotated to install the timing belts, #2 intake and #4 exhaust cam of camshafts (LH) are held to push their corresponding valves down. (Under this condition, these valves are held lifted.) Right-side camshafts are held so that their cams do not push valves down.
- Camshafts (LH) must be rotated from the zero-lift position to the position where the timing belt is to be installed with the smallest possible angle, in order to prevent mutual interference of intake and exhaust valve heads.

- Do not allow the camshafts to rotate in the direction shown in the upper illustration. Doing this may cause both the intake and exhaust valves to lift simultaneously, resulting in mutual interference of valve heads.



(A) Direction of rotation
(B) Timing belt installation position

Fig. 89: Identifying Correct Timing Belt Installation Position
Courtesy of SUBARU OF AMERICA, INC.

8. Install the timing belt.

Align the alignment mark on the timing belt with marks on the sprockets in the alphabetical order shown in the illustration. While aligning marks, position the timing belt properly.

CAUTION:

- Disengagement of more than three timing belt teeth may result in interference between the valve and piston.
- Make sure that the direction of belt rotation is correct.

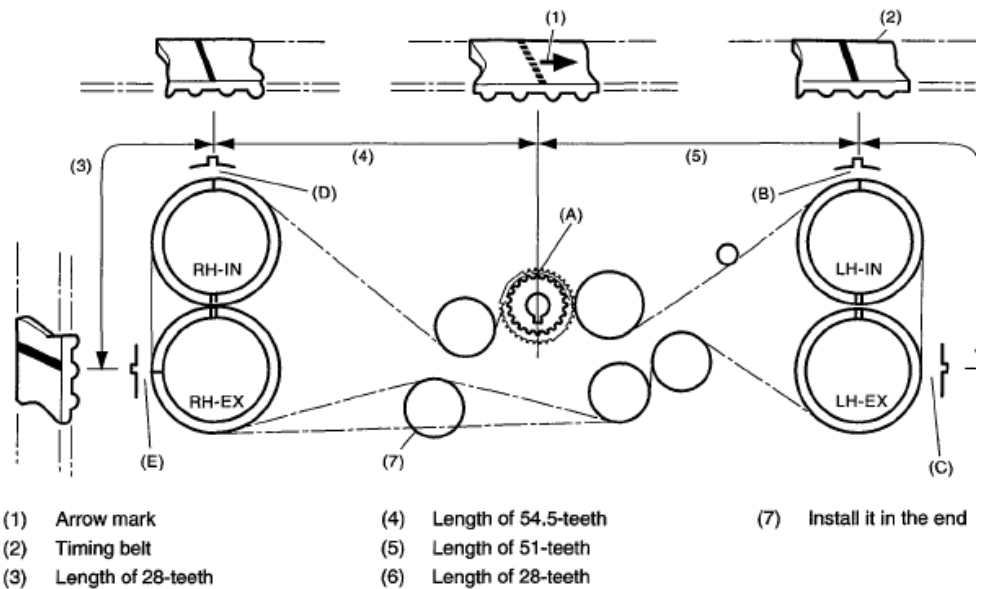


Fig. 90: Installing Timing Belt
 Courtesy of SUBARU OF AMERICA, INC.

9. Install the belt idlers.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)

NOTE: Make sure that the marks on the timing belt and sprockets are aligned.

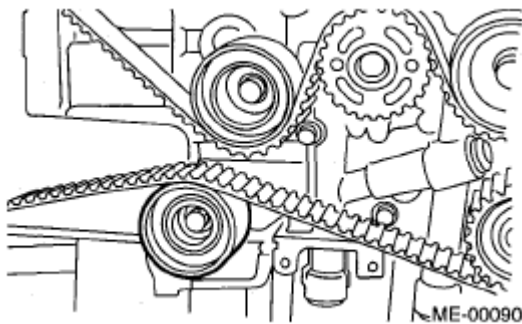


Fig. 91: Identifying Belt Idlers
 Courtesy of SUBARU OF AMERICA, INC.

10. After ensuring that the marks on the timing belt and sprockets are aligned, remove the stopper pin from tensioner adjuster.

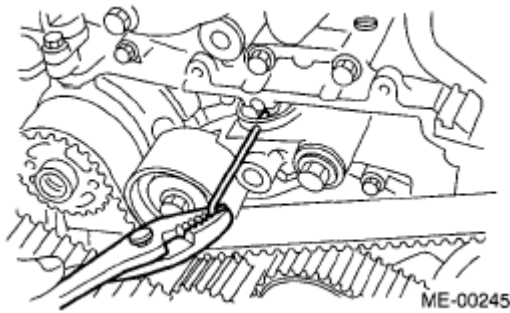


Fig. 92: Removing Stopper Pin From Belt Tension Adjuster
Courtesy of SUBARU OF AMERICA, INC.

11. Install the timing belt guide. (MT model)

NOTE:

- Clean the timing belt cover screw holes before installing bolts.
- Apply liquid gasket to the threaded portion of cam sprocket, (when reusing bolts)

Liquid gasket

THREE BOND 1324 (Part No. 004403042) or the equivalent

1. Temporarily tighten the bolts mounting the timing belt guide.

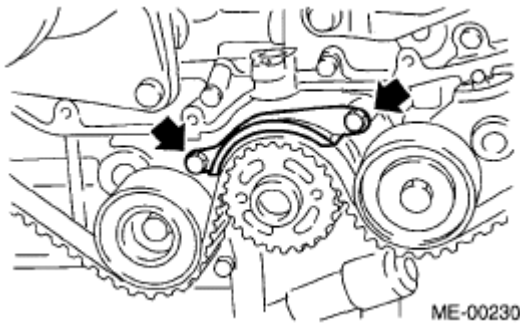


Fig. 93: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Check and adjust the clearance between timing belt and timing belt guide using a thickness gauge.

Clearance:

1.0 ± 0.5 mm (0.039 ± 0.020 in)

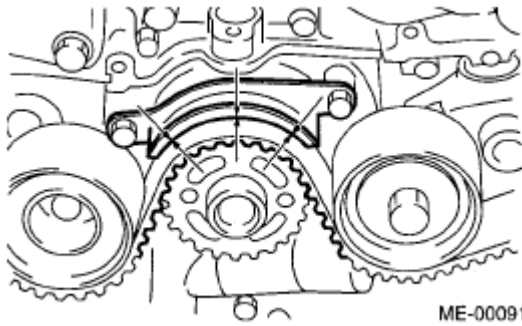


Fig. 94: Checking Clearance Between Timing Belt And Timing Belt Guide (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

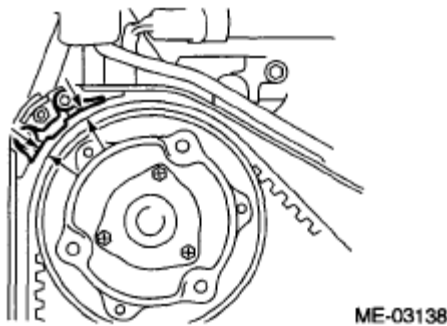


Fig. 95: Checking Clearance Between Timing Belt And Timing Belt Guide (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

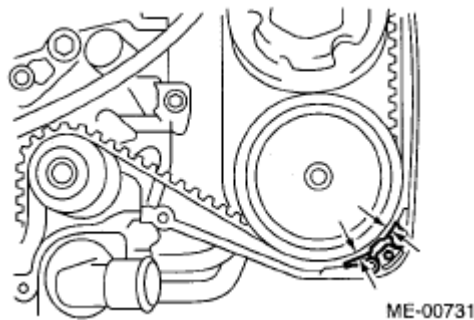


Fig. 96: Checking Clearance Between Timing Belt And Timing Belt Guide (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

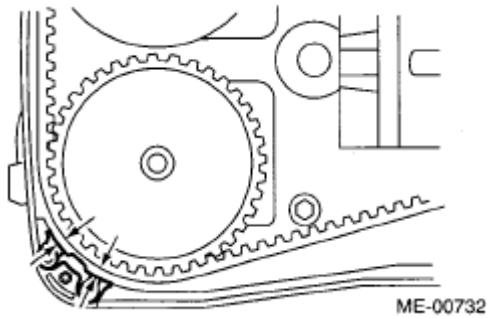


Fig. 97: Checking Clearance Between Timing Belt And Timing Belt Guide (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

Tightening torque:

9.75 N.m (1.0 kgf-m, 7.2 ft-lb)

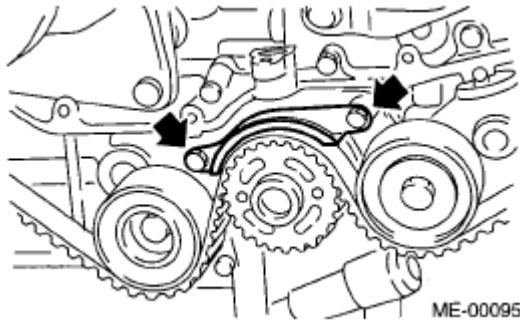


Fig. 98: Locating Timing Belt Guide Bolts (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

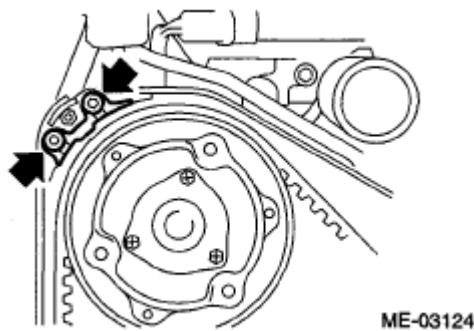


Fig. 99: Locating Timing Belt Guide Bolts (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

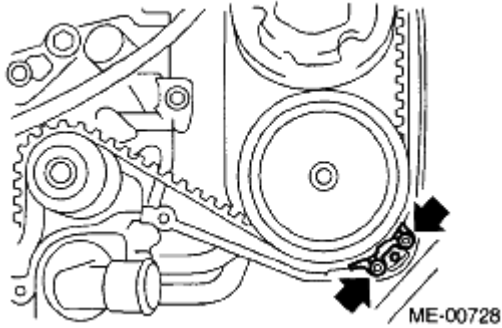
Tightening torque:**6.4 N.m (0.65 kgf-m, 4.7 ft-lb)**

Fig. 100: Locating Timing Belt Guide Bolts (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

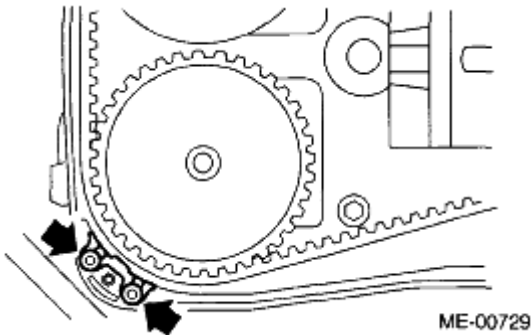
Tightening torque:**6.4 N.m (0.65 kgf-m, 4.7 ft-lb)**

Fig. 101: Locating Timing Belt Guide Bolts (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

12. Install the timing belt cover.
< Ref. to **INSTALLATION**, Timing Belt Cover.>
13. Install the crank pulley.
< Ref. to **INSTALLATION**, Crank Pulley.>
14. Install the V-belts. < Ref. to **INSTALLATION**, V-belt.>

INSPECTION**TIMING BELT**

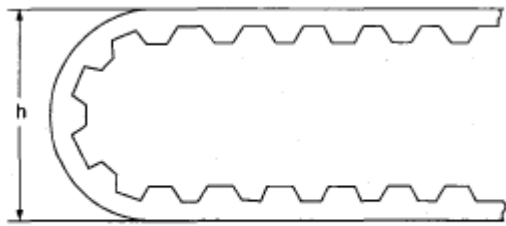
1. Check the timing belt teeth for breaks, cracks or wear. If any fault is found, replace the timing belt.
2. Check the condition on the back surface of the timing belt. If cracks are found, replace the timing belt.

CAUTION:

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

Bending diameter: h

60 mm (2.36 in) or more



ME-00099

Fig. 102: Inspecting Timing Belt Bending Diameter
Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

1. Visually check the oil seals for leaks, and rod ends for uneven wear and scratches. If necessary, replace the automatic belt tension adjuster assembly.

NOTE:

Slight traces of oil at rod's oil seal does not indicate a problem.

2. Check that the adjuster rod does not move when a pressure of 165 N (16.8 kgf, 37.1 lbf) is applied to it. This is to check the adjuster rod stiffness.
3. If the adjuster rod is not stiff and moves freely when applying 165 N (16.8 kgf, 37.1 lbf), check it using the following procedures:
 1. Slowly press the adjuster rod down to the end surface of cylinder. Repeat this operation two to three times.
 2. With the adjuster rod moved all the way up, apply a pressure of 165 N (16.8 kgf, 37.1 lbf) to it, and check the adjuster rod stiffness.
 3. If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new part.

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 three minutes or more.
 - Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lbf).
 - Press the adjuster rod to the end surface of the cylinder. However, do not press the adjuster rod below the end face of the cylinder. Doing so may damage the cylinder.
4. Measure the rod protrusion amount "H" from the body edge. If it is not within specifications, replace with new part.

Amount of rod protrusion: H

5.2 - 6.2 mm (0.204 - 0.244 in)

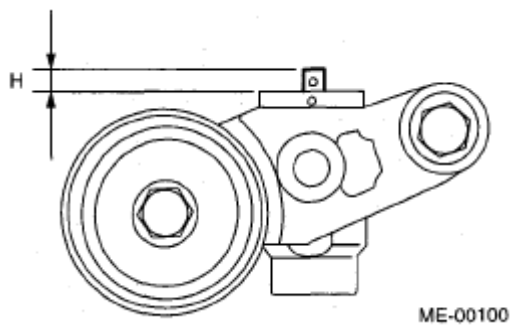


Fig. 103: Identifying Amount Of Rod Protrusion
Courtesy of SUBARU OF AMERICA, INC.

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 tensioner adjuster assembly if faulty.
2. Check the belt tension pulley for smooth rotation. Replace if noise or excessive play occurs.
3. Check the belt tension pulley for grease leakage.

BELT IDLER

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

CAM SPROCKET

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part.

1. Remove the V-belts. < Ref. to **REMOVAL**, V-belt.>
2. Remove the crank pulley.

< Ref. to **REMOVAL**, Crank Pulleys.>
3. Remove the timing belt cover.

< Ref. to **REMOVAL**, Timing Belt Cover.>
4. Remove the timing belt.

< Ref. to **REMOVAL**, Timing Belt.>
5. Remove the actuator cover of the intake cam sprocket.
6. Fasten the cam sprocket and remove from the cam shaft using ST.

ST 499207400 CAM SPROCKET WRENCH

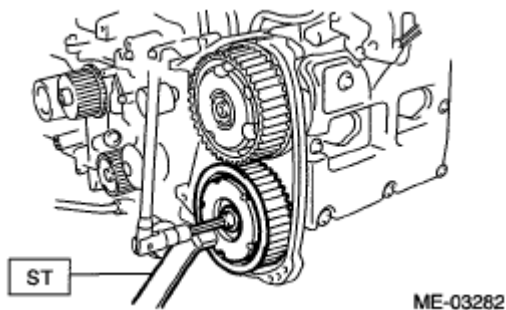


Fig. 104: Removing/Installing Cam Sprocket Using ST 499207400
Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH

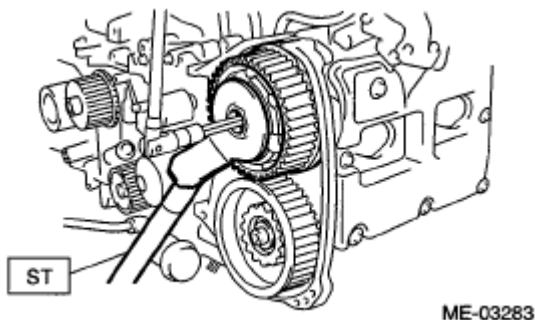


Fig. 105: Removing/Installing Cam Sprocket Using ST 499977500
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Fasten the cam sprocket and install to the cam shaft using ST.

NOTE: Do not confuse left and right side cam sprockets during installation.

ST 499207400 CAM SPROCKET WRENCH

Tightening torque:

Tighten to 30 N.m (3,1 kgf-m, 22.1 ft-lb) of torque, and then tighten further by 45°.

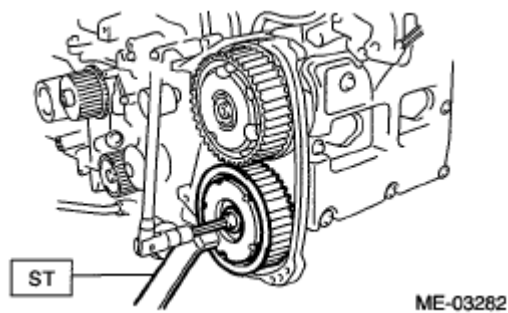


Fig. 106: Removing/Installing Cam Sprocket Using ST
Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH

Tightening torque:

Tighten to 30 N.m (3.1 kgf-m, 22.1 ft-lb) of torque, and then tighten further by 45°.

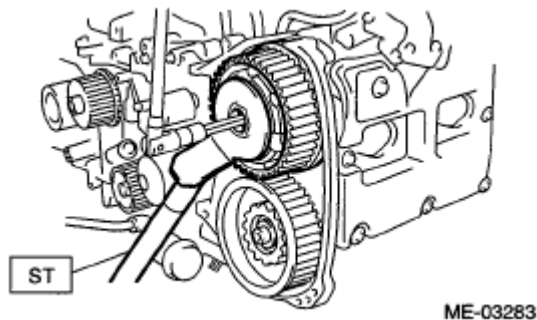


Fig. 107: Removing/Installing Cam Sprocket Using ST 499977500
Courtesy of SUBARU OF AMERICA, INC.

2. Attach the actuator cover of the intake cam sprocket.

NOTE: Use new O-rings.

Tightening torque:***3.4 N.m (0.3 kgf-m, 2.5 ft-lb)***

3. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt.>
4. Install the timing belt cover.

< Ref. to **INSTALLATION**, Timing Belt Cover.>
5. Install the crank pulley.

< Ref. to **INSTALLATION**, Crank Pulley.>
6. Install the V-belts. < Ref. to **INSTALLATION**, V-belt.>

INSPECTION

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

CRANK SPROCKET**REMOVAL**

NOTE: Perform the work with the engine installed to body when replacing a single part.

1. Remove the V-belts. < Ref. to **REMOVAL**, V-belt.>
2. Remove the crank pulley.

< Ref. to **REMOVAL**, Crank Pulleys.>
3. Remove the timing belt cover.

< Ref. to **REMOVAL**, Timing Belt Cover.>
4. Remove the timing belt.

< Ref. to **REMOVAL**, Timing Belt.>
5. Remove the crank sprocket.

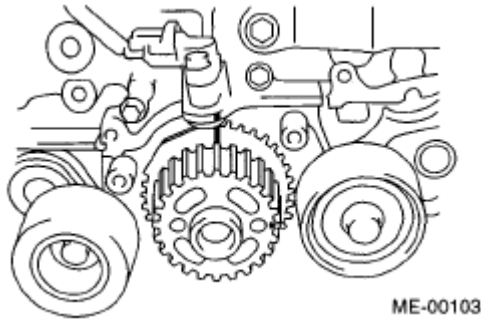


Fig. 108: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

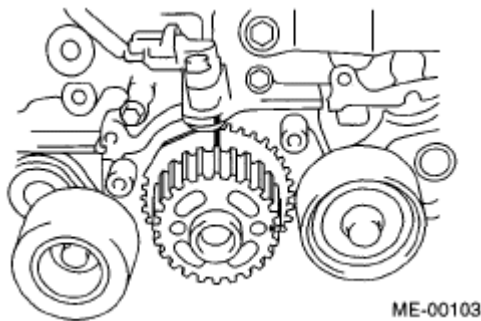


Fig. 109: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing belt.
< Ref. to **INSTALLATION**, Timing Belt.>
3. Install the timing belt cover.
< Ref. to **INSTALLATION**, Timing Belt Cover.>
4. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley.>
5. Install the V-belts. < Ref. to **INSTALLATION**, V-belt.>

INSPECTION

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

CAMSHAFT

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. Refer to "Valve Clearance" for preparation. < Ref. to INSPECTION, Valve Clearance.>

1. Remove the V-belts. < Ref. to REMOVAL, V-belt.>
 2. Remove the crank pulley. < Ref. to REMOVAL, Crank Pulley.>
 3. Remove the timing belt cover.
- < Ref. to REMOVAL, Timing Belt Cover.>
4. Remove the timing belt. < Ref. to REMOVAL, Timing Belt.>
 5. Remove the cam sprocket. < Ref. to REMOVAL, Cam Sprocket.>
 6. Disconnect the oil flow control solenoid valve assembly connector.

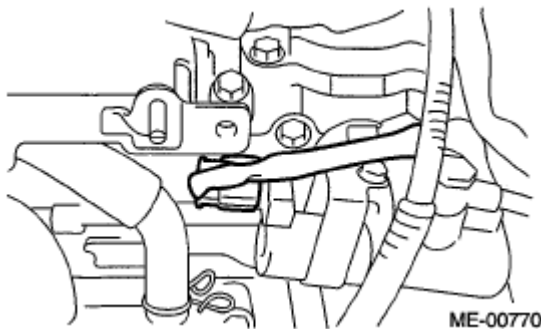


Fig. 110: Identifying Oil Flow Control Solenoid Valve Assembly Connector
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the timing belt cover No. 2 (LH).

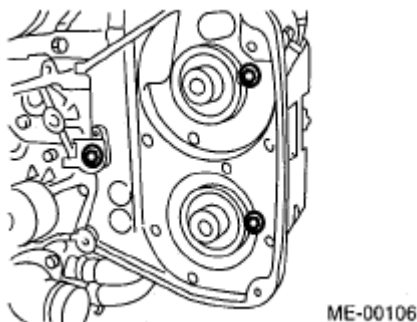


Fig. 111: Identifying Timing Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt cover No. 2 (RH).

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

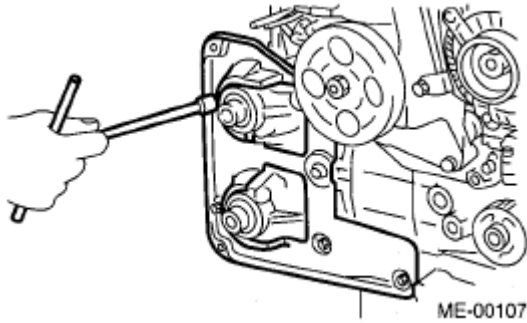


Fig. 112: Identifying Timing Belt Cover Bolts (RH)
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the tensioner bracket.

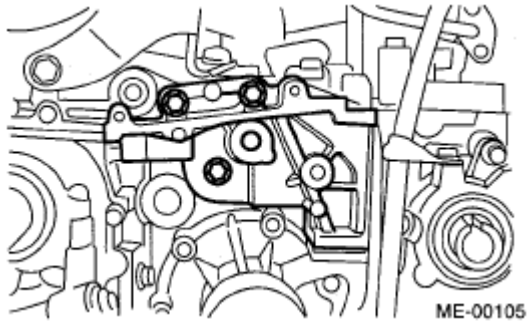
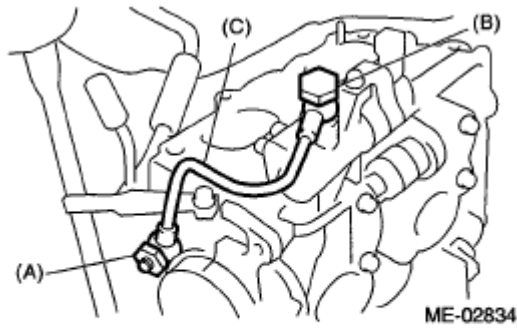


Fig. 113: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the ignition coil.
11. Remove the rocker cover and gasket.
12. Remove the oil pipe.



- (A) Union screw with filter (with protrusion)
- (B) Union screw without filter (without protrusion)
- (C) Oil pipe

Fig. 114: Identifying Union Screw With Filter
Courtesy of SUBARU OF AMERICA, INC.

13. Loosen the oil flow control solenoid valve assembly and intake camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the illustration.

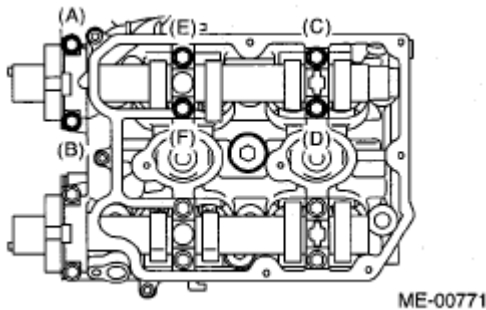


Fig. 115: Identifying Intake Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

14. Loosen the exhaust camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the illustration.

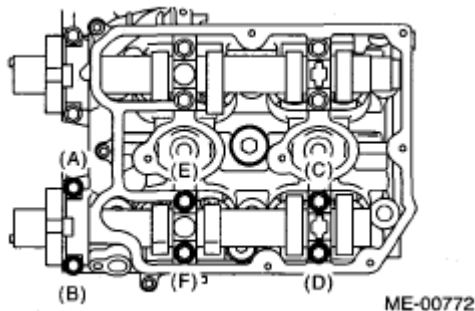


Fig. 116: Identifying Exhaust Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the oil flow control solenoid valve assembly, intake camshaft cap and camshaft.
16. Remove the exhaust camshaft caps and camshaft.

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

17. Remove the oil seal.

CAUTION: Do not scratch the journal surface when removing the oil seal.

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

INSTALLATION

1. Install the camshaft.

Apply engine oil to the cylinder head at camshaft journal installation location before installing the camshaft. Install the camshaft so that each valve is close to or in contact with base circle of the cam.

NOTE:

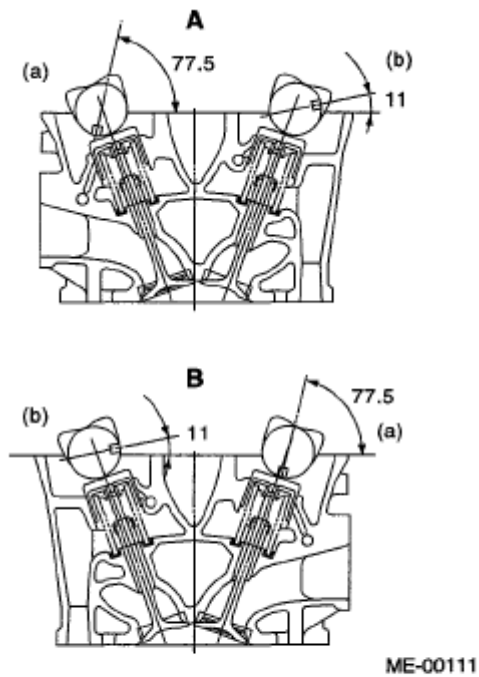
- **Set the cam shaft to the position shown in the illustration.**
- **When set at the position shown in the illustration, it is not necessary to rotate the camshaft (RH) when installing the timing belt, but it is necessary to rotate the camshaft (LH) slightly.**

Intake camshaft (LH):

Rotate 80° clockwise.

Exhaust camshaft (LH):

Rotate 45° counterclockwise.



- A Cylinder head (LH)
 B Cylinder head (RH)
 (a) Intake camshaft
 (b) Exhaust camshaft

Fig. 117: Identifying Cam Shaft Positions
 Courtesy of SUBARU OF AMERICA, INC.

2. Install the camshaft cap and oil flow control solenoid valve assembly.
 1. Apply small amount of liquid gasket to the mating surface of cap.

NOTE:

- Install within 5 min. after applying liquid gasket.
- Do not apply liquid gasket excessively. Applying excessively may cause excess gasket to come out and flow toward oil seal, resulting in oil leak.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

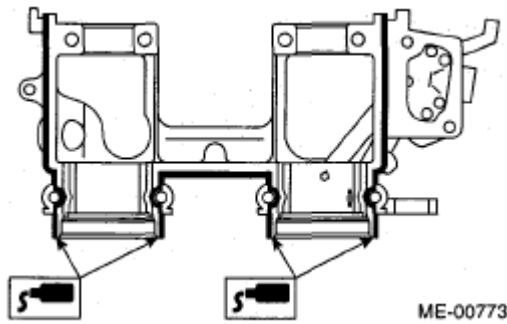


Fig. 118: Applying Liquid Gasket To Cap Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

2. Apply a thin coat of engine oil to cap bearing surface, and install the cap to the camshaft.
3. Gradually tighten the camshaft cap and oil control valve assembly in at least two stages in alphabetical sequence shown in the illustration, and then tighten to specified torque.

Tightening torque:

T1: 9.75 N.m (1.0 kgf-m, 7.2 ft-lb)

T2: 20 N.m (2.0 kgf-m, 14.8 ft-lb)

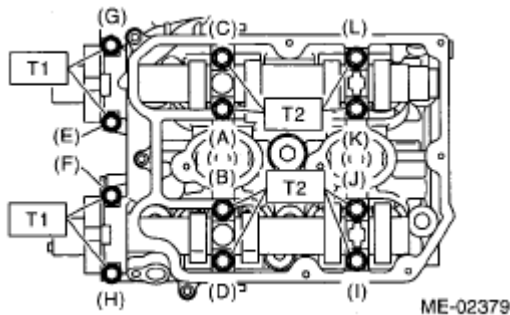


Fig. 119: Identifying Camshaft Bearing Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. After tightening the camshaft cap, ensure the camshaft rotates only slightly while holding it at base circle.
3. Apply a coat of engine oil to the camshaft oil seal periphery and oil seal lips, then install the oil seal on the camshaft using ST1 and ST2.

NOTE: Use a new oil seal.

ST1 499587600 OIL SEAL INSTALLER

ST2 499597200 OIL SEAL GUIDE

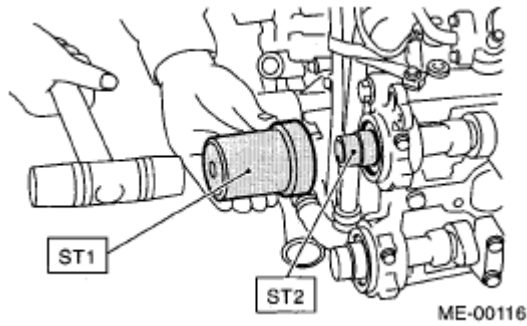


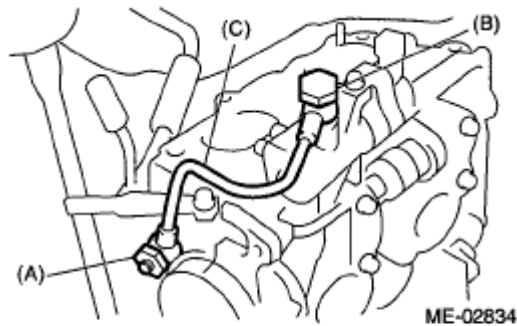
Fig. 120: Identifying Oil Seal Guide ST1499587600 And Oil Seal Guide ST2 499597200
 Courtesy of SUBARU OF AMERICA, INC.

4. Install the oil pipe.

NOTE: Make sure not to mix up the union screws with filter and without filter as their installation positions are different.

Tightening torque:

29 N.m (3.0 kgf-m, 21.4 ft-lb)



- (A) Union screw with filter (with protrusion)
- (B) Union screw without filter (without protrusion)
- (C) Oil pipe

Fig. 121: Installing Oil Pipe
 Courtesy of SUBARU OF AMERICA, INC.

5. Connect the oil flow control solenoid valve connector.

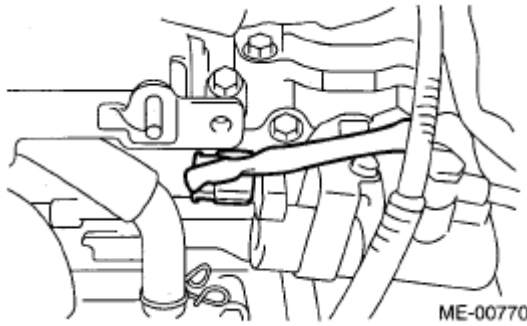


Fig. 122: Identifying Oil Flow Control Solenoid Valve Assembly Connector
Courtesy of SUBARU OF AMERICA, INC.

6. Similarly, install the parts on right-hand side.
7. Install the tensioner bracket.

Tightening torque:

24.5 N.m (2.5 kgf-m, 18.1 ft-lb)

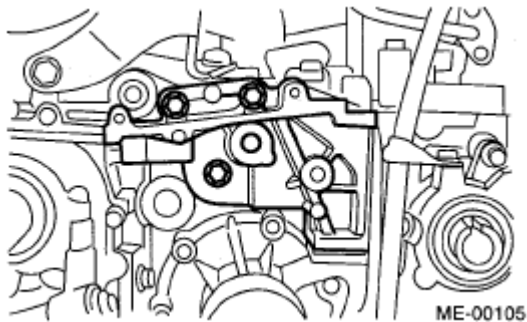


Fig. 123: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)

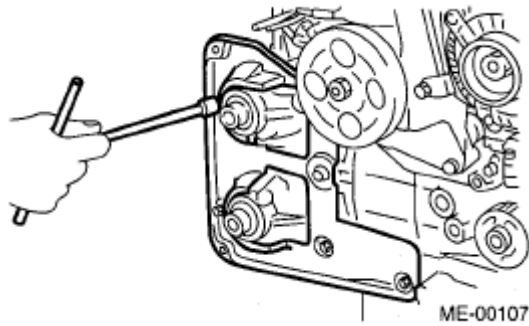


Fig. 124: Identifying Timing Belt Cover Bolts (RH)
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)

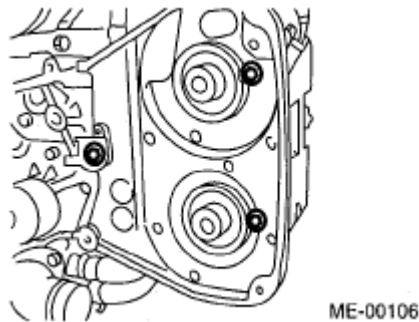


Fig. 125: Identifying Timing Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

10. Install the cam sprocket.

< Ref. to **INSTALLATION**, Cam Sprockets.>

11. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt.>

12. Adjust the valve clearance. < Ref. to **ADJUSTMENT**, Valve Clearances.>

13. Install the rocker cover.

1. Install the rocker cover gasket to the rocker cover.

NOTE: Use a new gasket.

2. Apply liquid gasket to the specified point of the cylinder head. Apply extra amount of liquid gasket around plugs 5 mm (0.2 in) or more.

NOTE: Install within 5 min. after applying liquid gasket.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

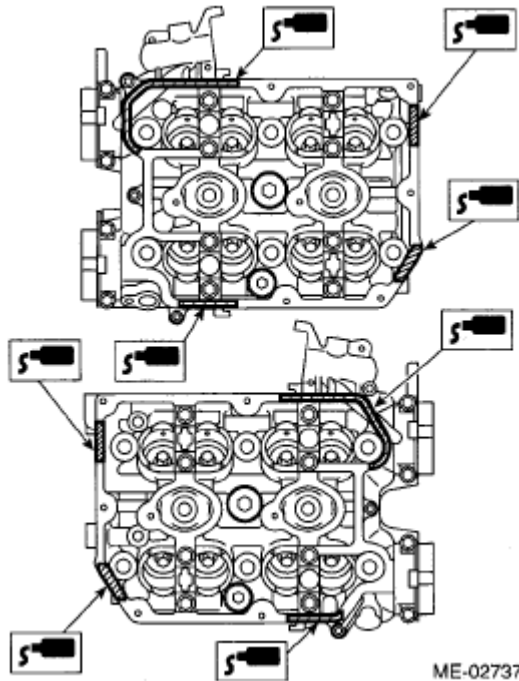


Fig. 126: Applying Liquid Gasket To Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover on cylinder head. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover tightening bolts in alphabetical sequence shown in the illustration, and then tighten to specified torque in alphabetical sequence.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

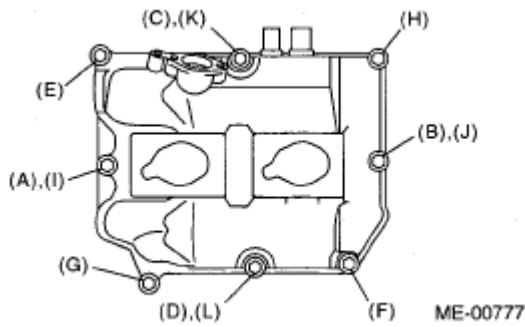


Fig. 127: Identifying Rocker Cover Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Connect the PCV hose.
14. Tighten the ignition coil.
15. Install the timing belt cover.

< Ref. to **INSTALLATION**, Timing Belt Cover.>
16. Install the crank pulley.

< Ref. to **INSTALLATION**, Crank Pulley.>
17. Install the V-belts. < Ref. to **INSTALLATION**, V-belt>

INSPECTION

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

Service limit:

0.020 mm (0.0008 in)

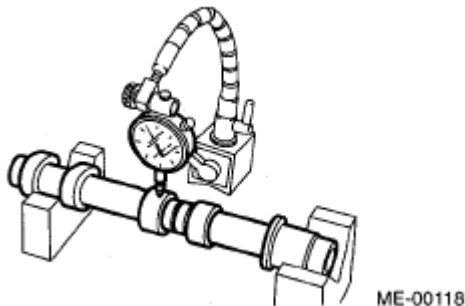


Fig. 128: Checking Camshaft
Courtesy of SUBARU OF AMERICA, INC.

2. Check the journal for damage and wear. place if faulty.

3. Check the cutout portion used for camshaft sensor for damage. Replace if faulty.
4. Measure the outside diameter of camshaft journal. If the journal diameter is not within the standard, check the oil clearance.

OUTSIDE DIAMETER OF CAMSHAFT JOURNAL

	Camshaft journal	
	Front	Center, rear
Standard	37.946 - 37.963 mm (1.4939 - 1.4946 in)	29.946 - 29.963 mm (1.1790 - 1.1796 in)

5. Measurement of the camshaft journal oil clearance
 1. Clean the bearing caps and camshaft journals.
 2. Place the camshafts on cylinder head. (Without installing the valve lifter.)
 3. Place a plastigauge across each camshaft journals.
 4. Gradually tighten the cap in at least two stages in alphabetical sequence shown in the illustration, and then tighten to specified torque. Do not turn the camshaft.

Tightening torque:

T1: 9.75 N.m (1.0 kgf-m, 7.2 ft-lb)

T2: 20 N.m (2.0 kgf-m, 14.8 ft-lb)

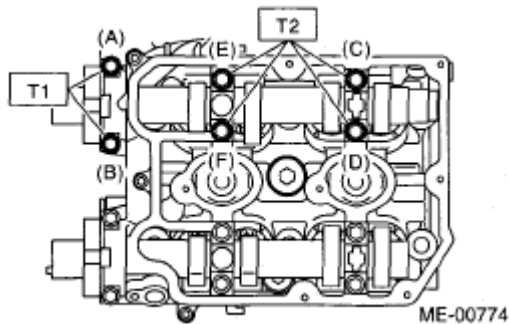


Fig. 129: Identifying Camshaft Bearing Caps Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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

Standard:

0.037 - 0.072 mm (0.0015 - 0.0028 in)

Service limit:

0.1 mm (0.0039 in)

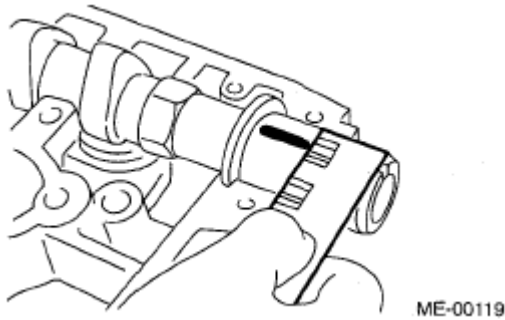


Fig. 130: Measuring Widest Point Of Plastigage
Courtesy of SUBARU OF AMERICA, INC.

7. Completely remove the plastigage.
6. Check the cam face condition; remove the minor faults by grinding with oil stone. Measure the cam height H. Replace if it exceeds the limit or there is uneven wear.

Cam height H:

Intake Standard

46.55 - 46.65 mm (1.833 - 1.837 in)

Limit

46.45 mm (1.829 in)

Exhaust Standard

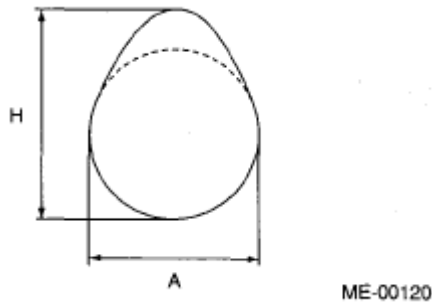
46.75 - 46.85 mm (1.841 - 1.844 in)

Limit

46.65 mm (1.837 in)

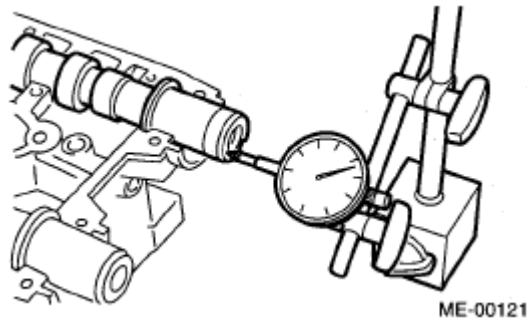
Cam base circle diameter A:

37.0 mm (1.457 in)

**Fig. 131: Checking Cam Height**

Courtesy of SUBARU OF AMERICA, INC.

7. Measure the thrust clearance of camshaft with setting the dial gauge at end of camshaft. If the thrust clearance exceeds the limit, replace the caps and cylinder head as a set. If necessary replace the camshaft.

Standard:**0.068 - 0.116 mm (0.0027 - 0.0046 in)****Service limit:****0.14 mm (0.0055 in)****Fig. 132: Measuring Thrust Clearance Of Camshaft**

Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD**REMOVAL**

NOTE: Perform the work with the engine installed to body when replacing a single part. Refer to "Valve Clearance" for preparation. < Ref. to INSPECTION, Valve Clearance.>

1. Remove the V-belts. < Ref. to REMOVAL, V-belt.>
2. Remove the crank pulley.

< Ref. to **REMOVAL**, Crank Pulleys.>

3. Remove the timing belt cover.

< Ref. to **REMOVAL**, Timing Belt Cover.>

4. Remove the timing belt.

< Ref. to **REMOVAL**, Timing Belt.>

5. Remove the cam sprocket.

< Ref. to **REMOVAL**, Cam Sprocket.>

6. Remove the intake manifold.

< Ref. to **REMOVAL** , Intake Manifold .>

7. Remove the bolt which installs the A/C compressor bracket on cylinder head.

8. Remove the camshaft. < Ref. to **REMOVAL**, Camshafts.>

9. Remove the oil level gauge guide. (LH side)

10. Remove the cylinder head bolts in alphabetical sequence shown in the illustration.

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

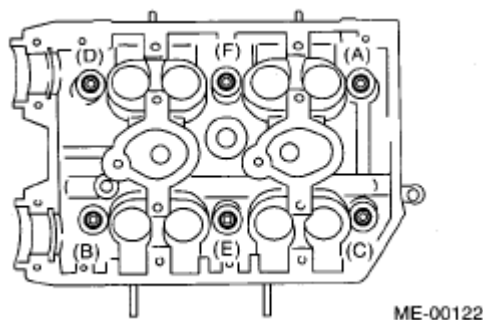


Fig. 133: Identifying Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

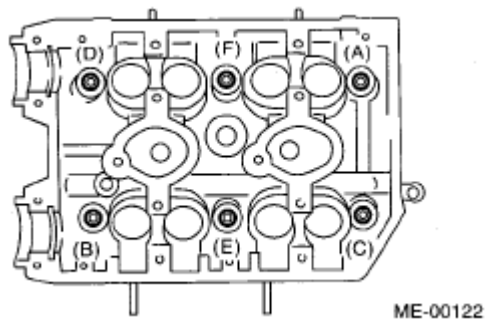


Fig. 134: Identifying Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the cylinder head gasket.

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

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

INSTALLATION

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

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

NOTE: Use new cylinder head gaskets.

2. Tighten the cylinder head bolts.
 1. Apply a thin coat of engine oil to washer and bolt thread.
 2. Tighten all bolts to 29 N.m (3.0 kgf-m, 21.4 ft-lb) in alphabetical order.
 3. Further tighten all bolts to 69 N.m (7.0 kgf-m, 50.9 ft-lb) in alphabetical order.
 4. Loosen all the bolts by 180° in the reverse order of tightening, and loosen again by 180°.
 5. Tighten all bolts to 49 N.m (5.0 kgf-m, 36.1 ft-lb) in alphabetical sequence.
 6. Tighten all bolts by 80 to 90° in alphabetical sequence.
 7. Tighten all bolts by 40 to 45° in alphabetical sequence.

CAUTION: The tightening angle of the bolt should not exceed 45°.

8. Further tighten the bolts (A) and (B) by 40 to 45°.

CAUTION: Make sure the total "re-tightening angle" of the step (7) and (8) does not exceed 90°.

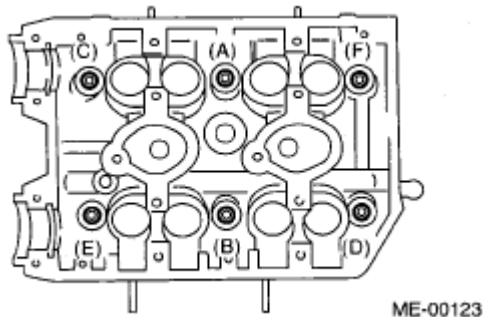


Fig. 135: Identifying Cylinder Head Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Install the oil level gauge guide. (LH side)

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

4. Install the camshaft. < Ref. to **INSTALLATION**, Camshaft.>
5. Install the bolt of A/C compressor bracket to the cylinder head.

Tightening torque:

36 N.m (3.7 kgf-m, 26.6 ft-lb)

6. Install the intake manifold.

< Ref. to **INSTALLATION** , Intake Manifold .>

7. Install the cam sprocket.

< Ref. to **INSTALLATION**, Cam Sprocket.>

8. Install the timing belt.

< Ref. to **INSTALLATION**, Timing Belt.>

9. Adjust the valve clearance. < Ref. to **ADJUSTMENT**, Valve Clearance.>
10. Install the rocker cover.
 1. Install the rocker cover gasket to the rocker cover.

NOTE: Use a new gasket.

2. Apply liquid gasket to the specified point of the cylinder head. Apply extra amount of liquid gasket around plugs 5 mm (0.2 in) or more.

NOTE: Install within 5 min. after applying liquid gasket.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

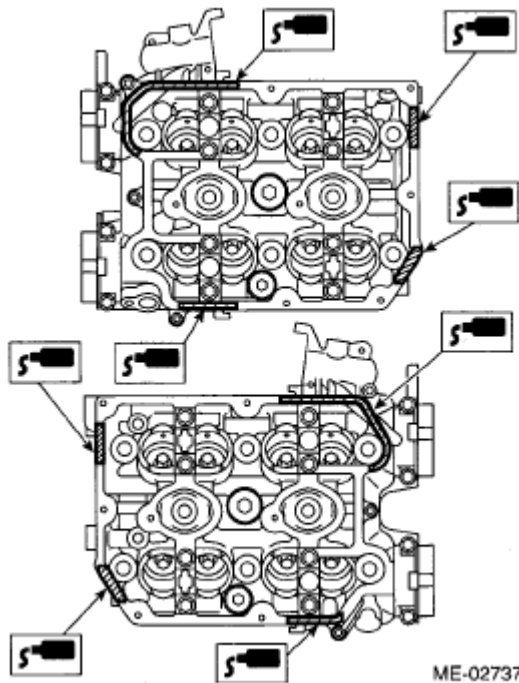


Fig. 136: Applying Liquid Gasket To Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover on cylinder head. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover tightening bolts in alphabetical sequence shown in the illustration, and then tighten to specified torque in alphabetical sequence.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

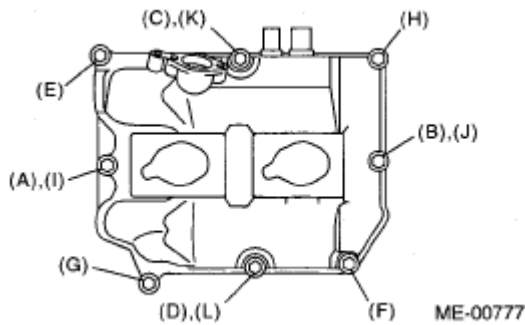


Fig. 137: Identifying Rocker Cover Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Connect the PCV hose.
11. Install the timing belt cover.
 < Ref. to **INSTALLATION**, Timing Belt Cover.>
12. Install the crank pulley.
 < Ref. to **INSTALLATION**, Crank Pulley.>
13. Install the V-belts. < Ref. to **INSTALLATION**, V-belt.>

DISASSEMBLY

1. Remove the valve lifter.
2. Place the cylinder head on ST1.

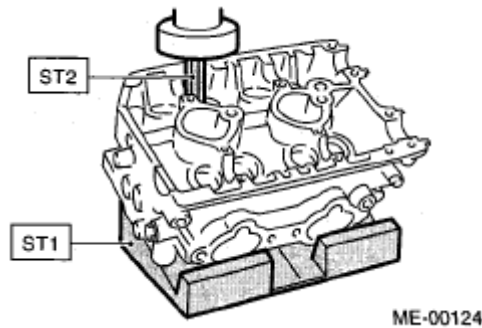
ST1 498267600 CYLINDER HEAD TABLE

3. Using ST2, compress the valve spring and remove the valve spring retainer key. Remove each valve and valve spring.

ST2 499718000 VALVE SPRING REMOVER

NOTE:

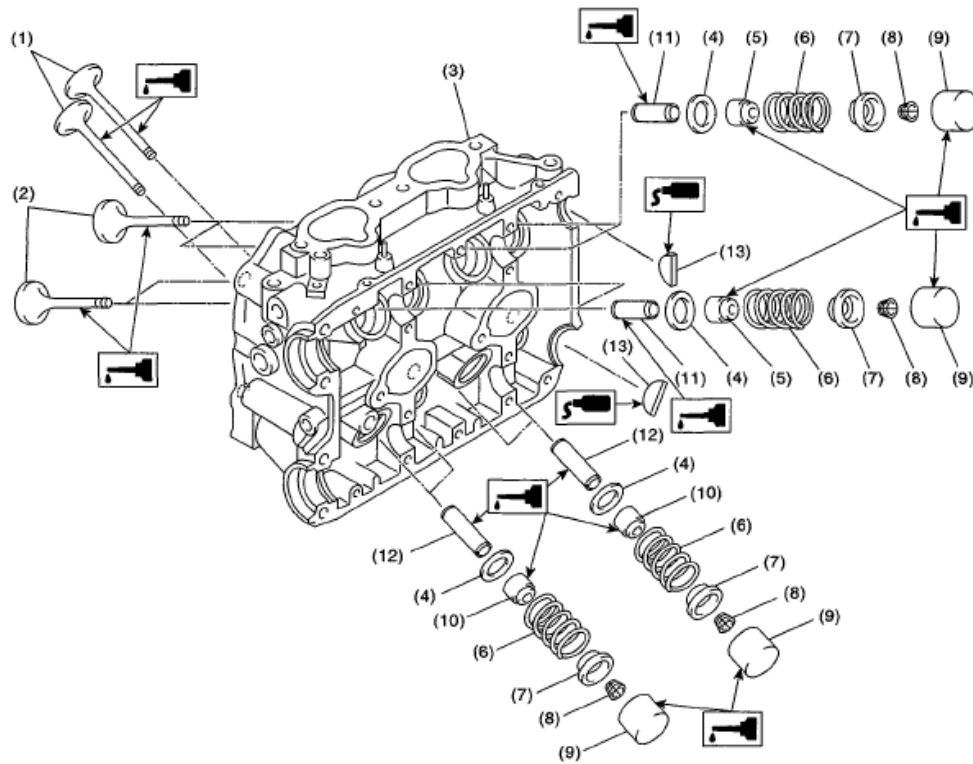
- Mark each valve to prevent confusion.
- Pay careful attention not to damage the lips of intake valve oil seals and exhaust valve oil seals.
- Keep all the removed parts in order for re-installing in their original positions.



ME-00124

Fig. 138: Identifying Cylinder Head Table ST1498267600 And Valve Spring Remover ST2 499718000
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



ME-03117

- | | | |
|---------------------------|------------------|-----------------------------|
| (1) Exhaust valve | (6) Valve spring | (10) Exhaust valve oil seal |
| (2) Intake valve | (7) Retainer | (11) Intake valve guide |
| (3) Cylinder head | (8) Retainer key | (12) Exhaust valve guide |
| (4) Valve spring seat | (9) Valve lifter | (13) Plug |
| (5) Intake valve oil seal | | |

Fig. 139: Identifying Cylinder Head Components
Courtesy of SUBARU OF AMERICA, INC.

1. Install the valve spring and valve.

1. Coat the stem of each valve with engine oil and insert the valve into valve guide.

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

2. Set the cylinder head on ST1.

ST1 498267600 CYLINDER HEAD TABLE

3. Install the valve spring and retainer.

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

4. Set the ST2 on valve spring.

ST2 499718000 VALVE SPRING REMOVER

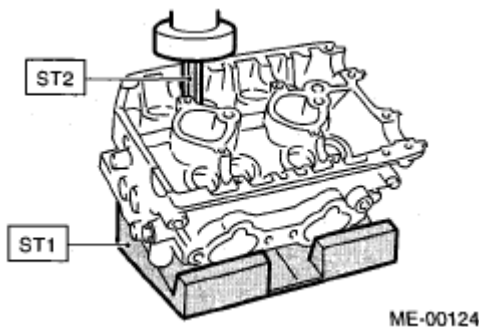


Fig. 140: Identifying Cylinder Head Table ST1498267600 And Valve Spring Remover ST2 499718000

Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

CYLINDER HEAD

1. Check for cracks or damage. Use liquid penetrant tester on the important sections to check for fissures. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2. Measure the warping of the cylinder head surface that mates with crankcase using a straight edge (A) and

thickness gauge (B).

If the warping exceeds 0.035 mm (0.0014 in), correct the surface by grinding it with a surface grinder.

Warping limit:

0.035 mm (0.0014 in)

Grinding limit:

0.3 mm (0.012 in)

Standard height of cylinder head:

127.5 mm (5.02 in)

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

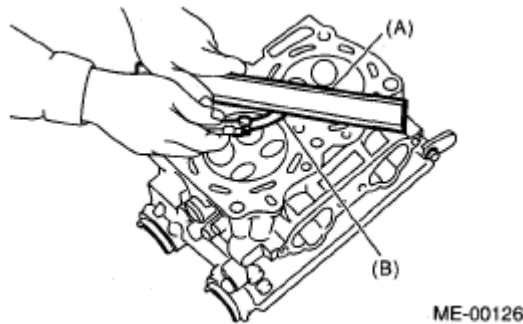


Fig. 141: Checking Cylinder Head Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Valve seat width W:

Intake Standard

0.6 - 1.4 mm (0.024 - 0.055 in)

Limit

1.7 mm (0.067 in)

Exhaust Standard

1.2 - 1.8 mm (0.047 - 0.071 in)

Limit

2.2 mm (0.087 in)

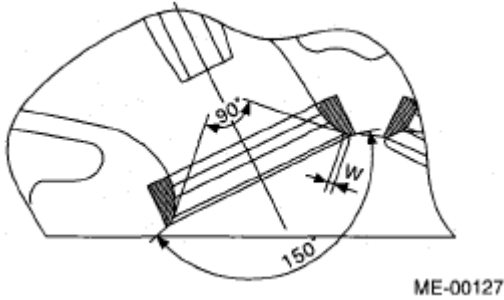


Fig. 142: Checking Valve Seat Width
Courtesy of SUBARU OF AMERICA, INC.

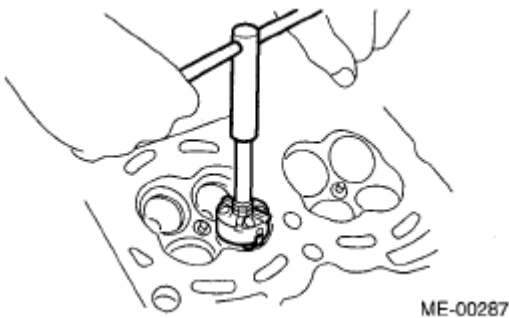


Fig. 143: Inspecting Intake And Exhaust Valve Seats
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

Clearance between the valve guide and valve stem:

Standard Intake

0.030 - 0.057 mm (0.0012 - 0.0022 in)

Exhaust

0.040 - 0.067 mm (0.0016 - 0.0026 in)

Limit

0.15 mm (0.0059 in)

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

Valve guide inner diameter:

6.000 - 6.012 mm (0.2362 - 0.2367 in)

Valve stem outer diameters:

Intake

5.955 - 5.970 mm (0.2344 - 0.2350 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 fit the holes in ST1.
2. Insert the ST2 into valve guide and press it down to remove the valve guide.

ST1 498267600 CYLINDER HEAD TABLE

ST2 499767200 VALVE GUIDE REMOVER

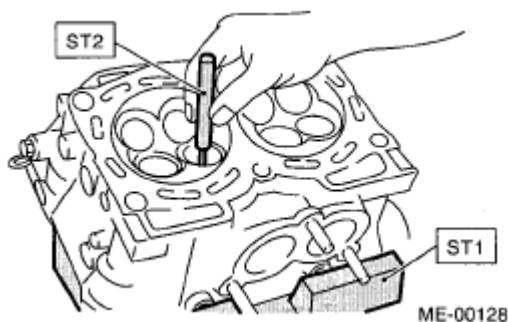


Fig. 144: Identifying Cylinder Head Table ST1498267600 And Valve Spring Remover ST2 499718000

Courtesy of SUBARU OF AMERICA, INC.

3. Turn the cylinder head upside down and place the ST as shown in the illustration.

ST 18251AA020 VALVE GUIDE ADJUSTER

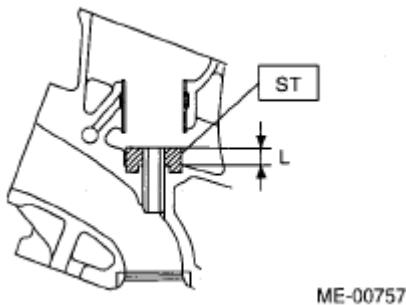


Fig. 145: Identifying Valve Guide Adjuster ST 18251AA020 On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

4. Before installing a new valve guide, make sure that neither scratches nor damages exist on the inner surface of valve guide holes in cylinder head.
5. Put a new valve guide, coated with sufficient oil, in cylinder, and insert the ST1 into valve guide. Press in until the valve guide upper end is flush with the upper surface of ST2.

ST1 499767200 VALVE GUIDE REMOVER

ST2 18251AA020 VALVE GUIDE ADJUSTER

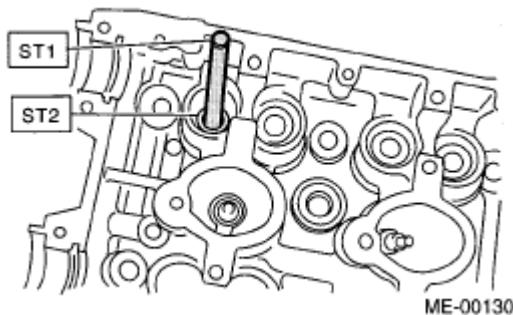


Fig. 146: Identifying Valve Guide Remover ST1 499767200 And Valve Guide Adjuster ST2 18251Aa020
Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion.

Valve guide protrusion L:

15.8 - 16.2 mm (0.622 - 0.638 in)

7. Ream the inside of valve guide using ST. Put the ST in valve guide, and rotate the ST slowly clockwise while pushing it lightly. Bring the ST back while rotating it clockwise.

NOTE:

- Apply engine oil to the ST when reaming.
- If the inner surface of valve guide is damaged, the edge of ST should be slightly ground with oil stone.
- If the inner surface of valve guide becomes lustrous and the ST does not chip, use a new ST or remedy the ST.

ST 499767400 VALVE GUIDE REAMER



Fig. 147: Reaming Inside Of Valve Guide Using ST
Courtesy of SUBARU OF AMERICA, INC.

8. After reaming, clean the valve guide to remove chips.
9. Recheck the contact condition between valve and valve seat after replacing the valve guide.

INTAKE AND EXHAUST VALVE

1. Inspect the flange and stem of valve, and replace if damaged, worn, or deformed. If "H" is less than the specified limit, replace with a new valve.

Head edge thickness H:

Intake (A)

Standard

1.0 - 1.4 mm (0.039 - 0.055 in)

Limit

0.8 mm (0.031 in)

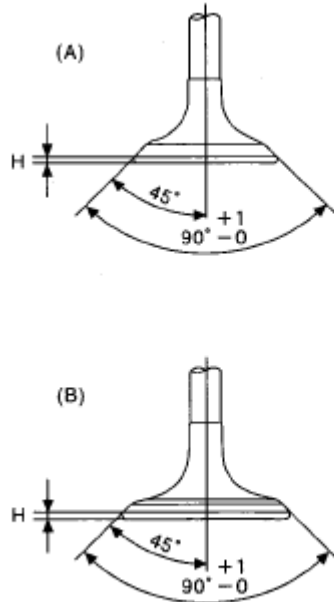
Exhaust (B)

Standard

1.3 - 7.7 mm (0.057-- 0.067 in)

Limit

0.8 mm (0.031 in)



ME-00758

Fig. 148: Identifying Valve Overall Length And Head Edge Thickness
 Courtesy of SUBARU OF AMERICA, INC.

- Put a small amount of grinding compound on the seat surface, and lap the valve and valve seat. Replace with a new valve oil seal after lapping.

NOTE: It is possible to differentiate between the intake valve and the exhaust valve by their overall length.

Valve overall length:

Intake (A)

104.4 mm (4.110 in)

Exhaust (B)

104.65 mm (4.120 in)

VALVE SPRING

- Check the valve springs for damage, free length, and spring constant. Replace the valve spring if it is not within the standard value presented in the table.
- To measure the squareness of the valve spring, stand the spring on a surface plate and measure its

deflection at the top of spring using a try square.

TENSION/SPRING HEIGHT SPECIFICATION

Free length	mm (in)	47.32 (1.863)
Tension/spring height N (kgf, lbf)/mm (in)	Set	205 - 235 (20.9 - 24.0, 46.1 - 52.8) / 36.0 (1.417)
	Lift	426 - 490 (43.4 - 50.0, 95.8 - 110) / 26.50 (1.041)
Squareness		2.5°, 2.1 mm (0.083 in) or less

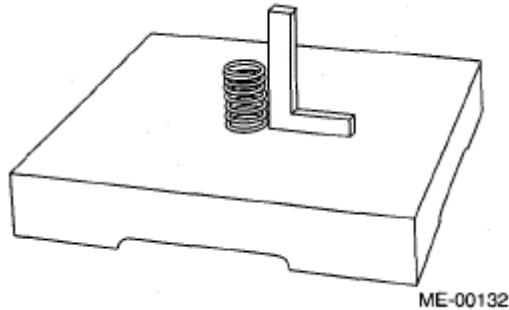


Fig. 149: Measuring Squareness Of Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

1. For the following, replace the oil seal with a new part.

See the procedure 2) and subsequent for replacement procedures.

- When the lip is damaged.
 - When the spring is out of the specified position.
 - When readjusting the surfaces of intake valve and valve sheet.
 - When replacing the intake valve guide.
2. Place the cylinder head on ST1.
 3. Using the ST2, press-fit the oil seal.

ST1 498267600 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

NOTE:

- Apply engine oil to oil seal before press-fitting.
- When press-fitting the oil seal, do not use a hammer or strike in.
- The intake valve oil seal and exhaust valve oil seal can be differentiated by colors.

Color of rubber part:

Intake [Gray]

Exhaust [Green]

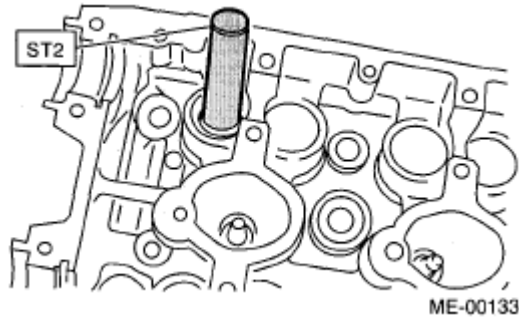


Fig. 150: Identifying Valve Oil Seal Guide ST2 498857100
Courtesy of SUBARU OF AMERICA, INC.

VALVE LIFTER

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

Outer diameter:

34.959 - 34.975 mm (1.3763 - 1.3770 in)

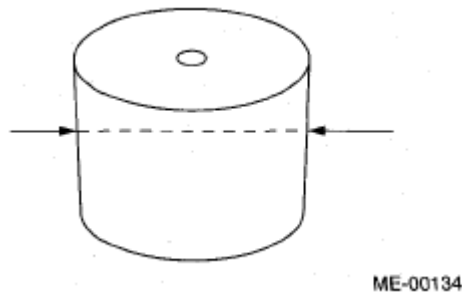


Fig. 151: Checking Outer Diameter Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

3. Measure the inner diameter of valve lifter mating surface on cylinder head.

Inner diameter:

34.994 - 35.016 mm (1.3777 - 1.3786 in)

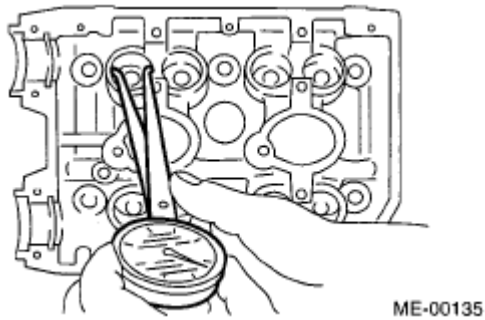


Fig. 152: Measuring Inner Diameter Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

NOTE: If difference between outer diameter of valve lifter and inner diameter of its mating surface exceeds the service limit or there is uneven wear, replace the cylinder head.

Standard:

0.019 - 0.057 mm (0.0007 - 0.0022 in)

Service limit:

0.100 mm (0.0039 in)

CYLINDER BLOCK

REMOVAL

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

1. Remove the intake manifold.
< Ref. to **REMOVAL** , Intake Manifold .>
2. Remove the V-belts. < Ref. to **REMOVAL**, V-belt.>
3. Remove the crank pulley.
< Ref. to **REMOVAL**, Crank Pulleys.>
4. Remove the timing belt cover.
< Ref. to **REMOVAL**, Timing Belt Covers.>
5. Remove the timing belt.

< Ref. to **REMOVAL**, Timing Belts.>

6. Remove the cam sprocket.

< Ref. to **REMOVAL**, Cam Sprockets.>

7. Remove the crank sprocket.

< Ref. to **REMOVAL**, Crank Sprockets.>

8. Remove the generator and A/C compressor with their brackets.
9. Remove the cylinder head.

< Ref. to **REMOVAL**, Cylinder Heads.>

10. Remove the clutch disc and cover. (MT model) < Ref. to **REMOVAL** , Clutch Disc and Cover .>
11. Remove the flywheel. (MT model) < Ref. to **REMOVAL** , Flywheel .>
12. Remove the drive plate. (AT model) Lock the crankshaft using ST.

ST 498497100 CRANKSHAFT STOPPER

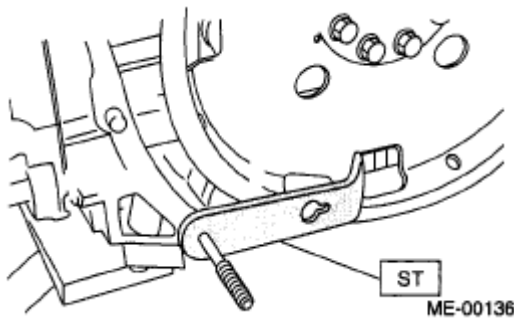


Fig. 153: Identifying Crankshaft Stopper ST498497100
 Courtesy of SUBARU OF AMERICA, INC.

13. Remove the oil separator cover.
14. Remove the water by-pass pipe for heater.
15. Remove the oil filter. < Ref. to **REMOVAL** , Engine Oil Filter .>
16. Remove the water pump. < Ref. to **REMOVAL** , Water Pump .>
17. Remove the bolts which install oil pump onto cylinder block.

NOTE: When disassembling and checking the oil pump, loosen the relief valve plug before removing the oil pump.

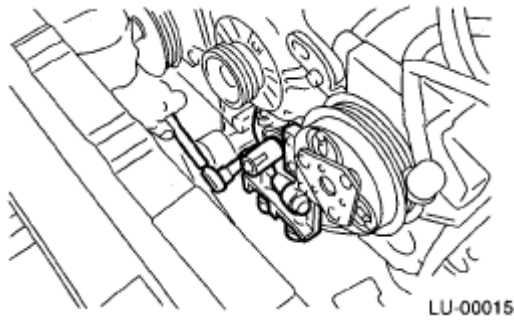


Fig. 154: Identifying Bolts

Courtesy of SUBARU OF AMERICA, INC.

18. Remove the oil pump from cylinder block using a flat tip screwdriver.

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

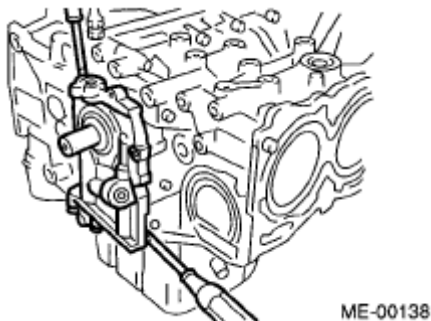


Fig. 155: Identifying Oil Pump From Cylinder Block

Courtesy of SUBARU OF AMERICA, INC.

19. Remove the front oil seal from the oil pump.
20. Remove the oil pan.
 1. Set the part so that the cylinder block (LH) is on the upper side.
 2. Remove the bolts which secure oil pan to cylinder block.
 3. Insert an oil pan cutter blade between cylinder block-to-oil pan clearance and remove the oil pan.

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

21. Remove the oil strainer stay.
22. Remove the oil strainer.
23. Remove the baffle plate.
24. Remove the water pipe.

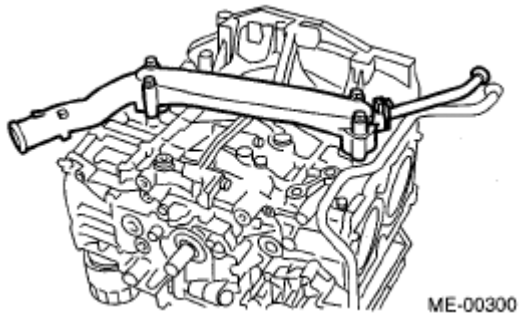
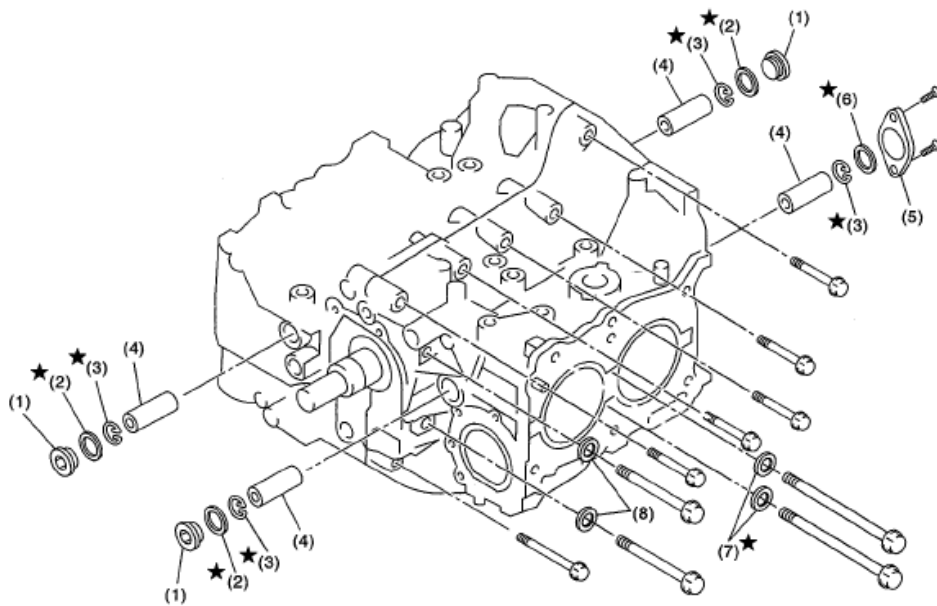


Fig. 156: Identifying Water Pipe
Courtesy of SUBARU OF AMERICA, INC.



- | | | |
|-----------------------|------------------------|-----------------|
| (1) Service hole plug | (4) Piston pin | (7) Seal washer |
| (2) Gasket | (5) Service hole cover | (8) Washer |
| (3) Snap ring | (6) O-ring | |

Fig. 157: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

25. Remove the service hole plugs using a hexagon wrench [14 mm].

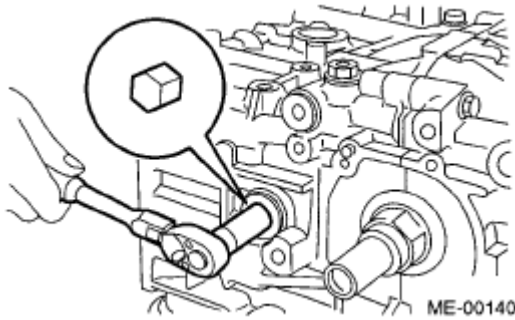


Fig. 158: Removing Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

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

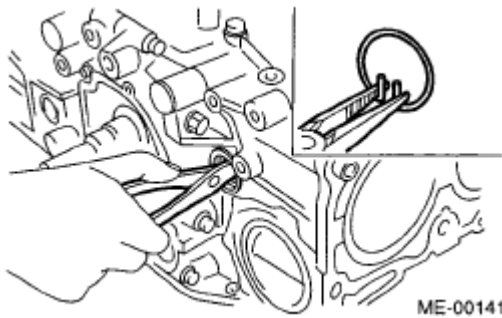


Fig. 159: Removing Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 499097700 PISTON PIN REMOVER

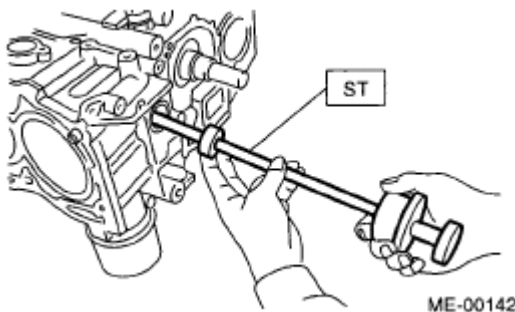


Fig. 160: Pulling Piston Pin From Pistons

Courtesy of SUBARU OF AMERICA, INC.

29. Similarly remove the piston pins from #3 and #4 pistons.
30. Remove the cylinder block connecting bolt on the RH side.
31. Loosen the cylinder block connecting bolt on the LH side by two or three turns.
32. Set the part so that the cylinder block (LH) is on the upper side, and remove the cylinder block connecting bolt.
33. Separate the cylinder block (LH) and (RH).

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

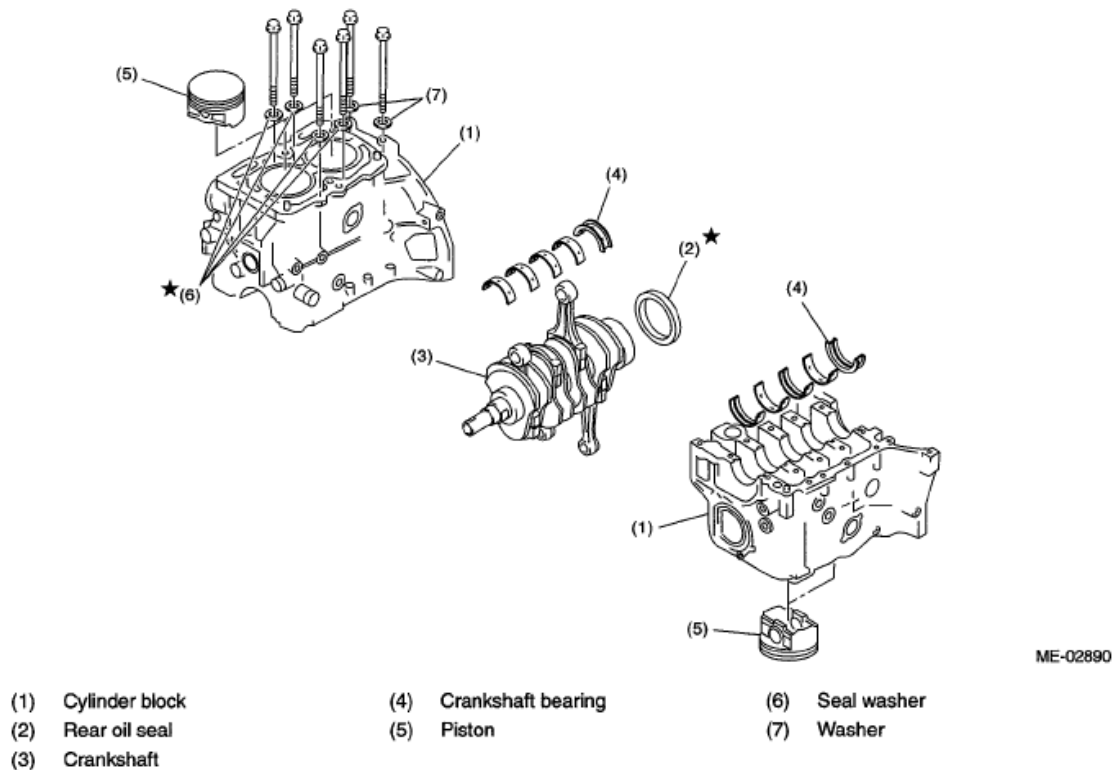


Fig. 161: Exploded View Of Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

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

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

37. Remove each piston from cylinder block using wooden bar or hammer handle.

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

INSTALLATION

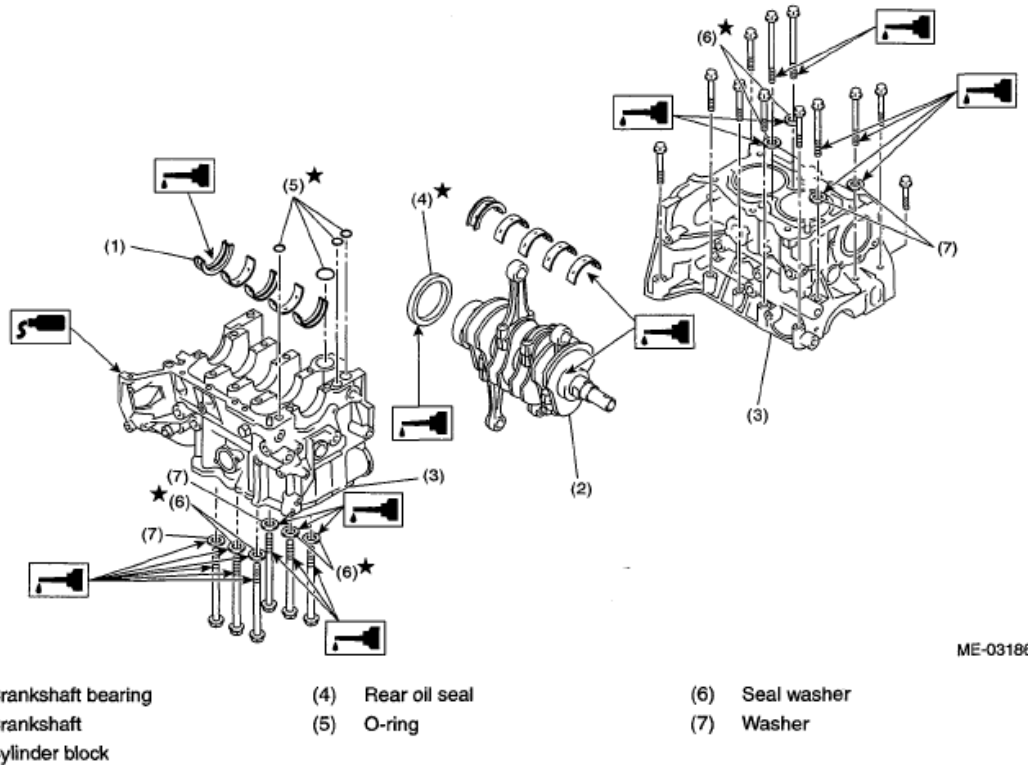


Fig. 162: Exploded View Of Cylinder Block Components

Courtesy of SUBARU OF AMERICA, INC.

1. Remove oil on the mating surface of cylinder block before installation. Apply a coat of engine oil to the bearing and crankshaft journal.
2. Position the crankshaft and O-ring on the cylinder block (RH).
3. Apply liquid gasket to the mating surfaces of cylinder block (RH), and position the cylinder block (LH).

NOTE:

- Install within 5 min. after applying liquid gasket.
- Do not allow liquid gasket to jut into O-ring grooves, oil passages, bearing grooves, etc.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

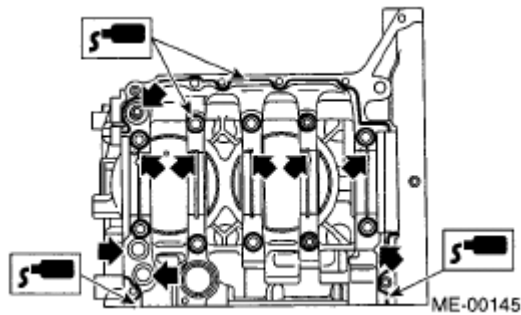


Fig. 163: Applying Liquid Gasket To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new seal washer.

5. Tighten the 10 mm cylinder block connecting bolts on the LH side (A - D) in alphabetical order.

Tightening torque:

10 N.m (1.0 kgf-m, 7.2 ft-lb)

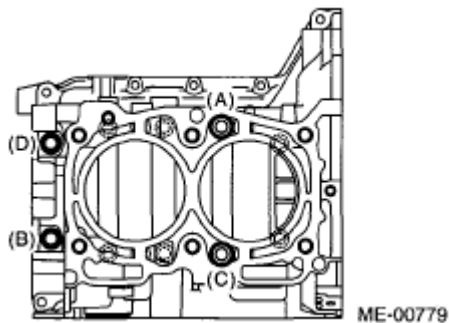


Fig. 164: Identifying Cylinder Block Bolts Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

6. Tighten the 10 mm cylinder block connecting bolts on the RH side (E - J) in alphabetical order.

Tightening torque:

10 N.m (1.0 kgf-m, 7.2 ft-lb)

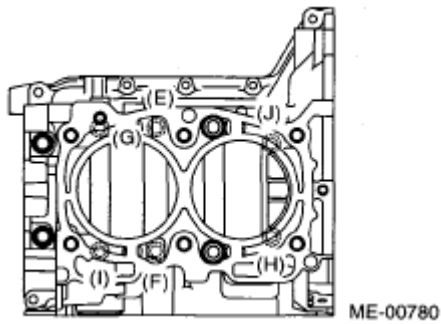


Fig. 165: Identifying Cylinder Block Bolts Tightening Sequence (RH Side)
 Courtesy of SUBARU OF AMERICA, INC.

7. Further tighten the cylinder block connecting bolts on the LH side (A - D) in alphabetical sequence.

Tightening torque:

18 N.m (1.8 kgf-m, 13.3 ft-lb)

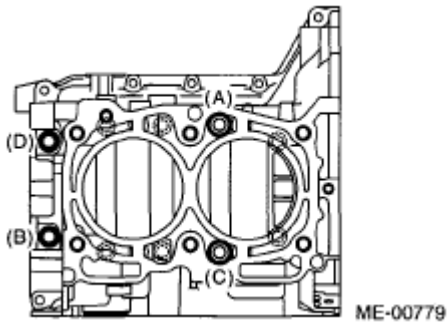


Fig. 166: Identifying Cylinder Block Bolts Tightening Sequence (LH Side)
 Courtesy of SUBARU OF AMERICA, INC.

8. Further tighten the cylinder block connecting bolts on the RH side (E - J) in alphabetical sequence.

Tightening torque:

18 N.m (1.8 kgf-m, 13.3 ft-lb)

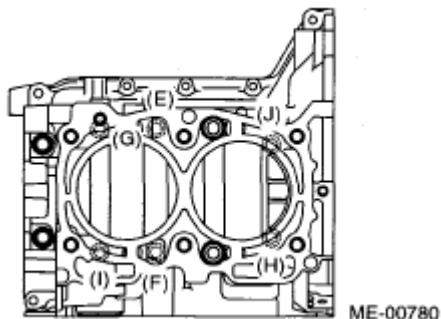


Fig. 167: Identifying Cylinder Block Bolts Tightening Sequence (RH Side)
 Courtesy of SUBARU OF AMERICA, INC.

9. Further tighten the cylinder block connecting bolts on the LH side (A - D) in alphabetical sequence.

- (A), (C): Angle tightening

Tightening angle:

90°

- (B), (D): Torque tightening

Tightening torque:

40 N.m (4.1 kgf-m, 29.6 ft-lb)

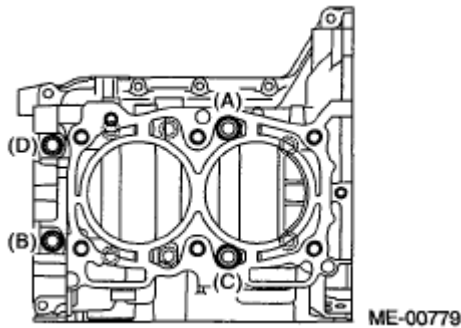


Fig. 168: Identifying Cylinder Block Connecting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle:

90°

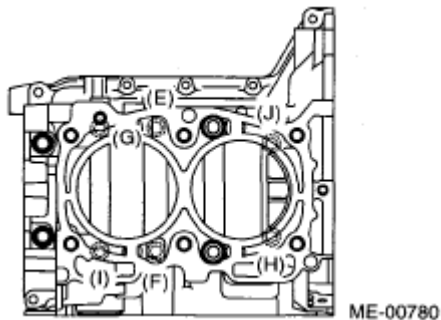


Fig. 169: Identifying Cylinder Block Bolts Tightening Sequence (RH Side)
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

(A) - (G): 25 N.m (2.5 kgf-m, 18.4 ft-lb)

(H): 6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

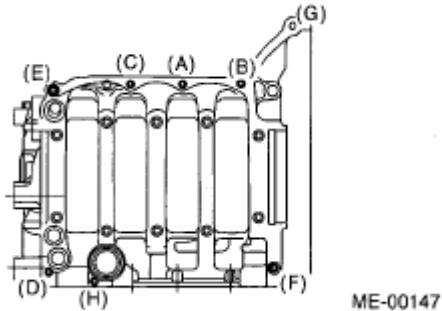


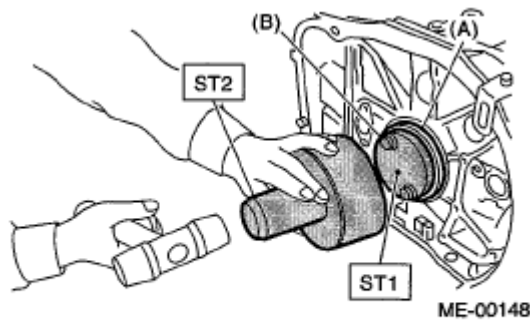
Fig. 170: Identifying Cylinder Block Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rear oil seal.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER



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

Fig. 171: Installing Rear Oil Seal Using ST1 And ST2
 Courtesy of SUBARU OF AMERICA, INC.

13. Position the top ring gap at (A) or (B) in the illustration.
14. Position the second ring gap at 180° on the reverse side the top ring gap.

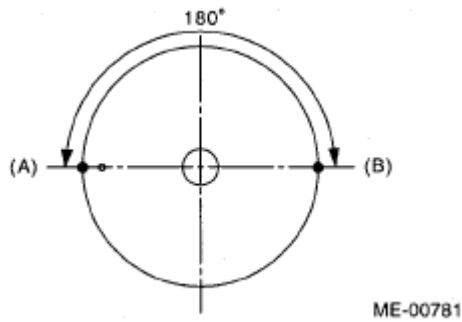


Fig. 172: Identifying Top Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

15. Position the upper rail gap at (C) in the illustration.

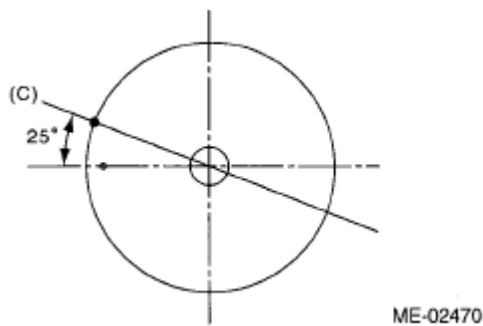


Fig. 173: Identifying Upper Rail Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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

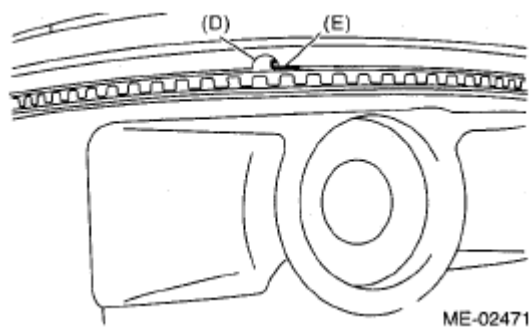


Fig. 174: Aligning Upper Rail Spin Stopper With Piston Side Surface Hole
Courtesy of SUBARU OF AMERICA, INC.

17. Position the expander gap at (F) in the illustration.

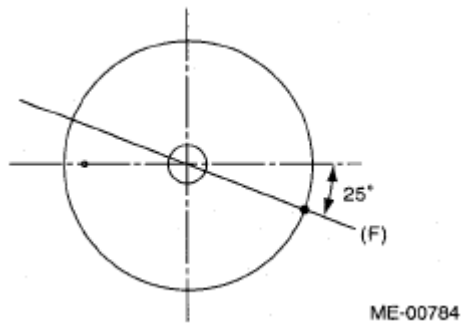


Fig. 175: Identifying Expander Gap Position
Courtesy of SUBARU OF AMERICA, INC.

18. Position the lower rail gap at (G) in the illustration.

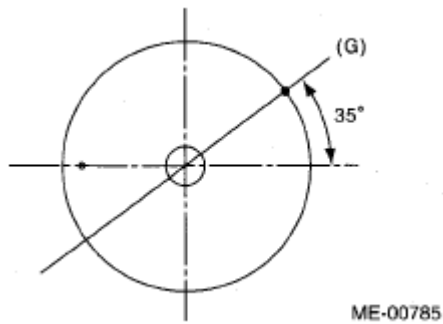


Fig. 176: Identifying Lower Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

NOTE:

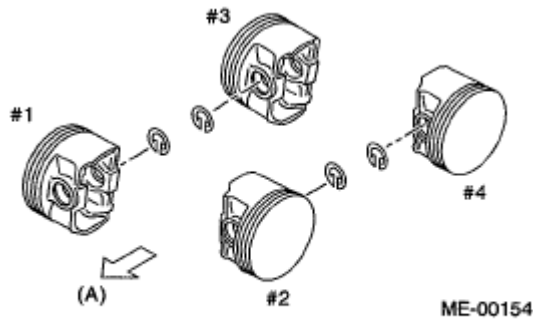
- Make sure the ring gaps do not face the same direction.
- Make sure ring gaps are not within the piston skirt area.

19. Install the snap ring.

Install the snap rings in the piston holes located opposite to the service holes in cylinder block before positioning pistons to the cylinder.

NOTE:

Use new snap rings.



(A) Front side

Fig. 177: Installing Snap Rings In Piston Holes
Courtesy of SUBARU OF AMERICA, INC.

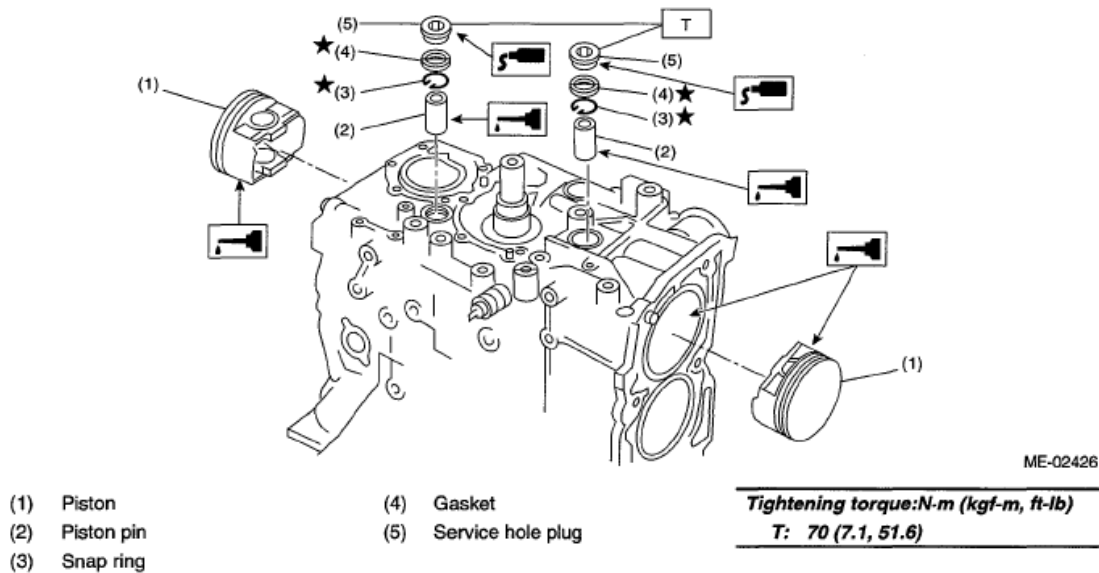


Fig. 178: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

20. Install piston.

1. Set the parts so that the #1 and #2 cylinders are on the upper side.
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 the pistons and cylinders and insert pistons in their cylinders using ST2.

ST2 498747300 PISTON GUIDE

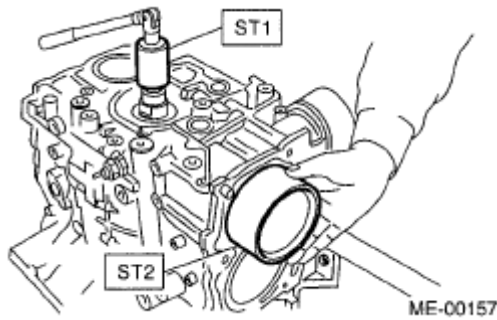
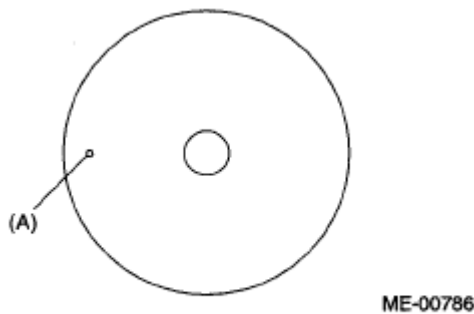


Fig. 179: Inserting Pistons In Cylinders Using Piston Guide ST2 498747300
 Courtesy of SUBARU OF AMERICA, INC.

NOTE: Face the piston front mark towards the front of the engine.



(A) Front mark

Fig. 180: Identifying Piston Front Mark
 Courtesy of SUBARU OF AMERICA, INC.

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

ST3 499017100 PISTON PIN GUIDE

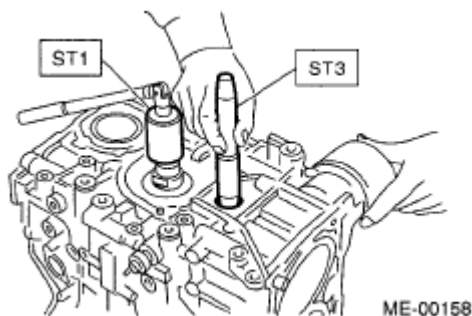


Fig. 181: Inserting ST3 Into Service Hole To Align Piston Pin Hole With Connecting Rod Small End

Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.

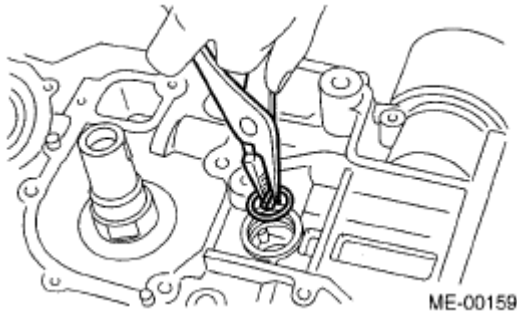


Fig. 182: Identifying Snap Ring

Courtesy of SUBARU OF AMERICA, INC.

5. Apply liquid gasket to the threaded portion of the service hole plug.

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

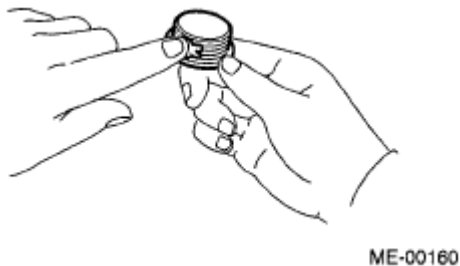


Fig. 183: Applying Fluid Packing Around Service Hole Plug

Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

NOTE: Use a new gasket.

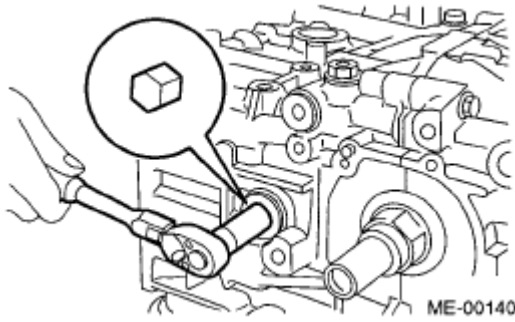


Fig. 184: Identifying Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

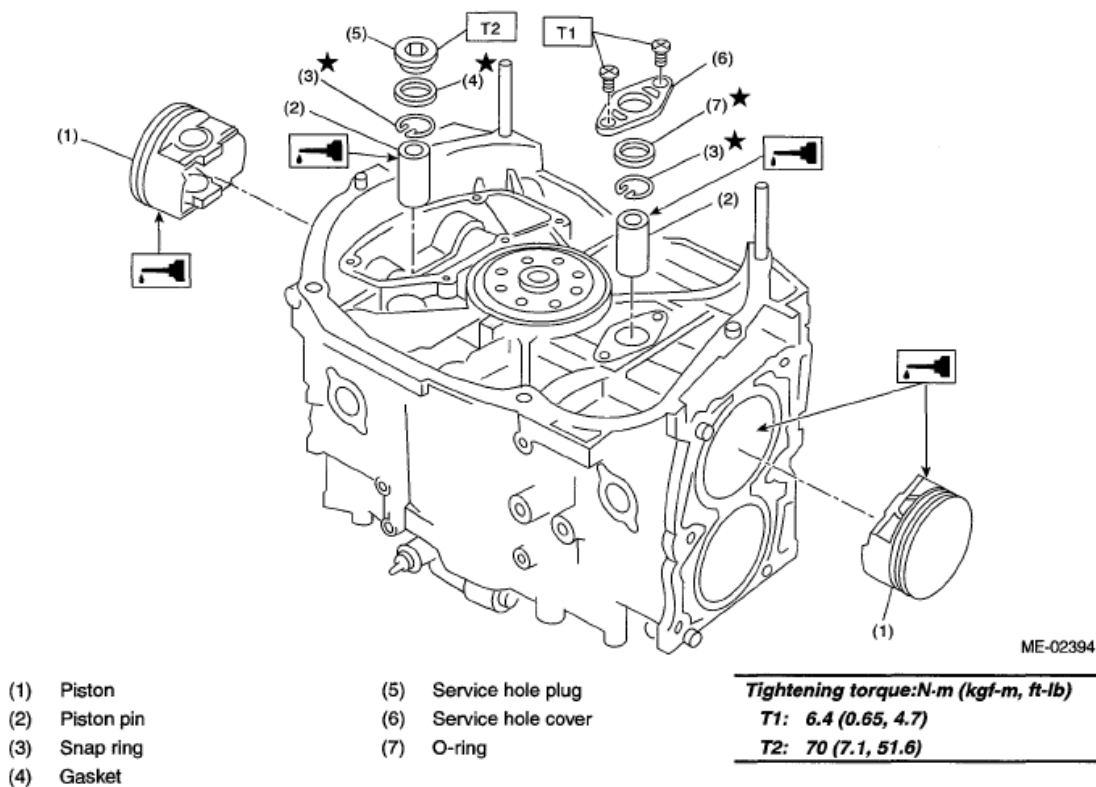


Fig. 185: Installing Service Hole Plug And Gasket
Courtesy of SUBARU OF AMERICA, INC.

7. Set the parts so that the #3 and #4 cylinders are on the upper side. Following the same procedures as used for #1 and #2 cylinders, install the pistons and piston pins.
22. Install the service hole cover.

NOTE: Use new O-rings.

23. Install the water pipe.

NOTE: Use new O-rings.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

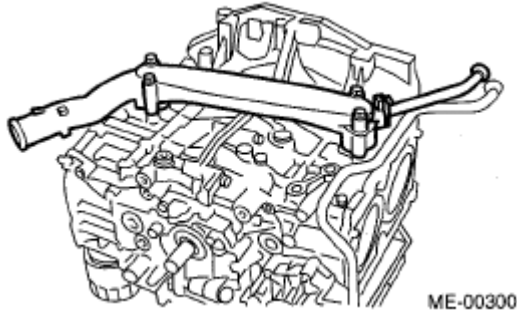


Fig. 186: Identifying Water Pipe
Courtesy of SUBARU OF AMERICA, INC.

24. Install the baffle plate.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

25. Install the oil strainer.

NOTE: Use new O-rings.

Tightening torque:

10 N.m (1.0 kgf-m, 7 ft-lb)

26. Install the oil strainer stay.

NOTE: Tighten the oil strainer stay together with the baffle plate.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

27. Apply liquid gasket to the mating surfaces of oil pan, and install the oil pan.

NOTE: Install within 5 min. after applying liquid gasket.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)

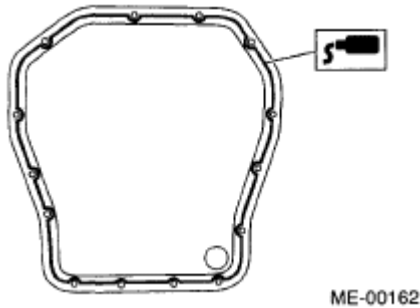


Fig. 187: Applying Liquid Gasket To Mating Surfaces Of Oil Pan
Courtesy of SUBARU OF AMERICA, INC.

28. Apply liquid gasket to the mating surface of oil separator cover and the threaded portion of bolt (A) shown in the illustration (when reusing the bolt), and then install the oil separator cover.

NOTE:

- Install within 5 min. after applying liquid gasket.
- Use new oil separator cover.

Liquid gasket:

Mating surface

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

Bolt (A) thread (when reusing the bolt) THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

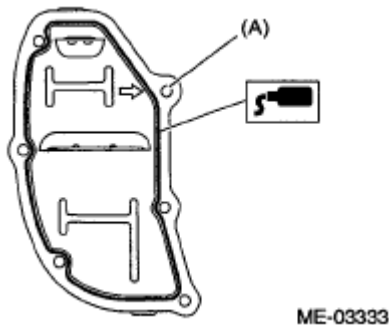


Fig. 188: Applying Liquid Gasket To Mating Surface Of Oil Separator Cover And Threaded Portion Of Bolt

Courtesy of SUBARU OF AMERICA, INC.

29. Install the flywheel. (MT model) < Ref. to **INSTALLATION** , Flywheel .>
30. Install the drive plate. (AT model) To lock the crankshaft, use ST.

ST 498497100 CRANKSHAFT STOPPER

Tightening torque:

72 N.m (7.3 kgf-m, 53.1 ft-lb)

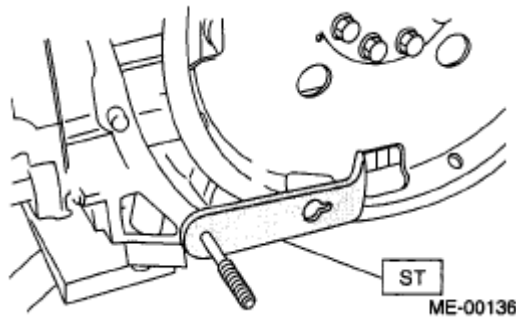


Fig. 189: Identifying Crankshaft Stopper ST498497100

Courtesy of SUBARU OF AMERICA, INC.

31. Install the clutch disc and cover. (MT model) < Ref. to **INSTALLATION** , Clutch Disc and Cover .>
32. Install the oil pump.
 1. Using the ST, install the front oil seal.

ST 499587100 OIL SEAL INSTALLER

NOTE: Use a new front oil seal.

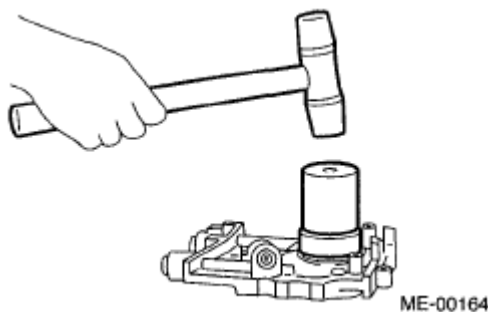


Fig. 190: Installing Front Oil Seal Using Oil Seal Installer ST 499587100

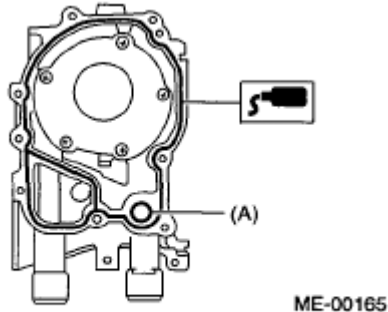
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Install within 5 min. after applying liquid gasket.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent



(A) O-ring

Fig. 191: Applying Liquid Gasket To Matching Surface Of Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

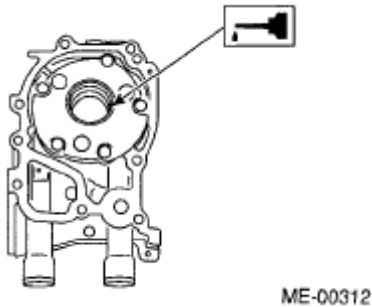


Fig. 192: Applying Coat Of Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- Make sure the oil seal lip is not folded.
- Align the flat surface of oil pump's inner rotor with crankshaft before installation.
- Use new O-rings and oil seals.
- Do not forget to assemble O-rings.

5. Apply liquid gasket to the three bolts thread shown in illustration, (when reusing bolts)

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

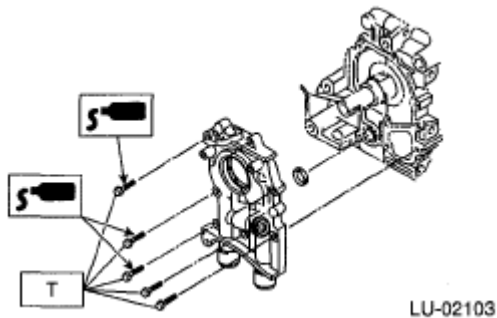


Fig. 193: Applying Fluid Packing To Threads Of Bolts
Courtesy of SUBARU OF AMERICA, INC.

33. Install the service hole plug and gasket.

NOTE:

- When installing the water pump, tighten bolts in two stages in alphabetical sequence as shown in the illustration.
- Use a new gasket.

Tightening torque:

First: 12 N.m (1.2 kgf-m, 8.9 ft-lb)

Second: 12 N.m (1.2 kgf-m, 8.9 ft-lb)

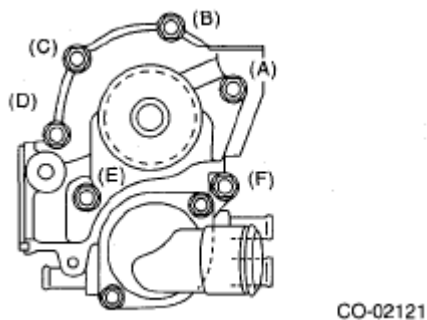


Fig. 194: Identifying Water Pump Bolts

Courtesy of SUBARU OF AMERICA, INC.

34. Install the water by-pass pipe for heater.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

35. Install the oil filter. < Ref. to **INSTALLATION** , Engine Oil Filter .>

36. Install the cylinder head.

< Ref. to **INSTALLATION**, Cylinder Head.>

37. Install the camshaft. < Ref. to **INSTALLATION**, Camshaft.>

38. Install the crank sprocket.

< Ref. to **INSTALLATION**, Crank Sprocket.>

39. Install the cam sprocket.

< Ref. to **INSTALLATION**, Cam Sprockets.>

40. Install the timing belt.

< Ref. to **INSTALLATION**, Timing Belt.>

41. Adjust the valve clearance.

< Ref. to **ADJUSTMENT**, Valve Clearances.>

42. Install the rocker cover.

1. Install the rocker cover gasket to the rocker cover.

NOTE: Use a new gasket.

2. Apply liquid gasket to the specified point of the cylinder head. Apply extra amount of liquid gasket around plugs 5 mm (0.2 in) or more.

NOTE: Install within 5 min. after applying liquid gasket.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0W0) or equivalent

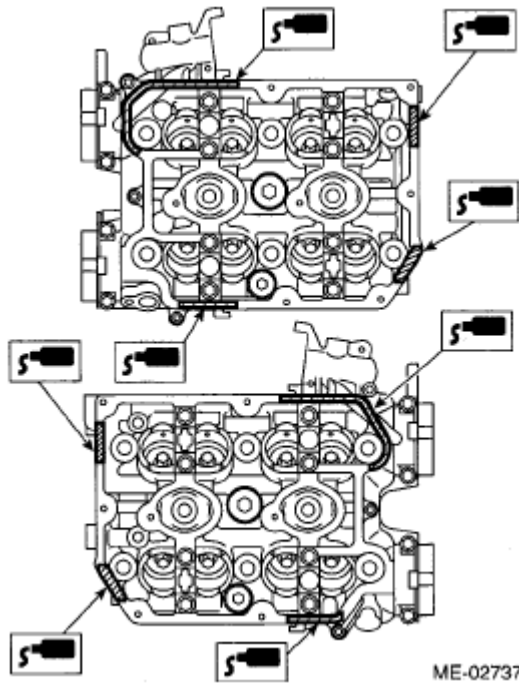


Fig. 195: Applying Liquid Gasket To Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover on cylinder head. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover tightening bolts in alphabetical sequence shown in the illustration, and then tighten to specified torque in alphabetical sequence.

Tightening torque:

6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

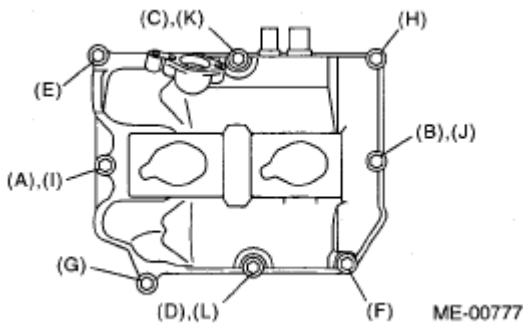


Fig. 196: Identifying Rocker Cover Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Connect the PCV hose.
43. Install the timing belt cover.

< Ref. to **INSTALLATION**, Timing Belt Cover.>

44. Install the crank pulley.

< Ref. to **INSTALLATION**, Crank Pulley.>

45. Install the intake manifold.

< Ref. to **INSTALLATION** , Intake Manifold .>

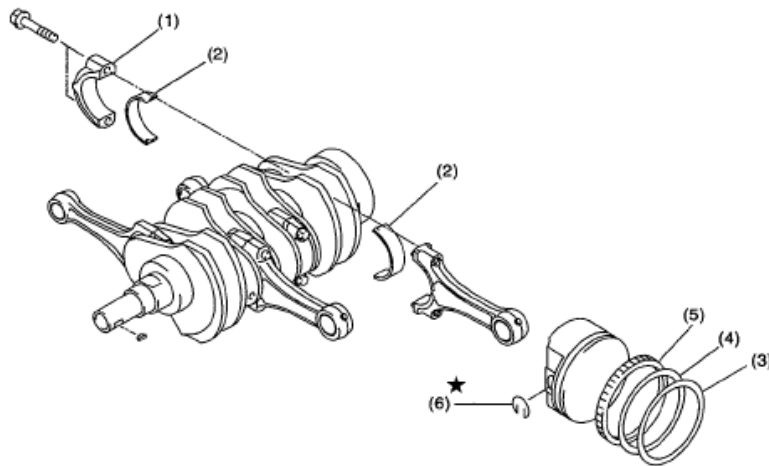
46. Install the generator and A/C compressor with their brackets.

Tightening torque:

36 N.m (3.7 kgf-m, 26.6 ft-lb)

47. Install the V-belts. < Ref. to **INSTALLATION**, V-belt.>

DISASSEMBLY



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

Fig. 197: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

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 piston ring expander.

4. Remove the oil ring by hand.

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

5. Remove the snap ring.

ASSEMBLY

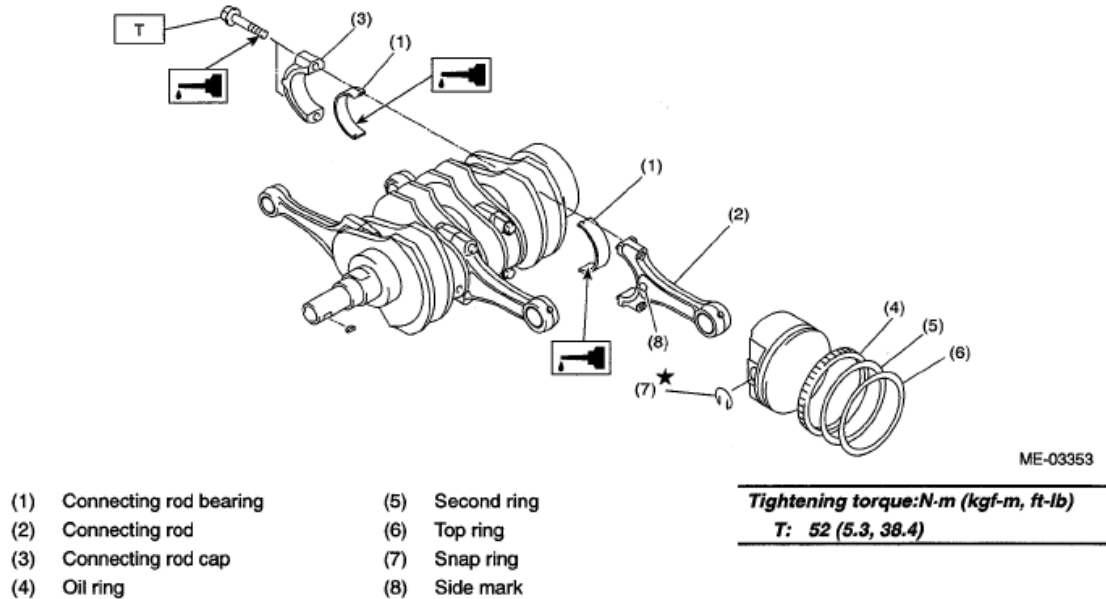


Fig. 198: Exploded View Of Cylinder Block Components
 Courtesy of SUBARU OF AMERICA, INC.

1. Apply oil to the surface of the connecting rod bearings, and install the connecting rod bearings on connecting rods and connecting rod caps.
2. Position each connecting rod with the side with a side mark facing forward, and install it.
3. Tighten the connecting rod cap with the connecting rod bolt. Make sure the arrow on connecting rod cap faces the front during installation.

NOTE:

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

Tightening torque:

52 N.m (5.3 kgf-m, 38.4 ft-lb)

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

INSPECTION**CYLINDER BLOCK**

1. Check for cracks or damage. Use liquid penetrant tester on the important sections to check for fissures. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2. Check the oil passages for clogging.
3. Inspect the cylinder block surface that mates with cylinder head for warping by using a straight edge, and correct by grinding if necessary.

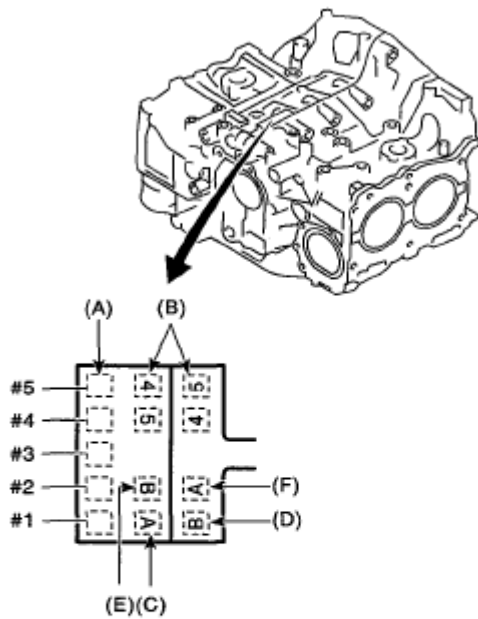
Warping limit:***0.025 mm (0.00098 in)******Grinding limit:******0.1 mm (0.004 in)******Standard height of cylinder block:******201.0 mm (7.91 in)*****CYLINDER AND PISTON**

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

NOTE:

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

Standard diameter:***A: 99.505 - 99.515 mm (3.9175 - 3.9179 in)******B: 99.495 - 99.505 mm (3.9171 - 3.9175 in)***



ME-00170

- (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

Fig. 199: Identifying Cylinder Bore Size Stamp On Cylinder Block Front Upper Surface
Courtesy of SUBARU OF AMERICA, INC.

2. Cylinder inner diameter measurement Measure the inner diameter of each cylinder in both the thrust and piston pin directions at the heights as shown in the illustration, using a cylinder bore gauge.

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

Taper:

Standard:

0.015 mm (0.0006 in)

Service limit:

0.050 mm (0.0020 in)

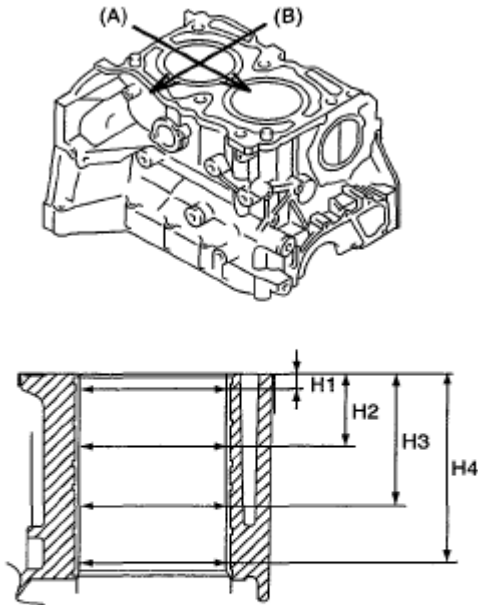
Out-of-roundness:

Standard:

0.010 mm (0.0004 in)

Service limit:

0.050 mm (0.0020 in)



ME-00171

(A) Piston pin direction

(B) Thrust direction

H1: 10 mm (0.39 in)

H2: 45 mm (1.77 in)

H3: 80 mm (3.15 in)

H4: 115 mm (4.53 in)

Fig. 200: Identifying Cylinder Inner Diameter Measurement

Courtesy of SUBARU OF AMERICA, INC.

3. When the piston is to be replaced due to general or cylinder wear, select a suitable sized piston by measuring the piston clearance.
4. Piston outer diameter measurement

Measure the outer diameter of each piston at the height as shown in the illustration. (Thrust direction)

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

Piston grade point H:

38.2 mm (1.50 in)

Piston outer diameter:

Standard

A: 99.505 - 99.515 mm (3.9175 - 3.9179 in)

B: 99.495 - 99.505 mm (3.9171 - 3.9175 in)

0.25 mm (0.0098 in) oversize: 99.745 - 99.765 mm (3.9270 - 3.9278 in)

0.50 mm (0.0197 in) oversize: 99.995 - 100.015 mm (3.9368 - 3.9376 in)

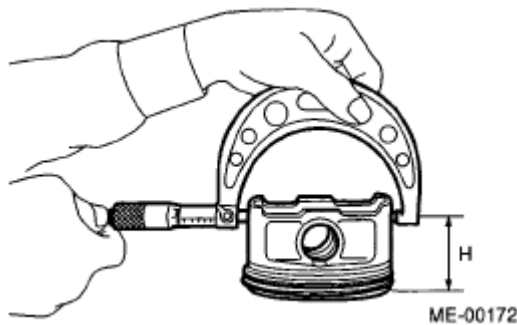


Fig. 201: Measuring Outer Diameter Of Piston
 Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

Cylinder to piston clearance at 20°C (68°F):

Standard

-0.010 - 0.010 mm (-0.0004 - 0.0004 in)

Limit

0.030 mm (0.0012 in)

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

CAUTION: When any of the cylinders needs reboring, all other cylinders must be bored at the same time, and replace to oversize pistons.

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

NOTE: Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, when measuring the cylinder diameter, wait until it has cooled to room temperature.

Cylinder inner boring limit (diameter):

100.005 mm (3.9372 in)

PISTON AND PISTON PIN

1. Check the piston and piston pin for breaks, cracks or wear. Replace if faulty.
2. Check the piston ring groove for wear and damage. Replace if faulty.
3. Make sure that the piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F). Replace if faulty.

Standard clearance between piston pin and hole in piston:

Standard:

0.004 - 0.008 mm (0.0002 - 0.0003 in)

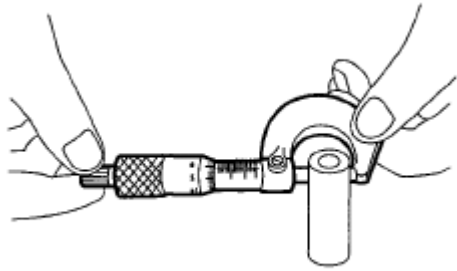
Service limit:

0.020 mm (0.0008 in)



ME-00173

Fig. 202: Checking Clearance Between Piston Pin And Hole In Piston
Courtesy of SUBARU OF AMERICA, INC.

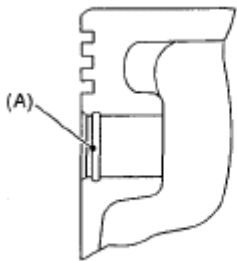


ME-00174

Fig. 203: Checking Piston Pin

Courtesy of SUBARU OF AMERICA, INC.

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



ME-00175

Fig. 204: Identifying Circlip Installation Groove On Piston

Courtesy of SUBARU OF AMERICA, INC.

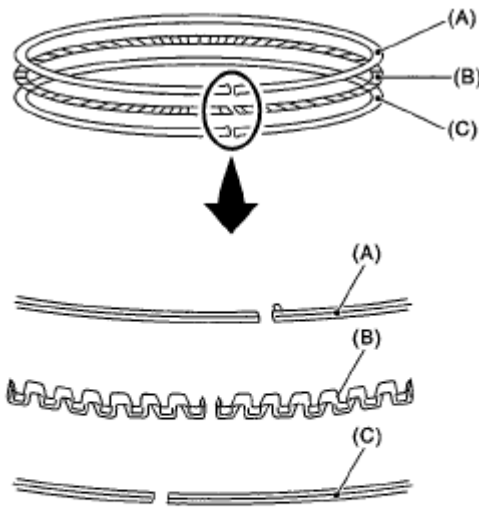
5. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

NOTE:

- Marks that shows the installing direction are shown on the end of top and second rings. When installing them to piston, face this mark to the top side.
- Oil ring consists of the upper rail, expander and lower rail. When installing the oil ring on piston, be careful of each rails direction.



ME-02472

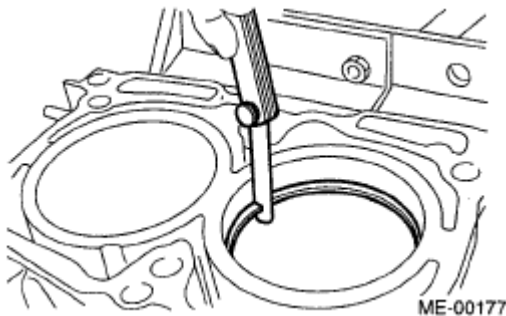
- (A) Upper rail
- (B) Expander
- (C) Lower rail

Fig. 205: Identifying Oil Ring
Courtesy of SUBARU OF AMERICA, INC.

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

PISTON RING GAP SPECIFICATION

		Unit: mm (in)	
		Standard	Limit
Piston ring gap	Top ring	0.20 - 0.25 (0.0079 - 0.0098)	1.0 (0.039)
	Second ring	0.37 - 0.52 (0.015 - 0.020)	1.0 (0.039)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)	1.5 (0.059)



ME-00177

Fig. 206: Measuring Piston Ring Closed Gap
Courtesy of SUBARU OF AMERICA, INC.

- Fit the piston ring straight into the piston ring groove, then measure the clearance between piston ring and piston ring groove with a thickness gauge.

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

PISTON RING GROOVE AND PISTON RING SPECIFICATION

			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)

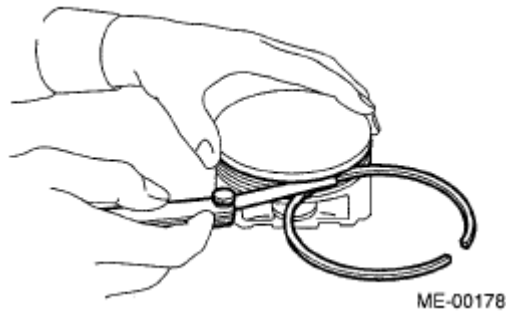


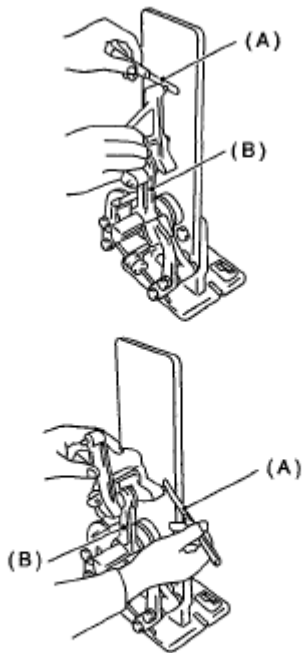
Fig. 207: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

- Replace the connecting rod, if the large or small end thrust surface is damaged.
- 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)



ME-00179

(A) Thickness gauge

(B) Connecting rod

Fig. 208: Checking Bend Or Twist Using Connecting Rod Aligner
Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod fitted with bearing to the crankshaft, and measure the thrust clearance using a thickness gauge. Replace the connecting rod if the thrust clearance exceeds the specified limit.

Connecting rod thrust clearance:

Standard

0.070 - 0.330 mm (0.0028 - 0.0130 in)

Limit

0.4 mm (0.016 in)

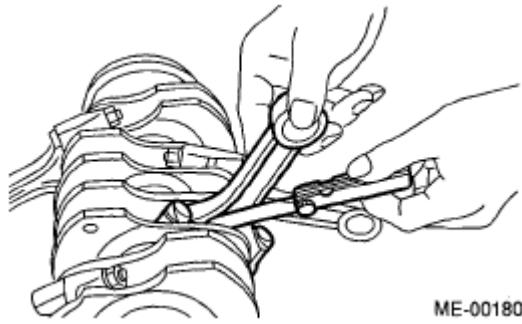


Fig. 209: Checking Connecting Rod Side Clearance
Courtesy of SUBARU OF AMERICA, INC.

4. Inspect the connecting rod bearing for scar, peeling, seizure, melting, wear, etc.
5. Measure the oil clearance on each connecting rod bearing using plastigauge. If any oil clearance is not within the standard, replace the defective bearing with a new part of standard size or undersize as necessary.

Connecting rod oil clearance:

Standard:

0.017-- 0.045 mm (0.0007 - 0.0018 in)

Service limit:

0.05 mm (0.0020 in)

CONNECTING ROD OIL CLEARANCE SPECIFICATION

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 (2.0447 - 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 with a new part if worn or damaged.
7. Measure the piston pin clearance at connecting rod small end. Replace it with a new part if the clearance exceeds the limit.

Clearance between piston pin and bushing:

Standard:

0 - 0.022 mm (0 - 0.0009 in)

Service limit:

0.030 mm (0.0012 in)

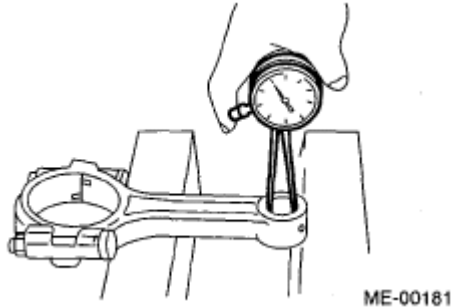


Fig. 210: Checking Clearance Between Piston Pin And Bushing
Courtesy of SUBARU OF AMERICA, INC.

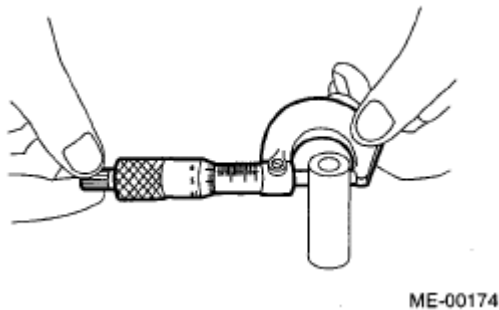


Fig. 211: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

8. The replacement procedure for the connecting rod small end bushing is as follows.
 1. Remove the bushing from connecting rod with ST and press.
 2. Press the bushing with the ST after applying oil on the periphery of new bushing.

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

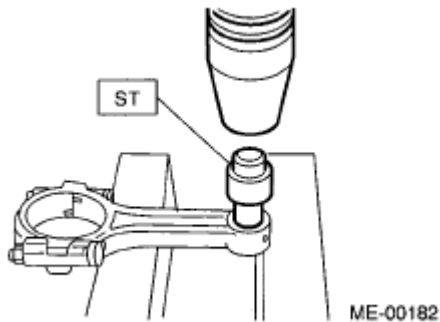


Fig. 212: Identifying Connecting Rod Bushing Remover And Installer ST499037100
Courtesy of SUBARU OF AMERICA, INC.

3. Make two 3 mm (0.12 in) holes in the pressed bushing according to the pre-manufactured holes on the connecting rod to ream the inside of bushing.
4. After completion of reaming, clean the bushing to remove chips.

CRANKSHAFT AND CRANKSHAFT BEARING

1. Clean the crankshaft completely, and check for cracks by means of red lead check etc. If faulty, replace with new a new crankshaft.
2. Measure the bend of crankshaft. If it exceeds the limit, correct or replace it.

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

Crankshaft bend limit:

0.035 mm (0.0014 in)

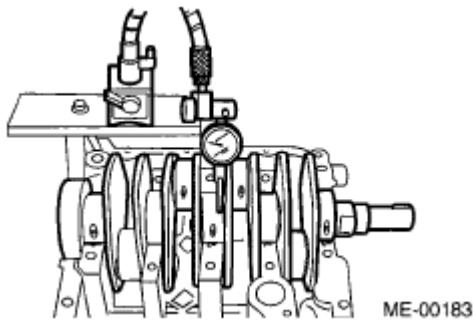


Fig. 213: Measuring Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

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

Crank pin:

Out-of-roundness:

0.003 mm (0.0001 in)

Cylindricity:

0.004 mm (0.0002 in)

Grinding limit:

To 51.750 mm (2.0374 in) dia.

Crank journal:

Out-of-roundness:

0.005 mm (0.0002 in)

Cylindricity:

0.006 mm (0.0002 in)

Grinding limit:

To 59.758 mm (2.3527 in) dia.



Fig. 214: Inspecting Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

GRINDING LIMIT SPECIFICATION

		Unit: mm (in)		
		Crank journal outer diameter		Crank pin outer diameter
		#1, #3	#2, #4, #5	
Standard	Journal O.D.	59.992 - 60.008 (2.3619 - 2.3625)	59.992 - 60.008 (2.3619 - 2.3625)	51.984 - 52.000 (2.0466 - 2.0472)
	Bearing size (Thickness at center)	1.998 - 2.011 (0.0787 - 0.0792)	2.000 - 2.013 (0.0787 - 0.0793)	1.490 - 1.502 (0.0587 - 0.0591)
0.03 (0.0012) undersize	Journal O.D.	59.962 - 59.978 (2.3607 - 2.3613)	59.962 - 59.978 (2.3607 - 2.3613)	51.954 - 51.970 (2.0454 - 2.0461)
	Bearing size (Thickness at center)	2.017 - 2.020 (0.0794 - 0.0795)	2.019 - 2.022 (0.0795 - 0.0796)	1.504 - 1.512 (0.0592 - 0.0595)
0.05 (0.0020) undersize	Journal O.D.	59.942 - 59.958 (2.3599 - 2.3605)	59.942 - 59.958 (2.3599 - 2.3605)	51.934 - 51.950 (2.0447 - 2.0453)
	Bearing size (Thickness at center)	2.027 - 2.030 (0.0798 - 0.0799)	2.029 - 2.032 (0.0799 - 0.0800)	1.514 - 1.522 (0.0596 - 0.0599)
	Journal O.D.	59.742 - 59.758 (2.3520 - 2.3527)	59.742 - 59.758 (2.3520 - 2.3527)	51.734 - 51.750 (2.0368 - 2.0374)

0.25 (0.0098) undersize	Bearing size (Thickness at center)	2.127 - 2.130 (0.0837 - 0.0839)	2.129 - 2.132 (0.0838 - 0.0839)	1.614 - 1.622 (0.0635 - 0.0639)
----------------------------	---------------------------------------	------------------------------------	------------------------------------	------------------------------------

- Use a thickness gauge to measure the thrust clearance of crankshaft at #5 crank journal bearing. If the clearance exceeds the limit, replace the bearing.

Crankshaft thrust clearance:

Standard

0.030 - 0.115 mm (0.0012 - 0.0045 in)

Limit

0.25 mm (0.0098 in)

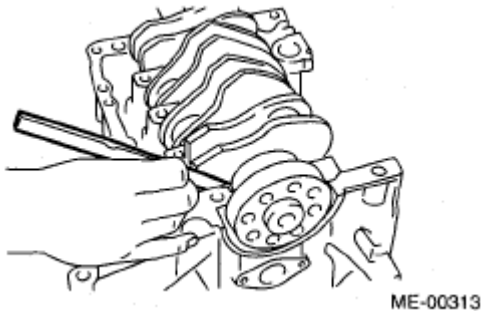


Fig. 215: Measuring Crankshaft Side Clearance
Courtesy of SUBARU OF AMERICA, INC.

- Inspect individual crankshaft bearings for signs of flaking, seizure, melting and wear.
- Measure the oil clearance on each crankshaft bearing using plastigauge. If the measured value exceeds the limit, replace the defective bearing with an undersize one, and replace or grind to correct the crankshaft as necessary.

Crankshaft oil clearance:

Standard:

0.010 - 0.030 mm (0.0004 - 0.0012 in)

Service limit:

0.040 mm (0.0016 in)

INTAKE AND EXHAUST VALVE

SPECIFICATION

Refer to "Cylinder Head" for removal and installation procedures of intake and exhaust valves.

< Ref. to **REMOVAL**, Cylinder Head.> < Ref. to **INSTALLATION**, Cylinder Head.>

PISTON

SPECIFICATION

Refer to "Cylinder Block" for removal and installation procedures of pistons.

< Ref. to **REMOVAL**, Cylinder Block.> < Ref. to **INSTALLATION**, Cylinder Block.>

CONNECTING ROD

SPECIFICATION

Refer to "Cylinder Block" for removal and installation procedures of connecting rod. < Ref. to **REMOVAL**, Cylinder Block.> < Ref. to **INSTALLATION**, Cylinder Block.>

CRANKSHAFT

SPECIFICATION

Refer to "Cylinder Block" for removal and installation procedures of crankshaft.

< Ref. to **REMOVAL**, Cylinder Block.> < Ref. to **INSTALLATION**, Cylinder Block.>

ENGINE TROUBLE IN GENERAL

INSPECTION

NOTE: "RANK" shown in the chart refers to the possibility of the cause of trouble in order "Very often" to "Rarely"

A - Very often

B - Sometimes

C - Rarely

SYMPTOMS CHART

Symptoms	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
		Defective battery-to-starter harness	B

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

1) Starter does not turn.	Starter	Defective starter switch	C
		Defective inhibitor switch or neutral switch	C
		Defective starter	B
	Battery	Improper connection of terminal	A
		Run-down battery	A
		Defective charging system	B
	Excessive 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 BASIC DIAGNOSTIC PROCEDURES .>		A
	Fuel line	Defective fuel pump and relay	A
		Clogged fuel line	C
		Lack of or insufficient fuel	B
	Timing belt	Degradation, etc.	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
3) Initial combustion occurs.	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURES .>		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
	Timing belt	Degradation, etc.	B
		Defective timing	B
		Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective	C

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

	Compression	head gasket	
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
4) Engine stalls after initial combustion.	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		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
	Timing belt	Degradation, etc.	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		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
		Defective fuel pump and relay	C

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

2. Rough idle and engine stall	Fuel line	Clogged fuel line	C
		Lack of or insufficient fuel	B
	Timing belt	Defective timing	C
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective head gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Overheating	C
	Others	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
3. Low output, hesitation and poor acceleration	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		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
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective head gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and	

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

		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	Evaporative emission control system malfunction	A
4. Surging	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		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
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Cooling system	Overheating	B
	Others	Evaporative emission control system malfunction	C
5. Engine does not return to idle.	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		A
	Intake system	Loosened or cracked vacuum hose	A
	Others	Stuck or damaged throttle valve	A
		Accelerator cable out of adjustment	B

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

6. Dieseling (Run-on)	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		A
	Cooling system	Overheating	B
	Others	Evaporative emission control system malfunction	B
7. After burning in exhaust system	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		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
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective head gasket	C
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C
	Others	Evaporative emission control system malfunction	C
8. Knocking	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		A
	Intake system	Loosened oil filler cap	B
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
9. Excessive engine oil	Cooling system	Overheating	A
	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
		Loosened oil pump attaching bolts and defective gasket	B

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

consumption	Lubrication system	Defective oil filter gasket	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
10. Excessive fuel consumption	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURES</u> .>		A
	Intake system	Dirty air cleaner element	A
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective head gasket	C
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	B
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C

ENGINE NOISE

INSPECTION

SYMPTOM CHART

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	- Valve mechanism is defective. - Incorrect valve clearance adjustment - Worn camshaft - Broken valve spring
Heavy and dull clank	Oil pressure is low.	- Worn crankshaft main bearing - Worn connecting rod bearing (large end)
		Loosened flywheel mounting

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

	Oil pressure is normal.	bolt Damaged engine mounting
High-pitched clank	Sound is noticeable when accelerating with an overload condition.	- Ignition timing advanced - Accumulation of carbon inside combustion chamber - Wrong heat-durability spark plug - Improper octane value gasoline
Clank when engine speed is 1,000 to 2,000 rpm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	- Worn crankshaft main bearing - Worn connecting rod bearing (large end)
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. ⁽¹⁾	- Worn cylinder liner and piston ring - Broken or stuck piston ring - Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	- Unusually worn valve lifter - Worn cam sprocket - Worn camshaft journal bore in cylinder head
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Poor contact of generator brush and rotor
Gear scream when starting engine	-	- Defective ignition starter switch - Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	- Loose V-belt - Defective water pump shaft
Hissing sound	-	- Insufficient compression - Air leakage in air intake system, hose, connection or manifold
Timing belt noise	-	- Loose timing belt - Belt contacting with case/adjacent part
Valve noise	-	Incorrect valve clearance
⁽¹⁾ When disconnecting the fuel injector connector, the malfunction indicator light illuminates and DTC is stored in ECM memory. Therefore, perform the Clear Memory Mode and Inspection Mode after		

2008 Subaru Forester X

2008 ENGINE Mechanical (H4DOTC) - Forester

connecting the fuel injector connector. < Ref. to **OPERATION** , Clear Memory Mode .> < Ref. to **PROCEDURE** , Inspection Mode .>