

2007 ENGINE

Mechanical (H4SO) - Legacy & Outback

GENERAL DESCRIPTION

SPECIFICATION

GENERAL SPECIFICATION

	Model	2.5 L	
Engine	Cylinder arrangement	Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine	
	Valve system mechanism	Belt driven Single overhead camshaft 4 valve/4 cylinder	
	Bore x Stroke	mm (in)	99.5 x 79.0 (3.917 x 3.110)
	Piston displacement	cm ³ (cu in)	2,457 (150)
	Compression ratio	10.0	
	Compression pressure (at 350 rpm)	kPa (kg/cm ² , psi)	1,020 - 1,275 (10.4 - 13.0, 148 - 185)
	Number of piston rings	Pressure ring: 2, Oil ring: 1	
	Intake valve timing	Constant	Open BTDC 0°
			Close ABDC 58°
		Low speed	Open BTDC 0°
			Close ABDC -50°
		High speed	Open BTDC 14°
			Close ABDC 62°
	Exhaust valve timing	Open	BBDC46°
		Close	ATDC 14°
	Valve clearance	Intake	0.20±0.04 (0.0079±0.0016)
		Exhaust	0.25±0.04 (0.0098±0.0016)
	Idling speed [at neutral position on MT, or "P" or "N" position on AT]	MT	650±100 (No load) 850±100 (A/CON)
		AT	700±100 (No load) 850±100 (A/CON)
	Ignition order	1 --> 3 --> 2 --> 4	
	Ignition timing	MT	10°±8°/650
		AT	15°±8°/700

NOTE: US: Undersize OS: Oversize

GENERAL SPECIFICATION

Belt tension		
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adjuster	Protrusion of adjuster rod			mm (in)	5.2 - 6.2 (0.205 - 0.244)	
Belt tensioner	Spacer O.D.			mm (in)	17.955 - 17.975 (0.7069 - 0.7077)	
	Tensioner bushing I.D.			mm (in)	18.00 - 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	0.20 - 0.55 (0.0079 - 0.0217)	
Valve rocker arm	Clearance between shaft and arm		mm (in)	Standard	0.020 - 0.054 (0.0008 - 0.0021)	
Camshaft	Bending limit			mm (in)	0.025 (0.0010)	
	Thrust clearance			mm (in)	Standard 0.030 - 0.090 (0.0012 - 0.0035)	
	Cam lobe height	mm (in)	Intake	Constant	Standard	40.075 - 40.175 (1.5778 - 1.5817)
			Low speed	Standard	35.182 - 35.282 (1.3851 - 1.3891)	
			High speed	Standard	40.315 - 40.415 (1.5872 - 1.5911)	
		Exhaust		Standard	40.088 - 40.188 (1.5783 - 1.5822)	
	Camshaft journal O.D.			mm (in)	31.928 - 31.945 (1.2570 - 1.2577)	
	Camshaft journal hole I.D.			mm (in)	32.000 - 32.018 (1.2598 - 1.2605)	
Oil clearance		mm (in)	Standard	0.055 - 0.090 (0.0022 - 0.0035)		
Cylinder head	Surface warpage limit (Mating surface with cylinder block)			mm (in)	0.035 (0.0014)	
	Grinding limit			mm (in)	0.1 (0.004)	
	Standard height			mm (in)	97.5 (3.84)	
Valve seat	Seating angle				90°	
	Contacting width	mm (in)	Intake	Standard	0.8 - 1.4 (0.03 - 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)	Intake	20.0 - 21.0 (0.787 - 0.827)	
			Exhaust	16.5 - 17.5 (0.650 - 0.689)		
Valve	Head edge thickness	mm (in)	Intake	Standard	0.8 - 1.2 (0.03 - 0.047)	
			Exhaust	Standard	1.0 - 1.4 (0.039 - 0.055)	
	Stem outer diameter		mm (in)	Intake	5.950 - 5.965 (0.2343 - 0.2348)	
			Exhaust	5.945 - 5.960 (0.2341 - 0.2346)		
	Valve stem gap	mm (in)	Standard	Intake	0.035 - 0.062 (0.0014 - 0.0024)	
			Exhaust	0.040 - 0.067 (0.0016 - 0.0026)		
	Overall length		mm (in)	Intake	120.6 (4.75)	
Exhaust			121.7 (4.79)			
Valve spring	Free length			mm (in)	55.2 (2.173)	
	Squareness				2.5°, 2.4 (0.094) or less	
	Tension/spring height		N (kgf, lb)/mm (in)	Set	235.3 - 270.7 (24 - 27.6, 52.9 - 60.8)/45.0 (1.772)	
			Lift	578.9 - 639.9 (59.1 - 65.3, 130.3 - 143.9)/34.7 (1.366)		
	Surface warpage limit (mating with cylinder					

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Cylinder block	head)		mm (in)	0.025 (0.00098)		
	Grinding limit		mm (in)	0.1 (0.004)		
	Standard height		mm (in)	201.0 (7.91)		
	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 specified diameter				mm (in)	23.000 - 23.006 (0.9055 - 0.9057)	
Piston pin	Outer diameter				mm (in)	22.994 - 23.000 (0.9053 - 0.9055)
	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 - 0.35 (0.0079 - 0.0138)	
			Second ring	Standard	0.37 - 0.52 (0.0144 - 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		0.016 - 0.044 (0.00063 - 0.0017)
	Bearing size (Thickness at center)	mm (in)	Standard		1.492 - 1.501 (0.0587 - 0.0591)	
			0.03 (0.0012) US		1.510 - 1.513 (0.0594 - 0.0596)	
			0.05 (0.0020) US		1.520 - 1.523 (0.0598 - 0.0600)	
			0.25 (0.0098) US		1.620 - 1.623 (0.0638 - 0.0639)	
Bushing of small end	Clearance between piston pin and bushing			mm (in)	Standard	0 - 0.022 (0 - 0.0009)
	Bend 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)	

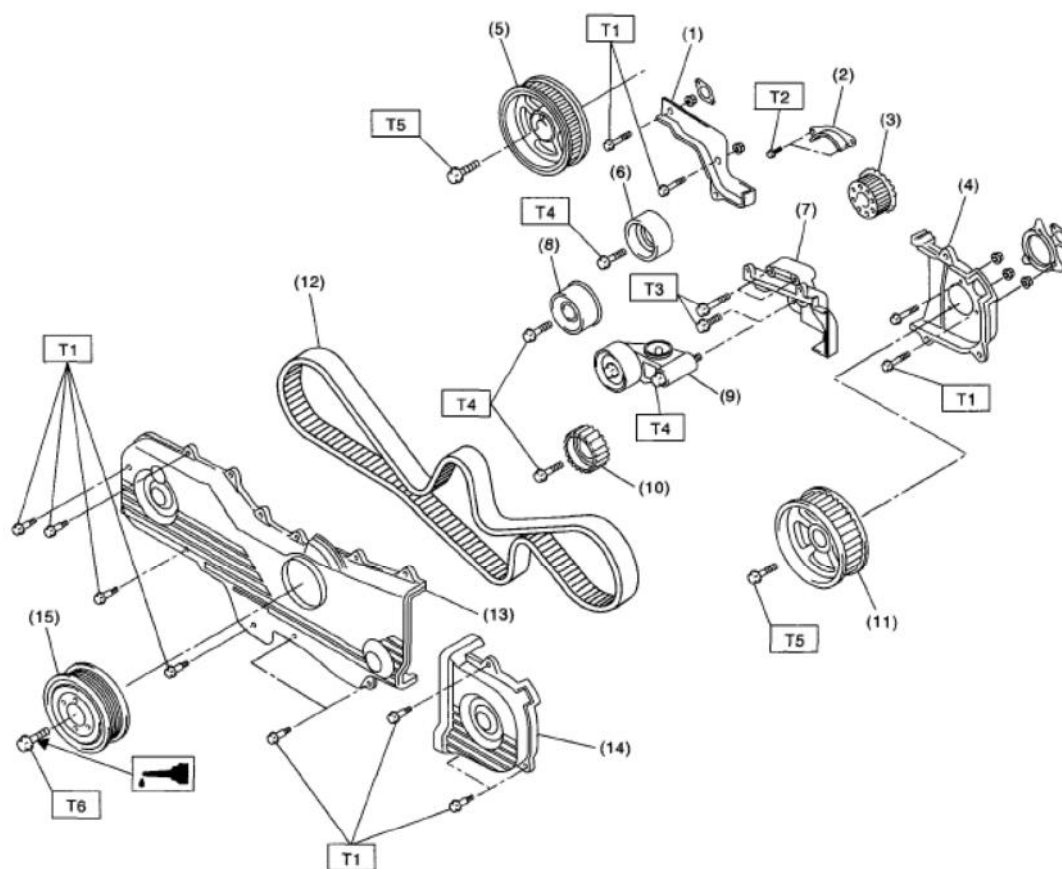
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Crankshaft	Crank journal	Out-of-roundness	mm (in)	0.005 (0.0002)
		Cylindricity	mm (in)	0.006 (0.0002)
		Grinding limit (dia.)	mm (in)	To 59.758 (2.3527)
	Crank pin outer diameter	mm (in)	Standard	51.984 - 52.000 (2.0466 - 2.0472)
			0.03 (0.0012) US	51.954 - 51.970 (2.0454 - 2.0461)
			0.05 (0.0020) US	51.934 - 51.950 (2.0446 - 2.0453)
			0.25 (0.0098) US	51.734 - 51.750 (2.0368 - 2.0374)
	Crank journal outer diameter	mm (in)	Standard	59.992 - 60.008 (2.3619 - 2.3625)
			0.03 (0.0012) US	59.962 - 59.978 (2.3607 - 2.3613)
			0.05 (0.0020) US	59.942 - 59.958 (2.3599 - 2.3605)
			0.25 (0.0098) US	59.742 - 59.758 (2.3520 - 2.3527)
	Thrust clearance	mm (in)	Standard	0.030 - 0.115 (0.0012 - 0.0045)
	Oil clearance	mm (in)	Standard	0.010 - 0.030 (0.0001 - 0.0012)
Main bearing	Main bearing	#1, #3	mm (in)	
			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-03179

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

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)

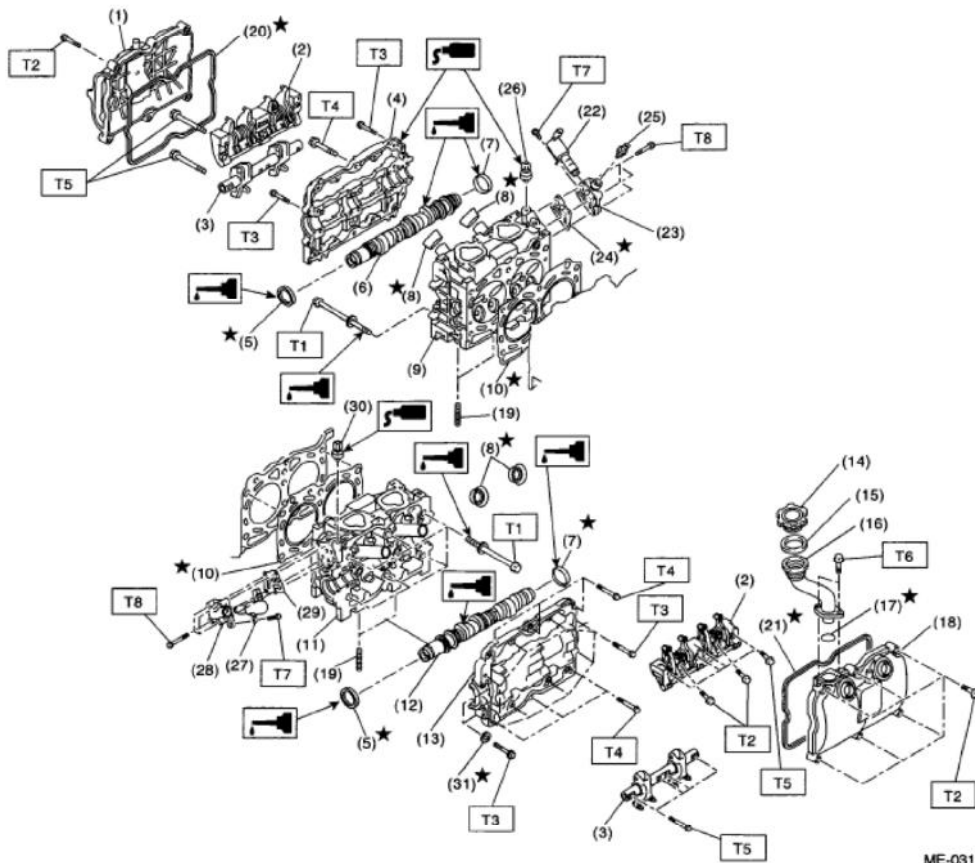
T4: 39 (4.0, 28.9)

T5: 78 (8.0, 57.9)

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

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

CYLINDER HEAD AND CAMSHAFT



ME-03113

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

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

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

T2: <Ref. to INSTALLATION, Valve Rocker Assembly.>

T3: 9.75 (1.0, 7.2)

T4: 18 (1.8, 13.0)

T5: 25 (2.5, 18.1)

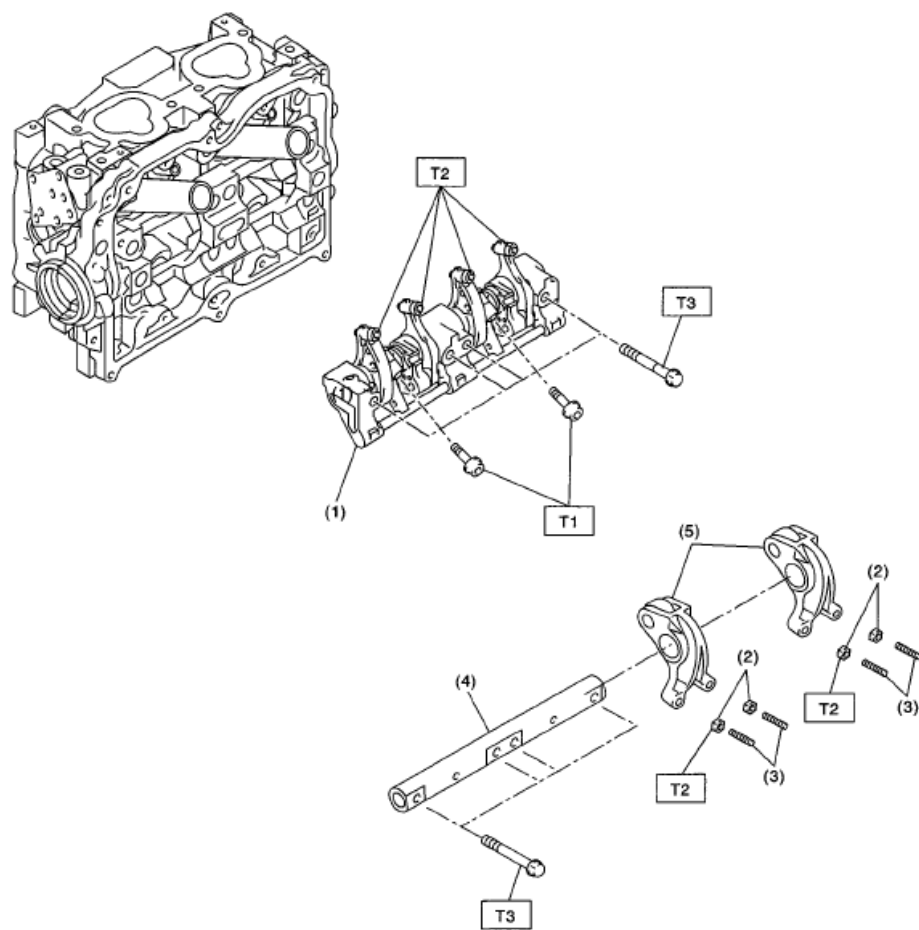
T6: 6.4 (0.65, 4.7)

T7: 8 (0.8, 5.9)

T8: 10 (1.0, 7.4)

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

VALVE ROCKER ASSY



ME-02691

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

Tightening torque:N·m (kgf-m, ft-lb)

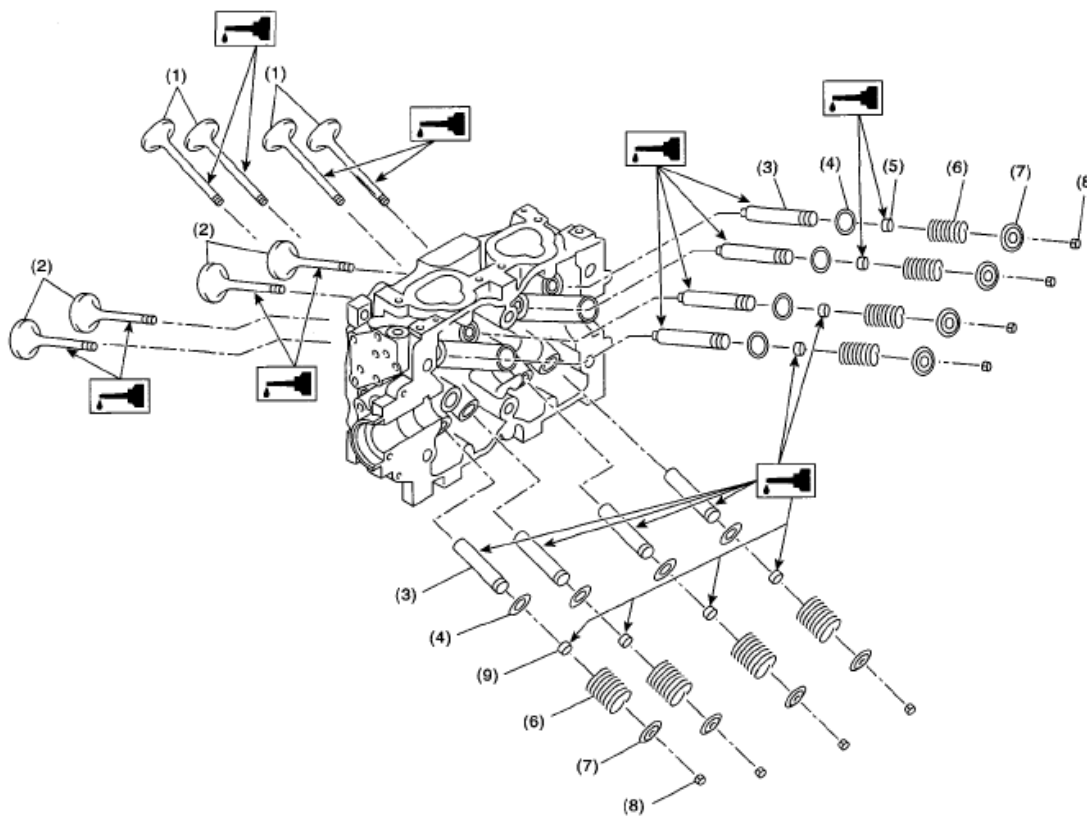
T1: 6 (0.6, 4.3)

T2: 9.75 (1.0, 7.2)

T3: 25 (2.5, 18.1)

Fig. 3: Identifying Valve Rocker Assy Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD AND VALVE ASSEMBLY

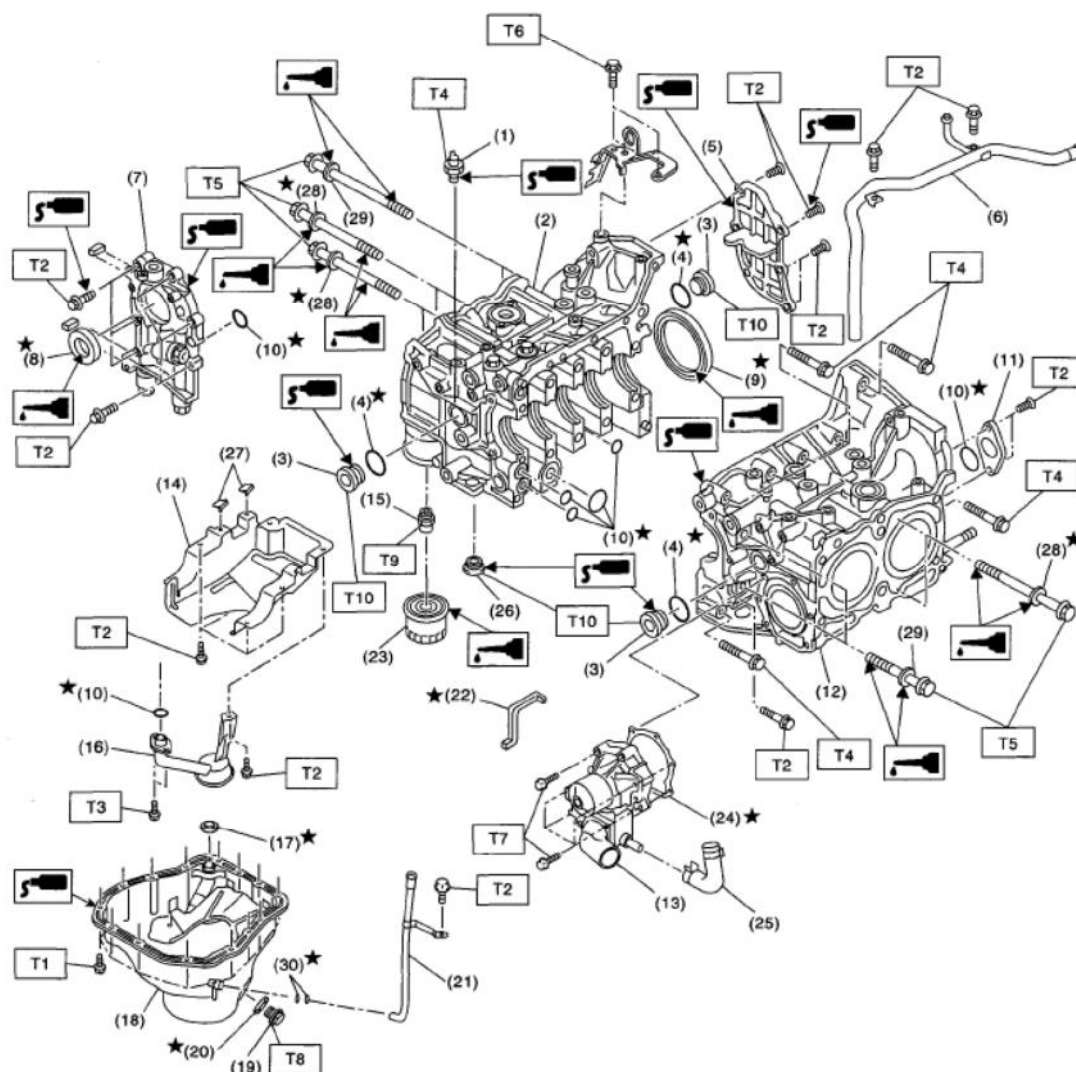


ME-03112

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

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

CYLINDER BLOCK



ME-03180

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

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, 7.4)

T4: 25 (2.5, 18.1)

T5: <Ref. to **INSTAL-**
LATION, Cylinder Block>

T6: 16 (1.6, 11.6)

T7: First 12 (1.2, 8.7)

Second 12 (1.2, 8.7)

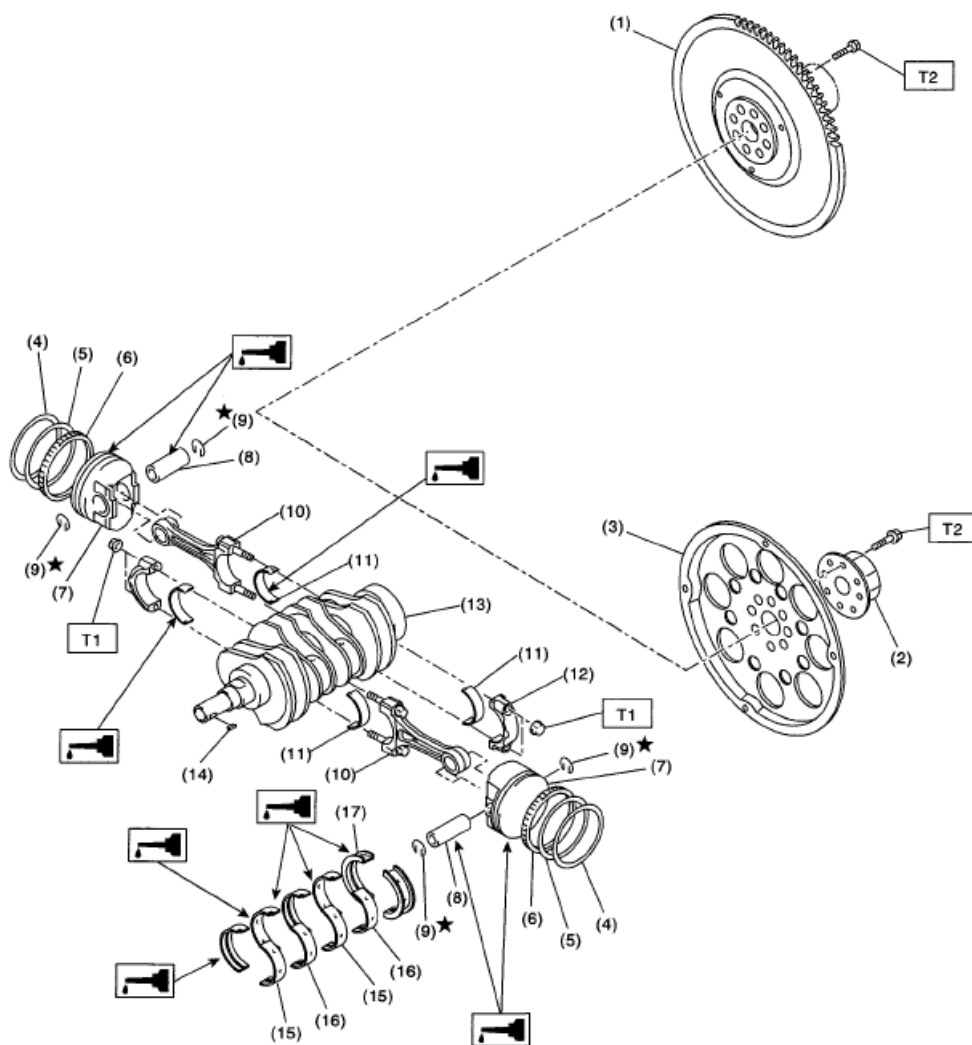
T8: 44 (4.5, 33)

T9: 45 (4.6, 33.3)

T10: 70 (7.1, 50.6)

Fig. 5: Identifying Cylinder Block Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

CRANKSHAFT AND PISTON



ME-02974

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

Tightening torque: N·m (kgf-m, ft-lb)

T1: 45 (4.6, 33.3)

T2: 72 (7.3, 52.8)

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

ENGINE MOUNTING

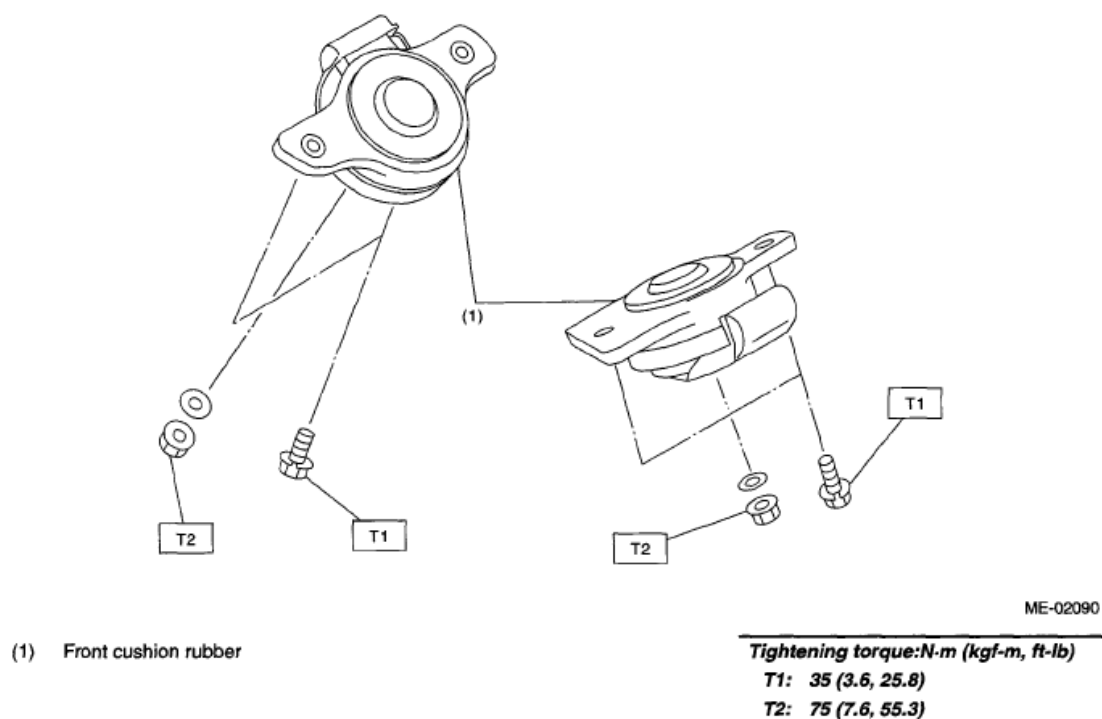


Fig. 7: Identifying Engine Mounting Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

CAUTION

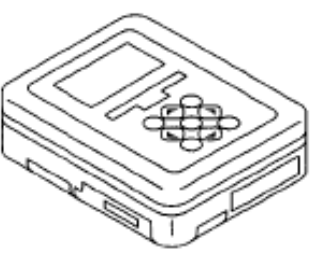
- Wear appropriate work clothing, including a cap, protective goggles and protective shoes when performing any work.
- Remove contamination including dirt and corrosion before removal, installation or disassembly.
- Keep the disassembled parts in order and protect them from dust and dirt.
- Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly and replacement.
- Vehicle components are extremely hot after driving. Be wary of receiving burns from heated parts.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or rigid racks at the specified points.
- Before disconnecting 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

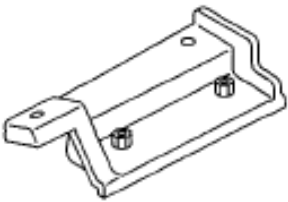
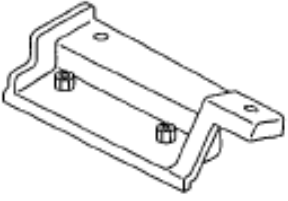
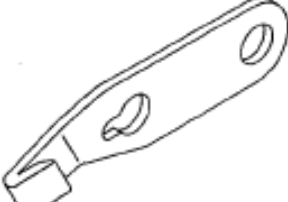
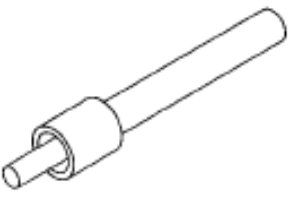
SPECIAL TOOL

SPECIAL TOOL DESCRIPTION CHART

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-498277200	18231AA010	CAM SPROCKET WRENCH	• Used for removing and installing cam sprocket. • CAMSHAFT SPROCKET WRENCH (499207100) can also be used.
 ST1B020XU0	1B020XU0	SUBARU SELECT MONITOR KIT	Used for troubleshooting for electrical system.
	498267800	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.

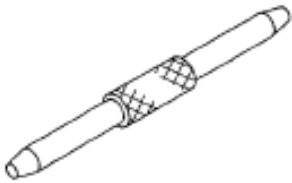
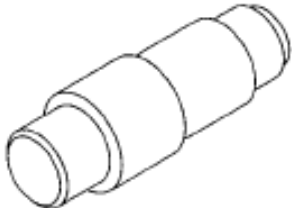
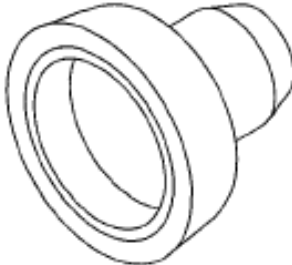
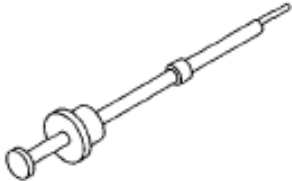
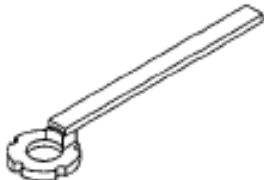
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 ST-498457000			
 ST-498457100	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST-498497100	498457000	ENGINE STAND ADAPTER RH	Used together with the ENGINE STAND (499817100).
 ST-498747300	498457100	ENGINE STAND ADAPTER LH	Used together with the ENGINE STAND (499817100).
 ST-498857100	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of the flywheel when loosening/tightening crank pulley bolt.

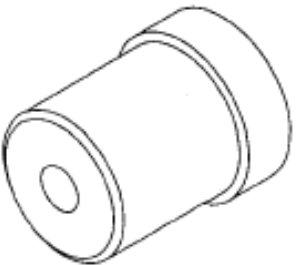
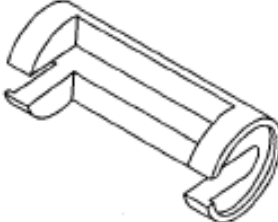
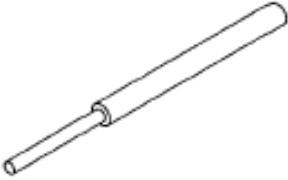
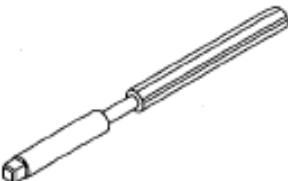
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 ST-499017100	498747300	PISTON GUIDE	Used for installing piston in cylinder.
 ST-499037100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST-499587200	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST-499097700	499037100	CONNECTING ROD BUSHING REMOVER & INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499207400	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with the CRANKSHAFT OIL SEAL GUIDE (499597100).

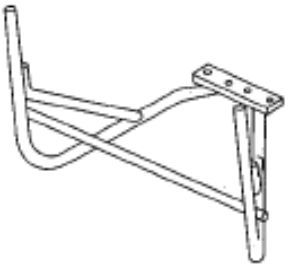
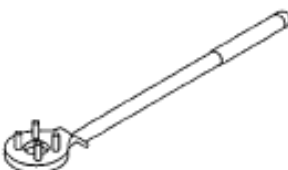
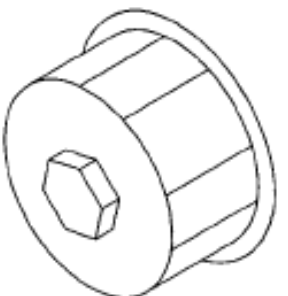
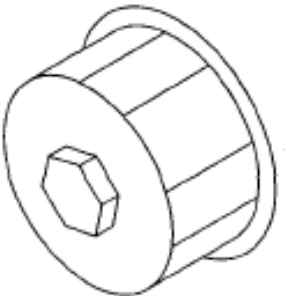
2007 Subaru Legacy Limited

2007 ENGINE Mechanical (H4SO) - Legacy & Outback

 ST-499587100	499587500	OIL SEAL INSTALLER	• Used for installing the camshaft oil seal. • Used together with the OIL SEAL GUIDE (499597000).
 ST-499597100	499587700	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.
 ST-499718000	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499767200	499497000	TORX® PLUS	Used for removing and installing camshaft cap.
 ST-499767400	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.

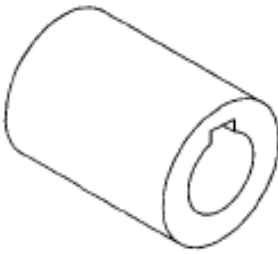
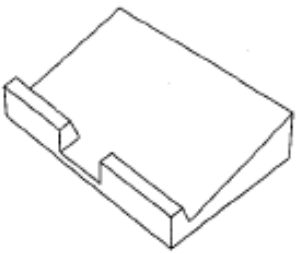
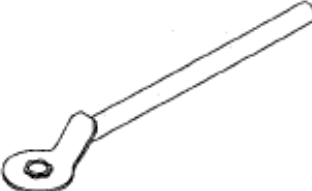
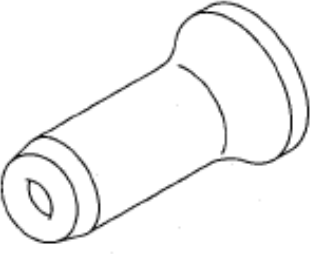
2007 Subaru Legacy Limited

2007 ENGINE Mechanical (H4SO) - Legacy & Outback

 ST-499817100	499597000	OIL SEAL GUIDE	• Used for installing the camshaft oil seal. • Used together with the CAMSHAFT OIL SEAL INSTALLER (499587500).
 ST-499977100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with the CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST18332AA000	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST18332AA010	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.

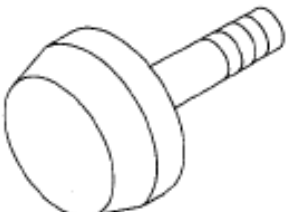
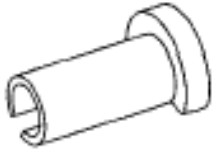
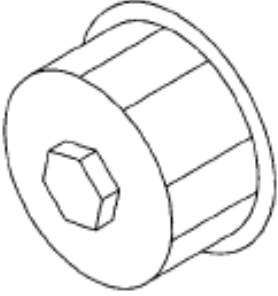
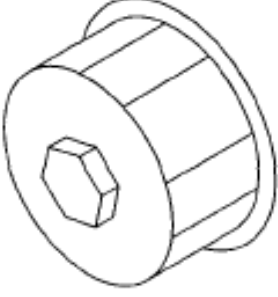
2007 Subaru Legacy Limited

2007 ENGINE Mechanical (H4SO) - Legacy & Outback

 ST-499987500			
 ST-498267600	499767700	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Intake side)
 ST-499977500	499767800	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Exhaust side)
 ST18251AA020	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used together with the ENGINE STAND ADAPTER RH (498457000) & LH (498457100).
 ST-499587600	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when loosening/tightening crank pulley bolt.

2007 Subaru Legacy Limited

2007 ENGINE Mechanical (H4SO) - Legacy & Outback

 ST-499597200	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST42099AE000	42099AE000	CONNECTOR REMOVER	Used for removing the quick connector.
 ST18332AA000	18354AA000	VALVE ROCKER HOLDER	Used for installing the valve rocker assembly (intake). (2-piece set)
 ST18332AA010	18258AA000	SPRING INSTALLER	Used for installing the valve rocker assembly (intake).

GENERAL TOOL**GENERAL TOOL DESCRIPTION CHART**

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
Vacuum gauge	Used for vacuum measurement of the intake manifold.

Oil pressure gauge	Used for measuring engine oil pressure.
Fuel pressure gauge	Used for measuring fuel pressure.
Timing light	Used for measuring ignition timing.

PROCEDURE

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

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

COMPRESSION

INSPECTION

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

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

NOTE: When using a screw-in type compression gauge, the screw (put into cylinder head spark plug hole) should be less than 18 mm (0.71 in) long.

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

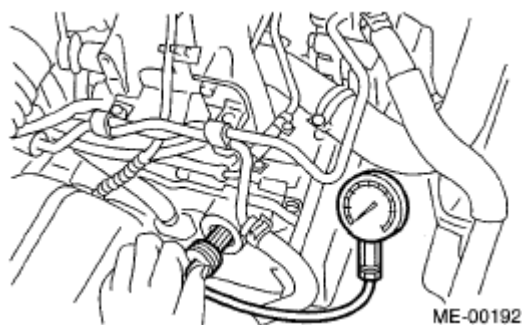


Fig. 8: Checking Compression Of Engine Using Compression Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

Compression (350 rpm and fully open throttle):

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

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

IDLE SPEED

INSPECTION

1. Before checking the idle speed, check the following item:
 1. Check the air cleaner element is free from clogging, ignition timing is correct, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm-up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Connect the Subaru Select Monitor to the data link connector.

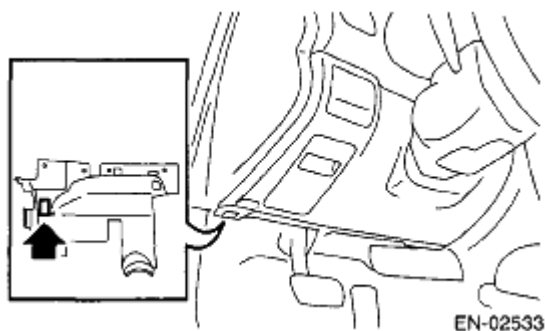


Fig. 9: Locating Data Link Connector
Courtesy of SUBARU OF AMERICA, INC.

5. Turn the ignition switch to ON and run the Subaru Select Monitor.
6. Select {Each System Check} in Main Menu.
7. Select {Engine Control System} in Selection Menu.
8. Select {Current Data Display & Save} in Engine Control System Diagnosis.
9. Select {Data Display} in Data Display Menu.
10. Start the engine, and read the engine idle speed.
11. Check the idle speed when no-loaded. (Headlight, heater fan, rear defroster, radiator fan, A/C and etc. are OFF)

Idle speed [No load and gears in "N" or "P" range]: 650±100 rpm (MT model)

700±100 rpm (AT model)

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 "N" or "P" range]: 850±100 rpm

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

IGNITION TIMING

INSPECTION

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm-up the engine.
3. When checking the ignition timing, connect the timing light to the #1 cylinder spark plug cord and illuminate the timing mark with the timing light.
4. Start the engine and check the ignition timing at idle speed as shown below.

Ignition timing [BTDC/rpm]: 10°±8°/650 (MT Model)

15°±8°/700 (AT model)

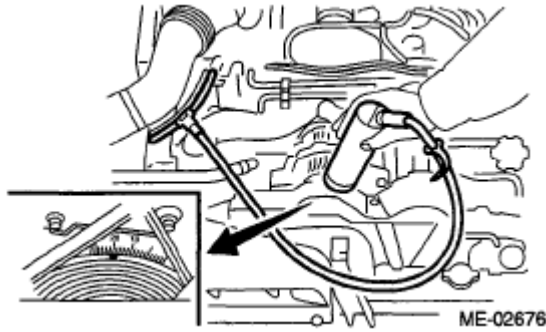


Fig. 10: Checking Ignition Timing At Idle Speed
Courtesy of SUBARU OF AMERICA, INC.

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

INTAKE MANIFOLD VACUUM

INSPECTION

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

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

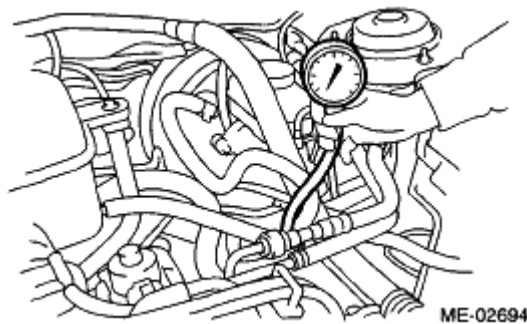


Fig. 11: Checking Intake Manifold Vacuum Pressure
Courtesy of SUBARU OF AMERICA, INC.

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

INTAKE MANIFOLD VACUUM DIAGNOSIS CHART

Diagnosis of engine condition by measurement of intake manifold vacuum	
Vacuum gauge indication	Possible engine condition
	Air leakage around intake manifold

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

ENGINE OIL PRESSURE

INSPECTION

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

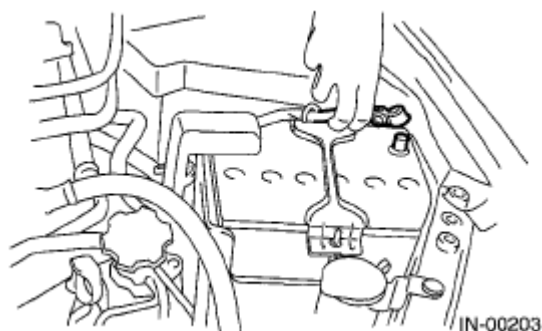


Fig. 12: Connecting/Disconnecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

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

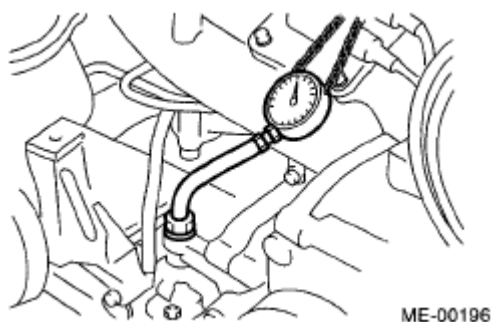


Fig. 13: Checking Oil Pressure Using Pressure Gauge

Courtesy of SUBARU OF AMERICA, INC.

Oil pressure:

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

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

- If the oil pressure is out of specification, check the 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).**

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

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

FUEL PRESSURE

INSPECTION

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

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

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

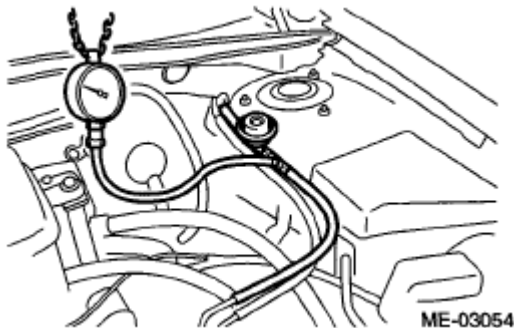


Fig. 14: Identifying Fuel Pressure Gauge Connection
Courtesy of SUBARU OF AMERICA, INC.

3. Install the fuse of fuel pump to main fuse box.
4. Start the engine.
5. Measure the fuel pressure after warming up the engine.

Fuel pressure:

Standard: 339.5 - 360.5 kPa (3.5 - 3.7 kg/cm² , 49 - 52 psi)

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

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. Lift up the vehicle.
3. Remove the under cover.
4. Lower the vehicle.
5. Disconnect the ground cable from the battery.

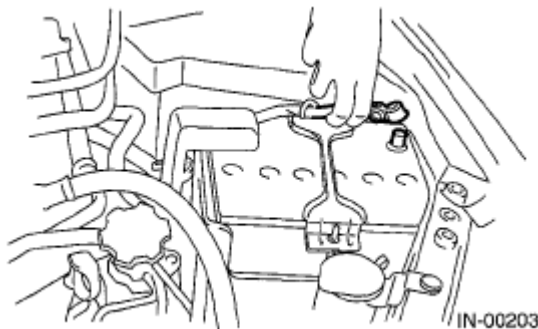


Fig. 15: Connecting/Disconnecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the timing belt cover (LH).

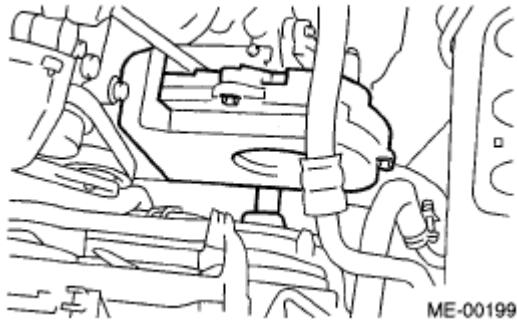


Fig. 16: Identifying Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

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

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

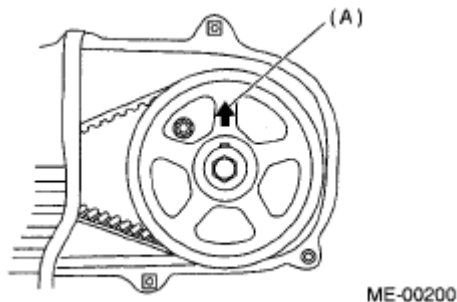


Fig. 17: Identifying Arrow Mark On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

Valve clearance (standard):

Intake

$0.20 \pm 0.04 \text{ mm } (0.0079 \pm 0.0016 \text{ in})$

Exhaust

$0.25 \pm 0.04 \text{ mm } (0.0098 \pm 0.0016 \text{ in})$

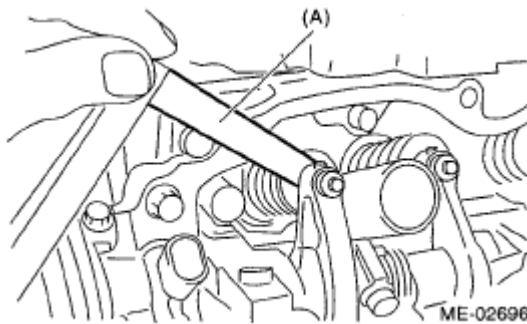


Fig. 18: Measuring Exhaust Valve Clearances Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

12. If necessary, adjust the valve clearance. <Ref. to **ADJUSTMENT** .>
13. Measure the valve clearance in #3, #2 and #4 cylinder in the same measurement procedure as #1 cylinder in this order.

NOTE:

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

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

using the socket wrench.

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

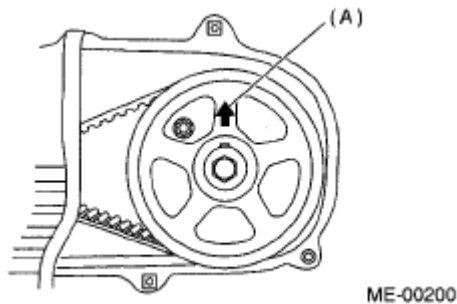


Fig. 19: Identifying Arrow Mark On Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

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

NOTE:

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

Valve clearance:

Intake

0.20 ± 0.04 mm (0.0079 ± 0.0016 in)

Exhaust

0.25 ± 0.04 mm (0.0098 ± 0.0016 in)

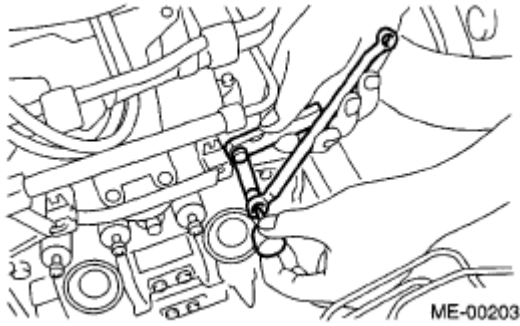


Fig. 20: Adjusting Valve Clearances

Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

4. Ensure the valve clearances of each cylinder are within specifications. If necessary, readjust the valve clearances.

ENGINE ASSEMBLY

REMOVAL

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

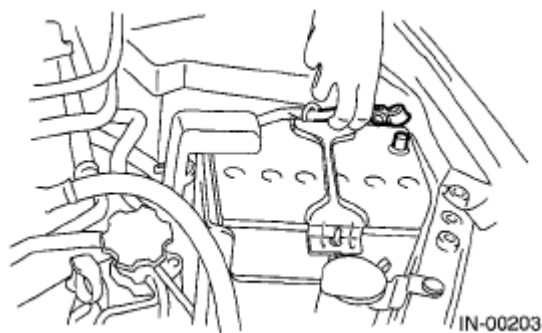


Fig. 21: Connecting/Disconnecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

6. Open the fuel filler flap lid, and remove the fuel filler cap.
7. Remove the air intake duct, air cleaner case and air intake chamber. <Ref. to **REMOVAL** , Air Intake Duct .> <Ref. to **REMOVAL** , Air Cleaner Case .> <Ref. to **REMOVAL** , Air Intake Chamber .>
8. Remove the under cover.
9. Remove the radiator from the vehicle. <Ref. to **REMOVAL** , Radiator .>
10. Disconnect the A/C pressure hoses from A/C compressor.
11. Remove the air intake chamber stay.

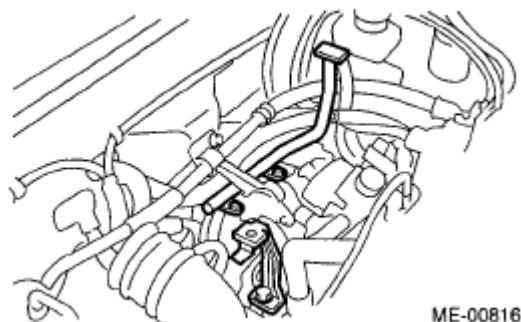
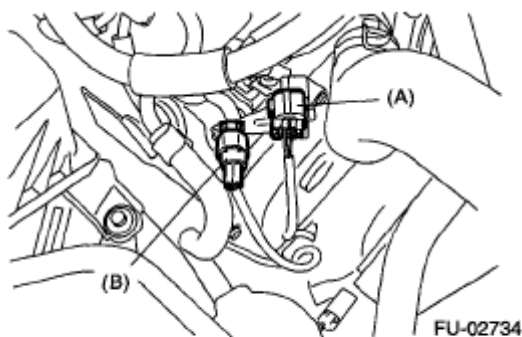


Fig. 22: Identifying Air Intake Chamber Stay
Courtesy of SUBARU OF AMERICA, INC.

12. Disconnect the following connectors and cables.
 1. Front oxygen (A/F) sensor connector
 2. Rear oxygen sensor connector



- (A) Front oxygen (A/F) sensor connector
- (B) Rear oxygen sensor connector

Fig. 23: Identifying Front Oxygen (A/F) And Rear Oxygen Sensor Connector
Courtesy of SUBARU OF AMERICA, INC.

- 3. Engine ground cable

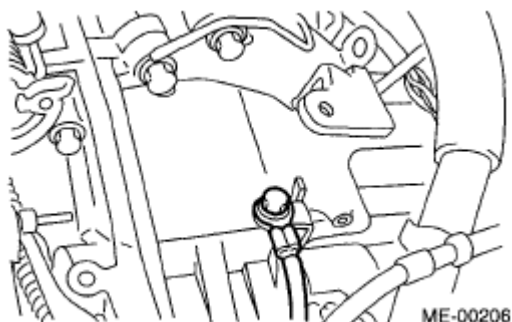


Fig. 24: Identifying Engine Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

- 4. Engine harness connectors

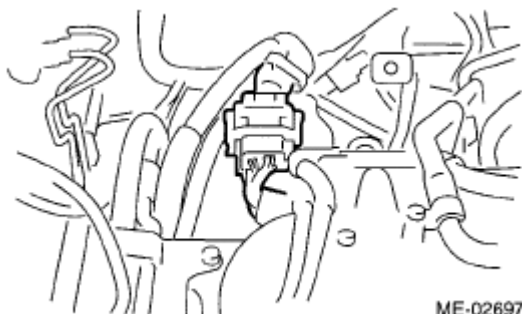


Fig. 25: Identifying Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

- 5. Generator connector and terminal



(A) Terminal
(B) Generator connector

Fig. 26: Identifying Generator Connector And Terminal
Courtesy of SUBARU OF AMERICA, INC.

6. A/C compressor connector

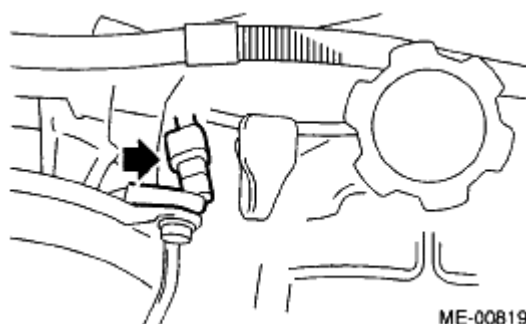


Fig. 27: Locating A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

7. Power steering switch connector

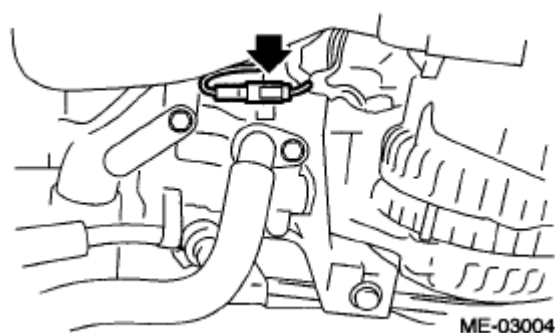


Fig. 28: Locating Power Steering Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

13. Disconnect the following hoses.

1. Brake booster vacuum hose

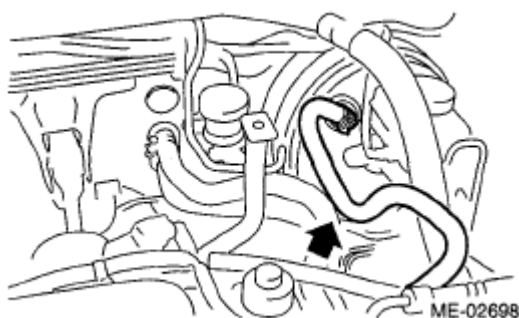


Fig. 29: Locating Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

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

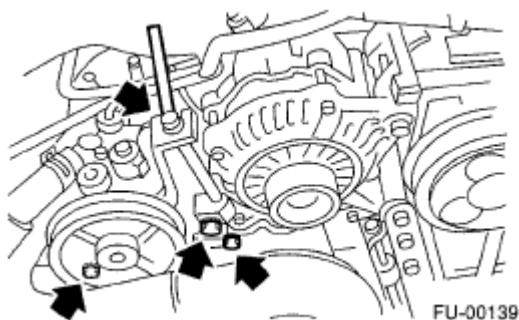


Fig. 30: Locating Power Steering Pump Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Place the power steering pump on the right side wheel apron.
15. Remove the front and center exhaust pipes. <Ref. to **REMOVAL** , Front Exhaust Pipe .>
16. Remove the bolts and nuts which hold lower side of transmission to engine.

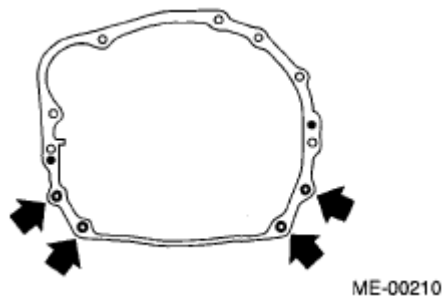


Fig. 31: Locating Lower Side Of Transmission To Engine Nuts Location
Courtesy of SUBARU OF AMERICA, INC.

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

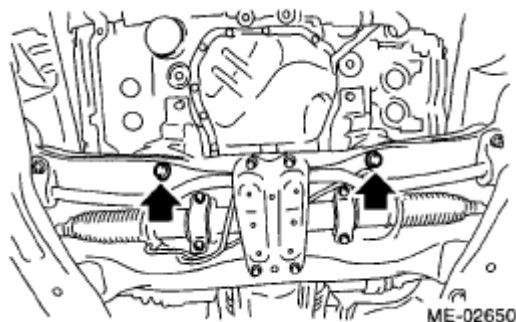


Fig. 32: Locating Nuts Installing Front Cushion Rubber Onto Front Crossmember
Courtesy of SUBARU OF AMERICA, INC.

18. 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 all bolts while turning the crankshaft with a socket wrench.

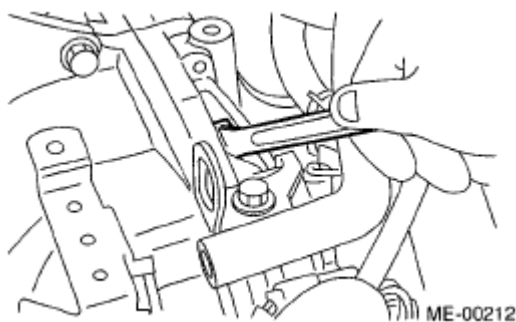
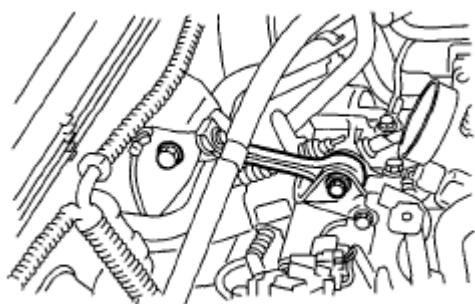


Fig. 33: Turning Crankshaft Using Socket Wrench
Courtesy of SUBARU OF AMERICA, INC.

19. Remove the pitching stopper.



ME-03187

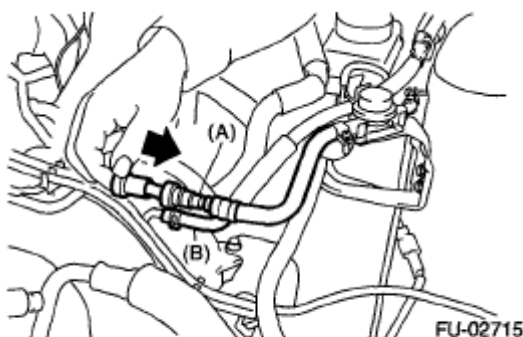
Fig. 34: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

20. Disconnect the fuel hoses from fuel pipe.
 1. Disconnect the quick connector on the fuel delivery line by pushing the ST in the direction of the arrow.

ST 42099AE000 CONNECTOR REMOVER

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

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



(A) Fuel delivery hose
(B) Evaporation hose

Fig. 35: Removing Clip For Disconnecting Evaporation Hose
Courtesy of SUBARU OF AMERICA, INC.

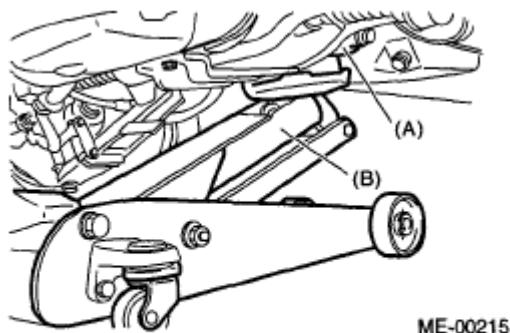
21. Support the engine with a lifting device and wire ropes.



Fig. 36: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

22. Support the transmission with a garage jack.

CAUTION: Be sure to perform this work to prevent the transmission from lowering due to its own weight.

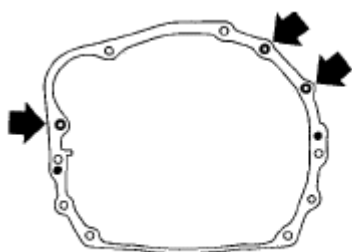


- (A) Transmission
(B) Garage jack

Fig. 37: Supporting Transmission Using 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.

23. Separation of engine and transmission.
 1. Remove the starter. <Ref. to **REMOVAL** , Starter .>
 2. Remove the bolts which hold upper side of transmission to engine.

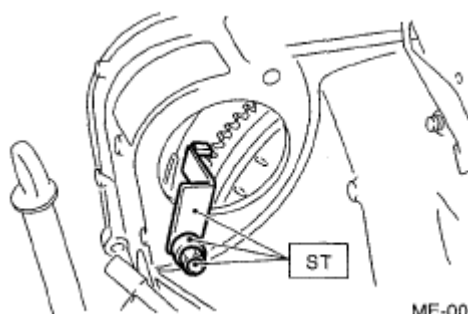


ME-00216

Fig. 38: Locating Upper Side Of Transmission Bolts
Courtesy of SUBARU OF AMERICA, INC.

24. Attach the ST to the converter case. (AT model)

ST 498277200 STOPPER SET



ME-00217

Fig. 39: Identifying ST 498277200 Stopper Set On Converter
Courtesy of SUBARU OF AMERICA, INC.

25. 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.

26. 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. 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.

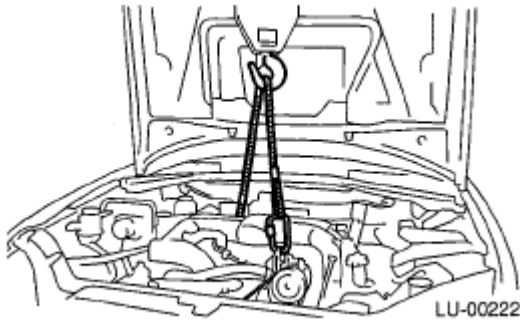


Fig. 40: Supporting Engine With Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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

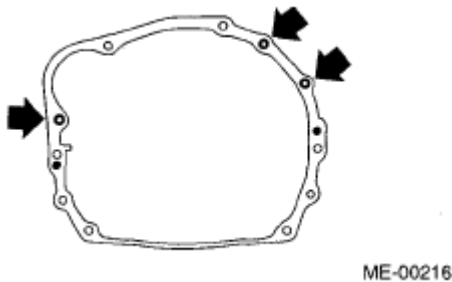


Fig. 41: Locating Upper Side Of Transmission Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.
6. Remove the garage jack.
7. Install the pitching stopper.

Tightening torque:

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

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

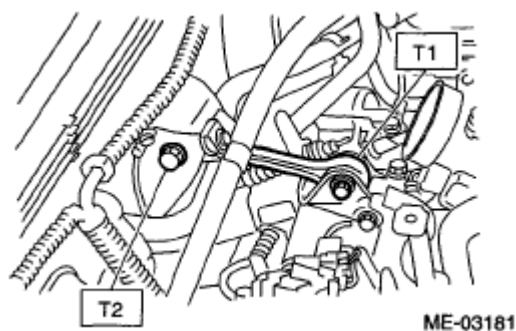


Fig. 42: Identifying Pitching Stopper Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

9. Install the starter. <Ref. 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)

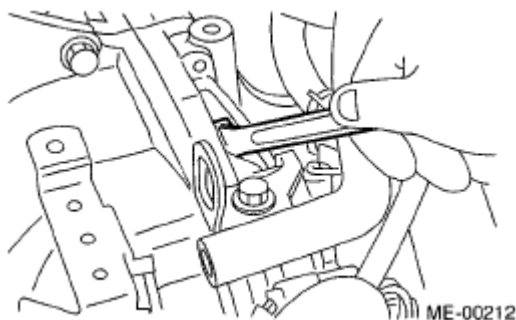


Fig. 43: Turning Crankshaft Using Socket Wrench
Courtesy of SUBARU OF AMERICA, INC.

3. Attach the service hole plug to prevent entry of foreign objects.
11. Install the power steering pump.
 1. Install the power steering pump to the bracket, and tighten the bolts.

Tightening torque: 22 N.m (2.2 kgf-m, 16 ft-lb)

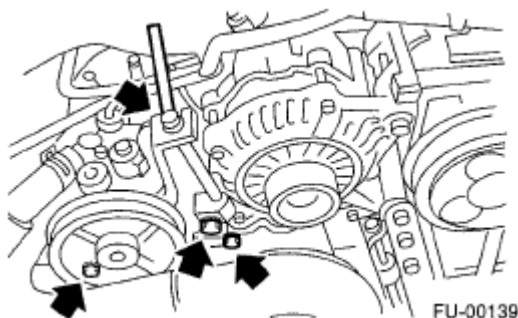


Fig. 44: Locating Power Steering Pump Bracket Bolts
 Courtesy of SUBARU OF AMERICA, INC.

2. Connect the power steering switch connector.

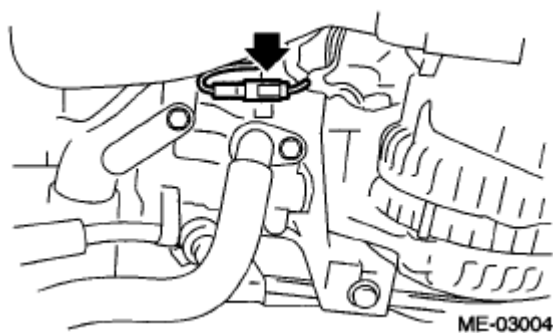


Fig. 45: Locating Power Steering Switch Connector
 Courtesy of SUBARU OF AMERICA, INC.

3. Install and adjust the front side belt. <Ref. to **FRONT SIDE BELT** .>
12. Lift up the vehicle.
13. 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)

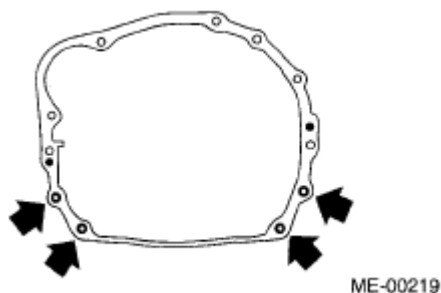


Fig. 46: Locating Bolts And Nuts Holding Lower Side Of Transmission To Engine
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque: 75 N.m (7.6 kgf-m, 55.3 ft-lb)

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

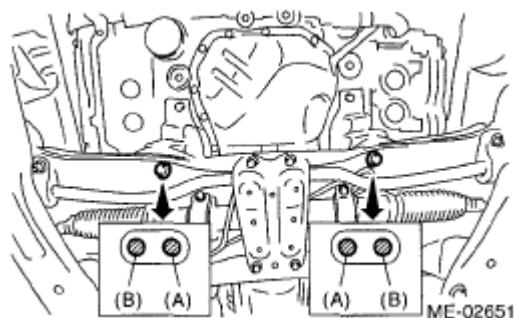


Fig. 47: Locating Front Cushion Rubber Mounting Bolts And Locator
Courtesy of SUBARU OF AMERICA, INC.

15. Install the front and center exhaust pipe. <Ref. to INSTALLATION , Front Exhaust Pipe .>
16. Lower the vehicle.
17. Connect the following hoses.
 1. Fuel delivery hose and evaporation hose
 2. Heater inlet and outlet hoses
 3. Brake booster vacuum hose
18. Connect the following connectors.
 1. Front oxygen (A/F) sensor connector
 2. Rear oxygen sensor connector
 3. Engine harness connectors
 4. Generator connector and terminal
 5. A/C compressor connector
19. Install the air intake chamber stay.

Tightening torque: 16 N.m (1.6 kgf-m, 11.6 ft-lb)

20. Tighten the engine ground cable.

Tightening torque: 14 N.m (1.4 kgf-m, 10.1 ft-lb)

21. Install the A/C pressure hoses. <Ref. to INSTALLATION , Hose and Tube.>
22. Install the radiator to vehicle. <Ref. to INSTALLATION , Radiator.>
23. Install the air intake duct, air cleaner case and air intake chamber. <Ref. to INSTALLATION , Air

Intake Duct .> <Ref. to **INSTALLATION** , Air Cleaner Case .> <Ref. to **INSTALLATION** , Air Intake Chamber .>

24. Install the under cover.
25. Install the battery in the vehicle, and connect cables.
26. Fill engine coolant. <Ref. to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant.>
27. Check the ATF level and replenish it if necessary. <Ref. to **REPLACEMENT** , Automatic Transmission Fluid .>
28. Charge the A/C system with refrigerant. <Ref. to **PROCEDURE** , Refrigerant Charging Procedure .>
29. Remove the front hood stay, and close the front hood.
30. Lower the vehicle from the lift.

INSPECTION

1. Check that pipes, hoses, connectors and clamps are installed firmly.
2. Check the engine coolant and ATF are at specified levels.
3. Start the engine and check for exhaust gas, engine coolant, leaks of fuel, etc. Also check for noise and vibrations.

ENGINE MOUNTING

REMOVAL

1. Remove the engine unit. <Ref. to **REMOVAL** .>
2. Remove the engine mounting from engine assembly.

INSTALLATION

Install in the reverse order of removal.

Tightening torque:

Engine mounting

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

INSPECTION

Make sure that no crack or other 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

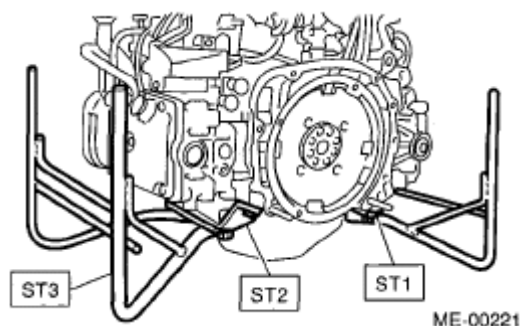


Fig. 48: Identifying Engine Stand Adapter RH (498457000) And Engine Stand Adapter LH (498457100)

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 V-belt covers.

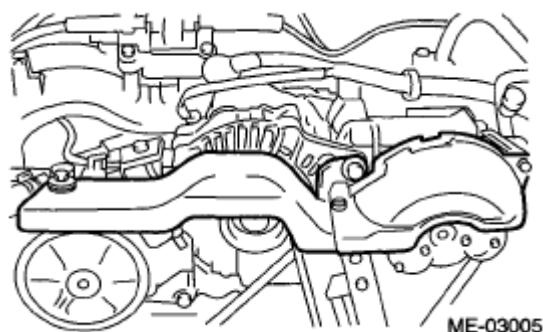


Fig. 49: Identifying V-Belt Cover

Courtesy of SUBARU OF AMERICA, INC.

2. Loosen the lock bolt (A).
3. Loosen the slider bolt (B).

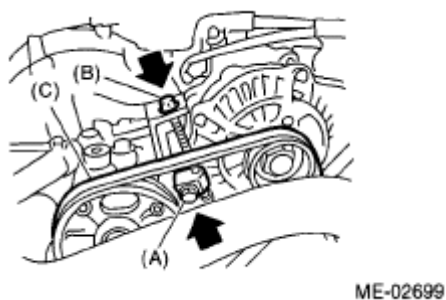


Fig. 50: Locating Front Side Belt Slider Bolt And Lock Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the front side belt (C).

REAR SIDE BELT

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

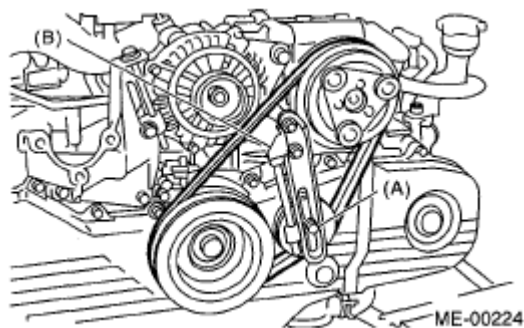


Fig. 51: Identifying Lock Nut And Slider Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

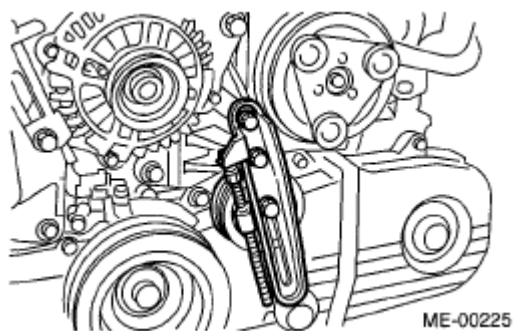


Fig. 52: Identifying A/C Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

FRONT SIDE BELT

1. Install the front side belt (C), and tighten the slider bolt so as to obtain the specified belt tension. <Ref. to **INSPECTION** .>
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, 5.8 ft-lb)

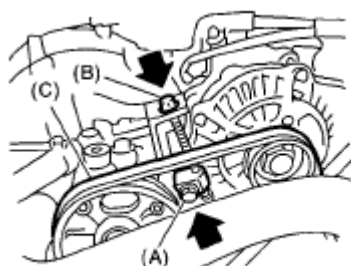


Fig. 53: Locating Front Side Belt Slider Bolt And Lock Bolt
Courtesy of SUBARU OF AMERICA, INC.

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** .>
3. Tighten the lock nut (A).

Tightening torque:

Lock nut (A)

23 N.m (2.3 kgf-m, 17.0 ft-lb)

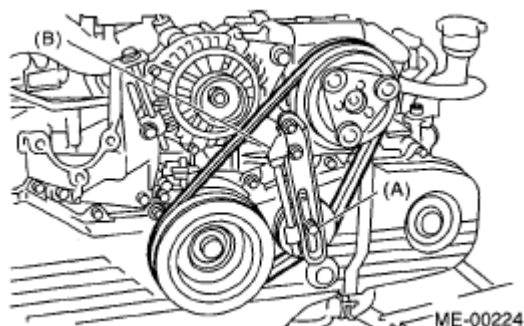


Fig. 54: Identifying Rear Side Belt Slider Bolt And Lock Nut
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Replace the belts, if crack, fraying or wear is found.
2. Remove the V-belt cover and reservoir tank, (with belt tension gauge)
3. 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 - 775 lb)

At inspection

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

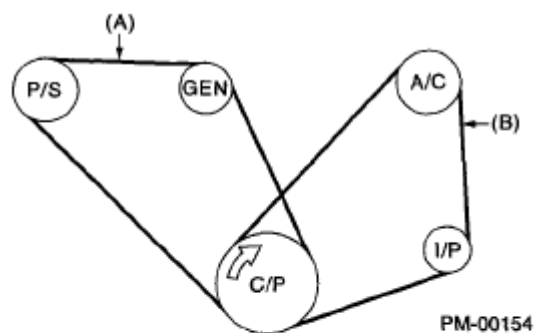
(B)

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 Air conditioning compressor pulley
- I/P Idler pulley

Fig. 55: View Of Pulley And Drive Belt
 Courtesy of SUBARU OF AMERICA, INC.

Belt tension (without belt tension gauge):

(A)

When installing new parts:

7 - 9 mm (0.276 - 0.354 in)

At inspection

9 - 11 mm (0.354 - 0.433 in)

(B)

When installing new parts:

7.5 - 8.5 mm (0.295 - 0.335 in)

At inspection

9.0 - 10.0 mm (0.354 - 0.394 in)

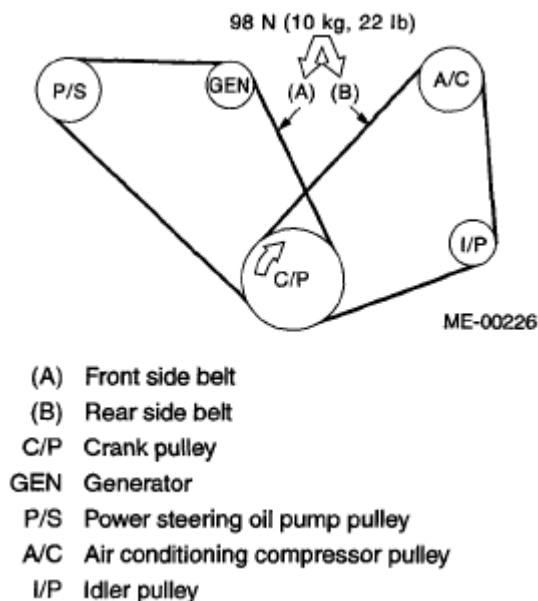


Fig. 56: View Of Pulley And Drive Belt
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499977100 CRANK PULLEY WRENCH

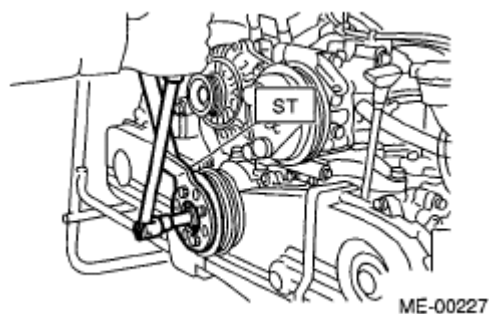


Fig. 57: Removing/Installing Crank Pulley Bolt Using Crank Pulley Wrench (ST 499977100)
Courtesy of SUBARU OF AMERICA, INC.

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 (18.4 kgf-m, 132.8 ft-lb)

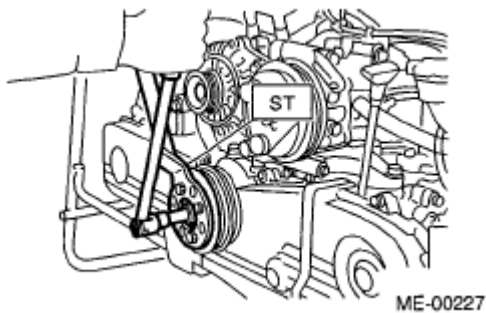


Fig. 58: Removing/Installing Crank Pulley Bolt Using Crank Pulley Wrench (ST 499977100)
Courtesy of SUBARU OF AMERICA, INC.

3. Check that the tightening angle of the crank pulley bolt is 65° or more. Perform the following procedures 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: 12369A A011

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.

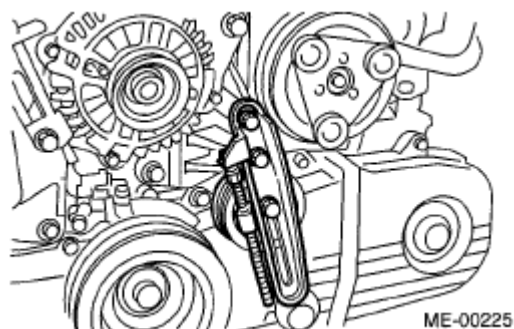


Fig. 59: Identifying A/C Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

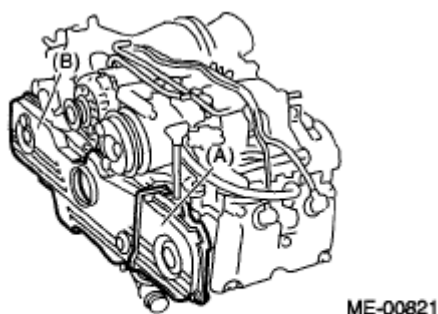
1. Make sure the V-belt is not worn or otherwise damaged.
2. Check the tension of the belt. <Ref. to **INSPECTION** .>

TIMING BELT COVER

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL** .>
2. Remove the crank pulley. <Ref. to **REMOVAL** .>
3. Remove the timing belt cover (LH).
4. Remove the front timing belt cover.



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

Fig. 60: Identifying Timing Belt Cover (LH) And Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

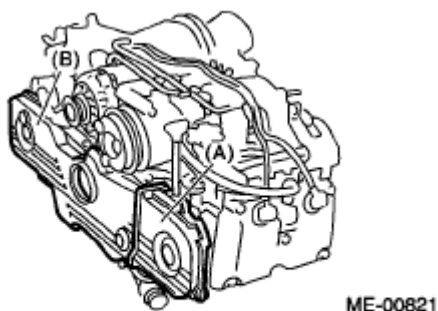
INSTALLATION

1. Install the front timing belt cover.

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

2. Install the timing belt cover (LH).

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



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

Fig. 61: Identifying Timing Belt Cover (LH) And Front Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

3. Install the crank pulley. <Ref. to **INSTALLATION** .>
4. Install the V-belts. <Ref. to **INSTALLATION** .>

INSPECTION

Check the cover for damage.

TIMING BELT

REMOVAL

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

TIMING BELT

1. Remove the V-belts. <Ref. to REMOVAL .>
2. Remove the crank pulley. <Ref. to REMOVAL .>
3. Remove the timing belt cover. <Ref. to REMOVAL .>
4. Remove the timing belt guide. (MT model)

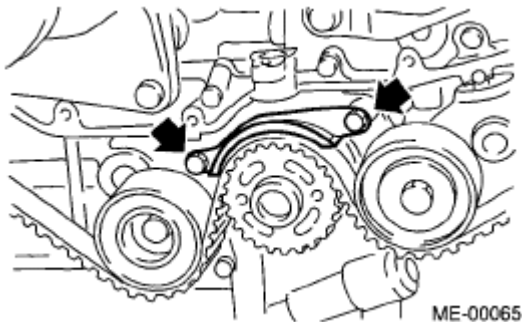


Fig. 62: Locating Timing Belt Guides
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499987500 CRANKSHAFT SOCKET

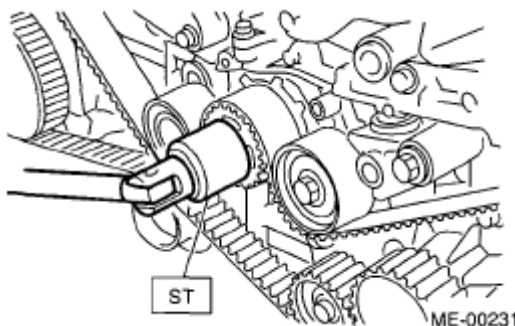


Fig. 63: Turning Crankshaft Using ST (499987500) Crankshaft Socket

Courtesy of SUBARU OF AMERICA, INC.

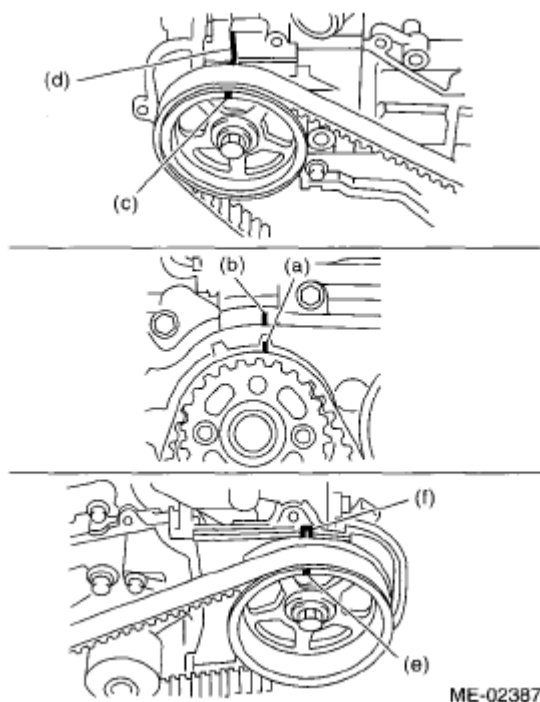


Fig. 64: Aligning Mark Of Sprocket To Cylinder Block Notch
Courtesy of SUBARU OF AMERICA, INC.

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

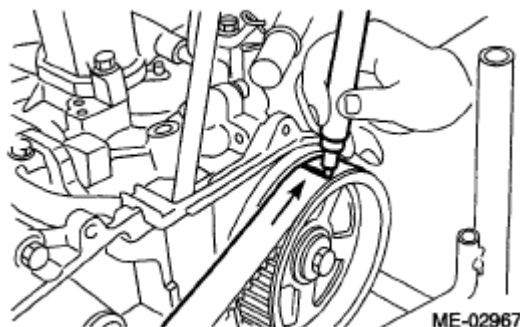


Fig. 65: Putting Alignment Marks Or Arrow Marks On Timing Belts
Courtesy of SUBARU OF AMERICA, INC.

Specified data: Z_1 : 46.8 teeth

Z_2 : 43.7 teeth

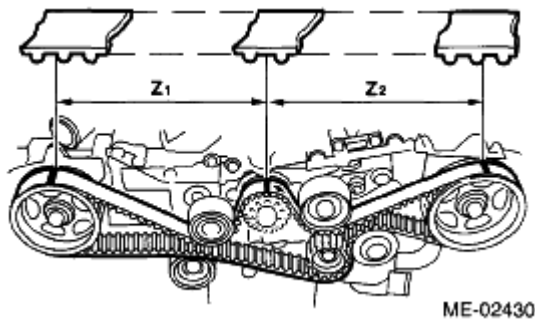
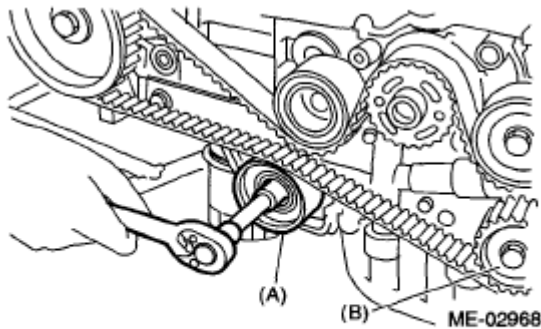


Fig. 66: Identifying Alignment Marks Dimension
Courtesy of SUBARU OF AMERICA, INC.

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



- (A) Belt idler (No. 2)
- (B) Belt idler No. 2

Fig. 67: Identifying Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt.

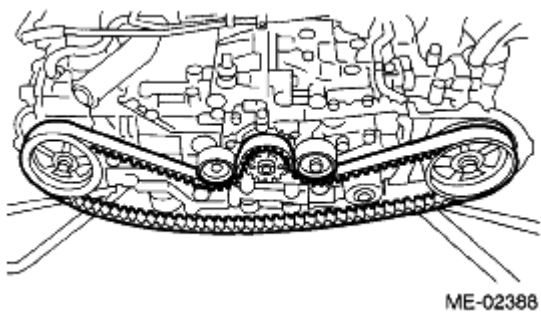


Fig. 68: Identifying Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY

1. Remove the belt idler (No. 1).

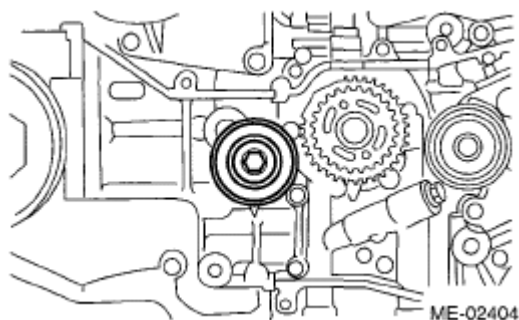


Fig. 69: Identifying Belt Idler (No. 1)
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the automatic belt tension adjuster assembly.

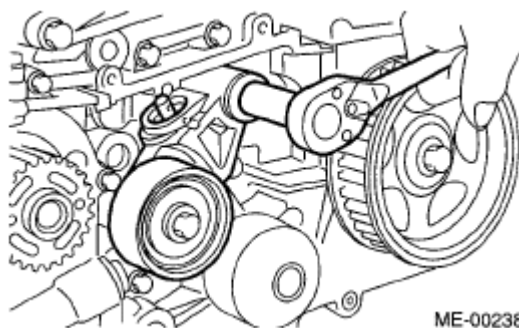


Fig. 70: Removing Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

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

CAUTION:

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

press the adjuster rod into cylinder. Doing so may damage the cylinder.

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

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

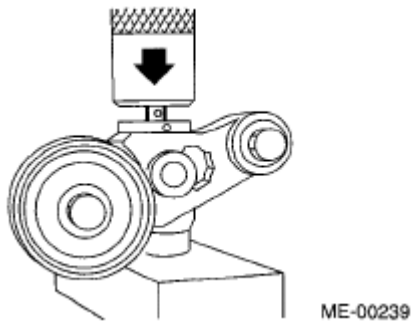


Fig. 71: Attaching Automatic Belt Tension Adjuster Assembly To Vertical Pressing Tool
Courtesy of SUBARU OF AMERICA, INC.

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

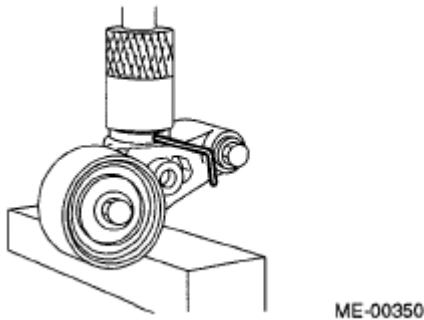


Fig. 72: Positioning Hex Wrench Into Stopper Pin Hole In Cylinder
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

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

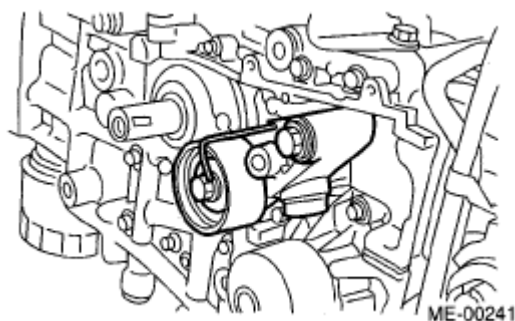


Fig. 73: Identifying Automatic Belt Tension Adjuster Assembly
 Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idler (No. 1).

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

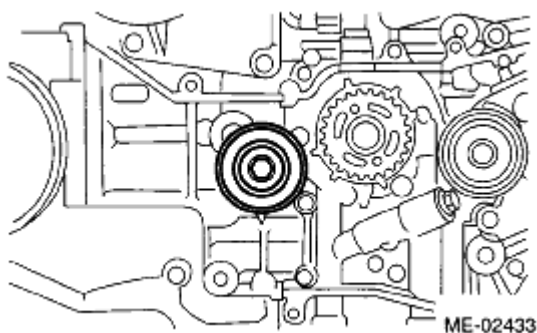


Fig. 74: Identifying Belt Idler (No. 1)
 Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

1. Prepare for installation of the automatic belt tension adjuster assembly. <Ref. to **AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER** .>
2. Installation of timing belt:
 1. Turn the cam sprocket No. 1 and No. 2 using an ST, and position the alignment marks (A) on each at the highest positions.

ST1 18231AA010 CAM SPROCKET WRENCH

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

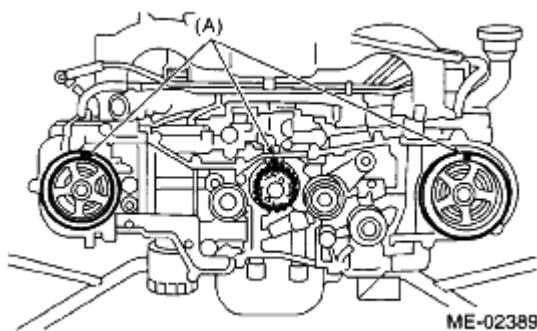


Fig. 75: Identifying Alignment Marks
Courtesy of SUBARU OF AMERICA, INC.

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

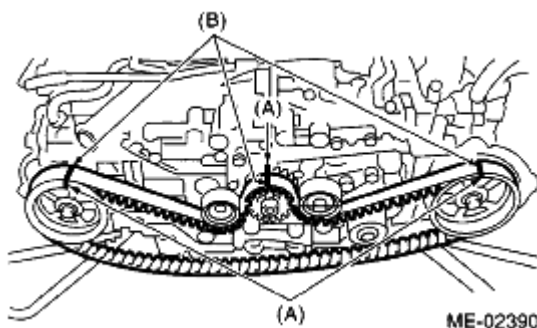
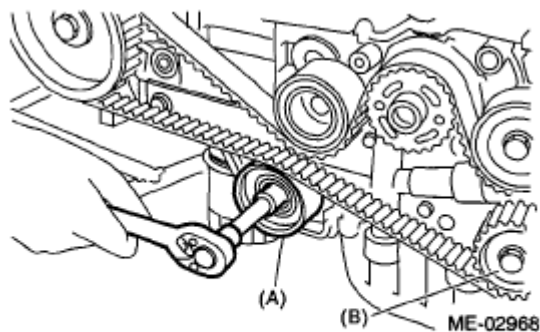


Fig. 76: Identifying Alignment Mark On Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idlers (A) and (B), with (B) first.

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



- (A) Belt idler (No. 2)
(B) Belt idler No. 2

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

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

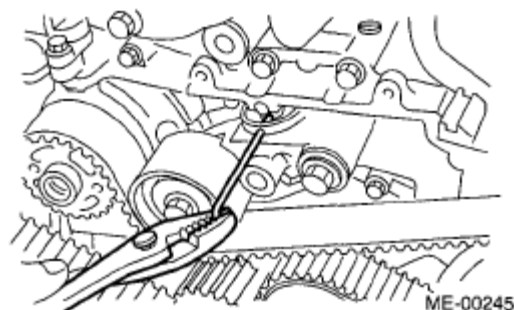


Fig. 78: Removing Stopper Pin From Belt Tension Adjuster
 Courtesy of SUBARU OF AMERICA, INC.

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

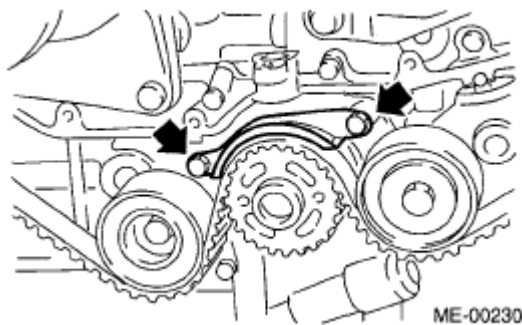


Fig. 79: Locating Timing Belt Guide Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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

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

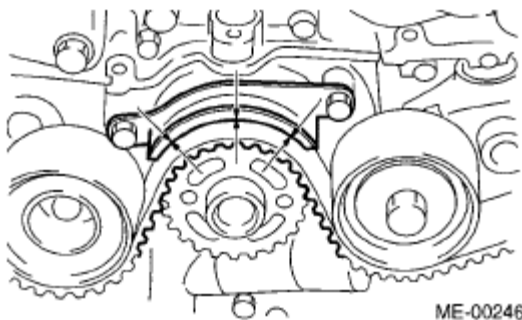


Fig. 80: Identifying Clearance Between Timing Belt And Timing Belt Guide

Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts mounting the timing belt guide.

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

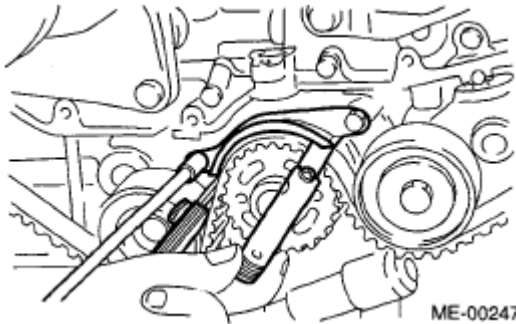


Fig. 81: Tightening Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Install the timing belt cover. <Ref. to INSTALLATION .>
7. Install the crank pulley. <Ref. to INSTALLATION .>
8. Install the V-belts. <Ref. to INSTALLATION .>

INSPECTION

TIMING BELT

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

CAUTION:

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

In radial diameter h: 60 mm (2.36 in) or more

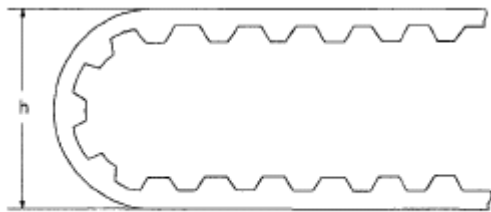


Fig. 82: Identifying Timing Belt Radial Diameter

Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

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

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

2. Check that the adjuster rod does not move when a pressure of 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 movement.
 3. If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new part.

CAUTION:

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

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

Amount of rod protrusion H: 5.2 - 6.2 mm (0.204 - 0.244 in)

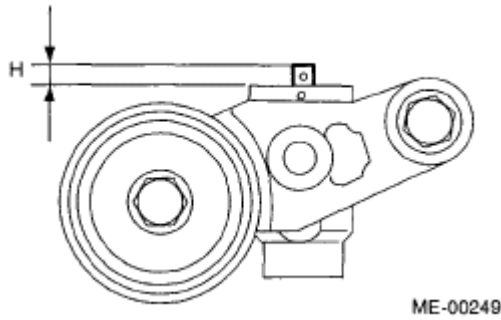


Fig. 83: Identifying Amount Of Rod Protrusion
Courtesy of SUBARU OF AMERICA, INC.

BELT TENSION PULLEY

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

BELT IDLER

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

CAM SPROCKET

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL** .>
2. Remove the crank pulley. <Ref. to **REMOVAL** .>
3. Remove the timing belt cover. <Ref. to **REMOVAL** .>
4. Remove the timing belt. <Ref. to **REMOVAL** .>
5. Remove the camshaft position sensor. <Ref. to **REMOVAL** , Camshaft Position Sensor .>
6. Remove the cam sprockets No. 1 and No. 2. To lock the camshaft, use the ST.

ST 18231AA010 CAM SPROCKET WRENCH

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

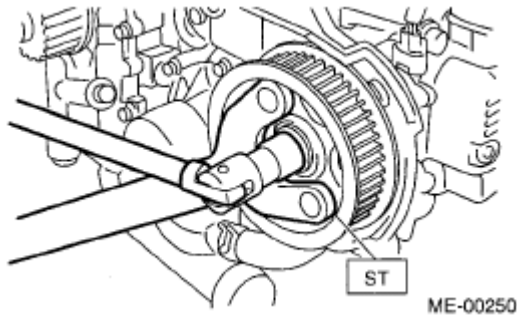


Fig. 84: Removing/Installing Cam Sprocket Using Cam Sprocket Wrench (499207100)
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the cam sprocket No. 1 and No. 2. To lock the camshaft, use the ST.

ST 18231AA010 CAM SPROCKET WRENCH

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

Tightening torque: 78 N.m (8.0 kgf-m, 57.9 ft-lb)

NOTE: Do not confuse left and right side cam sprockets during installation. They should be distinguished by the L or R indication.

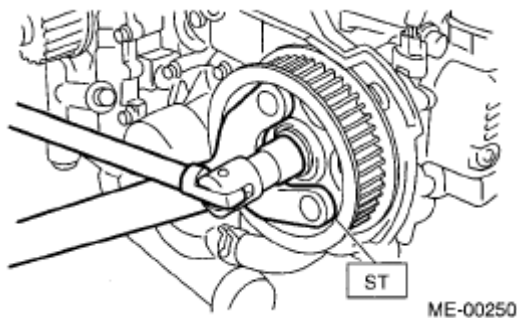


Fig. 85: Removing/Installing Cam Sprocket Using Cam Sprocket Wrench (499207100)
Courtesy of SUBARU OF AMERICA, INC.

2. Install the camshaft position sensor. <Ref. to INSTALLATION , Camshaft Position Sensor .>
3. Install the timing belt. <Ref. to INSTALLATION .>
4. Install the timing belt cover. <Ref. to INSTALLATION .>
5. Install the crank pulley. <Ref. to INSTALLATION .>
6. Install the V-belts. <Ref. to INSTALLATION .>

INSPECTION

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

CRANK SPROCKET

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL** .>
2. Remove the crank pulley. <Ref. to **REMOVAL** .>
3. Remove the timing belt cover. <Ref. to **REMOVAL** .>
4. Remove the timing belt. <Ref. to **REMOVAL** .>
5. Remove the crank sprocket.

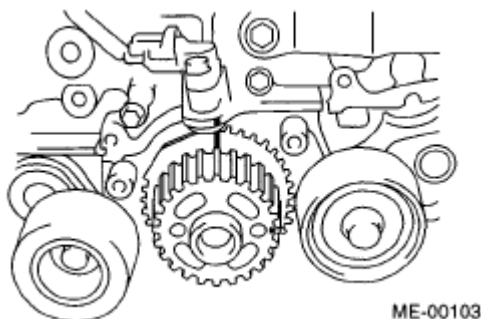


Fig. 86: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

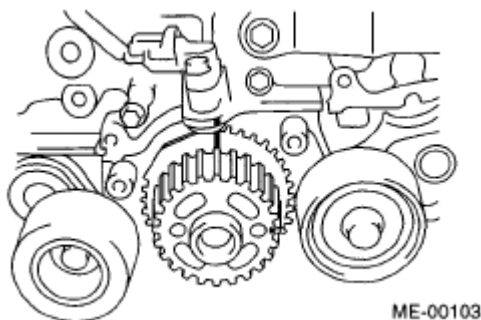


Fig. 87: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing belt. <Ref. to INSTALLATION .>
3. Install the timing belt cover. <Ref. to INSTALLATION .>
4. Install the crank pulley. <Ref. to INSTALLATION .>
5. Install the V-belts. <Ref. to INSTALLATION .>

INSPECTION

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

VALVE ROCKER ASSEMBLY

REMOVAL

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

1. Remove the V-belts. <Ref. to REMOVAL .>
2. Remove the crank pulley. <Ref. to REMOVAL .>
3. Remove the timing belt cover. <Ref. to REMOVAL .>
4. Remove the timing belt. <Ref. to REMOVAL .>
5. Remove the cam sprocket. <Ref. to REMOVAL .>
6. Disconnect the PCV hose and remove the rocker cover.
7. Remove the valve rocker assembly.
 1. Use the ST to rotate the spring stopper in the direction of the arrow to remove it from adjuster pin.

ST 18258AA000 SPRING INSTALLER

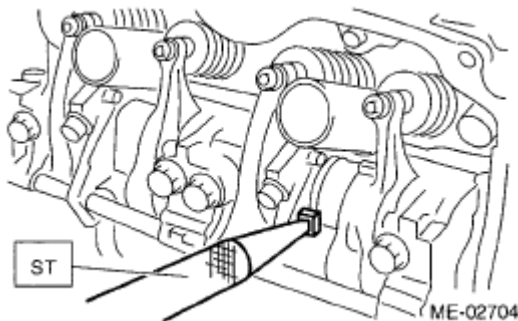
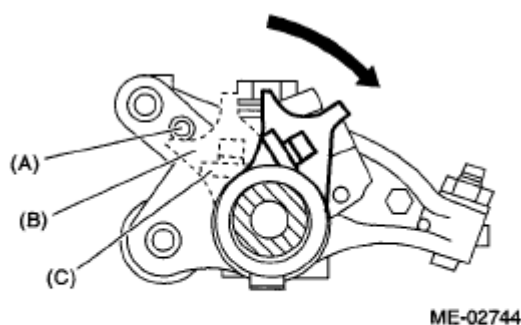


Fig. 88: Identifying ST (18258AA000) Spring Installer
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 89: Rotating Spring Stopper

Courtesy of SUBARU OF AMERICA, INC.

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

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

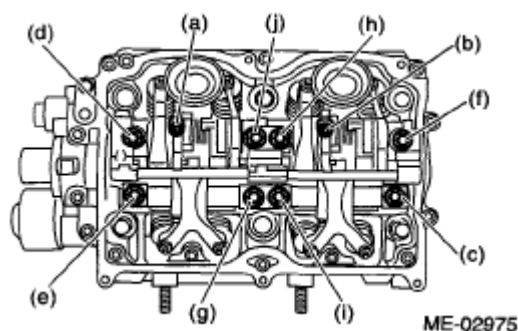


Fig. 90: Identifying Valve Rocker Assembly Bolts Removing Sequence

Courtesy of SUBARU OF AMERICA, INC.

3. Remove the valve rocker assembly.

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

ST 18354AA000 VALVE ROCKER HOLDER

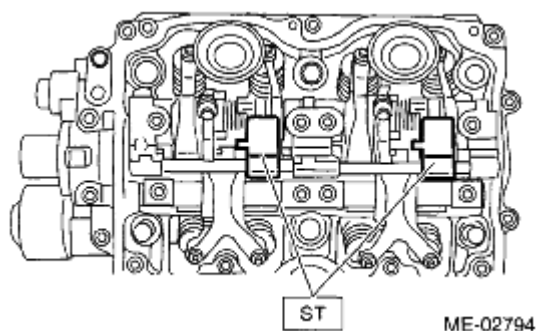


Fig. 91: Identifying ST (18354AA000) Valve Rocker Holder
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

NOTE:

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

ST 18354AA000 VALVE ROCKER HOLDER

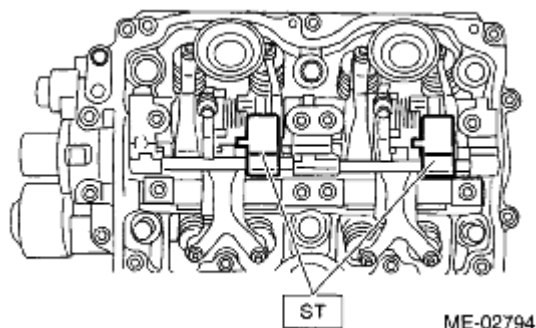


Fig. 92: Identifying ST (18354AA000) Valve Rocker Holder
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

Tightening torque: 6 N.m (0.6 kgf-m, 4.3 ft-lb)

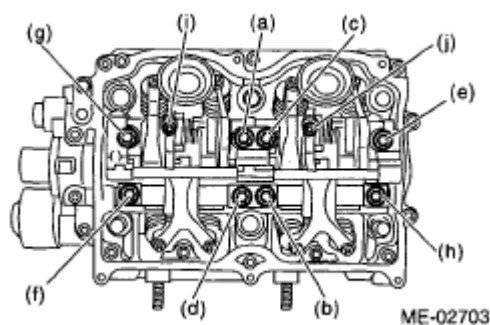


Fig. 93: Identifying Valve Rocker Assembly Bolt Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

ST 18258AA000 SPRING INSTALLER

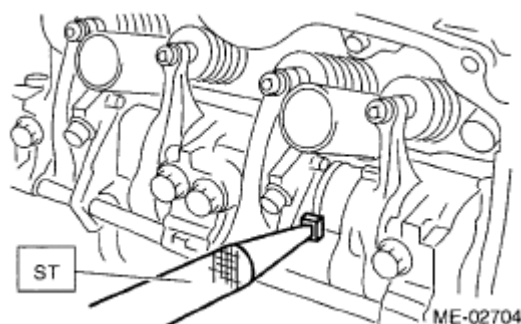
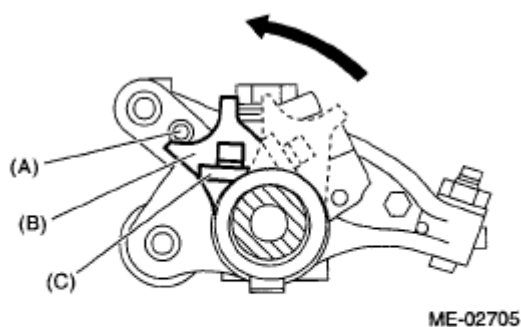


Fig. 94: Identifying ST (18258AA000) Spring Installer
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 95: Rotating Spring Stopper
Courtesy of SUBARU OF AMERICA, INC.

2. Install the cam sprocket. <Ref. to **INSTALLATION** .>

3. Install the timing belt. <Ref. to **INSTALLATION** .>
4. Adjust the valve clearance. <Ref. to **ADJUSTMENT** .>
5. Install the rocker cover and rocker cover gasket, and then connect PCV hose.

NOTE:

- Use a new rocker cover gasket.
- Tighten the bolts in two stages in alphabetical sequence as shown in figure.

Tightening torque:***1st***

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

2nd (only (a) and (b) are tightened)

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

RH side

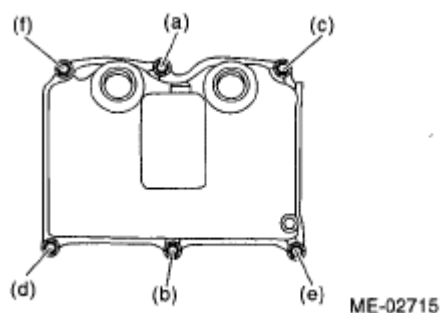


Fig. 96: Tightening Sequence Of Rocker Cover Bolts - RH Side
Courtesy of SUBARU OF AMERICA, INC.

LH side

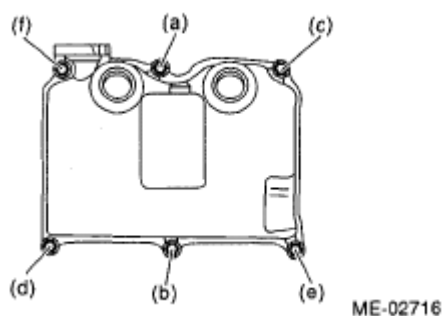


Fig. 97: Tightening Sequence Of Rocker Cover Bolts - LH Side

Courtesy of SUBARU OF AMERICA, INC.

6. Install the timing belt cover. <Ref. to **INSTALLATION** .>
7. Install the crank pulley. <Ref. to **INSTALLATION** .>
8. Install the V-belts. <Ref. to **INSTALLATION** .>

DISASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

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

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

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

ASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

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

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

INSPECTION

INTAKE VALVE ROCKER ASSEMBLY

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

EXHAUST VALVE ROCKER ASSEMBLY

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

Clearance between arm and shaft:

Standard: 0.020 - 0.054 mm (0.0008 - 0.0021 in)

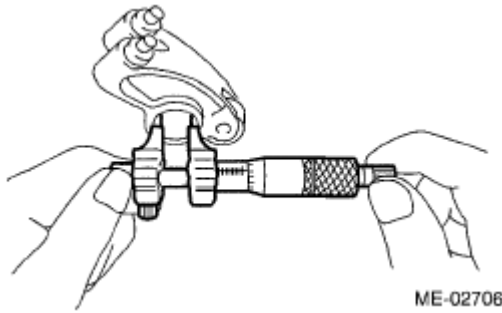


Fig. 98: Measuring Inner Diameter Of Valve Rocker Arm
Courtesy of SUBARU OF AMERICA, INC.

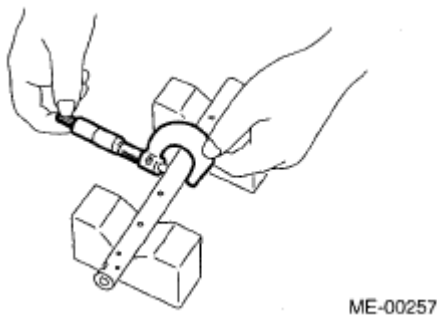


Fig. 99: Measuring Outer Diameter Of Valve Rocker Shaft
Courtesy of SUBARU OF AMERICA, INC.

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

Rocker arm inside diameter: 22.020 - 22.041 mm (0.8669 - 0.8678 in)

Rocker shaft diameter: 21.987 - 22.000 mm (0.8656 - 0.8661 in)

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

CAMSHAFT

REMOVAL

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

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

4. Remove the timing belt. <Ref. to **REMOVAL** .>
5. Remove the cam sprocket. <Ref. to **REMOVAL** .>
6. Remove the timing belt cover No. 2 (LH).
7. Remove the timing belt cover No. 2 (RH).

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

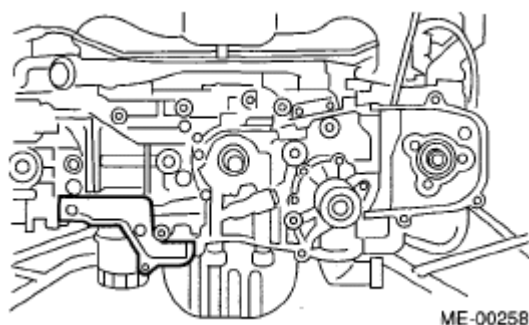


Fig. 100: Identifying Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the tensioner bracket.

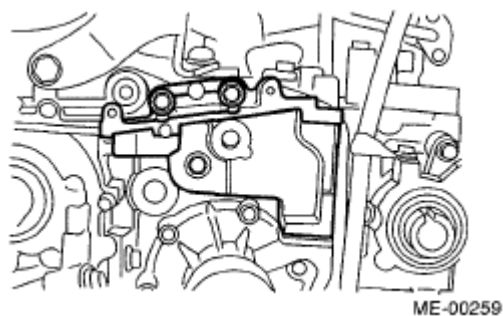


Fig. 101: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the camshaft position sensor support. (LH side only)
10. Remove the oil level gauge guide. (LH side only)
11. Remove the valve rocker assembly. <Ref. to **REMOVAL** .>
12. Remove the camshaft cap.
 1. Remove the bolts (a) and (b) in alphabetical sequence.

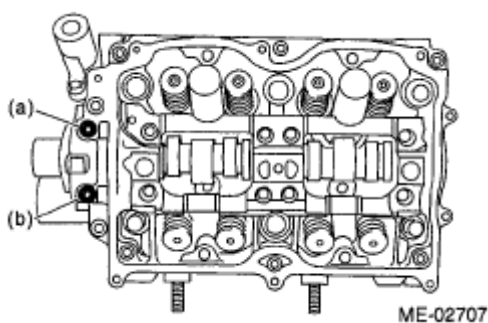


Fig. 102: Removing Sequence Of Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

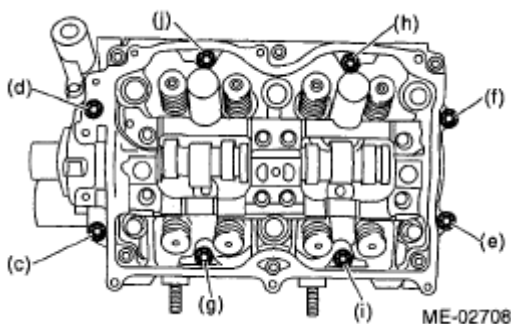


Fig. 103: Removing Sequence Of Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX® PLUS

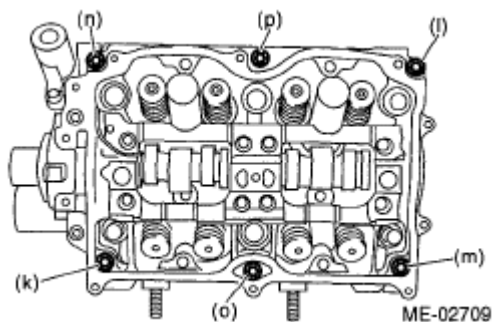


Fig. 104: Removing Sequence Of Camshaft Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the camshaft cap.
13. Remove the camshaft.

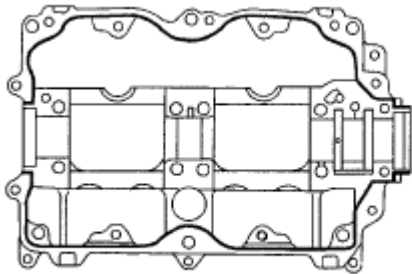
14. Remove the oil seal.
15. Remove the plug from rear side of camshaft.

- CAUTION:**
- Do not remove the oil seal unless necessary.
 - Do not scratch the journal surface when removing the oil seal.

INSTALLATION

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

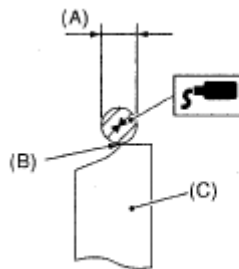
Liquid gasket: THREE BOND 1280B (Part No. K0877YA018)



ME-02710

Fig. 105: Identifying Liquid Gasket On Mating Surfaces Of Camshaft Cap
Courtesy of SUBARU OF AMERICA, INC.

- NOTE:**
- Apply a coat of liquid gasket of 3 mm (0.12 in) in diameter (A) along the edge (B) of camshaft cap (C) mating surface.
 - Install within 5 min. after applying liquid gasket.



ME-00265

Fig. 106: Identifying Area For Applying Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

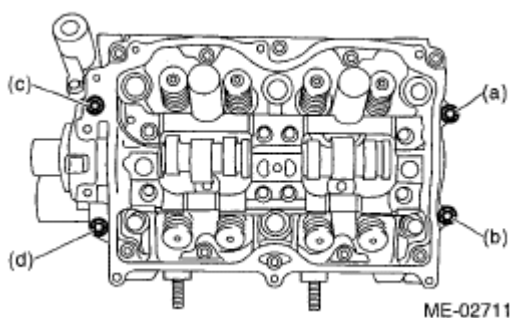


Fig. 107: Tightening Sequence Of Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX® PLUS

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

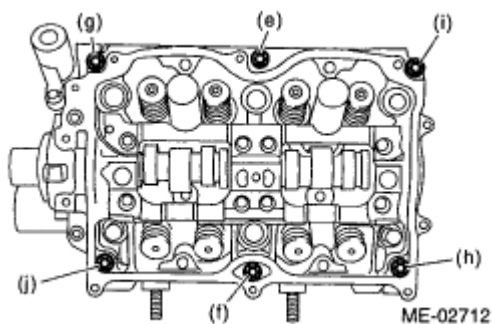


Fig. 108: Tightening Sequence Of Torx Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

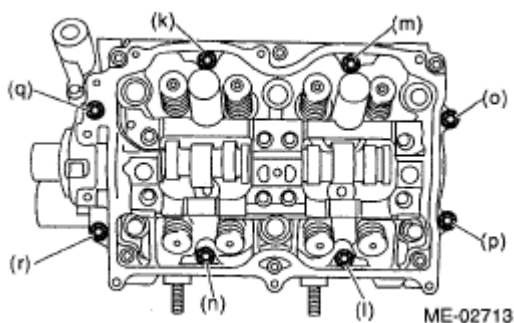


Fig. 109: Tightening Sequence Of Bolts

Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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

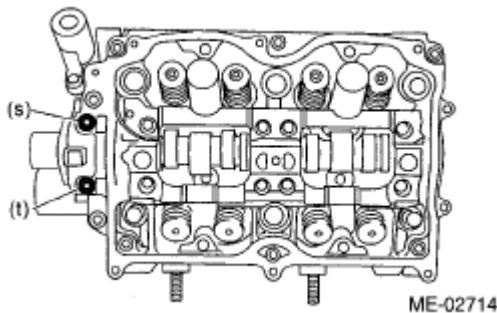


Fig. 110: Tightening Sequence Of Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new oil seal.

ST1 499597000 OIL SEAL GUIDE

ST2 499587500 OIL SEAL INSTALLER

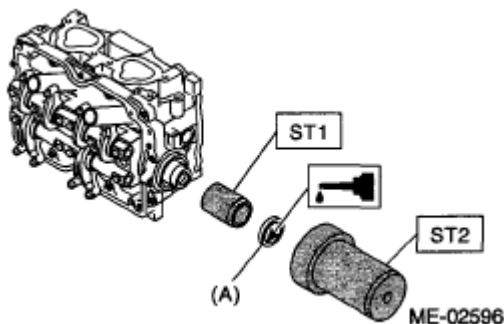


Fig. 111: Installing Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

4. Install the plug (A) using ST.

ST 499587700 CAMSHAFT OIL SEAL INSTALLER

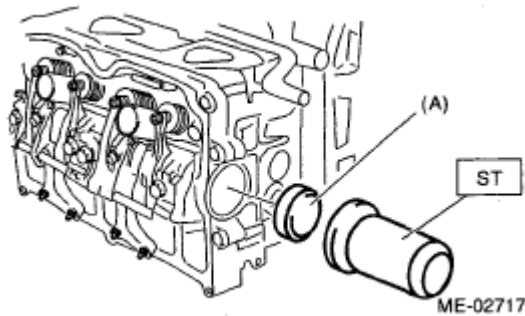


Fig. 112: Installing Plug Using Camshaft Oil Seal Installer ST (499587700)
Courtesy of SUBARU OF AMERICA, INC.

5. Adjust the valve clearance. <Ref. to ADJUSTMENT .>
6. Install the rocker cover and rocker cover gasket, and then connect PCV hose.

NOTE:

- Use a new rocker cover gasket.
- Tighten the bolts in two stages in alphabetical sequence as shown in figure.

Tightening torque:

1st

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

2nd (only (a) and (b) are tightened)

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

RH side

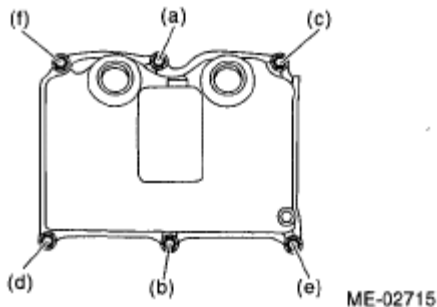


Fig. 113: Tightening Sequence Of Rocker Cover Bolts - RH Side
Courtesy of SUBARU OF AMERICA, INC.

LH side

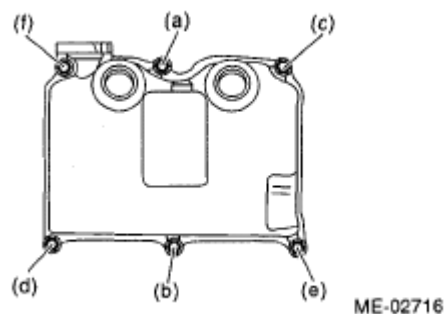


Fig. 114: Tightening Sequence Of Rocker Cover Bolts - LH Side
Courtesy of SUBARU OF AMERICA, INC.

7. Install the oil level gauge guide. (LH side only)
8. Install the camshaft position sensor support. (LH side only)
9. Install the tensioner bracket.

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

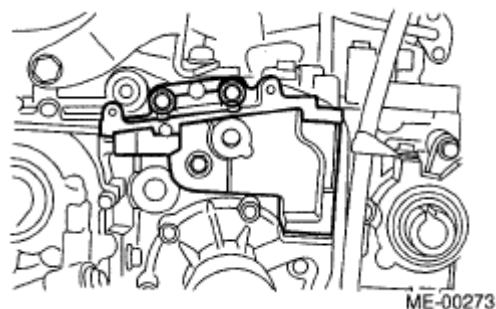


Fig. 115: Identifying Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

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

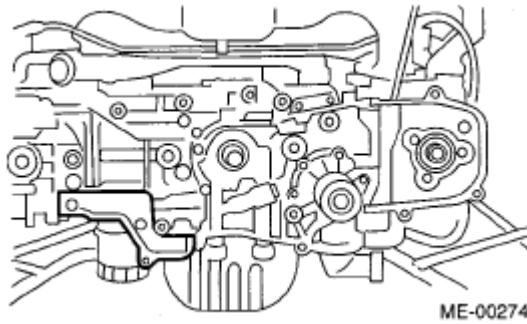


Fig. 116: Identifying Timing Belt Cover No. 2 (LH)
Courtesy of SUBARU OF AMERICA, INC.

12. Install the cam sprocket. <Ref. to INSTALLATION .>
13. Install the timing belt. <Ref. to INSTALLATION .>
14. Install the timing belt cover. <Ref. to INSTALLATION .>
15. Install the crank pulley. <Ref. to INSTALLATION .>
16. Install the V-belts. <Ref. to INSTALLATION .>

INSPECTION

CAMSHAFT

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

Service limit: 0.025 mm (0.00098 in)

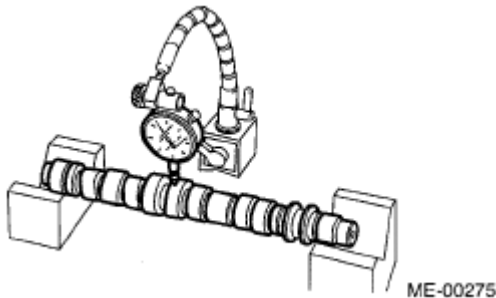


Fig. 117: Measuring Camshaft Bend
Courtesy of SUBARU OF AMERICA, INC.

2. Check the journal for damage and wear. Replace if faulty.
3. Measure the outer diameter of camshaft journal and inner diameter of cylinder head journal, and confirm the difference (oil clearance) between the two values. If the oil clearance exceeds the standard, replace the camshaft or cylinder head as necessary.

OIL CLEARANCE SPECIFICATION

Unit: mm (in)

Oil clearance	Standard	0.055 - 0.090 (0.0022 - 0.0035)
Camshaft journal O.D.		31.928 - 31.945 (1.2570 - 1.2577)
Journal hole I.D.		32.000 - 32.018 (1.2598 - 1.2605)

4. Check the cam face condition, and remove the minor faults by grinding with oil stone. Measure the cam height H. If it exceeds the standard, replace it.

Cam height H:

CAM HEIGHT SPECIFICATION

Part			Unit: mm (in)
Intake	Constant	Standard	40.075 - 40.175 (1.5778 - 1.5817)
	Low speed	Standard	35.182 - 35.282 (1.3851 - 1.3891)
	High speed	Standard	40.315 - 40.415 (1.5872 - 1.5911)
Exhaust		Standard	40.088 - 40.188 (1.5783 - 1.5822)

Cam base circle diameter A:

Intake

34.00 mm (1.3386 in)

Exhaust

34.00 mm (1.3386 in)

Base circle step of adjacent intake cams (low speed and high speed): 0.03 mm (0.001 in) or less

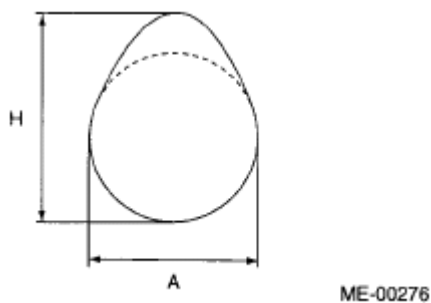


Fig. 118: Identifying Cam Height
Courtesy of SUBARU OF AMERICA, INC.

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

Standard: 0.030 - 0.090 mm (0.0012 - 0.0035 in)

CYLINDER HEAD

REMOVAL

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

1. Remove the V-belts. <Ref. to REMOVAL .>
2. Remove the crank pulley. <Ref. to REMOVAL .>
3. Remove the timing belt cover. <Ref. to REMOVAL .>
4. Remove the timing belt. <Ref. to REMOVAL .>
5. Remove the cam sprocket. <Ref. to REMOVAL .>
6. Remove the intake manifold. <Ref. to REMOVAL , Intake Manifold .>
7. Remove the bolt which installs the A/C compressor bracket on cylinder head.
8. Remove the valve rocker assembly. <Ref. to REMOVAL .>
9. Remove the camshaft. <Ref. to REMOVAL .>
10. Remove the cylinder head bolts in alphabetical sequence as shown in the figure.

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

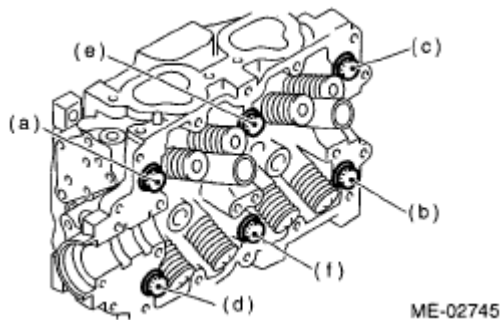


Fig. 119: Removing Sequence Of Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

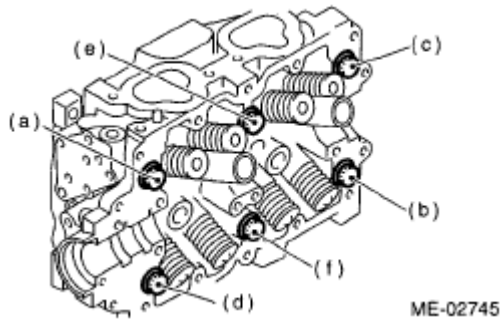


Fig. 120: Removing Sequence Of Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the cylinder head gasket.

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

14. Similarly, remove the right side cylinder head.

INSTALLATION

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

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

NOTE: Use a new 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, 22 ft-lb) in alphabetical order. Then tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.
 3. Loosen all the bolts by 180° in reverse order of installation, and loosen again by 180° in the same order.
 4. Tighten all bolts to 42 N.m (3.9 kgf-m, 31 ft-lb) in alphabetical order.
 5. Tighten all bolts by 80 to 90° in alphabetical sequence.
 6. Tighten all bolts by 40 to 45° in alphabetical sequence.

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

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

CAUTION: Make sure the total "re-tightening angle" of the step (6) and (7) does not exceed 90°.

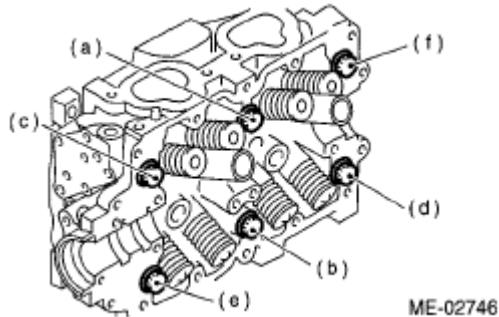


Fig. 121: Tightening Sequence Of Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install the camshaft. <Ref. to INSTALLATION .>
4. Install the valve rocker assembly. <Ref. to INSTALLATION .>
5. Install the A/C compressor bracket on cylinder head.
6. Install the intake manifold. <Ref. to INSTALLATION , Intake Manifold .>
7. Install the cam sprocket. <Ref. to INSTALLATION .>
8. Install the timing belt. <Ref. to INSTALLATION .>
9. Adjust the valve clearance. <Ref. to ADJUSTMENT .>
10. Install the rocker cover and rocker cover gasket, and then connect PCV hose.

NOTE: Use a new gasket.

11. Install the timing belt cover. <Ref. to INSTALLATION .>
12. Install the crank pulley. <Ref. to INSTALLATION .>
13. Install the V-belts. <Ref. to INSTALLATION .>

DISASSEMBLY

1. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

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

ST 499718000 VALVE SPRING REMOVER

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

positions.

- Mark each valve to prevent confusion.
- Pay careful attention not to damage the lips of intake valve oil seals and exhaust valve oil seals.

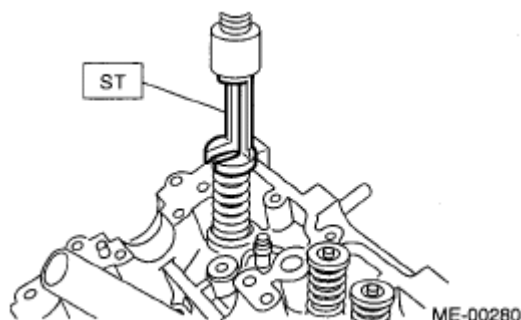
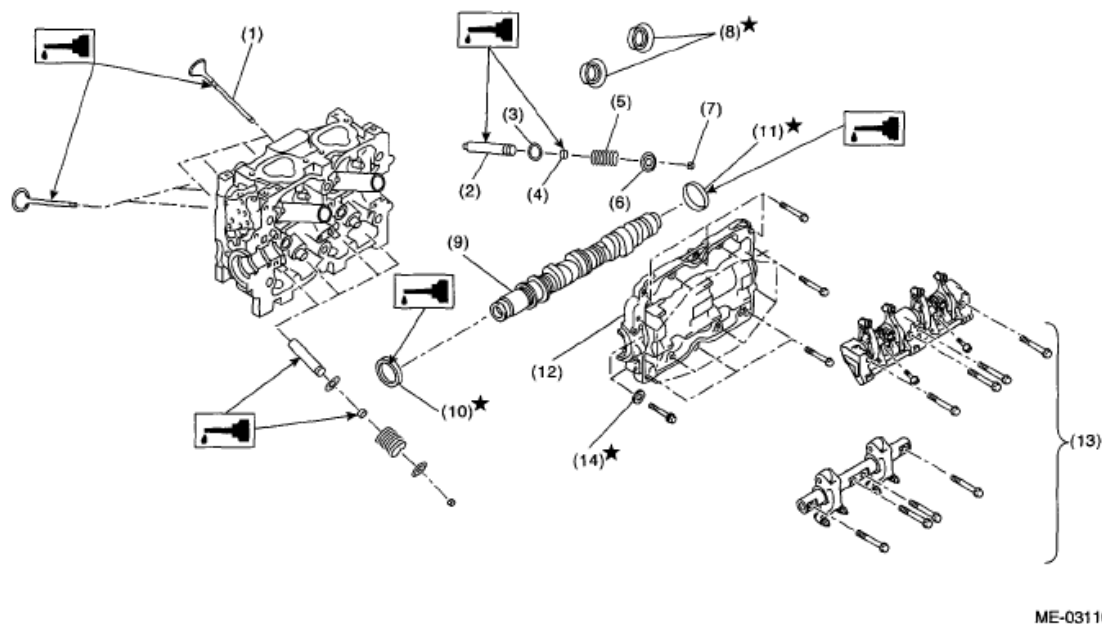


Fig. 122: Setting ST On Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



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

Fig. 123: Exploded View Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

1. Installation of valve spring and valve:

1. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

2. 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.

3. Install the valve spring and retainer.

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

4. Set the ST on valve spring.

ST 499718000 VALVE SPRING REMOVER

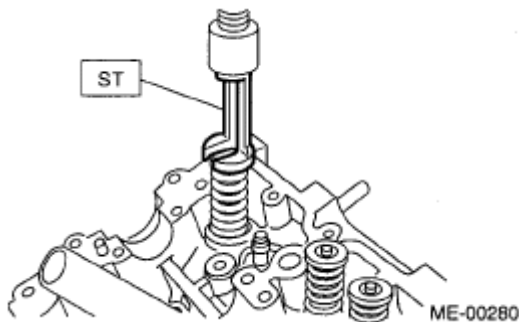
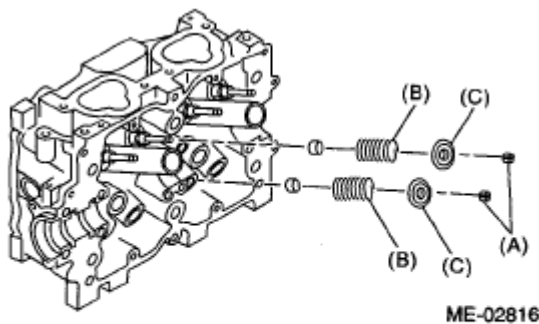


Fig. 124: Setting ST On Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

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



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

Fig. 125: Identifying Valve Spring, Valve Spring Retainer Key And Retainer
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

CYLINDER HEAD

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

ST 498267800 CYLINDER HEAD TABLE

3. Measure the warping of the cylinder head surface that mates with the cylinder block using a straight edge and thickness gauge.

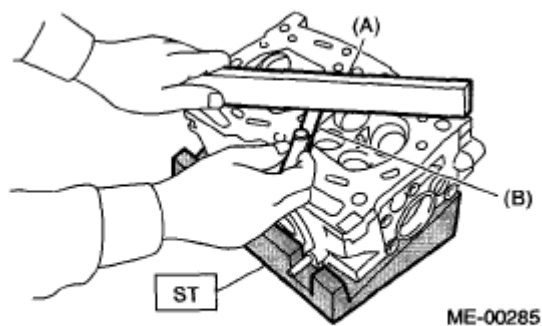
If the warping exceeds the limit, correct the surface by grinding it with a surface grinder.

Warping limit: 0.035 mm (0.0014 in)

Grinding limit: 0.1 mm (0.004 in)

Standard height of cylinder head: 97.5 mm (3.839 in)

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



- (A) Straight edge
(B) Thickness gauge

Fig. 126: Checking Cylinder Head
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 :

Standard:

Intake (A)

0.8 - 1.4 mm (0.03 - 0.055 in)

Exhaust (B)

1.2 - 1.8 mm (0.047 - 0.071 in)

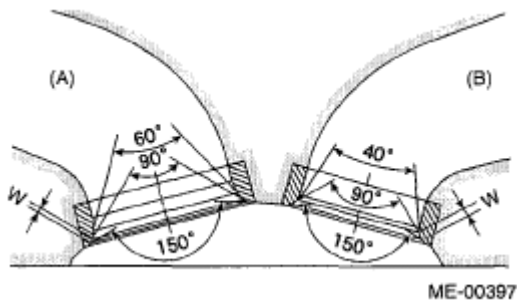


Fig. 127: Identifying Valve Seat Width
Courtesy of SUBARU OF AMERICA, INC.

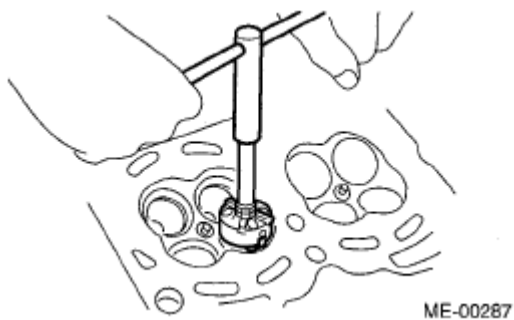


Fig. 128: Repairing Contact Surfaces With Valve Seat Cutter
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

Clearance between the valve guide and valve stem:

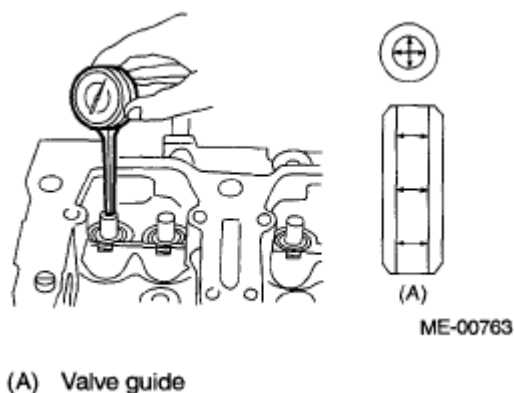
Standard:**Intake****0.035 - 0.062 mm (0.0014 - 0.0024 in)****Exhaust****0.040 - 0.067 mm (0.0016 - 0.0026 in)**

Fig. 129: Checking Inner Diameter Of Valve Guide With Caliper Gauge
 Courtesy of SUBARU OF AMERICA, INC.

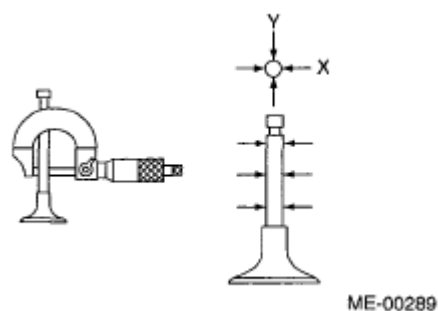


Fig. 130: Checking Outer Diameter Of Valve Stem With Micrometer
 Courtesy of SUBARU OF AMERICA, INC.

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

Valve guide inner diameter: 6.000 - 6.012 mm (0.2362 - 0.2367 in)**Valve stem outer diameters:****Intake****5.950 - 5.965 mm (0.2343 - 0.2348 in)**

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

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

ST1 498267800 CYLINDER HEAD TABLE

ST2 499767200 VALVE GUIDE REMOVER

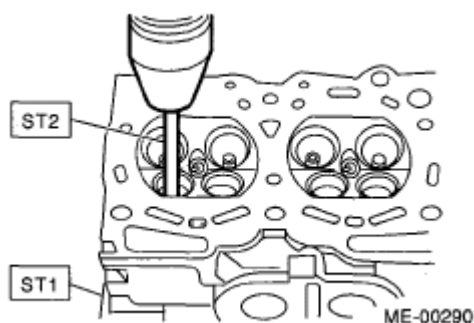


Fig. 131: Removing Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

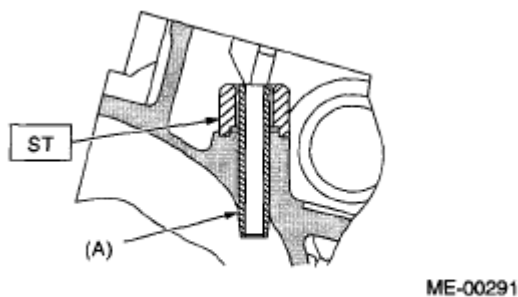
3. Turn the cylinder head upside down and place the ST as shown in the figure.

Intake side

ST 499767700 VALVE GUIDE ADJUSTER

Exhaust side

ST 499767800 VALVE GUIDE ADJUSTER



(A) Valve guide

Fig. 132: Identifying ST Position

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

Intake side

ST2 499767700 VALVE GUIDE ADJUSTER

Exhaust side

ST2 499767800 VALVE GUIDE ADJUSTER

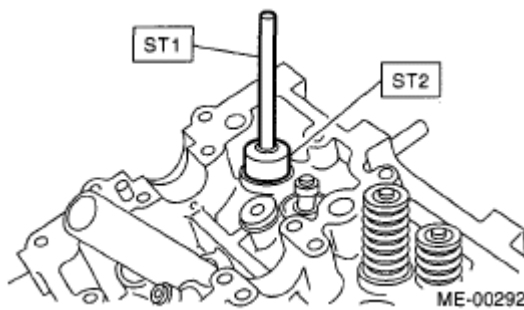


Fig. 133: Inserting ST1 Into Valve Guide Using Valve Guide Remover ST1 (499767200)
Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion.

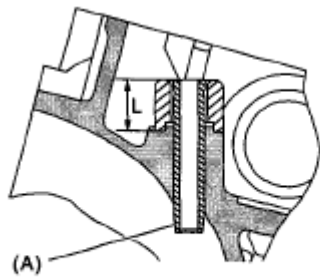
Valve guide protrusion L:

Intake

20.0 - 21.0 mm (0.787 - 0.827 in)

Exhaust

16.5 - 17.5 mm (0.650 - 0.689 in)



ME-00293

(A) Valve guide

Fig. 134: Checking Valve Guide Protrusion
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

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



ME-00294

Fig. 135: 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 if damaged, worn, or deformed, or if H is outside of the specified limit.

H:

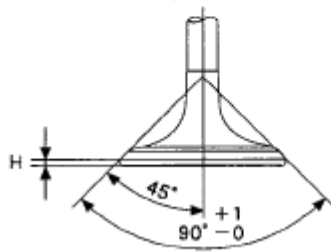
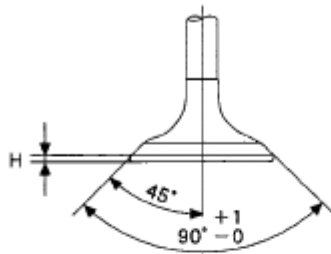
Intake Standard:

0.8 - 1.2 mm (0.03 - 0.047 in)

Exhaust

Standard:

1.0 - 1.4 mm (0.039 - 0.055 in)



ME-00295

Fig. 136: Identifying Intake And Exhaust Valve Dimension

Courtesy of SUBARU OF AMERICA, INC.

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

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

Valve overall length:

Intake

120.6 mm (4.75 in)

Exhaust

121.7 mm (4.79 in)

VALVE SPRING

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

VALVE SPRING SPECIFICATION

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

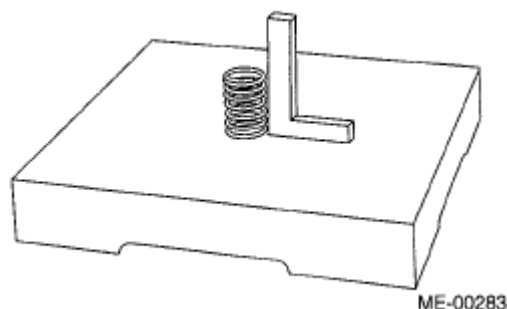


Fig. 137: Measuring Squareness Of Valve Spring
 Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

1. For the following, remove the oil seal from the valve guide and replace it with a new part.
 - 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 498267800 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

NOTE:

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

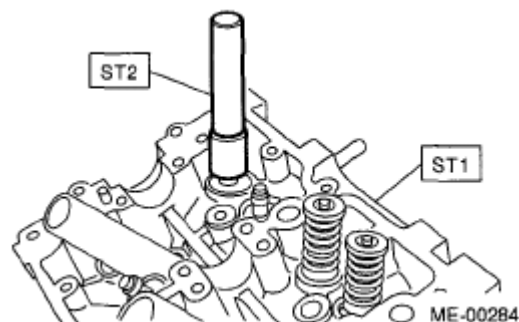


Fig. 138: Installing Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

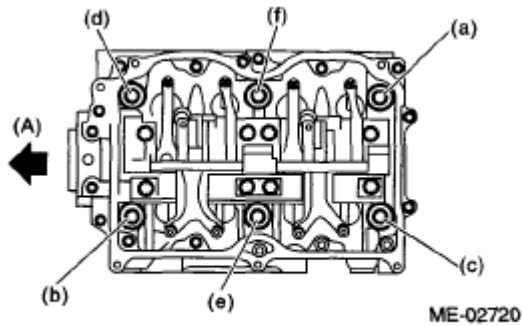
CYLINDER BLOCK

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** .>
3. Remove the crank pulley. <Ref. to **REMOVAL** .>
4. Remove the timing belt cover. <Ref. to **REMOVAL** .>
5. Remove the timing belt. <Ref. to **REMOVAL** .>
6. Remove the cam sprocket. <Ref. to **REMOVAL** .>
7. Remove the crank sprocket. <Ref. to **REMOVAL** .>
8. Remove the generator and A/C compressor with their brackets.
9. Remove the rocker cover.
10. Remove the cylinder head bolts in alphabetical order shown in the figure.

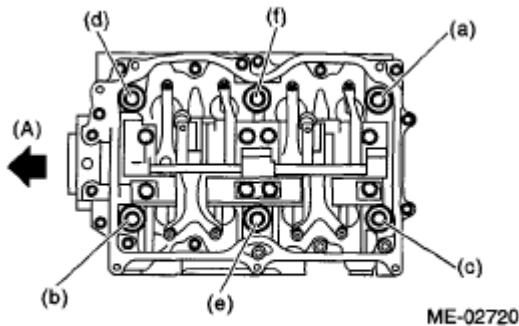
NOTE: Leave bolts (a) and (d) engaged by three or four threads to prevent the cylinder head from falling.



(A) Front side

Fig. 139: Removing Sequence Of Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front side

Fig. 140: Removing Sequence Of Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the cylinder head gasket.

NOTE: Do not scratch the mating surface of cylinder head and cylinder block.

14. Similarly, remove the right side cylinder head.
15. Remove the clutch cover. (MT model)
16. Remove the flywheel (MT model) or drive plate (AT model).

Using the ST, lock the crankshaft.

ST 498497100 CRANKSHAFT STOPPER

- MT model

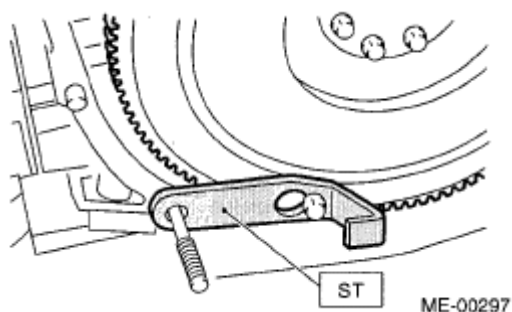


Fig. 141: Locking Crankshaft Using Crankshaft Stopper ST (498497100)- MT Model
Courtesy of SUBARU OF AMERICA, INC.

- AT model

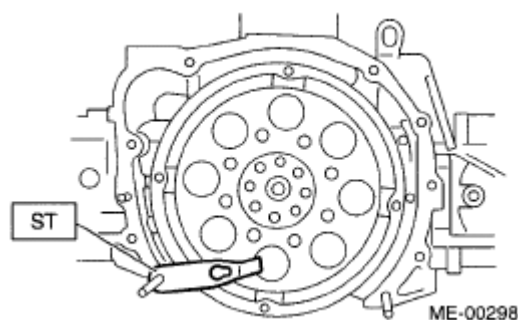


Fig. 142: Locking Crankshaft Using Crankshaft Stopper ST (498497100)- AT Model
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the oil separator cover.
18. Remove the water by-pass pipe for heater.
19. Remove the water pump after loosening the bolts in alphabetical sequence as shown in the figure.

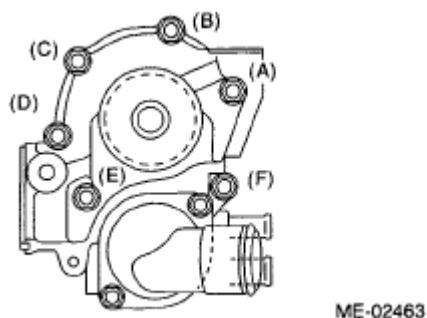


Fig. 143: Removing Sequence Of Water Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

20. 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.

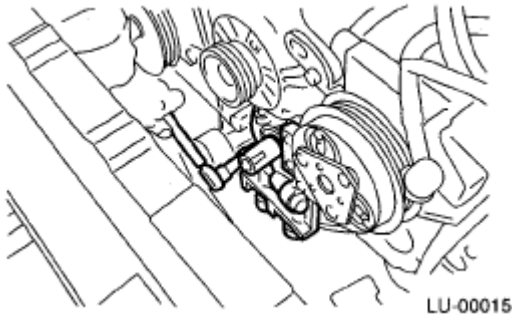


Fig. 144: Removing Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

21. 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.

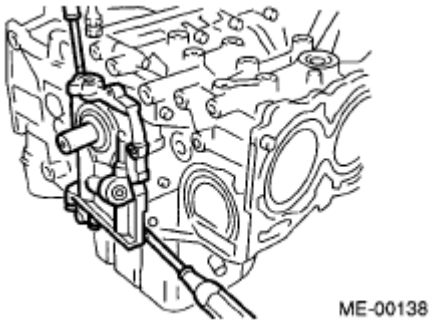


Fig. 145: Removing Oil Pump From Cylinder Block Using Flat Tip Screwdriver
Courtesy of SUBARU OF AMERICA, INC.

22. 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.

23. Remove the oil strainer stay.
24. Remove the oil strainer.
25. Remove the baffle plate.

26. Remove the oil filter. <Ref. to **REMOVAL** , Engine Oil Filter .>
27. Remove the water pipe.

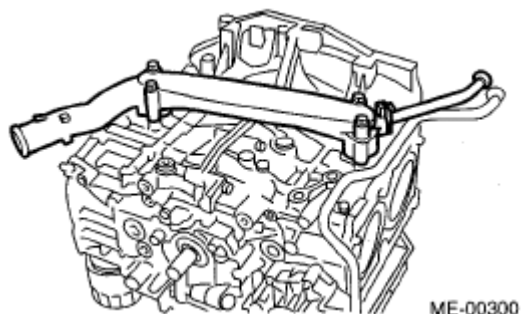
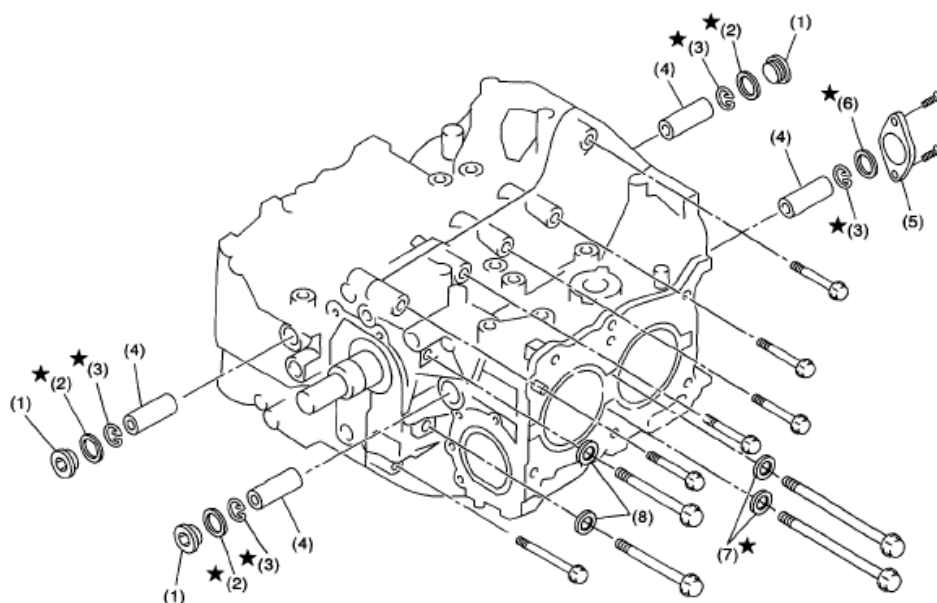


Fig. 146: Identifying Water Pipe
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 147: Identifying Service Hole Plug And Cover, Piston Pin, Seal Washer And Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

28. Remove the service hole plug using a hexagon wrench (14 mm).

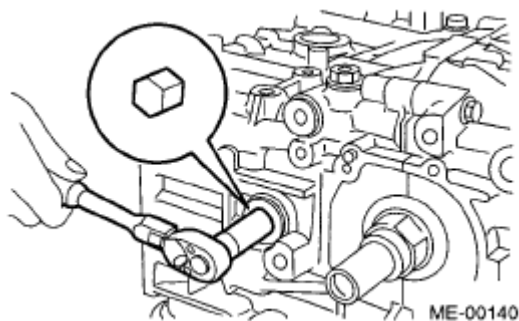


Fig. 148: Removing Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

29. Remove the service hole cover.
30. 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.

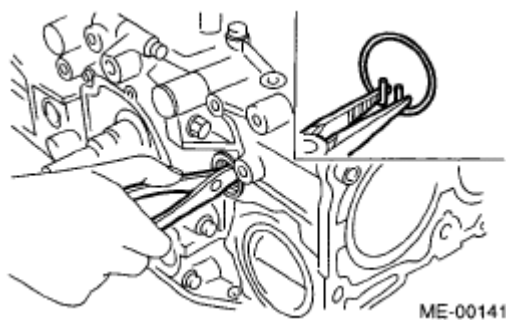


Fig. 149: Removing Piston Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

31. 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.

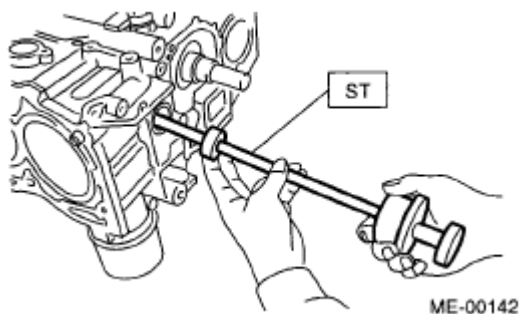


Fig. 150: Removing Piston Pin From Piston

Courtesy of SUBARU OF AMERICA, INC.

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

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

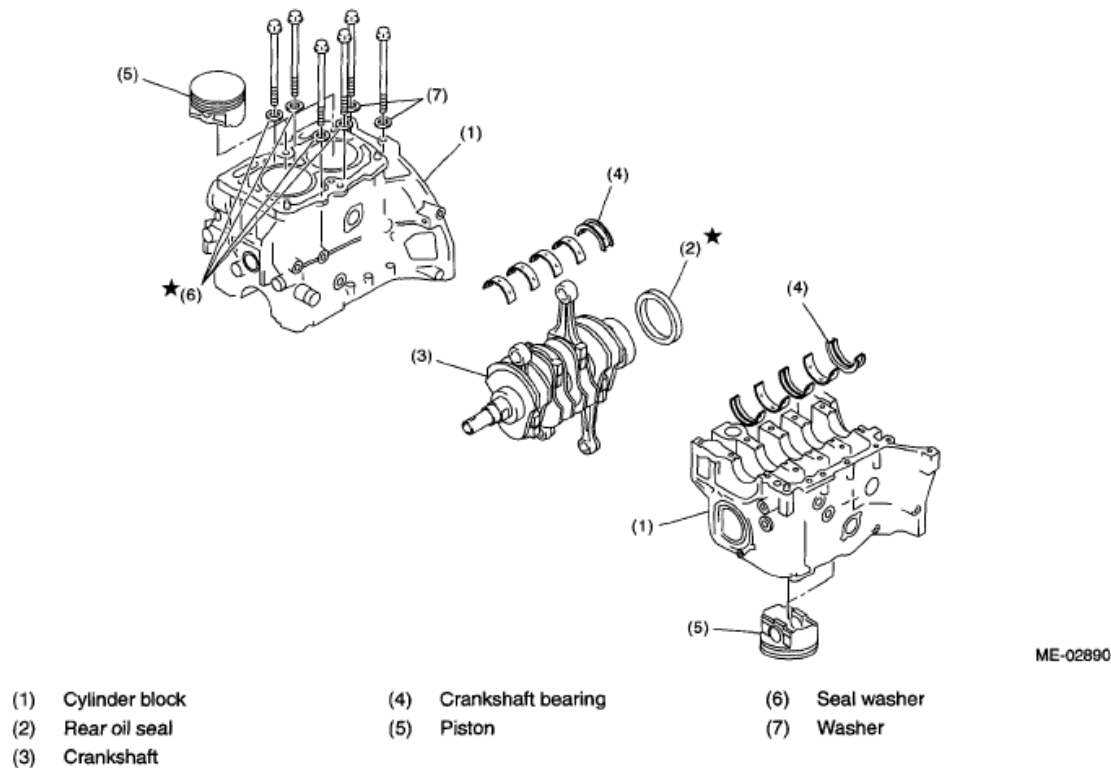


Fig. 151: Identifying Cylinder Block, Piston, Crankshaft, Rear Oil Seal And Seal Washer
Courtesy of SUBARU OF AMERICA, INC.

37. Remove the rear oil seal.
38. Remove the crankshaft along with the connecting rods.
39. Remove the crankshaft bearings from cylinder block using a hammer handle.

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

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

NOTE: Do not confuse the combination of piston and cylinder.

INSTALLATION

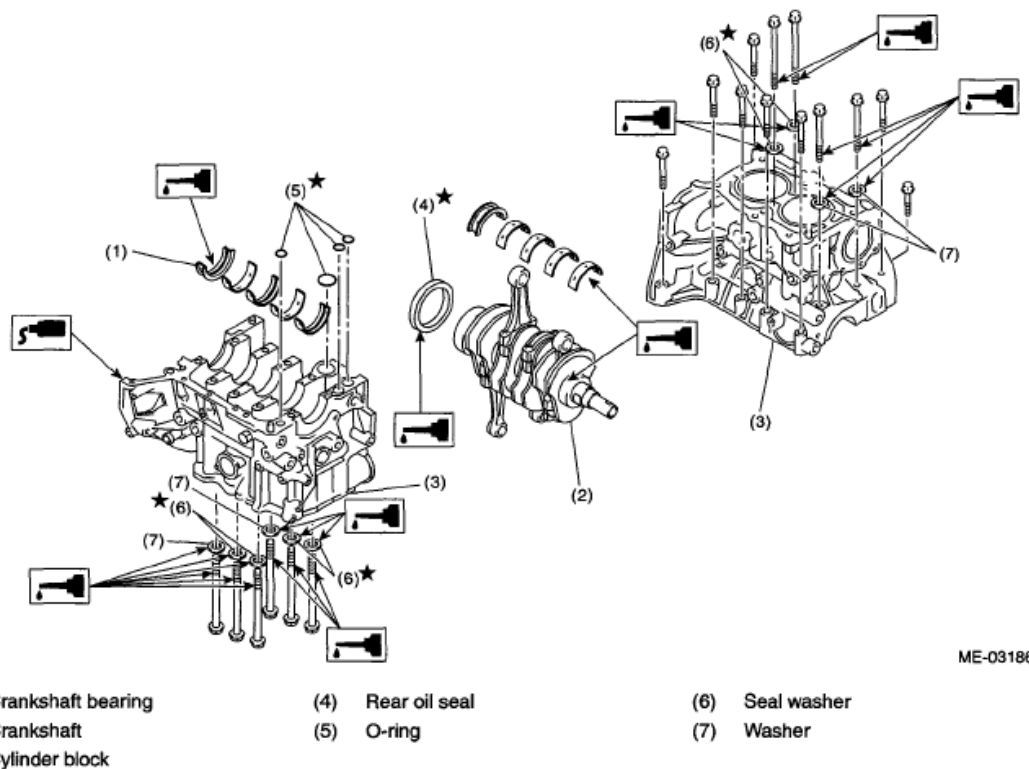


Fig. 152: Identifying Cylinder Block, Crankshaft, Rear Oil Seal And Seal Washer
Courtesy of SUBARU OF AMERICA, INC.

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.

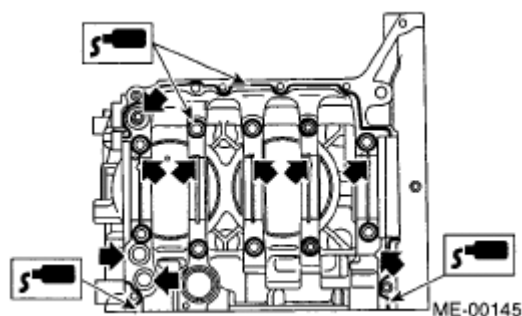


Fig. 153: Applying Liquid Gasket To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new seal washer.

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

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

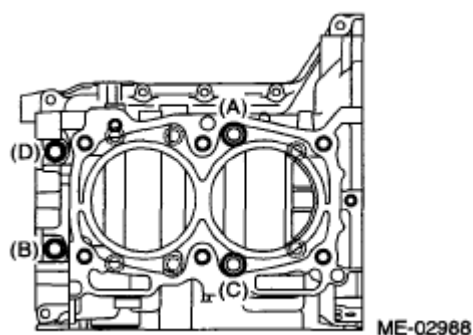


Fig. 154: Tightening Sequence Of Cylinder Block Connecting Bolts - LH Side
Courtesy of SUBARU OF AMERICA, INC.

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

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

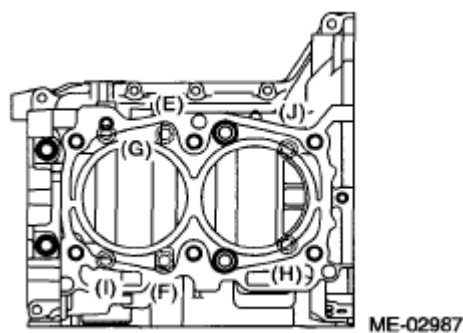


Fig. 155: Tightening Sequence Of Cylinder Block Connecting Bolts - RH Side
 Courtesy of SUBARU OF AMERICA, INC.

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 ft-lb)

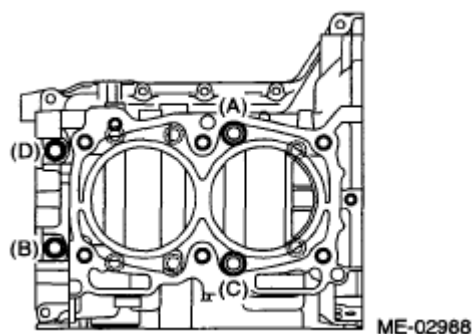


Fig. 156: Tightening Sequence Of Cylinder Block Connecting Bolts - LH Side
 Courtesy of SUBARU OF AMERICA, INC.

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 ft-lb)

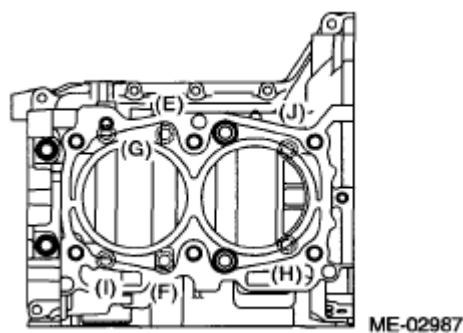


Fig. 157: Tightening Sequence Of Cylinder Block Connecting Bolts - RH Side
 Courtesy of SUBARU OF AMERICA, INC.

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, 29.6 ft-lb)

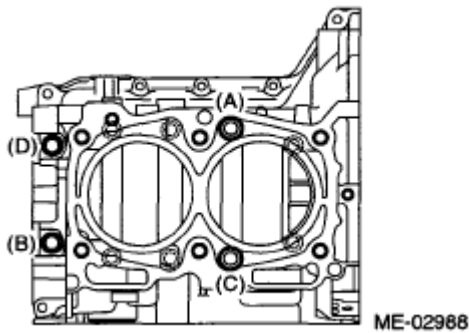


Fig. 158: Tightening Sequence Of Cylinder Block Connecting Bolts - LH Side
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle: 90°

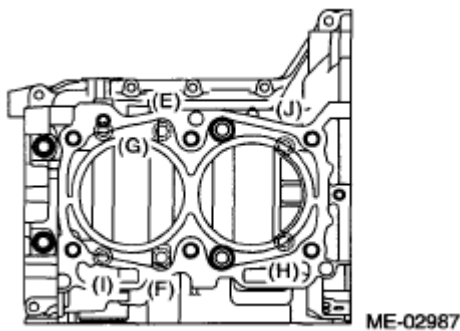


Fig. 159: Tightening Sequence Of Cylinder Block Connecting Bolts - RH Side
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

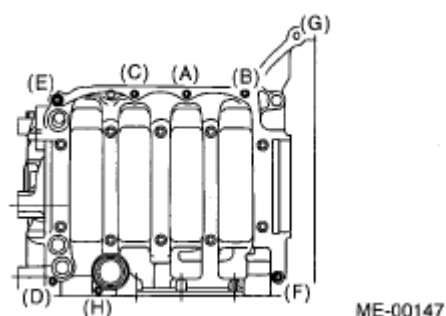


Fig. 160: Tightening Sequence Of Cylinder Block Connecting Bolts - LH Side
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new rear oil seal.

ST1 499597100 OIL SEAL GUIDE

ST2 499587200 OIL SEAL INSTALLER

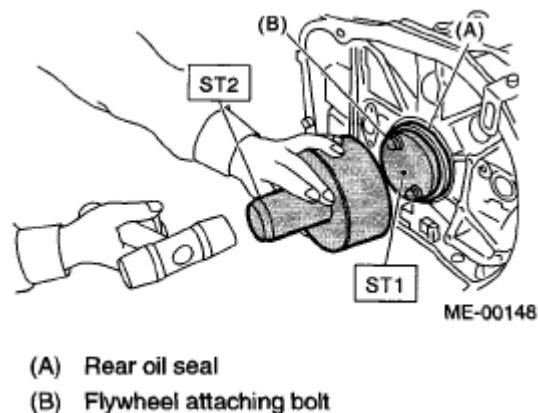


Fig. 161: Installing Rear Oil Seal Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

13. Position the top ring gap at (A) or (B) in the figure.

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

14. Position the second ring gap at 180° on the reverse side the top ring gap.

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

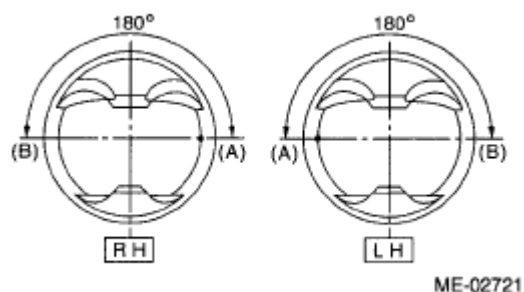


Fig. 162: Identifying Second Ring Gap Position
 Courtesy of SUBARU OF AMERICA, INC.

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

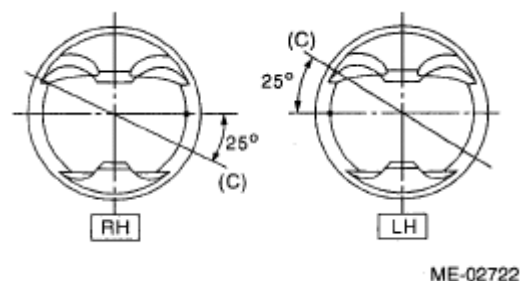


Fig. 163: Identifying Upper Rail Gap Position
 Courtesy of SUBARU OF AMERICA, INC.

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

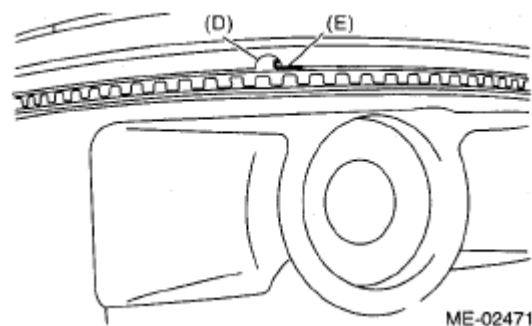


Fig. 164: Aligning Upper Rail Spin Stopper To Side Hole On Piston
 Courtesy of SUBARU OF AMERICA, INC.

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

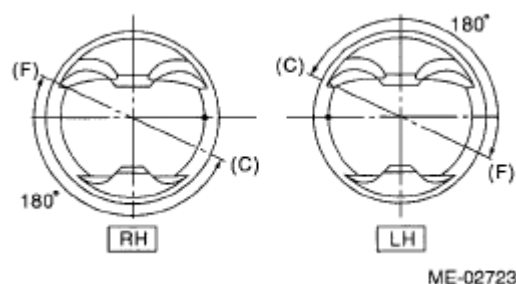


Fig. 165: Identifying Expander Gap Position
Courtesy of SUBARU OF AMERICA, INC.

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

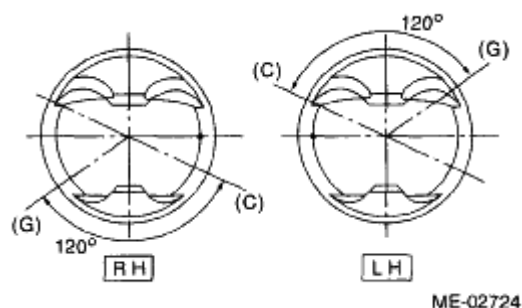


Fig. 166: Identifying Lower Rail Gap Position
Courtesy of SUBARU OF AMERICA, INC.

NOTE:

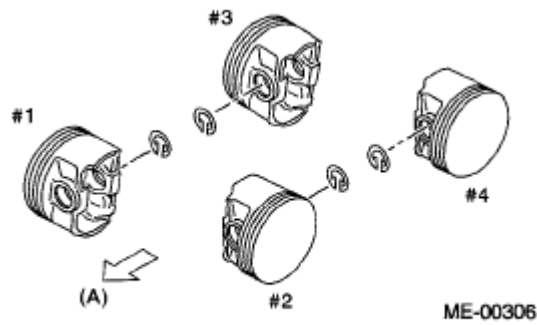
- Make sure ring gaps do not face the same direction.
- Make sure ring gaps are not within the piston skirt area.

19. Install the snap ring.

Before installing the piston to the cylinder block, install the snap rings to the piston holes on the opposite side of the service holes on the cylinder block.

NOTE:

Use new snap rings.



(A) Front side

Fig. 167: Identifying Piston And Snap Rings Position
Courtesy of SUBARU OF AMERICA, INC.

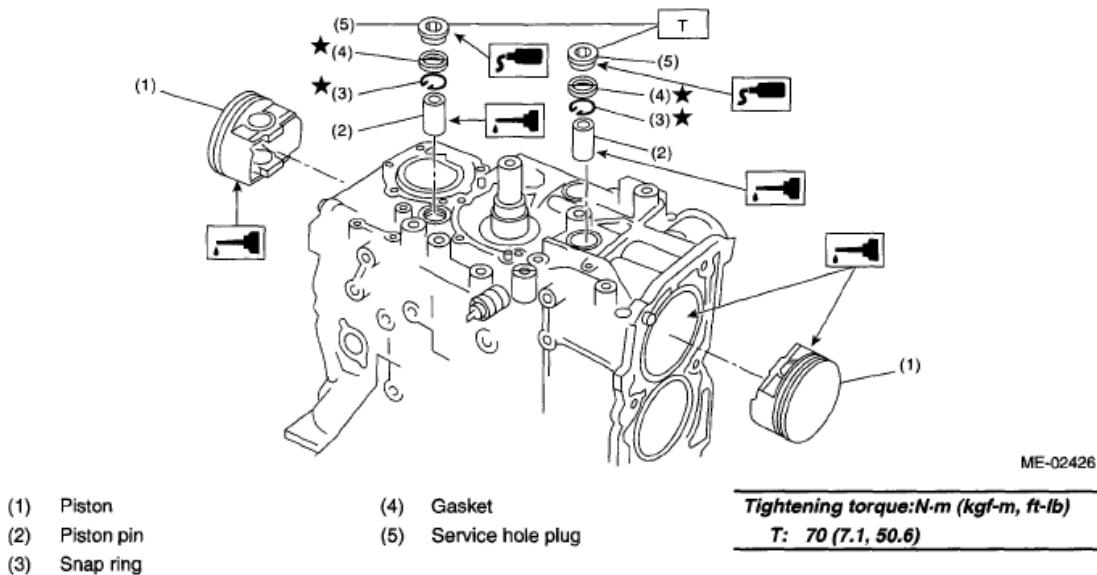


Fig. 168: Identifying Piston, Piston Pin, Service Hole Plug, Gasket And Snap Ring With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

ST1 499987500 CRANKSHAFT SOCKET

Tightening torque: N·m (kgf-m, ft-lb)

T: 70 (7.1, 50.6)

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

ST2 498747300 PISTON GUIDE

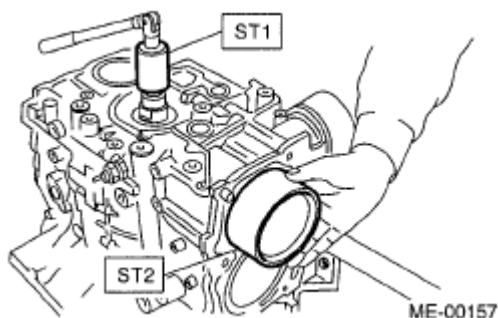
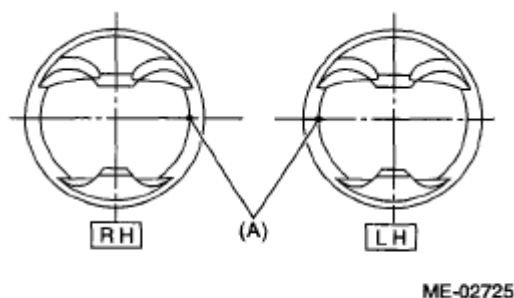


Fig. 169: Inserting Pistons In Cylinders Using Piston Guide ST2 498747300
Courtesy of SUBARU OF AMERICA, INC.

CAUTION: Piston front mark faces towards the front of engine.



(A) Front mark

Fig. 170: Identifying Piston Front Mark Position
Courtesy of SUBARU OF AMERICA, INC.

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

ST3 499017100 PISTON PIN GUIDE

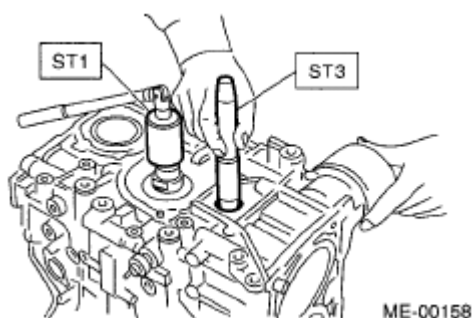


Fig. 171: Aligning Piston Pin Hole With Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.

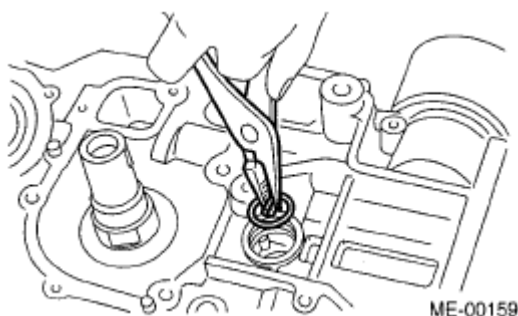


Fig. 172: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

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

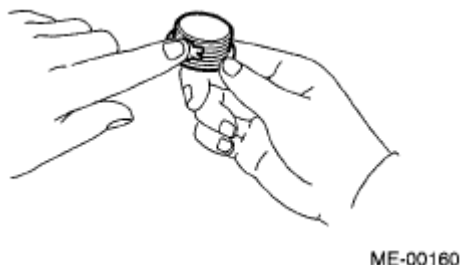


Fig. 173: Applying Liquid Gasket To Threaded Portion Of Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

NOTE: Use a new gasket.

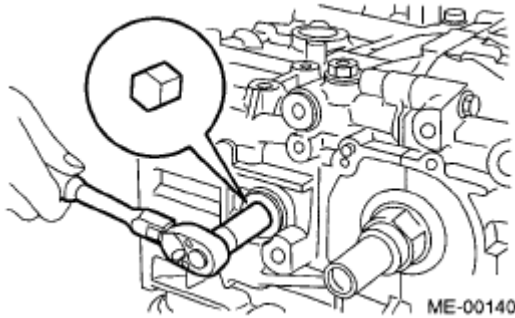


Fig. 174: Installing Service Hole Plug And Gasket
Courtesy of SUBARU OF AMERICA, INC.

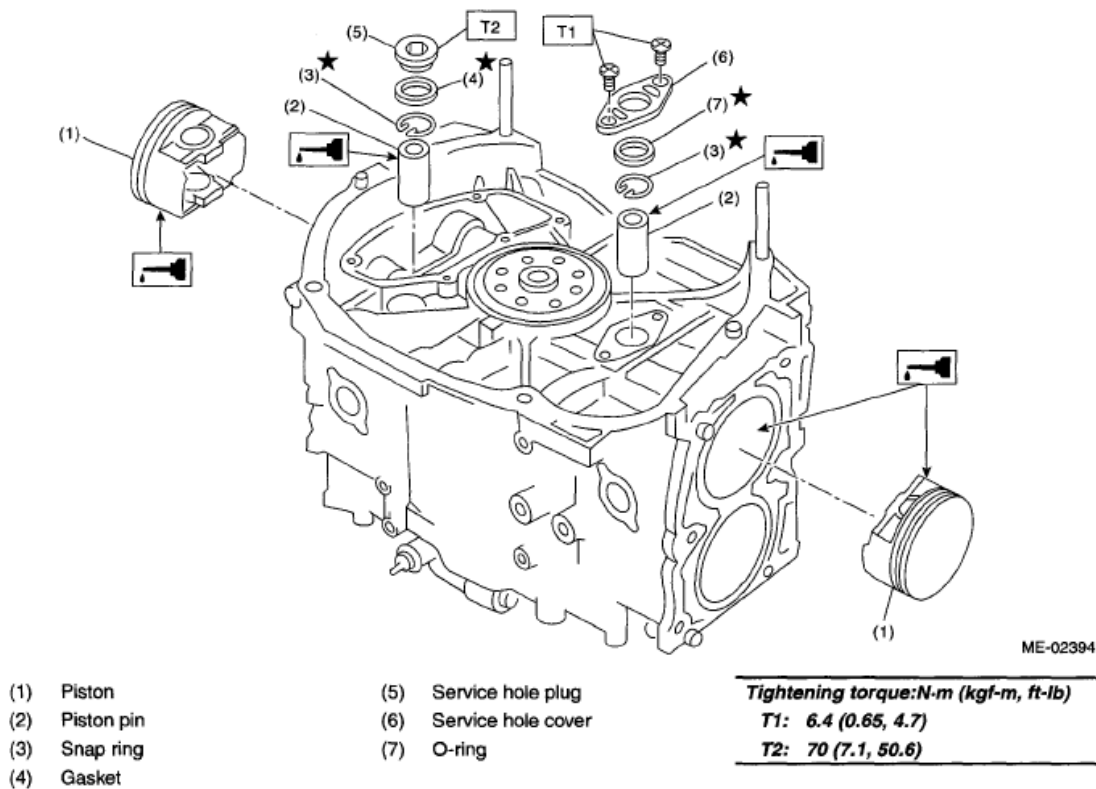


Fig. 175: Identifying Piston, Piston Pin, Service Hole Plug And Cover, Gasket And Snap Ring With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

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

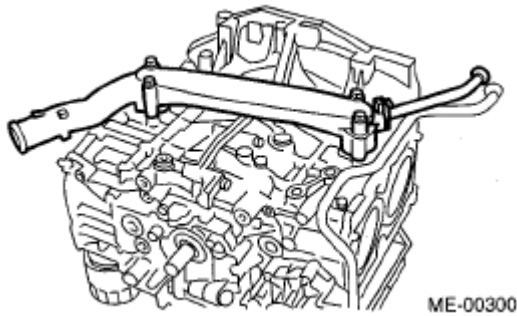


Fig. 176: Identifying Water Pipe
Courtesy of SUBARU OF AMERICA, INC.

23. Install the baffle plate.

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

24. Install the O-ring to the oil strainer, then install it to the cylinder block.

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

25. Install the oil strainer stay.

Tighten the oil strainer together with the baffle plate.

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

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

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

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

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

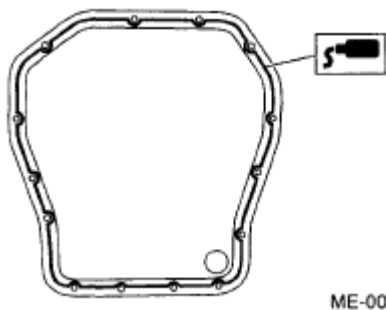


Fig. 177: Applying Liquid Gasket To Mating Surfaces Of Oil Pan

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

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

THREE BOND 1324 (Part No. 004403042) or equivalent

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

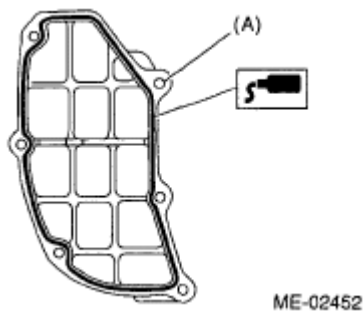


Fig. 178: Applying Liquid Gasket To Mating Surfaces Of Oil Separator Cover
Courtesy of SUBARU OF AMERICA, INC.

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

To lock the crankshaft, use the ST.

ST 498497100 CRANKSHAFT STOPPER

Tightening torque: 72 N.m (7.3 kgf-m, 52.8 ft-lb)

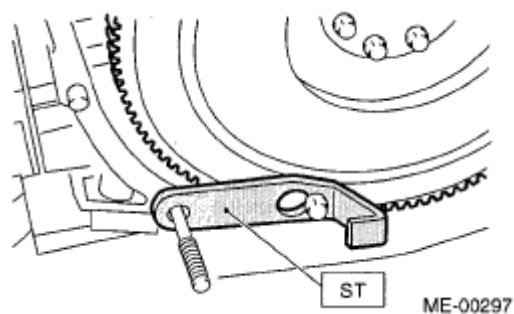


Fig. 179: Locking Crankshaft Using Crankshaft Stopper ST (498497100)- MT Model
 Courtesy of SUBARU OF AMERICA, INC.

29. Install the drive plate. (AT model)

To lock the crankshaft, use the ST.

ST 498497100 CRANKSHAFT STOPPER

Tightening torque: 72 N.m (7.3 kgf-m, 52.8 ft-lb)

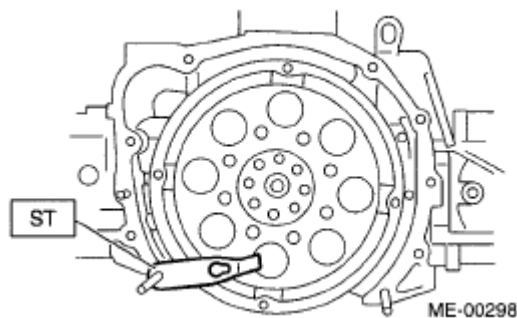


Fig. 180: Locking Crankshaft Using Crankshaft Stopper ST (498497100)- AT Model
 Courtesy of SUBARU OF AMERICA, INC.

30. Install the clutch cover. (MT model)
31. Installation of oil pump:
1. Replace the front oil seal with a new part using ST.

ST 499587100 OIL SEAL INSTALLER

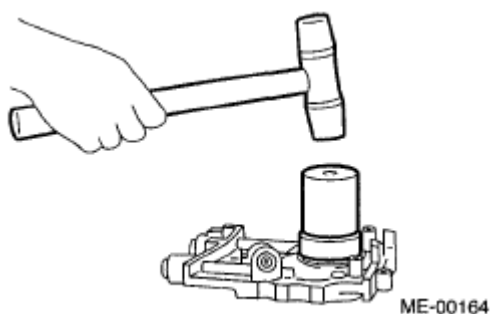
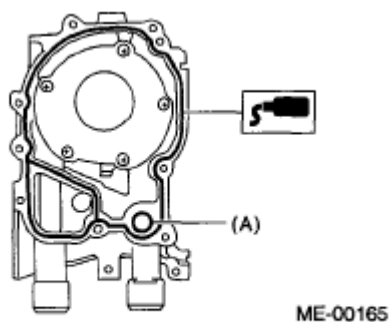


Fig. 181: Installing Front Oil Seal Using Oil Seal Installer ST 499587100
 Courtesy of SUBARU OF AMERICA, INC.

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. 182: 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.

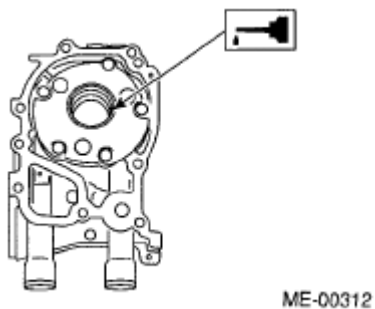


Fig. 183: Applying Coat Of Engine Oil To Inside Of Oil Seal
 Courtesy of SUBARU OF AMERICA, INC.

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

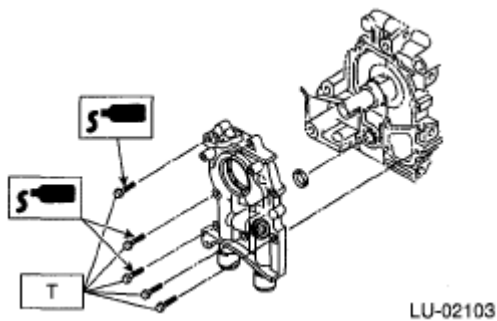


Fig. 184: Applying Fluid Packing To Threads Of Bolts
Courtesy of SUBARU OF AMERICA, INC.

32. Install the water pump and gasket.

Tightening torque:

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

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

NOTE:

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

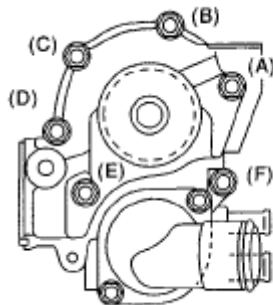


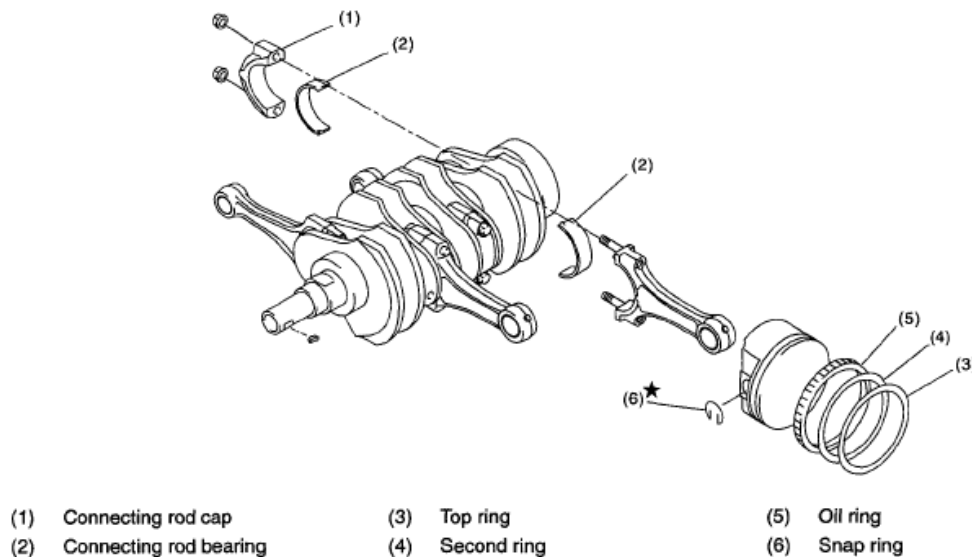
Fig. 185: Tightening Sequence Of Water Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

33. Install the water by-pass pipe for heater.
34. Install the oil filter. <Ref. to **INSTALLATION** , Engine Oil Filter .>
35. Tighten the cylinder head bolts. <Ref. to **INSTALLATION** .>
36. Install the oil level gauge guide and tighten the bolts. (LH side only)
37. Install the crank sprocket. <Ref. to **INSTALLATION** .>
38. Install the cam sprocket. <Ref. to **INSTALLATION** .>
39. Install the timing belt. <Ref. to **INSTALLATION** .>
40. Adjust the valve clearance. <Ref. to **ADJUSTMENT** .>
41. Install the rocker cover gasket to the rocker cover, install it to the cylinder head, and then connect the PCV hose.

NOTE: Use a new gasket.

42. Install the timing belt cover. <Ref. to **INSTALLATION** .>
43. Install the crank pulley. <Ref. to **INSTALLATION** .>
44. Install the generator and A/C compressor brackets on cylinder head.
45. Install the V-belts. <Ref. to **INSTALLATION** .>
46. Install the intake manifold. <Ref. to **INSTALLATION** , Intake Manifold .>

DISASSEMBLY



ME-02411

Fig. 186: Identifying Connecting Rod Bearing And Cap, Second Ring, Oil Ring, Top Ring And Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

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

5. Remove the snap ring.

ASSEMBLY

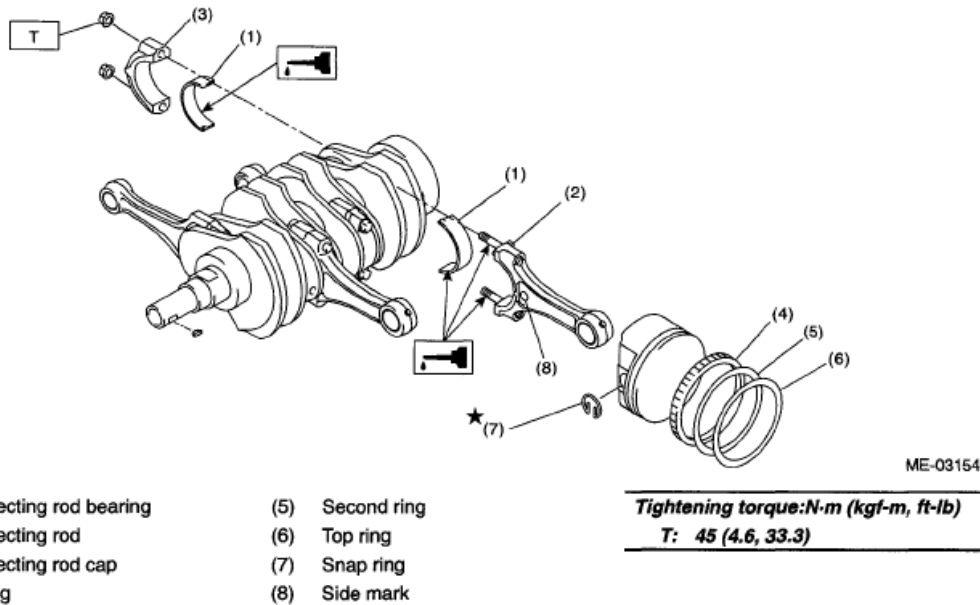


Fig. 187: Identifying Connecting Rod Bearing And Cap, Second Ring, Oil Ring, Top Ring And Snap Ring With Torque Specifications

Courtesy of SUBARU OF AMERICA, INC.

1. Apply oil to the surfaces of the connecting rod bearings.
2. Install the connecting rod bearings on connecting rods and connecting rod caps.
3. Position each connecting rod with the marking side facing forward, and install it.
4. Install the connecting rod cap with connecting rod nut.

Make sure the arrow on connecting rod cap faces toward 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.**

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

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

T: 45 (4.6, 33.3)

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 cylinder block surface that mates with cylinder head for warping by using a straight edge, and correct by grinding if necessary.

Warping limit: 0.025 mm (0.00098 in)

Grinding limit: 0.1 mm (0.004 in)

Standard height of cylinder block: 201.0 mm (7.91 in)

CYLINDER AND PISTON

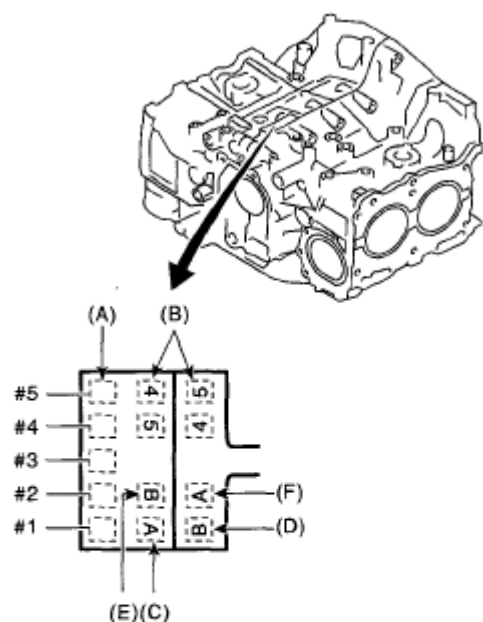
1. The cylinder bore size is stamped on the front upper face of the cylinder block.

NOTE:

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

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

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



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. 188: Identifying Cylinder Bore Size Stamped
 Courtesy of SUBARU OF AMERICA, INC.

2. How to measure the inner diameter of each cylinder

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

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

Taper:

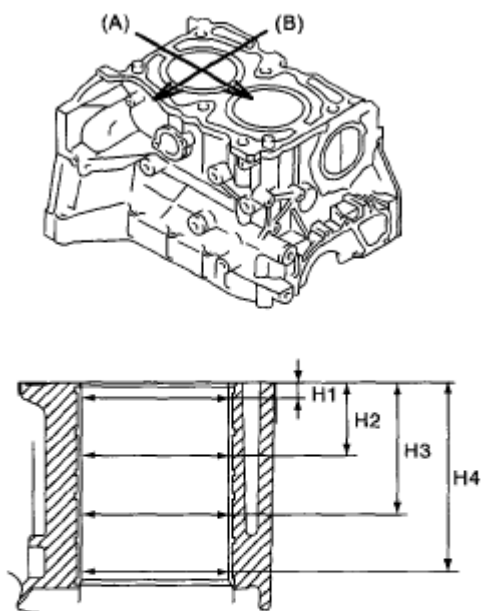
Standard:

0.015 mm (0.0006 in)

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

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

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

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

Piston grade point H: 38.2 mm (1.504 in)

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)

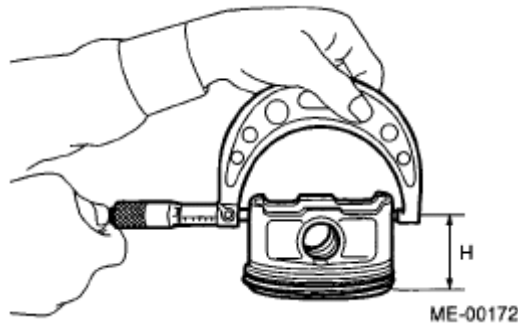


Fig. 190: Measuring Outer Diameter Of Piston
Courtesy of SUBARU OF AMERICA, INC.

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, rebore it to replace with an oversize piston.

CAUTION:

- When any of the cylinders needs reboring, 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, pay attention when measuring the cylinder diameter.

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

PISTON AND PISTON PIN

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

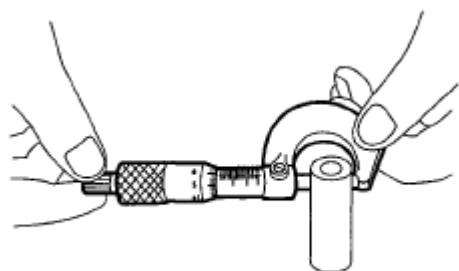
Clearance between piston hole and piston pin:

Standard: 0.004 - 0.008 mm (0.0002 - 0.0003 in)



ME-00173

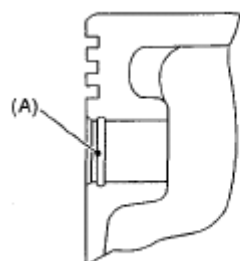
Fig. 191: Checking Piston Pin Hole
Courtesy of SUBARU OF AMERICA, INC.



ME-00174

Fig. 192: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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



ME-00175

Fig. 193: Identifying Snap Ring Installation Groove
 Courtesy of SUBARU OF AMERICA, INC.

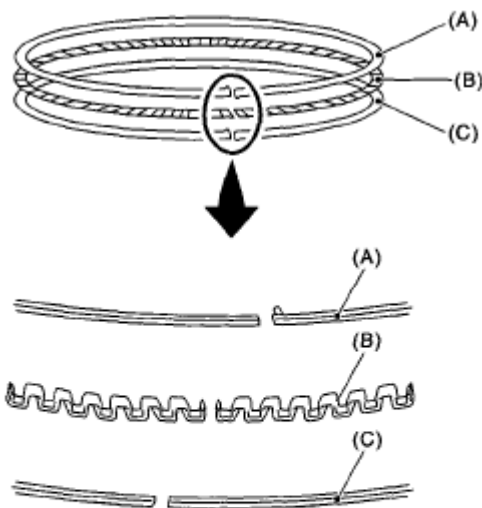
5. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

NOTE:

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



ME-02472

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

Fig. 194: Identifying Upper Rail, Expander And Lower Rail Position

Courtesy of SUBARU OF AMERICA, INC.

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

PISTON RING SPECIFICATION

mm (in)		
		Standard
Piston ring gap	Top ring	0.20 - 0.35 (0.0079 - 0.0138)
	Second ring	0.37 - 0.52 (0.0144 - 0.0203)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)

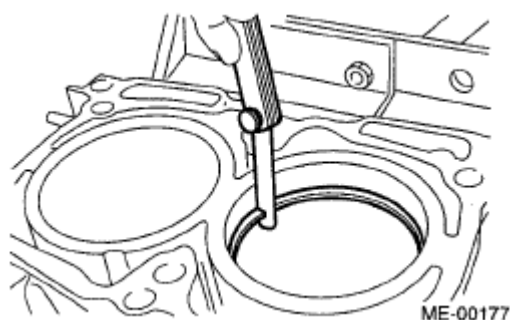


Fig. 195: Measuring Piston Ring End Gap
 Courtesy of SUBARU OF AMERICA, INC.

4. Measure the clearance between piston ring and piston ring groove with a thickness gauge.

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

PISTON RING SPECIFICATION

mm (in)		
		Standard
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)

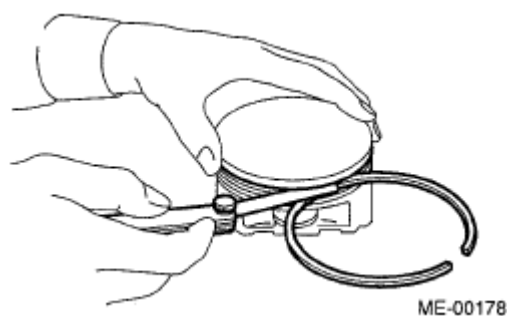
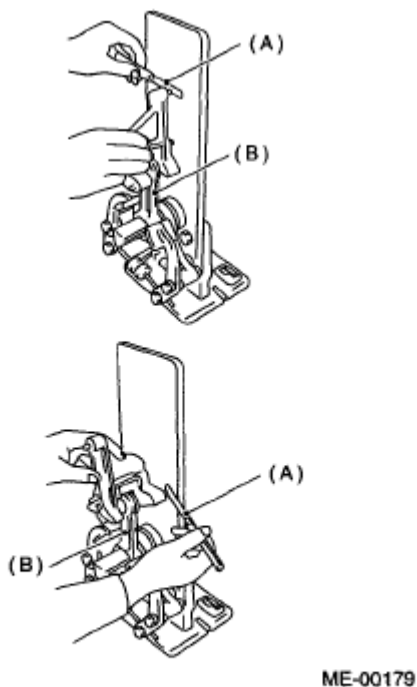


Fig. 196: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

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. 197: Checking Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod fitted with bearing to crankshaft and measure the thrust clearance. Replace the

connecting rod if the thrust clearance exceeds the standard.

Connecting rod thrust clearance:

Standard: 0.070 - 0.330 mm (0.0028 - 0.0130 in)

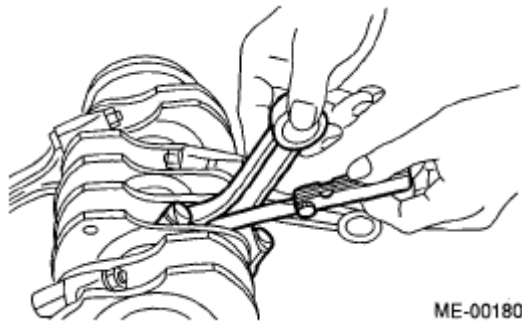


Fig. 198: Checking Connecting Rod Thrust Clearance
Courtesy of SUBARU OF AMERICA, INC.

4. Inspect the connecting rod bearing for scar, peeling, seizure, melting, wear, etc.
5. Measure the oil clearance on each connecting rod bearing using 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: 0.016 - 0.044 mm (0.00063 - 0.0017 in)

CONNECTING ROD SPECIFICATION

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

6. Inspect the bushing at connecting rod small end, and replace 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)

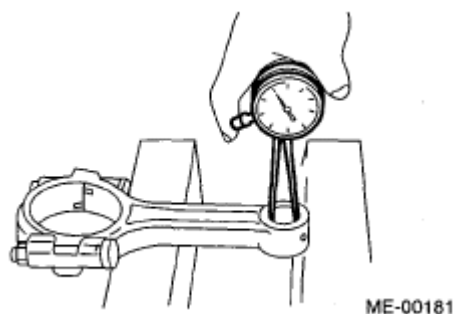


Fig. 199: Checking Clearance Between Piston Pin And Bushing
Courtesy of SUBARU OF AMERICA, INC.

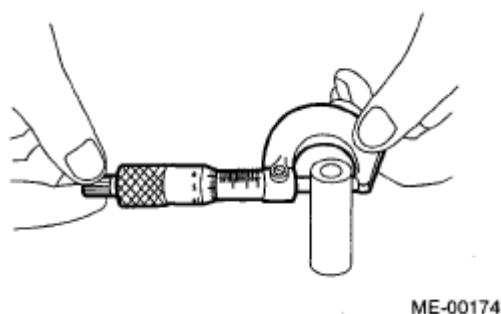


Fig. 200: Checking Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

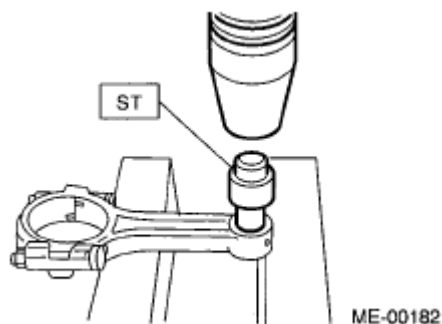


Fig. 201: Installing Connecting Rod Bushing
Courtesy of SUBARU OF AMERICA, INC.

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

CRANKSHAFT AND CRANKSHAFT BEARING

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

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

Crankshaft bend limit: 0.035 mm (0.0014 in)

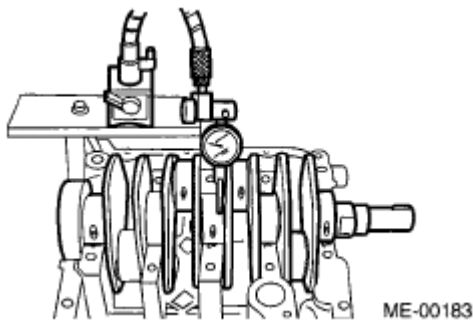


Fig. 202: Measuring Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

3. Inspect the crank journal and crank pin for wear. If they are not within the standard, replace the bearing with a suitable (undersize) one, and replace or readjust 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: To 51.750 mm (2.0374 in) dia.

Crank journal

Out-of-roundness: 0.005 mm (0.0002 in)

Cylindricity: 0.006 mm (0.0002 in)

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



Fig. 203: Inspecting Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL OUTER DIAMETER SPECIFICATION

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

4. Measure the thrust clearance of crankshaft at center bearing by using thickness gauge. If the thrust clearance is not within the standard, replace the bearing.

Crankshaft thrust clearance:

Standard: 0.030 - 0.115 mm (0.0012 - 0.0045 in)

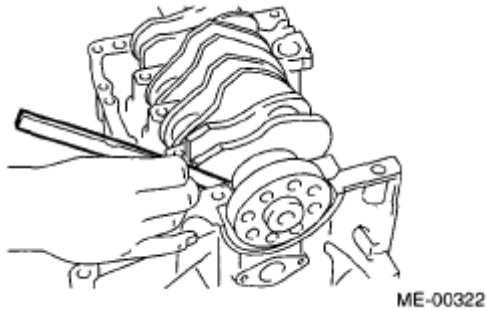


Fig. 204: Checking Crankshaft Thrust Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

Crankshaft oil clearance:

Standard: 0.010 - 0.030 mm (0.0004 - 0.0012 in)

OIL SWITCHING SOLENOID VALVE

REMOVAL

RH SIDE

1. Disconnect the ground cable from the battery.

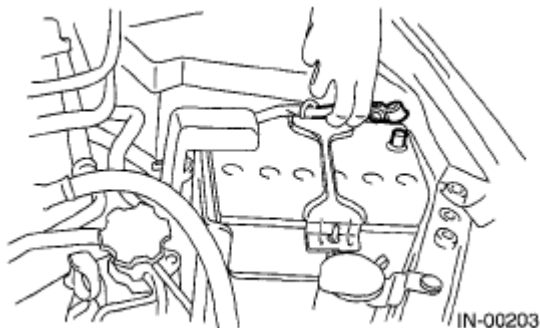


Fig. 205: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake chamber. <Ref. to **REMOVAL** , Air Intake Chamber .>
3. Remove the engine harness connector from the bracket.

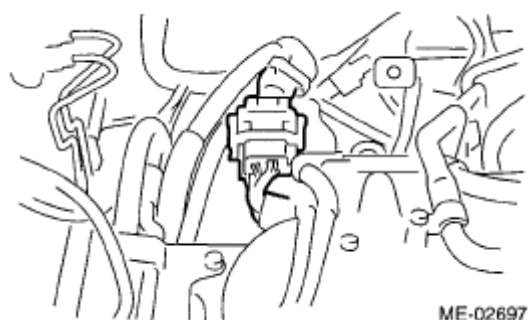
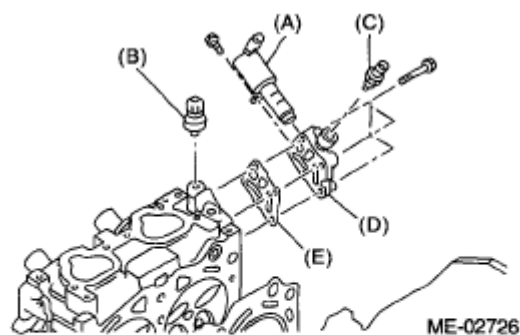


Fig. 206: Identifying Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

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



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

Fig. 207: Identifying Oil Switching Solenoid Valve And Holder, Oil Temperature Sensor And Gasket
Courtesy of SUBARU OF AMERICA, INC.

LH SIDE

1. Disconnect the ground cable from the battery.

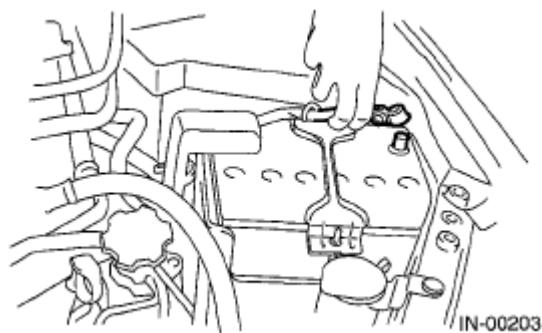
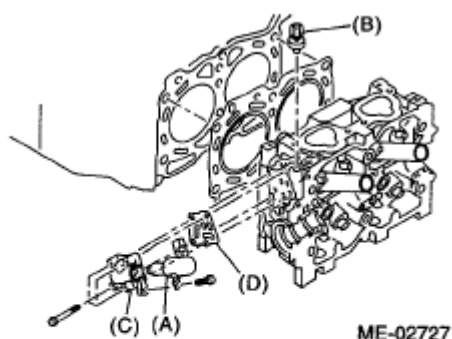


Fig. 208: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the V-belts. <Ref. to **REMOVAL** .>
3. Remove the crank pulley. <Ref. to **REMOVAL** .>
4. Remove the timing belt cover. <Ref. to **REMOVAL** .>
5. Remove the timing belt. <Ref. to **REMOVAL** .>
6. Remove the cam sprocket. <Ref. to **REMOVAL** .>
7. Remove the timing belt cover No. 2 (LH).
8. Disconnect the connector from the oil switching solenoid valve.
9. Remove the oil switching solenoid valve.
10. Remove the variable valve lift diagnosis oil pressure switch. <Ref. to **REMOVAL** , Variable Valve Lift Diagnosis Oil Pressure Switch .>
11. Remove the oil switching solenoid valve holder from the cylinder head.



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

Fig. 209: Identifying Oil Switching Solenoid Valve And Variable Valve Lift Diagnosis Oil Pressure Switch
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

RH SIDE

Install in the reverse order of removal.

NOTE:

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

Tightening torque:***T1***

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

T2

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

T3

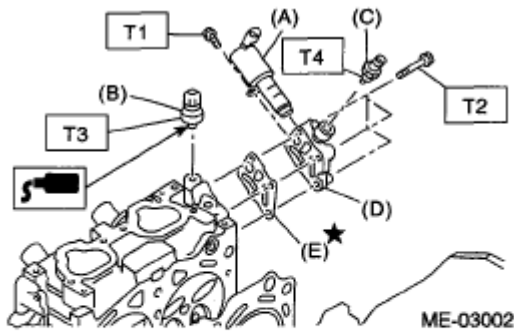
17 N.m (1.7 kgf-m, 12.5 ft-lb)

T4

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

Liquid gasket

THREE BOND 1324 (Part No. 004403042)



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

Fig. 210: Identifying Oil Switching Solenoid Valve And Holder, Oil Temperature Sensor And Gasket
 Courtesy of SUBARU OF AMERICA, INC.

LH SIDE

Install in the reverse order of removal.

NOTE:

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

Tightening torque:

T1

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

T2

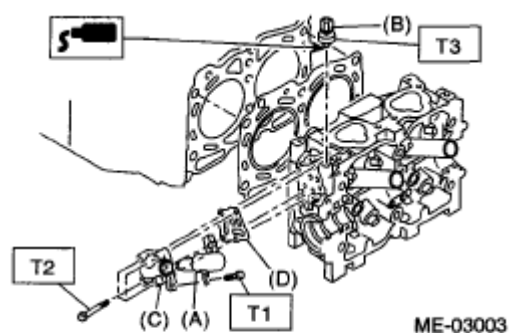
10 N.m (1.0 kgf-m, 7.4 ft-lb)

T3

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

Liquid gasket

THREE BOND 1324 (Part No. 004403042)



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

Fig. 211: Identifying Oil Switching Solenoid Valve And Variable Valve Lift Diagnosis Oil Pressure Switch

Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE

SPECIFICATION

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

PISTON

SPECIFICATION

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

CONNECTING ROD

SPECIFICATION

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

CRANKSHAFT

SPECIFICATION

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

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".

SYMPTOM POSSIBLE CAUSE

Symptoms	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
1) Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective inhibitor switch	C
		Defective starter	B
	Battery	Improper connection of the 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
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Fuel line	Defective fuel pump and relay	A
		Clogged fuel line	B
		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 BASIC DIAGNOSTIC		A

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3) Initial combustion occurs.	PROCEDURE . >		
	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
4) Engine stalls after initial combustion.	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Loosened or cracked intake duct	B
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	C
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Dirty air cleaner element	C
	Fuel line	Clogged fuel line	C
		Lack of or insufficient fuel	B
	Timing belt	Degradation, etc.	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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 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
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
	Defective fuel pump and relay	B

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

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

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	Compression	Incorrect valve timing	B
	Cooling system	Overheating	A
9. Excessive engine oil consumption	Intake system	Loosened or cracked PCV hose	A
		Defective PCV valve	B
		Loosened oil filler cap	C
	Compression	Defective valve stem	A
		Worn or stuck piston rings, cylinder and piston	A
	Lubrication system	Loosened oil pump attaching bolts and defective gasket	B
		Defective oil filter seal	B
		Defective crankshaft oil seal	B
		Defective rocker cover gasket	B
		Loosened oil drain plug or defective gasket	B
		Loosened oil pan fitting bolts or defective oil pan	B
10. Excessive fuel consumption	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Dirty air cleaner element	A
	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective 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

CONDITION POSSIBLE CAUSE

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Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	- Valve mechanism is defective. - Incorrect valve clearance - Worn valve rocker - Worn camshaft - Broken valve spring
Heavy and dull clank	Oil pressure is low.	- Worn crankshaft main bearing - Worn connecting rod bearing (large end)
	Oil pressure is normal.	Damaged engine mounting
High-pitched clank (Spark knock)	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 1,000 to 2,000 rpm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected ⁽¹⁾ .	- Worn crankshaft main bearing - Worn connecting rod bearing (large end)
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected ⁽¹⁾ .	- Worn cylinder liner and piston ring - Broken or stuck piston ring - Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn ⁽¹⁾ .	- Worn cam sprocket - Worn camshaft journal bore in cylinder head assembly
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Poor contact of generator brush and rotor
Gear scream when starting engine	-	- Defective ignition starter switch - Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	- Loose drive belt - Defective water pump shaft
Hissing sound	-	- Insufficient compression - Air leakage in air intake system, hose, connection or manifold

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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.