

2007 Subaru B9 Tribeca

2007 ENGINE Mechanical (H6DO) - B9 Tribeca

2007 ENGINE**Mechanical (H6DO) - B9 Tribeca****GENERAL DESCRIPTION****SPECIFICATION****GENERAL SPECIFICATION**

Engine	Cylinder arrangement			Horizontally opposed, liquid cooled, 6-cylinder, 4-stroke gasoline engine
	Valve system mechanism			Chain driven, double overhead camshaft, 4-valve/cylinder
	Inside diameter x stroke		mm (in)	89.2 x 80 (3.512 x 3.150)
	Displacement		cm ³ (cu in)	3,000 (183)
	Compression ratio			10.7
	Compression pressure (350 rpm and fully open throttle):		kPa (kgf/cm ² psi)	1,275 - 1,471 (13.0 - 15.0, 185 - 213)
	Number of piston rings			Pressure ring: 2, Oil ring: 1
	Intake valve timing	Min. advance	Open	BTDC 47°
			Close	ABDC 23°
		Max. retard	Open	ATDC 3°
			Close	ABDC 73°
	Exhaust valve timing		Open	BBDC 60°
			Close	ATDC 6°
	Valve clearance	mm (in)	Intake	0.20 ^{+0.04} _{-0.06} (0.0079 ^{+0.0016} _{-0.0024})
			Exhaust	0.35±0.05 (0.0138±0.020)
Idle speed ["P" or "N" range]		No load	650±50	
		A/C ON	770±50	
Ignition order			1 --> 6 --> 3 --> 2 --> 5 --> 4	
Ignition timing			BTDC/rpm 15°±8°/650	

Idle speed ["P" or "N" range]	rpm	No load	650±50
		A/C ON	770±50

Ignition order	1 --> 6 --> 3 --> 2 --> 5 --> 4
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Ignition timing	BTDC/rpm	15°±8°/650
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NOTE: OS: Oversize US: Undersize**GENERAL SPECIFICATION**

	Thrust clearance	mm (in)	Intake		Standard	0.075 - 0.135 (0.0030 - 0.0053)
			Exhaust		Standard	0.030 - 0.090 (0.0012 - 0.0035)
			Intake	HIGH	Standard	42.09 - 42.19 (1.6571 - 1.6610)
				LOW1	Standard	38.14 - 38.24 (1.5016 -

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Camshaft	Cam lobe height	mm (in)		LOW2	Standard	1.5055)	
			Exhaust		Standard	35.44 - 35.54 (1.3953 - 1.3992)	
		Cam base circle diameter	mm (in)	Intake	HIGH	Standard	41.65 - 41.75 (1.6398 - 1.6437)
	LOW1				Standard	32.00 (1.2598)	
	LOW2			Standard	31.84 (1.2535)		
	Exhaust		Standard	32.00 (1.2598)			
	Journal O.D.	mm (in)	Front		Standard	37.946 - 37.963 (1.4939 - 1.4946)	
			Except for front		Standard	25.946 - 25.963 (1.0215 - 1.0222)	
	Oil clearance				mm (in)	Standard	0.037 - 0.072 (0.0015 - 0.0028)
Cylinder head	Flatness				mm (in)	Standard	0.02 (0.0008)
	Inner diameter of valve lifter hole				mm (in)		32.994 - 33.016 (1.2990 - 1.2998)
	Standard height				mm (in)		124±0.05 (4.88±0.0020)
Valve seat	Seating angle						90°
	Contacting width	mm (in)	Intake		Standard	1.0 (0.039)	
Exhaust			Standard	1.5 (0.059)			
Valve guide	Inside diameter					mm (in)	5.500 - 5.512 (0.2165 - 0.2170)
	Protrusion above head					mm (in)	11.4 - 11.8 (0.449 - 0.465)
Valve	Head edge thickness	mm (in)	Intake		Standard	1.0 (0.039)	
			Exhaust		Standard	1.2 (0.047)	
	Stem outer diameter	mm (in)	Intake			5.455 - 5.470 (0.2148 - 0.2154)	
			Exhaust			5.445 - 5.460 (0.2144 - 0.2150)	
	Stem oil clearance	mm (in)	Intake		Standard	0.030 - 0.057 (0.0012 - 0.0022)	
			Exhaust		Standard	0.040 - 0.067 (0.0016 - 0.0026)	
	Overall length	mm (in)	Intake			99.7 (3.925)	
			Exhaust			105.2 (4.142)	
Outer diameter of valve lifter					mm (in)	32.959 - 32.975 (1.2976 - 1.2982)	
Valve spring	Free length	mm (in)	Intake		Inner	39.55 (1.5571)	
					Outer	41.18 (1.6213)	
			Exhaust			46.32 (1.8236)	
					Inner	2.5°, 1.7 mm (0.067 in)	

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	Squareness	Intake	Outer	2.5°, 1.8 mm (0.071 in)
		Exhaust		2.5°, 2.0 mm (0.079 in)
Cylinder block	Standard height mm (in)			202 (7.95)
	Cylinder inner diameter mm (in)	Standard	A	89.205 - 89.215 (3.5120 - 3.5124)
			B	89.195 - 89.205 (3.5116 - 3.5120)
	Cylindrically mm (in)	Standard	0.030 (0.0012)	
	Out-of-roundness mm (in)	Standard	0.010 (0.0004)	
Piston clearance mm (in)	Standard	-0.010 - 0.010 (-0.0004 - 0.0004)		
Piston	Outer diameter mm (in)	Standard	A	89.205 - 89.215 (3.5120 - 3.5124)
			B	89.195 - 89.205 (3.5116 - 3.5120)
		0.25 (0.0098) OS		89.445 - 89.465 (3.5215 - 3.5222)
		0.50 (0.0197) OS		89.695 - 89.715 (3.5313 - 3.5321)
	Inner diameter of piston pin hole		Standard	22.000 - 22.006 (0.8661 - 0.8664)
Piston pin	Outer diameter mm (in)		Standard	21.994 - 22.000 (0.8659 - 0.8661)
	Standard clearance between piston and piston pin mm (in)		Standard	0.004 - 0.008 (0.0002 - 0.0003)
Piston ring	Ring closed gap mm (in)	Top ring	Standard	0.20 - 0.35 (0.0079 - 0.0138)
		Second ring	Standard	0.35 - 0.50 (0.0138 - 0.0197)
		Oil ring	Standard	0.20 - 0.60 (0.0079 - 0.0236)
	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)
		Oil ring	Standard	0.045 - 0.125 (0.0018 - 0.0049)
Connecting rod	Thrust clearance mm (in)		Standard	0.070 - 0.330 (0.0028 - 0.0130)
Bearing of large	Oil clearance mm (in)		Standard	0.016 - 0.043 (0.0006 - 0.0017)
		Standard		1.490 - 1.506 (0.0587 - 0.0593)
				1.509 - 1.513 (0.0594 -

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end	Bearing size (Thickness at center) mm (in)		0.03 (0.0012) US	0.0596)
			0.05 (0.0020) US	1.519 - 1.523 (0.0598 - 0.0600)
			0.25 (0.0098) US	1.619 - 1.623 (0.0637 - 0.0639)
Bushing of small end	Clearance between piston pin and bushing mm (in)		Standard	0 - 0.022 (0 - 0.0009)
Crankshaft	Crank pin and crank journal	Out-of-roundness mm (in)	0.005 (0.0002)	
		Cylindrically mm (in)	0.006 (0.0002)	
	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)	#1, #3, #5, #7	Standard	63.992 - 64.008 (2.5194 - 2.5200)
			0.03 (0.0012) US	63.962 - 63.978 (2.5182 - 2.5188)
			0.05 (0.0020) US	63.942 - 63.958 (2.5174 - 2.5180)
			0.25 (0.0098) US	63.742 - 63.758 (2.5095 - 2.5102)
		#2, #4, #6	Standard	63.992 - 64.008 (2.5194 - 2.5200)
			0.03 (0.0012) US	63.962 - 63.978 (2.5182 - 2.5188)
			0.05 (0.0020) US	63.942 - 63.958 (2.5174 - 2.5180)
			0.25 (0.0098) US	63.742 - 63.758 (2.5095 - 2.5102)
	Thrust clearance mm (in)		Standard	0.030 - 0.115 (0.0012 - 0.0045)
	Oil clearance mm (in)		Standard	0.010 - 0.030 (0.0004 - 0.0012)
	#1, #3, #5, #7	Standard	1.992 - 2.005 (0.0784 - 0.0789)	
		0.03 (0.0012) US	2.011 - 2.014 (0.0792 - 0.0793)	
		0.05 (0.0020) US	2.021 - 2.024 (0.0796 - 0.0797)	
		0.25 (0.0098) US	2.121 - 2.124 (0.0835 -	

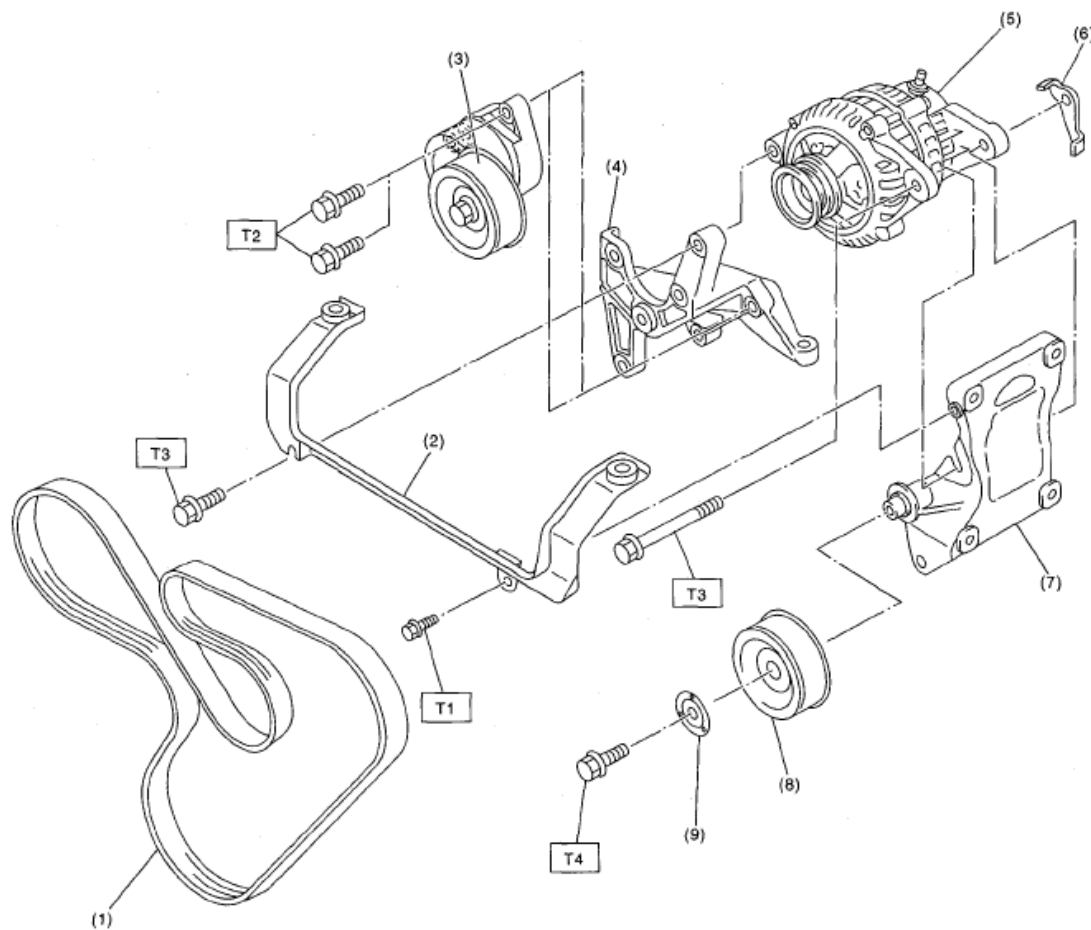
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Main bearing	Bearing size (Thickness at center)	mm (in)#2, #4, #6		0.0836)
			Standard	1.996 - 2.009(0.0786 - 0.0791)
			0.03 (0.0012) US	2.015 - 2.018 (0.0793 - 0.0794)
			0.05 (0.0020) US	2.025 - 2.028 (0.0797 - 0.0798)
			0.25 (0.0098) US	2.125 - 2.128 (0.0837 - 0.0838)

COMPONENT

V-BELT



ME-02730

- | | |
|---------------------------------|-------------------------|
| (1) V-belt | (6) Generator plate |
| (2) Collector cover bracket | (7) A/C compressor stay |
| (3) Belt tension adjuster ASSY | (8) Idler pulley |
| (4) Power steering pump bracket | (9) Idler pulley cover |
| (5) Generator | |

Tightening torque:N·m (kgf-m, ft-lb)

T1: 6.4 (0.65, 4.7)

T2: 20 (2.0, 14)

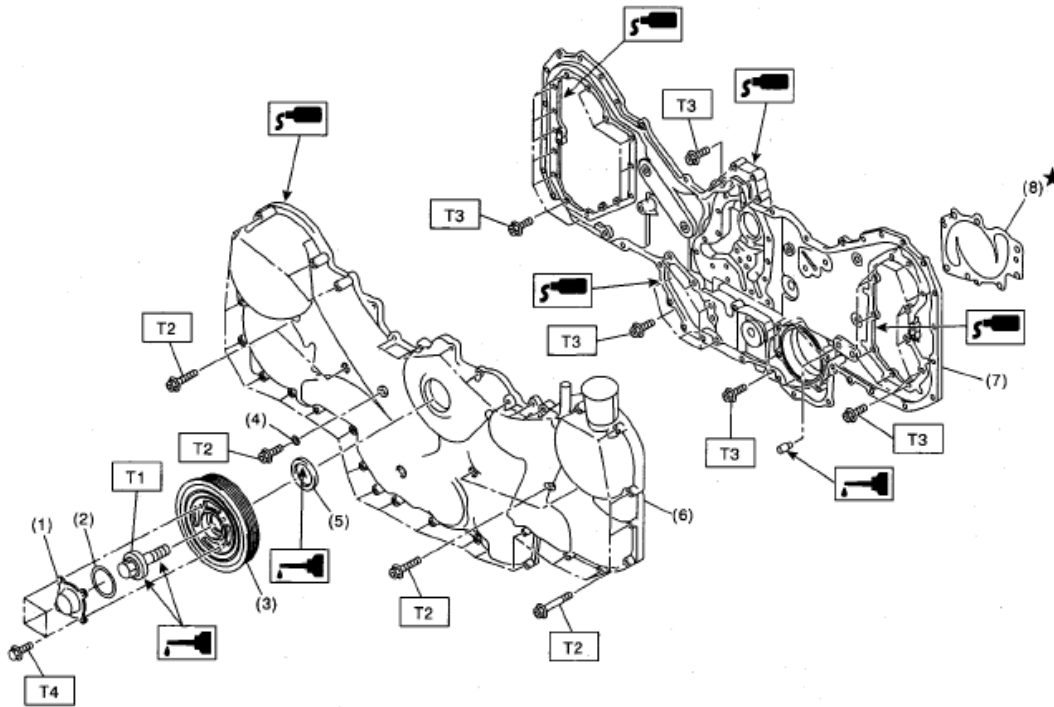
T3: 25 (2.5, 18)

T4: 33 (3.4, 24.3)

Fig. 1: Exploded View Of V-Belt Components With Torque Specifications

Courtesy of SUBARU OF AMERICA, INC.

TIMING CHAIN COVER



ME-03074

- | | |
|------------------------|-----------------------|
| (1) Crank pulley cover | (5) Oil seal |
| (2) O-ring | (6) Front chain cover |
| (3) Crank pulley | (7) Rear chain cover |
| (4) Sealing washer | (8) Water pump gasket |

Tightening torque:N·m (kgf-m, ft-lb)

T1: <Ref. to ME(H6DO)-41, Crank Pulley.>

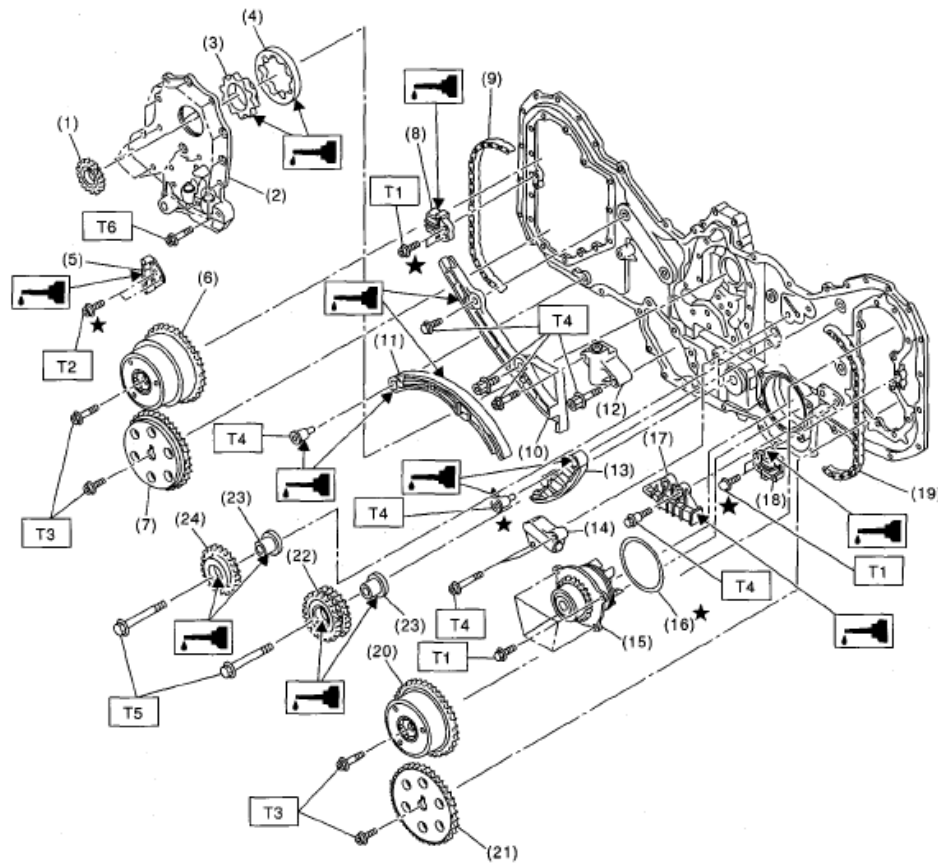
T2: <Ref. to ME(H6DO)-42, Front Chain Cover.>

T3: <Ref. to ME(H6DO)-52, Rear Chain Cover.>

T4: 6.4 (0.65, 4.7)

Fig. 2: Exploded View Of Timing Chain Cover Components With torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

TIMING CHAIN



ME-02380

- | | |
|------------------------------------|-------------------------------------|
| (1) Crank sprocket | (13) Chain tensioner lever (LH) |
| (2) Oil relief case | (14) Chain tensioner (LH) |
| (3) Inner rotor | (15) Water pump |
| (4) Outer rotor | (16) O-ring |
| (5) Chain guide (center) | (17) Chain guide (LH) |
| (6) Intake cam sprocket (RH) | (18) Chain guide (LH: between cams) |
| (7) Exhaust cam sprocket (RH) | (19) Timing chain (LH) |
| (8) Chain guide (RH: between cams) | (20) Intake cam sprocket (LH) |
| (9) Timing chain (RH) | (21) Exhaust cam sprocket (LH) |
| (10) Chain guide (RH) | (22) Idler sprocket (lower) |
| (11) Chain tensioner lever (RH) | (23) Idler sprocket collar |
| (12) Chain tensioner (RH) | |

- (24) Idler sprocket (upper)

Tightening torque: N·m (kgf-m, ft-lb)

T1: 6.4 (0.65, 4.7)

T2: 7.8 (0.8, 5.8)

T3: <Ref. to ME(H6DO)-50, Cam Sprocket.>

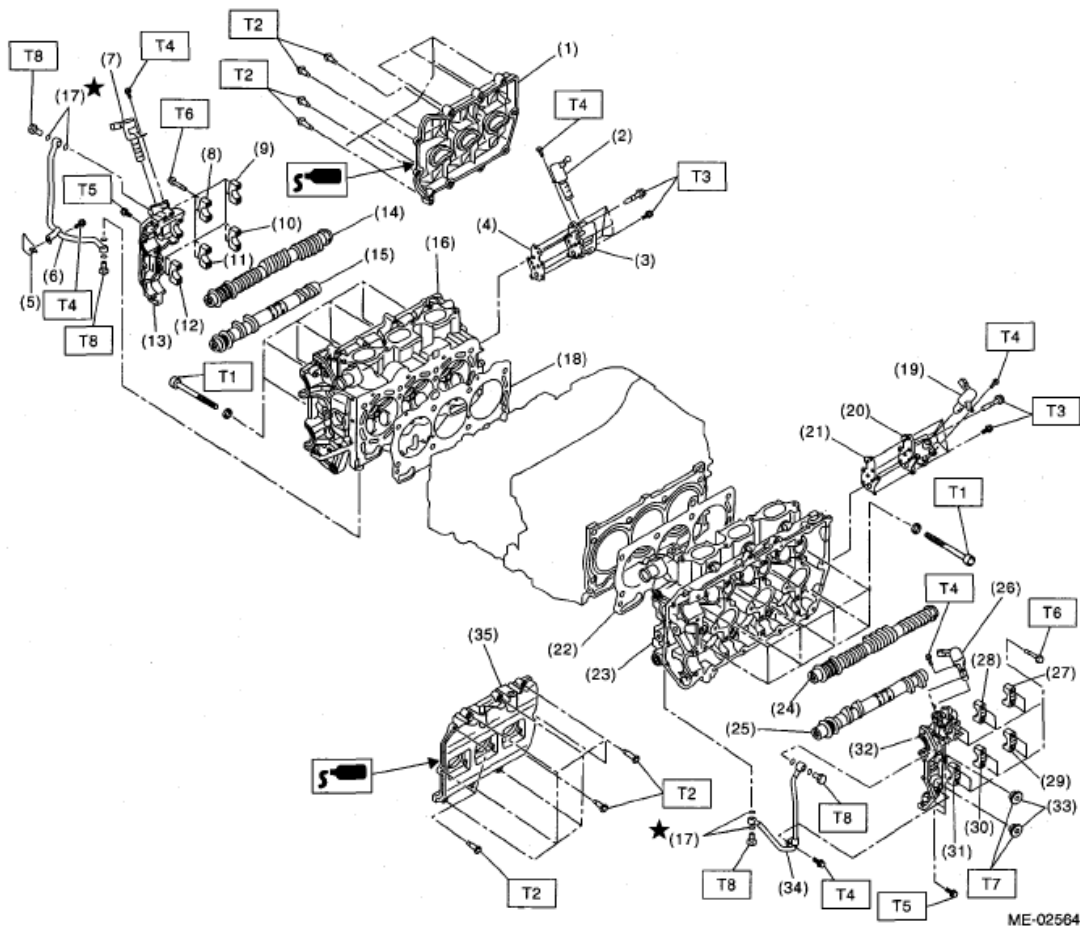
T4: 16 (1.6, 12)

T5: 69 (7.0, 50.6)

T6: <Ref. to LU(H6DO)-8, Oil Pump.>

Fig. 3: Exploded View Of Timing Chain Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD AND CAMSHAFT



ME-02564

- | | |
|--|---|
| (1) Rocker cover (RH) | (17) Gasket |
| (2) Oil switching solenoid valve (RH) | (18) Cylinder head gasket (RH) |
| (3) Oil switching solenoid valve holder (RH) | (19) Oil switching solenoid valve (LH) |
| (4) Oil switching solenoid valve gasket | (20) Oil switching solenoid valve holder (LH) |
| (5) Front chain cover | (21) Oil switching solenoid valve gasket |
| (6) Oil pipe (RH) | (22) Cylinder head gasket (LH) |
| (7) Oil flow control solenoid valve (RH) | (23) Cylinder head (LH) |
| (8) Intake camshaft cap (Center RH) | (24) Intake camshaft (LH) |
| (9) Intake camshaft cap (Rear RH) | (25) Exhaust camshaft (LH) |
| (10) Exhaust camshaft cap (Rear RH) | (26) Oil flow control solenoid valve (LH) |
| (11) Exhaust camshaft cap (Center RH) | (27) Intake camshaft cap (Rear LH) |
| (12) Exhaust camshaft cap (Front RH) | (28) Intake camshaft cap (Center LH) |
| (13) Front camshaft cap (RH) | (29) Exhaust camshaft cap (Rear LH) |
| (14) Intake camshaft (RH) | (30) Exhaust camshaft cap (Center LH) |
| (15) Exhaust camshaft (RH) | (31) Exhaust camshaft cap (Front LH) |
| (16) Cylinder head (RH) | (32) Front camshaft cap (LH) |

- | |
|------------------------|
| (33) Plug |
| (34) Oil pipe (LH) |
| (35) Rocker cover (LH) |

Tightening torque:N·m (kgf-m, ft-lb)

T1: <Ref. to ME(H6DO)-58, Cylinder Head.>

T2: <Ref. to ME(H6DO)-54, Camshaft.>

T3: <Ref. to ME(H6DO)-80, Oil Switching Solenoid Valve.>

T4: 6.4 (0.65, 4.7)

T5: 9.75 (1.0, 7.2)

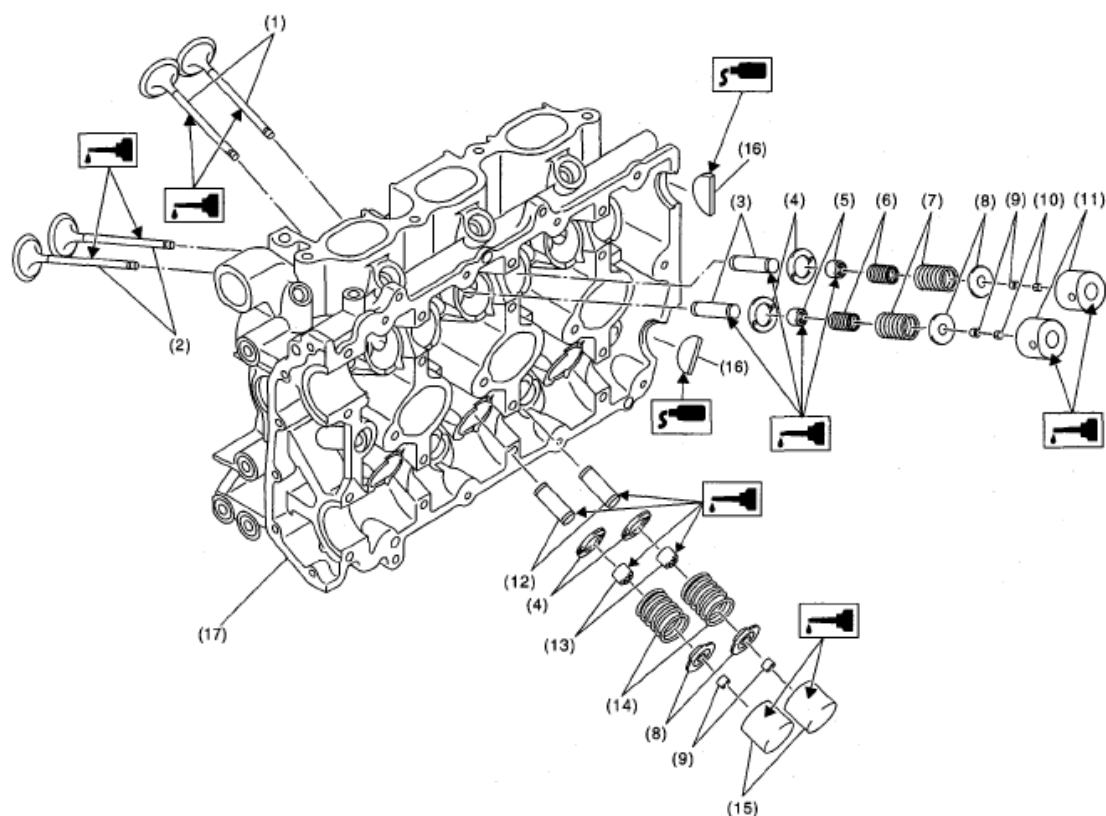
T6: 16 (1.6, 12)

T7: 60 (6.1, 44)

T8: 29 (3.0, 21.4)

Fig. 4: Exploded View Of Cylinder Head And Camshaft Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD AND VALVE ASSEMBLY

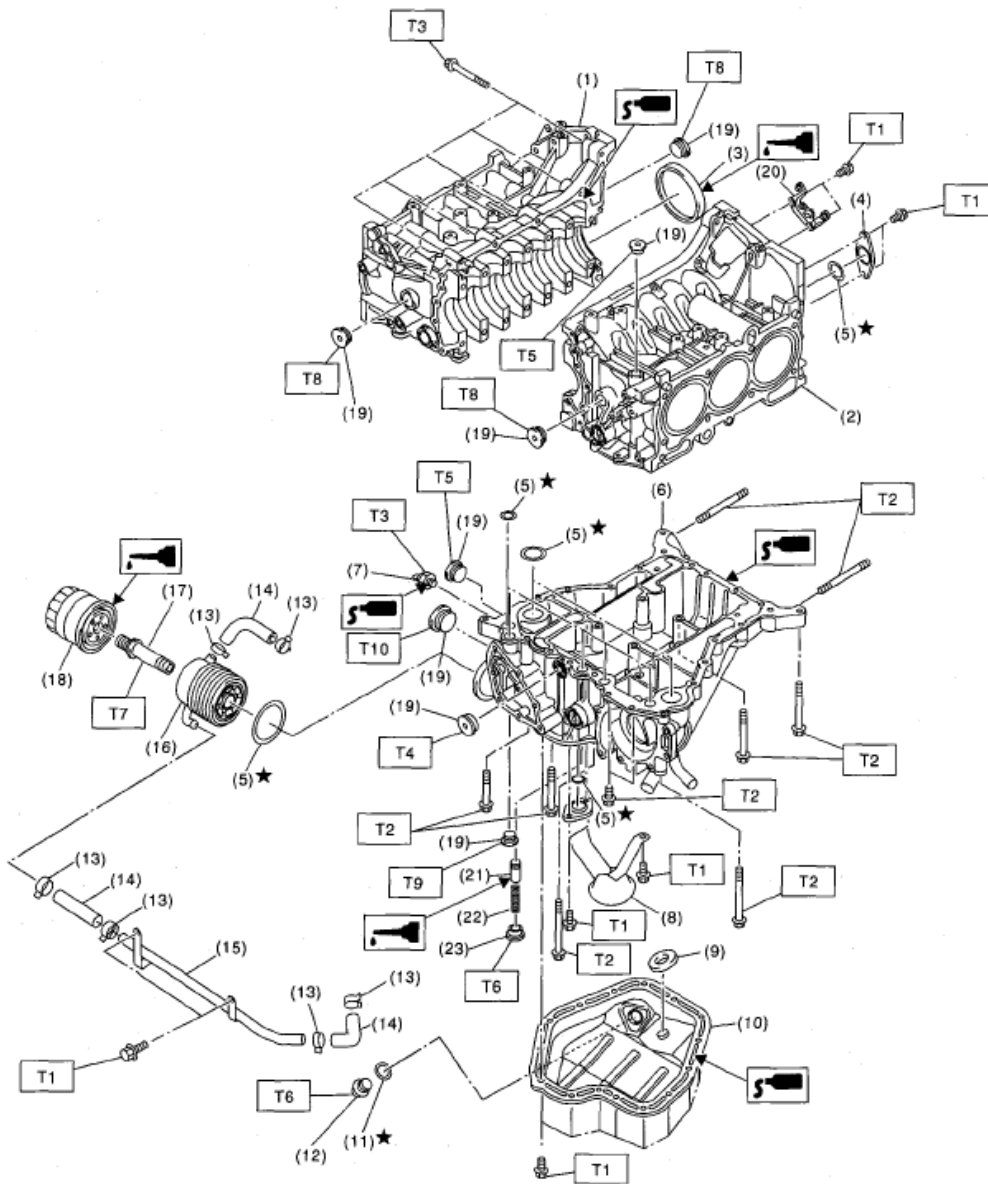


ME-03055

- | | | |
|----------------------------|----------------------------|------------------------------|
| (1) Exhaust valve | (7) Valve spring (Outer) | (13) Exhaust valve stem seal |
| (2) Intake valve | (8) Retainer | (14) Valve spring |
| (3) Intake valve guide | (9) Retainer key | (15) Valve lifter (Exhaust) |
| (4) Valve spring seat | (10) Shim | (16) Cylinder head plug |
| (5) Intake valve stem seal | (11) Valve lifter (Intake) | (17) Cylinder head |
| (6) Valve spring (Inner) | (12) Exhaust valve guide | |

Fig. 5: Exploded View Of Cylinder Head And Valve Assembly
 Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK



ME-02381

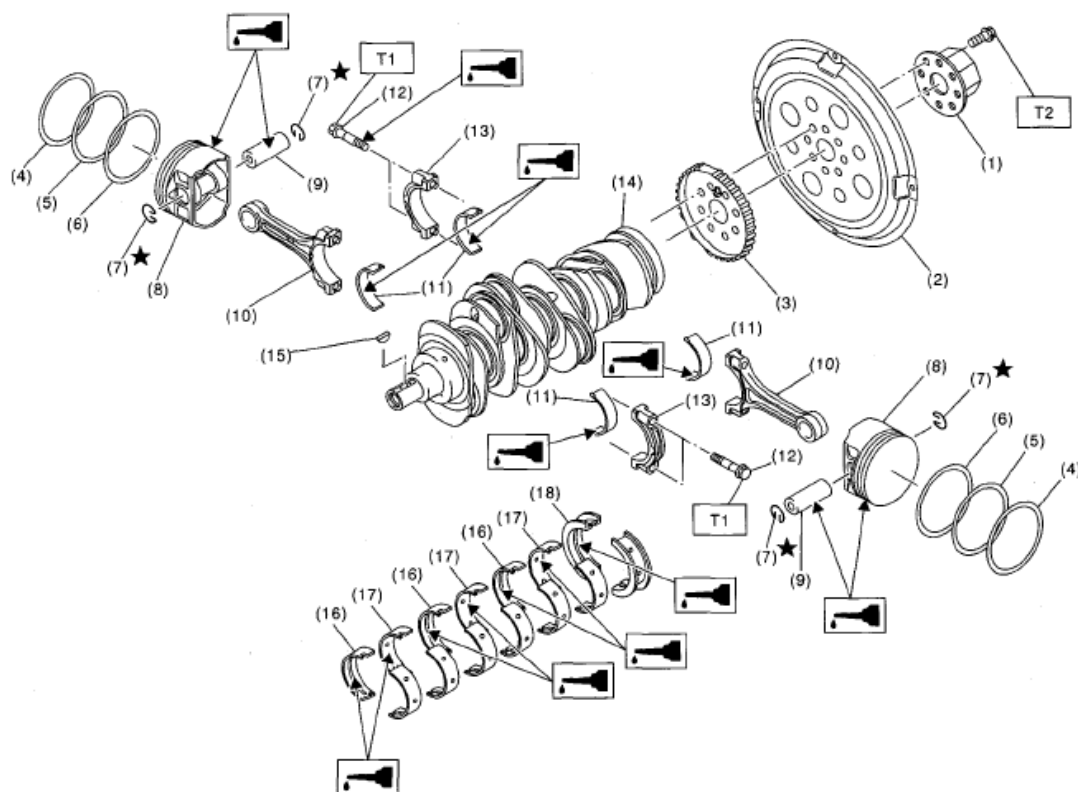
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| (1) Cylinder block (RH) | (13) Clamp |
| (2) Cylinder block (LH) | (14) Hose |
| (3) Rear oil seal | (15) Oil cooler pipe |
| (4) Service hole cover | (16) Oil cooler |
| (5) O-ring | (17) Connector |
| (6) Oil pan upper | (18) Oil filter |
| (7) Oil pressure switch | (19) Plug |
| (8) Oil strainer | (20) Crankshaft position sensor holder |
| (9) Magnet | (21) Relief valve |
| (10) Oil pan lower | (22) Relief valve spring |
| (11) Metal gasket | (23) Plug |
| (12) Drain plug | |

Tightening torque: N·m (kgf-m, ft-lb)

- | | |
|-------------|------------------------|
| T1: | 6.4 (0.65, 4.7) |
| T2: | 18 (1.8, 13.3) |
| T3: | 25 (2.5, 18) |
| T4: | 16 (1.6, 12) |
| T5: | 37 (3.8, 27) |
| T6: | 44 (4.5, 33) |
| T7: | 54 (5.5, 40) |
| T8: | 70 (7.1, 52) |
| T9: | 23 (2.3, 17) |
| T10: | 90 (9.2, 67) |

Fig. 6: Exploded View Of Cylinder Block Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

CRANKSHAFT AND PISTON



ME-02454

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

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

T1: 53 (5.4, 39)

T2: 81 (8.3, 60)

Fig. 7: Exploded View Of Crankshaft And Piston Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

ENGINE MOUNTING

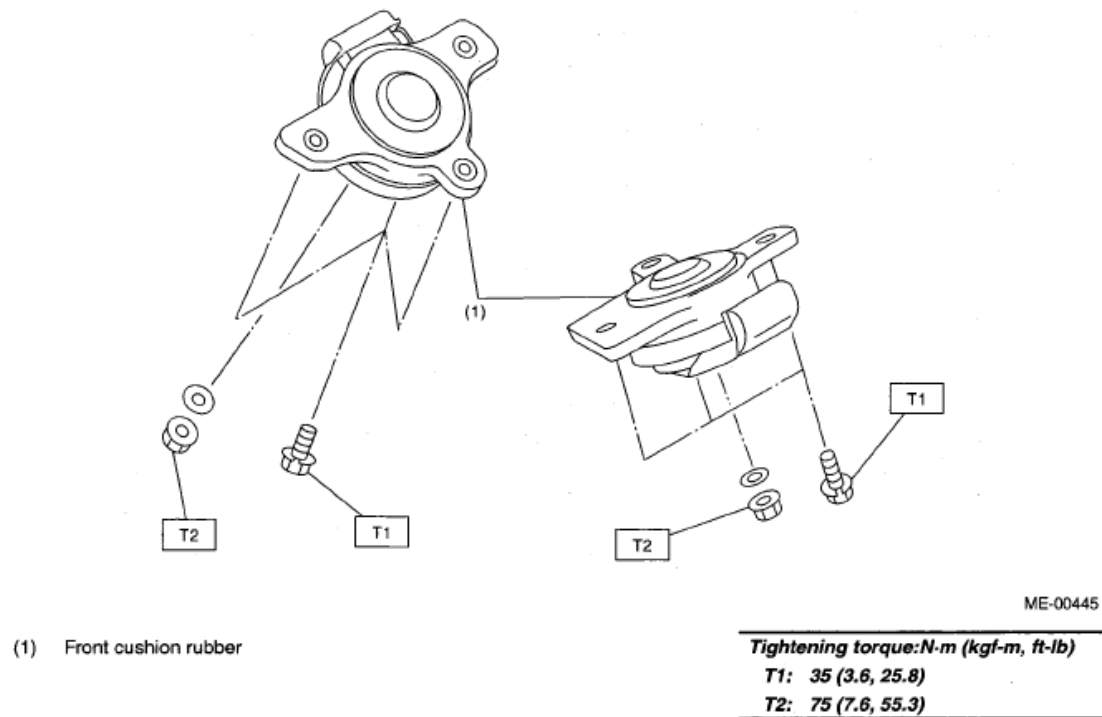


Fig. 8: Identifying Engine Mounting With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

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.
- 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.

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- 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:

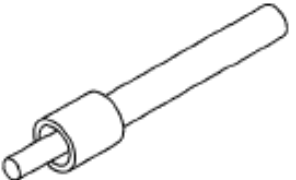
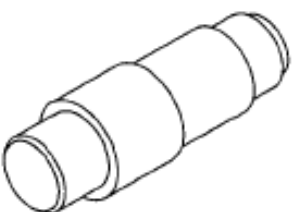
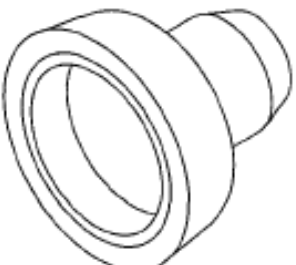
Service tools, clean cloth, containers to catch coolant and oil, wire ropes, chain hoist, transmission jacks, etc.

- Lift-up or lower the vehicle when necessary. Make sure to support the correct positions.

PREPARATION TOOL

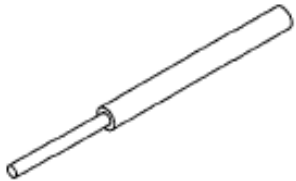
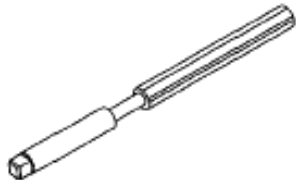
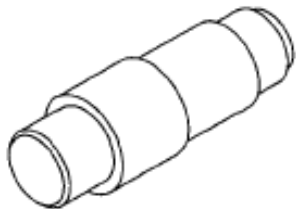
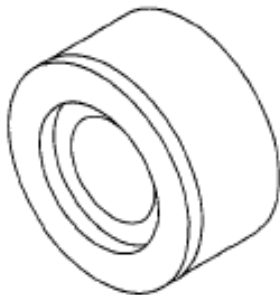
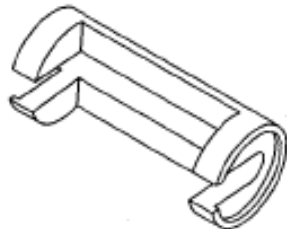
SPECIAL TOOL

SPECIAL TOOL REFERENCE

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499585500	18250AA010	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST18350AA000	18232AA000	ENGINE STAND	Used for disassembling and assembling engine.
 ST-499587200	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of flywheel or drive plate when loosening / tightening crank pulley bolt.

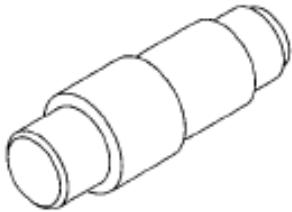
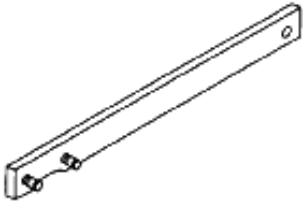
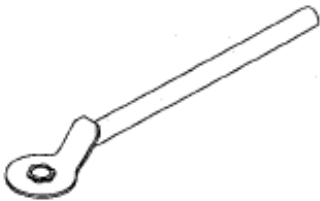
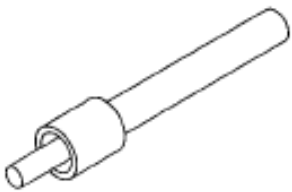
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 ST-499765700	18254AA000	PISTON GUIDE	Used for installing piston in cylinder.
 ST-499765900	499585500	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST18350AA000	18253AA000	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST18251AA040	18350AA000	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499718000	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.

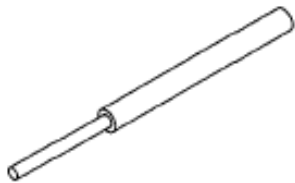
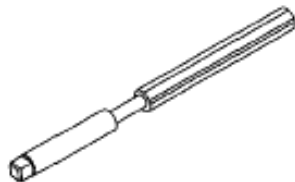
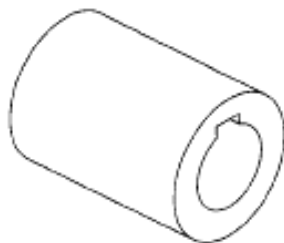
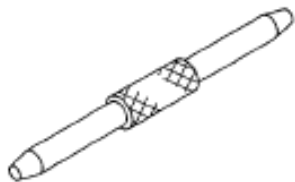
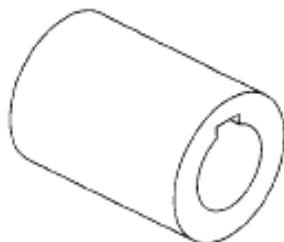
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 ST-499037100	499977500	CAM SPROCKET WRENCH	Used for removing and installing intake cam sprocket.
 ST18231AA020	18231AA020	CAM SPROCKET WRENCH	Used for removing and installing exhaust cam sprocket.
 ST-499597100	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499977500	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-498857100	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.

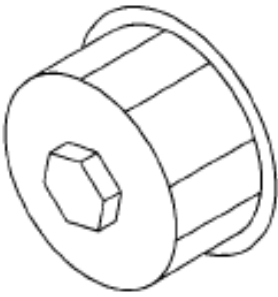
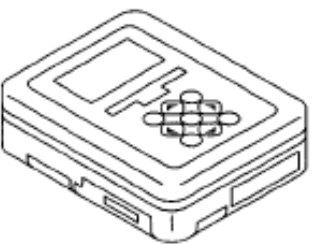
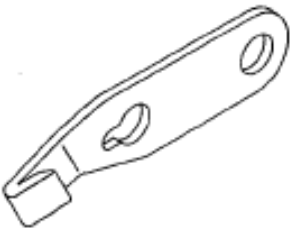
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 ST-499765700	18251AA040	VALVE GUIDE ADJUSTER	Used for installing valve guides.
 ST-499765900	499765700	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST18252AA000	499765900	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499017100	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when loosening/tightening crank pulley bolt.
 ST18252AA000	18252AA000	CRANKSHAFT SOCKET	Used for rotating crankshaft.

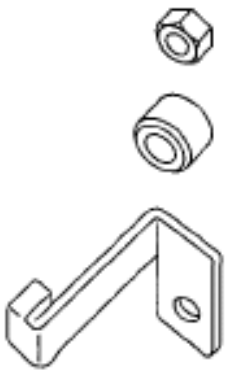
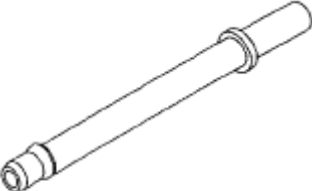
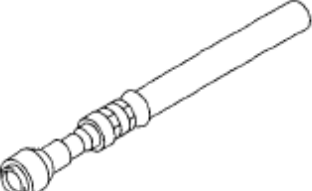
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 ST-498547000	498547000	OIL FILTER WRENCH	Used for removing and installing oil filter.
 ST1B020XU0	1B020XU0	SUBARU SELECT MONITOR KIT	Used for troubleshooting the electrical system.
 ST18233AA000	18233AA000	PISTON PIN SNAP RING PLIERS	Used for removing and installing snap ring of piston pin.
 ST-498497100	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
	42099AE000	CONNECTOR REMOVER	Used for disconnecting quick connector of the engine compartment.

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 ST-498277200			
 ST18471AA000	18471AA000	FUEL PIPE ADAPTER	Used for measuring fuel pressure.
 ST42075AG690	42075AG690	FUEL HOSE	• Used for measuring fuel pressure. • This is a genuine Subaru part.

GENERAL TOOL**GENERAL TOOL REFERENCE**

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

PROCEDURE

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

- V-belt

- Timing chain
- 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 the spark plugs. <Ref. to **REMOVAL** , Spark Plug .>
5. Check the starter motor for satisfactory performance and operation.
6. Hold the compression gauge tightly against the spark plug hole.

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

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

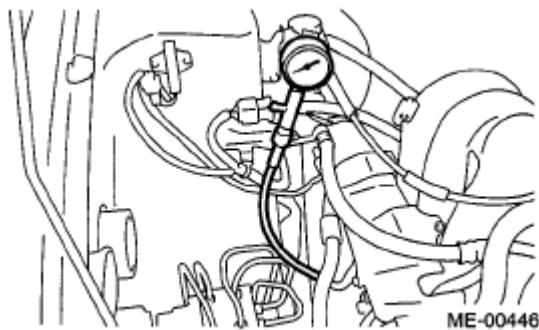


Fig. 9: Identifying Starter Motor For Satisfactory Performance And Operation
Courtesy of SUBARU OF AMERICA, INC.

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

Compression (350 rpm and fully open throttle):

Standard:

1,275 - 1,471 kPa (13.0 - 1.50 kgf/cm² , 185 - 213 psi)

Service limit:

1,128 kPa (11.5 kgf/cm² , 164 psi)

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

Idle speed [No load and gears in neutral]:

650±50 rpm

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

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

770±50 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 General Diagnosis Table under "Engine Control System". <Ref. to BASIC DIAGNOSTIC PROCEDURE . >

IGNITION TIMING

INSPECTION

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

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. Idle the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Connect the Subaru Select Monitor to the data link connector.
5. Turn the ignition switch to ON and run the Subaru Select Monitor.
6. Select {Each System Check} in Main Menu.
7. Select {Engine Control System} in Selection Menu.
8. Select {Current Data Display & Save} in Engine Control System Diagnosis.
9. Select {Data Display} in Data Display Menu.
10. Start the engine and check the ignition timing at idle speed.

Ignition timing [BTDC/rpm]:

15°±8°/650

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

INTAKE MANIFOLD VACUUM**INSPECTION**

1. Idle the engine.
2. Disconnect the brake vacuum hose from the intake manifold, and install the vacuum gauge.
3. Keep the engine at idle speed and read the vacuum gauge indication. By observing the vacuum gauge needle movement, internal condition of the engine can be diagnosed as described below.

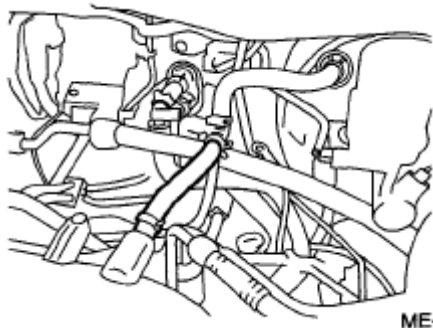


Fig. 10: Identifying Intake Manifold Vacuum
Courtesy of SUBARU OF AMERICA, INC.

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

-60.0 kPa (-450 mmHg, -17.72 inHg) or less

VACUUM PRESSURE SPECIFICATION

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

ENGINE OIL PRESSURE

INSPECTION

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

OIL PRESSURE (at oil temperature of 80°C (176°F)):

Standard:

135 kPa (1.4 kgf/cm² , 20 psi) or more (at 600 rpm)

500 kPa (5.1 kgf/cm² , 73 psi) or more (at 5,000 rpm)

- If the oil pressure is out of specification, check oil pump, oil filter and lubrication line. <Ref. to **INSPECTION** , General Diagnostic Table .>
 - If the oil pressure warning light is ON and oil pressure is within specification, check the oil pressure switch. <Ref. to **INSPECTION** , General Diagnostic Table .>
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 ft-lb)

FUEL PRESSURE

INSPECTION

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

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

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

1. Release the fuel pressure. <Ref. to **RELEASING OF FUEL PRESSURE** , Procedure, Fuel .>
2. Disconnect the fuel delivery hose and connect fuel pressure gauge.
 1. Disconnect the fuel delivery hose using the ST1.

ST1 42099AE000 CONNECTOR REMOVER

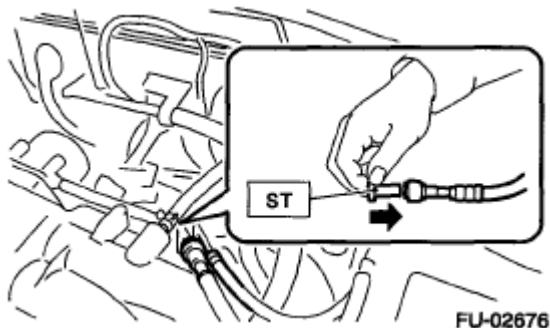


Fig. 11: Identifying Fuel Delivery Hose With ST1
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the fuel pressure meter using the ST2 and ST3.

NOTE: ST2 is a genuine Subaru part.
ST2 42075AG690 FUEL HOSE
ST3 18471AA000 FUEL PIPE ADAPTER

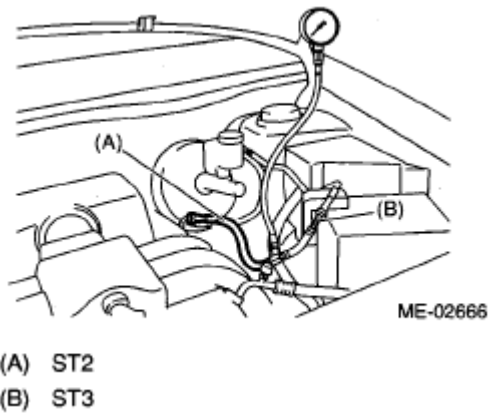


Fig. 12: Identifying Fuel Pipe Adapter And Fuel Hose
Courtesy of SUBARU OF AMERICA, INC.

3. Install the fuse of fuel pump to the main fuse box.

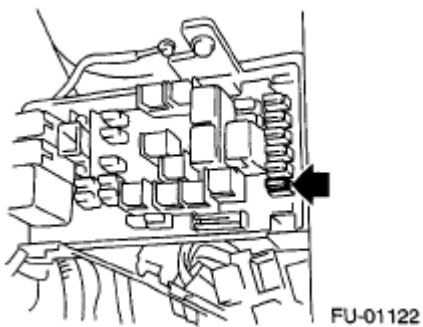


Fig. 13: Identifying Fuse Of Fuel Pump To Main Fuse Box
Courtesy of SUBARU OF AMERICA, INC.

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

Fuel pressure:

Standard: 338 - 348 kPa (3.4 - 3.5 kgf/cm² , 49 - 50.5 psi)

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

VALVE CLEARANCE

INSPECTION

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

1. Set the vehicle on a lift.
2. Remove the collector cover.
3. Disconnect the ground cable from the battery.
4. Lift-up the vehicle.
5. Remove the under cover.
6. Lower the vehicle.
7. When inspecting RH side cylinders:
 1. Remove the air intake duct and air cleaner case. <Ref. to **REMOVAL** , Air Intake Duct .> <Ref. to **REMOVAL** , Air Cleaner Case .>
 2. Remove the fuel pipe protector (RH).

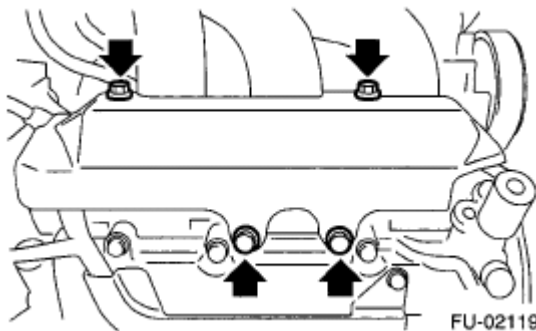


Fig. 14: Identifying Fuel Pipe Protector (RH)
Courtesy of SUBARU OF AMERICA, INC.

3. Disconnect the connector of oil pressure switch.
4. Remove the ignition coil. <Ref. to **REMOVAL** , Ignition Coil .>
5. Remove the rocker cover (RH).
8. When inspecting LH side cylinders:
 1. Disconnect the battery cable, and then remove the battery and battery carrier.
 2. Disconnect the PCV hose and blow-by hose from the rocker cover (LH).

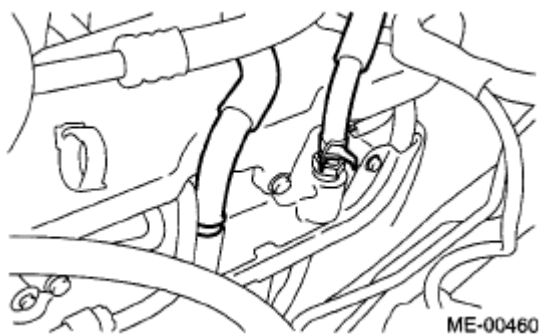


Fig. 15: Identifying PCV Hose And Rocker Cover (LH)
 Courtesy of SUBARU OF AMERICA, INC.

3. Remove the fuel pipe protector (LH).

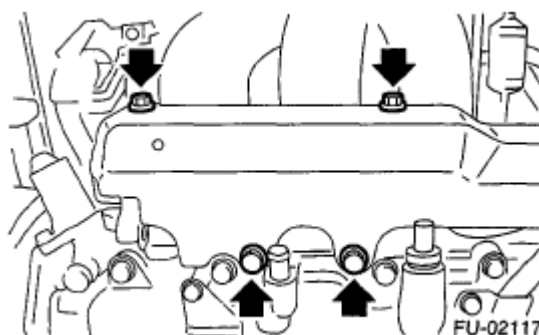
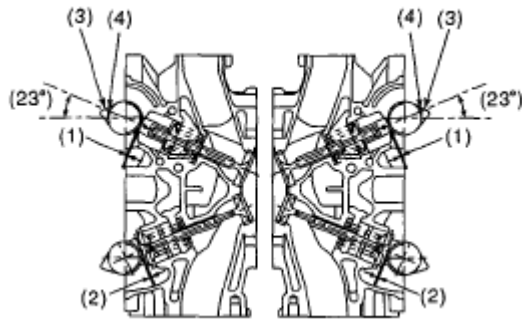


Fig. 16: Identifying Fuel Pipe Protector (LH)
 Courtesy of SUBARU OF AMERICA, INC.

4. Remove the ignition coil. <Ref. to **REMOVAL** .>
5. Remove the rocker cover (LH).
9. Turn the crankshaft clockwise until the cam is set to position shown in the figure.



ME-02565

- (1) Valve clearance (Intake side)
- (2) Valve clearance (Exhaust side)
- (3) High lift cam
- (4) Low lift cam

Fig. 17: Identifying Rocker Cover (LH)
Courtesy of SUBARU OF AMERICA, INC.

10. Measure the clearance of intake valve and exhaust valve using thickness gauge (A).

NOTE:

- Measure it within the range of $\pm 30^\circ$ from specified position shown in the figure.
- Measure it in low lift cam for intake side.
- Insert a thickness gauge in a direction as horizontal as possible with respect to the valve lifter.

Valve clearance:

Intake:

$0.20^{+0.04}_{-0.06} \text{ mm } (0.0079^{+0.0016}_{-0.0024} \text{ in})$

Exhaust:

$0.35 \pm 0.05 \text{ mm } (0.0138 \pm 0.0020 \text{ in})$

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

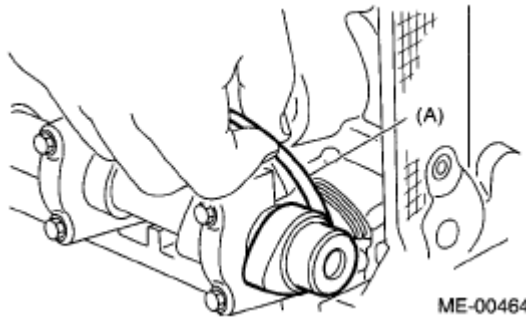


Fig. 18: Identifying Within Range Of $\pm 30^\circ$ From Specified Position
 Courtesy of SUBARU OF AMERICA, INC.

11. If necessary, adjust the valve clearance. <Ref. to ADJUSTMENT, Valve Clearance .>
12. Further turn the crank pulley clockwise and then measure the valve clearances again.
13. After inspection, install the related parts in the reverse order of removal.

ADJUSTMENT

INTAKE SIDE

NOTE:

- Adjustment of valve clearance should be performed while engine is cold.
- Do not wear gloves during removal and installation of valve lifter.
- Do not use valve lifters that were dropped or otherwise exposed to strong impacts.
- When installing the valve lifter, align the anti-rotation of valve lifter with groove on cylinder head, and insert the valve lifter.

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

NOTE: Record each valve clearance after measurement.

2. Remove the camshaft. <Ref. to REMOVAL, Camshaft .>
3. Remove the valve lifter.
4. Remove the shim from valve lifter.
5. Check the thickness of the shim from the markings on the side of the shim that was removed.
6. Select a shim of suitable thickness from the following table using the measured valve clearance and shim thickness.

THICKNESS SPECIFICATION

Unit: (mm)
$S = (V + T) - 0.20$
S: Required shim thickness
V: Measured valve clearance

T: Shim thickness to be used

THICKNESS SPECIFICATION

Part No.	Thickness mm (in)
13218AK890	1.92 (0.0756)
13218AK900	1.94 (0.0764)
13218AK910	1.96 (0.0772)
13218AK920	1.98 (0.0780)
13218AK930	2.00 (0.0787)
13218AK940	2.02 (0.0795)
13218AK950	2.04 (0.0803)
13218AK960	2.06 (0.0811)
13218AK970	2.07 (0.0815)
13218AK980	2.08 (0.0819)
13218AK990	2.09 (0.0823)
13218AL000	2.10 (0.0827)
13218AL010	2.11 (0.0831)
13218AL020	2.12 (0.0835)
13218AL030	2.13 (0.0839)
13218AL040	2.14 (0.0843)
13218AL050	2.15 (0.0846)
13218AL060	2.16 (0.0850)
13218AL070	2.17 (0.0854)
13218AL080	2.18 (0.0858)
13218AL090	2.19 (0.0862)
13218AL100	2.20 (0.0866)
13218AL110	2.21 (0.0870)
13218AL120	2.22 (0.0874)
13218AL130	2.23 (0.0878)
13218AL140	2.24 (0.0882)
13218AL150	2.25 (0.0886)
13218AL160	2.26 (0.0890)
13218AL170	2.27 (0.0894)
13218AL180	2.28 (0.0898)
13218AL190	2.29 (0.0902)
13218AL200	2.30 (0.0906)
13218AL210	2.31 (0.0909)
13218AL220	2.32 (0.0913)
13218AL230	2.33 (0.0917)
13218AL240	2.34 (0.0921)
13218AL250	2.35 (0.0925)

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13218AL260	2.36 (0.0929)
13218AL270	2.37 (0.0933)
13218AL280	2.38 (0.0937)
13218AL290	2.39 (0.0941)
13218AL300	2.40 (0.0945)
13218AL310	2.41 (0.0949)
13218AL320	2.42 (0.0953)
13218AL330	2.43 (0.0957)
13218AL340	2.44 (0.0961)
13218AL350	2.45 (0.0965)
13218AL360	2.46 (0.0969)
13218AL370	2.47 (0.0972)
13218AL380	2.48 (0.0976)
13218AL390	2.49 (0.0980)
13218AL400	2.50 (0.0984)
13218AL410	2.51 (0.0988)
13218AL420	2.52 (0.0992)
13218AL430	2.53 (0.0996)
13218AL440	2.54 (0.1000)
13218AL450	2.55 (0.1004)
13218AL460	2.56 (0.1008)
13218AL470	2.57 (0.1012)
13218AL480	2.58 (0.1016)
13218AL490	2.59 (0.1020)
13218AL500	2.60 (0.1024)
13218AL510	2.61 (0.1028)
13218AL520	2.62 (0.1032)
13218AL530	2.64 (0.1039)
13218AL540	2.66 (0.1047)
13218AL550	2.68 (0.1055)
13218AL560	2.70 (0.1063)
13218AL570	2.72 (0.1071)
13218AL580	2.74 (0.1079)
13218AL590	2.76 (0.1087)

EXHAUST SIDE

NOTE:

- Adjustment of valve clearance should be performed while engine is cold.
- Do not wear gloves during removal and installation of valve lifter.
- Do not use valve lifters that were dropped or otherwise exposed to strong impacts.

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

NOTE: Record each valve clearance after measurement.

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

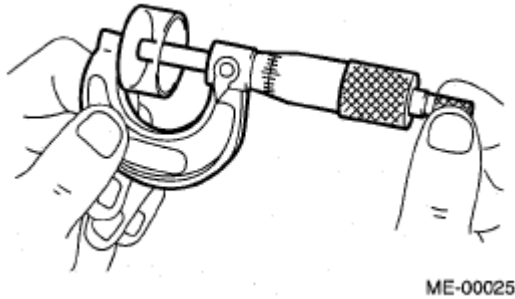


Fig. 19: Measuring Thickness Of Valve Lifter With Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

THICKNESS SPECIFICATION

Unit: (mm)
$S = (V + T) - 0.35$
S: Valve lifter thickness required
V: Measured valve clearance
T: Valve lifter thickness to be used

THICKNESS SPECIFICATION

Part No.	Thickness mm (in)
13228AD181	4.32 (0.1701)
13228AD191	4.34 (0.1709)
13228AD201	4.36 (0.1717)
13228AD211	4.38 (0.1724)
13228AD221	4.40 (0.1732)
13228AD231	4.42 (0.1740)
13228AD241	4.44 (0.1748)
13228AD251	4.46 (0.1756)
13228AD261	4.48 (0.1764)
13228AD271	4.50 (0.1772)
13228AD281	4.52 (0.1780)

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13228AD291	4.54 (0.1787)
13228AD301	4.56 (0.1795)
13228AD311	4.58 (0.1803)
13228AD321	4.60 (0.1811)
13228AC581	4.62 (0.1819)
13228AC591	4.63 (0.1823)
13228AC601	4.64 (0.1827)
13228AC611	4.65 (0.1831)
13228AC621	4.66 (0.1835)
13228AC631	4.67 (0.1839)
13228AC641	4.68 (0.1843)
13228AC651	4.69 (0.1846)
13228AC661	4.70 (0.1850)
13228AC671	4.71 (0.1854)
13228AC681	4.72 (0.1858)
13228AC691	4.73 (0.1862)
13228AC701	4.74 (0.1866)
13228AC711	4.75 (0.1870)
13228AC721	4.76 (0.1874)
13228AC731	4.77 (0.1878)
13228AC741	4.78 (0.1882)
13228AC751	4.79 (0.1886)
13228AC761	4.80 (0.1890)
13228AC771	4.81 (0.1894)
13228AC781	4.82 (0.1898)
13228AC791	4.83 (0.1902)
13228AC801	4.84 (0.1906)
13228AC811	4.85 (0.1909)
13228AC821	4.86 (0.1913)
13228AC831	4.87 (0.1917)
13228AC841	4.88 (0.1921)
13228AC851	4.89 (0.1925)
13228AC861	4.90 (0.1929)
13228AC871	4.91 (0.1933)
13228AC881	4.92 (0.1937)
13228AC891	4.93 (0.1941)
13228AC901	4.94 (0.1945)
13228AC911	4.95 (0.1949)
13228AC921	4.96 (0.1953)
13228AC931	4.97 (0.1957)
13228AC941	4.98 (0.1961)

2007 Subaru B9 Tribeca

2007 ENGINE Mechanical (H6DO) - B9 Tribeca

	4.99 (0.1965)
13228AC961	5.00 (0.1969)
13228AC971	5.01 (0.1972)
13228AC981	5.02 (0.1976)
13228AC991	5.03 (0.1980)
13228AD001	5.04 (0.1984)
13228AD011	5.05 (0.1988)
13228AD021	5.06 (0.1992)
13228AD031	5.07 (0.1996)
13228AD041	5.08 (0.2000)
13228AD051	5.09 (0.2004)
13228AD061	5.10 (0.2008)
13228AD071	5.11 (0.2012)
13228AD081	5.12 (0.2016)
13228AD091	5.13 (0.2020)
13228AD101	5.14 (0.2024)
13228AD111	5.15 (0.2028)
13228AD121	5.16 (0.2032)
13228AD131	5.17 (0.2035)
13228AD141	5.18 (0.2039)
13228AD151	5.19 (0.2043)
13228AD161	5.20 (0.2047)
13228AD171	5.21 (0.2051)
13228AD331	5.23 (0.2059)
13228AD341	5.25 (0.2067)
13228AD351	5.27 (0.2075)
13228AD361	5.29 (0.2083)
13228AD371	5.31 (0.2091)
13228AD381	5.33 (0.2098)
13228AD391	5.35 (0.2106)
13228AD401	5.37 (0.2114)
13228AD411	5.39 (0.2122)
13228AD421	5.41 (0.2130)
13228AD431	5.43 (0.2138)
13228AD441	5.45 (0.2146)
13228AD451	5.47 (0.2154)
13228AD461	5.49 (0.2161)
13228AD471	5.51 (0.2169)
13228AD481	5.53 (0.2177)
13228AD491	5.55 (0.2185)
13228AD501	5.57 (0.2193)

5.59 (0.2201)

ENGINE ASSEMBLY

REMOVAL

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

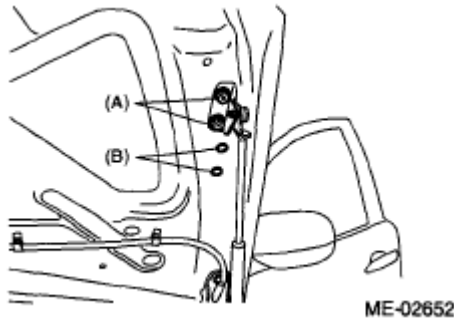


Fig. 20: Identifying Bolt Mounting Position
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the collector cover.
4. Collect the refrigerant from A/C system. <Ref. to **PROCEDURE** , Refrigerant Recovery Procedure .>
5. Release the fuel pressure. <Ref. to **RELEASING OF FUEL PRESSURE** .>
6. Remove the battery from vehicle. <Ref. to **REMOVAL** , Battery .>
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 engine front cover.

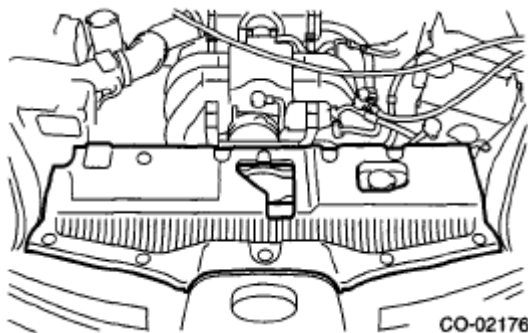


Fig. 21: Identifying Engine Front Cover
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the radiator from the vehicle. <Ref. to **REMOVAL** , Removal, Radiator .>

NOTE: Protect the condenser so that it will not be damaged.

10. Remove the fuel hose bracket.

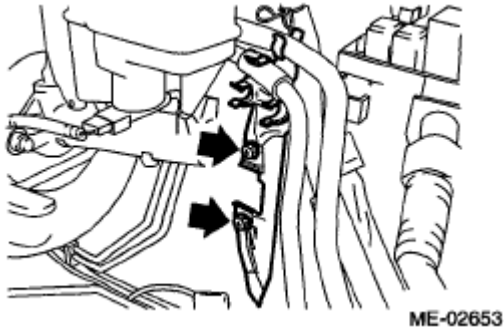


Fig. 22: Identifying Fuel Hose Bracket
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the V-belts. <Ref. to **REMOVAL**, V-belt .>
12. Disconnect the A/C pressure hoses from the A/C compressor. <Ref. to **REMOVAL** , Hose and Tube .>
13. Remove the engine ground terminal.

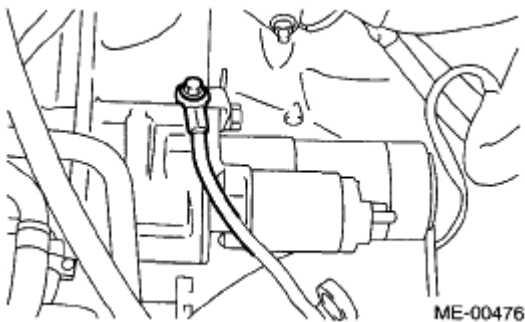


Fig. 23: Identifying Engine Grounding Terminal
Courtesy of SUBARU OF AMERICA, INC.

14. Disconnect the following connector.
 1. Engine harness connectors

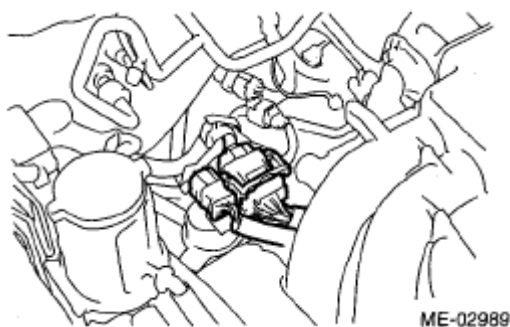


Fig. 24: Identifying Engine Harness Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Generator connector, terminal and A/C compressor connector
3. Power steering switch connector
15. Disconnect the following hoses.
 1. Brake booster vacuum hose

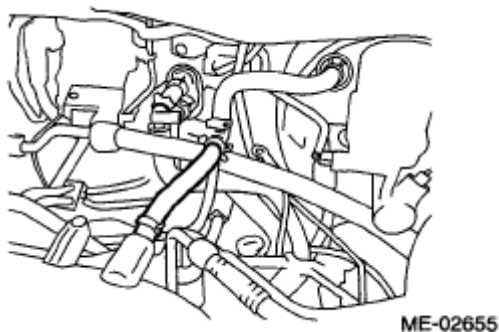


Fig. 25: Identifying Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

2. Heater inlet and outlet hoses
16. Remove the power steering pump with the bracket.

NOTE: Do not disconnect the hose and pipe from the power steering pump body.



Fig. 26: Identifying Power Steering Pump With Bracket
Courtesy of SUBARU OF AMERICA, INC.

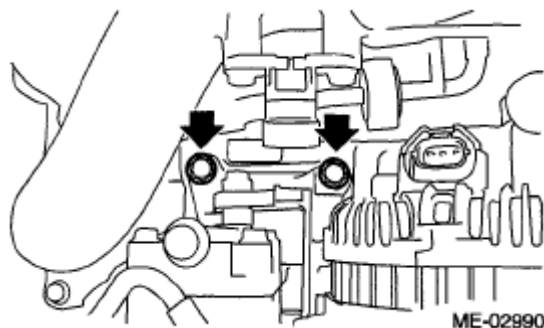


Fig. 27: Identifying Power Steering Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the reservoir tank with the bracket.

NOTE: Do not disconnect the hose from the reservoir tank body.

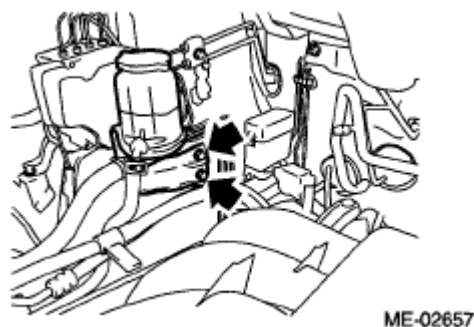


Fig. 28: Identifying Reservoir Tank With Bracket
Courtesy of SUBARU OF AMERICA, INC.

18. Suspend the power steering pump using wire, etc.



Fig. 29: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

19. Remove the bolts which hold the vacuum pump bracket to the engine and transmission.

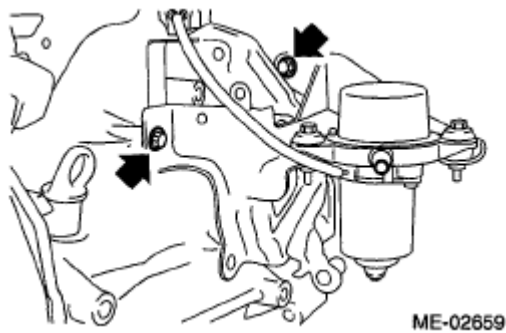


Fig. 30: Identifying Vacuum Pump Bracket, Transmission And Bolts
Courtesy of SUBARU OF AMERICA, INC.

20. Lift-up the vehicle.
21. Remove the front exhaust pipe. <Ref. to **REMOVAL** , Front Exhaust Pipe .>

NOTE: Be careful not to let the front exhaust pipe interfere with water pipes on engine side.

22. Remove the ground cable.

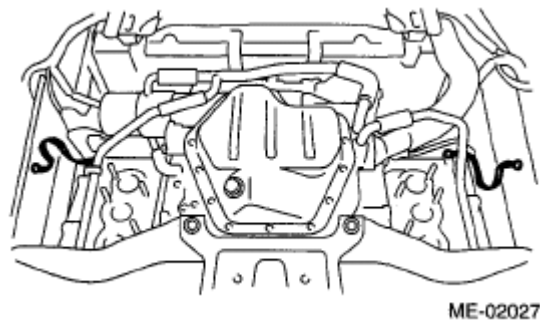


Fig. 31: Identifying Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

23. Remove the bolts which hold the vacuum pump bracket to the engine and transmission, then remove the vacuum pump with the bracket.

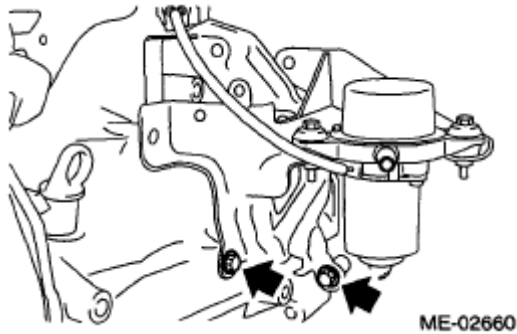


Fig. 32: Identifying Vacuum Pump With Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

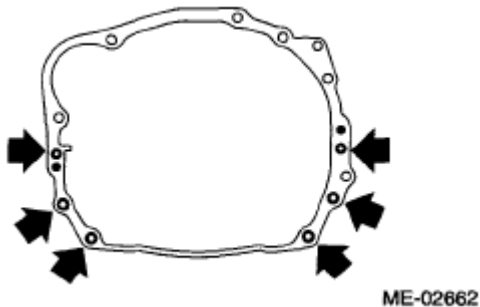


Fig. 33: Identifying Transmission Gasket Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

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

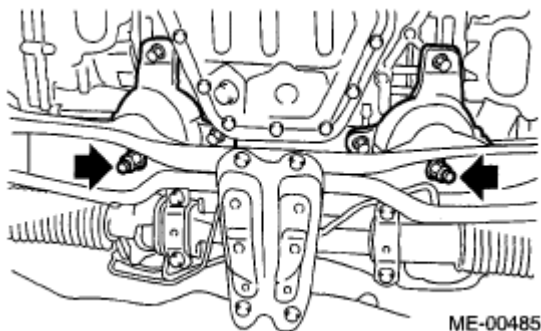
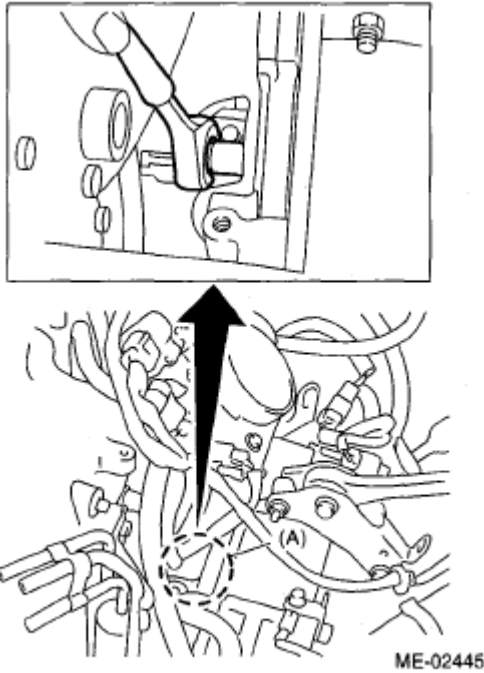


Fig. 34: Identifying Crossmember Nuts
Courtesy of SUBARU OF AMERICA, INC.

26. Lower the vehicle.
27. Separate the torque converter clutch from drive plate.
1. Remove the service hole plug.
 2. Remove the bolts which hold torque converter clutch to drive plate.

3. Remove other bolts while rotating the crankshaft using socket wrench.



(A) Service hole plug

Fig. 35: Identifying Bolts With Torque Converter Clutch To Drive Plate
Courtesy of SUBARU OF AMERICA, INC.

28. Remove the pitching stopper.

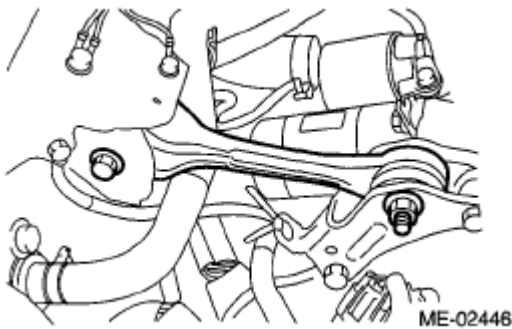


Fig. 36: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

29. Disconnect the fuel delivery hose and evaporation hose.
 1. Disconnect the connector of fuel pipe by pushing the ST in the direction of arrow.

ST 42099AE000 CONNECTOR REMOVER

2. Remove the clamp, 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.

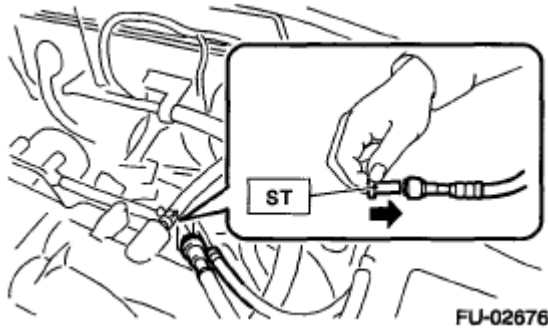
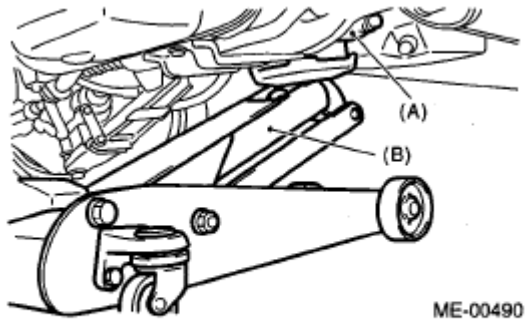


Fig. 37: Identifying Fuel Delivery Hose With ST1
Courtesy of SUBARU OF AMERICA, INC.

30. Support the engine with a lifting device and wire ropes.
31. Support the transmission with a garage jack.

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



- (A) Transmission
(B) Garage jack

Fig. 38: Identifying Transmission And Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

32. Separation of engine and transmission:

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

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

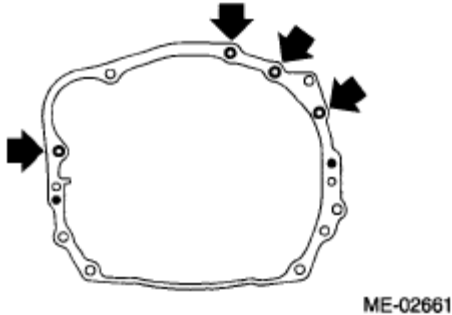


Fig. 39: Identifying Transmission Gasket
Courtesy of SUBARU OF AMERICA, INC.

33. Attach the ST to converter case.

ST 498277200 STOPPER SET

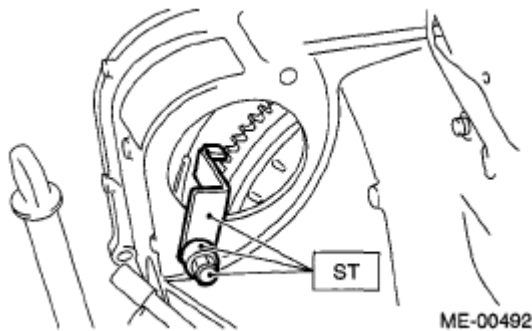


Fig. 40: Identifying ST To Converter Case
Courtesy of SUBARU OF AMERICA, INC.

34. 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.

35. Remove the front cushion rubbers.

INSTALLATION

1. Install the front cushion rubbers.

Tightening torque:

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

2. 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.

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

Tightening torque:

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

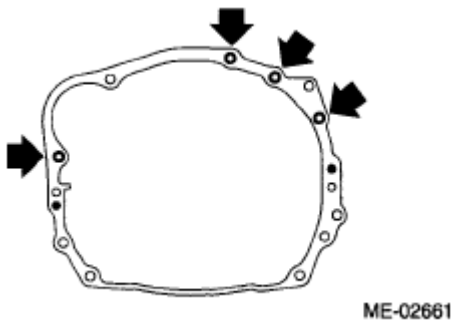


Fig. 41: Identifying Transmission Gasket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

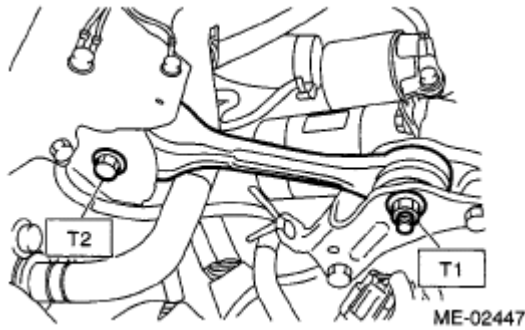


Fig. 42: Identifying Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the ST from converter case.

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

ST 498277200 STOPPER SET

8. Install the starter. <Ref. to **INSTALLATION** , Starter .>
9. Install the torque converter clutch to drive plate.
 1. Tighten the bolts which hold torque converter clutch to drive plate.
 2. Tighten other bolts while rotating the crankshaft using socket wrench.

Tightening torque:

25 N.m (2.5 kgf-m, 18 ft-lb)

3. Install the service hole plug to prevent foreign matter from being mixed.

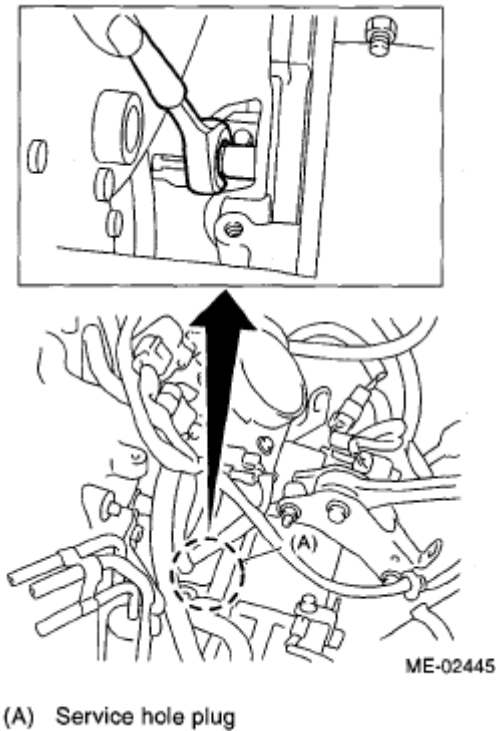


Fig. 43: Identifying Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

10. Lift-up the vehicle.
11. Tighten the bolts and nuts which hold lower side of the transmission to engine.

Tightening torque:

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

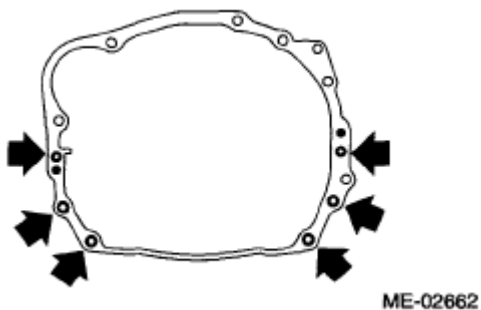


Fig. 44: Identifying Transmission Gasket Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

12. Fasten the vacuum pump bracket to the engine and transmission using the bolts.

Tightening torque:

25 N.m (2.5 kgf-m, 18 ft-lb)

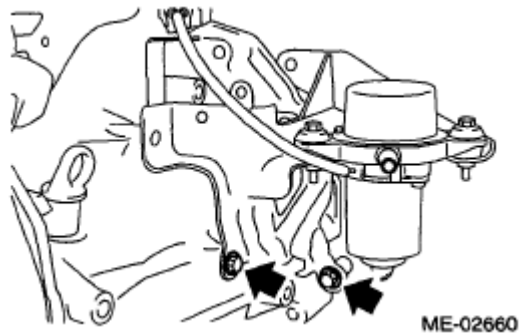


Fig. 45: Identifying Transmission Bolts
Courtesy of SUBARU OF AMERICA, INC.

13. 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.

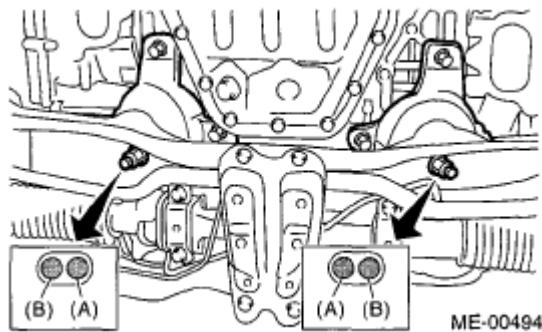


Fig. 46: Identifying Cushion Rubber Mounting Bolts And Locator
Courtesy of SUBARU OF AMERICA, INC.

14. Install the front exhaust pipe. <Ref. to INSTALLATION , Front Exhaust Pipe .>

NOTE:

- Be care not to let the front exhaust pipe interfere with water pipes and crossmember on engine side.
- Be care not to scratch the flange surface of front exhaust pipe with stud bolt on engine.

15. Connect the ground cable.

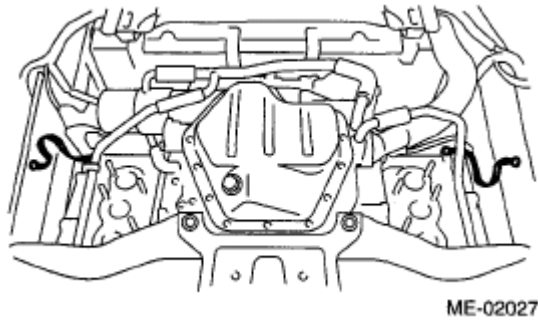


Fig. 47: Identifying Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

16. Lower the vehicle.
17. Install the fuel hose bracket.

Tightening torque:

7.5 N.m (0.76 kgf-m, 5.53 ft-lb)

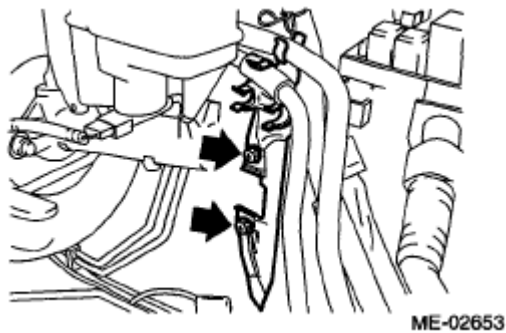


Fig. 48: Identifying Fuel Hose Bracket
Courtesy of SUBARU OF AMERICA, INC.

18. Fasten the vacuum pump bracket to the engine and transmission using the bolts.

Tightening torque:

25 N.m (2.5 kgf-m, 18 ft-lb)

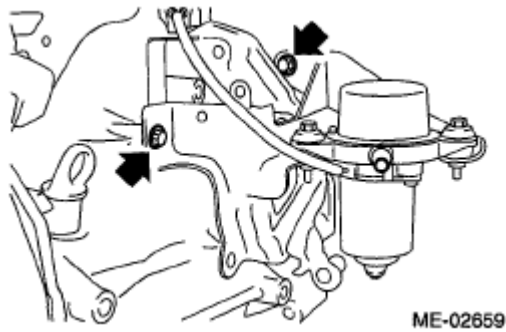


Fig. 49: Identifying Vacuum Pump Bracket, Transmission And Bolts
Courtesy of SUBARU OF AMERICA, INC.

19. Install the power steering pump.

Tightening torque:

(A) 25 N.m (2.5 kgf-m, 18 ft-lb)

(B) 33 N.m (3.4 kgf-m, 24.3 ft-lb)

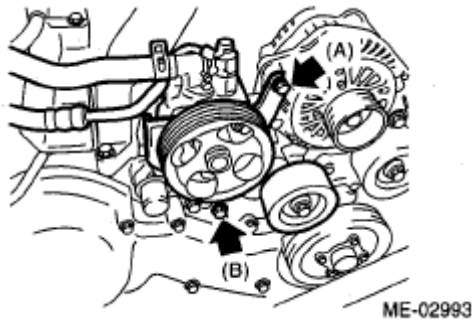


Fig. 50: Identifying Power Steering Pump
Courtesy of SUBARU OF AMERICA, INC.

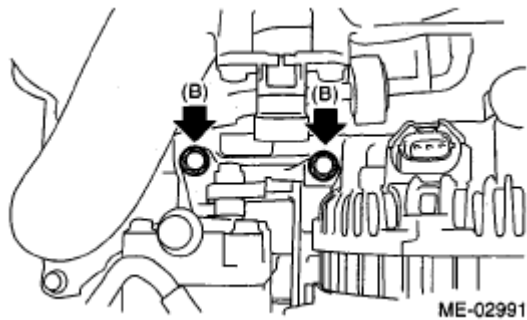


Fig. 51: Identifying Power Steering Pump Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

20. Install the reservoir tank.

Tightening torque:

33 N.m (3.4 kgf-m, 24.3 ft-lb)

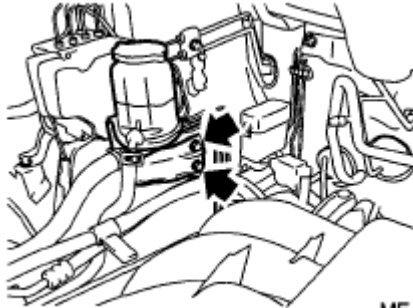


Fig. 52: Identifying Reservoir Tank With Bracket
Courtesy of SUBARU OF AMERICA, INC.

21. Connect the following hoses.
 1. Fuel delivery hose and evaporation hose
 2. Heater inlet and outlet hoses
 3. Brake booster vacuum hose
22. Connect the following connectors.
 1. Engine harness connectors

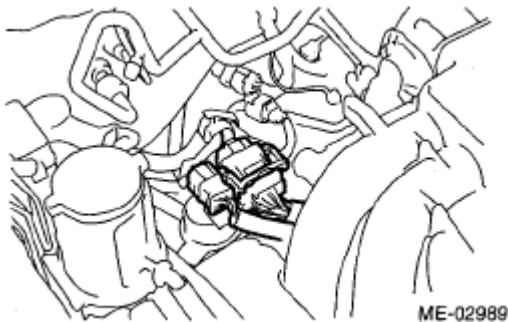


Fig. 53: Identifying Engine Harness Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Generator connector and terminal
 3. A/C compressor connector
 4. Power steering switch connector
23. Connect the engine ground terminal.

Tightening torque:

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

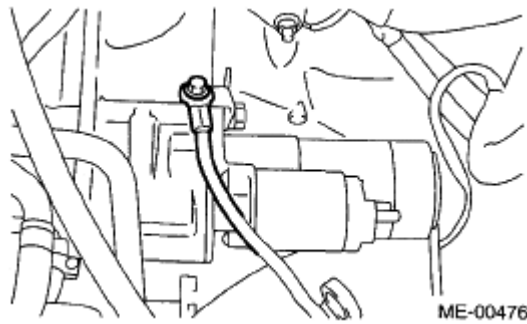


Fig. 54: Identifying Engine Grounding Terminal
Courtesy of SUBARU OF AMERICA, INC.

24. Install the A/C pressure hoses. <Ref. to **INSTALLATION** , Hose and Tube .>
25. Install the V-belts. <Ref. to **INSTALLATION** , V-belt .>
26. Install the radiator to vehicle. <Ref. to **INSTALLATION** , Installation, Radiator .>
27. Install the fuse of fuel pump to the main fuse box.
28. Install the battery to vehicle. <Ref. to **INSTALLATION** , Battery .>
29. Fill engine coolant. <Ref. to **FILLING OF ENGINE COOLANT** , Replacement, Engine Coolant .>
30. Check the ATF level and replenish it if necessary. <Ref. to **INSPECTION** , Automatic Transmission Fluid .>
31. Charge the A/C system with refrigerant. <Ref. to **PROCEDURE** , Refrigerant Charging Procedure .>
32. Install the engine front cover.
33. 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 .>
34. Install the collector cover.
35. Change the bolt mounting position from (B) to (A), then close the front hood.

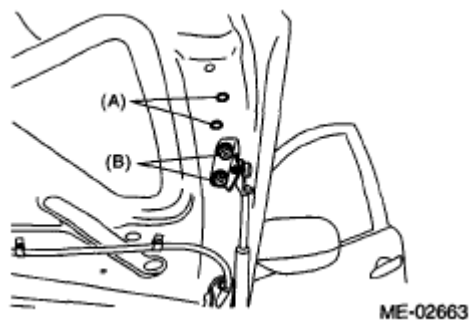


Fig. 55: Identifying Mounting Bolt Position
Courtesy of SUBARU OF AMERICA, INC.

36. Lower the vehicle from the lift.

INSPECTION

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

ENGINE MOUNTING

REMOVAL

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

INSTALLATION

Install in the reverse order of removal.

Tightening torque:

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

REMOVAL

1. Remove the engine assembly from the body. <Ref. to **REMOVAL**, Engine Assembly .>
2. Set the engine on ST.

ST 18232AA000 ENGINE STAND

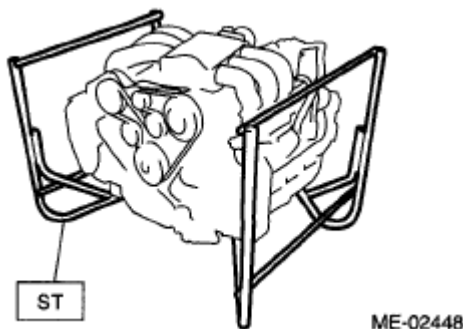


Fig. 56: Identifying Engine On ST
Courtesy of SUBARU OF AMERICA, INC.

3. Before servicing overhaul, remove the sensor, pipe and hose that installed to engine.
 1. Remove the intake manifold. <Ref. to **REMOVAL** , Intake Manifold .>
 2. Remove the generator. <Ref. to **REMOVAL** , Generator .>
 3. Remove the A/C compressor. <Ref. to **REMOVAL** , Compressor .>
 4. Disconnect the water pipe and hose.
 5. Disconnect the engine harness.
 6. Remove the spark plug. <Ref. to **REMOVAL** , Spark Plug .>
 7. Remove the camshaft position sensor. <Ref. to **REMOVAL** , Camshaft Position Sensor .>
 8. Remove the crankshaft position sensor. <Ref. to **REMOVAL** , Crankshaft Position Sensor .>
 9. Remove the knock sensor. <Ref. to **REMOVAL** , Knock Sensor .>
 10. Remove the engine coolant temperature sensor. <Ref. to **REMOVAL** , Engine Coolant Temperature Sensor .>
 11. Remove the oil pressure switch. <Ref. to **REMOVAL** , Oil Pressure Switch .>
 12. Remove the oil filter. <Ref. to **REMOVAL** , Engine Oil Filter .>
 13. Remove the oil cooler. <Ref. to **REMOVAL** , Oil Cooler .>

V-BELT

REMOVAL

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

1. Remove the collector cover.
2. Install the tool to belt tension adjuster assembly installation bolt.
3. Rotate the tool clockwise and loosen the V-belt to remove.

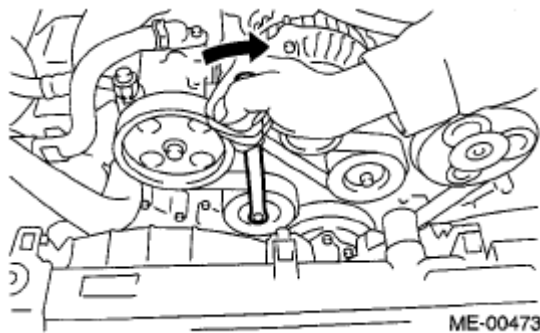
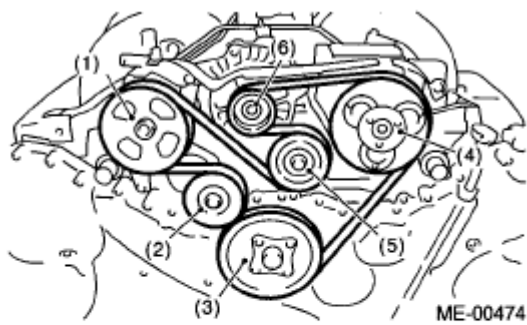


Fig. 57: Identifying Tool Clockwise And Loosen V-belt
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

Install in the reverse order of removal.

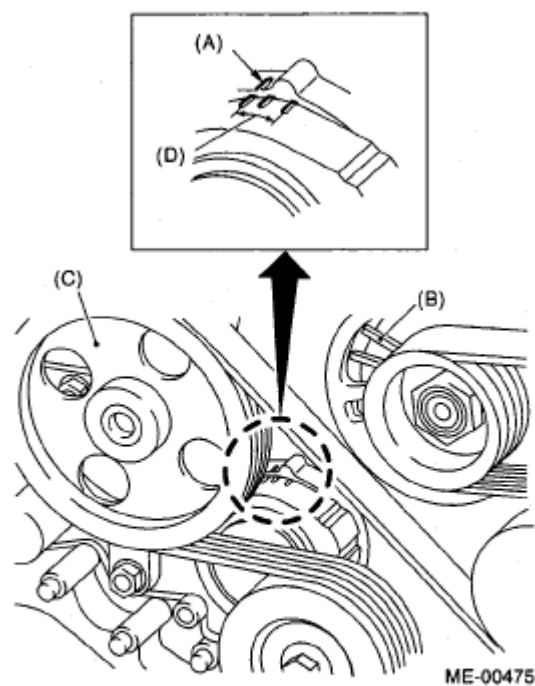


- (1) Power steering oil pump pulley
- (2) Belt tension adjuster ASSY
- (3) Crank pulley
- (4) A/C compressor
- (5) Belt idler
- (6) Generator

Fig. 58: Identifying V-Belt Part Location
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Replace the V-belt, if cracks, fraying or wear is found.
2. Make sure that the V-belt automatic belt tension indicator (A) is within the range (D).



- (A) Indicator
- (B) Generator
- (C) Power steering oil pump pulley
- (D) Service limit

Fig. 59: Identifying V-Belt Automatic Belt Tension Indicator
Courtesy of SUBARU OF AMERICA, INC.

CRANK PULLEY

REMOVAL

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

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

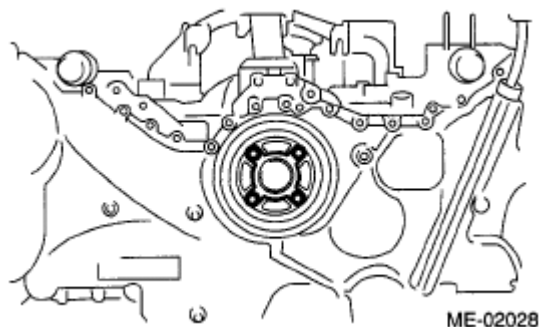


Fig. 60: Identifying Crank Pulley Cover
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499977100 CRANK PULLEY WRENCH

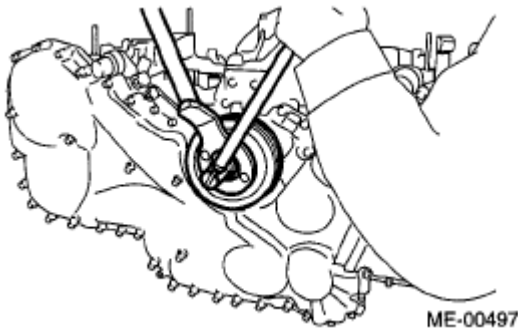


Fig. 61: Identifying Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the crank pulley.

INSTALLATION

1. Install the crank pulley.
2. Install the crank 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 crank pulley bolts.

Tightening torque:

178 N.m (18.1 kgf-m, 131 ft-lb)

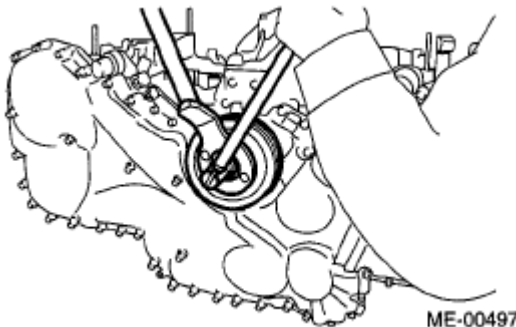


Fig. 62: Identifying Crank Pulley Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install the crank pulley cover.

NOTE: Assemble the O-ring to crank pulley cover.

Tightening torque:

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

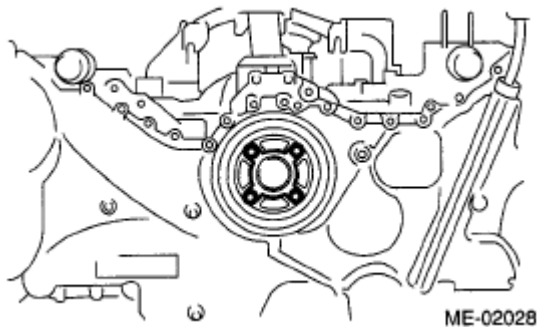


Fig. 63: Identifying Crank Pulley Cover
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

1. Check the crank pulley cover for oil and air leakage.
2. Check the crank pulley for looseness.

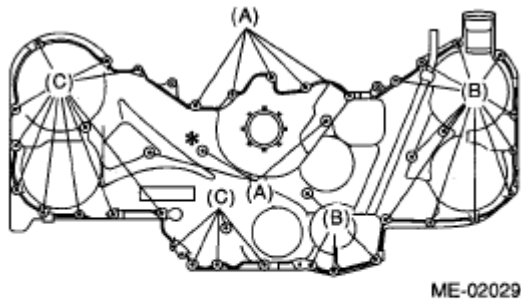
FRONT CHAIN COVER

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt .>
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley .>
3. Remove the bolts which install oil pipe (RH) onto the front chain cover.
4. Remove the front chain cover.

NOTE: Chain cover installation bolt has three different sizes. To prevent the confusion in installation, keep these bolts on container individually.



- (A) M6 × 16
- (B) M6 × 30
- (C) M6 × 45
- *: Sealing washer

Fig. 64: Identifying Front Chain Cover Bolt Location
 Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Remove the used liquid gasket from mating surface, and degrease it.
2. Apply liquid gasket to the mating surface of front chain cover.

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

Applying liquid gasket diameter:

2.5±0.5 mm (0.098±0.020 in)

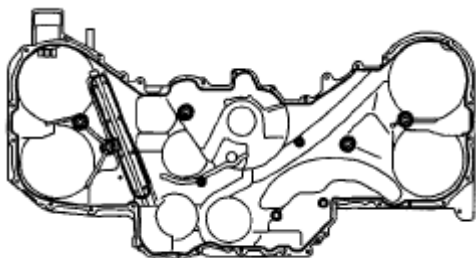
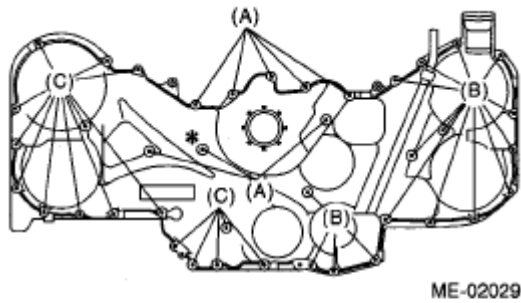


Fig. 65: Identifying Area Of Liquid Gasket To Front Chain Cover
 Courtesy of SUBARU OF AMERICA, INC.

3. Install the front chain cover. Temporarily tighten the bolts.

CAUTION: Do not install the bolts in wrong place.



- (A) M6 x 16
- (B) M6 x 30
- (C) M6 x 45
- *: Sealing washer

Fig. 66: Identifying Front Chain Cover Bolt Location
 Courtesy of SUBARU OF AMERICA, INC.

4. Tighten the bolts in the numerical order as shown in the figure.

Tightening torque:

6.6 N.m (0.67 kgf-m, 4.8 ft-lb)

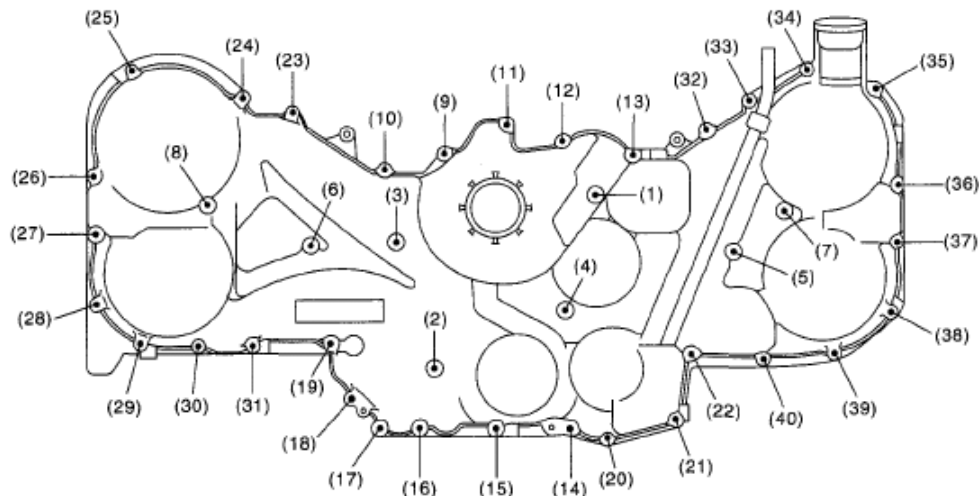


Fig. 67: Identifying Front Chain Cover Bolt Location
 Courtesy of SUBARU OF AMERICA, INC.

5. Tighten the bolts which install oil pipe (RH) onto the front chain cover.

Tightening torque:

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

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

INSPECTION

1. Check the cover surface for scratch and damage.
2. Check for oil leakage on cover mating surface and installation part of crank pulley.

TIMING CHAIN ASSEMBLY

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt .>
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley .>
3. Remove the front chain cover. <Ref. to **REMOVAL**, Front Chain Cover .>
4. Remove the chain tensioner (RH).

NOTE: Be careful not to come out the plunger (A).

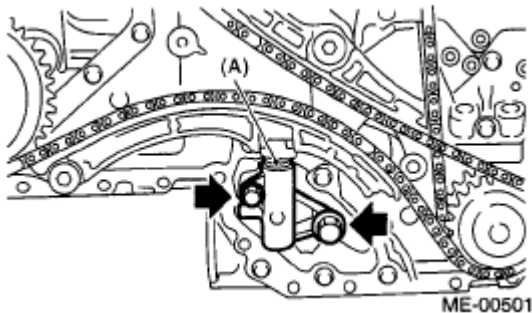
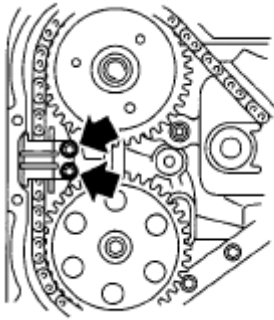


Fig. 68: Identifying Plunger Location
Courtesy of SUBARU OF AMERICA, INC.

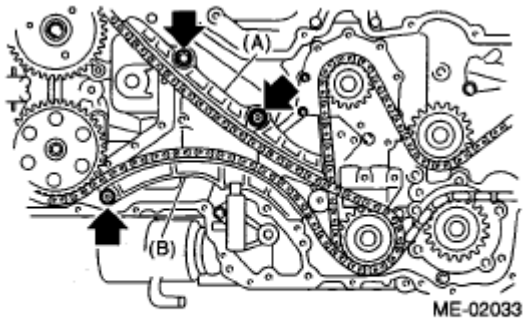
5. Remove the chain guide (RH: between cams).



ME-02032

Fig. 69: Identifying Chain Guide
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the chain guide (RH).
7. Remove the chain tensioner lever (RH).



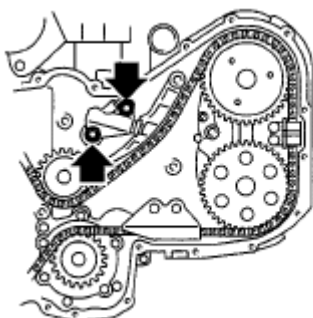
ME-02033

- (A) Chain guide (RH)
(B) Chain tensioner lever (RH)

Fig. 70: Identifying Chain Tensioner Lever (RH)
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing chain (RH).
9. Remove the chain tensioner (LH).

NOTE: Be careful not to come out the plunger.



ME-02034

Fig. 71: Identifying Timing Chain (RH) And Chain Tensioner (LH)
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the chain tensioner lever (LH).

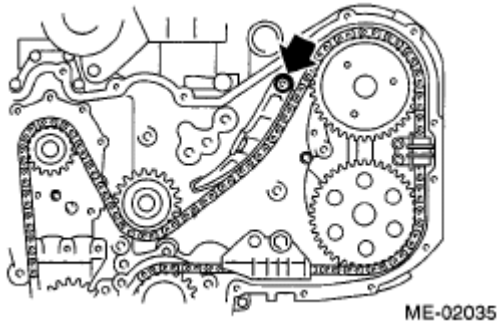


Fig. 72: Identifying Chain Tensioner Lever (LH)
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the chain guide (LH: between cams).

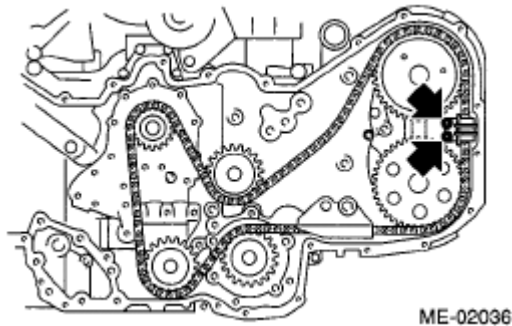


Fig. 73: Identifying Chain Guide
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the chain guide (LH).

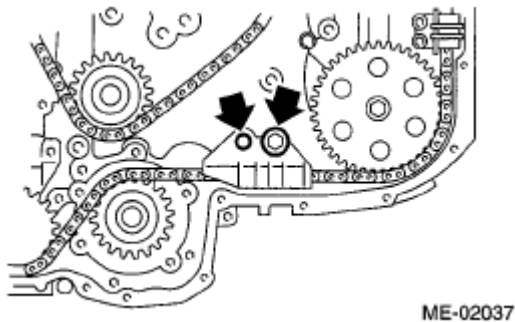


Fig. 74: Identifying Chain Guide (LH)
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the chain guide (center).

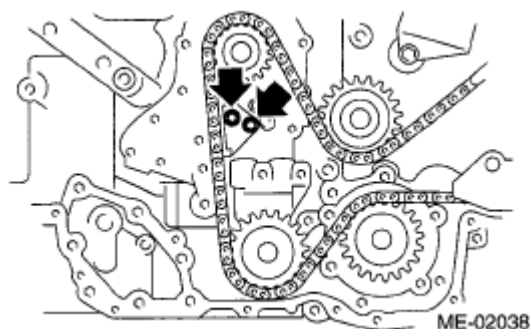


Fig. 75: Identifying Chain Guide (Center)
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the idler sprocket (upper).

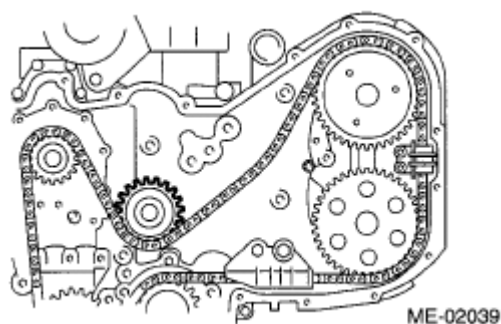


Fig. 76: Identifying Idler Sprocket (Upper)
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the timing chain (LH).
16. Remove the idler sprocket (lower).

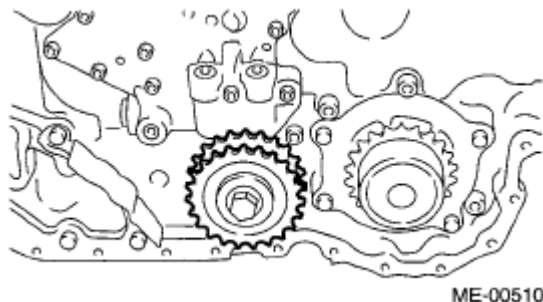


Fig. 77: Identifying Timing Chain (LH)
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

NOTE:

- Be careful that the foreign matter is not into or onto assembled component during installation.
- Apply engine oil to the chain guide, chain tensioner lever and idler sprocket when installing.

1. Preparation for chain tensioner installation

1. Insert the screw, spring pin and tension rod into tensioner body.
2. While depressing the tensioner onto rubber mat, twist it to shorten tension rod. Then insert the thin pin into the hole between tension rod and tension body to keep it.

NOTE: Work on the rubber mat or other anti-skid materials.

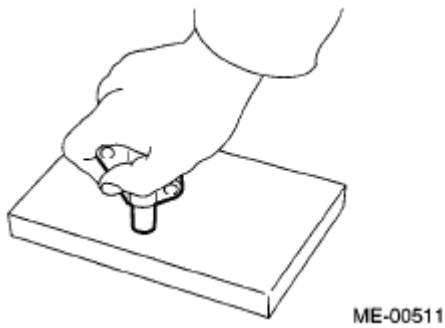


Fig. 78: Inserting Thin Pin Into Hole Between Tension Rod And Tension Body
Courtesy of SUBARU OF AMERICA, INC.

2. Using the ST, align the "Top mark" on crank sprocket to 9 o'clock position as shown in the figure

ST 18252AA000 CRANKSHAFT SOCKET

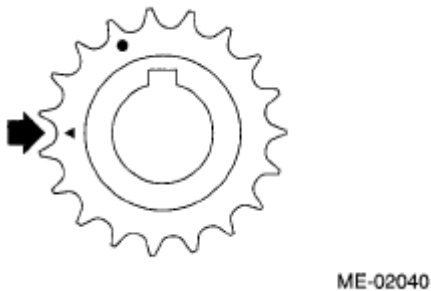
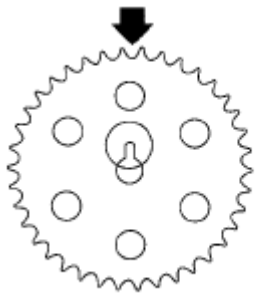


Fig. 79: Identifying "Top Mark" On Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

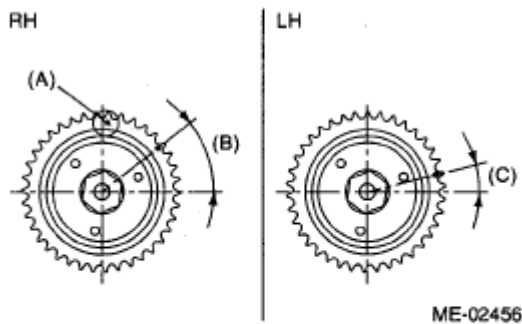
3. Align the key groove on exhaust cam sprocket to 12 o'clock position as shown in the figure.



ME-02041

Fig. 80: Identifying Exhaust Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

4. Align the intake cam sprocket as shown in the figure.



ME-02456

- (A) Top mark
- (B) 40°
- (C) 15°

Fig. 81: Identifying Intake Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

5. Turn the crank sprocket clockwise, align the "Top mark" to 12 o'clock position. (Piston #1 is in TDC position)

NOTE: Do not rotate the crank shaft and cam sprocket before completing timing chain installation.

6. Install the idler sprocket (lower).

Tightening torque:

69 N.m (7.0 kgf-m, 50.6 ft-lb)

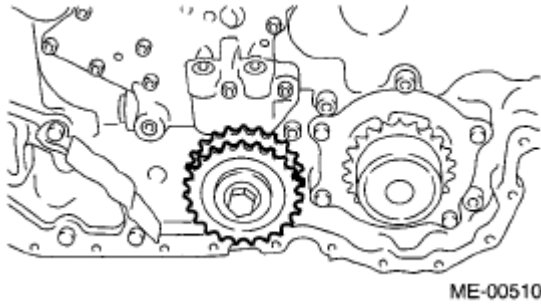


Fig. 82: Identifying Idler Sprocket (Lower)
 Courtesy of SUBARU OF AMERICA, INC.

7. Install the timing chain (LH).
 1. Align the timing mark (B) on the crank sprocket with mark (A) on the timing chain (LH).

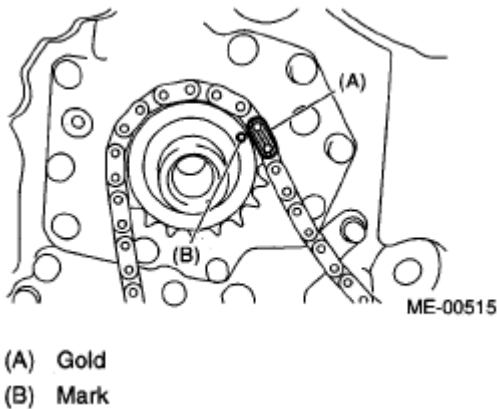


Fig. 83: Identifying Timing Mark On Crank Sprocket
 Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing chain (LH) to the idler sprocket (lower), water pump, exhaust cam sprocket (LH) and intake cam sprocket (LH) in this order.

NOTE: Check that the mark on timing chain (A) and cam sprocket (B) is aligned as same as aligned on crank sprocket.

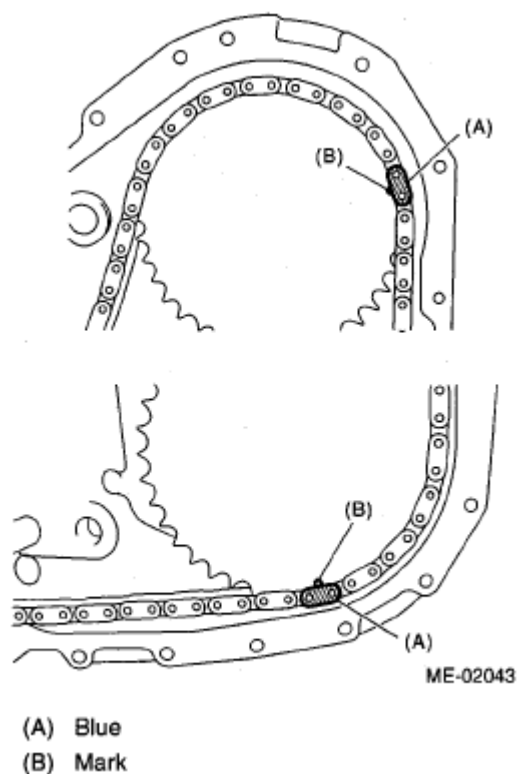


Fig. 84: Identifying Timing Chain Mark Location
Courtesy of SUBARU OF AMERICA, INC.

3. Install the chain idler (upper).

Tightening torque:

69 N.m (7.0 kgf-m, 50.6 ft-lb)

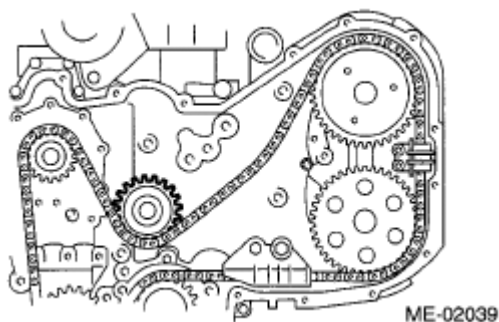


Fig. 85: Identifying Chain Idler (Upper)
Courtesy of SUBARU OF AMERICA, INC.

4. Install the chain guide (LH: between cams).

Tightening torque:

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

NOTE: Use a new installing bolt.

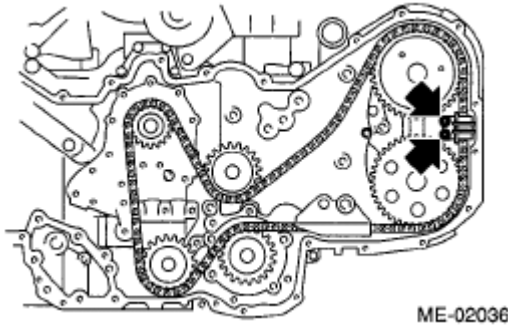


Fig. 86: Identifying Timing Chain Assembly Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Install the chain guide (LH).

Tightening torque:

16 N.m (1.6 kgf-m, 12 ft-lb)

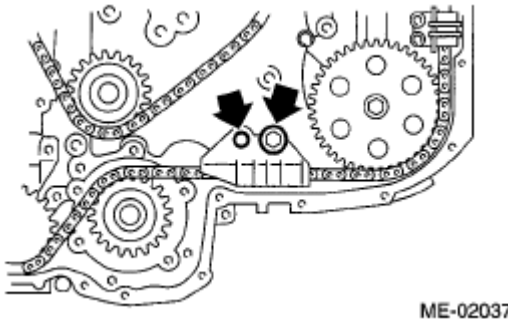


Fig. 87: Identifying Chain Guide (LH)
Courtesy of SUBARU OF AMERICA, INC.

6. Install the chain tensioner lever (LH).

Tightening torque:

16 N.m (1.6 kgf-m, 12 ft-lb)

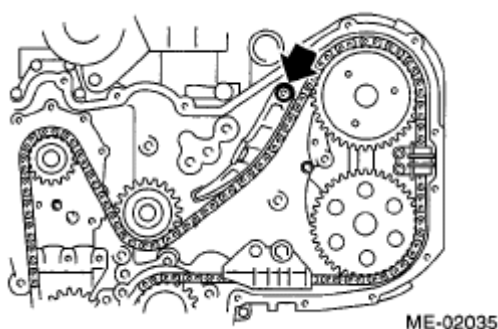


Fig. 88: Identifying Chain Tensioner Lever (LH)
 Courtesy of SUBARU OF AMERICA, INC.

7. Install the chain tensioner (LH).

Tightening torque:

16 N.m (1.6 kgf-m, 12 ft-lb)

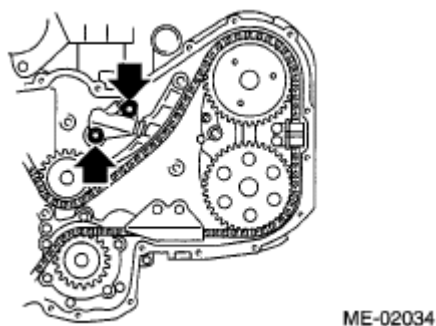
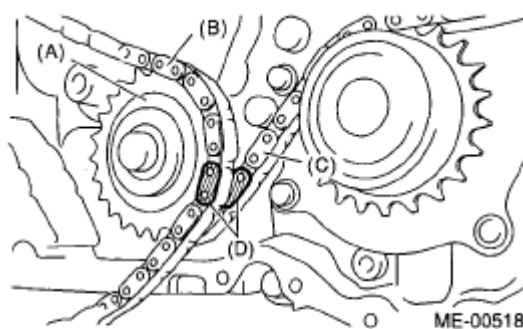


Fig. 89: Identifying Timing Chain (RH) And Chain Tensioner (LH)
 Courtesy of SUBARU OF AMERICA, INC.

8. Install the timing chain (RH).
 1. Align the marks of timing chain LH and RH on the idler sprocket (lower).

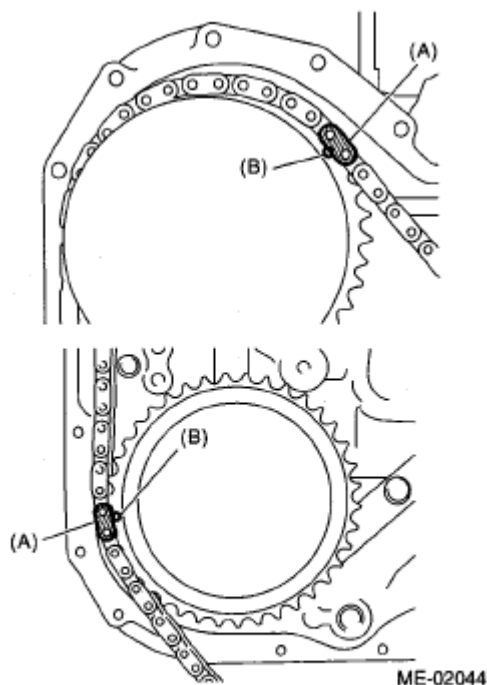


- (A) Idler sprocket (lower)
- (B) Timing chain (RH)
- (C) Timing chain (LH)
- (D) Blue

Fig. 90: Identifying Timing Chain Mark Location
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing chain (RH) to the intake cam sprocket (RH) and exhaust cam sprocket (RH) in this order.

NOTE: Check that the mark on timing chain (A) and cam sprocket (B) is aligned as same as aligned on crank sprocket.



- (A) Gold
- (B) Mark

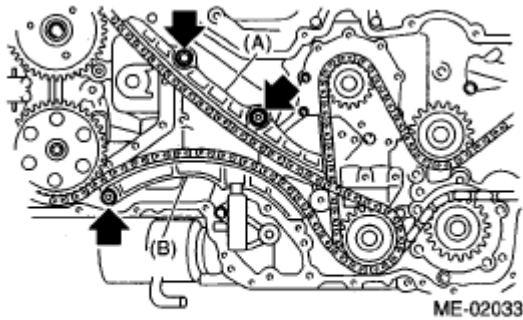
Fig. 91: Identifying Crank Sprocket Mark Location

Courtesy of SUBARU OF AMERICA, INC.

3. Install the chain guide (RH).
4. Install the chain tensioner lever (RH).

Tightening torque:

16 N.m (1.6 kgf-m, 12 ft-lb)



- (A) Chain guide (RH)
(B) Chain tensioner lever (RH)

Fig. 92: Identifying Chain Tensioner Lever (RH) And Chain Guide (RH)
Courtesy of SUBARU OF AMERICA, INC.

5. Install the chain guide (RH: between cams).

Tightening torque:

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

NOTE: Use a new installing bolt.

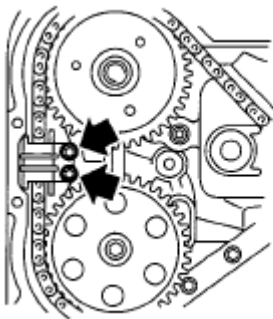


Fig. 93: Identifying Chain Guide
Courtesy of SUBARU OF AMERICA, INC.

6. Install the chain tensioner (RH).

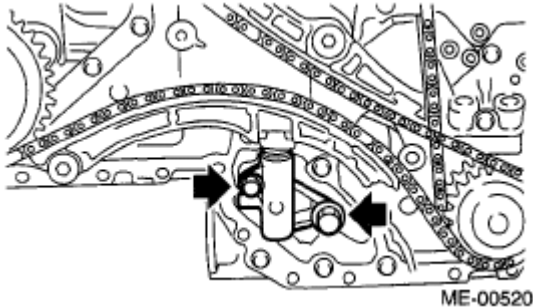
Tightening torque:***16 N.m (1.6 kgf-m, 12 ft-lb)***

Fig. 94: Identifying Chain Tensioner (RH)
 Courtesy of SUBARU OF AMERICA, INC.

7. Adjust the clearance between chain guide (RH) and chain guide (center) within 8.4 - 8.6 mm (0.331 - 0.339 in). Install the chain guide (center).

Tightening torque:***7.8 N.m (0.8 kgf-m, 5.8 ft-lb)***

NOTE: Use a new installing bolt.

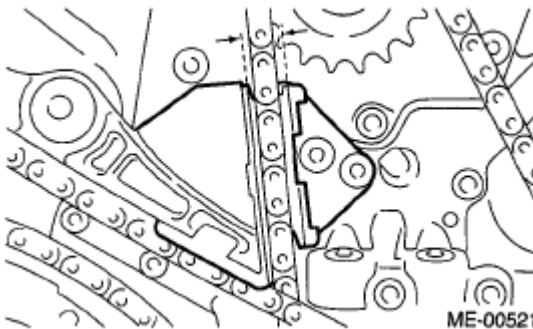


Fig. 95: Identifying Chain Guide Bolts
 Courtesy of SUBARU OF AMERICA, INC.

8. Check that each mark on the sprocket and timing chain is matched, and then draw out the stopper pin from chain tensioner.
9. Install the front chain cover. <Ref. to **INSTALLATION**, Front Chain Cover .>
10. Install the crank pulley. <Ref. to **INSTALLATION**, Crank Pulley .>
11. Install the V-belts. <Ref. to **INSTALLATION**, V-belt .>

CAM SPROCKET

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt .>
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley .>
3. Remove the front chain cover. <Ref. to **REMOVAL**, Front Chain Cover .>
4. Remove the timing chain assembly. <Ref. to **REMOVAL**, Timing Chain Assembly .>
5. Remove the cam sprocket. To lock the camshaft, use the ST.

ST 499977500 CAM SPROCKET WRENCH

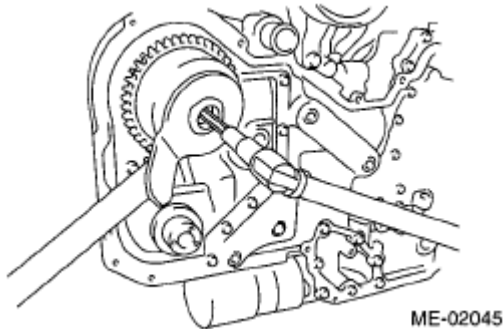


Fig. 96: Identifying Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

ST 18231AA020 CAM SPROCKET WRENCH

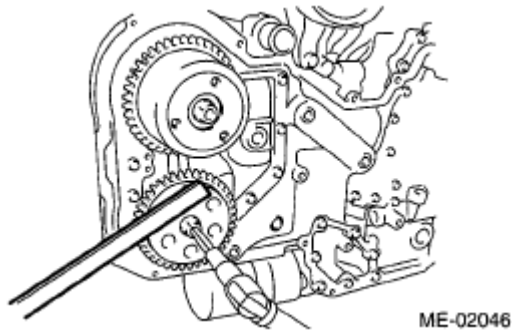


Fig. 97: Identifying Cam Sprocket Wrench (ST 18231AA020)
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the cam sprocket. To lock the camshaft, use the ST.

Tightening torque:

29.5 N.m (3.0 kgf-m, 21.8 ft-lb)

2. Further tighten the bolt.

Tightening angle:

Intake side:

$45^{\circ} \pm 5^{\circ}$

Exhaust side:

$25^{\circ} \pm 5^{\circ}$

ST 499977500 CAM SPROCKET WRENCH

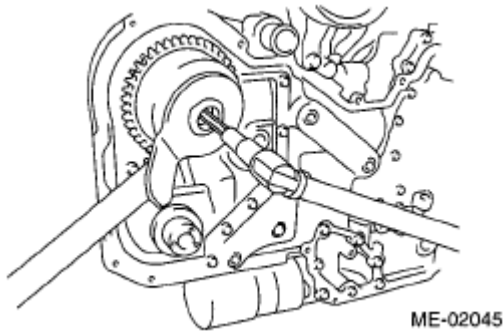


Fig. 98: Identifying Cam Sprocket
Courtesy of SUBARU OF AMERICA, INC.

ST 18231AA020 CAM SPROCKET WRENCH

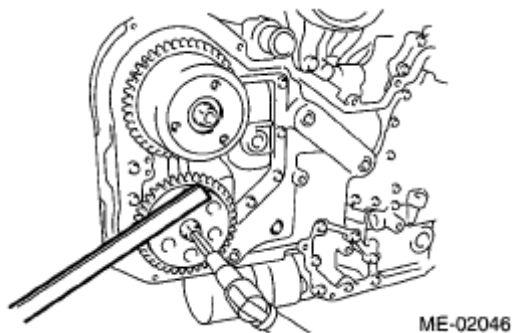


Fig. 99: Identifying Cam Sprocket Wrench
Courtesy of SUBARU OF AMERICA, INC.

3. Install the timing chain assembly. <Ref. to **INSTALLATION**, Timing Chain Assembly .>
4. Install the front chain cover. <Ref. to **INSTALLATION**, Front Chain Cover .>

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

INSPECTION

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

CRANK SPROCKET

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt .>
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley .>
3. Remove the front chain cover. <Ref. to **REMOVAL**, Front Chain Cover .>
4. Remove the timing chain assembly. <Ref. to **REMOVAL**, Timing Chain Assembly .>
5. Remove the crank sprocket (A).

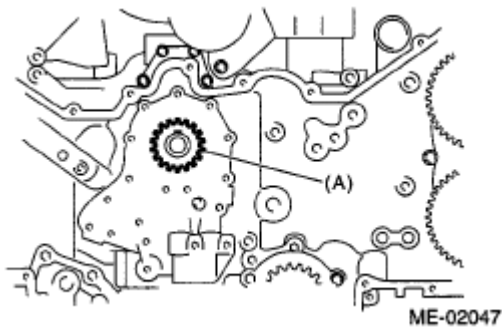


Fig. 100: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket (A).

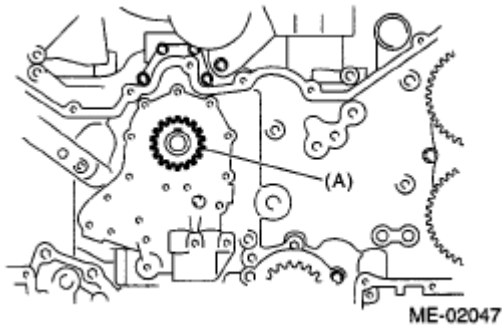


Fig. 101: Identifying Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing chain assembly. <Ref. to **INSTALLATION**, Timing Chain Assembly .>
3. Install the front chain cover. <Ref. to **INSTALLATION**, Front Chain Cover .>
4. Install the crank pulley. <Ref. to **INSTALLATION**, Crank Pulley .>
5. Install the V-belts. <Ref. to **INSTALLATION**, V-belt .>

INSPECTION

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

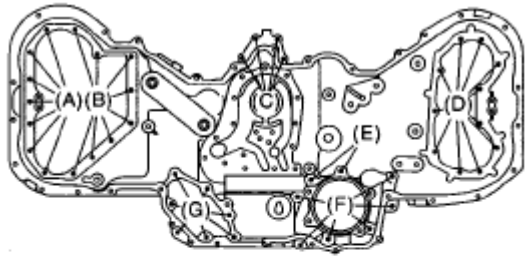
REAR CHAIN COVER

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt .>
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley .>
3. Remove the front chain cover. <Ref. to **REMOVAL**, Front Chain Cover .>
4. Remove the timing chain. <Ref. to **REMOVAL**, Timing Chain Assembly .>
5. Remove the cam sprocket. <Ref. to **REMOVAL**, Cam Sprocket .>
6. Remove the crank sprocket. <Ref. to **REMOVAL**, Crank Sprocket .>
7. Remove the oil pump. <Ref. to **REMOVAL** , Oil Pump .>
8. Remove the water pump. <Ref. to **REMOVAL** , Removal, Water Pump .>
9. Remove the rear chain cover.

NOTE: Installation bolt has seven different sizes. To prevent the confusion in installation, keep these bolts on container individually.



ME-02048

- (A) M6 x 14
- (B) M6 x 18 (Silver)
- (C) M6 x 30
- (D) M6 x 18
- (E) M8 x 43
- (F) M8 x 30
- (G) M6 x 22

Fig. 102: Identifying Rear Chain Cover Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

NOTE: When replacing the rear chain cover, suitable size cover must be selected. <Ref. to INSPECTION , Oil Pump .>

1. Remove the used liquid gasket from mating surface, and degrease it.
2. Apply liquid gasket to the mating surface of rear chain cover.

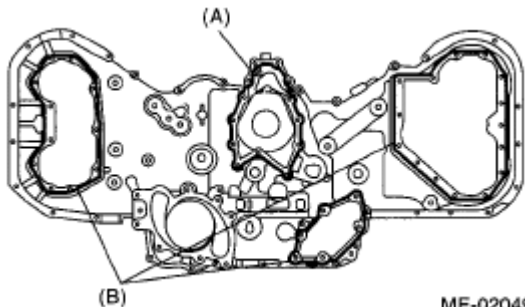
Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

Applying liquid gasket diameter:

(A) 1.0 ± 0.5 mm (0.039 ± 0.020 in)

(B) 3.0 ± 1.0 mm (0.118 ± 0.039 in)



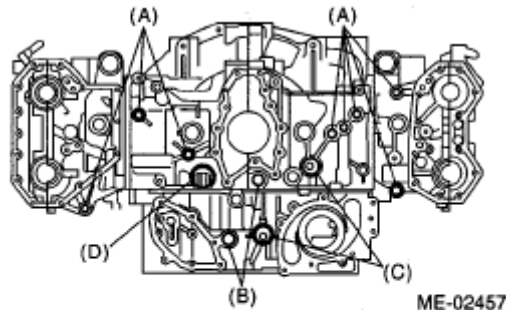
ME-02049

Fig. 103: Identifying Rear Chain Cover Gasket Area
Courtesy of SUBARU OF AMERICA, INC.

3. Install the O-ring.

NOTE:

- Use new O-rings.
- Do not install the O-ring in wrong place.



- (A) 14.2 × 1.9
(B) 19.2 × 2.4
(C) 25 × 2
(D) 31.2 × 1.9

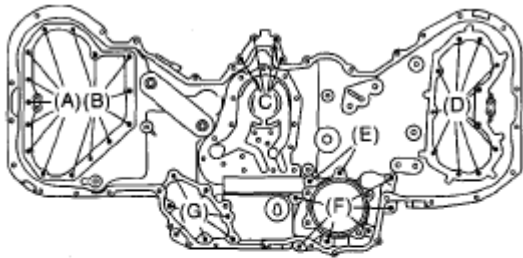
Fig. 104: Identifying Rear Chain Cover Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

4. Install the water pump gasket.

NOTE: Use a new gasket.

5. Temporarily tighten the rear chain cover.

NOTE: Do not install the bolts in wrong place.



ME-02048

- (A) M6 × 14
- (B) M6 × 18 (Silver)
- (C) M6 × 30
- (D) M6 × 18
- (E) M8 × 43
- (F) M8 × 30
- (G) M6 × 22

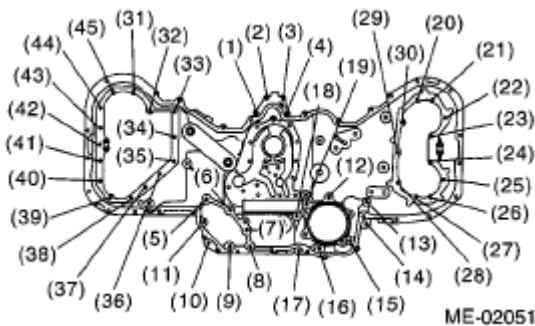
Fig. 105: Identifying Rear Chain Cover Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

6. Tighten the bolts in the numerical order as shown in the figure.

Tightening torque:

TIGHTENING TORQUE SPECIFICATION

(1) - (11)	9 N.m (0.9 kgf-m, 6.5 ft-lb)
(12) - (19)	20 N.m (2.0 kgf-m, 14 ft-lb)
(20) - (30)	9 N.m (0.9 kgf-m, 6.5 ft-lb)
(31) - (38)	12 N.m (1.2 kgf-m, 8.7 ft-lb)
(39) - (45)	9 N.m (0.9 kgf-m, 6.5 ft-lb)



ME-02051

Fig. 106: Identifying Rear Chain Cover Bolt Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

7. Install the water pump. <Ref. to **INSTALLATION** , Installation, Water Pump .>
8. Install the oil pump. <Ref. to **INSTALLATION** , Oil Pump .>

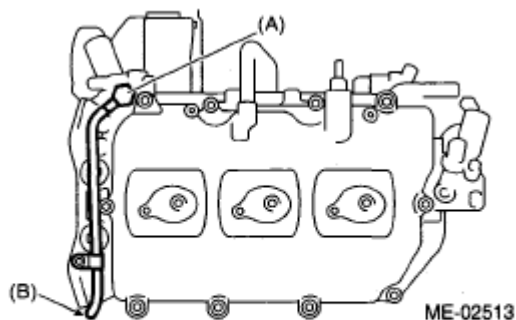
9. Install the crank sprocket. <Ref. to **INSTALLATION**, Crank Sprocket .>
10. Install the cam sprocket. <Ref. to **INSTALLATION**, Cam Sprocket .>
11. Install the timing chain. <Ref. to **INSTALLATION**, Timing Chain Assembly .>
12. Install the front chain cover. <Ref. to **INSTALLATION**, Front Chain Cover .>
13. Install the crank pulley. <Ref. to **INSTALLATION**, Crank Pulley .>
14. Install the V-belts. <Ref. to **INSTALLATION**, V-belt .>

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**, V-belt .>
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley .>
3. Remove the front chain cover. <Ref. to **REMOVAL**, Front Chain Cover .>
4. Remove the timing chain assembly. <Ref. to **REMOVAL**, Timing Chain Assembly .>
5. Remove the cam sprocket. <Ref. to **REMOVAL**, Cam Sprocket .>
6. Remove the crank sprocket. <Ref. to **REMOVAL**, Crank Sprocket .>
7. Remove the rear chain cover. <Ref. to **REMOVAL**, Rear Chain Cover .>
8. Disconnect the oil pipe.



- (A) Bolt without filter (with white mark)
(B) Bolt with filter (without white mark)

Fig. 107: Identifying Rear Chain Cover Bolt Paint Mark Location
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the rocker cover (LH).

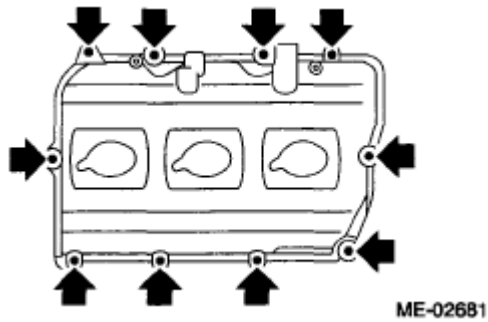


Fig. 108: Identifying Rocker Cover (LH)
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the plugs (LH).

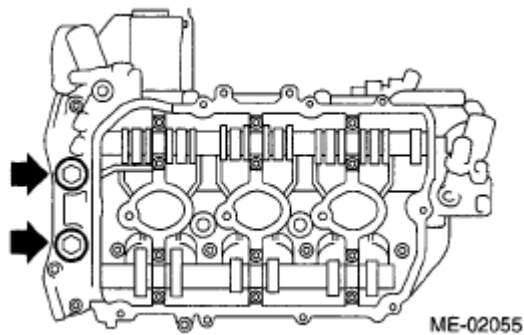


Fig. 109: Identifying Plugs (LH)
Courtesy of SUBARU OF AMERICA, INC.

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

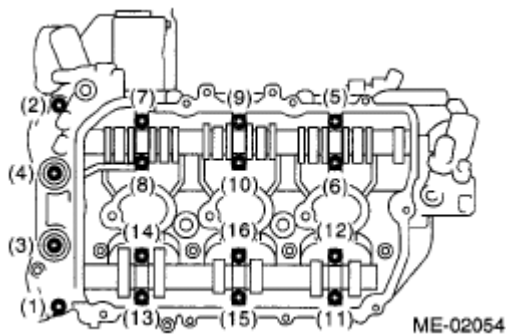


Fig. 110: Identifying Camshaft Cap Bolts Loosen Sequence
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the camshaft caps and camshaft (LH).

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

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

INSTALLATION

1. Apply engine oil to camshaft journals, and install the camshaft.
2. Install the camshaft cap.
 1. Apply liquid gasket sparingly to back side of front camshaft cap as shown in the figure.

CAUTION: Do not apply liquid gasket excessively. Applying excessively may cause excess gasket to flow toward cam journal, resulting in engine seizure.

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

Applying liquid gasket diameter:

$2.0 \pm 0.5 \text{ mm}$ ($0.079 \pm 0.020 \text{ in}$)

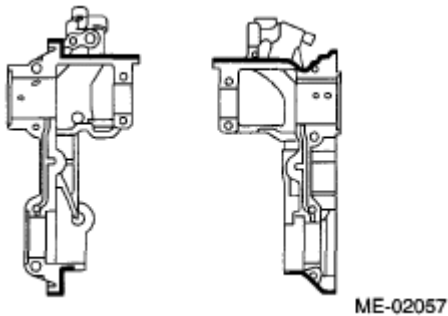


Fig. 111: Identifying Cam Journal
Courtesy of SUBARU OF AMERICA, INC.

2. Apply engine oil to cap bearing surface, and install the cap to camshaft.
3. Tighten the rocker cover bolts in the numerical order as shown in the figure.

Tightening torque:

(1) - (12): 16 N.m (1.6 kgf-m, 12 ft-lb)

(13) - (16): 9.75 N.m (1.0 kgf-m, 7.2 ft-lb)

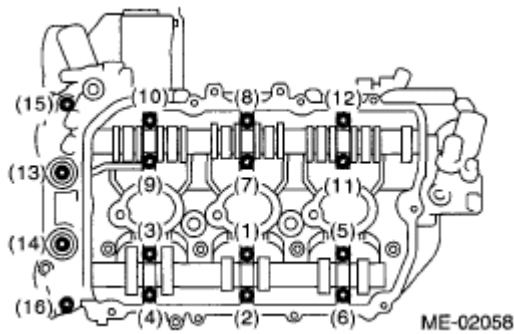


Fig. 112: Identifying Rocker Cover Bolts Tighten Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Install the plugs.

Tightening torque:

60 N.m (6.1 kgf-m, 44 ft-lb)

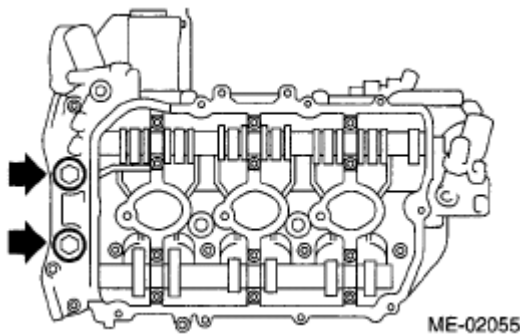


Fig. 113: Identifying Plugs
Courtesy of SUBARU OF AMERICA, INC.

4. Install the rocker cover.
 1. Apply liquid gasket sparingly to the mating surface of cylinder head and rocker cover as shown in the figure.

CAUTION: Do not apply liquid gasket excessively. Applying excessively may cause excess gasket to flow toward cam journal, resulting in engine seizure.

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

- LH side

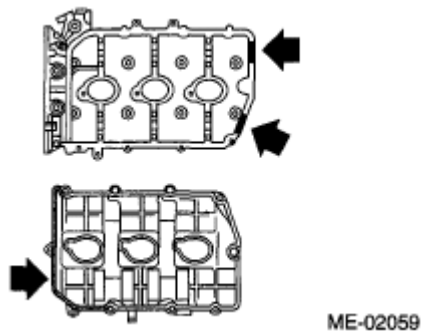


Fig. 114: Identifying Locker Cover (LH Side)
Courtesy of SUBARU OF AMERICA, INC.

- RH side

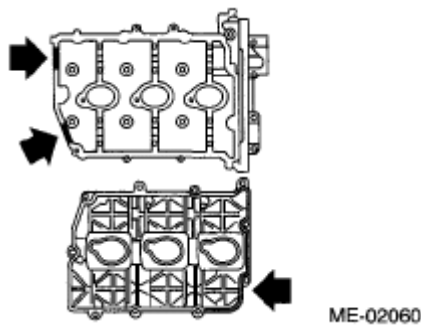


Fig. 115: Identifying Locker Cover (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

2. Tighten the rocker cover bolts in the numerical order as shown in the figure.

Tightening torque:

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

- LH side

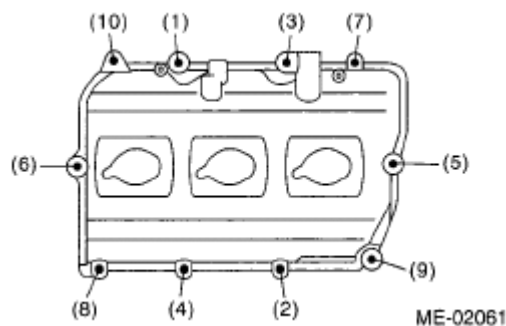


Fig. 116: Identifying Rocker Cover Bolts (LH Side)

Courtesy of SUBARU OF AMERICA, INC.

- RH side

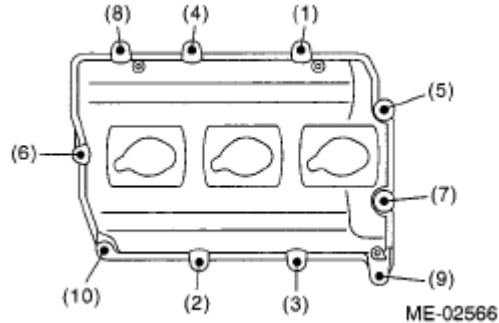


Fig. 117: Identifying Rocker Cover Bolts (RH Side)
Courtesy of SUBARU OF AMERICA, INC.

5. Connect the oil pipe.

CAUTION:

- Be careful not to mistake the location of (A) and (B).
- Be sure to use a new gasket.

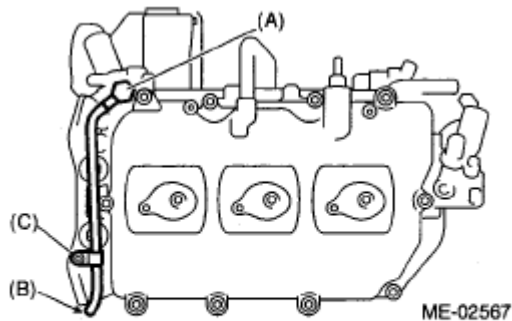
Tightening torque:

(A), (B)

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

(C)

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



- (A) Bolt without filter (with white mark)
- (B) Bolt with filter (without white mark)
- (C) Oil pipe bolt

Fig. 118: Identifying Filter Paint Mark

Courtesy of SUBARU OF AMERICA, INC.

6. Install the rear chain cover. <Ref. to **INSTALLATION**, Rear Chain Cover .>
7. Install the crank sprocket. <Ref. to **INSTALLATION**, Crank Sprocket .>
8. Install the cam sprocket. <Ref. to **INSTALLATION**, Cam Sprocket .>
9. Install the timing chain assembly. <Ref. to **INSTALLATION**, Timing Chain Assembly .>
10. Install the front chain cover. <Ref. to **INSTALLATION**, Front Chain Cover .>
11. Install the crank pulley. <Ref. to **INSTALLATION**, Crank Pulley .>
12. Install the V-belts. <Ref. to **INSTALLATION**, V-belt .>

INSPECTION

1. Measure the bend of camshaft. Repair or replace if bend.

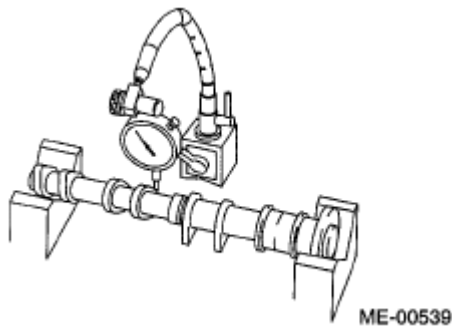


Fig. 119: Identifying Bend Of Camshaft
Courtesy of SUBARU OF AMERICA, INC.

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

CAMSHAFT JOURNAL SPECIFICATION

	Camshaft journal	
	Front	Except for front
Standard mm (in)	37.946 - 37.963 (1.4939 - 1.4946)	25.946 - 25.963 (1.0215 - 1.0222)

5. Measurement of the camshaft journal oil clearance:
 1. Clean the bearing caps and camshaft journals.
 2. Place the camshafts on cylinder head. (Without installing the valve rocker.)
 3. Place a plastigage across each camshaft journals.
 4. Install the bearing cap.

NOTE: Do not turn the camshaft.

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

Standard:

0.037 - 0.072 mm (0.0015 - 0.0028 in)

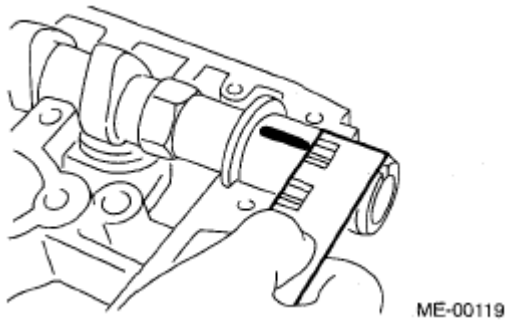


Fig. 120: Measuring Widest Point Of Plastigage
Courtesy of SUBARU OF AMERICA, INC.

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

Cam height H:

Standard:

Intake:

HIGH 42.09 - 42.19 mm (1.6571 - 1.6610 in)

LOW1 38.14 - 38.24 mm (1.5016 - 1.5055 in)

LOW2 35.44 - 35.54 mm (1.3953 - 1.3992 in)

Exhaust:

41.65 - 41.75 mm (1.6398 - 1.6437 in)

Cam base circle diameter A:

Intake:

HIGH 32.0 mm (1.2598 in)

LOW1 31.84 mm (1.2535 in)

LOW2 31.84 mm (1.2535 in)

Exhaust:

32.0 mm (1.2598 in)

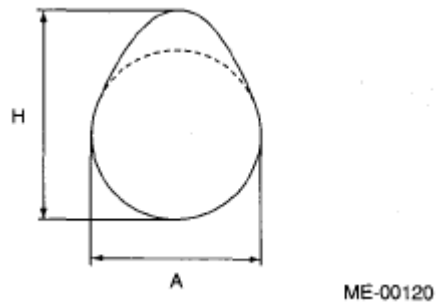


Fig. 121: Identifying Cam Height
Courtesy of SUBARU OF AMERICA, INC.

7. Measure the thrust clearance of camshaft with dial gauge. If the clearance exceeds the standard or offset wear occurs, replace the caps and cylinder head as a set. If necessary replace the camshaft.

Standard:

Intake:

0.075 - 0.135 mm (0.0030 - 0.0053 in)

Exhaust:

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, V-belt .>
2. Remove the crank pulley. <Ref. to REMOVAL, Crank Pulley .>
3. Remove the front chain cover. <Ref. to REMOVAL, Front Chain Cover .>
4. Remove the timing chain assembly. <Ref. to REMOVAL, Timing Chain Assembly .>

5. Remove the cam sprocket. <Ref. to **REMOVAL**, Cam Sprocket .>
6. Remove the crank sprocket. <Ref. to **REMOVAL**, Crank Sprocket .>
7. Remove the rear chain cover. <Ref. to **REMOVAL**, Rear Chain Cover .>
8. Remove the camshaft. <Ref. to **REMOVAL**, Camshaft .>
9. Remove the cylinder head bolts in the numerical order as shown in the figure. Leave bolts (2) and (4) engaged by three or four threads to prevent the cylinder head from falling.

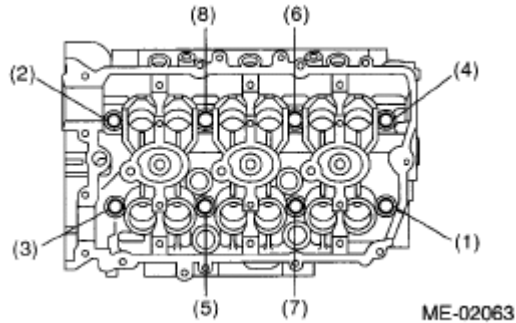


Fig. 122: Identifying Cylinder Head Bolts In Numerical Order
Courtesy of SUBARU OF AMERICA, INC.

10. While tapping the cylinder head with a plastic hammer, separate it from cylinder block.
11. Remove the bolts (2) and (4) to remove cylinder head.

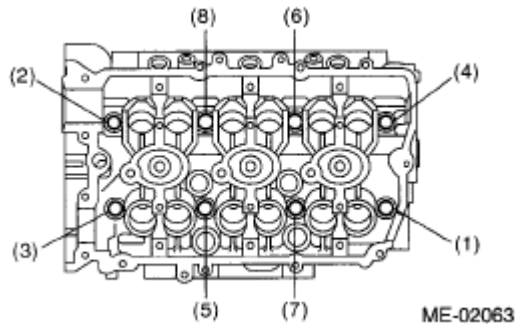


Fig. 123: Identifying Cylinder Head Bolts In Numerical Order
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the cylinder head gasket.

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

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

INSTALLATION

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

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

NOTE: Use a new cylinder head gasket.

2. Tighten the cylinder head bolts.
 1. Apply a coat of engine oil to washers and cylinder head bolt threads.
 2. Install the cylinder head to cylinder block, and then tighten the bolts with torque of 20 N.m (2.0 kgf-m, 14 ft-lb) in numerical sequence as shown in the figure.
 3. Tighten the bolts with torque of 50 N.m (5.1 kgf-m, 37 ft-lb) in numerical sequence as shown in the figure.
 4. Loosen all the bolts by 180° in reverse order of installation, and loosen again by 180° in the same order.
 5. Tighten the bolts with torque of 20 N.m (2.0 kgf-m, 14 ft-lb) in numerical sequence as shown in the figure.
 6. Tighten the bolts (1) - (4) with torque of 48 N.m (4.9 kgf-m, 35.4 ft-lb) in numerical sequence.
 7. Tighten the bolts (5) - (8) with torque of 44 N.m (4.5 kgf-m, 33 ft-lb) in numerical sequence.
 8. Tighten all bolts 90° in the numerical order as shown in the figure.
 9. Tighten the bolt (1) - (4) by 45° in the numerical order.

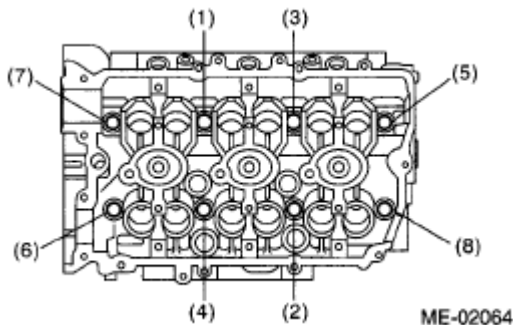


Fig. 124: Identifying Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install the camshaft. <Ref. to INSTALLATION, Camshaft .>
4. Install the rear chain cover. <Ref. to INSTALLATION, Rear Chain Cover .>
5. Install the crank sprocket. <Ref. to INSTALLATION, Crank Sprocket .>
6. Install the cam sprocket. <Ref. to INSTALLATION, Cam Sprocket .>
7. Install the timing chain assembly. <Ref. to INSTALLATION, Timing Chain Assembly .>
8. Install the front chain cover. <Ref. to INSTALLATION, Front Chain Cover .>
9. Install the crank pulley. <Ref. to INSTALLATION, Crank Pulley .>

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

DISASSEMBLY

1. Set the cylinder head on ST.

ST 18250AA010 CYLINDER HEAD TABLE

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

ST 499718000 VALVE SPRING REMOVER

NOTE:

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

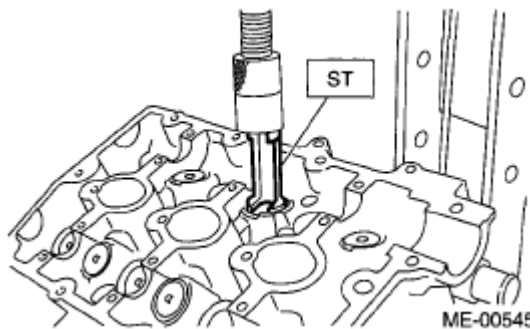


Fig. 125: Identifying Valve Spring Remover
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY

1. Installation of valve spring and valve:
1. Set the cylinder head on ST.

ST 18250AA010 CYLINDER HEAD TABLE

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

NOTE:

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

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.
- For the valve spring on intake side, install two of them (inner and outer).
- Install the valve spring with the painted side facing to retainer.

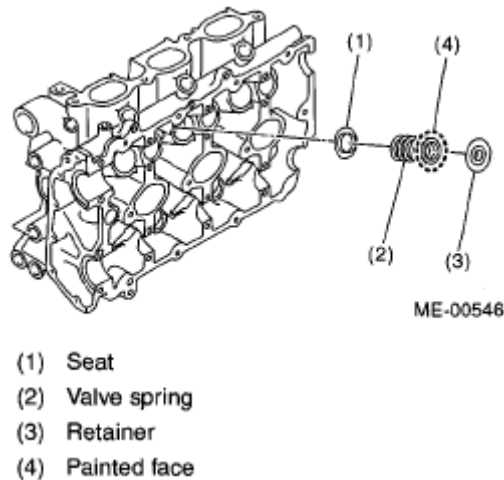


Fig. 126: Identifying Valve Spring And Retainer
Courtesy of SUBARU OF AMERICA, INC.

4. Set the ST on valve spring.

ST 499718000 VALVE SPRING REMOVER

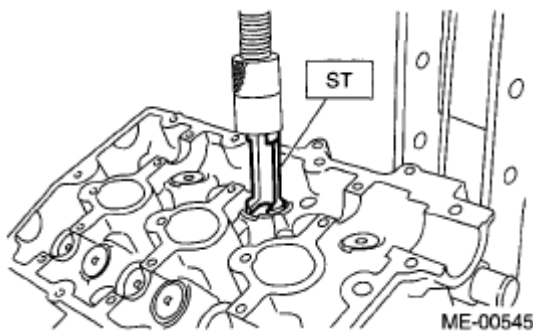


Fig. 127: Identifying Valve Spring Remover
Courtesy of SUBARU OF AMERICA, INC.

5. Compress the valve spring and fit the valve spring retainer key.
6. After installing, tap the valve spring retainers lightly with a wooden hammer for better seating.
2. Apply oil to the surface of valve lifter and valve shim.

3. Install the valve lifter and valve shim.

INSPECTION

CYLINDER HEAD

1. Make sure that no crack or other damages do not exist. In addition to visual inspection, inspect important areas using liquid penetrant tester. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2. Set the cylinder head on ST.

ST 18250AA010 CYLINDER HEAD TABLE

3. Measure the flatness of the cylinder head surface that mates with cylinder block using a straight edge (A) and thickness gauge (B).

Flatness:

Standard:

0.02 mm (0.0008 in)

Standard height of cylinder head:

124±0.05 mm (4.88±0.0020 in)

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

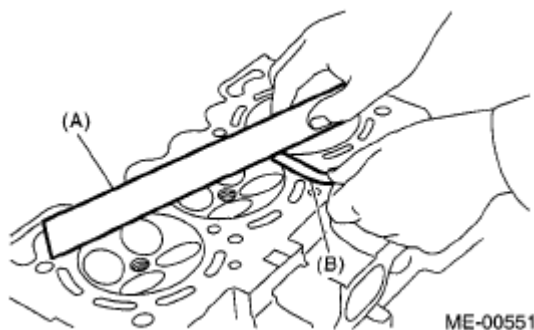


Fig. 128: Measuring Flatness Of Cylinder Head Surface Mates With Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Valve seat width *W*:

Intake:

Standard:

1.0 mm (0.039 in)

Exhaust:

Standard:

1.5 mm (0.059 in)

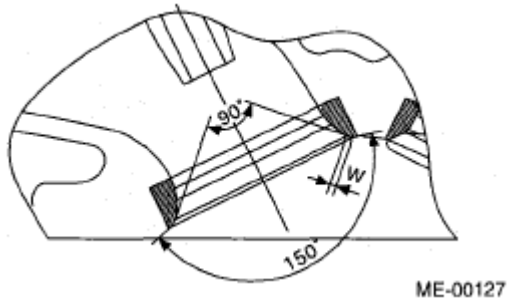


Fig. 129: Identifying Valve Seat Width
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

Clearance between the valve guide and valve stem:

Standard:

Intake:

0.030 - 0.057 mm (0.0012 - 0.0022 in)

Exhaust:

0.040 - 0.067 mm (0.0016 - 0.0026 in)

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

Valve guide inner diameter:***5.500 - 5.512 mm (0.2165 - 0.2170 in)******Valve stem outer diameter:******Intake:******5.455 - 5.470 mm (0.2148 - 0.2154 in)******Exhaust:******5.445 - 5.460 mm (0.2144 - 0.2150 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 18250AA010 CYLINDER HEAD TABLE

ST2 499765700 VALVE GUIDE REMOVER

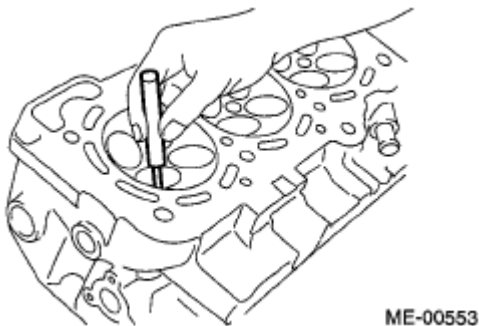
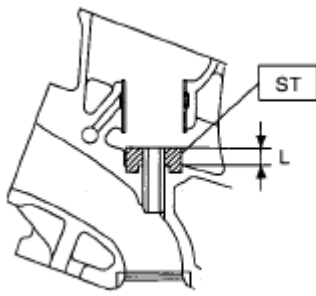


Fig. 130: Identifying Cylinder Head Table And Valve Guide Remover
Courtesy of SUBARU OF AMERICA, INC.

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

ST 18251AA040 VALVE GUIDE ADJUSTER



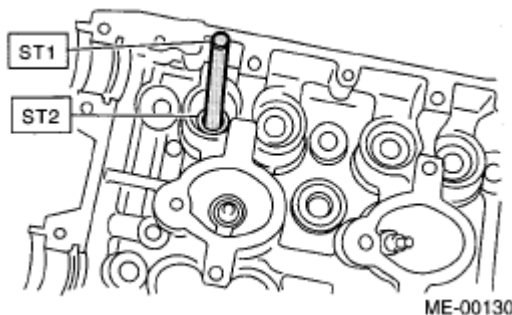
ME-00757

Fig. 131: Identifying Valve Guide Adjuster ST 18251AA020 On Cylinder Head
 Courtesy of SUBARU OF AMERICA, INC.

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

ST1 499765700 VALVE GUIDE REMOVER

ST2 18251AA040 VALVE GUIDE ADJUSTER



ME-00130

Fig. 132: Identifying Valve Guide Remover ST1 499767200 And Valve Guide Adjuster ST2 18251AA020

Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion.

Valve guide protrusion L:

11.4 - 11.8 mm (0.449 - 0.465 in)

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

ST 499765900 VALVE GUIDE REAMER

NOTE:

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

8. After reaming, clean the valve guide to remove chips.

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

INTAKE AND EXHAUST VALVE

1. Inspect the flange and stem of valve, and replace if damaged, worn or deformed, or if dimension of "H" in the figure exceeds the standard, or if offset wear occurs.

Head edge thickness H:

Intake (A):

Standard

1.0 mm (0.039 in)

Exhaust (B):

Standard

1.2 mm (0.047 in)

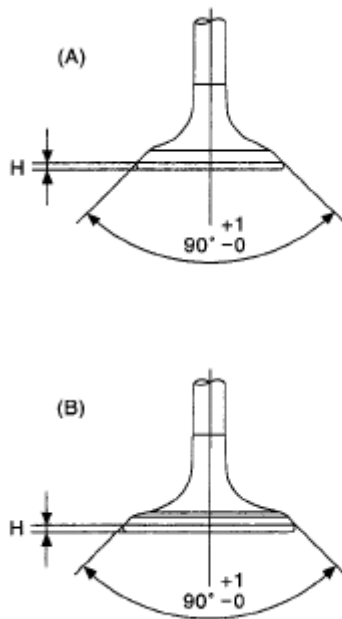
Valve overall length:

Intake (A):

99.7 mm (3.925 in)

Exhaust (B):

105.2 mm (4.142 in)



ME-02096

Fig. 133: 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. Install a new valve oil seal after lapping.

VALVE SPRING

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

VALVE SPRING LENGTH

Free length mm (in)	Intake	Inner	39.55 (1.5571)
		Outer	41.18 (1.6213)
	Exhaust		46.32 (1.8236)
Squareness	Intake	Inner	2.5°, 1.7 mm (0.067 in)
		Outer	2.5°, 1.8 mm (0.071 in)
	Exhaust		2.5°, 2.0 mm (0.079 in)

- 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.

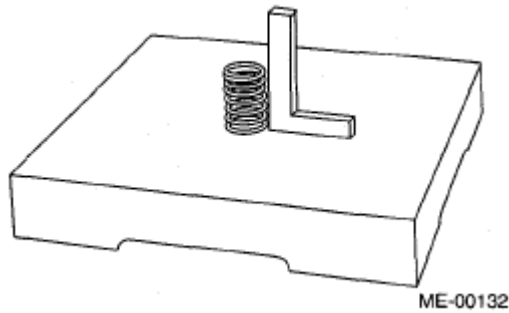


Fig. 134: Measuring Squareness Of Valve Spring
 Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

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

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

1. Set the cylinder head on ST1.
2. Using the ST2, press in the oil seal.

ST1 18250AA010 CYLINDER HEAD TABLE

ST2 499585500 VALVE OIL SEAL GUIDE

NOTE:

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

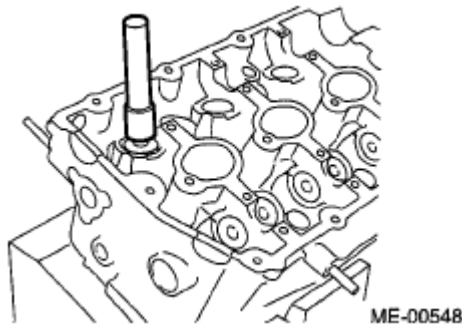


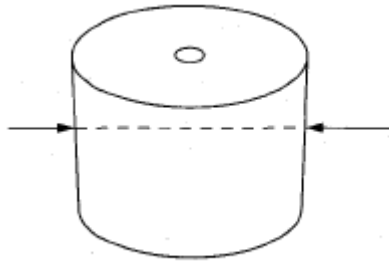
Fig. 135: Identifying Intake And Exhaust Valve Oil Seal
 Courtesy of SUBARU OF AMERICA, INC.

VALVE LIFTER

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

Outer diameter:

32.959 - 32.975 mm (1.2976 - 1.2982 in)



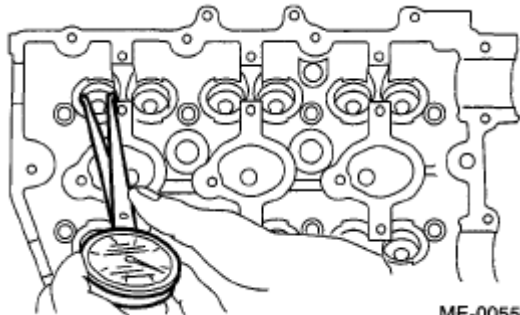
ME-00134

Fig. 136: Identifying Outer Diameter Of Valve Lifter
Courtesy of SUBARU OF AMERICA, INC.

3. Measure the inner diameter of valve lifter hole of cylinder head.

Inner diameter:

32.994 - 33.016 mm (1.2990 - 1.2998 in)



ME-00550

Fig. 137: Measuring Inner Diameter Of Valve Lifter Hole Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

NOTE: If difference between outer diameter of valve lifter and inner diameter of valve lifter hole is out of the standard or offset wearing is emitted, replace the cylinder head.

Standard:

0.019 - 0.057 mm (0.0007 - 0.0022 in)

CYLINDER BLOCK

REMOVAL

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

1. Remove the V-belts. <Ref. to **REMOVAL**, V-belt .>
2. Remove the crank pulley. <Ref. to **REMOVAL**, Crank Pulley .>
3. Remove the front chain cover. <Ref. to **REMOVAL**, Front Chain Cover .>
4. Remove the timing chain assembly. <Ref. to **REMOVAL**, Timing Chain Assembly .>
5. Remove the cam sprocket. <Ref. to **REMOVAL**, Cam Sprocket .>
6. Remove the crank sprocket. <Ref. to **REMOVAL**, Crank Sprocket .>
7. Remove the rear chain cover. <Ref. to **REMOVAL**, Rear Chain Cover .>
8. Remove the camshaft. <Ref. to **REMOVAL**, Camshaft .>
9. Remove the cylinder head. <Ref. to **REMOVAL**, Cylinder Head .>
10. Remove the drive plate. Using the ST, lock the crankshaft.

ST 498497100 CRANKSHAFT STOPPER

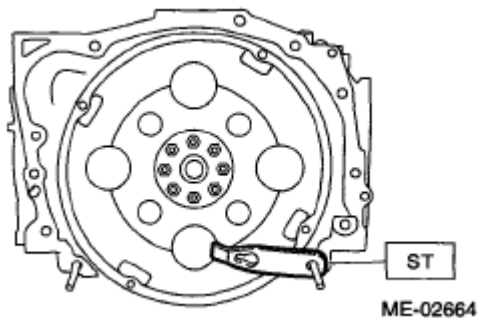


Fig. 138: Identifying Crankshaft Stopper
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the crankshaft position sensor plate.

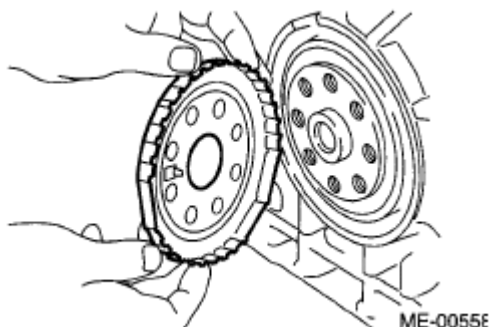


Fig. 139: Identifying Crankshaft Position Sensor Plate
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the crankshaft position sensor bracket.

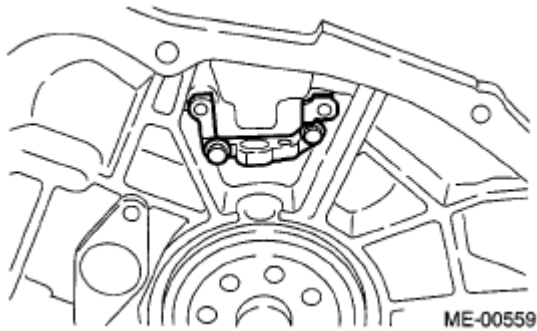


Fig. 140: Identifying Crankshaft Position Sensor Bracket
Courtesy of SUBARU OF AMERICA, INC.

13. Rotate the engine to set oil pan upper.
14. Remove the bolts which secure oil pan lower to oil pan upper.

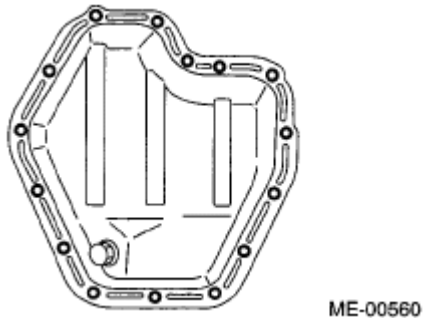
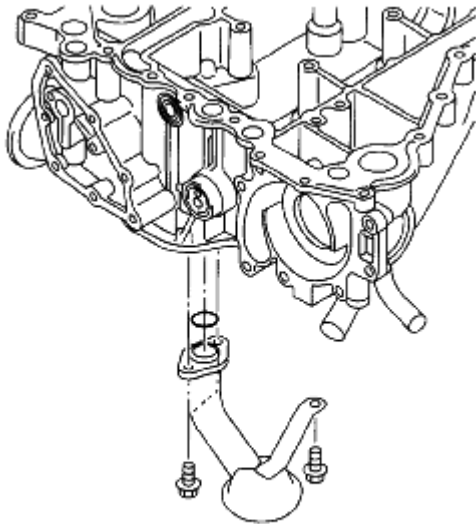


Fig. 141: Identifying Oil Pan Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

15. 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.

16. Remove the oil strainer.

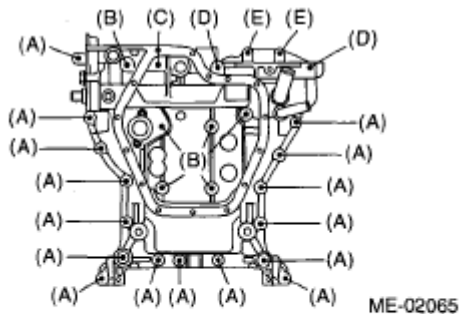


LU-02108

Fig. 142: Identifying Oil Strainer
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the bolts which install oil pan upper onto cylinder block.

NOTE: Installation bolt has five different sizes. To prevent the confusion in installation, keep these bolts on container individually.



ME-02065

- (A) M8 × 40
- (B) M8 × 65
- (C) M8 × 85
- (D) M8 × 130.5
- (E) M8 × 24

Fig. 143: Identifying Cylinder Block Location
Courtesy of SUBARU OF AMERICA, INC.

18. Remove the service hole cover and service hole plugs using a hexagon wrench.

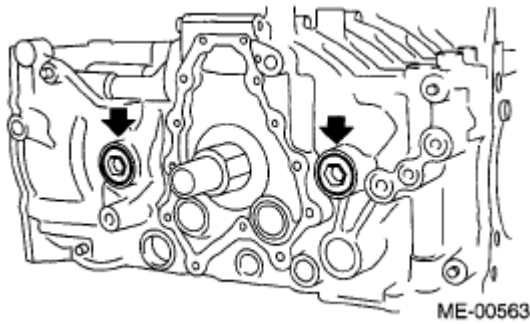


Fig. 144: Identifying Service Hole Cover
Courtesy of SUBARU OF AMERICA, INC.

19. Rotate the crankshaft to bring #1 and #2 pistons to bottom dead center position, then, using the ST, remove the piston snap ring through service hole of #1 and #2 cylinders.

ST 18233AA000 PISTON PIN SNAP RING PLIERS

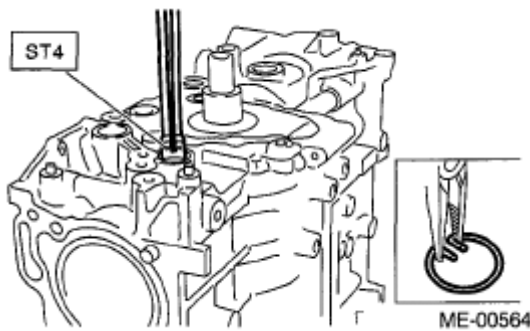


Fig. 145: Identifying Piston Pin Snap Ring Pliers
Courtesy of SUBARU OF AMERICA, INC.

20. 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.

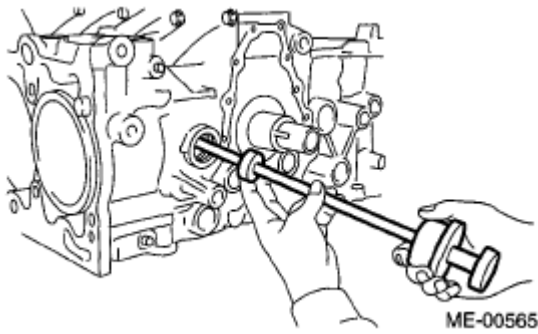


Fig. 146: Identifying Piston Pin Remover
 Courtesy of SUBARU OF AMERICA, INC.

21. Similarly remove the piston pins from #3, #4, #5, and #6 pistons.
22. Remove the bolts which connect cylinder block.

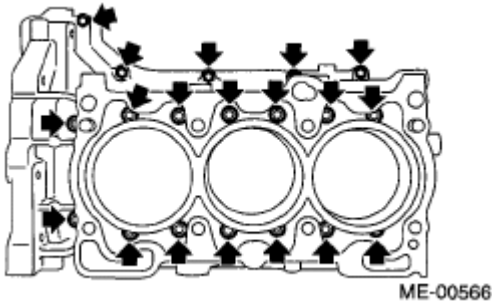


Fig. 147: Identifying Cylinder Block Bolts
 Courtesy of SUBARU OF AMERICA, INC.

23. Separate the cylinder block (LH) and (RH).

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

24. Remove the rear oil seal.
25. Remove the crankshaft together with connecting rod.
26. 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.

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

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

INSTALLATION

1. After setting the cylinder block to ST, install the crankshaft bearing.

ST 18232AA000 ENGINE STAND

NOTE: 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 on #1, #3 and #5 cylinder block.
3. Apply liquid gasket to the mating surface of the #1, #3 and #5 cylinder blocks, and position it on #2, #4 and #6 cylinder blocks.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007)

NOTE: Do not allow liquid gasket to run over to oil passages, bearing grooves, etc.

Applying liquid gasket diameter:

$1.0 \pm 0.2 \text{ mm}$ ($0.039 \pm 0.008 \text{ in}$)

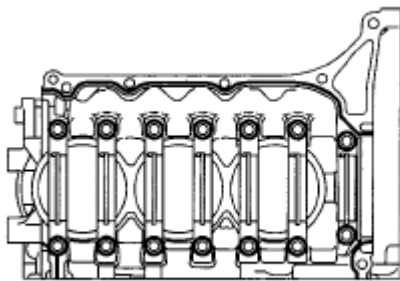


Fig. 148: Identifying Cylinder Block Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

4. Apply a coat of engine oil to the washer and bolt thread.
5. Tighten all bolts in the numerical order as shown in the figure.

Tightening torque:

(1) - (11), (13): 25 N.m (2.5 kgf-m, 18 ft-lb)

(12), (14): 20 N.m (2.0 kgf-m, 14 ft-lb)

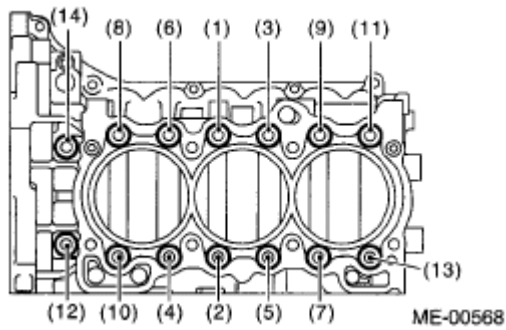


Fig. 149: Identifying Cylinder Bolts Numerical Order
Courtesy of SUBARU OF AMERICA, INC.

6. Retighten all bolts in the numerical order as shown in the figure.

Tightening torque:

(1) - (11), (13): 25 N.m (2.5 kgf-m, 18 ft-lb)

(12), (14): 20 N.m (2.0 kgf-m, 14 ft-lb)

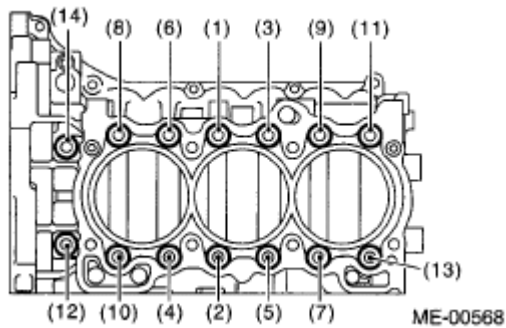


Fig. 150: Identifying Cylinder Bolts Numerical Order
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten all bolts 90° in the numerical order as shown in the figure.

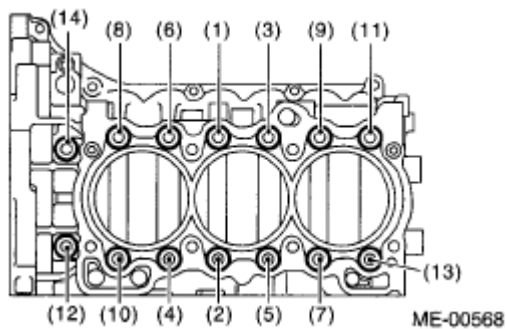


Fig. 151: Identifying Cylinder Bolts Numerical Order

Courtesy of SUBARU OF AMERICA, INC.

8. Install the upper bolt to cylinder block.

Tightening torque:

25 N.m (2.5 kgf-m, 18 ft-lb)

NOTE: After tightening the cylinder block connecting bolts, remove the liquid gasket which is running over to the sealing surface for rear chain cover and oil pan upper.

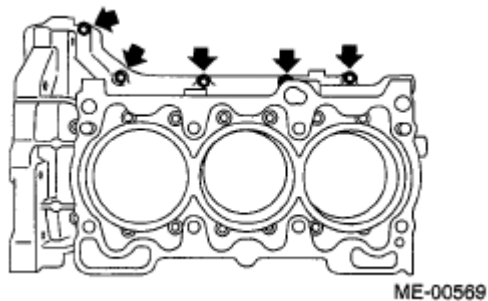


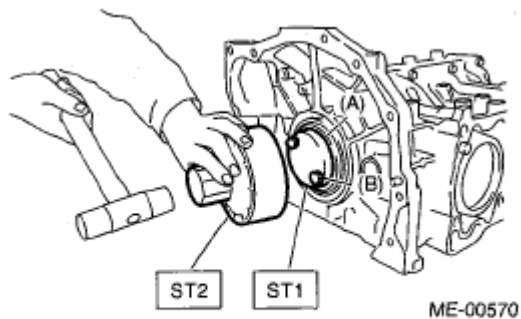
Fig. 152: Identifying Cylinder Block Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. 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 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER

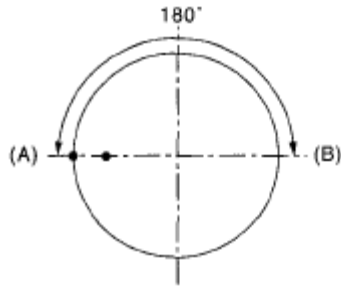


(A) Rear oil seal

(B) Drive plate installation bolt

Fig. 153: Installing Rear Oil Seal With ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

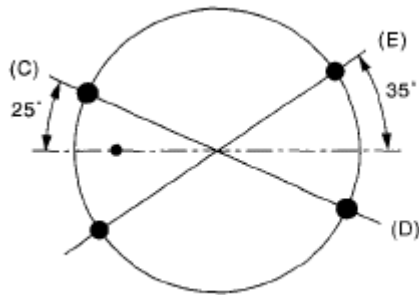
10. Position the top ring gap at (A) in the figure.
11. Position the second ring gap at (B).



ME-02066

Fig. 154: Identifying Top Ring Gap And Second Ring Gap
 Courtesy of SUBARU OF AMERICA, INC.

12. Position the upper rail gap at (C) in the figure.
13. Position the expander gap at (D) in the figure.
14. Position the lower rail gap at (E) in the figure.



ME-02067

Fig. 155: Identifying Lower Rail Gap, Expander Gap And Lower Rail Gap
 Courtesy of SUBARU OF AMERICA, INC.

CAUTION:

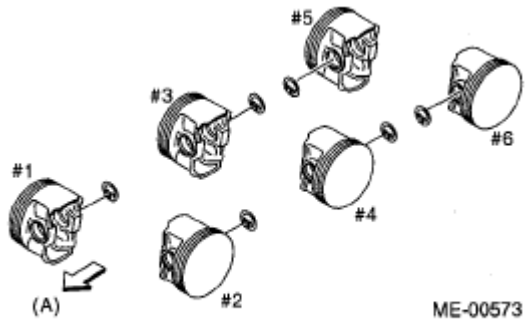
- Make sure ring gaps do not face the same direction.
- Make sure ring gaps are not within the piston skirt area.
- Assemble it so that R mark faces to top side of piston.

15. Install the snap ring.

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

NOTE:

Use new snap rings.



(A) Front side of vehicle

Fig. 156: Identifying Snap Rings
Courtesy of SUBARU OF AMERICA, INC.

16. Installation of piston:

1. Using the ST1, turn the crankshaft so that #3 and #4 connecting rod small ends are set on the service hole (A).

ST1 18252AA000 CRANKSHAFT SOCKET

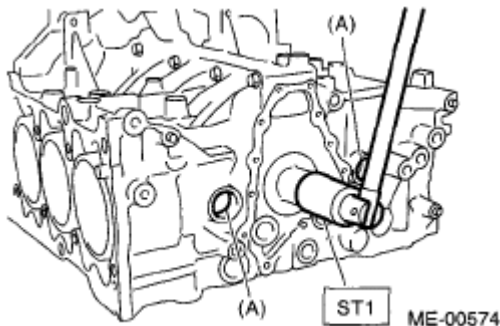


Fig. 157: Identifying Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

2. Apply a thin coat of engine oil to piston and cylinder.
3. Using the ST2, press-fit the piston into cylinder.

ST2 18254AA000 PISTON GUIDE

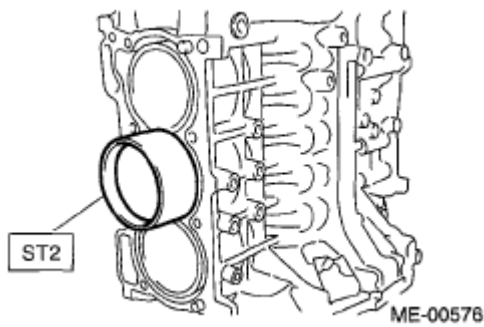


Fig. 158: Identifying Piston Into Cylinder With ST2
Courtesy of SUBARU OF AMERICA, INC.

NOTE: Let the piston front mark (A) face towards the front of engine.

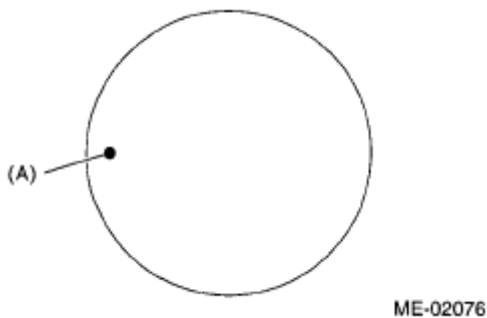


Fig. 159: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

17. Installing piston pin:

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

ST3 18253AA000 PISTON PIN GUIDE

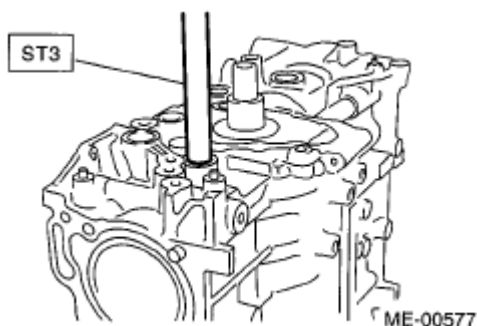


Fig. 160: Identifying Piston Pin Guide
Courtesy of SUBARU OF AMERICA, INC.

2. Apply a coat of engine oil to piston pin, and insert the piston pin into piston and connecting rod through service hole.
3. Using the ST4, install the snap ring.

ST4 18233AA000 PISTON PIN SNAP RING PLIERS

NOTE: Use new snap rings.

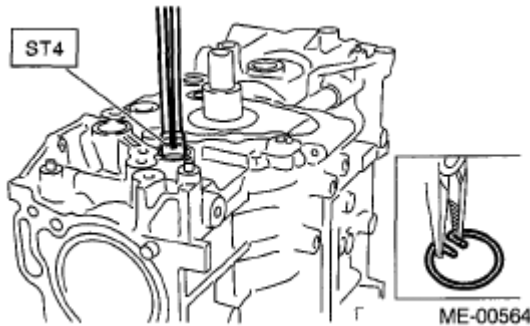


Fig. 161: Identifying Piston Pin Snap Ring Pliers
Courtesy of SUBARU OF AMERICA, INC.

4. Similarly install the #1, #2, #5 and #6 pistons.
18. Install the service hole plug and O-ring.

NOTE: Use new O-rings.

19. Apply liquid gasket to the mating surface of oil pan upper.

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

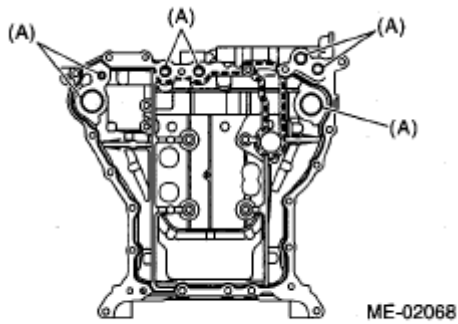
Applying liquid gasket diameter:

Full line part

3.0±1.0 mm (0.12±0.04 in)

Broken line part

1.0 mm (0.04 in)



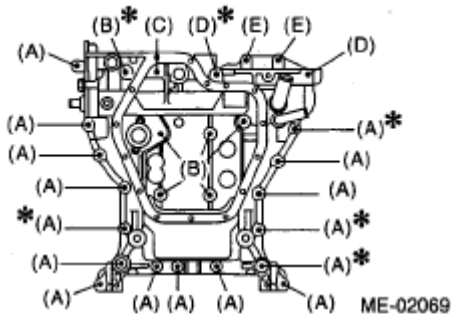
(A) O-ring

Fig. 162: Identifying Oil Pan Upper O-Ring Location
Courtesy of SUBARU OF AMERICA, INC.

NOTE: Use new O-rings.

20. Temporarily tighten the oil pan upper.

NOTE: Do not install the bolts in wrong place.



- (A) M8 × 40
- (B) M8 × 65
- (C) M8 × 85
- (D) M8 × 130.5
- (E) M8 × 24
- *: Coating

Fig. 163: Identifying Oil Pan Upper Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

21. Tighten the oil pan upper installing bolts in the numerical order as shown in the figure.

Tightening torque:

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

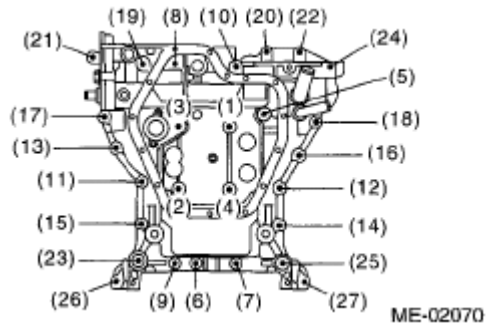


Fig. 164: Identifying Oil Pan Upper Bolt Location
Courtesy of SUBARU OF AMERICA, INC.

22. Install the oil strainer.

Tightening torque:

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

NOTE: Use new O-rings.

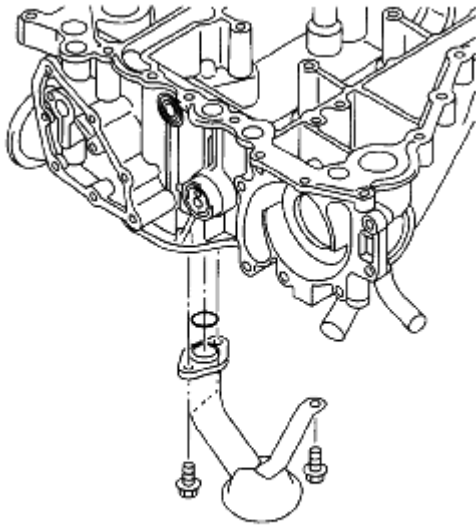


Fig. 165: Identifying Oil Strainer
Courtesy of SUBARU OF AMERICA, INC.

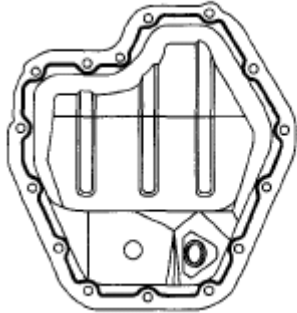
23. Apply liquid gasket to the matching surface of oil pan lower.

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

Applying liquid gasket diameter:

5.0±1.0 mm (0.20±0.04 in)



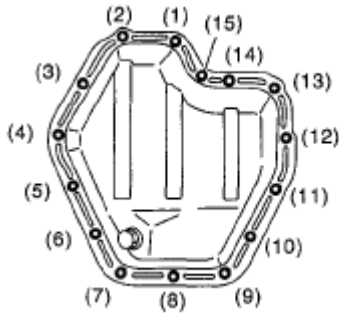
ME-00581

Fig. 166: Identifying Matching Surface Of Oil Pan Lower
 Courtesy of SUBARU OF AMERICA, INC.

24. Tighten the oil pan lower installing bolts in the numerical order as shown in the figure.

Tightening torque:

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



ME-00582

Fig. 167: Identifying Oil Pan Lower Bolts
 Courtesy of SUBARU OF AMERICA, INC.

25. Install the crankshaft sensor bracket.

Tightening torque:

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

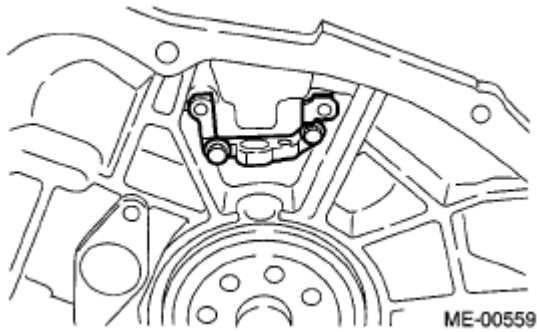


Fig. 168: Identifying Crankshaft Sensor Bracket
Courtesy of SUBARU OF AMERICA, INC.

26. Install the crankshaft sensor plate.

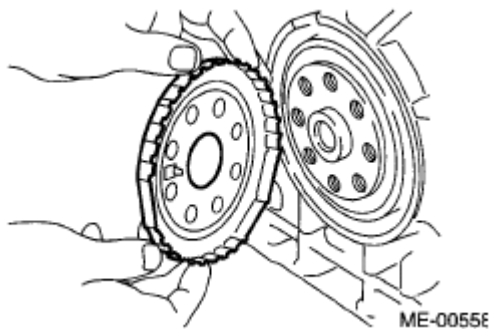


Fig. 169: Identifying Crankshaft Sensor Plate
Courtesy of SUBARU OF AMERICA, INC.

27. Install the drive plate.

To lock the crankshaft, use ST.

ST 498497100 CRANKSHAFT STOPPER

Tightening torque:

81 N.m (8.3 kgf-m, 60 ft-lb)

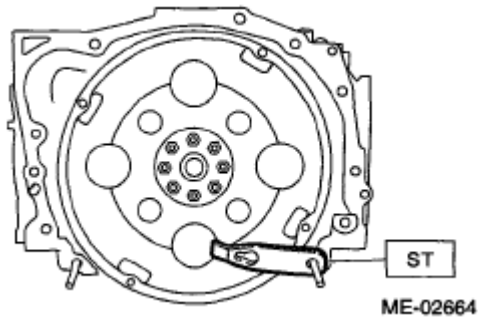
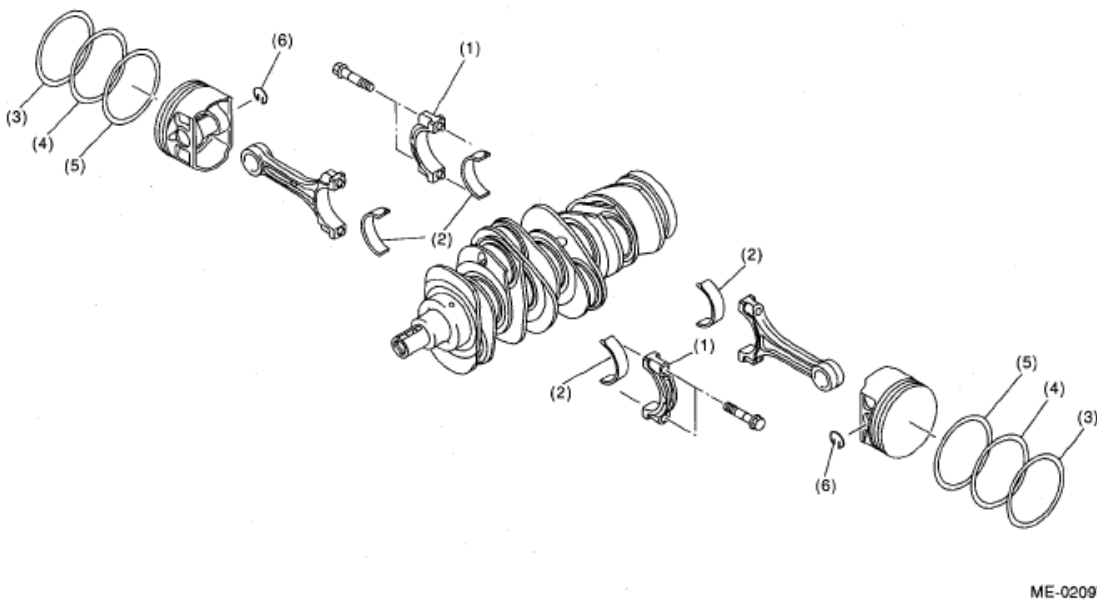


Fig. 170: Identifying Drive Plate
Courtesy of SUBARU OF AMERICA, INC.

28. Install the cylinder head. <Ref. to **INSTALLATION**, Cylinder Head .>
29. Install the camshaft. <Ref. to **INSTALLATION**, Camshaft .>
30. Install the rear chain cover. <Ref. to **INSTALLATION**, Rear Chain Cover .>
31. Install the crank sprocket. <Ref. to **INSTALLATION**, Crank Sprocket .>
32. Install the cam sprocket. <Ref. to **INSTALLATION**, Cam Sprocket .>
33. Install the timing chain assembly. <Ref. to **INSTALLATION**, Timing Chain Assembly .>
34. Install the front chain cover. <Ref. to **INSTALLATION**, Front Chain Cover .>
35. Install the crank pulley. <Ref. to **INSTALLATION**, Crank Pulley .>
36. Install the V-belts. <Ref. to **INSTALLATION**, V-belt .>

DISASSEMBLY



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

Fig. 171: Identifying Piston And Connecting Rod Assembly

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

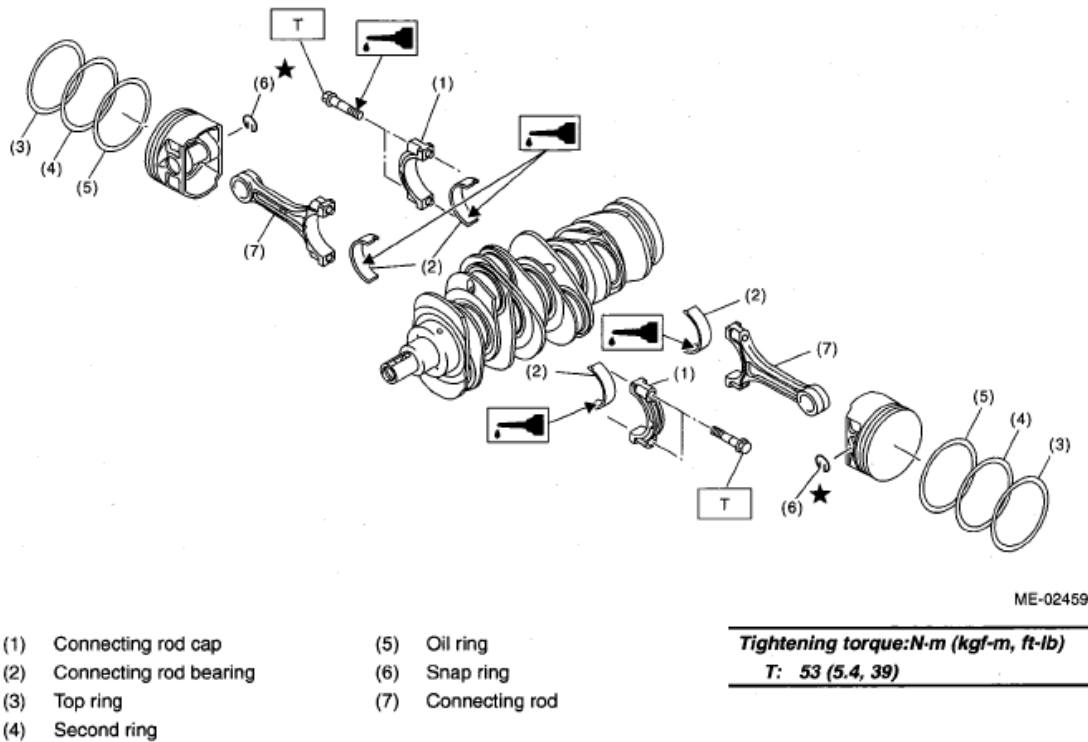


Fig. 172: Identifying Piston And Connecting Rod Assembly With Torque Specification
 Courtesy of SUBARU OF AMERICA, INC.

1. Apply oil to the surfaces of the connecting rod bearings. Install the connecting rod bearings on connecting rods and connecting rod caps.
2. Install the connecting rod on crankshaft.

NOTE: Position each connecting rod with the marking side facing forward.

3. Install the connecting rod cap. Make sure the arrow mark on connecting rod cap facing front during installation.

- CAUTION:**
- 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 bolts, apply oil on the threads and flange end.

Tightening torque:

53 N.m (5.4 kgf-m, 39 ft-lb)

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

INSPECTION

CYLINDER BLOCK

1. Visually check for cracks and damage. Especially, inspect the important parts using liquid penetrant tester.
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.

Standard height of cylinder block:

202 mm (7.95 in)

CYLINDER AND PISTON

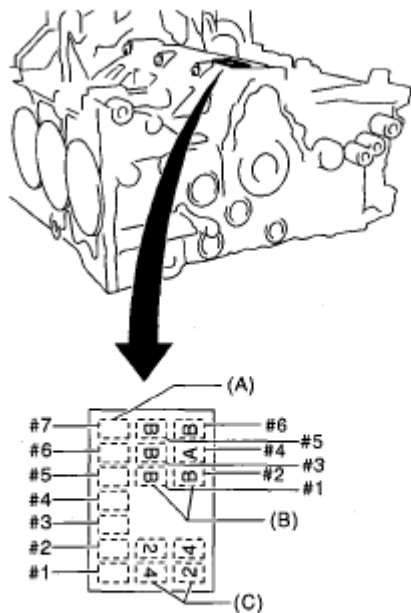
1. The cylinder bore size is stamped on the front upper face of the cylinder block.

- 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: 89.205 - 89.275 mm (3.5120 - 3.5124 in)

B: 89.195 - 89.205 mm (3.5116 - 3.5720 in)



ME-00585

- (A) Main journal size mark
- (B) Cylinder bore size mark
- (C) Cylinder block (RH) - (LH) combination mark

Fig. 173: Identifying Cylinder Bore Size Stamped On Front Upper Face Of Cylinder Block
 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).

Cylindrically:

Standard:

0.030 mm (0.0012 in)

Out-of-roundness:

Standard:

0.010 mm (0.0004 in)

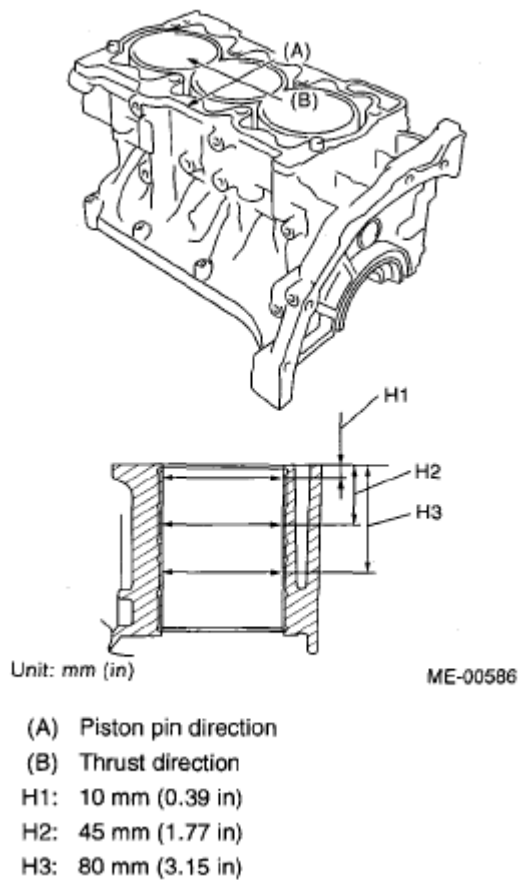


Fig. 174: Identifying Inner Diameter Of Cylinder Diameter
Courtesy of SUBARU OF AMERICA, INC.

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

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

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

Piston grade point H:

37.3 mm (1.4685 in)

Piston outer diameter:

Standard:

A: 89.205 - 89.215 mm (3.5120 - 3.5124 in)

B: 89.195 - 89.205 mm (3.5116 - 3.5120 in)

0.25 mm (0.0098 in) oversize:

89.445 - 89.465 mm (3.5215 - 3.5222 in)

0.50 mm (0.0197 in) oversize:

89.695 - 89.715 mm (3.5313 - 3.5321 in)

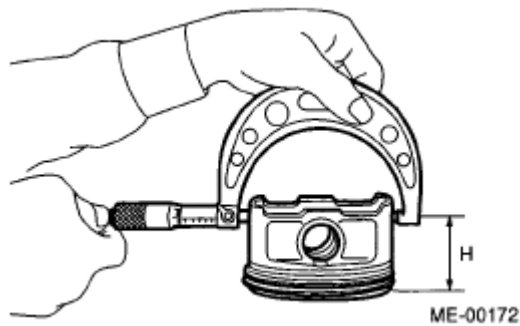


Fig. 175: Measuring Outer Diameter Of Piston
Courtesy of SUBARU OF AMERICA, INC.

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 the value of cylindrically, out-of-round-ness, or cylinder-to-piston clearance measured is out of standard or if there is any damage on the cylinder wall, rebore it to use an oversize piston.

CAUTION:

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

2. If the cylinder inner diameter exceeds 89.715 mm (3.5321 in) after boring and honing, replace the cylinder block.

NOTE: Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, pay attention to this when measuring the cylinder diameter.

PISTON AND PISTON PIN

1. Check the pistons and piston pins for damage, cracks and wear, and the piston ring grooves for wear and damage. Replace if faulty.
2. Measure the piston-to-cylinder clearance at each cylinder. <Ref. to **CYLINDER AND PISTON**, Inspection, Cylinder Block .> If any of the clearances is not within standard, replace the piston, or bore the cylinder to use an oversize piston.
3. Make sure that the piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F). Replace if faulty.

Standard clearance between piston pin and hole in piston:

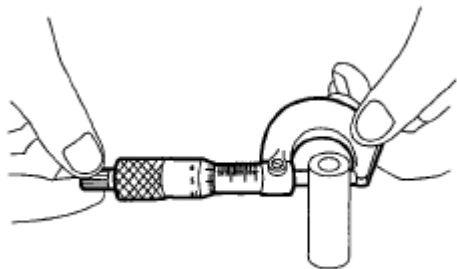
Standard:

0.004 - 0.008 mm (0.0002 - 0.0003 in)



ME-00173

Fig. 176: Identifying Clearance Between Piston Pin And Hole In Piston
Courtesy of SUBARU OF AMERICA, INC.

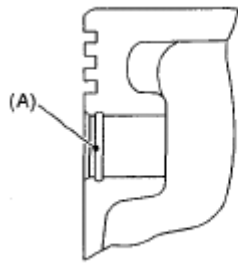


ME-00174

Fig. 177: Identifying 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. 178: Identifying Circlip Installation Groove On Piston
Courtesy of SUBARU OF AMERICA, INC.

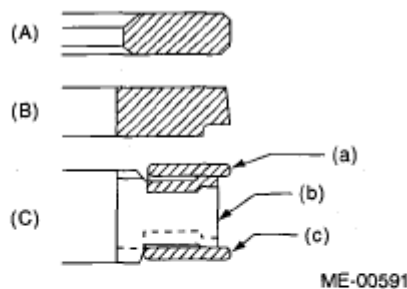
5. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

CAUTION:

- Marks are displayed on the end of top and second rings. When installing the ring to piston, face this mark upward.
- Oil ring consists of the upper rail, expander and lower rail. When installing on the piston, be careful of the direction of each rail



ME-00591

- (A) Top ring
- (B) Second ring
- (C) Oil ring
- (a) Upper rail
- (b) Expander
- (c) Lower rail

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

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

gauge.

TIGHTENING TORQUE SPECIFICATION

		Standard
		mm (in)
Piston ring gap	Top ring	0.20 - 0.35 (0.0079 - 0.0138)
	Second ring	0.35 - 0.50 (0.0138 - 0.0197)
	Oil ring	0.20 - 0.60 (0.0079 - 0.0236)

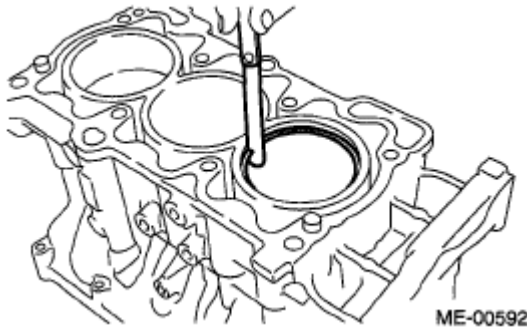


Fig. 180: Identifying Piston Ring Gap With Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

- 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.

THICKNESS SPECIFICATION

		Standard
		mm (in)
Clearance between piston ring and piston ring groove	Top ring	0.040 - 0.080 (0.0016 - 0.0031)
	Second ring	0.030 - 0.070 (0.0012 - 0.0028)
Clearance between oil ring and oil ring groove		0.045 - 0.125 (0.0018 - 0.0049)

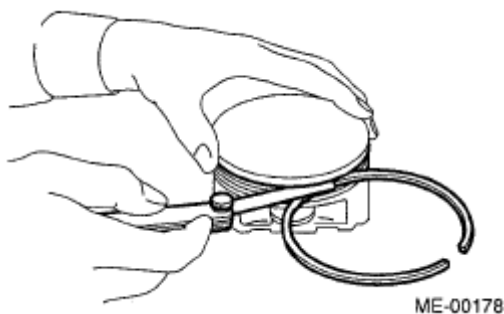
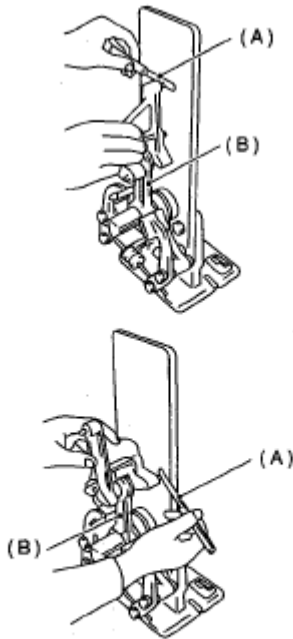


Fig. 181: Identifying Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

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



ME-00179

- (A) Thickness gauge
(B) Connecting rod

Fig. 182: Identifying Thickness Gauge And Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod fitted with bearing to crankshaft and measure the thrust clearance. If the clearance exceeds the standard or offset wear occurs, replace the connecting rod.

Connecting rod thrust clearance:

Standard:

0.070 - 0.330 mm (0.0028 - 0.0130 in)

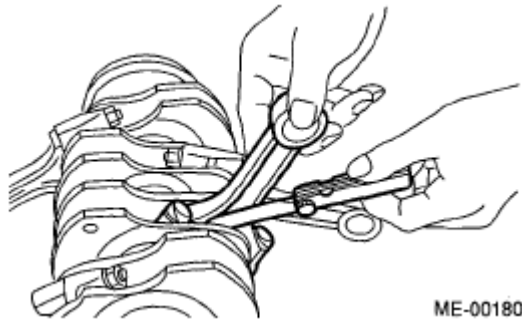


Fig. 183: Identifying Connecting Rod Side Clearance
Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard:

0.016 - 0.043 mm (0.0006 - 0.0017 in)

STANDARD SPECIFICATION

Unit: mm (in)		
Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.490 - 1.506 (0.0587 - 0.0593)	51.984 - 52.000 (2.0466 - 2.0472)
0.03 (0.0012) undersize	1.509 - 1.513 (0.0594 - 0.0596)	51.954 - 51.970 (2.0454 - 2.0461)
0.05 (0.0020) undersize	1.519 - 1.523 (0.0598 - 0.0600)	51.934 - 51.950 (2.0446 - 2.0453)
0.25 (0.0098) undersize	1.619 - 1.623 (0.0637 - 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. Also measure the piston pin clearance at connecting rod small end.

Clearance between piston pin and bushing:

Standard:

0 - 0.022 mm (0 - 0.0009 in)

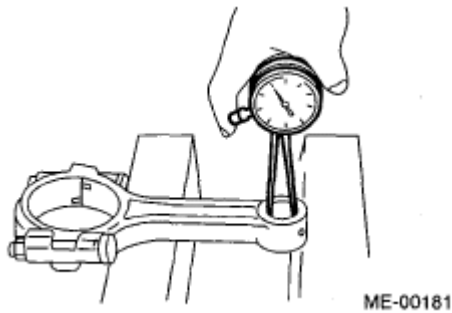


Fig. 184: Identifying Clearance Between Piston Pin And Bushing
Courtesy of SUBARU OF AMERICA, INC.

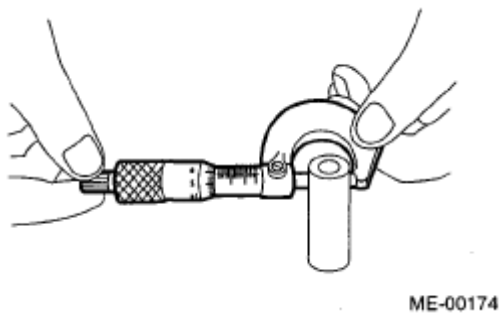


Fig. 185: Identifying Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

7. Replacement procedure is as follows.

1. Remove the bushing from connecting rod with ST and press.
2. Press the bushing with ST after applying oil on the periphery of the new bushing.

ST 18350AA000 CONNECTING ROD BUSHING REMOVER AND INSTALLER

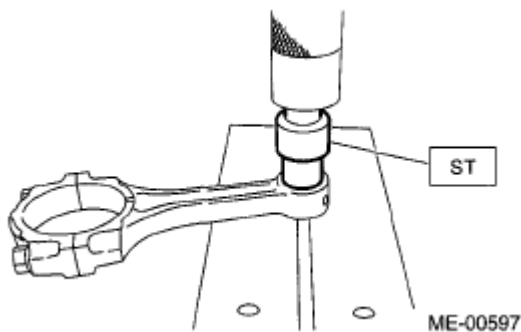


Fig. 186: Identifying Bushing With ST
Courtesy of SUBARU OF AMERICA, INC.

3. Make two 3 mm (0.12 in) holes in the pressed bushing by aligning with the pre-manu-factured holes on the connecting rod. 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 defective.
2. Check the crankshaft for bend, and repair or replace if needed. Repair or replace if bend.

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 check the crankshaft bend using a dial gauge.

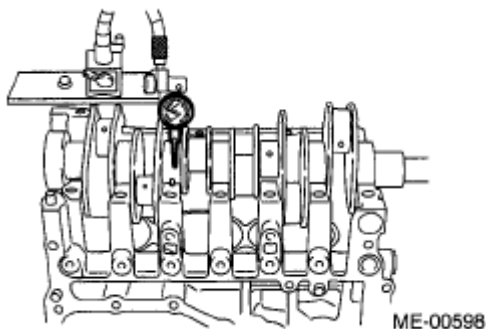


Fig. 187: Identifying Crankshaft And Crankshaft Bearing
Courtesy of SUBARU OF AMERICA, INC.

3. Inspect the crank journal and crank pin for wear. If they are not within the specification, replace the bearing with a suitable (undersize) one, and replace or 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 and crank journal:

Out-of-roundness:

0.005 mm (0.0002 in)

Cylindrically:

0.006 mm (0.0002 in)



Fig. 188: Identifying Crank Journal And Crank Pin
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL AND CRANK PIN SPECIFICATION

		Unit: mm (in)		
		Crank journal diameter		Crank pin outer diameter
		#1, #3, #5, #7	#2, #4, #6	
Standard	Journal O.D.	63.992 - 64.008 (2.5194 - 2.5200)		51.984 - 52.000 (2.0466 - 2.0472)
	Bearing size (Thickness at center)	1.992 - 2.005 (0.0784 - 0.0789)	1.996 - 2.009 (0.0786 - 0.0791)	1.490 - 1.506 (0.0587 - 0.0593)
0.03 (0.0012) undersize	Journal O.D.	63.962 - 63.978 (2.5182 - 2.5188)		51.954 - 51.970 (2.0454 - 2.0461)
	Bearing size (Thickness at center)	2.011 - 2.014 (0.0792 - 0.0793)	2.015 - 2.018 (0.0793 - 0.0794)	1.509 - 1.513 (0.0594 - 0.0596)
0.05 (0.0020) undersize	Journal O.D.	63.942 - 63.958 (2.5174 - 2.5180)		51.934 - 51.950 (2.0446 - 2.0453)
	Bearing size (Thickness at center)	2.021 - 2.024 (0.0796 - 0.0797)	2.025 - 2.028 (0.0797 - 0.0798)	1.519 - 1.523 (0.0598 - 0.0600)
0.25 (0.0098) undersize	Journal O.D.	63.742 - 63.758 (2.5095 - 2.5102)		51.734 - 51.750 (2.0368 - 2.0374)
	Bearing size (Thickness at center)	2.121 - 2.124 (0.0835 - 0.0836)	2.125 - 2.128 (0.0837 - 0.0838)	1.619 - 1.623 (0.0637 - 0.0639)

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

Crankshaft thrust clearance:

Standard:

0.030 - 0.115 mm (0.0012 - 0.0045 in)

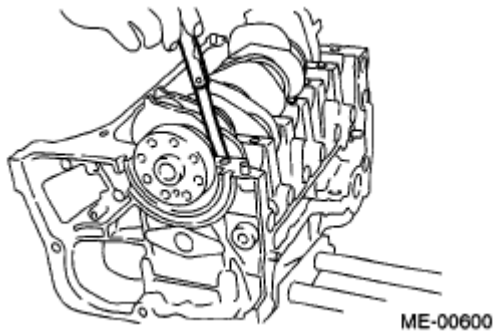


Fig. 189: Identifying Thrust Clearance Of Crankshaft
 Courtesy of SUBARU OF AMERICA, INC.

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

Crankshaft oil clearance:

Standard:

0.010 - 0.030 mm (0.0004 - 0.0012 in)

OIL FLOW CONTROL SOLENOID VALVE

REMOVAL

Oil flow control solenoid valve is a unit with camshaft cap. Refer to "Camshaft" for removal. <Ref. to **REMOVAL**, Camshaft .>

INSTALLATION

Install in the reverse order of removal.

OIL SWITCHING SOLENOID VALVE

REMOVAL

1. Disconnect the ground cable from the battery.
2. Remove the air intake chamber. <Ref. to **REMOVAL** , Air Intake Chamber .>
3. Disconnect the connector from oil switching solenoid valve.

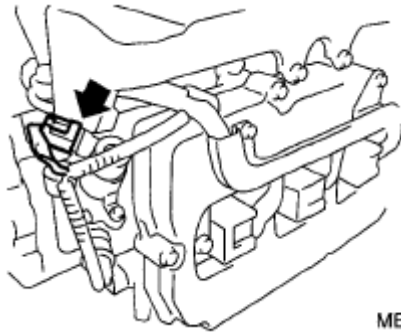


Fig. 190: Identifying Connector And Oil Switching Solenoid Valve
 Courtesy of SUBARU OF AMERICA, INC.

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

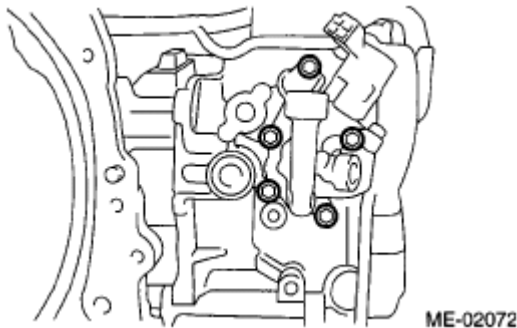


Fig. 191: Identifying Oil Flow Control Solenoid Valve Holder And Cylinder Head
 Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the oil switching solenoid valve holder.

NOTE: **Use a new gasket.**

1. Temporarily tighten the bolts by tightening torque of 5 - 10 N.m (0.5 - 1.0 kgf-m, 3.7 - 7.4 ft-lb) in order shown in the figure.
2. Tighten the bolts by tightening torque of 10 ± 0.5 N.m (1.0 ± 0.05 kgf-m, 7.4 ± 0.37 ft-lb) in order shown in the figure.

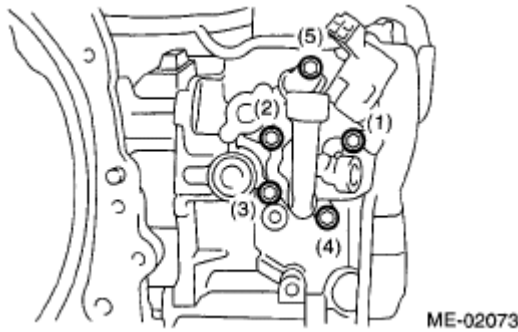


Fig. 192: Identifying Oil Switching Solenoid Valve Holder Bolt
Courtesy of SUBARU OF AMERICA, INC.

2. Install the oil temperature sensor. <Ref. to **INSTALLATION** , Oil Temperature Sensor .>
3. Install the variable valve lift diagnosis oil pressure switch. <Ref. to **INSTALLATION** , Variable Valve Lift Diagnosis Oil Pressure Switch .>
4. Install the oil switching solenoid valve.
5. Connect the connector to oil switching solenoid valve.

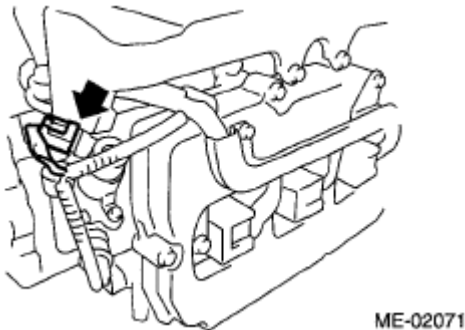


Fig. 193: Identifying Connector To Oil Switching Solenoid Valve
Courtesy of SUBARU OF AMERICA, INC.

6. Install the air intake chamber. <Ref. to **INSTALLATION** , Air Intake Chamber .>
7. Connect the battery ground cable to the battery.

INTAKE AND EXHAUST VALVE

SPECIFICATION

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

PISTON

SPECIFICATION

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

CONNECTING ROD

SPECIFICATION

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

CRANKSHAFT

SPECIFICATION

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

ENGINE TROUBLE IN GENERAL

INSPECTION

NOTE: The "RANK" shown in the chart shows the possibilities of the cause of trouble in order from "most likely" to "rarely".

SYMPTOM REFERENCE

Symptom	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
1) Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective inhibitor switch or neutral switch	C
		Defective starter	B
	Battery	Improper connection of terminal	A
		Run-down battery	A
		Defective charging system	B
	Friction	Seizure of crankshaft and connecting rod bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
	Starter	Defective starter	C
	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Fuel line	Defective fuel pump and relay	A
		Clogged fuel line	C
		Lack of or insufficient fuel	B

2007 Subaru B9 Tribeca

2007 ENGINE Mechanical (H6DO) - B9 Tribeca

2) Initial combustion does not occur.	Timing chain	Trouble	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
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
3) Initial combustion occurs.	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Defective intake manifold gasket	B
		Defective throttle body gasket	B
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of or insufficient fuel	B
	Timing chain	Trouble	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
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
		Loosened or cracked intake duct	B
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	C

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4) Engine stalls after initial combustion.	Intake system	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 chain	Trouble	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
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
2. Rough idle and engine stall	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	C
		Loosened oil filler cap	B
		Dirty air cleaner element	C
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of or insufficient fuel	B
	Timing chain	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

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		Improper engine oil (low viscosity)	B
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Overheating	C
	Others	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
3. Low output, hesitation and poor acceleration	Engine control system	<Ref. to BASIC DIAGNOSTIC PROCEDURE . >	A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	B
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	A
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of or insufficient fuel	C
	Timing chain	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
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
	Lubrication system	Incorrect oil pressure	B
	Cooling	Overheating	C

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	system	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 chain	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
	Cooling system	Overheating	B
	Others	Evaporative emission control system malfunction	C
5. Engine does not return to idle.	Engine control	system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >	A
	Intake system	Loosened or cracked vacuum hose	A
	Others	Stuck or damaged throttle valve	A
6. Dieseling (Run-on)	Engine control	system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >	A
	Cooling system	Overheating	B
	Others	Evaporative emission control system malfunction	B
	Engine control	system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >	A
		Loosened or cracked intake duct	C
		Loosened or cracked PCV hose	C

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7. After burning in exhaust system	Intake system	Loosened or cracked vacuum hose	B
		Defective PCV valve	B
		Loosened oil filler cap	C
	Timing chain	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
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C
	Others	Evaporative emission control system malfunction	C
8. Knocking	Engine control system	system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >	A
	Intake system	Loosened oil filler cap	B
	Timing chain	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	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	Loosened oil pump attaching bolts and defective gasket	B
		Defective oil filter o-ring	B
		Defective crankshaft oil seal	B

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10. Excessive fuel consumption	system	Defective rocker cover gasket	B
		Loosened oil drain plug or defective gasket	B
		Loosened oil pan fitting bolts or defective oil pan	B
	Engine control system	<Ref. to BASIC DIAGNOSTIC PROCEDURE . >	A
	Intake system	Dirty air cleaner element	A
	Timing chain	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
		Trouble of tappet	C
		Trouble of tappet. In case noise occurs with valve moving. Or the harness involved to oil switching solenoid valve, variable valve lift diagnosis oil pressure switch and variable valve lift has trouble in a past.	B
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C
A - Most likely B - Sometimes C - Rarely			

ENGINE NOISE

INSPECTION

ENGINE NOISE SPECIFICATION

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

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	Oil pressure is normal.	Damaged engine mounting
High-pitched clank	Sound is noticeable when accelerating with an overload condition.	• Ignition timing advanced • Accumulation of carbon inside combustion chamber • Wrong spark plug • Improper gasoline
Clank when engine speed is between 1,000 and 2,000 rpm.	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	• Worn crankshaft main bearing • Worn connecting rod bearing (large end)
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	• Worn cylinder liner and piston ring • Broken or stuck piston ring • Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	• Unusually worn valve lifter • Worn cam gear • Worn camshaft journal bore in cylinder head
Squeaky sound	-	• Insufficient generator lubrication
Rubbing sound	-	• Poor contact of generator brush and rotor
Gear scream when starting engine	-	• Defective ignition starter switch • Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	• Loose drive belt • Defective water pump shaft
Hissing sound	-	• Insufficient compression • Air leakage in air intake system, hose, connection or manifold
Timing chain noise	-	• Loose timing chain • Chain contacting with case/adjacent part
Valve tappet noise	-	• Incorrect valve clearance • Trouble of tappet
NOTE:		

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- (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 .> and Inspection Mode <Ref. to PROCEDURE .> after connecting the fuel injector connector.