

2011 Subaru Impreza 2.5i

2011 ENGINE Engine Mechanical (H4SO) (Except WRX STi)

2011 ENGINE**Engine Mechanical (H4SO) (Except WRX STi)****GENERAL DESCRIPTION****SPECIFICATION****GENERAL SPECIFICATION CHART**

Engine	Model			2.5 L	
	Cylinder arrangement			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine	
	Valve system mechanism			Belt driven, single overhead camshaft, 4 valve/cylinder	
	Bore x Stroke		mm (in)	99.5 x 79.0 (3.92 x 3.11)	
	Displacement		cm ³ (cu in)	2, 457 (149.94)	
	Compression ratio			10.0	
	Compression pressure (at 200 - 300 rpm)		kPa (kg/cm ² , psi), Standard	1, 020 - 1, 275 (10.4 - 13.0, 148 - 185)	
	Number of piston rings			Pressure ring: 2, Oil ring: 1	
	Intake valve timing	Constant	Open	BTDC 0°	
			Close	ABDC 58°	
		Low speed	Open	BTDC 0°	
			Close	ABDC -10°	
		High speed	Open	BTDC 14°	
			Close	ABDC 62°	
	Exhaust valve timing		Open	BBDC 30°	
			Close	ATDC 14°	
	Valve clearance		Intake	0.20±0.04 (0.0079±0.0016)	
			Exhaust	0.25±0.04 (0.0098±0.0016)	
	Idling speed (Select lever is in "P" or "N" range on AT model; Gear shift lever is in neutral position on MT model.)		No load	Standard	AT model: 700±100
					MT model: 650±100
			A/C ON	Standard	850±100
	Ignition order			1 --> 3 --> 2 --> 4	
	Ignition timing		BTDC/rpm	Standard	AT model: 15°±10°/700
					MT model: 10°±8°/650

NOTE: US: Undersize OS: Oversize

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Belt tension adjuster	Adjuster rod protrusion amount			mm (in)	5.2 - 6.2 (0.205 - 0.244)	
Valve rocker arm	Clearance between arm and shaft		mm (in)	Standard	0.020 - 0.054 (0.0008 - 0.0021)	
	Rocker arm inside diameter		mm (in)	Standard	22.020 - 22.041 (0.8669 - 0.8678)	
	Rocker shaft diameter		mm (in)	Standard	21.987 - 22.000 (0.8656 - 0.8661)	
Camshaft	Bending limit			mm (in)	0.025 (0.00098)	
	Cam lobe height	Intake	mm (in)	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) or less	
	Oil clearance		mm (in)	Standard	0.055 - 0.090 (0.0022 - 0.0035)	
	Journal O.D.		mm (in)	Standard	31.928 - 31.945 (1.2570 - 1.2577)	
	Cylinder head journal I.D.		mm (in)	Standard	32.000 - 32.018 (1.2598 - 1.2605)	
	Thrust clearance		mm (in)	Standard	0.030 - 0.090 (0.0012 - 0.0035)	
Cylinder head	Warping limit (mating surface with cylinder block)			mm (in)	0.035 (0.0014)	
	Grinding limit			mm (in)	0.1 (0.004)	
	Standard height			mm (in)	97.5 (3.84)	
Valve seat	Seating angle between valve and valve seat				90°	
	Contacting width between valve and valve seat	mm (in)	Intake	Standard	0.8 - 1.4 (0.03 - 0.055)	
			Exhaust	Standard	1.2 - 1.8 (0.047 - 0.071)	
Valve guide	Clearance between the valve guide and valve stem	mm (in)	Intake	Standard	0.035 - 0.062 (0.0014 - 0.0024)	
			Exhaust	Standard	0.040 - 0.067 (0.0016 - 0.0026)	
	Inside diameter			mm (in)	6.000 - 6.012 (0.2362 - 0.2367)	
				Intake	5.950 - 5.965 (0.2343 - 0.2348)	

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	Valve stem outer diameters		mm (in)	Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
	Valve guide protrusion amount		mm (in)	Intake	20.3 - 20.7 (0.799 - 0.815)
				Exhaust	16.8 - 17.2 (0.661 - 0.677)
Valve	Head edge thickness	mm (in)	Intake	Standard	0.8 - 1.2 (0.03 - 0.047)
			Exhaust	Standard	1.0 - 1.4 (0.039 - 0.055)
	Overall length	mm (in)	Intake		120.6 (4.75)
Exhaust				121.7 (4.79)	
Valve spring	Free length			mm (in)	55.2 (2.173)
	Tension/spring height	N (kgf, lb)/mm (in)	Set		235.3 - 270.7 (24 - 27.6, 52.9 - 60.8)/ 45.0 (1.772)
			Lift		578.9 - 639.9 (59.1 - 65.3, 130.3 - 143.9)/34.7 (1.366)
	Squareness				2.5°, 2.4 mm (0.094 in) or less
Cylinder block	Warping limit (mating surface with cylinder head)			mm (in)	0.025 (0.00098)
	Grinding limit			mm (in)	0.1 (0.004)
	Standard height			mm (in)	201.0 (7.91)
	Cylindricity		mm (in)	Standard	0.015 (0.0006)
	Out-of-roundness		mm (in)	Standard	0.010 (0.0004)
	Clearance between cylinder and piston at 20°C (68°F)		mm (in)	Standard	-0.010 - 0.010 (-0.00039 - 0.00039)
	Cylinder inner diameter boring limit (diameter)			mm (in)	To 100.005 (3.9372)
Piston	Piston grade point			mm (in)	38.2 (1.504)
	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 pin hole and piston pin		mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)
		Top ring	Standard		0.20 - 0.35 (0.0079 - 0.0138)
		Second			0.37 - 0.52 (0.0146 -

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Piston ring	Piston ring gap	mm (in)	ring	Standard	0.0205)	
			Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)	
	Clearance between piston ring and piston ring groove	mm (in)	Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)	
			Second ring	Standard	0.030 - 0.070 (0.0012 - 0.0028)	
Connecting rod and connecting rod bearing	Bend or twist per 100 mm (3.94 in) in length		mm (in)	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)	
	Bending limit		mm (in)		0.035 (0.0014)	
	Crank pin		Out-of-roundness	mm (in)	Standard	0.003 (0.0001)
			Cylindricality	mm (in)	Standard	0.004 (0.0002)
			Grinding limit (dia.)		mm (in)	To 51.750 (2.0374)
	Crank journal		Out-of-roundness	mm (in)	Standard	0.005 (0.0002)
			Cylindricality	mm (in)	Standard	0.006 (0.0002)
			Grinding limit (dia.)		mm (in)	To 59.758 (2.3527)
	Crank pin outer diameter		mm (in)	Standard		51.984 - 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			Standard		59.992 - 60.008 (2.3619 - 2.3625)
				0.03 (0.0012) US		59.962 - 59.978 (2.3607 - 2.3613)

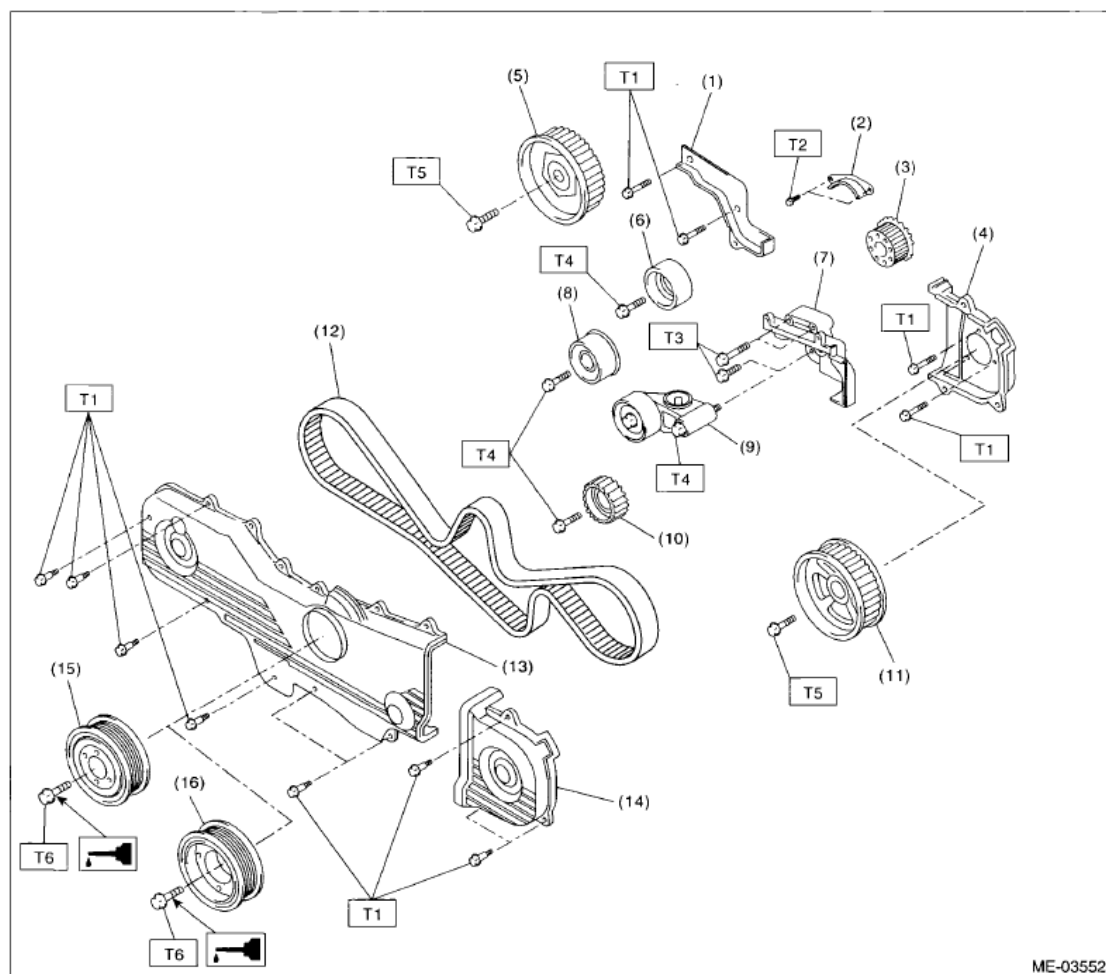
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Crankshaft and crankshaft bearing	diameter		mm (in)	0.05 (0.0020) US	59.942 - 59.958 (2.3599 - 2.3605)
				0.25 (0.0098) US	59.742 - 59.758 (2.3520 - 2.3527)
	Bearing size (Thickness of center)	#1, #3		Standard	1.998 - 2.011 (0.0787 - 0.0792)
				0.03 (0.0012) US	2.017 - 2.020 (0.0794 - 0.0795)
				0.05 (0.0020) US	2.027 - 2.030 (0.0798 - 0.0799)
				0.25 (0.0098) US	2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #5		Standard	2.000 - 2.013 (0.0787 - 0.0793)
				0.03 (0.0012) US	2.019 - 2.022 (0.0795 - 0.0796)
				0.05 (0.0020) US	2.029 - 2.032 (0.0799 - 0.0800)
				0.25 (0.0098) US	2.129 - 2.132 (0.0838 - 0.0839)
	Thrust clearance		mm (in)	Standard	0.030 - 0.115 (0.0012 - 0.0045)
Oil clearance		mm (in)	Standard	0.010 - 0.030 (0.0004 - 0.0012)	

COMPONENT

TIMING BELT



ME-03552

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

Fig. 1: Exploded View Of 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)

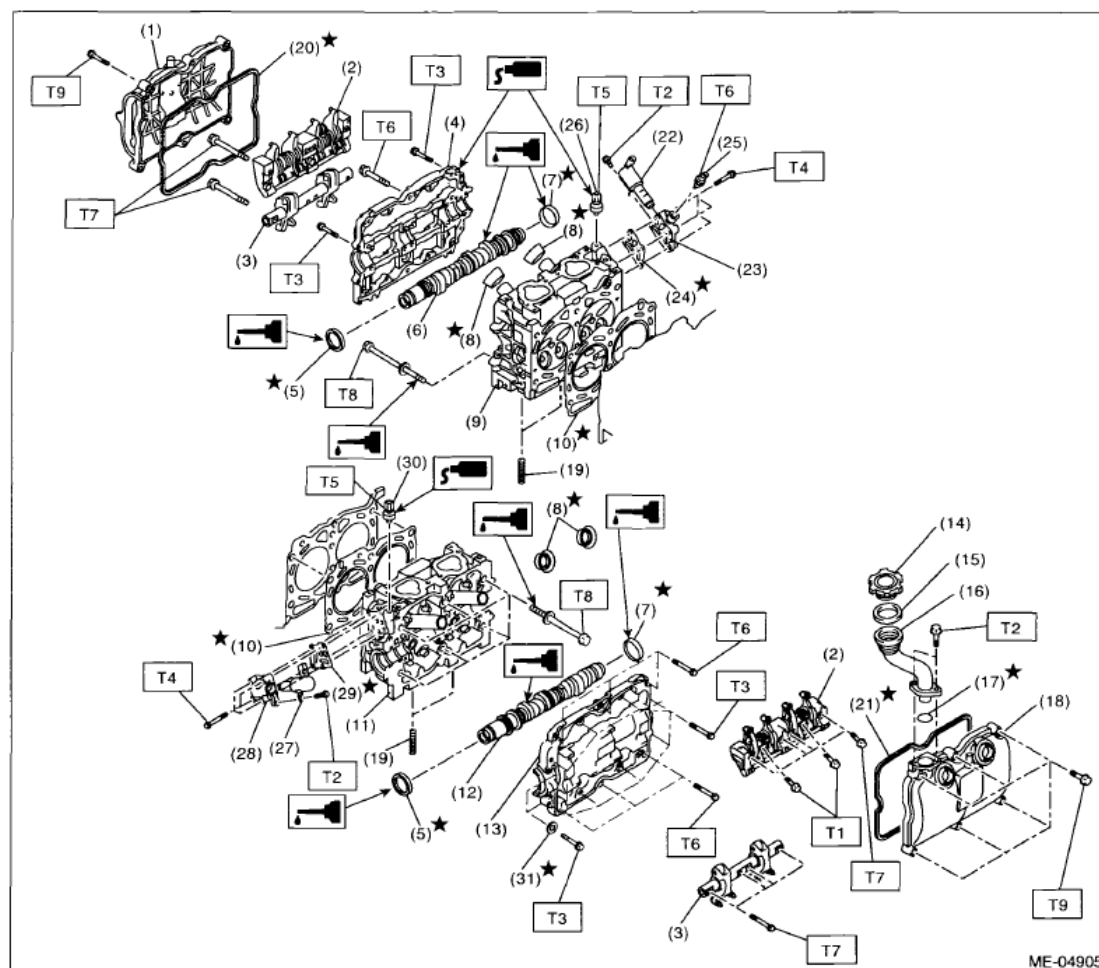
T3: 24.5 (2.5, 18.1)

T4: 39 (4.0, 28.8)

T5: 78 (8.0, 57.5)

T6: < Ref. to INSTALLATION, Crank Pulley. >

CYLINDER HEAD AND CAMSHAFT



ME-04905

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

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

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

T1: 6 (0.6, 4.4)

T2: 6.4 (0.7, 4.7)

T3: 9.75 (1.0, 7.2)

T4: 10 (1.0, 7.4)

T5: 17 (1.7, 12.5)

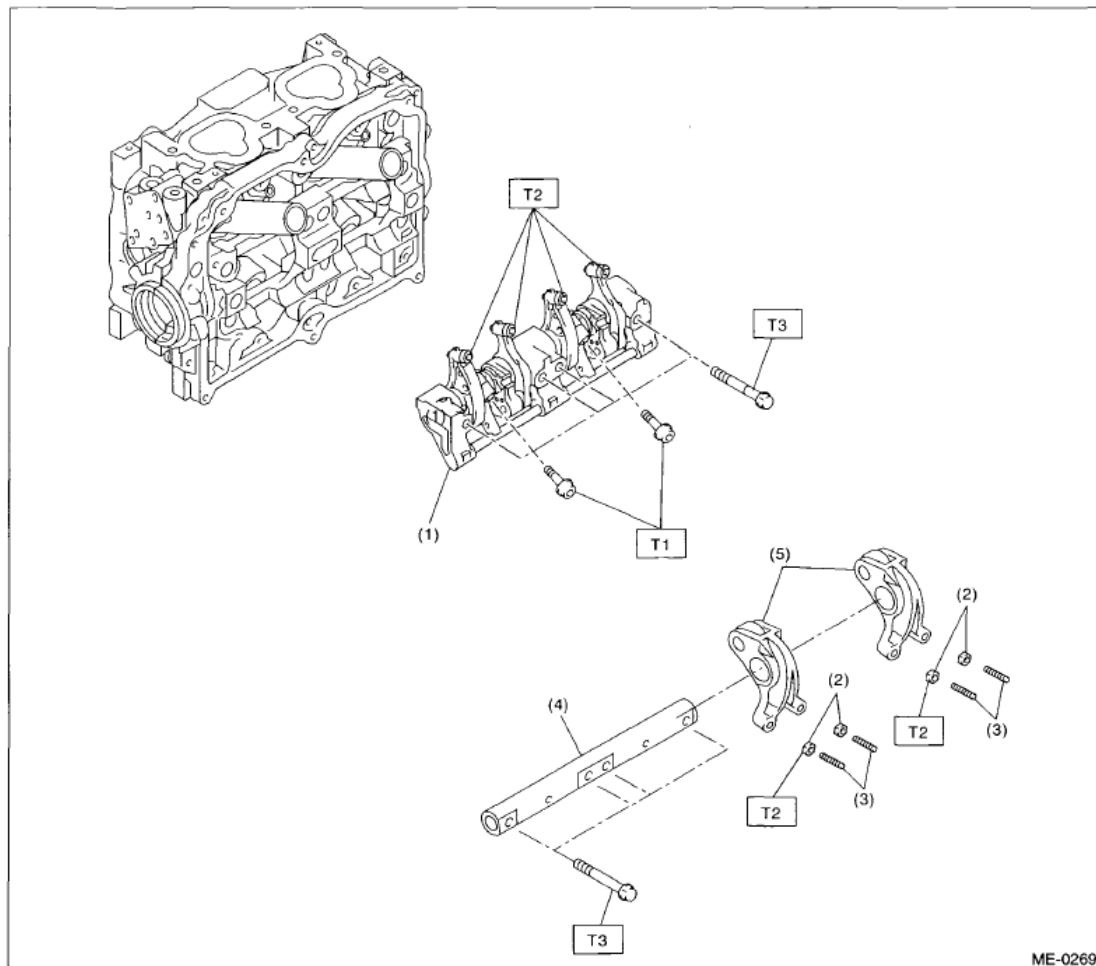
T6: 18 (1.8, 13.3)

T7: 25 (2.5, 18.4)

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

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

VALVE ROCKER ASSY



- | | |
|----------------------------------|------------------------------|
| (1) Intake valve rocker ASSY | (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.

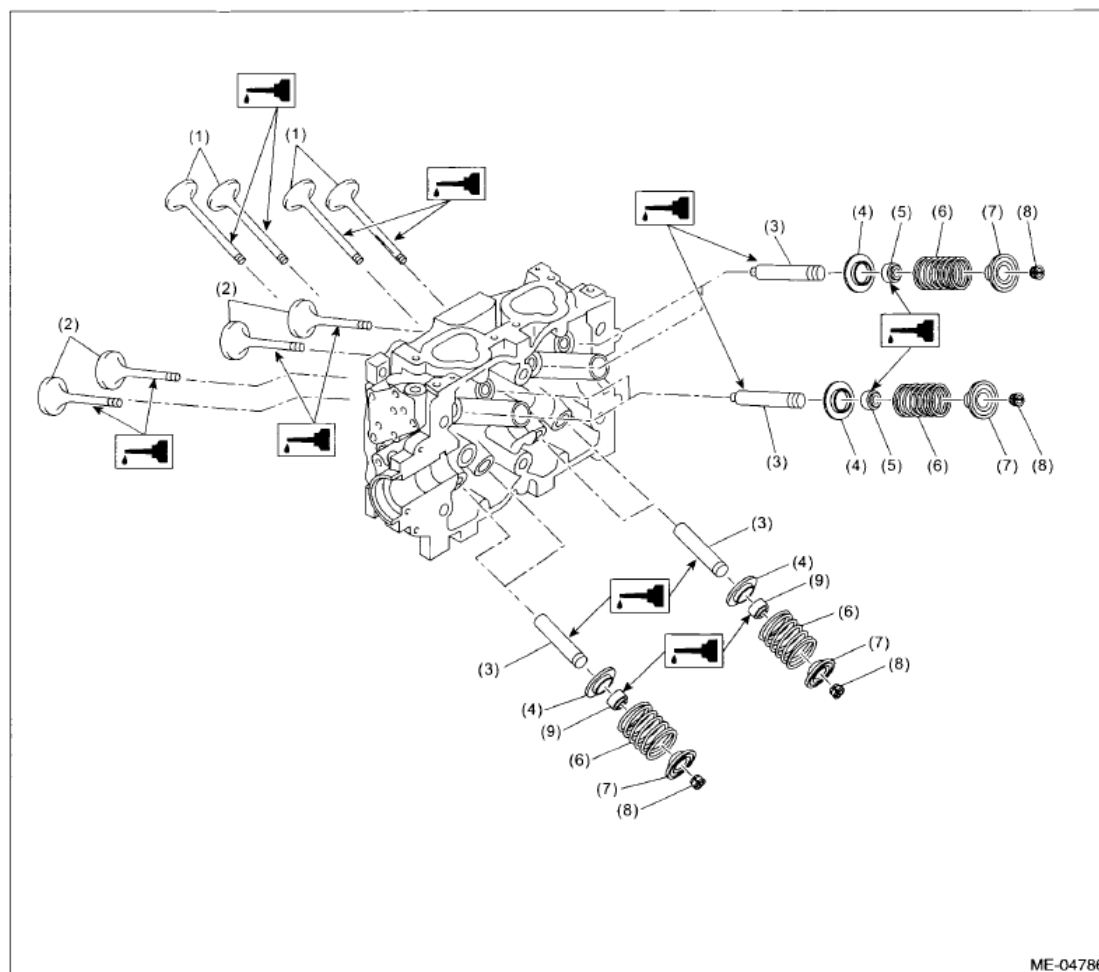
Tightening torque: N.m (kgf-m, ft-lb)

T1: 6 (0.6, 4.4)

T2: 9.75 (1.0, 7.2)

T3: 25 (2.5, 18.4)

CYLINDER HEAD AND VALVE ASSEMBLY



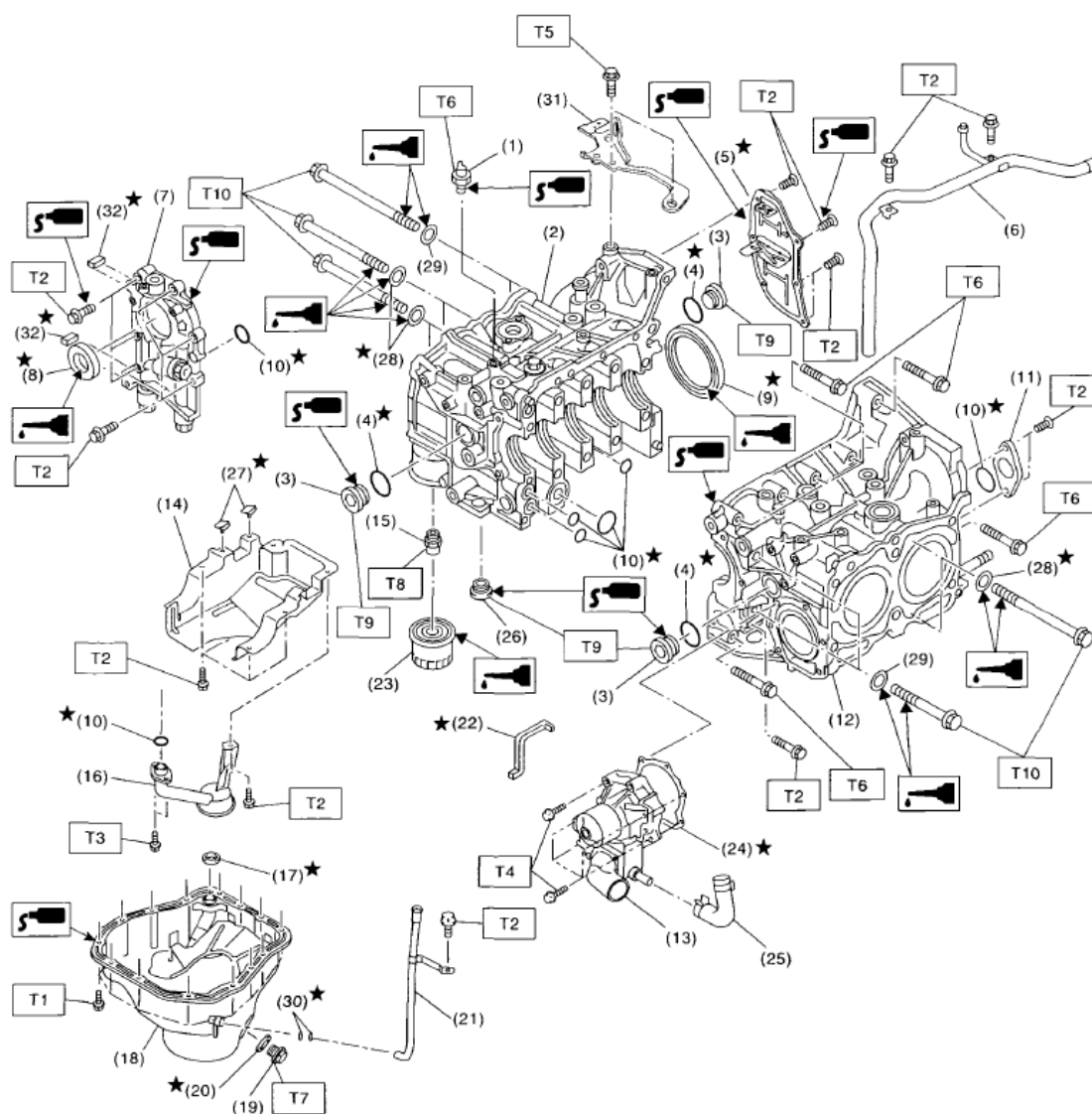
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|-------------------|---------------------------|----------------------------|
| (1) Exhaust valve | (4) Valve spring seat | (7) Retainer |
| (2) Intake valve | (5) Intake valve oil seal | (8) Retainer key |
| (3) Valve guide | (6) Valve spring | (9) 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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ME-04824

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

Fig. 5: Exploded View Of 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: First 12 (1.2, 8.9) Second 12 (1.2, 8.9)

T5: 16 (1.6, 11.8)

T6: 25 (2.5, 18.4)

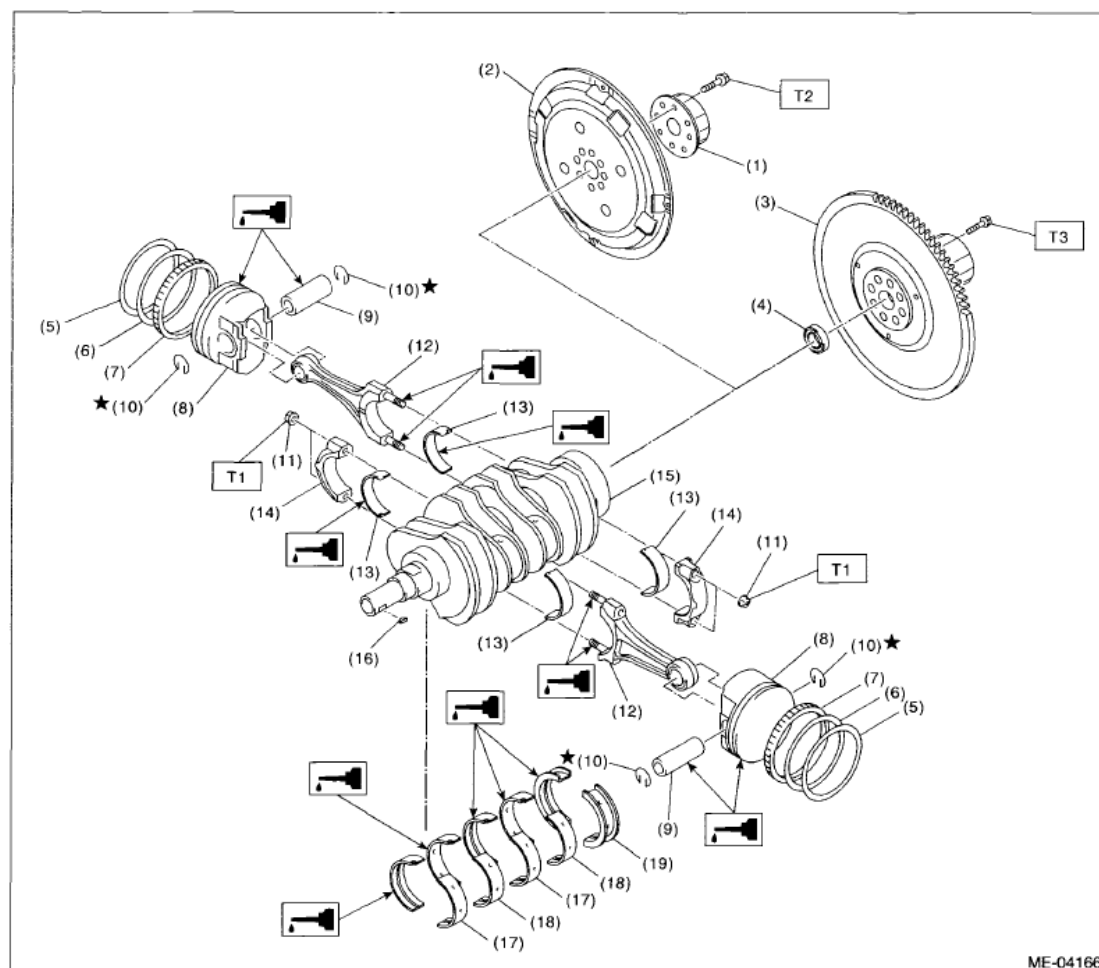
T7: 44 (4.5, 32.5)

T8: 45 (4.6, 33.2)

T9: 70 (7.1, 51.6)

T10: < Ref. to INSTALLATION, Cylinder Block. >

CRANKSHAFT AND PISTON



- | | | |
|------------------------------|-----------------------------|--------------------------------|
| (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: Exploded View Of Crankshaft And Piston Components
Courtesy of SUBARU OF AMERICA, INC.

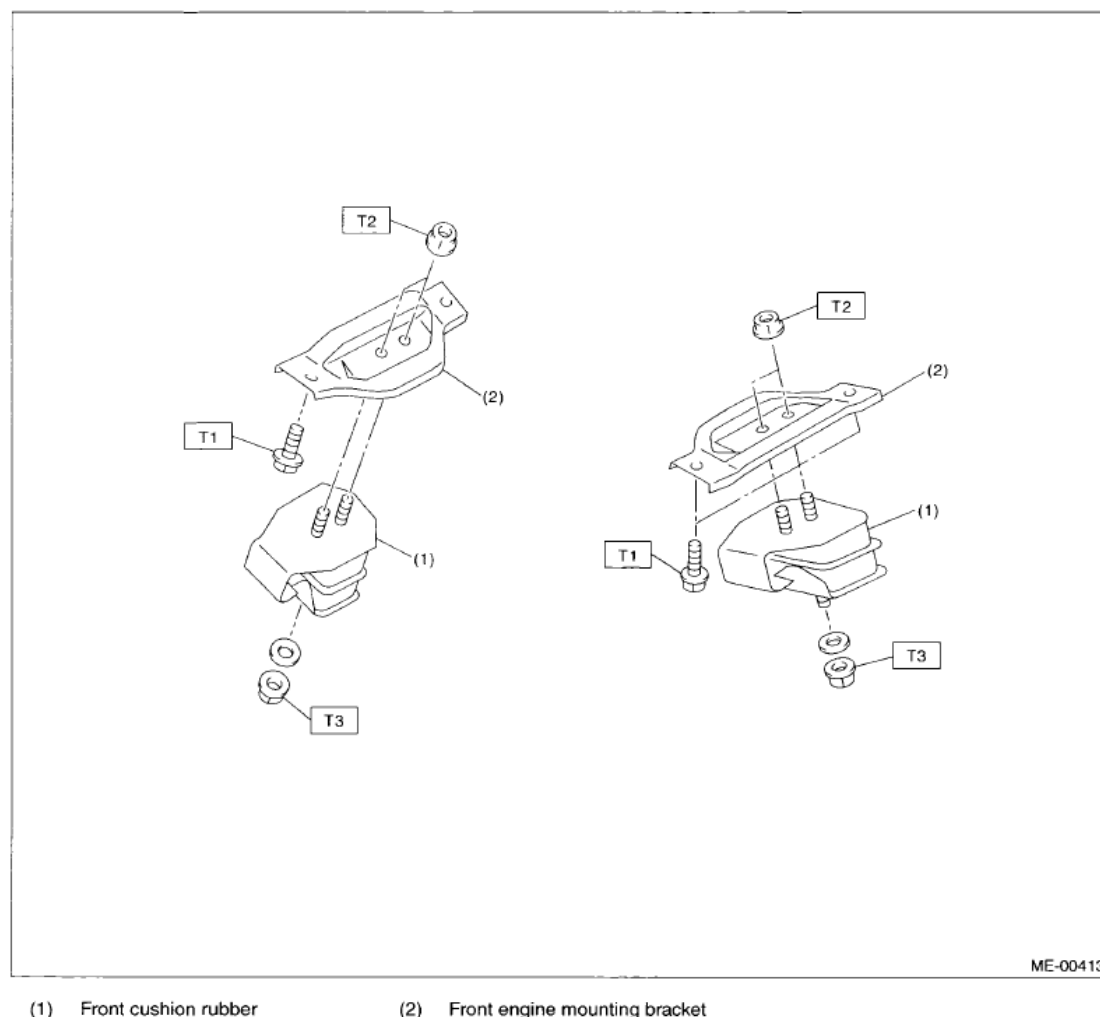
Tightening torque: N.m (kgf-m, ft-lb)

T1: 45 (4.6, 33.2)

T2: < Ref. to INSTALLATION , Drive Plate. >

T3: < Ref. to INSTALLATION , Flywheel. >

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,

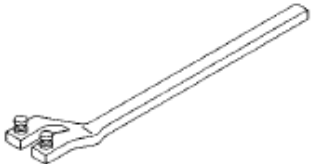
installation, disassembly and replacement.

- 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 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

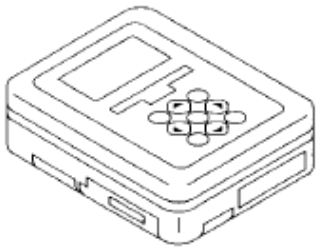
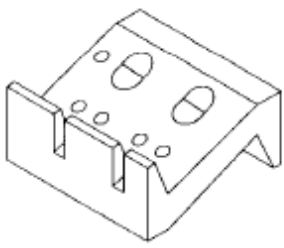
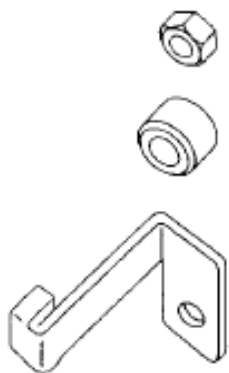
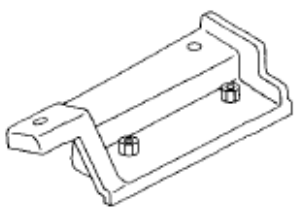
SPECIAL TOOL

SPECIAL TOOL DESCRIPTION CHART

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18231AA010	18231AA010	CAM SPROCKET WRENCH	• Used for removing and installing cam sprocket. (LH side) • CAM SPROCKET WRENCH (499207100) can also be used.
	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for various inspections.

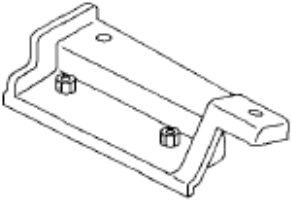
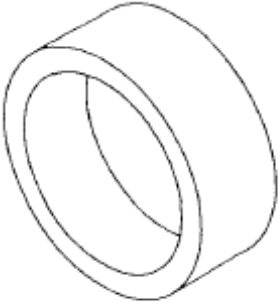
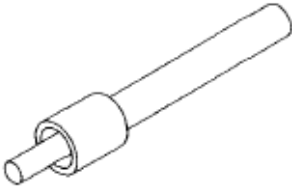
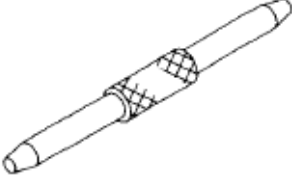
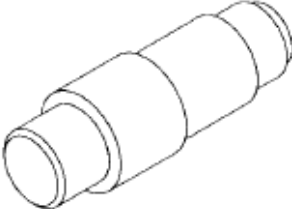
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 ST1B022XU0			
 ST-498267800	498267800	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498277200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST-498457000	498457000	ENGINE STAND ADAPTER RH	Used together with ENGINE STAND (499817100).
	498457100	ENGINE STAND ADAPTER LH	Used together with ENGINE STAND (499817100).

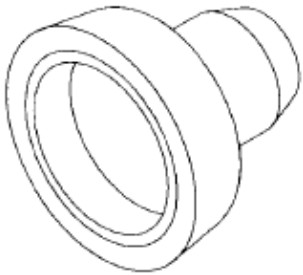
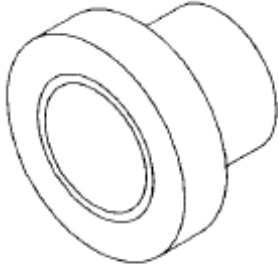
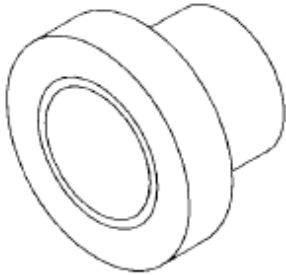
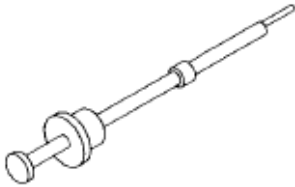
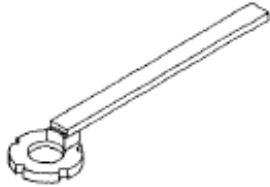
2011 Subaru Impreza 2.5i

2011 ENGINE Engine Mechanical (H4SO) (Except WRX STi)

 ST-498457100			
 ST-498747300	498747300	PISTON GUIDE	Used for installing piston in cylinder.
 ST-498857100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST-499017100	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST-499037100	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.

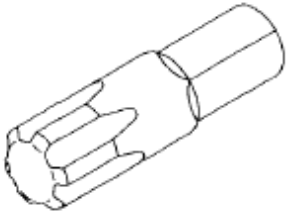
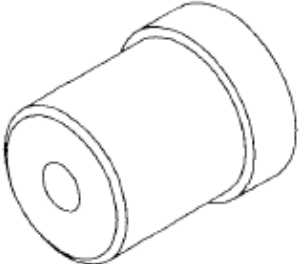
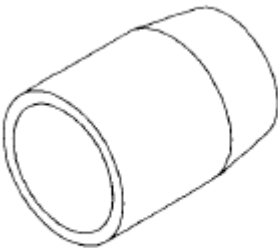
2011 Subaru Impreza 2.5i

2011 ENGINE Engine Mechanical (H4SO) (Except WRX STi)

 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499587500	499587500	OIL SEAL INSTALLER	• Used for installing the camshaft oil seal. • Used together with OIL SEAL GUIDE (499597000).
 ST-499587700	499587700	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.
 ST18320AA010	18320AA010	PISTON PIN REMOVER ASSY	• Used for removing piston pin. • PISTON PIN REMOVER ASSY (499097700) can also be used.
 ST-499207400	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (RH side)

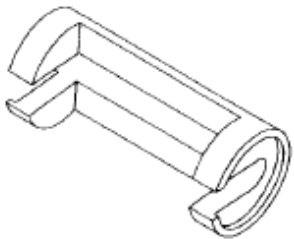
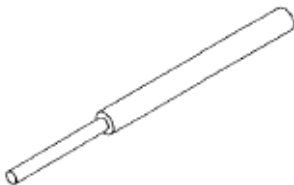
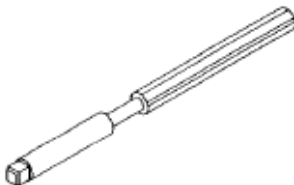
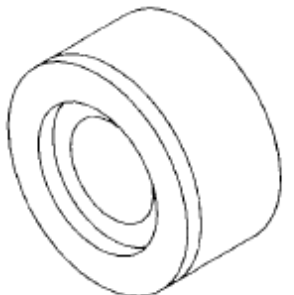
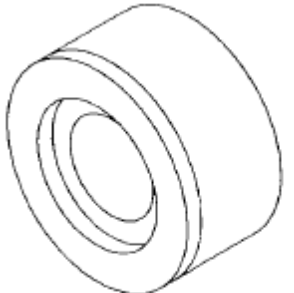
2011 Subaru Impreza 2.5i

2011 ENGINE Engine Mechanical (H4SO) (Except WRX STi)

 ST-499497000	499497000	TORX® PLUS	Used for removing and installing camshaft cap.
 ST-499587100	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499597000	499597000	OIL SEAL GUIDE	• Used for installing the camshaft oil seal. • Used together with CAMSHAFT OIL SEAL INSTALLER (499587500).
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring

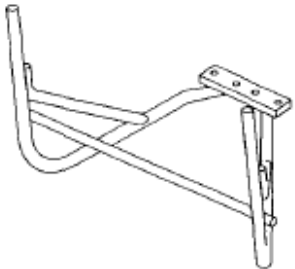
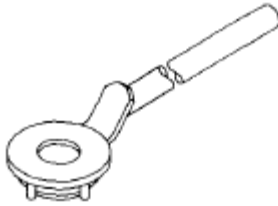
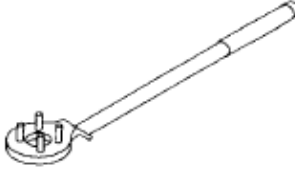
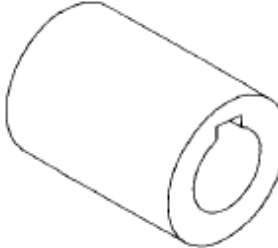
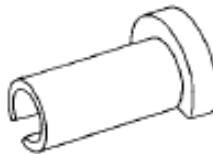
2011 Subaru Impreza 2.5i

2011 ENGINE Engine Mechanical (H4SO) (Except WRX STi)

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

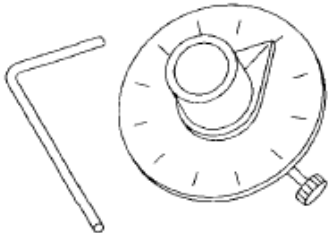
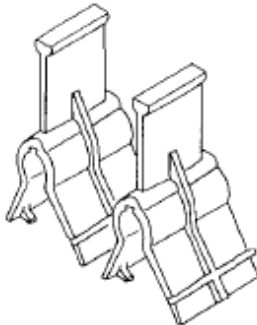
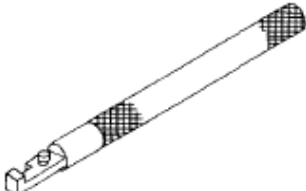
2011 Subaru Impreza 2.5i

2011 ENGINE Engine Mechanical (H4SO) (Except WRX STi)

 ST-499817100	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-499977100	499977100	CRANK PULLEY WRENCH	Used to stop rotation of the crank pulley when loosening or tightening crank pulley bolts. (MT model)
 ST-499987500	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST42099AE000	42099AE000	QUICK CONNECTOR RELEASE	Used for removing the quick connector.

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2011 ENGINE Engine Mechanical (H4SO) (Except WRX STi)

 ST18854AA000	18854AA000	ANGLE GAUGE	Used for installing the crank pulley.
 ST18354AA000	18354AA000	VALVE ROCKER HOLDER	Used for installing the valve rocker assembly (intake). (2-piece set)
 ST18258AA000	18258AA000	SPRING INSTALLER	Used for installing the valve rocker assembly (intake).

GENERAL TOOL

SPECIAL TOOL DESCRIPTION CHART

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

COMPRESSION

INSPECTION

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

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

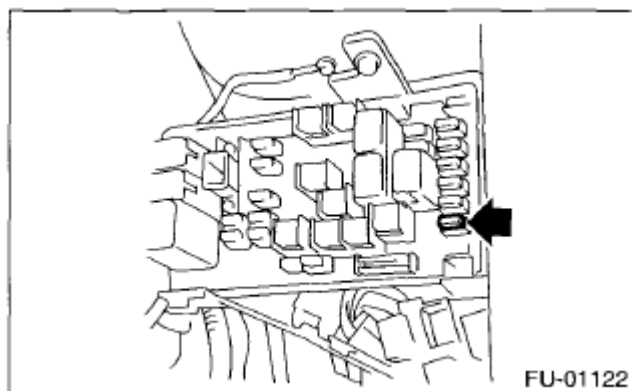


Fig. 8: Locating Fuel Pump Fuse
 Courtesy of SUBARU OF AMERICA, INC.

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

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

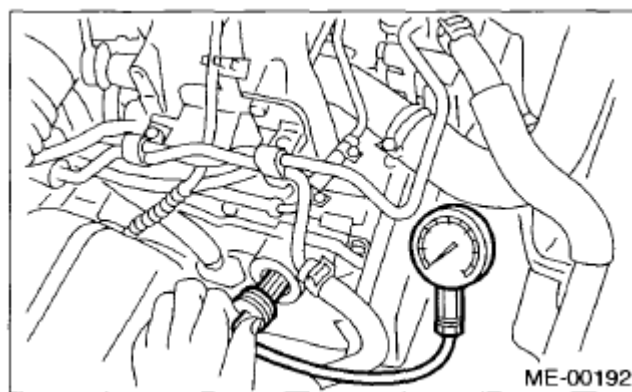


Fig. 9: Checking Compression
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

Compression (fully open throttle):

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

Difference between cylinders 49 kPa (0.5 kgf/cm² , 7 psi) or less

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

IDLE SPEED

INSPECTION

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

NOTE:

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

1. Check the idle speed when no-loaded. (Headlight, heater fan, rear defroster, radiator fan, A/C and etc. are OFF)

Idling speed (At no load; Select lever is in "P" or "N" range on AT model; Gear shift lever is in neutral position on MT model.):

Standard

700±100 rpm (AT model)

650±100 rpm (MT model)

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

Idling speed (With A/C "ON"; Select lever is in "P" or "N" range on AT model; Gear shift lever is in neutral position on MT model.):

Standard 850±100 rpm

IGNITION TIMING

INSPECTION

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

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. 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]:

Standard

15°±10°/700 (AT model)

10°±8°/650 (MT model)

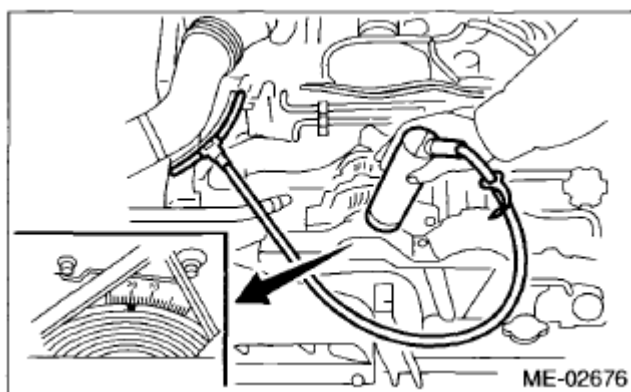


Fig. 10: Checking Ignition Timing

Courtesy of SUBARU OF AMERICA, INC.

NOTE: If ignition timing is out of standard, check the ignition control system. < Ref. 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.

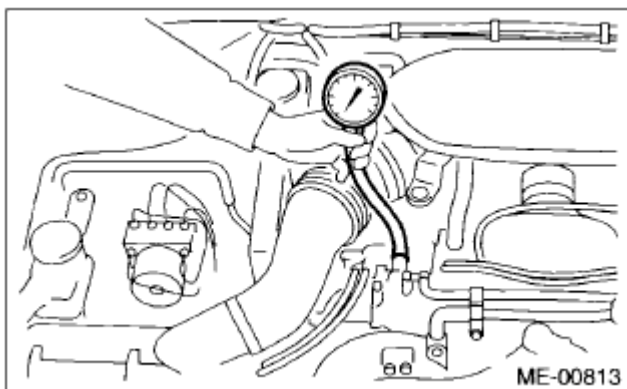


Fig. 11: Installing Vacuum Gauge Into Intake Manifold

Courtesy of SUBARU OF AMERICA, INC.

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

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

Intake manifold vacuum (at idling, A/C OFF): -60.0 kPa (-450 mmHg, -17.72 inHg) or more

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

POSSIBLE ENGINE CONDITION CHART

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

ENGINE OIL PRESSURE

INSPECTION

- Disconnect the ground cable from battery.

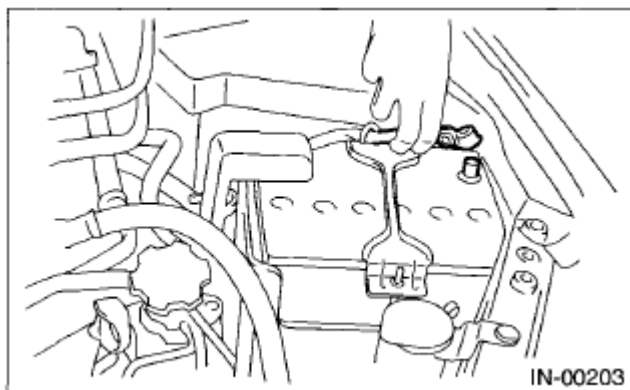


Fig. 12: Disconnecting Ground Cable From Battery
 Courtesy of SUBARU OF AMERICA, INC.

- Remove the oil pressure switch. < Ref. to **REMOVAL** , Oil Pressure Switch. >
- Install the oil pressure gauge to cylinder block.

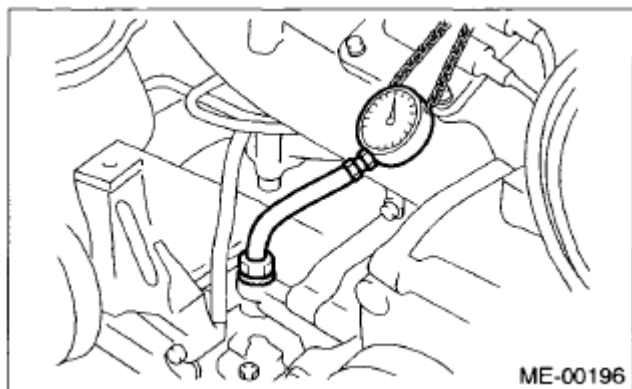


Fig. 13: Installing Oil Pressure Gauge To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

4. Connect the battery ground terminal.

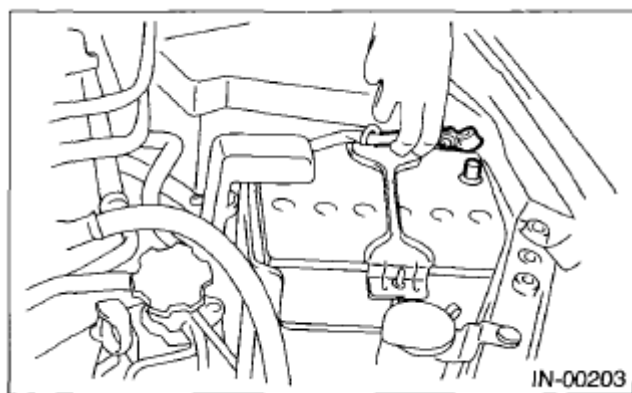


Fig. 14: Connecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- Standard value is based on an engine oil temperature of 80°C (176°F).
- If the oil pressure is out of specification, check oil pump, oil filter and lubrication line. < Ref. to INSPECTION , Engine Lubrication System Trouble in General. >
- If the oil pressure warning light is ON and oil pressure is within specification, check the oil pressure switch. < Ref. to INSPECTION , Engine Lubrication System Trouble in General. >

Engine oil pressure:

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

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

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

FUEL PRESSURE

INSPECTION

CAUTION:

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

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

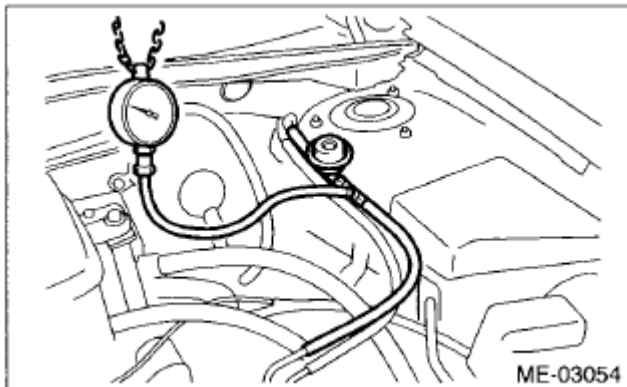


Fig. 15: Connecting Fuel Pressure Gauge To Fuel Damper
Courtesy of SUBARU OF AMERICA, INC.

4. Start the engine.
5. Check 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.
- Check or replace the fuel pump and fuel delivery line if the fuel pressure is out of the standard.

Fuel pressure:

Standard 340 - 400 kPa (3.5 - 4.1 kgf/cm² , 49 - 58 psi)

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

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

VALVE CLEARANCE

INSPECTION

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 of valve clearance should be performed while engine is cold.

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

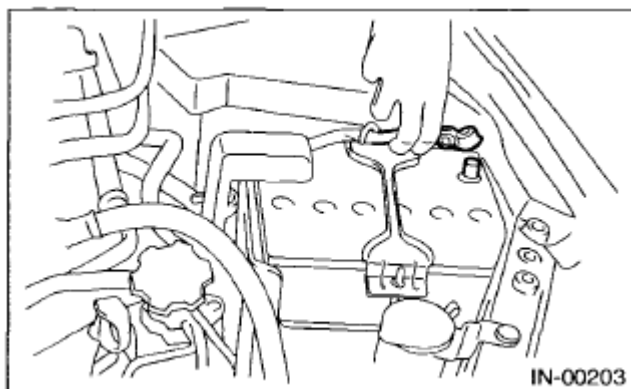


Fig. 16: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the timing belt cover LH.

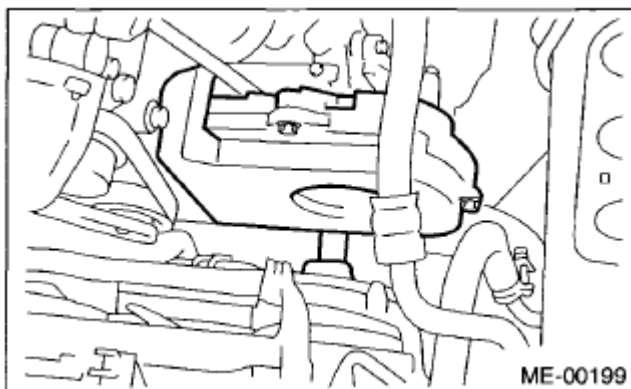


Fig. 17: Identifying Timing Belt Cover LH
Courtesy of SUBARU OF AMERICA, INC.

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

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

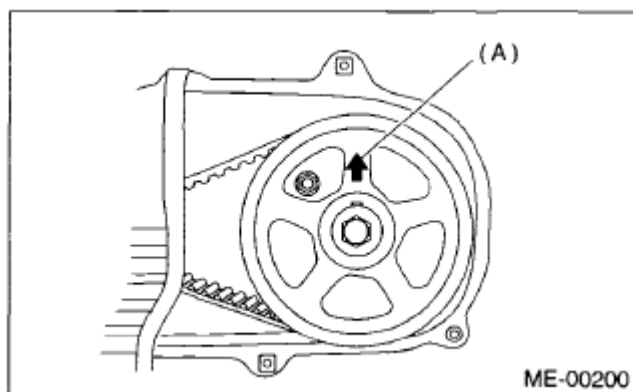


Fig. 18: Identifying Mark On Cam Sprocket LH
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- Insert the thickness gauge (A) in as horizontally as possible with respect to the valve stem end face.
- Lift up the vehicle, and then measure the exhaust valve clearances.
- If the measured value is not within the inspection value, take notes of

the value in order to adjust the valve clearance later on.

Valve clearance (inspection value):

Intake 0.20 ± 0.04 mm (0.0079 ± 0.0016 in)

Exhaust 0.25 ± 0.04 mm (0.0098 ± 0.0016 in)

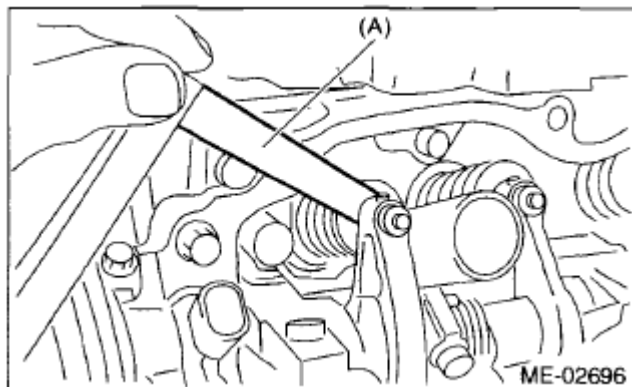


Fig. 19: Measuring #1 Cylinder Valve Clearance Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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

NOTE: Use a new rocker cover gasket.

ADJUSTMENT

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

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

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

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

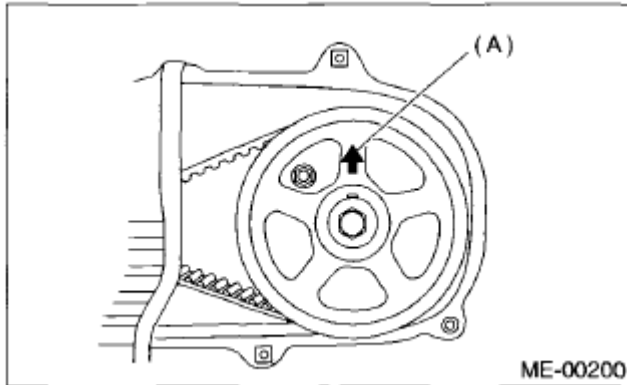


Fig. 20: Identifying Mark On Cam Sprocket LH
 Courtesy of SUBARU OF AMERICA, INC.

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)

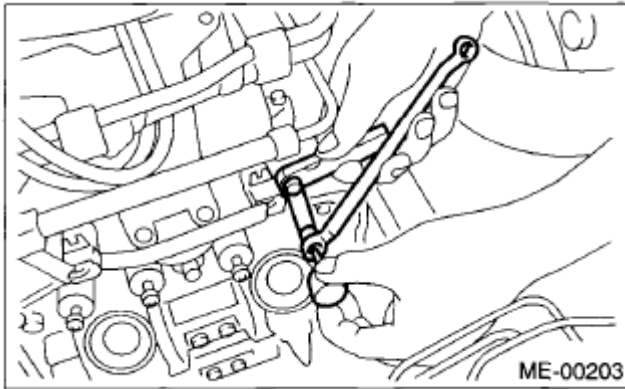


Fig. 21: Tightening Valve Rocker Adjusting Screw
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rocker cover gasket.

ENGINE ASSEMBLY

REMOVAL

1. 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)

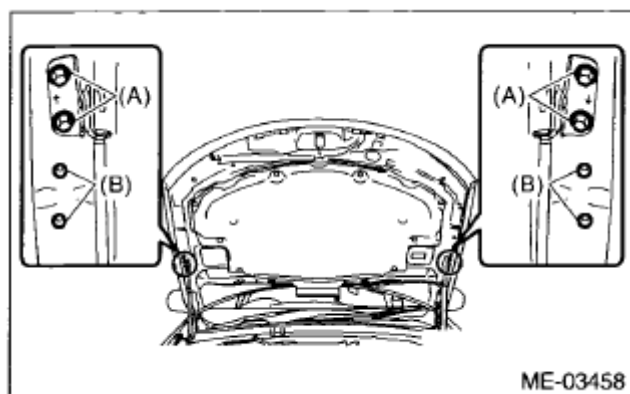


Fig. 22: Identifying Front Hood Bolts

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the V-belt covers.

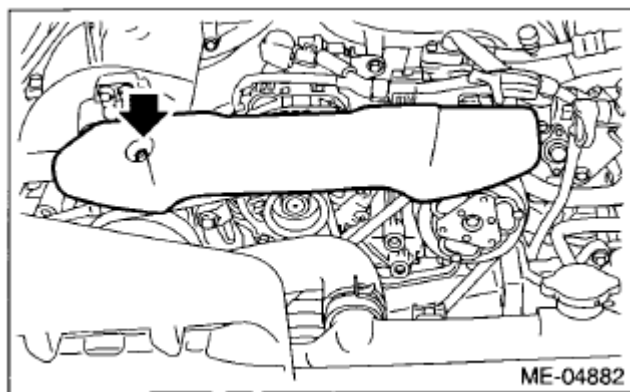


Fig. 23: Locating V-Belt Cover Screw

Courtesy of SUBARU OF AMERICA, INC.

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

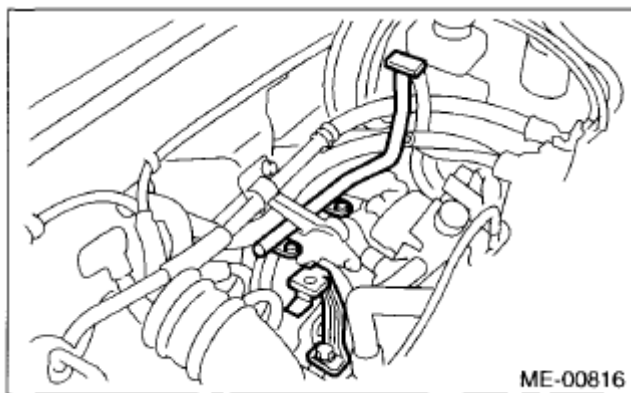


Fig. 24: Identifying Air Intake Chamber Stay
Courtesy of SUBARU OF AMERICA, INC.

13. 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.

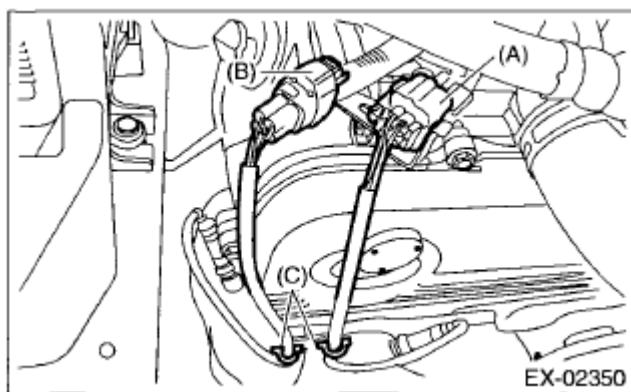


Fig. 25: Identifying Front Oxygen (A/F) Sensor Connector And Rear Oxygen Sensor Connector With Clip
Courtesy of SUBARU OF AMERICA, INC.

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

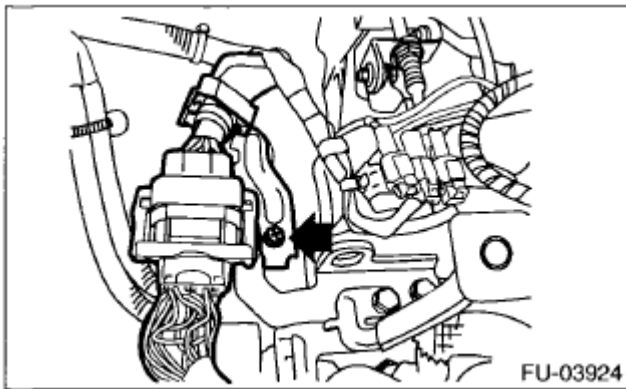


Fig. 26: Locating Engine Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

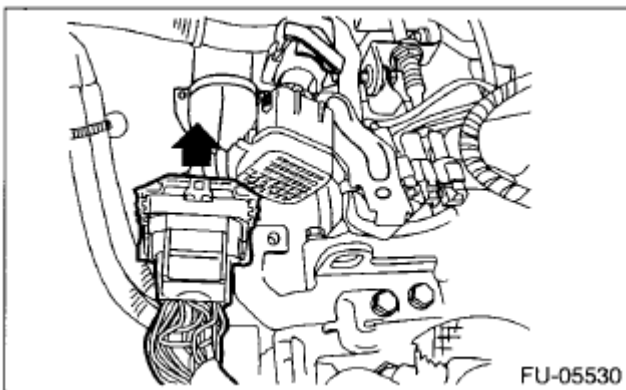


Fig. 27: Sliding Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

4. Generator connector and terminal

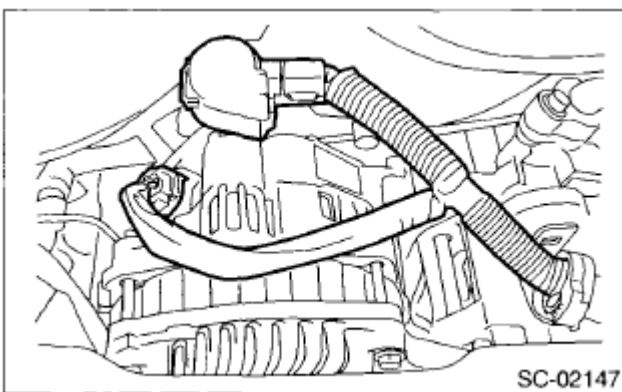


Fig. 28: Identifying Generator Connector And Terminal

Courtesy of SUBARU OF AMERICA, INC.

5. A/C compressor connector

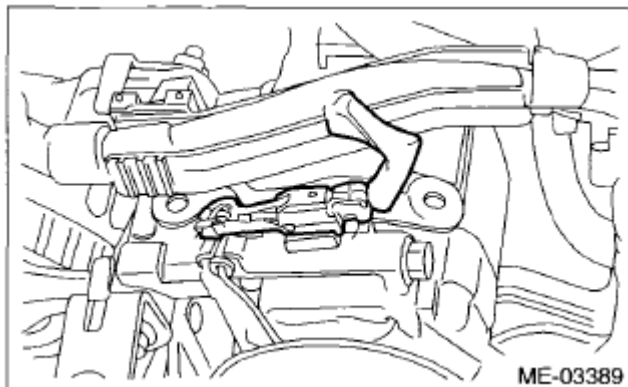


Fig. 29: Identifying A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

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

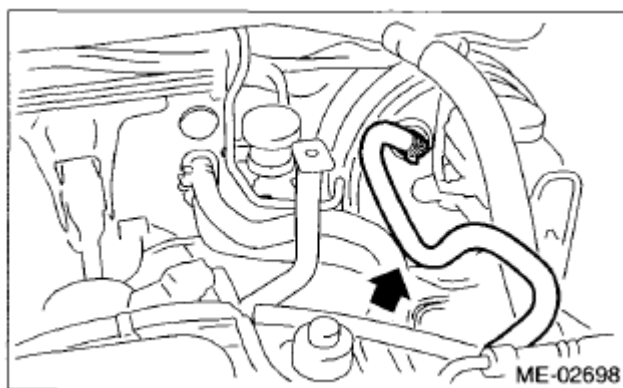


Fig. 30: Locating Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

2. Heater inlet and outlet hoses
15. Remove the power steering pump from the engine.
 1. Remove the front side belts. < Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt. >
 2. Power steering pump switch connector

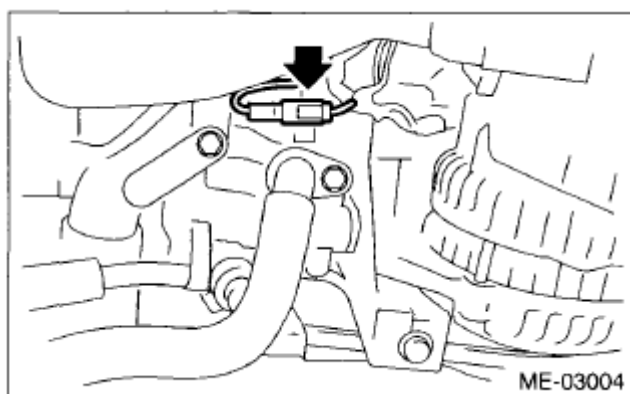


Fig. 31: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the bolts which secure the power steering pump to the bracket.

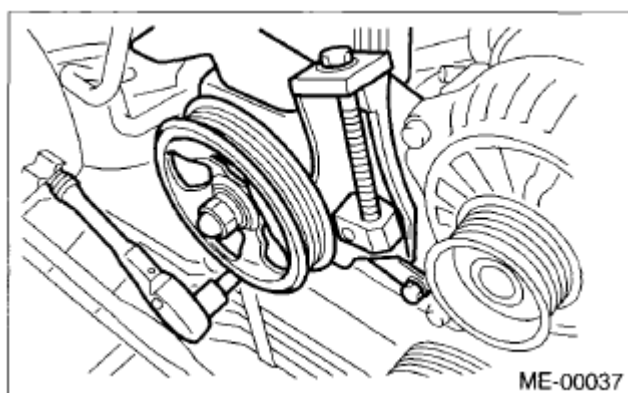


Fig. 32: Identifying Power Steering Pump And Bracket With Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

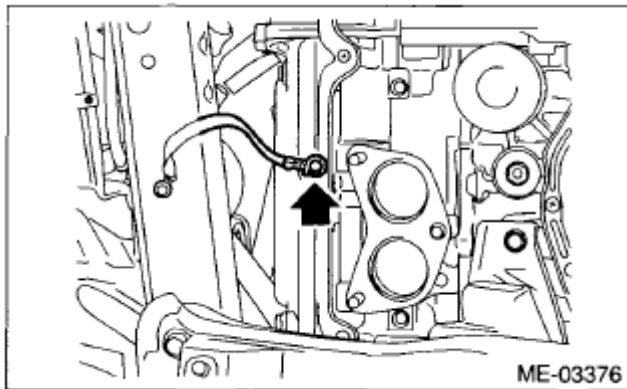


Fig. 33: Locating Ground Cable With Bolt (1 Of 2)
Courtesy of SUBARU OF AMERICA, INC.

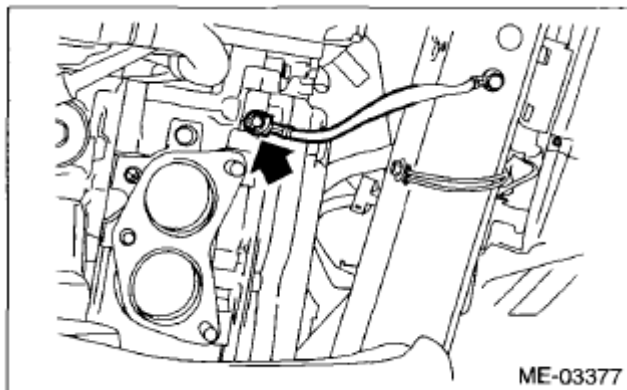


Fig. 34: Locating Ground Cable With Bolt (2 Of 2)
Courtesy of SUBARU OF AMERICA, INC.

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

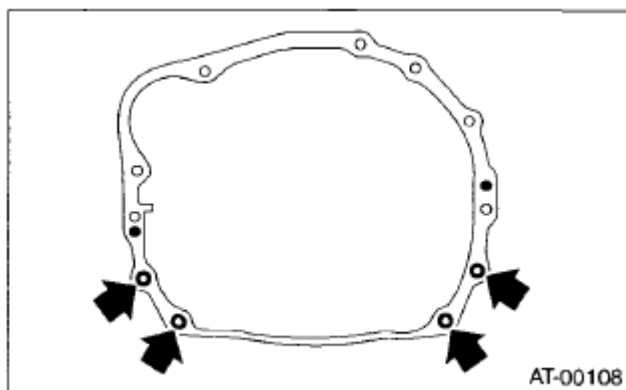


Fig. 35: Locating Lower Side Of The Transmission Bolts And Nuts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

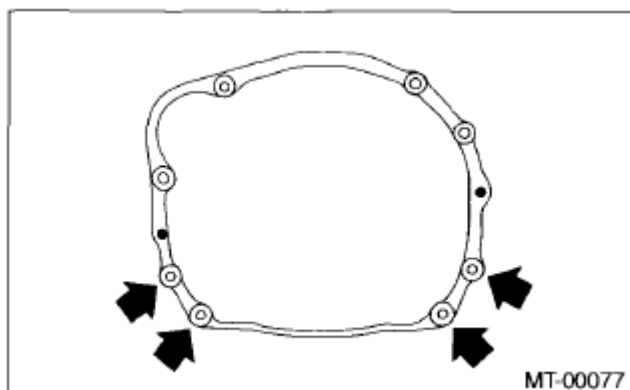


Fig. 36: Locating Lower Side Of The Transmission Bolts And Nuts (MT Model)
 Courtesy of SUBARU OF AMERICA, INC.

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

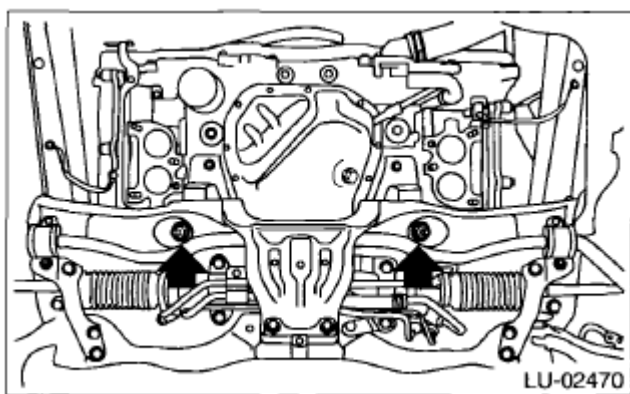


Fig. 37: Locating Front Crossmember Engine Mounting Nuts
 Courtesy of SUBARU OF AMERICA, INC.

21. 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.

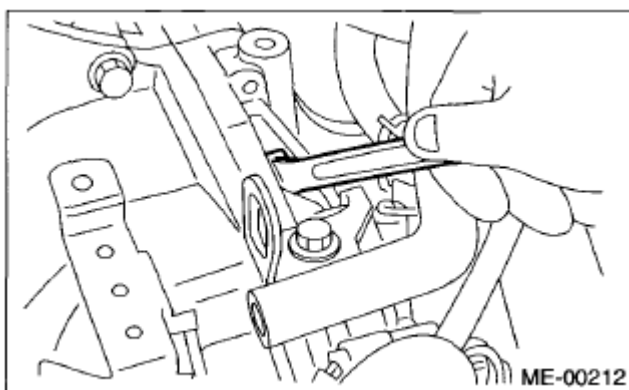


Fig. 38: Inserting Wrench Into Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

22. Remove the pitching stopper.



Fig. 39: Locating Pitching Stopper Bolt And Nut
Courtesy of SUBARU OF AMERICA, INC.

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

CAUTION:

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

1. 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.

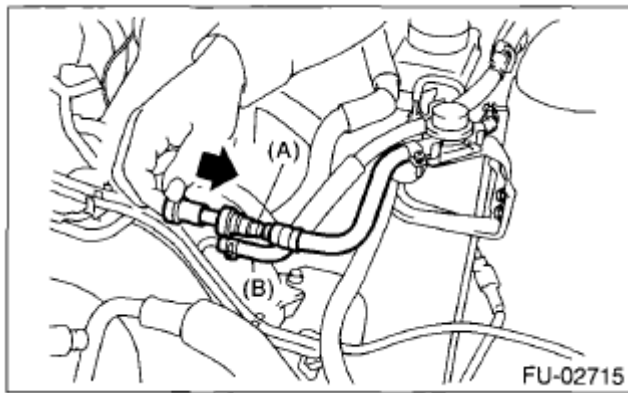


Fig. 40: Disconnecting Fuel Delivery Hose And Evaporation Hose
Courtesy of SUBARU OF AMERICA, INC.

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

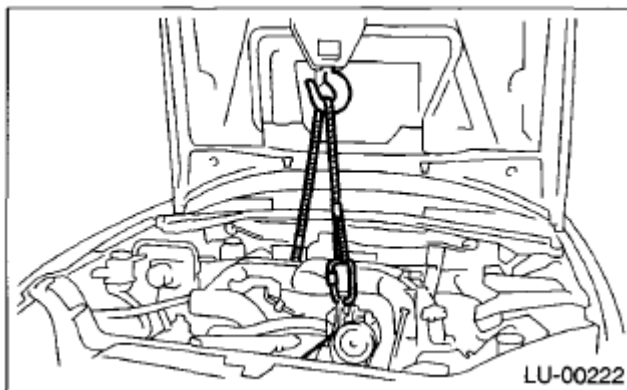
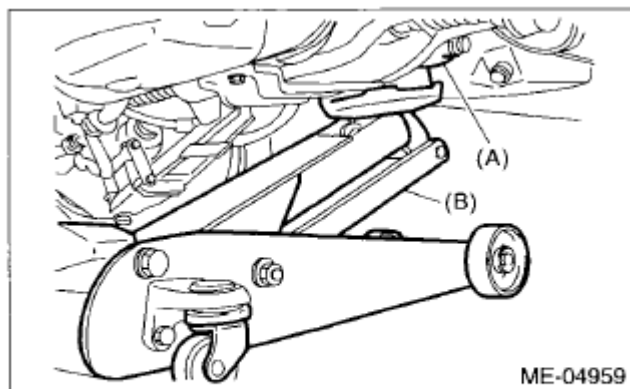


Fig. 41: Lifting Engine Using Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

25. Support the transmission with a garage jack.

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



- (A) Transmission
(B) Garage jack

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

26. Separation of engine and transmission

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

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

ST 498277200 STOPPER SET

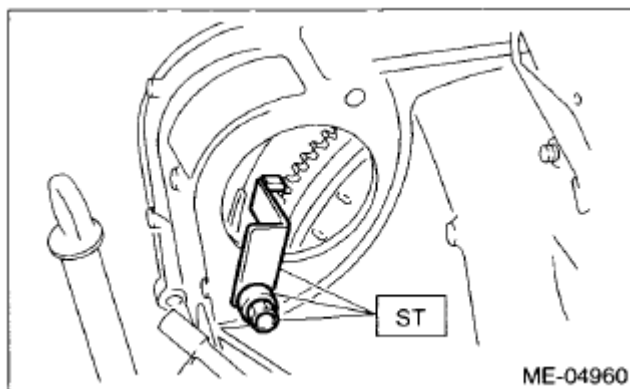


Fig. 43: Attaching ST To Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

27. Remove the bolts which hold the upper side of the transmission to the engine.
- AT model

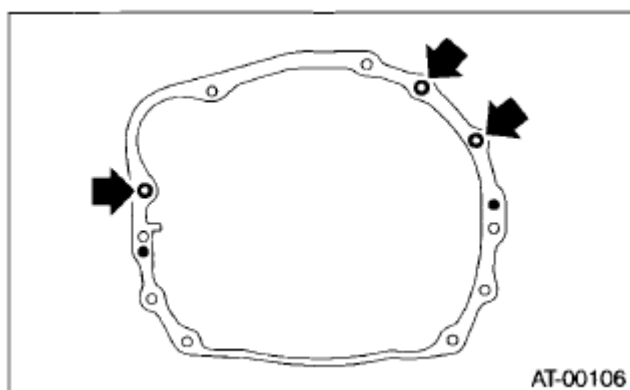


Fig. 44: Locating Upper Side Of The Transmission Bolts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

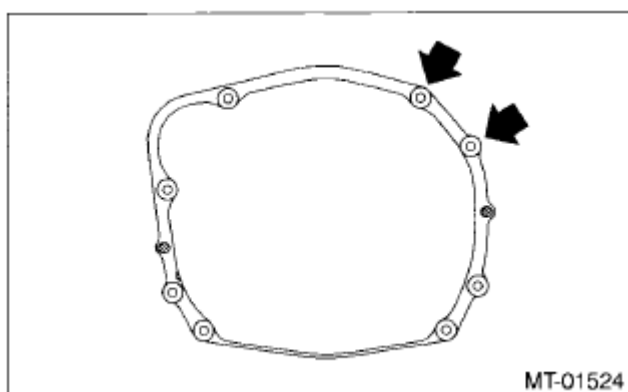


Fig. 45: Locating Upper Side Of The Transmission Bolts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

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

29. 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

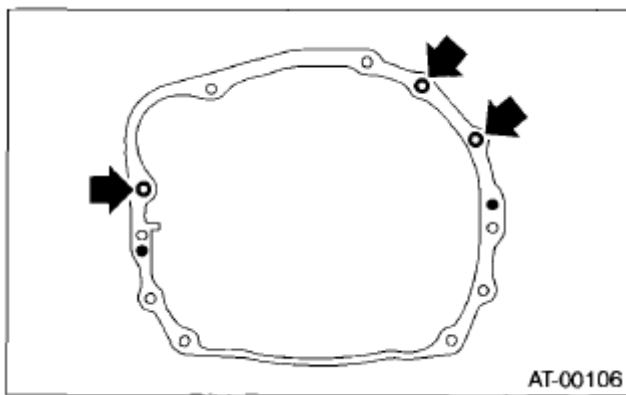


Fig. 46: Locating Upper Side Of The Transmission Bolts (AT Model)
 Courtesy of SUBARU OF AMERICA, INC.

- MT model

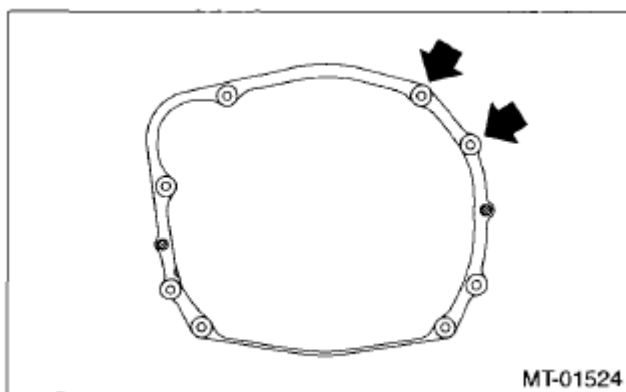


Fig. 47: Locating Upper Side Of The Transmission Bolts (MT Model)

Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.

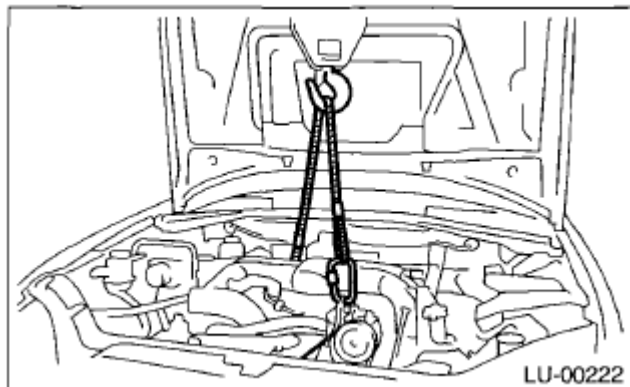


Fig. 48: Removing Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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)

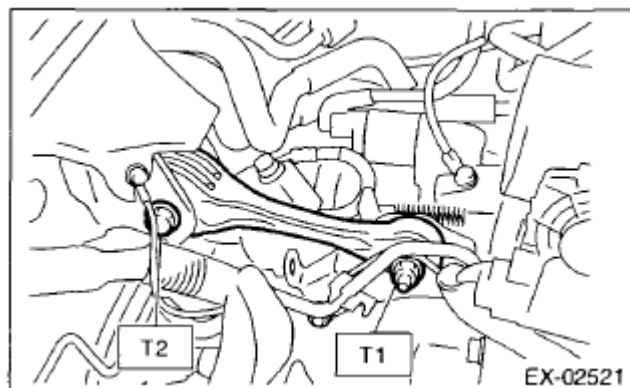


Fig. 49: Identifying Pitching Stopper Bolt And Nut
Courtesy of SUBARU OF AMERICA, INC.

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

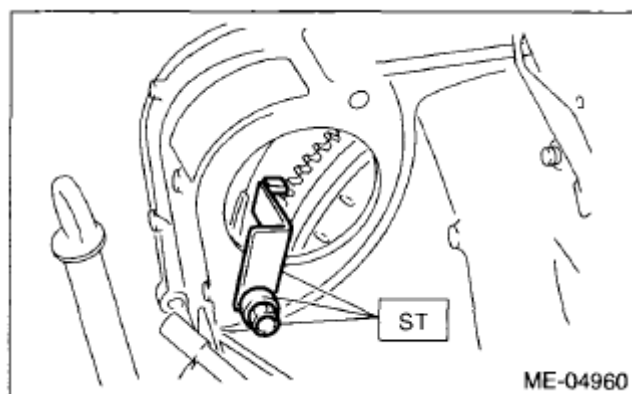


Fig. 50: Removing ST From Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

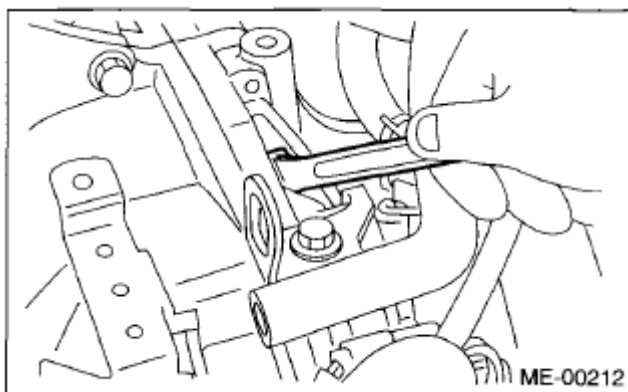


Fig. 51: Inserting Wrench Into Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

Refer to "COMPONENT" of "Power Steering" for the tightening torque. < Ref. to

COMPONENT , General Description. >

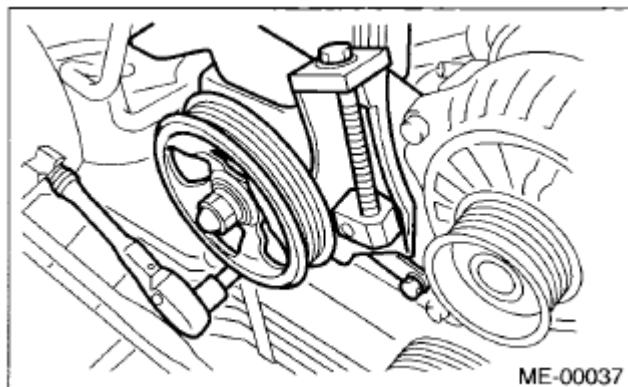


Fig. 52: Identifying Power Steering Pump And Bracket With Bolt
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the power steering pump switch connector.

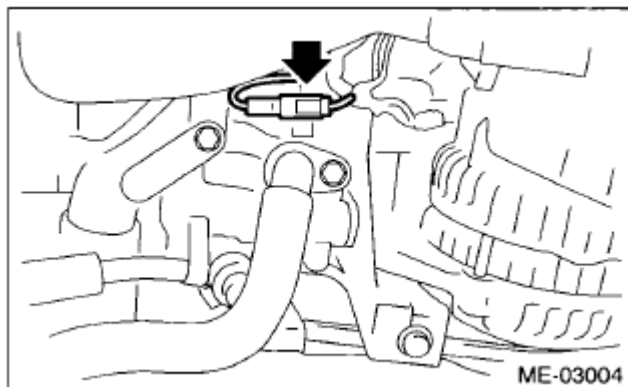


Fig. 53: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

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

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

- AT model

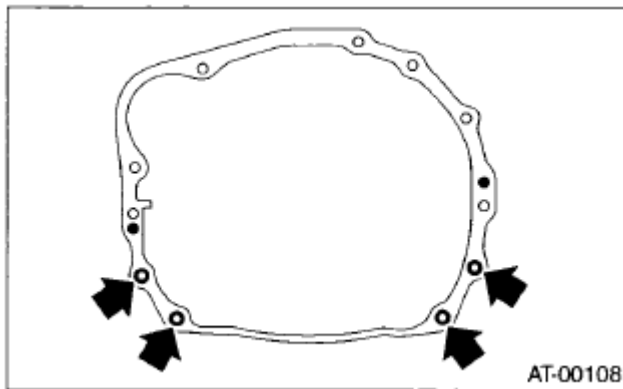


Fig. 54: Locating Lower Side Of The Transmission Bolts And Nuts (AT Model)
 Courtesy of SUBARU OF AMERICA, INC.

- MT model

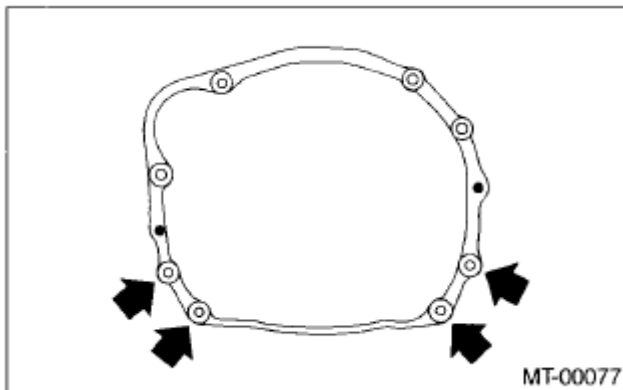


Fig. 55: Locating Lower Side Of The Transmission Bolts And Nuts (MT Model)
 Courtesy of SUBARU OF AMERICA, INC.

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)

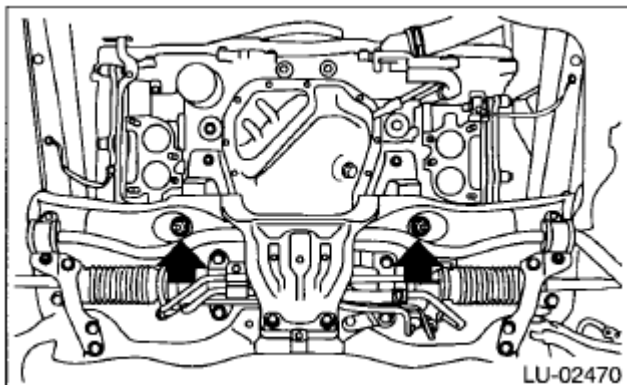


Fig. 56: Locating Crossmember Engine Mounting Nuts
Courtesy of SUBARU OF AMERICA, INC.

15. Connect the ground cable.

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

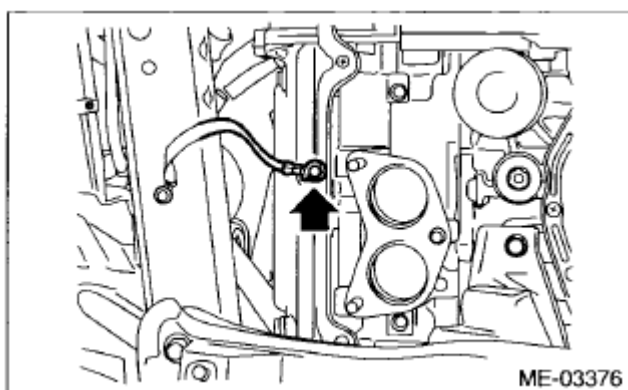


Fig. 57: Locating Ground Cable With Bolt (1 Of 2)
Courtesy of SUBARU OF AMERICA, INC.

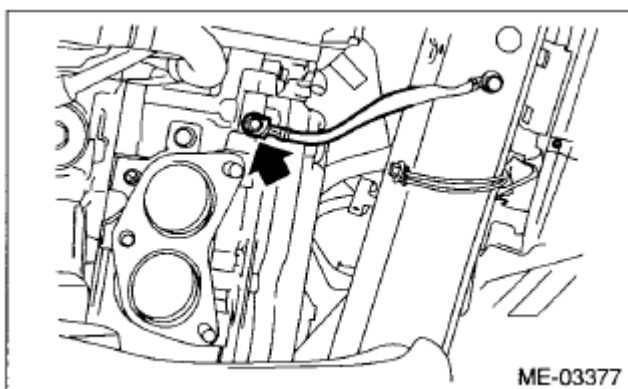


Fig. 58: Locating Ground Cable With Bolt (2 Of 2)
Courtesy of SUBARU OF AMERICA, INC.

16. Install the front and center exhaust pipe. < Ref. 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)

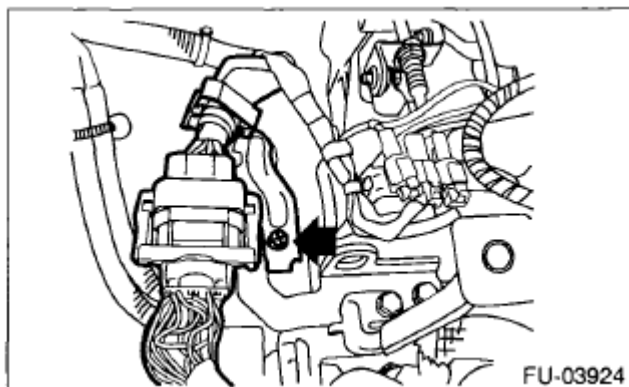


Fig. 59: Locating Engine Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

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. < Ref. to **INSTALLATION** , Hose and Pipe. >

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

23. Install the air cleaner case. < Ref. to **INSTALLATION** , Air Cleaner Case. >

24. Install the air intake chamber. < Ref. to **INSTALLATION** , Air Intake Chamber. >

25. Install the air intake duct. < Ref. to **INSTALLATION** , Air Intake Duct. >

26. Install the under cover. < Ref. to **INSTALLATION** , Front Under Cover. >

27. Install the battery. < Ref. to **INSTALLATION** , Battery. >

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

29. Check the ATF level and replenish it if necessary. (AT model) < Ref. to **INSPECTION** , Automatic Transmission Fluid. >

30. Charge the A/C system with refrigerant. < Ref. to **PROCEDURE** , Refrigerant Charging Procedure. >

31. Install the V-belt cover.

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

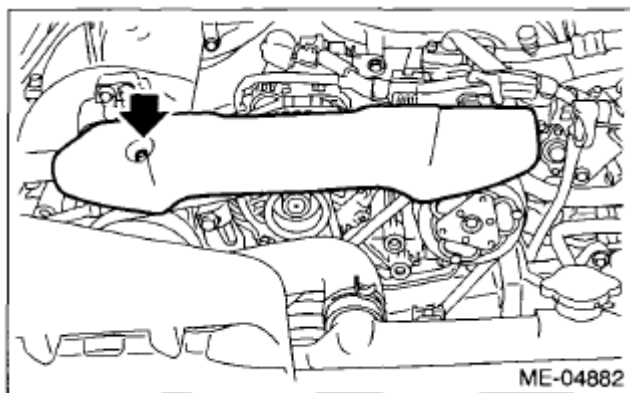


Fig. 60: Locating V-Belt Cover Screw

Courtesy of SUBARU OF AMERICA, INC.

32. 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)

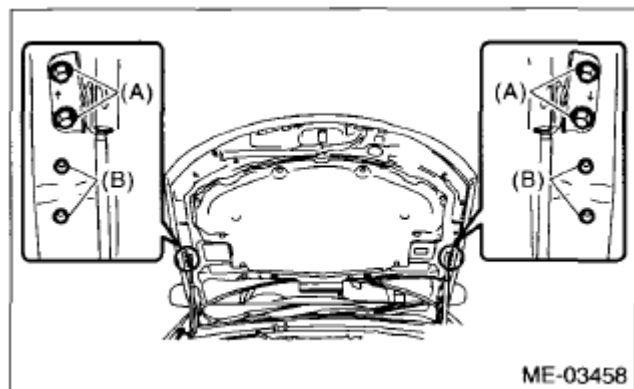


Fig. 61: Identifying Front Hood Bolts Installation Position

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. < Ref. 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

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

PREPARATION FOR OVERHAUL

PROCEDURE

1. After removing the engine from body, secure the engine to ST as shown in the figure.

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 499817100 ENGINE STAND

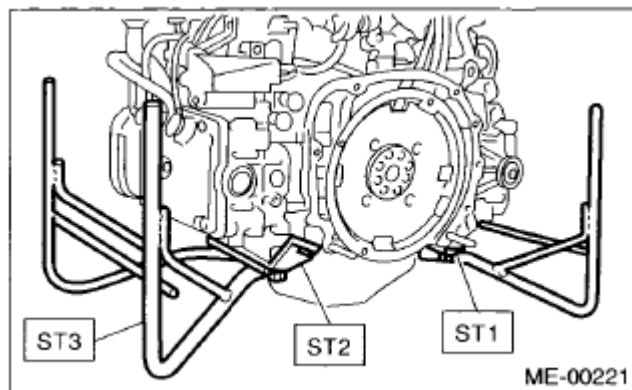


Fig. 62: Securing Engine To ST
Courtesy of SUBARU OF AMERICA, INC.

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

Therefore, in this article, to conduct the particular procedure within the flow of an area, you need to go

back and conduct the procedure described previously in order to do that particular procedure.

V-BELT

REMOVAL

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

FRONT SIDE BELT

1. Remove the V-belt covers.

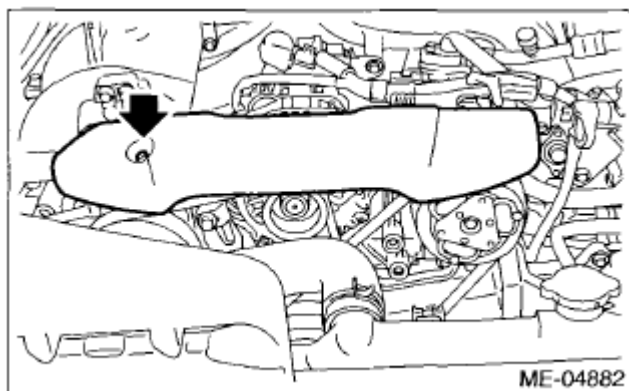


Fig. 63: Locating V-Belt Cover Screw
Courtesy of SUBARU OF AMERICA, INC.

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

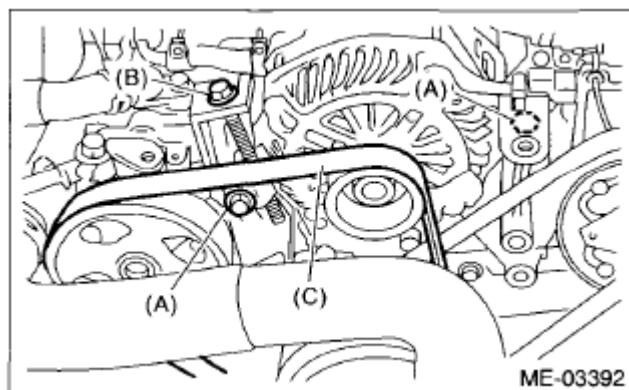


Fig. 64: Identifying Front Side Belt And Slider Bolt

Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

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

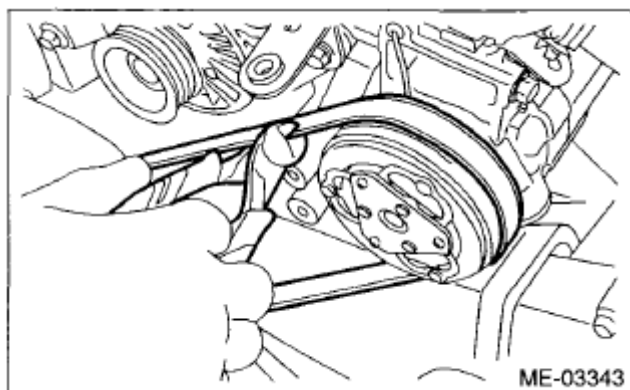


Fig. 65: Cutting Rear Side Belt With Wire Cutter
Courtesy of SUBARU OF AMERICA, INC.

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. < Ref. to **INSPECTION**, V-belt. >
3. Tighten the bolt (A).
4. Tighten the slider bolt (B).

Tightening torque:

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

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

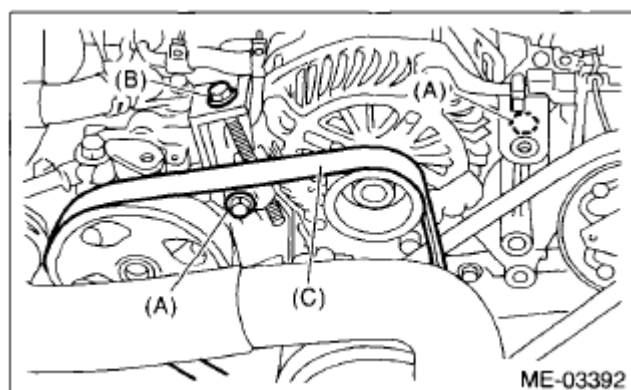


Fig. 66: Identifying Front Side Belt And Slider Bolt
 Courtesy of SUBARU OF AMERICA, INC.

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

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

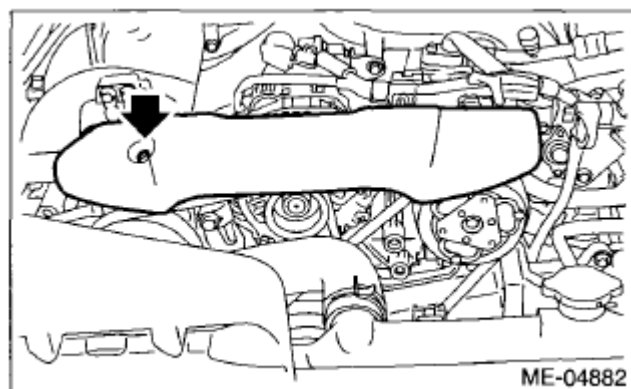


Fig. 67: Locating V-Belt Cover Screw
 Courtesy of SUBARU OF AMERICA, INC.

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 co may cause injury.
- To install the rear side belt, always use the provided tools (belt stoppe belt guide, belt guide holder, and bolt).

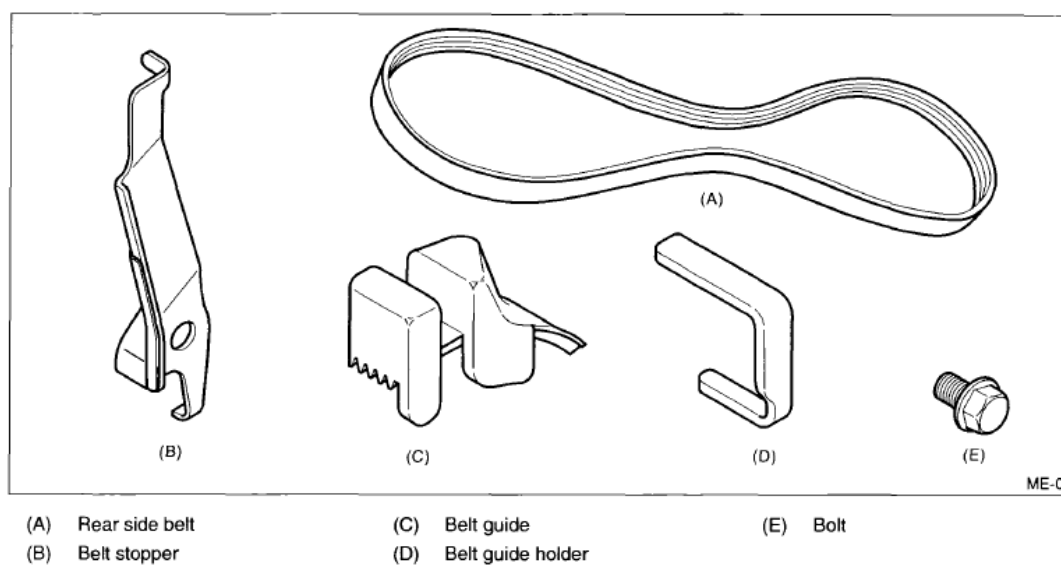


Fig. 68: Identifying Rear Side Belt, Belt Guide, Belt Stopper, Belt Guide Holder And Bolt
Courtesy of SUBARU OF AMERICA, INC.

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.

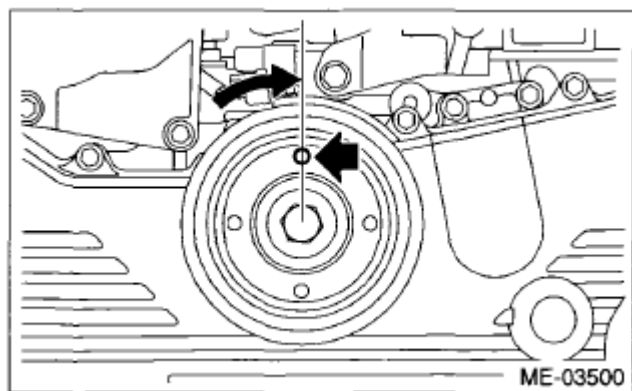


Fig. 69: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

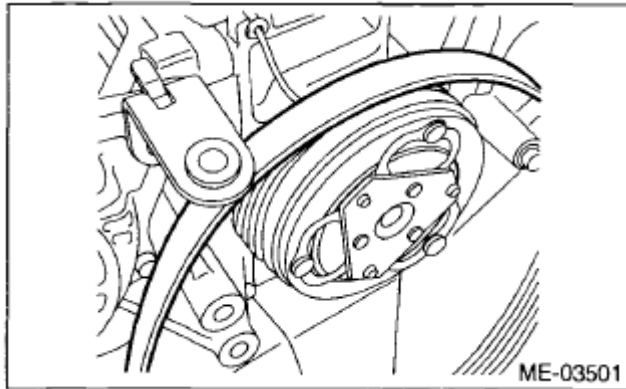


Fig. 70: Hooking Rear Side Belt On A/C Compressor Pulley
Courtesy of SUBARU OF AMERICA, INC.

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).

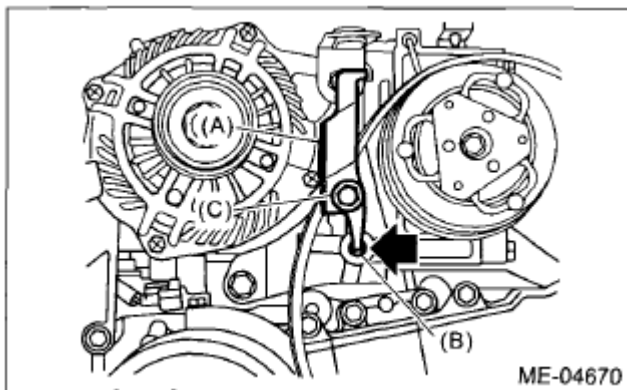


Fig. 71: Inserting Claw Of Belt Stopper To Lower Hole Of Compressor Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

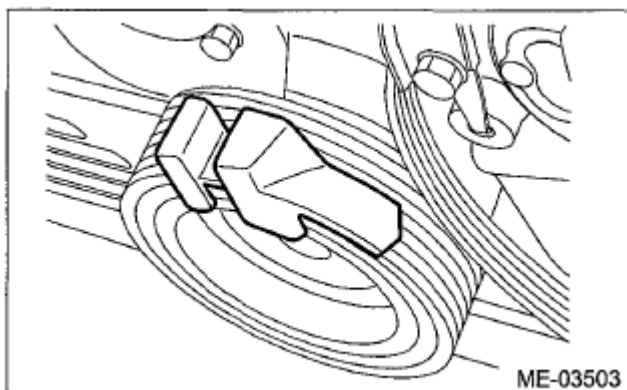


Fig. 72: Aligning Belt Guide With Belt Line Of Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

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

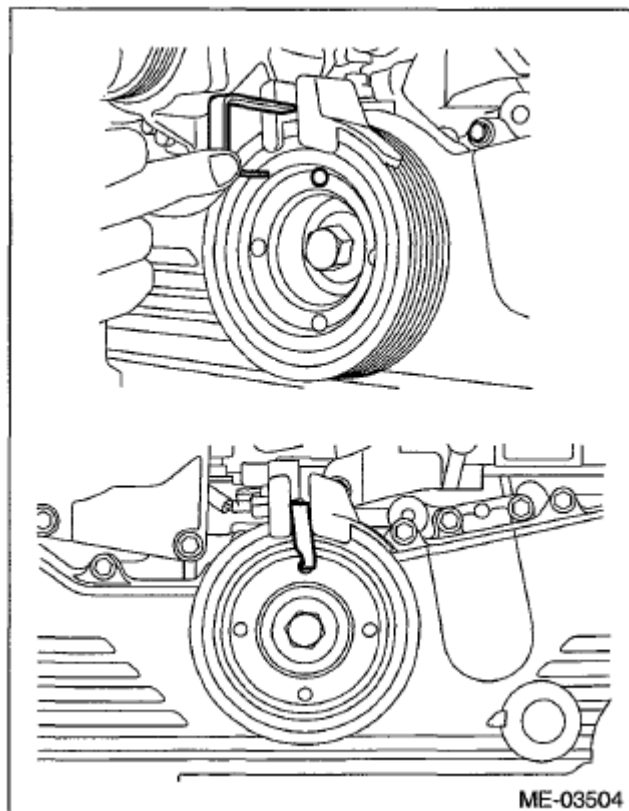


Fig. 73: Inserting Belt Guide Holder Into Service Hole Of Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

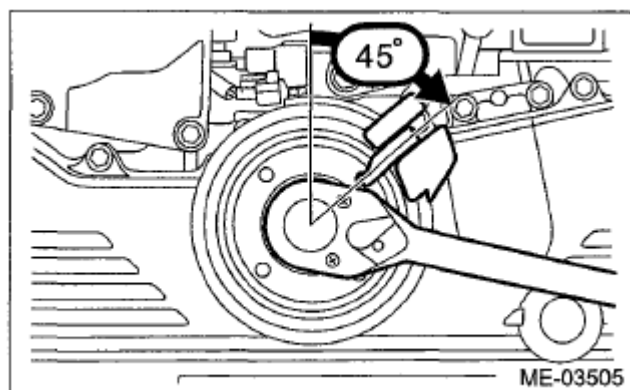


Fig. 74: Turning Crank Pulley

Courtesy of SUBARU OF AMERICA, INC.

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

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

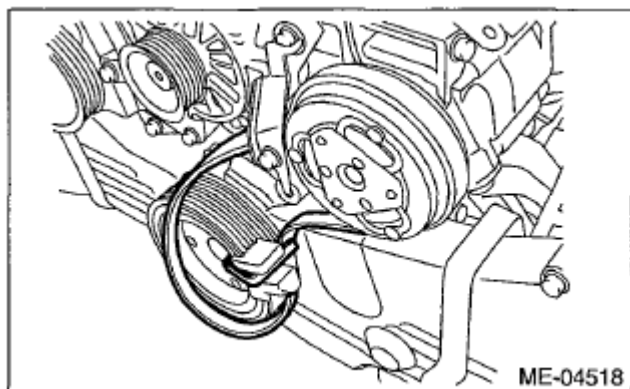


Fig. 75: Identifying Rear Side Belt

Courtesy of SUBARU OF AMERICA, INC.

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

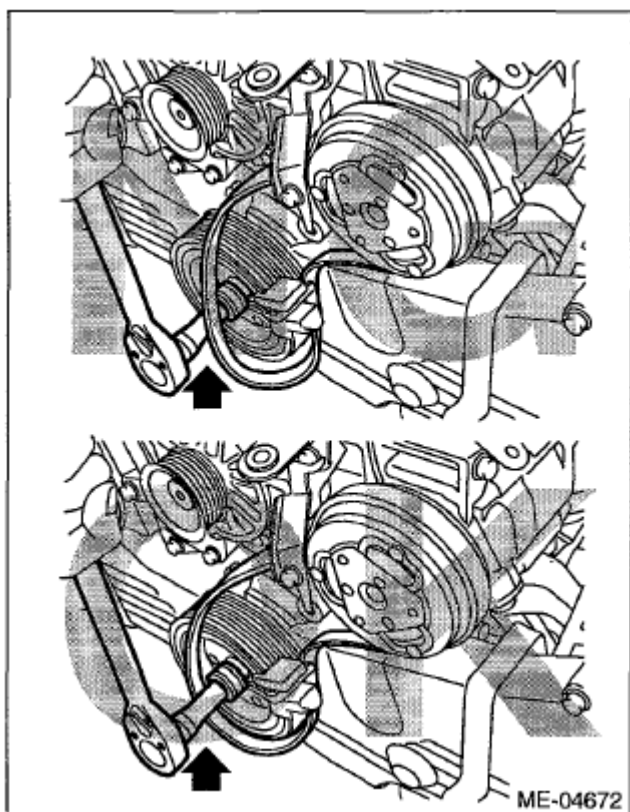


Fig. 76: Identifying Correct And Incorrect Installation Position Of Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

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.

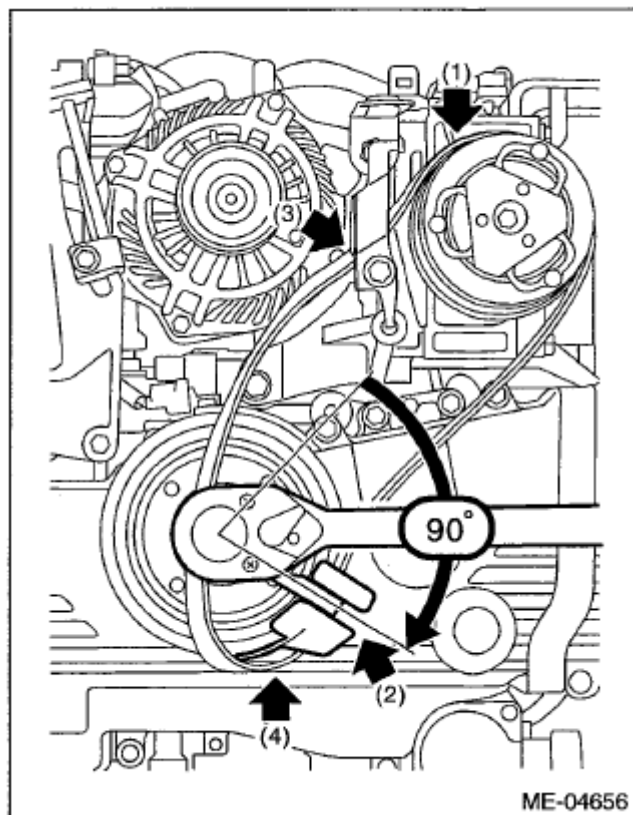


Fig. 77: Turning Crank Pulley

Courtesy of SUBARU OF AMERICA, INC.

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

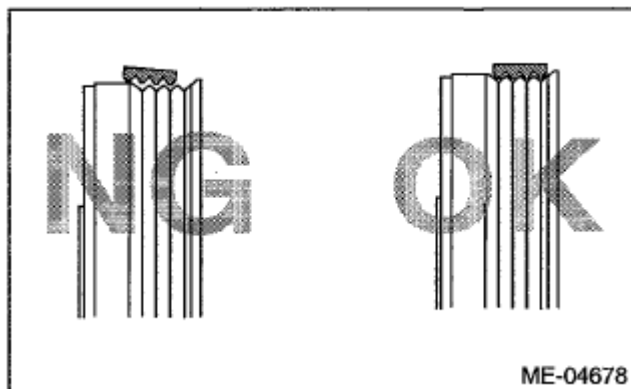


Fig. 78: Identifying Correct And Incorrect Installation Position Of Rear Side Belt (A/C Compressor Pulley)

Courtesy of SUBARU OF AMERICA, INC.

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

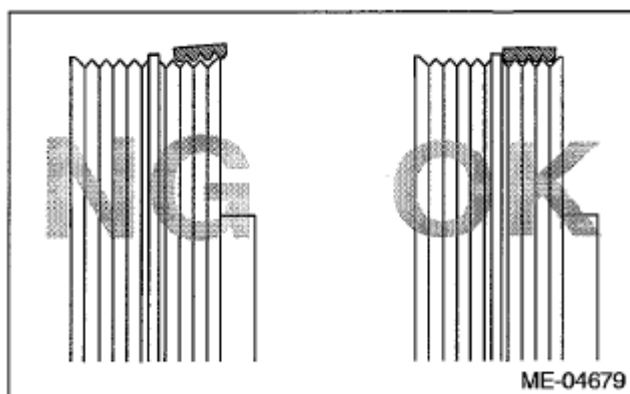


Fig. 79: Identifying Correct And Incorrect Installation Position Of Rear Side Belt (Crank Pulley)

Courtesy of SUBARU OF AMERICA, INC.

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

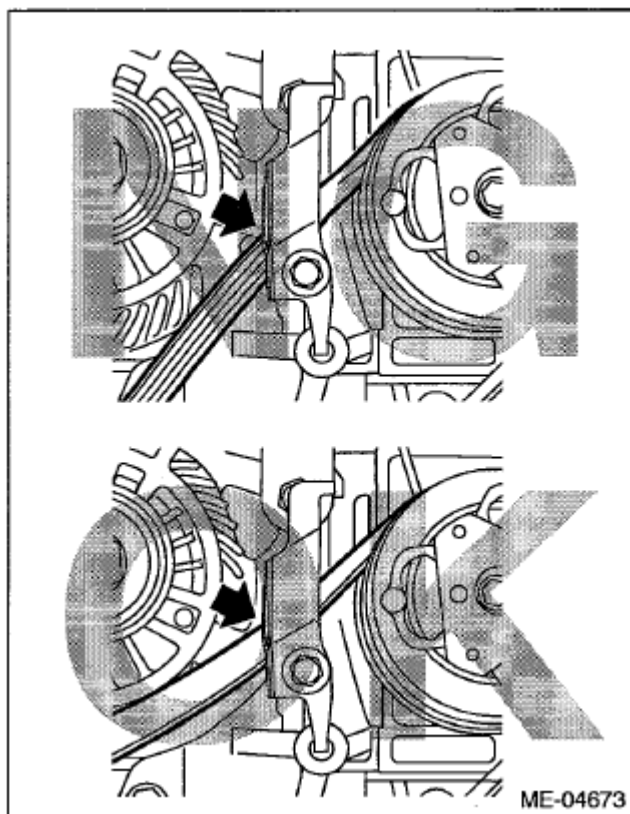


Fig. 80: Identifying Correct And Incorrect Rear Side Belt Position

Courtesy of SUBARU OF AMERICA, INC.

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

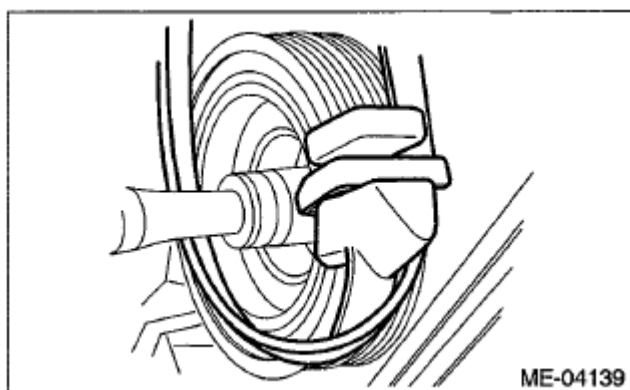


Fig. 81: Identifying Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

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.

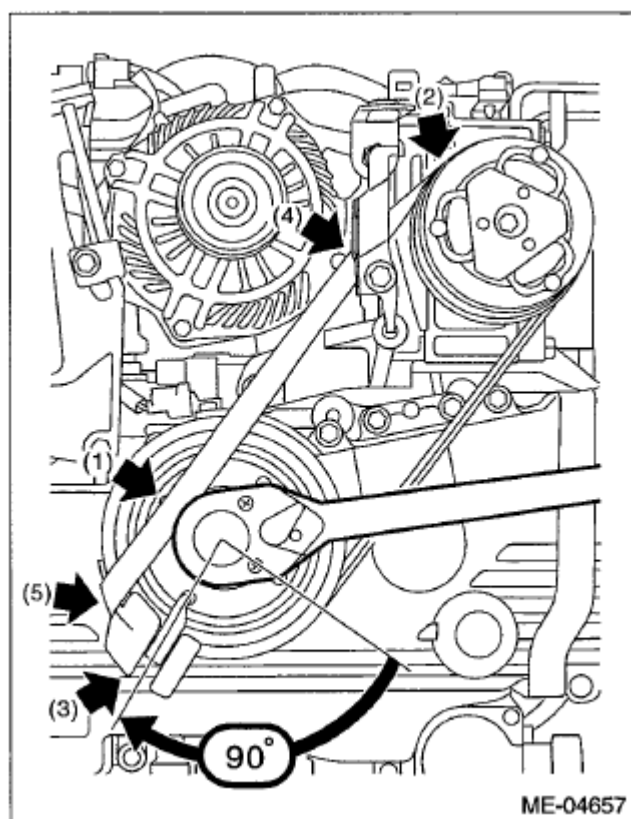


Fig. 82: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

1. The rear side belt is not twisted.

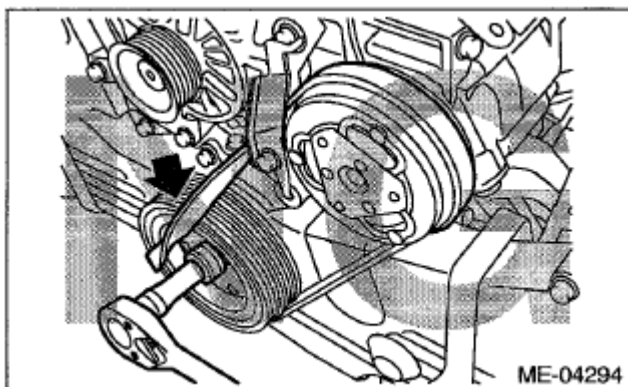


Fig. 83: Inspecting Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

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

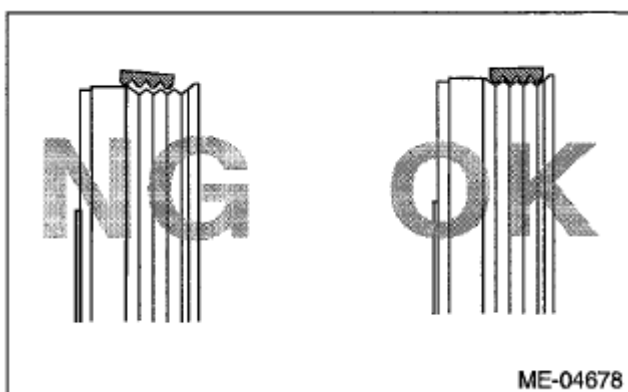


Fig. 84: Identifying Correct And Incorrect Installation Position Of Rear Side Belt (A/C Compressor Pulley)
Courtesy of SUBARU OF AMERICA, INC.

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

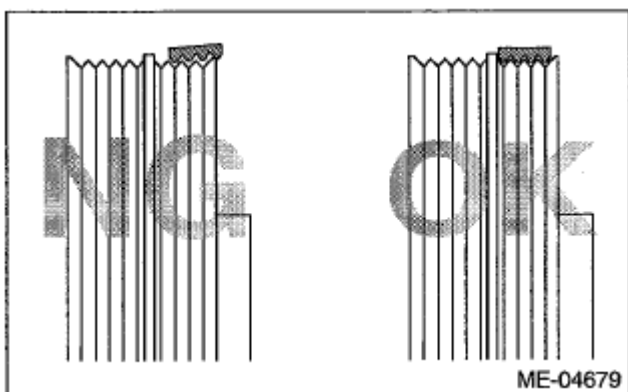
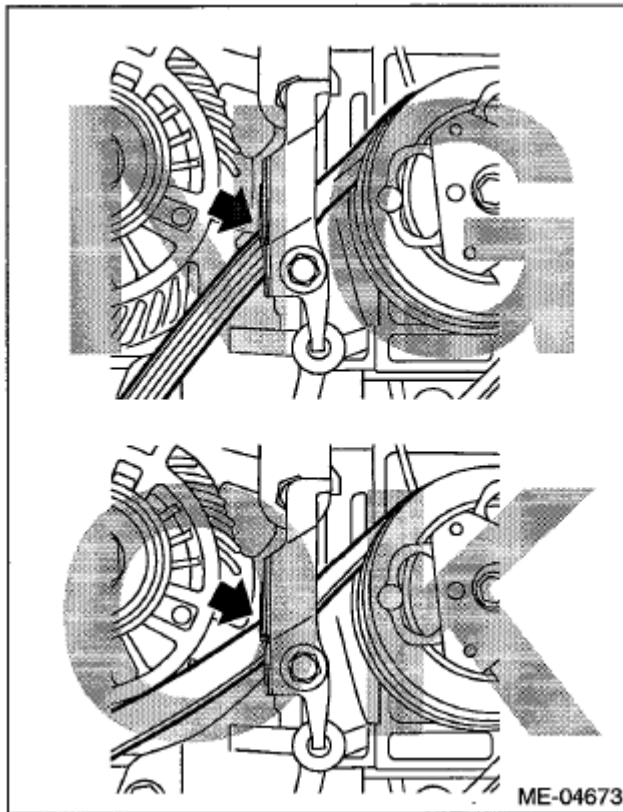


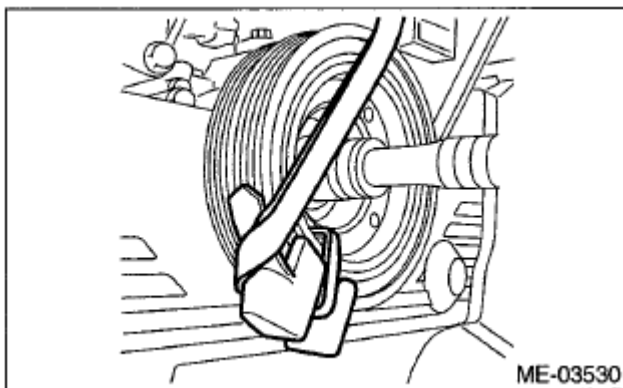
Fig. 85: Identifying Correct And Incorrect Installation Position Of Rear Side Belt (Crank

Pulley)**Courtesy of SUBARU OF AMERICA, INC.**

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

**Fig. 86: Identifying Correct And Incorrect Rear Side Belt Position****Courtesy of SUBARU OF AMERICA, INC.**

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

**Fig. 87: Identifying 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.

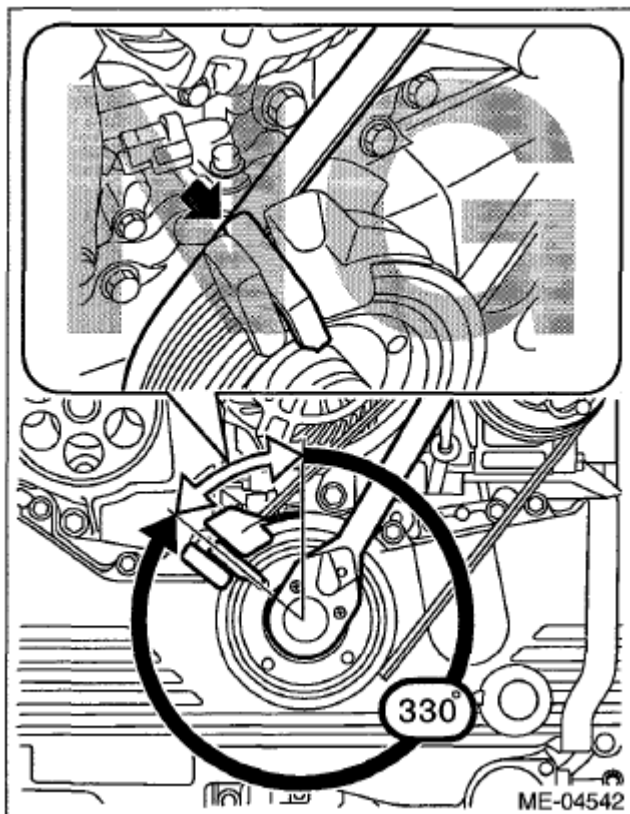


Fig. 88: Turning Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

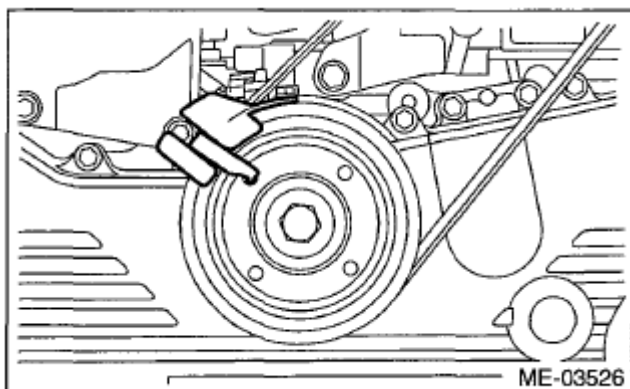
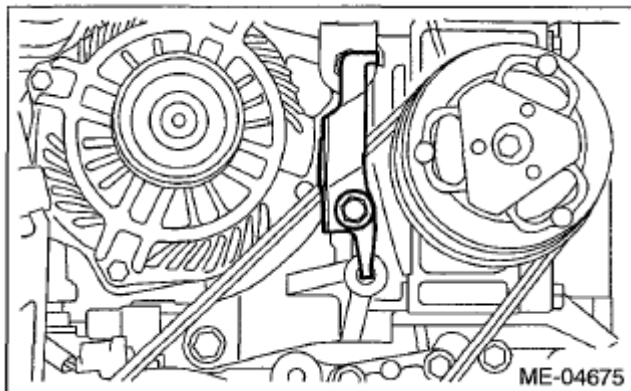


Fig. 89: Identifying Belt Guide

Courtesy of SUBARU OF AMERICA, INC.

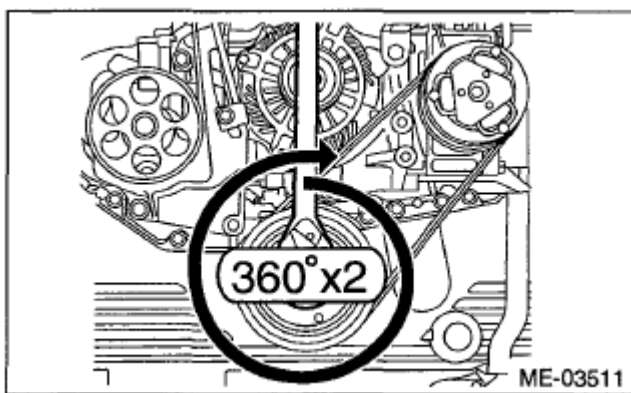
15. Remove the belt stopper from the compressor bracket.

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

**Fig. 90: 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. 91: Turning Crank Pulley**

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. < Ref. to **FRONT SIDE BELT**, INSTALLATION, V-belt. >

INSPECTION

FRONT SIDE BELT

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

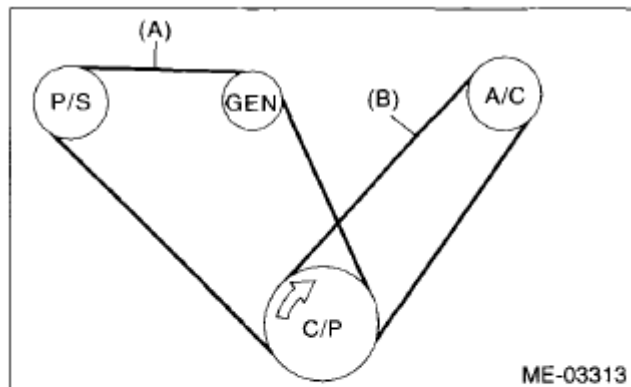
- If the front side belt tension is higher, unexpected force is generated at the power steering oil pump, generator and crankshaft bearing, causing abnormal noise due to abnormal wear of the bearing.
- If the front side belt tension is lower, the front side belt and crank pulley slip, causing abnormally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

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

Front side belt tension (with belt tension gauge):

When installing new parts 640 - 780 N (65 - 80 kgf, 144 - 175 lbf)

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



- (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

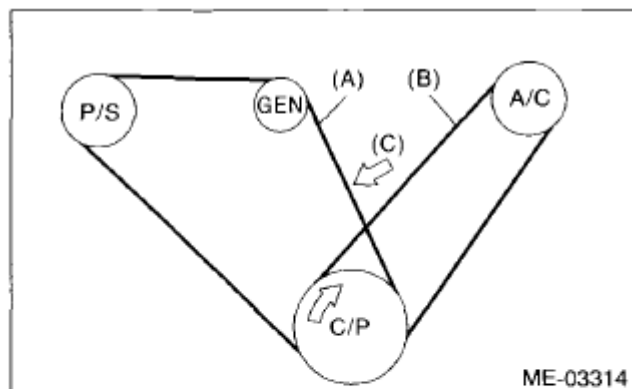
Fig. 92: Identifying Belt Tension Check Points

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. 93: Identifying Belt Tension Check Points

Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

Replace the rear side belt, if crack, fraying or wear is found, or noise is emitted.

NOTE: For the rear side belt, a stretch type belt is used, and therefore, it is not necessary to check deflection nor tension.

CRANK PULLEY

REMOVAL

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

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

ST 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

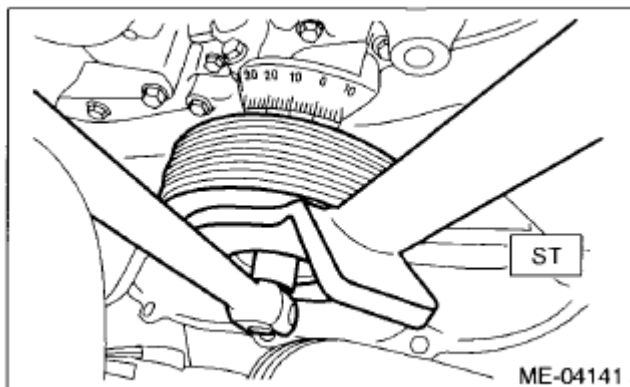


Fig. 94: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION**METHOD WITHOUT ANGLE GAUGE**

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

ST 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

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

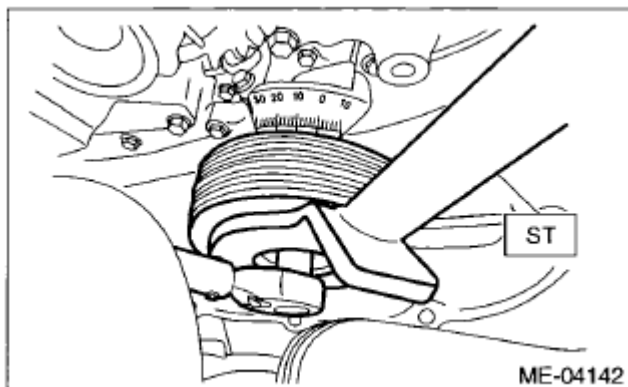


Fig. 95: Tightening Crank Pulley Bolts

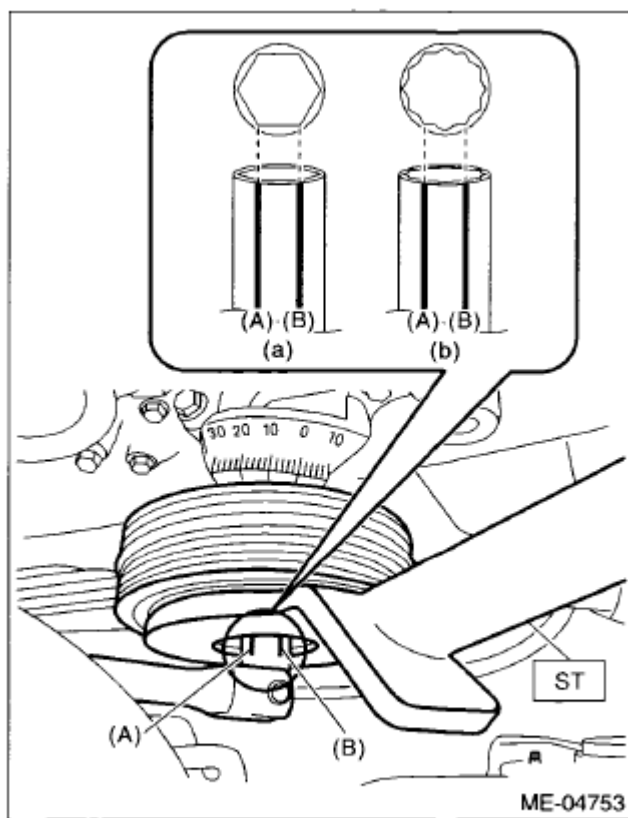
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

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



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

Fig. 96: Setting Socket Onto Crank Pulley Bolt

Courtesy of SUBARU OF AMERICA, INC.

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

ST 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

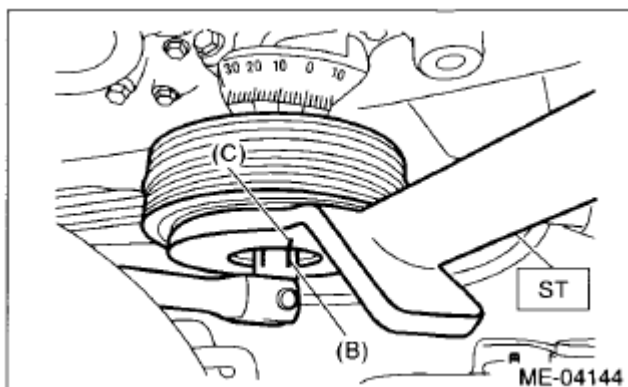


Fig. 97: [Drawing End Line On ST]
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST 499977100 CRANK PULLEY WRENCH (MT MODEL)

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

Tightening angle: 60°±5°

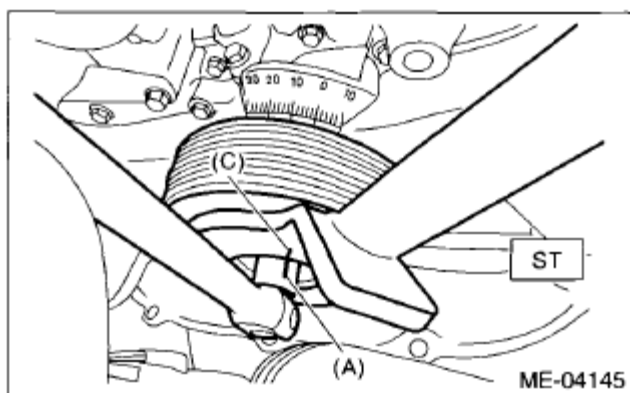


Fig. 98: Tightening Crank Pulley Bolt To Reference Line And End Line
Courtesy of SUBARU OF AMERICA, INC.

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

METHOD WITH ANGLE GAUGE

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

ST1 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST1 499977100 CRANK PULLEY WRENCH (MT MODEL)

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

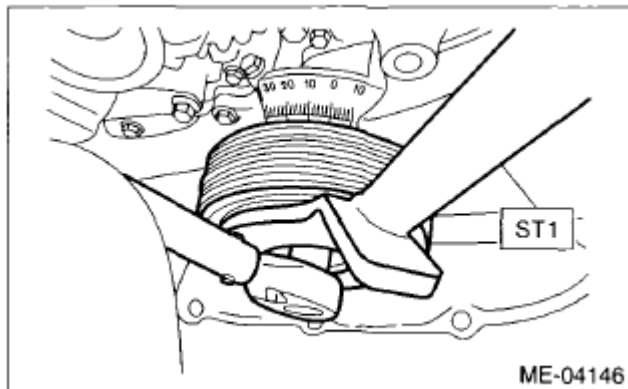


Fig. 99: Tightening Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

ST1 499977400 CRANK PULLEY WRENCH (AT MODEL)

ST1 499977100 CRANK PULLEY WRENCH (MT MODEL)

ST2 18854AA000 ANGLE GAUGE

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

Tightening angle: 60°±5°

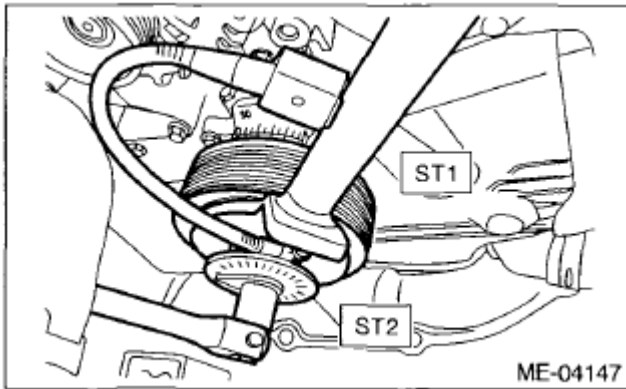


Fig. 100: Attaching Magnet Used For Securing ST2 To ST1
Courtesy of SUBARU OF AMERICA, INC.

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

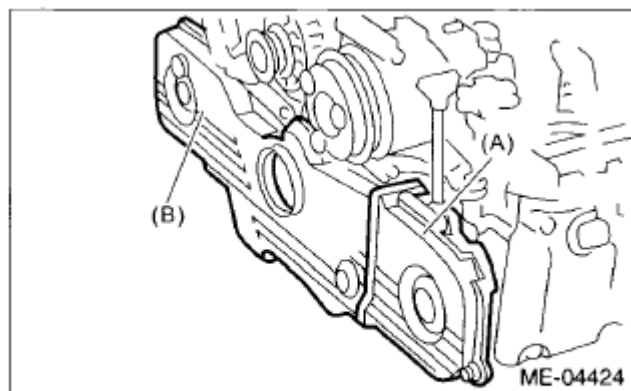
INSPECTION

1. Check that the crank pulley has no deformation, cracks or other damages.
2. Make sure the V-belt is not worn or otherwise damaged.
3. Check the tension of the front side belt. < Ref. to **INSPECTION**, V-belt. >

TIMING BELT COVER

REMOVAL

1. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
2. Remove the timing belt cover LH (A).
3. Remove the front timing belt cover (B).



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

Fig. 101: Identifying Front Timing Belt Cover And Timing Belt Cover LH
 Courtesy of SUBARU OF AMERICA, INC.

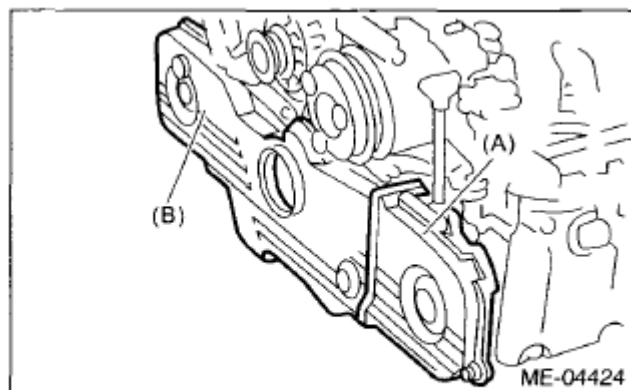
INSTALLATION

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

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

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

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



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

Fig. 102: Identifying Front Timing Belt Cover And Timing Belt Cover LH
 Courtesy of SUBARU OF AMERICA, INC.

3. Install the crank pulley. < Ref. to INSTALLATION, Crank Pulley. >

INSPECTION

Check the timing belt cover for damage.

TIMING BELT

REMOVAL

NOTE:

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

TIMING BELT

1. Remove the crank pulley. < Ref. to REMOVAL, Crank Pulley. >
2. Remove the timing belt cover. < Ref. to REMOVAL, Timing Belt Cover. >
3. Remove the timing belt guide. (MT model)

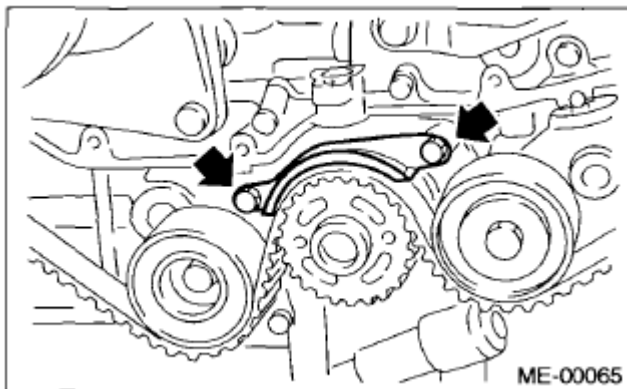


Fig. 103: Locating Timing Belt Guide Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. If the alignment mark or arrow mark (which indicates the direction of rotation) on timing belt fade away, put new marks before removing the timing belt as shown in procedures below.
 1. 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

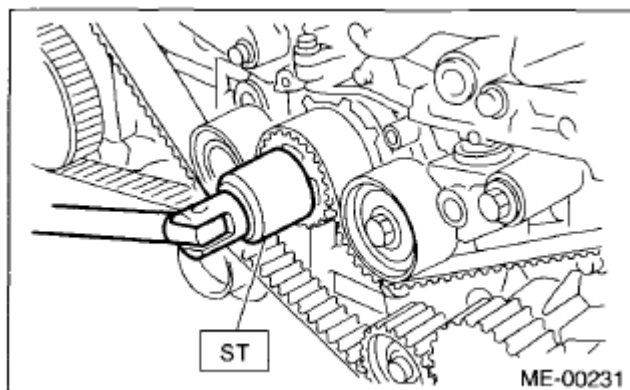


Fig. 104: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

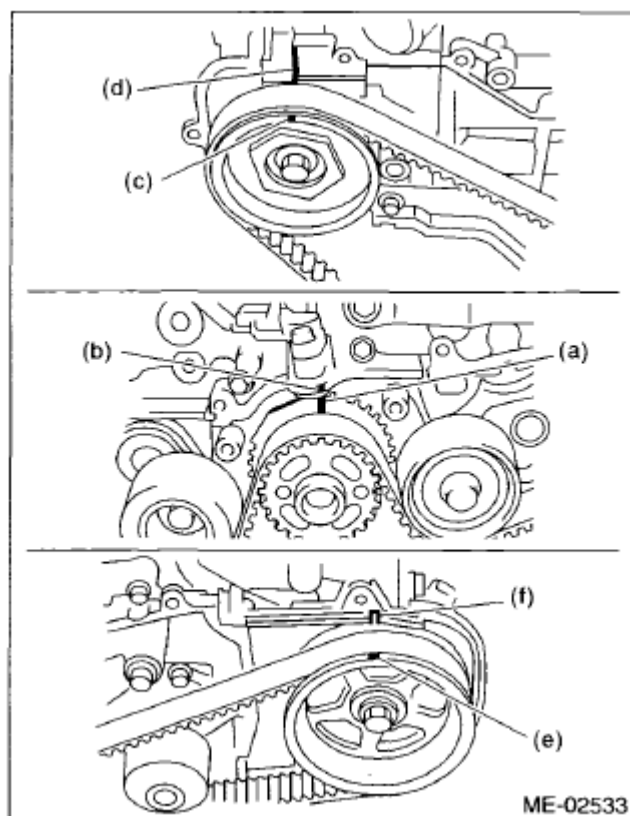


Fig. 105: Aligning Mark Of Sprocket To Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

sprocket and cam sprockets.

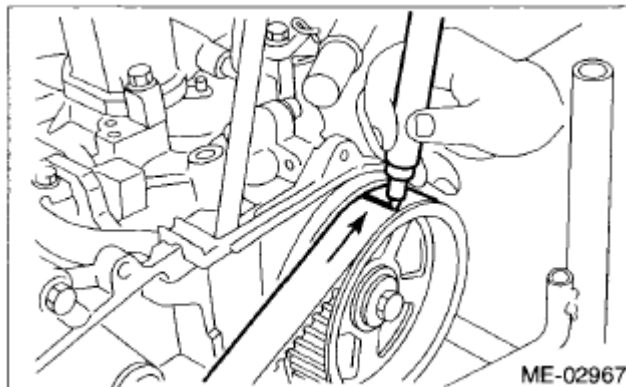


Fig. 106: Putting Alignment Mark Or Arrow Mark On Timing Belts
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 46.8 teeth

Z_2 : 43.7 teeth

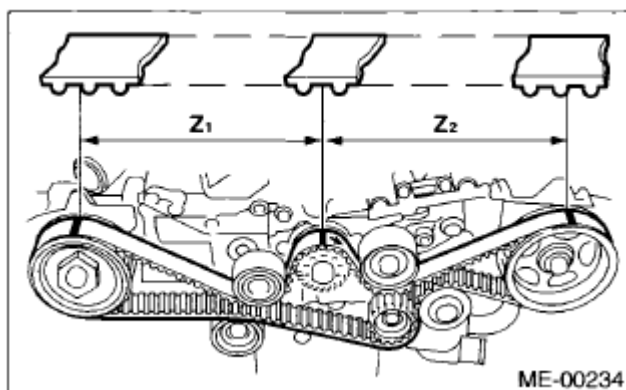


Fig. 107: Identifying Drive Belt Length
Courtesy of SUBARU OF AMERICA, INC.

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

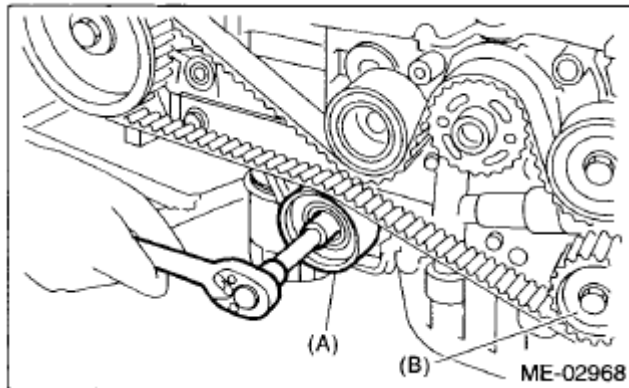


Fig. 108: Removing Belt Idler Bolt
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the timing belt.

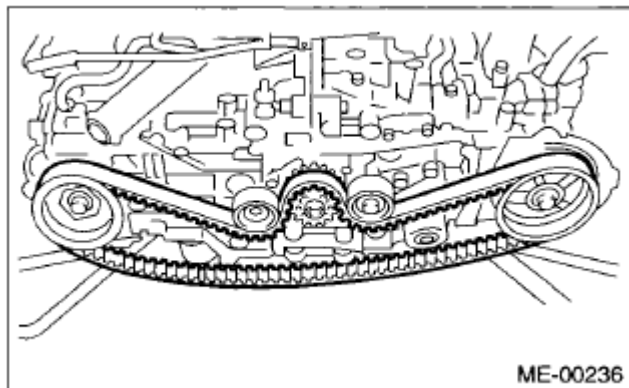


Fig. 109: Identifying Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY

1. Remove the belt idler.

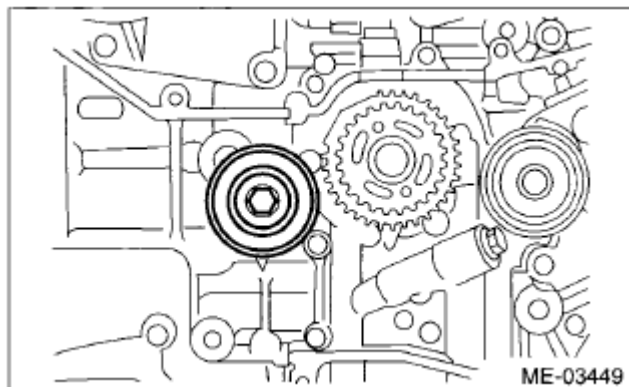
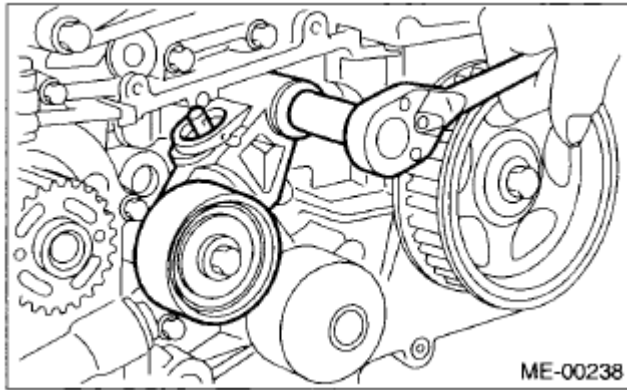


Fig. 110: Identifying Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the automatic belt tension adjuster assembly.

**Fig. 111: Removing Automatic Belt Tension Adjuster Assembly**

Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

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

CAUTION:

- Always use a vertical type pressing tool to move the adjuster rod down.
 - Do not use a lateral type vise.
 - Push the adjuster rod vertically.
 - Press-in the push adjuster rod gradually taking three minutes or more.
 - Do not allow press pressure to exceed 9, 807 N (1, 000 kgf, 2, 205 lb).
 - Push in the adjuster rod to the end face of the cylinder. However, do not push in the adjuster rod below the end face of the cylinder. Doing so may damage the cylinder.
 - Do not release the press pressure until stopper pin is completely inserted.
1. Attach the automatic belt tension adjuster assembly to vertical pressing tool.
 2. Slowly push in the adjuster rod with a pressure of 165 N (16.8 kgf, 37.1 lbf) or more until the adjuster rod is aligned with the stopper pin hole in the cylinder.

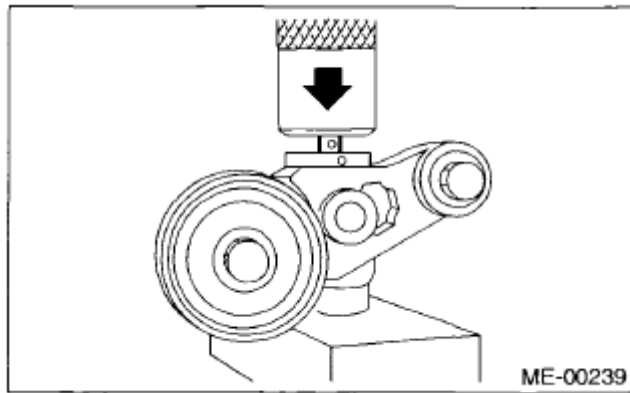


Fig. 112: Pushing Adjuster Rod
Courtesy of SUBARU OF AMERICA, INC.

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

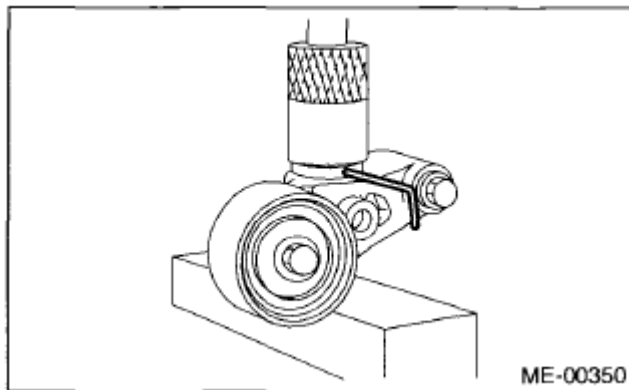


Fig. 113: Inserting Hex Wrench Into Stopper Pin Hole In Cylinder
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tensioner assembly.

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

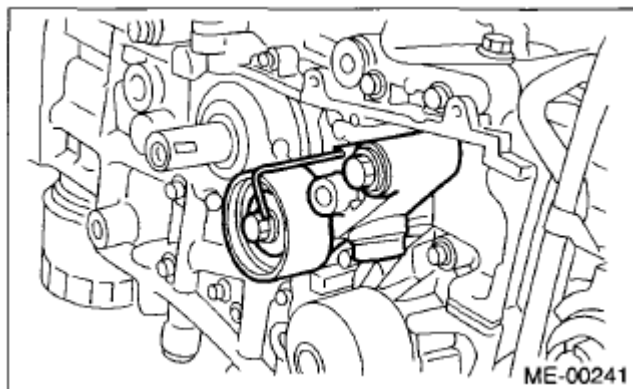


Fig. 114: Identifying Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idlers.

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

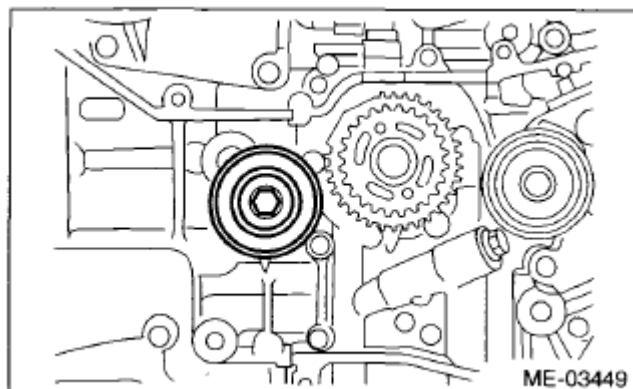


Fig. 115: Identifying Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

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

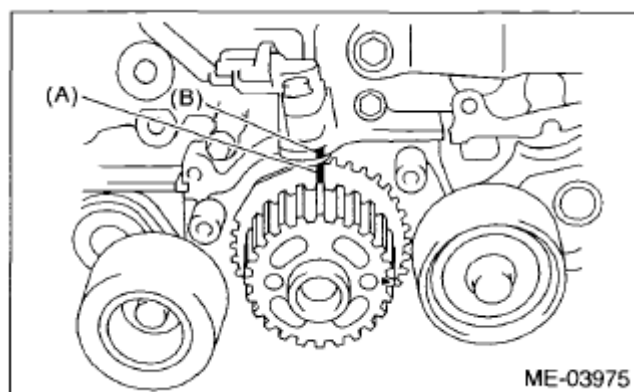


Fig. 116: Identifying Alignment Mark On Oil Pump And Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

ST1 18231AA010 CAM SPROCKET WRENCH

NOTE: CAM SPROCKET WRENCH (499207100) can also be used.
ST2 499207400 CAM SPROCKET WRENCH

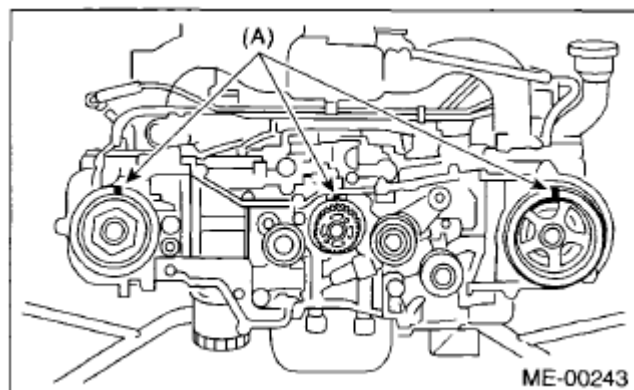


Fig. 117: Identifying Alignment Marks On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

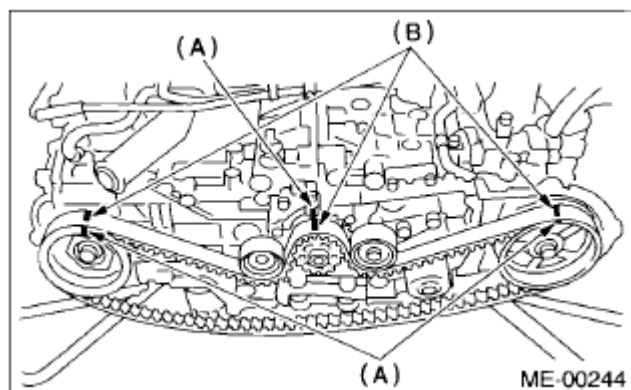


Fig. 118: Identifying Aligning Mark On Timing Belt
 Courtesy of SUBARU OF AMERICA, INC.

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

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

6. Install the belt idler (A).

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

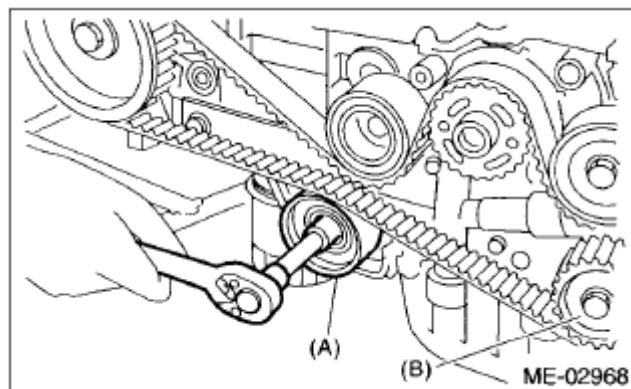


Fig. 119: Installing Belt Idler Bolt
 Courtesy of SUBARU OF AMERICA, INC.

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

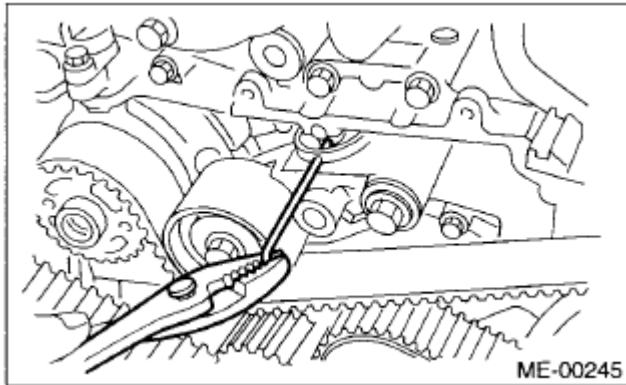


Fig. 120: Removing Stopper Pin From Belt Tension Adjuster
Courtesy of SUBARU OF AMERICA, INC.

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

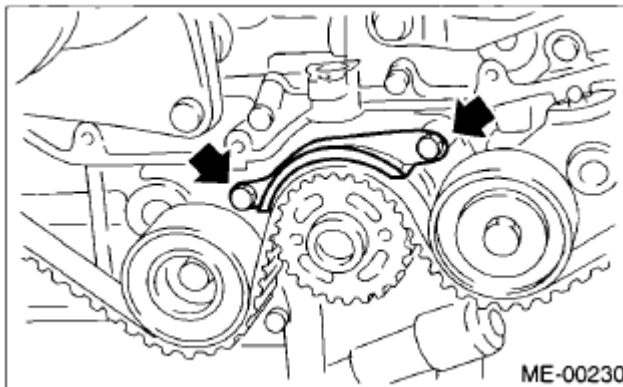


Fig. 121: Locating Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

Clearance: 1.0±0.5 mm (0.039±0.020 in)

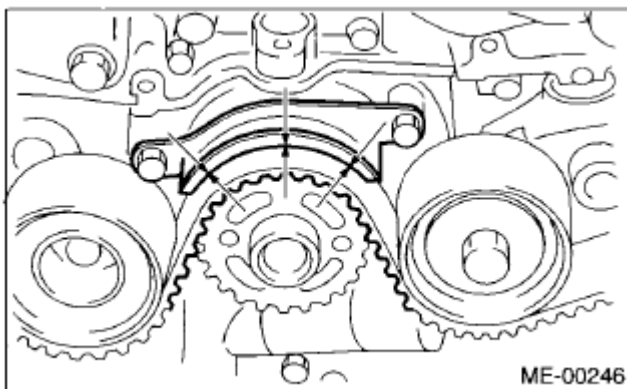


Fig. 122: Identifying Clearance Between Timing Belt And Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

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

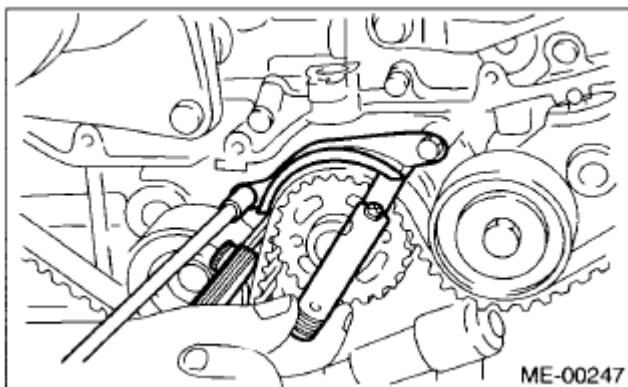


Fig. 123: Tightening Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

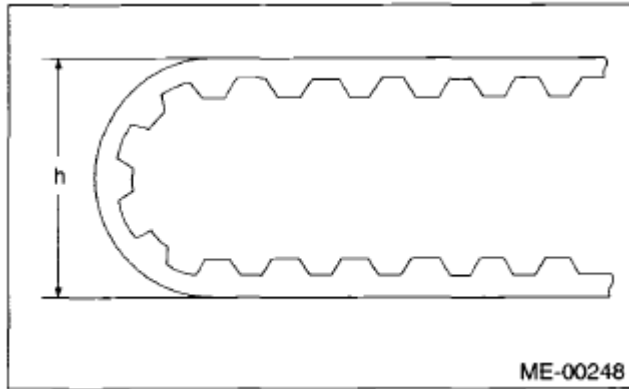


Fig. 124: Identifying Timing Belt Radial Diameter
Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

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

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

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

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

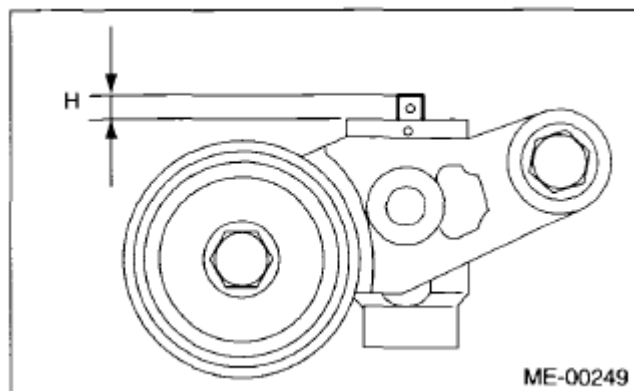


Fig. 125: Identifying Adjuster Rod Protrusion Height
Courtesy of SUBARU OF AMERICA, INC.

BELT TENSION PULLEY

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

BELT IDLER

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

CAM SPROCKET

REMOVAL

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

1. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
2. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
3. Remove the timing belt. < Ref. to **REMOVAL**, Timing Belt. >
4. Remove the camshaft position sensor. < Ref. to **REMOVAL**, Camshaft Position Sensor. >
5. Use the ST to lock the cam sprocket, and remove the cam sprocket bolt.

ST 18231AA010 CAM SPROCKET WRENCH

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

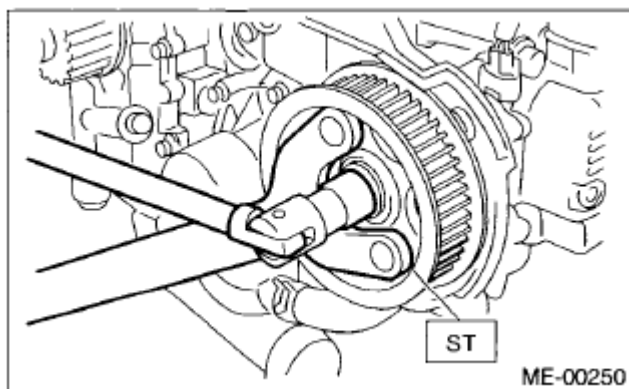


Fig. 126: Removing Cam Sprocket Bolt
Courtesy of SUBARU OF AMERICA, INC.

ST 499207400 CAM SPROCKET WRENCH

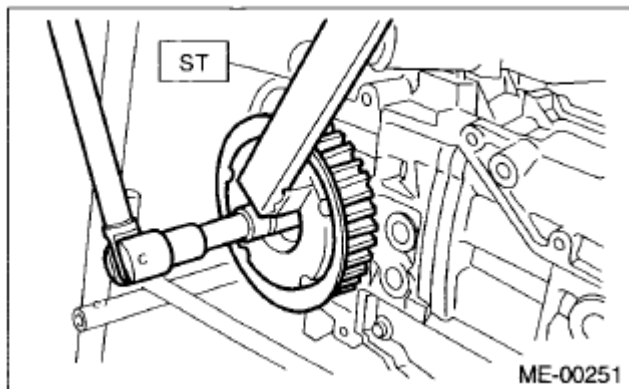


Fig. 127: Tightening Cam Sprocket Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the cam sprocket.

INSTALLATION

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

NOTE:

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

ST 18231AA010 CAM SPROCKET WRENCH

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

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

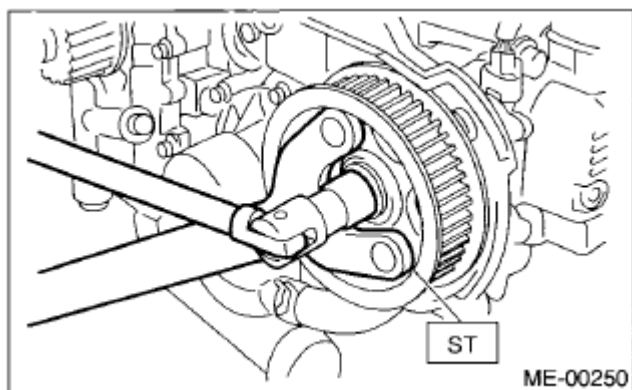


Fig. 128: Installing Cam Sprocket Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

ST 499207400 CAM SPROCKET WRENCH

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

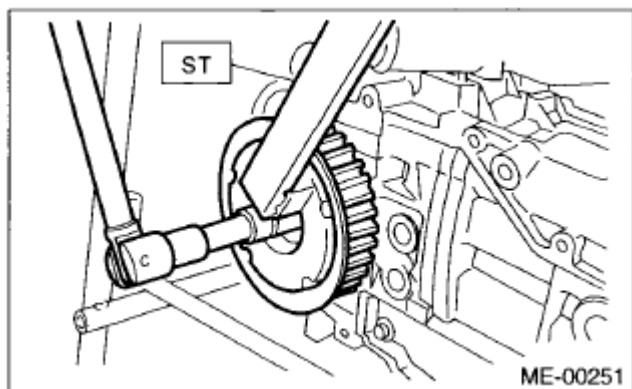


Fig. 129: Tightening Cam Sprocket Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

3. Install the camshaft position sensor. < Ref. to **INSTALLATION**, Camshaft Position Sensor. >
4. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt. >
5. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
6. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >

INSPECTION

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

CRANK SPROCKET

REMOVAL

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

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

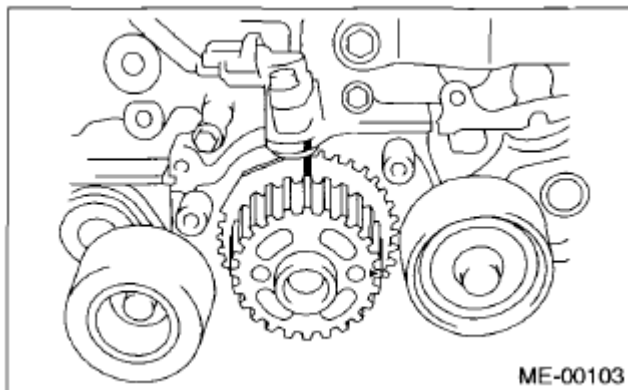


Fig. 130: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

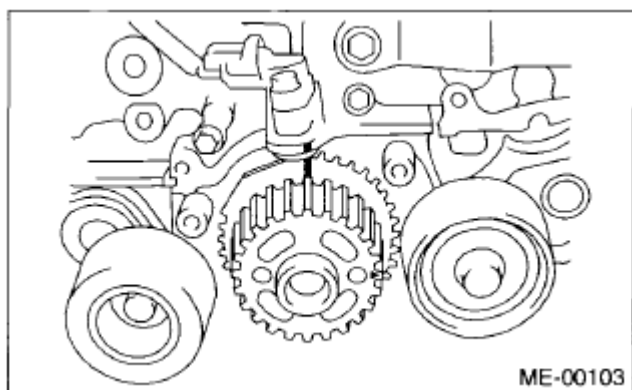


Fig. 131: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

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

VALVE ROCKER ASSEMBLY

REMOVAL

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

1. Remove the spark plug cords.
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

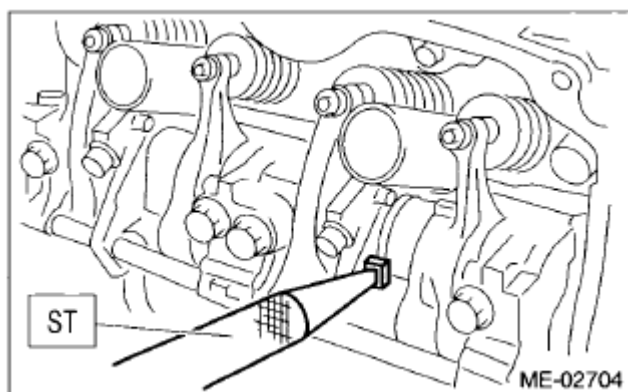
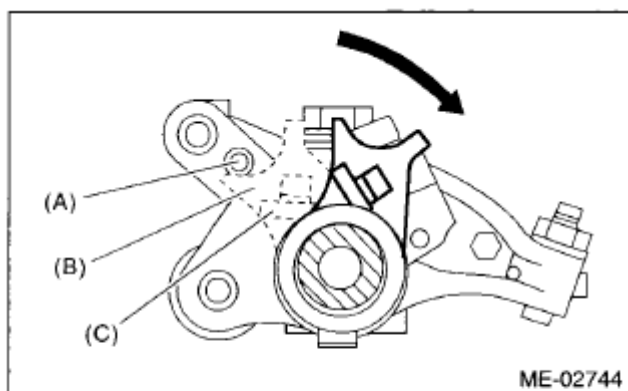


Fig. 132: Removing Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 133: Rotating Spring Stopper
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.

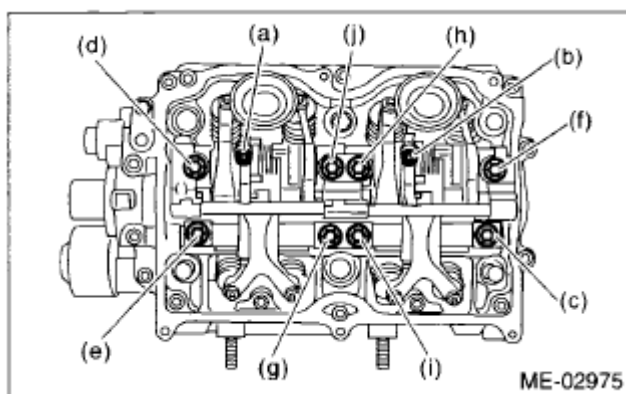


Fig. 134: Identifying Valve Rocker Assembly Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

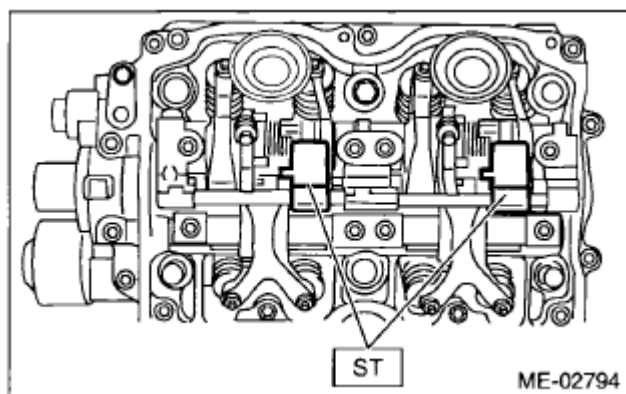


Fig. 135: Removing Intake Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

NOTE:

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

ST 18354AA000 VALVE ROCKER HOLDER

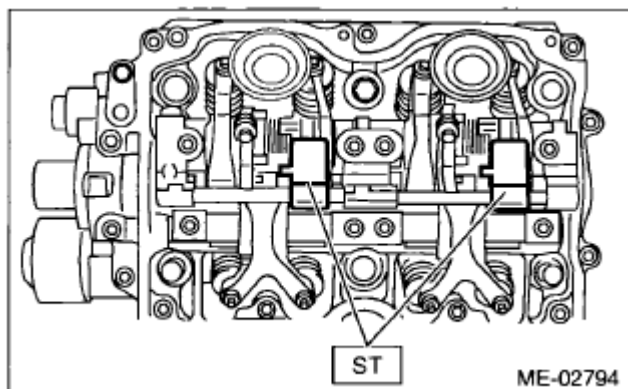


Fig. 136: Mounting Intake Valve Rocker Assembly
 Courtesy of SUBARU OF AMERICA, INC.

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

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

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

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

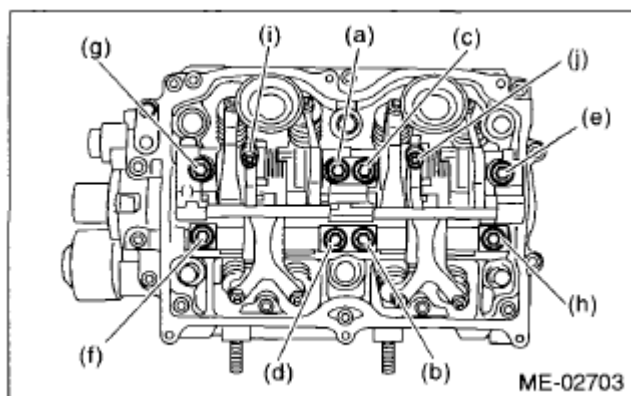


Fig. 137: Identifying Valve Rocker Assembly Bolts Tighten Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

ST 18258AA000 SPRING INSTALLER

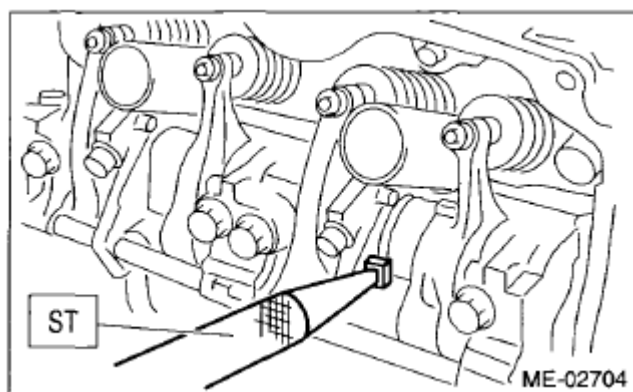
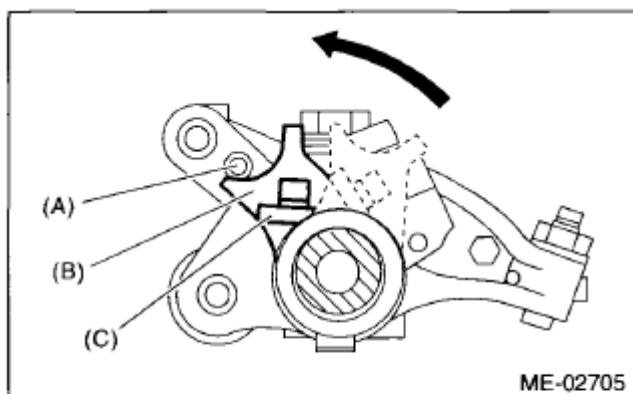


Fig. 138: Installing Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 139: Rotating Spring Stopper
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

NOTE: Use a new rocker cover gasket.

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

Tightening torque:***1st 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)******Second (only (a) and (b) are tightened) 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)***

RH side

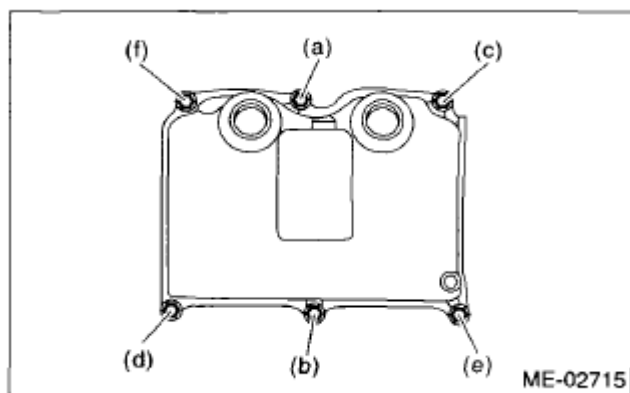


Fig. 140: Identifying Rocker Cover Bolts - RH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

LH side

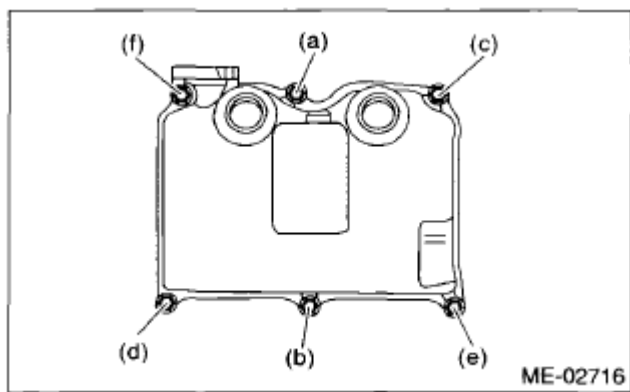


Fig. 141: Identifying Rocker Cover Bolts - LH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the PCV hose.
6. Install the spark plug cords.

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 ASSY

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 ASSY

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)

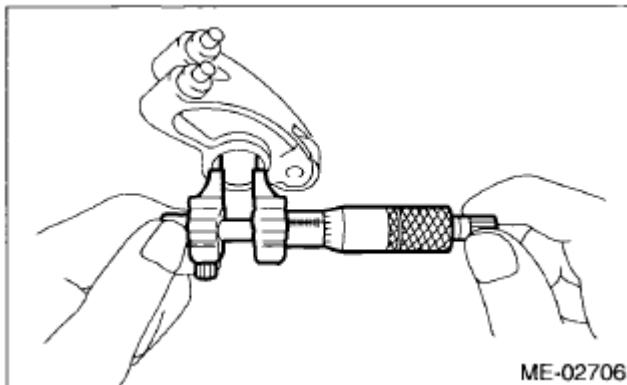


Fig. 142: Measuring Inner Diameter Of Valve Rocker Arm
 Courtesy of SUBARU OF AMERICA, INC.

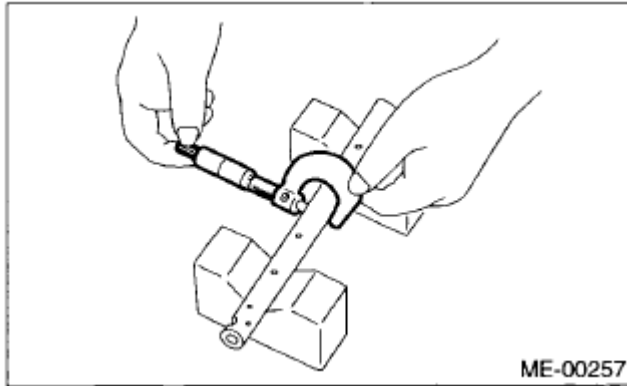


Fig. 143: Measuring Outer Diameter Of Valve Rocker Shaft
 Courtesy of SUBARU OF AMERICA, INC.

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.

CAM SHAFT

REMOVAL

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

1. Remove the crank pulley. < Ref. to REMOVAL, Crank Pulley. >
2. Remove the timing belt cover. < Ref. to REMOVAL, Timing Belt Cover. >
3. Remove the timing belt. < Ref. to REMOVAL, Timing Belt. >
4. Remove the cam sprocket. < Ref. to REMOVAL, Cam Sprocket. >
5. Remove the timing belt cover No. 2 LH.
6. Remove the timing belt cover No. 2 RH.

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

covers.

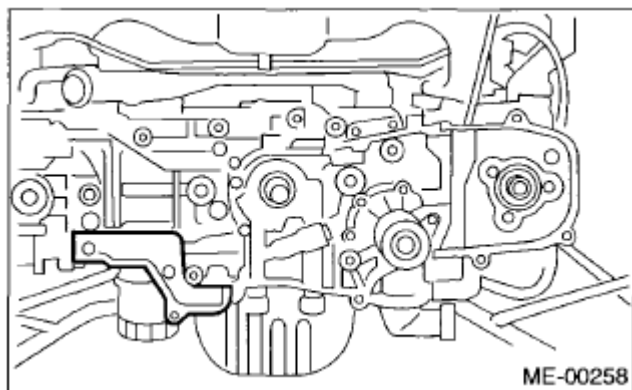


Fig. 144: Identifying Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the tensioner bracket.

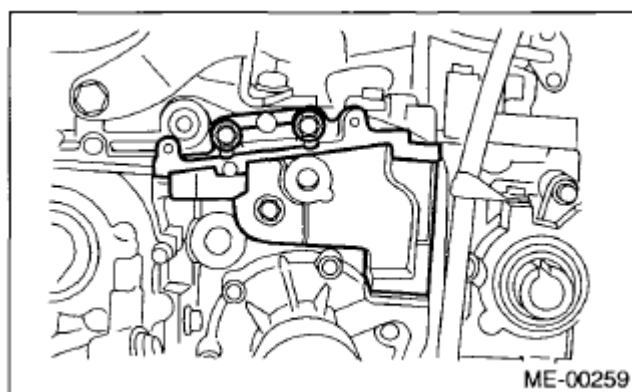


Fig. 145: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

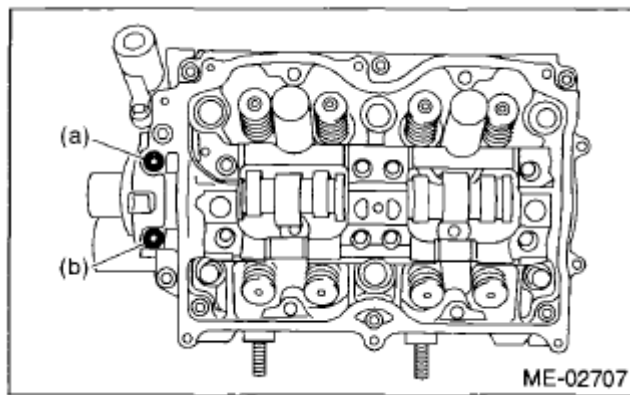


Fig. 146: Identifying Camshaft Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

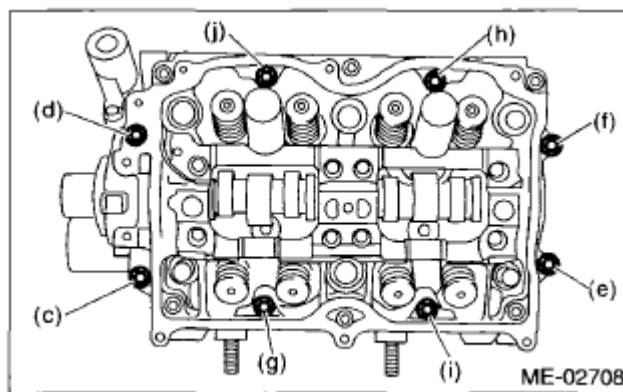


Fig. 147: Identifying Camshaft Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX® PLUS

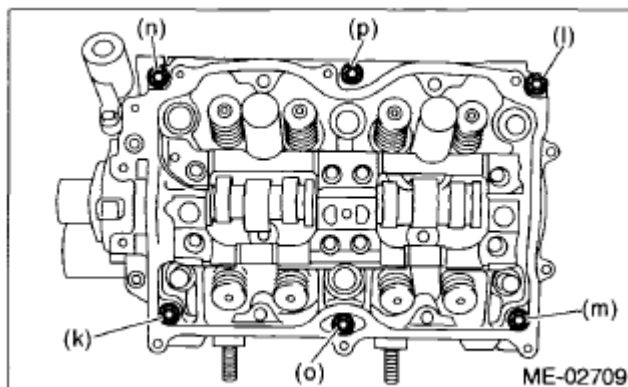


Fig. 148: Identifying Camshaft Bolts Removal Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

INSTALLATION

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

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

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

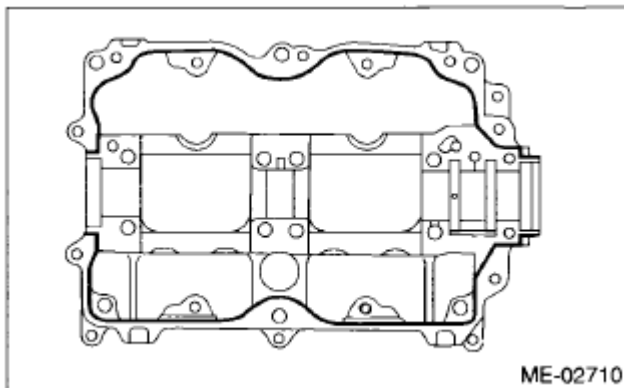


Fig. 149: Identifying Liquid Gasket Applying Area On Mating Surfaces Of Camshaft Cap
Courtesy of SUBARU OF AMERICA, INC.

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

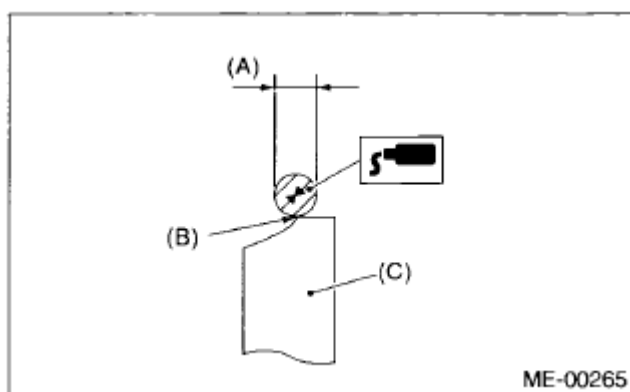


Fig. 150: Applying Coat Of Liquid Gasket On Camshaft Cap Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

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

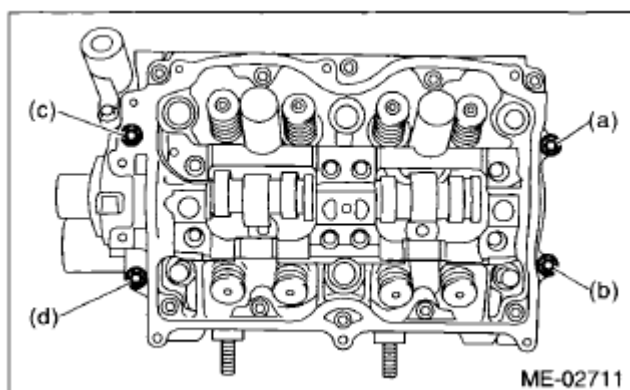


Fig. 151: Identifying Camshaft Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX® PLUS

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

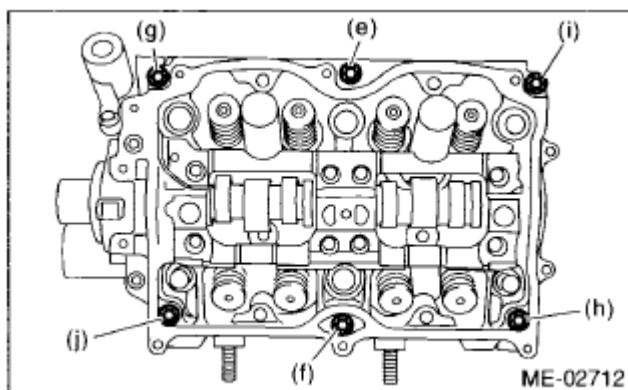


Fig. 152: Identifying TORX® Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

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

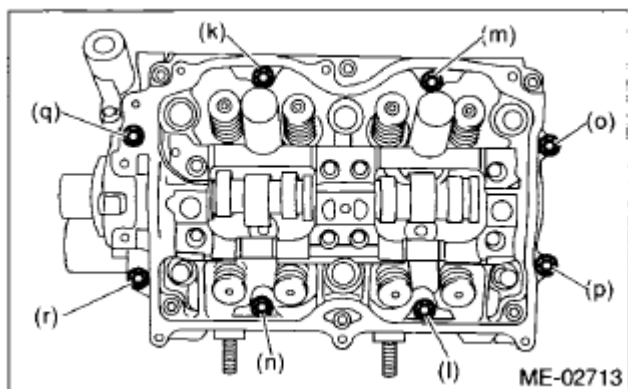


Fig. 153: Identifying TORX® Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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

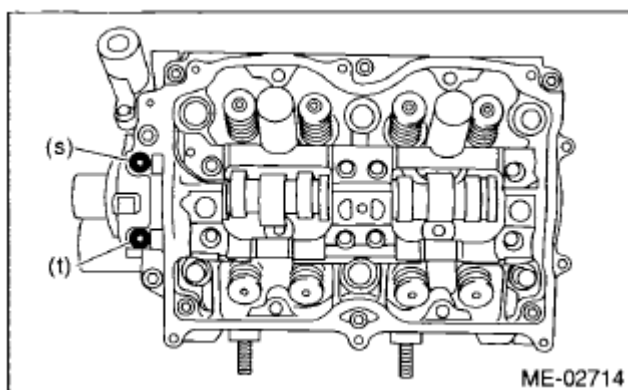


Fig. 154: Identifying Seal Washer Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

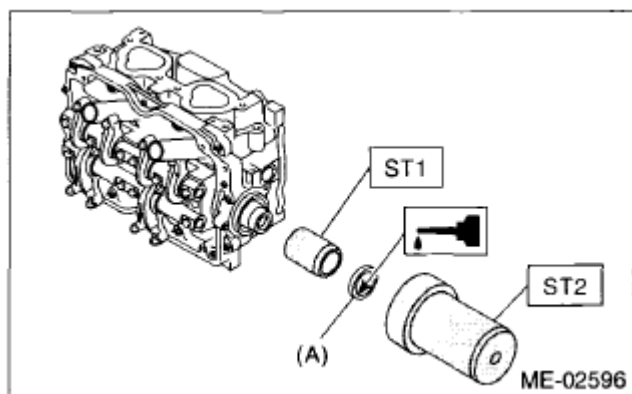


Fig. 155: Applying Coat Of Engine Oil Onto Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499587700 CAMSHAFT OIL SEAL INSTALLER

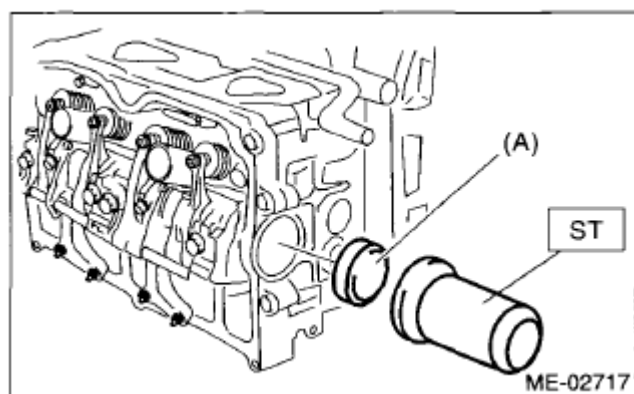


Fig. 156: Installing Plug Using ST
 Courtesy of SUBARU OF AMERICA, INC.

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)

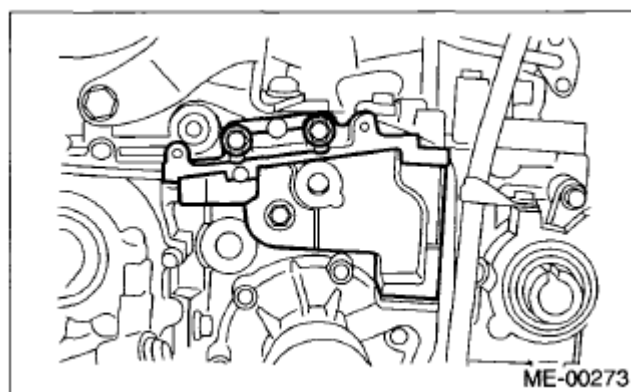


Fig. 157: Identifying Tensioner Bracket With Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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)

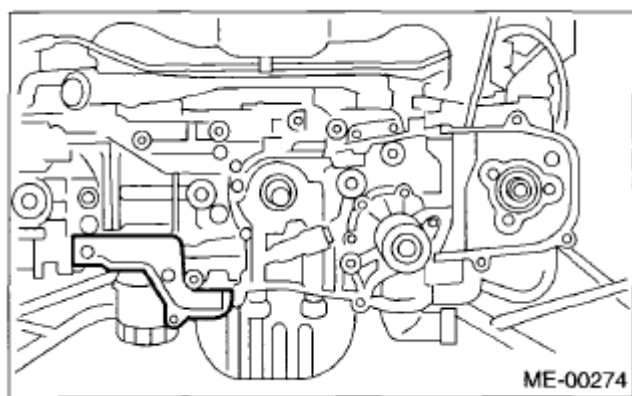


Fig. 158: Identifying Timing Belt Cover No. 2
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rocker cover gasket.

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

Tightening torque:

1st 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

Second (only (a) and (b) are tightened) 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

RH side

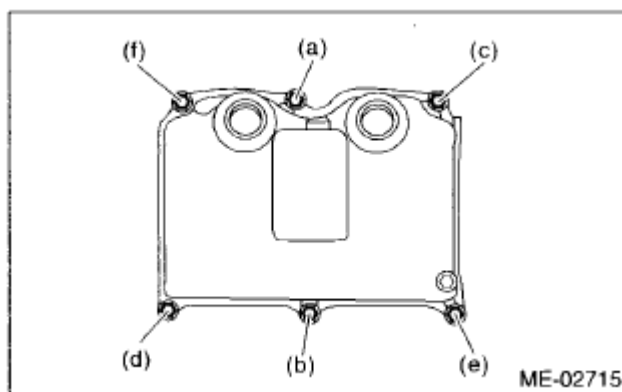


Fig. 159: Identifying Rocker Cover Bolts - RH Side Tightening Sequence

Courtesy of SUBARU OF AMERICA, INC.

LH side

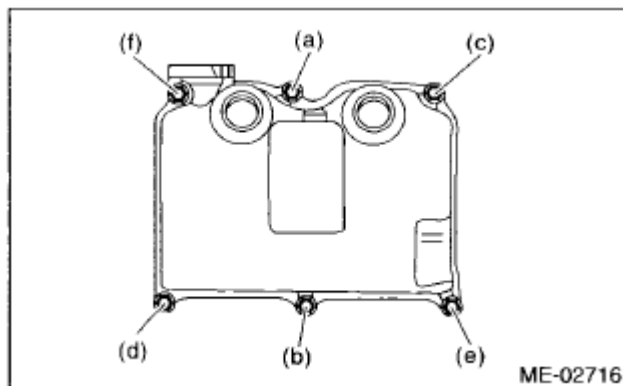


Fig. 160: Identifying Rocker Cover Bolts - LH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the PCV hose.
14. Install the spark plug cords.
15. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
16. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >

INSPECTION

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

Camshaft bend limit: 0.025 mm (0.00098 in)

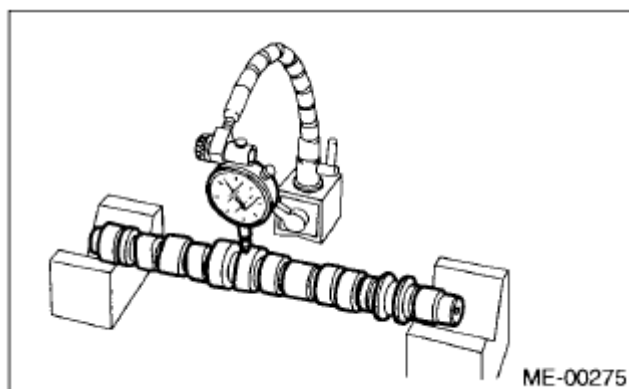


Fig. 161: Measuring Camshaft Bend
Courtesy of SUBARU OF AMERICA, INC.

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

occurs, replace it.

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

Cam lobe height H:

CAM LOBE HEIGHT SPECIFICATION CHART

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

Cam base circle diameter A:

Standard 34.00 mm (1.3386 in)

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

Standard 0.03 mm (0.001 in) or less

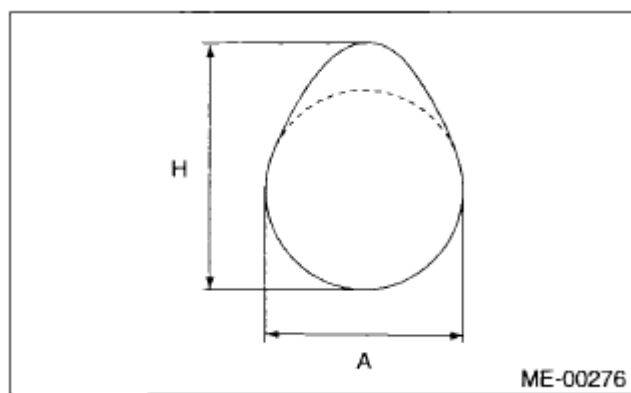


Fig. 162: Measuring Cam Height
Courtesy of SUBARU OF AMERICA, INC.

5. Measure the outer diameter of camshaft journal and inner diameter of cylinder head journal, and 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.

OIL CLEARANCE SPECIFICATION CHART

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

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

Front exhaust pipe < Ref. to REMOVAL , Front Exhaust Pipe. > < Ref. to INSTALLATION , Front Exhaust Pipe. >

1. Remove the intake manifold. < Ref. to REMOVAL , Intake Manifold. >
2. Remove the crank pulley. < Ref. to REMOVAL , Crank Pulley. >
3. Remove the timing belt cover. < Ref. to REMOVAL , Timing Belt Cover. >
4. Remove the timing belt. < Ref. to REMOVAL , Timing Belt. >
5. Remove the cam sprocket. < Ref. to REMOVAL , Cam Sprocket. >
6. Remove the bolts which secure A/C compressor bracket to cylinder head.
7. Remove the valve rocker assembly. < Ref. to REMOVAL , Valve Rocker Assembly. >
8. Remove the camshaft. < Ref. to REMOVAL , Camshaft. >
9. Remove the oil level gauge guide. (LH side)
10. 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.**

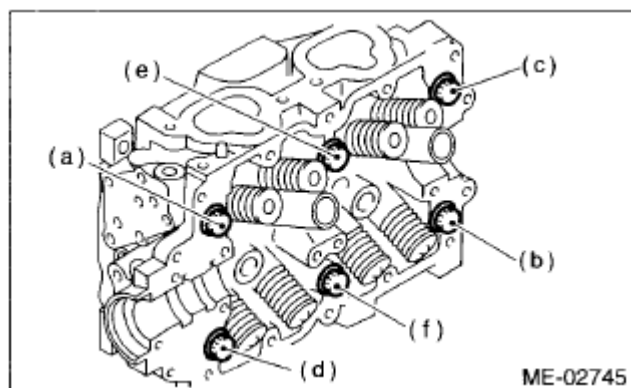


Fig. 163: Identifying Cylinder Head Bolts Removal Sequence

Courtesy of SUBARU OF AMERICA, INC.

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

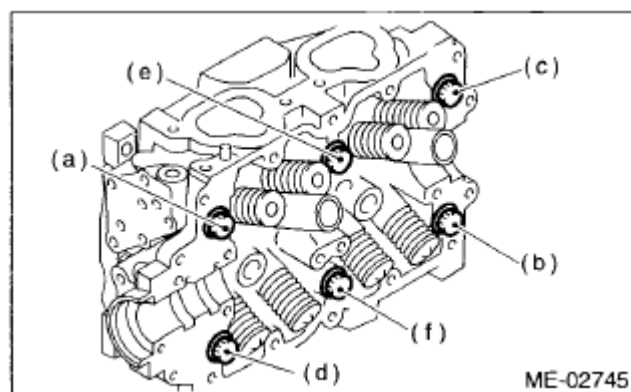


Fig. 164: Identifying Cylinder Head Bolts

Courtesy of SUBARU OF AMERICA, INC.

12. Remove the cylinder head gasket.

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

13. Similarly, remove the right side cylinder head.

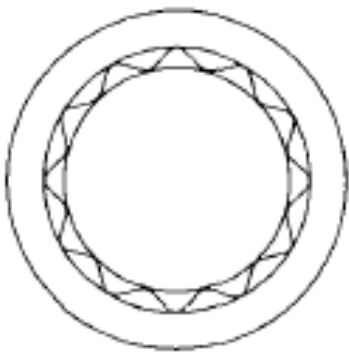
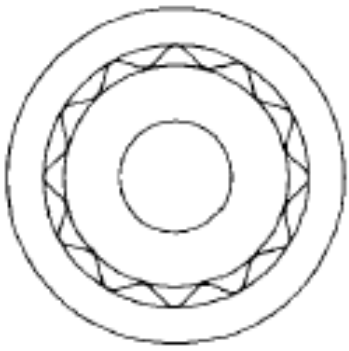
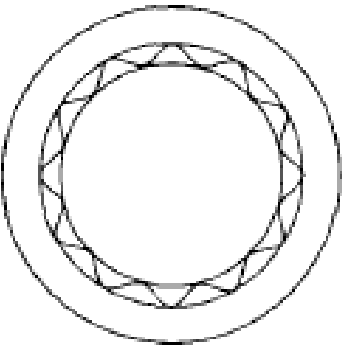
INSTALLATION

1. Install the cylinder head to the cylinder block.

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

- Be aware that the center bolts and corner bolts are different.

BOLT SPECIFICATION CHART

Bolt type	Center bolt	Corner bolt
Silver bolt	 FU-05486	 FU-05487
Black bolt	 FU-05488	 FU-05486

NOTE: Use a new cylinder head gasket.

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

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

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

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

5. Loosen all the bolts by 180° in the reverse order of installing, and loosen them further by 180°.
6. Tighten all bolts to 10 N.m (1.0 kgf-m, 7.4 ft-lb) in alphabetical order.
7. Retighten all bolts to 30 N.m (3.1 kgf-m, 22.1 ft-lb) in alphabetical order.
8. Retighten all bolts to 60 N.m (6.1 kgf-m, 44.3 ft-lb) in alphabetical order.
9. Retighten all bolts by 80 - 90° in alphabetical order.
10. Retighten all bolts by 40 - 45° in alphabetical order.

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

11. Retighten bolts (a) and (b) by 40 - 45°.

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

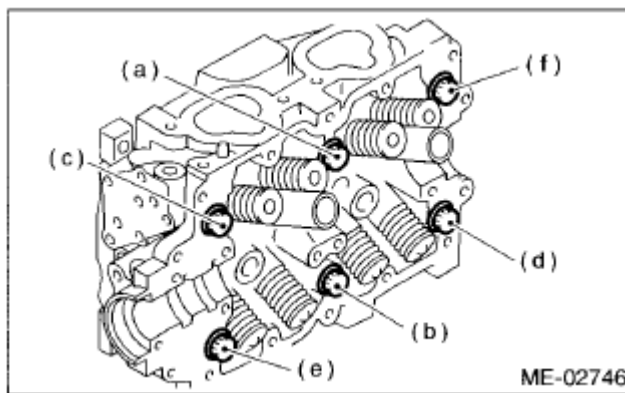


Fig. 165: Identifying Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

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

6. Install the cam sprocket. < Ref. to INSTALLATION, Cam Sprocket. >
7. Install the timing belt. < Ref. to INSTALLATION, Timing Belt. >
8. Adjust the valve clearance. < Ref. to ADJUSTMENT, Valve Clearance. >
9. Install the rocker cover.
 1. Install the rocker cover gasket to the rocker cover.

NOTE: Use a new rocker cover gasket.

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

Tightening torque:

1st 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

Second (only (a) and (b) are tightened) 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

RH side

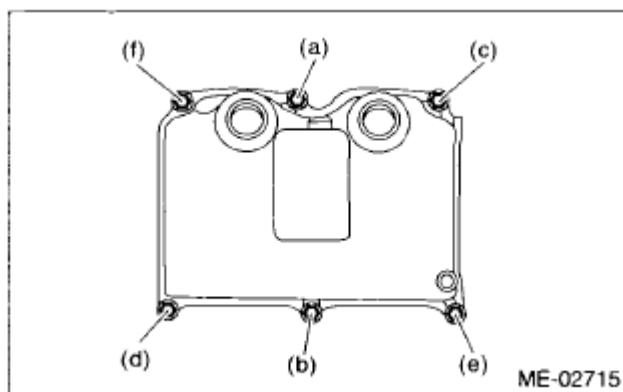


Fig. 166: Identifying Rocker Cover Bolts - RH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

LH side

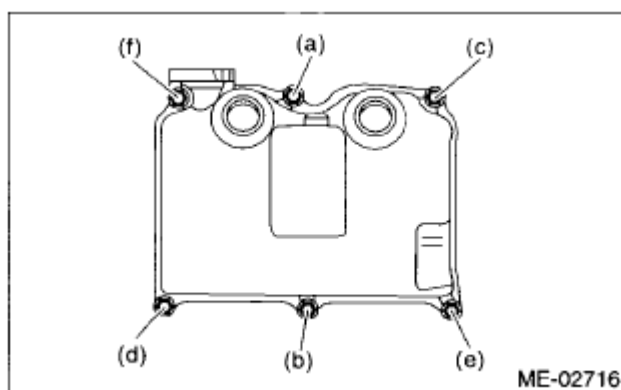


Fig. 167: Identifying Rocker Cover Bolts - LH Side Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

10. Install the timing belt cover. < Ref. to INSTALLATION, Timing Belt Cover. >
11. Install the crank pulley. < Ref. to INSTALLATION, Crank Pulley. >
12. Install the intake manifold. < Ref. to INSTALLATION, Intake Manifold. >

DISASSEMBLY

1. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

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

ST 499718000 VALVE SPRING REMOVER

NOTE:

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

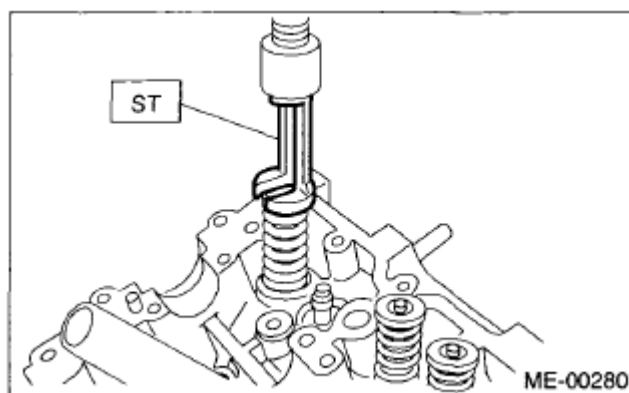
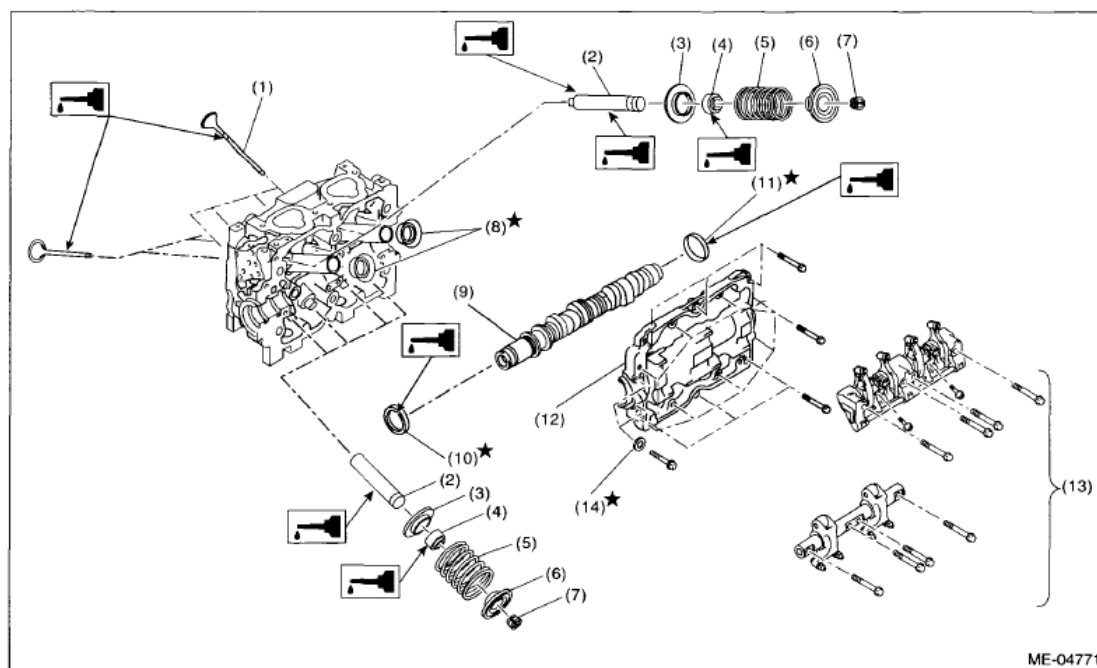


Fig. 168: Installing Valve Spring And Retainer Using ST
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



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

Fig. 169: Exploded View Of Cylinder Head Components
Courtesy of SUBARU OF AMERICA, INC.

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

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

2. Set the cylinder head on 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

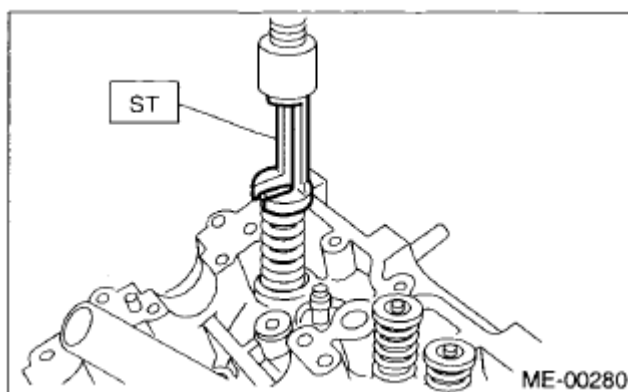
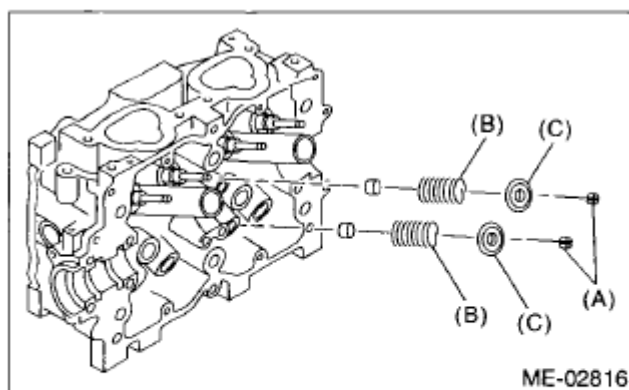


Fig. 170: Installing Valve Spring And Retainer Using ST
Courtesy of SUBARU OF AMERICA, INC.

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



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

Fig. 171: Identifying Retainer Key, Valve Spring And Retainer
 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 areas 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.

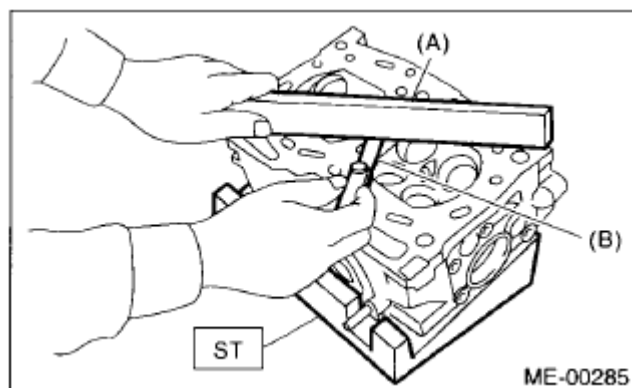


Fig. 172: Measuring Warping Of Cylinder Head Surface Using Straight Edge
 Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Contacting width 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)

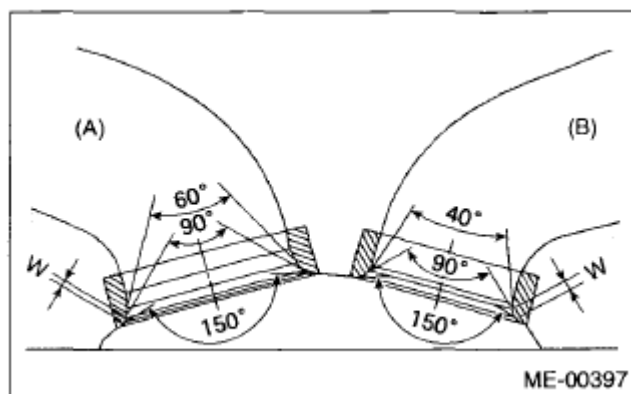


Fig. 173: Identifying Seat Guide Dimension
 Courtesy of SUBARU OF AMERICA, INC.

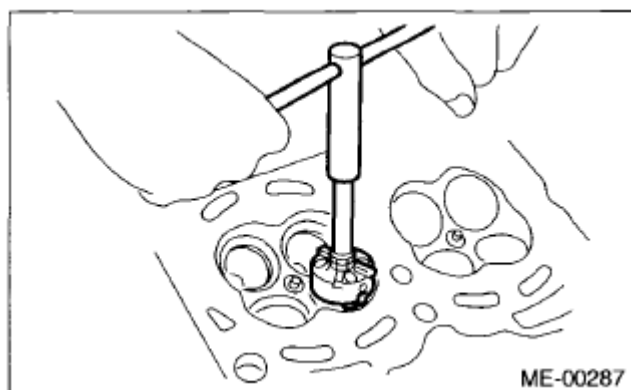


Fig. 174: Inspecting Intake And Exhaust Valve Seats
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

Clearance between the valve guide and valve stem:

Standard

Intake 0.035 - 0.062 mm (0.0014 - 0.0024 in)

Exhaust 0.040 - 0.067 mm (0.0016 - 0.0026 in)

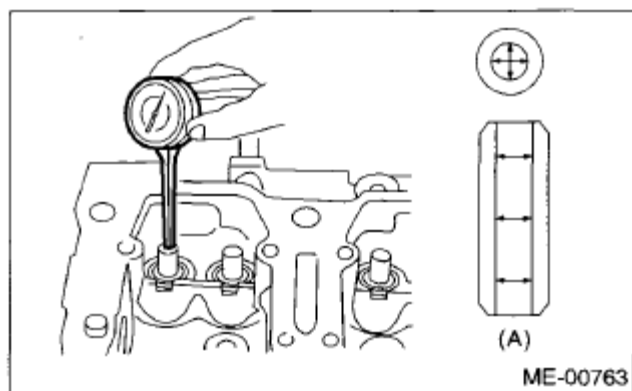


Fig. 175: Measuring Clearance Between Valve Guide And Valve Stem
Courtesy of SUBARU OF AMERICA, INC.

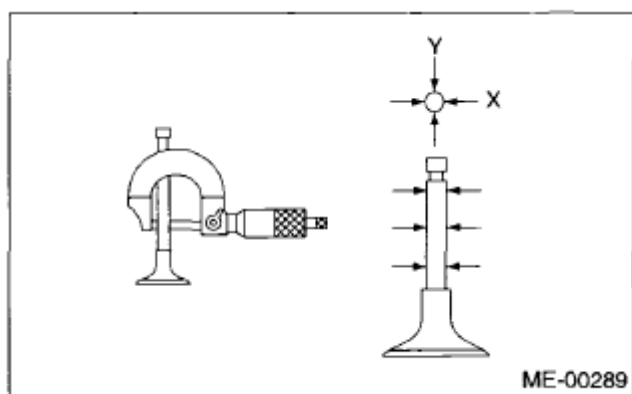


Fig. 176: Measuring Outer Diameter Of Valve Stem With Micrometer
 Courtesy of SUBARU OF AMERICA, INC.

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

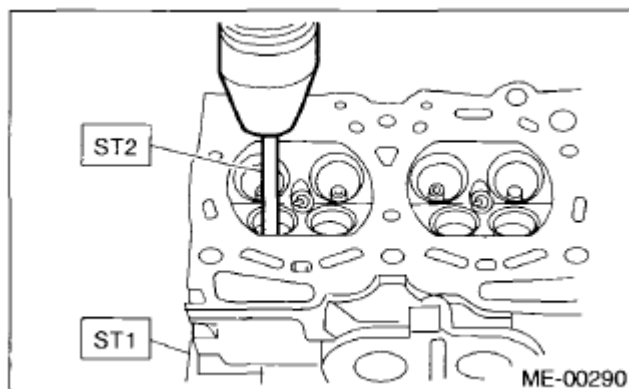


Fig. 177: Inserting ST2 Into Valve Guide Using Valve Guide Remover
Courtesy of SUBARU OF AMERICA, INC.

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

Intake side

ST 499767700 VALVE GUIDE ADJUSTER

Exhaust side

ST 499767800 VALVE GUIDE ADJUSTER

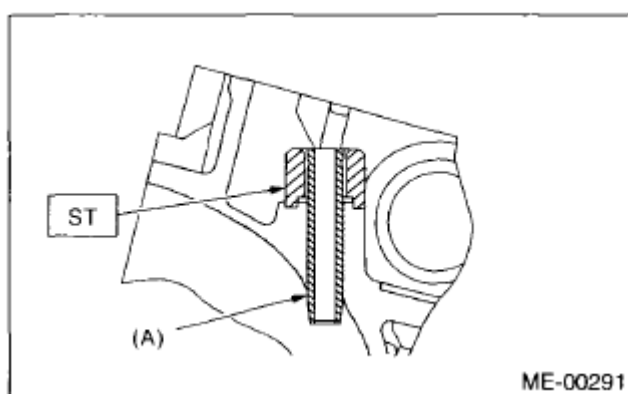


Fig. 178: Adjusting Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

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

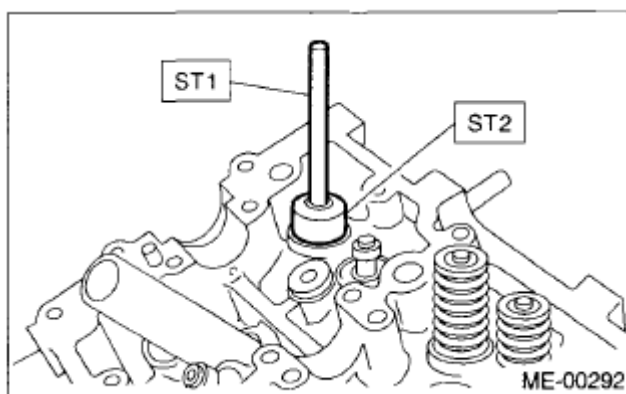


Fig. 179: Inserting ST1 Into Valve Guide Using Valve Guide Remover
Courtesy of SUBARU OF AMERICA, INC.

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

Amount of valve guide protrusion L:

Intake 20.3 - 20.7 mm (0.799 - 0.815 in)

Exhaust 16.8 - 17.2 mm (0.661 - 0.677 in)

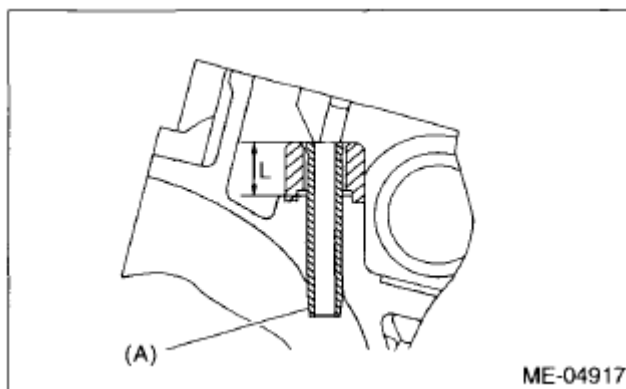


Fig. 180: Checking Valve Guide Protrusion Amount
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

ST 499767400 VALVE GUIDE REAMER

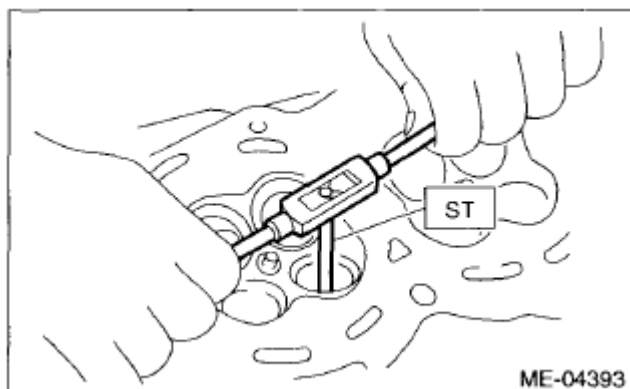


Fig. 181: Reaming Inside Of Valve Guide Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

INTAKE AND EXHAUST VALVE

1. Inspect the flange 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)

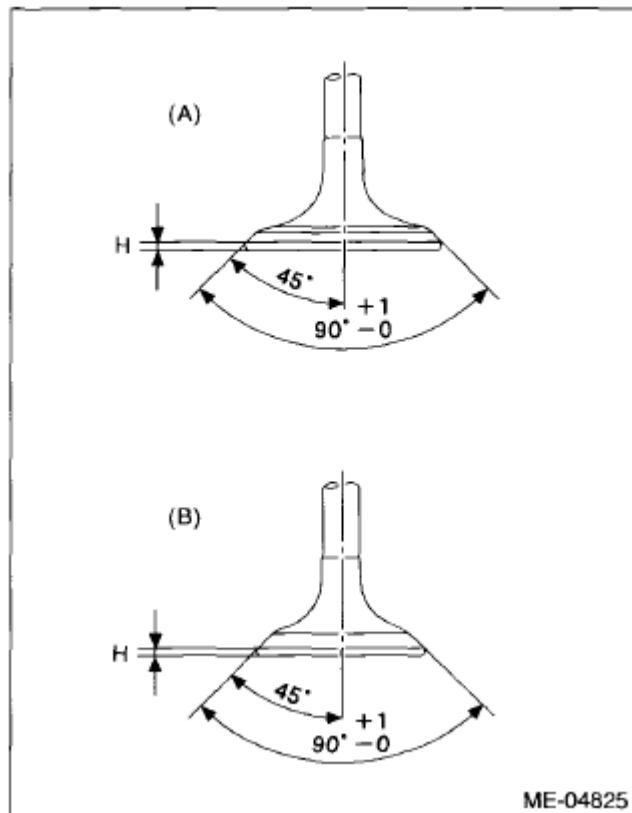


Fig. 182: Identifying Valve Overall Length And Head Edge Thickness
Courtesy of SUBARU OF AMERICA, INC.

- 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

- 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.
- 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 CHART

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

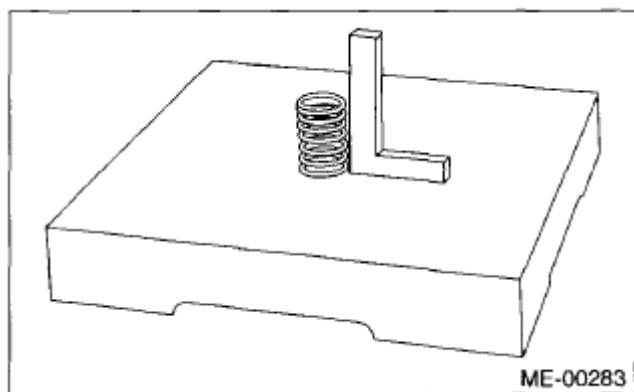


Fig. 183: Measuring Squareness Of Valve Spring
 Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

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

See the procedure 2) and subsequent for replacement procedures.

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

ST1 498267800 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

NOTE:

- Apply engine oil to oil seal before press-fitting.
- When press-fitting the oil seal, do not use a hammer 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]

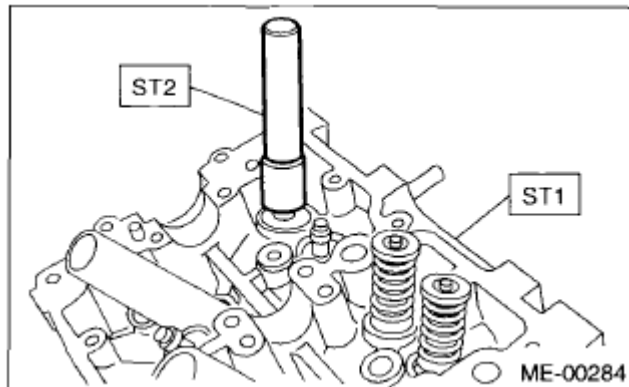


Fig. 184: Pressing Oil Seal Using ST2
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK

REMOVAL

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

1. Remove the engine from the vehicle. < Ref. to **REMOVAL**, Engine Assembly. >
2. Remove the intake manifold. < Ref. to **REMOVAL**, Intake Manifold. >
3. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
4. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
5. Remove the timing belt. < Ref. to **REMOVAL**, Timing Belt. >
6. Remove the crank sprocket. < Ref. to **REMOVAL**, Crank Sprocket. >
7. Remove the generator and A/C compressor with their brackets.
8. Remove the cylinder head. < Ref. to **REMOVAL**, Cylinder Head. >
9. Remove the drive plate. (AT model) < Ref. to **REMOVAL**, Drive Plate. >
10. Remove the clutch disc and cover. (MT model) < Ref. to **REMOVAL**, Clutch Disc and Cover. >
11. Remove the flywheel. (MT model) < Ref. to **REMOVAL**, Flywheel. >
12. Remove the oil separator cover.
13. Remove the water by-pass pipe for heater.
14. Remove the water pump. < Ref. 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.

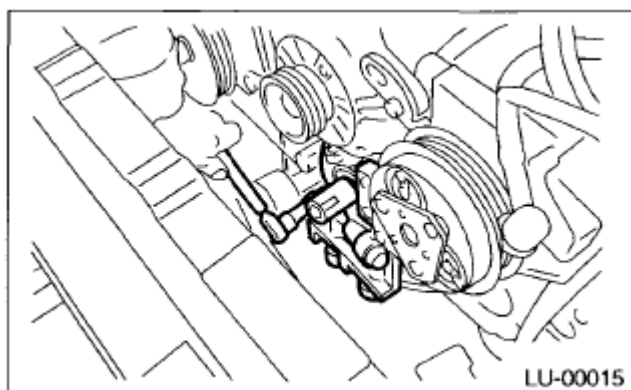


Fig. 185: Identifying Oil Pump Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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.

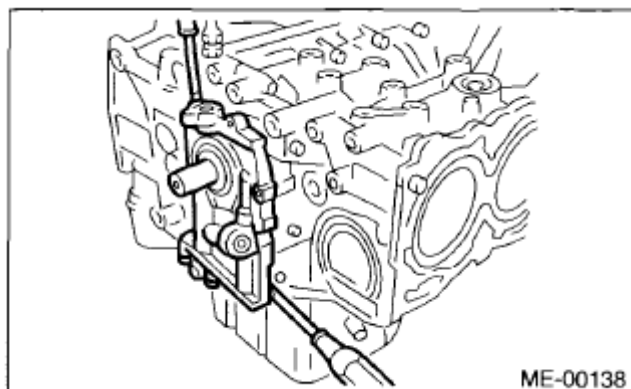


Fig. 186: Removing Oil Pump From Cylinder Block
 Courtesy of SUBARU OF AMERICA, INC.

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. < Ref. to **REMOVAL** , Engine Oil Filter. >
22. Remove the water pipe assembly.

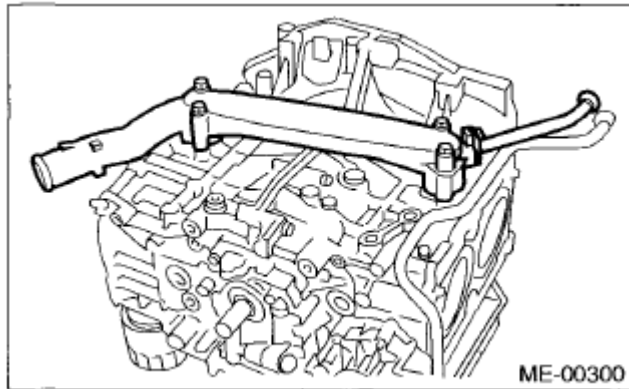
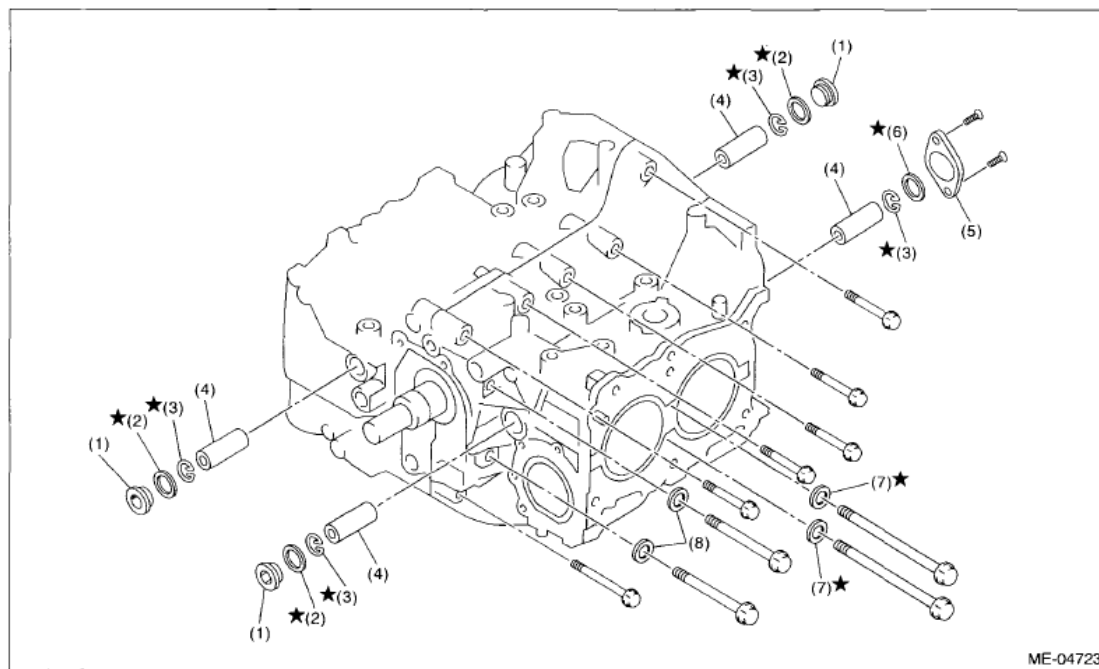


Fig. 187: Identifying Water Pipe Assembly
Courtesy of SUBARU OF AMERICA, INC.



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

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

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

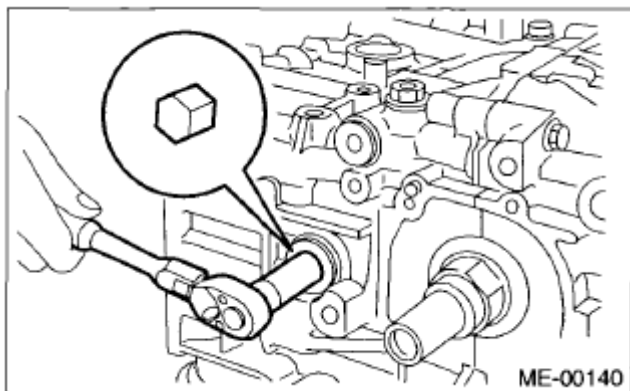


Fig. 189: Removing Service Hole Plug Using Hexagon Wrench
Courtesy of SUBARU OF AMERICA, INC.

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.

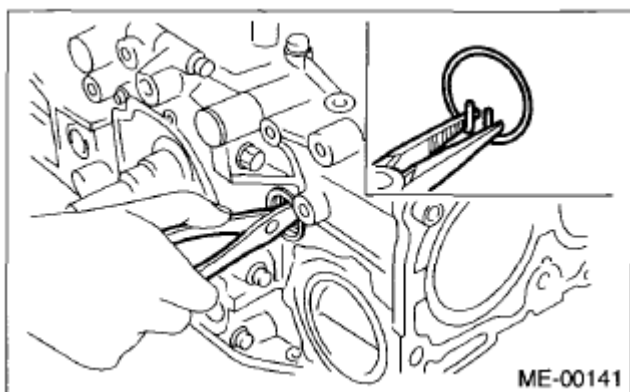


Fig. 190: Removing Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

ST 18320AA010 PISTON PIN REMOVER ASSY

NOTE:

- **PISTON PIN REMOVER ASSY (499097700) can also be used.**
- **Be careful not to confuse the original combination of piston, piston pin and cylinder.**

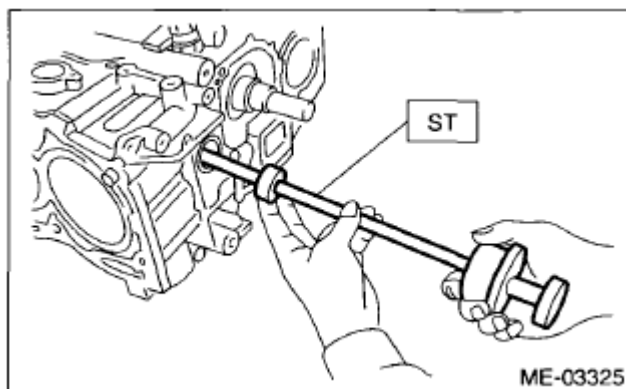
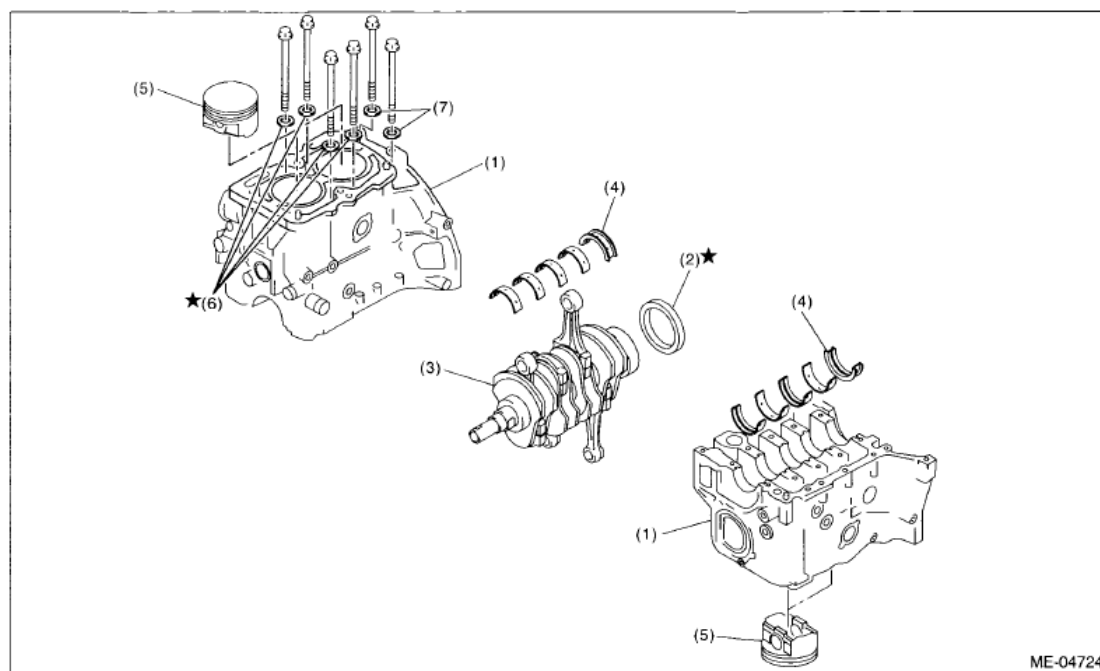


Fig. 191: Removing Piston Pin Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

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

NOTE:

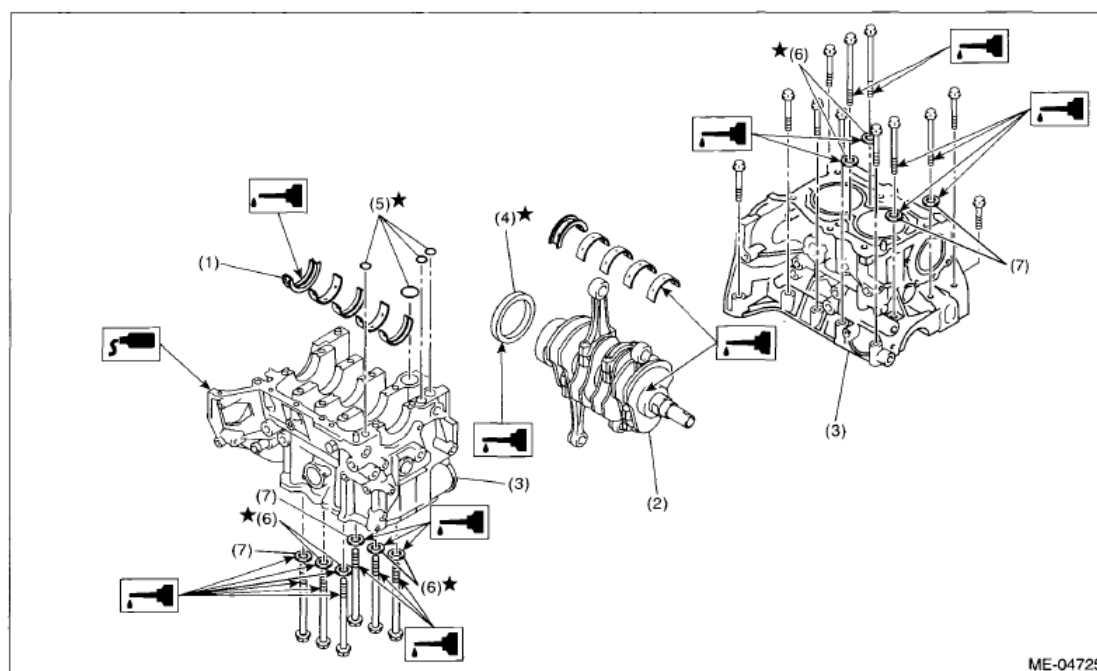
- Press the crankshaft bearing at the end opposite to locking lip to remove.
- Be careful not to confuse the crankshaft bearing combination.

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
(2) Crankshaft
(3) Cylinder block

- (4) Rear oil seal
(5) O-ring

- (6) Seal washer
(7) Washer

Fig. 193: 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

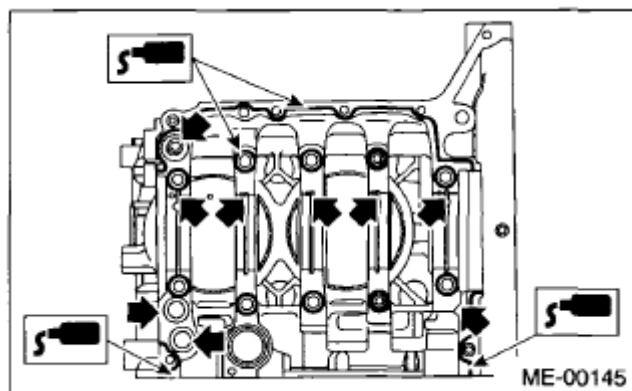


Fig. 194: Applying Liquid Gasket To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new seal washer.

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

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

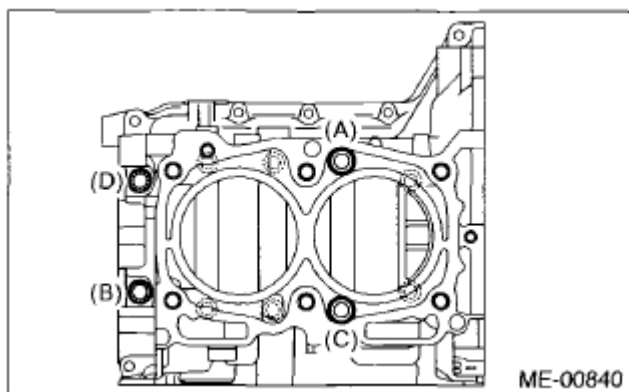


Fig. 195: Identifying Cylinder Block Connecting Bolts On LH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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)

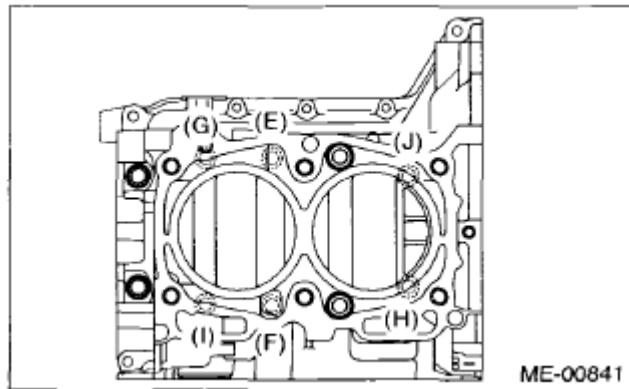


Fig. 196: Identifying Cylinder Block Connecting Bolts On RH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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)

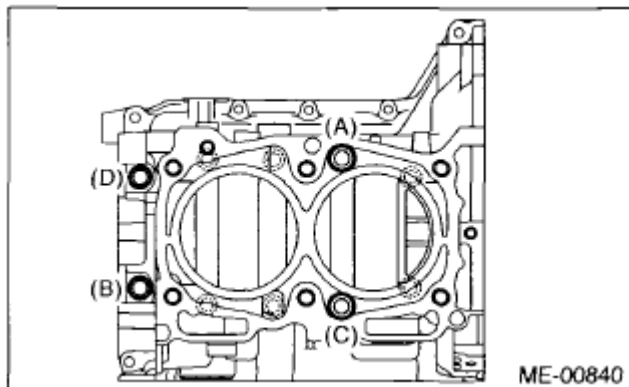


Fig. 197: Identifying Cylinder Block Connecting Bolts On LH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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)

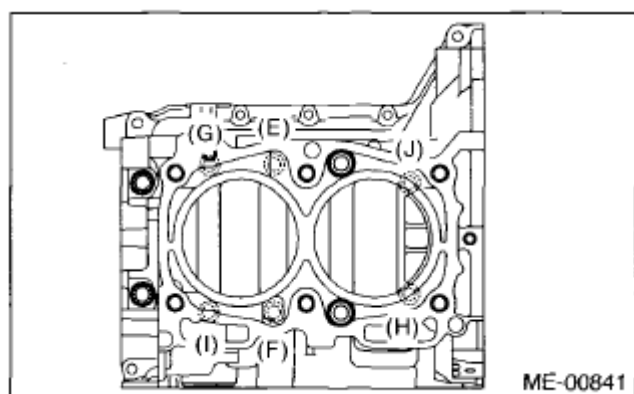


Fig. 198: Identifying Cylinder Block Connecting Bolts On RH Side Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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)

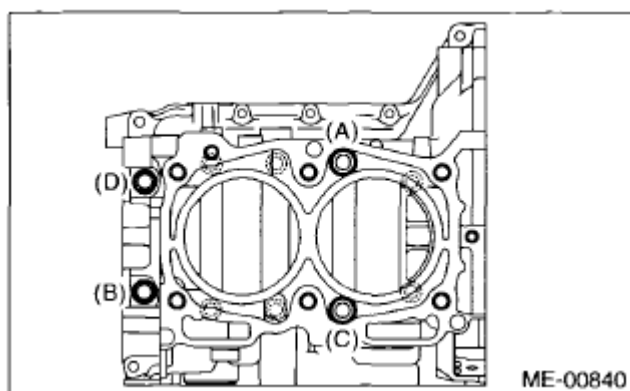


Fig. 199: Identifying Cylinder Block Connecting Bolts On LH Side Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle: 90°

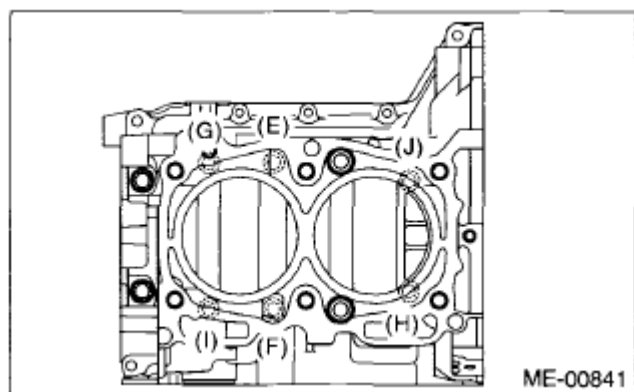


Fig. 200: Identifying Cylinder Block Connecting Bolts On RH Side Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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)

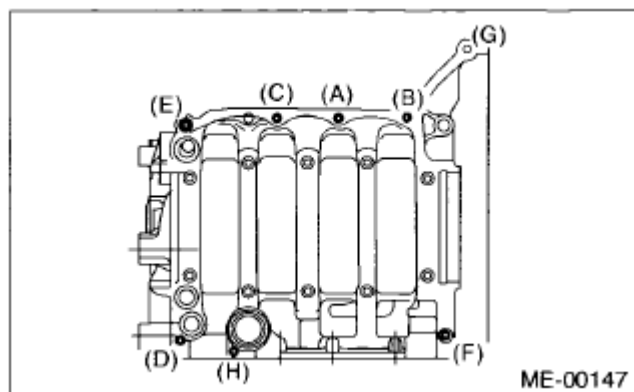


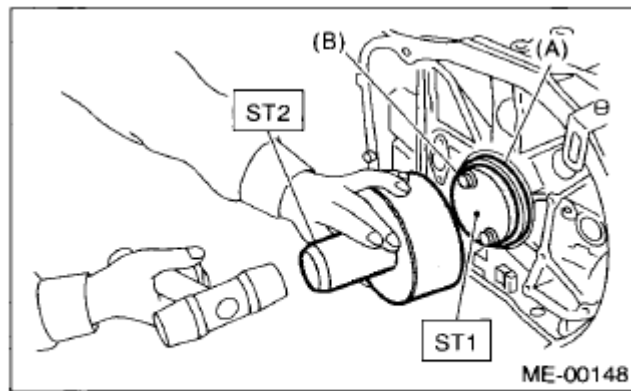
Fig. 201: Identifying Cylinder Block Connecting Bolts On LH Side Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rear oil seal.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER



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

Fig. 202: Installing Rear Oil Seal Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

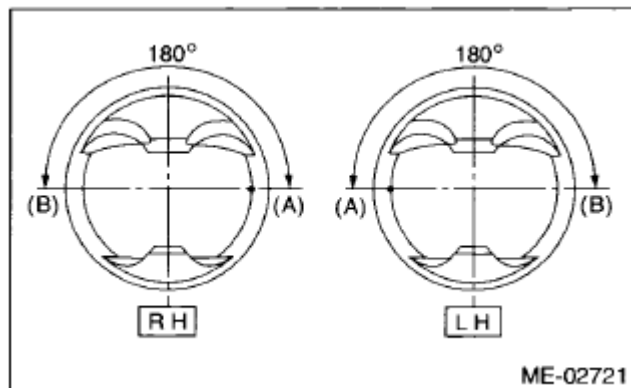


Fig. 203: Identifying Ring Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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

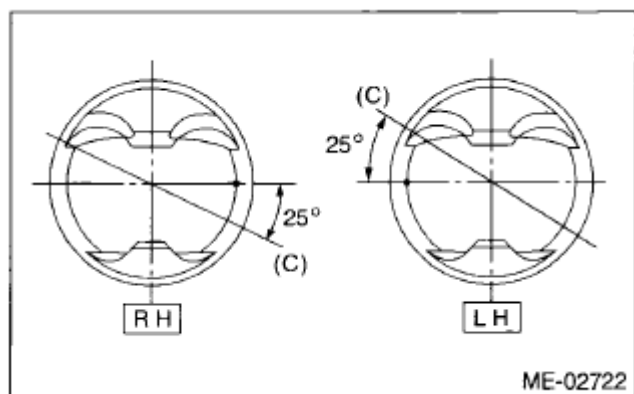


Fig. 204: Positioning Upper Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

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

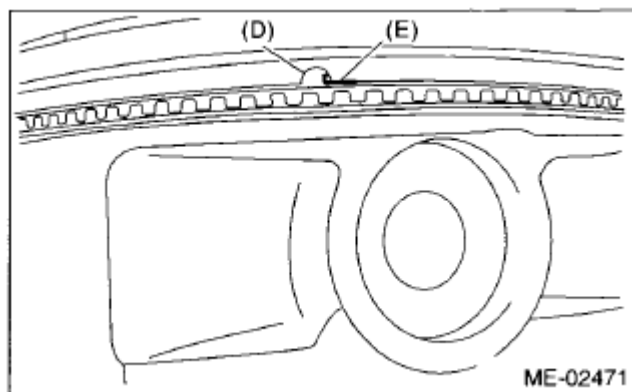


Fig. 205: Aligning Upper Rail Spin Stopper With Piston Side Surface Hole
Courtesy of SUBARU OF AMERICA, INC.

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

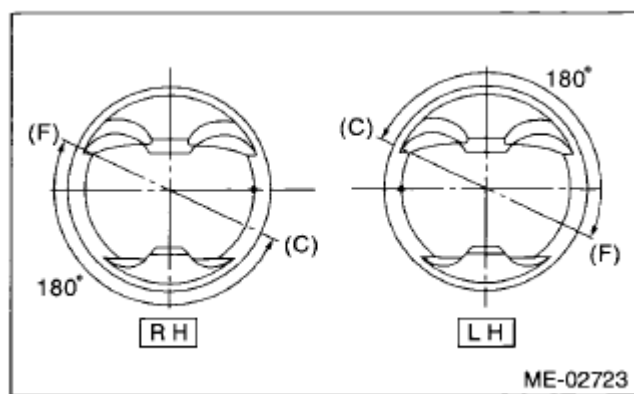


Fig. 206: Identifying Expander Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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

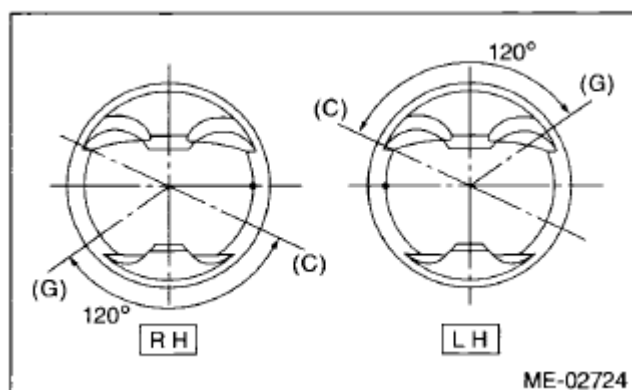


Fig. 207: Identifying Lower Rail Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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.

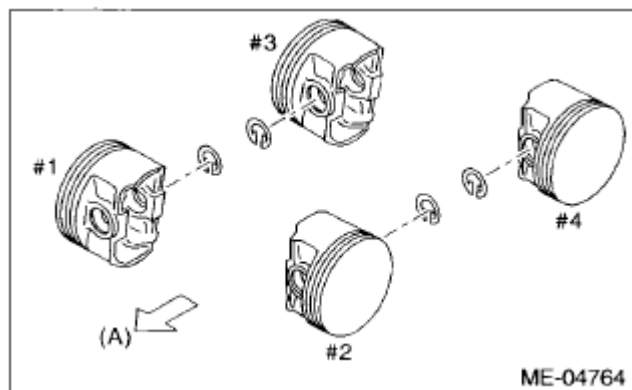
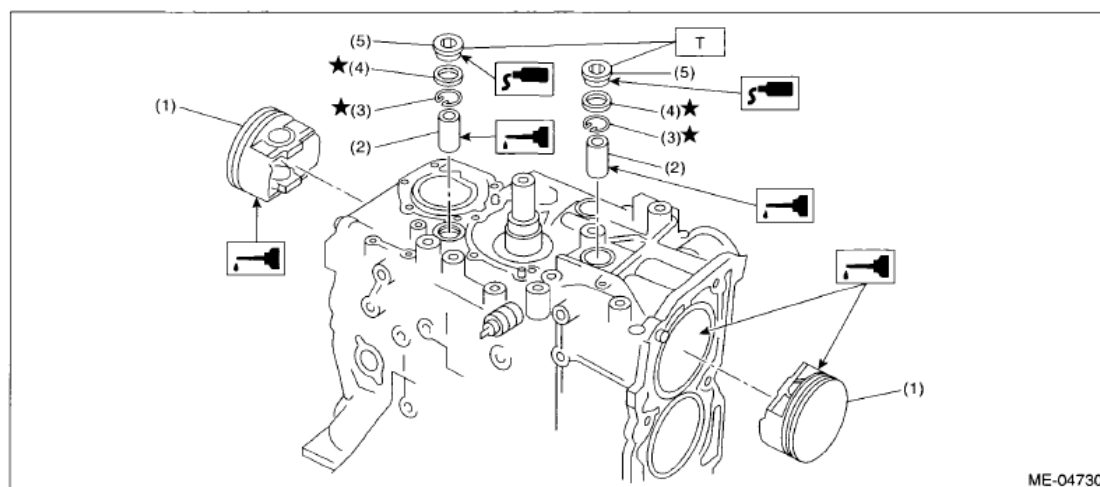


Fig. 208: Identifying Snap Rings
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 209: Identifying Piston, Piston Pin, Snap Ring, Gasket And Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

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

T: 70 (7.1, 51.6)

20. Install the piston.

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

ST1 499987500 CRANKSHAFT SOCKET

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

ST2 498747300 PISTON GUIDE

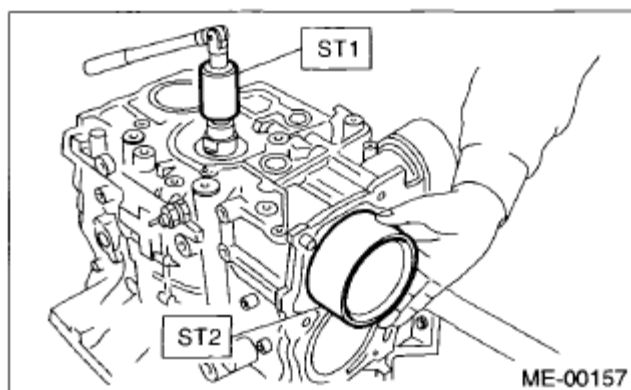
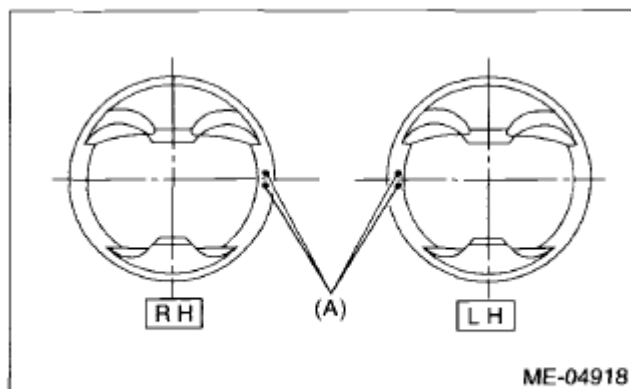


Fig. 210: Inserting Pistons In Cylinders Using Piston Guide ST2
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front mark

Fig. 211: Identifying Piston Front Mark Of Engine
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

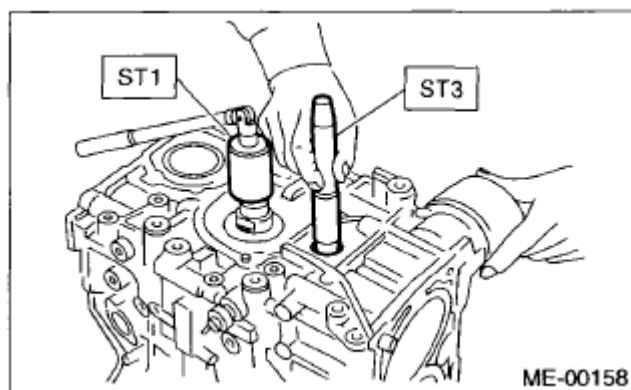


Fig. 212: Installing Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.

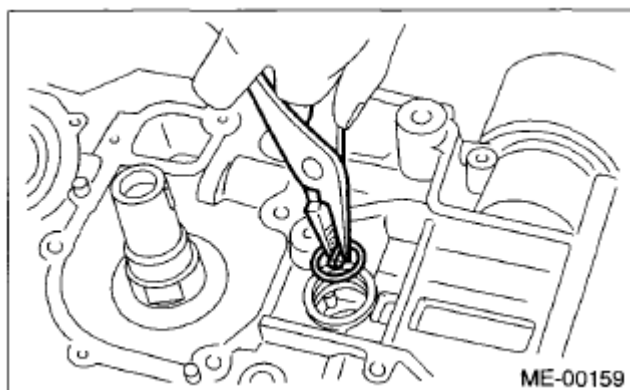


Fig. 213: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

Liquid gasket: THREE BOND 1105 (Part No. 004403010) or equivalent

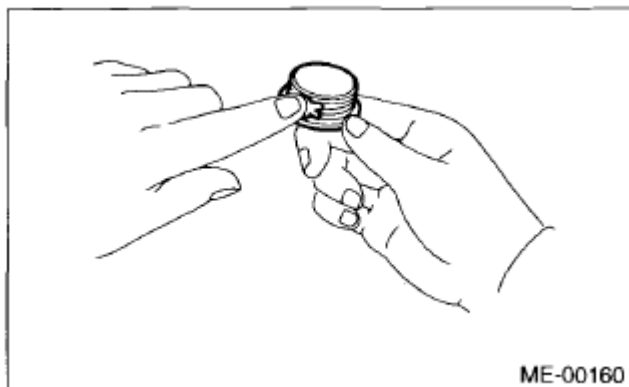


Fig. 214: Applying Fluid Packing Around Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

NOTE: Use a new gasket.

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

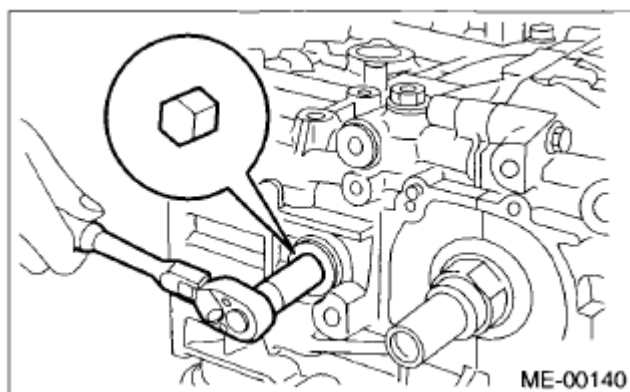
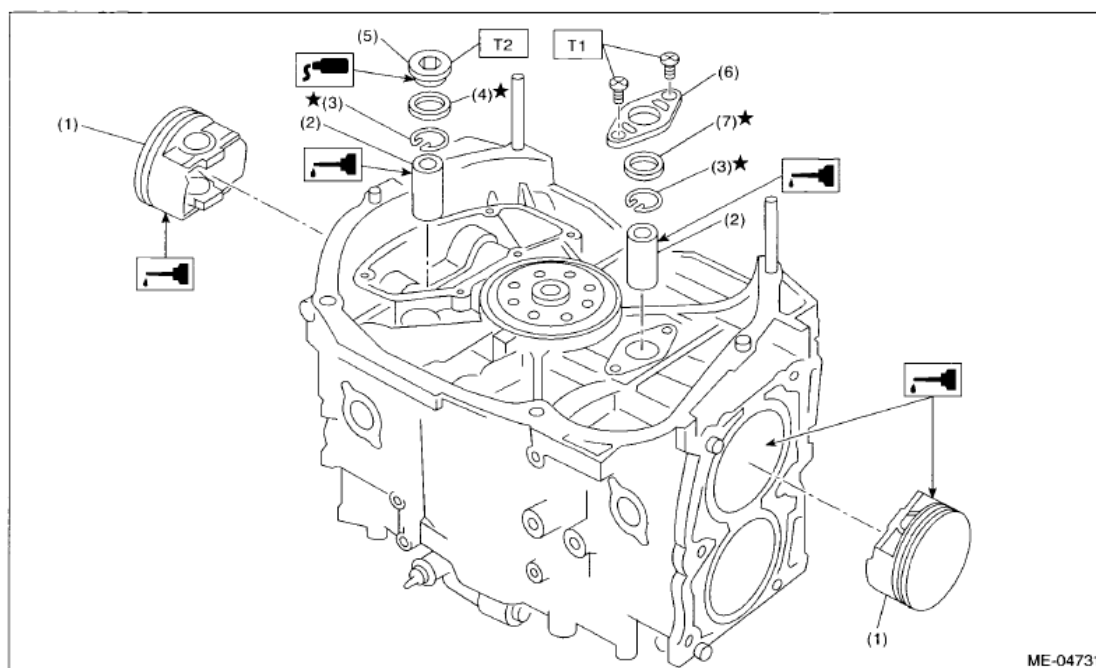


Fig. 215: Installing Service Hole Plug And Gasket
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 216: Identifying O-Ring, Gasket, Piston, Piston Pin, Snap Ring And Service Hole Plug
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)

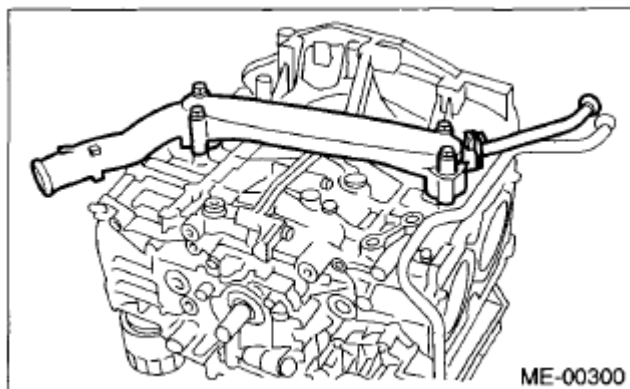


Fig. 217: Identifying Water Pipe
Courtesy of SUBARU OF AMERICA, INC.

23. Install the baffle plate.

NOTE:

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

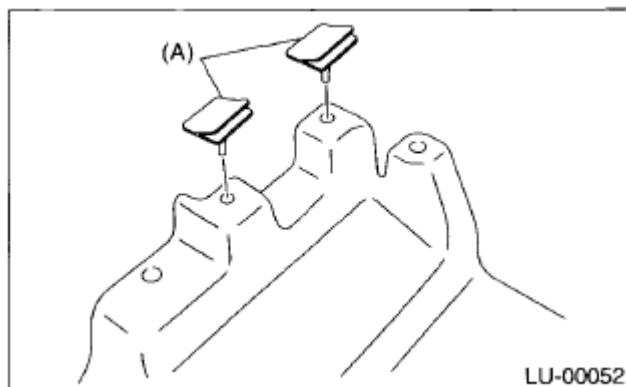


Fig. 218: Identifying Seals On Baffle Plate
Courtesy of SUBARU OF AMERICA, INC.

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

24. 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.

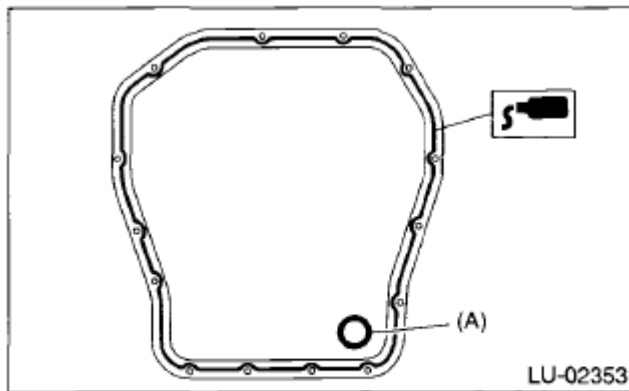
Tightening torque: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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. 219: Identifying Oil Pan Liquid Gasket Applying Area
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)

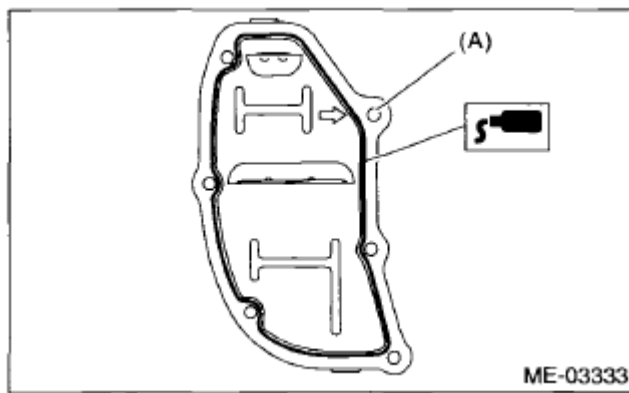


Fig. 220: Identifying Oil Separator Cover Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

28. Install the drive plate. (AT model) < Ref. to **INSTALLATION** , Drive Plate. >
29. Install the flywheel. (MT model) < Ref. to **INSTALLATION** , Flywheel. >
30. Install the clutch disc and cover. (MT model) < Ref. 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.

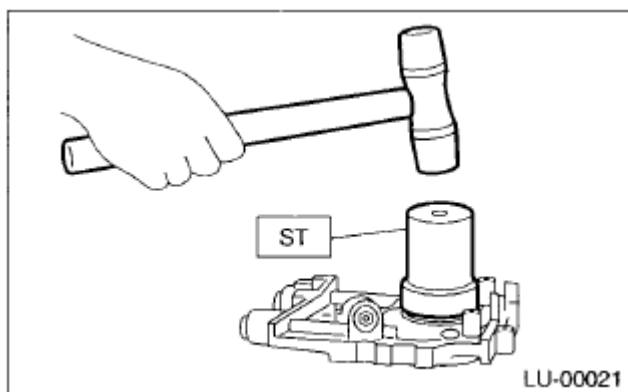


Fig. 221: Installing Front Oil Seal

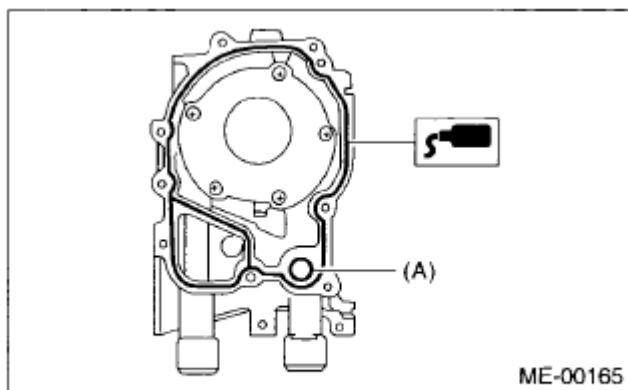
Courtesy of SUBARU OF AMERICA, INC.

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

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

Liquid gasket:

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



(A) O-ring

Fig. 222: Applying Liquid Gasket To Mating Surfaces Of Oil Pump

Courtesy of SUBARU OF AMERICA, INC.

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

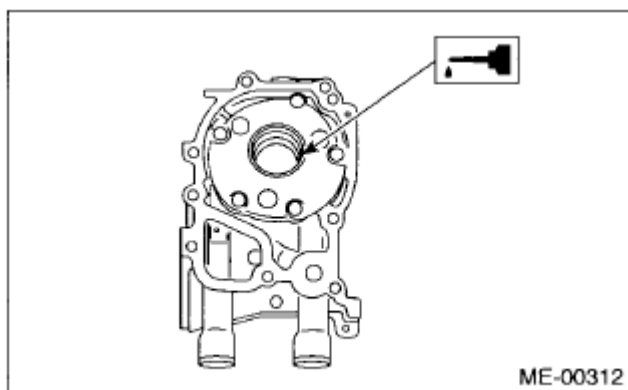


Fig. 223: Applying Coat Of Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

4. Install the oil pump to cylinder block.

CAUTION:

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

NOTE:

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

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

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

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

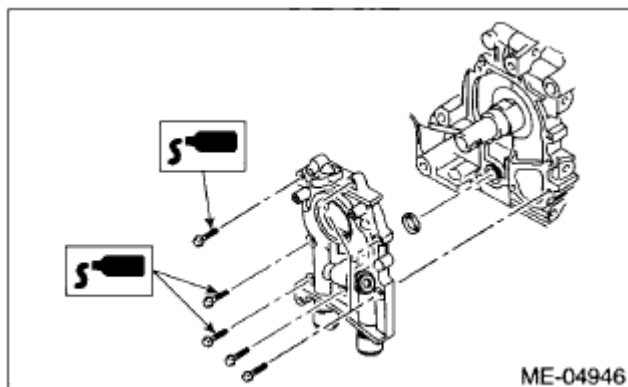


Fig. 224: Applying Fluid Packing To Threads Of Bolts
Courtesy of SUBARU OF AMERICA, INC.

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)

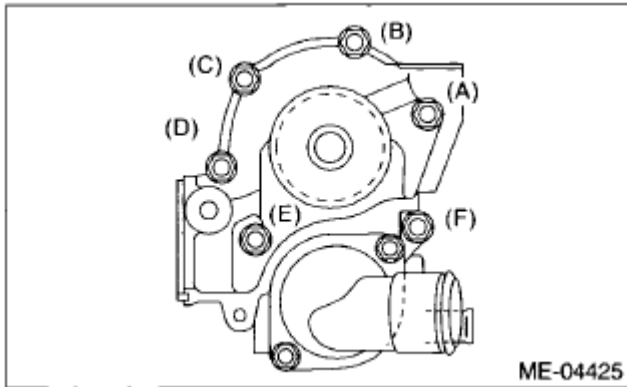


Fig. 225: Identifying Water Pump Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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. < Ref. to **INSTALLATION** , Engine Oil Filter. >
35. Install the cylinder head. < Ref. 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. < Ref. to **INSTALLATION**, Crank Sprocket. >
38. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt. >
39. Adjust the valve clearance. < Ref. 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 rocker cover bolts in alphabetical order shown in the figure, and then tighten to specified torque in alphabetical order in two steps.

Tightening torque:

1st 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

Second (only (a) and (b) are tightened) 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

RH side

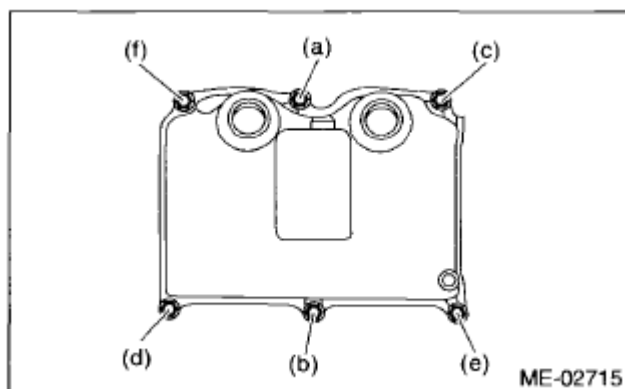


Fig. 226: Identifying Rocker Cover Bolts - RH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

LH side

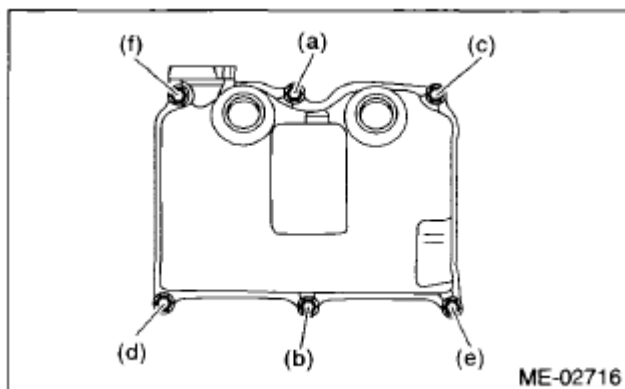
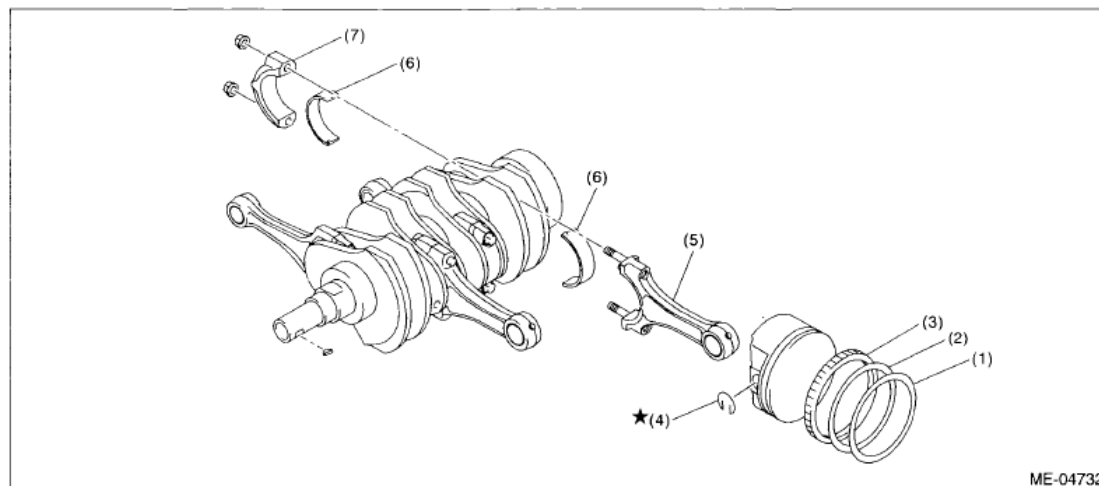


Fig. 227: Identifying Rocker Cover Bolts - LH Side Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

41. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
42. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >
43. Install the intake manifold. < Ref. to **INSTALLATION**, Intake Manifold. >

44. Install the engine to the vehicle. < Ref. to **INSTALLATION**, Engine Assembly. >

DISASSEMBLY



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

Fig. 228: Exploded View Of Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

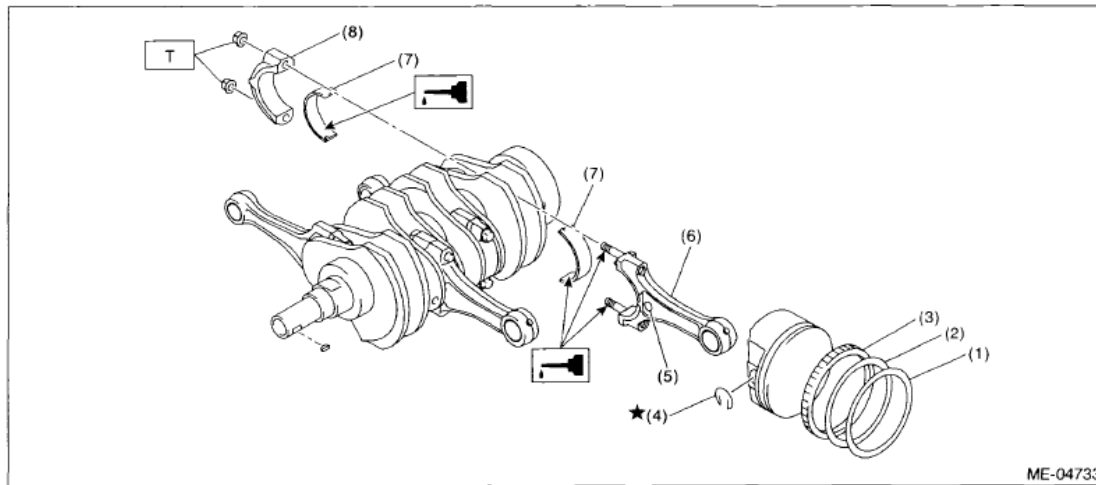
NOTE: Keep the removed connecting rods, connecting rod caps and bearings in order so that they are kept in their original combinations/groups, and not mixed together.

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

Fig. 229: Exploded View Of Cylinder Block
 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 areas 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

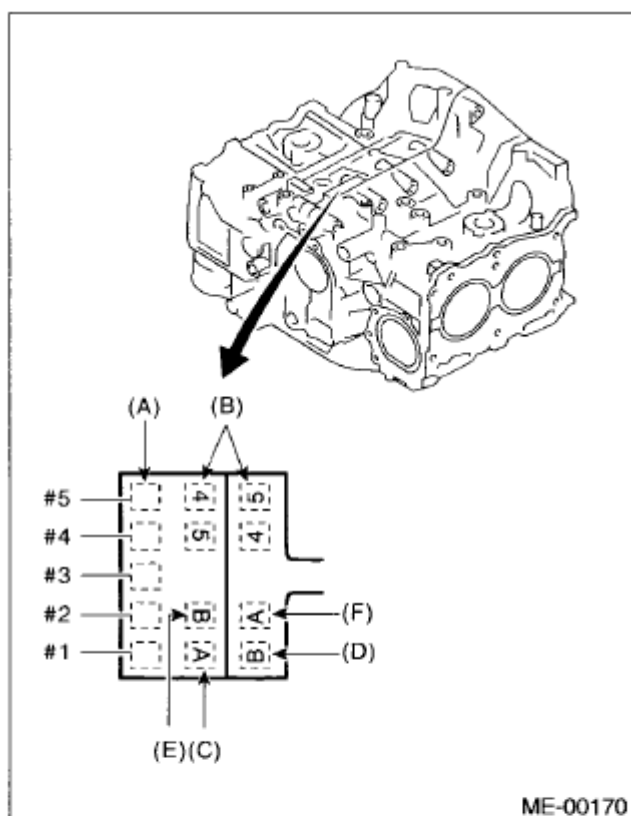
1. The cylinder bore size is stamped on the front upper face of the cylinder block.

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. 230: 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.

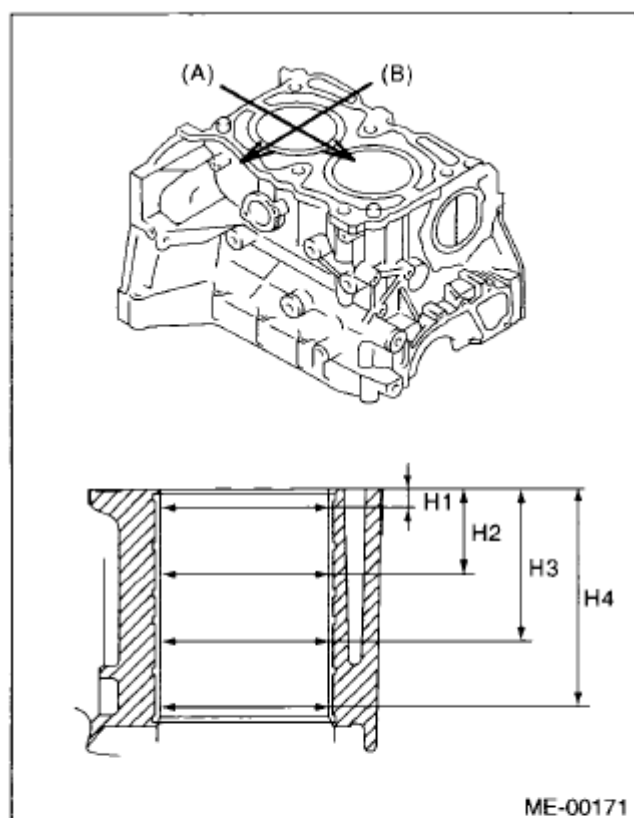
NOTE: Measurement should be performed at a temperature of 20°C (68°F).

Cylindricity:

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. 231: 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)

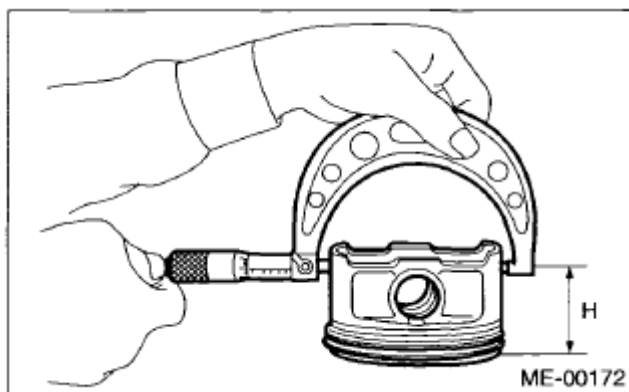


Fig. 232: Measuring Outer Diameter Of Piston
Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

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

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

6. Boring and honing

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

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

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

NOTE: Immediately after reboring, the cylinder diameter may differ from its

real diameter due to temperature rise. Thus, when measuring the cylinder diameter, wait until it has cooled to room temperature.

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

PISTON AND PISTON PIN

1. Check the piston and piston pin for damage, cracks or wear. Replace if faulty.
2. Check the piston ring groove for wear or damage. Replace if faulty.
3. Make sure 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 pin hole and piston pin:

Standard 0.004 - 0.008 mm (0.0002 - 0.0003 in)

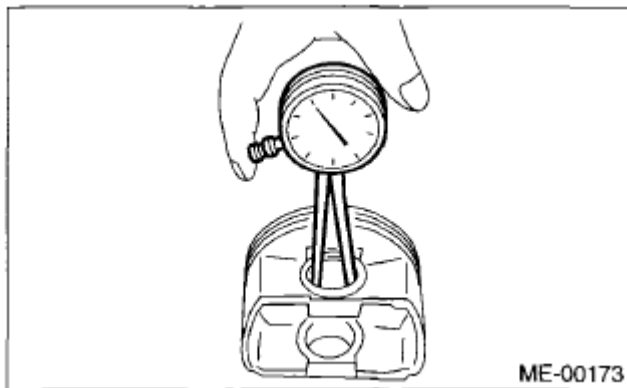


Fig. 233: Checking Clearance Between Piston Pin And Hole In Piston
Courtesy of SUBARU OF AMERICA, INC.

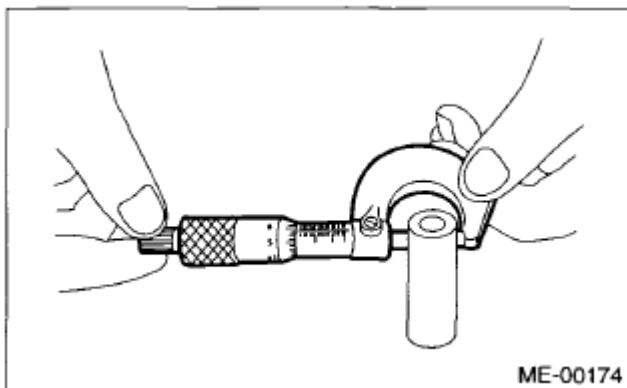


Fig. 234: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

4. Check the snap ring installation groove (A) on the piston for burr. If necessary, remove burr from the

groove so that the piston pin can lightly move.

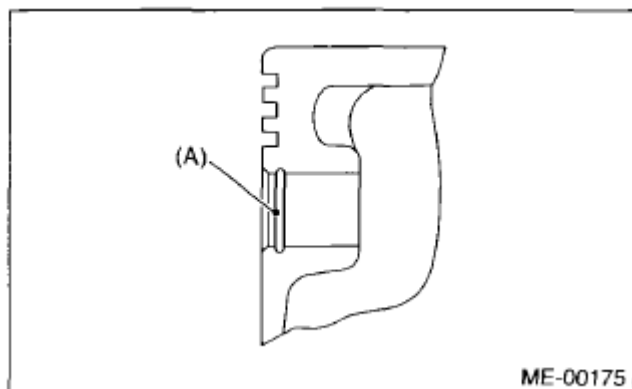


Fig. 235: Identifying Circlip Installation Groove On Piston
Courtesy of SUBARU OF AMERICA, INC.

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

PISTON RING

1. If the piston ring is broken, damaged and 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 the 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.

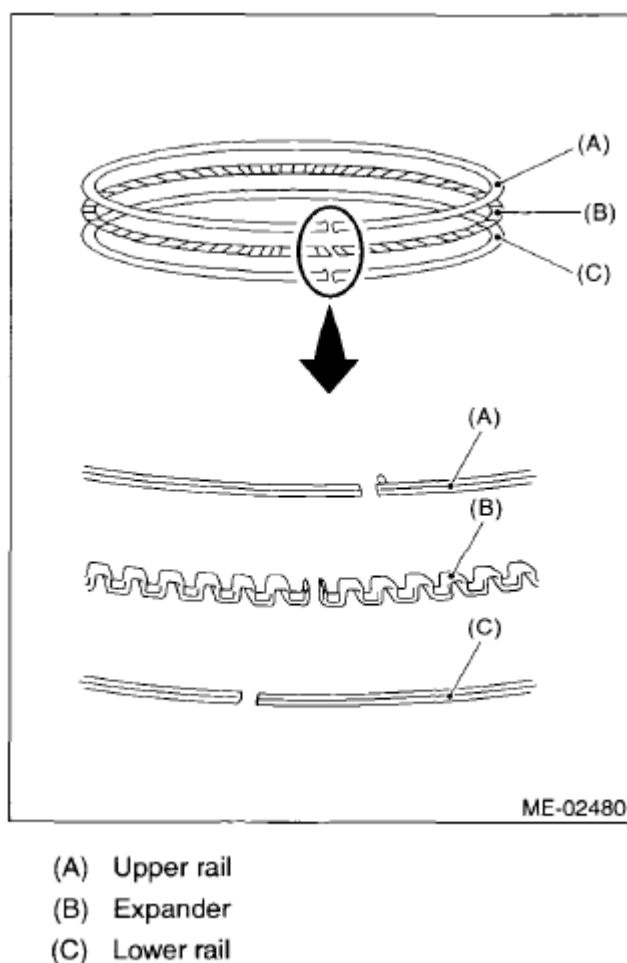


Fig. 236: Identifying Piston Ring (Upper Rail, Expander And Lower Rail)

Courtesy of SUBARU OF AMERICA, INC.

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

PISTON RING SPECIFICATION CHART

		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)

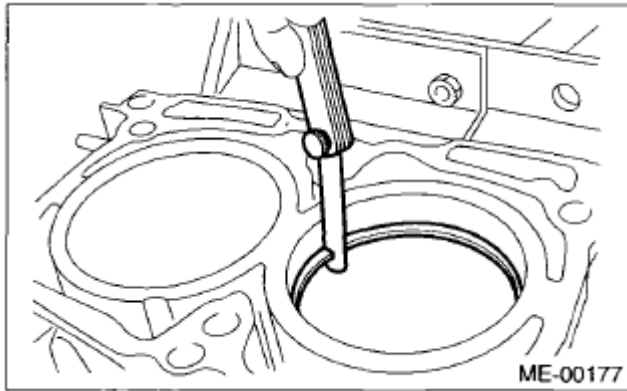


Fig. 237: Measuring Piston Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

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

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

PISTON RING SPECIFICATION CHART

		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)

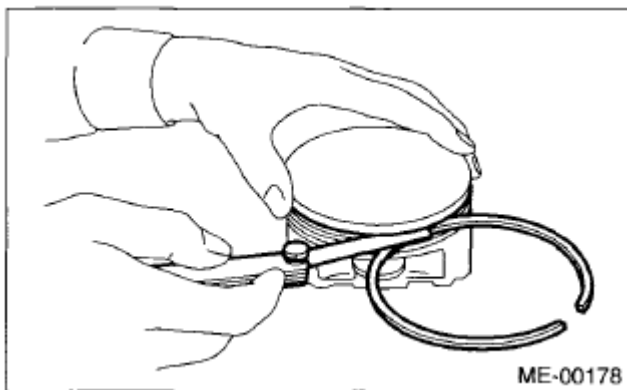
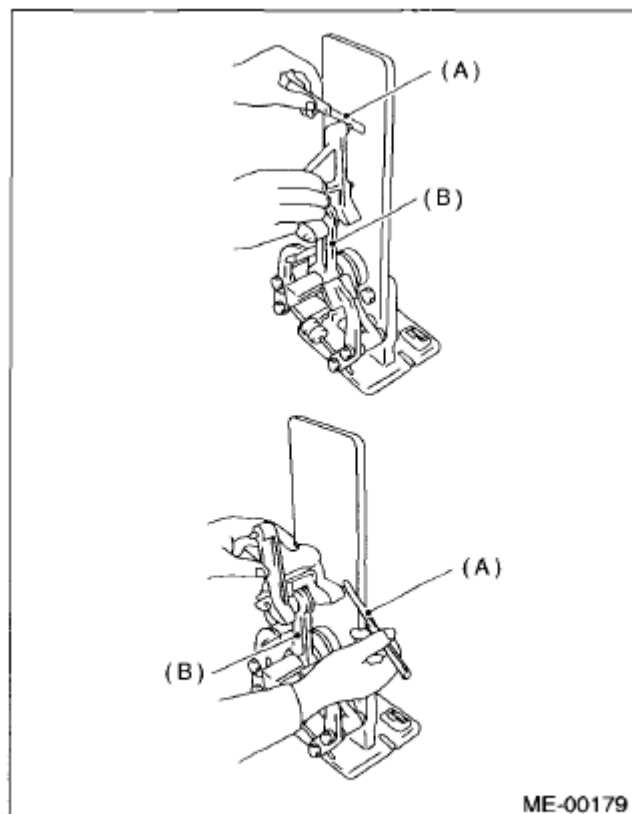


Fig. 238: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

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

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



- (A) Thickness gauge
- (B) Connecting rod

Fig. 239: Checking Bend Or Twist Using Connecting Rod Aligner
Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod with bearings attached to the crankshaft, and 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)

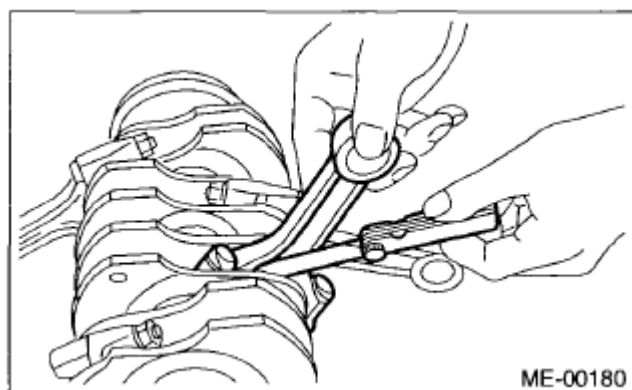


Fig. 240: Checking Connecting Rod Side Clearance
 Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard 0.016 - 0.044 mm (0.0006 - 0.0017 in)

BEARING SPECIFICATION CHART

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

6. Inspect the bushing at connecting rod small end, and replace with a new part if worn or damaged.
7. Measure the piston pin clearance at connecting rod small end. 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)

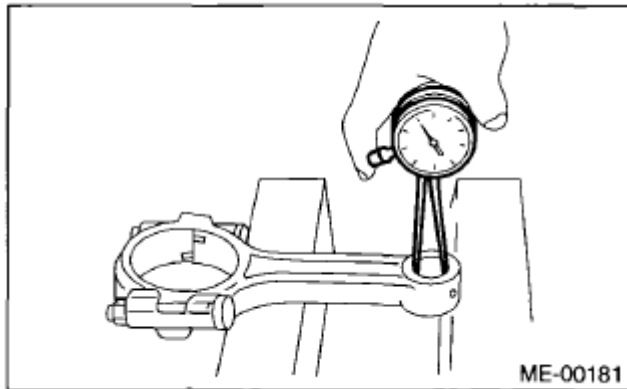


Fig. 241: Checking Clearance Between Piston Pin And Bushing
Courtesy of SUBARU OF AMERICA, INC.

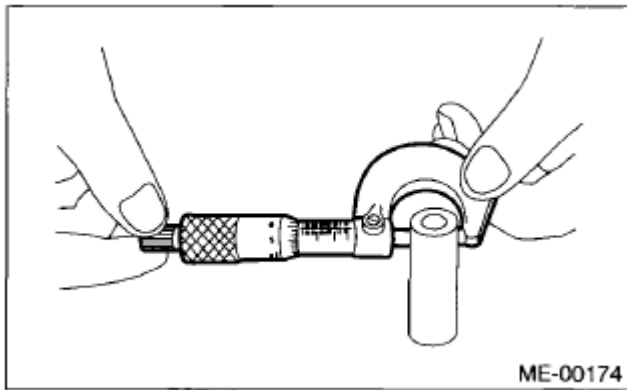


Fig. 242: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

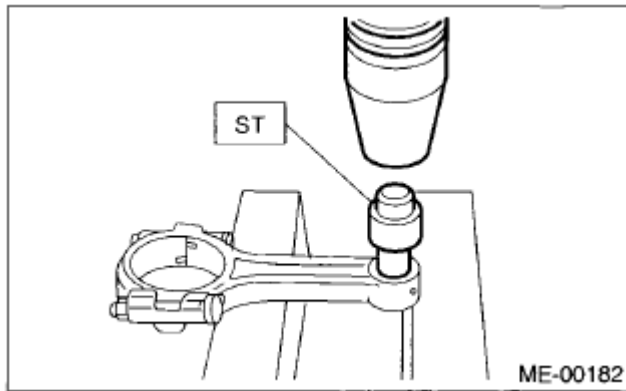


Fig. 243: Pressing Bushing With ST
 Courtesy of SUBARU OF AMERICA, INC.

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

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)

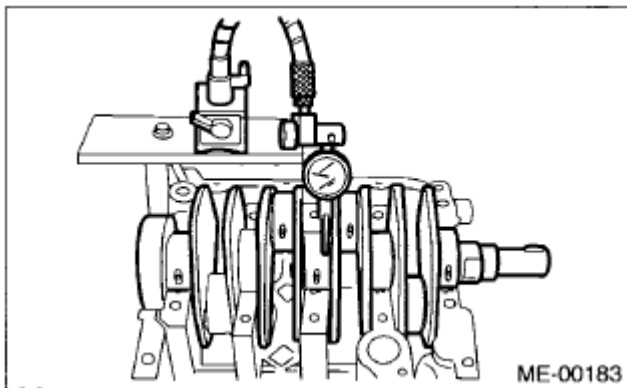


Fig. 244: Measuring Crankshaft Bend Using Dial Gauge
 Courtesy of SUBARU OF AMERICA, INC.

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

with a suitable (undersize) one, and replace or grind to correct the crankshaft as necessary. When grinding the crank journal or crank pin, finish them to the specified dimensions according to the undersize bearing to be used.

Crank pin:

Out-of-roundness

Standard 0.003 mm (0.0001 in)

Cylindricity

Standard 0.004 mm (0.0002 in)

Grinding limit (dia.) To 51.750 mm (2.0374 in)

Crank journal:

Out-of-roundness

Standard 0.005 mm (0.0002 in)

Cylindricity

Standard 0.006 mm (0.0002 in)

Grinding limit (dia.) To 59.758 mm (2.3527 in)

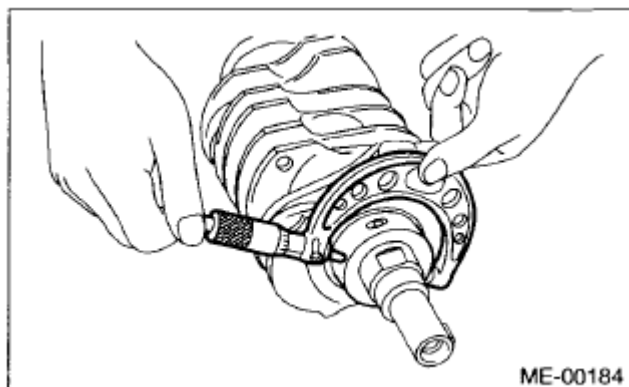


Fig. 245: Inspecting Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

CRANKSHAFT AND CRANKSHAFT BEARING SPECIFICATION CHART

			Unit: mm (in)
	Crank journal outer diameter		Crank pin outer diameter
	#1,#3	#2, #4, #5	

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

- 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)

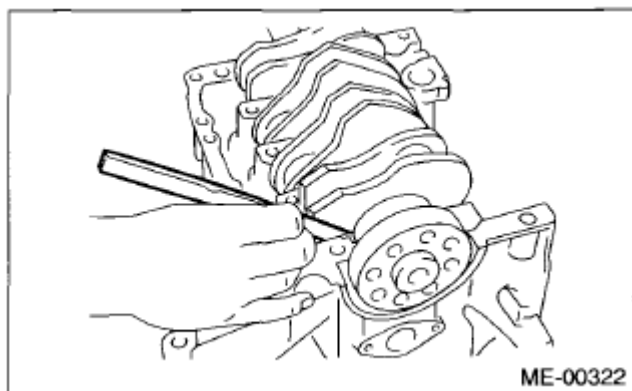


Fig. 246: Measuring Side Clearance Of Crankshaft At Center Bearing
Courtesy of SUBARU OF AMERICA, INC.

- Inspect individual crankshaft bearings for signs of flaking, seizure, melting and wear.
- Measure the oil clearance on each crankshaft bearing using plastigauge. If the measured value 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.

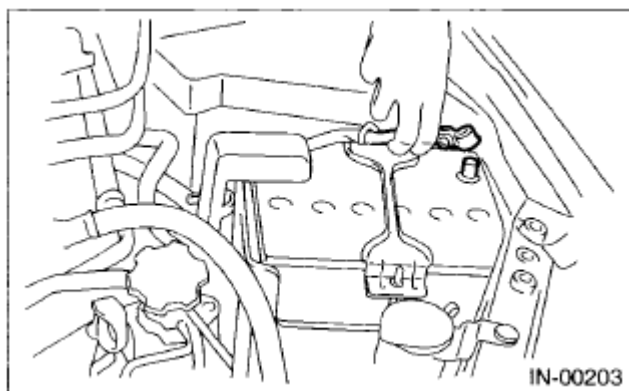


Fig. 247: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

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

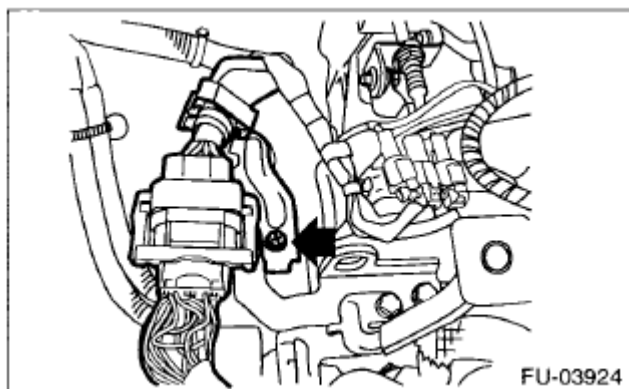


Fig. 248: Locating Engine Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

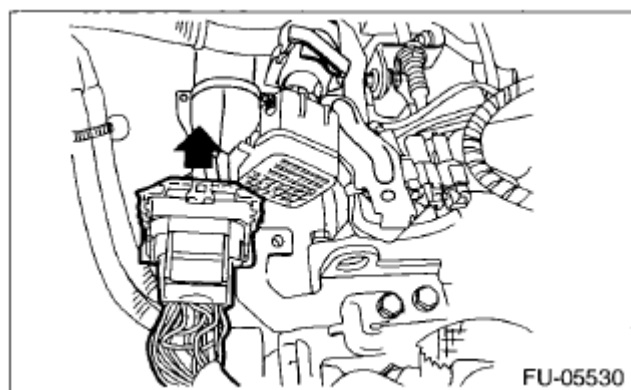
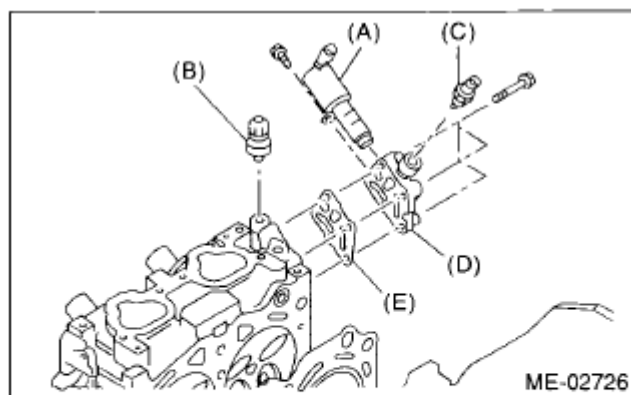


Fig. 249: Sliding Engine Harness Connector
 Courtesy of SUBARU OF AMERICA, INC.

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



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

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

LH SIDE

1. Disconnect the ground cable from battery.

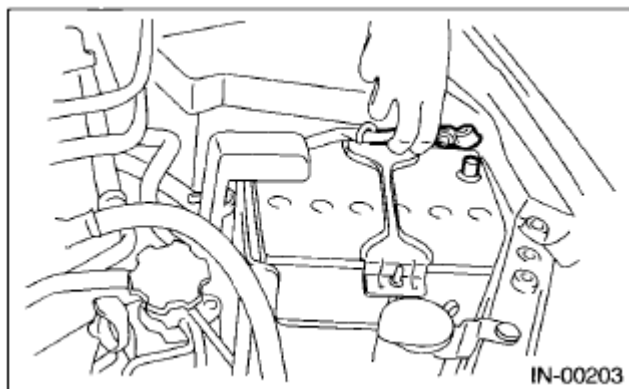
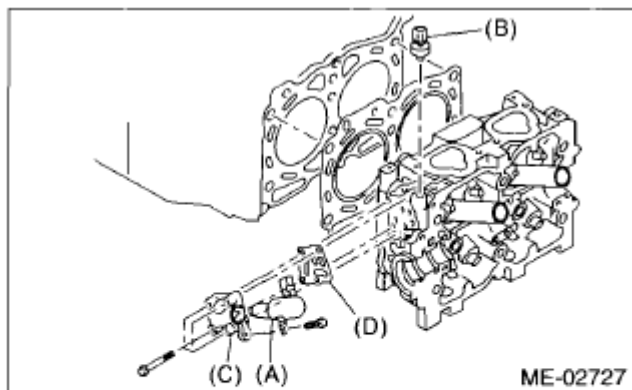


Fig. 251: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
3. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
4. Remove the timing belt. < Ref. to **REMOVAL**, Timing Belt. >
5. Remove the cam sprocket. < Ref. to **REMOVAL**, Cam Sprocket. >
6. Remove the timing belt cover No. 2 (LH).
7. Disconnect the connector from the oil switching solenoid valve.
8. Remove the oil switching solenoid valve.
9. Remove the variable valve lift diagnosis oil pressure switch. < Ref. to **REMOVAL**, Variable Valve Lift Diagnosis Oil Pressure Switch. >
10. 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. 252: Identifying Oil Switching Solenoid Valve, Holder, Oil Pressure Switch And Gasket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

RH SIDE

Install in the reverse order of removal.

NOTE:

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

Tightening torque:

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

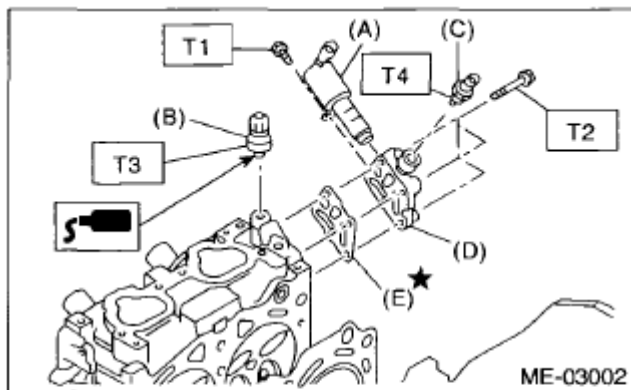
T2: 10 N.m (1.0 kgf-m, 7.4 ft-lb)

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

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

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent



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

Fig. 253: Installing Oil Switching Solenoid Valve To Holder
Courtesy of SUBARU OF AMERICA, INC.

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

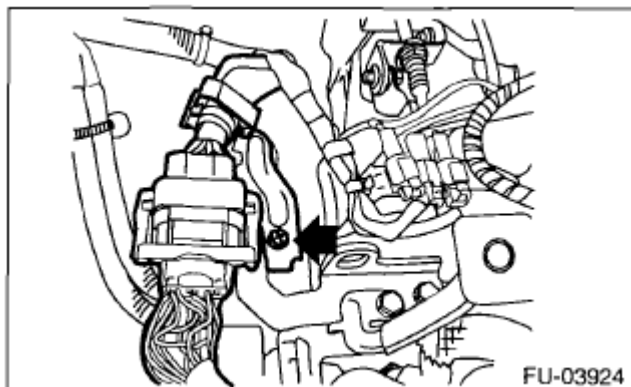


Fig. 254: Locating Engine Harness Connector Bolt
Courtesy of SUBARU OF AMERICA, INC.

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:

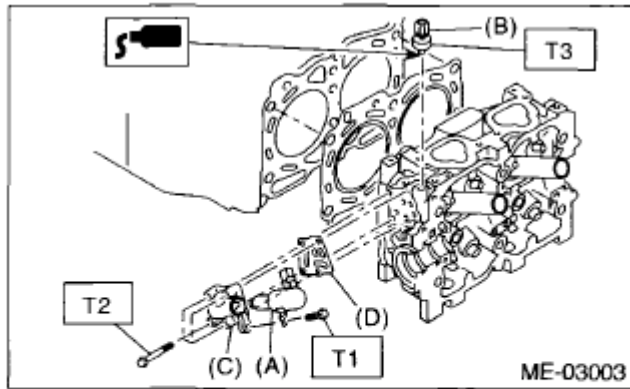
T1: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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

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

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent



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

Fig. 255: Identifying Oil Switching Solenoid Valve, Holder, Oil Pressure Switch And Gasket
 Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE

SPECIFICATION

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

PISTON

SPECIFICATION

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

CONNECTING ROD

SPECIFICATION

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

CRANKSHAFT

SPECIFICATION

Refer to "Cylinder Block" for removal and installation procedures of the crankshaft. < Ref. to **REMOVAL**,

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

ENGINE TROUBLE IN GENERAL

INSPECTION

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

- A. - Very often
- B. - Sometimes
- C. - Rarely

POSSIBLE CAUSE REFERENCE CHART

Symptoms	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
1) Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective inhibitor switch	C
		Defective starter	B
	Battery	Improper connection of terminal	A
		Run-down battery	A
		Defective charging system	B
	Friction	Seizure of crankshaft and connecting rod bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
	Immobilizer system < Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Fuel line	Defective fuel pump and relay	A
		Clogged fuel line	C
		Lack of fuel or insufficient fuel	B
	Timing belt	Degradation, etc.	B
		Defective timing	B
		Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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
3) Initial combustion occurs.	Engine control system < Ref. 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
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
4) Engine stalls after initial combustion.	Engine control system < Ref. to <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
		Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C

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	Compression	Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
2. Rough idle and engine stall	Engine control system < Ref. to <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
	Timing belt	Defective timing	C
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective cylinder head gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Over-heating	C
	Others	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
		Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A

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3. Low output, hesitation and poor acceleration	Intake system	Loosened or cracked vacuum hose	B
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	A
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of fuel or insufficient fuel	C
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective cylinder head gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
	Cooling system	Over-heating	C
		Over-cooling	C
	Others	Evaporative emission control system malfunction	A
4. Surging	Engine control system < Ref. to <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
		Incorrect valve clearance	B

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	Compression	Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Cooling system	Over-heating	B
	Others	Evaporative emission control system malfunction	C
5. Engine does not return to idle.	Engine control system < Ref. to <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 < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Cooling system	Over-heating	B
	Others	Evaporative emission control system malfunction	B
7. After burning in exhaust system	Engine control system < Ref. 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

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	Others	Evaporative emission control system malfunction	C
8. Knocking	Engine control system < Ref. 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 PCV hose	A
		Defective PCV valve	B
		Loosened oil filler cap	C
	Compression	Defective valve stem	A
		Worn or stuck piston rings, cylinder and piston	A
	Lubrication system	Loosened oil pump attaching bolts and defective gasket	B
		Defective oil filter gasket	B
		Defective crankshaft oil seal	B
		Defective rocker cover gasket	B
		Loosened oil drain plug or defective gasket	B
		Loosened oil pan fitting bolts or defective oil pan	B
10. Excessive fuel consumption	Engine control system < Ref. to <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
POSSIBLE CAUSE REFERENCE CHART

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	• Valve mechanism is defective. • Incorrect valve clearance • Worn valve rocker • Worn camshaft • Broken valve spring
Heavy and dull clank	Oil pressure is low.	• Worn crankshaft main bearing • Worn connecting rod bearing (large end)
	Oil pressure is normal.	• Damaged engine mounting • Loosened flywheel mounting bolt
High-pitched clank (Spark knock)	Sound is noticeable when accelerating with an overload condition.	• Ignition timing advanced • Accumulation of carbon inside combustion chamber • Wrong heat range of spark plug • Improper octane value gasoline
Clank when engine speed is 1, 000 to 2, 000 rpm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	• Worn crankshaft main bearing • Worn connecting rod bearing (large end)
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	• Worn cylinder liner and piston ring • Broken or stuck piston ring • Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	• Worn cam sprocket • Worn camshaft journal bore in cylinder head
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Poor contact of generator brush and rotor
Gear scream when starting		• Defective ignition starter

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engine	-	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 < Ref. to OPERATION , Clear Memory Mode. > and Inspection Mode < Ref. to PROCEDURE , Inspection Mode. > after connecting the fuel injector connector.