

2007 Subaru Forester X

2007 ENGINE H4DOTC Engine - Mechanical - Forester

2007 ENGINE**H4DOTC Engine - Mechanical - Forester****GENERAL DESCRIPTION****SPECIFICATION****GENERAL SPECIFICATION**

Engine	Model		2.5 L	
	Cylinder arrangement		Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine	
	Valve system mechanism		Belt driven, double overhead camshaft, 4-valve/cylinder	
	Bore x Stroke		mm (in)	99.5x79.0 (3.92x3.11)
	Piston displacement		cm ³ (cu in)	2,457 (149.94)
	Compression ratio		8.4	
	Compression pressure (at 350 rpm)		kPa (kgf/cm ² , psi)	981 - 1,177 (10 - 12, 142 - 171)
	Number of piston rings		Pressure ring: 2, Oil ring: 1	
	Intake valve timing	Open	Max. retard	5° ATDC
			Min. advance	35° BTDC
		Close	Max. retard	65° ABDC
			Min. advance	25° ABDC
	Exhaust valve timing	Open		55° BBDC
		Close		5° ATDC
	Valve clearance	Intake	mm (in)	0.20±0.02 (0.0079±0.0008)
		Exhaust	mm (in)	0.35±0.02 (0.0138±0.0008)
	Idle speed [At neutral position on MT, or "P" or "N" range on AT]		No Load	MT: 700±100 AT: 700±100
			A/C ON	A/C refrigerant pressure is low MT: 725±100 AT: 750±100
				A/C refrigerant pressure is high MT: 800±100 AT: 825±100
	Ignition order		1-->3-->2-->4	
	Ignition timing	BTDC/rpm	MT Model	17°±107700
			AT Model	17°±107700

NOTE: OS: Oversize US: Undersize

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BELT TENSION ADJUSTER SPECIFICATION

Belt tension adjuster	Protrusion of adjuster rod			5.2 - 6.2 mm (0.204 - 0.244 in)
Belt tensioner	Spacer O.D.			17.955 - 17.975 mm (0.7069 - 0.7077 in)
	Tensioner bushing I.D.			18.0 - 18.08 mm (0.7087 - 0.7118 in)
	Clearance between spacer and bushing	Standard		0.025 - 0.125 mm (0.0010 - 0.0049 in)
		Limit		0.175 mm (0.069 in)
	Side clearance of spacer	Standard		0.2 - 0.55 mm (0.0079 - 0.0217 in)
		Limit		0.81 mm (0.0319 in)
Camshaft	Bend limit			0.020 mm (0.0079 in)
	Thrust clearance		Standard	0.068 - 0.116 mm (0.0027 - 0.0046 in)
			Limit	0.14 mm (0.0055 in)
	Cam lobe height	Intake	Standard	46.55 - 46.65 mm (1.833 - 1.837 in)
			Limit	46.45 mm (1.829 in)
		Exhaust	Standard	46.75 - 46.85 mm (1.841 - 1.844 in)
			Limit	46.65 mm (1.837 in)
	Camshaft journal O.D.	Standard	Front	37.946 - 37.963 mm (1.4939 - 1.4946 in)
			Center rear	29.946 - 29.963 mm (1.1790 - 1.1796 in)
	Oil clearance		Standard	0.037 - 0.072 mm (0.0015 - 0.0028 in)
			Limit	0.10 mm (0.0039 in)
Cylinder head	Surface warpage limit (Mating surface with cylinder block)			0.035 mm (0.0014 in)
	Grinding limit			0.3 mm (0.012 in)
	Standard height			127.5 mm (5.02 in)
Valve seat	Seating angle			90°
	Contacting width	Intake	Standard	0.6 - 1.4 mm (0.024 - 0.055 in)
			Limit	1.7 mm (0.067 in)
		Exhaust	Standard	1.2 - 1.8 mm (0.047 - 0.071 in)
Limit			2.2 mm (0.087 in)	
Valve guide	Inside diameter			6.000 - 6.012 mm (0.2362 - 0.2367 in)
	Protrusion above head			15.8 - 16.2 mm (0.622 - 0.638 in)
	Head edge thickness	Intake	Standard	1.0 - 1.4 mm (0.039 - 0.055 in)
			Limit	0.8 mm (0.031 in)
		Exhaust	Standard	1.3 - 1.7 mm (0.051 - 0.067 in)
			Limit	0.8 mm (0.031 in)

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Valve	Stem outer diameter		Intake	5.955 - 5.970 mm (0.2344 - 0.2350 in)
			Exhaust	5.945 - 5.960 mm (0.2341 - 0.2346 in)
	Valve stem gap	Standard	Intake	0.030 - 0.057 mm (0.0012 - 0.0022 in)
			Exhaust	0.040 - 0.067 mm (0.0016 - 0.0026 in)
		Limit	-	0.15 mm (0.0059 in)
	Overall length		Intake	104.4 mm (4.110 in)
			Exhaust	104.65 mm (4.120 in)
Valve spring	Free length			47.32 mm (1.863 in)
	Squareness			2.5°, 2.1 mm (0.083 in) or less
	Tension/spring height	Set	205 - 235 N (20.9 - 24.0 kgf, 46.1 - 52.8 lb)/ 36.0 mm (1.417 in)	
		Lift	426 - 490 N (43.4 - 50.0 kgf, 95.8 - 110 lb)/ 26.50 mm (1.043 in)	
Valve lifter	Outer diameter			34.959 - 34.975 mm (1.3763 - 1.3770 in)
	Inner diameter (cylinder head)			34.994 - 35.016 mm (1.3777 - 1.3786 in)
	Valve lifter clearance	Standard	0.019 - 0.057 mm (0.0007 - 0.0022 in)	
		Limit	0.100 mm (0.0039 in)	
Cylinder block	Surface warpage limit (Mating surface with cylinder head)			0.025 mm (0.0098 in)
	Grinding limit			0.1 mm (0.004 in)
	Standard height			201.0 mm (7.91 in)
	Cylinder inner diameter	Standard	A	99.505 - 99.515 mm (3.9175 - 3.9179 in)
			B	99.495 - 99.505 mm (3.9171 - 3.9175 in)
	Taper		Standard	0.015 mm (0.0006 in)
			Limit	0.050 mm (0.0020 in)
	Out-of-roundness		Standard	0.010 mm (0.0004 in)
			Limit	0.050 mm (0.0020 in)
	Piston clearance		Standard	-0.010 - 0.010 mm (-0.0004 - 0.0004 in)
			Limit	0.030 mm (0.0012 in)
	Cylinder inner boring limit (diameter)			100.005 mm (3.9372 in)
			Standard	A
			B	99.495 - 99.505 mm (3.9171 -

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Piston	Outer diameter			3.9175 in)
		0.25 mm (0.0098 in) OS		99.745 - 99.765 mm (3.9270 - 3.9278 in)
		0.50 mm (0.0197 in) OS		99.995 - 100.015 mm (3.9368 - 3.9376 in)
Piston pin	Standard clearance between piston and piston pin		Standard	0.004 - 0.008 mm (0.0002 - 0.0003 in)
			Limit	0.020 mm (0.0008 in)
	Degree of fit			Piston pin must be fitted into position with thumb at 20°C (68°F).
Piston ring	Ring closed gap	Top ring	Standard	0.20 - 0.25 mm (0.0079 - 0.0098 in)
			Limit	1.0 mm (0.039 in)
		Second ring	Standard	0.37 - 0.52 mm (0.015 - 0.020 in)
			Limit	1.0 mm (0.039 in)
		Oil ring	Standard	0.20 - 0.50 mm (0.0079 - 0.0197 in)
			Limit	1.5 mm (0.059 in)
	Ring groove gap	Top ring	Standard	0.040 - 0.080 mm (0.0016 - 0.0031 in)
			Limit	0.15 mm (0.0059 in)
		Second ring	Standard	0.030 - 0.070 mm (0.0012 - 0.0028 in)
			Limit	0.15 mm (0.0059 in)
Connecting rod	Bend or twist per 100 mm (3.94 in) in length		Limit	0.10 mm (0.0039 in)
	Side clearance of large end		Standard	0.070 - 0.330 mm (0.0028 - 0.0130 in)
			Limit	0.4 mm (0.016 in)
Bearing of large end	Oil clearance		Standard	0.017 - 0.045 mm (0.0007 - 0.0018 in)
			Limit	0.05 mm (0.0020 in)
	Thickness at center portion		Standard	1.490 - 1.502 mm (0.0587 - 0.0591 in)
			0.03 mm (0.0012 in) US	1.504 - 1.512 mm (0.0592 - 0.0595 in)
			0.05 mm (0.0020 in) US	1.514 - 1.522 mm (0.0596 - 0.0599 in)
			0.25 mm (0.0098 in) US	1.614 - 1.622 mm (0.0635 - 0.0639 in)
Bushing of small end	Clearance between piston pin and bushing		Standard	0 - 0.022 mm (0 - 0.0009 in)
			Limit	0.030 mm (0.0012 in)
	Bending limit			0.035 mm (0.0014 in)
	Crank pin	Out-of-roundness		0.003 mm (0.0001 in)
		Cylindrically		0.004 mm (0.0002 in)

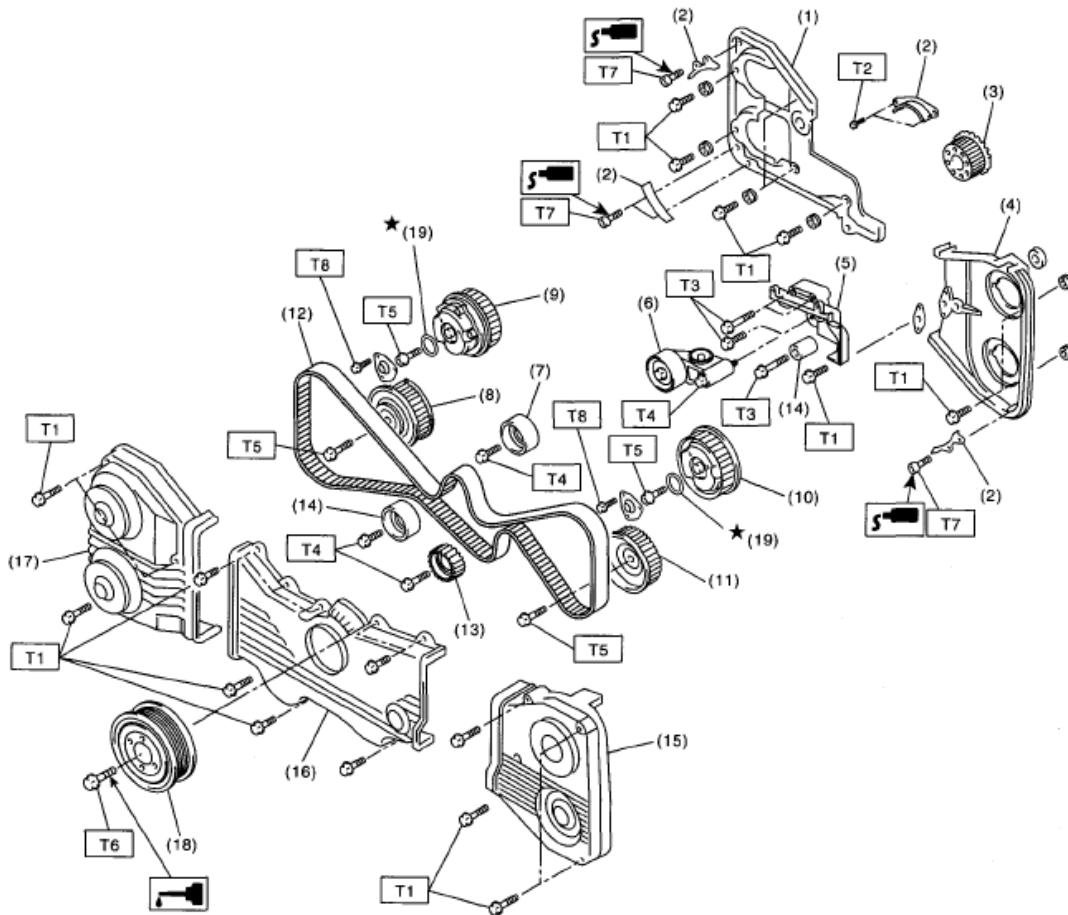
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Crankshaft	Crank journal	Grinding limit (dia.)		To 51.750 mm (2.0374 in)
		Out-of-roundness		0.005 mm (0.0002 in)
		Cylindrically		0.006 mm (0.0002 in)
		Grinding limit (dia.)		To 59.758 mm (2.3527 in)
	Crank pin outer diameter		Standard	51.984 - 52.000 mm (2.0466 - 2.0472 in)
			0.03 mm (0.0012 in) US	51.954 - 51.970 mm (2.0454 - 2.0461 in)
			0.05 mm (0.0020 in) US	51.934 - 51.950 mm (2.0447 - 2.0453 in)
			0.25 mm (0.0098 in) US	51.734 - 51.750 mm (2.0368 - 2.0374 in)
	Crank journal outer diameter		Standard	59.992 - 60.008 mm (2.3619 - 2.3625 in)
			0.03 mm (0.0012 in) US	59.962 - 59.978 mm (2.3607 - 2.3613 in)
			0.05 mm (0.0020 in) US	59.942 - 59.958 mm (2.3599 - 2.3605 in)
			0.25 mm (0.0098 in) US	59.742 - 59.758 mm (2.3520 - 2.3527 in)
	Thrust clearance		Standard	0.030 - 0.115 mm (0.0012 - 0.0045 in)
			Limit	0.25 mm (0.0098 in)
	Oil clearance		Standard	0.010 - 0.030 mm (0.0004 - 0.0012 in)
			Limit	0.040 mm (0.0016 in)
Main bearing	Thickness of main bearing	#1, #3	Standard	1.998 - 2.011 mm (0.0787 - 0.0792 in)
			0.03 mm (0.0012 in) US	2.017 - 2.020 mm (0.0794 - 0.0795 in)
			0.05 mm (0.0020 in) US	2.027 - 2.030 mm (0.0798 - 0.0799 in)
			0.25 mm (0.0098 in) US	2.127 - 2.130 mm (0.0837 - 0.0839 in)
		#2, #4, #5	Standard	2.000 - 2.013 mm (0.0787 - 0.0793 in)
			0.03 mm (0.0012 in) US	2.019 - 2.022 mm (0.0795 - 0.0796 in)
			0.05 mm (0.0020 in) US	2.029 - 2.032 mm (0.0799 - 0.0800 in)
			0.25 mm (0.0098 in) US	2A 29 - 2.132 mm (0.0838 - 0.0839 in)

COMPONENT

TIMING BELT



ME-03010

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

Tightening torque: N·m (kgf-m, ft-lb)

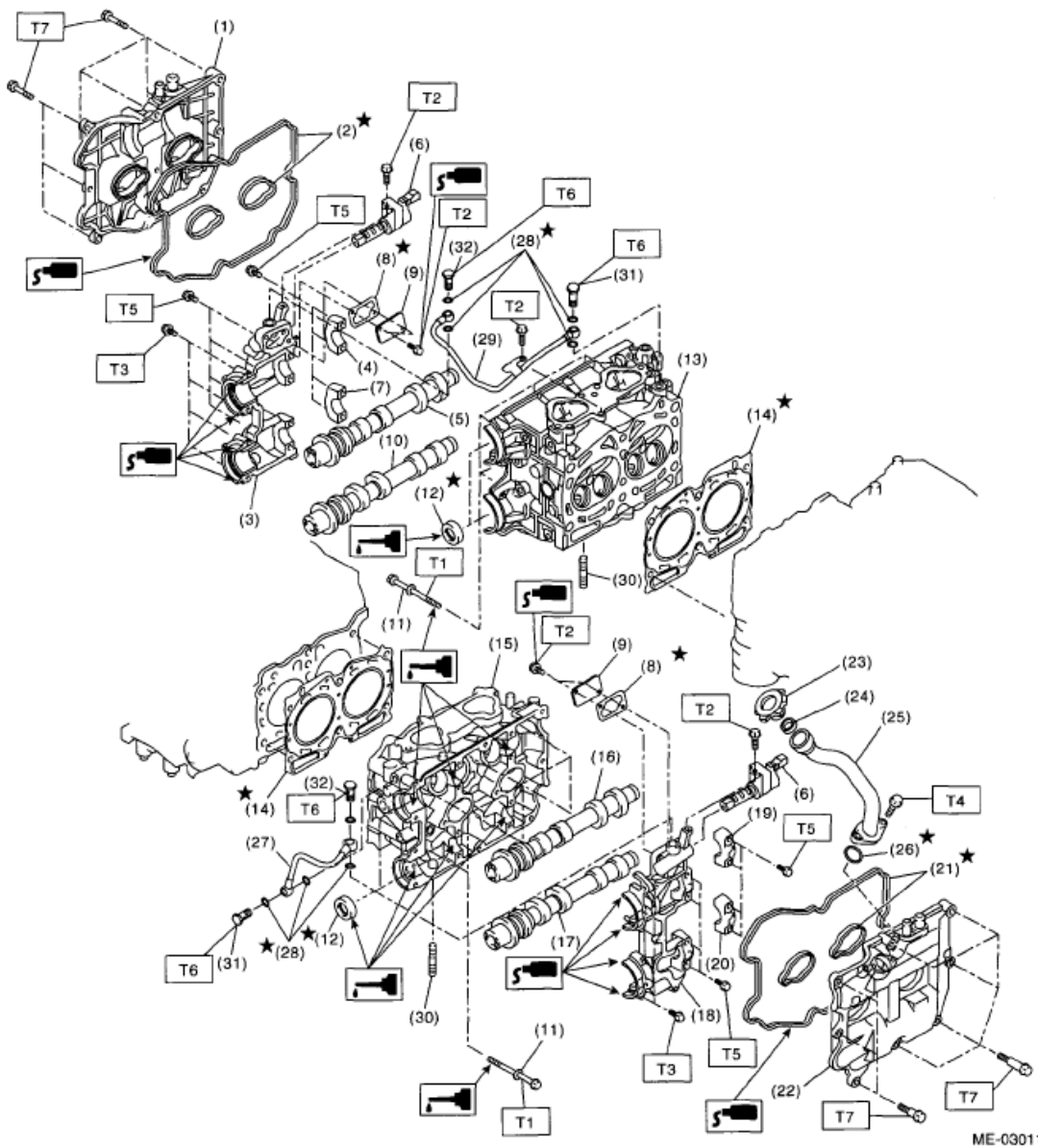
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|------------|--|
| T1: | 5 (0.5, 3.6) |
| T2: | 9.75 (1.0, 7.2) |
| T3: | 24.5 (2.5, 18.1) |
| T4: | 39 (4.0, 28.9) |
| T5: | <Ref. to ME(H4DOTC)-52, INSTALLATION, Cam Sprocket.> |
| T6: | <Ref. to ME(H4DOTC)-42, INSTALLATION, Crank Pulley.> |
| T7: | 6.4 (0.65, 4.7) |
| T8: | 3.4 (0.35, 2.5) |

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

CYLINDER HEAD AND CAMSHAFT

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ME-03011

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

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

T1: <Ref. to ME(H4DOTC)-60, INSTALLATION, Cylinder Head.>

T2: 8 (0.8, 5.9)

T3: 9.75 (1.0, 7.2)

T4: 6.4 (0.65, 4.7)

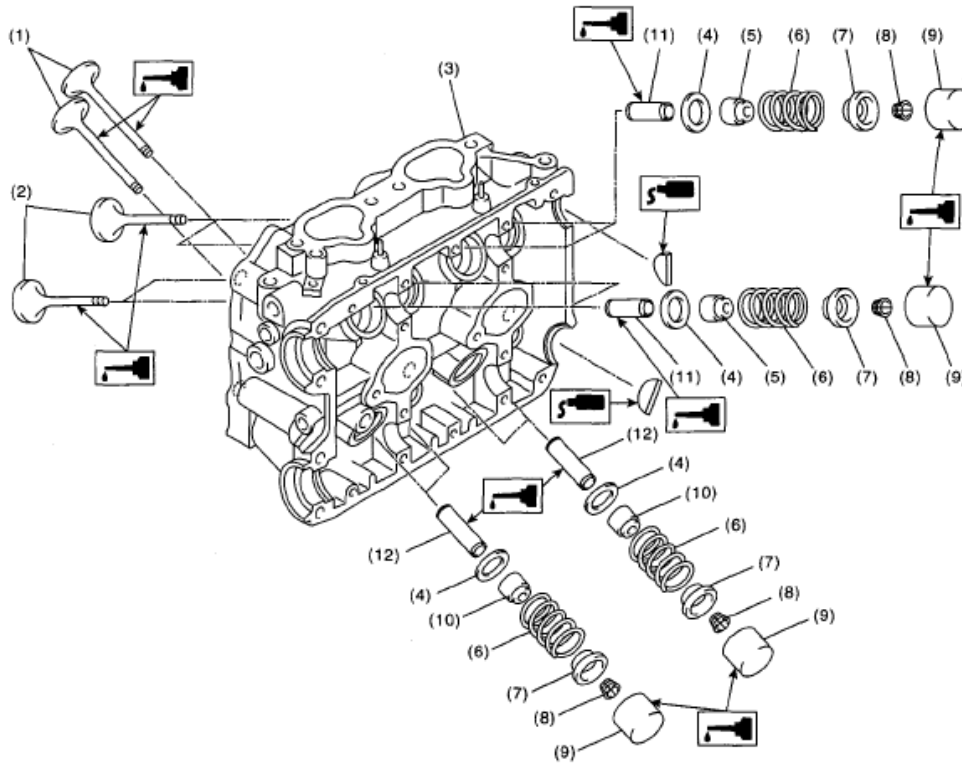
T5: 20 (2.0, 14.5)

T6: 29 (3.0, 21.4)

T7: <Ref. to ME(H4DOTC)-55, INSTALLATION, Camshaft.>

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

CYLINDER HEAD AND VALVE ASSEMBLY

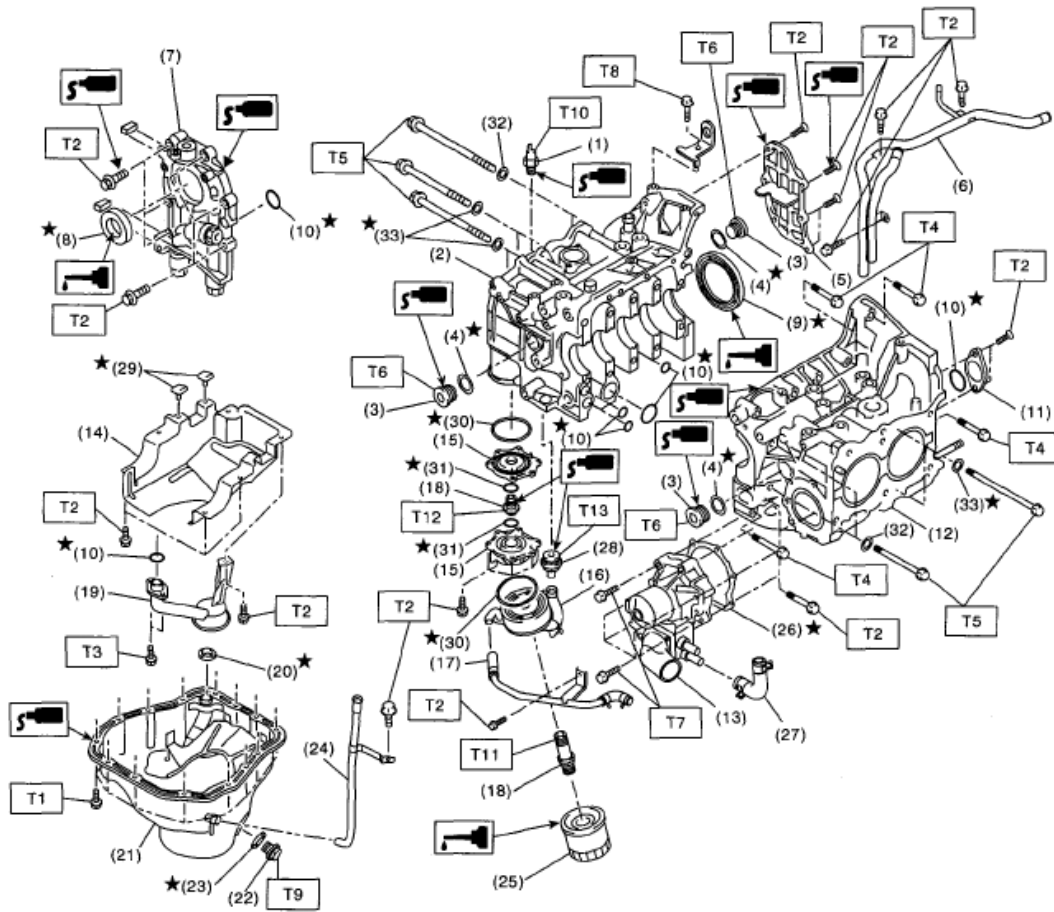


ME-02583

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

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

CYLINDER BLOCK



ME-03012

- | | |
|--------------------------|----------------------------|
| (1) Oil pressure switch | (18) Connector |
| (2) Cylinder block (RH) | (19) Oil strainer |
| (3) Service hole plug | (20) Gasket |
| (4) Gasket | (21) Oil pan |
| (5) Oil separator cover | (22) Drain plug |
| (6) Water by-pass pipe | (23) Metal gasket |
| (7) Oil pump | (24) Oil level gauge guide |
| (8) Front oil seal | (25) Oil filter |
| (9) Rear oil seal | (26) Gasket |
| (10) O-ring | (27) Water pump hose |
| (11) Service hole cover | (28) Plug |
| (12) Cylinder block (LH) | (29) Seal |
| (13) Water pump | (30) Gasket |
| (14) Baffle plate | (31) O-ring |
| (15) Adapter | (32) Washer |
| (16) Oil cooler | (33) Seal washer |
| (17) Water by-pass pipe | |

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

T1: 5 (0.5, 3.6)

T2: 6.4 (0.65, 4.7)

T3: 10 (1.0, 7.2)

T4: 25 (2.5, 18.1)

T5: <Ref. to ME(H4DOTC)-71,
INSTALLATION, Cylinder
Block.>

T6: 70 (7.1, 50.6)

T7: First 12 (1.2, 8.7)

Second 12 (1.2, 8.7)

T8: 16 (1.6, 11.6)

T9: 44 (4.5, 33)

T10: 25 (2.5, 18.1)

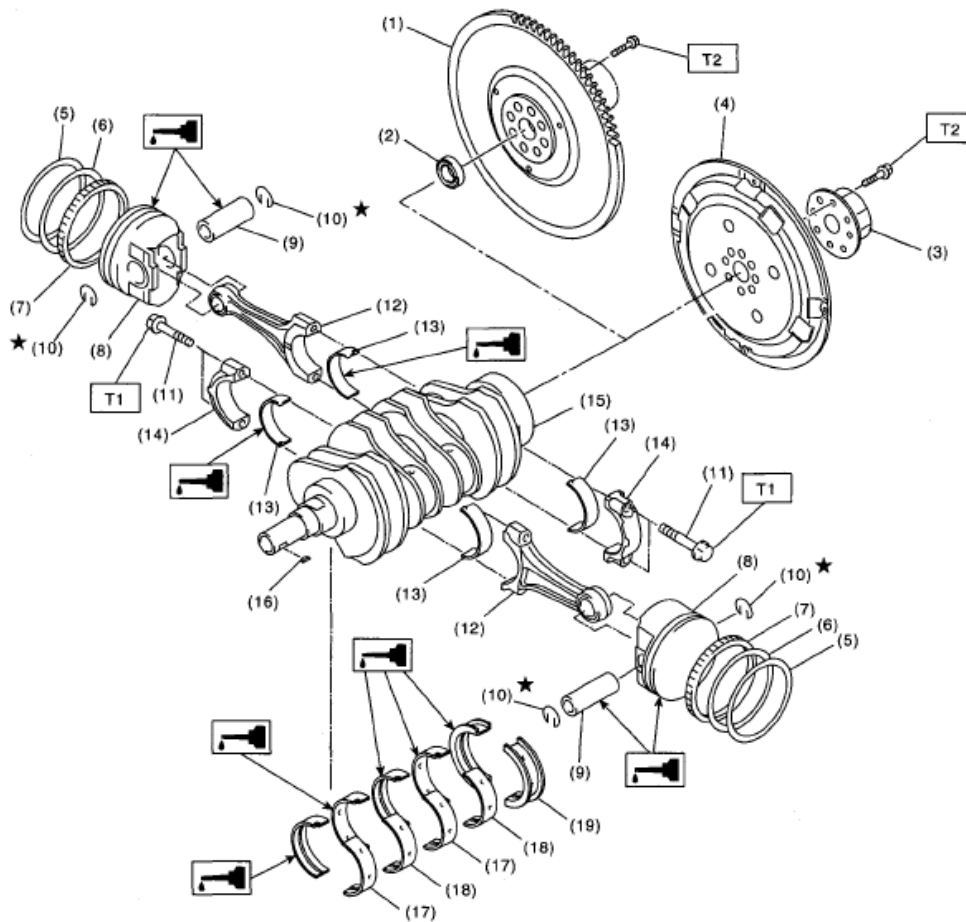
T11: 54 (5.3, 39)

T12: 45 (4.6, 33)

T13: 69 (7.0, 50.9)

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

CRANKSHAFT AND PISTON



ME-02467

- | | | |
|------------------------------|-----------------------------|--------------------------------|
| (1) Flywheel (MT model) | (9) Piston pin | (17) Crankshaft bearing #1, #3 |
| (2) Ball bearing (MT model) | (10) Snap ring | (18) Crankshaft bearing #2, #4 |
| (3) Reinforcement (AT model) | (11) Connecting rod bolt | (19) Crankshaft bearing #5 |
| (4) Drive plate (AT 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 | |

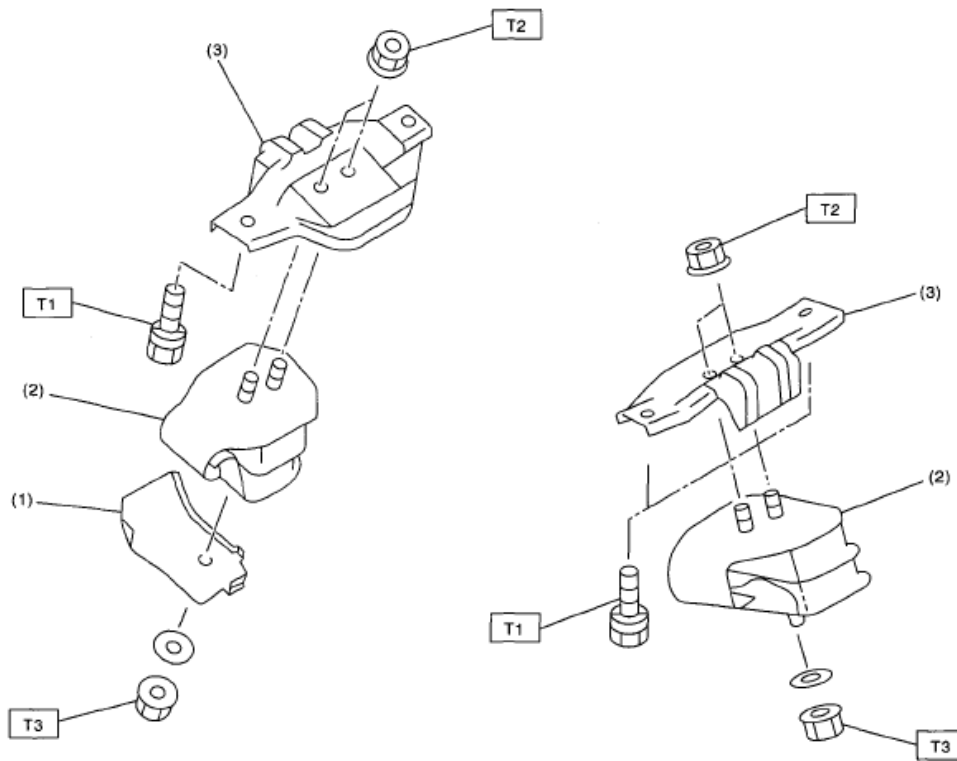
Tightening torque: N·m (kgf-m, ft-lb)

T1: 52 (5.3, 38.4)

T2: 72 (7.3, 52.8)

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

ENGINE MOUNTING



ME-00706

- (1) Heat shield cover
(2) Front cushion rubber

- (3) Front engine mounting bracket

Tightening torque: N·m (kgf-m, ft-lb)

T1: 35 (3.6, 25.8)

T2: 42 (4.3, 30.9)

T3: 85 (8.7, 62.7)

Fig. 6: Identifying Engine Mounting Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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 electrical 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

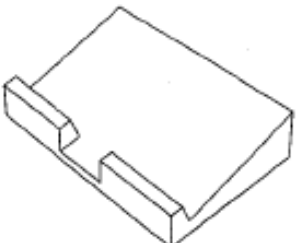
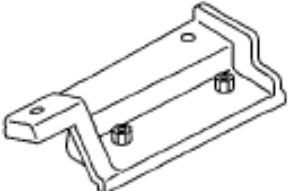
bearings.

- 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 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

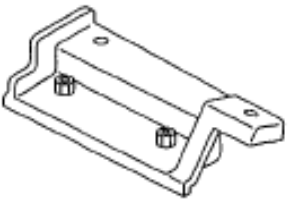
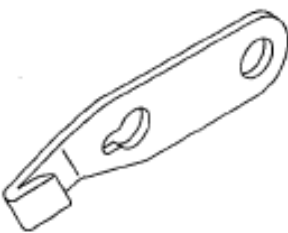
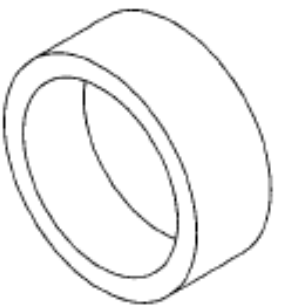
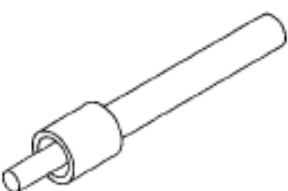
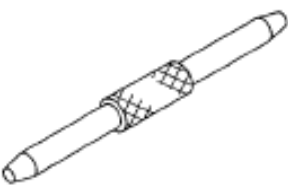
SPECIAL TOOL

SPECIAL TOOL CHART

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-498267600	498267600	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498457000	498457000	ENGINE STAND ADAPTER RH	Used together with ENGINE STAND (499817100).
		ENGINE STAND	Used together with ENGINE

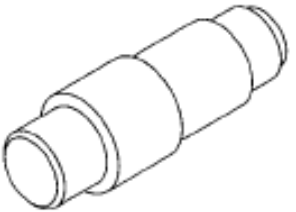
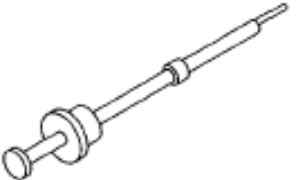
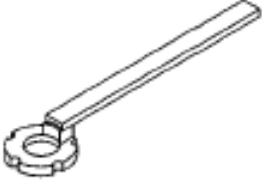
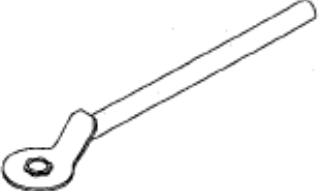
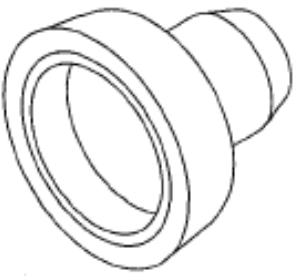
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 ST-498457100	498457100	ADAPTER LH	STAND (499817100).
 ST-498497100	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of flywheel when loosening/tightening crank pulley bolt.
 ST-498747300	498747300	PISTON GUIDE	Used for installing piston in cylinder. (2.5 L model)
 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.

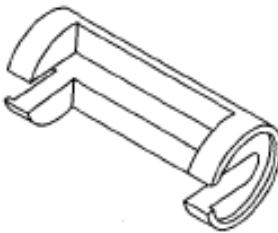
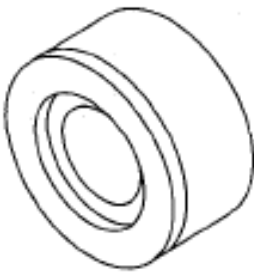
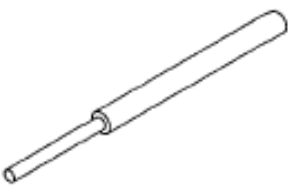
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 ST-499037100	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499097700	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499207400	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (Exhaust side)
 ST-499977500	499977500	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (Intake side)
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).

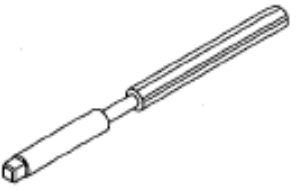
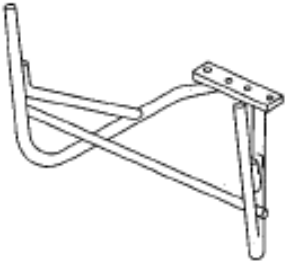
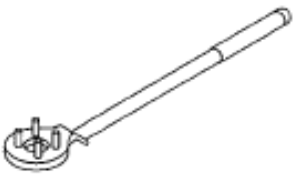
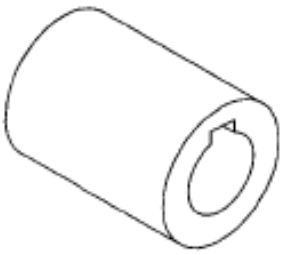
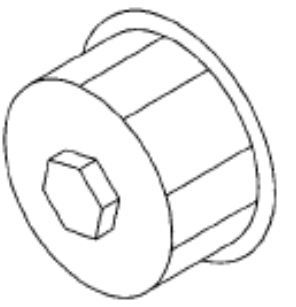
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 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499718000	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST18251AA020	18251AA020	VALVE GUIDE ADJUSTER	Used for installing intake and exhaust valve guides.
 ST-499767200	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.

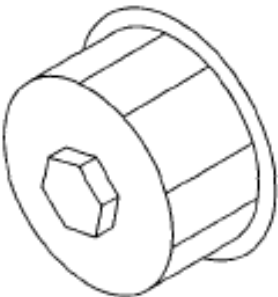
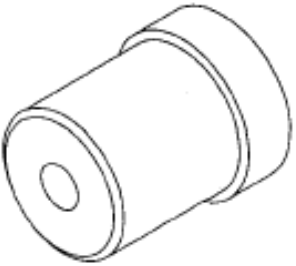
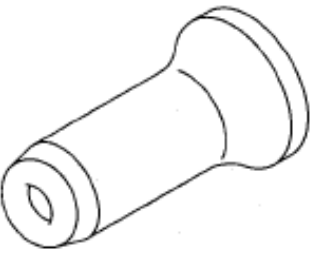
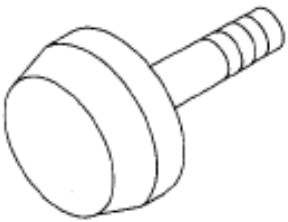
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 ST-499767400			
 ST-499817100	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used together with ENGINE STAND ADAPTER RH (498457000) & LH (498457100).
 ST-499977100	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when loosening/tightening crank pulley bolt.
 ST-499987500	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST18332AA000	18332AA000	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 68 mm (2.68 in))

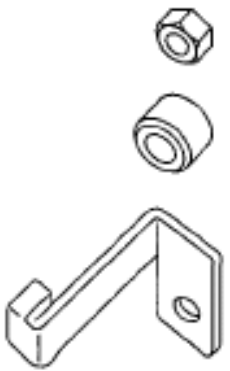
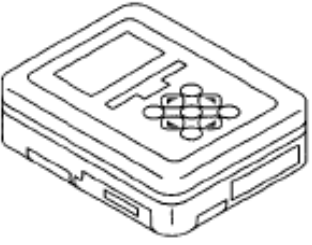
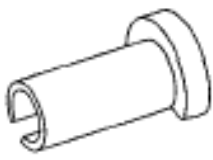
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 ST18332AA010	18332AA010	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 65 mm (2.56 in))
 ST-499587100	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499587600	499587600	OIL SEAL INSTALLER	Used for installing camshaft oil seal for DOHC engine.
 ST-499597200	499597200	OIL SEAL GUIDE	• Used for installing camshaft oil seal for DOHC engine. • Used together with OIL SEAL INSTALLER (499587600).
	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.

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 ST-498277200			
 ST1B020XU0	1B020XU0	SUBARU SELECT MONITOR KIT	Used for troubleshooting the electrical system.
 ST42099AE000	42099AE000	CONNECTOR REMOVER	Used for removing the quick connector in engine compartment.

GENERAL TOOL**GENERAL TOOL**

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
Vacuum gauge	Used for measuring negative pressure.
Oil pressure gauge	Used for measuring oil pressure.
Fuel pressure gauge	Used for measuring fuel pressure.

PROCEDURE

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

- V-belt
- Timing belt
- Camshaft
- Cylinder head

COMPRESSION

INSPECTION

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

1. After warming-up the engine, turn the ignition switch to OFF.
2. Make sure that the battery is fully charged.
3. Release the fuel pressure. <Ref. to **RELEASING OF FUEL PRESSURE** , Procedure, Fuel. >
4. Remove all the spark plugs.

<Ref. **REMOVAL** , Spark Plug. >

5. Fully open the throttle valve.
6. Check the starter motor for satisfactory performance and operation.
7. Hold the compression gauge tightly against the spark plug hole.

NOTE: The screw of a screw-in type compression gauge should be less than 18 mm (0.71 in) in length.

8. Crank the engine by means of the starter motor, and read the maximum value on the gauge when the pointer is steady.



Fig. 7: Holding Compression Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

Compression (350 rpm and fully open throttle):

Standard:

981 - 1,177 kPa (10 - 12 kgf/cm² , 142 - 171 psi)

Service limit:

882 kPa (9.0 kgf/cm² , 128 psi)

Difference between cylinders:

49 kPa (0.5 kgf/cm² , 7 psi), or less

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. Stop the engine, and turn the ignition switch to OFF.
4. Connect the Subaru Select Monitor to the data link connector.

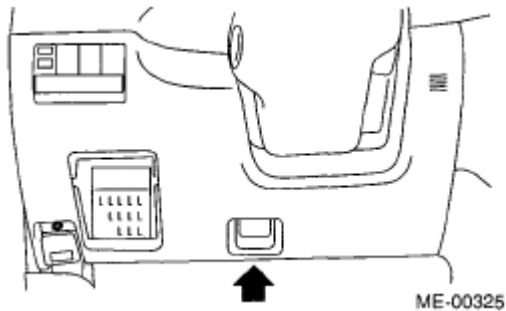


Fig. 8: Locating Subaru Data Link Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Turn the ignition switch to ON and run the Subaru Select Monitor.
6. Select {Each System Check} in Main Menu.
7. Select {Engine Control System} in Selection Menu.
8. Select {Current Data Display & Save} in Engine Control System Diagnosis.
9. Select {Data Display} in Data Display Menu.

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

Idle speed [No load and gears in neutral]: 700±100 rpm

12. Check the idle speed when loaded. (Turn the air conditioning switch to "ON" and operate the compressor for at least one minute before measurement.)

Idle speed [A/C "ON" and gears In neutral]:

When A/C refrigerant pressure is low.

MT: 725±100 rpm

AT: 750±100 rpm

When A/C refrigerant pressure is low.

MT: 800±100 rpm

AT: 825±100 rpm

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

IGNITION TIMING

INSPECTION

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 Subaru Select Monitor to the data link connector.

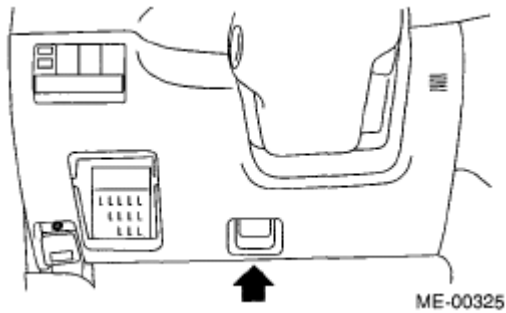


Fig. 9: Locating Subaru Data Link Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Turn the ignition switch to ON and run the Subaru Select Monitor.
6. Select {Each System Check} in Main Menu.
7. Select {Engine Control System} in Selection Menu.
8. Select {Current Data Display & Save} in Engine Control System Diagnosis.
9. Select {Data Display} in Data Display Menu.
10. Start the engine and check the ignition timing at idle speed.

Ignition timing [BTDC/rpm]: $17^{\circ} \pm 10^{\circ} / 700$

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

INTAKE MANIFOLD VACUUM

INSPECTION

1. Remove the collector cover.
2. Warm up the engine.
3. Disconnect the brake vacuum hose from the brake vacuum hose, and then install the vacuum gauge.
4. Keep the engine at idle speed and read the vacuum gauge indication.

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

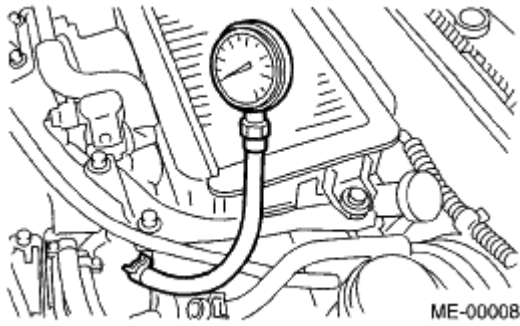


Fig. 10: Identifying Vacuum Gauge
 Courtesy of SUBARU OF AMERICA, INC.

Vacuum pressure (at idling, A/C "OFF"): -60.0 kPa (-450 mmHg, -17.72 inHg) or less

VACUUM PRESSURE SPECIFICATION

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

ENGINE OIL PRESSURE

INSPECTION

1. Remove the collector cover.
2. Remove the oil pressure switch. <Ref. to **REMOVAL**, Oil Pressure Switch. >
3. Connect the oil pressure gauge hose to cylinder block.
4. Connect the ground cable to the battery.

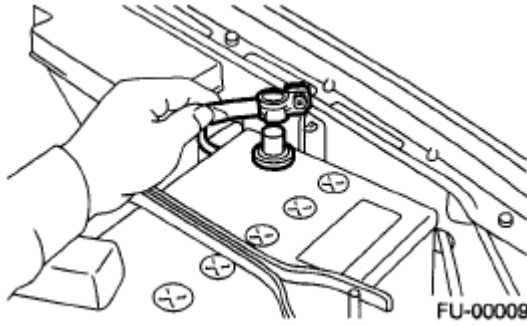


Fig. 11: Connecting Ground Cable To Battery
Courtesy of SUBARU OF AMERICA, INC.

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

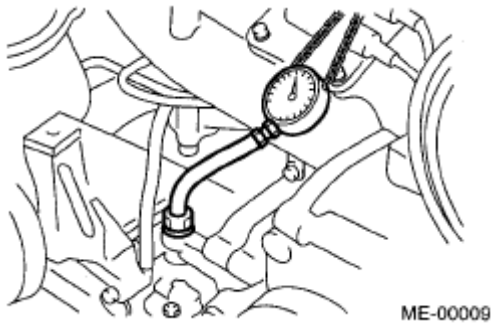


Fig. 12: Measuring Oil Pressure
Courtesy of SUBARU OF AMERICA, INC.

Oil pressure: 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

CAUTION:

- If the oil pressure is out of standard values, check the oil pump, oil filter and lubrication line. <Ref. to INSPECTION , Engine Lubrication System Trouble in General. >
- If the oil pressure warning light is turned on and oil pressure is in the specified range, check the oil pressure switch. <Ref. to INSPECTION INSPECTION, Engine Lubrication System Trouble in General. >

NOTE:

The specified data is based on an engine oil temperature of 80°C (176°F).

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

Tightening torque:

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

FUEL PRESSURE

INSPECTION

CAUTION: Before removing the fuel pressure gauge, release the fuel pressure.

NOTE: If out of specification, check or replace the pressure regulator and pressure regulator vacuum hose.

1. Release the fuel pressure. <Ref. to **RELEASING OF FUEL PRESSURE** , Procedure, Fuel. >
2. Disconnect the fuel delivery hose from fuel damper, and connect fuel pressure gauge.

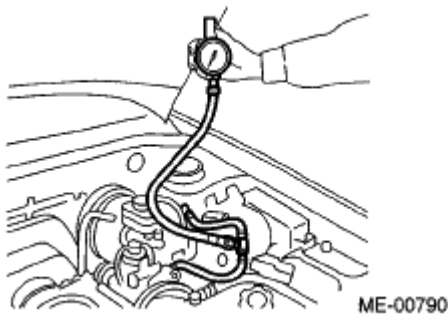


Fig. 13: Connecting Fuel Pressure Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the connector of fuel pump relay.

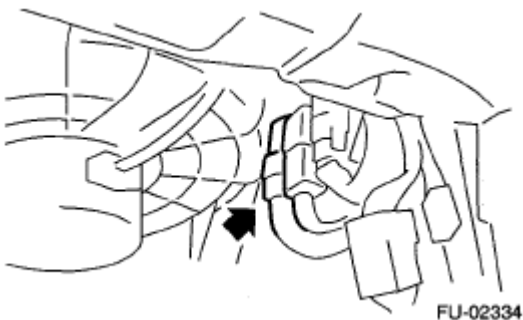


Fig. 14: Identifying Fuel Pump Relay Connector
Courtesy of SUBARU OF AMERICA, INC.

4. Start the engine.
5. After warming up, disconnect the pressure regulator vacuum hose from the intake manifold, and measure the fuel pressure.

Fuel pressure:***Standard: 284 - 314 kPa (2.9 - 3.2 kgf/cm² , 41 - 46 psi)***

6. Connect the pressure regulator vacuum hose and measure the fuel pressure.

Fuel pressure:***Standard: 230 - 260 kPa (2.35 - 2.65 kgf/cm² , 33 - 38 psi)***

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

VALVE CLEARANCE

INSPECTION

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

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

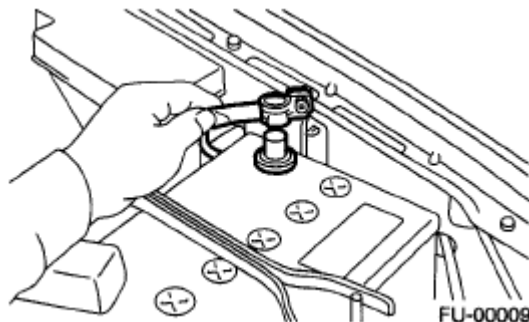


Fig. 15: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the collector cover.
4. Remove the air intake duct. <Ref. IN (H4DOTC)-9, REMOVAL, Air Intake Duct. >
5. Remove a bolt which secures timing belt cover (RH).
6. Lift-up the vehicle.
7. Remove the under cover.
8. Loosen the remaining bolts which secure timing belt cover (RH), then remove the timing belt cover.
9. Lower the vehicle.
10. When inspecting #1 and #3 cylinders:

1. Remove the air cleaner case. <Ref. to **REMOVAL** , Air Cleaner Case. >
 2. Disconnect the connector of ignition coil.
 3. Remove the ignition coil.
 4. Place a suitable container under the vehicle.
 5. Disconnect the PCV hose from rocker cover (RH).
 6. Remove the bolts, then remove the rocker cover (RH).
11. When inspecting #2 and #4 cylinders:
1. Disconnect the battery cable, and then remove the battery and battery carrier.

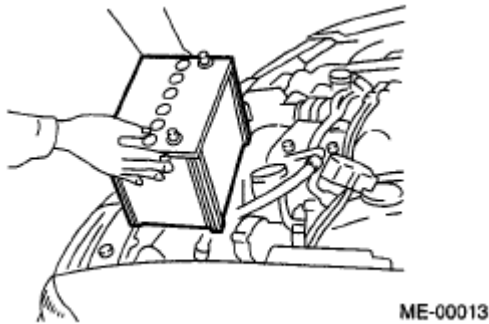


Fig. 16: Identifying Battery And Battery Carrier
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the bolt which holds the engine harness bracket on the body.

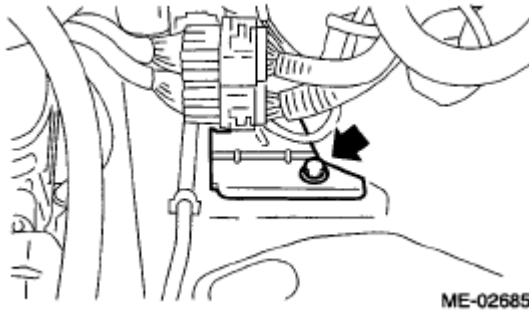


Fig. 17: Identifying Engine Harness Bracket Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the secondary air pump. <Ref. **REMOVAL** , Secondary Air Pump. >
 4. Disconnect the connector of ignition coil.
 5. Remove the ignition coil.
 6. Place a suitable container under the vehicle.
 7. Disconnect the PCV hose from rocker cover (LH).
 8. Remove the bolts, then remove the rocker cover (LH).
12. Turn the crank pulley clockwise until arrow mark on the camshaft sprocket is set to position shown in the

figure.

NOTE: Turn the crankshaft using socket wrench.

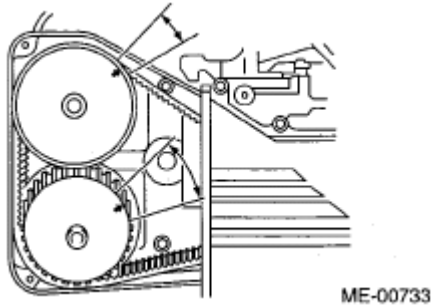


Fig. 18: Identifying Arrow Mark On Camshaft Sprocket
 Courtesy of SUBARU OF AMERICA, INC.

13. Measure the #1 cylinder intake valve and #3 cylinder exhaust valve clearance by using thickness gauge (A).

NOTE:

- Insert a thickness gauge in a direction as horizontal as possible with respect to the valve lifter.
- Lift-up the vehicle and measure the exhaust valve clearance.

Valve clearance:

Intake

$0.20 \pm 0.02 \text{ mm}$ ($0.0079 \pm 0.0008 \text{ in}$)

Exhaust

$0.35 \pm 0.02 \text{ mm}$ ($0.0138 \pm 0.0008 \text{ in}$)

- If the measured value is not within specification, take notes of the value in order to adjust the valve clearance later on.

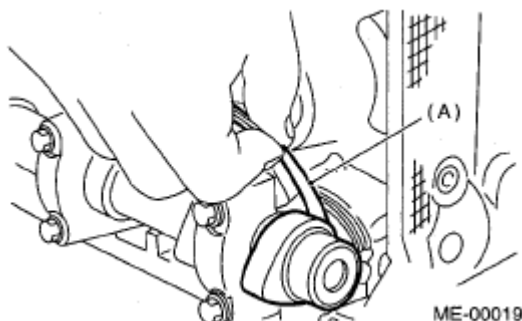
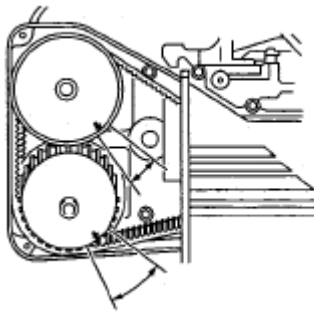


Fig. 19: Measuring #1 Cylinder Intake Valve And #3 Cylinder Exhaust Valve Clearance
Courtesy of SUBARU OF AMERICA, INC.

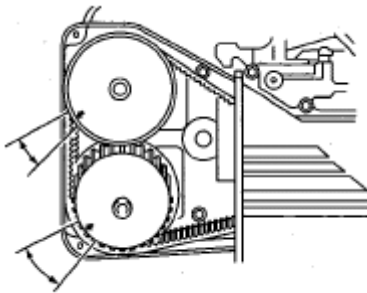
14. If necessary, adjust the valve clearance. <Ref. to **ADJUSTMENT**, Valve Clearance . >
15. Further turn the crank pulley clockwise. Using the same procedures described previously, then measure valve clearances again.
 1. Set the arrow mark on cam sprocket to the position shown in the figure, and measure the #2 cylinder exhaust valve and #3 cylinder intake valve clearances.



ME-00734

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

2. Set the arrow mark on cam sprocket to the position shown in the figure, and measure the #2 cylinder intake valve and #4 cylinder exhaust valve clearances.



ME-00735

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

3. Set the arrow mark on cam sprocket to the position shown in the figure, and measure the #1 cylinder exhaust valve and #4 cylinder intake valve clearances.

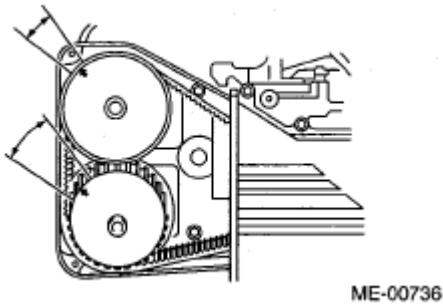


Fig. 22: Identifying Arrow Mark On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

33 N.m (3.4 kgf-m, 25 ft-lb)

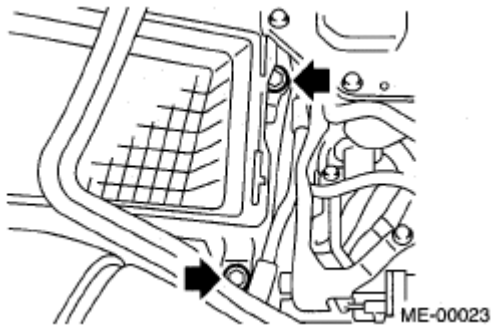


Fig. 23: Identifying Bolts
Courtesy of SUBARU OF AMERICA, INC.

ADJUSTMENT

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

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

NOTE: Record each valve clearance after measurement.

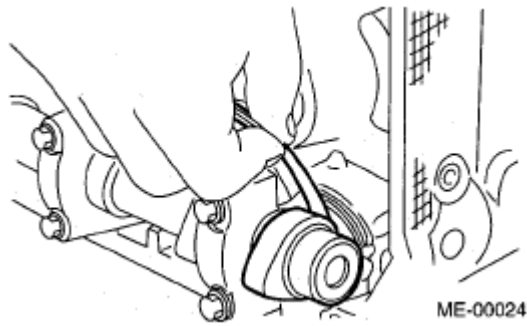


Fig. 24: Measuring Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

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

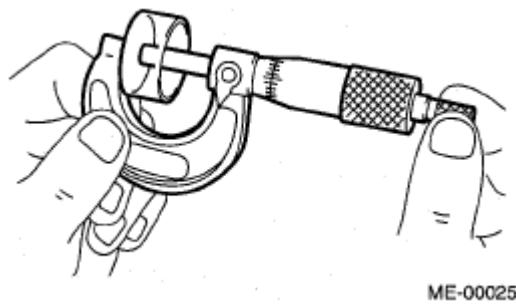


Fig. 25: Measuring Thickness Of Valve Lifter Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

VALVE LIFTER THICKNESS SPECIFICATION

Unit: (mm)
Intake valve: $S = (V + T) - 0.20$
Exhaust valve: $S = (V + T) - 0.35$
S: Required thickness of valve lifter
V: Measured valve clearance
T: Used valve lifter thickness

VALVE LIFTER THICKNESS SPECIFICATION

Part No.	Thickness mm (in)
13228 AB102	4.68 (0.1843)
13228 AB112	4.69 (0.1846)
13228 AB122	4.70 (0.1850)

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13228 AB132	4.71 (0.1854)
13228 AB142	4.72 (0.1858)
13228 AB152	4.73 (0.1862)
13228 AB162	4.74 (0.1866)
13228 AB172	4.75 (0.1870)
13228 AB182	4.76 (0.1874)
13228 AB192	4.77 (0.1878)
13228 AB202	4.78 (0.1882)
13228 AB212	4.79 (0.1886)
13228 AB222	4.80 (0.1890)
13228 AB232	4.81 (0.1894)
13228 AB242	4.82 (0.1898)
13228 AB252	4.83 (0.1902)
13228 AB262	4.84 (0.1906)
13228 AB272	4.85 (0.1909)
13228 AB282	4.86 (0.1913)
13228 AB292	4.87 (0.1917)
13228 AB302	4.88 (0.1921)
13228 AB312	4.89 (0.1925)
13228 AB322	4.90 (0.1929)
13228 AB332	4.91 (0.1933)
13228 AB342	4.92 (0.1937)
13228 AB352	4.93 (0.1941)
13228 AB362	4.94 (0.1945)
13228 AB372	4.95 (0.1949)
13228 AB382	4.96 (0.1953)
13228 AB392	4.97 (0.1957)
13228 AB402	4.98 (0.1961)
13228 AB412	4.99 (0.1965)
13228 AB422	5.00 (0.1969)
13228 AB432	5.01 (0.1972)
13228 AB442	5.02 (0.1976)
13228 AB452	5.03 (0.1980)
13228 AB462	5.04 (0.1984)
13228 AB472	5.05 (0.1988)
13228 AB482	5.06 (0.1992)
13228 AB492	5.07 (0.1996)
13228 AB502	5.08 (0.2000)
13228 AB512	5.09 (0.2004)
13228 AB522	5.10 (0.2008)
13228 AB532	5.11 (0.2012)

2007 Subaru Forester X

2007 ENGINE H4DOTC Engine - Mechanical - Forester

	5.12 (0.2016)
13228 AB552	5.13 (0.2020)
13228 AB562	5.14 (0.2024)
13228 AB572	5.15 (0.2028)
13228 AB582	5.16 (0.2031)
13228 AB592	5.17 (0.2035)
13228 AB602	5.18 (0.2039)
13228 AB612	5.19 (0.2043)
13228 AB622	5.20 (0.2047)
13228 AB632	5.21 (0.2051)
13228 AB642	5.22 (0.2055)
13228 AB652	5.23 (0.2059)
13228 AB662	5.24 (0.2063)
13228 AB672	5.25 (0.2067)
13228 AB682	5.26 (0.2071)
13228 AB692	5.27 (0.2075)
13228 AB702	4.38 (0.1724)
13228 AB712	4.40 (0.1732)
13228 AB722	4.42 (0.1740)
13228 AB732	4.44 (0.1748)
13228 AB742	4.46 (0.1756)
13228 AB752	4.48 (0.1764)
13228 AB762	4.50 (0.1771)
13228 AB772	4.52 (0.1780)
13228 AB782	4.54 (0.1787)
13228 AB792	4.56 (0.1795)
13228 AB802	4.58 (0.1803)
13228 AB812	4.60 (0.1811)
13228 AB822	4.62 (0.1819)
13228 AB832	4.64 (0.1827)
13228 AB842	4.66 (0.1835)
13228 AB852	5.29 (0.2083)
13228 AB862	5.31 (0.2091)
13228 AB872	5.33 (0.2098)
13228 AB882	5.35 (0.2106)
13228 AB892	5.37 (0.2114)
13228 AB902	5.39 (0.2122)
13228 AB912	5.41 (0.2123)
13228 AB922	5.43 (0.2138)
13228 AB932	5.45 (0.2146)
13228 AB942	5.47 (0.2154)

	5.49 (0.2161)
13228 AB962	5.51 (0.2169)
13228 AB972	5.53 (0.2177)
13228 AB982	5.55 (0.2185)
13228 AB992	5.57 (0.2193)
13228 AC002	5.59 (0.2201)
13228 AC012	5.61 (0.2209)
13228 AC022	5.63 (0.2217)
13228 AC032	5.65 (0.2224)

6. Inspect all valves for clearance again at this stage. If the valve clearance is not correct, repeat the procedure over again from the first step.
7. After inspection, install the related parts in the reverse order of removal.

ENGINE ASSEMBLY

REMOVAL

1. Set the vehicle on a lift.
2. Open the front hood fully and support with the front food stay.
3. Remove the collector cover.
4. Collect the refrigerant from A/C system. <Ref. to **REFRIGERANT RECOVERY PROCEDURE** . >
5. Release the fuel pressure. <Ref. **RELEASING OF FUEL PRESSURE** , Procedure, Fuel. >
6. Disconnect the ground cable from the battery.

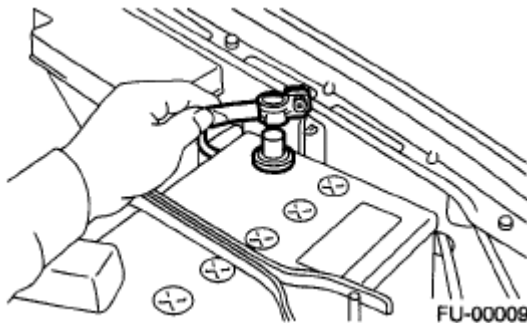


Fig. 26: Disconnecting Ground Cable From Battery
 Courtesy of SUBARU OF AMERICA, INC.

7. Open the fuel filler flap lid, and remove the filler cap.
8. Remove the air cleaner case and air intake boot. <Ref. to **REMOVAL** , Air Cleaner Case. >
9. Remove the under cover.
10. Remove the radiator from the vehicle. <Ref. **REMOVAL** , Radiator. >
11. Remove the coolant filler tank. <Ref. **REMOVAL** , Coolant Filler Tank. >

12. Remove the secondary air pump. <Ref. **INSPECTION** , Secondary Air Pump. >
13. Disconnect the A/C pressure hoses from A/C compressor.

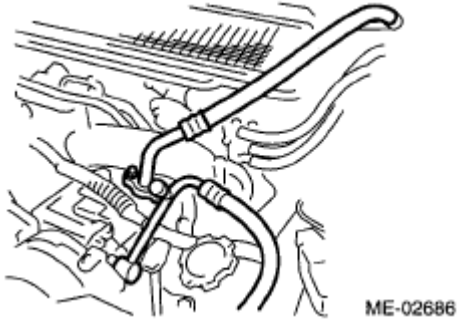


Fig. 27: Identifying A/C Pressure Hoses From A/C Compressor
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the intercooler. <Ref. to **REMOVAL** , Intercooler. >
15. Disconnect the following connectors and cables.
 1. Engine harness connectors

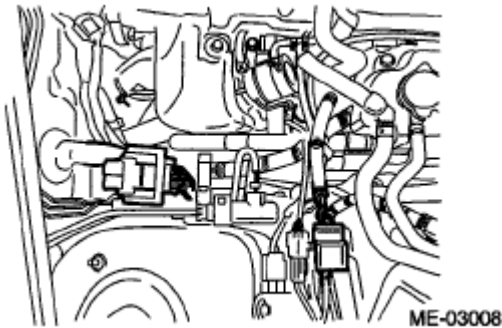


Fig. 28: Identifying Harness Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Engine ground terminal

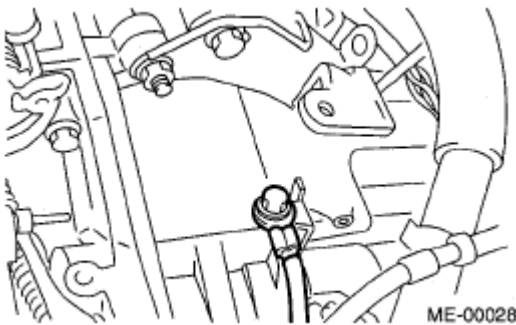


Fig. 29: Identifying Engine Ground Terminal

Courtesy of SUBARU OF AMERICA, INC.

3. Right and left engine ground cables

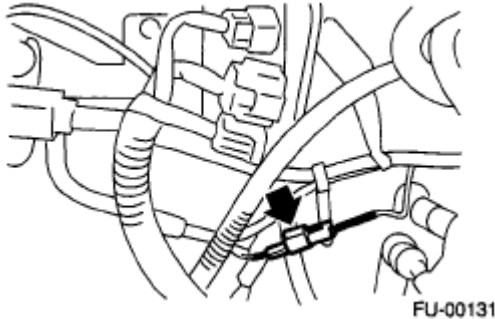


Fig. 30: Identifying Right Engine Ground Cables
Courtesy of SUBARU OF AMERICA, INC.

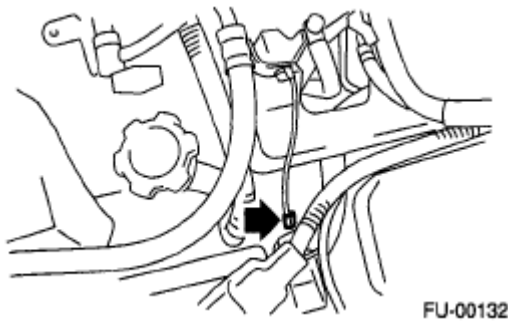
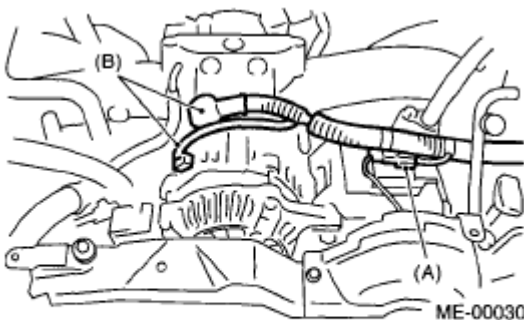


Fig. 31: Identifying Left Engine Ground Cables
Courtesy of SUBARU OF AMERICA, INC.

4. Generator connector, terminal and A/C compressor connector



- (A) A/C compressor connector
(B) Generator connector and terminal

Fig. 32: Identifying A/C Compressor Connector And Generator Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Power steering switch connector

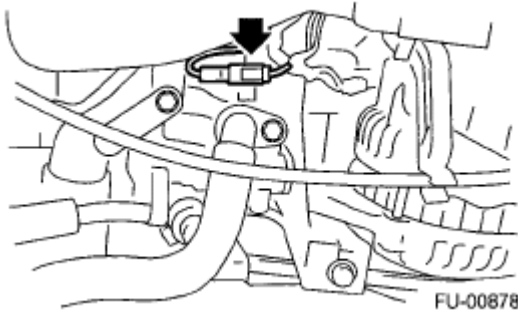


Fig. 33: Identifying Power Steering Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

16. Disconnect the following hoses.

1. Brake booster vacuum hose

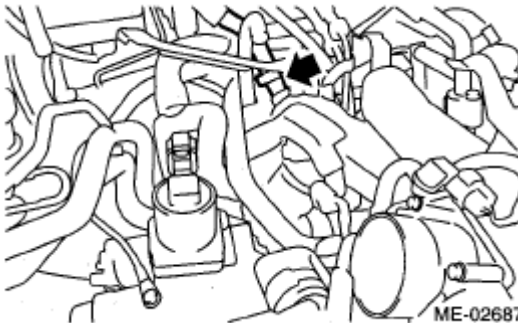


Fig. 34: Identifying Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

2. Heater inlet and outlet hoses

17. Remove the power steering pump.

1. Remove the front side V-belt. <Ref. to **FRONT SIDE BELT**, Removal, V-belt . >
2. Remove the power steering pipe from the fuel pipe protector RH along with the bracket.

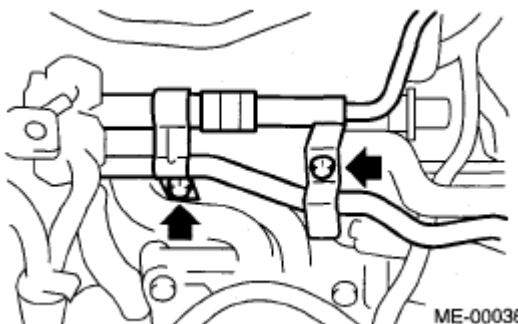


Fig. 35: Identifying Fuel Pipe Protector Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the power steering pump.

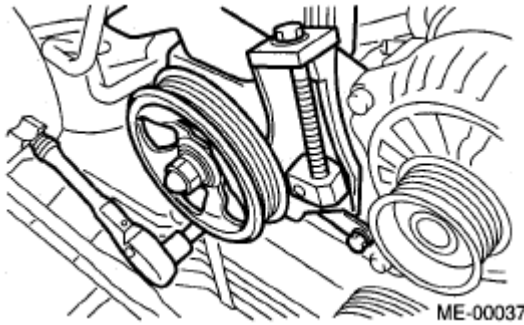


Fig. 36: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the reservoir tank from the bracket by pulling it upwards.

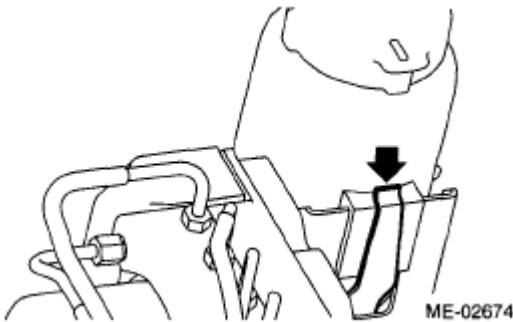


Fig. 37: Identifying Reservoir Tank From Bracket
Courtesy of SUBARU OF AMERICA, INC.

5. Place the power steering pump on the right side wheel apron.

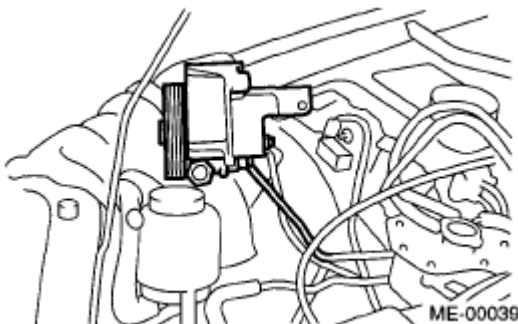


Fig. 38: Identifying Power Steering Pump On Right Side Wheel Apron
Courtesy of SUBARU OF AMERICA, INC.

18. Lift-up the vehicle.
19. Remove the center exhaust pipe.

<Ref. **REMOVAL** , Center Exhaust Pipe. >

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

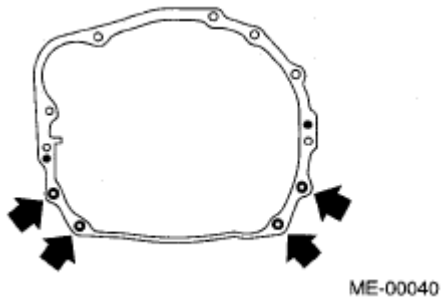


Fig. 39: Identifying Lower Side Of Transmission Fastener Location
Courtesy of SUBARU OF AMERICA, INC.

21. Remove the nuts which install front cushion rubber onto front crossmember.

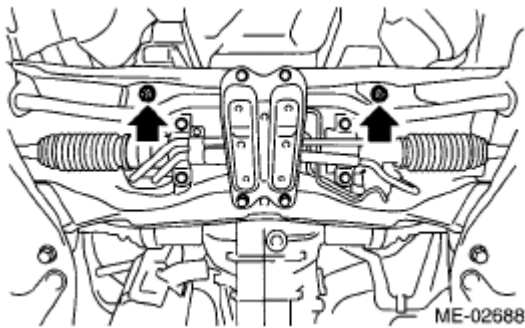


Fig. 40: Identifying Front Cushion Rubber Onto Front Crossmember Nuts
Courtesy of SUBARU OF AMERICA, INC.

22. Separate the torque converter clutch from drive plate. (AT model)
 1. Lower the vehicle.
 2. Remove the service hole plug.
 3. Remove the bolts which hold torque converter clutch to drive plate.
 4. Remove other bolts while rotating the crankshaft using socket wrench.

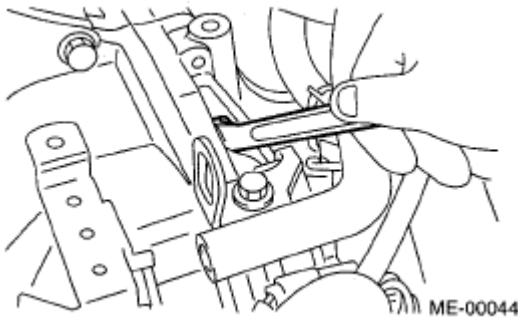


Fig. 41: Tightening Bolt Using Socket Wrench
Courtesy of SUBARU OF AMERICA, INC.

23. Remove the pitching stopper.

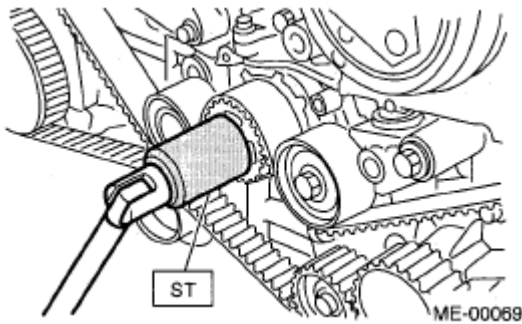


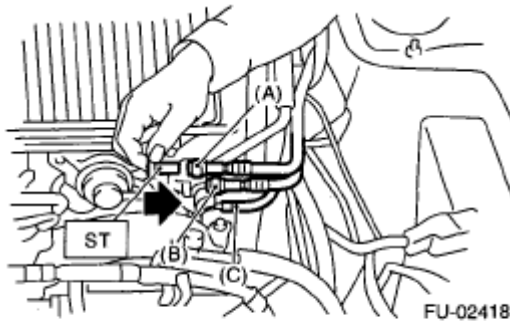
Fig. 42: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

24. Using the ST to remove the fuel hose from each fuel pipe. <Ref. to **REMOVAL** , Fuel Delivery, Return and Evaporation Lines. >

CAUTION:

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

ST 42099AE000 CONNECTOR REMOVER



- (A) Fuel delivery hose
- (B) Return hose
- (C) Evaporation hose

Fig. 43: Removing Fuel Hose Using ST 42099AE000 Connector Remover
Courtesy of SUBARU OF AMERICA, INC.

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

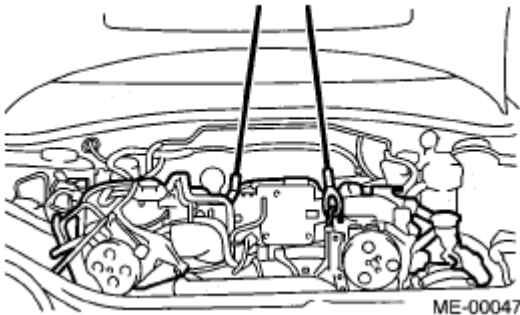
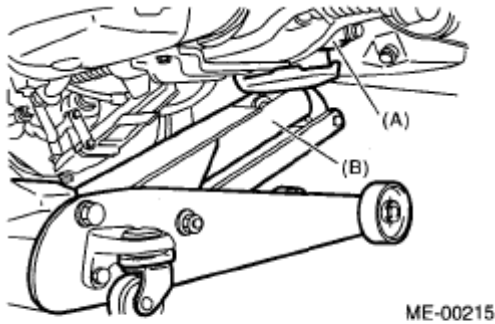


Fig. 44: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

26. 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. 45: Supporting Transmission With Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

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

27. Separation of engine and transmission.

1. Remove the starter. <Ref. **REMOVAL** , Starter. >
2. Set the ST to torque converter clutch case. (AT model) ST 498277200 STOPPER SET

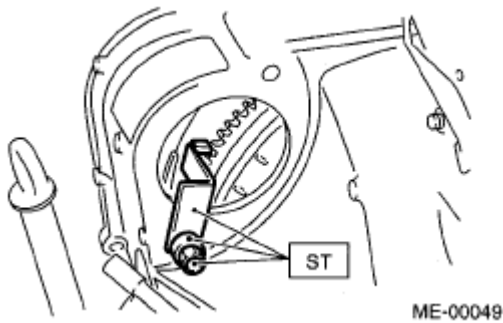


Fig. 46: Setting ST To Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

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

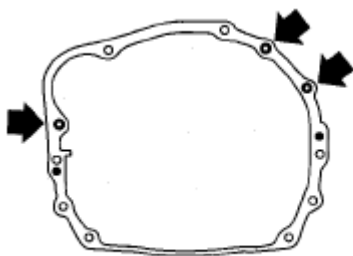


Fig. 47: Identifying Upper Side Of Transmission Fastener Location
Courtesy of SUBARU OF AMERICA, INC.

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.
 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 front cushion rubbers.

INSTALLATION

1. Install the front cushion rubbers.

Tightening torque:

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

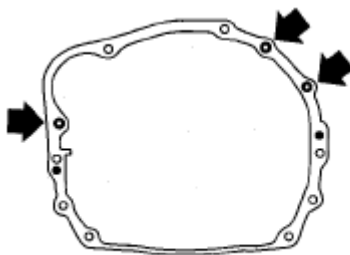
2. Apply a small amount of grease to splines of mainshaft. (MT model)
3. Position the engine in engine compartment and connect the engine to the transmission.

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)



ME-00050

Fig. 48: Identifying Upper Side Of Transmission Fastener Location
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.

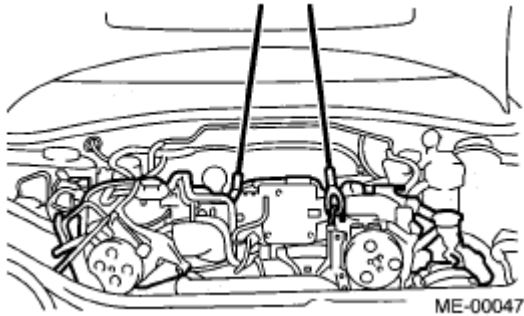


Fig. 49: Identifying Lifting Device And Wire Ropes
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

T1: 50 N.m (5.1 kgf-m, 37 ft-lb)

T2: 58 N.m (5.9 kgf-m, 43 ft-lb)

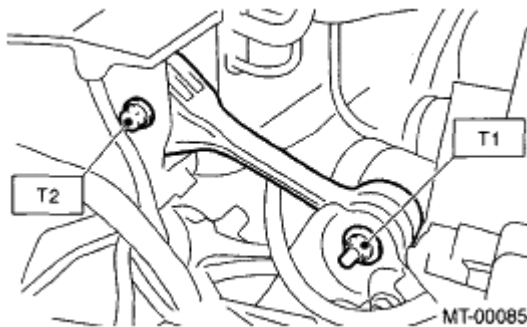


Fig. 50: Identifying Pitching Stopper
 Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

9. Install the starter. <Ref. **INSTALLATION** , Starter. >
10. Install the torque converter clutch to drive plate. (AT model)

1. Tighten the bolts which hold torque converter clutch to drive plate.
2. Tighten other bolts while rotating the crankshaft using socket wrench.

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

Tightening torque:

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

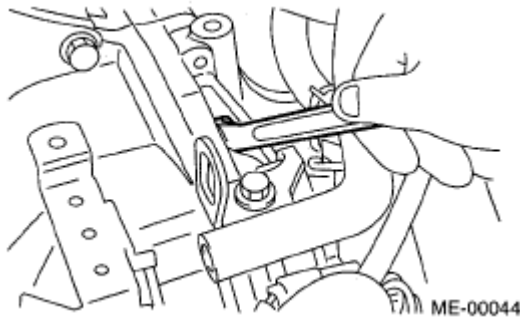


Fig. 51: Tightening Bolt Using Socket Wrench
Courtesy of SUBARU OF AMERICA, INC.

3. Install the service hole plug.
11. Install the power steering pump.
 1. Install the reservoir tank to the bracket.

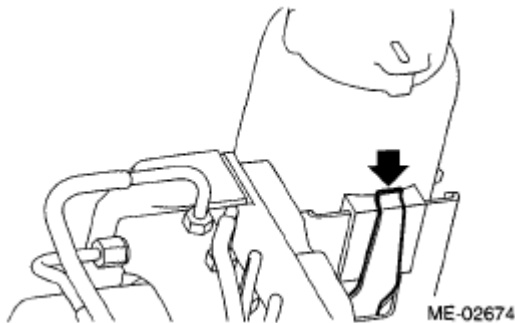


Fig. 52: Identifying Reservoir Tank Bracket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the power steering pump.

Tightening torque:

20.1 N.m (2.05 kgf-m, 14.8 ft-lb)

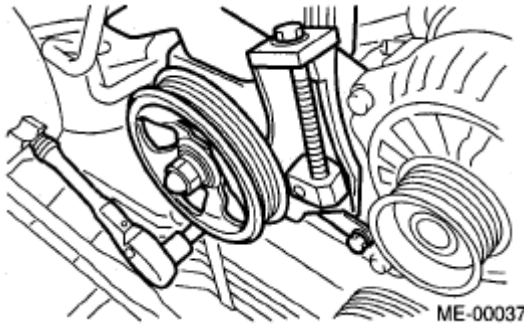


Fig. 53: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

3. Install the power steering pipes onto the fuel pipe protector RH.

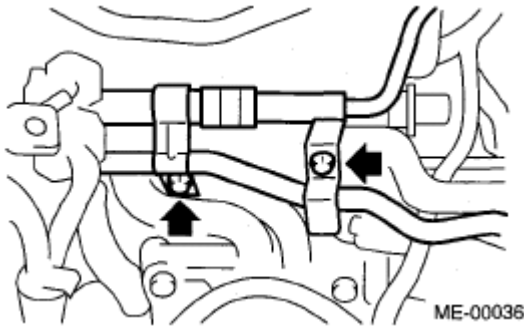


Fig. 54: Identifying Power Steering Pipes Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

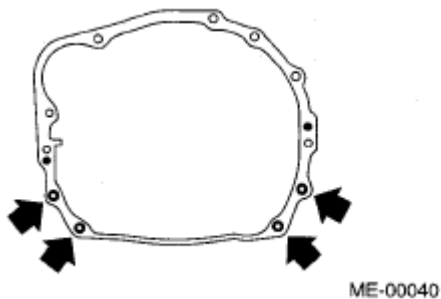


Fig. 55: Identifying Lower Side Of Transmission Fastener Location
Courtesy of SUBARU OF AMERICA, INC.

14. Tighten the nuts which install the front cushion rubber onto crossmember.

Tightening torque:

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

NOTE: Make sure the front cushion rubber mounting bolts (A) and locator (B) are securely installed.

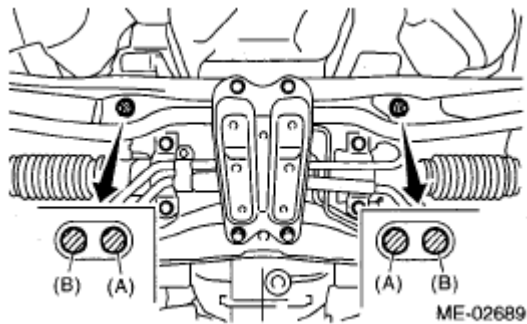


Fig. 56: Identifying Front Cushion Rubber Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

15. Install the center exhaust pipe.

<Ref. **INSTALLATION** , Center Exhaust Pipe. >

16. Lower the vehicle.

17. Connect the following hoses.

1. Fuel delivery hose, return hose and evaporation hose
2. Heater inlet and outlet hoses
3. Brake booster vacuum hose

18. Connect the following connectors and terminals.

1. Engine ground terminal
2. Engine harness connectors
3. Generator connector and terminal
4. A/C compressor connector
5. Power steering switch connector

19. Install the air intake system.

1. Install the intercooler. <Ref. to **INSTALLATION** , Intercooler. >
2. Install the air cleaner case and air intake boot. <Ref. to **INSTALLATION** , Air Cleaner Case. >

20. Install the A/C pressure hoses.

NOTE: Use new O-rings.

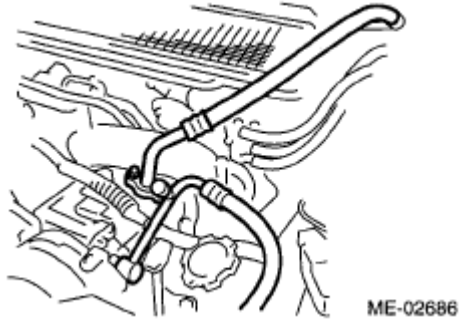
Tightening torque:***15 N.m (1.5 kgf-m, 10.8 ft-lb)***

Fig. 57: Identifying A/C Pressure Hoses
Courtesy of SUBARU OF AMERICA, INC.

21. Install the radiator. <Ref. **INSTALLATION** , Radiator. >
22. Install the under cover.
23. Install the coolant filler tank.

<Ref. **INSTALLATION** , Coolant Filler Tank. >

24. Install the secondary air pump. <Ref. **INSTALLATION** , Secondary Air Pump. >
25. Install the battery in the vehicle, and connect cables.
26. Refill engine coolant.

<Ref. **FILLING OF ENGINE COOLANT** , Replacement, Engine Coolant. >

27. Charge the A/C system with refrigerant. <Ref. to **PROCEDURE** , Refrigerant Charging Procedure. >
28. Install the collector cover.
29. Remove the front hood stay, and close the front hood.
30. Lower the vehicle from lift.

INSPECTION

1. Check that the pipes and hoses are correctly installed.
2. Check that the engine coolant and ATF are at specified levels. (AT model)
3. 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 unit. <Ref. to **REMOVAL**, Engine Assembly . >
2. Remove the engine mounting from engine assembly.

INSTALLATION

Install in the reverse order of removal.

Tightening torque:

Engine mounting:

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

INSPECTION

Make sure that no crack or other damage do not exists.

PREPARATION FOR OVERHAUL

PROCEDURE

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

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER

LH ST3 499817100 ENGINE STAND

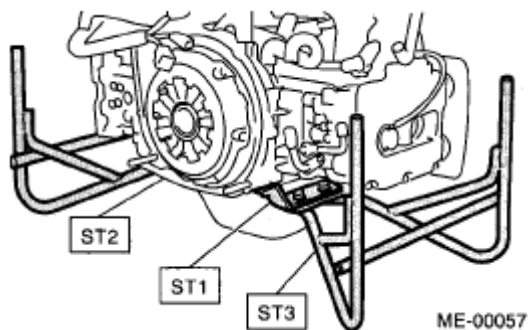


Fig. 58: Identifying Engine Stand Adapter
Courtesy of SUBARU OF AMERICA, INC.

2. In this section 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 section, to conduct the particular procedure within the flow of a section, you need to go

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

V-BELT

REMOVAL

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

FRONT SIDE BELT

1. Remove the collector cover.
2. Loosen the lock bolt (A).
3. Loosen the slider bolt (B).

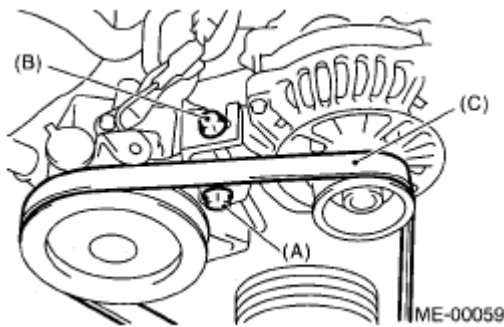


Fig. 59: Identifying Lock Bolt, Slider Bolt And Collector Cover
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the front side belt (C).

REAR SIDE BELT

1. Loosen the lock nut (A).
2. Loosen the slider bolt (B).

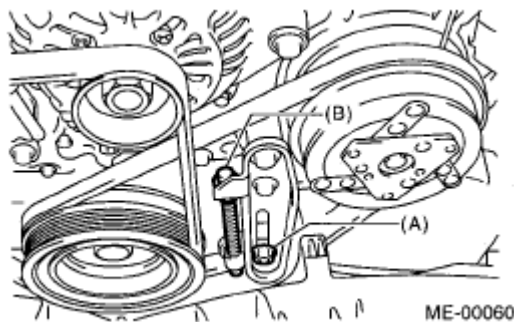


Fig. 60: Identifying Rear Side Belt Lock Nut And Slider Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the rear side belt.
4. Remove the belt tensioner.

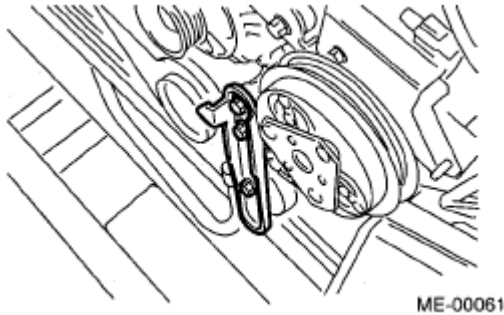


Fig. 61: Identifying Rear Side Belt And Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

CAUTION: Wipe off any oil and water on the belt and pulley.

FRONT SIDE BELT

1. Install the front side belt (C), and tighten the slider bolt so as to obtain the specified belt tension. <Ref. to **INSPECTION**, V-belt . >
2. Tighten the lock bolt (A).
3. Tighten the slider bolt (B).

Tightening torque:

Lock bolt through bolt:

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

Slider bolt

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

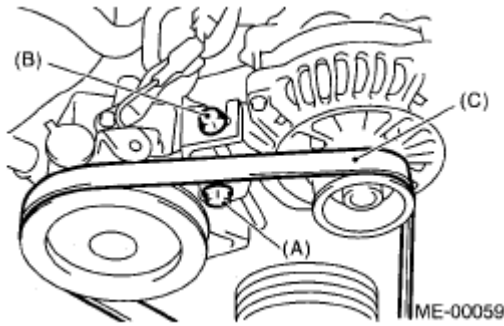


Fig. 62: Identifying Slider Bolt And Lock Bolt
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

1. Install the belt tensioner.
2. Install a rear side belt, and tighten the slider bolt (B) so as to obtain the specified belt tension. <Ref. to **INSPECTION**, V-belt . >
3. Tighten the lock nut (A).

Tightening torque:

Lock nut (A)

22.6 N.m (2.3 kgf-m, 16.6 ft-lb)

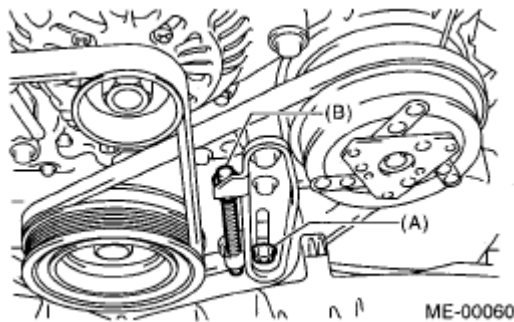


Fig. 63: Identifying Lock Nut
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Replace the belts, if crack, fraying or wear is found.
2. Check the V-belt tension and adjust it if necessary by changing generator installing position and/ or idler pulley installing position.

Belt tension (with belt tension gauge):

(A)

When installing new parts

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

At inspection:

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

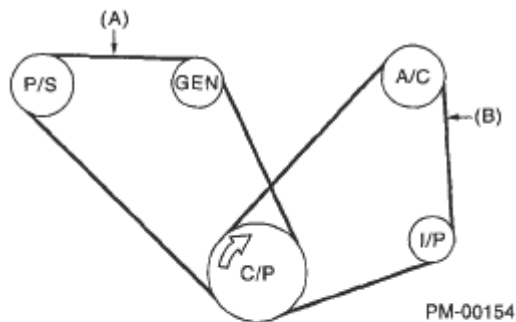
(B)

When installing new parts

650 - 750 N (66 - 76 kgf, 146 - 169 lb)

At inspection

350 - 450 N (36 - 46 kgf, 78 - 101 lb)



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

Fig. 64: Checking V-Belt Tension (With Belt Tension Gauge)
Courtesy of SUBARU OF AMERICA, INC.

Belt tension (without belt tension gauge):

(A)

When installing new parts

7 - 9 mm (0.276 - 0.354 in)

At inspection

9 - 11 mm (0.354 - 0.433 in)

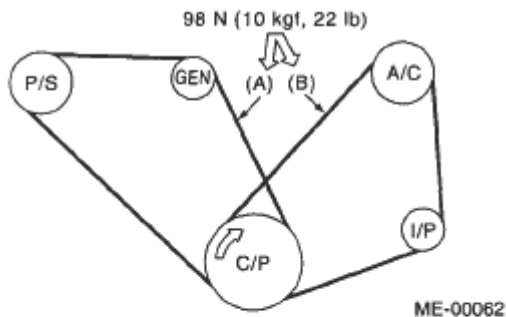
(B)

When installing new parts

7.5 - 8.5 mm (0.295 - 0.335 in)

At inspection

9.0 - 10.0 mm (0.354 - 0.394 in)



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

Fig. 65: Checking V-Belt Tension (Without Belt Tension Gauge)
Courtesy of SUBARU OF AMERICA, INC.

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. Remove the crank pulley bolt. To lock the crankshaft, use ST.

ST 499977100 CRANK PULLEY WRENCH

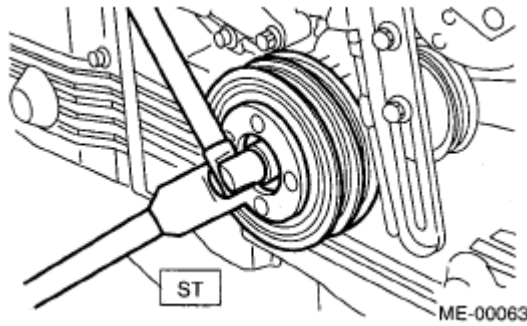


Fig. 66: Removing Crank Pulley Bolt With ST
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION

1. Install the crank pulley.
2. Install the pulley bolt.

To lock the crankshaft, use ST.

ST 499977100 CRANK PULLEY WRENCH

1. Clean the crank pulley thread using compressed air.
2. Apply engine oil to the crank pulley bolt seat and thread.
3. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 33 ft-lb).
4. Tighten the crank pulley bolts.

Tightening torque:

180 N.m (18.3 kgf-m, 132.7 ft-lb)

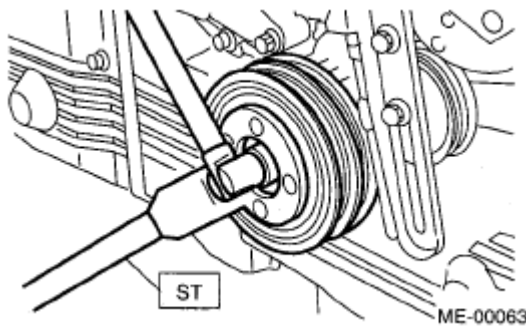


Fig. 67: Tightening Crank Pulley Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Check that the tightening angle of the clamp pulley bolt is a minimum of 65°. Perform the following procedure when less than 65°.

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

1. Replace the crank pulley bolts and clean them.

Crank pulley bolt:

Part No. 12369AA011

2. Clean the crankshaft thread using compressed air.
3. Apply engine oil to the crank pulley bolt seat and thread.
4. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 33 ft-lb).
5. Tighten the crank pulley bolts 65° to 75°.

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

4. Install the belt tensioner.

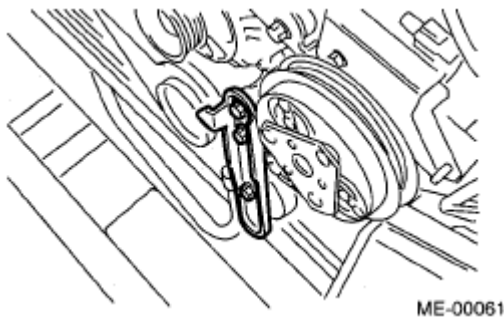


Fig. 68: Identifying Rear Side Belt And Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

1. Check the V-belt is not worn or otherwise damaged.
2. Check the tension of the belt. <Ref. ME(H4DOTC)-41, INSPECTION, V-belt. >

TIMING BELT COVER

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt . >
2. Remove the crank pulley.

<Ref. to **REMOVAL**, Crank Pulley . >

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

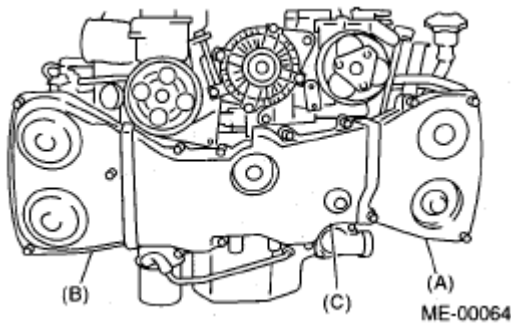


Fig. 69: Identifying Front Timing Belt Cover And Timing Belt Cover (LH/RH)
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

Tightening torque:

5 N.m (0.5 kgf-m, 3.6 ft-lb)

2. Install the timing belt cover (RH) (B).

Tightening torque:

5 N.m (0.5 kgf-m, 3.6 ft-lb)

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

Tightening torque:

5 N.m (0.5 kgf-m, 3.6 ft-lb)

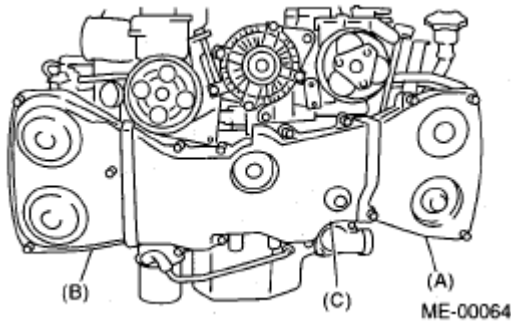


Fig. 70: Identifying Front Timing Belt Cover And Timing Belt Cover (LH/RH)
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

Make sure the cover is not damaged.

TIMING BELT

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. For operation procedures, refer to 'Timing Belt" of the PM section. <Ref. to **TIMING BELT** . >

TIMING BELT

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt . >
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley . >
3. Remove the timing belt cover.

<Ref. to **REMOVAL**, Timing Belt Cover . >

4. Remove the timing belt guide. (MT model)

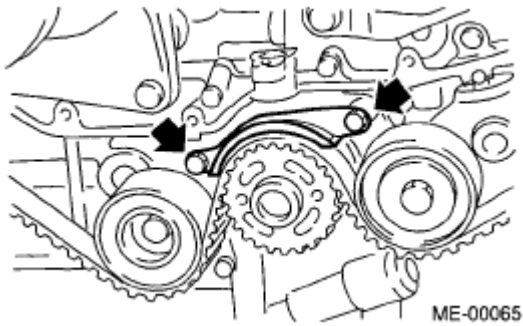


Fig. 71: Identifying Timing Belt Guide (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

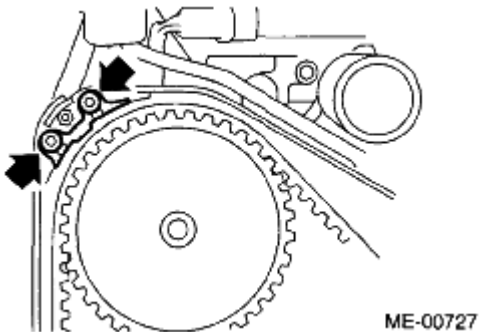


Fig. 72: Identifying Timing Belt Guide (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

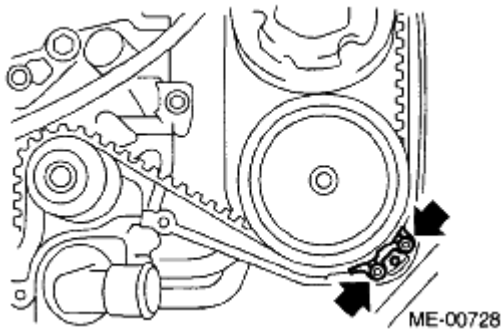


Fig. 73: Identifying Timing Belt Guide (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

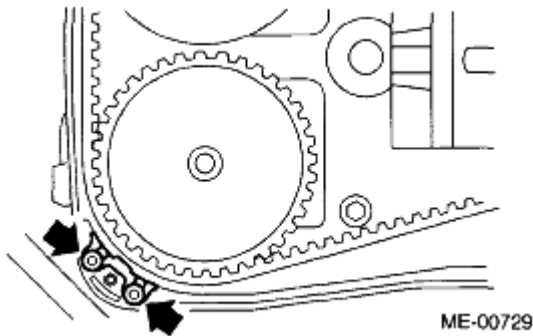


Fig. 74: Identifying Timing Belt Guide (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499987500 CRANKSHAFT SOCKET

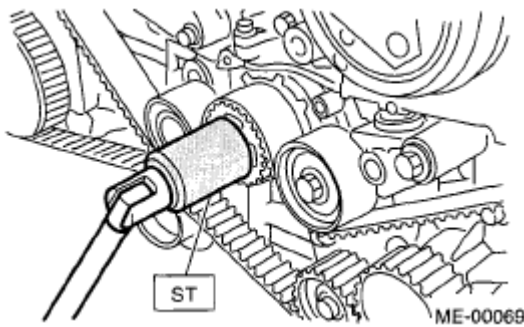


Fig. 75: Turning Crankshaft Using ST
Courtesy of SUBARU OF AMERICA, INC.

2. Using white paint, put alignment and/or arrow marks on timing belts in relation to the cam sprockets.

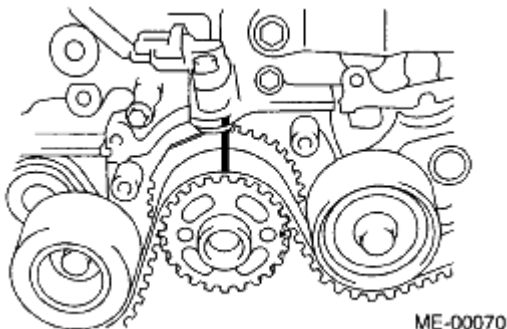


Fig. 76: Identifying Marks On Timing Belts In Relation To Cam Sprockets
Courtesy of SUBARU OF AMERICA, INC.

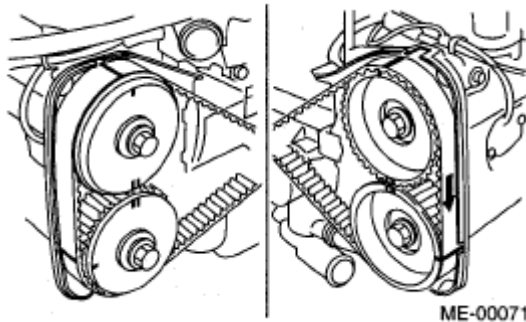


Fig. 77: Identifying Timing Marks Location
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 54.5-teeth length

Z_2 : 51-teeth length

Z_3 : 28-teeth length

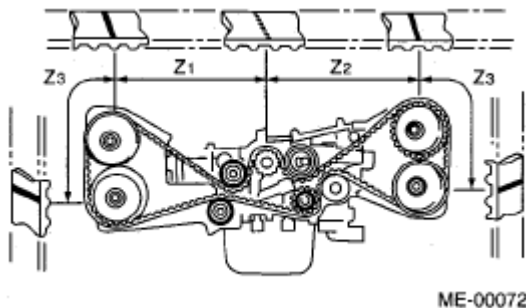


Fig. 78: Identifying Teeth Length
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the belt idler (A).

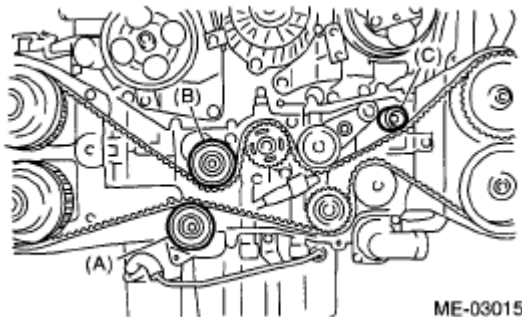


Fig. 79: Identifying Belt Idler

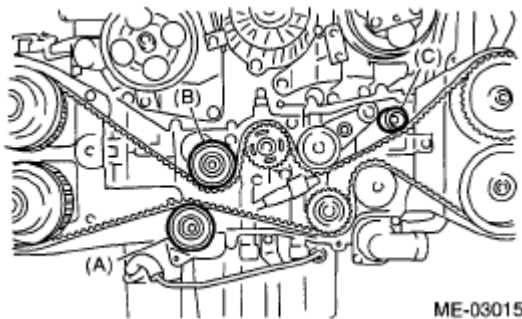
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the timing belt.

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

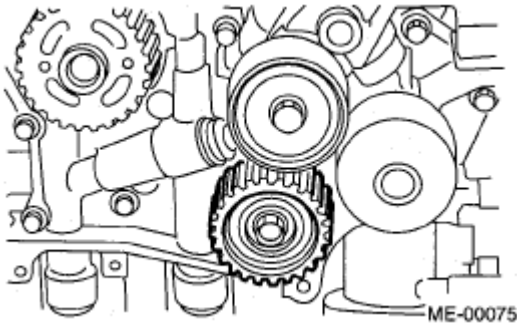
AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

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

**Fig. 80: Identifying Belt Idler (B) And (C)**

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the belt idler No. 2.

**Fig. 81: Identifying Belt Idler No. 2**

Courtesy of SUBARU OF AMERICA, INC.

3. Remove the automatic belt tension adjuster assembly.

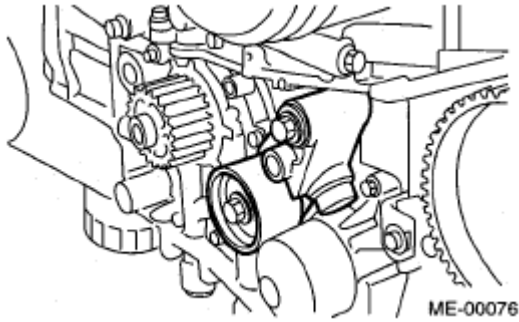


Fig. 82: Identifying Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

1. Preparation for installation of 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 more than three minutes.
 - Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).
 - Press the adjuster rod as far as the end surface of the cylinder. Do not press the adjuster rod into 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 move the adjuster rod down with a pressure of more than 294 N (30 kgf, 66 lb) until the adjuster rod is aligned with the stopper pin hole in the cylinder.

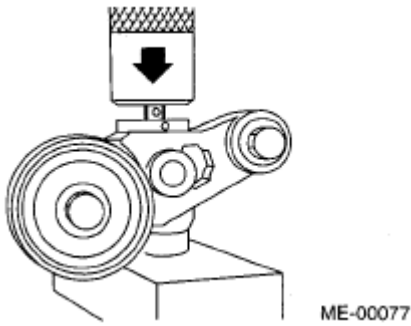


Fig. 83: Identifying Stopper Pin Hole In Cylinder
 Courtesy of SUBARU OF AMERICA, INC.

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

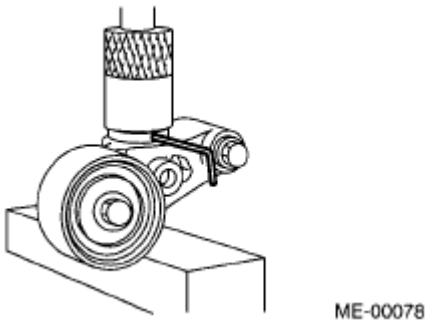


Fig. 84: Identifying Stopper Pin Hole In Cylinder
 Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

39 N.m (4.0 kgf-m, 28.9 ft-lb)

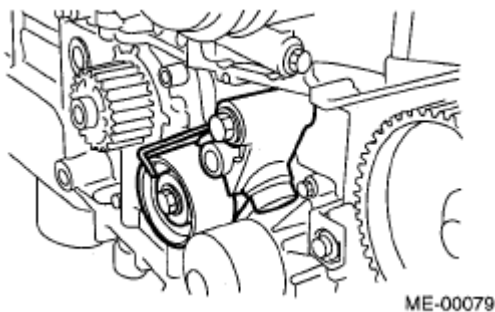


Fig. 85: Identifying Automatic Belt Tension Adjuster Assembly
 Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idler No. 2.

Tightening torque:

39 N.m (4.0 kgf-m, 28.9 ft-lb)

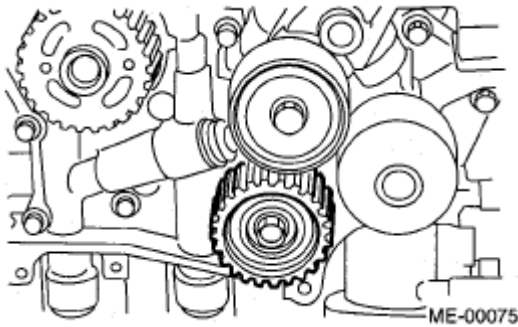


Fig. 86: Identifying Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

4. Install the belt idlers.

Tightening torque:

39 N.m (4.0 kgf-m, 28.9 ft-lb)

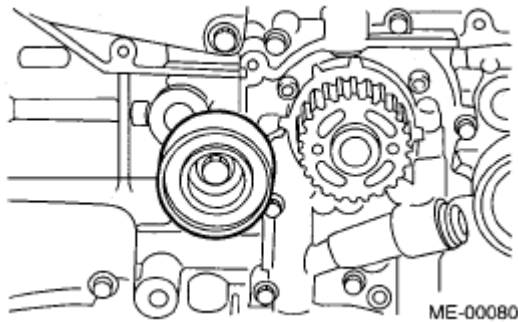


Fig. 87: Identifying Belt Idlers
Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

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

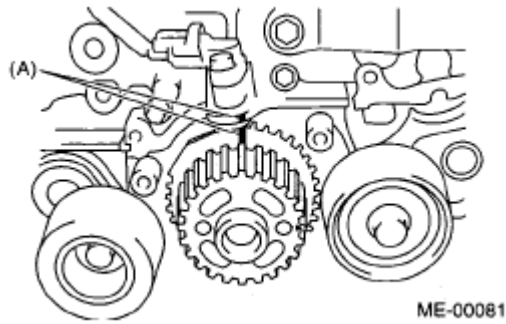


Fig. 88: Identifying Mark On Crank Sprocket With Oil Pump Cover
Courtesy of SUBARU OF AMERICA, INC.

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

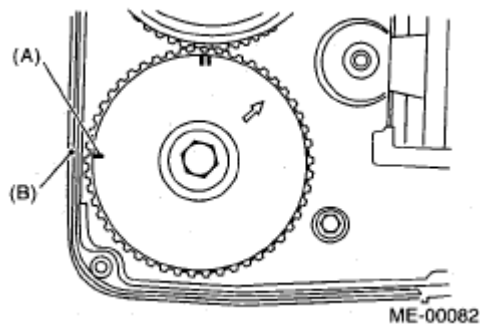


Fig. 89: Identifying Single Line Mark On Exhaust Cam Sprocket (RH) And Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

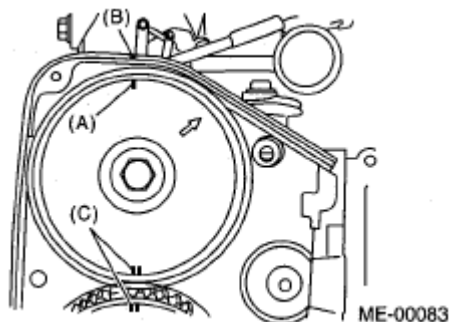


Fig. 90: Identifying Mark On Intake Cam Sprocket (RH) And Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

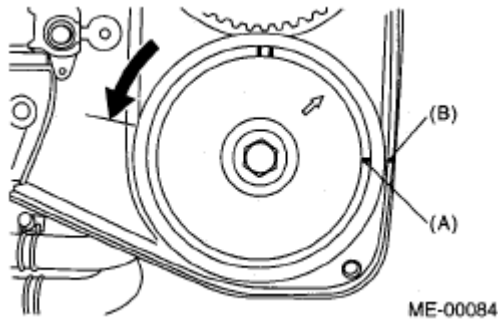


Fig. 91: Identifying Mark On Exhaust Cam Sprocket (LH) And Timing Belt Cover
 Courtesy of SUBARU OF AMERICA, INC.

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

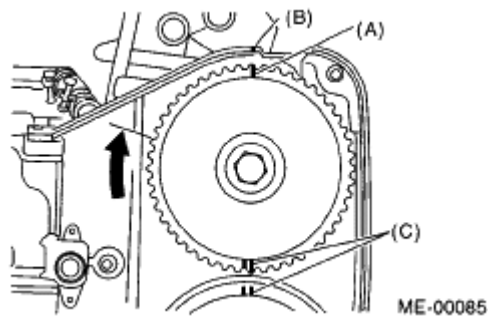
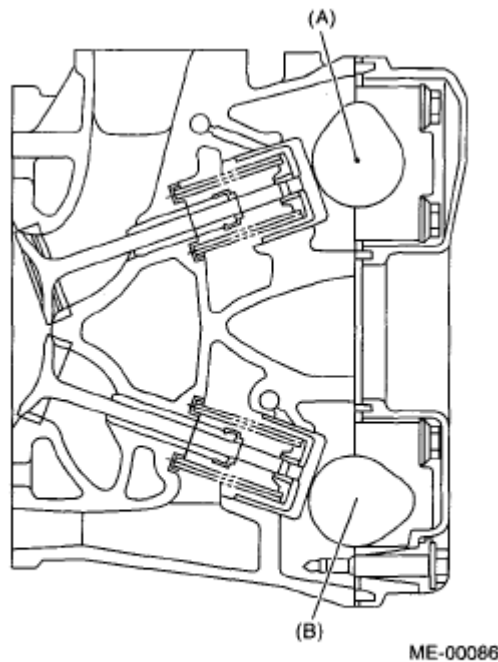


Fig. 92: Identifying Mark On Intake Cam Sprocket (LH) And Timing Belt Cover
 Courtesy of SUBARU OF AMERICA, INC.

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

CAUTION:

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



- (A) Intake camshaft
(B) Exhaust camshaft

Fig. 93: Identifying Intake And Exhaust Camshafts
Courtesy of SUBARU OF AMERICA, INC.

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

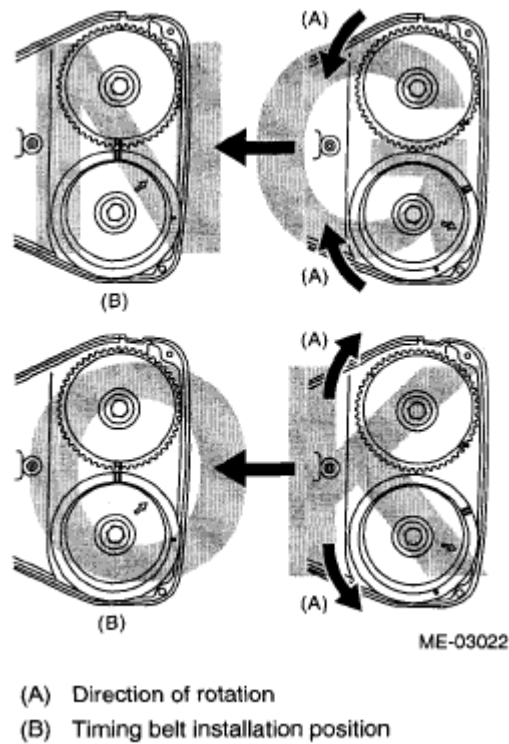


Fig. 94: Identifying Timing Belts Installation Position
Courtesy of SUBARU OF AMERICA, INC.

8. Installation of timing belt:

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

CAUTION:

- Disengagement of more than three timing belt teeth may result in interference between the valve and piston.
- Make sure that the direction of belt rotation is correct.

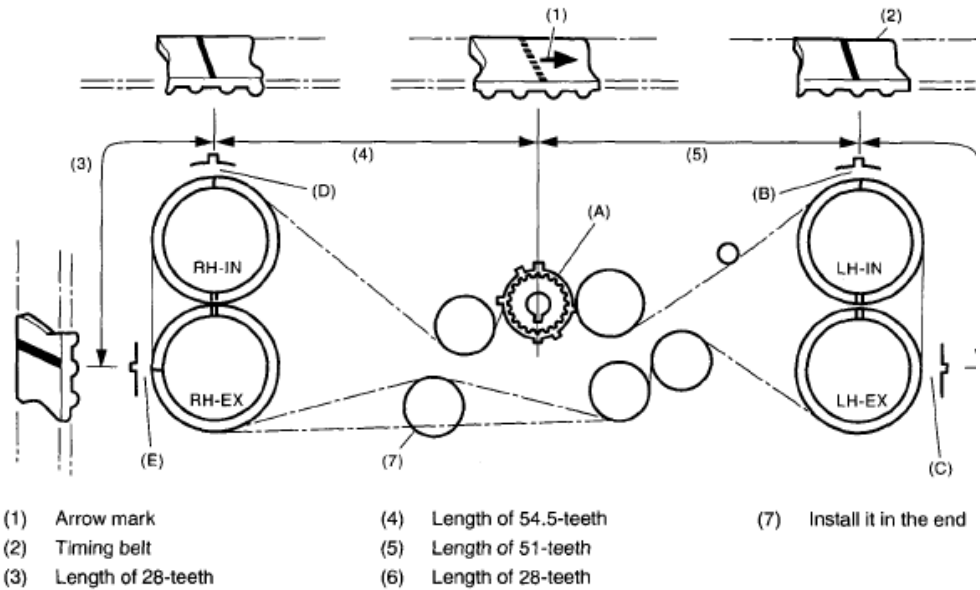


Fig. 95: Identifying Timing Mark Location
 Courtesy of SUBARU OF AMERICA, INC.

9. Install the belt idlers.

Tightening torque:

39 N.m (4.0 kgf-m, 28.9 ft-lb)

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

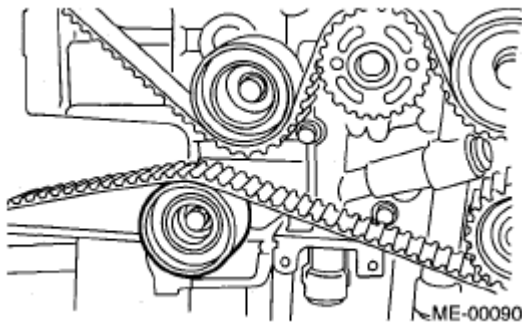


Fig. 96: Identifying Marks On Timing Belt And Sprockets
 Courtesy of SUBARU OF AMERICA, INC.

10. After ensuring that the marks on the timing belt and sprockets are aligned, remove the stopper pin from tensioner adjuster.
11. Install the timing belt guide. (MT model)

NOTE: • Clean the timing belt cover screw holes before installing bolts.

- Apply liquid gasket to the bolt threads. (Cam sprocket side only)

Liquid gasket***THREE BOND 1324 (Part No. 004403042) or the equivalent***

1. Temporarily tighten the bolts mounting the timing belt guide.
2. Check and adjust the clearance between timing belt and timing belt guide.

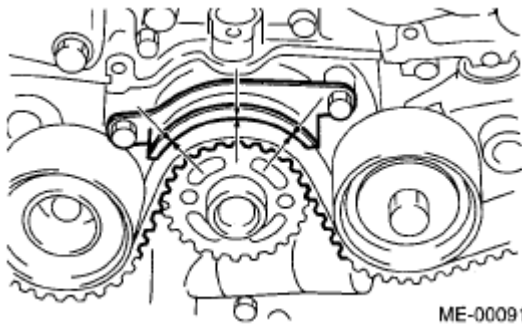
Clearance:***1.0±0.5 mm (0.039±0.020 in)***

Fig. 97: Identifying Clearance Between Timing Belt And Timing Belt Guide (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

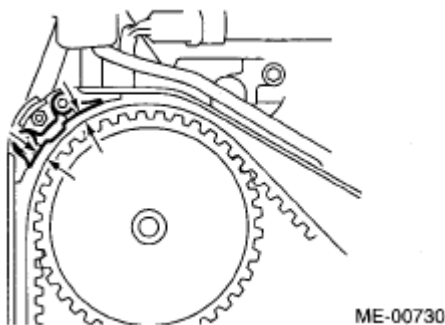


Fig. 98: Identifying Clearance Between Timing Belt And Timing Belt Guide (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

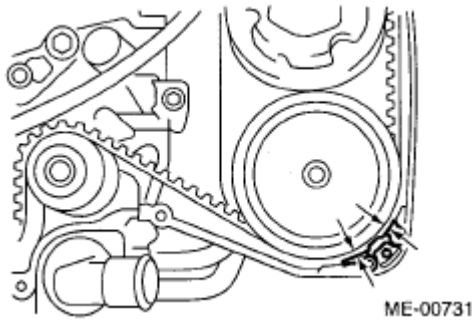


Fig. 99: Identifying Clearance Between Timing Belt And Timing Belt Guide (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

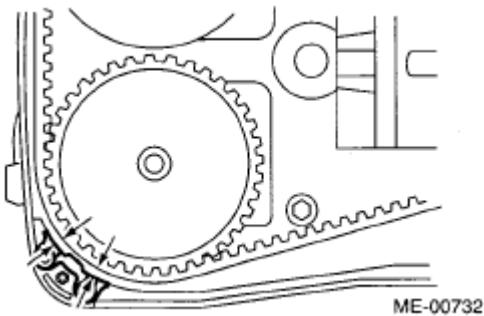


Fig. 100: Identifying Clearance Between Timing Belt And Timing Belt Guide (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

Tightening torque:

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

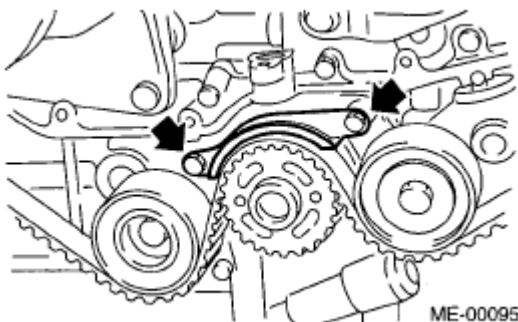


Fig. 101: Identifying Timing Belt Guide Mounting Bolts (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

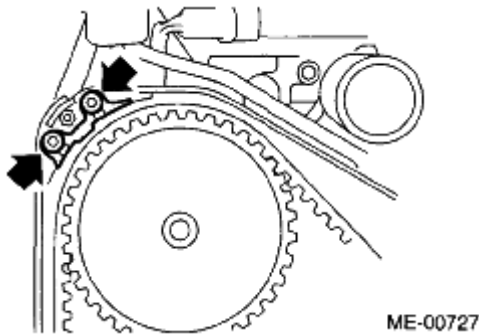


Fig. 102: Identifying Timing Belt Guide Mounting Bolts (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

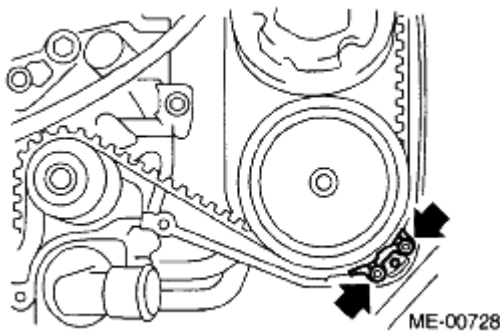


Fig. 103: Identifying Timing Belt Guide Mounting Bolts (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

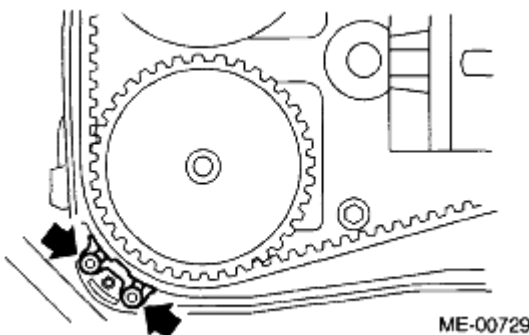


Fig. 104: Identifying Timing Belt Guide Mounting Bolts (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

12. Install the timing belt cover.

<Ref. to **INSTALLATION**, Timing Belt Cover . >

13. Install the crank pulley.

<Ref. to **INSTALLATION**, Crank Pulley . >

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

INSPECTION

TIMING BELT

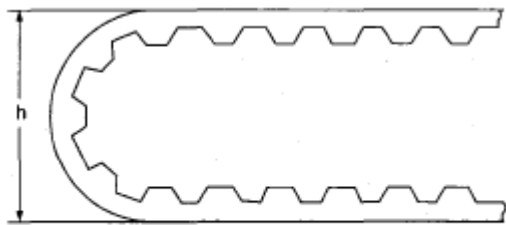
1. Check the timing belt teeth for breaks, cracks or wear. If any fault is found, replace the belt.
2. Check the condition of the backside of belt. If cracks are found, replace the belt.

CAUTION:

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

Bending diameter: h

60 mm (2.36 in) or more



ME-00099

Fig. 105: Identifying Timing Belt Bending Diameter
Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

1. Visually check the oil seals for leaks, and rod ends for uneven 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 294 N (30 kgf, 66 lb) is applied to it. This is to check the adjuster rod stiffness.

3. If the adjuster rod is not stiff and moves freely when applying 294 N (30 kgf, 66 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 extended all the way up, apply a pressure of 294 N (30 kgf, 66 lb) to it to inspect the stiffness of the adjuster rod.
 3. If the adjuster rod is not stiff and compresses, replace the automatic belt tension adjuster assembly with a new part.

CAUTION:

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

4. Measure the rod protrusion amount "H" from the body edge. If it is not within specifications, replace with new part.

Amount of rod protrusion: H

5.2 - 6.2 mm (0.204 - 0.244 in)

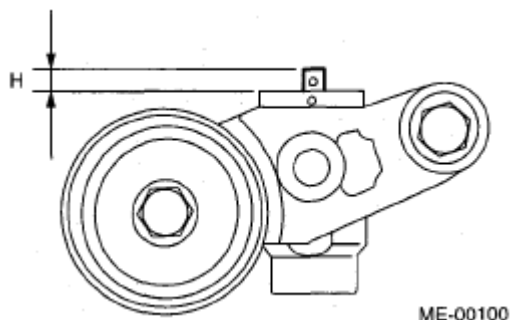


Fig. 106: Measuring Rod Protrusion Amount H From Body Edge
Courtesy of SUBARU OF AMERICA, INC.

BELT TENSION PULLEY

1. Check the mating surfaces of timing belt and contact point of adjuster rod for uneven wear or scratches. Replace the automatic belt tension adjuster assembly if faulty.

2. Check the belt tension pulley for smooth rotation. Replace if noise or excessive play occurs.
3. Check the belt tension pulley for grease leakage.

BELT IDLER

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

CAM SPROCKET**REMOVAL**

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt . >
2. Remove the crank pulley.

<Ref. to **REMOVAL**, Crank Pulley . >

3. Remove the timing belt cover.

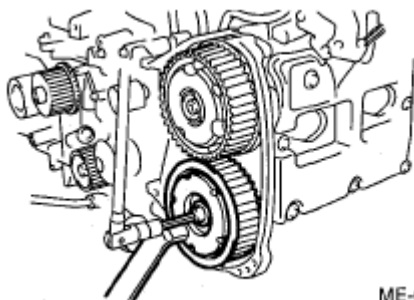
<Ref. to **REMOVAL**, Timing Belt Cover . >

4. Remove the timing belt.

<Ref. to **REMOVAL**, Timing Belt . >

5. Fasten the cam sprocket and remove from the cam shaft using ST.

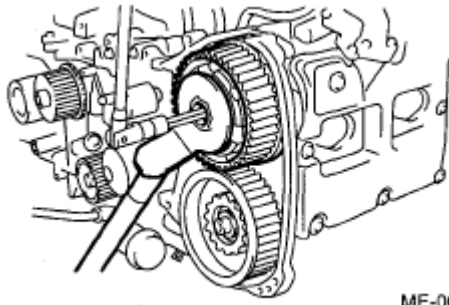
ST 499207400 CAM SPROCKET WRENCH



ME-00709

Fig. 107: Removing/Installing Cam Shaft
Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH



ME-00710

Fig. 108: Removing/Installing Cam Shaft
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

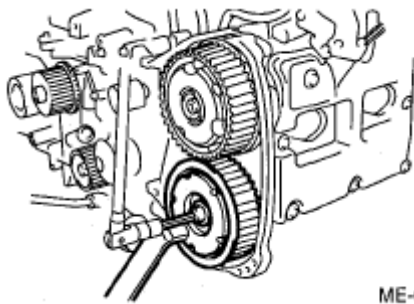
1. Fasten the cam sprocket and install to the cam shaft using ST.

NOTE: Do not confuse left and right side cam sprockets during installation.

ST 499207400 CAM SPROCKET WRENCH

Tightening torque:

Tighten to 30 N.m (3.0 kgf-m, 21.8 ft-lb), and then tighten further by 45°.



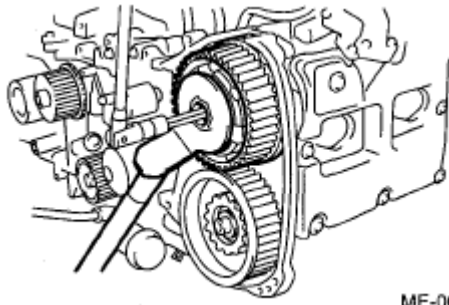
ME-00709

Fig. 109: Removing/Installing Cam Shaft
Courtesy of SUBARU OF AMERICA, INC.

499977500 CAM SPROCKET WRENCH

Tightening torque:

Tighten to 30 N.m (3.0 kgf-m, 21.8 ft-lb), and then tighten further by 45°.



ME-00710

Fig. 110: Identifying 499977500 CAM Sprocket Wrench
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing belt. <Ref. to **INSTALLATION**, Timing Belt . >
3. Install the timing belt cover.

<Ref. to **INSTALLATION**, Timing Belt Cover . >

4. Install the crank pulley.

<Ref. to **INSTALLATION**, Crank Pulley . >

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

INSPECTION

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

CRANK SPROCKET

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt . >
2. Remove the crank pulley.

<Ref. to **REMOVAL**, Crank Pulley . >

3. Remove the timing belt cover.

<Ref. to **REMOVAL**, Timing Belt Cover . >

4. Remove the timing belt.

<Ref. to **REMOVAL**, Timing Belt . >

5. Remove the crank sprocket.

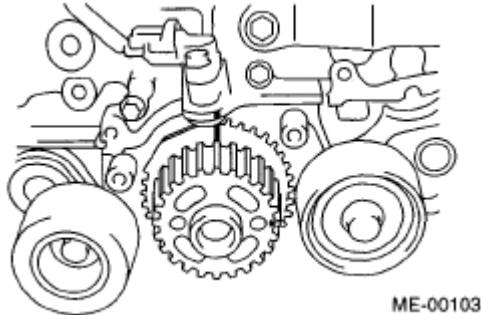


Fig. 111: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

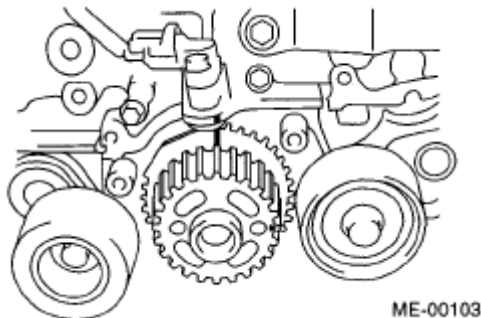


Fig. 112: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing belt.

<Ref. to **INSTALLATION**, Timing Belt . >

3. Install the timing belt cover.

<Ref. to **INSTALLATION**, Timing Belt Cover . >

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

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

INSPECTION

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

CAMSHAFT

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. Refer to "Valve Clearance" for preparation. <Ref. to INSPECTION, Valve Clearance . >

1. Remove the V-belts. <Ref. to REMOVAL, V-belt . >
2. Remove the crank pulley. <Ref. to REMOVAL, Crank Pulley . >
3. Remove the timing belt cover.

<Ref. to REMOVAL, Timing Belt Cover . >
4. Remove the timing belt. <Ref. to REMOVAL, Timing Belt . >
5. Remove the cam sprocket. <Ref. to REMOVAL, Cam Sprocket . >
6. Disconnect the oil flow control solenoid valve assembly connector.

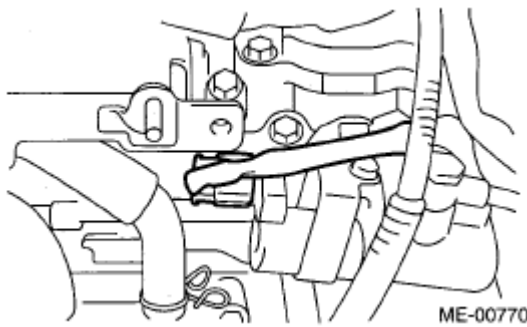


Fig. 113: Identifying Oil Flow Control Solenoid Valve Assembly Connector
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the tensioner bracket.

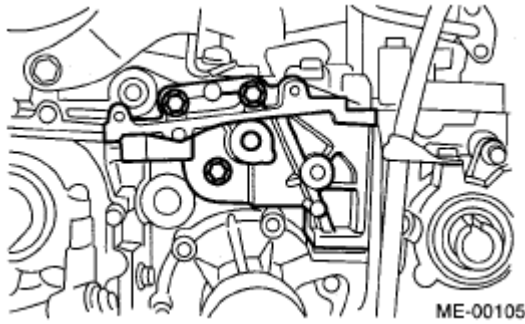


Fig. 114: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt cover No. 2 (LH).

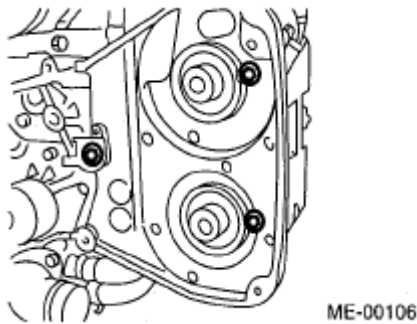


Fig. 115: Identifying Timing Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the timing belt cover No. 2 (RH).

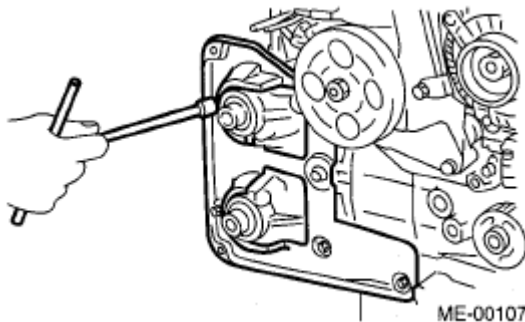
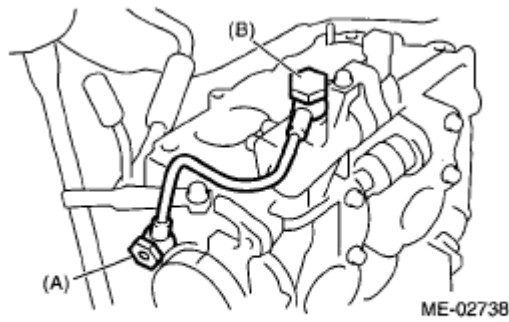


Fig. 116: Removing/Installing Timing Belt Cover No. 2 (RH)
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the oil level gauge guide. (LH side)
11. Remove the rocker cover and gasket.
12. Remove the oil pipe.



- (A) Union screw with filter (With protrusion)
 (B) Union screw without filter (Without protrusion)

Fig. 117: Identifying Union Screw With Filter
 Courtesy of SUBARU OF AMERICA, INC.

13. Loosen the oil flow control solenoid valve assembly and intake camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the figure.

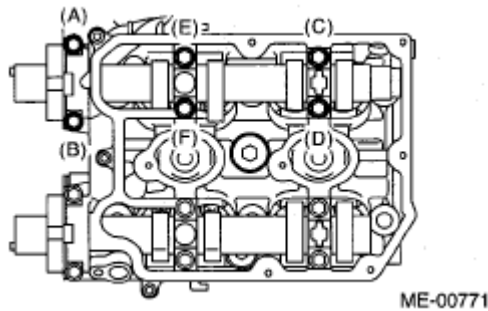


Fig. 118: Identifying Camshaft Cap Bolts Alphabetical Sequence
 Courtesy of SUBARU OF AMERICA, INC.

14. Loosen the exhaust camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the figure.

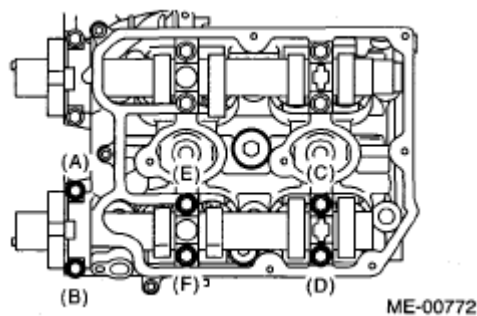


Fig. 119: Identifying Exhaust Camshaft Cap Bolts Alphabetical Sequence
 Courtesy of SUBARU OF AMERICA, INC.

15. Remove the oil flow control solenoid valve assembly, intake camshaft cap and camshaft.

16. Remove the exhaust camshaft caps and camshaft.

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

17. Similarly, remove the camshafts (RH) and related parts.

INSTALLATION

1. Camshaft installation:

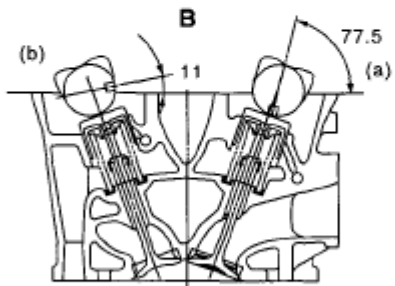
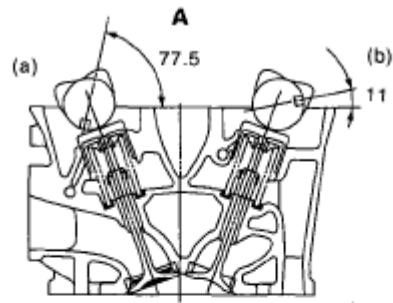
Apply engine oil to the cylinder head at camshaft bearing installation location before installing the camshaft. Install the camshaft so that each valve is close to or in contact with base circle of the cam.

NOTE:

- **Set the cam shaft to the position shown in the figure. It is necessary to rotate the cam shaft (LH) slightly when installing the timing belt.**
- **Camshaft RH must be rotated when set at the position shown in the figure.**

Intake camshaft LH: Rotate 80° clockwise.

Exhaust camshaft LH: Rotate 45° clockwise.



ME-00111

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

Fig. 120: Identifying Camshaft Position Angle
 Courtesy of SUBARU OF AMERICA, INC.

2. Camshaft cap and oil flow control solenoid valve assembly installation:
 1. Apply small amount of liquid gasket to the mating surface of cap.

NOTE: Do not apply liquid gasket excessively. Applying excessively may cause excess gasket to come out and flow toward oil seal, resulting in oil leak.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent

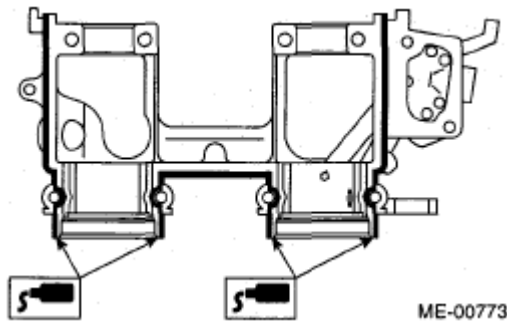


Fig. 121: Applying Liquid Gasket To Mating Surface Of Cap
Courtesy of SUBARU OF AMERICA, INC.

2. Apply a thin coat of engine oil to cap bearing surface, and install the cap to the camshaft.
3. Gradually tighten the camshaft cap and oil control valve assembly in at least two stages in alphabetical sequence shown in the figure, and then tighten to specified torque.

Tightening torque:

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

T2: 20 N.m (2.0 kgf-m, 14.5 ft-lb)

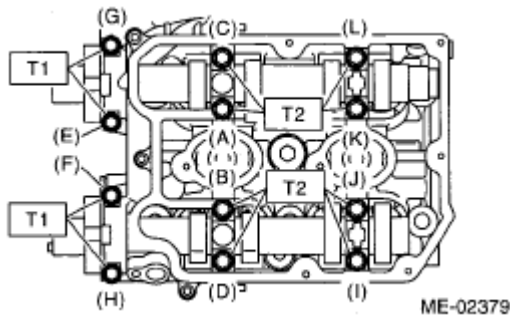


Fig. 122: Identifying Camshaft Cap And Oil Control Valve Assembly Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. After tightening the camshaft cap, ensure the camshaft rotates only slightly while holding it at base circle.
3. Apply a coat of engine oil to the oil seal periphery and oil seal lip, then install the oil seal on camshaft using ST1 and ST2.

NOTE: Use a new oil seal.

ST1 499587600 OIL SEAL INSTALLER

ST2 499597200 OIL SEAL GUIDE

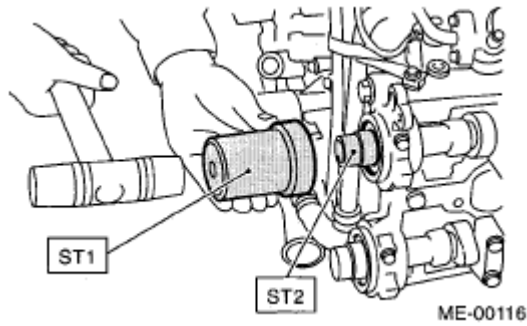


Fig. 123: Installing Oil Seal On Camshaft Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

4. Rocker cover installation:

1. Install the gasket on rocker cover. Install the peripheral gasket and ignition coil unit gasket.

NOTE: Use a new gasket.

2. Apply liquid gasket to the specified point of the cylinder head. Apply extra amount of liquid gasket around plugs 5 mm (0.2 in) or more.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent

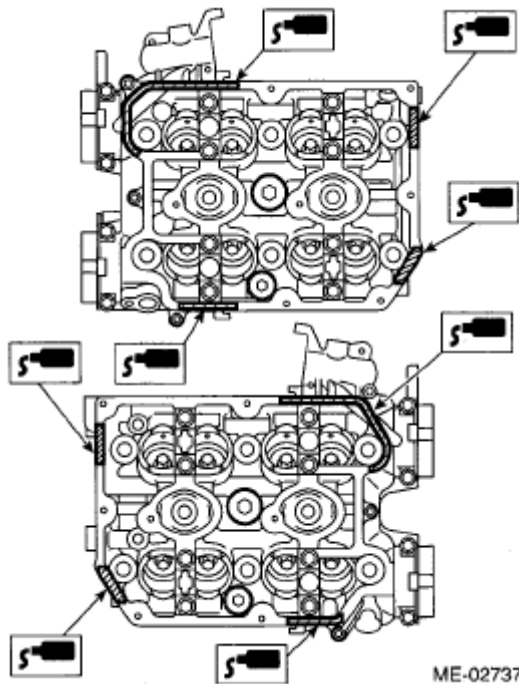


Fig. 124: Applying Liquid Gasket To Cylinder Head Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

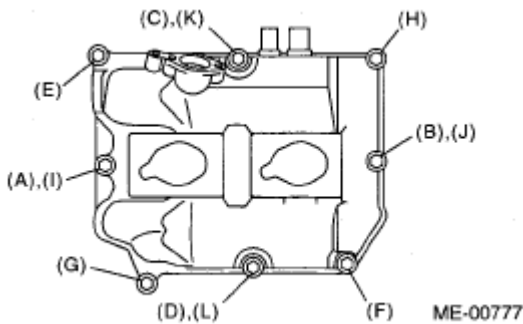


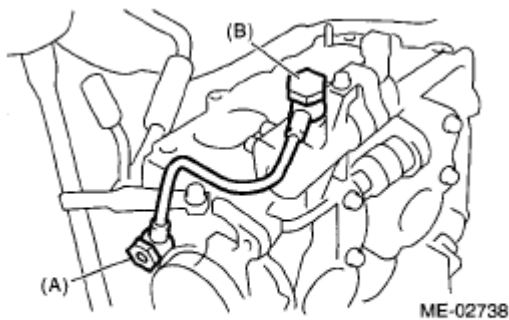
Fig. 125: Identifying Rocker Cover Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

5. Install the oil pipe.

NOTE: Make sure not to mix up the union screws with filter and without filter as their installation positions are different.

Tightening torque:

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



- (A) Union screw with filter (With protrusion)
(B) Union screw without filter (Without protrusion)

Fig. 126: Identifying Union Screws With Filter
Courtesy of SUBARU OF AMERICA, INC.

6. Connect the oil flow control solenoid valve connector.

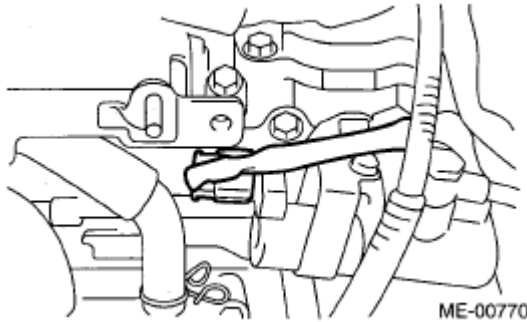


Fig. 127: Identifying Oil Flow Control Solenoid Valve Connector
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

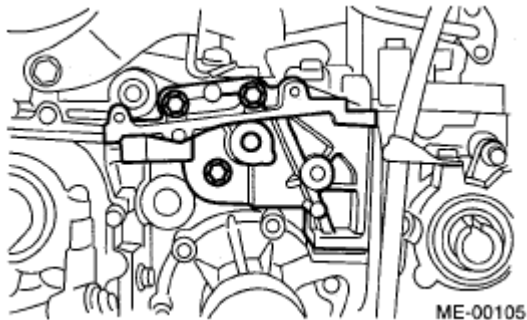


Fig. 128: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

9. Install the timing belt cover No. 2 (RH).

Tightening torque:

5 N.m (0.5 kgf-m, 3.6 ft-lb)

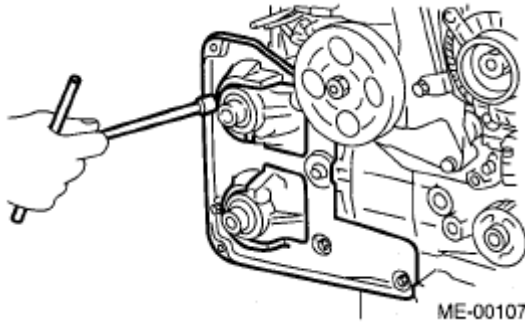


Fig. 129: Removing/Installing Timing Belt Cover No. 2 (RH)
Courtesy of SUBARU OF AMERICA, INC.

10. Install the timing belt cover No. 2 (LH).

Tightening torque:

5 N.m (0.5 kgf-m, 3.6 ft-lb)

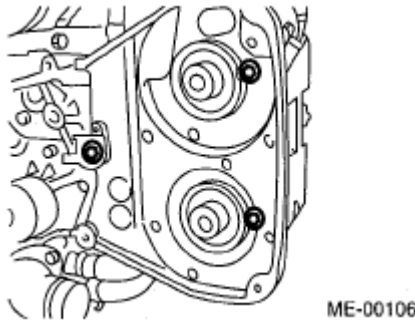


Fig. 130: Identifying Timing Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

11. Install the cam sprocket.

<Ref. to **INSTALLATION**, Cam Sprocket . >

12. Install the timing belt. <Ref. to **INSTALLATION**, Timing Belt . >

13. Install the timing belt cover.

<Ref. to **INSTALLATION**, Timing Belt Cover . >

14. Install the crank pulley.

<Ref. to **INSTALLATION**, Crank Pulley . >

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

INSPECTION

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

Service limit:

0.020 mm (0.0008 in)

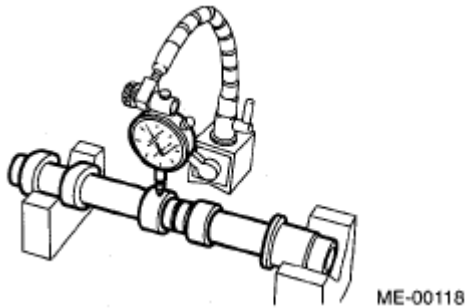


Fig. 131: Measuring Bend Of Camshaft
Courtesy of SUBARU OF AMERICA, INC.

2. Check the journal for damage and wear. Replace if faulty.
3. Check the cutout portion used for camshaft sensor for damage. Replace if faulty.
4. Measure the outside diameter of camshaft journal. If the journal diameter is not within the standard, check the oil clearance.

CAMSHAFT JOURNAL SPECIFICATION

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

5. Measurement of the camshaft journal oil clearance:
 1. Clean the bearing caps and camshaft journals.
 2. Place the camshafts on cylinder head. (Without installing the valve lifter.)
 3. Place a plastigage across each camshaft journals.
 4. Gradually tighten the cap in at least two stages in alphabetical sequence shown in the figure, and then tighten to specified torque. Do not turn the camshaft.

Tightening torque:

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

T2: 20 N.m (2.0 kgf-m, 14.5 ft-lb)

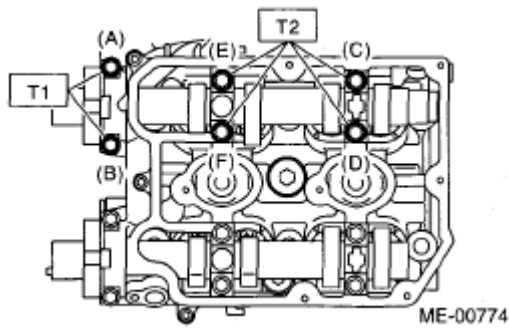


Fig. 132: Identifying Camshaft Cap Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Standard:

0.037 - 0.072 mm (0.0015 - 0.0028 in)

Service limit:

0.10 mm (0.0039 in)

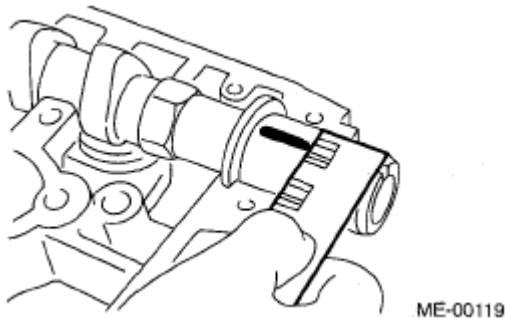


Fig. 133: Measuring Widest Point Of Plastigage On Journal
Courtesy of SUBARU OF AMERICA, INC.

7. Completely remove the plastigage.
6. Check the cam face condition; remove the minor faults by grinding with oil stone. Measure the cam height H. Replace if it exceeds the limit.

Cam height H:

Standard:

Intake

46.55 - 46.65 mm (1.833 - 1.837 in)

Exhaust

46.75 - 46.85 mm (1.841 - 1.844 in)

Service limit:

Intake

46.45 mm (1.829 in)

Exhaust

46.65 mm (1.837 in)

Cam base circle diameter A:

37.0 mm (1.457 in)

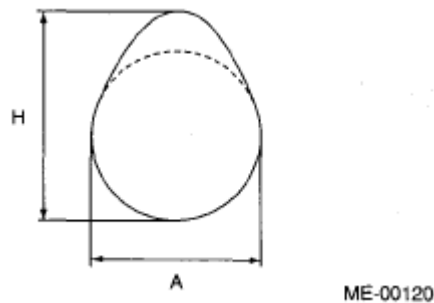


Fig. 134: Measuring Cam Height H
Courtesy of SUBARU OF AMERICA, INC.

7. Measure the thrust clearance of camshaft with setting the dial gauge at end of camshaft. If the thrust clearance exceeds the limit, replace the caps and cylinder head as a set. If necessary replace the camshaft.

Standard:

0.068 - 0.116 mm (0.0027 - 0.0046 in)

Service limit:

0.14 mm (0.0055 in)

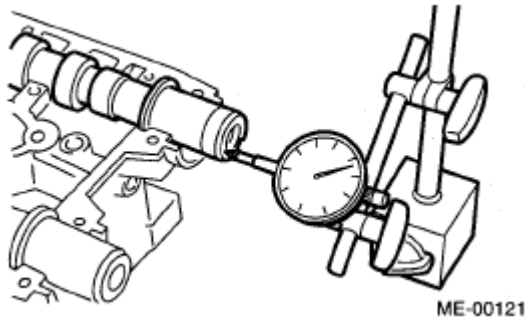


Fig. 135: Measuring Thrust Clearance Of Camshaft
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD

REMOVAL

NOTE: Perform the work with the engine installed to body when replacing a single part. Refer to "Valve Clearance" for preparation. <Ref. to INSPECTION, Valve Clearance . >

1. Remove the V-belts. <Ref. to REMOVAL, V-belt . >
2. Remove the crank pulley.

<Ref. to REMOVAL, Crank Pulley . >

3. Remove the timing belt cover.

<Ref. to REMOVAL, Timing Belt Cover . >

4. Remove the timing belt.

<Ref. to REMOVAL, Timing Belt . >

5. Remove the cam sprocket.

<Ref. to REMOVAL, Cam Sprocket . >

6. Remove the intake manifold.

<Ref. to REMOVAL , Intake Manifold. >

7. Remove the bolt which installs the A/C compressor bracket on cylinder head.
8. Remove the camshaft. <Ref. to REMOVAL, Camshaft . >
9. Remove the cylinder head bolts in alphabetical sequence shown in the figure.

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

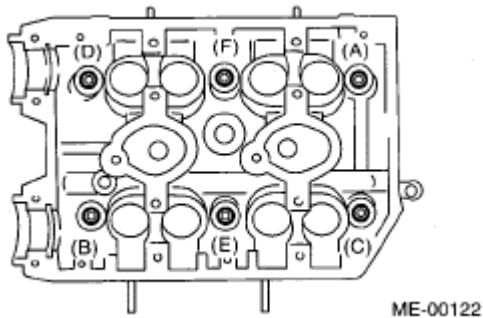


Fig. 136: Identifying Cylinder Head Bolts In Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

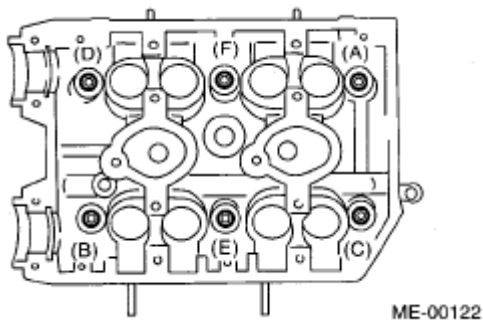


Fig. 137: Identifying Cylinder Head Bolts In Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the cylinder head gasket.

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

12. Similarly, remove the cylinder head (RH).

INSTALLATION

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

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

NOTE: Use new cylinder head gaskets.

2. Tighten the cylinder head bolts.
 1. Apply a thin coat of engine oil to washer and bolt thread.
 2. Tighten all bolts to 29 N.m (3.0 kgf-m, 22 ft-lb) in alphabetical sequence.
 3. Tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.
 4. Loosen all the bolts by 180° in the reverse order of tightening, and loosen again by 180°.
 5. Tighten all bolts to 49 N.m (5.0 kgf-m, 36 ft-lb) in alphabetical sequence.
 6. Tighten all bolts by 80 to 90° in alphabetical sequence.
 7. Tighten all bolts by 40 to 45° in alphabetical sequence.

CAUTION: Do not tighten the bolts more than 45°.

8. Further tighten the bolts (A) and (B) by 40 to 45°.

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

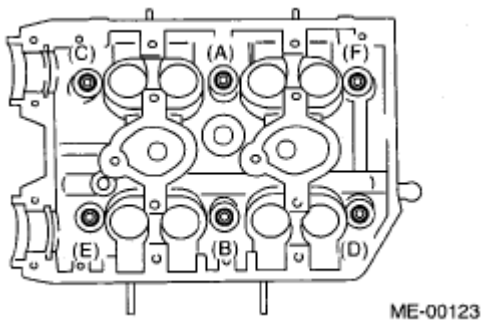


Fig. 138: Identifying Cylinder Head Bolts Alphabetical Sequence
 Courtesy of SUBARU OF AMERICA, INC.

3. Install the camshaft. <Ref. to INSTALLATION, Camshaft . >
4. Install the A/C compressor bracket on cylinder head.
5. Install the intake manifold.

<Ref. to INSTALLATION , Intake Manifold. >

6. Install the cam sprocket.

<Ref. to INSTALLATION, Cam Sprocket . >

7. Install the timing belt.

<Ref. to INSTALLATION, Timing Belt . >

8. Install the timing belt cover.

<Ref. to **INSTALLATION**, Timing Belt Cover . >

9. Install the crank pulley.

<Ref. to **INSTALLATION**, Crank Pulley . >

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

DISASSEMBLY

1. Remove the valve lifter.
2. Compress the valve spring and remove the valve spring retainer key. Remove each valve and valve spring.

ST1 498267600 CYLINDER HEAD TABLE

ST2 499718000 VALVE SPRING REMOVER

NOTE:

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

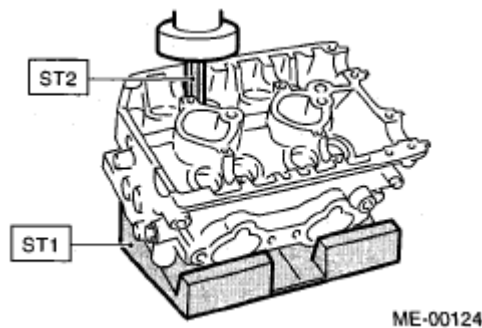
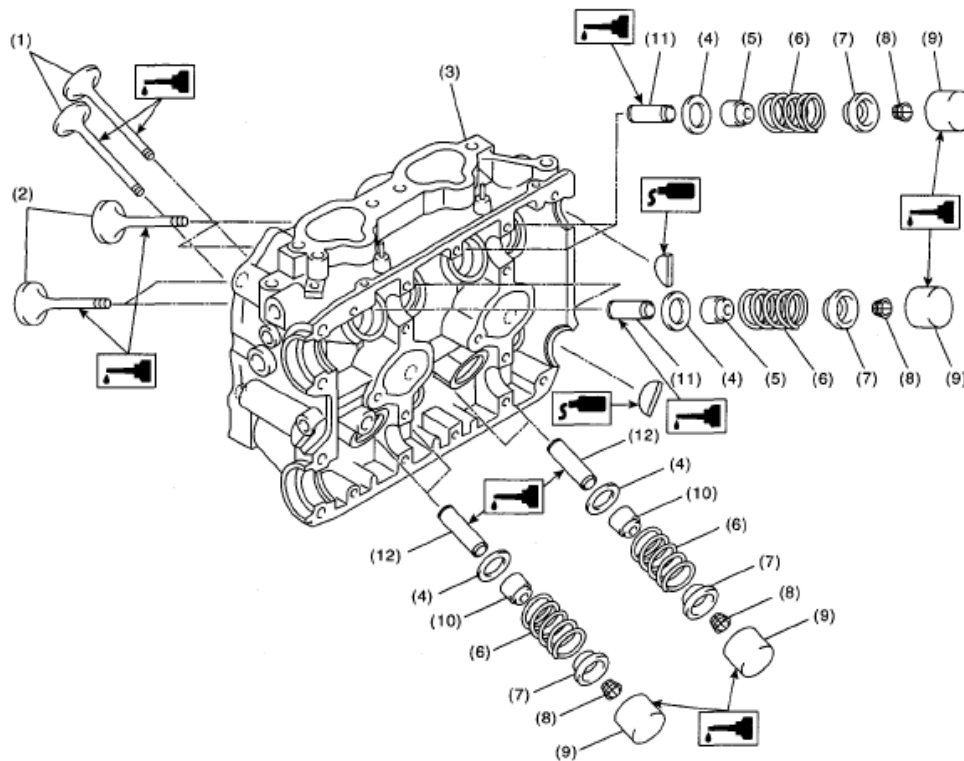


Fig. 139: Identifying Valve And Valve Spring Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



ME-02583

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

Fig. 140: Identifying Cylinder Head Assembly Components Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

1. Installation of valve spring and valve:

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

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

2. Set the cylinder head on ST1.
3. Install the valve spring and retainer using ST2.

ST1 498267600 CYLINDER HEAD TABLE

ST2 499718000 VALVE SPRING REMOVER

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

seat on cylinder head.

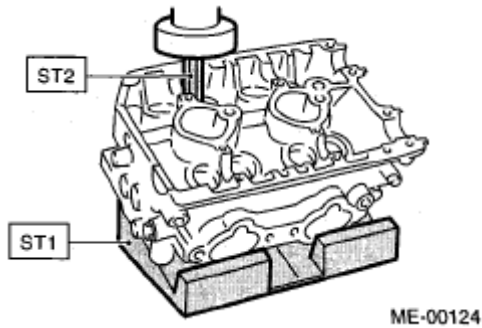


Fig. 141: Identifying Valve Spring And Valve Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

4. Compress the valve spring and install the retainer key.
5. After installing, tap the valve spring retainers lightly with a wooden hammer for better seating.
2. Apply oil to the surfaces of the valve lifter.
3. Install the valve lifter.

INSPECTION

CYLINDER HEAD

1. Visually check for cracks and damage. Use liquid penetrant tester on the important sections to check for fissures.
2. Measure the warping of the cylinder head surface that mates with crankcase using a straight edge (A) and thickness gauge (B).

If the warping exceeds 0.035 mm (0.0014 in), re-grind the surface with a surface grinder.

Warping limit:

0.035 mm (0.0014 in)

Grinding limit:

0.3 mm (0.012 in)

Standard height of cylinder head:

127.5 mm (5.02 in)

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

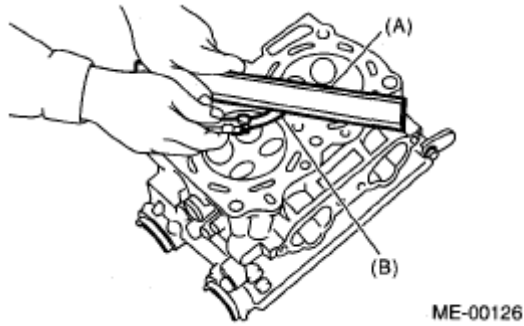


Fig. 142: Measuring Cylinder Head Surface
 Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Valve seat width: W

Intake

Standard:

0.6 - 1.4 mm (0.024 - 0.055 in)

Service limit:

1.7 mm (0.067 in)

Exhaust

Standard:

1.2 - 1.8 mm (0.047 - 0.071 in)

Service limit:

2.2 mm (0.087 in)

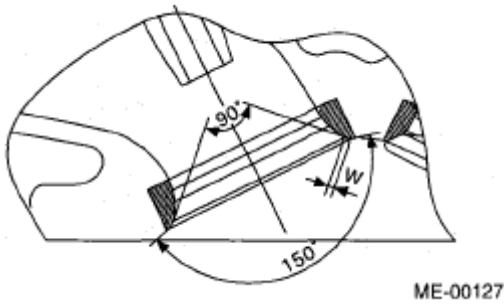


Fig. 143: Identifying Valve Seat Angle Position
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

Clearance between the valve guide and valve stem:

Standard:

Intake

0.030 - 0.057 mm (0.0012 - 0.0022 in)

Exhaust

0.040 - 0.067 mm (0.0016 - 0.0026 in)

Service limit:

0.15 mm (0.0059 in)

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

Valve guide inner diameter:

6.000 - 6.012 mm (0.2362 - 0.2367 in)

Valve stem outer diameters:

Intake

5.955 - 5.970 mm (0.2344 - 0.2350 in)

Exhaust**5.945 - 5.960 mm (0.2341 - 0.2346 in)**

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

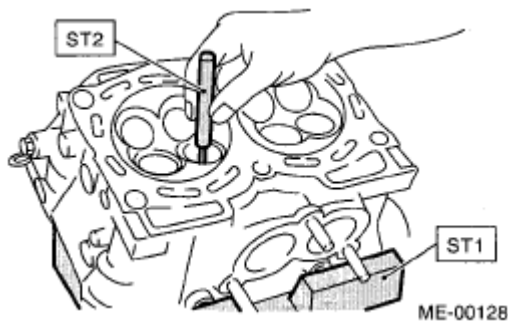
ST1 498267600 CYLINDER HEAD TABLE**ST2 499767200 VALVE GUIDE REMOVER**

Fig. 144: Inserting ST2 Into Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

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

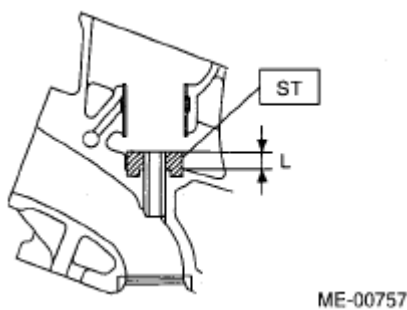
ST 18251AA020 VALVE GUIDE ADJUSTER

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

4. Before installing a new valve guide, make sure that neither scratches nor damages exist on the inner surface of valve guide holes in cylinder head.
5. Put a new valve guide, coated with sufficient oil, in the cylinder head, and insert the ST1 into valve guide. Press in until the valve guide upper end is flush with the upper surface of ST2.

ST1 499767200 VALVE GUIDE REMOVER

ST2 18251AA020 VALVE GUIDE ADJUSTER

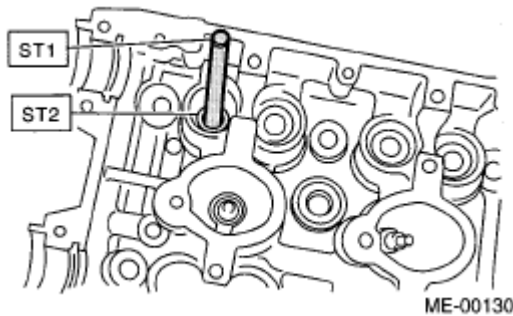


Fig. 146: Identifying ST1 Into Valve Guide
 Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion.

Valve guide protrusion: L

15.8 - 16.2 mm (0.622 - 0.638 in)

7. Insert the ST in valve guide, and rotate the ST slowly clockwise while pushing it lightly. Bring the ST back while rotating it clockwise. (Reaming Work)
8. After reaming, clean the valve guide to remove chips.

ST 499767400 VALVE GUIDE REAMER

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.

9. Recheck the contact condition between valve face and valve seat after replacing the valve guide.

INTAKE AND EXHAUST VALVE

1. Inspect the flange and stem of valve, and replace if damaged, worn, or deformed. If "H" is less than the specified limit, replace with a new valve.

H:

Intake (A)

Standard:

1.0 - 1.4 mm (0.039 - 0.055 in)

Service limit:

0.8 mm (0.031 in)

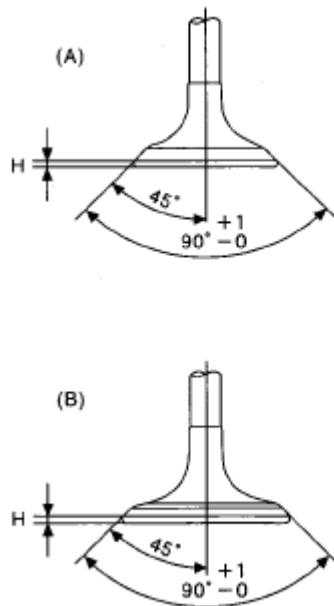
Exhaust (B)

Standard:

1.3 - 1.7 mm (0.051 - 0.067 in)

Service limit:

0.8 mm (0.031 in)



ME-00758

Fig. 147: Identifying Valve Seat Margin

Courtesy of SUBARU OF AMERICA, INC.

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

104.4 mm (4.110 in)

Exhaust (B)

104.65 mm (4.120 in)

VALVE SPRING

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

VALVE SPRING SPECIFICATION

		Valve spring
Free length		47.32 mm (1.863 in)
Tension/spring height	Set	205 - 235 N (20.9 - 24.0 kgf, 46.1 - 52.8 lb) /36.0 mm (1.417 in)
	Lift	426 - 490 N (43.4 - 50.0 kgf, 95.8 - 110 lb) /26.50 mm (1.041 in)
Squareness		2.5°, 2.1 mm (0.083 in) or less

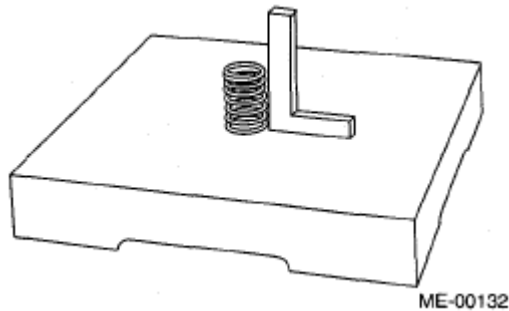


Fig. 148: Measuring Squareness Of Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

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.

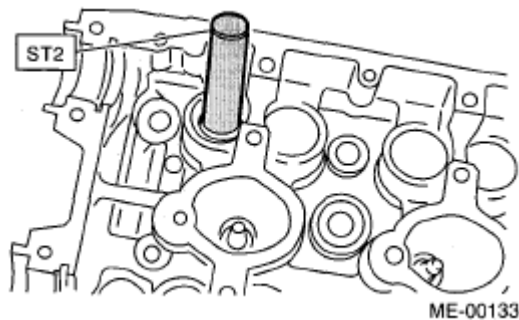
- When the lip is damaged.
 - When the spring is out of the specified position.
 - When readjusting the surfaces of intake valve and valve sheet.
 - When replacing the intake valve guide.
2. Place the cylinder head on ST1.
 3. Using the ST2, press-fit the oil seal.

ST1 498267600 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

NOTE:

- Apply engine oil to oil seal before press-fitting.
- When press-fitting the oil seal, do not use a hammer or strike in.
- The intake valve oil seal and exhaust valve oil seal can be differentiated by colors.

*Color of rubber part:**Intake [Gray]**Exhaust [Green]***Fig. 149: Installing Oil Seal**

Courtesy of SUBARU OF AMERICA, INC.

VALVE LIFTER

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

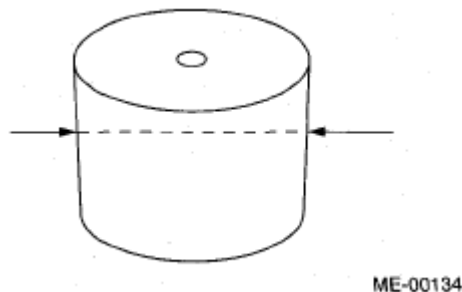
*Outer diameter:***34.959 - 34.975 mm (1.3763 - 1.3770 in)**

Fig. 150: Measuring Outer Diameter Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

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

Inner diameter:

34.994 - 35.016 mm (1.3777 - 1.3786 in)

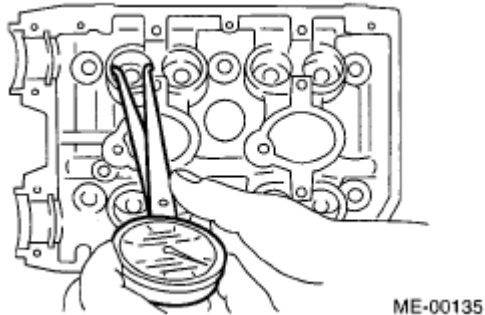


Fig. 151: Measuring Inner Diameter Of Valve Lifter Mating Surface On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

NOTE: If difference between outer diameter of valve lifter and inner diameter of valve lifter mating part is over the limit, replace the cylinder head.

Standard:

0.019 - 0.057 mm (0.0007 - 0.0022 in)

Service limit:

0.100 mm (0.0039 in)

CYLINDER BLOCK

REMOVAL

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

1. Remove the intake manifold.
<Ref. to **REMOVAL** , Intake Manifold. >
2. Remove the V-belts. <Ref. to **REMOVAL**, V-belt . >
3. Remove the crank pulley.

<Ref. to **REMOVAL**, Crank Pulley . >

4. Remove the timing belt cover.

<Ref. to **REMOVAL**, Timing Belt Cover . >

5. Remove the timing belt.

<Ref. to **REMOVAL**, Timing Belt . >

6. Remove the cam sprocket.

<Ref. to **REMOVAL**, Cam Sprocket . >

7. Remove the crank sprocket.

<Ref. to **REMOVAL**, Crank Sprocket . >

8. Remove the generator and A/C compressor with their brackets.

9. Remove the cylinder head.

<Ref. to **REMOVAL**, Cylinder Head . >

10. Remove the clutch disc and cover. <Ref. to **REMOVAL** , Clutch Disc and Cover. >

11. Remove the flywheel. (MT model) <Ref. to **REMOVAL** , Flywheel. >

ST 498497100 CRANKSHAFT STOPPER

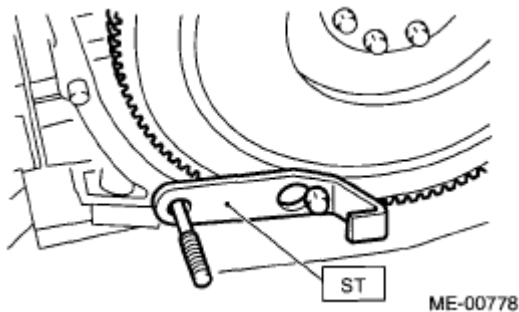


Fig. 152: Identifying Crankshaft Stopper
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the drive plate. (AT model)

Lock the crankshaft using ST.

ST 498497100 CRANKSHAFT STOPPER

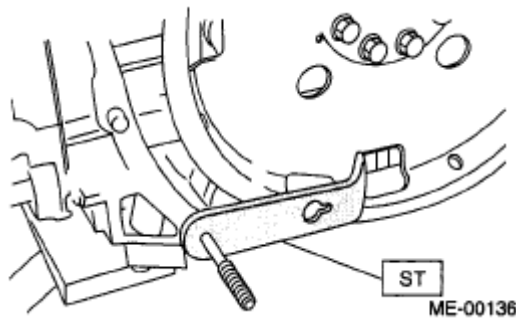
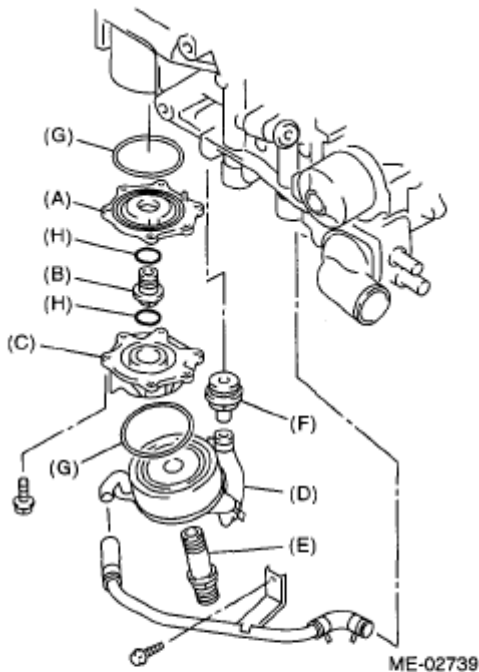


Fig. 153: Locking Crankshaft Using ST
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the oil separator cover.
14. Remove the water bypass pipe for heater.
15. Remove the oil filter. <Ref. to **REMOVAL**, Engine Oil Filter. >
16. Remove the oil cooler.



- (A) Adapter (1)
- (B) Adapter connector
- (C) Adapter (2)
- (D) Oil cooler
- (E) Oil cooler connector
- (F) Plug
- (G) Gasket
- (H) O-ring

Fig. 154: Identifying Adapter, Adapter Connector And Oil Cooler

Courtesy of SUBARU OF AMERICA, INC.

17. Remove the water pump.
18. Remove the oil pump from cylinder block.

NOTE:

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

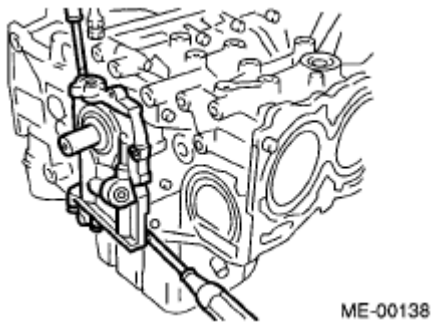
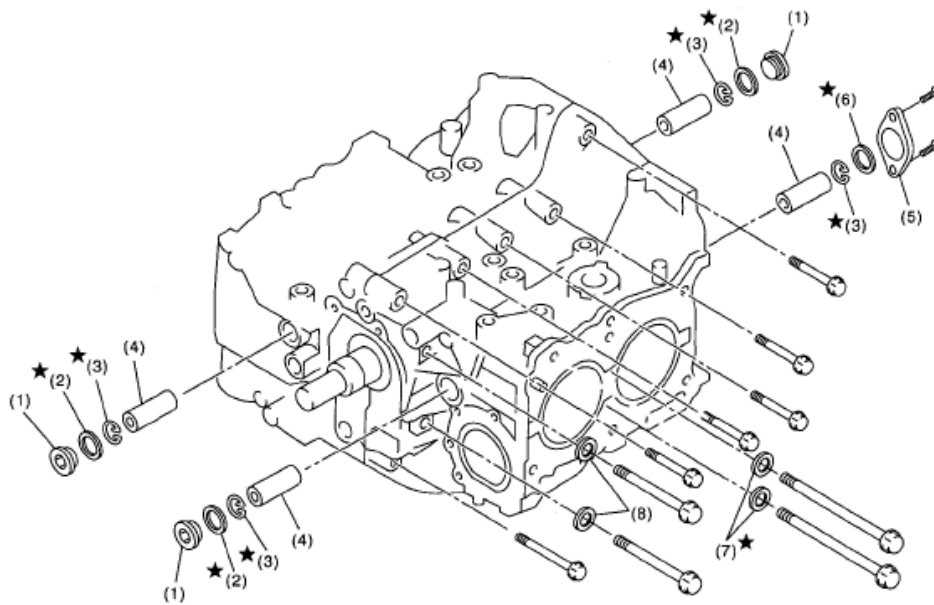


Fig. 155: Removing Oil Pump From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

19. Removal of oil pan:
 1. Turn the cylinder block with #2 and #4 piston sides facing upward.
 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 tool in place of oil pan cutter.

20. Remove the oil strainer stay.
21. Remove the oil strainer.
22. Remove the baffle plate.
23. Remove the water pipe.



- | | | |
|-----------------------|------------------------|-----------------|
| (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. 156: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

24. Remove the service hole cover and service hole plugs using a hexagon wrench [14 mm].

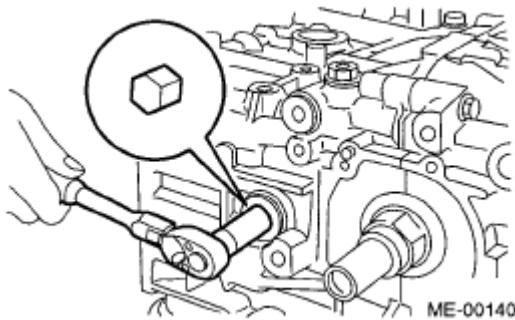


Fig. 157: Removing Service Hole Cover And Service Hole Plugs
Courtesy of SUBARU OF AMERICA, INC.

25. Rotate the crankshaft to bring #1 and #2 pistons to bottom dead center position, then remove the piston snap ring by inserted the radio pincers into the service hole of #1 and #2 cylinders.

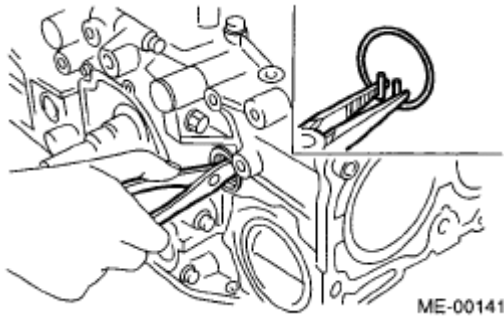


Fig. 158: Removing Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499097700 PISTON PIN REMOVER

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

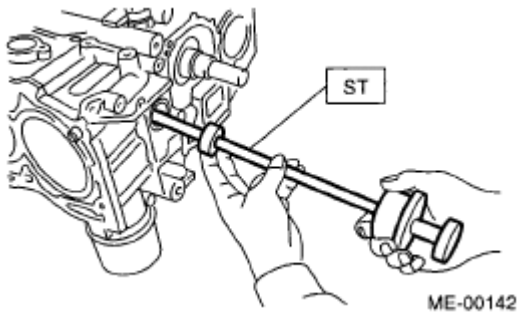
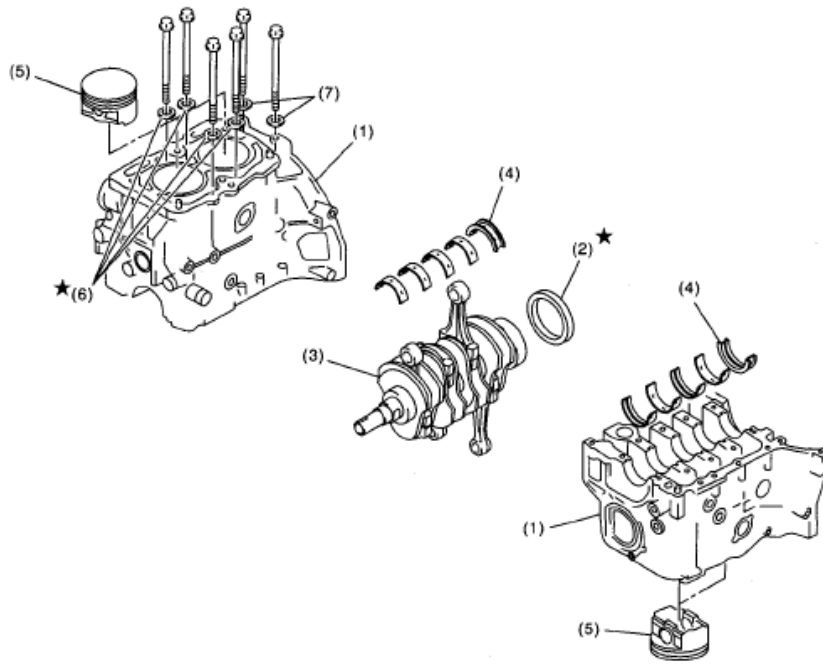


Fig. 159: Removing Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

27. Similarly remove the piston pins from #3 and #4 pistons.
28. Remove the bolts which connect cylinder block on the side of #1 and #3 cylinders.
29. Loosen the bolts which connect cylinder block on the side of #2 and #4 cylinders two or three turns.
30. Set up the cylinder block so that #2 and #4 cylinders are on the upper side, then remove bolts connecting the cylinder block.
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.



ME-02890

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

Fig. 160: Identifying Cylinder Block Components
 Courtesy of SUBARU OF AMERICA, INC.

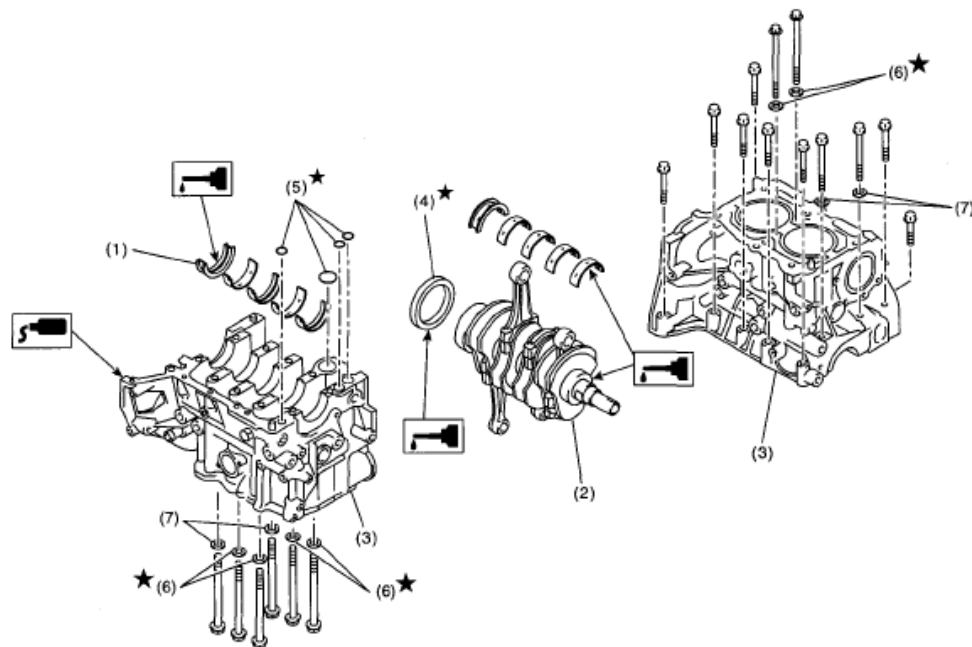
32. Remove the rear oil seal.
33. Remove the crankshaft together with connecting rod.
34. Remove the crankshaft bearings from cylinder block using a hammer handle.

NOTE: Do not confuse the combination of crankshaft bearings. Press the bearing at the end opposite to locking lip.

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

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

INSTALLATION



ME-03021

Fig. 161: Identifying Lubricating Applying Area
 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 the O-ring on the #1 and #3 cylinder block.
3. Apply liquid gasket to the mating surface of #1 and #3 cylinder blocks, and position #2 and #4 cylinder blocks.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent

NOTE: Do not allow liquid gasket to jut into O-ring grooves, oil passages, bearing grooves, etc.

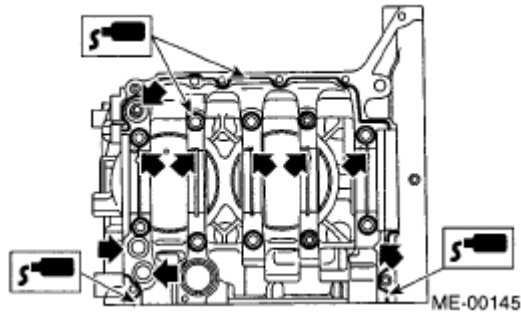


Fig. 162: Applying Liquid Gasket To Mating Surface Of Cylinder Blocks
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use 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, 7.2 ft-lb)

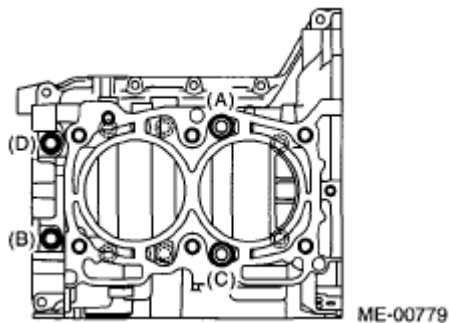


Fig. 163: Identifying Cylinder Block Connecting Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

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, 7.2 ft-lb)

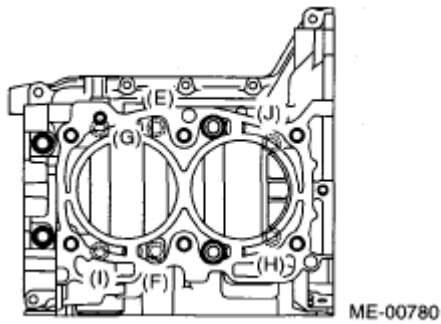


Fig. 164: Identifying Cylinder Block Connecting Bolts Alphabetical Sequence
 Courtesy of SUBARU OF AMERICA, INC.

7. Further tighten the cylinder block connecting bolts on the LH side (A - D) in alphabetical sequence.

Tightening torque:

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

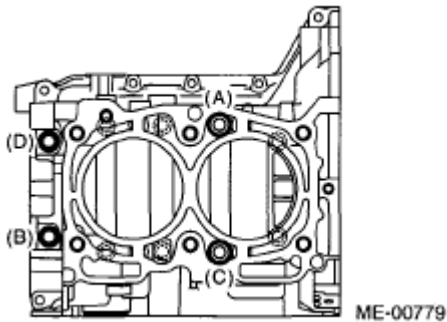


Fig. 165: Identifying Cylinder Block Connecting Bolts Alphabetical Sequence
 Courtesy of SUBARU OF AMERICA, INC.

8. Further tighten the cylinder block connecting bolts on the RH side (E - J) in alphabetical sequence.

Tightening torque:

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

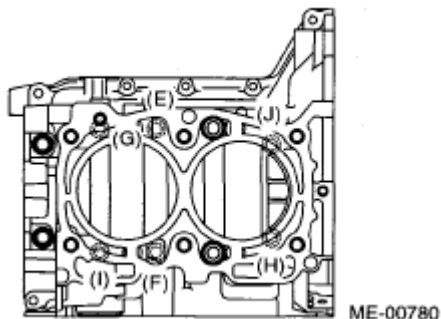


Fig. 166: Identifying Cylinder Block Connecting Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

9. Further tighten the cylinder block connecting bolts on the LH side (A - D) in alphabetical sequence.

- (A), (C): Angle tightening

Tightening angle: 90°

- (B), (D): Torque tightening

Tightening torque:

40 N.m (4.1 kgf-m, 29.6 ft-lb)

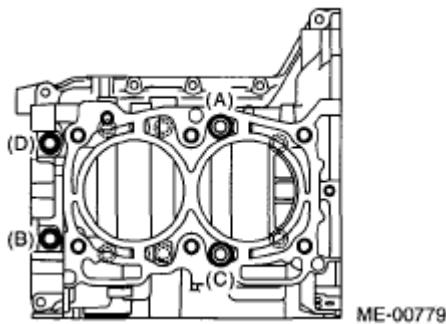


Fig. 167: Identifying Cylinder Block Connecting Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle:

90°

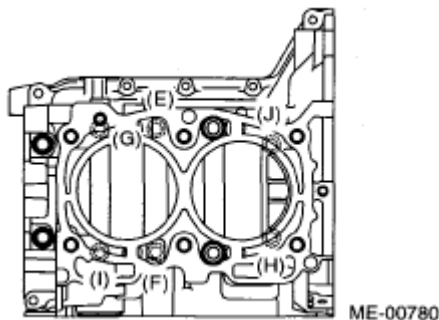


Fig. 168: Identifying Cylinder Block Connecting Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

(A) - (G): 25 N.m (2.5 kgf-m, 18.1 ft-lb)

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

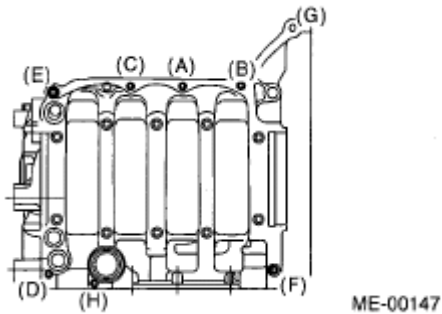


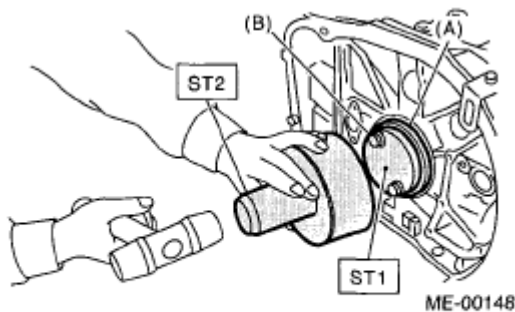
Fig. 169: Identifying Cylinder Block Connecting Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

12. Apply a coat of engine oil to the oil seal periphery, then 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. 170: Installing Rear Oil Seal
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.

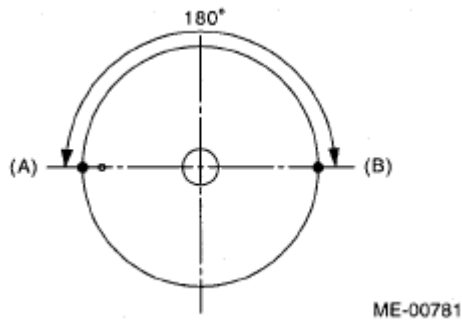


Fig. 171: Identifying Second Ring Gap Position
 Courtesy of SUBARU OF AMERICA, INC.

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

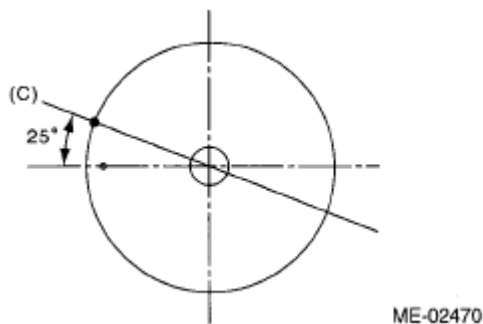


Fig. 172: Positioning Upper Rail Gap
 Courtesy of SUBARU OF AMERICA, INC.

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

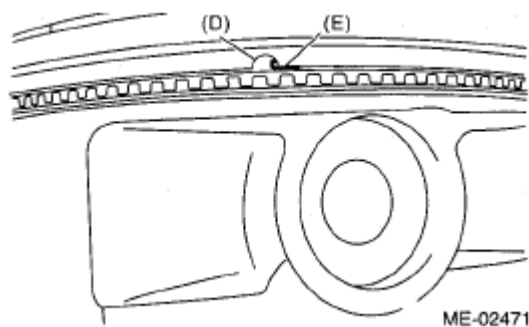


Fig. 173: Identifying Upper Rail Spin Stopper To Side Hole
 Courtesy of SUBARU OF AMERICA, INC.

17. Position the expander gap at (F) in the figure.

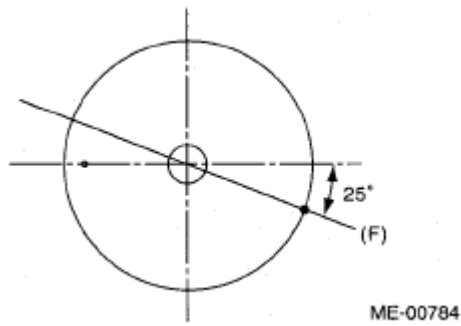


Fig. 174: Positioning Expander Gap
Courtesy of SUBARU OF AMERICA, INC.

18. Position the lower rail gap at (G) in the figure.

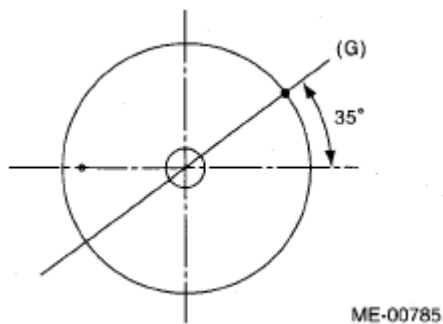


Fig. 175: Positioning Lower Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

NOTE:

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

19. Install the snap ring.

Install the snap rings in the piston holes located opposite to the service holes in cylinder block before positioning pistons to the cylinder.

NOTE:

Use new snap rings.

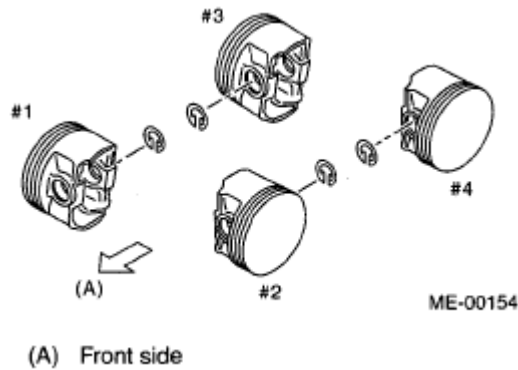


Fig. 176: Identifying Snap Rings
Courtesy of SUBARU OF AMERICA, INC.

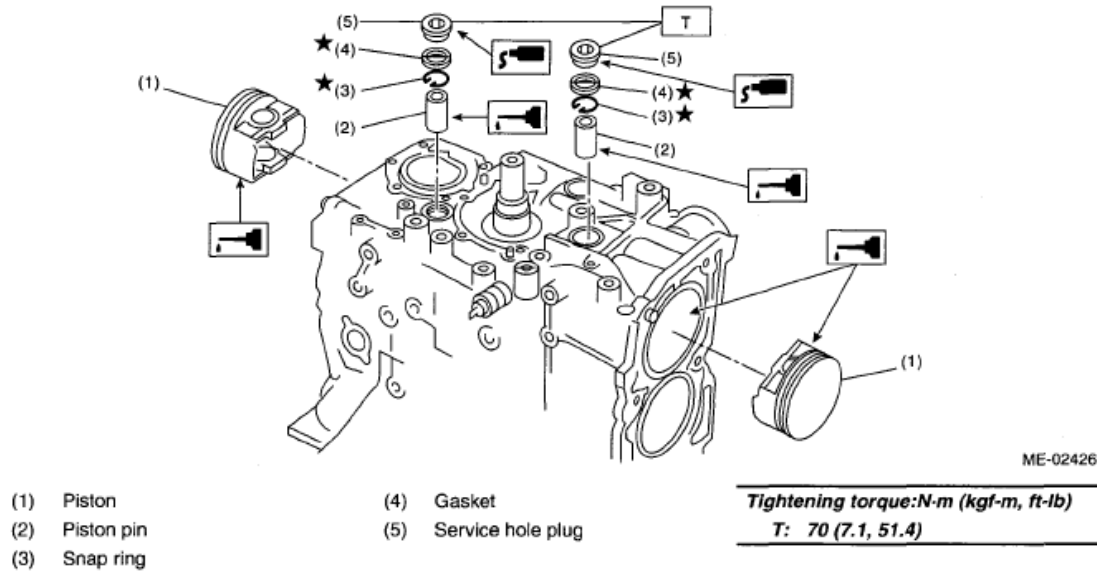


Fig. 177: Identifying Lubrication Area With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque: N·m (kgf-m, ft-lb)

T: 70 (7.1, 51.4)

20. Installing piston:

1. Place the cylinder block to face the #1 and #2 cylinder side upward.
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

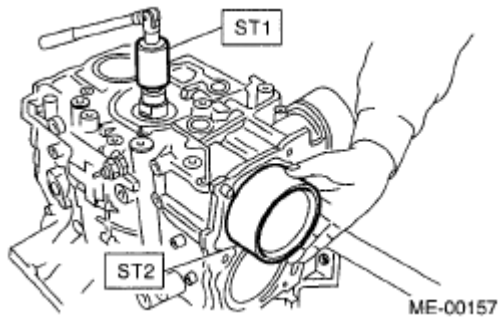
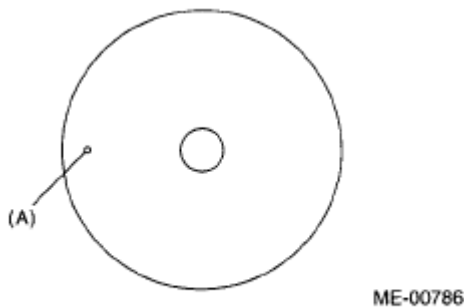


Fig. 178: Turning Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front mark

Fig. 179: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

21. Installing piston pin:

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

ST3 499017100 PISTON PIN GUIDE

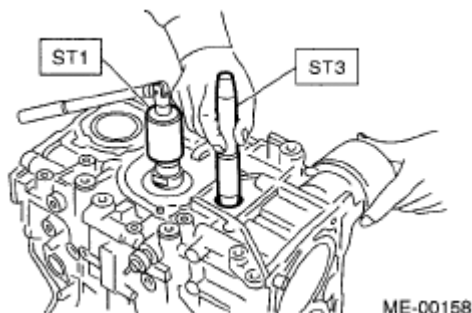


Fig. 180: Inserting ST3 Into Service Hole
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: **Use new snap rings.**

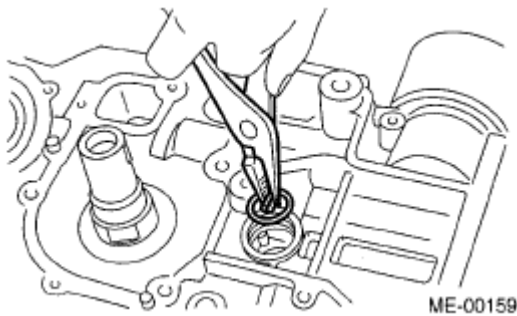


Fig. 181: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

5. Apply liquid gasket around the service hole plug.

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

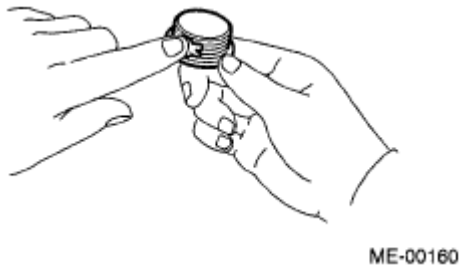


Fig. 182: Applying Liquid Gasket Around Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

NOTE: **Use a new gasket.**

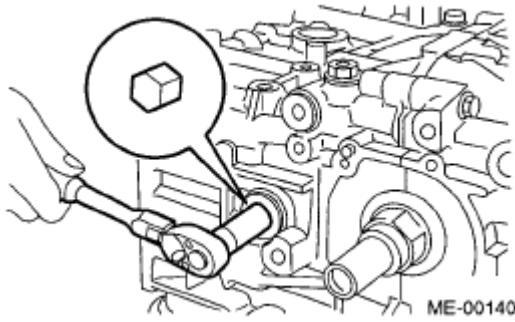


Fig. 183: Installing Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

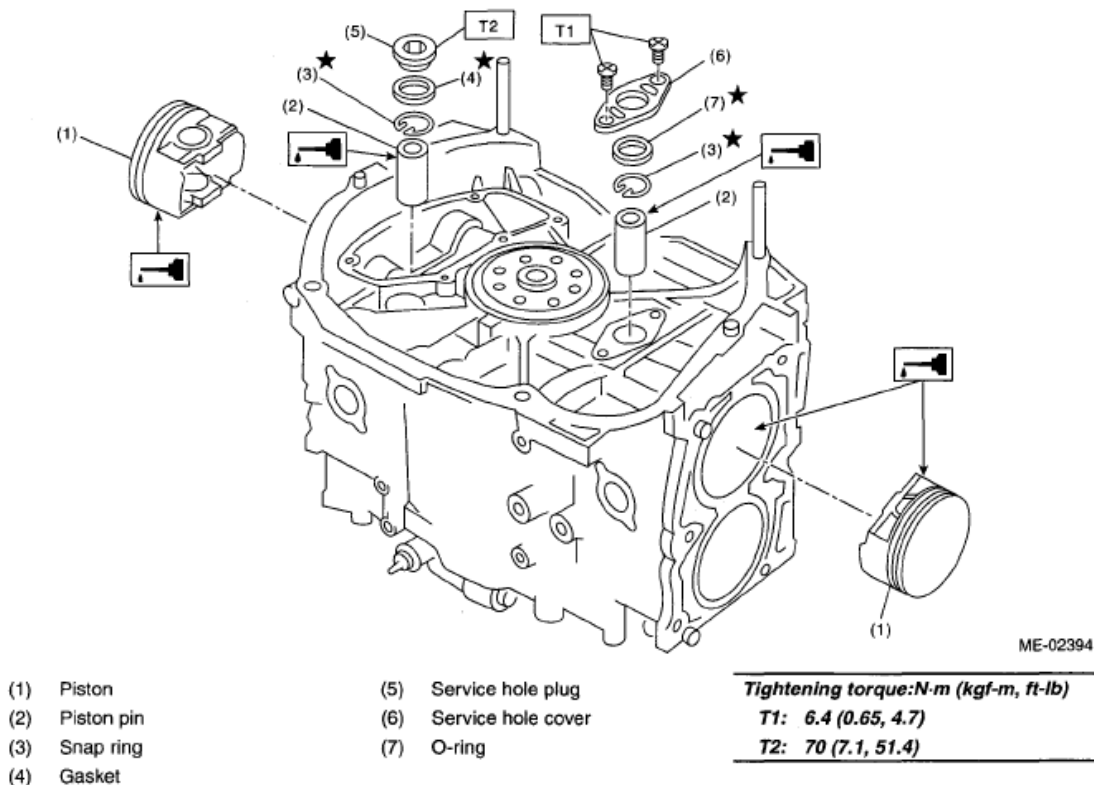


Fig. 184: Identifying Lubricating Applying Area With Torque Specification
Courtesy of SUBARU OF AMERICA, INC.

7. Place the cylinder block to face the #3 and #4 cylinder side upward. Following the same procedures as used for #1 and #2 cylinders, install the pistons and piston pins.
22. Install the water pipe.
23. Install the baffle plate.

Tightening torque:

6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

24. Install the oil strainer and O-ring.

Tightening torque:

10 N.m (1.0 kgf-m, 7 ft-lb)

25. Install the oil strainer stay.

NOTE: Tighten the oil strainer stay together with the baffle plate.

Tightening torque:

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

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

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

Liquid gasket:

THREE BOND 1207C (Part No. 004403012) or equivalent

Tightening torque:

5 N.m (0.5 kgf-m, 3.6 ft-lb)

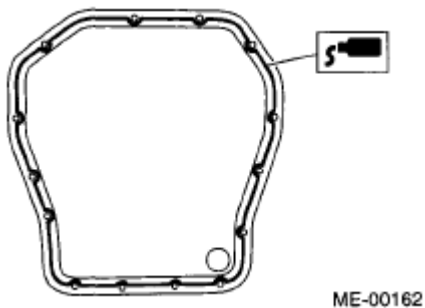


Fig. 185: Applying Liquid Gasket To Mating Surfaces
Courtesy of SUBARU OF AMERICA, INC.

27. Apply liquid gasket to the mating surfaces 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.

Liquid gasket:

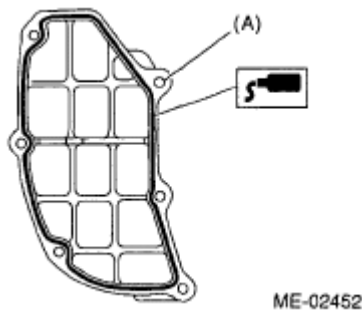
Mating surface***THREE BOND 1217G or equivalent******Bolt (A) thread (when reusing the bolt)******THREE BOND 1324 (Part No. 004403042) or equivalent******Tightening torque:******6.4 N.m (0.65 kgf-m, 4.7 ft-lb)***

Fig. 186: Applying Liquid Gasket To Mating Surfaces
Courtesy of SUBARU OF AMERICA, INC.

28. Install the flywheel. (MT model) <Ref. to **INSTALLATION** , Flywheel. >

ST 498497100 CRANKSHAFT STOPPER

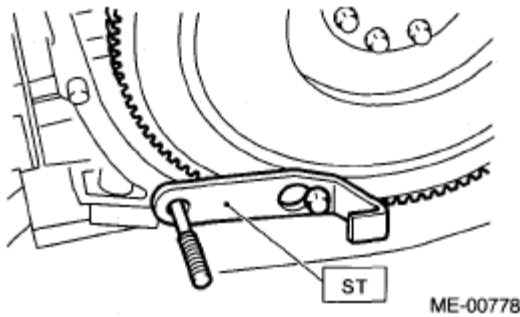


Fig. 187: Installing Crankshaft Stopper
Courtesy of SUBARU OF AMERICA, INC.

29. Install the drive plate. (AT model)

To lock the crankshaft, use ST.

ST 498497100 CRANKSHAFT STOPPER

Tightening torque:

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

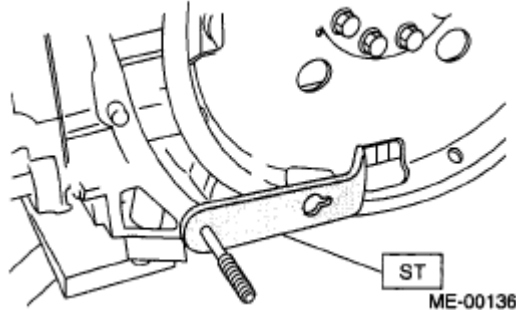


Fig. 188: Locking Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

30. Install the clutch disc and cover. <Ref. to **INSTALLATION** , Clutch Disc and Cover. >
31. Installation of oil pump:
 1. Install a new oil seal using ST.

ST 499587100 OIL SEAL INSTALLER

NOTE: Use a new front oil seal.

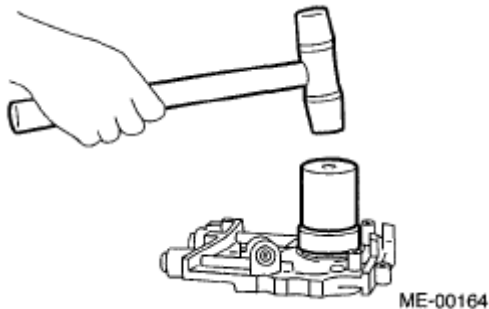
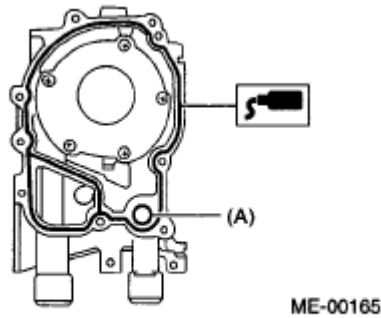


Fig. 189: Installing Oil Seal Using ST
Courtesy of SUBARU OF AMERICA, INC.

2. Apply liquid gasket to the matching surface of oil pump.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent



(A) O-ring

Fig. 190: Applying Liquid Gasket To Matching Surface Of Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

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

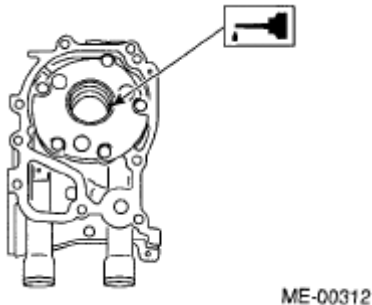


Fig. 191: Applying Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

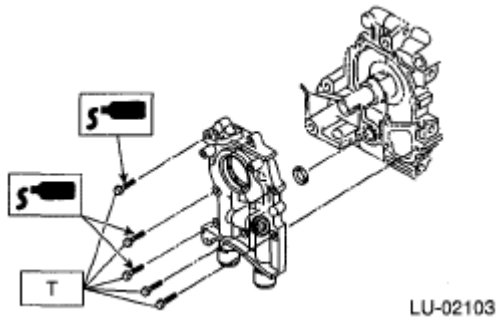
5. When reusing three bolts shown in the figure, apply liquid gasket to the bolt threads.

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

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



LU-02103

Fig. 192: Applying Liquid Gasket To Bolt Threads
Courtesy of SUBARU OF AMERICA, INC.

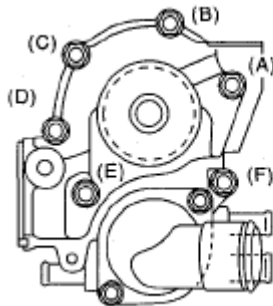
32. Install the service hole plug and gasket.

Tightening torque: First: 12 N.m (1.2 kgf-m, 8.7 ft-lb)

Second: 12 N.m (1.2 kgf-m, 8.7 ft-lb)

NOTE:

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



CO-02121

Fig. 193: Identifying Water Pump Bolts Alphabetical Sequence
Courtesy of SUBARU OF AMERICA, INC.

33. Install the water bypass pipe for heater.

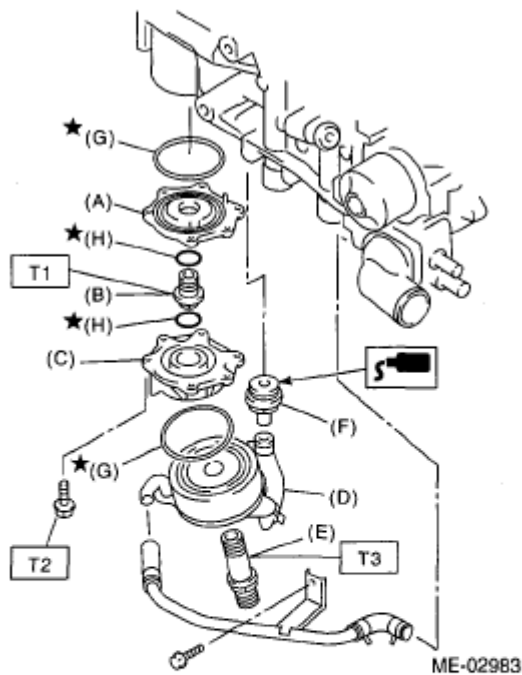
34. Install the oil cooler.

Tightening torque:

T1: 45 N.m (4.6 kgf-m, 33 ft-lb)

T2: 6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

T3: 54 N.m (5.3 kgf-m, 39 ft-lb)



- (A) Adapter (1)
- (B) Adapter connector
- (C) Adapter (2)
- (D) Oil cooler
- (E) Oil cooler connector
- (F) Plug
- (G) Gasket
- (H) O-ring

Fig. 194: Identifying Oil Cooler Components
Courtesy of SUBARU OF AMERICA, INC.

35. Install the oil filter. <Ref. to **INSTALLATION** , Engine Oil Filter. >
36. Install the water bypass pipe between oil cooler and water pump.
37. Install the water pipe.

NOTE: Use new O-rings.

38. Install the cylinder head.

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

39. Install the oil level gauge guide and tighten the attaching bolt (left side).
40. Install the rocker cover and rocker cover gasket.

NOTE: Use a new gasket.

41. Install the crank sprocket.

<Ref. to **INSTALLATION**, Crank Sprocket . >

42. Install the cam sprocket.

<Ref. to **INSTALLATION**, Cam Sprocket . >

43. Install the timing belt.

<Ref. to **INSTALLATION**, Timing Belt . >

44. Install the timing belt cover.

<Ref. to **INSTALLATION**, Timing Belt Cover . >

45. Install the crank pulley.

<Ref. to **INSTALLATION**, Crank Pulley . >

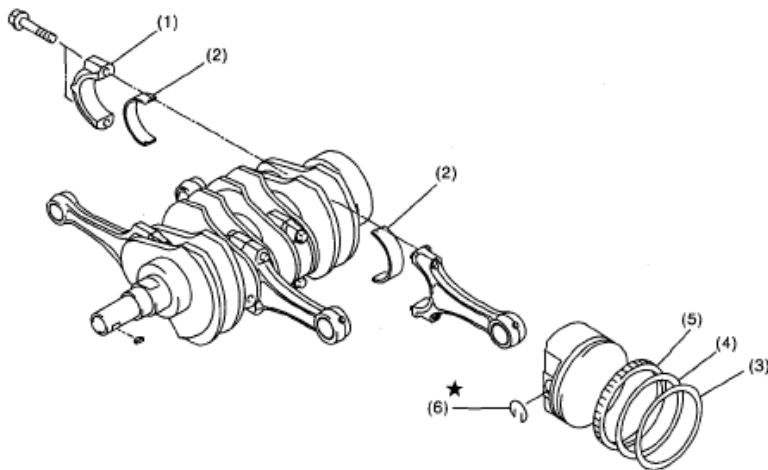
46. Install the intake manifold.

<Ref. to **INSTALLATION** , Intake Manifold. >

47. Install the generator and A/C compressor brackets on cylinder head.

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

DISASSEMBLY



ME-02741

(1) Connecting rod cap
(2) Connecting rod bearing

(3) Top ring
(4) Second ring

(5) Oil ring
(6) Snap ring

Fig. 195: Identifying Connecting Rod Assembly Components

Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Arrange the removed connecting rod, connecting rod cap and bearing in order to prevent confusion.

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

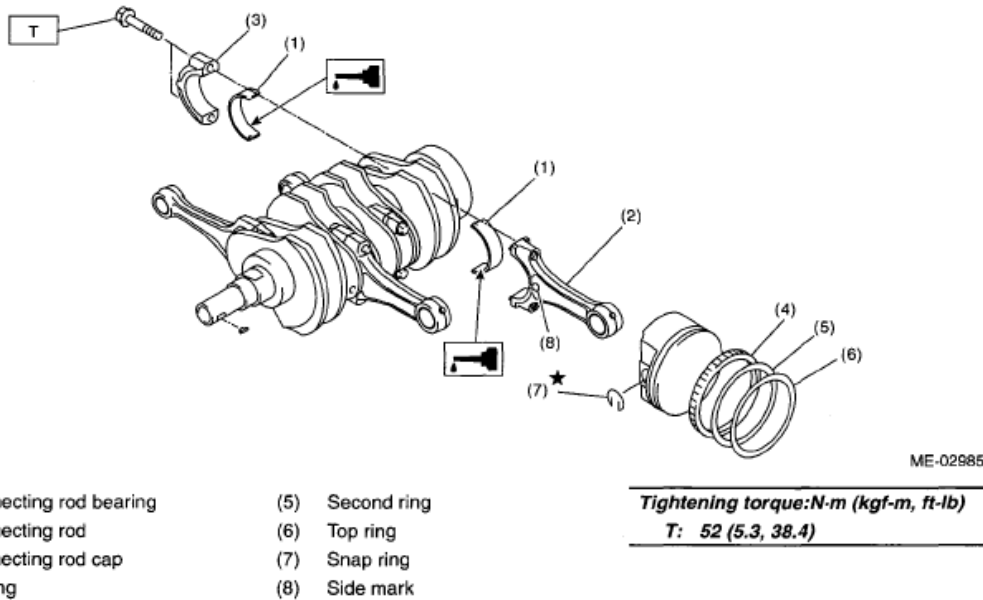


Fig. 196: Identifying Lubricating Applying Area On Connecting Rod With Torque Specification
 Courtesy of SUBARU OF AMERICA, INC.

1. Apply oil to the surface of the connecting rod bearings, and install the connecting rod bearings on connecting rods and connecting rod caps.
2. Install the connecting rod on crankshaft.
3. Position each connecting rod with the marking side facing forward.
4. Tighten the connecting rod cap with the connecting rod bolt. Make sure the arrow on connecting rod cap faces the front during installation.

Tightening torque:

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

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.

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

INSPECTION**CYLINDER BLOCK**

1. Visually check for cracks and damage. Use liquid penetrant tester on the important sections to check for fissures.
2. Check the oil passages for clogging.
3. Inspect the crankcase surface that mates with cylinder head for warping by using a straight edge, and correct by grinding if necessary.

Warping limit:

0.025 mm (0.00098 in)

Grinding limit:

0.1 mm (0.004 in)

Standard height of cylinder block:

201.0 mm (7.91 in)

CYLINDER AND PISTON

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

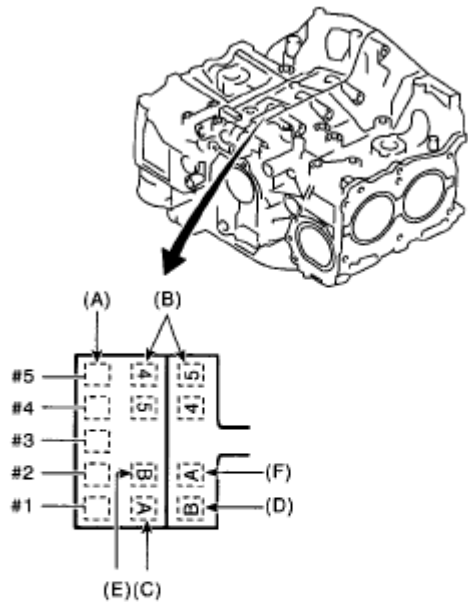
NOTE:

- 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)



ME-00170

- (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. 197: Identifying Piston Grades Number
 Courtesy of SUBARU OF AMERICA, INC.

2. How to measure the inner diameter of each cylinder:

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

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

Taper:

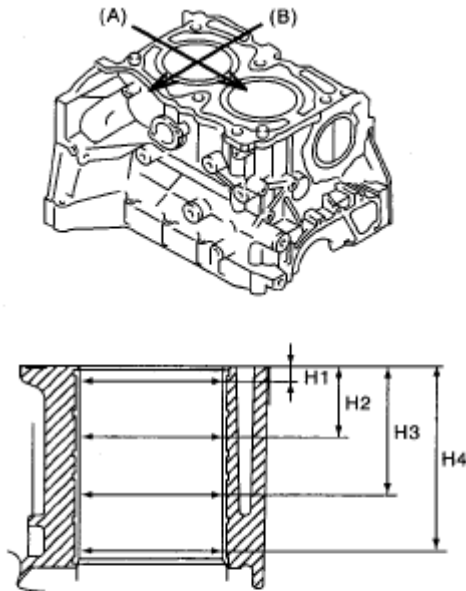
Standard:

0.015 mm (0.0006 in)

Service limit:

0.050 mm (0.0020 in)

Out-of-roundness:

Standard:**0.010 mm (0.0004 in)****Service limit:****0.050 mm (0.0020 in)**

ME-00171

(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. 198: Measuring Inner Diameter Of Cylinder In Thrust And Piston Pin Directions**Courtesy of SUBARU OF AMERICA, INC.**

3. When the piston is to be replaced due to general or cylinder wear, determine a suitable sized piston by measuring the piston clearance.
4. How to measure the outer diameter of each piston:

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

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

Piston grade point H:**38.2 mm (1.50 in)**

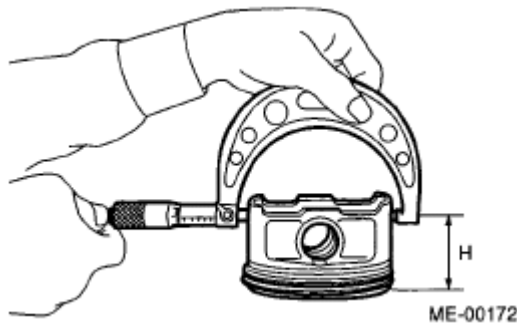
Piston outer diameter:***Standard:******A: 99.505 - 99.515 mm (3.9175 - 3.9179 in)******B: 99.495 - 99.505 mm (3.9171 - 3.9175 in)******0.25 mm (0.0098 in) oversize:******99.745 - 99.765 mm (3.9270 - 3.9278 in)******0.50 mm (0.0197 in) oversize:******99.995 - 100.015 mm (3.9368 - 3.9376 in)***

Fig. 199: Measuring Outer Diameter Of Piston Height
Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

Cylinder to piston clearance at 20°C (68°F):***Standard:******-0.010 - 0.010 mm (-0.0004 - 0.0004 in)******Service limit:******0.030 mm (0.0012 in)***

6. Boring and honing:

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

CAUTION:

- When any of the cylinders needs reboring, all other cylinders must be bored at the same time, and replace to oversize pistons.
- Do not perform boring on one cylinder only. Nor replace an oversize piston for one cylinder only.

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, pay attention to this when measuring the cylinder diameter.

Cylinder inner boring limit (diameter):

100.005 mm (3.9372 in)

PISTON AND PISTON PIN

1. Check the piston and piston pin for breaks, cracks or wear. Replace if faulty.
2. Check the piston ring groove for wear and damage. Replace if faulty.
3. Measure the piston-to-cylinder clearance at each cylinder. <Ref. to **CYLINDER AND PISTON**, Inspection, Cylinder Block . > If any of the clearances exceeds the limit, replace the piston or bore the cylinder to use an oversize piston.
4. 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.

Standard clearance between piston pin and hole in piston:

Standard:

0.004 - 0.008 mm (0.0002 - 0.0003 in)

Service limit:

0.020 mm (0.0008 in)



ME-00173

Fig. 200: Measuring Snap Ring Diameter
Courtesy of SUBARU OF AMERICA, INC.

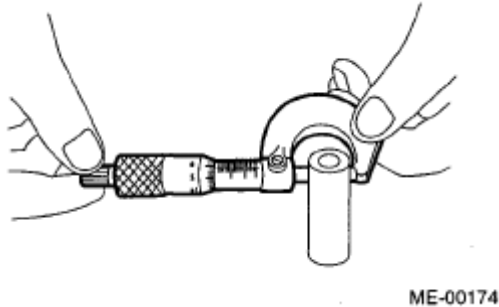


Fig. 201: Measuring Piston Pin Diameter
Courtesy of SUBARU OF AMERICA, INC.

5. 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.

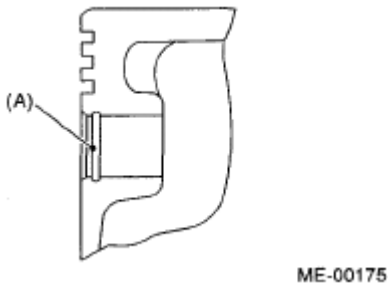


Fig. 202: Identifying Snap Ring Installation Groove
Courtesy of SUBARU OF AMERICA, INC.

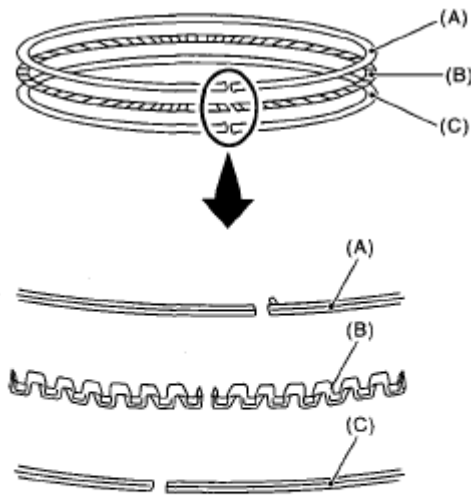
6. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

NOTE:

- Marks that shows the installing direction are shown on the end of top and second rings. Face these marks upward when installing the rings to piston.
- Oil ring consists of the upper rail, expander and lower rail. When installing the oil ring on piston, be careful of each rails direction.



ME-02472

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

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

2. Squarely place the piston ring and oil ring in cylinder using the piston, and measure the piston ring gap with a thickness gauge.

PISTON RING GAP SPECIFICATION

Unit: mm (in)			
		Standard	Limit
Piston ring gap	Top ring	0.20 - 0.25 (0.0079 - 0.0098)	1.0 (0.039)
	Second ring	0.37 - 0.52 (0.015 - 0.020)	1.0 (0.039)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)	1.5 (0.059)

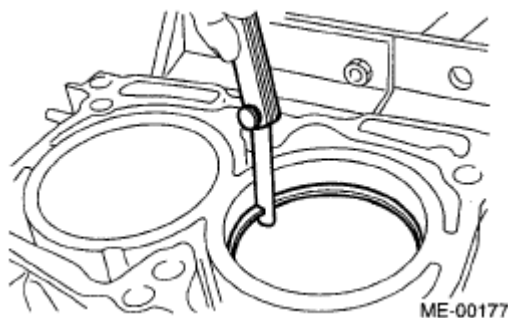


Fig. 204: Measuring Piston Ring Gap With Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

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

PISTON RING GAP SPECIFICATION

		Unit: mm (in)	
		Standard	Limit
Clearance between piston ring and piston ring groove	Top ring	0.040 - 0.080 (0.0016 - 0.0031)	0.15 (0.0059)
	Second ring	0.030 - 0.070 (0.0012 - 0.0028)	0.15 (0.0059)

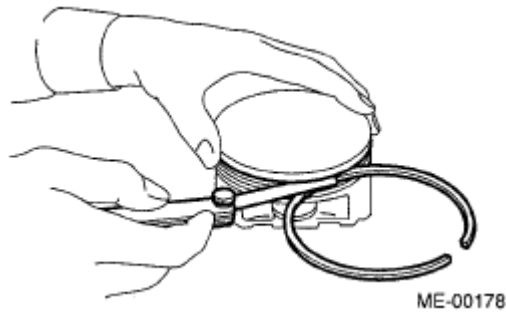


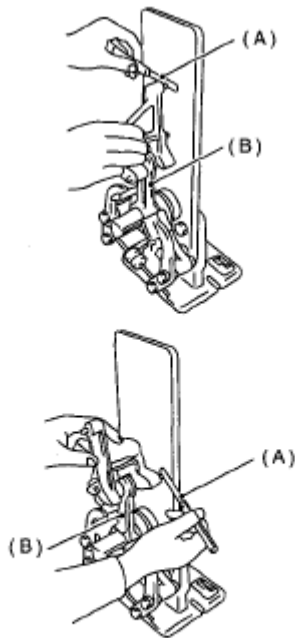
Fig. 205: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

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

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

0.10 mm (0.0039 in)



ME-00179

(A) Thickness gauge

(B) Connecting rod

Fig. 206: Checking Connecting Rod Alignment
Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod fitted with bearing to the crankshaft and measure the side clearance (thrust clearance) using a thickness gauge. Replace the connecting rod if the side clearance exceeds the specified limit.

Connecting rod side clearance:

Standard:

0.070 - 0.330 mm (0.0028 - 0.0130 in)

Service limit:

0.4 mm (0.016 in)

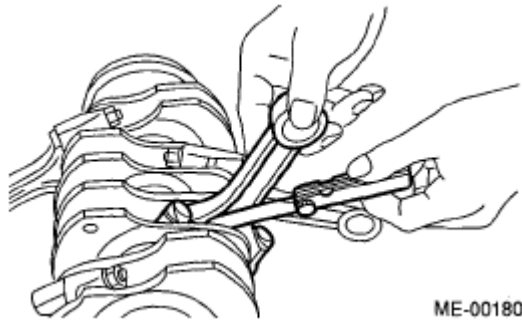


Fig. 207: Measuring Side Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard:

0.017- 0.045 mm (0.0007 - 0.0018 in)

Service limit:

0.05 mm (0.0020 in)

BEARING SIZE SPECIFICATION

Unit: mm (in)		
Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.490 - 1.502 (0.0587 - 0.0591)	51.984 - 52.000 (2.0466 - 2.0472)
0.03 (0.0012) undersize	1.504 - 1.512 (0.0592 - 0.0595)	51.954 - 51.970 (2.0454 - 2.0461)
0.05 (0.0020) undersize	1.514 - 1.522 (0.0596 - 0.0599)	51.934 - 51.950 (2.0447 - 2.0453)
0.25 (0.0098) undersize	1.614 - 1.622 (0.0635 - 0.0639)	51.734 - 51.750 (2.0368 - 2.0374)

6. Inspect the bushing at connecting rod small end, and replace with a new part if worn or damaged.
7. Measure the piston pin clearance at connecting rod small end. Replace it with a new part if the limit has been exceeded.

Clearance between piston pin and bushing:

Standard:

0 - 0.022 mm (0 - 0.0009 in)

Service limit:

0.030 mm (0.0012 in)

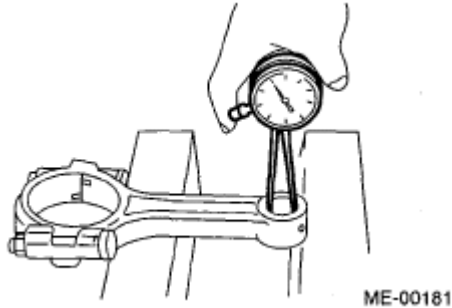


Fig. 208: Measuring Snap Ring Diameter
Courtesy of SUBARU OF AMERICA, INC.

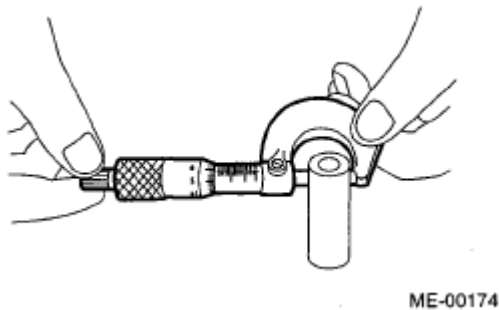


Fig. 209: Measuring Piston Pin Diameter
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

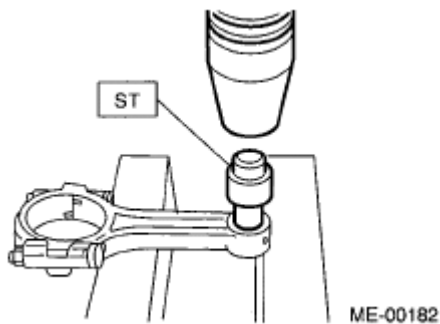


Fig. 210: Pressing Bushing With ST
Courtesy of SUBARU OF AMERICA, INC.

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

CRANKSHAFT AND CRANKSHAFT BEARING

1. Clean the crankshaft completely, and check for cracks by means of red lead check etc. If faulty, replace with new a new crankshaft.
2. Measure the bend of crankshaft. If it exceeds the limit, correct or replace it.

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

Crankshaft bend limit:

0.035 mm (0.0014 in)

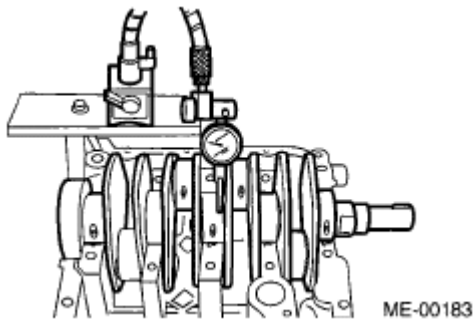


Fig. 211: Measuring Bend Of Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

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

Crank pin:

Out-of-roundness:

0.003 mm (0.0001 in)

Cylindrically:

0.004 mm (0.0002 in)

Grinding limit:

To 51.750 mm (2.0374 in) dia.

Crank journal:

Out-of-roundness:

0.005 mm (0.0002 in)

Cylindrically:

0.006 mm (0.0002 in)

Grinding limit:

To 59.758 mm (2.3527 in) dia.



Fig. 212: Inspecting Crank Journal And Crank Pin Dimensions For Wear
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL OUTER DIAMETER

		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)	1.490 - 1.502 (0.0587 - 0.0591)
0.03 (0.0012) undersize	Journal O.D.	59.962 - 59.978 (2.3607 - 2.3613)	59.962 - 59.978 (2.3607 - 2.3613)	51.954 - 51.970 (2.0454 - 2.0461)
	Bearing size (Thickness at center)	2.017 - 2.020 (0.0794 - 0.0795)	2.019 - 2.022 (0.0795 - 0.0796)	1.504 - 1.512 (0.0592 - 0.0595)
0.05 (0.0020) undersize	Journal O.D.	59.942 - 59.958 (2.3599 - 2.3605)	59.942 - 59.958 (2.3599 - 2.3605)	51.934 - 51.950 (2.0447 - 2.0453)
	Bearing size (Thickness at center)	2.027 - 2.030 (0.0798 - 0.0799)	2.029 - 2.032 (0.0799 - 0.0800)	1.514 - 1.522 (0.0596 - 0.0599)
	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)

0.25 (0.0098) undersize	Bearing size (Thickness at center)	2.127 - 2.130 (0.0837 - 0.0839)	2.129 - 2.132 (0.0838 - 0.0839)	1.614 - 1.622 (0.0635 - 0.0639)
----------------------------	---------------------------------------	------------------------------------	------------------------------------	------------------------------------

- Use a thickness gauge to measure the thrust clearance of crankshaft at center bearing. If the clearance exceeds the limit, replace the bearing.

Crankshaft thrust clearance:

Standard:

0.030 - 0.115 mm (0.0012 - 0.0045 in)

Service limit:

0.25 mm (0.0098 in)

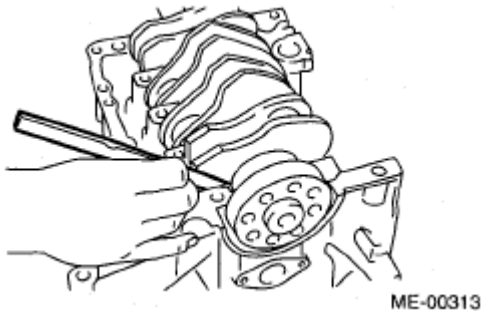


Fig. 213: Measuring Thrust Clearance Of Crankshaft At Center Bearing
Courtesy of SUBARU OF AMERICA, INC.

- Inspect individual crankshaft bearings for signs of flaking, seizure, melting and wear.
- Measure the oil clearance on each crankshaft bearing using plastigage. If the measured value exceeds the limit, replace the defective bearing with an undersize one, and replace or readjust the crankshaft if necessary.

Crankshaft oil clearance:

Standard:

0.010 - 0.030 mm (0.0004 - 0.0012 in)

Service limit:

0.040 mm (0.0016 in)

INTAKE AND EXHAUST VALVE

SPECIFICATION

Refer to "**19. CYLINDER HEAD**" for work relating to the intake and the exhaust valves.

<Ref. to **REMOVAL**, Cylinder Head . > <Ref. to **INSTALLATION**, Cylinder Head . >

PISTON

SPECIFICATION

Refer to "**20. CYLINDER BLOCK**" for work relating to the piston.

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

CONNECTING ROD

SPECIFICATION

Refer to "**20. CYLINDER BLOCK**" for work relating to the connecting rods.

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

CRANKSHAFT

SPECIFICATION

Refer to "**20. CYLINDER BLOCK**" for work relating to the crankshaft.

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

ENGINE TROUBLE IN GENERAL

INSPECTION

PROBLEM SYMPTOM 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 or neutral switch	C
		Defective starter	B
	Battery	Improper connection of terminal	A
		Run-down battery	A
		Defective charging system	B
		Seizure of crankshaft and connecting rod	

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2) Initial combustion does not occur.	Excessive friction	bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
	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 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 head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
3) Initial combustion occurs.	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Defective intake manifold gasket	B
		Defective throttle body gasket	B
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of 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 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

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

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	Compression	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	Overheating	C
	Others	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
		Accelerator cable out of adjustment	C
3. Low output, hesitation and poor acceleration	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	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 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 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	Overheating	C
		Over-cooling	C

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	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 or insufficient fuel	C
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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	Overheating	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
		Accelerator cable out of adjustment	B
6. Dieseling (Run-on)	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Cooling system	Overheating	B
	Others	Evaporative emission control system malfunction	B
	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A

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7. After burning in exhaust system	Intake system	Loosened or cracked intake duct	C
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	B
		Defective PCV valve	B
		Loosened oil filler cap	C
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective head gasket	C
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C
	Others	Evaporative emission control system malfunction	C
8. Knocking	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Loosened oil filler cap	B
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
	Cooling system	Overheating	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 o-ring	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	B

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		oil pan	
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 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
NOTE: "RANK" shown in the chart refers to the possibility of the cause of trouble in order "Very often" to "Rarely" A - Very often B - Sometimes C - Rarely			

ENGINE NOISE

INSPECTION

INSPECTION CHART

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	- Valve mechanism is defective. - Incorrect valve clearance adjustment - Worn camshaft - Broken valve spring
Heavy and dull clank	Oil pressure is low.	- Worn camshaft main bearing - Worn connecting rod bearing (large end)
	Oil pressure is normal.	- Loosened flywheel mounting bolt - Damaged engine mounting

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High-pitched clank	Sound is noticeable when accelerating with an overload condition.	• Ignition timing advanced • Accumulation of carbon inside combustion chamber • Wrong heat-durability 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 camshaft 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⁾	• Unusually worn valve lifter • Worn cam sprocket • Worn camshaft journal bore in cylinder head assembly
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Poor contact of generator brush and rotor
Gear scream when starting engine	-	• Defective ignition starter switch • Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	• Loose drive 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 • Belt contacting with case/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 and Inspection Mode after connecting the fuel injector connector. <Ref. to OPERATION , Clear Memory Mode. > <Ref. to PROCEDURE , Inspection Mode. >