2010 ENGINE

Mechanical (H4SO) - Legacy and Outback

GENERAL DESCRIPTION

SPECIFICATION

ENGINE MODEL SPECIFICATION

Engine	Model			2.5 L
	Cylinder arrangement			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve system mechanism			Belt driven Single 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			10.0
	Compression pressure (at 200 - 300 RPM)	kPa (kg/cm^2 , psi) (at 200 - 300 RPM)	Standard	1,020 - 1,275 (10.4 - 13.0, 148 - 185)
	Number of piston rings			Pressure ring: 2, Oil ring: 1
	Intake valve timing	Constant	Open	BTDC 0°
			Close	ABDC 58°
		Low speed	Open	BTDC 0°
			Close	ABDC - 10°
		High speed	Open	BTDC 14°
			Close	ABDC 62°
	Exhaust valve timing		Open	BBDC 30°
			Close	ATDC14°
	Valve clearance mm (in)	Intake		0.20±0.04 (0.0079±0.0016)
		Exhaust		0.25±0.04 (0.0098±0.0016)
	Idle speed (For CVT model, select lever in "P" or "N" range. For MT model, gear shift lever in neutral position.) RPM	No load	Standard	CVT model: 675±100 MT Model: 650±100
		A/C ON	Standard	700 - 850±100
	Ignition order			1 -->3-->2-->4
	Ignition timing	BTDC/RPM	Standard	CVT model: 15°±107675 MT Model: 10°±107650

NOTE: US: Undersize OS: Oversize

BELT TENSION ADJUSTER REFERENCE

Belt tension adjuster	Adjuster rod protrusion amount			mm (in)	5.2 - 6.2 (0.205 - 0.244)
Valve rocker arm	Clearance between arm and shaft		Standard	mm (in)	0.020 - 0.054 (0.0008 - 0.0021)
	Rocker arm inside diameter		Standard	mm (in)	22.020 - 22.041 (0.8669 - 0.8678)
	Rocker shaft diameter		Standard	mm (in)	21.987 - 22.000 (0.8656 - 0.8661)
Camshaft	Bending limit			mm (in)	0.025 (0.00098)
	Cam lobe height mm (in)	Intake Constant	Standard		40.075 - 40.175 (1.5778 - 1.5817)
		Intake Low speed	Standard		35.496 - 35.596 (1.3975 - 1.4014)
		Intake High speed	Standard		40.315 - 40.415 (1.5872 - 1.5911)
		Exhaust	Standard		39.289 - 39.389 (1.5468 - 1.5507)
	Cam base circle diameter		Standard	mm (in)	34.00 (1.3386)
	Base circle step of adjacent intake cams (low speed and high speed)		Standard	mm (in)	0.03 (0.001)
	Oil clearance		Standard	mm (in)	0.055 - 0.090 (0.0022 - 0.0035)
	Journal O.D.		Standard	mm (in)	31.928 - 31.945 (1.2570 - 1.2577)
	Cylinder head journal inner diameter		Standard	mm (in)	32.000 - 32.018 (1.2598 - 1.2605)
	Thrust clearance		Standard	mm (in)	0.030 - 0.090 (0.0012 - 0.0035)
Cylinder head	Warping limit (Mating surface with cylinder block)			mm (in)	0.035 (0.0014)
	Grinding limit			mm (in)	0.1 (0.004)
	Standard height			mm (in)	97.5 (3.84)
Valve seat	Seating angle between valve and valve seat				90°
	Contacting width of valve and valve seat	mm (in)	Intake	Standard	0.8 - 1.4 (0.03 - 0.055)
			Exhaust	Standard	1.2 - 1.8 (0.047 - 0.071)
Valve guide	Clearance between the valve guide and valve stem	mm (in)	Intake	Standard	0.035 - 0.062 (0.0014 - 0.0024)
			Exhaust	Standard	0.040 - 0.067 (0.0016 - 0.0026)
	Inside diameter			mm (in)	6.000 - 6.012 (0.2362 - 0.2367)
	Valve stem outer diameter			mm (in)	Intake 5.950 - 5.965 (0.2343 - 0.2348)
					5.945 - 5.960 (0.2341 -

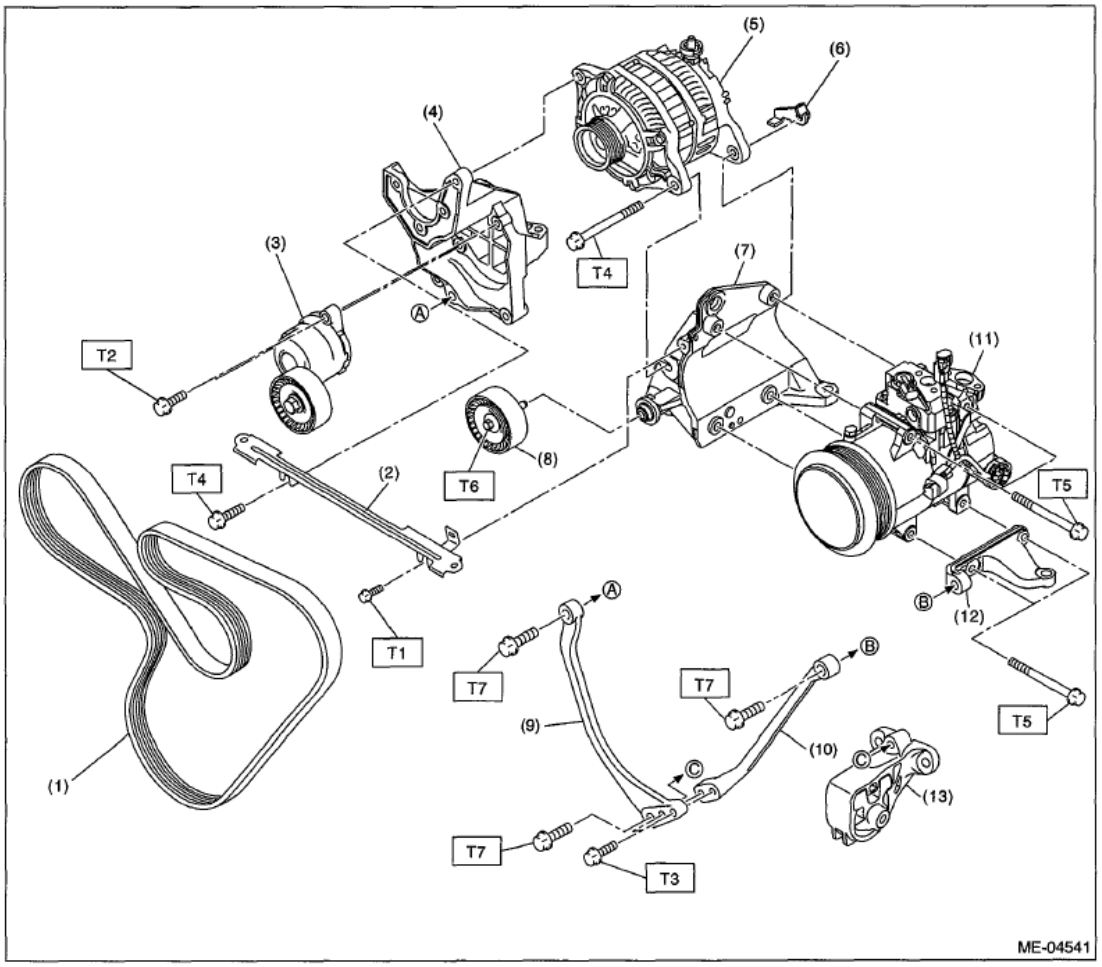
				Exhaust	0.2346)
	Valve guide protrusion amount	mm (in)		Intake	20.0 - 21.0 (0.787 - 0.827)
				Exhaust	16.5 - 17.5 (0.650 - 0.689)
Valve	Head edge thickness	mm (in)	Intake	Standard	0.8 - 1.2 (0.03 - 0.047)
			Exhaust	Standard	1.0 - 1.4 (0.039 - 0.055)
	Overall length	mm (in)		Intake	120.6 (4.75)
				Exhaust	121.7 (4.79)
Valve spring	Free length	mm (in)			55.2 (2.173)
	Tension/spring height	N (kgf, lb)/mm (in)		Set	235.3 - 270.7 (24 - 27.6, 52.9 - 60.8)/45.0 (1.772)
				Lift	578.9 - 639.9 (59.1 - 65.3, 130.3 - 143.9)/34.7 (1.366)
	Squareness				2.5°, 2.4 mm (0.094 in) or less
Cylinder block	Warping limit (Mating surface with cylinder head)	mm (in)			0.025 (0.00098)
	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	-0.015 - 0.005 (-0.00059 - 0.00020)
	Cylinder inner diameter boring limit (diameter)	mm (in)			To 100.005 (3.9372)
Piston	Piston grade point	mm (in)			38.2 (1.504)
	Outer diameter	mm (in)	Standard	A	99.510 - 99.520 (3.9177 - 3.9181)
				B	99.500 - 99.510 (3.9173 - 3.9177)
			0.25 (0.0098) OS		99.750 - 99.770 (3.9272 - 3.9280)
			0.50 (0.0197) OS		100.000 - 100.020 (3.9370 - 3.9378)
Piston pin	Degree of fit				Piston pin must be fitted into position with thumb at 20°C (68°F).
	Clearance between piston pin hole and piston pin	mm (m)		Standard	0.004 - 0.008 (0.0002 - 0.0003)
Piston ring	Piston ring gap	mm (in)	Top ring	Standard	0.20 - 0.35 (0.0079 - 0.0138)
			Second ring	Standard	0.37 - 0.52 (0.0146 - 0.0205)
			Oil ring	Standard	0.20 - 0.50 (0.0079 -

					0.0197)
	Clearance between piston ring and piston ring groove	mm (in)	Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)
			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)		Service limit	0.10 (0.0039)
	Thrust clearance	mm (in)		Standard	0.070 - 0.330 (0.0028 - 0.0130)
	Oil clearance	mm (in)		Standard	0.016 - 0.044 (0.0006 - 0.0017)
	Bearing size (Thickness at center)	mm (in)	Standard		1.492 - 1.501 (0.0587 - 0.0591)
			0.03 (0.0012) US		1.510 - 1.513 (0.0594 - 0.0596)
			0.05 (0.0020) US		1.520 - 1.523 (0.0598 - 0.0600)
			0.25 (0.0098) US		1.620 - 1.623 (0.0638 - 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)
		Cylindricality		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)
		Cylindricality		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 (2.0446 - 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)
	Bearing size (Thickness at center) mm (in)	#1,#3		Standard	1.998 - 2.011 (0.0787 - 0.0792)
				0.03 (0.0012) US	2.017 - 2.020 (0.0794 - 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)

COMPONENT

V-BELT



(1)	V-belt	(8)	Idler pulley ASSY	*Tightening torque:N·m (kgf-m, ft-lb)*
(2)	V-belt cover bracket	(9)	Stopper rod RH	*T1: 6.4 (0.7, 4.7)*
(3)	V-belt tensioner ASSY	(10)	Stopper rod LH	*T2: 20 (2.0, 14.8)*
(4)	Power steering pump bracket	(11)	A/C compressor	*T3: 22 (2.2, 16.2)*
(5)	Generator	(12)	A/C compressor bracket B	*T4: 25 (2.5, 18.4)*
(6)	Generator plate	(13)	Front cushion rubber	*T5: 26.5 (2.7, 19.5)*
(7)	A/C compressor bracket A			*T6: 33 (3.4, 24.3)*
				T7: 36 (3.7, 26.6)

Fig. 1: Identifying V-BELT Component With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7,4.7)

T2: 20 (2.0, 14.8)

T3: 22 (2.2, 16.2)

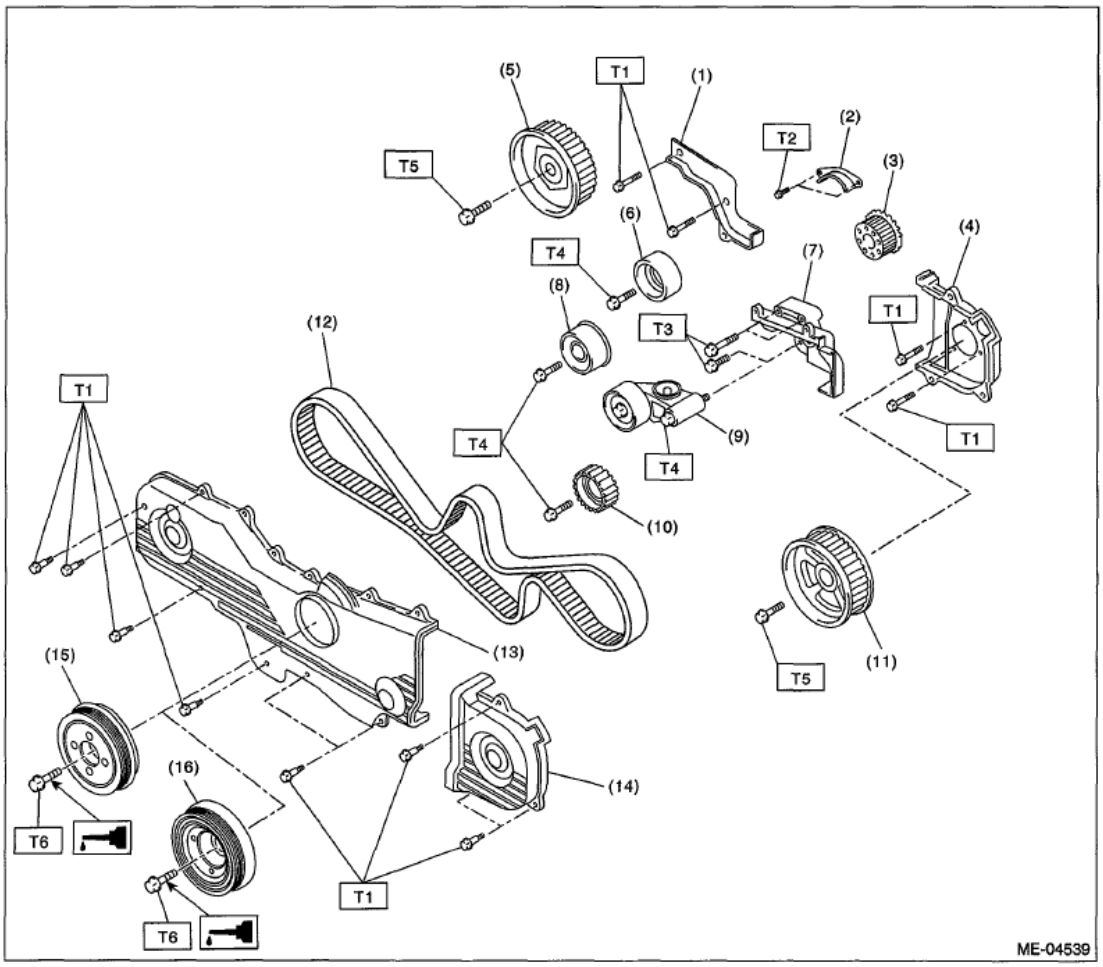
T4: 25 (2.5, 18.4)

T5: 26.5 (2.7,19.5)

T6; 33 (3.4,24.3)

T7: 36 (3.7,26.6)

TIMING BELT



(1)	Timing belt cover No. 2 RH	(9)	Automatic belt tension adjuster ASSY	
(2)	Timing belt guide (MT model)	(10)	Belt idler No. 2	
(3)	Crank sprocket	(11)	Cam sprocket No. 2	
(4)	Timing belt cover No. 2 LH	(12)	Timing belt	
(5)	Cam sprocket No. 1	(13)	Front timing belt cover	
(6)	Belt idler (A)	(14)	Timing belt cover LH	
(7)	Tensioner bracket	(15)	Crank pulley (MT model)	
(8)	Belt idler (B)	(16)	Crank pulley (CVT model)	

Tightening torque:N·m (kgf-m, ft-lb)

T1: 5 (0.5, 3.7)
T2: 9.75 (1.0, 7.2)
T3: 24.5 (2.5, 18.1)
T4: 39 (4.0, 28.8)
T5: 78 (8.0, 57.5)
T6: <Ref. to ME(H4SO)-44, INSTALLATION, Crank Pulley.>

Fig. 2: Identifying Timing Belt Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 5 (0.5,3.7)

T2: 9.75 (1.0,7.2)

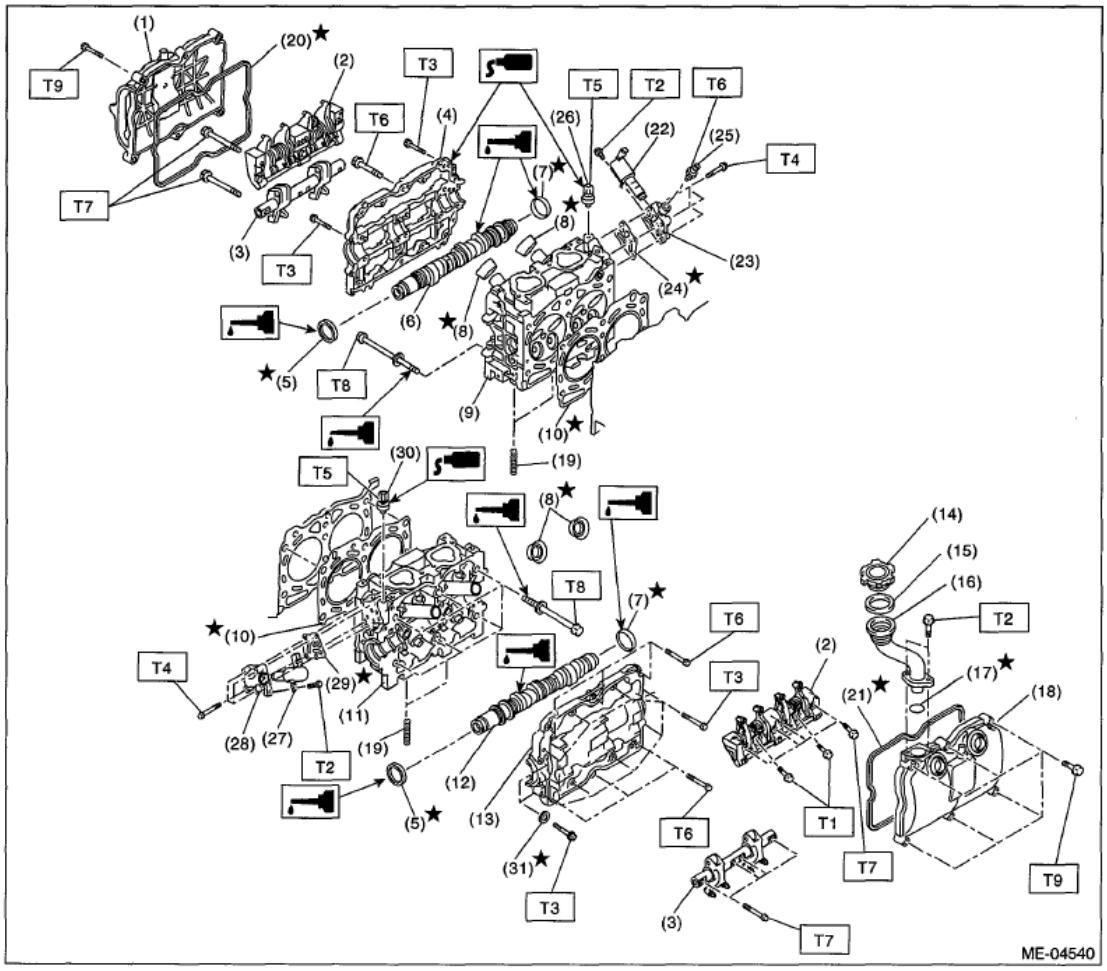
T3: 24.5 (2.5, 18.1)

T4: 39 (4.0,28.8)

T5: 78 (8.0,57.5)

T6: Ref. to **INSTALLATION**, Crank Pulley.

CYLINDER HEAD AND CAMSHAFT



(1)	Rocker cover RH	(16)	Oil filler duct	(31)	Seal washer
(2)	Intake valve rocker ASSY	(17)	O-ring		
(3)	Exhaust valve rocker ASSY	(18)	Rocker cover LH	***Tightening torque:N·m (kgf-m, ft-lb)***	
(4)	Camshaft cap RH	(19)	Stud bolt	***T1:***	***6 (0.6, 4.4)***
(5)	Oil seal	(20)	Rocker cover gasket RH	***T2:***	***6.4 (0.7, 4.7)***
(6)	Camshaft RH	(21)	Rocker cover gasket LH	***T3:***	***9.75 (1.0, 7.2)***
(7)	PLUG	(22)	Oil switching solenoid valve RH	***T4:***	***10 (1.0, 7.4)***
(8)	Spark plug pipe gasket	(23)	Oil switching solenoid valve holder RH	***T5:***	***17 (1.7, 12.5)***
(9)	Cylinder head RH	(24)	Gasket	***T6:***	***18 (1.8, 13.3)***
(10)	Cylinder head gasket	(25)	Oil temperature sensor	***T7:***	***25 (2.5, 18.4)***
(11)	Cylinder head LH	(26)	Variable valve lift diagnosis oil pressure switch RH	***T8:***	***<Ref. to ME(H4SO)-61, INSTALLATION, Cylinder Head.>***
(12)	Camshaft LH	(27)	Oil switching solenoid valve LH	***T9:***	***<Ref. to ME(H4SO)-54, INSTALLATION, Valve Rocker Assembly.>***
(13)	Camshaft cap LH	(28)	Oil switching solenoid valve holder LH		
(14)	Oil filler cap	(29)	Gasket		
(15)	Gasket	(30)	Variable valve lift diagnosis oil pressure switch LH		

Fig. 3: Identifying Cylinder Head And Camshaft Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6 (0.6,4.4)

T2: 6.4 (0.7,4.7)

T3: 9.75 (1.0,7.2)

T4: 10 (1.0,7.4)

T5: 17 (1.7, 12.5)

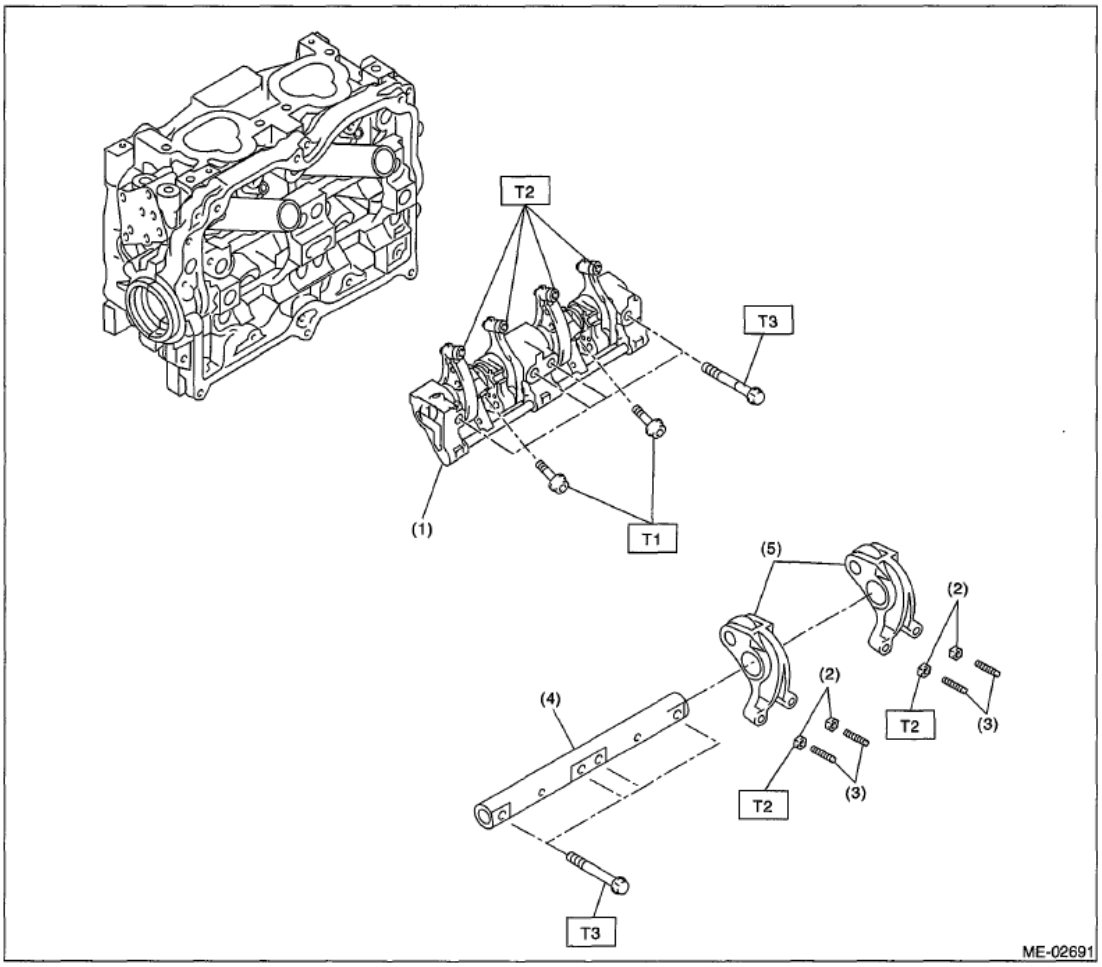
T6: 18 (1.8,13.3)

T7: 25 (2.5, 18.4)

T8: Ref. to **INSTALLATION**, Cylinder Head.

T9: Ref. to **INSTALLATION**, Valve Rocker Assembly.

VALVE ROCKER ASSY



(1) Intake valve rocker ASSY
(2) Valve rocker nut
(3) Valve rocker adjusting screw
(4) Exhaust rocker shaft
(5) Exhaust valve rocker arm

Tightening torque:N·m (kgf-m, ft-lb)
T1: 6 (0.6, 4.4)
T2: 9.75 (1.0, 7.2)
T3: 25 (2.5, 18.4)

Fig. 4: Identifying Valve Rocker Assembly With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

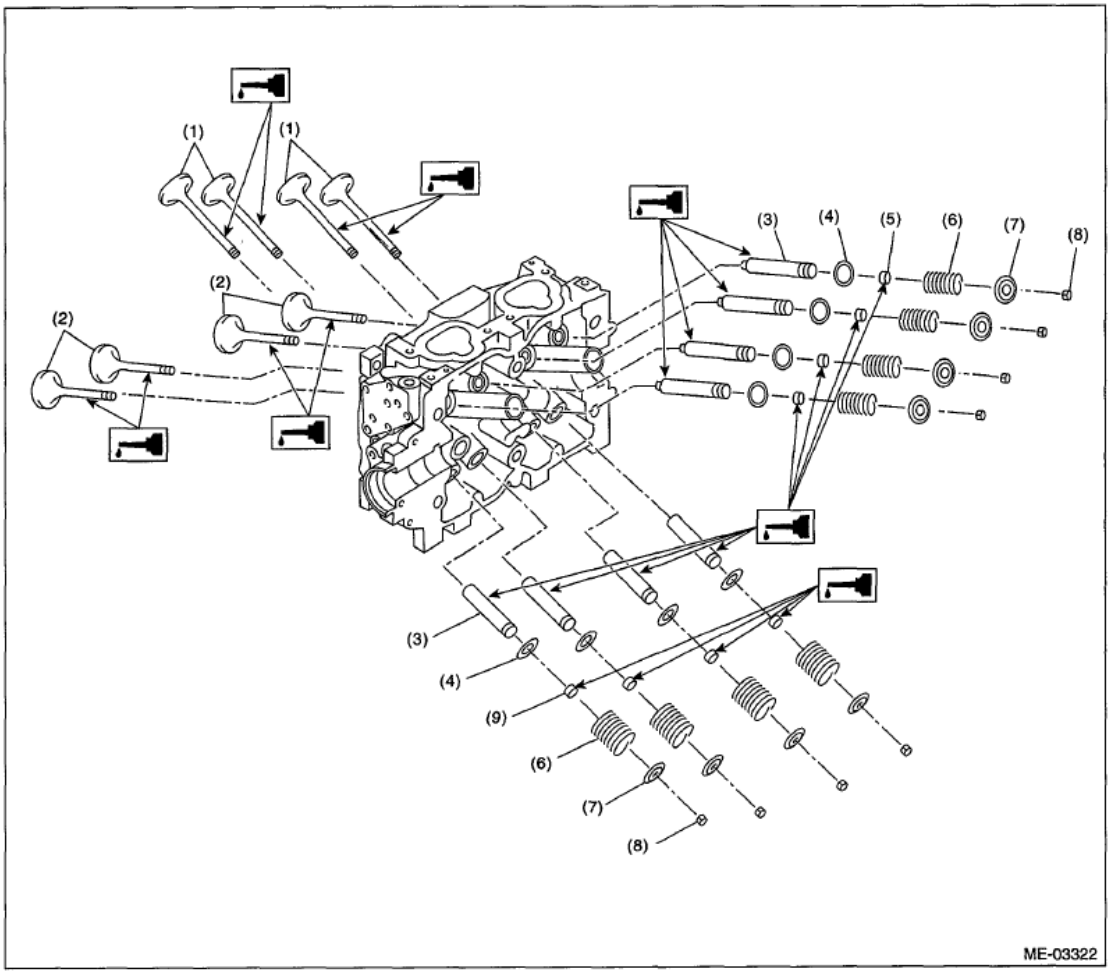
Tightening torque: N.m (kgf-m, ft-lb)

T1: 6 (0.6, 4.4)

T2: 9.75 (1.0,7.2)

T3: 25 (2.5, 18.4)

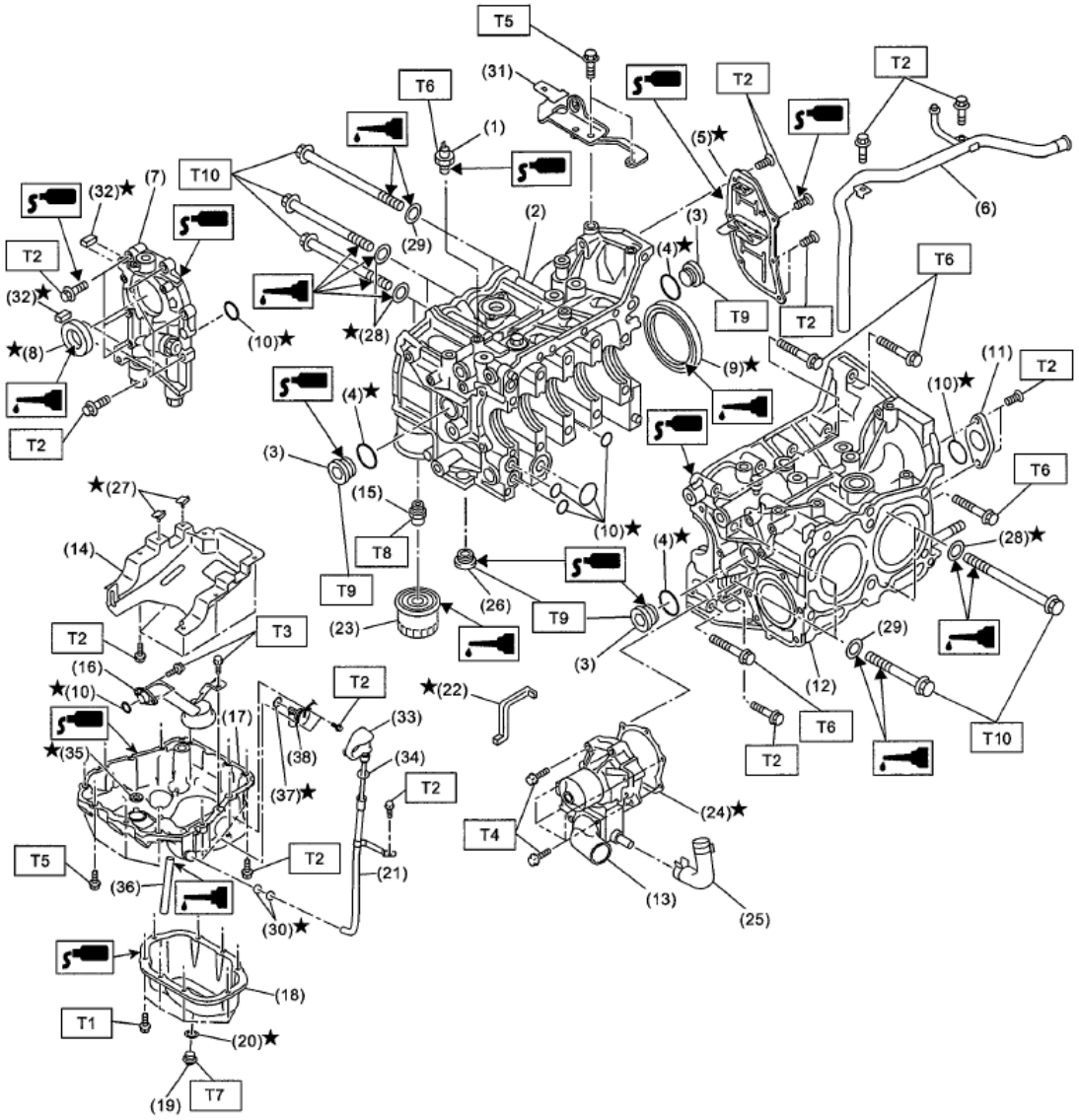
CYLINDER HEAD AND VALVE ASSEMBLY



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

Fig. 5: Identifying Cylinder Head And Valve Assembly
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK



ME-04434

(1)	Oil pressure switch	(18)	Oil pan	(35)	O-ring
(2)	Cylinder block RH	(19)	Drain plug	(36)	Oil drain pipe
(3)	Service hole plug	(20)	Drain plug gasket	(37)	O-ring
(4)	Gasket	(21)	Oil level gauge guide	(38)	Oil level switch
(5)	Oil separator cover	(22)	Water pump sealing		
(6)	Water by-pass pipe	(23)	Oil filter		
(7)	Oil pump	(24)	Gasket		
(8)	Front oil seal	(25)	Water pump hose		
(9)	Rear oil seal	(26)	PLUG		
(10)	O-ring	(27)	Seal		
(11)	Service hole cover	(28)	Seal washer		
(12)	Cylinder block LH	(29)	Washer		
(13)	Water pump	(30)	O-ring		
(14)	Baffle plate	(31)	Engine rear hanger		
(15)	Oil filter connector	(32)	Oil pump seal		
(16)	Oil strainer	(33)	Oil level gauge		

Tightening torque:N·m (kgf-m, ft-lb)

T1:	***5 (0.5, 3.7)***
T2:	***6.4 (0.7, 4.7)***
T3:	***10 (1.0, 7.4)***
T4:	***First 12 (1.2, 8.7) Second 12 (1.2, 8.7)***
T5:	***16 (1.6, 11.8)***
T6:	***25 (2.5, 18.4)***
T7:	***41.7 (4.3, 30.8)***
T8:	***45 (4.6, 33.2)***
T9:	***70 (7.1, 51.6)***
T10:	***<Ref. to ME(H4SO)-73, INSTALLATION, Cylinder Block.>***

Fig. 6: Identifying Cylinder Block With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 5 (0.5,3.7)

T2: 6.4 (0.7,4.7)

T3: 10 (1.0,7.4)

T4: First 12 (1.2, 8.7) Second 12 (1.2, 8.7)

T5: 16 (1.6,11.8)

T6: 25 (2.5,18.4)

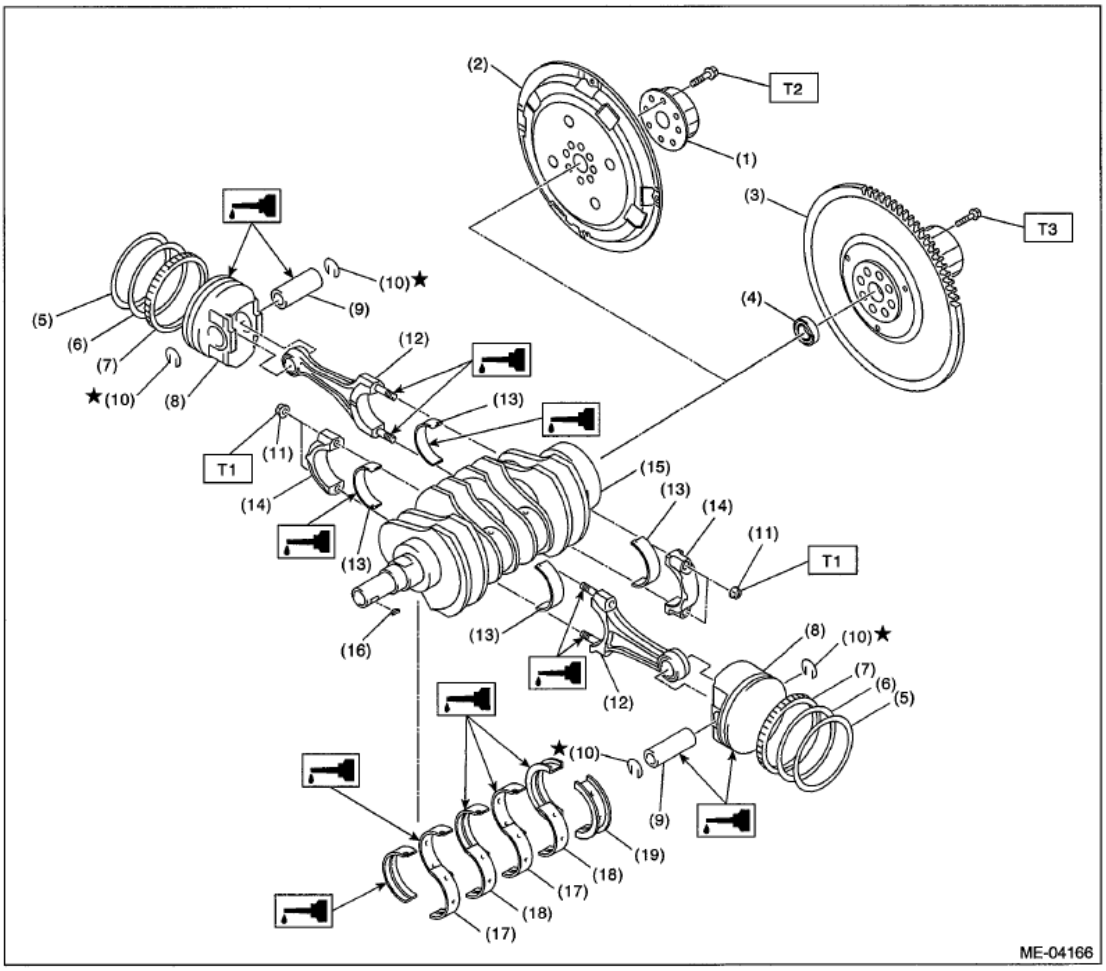
T7: 41.7 (4.3,30.8)

T8: 45 (4.6, 33.2)

T9: 70 (7.1,51.6)

T10: Ref. to **INSTALLATION**, Cylinder Block.

CRANKSHAFT AND PISTON



(1)	Reinforcement (CVT model)	(9)	Piston pin	(17)	Crankshaft bearing #1, #3
(2)	Drive plate (CVT model)	(10)	Snap ring	(18)	Crankshaft bearing #2, #4
(3)	Flywheel (MT model)	(11)	Connecting rod nut	(19)	Crankshaft bearing #5
(4)	Ball bearing (MT model)	(12)	Connecting rod		
(5)	Top ring	(13)	Connecting rod bearing	*Tightening torque:N·m (kgf-m, ft-lb)*	
(6)	Second ring	(14)	Connecting rod cap	*T1:*	*45 (4.6, 33.2)*
(7)	Oil ring	(15)	Crankshaft	*T2:*	*<Ref. to CVT-135, INSTALLATION, Drive Plate.>*
(8)	Piston	(16)	Woodruff key	*T3:*	*<Ref. to CL-14, INSTALLATION, Flywheel.>*

Fig. 7: Identifying Crankshaft And Piston Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

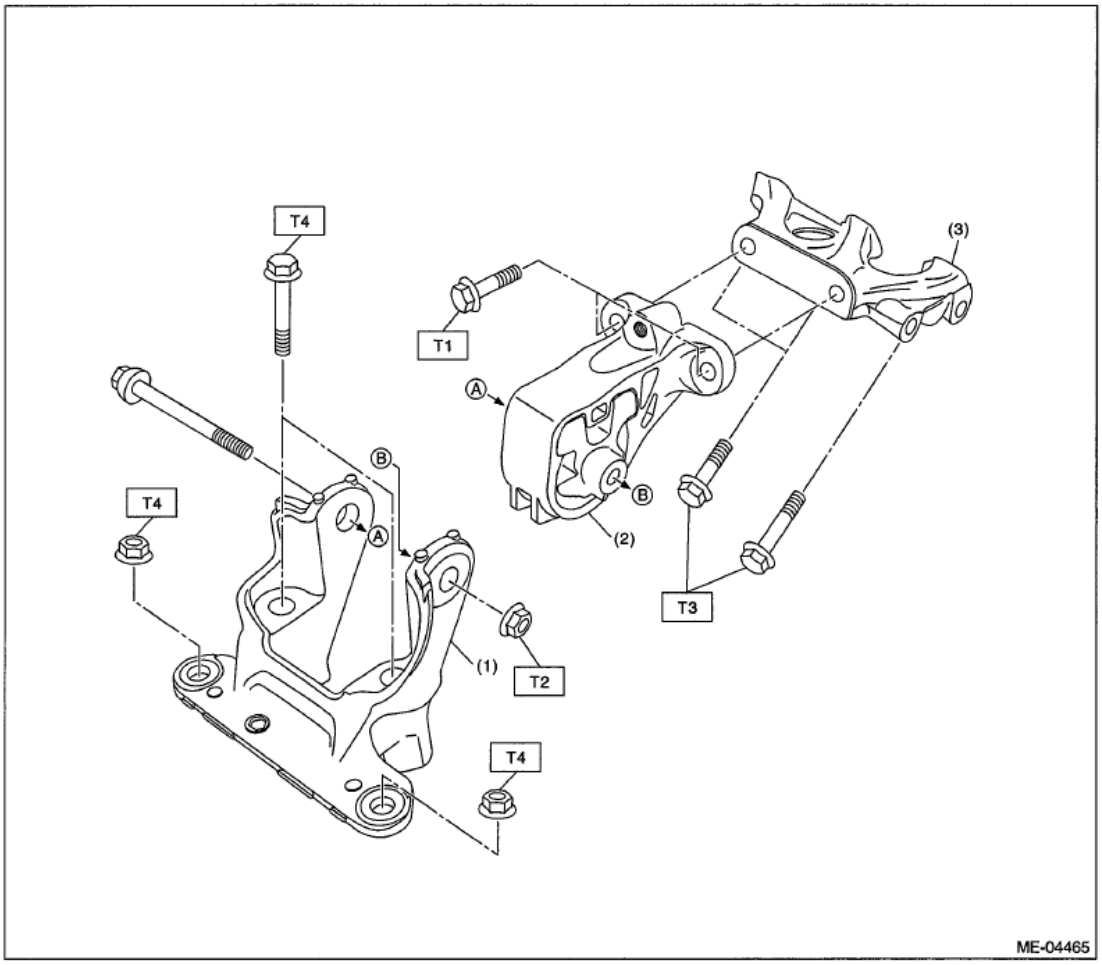
Tightening torque: N.m (kgf-m, ft-lb)

T1: 45 (4.6,33.2)

T2: Ref. to **INSTALLATION** , Drive Plate.

T3: Ref. to **INSTALLATION** , Flywheel.

ENGINE MOUNTING



(1) Front mounting bracket
(2) Front cushion rubber
(3) Engine mounting bracket

Tightening torque:N·m (kgf-m, ft-lb)
T1: 25 (2.5, 18.4)
T2: 45 (4.6, 33.2)
T3: 58 (5.9, 42.8)
T4: 60 (6.1, 44.3)

Fig. 8: Identifying Engine Mounting Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 25 (2.5, 18.4)

T2: 45 (4.6,33.2)

T3: 58 (5.9,42.8)

T4: 60 (6.1,44.3)

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 assembly.
- Be careful not to let oil, grease or coolant contact the timing belt, clutch disc and flywheel.
- All removed parts, if to be reused, should be reinstalled in the original positions and directions.
- Bolts, nuts and washers should be replaced with new 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.

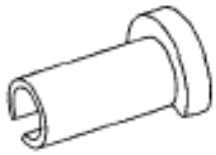
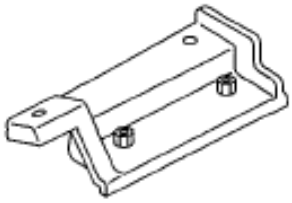
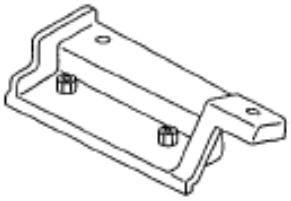
- Lift up or lower the vehicle when necessary. Make sure to support the correct positions.

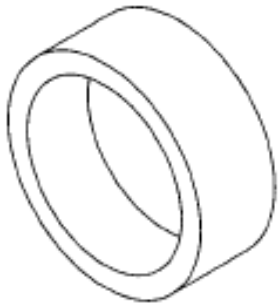
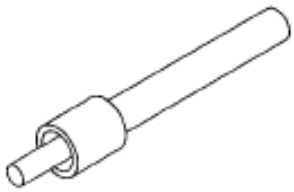
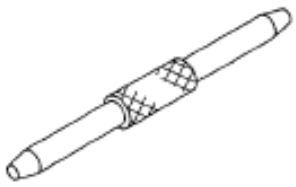
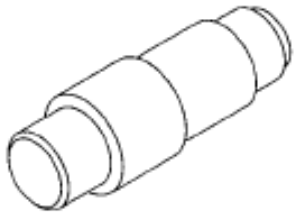
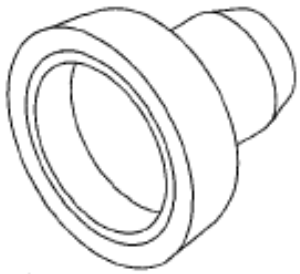
PREPARATION TOOL

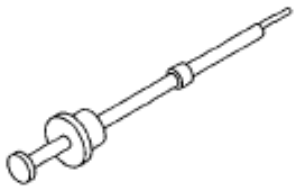
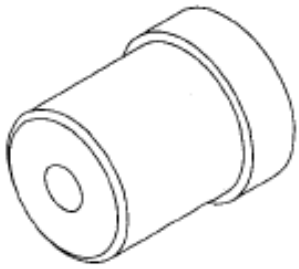
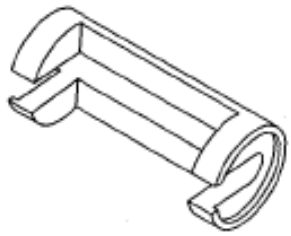
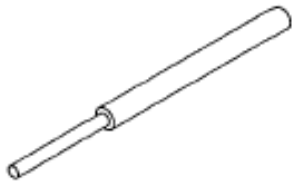
SPECIAL TOOL

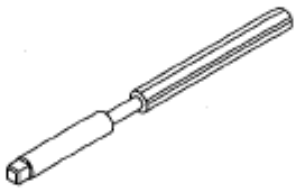
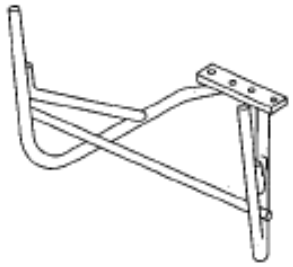
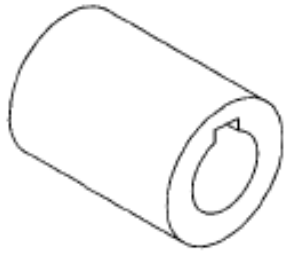
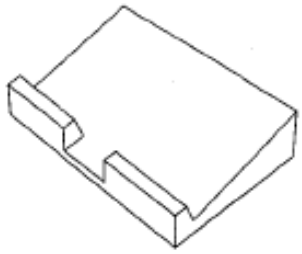
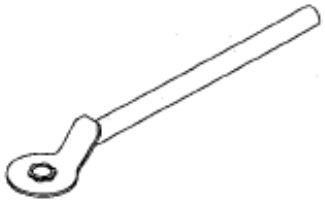
SPECIAL TOOL REFERENCE

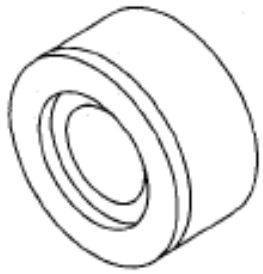
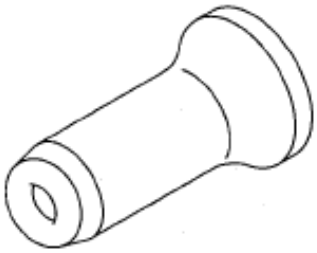
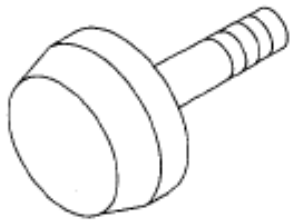
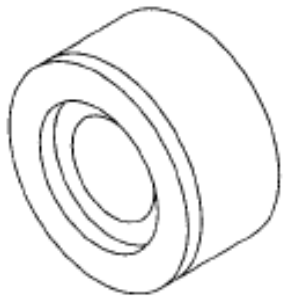
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	18231AA010	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (LH side) **NOTE:**

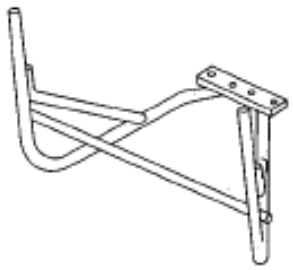
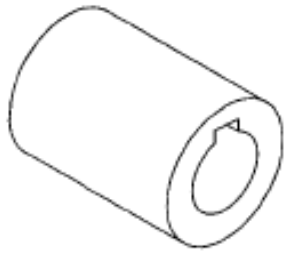
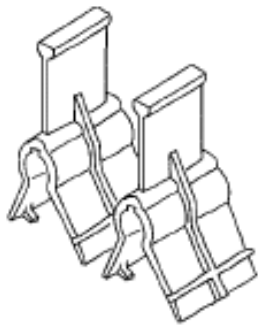
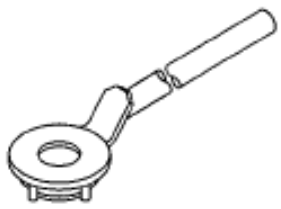
 ST42099AE000			**CAM SPROCKET WRENCH (499207100) can also be used.**
 ST1B022XU0	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for each inspection.
 ST18231AA010	498267800	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498457000	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST-498457100	498457000	ENGINE STAND ADAPTER RH	Used together with ENGINE STAND (499817100).

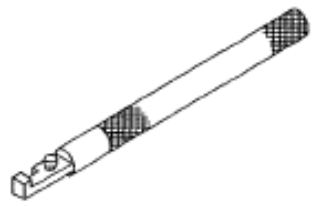
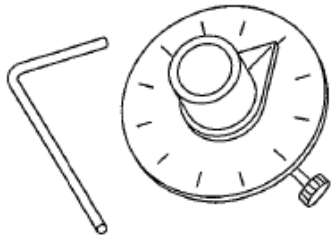
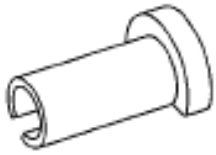
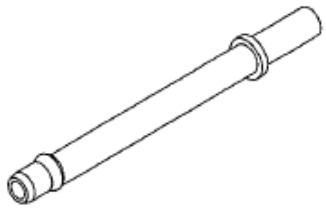
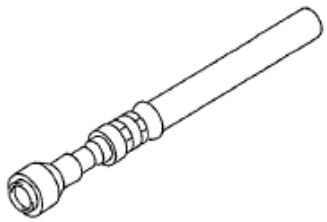
 ST-498747300	498457100	ENGINE STAND ADAPTER LH	Used together with ENGINE STAND (499817100).
 ST-498857100	498497100	CRANKSHAFT STOPPER	Used for removing and installing drive plate.
 ST-499017100	498747300	PISTON GUIDE	Used for installing piston in cylinder.
 ST-499037100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST-499587200	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.

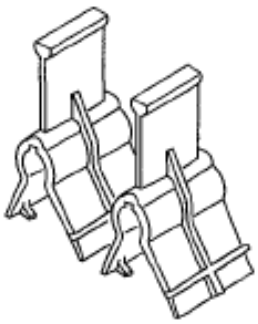
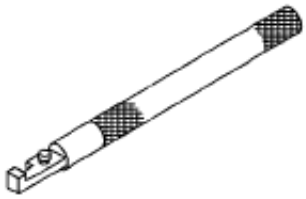
 ST-499097700	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499587100	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499597100	499587500	OIL SEAL INSTALLER	• Used for installing the camshaft oil seal. • Used together with OIL SEAL GUIDE (499597000).
 ST-499718000	499587700	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.
 ST-499767200	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.

 ST-499767400	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (RH side)
 ST-499817100	499497000	TORX® PLUS	Used for removing and installing camshaft cap.
 ST-499987500	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-498267600	499597000	OIL SEAL GUIDE	• Used for installing the camshaft oil seal. • Used together with CAMSHAFT OIL SEAL INSTALLER (499587500).
 ST-499977500	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).

 ST18251AA020	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST-499587600	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST-499597200	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499767800	499767700	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Intake side)
	499767800	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Exhaust side)

 ST-499817100			
 ST-499987500	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used together with ENGINE STAND ADAPTER RH (498457000) & LH (498457100).
 ST18354AA000	499977100	CRANK PULLEY WRENCH	Used for removing and installing the crank pulley. (MT model)
 ST-499977400	499977400	CRANK PULLEY WRENCH	Used for removing and installing the crank pulley. (CVT model)
	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.

 ST18258AA000			
 ST18854AA000	18854AA000	ANGLE GAUGE	Used for installing the crank pulley.
 ST42099AE000	42099AE000	QUICK CONNECTOR RELEASE	Used for disconnecting quick connector of the engine compartment.
 ST18471AA000	18471AA000	FUEL PIPE ADAPTER	Used for inspecting the fuel pressure.
 ST42075AG690	42075AG690	FUEL HOSE	Used for inspecting the fuel pressure. **NOTE:** **This is the SUBARU genuine part.**

 ST18354AA000	18354AA000	VALVE ROCKER HOLDER	Used for installing the valve rocker assembly (intake). (2-piece set)
 ST18258AA000	18258AA000	SPRING INSTALLER	Used for installing the valve rocker assembly (intake).

GENERAL TOOL

GENERAL TOOL REFERENCE

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
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.
Timing light	Used for measuring ignition timing.

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.

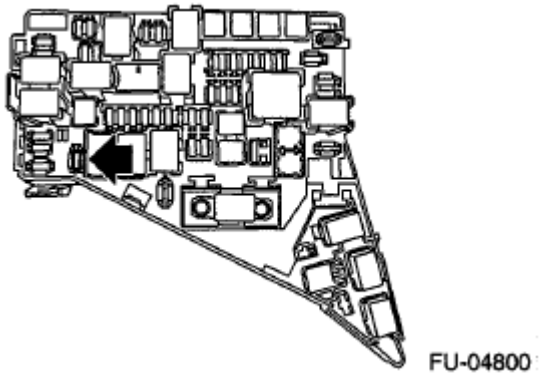


Fig. 9: Locating Main Fuse Box
Courtesy of SUBARU OF AMERICA, INC.

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. Install the compression gauge to 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.

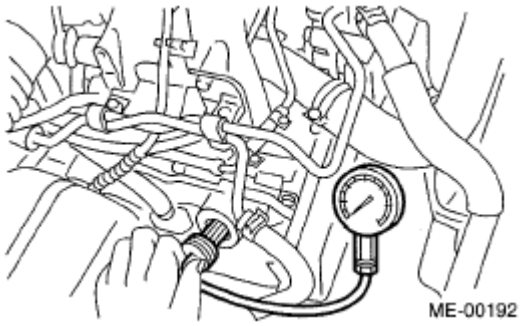


Fig. 10: Checking Compression Of Engine Using Compression Gauge
Courtesy of SUBARU OF AMERICA, INC.

11. Crank the engine by starter motor and read the value when the needle of the compression gauge becomes stable.

NOTE:

- **Perform at least two measurements per cylinder, and make sure that the values are correct.**
- **If the compression pressure is out of standard, check or adjust the**

pistons, valves and cylinders.

Compression (fully open throttle):

Standard

1,020 - 1,275 kPa (10.4 - 13.0 kgf/cm^2 , 148-185 psi)

Difference between cylinders

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

12. 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.

NOTE:

- **Idle speed cannot be adjusted manually, because the idle speed is automatically adjusted.**
- **If idle speed is out of standard, refer to the General Diagnosis Table under "Engine Control System". Ref. to BASIC DIAGNOSTIC PROCEDURE .**

1. 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 for CVT model, select lever in "P" or "N" range, for MT model, gear shift lever in neutral position.):

Standard

675±100 RPM (CVT model)

650±100 RPM (MT model)

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

   Idle speed (A/C on, and for CVT model, select lever in "P" or "N" range, for MT model, gear shift lever in neutral position.):

   Standard

   700 - 850±100 RPM

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.

   NOTE: If ignition timing is out of standard, check the ignition control system. Refer to "Engine Control System". Ref. to BASIC DIAGNOSTIC PROCEDURE .

   Ignition timing [BTDC/RPM]:

   Standard

   15°±107675 (CVT model)

   10°±87650 (MT model)

METHOD WITH TIMING LIGHT

1. Before checking the ignition timing, check the following item:
   1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.

2. Check the malfunction indicator light does not illuminate.

2. Warm up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Connect the timing light to the power wire of #1 ignition coil.
5. Start the engine, turn the timing light to the crank pulley, and check the ignition timing through the timing belt cover gauge.

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

Ignition timing [BTDC/RPM]:

Standard

15°±107675 (CVT model)

10°±107650 (MT model)

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

INTAKE MANIFOLD VACUUM

INSPECTION

1. Warm up the engine.
2. Disconnect the brake booster vacuum hose from the intake manifold, and attach the vacuum gauge.

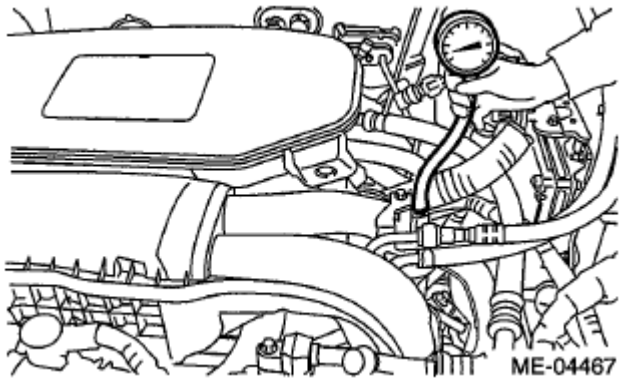


Fig. 11: Disconnecting Brake Booster Vacuum Hose From Intake Manifold
Courtesy of SUBARU OF AMERICA, INC.

3. Keep the engine at idle speed and read the vacuum gauge indication.

NOTE: Condition of engine inside can be diagnosed by observing the behavior of the vacuum gauge needle as described in table below.

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

Standard

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

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

STANDARD SPECIFICATION

Diagnosis of engine condition by inspection of intake manifold vacuum	
Vacuum gauge needle behavior	**Possible engine condition**
1. Needle is steady but lower than standard value. This tendency becomes more evident as engine temperature rises.	Leakage around intake manifold gasket, disconnection or damage of vacuum hose
2. Needle intermittently drops to position lower than standard value.	Leakage around cylinder
3. Needle drops suddenly and intermittently from standard value.	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 standard value in narrow range.	Defective ignition system

ENGINE OIL PRESSURE

INSPECTION

1. Disconnect the ground cable from battery.

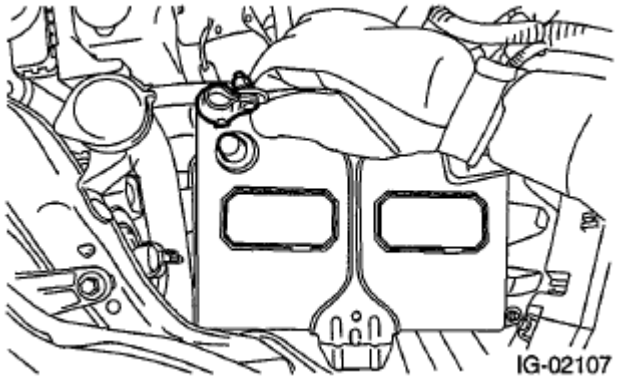


Fig. 12: Identifying Battery Ground Cable

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the oil pressure switch. Ref. to **REMOVAL** , Oil Pressure Switch.
3. Attach the oil pressure gauge to the cylinder block.

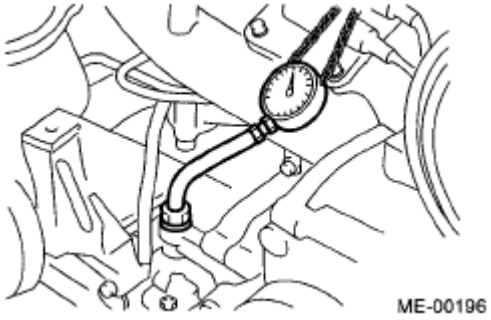


Fig. 13: Checking Oil Pressure Using Pressure Gauge
Courtesy of SUBARU OF AMERICA, INC.

4. Connect the ground cable to battery.

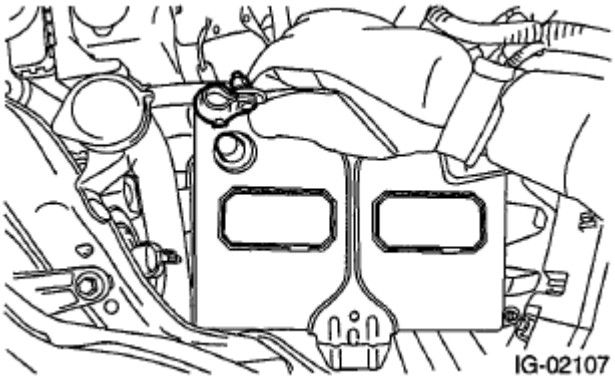


Fig. 14: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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

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

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.**

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.
3. Disconnect the fuel delivery hose and connect the fuel pressure gauge.

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

1. Attach ST to the fuel delivery pipe and push ST1 in the direction of arrow mark to disconnect the quick connector of the fuel delivery hose.

   ST 42099AE000 QUICK CONNECTOR RELEASE

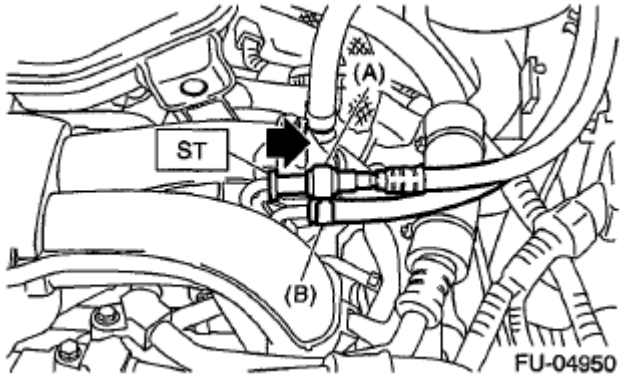
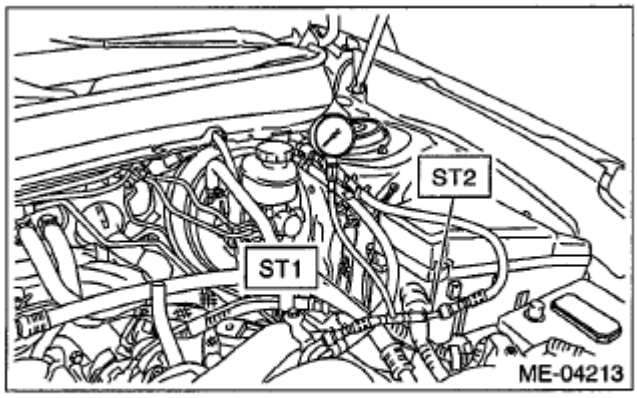


Fig. 15: Attaching ST To Fuel Delivery Pipe
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the fuel pressure gauge with ST2 and ST3.

NOTE: **ST2 is a SUBARU genuine part.**
ST2 42075AG690 FUEL HOSE
ST3 18471AA000 FUEL PIPE ADAPTER



(A) ST2
(B) ST3

Fig. 16: Connecting Fuel Pressure Gauge With ST2 And ST3
Courtesy of SUBARU OF AMERICA, INC.

4. Start the engine.
5. Measure the fuel pressure after warming up the engine.

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.**
- **Check or replace the fuel pump and fuel delivery line if the fuel pressure is out of the standard.**

Fuel pressure:

Standard

338-348 kPa (3.4 - 3.5 kgf/cm^2 , 49 - 50 psi)

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

VALVE CLEARANCE

INSPECTION

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. Lift up the vehicle.
2. Remove the under cover. Ref. to **REMOVAL** , Front Under Cover.
3. Lower the vehicle.
4. Disconnect the ground cable from battery.

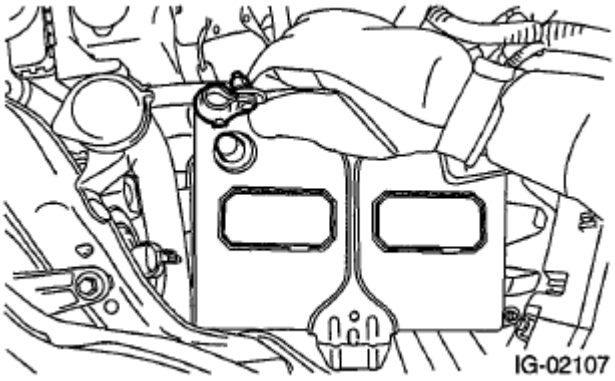


Fig. 17: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the timing belt cover LH.

Fig. 18: Identifying Timing Belt Cover LH
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the fuel injector. Ref. to **REMOVAL** , Fuel Injector.
7. When inspecting #1 and #3 cylinders
    1. Disconnect the ignition coil from spark plug on RH side. Ref. to **RH SIDE** , REMOVAL, Spark Plug.
    2. Place a suitable container under the vehicle.
    3. Disconnect the PCV hose from the rocker cover RH.

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

8. When inspecting #2 and #4 cylinders
   1. Disconnect the ignition coil from spark plug on LH side. Ref. to **LH SIDE** , REMOVAL, Spark Plug.
   2. Place a suitable container under the vehicle.
   3. Disconnect the PCV hose from the rocker cover LH.
   4. Remove the bolts, then remove the rocker cover LH.
9. Set #1 cylinder piston to top dead center of compression stroke by rotating the crank pulley clockwise using the socket wrench.

NOTE: When the arrow mark (A) on cam sprocket LH is at the top position, the #1 cylinder piston is at top dead center of the compression stroke.

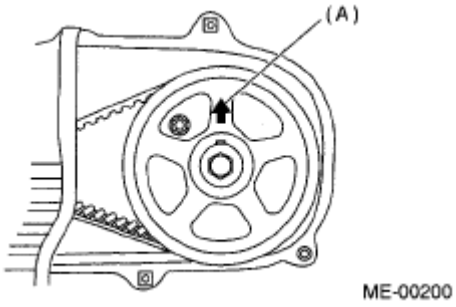


Fig. 19: Identifying Arrow Mark On Cam Sprocket (LH)
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:
- **Insert the thickness gauge (A) in as horizontally as possible with respect to the valve stem end face.**
- **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±0.04 mm (0.0079±0.0016 in)

Exhaust

0.25±0.04 mm (0.0098±0.0016 in)

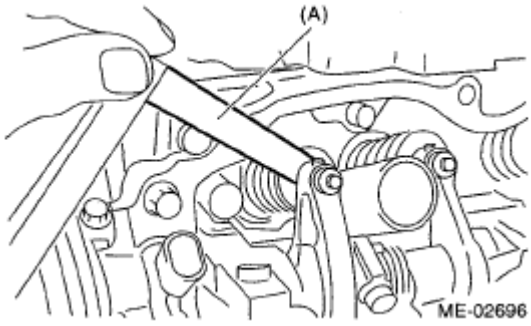


Fig. 20: Measuring Exhaust Valve Clearances Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

11. Measure the valve clearance in #3, #2 and #4 cylinder in the same measurement procedure as #1 cylinder in this order.

NOTE:
- **Be sure to set the cylinder pistons to their respective top dead centers on compression stroke before measuring valve clearances.**
- **By rotating the crank pulley clockwise every 180° from the state that #1 cylinder piston is on the top dead center of compression stroke, #3, #2 and #4 cylinder pistons come to the top dead center of compression stroke in this order.**

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

NOTE: Use a new rocker cover gasket.

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

NOTE: When the arrow mark (A) on cam sprocket LH is at the top position, the #1 cylinder piston is at top dead center of the compression stroke.

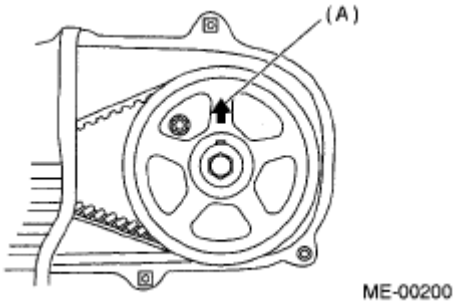


Fig. 21: Identifying Arrow Mark On Cam Sprocket (LH)
Courtesy of SUBARU OF AMERICA, INC.

2. Adjust the #1 cylinder valve clearance.
    1. Loosen the valve rocker nut and screw.
    2. Set a suitable thickness gauge.
    3. While noting the valve clearance, tighten the valve rocker adjusting screw.
    4. When the specified valve clearance is obtained, tighten the valve rocker nut.

NOTE:

- **Insert a thickness gauge in a direction as horizontal as possible with respect to the valve stem end face.**
- **Lift up the vehicle and adjust the exhaust valve clearances.**

Valve clearance (adjustment value):

Intake

0.20±0.04 mm (0.0079±0.0016 in)

Exhaust

0.25±0.04 mm (0.0098±0.0016 in)

Tightening torque:

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

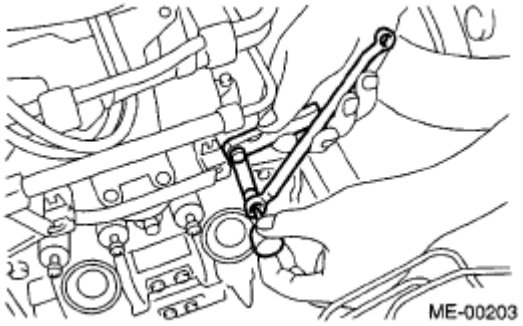


Fig. 22: Adjusting Exhaust Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

3. Adjust the valve clearance in #3, #2 and #4 cylinder in the same adjustment procedure as #1 cylinder in this order.

NOTE:
- **Be sure to set the cylinder pistons to their respective top dead centers on compression stroke before adjusting valve clearances.**
- **By rotating the crank pulley clockwise every 180° from the state that #1 cylinder piston is on the top dead center of compression stroke, #3, #2 and #4 cylinder pistons come to the top dead center of compression stroke in this order.**

4. Ensure the valve clearances of each cylinder are within specifications. If necessary, readjust the valve clearances.
5. After measuring, install the related parts in the reverse order of removal.

NOTE: Use a new rocker cover gasket.

ENGINE ASSEMBLY

REMOVAL

1. Change the front hood damper mounting position from (A) to (B), and completely open the front hood.

Tightening torque:

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

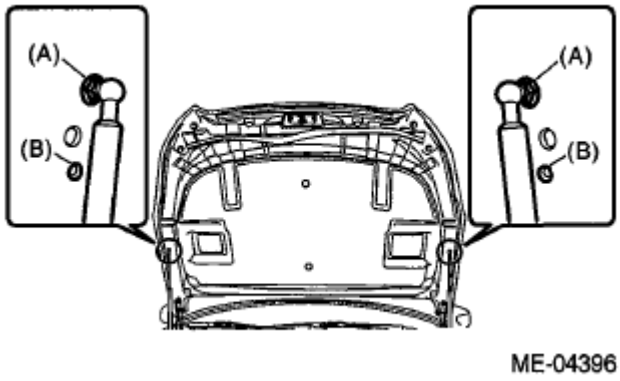


Fig. 23: Identifying Front Hood Damper Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the V-belt covers.
3. Collect the refrigerant from A/C system. Ref. to **REFRIGERANT RECOVERY PROCEDURE** .
4. Release the fuel pressure. Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel.
5. Disconnect the ground cable from battery.

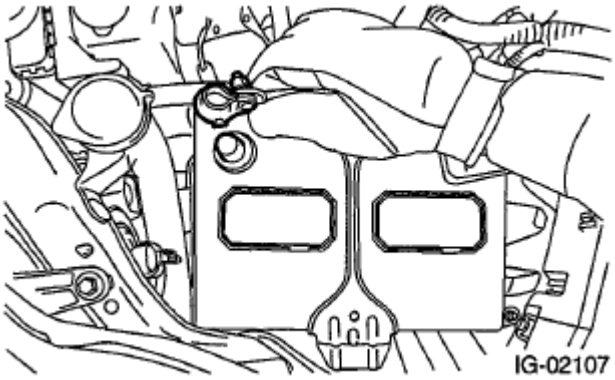


Fig. 24: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

6. Open the fuel filler lid and remove the fuel filler cap.
7. Remove the air intake duct. Ref. to **REMOVAL** , Air Intake Duct.
8. Remove the air intake boot assembly. Ref. to **REMOVAL** , Air Intake Boot.
9. Remove the radiator. Ref. to **REMOVAL** , Radiator.
10. Remove the front exhaust pipe. Ref. to **REMOVAL** , Front Exhaust Pipe.
11. Lower the vehicle.
12. Remove the bolt, and disconnect the bulkhead harness connector from the engine harness connector and rear engine hanger.

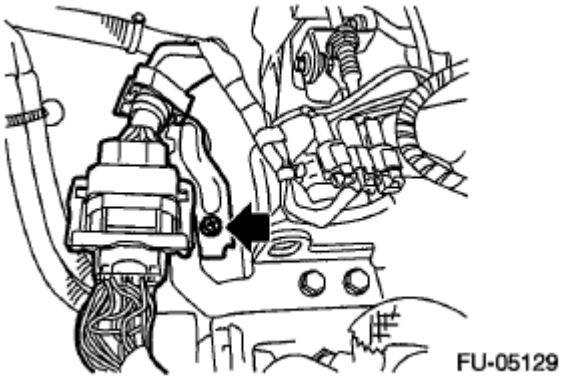


Fig. 25: Locating Bulkhead Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

13. Slide the engine harness connector in the direction of the arrow and remove it from the rear engine hanger.

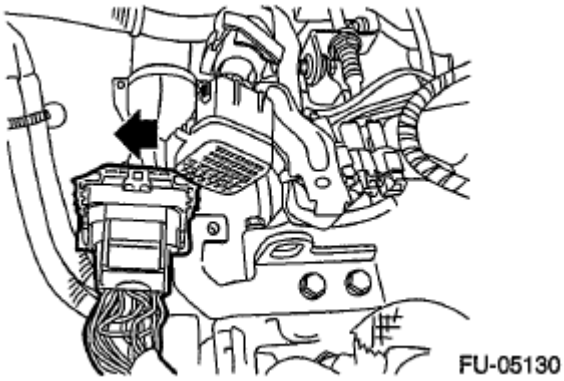


Fig. 26: Sliding Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

14. Disconnect connector (A) and terminal (B) from the generator, and remove the generator cord from clip (C).
15. Disconnect connector (D) from the A/C compressor.

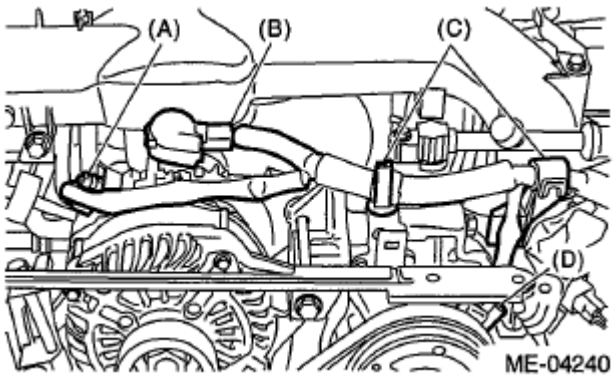


Fig. 27: Identifying A/C Compressor And Connector
Courtesy of SUBARU OF AMERICA, INC.

16. Remove the clip which secure the generator cord to the intake manifold protector LH.

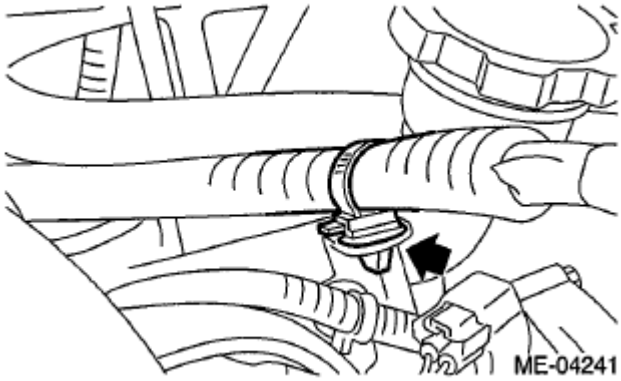


Fig. 28: Locating Intake Manifold Protector LH
Courtesy of SUBARU OF AMERICA, INC.

17. Disconnect the following hoses.
    1. A/C pressure hose Ref. to **REMOVAL** , Hose and Pipe.
    2. Brake booster vacuum hose

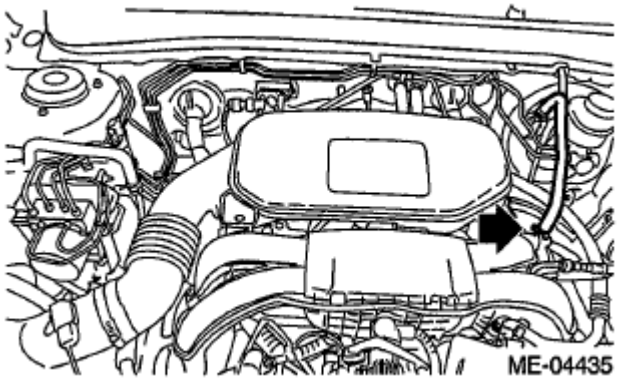


Fig. 29: Locating Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

    3. Heater inlet hose and heater outlet hose

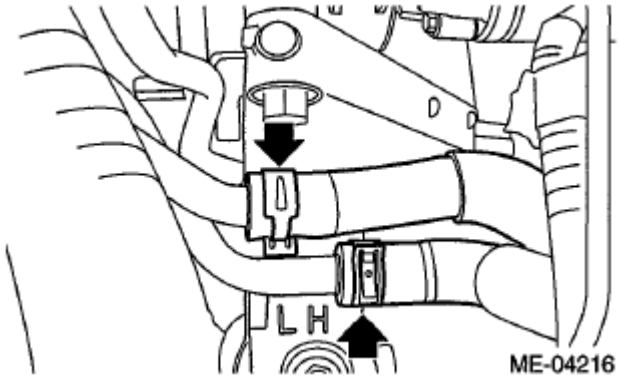


Fig. 30: Locating Heater Inlet Hose And Heater Outlet Hose
Courtesy of SUBARU OF AMERICA, INC.

18. Lift up the vehicle.
19. Disconnect the ground cable on the engine side.

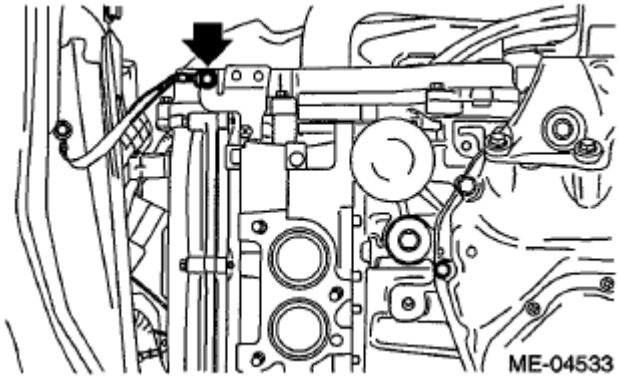


Fig. 31: Locating Ground Cable On Engine Side
Courtesy of SUBARU OF AMERICA, INC.

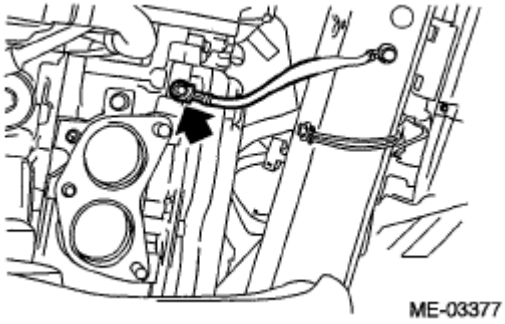


Fig. 32: Locating Ground Cable Bolt
Courtesy of SUBARU OF AMERICA, INC.

20. Lower the vehicle.
21. Separate the torque converter clutch from the drive plate. (CVT model)

1. Remove the service hole plug.
2. Insert the wrench into the crank pulley bolt, and rotate the crank pulley to remove the four bolts which hold torque converter clutch to the drive plate.

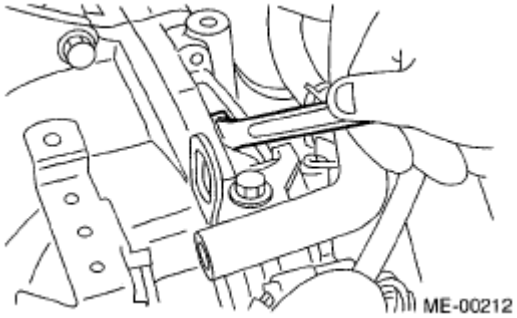


Fig. 33: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

22. Disconnect the fuel delivery hose (A) and evaporation hose (B).

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

1. Attach ST to the fuel delivery pipe and push ST in the direction of arrow mark to disconnect the quick connector of the fuel delivery hose (A).

   ST 42099AE000 QUICK CONNECTOR RELEASE

2. Remove the clip and disconnect the evaporation hose (B) from the evaporation pipe.

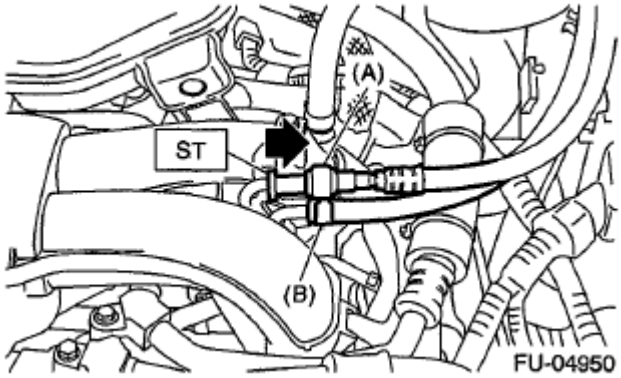


Fig. 34: Attaching ST To Fuel Delivery Pipe
Courtesy of SUBARU OF AMERICA, INC.

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

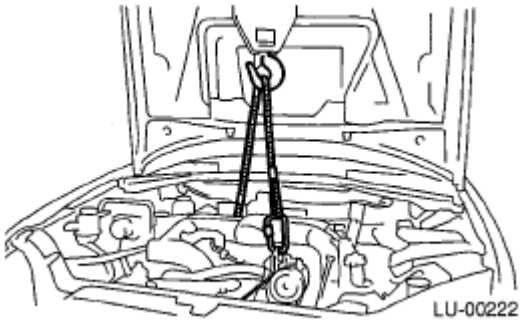


Fig. 35: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

24. Remove the stopper rod.

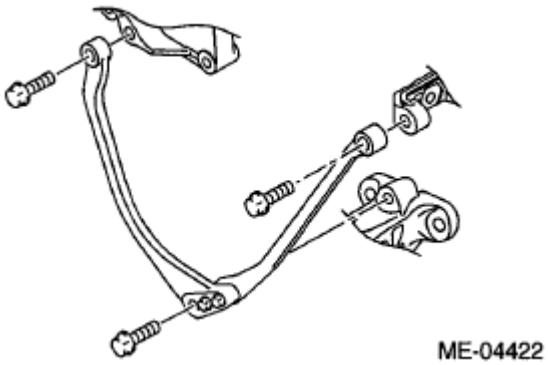


Fig. 36: Identifying Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

25. Remove the bolt and nut which secure engine mounting to the cradle.

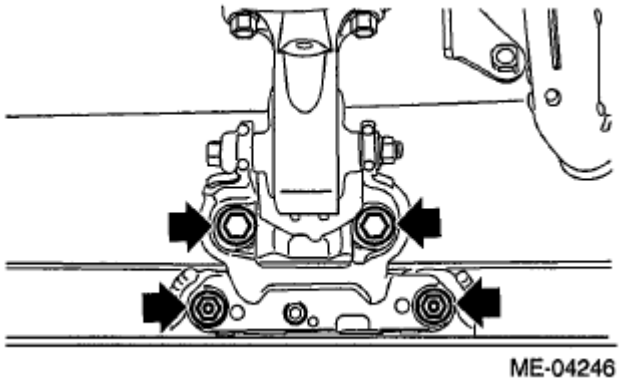


Fig. 37: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

26. Lift up the vehicle.

CAUTION: When lifting up the vehicle, raise up wire ropes at the same time.

27. Remove the bolts which secure the engine mounting onto the engine, and remove the engine mounting.

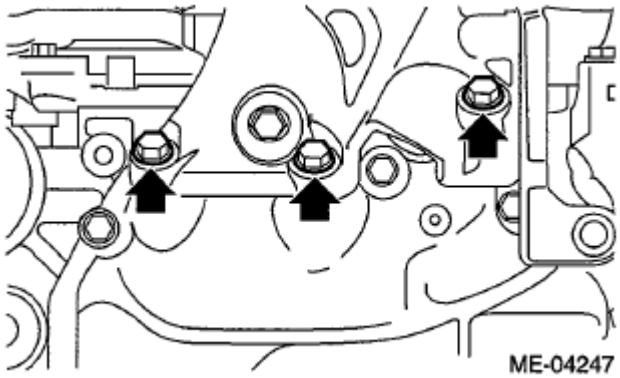


Fig. 38: Locating Engine Mounting
Courtesy of SUBARU OF AMERICA, INC.

28. Remove the bolts and nuts which hold the lower side of transmission to the engine.
    - CVT model

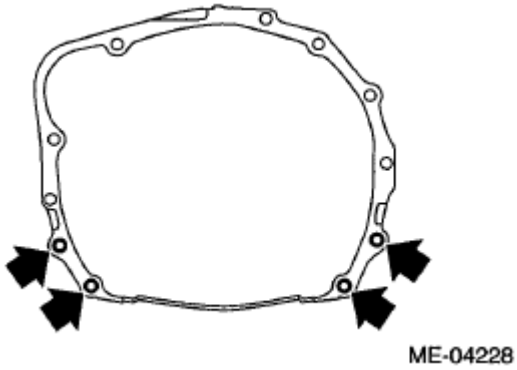


Fig. 39: Locating Transmission Bolts (CVT Model)
Courtesy of SUBARU OF AMERICA, INC.

    - MT model

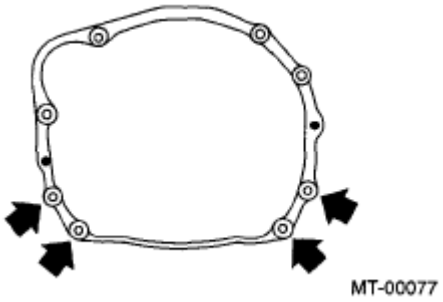


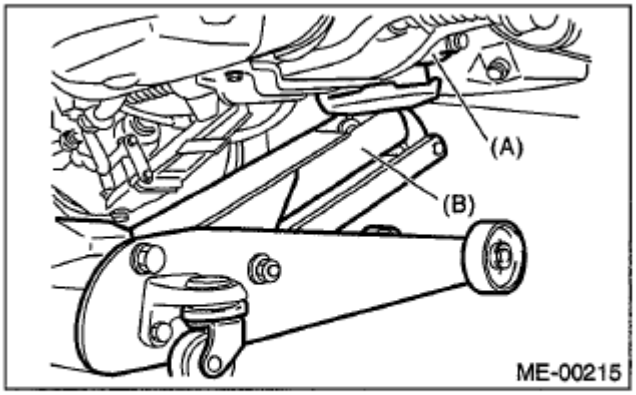
Fig. 40: Locating Transmission Bolts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

29. Lower the vehicle.

CAUTION: When lifting down the vehicle, lower wire ropes at the same time.

30. Support the transmission with a garage jack.

NOTE: Fine adjustment of the transmission height can be performed with this operation.



(A) TRANSMISSION
(B) Garage jack

Fig. 41: Supporting Transmission With Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

31. 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. (CVT model)

   ST 498277200 STOPPER SET

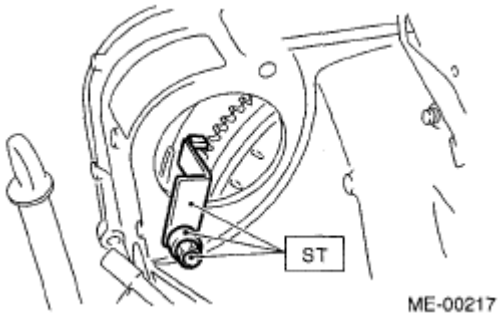


Fig. 42: Attaching ST To Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

32. Remove the bolts which hold the upper side of the transmission to the engine.
    - CVT model

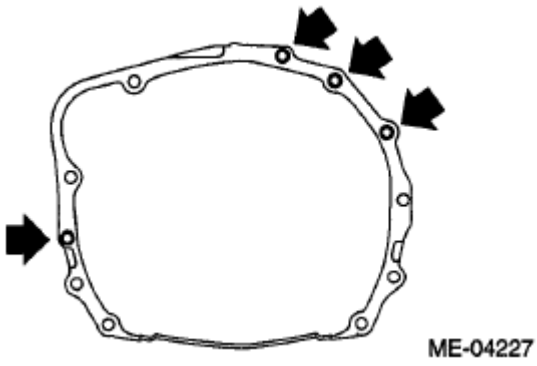


Fig. 43: Locating Transmission Bolts (CVT Model)
Courtesy of SUBARU OF AMERICA, INC.

    - MT model

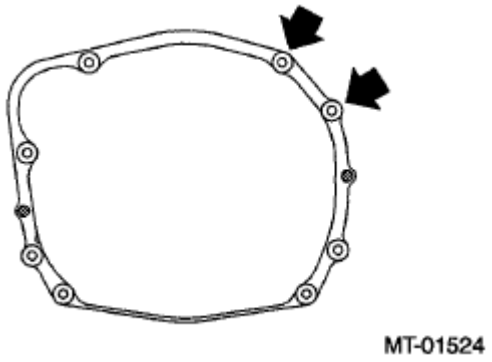


Fig. 44: Locating Transmission Bolts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

33. Remove the engine from vehicle.
    1. Slightly raise the engine.
    2. Adjust the height of the transmission with garage jack.
    3. Move the engine horizontally until main shaft is withdrawn from clutch cover. (MT model)
    4. Move the engine from engine compartment slowly.

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

INSTALLATION

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

   Grease:

   NICHIMOLY N-130 or equivalent

2. 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.

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

   Tightening torque:

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

   - CVT model

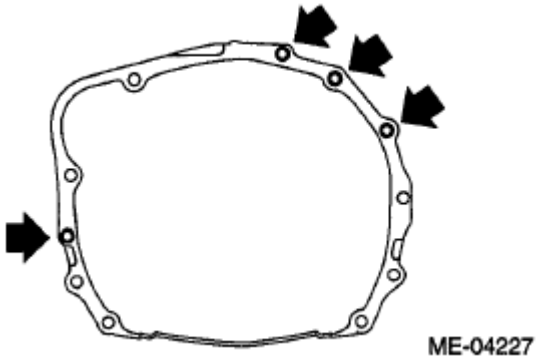


Fig. 45: Locating Transmission Bolts (CVT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

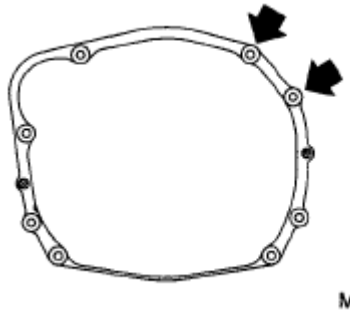


Fig. 46: Locating Transmission Bolts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the garage jack.
5. Remove the ST from torque converter clutch case. (CVT model)

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

ST 498277200 STOPPER SET

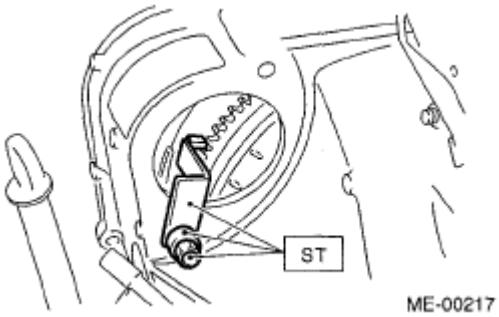


Fig. 47: Attaching ST To Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

6. Install the starter. Ref. to **INSTALLATION** , Starter.
7. Lift up the vehicle.

CAUTION: When lifting up the vehicle, raise up wire ropes at the same time.

8. Attach 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)

- CVT model

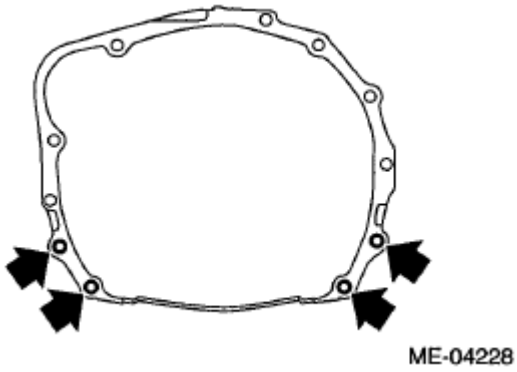


Fig. 48: Locating Transmission Bolts (CVT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

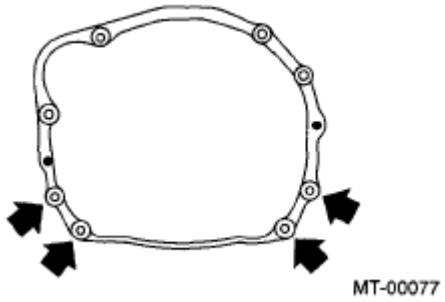


Fig. 49: Locating Transmission Bolts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

9. Set the engine mounting, and tighten the bolts which hold engine mounting to the engine.

   Tightening torque:

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

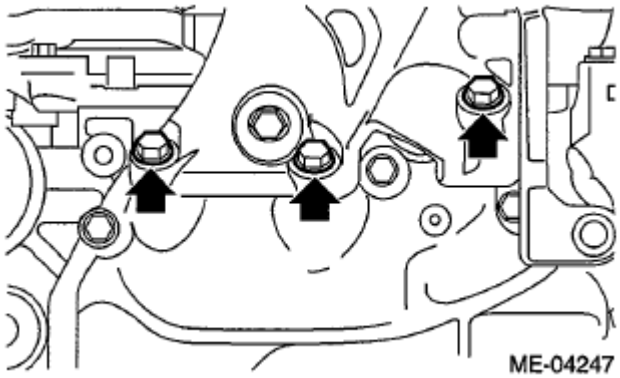


Fig. 50: Locating Engine Mounting
Courtesy of SUBARU OF AMERICA, INC.

10. Lower the vehicle.

CAUTION: When lifting down the vehicle, lower wire ropes at the same time.

11. Attach the bolts and nuts which secure engine mounting to the cradle.

Tightening torque:

60 N.m (6.1 kgf-m, 44.3 ft-lb)

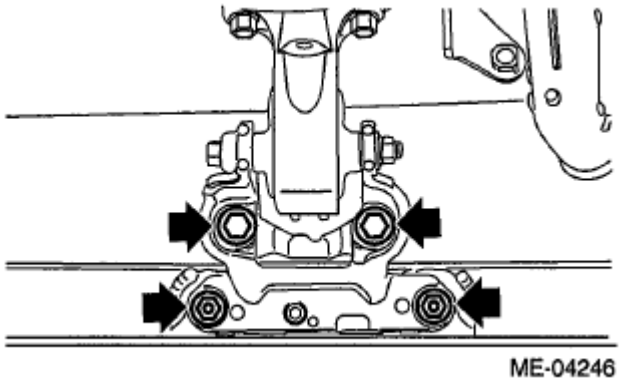


Fig. 51: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

12. Install the stopper rod.

Tightening torque:

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

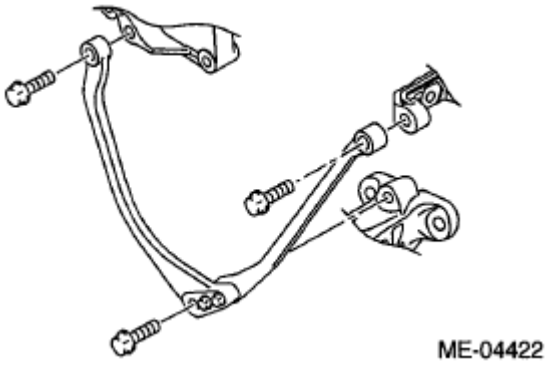


Fig. 52: Identifying Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the lifting device and wire ropes.

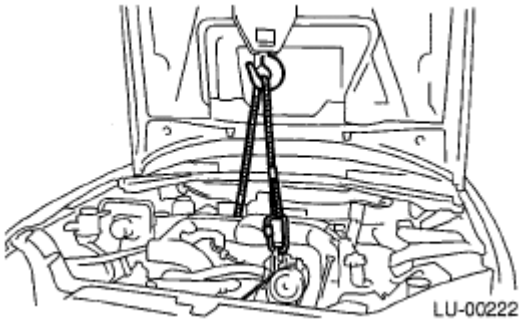


Fig. 53: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

14. Install the torque converter clutch to drive plate. (CVT model)
    1. Insert the wrench into the crank pulley bolt, and rotate the crank pulley to attach the four bolts which hold torque converter clutch to the 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)

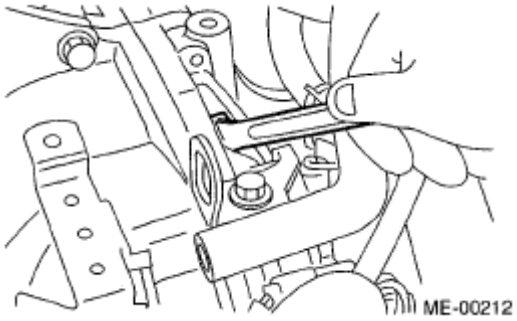


Fig. 54: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

2. Fit the plug to service hole.

15. Lift up the vehicle.
16. Install the engine harness cover, and connect the ground cable.

Tightening torque:

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

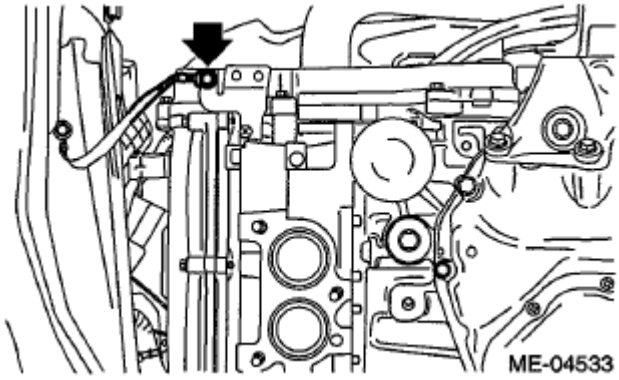


Fig. 55: Locating Ground Cable On Engine Side
Courtesy of SUBARU OF AMERICA, INC.

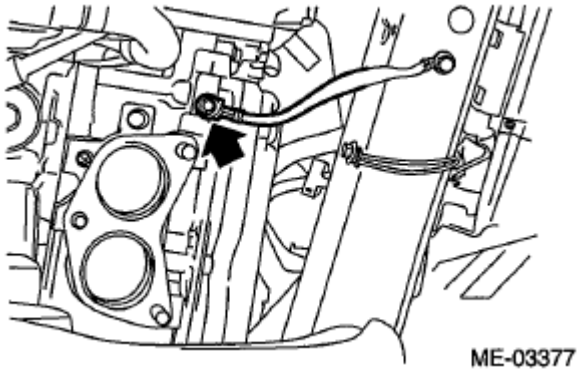


Fig. 56: Locating Ground Cable Bolt
Courtesy of SUBARU OF AMERICA, INC.

17. Lower the vehicle.
18. Connect the following hoses.
    1. Fuel delivery hose
    2. Evaporation hose
    3. Heater inlet hose and heater outlet hose
    4. Brake booster vacuum hose
    5. A/C pressure hose Ref. to **INSTALLATION** , Hose and Pipe.
19. Install the clip which secure the generator cord to the intake manifold protector LH.

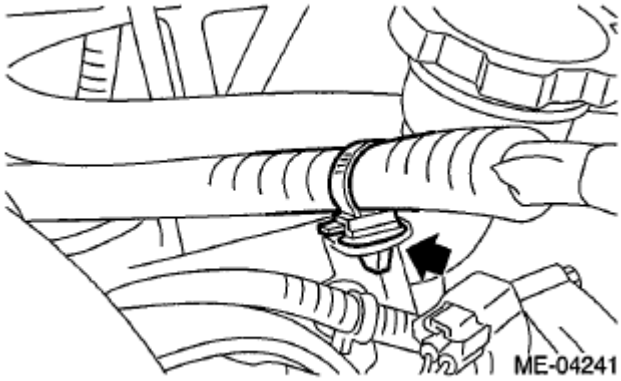


Fig. 57: Locating Intake Manifold Protector LH
Courtesy of SUBARU OF AMERICA, INC.

20. Connect connector (D) to the A/C compressor.
21. Install the generator cord to clip (C), and connect connector (A) and terminal (B) to the generator.

Tightening torque:

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

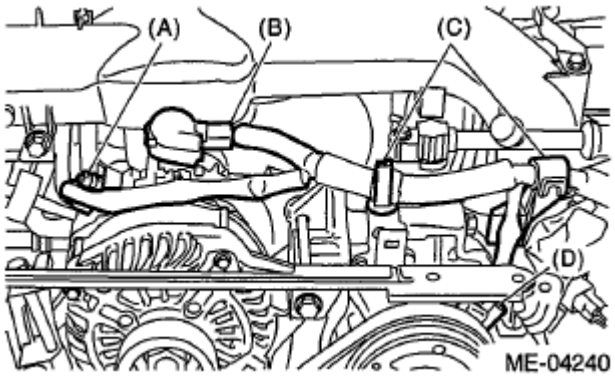


Fig. 58: Identifying A/C Compressor And Connector
Courtesy of SUBARU OF AMERICA, INC.

22. Connect the engine harness connector to the bulkhead harness connector, attach it to the rear engine hanger, and fasten with bolt.

    Tightening torque:

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

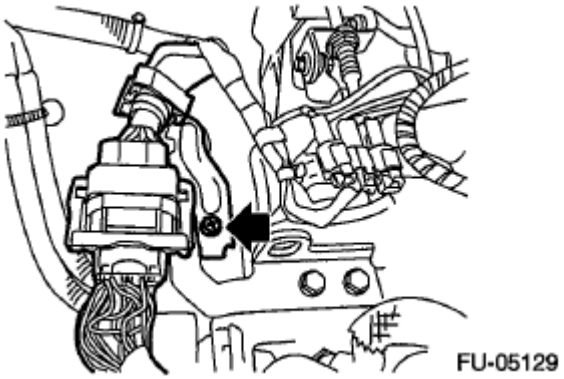


Fig. 59: Locating Bulkhead Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

23. Install the front exhaust pipe. Ref. to **INSTALLATION** , Front Exhaust Pipe.
24. Install the radiator. Ref. to **INSTALLATION** , Radiator.
25. Install the air intake boot assembly. Ref. to **INSTALLATION** , Air Intake Boot.
26. Install the air intake duct. Ref. to **INSTALLATION** , Air Intake Duct.
27. Connect the ground cable to battery.

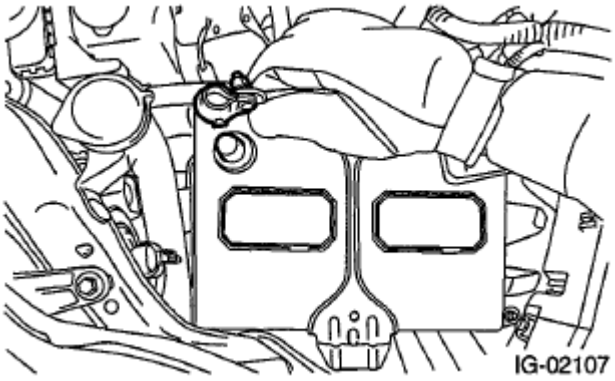


Fig. 60: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

28. Fill engine coolant. Ref. to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant.

29. Charge the A/C system with refrigerant. Ref. to **PROCEDURE** , Refrigerant Charging Procedure.
30. Check the CVTF level and replenish it if necessary. (CVT model) Ref. to **ADJUSTMENT** , CVTF.
31. Install the V-belt cover.
32. Change the front hood damper mounting position from (B) to (A), and close the front hood.

Tightening torque:

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

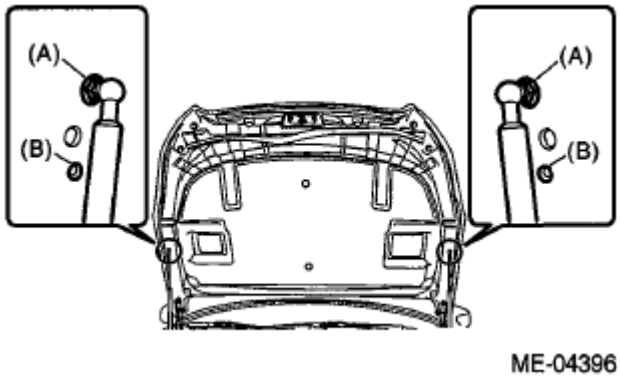


Fig. 61: Identifying Front Hood Damper Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Check that the pipes, hoses, connectors and clamps are securely connected.
2. Check that the engine coolant is up to specified level.
3. Check CVTF is at the specified level. (CVT model)
4. Start the engine and check for exhaust gas leakage, engine coolant leakage, fuel leakage, noise or vibration.

ENGINE MOUNTING

REMOVAL

1. Change the front hood damper mounting position from (A) to (B), and completely open the front hood.

Tightening torque:

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

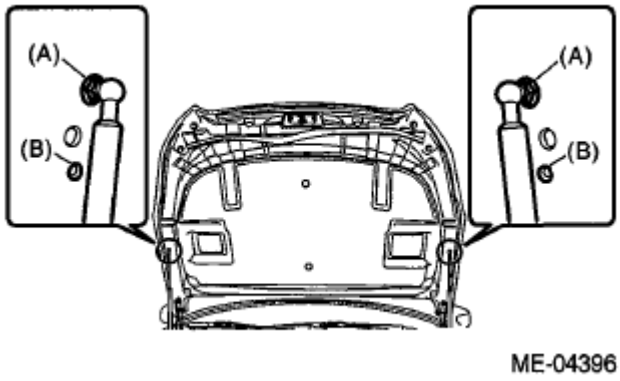


Fig. 62: Identifying Front Hood Damper Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

2. Disconnect the ground cable from battery.

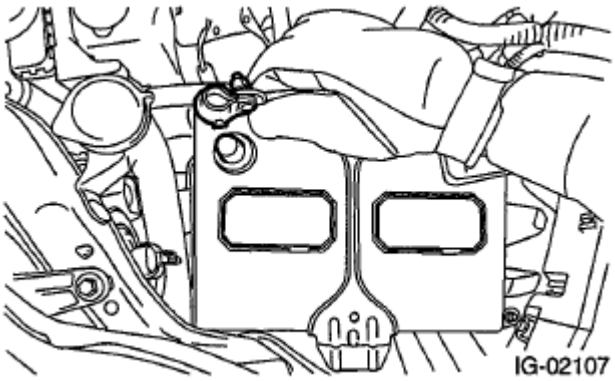


Fig. 63: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the radiator main fan motor assembly and radiator sub fan motor assembly. Ref. to **REMOVAL** , Radiator Main Fan and Fan Motor. Ref. to **REMOVAL** , Radiator Sub Fan and Fan Motor.
4. Lift up the vehicle.
5. Remove the under cover. Ref. to **REMOVAL** , Front Under Cover.
6. Remove the front exhaust pipe. Ref. to **REMOVAL** , Front Exhaust Pipe.
7. Lower the vehicle.
8. Support the engine with a lifting device and wire ropes.

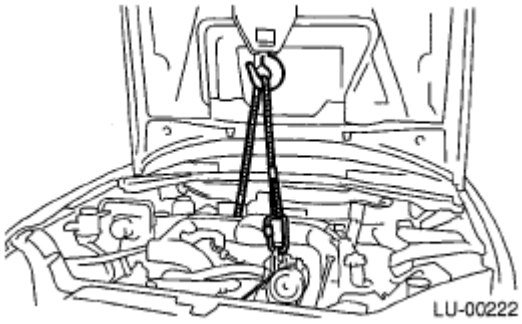


Fig. 64: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the stopper rod.

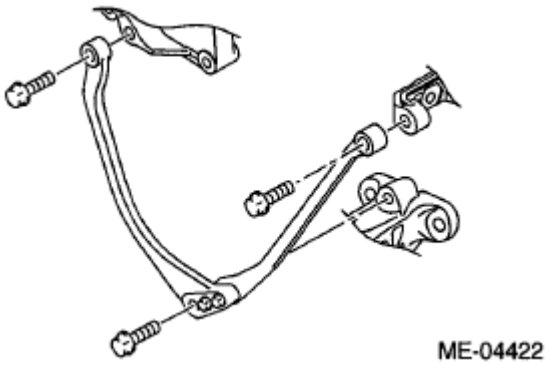


Fig. 65: Identifying Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the bolt and nut which secure engine mounting to the cradle.

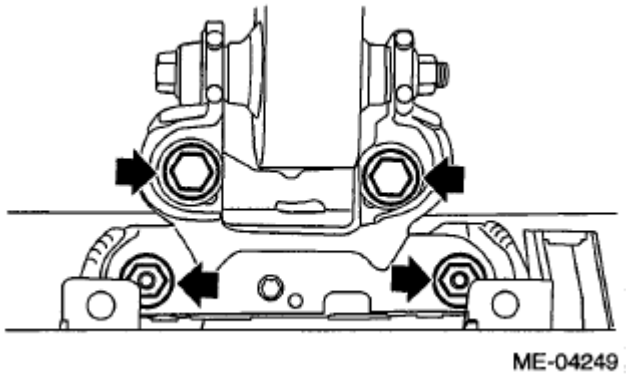


Fig. 66: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

11. Lift up the vehicle.

CAUTION: When lifting up the vehicle, raise up wire ropes at the same time.

12. Remove the bolts which secure the engine mounting onto the engine, and remove the engine mounting.

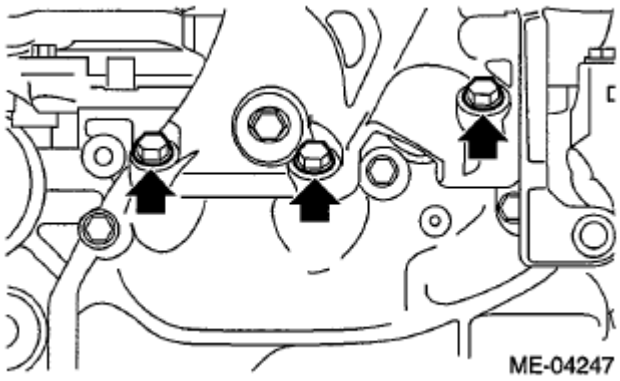


Fig. 67: Locating Engine Mounting
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Set the engine mounting, and tighten the bolts which hold engine mounting to the engine.

   Tightening torque:

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

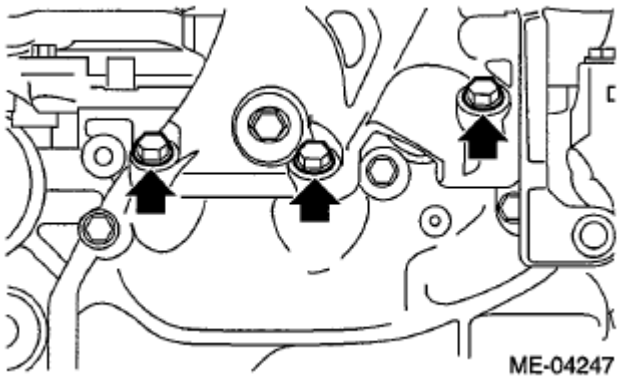


Fig. 68: Locating Engine Mounting
Courtesy of SUBARU OF AMERICA, INC.

2. Lower the vehicle.

CAUTION: When lifting down the vehicle, lower wire ropes at the same time.

3. Attach the bolts and nuts which secure engine mounting to the cradle.

   Tightening torque:

   60 N.m (6.1 kgf-m, 44.3 ft-lb)

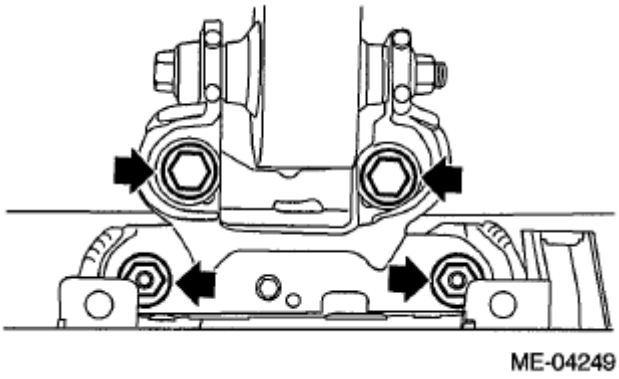


Fig. 69: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Install the stopper rod.

   Tightening torque:

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

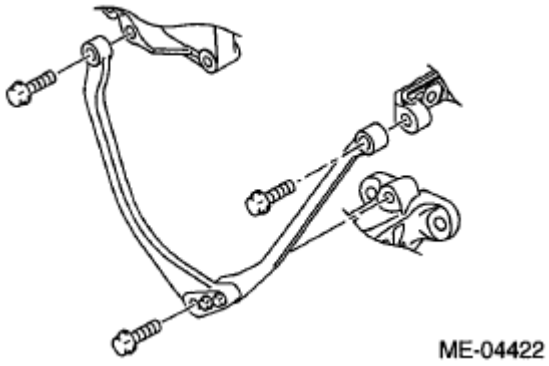


Fig. 70: Identifying Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.

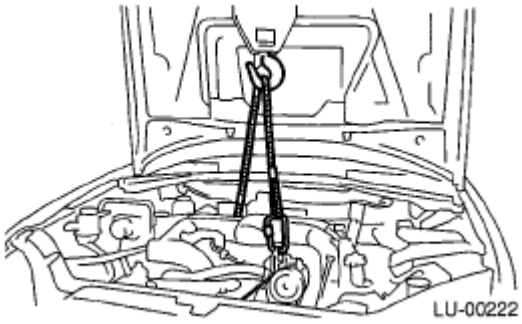


Fig. 71: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

6. Lift up the vehicle.
7. Install the front exhaust pipe. Ref. to **INSTALLATION** , Front Exhaust Pipe.
8. Install the under cover. Ref. to **INSTALLATION** , Front Under Cover.
9. Lower the vehicle.
10. Install the radiator main fan motor assembly and radiator sub fan motor assembly. Ref. to **INSTALLATION** , Radiator Main Fan and Fan Motor. Ref. to **INSTALLATION** , Radiator Sub Fan and Fan Motor.
11. Connect the ground cable to battery.

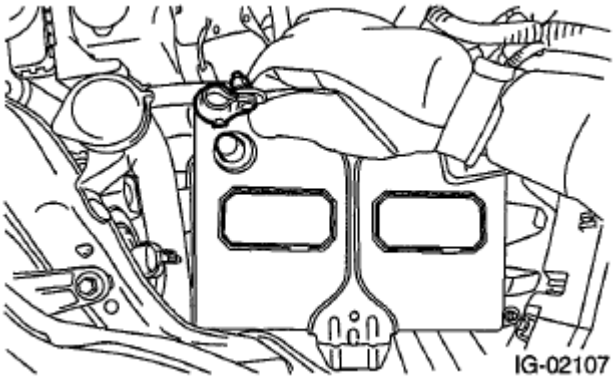


Fig. 72: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

12. Change the front hood damper mounting position from (B) to (A), and close the front hood.

    Tightening torque:

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

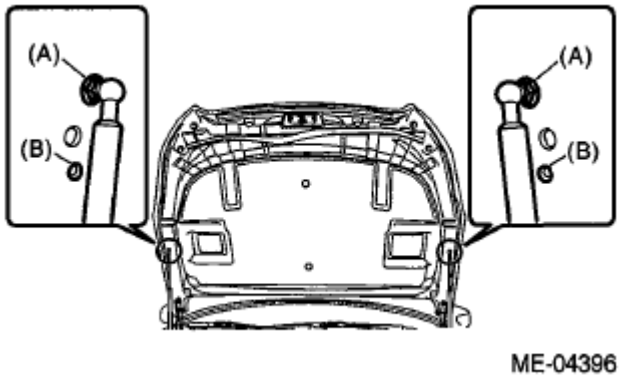


Fig. 73: Identifying Front Hood Damper Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

DISASSEMBLY

1. Remove the front cushion rubber from the engine mounting bracket.

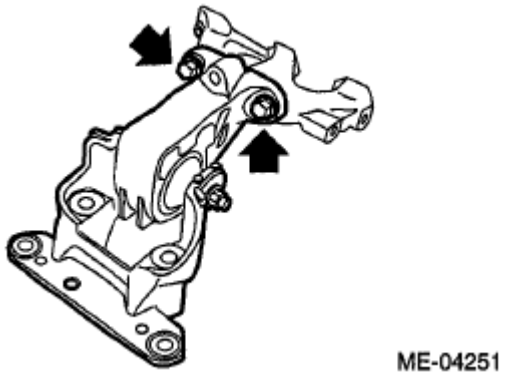


Fig. 74: Locating Engine Mounting Bracket
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the front cushion rubber from the front mounting bracket.

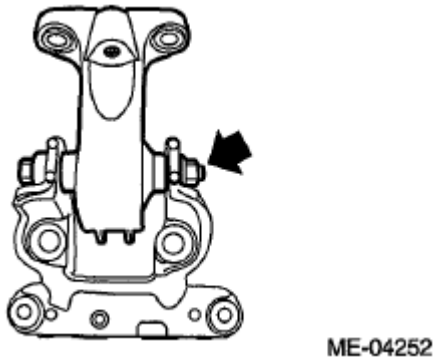


Fig. 75: Locating Front Mounting Bracket
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY

1. Install the front cushion rubber to the front mounting bracket.

   Tightening torque:

   45 N.m (4.6 kgf-m, 33.2 ft-lb)

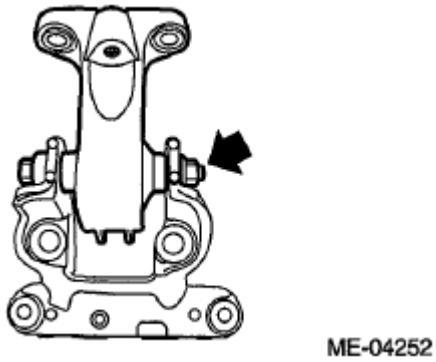


Fig. 76: Locating Front Mounting Bracket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the front cushion rubber to the engine mounting bracket.

   Tightening torque:

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

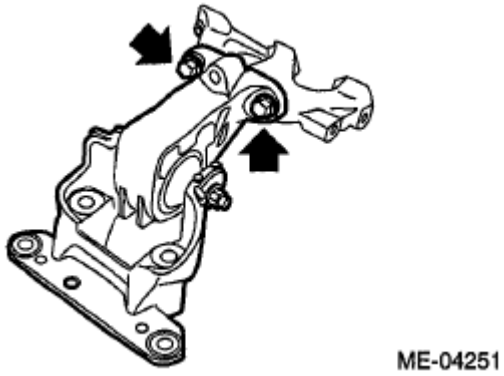


Fig. 77: Locating Engine Mounting Bracket
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

Check that the engine mounting does not have deformation, cracks and any other damage.

PREPARATION FOR OVERHAUL

PROCEDURE

1. After removing the engine from vehicle body, attach the ST to the engine as shown in the figure. ST1 498457000 ENGINE STAND ADAPTER RH

   ST2 498457100 ENGINE STAND ADAPTER LH

   ST3 499817100 ENGINE STAND

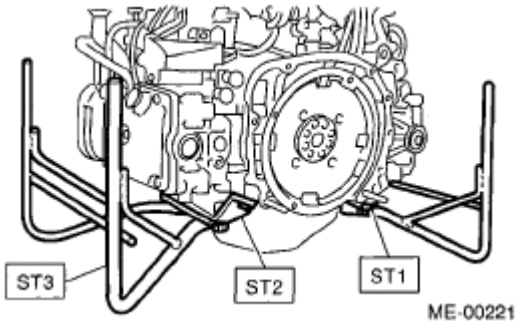


Fig. 78: Identifying Engine Stand Adapter RH (498457000) And Engine Stand Adapter LH (498457100)
Courtesy of SUBARU OF AMERICA, INC.

2. In this article the procedures described under each index are all connected and stated in order. Engine overhaul will be completed when you go through all steps in the procedure.

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

V-BELT

REMOVAL

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

V-BELT

1. Remove the collector cover.
2. Remove the air intake duct. Ref. to **REMOVAL** , Air Intake Duct.
3. Attach the tool to the V-belt tensioner assembly, and rotate the tool clockwise to loosen and remove the V-belt.

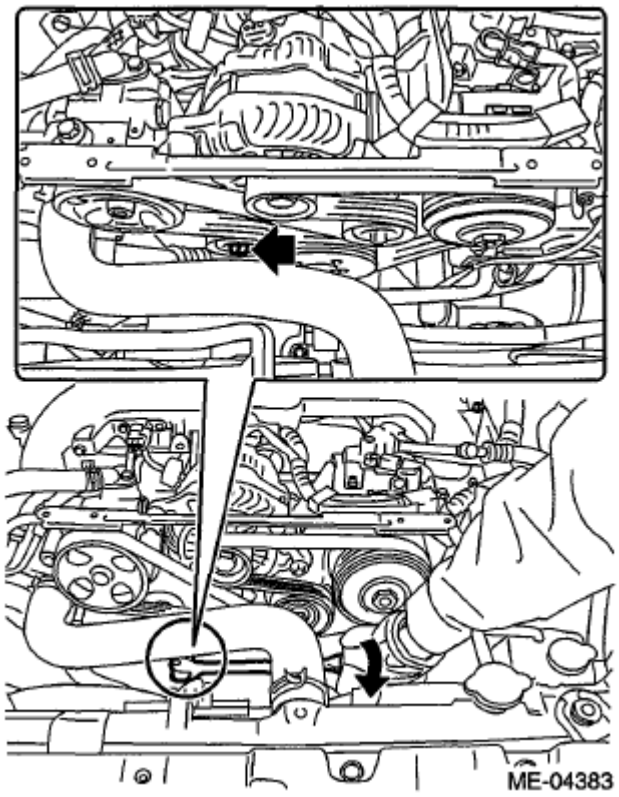


Fig. 79: Attaching Tool To V-belt Tensioner Assembly
Courtesy of SUBARU OF AMERICA, INC.

V-BELT TENSIONER ASSEMBLY AND IDLER PULLEY

1. Remove the V-belts. Ref. to **V-BELT**, REMOVAL, V-belt.
2. Remove the bolt securing the V-belt tensioner assembly to the power steering pump bracket, and remove the V-belt tensioner assembly.

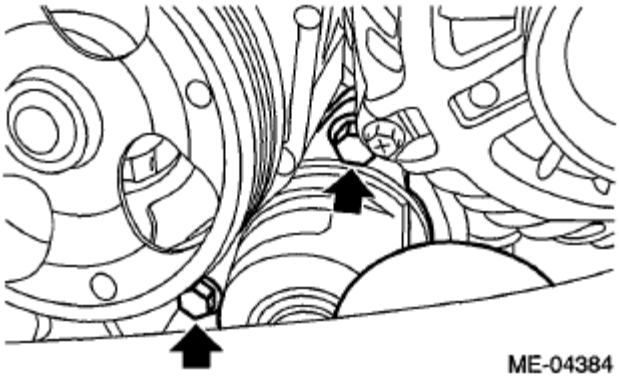


Fig. 80: Locating V-belt Tensioner Assembly
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the bolt securing the idler pulley to the A/C compressor bracket, and remove the idler pulley.

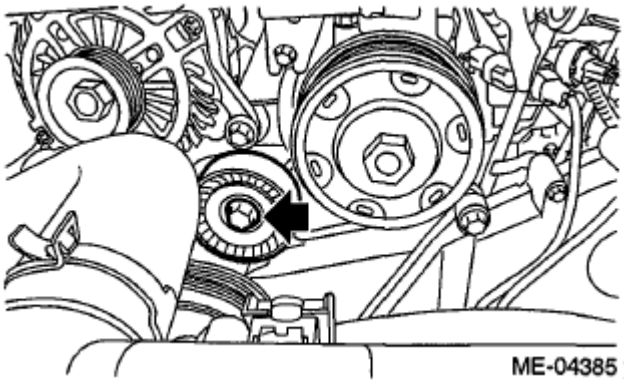


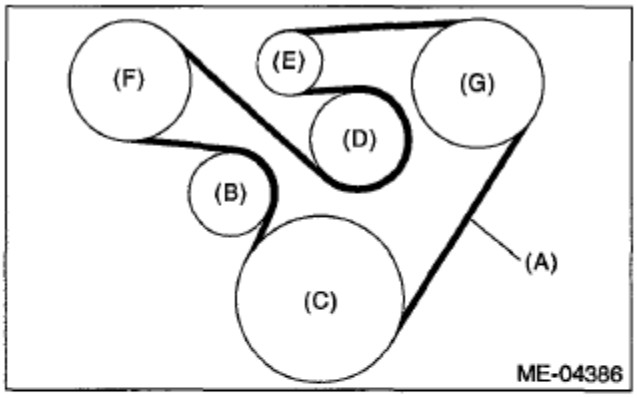
Fig. 81: Locating A/C Compressor Bracket Bolt
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

V-BELT

Install in the reverse order of removal.

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



(A) V-belt
(B) V-belt tensioner ASSY
(C) Crank pulley
(D) Idler pulley
(E) Generator pulley
(F) Power steering pump pulley
(G) A/C compressor pulley

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

V-BELT TENSIONER ASSEMBLY AND IDLER PULLEY

Install in the reverse order of removal.

Tightening torque:

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

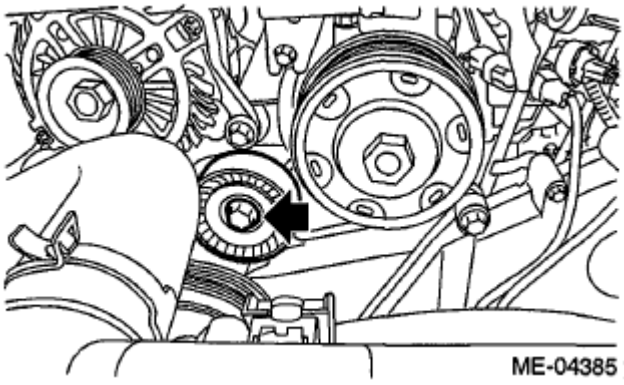


Fig. 83: Locating A/C Compressor Bracket Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

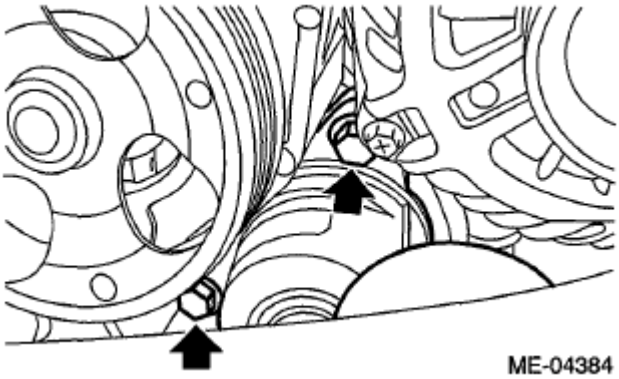


Fig. 84: Locating V-belt Tensioner Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Check the V-belt for cracks, tear or wear.
2. Remove the air intake duct. Ref. to **REMOVAL** , Air Intake Duct.
3. Check the V-belt tensioner assembly and idler pulley for deformation, cracks or other damages.
4. Check that the V-belt tension indicator (A) is within the limit (B).

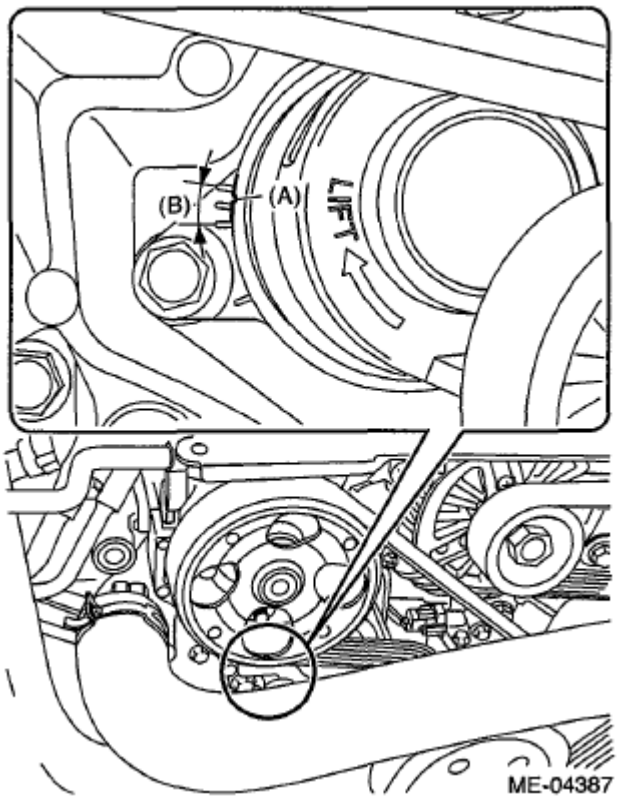


Fig. 85: Checking V-belt Tension Indicator With Limit
Courtesy of SUBARU OF AMERICA, INC.

CRANK PULLEY

REMOVAL

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

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 (CVT MODEL)

   ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

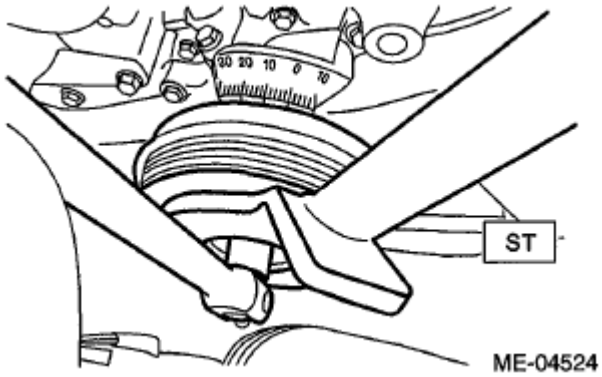


Fig. 86: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION

METHOD WITHOUT ANGLE GAUGE

1. Clean the crankshaft thread using compressed air.
2. Install the crank pulley.
3. Apply engine oil to the crank pulley bolt seat and thread.
4. Tighten the crank pulley bolts.
   1. Use the ST to lock the crank pulley, and temporarily tighten the crank pulley bolt.

      ST 499977400 CRANK PULLEY WRENCH (CVT MODEL)

ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

Tightening torque:

47 N.m (4.8 kgf-m, 34.7 ft-lb)

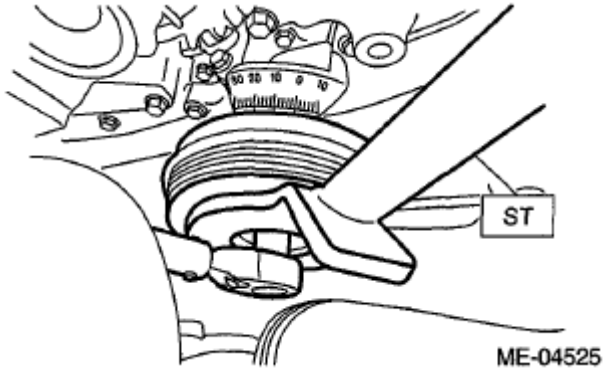


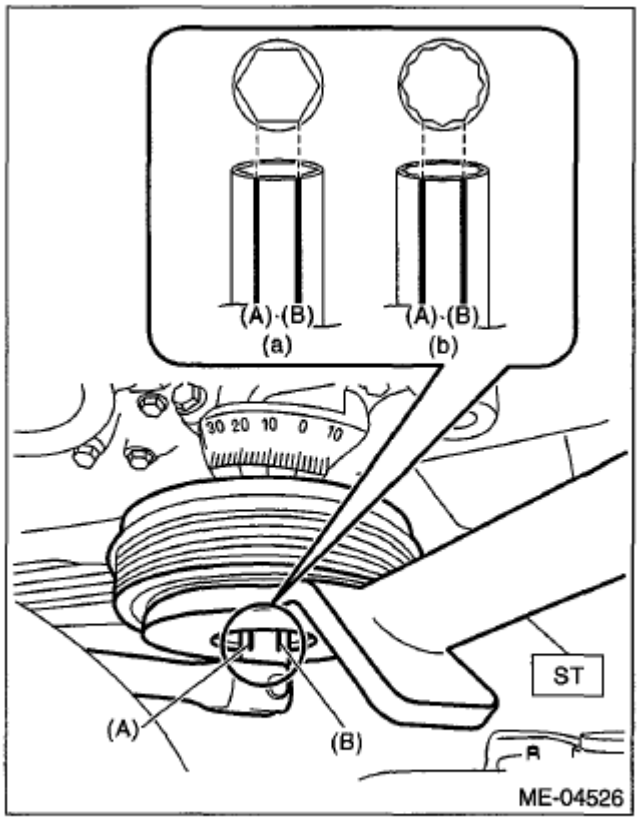
Fig. 87: Tightening Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

2. Draw reference lines (A) and (B) using a marker to set the socket to the crank pulley bolt as shown in the figure.

   ST 499977400 CRANK PULLEY WRENCH (CVT MODEL)

   ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

   NOTE: Set the socket onto the crank pulley bolt so that reference lines (A) and (B) is visible.



(a) When using 6-point socket
(b) When using 12-point socket

Fig. 88: Setting Socket To Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Draw end line (C) on ST using a marker at the same position as reference line (B) was drawn on the socket in step (2).

   ST 499977400 CRANK PULLEY WRENCH (CVT MODEL)

   ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

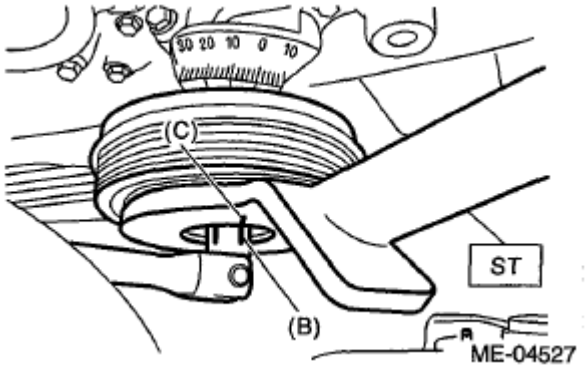


Fig. 89: Drawing End Line On ST
Courtesy of SUBARU OF AMERICA, INC.

4. Use the ST to lock the crank pulley, and tighten the crank pulley bolt to the angle where reference line (A) and end line (C) are aligned.

   ST 499977400 CRANK PULLEY WRENCH (CVT MODEL)

   ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

   NOTE: It should be approx. 60° when reference line (A) and end line (C) are aligned.

   Tightening angle:

   60°±5°

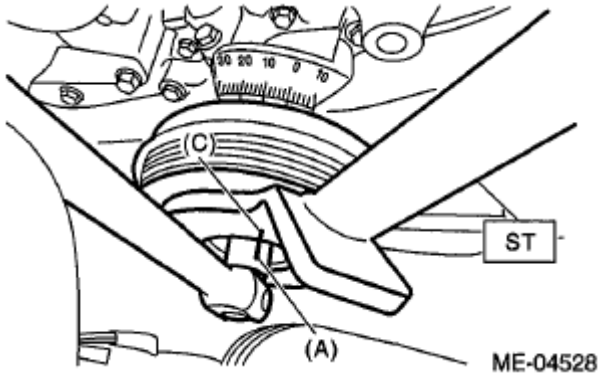


Fig. 90: Tightening Crank Pulley Bolt To Reference Line And End Line
Courtesy of SUBARU OF AMERICA, INC.

5. Install the V-belts. Ref. to **INSTALLATION**, V-belt.

METHOD WITH ANGLE GAUGE

1. Clean the crankshaft thread using compressed air.
2. Install the crank pulley.
3. Apply engine oil to the crank pulley bolt seat and thread.
4. Tighten the crank pulley bolts.
   1. Remove the radiator main fan motor assembly and radiator sub motor assembly. Ref. to **REMOVAL** , Radiator Main Fan and Fan Motor. Ref. to **REMOVAL** , Radiator Sub Fan and Fan Motor.
   2. Use the ST1 to lock the crank pulley, and temporarily tighten the crank pulley bolt.

      ST1 499977400 CRANK PULLEY WRENCH (CVT MODEL)

ST1 499977100 CRANK PULLEY WRENCH (MT MODEL)

Tightening torque:

47 N.m (4.8 kgf-m, 34.7 ft-lb)

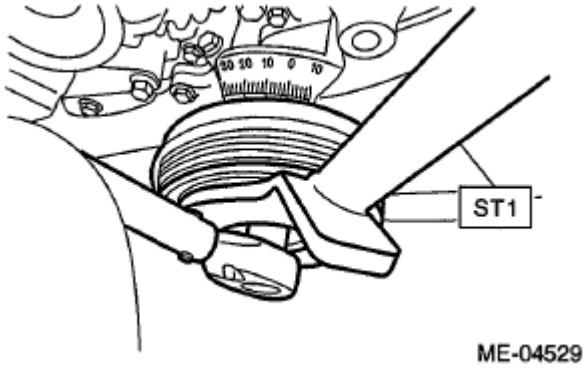


Fig. 91: Tightening Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Set the ST2, use the ST1 to lock the crank pulley, and tighten the crank pulley bolt to the specified angle.

   ST1 499977400 CRANK PULLEY WRENCH (CVT MODEL)

   ST1 499977100 CRANK PULLEY WRENCH (MT MODEL)

   ST2 18854AA000 ANGLE GAUGE

   NOTE: Attach the magnet used for securing the ST2 (ANGLE GAUGE) to ST1.

   Tightening angle:

   60°±5°

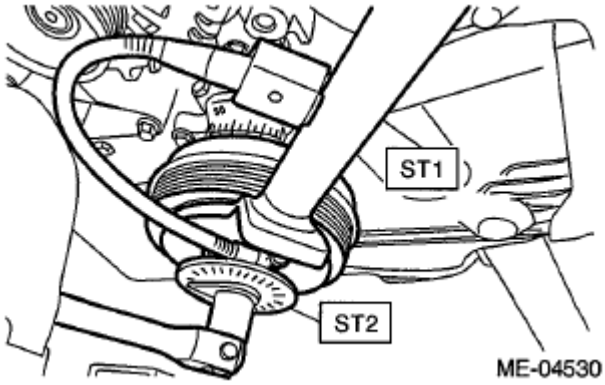


Fig. 92: Attaching Magnet Used For Securing ST2 To ST1
Courtesy of SUBARU OF AMERICA, INC.

4. Install the radiator main fan motor assembly and radiator sub motor assembly. Ref. to **INSTALLATION** , Radiator Main Fan and Fan Motor. Ref. to **INSTALLATION** , Radiator Sub Fan and Fan Motor.
5. Install the V-belts. Ref. to **INSTALLATION**, V-belt.

INSPECTION

1. Make sure the V belt is not worn or damaged.
2. Check the tension of the front side belt. Ref. to **INSPECTION**, V-belt.

TIMING BELT COVER

REMOVAL

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

1. Remove the V-belts. Ref. to **REMOVAL**, V-belt.
2. Remove the crank pulley. Ref. to **REMOVAL**, Crank Pulley.
3. Remove the stopper rod.

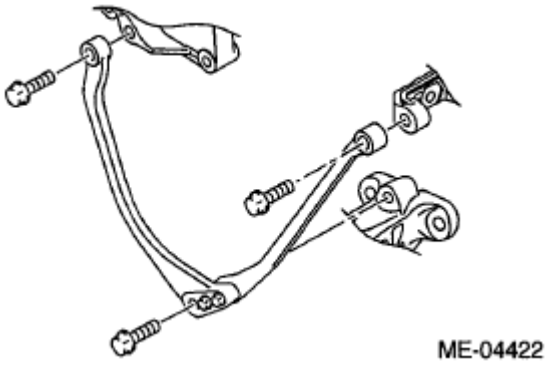


Fig. 93: Identifying Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

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

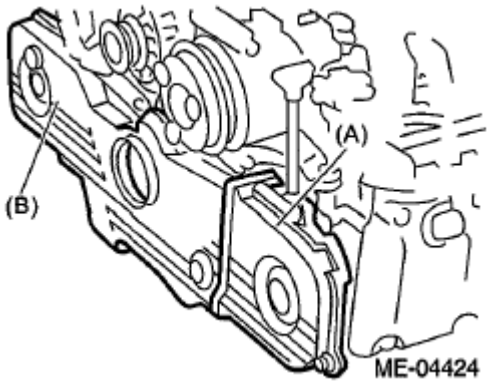


Fig. 94: Identifying Front Timing Belt Cover And Timing Belt Cover LH
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

   Tightening torque:

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

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

   Tightening torque:

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

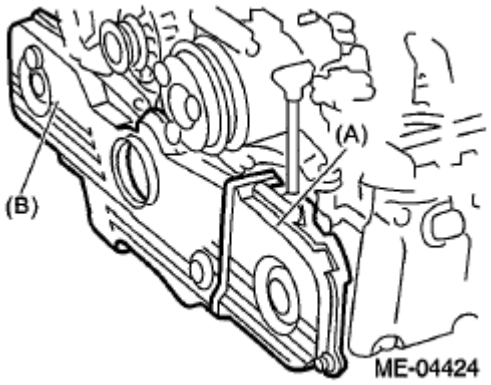


Fig. 95: Identifying Front Timing Belt Cover And Timing Belt Cover LH
Courtesy of SUBARU OF AMERICA, INC.

3. Install the stopper rod.

   Tightening torque:

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

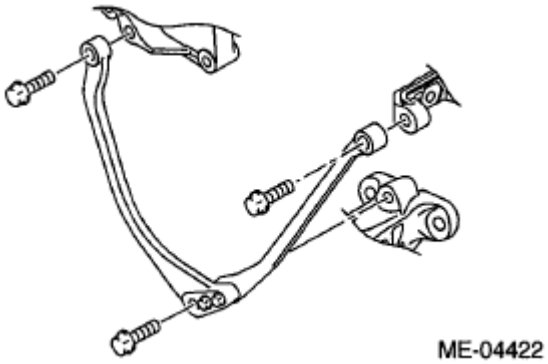


Fig. 96: Identifying Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

Check the timing belt cover for damage.

TIMING BELT

REMOVAL

NOTE:
- **When replacing the single part, perform the work with the engine installed**

to vehicle body.

- **When performing the work with the engine installed to body, the following parts must also be removed/installed.**
  - **Radiator main fan motor assembly Ref. to REMOVAL , Radiator Main Fan and Fan Motor. Ref. to INSTALLATION , Radiator Main Fan and Fan Motor.**
  - **Radiator sub fan motor assembly Ref. to REMOVAL , Radiator Sub Fan and Fan Motor. Ref. to INSTALLATION , Radiator Sub Fan and Fan Motor.**
- **When performing the work with the engine installed to body, protect the radiator with cardboards or blankets.**

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)

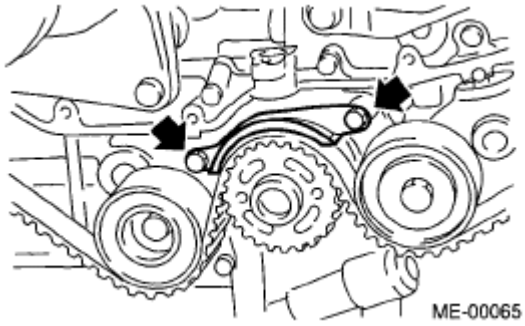


Fig. 97: Locating Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

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. Use the ST to turn crankshaft. Align the mark (a) of sprocket to the mark (b) of oil pump, and then ensure the right side cam sprocket mark (c), cam cap and cylinder head matching surface (d) or left side cam sprocket mark (e), timing belt cover notch (f) are properly adjusted.

      ST 499987500 CRANKSHAFT SOCKET

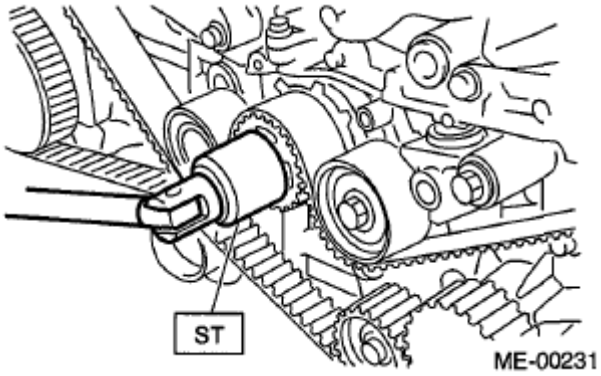
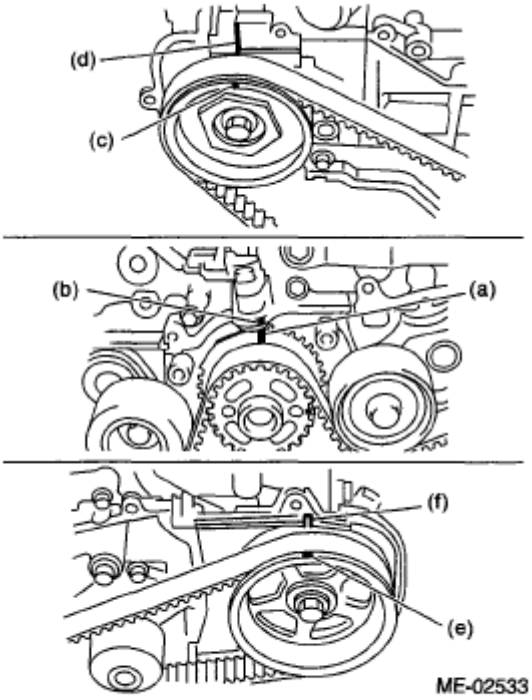


Fig. 98: Removing Timing Belt
Courtesy of SUBARU OF AMERICA, INC.



(a) (c) (e) Notch
(b) (d) (f) Alignment mark

Fig. 99: Aligning Mark Of Sprocket To Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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. 100: Identifying Align Mark On Timing Belts
Courtesy of SUBARU OF AMERICA, INC.

Z_1 ; 46.8 teeth

Z_2 : 43.7 teeth

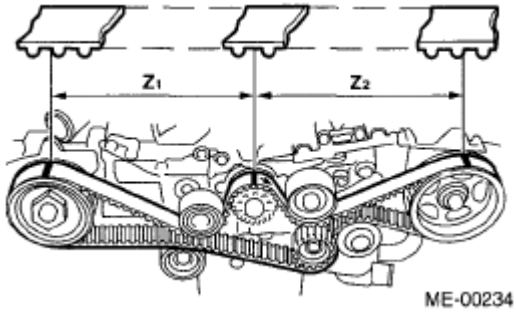


Fig. 101: Identifying Drive Belt Length
Courtesy of SUBARU OF AMERICA, INC.

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

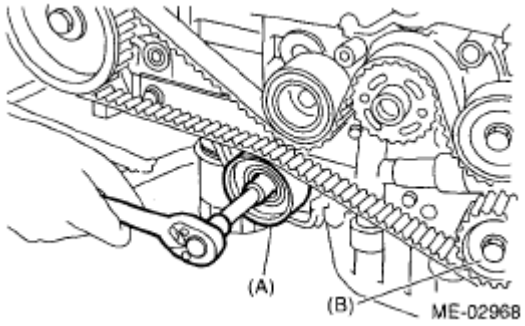


Fig. 102: Identifying Belt Idler No. 2 And Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt.

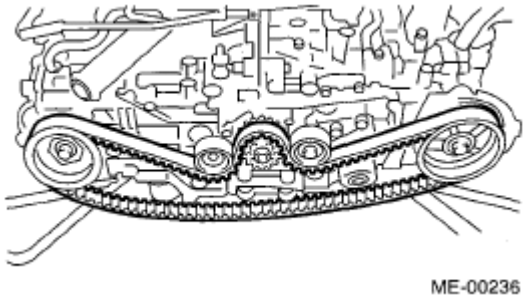


Fig. 103: Identifying Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY

1. Remove the belt idler.

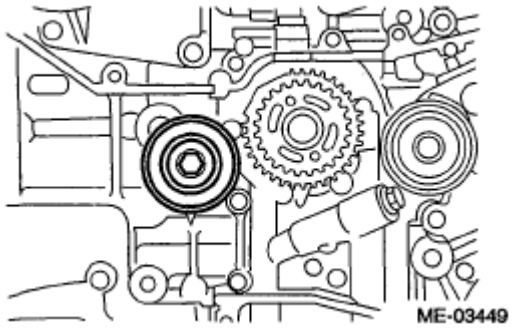


Fig. 104: Identifying Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the automatic belt tension adjuster assembly.

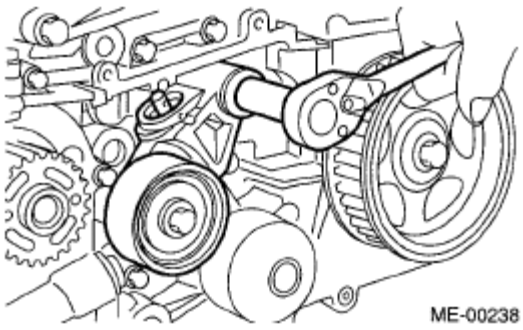


Fig. 105: Removing Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

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 push in the adjuster rod below the end face of the cylinder. Doing so may damage the cylinder.**
- **Do not release the press pressure until stopper pin is completely inserted.**

1. Attach the automatic belt tension adjuster assembly to vertical pressing tool.
2. Slowly push in the adjuster rod with a pressure of 165 N (16.8 kgf, 37.1 lbf) or more until the adjuster rod is aligned with the stopper pin hole in the cylinder.

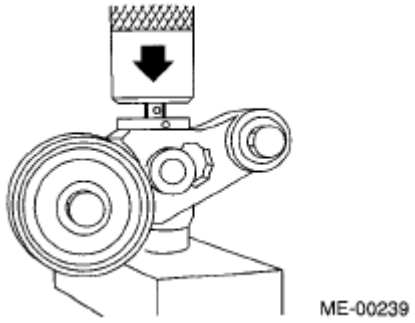


Fig. 106: Attaching Automatic Belt Tension Adjuster Assembly To Vertical Pressing Tool
Courtesy of SUBARU OF AMERICA, INC.

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

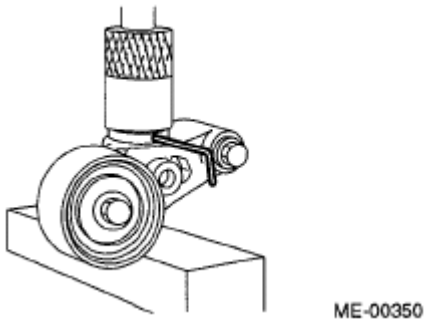


Fig. 107: Inserting Hex Wrench Into Stopper Pin Hole In Cylinder
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

   Tightening torque:

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

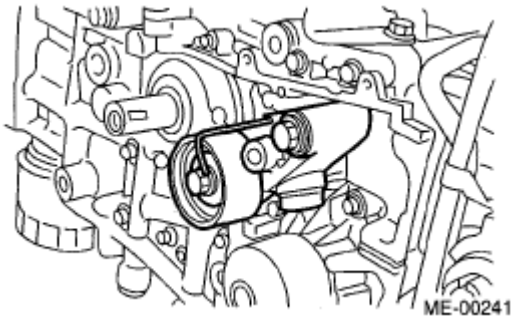


Fig. 108: Identifying Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idlers.

   Tightening torque:

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

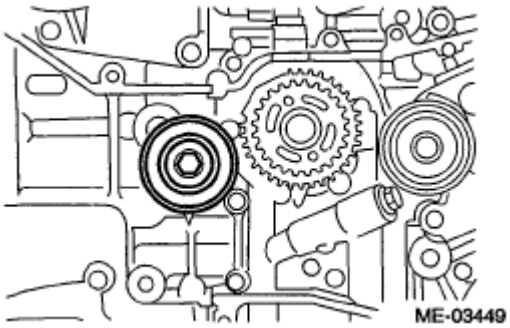


Fig. 109: Identifying Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

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

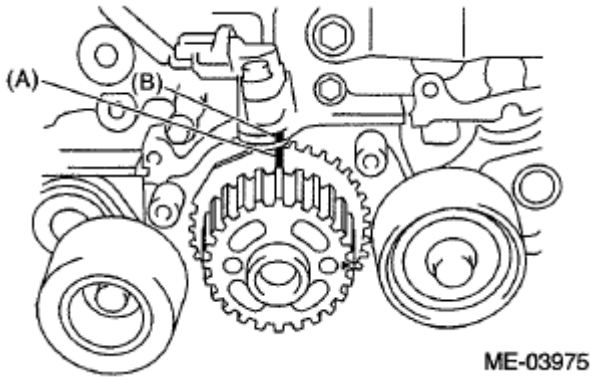


Fig. 110: Aligning Mark On Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

   ST1 18231AA010 CAM SPROCKET WRENCH

   NOTE: CAM SPROCKET WRENCH (499207100) can also be used.

   ST2 499207400 CAM SPROCKET WRENCH

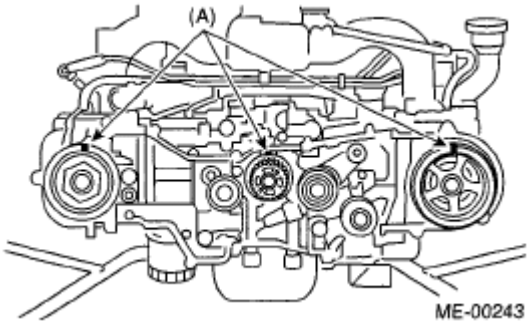


Fig. 111: Identifying Alignment Marks On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

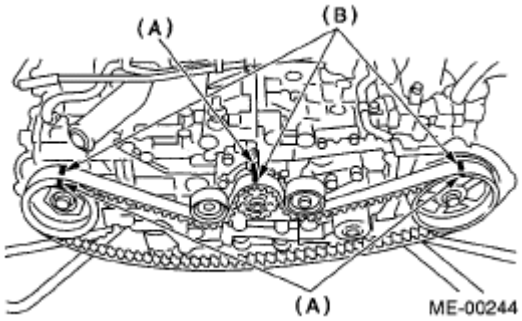


Fig. 112: Identifying Aligning Mark On Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

5. Install the belt idler No. 2 (B).

   Tightening torque:

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

6. Install the belt idler (A).

   Tightening torque:

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

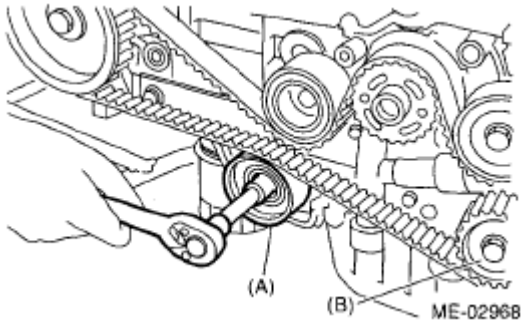


Fig. 113: Identifying Belt Idler No. 2 And Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

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

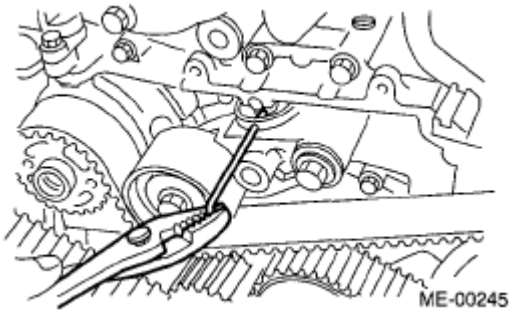


Fig. 114: Removing Stopper Pin From Belt Tension Adjuster
Courtesy of SUBARU OF AMERICA, INC.

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

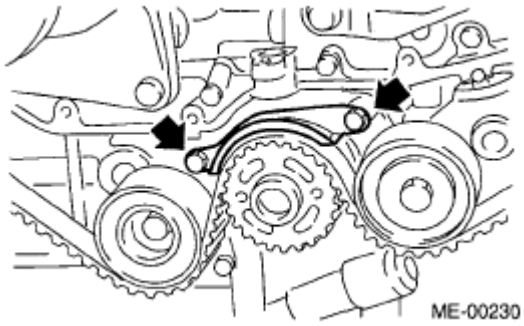


Fig. 115: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

Clearance:

1.0±0.5 mm (0.039±0.020 in)

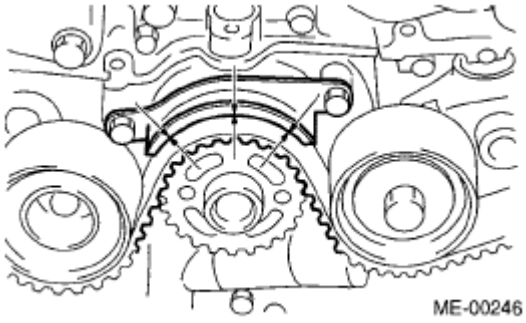


Fig. 116: Identifying Clearance Between Timing Belt And Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

   Tightening torque:

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

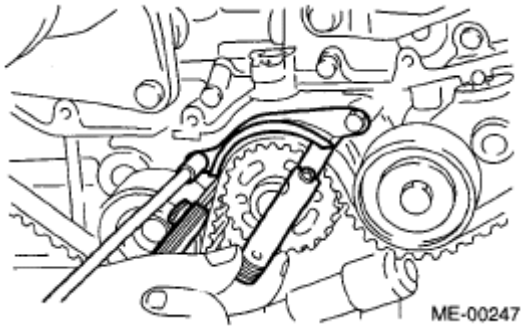


Fig. 117: Tightening Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. Install the timing belt cover. Ref. to **INSTALLATION**, Timing Belt Cover.
10. Install the crank pulley. Ref. to **INSTALLATION**, Crank Pulley.
11. 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

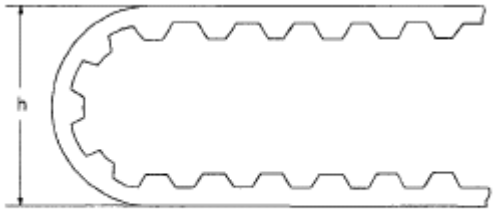


Fig. 118: Identifying Timing Belt Radial Diameter
Courtesy of SUBARU OF AMERICA, INC.

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 rod's oil seal does not indicate a problem.

2. Check that the adjuster rod does not move when a pressure of 165 N (16.8 kgf, 37.1 lbf) is applied to it. This is to check 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 the 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 adjuster rod protrusion "H" from the end surface of the cylinder. If it is not within specifications, replace the automatic belt tension adjuster assembly with a new part.

Amount of adjuster rod protrusion H:

5.2 - 6.2 mm (0.204 - 0.244 in)

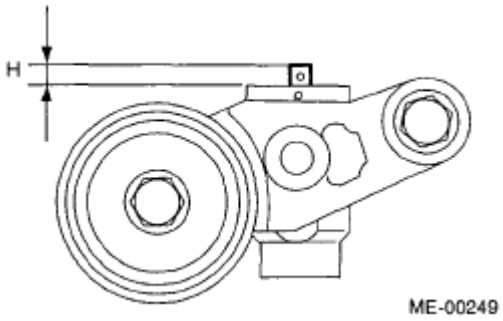


Fig. 119: Identifying Adjuster Rod Protrusion Height
Courtesy of SUBARU OF AMERICA, INC.

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

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 camshaft position sensor. Ref. to **REMOVAL** , Camshaft Position Sensor.
6. Use the ST to lock the cam sprocket, and remove the cam sprocket bolt.

ST 18231AA010 CAM SPROCKET WRENCH

NOTE: CAM SPROCKET WRENCH (499207100) can also be used.

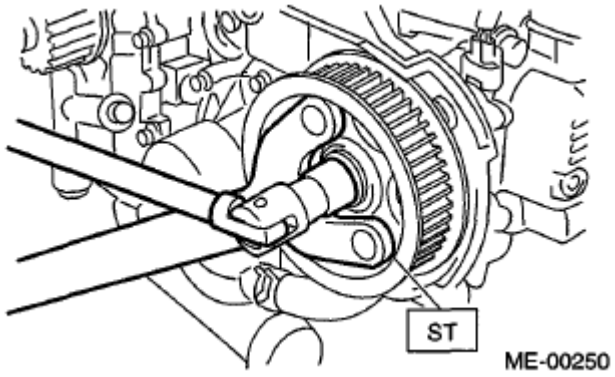


Fig. 120: Removing Cam Sprocket Bolt
Courtesy of SUBARU OF AMERICA, INC.

ST 499207400 CAM SPROCKET WRENCH

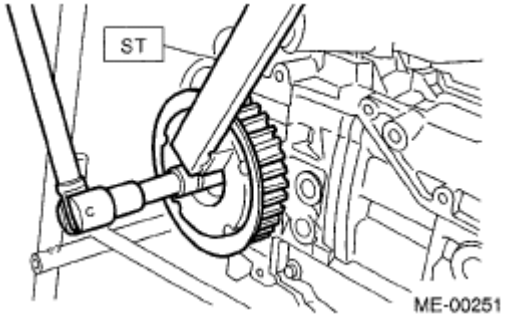


Fig. 121: Tightening Cam Sprocket Bolt Using Cam Sprocket Wrench ST (499207400)
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the cam sprocket.

INSTALLATION

1. Install the cam sprocket.
2. Use the ST to lock the cam sprocket, and install the cam sprocket bolt.

NOTE:
- **Do not confuse cam sprockets (LH) and (RH) during installation.**
- **They can be distinguished by the L or R indication.**

ST 18231AA010 CAM SPROCKET WRENCH

NOTE: CAM SPROCKET WRENCH (499207100) can also be used.

Tightening torque:

78 N.m (8.0 kgf-m, 57.5 ft-lb)

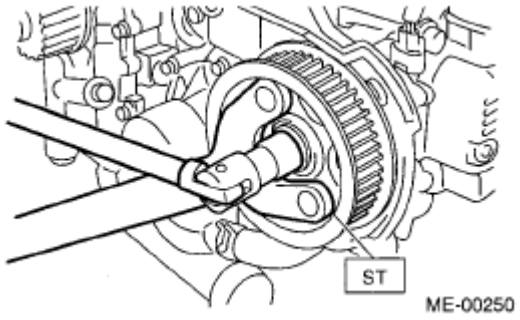


Fig. 122: Installing Cam Sprocket Bolt Using Cam Sprocket Wrench ST (499207400)
Courtesy of SUBARU OF AMERICA, INC.

ST 499207400 CAM SPROCKET WRENCH

Tightening torque:

78 N.m (8.0 kgf-m, 57.5 ft-lb)

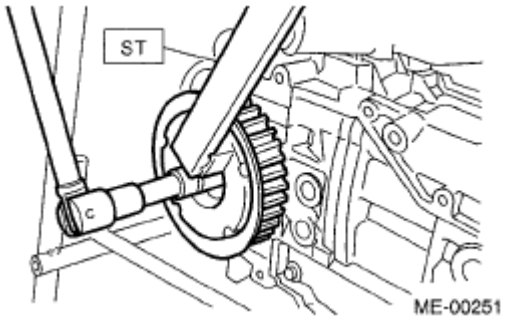


Fig. 123: Tightening Cam Sprocket Bolt Using Cam Sprocket Wrench ST (499207400)
Courtesy of SUBARU OF AMERICA, INC.

3. Install the camshaft position sensor. Ref. to **INSTALLATION** , Camshaft Position Sensor.
4. Install the timing belt. Ref. to **INSTALLATION**, Timing Belt.
5. Install the timing belt cover. Ref. to **INSTALLATION**, Timing Belt Cover.
6. Install the crank pulley. Ref. to **INSTALLATION**, Crank Pulley.
7. 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.
3. Check the cam sprocket protrusion used for sensor for damage and contamination of foreign matter.

CRANK SPROCKET

REMOVAL

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

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.

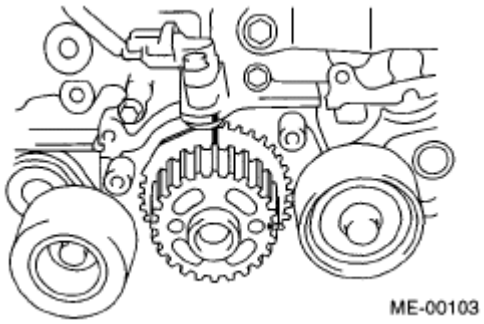


Fig. 124: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

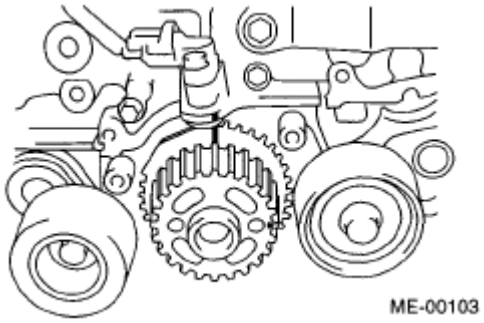


Fig. 125: Identifying Crank Sprocket

Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

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

VALVE ROCKER ASSEMBLY

REMOVAL

NOTE: When replacing the single part, perform the work with the engine installed to vehicle body. Refer to "Valve Clearance" for preparation procedures. Ref. to VALVE CLEARANCE.

1. Remove the ignition coil. Ref. to **REMOVAL** , Ignition Coil.
2. Disconnect the PCV hose and remove the rocker cover.
3. Remove the valve rocker assembly.
    1. Use the ST to rotate the spring stopper in the direction of the arrow to remove it from adjuster pin.

    ST 18258AA000 SPRING INSTALLER

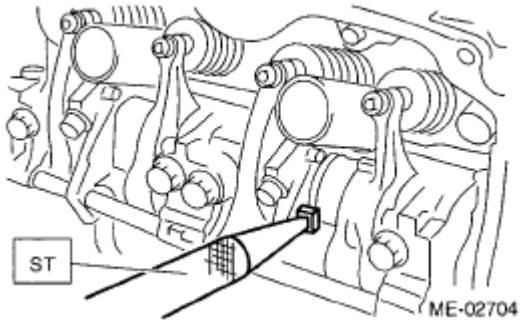
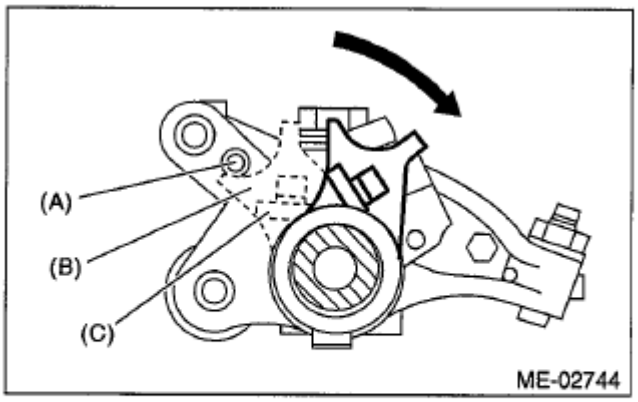


Fig. 126: Identifying Special Tool
Courtesy of SUBARU OF AMERICA, INC.



(A) Adjuster pin
(B) Spring stopper
(C) Spring

Fig. 127: Identifying Adjuster Pin, Spring Stopper And Spring
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the bolts (a) through (j) in alphabetical sequence.

NOTE: Leave two or three threads of bolts (i) and (j) engaged in order to retain the valve rocker assembly.

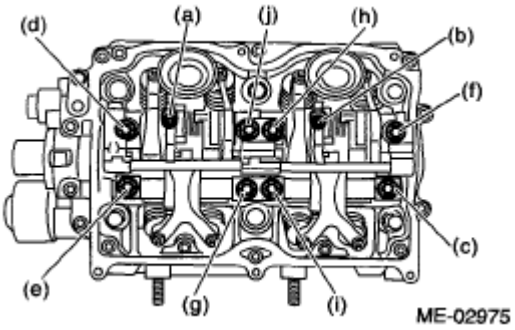


Fig. 128: Identifying Valve Rocker Assembly Bolts Remove Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the valve rocker assembly.

NOTE: Set the ST in the position shown in the drawing to remove the intake valve rocker assembly.

ST 18354AA000 VALVE ROCKER HOLDER

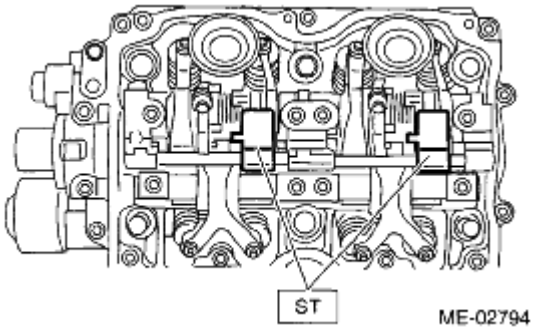


Fig. 129: Identifying Intake Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the valve rocker assembly.
    1. Temporarily tighten the bolts equally in alphabetical order as shown in the figure.

NOTE:

- **Do not temporarily tighten the bolts (i) and (j).**
- **Set the ST in the position shown in the drawing to mount the intake valve rocker assembly.**

ST 18354AA000 VALVE ROCKER HOLDER

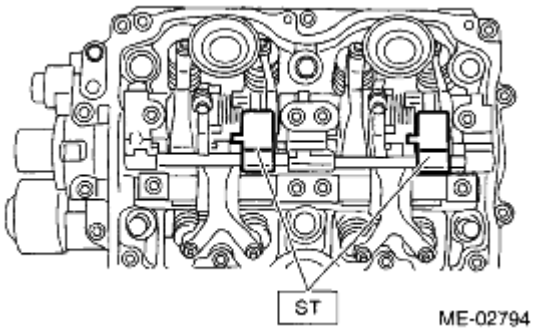


Fig. 130: Identifying Intake Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

3. Tighten the bolts (i) through (j) to specified torque.

Tightening torque:

6 N.m (0.6 kgf-m, 4.4 ft-lb)

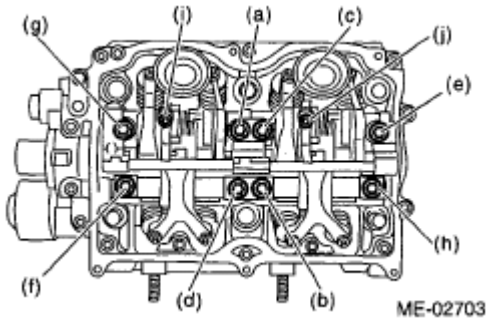


Fig. 131: Identifying Valve Rocker Assembly Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. Use the ST to rotate the spring stopper in the direction of the arrow to fasten the adjuster pin.

   ST 18258AA000 SPRING INSTALLER

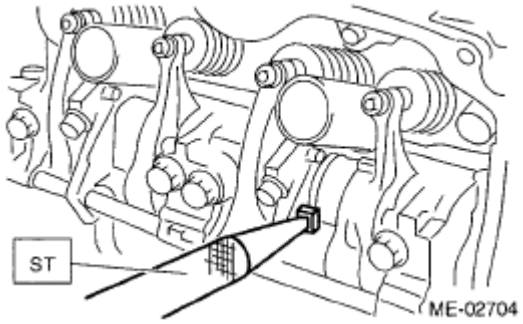
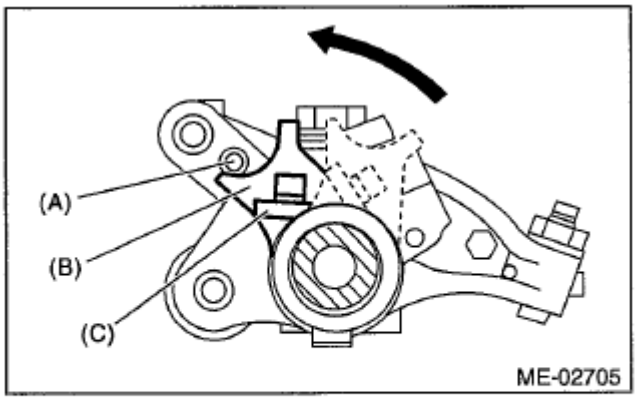


Fig. 132: Identifying Special Tool
Courtesy of SUBARU OF AMERICA, INC.



(A) Adjuster pin
(B) Spring stopper
(C) Spring

Fig. 133: Identifying Adjuster Pin, Spring Stopper And Spring
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the timing belt cover LH.
3. Adjust the valve clearance. Ref. to **ADJUSTMENT**, Valve Clearance.
4. Install the timing belt cover LH.

Tightening torque:

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

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

      NOTE: Use a new rocker cover gasket.

   2. Temporarily tighten the bolts in alphabetical order shown in the figure, tighten them in two stages.

      Tightening torque:

      1st

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

      2nd (only (a) and (b) are tightened)

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

      RH side

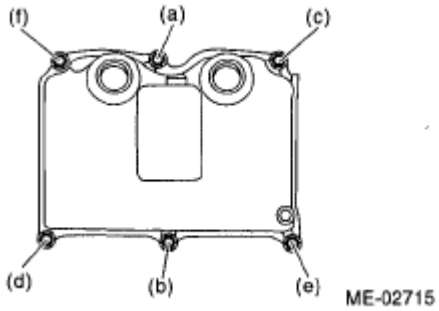


Fig. 134: Identifying Rocker Cover Bolts - RH Side
Courtesy of SUBARU OF AMERICA, INC.

LH side

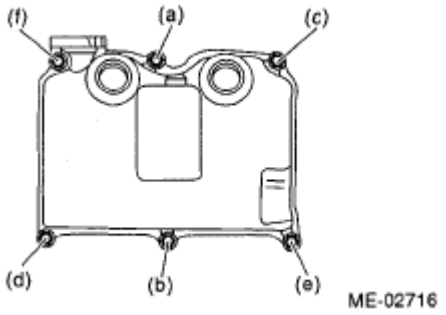


Fig. 135: Identifying Rocker Cover Bolts - LH Side
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the PCV hose.

6. Install the ignition coil. Ref. to **INSTALLATION** , Ignition Coil.

DISASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

1. Remove the exhaust valve rocker arm from the rocker shaft.

NOTE: Keep all the removed parts in order for re-installing in their original positions.

2. Remove the nut and adjusting screw from exhaust valve rocker.

ASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

1. Install the adjusting screw and nut to the exhaust valve rocker.
2. Insert the exhaust valve rocker arm to rocker shaft.

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

INSPECTION

INTAKE VALVE ROCKER ASSEMBLY

1. If the roller or valve contact surface of valve rocker arm is worn or dented excessively, replace the valve rocker assembly.
2. Check that the valve rocker arm roller rotates smoothly. If not, replace the valve rocker assembly.

EXHAUST VALVE ROCKER ASSEMBLY

1. Measure the inner diameter of valve rocker arm and outer diameter of valve rocker shaft, and confirm the difference (oil clearance) between the two values.

   Clearance between arm and shaft:

   Standard

   0.020 - 0.054 mm (0.0008 - 0.0021 in)

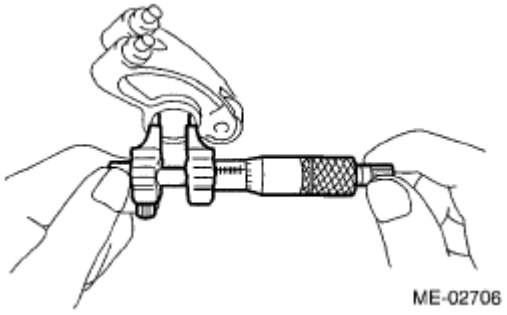


Fig. 136: Measuring Inner Diameter Of Valve Rocker Arm
Courtesy of SUBARU OF AMERICA, INC.

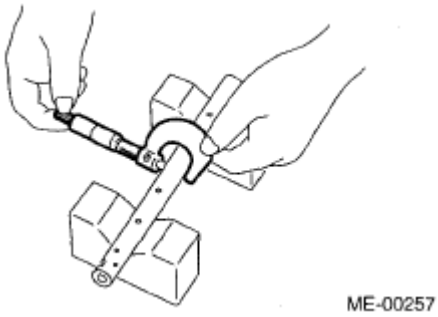


Fig. 137: Measuring Outer Diameter Of Valve Rocker Shaft
Courtesy of SUBARU OF AMERICA, INC.

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

   Rocker arm inside diameter:

   22.020 - 22.041 mm (0.8669 - 0.8678 in)

   Rocker shaft diameter:

   21.987 - 22.000 mm (0.8656 - 0.8661 in)

3. If the roller or valve contact surface of valve rocker arm is worn or dented excessively, replace the valve rocker arm.

4. Check that the valve rocker arm roller rotates smoothly. If not, replace the valve rocker arm.

CAMSHAFT

REMOVAL

NOTE: When replacing the single part, perform the work with the engine installed to vehicle body. Refer to "Valve Clearance" for preparation procedures. Ref. to 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. Remove the timing belt cover No. 2 LH.
7. Remove the timing belt cover No. 2 RH.

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

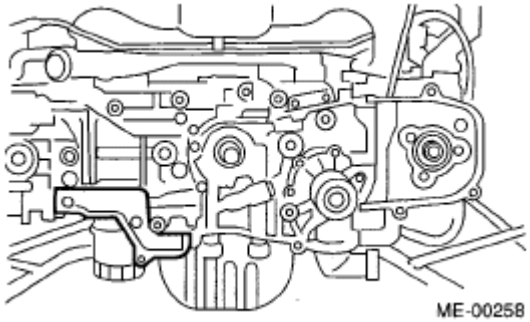


Fig. 138: Identifying Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the tensioner bracket.

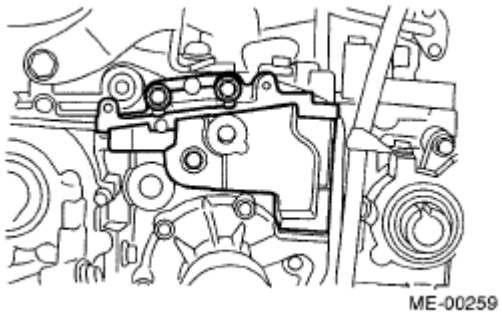


Fig. 139: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the camshaft position sensor support. (LH side only)
10. Remove the valve rocker assembly. Ref. to **REMOVAL**, Valve Rocker Assembly.
11. Remove the camshaft cap.
    1. Remove the bolts (a) and (b) in alphabetical sequence.

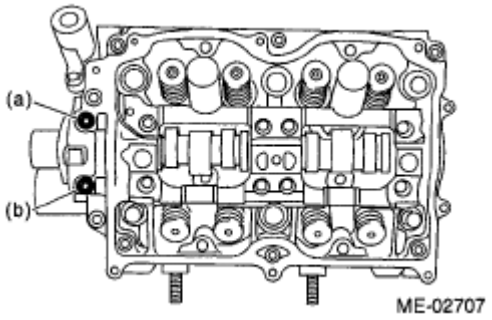


Fig. 140: Identifying Camshaft Bolts Remove Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

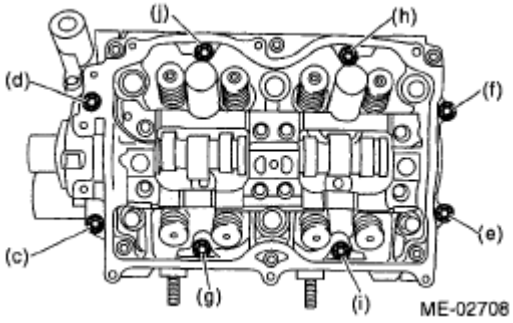


Fig. 141: Identifying Camshaft Bolts Loosen Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX® PLUS

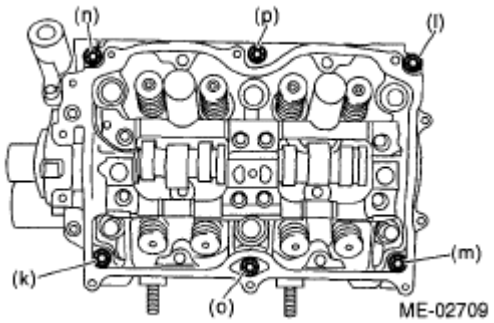


Fig. 142: Identifying Camshaft Bolts Remove Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the camshaft cap.

12. Remove the camshaft.
13. Remove the oil seal.
14. Remove the plug from rear side of camshaft.

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

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

INSTALLATION

1. Apply a thin coat of engine oil to camshaft journals, and install the camshaft.
2. Install the camshaft cap.
    1. Apply liquid gasket to the mating surfaces of camshaft cap.

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

Liquid gasket:

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

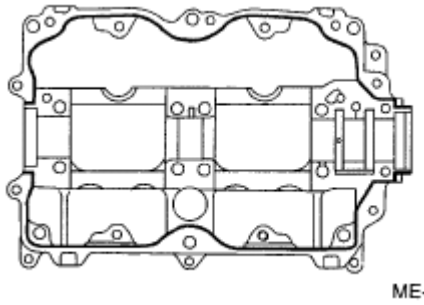


Fig. 143: Applying Liquid Gasket To Mating Surfaces Of Camshaft Cap
Courtesy of SUBARU OF AMERICA, INC.

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

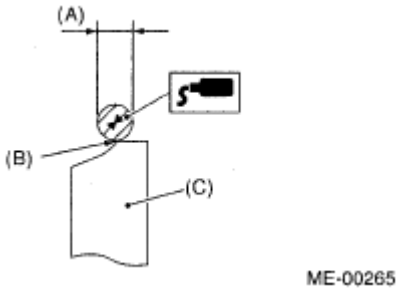


Fig. 144: Identifying Selanig Area Of Camshaft Cap
Courtesy of SUBARU OF AMERICA, INC.

2. Temporarily tighten the bolts (a) through (d) in alphabetical sequence.

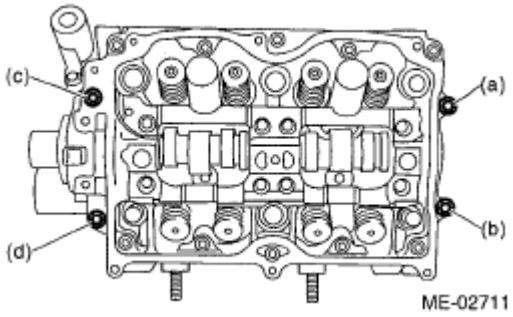


Fig. 145: Identifying Camshaft Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Install the valve rocker assembly. Ref. to **INSTALLATION**, Valve Rocker Assembly.
4. Tighten the TORX® bolts (e) through (j) in alphabetical sequence using the ST.

ST 499497000 TORX® PLUS

Tightening torque:

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

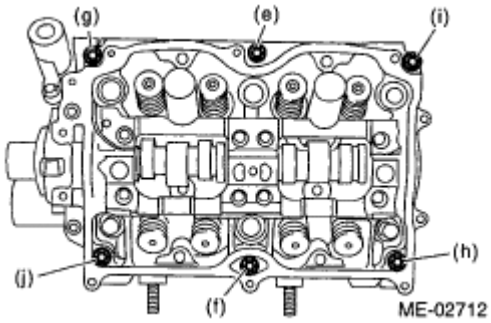


Fig. 146: Identifying TORX® Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

5. Tighten the bolts (k) through (r) in alphabetical sequence.

Tightening torque:

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

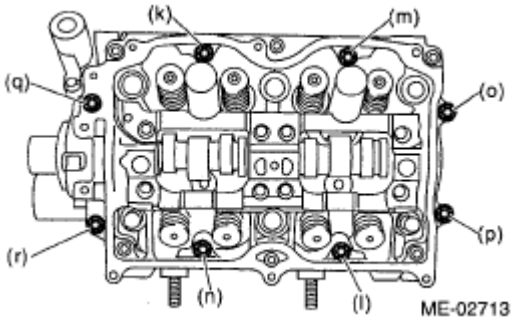


Fig. 147: Identifying TORX® Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Tighten the bolts (s) and (t) in alphabetical sequence.

NOTE:
- **Use a new seal washer.**
- **Install and tighten the seal washer to the bolt.**

Tightening torque:

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

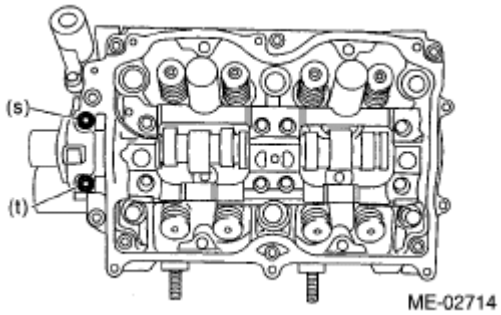


Fig. 148: Identifying Camshaft Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new oil seal.
ST1 499597000 OIL SEAL GUIDE
ST2 499587500 OIL SEAL INSTALLER

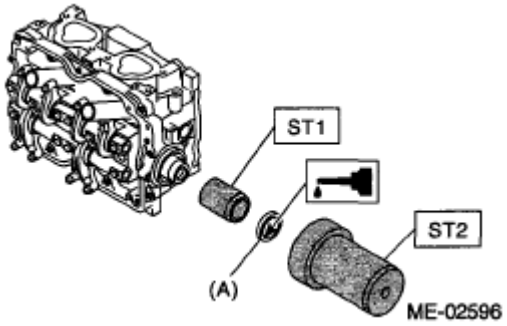


Fig. 149: Identifying Oil Seal Guide And Oil Seal Installer
Courtesy of SUBARU OF AMERICA, INC.

4. Apply a coat of engine oil to plug periphery and install the plug (A) using ST.

ST 499587700 CAMSHAFT OIL SEAL INSTALLER

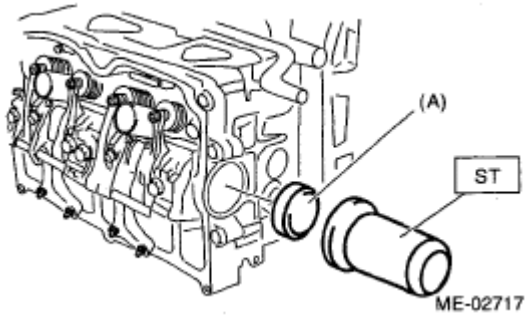


Fig. 150: Identifying Camshaft Oil Seal Installer ST (499587700)

Courtesy of SUBARU OF AMERICA, INC.

5. Install the camshaft position sensor support. (LH side only)

   Tightening torque:

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

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

   Tightening torque:

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

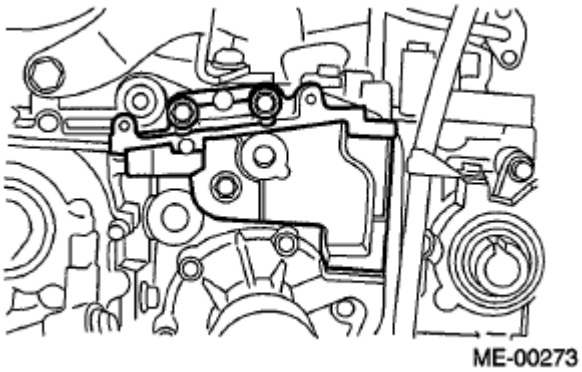


Fig. 151: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

   Tightening torque:

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

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

   Tightening torque:

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

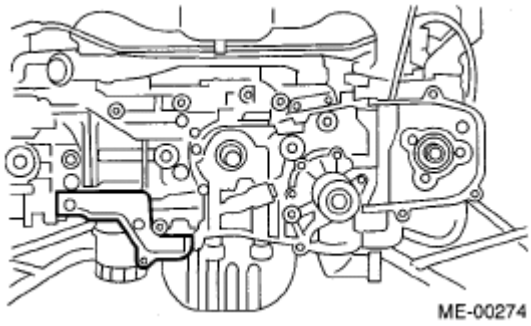


Fig. 152: Identifying Timing Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

10. Install the cam sprocket. Ref. to **INSTALLATION**, Cam Sprocket.
11. Install the timing belt. Ref. to **INSTALLATION**, Timing Belt.
12. Adjust the valve clearance. Ref. to **ADJUSTMENT**, Valve Clearance.
13. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover.

       NOTE: Use a new rocker cover gasket.

    2. Temporarily tighten the bolts in alphabetical order shown in the figure, tighten them in two stages.

       Tightening torque:

       1st

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

       2nd (only (a) and (b) are tightened)

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

       RH side

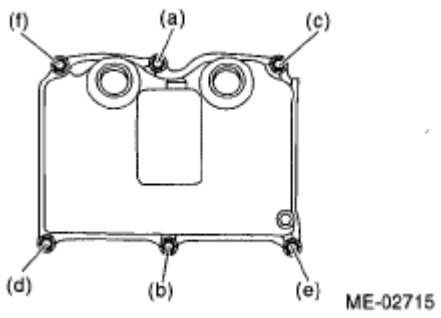


Fig. 153: Identifying Rocker Cover Bolts - RH Side

Courtesy of SUBARU OF AMERICA, INC.

LH side

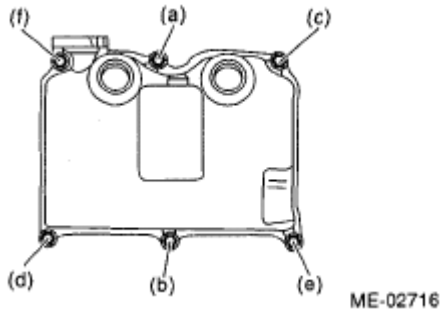


Fig. 154: Identifying Rocker Cover Bolts - LH Side
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the PCV hose.

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

INSPECTION

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

   Camshaft bend limit:

   0.025 mm (0.00098 in)

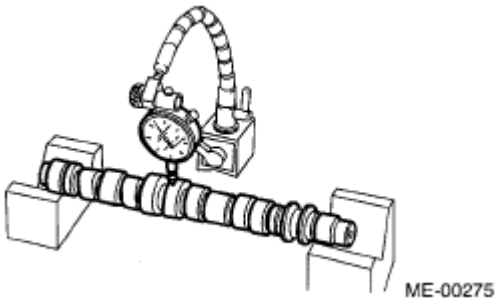


Fig. 155: Measuring Camshaft Bend
Courtesy of SUBARU OF AMERICA, INC.

2. Check the journal for damage and wear. Replace if faulty.
3. Check the cam face condition, and remove the minor faults by grinding with oil stone. Replace if there is uneven wear, etc.

4. Measure the Cam height "H", Cam base circle diameter "A", and base circle step of adjacent intake cams (low speed and high speed). If it exceeds the standard or offset wear occurs, replace it.

Cam lobe height H:

STANDARD SPECIFICATION

			Unit: mm (in)
Intake	Constant	Standard	40.075 - 40.175 (1.5778 - 1.5817)
	Low speed	Standard	35.496 - 35.596 (1.3975 - 1.4014)
	High speed	Standard	40.315 - 40.415 (1.5872 - 1.5911)
Exhaust		Standard	39.289 - 39.389 (1.5468 - 1.5507)

Cam base circle diameter A:

Standard

34.00 mm (1.3386 in)

Base circle step of adjacent intake cams (low speed and high speed):

Standard

0.03 mm (0.001 in) or less

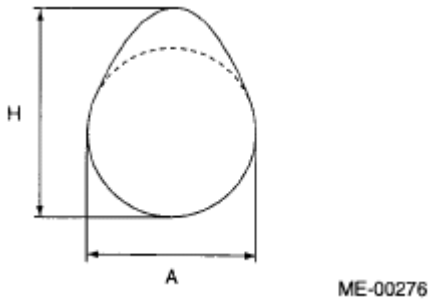


Fig. 156: Measuring Cam Height
Courtesy of SUBARU OF AMERICA, INC.

5. Measure the outer diameter of camshaft journal and inner diameter of cylinder head journal, and confirm the difference (oil clearance) between the two values. If the oil clearance is not within the standard, replace the camshaft or cylinder head as necessary.

STANDARD SPECIFICATION

		Unit: mm (in)
Oil clearance	Standard	0.055 - 0.090 (0.0022 - 0.0035)
Camshaft journal O.D.	Standard	31.928 - 31.945 (1.2570 - 1.2577)
Cylinder head journal inner diameter	Standard	32.000 - 32.018 (1.2598 - 1.2605)

6. Measure the thrust clearance of camshaft with the dial gauge set at end 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

   0.030 - 0.090 mm (0.0012 - 0.0035 in)

CYLINDER HEAD

REMOVAL

NOTE:

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

  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 bolt which holds A/C compressor bracket onto cylinder head.
8. Remove the valve rocker assembly. Ref. to **REMOVAL**, Valve Rocker Assembly.
9. Remove the camshaft. Ref. to **REMOVAL**, Camshaft.
10. Remove the oil level gauge guide. (LH side)
11. Remove the cylinder head bolts in alphabetical sequence as shown in the figure.

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

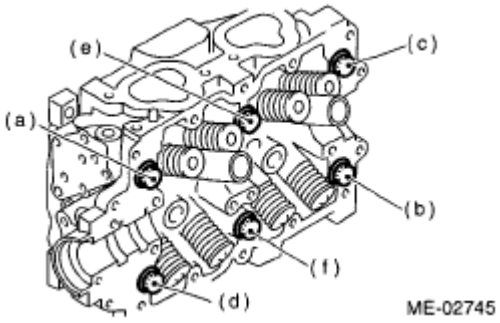


Fig. 157: Identifying Cylinder Head Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

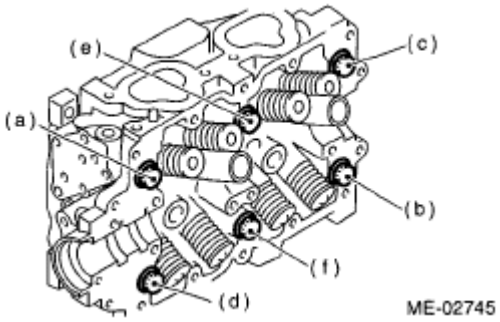


Fig. 158: Identifying Cylinder Head Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the cylinder head gasket.

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

14. Similarly, remove the right side cylinder head.

INSTALLATION

1. Install the cylinder head and gasket 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.

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. Tighten all bolts further 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 42 N.m (4.3 kgf-m, 31.0 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.

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

8. Further tighten the bolts (a) and (b) by 40 - 45°.

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

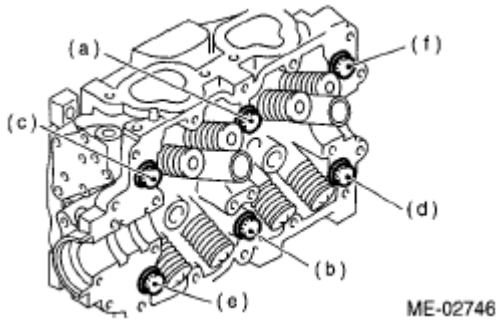


Fig. 159: Identifying Cylinder Head Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

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 valve rocker assembly. Ref. to **INSTALLATION**, Valve Rocker Assembly.
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 cam sprocket. Ref. to **INSTALLATION**, Cam Sprocket.

8. Install the timing belt. Ref. to **INSTALLATION**, Timing Belt.
9. Adjust the valve clearance. Ref. to **ADJUSTMENT**, Valve Clearance.
10. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover.

       NOTE: Use a new rocker cover gasket.

    2. Temporarily tighten the bolts in alphabetical order shown in the figure, tighten them in two stages.

       Tightening torque:

       1st

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

       2nd (only (a) and (b) are tightened)

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

       RH side

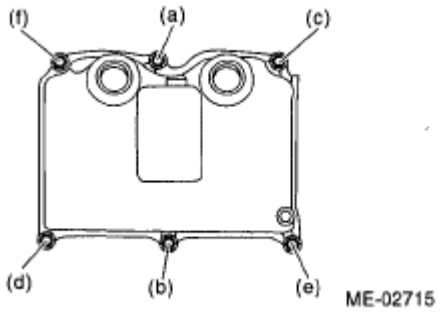


Fig. 160: Identifying Rocker Cover Bolts - RH Side
Courtesy of SUBARU OF AMERICA, INC.

       LH side

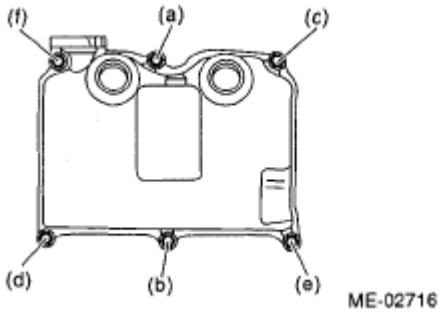


Fig. 161: Identifying Rocker Cover Bolts - LH Side

Courtesy of SUBARU OF AMERICA, INC.

11. Install the timing belt cover. Ref. to **INSTALLATION**, Timing Belt Cover.
12. Install the crank pulley. Ref. to **INSTALLATION**, Crank Pulley.
13. Install the intake manifold. Ref. to **INSTALLATION** , Intake Manifold.
14. Install the V-belts. Ref. to **INSTALLATION**, V-belt.

DISASSEMBLY

1. Place the cylinder head on the ST.

   ST 498267800 CYLINDER HEAD TABLE

2. Compress the valve spring and remove the valve spring retainer key using ST. Remove each valve and valve spring.

   ST 499718000 VALVE SPRING REMOVER

NOTE:

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

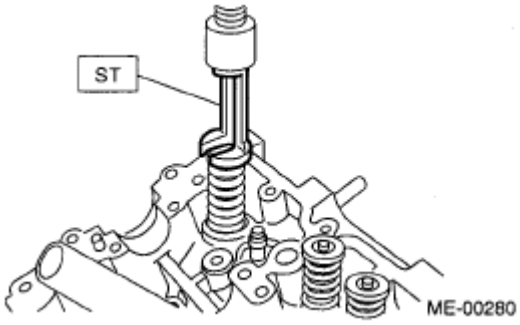
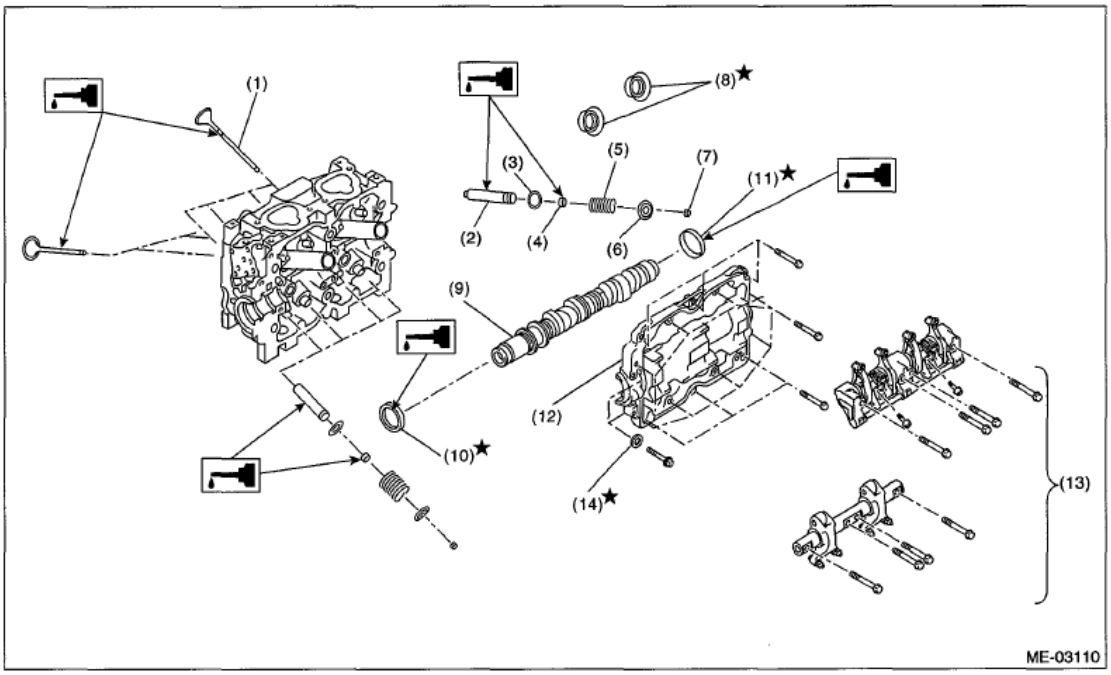


Fig. 162: Installing Valve Spring And Retainer Using Valve Spring Remover ST (499718000)
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



(1)	Valve	(6)	Retainer	(11)	PLUG
(2)	Valve guide	(7)	Retainer key	(12)	Camshaft cap
(3)	Valve spring seat	(8)	Spark plug gasket	(13)	Valve rocker ASSY
(4)	Oil seal	(9)	Camshaft	(14)	Seal washer
(5)	Valve spring	(10)	Oil seal		

Fig. 163: Identifying Camshaft, Valve, Plug, Seal Washer And Retainer
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 ST.

        ST 498267800 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.

    4. Set the ST to the valve spring.

        ST 499718000 VALVE SPRING REMOVER

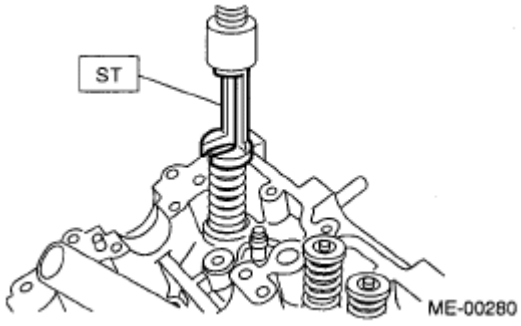
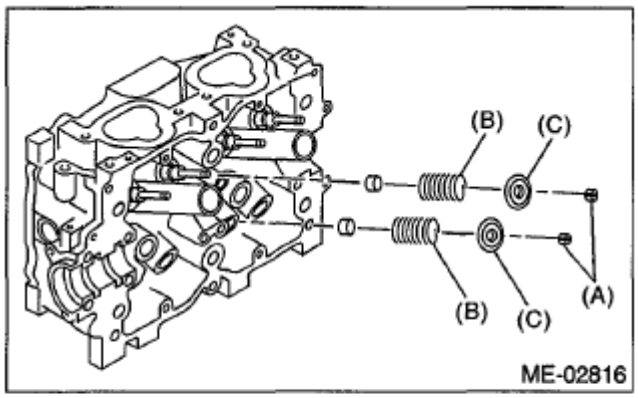


Fig. 164: Installing Valve Spring And Retainer Using Valve Spring Remover ST (499718000)
Courtesy of SUBARU OF AMERICA, INC.

5. Compress the valve spring and fit the valve spring retainer key.



(A) Retainer key
(B) Valve spring
(C) Retainer

Fig. 165: Compressing Valve Spring And Valve Spring Retainer Key
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

CYLINDER HEAD

1. Check for cracks or damage. Use liquid penetrant tester on the important sections to check for fissures.

   Check that there are no marks of gas leaking or water leaking on gasket installing surface.

2. Place the cylinder head on the ST.

   ST 498267800 CYLINDER HEAD TABLE

3. 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:

   0.1 mm (0.004 in)

   Standard height of cylinder head:

   97.5 mm (3.84 in)

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

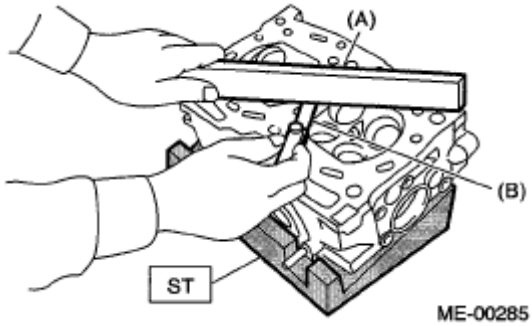


Fig. 166: Measuring Warping Of Cylinder Head Surface Using Straight Edge
Courtesy of SUBARU OF AMERICA, INC.

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 of valve and valve seat W:

Standard

Intake (A)

0.8 - 1.4 mm (0.03 - 0.055 in)

Exhaust (B)

1.2 - 1.8 mm (0.047 - 0.071 in)

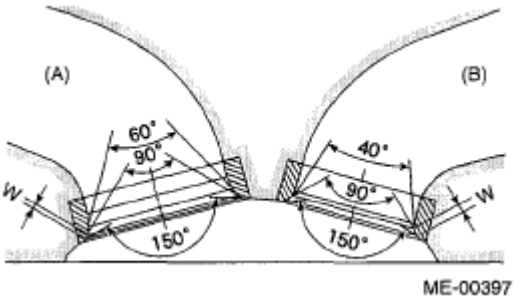


Fig. 167: Identifying Seat Guide Dimension
Courtesy of SUBARU OF AMERICA, INC.

Fig. 168: 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:

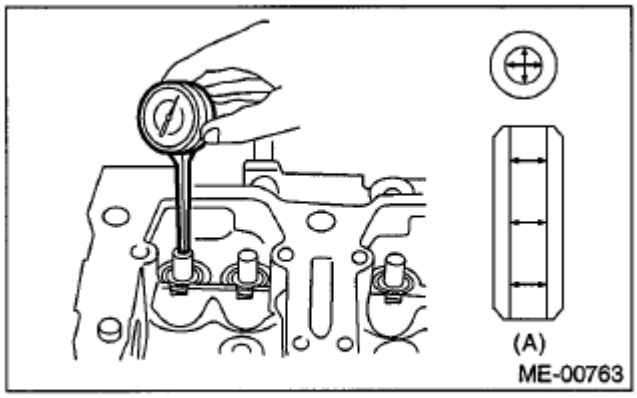
   Standard

   Intake

   0.035 - 0.062 mm (0.0014 - 0.0024 in)

   Exhaust

   0.040 - 0.067 mm (0.0016 - 0.0026 in)



(A) Valve guide

Fig. 169: Measuring Clearance Between Valve Guide And Valve Stem
Courtesy of SUBARU OF AMERICA, INC.

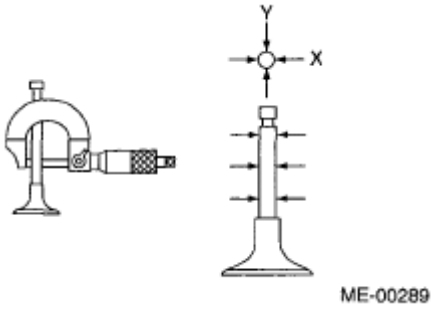


Fig. 170: Measuring Outer Diameter Of Valve Stem With Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

   Valve guide inner diameter:

   6.000 - 6.012 mm (0.2362 - 0.2367 in)

   Valve stem outer diameters:

   Intake

   5.950 - 5.965 mm (0.2343 - 0.2348 in)

   Exhaust

   5.945 - 5.960 mm (0.2341 - 0.2346 in)

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

   ST1 498267800 CYLINDER HEAD TABLE

   ST2 499767200 VALVE GUIDE REMOVER

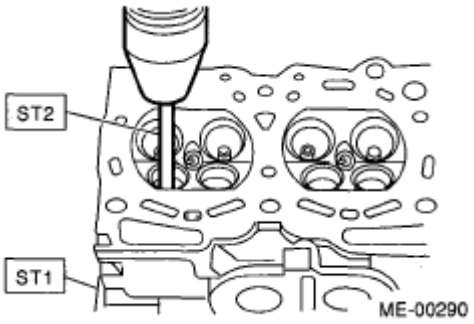


Fig. 171: Inserting ST2 Into Valve Guide Using Valve Guide Remover ST2 (499767200)
Courtesy of SUBARU OF AMERICA, INC.

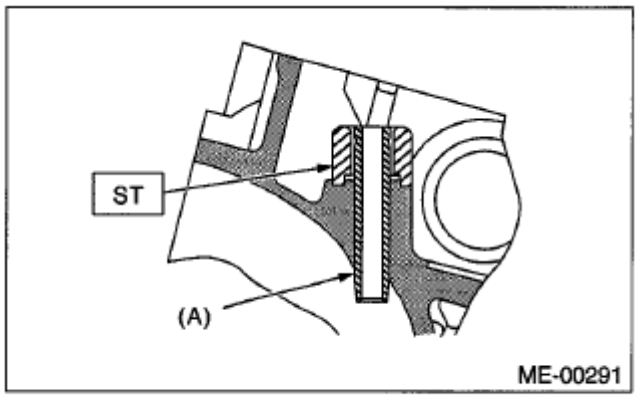
3. Turn the cylinder head upside down and place the ST as shown in the figure.

   Intake side

   ST 499767700 VALVE GUIDE ADJUSTER

   Exhaust side

   ST 499767800 VALVE GUIDE ADJUSTER



(A) Valve guide

Fig. 172: Identifying Valve Guide Adjuster (Intake Side And Exhaust Side)
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. Coat a new valve guide with sufficient oil, put it into the cylinder head, and insert the ST1 into the valve guide. Press in until the valve guide upper end is flush with the upper surface of ST2.

   ST1 499767200 VALVE GUIDE REMOVER

   Intake side

   ST2 499767700 VALVE GUIDE ADJUSTER

   Exhaust side

   ST2 499767800 VALVE GUIDE ADJUSTER

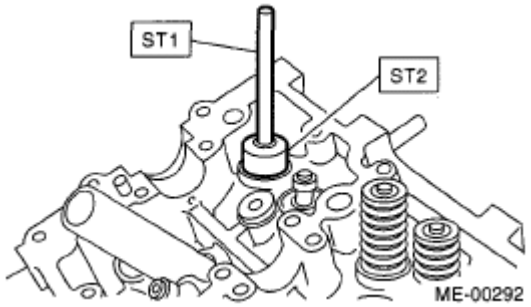


Fig. 173: Inserting ST1 Into Valve Guide Using Valve Guide Remover ST1 (499767200)
Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion amount

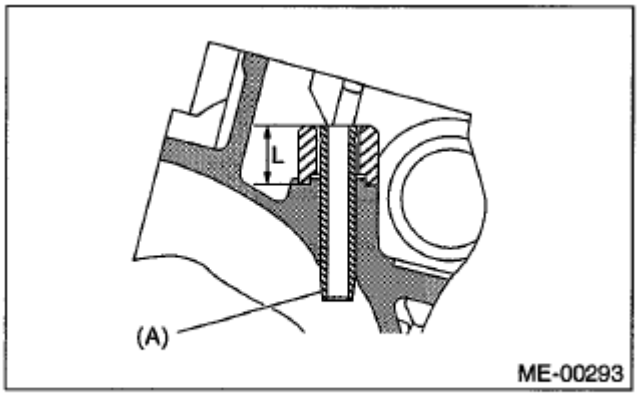
   Valve guide protrusion amount L:

   Intake

   20.0 - 21.0 mm (0.787 - 0.827 in)

   Exhaust

   16.5 - 17.5 mm (0.650 - 0.689 in)



(A) Valve guide

Fig. 174: Checking Valve Guide Protrusion Amount
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

ST 499767400 VALVE GUIDE REAMER

Fig. 175: Reaming Inside Of Valve Guide Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

INTAKE AND EXHAUST VALVE

1. Inspect the flange and valve stem of valve, 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:

Intake (A)

Standard

0.8 - 1.2 mm (0.03 - 0.047 in)

Exhaust (B)

Standard

1.0 - 1.4 mm (0.039 - 0.055 in)

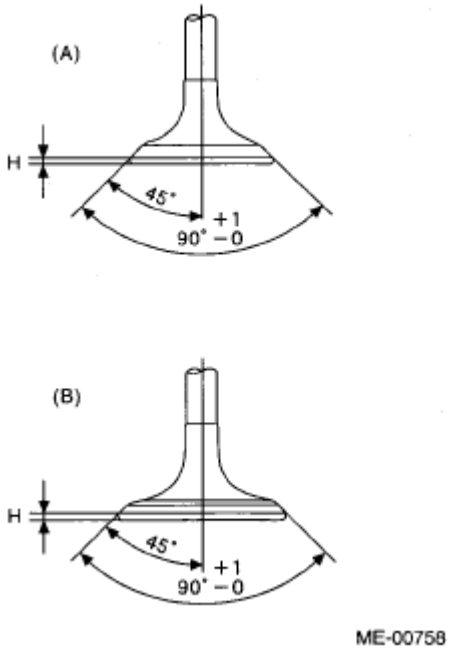


Fig. 176: Identifying Valve Overall Length And Head Edge Thickness
Courtesy of SUBARU OF AMERICA, INC.

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

120.6 mm (4.75 in)

Exhaust

121.7 mm (4.79 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 valve spring using a right angle gauge.

VALVE SPRING SPECIFICATION

Free length	mm (in)	55.2 (2.173)
Tension/spring height N (kgf, lb)/mm (in)	Set	235.3 - 270.7 (24 - 27.6,52.9 - 60.8)/45.0 (1.772)
	Lift	578.9 - 639.9 (59.1 - 65.3, 130.3 - 143.9)/34.7 (1.366)
Squareness		2.5°, 2.4 mm (0.094 in) or less

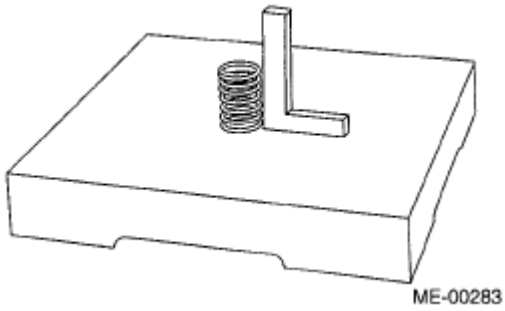


Fig. 177: Measuring Squareness Of Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

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 498267800 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

NOTE:

- **Apply engine oil to oil seal before press-fitting.**
- **When press-fitting the oil seal, do not use a hammer or strike in.**
- **The intake valve oil seals and exhaust valve oil seals are distinguished by their colors.**

Color of rubber part:

Intake [Gray]

Exhaust [Green]

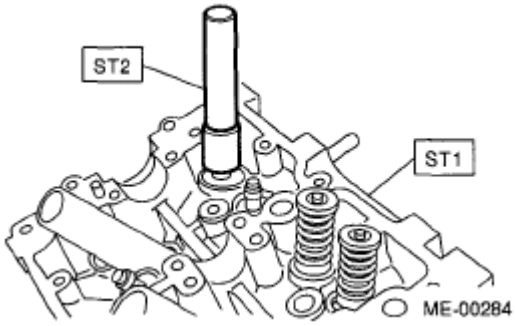


Fig. 178: Pressing Oil Seal Using ST2
Courtesy of SUBARU OF AMERICA, INC.

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 crank sprocket. Ref. to **REMOVAL**, Crank Sprocket.
7. Remove the generator and A/C compressor with their brackets.
8. Remove the cylinder head. Ref. to **REMOVAL**, Cylinder Head.
9. Remove the drive plate. (CVT model) Ref. to **REMOVAL** , Drive Plate.
10. Remove the clutch disc and cover. (MT model) Ref. to **REMOVAL** , Clutch Disc and Cover.
11. Remove the oil separator cover.

12. Remove the water by-pass pipe for heater.
13. Remove the water pump. Ref. to **REMOVAL** , Water Pump.
14. Remove the bolt which secures the oil pump to the cylinder block.

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

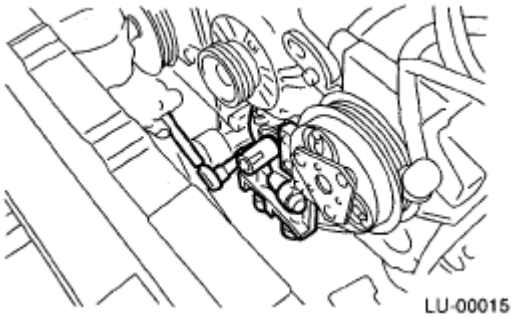


Fig. 179: Removing Oil Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

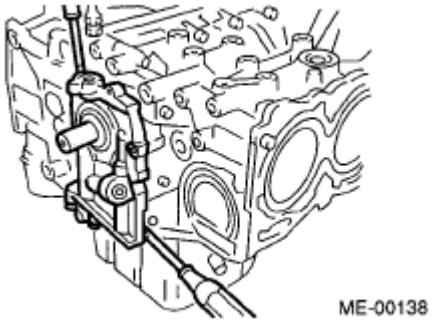


Fig. 180: Removing Oil Pump From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

16. Remove the front oil seal from the oil pump.
17. Remove the oil pan and cylinder block lower.
    1. Set the part so that the cylinder block LH is on the upper side.
    2. Remove the bolts which secure the oil pan to the cylinder block lower.
    3. Insert an oil pan cutter blade into the gap between cylinder block lower and oil pan, and remove the oil pan.

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

4. Remove the bolts which secure the cylinder block lower to the cylinder block, and remove the cylinder block lower by using flat tip screwdriver.

CAUTION: Insert the flat tip screwdriver to the position shown in the figure, and be careful not to damage the mating surface of the cylinder block and cylinder block lower.

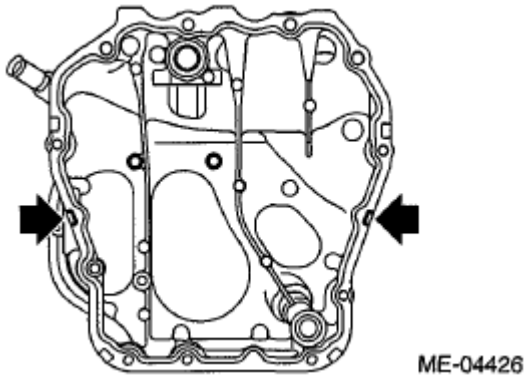


Fig. 181: Locating Cylinder Block Lower
Courtesy of SUBARU OF AMERICA, INC.

18. Remove the oil strainer.
19. Remove the baffle plate.
20. Remove the oil filter. Ref. to **REMOVAL** , Engine Oil Filter.
21. Remove the water pipe assembly.

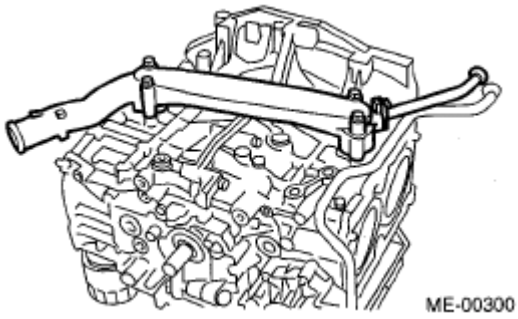
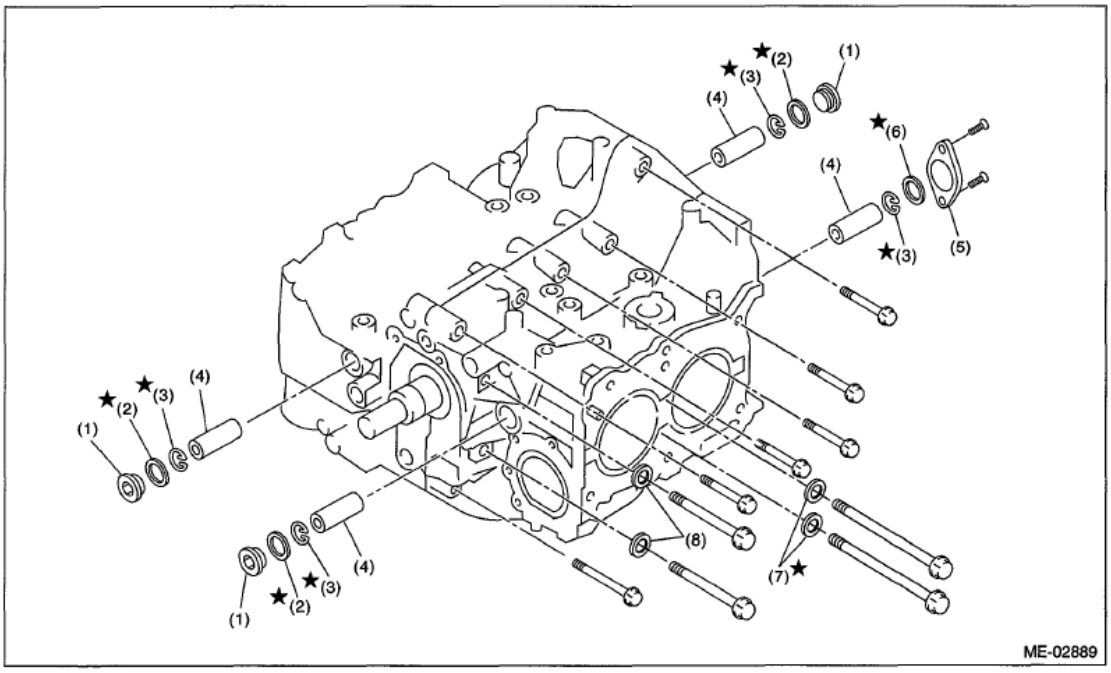


Fig. 182: Identifying Water Pipe Assembly
Courtesy of SUBARU OF AMERICA, INC.



(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. 183: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

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

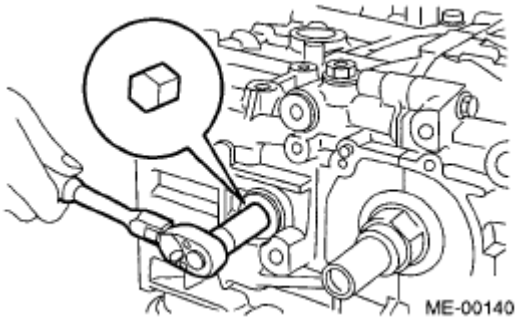


Fig. 184: Identifying Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

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

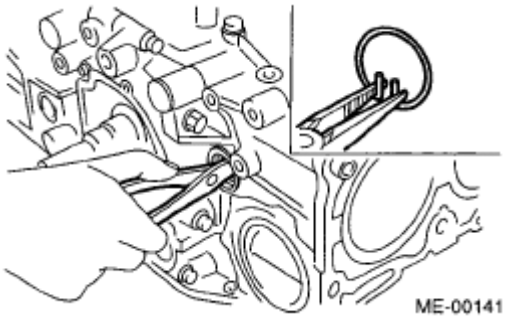


Fig. 185: Removing Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

    ST 499097700 PISTON PIN REMOVER

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

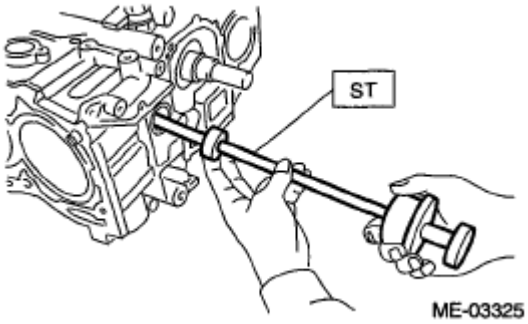
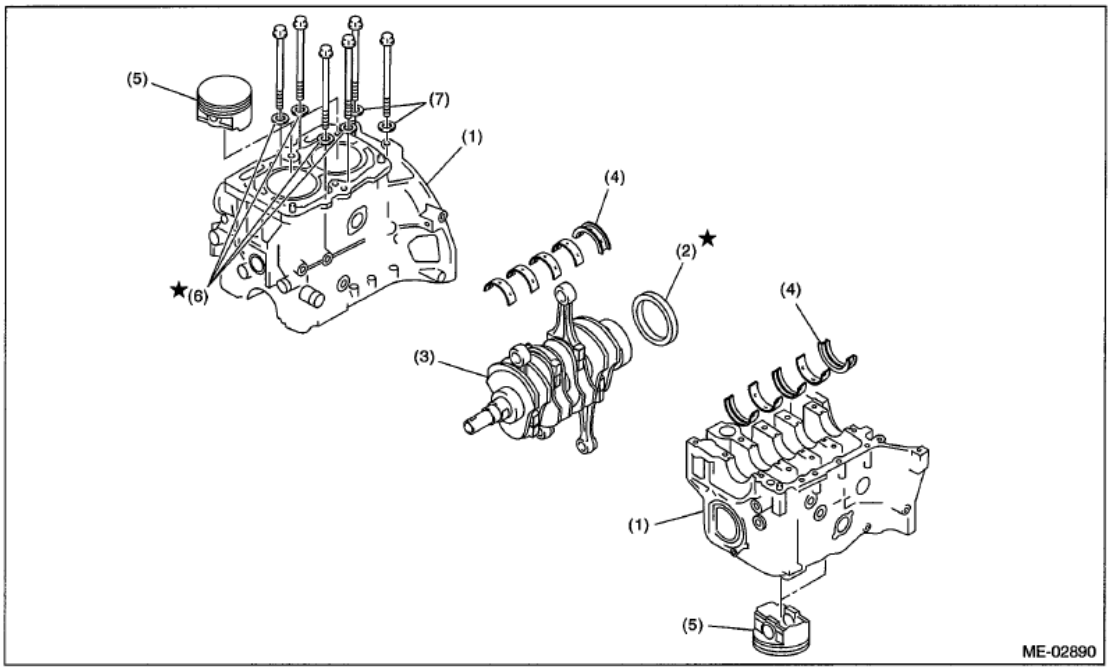


Fig. 186: Removing Piston Pin Using Piston Pin Remover
Courtesy of SUBARU OF AMERICA, INC.

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



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

Fig. 187: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

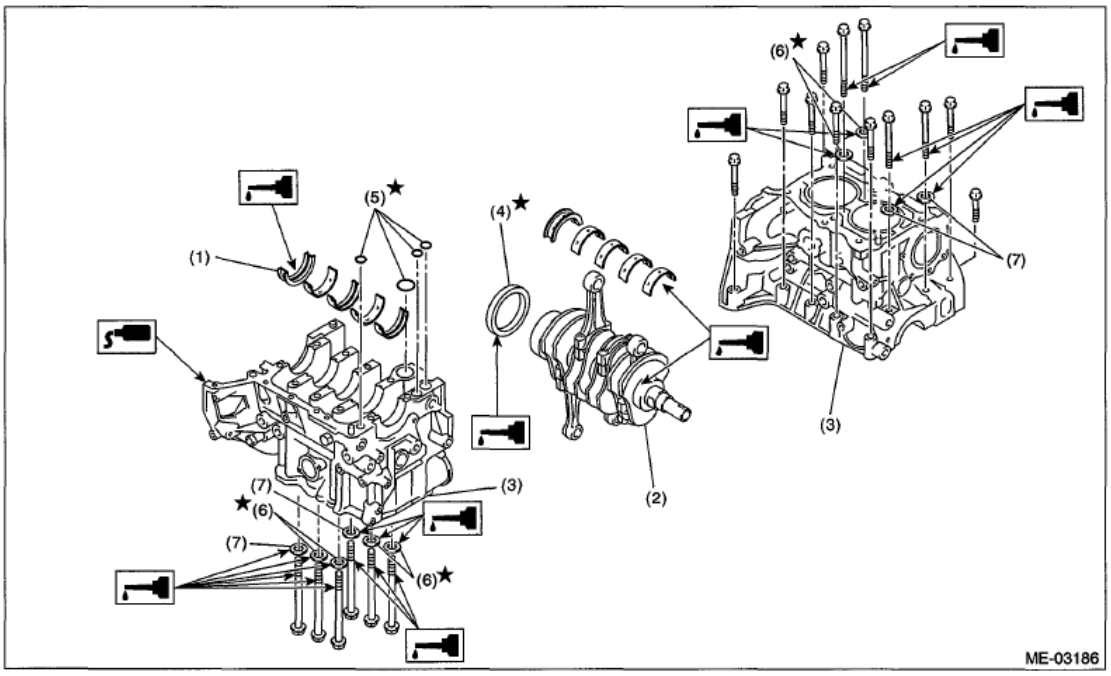
31. Remove the rear oil seal.
32. Remove the crankshaft along with the connecting rod.
33. Remove the crankshaft bearings from cylinder block using a hammer handle.

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

34. 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



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

Fig. 188: Identifying Camshaft Bearing, Camshaft, Cylinder Block And O-Ring
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

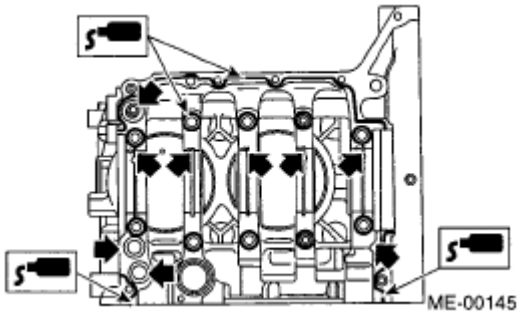


Fig. 189: Applying Liquid Gasket To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use 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)

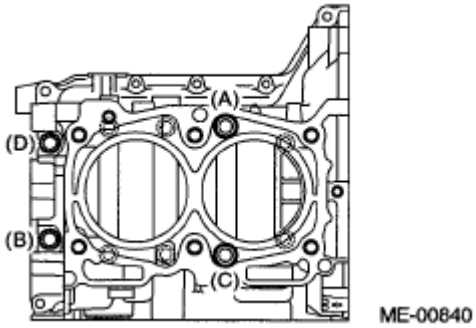


Fig. 190: Identifying Cylinder Block Connecting Bolts On LH Side (A - D)
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

10 N.m (1.0 kgf-m, 7.4 ft-lb)

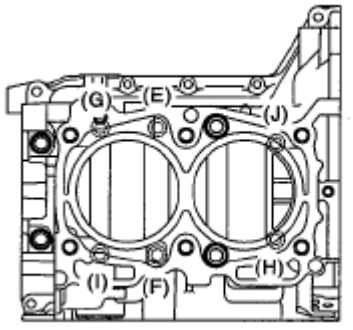


Fig. 191: Identifying Cylinder Block Connecting Bolts On RH Side (E - J)
Courtesy of SUBARU OF AMERICA, INC.

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)

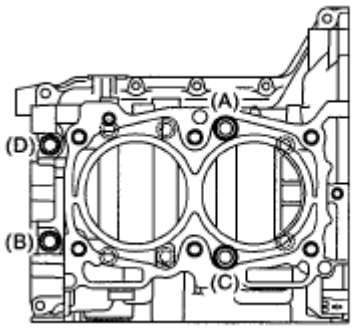


Fig. 192: Identifying Cylinder Block Connecting Bolts On LH Side (A - D)
Courtesy of SUBARU OF AMERICA, INC.

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)

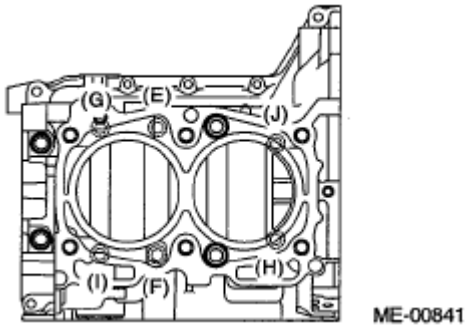


Fig. 193: Identifying Cylinder Block Connecting Bolts On RH Side (E - J)
Courtesy of SUBARU OF AMERICA, INC.

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)

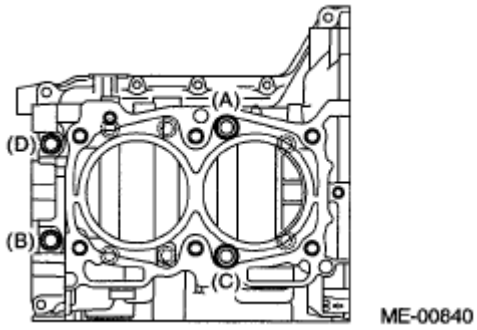


Fig. 194: Identifying Cylinder Block Connecting Bolts On LH Side (A - D)
Courtesy of SUBARU OF AMERICA, INC.

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

    Tightening angle:

    90°

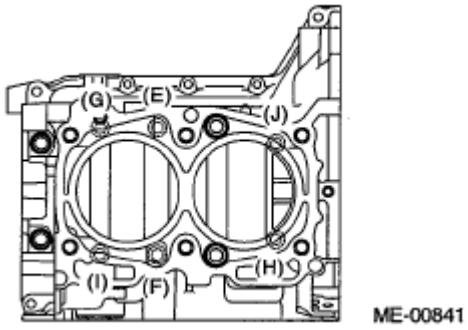


Fig. 195: Identifying Cylinder Block Connecting Bolts On RH Side (E - J)
Courtesy of SUBARU OF AMERICA, INC.

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)

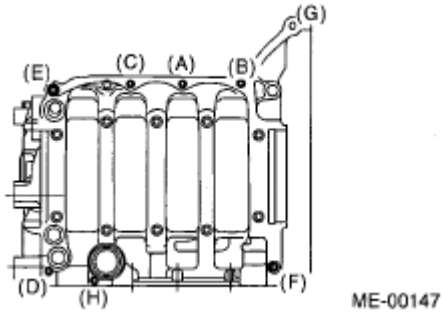


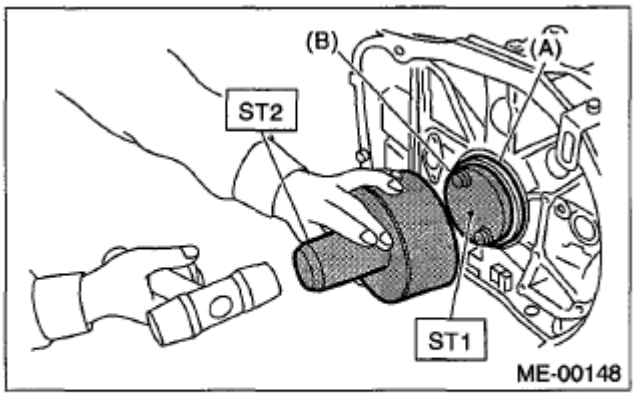
Fig. 196: Identifying Cylinder Block Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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 attaching bolt

Fig. 197: Installing Rear Oil Seal Using ST
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.

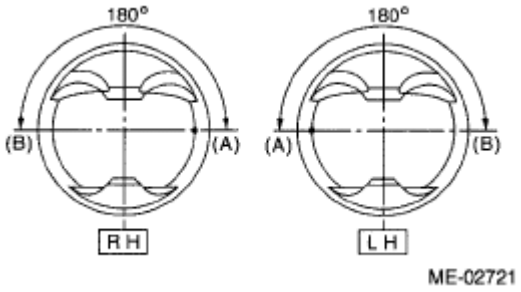


Fig. 198: Identifying Ring Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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

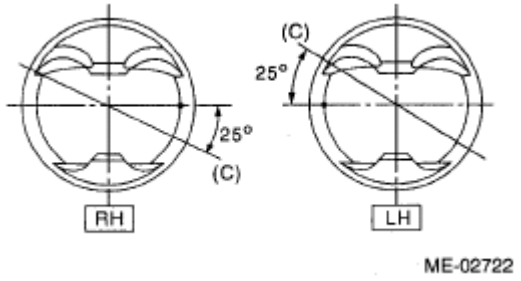


Fig. 199: Positioning Upper Rail Gap At (C)
Courtesy of SUBARU OF AMERICA, INC.

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

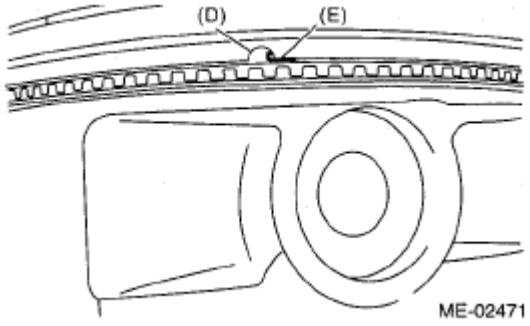


Fig. 200: Aligning Upper Rail Spin Stopper With Piston Side Surface Hole
Courtesy of SUBARU OF AMERICA, INC.

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

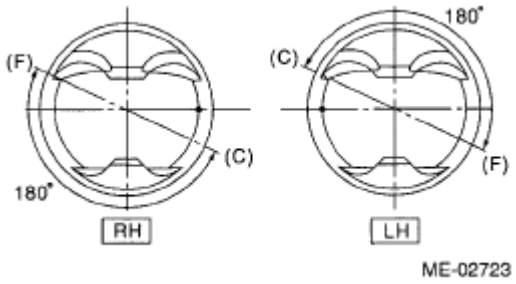


Fig. 201: Identifying Upper Rail Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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

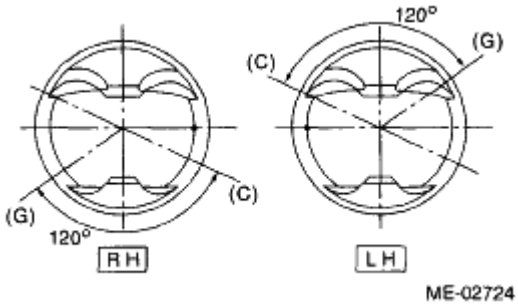


Fig. 202: Identifying Lower Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

NOTE:

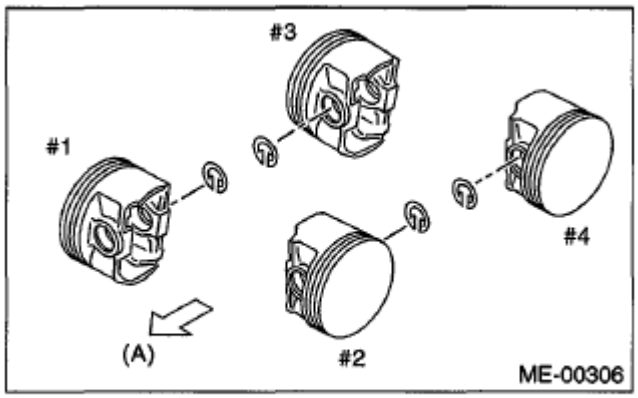
- **Make sure ring gaps do not face the same direction.**
- **Make sure ring gaps are not within the piston skirt area.**

19. Install the snap ring.

Before positioning the piston on the cylinder block, attach the snap ring in the service hole of the cylinder

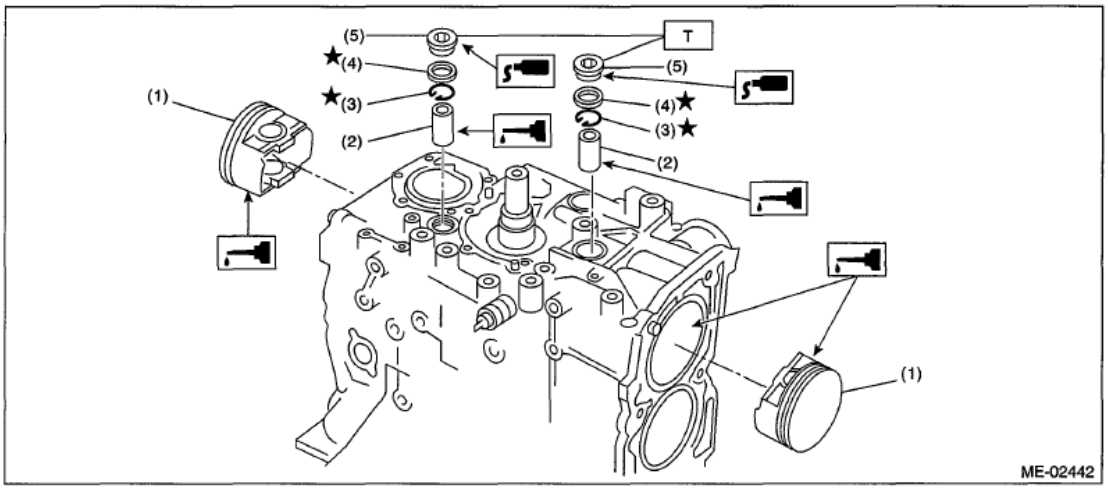
block, and the piston pin hole on the opposite side.

NOTE: Use new snap rings.



(A) Front side

Fig. 203: Identifying Snap Ring
Courtesy of SUBARU OF AMERICA, INC.



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

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

Fig. 204: Identifying Piston, Piston Pin, Snap Ring And Service Hole Plug With Torque Specification
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

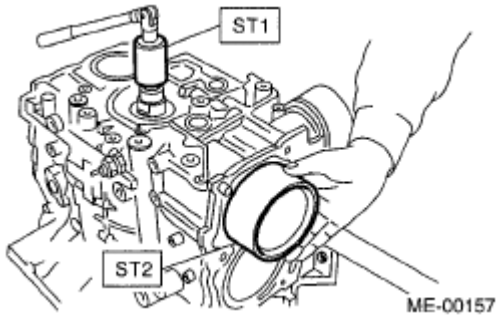
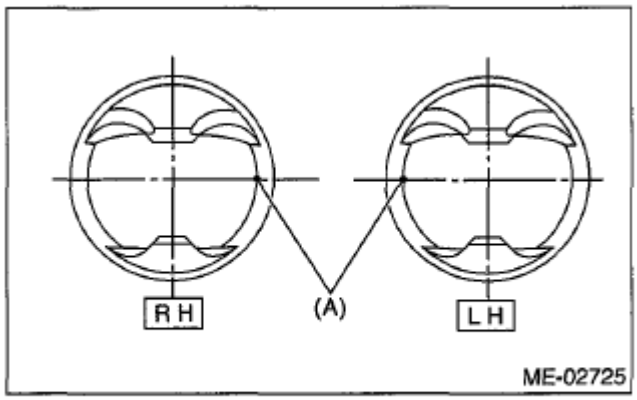


Fig. 205: Inserting Pistons In Cylinders Using Piston Guide ST2 498747300
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front mark

Fig. 206: Identifying Piston Front Mark Of Engine
Courtesy of SUBARU OF AMERICA, INC.

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

       ST3 499017100 PISTON PIN GUIDE

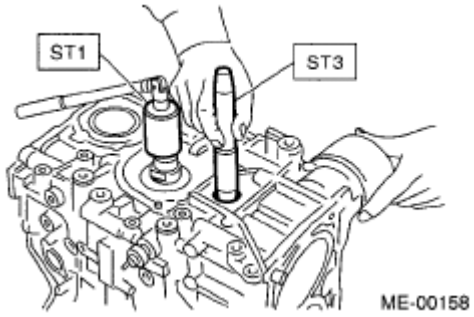


Fig. 207: Installing Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.

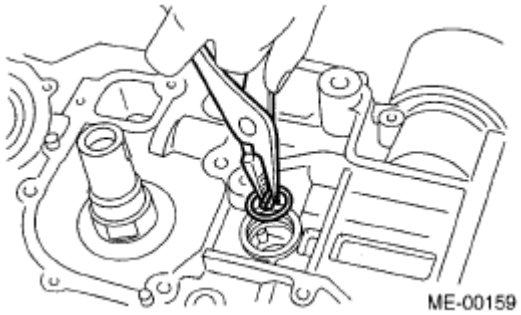


Fig. 208: Identifying Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

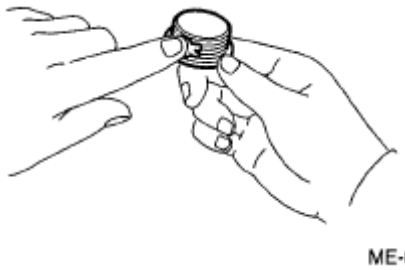


Fig. 209: Applying Fluid Packing Around Service Hole Plug

Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

NOTE: Use a new gasket.

Tightening torque:

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

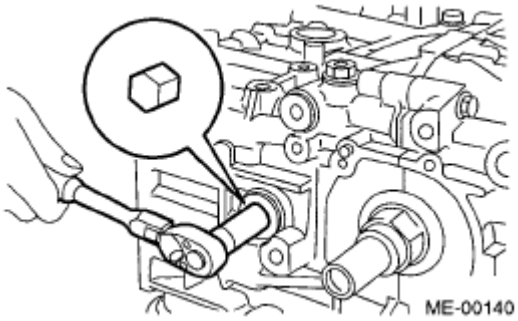
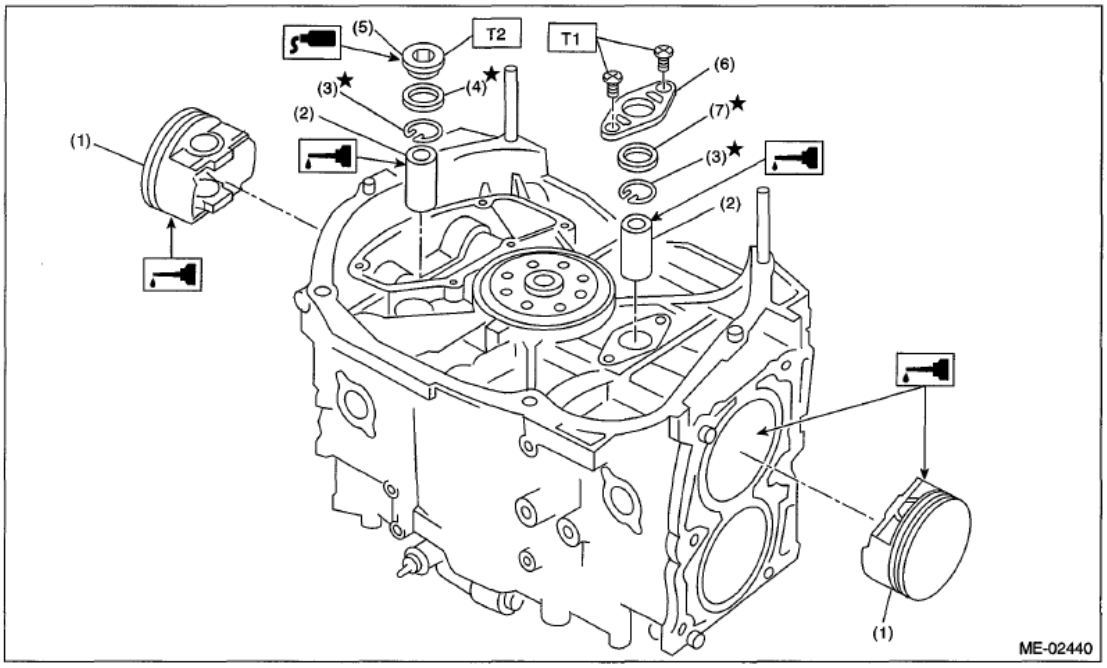


Fig. 210: Identifying Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.



(1)	Piston	(5)	Service hole plug	*Tightening torque:N·m (kgf-m, ft-lb)*
(2)	Piston pin	(6)	Service hole cover	*T1: 6.4 (0.7, 4.7)*
(3)	Snap ring	(7)	O-ring	*T2: 70 (7.1, 51.6)*
(4)	Gasket			

Fig. 211: Identifying Piston, Piston Pin, Snap Ring And Service Hole Plug With Torque

Specification
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7,4.7)

T2: 70 (7.1,51.6)

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)

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)

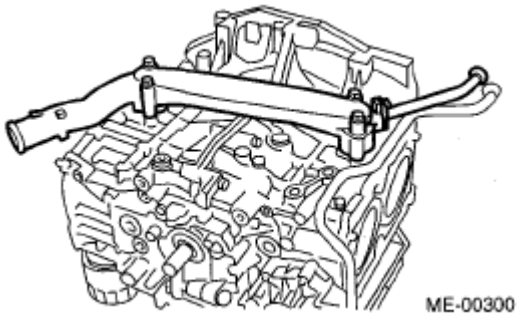


Fig. 212: Identifying Water Pipe Assembly
Courtesy of SUBARU OF AMERICA, INC.

23. Install the baffle plate.

NOTE:
- **Use a new seal.**
- **Make sure that the seals (A) are installed securely on the baffle plate in a direction as shown in the figure below.**

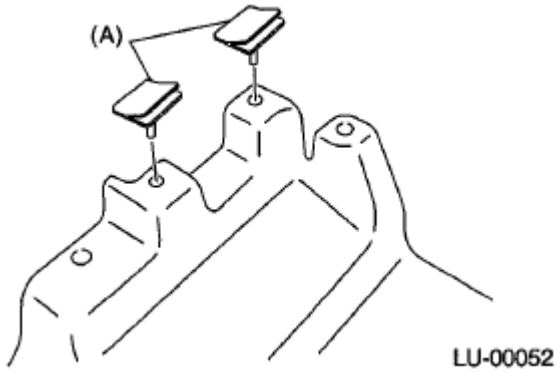


Fig. 213: Identifying Seals On Baffle Plate
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

24. Apply liquid gasket to the mating surfaces of cylinder block lower, and install the cylinder block lower.

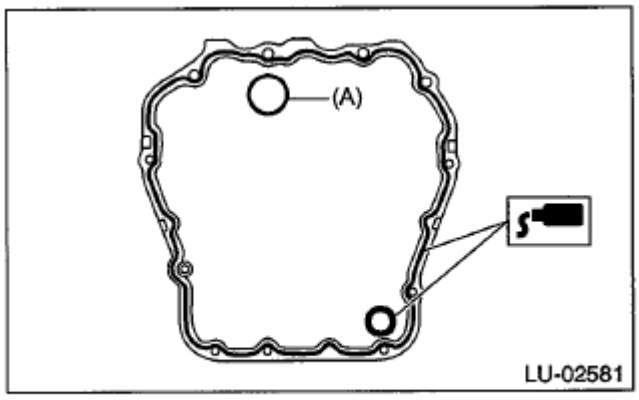
CAUTION: Be careful not to apply any liquid gasket to the O-ring attachment section.

NOTE:

- **Use new O-rings.**
- **Before installing the cylinder block lower, clean the mating surface of cylinder block lower and cylinder block.**
- **Install within 5 min. after applying liquid gasket.**

Liquid gasket:

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



(A) O-ring

Fig. 214: Identifying Cylinder Block Selant Area
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

T1: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

T2: 16 N.m (1.6 kgf-m, 11.8 ft-lb)

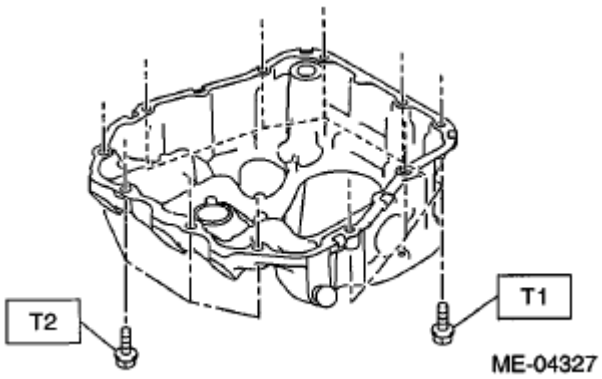


Fig. 215: Identifying Cylinder Block Bolts With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- **Before installing the oil pan, clean the mating surface of oil pan and cylinder block.**
- **Install within 5 min. after applying liquid gasket.**

Liquid gasket:

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

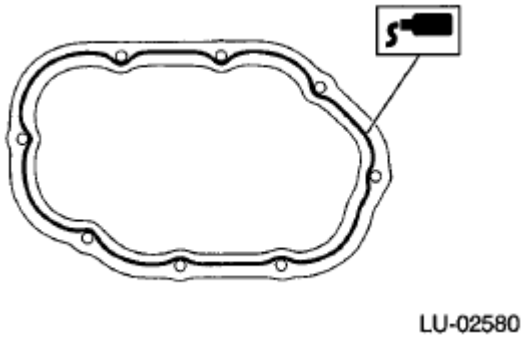


Fig. 216: Identifying Oil Pan Selant Area
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

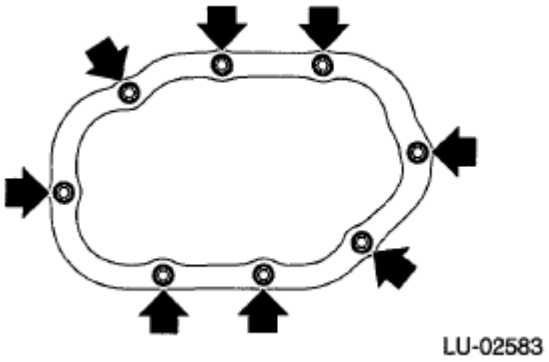


Fig. 217: Locating Oil Separator Cover Bolts
Courtesy of SUBARU OF AMERICA, INC.

26. Apply liquid gasket to the mating surfaces of the 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

- ***(A) bolt threads (when reusing bolts)***

  THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

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

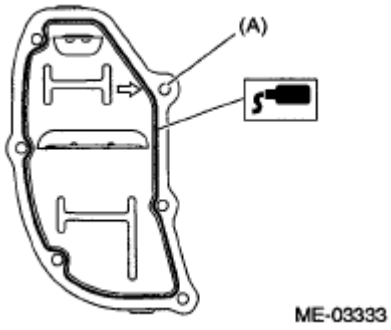


Fig. 218: Identifying Oil Separator Cover Selant Area
Courtesy of SUBARU OF AMERICA, INC.

27. Install the drive plate. Ref. to **INSTALLATION** , Drive Plate.
28. 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.

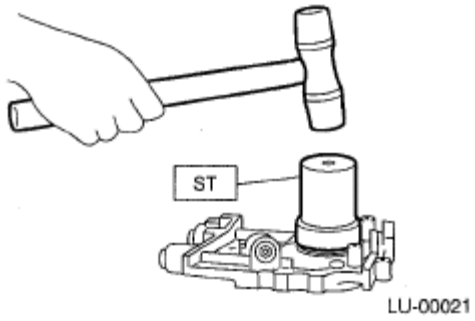


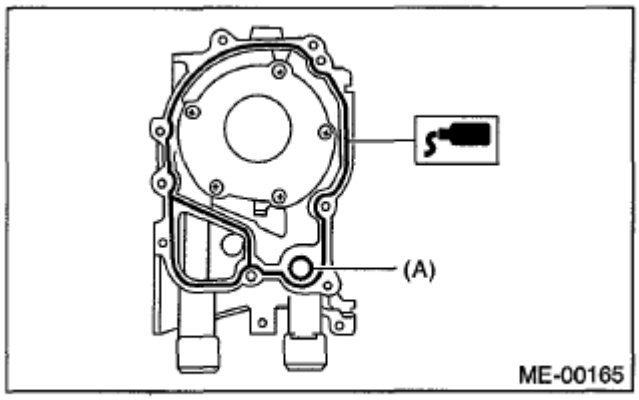
Fig. 219: Identifying Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

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

       Liquid gasket:

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



(A) O-ring

Fig. 220: 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.

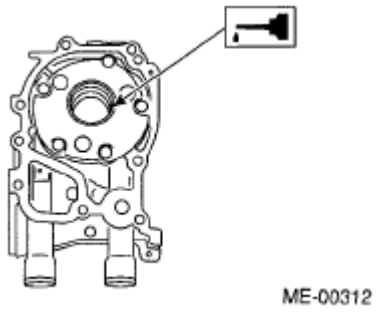


Fig. 221: Applying Coat Of Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

4. Install the oil pump to cylinder block.

CAUTION:
- **Be careful not to damage the front oil seal during installation.**
- **Make sure the front oil seal lip is not folded.**

NOTE:
- **Align the flat surface of oil pump's inner rotor with that of crankshaft before installation.**
- **Use new O-rings.**
- **Do not forget to assemble O-rings.**

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

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

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

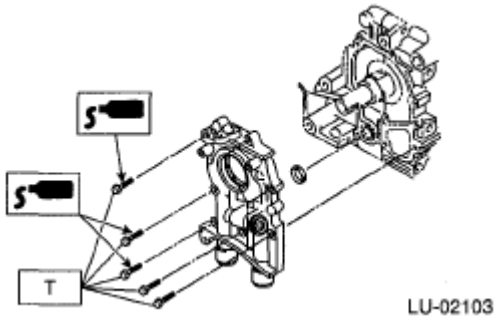


Fig. 222: Applying Fluid Packing To Threads Of Bolts
Courtesy of SUBARU OF AMERICA, INC.

29. 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)

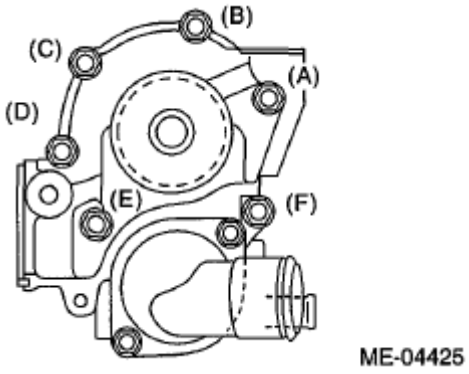


Fig. 223: Identifying Water Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

31. Install the oil filter.

    Ref. to **INSTALLATION** , Engine Oil Filter.

32. Install the cylinder head. Ref. to **INSTALLATION**, Cylinder Head.
33. Install the generator and A/C compressor with their brackets.

    Tightening torque:

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

34. Install the crank sprocket. Ref. to **INSTALLATION**, Crank Sprocket.
35. Install the timing belt. Ref. to **INSTALLATION**, Timing Belt.
36. Adjust the valve clearance. Ref. to **ADJUSTMENT**, Valve Clearance.
37. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover.

       NOTE: Use a new rocker cover gasket.

    2. Temporarily tighten the rocker cover bolts in alphabetical order shown in the figure, and then tighten to specified torque in alphabetical order in two steps.

       Tightening torque:

       1st

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

       2nd (only (a) and (b) are tightened)

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

       RH side

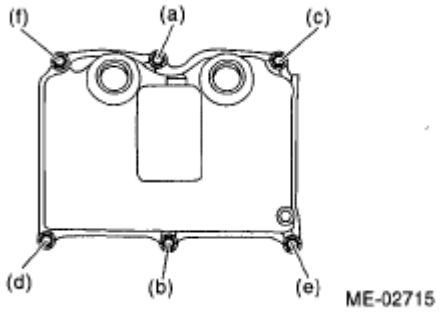


Fig. 224: Identifying Rocker Cover Bolts - RH Side
Courtesy of SUBARU OF AMERICA, INC.

LH side

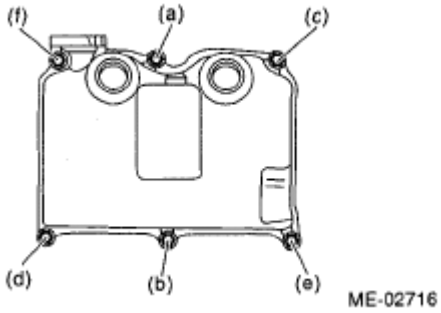
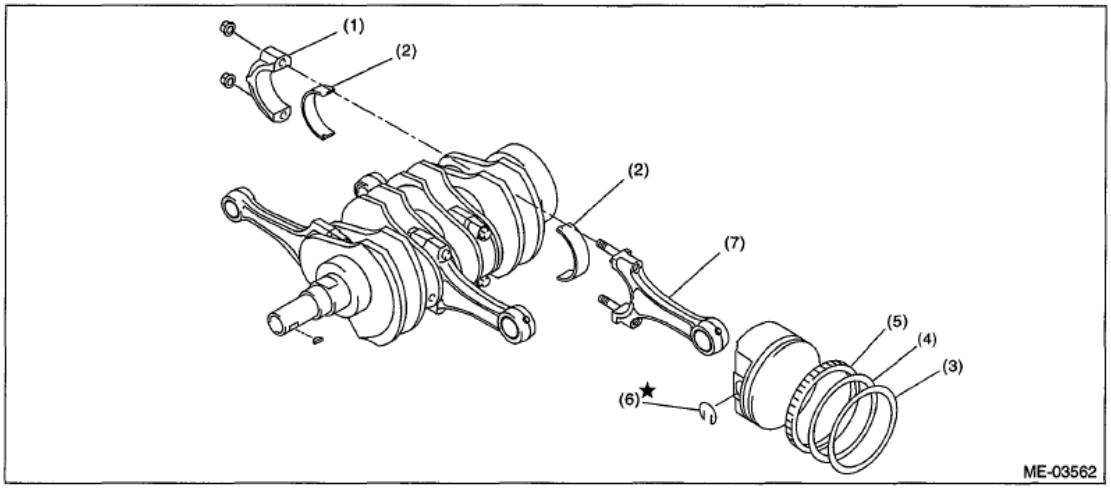


Fig. 225: Identifying Rocker Cover Bolts - LH Side
Courtesy of SUBARU OF AMERICA, INC.

38. Install the timing belt cover. Ref. to **INSTALLATION**, Timing Belt Cover.
39. Install the crank pulley. Ref. to **INSTALLATION**, Crank Pulley.
40. Install the intake manifold. Ref. to **INSTALLATION** , Intake Manifold.
41. 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

Fig. 226: Identifying Connecting Rod Bearing, Top Ring, Second Ring And Oil Ring
Courtesy of SUBARU OF AMERICA, INC.

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

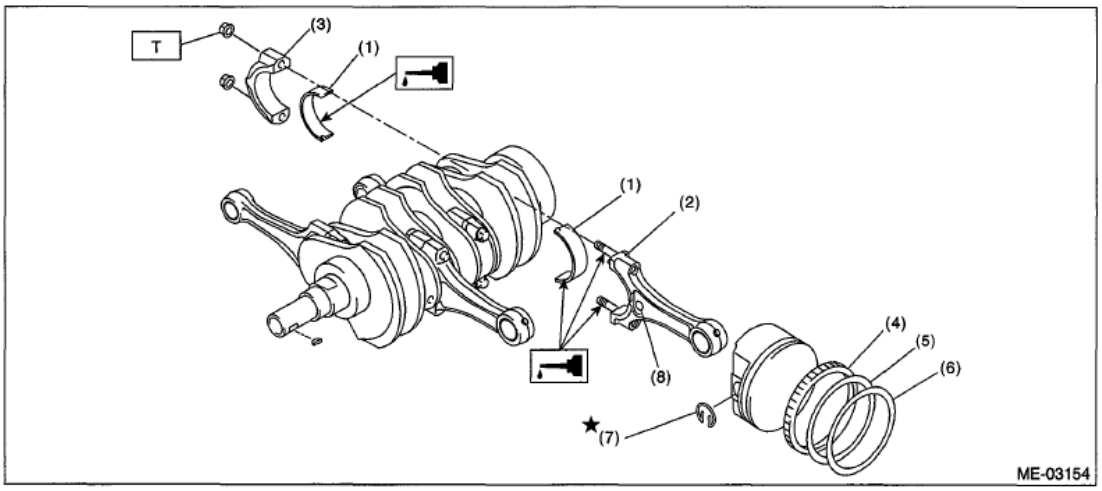
NOTE: Keep the removed connecting rods, connecting rod caps and bearings in order so that they are kept in their original combinations/groups, and not mixed together.

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	(5)	Second ring	*Tightening torque:N·m (kgf-m, ft-lb)*
(2)	Connecting rod	(6)	Top ring	*T: 45 (4.6, 33.2)*
(3)	Connecting rod cap	(7)	Snap ring	
(4)	Oil ring	(8)	Side mark	

Fig. 227: Identifying Connecting Rod Bearing, Connecting Rod And Top Ring With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

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

T: 45 (4.6,33.2)

1. Apply engine oil to the surface of the connecting rod bearings, and install the connecting rod bearings onto 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 with connecting rod nut.

   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 nuts, apply oil on the threads.**

Tightening torque:

45 N.m (4.6 kgf-m, 33.2 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 head surface that mates with cylinder block 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

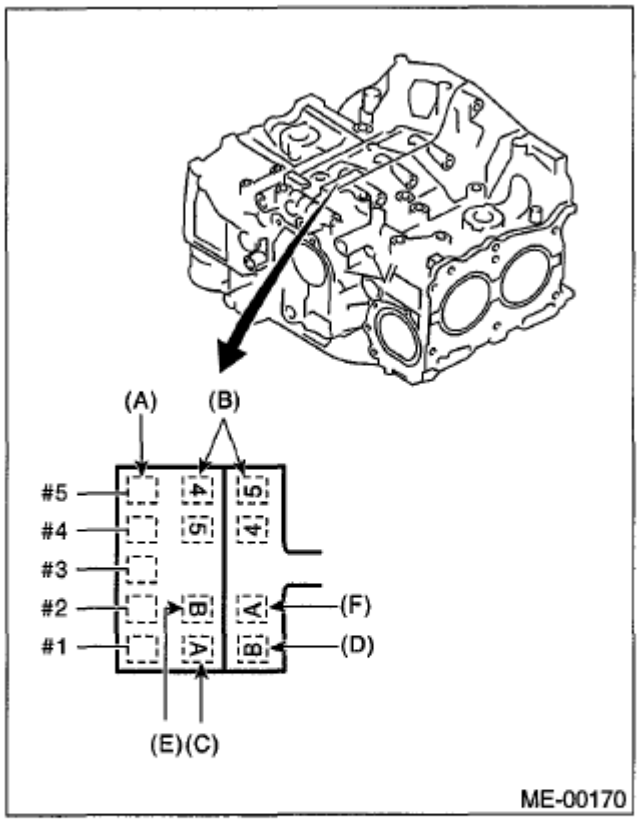
1. The cylinder bore size is stamped on the front upper face of the cylinder block.

   NOTE:
   - **Measurement should be performed at a temperature of 20°C (68°F).**
   - **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. 228: Identifying Cylinder Bore Size Mark
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.

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

Taper:

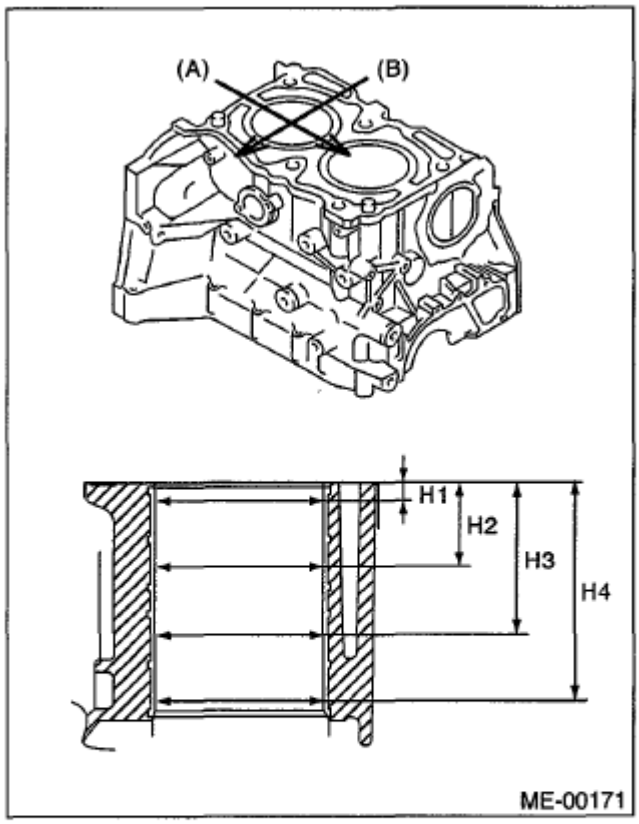
Standard

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. 229: Identifying Inner Diameter Of Cylinder
Courtesy of SUBARU OF AMERICA, INC.

3. When the piston is to be replaced due to general or cylinder wear, select a suitable sized piston by measuring the piston clearance.
4. 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 (1.504 in)

Piston outer diameter:

Standard

A: 99.510 - 99.520 mm (3.9177 - 3.9181 in)

B: 99.500 - 99.510 mm (3.9173 - 3.9177 in)

0.25 mm (0.0098 in) oversize:

99.750 - 99.770 mm (3.9272 - 3.9280 in)

0.50 mm (0.0197 in) oversize:

100,000 - 100.020 mm (3.9370 - 3.9378 in)

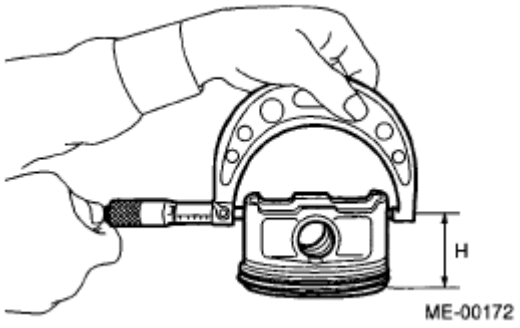


Fig. 230: Measuring Outer Diameter Of Piston
Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

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

Standard

-0.015 - 0.005 mm (-0.00059-0.00020 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

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 or damage. Replace if faulty.
3. Make sure the piston pin can be inserted into the piston pin hole by a thumb at 20°C (68°F). Replace if faulty.

Clearance between piston pin hole and piston pin:

Standard

0.004 - 0.008 mm (0.0002 - 0.0003 in)

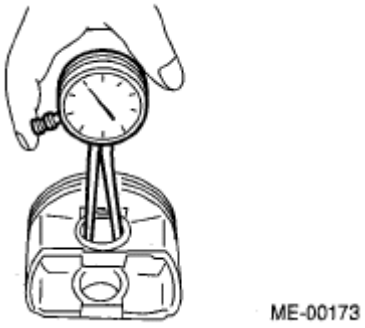


Fig. 231: Checking Clearance Between Piston Pin And Hole In Piston
Courtesy of SUBARU OF AMERICA, INC.

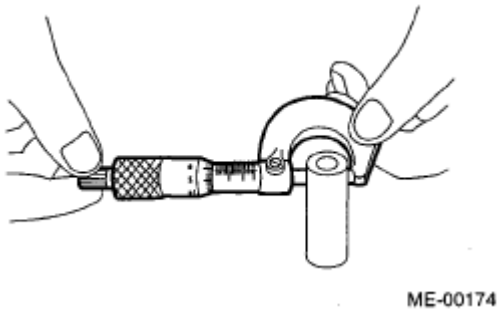


Fig. 232: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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.

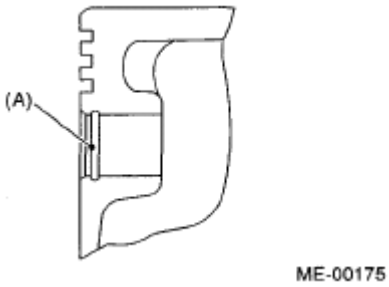


Fig. 233: Identifying Circlip Installation Groove On Piston
Courtesy of SUBARU OF AMERICA, INC.

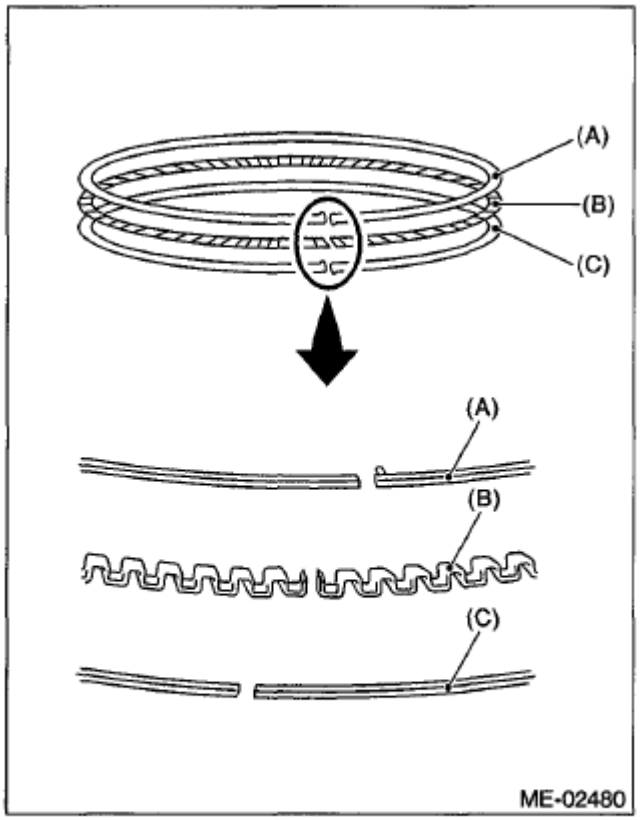
5. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

NOTE:

- **The top ring and second ring have the mark to determine the direction for installing. When attaching the ring to the piston, face these marks towards the top side.**
- **Oil ring consists of the upper rail, expander and lower rail. When attaching the oil ring to the piston, pay attention to the direction of each rail.**



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

Fig. 234: Identifying Piston Ring (Upper Rail, Expander And Lower Rail)
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.

STANDARD SPECIFICATION

		Standard mm (in)
Piston ring gap	Top ring	0.20 - 0.35 (0.0079 - 0.0138)
	Second ring	0.37 - 0.52 (0.0146 - 0.0205)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)

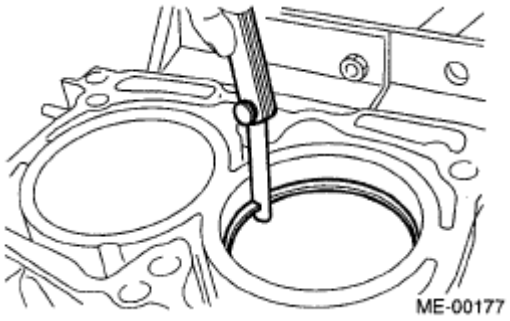


Fig. 235: Measuring Piston Ring Closed Gap
Courtesy of SUBARU OF AMERICA, INC.

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.

STANDARD SPECIFICATION

		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)

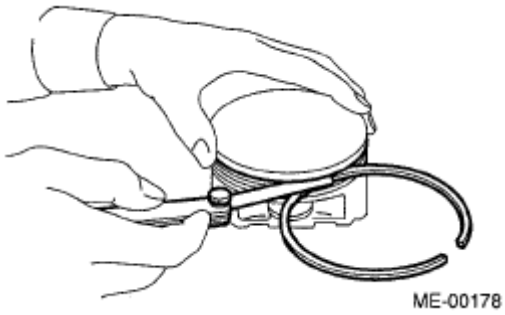


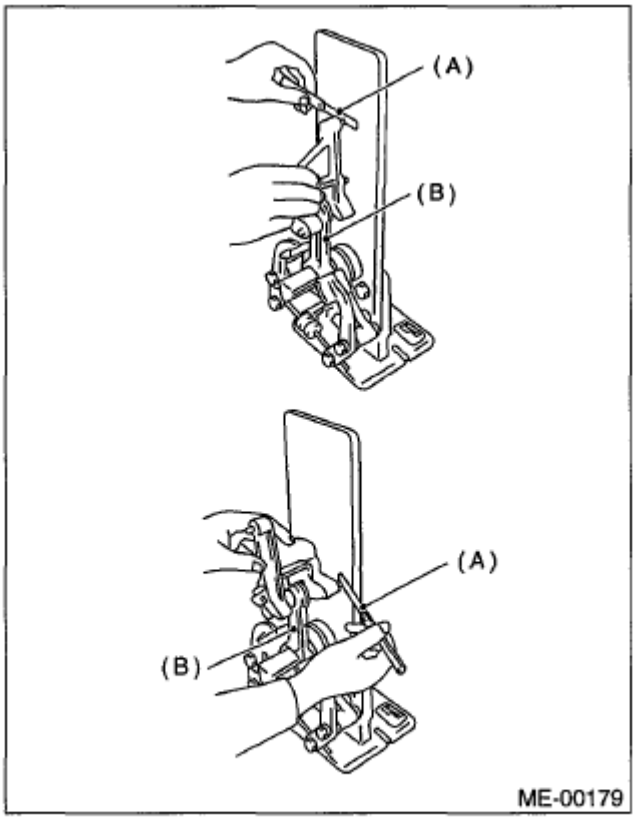
Fig. 236: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

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)



(A) Thickness gauge
(B) Connecting rod

Fig. 237: Checking Bend Or Twist Using Connecting Rod Aligner
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod thrust clearance:

Standard

0.070 - 0.330 mm (0.0028 - 0.0130 in)

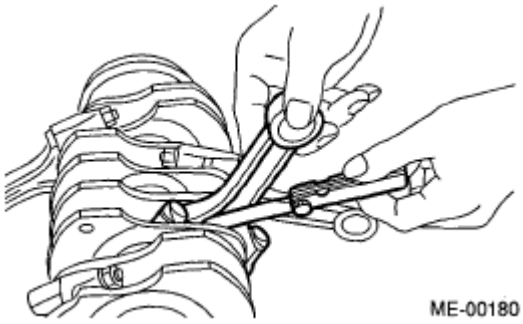


Fig. 238: Checking Connecting Rod Side Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard

0.016 - 0.044 mm (0.0006 - 0.0017 in)

BEARING THICKNESS CHART

		Unit: mm (in)
Bearing	**Bearing size (Thickness at center)**	**Outer diameter of crank pin**
Standard	1.492-1.501 (0.0587 - 0.0591)	51.984 - 52.000 (2.0466 - 2.0472)
0.03 (0.0012) Undersize	1.510 - 1.513 (0.0594 - 0.0596)	51.954 - 51.970 (2.0454 - 2.0461)
0.05 (0.0020) Undersize	1.520 - 1.523 (0.0598 - 0.0600)	51.934 - 51.950 (2.0446 - 2.0453)
0.25 (0.0098) Undersize	1.620 - 1.623 (0.0638 - 0.0639)	51.734 - 51.750 (2.0368 - 2.0374)

6. Inspect the bushing at connecting rod small end, and replace with a new part if worn or damaged.
7. Measure the piston pin clearance at connecting rod small end. Replace it with a new part if the value is not within the standard,

Clearance between piston pin and bushing:

Standard

0 - 0.022 mm (0 - 0.0009 in)

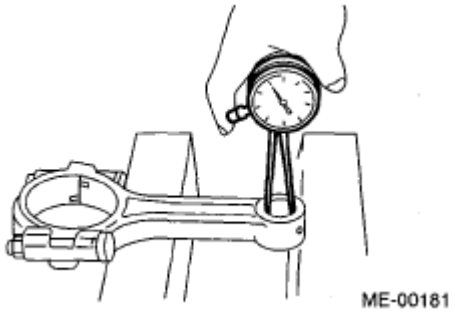


Fig. 239: Checking Clearance Between Piston Pin And Bushing
Courtesy of SUBARU OF AMERICA, INC.

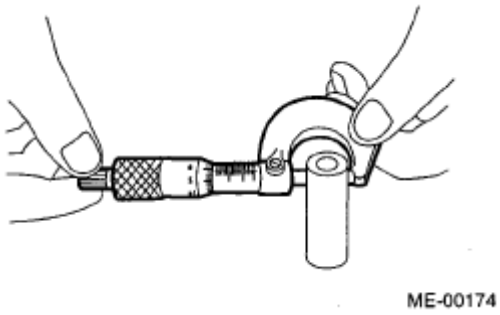


Fig. 240: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

       ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

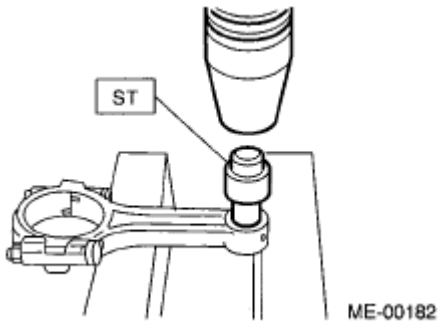


Fig. 241: Identifying Connecting Rod Bushing Remover And Installer ST499037100
Courtesy of SUBARU OF AMERICA, INC.

    3. Make two 3 mm (0.12 in) holes in the pressed bushing 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.

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)

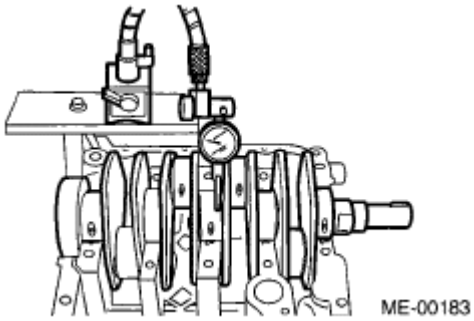


Fig. 242: Measuring Crankshaft Bend Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

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)

Cylindricality

0.004 mm (0.0002 in)

Grinding limit (dia.)

To 51.750 mm (2.0374 in)

Crank journal

Out-of-roundness

0.005 mm (0.0002 in)

Cylindricality

0.006 mm (0.0002 in)

Grinding limit (dia.)

To 59.758 mm (2.3527 in)

Fig. 243: Inspecting Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL OUTER DIAMETER CHART

Unit: mm (in)

		Crank journal outer diameter		Crank pin outer diameter
		#1,#3	#2, #4, #5	
Standard	Journal O.D.	59.992 - 60.008 (2.3619 - 2.3625)	59.992 - 60.008 (2.3619 - 2.3625)	51.984 - 52.000 (2.0466 - 2.0472)
	Bearing size (Thickness at center)	1.998 - 2.011 (0.0787 - 0.0792)	2.000 - 2.013 (0.0787 - 0.0793)	1.492 - 1.501 (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)	1.510 - 1.513 (0.0594 - 0.0596)
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 (2.0446 - 2.0453)
	Bearing size (Thickness at center)	2.027 - 2.030 (0.0798 - 0.0799)	2.029 - 2.032 (0.0799 - 0.0800)	1.520 - 1.523 (0.0598 - 0.0600)
0.25 (0.0098) Undersize	Journal O.D.	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)	1.620 - 1.623 (0.0638 - 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.

   Crankshaft thrust clearance:

   Standard

   0.030 - 0.115 mm (0.0012 - 0.0045 in)

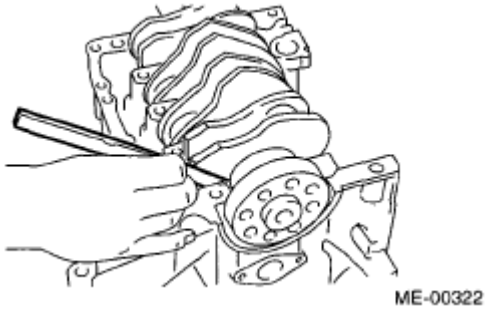


Fig. 244: Measuring Side Clearance Of Crankshaft At Center Bearing
Courtesy of SUBARU OF AMERICA, INC.

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)

OIL SWITCHING SOLENOID VALVE

REMOVAL

RH SIDE

1. Disconnect the ground cable from battery.

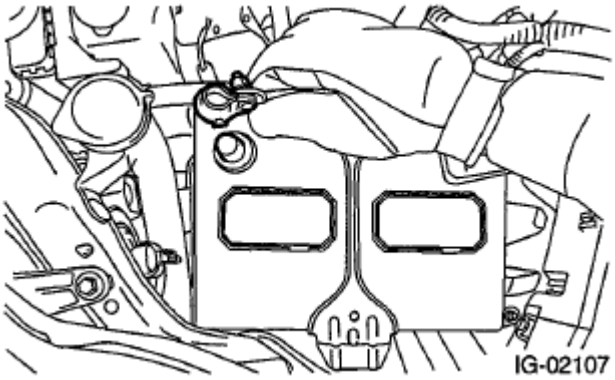


Fig. 245: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake boot assembly. Ref. to **REMOVAL** , Air Intake Boot.
3. Remove the bolt, and disconnect the bulkhead harness connector from the engine harness connector and rear engine hanger.

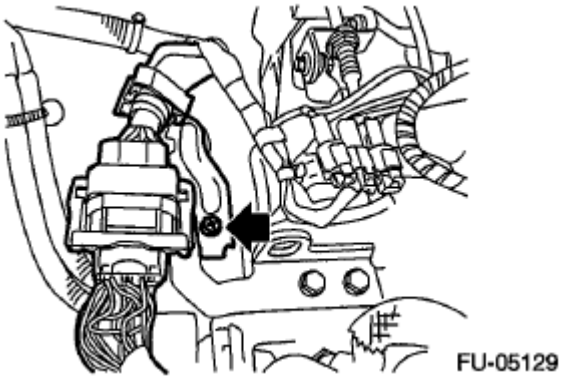


Fig. 246: Locating Bulkhead Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Slide the engine harness connector in the direction of the arrow and remove it from the rear engine hanger.

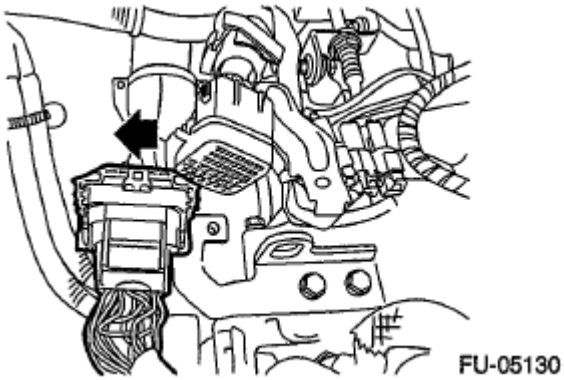
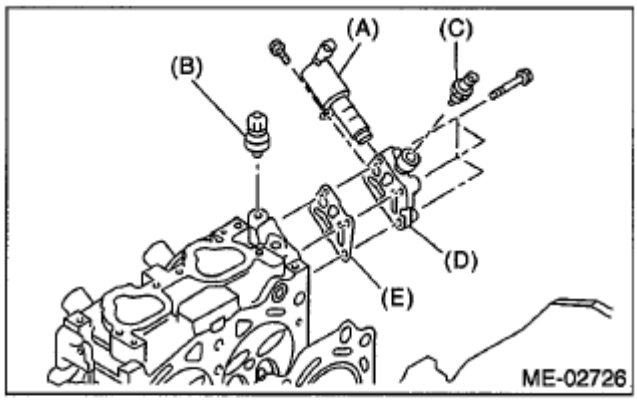


Fig. 247: Sliding Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Disconnect the connector from the oil switching solenoid valve.
6. Remove the oil switching solenoid valve.
7. Remove the variable valve lift diagnosis oil pressure switch. Ref. to **REMOVAL** , Variable Valve Lift Diagnosis Oil Pressure Switch.
8. Remove the oil temperature sensor. Ref. to **REMOVAL** , Oil Temperature Sensor.
9. Remove the oil switching solenoid valve holder from the cylinder head.



(A) Oil switching solenoid valve
(B) Variable valve lift diagnosis oil pressure switch
(C) Oil temperature sensor
(D) Oil switching solenoid valve holder
(E) Gasket

Fig. 248: Identifying Oil Switching Solenoid Valve Components
Courtesy of SUBARU OF AMERICA, INC.

LH SIDE

1. Disconnect the ground cable from battery.

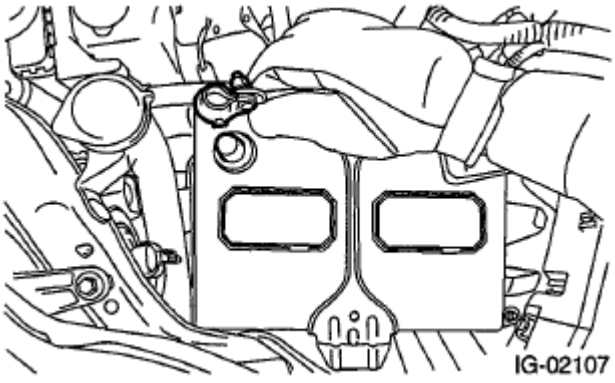
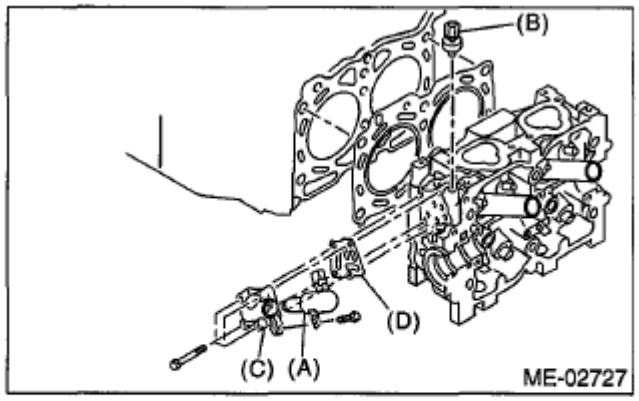


Fig. 249: Identifying Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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. 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 timing belt cover No. 2 LH.
8. Disconnect the connector from the oil switching solenoid valve.
9. Remove the oil switching solenoid valve.
10. Remove the variable valve lift diagnosis oil pressure switch. Ref. to **REMOVAL** , Variable Valve Lift Diagnosis Oil Pressure Switch.
11. Remove the oil switching solenoid valve holder from the cylinder head.



(A) Oil switching solenoid valve
(B) Variable valve lift diagnosis oil pressure switch
(C) Oil switching solenoid valve holder
(D) Gasket

Fig. 250: Identifying Oil Switching Solenoid Valve Holder, Oil Switching Solenoid Valve And Gasket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

RH SIDE

Install in the reverse order of removal.

NOTE:

- **Use a new gasket.**
- **Apply liquid gasket to variable valve lift diagnosis oil pressure switch**

threads.

- **Install the oil switching solenoid valve to the holder, then install it to the cylinder head.**

Tightening torque:

T1: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

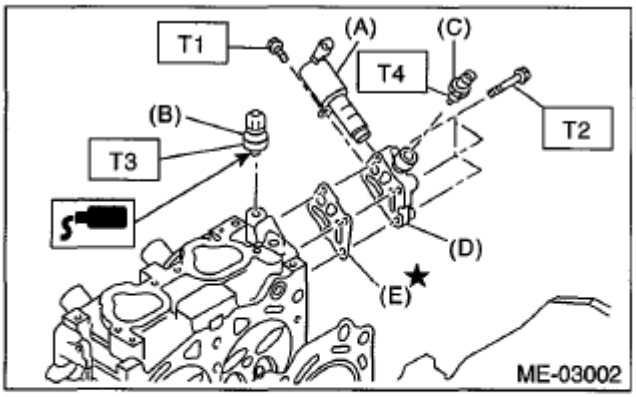
T2: 10 N.m (1.0 kgf-m, 7.4 ft-lb)

T3: 17 N.m (1.7 kgf-m, 12.5 ft-lb)

T4: 18 N.m (1.8 kgf-m, 13.3 ft-lb)

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent



(A) Oil switching solenoid valve
(B) Variable valve lift diagnosis oil pressure switch
(C) Oil temperature sensor
(D) Oil switching solenoid valve holder
(E) Gasket

Fig. 251: Identifying Oil Switching Solenoid Valve Holder And Oil Switching Solenoid Valve With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

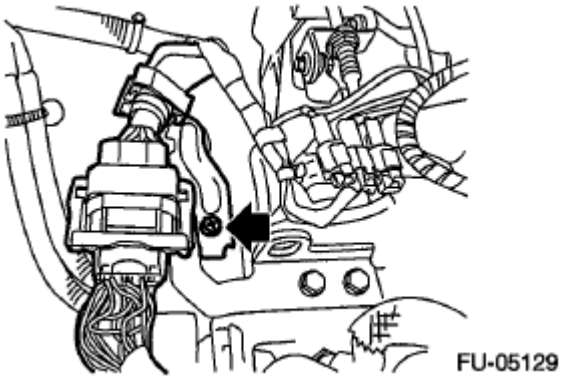


Fig. 252: Locating Bulkhead Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

LH SIDE

Install in the reverse order of removal.

NOTE:

- **Use a new gasket.**
- **Apply liquid gasket to variable valve lift diagnosis oil pressure switch threads.**
- **Install the oil switching solenoid valve to the holder, then install it to the cylinder head.**

Tightening torque:

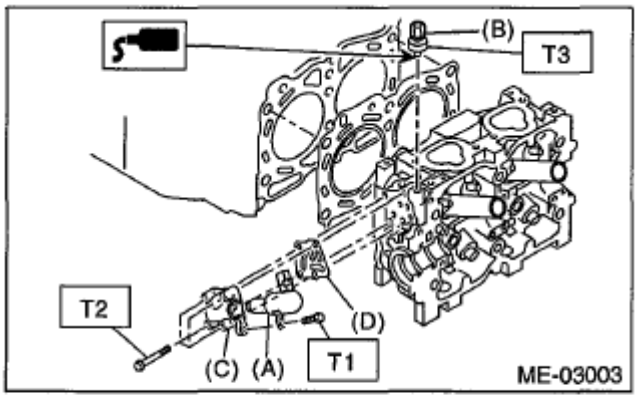
T1: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

T2: 10 N.m (1.0 kgf-m, 7.4 ft-lb)

T3: 17 N.m (1.7 kgf-m, 12.5 ft-lb)

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent



(A) Oil switching solenoid valve
(B) Variable valve lift diagnosis oil pressure switch
(C) Oil switching solenoid valve holder
(D) Gasket

Fig. 253: Identifying Oil Switching Solenoid Valve Holder, Oil Switching Solenoid Valve And Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

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

SYMPTOMS CHART

Symptoms	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
	Immobilizer system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A
	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
		Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective	C

	Compression	cylinder head gasket	
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
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
		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
		Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C

	Compression	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
		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
	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A

3. Low output, hesitation and poor acceleration	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	B
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	A
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of 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
	Engine control system Ref. to **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	B
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of fuel or insufficient fuel	C

4. Surging	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
	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
		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

SYMPTOM CHART

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	• Valve mechanism is defective. • Incorrect valve clearance • Worn valve rocker • 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.	• Damaged engine mounting • Loosened flywheel mounting bolt
High-pitched clank (Spark knock)	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 1,000 to 2,000 RPM	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. (1)	• Worn crankshaft main bearing • Worn connecting rod bearing (large end)
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. (1)	• Worn cylinder liner and piston ring • Broken or stuck piston ring • Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn(1).	• Worn cam sprocket • Worn camshaft journal bore in cylinder head
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Poor contact of generator brush and

		rotor
Gear scream when starting engine	-	• Defective ignition starter switch • Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	• Loose V-belt • Defective water pump shaft
Hissing sound	-	• Insufficient compression • Air leakage in air intake system, hose, connection or manifold
Timing belt noise	-	• Loose timing belt • 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.		

