

2009 Subaru Impreza 2.5 GT

2009 ENGINE Mechanical (H4SO) - Impreza (Except STi)

2009 ENGINE**Mechanical (H4SO) - Impreza (Except STi)****GENERAL DESCRIPTION****SPECIFICATION****GENERAL SPECIFICATION**

Engine	Model			2.5 L		
	Cylinder arrangement			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine		
	Valve system mechanism			Belt driven, single overhead camshaft, 4 valve/cylinder		
	Bore x Stroke			mm (in)	99.5x79.0 (3.92x3.11)	
	Displacement			cm ³ (cu in)	2,457 (149.94)	
	Compression ratio			10.0		
	Compression pressure 2 (at 200 - 300 RPM)			kPa (kg/cm ² , psi)	1,020 - 1,275 (10.4 - 13.0,148 - 185)	
	Number of piston rings			Pressure ring: 2, Oil ring: 1		
	Intake valve timing		Constant	Open	BTDC 0°	
				Close	ABDC 58°	
			Low speed	Open	BTDC 0°	
				Close	ABDC-10°	
			High speed	Open	BTDC 14°	
				Close	ABDC 62°	
	Exhaust valve timing			Open	BBDC30°	
				Close	ATDC14°	
	Valve clearance		mm (in)	Intake	0.20±0.04 (0.007910.0016)	
				Exhaust	0.25±0.04 (0.0098±0.0016)	
	Idling speed (at "P" or "N" position on AT model, or neutral position on MT model)			No load	AT model: 700±100	
					MT model: 650±100	
				A/CON	85±100	
	Ignition order			1-->3-->2-->4		
	Ignition liming			BTDC/RPM	AT model: 15°±10°/700	
					MT model: 10°±8°/650	

NOTE: US: Undersize OS: Oversize**GENERAL SPECIFICATION**

Belt tension adjuster	Protrusion of adjuster rod	mm (in)	5.2 - 6.2 (0.205 - 0.244)

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Valve rocker arm	Clearance between shaft and arm			mm (in)	Standard	0.020 - 0.054 (0.0008 - 0.0021)	
Camshaft	Bending limit				mm (in)	0.025 (0.00098)	
	Cam lobe height	mm (in)	intake	Constant	Standard	40.075 - 40.175 (1.5778 - 1.5817)	
				Low speed	Standard	35.496 - 35.596 (1.3975 - 1.4014)	
				High speed	Standard	40.315 - 40.415 (1.5872 - 1.5911)	
				Exhaust	Standard	39.289 - 39.389 (1.5468 - 1.5507)	
	Cam base circle diameter				mm (in)	Standard	34.00 (1.3386)
	Base circle step of adjacent intake cams (low speed and high speed)				mm (in)	Standard	0.03 (0.001)
	Journal O.D.				mm (in)		31.928 - 31.945 (1.2570 - 1.2577)
	Cylinder head journal I.D.				mm (in)		32.000 - 32.018 (1.2598 - 1.2605)
	Thrust clearance				mm (in)	Standard	0.030 - 0.090 (0.0012 - 0.0035)
	Oil clearance				mm (in)	Standard	0.055 - 0.090 (0.0022 - 0.0035)
Cylinder head	Warping limit (Mating surface with cylinder block)				mm (in)		0.035 (0.0014)
	Grinding limit				mm (in)		0.1 (0.004)
	Standard height				mm (in)		97.5 (3.84)
Valve seat	Seating angle between valve and valve seat						90°
	Contacting width between valve and valve seat	mm (in)	Standard	Intake		0.8 - 1.4 (0.03 - 0.055)	
Exhaust					1.2 - 1.8 (0.047 - 0.071)		
Valve guide	Clearance between the valve guide and valve stem	mm (in)	Standard	Intake		0.035 - 0.062 (0.0014 - 0.0024)	
				Exhaust		0.040 - 0.067 (0.0016 - 0.0026)	
	Inside diameter				mm (in)		6.000 - 6.012 (0.2362 - 0.2367)
	Valve stem outer diameters	mm (in)		Intake		5.950 - 5.965 (0.2343 - 0.2348)	
				Exhaust		5.945 - 5.960 (0.2341 - 0.2346)	
		Valve guide protrusion	mm (in)		Intake		20.0 - 21.0 (0.787 - 0.827)
				Exhaust		16.5 - 17.5 (0.650 - 0.689)	
Valve	Head edge thickness	mm (in)	Standard	Intake		0.8 - 1.2 (0.03 - 0.047)	
				Exhaust		1.0 - 1.4 (0.039 - 0.055)	

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	Overall length		mm (in)	Intake	120.6 (4.75)	
				Exhaust	121.7 (4.79)	
Valve spring	Free length		mm (in)		55.2 (2.173)	
	Tension/spring height	N (kgf, lb)/mm (in)	Set	235.3 - 270.7 (24 - 27.6, 52.9 - 60.8)/45.0 (1.772)		
			Lift	578.9 - 639.9 (59.1 - 65.3,130.3 - 143.9)/34.7 (1.366)		
	Squareness				2.5°, 2.4 mm (0.094 in) or less	
Cylinder block	Warping limit (Mating surface with cylinder head)		mm (in)		0.025 (0.00098)	
	Grinding limit		mm (in)		0.1 (0.004)	
	Standard height		mm (in)		201.0 (7.91)	
	Taper		mm (in)	Standard	0.015 (0.0006)	
	Out-of-roundness		mm (in)	Standard	0.010 (0.0004)	
	Cylinder to piston clearance at 20° C (68°F)		mm (in)	Standard	-0.010 - 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 (1.504)	
	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 - 3.9277)	
			0.50 (0.0197) OS		99.995 -100.015 (3.9368 - 3.9376)	
Piston pin	Degree of fit				Piston pin must be fitted into position with thumb at 20°C (68°F).	
	Clearance between piston hole and piston pin		mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)	
Piston ring	Piston ring gap	mm (in)	Top ring	Standard	0.20 - 0.35 (0.0079 - 0.0138)	
			Second ring	Standard	0.37 - 0.52 (0.0146 - 0.0205)	
			Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)	
	Clearance between piston ring and piston ring groove	mm (in)	Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)	
			Second ring	Standard	0.030 - 0.070 (0.0012 - 0.0028)	
	Bend or twist per 100 mm (3.94					

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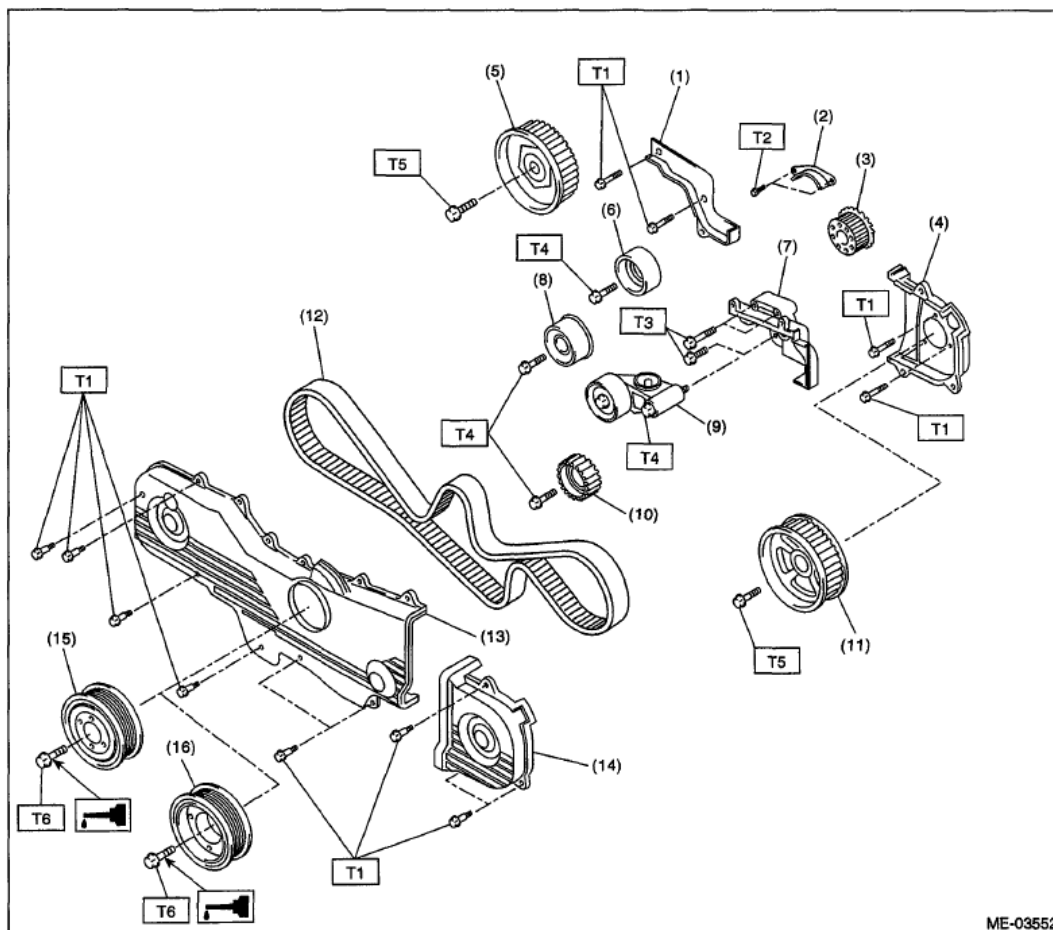
Connecting rod and connecting rod bearing	in) in length		mm (in)	Limit	0.10 (0.0039)
	Thrust clearance		mm (in)	Standard	0.070 - 0.330 (0.0028 - 0.0130)
	Oil clearance	mm (in)	Standard		0.016 - 0.044 (0.0006 - 0.0017)
	Bearing size (Thickness at center)	mm (in)	Standard		1.492 - 1.501 (0.0587 - 0.0591)
			0.03 (0.0012) US		1.510 - 1.513 (0.0594 - 0.0596)
			0.05 (0.0020) US		1.520 - 1.523 (0.0598 - 0.0600)
0.25 (0.0098) US			1.620 - 1.623 (0.0638 - 0.0639)		
Bushing of small end	Clearance between piston pin and bushing		mm (in)	Standard	0 - 0.022 (0 - 0.0009)
Crankshaft and crankshaft bearing	Bending limit		mm (in)		0.035 (0.0014)
	Crank pin	Out-of-roundness	mm (in)		0.003 (0.0001)
		Cylindricity	mm (in)		0.004 (0.0002)
		Grinding limit (dia.)	mm (in)		To 51.750 (2.0374)
		Crank journal	Out-of-roundness	mm (in)	
	Cylindricity		mm (in)		0.006 (0.0002)
	Grinding limit (dia.)		mm (in)		To 59.758 (2.3527)
	Crank pin outer diameter	mm (in)	Standard		51.984 - 52.000 (2.0466 - 2.0472)
			0.03 (0.0012) US		51.954 - 51.970 (2.0454 - 2.0461)
			0.05 (0.0020) US		51.934 - 51.950 (2.0446 - 2.0453)
			0.25 (0.0098) US		51.734 - 51.750 (2.0368 - 2.0374)
	Crank journal outer diameter	mm (in)	Standard		59.992 - 60.008 (2.3619 - 2.3625)
			0.03 (0.0012) US		59.962 - 59.978 (2.3607 - 2.3613)
			0.05 (0.0020) US		59.942 - 59.958 (2.3599 - 2.3605)
			0.25 (0.0098) US		59.742 - 59.758 (2.3520 - 2.3527)
		#1,#3	Standard		1.998 - 2.011 (0.0787 - 0.0792)
			0.03 (0.0012) US		2.017 - 2.020 (0.0794 - 0.0795)
			0.05 (0.0020) US		2.027 - 2.030 (0.0798 - 0.0799)

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

COMPONENT**TIMING BELT**



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

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

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

T1: 5 (0.5, 3.7)

T2: 9.75 (1.0, 7.2)

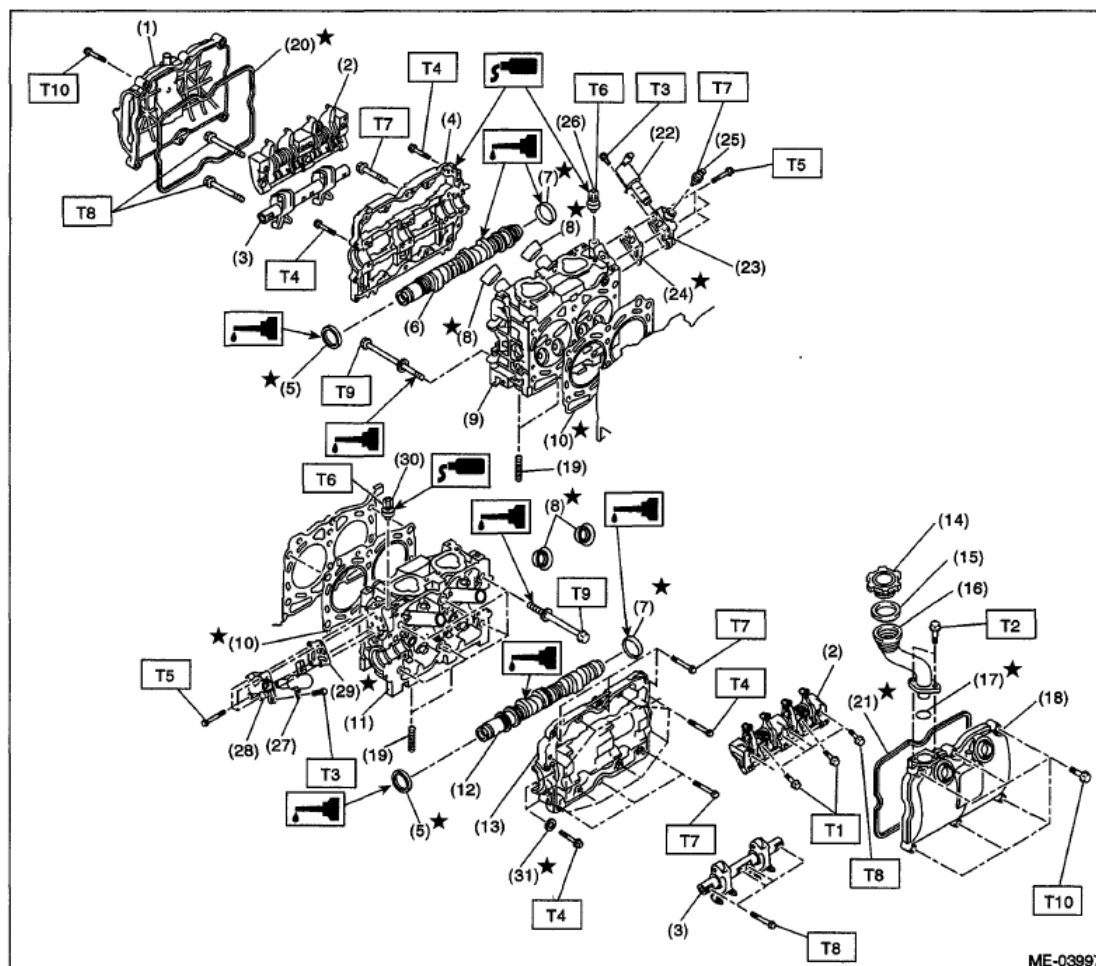
T3: 24.5 (2.5, 18.1)

T4: 39 (4.0, 28.8)

T5: 78 (8.0,57.5)

T6: Refer to INSTALLATION, Crank Pulley.

CYLINDER HEAD AND CAMSHAFT



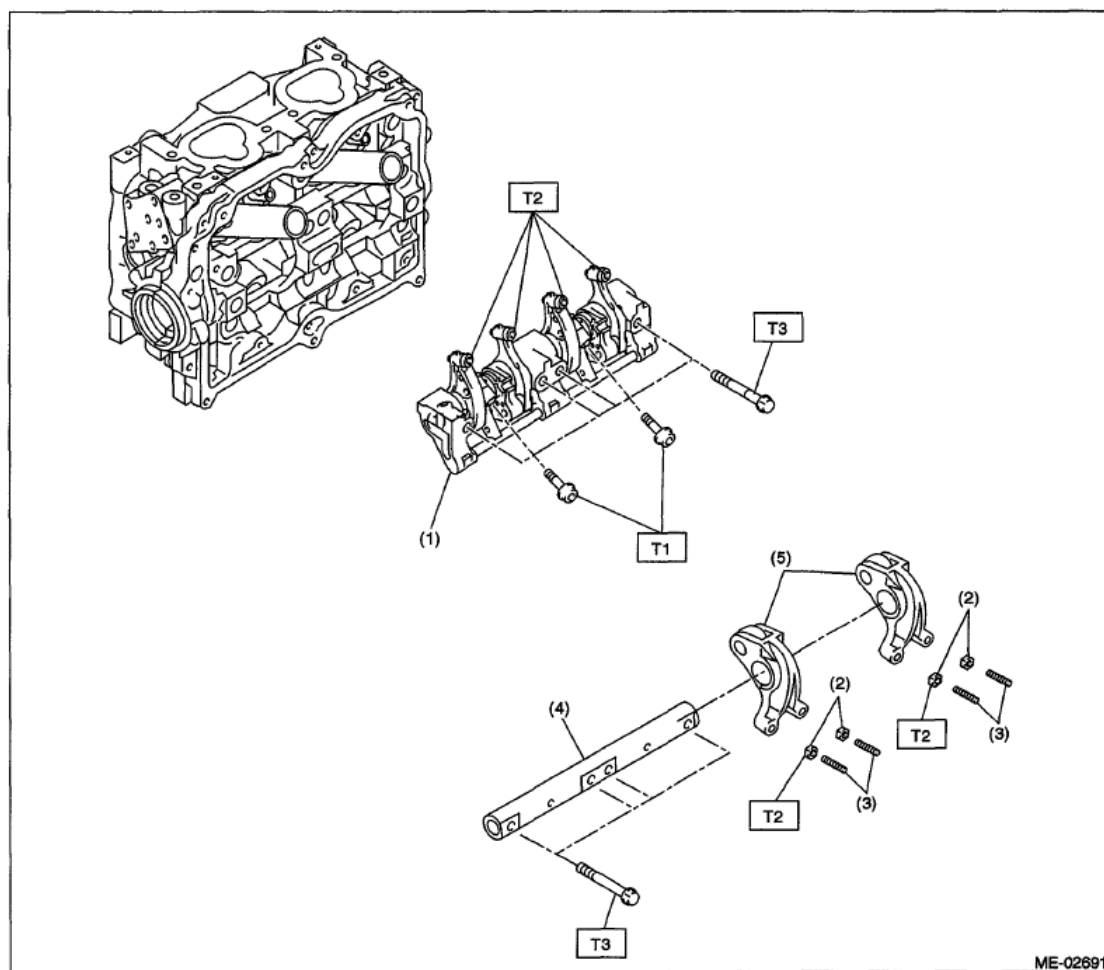
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|-------------------------------|---|------------------|
| (1) Rocker cover RH | (18) Rocker cover LH | (31) Seal washer |
| (2) Intake valve rocker ASSY | (19) Stud bolt | |
| (3) Exhaust valve rocker ASSY | (20) Rocker cover gasket RH | |
| (4) Camshaft cap RH | (21) Rocker cover gasket LH | |
| (5) Oil seal | (22) Oil switching solenoid valve RH | |
| (6) Camshaft RH | (23) Oil switching solenoid valve holder RH | |
| (7) Plug | (24) Gasket | |
| (8) Spark plug pipe gasket | (25) Oil temperature sensor | |
| (9) Cylinder head RH | (26) Variable valve lift diagnosis oil pressure switch RH | |
| (10) Cylinder head gasket | (27) Oil switching solenoid valve LH | |
| (11) Cylinder head LH | (28) Oil switching solenoid valve holder LH | |
| (12) Camshaft LH | (29) Gasket | |
| (13) Camshaft cap LH | (30) Variable valve lift diagnosis oil pressure switch LH | |
| (14) Oil filler cap | | |
| (15) Gasket | | |
| (16) Oil filler duct | | |
| (17) O-ring | | |

Fig. 2: Identifying Cylinder Head And Camshaft Components

Courtesy of SUBARU OF AMERICA, INC.

*Tightening torque: N.m (kgf-m, ft-lb)**T1: 6 (0.6,4A)**T2: 6.4 (0.7,4.7)**T3: 8 (0.8,5.9)**T4: 9.75 (1.0,7J2)**T5: 10 (1.0,7.4)**T6: 17 (1.7, 12.5)**T7: 18 (1.8,13.3)**T8: 25 (2.5,18.4)**T9: Refer to INSTALLATION, Cylinder Head.**T10: Refer to INSTALLATION, Valve Rocker Assembly.***VALVE ROCKER ASSEMBLY**



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

Fig. 3: Identifying Valve Rocker Assembly Components
Courtesy of SUBARU OF AMERICA, INC.

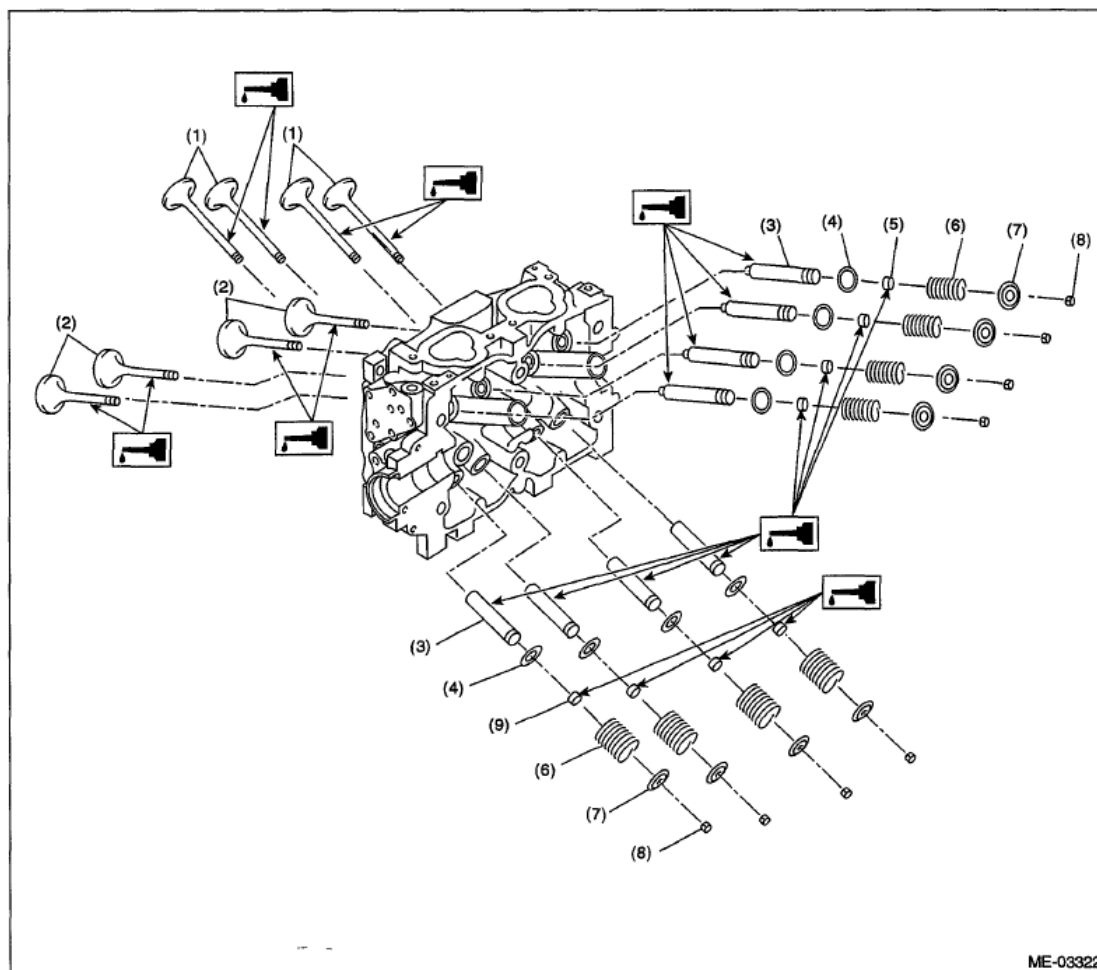
Tightening torque: N.m (kgf-m, ft-lb)

T1: 6 (0.6,4.4)

T2: 9.75 (1.0,7.2)

T3: 25 (2.5,18.4)

CYLINDER HEAD AND VALVE ASSEMBLY



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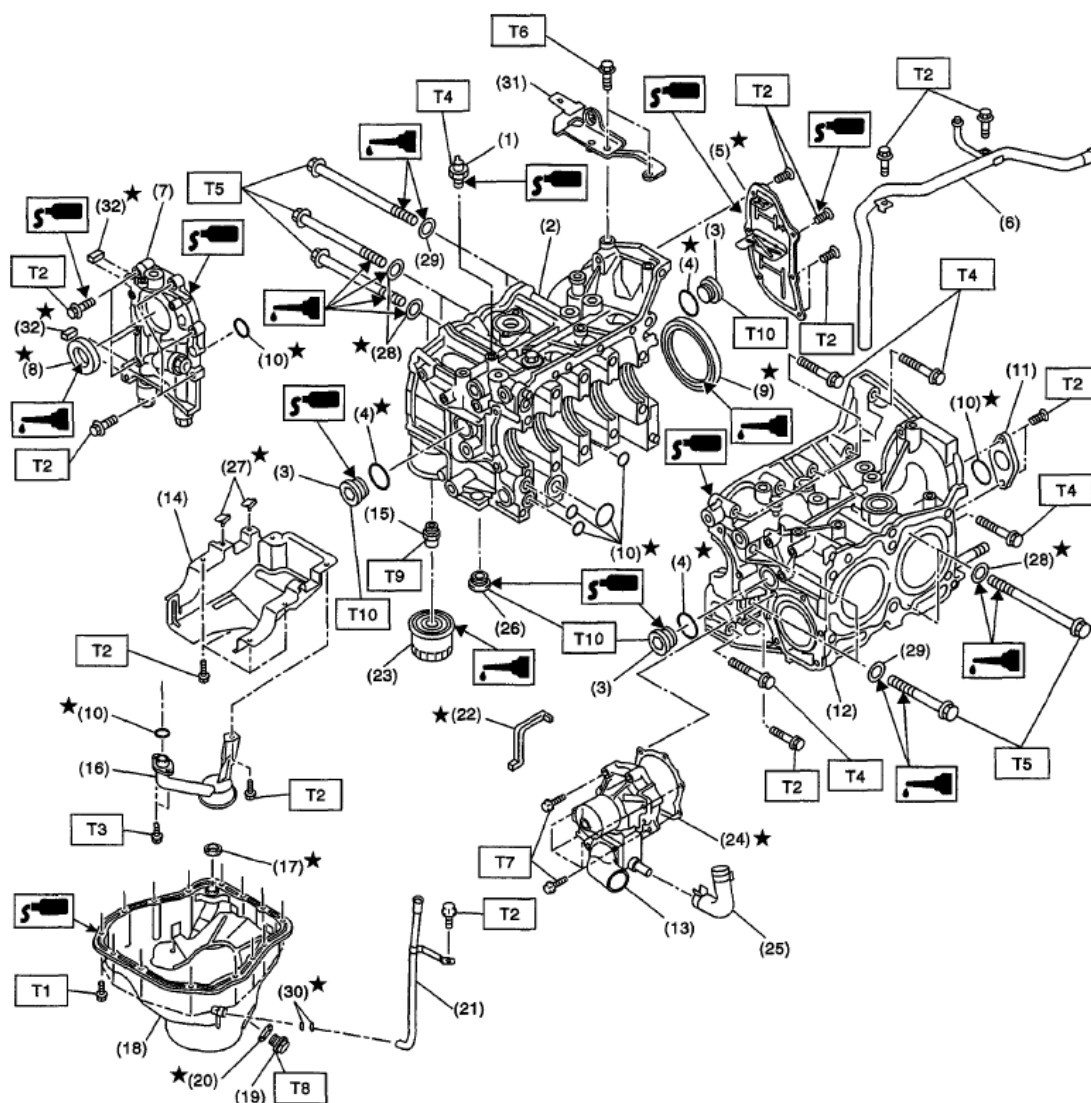
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|-------------------|---------------------------|----------------------------|
| (1) Exhaust valve | (4) Valve spring seat | (7) Retainer |
| (2) Intake valve | (5) Intake valve oil seal | (8) Retainer key |
| (3) Valve guide | (6) Valve spring | (9)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

Fig. 4: Identifying Cylinder Head And Valve Assembly Components
 Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK

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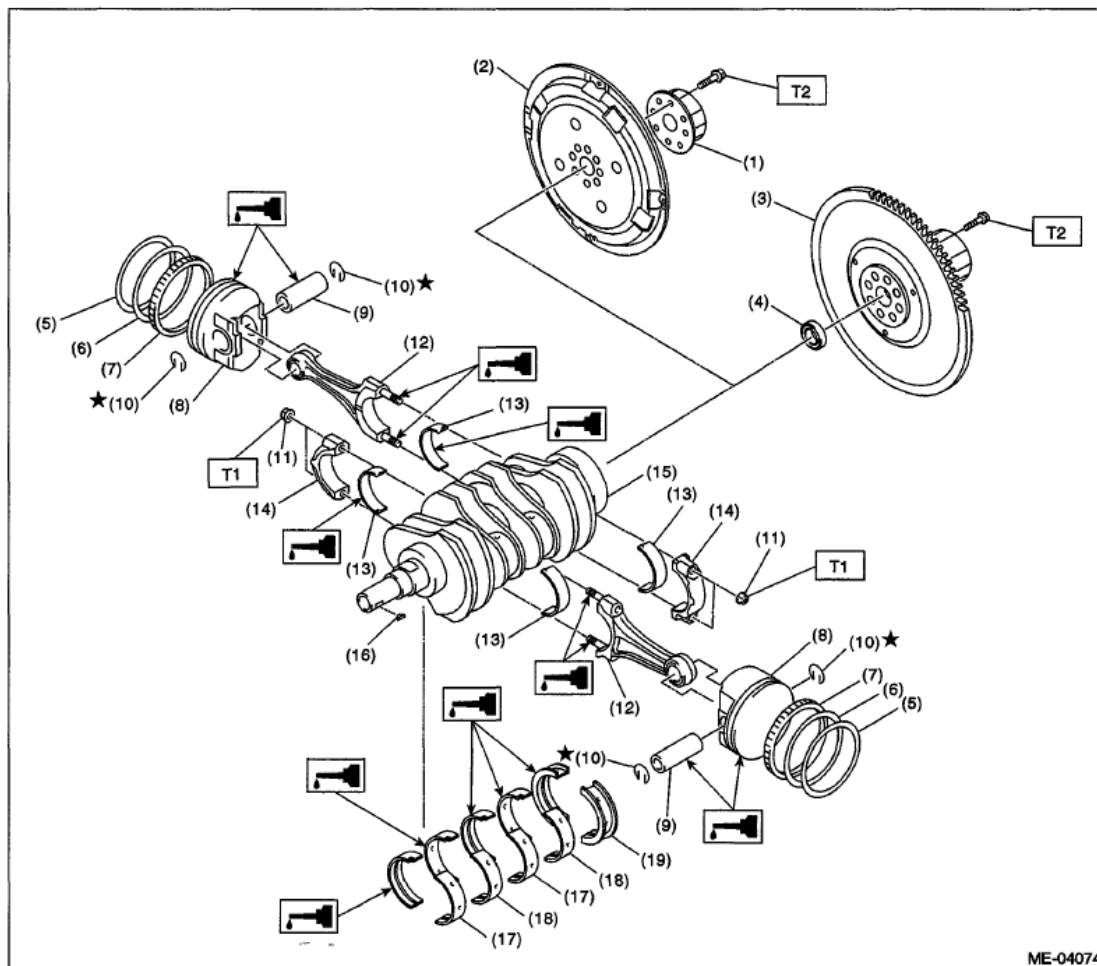
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|---------------------------|----------------------------|--------------------|
| (1) Oil pressure switch | (17) Gasket | (32) Oil pump seal |
| (2) Cylinder block RH | (18) Oil pan | |
| (3) Service hole plug | (19) Drain plug | |
| (4) Gasket | (20)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

Fig. 5: Identifying Cylinder Block Components

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: 25 (2.5, 18.4)**T5: Refer to INSTALLATION, Cylinder Block.**T6: 16 (1.6,11.8)**T7: First 12 (1,2,8.7) Second 12 (1.2, 8.7)**T8: 44 (4.5,32.5)**T9: 45 (4.6,33.2)**T10: 70 (7.1,51.6)***CRANKSHAFT AND PISTON**



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

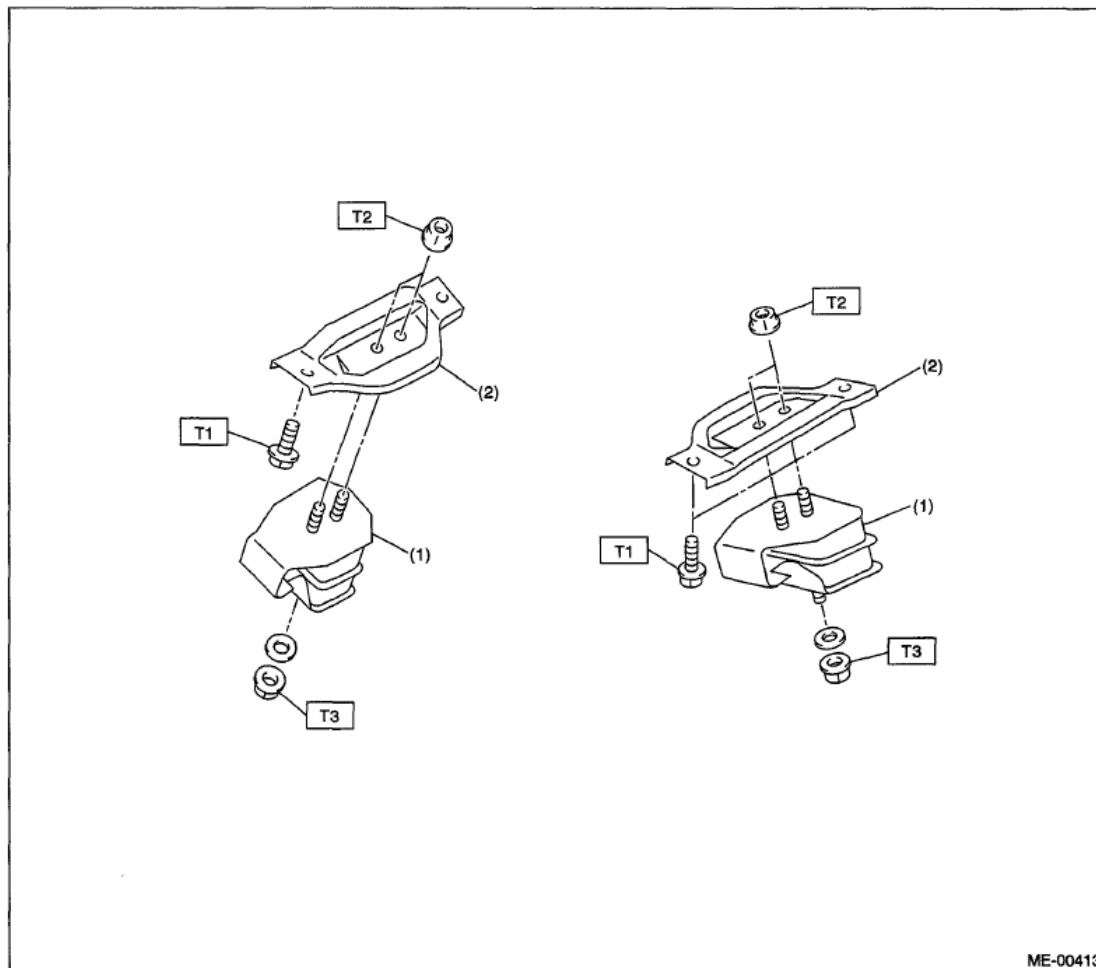
Fig. 6: Identifying Crankshaft And Piston Components
 Courtesy of SUBARU OF AMERICA, INC.

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

T1: 45 (4.6,33.2)

T2: 72 (7.3,53.1)

ENGINE MOUNTING



(1) Front cushion rubber

(2) Front engine mounting bracket

Fig. 7: Identifying Engine Mounting Components

Courtesy of SUBARU OF AMERICA, INC.

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

T1: 35 (3.6,25.8)

T2: 42 (4.3,31.0)

T3: 85 (8.7,62.7)

CAUTION

- Wear appropriate work clothing, including a cap, protective goggles and protective shoes when performing any work.
- Remove contamination including dirt and corrosion before removal, installation or disassembly.
- Keep the disassembled parts in order and protect them from dust and dirt.
- Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal,

installation, disassembly and replacement.

- Vehicle components are extremely hot after driving. Be wary of receiving burns from heated parts.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or rigid racks at the specified points.
- Before disconnecting connectors of sensors or units, be sure to disconnect the ground cable from the battery.
- All parts should be thoroughly cleaned, paying special attention to engine oil passages, pistons and bearings.
- Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.
- Be careful not to let oil, grease or coolant contact the timing belt, clutch disc and flywheel.
- All removed parts, if to be reused, should be reinstalled in the original positions and directions.
- Bolts, nuts and washers should be replaced with new parts as required.
- Even if necessary inspections have been made in advance, proceed with assembly work while making 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

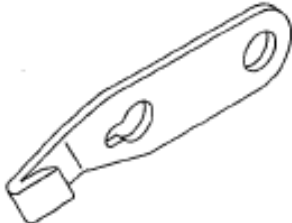
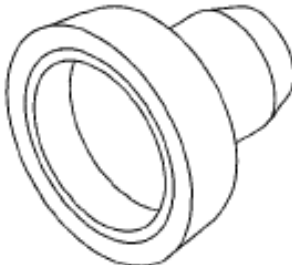
SPECIAL TOOL

SPECIAL TOOL SPECIFICATION

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-498277200	18231AA010	CAM SPROCKET WRENCH	• Used for removing and installing cam sprocket. (LH side) • CAM SPROCKET WRENCH (499207100) can also be used.

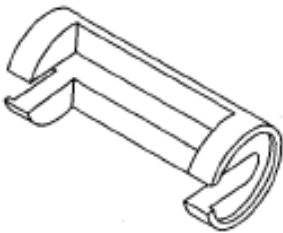
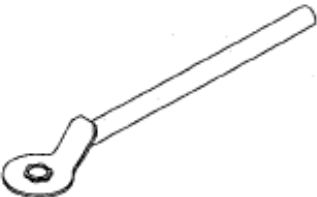
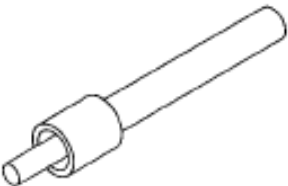
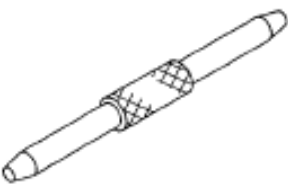
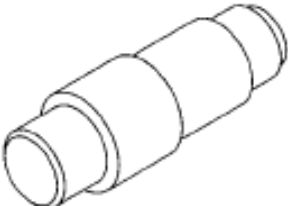
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 ST1B022XU0	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for various inspections.
 ST-498497100	498267800	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-499587200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST-499597100	498457000	ENGINE STAND ADAPTER RH	Used together with ENGINE STAND (499817100).
	498457100	ENGINE STAND ADAPTER LH	Used together with ENGINE STAND (499817100).

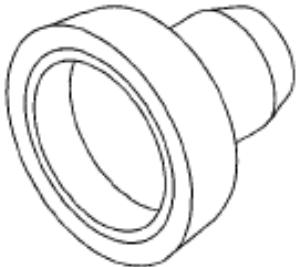
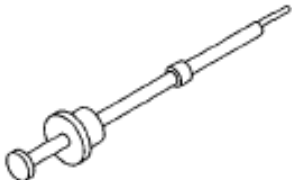
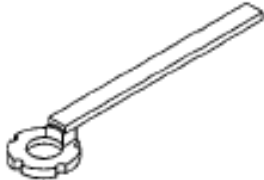
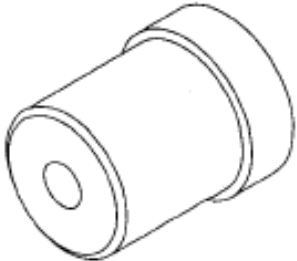
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 ST-499718000			
 ST-499977500	498497100	CRANKSHAFT STOPPER	Used for removing and installing the flywheel and drive plate.
 ST-498857100	498747300	PISTON GUIDE	Used for installing piston in cylinder.
 ST-499017100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST-499037100	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.

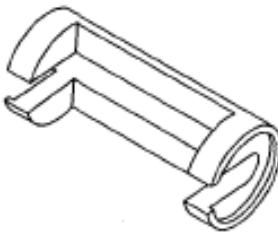
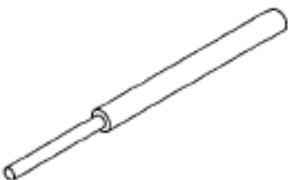
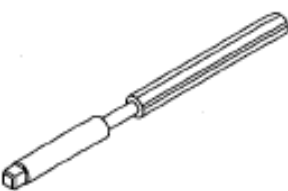
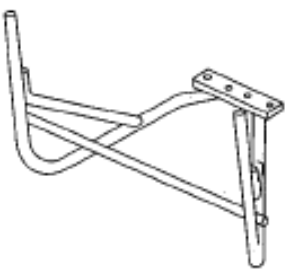
2009 Subaru Impreza 2.5 GT

2009 ENGINE Mechanical (H4SO) - Impreza (Except STi)

 ST-499587200	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499097700	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499207400	499587500	OIL SEAL INSTALLER	• Used for installing the camshaft oil seal. • Used together with OIL SEAL GUIDE (499597000).
 ST-499587100	499587700	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.
	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.

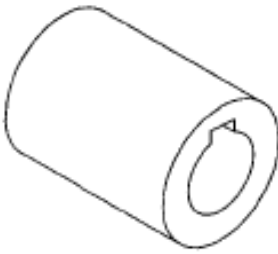
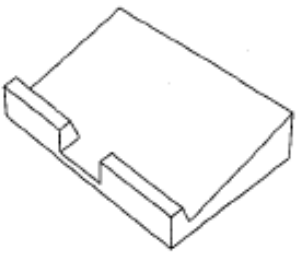
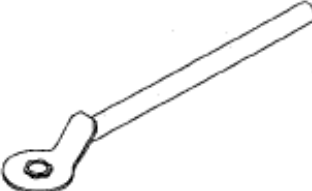
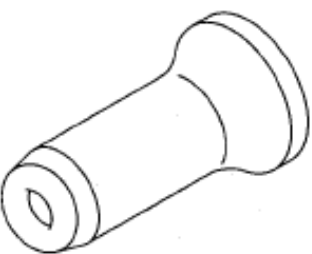
2009 Subaru Impreza 2.5 GT

2009 ENGINE Mechanical (H4SO) - Impreza (Except STi)

 ST-499597100			
 ST-499718000	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (RH side)
 ST-499767200	499497000	TORX® PLUS	Used for removing and installing camshaft cap.
 ST-499767400	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499817100	499597000	OIL SEAL GUIDE	• Used for installing the camshaft oil seal. • Used together with CAMSHAFT OIL SEAL INSTALLER (499587500).

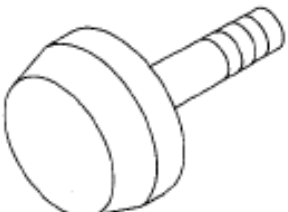
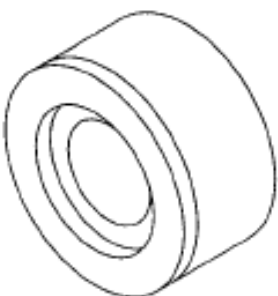
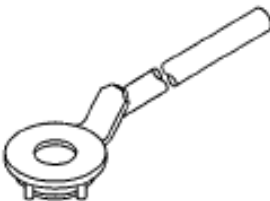
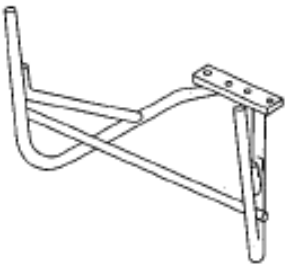
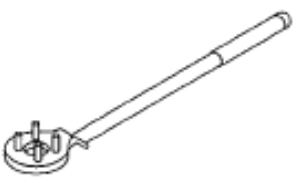
2009 Subaru Impreza 2.5 GT

2009 ENGINE Mechanical (H4SO) - Impreza (Except STi)

 ST-499987500	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-498267600	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST-499977500	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST18251AA020	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499587600	499767700	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Intake side)

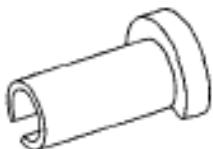
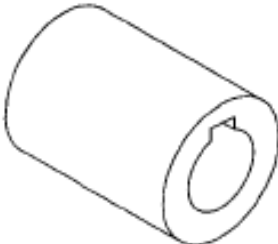
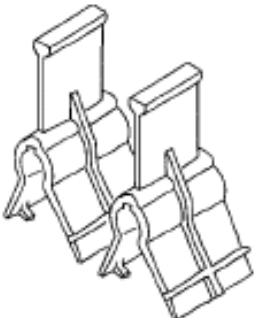
2009 Subaru Impreza 2.5 GT

2009 ENGINE Mechanical (H4SO) - Impreza (Except STi)

 ST-499597200	499767800	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Exhaust side)
 ST-499767800	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used together with ENGINE STAND ADAPTER RH (498457000)&LH (498457100).
 ST-499977400	499977400	CRANK PULLEY WRENCH	Used to stop rotation of the crank pulley when loosening or tightening crank pulley bolts. (AT model)
 ST-499817100	499977100	CRANK PULLEY WRENCH	Used to stop rotation of the crank pulley when loosening or tightening crank pulley bolts. (MT model)
 ST-499977100	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.

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2009 ENGINE Mechanical (H4SO) - Impreza (Except STi)

 ST42099AE000	42099AE000	QUICK CONNECTOR RELEASE	Used for removing the quick connector.
 ST-499987500	18354AA000	VALVE ROCKER HOLDER	Used for installing the valve rocker assembly (intake). (2-piece set)
 ST18354AA000	18258AA000	SPRING INSTALLER	Used for installing the valve rocker assembly (intake).

GENERAL TOOL**GENERAL TOOL SPECIFICATION**

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

PROCEDURE

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

- V-belt
- Timing belt
- Valve rocker assembly
- Camshaft
- Cylinder head

COMPRESSION

INSPECTION

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

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

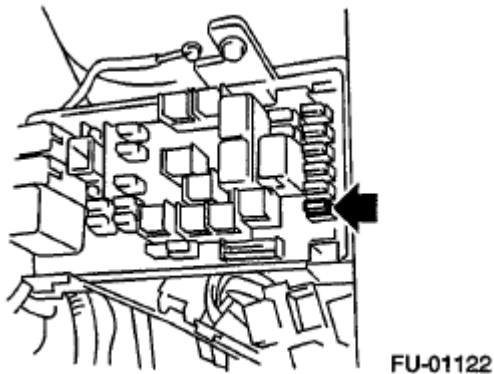


Fig. 8: Locating Fuse Of Fuel Pump
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

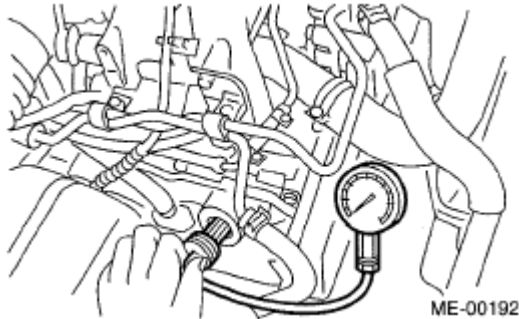


Fig. 9: Checking Engine Compression
Courtesy of SUBARU OF AMERICA, INC.

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

Compression (fully open throttle):

Standard

1,020 - 1,275 kPa (10.4 - 13.0 kgf/cm² , 148 - 185 psi)

Difference between cylinders

49 kPa (0.5 kgf/cm² , 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)** , OPERATION, Subaru Select Monitor.
4. Check the idle speed when no-loaded. (Headlight, heater fan, rear defroster, radiator fan, A/C and etc. are OFF)

Idle speed (No load and at "P" or "N" position on AT model, or neutral position on MT model):

700±100 RPM (AT model)

650±100 RPM (MT model)

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

Idle speed (A/C "ON" and at "P" or "N" position on AT model, or neutral position on MT model): 850±100 RPM

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

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. Stop the engine, and turn the ignition switch to OFF.
4. Connect the timing light to #1 cylinder spark plug cord, and then light the timing mark with the timing light.
5. Start the engine and check the ignition timing at idle speed as shown below.

Ignition timing [BTDC/RPM]:

15°±8°/700 (AT model)

10°±8°/650 (MT model)

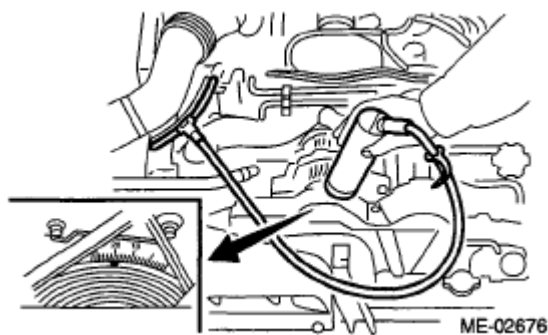


Fig. 10: Checking Ignition Timing

Courtesy of SUBARU OF AMERICA, INC.

If the timing is not correct, check the ignition control system. Refer to **BASIC DIAGNOSTIC PROCEDURE**.

INTAKE MANIFOLD VACUUM

INSPECTION

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

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

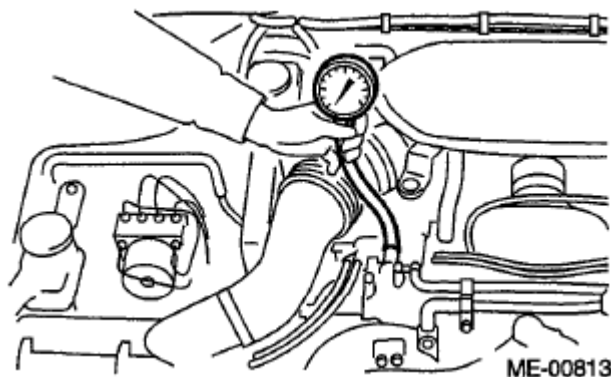


Fig. 11: Checking Intake Manifold Vacuum

Courtesy of SUBARU OF AMERICA, INC.

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

Less than -60.0 kPa (-450 mmHg, -17.72 inHg)

VACUUM GAUGE INDICATION CHART

Diagnosis of engine condition by measurement of intake manifold vacuum

Vacuum gauge indication	Possible engine condition
1. Needle is steady but lower than normal position. This tendency becomes more evident as engine temperature rises.	Air leakage around intake manifold gasket, disconnection or damage of vacuum hose
2. Needle intermittently drops to position lower than normal position.	Leakage around cylinder
3. Needle drops suddenly and intermittently from normal position.	Sticky valve
4. When engine speed is gradually increased, needle begins to vibrate rapidly at certain speed, and then vibration increases as engine speed increases.	Weak or broken valve springs
5. Needle vibrates above and below normal position in narrow range.	Defective ignition system

ENGINE OIL PRESSURE

INSPECTION

1. Disconnect the ground cable from battery.

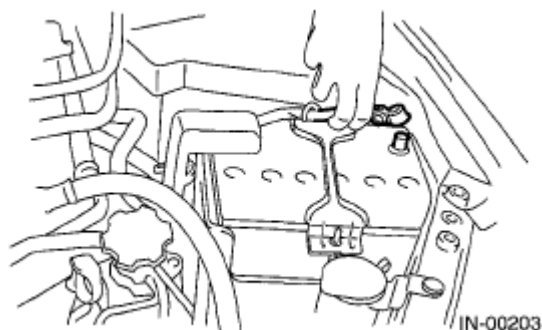


Fig. 12: Disconnecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

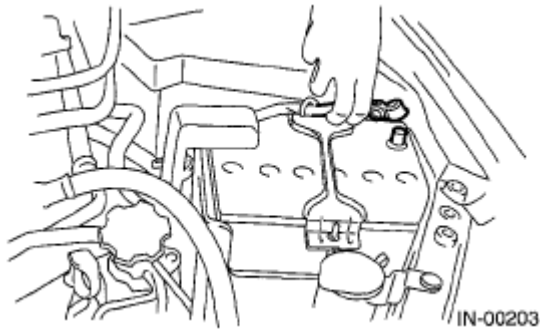


Fig. 13: Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

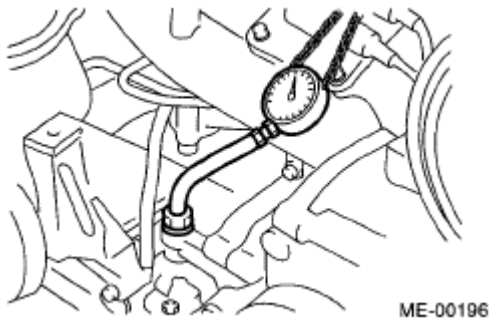


Fig. 14: Measuring Oil Pressure
Courtesy of SUBARU OF AMERICA, INC.

Engine oil pressure:

Standard

98 kPa (1.0 kg/cm² , 14 psi) or more at 600 RPM

294 kPa (3.0 kg/cm² , 43 psi) or more at 5,000 RPM

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

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

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

FUEL PRESSURE

INSPECTION

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

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

1. Release the fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel.
2. Open the fuel filler lid and remove the fuel filler cap.
3. Disconnect the fuel delivery hose from the fuel damper, and connect the fuel pressure gauge.

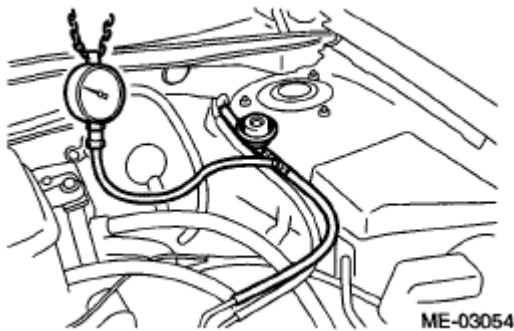


Fig. 15: Measuring Fuel Pressure
Courtesy of SUBARU OF AMERICA, INC.

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

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

Fuel pressure:

Standard

339.5 - 360.5 kPa

(3.5 - 3.7 kg/cm² , 49 - 52 psi)

VALVE CLEARANCE

INSPECTION

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

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

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

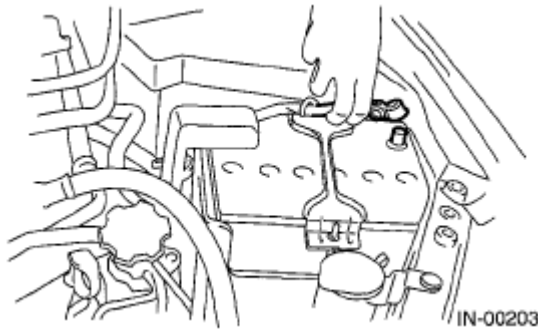


Fig. 16: Disconnecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the timing belt cover LH.

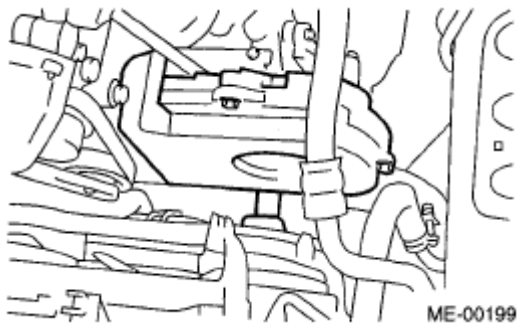


Fig. 17: Identifying Timing Belt Cover LH
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the fuel injector. Refer to **REMOVAL** , Fuel Injector.
8. When inspecting #1 and #3 cylinders
 1. Disconnect the spark plug cords from spark plugs on RH side. Refer to **RH SIDE** , REMOVAL,

Spark Plug.

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

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

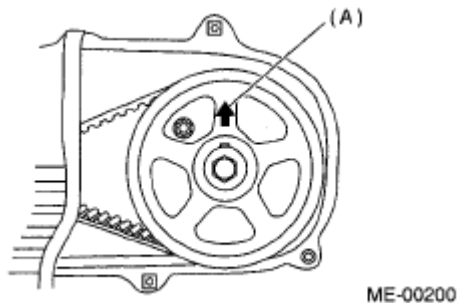


Fig. 18: Identifying Arrow Mark On Cam Sprocket LH
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- Insert the thickness gauge (A) in as horizontally as possible with respect to the valve stem end face.
- Lift up the vehicle, and then measure the exhaust valve clearances.

Valve clearance (inspection value):

Intake

0.20±0.04 mm (0.0079±0.0016 in)

Exhaust

0.25±0.04 mm (0.0098±0.0016 in)

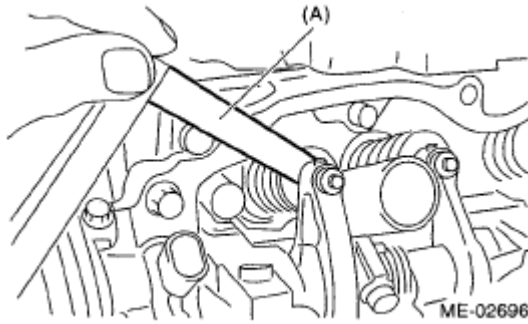


Fig. 19: Measuring Exhaust Valve Clearances
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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

NOTE: Use a new rocker cover gasket.

ADJUSTMENT

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

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

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

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

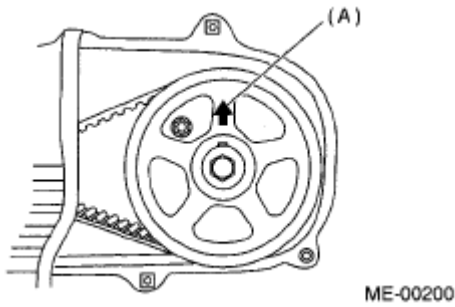


Fig. 20: Identifying Arrow Mark On Cam Sprocket LH

Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

Valve clearance (adjustment value):

Intake

0.20±0.04 mm (0.0079±0.0016 in)

Exhaust

0.25±0.04 mm (0.0098±0.0016 in)

Tightening torque:

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

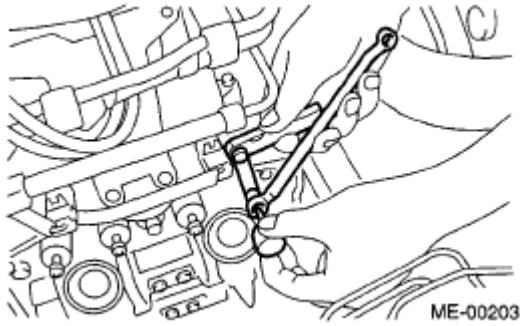


Fig. 21: Adjusting Exhaust Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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

NOTE: Use a new rocker cover gasket.

ENGINE ASSEMBLY

REMOVAL

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

Tightening torque:

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

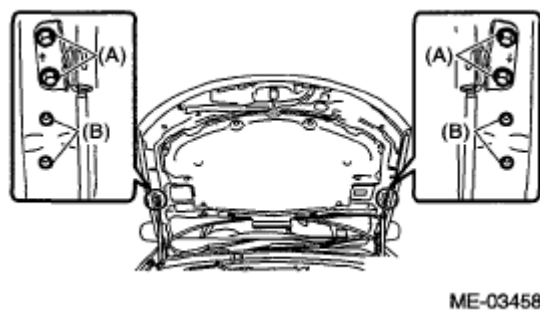


Fig. 22: Identifying Bolts Installation Position
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the V-belt covers.

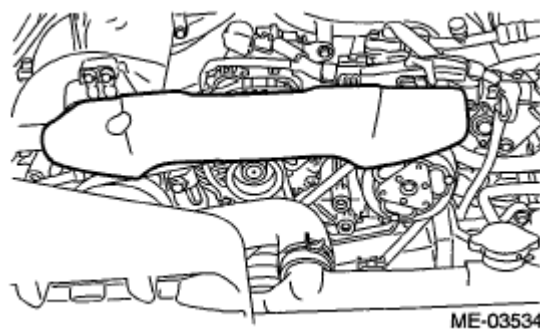


Fig. 23: Identifying V-Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

4. Collect the refrigerant from A/C system. Refer to **PROCEDURE** , Refrigerant Recovery Procedure.
5. Release the fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel.
6. Remove the battery. Refer to **REMOVAL** , Battery.
7. Remove the air intake duct, air cleaner case and air intake chamber. Refer to **REMOVAL** , Air Intake Duct. Refer to **REMOVAL** , Air Cleaner Case. Refer to **REMOVAL** , Air Intake Chamber.
8. Remove the under cover.
9. Remove the radiator from vehicle. Refer to **REMOVAL** , Radiator.
10. Disconnect the A/C pressure hoses from A/C compressor. Refer to **REMOVAL** , Hose and Pipe.
11. Remove the air intake chamber stay.

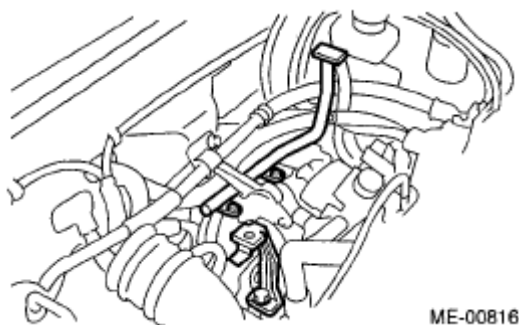


Fig. 24: Identifying Air Intake Chamber Stay
Courtesy of SUBARU OF AMERICA, INC.

12. Disconnect the following connectors and cables.
 1. Disconnect the front oxygen (A/F) sensor connector (A) and rear oxygen sensor connector (B) and remove the clip (C) fastening the harness.

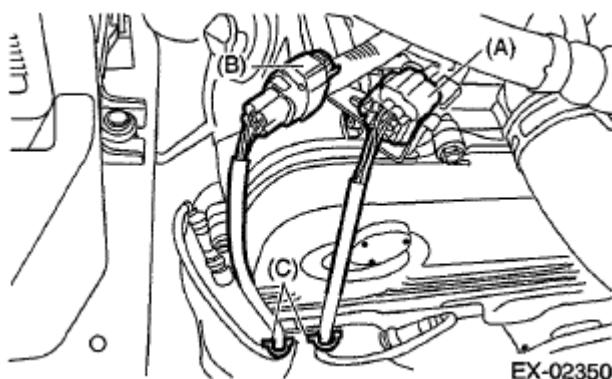


Fig. 25: Identifying Front Oxygen (A/F) Sensor Connector, Rear Oxygen Sensor Connector And Clip
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the bolt, and disconnect the engine harness connector from the bulkhead harness connector and rear engine hanger.

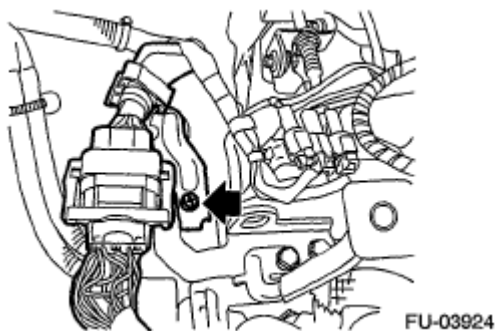


Fig. 26: Locating Engine Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Generator connector and terminal

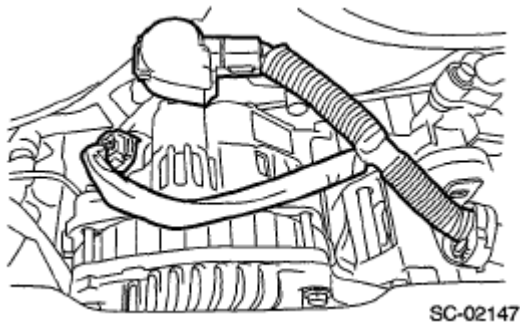


Fig. 27: Identifying Generator Connector And Terminal
Courtesy of SUBARU OF AMERICA, INC.

4. A/C compressor connector

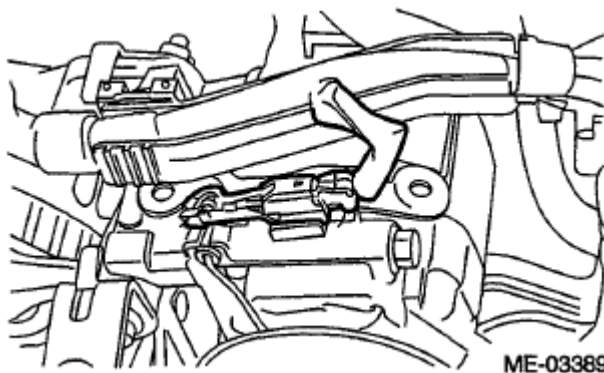


Fig. 28: Identifying A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Power steering pump switch connector

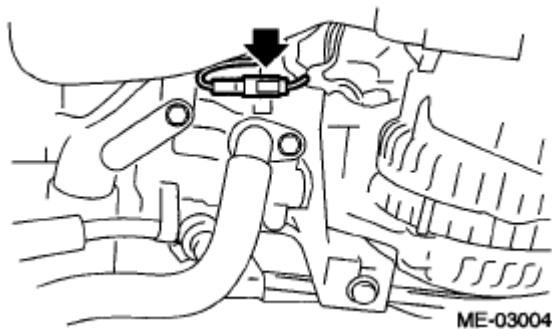


Fig. 29: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

13. Disconnect the following hoses.

1. Brake booster vacuum hose

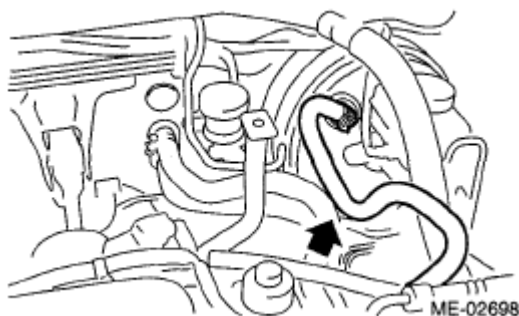


Fig. 30: Locating Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

2. Heater inlet and outlet hoses
14. Remove the power steering pump.
 1. Remove the front side belts. Refer to **FRONT SIDE BELT**, REMOVAL, V-belt.
 2. Remove the bolts which secure the power steering pump to the bracket.

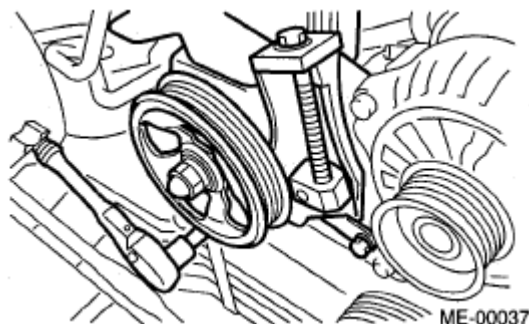


Fig. 31: Identifying Power Steering Pump Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Place the power steering pump on the right side wheel apron.
15. Lift up the vehicle.
16. Remove the front and center exhaust pipes. Refer to **REMOVAL** , Front Exhaust Pipe.
17. Disconnect the ground cable on the engine side.

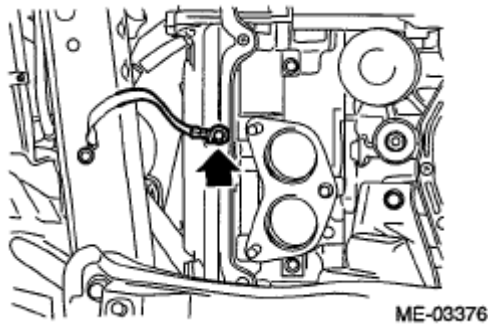


Fig. 32: Locating Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

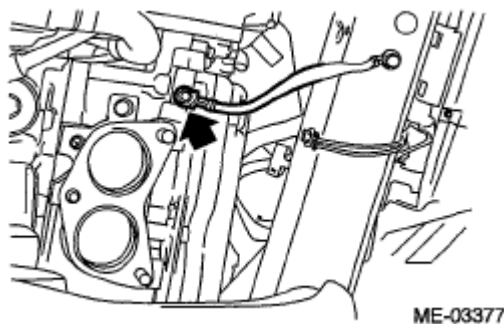


Fig. 33: Locating Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

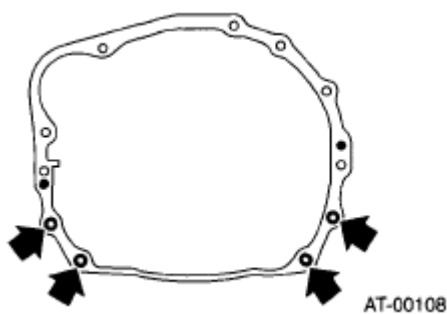


Fig. 34: Locating Lower Side Of Transmission To Engine Bolts And Nuts - AT Model
Courtesy of SUBARU OF AMERICA, INC.

- MT MODEL

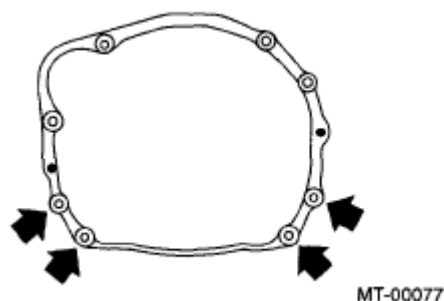


Fig. 35: Locating Lower Side Of Transmission To Engine Bolts And Nuts - MT Model
Courtesy of SUBARU OF AMERICA, INC.

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

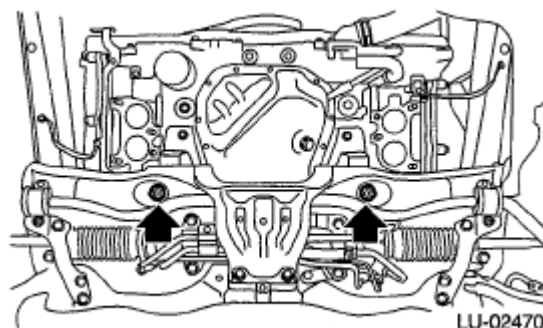


Fig. 36: Locating Engine Mounting To Front Crossmember Nuts
Courtesy of SUBARU OF AMERICA, INC.

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

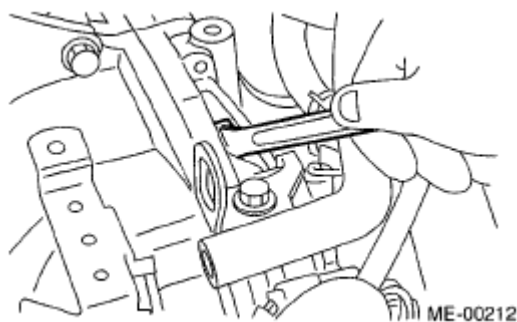


Fig. 37: Inserting Wrench Into Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

21. Remove the pitching stopper.

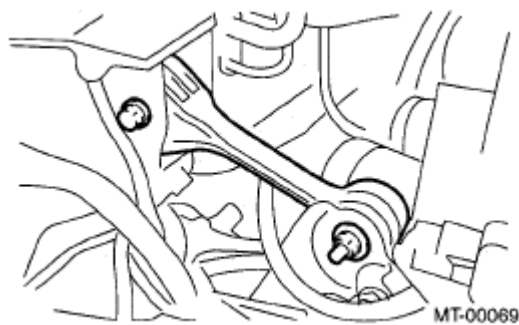


Fig. 38: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

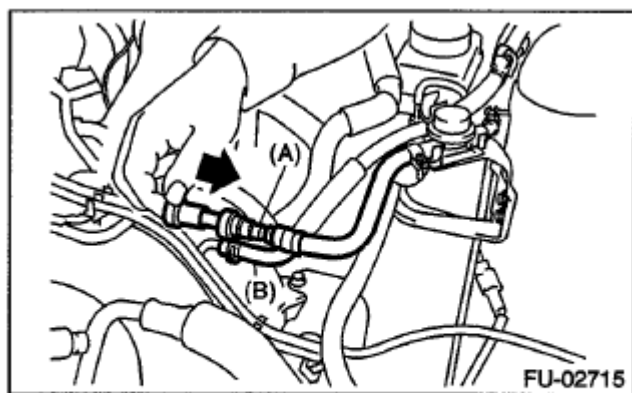
22. Disconnect the fuel delivery hose (A) and evaporation hose (B).
 1. Disconnect the quick connector of the fuel delivery hose by pushing the ST in the direction of the arrow.

ST 42099AE000 QUICK CONNECTOR RELEASE

2. Remove the clip and disconnect the evaporation hose from the pipe.

CAUTION:

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



(A) Fuel delivery hose
(B) Evaporation hose

Fig. 39: Disconnecting Quick Connector Of Fuel Delivery Hose
Courtesy of SUBARU OF AMERICA, INC.

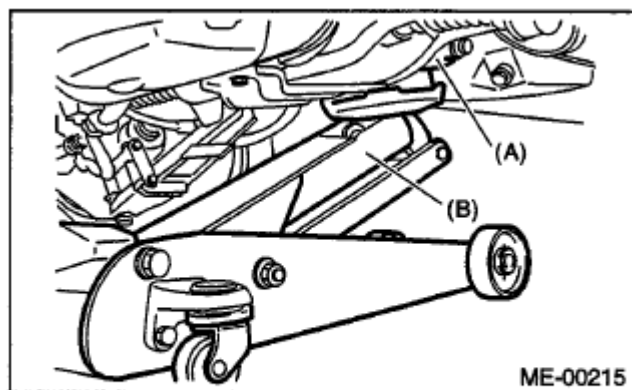
23. Support the engine with a lifting device and wire ropes.



Fig. 40: Identifying Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

24. Support the transmission with a garage jack.

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



- (A) Transmission
(B) Garage jack

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

25. 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 **REMOVAL**, Starter.
2. Attach the ST to the torque converter clutch case. (AT model)

ST 498277200 STOPPER SET

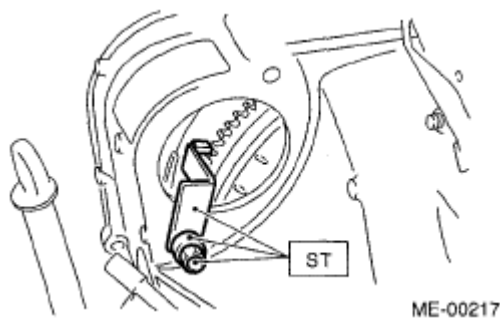


Fig. 42: Identifying Stopper Set 498277200 On Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

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

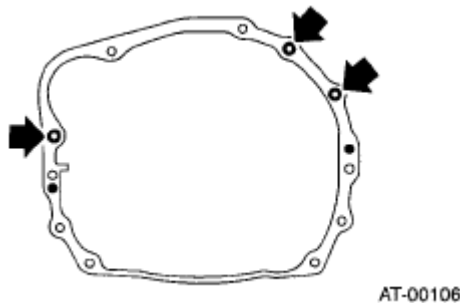


Fig. 43: Locating Upper Side Of Transmission To Engine Bolts - AT Model
Courtesy of SUBARU OF AMERICA, INC.

- MT MODEL

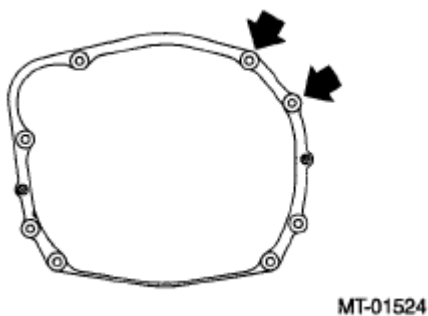


Fig. 44: Locating Upper Side Of Transmission To Engine Bolts - MT Model
Courtesy of SUBARU OF AMERICA, INC.

26. Remove the engine from vehicle.
 1. Slightly raise the engine.
 2. Raise the transmission with garage jack.
 3. Move the engine horizontally until main shaft is withdrawn from clutch cover. (MT model)

4. Slowly move the engine away from engine compartment.

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

27. Remove the engine mounting from the engine.

INSTALLATION

1. Install the engine mounting onto the engine.

Tightening torque:

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

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

Grease:

NICHIMOLY N-130 or equivalent

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

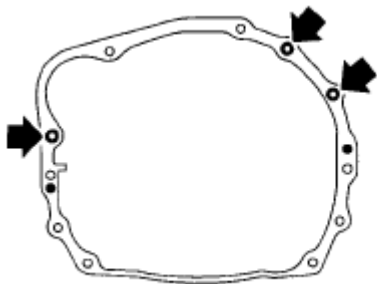
NOTE: Be careful not to damage adjacent parts or body panels with crank pulley, oil level gauge, etc.

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

Tightening torque:

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

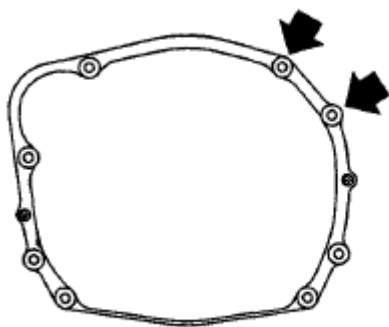
- AT MODEL



AT-00106

Fig. 45: Locating Upper Side Of Transmission To Engine Bolts - AT Model
Courtesy of SUBARU OF AMERICA, INC.

- MT MODEL



MT-01524

Fig. 46: Locating Upper Side Of Transmission To Engine Bolts - MT Model
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.

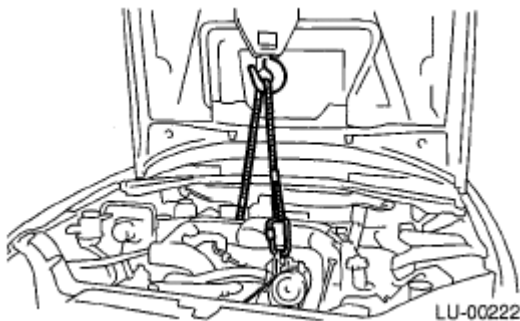


Fig. 47: Identifying Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

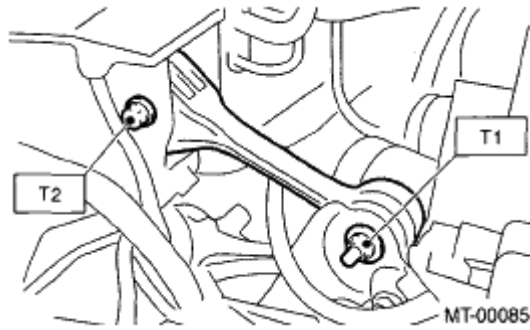


Fig. 48: Identifying Pitching Stopper Tightening Torque
Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

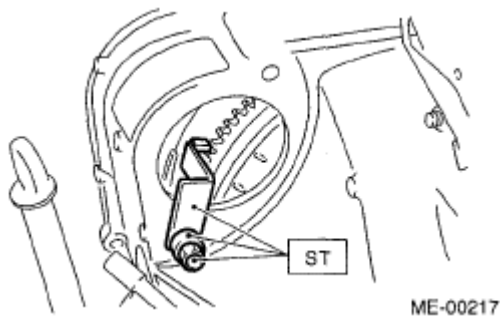


Fig. 49: Identifying Stopper Set 498277200 On Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

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

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

Tightening torque:

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

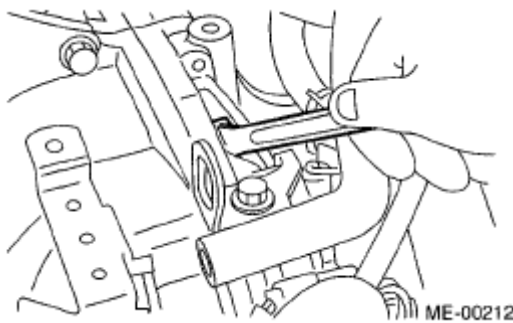


Fig. 50: Inserting Wrench Into Crank Pulley Bolt
 Courtesy of SUBARU OF AMERICA, INC.

2. Install the service hole plug.
11. Install the power steering pump.
 1. Install the power steering pump.

Tightening torque:

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

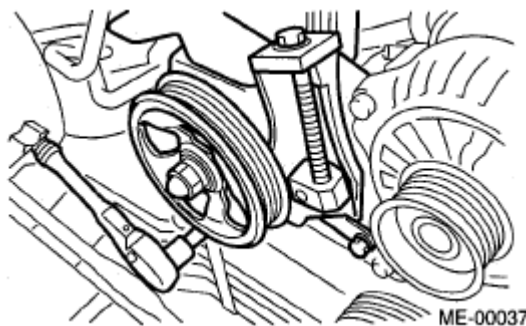


Fig. 51: Identifying Power Steering Pump Bracket Bolts
 Courtesy of SUBARU OF AMERICA, INC.

2. Connect the power steering pump switch connector.

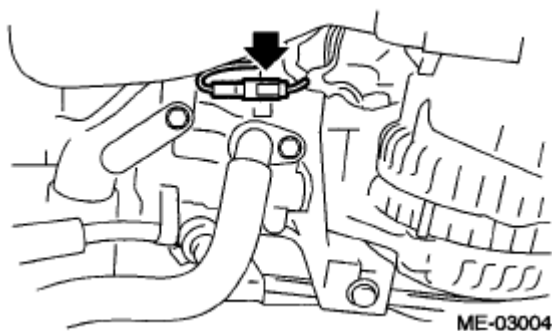


Fig. 52: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

- AT MODEL

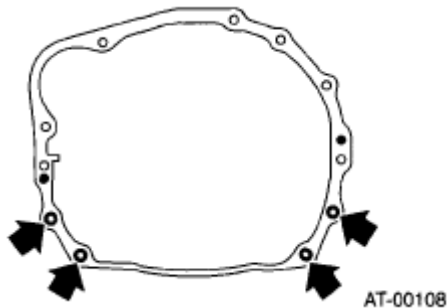


Fig. 53: Locating Lower Side Of Transmission To Engine Bolts And Nuts - AT Model
Courtesy of SUBARU OF AMERICA, INC.

- MT MODEL

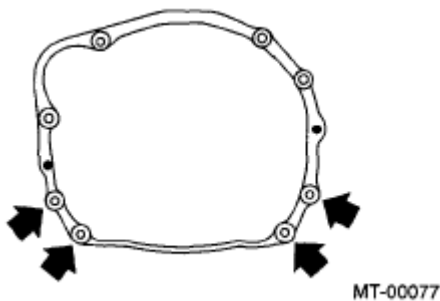


Fig. 54: Locating Lower Side Of Transmission To Engine Bolts And Nuts - MT Model
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

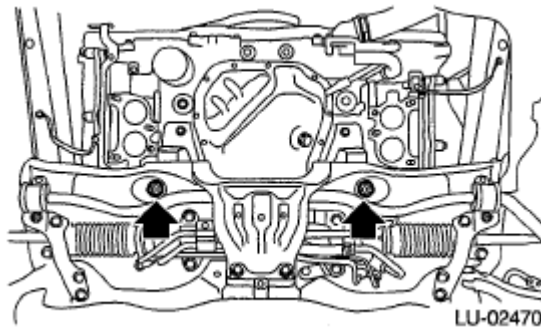


Fig. 55: Locating Engine Mounting To Front Crossmember Nuts
Courtesy of SUBARU OF AMERICA, INC.

15. Connect the ground cable.

Tightening torque:

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

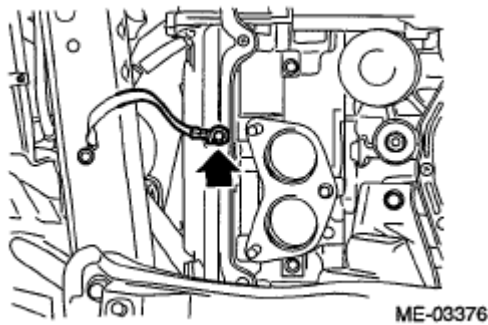


Fig. 56: Locating Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

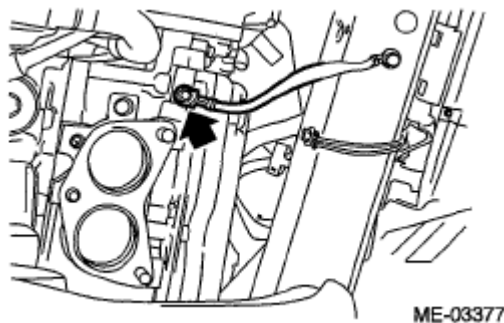


Fig. 57: Locating Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

16. Install the front and center exhaust pipe. Refer to **INSTALLATION** , Front Exhaust Pipe.
17. Lower the vehicle.

18. Connect the following hoses.
 1. Fuel delivery hose and evaporation hose
 2. Heater inlet and outlet hoses
 3. Brake booster vacuum hose
19. Connect the following connectors and terminals.
 1. Front oxygen (A/F) sensor connector
 2. Rear oxygen sensor connector
 3. Engine harness connectors

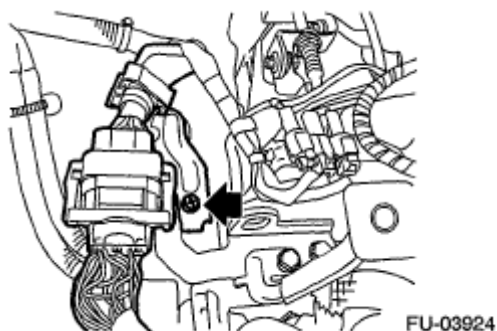
Tightening torque:**6.4 N.m (0.7 kgf-m, 4.7 ft-lb)**

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

4. Generator connector and terminal

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

5. A/C compressor connector
20. Install the air intake chamber stay.

Tightening torque:**16 N.m (1.6 kgf-m, 11.8 ft-lb)**

21. Install the A/C pressure hoses. Refer to **INSTALLATION** , Hose and Pipe.
22. Install the radiator to vehicle. Refer to **INSTALLATION** , Radiator.
23. Install the air intake duct, air cleaner case and air intake chamber. Refer to **INSTALLATION** , Air Intake Duct. Refer to **INSTALLATION** , Air Cleaner Case. Refer to **INSTALLATION** , Air Intake Chamber.
24. Install the under cover.

25. Install the battery. Refer to **INSTALLATION** , Battery.
26. Fill engine coolant. Refer to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant.
27. Check the ATF level and replenish it if necessary. (AT model) Refer to **INSPECTION** , Automatic Transmission Fluid.
28. Charge the A/C system with refrigerant. Refer to **PROCEDURE** , Refrigerant Charging Procedure.
29. Install the V-belt cover.

Tightening torque:

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

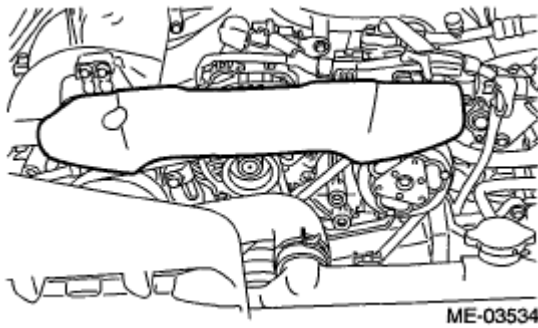


Fig. 59: Identifying V-Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

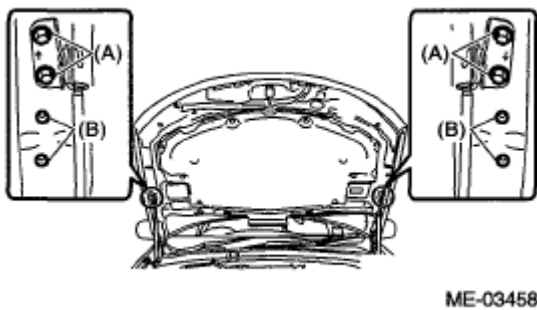


Fig. 60: Identifying Bolts Installation Position
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Check that pipes, hoses, connectors and clamps are installed firmly.

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

ENGINE MOUNTING

REMOVAL

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

INSTALLATION

Install in the reverse order of removal.

Tightening torque:

Engine mounting

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

INSPECTION

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

PREPARATION FOR OVERHAUL

PROCEDURE

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

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 499817100 ENGINE STAND

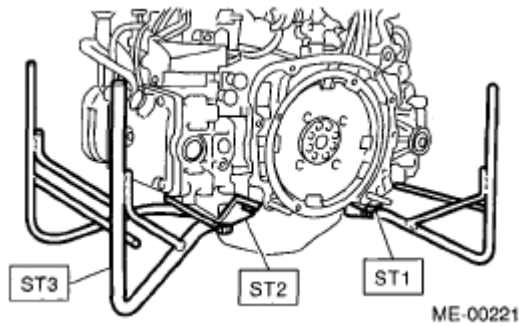


Fig. 61: Securing Engine To ST (Engine Stand)
Courtesy of SUBARU OF AMERICA, INC.

2. In this information the procedures described under each index are all connected and stated in order. The procedure for overhauling of the engine will be completed when you go through all steps in the process.

Therefore, in this information, to conduct the particular procedure within the flow of an area, you need to go back and conduct the procedure described previously in order to do that particular procedure.

V-BELT

REMOVAL

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

FRONT SIDE BELT

1. Remove the V-belt covers.

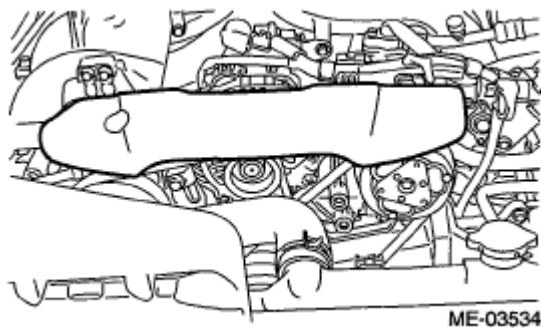


Fig. 62: Identifying V-Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

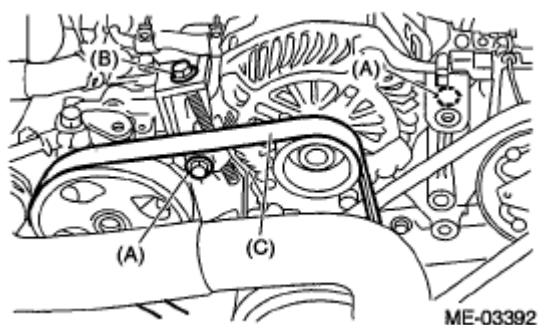


Fig. 63: Locating Slider Bolt And Front Side Belt
 Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

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

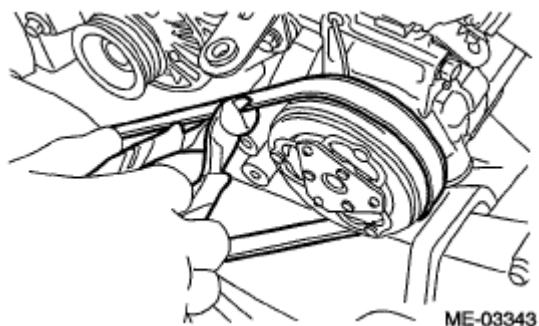


Fig. 64: Cutting Rear Side Belt With Wire Cutter
 Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

FRONT SIDE BELT

CAUTION:

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

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

Tightening torque:

Bolt (A)

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

Slider bolt (B)

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

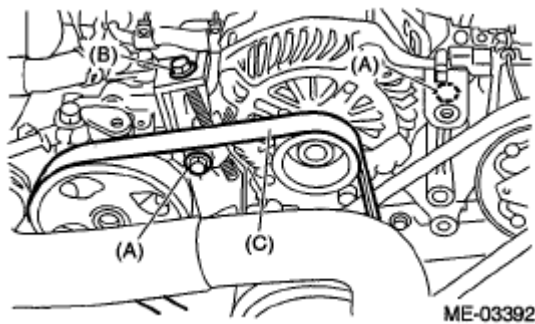


Fig. 65: Locating Slider Bolt And Front Side Belt
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

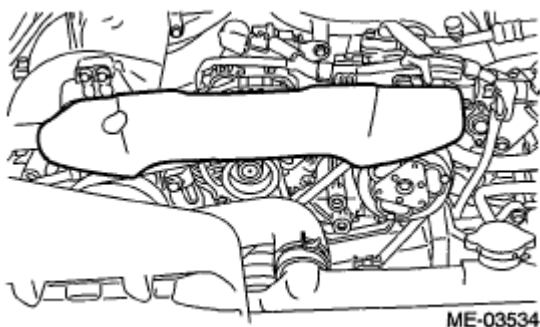


Fig. 66: Identifying V-Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

CAUTION: • Do not re-use the rear side belt.

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

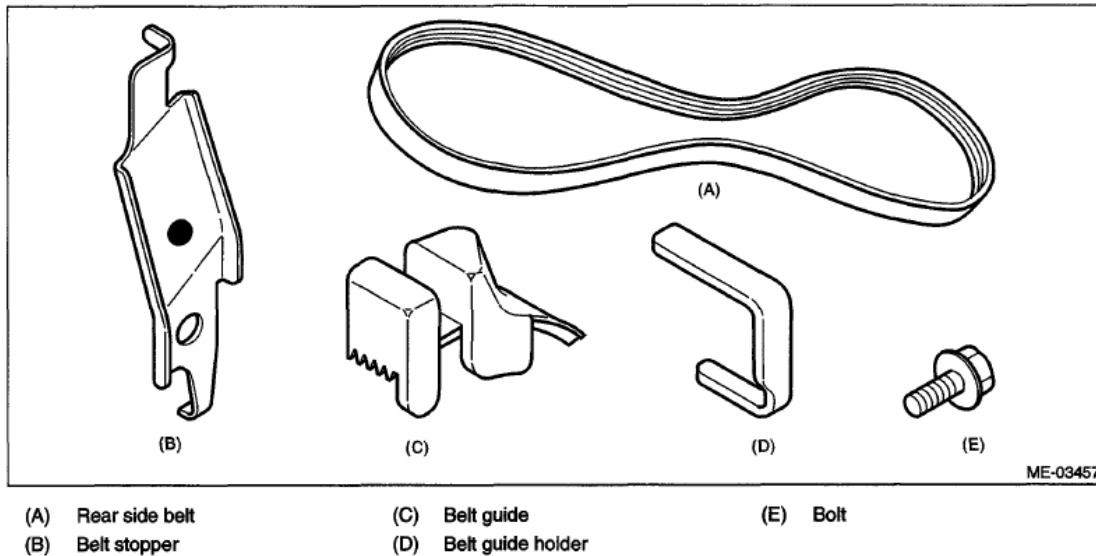


Fig. 67: Identifying Rear Side Belt Components
Courtesy of SUBARU OF AMERICA, INC.

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

CAUTION: Do not turn the crank pulley counterclockwise.

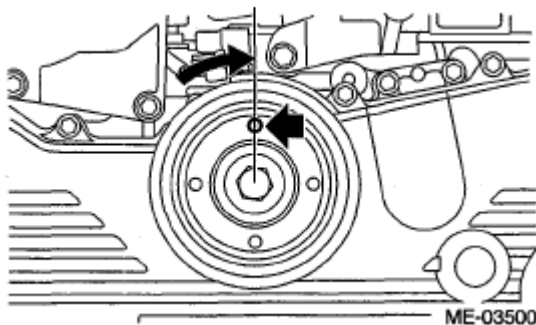


Fig. 68: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

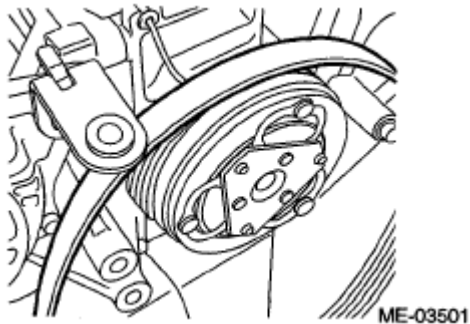


Fig. 69: Hooking Rear Side Belt On A/C Compressor Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

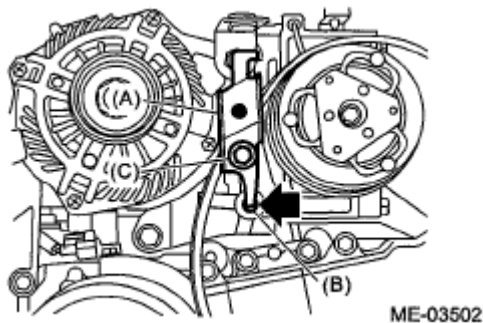


Fig. 70: Inserting Claw Of Belt Stopper To Lower Hole Of Compressor Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

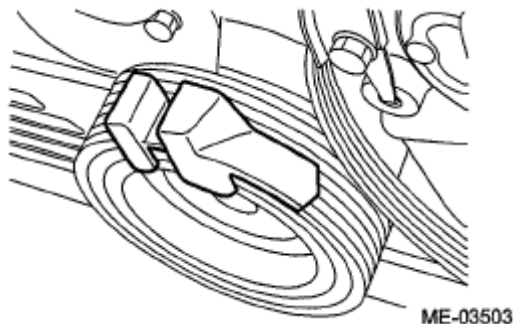


Fig. 71: Identifying Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

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

between.

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

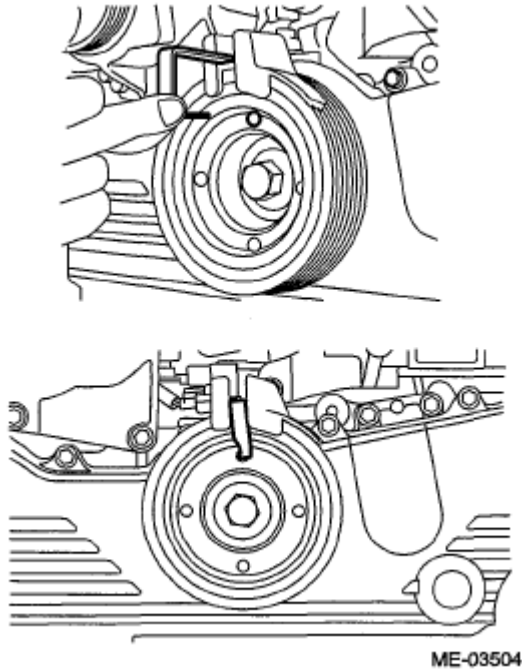


Fig. 72: Inserting Belt Guide Holder Into Service Hole Of Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

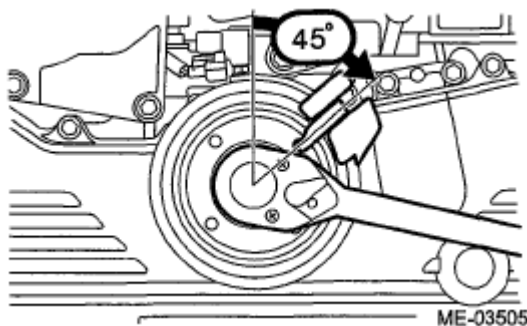


Fig. 73: Identifying Belt Guide Position
Courtesy of SUBARU OF AMERICA, INC.

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

CAUTION: When it is difficult to place the rear side belt to the crank pulley groove, pull out the belt guide holder half way, then place the rear

side belt into the groove so that it comes in between the belt guide holder.

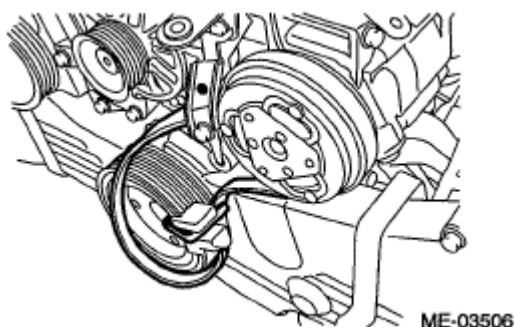


Fig. 74: Identifying Rib Surface Of Rear Side Belt Into Crank Pulley Groove
Courtesy of SUBARU OF AMERICA, INC.

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

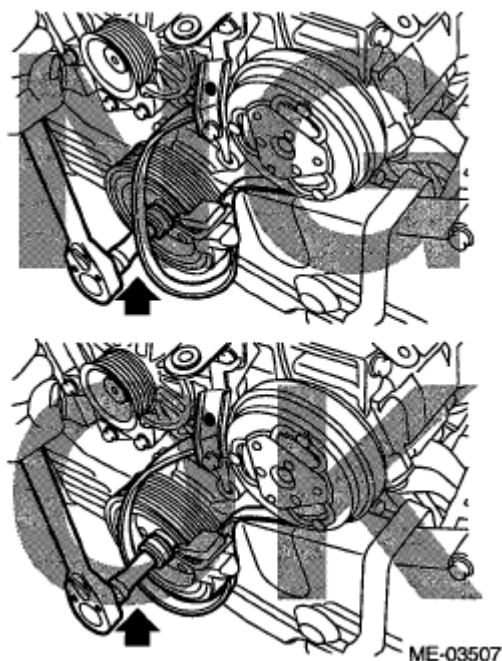
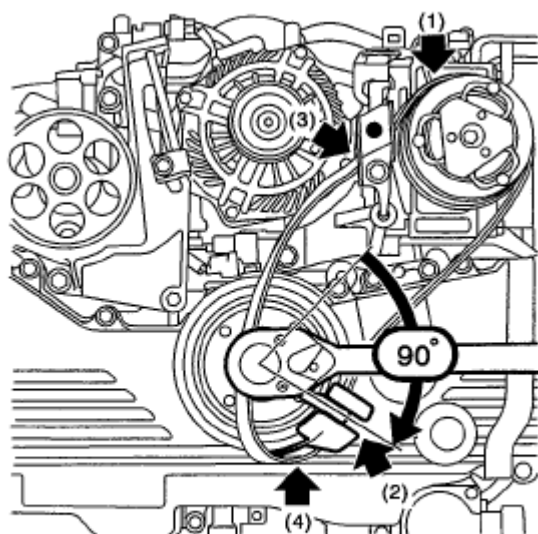


Fig. 75: Precaution For Special Tool Correct Position
Courtesy of SUBARU OF AMERICA, INC.

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

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



ME-03508

Fig. 76: Identifying Belt Guide Position
Courtesy of SUBARU OF AMERICA, INC.

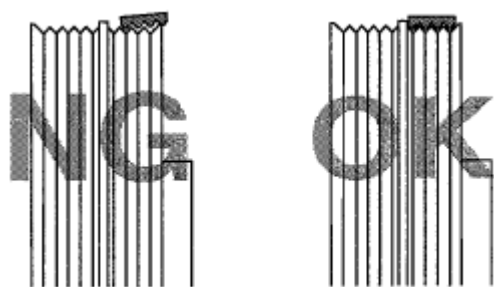
1. The rib of the rear side belt is securely placed on the groove of the A/C compressor pulley.



ME-03516

Fig. 77: Precaution For A/C Compressor Pulley Belt Position
Courtesy of SUBARU OF AMERICA, INC.

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



ME-03518

Fig. 78: Precaution For Crank Pulley Belt Position

Courtesy of SUBARU OF AMERICA, INC.

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

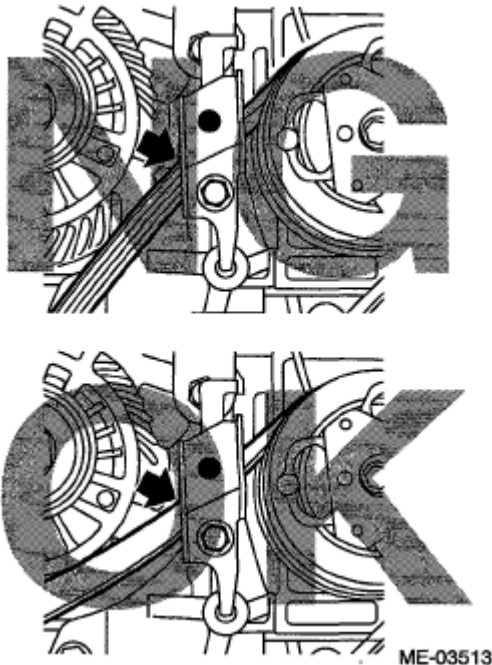


Fig. 79: Precaution For Surface Of Rear Side Belt Position
Courtesy of SUBARU OF AMERICA, INC.

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

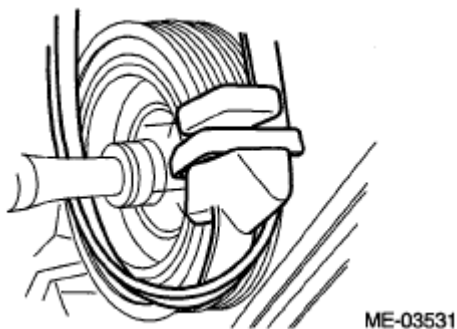
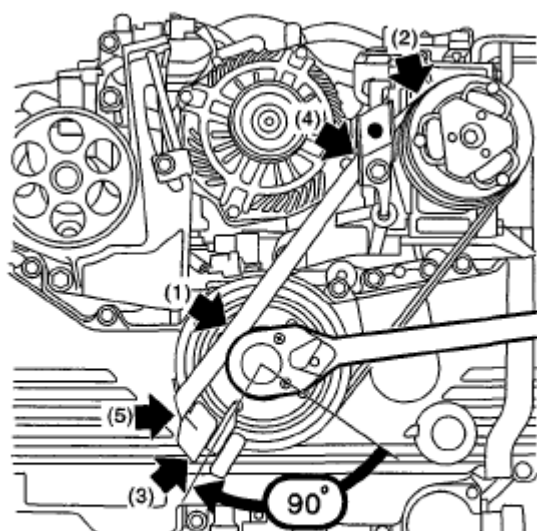


Fig. 80: Identifying Rear Side Belt Position On Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

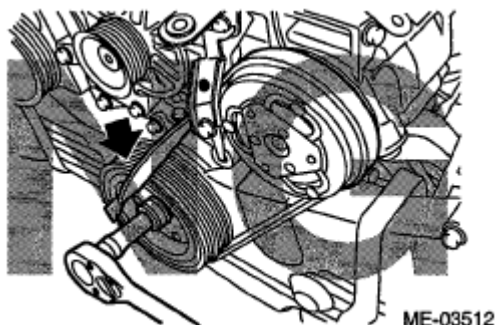
12. While checking the following, slowly turn the crank pulley approximately 90° clockwise so that the belt guide comes to the position shown in the figure.



ME-03509

Fig. 81: Identifying Belt Guide Position
Courtesy of SUBARU OF AMERICA, INC.

1. The rear side belt is not twisted.



ME-03512

Fig. 82: Precaution For Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

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



ME-03516

Fig. 83: Precaution For A/C Compressor Pulley Belt Position
Courtesy of SUBARU OF AMERICA, INC.

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

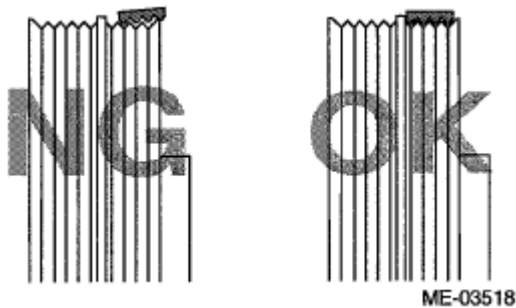


Fig. 84: Precaution For Crank Pulley Belt Position
Courtesy of SUBARU OF AMERICA, INC.

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

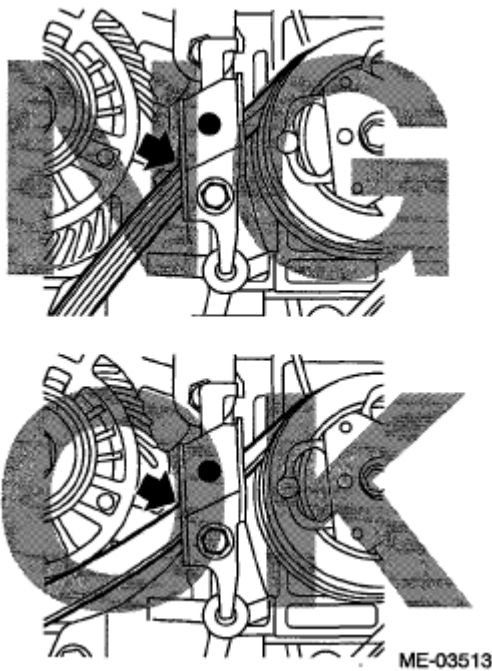


Fig. 85: Precaution For Surface Of Rear Side Belt Position
Courtesy of SUBARU OF AMERICA, INC.

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

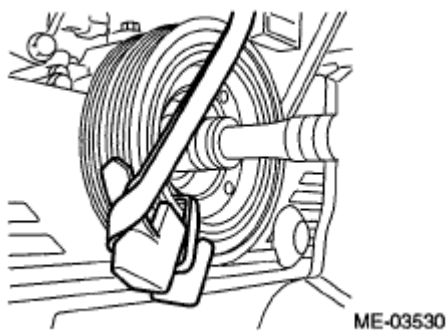


Fig. 86: Identifying Rear Side Belt Position On Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

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

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

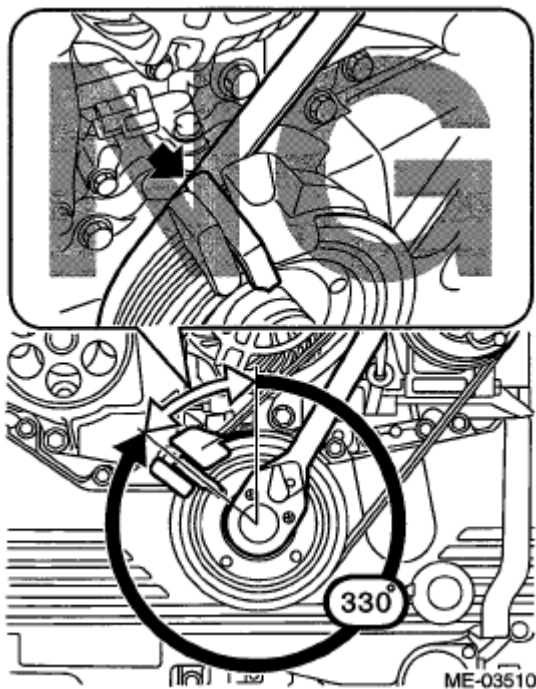


Fig. 87: Identifying Crank Pulley Position
Courtesy of SUBARU OF AMERICA, INC.

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

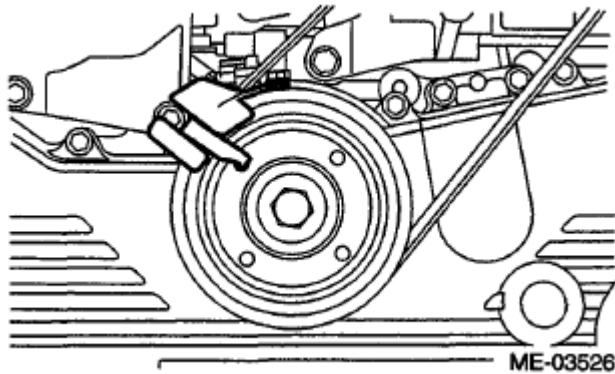


Fig. 88: Identifying Belt Guide And Belt Guide Holder
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the belt stopper from the compressor bracket.

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

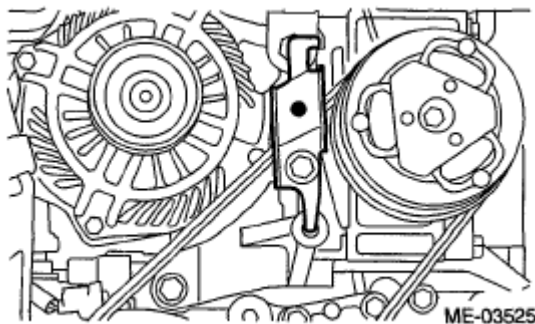


Fig. 89: Identifying Belt Stopper
Courtesy of SUBARU OF AMERICA, INC.

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

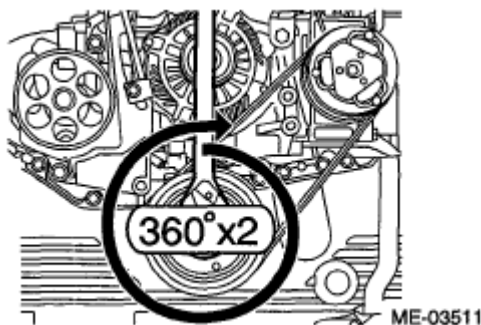


Fig. 90: Identifying Crank Pulley Position

Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

FRONT SIDE BELT

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

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

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

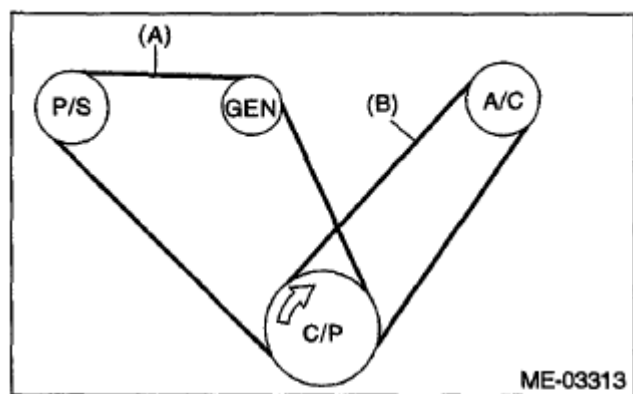
Front side belt tension (with belt tension gauge):

When installing new parts

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

At inspection

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



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

Fig. 91: Checking Front Side Belt Tension (With Belt Tension Gauge)
 Courtesy of SUBARU OF AMERICA, INC.

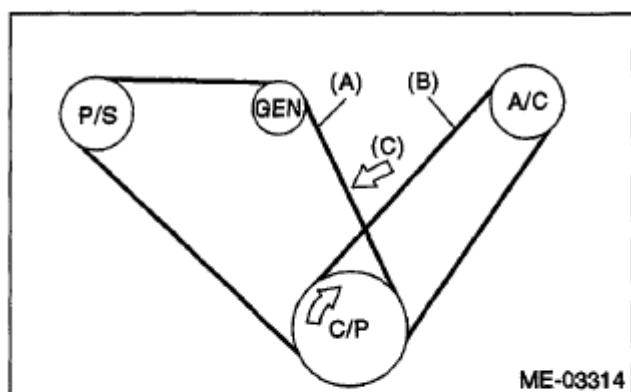
Front side belt tension (without belt tension gauge):

When installing new parts

7 - 9 mm (0.276 - 0.354 in)

At inspection

9 - 11 mm (0.354 - 0.433 in)



(A) Front side belt

(B) Rear side belt

(C) 98 N (10 kgf, 22 lbf)

C/P Crank pulley

GEN Generator pulley

P/S Power steering oil pump pulley

A/C A/C compressor pulley

Fig. 92: Checking Front Side Belt Tension (Without Belt Tension Gauge)

Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

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

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

CRANK PULLEY

REMOVAL

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

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

ST 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

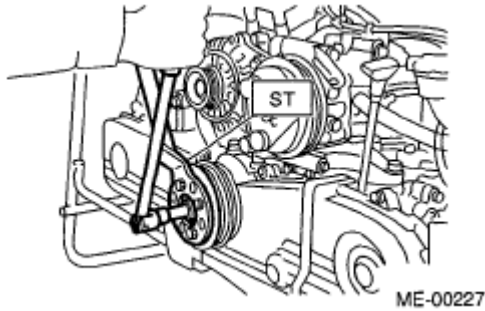


Fig. 93: Removing/Installing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION

AT MODEL

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

ST 499977400 CRANK PULLEY WRENCH

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

Tightening torque:

130 N.m (13.3 kgf-m, 95.9 ft-lb)

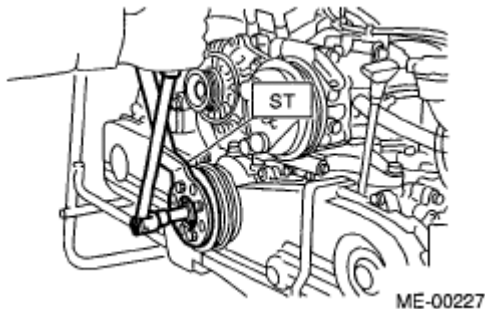


Fig. 94: Removing/Installing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

when less than 45°.

CAUTION: If the tightening angle of crank pulley bolt is less than 45°, the bolt is damaged. In this case, the bolt must be replaced.

1. Replace the crank pulley bolts and clean them.

Crank pulley bolt:

Part No. 12369AA011

2. Clean the crankshaft thread using compressed air.
3. Apply engine oil to the crank pulley bolt seat and thread.
4. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 32.5 ft-lb).
5. Tighten the crank pulley bolts by 45° to 60°.

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

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

MT MODEL

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

ST 499977100 CRANK PULLEY WRENCH

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

Tightening torque:

180 N.m (18.4 kgf-m, 132.8 ft-lb)

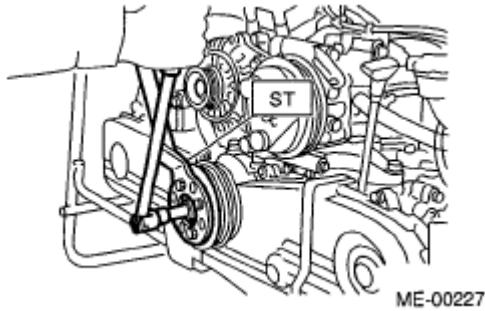


Fig. 95: Removing/Installing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

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

1. Replace the crank pulley bolts and clean them.

Crank pulley bolt:

Part No. 12369AA011

2. Clean the crankshaft thread using compressed air.
3. Apply engine oil to the crank pulley bolt seat and thread.
4. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 32.5 ft-lb).
5. Tighten the crank pulley bolts by 65° to 75°.

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

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

INSPECTION

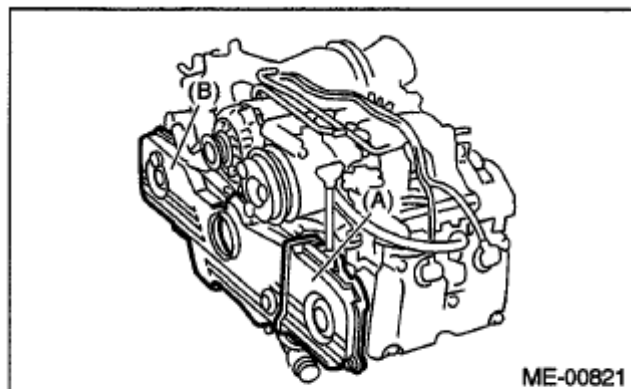
1. Make sure the V-belt is not worn or otherwise damaged.
2. Check the tension of the front side belt. Refer to **INSPECTION**, V-belt.

TIMING BELT COVER

REMOVAL

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

1. Remove the V-belts. Refer to **REMOVAL**, V-belt.
2. Remove the crank pulley. Refer to **REMOVAL**, Crank Pulley.
3. Remove the timing belt cover LH.
4. Remove the front timing belt cover.



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

Fig. 96: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the front timing belt cover.

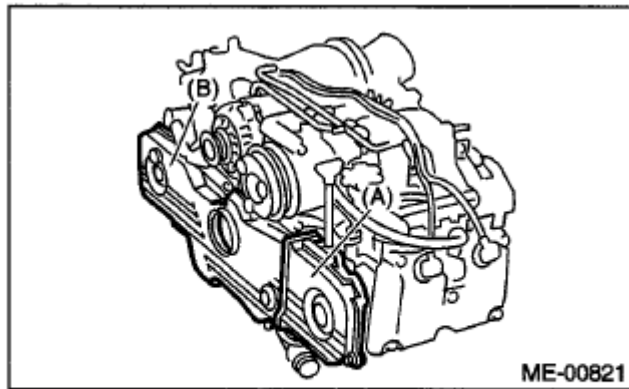
Tightening torque:

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

2. Install the timing belt cover LH.

Tightening torque:

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



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

Fig. 97: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

Check the timing belt cover for damage.

TIMING BELT

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. For operation procedures, refer to "**TIMING BELT**". Refer to **TIMING BELT**.

TIMING BELT

1. Remove the V-belts. Refer to **REMOVAL**, V-belt.
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 guide. (MT model)

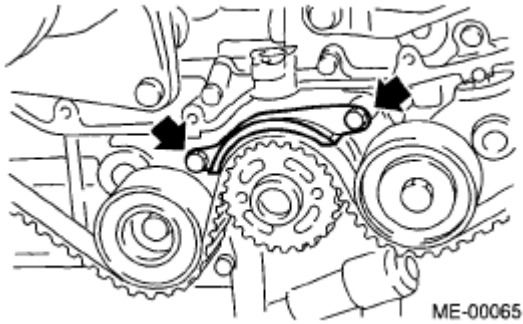


Fig. 98: Locating Timing Belt Guide Bolt (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

5. If the alignment mark or arrow mark (which indicates the direction of rotation) on timing belt fade away, put new marks before removing the timing belt as shown in procedures below.
 1. Use the ST to turn crankshaft. Align the mark (a) of sprocket to the mark (b) of oil pump, and then ensure the right side cam sprocket mark (c), cam cap and cylinder head matching surface (d) or left side cam sprocket mark (e), timing belt cover notch (f) are properly adjusted.

ST 499987500 CRANKSHAFT SOCKET

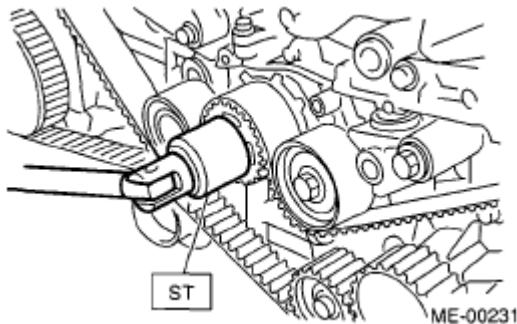


Fig. 99: Turning Crankshaft Using Crankshaft Socket 499987500
Courtesy of SUBARU OF AMERICA, INC.

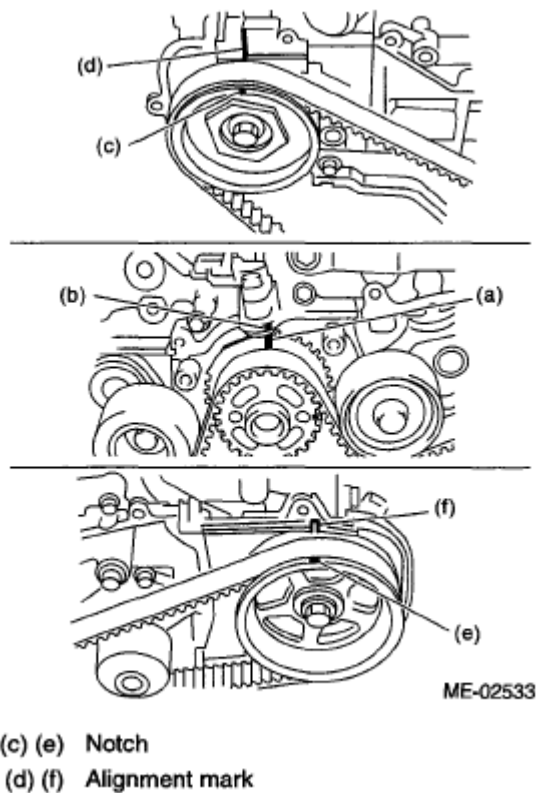


Fig. 100: Aligning Mark Of Sprocket To Mark Of Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

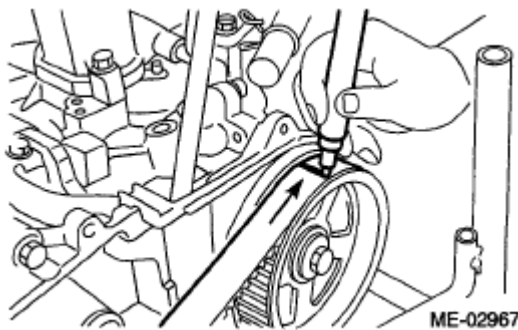


Fig. 101: Putting Alignment Mark On Timing Belts In Relation To Crank Sprocket And Cam Sprockets
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 46.8 teeth

Z_2 : 43.7 teeth

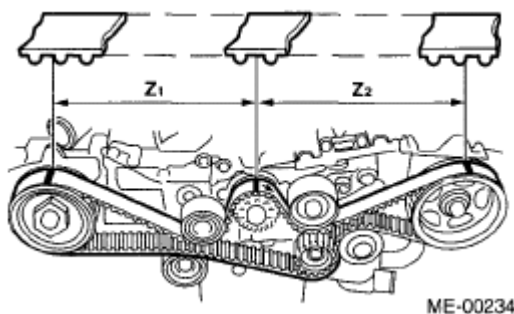


Fig. 102: Identifying Timing Belt Teeth
Courtesy of SUBARU OF AMERICA, INC.

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

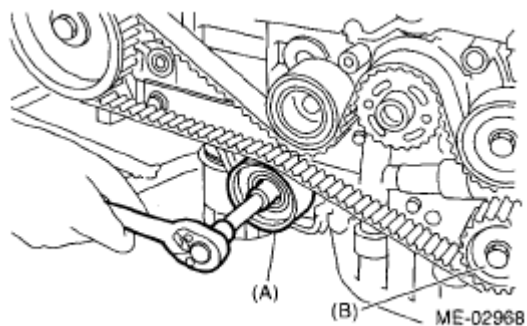


Fig. 103: Removing/Installing Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt.

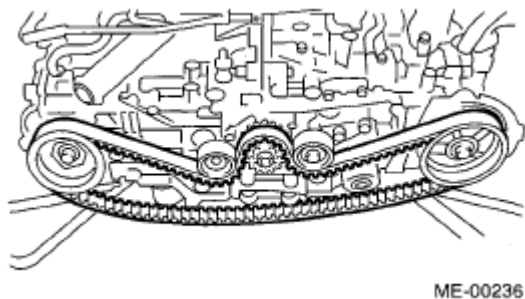


Fig. 104: Identifying Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY

1. Remove the belt idler.

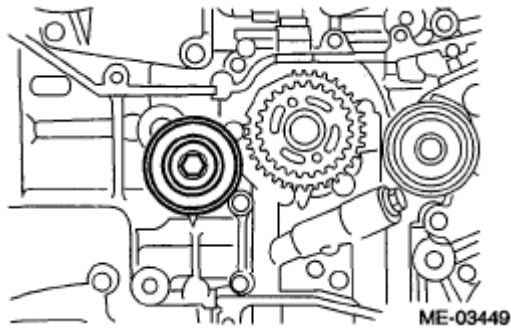


Fig. 105: Identifying Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the automatic belt tension adjuster assembly.

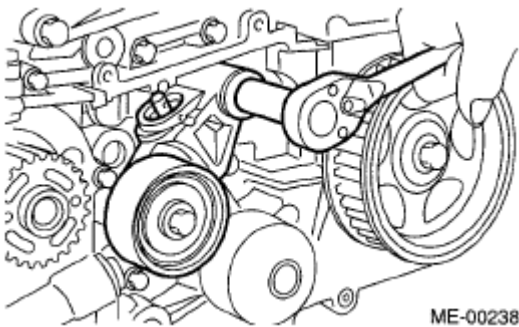


Fig. 106: Locating Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

1. Prepare for installation of the automatic belt tension adjuster assembly.

CAUTION:

- Always use a vertical type pressing tool to move the adjuster rod down.
- Do not use a lateral type vise.
- Push the adjuster rod vertically.
- Press-in the push adjuster rod gradually taking three minutes or more.
- Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).
- Push in the adjuster rod to the end face of the cylinder. However, do not push in the adjuster rod below the end face of the cylinder. Doing so may damage the cylinder.

- **Do not release the press pressure until stopper pin is completely inserted.**

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

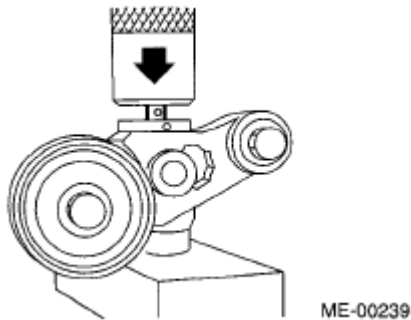


Fig. 107: Pushing In Adjuster Rod Until Adjuster Rod Is Aligned With Stopper Pin Hole In Cylinder

Courtesy of SUBARU OF AMERICA, INC.

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

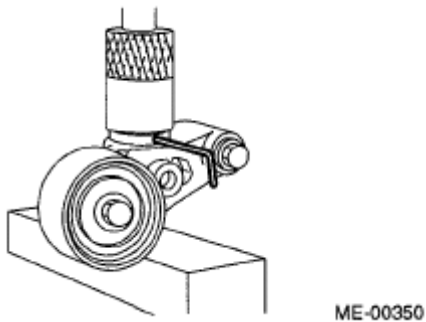


Fig. 108: Securing Adjuster Rod

Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

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

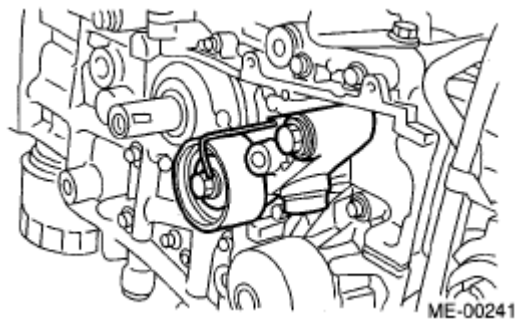


Fig. 109: Identifying Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idlers.

Tightening torque:

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

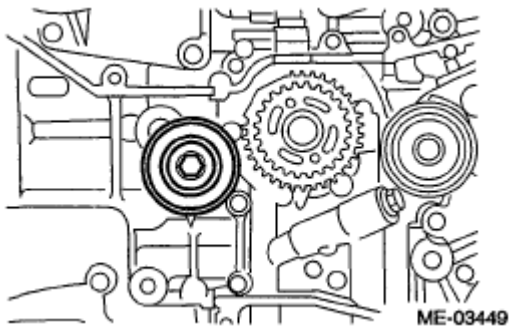


Fig. 110: Identifying Belt Idlers
Courtesy of SUBARU OF AMERICA, INC.

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

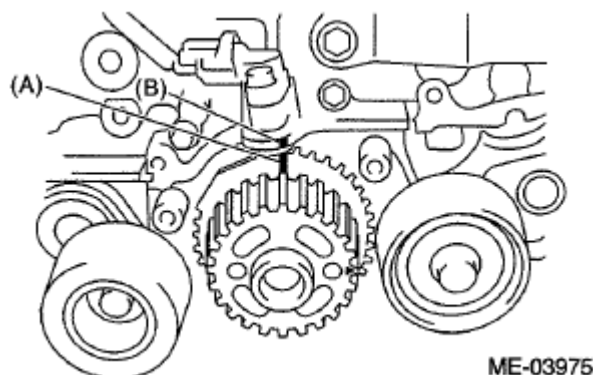


Fig. 111: Aligning Mark On Crank Sprocket With Mark On Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

ST 1 18231AA010 CAM SPROCKET WRENCH

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

ST2 499207400 CAM SPROCKET WRENCH

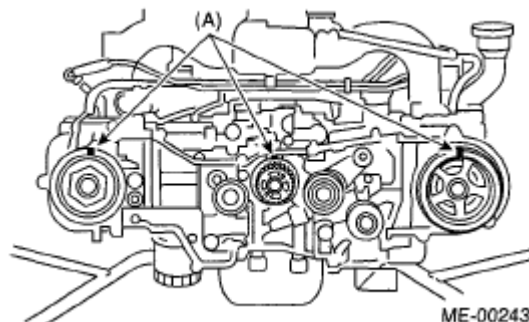


Fig. 112: Identifying Alignment Marks Of Cam Sprockets No. 1 And No. 2
Courtesy of SUBARU OF AMERICA, INC.

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

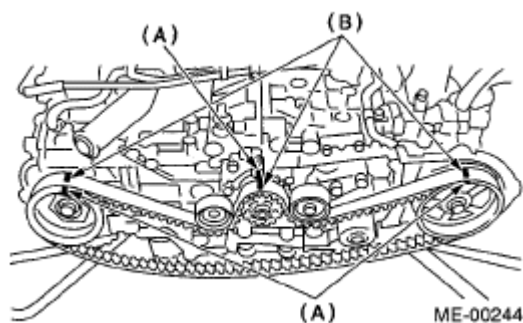


Fig. 113: Aligning Alignment Mark On Timing Belt With Mark On Sprockets
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

6. Install the belt idler (A).

Tightening torque:

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

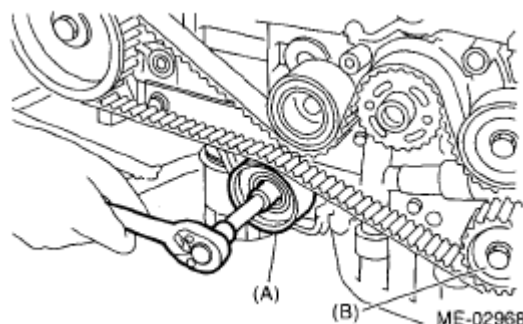


Fig. 114: Removing/Installing Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

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

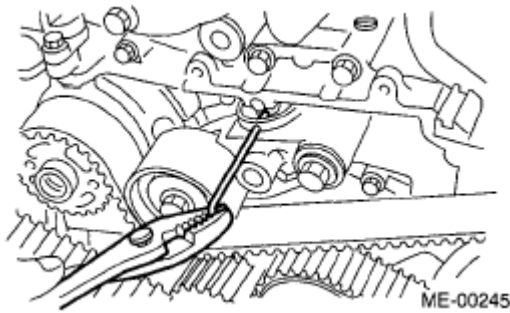


Fig. 115: View Of Removing Stopper Pin From Belt Tension Adjuster
Courtesy of SUBARU OF AMERICA, INC.

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

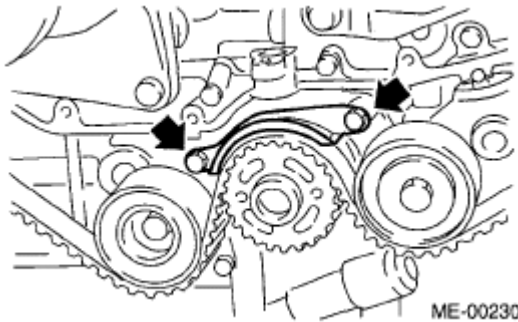


Fig. 116: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

Clearance:

1.0±0.5 mm (0.039±0.020 in)

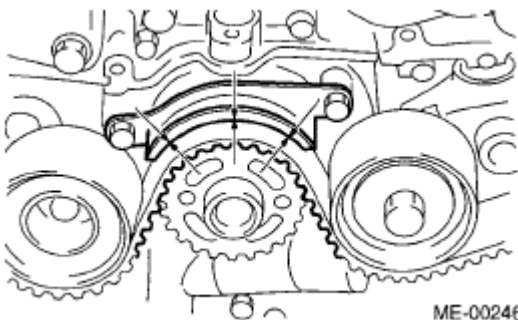


Fig. 117: Checking Clearance Between Timing Belt And Timing Belt Guide By Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

Tightening torque:

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

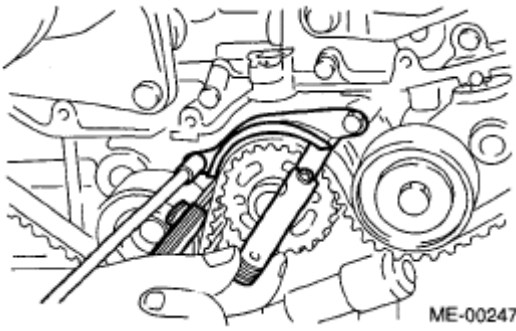


Fig. 118: Tightening Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION**TIMING BELT**

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

CAUTION:

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

In radial diameter h:

60 mm (2.36 in) or more

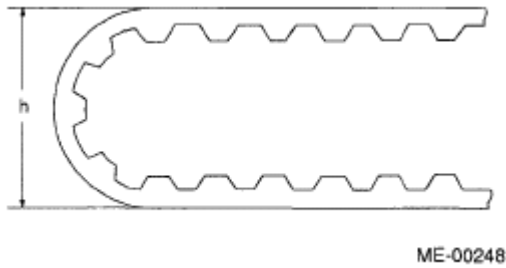


Fig. 119: Identifying Belt Radial Diameter H
Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

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

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

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

CAUTION:

- Always use a vertical type pressing tool to move the adjuster rod down.
- Do not use a lateral type vise.
- Push the adjuster rod vertically.
- Press the adjuster rod gradually taking three minutes or more.
- Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).
- Push in the adjuster rod to the end face of the cylinder. However, do not press the adjuster rod below the end face of the cylinder. Doing so may damage the cylinder.

4. Measure the amount of rod protrusion "H" from the end surface of the body. If it is not within specifications, replace the automatic belt tension adjuster assembly with a new part.

Amount of rod protrusion H:

5.2 - 6.2 mm (0.204 - 0.244 in)

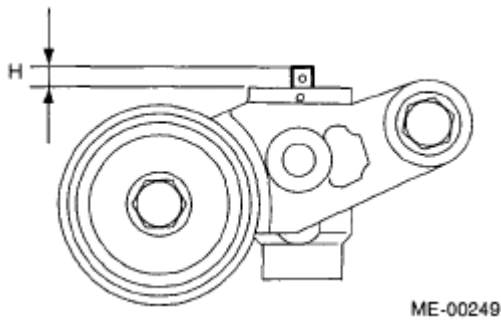


Fig. 120: Identifying Amount Of Rod Protrusion "H" From End Surface Of Body
 Courtesy of SUBARU OF AMERICA, INC.

BELT TENSION PULLEY

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

BELT IDLER

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

CAM SPROCKET

REMOVAL

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

1. Remove the V-belts. Refer to **REMOVAL**, V-belt.
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 camshaft position sensor. Refer to **REMOVAL**, Camshaft Position Sensor.
6. Fasten the cam sprocket and remove from the camshaft using ST.

ST 18231AA010 CAM SPROCKET WRENCH

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

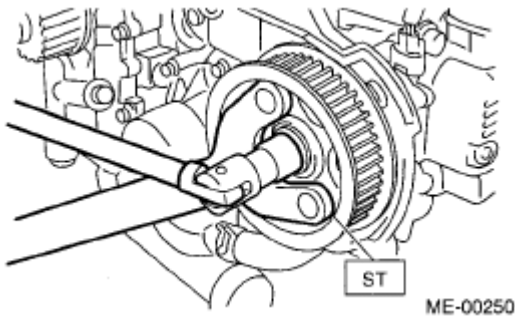


Fig. 121: Identifying Cam Sprocket No. 2 Using Cam Sprocket Wrench ST (18231AA010)
Courtesy of SUBARU OF AMERICA, INC.

ST 499207400 CAM SPROCKET WRENCH

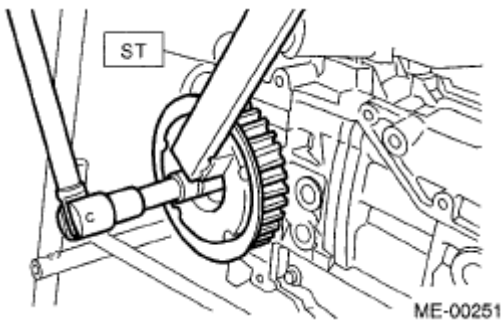


Fig. 122: Identifying Cam Sprocket No. 1 Using Cam Sprocket Wrench ST (499207400)
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

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

ST 18231AA010 CAM SPROCKET WRENCH

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

Tightening torque:

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

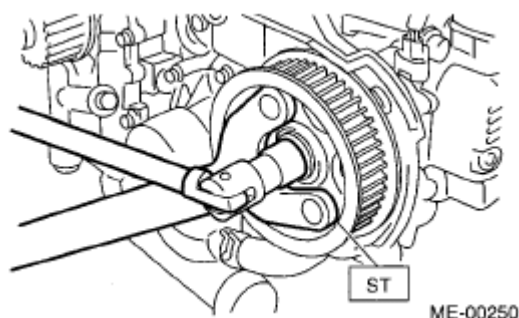


Fig. 123: Identifying Cam Sprocket No. 2 Using Cam Sprocket Wrench ST (18231AA010)
Courtesy of SUBARU OF AMERICA, INC.

ST 499207400 CAM SPROCKET WRENCH

Tightening torque:

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

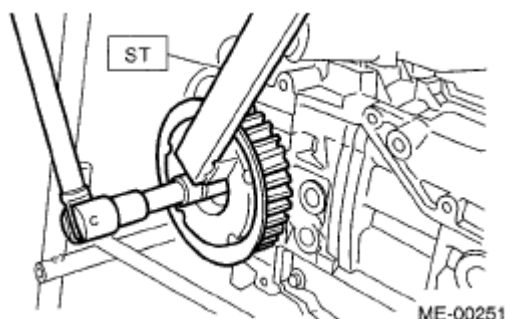


Fig. 124: Identifying Cam Sprocket No. 1 Using Cam Sprocket Wrench ST (499207400)
Courtesy of SUBARU OF AMERICA, INC.

2. Install the camshaft position sensor. Refer to **INSTALLATION**, Camshaft Position Sensor.
3. Install the timing belt. Refer to **INSTALLATION**, Timing Belt.
4. Install the timing belt cover. Refer to **INSTALLATION**, Timing Belt Cover.
5. Install the crank pulley. Refer to **INSTALLATION**, Crank Pulley.
6. Install the V-belts. Refer to **INSTALLATION**, V-belt.

INSPECTION

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

CRANK SPROCKET

REMOVAL

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

1. Remove the V-belts. Refer to **REMOVAL**, V-belt.
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 crank sprocket.

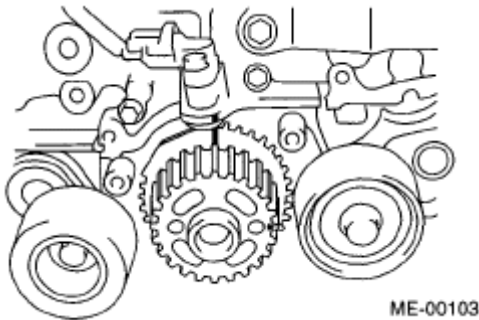


Fig. 125: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

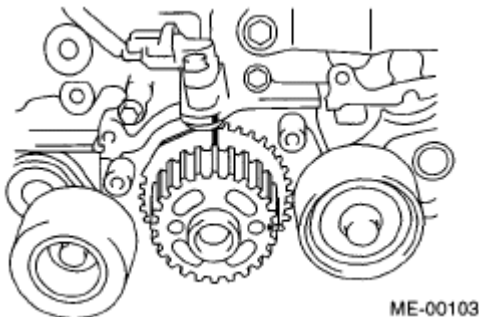


Fig. 126: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

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

VALVE ROCKER ASSEMBLY

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. Refer to "Valve Clearance" for preparation procedures. Refer to VALVE CLEARANCE.

1. Remove the high tension cord.
 2. Disconnect the PCV hose and remove the rocker cover.
 3. Remove the valve rocker assembly.
1. Use the ST to rotate the spring stopper in the direction of the arrow to remove it from adjuster pin.

ST 18258AA000 SPRING INSTALLER

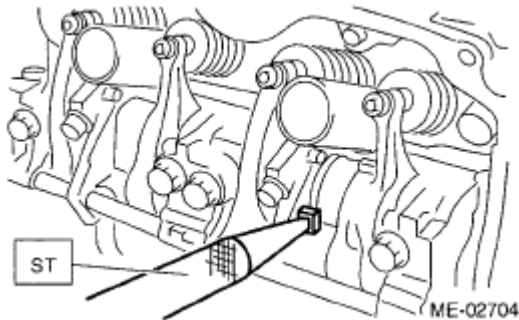
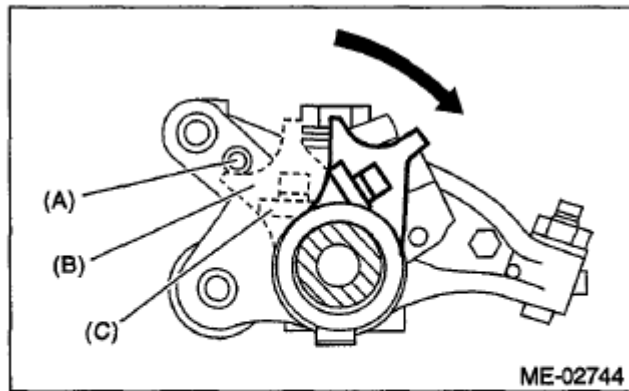


Fig. 127: Rotating Spring Stopper Using Spring Installer 18258AA000
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 128: Identifying Spring Stopper, Spring And Adjuster Pin
Courtesy of SUBARU OF AMERICA, INC.

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

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

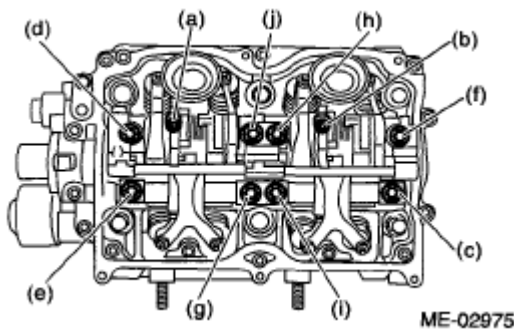


Fig. 129: Identifying Valve Rocker Assembly Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the valve rocker assembly.

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

ST 18354AA000 VALVE ROCKER HOLDER

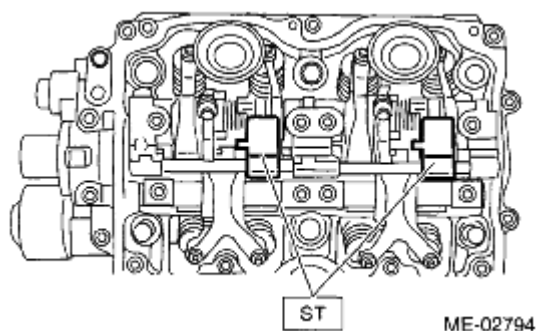


Fig. 130: Identifying Valve Rocker Holder 18354AA000 On Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

NOTE:

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

ST 18354AA000 VALVE ROCKER HOLDER

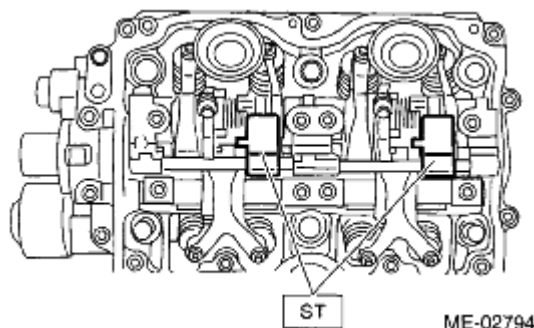


Fig. 131: Identifying Valve Rocker Holder 18354AA000 On Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

Tightening torque:

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

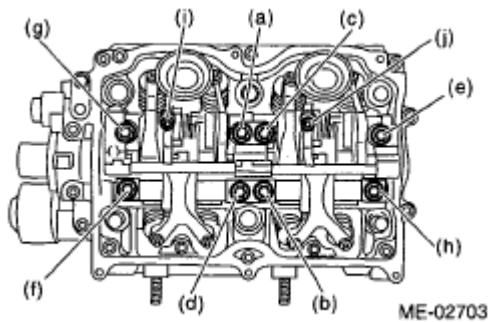


Fig. 132: Identifying Valve Rocker Assembly Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

ST 18258AA000 SPRING INSTALLER

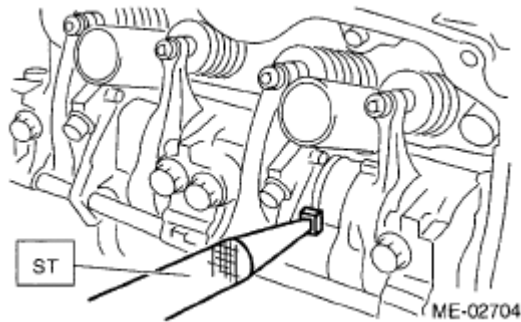
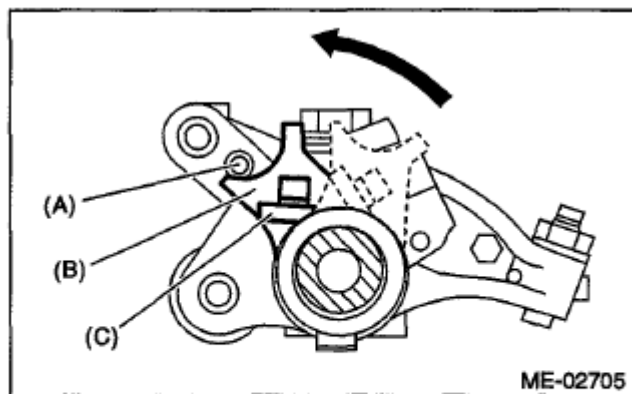


Fig. 133: Rotating Spring Stopper Using Spring Installer 18258AA000
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 134: Identifying Spring Stopper, Spring And Adjuster Pin
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the timing belt cover LH.
3. Adjust the valve clearance. Refer to ADJUSTMENT, Valve Clearance.
4. Install the timing belt cover LH.
5. Install the rocker cover.
 1. Install the rocker cover gasket to the rocker cover.

NOTE: Use a new rocker cover gasket.

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

Tightening torque:

First

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

Second (only (a) and (b) are tightened)

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

RH side

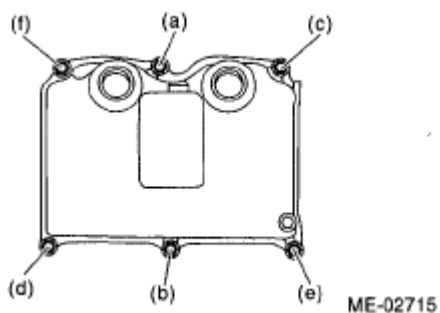


Fig. 135: Identifying Rocker Cover Bolts Tightening Sequence - RH Side
Courtesy of SUBARU OF AMERICA, INC.

LH side

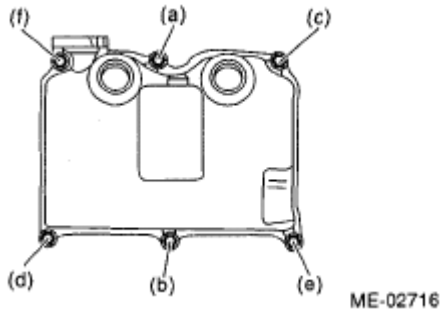


Fig. 136: Identifying Rocker Cover Bolts Tightening Sequence - LH Side
 Courtesy of SUBARU OF AMERICA, INC.

3. Connect the PCV hose.
6. Install the high tension cord.

DISASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

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

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

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

ASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

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

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

INSPECTION

INTAKE VALVE ROCKER ASSEMBLY

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

EXHAUST VALVE ROCKER ASSEMBLY

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

Clearance between arm and shaft:

Standard

0.020 - 0.054 mm (0.0008 - 0.0021 in)

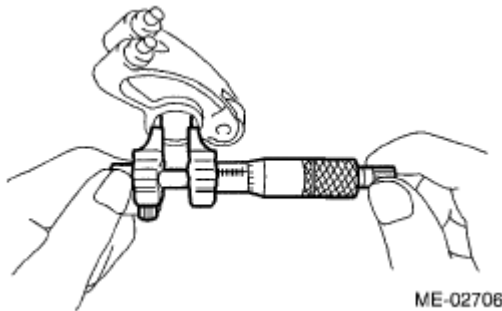


Fig. 137: Measuring Inner Diameter Of Valve Rocker Arm
Courtesy of SUBARU OF AMERICA, INC.

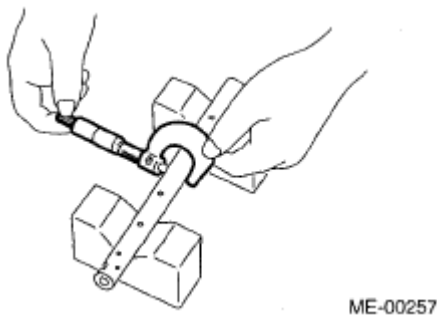


Fig. 138: Measuring Outer Diameter Of Valve Rocker Shaft
Courtesy of SUBARU OF AMERICA, INC.

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

Rocker arm inside diameter:

22.020 - 22.041 mm (0.8669 - 0.8678 in)

Rocker shaft diameter:

21.987 - 22.000 mm (0.8656 - 0.8661 in)

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

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

CAMSHAFT

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. Refer to "Valve Clearance" for preparation procedures. Refer to **VALVE CLEARANCE**.

1. Remove the V-belts. Refer to **REMOVAL**, V-belt.
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. Remove the timing belt cover No. 2 LH.
7. Remove the timing belt cover No. 2 RH.

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

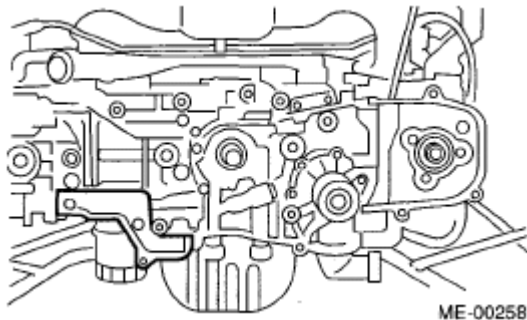


Fig. 139: Identifying Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the tensioner bracket.

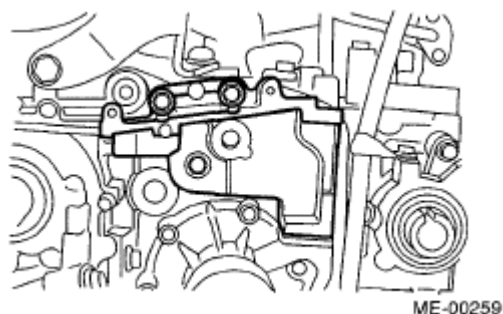


Fig. 140: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

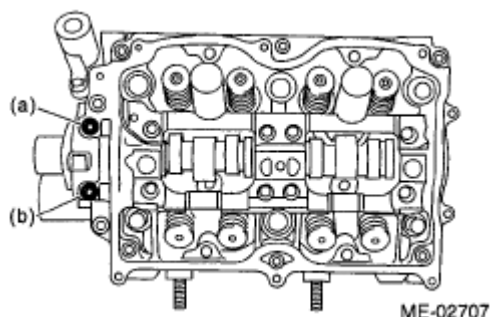


Fig. 141: Identifying Camshaft Cap Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

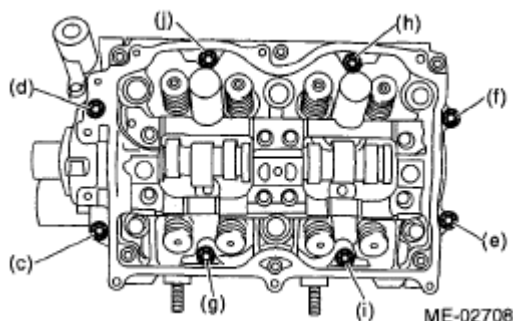


Fig. 142: Identifying Camshaft Cap Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX® PLUS

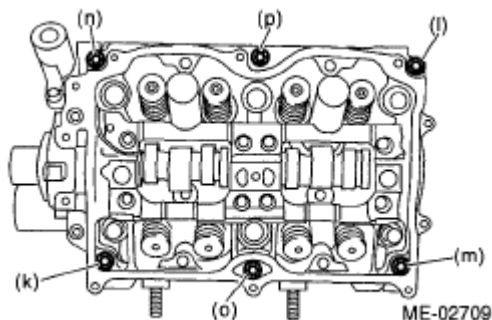


Fig. 143: Identifying Camshaft Cap Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

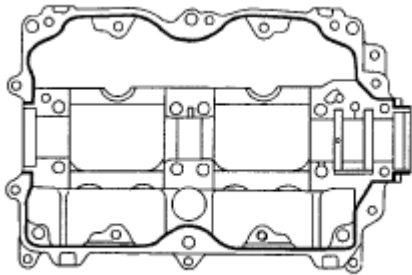
INSTALLATION

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

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

Liquid gasket:

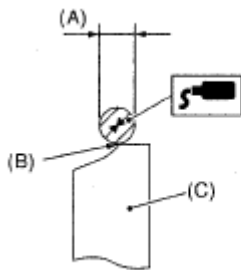
THREE BOND 1217G (Part No. K0877Y0100) or equivalent



ME-02710

Fig. 144: Applying Liquid Gasket To Mating Surfaces Of Camshaft Cap
Courtesy of SUBARU OF AMERICA, INC.

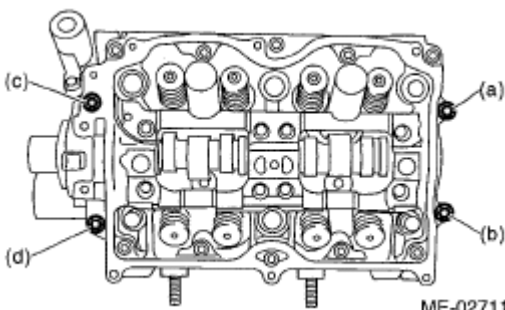
NOTE: Apply a coat of liquid gasket of 3 mm (0.12 in) in diameter (A) along the edge (B) of camshaft cap (C) mating surface.



ME-00265

Fig. 145: Applying Coat Of Liquid Gasket To Camshaft Cap Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

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



ME-02711

Fig. 146: Identifying Camshaft Cap Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX® PLUS

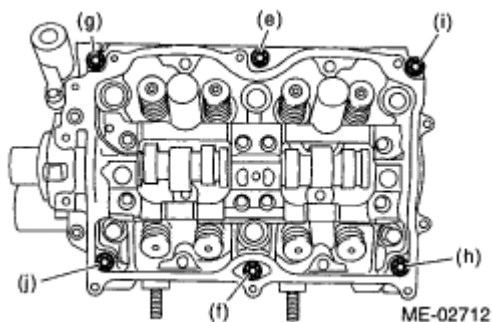
Tightening torque:***18 N.m (1.8 kgf-m, 13.3 ft-lb)***

Fig. 147: Identifying Camshaft Cap Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

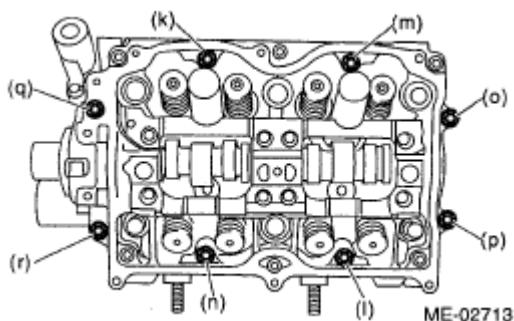
Tightening torque:***9.75 N.m (1.0 kgf-m, 7.2 ft-lb)***

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

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

NOTE:

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

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

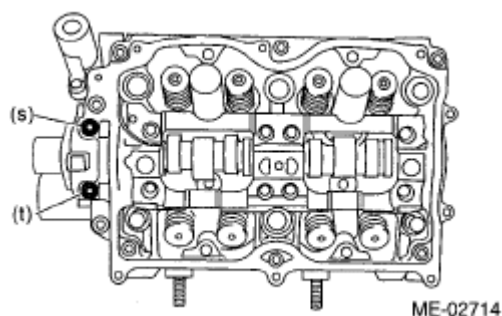


Fig. 149: Identifying Camshaft Cap Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new oil seal.

ST1 499597000 OIL SEAL GUIDE

ST2 499587500 OIL SEAL INSTALLER

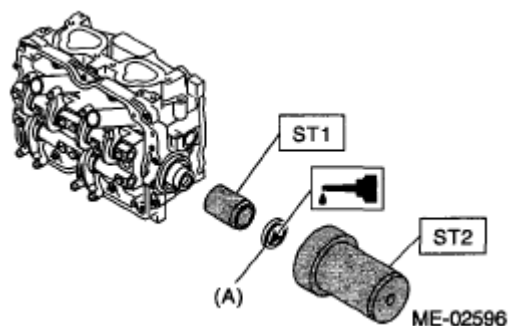


Fig. 150: Applying Coat Of Engine Oil To Camshaft Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499587700 CAMSHAFT OIL SEAL INSTALLER

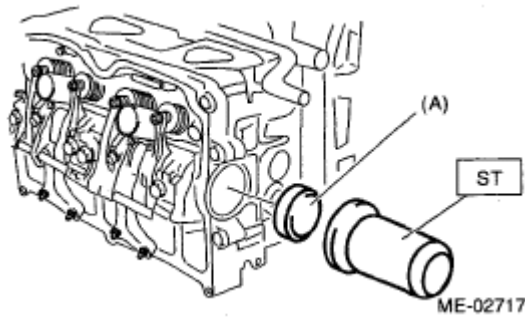


Fig. 151: Installing Plug Using Camshaft Oil Seal Installer 499587700
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

Tightening torque:

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

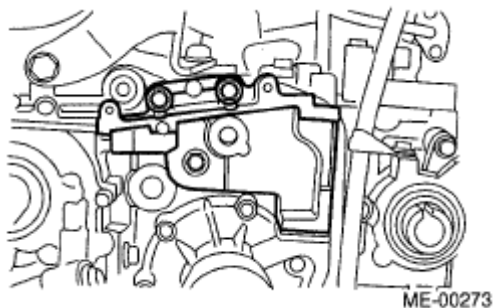


Fig. 152: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

Tightening torque:

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

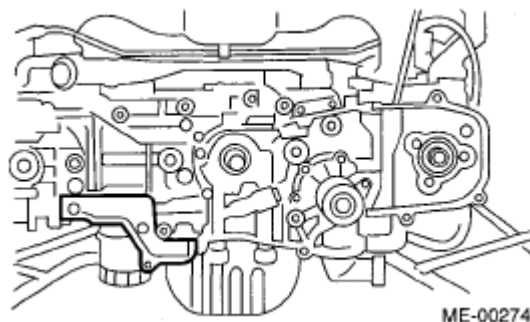


Fig. 153: Identifying Timing Belt Cover No. 2 LH
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rocker cover gasket.

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

Tightening torque:

First

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

Second (only (a) and (b) are tightened)

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

RH side

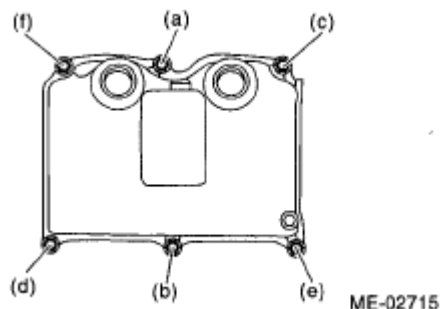


Fig. 154: Identifying Rocker Cover Bolts Tightening Sequence - RH Side
Courtesy of SUBARU OF AMERICA, INC.

LH side

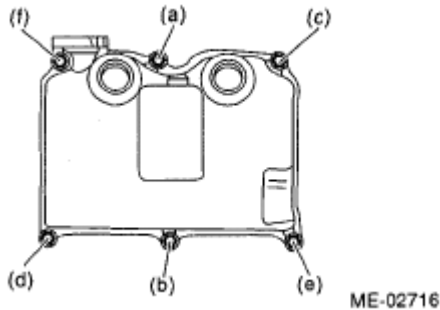


Fig. 155: Identifying Rocker Cover Bolts Tightening Sequence - LH Side
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the PCV hose.
14. Install the high tension cord.
15. Install the timing belt cover. Refer to **INSTALLATION**, Timing Belt Cover.
16. Install the crank pulley. Refer to **INSTALLATION**, Crank Pulley.
17. Install the V-belts. Refer to **INSTALLATION**, V-belt.

INSPECTION

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

Camshaft bend limit:

0.025 mm (0.00098 in)

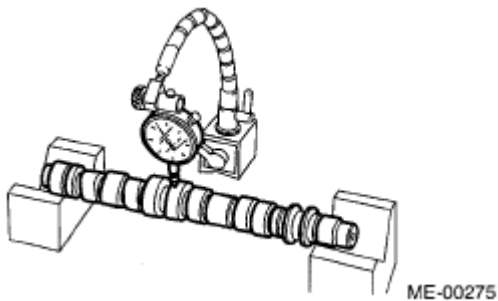


Fig. 156: Checking Camshaft For Bend
Courtesy of SUBARU OF AMERICA, INC.

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

occurs, replace it.

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

Cam lobe height H:

CAM LOBE HEIGHT SPECIFICATION

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

Cam base circle diameter A:

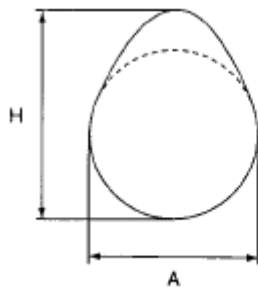
Standard

34.00 mm (1.3386 in)

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

Standard

0.03 mm (0.001 in) or less



ME-00276

Fig. 157: Identifying Cam Base Circle Diameter
Courtesy of SUBARU OF AMERICA, INC.

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

CAMSHAFT JOURNAL SPECIFICATION

		Unit: mm (in)
Oil clearance	Standard	0.055 - 0.090 (0.0022 - 0.0035)
Camshaft journal O.D.		31.928 - 31.945 (1.2570 - 1.2577)

Journal hole I.D.	32.000 - 32.018 (1.2598 - 1.2605)
-------------------	-----------------------------------

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

Camshaft thrust clearance:***Standard******0.030 - 0.090 mm (0.0012 - 0.0035 in)*****CYLINDER HEAD****REMOVAL****NOTE:**

- Perform the work with the engine installed to body when replacing a single part. Refer to "Valve Clearance" for preparation procedures. Refer to **VALVE CLEARANCE**.
 - When performing the work with the engine installed to body, the following parts must also be removed/installed.
- Front exhaust pipe Refer to **REMOVAL** , Front Exhaust Pipe. Refer to **INSTALLATION** , Front Exhaust Pipe.
1. Remove the V-belts. Refer to **REMOVAL**, V-belt.
 2. Remove the intake manifold. Refer to **REMOVAL** , 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.
 8. Remove the valve rocker assembly. Refer to **REMOVAL**, Valve Rocker Assembly.
 9. Remove the camshaft. Refer to **REMOVAL**, Camshaft.
 10. Remove the oil level gauge guide. (LH side)
 11. Remove the cylinder head bolts in alphabetical sequence as shown in the figure.

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

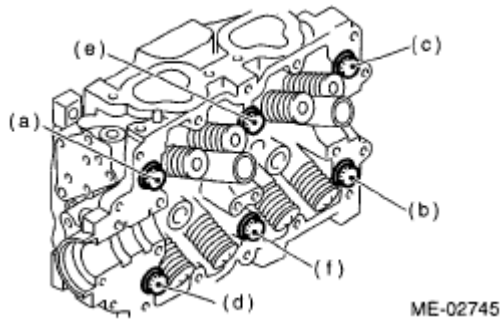


Fig. 158: Identifying Cylinder Head Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

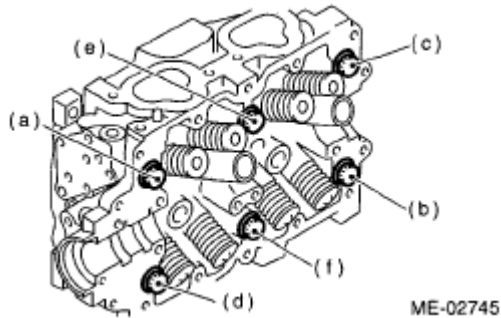


Fig. 159: Identifying Cylinder Head Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the cylinder head gasket.

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

14. Similarly, remove the right side cylinder head.

INSTALLATION

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

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

NOTE: Use a new cylinder head gasket.

2. Tighten the cylinder head bolts.

1. Apply a thin coat of engine oil to washer and bolt thread.
2. Tighten all bolts to 29 N.m (3.0 kgf-m, 21.4 ft-lb) in alphabetical order.
3. Retighten all bolts to 69 N.m (7.0 kgf-m, 50.9 ft-lb) in alphabetical order.
4. Loosen all the bolts by 180° in the reverse order of installing, and loosen them further by 180°.
5. Tighten all bolts to 42 N.m (4.3 kgf-m, 31.0 ft-lb) in alphabetical order.
6. Tighten all bolts by 80 to 90° in alphabetical order.
7. Tighten all bolts by 40 to 45° in alphabetical order.

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

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

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

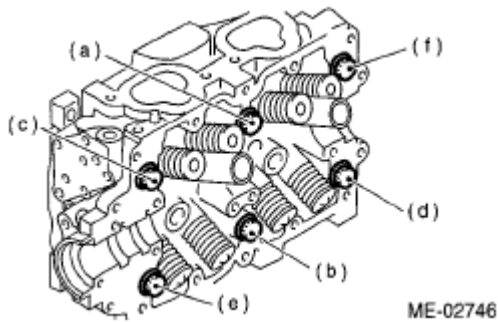


Fig. 160: Identifying Cylinder Head Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

4. Install the camshaft. Refer to INSTALLATION, Camshaft.
5. Install the valve rocker assembly. Refer to INSTALLATION, Valve Rocker Assembly.
6. Install the A/C compressor bracket on cylinder head.

Tightening torque:

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

7. Install the cam sprocket. Refer to INSTALLATION, Cam Sprocket.

8. Install the timing belt. Refer to **INSTALLATION**, Timing Belt.
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.

NOTE: Use a new rocker cover gasket.

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

Tightening torque:

First

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

Second (only (a) and (b) are tightened)

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

RH side

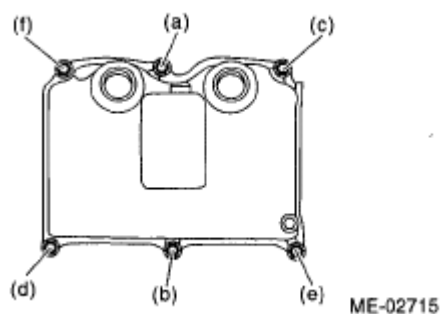


Fig. 161: Identifying Rocker Cover Bolts Tightening Sequence - RH Side
 Courtesy of SUBARU OF AMERICA, INC.

LH side

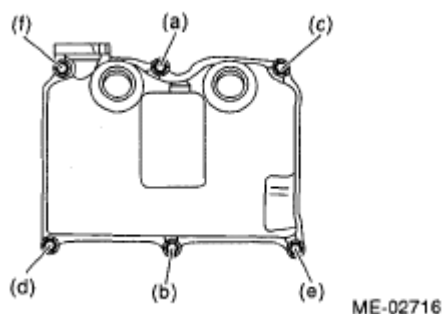


Fig. 162: Identifying Rocker Cover Bolts Tightening Sequence - LH Side

Courtesy of SUBARU OF AMERICA, INC.

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

DISASSEMBLY

1. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

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

ST 499718000 VALVE SPRING REMOVER

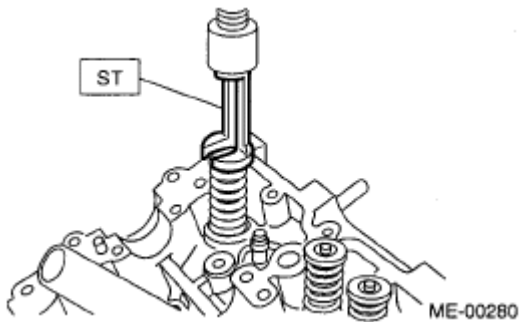


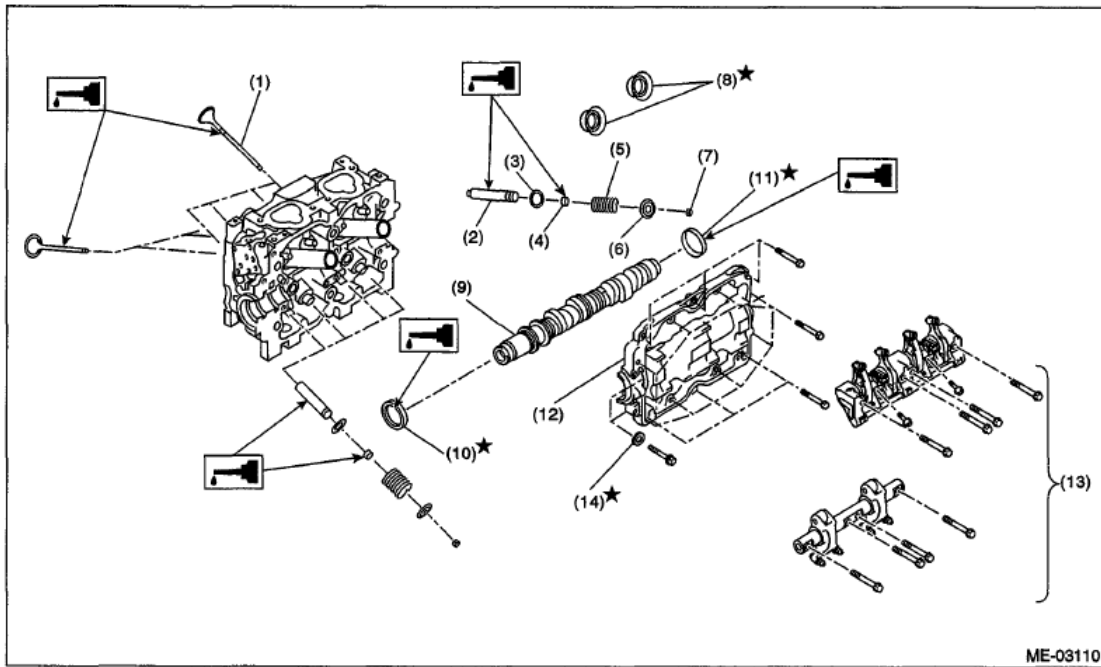
Fig. 163: Removing Valve Spring Retainer Key Using Valve Spring Remover 499718000

Courtesy of SUBARU OF AMERICA, INC.

NOTE:

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

ASSEMBLY



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

Fig. 164: Exploded View Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

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

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

2. Set the cylinder head on ST.

ST 498267800 CYLINDER HEAD TABLE

3. Install the valve spring and retainer.

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

4. Set the ST on valve spring.

ST 499718000 VALVE SPRING REMOVER

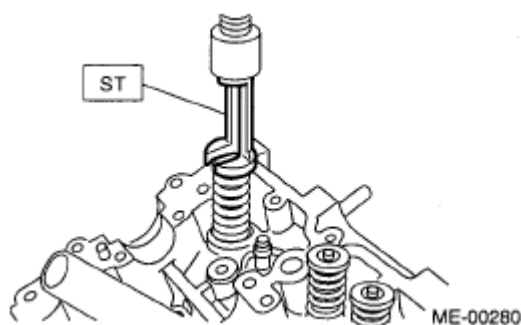
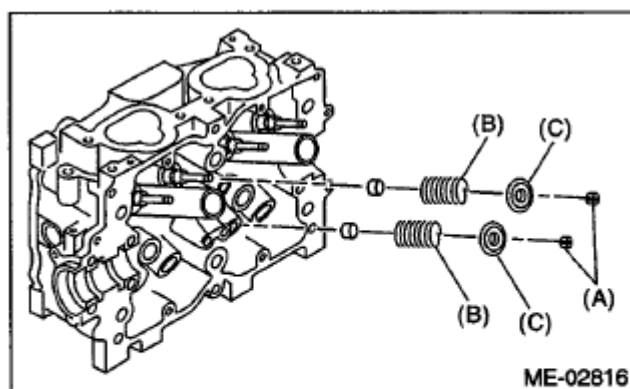


Fig. 165: Installing Valve Spring Retainer Key Using Valve Spring Remover 499718000
Courtesy of SUBARU OF AMERICA, INC.

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



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

Fig. 166: Identifying Valve Spring And Retainer Key
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

CYLINDER HEAD

1. Check for cracks or damage. Use liquid penetrant tester on the important informations to check for fissures. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

3. Measure the warping of the cylinder head surface that mates with cylinder block using a straight edge (A)

and thickness gauge (B).

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

Warping limit:

0.035 mm (0.0014 in)

Grinding limit:

0.1 mm (0.004 in)

Standard height of cylinder head:

97.5 mm (3.84 in)

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

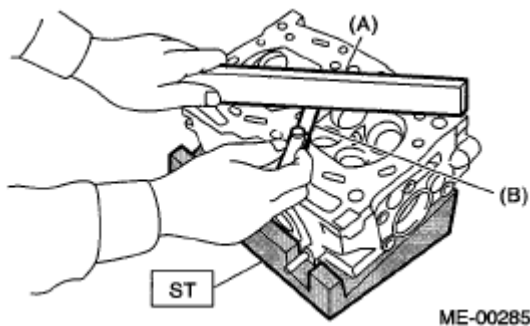


Fig. 167: Measuring Warping Of Cylinder Head Surface
Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Contacting width W between valve and valve seat:

Standard:

Intake (A)

0.8 - 1.4 mm (0.03 - 0.055 in)

Exhaust (B)

1.2 - 1.8 mm (0.047- 0.071 in)

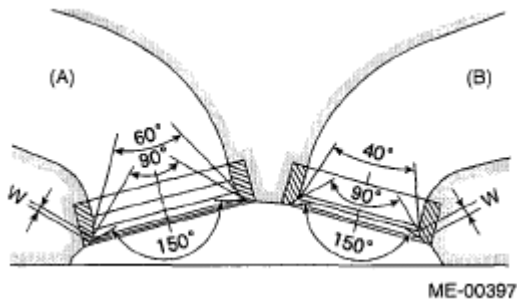


Fig. 168: Inspecting Intake And Exhaust Valve Seats
Courtesy of SUBARU OF AMERICA, INC.

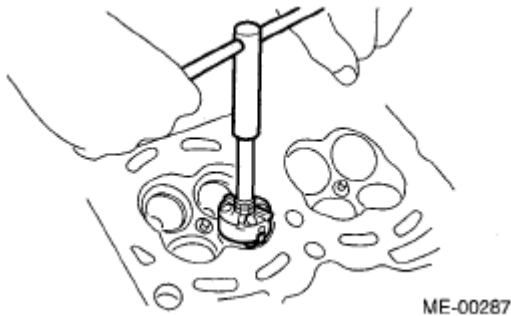


Fig. 169: Correcting Contact Surfaces With Valve Seat Cutter
Courtesy of SUBARU OF AMERICA, INC.

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:

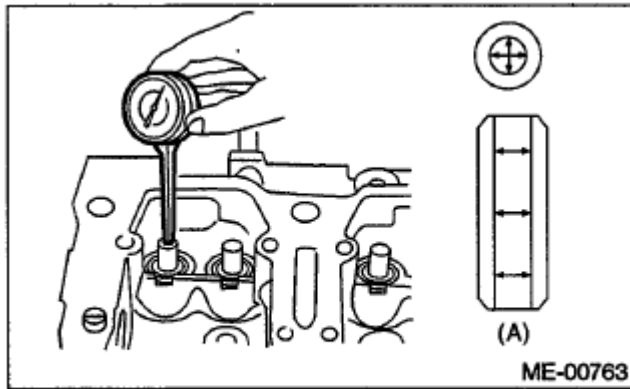
Standard:

Intake

0.035 - 0.062 mm (0.0014 - 0.0024 in)

Exhaust

0.040 - 0.067 mm (0.0016 - 0.0026 in)



(A) Valve guide

Fig. 170: Measuring Inner Diameter Of Valve Guide With Caliper Gauge
Courtesy of SUBARU OF AMERICA, INC.

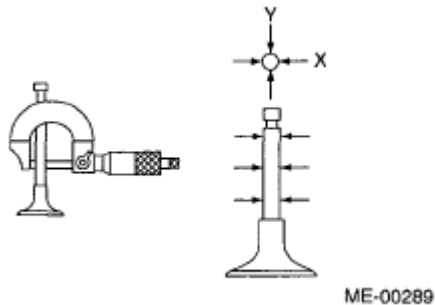


Fig. 171: Measuring Outer Diameter Of Valve Stem With Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

Valve guide inner diameter:

6.000 - 6.012 mm (0.2362 - 0.2367 in)

Valve stem outer diameters:

Intake

5.950 - 5.965 mm (0.2343 - 0.2348 in)

Exhaust

5.945 - 5.960 mm (0.2341 - 0.2346 in)

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

ST1 498267800 CYLINDER HEAD TABLE

ST2 499767200 VALVE GUIDE REMOVER

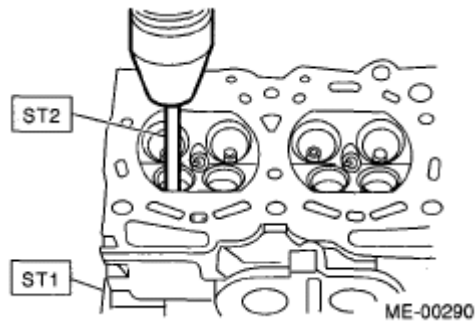


Fig. 172: Identifying ST2 Into Valve Guide Using Valve Guide Remover ST2 (499767200)
Courtesy of SUBARU OF AMERICA, INC.

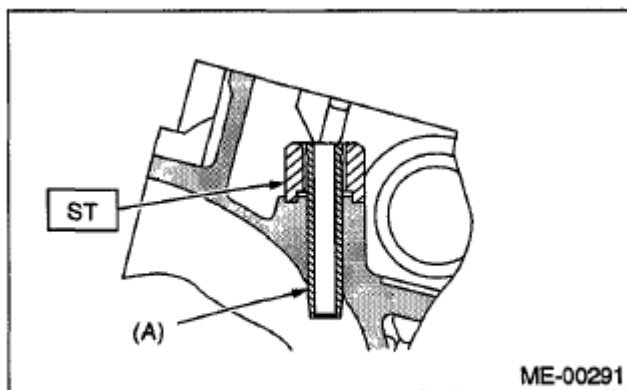
3. Turn the cylinder head upside down and place the ST as shown in the figure.

Intake side

ST 499767700 VALVE GUIDE ADJUSTER

Exhaust side

ST 499767800 VALVE GUIDE ADJUSTER



(A) Valve guide

Fig. 173: 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. Put a new valve guide, coated with sufficient oil, in the cylinder head, and insert the ST1 into valve guide. Press in until the valve guide upper end is flush with the upper surface of ST2.

ST1 499767200 VALVE GUIDE REMOVER

Intake side

ST2 499767700 VALVE GUIDE ADJUSTER

Exhaust side

ST2 499767800 VALVE GUIDE ADJUSTER

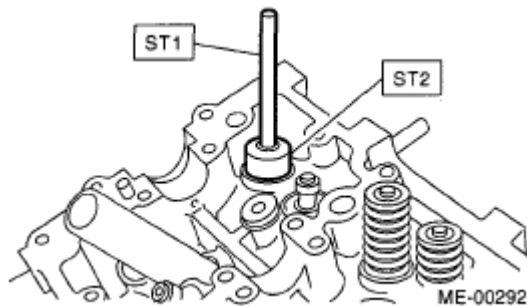


Fig. 174: Installing Valve Guide Using Valve Guide Adjuster And Remover
Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion.

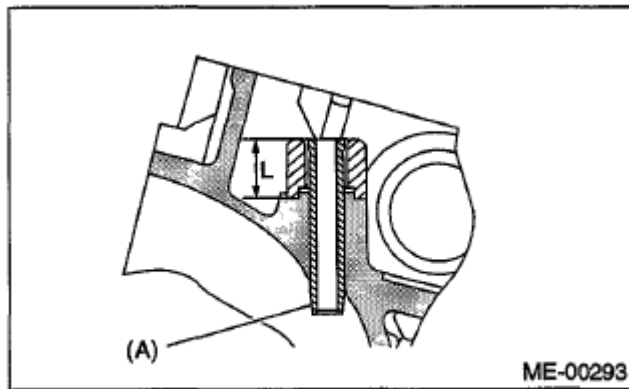
Valve guide protrusion L:

Intake

20.0 - 21.0 mm (0.787 - 0.827 in)

Exhaust

16.5 - 17.5 mm (0.650 - 0.689 in)



(A) Valve guide

Fig. 175: Identifying Valve Guide Protrusion
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

ST 499767400 VALVE GUIDE REAMER



Fig. 176: Reaming Inside Of Valve Guide Using Valve Guide Reamer 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:

Intake (A)

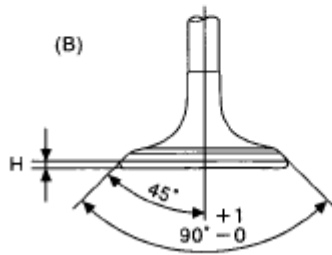
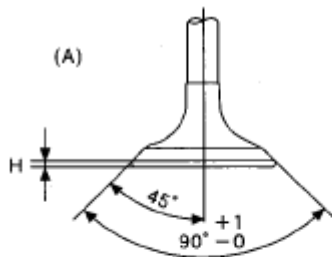
Standard:

0.8 - 1.2 mm (0.03 - 0.047 in)

Exhaust (B)

Standard:

1.0 - 1.4 mm (0.039 - 0.055 in)



ME-00758

Fig. 177: Identifying Head Edge Thickness
Courtesy of SUBARU OF AMERICA, INC.

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

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

Valve overall length:

Intake

120.6 mm (4.75 in)

Exhaust

121.7 mm (4.79 in)

VALVE SPRING

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

VALVE SPRING SPECIFICATION

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

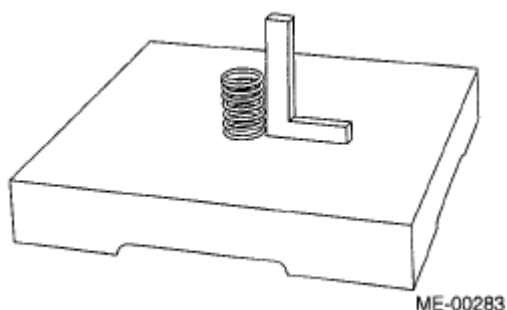


Fig. 178: Checking Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

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

See the procedure 2) and subsequent for replacement procedures.

- When the lip is damaged.
- When the spring is out of the specified position.
- When readjusting the surfaces of valve and valve seat.
- When replacing the valve guide.

2. Place the cylinder head on ST1, and use ST2 to press-fit the oil seal.

ST1 498267800 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

NOTE:

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

Color of rubber part:

Intake [Gray]

Exhaust [Green]

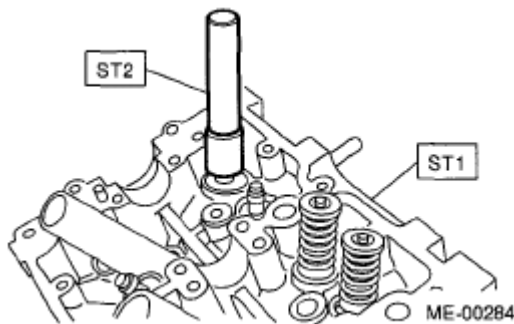


Fig. 179: Installing Oil Seal Using Valve Oil Seal Guide 498857100
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK

REMOVAL

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

1. Remove the V-belts. Refer to **REMOVAL**, V-belt.
2. Remove the intake manifold. Refer to **REMOVAL**, 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 crank sprocket. Refer to **REMOVAL**, Crank Sprocket.
7. Remove the generator and A/C compressor with their brackets.
8. Remove the cylinder head. Refer to **REMOVAL**, Cylinder Head.
9. Use the ST to lock the crankshaft, and remove the drive plate. (AT model)

ST 498497100 CRANKSHAFT STOPPER

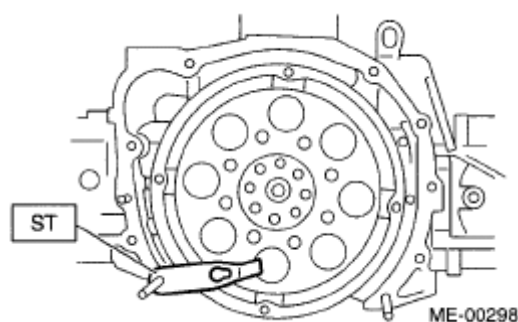


Fig. 180: Locking Crankshaft Using Crankshaft Stopper 498497100
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the clutch disc and cover. (MT model) Refer to **REMOVAL** , Clutch Disc and Cover.
11. Remove the flywheel. (MT model) Refer to **REMOVAL** , Flywheel.
12. Remove the oil separator cover.
13. Remove the water by-pass pipe for heater.
14. Remove the water pump. Refer to **REMOVAL** , Water Pump.
15. 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.

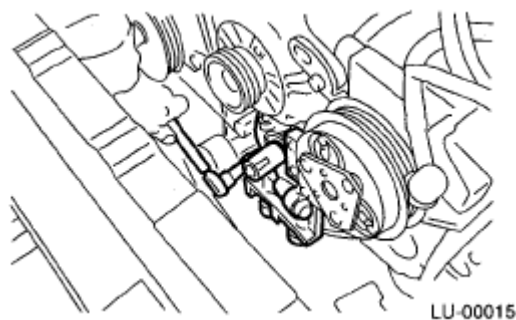


Fig. 181: Identifying Oil Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

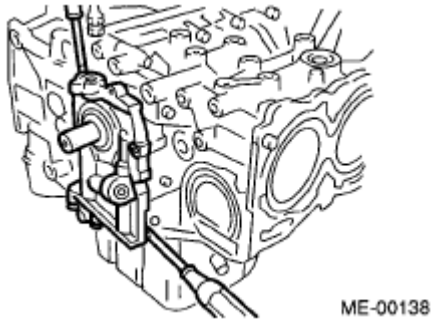


Fig. 182: Identifying Oil Pump And Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

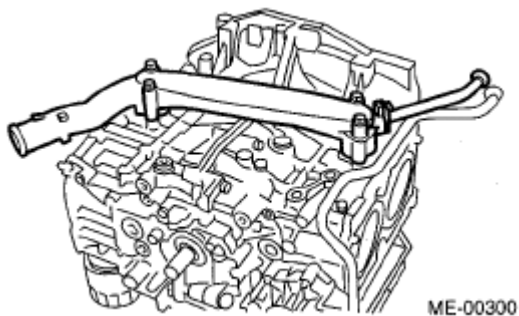
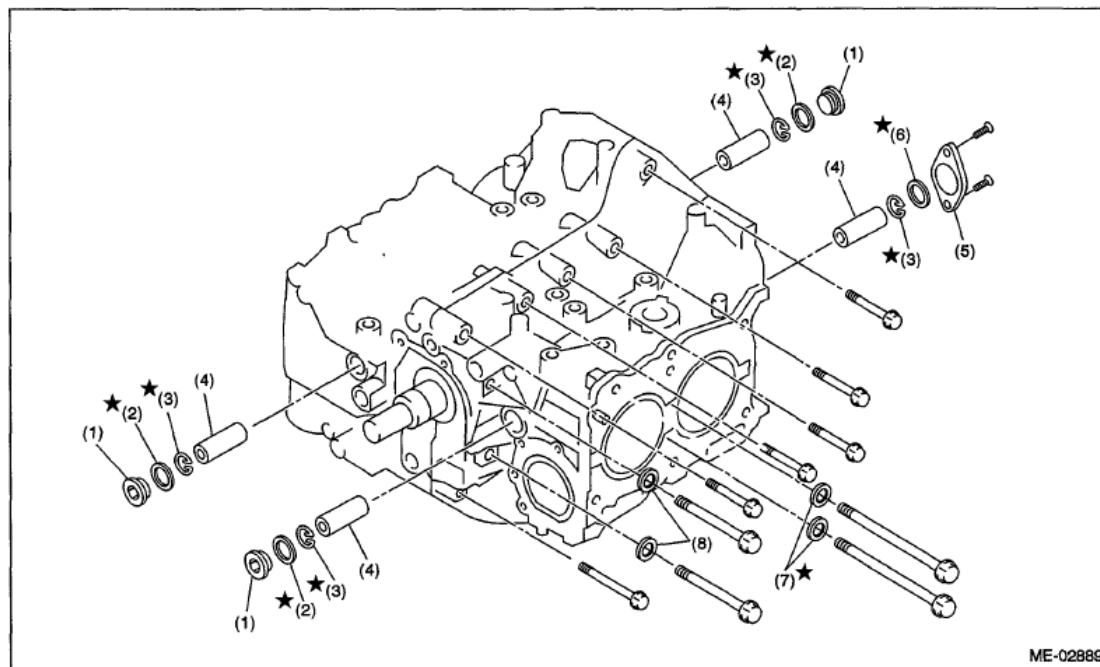


Fig. 183: Identifying Water Pipe Assembly
Courtesy of SUBARU OF AMERICA, INC.



- (1) Service hole plug
- (2) Gasket
- (3) Snap ring

- (4) Piston pin
- (5) Service hole cover
- (6) O-ring

- (7) Seal washer
- (8) Washer

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

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

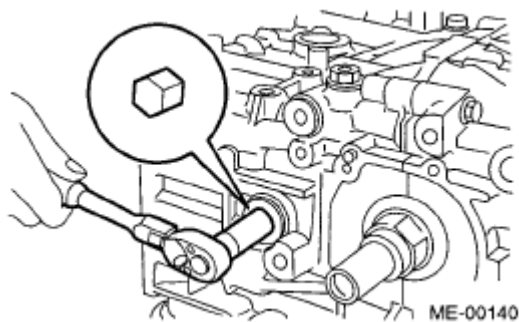


Fig. 185: Identifying Service Hole Plugs
Courtesy of SUBARU OF AMERICA, INC.

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

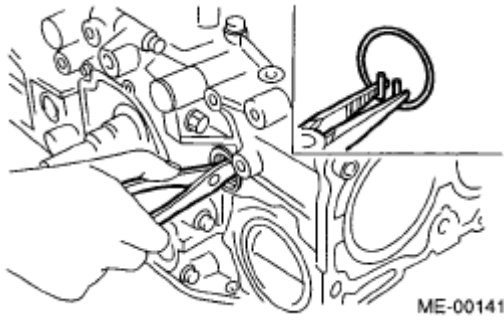


Fig. 186: Locating Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499097700 PISTON PIN REMOVER

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

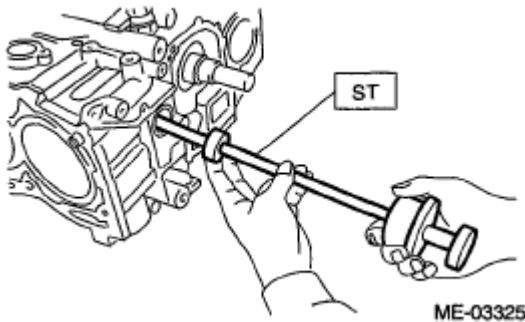
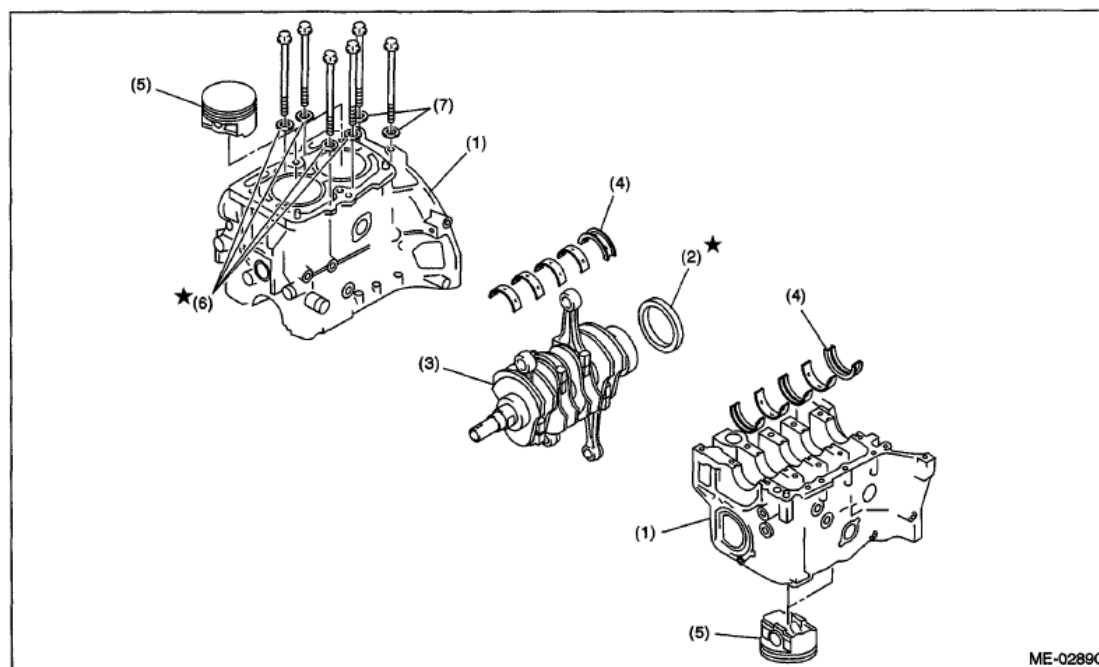


Fig. 187: Drawing Out Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

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



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

(4) Crankshaft bearing
(5) Piston

(6) Seal washer
(7) Washer

Fig. 188: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

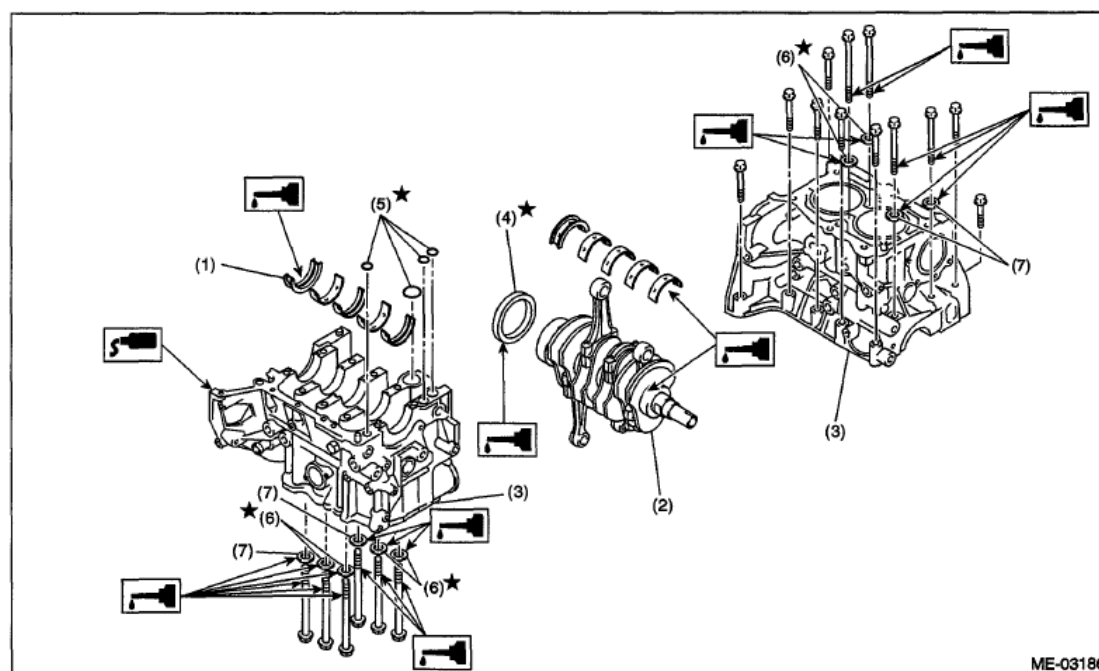
- Press the crankshaft bearing at the end opposite to locking lip to remove.
- Be careful not to confuse the crankshaft bearing combination.

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

NOTE:

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

INSTALLATION



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

Fig. 189: Exploded View Of Cylinder Block
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new O-rings.

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

NOTE:

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

Liquid gasket:

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

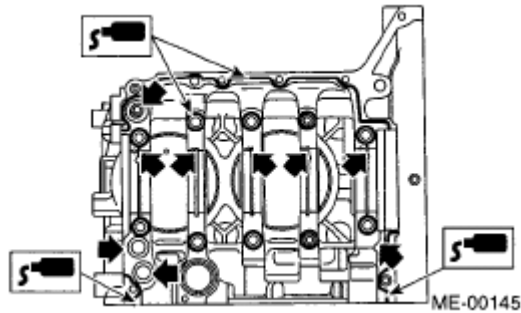


Fig. 190: Applying Liquid Gasket To Mating Surfaces Of Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new seal washer.

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

Tightening torque:

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

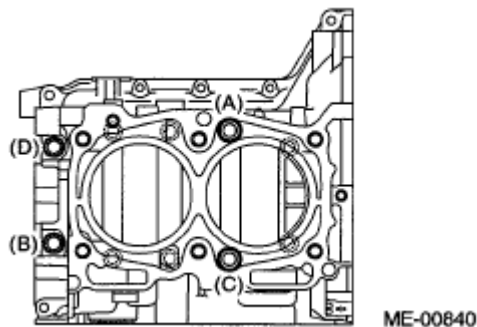


Fig. 191: Identifying LH Side Cylinder Block Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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)

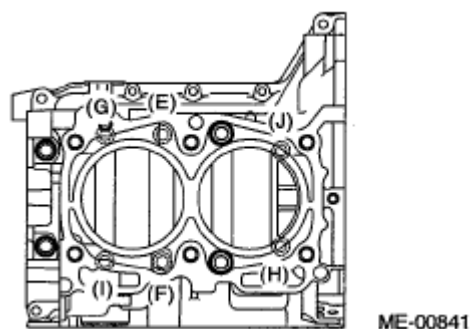


Fig. 192: Identifying RH Side Cylinder Block Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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)

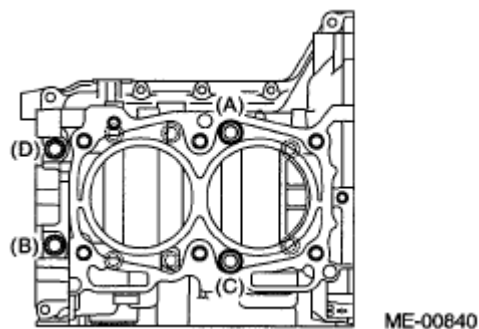


Fig. 193: Identifying LH Side Cylinder Block Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

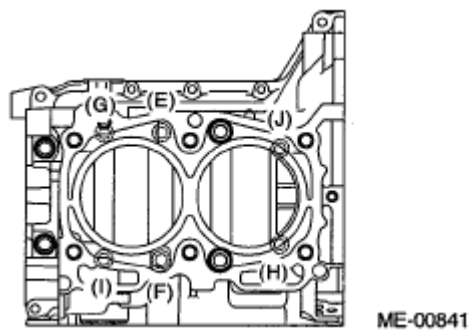


Fig. 194: Identifying RH Side Cylinder Block Connecting Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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)

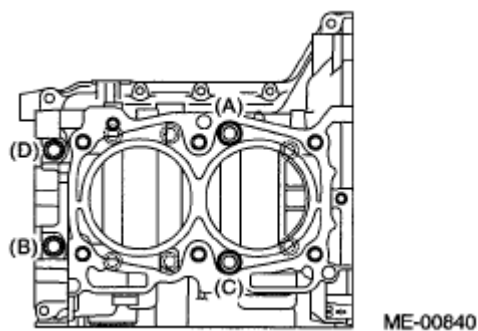


Fig. 195: Identifying LH Side Cylinder Block Connecting Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle: 90°

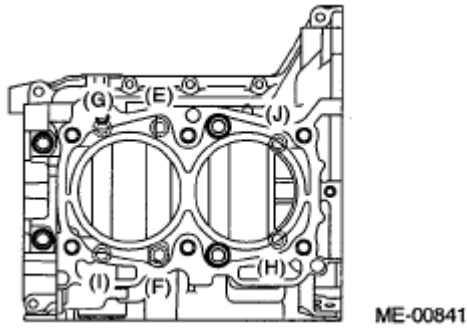


Fig. 196: Identifying RH Side Cylinder Block Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

(A) - (G): 25 N.m (2.5 kgf-m, 18.4 ft-lb) (H): 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

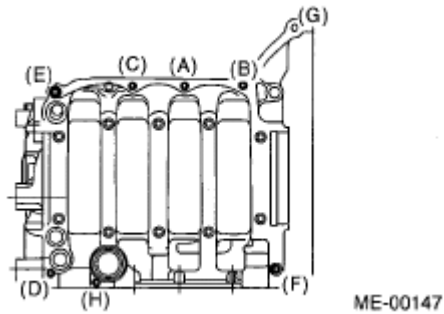


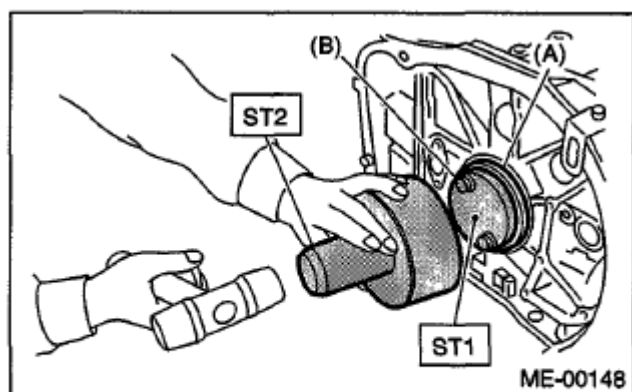
Fig. 197: Identifying LH Side Cylinder Block Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rear oil seal.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER



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

Fig. 198: Installing Rear Oil Seal Using Crankshaft Oil Seal Installer 499587200
 Courtesy of SUBARU OF AMERICA, INC.

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

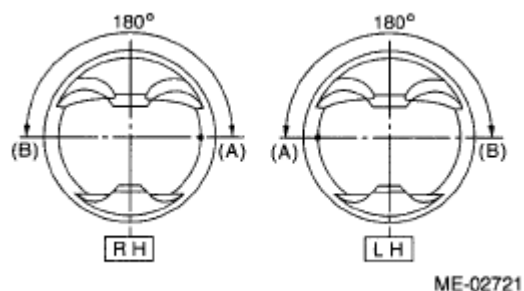


Fig. 199: Identifying Second Ring Gap Position
 Courtesy of SUBARU OF AMERICA, INC.

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

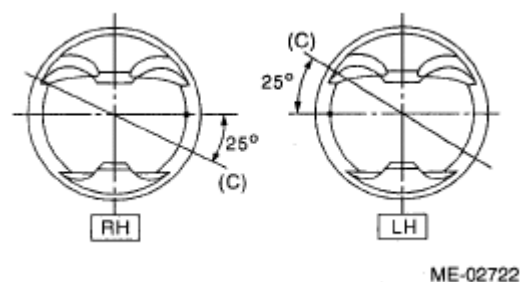


Fig. 200: Identifying Upper Rail Gap Position
 Courtesy of SUBARU OF AMERICA, INC.

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

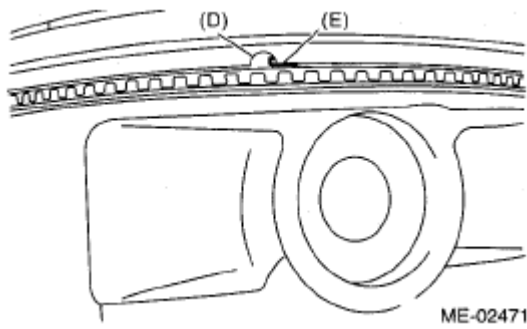


Fig. 201: Aligning Upper Rail Spin Stopper To Side Hole On Piston
Courtesy of SUBARU OF AMERICA, INC.

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

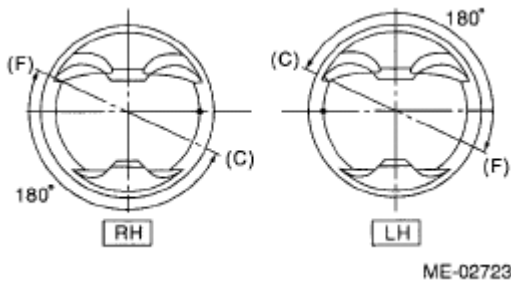


Fig. 202: Identifying Expander Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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

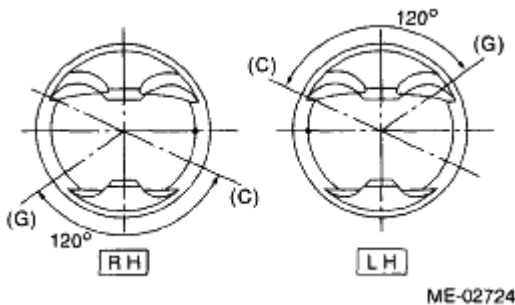


Fig. 203: Identifying Lower Rail Gap Position
Courtesy of SUBARU OF AMERICA, INC.

NOTE:

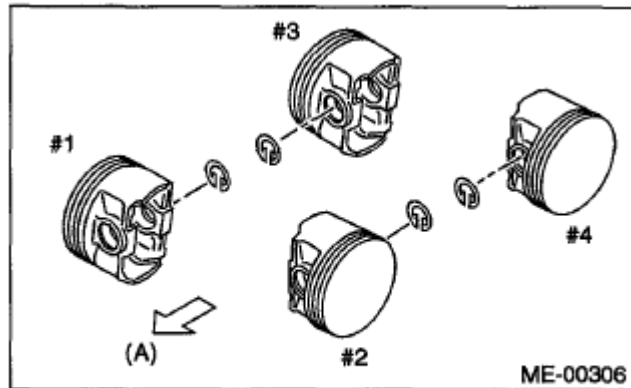
- Make sure ring gaps do not face the same direction.
- Make sure ring gaps are not within the piston skirt area.

19. install the snap ring.

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

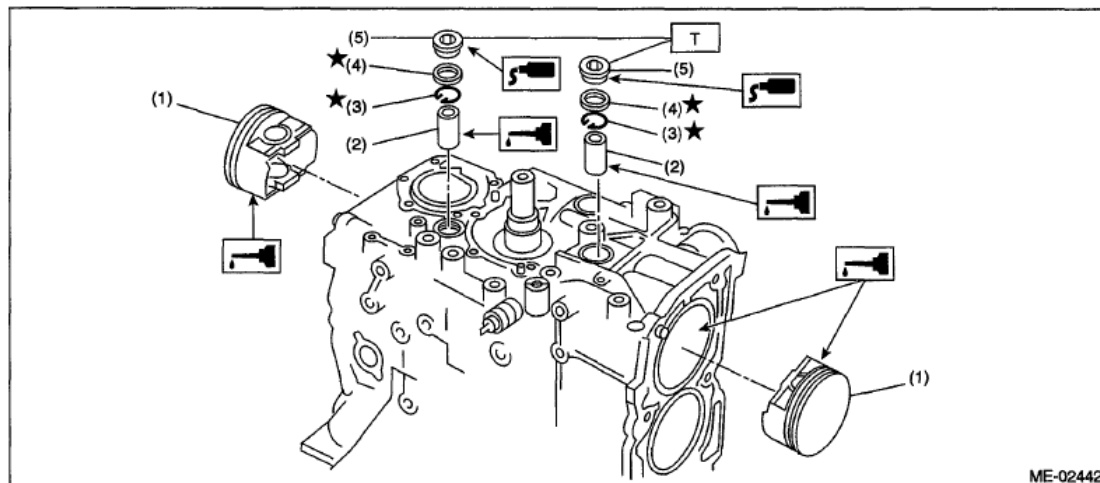
block, and the piston hole on the opposite side.

NOTE: Use new snap rings.



(A) Front side

Fig. 204: Identifying Snap Ring
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 205: Identifying Snap Ring And Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

20. Install the piston.

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

T: 70 (7.1,51.6)

1. Set the parts so that the #1 and #2 cylinders are on the upper side.
2. Using the ST1, turn the crankshaft so that #1 and #2 connecting rods are set at bottom dead center

ST1 499987500 CRANKSHAFT SOCKET

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

ST2 498747300 PISTON GUIDE

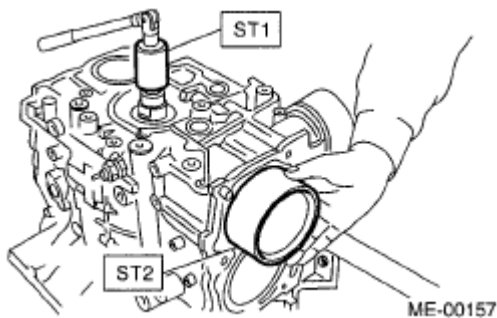
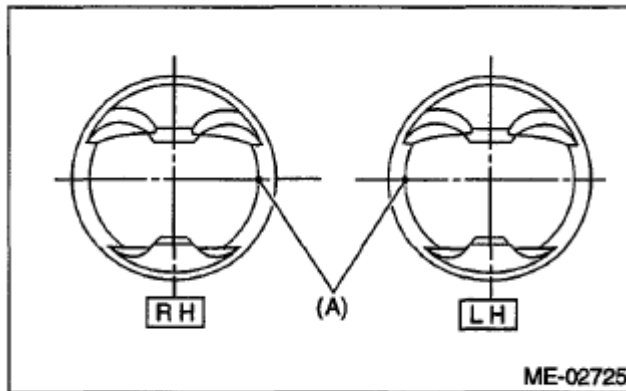


Fig. 206: Inserting Pistons In Cylinders Using Piston Guide 498747300
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front mark

Fig. 207: Identifying Piston Front Mark Position
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 piston pin hole with connecting rod small end.

ST3 499017100 PISTON PIN GUIDE

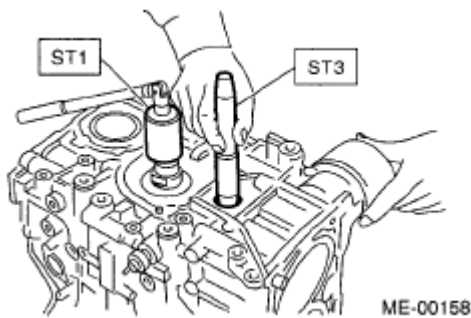


Fig. 208: Aligning Piston Pin Hole With Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.

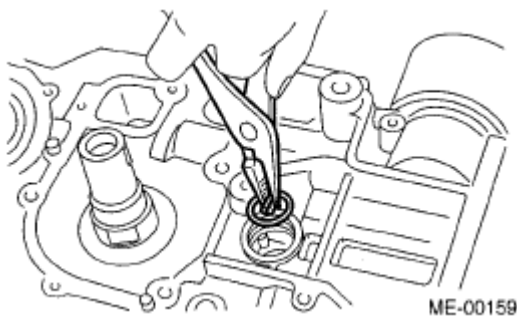


Fig. 209: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

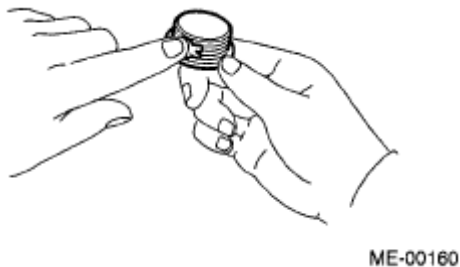


Fig. 210: Applying Liquid Gasket To Threaded Portion Of Service Hole Plug

Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

NOTE: Use a new gasket.

Tightening torque:

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

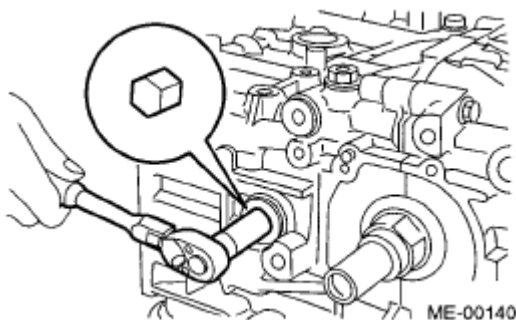
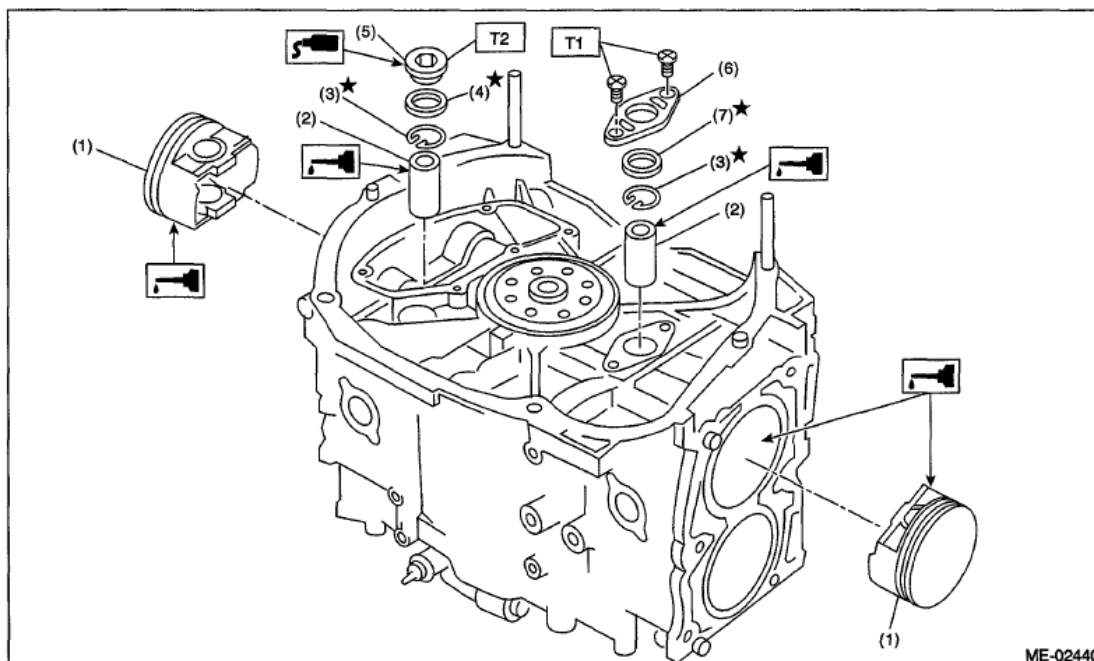


Fig. 211: Identifying Service Hole Plugs
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 212: Identifying Service Hole Plug And Gasket

Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7,4.7)

T2: 70 (7.1,51.6)

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

NOTE: Use new O-rings.

Tightening torque:

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

22. Install the water pipe assembly.

NOTE: Use new O-rings.

Tightening torque:

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

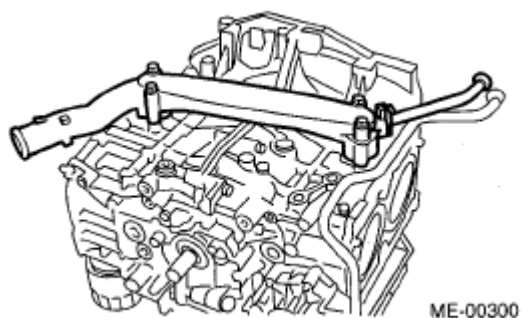


Fig. 213: Identifying Water Pipe Assembly
Courtesy of SUBARU OF AMERICA, INC.

23. Install the baffle plate.

Tightening torque:

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

24. Install the oil strainer.

NOTE: Use new O-rings.

Tightening torque:

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

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

Tightening torque:

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

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

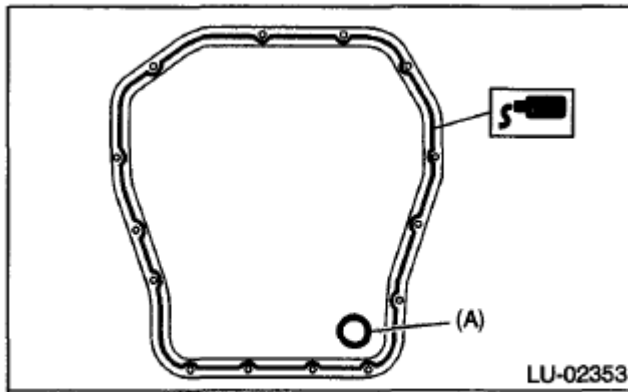
NOTE: Install within 5 min. after applying liquid gasket.

Liquid gasket:

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

Tightening torque:

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



(A) Gasket

Fig. 214: Applying Liquid Gasket To Mating Surfaces Of Oil Pan
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

Liquid gasket:

- ***Mating surface***

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

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

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

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

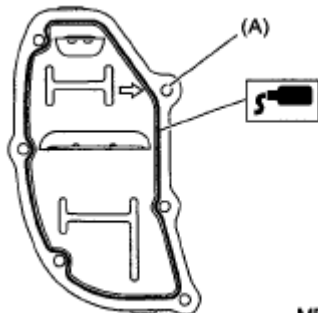


Fig. 215: Applying Liquid Gasket To Mating Surfaces Of Oil Separator Cover And Threaded Portion Of Bolt

Courtesy of SUBARU OF AMERICA, INC.

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

ST 498497100 CRANKSHAFT STOPPER

Tightening torque:

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

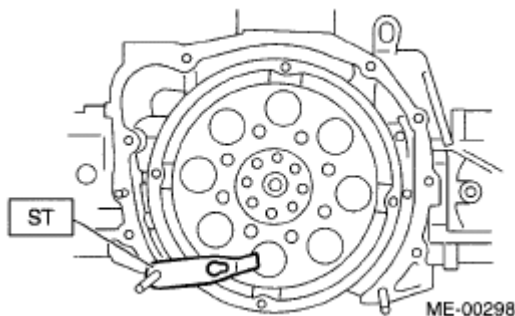


Fig. 216: Locking Crankshaft Using Crankshaft Stopper 498497100

Courtesy of SUBARU OF AMERICA, INC.

29. Install the flywheel. (MT model) Refer to **INSTALLATION** , Flywheel.
30. Install the clutch disc and cover. (MT model) Refer to **INSTALLATION** , Clutch Disc and Cover.
31. 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.

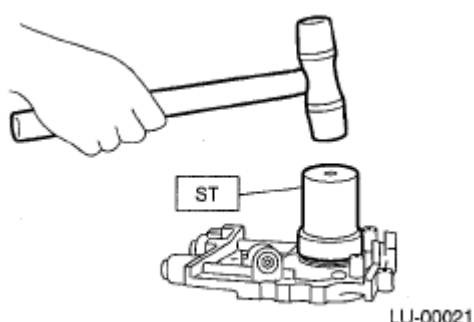


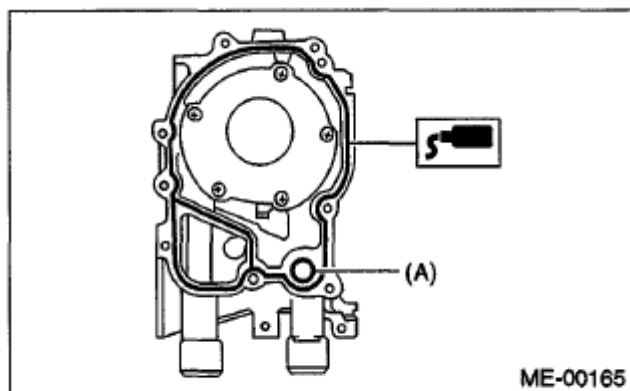
Fig. 217: Installing Front Oil Seal Using Oil Seal Installer 499587100
Courtesy of SUBARU OF AMERICA, INC.

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

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

Liquid gasket:

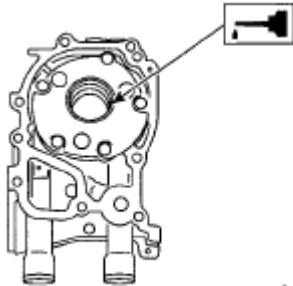
THREE BOND 1217G (Part No. K0877Y0100) or equivalent



(A) O-ring

Fig. 218: Applying Liquid Gasket To Matching Surface Of Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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



ME-00312

Fig. 219: Applying Coat Of Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

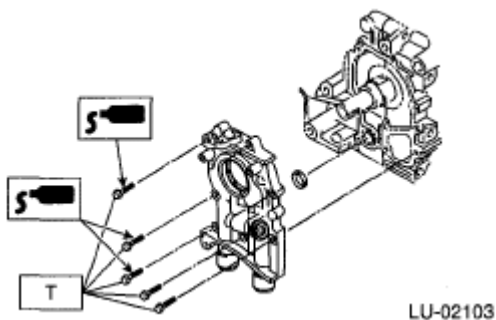
5. Apply liquid gasket to the three bolts thread shown in figure, (when reusing bolts)

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

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



LU-02103

Fig. 220: Applying Liquid Gasket To Bolts Thread

Courtesy of SUBARU OF AMERICA, INC.

32. Install the water pump and gasket.

NOTE:

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

Tightening torque:

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

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

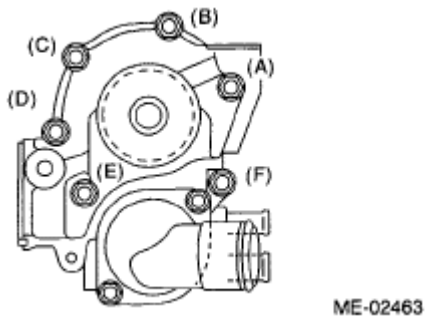


Fig. 221: Identifying Water Pump Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

34. Install the oil filter.

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

35. Install the cylinder head. Refer to **INSTALLATION**, Cylinder Head.

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

Tightening torque:

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

37. Install the crank sprocket. Refer to **INSTALLATION**, Crank Sprocket.

38. Install the timing belt. Refer to **INSTALLATION**, Timing Belt.

39. Adjust the valve clearance. Refer to ADJUSTMENT, Valve Clearance.

40. Install the rocker cover.

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

NOTE: Use a new rocker cover gasket.

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

Tightening torque:

First

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

Second (only (a) and (b) are tightened)

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

RH side

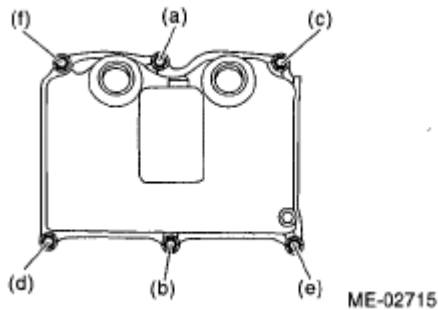


Fig. 222: Identifying Rocker Cover Bolts Tightening Sequence - RH Side
 Courtesy of SUBARU OF AMERICA, INC.

LH side

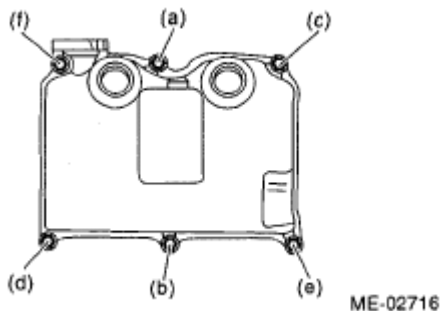


Fig. 223: Identifying Rocker Cover Bolts Tightening Sequence - LH Side
 Courtesy of SUBARU OF AMERICA, INC.

41. Install the timing belt cover. Refer to **INSTALLATION**, Timing Belt Cover.
42. Install the crank pulley. Refer to **INSTALLATION**, Crank Pulley.
43. Install the intake manifold. Refer to **INSTALLATION**, Intake Manifold.
44. Install the V-belts. Refer to **INSTALLATION**, V-belt.

DISASSEMBLY

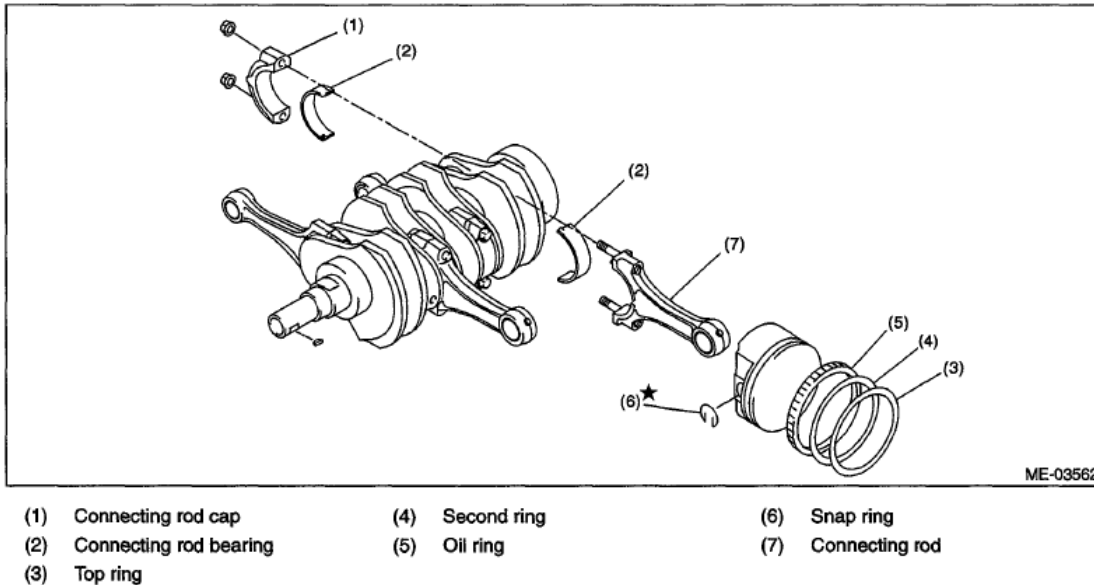


Fig. 224: Identifying Connecting Rod, Connecting Rod Cap And Top Ring
 Courtesy of SUBARU OF AMERICA, INC.

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

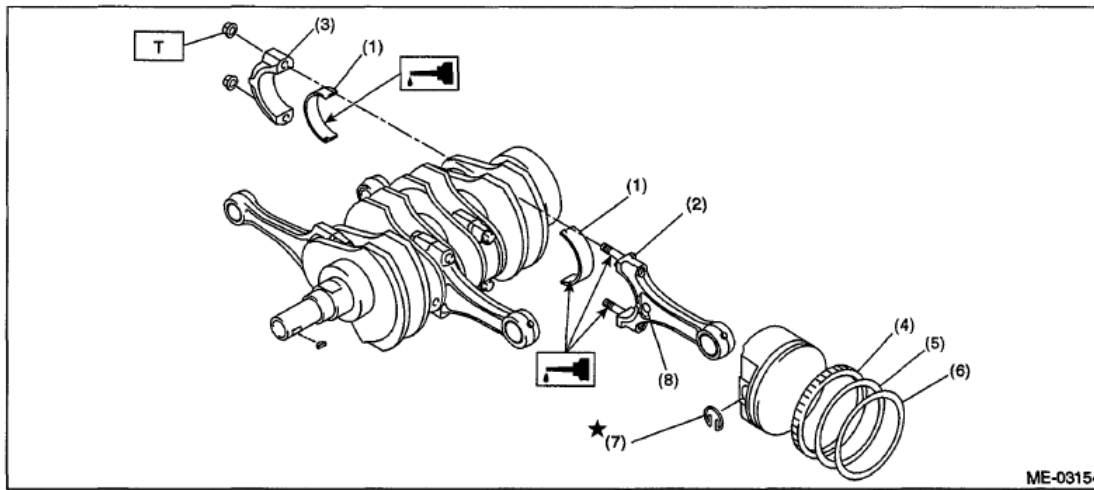
NOTE: Keep the removed connecting rods, connecting rod caps and bearings in order so that they are kept in their original combinations/groups, and not mixed together.

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

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

5. Remove the snap ring.

ASSEMBLY



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

Fig. 225: Identifying Connecting Rod, Connecting Rod Cap And Top Ring
 Courtesy of SUBARU OF AMERICA, INC.

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

T: 45 (4.6,33.2)

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

Make sure the arrow on connecting rod cap faces the front during installation.

NOTE:

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

Tightening torque:

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

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

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

INSPECTION**CYLINDER BLOCK**

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

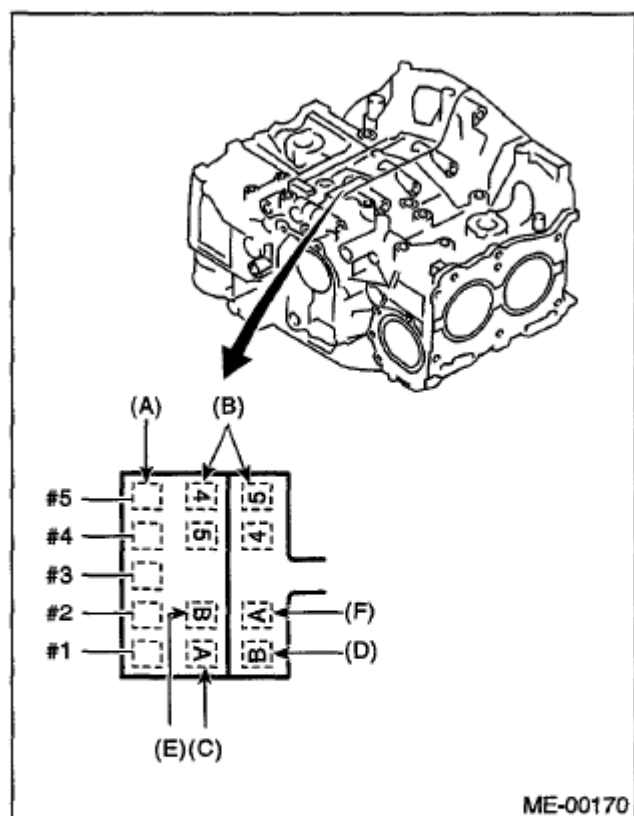
Warping limit:***0.025 mm (0.00098 in)******Grinding limit:******0.1 mm (0.004 in)******Standard height of cylinder block:******201.0 mm (7.91 in)*****CYLINDER AND PISTON**

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

NOTE:

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

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



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

Fig. 226: Identifying Cylinder Bore Size Mark

Courtesy of SUBARU OF AMERICA, INC.

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

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

Taper:

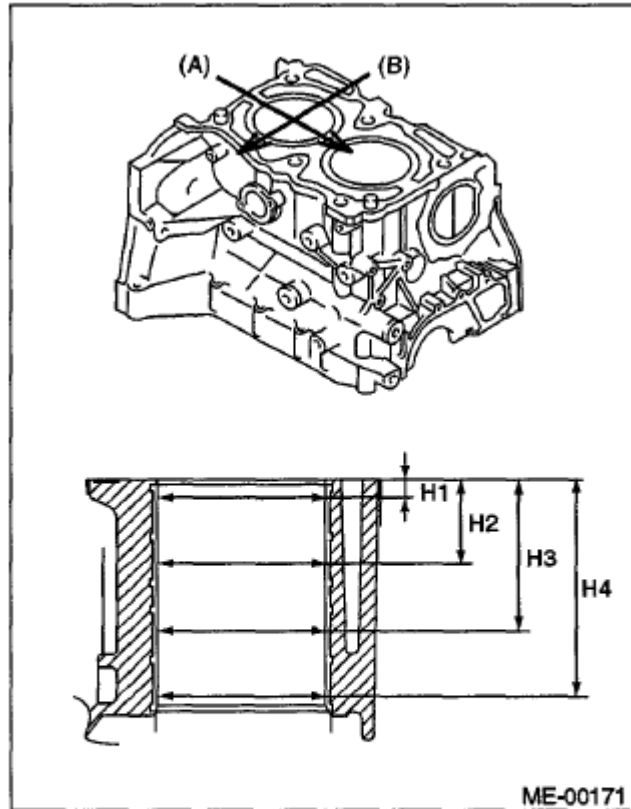
Standard:

0.015 mm (0.0006 in)

Out-of-roundness:

Standard:

0.010 mm (0.0004 in)



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

Fig. 227: Identifying Inner Diameter Of Cylinder
 Courtesy of SUBARU OF AMERICA, INC.

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

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

Piston grade point H:

38.2 mm (1.504 in)

Piston outer diameter:

Standard

A: 99.505 - 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 - 3.9277 in)

0.50 mm (0.0197 in) oversize:

99.995 - 100.015 mm (3.9368 - 3.9376 in)

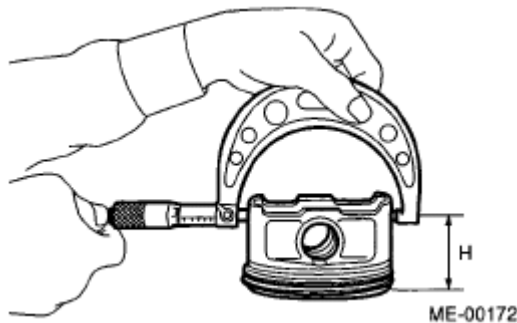


Fig. 228: Identifying Piston Outer Diameter
Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

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

Standard:

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

6. Boring and honing

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

CAUTION: When any of the cylinders needs reboring, all other cylinders must be

bored at the same time, and replaced with oversize pistons.

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

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

Cylinder inner diameter boring limit:

To 100.005 mm (3.9372 in)

PISTON AND PISTON PIN

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

Clearance between piston hole and piston pin:

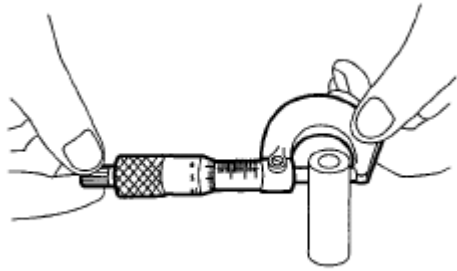
Standard:

0.004 - 0.008 mm (0.0002 - 0.0003 in)



ME-00173

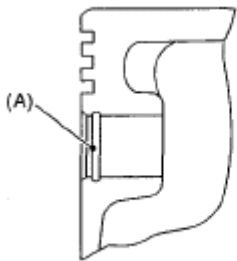
Fig. 229: Measuring Piston Hole Diameter
Courtesy of SUBARU OF AMERICA, INC.



ME-00174

Fig. 230: Measuring Piston Pin Diameter
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.



ME-00175

Fig. 231: Identifying Snap Ring Installation Groove
Courtesy of SUBARU OF AMERICA, INC.

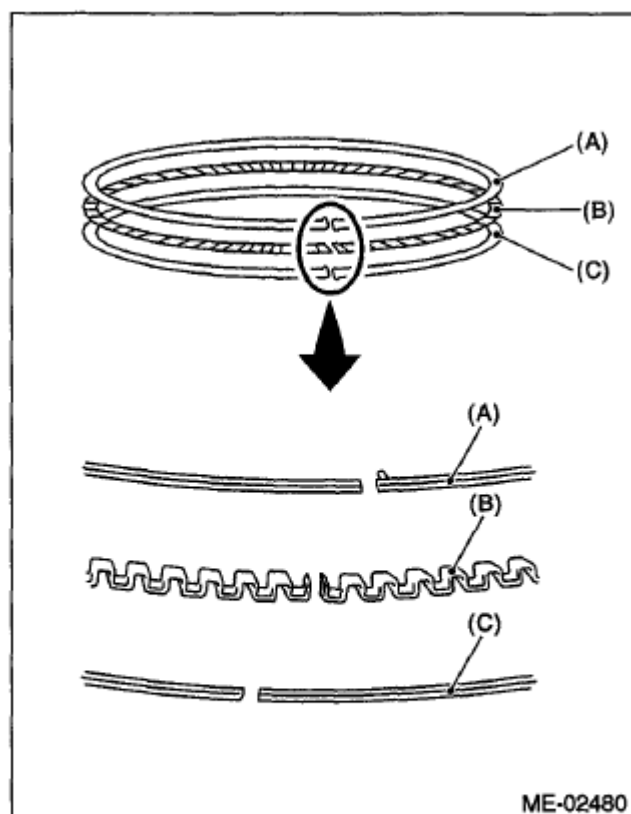
5. Check the piston pin snap ring for distortion, cracks and wear.

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.



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

Fig. 232: Identifying Piston Rings Position
Courtesy of SUBARU OF AMERICA, INC.

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

PISTON RING GAP SPECIFICATION

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

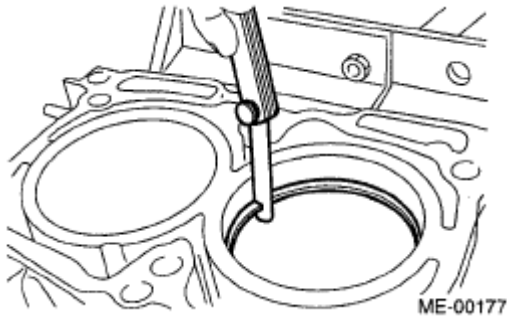


Fig. 233: Measuring Piston Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

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

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

RING SPECIFICATION

		Standard 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)

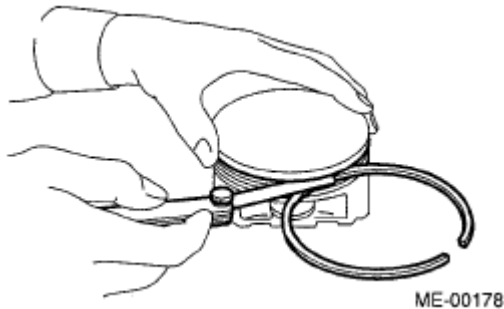


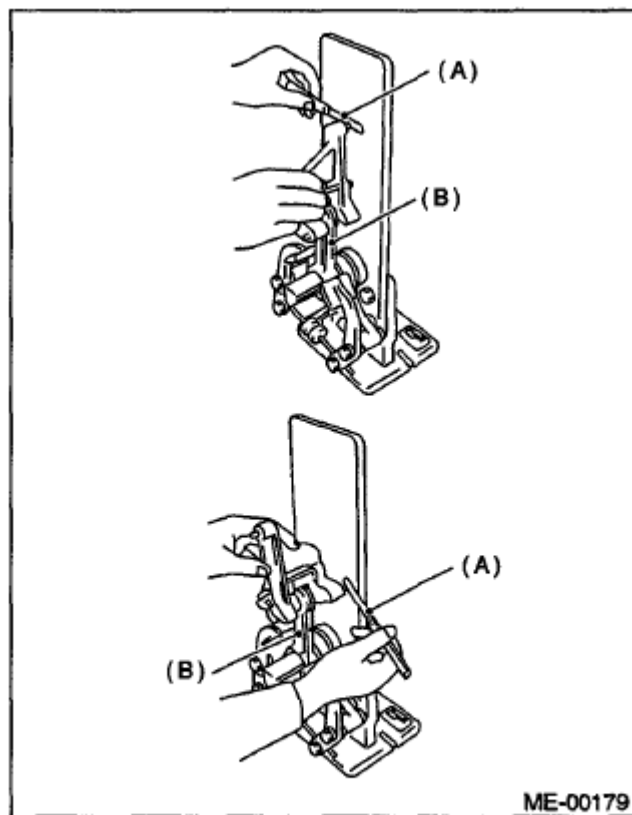
Fig. 234: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

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

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

0.10 mm (0.0039 in)



(A) Thickness gauge

(B) Connecting rod

Fig. 235: Checking Connecting Rod For Bend Or Twist
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod thrust clearance:

Standard:

0.070 - 0.330 mm (0.0028 - 0.0130 in)

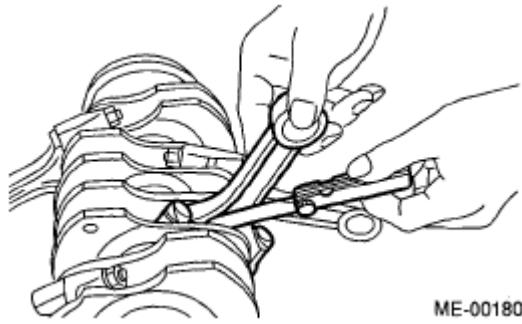


Fig. 236: Checking Connecting Rod Thrust Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard:

0.016 - 0.044 mm (0.0006 - 0.0017 in)

BEARING SPECIFICATION

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

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

Clearance between piston pin and bushing:

Standard:

0 - 0.022 mm (0 - 0.0009 in)

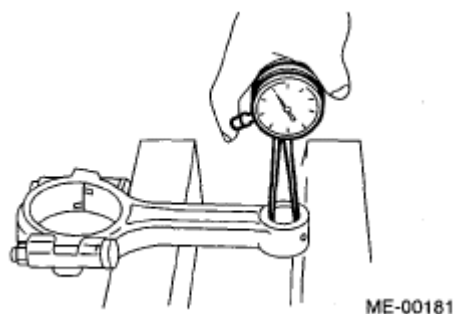


Fig. 237: Measuring Bushing Diameter At Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

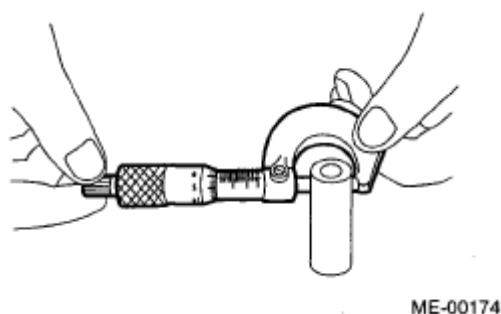


Fig. 238: Measuring Piston Pin Diameter
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

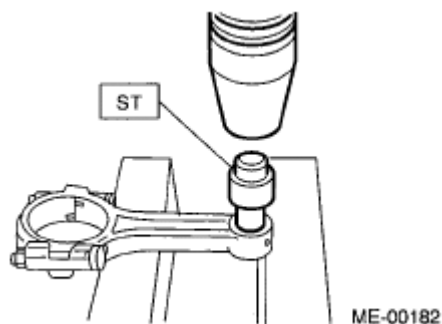


Fig. 239: Pressing Bushing With Connecting Rod Bushing Remover And Installer 499037100
Courtesy of SUBARU OF AMERICA, INC.

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

CRANKSHAFT AND CRANKSHAFT BEARING

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

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

Crankshaft bend limit:

0.035 mm (0.0014 in)

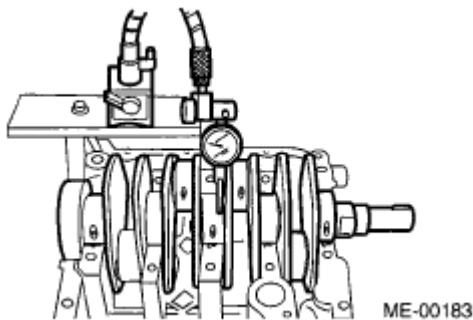


Fig. 240: Measuring Crankshaft For Bend
Courtesy of SUBARU OF AMERICA, INC.

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

Crank pin

Out-of-roundness

0.003 mm (0.0001 in)

Cylindricity

0.004 mm (0.0002 in)

Grinding limit (dia.)

To 51.750 mm (2.0374 in)

Crank journal

Out-of-roundness

0.005 mm (0.0002 in)

Cylindricity

0.006 mm (0.0002 in)

Grinding limit (dia.)

To 59.758 mm (2.3527 in)



Fig. 241: Measuring Crank Journal
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL OUTER DIAMETER SPECIFICATION

		Unit: mm (in)		
		Crank journal outer diameter		Crank pin outer diameter
		#1,#3	#2, #4, #5	
Standard	Journal O.D.	59.992 - 60.008 (2.3619 - 2.3625)	59.992 - 60.008 (2.3619 - 2.3625)	51.984 - 52.000 (2.0466 - 2.0472)
	Bearing size (Thickness at center)	1.998 - 2.011 (0.0787 - 0.0792)	2.000 - 2.013 (0.0787 - 0.0793)	1.492 - 1.501 (0.0587 - 0.0591)
0.03 (0.0012) Undersize	Journal O.D.	59.962 - 59.978 (2.3607 - 2.3613)	59.962 - 59.978 (2.3607 - 2.3613)	51.954 - 51.970 (2.0454 - 2.0461)
	Bearing size (Thickness at center)	2.017 - 2.020 (0.0794 - 0.0795)	2.019 - 2.022 (0.0795 - 0.0796)	1.510 - 1.513 (0.0594 - 0.0596)
0.05 (0.0020) Undersize	Journal O.D.	59.942 - 59.958 (2.3599 - 2.3605)	59.942 - 59.958 (2.3599 - 2.3605)	51.934 - 51.950 (2.0446 - 2.0453)
	Bearing size (Thickness at center)	2.027 - 2.030 (0.0798 - 0.0799)	2.029 - 2.032 (0.0799 - 0.0800)	1.520 - 1.523 (0.0598 - 0.0600)
0.25 (0.0098) Undersize	Journal O.D.	59.742 - 59.758 (2.3520 - 2.3527)	59.742 - 59.758 (2.3520 - 2.3527)	51.734 - 51.750 (2.0368 - 2.0374)
	Bearing size (Thickness at center)	2.127 - 2.130 (0.0837 - 0.0839)	2.129 - 2.132 (0.0838 - 0.0839)	1.620 - 1.623 (0.0638 - 0.0639)

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

Crankshaft thrust clearance:***Standard:***

0.030 - 0.115 mm (0.0012 - 0.0045 in)

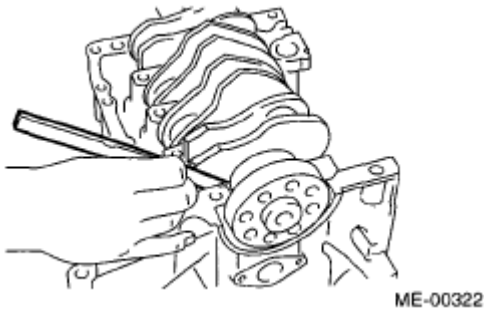


Fig. 242: Checking Crankshaft Thrust Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

Crankshaft oil clearance:***Standard:***

0.010 - 0.030 mm (0.0004 - 0.0012 in)

OIL SWITCHING SOLENOID VALVE

REMOVAL

RH SIDE

1. Disconnect the ground cable from battery.

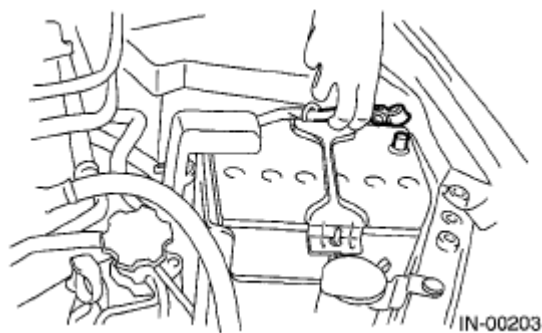


Fig. 243: Disconnecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake chamber. Refer to **REMOVAL** , Air Intake Chamber.
3. Remove the bolt, and disconnect the engine harness connector from the bulkhead harness connector and rear engine hanger.

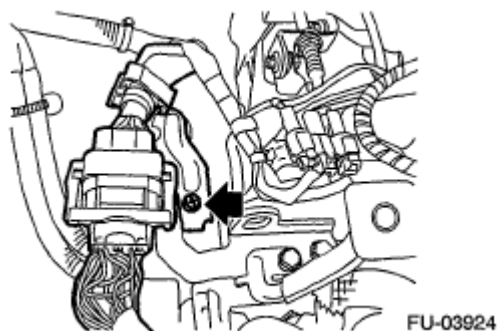


Fig. 244: Locating Engine Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

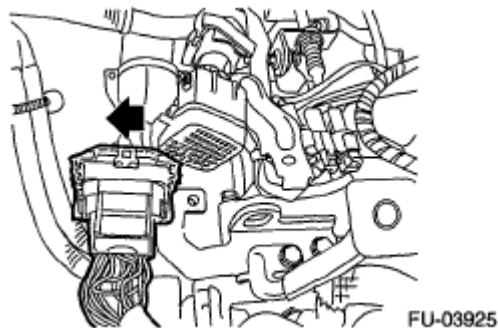
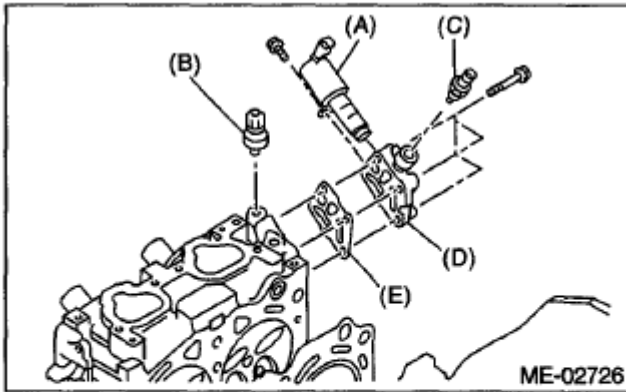


Fig. 245: Sliding Bulkhead Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Disconnect the connector from the oil switching solenoid valve.

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



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

Fig. 246: Identifying Oil Switching Solenoid Valve Holder And Gasket
Courtesy of SUBARU OF AMERICA, INC.

LH SIDE

1. Disconnect the ground cable from battery.

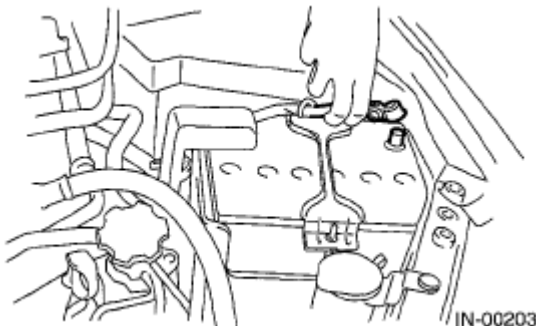
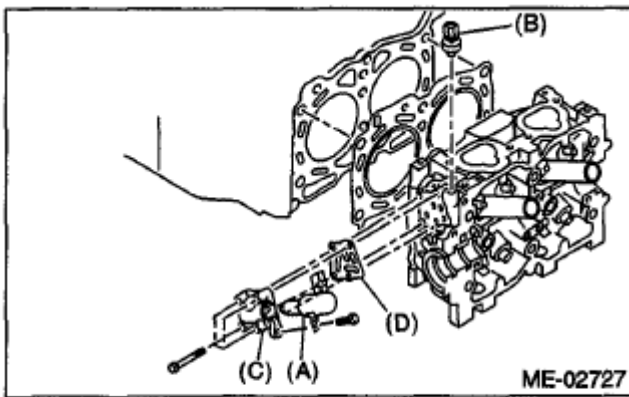


Fig. 247: Disconnecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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



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

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

INSTALLATION

RH SIDE

Install in the reverse order of removal.

NOTE:

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

Tightening torque:

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

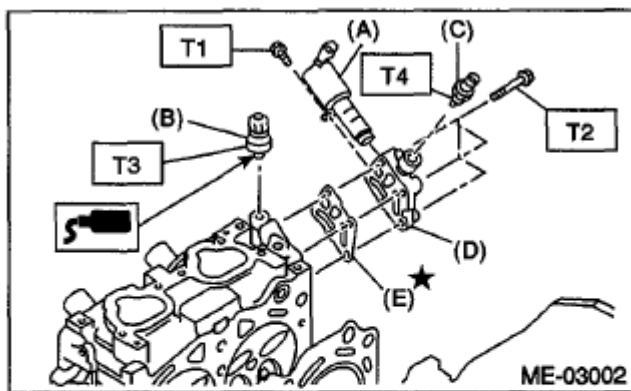
T2:10 N.m (1.0 kgf-m, 7.4 ft-lb)

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

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

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent



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

Fig. 249: Applying Liquid Gasket To Variable Valve Lift Diagnosis Oil Pressure Switch Threads
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

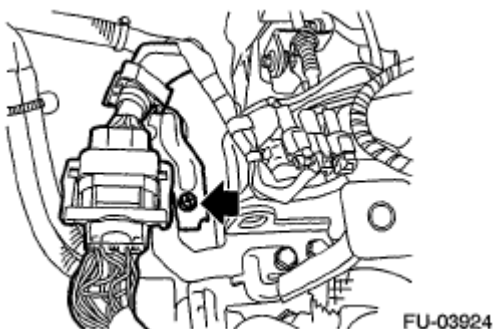


Fig. 250: Locating Engine Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

LH SIDE

Install in the reverse order of removal.

NOTE:

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

Tightening torque:

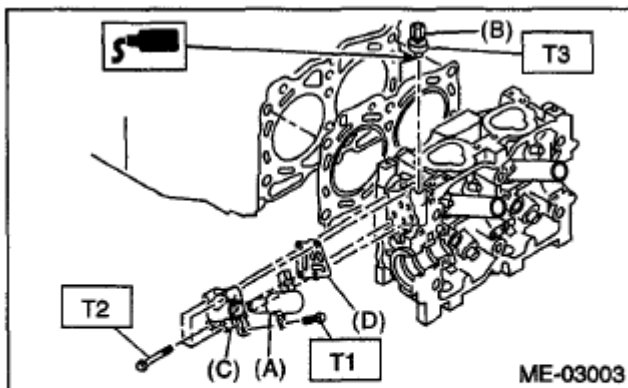
T1: 8 N.m (0.8 kgf-m, 5.9 ft-lb)

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

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

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent



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

Fig. 251: Identifying Oil Switching Solenoid Valve And Gasket
Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE

SPECIFICATION

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

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

ENGINE INSPECTION CHART

Symptom	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C

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1) Starter does not turn.		Defective inhibitor switch	C
		Defective starter	B
		Improper connection of terminal	A
	Battery	Run-down battery	A
		Defective charging system	B
	Friction	Seizure of crankshaft and connecting rod bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		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
3) Initial combustion occurs.	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		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
		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

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	Compression	Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
4) Engine stalls after initial combustion.	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		A
	Intake system	Loosened or cracked intake duct	B
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	C
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Dirty air cleaner element	C
	Fuel line	Clogged fuel line	C
		Lack of 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
	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	C
		Loosened oil filler cap	B
		Dirty air cleaner element	C
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of fuel or insufficient fuel	B

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

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		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
	Cooling system	Over-heating	C
		Over-cooling	C
	Others	Evaporative emission control system malfunction	A
4. Surging	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	B
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of 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 <u>BASIC DIAGNOSTIC PROCEDURE</u> .		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 <u>BASIC DIAGNOSTIC PROCEDURE</u> .		A
	Cooling system	Over-heating	B

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	Others	Evaporative emission control system malfunction	B
7. After burning in exhaust system	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		A
	Intake system	Loosened or cracked intake duct	C
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	B
		Defective PCV valve	B
		Loosened oil filler cap	C
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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 <u>BASIC DIAGNOSTIC PROCEDURE</u> .		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 PC V 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	Loosened oil pump attaching bolts and defective gasket	B
		Defective oil filter gasket	B
		Defective crankshaft oil seal	B

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	system	Defective rocker cover gasket	B
		Loosened oil drain plug or defective gasket	B
		Loosened oil pan fitting bolts or defective oil pan	B
10. Excessive fuel consumption	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		A
	Intake system	Dirty air cleaner element	A
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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

ENGINE INSPECTION CHART

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

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High-pitched clank (Spark knock)	Sound is noticeable when accelerating with an overload condition.	• Ignition timing advanced • Accumulation of carbon inside combustion chamber • Wrong heat range of spark plug • Improper octane value gasoline
Clank when engine speed is 1,000 to 2,000 RPM	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	• Worn crankshaft main bearing • Worn connecting rod bearing (large end)
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	• Worn cylinder liner and piston ring • Broken or stuck piston ring • Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	• Worn cam sprocket • Worn camshaft journal bore in cylinder head
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Poor contact of generator brush and rotor
Gear scream when starting engine	-	• Defective ignition starter switch • Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	• Loose V-belt • Defective water pump shaft
Hissing sound	-	• insufficient compression • Air leakage in air intake system, hose, connection or manifold
Timing belt noise	-	• Loose timing belt • Timing belt contacting with adjacent part
Valve noise	-	Incorrect valve clearance

NOTE:

(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 OPERATION , Clear Memory Mode and Inspection Mode Refer to PROCEDURE , Inspection Mode after connecting the fuel injector connector.