

2008 Subaru Outback

2008 ENGINE Mechanical (H4DOTC) - Legacy & Outback

2008 ENGINE**Mechanical (H4DOTC) - Legacy & Outback****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)	99.5 x 79.0(3.92 x 3.11)
	Piston displacement	cm ³ (cu in)	2,457 (149.94)
	Compression ratio		8.4
	Compression pressure (at 200 - 300rpm)	kPa (kg/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 ATDC 5°
			Min. advance BTDC 35°
		Close	Max. retard ABDC 65°
			Min. advance ABDC 25°
	Exhaust valve timing	Open	BBDC 55°
		Close	ATDC 5°
	Valve clearance	Intake	mm (in) 0.20±0.02 (0.0079±0.0008)
		Exhaust	0.35±0.02 (0.0138±0.0008)
	Idling speed [at neutral position on MT, or "P" or "N" position on AT]	No load	rpm 750±100
		A/C ON	800±100 (MT model) 825±100 (AT model)
	Ignition order		1 --> 3 --> 2 --> 4
	Ignition timing	BTDC/rpm MT model	12°±10°/750
		AT model	17°±10°/750

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

Belt tension adjuster	Protrusion of adjuster rod	mm (in)	5.2 - 6.2 (0.205 - 0.244)
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Belt tensioner	Spacer O.D.		mm (in)	17.955 - 17.975 (0.7069 - 0.7077)	
	Tensioner bushing I.D.		mm (in)	18.0 - 18.08 (0.7087 - 0.7118)	
	Clearance between spacer and bushing		mm (in)	Standard	0.025 - 0.125 (0.0010 - 0.0049)
	Side clearance of spacer		mm (in)	Standard	0.2 - 0.55 (0.0079 - 0.0217)
Camshaft	Bending limit		mm (in)	0.020 (0.0079) or less	
	Thrust clearance		mm (in)	Standard	0.068 - 0.116 (0.0027 - 0.0047)
	Cam lobe height	mm (in)	Intake	Standard	46.55 - 46.65 (1.833 - 1.837)
			Exhaust	Standard	46.75 - 46.85 (1.841 - 1.844)
	Journal O.D.	mm (in)	Standard	Front	37.946 - 37.963 (1.4939 - 1.4946)
				Center rear	29.946 - 29.963 (1.1790 - 1.1796)
Journal clearance		mm (in)	Standard	0.037 - 0.072 (0.0015 - 0.0028)	
Cylinder head	Surface warpage limit		mm (in)	0.035(0.0014)	
	Grinding limit		mm (in)	0.3 (0.012)	
	Standard height		mm (in)	127.5 (5.02)	
Valve seat	Seating angle			90°	
	Contacting width	mm (in)	Intake	Standard	0.6 - 1.4 (0.024 - 0.055)
			Exhaust	Standard	1.2 - 1.8 (0.047 - 0.071)
Valve guide	Inside diameter		mm (in)	6.000 - 6.012 (0.2362 - 0.2367)	
	Protrusion above head		mm (in)	15.8 - 16.2 (0.622 - 0.638)	
Valve	Head edge thickness	mm (in)	Intake	Standard	1.0 - 1.4 (0.039 - 0.055)
			Exhaust	Standard	1.3 - 1.7 (0.051 - 0.067)
	Stem outer diameter	mm (in)	Intake		5.955 - 5.970 (0.2344 - 0.2350)
			Exhaust		5.945 - 5.960 (0.2341 - 0.2346)
	Valve stem gap	mm (in)	Standard	Intake	0.030 - 0.057 (0.0012 - 0.0022)
				Exhaust	0.040 - 0.067 (0.0016 - 0.0026)
	Overall length	mm (in)	Intake		104.4 (4.110)
Exhaust			104.65 (4.1201)		
Valve spring	Free length		mm (in)	47.32 (1.863)	
	Squareness			2.5°, 2.1 mm (0.083 in) or less	
	Tension/spring height	(kgf, lb)/mm (in)	Set	205 - 235 (20.9 - 24.0, 46.1 - 52.8)/36.0 (1.417)	
			Lift	426 - 490 (43.4 - 50.0, 95.8 - 110)/26.50 (1.043)	
Valve lifter	Outer diameter		mm (in)	Standard	34.959 - 34.975 (1.3763 - 1.3770)
	Inner diameter (cylinder head)		mm (in)	Standard	34.990 - 35.016 (1.3777 - 1.3786)
	Valve lifter clearance		mm (in)	Standard	0.019 - 0.057 (0.0007 - 0.0022)
	Surface warpage limit (Mating surface with cylinder head)		mm (in)	0.025 (0.0098)	
	Grinding limit		mm (in)	0.1 (0.004)	
	Standard height		mm (in)	201.0 (7.91)	

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Cylinder block	Cylinder inner diameter	mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)
				B	99.495 - 99.505 (3.9171 - 3.9175)
	Taper		mm (in)	Standard	0.015(0.0006)
	Out-of-roundness		mm (in)	Standard	0.010(0.0004)
	Piston clearance		mm (in)	Standard	-0.010 - 0.010 (-0.00039 - 0.00039)
	Cylinder inner diameter boring limit (diameter)		mm (in)		To 100.005 (3.9372)
Piston	Outer diameter	mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)
				B	99.495 - 99.505 (3.9171 - 3.9175)
			0.25 (0.0098) OS		99.745 - 99.765 (3.9270 - 3.9278)
			0.50 (0.0197) OS		99.995 - 100.015 (3.9368 - 3.9376)
Piston pin	Standard clearance between piston and piston pin		mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)
	Degree of fit				Piston pin must be fitted into position with thumb at 20°C (68° F).
Piston ring	Ring closed gap	mm (in)	Top ring	Standard	0.20 - 0.25 (0.0079 - 0.0098)
			Second ring	Standard	0.37 - 0.52 (0.015 - 0.0203)
			Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)
	Ring groove gap	mm (in)	Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)
			Second ring	Standard	0.030 - 0.070 (0.0012 - 0.0028)
Connecting rod	Bend or twist per 100 mm (3.94 in) in length		mm (in)	Limit	0.10 (0.0039)
	Thrust clearance		mm (in)	Standard	0.070 - 0.330 (0.0028 - 0.0130)
Bearing of large end	Oil clearance		mm (in)	Standard	0.017 - 0.045 (0.0007 - 0.0018)
	Bearing size (Thickness at center)	mm (in)	Standard		1.490 - 1.502 (0.0587 - 0.0591)
			0.03 (0.0012) US		1.504 - 1.512 (0.0592 - 0.0595)
			0.05 (0.0020) US		1.514 - 1.522 (0.0596 - 0.0599)
			0.25 (0.0098) US		1.614 - 1.622 (0.0635 - 0.0639)
Bushing of small end	Clearance between piston pin and bushing		mm (in)	Standard	0 - 0.022 (0 - 0.0009)
	Bending limit		mm (in)		0.035 (0.0014)
	Crank pin	Out-of-roundness		mm (in)	0.003 (0.0001)
		Cylindricity		mm (in)	0.004 (0.0002)
		Grinding limit (dia.)		mm (in)	To 51.750 (2.0374)
		Crank journal	Out-of-roundness		mm (in)
	Cylindricity		mm (in)	0.006 (0.0002)	
	Grinding limit (dia.)		mm (in)	To 59.758 (2.3527)	
			Standard		51.984 - 52.000 (2.0466 - 2.0472)

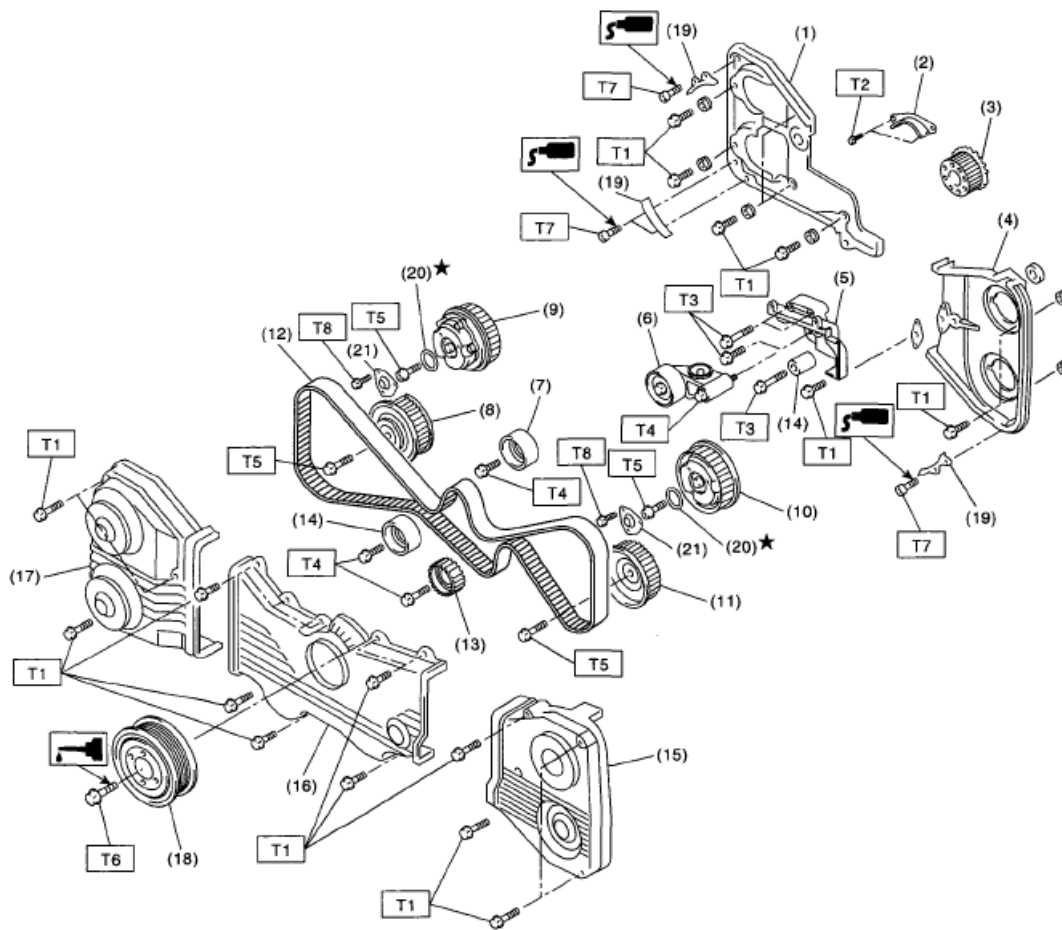
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Crankshaft	Crank pin outer diameter	mm (in)	0.03 (0.0012) US	51.954 - 51.970 (2.0454 - 2.0461)
			0.05 (0.0020) US	51.934 - 51.950 (2.0447 - 2.0453)
			0.25 (0.0098) US	51.734 - 51.750 (2.0368 - 2.0374)
	Crank journal outer diameter	mm (in)	Standard	59.992 - 60.008 (2.3619 - 2.3625)
			0.03 (0.0012) US	59.962 - 59.978 (2.3607 - 2.3613)
			0.05 (0.0020) US	59.942 - 59.958 (2.3599 - 2.3605)
			0.25 (0.0098) US	59.742 - 59.758 (2.3520 - 2.3527)
	Thrust clearance		mm (in)	Standard
Oil clearance		mm (in)		0.010 - 0.030 (0.0004 - 0.0012)
Main bearing	Bearing size (Thickness at center) mm (in)	#1, #3	Standard	1.998 - 2.011 (0.0787 - 0.0792)
			0.03 (0.0012) US	2.017 - 2.020 (0.0794 - 0.0795)
			0.05 (0.0020) US	2.027 - 2.030 (0.0798 - 0.0799)
			0.25 (0.0098) US	2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #5	Standard	2.000 - 2.013 (0.0787 - 0.0793)
			0.03 (0.0012) US	2.019 - 2.022 (0.0795 - 0.0796)
			0.05 (0.0020) US	2.029 - 2.032 (0.0799 - 0.0800)
			0.25 (0.0098) US	2.129 - 2.132 (0.0838 - 0.0839)

COMPONENT

TIMING BELT



ME-03089

- | | |
|--|-----------------------------------|
| (1) Timing belt cover No. 2 (RH) | (12) Timing belt |
| (2) Timing belt guide (MT model) | (13) Belt idler No. 2 |
| (3) Crank sprocket | (14) Belt idler |
| (4) Timing belt cover No. 2 (LH) | (15) Timing belt cover (LH) |
| (5) Tensioner bracket | (16) Front belt cover |
| (6) Automatic belt tension adjuster ASSY | (17) Timing belt cover (RH) |
| (7) Belt idler | (18) Crank pulley |
| (8) Exhaust cam sprocket (RH) | (19) Timing belt guide (MT model) |
| (9) Intake cam sprocket (RH) | (20) O-ring |
| (10) Intake cam sprocket (LH) | (21) Actuator cover |
| (11) Exhaust cam sprocket (LH) | |

Tightening torque: N·m (kgf-m, ft-lb)

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
INSTALLATION, Cam
Sprocket.>**

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

T7: 6.4 (0.65, 4.7)

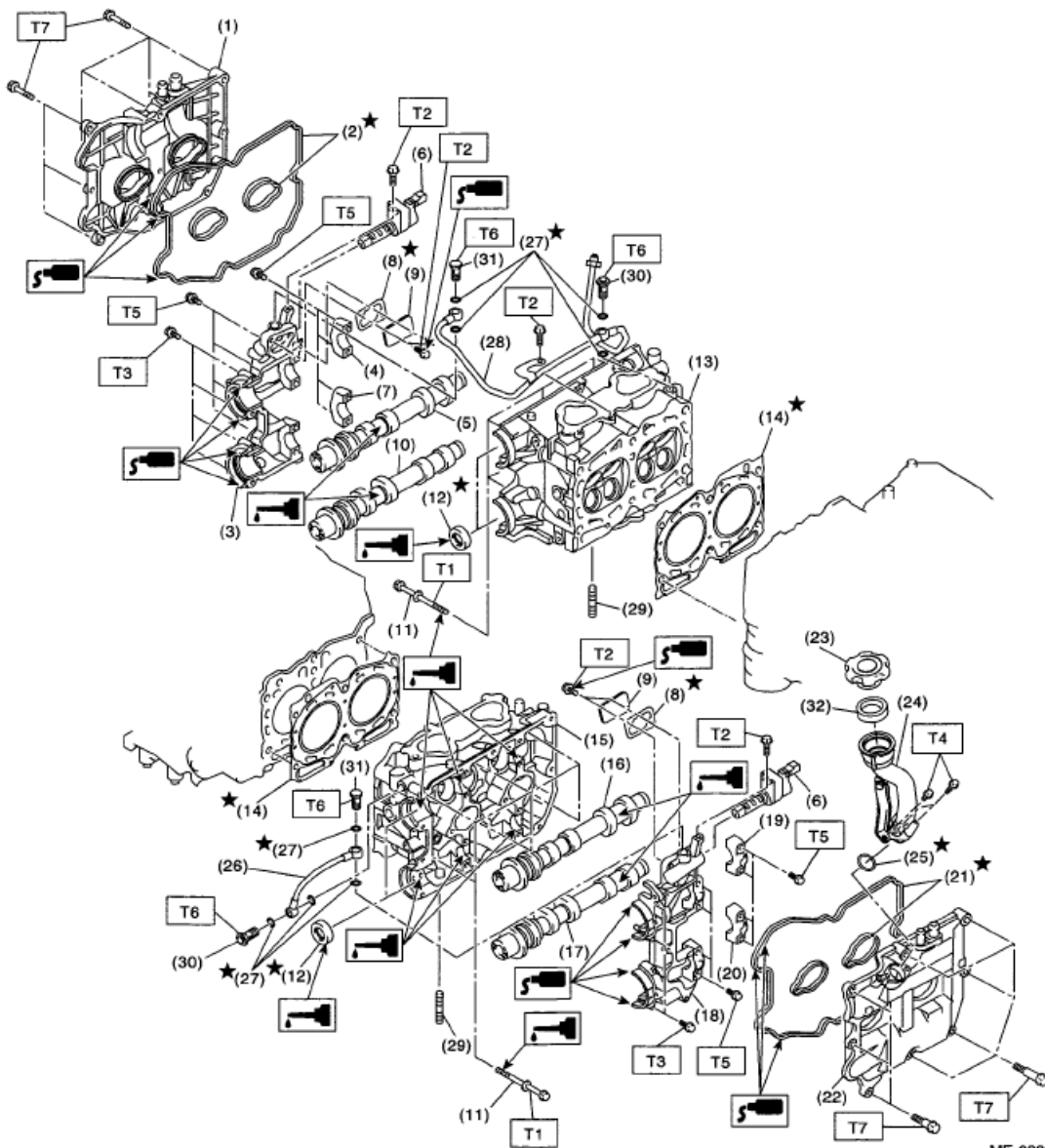
T8: 3.4 (0.3, 2.5)

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

CYLINDER HEAD AND CAMSHAFT

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ME-03090

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

- (32) Gasket

Tightening torque: N·m (kgf-m, ft-lb)

T1: <Ref. to
INSTALLATION, Cylinder
Head.>

T2: 8 (0.8, 5.9)

T3: <Ref. to
INSTALLATION, Camshaft.>

T4: 6.4 (0.65, 4.7)

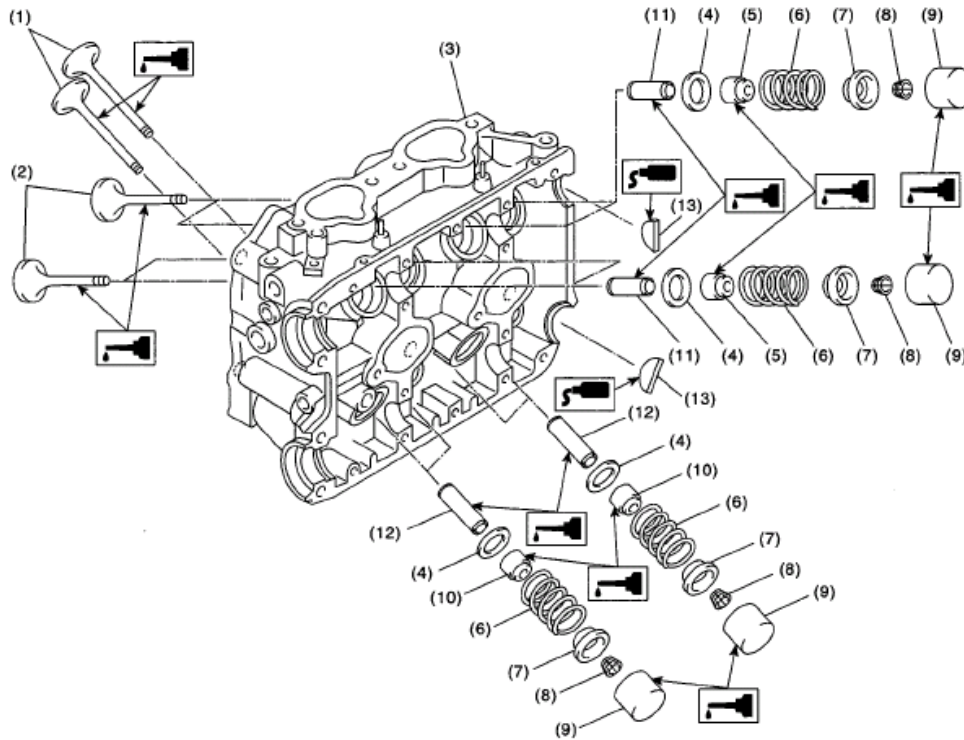
T5: <Ref. to
INSTALLATION, Camshaft.>

T6: 29 (3.0, 21.4)

T7: <Ref. to
INSTALLATION, Camshaft.>

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

CYLINDER HEAD AND VALVE ASSEMBLY

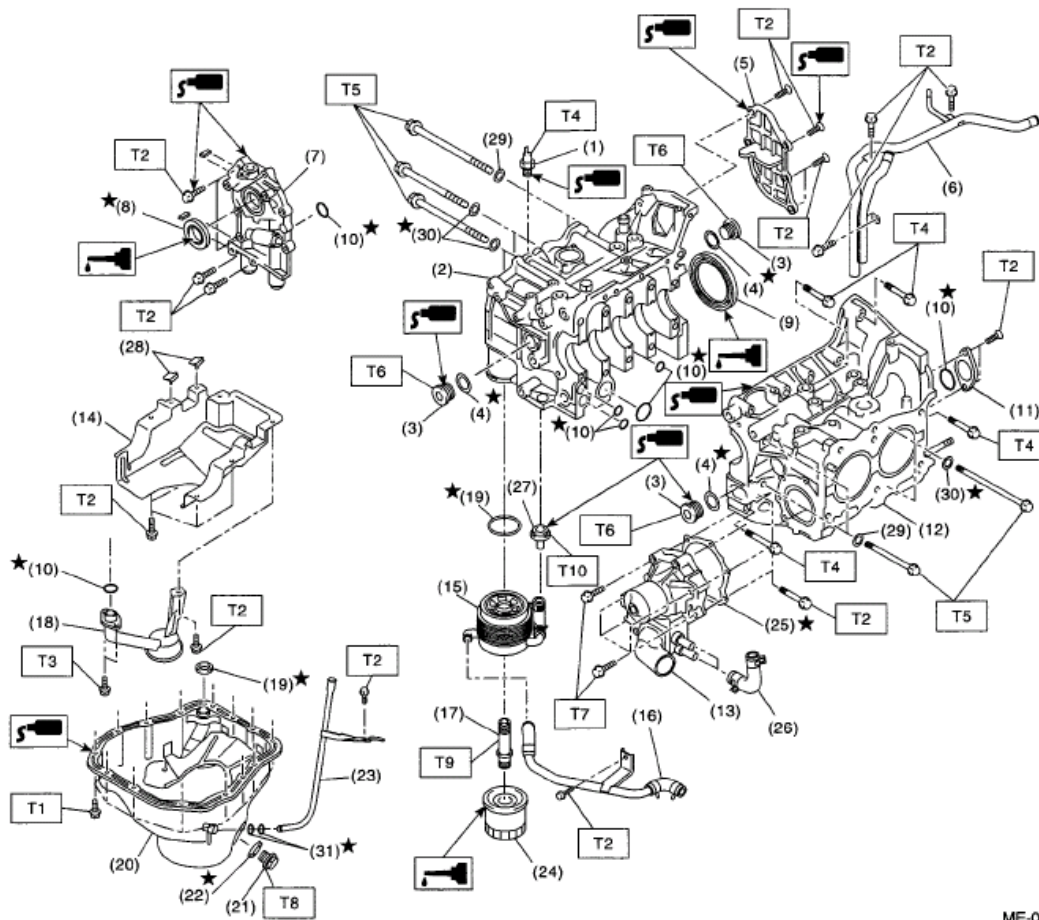


ME-03157

- | | | |
|---------------------------|-----------------------------|--------------------------|
| (1) Exhaust valve | (6) Valve spring | (11) Intake valve guide |
| (2) Intake valve | (7) Retainer | (12) Exhaust valve guide |
| (3) Cylinder head | (8) Retainer key | (13) Plug |
| (4) Valve spring seat | (9) Valve lifter | |
| (5) Intake valve oil seal | (10) Exhaust valve oil seal | |

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

CYLINDER BLOCK



ME-03091

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

T6: 70 (7.1, 51.6)

**T7: First 12 (1.2, 8.9)
Second 12 (1.2, 8.9)**

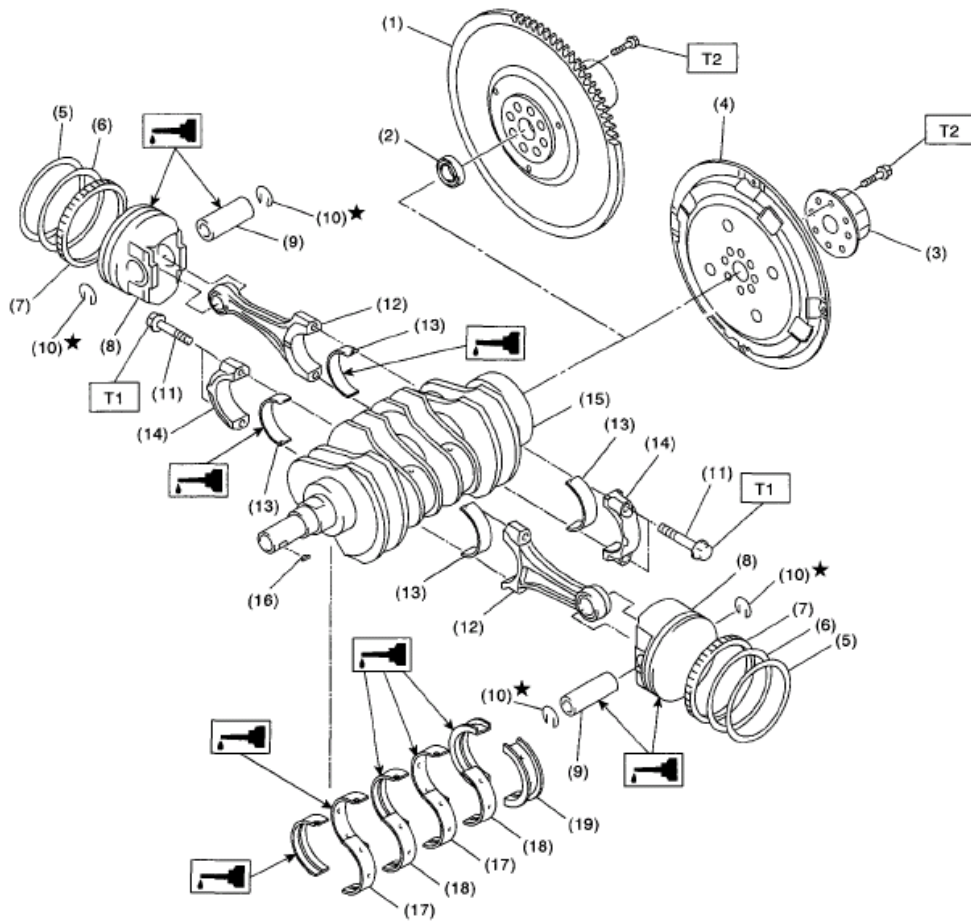
T8: 44 (4.5, 33)

T9: 54 (5.5, 40)

T10: 69 (7.0, 50.9)

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

CRANKSHAFT AND PISTON



ME-02437

- | | | |
|------------------------------|-----------------------------|--------------------------------|
| (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 Specification
Courtesy of SUBARU OF AMERICA, INC.

ENGINE MOUNTING

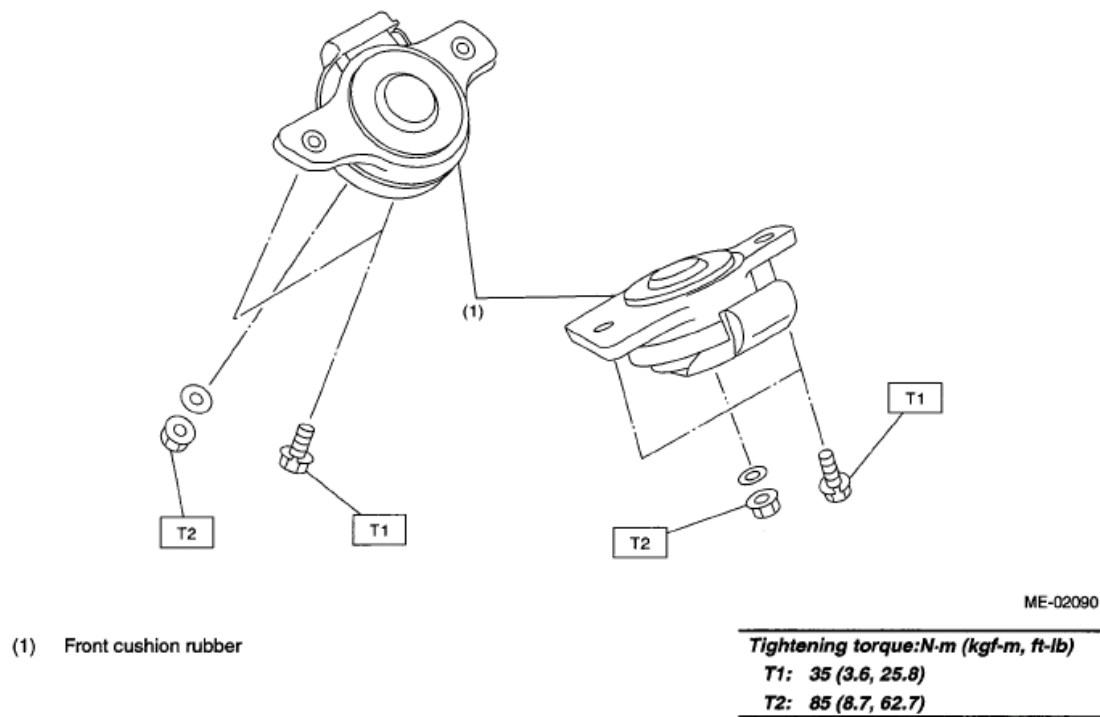


Fig. 6: Identifying Engine Mounting Components With Torque Specification
 Courtesy of SUBARU OF AMERICA, INC.

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 connectors of sensors or units, be sure to disconnect the ground cable from the battery.
- All parts should be thoroughly cleaned, paying special attention to engine oil passages, pistons and bearings.
- Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.
- Be careful not to let oil, grease or coolant contact the timing belt, clutch disc and flywheel.
- All removed parts, if to be reused, should be reinstalled in the original positions and directions.
- Bolts, nuts and washers should be replaced with new parts as required.
- Even if necessary inspections have been made in advance, proceed with assembly work while making

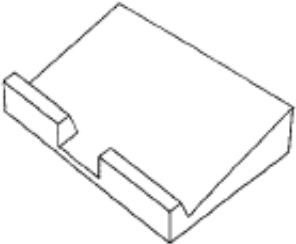
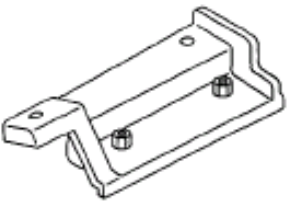
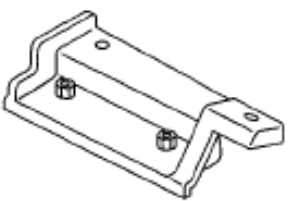
rechecks.

- Remove or install the engine in an area where chain hoists, lifting devices, etc. are available for ready use.
- Be sure not to damage coated surfaces of body panels with tools, or not to stain seats and windows with coolant or oil. Place a cover over fender, as required, for protection.
- Prior to starting work, prepare the following: Service tools, clean cloth, containers to catch coolant and oil, wire ropes, chain hoist, transmission jacks, etc.
- Lift-up or lower the vehicle when necessary. Make sure to support the correct positions.

PREPARATION TOOL

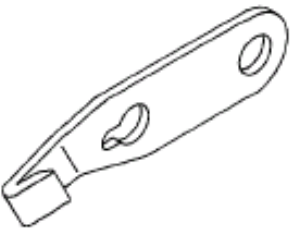
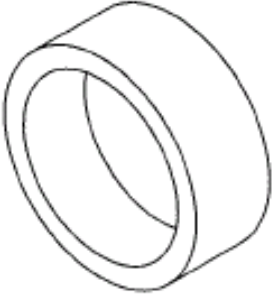
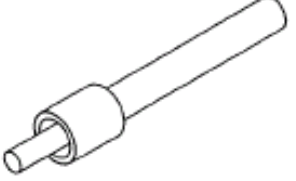
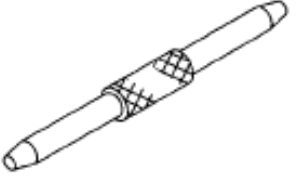
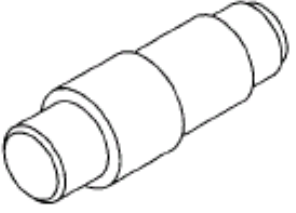
SPECIAL TOOL

SPECIAL TOOL 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 the ENGINE STAND (499817100).
 ST-498457100	498457100	ENGINE STAND ADAPTER LH	Used together with the ENGINE STAND (499817100).
			Used for stopping rotation of the

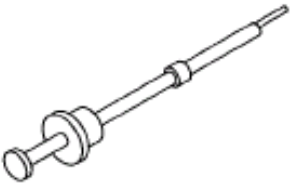
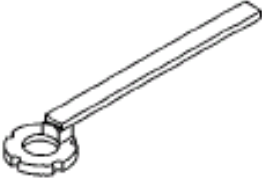
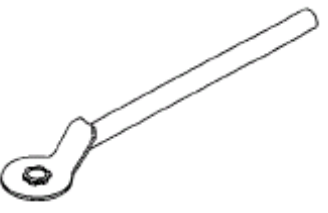
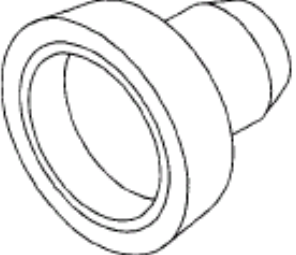
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 ST-498497100	498497100	CRANKSHAFT STOPPER	drive plate when loosening/tightening the crank pulley bolt.
 ST-498747300	498747300	PISTON GUIDE	Used for installing the cup to the wheel cylinder piston. (2.5 L model)
 ST-498857100	498857100	VALVE OIL SEAL 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.
 ST-499037100	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.

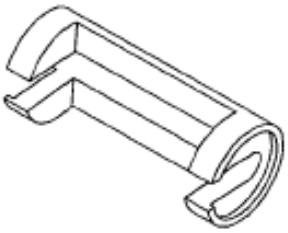
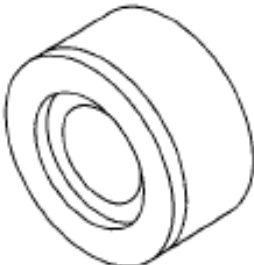
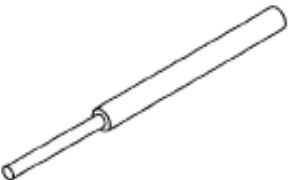
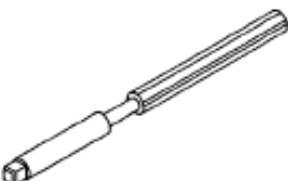
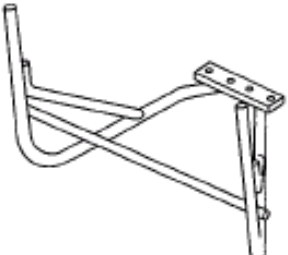
2008 Subaru Outback

2008 ENGINE Mechanical (H4DOTC) - Legacy & Outback

 ST-499097700	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499207400	499207400	CAM SPROCKET WRENCH	Used for removing and installing exhaust cam sprocket.
 ST-499977500	499977500	CAM SPROCKET WRENCH	Used for removing and installing intake cam sprocket.
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with the CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with the CRANKSHAFT OIL SEAL INSTALLER (499587200).

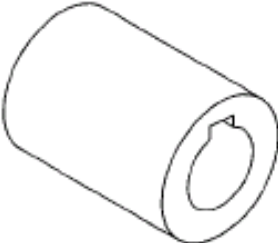
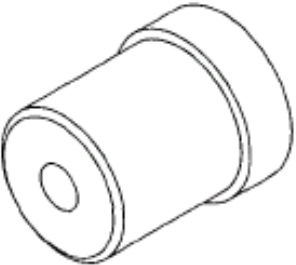
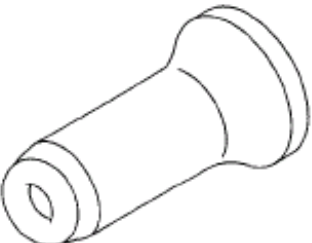
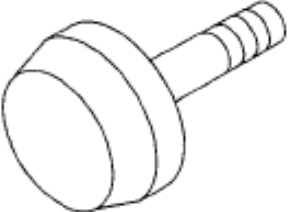
2008 Subaru Outback

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 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.
 ST-499767400	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499817100	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used together with the ENGINE STAND ADAPTER RH (498457000) & LH (498457100).

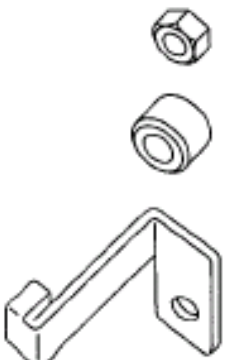
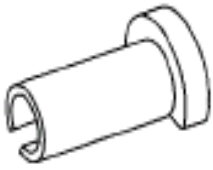
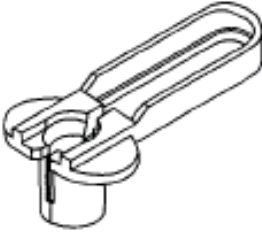
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2008 ENGINE Mechanical (H4DOTC) - Legacy & Outback

 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.
 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 the OIL SEAL INSTALLER (499587600).

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 ST-498277200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST42099AE000	42099AE000	CONNECTOR REMOVER	Used for disconnecting quick connector of the engine compartment.
 ST18371AA000	18371AA000 (Newly adopted tool)	CONNECTOR REMOVER	Used for disconnecting the quick connector on the fuel return hose of the engine compartment.
 ST1B020XU0	1B020XU0	SUBARU SELECT MONITOR KIT	Used for troubleshooting the electrical system.

GENERAL TOOL

GENERAL TOOL CHART

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.

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Timing light	Used for measuring ignition timing.
Vacuum gauge	Used for measuring intake manifold vacuum.
Oil pressure gauge	Used for measuring engine oil pressure.
Fuel pressure gauge	Used for measuring fuel pressure.

PROCEDURE

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

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

COMPRESSION

INSPECTION

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

1. Remove the collector cover.
2. After warming-up the engine, turn the ignition switch to OFF.
3. Make sure that the battery is fully charged.
4. Release the fuel pressure. <Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel.>
5. Remove all the spark plugs. <Ref. to **REMOVAL** , Spark Plug .>
6. Fully open the throttle valve.
7. Check the starter motor for satisfactory performance and operation.
8. Hold the compression gauge tightly against the spark plug hole.

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

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



Fig. 7: Measuring Cylinder Compression
 Courtesy of SUBARU OF AMERICA, INC.

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

Compression (200 - 300 rpm and fully open throttle):

Standard:

981 - 1,177 kPa (10 - 12 kgf/cm² , 142 - 171 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.
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, "P" or "N" range]:

750±100 rpm

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

Idle speed [A/C ON and gears in neutral, "P" or "N" range]:

800±100 rpm (MT model)

825±100 rpm (MT model)

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

IGNITION TIMING

INSPECTION

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

METHOD WITH SUBARU SELECT MONITOR

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm-up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Connect the Subaru Select Monitor to the data link connector.
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]:***12°±10°/750 (MT Model)******17°±10°/750 (AT Model)***

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

METHOD WITH TIMING LIGHT

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm-up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Remove the air intake duct.
5. Disconnect the connector of the air flow meter.
6. Remove the air cleaner cover and element.
7. Connect the timing light alligator clip to the power wire of #1 ignition coil.
8. Install the air cleaner cover, element and airflow sensor.
9. Start the engine, turn the timing light to the crank pulley, and check the ignition timing by means of crank pulley indicator.

Ignition timing [BTDC/rpm]:***12°±10°/750 (MT Model)******17°±10°/750 (AT Model)***

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 intake manifold, 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, the internal condition of the engine can be diagnosed as

described below.

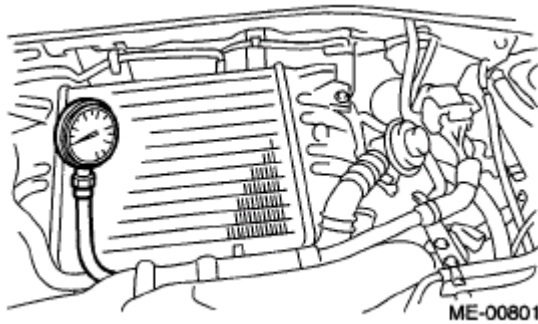


Fig. 8: Checking Vacuum Pressure

Courtesy of SUBARU OF AMERICA, INC.

Vacuum pressure (at idling, A/C OFF):

Less than -70.6 kPa (-530 mmHg, -20.85 inHg) (MT model)

Less than -68.0 kPa (-510 mmHg, -20.08 inHg) (AT model)

VACUUM GAUGE INDICATION CHART

Diagnosis of engine condition by measurement of intake manifold vacuum	
Vacuum gauge Indication	Possible engine condition
1. Needle is steady but lower than normal position. This tendency becomes more evident as engine temperature rises.	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. Disconnect the ground cable from the battery.

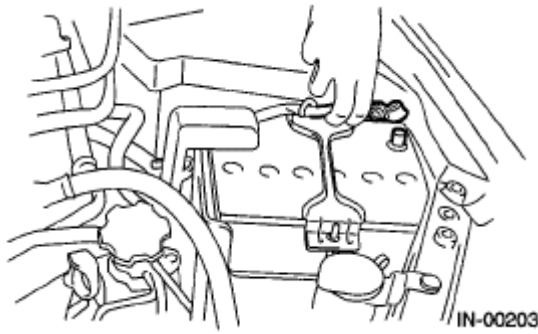


Fig. 9: Disconnecting Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

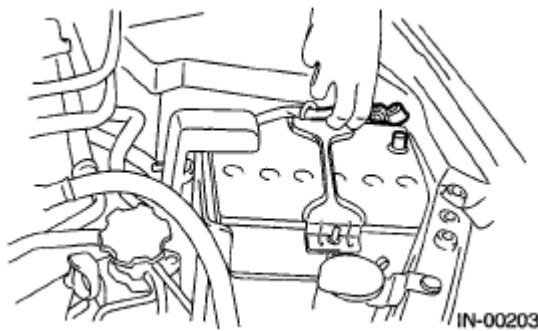


Fig. 10: Connecting Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

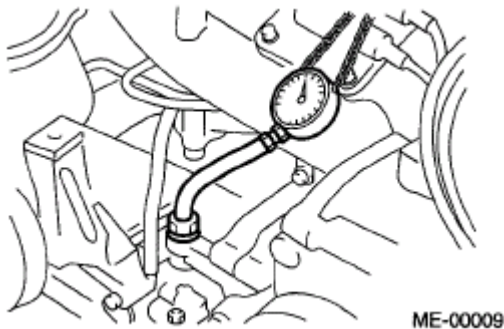


Fig. 11: Measuring Oil Pressure
Courtesy of SUBARU OF AMERICA, INC.

Oil pressure:

Standard:

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

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

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

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

7. 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.
 - Be careful not to spill fuel.
 - Catch the fuel from hoses using a container or cloth.

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

1. Remove the collector cover.
2. Release the fuel pressure. <Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel.>
3. Open the fuel filler flap lid, and remove the fuel filler cap.
4. Disconnect the fuel delivery hose from fuel damper valve, and connect fuel pressure gauge.
5. Install the fuse of fuel pump to the main fuse box.

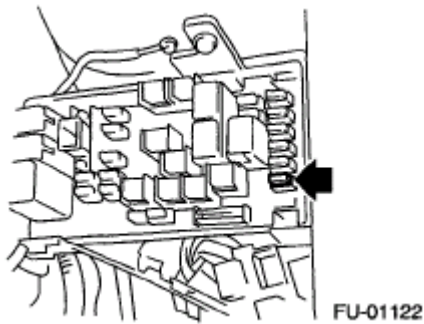


Fig. 12: Locating Fuse
Courtesy of SUBARU OF AMERICA, INC.

6. Start the engine.
7. Measure the fuel pressure while disconnecting pressure regulator vacuum hose from intake manifold.

Fuel pressure:

Standard: 284 - 314 kPa

(2.9 - 3.2 kgf/cm² , 41 - 46 psi)

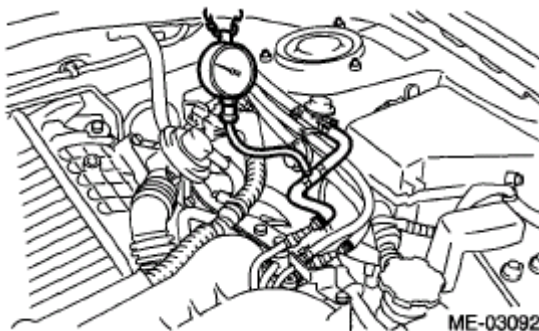


Fig. 13: Measuring Fuel Pressure
Courtesy of SUBARU OF AMERICA, INC.

8. After connecting the pressure regulator vacuum hose, measure the fuel pressure.

Fuel pressure:

Standard: 230 - 260 kPa

(2.35 - 2.65 kgf/cm² , 33 - 38 psi)

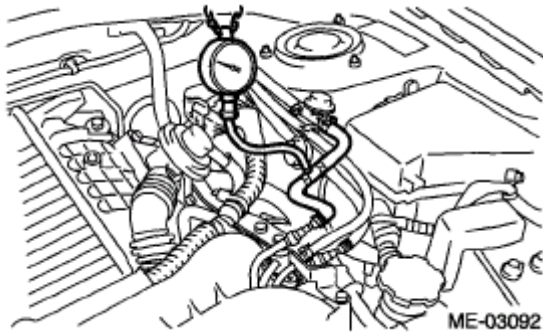


Fig. 14: Measuring Fuel Pressure
Courtesy of SUBARU OF AMERICA, INC.

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

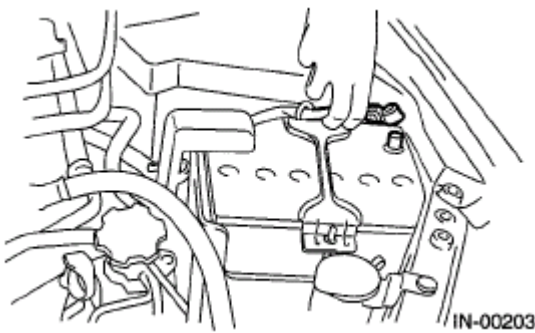


Fig. 15: Disconnecting Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the air intake duct. <Ref. to **REMOVAL** , Air Intake Duct.>
5. Remove a bolt which secures timing belt cover (RH).
6. Lift 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 the 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.
 2. Remove the secondary air pump. <Ref. to **REMOVAL** , Secondary Air Pump.>
 3. Disconnect the connector of ignition coil.
 4. Remove the ignition coil.
 5. Place a suitable container under the vehicle.
 6. Disconnect the PCV hose from the rocker cover (LH).
 7. Remove the bolts, then remove the rocker cover (LH).
12. Turn the crank pulley clockwise until the round mark and arrow mark on the camshaft sprocket are set to position shown in the figure.

NOTE: Turn the crankshaft using socket wrench.

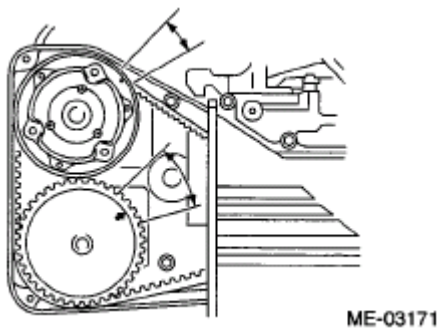


Fig. 16: Identifying Arrow Mark On Camshaft Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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.
- Measure the exhaust valve clearances while lifting-up the vehicle.

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.

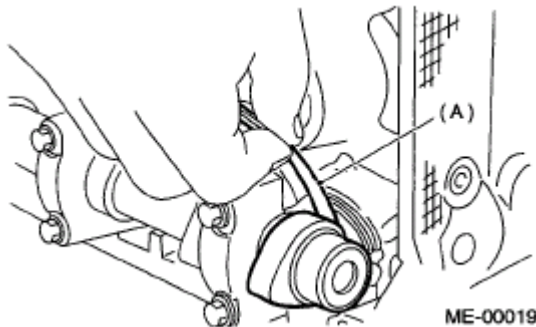


Fig. 17: Checking Valve Clearance
Courtesy of SUBARU OF AMERICA, INC.

14. If necessary, adjust the valve clearance. <Ref. to ADJUSTMENT, Valve Clearance.>
15. Further turn the crank pulley clockwise and then measure the valve clearances again.
 1. Set the round mark and 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.

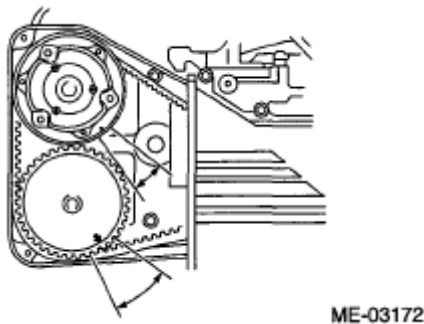
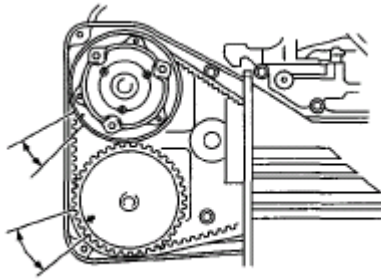


Fig. 18: Measuring #2 Cylinder Exhaust Valve And #3 Cylinder Intake Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

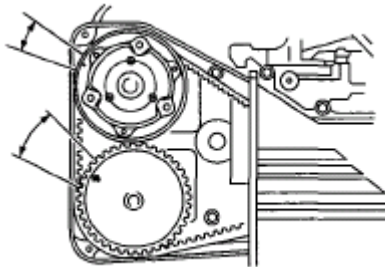
2. Set the round mark and arrow mark on cam sprocket to the position shown in the figure, and measure the #2 cylinder intake valve and #4 cylinder exhaust valve clearances.



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Fig. 19: Measuring #2 Cylinder Intake Valve And #4 Cylinder Exhaust Valve Clearances
Courtesy of SUBARU OF AMERICA, INC.

3. Set the round mark and 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.



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Fig. 20: Measuring #1 Cylinder Exhaust Valve And #4 Cylinder Intake Valve Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

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.

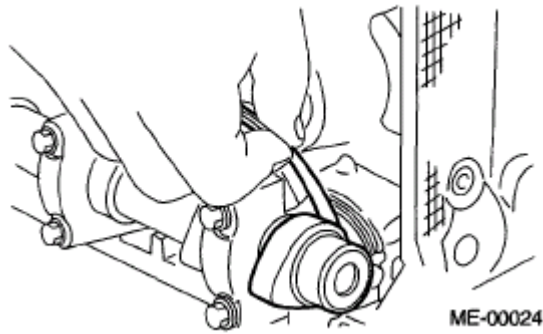


Fig. 21: Measuring Valve Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

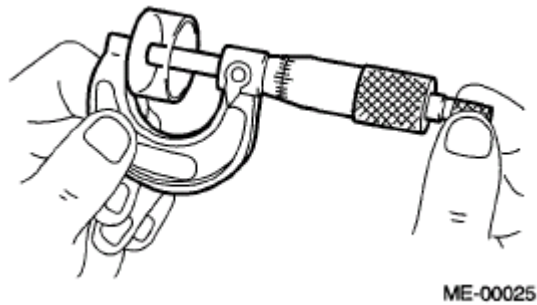


Fig. 22: Measuring Thickness Of Valve Lifter With Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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: Valve lifter thickness required
V: Measured valve clearance
T: Valve lifter thickness to be used

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)

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	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 valve clearance again at this time. 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. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel.>
6. Disconnect the ground cable from the battery.

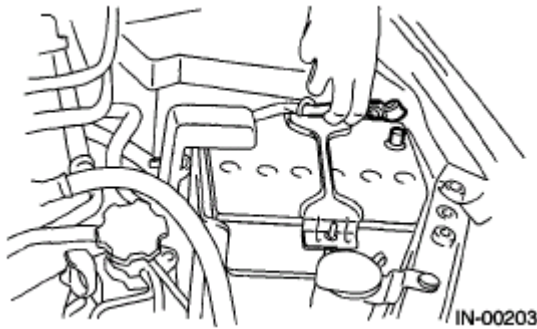


Fig. 23: Disconnecting Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

7. Open the fuel filler flap lid, and remove the fuel filler cap.
8. Remove the air intake duct and air cleaner case. <Ref. to **REMOVAL** , Air Intake Duct.> <Ref. to **REMOVAL** , Air Cleaner Case.>
9. Remove the intercooler. <Ref. to **REMOVAL** , Intercooler.>
10. Remove the radiator from vehicle. <Ref. to **REMOVAL** , Radiator.>

11. Remove the coolant filler tank. <Ref. to **REMOVAL** , Coolant Filler Tank.>
12. Disconnect the A/C pressure hoses from A/C compressor. <Ref. to **REMOVAL** , Hose and Tube.>
13. Disconnect the following connectors and cables.
 1. Engine harness connectors



Fig. 24: Locating Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

2. Engine ground terminal

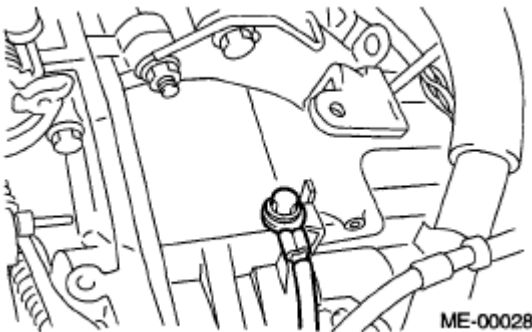


Fig. 25: Identifying Engine Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

3. Generator connector and terminal

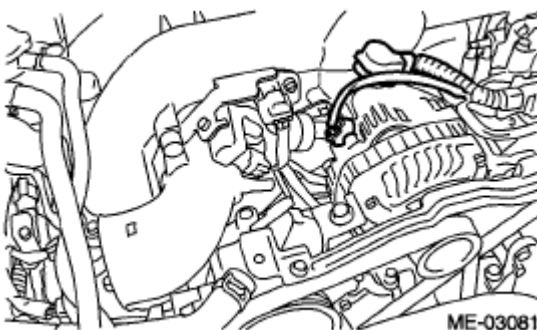


Fig. 26: Identifying Generator Connector

Courtesy of SUBARU OF AMERICA, INC.

4. A/C compressor connector

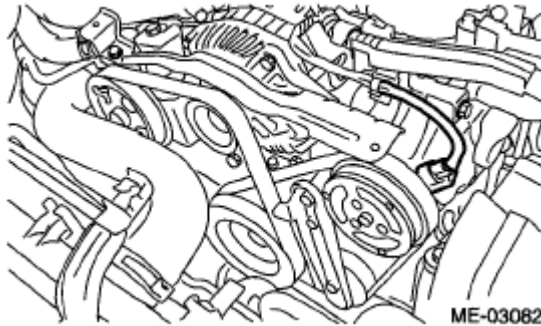


Fig. 27: Identifying A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

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

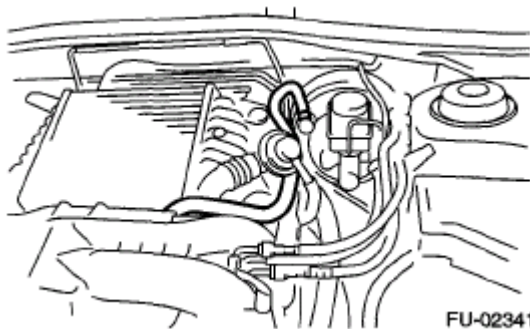


Fig. 28: Identifying Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

2. Heater inlet and outlet hoses
15. Remove the power steering pump from the bracket.
 1. Loosen the lock bolt and slider bolt, and remove the front side belt. <Ref. to **FRONT SIDE BELT, REMOVAL, V-belt.**>
 2. Disconnect the power steering pump switch connector.

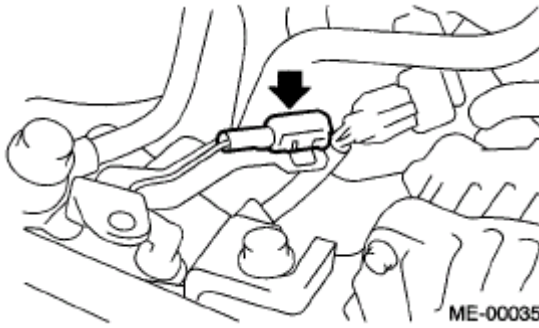


Fig. 29: Locating Power Steering Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the power steering pump from the engine. <Ref. to **REMOVAL** , Oil Pump.>

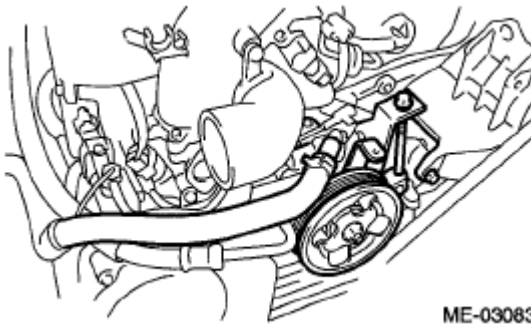


Fig. 30: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

4. Place the power steering pump on the right side wheel apron.
16. Lift the vehicle.
17. Remove the center exhaust pipe. <Ref. to **REMOVAL** , Center Exhaust Pipe .>
18. Remove the bolts and nuts which hold the lower side of transmission to the engine.

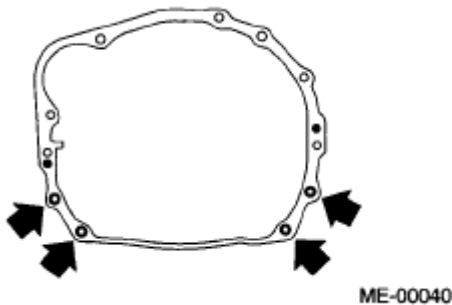


Fig. 31: Identifying Engine Transmission Bolts - Lower Side
Courtesy of SUBARU OF AMERICA, INC.

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

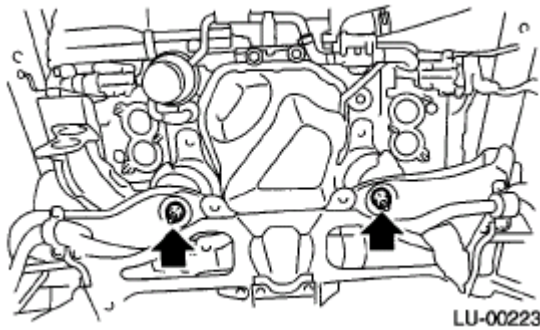


Fig. 32: Locating Front Cushion Rubber Onto Front Crossmember Nuts
Courtesy of SUBARU OF AMERICA, INC.

20. 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.

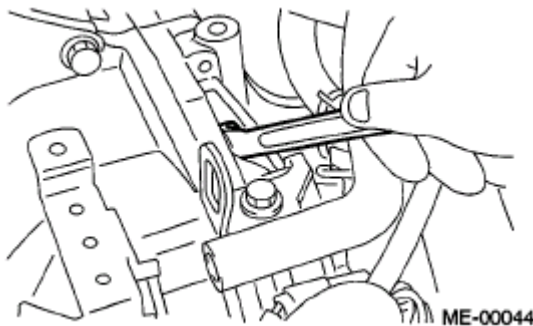


Fig. 33: Removing Torque Converter Bolts
Courtesy of SUBARU OF AMERICA, INC.

21. Remove the pitching stopper.

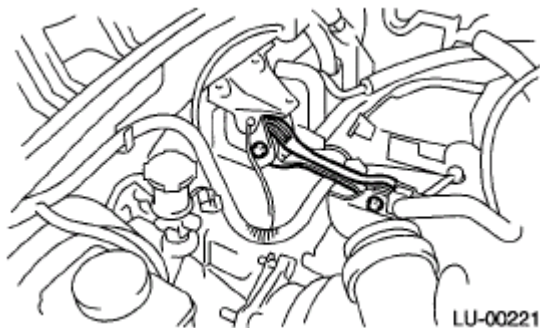


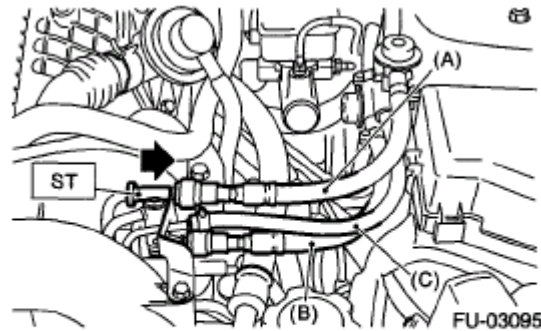
Fig. 34: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

22. Attach ST to the fuel delivery pipe and push ST in the direction of arrow mark to disconnect the fuel delivery hose.

ST 42099AE000 CONNECTOR REMOVER

CAUTION:

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



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

Fig. 35: Attaching ST To Fuel Delivery Pipe
Courtesy of SUBARU OF AMERICA, INC.

23. Disconnect the fuel return hose using the ST.

ST 18371AA000 CONNECTOR REMOVER

CAUTION:

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

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

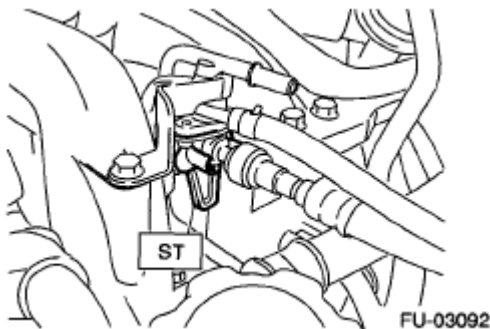


Fig. 36: Attaching ST To Fuel Return Pipe

Courtesy of SUBARU OF AMERICA, INC.

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

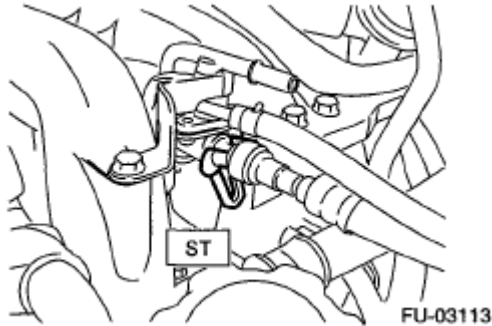


Fig. 37: Inserting Front Side Of ST Into Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

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

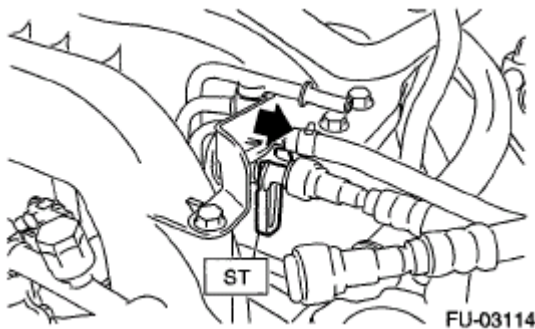


Fig. 38: Inserting Back Side Of ST Into Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

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

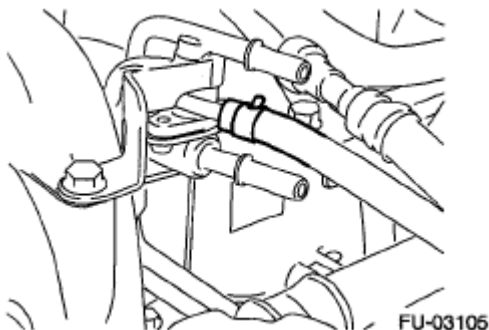


Fig. 39: Identifying Evaporation Hose
Courtesy of SUBARU OF AMERICA, INC.

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

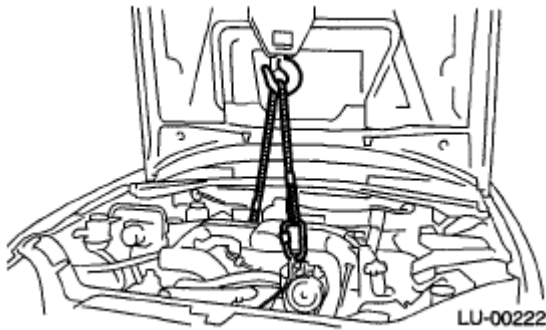
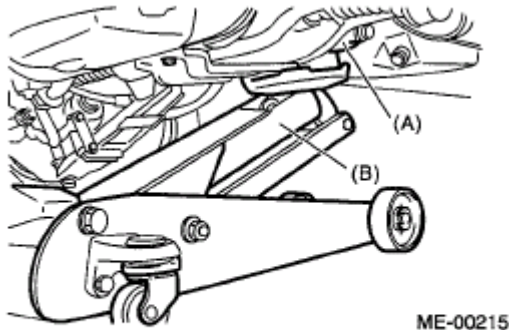


Fig. 40: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

26. Support the transmission with a garage jack.

CAUTION: Doing this is very important to prevent the transmission from lowering due to its own weight.



- (A) Transmission
(B) Garage jack

Fig. 41: 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. to **REMOVAL**, Starter.>
 2. Set the ST to torque converter clutch case. (AT model)

ST 498277200 STOPPER SET

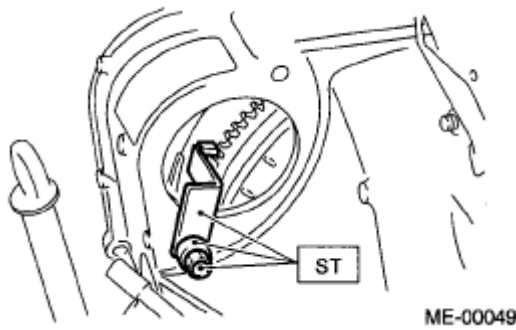


Fig. 42: Identifying Stopper Set ST 498277200 On Torque Converter
Courtesy of SUBARU OF AMERICA, INC.

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

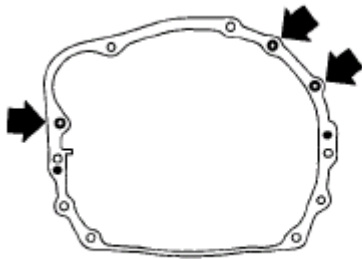


Fig. 43: Identifying Bolts For Right Upper Side Of Transmission To Engine
Courtesy of SUBARU OF AMERICA, INC.

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 to engine.

Tightening torque:

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

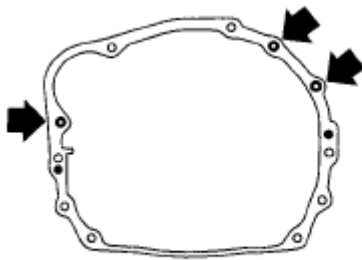
2. Apply a small amount of grease to splines of main shaft. (MT model)
3. Position the engine in engine compartment and align it with transmission.

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

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

Tightening torque:

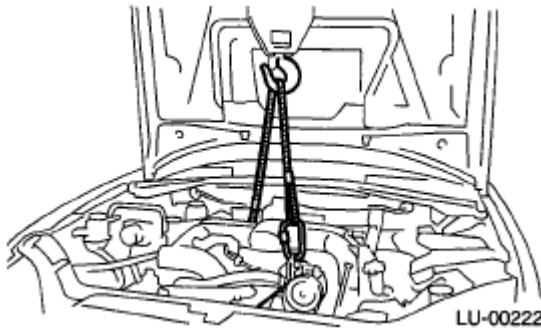
50 N.m (5.1 kgf-m, 36.9 ft-lb)



ME-00050

Fig. 44: Identifying Bolts For Right Upper Side Of Transmission To Engine
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.



LU-00222

Fig. 45: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

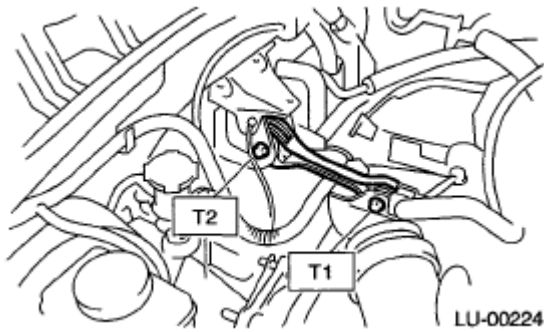


Fig. 46: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

9. Install the starter. <Ref. to **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)

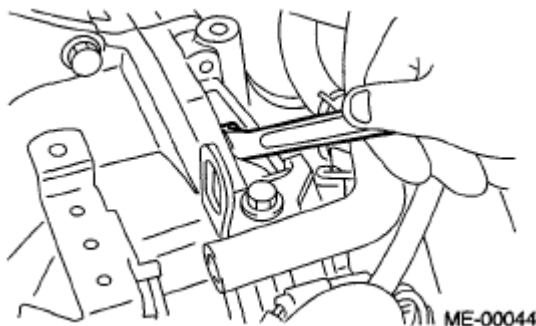


Fig. 47: Holding Torque Converter
Courtesy of SUBARU OF AMERICA, INC.

11. Fit the plug to service hole.
12. Install the power steering pump.

1. Install the power steering pump.

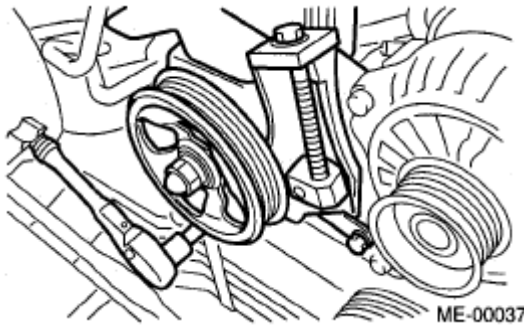
Tightening torque:***20.1 N.m (2.05 kgf-m, 14.8 ft-lb)***

Fig. 48: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the power steering pump switch connector.

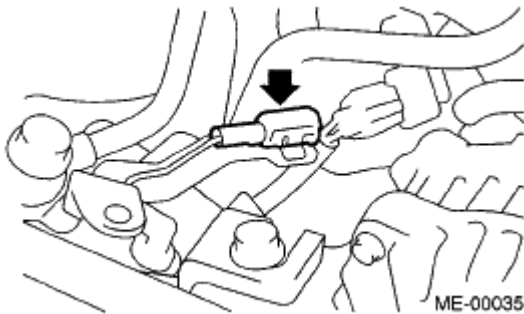


Fig. 49: Locating Power Steering Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

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

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

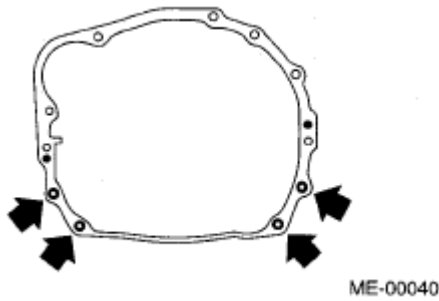


Fig. 50: Identifying Engine Transmission Nuts - Lower Side
Courtesy of SUBARU OF AMERICA, INC.

15. 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 that the front cushion rubber mounting bolts and locator are securely installed.

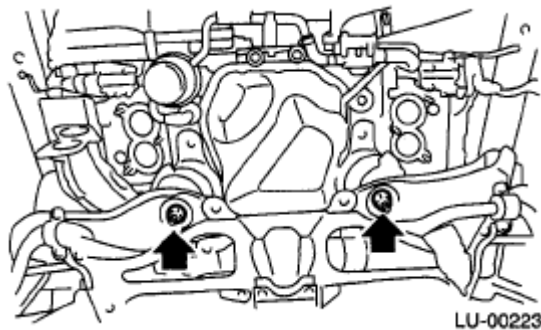


Fig. 51: Locating Front Cushion Rubber Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

16. Install the center exhaust pipe. <Ref. to **INSTALLATION** , Center Exhaust Pipe .>
17. Lower the vehicle.
18. Connect the following hoses.
 1. Fuel delivery hose, return hose and evaporation hose
 2. Heater inlet and outlet hoses
 3. Brake booster vacuum hose
 4. Pressure regulator hose
19. Connect the following connectors and terminals.
 1. Engine ground terminal
 2. Engine harness connectors

3. Generator connector and terminal
4. A/C compressor connector
20. Install the intercooler. <Ref. to **INSTALLATION** , Intercooler.>
21. Install the air cleaner case and air intake duct. <Ref. to **INSTALLATION** , Air Cleaner Case.> <Ref. to **INSTALLATION** , Air Intake Duct.>
22. Install the A/C pressure hoses. <Ref. to **INSTALLATION** , Hose and Tube.>
23. Install the radiator. <Ref. to **INSTALLATION** , Radiator.>
24. Install the coolant filler tank. <Ref. to **INSTALLATION** , Coolant Filler Tank.>
25. Install the battery to the vehicle, and connect the battery ground terminal.
26. Fill engine coolant. <Ref. to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant.>
27. Charge the A/C system with refrigerant. <Ref. to **PROCEDURE** , Refrigerant Charging Procedure.>
28. Check the ATF level and replenish it if necessary. <Ref. to **REPLACEMENT** , Automatic Transmission Fluid .>
29. Install the collector cover.
30. Remove the front hood stay, and close the front hood.
31. Lower the vehicle from the lift.

INSPECTION

1. Check that the pipes and hoses are connected securely.
2. Check the engine coolant and ATF are at specified levels.

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.

NOTE: **Make sure the engine mounting cover of the RH side is securely installed.**

Tightening torque:

Engine mounting:

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

INSPECTION

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

PREPARATION FOR OVERHAUL

PROCEDURE

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

ST1 498457000 ENGINE STAND ADAPTER

RH ST2 498457100 ENGINE STAND ADAPTER

LH ST3 499817100 ENGINE STAND

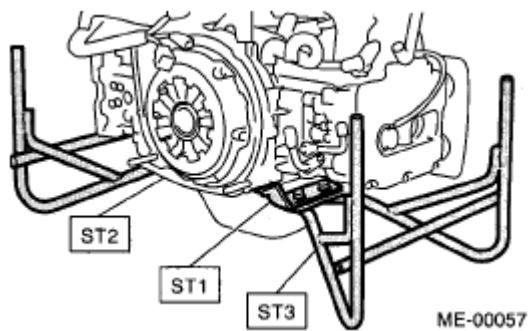


Fig. 52: Identifying Engine Stand Adapters And Engine Stand
Courtesy of SUBARU OF AMERICA, INC.

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. Remove the air intake duct. <Ref. to **REMOVAL** , Air Intake Duct.>.
3. Remove the collector cover bracket.

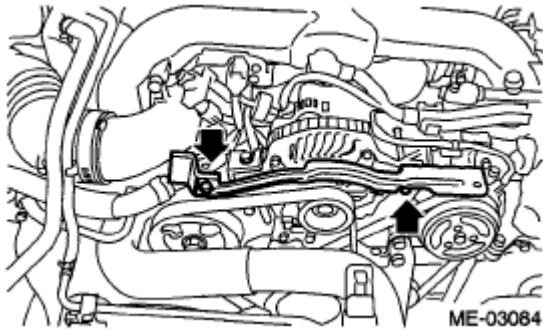


Fig. 53: Locating Collector Cover Bracket
Courtesy of SUBARU OF AMERICA, INC.

4. Loosen the lock bolt (A).
5. Loosen the slider bolt (B).
6. Remove the front side belt (C).

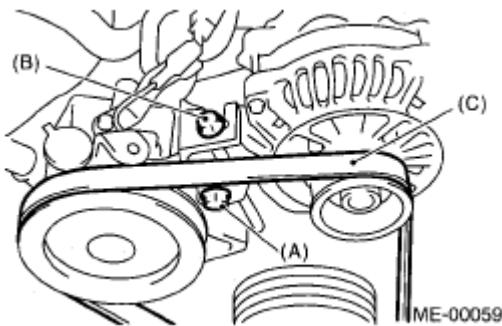


Fig. 54: Identifying Front Side Belt
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

1. Remove the front side belts. <Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt.>
2. Loosen the lock nut (A).
3. Loosen the slider bolt (B).

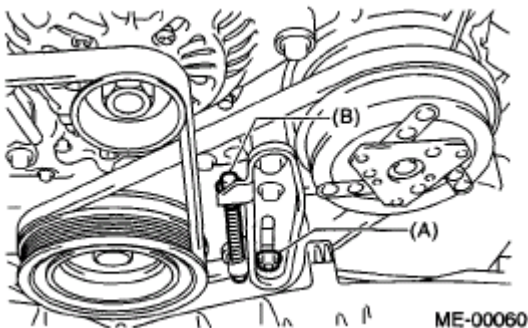


Fig. 55: Identifying Rear Side Belt Slider Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

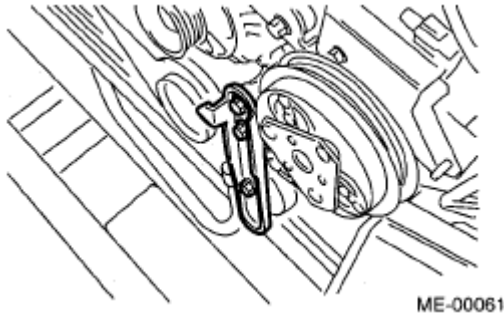


Fig. 56: Identifying A/C Belt And A/C Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

NOTE: Wipe off any oil or 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 (A):

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

Slider bolt (B):

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

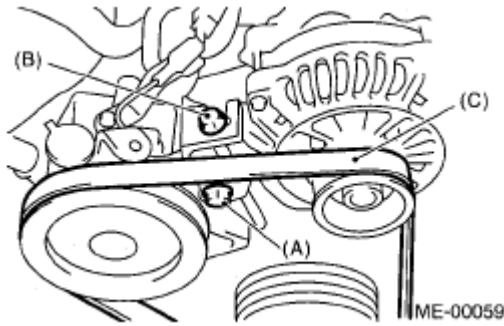


Fig. 57: Identifying Front Side Belt
Courtesy of SUBARU OF AMERICA, INC.

4. Install the collector cover bracket.

Tightening torque:

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

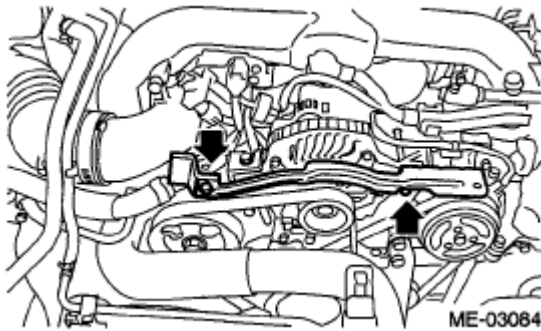


Fig. 58: Locating Collector Cover Bracket
Courtesy of SUBARU OF AMERICA, INC.

5. Install the air intake duct. <Ref. to INSTALLATION , Air Intake Duct.>
6. Install the collector cover.

REAR SIDE BELT

1. Install the belt tensioner.
2. Install the 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)

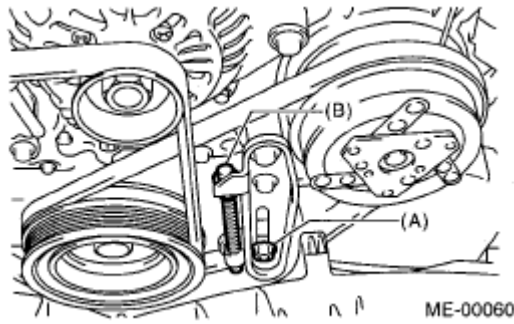


Fig. 59: Identifying Lock And Slider Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Install the front side belt. <Ref. to **FRONT SIDE BELT**, INSTALLATION, V-belt.>

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 the generator installing position 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 - 640 N (50 - 65 kgf, 110 - 144 lb)

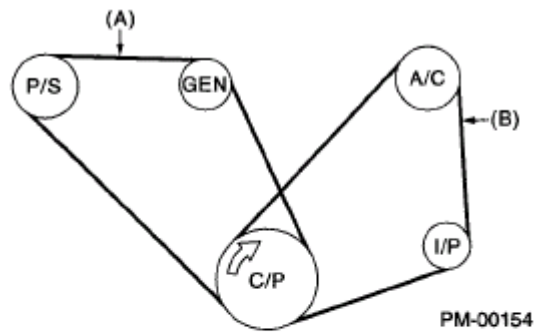
(B)

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. 60: V-Belt Operation Diagram

Courtesy of SUBARU OF AMERICA, INC.

Belt tension (when not using a 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)

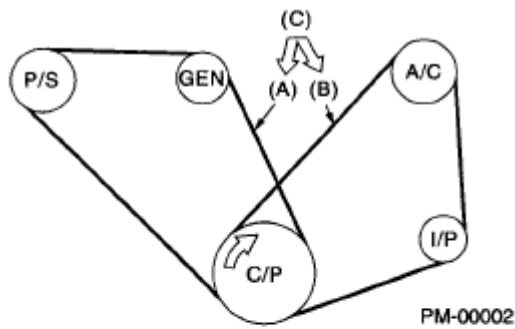
(B)

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) 98 N (10 kgf, 22 lbf)
- C/P Crank pulley
- GEN Generator
- P/S Power steering oil pump pulley
- A/C Air conditioning compressor pulley
- I/P Idler pulley

Fig. 61: V-Belt Operation Diagram
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

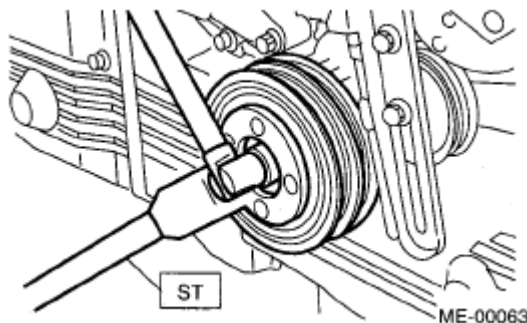


Fig. 62: Installing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

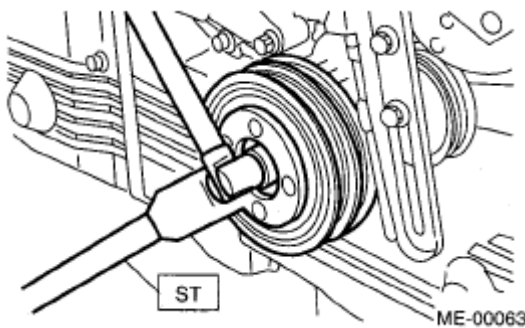


Fig. 63: Installing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

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

1. Replace the crank pulley bolts and clean them.

Crank pulley bolt:***Part No. 12369AA011***

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

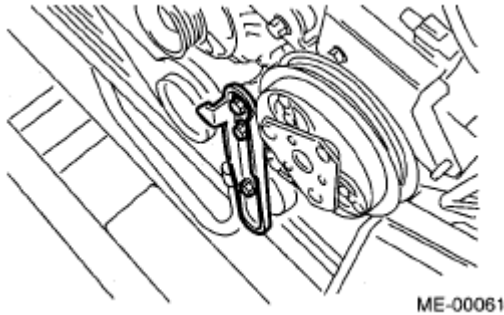


Fig. 64: Identifying A/C Belt And A/C Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

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. to INSPECTION, V-belt.>

TIMING BELT COVER

REMOVAL

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

1. Remove the secondary air pump. <Ref. to REMOVAL , Secondary Air Pump.>
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 (LH) (A).
5. Remove the timing belt cover (RH) (B).
6. Remove the front timing belt cover (C).

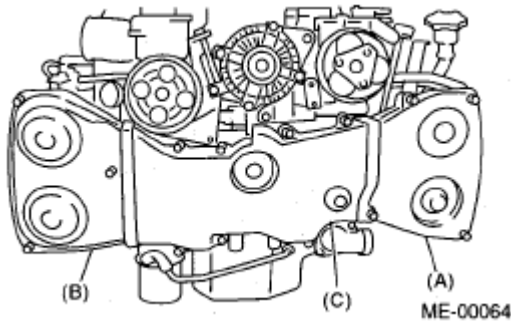


Fig. 65: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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)

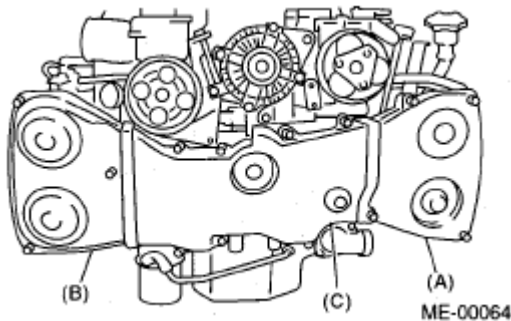


Fig. 66: Identifying Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

5. Install the V-belts. <Ref. to **INSTALLATION**, V-belt.>
6. Install the secondary air pump. <Ref. to **INSTALLATION** , Secondary Air Pump.>

INSPECTION

Check the cover for damage.

TIMING BELT

REMOVAL

TIMING BELT

NOTE: Perform the work with the engine installed to body when replacing a single part.
For operation procedures, <Ref. to **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)

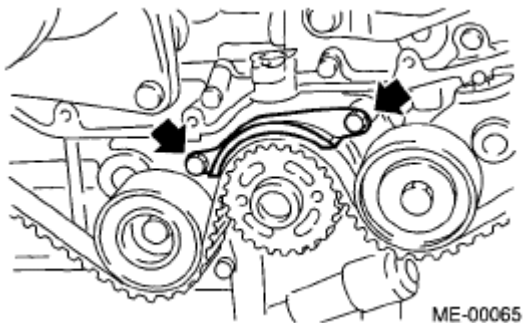


Fig. 67: Identifying Timing Belt Guides (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

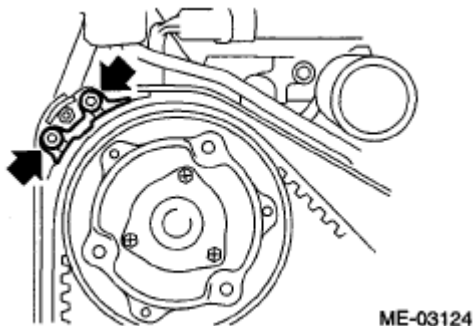


Fig. 68: Identifying Timing Belt Guides (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

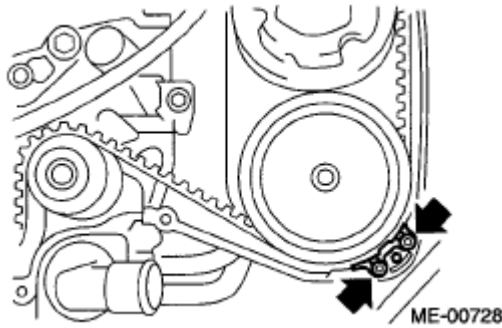


Fig. 69: Identifying Timing Belt Guides (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

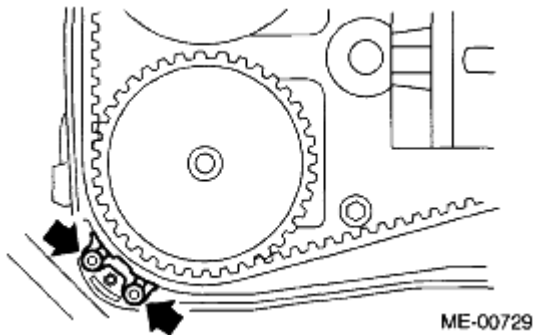


Fig. 70: Identifying Timing Belt Guide Bolts (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

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

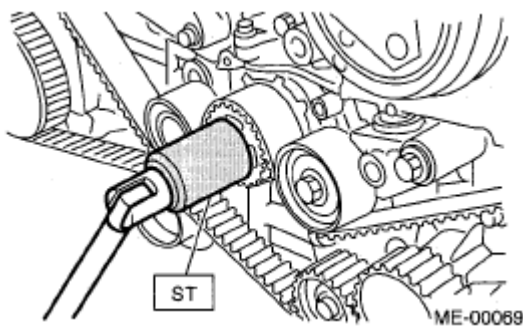


Fig. 71: Turning Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

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

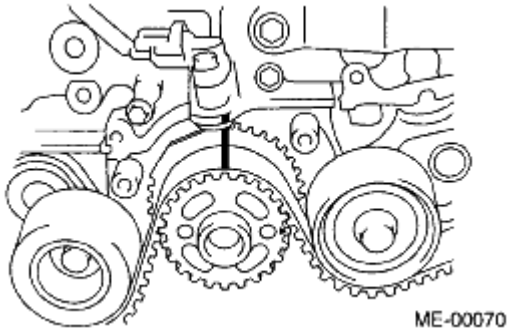


Fig. 72: Aligning Alignment Marks On Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

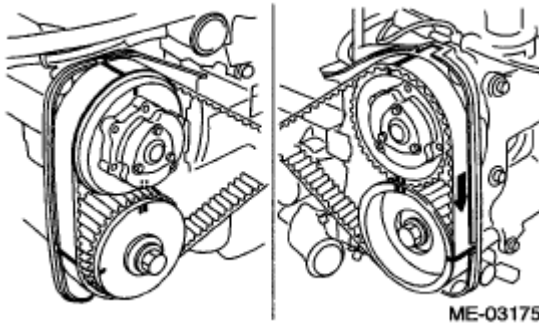


Fig. 73: Aligning Alignment Marks On Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 54.5 teeth

Z_2 : 51 teeth

Z_3 : 28 teeth

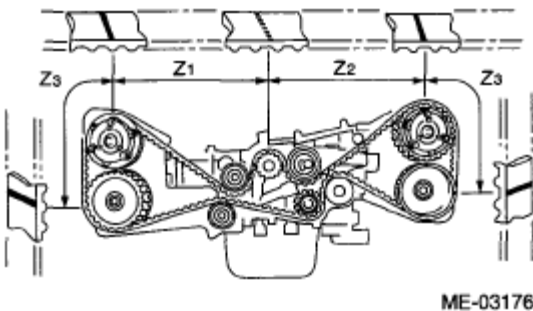


Fig. 74: Aligning Timing Belt Teeth

Courtesy of SUBARU OF AMERICA, INC.

6. Remove the belt idler (A).

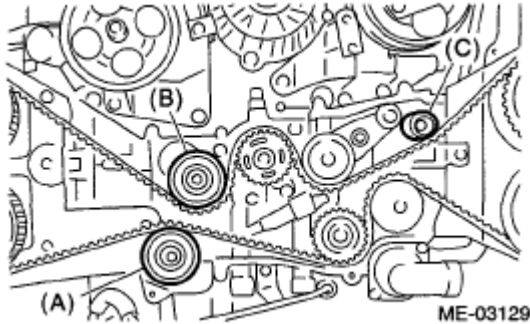


Fig. 75: Identifying Belt Idler

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).

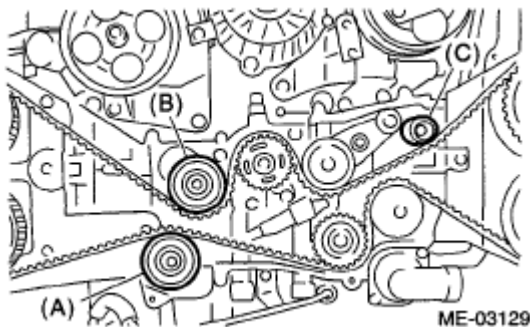


Fig. 76: Identifying Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the belt idler No. 2.

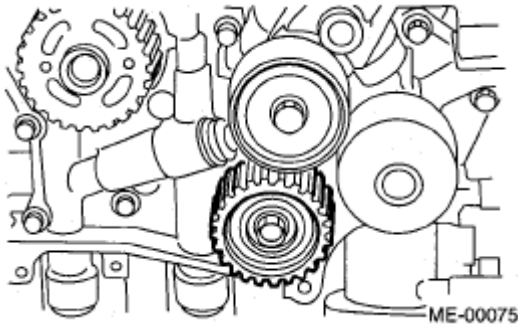


Fig. 77: Identifying Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the automatic belt tension adjuster assembly.

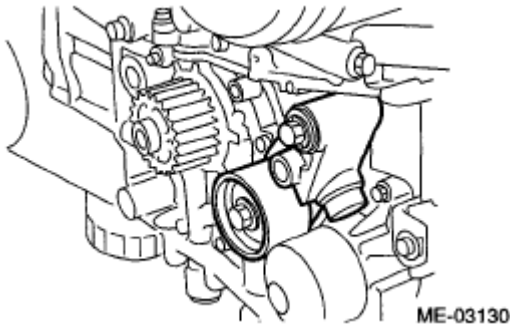


Fig. 78: Identifying Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

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

CAUTION:

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

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

1. Attach the automatic belt tension adjuster assembly to vertical pressing tool.
2. Slowly move the adjuster rod down with a pressure of 294 N (30 kgf, 66 lb) or more until the adjuster rod is aligned with the stopper pin hole in the cylinder.

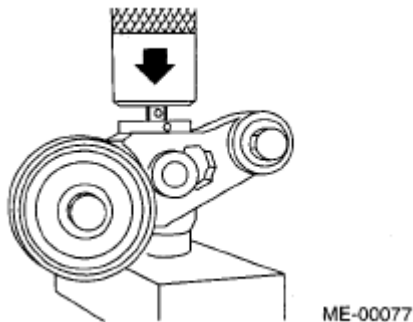


Fig. 79: Attaching Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

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

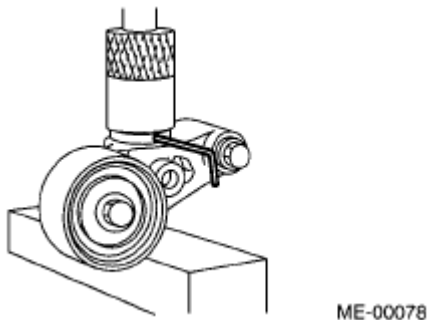
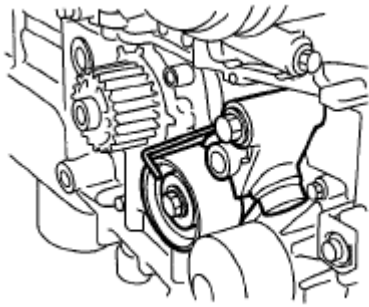


Fig. 80: Identifying Stopper Pin Hole In Cylinder
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

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



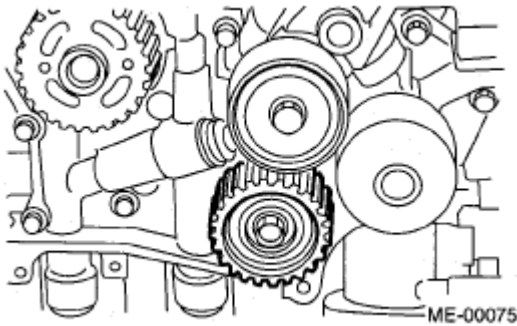
ME-03131

Fig. 81: 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)



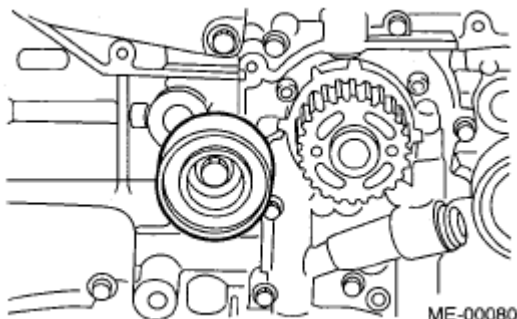
ME-00075

Fig. 82: 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)



ME-00080

Fig. 83: Identifying Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

1. Prepare 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.

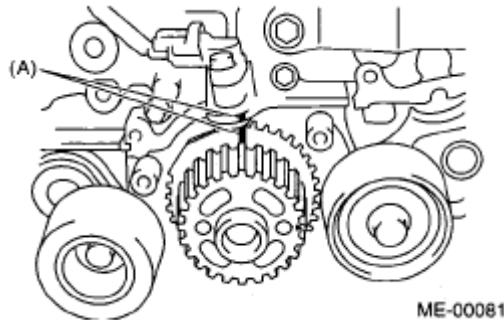


Fig. 84: Aligning Mark On Crank Sprocket With Mark On Oil Pump Cover Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

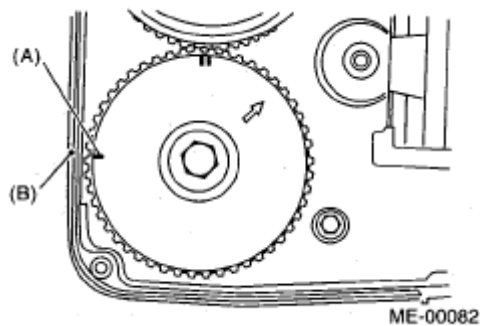


Fig. 85: Aligning Single Line Mark On Exhaust Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

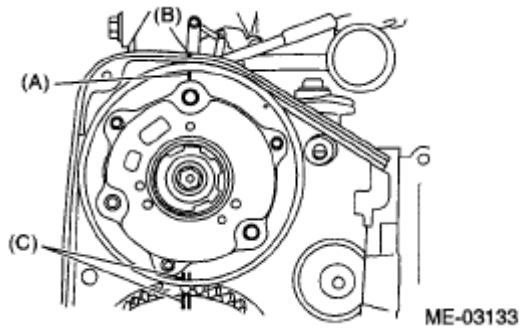


Fig. 86: Aligning Single Line Mark On Intake Cam Sprocket With Notch On Timing Belt Cover
 Courtesy of SUBARU OF AMERICA, INC.

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).

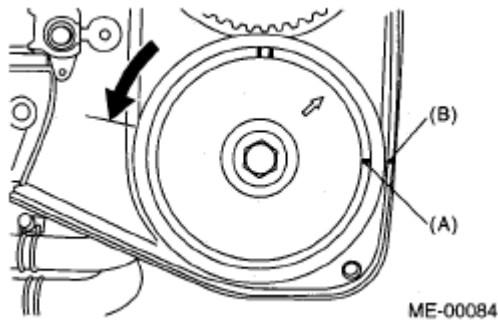


Fig. 87: Aligning Single Line Mark On Exhaust Cam Sprocket
 Courtesy of SUBARU OF AMERICA, INC.

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 the intake and exhaust cam sprockets are aligned.

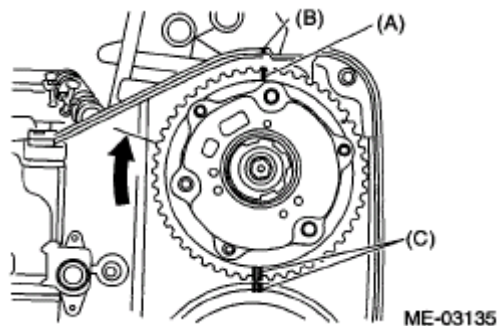


Fig. 88: Aligning Single Line Mark On Intake Cam Sprocket With Notch On Timing Belt Cover
 Courtesy of SUBARU OF AMERICA, INC.

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.

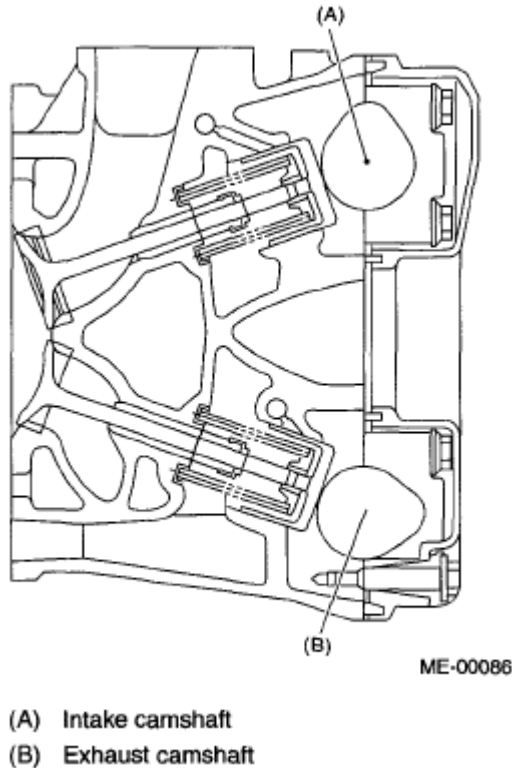
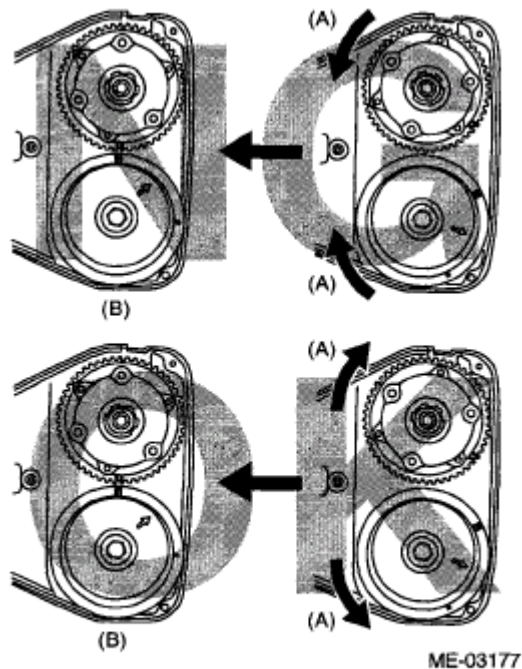


Fig. 89: Identifying Intake And Exhaust Camshaft
Courtesy of SUBARU OF AMERICA, INC.

- 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 heads.



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

Fig. 90: Caution For - Camshafts Rotation
Courtesy of SUBARU OF AMERICA, INC.

8. Install the 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:

- If the timing belt slips by 3 or more teeth, the valve and piston may hit each other.
- Make sure that the direction of belt rotation is correct.

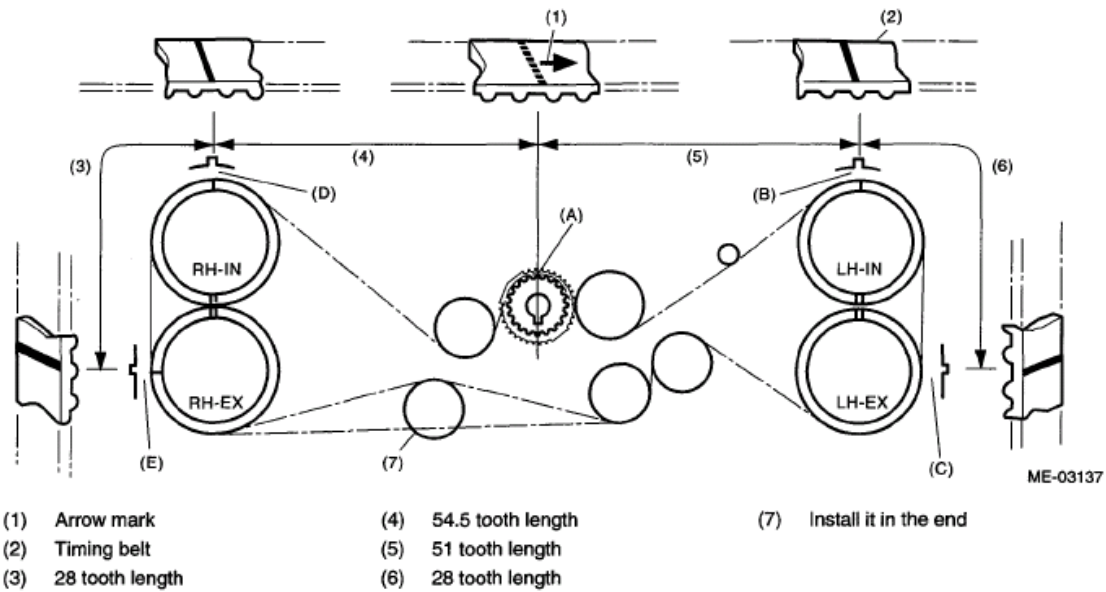


Fig. 91: Drive Belt Rotation Diagram
Courtesy of SUBARU OF AMERICA, INC.

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.

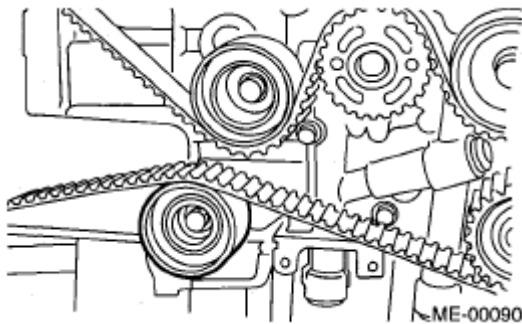


Fig. 92: Identifying Belt Idler
Courtesy of SUBARU OF AMERICA, INC.

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 threaded portion of timing belt cover before attaching

bolts.

- **Apply liquid gasket to the threaded portion of cam sprocket, (when reusing bolts)**

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or 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)

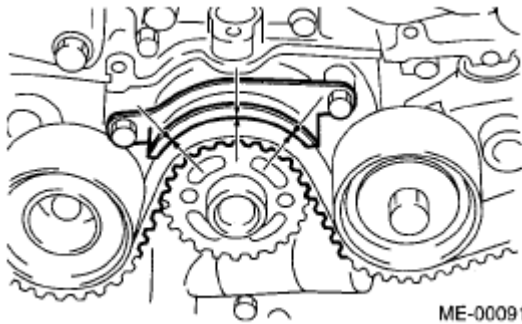


Fig. 93: Checking Clearance Between Timing Belt And Timing Belt Guide (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

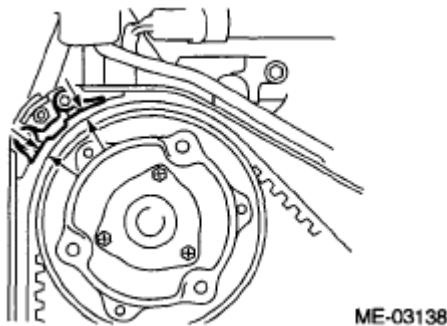


Fig. 94: Checking Clearance Between Timing Belt And Timing Belt Guide (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

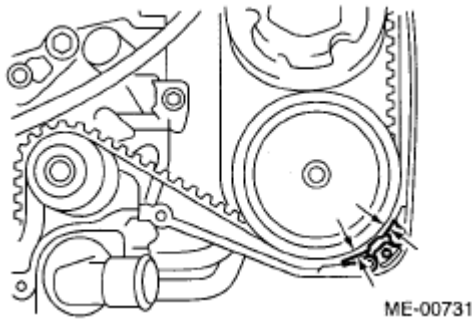


Fig. 95: Checking Clearance Between Timing Belt And Timing Belt Guide (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

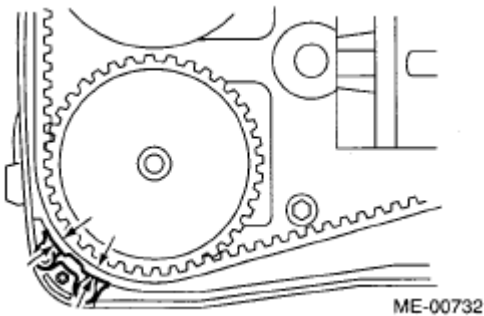


Fig. 96: Checking Clearance Between Timing Belt And Timing Belt Guide (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

Tightening torque:

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

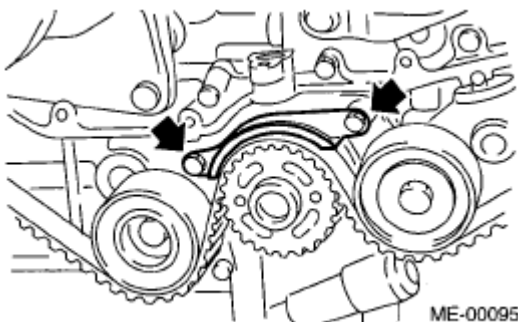


Fig. 97: Identifying Timing Belt Guide Bolts (1 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

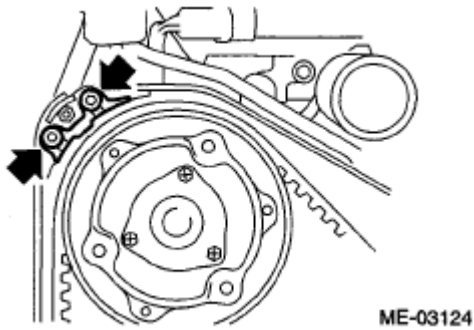


Fig. 98: Identifying Timing Belt Guide Bolts (2 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

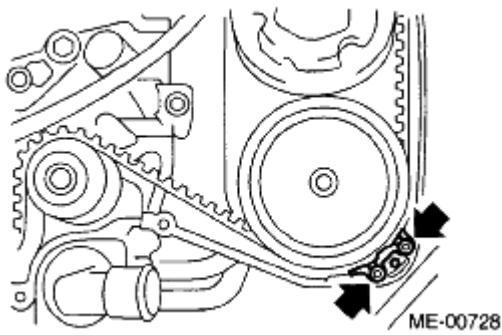


Fig. 99: Identifying Timing Belt Guide Bolts (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

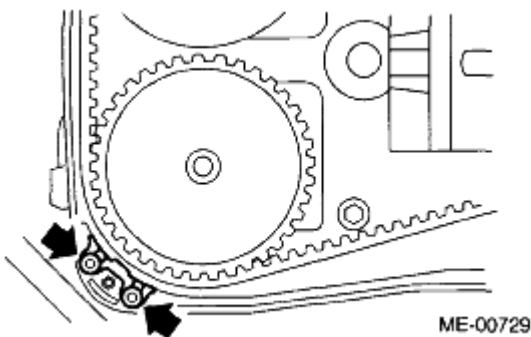


Fig. 100: Identifying Timing Belt Guide Bolts (4 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

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

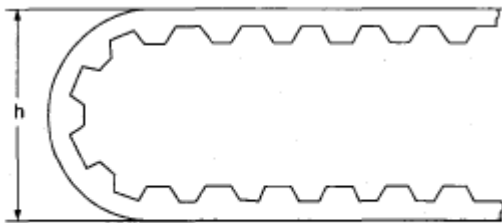
1. Check the timing belt teeth for breaks, cracks or wear. If any fault is found, replace the timing belt.
2. Check the condition on the back surface of the timing belt. If cracks are found, replace the timing belt.

CAUTION:

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

In radial diameter h:

60 mm (2.36 in) or more



ME-00099

Fig. 101: Identifying Bending Radius
Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

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

NOTE: Slight traces of oil on the oil seal of the rod does not indicate a problem.

2. Check that the adjuster rod does not move when a pressure of 294 N (30 kgf, 66 lb) is applied to it. This is to check adjuster rod stiffness.
3. If the adjuster rod is not stiff and moves freely when applying 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 moved all the way up, apply a pressure of 294 N (30 kgf, 66 lb) to it. Check

the adjuster rod stiffness.

3. If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new part.

CAUTION:

- Always use a vertical type pressing tool to move the adjuster rod down.
- Do not use a lateral type vise.
- Push the adjuster rod vertically.
- Press-in the push adjuster rod gradually taking three minutes or more.
- Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 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.

4. Measure the amount of rod protrusion "H" beyond the body. If it is not within specified range, replace with new part.

Amount of rod protrusion H:

5.2 - 6.2 mm (0.205 - 0.244 in)

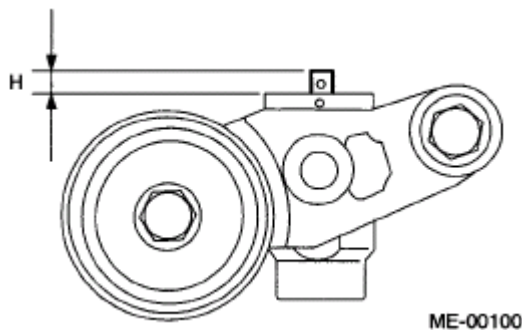


Fig. 102: Measuring Amount Of Rod Protrusion
 Courtesy of SUBARU OF AMERICA, INC.

BELT TENSION PULLEY

1. Check the mating surfaces of timing belt and contact point of adjuster rod for abnormal wear or scratches. If defective, replace the belt tension pulley.
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. Remove the actuator cover of the intake cam sprocket.
6. Fasten the cam sprocket and remove from the cam shaft using ST.

ST 499207400 CAM SPROCKET WRENCH

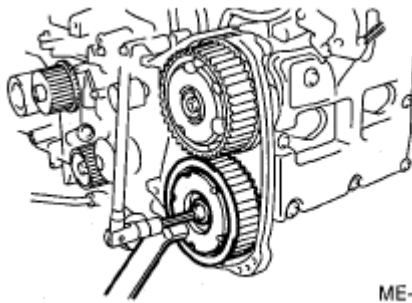


Fig. 103: Fastening Cam Sprocket (Exhaust)
Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH

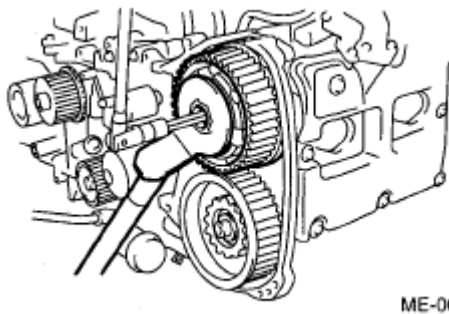


Fig. 104: Fastening Cam Sprocket (Intake)
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

NOTE: Do not confuse the cam sprockets (LH) and (RH) during installation.

ST 499207400 CAM SPROCKET WRENCH

Tightening torque:

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

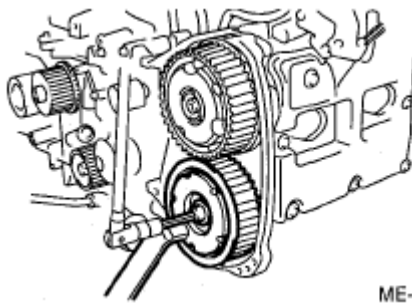


Fig. 105: Installing Cam Sprocket (Exhaust)
Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH

Tightening torque:

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

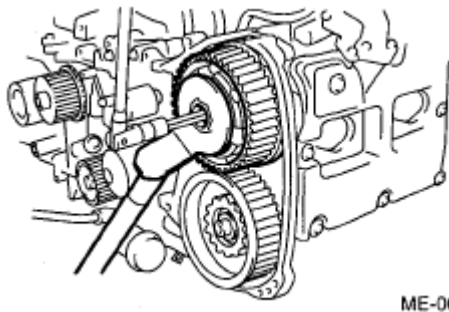


Fig. 106: Installing Cam Sprocket (Intake)
Courtesy of SUBARU OF AMERICA, INC.

2. Attach the actuator cover of the intake cam sprocket.

NOTE: Use new O-rings.

Tightening torque:***3.4 N.m (0.3 kgf-m, 2.5 ft-lb)***

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

INSPECTION

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

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.

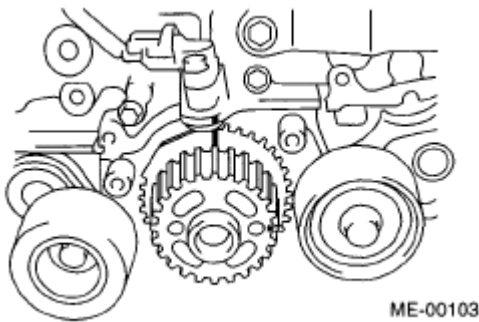


Fig. 107: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

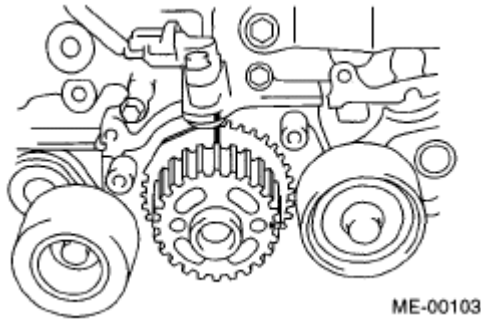


Fig. 108: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

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

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.

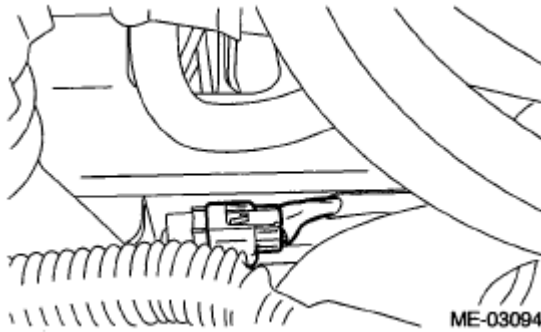


Fig. 109: Identifying Oil Flow Control Solenoid Valve Assembly Connector
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the tensioner bracket.

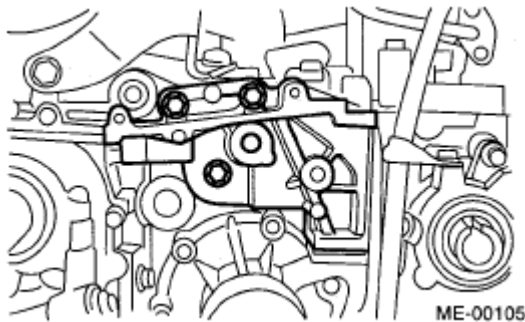


Fig. 110: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

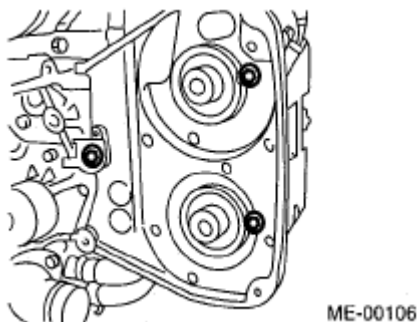


Fig. 111: Identifying Timing Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

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

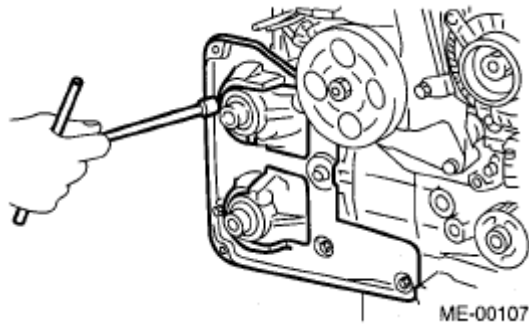
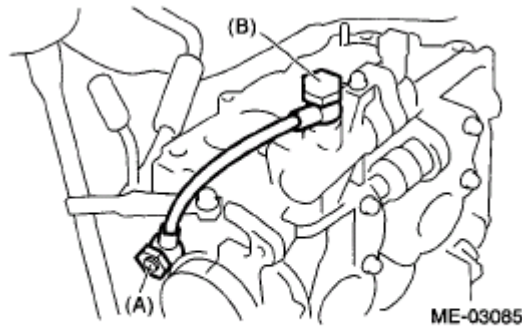


Fig. 112: Identifying Timing Belt Cover Bolts (RH)
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the ignition coil.
11. Disconnect the PCV hose from the rocker cover.
12. Remove the oil level gauge guide. (LH side)
13. Remove the rocker cover and gasket.
14. Remove the oil pipe.



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

Fig. 113: Identifying Oil Pipe Screw
Courtesy of SUBARU OF AMERICA, INC.

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

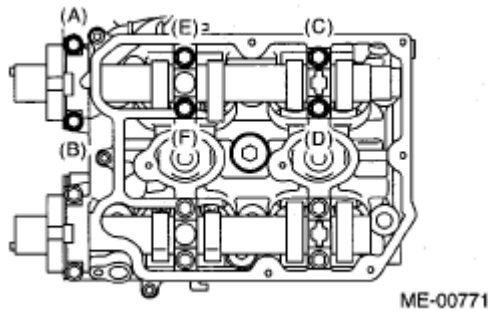


Fig. 114: Identifying Intake Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

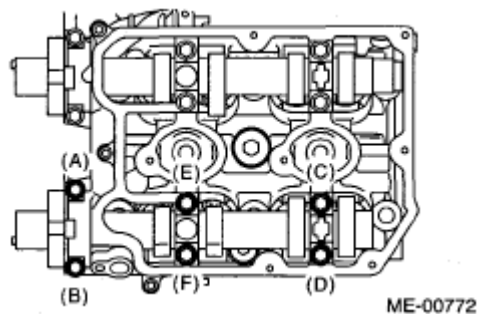


Fig. 115: Identifying Exhaust Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the oil flow control solenoid valve assembly, intake camshaft cap and camshaft.
18. Remove the exhaust camshaft caps and camshaft.

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

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

INSTALLATION

1. Install the camshaft.

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 lobe.

NOTE:

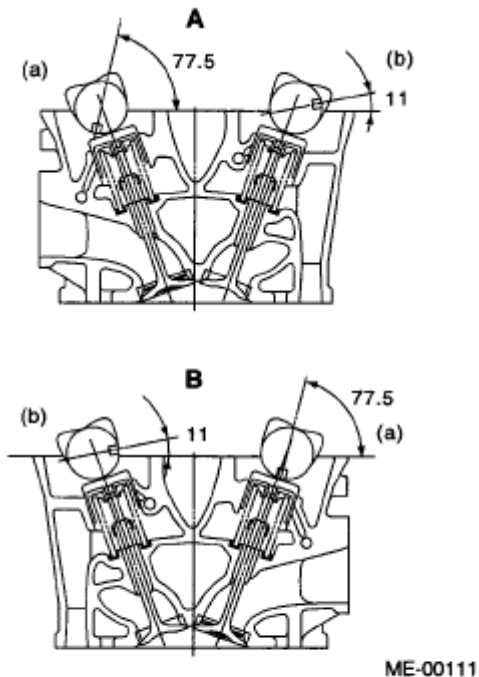
- Set the camshaft to the position shown in the figure. It is necessary to rotate the camshaft (LH) slightly when installing the timing belt.
- Camshaft (RH) need not be rotated when set at the position shown in the figure.

Intake camshaft (LH):

Rotate 80° clockwise.

Exhaust camshaft (LH):

Rotate 45° counterclockwise.



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

Fig. 116: Identifying Camshaft Angle & Position

Courtesy of SUBARU OF AMERICA, INC.

2. Install the camshaft cap and oil flow control solenoid valve assembly.
 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

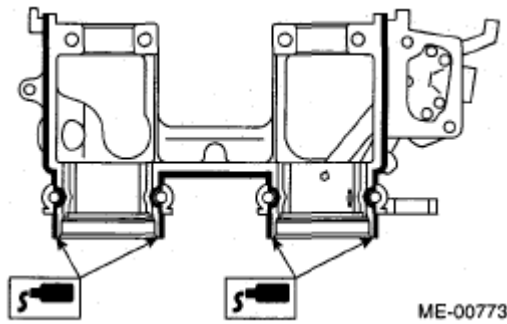


Fig. 117: Applying Liquid Gasket To Cap Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

2. Apply a thin coat of engine oil to the cap bearing surface, and install the cap to the camshaft according to the identification mark.
3. Gradually tighten the camshaft cap and oil control valve assembly in at least two stages in alphabetical order 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)

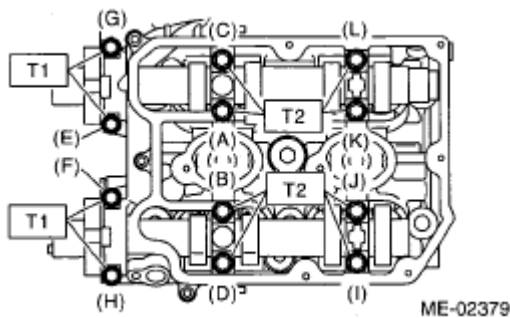


Fig. 118: Identifying Camshaft Caps Bolts
Courtesy of SUBARU OF AMERICA, INC.

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 camshaft oil seal periphery and oil seal lips, then install the oil seal on the camshaft using ST1 and ST2.

NOTE: Use a new oil seal.

ST1 499587600 OIL SEAL INSTALLER

ST2 499597200 OIL SEAL GUIDE

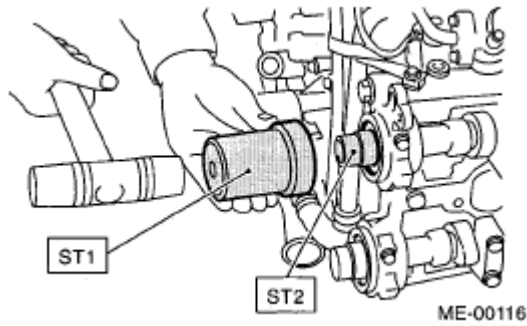


Fig. 119: Installing Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: **Use a new gasket.**

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

NOTE: **Apply extra amount of liquid gasket around semicircular plugs 5 mm or more.**

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent

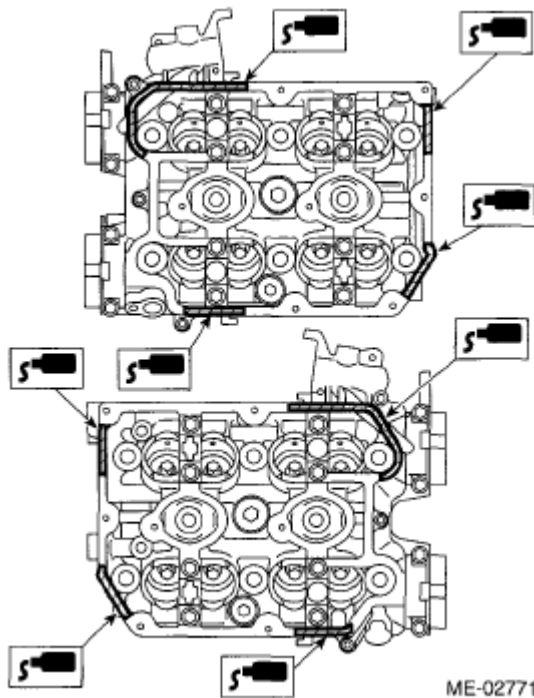


Fig. 120: Identifying Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

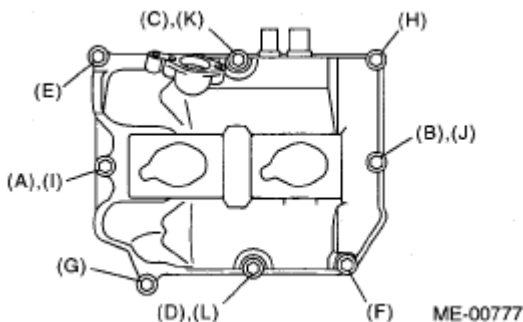


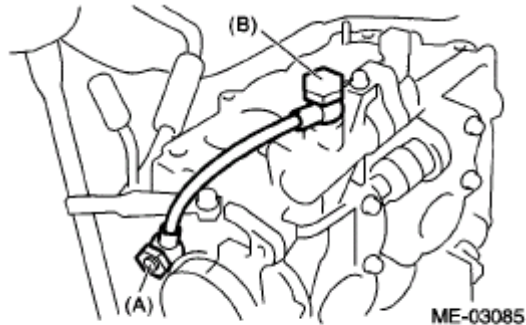
Fig. 121: Identifying Rocker Cover Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Install the oil pipe.

CAUTION: Install to the position shown in the figure as the head side and oil flow control solenoid valve side of union screw are of different specification.

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. 122: Identifying Oil Pipe Screw
Courtesy of SUBARU OF AMERICA, INC.

6. Connect the oil flow control solenoid valve connector.

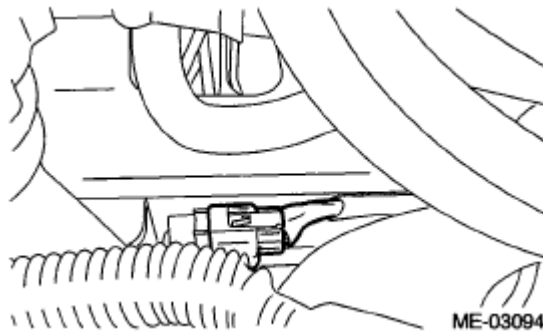


Fig. 123: Identifying Oil Flow Control Solenoid Valve Connector
Courtesy of SUBARU OF AMERICA, INC.

7. Connect the PCV hose to the rocker cover.
8. Tighten the ignition coil.
9. Similarly, install the parts on right-hand side.
10. Install the tensioner bracket.

Tightening torque:

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

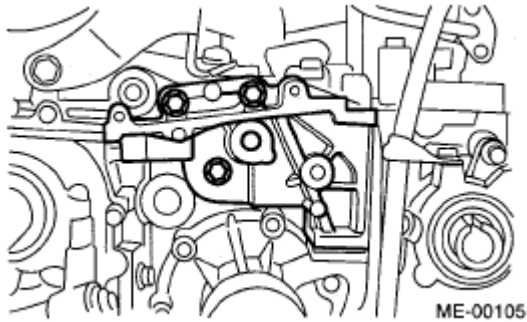


Fig. 124: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

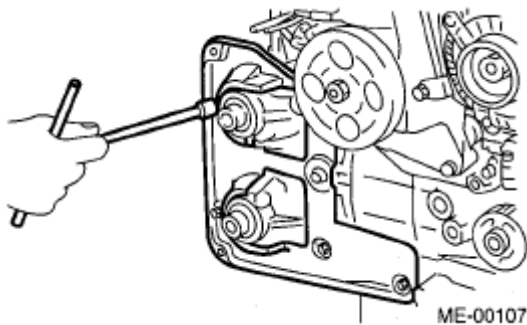


Fig. 125: Identifying Timing Belt Cover Bolts (RH)
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

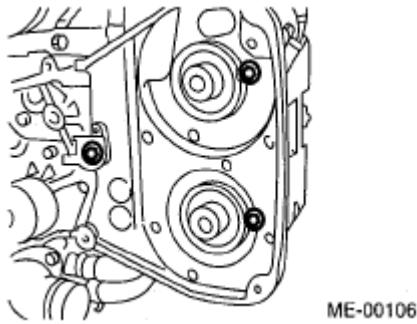


Fig. 126: Identifying Timing Belt Cover No. 2 (LH)
 Courtesy of SUBARU OF AMERICA, INC.

13. Install the cam sprocket. <Ref. to **INSTALLATION**, Cam Sprocket.>
14. Install the timing belt. <Ref. to **INSTALLATION**, Timing Belt.>
15. Install the timing belt cover. <Ref. to **INSTALLATION**, Timing Belt Cover.>
16. Install the crank pulley. <Ref. to **INSTALLATION**, Crank Pulley.>
17. Install the V-belts. <Ref. to **INSTALLATION**, V-belt.>

INSPECTION

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

Service limit:

0.020 mm (0.0008 in) or less

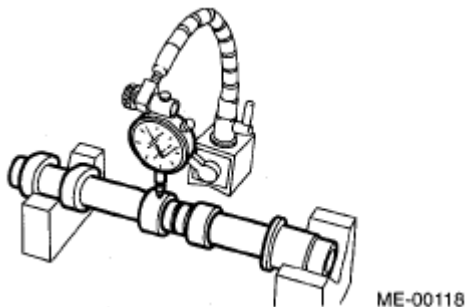


Fig. 127: Checking Camshaft Bend
 Courtesy of SUBARU OF AMERICA, INC.

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

CAMSHAFT JOURNAL SPECIFICATION

Camshaft journal	

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

4. 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 plastigauge across each camshaft journals.
4. Gradually tighten the cap in at least two stages in alphabetical order 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)

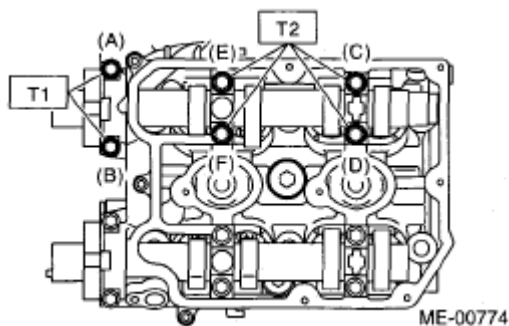


Fig. 128: Identifying Camshaft Bearing Caps Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

Standard:

0.037 - 0.072 mm (0.0015 - 0.0028 in)

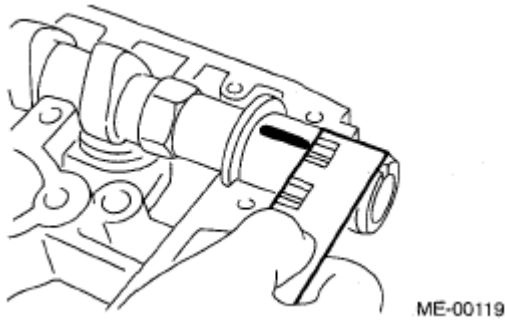


Fig. 129: Measuring Widest Point Of Plastigauge
Courtesy of SUBARU OF AMERICA, INC.

7. Completely remove the plastigauge.
5. Check the cam face condition; remove the minor faults by grinding with oil stone. Measure the cam height H. If it exceeds the standard or offset wear occurs, replace it.

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)

Cam base circle diameter A:

37.0 mm (1.457 in)

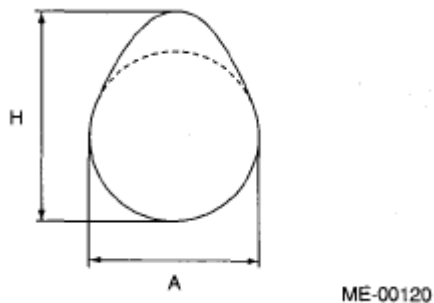


Fig. 130: Checking Cam Height
Courtesy of SUBARU OF AMERICA, INC.

6. Measure the thrust clearance of camshaft with setting the dial gauge at end of camshaft. If the thrust clearance exceeds the standard or there is offset wear, replace the caps and cylinder head as a set. If necessary replace the camshaft.

Standard:

0.068 - 0.116 mm (0.0027 - 0.0047 in)

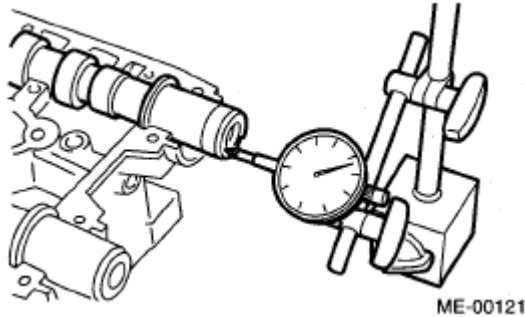


Fig. 131: Measuring Thrust Clearance Of Camshaft
Courtesy of SUBARU OF AMERICA, INC.

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 secondary air combination valve. <Ref. to REMOVAL, Secondary Air Combi Valve.>
8. Remove the bolt which installs the A/C compressor bracket on cylinder head.
9. Remove the camshaft. <Ref. to REMOVAL, Camshaft.>
10. Remove the cylinder head bolts in alphabetical order shown in the figure. Leave the bolts (A) and (D) engaged by three or four threads to prevent the cylinder head from falling.

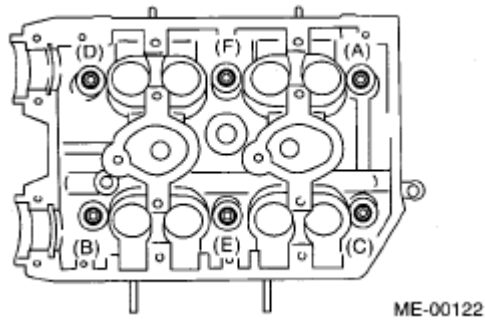


Fig. 132: Identifying Cylinder Head Bolts Removing Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

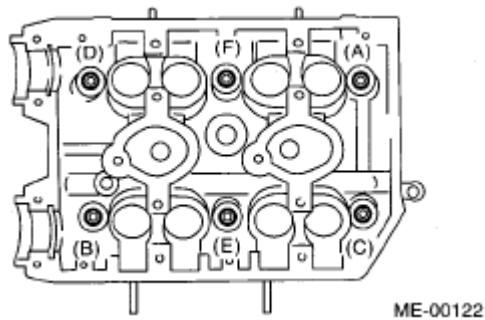


Fig. 133: Identifying Cylinder Head Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the cylinder head gasket.

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

13. Similarly, remove the 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 head and cylinder block.

NOTE: Use a new gasket.

2. Tighten the cylinder head bolts.

1. Apply a thin coat of engine oil to washer and bolt thread.
2. Tighten all bolts to 29 N.m (3.0 kgf-m, 21.4 ft-lb) in alphabetical order.
3. Further tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical order.
4. Loosen all the bolts by 180° in the reverse order of installing, and loosen them further by 180°.
5. Tighten all bolts to 49 N.m (5.0 kgf-m, 36 ft-lb) in alphabetical order.
6. Tighten all bolts by 80 to 90° in alphabetical order.
7. Tighten all bolts by 40 to 45° in alphabetical order.

CAUTION: Do not tighten the bolts 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°.

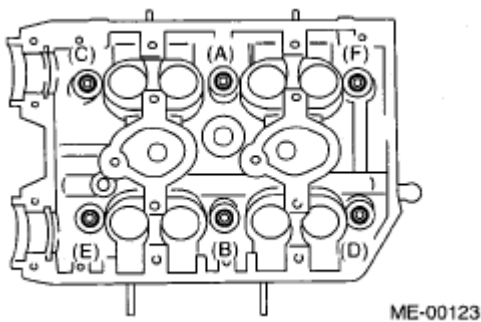


Fig. 134: Identifying Cylinder Head Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Install the camshaft. <Ref. to INSTALLATION, Camshaft.>
4. Install the A/C compressor bracket on cylinder head.
5. Install the secondary air combination valve. <Ref. to INSTALLATION , Secondary Air Combi Valve.>
6. Install the intake manifold. <Ref. to INSTALLATION , Intake Mani-fold.>
7. Install the cam sprocket. <Ref. to INSTALLATION, Cam Sprocket.>
8. Install the timing belt. <Ref. to INSTALLATION, Timing Belt.>
9. Install the timing belt cover. <Ref. to INSTALLATION, Timing Belt Cover.>
10. Install the crank pulley. <Ref. to INSTALLATION, Crank Pulley.>
11. Install the V-belts. <Ref. to INSTALLATION, V-belt.>

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.

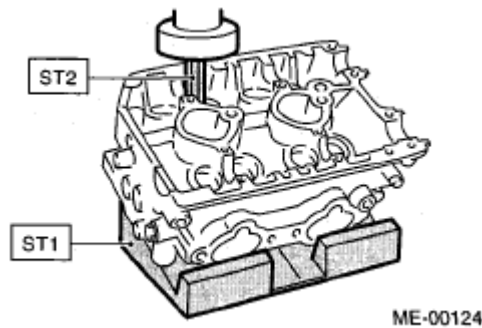
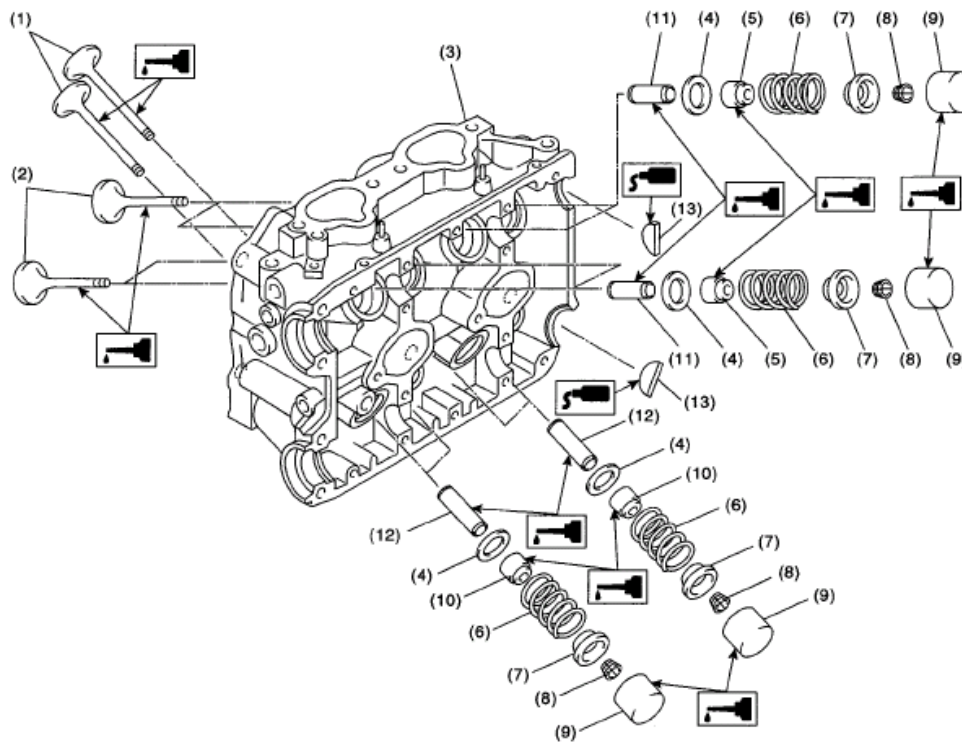


Fig. 135: Identifying Special Tool
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



ME-03157

- | | | |
|---------------------------|-----------------------------|--------------------------|
| (1) Exhaust valve | (6) Valve spring | (11) Intake valve guide |
| (2) Intake valve | (7) Retainer | (12) Exhaust valve guide |
| (3) Cylinder head | (8) Retainer key | (13) Plug |
| (4) Valve spring seat | (9) Valve lifter | |
| (5) Intake valve oil seal | (10) Exhaust valve oil seal | |

Fig. 136: Identifying Cylinder Head Components
Courtesy of SUBARU OF AMERICA, INC.

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

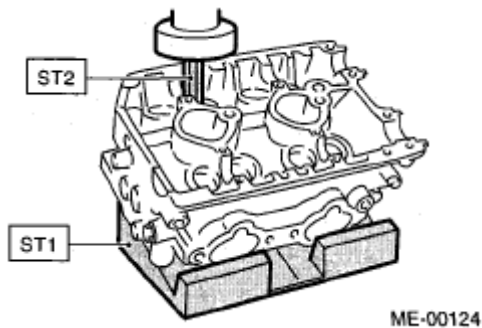


Fig. 137: Identifying Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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

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

Warping limit:

0.035 mm (0.0014 in)

Grinding limit:

0.3 mm (0.012 in)

Standard height of cylinder head:

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.

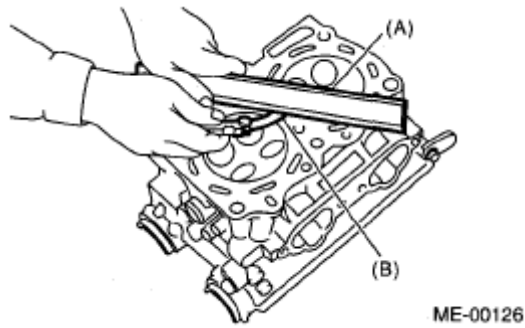


Fig. 138: Checking Cylinder Head Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

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)

Exhaust

Standard

1.2 - 1.8 mm (0.047 - 0.071 in)

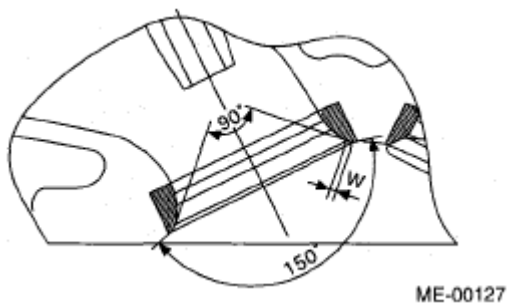


Fig. 139: Checking Valve Seat Width
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

1. Check the clearance between valve guide and valve stem. The clearance can be checked by measuring

respectively the outer diameter of valve stem with a micrometer and the inner diameter of valve guide with a caliper gauge.

Clearance between the valve guide and valve stem:

Standard

Intake

0.030 - 0.057 mm (0.0012 - 0.0022 in)

Exhaust

0.040 - 0.067 mm (0.0016 - 0.0026 in)

2. If the clearance between valve guide and valve stem exceeds the standard, replace the valve guide or valve itself whichever shows greater amount of wear or damaged and etc. 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

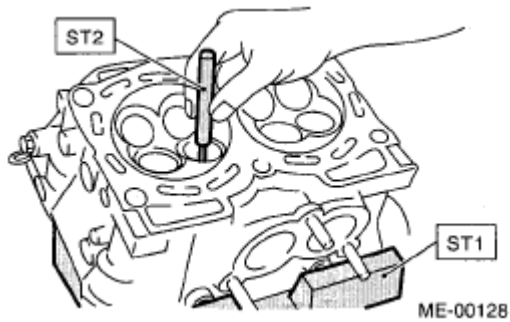


Fig. 140: Inserting ST2 Into Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

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

ST 18251AA020 VALVE GUIDE ADJUSTER

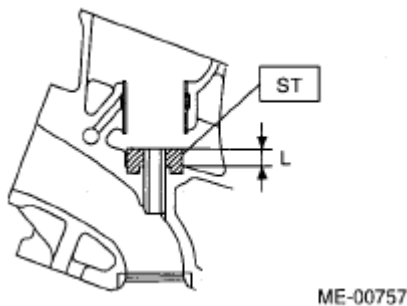


Fig. 141: Identifying Valve Guide Adjuster ST 18251AA020 On Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

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 cylinder, 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

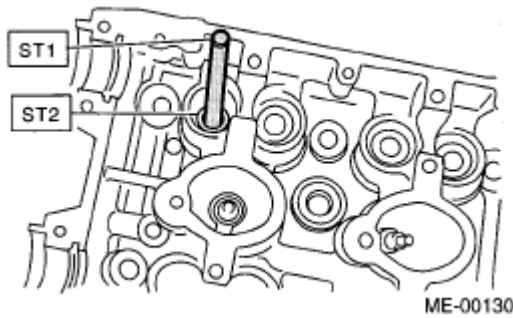


Fig. 142: Identifying ST1 499767200 Valve Guide Remover
 Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion.

Valve guide protrusion L:

15.8 - 16.2 mm (0.622 - 0.638 in)

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

NOTE:

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

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

ST 499767400 VALVE GUIDE REAMER



Fig. 143: Reaming Inside Of Valve Guide Using ST
 Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE

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

Head edge thickness H:

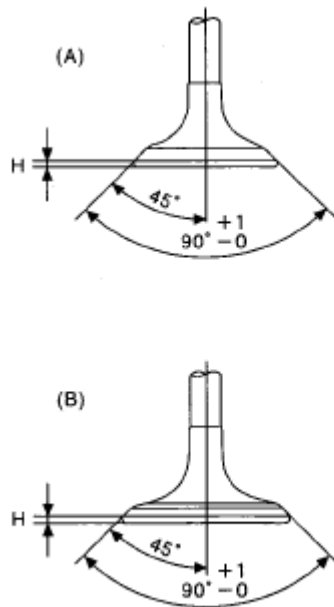
Standard

Intake (A)

1.0 - 1.4 mm (0.039 - 0.055 in)

Exhaust (B)

1.3 - 1.7 mm (0.051 - 0.067 in)



ME-00758

Fig. 144: Identifying Valve Overall Length And Head Edge Thickness
 Courtesy of SUBARU OF AMERICA, INC.

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

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

Valve overall length:

Intake

104.4 mm (4.110 in)

Exhaust

104.65 mm (4.1201 in)

VALVE SPRING

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

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

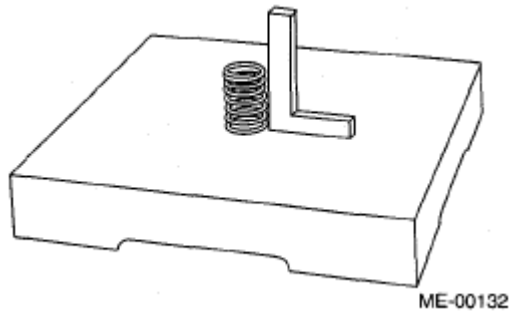


Fig. 145: Measuring Squareness Of Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

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

Color of rubber part:

Intake [Gray]

Exhaust [Green]

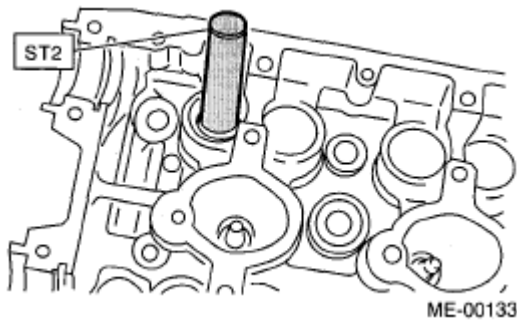


Fig. 146: Identifying Valve Oil Seal Guide ST2 498857100
Courtesy of SUBARU OF AMERICA, INC.

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)

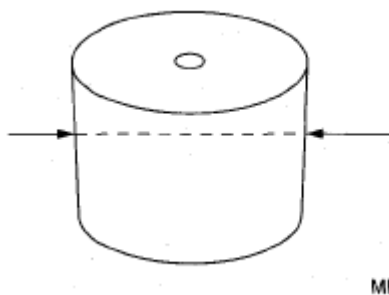


Fig. 147: Checking Outer Diameter Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

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)

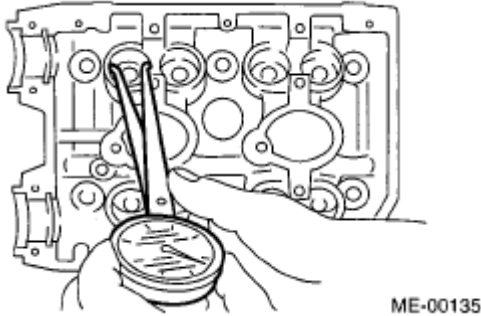


Fig. 148: Measuring Inner Diameter Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

NOTE: If difference between outer diameter of valve lifter and inner diameter of its mating surface is not within the standard or there is uneven wear, replace the cylinder head.

Standard:

0.019 - 0.057 mm (0.0007 - 0.0022 in)

CYLINDER BLOCK

REMOVAL

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

1. Remove the 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

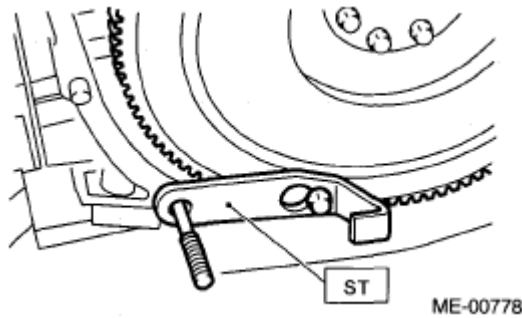


Fig. 149: Identifying Crankshaft Stopper ST 498497100 On Flywheel
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the drive plate. (AT model)

Using the ST, lock the crankshaft.

ST 498497100 CRANKSHAFT STOPPER

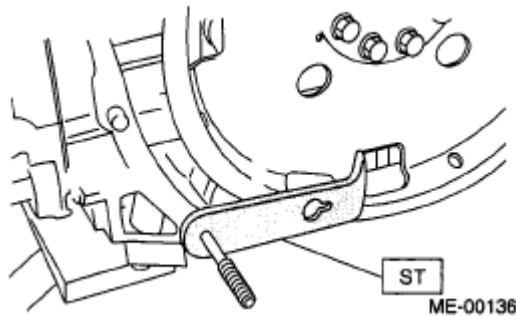


Fig. 150: Identifying Crankshaft Stopper ST498497100
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the oil separator cover.
14. Remove the water by-pass pipe for heater.
15. Remove the oil filter. <Ref. to **REMOVAL** , Engine Oil Filter.>
16. Remove the oil cooler. <Ref. to **REMOVAL** , Engine Oil Filter.>
17. Remove the water pump. <Ref. to **REMOVAL** , Water Pump.>
18. Remove the bolts which install oil pump onto cylinder block.

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

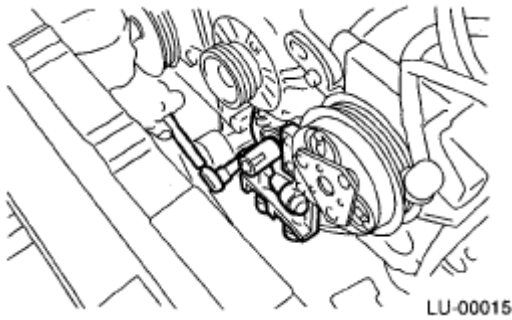


Fig. 151: Removing Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

19. 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.

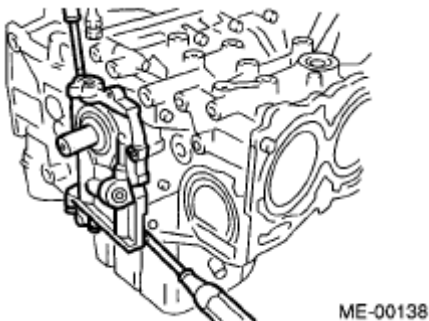
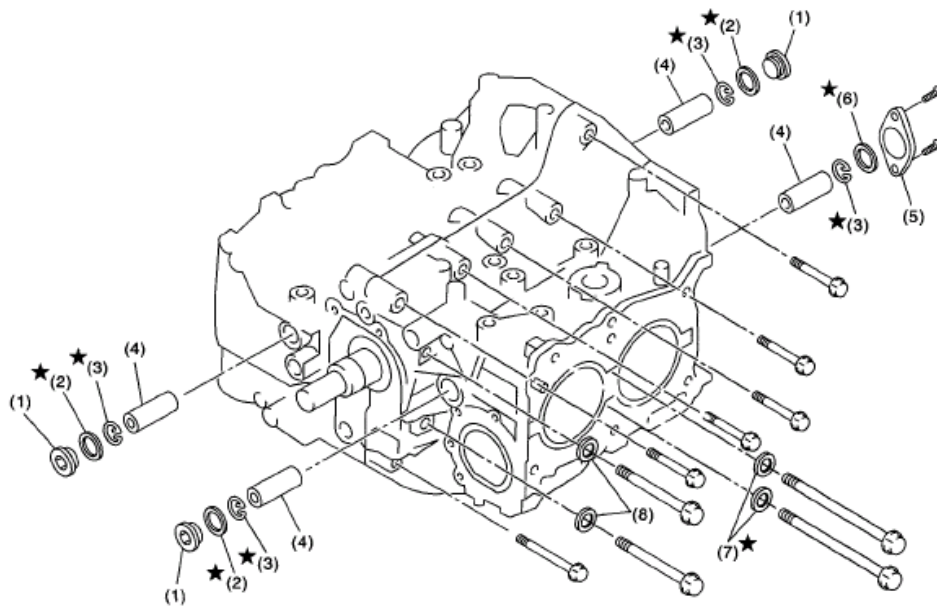


Fig. 152: Removing Oil Pump From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

20. Remove the oil pan.
 1. Set the part so that the cylinder block (LH) is on the upper side.
 2. Remove the bolts which secure oil pan to cylinder block.
 3. Insert an oil pan cutter blade between cylinder block-to-oil pan clearance and remove the oil pan.

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

21. Remove the oil strainer stay.
22. Remove the oil strainer.
23. Remove the baffle plate.
24. 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. 153: Identifying Water Pipe
Courtesy of SUBARU OF AMERICA, INC.

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

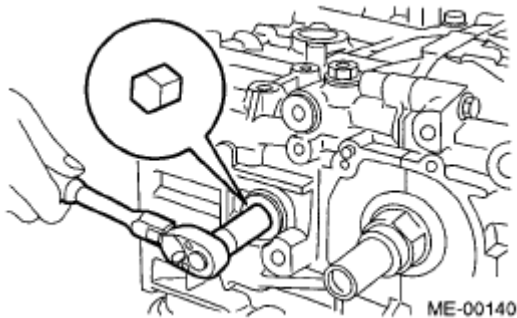


Fig. 154: Removing Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

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

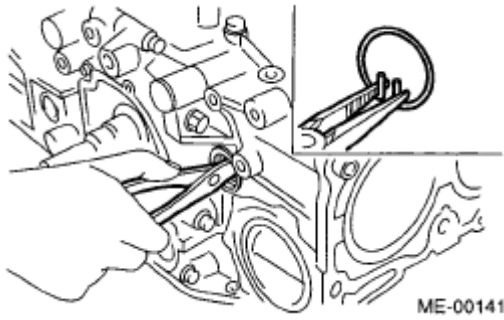


Fig. 155: Removing Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

28. 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.

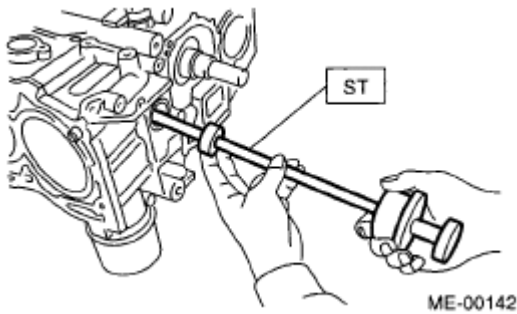
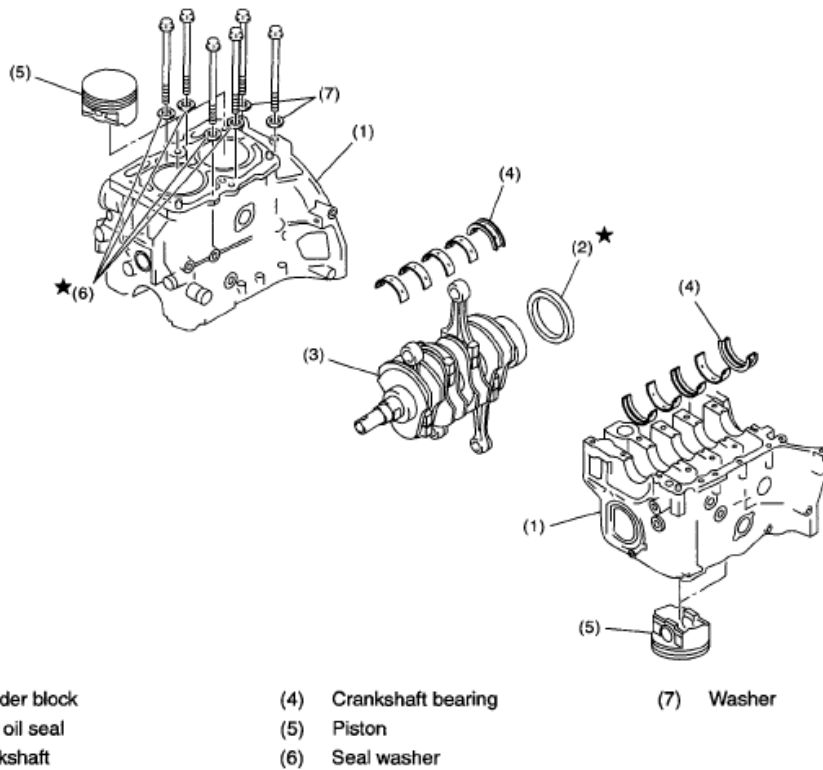


Fig. 156: Removing Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

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



ME-02890

Fig. 157: Identifying Cylinder Block Components
 Courtesy of SUBARU OF AMERICA, INC.

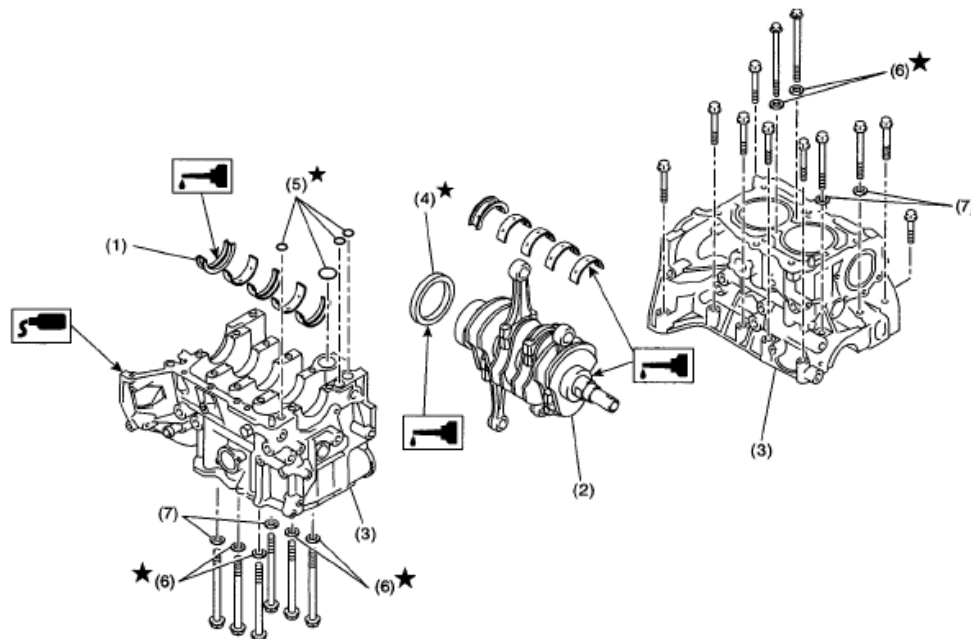
34. Remove the rear oil seal.
35. Remove the crankshaft together with connecting rod.
36. Remove the crankshaft bearings from cylinder block using a hammer handle.

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

37. Draw out each piston from cylinder block using wooden bar or hammer handle.

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

INSTALLATION



ME-03021

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

Fig. 158: Identifying Cylinder Block Components
Courtesy of SUBARU OF AMERICA, INC.

1. Remove oil on the mating surface of cylinder block before installation. Apply a coat of engine oil to the bearing and crankshaft journal.
2. Position the crankshaft and O-ring on the cylinder block (RH).
3. Apply liquid gasket to the mating surfaces of cylinder block (RH), and position the cylinder block (LH).

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.

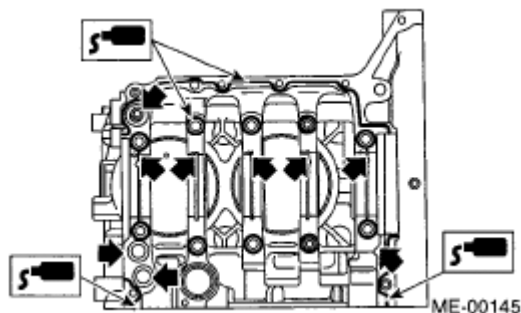


Fig. 159: Applying Liquid Gasket To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new seal washer.

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

Tightening torque:

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

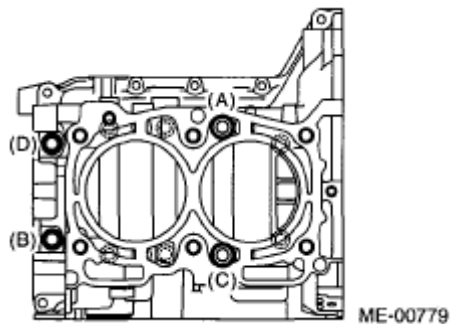


Fig. 160: Identifying Cylinder Block Bolts Tightening Sequence (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

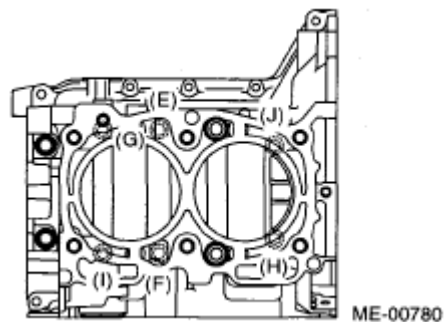


Fig. 161: Identifying Cylinder Block Bolts Tightening Sequence (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

18 N.m (1.8 kgf-m, 13.0 ft-lb)

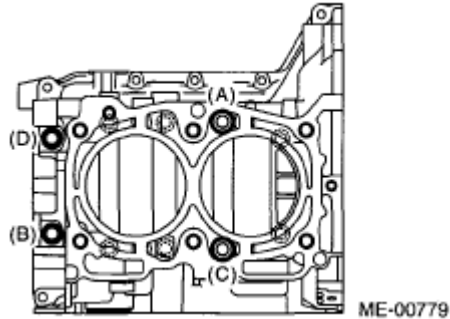


Fig. 162: Identifying Cylinder Block Bolts Tightening Sequence (LH Side)
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

18 N.m (1.8 kgf-m, 13.0 ft-lb)

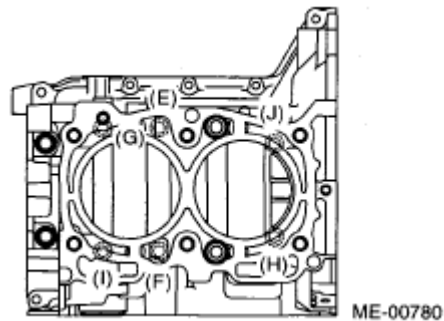


Fig. 163: Identifying Cylinder Block Bolts Tightening Sequence (RH Side)
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle: 90°

- (B), (D): Torque tightening

Tightening torque:

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

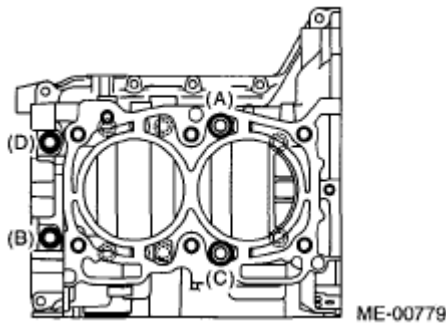


Fig. 164: Identifying Cylinder Block Bolts Tightening Sequence (LH Side)
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle: 90°

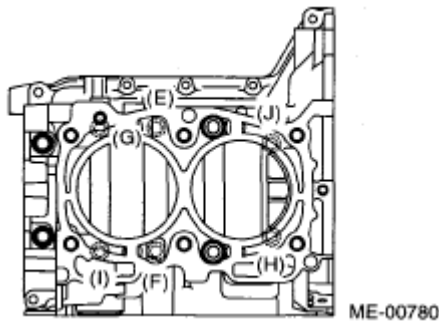


Fig. 165: Identifying Cylinder Block Bolts Tightening Sequence (RH Side)
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

(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)

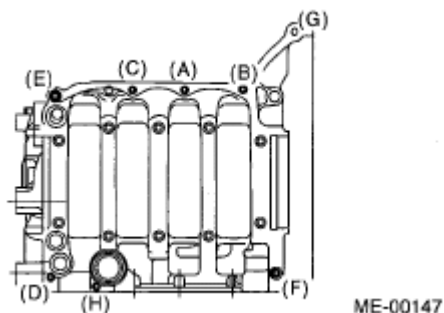


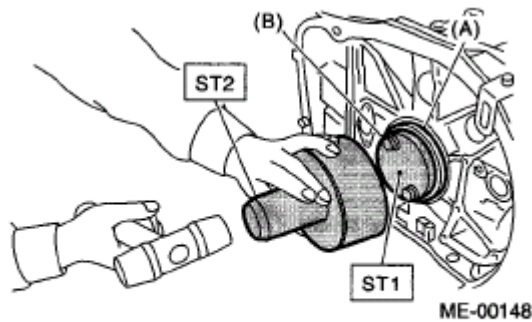
Fig. 166: Identifying Cylinder Block Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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 oil seal.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER



(A) Rear oil seal

(B) Flywheel attaching bolt

Fig. 167: 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.

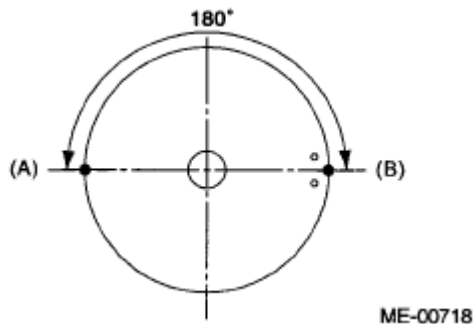


Fig. 168: Positioning Second Ring Gap
 Courtesy of SUBARU OF AMERICA, INC.

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

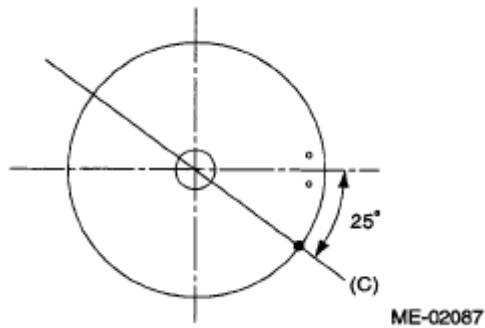


Fig. 169: Positioning Upper Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

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

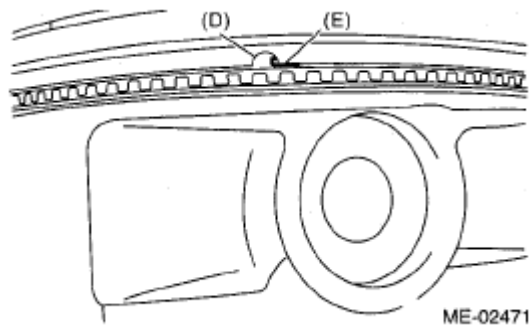


Fig. 170: Aligning Upper Rail Spin Stopper With Piston Side Surface Hole
Courtesy of SUBARU OF AMERICA, INC.

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

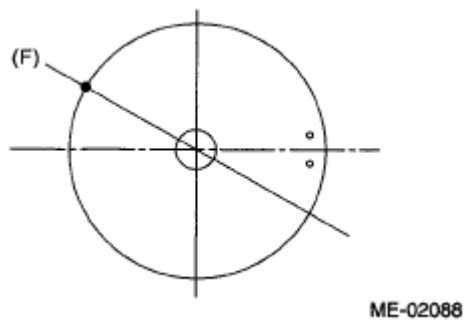


Fig. 171: Positioning Expander Gap
Courtesy of SUBARU OF AMERICA, INC.

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

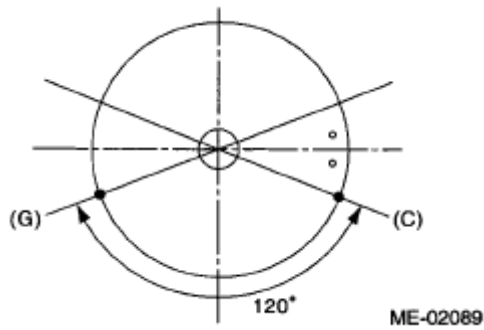


Fig. 172: Positioning Lower Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

NOTE:

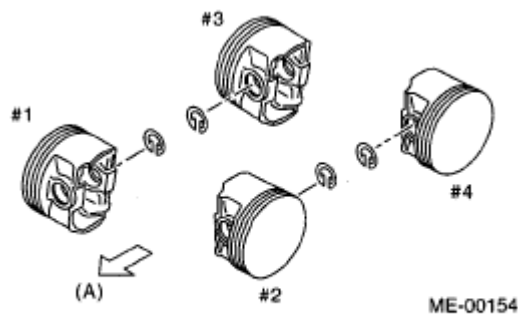
- Make sure ring gaps do not face the same direction.
- Make sure ring gaps are not within the piston skirt area.

19. Install the snap ring.

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

NOTE:

Use new snap rings.



(A) Front side

Fig. 173: Identifying Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

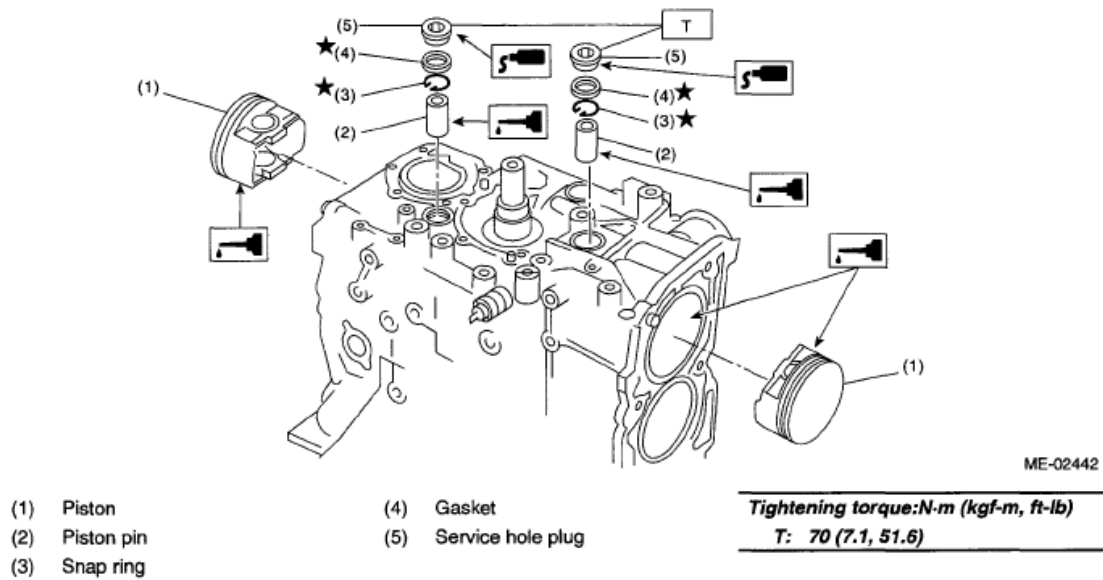


Fig. 174: Identifying Piston Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

20. Install piston.

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

ST1 499987500 CRANKSHAFT SOCKET

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

ST2 498747300 PISTON GUIDE

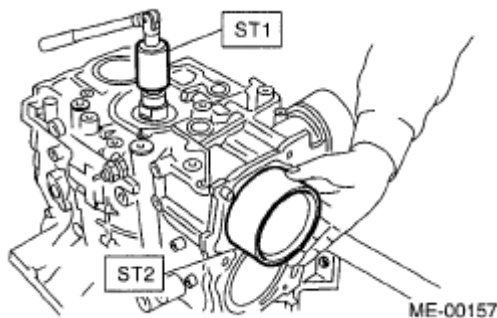
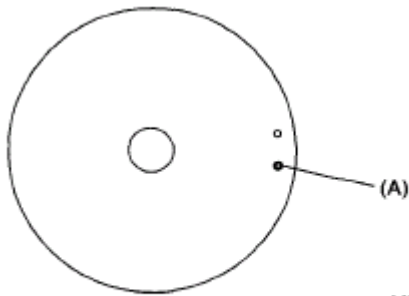


Fig. 175: Inserting Pistons In Cylinders Using Piston Guide ST2 498747300
 Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front mark

Fig. 176: Identifying Front Mark
Courtesy of SUBARU OF AMERICA, INC.

21. Install piston pin.
1. Apply a coat of engine oil to ST3 before insertion, and then insert it into the service hole to align piston pin hole with connecting rod small end.

ST3 499017100 PISTON PIN GUIDE

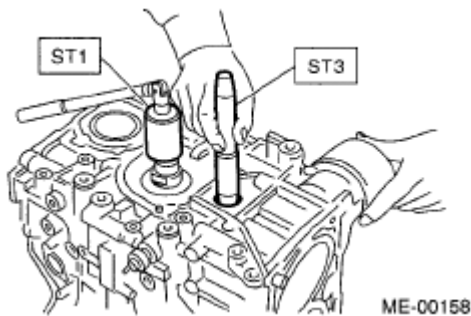


Fig. 177: Installing Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.

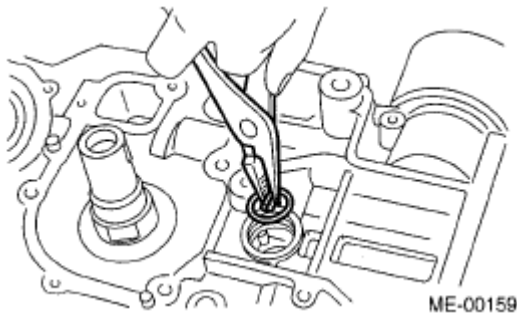


Fig. 178: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

4. Apply liquid gasket around the service hole plug.

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

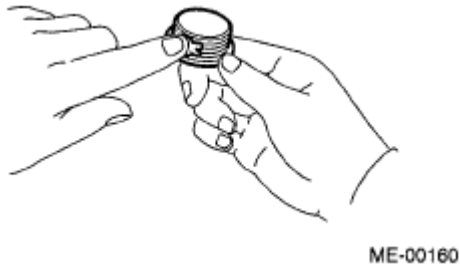


Fig. 179: Applying Fluid Packing Around Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

5. Install the service hole plug and gasket.

NOTE: Use a new gasket.

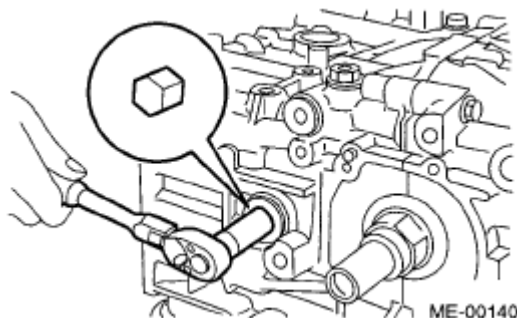


Fig. 180: Installing Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

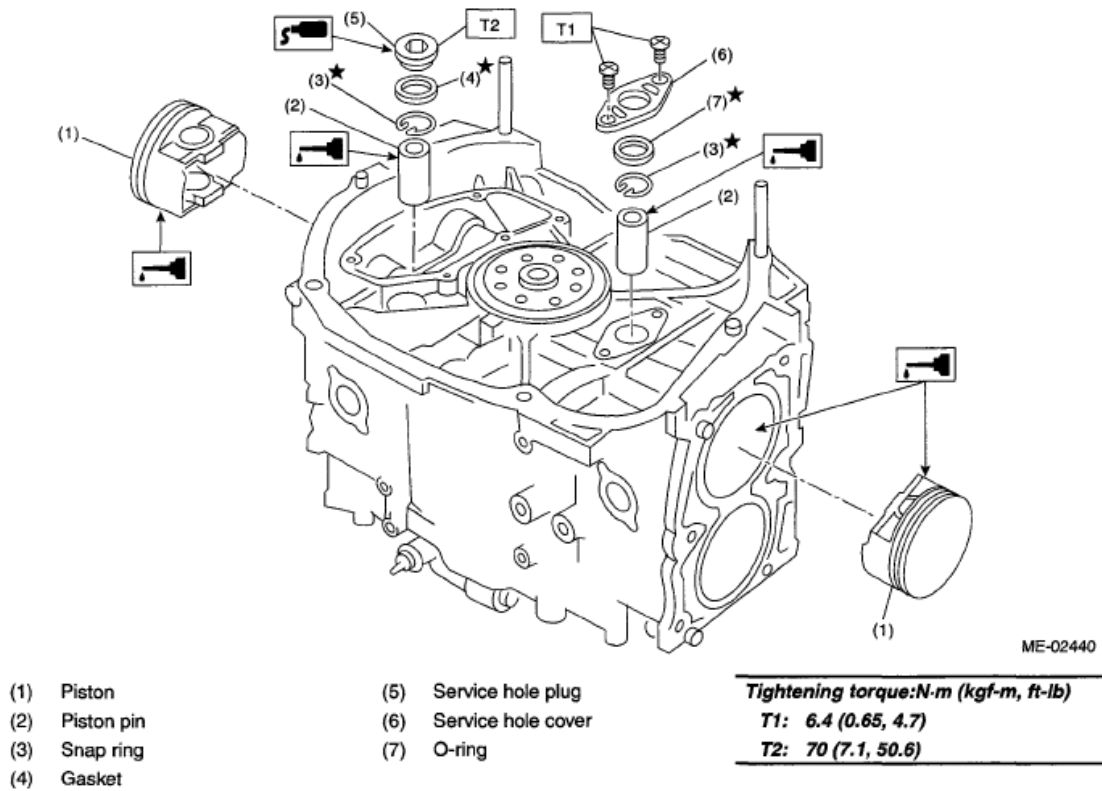


Fig. 181: Identifying Piston Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

6. Set the parts so that the #3 and #4 cylinders are on the upper side. Following the same procedures as used for #1 and #2 cylinders, install the pistons and piston pins.
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 to the cylinder block.

NOTE: Use new O-rings.

Tightening torque:

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

25. Install the oil strainer stay.

NOTE: Tighten the oil strainer stay together with 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.

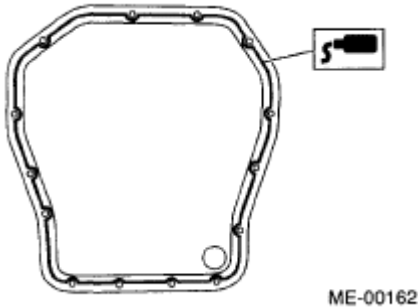
Liquid gasket:***THREE BOND 1207C (Part No. 004403012) or equivalent******Tightening torque:******5 N.m (0.5 kgf-m, 3.6 ft-lb)***

Fig. 182: Applying Liquid Gasket To Mating Surfaces Of Oil Pan
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 thread (A) (when reusing the bolt)******THREE BOND 1324 (Part No. 004403042) or equivalent******Tightening torque:******6.4 N.m (0.65 kgf-m, 4.7 ft-lb)***

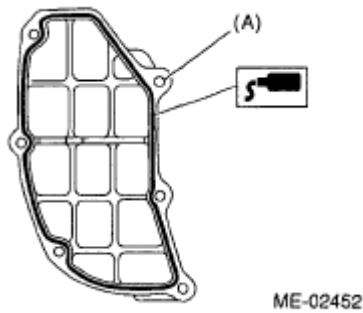


Fig. 183: Applying Liquid Gasket To Mating Surfaces
Courtesy of SUBARU OF AMERICA, INC.

28. Install the flywheel. (MT model) <Ref. to INSTALLATION , Flywheel.>
29. Install the clutch disc and cover. (MT model) <Ref. to INSTALLATION , Clutch Disc and Cover.>
30. 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, 52.8 ft-lb)

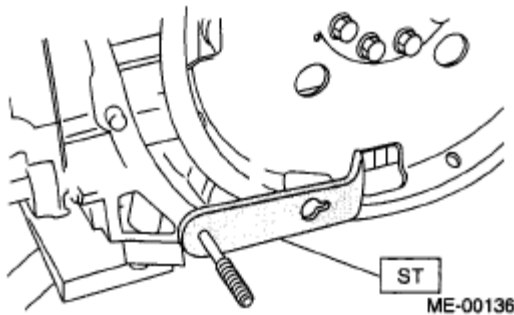


Fig. 184: Identifying Crankshaft Stopper ST498497100
Courtesy of SUBARU OF AMERICA, INC.

31. Install the oil pump.
 1. Using the ST, install the front oil seal.

ST 499587100 OIL SEAL INSTALLER

NOTE: Use a new oil seal.

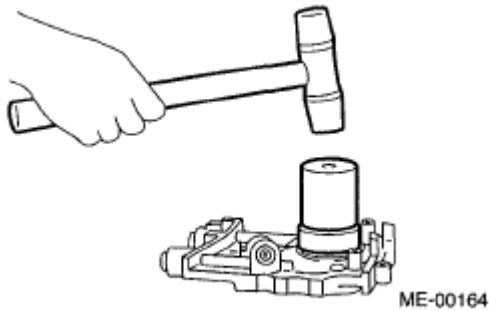
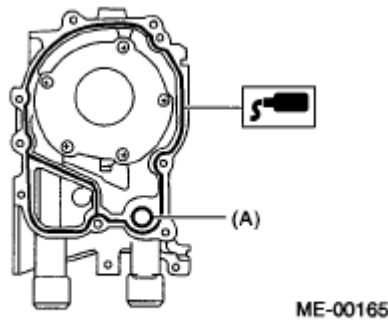


Fig. 185: Installing Front Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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. 186: 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.

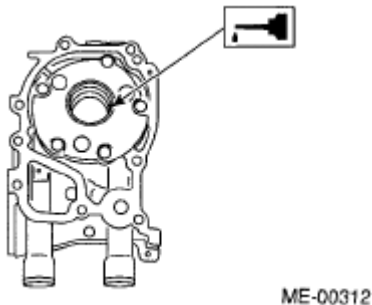


Fig. 187: Applying Coat Of Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

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

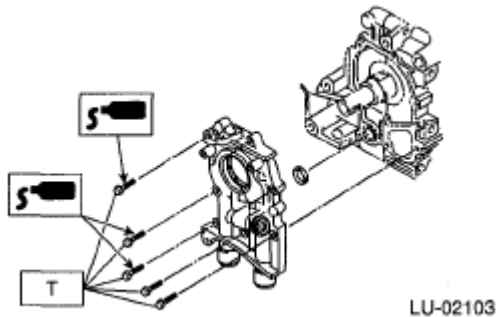


Fig. 188: Applying Fluid Packing To Threads Of Bolts
Courtesy of SUBARU OF AMERICA, INC.

32. Install the water pump and gasket.

Tightening torque:

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

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

NOTE:

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

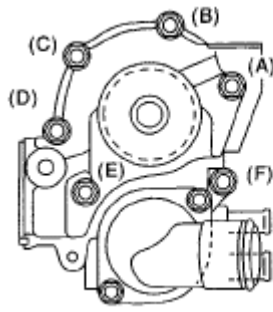


Fig. 189: Identifying Alphabetical Sequence Of Water Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

33. Install the water by-pass pipe for heater.
34. Install the oil cooler. <Ref. to **INSTALLATION** , Engine Oil Cooler.>
35. Install the oil filter. <Ref. to **INSTALLATION** , Engine Oil Filter.>
36. Install the water by-pass 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 attachment bolts. (LH side)

Tightening torque:

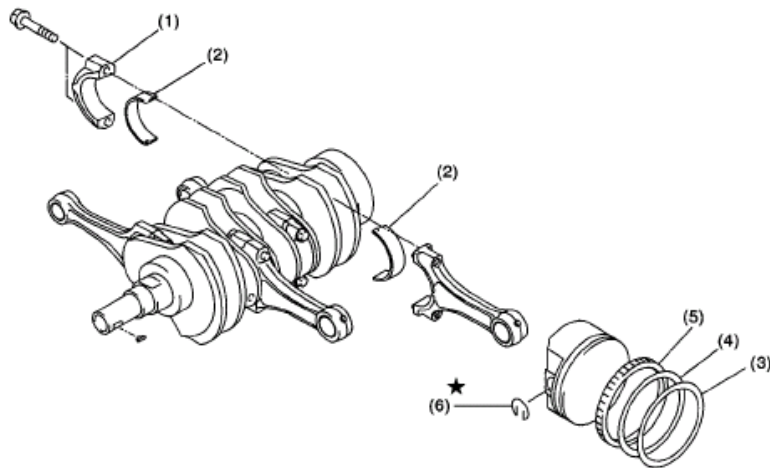
6.4 N.m (0.65 kgf-m, 4.7 ft-lb)

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 generator and A/C compressor brackets on cylinder head.
47. Install the V-belts. <Ref. to **INSTALLATION**, V-belt.>
48. Install the intake manifold. <Ref. to **INSTALLATION** , Intake Manifold.>

DISASSEMBLY



ME-02741

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

Fig. 190: Identifying Connecting Rod Components
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

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

5. Remove the snap ring.

ASSEMBLY

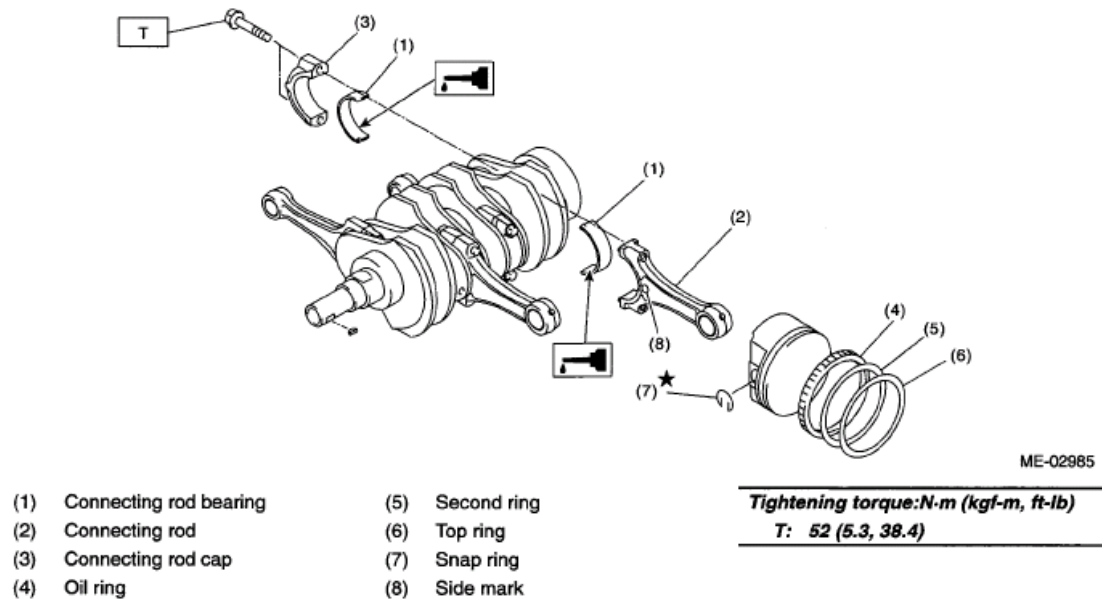


Fig. 191: Identifying Connecting Rod Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

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. Position each connecting rod with the marking side facing forward.
3. Tighten the connecting rod cap with connecting rod bolt. Make sure the arrow mark on connecting rod cap facing front during installation.

NOTE:

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

Tightening torque:

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

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

INSPECTION

CYLINDER BLOCK

1. Check for cracks or damage. Use liquid penetrant tester on the important sections to check for fissures. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2. Check the oil passages for clogging.
3. Inspect the 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 front upper face of the cylinder block.

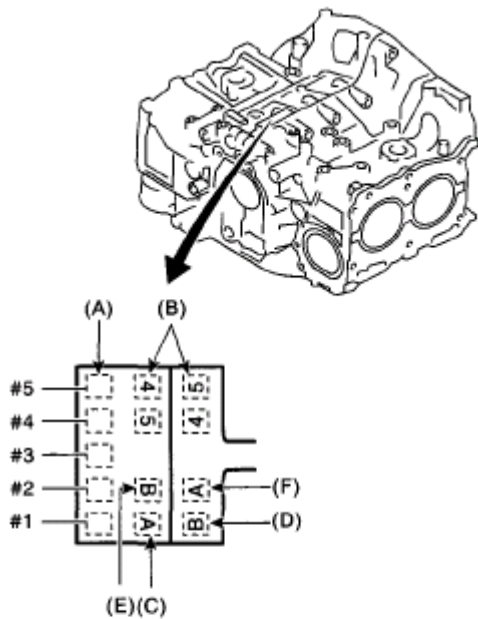
NOTE:

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

Standard diameter:

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

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



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. 192: Identifying Cylinder And Piston Grade
 Courtesy of SUBARU OF AMERICA, INC.

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

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

Taper:

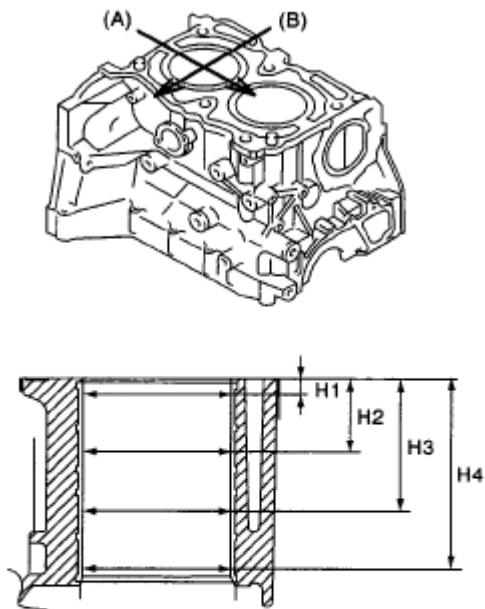
Standard

0.015 mm (0.0006 in)

Out-of-roundness:

Standard

0.010 mm (0.0004 in)



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. 193: Measuring Inner Diameter Of Cylinder

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. Cylinder outer diameter measurement 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)

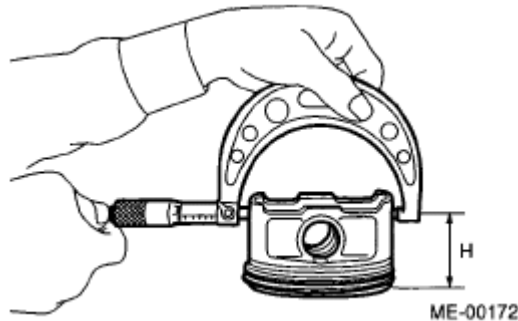


Fig. 194: Measuring Outer Diameter Of Piston
Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

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

Standard

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

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

CAUTION:

- When any of the cylinders needs reboring, all other cylinders must be bored at the same time, and replaced with oversize pistons.
- Do not perform boring on one cylinder only. Do not replace only a single cylinder for an oversize piston.

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

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

Cylinder inner diameter boring limit (diameter):

100.015 mm (3.9376 in)

PISTON AND PISTON PIN

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

Standard clearance between piston pin and hole in piston:

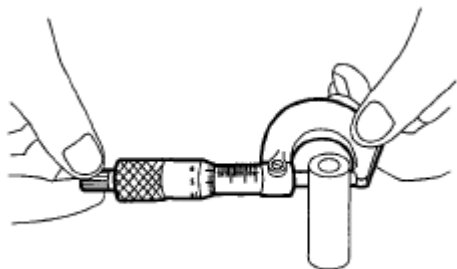
Standard

0.004 - 0.008 mm (0.0002 - 0.0003 in)



ME-00173

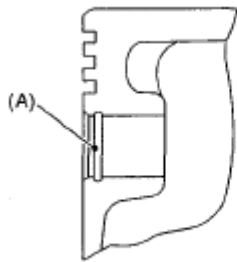
Fig. 195: Checking Clearance Between Piston Pin And Hole In Piston
Courtesy of SUBARU OF AMERICA, INC.



ME-00174

Fig. 196: Measuring Piston Pin Outer Diameter
Courtesy of SUBARU OF AMERICA, INC.

4. Check the snap ring installation groove (A) on the piston for burr. If necessary, remove burr from the groove so that the piston pin can lightly move.



ME-00175

Fig. 197: Identifying Circlip Installation Groove On Piston
 Courtesy of SUBARU OF AMERICA, INC.

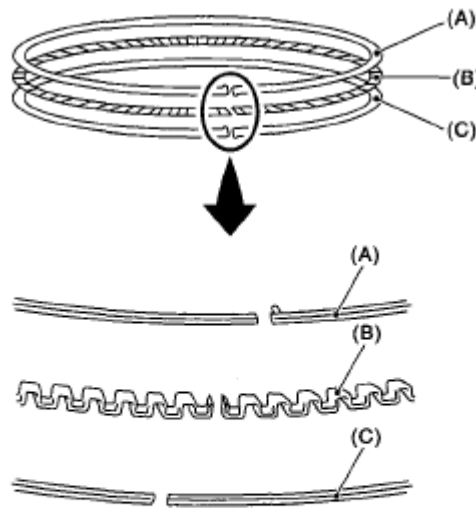
5. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

NOTE:

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



ME-02480

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

Fig. 198: Identifying Piston Ring

Courtesy of SUBARU OF AMERICA, INC.

- 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 SPECIFICATION

		Standard mm (in)
Piston ring gap	Top ring	0.20 - 0.25 (0.0079 - 0.0098)
	Second ring	0.37 - 0.52 (0.015 - 0.020)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)

NOTE: Difference between outer and inner circumference of top ring is within 0.05 mm (0.0020 in).

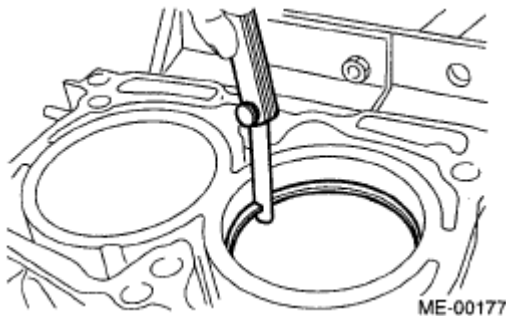


Fig. 199: Measuring Piston Ring Gap

Courtesy of SUBARU OF AMERICA, INC.

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

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

PISTON RING GAP SPECIFICATION

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

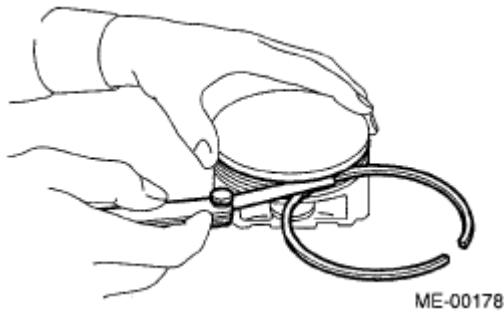


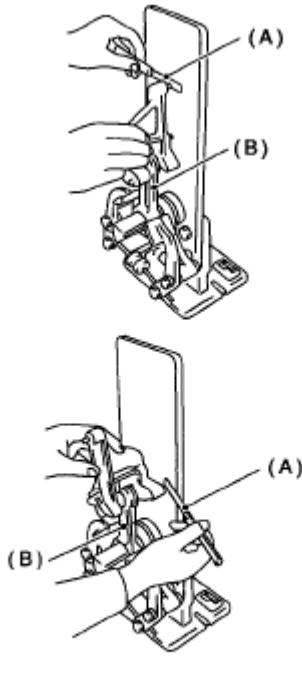
Fig. 200: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

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

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

0.10 mm (0.0039 in)



- (A) Thickness gauge
(B) Connecting rod

Fig. 201: Checking Bend Or Twist Using Connecting Rod Aligner
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod thrust clearance:

Standard

0.070 - 0.330 mm (0.0028 - 0.0130 in)

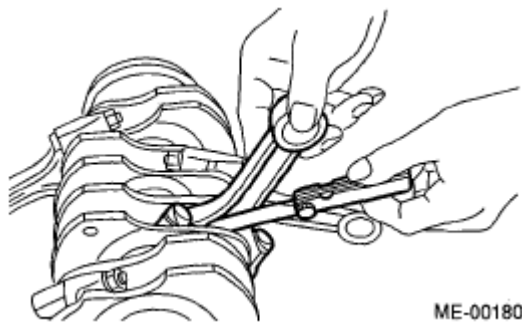


Fig. 202: Checking Connecting Rod Side Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard

0.017 - 0.045 mm (0.0007 - 0.0018 in)

CONNECTING ROD OIL CLEARANCE

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. If the measured value is not within the standard, replace it with a new part.

Clearance between piston pin and bushing:

Standard

0 - 0.022 mm (0 - 0.0009 in)

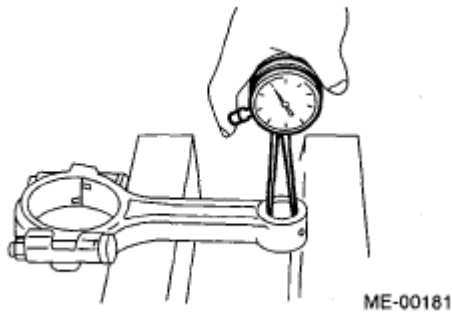


Fig. 203: Checking Clearance Between Piston Pin And Bushing
 Courtesy of SUBARU OF AMERICA, INC.

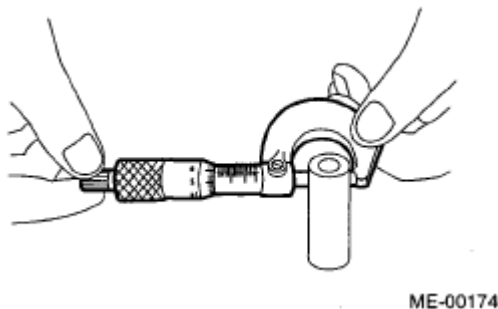


Fig. 204: Measuring Piston Pin Outer Diameter
 Courtesy of SUBARU OF AMERICA, INC.

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

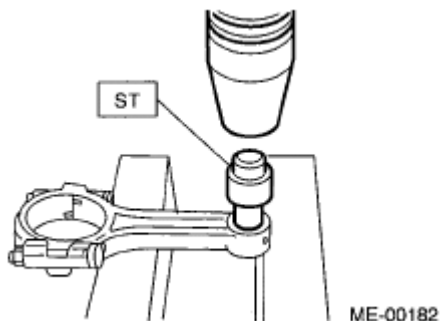


Fig. 205: Removing Bushing From Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

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

CRANKSHAFT AND CRANKSHAFT BEARING

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

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

Crankshaft bend limit:

0.035 mm (0.0014 in)

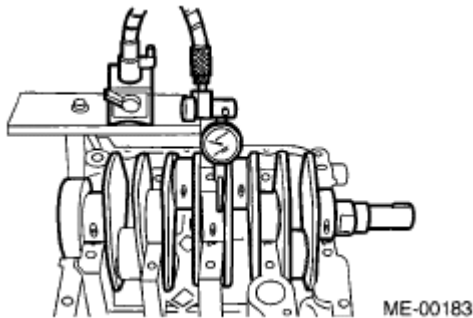


Fig. 206: Measuring Crankshaft Bend Limit
Courtesy of SUBARU OF AMERICA, INC.

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)

Cylindricity

0.004 mm (0.0002 in)

Grinding limit (dia.)

To 51.750 mm (2.0374 in)

Crank journal:

Out-of-roundness

0.005 mm (0.0002 in)

Cylindricity

0.006 mm (0.0002 in)

Grinding limit (dia.)

To 59.758 mm (2.3527 in)



Fig. 207: Inspecting Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL SPECIFICATION

		Unit: mm (in)		
		Crank journal 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)	1.486 - 1.498 (0.0585 - 0.0590)
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)	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)

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

4. Measure the thrust clearance of crankshaft at center bearing by using thickness gauge. If clearance exceeds the standard, replace the bearing.

Crankshaft thrust clearance:

Standard

0.030 - 0.115 mm (0.0012 - 0.0045 in)

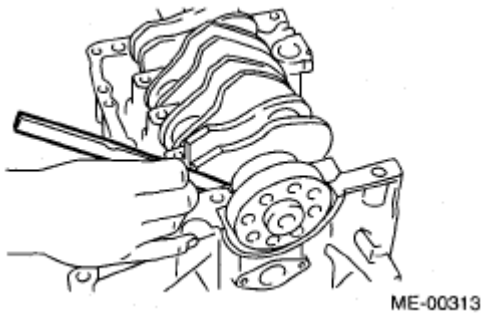


Fig. 208: Measuring Crankshaft Side Clearance

Courtesy of SUBARU OF AMERICA, INC.

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

Crankshaft oil clearance:

Standard

0.010 - 0.030 mm (0.0004 - 0.0012 in)

INTAKE AND EXHAUST VALVE

SPECIFICATION

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

PISTON

SPECIFICATION

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

CONNECTING ROD

SPECIFICATION

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

CRANKSHAFT

SPECIFICATION

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

ENGINE TROUBLE IN GENERAL

INSPECTION

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

PROBLEM SYMPTOM CHART

Symptom	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
	Friction	Seizure of crankshaft and connecting rod bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C

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2) Initial combustion does not occur.	Starter		Defective starter	C
	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >			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 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 <u>BASIC DIAGNOSTIC PROCEDURE</u> . >			A
	Intake system	Defective intake manifold gasket		B
		Defective throttle body gasket		B
	Fuel line	Defective fuel pump and relay		C
		Clogged fuel line		C
		Lack of 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 gasket		C
		Improper valve sealing		C
		Defective valve stem		C
		Worn or broken valve spring		B
		Worn or stuck piston rings, cylinder and piston		C
		Incorrect valve timing		B
		Improper engine oil (low viscosity)		B
	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >			A
		Loosened or cracked intake duct		B

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

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		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
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 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
	Others	Evaporative emission control system malfunction	A
	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A

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4. Surging	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 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
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
	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

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7. After burning in exhaust system	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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
8. Knocking	Others	Evaporative emission control system malfunction	C
	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Loosened oil filler cap	B
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
9. Excessive engine oil consumption	Cooling system	Overheating	A
	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 oil pan	B
	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Dirty air cleaner element	A
	Timing belt	Defective timing	B
		Incorrect valve clearance	B

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10. Excessive fuel consumption	Compression	Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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
A - Very often B - Sometimes C - Rarely			

ENGINE NOISE

INSPECTION

ENGINE NOISE - SYMPTOM CHART

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

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