2009 ENGINE

Mechanical (H4DOTC) - Impreza (Except STi)

GENERAL DESCRIPTION

SPECIFICATION

SPECIFICATION CHART

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)	99.5 x 79.0 (3.92 x 3.11)
	Displacement			cm^3 (cu in)	2,457 (149.94)
	Compression ratio				8.4
	Compression pressure (at 200 - 300 RPM)			kPa (kg/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	ATDC 5°
				Min. advance	BTDC 35°
			Close	Max. retard	ABDC 65°
				Min. advance	ABDC 25°
	Exhaust valve timing		Open		BBDC 55°
			Close		ATDC 5°
	Valve clearance mm (in)	Inspection value	Intake		$0.20^{+004}_{-0.06}$ ($0.0079^{+00016}_{-0.0024}$)
			Exhaust		0.35±0.05 (0.0138±0.0020)
		Adjustment value	Intake		$0.20^{+001}_{-0.03}$ ($0.0079^{+00004}_{-0.0012}$)
			Exhaust		0.35±0.02 (0.0138±0.0008)
	Idling speed (at "P" or "N" position on AT model, or neutral position on MT model)		RPM	No load	700±100
				A/C ON	AT model: 825±100
					MT model: 800±100

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	Ignition order				1 --> 3 --> 2 --> 4
	Ignition timing			BTDC/RPM	AT model: 17°±10°/700
					MT model: 12°±10°/700
Belt tension adjuster	Protrusion of adjuster rod			mm (in)	5.2 - 6.2 (0.205 - 0.244)
Camshaft	Bending limit			mm (in)	0.020 (0.00079)
	Cam lobe height	mm (in)	Intake	Standard	46.55 - 46.65 (1.833 - 1.837)
			Exhaust	Standard	46.75 - 46.85 (1.841 - 1.844)
	Cam base circle diameter		mm (in)	Standard	37.0 (1.457)
	Journal O.D.	mm (in)	Front	Standard	37.946 - 37.963 (1.4939 - 1.4946)
			Center, rear		29.946 - 29.963 (1.1790 - 1.1796)
	Oil clearance		mm (in)	Standard	0.037 - 0.072 (0.0015 - 0.0028)
	Thrust clearance		mm (in)	Standard	0.068 - 0.116 (0.0027 - 0.0047)
Cylinder head	Warping limit (Mating surface with cylinder block)			mm (in)	0.035 (0.0014)
	Grinding limit			mm (in)	0.3 (0.012)
	Standard height			mm (in)	127.5 (5.02)
Valve seat	Seating angle between valve and valve seat				90°
	Contacting width between valve and valve seat	mm (in)	Intake	Standard	0.6 - 1.4 (0.024 - 0.055)
			Exhaust	Standard	1.2 - 1.8 (0.047 - 0.071)
Valve guide	Clearance between the valve and valve stem	mm (in)	Intake	Standard	0.030 - 0.057 (0.0012 - 0.0022)
			Exhaust		0.040 - 0.067 (0.0016 - 0.0026)
	Inside diameter			mm (in)	6.000 - 6.012 (0.2362 - 0.2367)
	Valve stem outer diameters	mm (in)	Intake		5.955 - 5.970 (0.2344 - 0.2350)
			Exhaust		5.945 - 5.960 (0.2341 - 0.2346)
	Valve guide protrusion			mm (in)	15.8 - 16.2 (0.622 - 0.638)
Valve	Head edge thickness	mm (in)	Intake	Standard	1.0 - 1.4 (0.039 - 0.055)
			Exhaust	Standard	1.3 - 1.7 (0.051 - 0.067)
	Overall length	mm (in)	Intake		104.4 (4.110)
			Exhaust		104.65 (4.1201)
	Free length			mm (in)	47.32 (1.863)

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Valve spring	Tension/spring height N (kgf, lb)/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 (1.043)
	Squareness			2.5°, 2.1 mm (0.083 in) or less
Valve lifter	Outer diameter mm (in)		Standard	34.959 - 34.975 (1.3763 - 1.3770)
	Valve lifter mating surface inner diameter mm (in)		Standard	34.994 - 35.016 (1.3777 - 1.3786)
	Valve lifter and valve lifter mating surface clearance mm (in)		Standard	0.019 - 0.057 (0.0007 - 0.0022)
Cylinder block	Warping limit (Mating surface with cylinder head) mm (in)			0.025 (0.0098)
	Grinding limit mm (in)			0.1 (0.004)
	Standard height mm (in)			201.0 (7.91)
	Taper mm (in)		Standard	0.015 (0.0006)
	Out-of-roundness mm (in)		Standard	0.010 (0.0004)
	Cylinder to piston clearance at 20°C (68°F) mm (in)		Standard	-0.010 - 0.010 (-0.00039 - 0.00039)
	Cylinder inner diameter boring limit (diameter) mm (in)			To 100.005 (3.9372)
Piston	Piston grade point mm (in)			38.2 (1.50)
	Outer diameter mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)
			B	99.495 - 99.505 (3.9171 - 3.9175)
		0.25 (0.0098) OS		99.745 - 99.765 (3.9270 - 3.9278)
		0.50 (0.0197) OS		99.995 - 100.015 (3.9368 - 3.9376)
Piston pin	Degree of fit			Piston pin must be fitted into position with thumb at 20°C (68°F).
	Clearance between piston hole and piston pin mm (in)		Standard	0.004 - 0.008 (0.0002 - 0.0003)
Piston ring	Piston ring gap mm (in)	Top ring	Standard	0.20 - 0.25 (0.0079 - 0.0098)
		Second ring	Standard	0.37 - 0.52 (0.015 - 0.0203)
		Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)
	Clearance between	Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)

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	piston ring and piston ring groove	mm (in)	Second ring	Standard	0.030 - 0.070 (0.0012 - 0.0028)
Connecting rod and connecting rod bearing	Bend or twist per 100 mm (3.94 in) in length	mm (in)		Limit	0.10 (0.0039)
	Thrust clearance	mm (in)		Standard	0.070 - 0.330 (0.0028 - 0.0130)
	Oil clearance	mm (in)		Standard	0.017 - 0.045 (0.0007 - 0.0018)
	Bearing size (Thickness at center)	mm (in)	Standard		1.490 - 1.502 (0.0587 - 0.0591)
			0.03 (0.0012) US		1.504 - 1.512 (0.0592 - 0.0595)
			0.05 (0.0020) US		1.514 - 1.522 (0.0596 - 0.0599)
			0.25 (0.0098) US		1.614 - 1.622 (0.0635 - 0.0639)
Bushing of small end	Clearance between piston pin and bushing	mm (in)		Standard	0 - 0.022 (0 - 0.0009)
Crankshaft and crankshaft bearing	Bending limit			mm (in)	0.035 (0.0014)
	Crank pin	Out-of-roundness		mm (in)	0.003 (0.0001)
		Cylindrically		mm (in)	0.004 (0.0002)
		Grinding limit (dia.)		mm (in)	To 51.750 (2.0374)
	Crank journal	Out-of-roundness		mm (in)	0.005 (0.0002)
		Cylindrically		mm (in)	0.006 (0.0002)
		Grinding limit (dia.)		mm (in)	To 59.758 (2.3527)
	Crank pin outer diameter	mm (in)	Standard		51.984 - 52.000 (2.0466 - 2.0472)
			0.03 (0.0012) US		51.954 - 51.970 (2.0454 - 2.0461)
			0.05 (0.0020) US		51.934 - 51.950 (2.0447 - 2.0453)
			0.25 (0.0098) US		51.734 - 51.750 (2.0368 - 2.0374)
	Crank journal outer diameter	mm (in)	Standard		59.992 - 60.008 (2.3619 - 2.3625)
			0.03 (0.0012) US		59.962 - 59.978 (2.3607 - 2.3613)
			0.05 (0.0020) US		59.942 - 59.958 (2.3599 - 2.3605)
			0.25 (0.0098) US		59.742 - 59.758 (2.3520 - 2.3527)
			Standard		1.998 - 2.011 (0.0787 - 0.0792)
					2.017 - 2.020 (0.0794 -

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	Bearing size (Thickness at center) mm (in)	#1, #3	0.03 (0.0012) US		0.0795)
			0.05 (0.0020) US		2.027 - 2.030 (0.0798 - 0.0799)
			0.25 (0.0098) US		2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #5	Standard		2.000 - 2.013 (0.0787 - 0.0793)
			0.03 (0.0012) US		2.019 - 2.022 (0.0795 - 0.0796)
			0.05 (0.0020) US		2.029 - 2.032 (0.0799 - 0.0800)
			0.25 (0.0098) US		2.129 - 2.132 (0.0838 - 0.0839)
	Thrust clearance mm (in)			Standard	0.030 - 0.115 (0.0012 - 0.0045)
	Oil clearance mm (in)			Standard	0.010 - 0.030 (0.0004 - 0.0012)

NOTE:
OS: Oversize US: Undersize

COMPONENT

TIMING BELT

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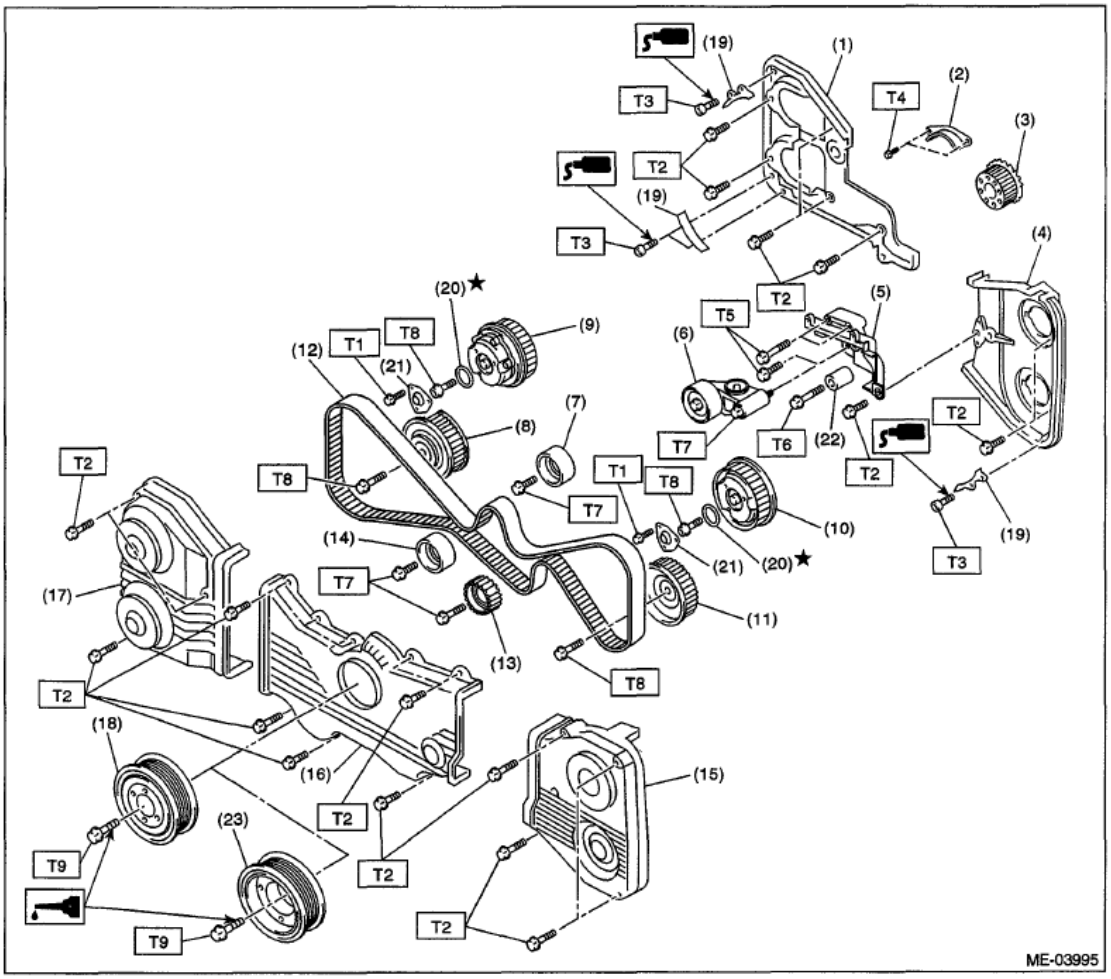

(1)	Timing belt cover No. 2 RH	(12)	Timing belt
(2)	Timing belt guide (MT model)	(13)	Belt idler No. 2
(3)	Crank sprocket	(14)	Belt idler
(4)	Timing belt cover No. 2 LH	(15)	Timing belt cover LH
(5)	Tensioner bracket	(16)	Front belt cover
(6)	Automatic belt tension adjuster ASSY	(17)	Timing belt cover RH
		(18)	Crank pulley (MT model)
(7)	Belt idler	(19)	Timing belt guide (MT model)
(8)	Exhaust cam sprocket RH	(20)	O-ring
(9)	Intake cam sprocket RH	(21)	Actuator cover
(10)	Intake cam sprocket LH	(22)	Belt idler
(11)	Exhaust cam sprocket LH	(23)	Crank pulley (AT model)

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

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

T1: 3.4 (0.3, 2.5)

T2: 5 (0.5, 3.7)

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T3: 6.4 (0.7, 4.7)

T4: 9.75 (1.0, 7.2)

T5: 24.5 (2.5, 18.1)

T6: 25 (2.5, 18A)

T7: 39 (4.0, 28.8)

T8: Ref. to INSTALLATION, Cam Sprocket.

T9: Ref. to INSTALLATION, Crank Pulley.

CYLINDER HEAD AND CAMSHAFT

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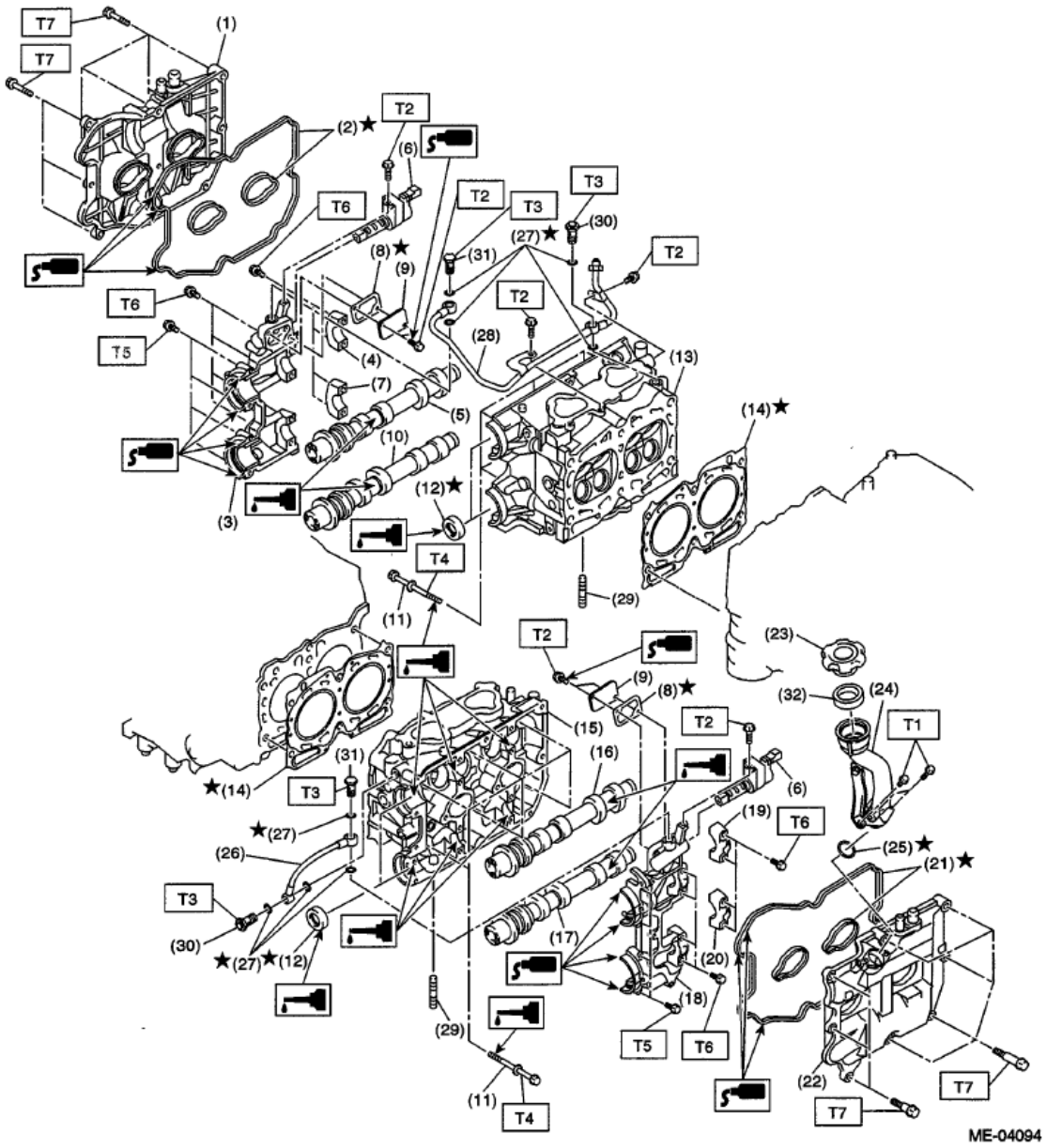

(1) Rocker cover RH
(2) Rocker cover gasket RH
(3) Front camshaft cap RH
(4) Intake camshaft cap RH
(5) Intake camshaft RH
(6) Oil flow control solenoid valve
(7) Exhaust camshaft cap RH
(8) Gasket
(9) Oil return cover
(10) Exhaust camshaft RH
(11) Cylinder head bolt
(12) Oil seal
(13) Cylinder head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

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

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

T1: 6.4 (0.7, 4.7)

T2: 8 (0.8, 5.9)

T3: 29 (3.0, 21.4)

T4: Ref. to INSTALLATION, Cylinder Head.

T5: Ref. to INSTALLATION, Camshaft.

T6: Ref. to INSTALLATION, Camshaft.

T7: Ref. to INSTALLATION, Camshaft.

CYLINDER HEAD AND VALVE ASSEMBLY

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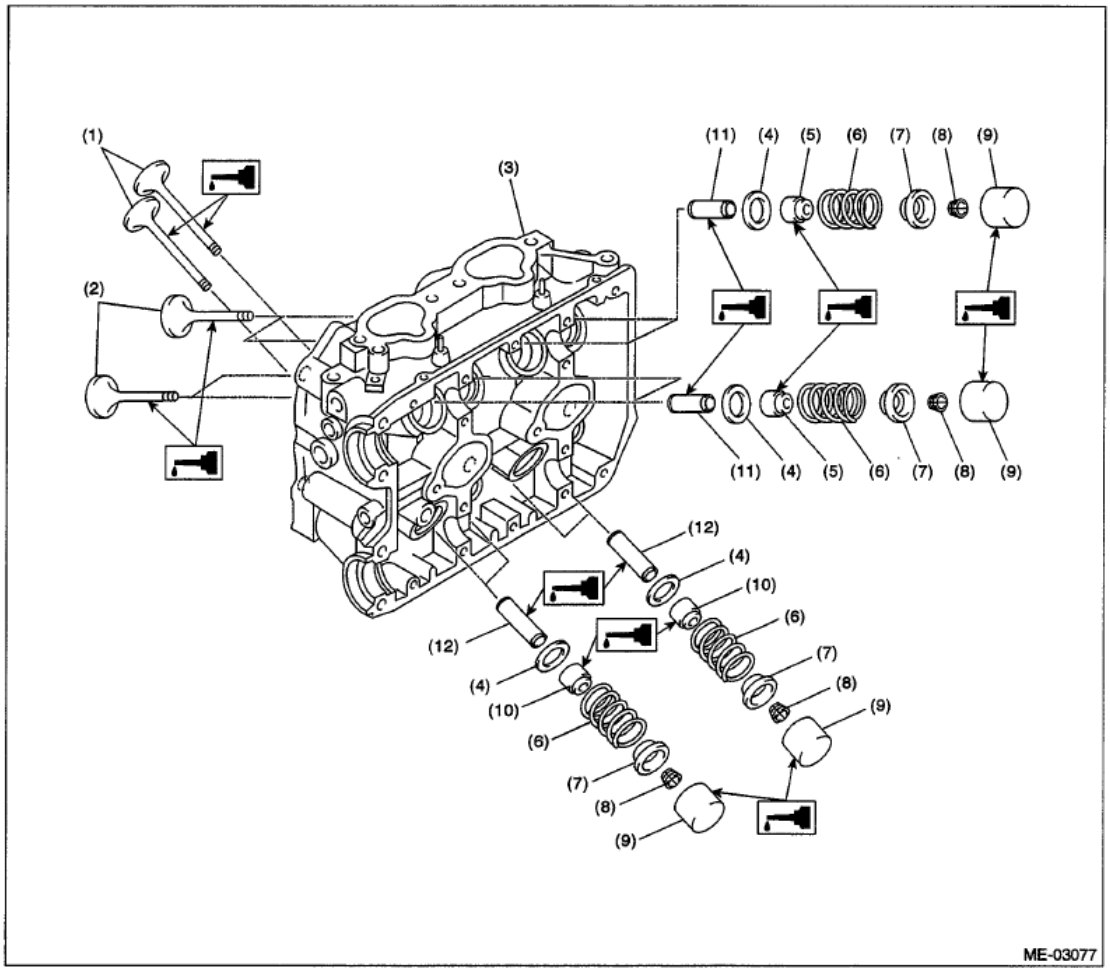

(1)	Exhaust valve	(5)	Intake valve oil seal	(9)	Valve lifter
(2)	Intake valve	(6)	Valve spring	(10)	Exhaust valve oil seal
(3)	Cylinder head	(7)	Retainer	(11)	Intake valve guide
(4)	Valve spring seat	(8)	Retainer key	(12)	Exhaust valve guide

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

CYLINDER BLOCK

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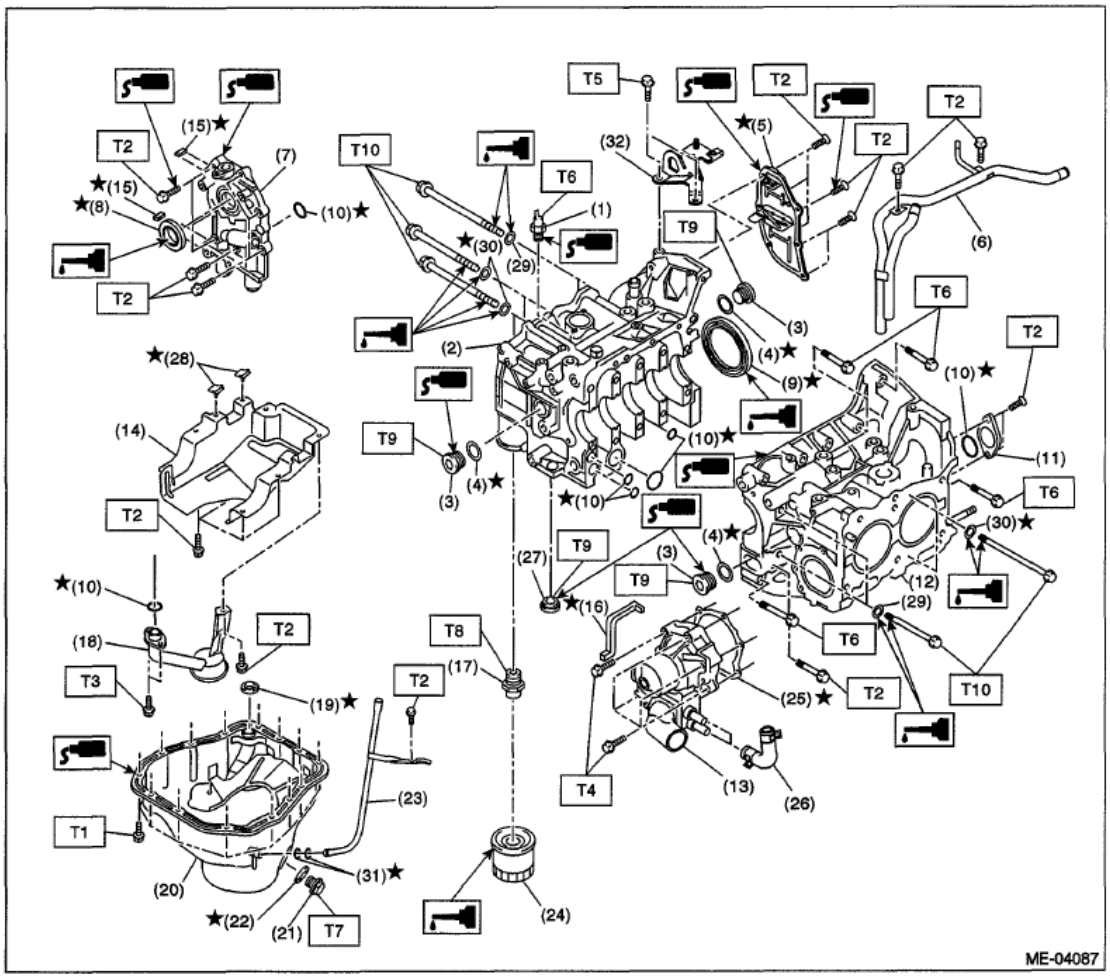

(1)	Oil pressure switch	(17)	Oil filter connector	(32)	Engine rear hanger
(2)	Cylinder block RH	(18)	Oil strainer		
(3)	Service hole plug	(19)	Gasket		
(4)	Gasket	(20)	Oil pan		
(5)	Oil separator cover	(21)	Drain plug		
(6)	Water by-pass pipe	(22)	Drain plug gasket		
(7)	Oil pump	(23)	Oil level gauge guide		
(8)	Front oil seal	(24)	Oil filter		
(9)	Rear oil seal	(25)	Gasket		
(10)	O-ring	(26)	Water pump hose		
(11)	Service hole cover	(27)	Plug		
(12)	Cylinder block LH	(28)	Seal		
(13)	Water pump	(29)	Washer		
(14)	Baffle plate	(30)	Seal washer		
(15)	Oil pump seal	(31)	O-ring		
(16)	Water pump sealing				

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

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

T1: 5 (0.5, 3.7)

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T2: 6.4 (0.7, 4.7)

T3: 10 (1.0, 7.2)

T4:

First 12 (1.2, 8.9)

Second 12 (1.2, 8.9)

T5: 16 (1.6, 11.8)

T6: 25 (2.5, 18.4)

T7: 44 (4.5, 32.5)

T8: 45 (4.6, 33.2)

T9: 70 (7.1, 51.6)

T10: Ref. to INSTALLATION, Cylinder Block.

CRANKSHAFT AND PISTON

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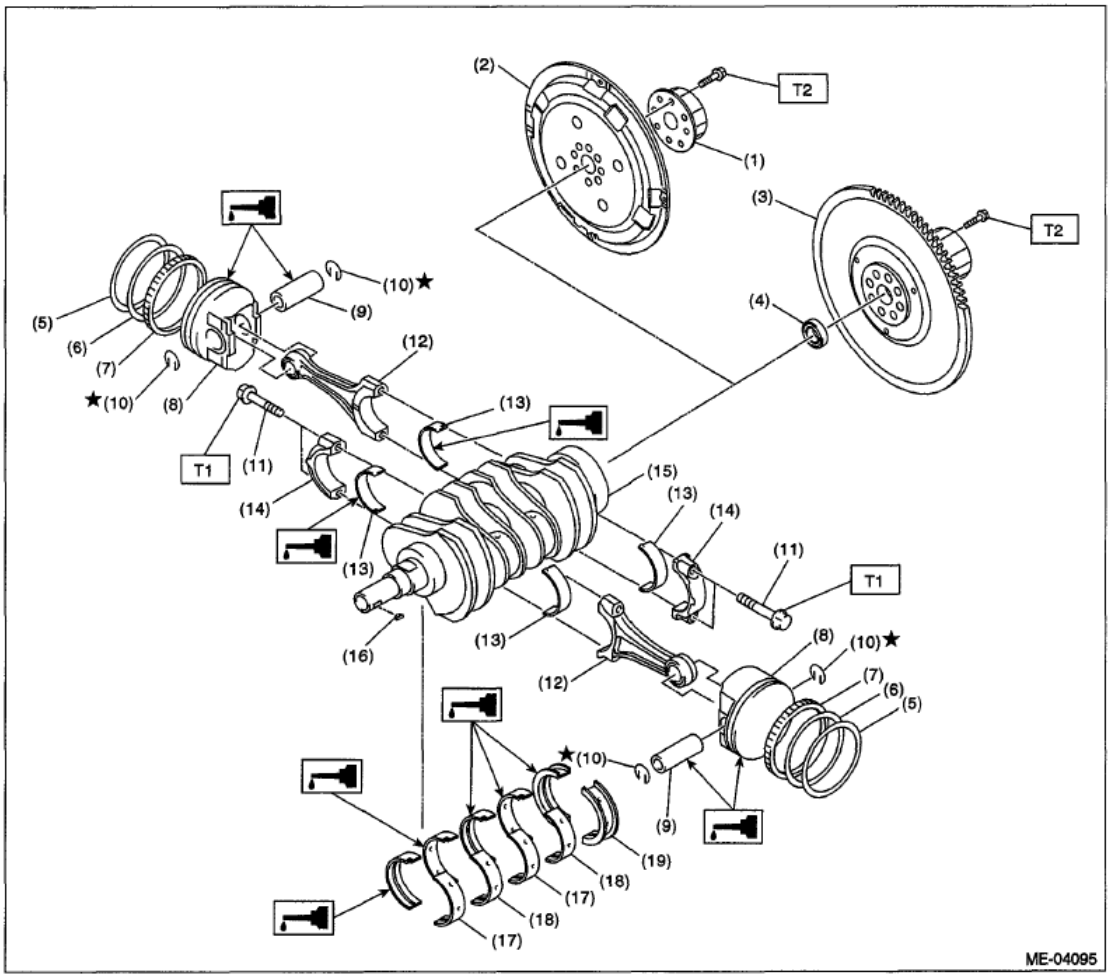

(1)	Reinforcement (AT model)	(9)	Piston pin	(17)	Crankshaft bearing #1, #3
(2)	Drive plate (AT model)	(10)	Snap ring	(18)	Crankshaft bearing #2, #4
(3)	Flywheel (MT model)	(11)	Connecting rod bolt	(19)	Crankshaft bearing #5
(4)	Ball bearing (MT model)	(12)	Connecting rod		
(5)	Top ring	(13)	Connecting rod bearing		
(6)	Second ring	(14)	Connecting rod cap		
(7)	Oil ring	(15)	Crankshaft		
(8)	Piston	(16)	Woodruff key		

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

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

T1: 52 (5.3, 38.4)

T2: 72 (7.3, 53.1)

ENGINE MOUNTING

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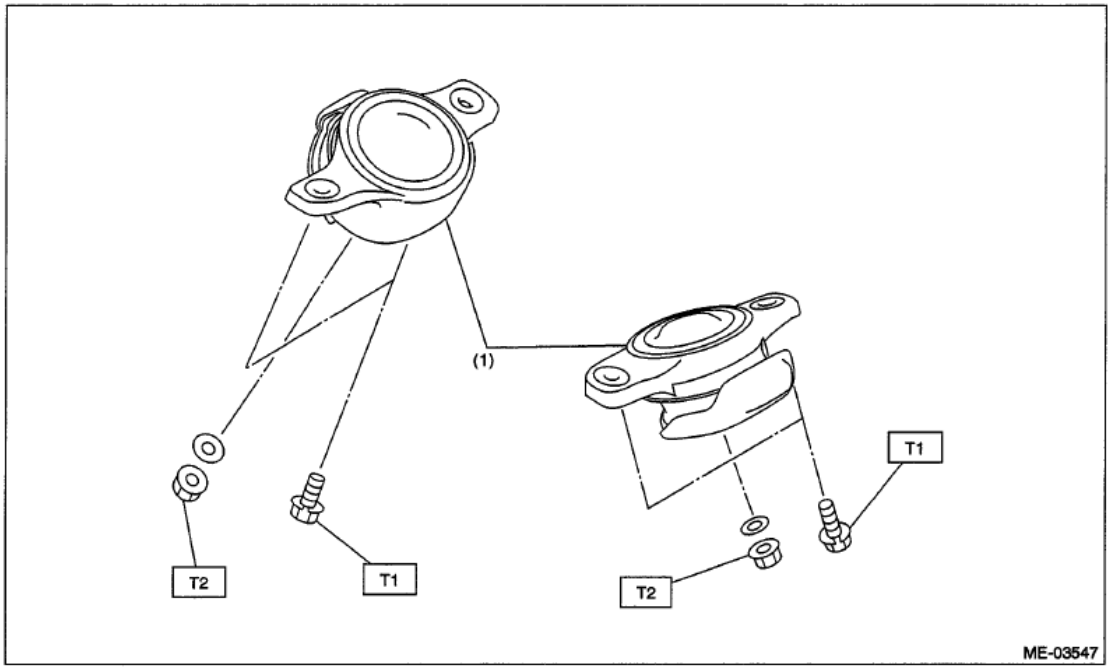

(1) Front cushion rubber

Fig. 6: Identifying Front Cushion Rubber
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 35 (3.6, 25.8)

T2: 85 (8.7, 62.7)

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 connectors of sensors or units, be sure to disconnect the ground cable from the 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

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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 re-checks.
- 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 not to stain seats and windows with coolant or oil. Place a cover over fender, as required, for protection.
- Prior to starting work, prepare the following:

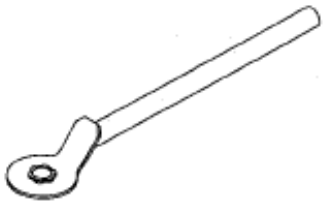
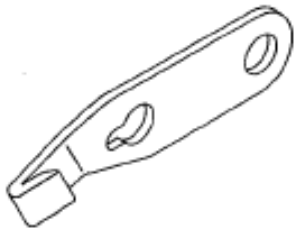
  Service tools, clean cloth, containers to catch coolant and oil, wire ropes, chain hoist, transmission jacks, etc.

- 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-499977500	498267600	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498497100	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
		ENGINE STAND	Used together with ENGINE STAND

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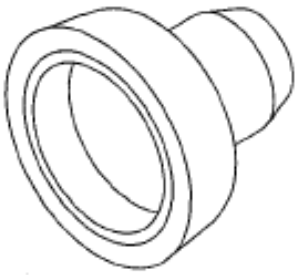
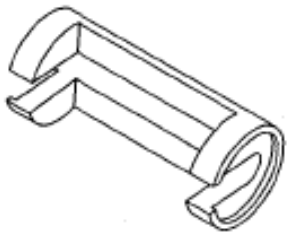
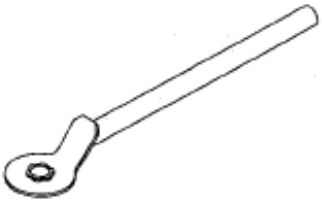
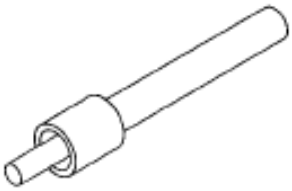
 ST-499587200	498457000	ADAPTER RH	(499817100).
ST-499597100	498457100	ENGINE STAND ADAPTER LH	Used together with ENGINE STAND (499817100).
 ST-499718000	498497100	CRANKSHAFT STOPPER	Used for removing and installing the flywheel and drive plate.
 ST-499977500	498747300	PISTON GUIDE	Used for installing the piston into the cylinder.
 ST-498857100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.

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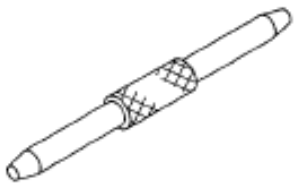
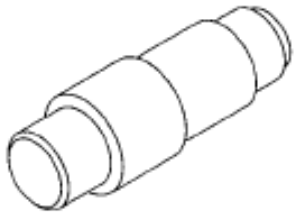
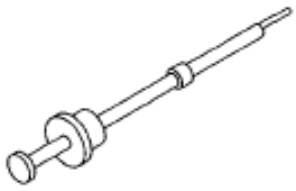
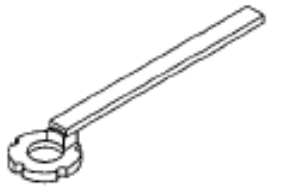
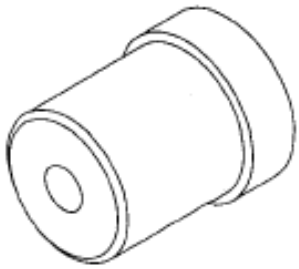
 ST-499017100	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST-499037100	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499097700	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499207400	499207400	CAM SPROCKET WRENCH	Used for removing and installing exhaust cam sprocket.
 ST-499587100	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.

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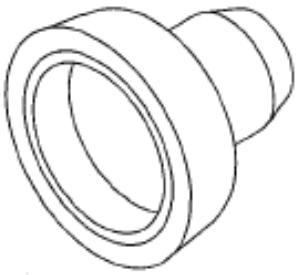
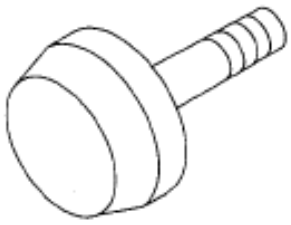
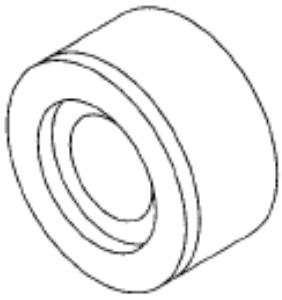
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499597200	499587600	OIL SEAL INSTALLER	Used for installing the camshaft oil seal.
ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499767800	499597200	OIL SEAL GUIDE	• Used for installing the camshaft oil seal. • Used together with OIL SEAL INSTALLER (499587600).
	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.

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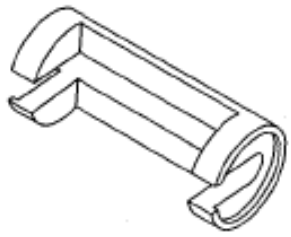
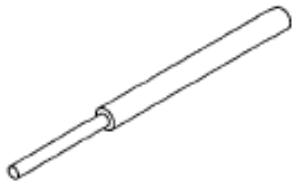
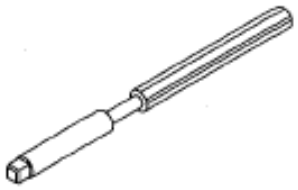
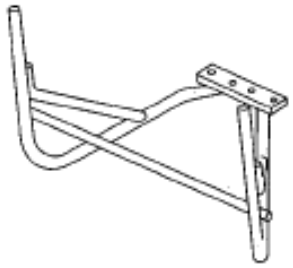
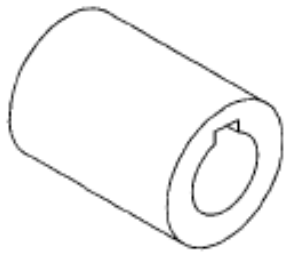
 ST-499718000			
 ST-499767200	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST-499767400	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499817100	499817100	ENGINE STAND	• Used for disassembling and assembling engine. • Used together with ENGINE STAND ADAPTER RH (498457000)&LH (498457100).
 ST-499987500	499977100	CRANK PULLEY WRENCH	Used to stop rotation of the crank pulley when loosening or tightening crank pulley bolts. (MT model)

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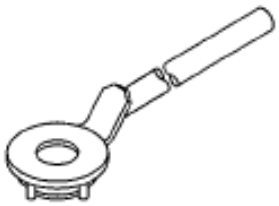
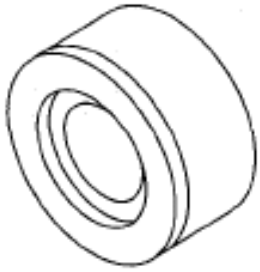
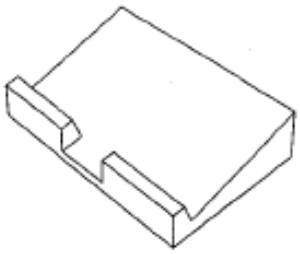
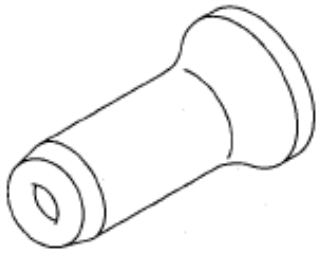
 ST-499977400	499977400	CRANK PULLEY WRENCH	Used to stop rotation of the crank pulley when loosening or tightening crank pulley bolts. (AT model)
 ST18251AA020	499977500	CAM SPROCKET WRENCH	Used for removing and installing intake cam sprocket.
 ST-498267600	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST-499587600	18251AA020	VALVE GUIDE ADJUSTER	Used for installing intake and exhaust valve guides.
ST18353AA000	18353AA000	CLAMP PLIERS	• Used for removing and installing the PCV hose. • This tool is made by the French company CAILLAU. (code) 54.0.000.205 To make it easier to obtain, it has been provided with a tool number.

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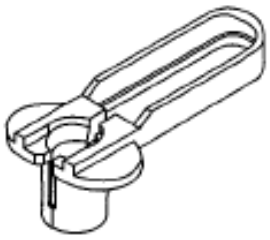
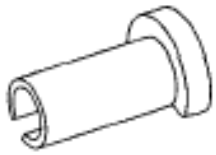
 ST18371AA000	18371AA000	CONNECTOR REMOVER	Used for disconnecting the quick connector on the fuel return hose of the engine compartment.
 ST42099AE000	42099AE000	QUICK CONNECTOR RELEASE	Used for disconnecting quick connector of the engine compartment.
ST1B022XU0	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for various inspections.

GENERAL TOOL

GENERAL TOOL DESCRIPTION

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
Timing light	Used for measuring ignition timing.
Vacuum gauge	Used for measuring intake manifold vacuum.
Oil pressure gauge	Used for measuring engine oil pressure.
Fuel pressure gauge	Used for measuring fuel pressure.

PROCEDURE

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

- V-belt
- Timing belt

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- Camshaft
- Cylinder head

COMPRESSION

INSPECTION

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

1. After warming-up the engine, turn the ignition switch to OFF.
2. Make sure that the battery is fully charged.
3. Remove the fuse of fuel pump from main fuse box.

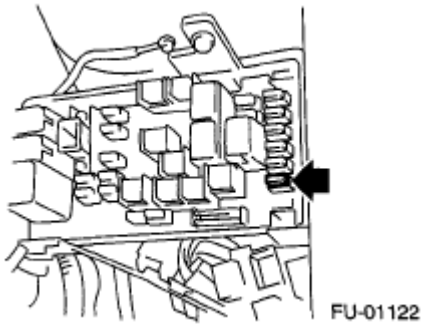

Fig. 7: Locating Fuel Pump Fuse
Courtesy of SUBARU OF AMERICA, INC.

4. Start the engine and run it until it stalls.
5. After the engine stalls, crank it for five more seconds.
6. Turn the ignition switch to OFF.
7. Remove all spark plugs. Ref. to **REMOVAL** , Spark Plug.
8. Fully open the throttle valve.
9. Check the starter motor for satisfactory performance and operation.
10. Secure the compression gauge tightly against the spark plug hole.

NOTE: When using a screw-in type compression gauge, the screw should be less than 18 mm (0.71 in) long.

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

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Fig. 8: Checking Compression Using Compression Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

    Compression (fully open throttle):

    Standard

    981 - 1,177 kPa (10 - 12 kgf/cm^2 , 142 - 171 psi)

    Difference between cylinders

    49 kPa (0.5 kgf/cm^2 , 7 psi) or less

13. 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 Monitor.
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 at "P" or "N" position on AT model, or neutral position on MT model): 700±100 RPM

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

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one minute before measurement.)

Idle speed (A/C ON and at "P" or "N" position on AT model, or neutral position on MT model):

825±100 RPM (AT model)

800±100 RPM (MT model)

NOTE: Idle speed cannot be adjusted manually, because the idle speed is automatically adjusted. If the prescribed idle speed cannot be maintained, 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 Monitor.

Ignition timing [BTDC/RPM]:

17°±10°/700 (AT model)

12°±10°/700 (MT model)

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.

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2. Warm up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Disconnect the ground cable from battery.

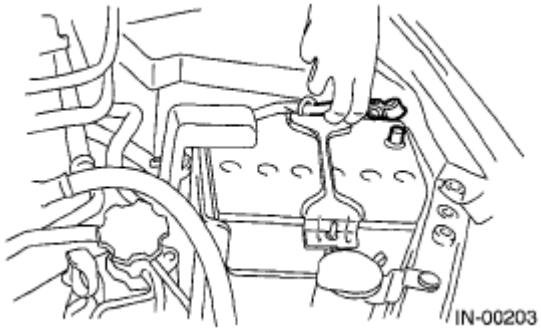

Fig. 9: Disconnecting/Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the air intake duct. Ref. to **REMOVAL** , Air Intake Duct.
6. Disconnect the connector from mass air flow and intake air temperature sensor.
7. Remove the air cleaner case and element.
8. Connect the timing light to the power wire of #1 ignition coil.
9. Install the connectors of air cleaner case, element, and the mass air flow and intake air temperature sensor.
10. Connect the ground cable to battery.

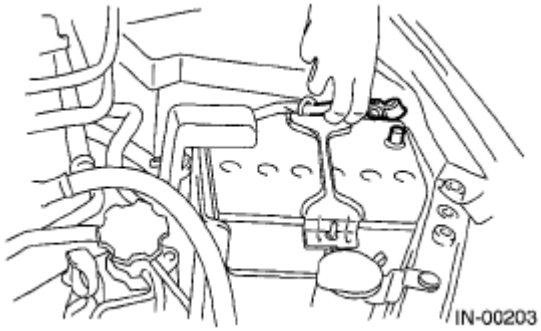

Fig. 10: Disconnecting/Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

11. 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 (AT model)

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12°±10°/700 (MT model)

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

INTAKE MANIFOLD VACUUM

INSPECTION

1. Warm up the engine.
2. Remove the intercooler. Ref. to **REMOVAL** , Intercooler.
3. Disconnect the brake booster vacuum hose from the intake manifold, and install the vacuum gauge.
4. Install the intercooler. Ref. to **INSTALLATION** , Intercooler.
5. Keep the engine at idle speed and read the vacuum gauge indication.

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

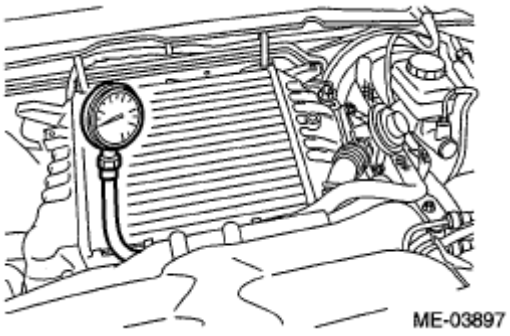

Fig. 11: Checking Intake Manifold Vacuum Using Vacuum Gauge
Courtesy of SUBARU OF AMERICA, INC.

Intake manifold vacuum (at idling, A/C OFF):

Less than -68.0 kPa (-510 mmHg, -20.08 inHg) (AT model)

Less than -70.6 kPa

(-530 mmHg, -20.85 inHg) (MT model)

INTAKE MANIFOLD VACUUM REFERENCE

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

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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

ENGINE OIL PRESSURE

INSPECTION

1. Disconnect the ground cable from battery.

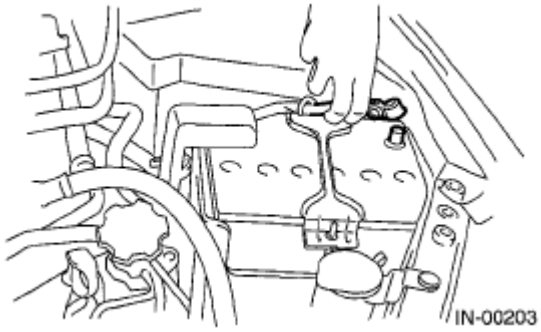

Fig. 12: Disconnecting/Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the oil pressure switch. Ref. to **REMOVAL** , Oil Pressure Switch.
3. Install the oil pressure gauge to cylinder block.
4. Connect the ground cable to battery.

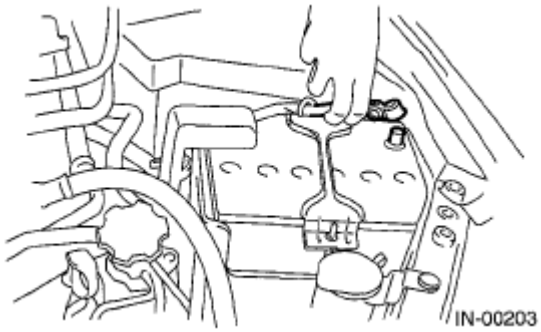

Fig. 13: Disconnecting/Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

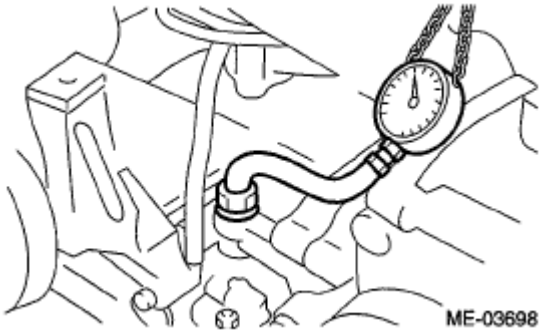

Fig. 14: Measuring Engine Oil Pressure
Courtesy of SUBARU OF AMERICA, INC.

Engine oil pressure:

Standard 98 kPa (1.0 kgf/cm^2 , 14 psi) or more (at 600 RPM)

294 kPa (3.0 kgf/cm^2 , 43 psi) or more (at 5,000 RPM)

- If the oil pressure is out of specification, check 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 **INSPECTION** , Engine Lubrication System Trouble in General.

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

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

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. Open the fuel filler lid and remove the fuel filler cap.

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3. Disconnect the fuel delivery hose from fuel damper, and connect fuel pressure gauge.

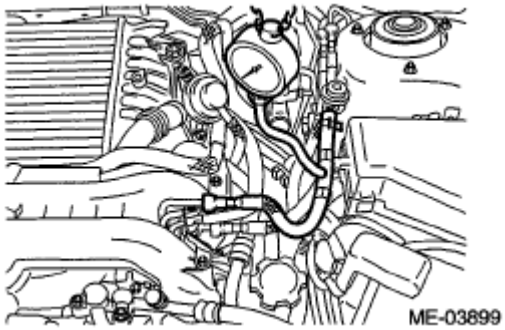

Fig. 15: Measuring Fuel Pressure Using Fuel Pressure Gauge
Courtesy of SUBARU OF AMERICA, INC.

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/cm^2 , 1 to 3 psi) higher than standard values during high-altitude operations.**

Fuel pressure:

Standard

284 - 314 kPa

(2.9 - 3.2 kgf/cm^2 , 41 - 46 psi)

6. After connecting the pressure regulator vacuum hose, measure the fuel pressure.

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

Fuel pressure:

Standard

230 - 260 kPa

(2.35 - 2.65 kgf/cm^2 , 33 - 38 psi)

VALVE CLEARANCE

INSPECTION

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CAUTION: If engine oil is spilt onto the exhaust pipe, wipe it off with cloth to avoid emission of smoke or causing a fire.

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

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

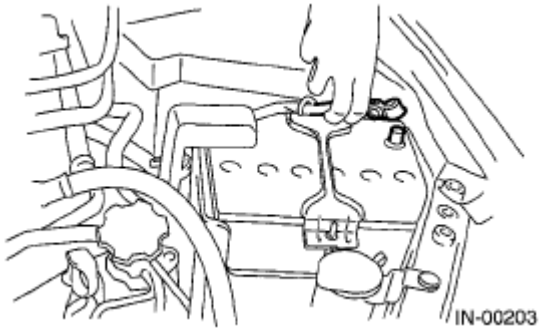

Fig. 16: Disconnecting/Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: For the PCV hose affixed with the clamp, fit the depression in the ST with the protrusion of the clamp as shown in the figure below, unlock the clamp and disconnect.

ST 18353AA000 CLAMP PLIERS

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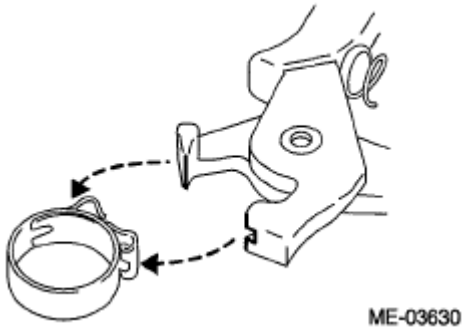

Fig. 17: Identifying PCV Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the bolts, then remove the rocker cover RH.

10. When inspecting #2 and #4 cylinders
    1. Remove the battery. Ref. to **REMOVAL** , Battery.
    2. Remove the secondary air pump. Ref. to **REMOVAL** , Secondary Air Pump.
    3. Remove the ignition coil. Ref. to **REMOVAL** , Ignition Coil.
    4. Place a suitable container under the vehicle.
    5. Disconnect the PCV hose from the rocker cover LH.

NOTE: For the PCV hose affixed with the clamp, fit the depression in the ST with the protrusion of the clamp as shown in the figure below, unlock the clamp and disconnect.

ST 18353AA000 CLAMP PLIERS

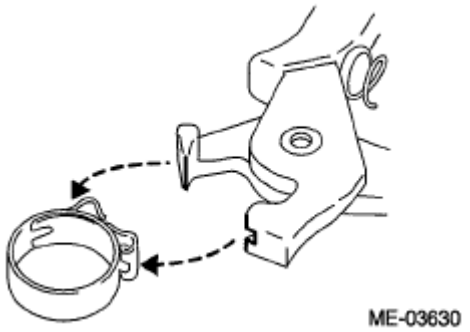

Fig. 18: Identifying PCV Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the bolts, then remove the rocker cover LH.

11. Turn the crank pulley clockwise until the round mark and arrow mark on the cam sprocket are set to position shown in the figure.

NOTE: Turn the crank pulley using a socket wrench.

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- Measurement of clearance of #1 cylinder intake valve and #3 cylinder exhaust valve

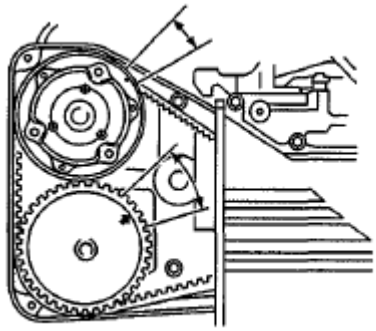

Fig. 19: Measuring Clearance Of 1 Cylinder Intake Valve And 3 Cylinder Exhaust Valve
Courtesy of SUBARU OF AMERICA, INC.

- Measurement of clearance of #2 cylinder exhaust valve and #3 cylinder intake valve

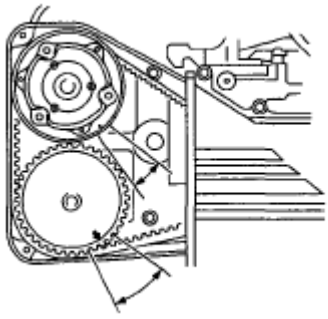

Fig. 20: Measuring Clearance Of 2 Cylinder Exhaust Valve And 3 Cylinder Intake Valve
Courtesy of SUBARU OF AMERICA, INC.

- Measurement of clearance of #2 cylinder intake valve and #4 cylinder exhaust valve

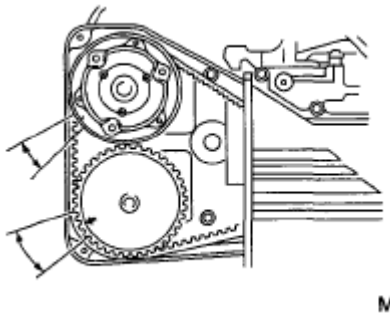

Fig. 21: Measuring Clearance Of 2 Cylinder Intake Valve And 4 Cylinder Exhaust Valve
Courtesy of SUBARU OF AMERICA, INC.

- Measurement of clearance of #1 cylinder exhaust valve and #4 cylinder intake valve

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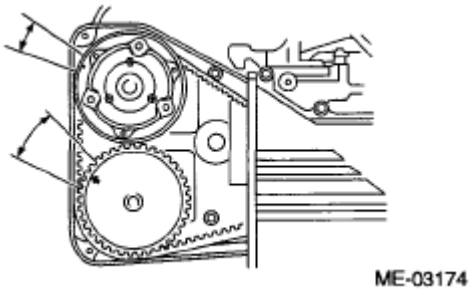

Fig. 22: Measuring Clearance Of 1 Cylinder Exhaust Valve And 4 Cylinder Intake Valve
Courtesy of SUBARU OF AMERICA, INC.

12. Measure the clearance of intake valve and exhaust valve 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 then measure the exhaust valve clearances.**
- **If the measured value is not within the inspection value, take notes of the value in order to adjust the valve clearance later on.**

Valve clearance (inspection value):

Intake

$0.20^{+004}_{-0.06}$ ***mm*** $(0.0079^{+00016}_{-0.0024}$ ***in)***

Exhaust

0.35±0.05 mm (0.0138±0.0020 in)

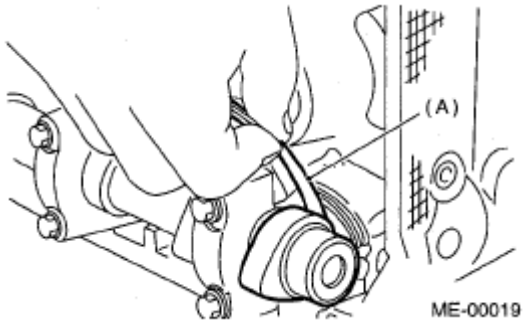

Fig. 23: Measuring Clearance Of Intake Valve And Exhaust Valve Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

13. If necessary, adjust the valve clearance. Ref. to **ADJUSTMENT**, Valve Clearance.
14. After inspection, install the related parts in the reverse order of removal.

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NOTE:

- **Use a new rocker cover gasket.**
- **Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the figure, and lock the clamp.**

ST 18353AA000 CLAMP PLIERS

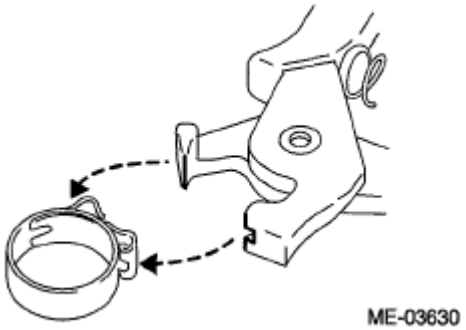

Fig. 24: Identifying PCV Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

ADJUSTMENT

CAUTION: If engine oil is spilt onto the exhaust pipe, wipe it off with cloth to avoid emission of smoke or causing a fire.

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

1. Measure all the valve clearances. Ref. to **INSPECTION**, Valve Clearance.

NOTE: Record each valve clearance after measurement.

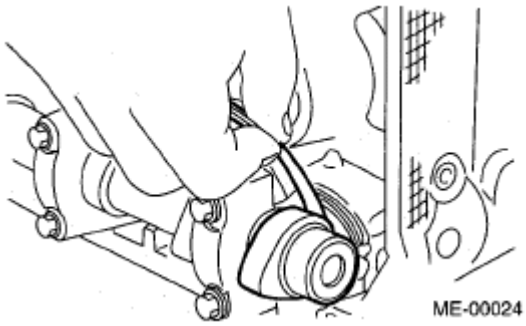

Fig. 25: Measuring Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the camshaft. Ref. to **REMOVAL**, Camshaft.

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3. Remove the valve lifter.
4. Measure the thickness of valve lifter using micrometer.

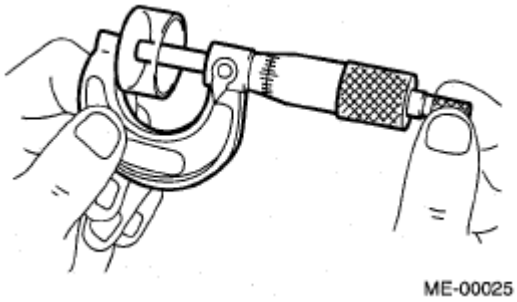

Fig. 26: Measuring Thickness Of Valve Lifter Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new valve lifter.

VALVE LIFTER THICKNESS REFERENCE

Unit: mm (in)
Intake valve: S = (V + T) - 0.19 (0.0075) Exhaust valve: S = (V + T) - 0.35 (0.0138)
S: Valve lifter thickness required V: Measured valve clearance T: Valve lifter thickness to be used

VALVE LIFTER THICKNESS REFERENCE

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)

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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)
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)

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	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)
13228 AB852	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)

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6. Install the camshaft. Ref. to **INSTALLATION**, Camshaft.
7. Install the cam sprocket. Ref. to **INSTALLATION**, Cam Sprocket.
8. Install the timing belt. Ref. to **TIMING BELT**, INSTALLATION, Timing Belt.
9. Measure all valves for valve clearance again at this time. If the valve clearance is not within the adjustment value, repeat the procedure over again from the first step.

   Valve clearance (adjustment value):

   Intake

   $0.20^{+001}_{-0.03}$ ***mm*** $(0.0079^{+00004}_{-0.0012}$ ***in)***

   Exhaust

   0.35±0.02 mm (0.0138±0.0008 in)

10. After measurement, install the related parts in the reverse order of removal.

NOTE:

- **Use a new rocker cover gasket.**
- **Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the figure, and lock the clamp.**

ST 18353AA000 CLAMP PLIERS

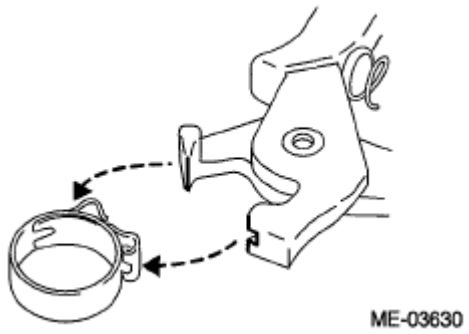

Fig. 27: Identifying PCV Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

ENGINE ASSEMBLY

REMOVAL

1. Set the vehicle on a lift.
2. Change the bolt installation position from (A) to (B), then open the front hood completely.

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Tightening torque:

7.5 N.m (0.8 kgf-m, 5.5 ft-lb)

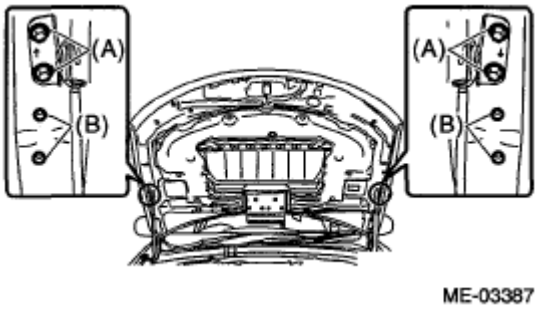

Fig. 28: Identifying Engine Assembly Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the V-belt covers.

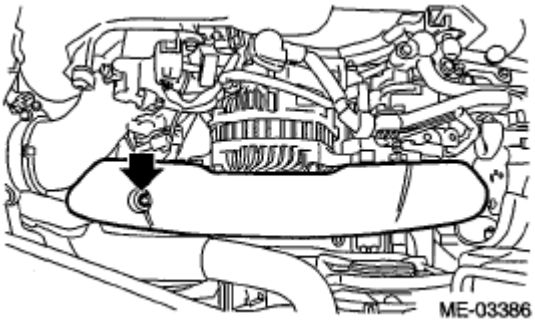

Fig. 29: Identifying V-Belt Covers
Courtesy of SUBARU OF AMERICA, INC.

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. Remove the battery. Ref. to **REMOVAL** , Battery.
7. Open the fuel filler lid and remove the fuel filler cap.
8. Remove the air intake duct and air cleaner case. Ref. to **REMOVAL** , Air Intake Duct. Ref. to **REMOVAL** , Air Cleaner Case.
9. Remove the intercooler. Ref. to **REMOVAL** , Intercooler.
10. Remove the radiator. Ref. to **REMOVAL** , Radiator.
11. Remove the coolant filler tank. Ref. to **REMOVAL** , Coolant Filler Tank.
12. Disconnect the A/C pressure hoses from A/C compressor. Ref. to **REMOVAL** , Hose and Pipe.
13. Disconnect the bulkhead harness connectors from the engine harness connectors.

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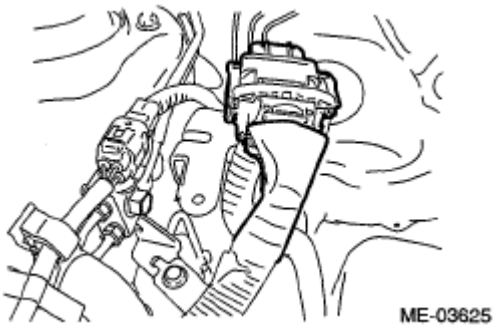

Fig. 30: Identifying Bulkhead Harness Connector And Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the engine harness connector from the engine harness bracket.

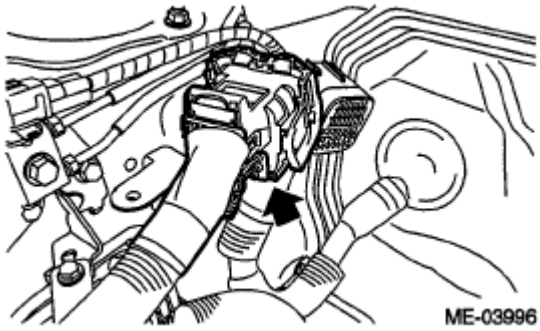

Fig. 31: Locating Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

15. Disconnect the following connectors and terminals.
    1. Generator connector and terminal

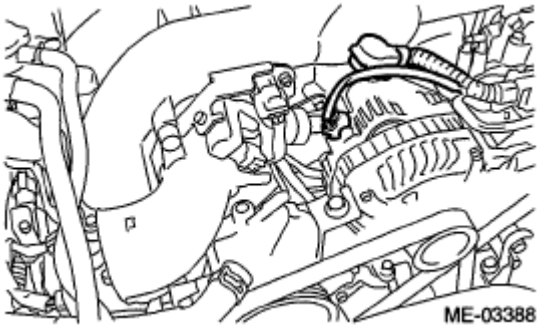

Fig. 32: Identifying Generator Connector And Terminal
Courtesy of SUBARU OF AMERICA, INC.

    2. A/C compressor connector

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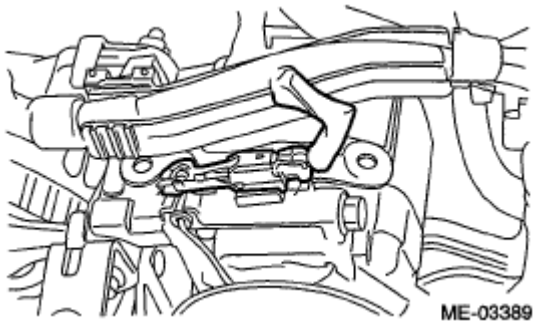

Fig. 33: Identifying A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Secondary air pump connector

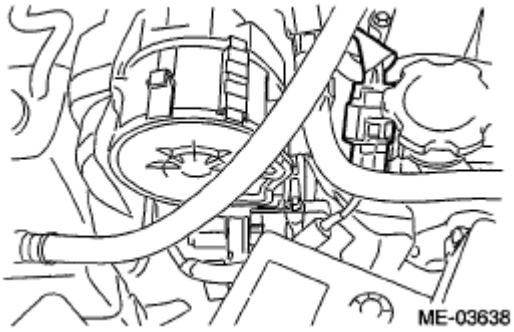

Fig. 34: Identifying Secondary Air Pump Connector
Courtesy of SUBARU OF AMERICA, INC.

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

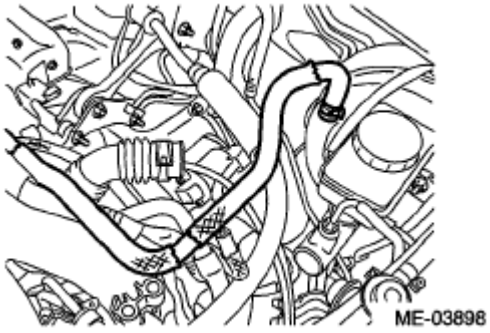

Fig. 35: Identifying Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

    2. Heater inlet and outlet hoses

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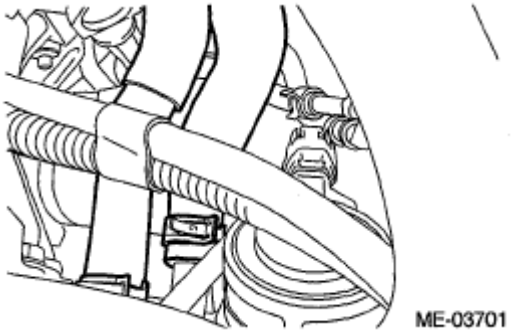

Fig. 36: Identifying Heater Inlet And Outlet Hoses
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the power steering pump.
    1. Remove the front side belts. Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt.
    2. Disconnect the power steering pump switch connector.

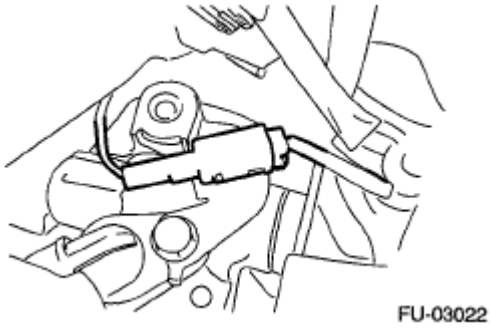

Fig. 37: Identifying Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

    3. Remove the power steering pump from the engine.

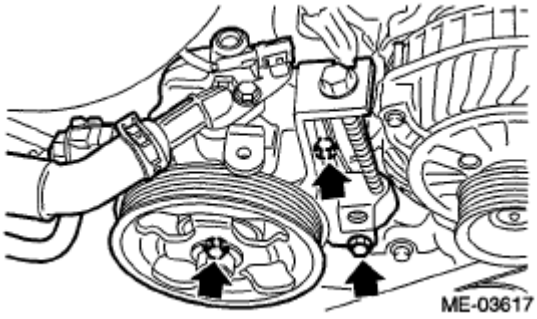

Fig. 38: Locating Power Steering Pump Bolt And Wheel Apron Bolt
Courtesy of SUBARU OF AMERICA, INC.

    4. Place the power steering pump on the right side wheel apron.
18. Remove the center exhaust pipe. Ref. to **REMOVAL** , Center Exhaust Pipe.

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19. Remove the turbocharger. Ref. to **REMOVAL** , Turbocharger.
20. Remove the joint pipe and front exhaust pipe. Ref. to **REMOVAL** , Joint Pipe. Ref. to **REMOVAL** , Front Exhaust Pipe.
21. Disconnect the ground cable on the engine side.

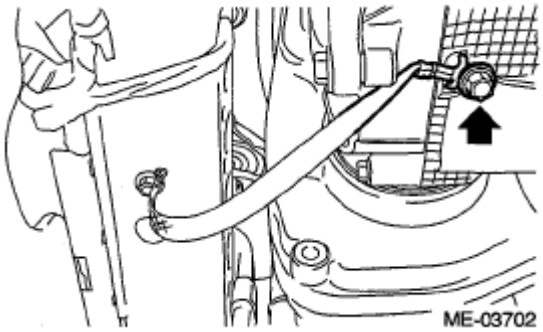

Fig. 39: Locating Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

22. Remove the bolts and nuts which hold the lower side of transmission to the engine.
    - AT MODEL

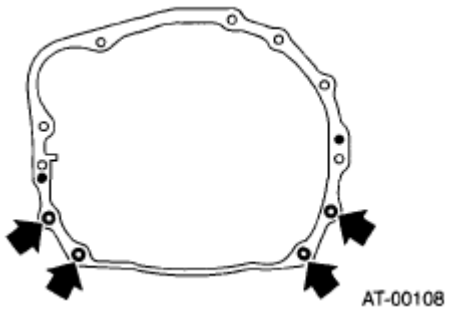

Fig. 40: Locating Transmission Bolts And Nuts - AT Model
Courtesy of SUBARU OF AMERICA, INC.

    - MT MODEL

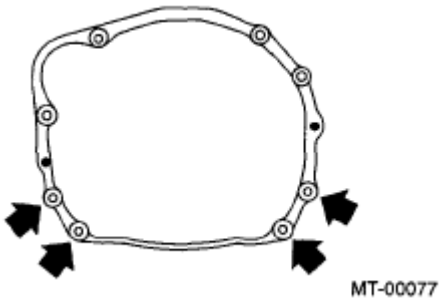

Fig. 41: Locating Transmission Bolts And Nuts - MT Model

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Courtesy of SUBARU OF AMERICA, INC.

23. Remove the nuts which secure the engine mounting to the front crossmember.

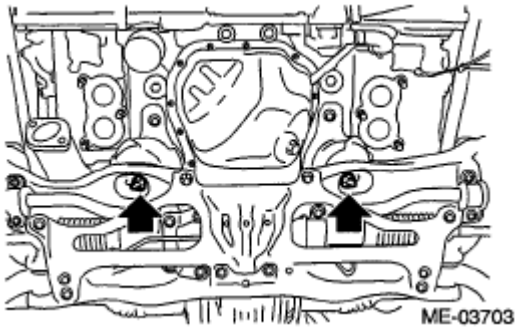

Fig. 42: Locating Engine Mounting Securing Nuts
Courtesy of SUBARU OF AMERICA, INC.

24. Lower the vehicle.
25. Separate the torque converter clutch from the drive plate. (AT model)
    1. Remove the service hole plug.
    2. Insert the wrench into the crank pulley bolt and rotate the crank pulley to remove the bolts which hold torque converter clutch to drive plate.

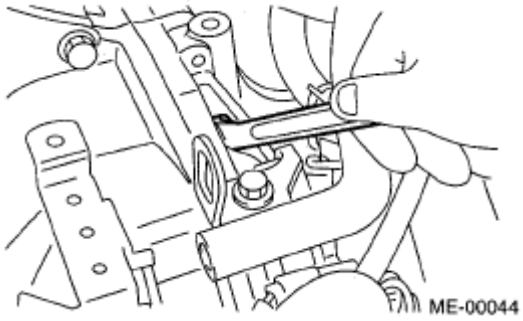

Fig. 43: Holding Torque Converter
Courtesy of SUBARU OF AMERICA, INC.

26. Remove the pitching stopper.

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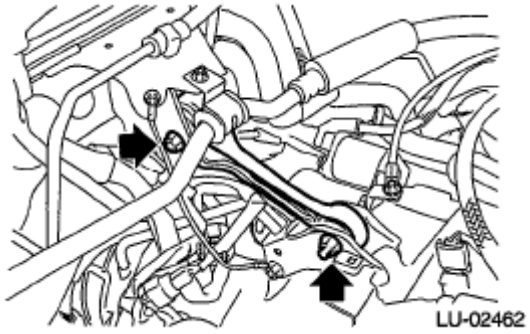
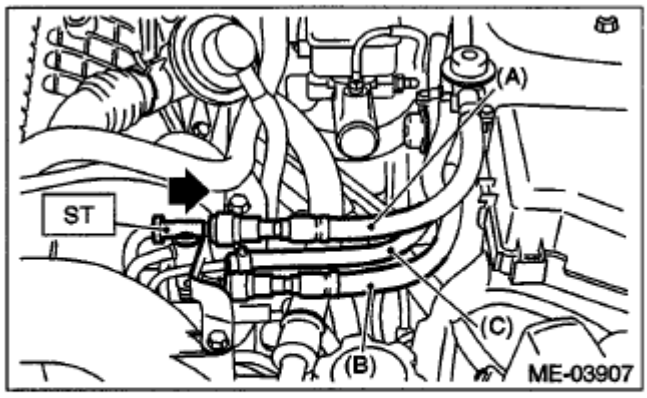


Fig. 44: Locating Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

27. Attach ST to the fuel delivery pipe and push ST in the direction of arrow mark to disconnect the fuel delivery hose.

    ST 42099AE000 QUICK CONNECTOR RELEASE

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



(A) Fuel delivery hose
(B) Fuel return hose
(C) Evaporation hose

Fig. 45: Identifying Fuel Delivery Pipe, Fuel Return Hose And Evaporation Hose
Courtesy of SUBARU OF AMERICA, INC.

28. Disconnect the fuel return hose using the ST.

    ST 18371AA000 CONNECTOR REMOVER

    CAUTION:
    - **Be careful not to spill fuel.**

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- **Catch the fuel from hoses using a container or cloth.**

1. Attach ST to the fuel return pipe as shown in the figure.

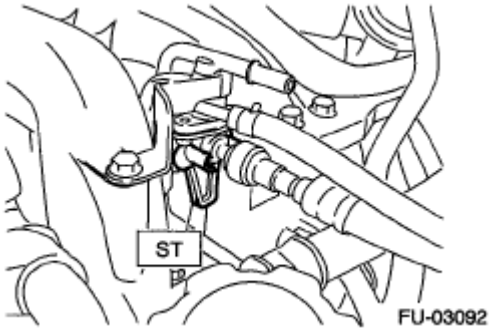

Fig. 46: Identifying Fuel Return Pipe
Courtesy of SUBARU OF AMERICA, INC.

2. Insert the front side of ST into the quick connector.

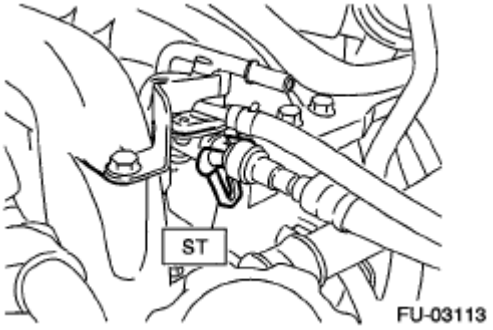

Fig. 47: Identifying Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Insert the back side of ST into the quick connector and push ST in the direction of arrow mark to disconnect the fuel return hose.

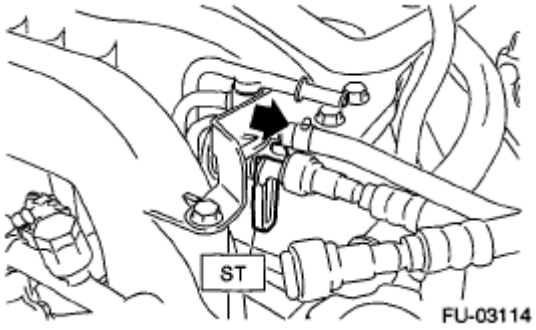

Fig. 48: Identifying Fuel Return Hose
Courtesy of SUBARU OF AMERICA, INC.

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29. Remove the clip and disconnect the evaporation hose from the fuel pipe.

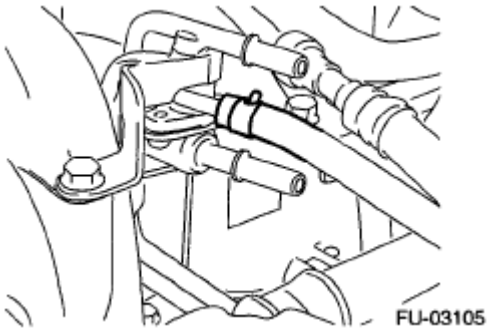

Fig. 49: Identifying Evaporation Hose And Fuel Pipe
Courtesy of SUBARU OF AMERICA, INC.

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

Fig. 50: Identifying Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

31. Support the transmission with a garage jack.

CAUTION: Be sure to perform this procedure to prevent the transmission from lowering by its own weight.

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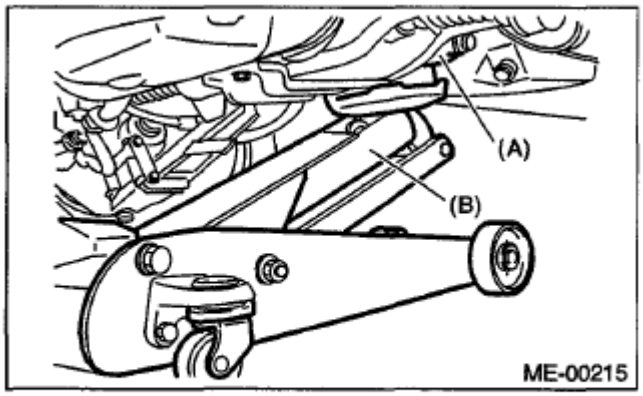

(A) Transmission
(B) Garage jack

Fig. 51: Identifying Transmission And Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

32. 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. Attach the ST to the torque converter clutch case. (AT model)

   ST 498277200 STOPPER SET

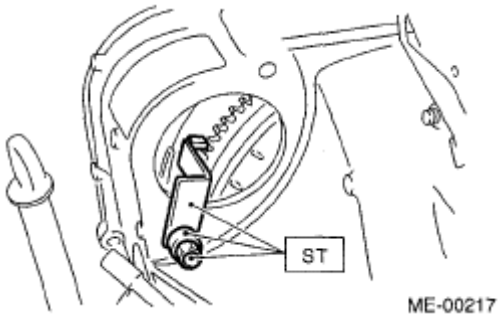

Fig. 52: Identifying Stopper Set
Courtesy of SUBARU OF AMERICA, INC.

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

- AT MODEL

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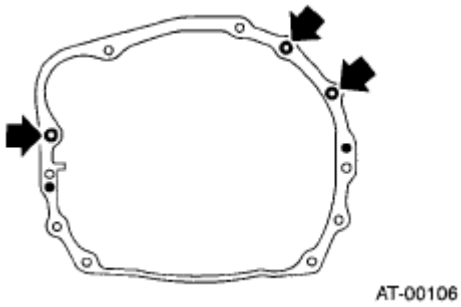

Fig. 53: Locating Bolts Holding Upper Side Of Transmission To Engine - AT Model
Courtesy of SUBARU OF AMERICA, INC.

- MT MODEL

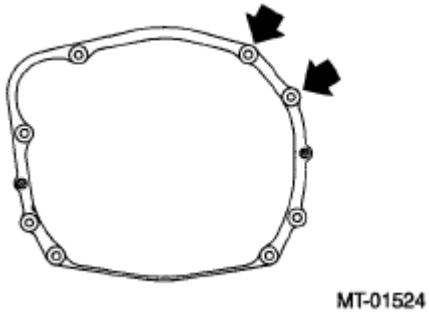

Fig. 54: Locating Bolts Holding Upper Side Of Transmission To Engine - MT Model
Courtesy of SUBARU OF AMERICA, INC.

33. 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. (MT model)
    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.

34. Remove the engine mounting from the engine.

INSTALLATION

1. Install the engine mounting onto the engine.

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

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

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Grease: NICHIMOLY N-130 or equivalent

3. Position the engine in engine compartment and align it with 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)

- AT MODEL

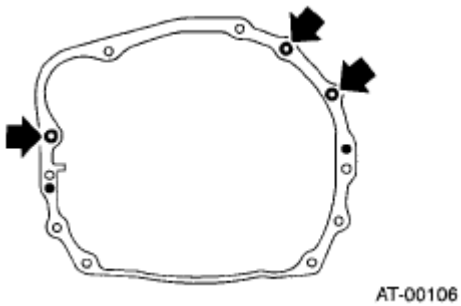

Fig. 55: Locating Bolts Holding Upper Side Of Transmission To Engine - AT Model
Courtesy of SUBARU OF AMERICA, INC.

- MT MODEL

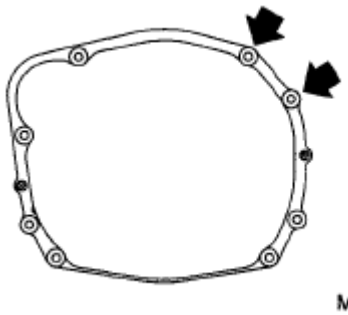

Fig. 56: Locating Bolts Holding Upper Side Of Transmission To Engine - MT Model
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.

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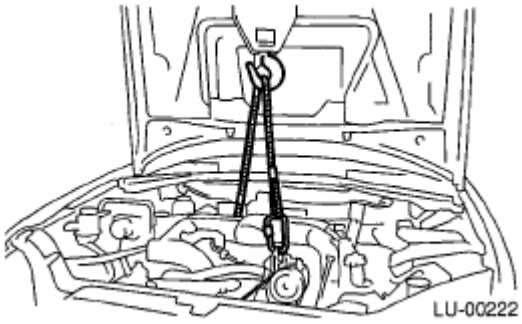

Fig. 57: Identifying Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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)

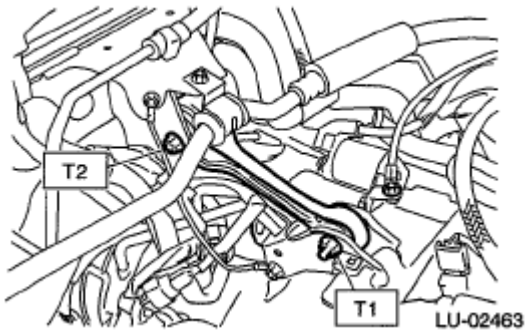

Fig. 58: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

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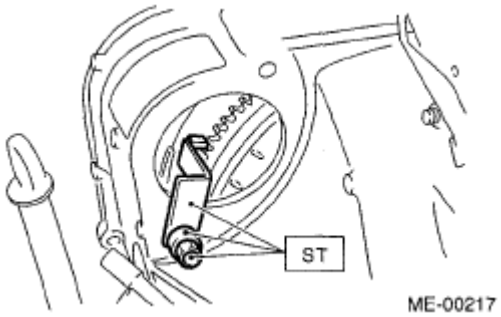

Fig. 59: Identifying Stopper Set
Courtesy of SUBARU OF AMERICA, INC.

9. Install the starter. Ref. to **INSTALLATION** , Starter.
10. Install the torque converter clutch to drive plate. (AT model)
    1. Insert the wrench into the crank pulley bolt and rotate the crank pulley to install the bolts which hold torque converter clutch to drive plate.

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

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

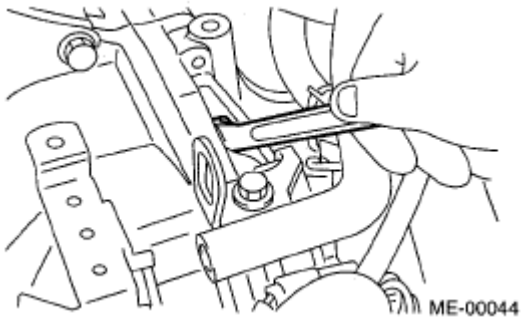

Fig. 60: Holding Torque Converter
Courtesy of SUBARU OF AMERICA, INC.

    2. Fit the plug to service hole.
11. Install the power steering pump.
    1. Install the power steering pump onto the engine.

       Tightening torque:

       Refer to "COMPONENT" of "Power Steering" for the tightening torque. Ref. to COMPONENT , General Description.

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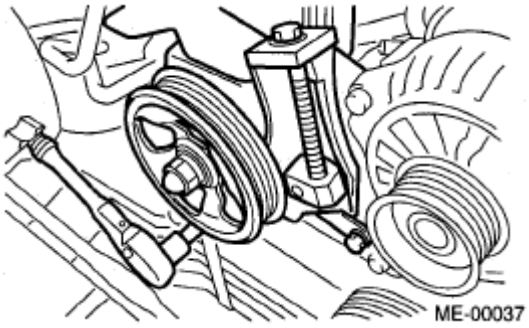

Fig. 61: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the power steering pump switch connector.

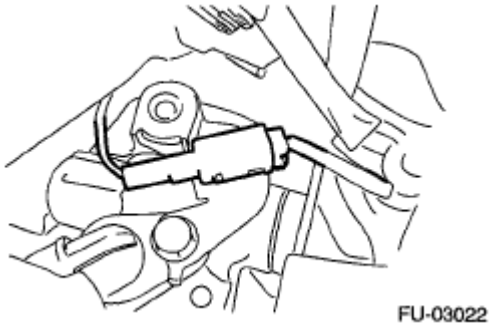

Fig. 62: Identifying Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Install and adjust the front side belt. Ref. to **FRONT SIDE BELT**, INSTALLATION, V-belt.

12. Lift up the vehicle.
13. Install the bolts and nuts which hold lower side of the transmission to engine.

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

- AT MODEL

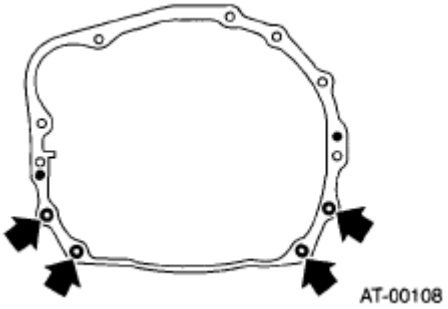

Fig. 63: Locating Transmission Bolts And Nuts - AT Model

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Courtesy of SUBARU OF AMERICA, INC.

- MT MODEL

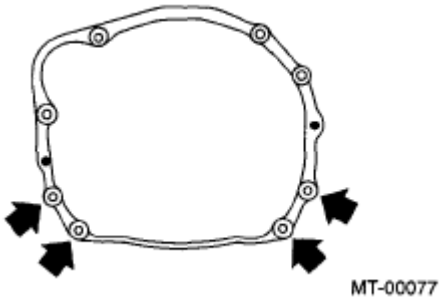

Fig. 64: Locating Transmission Bolts And Nuts - MT Model
Courtesy of SUBARU OF AMERICA, INC.

14. Install the nuts which hold the engine mounting to the crossmember.

NOTE: Make sure that the engine mounting nuts (A) and locator (B) are securely installed.

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

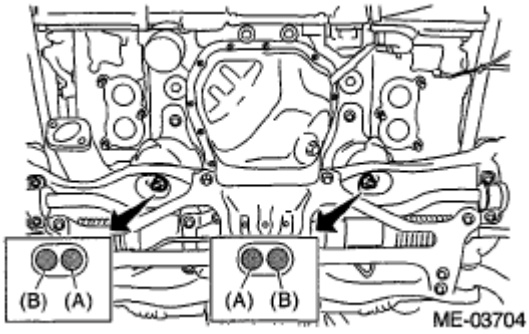

Fig. 65: Identifying Engine Mounting Nuts And Locator
Courtesy of SUBARU OF AMERICA, INC.

15. Install the joint pipe and front exhaust pipe. Ref. to **INSTALLATION** , Front Exhaust Pipe. Ref. to **INSTALLATION** , Joint Pipe.
16. Install the turbocharger. Ref. to **INSTALLATION** , Turbocharger.
17. Install the center exhaust pipe. Ref. to **INSTALLATION** , Center Exhaust Pipe.
18. Connect the ground cable.

Tightening torque: 7.5 N.m (0.8 kgf-m, 5.5 ft-lb)

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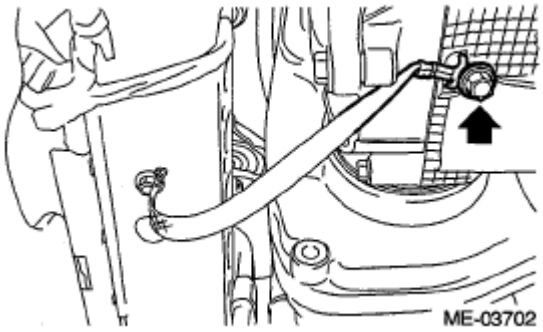

Fig. 66: Locating Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

19. Lower the vehicle.
20. Connect the following hoses.
    1. Fuel delivery hose, fuel return hose and evaporation hose
    2. Heater inlet and outlet hoses
    3. Brake booster vacuum hose
21. Connect the following connectors and terminals.
    1. Generator connector and terminal

       Tightening torque: 15 N.m (1.5 kgf-m, 11.1 ft-lb)

    2. A/C compressor connector
    3. Secondary air pump connector
22. Install the engine harness connector to engine harness bracket, then connect the bulkhead harness connector to the engine harness connector.

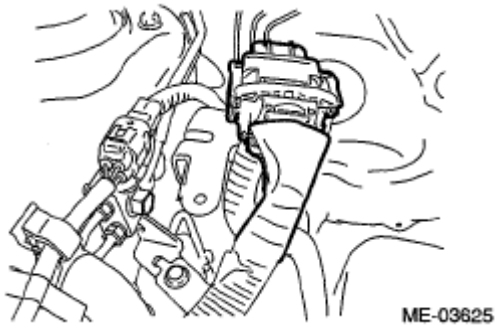

Fig. 67: Identifying Bulkhead Harness Connector And Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

23. Install the intercooler. Ref. to **INSTALLATION** , Intercooler.
24. Install the A/C pressure hoses to A/C compressor. Ref. to **INSTALLATION** , Hose and Pipe.
25. Install the radiator. Ref. to **INSTALLATION** , Radiator.

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26. Install the coolant filler tank. Ref. to **INSTALLATION** , Coolant Filler Tank.
27. Install the air cleaner case and air intake duct. Ref. to **INSTALLATION** , Air Cleaner Case. Ref. to **INSTALLATION** , Air Intake Duct.
28. Install the battery. Ref. to **INSTALLATION** , Battery.
29. Fill engine coolant. Ref. to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant.
30. Charge the A/C system with refrigerant. Ref. to **PROCEDURE** , Refrigerant Charging Procedure.
31. Check the ATF level and replenish it if necessary. (AT model) Ref. to **INSPECTION** , Automatic Transmission Fluid.
32. Install the V-belt cover.

Tightening torque: 13 N.m (1.3 kgf-m, 9.6 ft-lb)

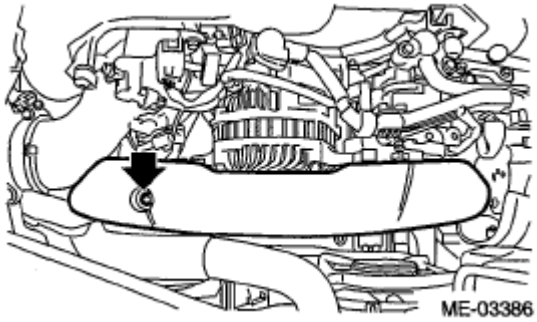

Fig. 68: Identifying V-Belt Covers
Courtesy of SUBARU OF AMERICA, INC.

33. Change the bolt installation position from (B) to (A), then close the front hood.

Tightening torque: 7.5 N.m (0.8 kgf-m, 5.5 ft-lb)

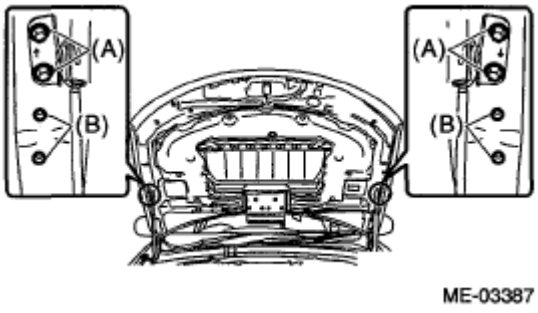

Fig. 69: Identifying Front Hood Bolt Installation Position
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Check that pipes, hoses, connectors and clamps are installed firmly.
2. Check the engine coolant is at specified level.

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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 assembly. Ref. to **REMOVAL**, Engine Assembly.
2. Remove the engine mounting from the 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

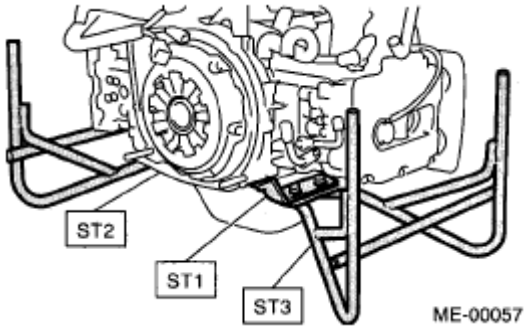

Fig. 70: Identifying Engine Stand Adapters And Engine Stand
Courtesy of SUBARU OF AMERICA, INC.

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2. In this article 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 article, to conduct the particular procedure within the flow of a article, you need to go back and conduct the procedure described previously in order to do that particular procedure.

V-BELT

REMOVAL

NOTE: When replacing the single part, perform the work with the engine installed to body.

FRONT SIDE BELT

1. Remove the V-belt covers.

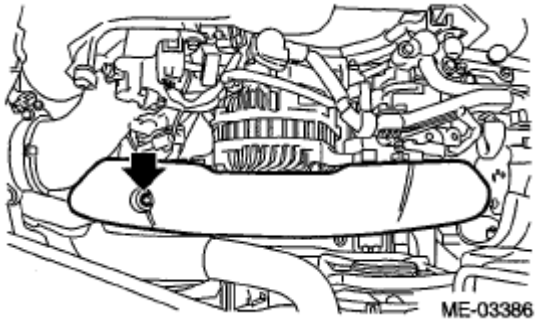

Fig. 71: Identifying V-Belt Covers
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake duct. Ref. to **REMOVAL** , Air Intake Duct.
3. Loosen the bolt (A).
4. Loosen the slider bolt (B).
5. Remove the front side belt (C).

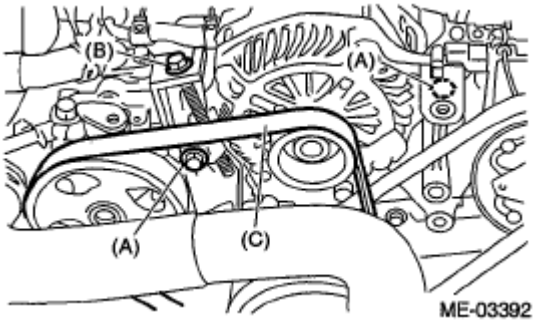

Fig. 72: Identifying Slider Bolt And Front Side Belt

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Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

1. Remove the front side belts. Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt.
2. Cut the rear side belt with a wire cutter, etc., and discard.

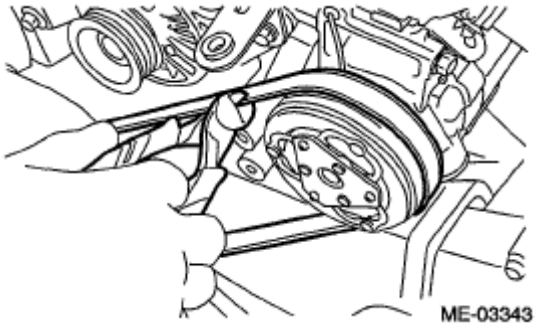

Fig. 73: Cutting Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

FRONT SIDE BELT

CAUTION:
- **When reusing the front side belt, wipe off dust and water with cloth.**
- **Do not use the front side belt if there is any oil, grease or coolant on the belt.**
- **Be careful not to rub the belt end surface with bare hands; exposed core may cause injury.**

1. Wipe off any dust, oil and water on the groove of each pulley with cloth.
2. Install the front side belt (C), and adjust the slider bolt (B) so as to obtain the specified belt tension. Ref. to **INSPECTION**, V-belt.
3. Tighten the bolt (A).
4. Tighten the slider bolt (B).

Tightening torque:

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)

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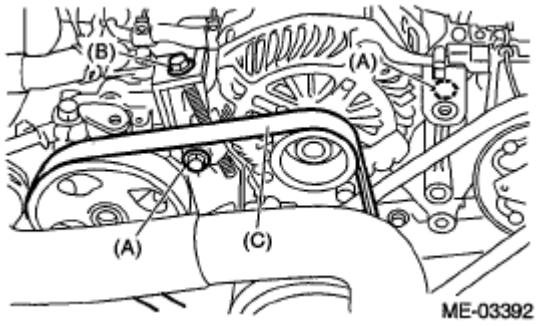

Fig. 74: Identifying Slider Bolt And Front Side Belt
Courtesy of SUBARU OF AMERICA, INC.

5. Install the air intake duct. Ref. to **INSTALLATION** , Air Intake Duct.
6. Install the V-belt cover.

Tightening torque:

13 N.m (1.3 kgf-m, 9.6 ft-lb)

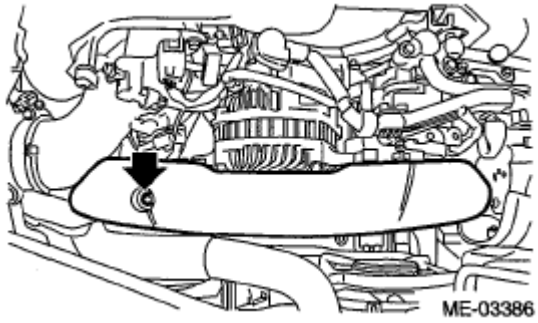

Fig. 75: Identifying V-Belt Covers
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

CAUTION:

- **Do not re-use the rear side belt.**
- **Be careful not to let oil, grease or coolant contact a new rear side belt.**
- **Be careful not to rub the belt end surface with bare hands; exposed core may cause injury.**
- **To install the rear side belt, always use the provided tools (belt stopper, belt guide, belt guide holder, and bolt).**

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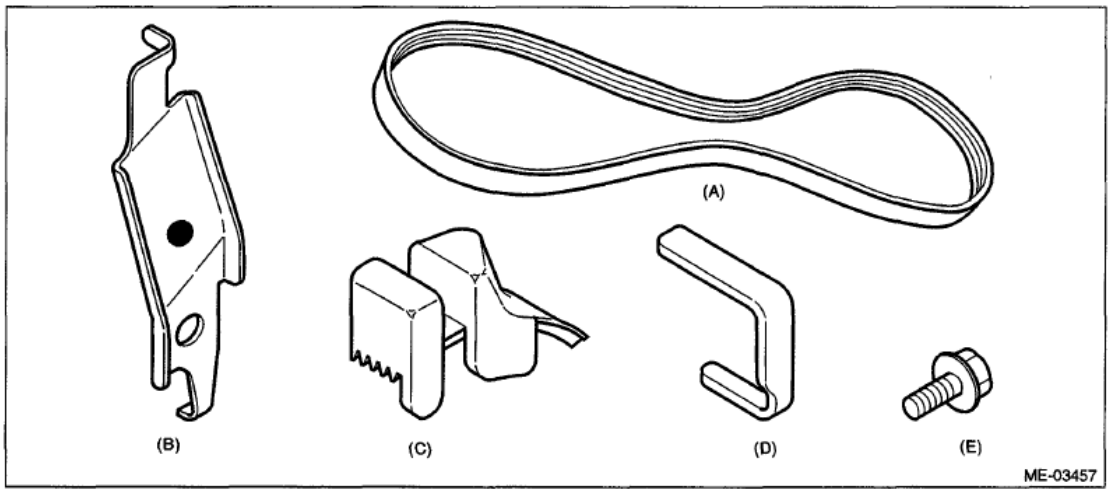

(A) Rear side belt
(B) Belt stopper
(C) Belt guide
(D) Belt guide holder
(E) Bolt

Fig. 76: Identifying Rear Side Belt Components
Courtesy of SUBARU OF AMERICA, INC.

1. Wipe off any dust, oil and water on the groove of each pulley with cloth.
2. Wipe off any oil, water, dirt, and rust on the front of the crank pulley with cloth.
3. Slowly turn the crank pulley clockwise so that the service hole of the crank pulley comes around the top.

CAUTION: Do not turn the crank pulley counterclockwise.

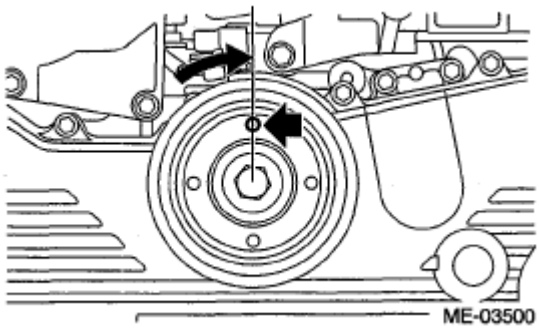

Fig. 77: Turning Crank Pulley Clockwise
Courtesy of SUBARU OF AMERICA, INC.

4. Hook a new rear side belt on the A/C compressor pulley.

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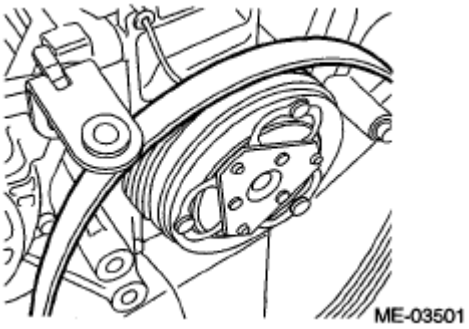

Fig. 78: Hooking Rear Side Belt On A/C Compressor Pulley
Courtesy of SUBARU OF AMERICA, INC.

5. As shown in the figure, insert the claw of the belt stopper (A) to the lower hole (B) of the compressor bracket, then attach with bolt (C).

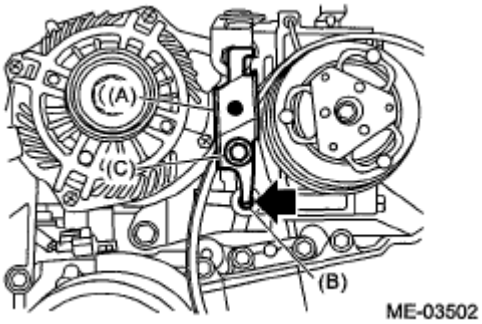

Fig. 79: Identifying Belt Stopper, Compressor Bracket Lower Hole And Bolt
Courtesy of SUBARU OF AMERICA, INC.

6. Place the belt guide while aligning it with the belt line of the crank pulley on the front side belt side.

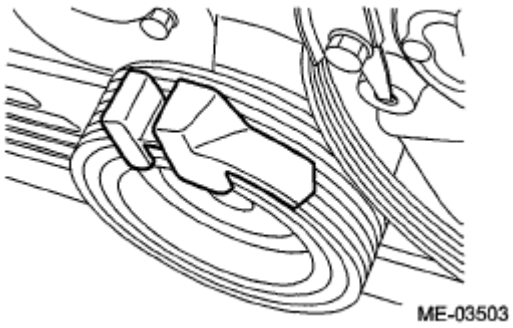

Fig. 80: Identifying Belt Guide On Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

7. Insert the belt guide holder into the service hole of the crank pulley so that the belt guide comes in between.

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NOTE: Place the belt guide holder with the longer side up.

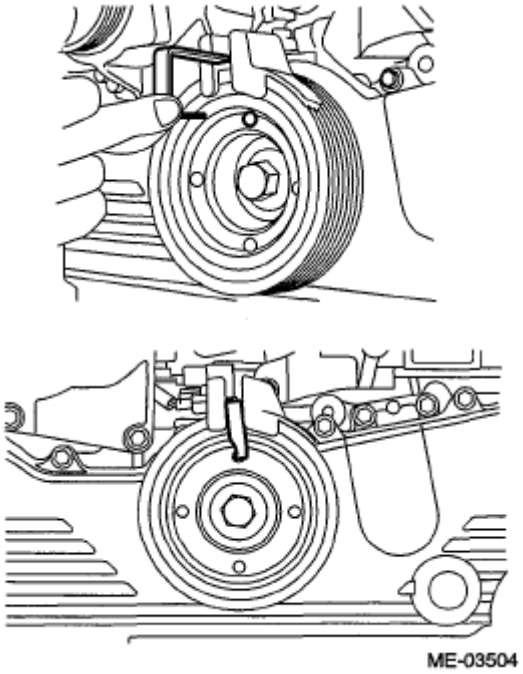

Fig. 81: Inserting Belt Guide Holder Into Service Hole Of Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

8. Slowly turn the crank pulley clockwise until the belt guide comes to approximately 45°.

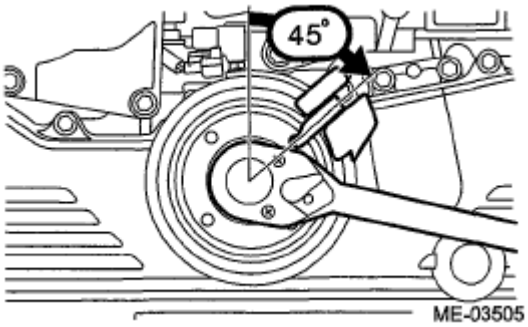

Fig. 82: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

9. Place the rib surface of the rear side belt into the crank pulley groove, so that the rear side belt comes in between the belt guide holder.

CAUTION: When it is difficult to place the rear side belt to the crank pulley groove, pull out the belt guide holder half way, then place the rear side belt into the groove so that it comes in between the belt guide holder.

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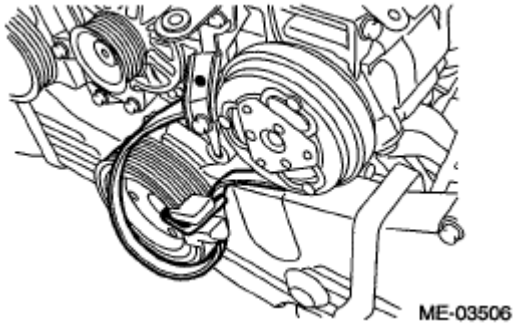

Fig. 83: Placing Rib Face Of Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

10. Place the tool through the loop of the rear side belt, and set on the crank pulley bolt.

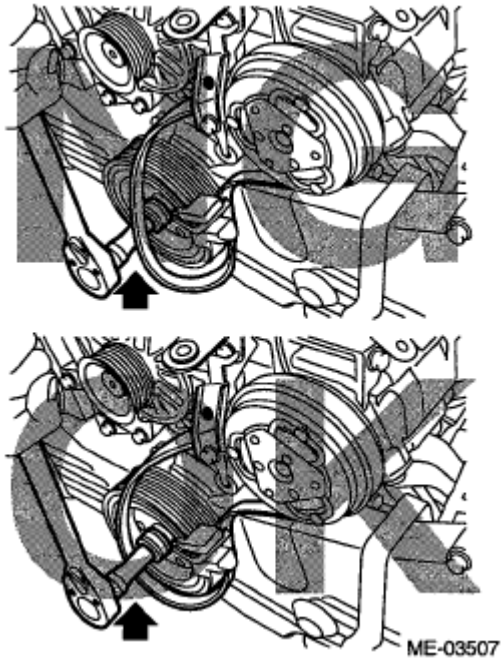

Fig. 84: Identifying Tool Correct And Incorrect Position
Courtesy of SUBARU OF AMERICA, INC.

11. While checking the following, slowly turn the crank pulley approximately 90° clockwise so that the belt guide comes to the position shown in the figure.

CAUTION: When turning the crank pulley, always make sure that the belt guide is not off from the crank pulley groove.

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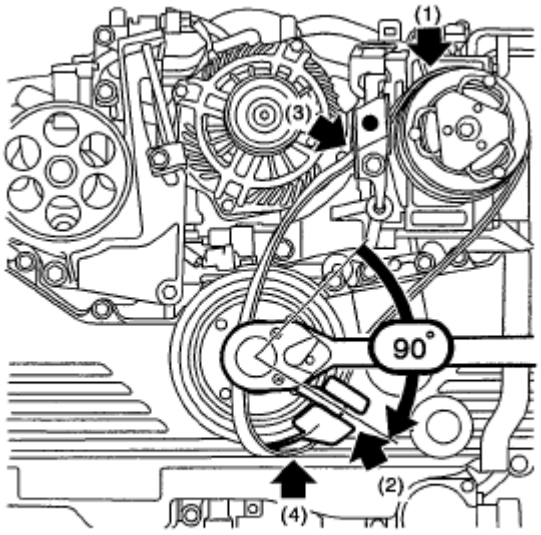
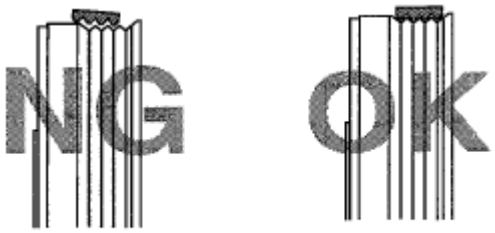


ME-03508

Fig. 85: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

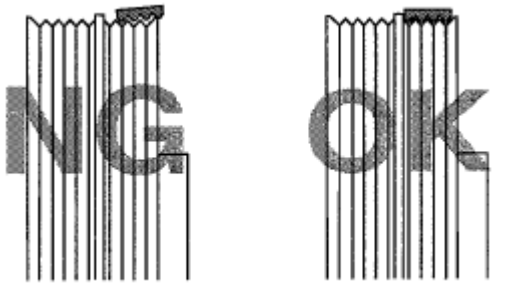
1. The rib of the rear side belt is securely placed on the groove of the A/C compressor pulley.



ME-03516

Fig. 86: Identifying Correct And Incorrect Position Of Rear Side Belt Rib On A/C Compressor Pulley
Courtesy of SUBARU OF AMERICA, INC.

2. The rib of the rear side belt is securely placed on the groove of the crank pulley.



ME-03518

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Fig. 87: Identifying Correct And Incorrect Position Of Rear Side Belt Rib On Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

3. The surface of the rear side belt is held by the belt stopper.

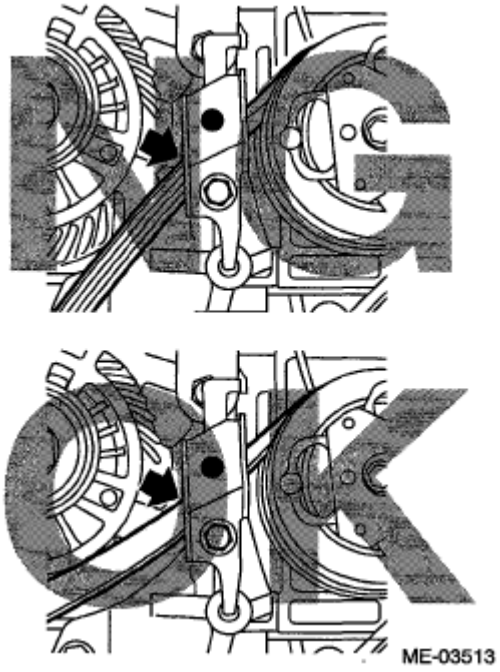

Fig. 88: Identifying Correct And Incorrect Position Of Rear Side Belt Surface By Belt Stopper
Courtesy of SUBARU OF AMERICA, INC.

4. The rear side belt is securely placed on the belt guide.

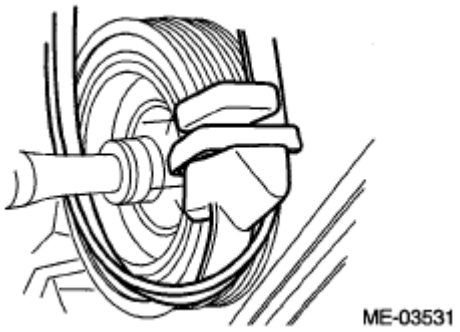

Fig. 89: Identifying Rear Side Belt On Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

12. While checking the following, slowly turn the crank pulley approximately 90° clockwise so that the belt guide comes to the position shown in the figure.

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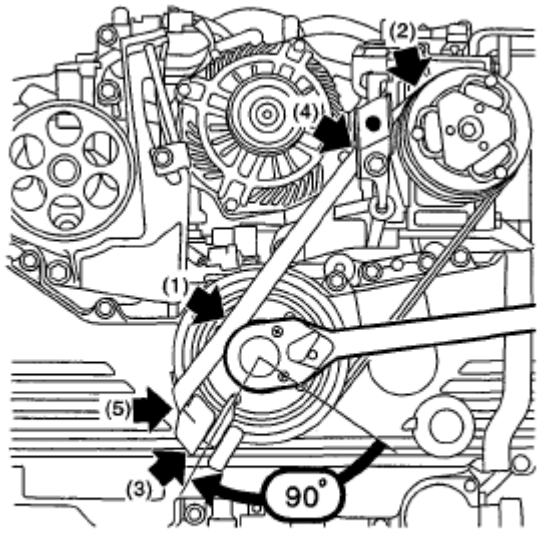
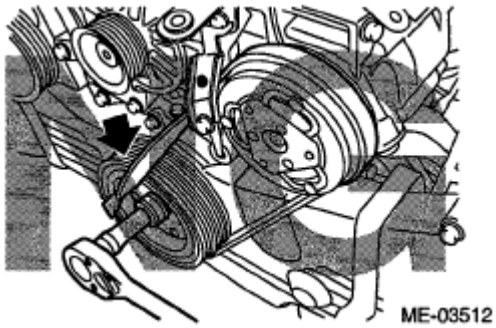


ME-03509

Fig. 90: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

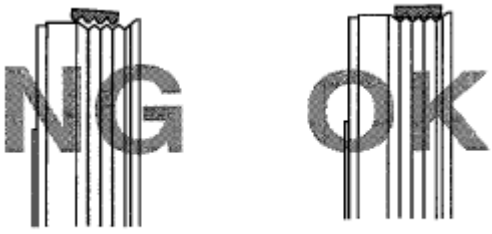
1. The rear side belt is not twisted.



ME-03512

Fig. 91: Identifying Rear Side Belt And Incorrect Position
Courtesy of SUBARU OF AMERICA, INC.

2. The rib of the rear side belt is securely placed on the groove of the A/C compressor pulley.



ME-03516

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Fig. 92: Identifying Correct And Incorrect Position Of Rear Side Belt Rib On A/C Compressor Pulley
Courtesy of SUBARU OF AMERICA, INC.

3. The rib of the rear side belt is securely placed on the groove of the crank pulley.

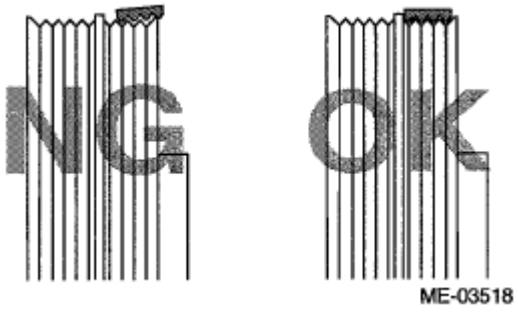

Fig. 93: Identifying Correct And Incorrect Position Of Rear Side Belt Rib On Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

4. The surface of the rear side belt is held by the belt stopper.

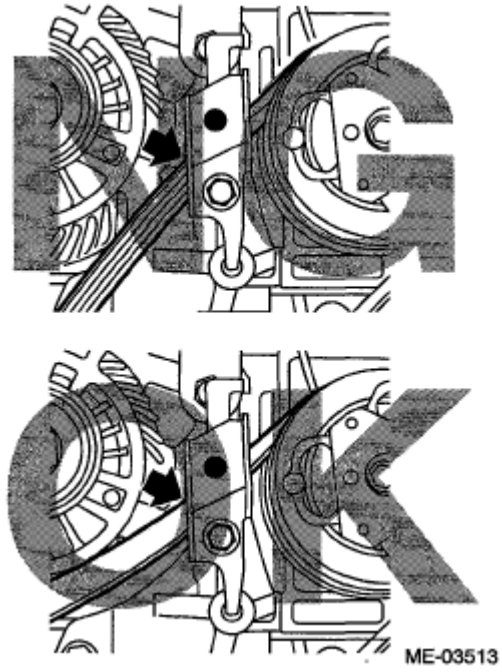

Fig. 94: Identifying Correct And Incorrect Position Of Rear Side Belt Surface By Belt Stopper
Courtesy of SUBARU OF AMERICA, INC.

5. The rear side belt is securely placed on the belt guide.

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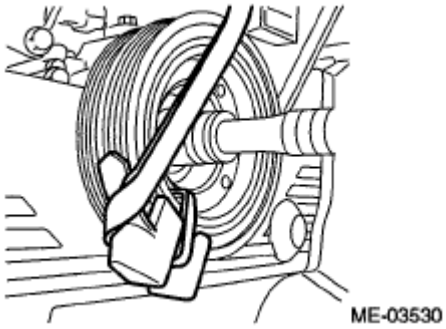

Fig. 95: Identifying Rear Side Belt On Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

13. Slowly turn the crank pulley clockwise, and install the rear side belt.

CAUTION: Be careful that the total of procedures in steps 8, 11, 12 and 13) does not exceed 330°; failure to do so may cause damage to the rear side belt and fall of the belt guide holder.

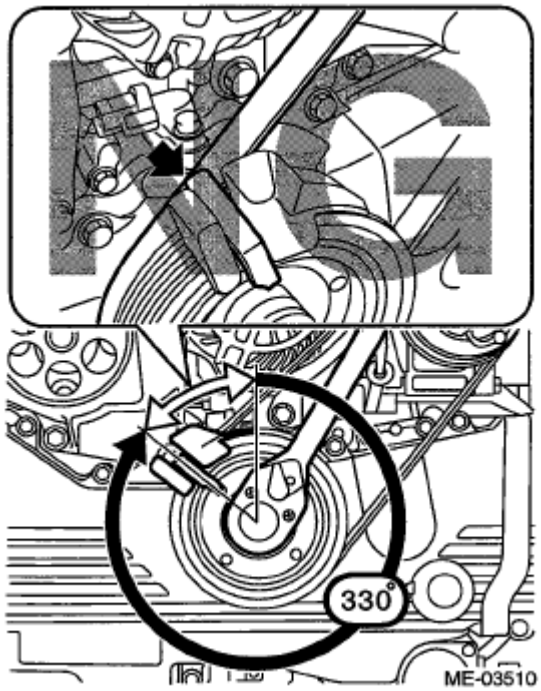

Fig. 96: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the belt guide and belt guide holder from the crank pulley.

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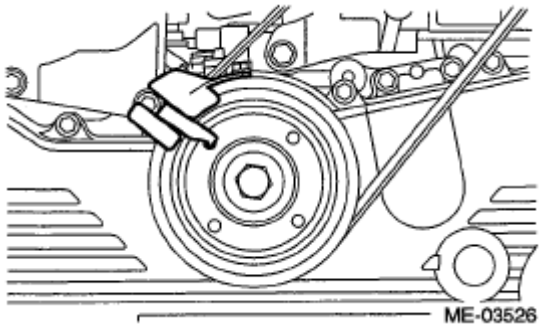

Fig. 97: Identifying Belt Guide And Belt Guide Holder
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the belt stopper from the compressor bracket.

CAUTION: Always remove the belt stopper; failure to do so may cause smoke, fire, or belt cutting.

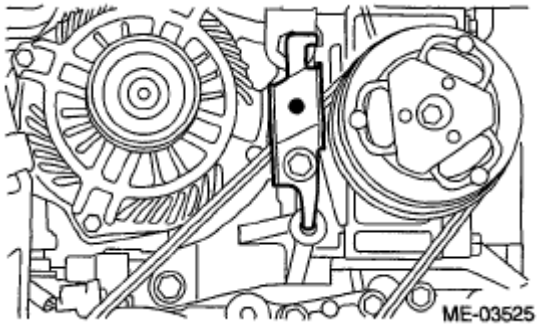

Fig. 98: Identifying Belt Stopper And Compressor Bracket
Courtesy of SUBARU OF AMERICA, INC.

16. Make sure that the belt rib is securely installed on the groove of each pulley, then turn the crank pulley slowly, twice in the clockwise direction, to seat the rear side belt properly.

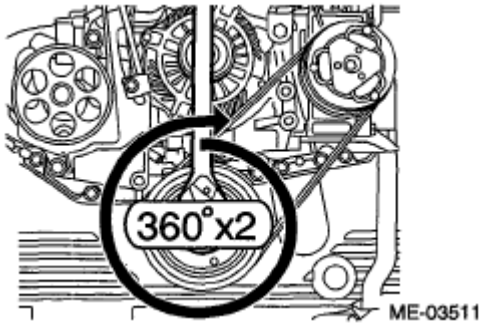

Fig. 99: Turning Crank Pulley To Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

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17. Discard the provided tools (belt stopper, belt guide, belt guide holder, and bolt) that are used.
18. Install the front side belt. Ref. to **FRONT SIDE BELT**, INSTALLATION, V-belt.

INSPECTION

FRONT SIDE BELT

CAUTION: Check and adjust the front side belt tension so that it is within the specified range. Using the belt with a tension out of the specified range may result in a fault such as the following:

- **If the front side belt tension is higher, unexpected force is generated at the power steering oil pump, generator and crankshaft bearing, causing abnormal noise due to abnormal wear of the bearing.**
- **If the front side belt tension is lower, the front side belt and crank pulley slip, causing abnormally high temperature on the crank pulley due to frictional heat. If this condition repeatedly occurs, the front side belt may abnormally wear, causing abnormal noise, front side belt damage or crank pulley damage.**

1. Replace the front side belt, if crack, fraying or wear is found.
2. Check the front side belt tension and adjust it if necessary by changing the generator installing position.

Front side belt tension (with belt tension gauge):

When installing new parts

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

At inspection

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

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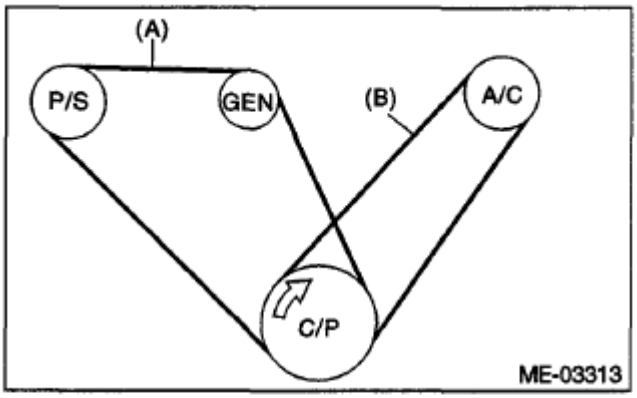

(A) Front side belt
(B) Rear side belt
C/P Crank pulley
GEN Generator pulley
P/S Power steering oil pump pulley
A/C A/C compressor pulley

Fig. 100: Identifying Front Side Belt Tension (With Belt Tension Gauge)
Courtesy of SUBARU OF AMERICA, INC.

Front side belt tension (without belt tension gauge):

When installing new parts

7 - 9 mm (0.276 - 0.354 in)

At inspection

9 - 11 mm (0.354 - 0.433 in)

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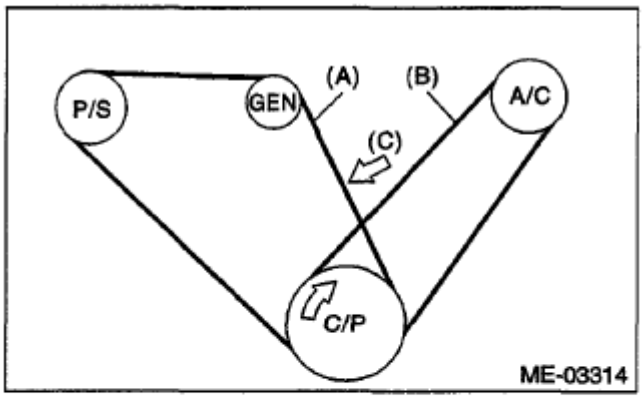

(A) Front side belt
(B) Rear side belt
(C) 98 N (10 kgf, 22 lbf)
C/P Crank pulley
GEN Generator pulley
P/S Power steering oil pump pulley
A/C A/C compressor pulley

Fig. 101: Identifying Front Side Belt Tension (Without Belt Tension Gauge)
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

If cracks, fraying or wear is found, and when abnormal noise is produced, replace the rear side belt.

NOTE: Because the rear side belt is a stretch type belt, it is not necessary to check deflection and tension.

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. Use the ST to lock the crank pulley, and remove the crank pulley bolt.

   ST 499977400 CRANK PULLEY WRENCH (AT MODEL)

   ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

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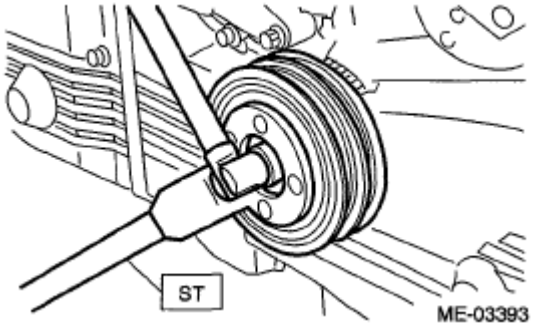

Fig. 102: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION

AT MODEL

1. Install the crank pulley.
2. Use the ST to secure the crank pulley, and attach the crank pulley bolts.

   ST 499977400 CRANK PULLEY WRENCH

   1. Clean the crankshaft 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: 130 N.m (13.3 kgf-m, 95.9 ft-lb)

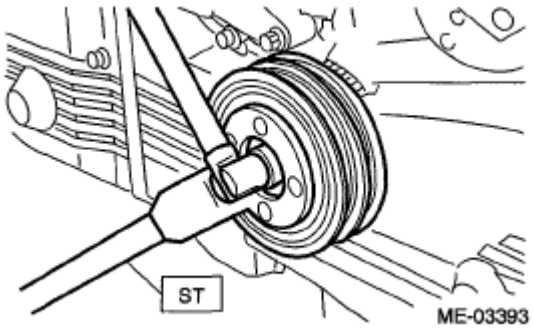

Fig. 103: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Check that the tightening angle of the crank pulley bolt is 45° or more. Perform the following procedure when less than 45°.

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CAUTION: If the tightening angle of crank pulley bolt is less than 45°, 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 by 45° to 60°.

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.

MT MODEL

1. Install the crank pulley.
2. Use the ST to lock the crank pulley, and attach the crank pulley bolts.

   ST 499977100 CRANK PULLEY WRENCH

   1. Clean the crankshaft thread using compressed air.
   2. Apply engine oil to the crank pulley bolt seat and thread.
   3. 44 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 (18.4 kgf-m, 132.8 ft-lb)

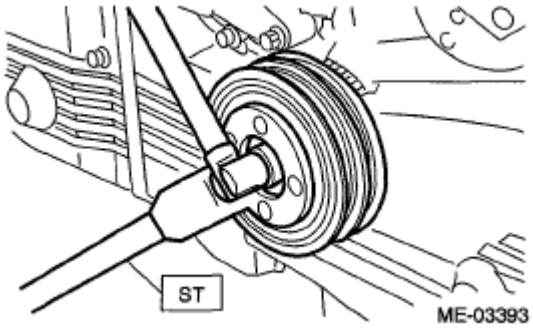

Fig. 104: Removing Crank Pulley Bolt

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Courtesy of SUBARU OF AMERICA, INC.

3. Check that the tightening angle of the crank pulley bolt is 65° or more. 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. 44 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 by 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. Make sure the V-belt is not worn or otherwise damaged.
2. Check the tension of the front side 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 secondary air pump. Ref. to **REMOVAL** , Secondary Air Pump.
2. Remove the V-belts. Ref. to **REMOVAL**, V-belt.
3. Remove the crank pulley. Ref. to **REMOVAL**, Crank Pulley.
4. Remove the timing belt cover LH (A).
5. Remove the timing belt cover RH (B).
6. Remove the front timing belt cover (C).

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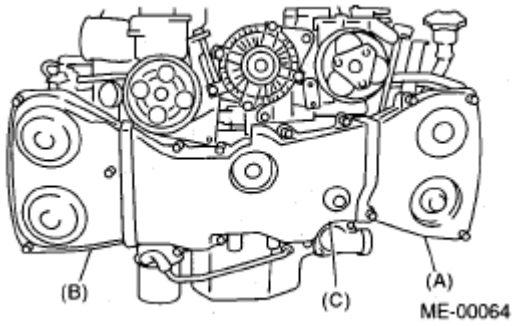

Fig. 105: Identifying Timing Belt Cover LH, Timing Belt Cover RH And Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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)

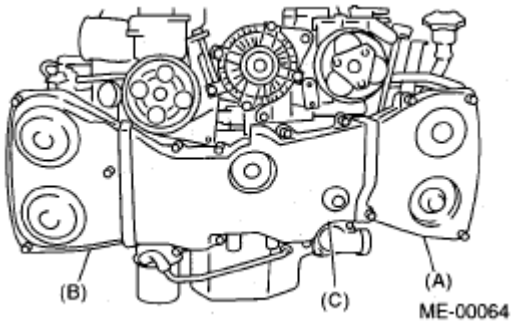

Fig. 106: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

4. Install the crank pulley. Ref. to **INSTALLATION**, Crank Pulley.
5. Install the V-belts. Ref. to **INSTALLATION**, V-belt.
6. Install the secondary air pump. Ref. to **INSTALLATION** , Secondary Air Pump.

INSPECTION

Check the timing belt cover for damage.

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TIMING BELT

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. For operation procedures. Ref. to TIMING BELT .

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)

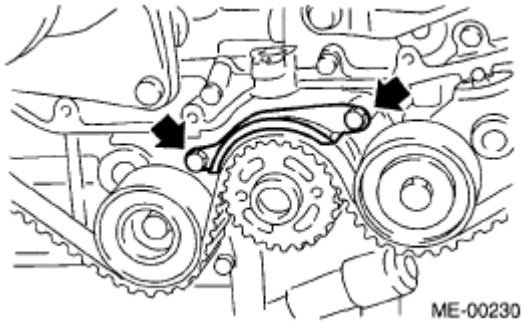

Fig. 107: Locating Timing Belt Guide (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

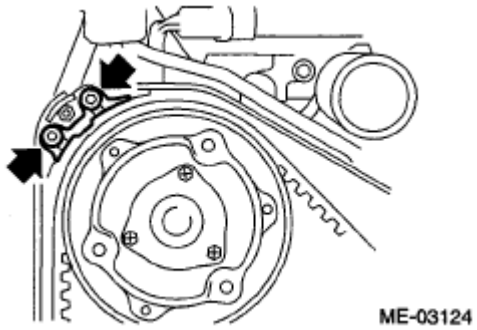

Fig. 108: Locating Timing Belt Guide (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

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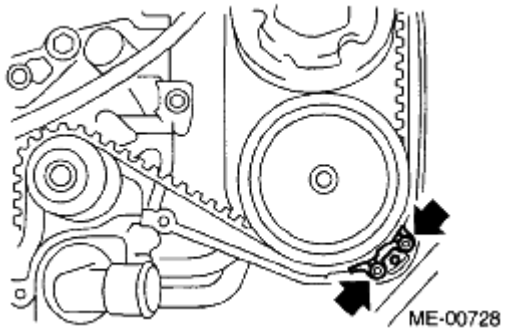

Fig. 109: Locating Timing Belt Guide (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

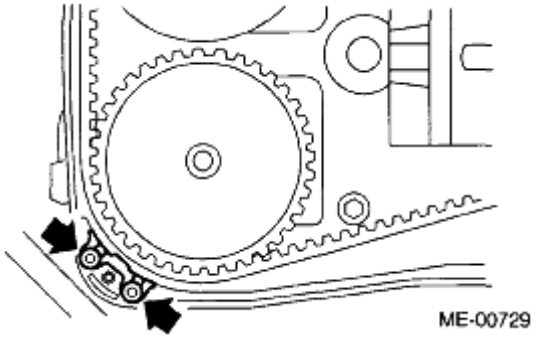

Fig. 110: Locating Timing Belt Guide (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

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 marks on oil pump and notches of timing belt cover.

       ST 499987500 CRANKSHAFT SOCKET

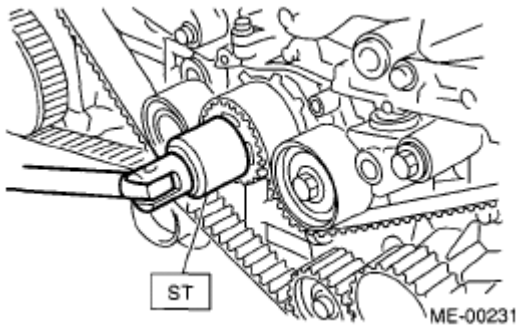

Fig. 111: Turning Crankshaft Using ST
Courtesy of SUBARU OF AMERICA, INC.

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2. Using white paint, put an alignment mark or an arrow mark on timing belts in relation to the crank sprocket and cam sprockets.

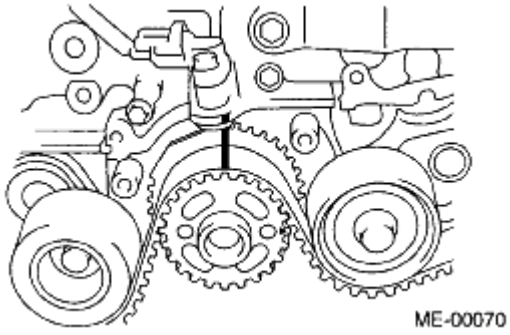

Fig. 112: Identifying Alignment Mark On Timing Belts
Courtesy of SUBARU OF AMERICA, INC.

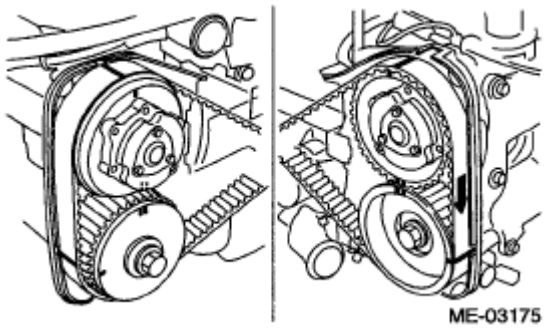

Fig. 113: Identifying Alignment Mark On Timing Belts With Crank Sprocket And Cam Sprockets
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 54.5 teeth

Z_2 : 51 teeth

Z_3 : 28 teeth

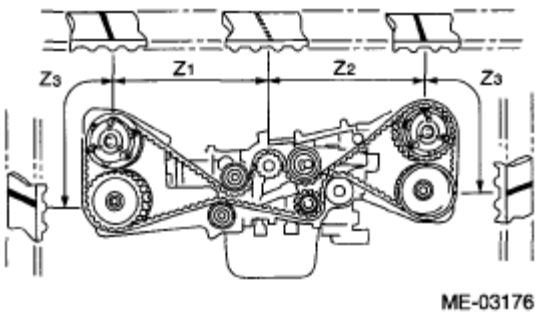

Fig. 114: Identifying Teeth Dimension

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Courtesy of SUBARU OF AMERICA, INC.

6. Remove the belt idler (A).

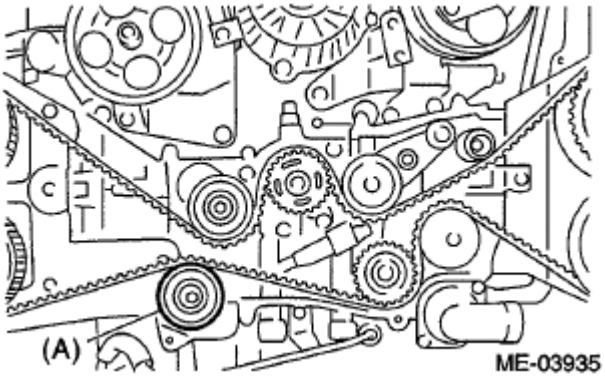

Fig. 115: Identifying Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

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 (A) and (B).

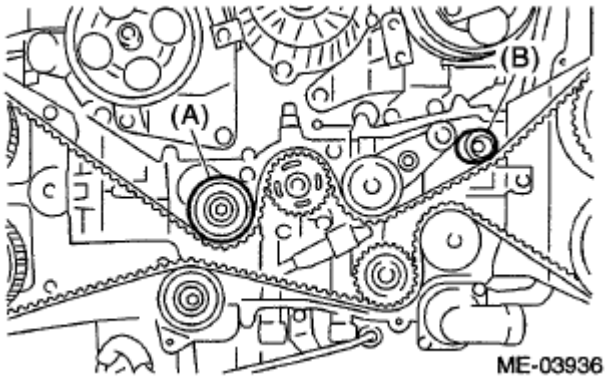

Fig. 116: Identifying Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the belt idler No. 2.

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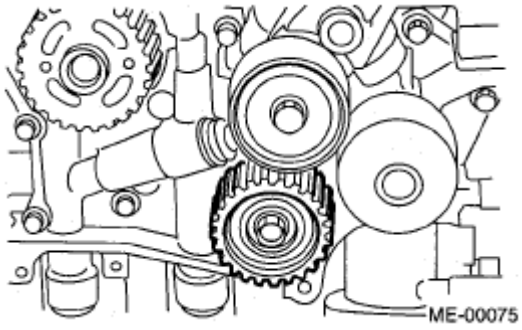

Fig. 117: Identifying Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the automatic belt tension adjuster assembly.

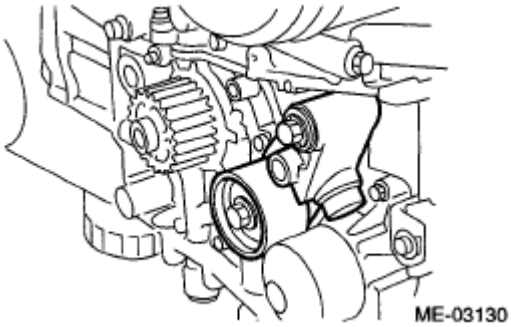

Fig. 118: Identifying Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

1. Prepare for installation of the 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 lb).**
- **Push in the adjuster rod to the end face of the cylinder. However, do not press the adjuster rod below the end face of the cylinder. Doing so may damage the cylinder.**

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- **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 push in the adjuster rod with a pressure of 165 N (16.8 kgf, 37.1 lb) or more until the adjuster rod is aligned with the stopper pin hole in the cylinder.

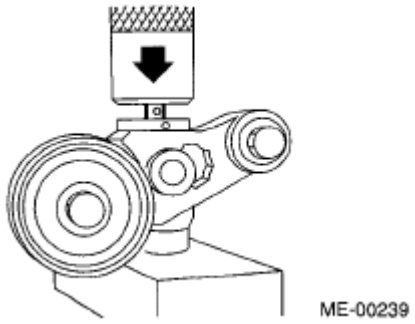

Fig. 119: Pushing Adjuster Rod
Courtesy of SUBARU OF AMERICA, INC.

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.

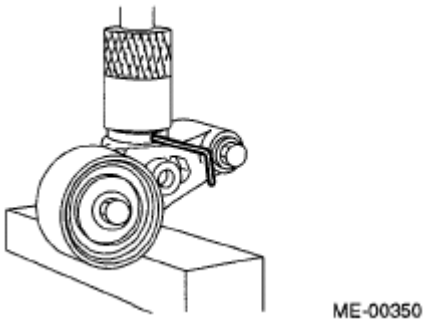

Fig. 120: Securing Adjuster Rod
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

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

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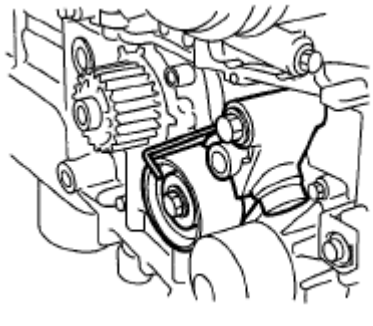

Fig. 121: Installing Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idler No. 2.

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

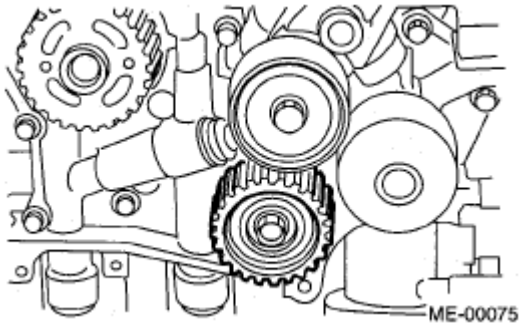

Fig. 122: Identifying Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

4. Install the belt idlers.

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

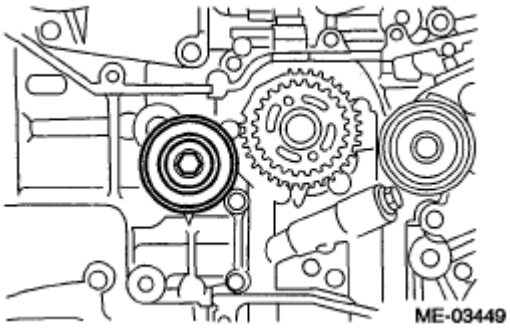

Fig. 123: Identifying Belt Idlers
Courtesy of SUBARU OF AMERICA, INC.

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

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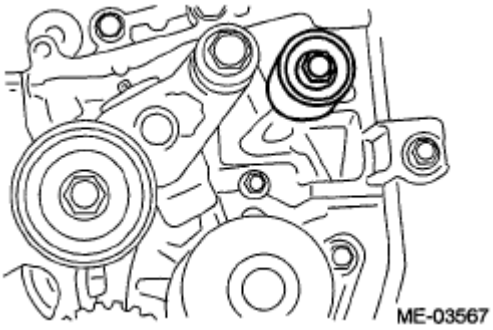

Fig. 124: Identifying Belt Idlers With Tightening Torque
Courtesy of SUBARU OF AMERICA, INC.

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 (B) on crank sprocket with the mark (A) on oil pump.

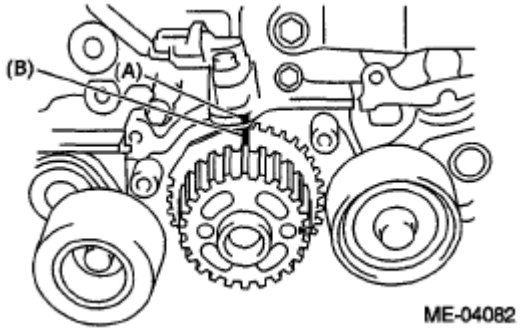

Fig. 125: Identifying Mark On Crank Sprocket And Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

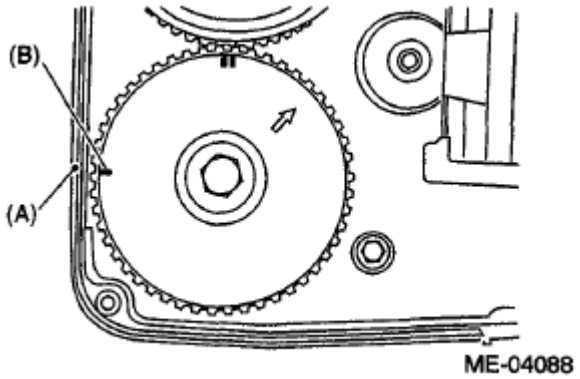

Fig. 126: Identifying Single Line Mark On Exhaust Cam Sprocket RH And Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

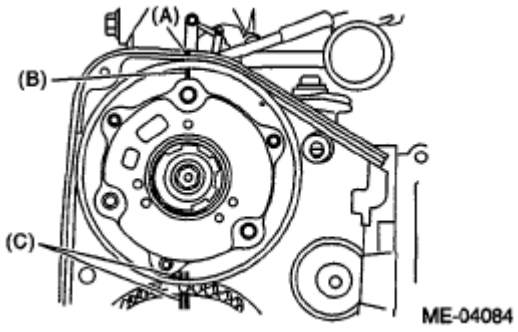

Fig. 127: Identifying Single Line Mark On Intake Cam Sprocket RH And Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

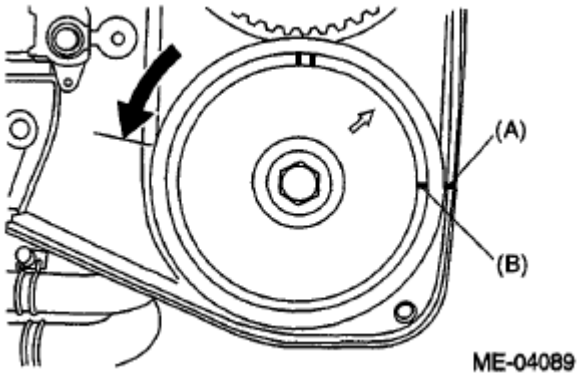

Fig. 128: Identifying Single Line Mark On Exhaust Cam Sprocket LH And Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

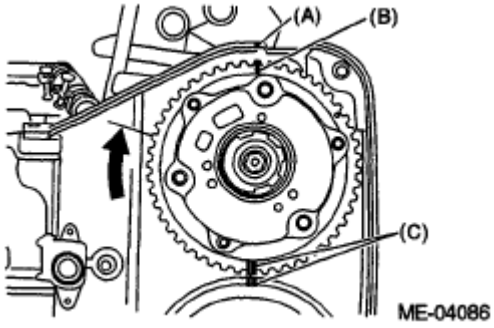

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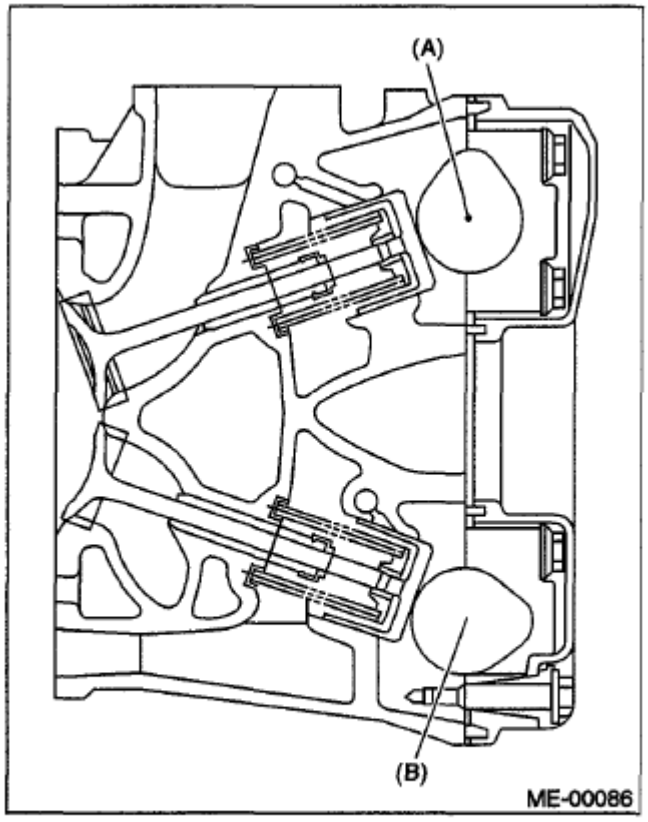
Fig. 129: Identifying Single Line Mark On Intake Cam Sprocket LH And Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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 figure, 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. 130: Positioning Of 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 are not pushing down on the intake and exhaust valves. (Under this condition, all valves remain unlifted.)**
- **When the camshafts are rotated to install the timing belts, #2 intake and #4 exhaust cam of camshaft LH are held, pushing**

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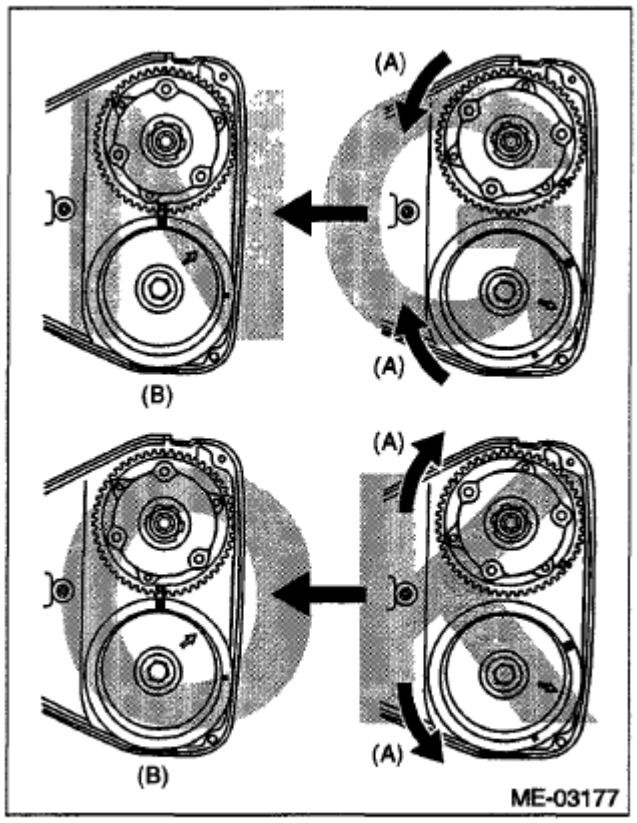
their corresponding valves down. (Under this condition, these valves are held lifted.) Camshaft RH are held so that their cams do not push the valves down.

- **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 figure. 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. 131: Caution For Rotating Of Camshafts
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 figure. While aligning marks, position the timing belt properly.

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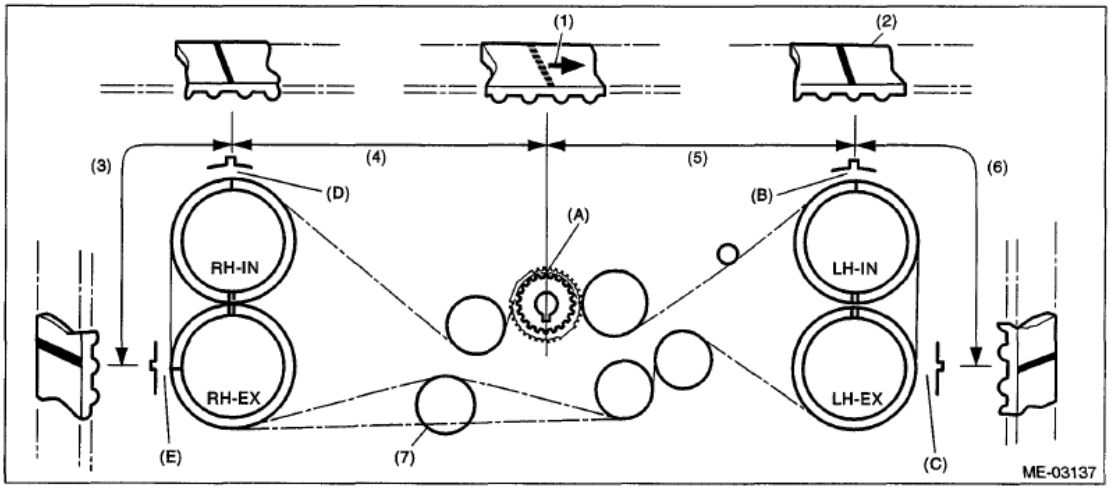
CAUTION:
- **If the timing belt slips by 1 or more teeth, the valve and piston may hit each other.**
- **Make sure that the direction of belt rotation is correct.**



(1) Arrow mark
(2) Timing belt
(3) 28 teeth
(4) 54.5 teeth
(5) 51 teeth
(6) 28 teeth
(7) Install it in the end

Fig. 132: Aligning Order Of Timing Belt With Marks On Sprockets
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.

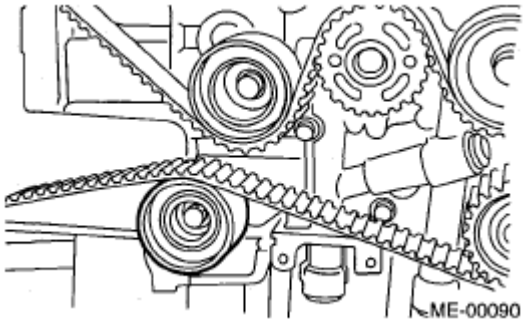


Fig. 133: Identifying Marks On Timing Belt And Sprockets
Courtesy of SUBARU OF AMERICA, INC.

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

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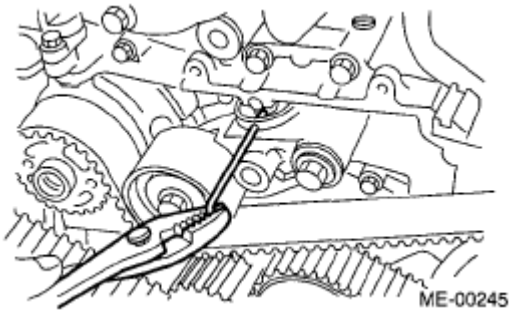

Fig. 134: Removing Stopper Pin From Tensioner Adjuster
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- **Before attaching the bolts, clean the bolt holes of the timing belt cover.**
- **Apply liquid gasket to the bolt thread of cam sprocket, (when reusing bolts)**

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

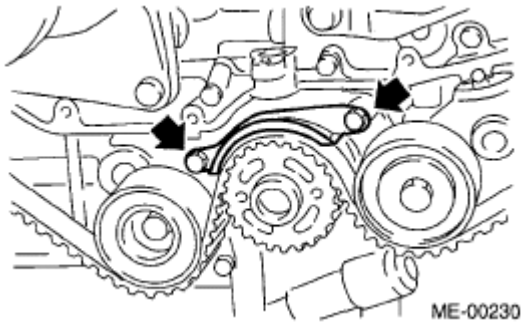

Fig. 135: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

    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)

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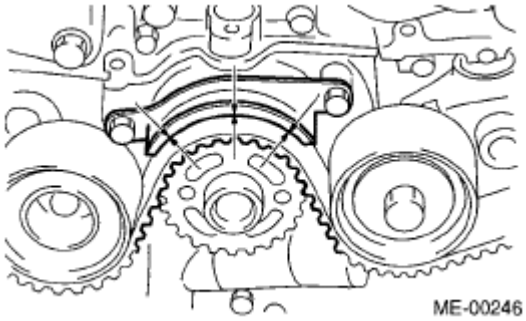

Fig. 136: Checking Clearance Between Timing Belt And Timing Belt Guide (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

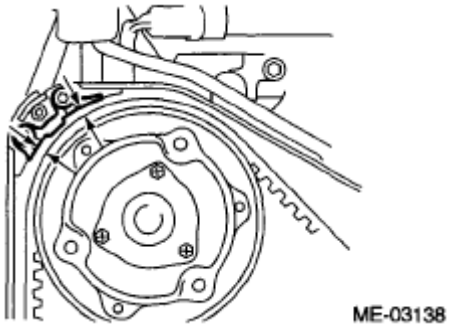

Fig. 137: Checking Clearance Between Timing Belt And Timing Belt Guide (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

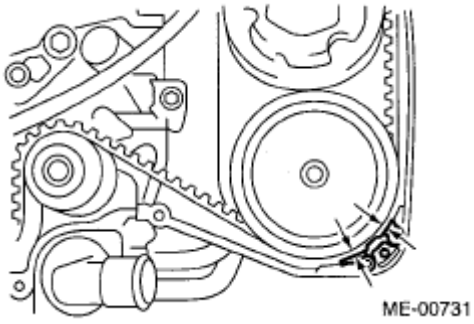

Fig. 138: Checking Clearance Between Timing Belt And Timing Belt Guide (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

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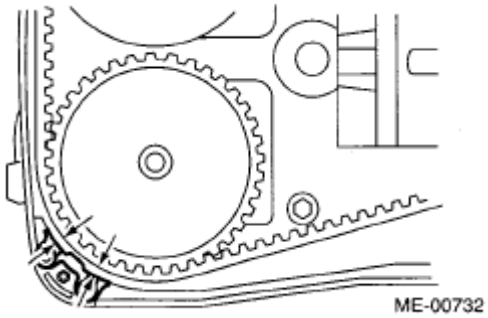

Fig. 139: Checking Clearance Between Timing Belt And Timing Belt Guide (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

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

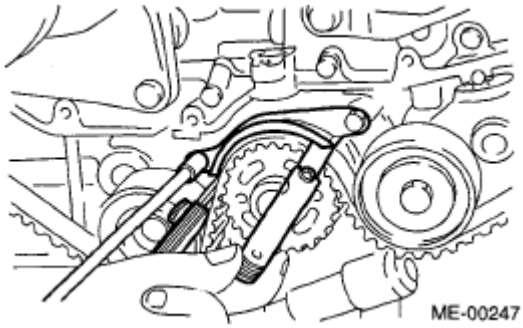

Fig. 140: Tightening Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

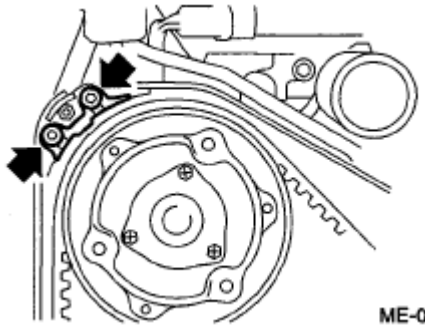

Fig. 141: Locating Timing Belt Guide And Bolts (1 Of 3)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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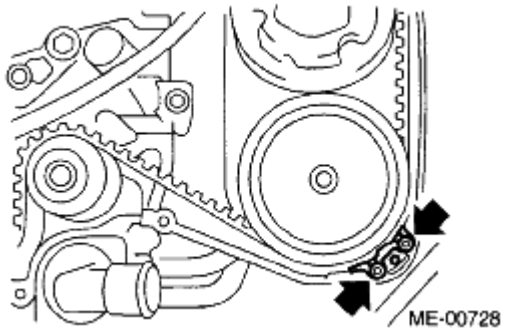

Fig. 142: Locating Timing Belt Guide And Bolts (2 Of 3)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

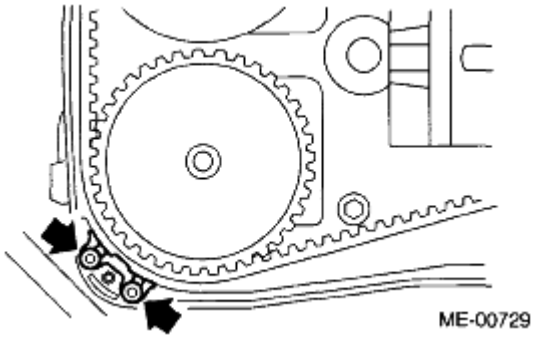

Fig. 143: Locating Timing Belt Guide And Bolts (3 Of 3)
Courtesy of SUBARU OF AMERICA, INC.

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 coolant contact the timing belt. Remove quickly and thoroughly if this happens.**
- **Do not bend the timing belt sharply.**

In radial diameter h: 60 mm (2.36 in) or more

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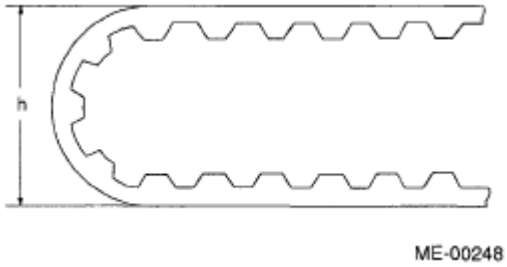

Fig. 144: Identifying Radial Diameter Height
Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

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

NOTE: Slight traces of oil at the rod 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 lb) is applied to it. This is to check adjuster rod stiffness.
3. If the adjuster rod is not stiff and moves freely when applying 165 N (16.8 kgf, 37.1 lb), 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 lb) 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 lb).**
- **Push in the adjuster rod to the end face 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 amount of rod protrusion "H" from the end surface of the body. If it is not within specifications, replace the automatic belt tension adjuster assembly with a new part.

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Amount of rod protrusion H: 5.2 - 6.2 mm (0.205 - 0.244 in)

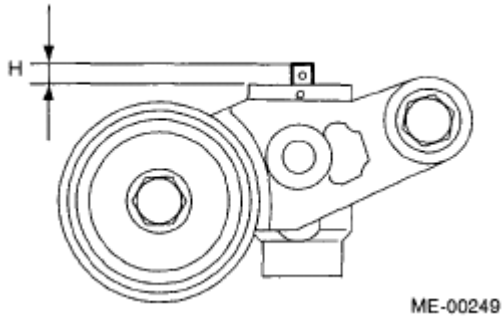

Fig. 145: Measuring Amount Of Rod Protrusion
Courtesy of SUBARU OF AMERICA, INC.

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 tension adjuster assembly with a new part if faulty.
2. Check the belt tension pulley for smooth rotation. Replace the automatic belt tension adjuster assembly with a new part if abnormal 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 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 actuator cover of the intake cam sprocket.
6. Fasten the cam sprocket and remove from the camshaft using ST.

ST 499207400 CAM SPROCKET WRENCH

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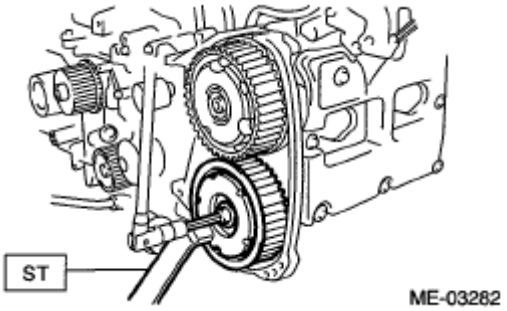

Fig. 146: Identifying ST 499207400 On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH

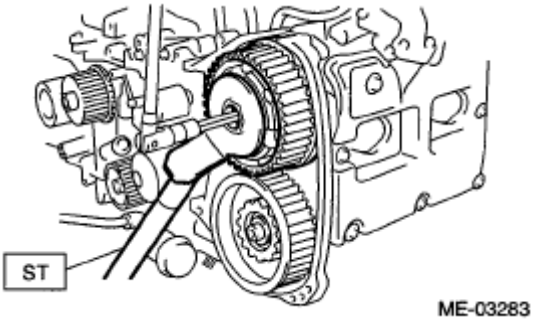

Fig. 147: Identifying ST 499977500 On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

   NOTE: Do not confuse cam sprockets (LH) and (RH) 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°.

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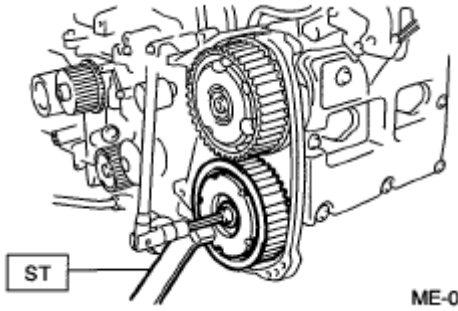

Fig. 148: Identifying ST 499207400 On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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°.

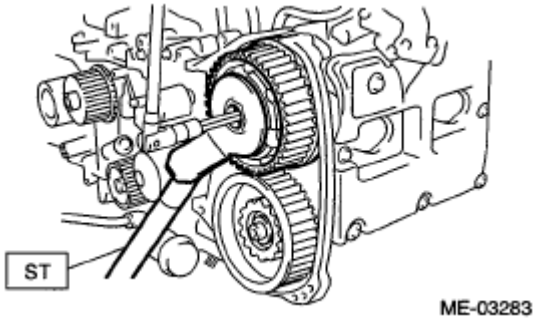

Fig. 149: Identifying ST 499977500 On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install 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.

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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 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 crank sprocket.

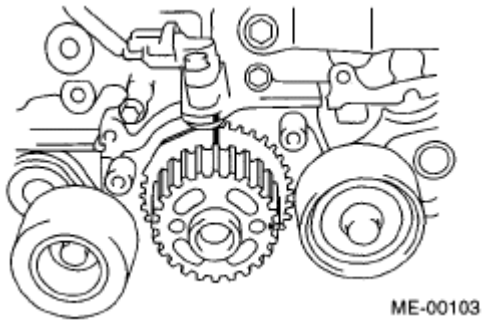

Fig. 150: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

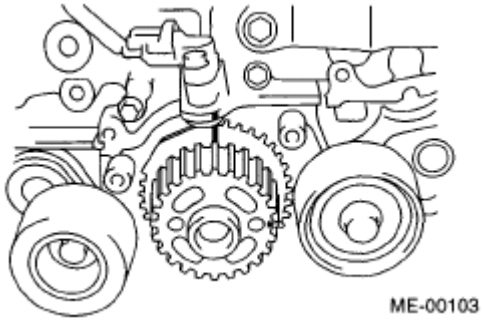

Fig. 151: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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.

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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 procedures. 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 connector.

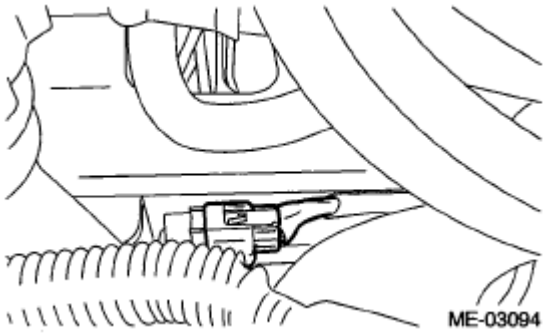

Fig. 152: Identifying Oil Flow Control Solenoid Valve Connector
Courtesy of SUBARU OF AMERICA, INC.

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

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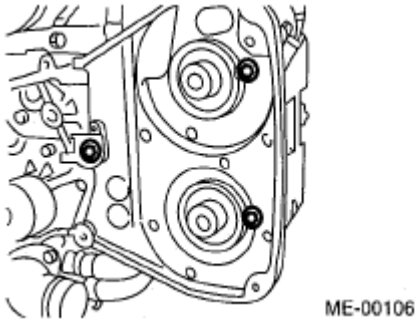

Fig. 153: Identifying Timing Belt Cover No. 2 LH
Courtesy of SUBARU OF AMERICA, INC.

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

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

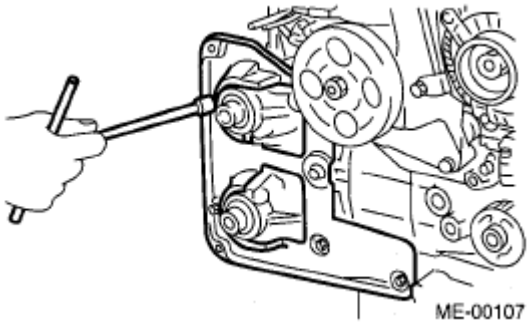

Fig. 154: Removing Timing Belt Cover No. 2 RH
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the tensioner bracket.

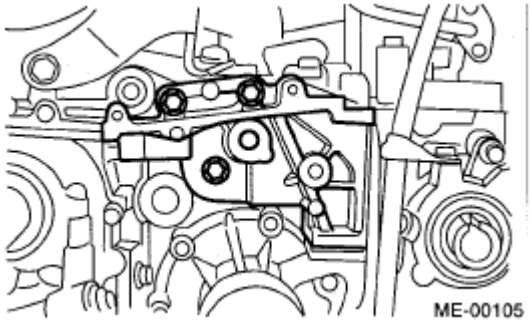

Fig. 155: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the ignition coil. Ref. to **REMOVAL** , Ignition Coil

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11. Disconnect the PCV hose from the rocker cover.

NOTE: For the PCV hose affixed with the clamp, fit the depression in the ST with the protrusion of the clamp as shown in the figure below, unlock the clamp and disconnect.

ST 18353AA000 CLAMP PLIERS

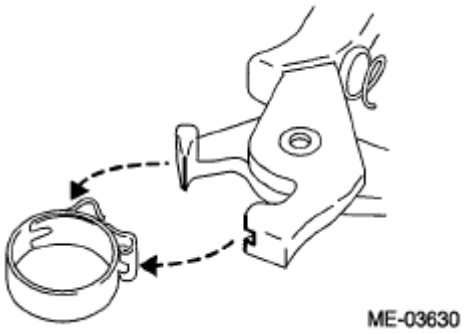
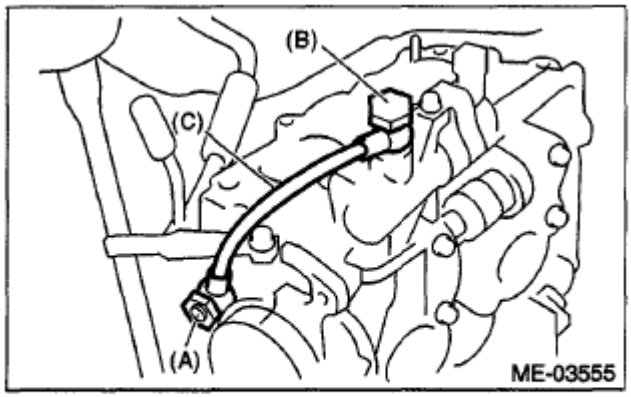


Fig. 156: Identifying PCV Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the rocker cover and gasket.
13. Remove the union screw without filter (without protrusion) which secures the oil pipe to the front camshaft cap.



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

Fig. 157: Identifying Union Screws And Oil Pipe
Courtesy of SUBARU OF AMERICA, INC.

14. Loosen the upper side of the front camshaft cap and the intake camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the figure.

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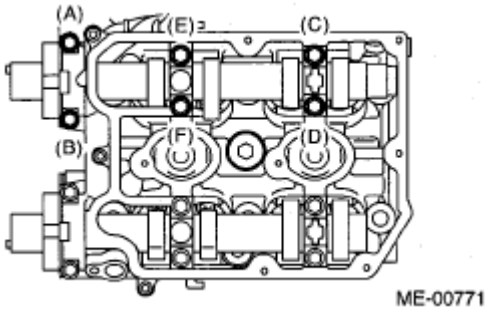

Fig. 158: Identifying Intake Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

15. Loosen the lower side of the front camshaft cap and the exhaust camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the figure.

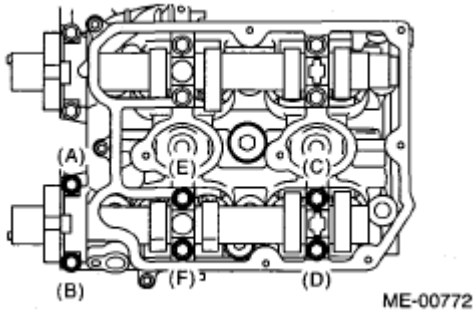

Fig. 159: Identifying Exhaust Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

16. Remove the front camshaft cap.
17. Remove the intake camshaft caps and intake camshaft.
18. Remove the exhaust camshaft caps and exhaust camshaft.

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

19. Remove the oil seal.

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

20. Similarly, remove the camshaft RH and related parts.

INSTALLATION

1. Install the camshaft.

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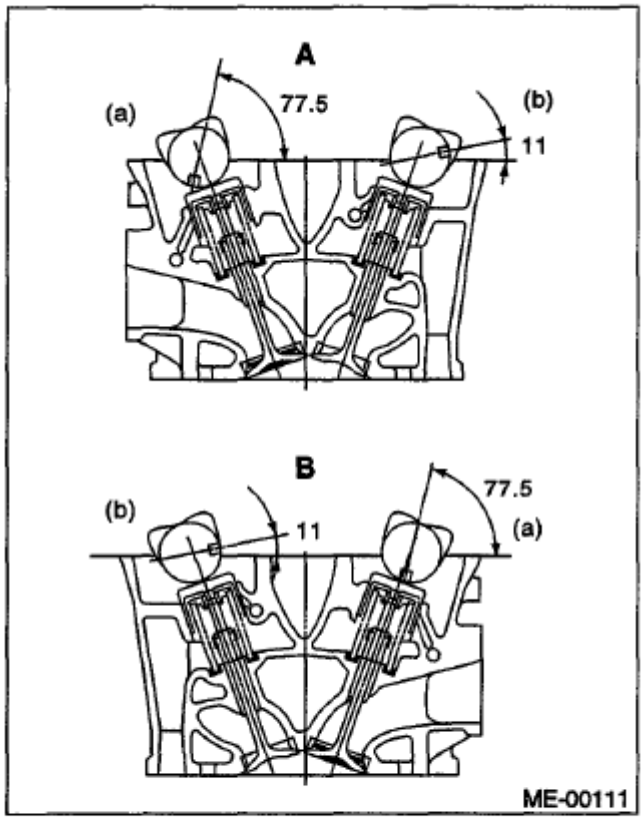
Apply engine oil to the cylinder head at camshaft bearing installation location before installing the camshaft. Install the camshaft so that each valve is close to or in contact with base circle of the cam lobe.

NOTE:

- **Set the camshaft to the position shown in the figure.**
- **When set at the position shown in the figure, 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. 160: Identifying Intake And Exhaust Camshaft Rotating Angle
Courtesy of SUBARU OF AMERICA, INC.

2. Install the camshaft cap.
    1. Apply small amount of liquid gasket to the mating surface of cap.

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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

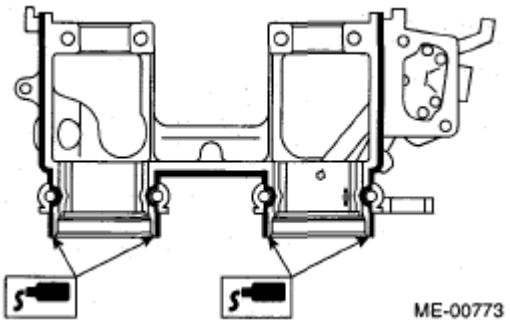

Fig. 161: Applying Amount Of Liquid Gasket To Mating Surface Of Cap
Courtesy of SUBARU OF AMERICA, INC.

2. Apply a thin coat of engine oil to the cap journal surface, and install the camshaft cap to the camshaft.
3. Gradually tighten the camshaft cap in at least two steps, in alphabetical order shown in the figure, and then tighten to the 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)

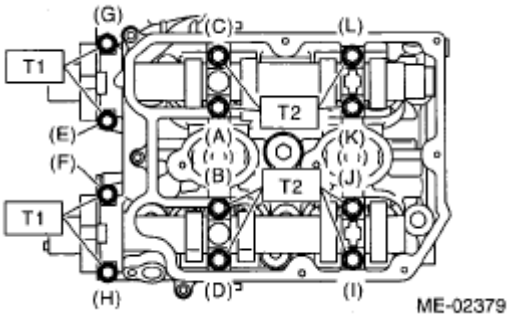

Fig. 162: Identifying Camshaft Cap Bolts In Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. After tightening the camshaft cap, ensure the camshaft rotates only slightly while holding it at base

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circle.

3. Apply a thin coat of engine oil to the periphery of the camshaft oil seal and oil seal lip, and 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

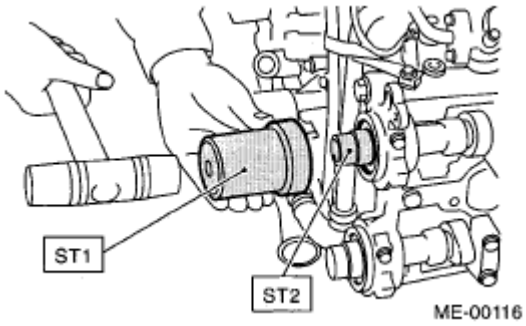
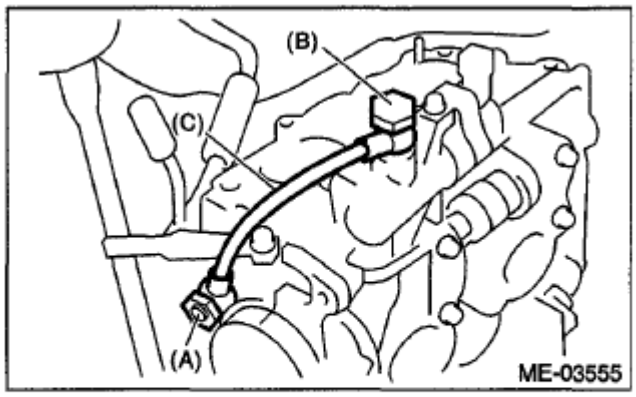


Fig. 163: Identifying Oil Seal Guide ST1499587600 And Oil Seal Guide ST2 499597200
Courtesy of SUBARU OF AMERICA, INC.

4. Install the oil pipe to the front camshaft cap using the union screw without filter (without protrusion).

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. 164: Identifying Union Screws And Oil Pipe
Courtesy of SUBARU OF AMERICA, INC.

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

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

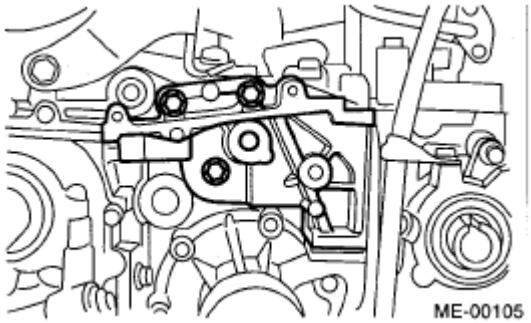

Fig. 165: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

7. Install the timing belt cover No. 2 RH.

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

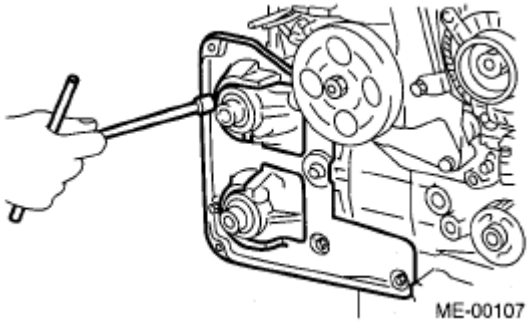

Fig. 166: Installing Timing Belt Cover No. 2 RH
Courtesy of SUBARU OF AMERICA, INC.

8. Install the timing belt cover No. 2 LH.

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

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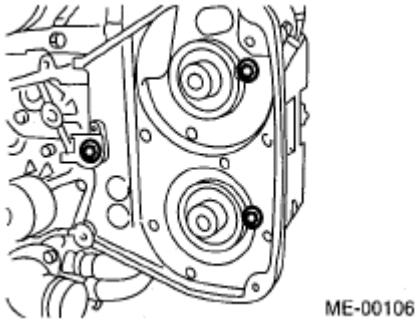

Fig. 167: Identifying Timing Belt Cover No. 2 LH
Courtesy of SUBARU OF AMERICA, INC.

9. Install the cam sprocket. Ref. to **INSTALLATION**, Cam Sprocket.
10. Install the timing belt. Ref. to **INSTALLATION**, Timing Belt.
11. Adjust the valve clearance. Ref. to <Ref. to **ADJUSTMENT**, Valve Clearance -->.
12. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover. (Outer and ignition coil)

       NOTE: Use a new rocker cover gasket

    2. Apply liquid gasket to the specified point of the cylinder head.

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

       Liquid gasket:

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

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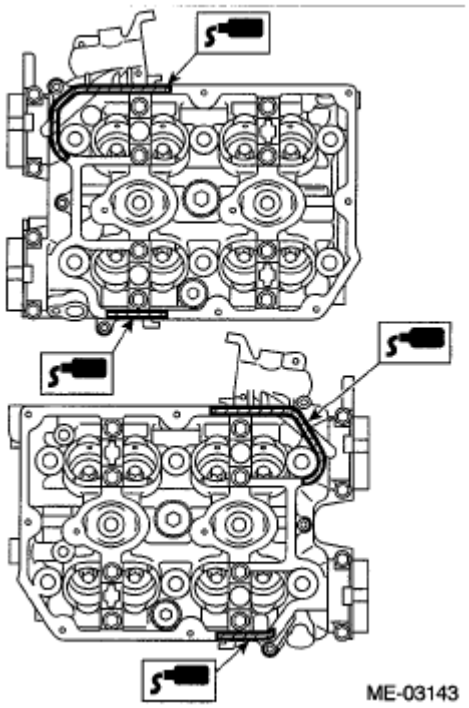

Fig. 168: Identifying Liquid Gasket Applying Area On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover onto cylinder heads. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover tightening bolts in alphabetical order shown in the figure, and then tighten to specified torque in alphabetical order.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

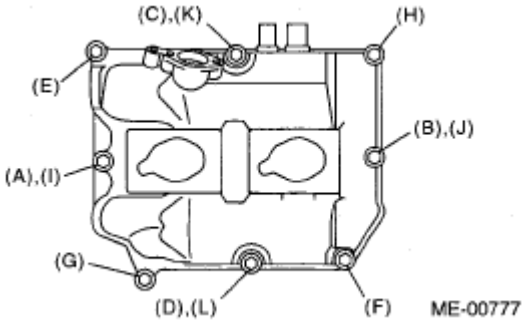

Fig. 169: Identifying Rocker Cover Bolts In Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

13. Connect the PCV hose to the rocker cover.

NOTE: Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the

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protrusion on the clamp as shown in the figure, and lock the clamp.

ST 18353AA000 CLAMP PLIERS

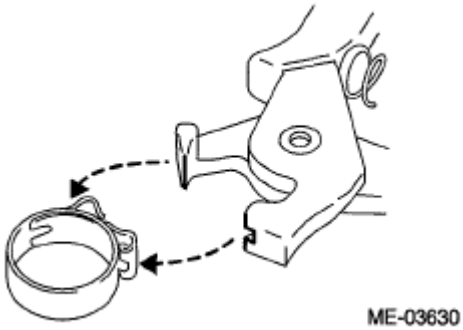

Fig. 170: Identifying PCV Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

14. Connect the connector to oil flow control solenoid valve.

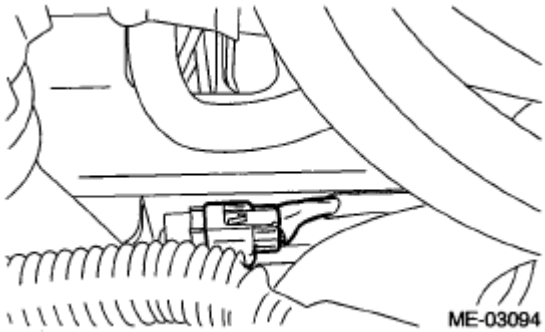

Fig. 171: Identifying Oil Flow Control Solenoid Valve Connector
Courtesy of SUBARU OF AMERICA, INC.

15. Install the ignition coil. Ref. to **INSTALLATION** , Ignition Coil.
16. Install the timing belt cover. Ref. to **INSTALLATION**, Timing Belt Cover.
17. Install the crank pulley. Ref. to **INSTALLATION**, Crank Pulley.
18. Install the V-belts. Ref. to **INSTALLATION**, V-belt.

INSPECTION

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

   Camshaft bend limit: 0.020 mm (0.00079 in)

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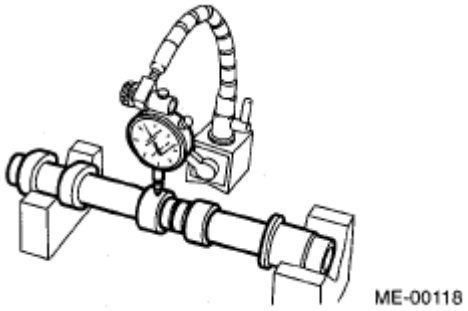

Fig. 172: Measuring Camshaft Bend
Courtesy of SUBARU OF AMERICA, INC.

2. Check the journal for damage and wear. Replace if faulty.
3. Check the cutout portion used for camshaft sensor for damage. Replace if faulty.
4. Check the cam face condition, and remove the minor faults by grinding with oil stone. If offset wear occurs, replace it.
5. Measure the cam lobe height H and cam base circle diameter A. If it exceeds the standard or offset wear occurs, replace it.

Cam lobe height H:

Standard

Intake

46.55 - 46.65 mm (1.833 - 1.837 in)

Exhaust

46.75 - 46.85 mm (1.841 - 1.844 in)

Cam base circle diameter A:

Standard

37.0 mm (1.457 in)

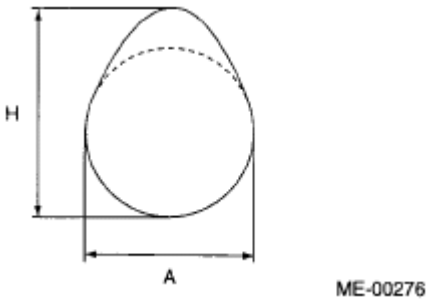

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Fig. 173: Identifying Cam Height And Base Circle Diameter
Courtesy of SUBARU OF AMERICA, INC.

6. Measure the outside diameter of camshaft journal. If the journal diameter is not within specification, check the oil clearance.

CAMSHAFT JOURNAL REFERENCE

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

7. Measure the oil clearance of camshaft journal.
   1. Clean the camshaft cap and the camshaft journal of the cylinder head.
   2. Place the camshaft on the cylinder head. (Without installing the valve lifter)
   3. Place a plastigauge across each camshaft journals.
   4. Gradually tighten the camshaft cap in at least two steps, in alphabetical order shown in the figure, and then tighten to the 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)

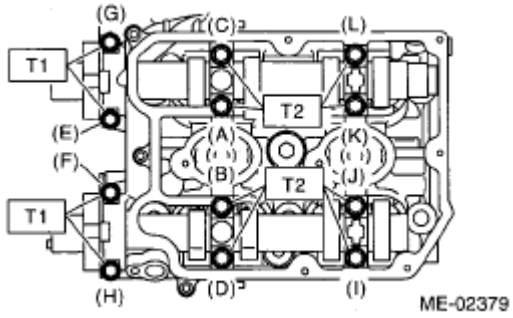

Fig. 174: Identifying Camshaft Cap Bolts In Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

      Camshaft oil clearance:

      Standard

      0.037 - 0.072 mm (0.0015 - 0.0028 in)

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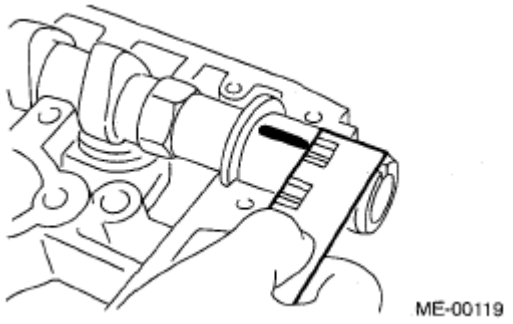

Fig. 175: Measuring Widest Point Of Plastigauge
Courtesy of SUBARU OF AMERICA, INC.

7. Completely remove the plastigauge.
8. Measure the thrust clearance with setting the dial gauge at end surface of camshaft. If the thrust clearance is not within the standard or there is offset wear, replace the camshaft caps and cylinder head as a set. If necessary, replace the camshaft.

   Camshaft thrust clearance:

   Standard

   0.068 - 0.116 mm (0.0027 - 0.0047 in)

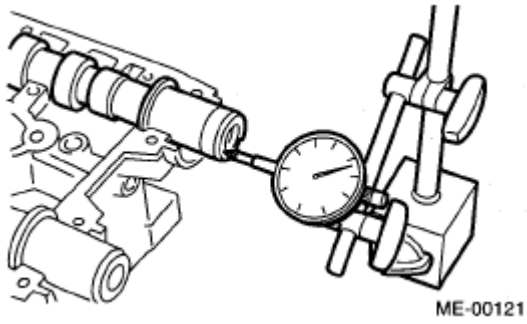

Fig. 176: Measuring Camshaft Thrust Clearance
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD

REMOVAL

NOTE:

- **When replacing the single part, perform the work with the engine installed to body. Refer to "Valve Clearance" for preparation procedures. Ref. to INSPECTION, Valve Clearance.**
- **When performing the work with the engine installed to body, the following parts must also be removed/installed.**

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- Center exhaust pipe <Ref. to **REMOVAL** , Center Exhaust Pipe. Ref. to **INSTALLATION** , Center Exhaust Pipe.
- Turbocharger Ref. to **REMOVAL** , Turbocharger. Ref. to **INSTALLATION** , Turbocharger.
- Joint pipe Ref. to **REMOVAL** , Joint Pipe. Ref. to **INSTALLATION** , Joint Pipe.
- Front exhaust pipe Ref. to **REMOVAL** , Front Exhaust Pipe. Ref. to **INSTALLATION** , Front Exhaust Pipe.

1. Remove the V-belts. Ref. to **REMOVAL**, V-belt.
2. Remove the intake manifold. Ref. to **REMOVAL** , Intake Manifold.
3. Remove the crank pulley. Ref. to **REMOVAL**, Crank Pulley.
4. Remove the timing belt cover. Ref. to **REMOVAL**, Timing Belt Cover.
5. Remove the timing belt. Ref. to **REMOVAL**, Timing Belt.
6. Remove the cam sprocket. Ref. to **REMOVAL**, Cam Sprocket.
7. Remove the secondary air combination valve. Ref. to **REMOVAL** , Secondary Air Combination Valve.
8. Remove the bolts which secure A/C compressor bracket to cylinder head.
9. Remove the oil pipe.

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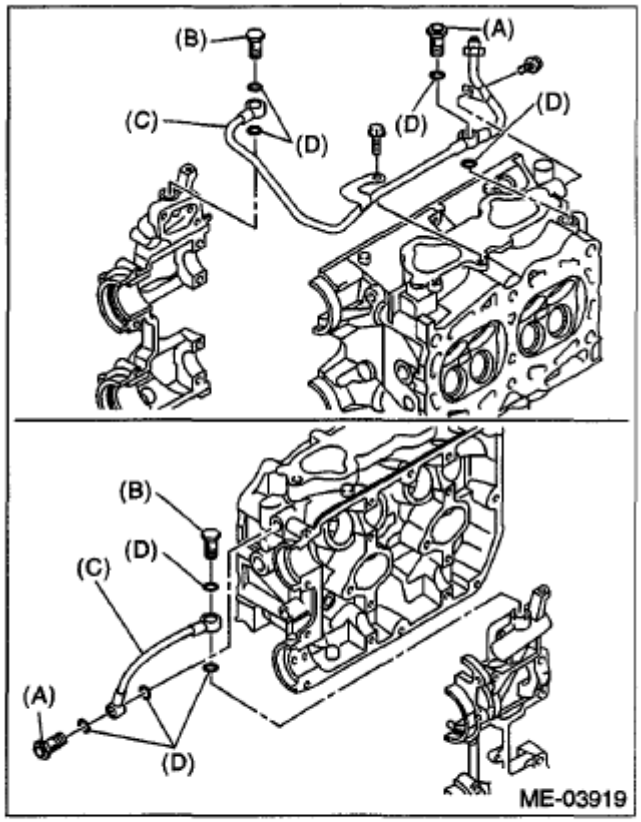

(A) Union screw with filter (with protrusion)
(B) Union screw without filter (without protrusion)
(C) Oil pipe
(D) Gasket

Fig. 177: Identifying Union Screw, Gasket And Oil Pipe
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the camshaft. Ref. to **REMOVAL**, Camshaft.
11. Remove the oil level gauge guide. (LH side only)
12. Remove the cylinder head bolts in alphabetical order shown in the figure.

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

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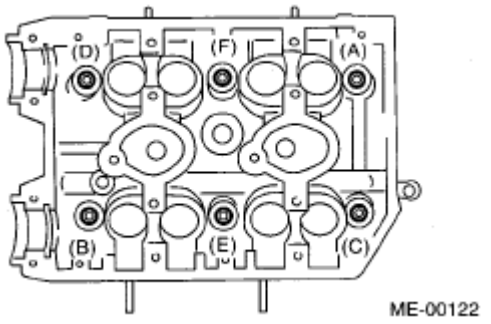

Fig. 178: Identifying Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

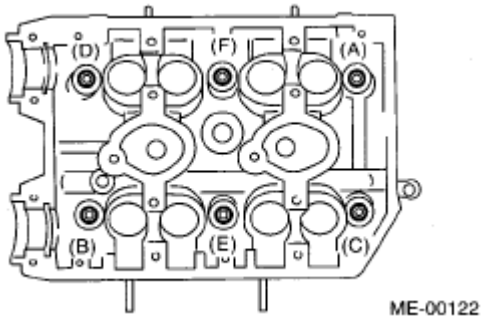

Fig. 179: Identifying Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the cylinder head gasket.

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

15. Similarly, remove the right side cylinder head.

INSTALLATION

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

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

NOTE: Use a new cylinder head gasket.

2. Tighten the cylinder head bolts.

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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. Retighten 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 installing, and loosen them further by 180°.
5. Tighten all bolts to 49 N.m (5.0 kgf-m, 36.1 ft-lb) in alphabetical order.
6. Tighten all bolts by 80 to 90° in alphabetical order.
7. Tighten all bolts by 40 to 45° in alphabetical order again.

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

8. Tighten bolts (A) and (B) further by 40 - 45°.

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

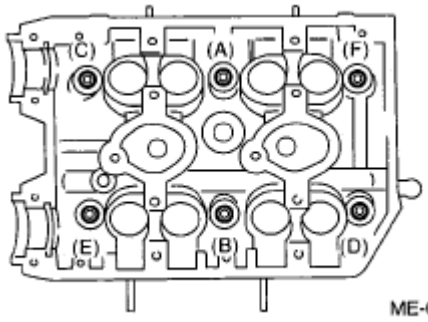

Fig. 180: Identifying Cylinder Head Bolts In Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

4. Install the camshaft. Ref. to **INSTALLATION**, Camshaft.
5. Install the oil pipe.

NOTE: Be careful of the install location of the union screw; the location will differ depending on whether or not there is a filter.

Tightening torque:

T1: 8 N.m (0.8 kgf-m, 5.9 ft-lb)

T2: 29 N.m (3.0 kgf-m, 21.4 ft-lb)

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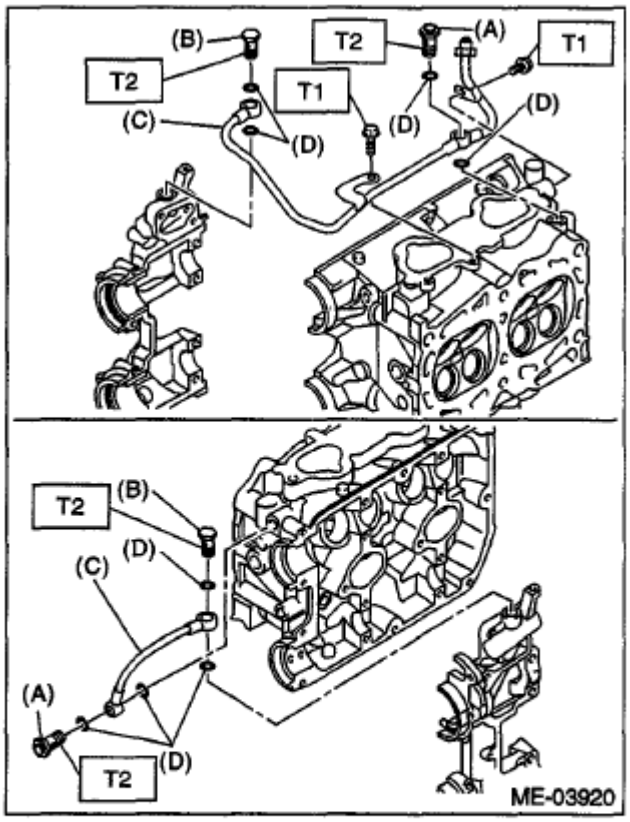

(A) Union screw with filter (with protrusion)
(B) Union screw without filter (without protrusion)
(C) Oil pipe
(D) Gasket

Fig. 181: Identifying Union Screw, Oil Pipe And Gasket
Courtesy of SUBARU OF AMERICA, INC.

6. Install the A/C compressor bracket on cylinder head.

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

7. Install the secondary air combination valve. Ref. to **INSTALLATION** , Secondary Air Combination Valve.
8. Install the cam sprocket. Ref. to **INSTALLATION**, Cam Sprocket.
9. Install the timing belt. Ref. to **INSTALLATION**, Timing Belt.
10. Adjust the valve clearance. Ref. to **ADJUSTMENT**, Valve Clearance.
11. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover. (Outer and ignition coil)

       NOTE: Use a new rocker cover gasket.

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2. Apply liquid gasket to the specified point of the cylinder head.

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

Liquid gasket:

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

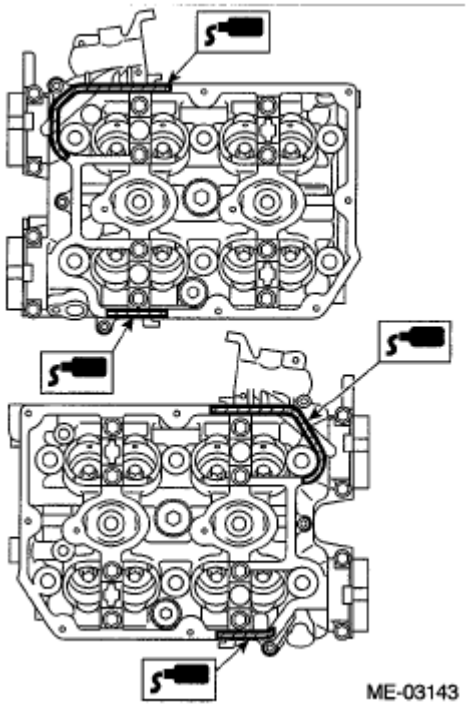

Fig. 182: Identifying Liquid Gasket Applying Area On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover onto cylinder heads. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover tightening bolts in alphabetical order shown in the figure, and then tighten to specified torque in alphabetical order.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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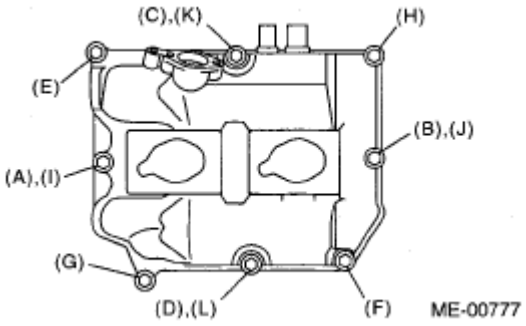

Fig. 183: Identifying Rocker Cover Bolts In Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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 intake manifold. Ref. to **INSTALLATION** , Intake Manifold.
15. 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.**
- **For removal and installation procedures of the valve guide, intake valve oil seal and exhaust valve oil seal, refer to "INSPECTION". Ref. to VALVE GUIDE, INSPECTION, Cylinder Head. Ref. to INTAKE AND EXHAUST VALVE OIL SEAL, INSPECTION, Cylinder Head.**

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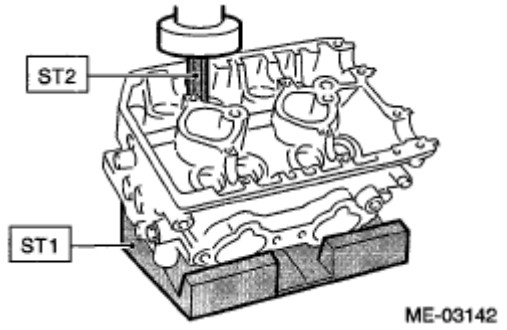
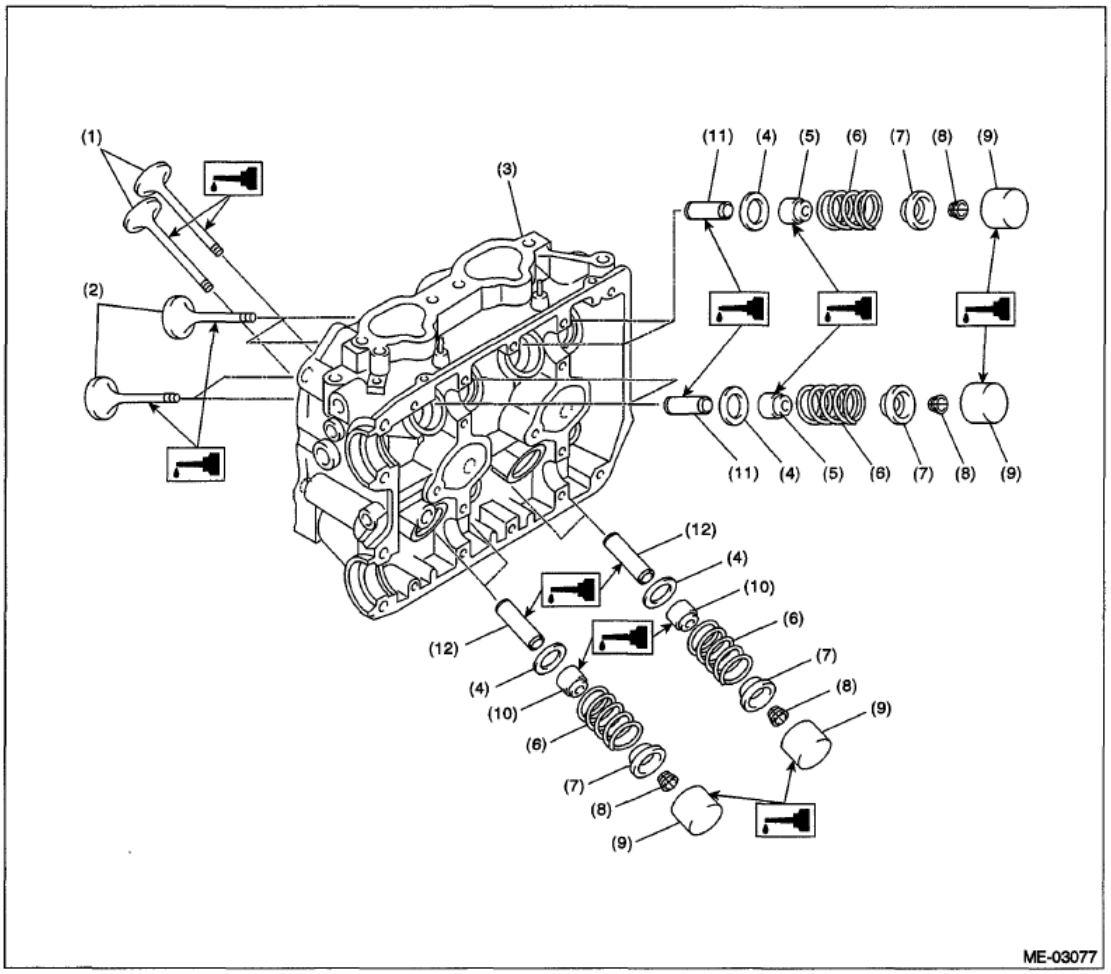


Fig. 184: Identifying Special Tools
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



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

Fig. 185: Exploded View Of Cylinder Head

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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 cylinder head side.

    4. Set the ST2 on valve spring.

        ST2 499718000 VALVE SPRING REMOVER

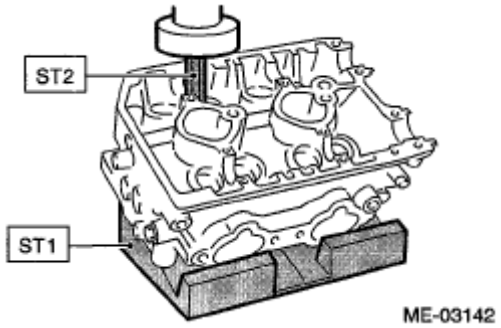

Fig. 186: Identifying Special Tools
Courtesy of SUBARU OF AMERICA, INC.

    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.

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2. Measure the warping of the cylinder head surface that mates with cylinder block using a straight edge (A) and thickness gauge (B).

If the warping exceeds the limit, 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 warpage. When reinstalling, pay special attention to the torque so as to tighten evenly.

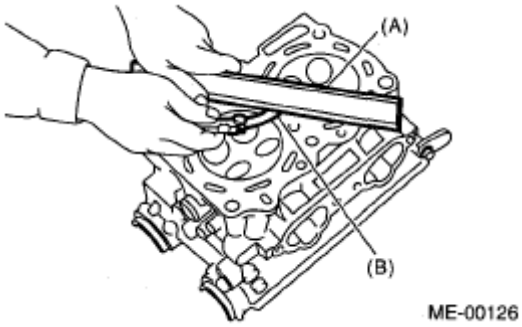

Fig. 187: Measuring Warping Of Cylinder Head Surface
Courtesy of SUBARU OF AMERICA, INC.

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.

Contacting width W between valve and valve seat:

Standard

Intake

0.6 - 1.4 mm (0.024 - 0.055 in)

Exhaust

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1.2 - 1.8 mm (0.047 - 0.071 in)

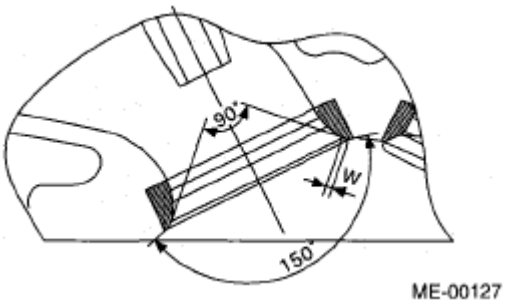

Fig. 188: Identifying Width Between Valve And Valve Seat
Courtesy of SUBARU OF AMERICA, INC.

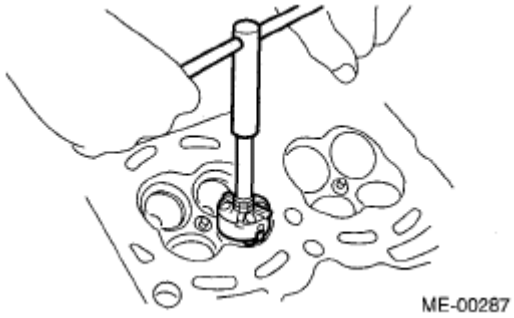

Fig. 189: Inspecting Intake And Exhaust Valve Seats
Courtesy of SUBARU OF AMERICA, INC.

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)

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

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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

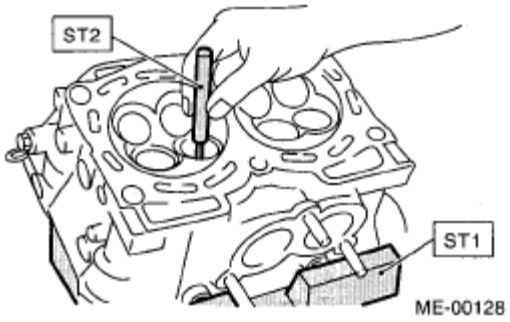

Fig. 190: Inserting ST2 Into Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

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

   ST 18251AA020 VALVE GUIDE ADJUSTER

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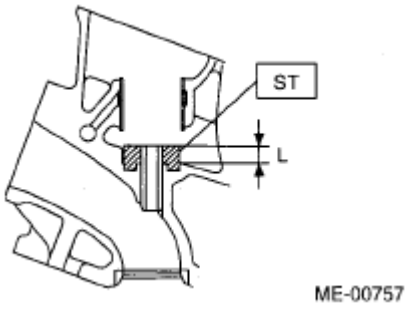

Fig. 191: Identifying ST On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

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 the cylinder head, 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

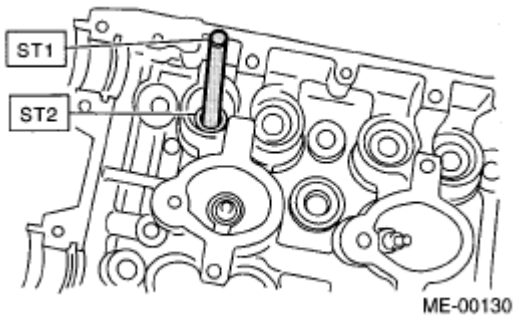

Fig. 192: Identifying ST1 And ST2 On Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

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.**

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- **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. 193: Reaming 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 of valve and valve stem, and replace the valve with a new part if damaged, worn, deformed, or if dimension "H" in the figure is outside of the specified limit.

   Head edge thickness H:

   Standard

   Intake (A)

   1.0 - 1.4 mm (0.039 - 0.055 in)

   Exhaust (B)

   1.3 - 1.7 mm (0.051 - 0.067 in)

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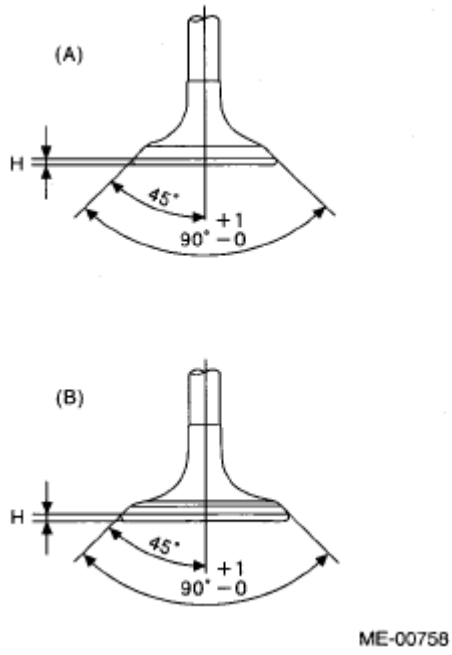

Fig. 194: Identifying Head Edge Thickness
Courtesy of SUBARU OF AMERICA, INC.

2. Put a small amount of grinding compound on the valve seat surface, and lap the valve and valve seat surface. 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

104.4 mm (4.110 in)

Exhaust

104.65 mm (4.1201 in)

VALVE SPRING

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

VALVE SPRING REFERENCE

Free length	mm (in)	47.32 (1.863)

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Tension/spring height N (kgf, lb)/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

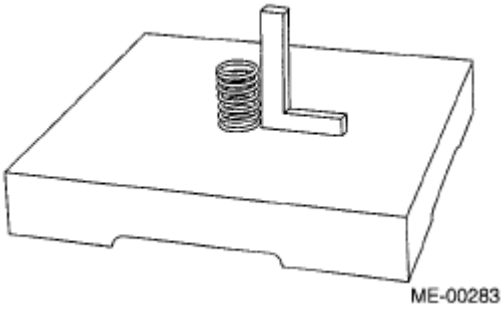

Fig. 195: Measuring Squareness Of Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

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 valve and valve seat.
   - When replacing the valve guide.
2. Place the cylinder head on ST1, and use ST2 to 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 to strike in.**
- **The intake valve oil seals and exhaust valve oil seals are distinguished by their colors.**

Color of rubber part:

Intake [Gray]

Exhaust [Green]

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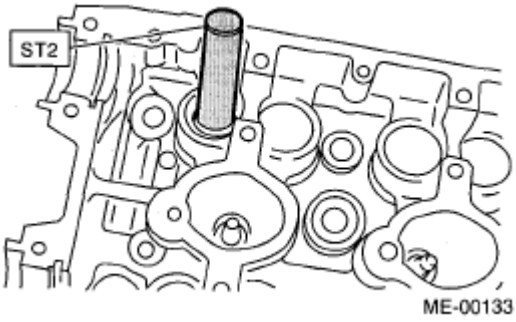

Fig. 196: Pressing Oil Seal Using ST2
Courtesy of SUBARU OF AMERICA, INC.

VALVE LIFTER

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

   Outer diameter of valve lifter:

   34.959 - 34.975 mm (1.3763 - 1.3770 in)

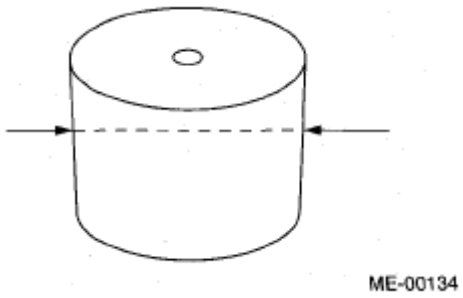

Fig. 197: Identifying Outer Diameter Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

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

   Valve lifter mating surface inner diameter:

   34.994 - 35.016 mm (1.3777 - 1.3786 in)

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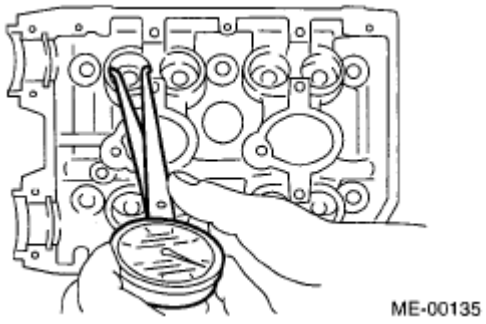

Fig. 198: Measuring Inner Diameter Of Valve Lifter Mating Surface On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

4. Check the clearance between valve lifter and valve lifter mating surface. The clearance can be checked by measuring respectively the outer diameter of valve lifter and the inner diameter of valve lifter. If it exceeds the standard or offset wear occurs, replace the cylinder head.

Valve lifter and valve lifter mating surface clearance:

Standard

0.019 - 0.057 mm (0.0007 - 0.0022 in)

CYLINDER BLOCK

REMOVAL

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

1. Remove the V-belts. Ref. to **REMOVAL**, V-belt.
2. Remove the intake manifold. Ref. to **REMOVAL** , Intake Manifold.
3. Remove the crank pulley. Ref. to **REMOVAL**, Crank Pulley.
4. Remove the timing belt cover. Ref. to **REMOVAL**, Timing Belt Cover.
5. Remove the timing belt. Ref. to **REMOVAL**, Timing Belt.
6. Remove the cam sprocket. Ref. to **REMOVAL**, Cam Sprocket.
7. Remove the crank sprocket. Ref. to **REMOVAL**, Crank Sprocket.
8. Remove the generator and A/C compressor with their brackets.
9. Remove the camshaft. Ref. to **REMOVAL**, Camshaft.
10. Remove the cylinder head. Ref. to **REMOVAL**, Cylinder Head.
11. Use the ST to lock the crankshaft, and remove the drive plate. (AT model)

    ST 498497100 CRANKSHAFT STOPPER

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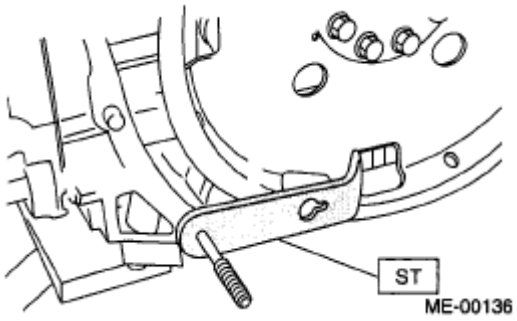

Fig. 199: Identifying Crankshaft Stopper
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the clutch disc and cover. (MT model) Ref. to **REMOVAL** , Clutch Disc and Cover.
13. Remove the flywheel. (MT model) Ref. to **REMOVAL** , Flywheel.
14. Remove the oil separator cover.
15. Remove the water by-pass pipe for heater.
16. Remove the oil filter. Ref. to **REMOVAL** , Engine Oil Filter.
17. Remove the water pump. Ref. to **REMOVAL** , Water Pump.
18. Remove the bolts which secure oil pump to cylinder block.

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

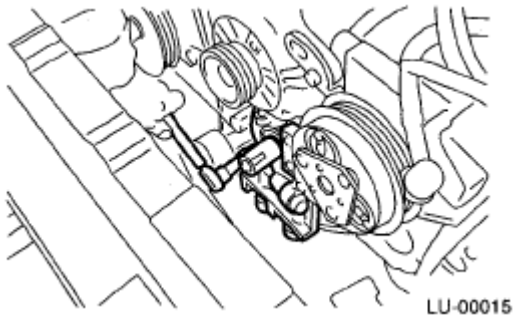

Fig. 200: Identifying Oil Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

19. 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.

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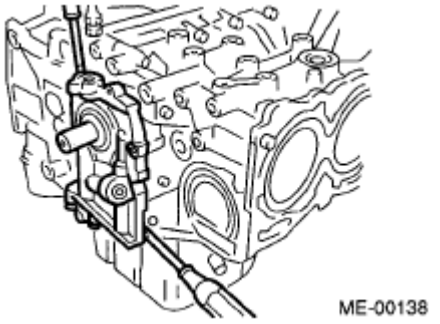

Fig. 201: Identifying Oil Pump And Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

20. Remove the front oil seal from the oil pump.
21. 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.

22. Remove the oil strainer.
23. Remove the baffle plate.
24. Remove the water tank pipe assembly.
25. Remove the water pipe assembly.

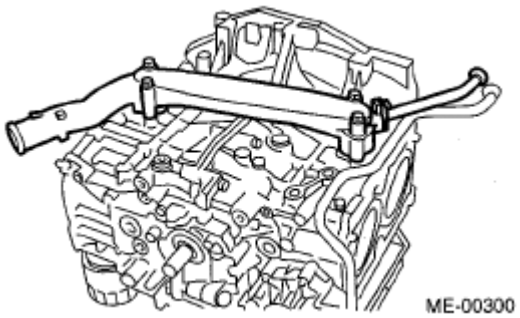

Fig. 202: Identifying Water Pipe Assembly
Courtesy of SUBARU OF AMERICA, INC.

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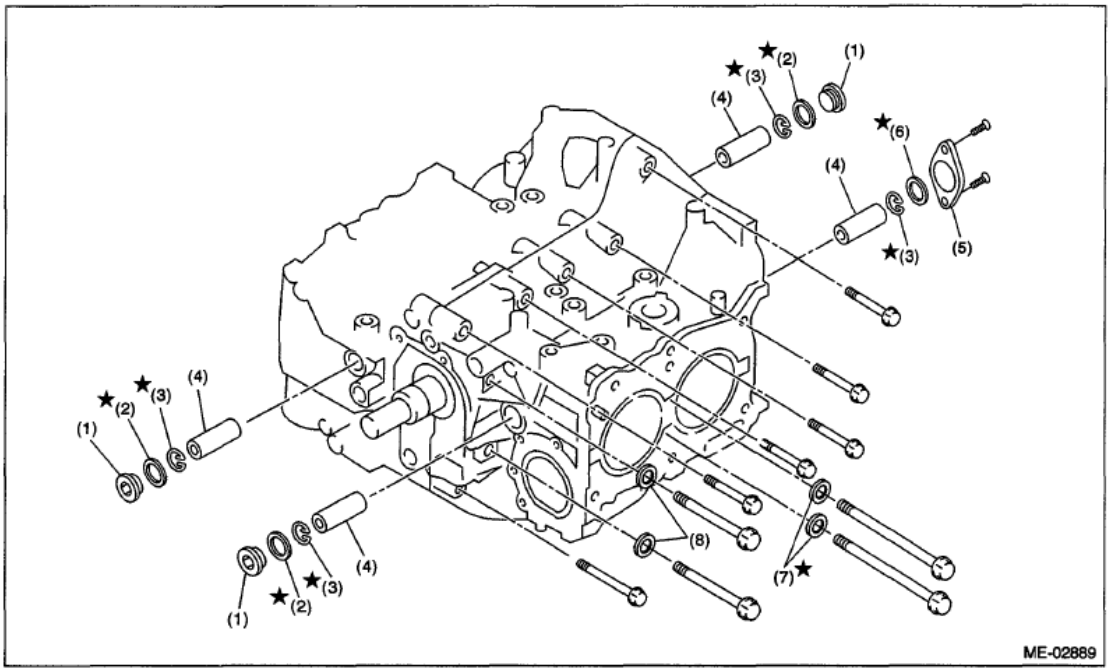

(1) Service hole plug
(2) Gasket
(3) Snap ring
(4) Piston pin
(5) Service hole cover
(6) O-ring
(7) Seal washer
(8) Washer

Fig. 203: Identifying Service Hole Plug, Piston Pin, Seal Washer, Gasket, Service Hole Cover, Snap Ring And O-Ring
Courtesy of SUBARU OF AMERICA, INC.

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

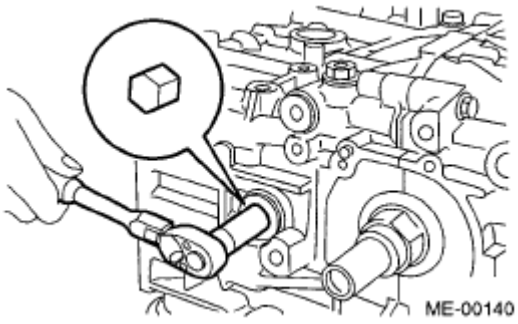

Fig. 204: Removing Service Hole Plugs Using Hexagon Wrench
Courtesy of SUBARU OF AMERICA, INC.

27. Remove the service hole cover.
28. 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.

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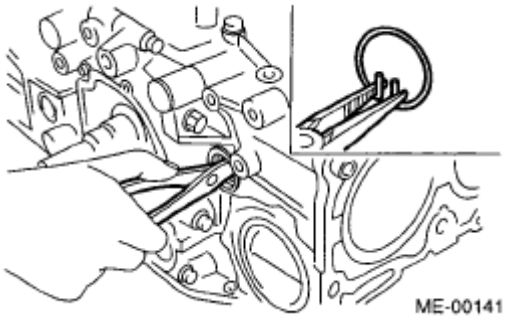

Fig. 205: Removing Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

    ST 499097700 PISTON PIN REMOVER ASSY

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

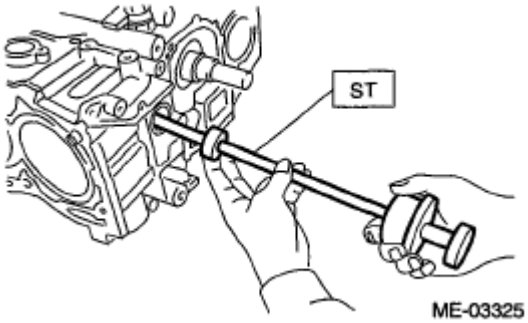

Fig. 206: Removing Piston Pin Using Piston Pin Remover
Courtesy of SUBARU OF AMERICA, INC.

30. Similarly draw out the piston pins from #3 and #4 pistons.
31. Remove the cylinder block connecting bolt on the RH side.
32. Loosen the cylinder block connecting bolt on the LH side by 2 to 3 turns.
33. Set the part so that the cylinder block LH is on the upper side, and remove the cylinder block connecting bolt.
34. Separate the cylinder block LH and RH.

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

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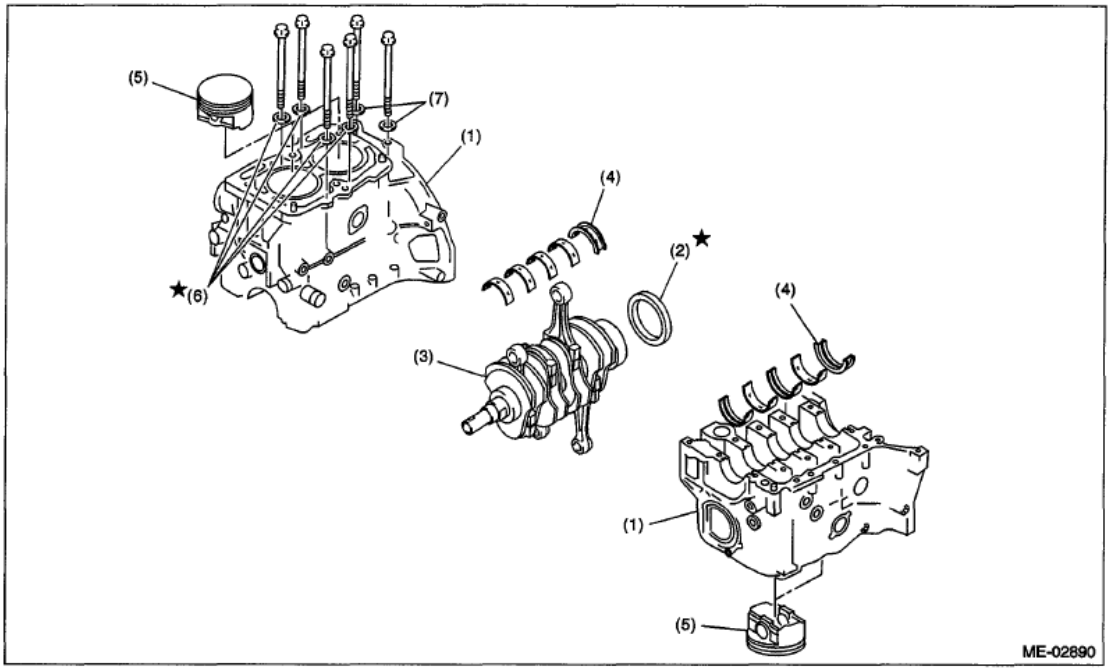

(1) Cylinder block
(2) Rear oil seal
(3) Crankshaft
(4) Crankshaft bearing
(5) Piston
(6) Seal washer
(7) Washer

Fig. 207: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

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

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

38. Remove each piston from the cylinder block using a wooden bar or hammer handle.

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

INSTALLATION

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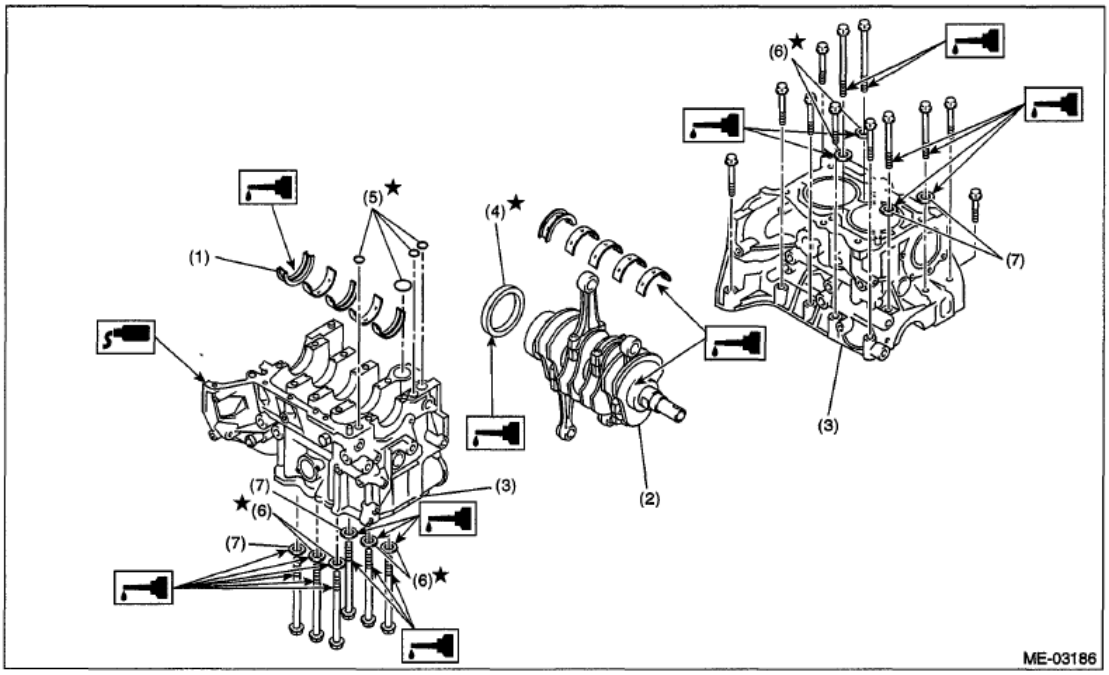

(1) Crankshaft bearing
(2) Crankshaft
(3) Cylinder block
(4) Rear oil seal
(5) O-ring
(6) Seal washer
(7) Washer

Fig. 208: Identifying Engine Oil Applying Area On Bearing And Crankshaft Journal
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 cylinder block RH.

NOTE: Use new O-rings.

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

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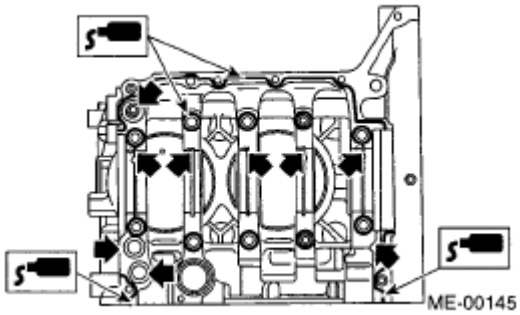

Fig. 209: Identifying Liquid Gasket Applying Area On Mating Surfaces Of Cylinder Block RH
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a 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, 7.4 ft-lb)

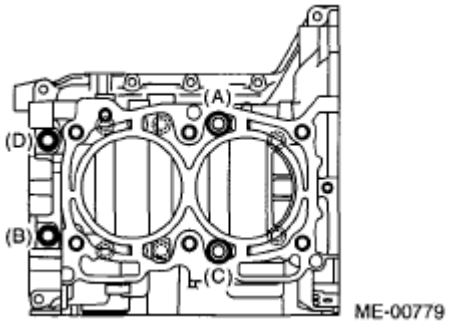

Fig. 210: Identifying Cylinder Block Connecting Bolts In Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

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, 7.4 ft-lb)

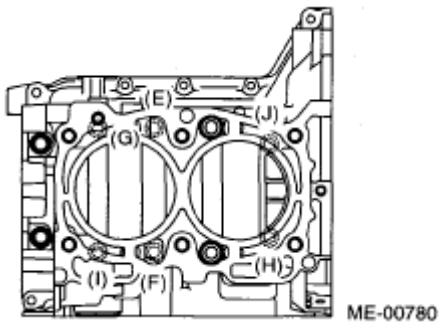

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Fig. 211: Identifying Cylinder Block Connecting Bolts In Tightening Sequence (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten the LH side cylinder block connecting bolts (A - D) further in alphabetical order.

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

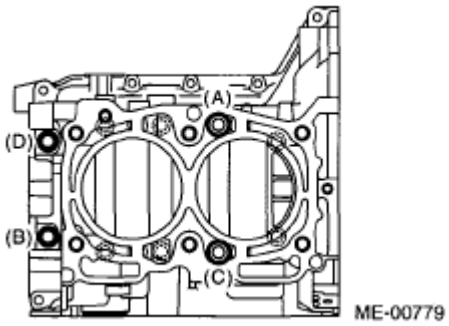

Fig. 212: Identifying Cylinder Block Connecting Bolts In Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

8. Tighten the RH side cylinder block connecting bolts (E - J) further in alphabetical order.

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

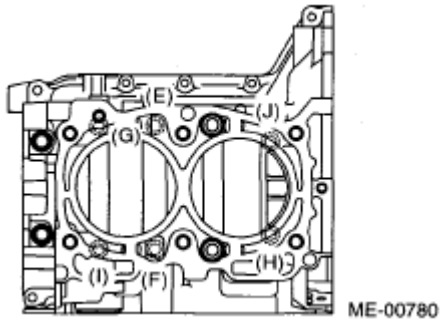

Fig. 213: Identifying Cylinder Block Connecting Bolts In Tightening Sequence (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

9. Tighten the LH side cylinder block connecting bolts (A - D) further in alphabetical order.
   - (A), (C): Angle tightening

   Tightening angle: 90°

   - (B), (D): Torque tightening

   Tightening torque: 40 N.m (4.1 kgf-m, 29.5 ft-lb)

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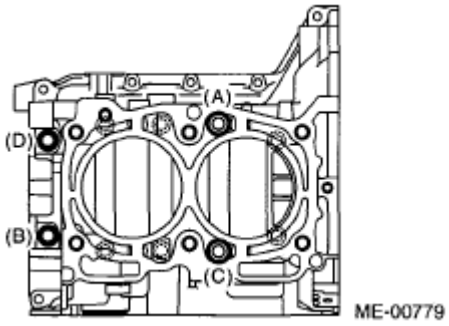

Fig. 214: Identifying Cylinder Block Connecting Bolts In Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

    Tightening angle: 90°

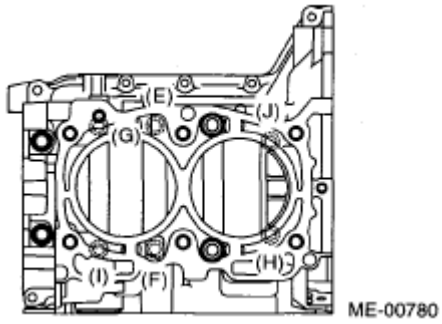

Fig. 215: Identifying Cylinder Block Connecting Bolts In Tightening Sequence (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

    Tightening torque:

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

    (H): 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

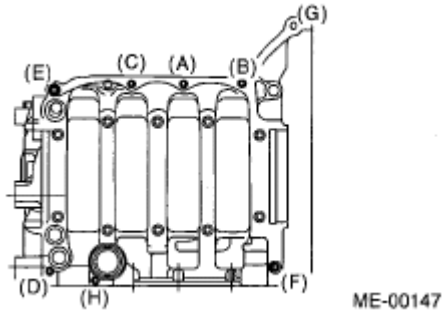

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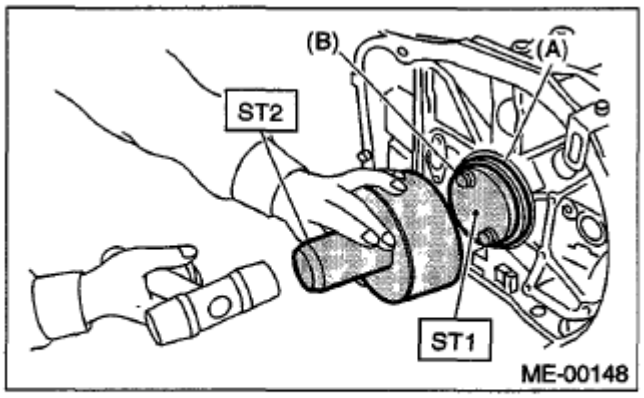
Fig. 216: Identifying Cylinder Block Connecting Bolts In Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

12. Apply a coat of engine oil to the oil seal periphery and 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 attachment bolt

Fig. 217: Identifying Rear Oil Seal And Flywheel Attachment Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

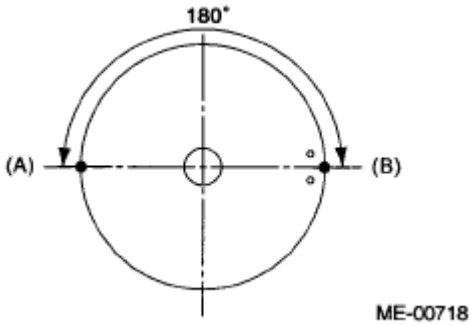


Fig. 218: Positioning Of Top Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

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

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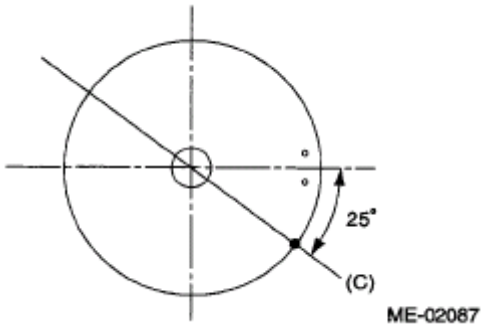

Fig. 219: Positioning Of Upper Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

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

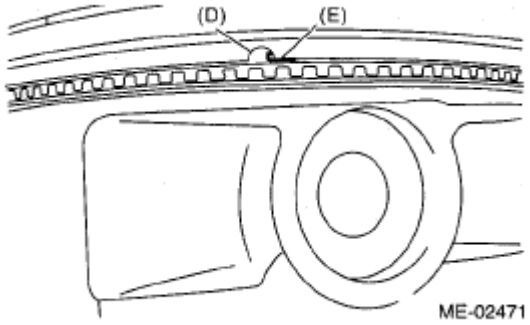

Fig. 220: Identifying Upper Rail Spin Stopper And Side Hole On Piston
Courtesy of SUBARU OF AMERICA, INC.

17. Position the expander gap at (F) in the figure on the 180° opposite direction of (C).

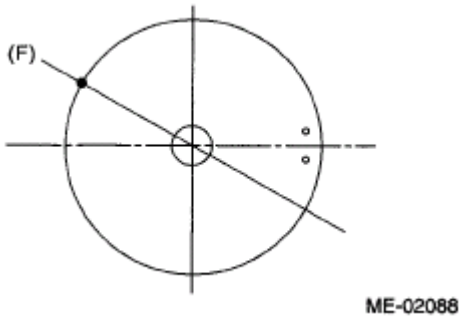

Fig. 221: Positioning Of Expander Gap
Courtesy of SUBARU OF AMERICA, INC.

18. Set the lower rail gap at position (G), located 120° clockwise from (C) in the figure.

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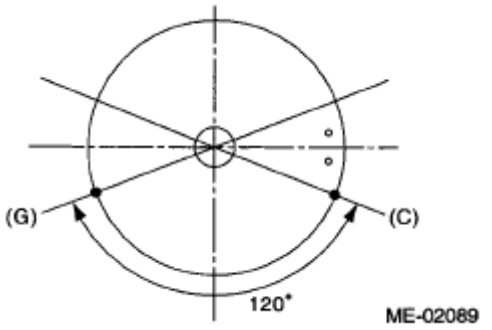


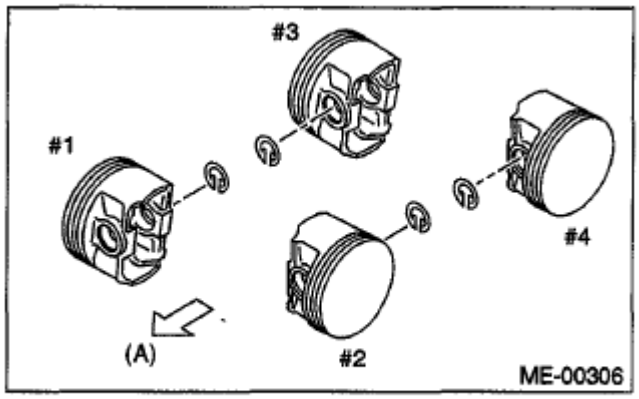
Fig. 222: Positioning Of Lower Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

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

19. Install the snap ring.

Before positioning the piston on the cylinder block, attach the snap ring in the service hole of the cylinder block, and the piston hole on the opposite side.

NOTE: Use new snap rings.



(A) Front side

Fig. 223: Identifying Snap Ring In Service Hole
Courtesy of SUBARU OF AMERICA, INC.

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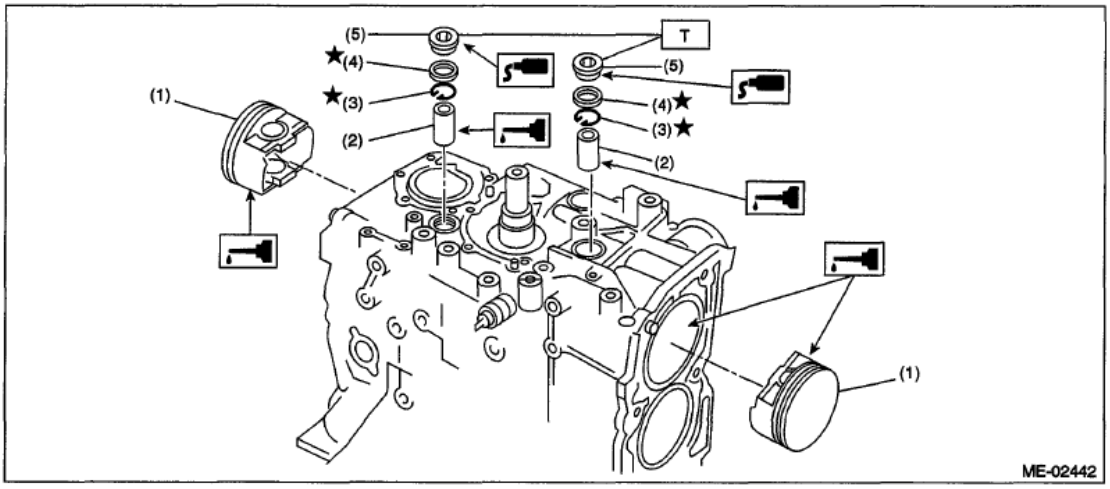

(1) Piston
(2) Piston pin
(3) Snap ring
(4) Gasket
(5) Service hole plug

Fig. 224: Identifying Piston, Piston Pin, Gasket, Snap Ring And Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

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

T: 70 (7.1, 51.6)

20. Install the 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

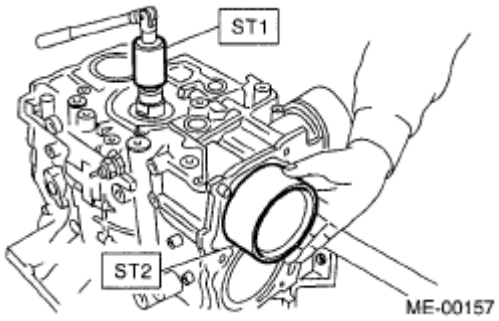

Fig. 225: Inserting Pistons In Cylinders Using ST2
Courtesy of SUBARU OF AMERICA, INC.

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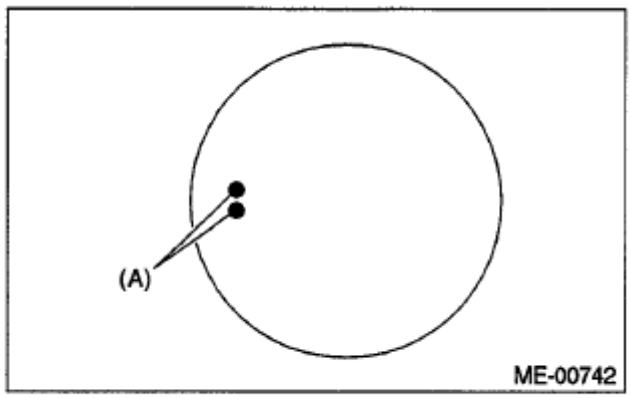
NOTE: Face the piston front mark towards the front of the engine.



(A) Front mark

Fig. 226: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

21. Install the 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

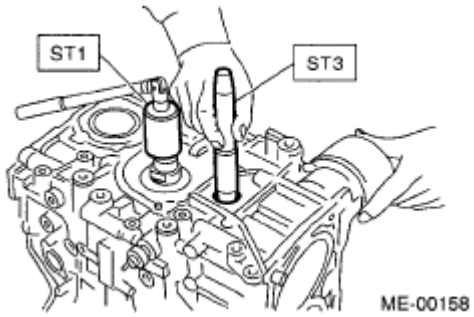


Fig. 227: Inserting ST3 Into Service Hole To Piston Pin Hole
Courtesy of SUBARU OF AMERICA, INC.

    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.

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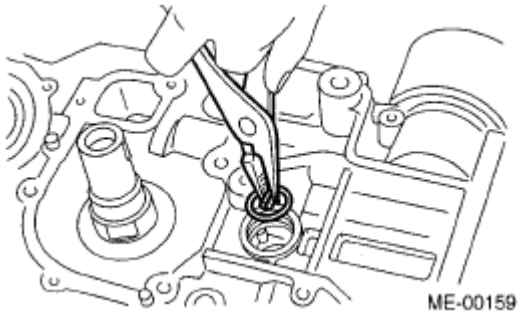

Fig. 228: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

   Liquid gasket:

   THREE BOND 1105 (Part No. 004403010) or equivalent

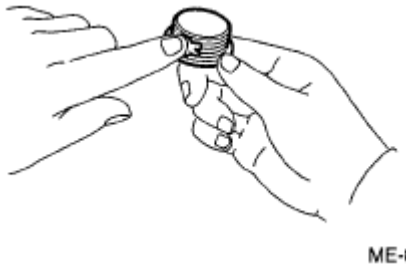

Fig. 229: Applying Liquid Gasket To Threaded Portion Of Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

   NOTE: Use a new gasket.

   Tightening torque: 70 N.m (7.1 kgf-m, 51.6 ft-lb)

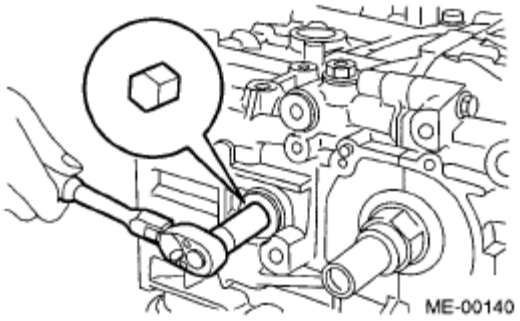

Fig. 230: Removing Service Hole Plugs Using Hexagon Wrench

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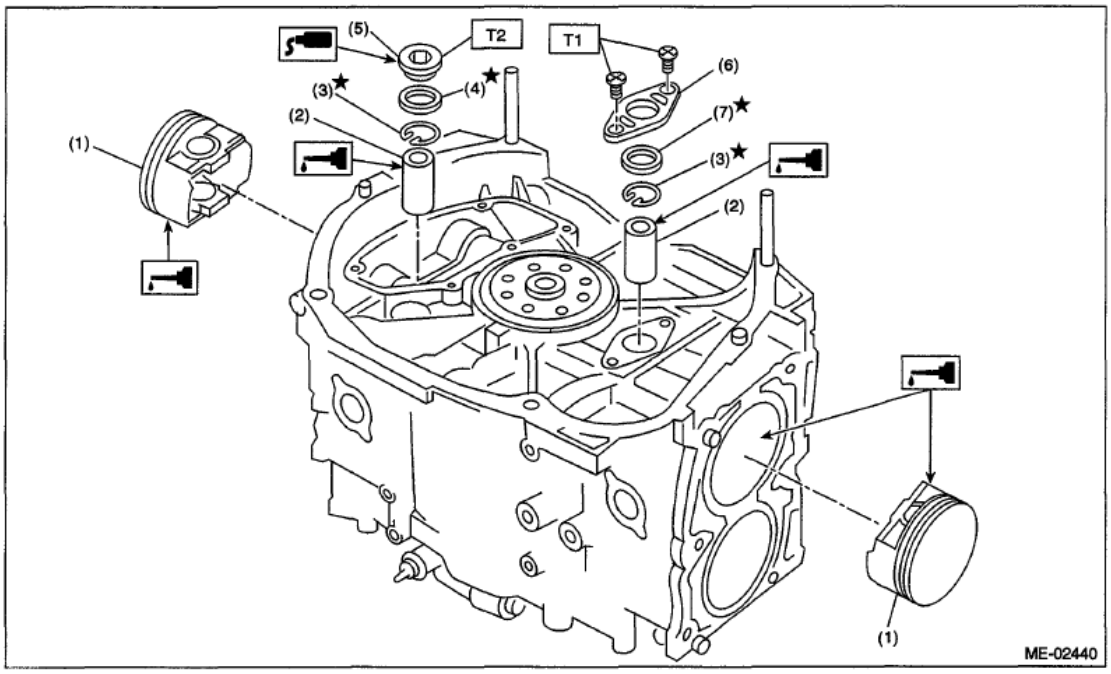
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 231: Exploded View Of Cylinder Block
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.
8. Install the service hole cover.

NOTE: Use new O-rings.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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

T1: 6.4 (0.7, 4.7)

T2: 70 (7.1, 51.6)

22. Install the water pipe assembly.

NOTE: Use new O-rings.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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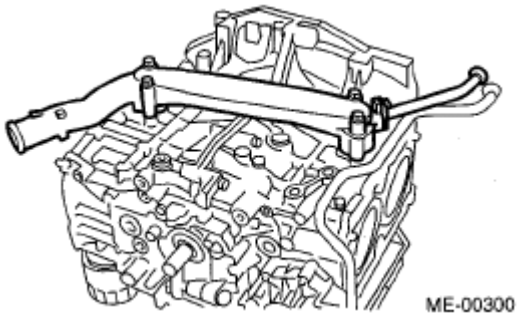

Fig. 232: Identifying Water Pipe Assembly
Courtesy of SUBARU OF AMERICA, INC.

23. Install the water tank pipe assembly.

    Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

24. Install the baffle plate.

    Tightening torque: 6.4 N.m (0.7 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, 7.4 ft-lb)

26. Tighten the oil strainer stay together with the baffle plate.

    Tightening torque: 6.4 N.m (0.7 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)

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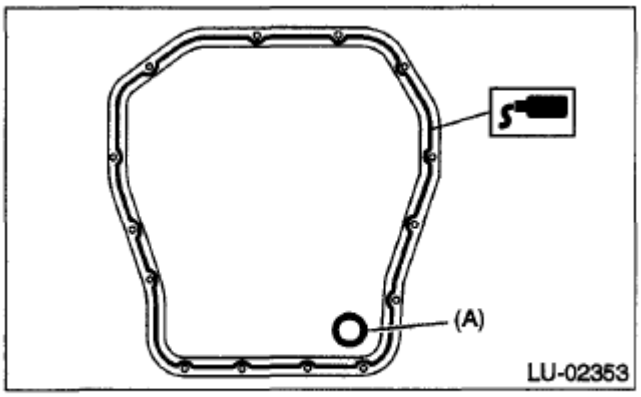

(A) Gasket

Fig. 233: Identifying Gasket
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 figure (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 thread (A) (when reusing the bolt)

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

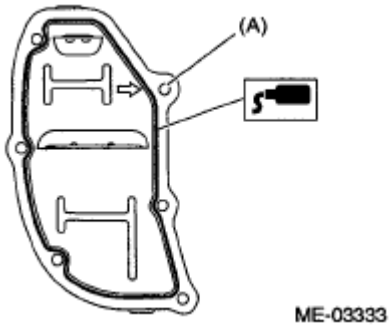

Fig. 234: Applying Liquid Gasket To Mating Surfaces Of Oil Separator Cover And Threaded Portion Of Bolt

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Courtesy of SUBARU OF AMERICA, INC.

29. Use the ST to lock the crankshaft, and install the drive plate. (AT model)

    ST 498497100 CRANKSHAFT STOPPER

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

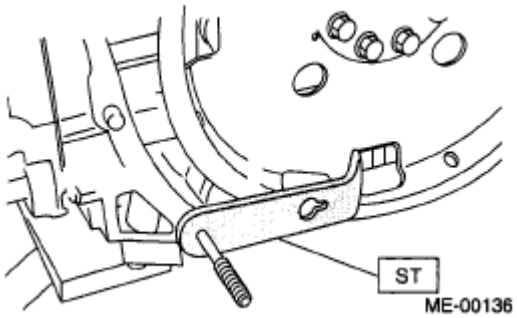

Fig. 235: Identifying Crankshaft Stopper
Courtesy of SUBARU OF AMERICA, INC.

30. Install the flywheel. (MT model) Ref. to **INSTALLATION** , Flywheel.
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.

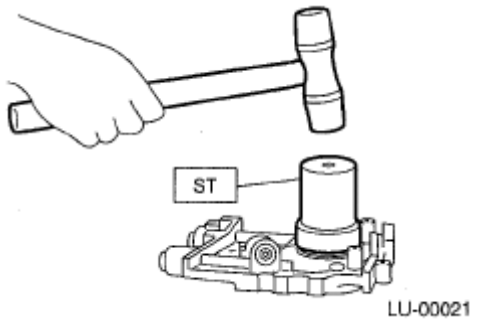

Fig. 236: Installing Front Oil Seal Using ST
Courtesy of SUBARU OF AMERICA, INC.

    2. Apply liquid gasket to the mating surfaces of oil pump.

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

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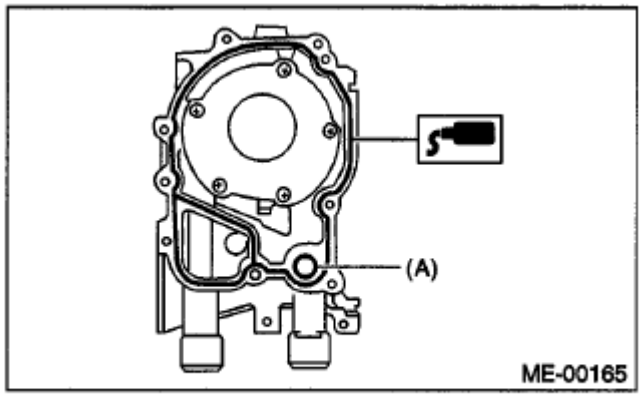
Liquid gasket:

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



(A) O-ring

Fig. 237: Applying Liquid Gasket To Mating Surfaces Of Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

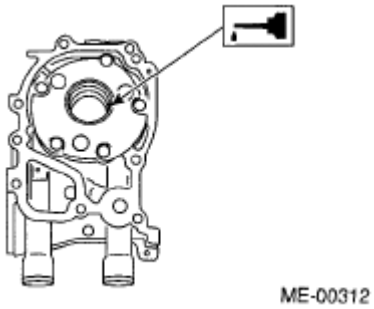


Fig. 238: Applying Coat Of Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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 figure, (when reusing bolts)

Liquid gasket:

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THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

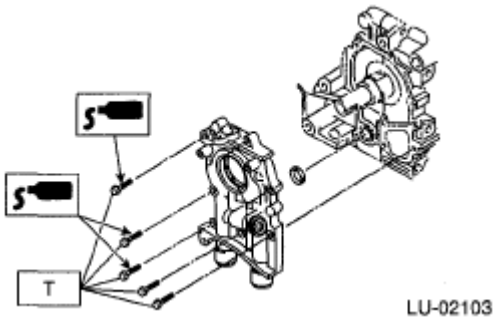

Fig. 239: Applying Liquid Gasket To Bolts Thread
Courtesy of SUBARU OF AMERICA, INC.

33. Install the water pump and gasket.

NOTE:

- **When installing the water pump, tighten bolts in two stages in alphabetical order as shown in the figure.**
- **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)

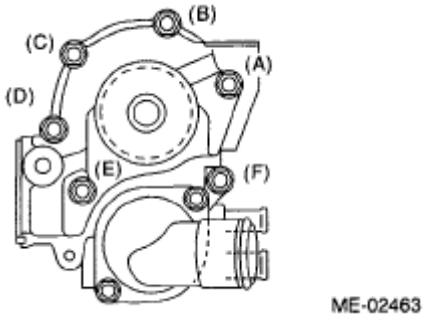

Fig. 240: Identifying Water Pump Bolts In Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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

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36. Install the cylinder head. Ref. to **INSTALLATION**, Cylinder Head.
37. Install the camshaft. Ref. to **INSTALLATION**, Camshaft.
38. Install the generator and A/C compressor with their brackets.

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

39. Install the crank sprocket. Ref. to **INSTALLATION**, Crank Sprocket.
40. Install the cam sprocket. Ref. to **INSTALLATION**, Cam Sprocket.
41. Install the timing belt. Ref. to **INSTALLATION**, Timing Belt.
42. Adjust the valve clearance. Ref. to **ADJUSTMENT**, Valve Clearance.
43. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover. (Outer and ignition coil)

       NOTE: Use a new rocker cover gasket.

    2. Apply liquid gasket to the specified point of the cylinder head.

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

       Liquid gasket:

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

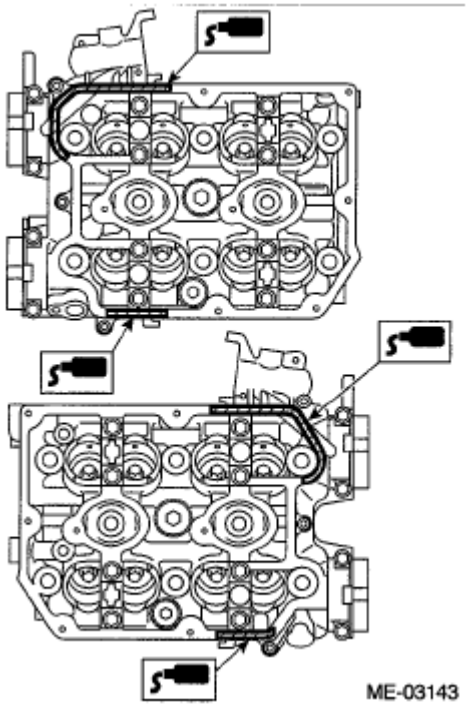

Fig. 241: Identifying Liquid Gasket Applying Area On Cylinder Head

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Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover onto cylinder heads. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover tightening bolts in alphabetical order shown in the figure, and then tighten to specified torque in alphabetical order.

Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

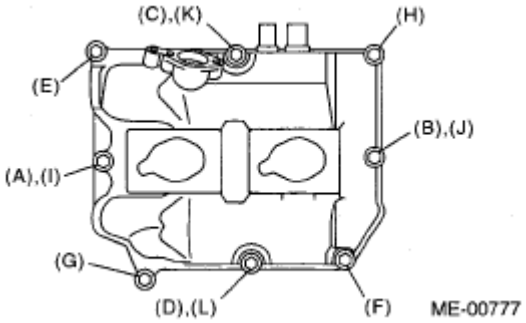
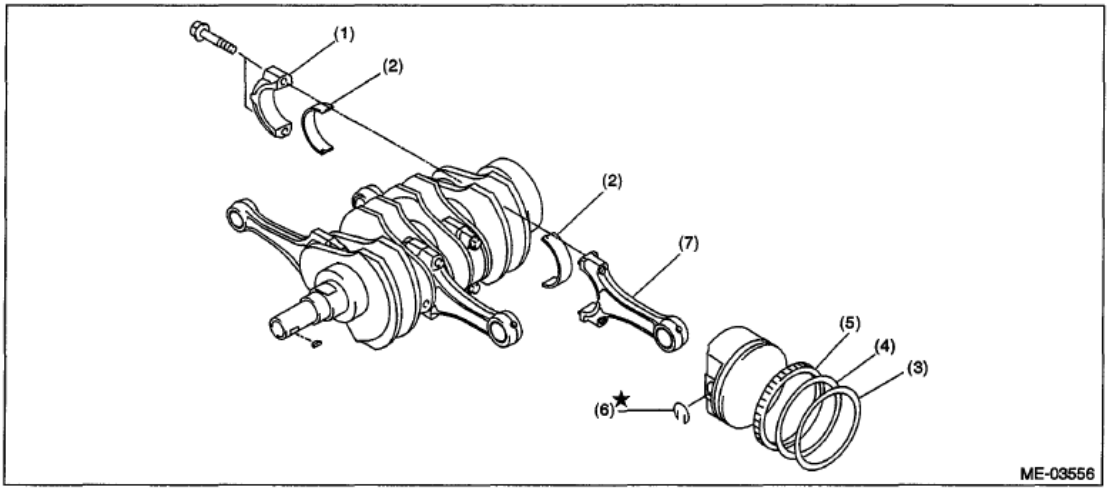


Fig. 242: Identifying Rocker Cover Bolts In Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

44. Install the timing belt cover. Ref. to **INSTALLATION**, Timing Belt Cover.
45. Install the crank pulley. Ref. to **INSTALLATION**, Crank Pulley.
46. Install the intake manifold. Ref. to **INSTALLATION** , Intake Manifold.
47. Install the V-belts. Ref. to **INSTALLATION**, V-belt.

DISASSEMBLY



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

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Fig. 243: Identifying Connecting Rod Cap, Connecting Rod Bearing, Second Ring, Snap Ring, Oil Ring And Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

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

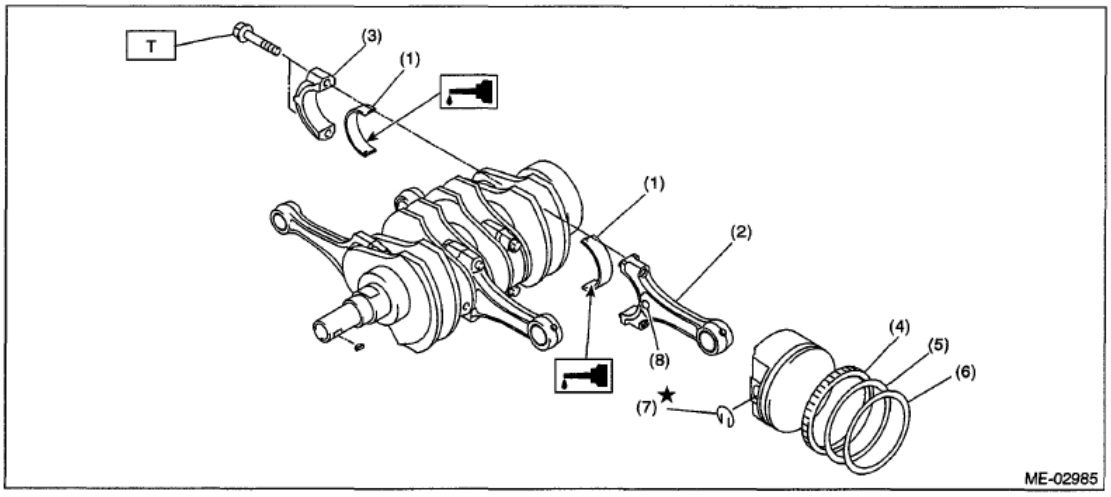
NOTE: Keep the removed connecting rods, connecting rod caps and bearings in order so that they are kept in their original combinations/groups, and not mixed together.

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



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

Fig. 244: Identifying Connecting Rod Cap, Connecting Rod Bearing, Second Ring, Snap Ring, Oil Ring, Top Ring And Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

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

T: 52 (5.3, 38.4)

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1. Apply engine 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. Attach the connecting rod cap and tighten it with 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.

NOTE: Assemble so that the piston ring mark "R" faces the top side of the piston.

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 front upper face of the cylinder block.

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

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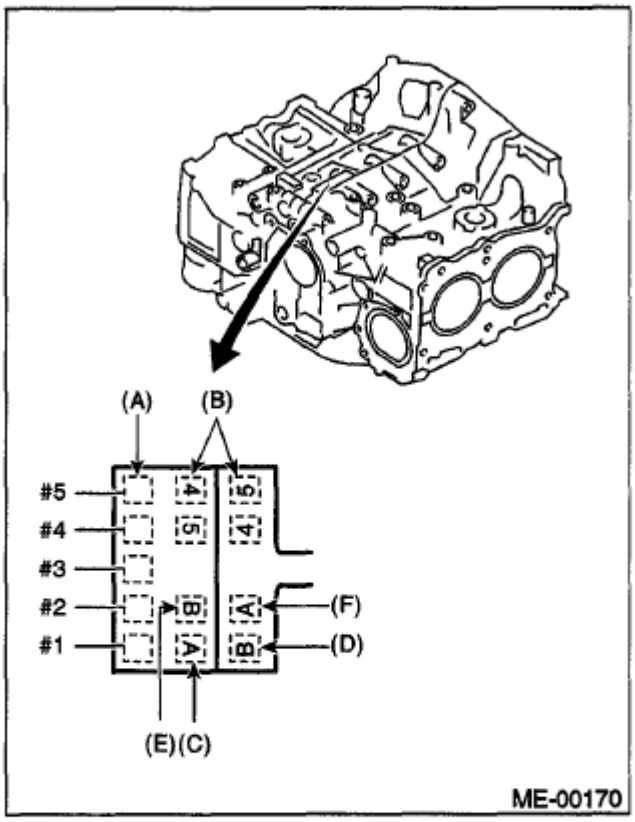
- **Standard sized pistons are classified into two grades, "A" and "B". These grades should be used as guide lines in selecting a standard piston.**

Standard diameter:

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

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



(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. 245: Identifying Cylinder Bore Size Marks Location
Courtesy of SUBARU OF AMERICA, INC.

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

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

Taper:

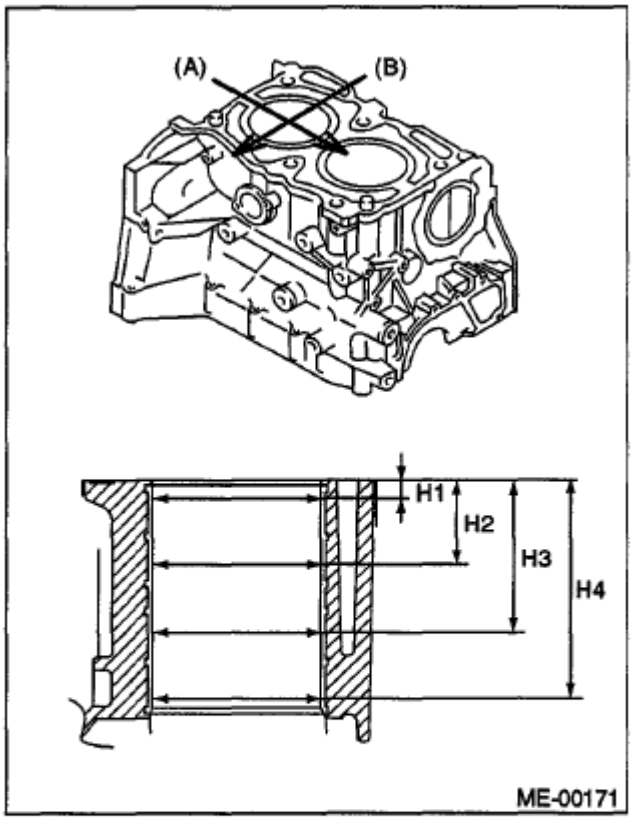
Standard

0.015 mm (0.0006 in)

Out-of-roundness:

Standard

0.010 mm (0.0004 in)



(A) Piston pin direction
(B) Thrust direction
H1: 10 mm (0.39 in)
H2: 45 mm (1.77 in)
H3: 80 mm (3.15 in)
H4: 115 mm (4.53 in)

Fig. 246: Measuring Inner Diameter Of Cylinder
Courtesy of SUBARU OF AMERICA, INC.

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

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

Piston grade point H:

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)

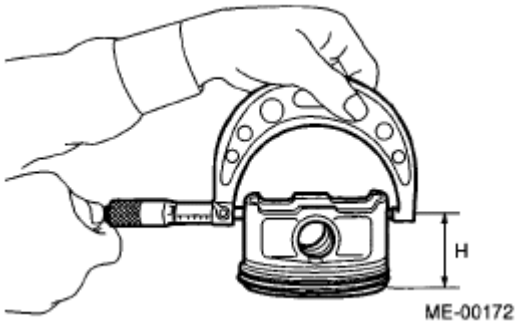

Fig. 247: Measuring Outer Diameter Of Piston
Courtesy of SUBARU OF AMERICA, INC.

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):

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Standard

-0.010 - 0.010 mm (-0.00039 - 0.00039 in)

6. Boring and honing
    1. If any of the measured value of taper, out-of-roundness or cylinder-to-piston clearance is out of standard or if there is any damage on the cylinder wall, rebore it to replace with an oversize piston.

CAUTION: When any of the cylinders needs reboring, all other cylinders must be bored at the same time, and replaced with 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 diameter boring limit (diameter):

To 100.005 mm (3.9372 in)

PISTON AND PISTON PIN

1. Check the piston and piston pin for damage, 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.

Clearance between piston hole and piston pin:

Standard

0.004 - 0.008 mm (0.0002 - 0.0003 in)

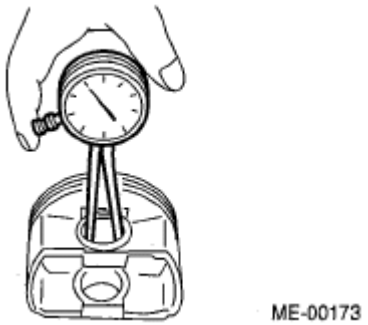

Fig. 248: Checking Clearance Between Piston Pin Hole

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Courtesy of SUBARU OF AMERICA, INC.

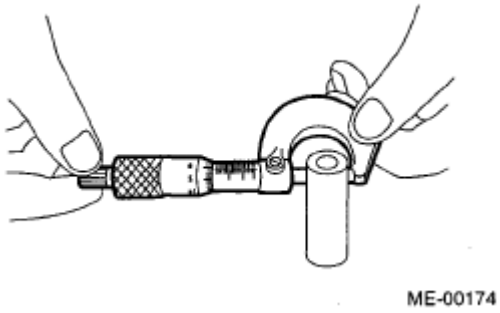

Fig. 249: Checking Clearance Between Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

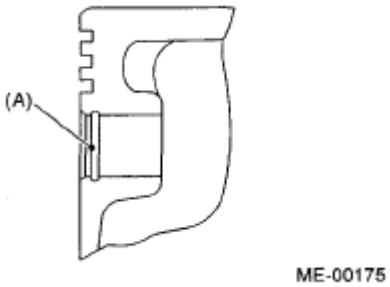

Fig. 250: Identifying Snap Ring Installation Groove On Piston
Courtesy of SUBARU OF AMERICA, INC.

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:

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

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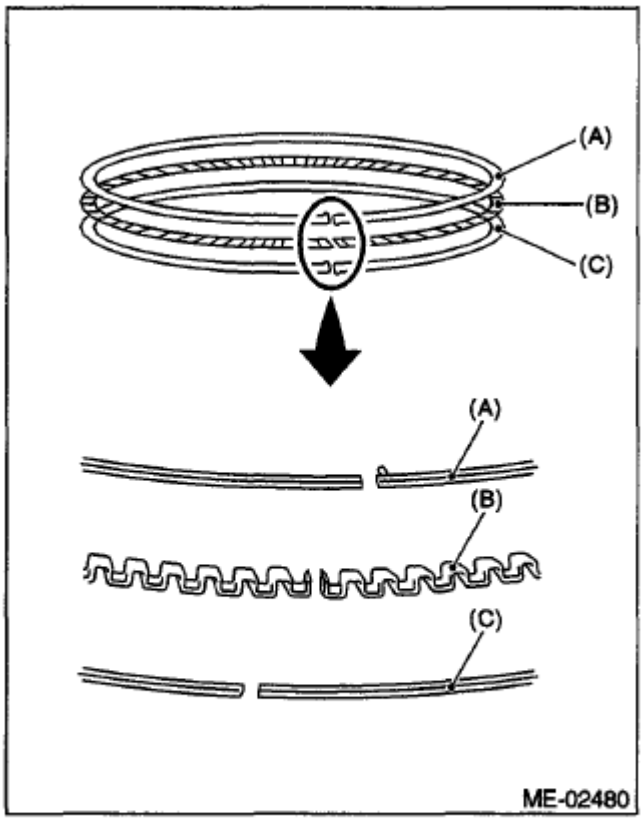

(A) Upper rail
(B) Expander
(C) Lower rail

Fig. 251: Identifying Piston Ring
Courtesy of SUBARU OF AMERICA, INC.

2. Using the piston, insert the piston ring and oil ring into the cylinder so that they are perpendicular to the cylinder wall, and measure the piston ring gap with a thickness gauge.

PISTON RING GAP REFERENCE

-		Standard
		mm (in)
Piston ring gap	Top ring	0.20 - 0.25 (0.0079 - 0.0098)
	Second ring	0.37 - 0.52 (0.015 - 0.020)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)

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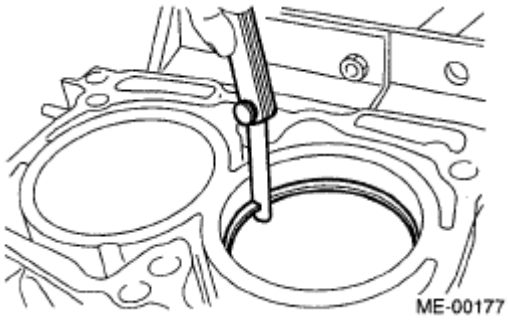

Fig. 252: Measuring Piston Ring Gap With Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

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

PISTON RING AND PISTON RING GROOVE CLEARANCE REFERENCE

-		Standard mm (in)
Clearance between piston ring and piston ring groove	Top ring	0.040 - 0.080 (0.0016 - 0.0031)
	Second ring	0.030 - 0.070 (0.0012 - 0.0028)

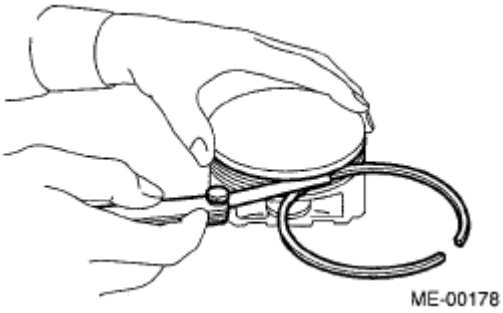

Fig. 253: Measuring Clearance Between Piston Ring And Piston Ring Groove With Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

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

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

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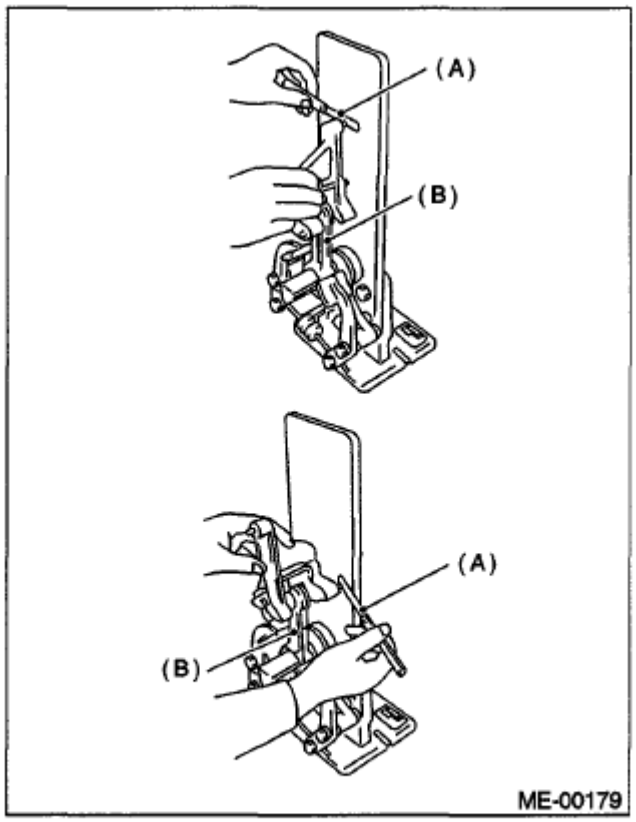

(A) Thickness gauge
(B) Connecting rod

Fig. 254: Identifying Thickness Gauge And Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod with bearings attached to the crankshaft, and measure the thrust clearance using a thickness gauge. If the thrust clearance exceeds the standard or uneven wear is found, replace the connecting rod.

Connecting rod thrust clearance:

Standard

0.070 - 0.330 mm (0.0028 - 0.0130 in)

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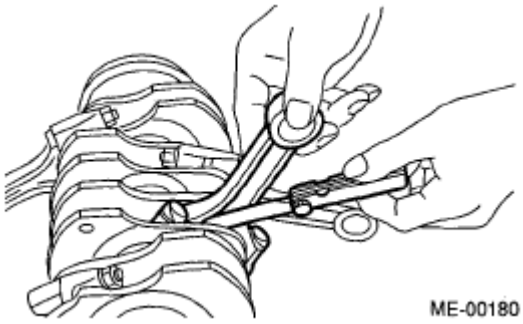

Fig. 255: Measuring Thrust Clearance Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

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)

CONNECTING ROD OIL CLEARANCE REFERENCE

		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. If the measured value is not within the standard, replace it with a new part.

Clearance between piston pin and bushing:

Standard

0 - 0.022 mm (0 - 0.0009 in)

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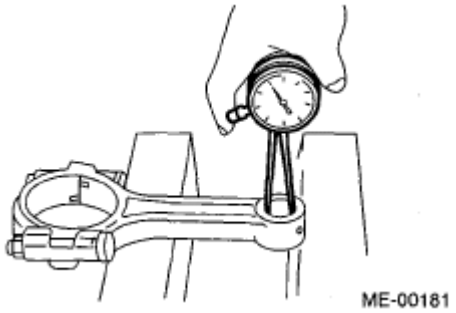

Fig. 256: Checking Piston Pin Clearance
Courtesy of SUBARU OF AMERICA, INC.

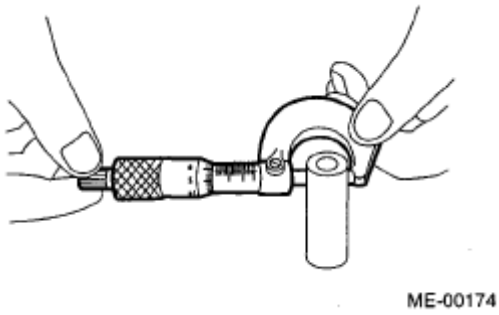

Fig. 257: Checking Bushing Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

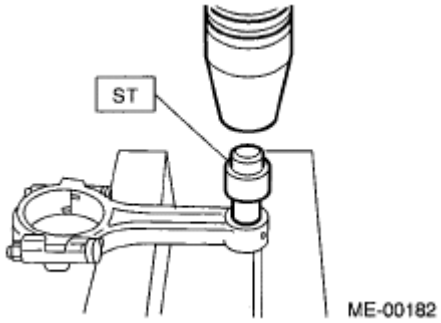

Fig. 258: Pressing Bushing With ST
Courtesy of SUBARU OF AMERICA, INC.

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

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CRANKSHAFT AND CRANKSHAFT BEARING

1. Clean the crankshaft completely, and check it for cracks using liquid penetrant tester. If defective, replace the crankshaft.
2. Measure warping of the crankshaft. If it exceeds the limit, correct or replace it.

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

Crankshaft bend limit: 0.035 mm (0.0014 in)

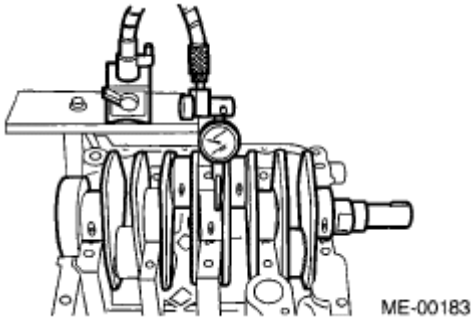

Fig. 259: Measuring Crankshaft Bend
Courtesy of SUBARU OF AMERICA, INC.

3. Inspect the crank journal and crank pin for wear. If they are not within the standard, 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)

Cylindrically

0.004 mm (0.0002 in)

Grinding limit (dia.)

To 51.750 mm (2.0374 in)

Crank journal:

Out-of-roundness

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0.005 mm (0.0002 in)

Cylindrically

0.006 mm (0.0002 in)

Grinding limit (dia.)

To 59.758 mm (2.3527 in)

Fig. 260: Measuring Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL DIAMETER REFERENCE

Unit: mm (in)

-		Crank journal 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)
0.25 (0.0098) undersize	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)
	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)

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

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Crankshaft thrust clearance:

Standard

0.030 - 0.115 mm (0.0012 - 0.0045 in)

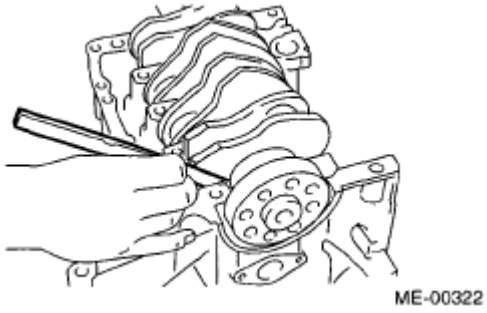

Fig. 261: Measuring Thrust Clearance Of Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

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

Crankshaft oil clearance:

Standard

0.010 - 0.030 mm (0.0004 - 0.0012 in)

INTAKE AND EXHAUST VALVE

SPECIFICATION

Refer to "Cylinder Head" for removal and installation procedures of the 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

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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 the crankshaft. Ref. to **REMOVAL**, Cylinder Block. Ref. to **INSTALLATION**, Cylinder Block.

ENGINE TROUBLE IN GENERAL

INSPECTION

NOTE: The "RANK" shown in the chart shows the possibilities of the cause of trouble in order from "Very often" to "Rarely".

A - Very often

B - Sometimes

C - Rarely

SYMPTOM CHART

Symptom	Problem parts etc.	Possible cause	RANK
1. Engine does not start.	-		
1) Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective inhibitor switch	C
		Defective starter	B
	Battery	Improper connection of terminal	A
		Run-down battery	A
		Defective charging system	B
	Friction	Seizure of crankshaft and connecting rod bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A

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	Fuel line	Defective fuel pump and relay	A
		Clogged fuel line	C
		Lack of fuel 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 cylinder 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 PROCEDURE** .		A
	Intake system	Defective intake manifold gasket	B
		Defective throttle body gasket	B
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of fuel 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 cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C

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		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 **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	B
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	C
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Dirty air cleaner element	C
	Fuel line	Clogged fuel line	C
		Lack of fuel 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 cylinder 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
2. Rough idle and engine stall	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	A

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		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	C
		Loosened oil filler cap	B
		Dirty air cleaner element	C
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of fuel 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 cylinder 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	Over-heating	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 **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked	A

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		intake duct	
		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 fuel 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 cylinder 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	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
	Cooling system	Over-heating	C
		Over-cooling	C
	Others	Evaporative emission control system malfunction	A
4. Surging	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	A

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		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 fuel 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 cylinder 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	Over-heating	B
	Others	Evaporative emission control system malfunction	C
5. Engine does not return to idle.	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked vacuum hose	A
	Others	Stuck or damaged throttle valve	A
6. Dieseling (Run-on)	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A

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	Cooling system	Over-heating	B
	Others	Evaporative emission control system malfunction	B
7. After burning in exhaust system	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	C
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	B
		Defective PCV valve	B
		Loosened oil filler cap	C
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder 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 **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened oil filler cap	B
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
	Cooling system	Over-heating	A
9. Excessive engine oil consumption	Intake system	Loosened or cracked PCV hose	A
		Defective PCV valve	B

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		Loosened oil filler cap	C
	Compression	Defective valve stem	A
		Worn or stuck piston rings, cylinder and piston	A
	Lubrication system	Loosened oil pump attaching bolts and defective gasket	B
		Defective oil filter 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 **BASIC DIAGNOSTIC PROCEDURE** .		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 cylinder 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

POSSIBLE CAUSE REFERENCE

Type of sound	Condition	Possible cause
		• Valve mechanism is

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Regular clicking sound	Sound increases as engine speed increases.	defective. • Incorrect valve clearance • Worn camshaft • Broken valve spring
Heavy and dull clank	Oil pressure is low.	• Worn crankshaft main bearing • Worn connecting rod bearing (large end)
	Oil pressure is normal.	• Loosened flywheel mounting 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 range of spark plug • Improper octane value gasoline
Clank when engine speed is between 1,000 and 2,000 rpms.	Noise 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	Noise 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

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		system, hose, connection or manifold
Timing belt noise	-	• Loose timing belt • Timing belt contacting with 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 Ref. to **OPERATION** , Clear Memory Mode. and Inspection Mode Ref. to **PROCEDURE** , Inspection Mode. after connecting the fuel injector connector.

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