2012 ENGINE

Mechanical MEH4DOTC - Legacy and Outback

GENERAL DESCRIPTION

SPECIFICATION

Engine	Model				2.5 L
	Cylinder arrangement				Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve system mechanism				Belt driven, double overhead camshaft, 4-valve/cylinder
	Bore x Stroke			mm (in)	99.5 x 79.0 (3.92 x 3.11)
	Displacement			cm^3 (cu in)	2, 457 (149.94)
	Compression ratio				9.5
	Compression pressure (at 200 - 300 RPM)	kPa (kg/cm^2 , psi)		Standard	981 - 1, 177 (10 - 12, 142 - 171)
	Number of piston rings				Pressure ring: 2, Oil ring: 1
	Intake valve timing		Open	Max. retard	ATDC 5°
				Min. advance	BTDC 35°
			Close	Max. retard	ABDC 65°
				Min. advance	ABDC 25°
	Exhaust valve timing		Open	Max. retard	BBDC 24°
				Min. advance	BBDC 64°
			Close	Max. retard	ATDC 26°
				Min. advance	BTDC 14°
	Valve clearance	mm (in)	Inspection value	Intake	$0.20^{+0.04}_{-0.06}$ ($0.0079^{+0.0016}_{-0.0024}$)
				Exhaust	0.35±0.05 (0.0138±0.0020)
			Adjustment value	Intake	$0.20^{+0.01}_{-0.03}$ ($0.0079^{+0.0004}_{-0.0012}$)

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			Exhaust		0.35±0.02 (0.0138±0.0008)
	Idle speed (Gear shift lever in neutral position)	RPM	No load	Standard	700±100
			A/C ON	Standard	700 - 850
	Ignition order				1 --> 3 --> 2 --> 4
	Ignition timing		BTDC/RPM	Standard	15°±10°/700

NOTE: OS: Oversize US: Undersize

Belt tension adjuster	Adjuster rod protrusion amount			mm (in)	5.2 - 6.2 (0.205 - 0.244)
Camshaft	Bending limit			mm (in)	0.020 (0.00079)
	Cam lobe height	mm (in)	Intake	Standard	46.55 - 46.65 (1.833 - 1.837)
			Exhaust	Standard	45.85 - 45.95 (1.805 - 1.809)
	Cam base circle diameter		mm (in)	Standard	37.0 (1.457)
	Journal O.D.	mm (in)	Front	Standard	37.946 - 37.963 (1.4939 - 1.4946)
			Center, rear	Standard	29.946 - 29.963 (1.1790 - 1.1796)
	Oil clearance		mm (in)	Standard	0.037 - 0.072 (0.0015 - 0.0028)
	Thrust clearance		mm (in)	Standard	0.068 - 0.116 (0.0027 - 0.0047)
Cylinder head	Warping limit (mating surface with cylinder block)			mm (in)	0.035 (0.0014)
	Grinding limit			mm (in)	0.3 (0.012)
	Standard height			mm (in)	127.5 (5.02)
Valve seat	Seating angle between valve and valve seat				90°
	Contacting width between valve and valve seat	mm (in)	Intake	Standard	0.6 - 1.4 (0.024 - 0.055)
			Exhaust	Standard	1.2 - 1.8 (0.047 - 0.071)
Valve guide	Clearance between the valve guide and valve stem	mm (in)	Intake	Standard	0.030 - 0.057 (0.0012 - 0.0022)
			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 diameters	mm (in)	Intake		5.955 - 5.970 (0.2344 - 0.2350)
			Exhaust		5.945 - 5.960 (0.2341 - 0.2346)
	Valve guide protrusion amount			mm (in)	15.8 - 16.2 (0.622 - 0.638)
Valve	Head edge thickness	mm (in)	Intake	Standard	1.0 - 1.4 (0.039 - 0.055)
			Exhaust	Standard	1.3 - 1.7 (0.051 - 0.067)
	Overall length	mm (in)	Intake		104.4 (4.110)
			Exhaust		104.65 (4.1201)
Valve spring	Free length			mm (in)	47.32 (1.863)
	Tension/spring height			N (kgf, lb)/mm (in)	Set: 205 - 235 (20.90 - 23.96, 46.09 - 52.84)/36.0 (1.417)
					Lift: 426 - 490 (43.44 - 49.96, 95.78 - 110.17)/26.5 (1.043)

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	Squareness			2.5°, 2.1 mm (0.083 in) or less
Valve lifter	Outer diameter	mm (in)	Standard	34.959 - 34.975 (1.3763 - 1.3770)
	Valve lifter mating surface inner diameter	mm (in)	Standard	34.994 - 35.016 (1.3777 - 1.3786)
	Valve lifter and valve lifter mating surface clearance	mm (in)	Standard	0.019 - 0.057 (0.0007 - 0.0022)
Cylinder block	Warping limit (mating surface with cylinder head)		mm (in)	0.025 (0.0098)
	Grinding limit		mm (in)	0.1 (0.004)
	Standard height		mm (in)	201.0 (7.91)
	Cylindricality	mm (in)	Standard	0.015 (0.0006)
	Out-of-roundness	mm (in)	Standard	0.010 (0.0004)
	Clearance between cylinder and piston at 20°C (68°F)	mm (in)	Standard	-0.010 - 0.010 (-0.00039 - 0.00039)
	Cylinder inner diameter boring limit (diameter)		mm (in)	To 100.005 (3.9372)

Piston	Piston grade point			mm (in)	38.2 (1.50)
	Outer diameter	mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)
				B	99.495 - 99.505 (3.9171 - 3.9175)
			0.25 (0.0098) OS		99.745 - 99.765 (3.9270 - 3.9278)
			0.50 (0.0197) OS		99.995 - 100.015 (3.9368 - 3.9376)
Piston pin	Degree of fit				Piston pin must be fitted into position with thumb at 20°C (68°F).
	Clearance between piston pin hole and piston pin		mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)
Piston ring	Piston ring gap	mm (in)	Top ring	Standard	0.20 - 0.25 (0.0079 - 0.0098)
			Second ring	Standard	0.37 - 0.52 (0.015 - 0.0203)
			Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)
	Clearance between 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)
	Bend or twist per 100 mm (3.94 in) in length		mm (in)	Limit	0.1 (0.0039)
					0.070 - 0.330 (0.0028 -

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Connecting rod and connecting rod bearing	Thrust clearance			mm (in)	Standard	0.0130)
	Oil clearance			mm (in)	Standard	0.017 - 0.045 (0.0007 - 0.0018)
	Bearing size (Thickness at center)			mm (in)	Standard	1.490 - 1.506 (0.0587 - 0.0593)
					0.03 (0.0012) US	1.504 - 1.512 (0.0592 - 0.0595)
					0.05 (0.0020) US	1.514 - 1.522 (0.0596 - 0.0599)
					0.25 (0.0098) US	1.614 - 1.622 (0.0635 - 0.0639)
Bushing of small end	Clearance between piston pin and bushing			mm (in)	Standard	0 - 0.022 (0 - 0.0009)
Crankshaft and crankshaft bearing	Bending limit				mm (in)	0.035 (0.0014)
	Crank pin	Out-of-roundness		mm (in)	Standard	0.003 (0.0001)
		Cylindricality		mm (in)	Standard	0.004 (0.0002)
		Grinding limit (dia.)			mm (in)	To 51.750 (2.0374)
	Crank journal	Out-of-roundness		mm (in)	Standard	0.005 (0.0002)
		Cylindricality		mm (in)	Standard	0.006 (0.0002)
		Grinding limit (dia.)			mm (in)	To 59.758 (2.3527)
	Crank pin outer diameter			mm (in)	Standard	51.976 - 52.000 (2.0463 - 2.0472)
					0.03 (0.0012) US	51.954 - 51.970 (2.0454 - 2.0461)
					0.05 (0.0020) US	51.934 - 51.950 (2.0447 - 2.0453)
					0.25 (0.0098) US	51.734 - 51.750 (2.0368 - 2.0374)
	Crank journal outer diameter			mm (in)	Standard	59.984 - 60.008 (2.3616 - 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)
			#1, #3		Standard	1.998 - 2.015 (0.0787 - 0.0793)
					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)

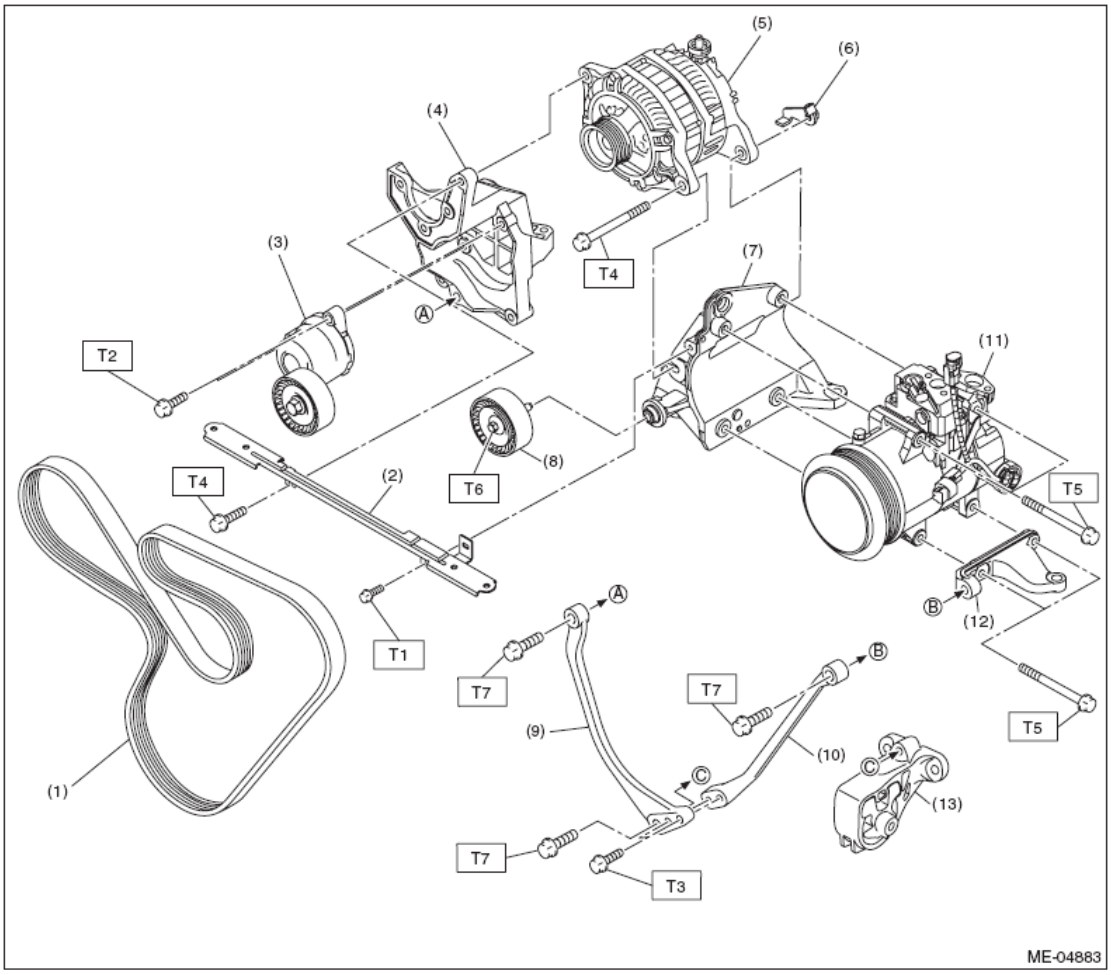
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	Bearing size (Thickness at center) mm (in)		0.25 (0.0098) US		2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #5	Standard		2.000 - 2.017 (0.0787 - 0.0794)
			0.03 (0.0012) US		2.019 - 2.022 (0.0795 - 0.0796)
			0.05 (0.0020) US		2.029 - 2.032 (0.0799 - 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 (0.00039 - 0.0012)

COMPONENT

V-BELT

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(1) V-belt
(2) Collector cover bracket
(3) V-belt tensioner ASSY
(4) Power steering pump bracket
(5) Generator
(6) Generator plate
(7) A/C compressor bracket A
(8) Idler pulley ASSY
(9) Stopper rod RH
(10) Stopper rod LH
(11) A/C compressor
(12) A/C compressor bracket B
(13) Front cushion rubber

Fig. 1: Exploded View Of V-Belt Components
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)

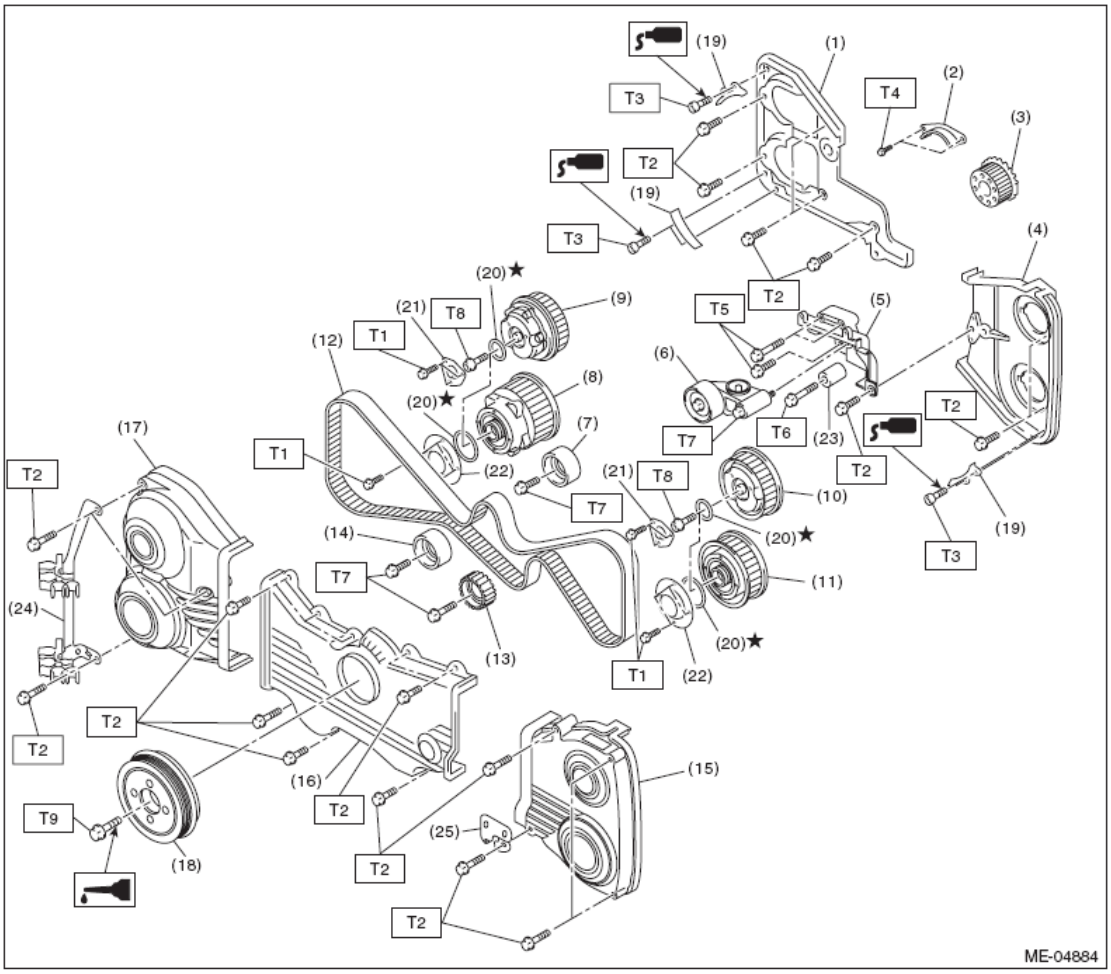
T5: 26.5 (2.7, 19.5)

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T6: 33 (3.4, 24.3)

T7: 36 (3.7, 26.6)

TIMING BELT



(1)	Timing belt cover No. 2 RH	(13)	Belt idler No. 2	(25)	Oxygen sensor bracket
(2)	Timing belt guide	(14)	Belt idler		
(3)	Crank sprocket	(15)	Timing belt cover LH		
(4)	Timing belt cover No. 2 LH	(16)	Front belt cover		
(5)	Tensioner bracket	(17)	Timing belt cover RH		
(6)	Automatic belt tension adjuster ASSY	(18)	Crank pulley		
(7)	Belt idler	(19)	Timing belt guide		
(8)	Exhaust cam sprocket RH	(20)	O-ring		
(9)	Intake cam sprocket RH	(21)	Intake actuator cover		
(10)	Intake cam sprocket LH	(22)	Exhaust actuator cover		
(11)	Exhaust cam sprocket LH	(23)	Belt idler		
(12)	Timing belt	(24)	Hose clip stay ASSY		

Fig. 2: Exploded View Of Timing Belt Components
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 3.4 (0.3, 2.5)

T2: 5 (0.5, 3.7)

T3: 6.4 (0.7, 4.7)

T4: 9.75 (1.0, 7.2)

T5: 24.5 (2.5, 18.1)

T6: 25 (2.5, 18.4)

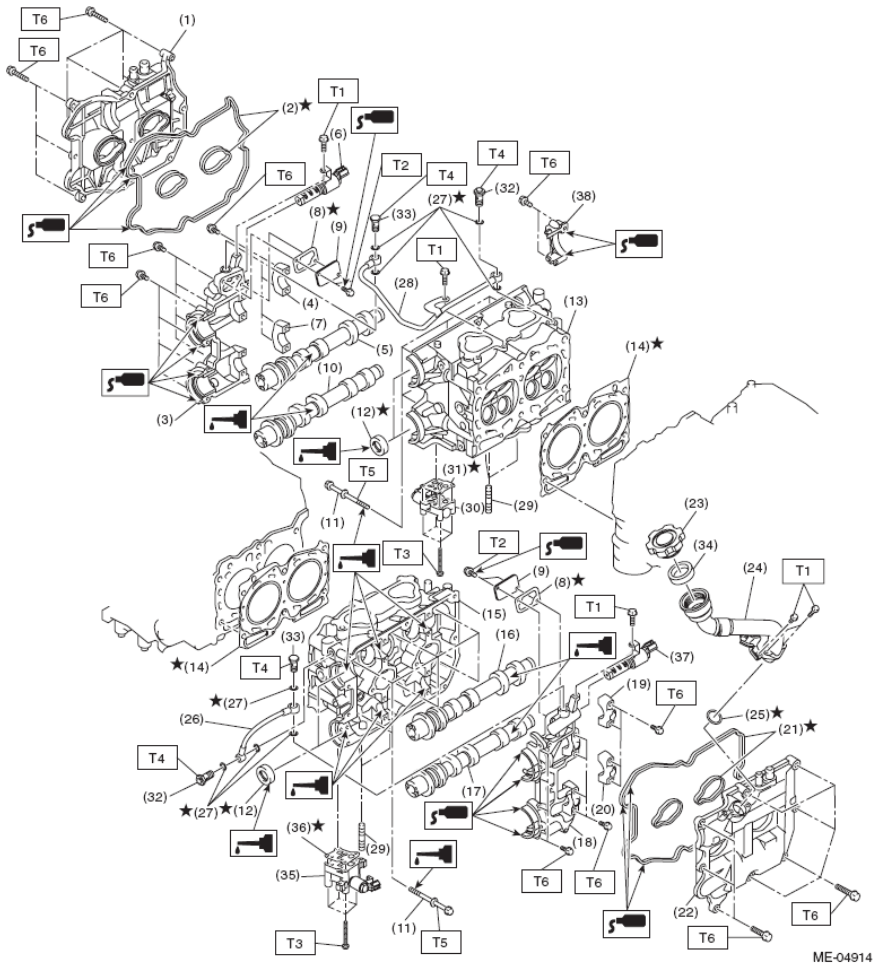
T7: 39 (4.0, 28.8)

T8: Refer to , INSTALLATION, Cam Sprocket.

T9: Refer to , INSTALLATION, Crank Pulley.

CYLINDER HEAD AND CAMSHAFT

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(1)	Rocker cover RH	(17)	Exhaust camshaft LH	(33)	Union bolt without filter (without protrusion)
(2)	Rocker cover gasket RH	(18)	Front camshaft cap LH	(34)	Gasket
(3)	Front camshaft cap RH	(19)	Intake camshaft cap LH	(35)	Exhaust oil flow control solenoid valve LH
(4)	Intake camshaft cap RH	(20)	Exhaust camshaft cap LH	(36)	Gasket LH
(5)	Intake camshaft RH	(21)	Rocker cover gasket LH	(37)	Intake oil flow control solenoid valve LH
(6)	Intake oil flow control solenoid valve RH	(22)	Rocker cover LH	(38)	Rear camshaft cap
(7)	Exhaust camshaft cap RH	(23)	Oil filler cap		
(8)	Gasket	(24)	Oil filler duct		
(9)	Oil return cover	(25)	O-ring		
(10)	Exhaust camshaft RH	(26)	Oil pipe LH		
(11)	Cylinder head bolt	(27)	Gasket		
(12)	Oil seal	(28)	Oil pipe RH		
(13)	Cylinder head RH	(29)	Stud bolt		
(14)	Cylinder head gasket	(30)	Exhaust oil flow control solenoid valve RH		
(15)	Cylinder head LH	(31)	Gasket RH		
(16)	Intake camshaft LH	(32)	Union bolt with filter (with protrusion)		

Fig. 3: Exploded View Of Cylinder Head And Camshaft Components
Courtesy of SUBARU OF AMERICA, INC.

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

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T1: 6.4 (0.7, 4.7)

T2: 9 (0.9, 6.6)

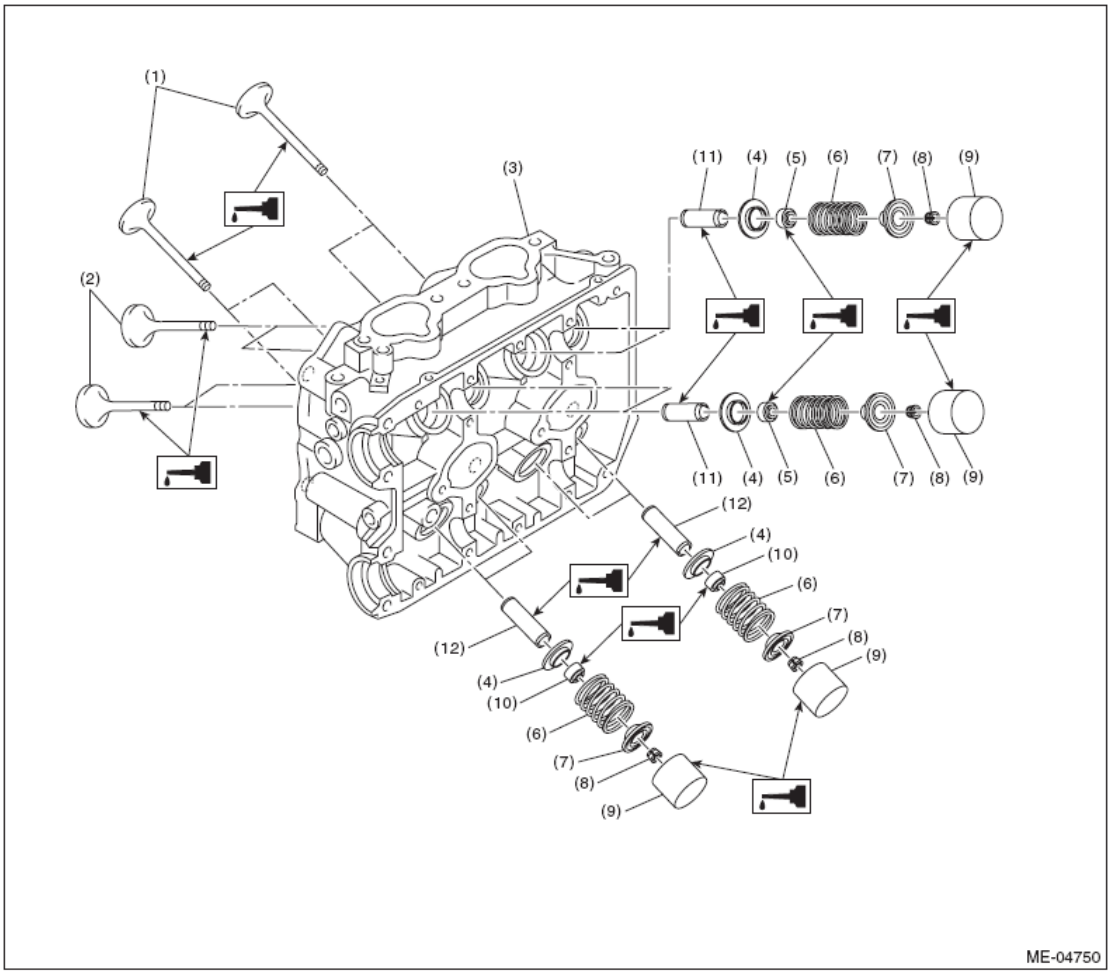
T3: 10 (1.0, 7.4)

T4: 29 (3.0, 21.4)

T5: Refer to , INSTALLATION, Cylinder Head.

T6: Refer to , INSTALLATION, Camshaft.

CYLINDER HEAD AND VALVE ASSEMBLY



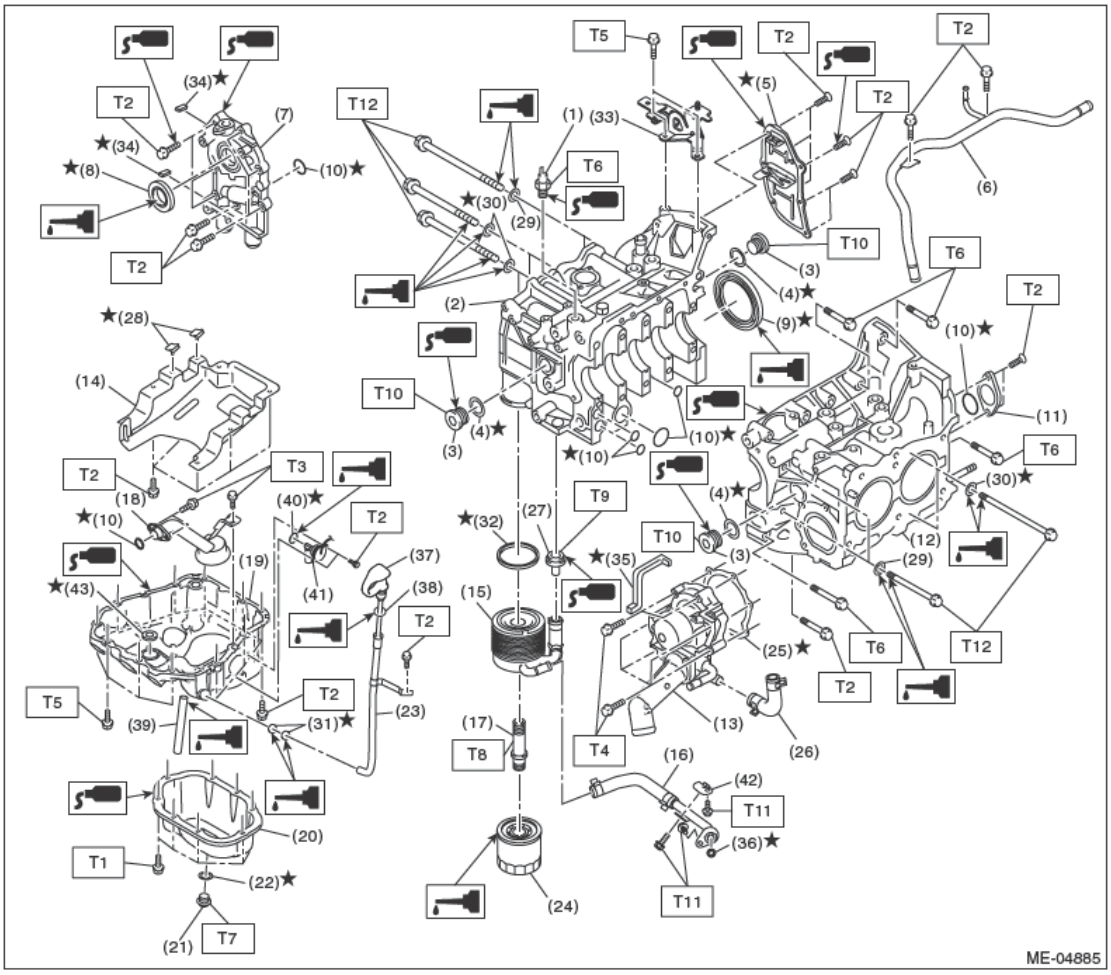
(1)	Exhaust valve	(5)	Intake valve oil seal	(9)	Valve lifter
(2)	Intake valve	(6)	Valve spring	(10)	Exhaust valve oil seal
(3)	Cylinder head	(7)	Retainer	(11)	Intake valve guide
(4)	Valve spring seat	(8)	Retainer key	(12)	Exhaust valve guide

Fig. 4: Exploded View Of Cylinder Head And Valve Assembly
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CYLINDER BLOCK

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

Fig. 5: Exploded View Of Cylinder Block Components

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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, 8.9)

Second 12 (1.2, 8.9)

T5: 16 (1.6, 11.8)

T6: 25 (2.5, 18.4)

T7: 41.7 (4.3, 30.8)

T8: 54 (5.5, 39.8)

T9: 69 (7.0, 50.9)

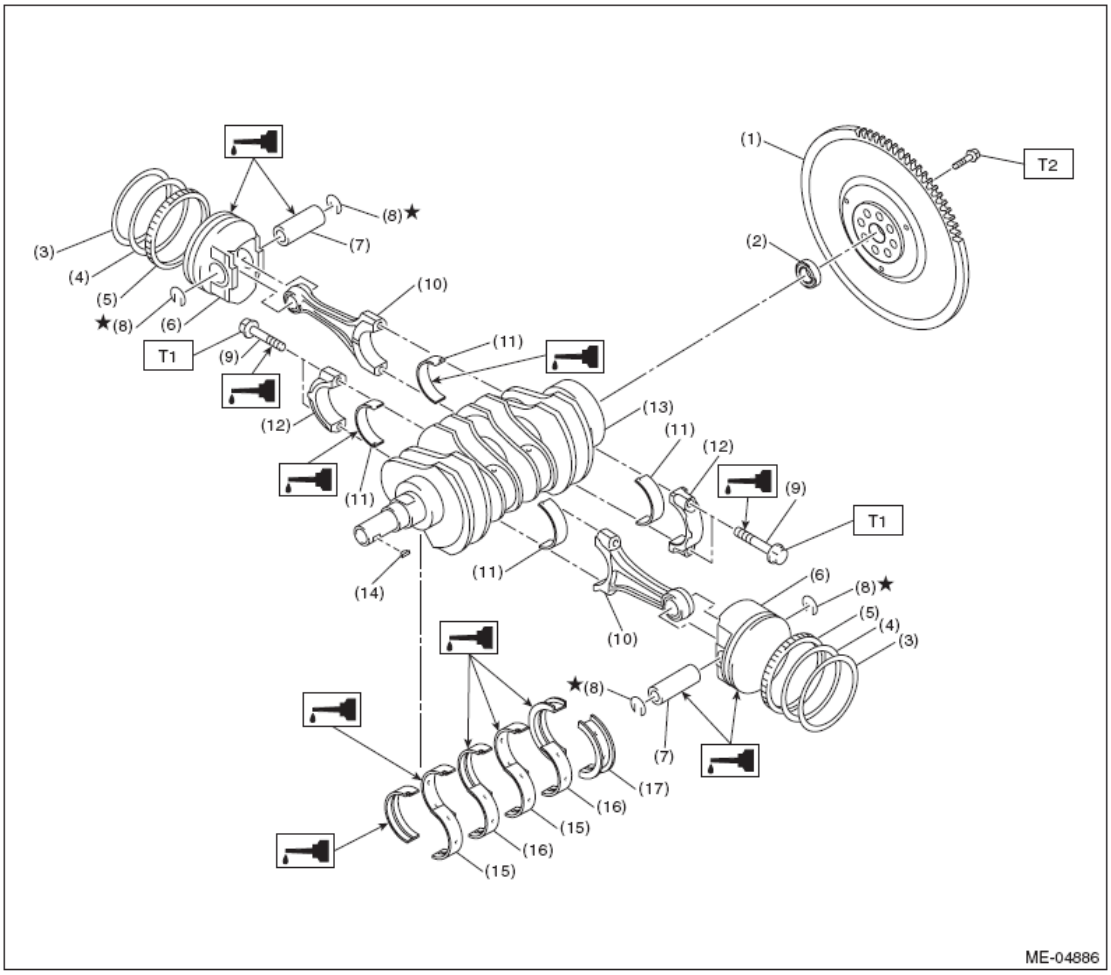
T10: 70 (7.1, 51.6)

T11: Refer to ENGINE OIL COOLER .

T12: Refer to , INSTALLATION, Cylinder Block.

CRANKSHAFT AND PISTON

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

Fig. 6: Exploded View Of Crankshaft And Piston
Courtesy of SUBARU OF AMERICA, INC.

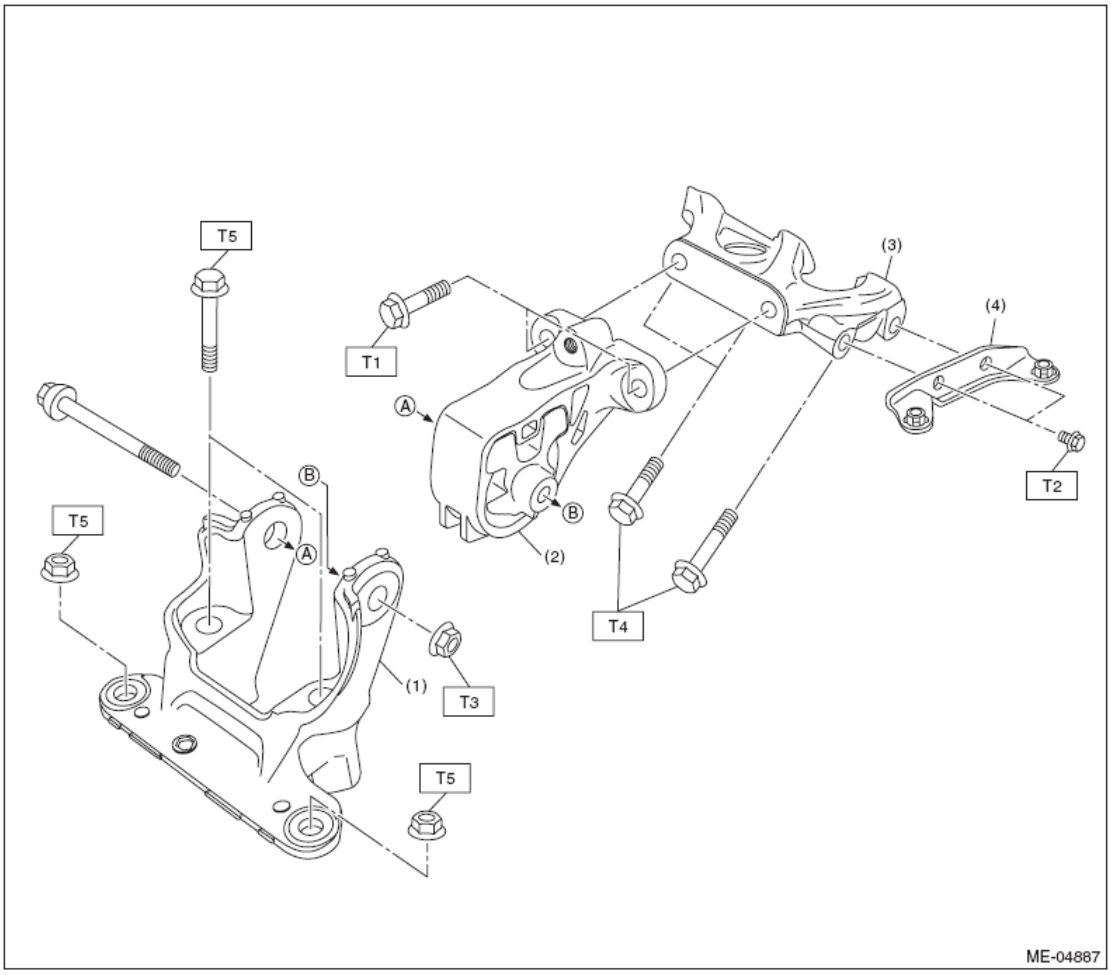
Tightening torque: N.m (kgf-m, ft-lb)

T1: 52 (5.3, 38.4)

T2: Refer to FLYWHEEL INSTALLATION .

ENGINE MOUNTING

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(1) Front mounting bracket
(2) Front cushion rubber
(3) Engine mounting bracket
(4) Turbocharger upper stay

Fig. 7: Exploded View Of Engine Mounting
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 25 (2.5, 18.4)

T2: 33 (3.4, 24.3)

T3: 45 (4.6, 33.2)

T4: 58 (5.9, 42.8)

T5: 60 (6.1, 44.3)

CAUTION

- Wear appropriate work clothing, including a cap, protective goggles and protective shoes when

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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 engine coolant contact the timing belt, clutch disc and flywheel.
- All removed parts, if to be reused, should be reinstalled in the original positions and directions.
- Bolts, nuts and washers should be replaced with new parts as required.
- Even if necessary inspections have been made in advance, proceed with assembly work while making rechecks.
- Remove or install the engine in an area where chain hoists, lifting devices, etc. are available for ready use.
- Be sure not to damage coated surfaces of body panels with tools, or 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.

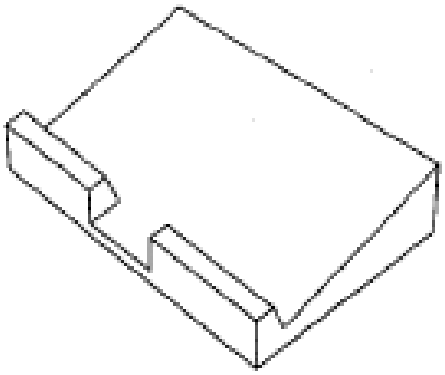
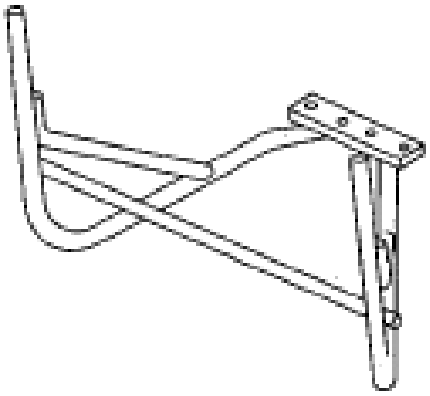
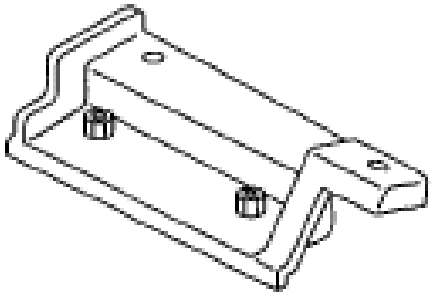
- Lift up or lower the vehicle when necessary. Make sure to support the correct positions.

PREPARATION TOOL

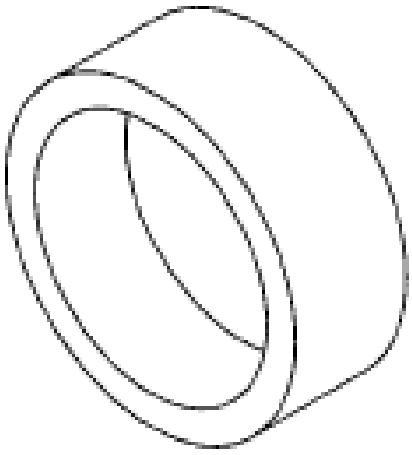
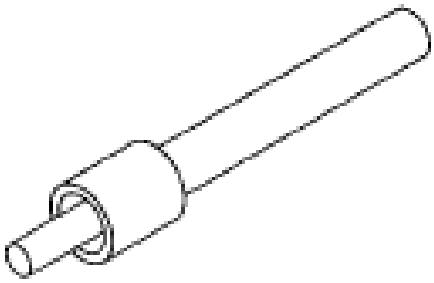
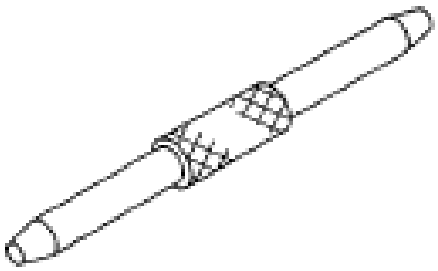
SPECIAL TOOL

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	498267600	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.

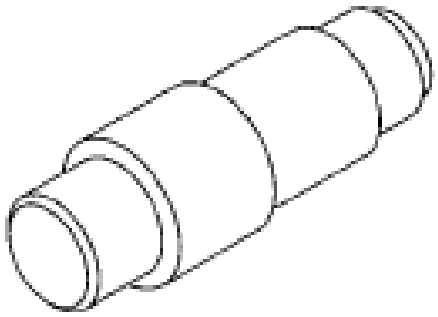
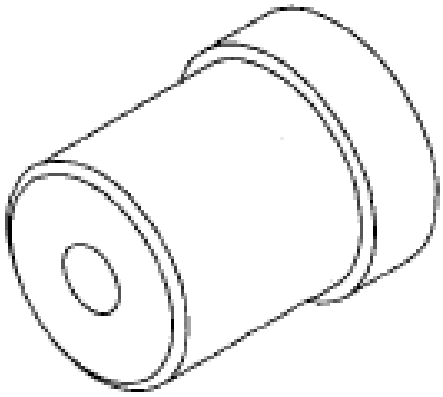
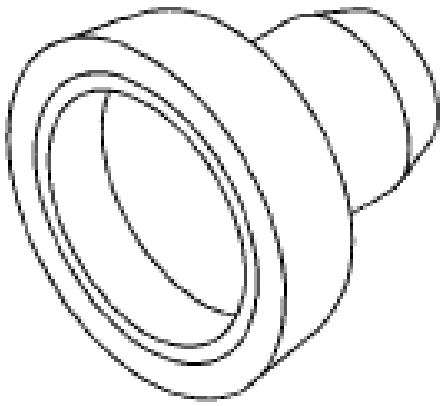
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 ST-498267600			
 ST-499817100	498457000	ENGINE STAND ADAPTER RH	Used together with ENGINE STAND (499817100).
 ST-498457100	498457100	ENGINE STAND ADAPTER LH	Used together with ENGINE STAND (499817100).
	498747300	PISTON GUIDE	Used for installing the piston into the cylinder.

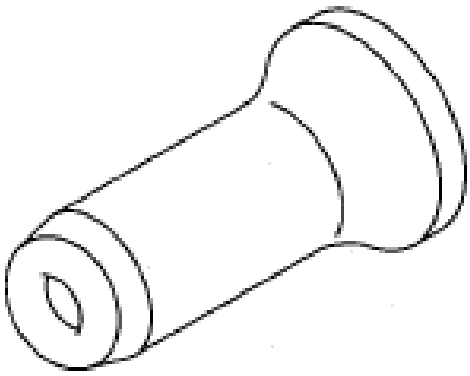
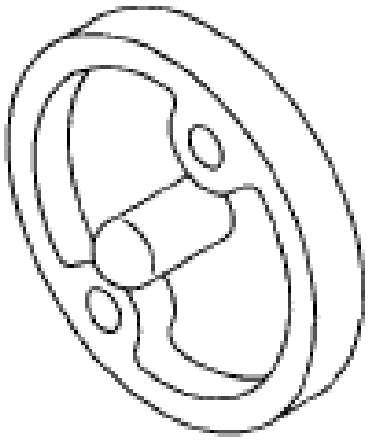
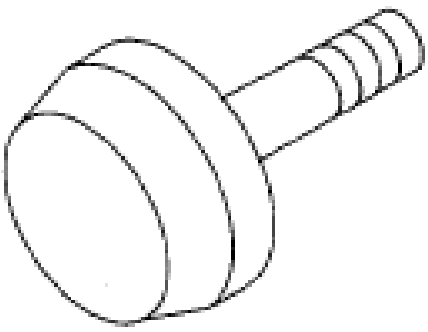
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 ST-498747300			
 ST-498857100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST-499017100	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.

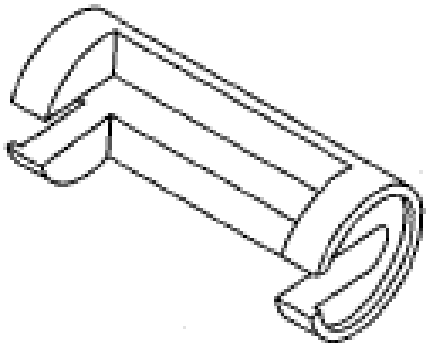
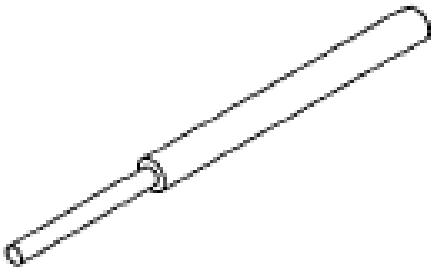
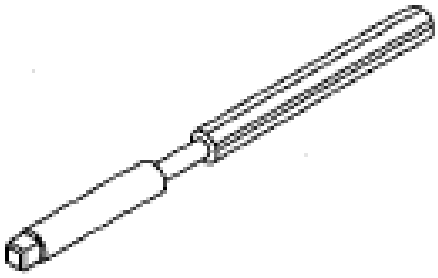
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 ST-499037100			
 ST-499587100	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
	499587600	OIL SEAL INSTALLER	Used for installing the camshaft oil seal.

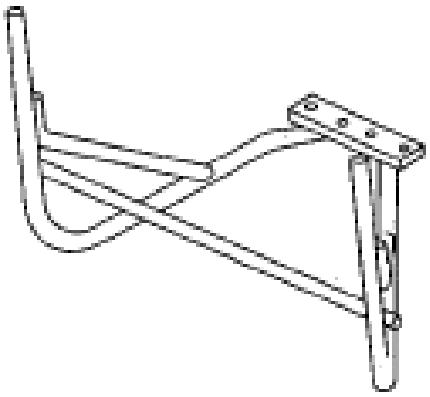
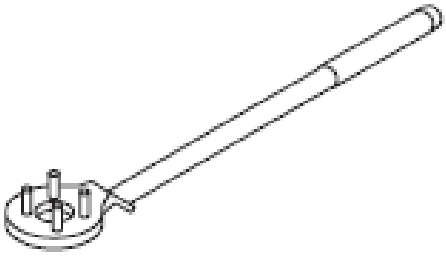
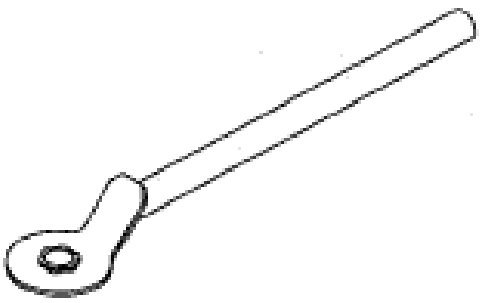
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 ST-499587600			
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499597200	499597200	OIL SEAL GUIDE	• Used for installing the camshaft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

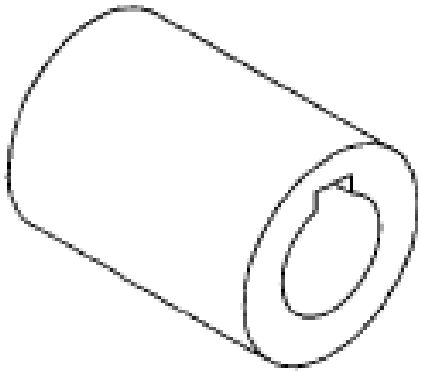
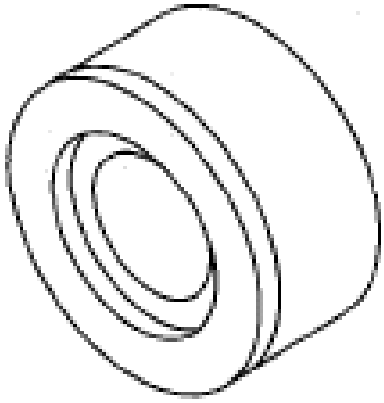
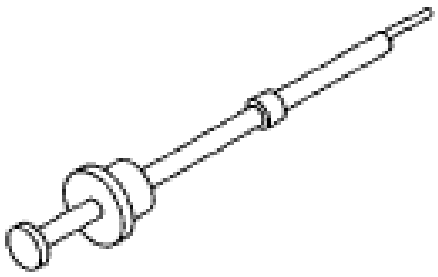
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 ST-499718000			
 ST-499767200	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST-499767400	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
	499817100	ENGINE STAND	• Used for disassembling and assembling engine. • Used together with ENGINE STAND

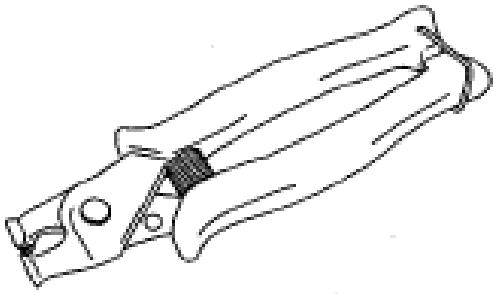
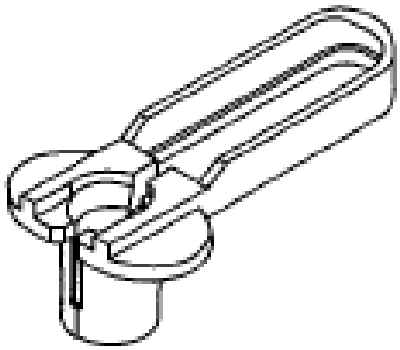
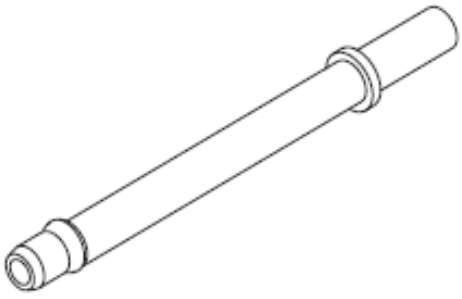
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 ST-499817100			ADAPTER RH (498457000) & LH (498457100).
 ST-499977100	499977100	CRANK PULLEY WRENCH	Used for removing and installing the crank pulley.
 ST-499977500	499977500	CAM SPROCKET WRENCH	Used for removing and installing intake cam sprocket and exhaust cam sprocket.
	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.

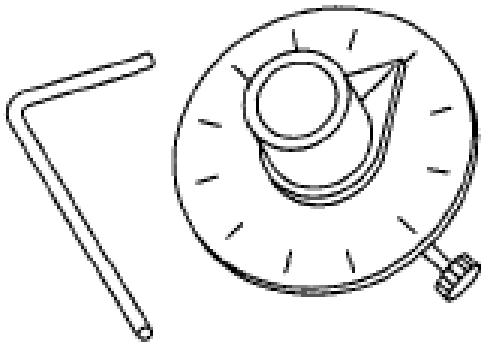
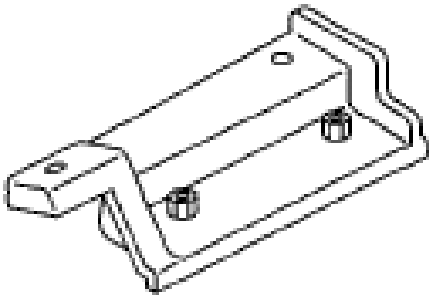
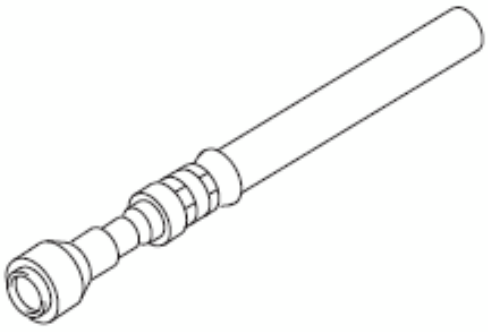
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 ST-499987500			
 ST18251AA020	18251AA020	VALVE GUIDE ADJUSTER	Used for installing intake and exhaust valve guides.
 ST-499097700	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
	18353AA000	CLAMP PLIERS	• Used for removing and installing the PCV hose. • This tool is made

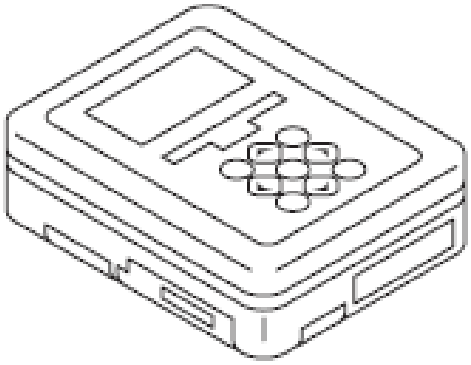
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 ST18353AA000			by the French company CAILLAU. (code) 54.0.000.205 To make it easier to obtain, it has been provided with a tool number.
 ST18371AA000	18371AA000	CONNECTOR REMOVER	Used for disconnecting the quick connector on the fuel return hose side of the engine compartment (intake manifold).
 ST18471AA000	18471AA000	FUEL PIPE ADAPTER	Used for inspecting the fuel pressure.
	18854AA000	ANGLE GAUGE	Used for installing the crank pulley.

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 ST18854AA000			
 ST-498457000	42099AE000	QUICK CONNECTOR RELEASE	Used for disconnecting quick connector of the engine compartment.
 ST42075AG690	42075AG690	FUEL HOSE	Used for inspecting the fuel pressure. **NOTE:** **This is the SUBARU genuine part.**
	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for various inspections.

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 ST1B022XU0			

GENERAL TOOL

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

COMPRESSION

INSPECTION

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

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

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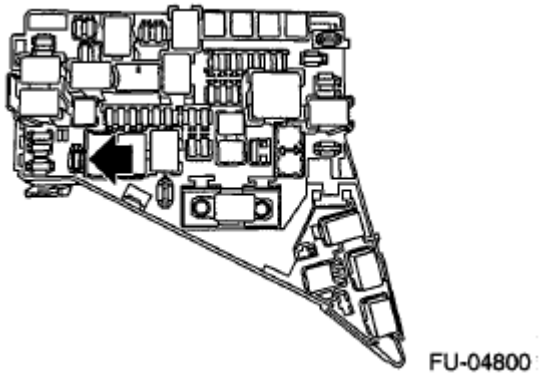


Fig. 8: Locating Fuse Of Fuel Pump
Courtesy of SUBARU OF AMERICA, INC.

5. Start the engine and run it until it stalls.
6. After the engine stalls, crank it for five more seconds.
7. Turn the ignition switch to OFF.
8. Remove all spark plugs. Refer to **SPARK PLUG** .
9. Fully open the throttle valve.
10. Check the starter motor for satisfactory performance and operation.
11. 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.

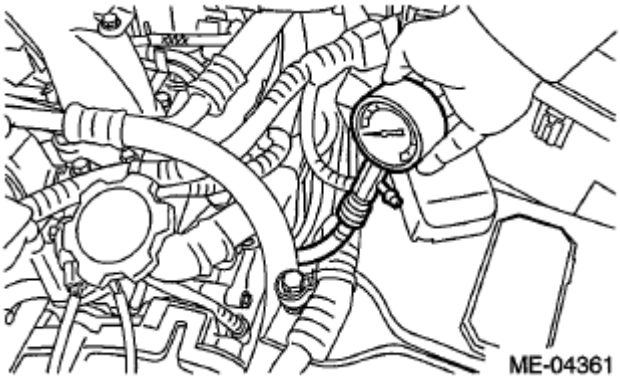


Fig. 9: Installing Compression Gauge To Spark Plug Hole
Courtesy of SUBARU OF AMERICA, INC.

12. 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.**

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- **If the compression pressure is out of standard, check or adjust the pistons, valves and cylinders.**

Compression (fully open throttle):

Standard

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

Difference between cylinders

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

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

IDLE SPEED

INSPECTION

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

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". Refer to EN(H4DOTC) 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 gear shift lever in neutral position):

Standard

700±100 RPM

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.)

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Idle speed (A/C ON and 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.

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. Refer to **READ CURRENT DATA FOR ENGINE (NORMAL MODE)** .

NOTE: If ignition timing is out of standard, check the ignition control system. Refer to "Engine Control System". Refer to EN(H4DOTC) (diag)-2, BASIC DIAGNOSTIC PROCEDURE .

Ignition timing [BTDC/RPM]:

Standard

15°±10°/700

INTAKE MANIFOLD VACUUM

INSPECTION

1. Warm up the engine.
2. Remove the collector cover.
3. Remove the intercooler. Refer to **INTERCOOLER** .
4. Disconnect the brake booster vacuum hose from the intake manifold, and attach the vacuum gauge.

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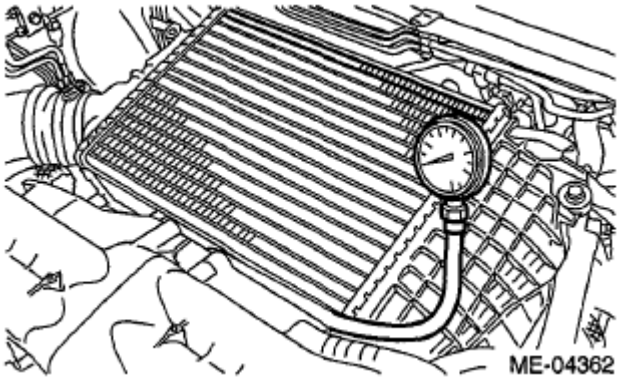


Fig. 10: Identifying Vacuum Gauge
Courtesy of SUBARU OF AMERICA, INC.

5. Install the intercooler. Refer to **INTERCOOLER** .
6. 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

-66.7 kPa (-500 mmHg, -19.70 inHg) or more

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

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, or disconnected or damaged 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

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

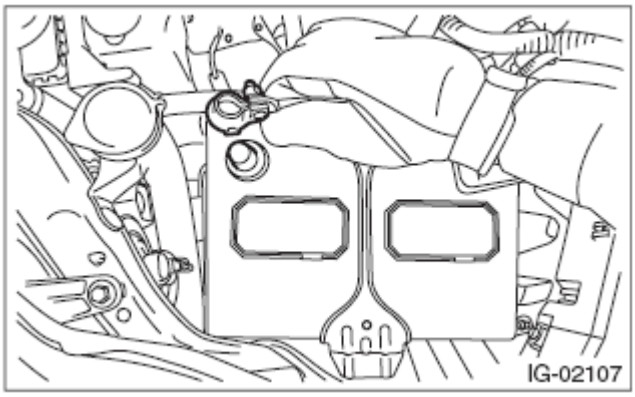


Fig. 11: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the oil pressure switch. Refer to **OIL PRESSURE SWITCH** .
4. Install the oil pressure gauge to cylinder block.

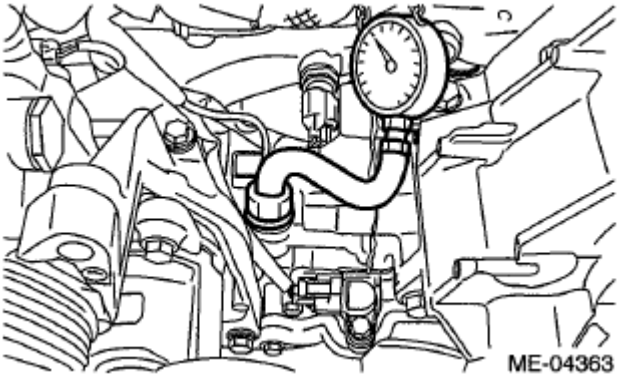


Fig. 12: Installing Oil Pressure Gauge To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

5. Connect the battery ground terminal.

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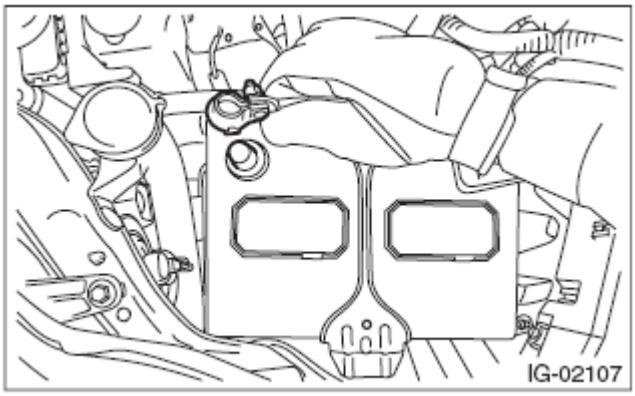


Fig. 13: Connecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

6. Start the engine, and check 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. Refer to 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. Refer to ENGINE LUBRICATION SYSTEM TROUBLE IN GENERAL .**

Engine oil pressure:

Standard

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

392 kPa (4.0 kgf/cm^2 , 57 psi) or more (at 6, 000 RPM)

7. 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. Remove the collector cover.

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2. Release the fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** .
3. Open the fuel filler lid and remove the fuel filler cap.
4. Disconnect the fuel delivery hose from fuel damper, and connect 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 ST in the direction of arrow mark to disconnect the quick connector of the fuel delivery hose.

   ST 42099AE000 QUICK CONNECTOR RELEASE

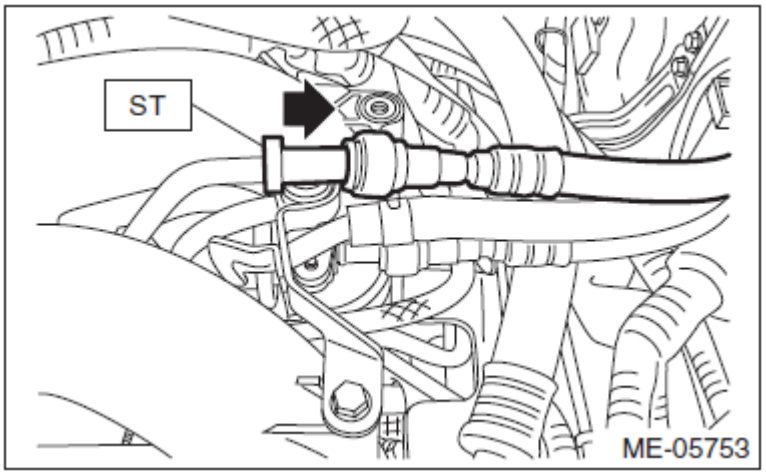


Fig. 14: Identifying Quick Connector Release
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the fuel pressure gauge with ST1 and ST2.

NOTE: **ST1 is a SUBARU genuine part**

ST1 42075AG690 FUEL HOSE

ST2 18471AA000 FUEL PIPE ADAPTER

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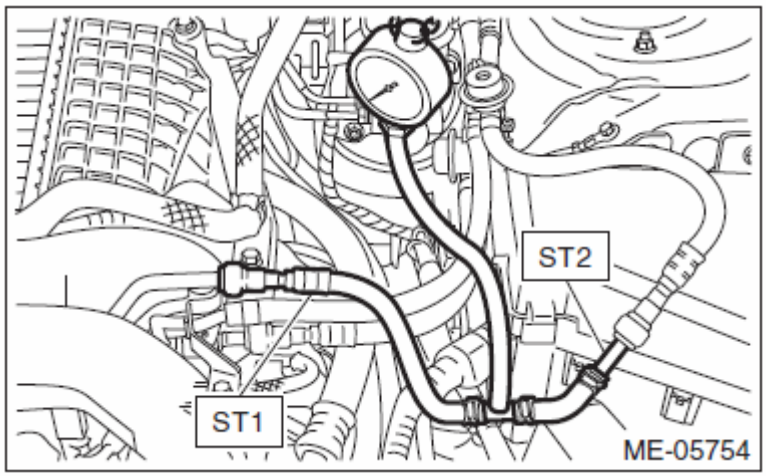


Fig. 15: Connecting Fuel Pressure Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- **The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kgf/cm^2 , 1 to 3 psi) higher than standard values during high-altitude operations.**
- **If the fuel pressure is out of specification, check or replace the fuel pump, fuel line, pressure regulator and pressure regulator vacuum hose.**

Fuel pressure:

Standard

328 - 358 kPa (3.3 - 3.7 kgf/cm^2 , 48 - 52 psi)

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

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.**
- **If the fuel pressure is out of specification, check or replace the fuel pump, fuel line, pressure regulator and pressure regulator vacuum hose.**

Fuel pressure:

Standard

274 - 304 kPa (2.8 - 3.1 kgf/cm^2 , 40 - 44 psi)

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

Tightening torque:

1.25 N.m (0.1 kgf-m, 0.9 ft-lb)

VALVE CLEARANCE

INSPECTION

1. Remove the engine from the vehicle. Refer to , **REMOVAL**, Engine Assembly.
2. When inspecting #1 and #3 cylinders
    1. Remove the timing belt cover RH. Refer to , **TIMING BELT**, REMOVAL, Timing Belt.
    2. Disconnect the connectors from exhaust oil flow control solenoid valve RH (A) and exhaust camshaft position sensor RH (B).

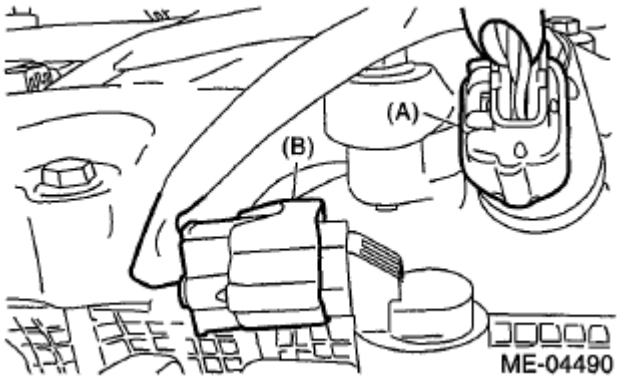


Fig. 16: Identifying Exhaust Oil Flow Control Solenoid Valve Connector And Exhaust Camshaft Position Sensor
Courtesy of SUBARU OF AMERICA, INC.

    3. Remove the clip which holds the engine harness to the rocker cover.

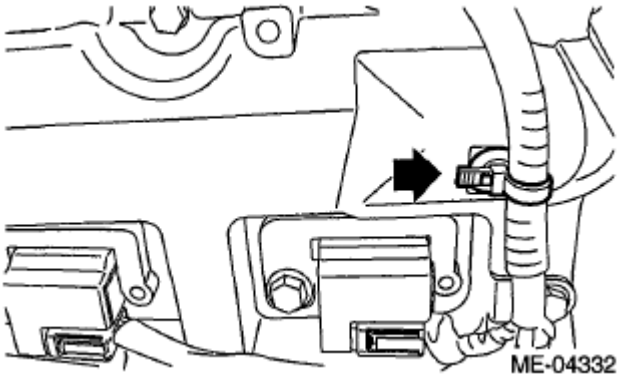


Fig. 17: Locating Engine Harness Clip

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Courtesy of SUBARU OF AMERICA, INC.

4. Remove the ignition coil. Refer to **IGNITION COIL** .
5. Disconnect PCV hose and vacuum hose from the rocker cover RH.

NOTE: Pinch the clamp of the PCV hose by fitting the cut out in the ST with the protrusion on the clamp as shown in the figure, and unlock the clamp.

ST 18353AA000 CLAMP PLIERS

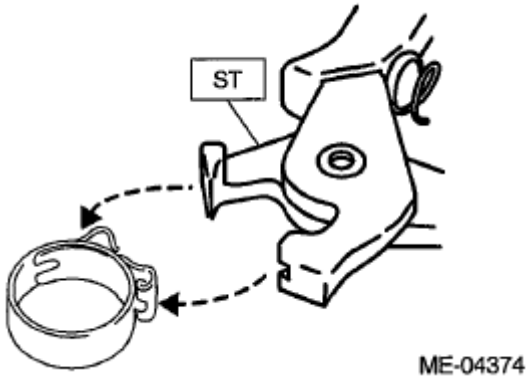


Fig. 18: Identifying Clamp Pliers (ST 18353AA000)
Courtesy of SUBARU OF AMERICA, INC.

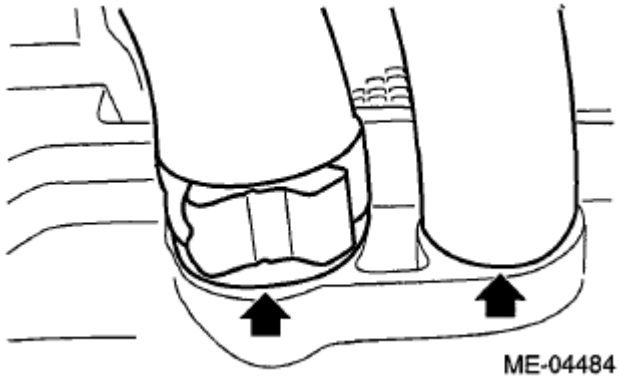


Fig. 19: Locating Rocker Cover
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the rocker cover RH.

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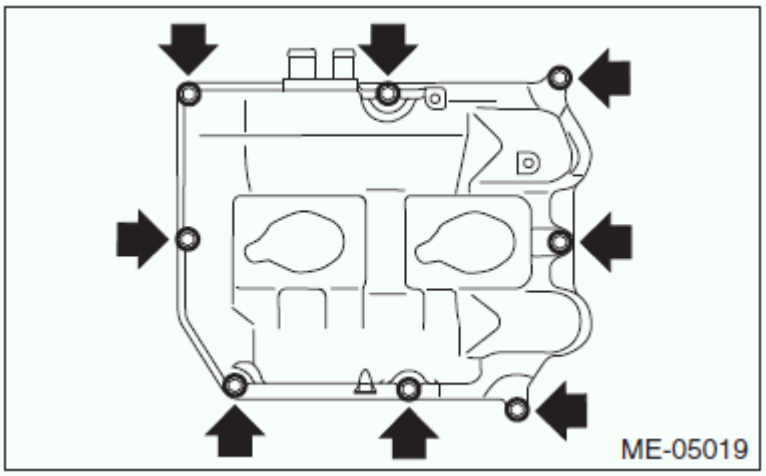


Fig. 20: Identifying Rocker Cover RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. When inspecting #2 and #4 cylinders
    1. Remove the timing belt cover RH. Refer to , **REMOVAL**, Timing Belt.
    2. Disconnect the connectors from exhaust oil flow control solenoid valve LH (A) and exhaust camshaft position sensor LH (B).

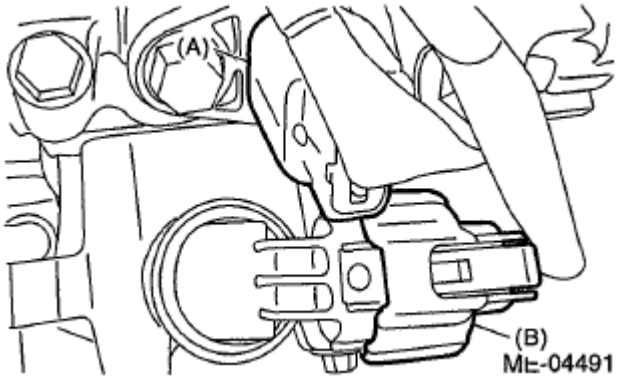


Fig. 21: Disconnecting Exhaust Oil Flow Control Solenoid Valve Connector
Courtesy of SUBARU OF AMERICA, INC.

    3. Disconnect the oil level switch connector.

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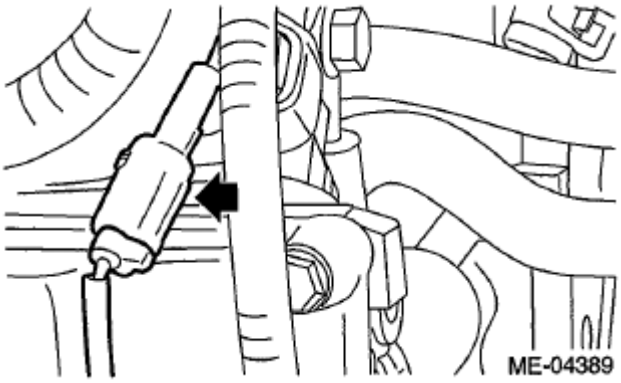


Fig. 22: Locating Oil Level Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the clip (A) and bolt (B) securing the engine harness or oil level switch harness to the rocker cover LH.

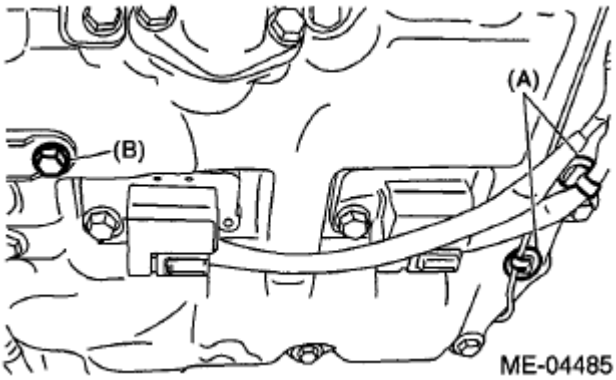


Fig. 23: Identifying Clip And Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the ignition coil. Refer to **IGNITION COIL** .
6. Disconnect PCV hose and vacuum hose from the rocker cover LH.

NOTE: Pinch the clamp of the PCV hose by fitting the cut out in the ST with the protrusion on the clamp as shown in the figure, and unlock the clamp.

ST 18353AA000 CLAMP PLIERS

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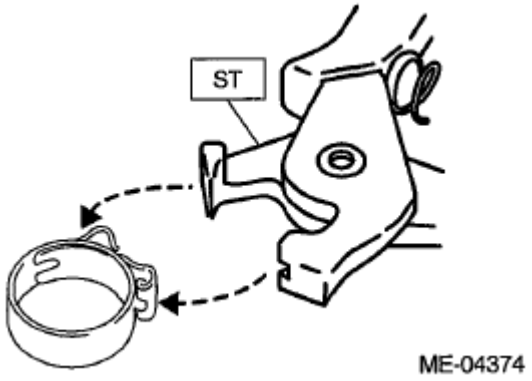


Fig. 24: Identifying Clamp Pliers (ST 18353AA000)
Courtesy of SUBARU OF AMERICA, INC.

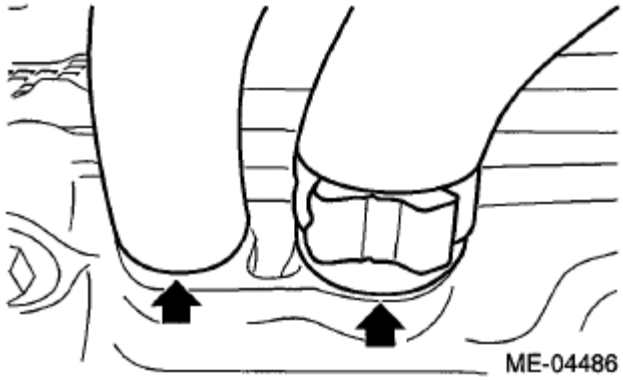


Fig. 25: Locating Rocker Cover
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the rocker cover LH.

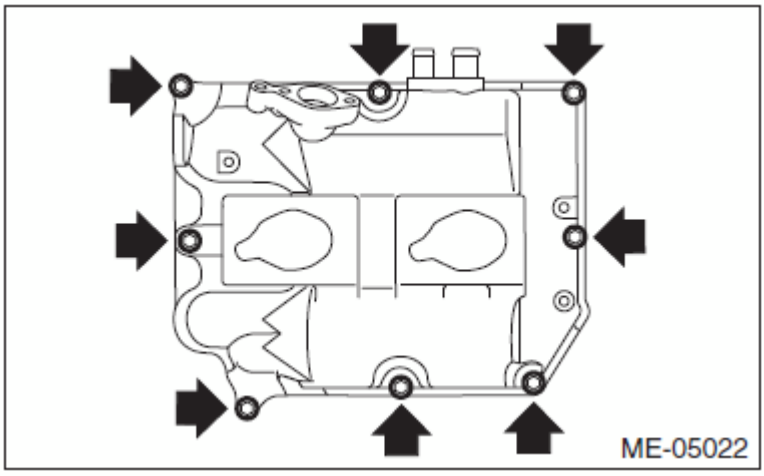


Fig. 26: Identifying Rocker Cover LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

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4. Turn the crank pulley clockwise until the round mark on the camshaft sprocket is set to position shown in the figure.

NOTE: Turn the crank pulley using a socket wrench.

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

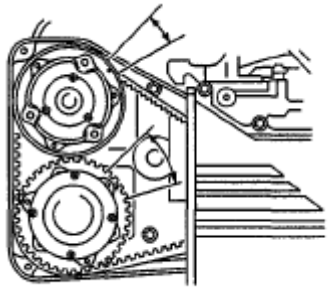


Fig. 27: Measuring Clearance Of #1 Cylinder Intake Valve And #3 Cylinder Exhaust Valve
Courtesy of SUBARU OF AMERICA, INC.

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

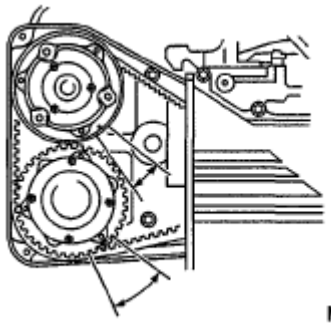
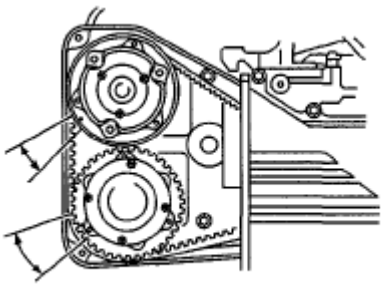


Fig. 28: Measuring Clearance Of #2 Cylinder Exhaust Valve And #3 Cylinder Intake Valve
Courtesy of SUBARU OF AMERICA, INC.

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



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Fig. 29: Measuring Clearance Of #2 Cylinder Intake Valve And #4 Cylinder Exhaust Valve
Courtesy of SUBARU OF AMERICA, INC.

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

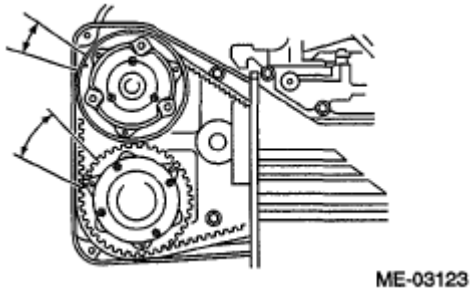


Fig. 30: Measuring Clearance Of Intake Valve And Exhaust Valve Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

5. Measure the clearance of intake valve and exhaust valve using thickness gauge (A).

NOTE:

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

Valve clearance (inspection value):

Intake

$0.20^{+0.04}_{-0.06}$ ***mm*** $(0.0079^{+0.0016}_{-0.0024}$ ***in)***

Exhaust

0.35±0.05 mm (0.0138±0.0020 in)

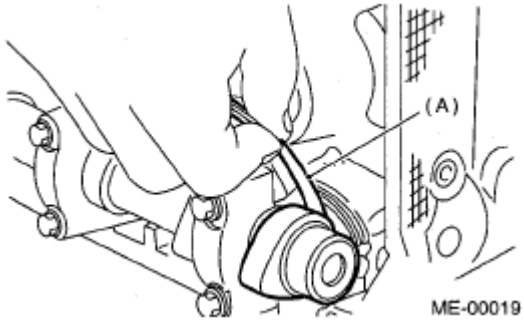


Fig. 31: Identifying Clamp Pliers (ST 18353AA000)

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Courtesy of SUBARU OF AMERICA, INC.

6. If necessary, adjust the valve clearance. Refer to , **ADJUSTMENT**, Valve Clearance.
7. After inspection, install the related parts in the reverse order of removal.

NOTE:

- **Refer to "Camshaft" when installing the rocker cover. Refer to , INSTALLATION, Camshaft.**
- **Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the figure, and lock the clamp.**

ST 18353AA000 CLAMP PLIERS

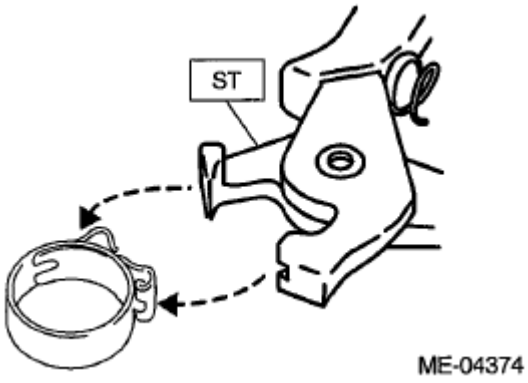


Fig. 32: Locating Oil Level Switch Harness Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

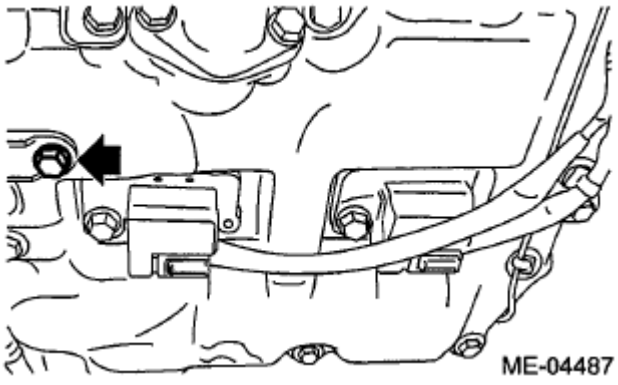


Fig. 33: Measuring Value Of Each Valve Clearance
Courtesy of SUBARU OF AMERICA, INC.

ADJUSTMENT

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

NOTE: Record the measured value of each valve clearance.

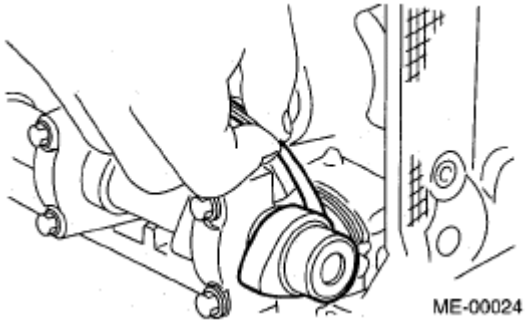


Fig. 34: Measuring Thickness Of Valve Lifter Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

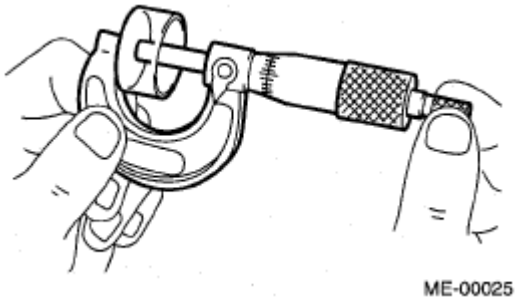


Fig. 35: Identifying Front Hood Damper Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new valve lifter.

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

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

   Valve clearance (adjustment value):

   Intake

   $0.20^{+0.01}_{-0.03}$ mm ($0.0079^{+0.0004}_{-0.0012}$ in)

   Exhaust

   0.35±0.02 mm (0.0138±0.0008 in)

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

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)

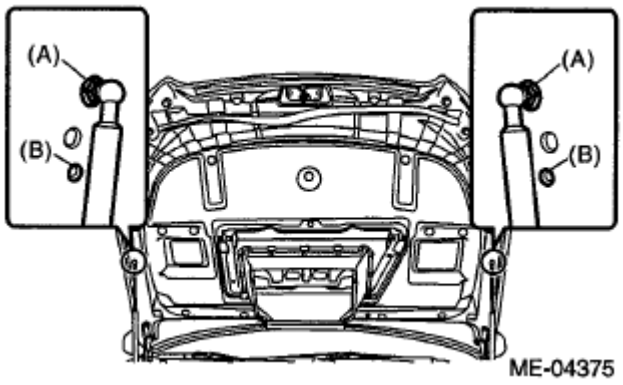


Fig. 36: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the collector cover.
3. Collect the refrigerant from A/C system. Refer to **REFRIGERANT RECOVERY PROCEDURE** .

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4. Release the fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** .
5. Disconnect the ground cable from battery.

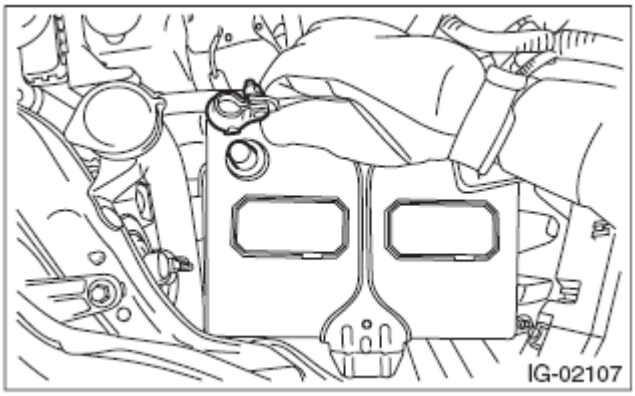


Fig. 37: Locating Bulkhead Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

6. Open the fuel filler lid and remove the fuel filler cap.
7. Remove the air intake duct. Refer to **AIR INTAKE DUCT** .
8. Remove the intercooler. Refer to **INTERCOOLER** .
9. Remove the air by-pass valve. Refer to **AIR BY-PASS VALVE** .
10. Remove the radiator. Refer to **RADIATOR** .
11. Remove the front exhaust pipe. Refer to **FRONT EXHAUST PIPE** .
12. Lower the vehicle.
13. Disconnect the bulkhead harness connector from the engine harness connector (brown).

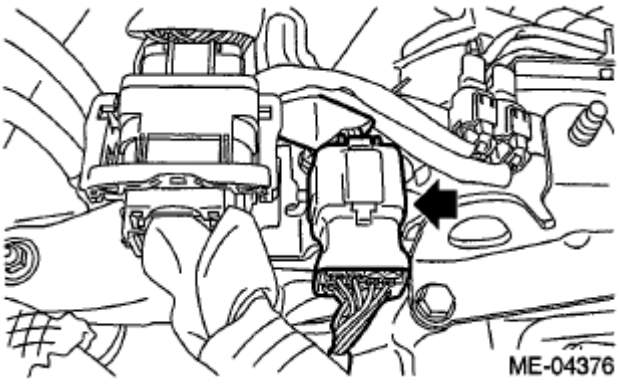


Fig. 38: Locating Bulkhead Harness Connector Bracket Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the bolt securing the bulkhead harness connector bracket, and disconnect the bulkhead harness connector from the engine harness connector (black).

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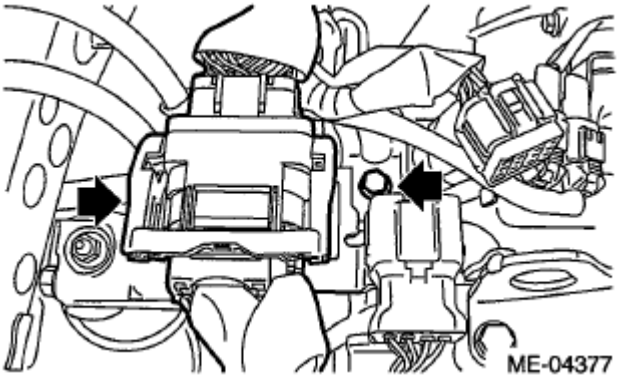


Fig. 39: Identifying A/C Compressor Connectors
Courtesy of SUBARU OF AMERICA, INC.

15. Disconnect the connector (A) and connector (B) from A/C compressor, and remove the clip (C) securing the generator cord to the intake manifold protector LH.

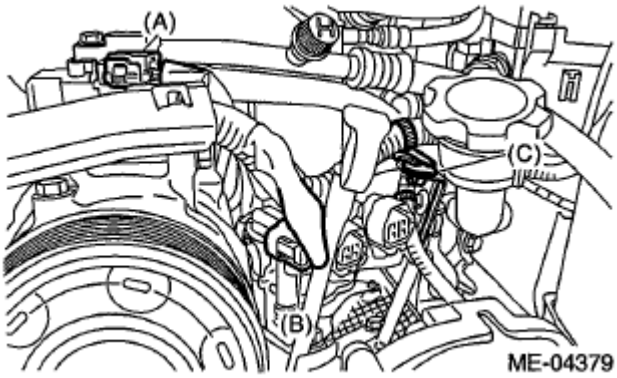
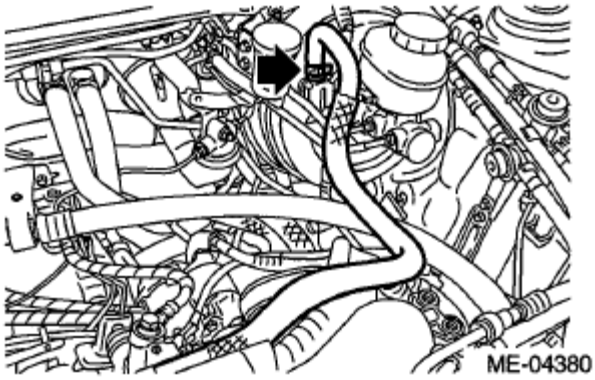


Fig. 40: Locating Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

16. Disconnect the following hoses.
    1. A/C pressure hose Refer to **REMOVAL** .
    2. Brake booster vacuum hose



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Fig. 41: Locating Heater Inlet Hose And Heater Outlet Hose
Courtesy of SUBARU OF AMERICA, INC.

3. Heater inlet hose and heater outlet hose

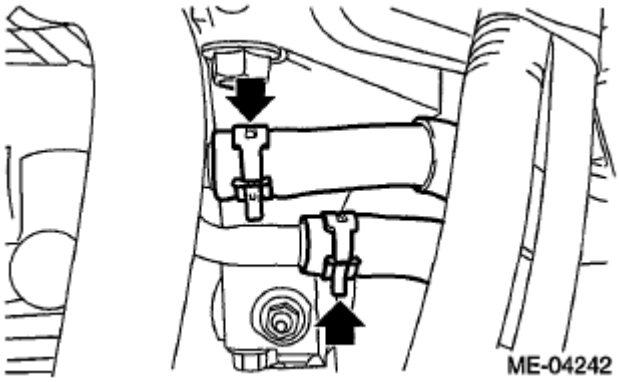


Fig. 42: Locating Air Intake Boot Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

17. Lift up the vehicle.
18. Remove the intake duct from the air intake boot.

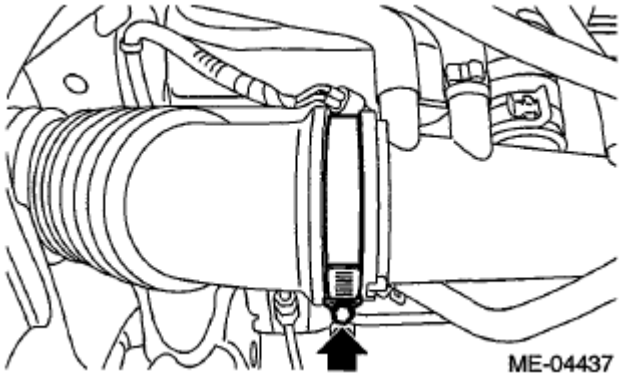


Fig. 43: Locating Engine Harness Cover Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

19. Disconnect the ground cable on the engine side, and remove the engine harness cover.

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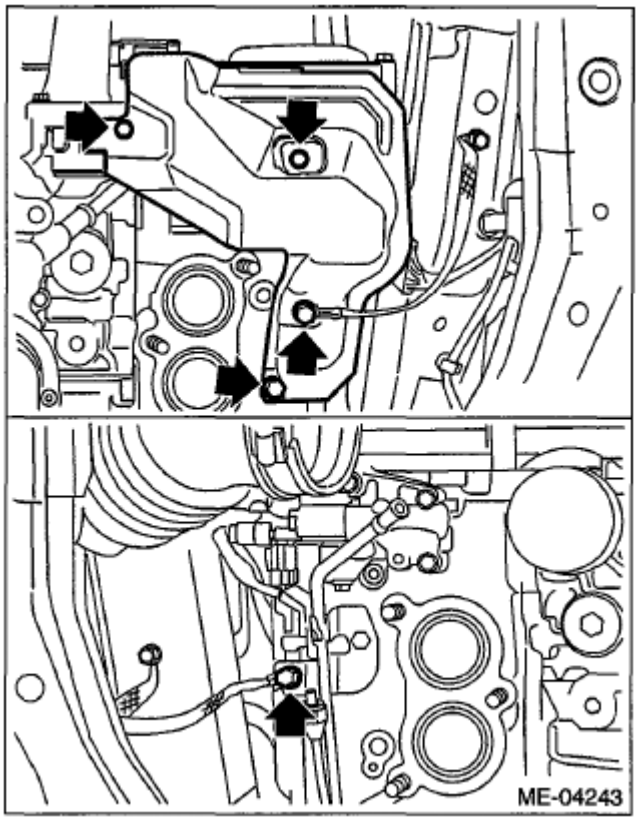


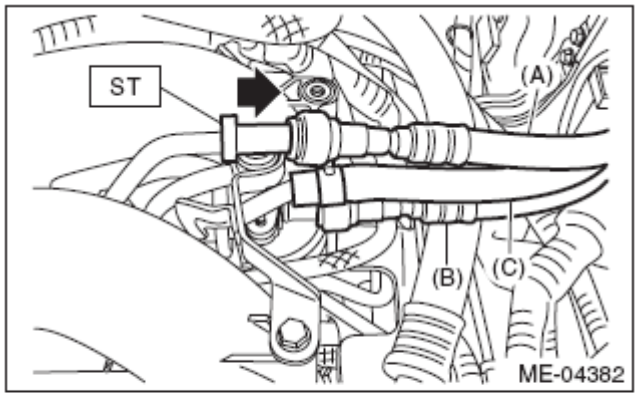
Fig. 44: Disconnecting Fuel Delivery Hose Using ST
Courtesy of SUBARU OF AMERICA, INC.

20. Lower the vehicle.
21. Attach ST to the fuel delivery pipe and push ST in the direction of arrow mark to disconnect the fuel delivery hose.

    ST 42099AE000 QUICK CONNECTOR RELEASE

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

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

Fig. 45: Disconnecting Fuel Return Hose Using ST
Courtesy of SUBARU OF AMERICA, INC.

22. Disconnect the fuel return hose using the ST.

ST 18371AA000 CONNECTOR REMOVER

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

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

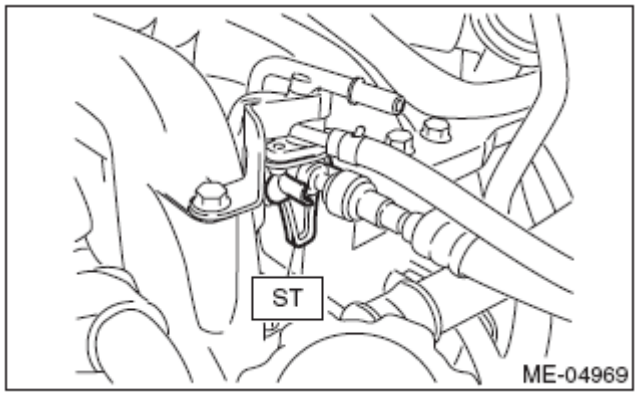


Fig. 46: Inserting ST Into Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

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

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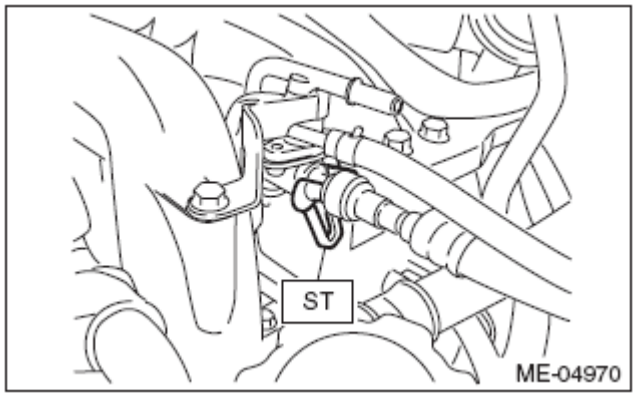


Fig. 47: Disconnecting Fuel Return Hose Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

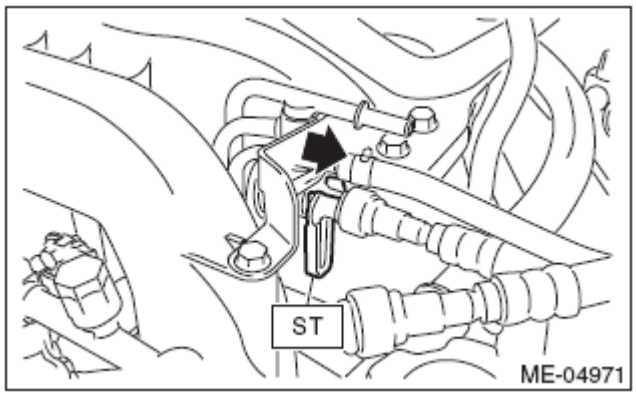


Fig. 48: Locating Evaporation Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

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

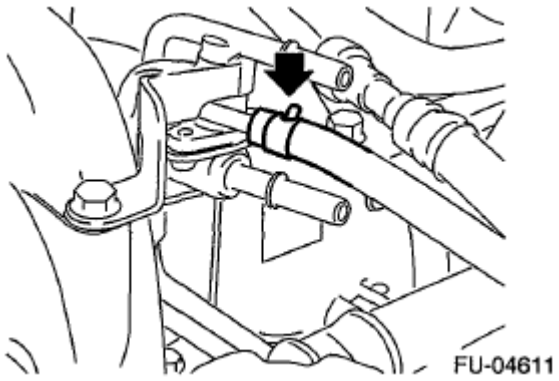


Fig. 49: Supporting Engine With Lifting Device And Wire Ropes

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Courtesy of SUBARU OF AMERICA, INC.

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

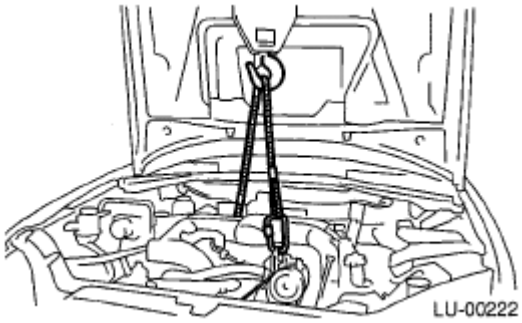


Fig. 50: Locating Stopper Rod Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

25. Remove the stopper rod.

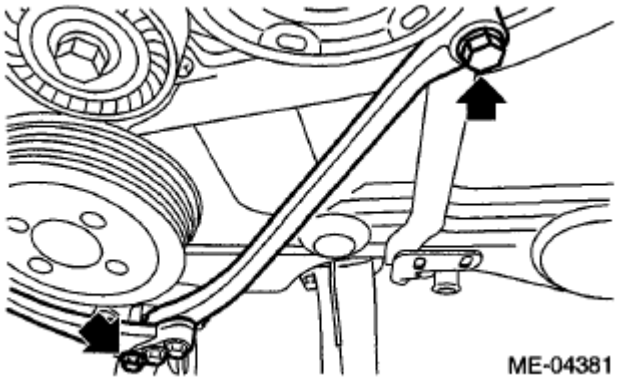
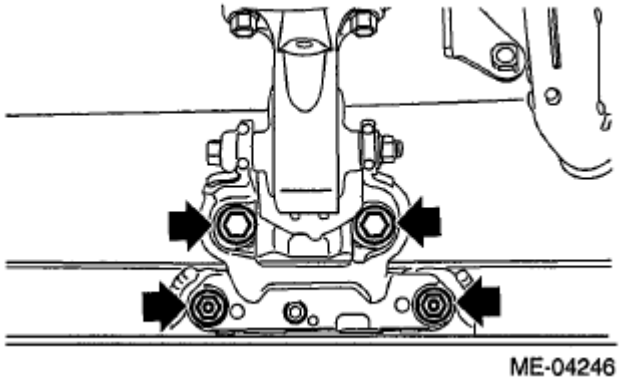


Fig. 51: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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



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Fig. 52: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

27. Lift up the vehicle.

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

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

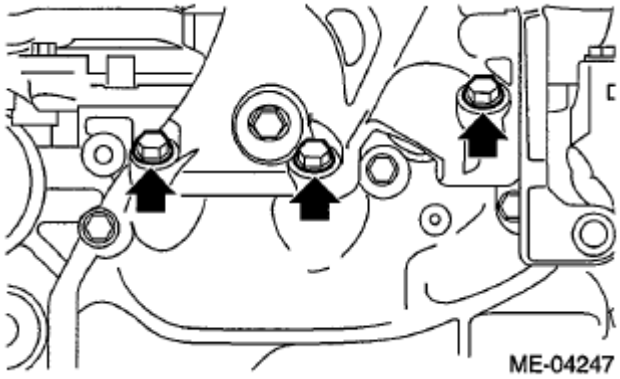


Fig. 53: Locating Transmission Lower Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

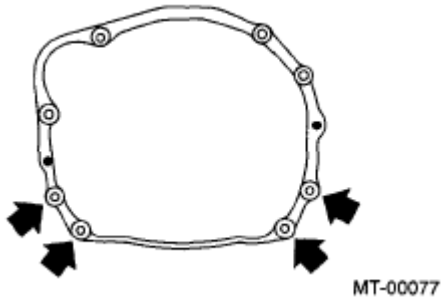


Fig. 54: Identifying Transmission And Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

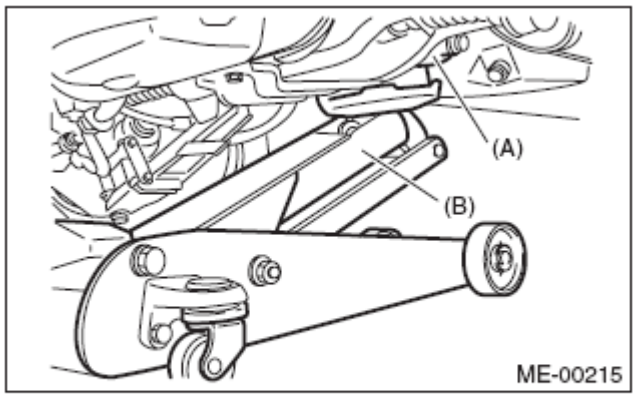
30. Lower the vehicle.

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

31. Support the transmission with a garage jack.

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



(A) Transmission
(B) Garage jack

Fig. 55: Locating Transmission Upper Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

32. Separation of engine and transmission

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

1. Remove the starter. Refer to **STARTER** .
2. Remove the bolts which hold the upper side of the transmission to the engine.

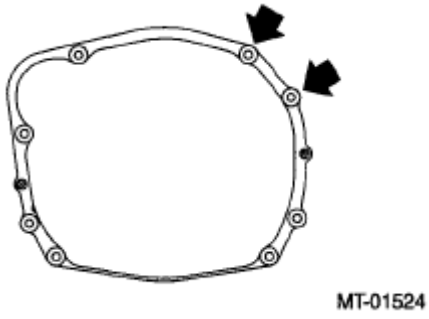


Fig. 56: Locating Transmission Upper Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

33. Remove the engine from vehicle.

1. Slightly raise the engine.
2. Adjust the height of the transmission with garage jack.

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3. Move the engine horizontally until main shaft is withdrawn from clutch cover.
4. Slowly move the engine away from engine compartment.

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

INSTALLATION

1. Apply a small amount of grease to splines of main shaft.

   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)

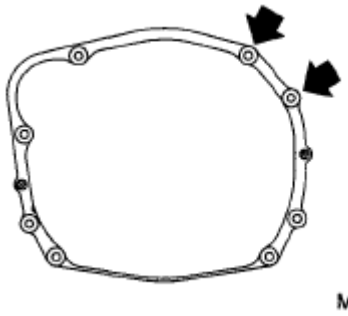


Fig. 57: Locating Transmission Lower Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the garage jack.
5. Install the starter. Refer to **STARTER** .
6. Lift up the vehicle.

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

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7. 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)

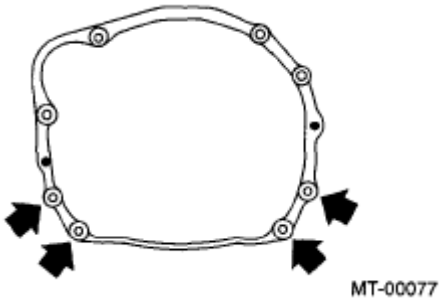


Fig. 58: Locating Engine Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

8. 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)

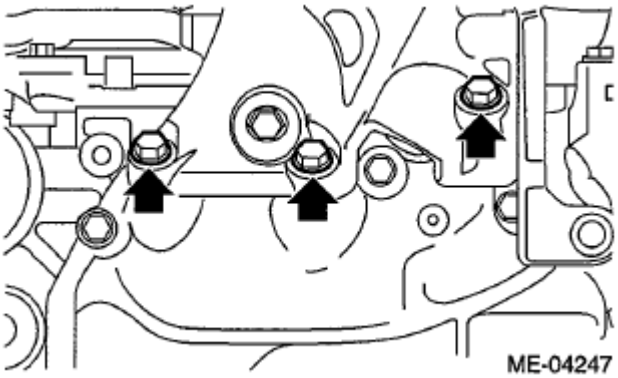


Fig. 59: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. Lower the vehicle.

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

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

    Tightening torque:

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

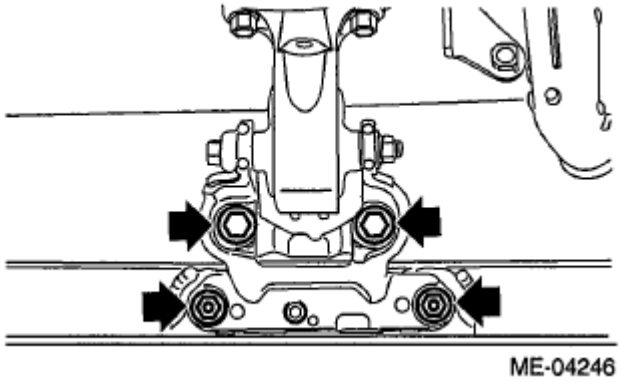


Fig. 60: Locating Stopper Rod Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

11. Install the stopper rod.

    Tightening torque:

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

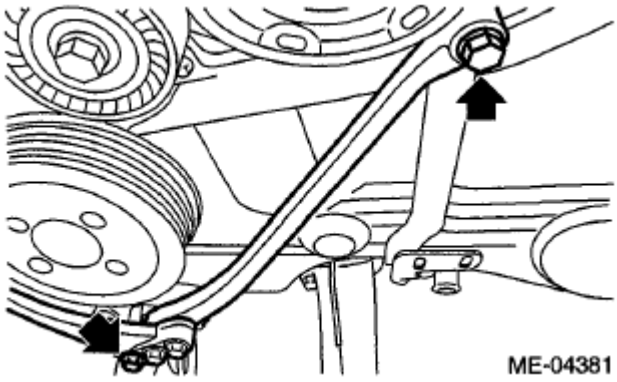


Fig. 61: Removing Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the lifting device and wire ropes.

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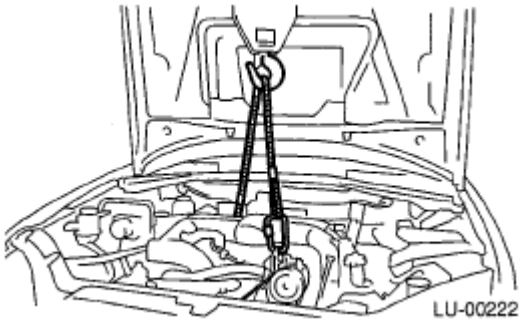


Fig. 62: Locating Air Intake Boot Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

13. Lift up the vehicle.
14. Install the intake duct to the air intake boot.

Tightening torque:

2.5 N.m (0.3 kgf-m, 1.8 ft-lb)

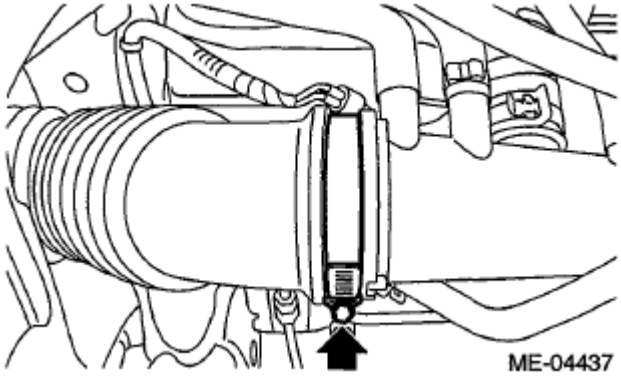


Fig. 63: Identifying Engine Harness Cover Mounting Bolt With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

15. Install the engine harness cover, and connect the ground cable.

Tightening torque:

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

T2: 7 N.m (0.7 kgf-m, 5.2 ft-lb)

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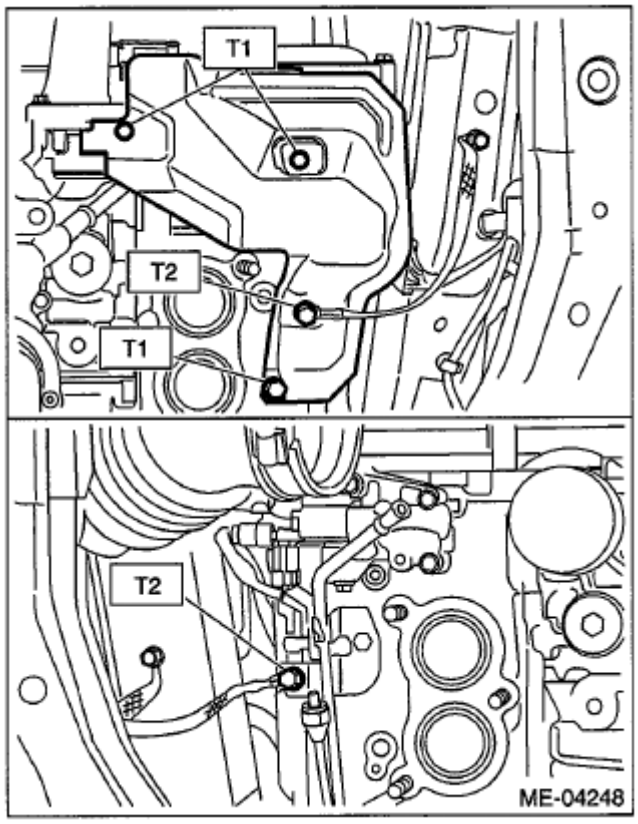


Fig. 64: Identifying A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

16. Lower the vehicle.
17. Connect the following hoses.
    1. Fuel delivery hose, fuel return hose and evaporation hose
    2. Heater inlet hose and heater outlet hose
    3. Brake booster vacuum hose
    4. A/C pressure hose Refer to **INSTALLATION** .
18. Install the clip (C) securing the generator cord to the intake manifold protector LH, and connect the connector (A) and connector (B) to the A/C compressor.

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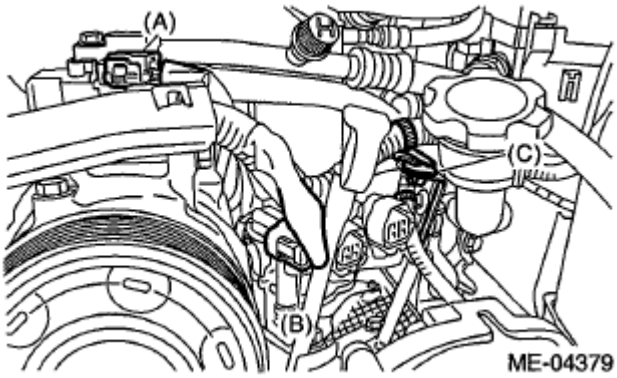


Fig. 65: Locating Bulkhead Harness Connector Bracket Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

19. Connect the bulkhead harness connector to the engine harness connector (black), and install the bolt securing the bulkhead harness connector bracket.

    Tightening torque:

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

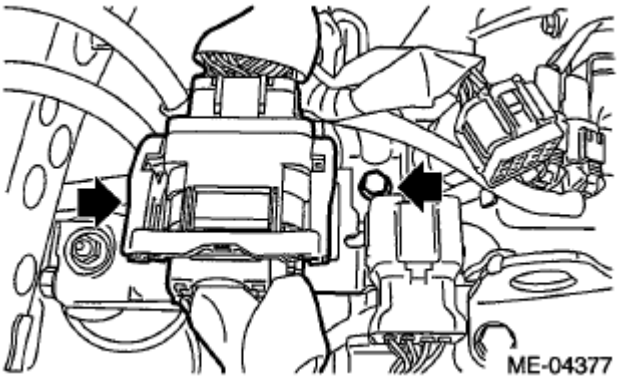


Fig. 66: Locating Bulkhead Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

20. Connect the bulkhead harness connector to the engine harness connector (brown).

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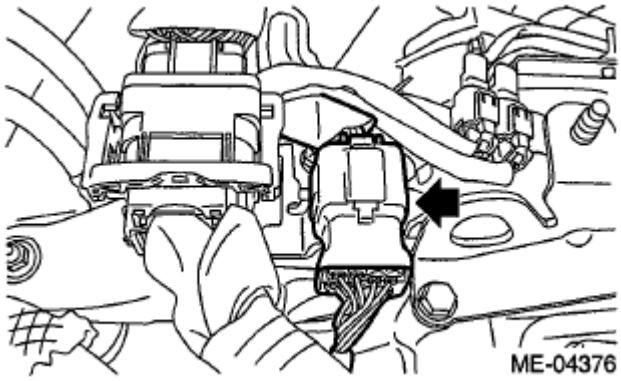


Fig. 67: Connecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

21. Install the front exhaust pipe. Refer to **FRONT EXHAUST PIPE** .
22. Install the radiator. Refer to **RADIATOR** .
23. Install the air by-pass valve. Refer to **AIR BY-PASS VALVE** .
24. Install the intercooler. Refer to **INTERCOOLER** .
25. Install the air intake duct. Refer to **AIR INTAKE DUCT** .
26. Connect the battery ground terminal.

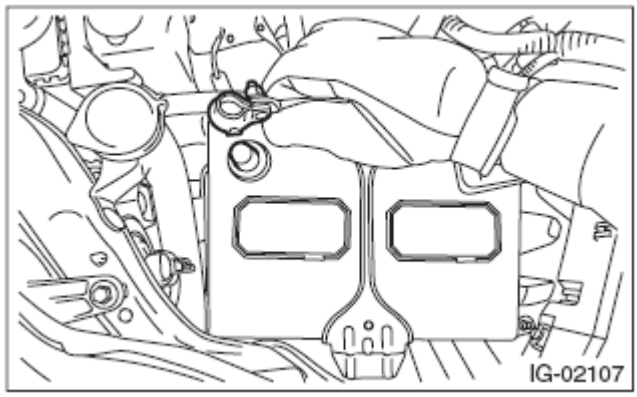


Fig. 68: Identifying Front Hood Damper Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

27. Fill engine coolant. Refer to **ENGINE COOLANT** .
28. Charge the A/C system with refrigerant. Refer to **PROCEDURE** .
29. Install the collector cover.
30. 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)

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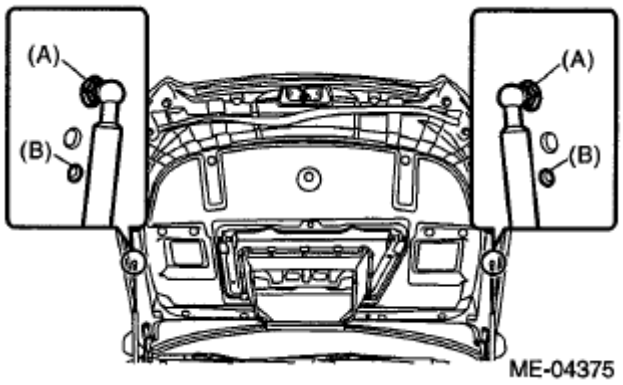


Fig. 69: Identifying Front Hood Damper Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

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. 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)

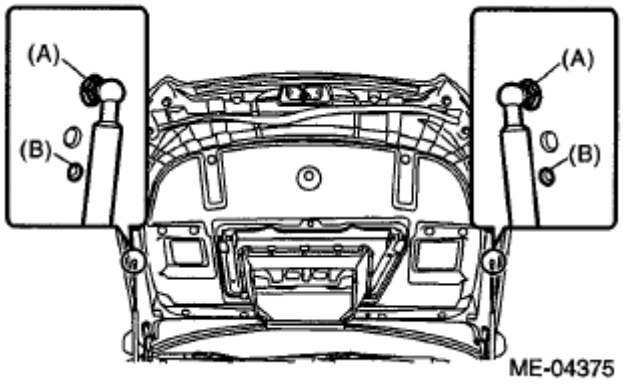


Fig. 70: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

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

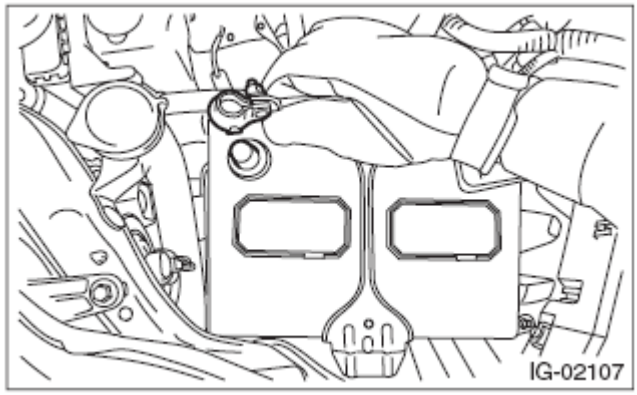


Fig. 71: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the intercooler. Refer to **INTERCOOLER** .
5. Remove the radiator main fan motor assembly and radiator sub fan motor assembly. Refer to **RADIATOR MAIN FAN AND FAN MOTOR** . Refer to **RADIATOR SUB FAN AND FAN MOTOR** .
6. Lift up the vehicle.
7. Remove the under cover. Refer to **FRONT UNDER COVER** .
8. Remove the front exhaust pipe. Refer to **FRONT EXHAUST PIPE** .
9. Lower the vehicle.
10. Support the engine with a lifting device and wire ropes.

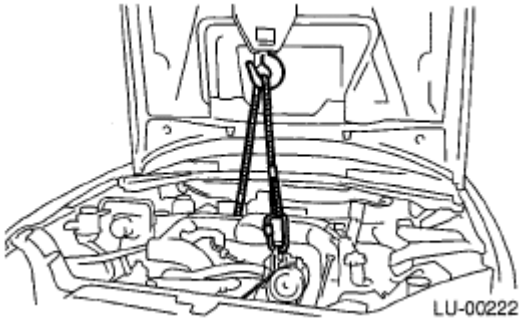


Fig. 72: Identifying Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the stopper rod.

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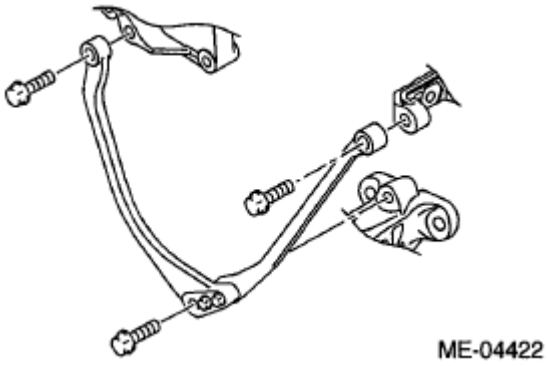


Fig. 73: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

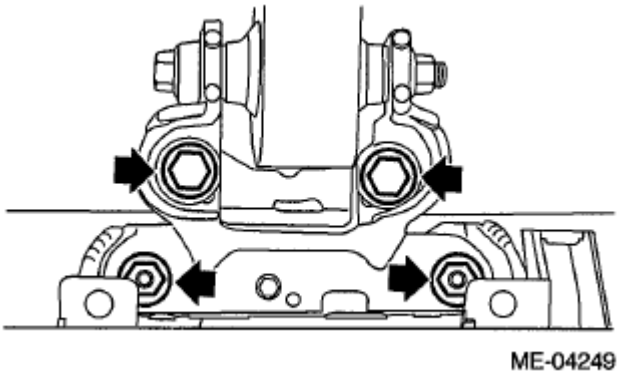


Fig. 74: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

13. Lift up the vehicle.

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

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

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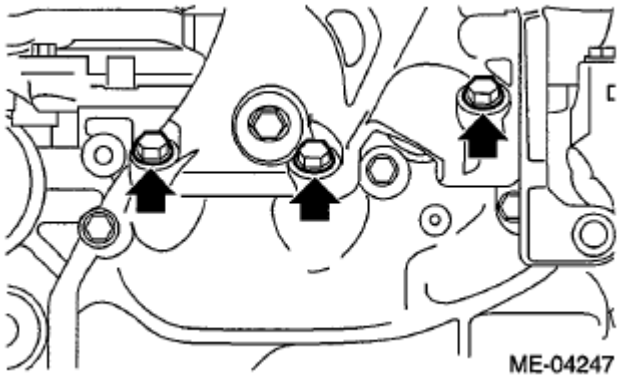


Fig. 75: Locating Engine Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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)

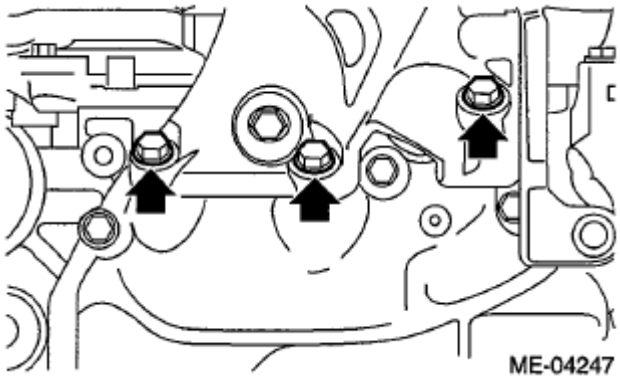


Fig. 76: Locating Engine Mounting Bolts And Nuts
Courtesy of SUBARU OF AMERICA, INC.

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)

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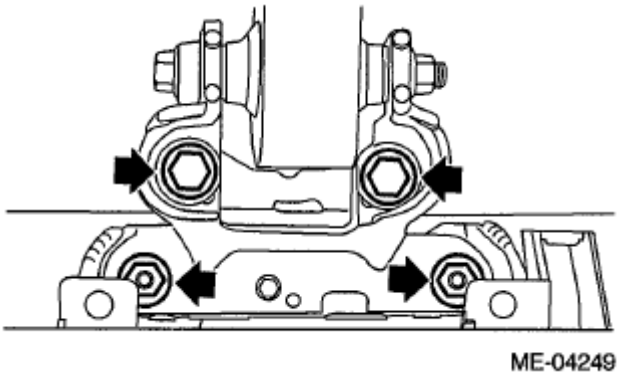


Fig. 77: Installing Stopper Rod
Courtesy of SUBARU OF AMERICA, INC.

4. Install the stopper rod.

   Tightening torque:

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

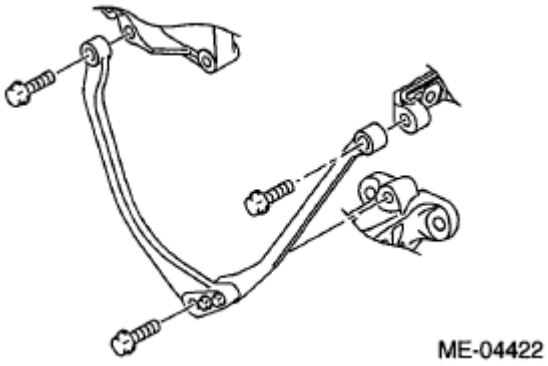


Fig. 78: Removing Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.

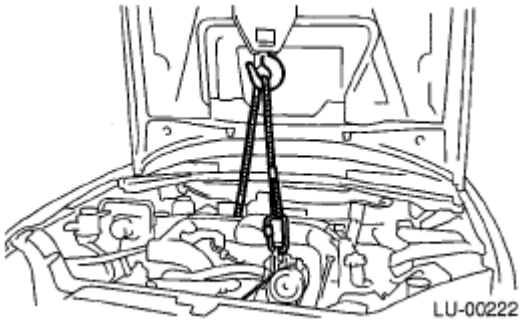


Fig. 79: Connecting Ground Cable To Battery

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Courtesy of SUBARU OF AMERICA, INC.

6. Lift up the vehicle.
7. Install the front exhaust pipe. Refer to **FRONT EXHAUST PIPE** .
8. Install the under cover. Refer to **FRONT UNDER COVER** .
9. Lower the vehicle.
10. Install the radiator main fan motor assembly and radiator sub fan motor assembly. Refer to **RADIATOR MAIN FAN AND FAN MOTOR** . Refer to **RADIATOR SUB FAN AND FAN MOTOR** .
11. Install the intercooler. Refer to **INTERCOOLER** .
12. Connect the ground cable to battery.

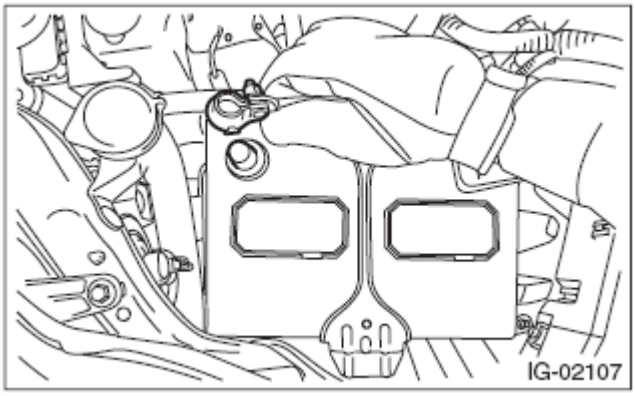


Fig. 80: Changing Front Hood Damper Mounting Position From (B) To (A)
Courtesy of SUBARU OF AMERICA, INC.

13. Install the collector cover.
14. 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)

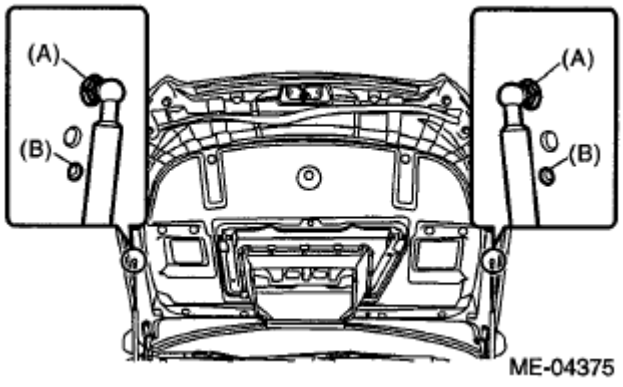


Fig. 81: Locating Turbocharger Upper Stay Clamping Bolts

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Courtesy of SUBARU OF AMERICA, INC.

DISASSEMBLY

1. Remove the turbocharger upper stay from the engine mounting bracket.

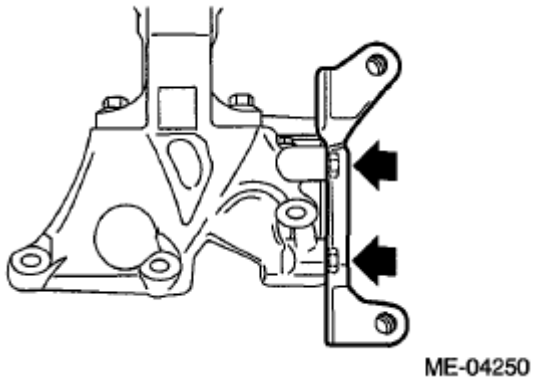


Fig. 82: Locating Engine Mounting Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

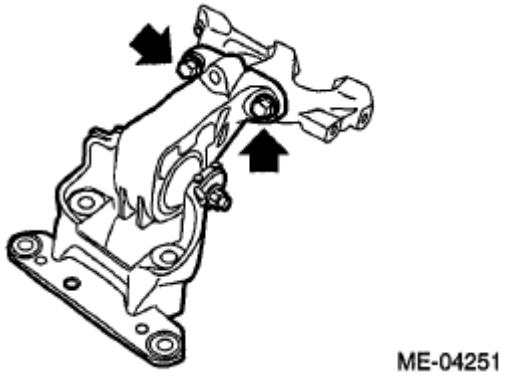


Fig. 83: Locating Front Mounting Cushion Rubber Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

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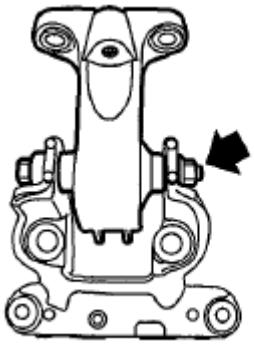


Fig. 84: Locating Front Mounting Cushion Rubber Bolt
Courtesy of SUBARU OF AMERICA, INC.

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)

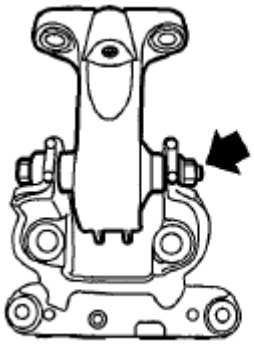


Fig. 85: Locating Engine Mounting Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

   Tightening torque:

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

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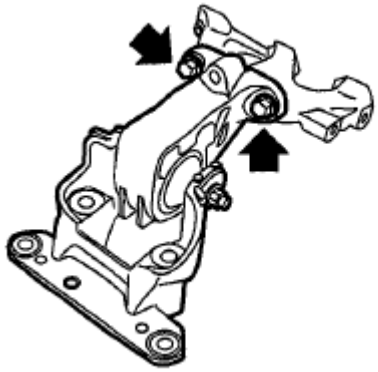


Fig. 86: Locating Turbocharger Upper Stay Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install the turbocharger upper stay to the engine mounting bracket.

Tightening torque:

33 N.m (3.4 kgf-m, 24.3 ft-lb)

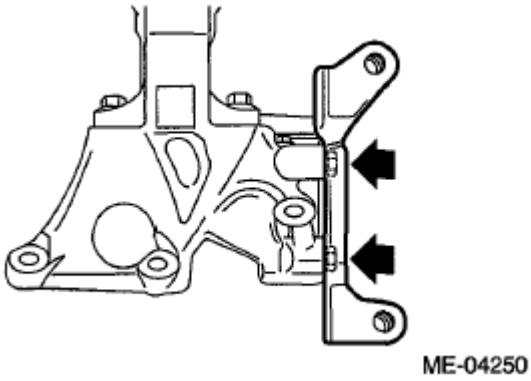


Fig. 87: Attaching ST To Engine After Removing Engine From Vehicle Body
Courtesy of SUBARU OF AMERICA, INC.

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

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ST2 498457100 ENGINE STAND ADAPTER LH

ST3 499817100 ENGINE STAND

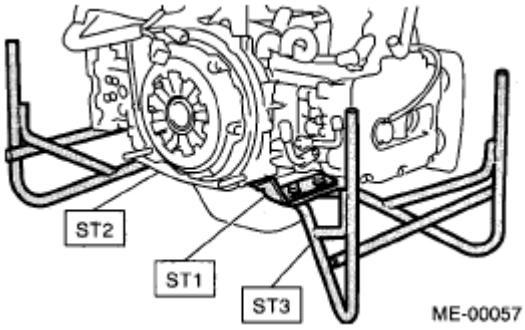


Fig. 88: Attaching Tool To V-Belt Tensioner Assembly
Courtesy of SUBARU OF AMERICA, INC.

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

V-BELT

REMOVAL

NOTE: 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. Refer to **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.

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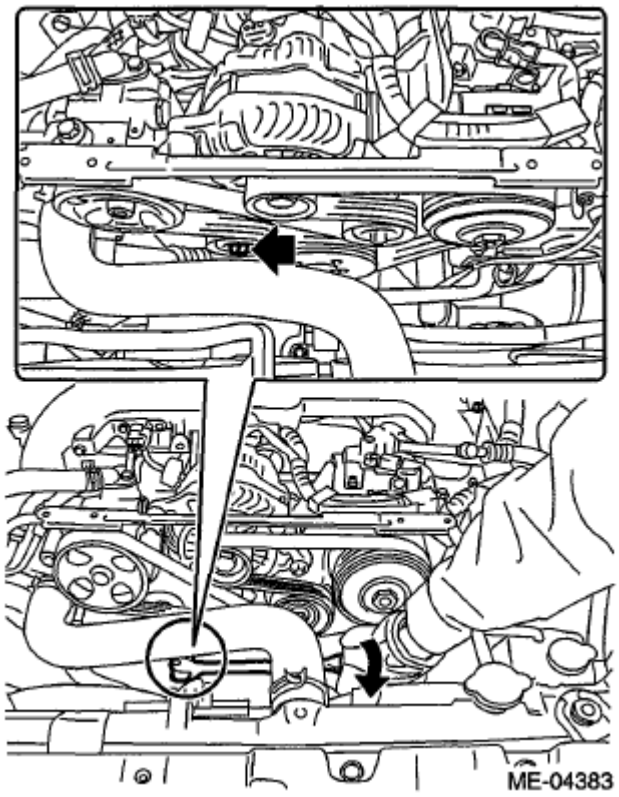


Fig. 89: Locating Bolt Securing V-Belt Tensioner Assembly
Courtesy of SUBARU OF AMERICA, INC.

V-BELT TENSIONER ASSEMBLY AND IDLER PULLEY

1. Remove the V-belts. Refer 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.

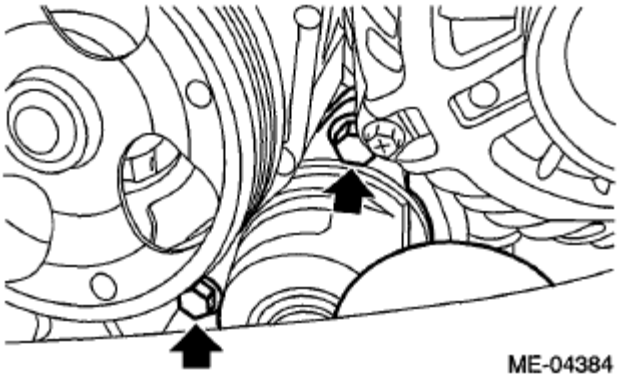


Fig. 90: Locating Idler Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

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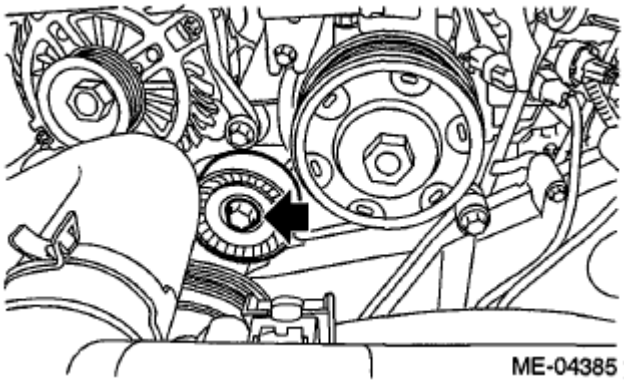


Fig. 91: Identifying V-Belt And Pulleys
Courtesy of SUBARU OF AMERICA, INC.

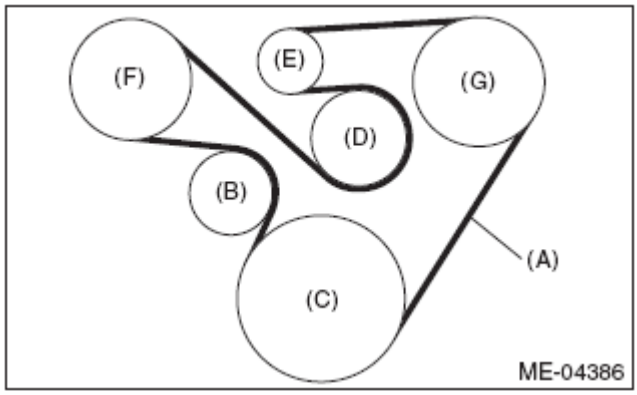
INSTALLATION

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.**

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(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. 92: Locating Idler Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

V-BELT TENSIONER ASSEMBLY AND IDLER PULLEY

Install in the reverse order of removal.

Tightening torque:

33 N.m (3.4 kgf-m, 24.3 ft-lb)

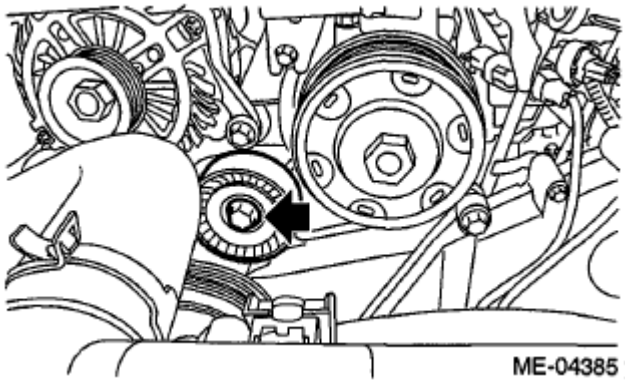


Fig. 93: Locating Bolt Securing V-Belt Tensioner Assembly
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

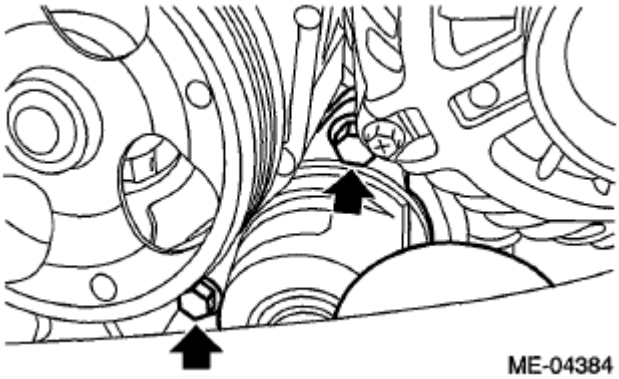


Fig. 94: Identifying V-Belt Tension Indicator (A)
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Check the V-belt for cracks, tear or wear.
2. Remove the air intake duct. Refer to **AIR INTAKE DUCT** .
3. Check that the V-belt tensioner assembly and idler pulley do not have deformation, cracks or other damages.
4. Check the V-belt tension indicator (A) shows within the limit (B).

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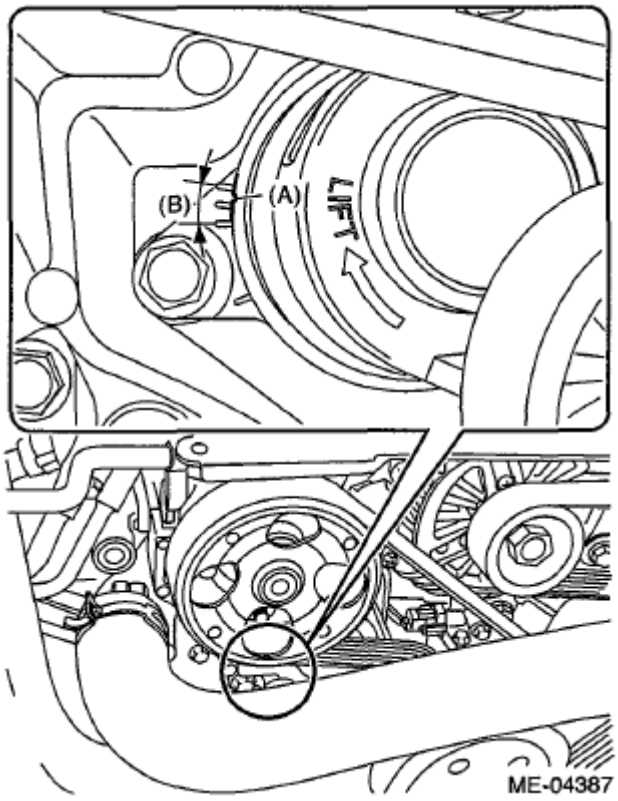


Fig. 95: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

CRANK PULLEY

REMOVAL

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

1. Remove the V-belts. Refer to , **REMOVAL**, V-belt.
2. Use the ST to lock the crank pulley, and remove the crank pulley bolt.

   ST 499977100 CRANK PULLEY WRENCH

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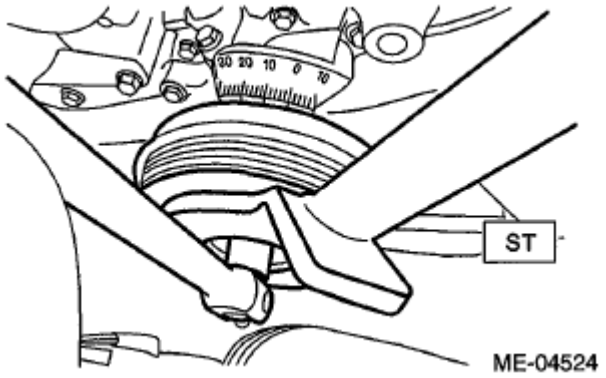


Fig. 96: Installing Crank Pulley Using Crank Pulley Wrench
Courtesy of SUBARU OF AMERICA, INC.

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 499977100 CRANK PULLEY WRENCH

       Tightening torque:

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

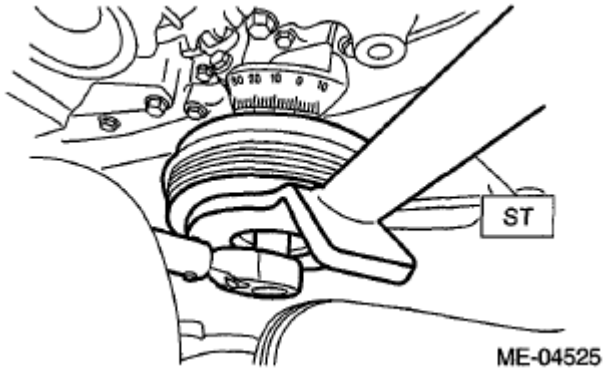


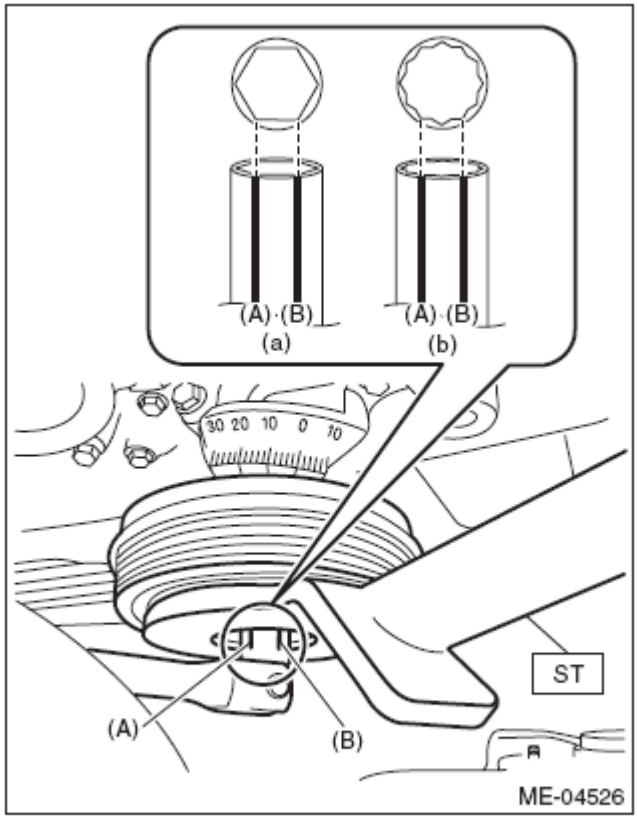
Fig. 97: Setting Socket To Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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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 499977100 CRANK PULLEY WRENCH

   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. 98: Identifying End Line (C) And Reference Line (B)
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 499977100 CRANK PULLEY WRENCH

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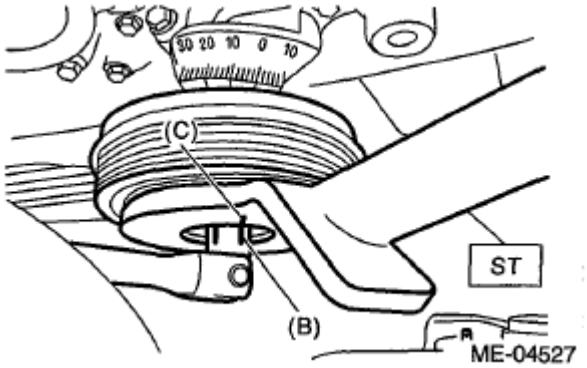


Fig. 99: Identifying Reference Line (A) And End Line (C)
Courtesy of SUBARU OF AMERICA, INC.

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 499977100 CRANK PULLEY WRENCH

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

   Tightening angle:

   60°±5°

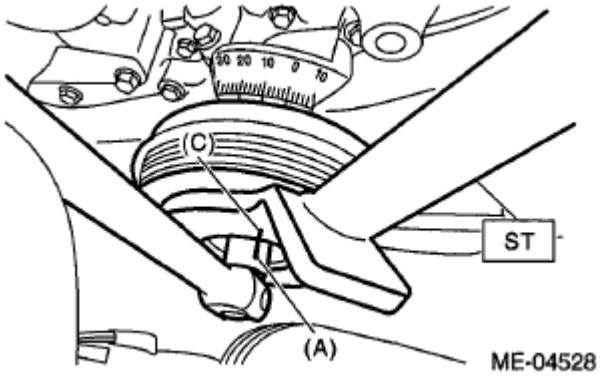


Fig. 100: Locking Crank Pulley Using ST1
Courtesy of SUBARU OF AMERICA, INC.

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

METHOD WITH ANGLE GAUGE

1. Clean the crankshaft thread using compressed air.
2. Install the crank pulley.

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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. Refer to **RADIATOR MAIN FAN AND FAN MOTOR** . Refer to **RADIATOR SUB FAN AND FAN MOTOR** .
    2. Use the ST1 to lock the crank pulley, and temporarily tighten the crank pulley bolt.

        ST1 499977100 CRANK PULLEY WRENCH

        Tightening torque:

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

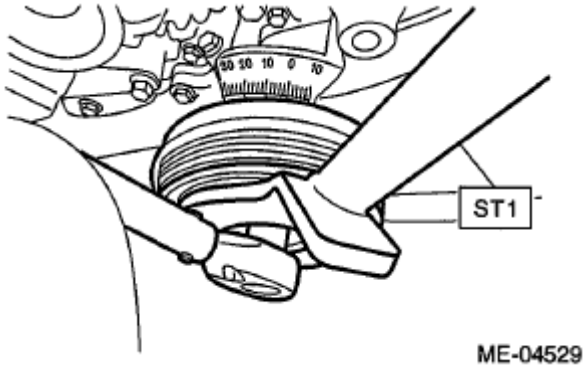


Fig. 101: Attaching Magnet Used For Securing ST2 (Angle Gauge) To ST1
Courtesy of SUBARU OF AMERICA, INC.

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

        ST1 499977100 CRANK PULLEY WRENCH

        ST2 18854AA000 ANGLE GAUGE

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

        Tightening angle:

        60°±5°

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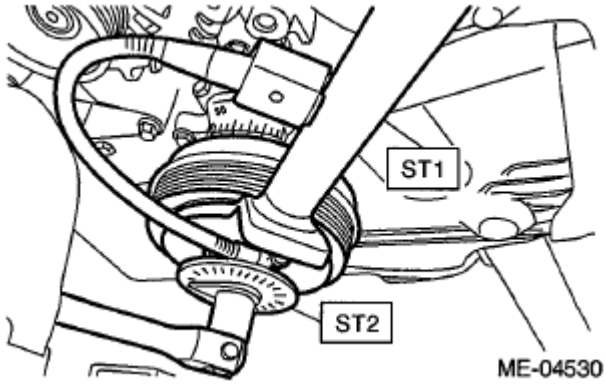


Fig. 102: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

4. Install the radiator main fan motor assembly and radiator sub motor assembly. Refer to **RADIATOR MAIN FAN AND FAN MOTOR** . Refer to **RADIATOR SUB FAN AND FAN MOTOR** .
5. Install the V-belts. Refer to , **INSTALLATION**, V-belt.

INSPECTION

Check that the crank pulley has no deformation, cracks or other damages.

TIMING BELT COVER

REMOVAL

WORK ON THE VEHICLE

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

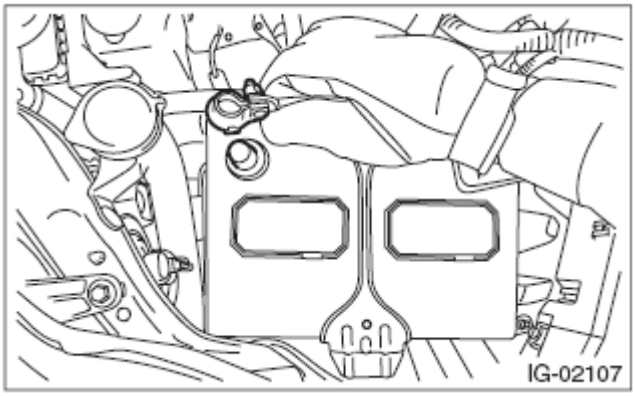


Fig. 103: Locating Intake Duct Clamp Bolt
Courtesy of SUBARU OF AMERICA, INC.

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3. When removing the timing belt cover RH
    1. Remove the air intake duct. Refer to **AIR INTAKE DUCT** .
    2. Loosen the clamp which holds the intake duct to intercooler.

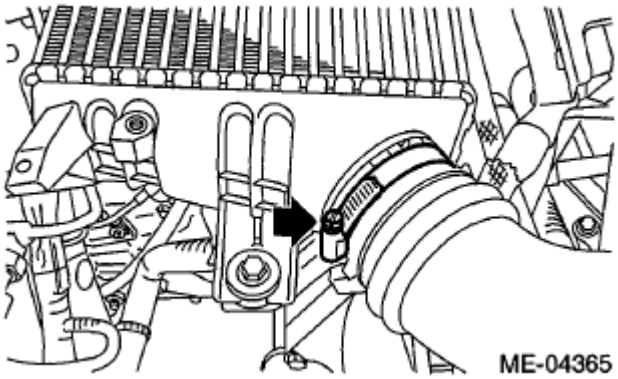


Fig. 104: Locating Suction Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

    3. Remove the V-belts. Refer to , **REMOVAL**, V-belt.
    4. Remove the generator. Refer to **GENERATOR** .
    5. Remove the suction hose from intake duct.

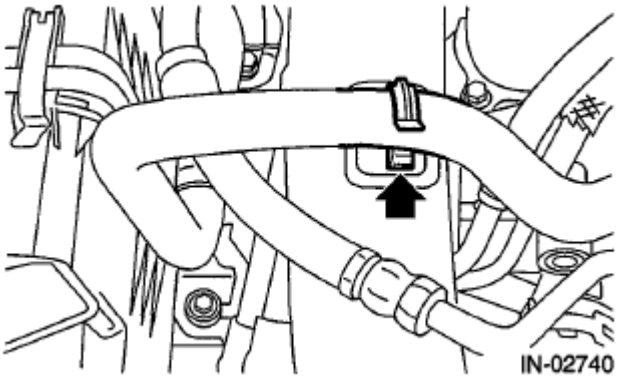


Fig. 105: Locating Power Steering Pump Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

    6. Disconnect the connector (A) from power steering pump, and remove the power steering pump together with the power steering pump bracket from engine and rod stopper.

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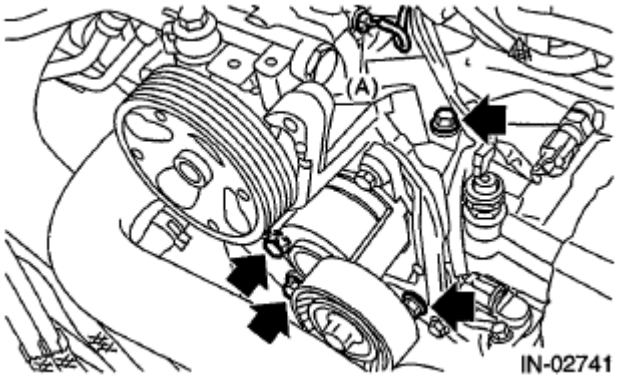


Fig. 106: Locating Intake Duct Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

7. Mount the power steering pump together with the power steering pump bracket on RH side wheel apron.
8. Remove the radiator sub fan motor assembly. Refer to **RADIATOR SUB FAN AND FAN MOTOR** .
9. Remove the engine coolant hose from the clip (A).
10. Remove the bolts which secure the intake duct to the turbocharger, and remove the air bypass valve from the intake duct.

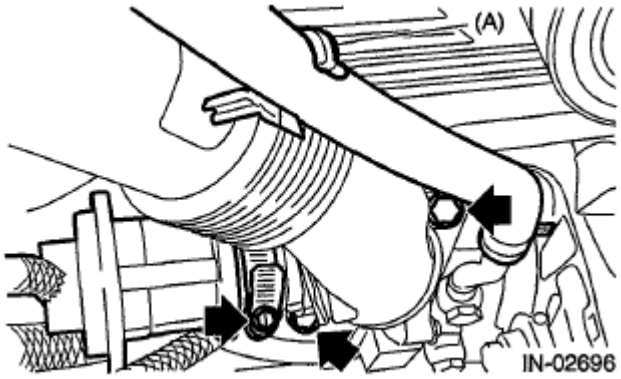


Fig. 107: Locating Intake Duct Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the intake duct from intake manifold.

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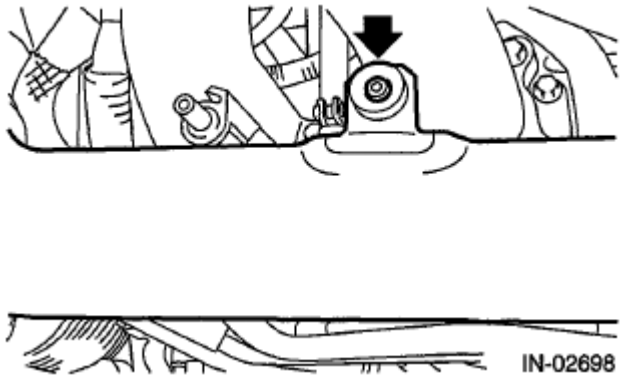


Fig. 108: Locating Blow-By Pipe Clamping Bolt And Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

12. Disconnect the vacuum hose from blow-by pipe, and remove the bolt securing the blow-by pipe from the intake manifold protector RH.



Fig. 109: Locating Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

13. Disconnect the vacuum hose from PCV pipe.

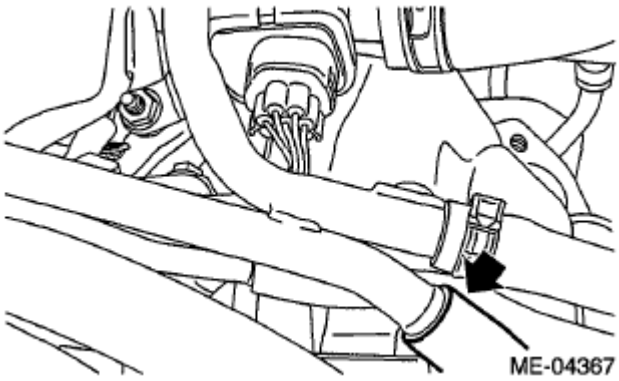


Fig. 110: Identifying Vacuum Hose (B), Vacuum Hose (C), Vacuum Hose (D), Vacuum Hose (E) Amd Clip (A)

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Courtesy of SUBARU OF AMERICA, INC.

14. Remove vacuum hose (B), vacuum hose (C), vacuum hose (D) and vacuum hose (E) from the clip (A).

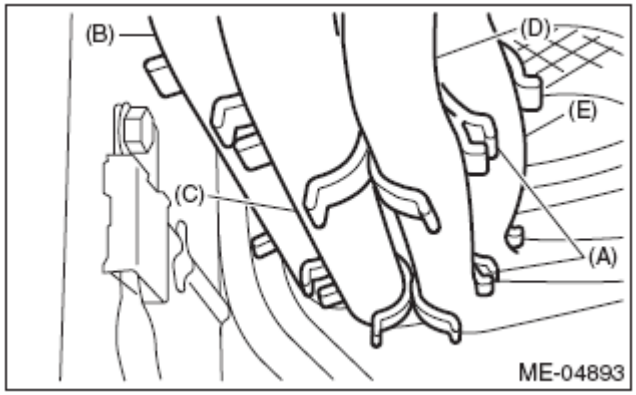


Fig. 111: Locating Engine Harness Clip
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the bolts which secure the upper side of the timing belt cover RH.
16. Lift up the vehicle.
17. Remove the under cover. Refer to **FRONT UNDER COVER** .
18. Remove the air by-pass valve. Refer to **AIR BY-PASS VALVE** .
19. Remove the clip holding the engine harness.

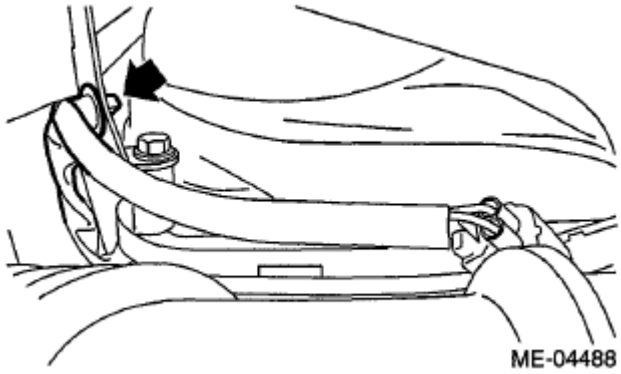


Fig. 112: Locating Front Oxygen (A/F) Sensor And Rear Oxygen Sensor Connectors
Courtesy of SUBARU OF AMERICA, INC.

20. Remove the remaining bolts which secure timing belt cover RH, and remove the timing belt cover RH together with the hose clip stay assembly (A).

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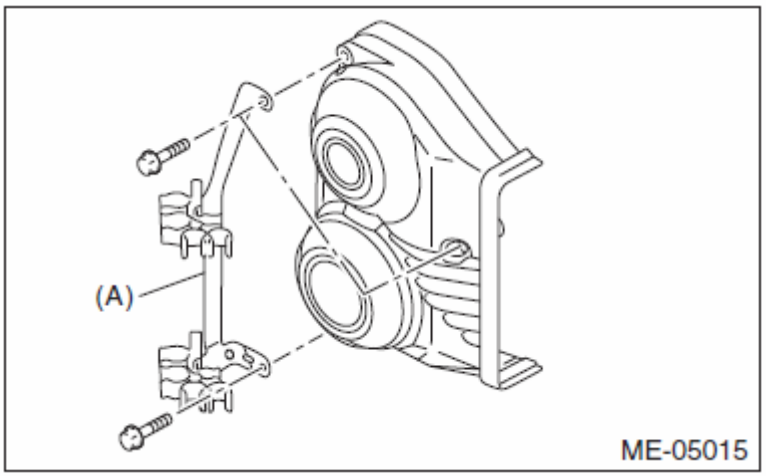


Fig. 113: Identifying Timing Belt Cover RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. When removing the timing belt cover LH
    1. Disconnect the connectors from front oxygen (A/F) sensor and rear oxygen sensor, and remove the clip (A) securing the front oxygen (A/F) sensor harness and rear oxygen sensor harness.

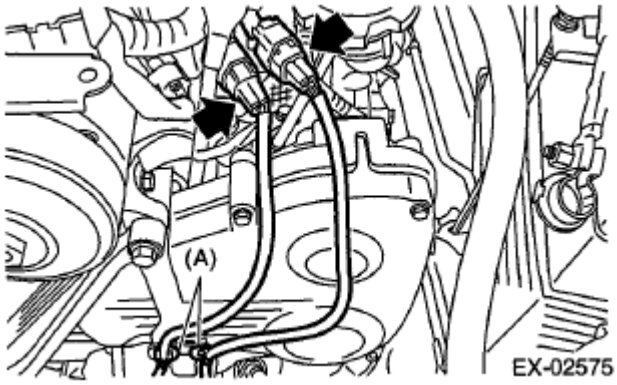


Fig. 114: Locating Stopper Rod Bolts
Courtesy of SUBARU OF AMERICA, INC.

    2. Remove the bolts which secure the upper side of the timing belt cover LH.
    3. Lift up the vehicle.
    4. Remove the under cover. Refer to **FRONT UNDER COVER** .
    5. Loosen the remaining bolts which secure timing belt cover LH, and remove the timing belt cover LH together with the oxygen sensor bracket (A).

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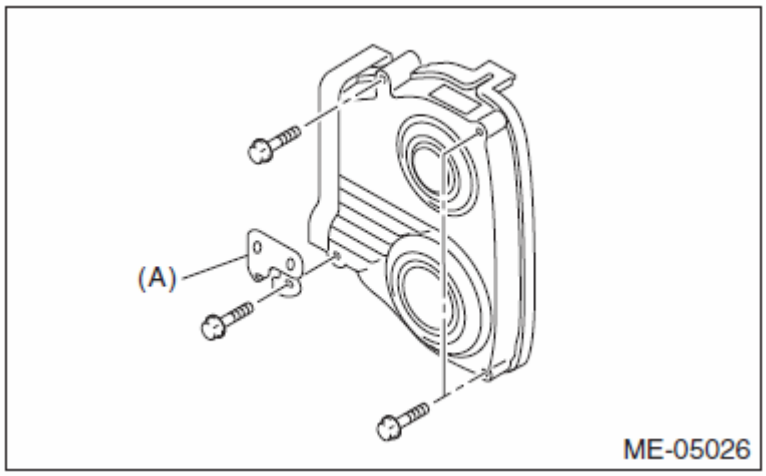


Fig. 115: Identifying Timing Belt Cover LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. When removing the front timing belt cover
    1. Remove the stopper rod.

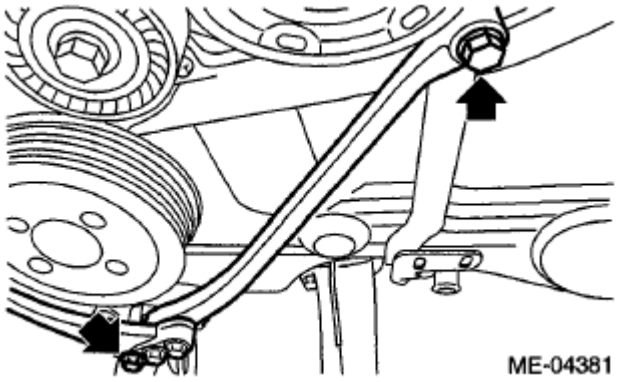


Fig. 116: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

    2. Remove the crank pulley. Refer to , **REMOVAL**, Crank Pulley.
    3. Remove the timing belt cover RH and timing belt cover LH. Refer to step 3) and step 4) for removal procedures.
    4. Remove the bolts securing the front timing belt cover, and remove the front timing belt cover.

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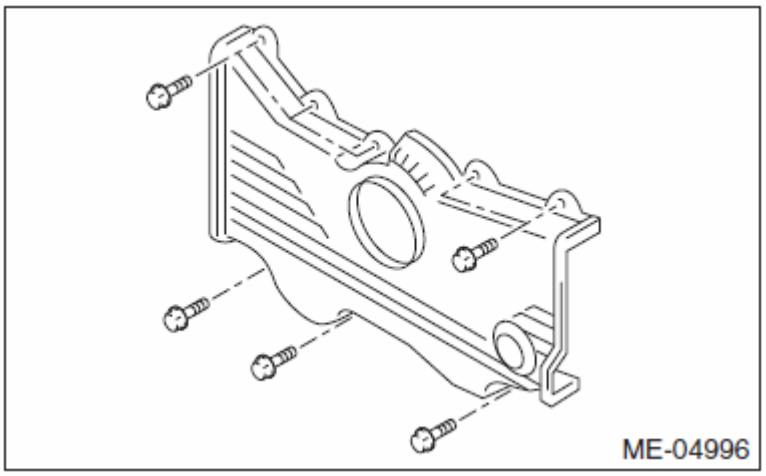


Fig. 117: Locating Blow-By Pipe Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

WORK ON THE ENGINE UNIT ONLY

1. Remove the crank pulley. Refer to , **REMOVAL**, Crank Pulley.
2. Remove the blow-by pipe from the intake manifold protector RH.

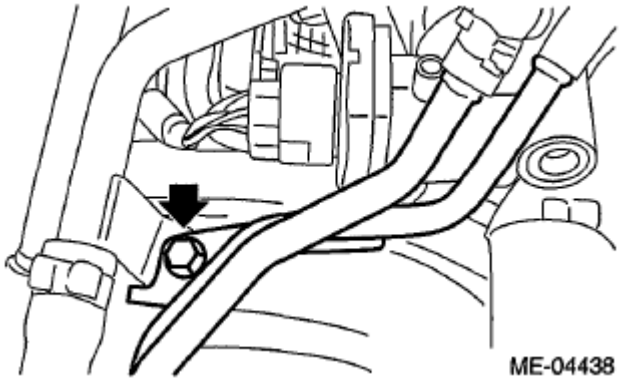


Fig. 118: Identifying Vacuum Hose (B), Vacuum Hose (C), Vacuum Hose (D), Vacuum Hose (E) And Clip (A)
Courtesy of SUBARU OF AMERICA, INC.

3. Remove vacuum hose (B), vacuum hose (C), vacuum hose (D) and vacuum hose (E) from the clip (A).

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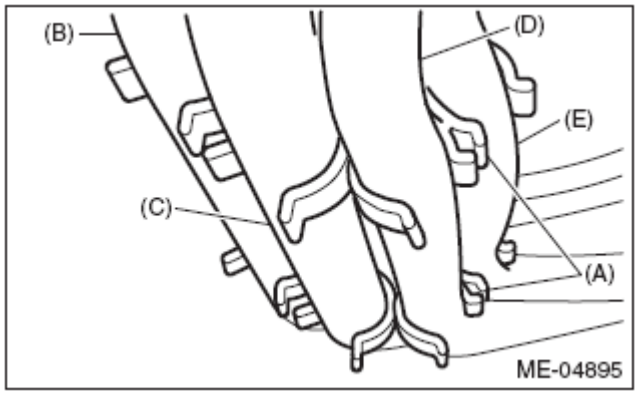


Fig. 119: Locating Engine Harness Clip
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the clip which holds the engine harness to the hose clip stay assembly.

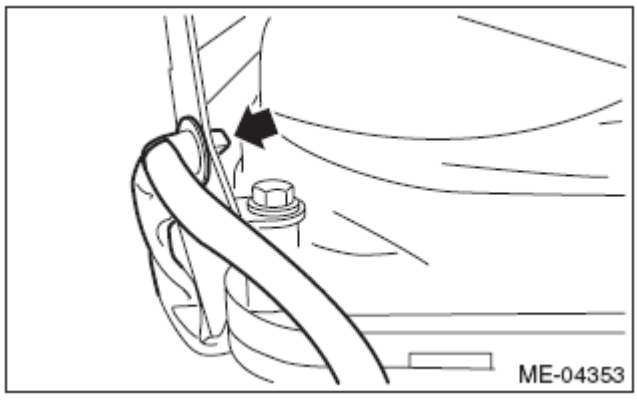


Fig. 120: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

5. Remove timing belt cover RH (B) together with the hose clip stay assembly (A).
6. Remove timing belt cover (LH) (D) together with the oxygen (A/F) sensor bracket (C).
7. Remove front timing belt cover (E).

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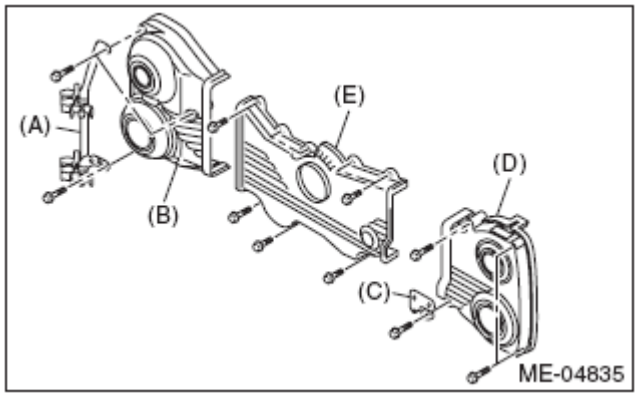


Fig. 121: Identifying Vacuum Hoses
Courtesy of SUBARU OF AMERICA, INC.

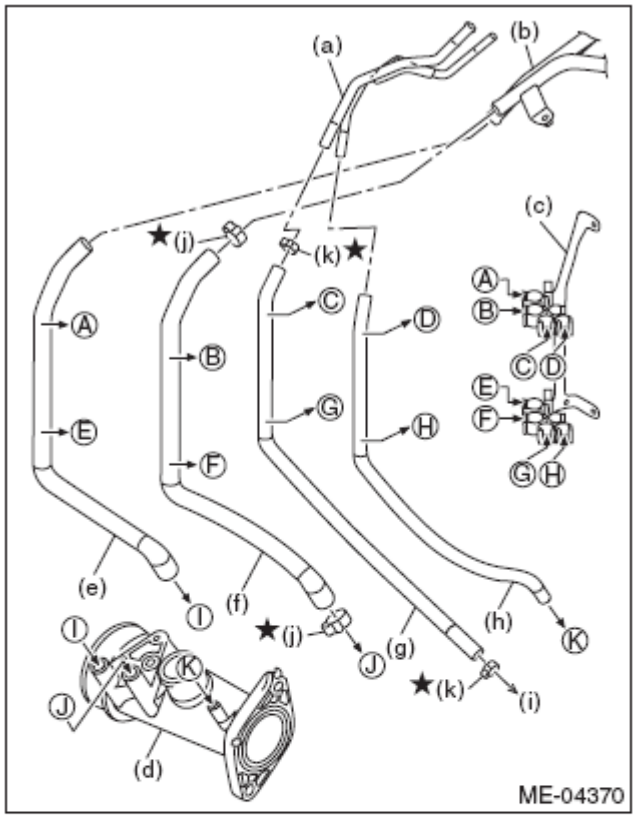
INSTALLATION

WORK ON THE VEHICLE

Install in the reverse order of removal.

NOTE: Install the vacuum hose as shown in the figure.

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(a) Blow-by pipe
(b) PCV pipe
(c) Hose clip stay ASSY
(d) Intake duct
(e) Vacuum hose (A)
(f) Vacuum hose (B)
(g) Vacuum hose (C)
(h) Vacuum hose (D)
(i) To Oil catch tank
(j) Clamp
(k) Clamp

Fig. 122: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

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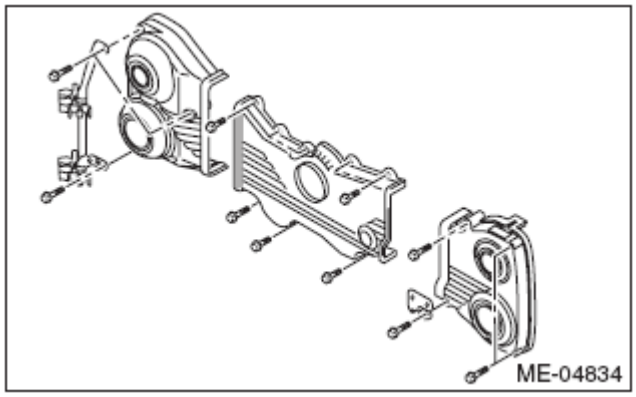


Fig. 123: Locating Blow-By Pipe Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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



Fig. 124: Locating Intake Duct Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

T1: 3 N.m (0.3 kgf-m, 2.2 ft-lb)

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

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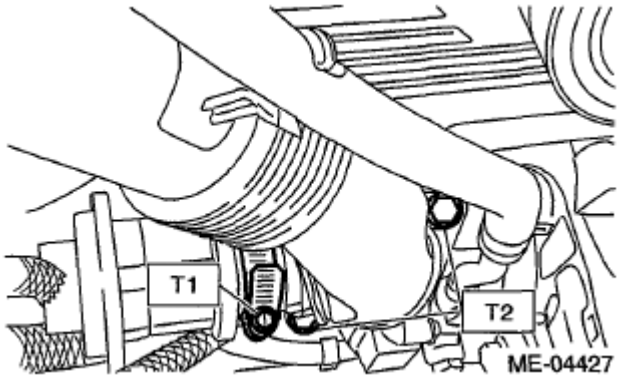


Fig. 125: Locating Power Steering Pump Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

Refer to "COMPONENT" of "STARTING/CHARGING SYSTEMS" for the tightening torque. Refer to GENERATOR .

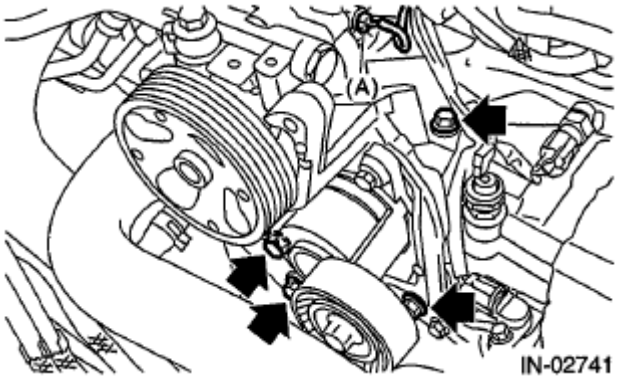


Fig. 126: Locating Intake Duct Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

3 N.m (0.3 kgf-m, 2.2 ft-lb)

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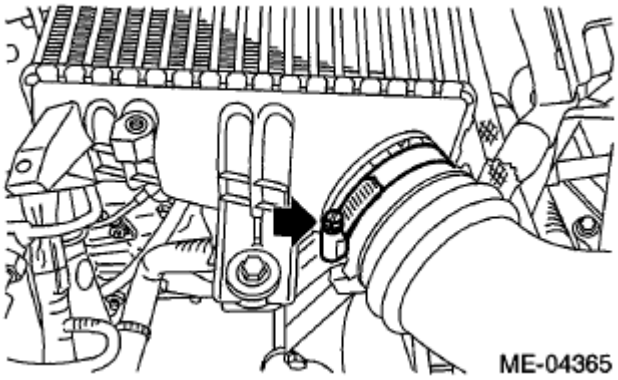


Fig. 127: Locating Stopper Rod Bolts
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

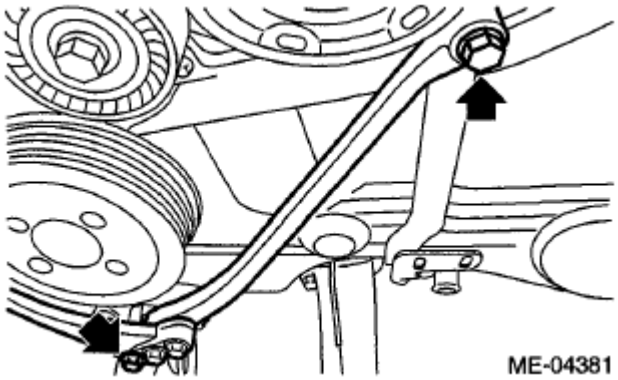


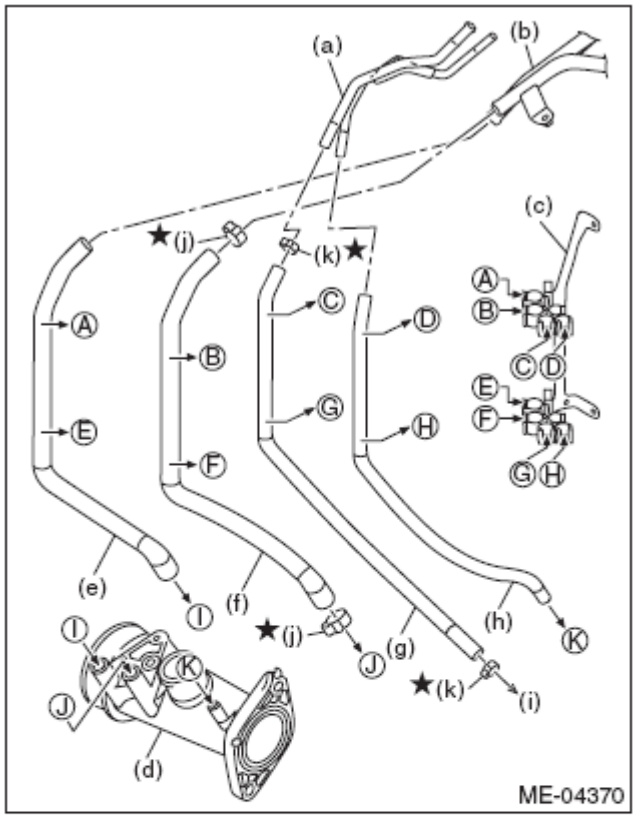
Fig. 128: Identifying Vacuum Hoses
Courtesy of SUBARU OF AMERICA, INC.

WORK ON THE ENGINE UNIT ONLY

Install in the reverse order of removal.

NOTE: Install the vacuum hose as shown in the figure.

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(a) Blow-by pipe
(b) PCV pipe
(c) Hose clip stay ASSY
(d) Intake duct
(e) Vacuum hose (A)
(f) Vacuum hose (B)
(g) Vacuum hose (C)
(h) Vacuum hose (D)
(i) To Oil catch tank
(j) Clamp
(k) Clamp

Fig. 129: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

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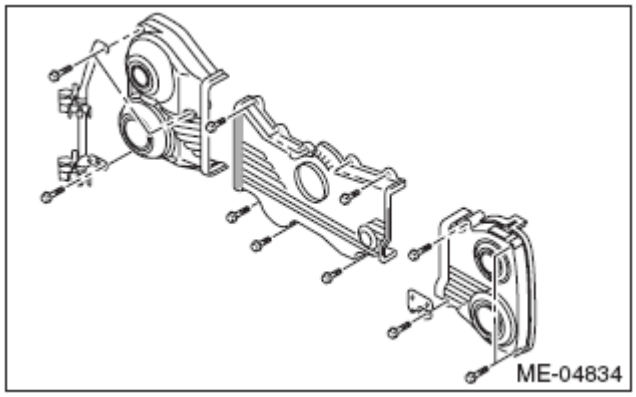


Fig. 130: Locating Vacuum Hoses Clamping Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

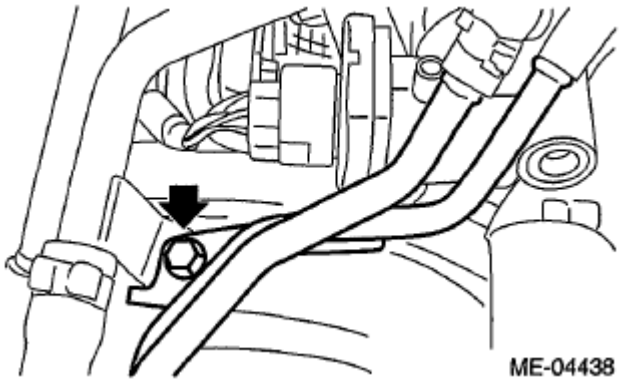


Fig. 131: Locating Timing Belt Cover Bolts
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

Check that the timing belt cover does not have deformation, cracks and any other 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.**

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- **Radiator main fan motor assembly Refer to RADIATOR MAIN FAN AND FAN MOTOR REMOVAL . Refer to RADIATOR MAIN FAN AND FAN MOTOR INSTALLATION .**
- **Radiator sub fan motor assembly Refer to RADIATOR SUB FAN AND FAN MOTOR REMOVAL . Refer to RADIATOR SUB FAN AND FAN MOTOR INSTALLATION .**

- **When performing the work with the engine installed to body, protect the radiator with cardboards or blankets.**

TIMING BELT

1. Remove the crank pulley. Refer to , **REMOVAL**, Crank Pulley.
2. Remove the timing belt cover. Refer to , **REMOVAL**, Timing Belt Cover.
3. Remove the timing belt guide.

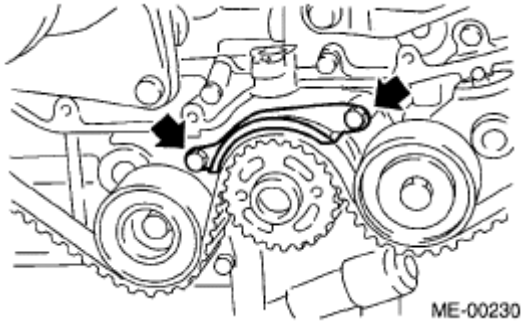


Fig. 132: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

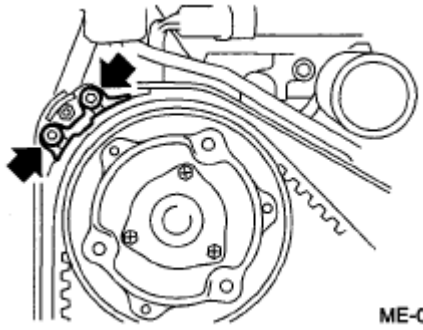


Fig. 133: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

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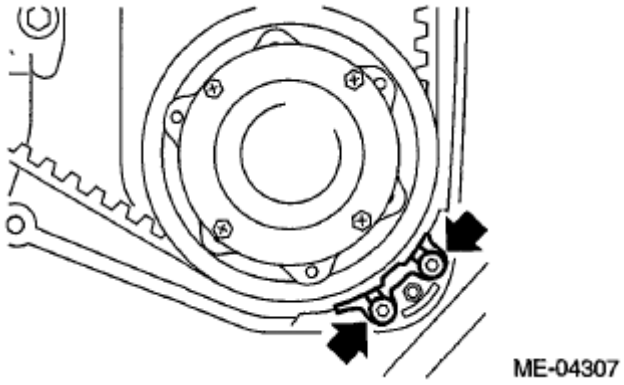


Fig. 134: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

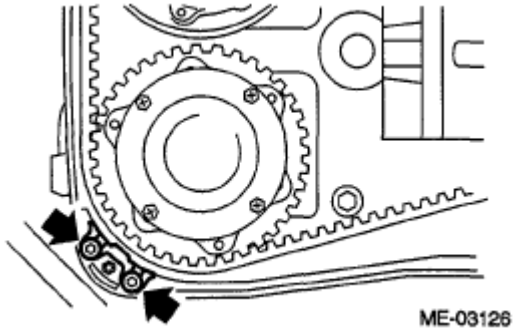


Fig. 135: Turning Crankshaft Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

       ST 499987500 CRANKSHAFT SOCKET

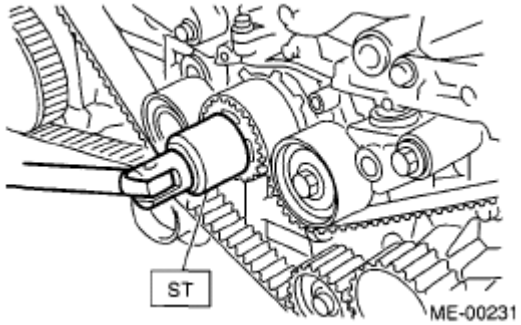


Fig. 136: Identifying Alignment Mark On Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

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

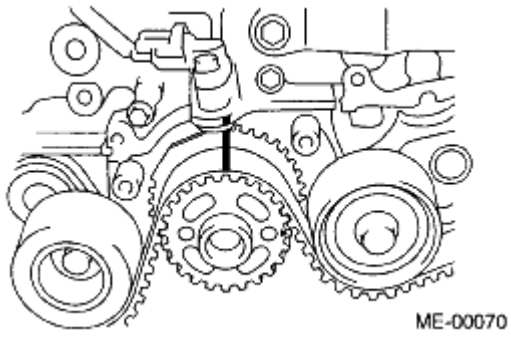


Fig. 137: Identifying Crank Sprocket And Cam Sprockets
Courtesy of SUBARU OF AMERICA, INC.

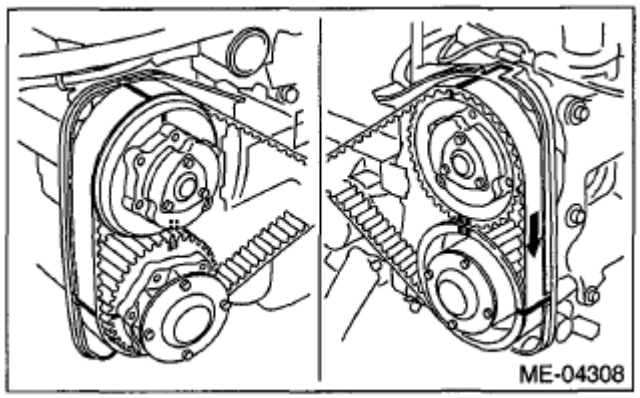
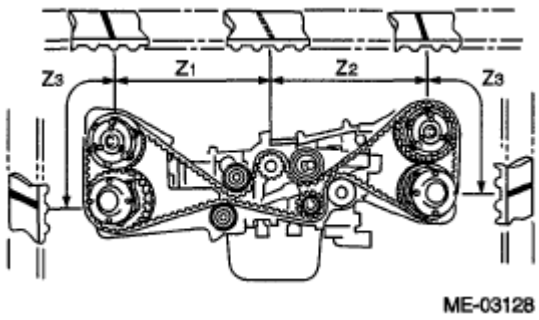


Fig. 138: Identifying Timing Belt Crank Sprocket And Cam Sprockets
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 54.5 teeth

Z_2 : 51 teeth

Z_3 : 28 teeth



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Fig. 139: Identifying Belt Idler (A)
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the belt idler (A).

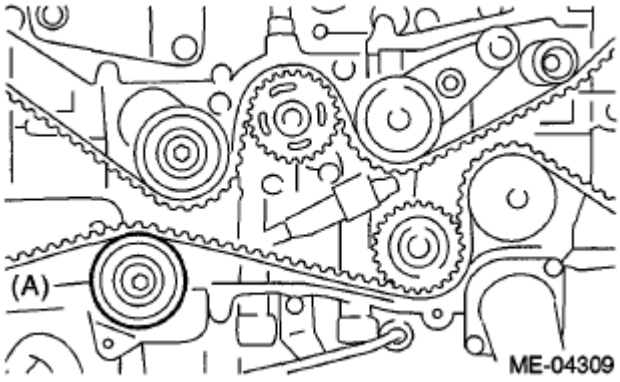


Fig. 140: Identifying Belt Idler (A)
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the timing belt.

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

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

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

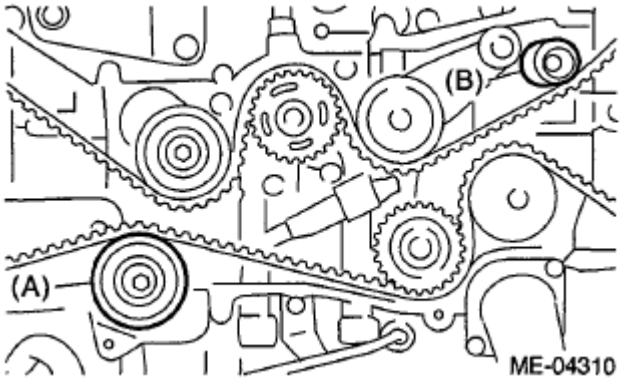


Fig. 141: Locating Belt Idler No. 2 Bolt
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the belt idler No. 2.

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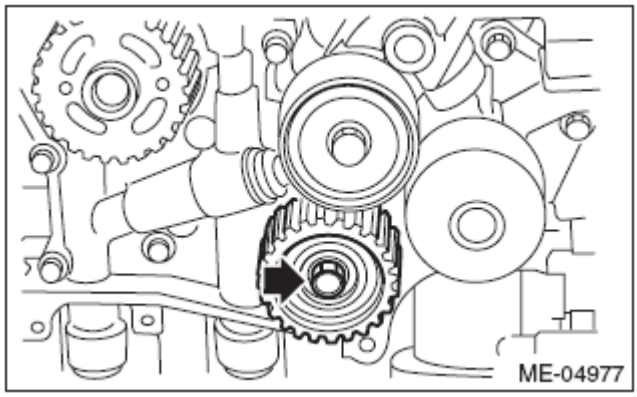


Fig. 142: Locating Automatic Belt Tension Adjuster Assembly Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the automatic belt tension adjuster assembly.

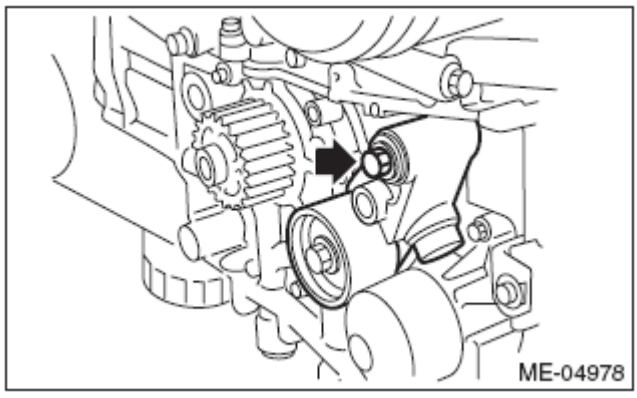


Fig. 143: Pushing Adjuster Rod With Pressure Of 165 N
Courtesy of SUBARU OF AMERICA, INC.

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 lbf).**

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- **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.**
- **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.

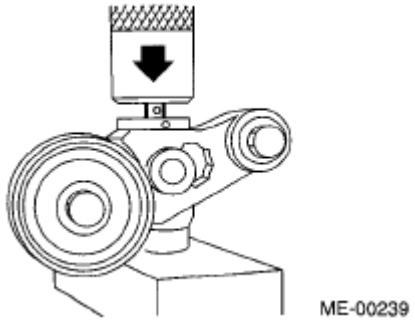


Fig. 144: Identifying Stopper Pin In Cylinder
Courtesy of SUBARU OF AMERICA, INC.

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

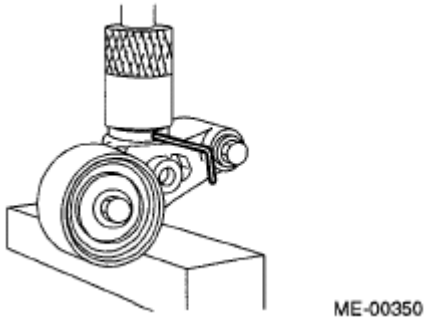


Fig. 145: Locating Automatic Belt Tension Adjuster Assembly Bolt
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

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

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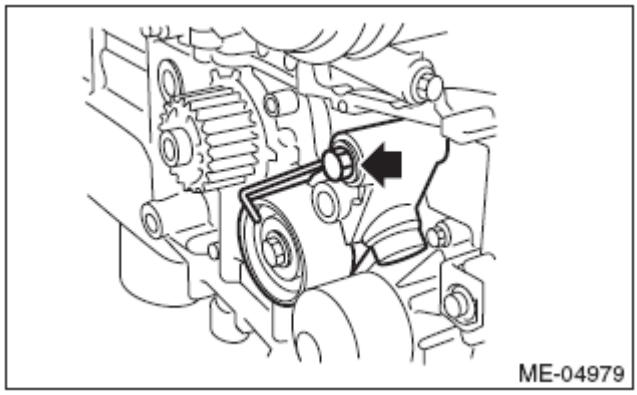


Fig. 146: Locating Belt Idler No. 2 Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idler No. 2.

   Tightening torque:

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

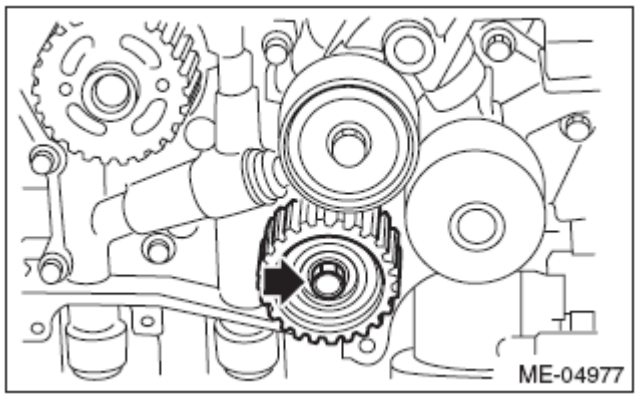


Fig. 147: Locating Belt Idler Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Install the belt idlers.

Tightening torque:

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

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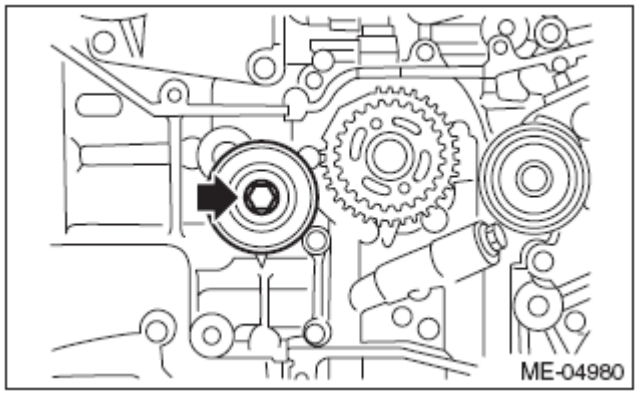


Fig. 148: Locating Belt Idler Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

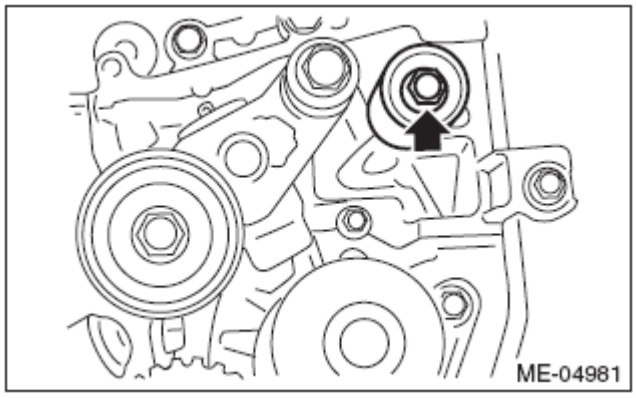


Fig. 149: Identifying Mark (B) On Crank Sprocket And Mark (A) On Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

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

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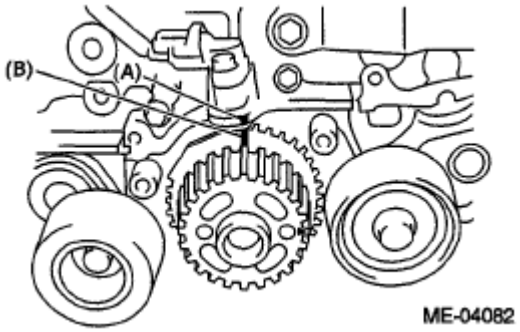


Fig. 150: Identifying Single Line Mark (B) On Exhaust Cam Sprocket RH And Notch (A) On Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

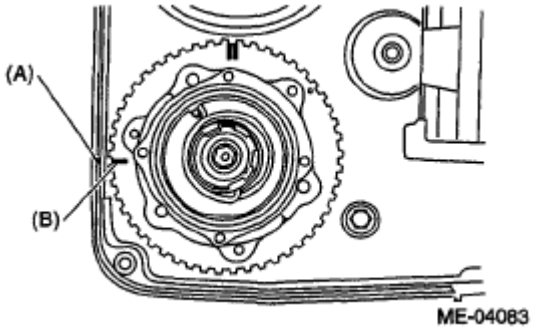


Fig. 151: Identifying Single Line Mark (B) On Intake Cam Sprocket RH And Notch (A) Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

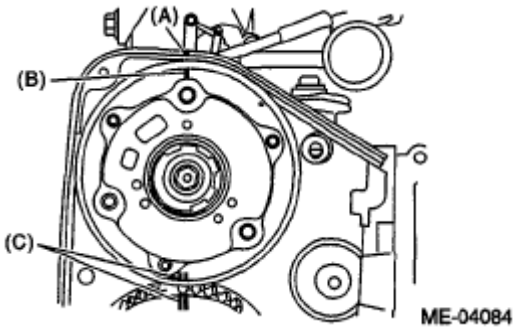


Fig. 152: Aligning Single Line Mark (B) On Exhaust Cam Sprocket LH With Notch (A) On Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

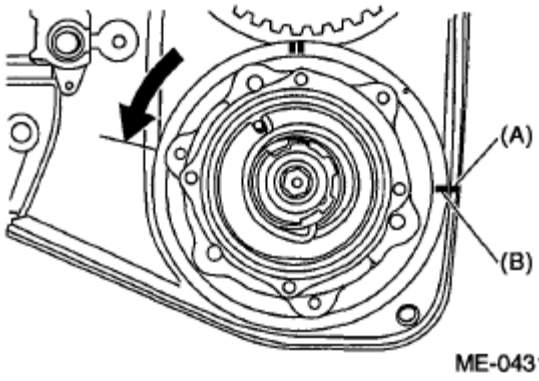


Fig. 153: Aligning Single Line Mark (B) On Intake Cam Sprocket LH With Notch (A) On Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

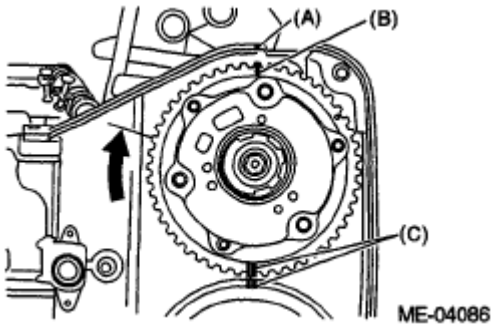
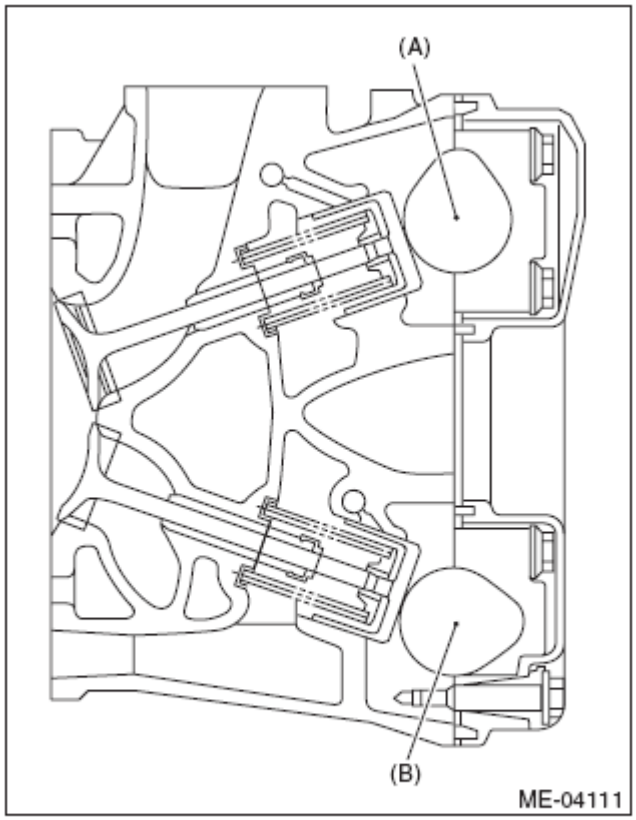


Fig. 154: Identifying Intake And Exhaust Camshafts
Courtesy of SUBARU OF AMERICA, INC.

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

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

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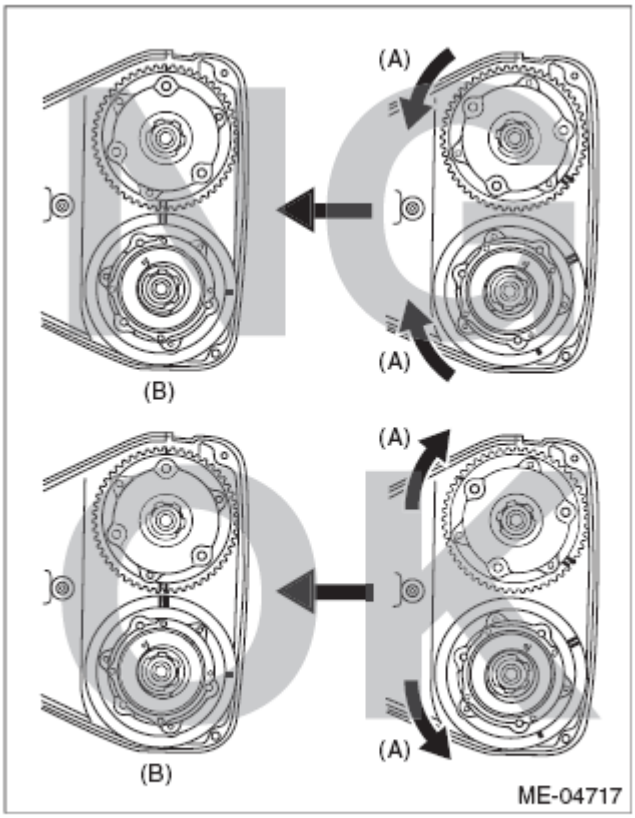


(A) Intake camshaft
(B) Exhaust camshaft

Fig. 155: Rotating Camshafts In Direction As Shown In Figure
Courtesy of SUBARU OF AMERICA, INC.

- **When the timing belts are not installed, four camshafts are held at the "zero-lift" position, where all cams on camshafts are not pushing down on the intake and exhaust valves. (Under this condition, all valves remain unlifted.)**
- **When the camshafts are rotated to install the timing belts, #2 intake and #4 exhaust cam of camshaft LH are held, pushing their corresponding valves down. (Under this condition, these valves are held lifted.) Camshaft RH are held so that their cams do not push the valves down.**
- **Camshafts LH must be rotated from the zero-lift position to the position where the timing belt is to be installed with the smallest possible angle, in order to prevent mutual interference of intake and exhaust valve heads.**
- **Do not allow the camshafts to rotate in the direction shown in the upper figure. Doing this may cause both the intake and exhaust valves to lift simultaneously, resulting in mutual interference of valve heads.**

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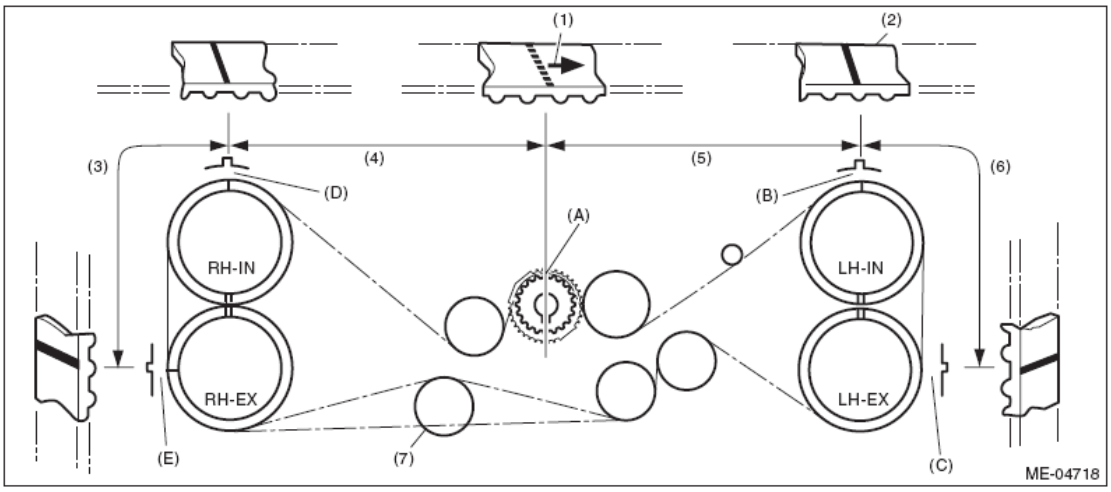
(A) Direction of rotation
(B) Timing belt installation position

Fig. 156: Aligning Alignment Mark On Timing Belt With Marks On Sprockets In Alphabetical Order
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

Fig. 157: Locating Belt Idlers Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

9. Install the belt idlers.

   Tightening torque:

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

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

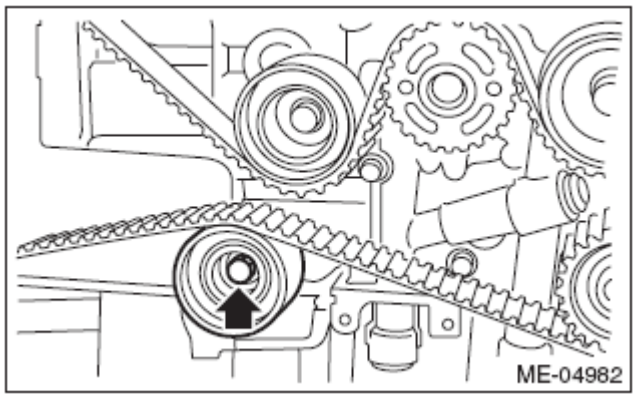


Fig. 158: Removing Stopper Pin From Tensioner Adjuster
Courtesy of SUBARU OF AMERICA, INC.

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

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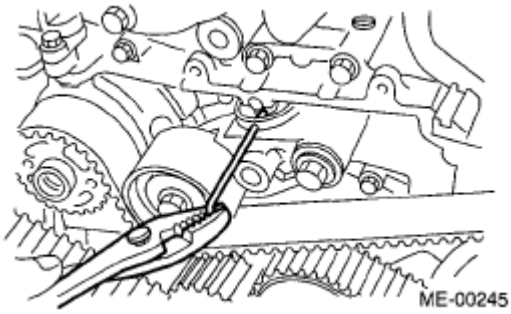


Fig. 159: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- **Before installing the timing belt guide, clean the timing belt guide mounting bolt holes of the timing belt cover No. 2.**
- **Apply liquid gasket to the thread of the timing belt guide mounting bolt on the cam sprocket section. (when reusing bolts)**

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

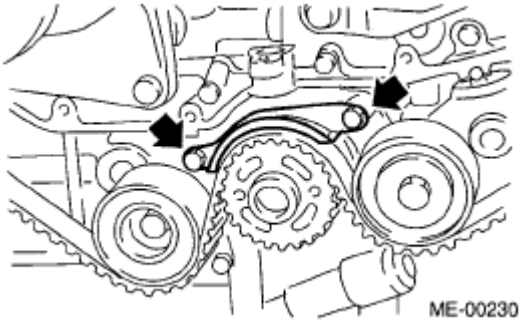


Fig. 160: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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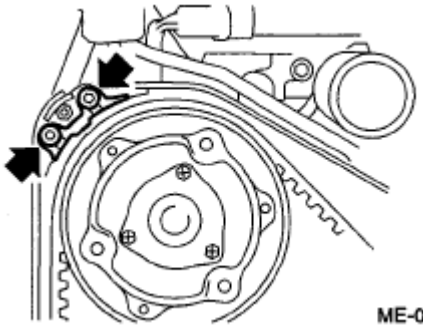


Fig. 161: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

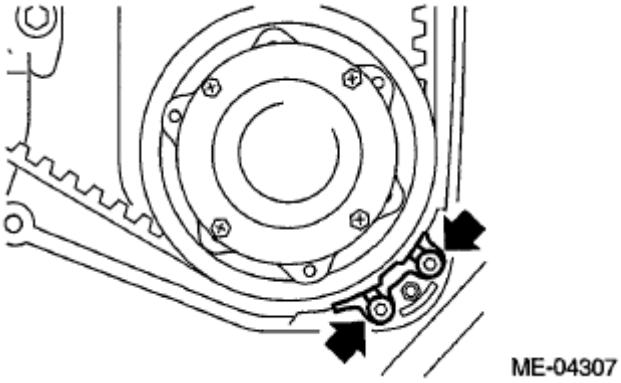


Fig. 162: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

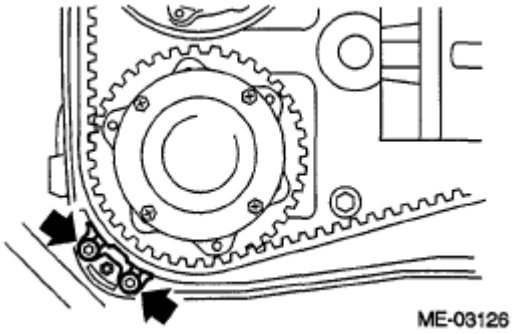


Fig. 163: Identifying Clearance Between Timing Belt And Timing Belt Guide Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

2. Adjust the clearance between timing belt and timing belt guide using a thickness gauge and tighten.

Clearance:

1.0±0.5 mm (0.039±0.020 in)

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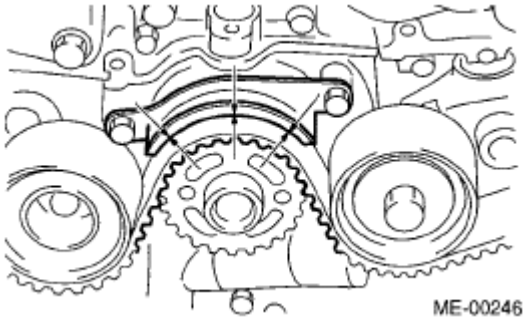


Fig. 164: Identifying Clearance Between Timing Belt And Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

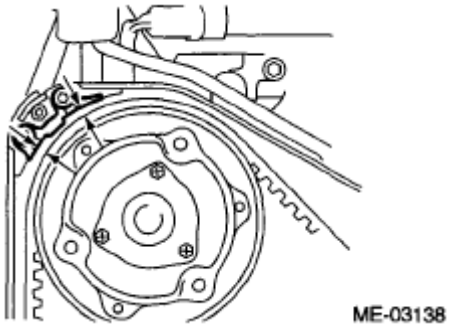


Fig. 165: Identifying Clearance Between Timing Belt And Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

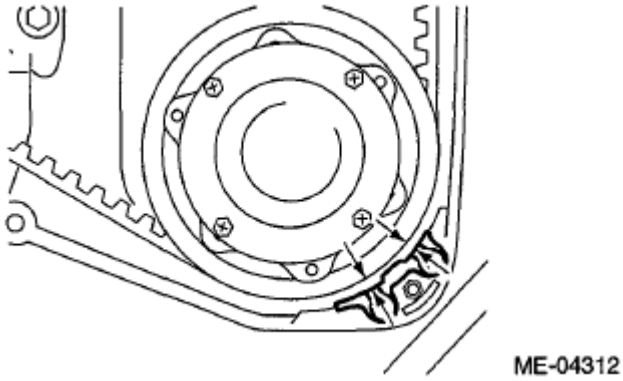


Fig. 166: Identifying Clearance Between Timing Belt And Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

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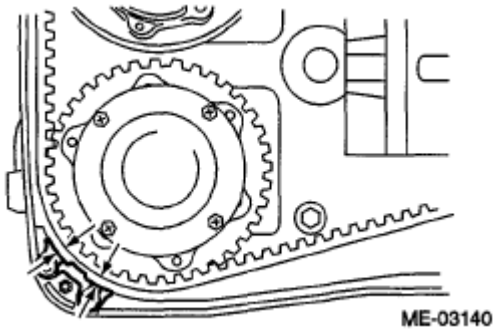


Fig. 167: Identifying Clearance Between Timing Belt And Timing Belt Guide Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

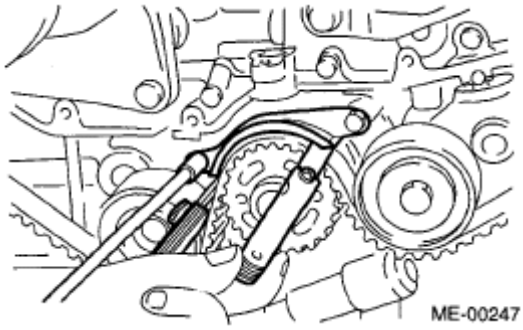


Fig. 168: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

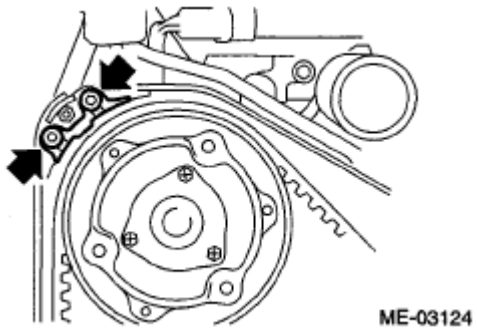


Fig. 169: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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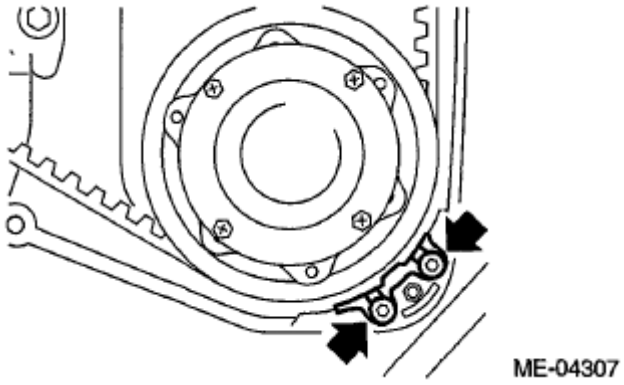


Fig. 170: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

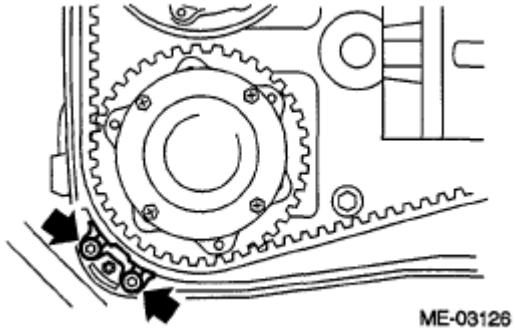


Fig. 171: Identifying Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

12. Install the timing belt cover. Refer to , **INSTALLATION**, Timing Belt Cover.
13. Install the crank pulley. Refer to , **INSTALLATION**, Crank Pulley.

INSPECTION

TIMING BELT

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

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

In radial diameter h:

60 mm (2.36 in) or more

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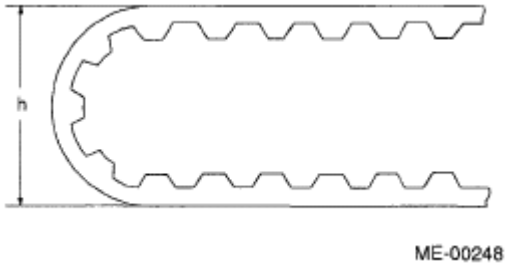


Fig. 172: Measuring Amount Of Adjuster Rod Protrusion L From End Surface Of Cylinder
Courtesy of SUBARU OF AMERICA, INC.

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

CAUTION:
- **Always use a vertical type pressing tool to move the adjuster rod down.**
- **Do not use a lateral type vise.**
- **Push the adjuster rod vertically.**
- **Press-in the push adjuster rod gradually taking three minutes or more.**
- **Do not allow press pressure to exceed 9, 807 N (1, 000 kgf, 2, 205 lbf).**
- **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 "L" from the end surface of the cylinder. If it is not within specifications, replace the automatic belt tension adjuster assembly with a new part.

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Protrusion amount of adjuster rod L:

5.2 - 6.2 mm (0.205 - 0.244 in)

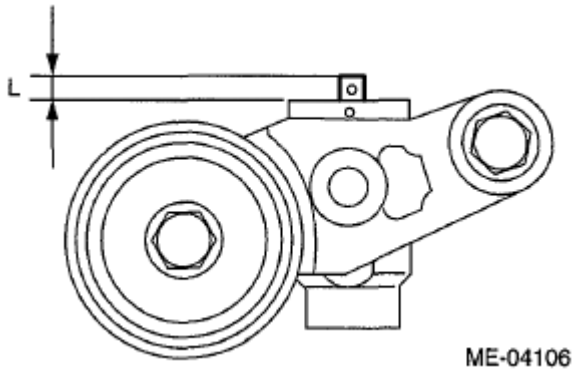


Fig. 173: Locking Cam Sprocket And Remove Cam Sprocket Bolt
Courtesy of SUBARU OF AMERICA, INC.

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 crank pulley. Refer to , **REMOVAL**, Crank Pulley.
2. Remove the timing belt cover. Refer to , **REMOVAL**, Timing Belt Cover.
3. Remove the timing belt. Refer to , **REMOVAL**, Timing Belt.
4. Remove the actuator covers of intake cam sprocket and exhaust cam sprocket.
5. Use the ST to lock the cam sprocket, and remove the cam sprocket bolt.

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ST 499977500 CAM SPROCKET WRENCH

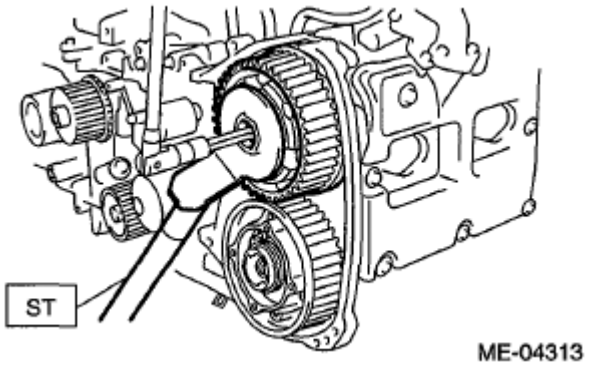


Fig. 174: Locking Cam Sprocket And Install Cam Sprocket Bolt
Courtesy of SUBARU OF AMERICA, INC.

6. 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) or (INT) and (EXH) during installation.

ST 499977500 CAM SPROCKET WRENCH

Tightening torque:

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

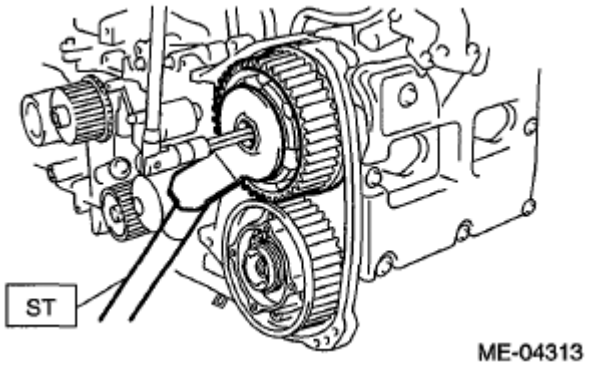


Fig. 175: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

3. Install the actuator covers of intake cam sprocket and exhaust cam sprocket.

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NOTE: Use new O-rings.

Tightening torque:

3.4 N.m (0.3 kgf-m, 2.5 ft-lb)

4. Install the timing belt. Refer to , **INSTALLATION**, Timing Belt.
5. Install the timing belt cover. Refer to , **INSTALLATION**, Timing Belt Cover.
6. Install the crank pulley. Refer to , **INSTALLATION**, Crank Pulley.

INSPECTION

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

CRANK SPROCKET

REMOVAL

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

1. Remove the crank pulley. Refer to , **REMOVAL**, Crank Pulley.
2. Remove the timing belt cover. Refer to , **REMOVAL**, Timing Belt Cover.
3. Remove the timing belt. Refer to , **REMOVAL**, Timing Belt.
4. Remove the crank sprocket.

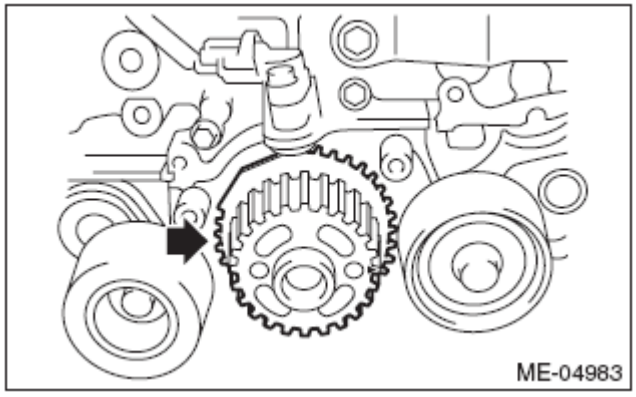


Fig. 176: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

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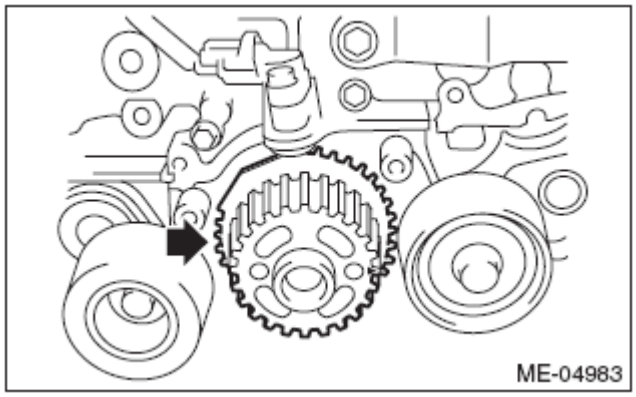


Fig. 177: Locating Intake Oil Flow Control Solenoid Valve Connector
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing belt. Refer to , **INSTALLATION**, Timing Belt.
3. Install the timing belt cover. Refer to , **INSTALLATION**, Timing Belt Cover.
4. Install the crank pulley. Refer to , **INSTALLATION**, Crank Pulley.

INSPECTION

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

CAMSHAFT

REMOVAL

1. Remove the engine from the vehicle. Refer to , **REMOVAL**, Engine Assembly.
2. Remove the crank pulley. Refer to , **REMOVAL**, Crank Pulley.
3. Remove the timing belt cover. Refer to , **REMOVAL**, Timing Belt Cover.
4. Remove the timing belt. Refer to , **REMOVAL**, Timing Belt.
5. Remove the cam sprocket. Refer to , **REMOVAL**, Cam Sprocket.
6. Disconnect the connector of the intake oil flow control solenoid valve.

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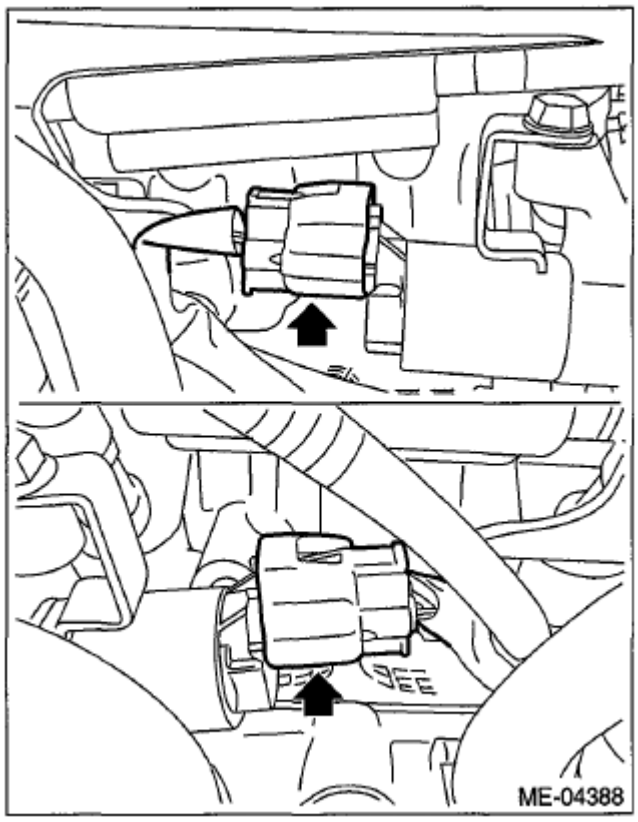


Fig. 178: Identifying Exhaust Camshaft Position Sensor And Exhaust Oil Flow Control Solenoid Valve Connectors
Courtesy of SUBARU OF AMERICA, INC.

7. Disconnect the connectors from the exhaust camshaft position sensor (A) and exhaust oil flow control solenoid valve (B).

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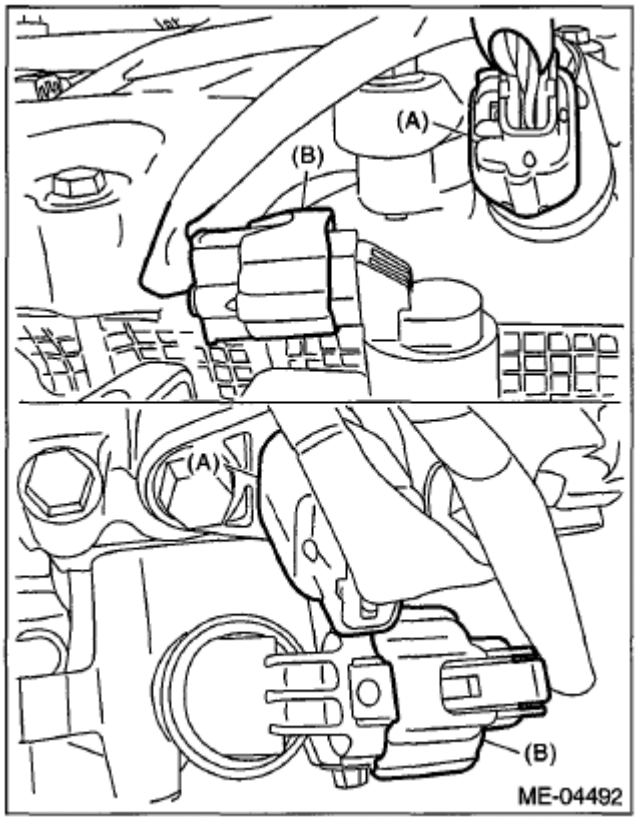


Fig. 179: Identifying Timing Belt Cover No. 2 (RH) And Timing Belt Cover No. 2 LH
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt cover No. 2 (RH) (A) and timing belt cover No. 2 LH (B).

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

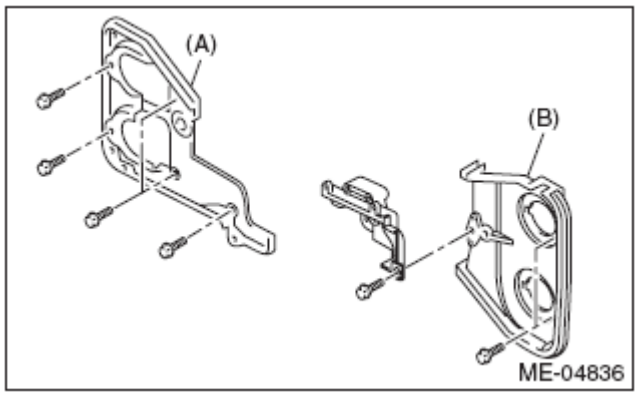


Fig. 180: Locating Tensioner Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the tensioner bracket.

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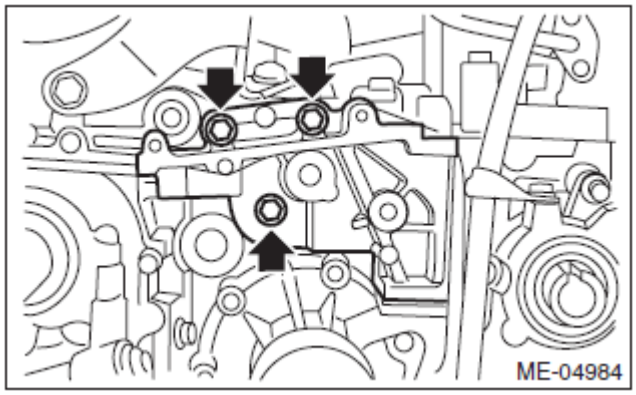


Fig. 181: Locating Oil Level Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

10. Disconnect the oil level switch connector.

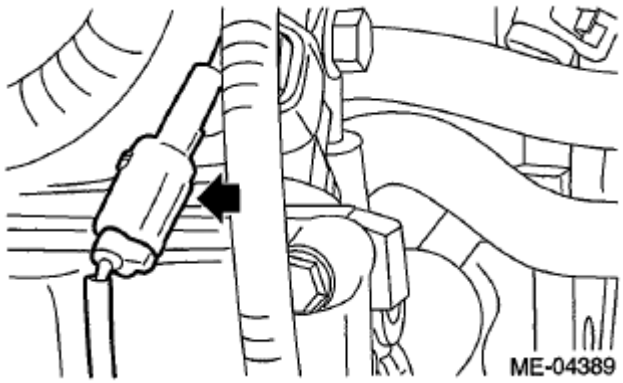


Fig. 182: Identifying Engine Harness Clip (A) And Bolt (B)
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the clip (A) and bolt (B) securing the engine harness or oil level switch harness to the rocker cover.

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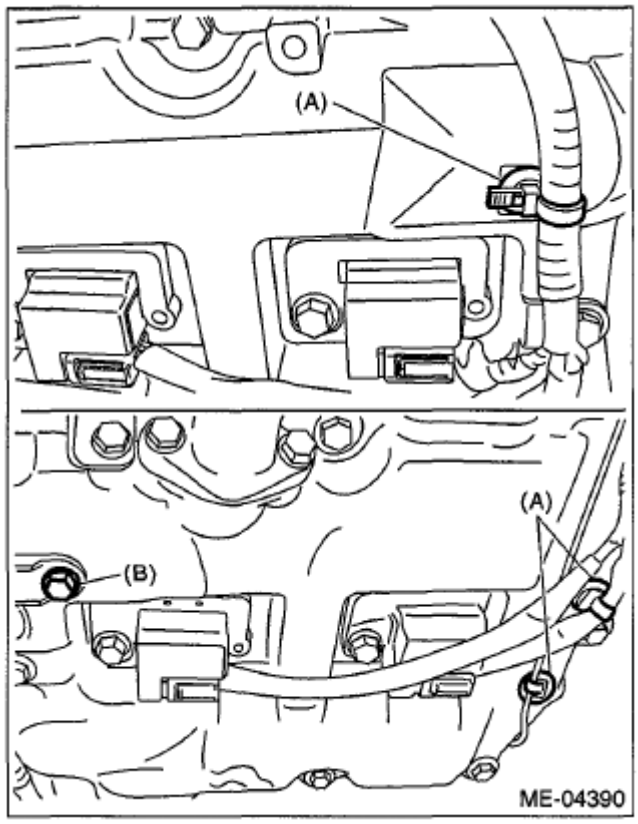
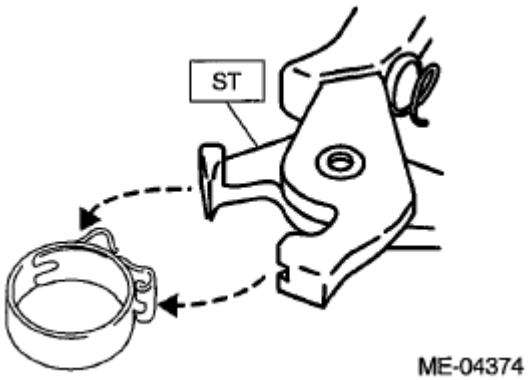


Fig. 183: Identifying Clamp Pliers (ST 18353AA000)
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the ignition coil. Refer to **IGNITION COIL** .
13. Remove the scavenge pump. (RH side only) Refer to **SCAVENGE PUMP** .
14. Disconnect PCV hose and vacuum hose from the rocker cover.

NOTE: Pinch the clamp of the PCV hose by fitting the cut out in the ST with the protrusion on the clamp as shown in the figure, and unlock the clamp.

ST 18353AA000 CLAMP PLIERS



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Fig. 184: Locating PCV Hose And Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

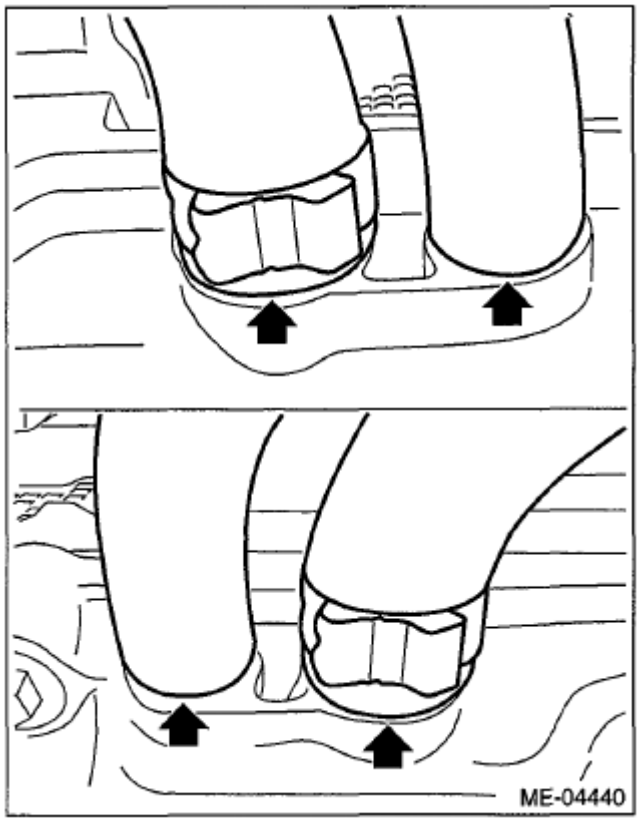


Fig. 185: Identifying Oil Pipe Union Bolt
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the rocker cover.

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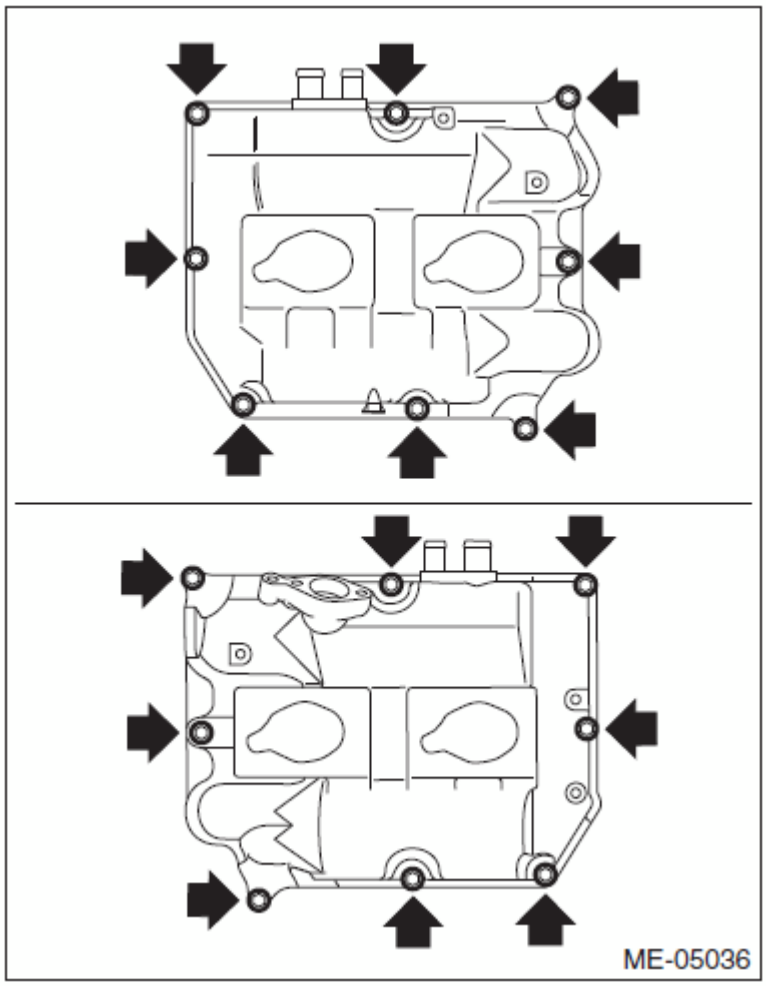
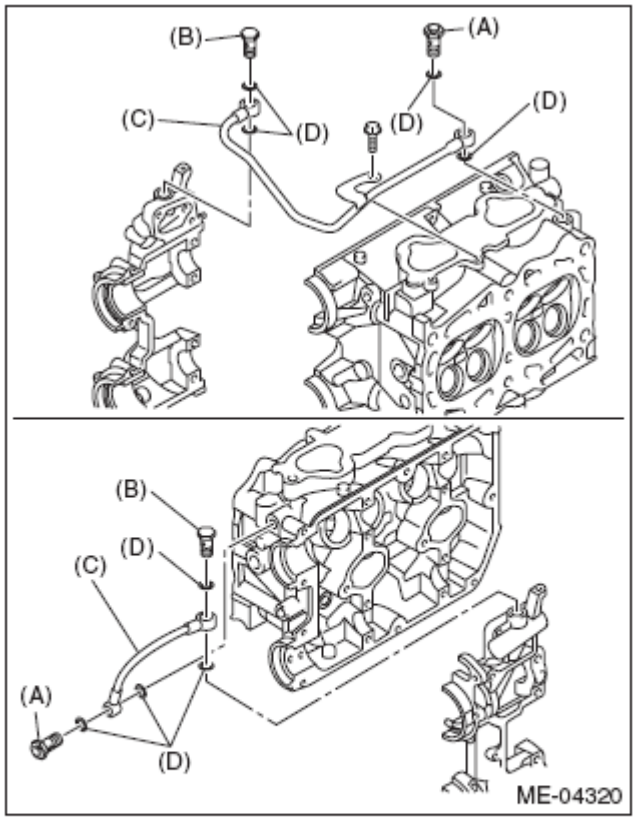


Fig. 186: Identifying Rocker Cover Bolts
Courtesy of SUBARU OF AMERICA, INC.

16. Remove the union bolt without filter (without protrusion) which secures the oil pipe to the front camshaft cap.

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

Fig. 187: Identifying Front Camshaft Cap, Intake Camshaft Cap And Rear Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

17. Loosen the bolts located on the upper side of the front camshaft cap, intake camshaft cap and rear camshaft cap (RH side only) equally, a little at a time in alphabetical order, as shown in the figure.

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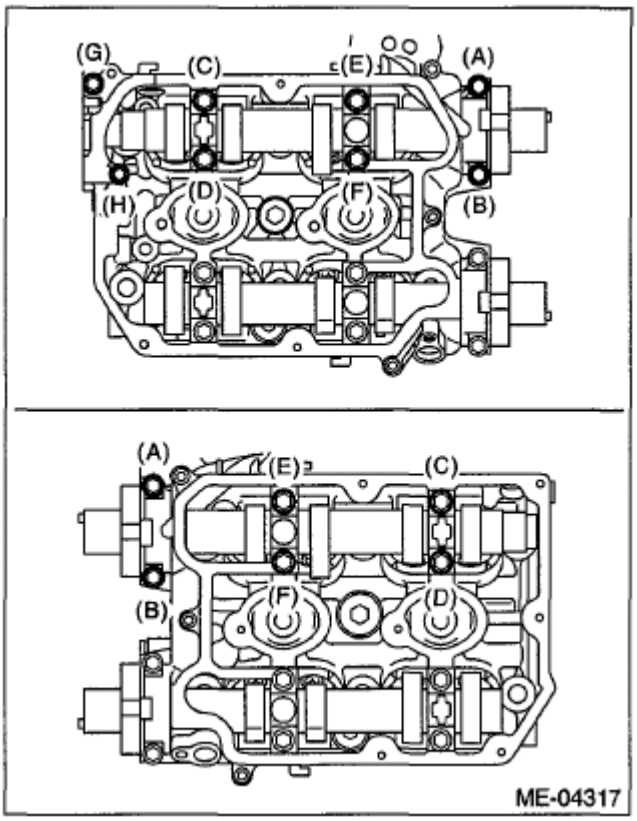


Fig. 188: Identifying Front Camshaft Cap And Exhaust Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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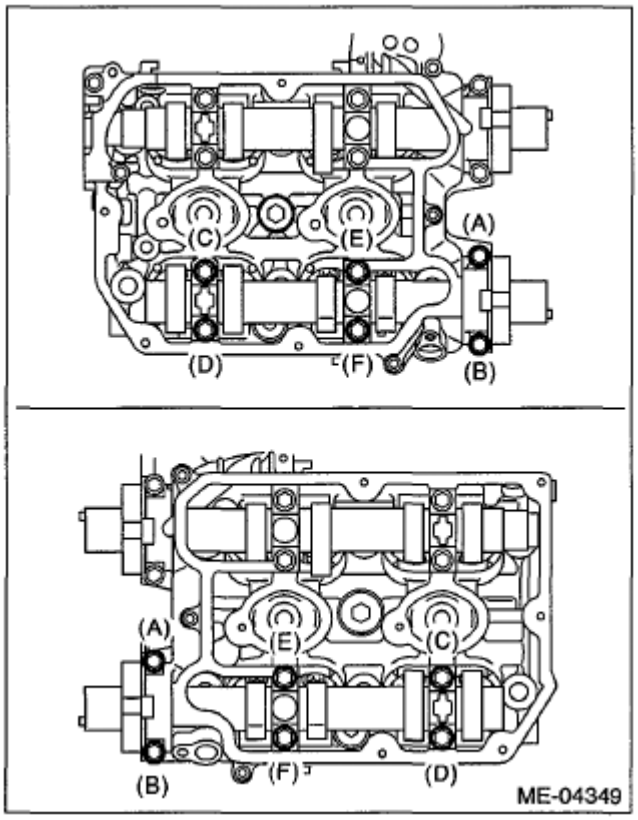


Fig. 189: Identifying Camshaft Position
Courtesy of SUBARU OF AMERICA, INC.

19. Remove the front camshaft cap.
20. Remove the intake camshaft caps, intake camshaft and rear camshaft caps (RH side only).
21. Remove the exhaust camshaft caps and exhaust camshaft.

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

22. Remove the oil seal.

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

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

INSTALLATION

1. Install the camshaft.

   Apply engine oil to the cylinder head at camshaft journal installation location before installing the

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camshaft. Install the camshaft so that each valve is close to or in contact with base circle of the cam lobe.

NOTE:

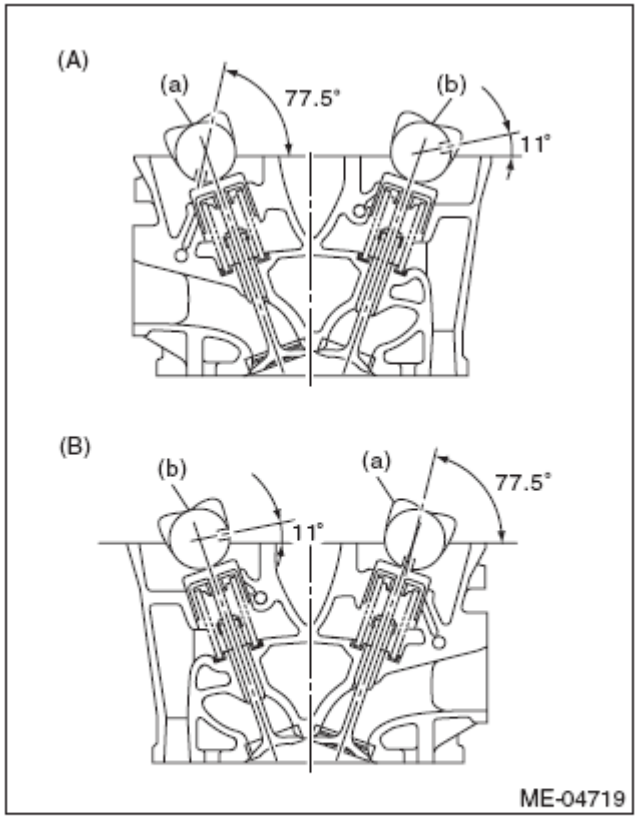
- **Set the camshaft to the position shown in the figure.**
- **When set at the position shown in the figure, it is not necessary to rotate the camshaft RH when installing the timing belt, but it is necessary to rotate the camshaft LH slightly.**

Intake camshaft LH:

Rotate 80° clockwise.

Exhaust camshaft LH:

Rotate 45° counterclockwise.



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

Fig. 190: Identifying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

Liquid gasket:

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

Liquid gasket applying diameter:

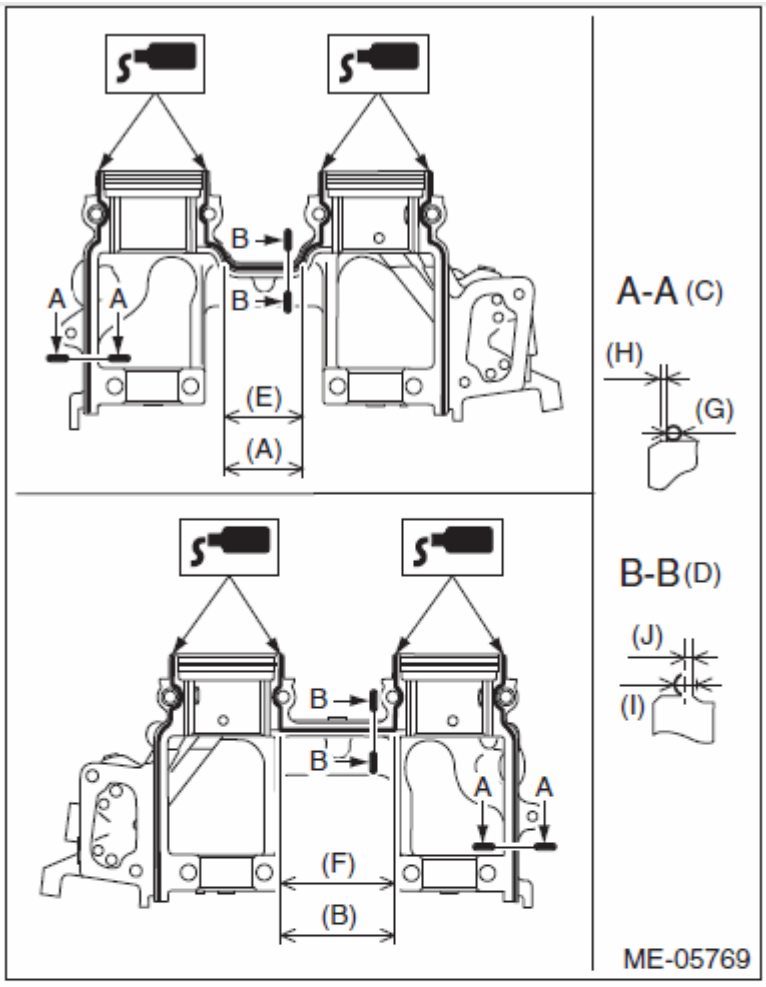
Mating surfaces other than ranges A and B

2±0.5 mm (0.0787±0.0197 in)

Mating surfaces of ranges A and B

3±1 mm (0.1181±0.0394 in)

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(A) Range A
(B) Range B
(C) Liquid gasket applying position of mating surfaces of ranges other than A and B
(D) Liquid gasket applying position of mating surfaces of ranges A and B
(E) 44.8 mm (1.7638 in)
(F) 65 mm (2.5591 in)
(G) ϕ2±0.5 mm (0.0787±0.0197 in)
(H) 0.5±0.5 mm (0.0197±0.0197 in)
(I) ϕ3±1 mm (0.1181±0.0394 in)
(J) 1 mm (0.0394 in) or less

Fig. 191: Identifying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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2. Apply small amount of liquid gasket to the mating surface of rear camshaft cap (RH side only).

NOTE:

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

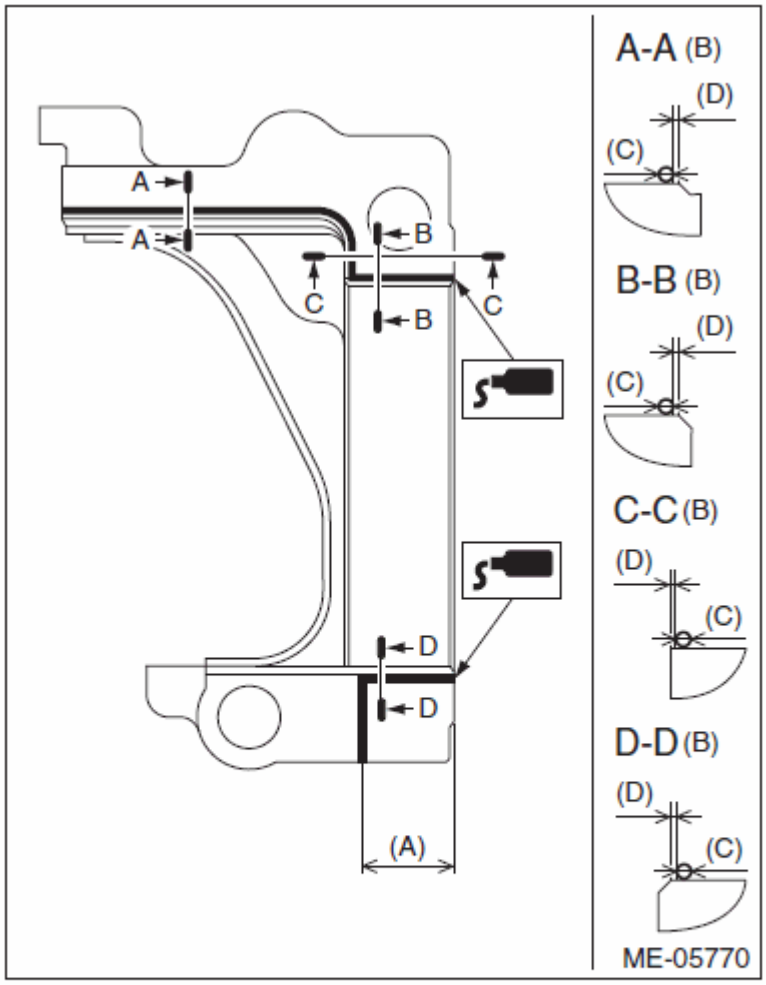
Liquid gasket:

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

Liquid gasket applying diameter:

2±0.5 mm (0.0787±0.0197 in)

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(A) 12.5±1.0 mm (0.4921±0.0394 in)
(B) Liquid gasket applying position
(C) ϕ2±0.5 mm (0.0787±0.0197 in)
(D) 0.5±0.5 mm (0.0197±0.0197 in)

Fig. 192: Identifying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

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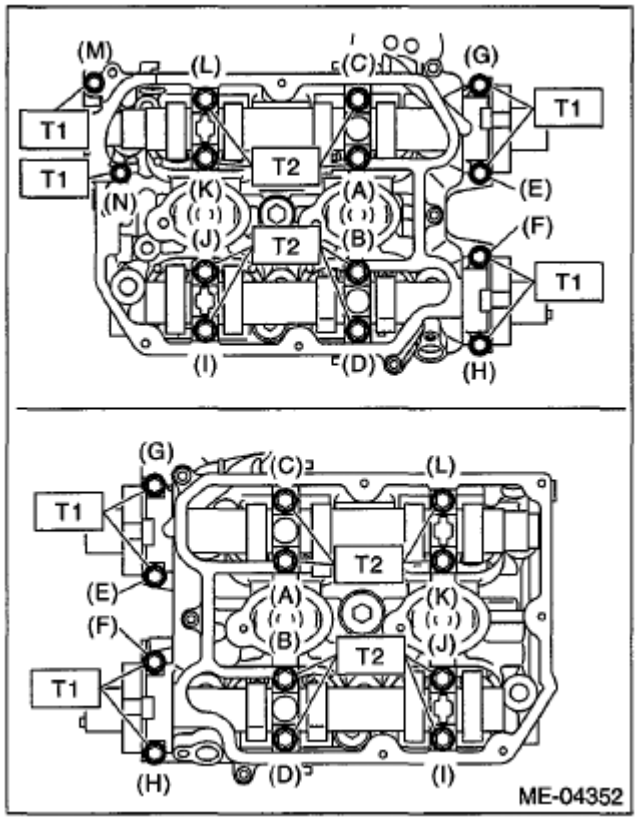


Fig. 193: Identifying Camshaft Cap Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

3. Apply a thin coat of engine oil to the periphery of the camshaft oil seal and oil seal lip, and install the oil seal on the camshaft using ST1 and ST2.

NOTE: Use a new oil seal.

ST1 499587600 OIL SEAL INSTALLER

ST2 499597200 OIL SEAL GUIDE

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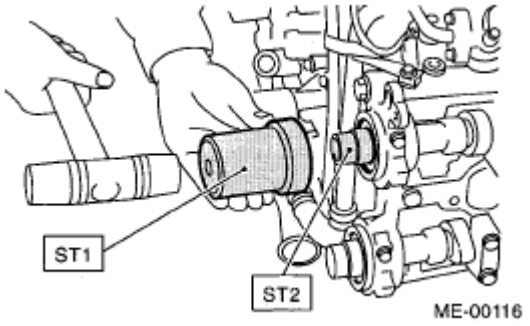
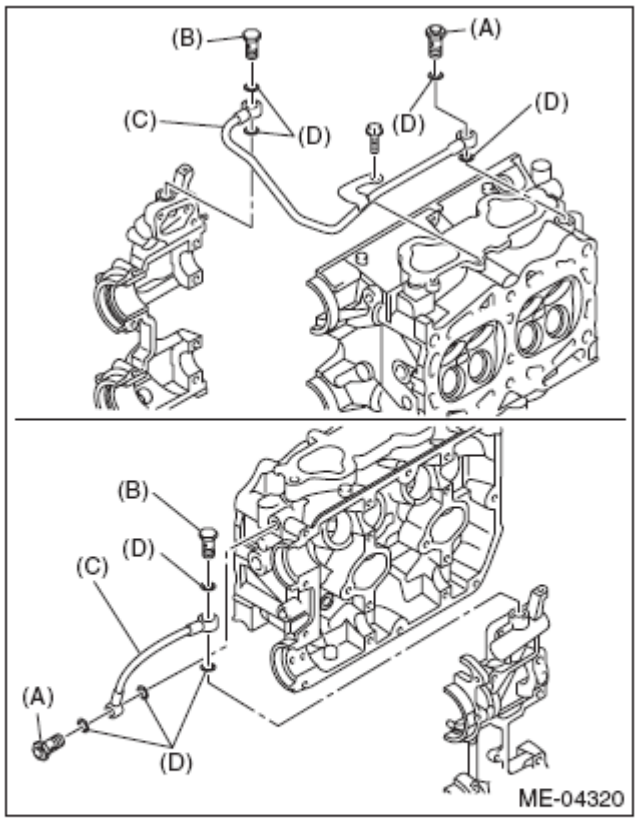


Fig. 194: Installing Oil Seal On Camshaft Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

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

   Tightening torque:

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



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

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Fig. 195: Identifying Oil Pipe Union Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Install the tensioner bracket.

   Tightening torque:

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

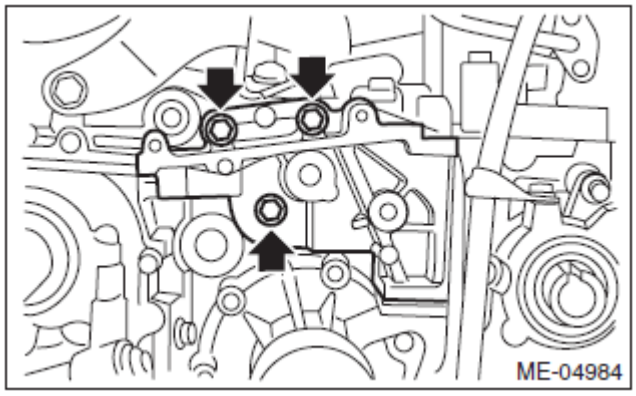


Fig. 196: Locating Tensioner Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Install the timing belt cover No. 2 RH (A) and timing belt cover No. 2 LH (B).

   Tightening torque:

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

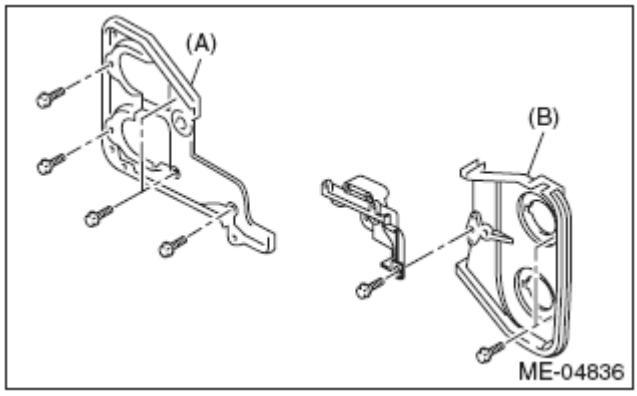


Fig. 197: Identifying Timing Belt Cover No. 2 RH And Timing Belt Coverc No. 2 LH
Courtesy of SUBARU OF AMERICA, INC.

7. Install the cam sprocket. Refer to , **INSTALLATION**, Cam Sprocket.
8. Install the timing belt. Refer to , **INSTALLATION**, Timing Belt.

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9. Adjust the valve clearance. Refer to , **ADJUSTMENT**, Valve Clearance.
10. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover. (Outer section and ignition coil section)

       NOTE: Use a new rocker cover gasket.

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

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

       Liquid gasket:

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

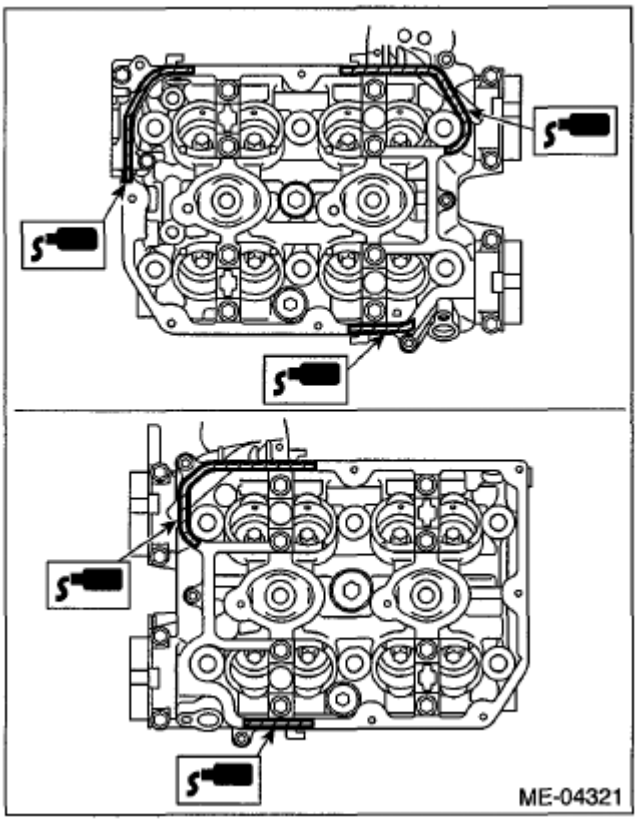


Fig. 198: Identifying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

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Tightening torque:

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

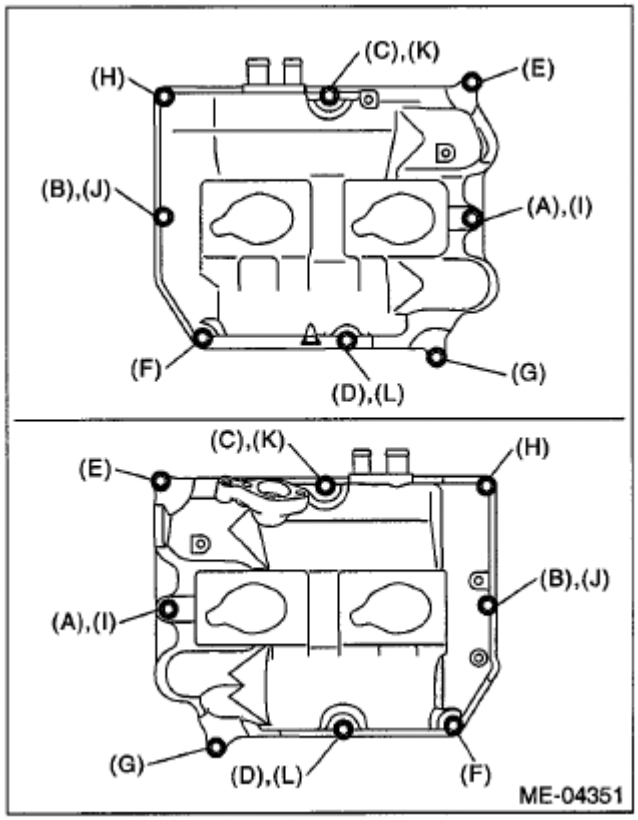


Fig. 199: Identifying Rocker Cover Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

5. Install the scavenge pump. Refer to **SCAVENGE PUMP** .
6. Connect the PCV hose and vacuum hose to the rocker cover.

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

ST 18353AA000 CLAMP PLIERS

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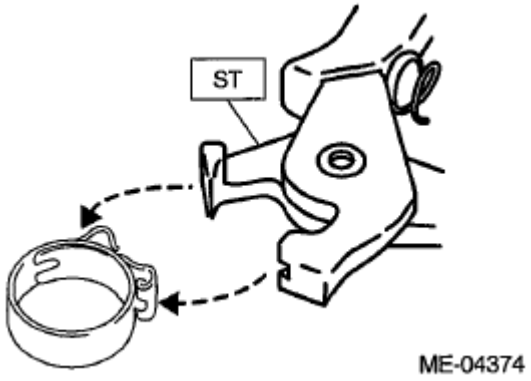


Fig. 200: Identifying Clamp Pliers (ST 18353AA000)
Courtesy of SUBARU OF AMERICA, INC.

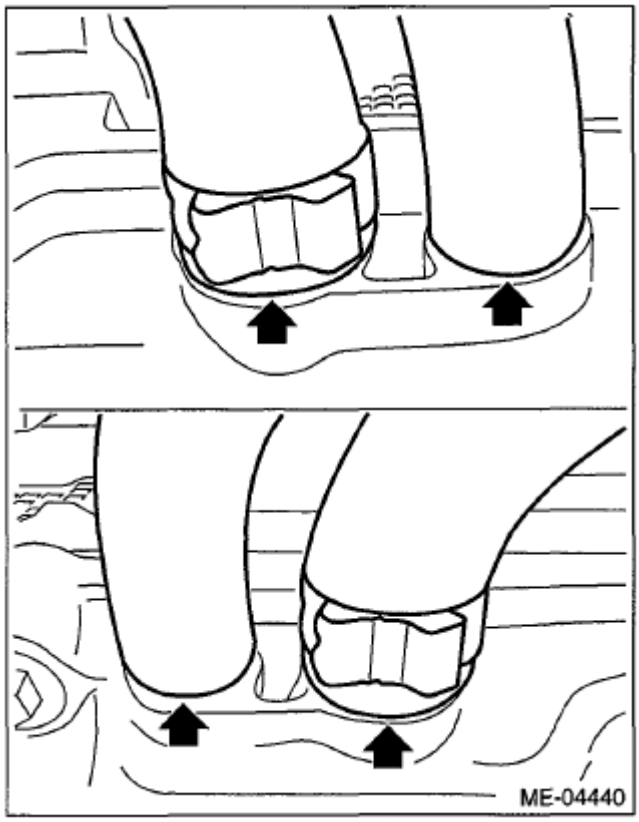


Fig. 201: Locating PCV Hose And Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

7. Install the ignition coil. Refer to **IGNITION COIL** .
8. Secure the engine harness or oil level switch harness to the rocker cover with the clip (A) and bolt (B).

Tightening torque:

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

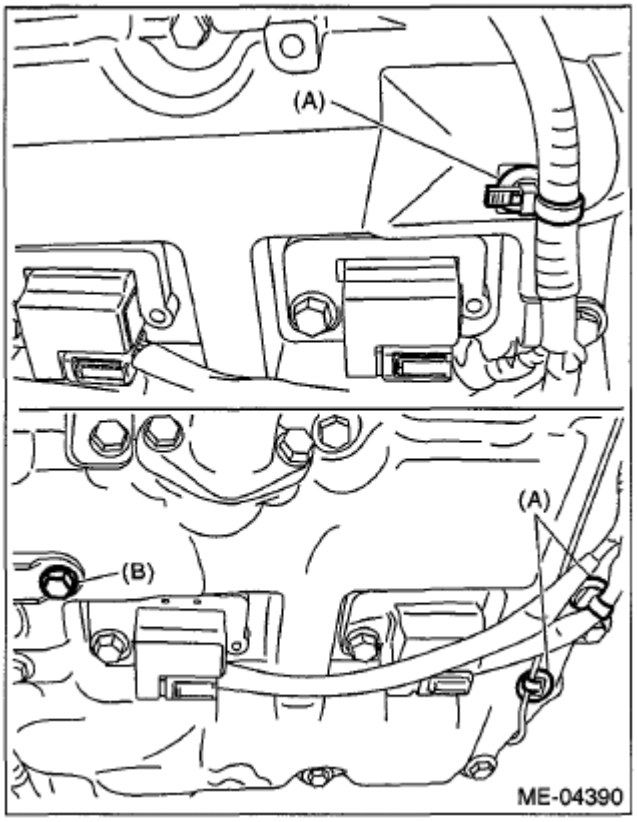


Fig. 202: Identifying Oil Level Switch Harness Clip And Bolt
Courtesy of SUBARU OF AMERICA, INC.

9. Connect the connector to the oil level switch.

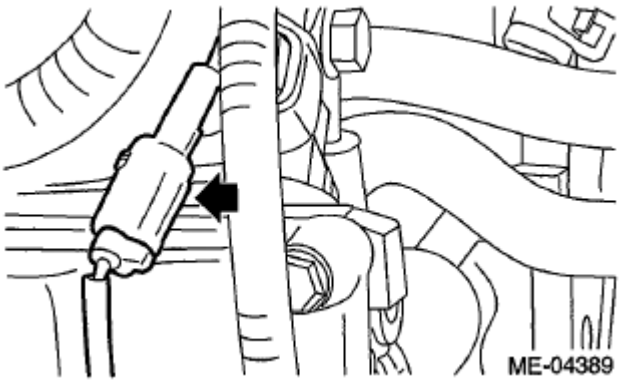


Fig. 203: Locating Oil Level Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

10. Connect the connector to the intake oil flow control solenoid valve.

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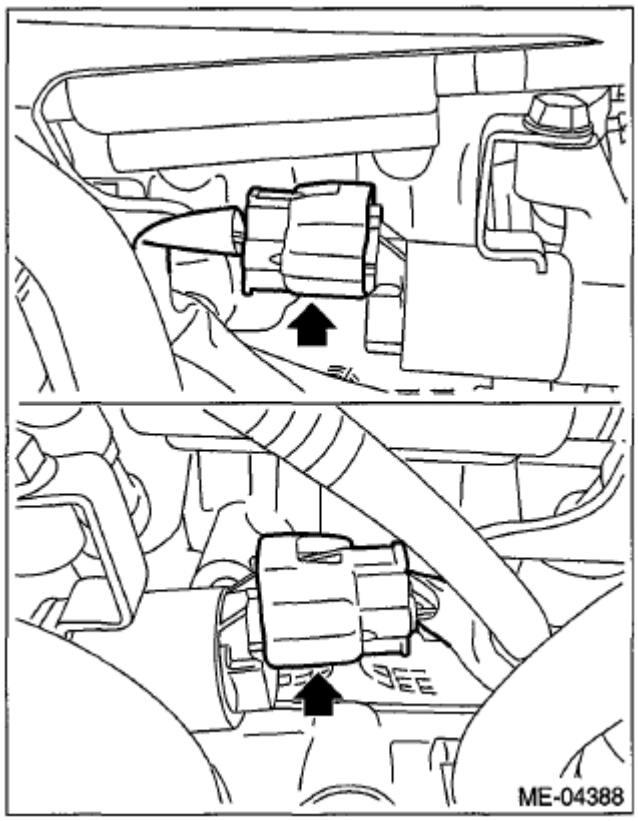


Fig. 204: Locating Intake Oil Flow Control Solenoid Valve Connector
Courtesy of SUBARU OF AMERICA, INC.

11. Connect the connectors to the exhaust camshaft position sensor (A) and exhaust oil flow control solenoid valve (B).

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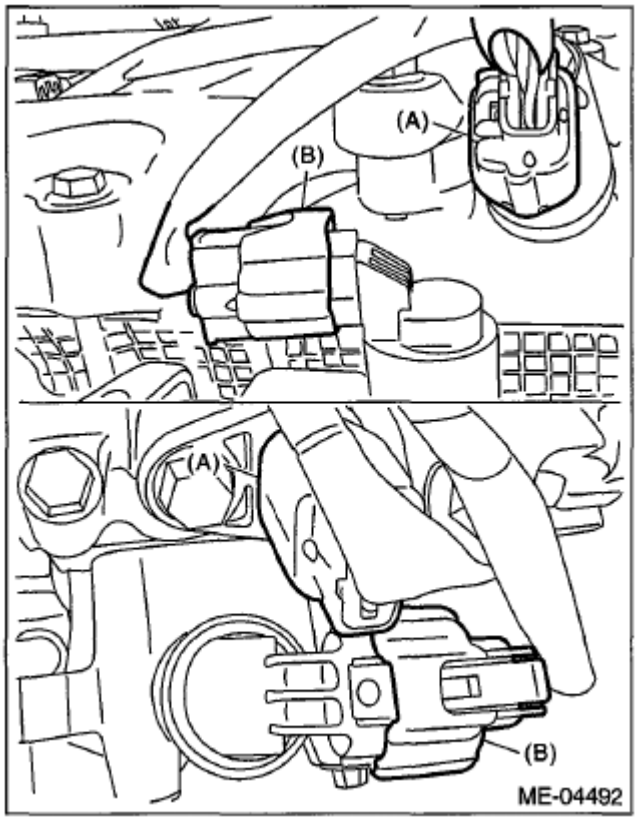


Fig. 205: Identifying Exhaust Camshaft Position Sensor And Exhaust Oil Flow Control Solenoid Valve Connectors
Courtesy of SUBARU OF AMERICA, INC.

12. Install the timing belt cover. Refer to , **INSTALLATION**, Timing Belt Cover.
13. Install the crank pulley. Refer to , **INSTALLATION**, Crank Pulley.
14. Install the engine to the vehicle. Refer to , **INSTALLATION**, Engine Assembly.

INSPECTION

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

   Camshaft bend limit:

   0.020 mm (0.00079 in)

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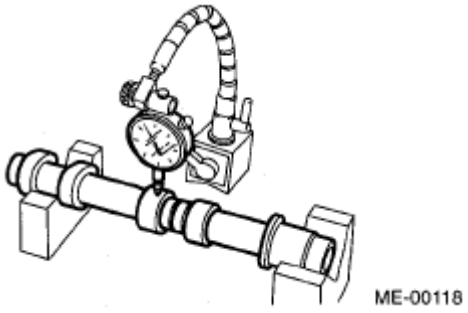


Fig. 206: Measuring Bend
Courtesy of SUBARU OF AMERICA, INC.

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

Cam lobe height H:

Standard

Intake

46.55 - 46.65 mm (1.833 - 1.837 in)

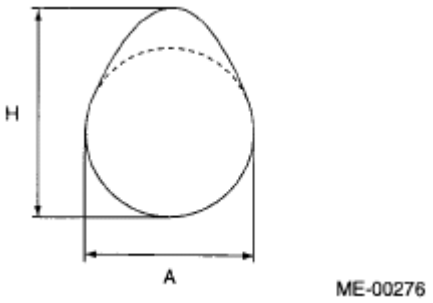
Exhaust

45.85 - 45.95 mm (1.805 - 1.809 in)

Cam base circle diameter A:

Standard

37.0 mm (1.457 in)



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Fig. 207: Identifying Cam Lobe Height H And Cam Base Circle Diameter A
Courtesy of SUBARU OF AMERICA, INC.

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

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

7. Measure the oil clearance of camshaft journal.
    1. Clean the camshaft cap and cylinder head camshaft journal.
    2. Place the camshaft on cylinder head. (Without installing the valve lifter)
    3. Place a plastigauge across each camshaft journals.
    4. Gradually tighten the camshaft cap in at least two steps, in alphabetical order shown in the figure, and then tighten to the specified torque. Do not turn the camshaft.

        Tightening torque:

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

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

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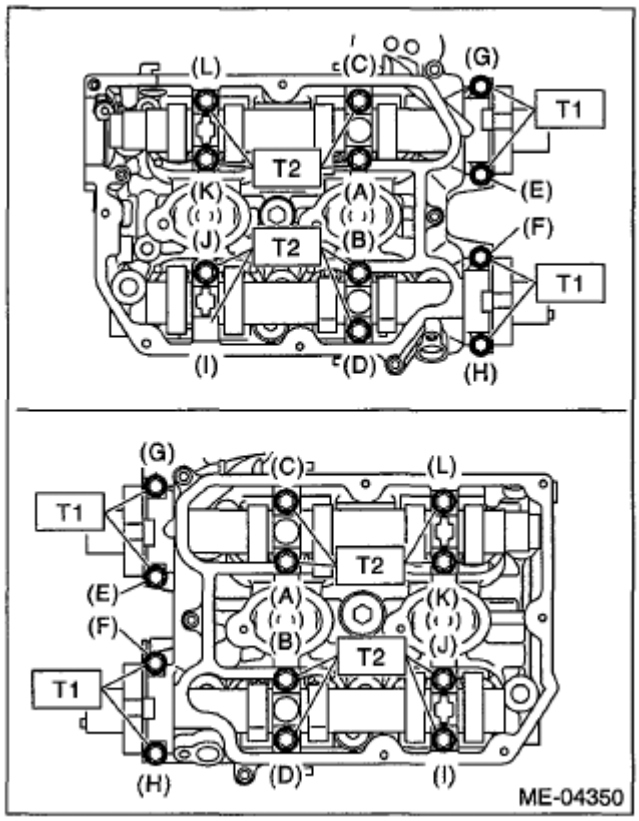


Fig. 208: Identifying Camshaft Cap Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Camshaft oil clearance:

Standard

0.037 - 0.072 mm (0.0015 - 0.0028 in)

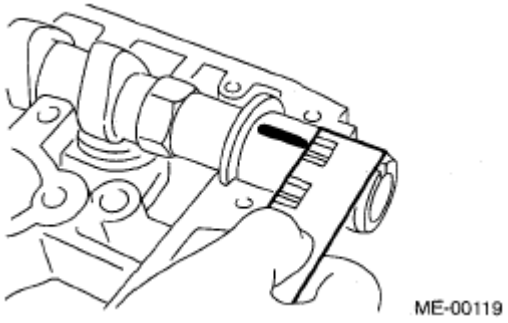


Fig. 209: Measuring Widest Point Of Plastigauge On Each Journal

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Courtesy of SUBARU OF AMERICA, INC.

7. Completely remove the plastigauge.
8. 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

0.068 - 0.116 mm (0.0027 - 0.0047 in)

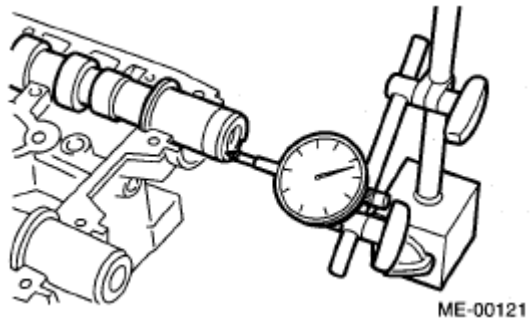


Fig. 210: Measuring Thrust Clearance Of Camshaft Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD

REMOVAL

1. Remove the engine from the vehicle. Refer to , **REMOVAL**, Engine Assembly.
2. Remove the intake manifold. Refer to **INTAKE MANIFOLD** .
3. Remove the crank pulley. Refer to , **REMOVAL**, Crank Pulley.
4. Remove the timing belt cover. Refer to , **REMOVAL**, Timing Belt Cover.
5. Remove the timing belt. Refer to , **REMOVAL**, Timing Belt.
6. Remove the cam sprocket. Refer to , **REMOVAL**, Cam Sprocket.
7. Remove the bolts which secure A/C compressor bracket to cylinder head. (LH side only)
8. Remove the oil pipe. Refer to **OIL PIPE** .
9. Remove the clip stay.

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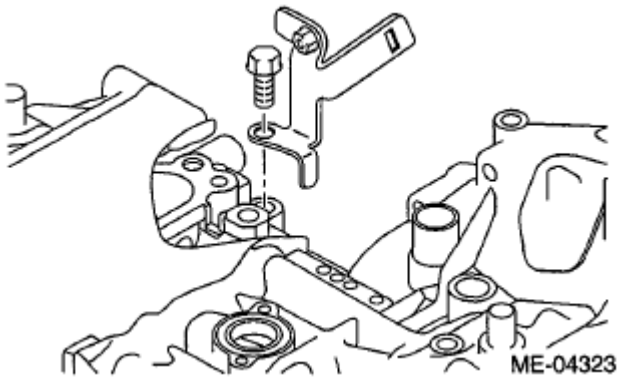


Fig. 211: Removing A/C Compressor Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

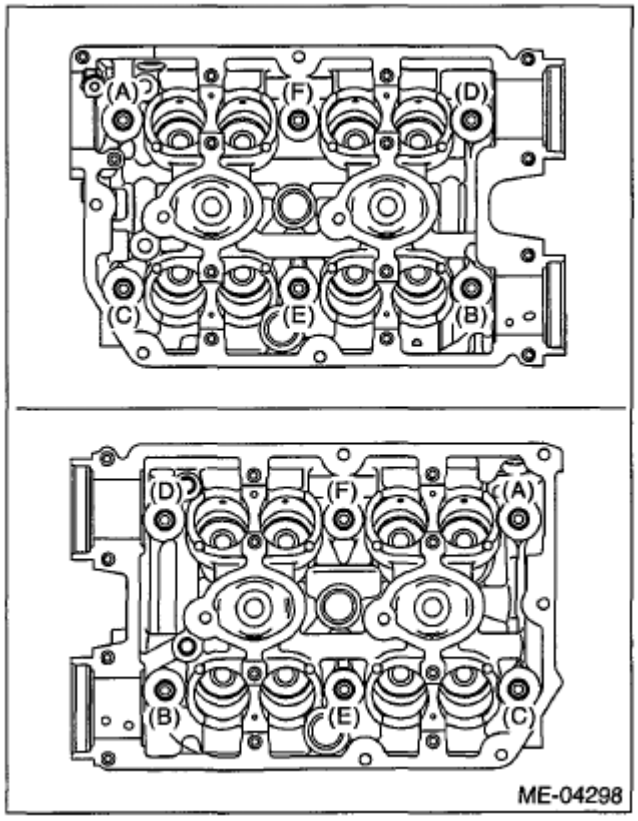


Fig. 212: Identifying Cylinder Head Bolts Removing Sequence

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Courtesy of SUBARU OF AMERICA, INC.

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

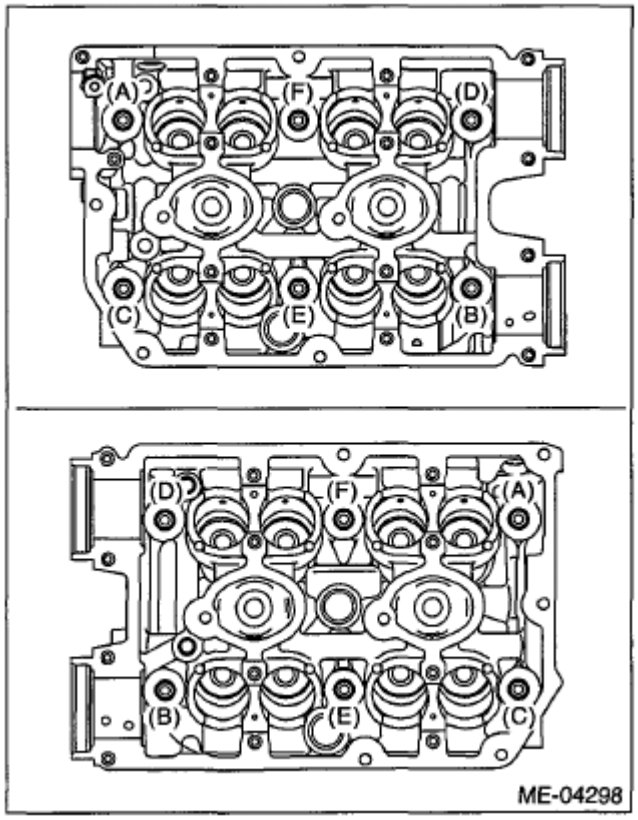


Fig. 213: Identifying Cylinder Head Bolts Removing Sequence
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the cylinder head gasket.

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

INSTALLATION

1. Install the cylinder head to the cylinder block.

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

NOTE: Use a new cylinder head gasket.

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1. Clean the bolt threads and the bolt holes in the cylinder block

CAUTION: To avoid erroneous tightening of the bolts, clean out the bolt holes sufficiently by blowing with compressed air to eliminate engine coolant etc.

2. Apply a sufficient coat of engine oil to the washer and bolt thread.
3. Tighten all bolts to 40 N.m (4.1 kgf-m, 29.5 ft-lb) in alphabetical order.
4. Retighten all bolts to 95 N.m (9.7 kgf-m, 70.1 ft-lb) in alphabetical order.

CAUTION: If the bolt makes stick-slip sound during tightening, repeat the procedure from step (1). In this case, the cylinder head gasket can be reused.

5. Loosen all the bolts by 180° in the reverse order of installing, and loosen them further by 180°.
6. Tighten all bolts to 10 N.m (1.0 kgf-m, 7.4 ft-lb) in alphabetical order.
7. Retighten all bolts to 30 N.m (3.1 kgf-m, 22.1 ft-lb) in alphabetical order.
8. Retighten all bolts to 70 N.m (7.1 kgf-m, 51.6 ft-lb) in alphabetical order.
9. Retighten all bolts by 80 - 90° in alphabetical order.
10. Retighten all bolts by 40 - 45° in alphabetical order.

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

11. Retighten bolts (A) and (B) by 40 - 45°.

CAUTION: Make sure the total "tightening angle" of steps (10) and (11) does not exceed 90°.

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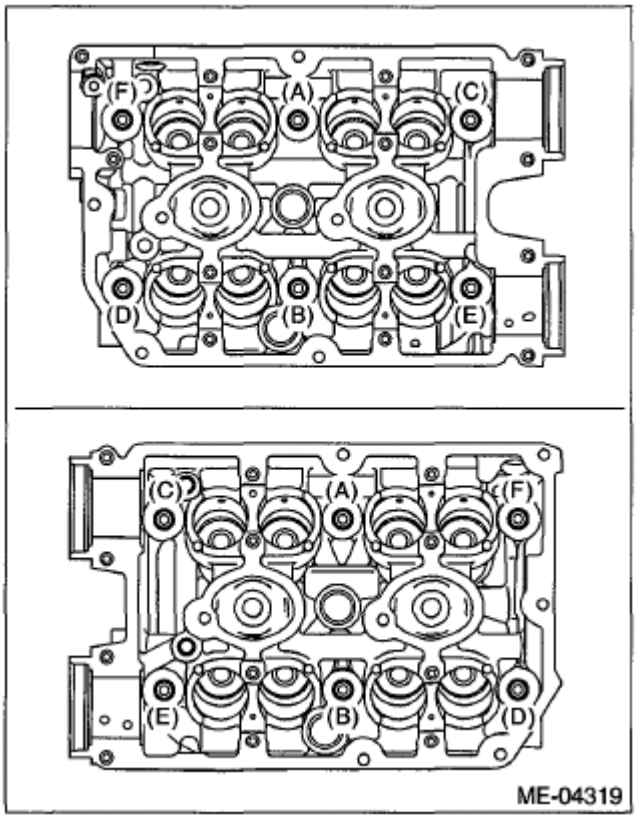


Fig. 214: Identifying Cylinder Head Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

    Tightening torque:

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

13. Install the camshaft. Refer to , **INSTALLATION**, Camshaft.
14. Install the clip stay.

    Tightening torque:

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

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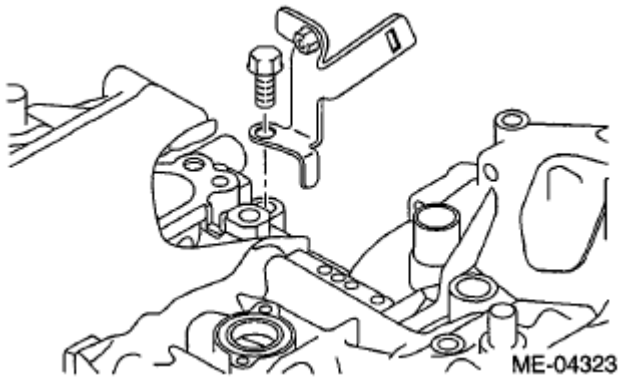


Fig. 215: Identifying A/C Compressor Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

15. Install the oil pipe. Refer to **OIL PIPE** .
16. Install the A/C compressor bracket on cylinder head. (LH side only)

    Tightening torque:

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

17. Install the cam sprocket. Refer to , **INSTALLATION**, Cam Sprocket.
18. Install the timing belt. Refer to , **INSTALLATION**, Timing Belt.
19. Adjust the valve clearance. Refer to , **ADJUSTMENT**, Valve Clearance.
20. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover. (Outer section and ignition coil section)

       NOTE: Use a new rocker cover gasket.

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

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

       Liquid gasket:

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

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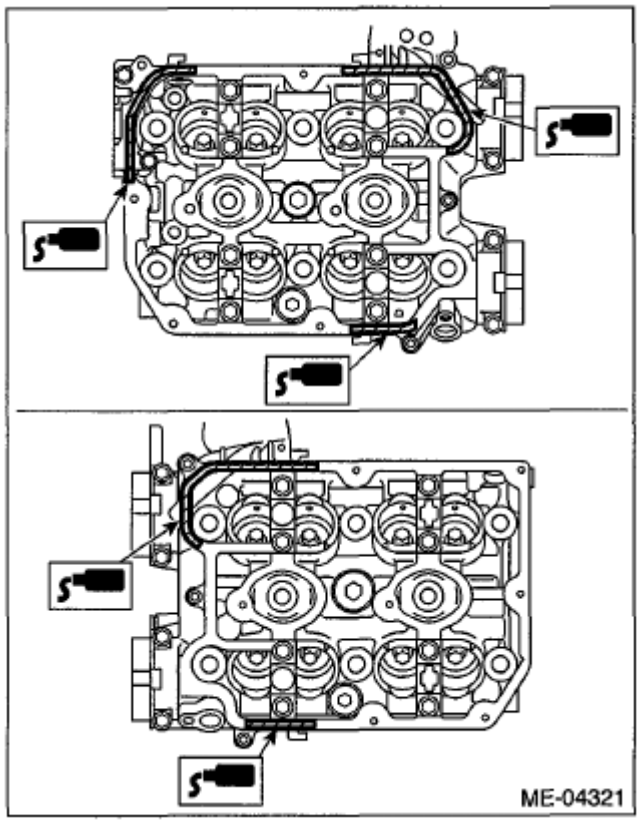


Fig. 216: Applying Liquid Gasket To Specified Point Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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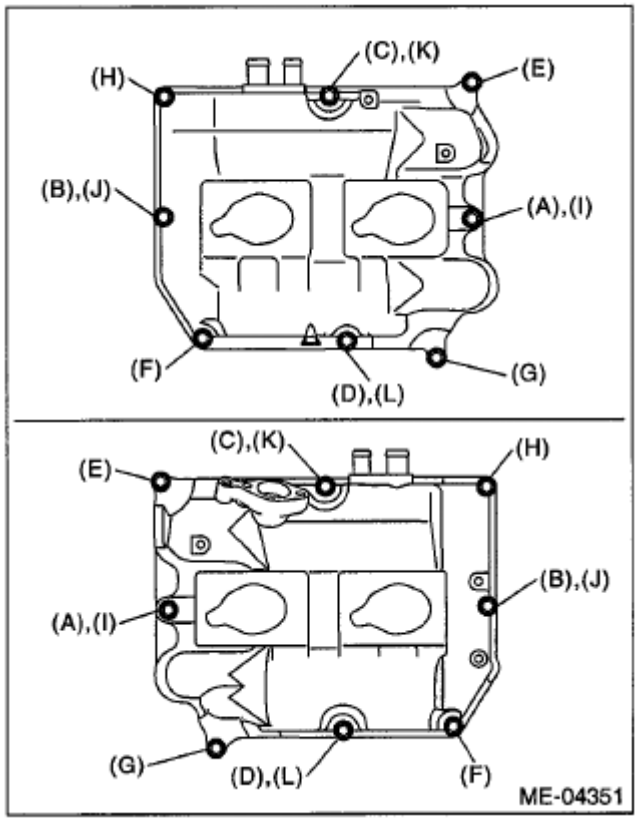


Fig. 217: Identifying Rocker Cover Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

21. Connect the PCV hose to the rocker cover.
22. Install the timing belt cover. Refer to , **INSTALLATION**, Timing Belt Cover.
23. Install the crank pulley. Refer to , **INSTALLATION**, Crank Pulley.
24. Install the intake manifold. Refer to **INTAKE MANIFOLD** .
25. Install the engine to the vehicle. Refer to , **INSTALLATION**, Engine Assembly.

DISASSEMBLY

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

   ST1 498267600 CYLINDER HEAD TABLE

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

ST2 499718000 VALVE SPRING REMOVER

NOTE:

- **Mark each valve to prevent confusion.**

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- **Pay careful attention not to damage the lips of intake valve oil seals and exhaust valve oil seals.**
- **Keep all the removed parts in order for re-installing in their original positions.**
- **For removal and installation procedures of the valve guide, intake valve oil seal and exhaust valve oil seal, refer to "INSPECTION". Refer to , VALVE GUIDE, INSPECTION, Cylinder Head. Refer to , INTAKE AND EXHAUST VALVE OIL SEAL, INSPECTION, Cylinder Head.**

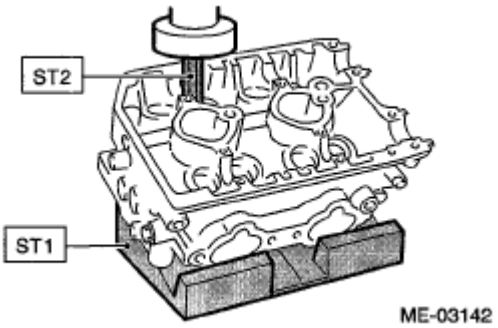
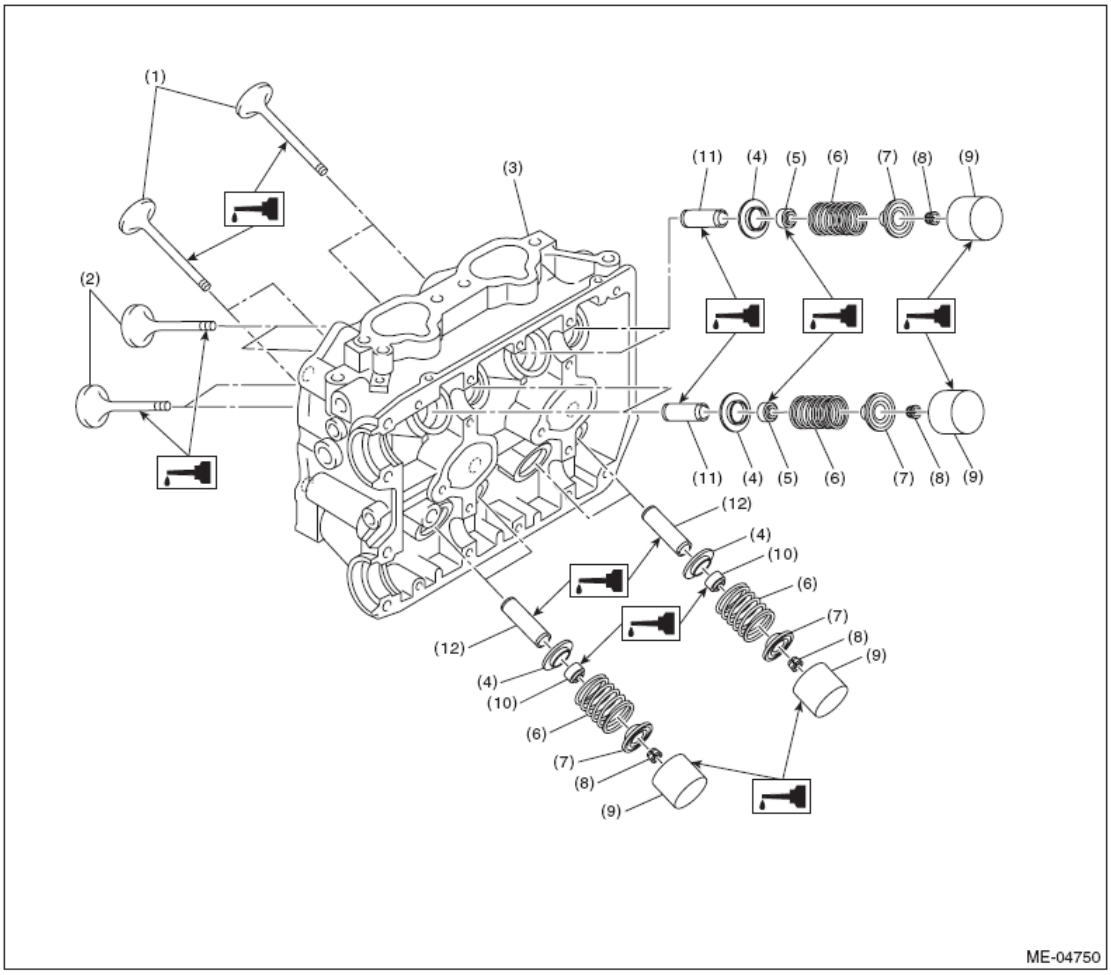


Fig. 218: Removing And Installing Valve Guide Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY

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

Fig. 219: Exploded View Of Valve Assembly
Courtesy of SUBARU OF AMERICA, INC.

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

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

    2. Set the cylinder head on ST1.

        ST1 498267600 CYLINDER HEAD TABLE

    3. Install the valve spring and retainer.

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

4. Set the ST2 on valve spring.

   ST2 499718000 VALVE SPRING REMOVER

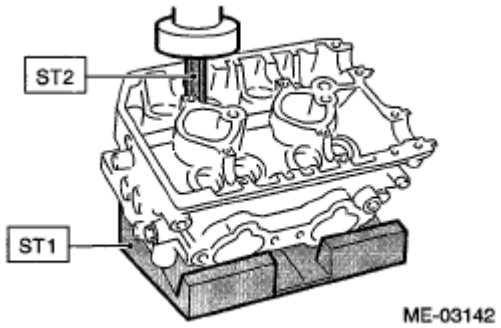


Fig. 220: Installing Valve Spring And Retainer
Courtesy of SUBARU OF AMERICA, INC.

5. Compress the valve spring and fit the valve spring retainer key.
6. After installing, tap the valve spring retainers lightly with a plastic hammer for better seating.

2. Apply oil to the surface of valve lifter.
3. Install the valve lifter.

INSPECTION

CYLINDER HEAD

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

If the warping exceeds the limit, correct the surface by grinding it with a surface grinder.

Warping limit:

0.035 mm (0.0014 in)

Grinding limit:

0.3 mm (0.012 in)

Standard height of cylinder head:

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127.5 mm (5.02 in)

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

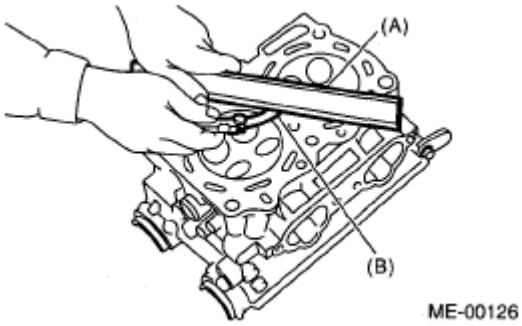


Fig. 221: Measuring Warping Of Cylinder Head Surface Using Straight Edge And Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Contacting width W between valve and valve seat:

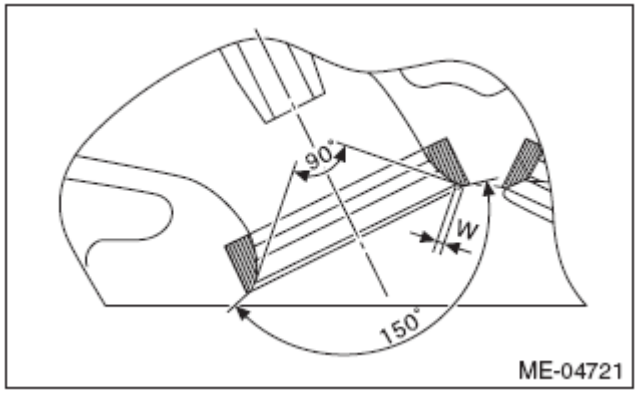
Standard

Intake

0.6 - 1.4 mm (0.024 - 0.055 in)

Exhaust

1.2 - 1.8 mm (0.047 - 0.071 in)



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Fig. 222: Inspecting Intake And Exhaust Valve Seats
Courtesy of SUBARU OF AMERICA, INC.



Fig. 223: Correcting Contact Surfaces Using Valve Seat Cutter
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

   Clearance between the valve guide and valve stem:

   Standard

   Intake

   0.030 - 0.057 mm (0.0012 - 0.0022 in)

   Exhaust

   0.040 - 0.067 mm (0.0016 - 0.0026 in)

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

Valve guide inner diameter:

6.000 - 6.012 mm (0.2362 - 0.2367 in)

Valve stem outer diameters:

Intake

5.955 - 5.970 mm (0.2344 - 0.2350 in)

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Exhaust

5.945 - 5.960 mm (0.2341 - 0.2346 in)

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

   ST1 498267600 CYLINDER HEAD TABLE

   ST2 499767200 VALVE GUIDE REMOVER

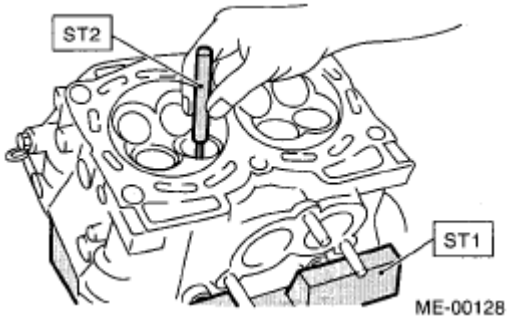


Fig. 224: Identifying Cylinder Head Table And Valve Guide Remover
Courtesy of SUBARU OF AMERICA, INC.

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

   ST 18251AA020 VALVE GUIDE ADJUSTER

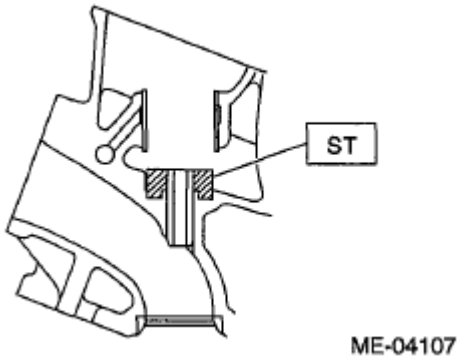


Fig. 225: Identifying Valve Guide Adjuster
Courtesy of SUBARU OF AMERICA, INC.

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.

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ST1 499767200 VALVE GUIDE REMOVER

ST2 18251AA020 VALVE GUIDE ADJUSTER

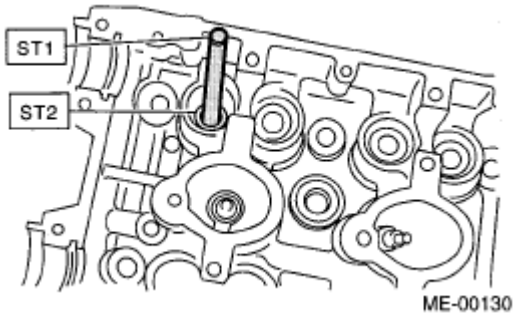


Fig. 226: Identifying Valve Guide Remover And Valve Guide Adjuster
Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion amount "L".

   Valve guide protrusion amount L:

   15.8 - 16.2 mm (0.622 - 0.638 in)

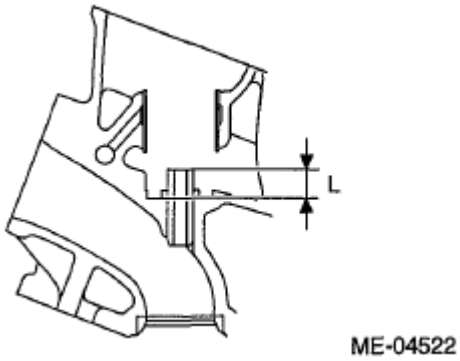


Fig. 227: Checking Valve Guide Protrusion Amount L
Courtesy of SUBARU OF AMERICA, INC.

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

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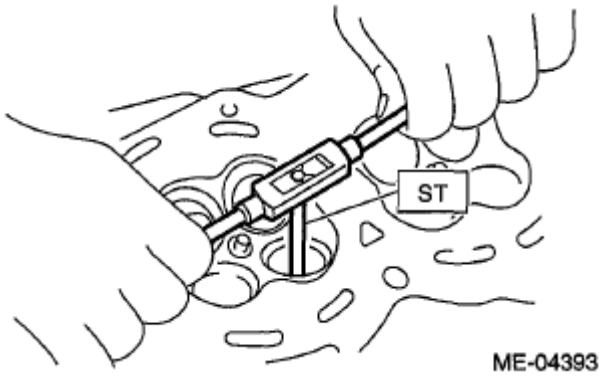


Fig. 228: Identifying Valve Guide Reamer (ST 499767400)
Courtesy of SUBARU OF AMERICA, INC.

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

INTAKE AND EXHAUST VALVE

1. Inspect the flange of valve and valve stem, and replace the valve with a new part if damaged, worn, deformed, or if dimension "H" in the figure is outside of the specified limit.

   Head edge thickness H:

   Standard

   Intake (A)

   1.0 - 1.4 mm (0.039 - 0.055 in)

   Exhaust (B)

   1.3 - 1.7 mm (0.051 - 0.067 in)

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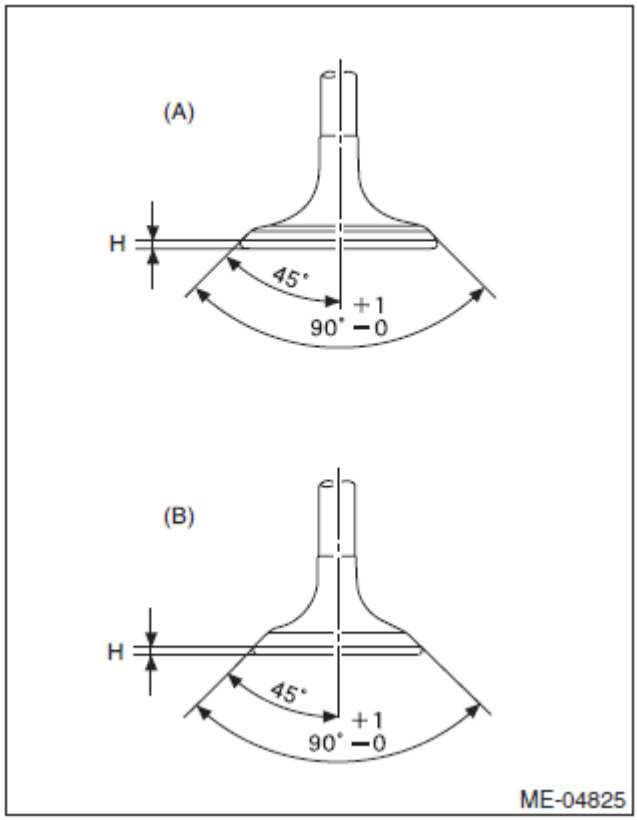


Fig. 229: Identifying Head Edge Thickness H
Courtesy of SUBARU OF AMERICA, INC.

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

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

Valve overall length:

Intake

104.4 mm (4.110 in)

Exhaust

104.65 mm (4.1201 in)

VALVE SPRING

1. Check the valve springs for damage, free length, and tension. Replace the valve spring if it is not within the standard value presented in the table.

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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.

Free length	mm (in)	47.32 (1.863)
Tension/spring height N (kgf, lbf)/mm (in)	Set	205 - 235 (20.90 - 23.96, 46.09 - 52.84)/36.0 (1.417)
	Lift	426 - 490 (43.44 - 49.96, 95.78 - 110.17)/26.5 (1.043)
Squareness		2.5°, 2.1 mm (0.083 in) or less

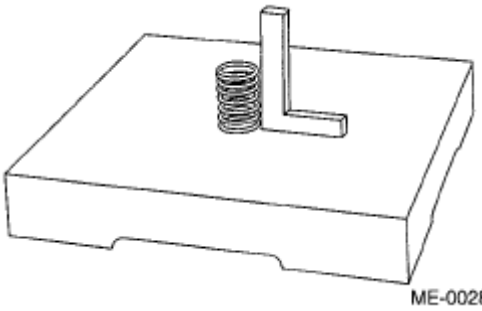


Fig. 230: Checking Valve Springs Free Length
Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

1. For the following, replace the oil seal with a new part. See the procedure 2) and subsequent for replacement procedures.
   - When the lip is damaged.
   - When the spring is out of the specified position.
   - When readjusting the surfaces of valve and valve seat.
   - When replacing the valve guide.
2. Place the cylinder head on ST1, and use ST2 to press-fit the oil seal.

ST1 498267600 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

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

Color of rubber part:

Intake [Gray]

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Exhaust [Green]

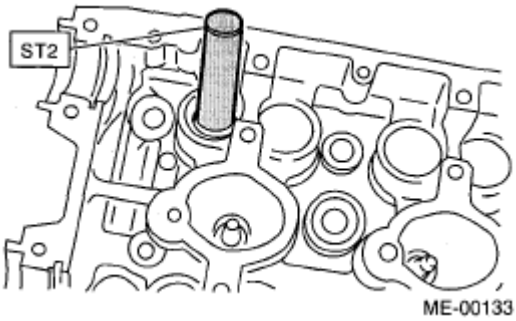


Fig. 231: Identifying Valve Oil Seal Guide (ST2 498857100)
Courtesy of SUBARU OF AMERICA, INC.

VALVE LIFTER

1. Perform visual check on the valve lifter.
2. Measure the valve lifter outer diameter.

   Outer diameter of valve lifter:

   34.959 - 34.975 mm (1.3763 - 1.3770 in)

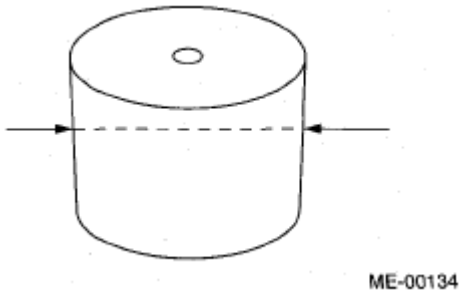


Fig. 232: Measuring Valve Lifter Outer Diameter
Courtesy of SUBARU OF AMERICA, INC.

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

   Inner diameter of valve lifter mating surface:

   34.994 - 35.016 mm (1.3777 - 1.3786 in)

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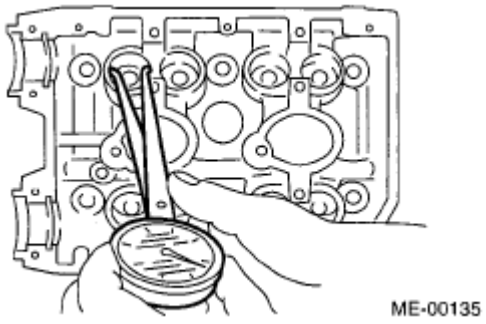


Fig. 233: Measuring Inner Diameter Of Valve Lifter Mating Surface On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

4. Check the clearance between valve lifter and valve lifter mating surface. The clearance can be determined from the measured value of the valve lifter outer diameter and valve lifter mating surface inner diameter. If it is not within the standard or there is uneven wear in the inner surface, replace the cylinder head.

Clearance between valve lifter and valve lifter mating surface:

Standard

0.019 - 0.057 mm (0.0007 - 0.0022 in)

CYLINDER BLOCK

REMOVAL

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

1. Remove the engine from the vehicle. Refer to , **REMOVAL**, Engine Assembly.
2. Remove the intake manifold. Refer to **INTAKE MANIFOLD** .
3. Remove the crank pulley. Refer to , **REMOVAL**, Crank Pulley.
4. Remove the timing belt cover. Refer to , **REMOVAL**, Timing Belt Cover.
5. Remove the timing belt. Refer to , **REMOVAL**, Timing Belt.
6. Remove the cam sprocket. Refer to , **REMOVAL**, Cam Sprocket.
7. Remove the crank sprocket. Refer to , **REMOVAL**, Crank Sprocket.
8. Remove the A/C compressor together with the bracket.
9. Remove the camshaft. Refer to , **REMOVAL**, Camshaft.
10. Remove the cylinder head. Refer to , **REMOVAL**, Cylinder Head.
11. Remove the clutch disc and cover. Refer to **CLUTCH DISC AND COVER** .
12. Remove the flywheel. Refer to **FLYWHEEL** .
13. Remove the oil separator cover.
14. Remove the oil filter. Refer to **ENGINE OIL FILTER** .

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15. Remove the oil cooler. Refer to **ENGINE OIL COOLER** .
16. Remove the water pump. Refer to **WATER PUMP** .
17. Remove the bolts which secure oil pump to cylinder block.

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

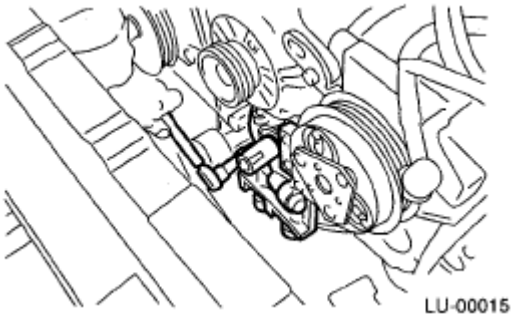


Fig. 234: Removing Oil Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

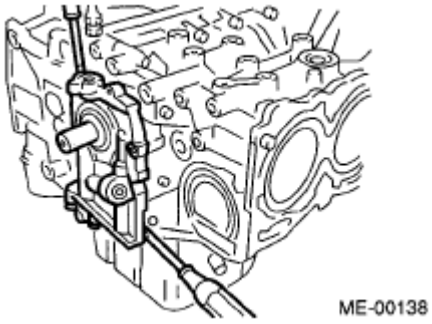


Fig. 235: Removing Oil Pump From Cylinder Block Using Flat Tip Screwdriver
Courtesy of SUBARU OF AMERICA, INC.

19. Remove the front oil seal from the oil pump.
20. Remove the clip holding the oil level switch harness from cylinder block.

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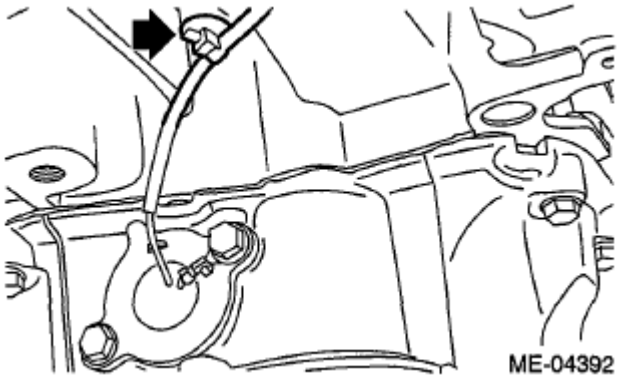


Fig. 236: Removing Oil Level Switch Harness Clip
Courtesy of SUBARU OF AMERICA, INC.

21. 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 at the position shown in the figure, and avoid scratching the mating surface of the cylinder block and cylinder block lower.

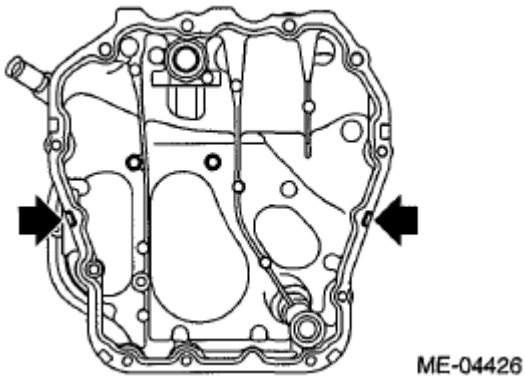


Fig. 237: Locating Flat Tip Screwdriver Inserting Location
Courtesy of SUBARU OF AMERICA, INC.

22. Remove the baffle plate.

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23. Remove blow-by pipe assembly (A), blow-by pipe (B), PCV hose assembly (C) and water pipe assembly (D).

NOTE: To unlock the clamp of the blow-by pipe assembly (A), blow-by pipe (B) and PCV hose assembly (C), pinch the clamp by fitting the cut out in the ST with the protrusion on the clamp as shown in the figure.

ST 18353AA000 CLAMP PLIERS

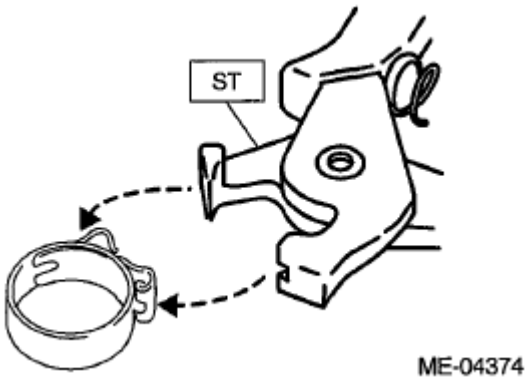
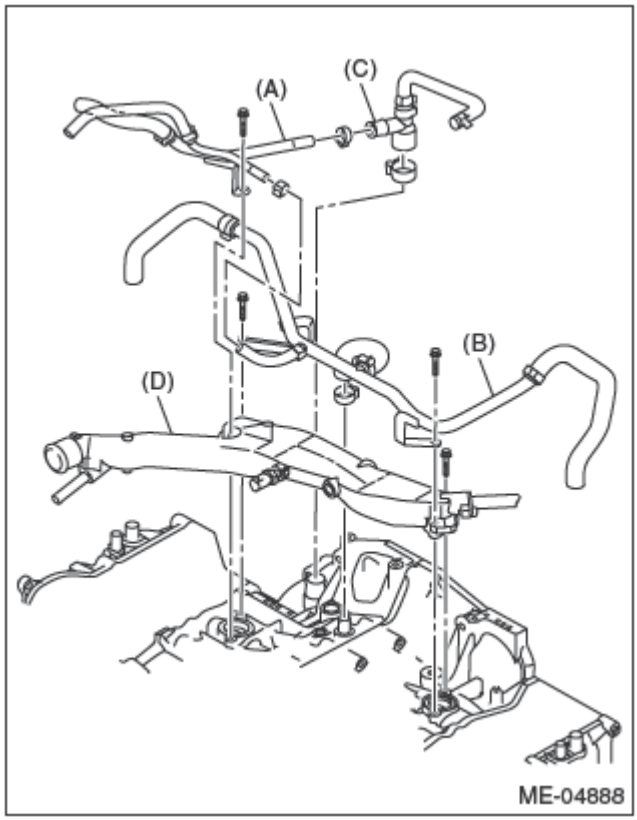


Fig. 238: Identifying Clamp Pliers (ST 18353AA000)
Courtesy of SUBARU OF AMERICA, INC.



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Fig. 239: Identifying Blow-By Pipe Assembly (A), Blow-By Pipe (B), PCV Hose Assembly (C) And Water Pipe Assembly (D)
Courtesy of SUBARU OF AMERICA, INC.

24. Remove the water by-pass pipe.

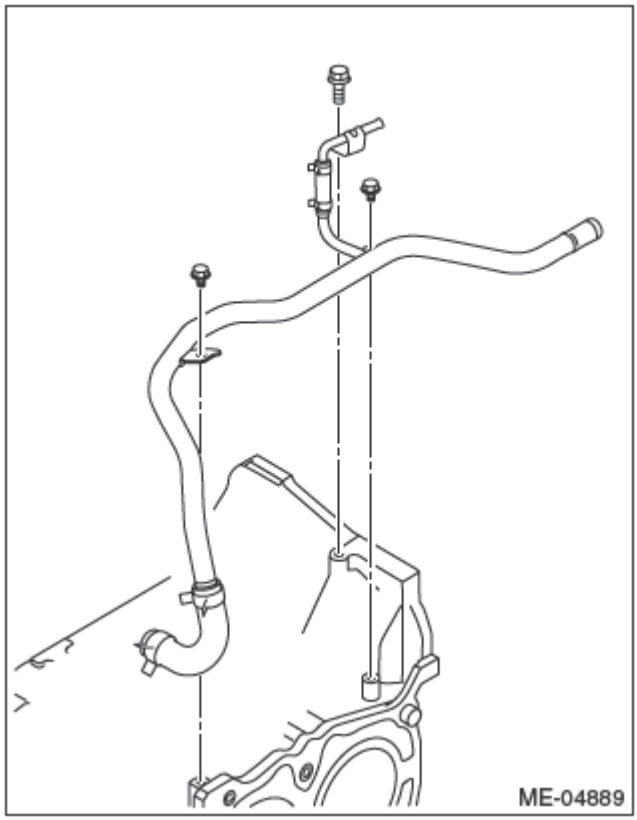
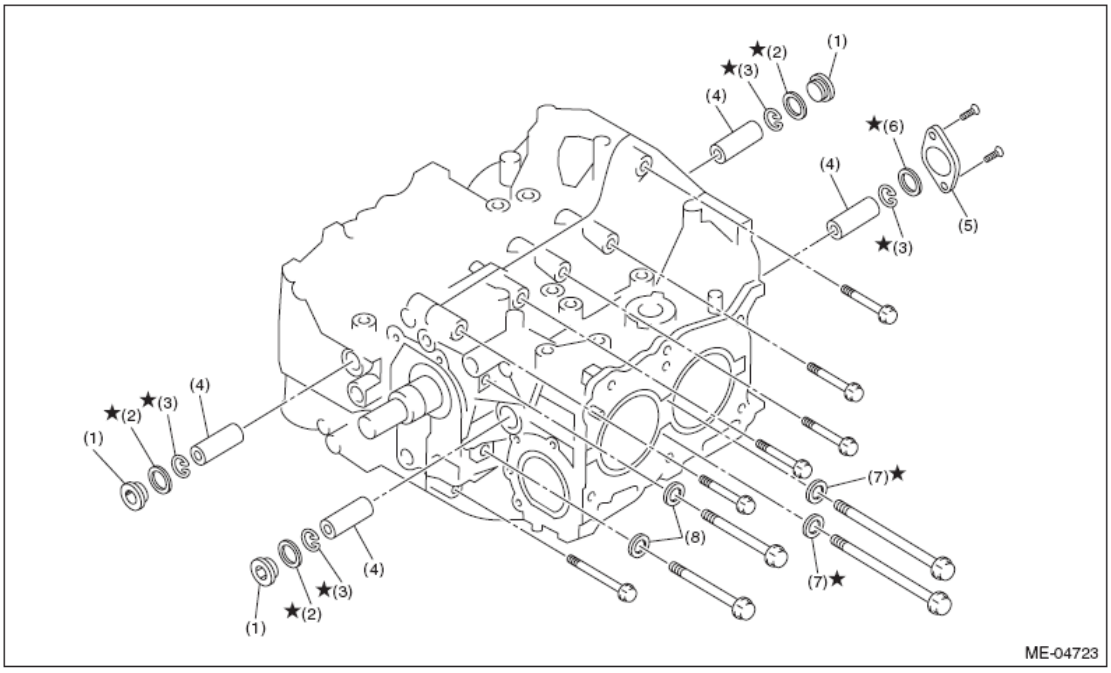


Fig. 240: Identifying Water By-Pass Pipe
Courtesy of SUBARU OF AMERICA, INC.

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

Fig. 241: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

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

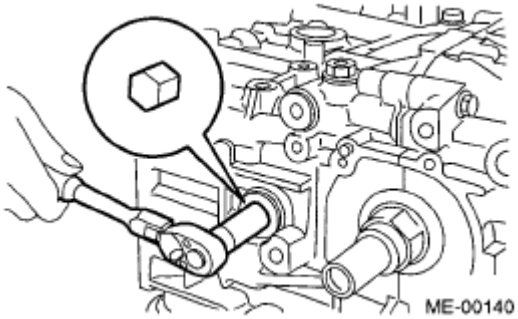


Fig. 242: Removing Service Hole Plugs Using Hexagon Wrench
Courtesy of SUBARU OF AMERICA, INC.

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

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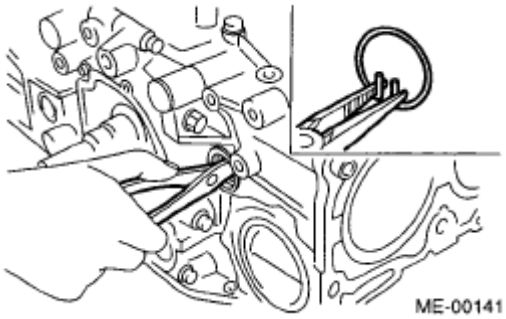


Fig. 243: Removing Piston Snap Ring Through Service Hole
Courtesy of SUBARU OF AMERICA, INC.

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

    ST 499097700 PISTON PIN REMOVER ASSY

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

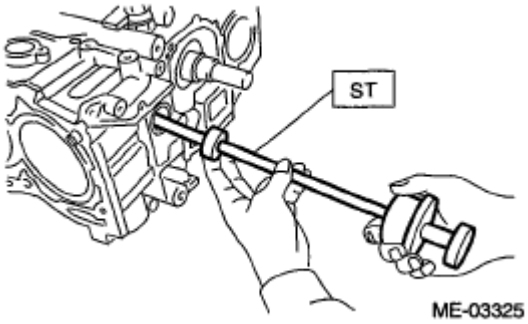
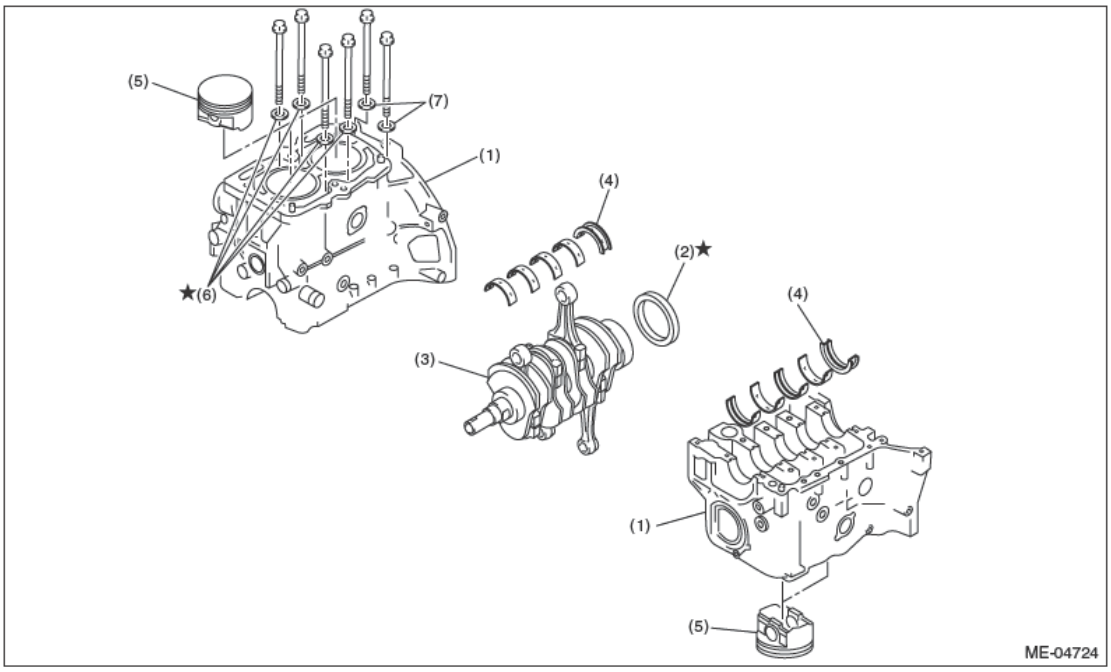


Fig. 244: Identifying Piston Pin Remover Assy (ST 499097700)
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

Fig. 245: Exploded View Of Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

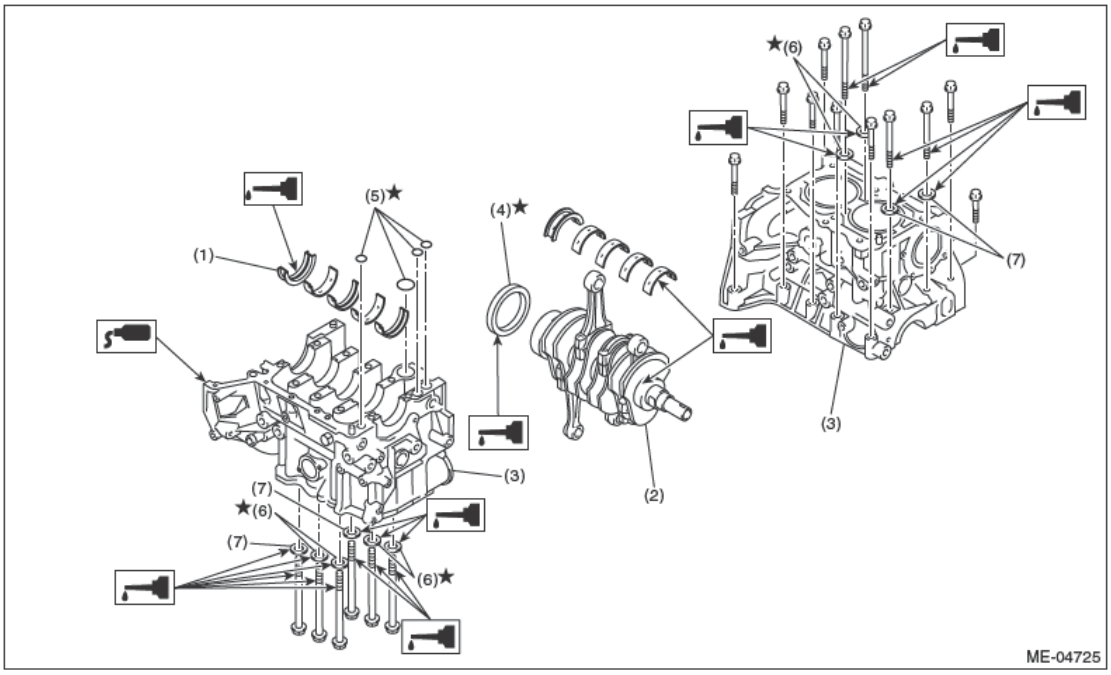
NOTE:
- **Press the crankshaft bearing at the end opposite to locking lip to remove.**
- **Be careful not to confuse the crankshaft bearing combination.**

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

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

INSTALLATION

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

Fig. 246: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

1. Remove oil on the mating surface of cylinder block before installation. Apply a coat of engine oil to the bearing and crankshaft journal.
2. Position the crankshaft and O-ring on cylinder block RH.

NOTE: Use new O-rings.

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

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

Liquid gasket:

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

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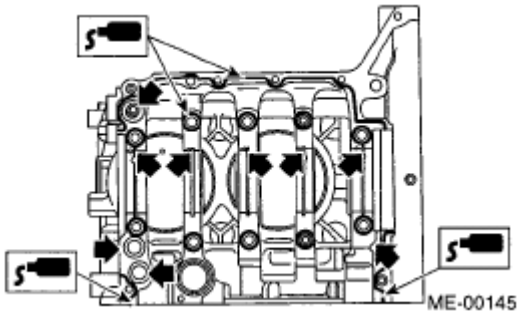


Fig. 247: Applying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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)

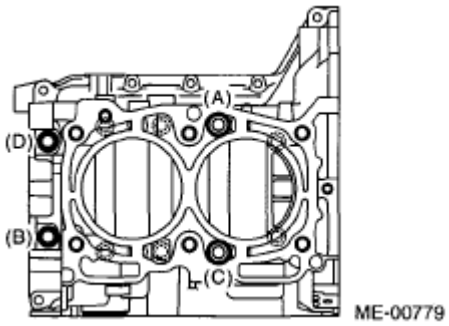


Fig. 248: Identifying Cylinder Block Connecting Bolts Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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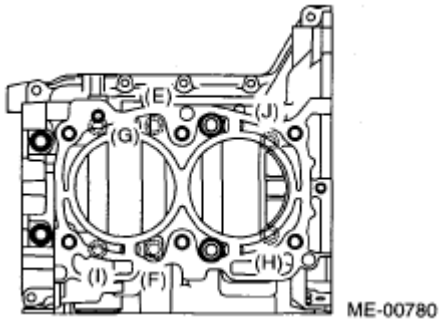


Fig. 249: Identifying Cylinder Block Connecting Bolts Tightening Sequence (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

   Tightening torque:

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

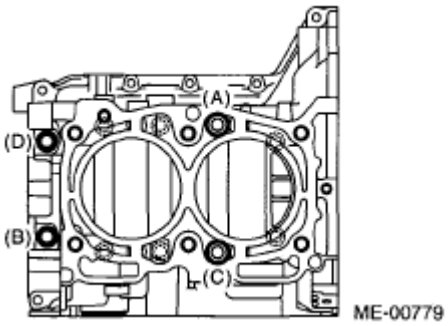
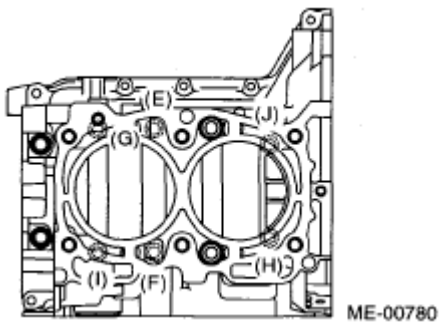


Fig. 250: Identifying Cylinder Block Connecting Bolts Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

   Tightening torque:

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



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Fig. 251: Identifying Cylinder Block Connecting Bolts Tightening Sequence (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

   Tightening angle: 90°

   - (B), (D): Torque tightening

   Tightening torque:

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

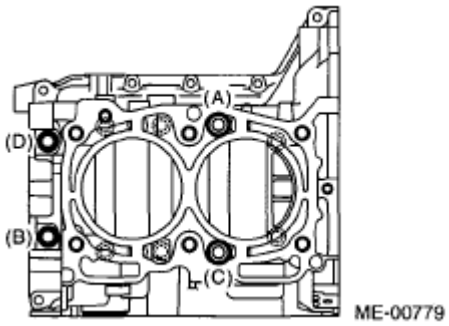


Fig. 252: Identifying Cylinder Block Connecting Bolts Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

    Tightening angle: 90°

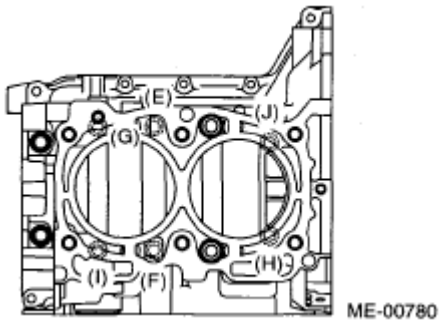


Fig. 253: Identifying Cylinder Block Connecting Bolts Tightening Sequence (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

    Tightening torque:

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(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)

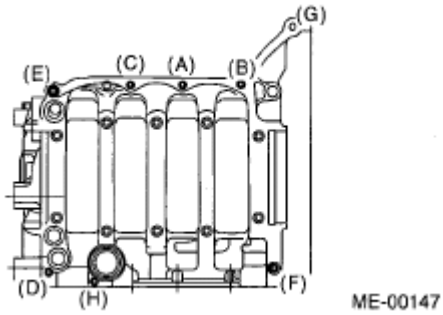


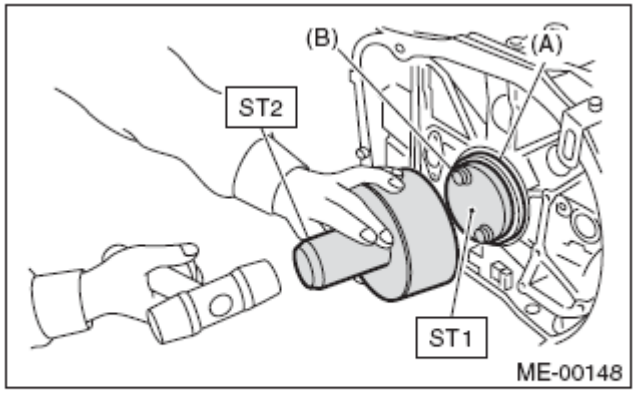
Fig. 254: Identifying Cylinder Block Connecting Bolts Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rear oil seal.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER



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

Fig. 255: Identifying Crankshaft Oil Seal Guide And Crankshaft Oil Seal Installer
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.

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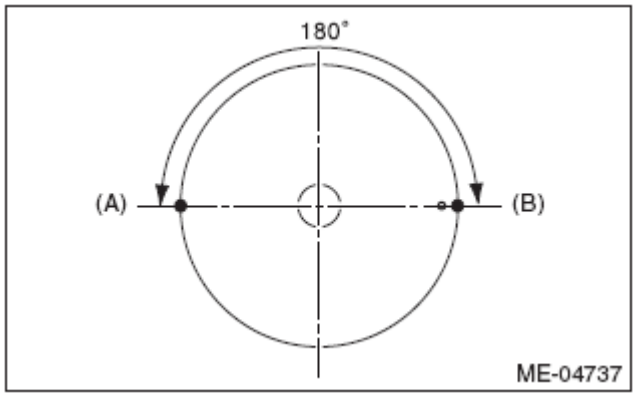


Fig. 256: Identifying Position Second Ring Gap At 180°
Courtesy of SUBARU OF AMERICA, INC.

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

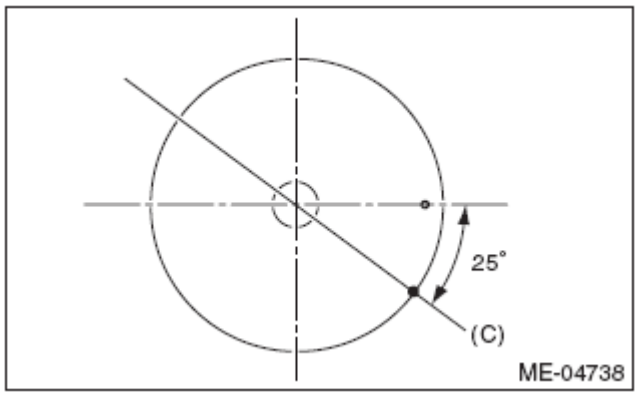


Fig. 257: Identifying Upper Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

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

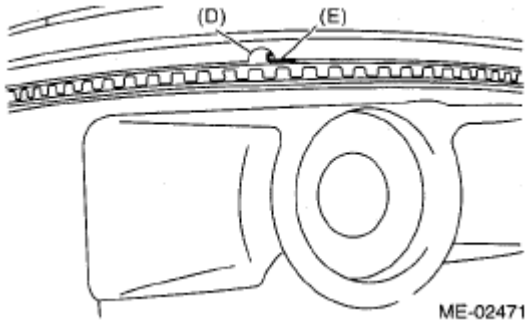


Fig. 258: Identifying Upper Rail Spin Stopper (E) And Side Hole (D)
Courtesy of SUBARU OF AMERICA, INC.

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

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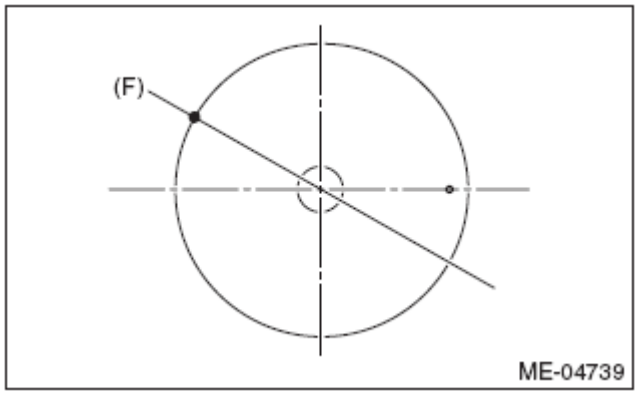


Fig. 259: Identifying Expander Gap At (F)
Courtesy of SUBARU OF AMERICA, INC.

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

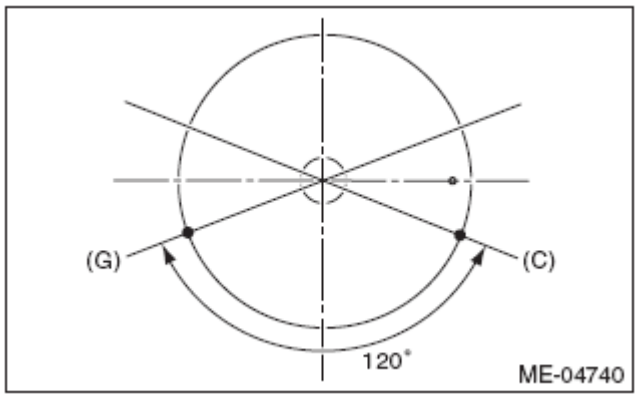


Fig. 260: Identifying Lower Rail Gap At Position (G), Located 120° Clockwise From (C)
Courtesy of SUBARU OF AMERICA, INC.

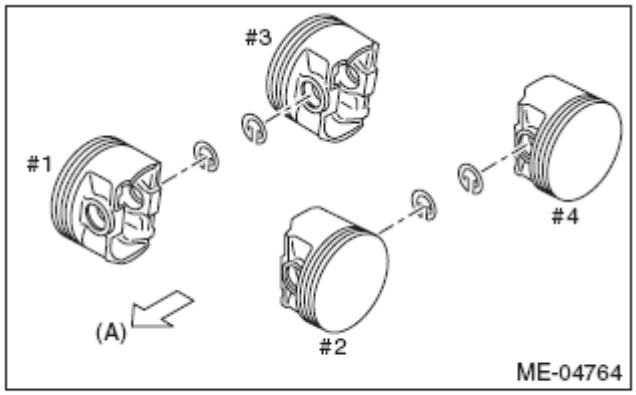
NOTE:
- **Make sure ring gaps do not face the same direction.**
- **Make sure ring gaps are not within the piston skirt area.**

19. Install the snap ring.

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

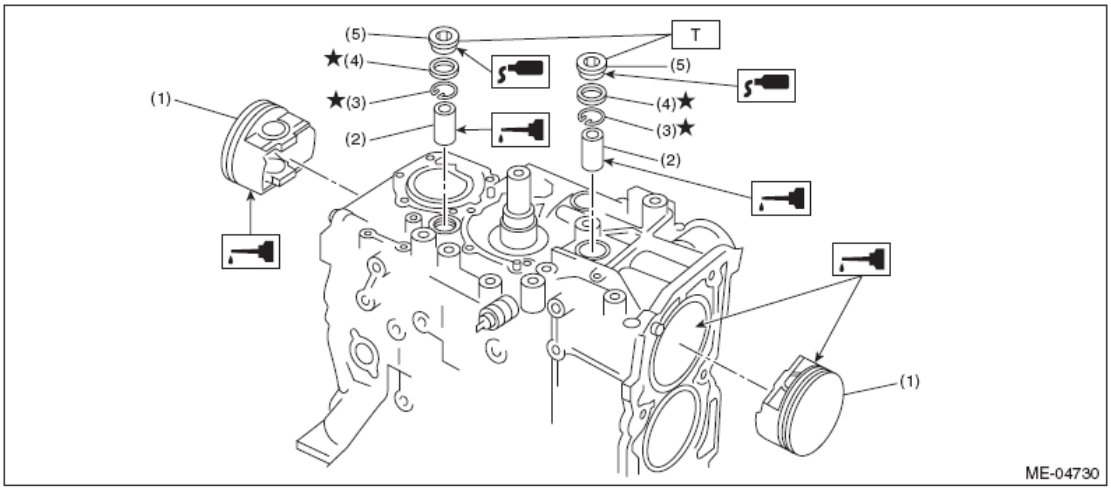
NOTE: Use new snap rings.

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(A) Front side

Fig. 261: Attaching Snap Ring In Service Hole Of Piston
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 262: Attaching Snap Ring In Service Hole Of Cylinder Block
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

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

ST2 498747300 PISTON GUIDE

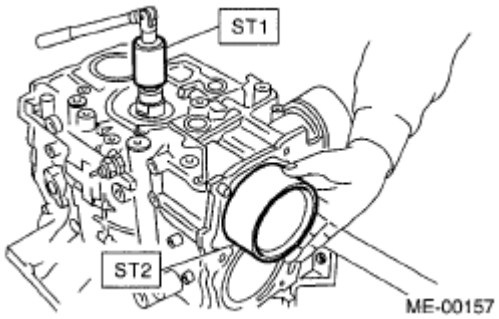
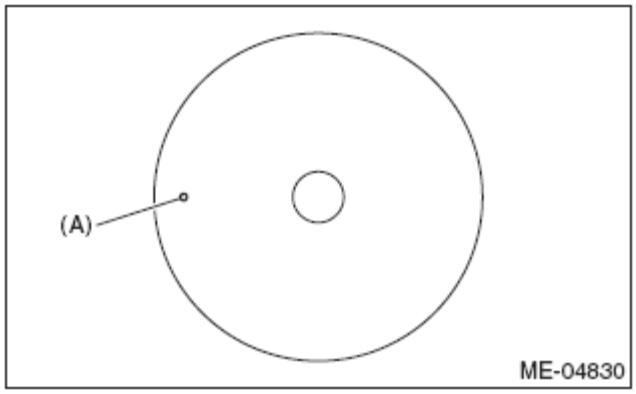


Fig. 263: Identifying Crankshaft Socket And Piston Guide
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front mark

Fig. 264: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

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

       ST3 499017100 PISTON PIN GUIDE

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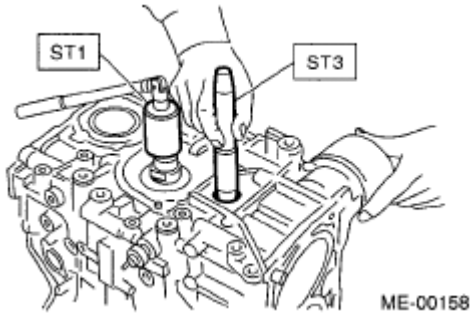


Fig. 265: Identifying Piston Pin Guide
Courtesy of SUBARU OF AMERICA, INC.

3. Apply a thin 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.

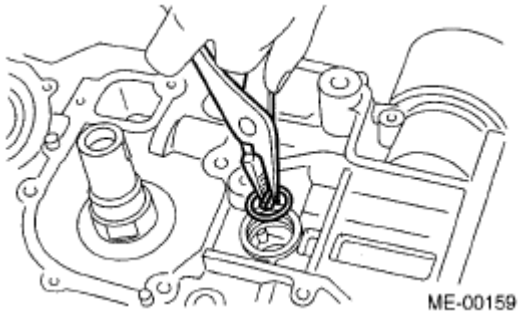


Fig. 266: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

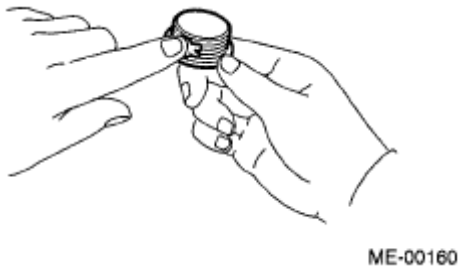


Fig. 267: Identifying Service Hole Plug

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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)

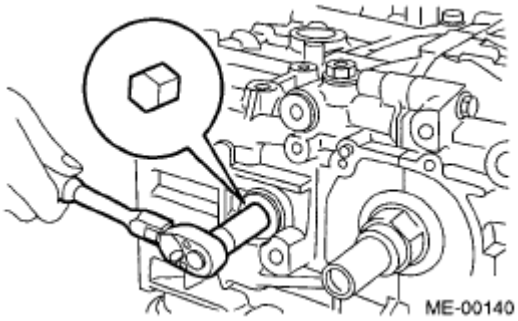
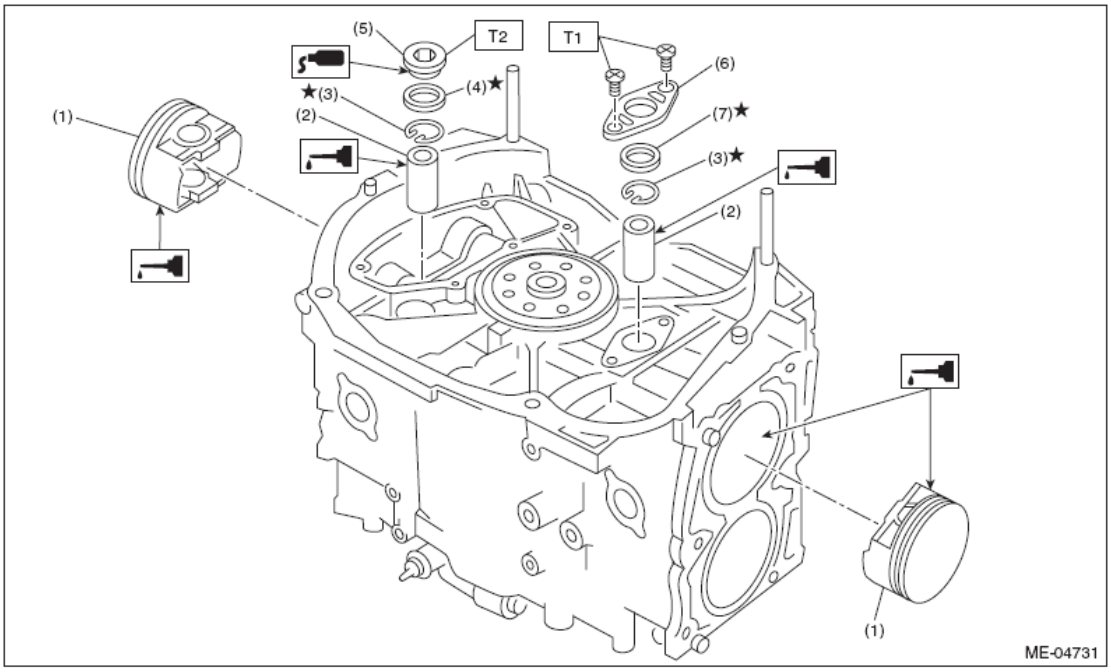


Fig. 268: Installing Service Hole Plug And Gasket
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 269: Identifying Cylinder Block Components

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Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new O-rings.

Tightening torque:

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

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

T1: 6.4 (0.7, 4.7)

T2: 70 (7.1, 51.6)

9. Install the water by-pass pipe.

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)

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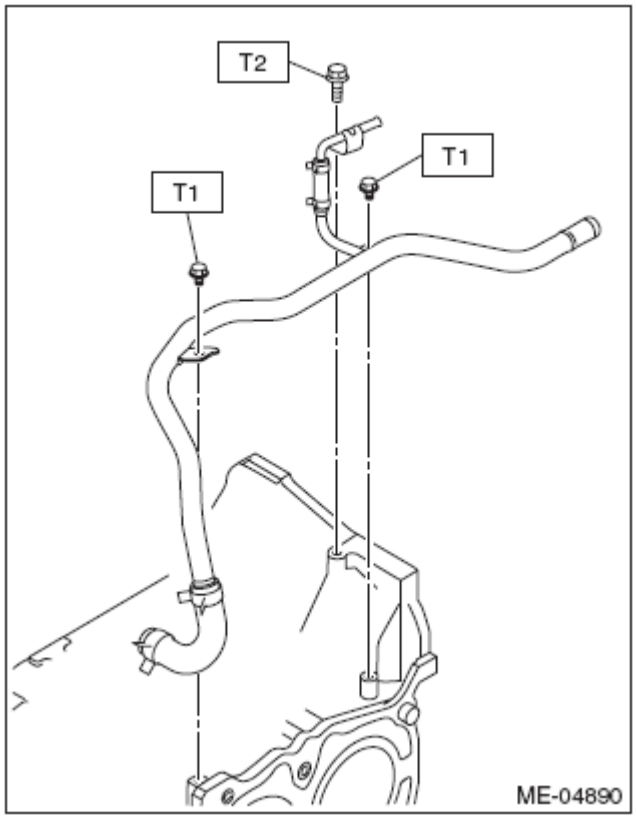
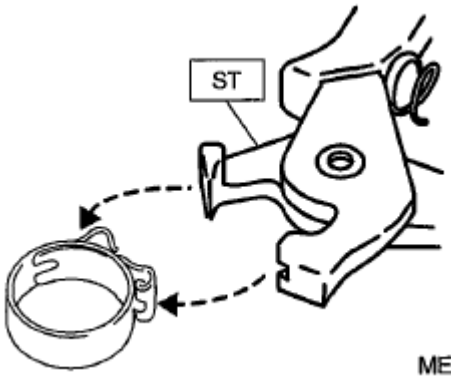


Fig. 270: Identifying Water By-Pass Pipe Clamping Bolts With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

10. Install blow-by pipe assembly (A), blow-by pipe (B), PCV hose assembly (C) and water pipe assembly (D).

NOTE: For the blow-by pipe assembly (A), blow-by pipe (B) and PCV hose assembly (C), use a new clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the figure, and lock the clamp.

ST 18353AA000 CLAMP PLIERS



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Fig. 271: Identifying Clamp Pliers (ST 18353AA000)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

6.5 N.m (0.7 kgf-m, 4.8 ft-lb)

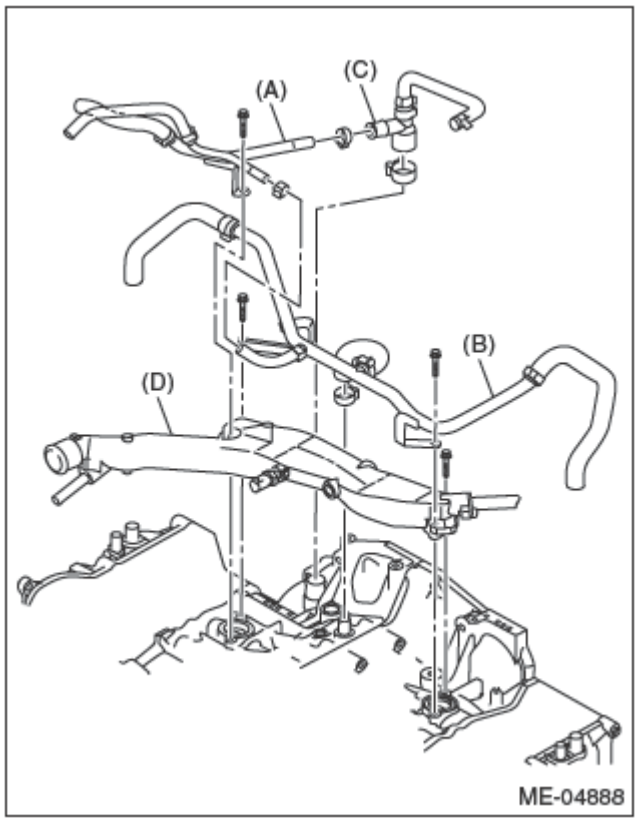


Fig. 272: Identifying Blow-By Pipe Assembly (A), Blow-By Pipe (B), PCV Hose Assembly (C) And Water Pipe Assembly (D)
Courtesy of SUBARU OF AMERICA, INC.

11. 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.**

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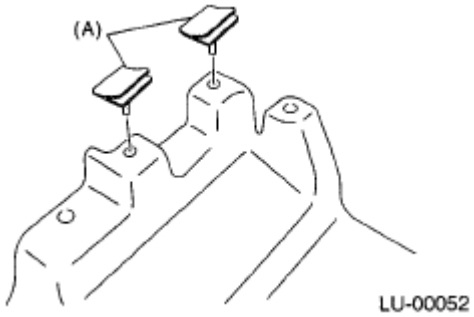


Fig. 273: Identifying Baffle Plate Seals
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

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

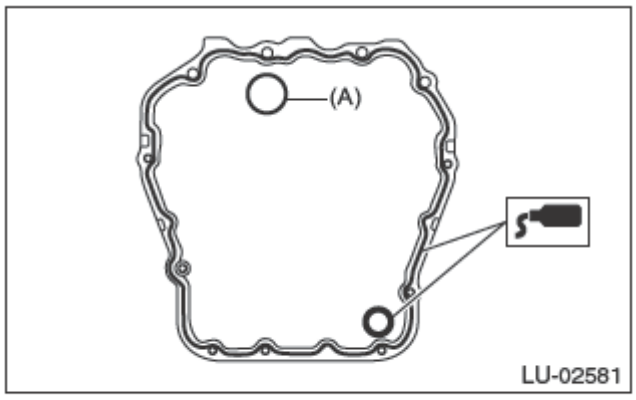
CAUTION: Be careful not to apply any liquid gasket to the O-ring attachment section.

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

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Fig. 274: Applying Liquid Gasket
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)

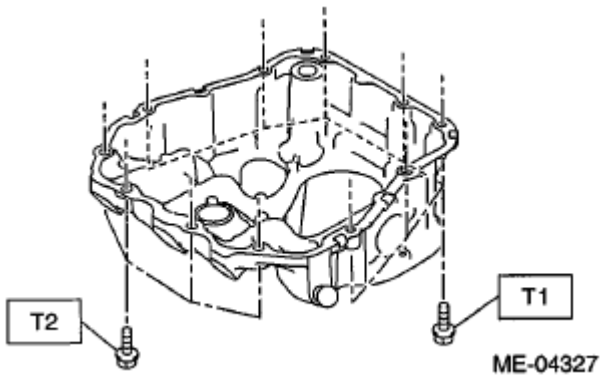


Fig. 275: Identifying Oil Pan Mounting Bolts With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

13. 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

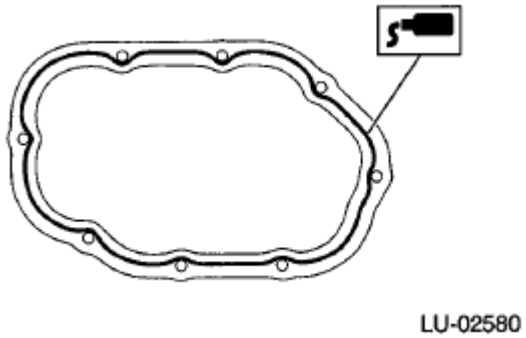


Fig. 276: Applying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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Tightening torque:

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

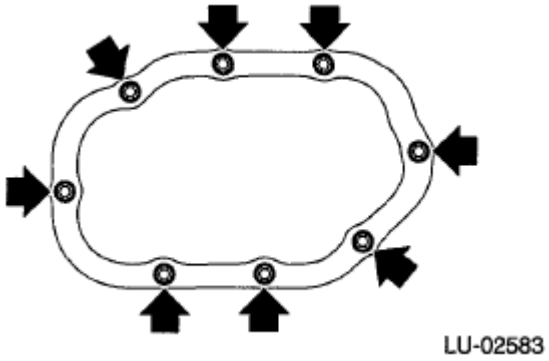


Fig. 277: Locating Oil Pan Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

14. Secure the oil level switch harness to the cylinder block with clip.

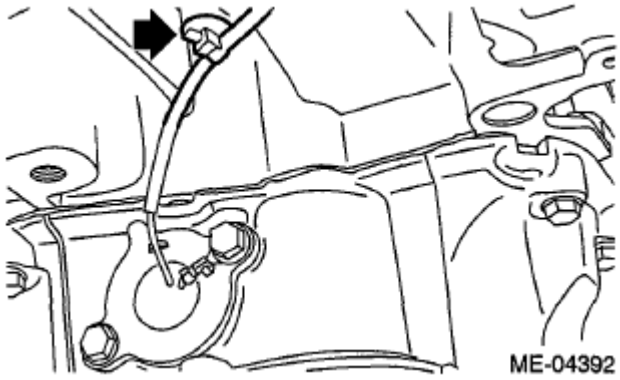


Fig. 278: Locating Oil Level Switch Harness Clip
Courtesy of SUBARU OF AMERICA, INC.

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

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

Liquid gasket:

Mating surface

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

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Bolt thread (A) (when reusing the bolt)

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

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

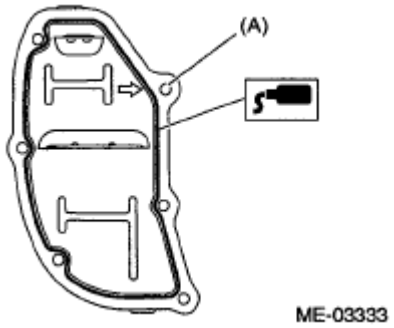


Fig. 279: Identifying Oil Separator Cover And Threaded Portion Of Bolt (A)
Courtesy of SUBARU OF AMERICA, INC.

16. Install the flywheel. Refer to **FLYWHEEL** .
17. Install the clutch disc and cover. Refer to **CLUTCH DISC AND COVER** .
18. 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.

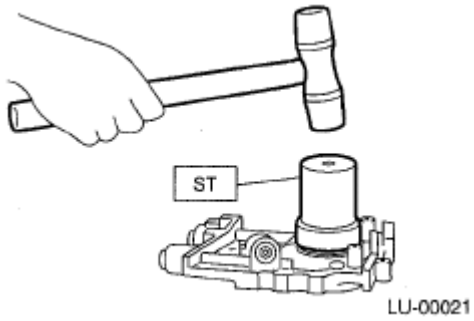


Fig. 280: Installing Front Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

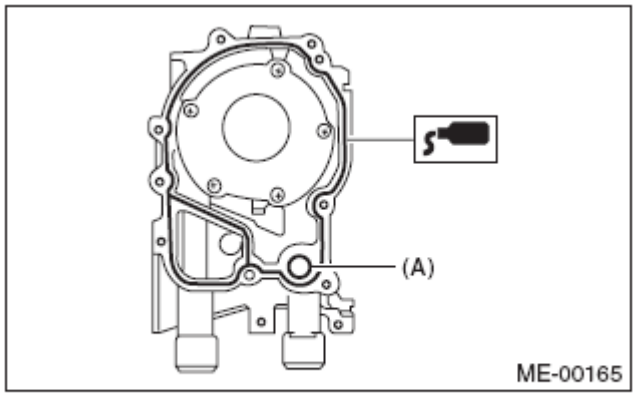
    2. Apply liquid gasket to the mating surfaces of oil pump.

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

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Liquid gasket:

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



(A) O-ring

Fig. 281: Applying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

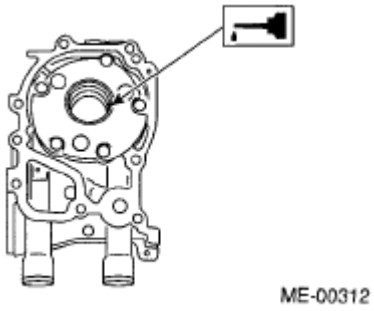


Fig. 282: Applying Thin Coat Of Engine Oil To Inside Of Front Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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.**

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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:

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

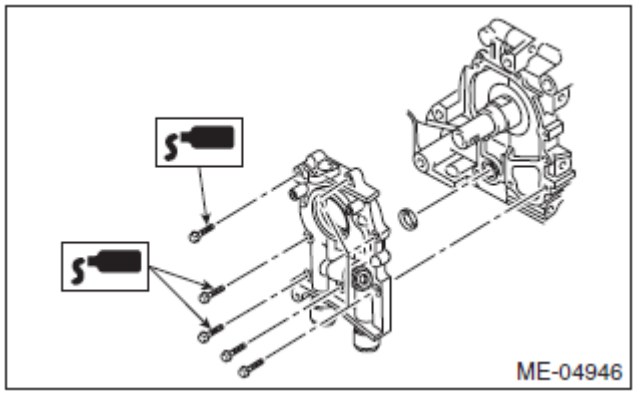


Fig. 283: Applying Liquid Gasket To Three Bolts Thread
Courtesy of SUBARU OF AMERICA, INC.

19. 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.**
- **Use new water pump sealing.**

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)

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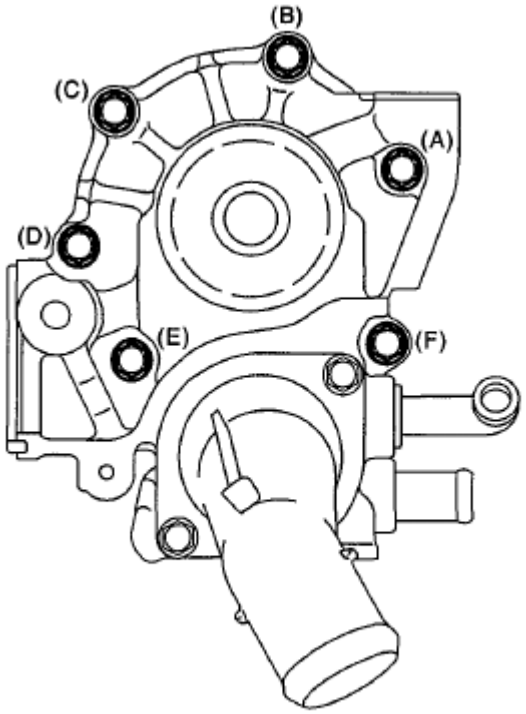


Fig. 284: Identifying Tightening Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

20. Install the hose to water pump.
21. Install the oil cooler. (MT model) Refer to **ENGINE OIL COOLER** .
22. Install the oil filter. Refer to **ENGINE OIL FILTER** .
23. Install the cylinder head. Refer to , **INSTALLATION**, Cylinder Head.
24. Install the camshaft. Refer to , **INSTALLATION**, Camshaft.
25. Install the A/C compressor together with the bracket.

    Tightening torque:

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

26. Install the crank sprocket. Refer to , **INSTALLATION**, Crank Sprocket.
27. Install the cam sprocket. Refer to , **INSTALLATION**, Cam Sprocket.
28. Install the timing belt. Refer to , **INSTALLATION**, Timing Belt.
29. Adjust the valve clearance. Refer to , **ADJUSTMENT**, Valve Clearance.
30. Install the rocker cover.
    1. Install the rocker cover gasket to the rocker cover. (Outer section and ignition coil section)

       NOTE: Use a new rocker cover gasket.

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

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

Liquid gasket:

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

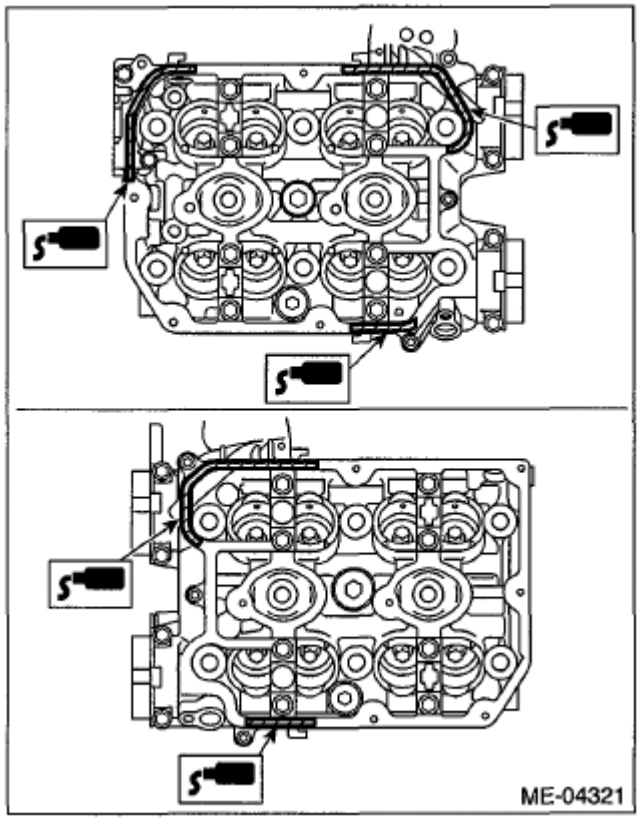


Fig. 285: Applying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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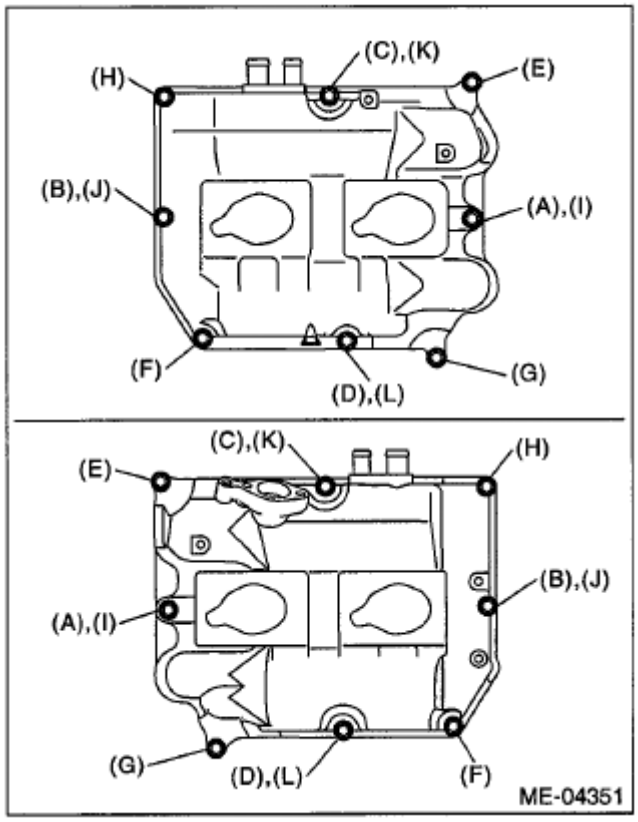
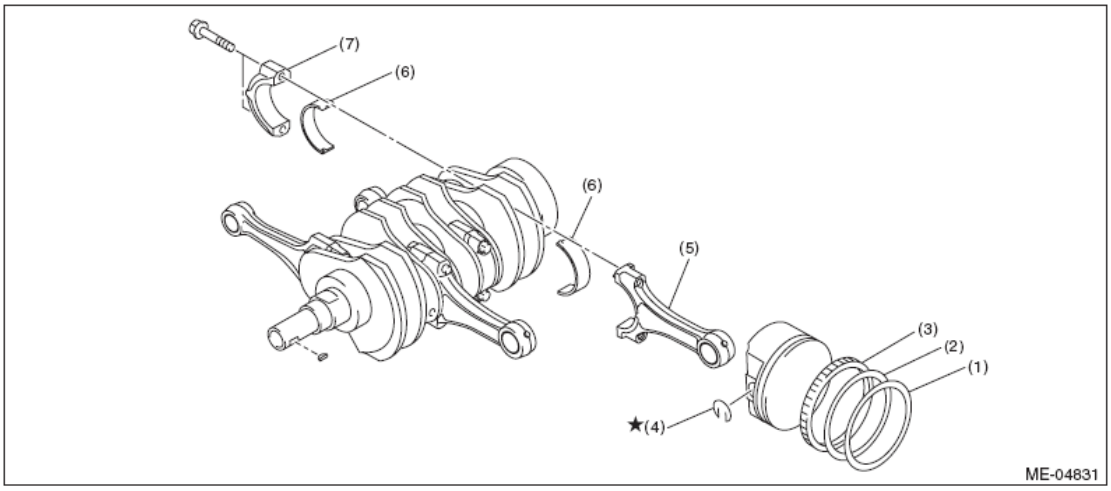


Fig. 286: Identifying Rocker Cover Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

31. Connect the PCV hose to the rocker cover.
32. Install the timing belt cover. Refer to , **INSTALLATION**, Timing Belt Cover.
33. Install the crank pulley. Refer to , **INSTALLATION**, Crank Pulley.
34. Install the intake manifold. Refer to **INTAKE MANIFOLD** .
35. Install the engine to the vehicle. Refer to , **INSTALLATION**, Engine Assembly.

DISASSEMBLY

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

Fig. 287: Identifying Connecting Rod And Crankshaft Components
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.

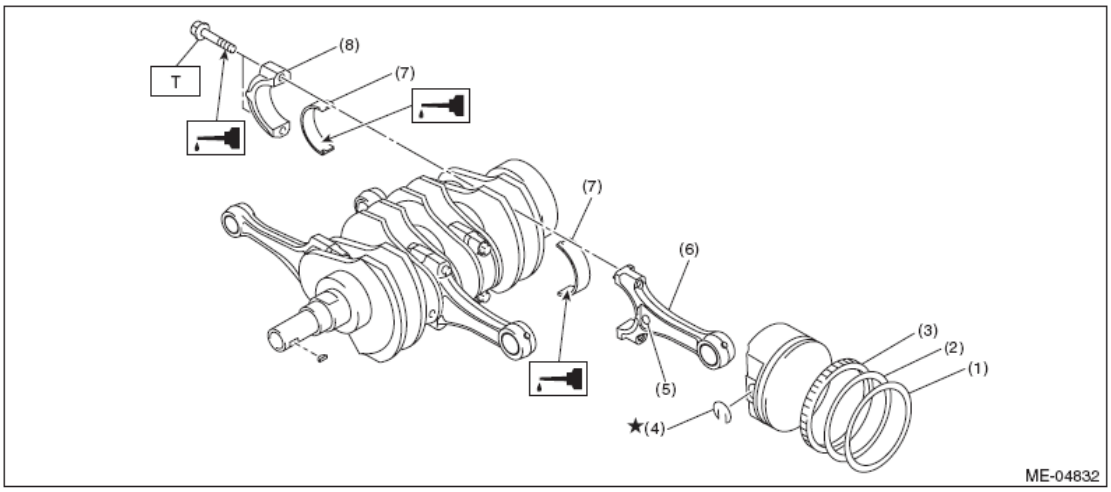
3. Remove the piston rings using piston ring expander.
4. Remove the oil ring by hand.

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

5. Remove the snap ring.

ASSEMBLY

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

Fig. 288: Identifying Connecting Rod And Crankshaft Components
Courtesy of SUBARU OF AMERICA, INC.

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

T: 52 (5.3, 38.4)

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

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

Tightening torque:

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

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

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

INSPECTION

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CYLINDER BLOCK

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

Warping limit:

0.025 mm (0.00098 in)

Grinding limit:

0.1 mm (0.004 in)

Standard height of cylinder block:

201.0 mm (7.91 in)

CYLINDER AND PISTON

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

NOTE:

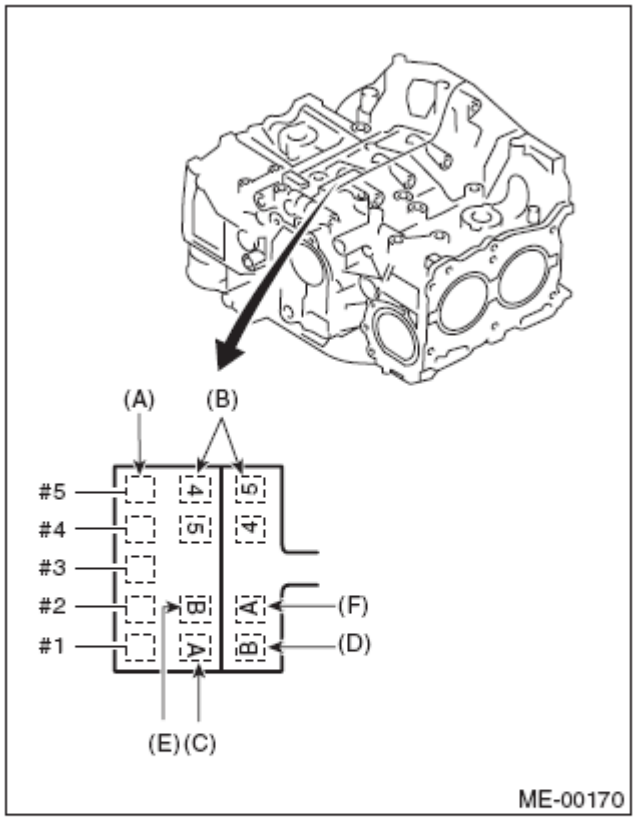
- **Measurement should be performed at a temperature of 20°C (68°F).**
- **Standard sized pistons are classified into two grades, "A" and "B". These grades should be used as guide lines in selecting a standard piston.**

Standard diameter:

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

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

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(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. 289: Identifying Standard Size Pistons
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).

   Cylindricality:

   Standard

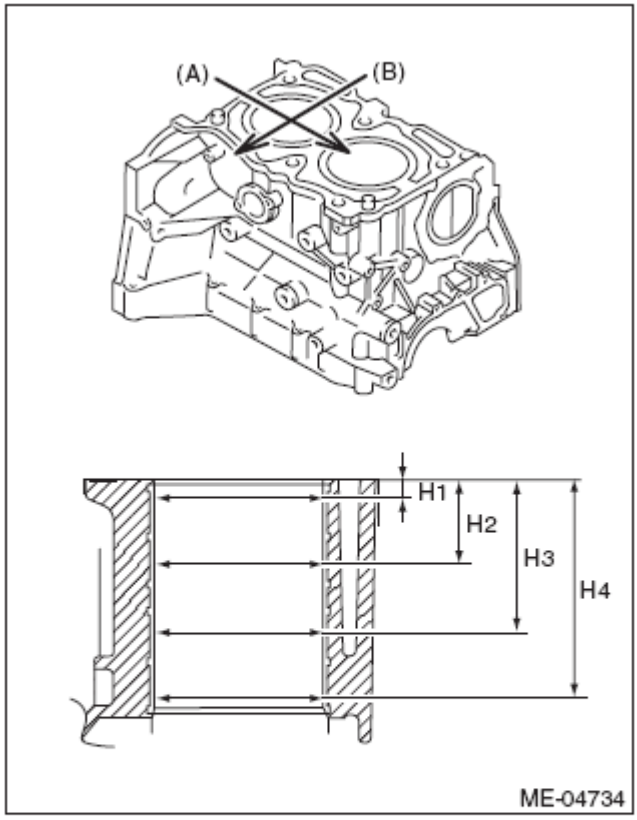
   0.015 mm (0.0006 in)

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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. 290: Measuring Inner Diameter Of Each 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).

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Piston grade point H:

38.2 mm (1.50 in)

Piston outer diameter:

Standard

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

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

0.25 mm (0.0098 in) oversize

99.745 - 99.765 mm (3.9270 - 3.9278 in)

0.50 mm (0.0197 in) oversize

99.995 - 100.015 mm (3.9368 - 3.9376 in)

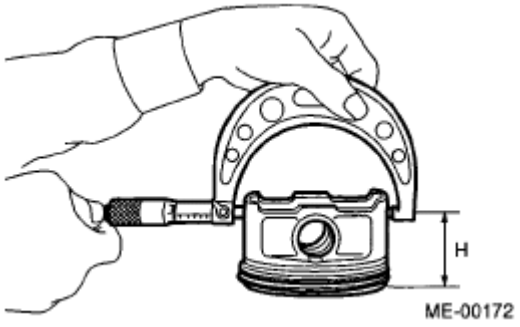


Fig. 291: Measuring Outer Diameter Of Each Piston
Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

Clearance between cylinder and piston at 20°C (68°F):

Standard

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

6. Boring and honing

1. If any of the measured value of cylindricality, 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.

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

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

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

Cylinder inner diameter boring limit (diameter): To 100.005 mm (3.9372 in)

PISTON AND PISTON PIN

1. Check the piston and piston pin for damage, cracks or wear. Replace if faulty.
2. Check the piston ring groove for wear 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)

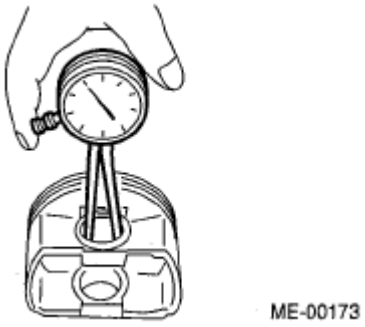


Fig. 292: Checking Piston Pin Hole
Courtesy of SUBARU OF AMERICA, INC.

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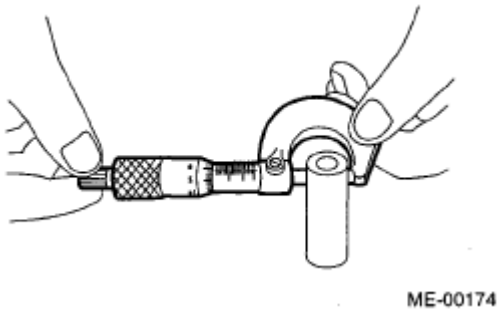


Fig. 293: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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.

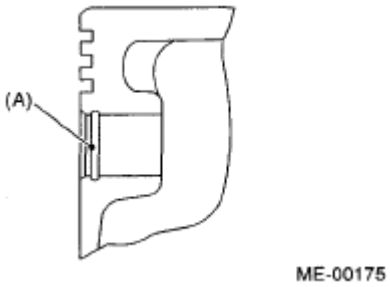


Fig. 294: Checking Snap Ring Installation Groove (A)
Courtesy of SUBARU OF AMERICA, INC.

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

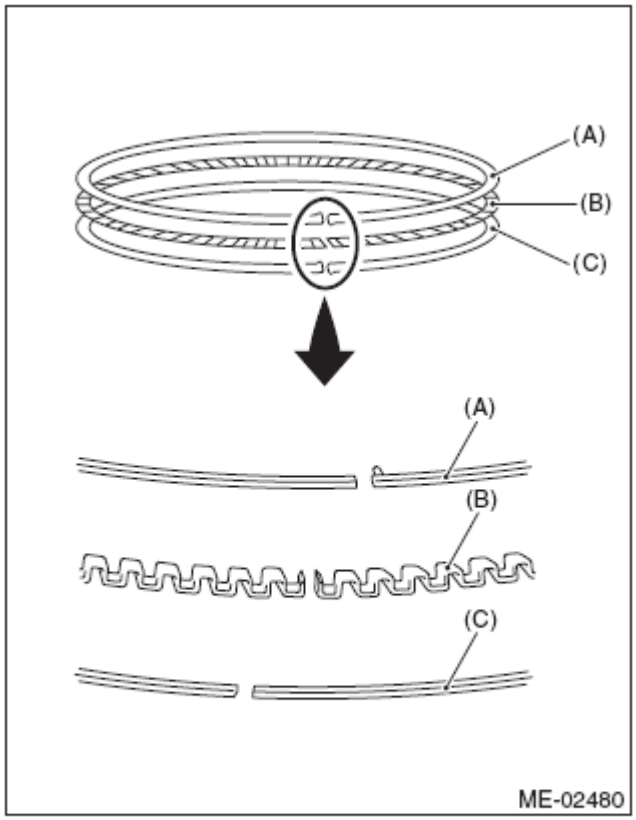
PISTON RING

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

NOTE:

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

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

Fig. 295: Identifying 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 mm (in)
Piston ring gap	Top ring	0.20 - 0.25 (0.0079 - 0.0098)
	Second ring	0.37 - 0.52 (0.015 - 0.020)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)

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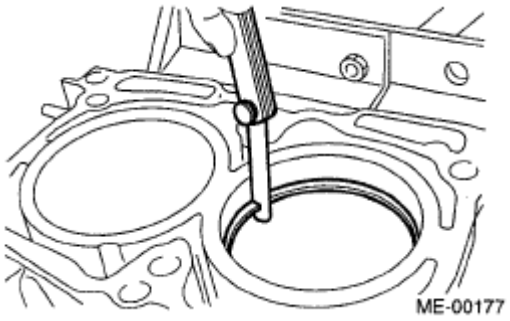


Fig. 296: Measuring Piston Ring Gap With Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

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

		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)

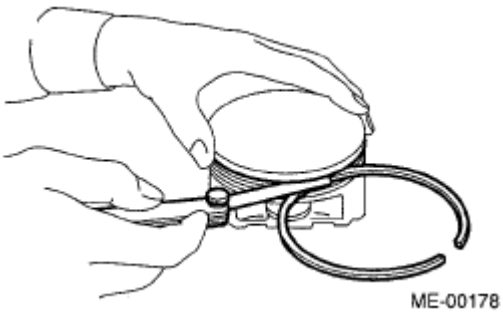


Fig. 297: Measuring Clearance Of Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

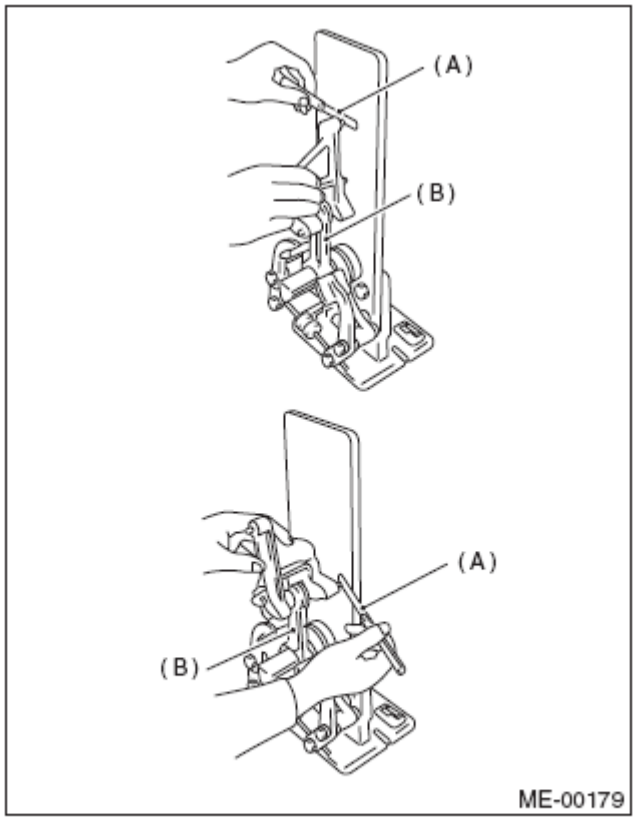
CONNECTING ROD

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)

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(A) Thickness gauge
(B) Connecting rod

Fig. 298: Checking For 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)

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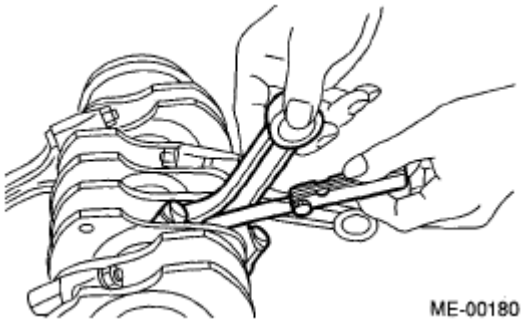


Fig. 299: Measuring Thrust Clearance Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard

0.017 - 0.045 mm (0.0007 - 0.0018 in)

		Unit: mm (in)
Bearing	**Bearing size (Thickness at center)**	**Outer diameter of crank pin**
Standard	1.490 - 1.506 (0.0587 - 0.0593)	51.976 - 52.000 (2.0463 - 2.0472)
0.03 (0.0012) Undersize	1.504 - 1.512 (0.0592 - 0.0595)	51.954 - 51.970 (2.0454 - 2.0461)
0.05 (0.0020) Undersize	1.514 - 1.522 (0.0596 - 0.0599)	51.934 - 51.950 (2.0447 - 2.0453)
0.25 (0.0098) Undersize	1.614 - 1.622 (0.0635 - 0.0639)	51.734 - 51.750 (2.0368 - 2.0374)

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

Clearance between piston pin and bushing:

Standard

0 - 0.022 mm (0 - 0.0009 in)

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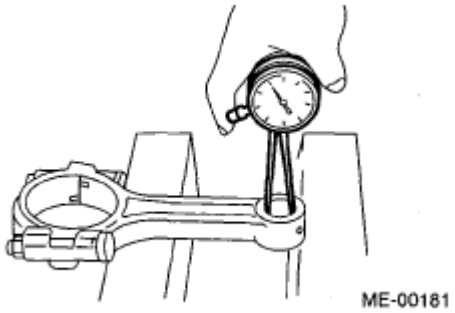


Fig. 300: Measuring Piston Pin Clearance At Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

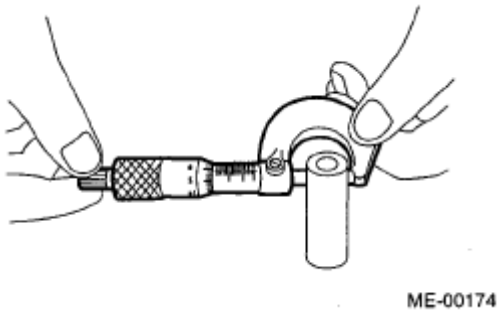


Fig. 301: Measuring Piston Pin Clearance
Courtesy of SUBARU OF AMERICA, INC.

8. The replacement procedure for the connecting rod small end bushing is as follows.

1. Remove the bushing from connecting rod with ST and press.
2. Apply oil on the periphery of the new bushing, and press the bushing in with the ST.

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

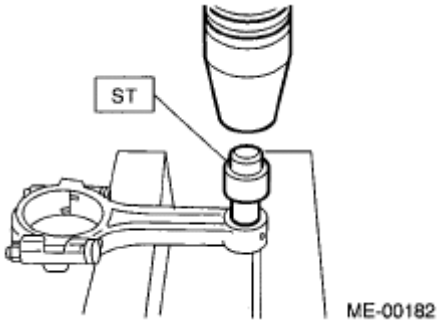


Fig. 302: Removing Bushing From Connecting Rod With ST And Press
Courtesy of SUBARU OF AMERICA, INC.

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.

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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)

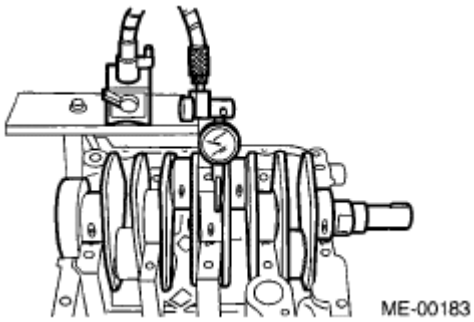


Fig. 303: Measuring Crankshaft Bend Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

Standard

0.003 mm (0.0001 in)

Cylindricality

Standard

0.004 mm (0.0002 in)

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Grinding limit (dia.)

To 51.750 mm (2.0374 in)

Crank journal:

Out-of-roundness

Standard

0.005 mm (0.0002 in)

Cylindricality

Standard

0.006 mm (0.0002 in)

Grinding limit (dia.)

To 59.758 mm (2.3527 in)



Fig. 304: Inspecting Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

Unit: mm (in)

		Crank journal diameter		Crank pin outer diameter
		#1, #3	#2, #4, #5	
Standard	Journal O.D.	59.984 - 60.008 (2.3616 - 2.3625)	59.984 - 60.008 (2.3616 - 2.3625)	51.976 - 52.000 (2.0463 - 2.0472)
	Bearing size (Thickness at center)	1.998 - 2.015 (0.0787 - 0.0793)	2.000 - 2.017 (0.0787 - 0.0794)	1.490 - 1.506 (0.0587 - 0.0593)
0.03 (0.0012) Undersize	Journal O.D.	59.962 - 59.978 (2.3607 - 2.3613)	59.962 - 59.978 (2.3607 - 2.3613)	51.954 - 51.970 (2.0454 - 2.0461)
	Bearing size (Thickness at center)	2.017 - 2.020 (0.0794 - 0.0795)	2.019 - 2.022 (0.0795 - 0.0796)	1.504 - 1.512 (0.0592 - 0.0595)
		59.942 - 59.958	59.942 - 59.958	51.934 - 51.950

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0.05 (0.0020) Undersize	Journal O.D.	(2.3599 - 2.3605)	(2.3599 - 2.3605)	(2.0447 - 2.0453)
	Bearing size (Thickness at center)	2.027 - 2.030 (0.0798 - 0.0799)	2.029 - 2.032 (0.0799 - 0.0800)	1.514 - 1.522 (0.0596 - 0.0599)
0.25 (0.0098) Undersize	Journal O.D.	59.742 - 59.758 (2.3520 - 2.3527)	59.742 - 59.758 (2.3520 - 2.3527)	51.734 - 51.750 (2.0368 - 2.0374)
	Bearing size (Thickness at center)	2.127 - 2.130 (0.0837 - 0.0839)	2.129 - 2.132 (0.0838 - 0.0839)	1.614 - 1.622 (0.0635 - 0.0639)

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

   Crankshaft thrust clearance:

   Standard

   0.030 - 0.115 mm (0.0012 - 0.0045 in)

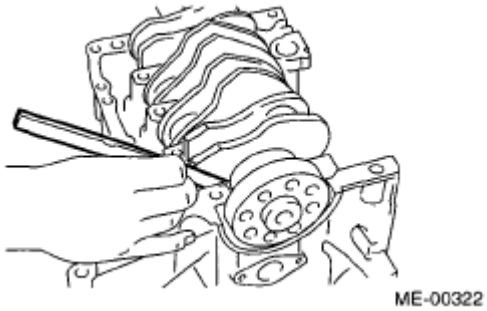


Fig. 305: Measuring Thrust Clearance Of Crankshaft At #5 Crank Journal Bearing
Courtesy of SUBARU OF AMERICA, INC.

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 (0.00039 - 0.0012 in)

INTAKE AND EXHAUST VALVE

SPECIFICATION

Refer to "Cylinder Head" for removal and installation procedures of the intake and exhaust valves. Refer to , **REMOVAL**, Cylinder Head. Refer to , **INSTALLATION**, Cylinder Head.

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PISTON

SPECIFICATION

Refer to "Cylinder Block" for removal and installation procedures of pistons. Refer to , **REMOVAL**, Cylinder Block. Refer to , **INSTALLATION**, Cylinder Block.

CONNECTING ROD

SPECIFICATION

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

CRANKSHAFT

SPECIFICATION

Refer to "Cylinder Block" for removal and installation procedures of the crankshaft. Refer to , **REMOVAL**, Cylinder Block. Refer 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	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective starter	B
	Battery	Improper connection of terminal	A
		Run-down battery	A
		Defective charging system	B
		Seizure of crankshaft and connecting rod	C

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	Friction	bearing	
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
	Immobilizer system Refer to **BASIC DIAGNOSTIC PROCEDURE** Basic Diagnostic Procedure.		A
Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system Refer to EN(H4DOTC) (diag)-2, **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
	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
Initial combustion occurs.	Engine control system Refer to EN(H4DOTC) (diag)-2, **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Defective intake manifold gasket	B
		Defective throttle body gasket	B
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of 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

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		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
Engine stalls after initial combustion.	Engine control system Refer to EN(H4DOTC) (diag)-2, **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	B
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	C
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Dirty air cleaner element	C
	Fuel line	Clogged fuel line	C
		Lack of fuel or insufficient fuel	B
	Timing belt	Degradation, etc.	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
2. Rough idle and engine stall	Engine control system Refer to EN(H4DOTC) (diag)-2, **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	C
		Loosened oil filler cap	B
		Dirty air cleaner element	C
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of fuel or insufficient fuel	B
	Timing belt	Defective timing	C
		Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective	

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	Compression	cylinder head gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Over-heating	C
	Others	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
3. Low output, hesitation and poor acceleration	Engine control system Refer to EN(H4DOTC) (diag)-2, **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	B
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	A
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of 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
		Over-heating	C

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	Cooling system	Over-cooling	C
	Others	Evaporative emission control system malfunction	A
4. Surging	Engine control system Refer to EN(H4DOTC) (diag)-2, **BASIC DIAGNOSTIC PROCEDURE** .		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	B
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of fuel or insufficient fuel	C
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Cooling system	Over-heating	B
	Others	Evaporative emission control system malfunction	C
5. Engine does not return to idle.	Engine control system Refer to EN(H4DOTC) (diag)-2, **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 Refer to EN(H4DOTC) (diag)-2, **BASIC DIAGNOSTIC PROCEDURE** .		A
	Cooling system	Over-heating	B
	Others	Evaporative emission control system malfunction	B
	Engine control system Refer to EN(H4DOTC) (diag)-2, **BASIC DIAGNOSTIC PROCEDURE** .		A

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7. After burning in exhaust system	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 Refer to EN(H4DOTC) (diag)-2, **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

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10. Excessive fuel consumption	Engine control system Refer to EN(H4DOTC) (diag)-2, **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

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	• Valve mechanism is defective. • Incorrect valve clearance • Worn camshaft • Broken valve spring
Heavy and dull clank	Oil pressure is low.	• Worn crankshaft main bearing • Worn connecting rod bearing (large end)
	Oil pressure is normal.	• Damaged engine mounting
High-pitched clank	Sound is noticeable when accelerating with an overload condition.	• Ignition timing advanced • Accumulation of carbon inside combustion chamber • Wrong heat range of spark plug • Improper octane value gasoline
Clank when engine speed is between 1, 000 and 2, 000	Noise is reduced when fuel injector connector of noisy cylinder is	• Worn crankshaft main bearing • Worn connecting rod bearing

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RPM.	disconnected. (1)	(large end)
Knocking sound when engine is operating under idling speed and engine is warm	Noise is reduced when fuel injector connector of noisy cylinder is disconnected. (1)	• Worn cylinder liner and piston ring • Broken or stuck piston ring • Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. (1)	• Unusually worn valve lifter • Worn cam sprocket • Worn camshaft journal bore in cylinder head
Squeaky sound	-	• Insufficient generator lubrication
Rubbing sound	-	• Poor contact of generator brush and rotor
Gear scream when starting engine	-	• Defective ignition starter switch • Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	• Loose V-belt • Defective water pump shaft
Hissing sound	-	• Insufficient compression • Air leakage in air intake 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 Refer to **CLEAR MEMORY MODE** EN(H4DOTC) . and Inspection Mode Refer to **INSPECTION MODE** after connecting the fuel injector connector.

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