

2006 Subaru Forester X

2006 ENGINE Mechanical (H4SO Engine) - Forester

2006 ENGINE**Mechanical (H4SO Engine) - Forester****GENERAL DESCRIPTION****SPECIFICATION****GENERAL SPECIFICATION**

	Model			2.5 L
Engine	Cylinder arrangement			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve system mechanism			Belt driven Single overhead camshaft 4-valve/cylinder
	Bore x Stroke		mm (in)	99.5 x 79.0 (3.917 x 3.110)
	Displacement		cm ³ (cu in)	2,457 (150)
	Compression ratio			10.0
	Compression pressure (at 350 rpm)		kPa (kg/cm ² , psi)	1,020 - 1,275 (10.4 - 13.0, 148 - 185)
	Number of piston rings			Pressure ring: 2, Oil ring: 1
	Intake valve timing	Constant	Open	BTDC 0°
			Close	ABDC 58°
		Low speed	Open	BTDC 0°
			Close	ABDC -50°
		High speed	Open	BTDC 14°
			Close	ABDC 62°
	Exhaust valve timing		Open	BBDC54°
			Close	ATDC14°
	Valve clearance mm (in)		Intake	0.20±0.04 (0.0079±0.0016)
			Exhaust	0.25±0.04 (0.0098±0.0016)
Idling speed [at neutral position on MT, or "P" or "N" position on AT] rpm		MT	650±100 (No load) 850±100 (A/C ON)	
		AT	700±100 (No load) 850±100 (A/C ON)	
Ignition order				1 --> 3 --> 2 --> 4
Ignition timing BTDC/rpm		MT	10°±8°/650	

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AT

15°±8°/700

NOTE: US: undersize OS: oversize

GENERAL SPECIFICATION

Belt tension adjuster	Protrusion of adjuster rod			mm (in)	5.2 - 6.2 (0.205 - 0.244)	
Belt tensioner	Spacer O.D.			mm (in)	17.955 - 17.975 (0.7069 - 0.7077)	
	Tensioner bushing I.D.			mm (in)	18.00 - 18.08 (0.7087 - 0.7118)	
	Clearance between spacer and bushing: mm (in)			Standard	0.025 - 0.125 (0.0010 - 0.0049)	
				Limit	0.175 (0.0069)	
	Side clearance of spacer mm (in)			Standard	0.20 - 0.55 (0.0079 - 0.0217)	
				Limit	0.81 (0.0319)	
Valve rocker arm	Clearance between shaft and arm mm (in)			Standard	0.020 - 0.054 (0.0008 - 0.0021)	
				Limit	0.10 (0.0039)	
	Bending limit			mm (in)	0.025 (0.0010)	
	Thrust clearance mm (in)			Standard	0.030 - 0.090 (0.0012 - 0.0035)	
				Limit	0.10 (0.0039)	
	Cam lobe height mm (in)	Intake	Constant	Standard	40.075 - 40.175 (1.5778 - 1.5817)	
				Limit:	39.975 (1.5738)	
			Low speed	Standard	35.182 - 35.282 (1.3851 - 1.3891)	
				Limit:	35.085 (1.3812)	

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Camshaft			High speed	Standard	40.315 - 40.415 (1.5872 - 1.5911)
				Limit:	40.215 (1.5833)
		Exhaust	Standard	40.149 - 40.249 (1.5807 - 1.5846)	
			Limit	40.049 (1.5767)	
	Camshaft journal O.D.			mm (in)	31.928 - 31.945 (1.2570 - 1.2577)
	Camshaft journal hole I.D.			mm (in)	32.000 - 32.018 (1.2598 - 1.2605)
	Oil clearance		mm (in)	Standard	0.055 - 0.090 (0.0022 - 0.0035)
				Limit	0.10 (0.0039)
Cylinder head	Surface warpage limit (Mating surface with cylinder block)			mm (in)	0.03 (0.001)
	Grinding limit			mm (in)	0.1 (0.004)
	Standard height			mm (in)	97.5 (3.84)
Valve seat	Refacing angle				90°
	Contacting width	mm (in)	Intake	Standard	0.8 - 1.4 (0.03 - 0.055)
				Limit	1.7 (0.067)
			Exhaust	Standard	1.2 - 1.8 (0.047 - 0.071)
				Limit	2.2 (0.087)
Valve guide	Inside diameter			mm (in)	6.000 - 6.012 (0.2362 - 0.2367)
	Protrusion above head		mm (in)	Intake	20.0 - 21.0 (0.787 - 0.827)
				Exhaust	16.5 - 17.5 (0.650 - 0.689)
	Head edge thickness	mm (in)	Intake	Standard	0.8 - 1.2 (0.03

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Valve					- 0.047)	
				Limit	0.6 (0.024)	
			Exhaust	Standard	1.0 - 1.4 (0.039 - 0.055)	
				Limit	0.6 (0.024)	
	Stem outer diameter		mm (in)	Intake	5.950 - 5.965 (0.2343 - 0.2348)	
				Exhaust	5.945 - 5.960 (0.2341 - 0.2346)	
	Valve stem gap	mm (in)	Standard	Intake	0.035 - 0.062 (0.0014 - 0.0024)	
				Exhaust	0.040 - 0.067 (0.0016 - 0.0026)	
			Limit	-	0.15 (0.0059)	
	Overall length		mm (in)	Intake	120.6 (4.75)	
Exhaust				121.7 (4.79)		
Valve spring	Free length				mm (in)	55.2 (2.173)
	Squareness					2.5°, 2.4 (0.094) or less
	Tension/spring height		N (kgf, lb)/mm (in)	Set	235.3 - 270.7 (24 - 27.6, 52.9 - 60.8)/45.0 (1.772)	
				Lift	578.9 - 639.9 (59.1 - 65.3, 130.3 - 143.9)/34.7 (1.366)	
	Surface warpage limit (mating with cylinder head)					mm (in)
Grinding limit					mm (in)	0.1 (0.004)
Standard height					mm (in)	201.0 (7.91)
Cylinder inner diameter		mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)	
				B	99.495 - 99.505 (3.9171 -	

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Cylinder block					3.9175)
	Taper		mm (in)	Standard	0.015 (0.0006)
				Limit	0.050 (0.0020)
	Out-of-roundness		mm (in)	Standard	0.010 (0.0004)
				Limit	0.050 (0.0020)
	Piston clearance		mm (in)	Standard	-0.010 - 0.010 (-0.00039 - 0.00039)
				Limit	0.030 (0.0012)
Boring limit			mm (in)	0.5 (0.020)	
Piston	Outer diameter	mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)
				B	99.495 - 99.505 (3.9171 - 3.9175)
			0.25 (0.0098) OS		99.745 - 99.765 (3.9270 - 3.9278)
			0.50 (0.0197) OS		99.995 - 100.015 (3.9368 - 3.9376)
			Piston pin specified diameter		
Piston pin	Outer diameter			mm (in)	22.994 - 23.000 (0.9053 - 0.9055)
	Clearance between piston and piston pin:	mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)	
			Limit	0.020 (0.0008)	
	Degree of fit				Piston pin must be fitted into position with thumb at 20°C (68°F).
			Top ring	Standard	0.20 - 0.35 (0.0079 -

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Piston ring	Ring closed gap	mm (in)			0.0138)
				Limit	1.0 (0.039)
			Second ring	Standard	0.37 - 0.52 (0.0144 - 0.0203)
				Limit	1.0 (0.039)
	Ring groove gap	mm (in)	Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)
				Limit	1.5 (0.059)
			Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)
				Limit	0.15 (0.0059)
Connecting rod	Bend or twist per 100 mm (3.94 in) in length	mm (in)		Limit	0.10 (0.0039)
			Side clearance of large end	Standard	0.070 - 0.330 (0.0028 - 0.0130)
				Limit	0.4 (0.016)
Bearing of large end	Oil clearance	mm (in)	Standard		0.016 - 0.044 (0.00063 - 0.0017)
			Limit		0.05 (0.0020)
	Bearing size (Thickness at center)	mm (in)	Standard		1.492 - 1.501 (0.0587 - 0.0591)
			0.03 (0.0012) US		1.510 - 1.513 (0.0594 - 0.0596)
			0.05 (0.0020) US		1.520 - 1.523 (0.0598 - 0.0600)
			0.25 (0.0098) US		1.620 - 1.623 (0.0638 - 0.0639)
Bushings of small end	Clearance between piston pin and bushing mm (in)		Standard		0 - 0.022 (0 - 0.0009)
			Limit		0.030 (0.0012)
	Bend limit		mm (in)		0.035 (0.0014)

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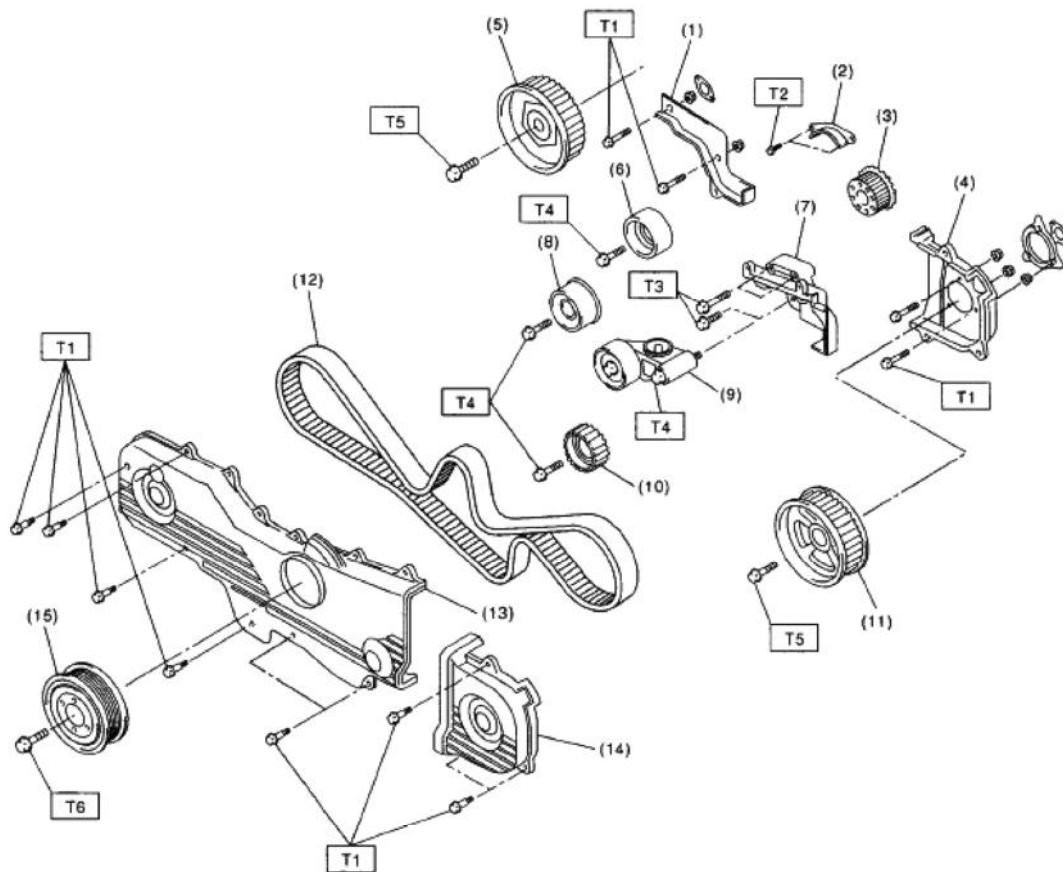
Crankshaft	Crank pin	Out-of-roundness	mm (in)	0.003 (0.0001)
		Cylindricality	mm (in)	0.004 (0.0002)
		Grinding limit (dia.)	mm (in)	To 51.750 (2.0374)
	Crank journal	Out-of-roundness	mm (in)	0.005 (0.0002)
		Cylindricality	mm (in)	0.006 (0.0002)
		Grinding limit (dia.)	mm (in)	To 59.750 (2.3524)
	Crank pin outer diameter	Standard	mm (in)	51.984 - 52.000 (2.0466 - 2.0472)
		0.03 (0.0012) US	mm (in)	51.954 - 51.970 (2.0454 - 2.0461)
		0.05 (0.0020) US	mm (in)	51.934 - 51.950 (2.0446 - 2.0453)
		0.25 (0.0098) US	mm (in)	51.734 - 51.750 (2.0368 - 2.0374)
	Crank Journal outer diameter	Standard	mm (in)	59.992 - 60.008 (2.3619 - 2.3625)
		0.03 (0.0012) US	mm (in)	59.962 - 59.978 (2.3607 - 2.3613)
		0.05 (0.0020) US	mm (in)	59.942 - 59.958 (2.3599 - 2.3605)
		0.25 (0.0098) US	mm (in)	59.742 - 59.758 (2.3520 - 2.3527)
	Thrust clearance	Standard	mm (in)	0.030 - 0.115 (0.0012 - 0.0045)
		Limit		0.25 (0.0098)
		Standard		0.010 - 0.030

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	Oil clearance	mm (in)		(0.0001 - 0.0012)
			Limit	0.40 (0.016)
Main bearing	Main bearing	#1, #3	Standard	1.998 - 2.011 (0.0787 - 0.0792)
			0.03 (0.0012)US	2.017 - 2.020 (0.0794 - 0.0795)
			0.05 (0.0020)US	2.027 - 2.030 (0.0798 - 0.0799)
			0.25 (0.0098)US	2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #5	Standard	2.000 - 2.013 (0.0787 - 0.0793)
			0.03 (0.0012)US	2.019 - 2.022 (0.0795 - 0.0796)
			0.05 (0.0020)US	2.029 - 2.032 (0.0799 - 0.0800)
			0.25 (0.0098)US	2.129 - 2.132 (0.0838 - 0.0839)

COMPONENT**TIMING BELT**



ME-02400

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

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

T1: 5 (0.5, 3.6)

T2: 9.75 (1.0, 7.2)

T3: 24.5 (2.5, 18.1)

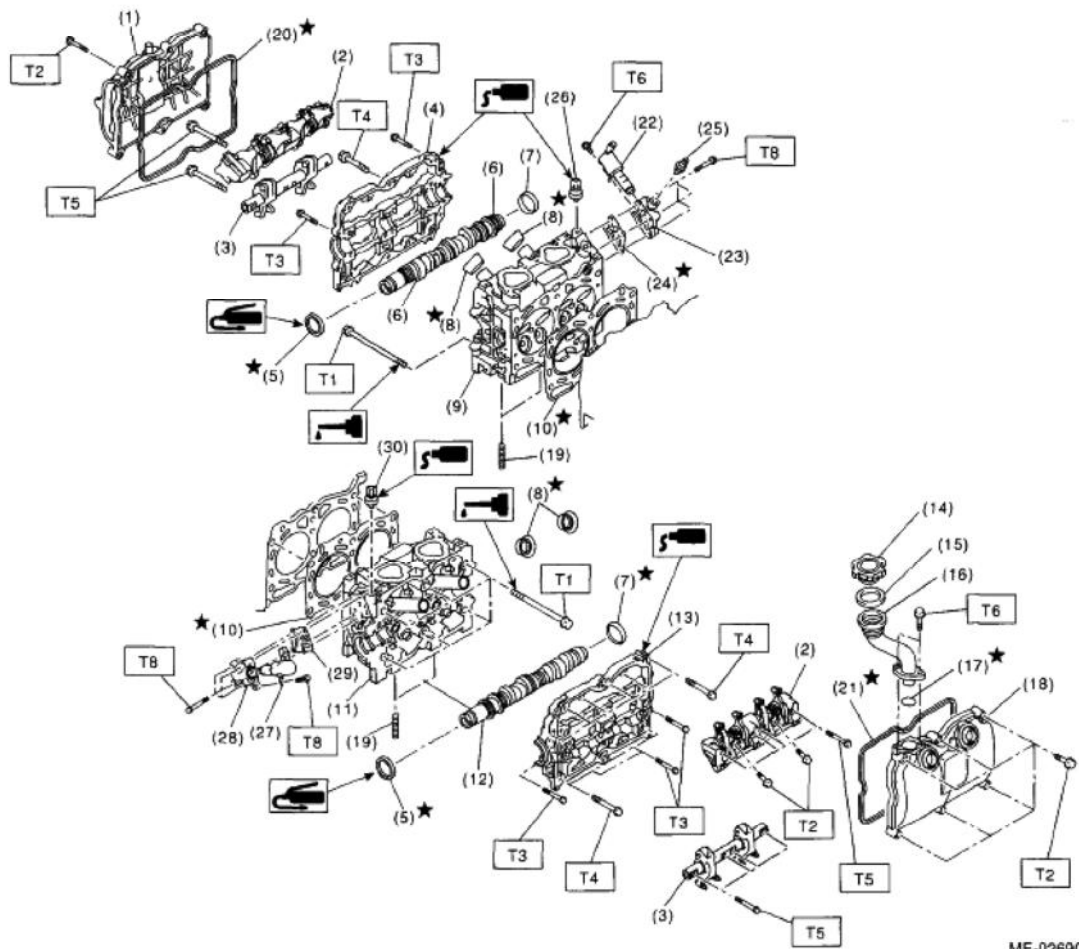
T4: 39 (4.0, 28.9)

T5: 78 (8.0, 57.9)

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

Fig. 1: Identifying Timing Belt Components

CYLINDER HEAD AND CAMSHAFT



ME-02690

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

Tightening torque: N·m (kgf-m, ft-lb)

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

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

T3: 9.75 (1.0, 7.2)

T4: 18 (1.8, 13.0)

T5: 25 (2.5, 18.1)

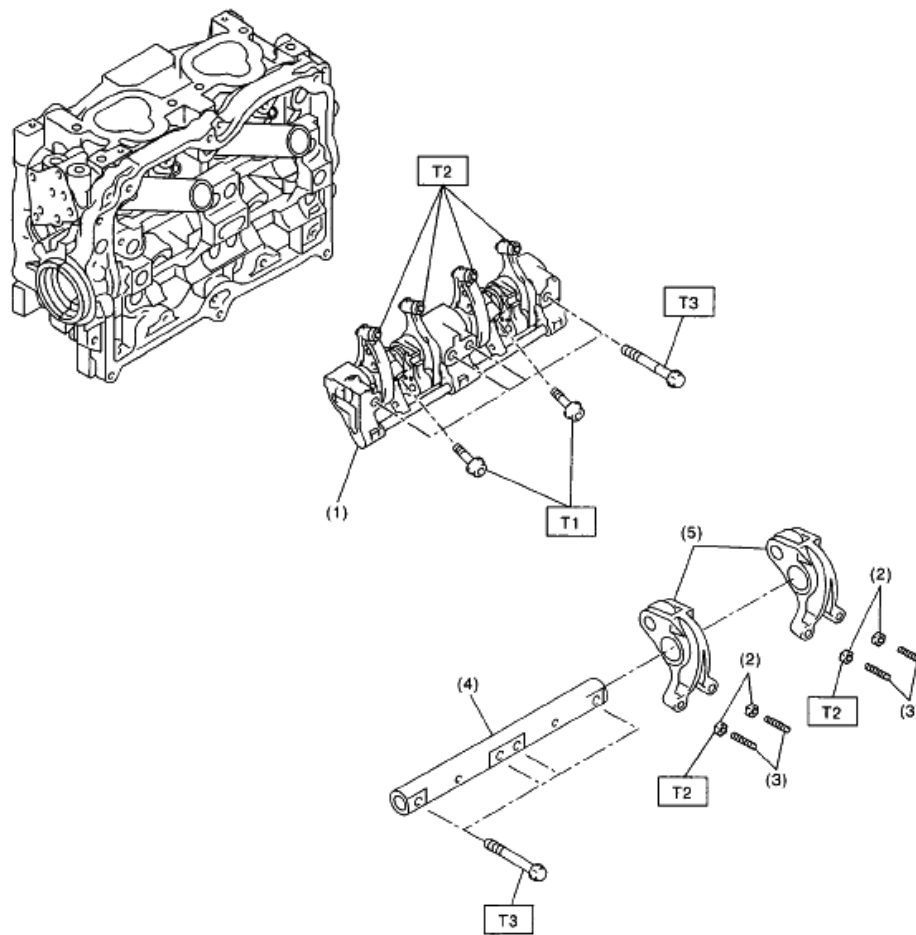
T6: 6.4 (0.65, 4.7)

T7: 8 (0.8, 5.9)

T8: 10 (1.0, 7.4)

Fig. 2: Identifying Cylinder Head And Camshaft Components

VALVE ROCKER ASSEMBLY



ME-02691

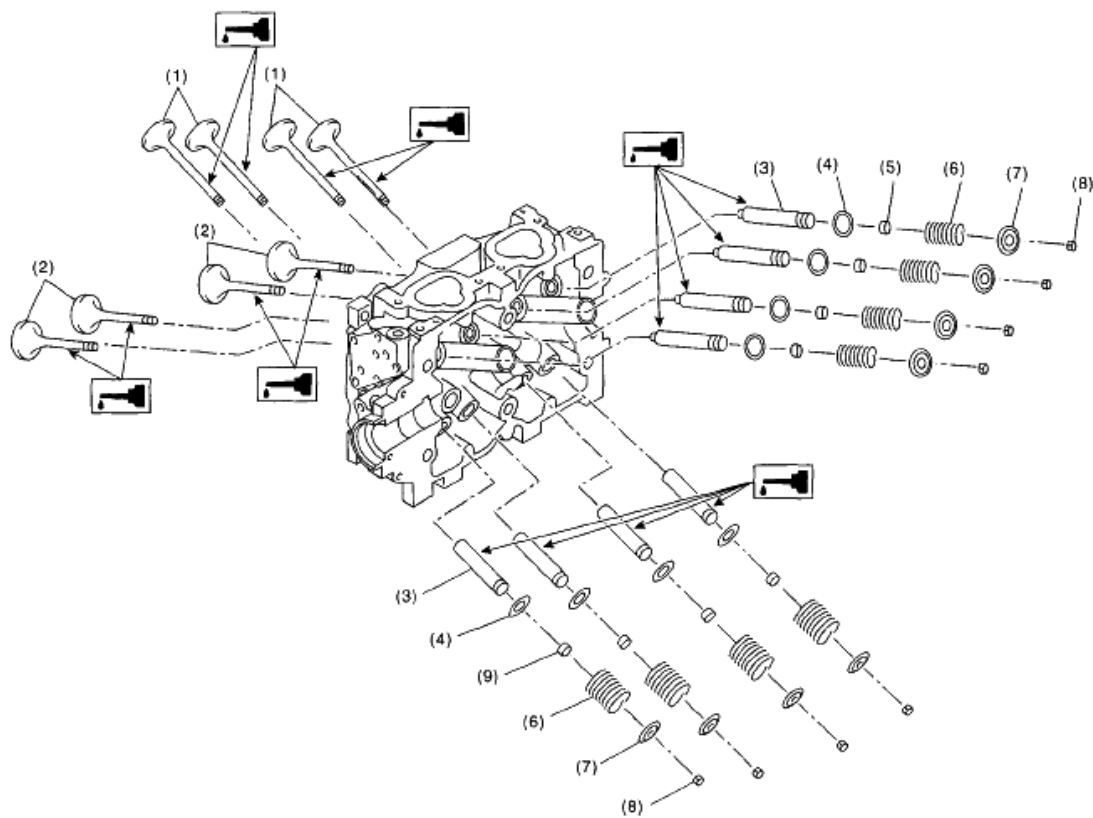
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|----------------------------------|------------------------------|
| (1) Intake valve rocker arm ASSY | (5) Exhaust valve rocker arm |
| (2) Valve rocker nut | |
| (3) Valve rocker adjusting screw | |
| (4) Exhaust rocker shaft | |

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

- T1: 8 (0.8, 5.9)**
T2: 9.75 (1.0, 7.2)
T3: 25 (2.5, 18.1)

Fig. 3: Identifying Valve Rocker Assembly Components

CYLINDER HEAD AND VALVE ASSEMBLY

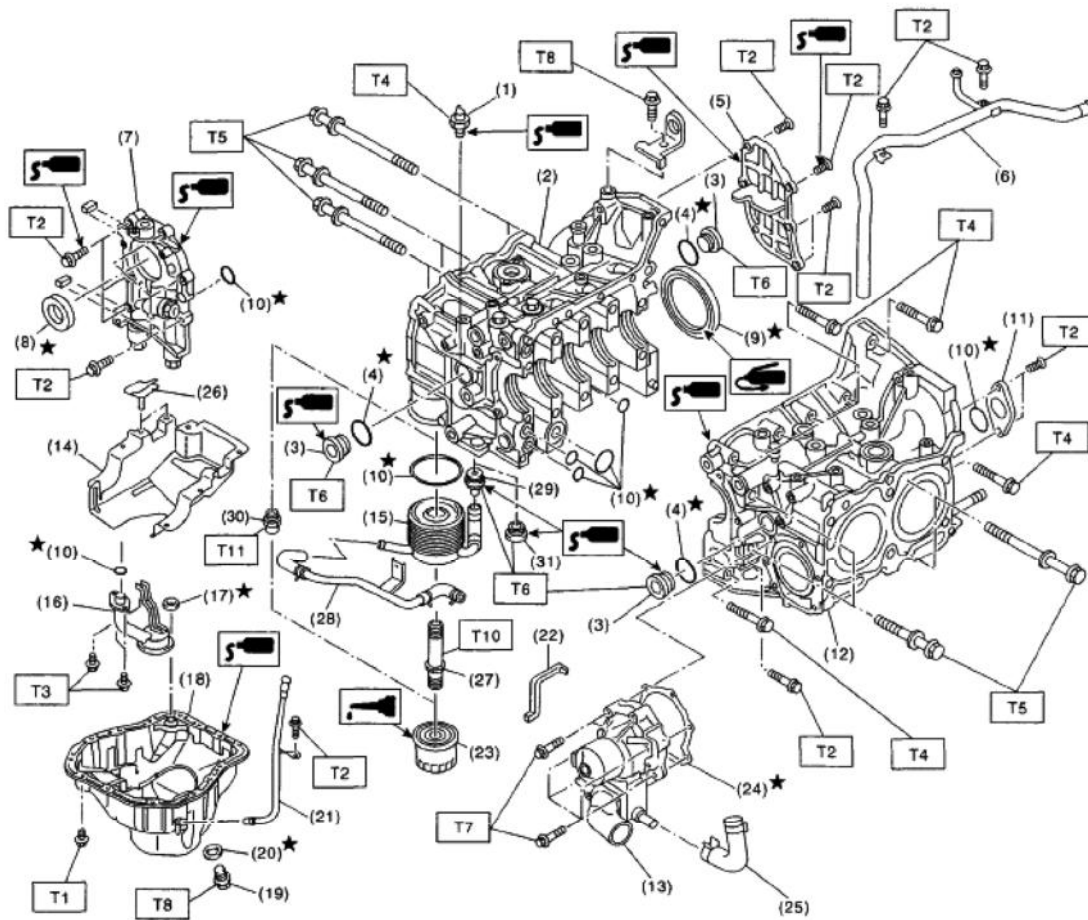


ME-02743

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

Fig. 4: Identifying Cylinder Head And Valve Assembly Components

CYLINDER BLOCK



ME-02692

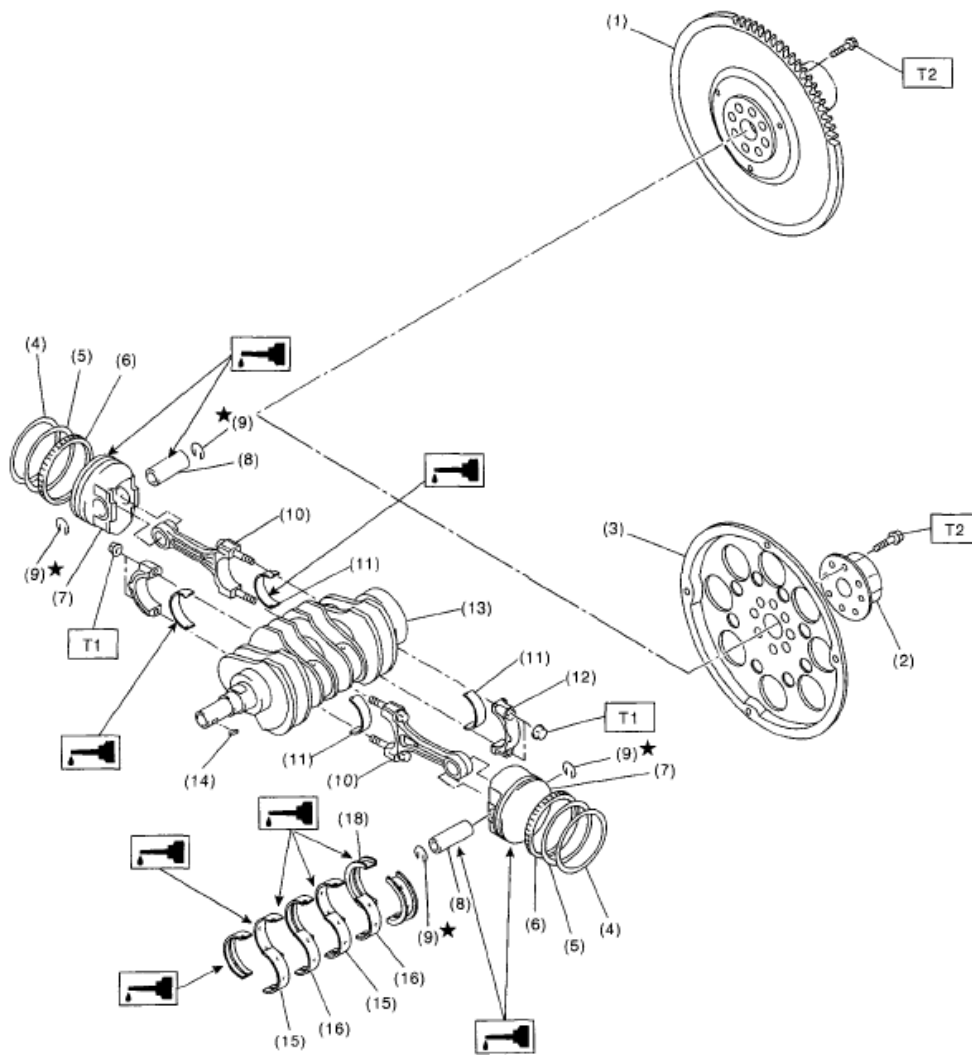
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|----------------------------|-----------------------------------|
| (1) Oil pressure switch | (17) Gasket |
| (2) Cylinder block (RH) | (18) Oil pan |
| (3) Service hole plug | (19) Drain plug |
| (4) Gasket | (20) Metal gasket |
| (5) Oil separator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

Tightening torque: N·m (kgf-m, ft-lb)

- | | |
|------|---|
| T1: | 5 (0.5, 3.6) |
| T2: | 6.4 (0.65, 4.7) |
| T3: | 10 (1.0, 7.2) |
| T4: | 25 (2.5, 18.1) |
| T5: | <Ref. to
LATION, Cylinder Block.> |
| T6: | 70 (7.1, 50.6) |
| T7: | First 12 (1.2, 8.7)
Second 12 (1.2, 8.7) |
| T8: | 16 (1.6, 11.6) |
| T9: | 44 (4.5, 33) |
| T10: | 54 (5.5, 40) |
| T11: | 45 (4.6, 33.3) |

Fig. 5: Identifying Cylinder Block Components

CRANKSHAFT AND PISTON



ME-02693

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

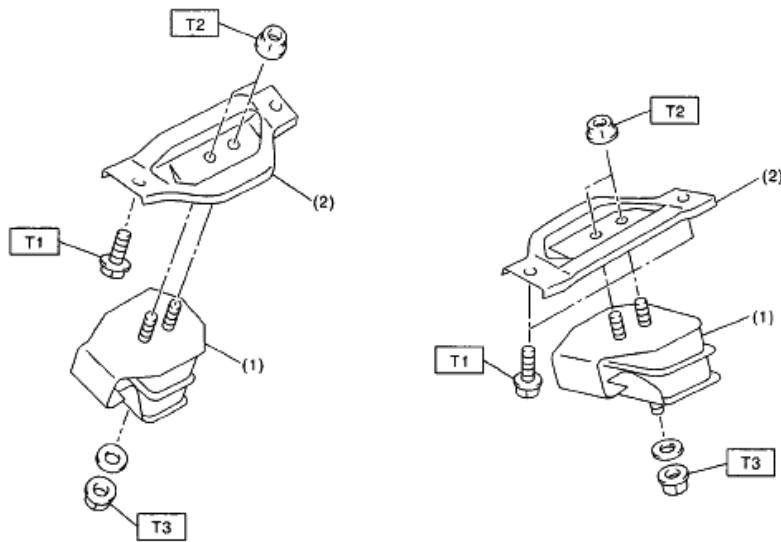
Tightening torque: N-m (kgf-m, ft-lb)

T1: 45 (4.6, 33.3)

T2: 72 (7.3, 52.8)

Fig. 6: Identifying Crankshaft And Piston Components

ENGINE MOUNTING



ME-00413

- (1) Front cushion rubber
- (2) Front engine mounting bracket

Tightening torque: N·m (kgf-m, ft-lb)

T1: 35 (3.6, 25.8)

T2: 42 (4.3, 31.0)

T3: 85 (8.7, 63)

Fig. 7: Identifying Engine Mounting Components

CAUTION

- Wear work clothing, including a cap, protective goggles and protective shoes during operation.
- 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.
- Be careful not to burn yourself, because each part on the vehicle is hot after running.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or rigid racks at the specified points.
- Before disconnecting connectors of sensors or units, be sure to disconnect the ground cable from battery.
- All parts should be thoroughly cleaned, paying special attention to engine oil passages, pistons and bearings.
- Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.
- Be careful not to let oil, grease or coolant contact the timing belt, clutch disc and flywheel.

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- 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 ones as required.
- Even if necessary inspections have been made in advance, proceed with assembly work while making re-checks.
- 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:

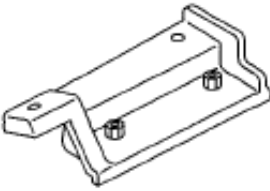
Service tools, clean cloth, containers to catch coolant and oil, wire ropes, chain hoist, transmission jacks, etc.

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

PREPARATION TOOL

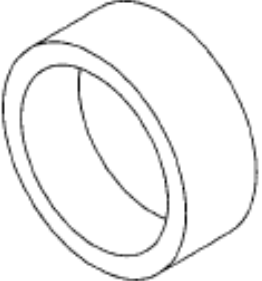
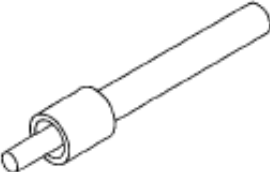
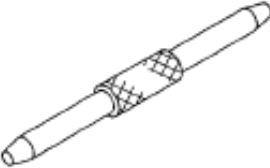
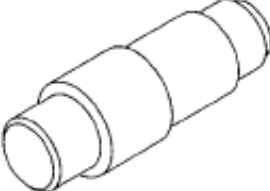
SPECIAL TOOL

SPECIAL TOOLS DESCRIPTION

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-498457000	18231AA010	CAM SPROCKET WRENCH	• Used for removing and installing cam sprocket. (LH side) • CAMSHAFT SPROCKET WRENCH (499207100) can also be used.
 ST22771AA030	18482AA010	CARTRIDGE	Troubleshooting for electrical system.
	22771AA030	SUBARU SELECT MONITOR KIT	Troubleshooting for electrical system.

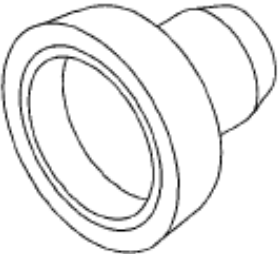
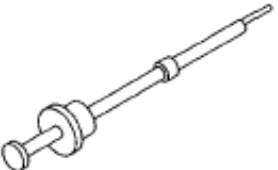
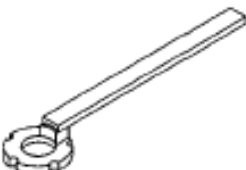
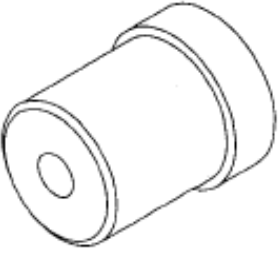
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 ST22771AA030			
 ST-498747300	498267800	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498857100	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST-499017100	498457000	ENGINE STAND ADAPTER RH	Used with ENGINE STAND (499817100).
 ST-499037100	498457100	ENGINE STAND ADAPTER LH	Used with ENGINE STAND (499817100).
	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of the flywheel when

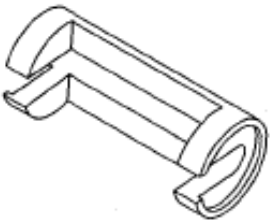
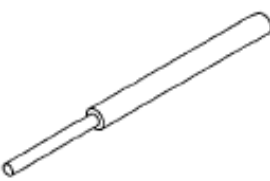
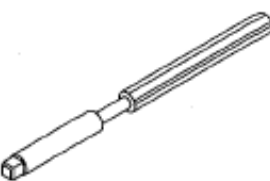
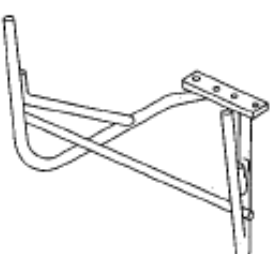
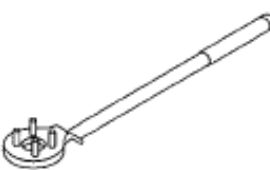
2006 Subaru Forester X

2006 ENGINE Mechanical (H4SO Engine) - Forester

 ST-499587200			loosening/tightening crank pulley bolt.
 ST-499097700	498747300	PISTON GUIDE	Used for installing piston in cylinder.
 ST-499207400	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST-499587100	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST-499597100	499037100	CONNECTING ROD BUSHING REMOVER & INSTALLER	Used for removing and installing connecting rod bushing.
	499587200	CRANKSHAFT OIL	• Used for installing

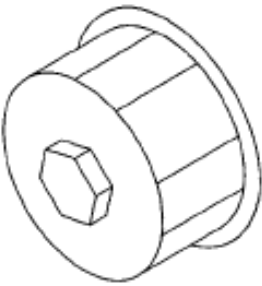
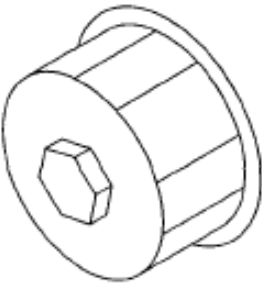
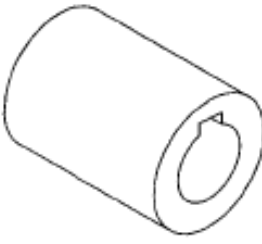
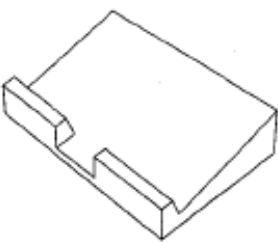
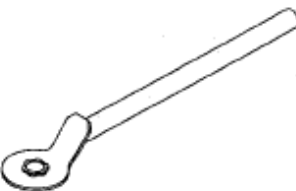
2006 Subaru Forester X

2006 ENGINE Mechanical (H4SO Engine) - Forester

 ST-499718000		SEAL INSTALLER	crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499767200	499587500	OIL SEAL INSTALLER	Used for installing CAMSHAFT oil seal. Used with OIL SEAL GUIDE (499597000).
 ST-499767400	499587700	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.
 ST-499817100	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499977100	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (RH side)
	499497000	TORX® PLUS	Used for removing and installing camshaft cap.

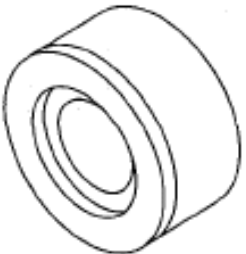
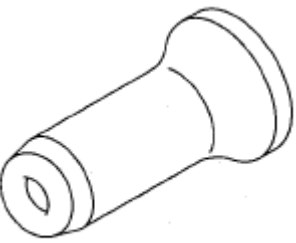
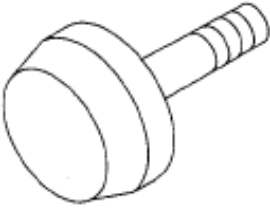
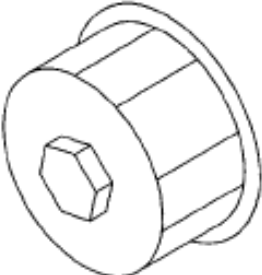
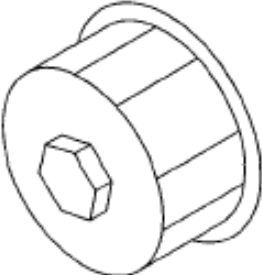
2006 Subaru Forester X

2006 ENGINE Mechanical (H4SO Engine) - Forester

 ST18332AA000			
 ST18332AA010	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499987500	499597000	OIL SEAL GUIDE	• Used for installing camshaft oil seal. • Used with camshaft OIL SEAL INSTALLER (499587500).
 ST-498267600	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499977500	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
	499767200	VALVE GUIDE	Used for removing valve

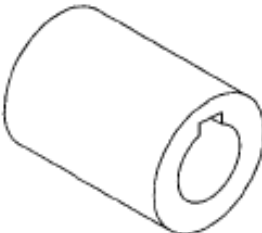
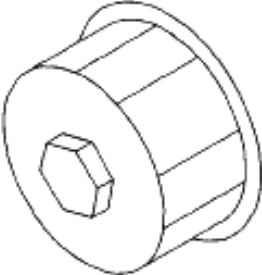
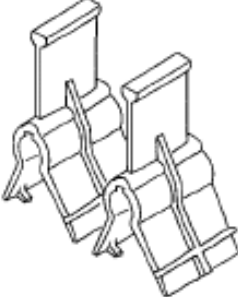
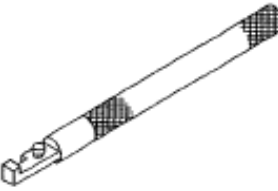
2006 Subaru Forester X

2006 ENGINE Mechanical (H4SO Engine) - Forester

 ST18251AA020		REMOVER	guides.
 ST-499587600	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499597200	499767700	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Intake side)
 ST18332AA000	499767800	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Exhaust side)
 ST18332AA010	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used with ENGINE STAND ADAPTER RH (498457000) & LH (498457100).

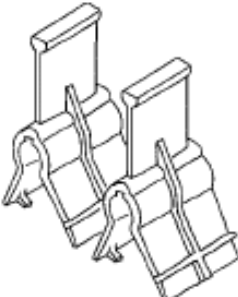
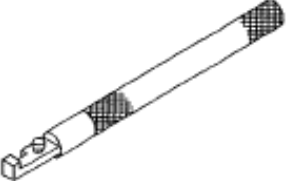
2006 Subaru Forester X

2006 ENGINE Mechanical (H4SO Engine) - Forester

 ST-499987500	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when loosening/tightening crank pulley bolt.
 ST18332AA000	18332AA000	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 68 mm (2.68 in))
 ST18354AA000	18332AA010	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 65 mm (2.56 in))
 ST18258AA000	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
	42099AE000	CONNECTOR REMOVER	Used for removing the quick connector.

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 ST-498277200			
 ST18354AA000	18354AA000	VALVE ROCKER HOLDER	Used for installing the valve rocker assembly (intake). (2 sets)
 ST18258AA000	18258AA000	SPRING INSTALLER	Used for installing the valve rocker assembly (intake).

GENERAL TOOL**GENERAL TOOLS DESCRIPTION**

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

PROCEDURE

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

- V-belt

- Timing belt
- Valve rocker assembly
- 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. Fully open the throttle valve.
6. Check the starter motor for satisfactory performance and operation.
7. Hold the compression gauge tightly against the spark plug hole.

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

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

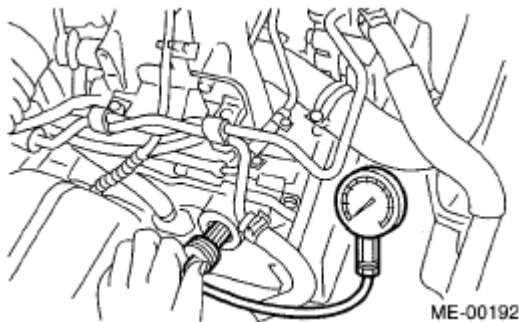


Fig. 8: Checking Compression

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 kPa (13.0 kgf/cm² , 185 psi)

Service limit:

1,020 kPa (10.4 kgf/cm² , 148 psi)

Difference between cylinders:

49 kPa (0.5 kgf/cm² , 7 psi), or less

IDLE SPEED

INSPECTION

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

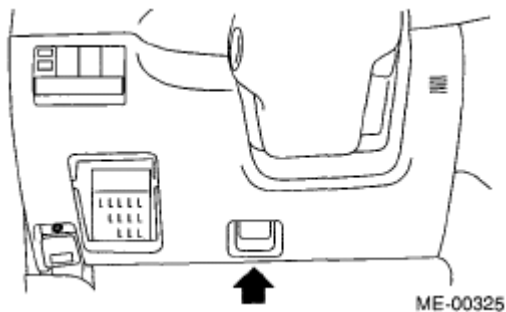


Fig. 9: Locating Data Link Connector

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

NOTE: The ignition system ignites #1 and #2 plugs simultaneously. The value of the actual engine speed x2 is recorded in the tacometer. Be careful.

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

Idle speed [No load and gears in "N" or "P" range]:

650±100 rpm (MT model)

700±100 rpm (AT model)

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

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

850±100 rpm

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

IGNITION TIMING

INSPECTION

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

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm-up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Insert the cartridge to Subaru Select Monitor.
5. Connect the Subaru Select Monitor to data link connector.
6. Turn the ignition switch to ON and Subaru Select Monitor to ON.
7. Select {Each System Check} in Main Menu.
8. Select {Engine Control System} in Selection Menu.
9. Select {Current Data Display & Save} in Engine Control System Diagnosis.
10. Select {Data Display} in Data Display Menu.
11. Start the engine and check the ignition timing at idle speed.

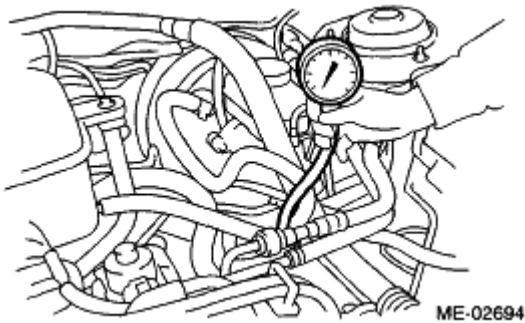
Ignition timing [BTDC/rpm]: **$10^{\circ} \pm 8^{\circ} / 650$ (MT model)** **$15^{\circ} \pm 8^{\circ} / 700$ (AT model)**

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

INTAKE MANIFOLD VACUUM**INSPECTION**

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

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

**Fig. 10: Checking Intake Manifold Vacuum Pressure*****Vacuum pressure (at idling, A/C "OFF"):******Less than -60.0 kPa (-450 mmHg, -17.72 inHg)*****DIAGNOSIS OF ENGINE CONDITION BY MEASUREMENT OF INTAKE MANIFOLD VACUUM**

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

ENGINE OIL PRESSURE

INSPECTION

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

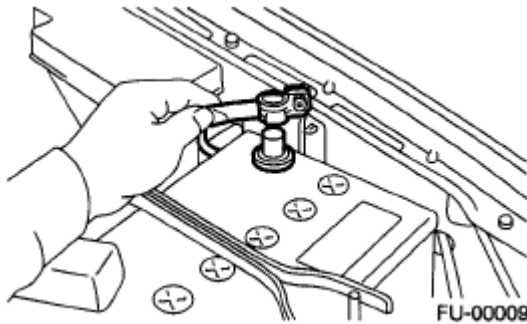


Fig. 11: Connecting Battery Ground Cable

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

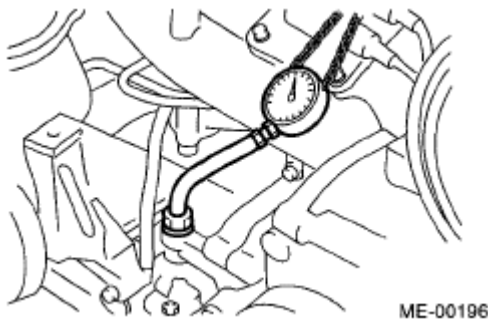


Fig. 12: Checking Engine Oil Pressure

Oil pressure:

Standard:

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

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

CAUTION:

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

NOTE:

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

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

Tightening torque:

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

FUEL PRESSURE

INSPECTION

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

1. Release the fuel pressure.

<Ref. to RELEASING OF FUEL PRESSURE , PROCEDURE, Fuel. >

2. Disconnect the fuel delivery hose from fuel damper, and connect fuel pressure gauge.

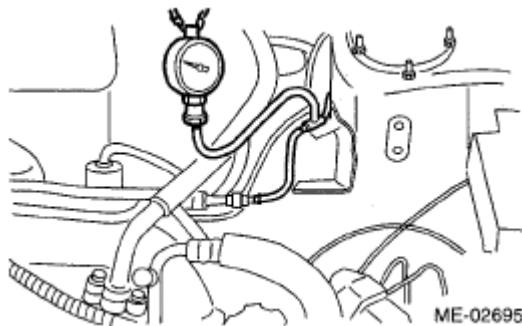


Fig. 13: Checking Fuel Pressure

3. Connect the connector of fuel pump relay.

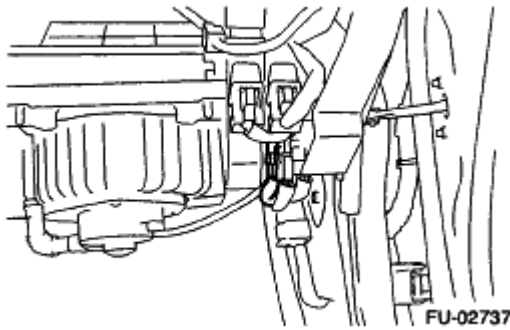


Fig. 14: Identifying Fuel Pump Relay Connector

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

Fuel pressure:

Standard:

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

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

VALVE CLEARANCE

INSPECTION

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

1. Set the vehicle on a lift.
2. Lift-up the vehicle.
3. Remove the under cover.
4. Lower the vehicle.
5. Disconnect the ground cable from battery.

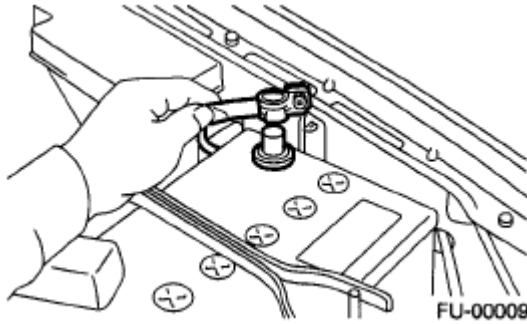


Fig. 15: Disconnecting Battery Ground Cable

6. Remove the timing belt cover (LH).

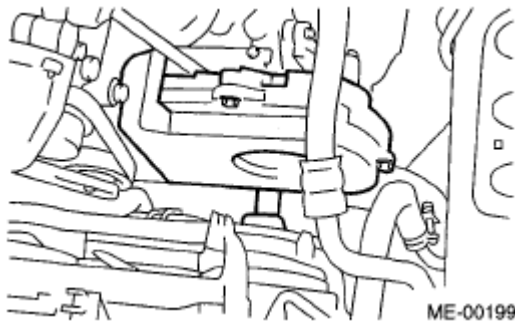


Fig. 16: Identifying Timing Belt Cover (LH)

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

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

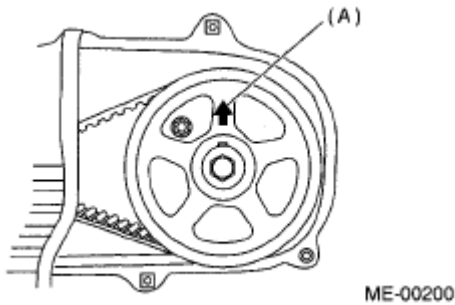


Fig. 17: Identifying Arrow Mark On Cam Sprocket

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

CAUTION:

- Insert the thickness gauge (A) in as horizontally as possible with respect to the valve stem end face.
- Measure the exhaust valve clearance while lifting-up the vehicle.

Valve clearance (standard):

Intake

0.20±0.04 mm (0.0079 ± 0.0016 in)

Exhaust

0.25±0.04 mm (0.0098 ± 0.0016 in)

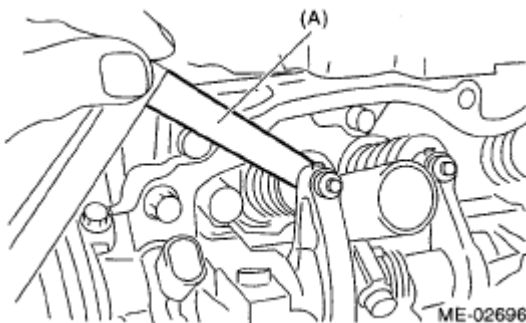


Fig. 18: Measuring Exhaust Valve Clearance

- If necessary, adjust the valve clearance. <Ref. to ADJUSTMENT, VALVE CLEARANCE. >
- Measure the valve clearance in #3, #2 and #4 cylinder in the same measurement procedure as #1 cylinder.

NOTE:

- Be sure to set the cylinder pistons to their respective top dead centers on compression stroke before measuring valve clearances.
- By rotating the crank pulley clockwise every 180° from the state that

#1 cylinder piston is on the top dead center of compression stroke, #3, #2 and #4 cylinder pistons come to the top dead center of compression stroke in this order.

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

ADJUSTMENT

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

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

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

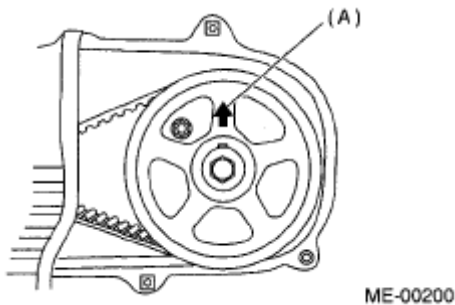


Fig. 19: Identifying Arrow Mark On Cam Sprocket

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

Tightening torque:

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

CAUTION:

- Insert a thickness gauge in as horizontally as possible with respect to the valve stem end face.
- Adjust the exhaust valve clearances while lifting-up the vehicle.

Valve clearance:

Intake

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

Exhaust

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

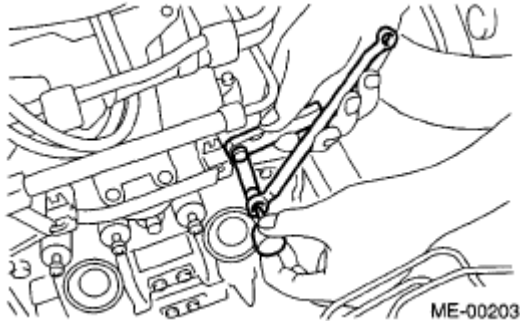


Fig. 20: Loosening Valve Rocker Nut

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

NOTE:

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

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

ENGINE ASSEMBLY

REMOVAL

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

<Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel. >

5. Disconnect the ground cable from battery.

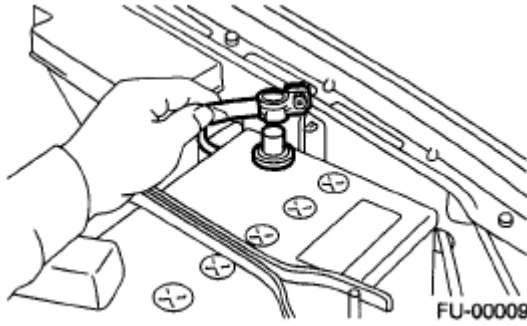


Fig. 21: Disconnecting Battery Ground Cable

6. Open the fuel filler flap lid, and remove the fuel filler cap.
7. Remove the air intake duct, air cleaner case and air intake chamber.

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

8. Remove the under cover.
9. Remove the radiator from vehicle. <Ref. to **REMOVAL** , Radiator. >
10. Disconnect the A/C pressure hoses from A/C compressor.
11. Remove the air intake chamber stay.

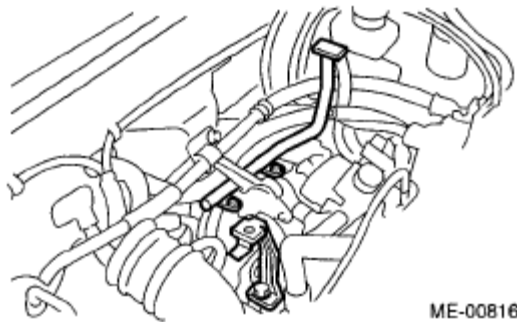
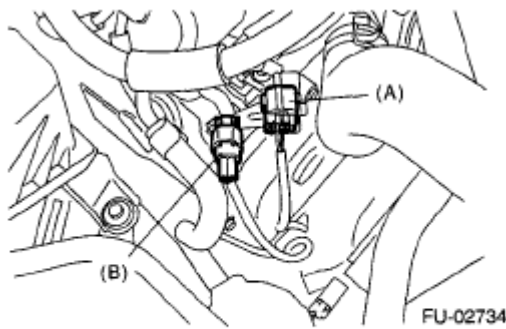


Fig. 22: Identifying Air Intake Chamber Stay

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



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

Fig. 23: Identifying Front And Rear Oxygen Sensor Connector

3. Engine ground cable

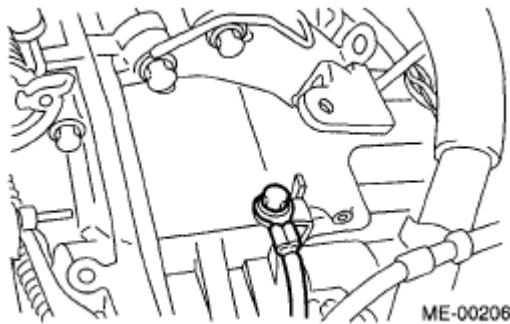


Fig. 24: Identifying Engine Ground Cable

4. Engine harness connectors

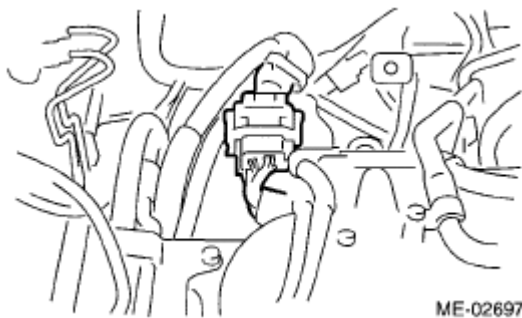
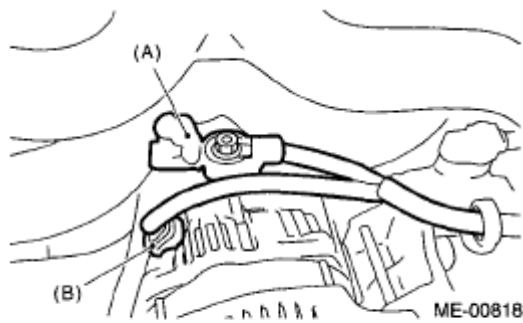


Fig. 25: Identifying Engine Harness Connector

5. Generator connector and terminal



- (A) Terminals
(B) Generator connector

Fig. 26: Identifying Generator Connector And Terminal

6. A/C compressor connector

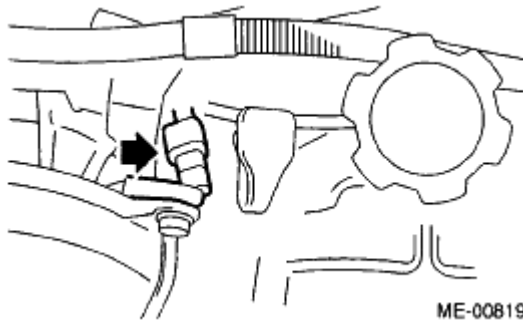


Fig. 27: Locating A/C Compressor Connector

7. Power steering switch connector

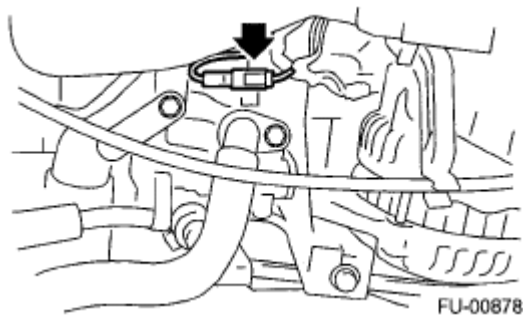


Fig. 28: Locating Power Steering Switch Connector

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

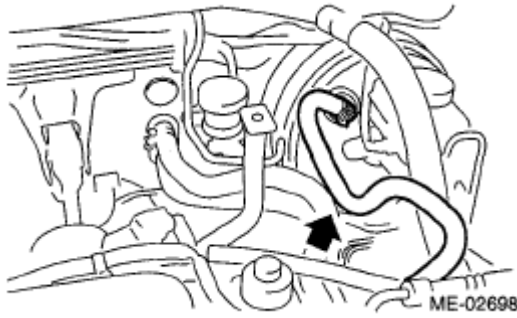


Fig. 29: Locating Brake Booster Vacuum Hose

2. Heater inlet and outlet hoses
14. Remove the power steering pump.
 1. Remove the front side V-belts. <Ref. to **FRONT SIDE BELT**, REMOVAL, V-BELT. >
 2. Remove the bolts which hold the power steering pipes onto the fuel pipe protector RH.

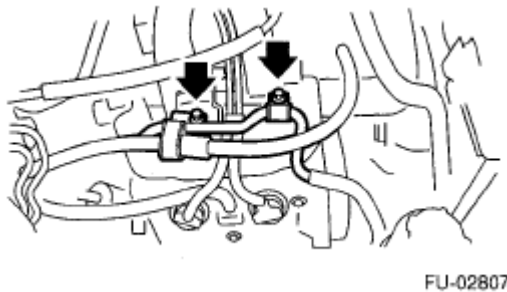


Fig. 30: Locating Power Steering Pipe Bolts

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

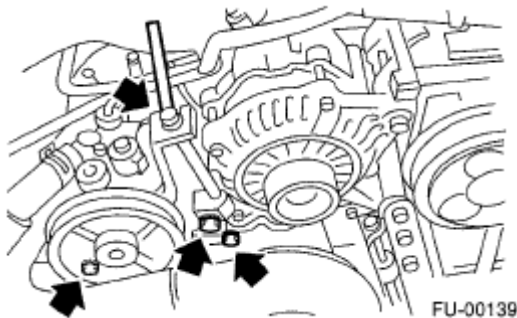
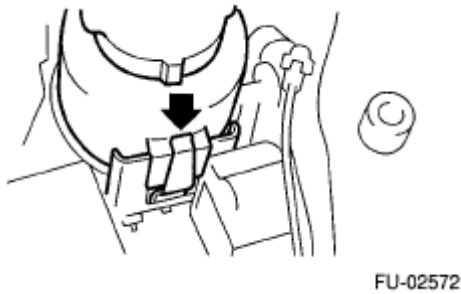
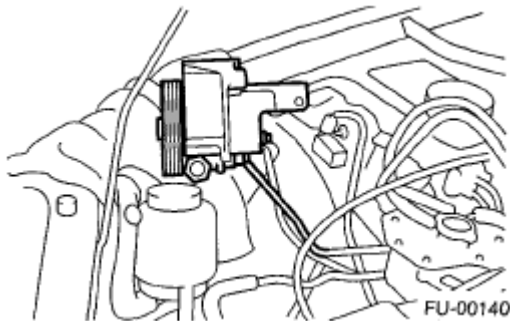


Fig. 31: Locating Power Steering Pump Bolts

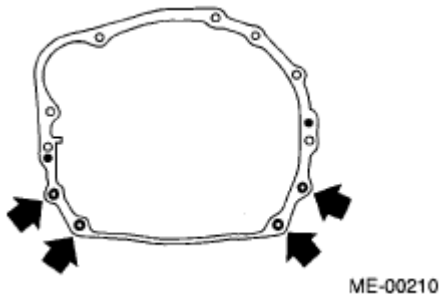
4. Remove the reservoir tank from the bracket by pulling it upwards.

**Fig. 32: Locating Bracket**

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

**Fig. 33: Identifying Power Steering Pump**

15. Remove the front and center exhaust pipes. <Ref. to **REMOVAL** , Front Exhaust Pipe. >
16. Remove the bolts and nuts which hold lower side of transmission to engine.

**Fig. 34: Locating Transmission Bolts And Nuts**

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

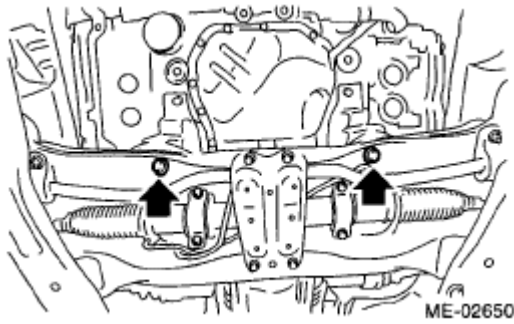


Fig. 35: Identifying Front Cushion Rubber Nuts

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

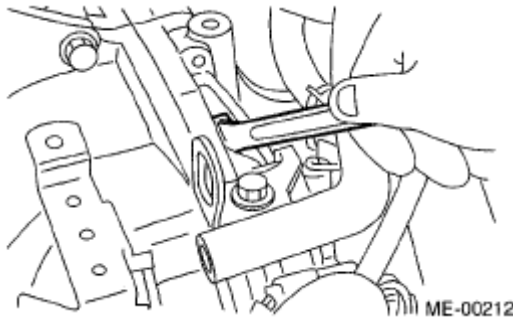


Fig. 36: Removing Torque Converter Clutch Bolts

19. Remove the pitching stopper.

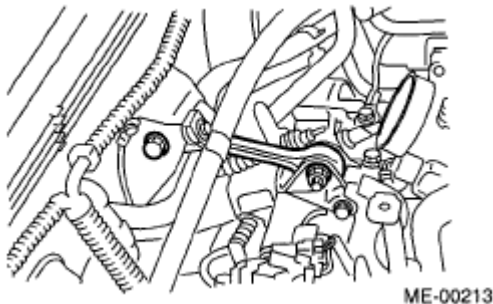


Fig. 37: Identifying Pitching Stopper

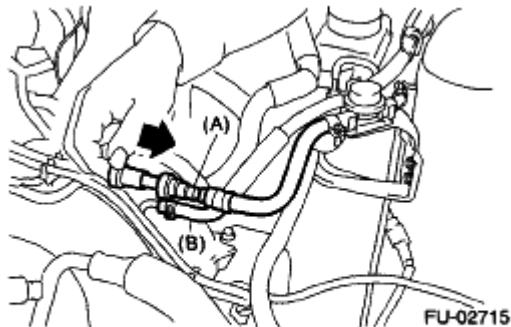
20. Disconnect the fuel hoses from fuel pipe.
 1. Disconnect the quick connector on the fuel delivery line by pushing the ST in the direction of the arrow.

ST 42099AE000 CONNECTOR REMOVER

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

WARNING:

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



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

Fig. 38: Disconnecting Evaporation Hose From Pipe

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

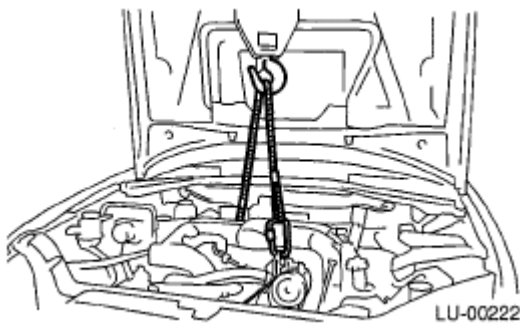
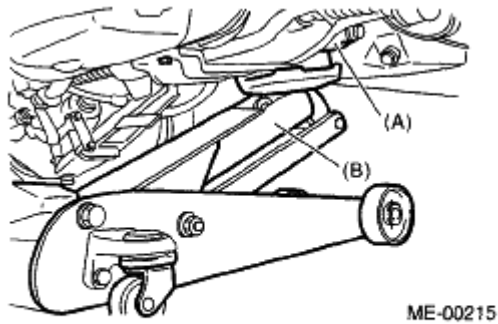


Fig. 39: Supporting Engine With Lifting Device And Wire Ropes

22. Support the transmission with a garage jack.

CAUTION: Doing this is very important because the transmission lowers for its own weight. This work is also of great importance for facilitating reinstallation.



- (A) Transmission
(B) Garage jack

Fig. 40: Supporting Transmission With Garage Jack

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

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

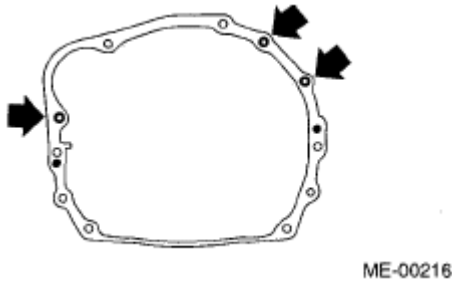


Fig. 41: Locating Transmission Bolts

24. Install the ST to converter case. (AT model) ST 498277200 STOPPER SET

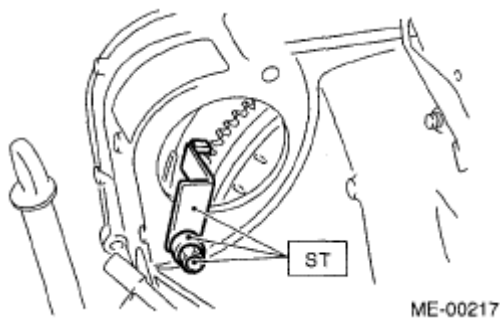


Fig. 42: Installing Stopper Set ST 498277200 To Converter Case

25. Remove the engine from vehicle.
 1. Slightly raise the engine.
 2. Raise the transmission with garage jack.
 3. Move the engine horizontally until main shaft is withdrawn from clutch cover.
 4. Slowly move the engine away from engine compartment.

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

26. Remove the front cushion rubbers.

INSTALLATION

1. Install the front cushion rubbers.

Tightening torque:

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

2. Position the engine in engine compartment and align it with transmission.

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

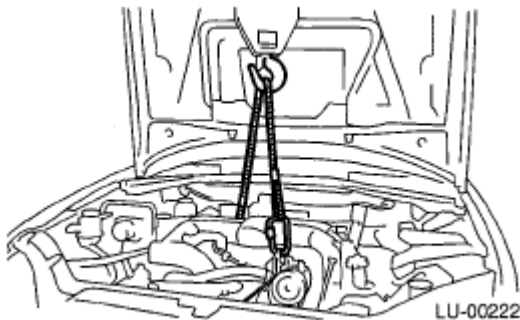
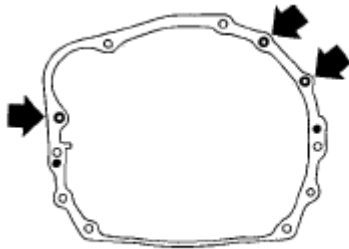


Fig. 43: Supporting Engine With Lifting Device And Wire Ropes

3. Apply a small amount of grease to splines of mainshaft. (MT model)
4. Tighten the bolts which hold upper side of transmission to engine.

Tightening torque:

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



ME-00216

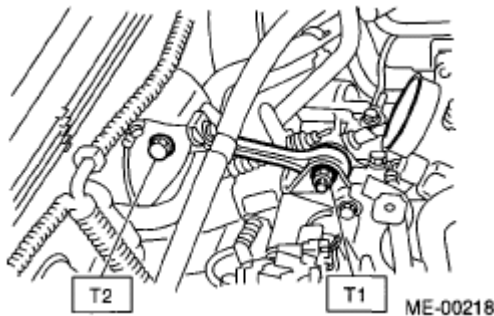
Fig. 44: Locating Transmission Bolts

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

Tightening torque:

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

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



ME-00218

Fig. 45: Identifying Pitching Stopper

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

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

ST 498277200 STOPPER SET

9. Install the starter. <Ref. to **INSTALLATION** , Starter. >
10. Install the torque converter clutch to drive plate. (AT model)
 1. Tighten the bolts which hold torque converter clutch to drive plate.
 2. Tighten other bolts while rotating the engine using socket wrench.

CAUTION: Be careful not to drop bolts into the torque converter clutch

housing.

Tightening torque:

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

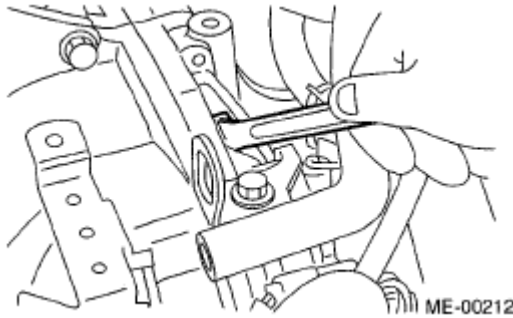


Fig. 46: Tightening Torque Converter Clutch Bolts

3. Install the service hole plug to prevent getting foreign matter inside.
11. Install the power steering pump.
1. Install the reservoir tank to the bracket.

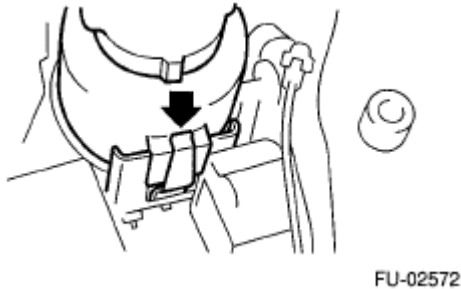


Fig. 47: Locating Bracket

2. Install the power steering pump to the bracket, and tighten the bolts.

Tightening torque:

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

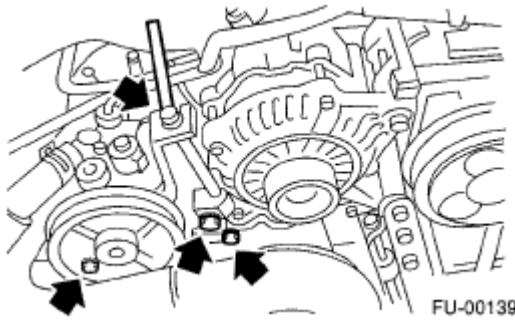


Fig. 48: Locating Power Steering Pump Bolts

3. Install the pipe along with the bracket.

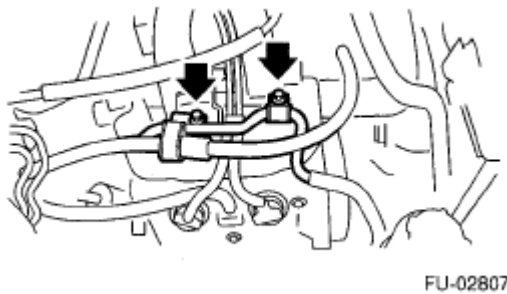


Fig. 49: Locating Power Steering Pipe Bolts

4. Connect the power steering switch connector.

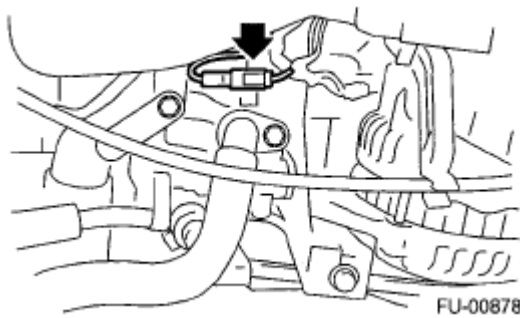


Fig. 50: Locating Power Steering Switch Connector

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

Tightening torque:

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

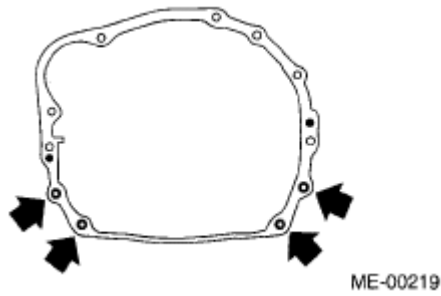


Fig. 51: Locating Transmission Bolts And Nuts

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

Tightening torque:

85 N.m (8.7 kgf-m, 63 ft-lb)

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

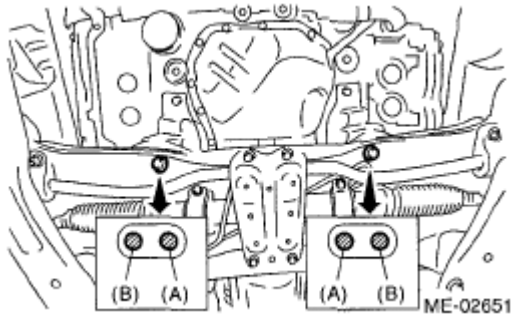


Fig. 52: Locating Front Cushion Rubber Mounting Bolts

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

19. Install the air intake chamber stay.

Tightening torque:

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

20. Tighten the engine ground cable.

Tightening torque:

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

21. Install the A/C pressure hoses.

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

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

23. Install the air intake duct, air cleaner case and air intake chamber. <Ref. to **INSTALLATION** , Air Intake Duct. > <Ref. to **INSTALLATION** , Air Cleaner Case. > <Ref. to **INSTALLATION** , Air Intake Chamber. >

24. Install the under cover.

25. Install the battery in the vehicle, and connect cables.

26. Fill engine coolant.

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

27. Check the ATF level and replenish it if necessary.

<Ref. to **INSPECTION** , Automatic Transmission Fluid. >

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

29. Remove the front hood stay, and close the front hood.

30. Take off the vehicle from lift.

INSPECTION

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

ENGINE MOUNTING

REMOVAL

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

INSTALLATION

Install in the reverse order of removal.

Tightening torque:

Engine mounting

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

INSPECTION

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

PREPARATION FOR OVERHAUL

PROCEDURE

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

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 499817100 ENGINE STAND

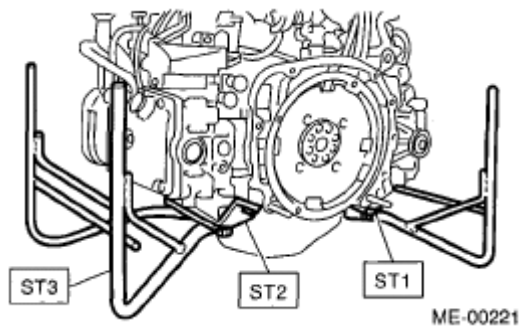


Fig. 53: Identifying Engine Stand Adapters

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

Therefore, in this article, to conduct the particular procedure within the flow of a information, you need to go back and conduct the procedure described previously in order to do that particular procedure.

V-BELT

REMOVAL

NOTE: Perform the following procedures with the engine installed to body.

FRONT SIDE BELT

1. Remove the V-belt covers.

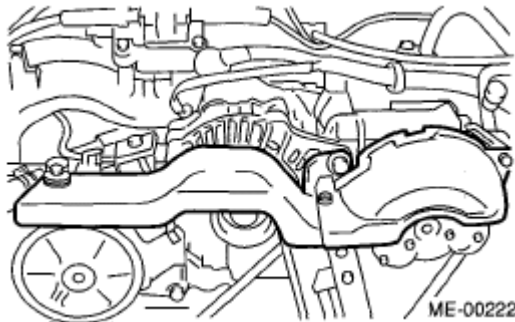


Fig. 54: Identifying V-Belt Cover

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

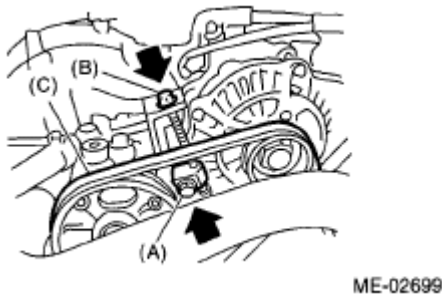


Fig. 55: Locating Lock Bolt And Slider Bolt

REAR SIDE BELT

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

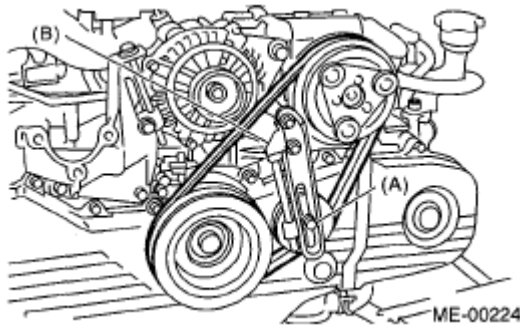


Fig. 56: Identifying Slider Bolt And Lock Bolt

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

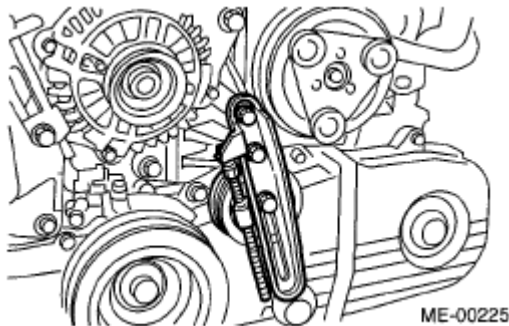


Fig. 57: Identifying Belt Tensioner

INSTALLATION

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

FRONT SIDE BELT

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

Tightening torque:

Lock bolt (A)

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

Slider bolt (B)

8 N.m (0.8 kgf-m, 5.8 ft-lb)

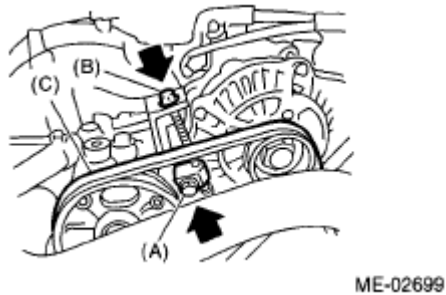


Fig. 58: Locating Lock Bolt And Slider Bolt

REAR SIDE BELT

1. Install the belt tensioner.
2. Install a V belt, and tighten the slider bolt (B) so as to obtain the specified belt tension.

<Ref. to **INSPECTION**, V-BELT. >

3. Tighten the lock nut (A).

Tightening torque:

Lock nut (A)

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

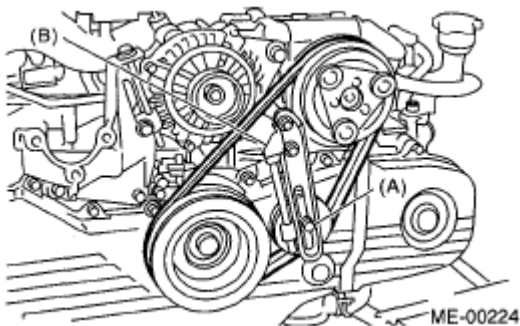


Fig. 59: Identifying Slider Bolt And Lock Bolt

INSPECTION

1. Replace the belts, if crack, fraying or wear is found.
2. Remove the V-belt cover and reservoir tank, (with belt tension gauge)
3. Check the V-belt tension and adjust it if necessary by changing the generator installing position or idler pulley installing position.

Belt tension (with belt tension gauge):

(A)

When installing new parts

618 - 755 N (63 - 77 kgf, 139 - 170 lb) At inspection

490 - 640 N (50.0 - 65.3 kgf, 110.2 - 143.9 lb)

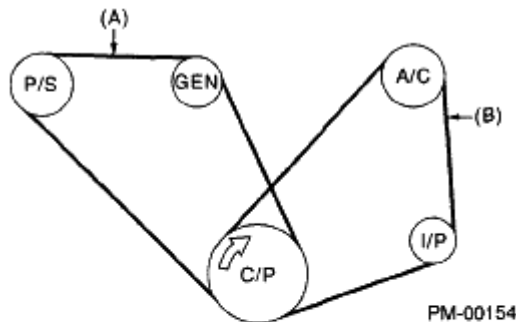
(B)

When installing new parts

740 - 880 N (75.5 - 89.7 kgf, 166 - 198 lb)

At inspection

350 - 450 N (35.7 - 45.9 kgf, 78.7 - 101.2 lb)



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

Fig. 60: Checking V-Belt Tension

Belt tension (without belt tension gauge):

(A)

When installing new parts

7 - 9 mm (0.276 - 0.354 in) At inspection

9 - 11 mm (0.354 - 0.433 in)

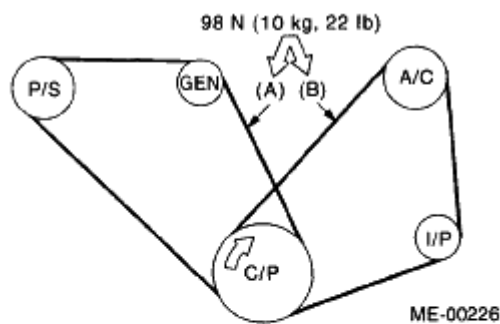
(B)

When installing new parts

7.5 - 8.5 mm (0.295 - 0.335 in)

At inspection

9.0 - 10.0 mm (0.354 - 0.394 in)



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

Fig. 61: Checking V-Belt Tension

CRANK PULLEY

REMOVAL

1. Remove the V-belts. <Ref. to **REMOVAL**, V-BELT. >
2. Remove the crank pulley bolt. To lock the crankshaft, use ST.

ST 499977100 CRANK PULLEY WRENCH

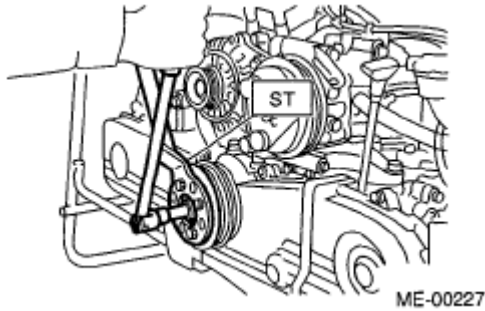


Fig. 62: Removing Crank Pulley Bolt Using Crank Pulley Wrench ST499977100

3. Remove the crank pulley.

INSTALLATION

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

To lock the crankshaft, use ST.

ST 499977100 CRANK PULLEY WRENCH

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

Tightening torque:

180 N.m (18.4 kgf-m, 132.8 ft-lb)

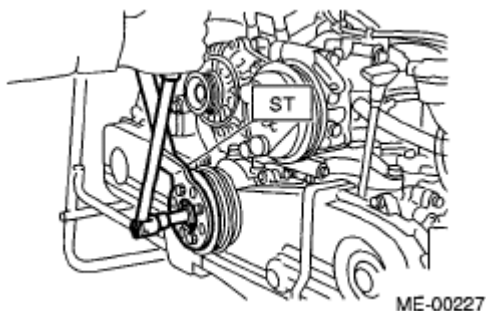


Fig. 63: Tightening Crank Pulley Bolt Using Crank Pulley Wrench ST499977100

3. Check that the tightening angle of the clamp pulley bolt is a minimum of 65°. Perform the following procedures when less than 65°.
 1. Replace the crank pulley bolts and clean them.

Crank pulley bolt:***12369AA011***

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

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

4. Install the belt tensioner.

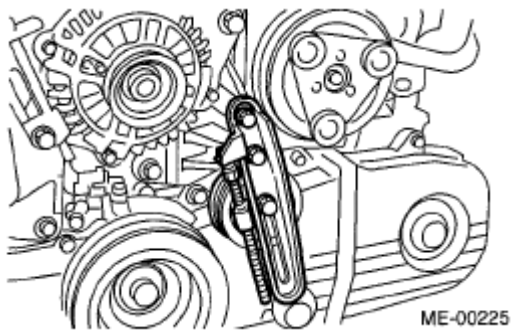


Fig. 64: Identifying Belt Tensioner

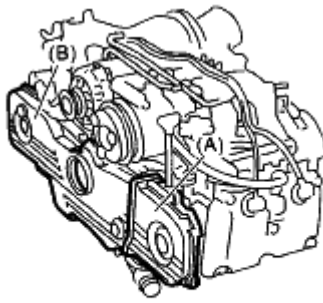
5. Install the V-belts. <Ref. to **INSTALLATION**, V-BELT. >

INSPECTION

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

TIMING BELT COVER**REMOVAL**

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



ME-00821

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

Fig. 65: Identifying Timing Belt Cover And Front Timing Belt Cover

INSTALLATION

1. Install the front timing belt cover.

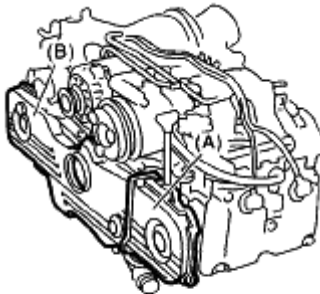
Tightening torque:

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

2. Install the timing belt cover (LH).

Tightening torque:

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



ME-00821

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

Fig. 66: Identifying Timing Belt Cover And Front Timing Belt Cover

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

INSPECTION

Check the cover for damage.

TIMING BELT

REMOVAL

TIMING BELT

1. Remove the V-belts. <Ref. to **REMOVAL**, V-BELT. >
2. Remove the crank pulley. <Ref. to **REMOVAL**, CRANK PULLEY. >
3. Remove the timing belt cover. <Ref. to **REMOVAL**, TIMING BELT COVER. >
4. Remove the timing belt guide. (MT model)

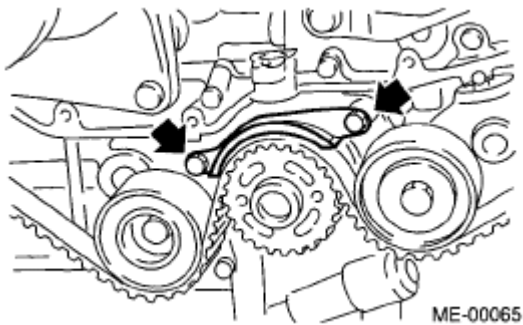


Fig. 67: Locating Timing Belt Guide Bolts (MT Model)

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

ST 499987500 CRANKSHAFT SOCKET

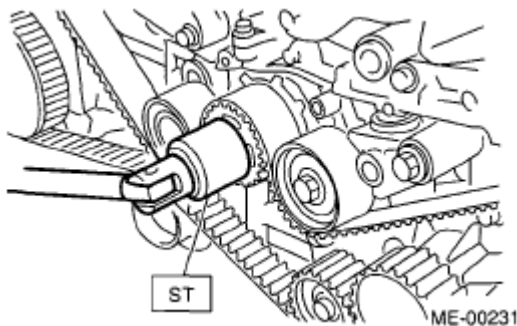


Fig. 68: Turning Crankshaft Using Crankshaft Socket ST499987500

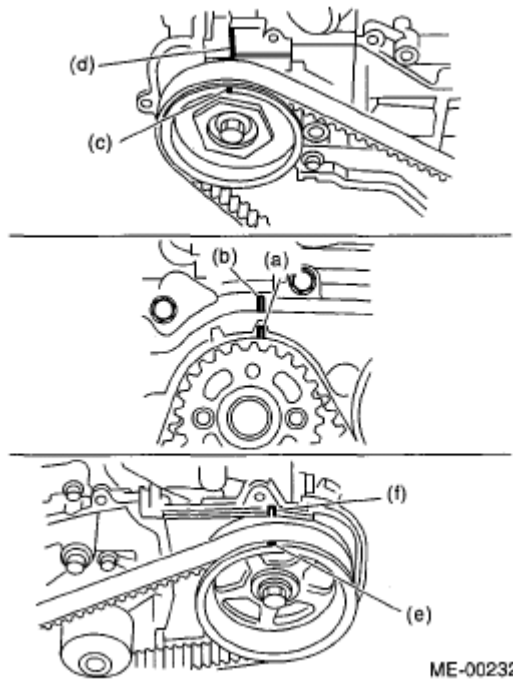


Fig. 69: Identifying Aligning Mark Of Sprocket

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

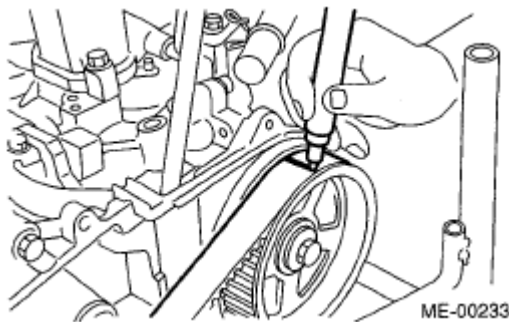
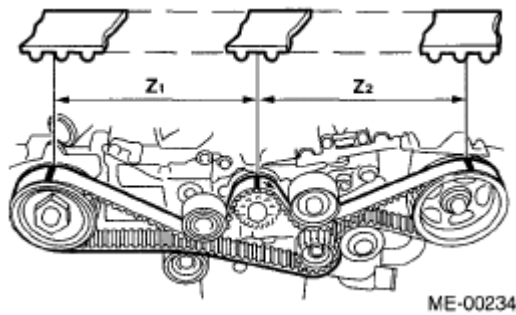


Fig. 70: Putting Alignment Marks On Timing Belt

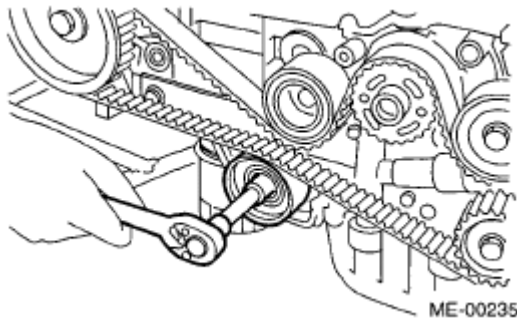
Specified data:

Z_1 : Length of 46.8-teeth

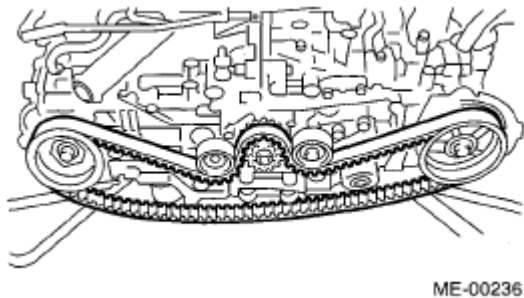
Z_2 : Length of 43.7-teeth

**Fig. 71: Identifying Drive Belt Length**

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

**Fig. 72: Locating Belt Idler**

8. Remove the timing belt.

**Fig. 73: Identifying Timing Belt****BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY**

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

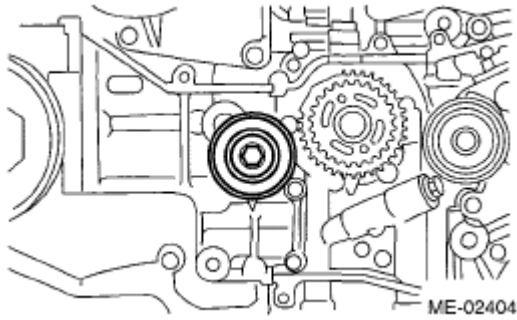


Fig. 74: Identifying Belt Idler

2. Remove the automatic belt tension adjuster assembly.

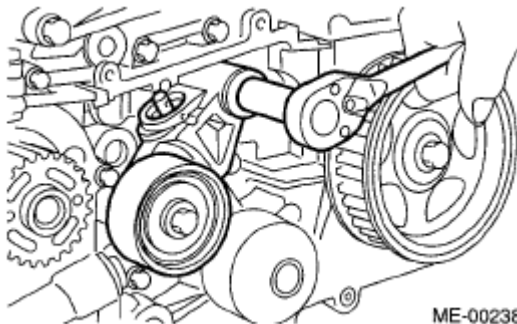


Fig. 75: Locating Automatic Belt Tension Adjuster Assembly

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

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

CAUTION:

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

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

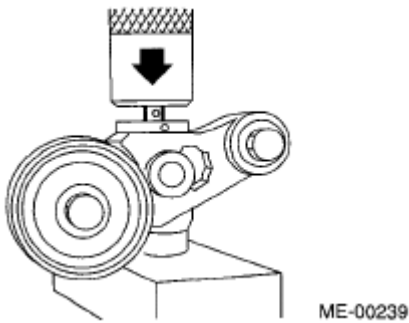


Fig. 76: Moving Adjuster Rod Down

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

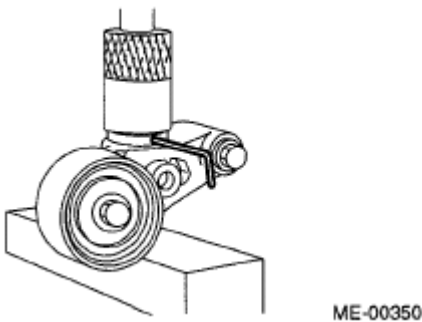


Fig. 77: Inserting Hex Wrench Into Stopper Pin Hole In Cylinder

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

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

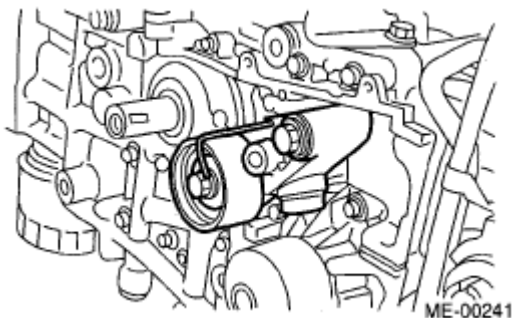


Fig. 78: Identifying Automatic Belt Tension Adjuster Assembly

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

Tightening torque:

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

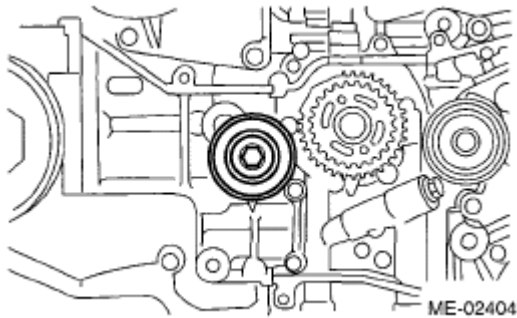


Fig. 79: Identifying Belt Idler

TIMING BELT

1. Prepare for installation of automatic belt tension adjuster assembly. <Ref. to **AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER, INSTALLATION, TIMING BELT.**>
2. Installation of timing belt:
 1. Turn the camshaft sprocket No. 2 using ST1, and turn the camshaft sprocket No. 1 using ST2 so that their alignment marks (A) come to top positions.

ST1 18231AA010 CAM SPROCKET WRENCH

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

ST2 499207400 CAM SPROCKET WRENCH

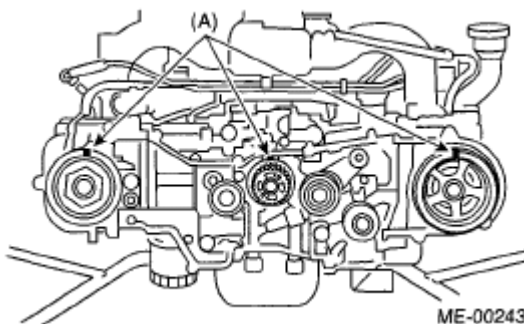


Fig. 80: Identifying Alignment Marks On Cam Sprocket

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

timing belt properly.

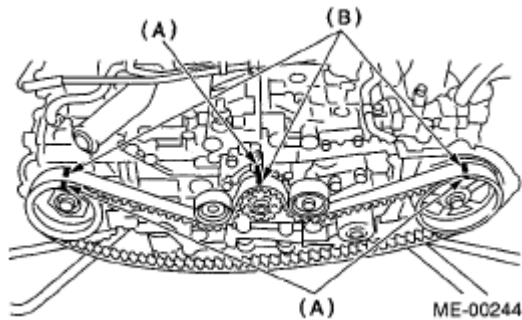


Fig. 81: Identifying Aligning Alignment Marks On Timing Belt

3. Install the belt idler (No. 2).

Tightening torque:

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

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

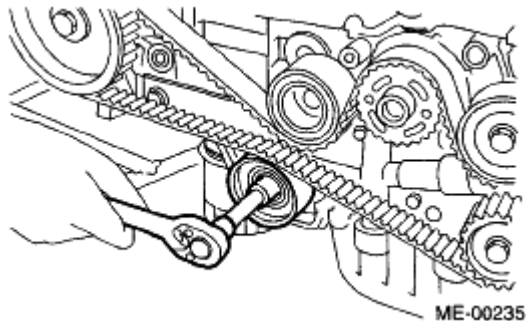


Fig. 82: Removing Stopper Pin From Belt Tension Adjuster

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

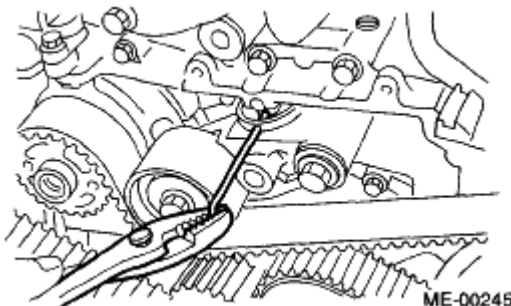


Fig. 83: Locating Timing Belt Guide Mounting Bolts

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

Clearance:

1.0±0.5 mm (0.039 ± 0.020 in)

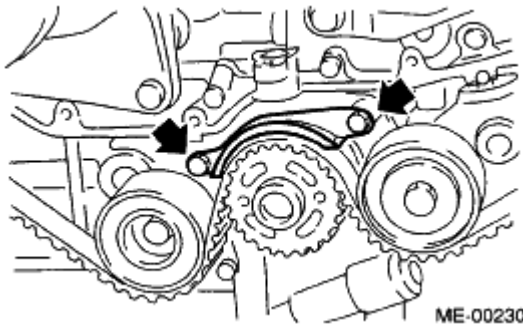


Fig. 84: Identifying Clearance Between Timing Belt And Timing Belt Guide

3. Tighten the bolts mounting the timing belt guide.

Tightening torque:

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

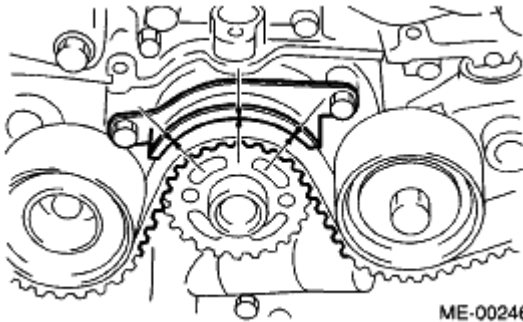


Fig. 85: Tightening Timing Belt Guide Mounting Bolts

6. Install the timing belt cover.

<Ref. to **INSTALLATION**, TIMING BELT COVER. >

7. Install the crank pulley. <Ref. to **INSTALLATION**, CRANK PULLEY. >

8. Install the V-belts. <Ref. to **INSTALLATION**, V-BELT. >

INSPECTION

TIMING BELT

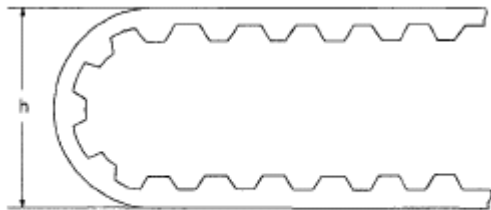
1. Check the timing belt teeth for breaks, cracks or wear. If any fault is found, replace the belt.
2. Check the condition of the backside of belt. If cracks are found, replace the belt.

CAUTION:

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

In radial diameter h:

60 mm (2.36 in) or more



ME-00248

Fig. 86: Identifying Timing Belt Radial Diameter

AUTOMATIC BELT TENSION ADJUSTER

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

NOTE:

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

2. Check that the adjuster rod does not move when a pressure of 294 N (30 kgf, 66 lb) is applied to it. This is to check adjuster rod stiffness.
3. If the adjuster rod is not stiff and moves freely when applying 294 N (30 kgf, 66 lb), check it using the following procedures:
 1. Slowly press the adjuster rod down to the end surface of cylinder. Repeat this operation two to three times.
 2. With the adjuster rod moved all the way up, apply a pressure of 294 N (30 kgf, 66 lb) to it. Check the adjuster rod stiffness.
 3. If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new one.

CAUTION:

- Always use a vertical type pressing tool to move the adjuster rod down.
- Do not use a lateral type vise.

- Push the adjuster rod vertically.
 - Press the adjuster rod gradually taking more than three minutes.
 - Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).
 - Press the adjuster rod as far as the end surface of the cylinder. Do not press the adjuster rod into cylinder. Doing so may damage the cylinder.
4. Measure the amount of rod protrusion beyond the body. If it is not within specified range, replace with new one.

Amount of rod protrusion H:

5.2 - 6.2 mm (0.204 - 0.244 in)

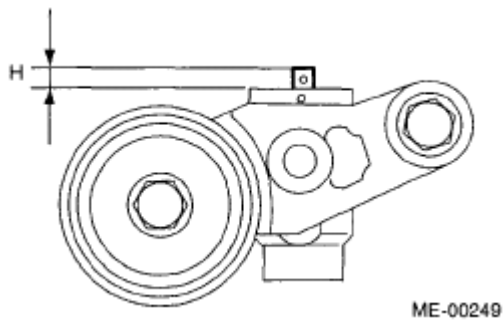


Fig. 87: Identifying Rod Protrusion

BELT TENSION PULLEY

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

BELT IDLER

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

CAM SPROCKET

REMOVAL

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

ST 18231AA010 CAM SPROCKET WRENCH

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

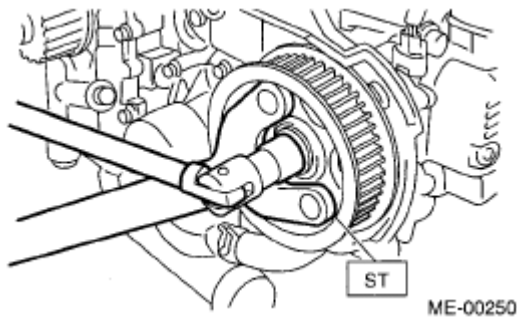


Fig. 88: Removing Cam Sprocket No 2 Using Cam Sprocket Wrench ST18231AA010

7. Remove the cam sprocket No. 1. To lock the camshaft, use the ST.

ST 499207400 CAM SPROCKET WRENCH

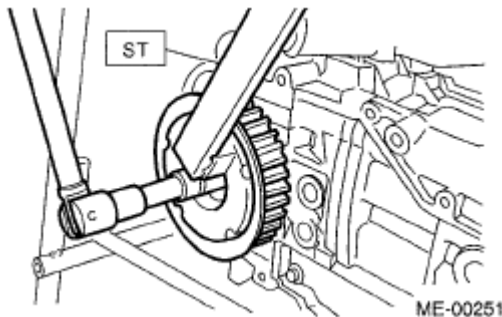


Fig. 89: Removing Cam Sprocket No 1 Using Cam Sprocket Wrench ST499207400

INSTALLATION

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

ST 499207400 CAM SPROCKET WRENCH

Tightening torque:

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

NOTE: Do not confuse left and right side cam sprockets during installation. Identify by L or R markings.

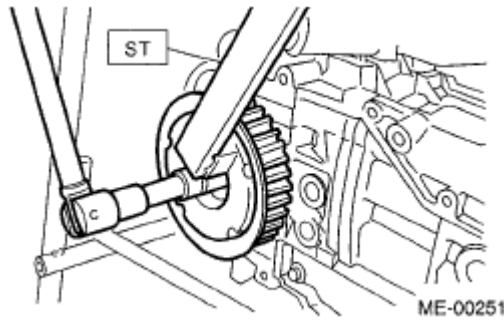


Fig. 90: Installing Cam Sprocket No 1 Using Cam Sprocket Wrench ST499207400

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

ST 18231AA010 CAM SPROCKET WRENCH

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

Tightening torque:

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

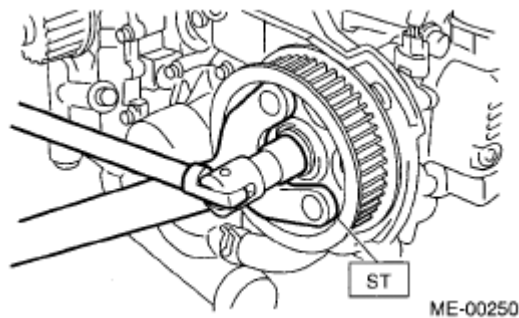


Fig. 91: Installing Cam Sprocket No 2 Using Cam Sprocket Wrench ST18231AA010

3. Install the camshaft position sensor. <Ref. to **INSTALLATION**, Camshaft Position Sensor. >
4. Install the timing belt. <Ref. to **INSTALLATION**, TIMING BELT. >
5. Install the timing belt cover.

<Ref. to **INSTALLATION**, TIMING BELT COVER. >

6. Install the crank pulley. <Ref. to **INSTALLATION**, CRANK PULLEY. >

7. 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.
3. Check the cam sprocket protrusion used for sensor for damage and contamination of foreign matter.

CRANK SPROCKET

REMOVAL

1. Remove the V-belts. <Ref. to **REMOVAL**, V-BELT. >
2. Remove the crank pulley. <Ref. to **REMOVAL**, CRANK PULLEY. >
3. Remove the timing belt cover. <Ref. to **REMOVAL**, TIMING BELT COVER. >
4. Remove the timing belt. <Ref. to **REMOVAL**, TIMING BELT. >
5. Remove the crank sprocket.

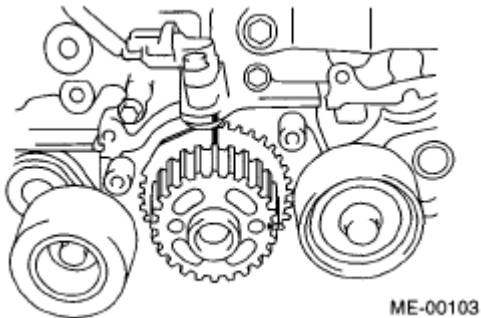


Fig. 92: Identifying Crank Sprocket

INSTALLATION

1. Install the crank sprocket.

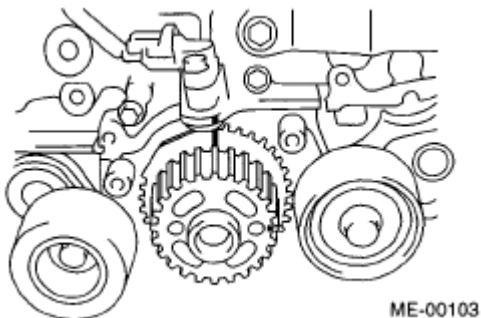


Fig. 93: Identifying Crank Sprocket

2. Install the timing belt. <Ref. to **INSTALLATION**, TIMING BELT. >
3. Install the timing belt cover.

<Ref. to **INSTALLATION**, TIMING BELT COVER. >

4. Install the crank pulley. <Ref. to **INSTALLATION**, CRANK PULLEY. >
5. Install the V-belts. <Ref. to **INSTALLATION**, V-BELT. >

INSPECTION

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

VALVE ROCKER ASSEMBLY

REMOVAL

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

ST 18258AA000 SPRING INSTALLER

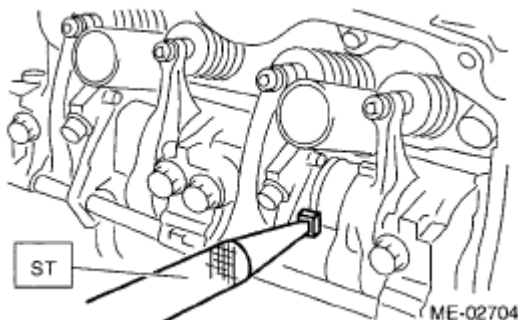
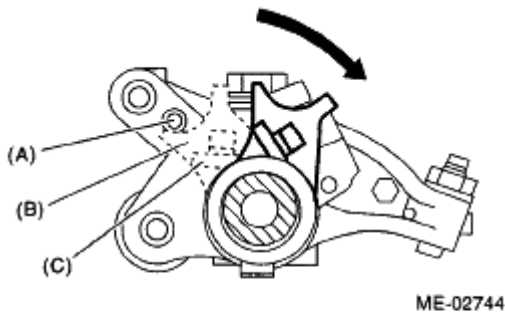


Fig. 94: Identifying Spring Installer ST 18258AA000



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

Fig. 95: Rotating Spring Stopper

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

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

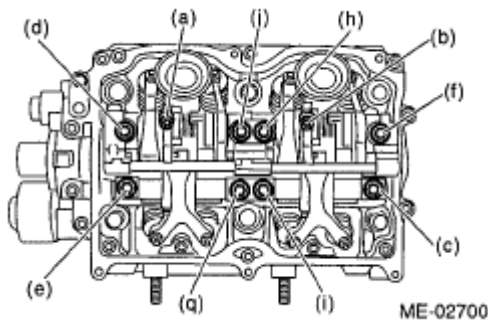


Fig. 96: Identifying Removal Sequence Of Valve Rocker Assembly Bolts

3. Remove the valve rocker assembly.

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

ST 18354AA000 VALVE ROCKER HOLDER

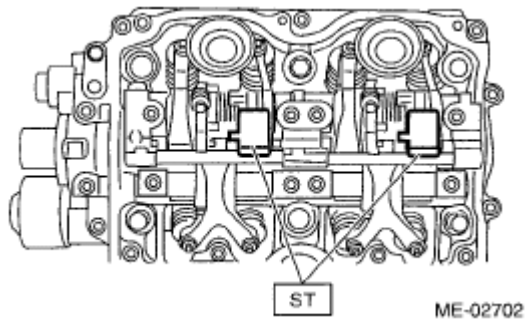


Fig. 97: Identifying Valve Rocker Holder ST 18354AA000

INSTALLATION

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

NOTE:

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

ST 18354AA000 VALVE ROCKER HOLDER

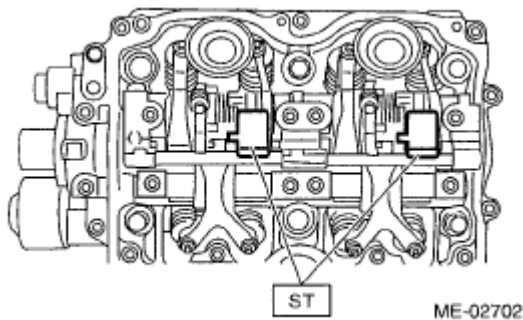


Fig. 98: Identifying Valve Rocker Holder ST 18354AA000

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

Tightening torque:

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

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

Tightening torque:

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

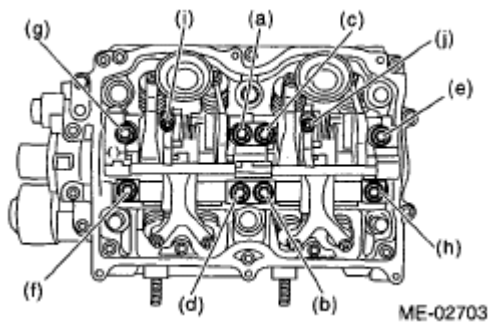


Fig. 99: Identifying Tightening Sequence Of Valve Rocker Assembly Bolts

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

ST 18258AA000 SPRING INSTALLER

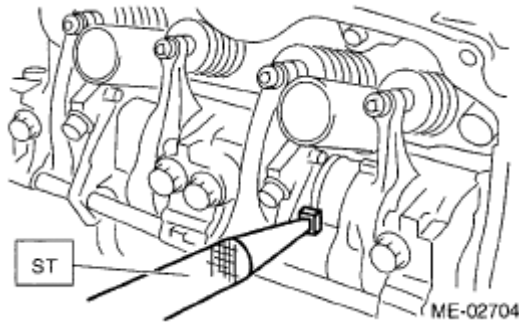
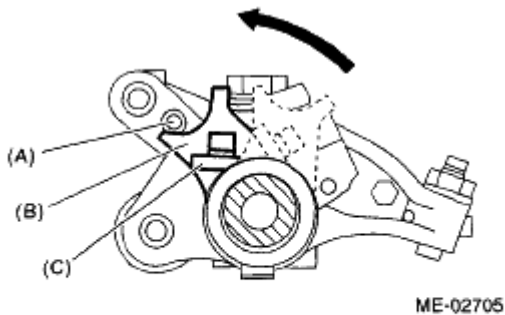


Fig. 100: Identifying Spring Installer ST 18258AA000



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

Fig. 101: Rotating Spring Stopper

2. Adjust the valve clearance. <Ref. to **ADJUSTMENT**, VALVE CLEARANCE. >
3. Install the rocker cover and rocker cover gasket, and then connect PCV hose.

NOTE:

- Use a new rocker cover gasket.

- Tighten the bolts in two stages in alphabetical sequence as shown in figure.

Tightening torque:

First time

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

Second time

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

RH side

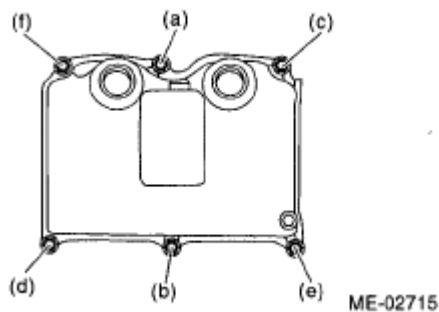


Fig. 102: Identifying Tightening Sequence Rocker Cover Of Bolts - RH Side

LH side

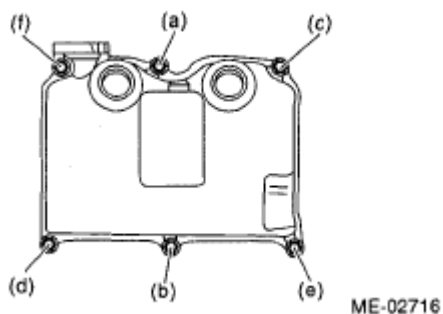


Fig. 103: Identifying Tightening Sequence Of Rocker Cover Bolts - LH Side

4. Install the cam sprocket. <Ref. to **INSTALLATION**, CAM SPROCKET. >
5. Install the timing belt. <Ref. to **INSTALLATION**, TIMING BELT. >
6. Install the timing belt cover.

<Ref. to **INSTALLATION**, TIMING BELT COVER. >

7. Install the crank pulley. <Ref. to **INSTALLATION**, CRANK PULLEY. >
8. Install the V-belts. <Ref. to **INSTALLATION**, V-BELT. >

DISASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

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

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

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

ASSEMBLY

NOTE: Intake valve rocker assembly cannot be disassembled.

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

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

INSPECTION**INTAKE VALVE ROCKER ASSEMBLY**

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

EXHAUST VALVE ROCKER ASSEMBLY

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

Clearance between arm and shaft:

Standard:

0.020 - 0.054 mm (0.0008 - 0.0021 in)

Service limit:

0.10 mm (0.0039 in)

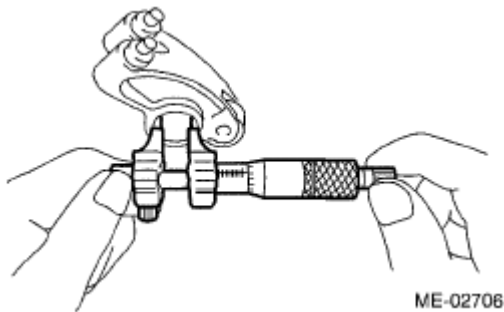


Fig. 104: Measuring Inner Diameter Of Valve Rocker Arm

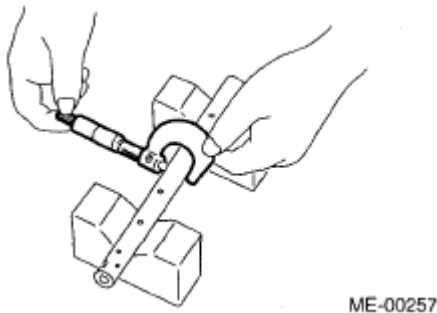


Fig. 105: Measuring Outer Diameter Of Valve Rocker Shaft

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

Rocker arm inside diameter:

22.020 - 22.041 mm (0.8669 - 0.8678 in)

Rocker shaft diameter:

21.987 - 22.000 mm (0.8656 - 0.8661 in)

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

CAMSHAFT

REMOVAL

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

3. Remove the timing belt cover. <Ref. to **REMOVAL**, TIMING BELT COVER. >
4. Remove the timing belt. <Ref. to **REMOVAL**, TIMING BELT. >
5. Remove the cam sprocket. <Ref. to **REMOVAL**, CAM SPROCKET. >
6. Remove the timing belt cover No. 2 (LH).
7. Remove the timing belt cover No. 2 (RH).

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

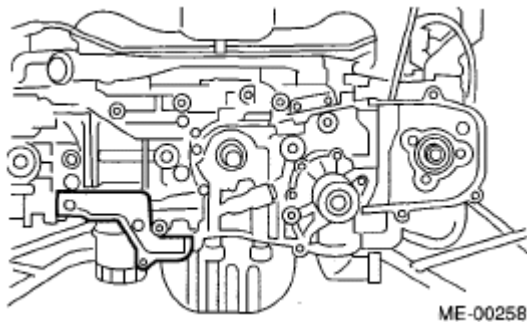


Fig. 106: Identifying Belt Cover

8. Remove the tensioner bracket.

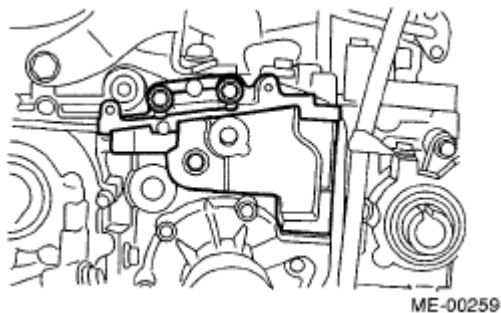


Fig. 107: Identifying Tensioner Bracket

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

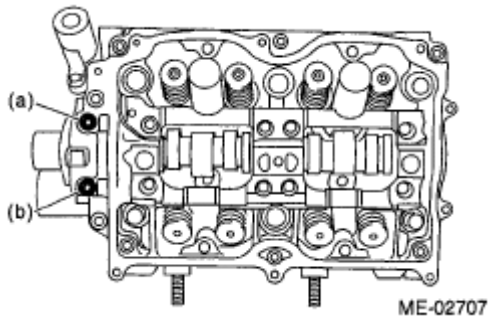


Fig. 108: Identifying Removal Sequence Of Bolts

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

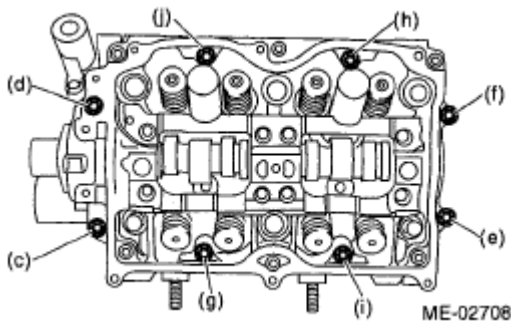


Fig. 109: Identifying Loosening Sequence Of Bolts

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

ST 499497000 TORX® plus

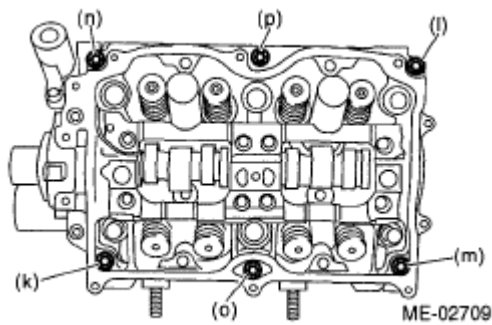


Fig. 110: Identifying Removal Sequence Of Bolts

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

CAUTION:

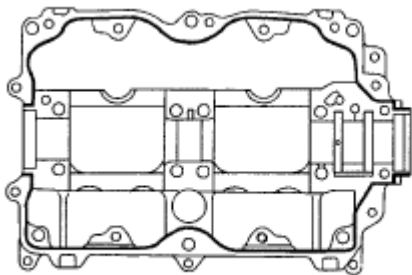
- Do not remove the oil seal unless necessary.
- Do not scratch the journal surface when removing the oil seal.

INSTALLATION

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

Liquid gasket:

Three bond 1280B (Part Number K0877YA018)

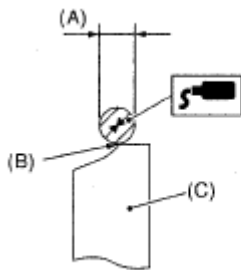


ME-02710

Fig. 111: Identifying Camshaft Cap

NOTE:

- Apply a coat of liquid gasket of 3 mm (0.12 in) in diameter (A) along the edge (B) of camshaft cap (C) mating surface.
- Install within 20 min. after applying liquid gasket.



ME-00265

Fig. 112: Identifying Liquid Gasket Applying Area

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

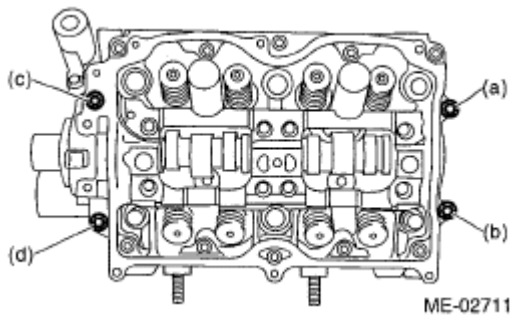


Fig. 113: Identifying Tightening Sequence Of Bolts

3. Install the valve rocker assembly.

<Ref. to **INSTALLATION**, VALVE ROCKER ASSEMBLY. >

4. Tighten the TORX® bolts (e) through (j) in alphabetical sequence using ST.

ST 499497000 TORX® plus

Tightening torque:

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

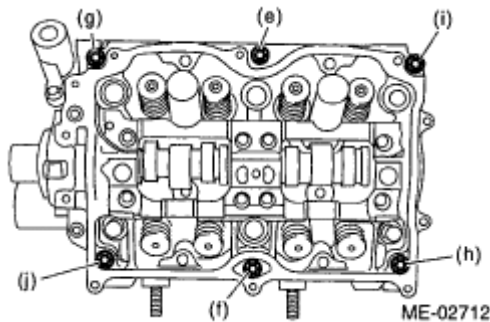


Fig. 114: Identifying Tightening Sequence Of Bolts

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

Tightening torque:

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

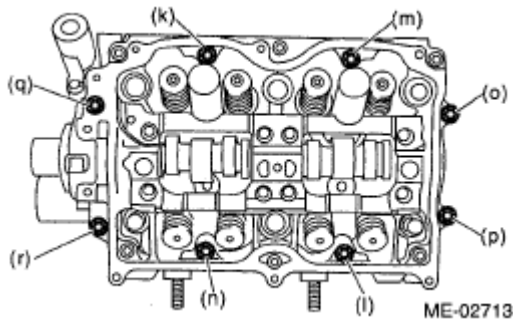


Fig. 115: Identifying Tightening Sequence Of Bolts

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

Tightening torque:

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

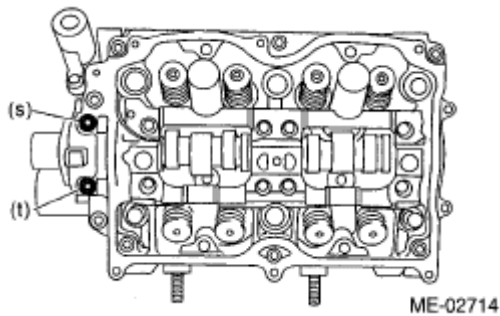


Fig. 116: Identifying Tightening Sequence Of Bolts

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

NOTE: Use a new oil seal.

ST1 499597000 OIL SEAL GUIDE

ST2 499587500 OIL SEAL INSTALLER

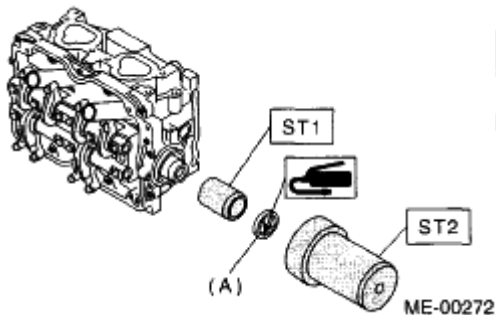


Fig. 117: Installing Oil Seal Using Oil Seal Guide ST1 499597000 And Oil Seal Installer ST2 499587500

4. Install the plug (A) using ST.

ST 499587700 CAMSHAFT OIL SEAL INSTALLER

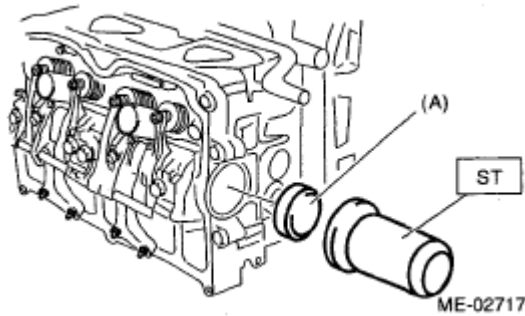


Fig. 118: Installing Plug Using Camshaft Oil Seal Installer ST499587700

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

NOTE:

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

Tightening torque:

First time

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

Second time

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

RH side

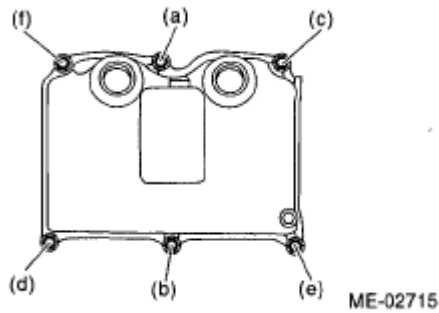


Fig. 119: Identifying Tightening Sequence Of Rocker Cover Bolts - RH Side

LH side

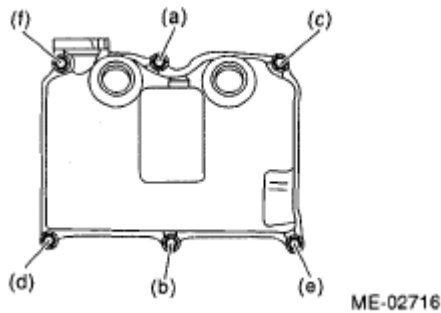


Fig. 120: Identifying Tightening Sequence Of Rocker Cover Bolts - LH Side

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

Tightening torque:

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

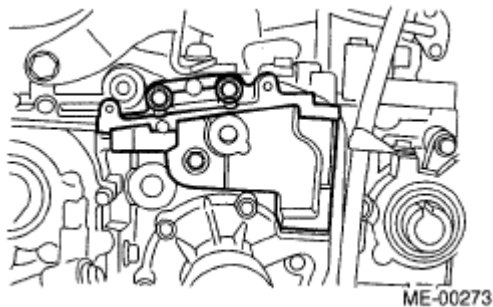
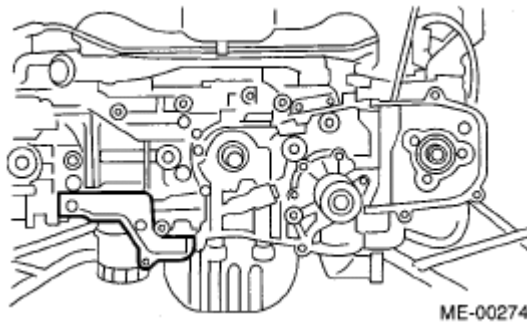


Fig. 121: Identifying Tensioner Bracket

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

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

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

Tightening torque:***5 N.m (0.5 kgf-m, 3.6 ft-lb)*****Fig. 122: Identifying Timing Belt Cover**

12. Install the cam sprocket. <Ref. to **INSTALLATION**, CAM SPROCKET. >
13. Install the timing belt. <Ref. to **INSTALLATION**, TIMING BELT. >
14. Install the timing belt cover.

<Ref. to **INSTALLATION**, TIMING BELT COVER. >
15. Install the crank pulley. <Ref. to **INSTALLATION**, CRANK PULLEY. >
16. Install the V-belts. <Ref. to **INSTALLATION**, V-BELT. >

INSPECTION**CAMSHAFT**

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

Service limit:***0.025 mm (0.00098 in)***

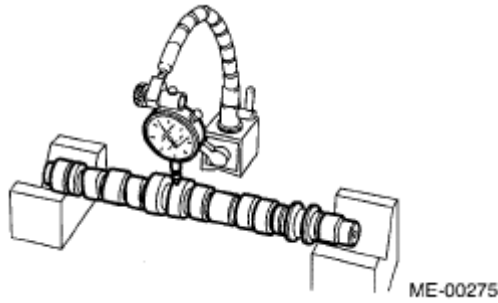


Fig. 123: Measuring Camshaft For Bend

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

OIL CLEARANCE AND CAMSHAFT JOURNAL OUTER DIAMETER SPECIFICATION

Unit: mm (in)		
Oil clearance	Standard	0.055 - 0.090 (0.0022 - 0.0035)
	Limit	0.10 (0.0039)
Camshaft journal O.D.		31.928 - 31.945 (1.2570 - 1.2577)
Journal hole I.D.		32.000 - 32.018 (1.2598 - 1.2605)

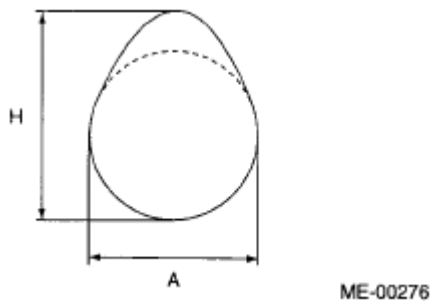
4. Check the cam face condition, and remove the minor faults by grinding with oil stone. Measure the cam height H. If it exceeds the limit, replace it.

Cam height H:

CAM HEIGHT SPECIFICATION

Part			Unit: mm (in)
Intake	Constant	Standard	40.075 - 40.175 (1.5778 - 1.5817)
		Limit	39.975 (1.5738)
	Low speed	Standard	35.182 - 35.282 (1.3851 - 1.3891)
		Limit	35.082 (1.3812)
	High speed	Standard	40.315 - 40.415 (1.5872 - 1.5911)
		Limit	40.215 (1.5833)
Exhaust	Standard		40.149 - 40.249 (1.5807 - 1.5846)
	Limit		40.049 (1.5767)

Cam base circle diameter A:

Intake**34.00 mm (1.3386 in)****Exhaust****34.00 mm (1.3386 in)****Base circle step of adjacent intake cams (low speed and high speed):****0.03 mm (0.001 in) or less****Fig. 124: Identifying Cam Height And Cam Base Circle Diameter**

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

Standard:**0.030 - 0.090 mm (0.0012 - 0.0035 in)****Service limit:****0.10 mm (0.0039 in)****CYLINDER HEAD****REMOVAL**

1. Remove the V-belts. <Ref. to **REMOVAL**, V-BELT. >
2. Remove the crank pulley. <Ref. to **REMOVAL**, CRANK PULLEY. >
3. Remove the timing belt cover. <Ref. to **REMOVAL**, TIMING BELT COVER. >
4. Remove the timing belt. <Ref. to **REMOVAL**, TIMING BELT. >
5. Remove the cam sprocket. <Ref. to **REMOVAL**, CAM SPROCKET. >
6. Remove the intake manifold. <Ref. to **REMOVAL**, Intake Manifold. >

7. Remove the bolt which installs the A/C compressor bracket on cylinder head.
8. Remove the valve rocker assembly. <Ref. to **REMOVAL**, VALVE ROCKER ASSEMBLY. >
9. Remove the camshaft. <Ref. to **REMOVAL**, CAMSHAFT. >
10. Remove the cylinder head bolts in alphabetical sequence as shown in the figure.

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

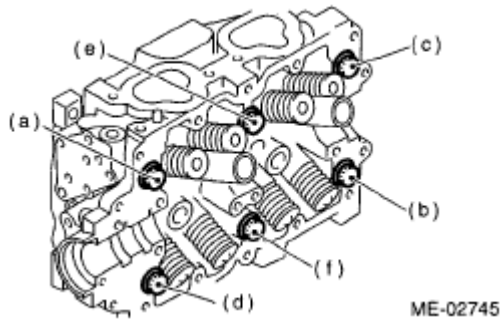


Fig. 125: Identifying Removal Sequence Of Cylinder Head Bolts

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

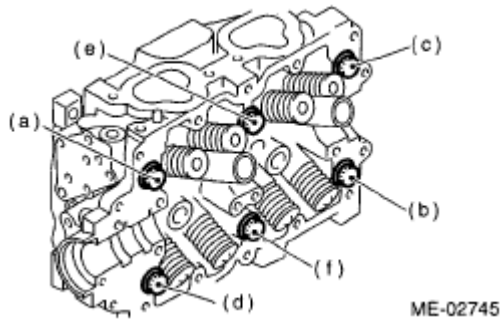


Fig. 126: Identifying Removal Sequence Of Cylinder Head Bolts

13. Remove the cylinder head gasket.

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

14. Similarly, remove the right side cylinder head.

INSTALLATION

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

CAUTION:

- Use new cylinder head gaskets.
- Be careful not to scratch the mating surface of cylinder block and cylinder head.

2. Tighten the cylinder head bolts.

1. Apply a thin coat of engine oil to washer and bolt thread.
2. Tighten all bolts to 29 N.m (3.0 kgf-m, 22 ft-lb) in alphabetical sequence. Then tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.
3. Back off all the bolts by 180° in reverse order of installation, and back them off again by 180°.
4. Tighten all bolts to 42 N.m (3.9 kgf-m, 31 ft-lb) in alphabetical sequence.
5. Tighten all bolts by 80 to 90° in alphabetical sequence.
6. Tighten all bolts by 40 to 45° in alphabetical sequence.

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

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

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

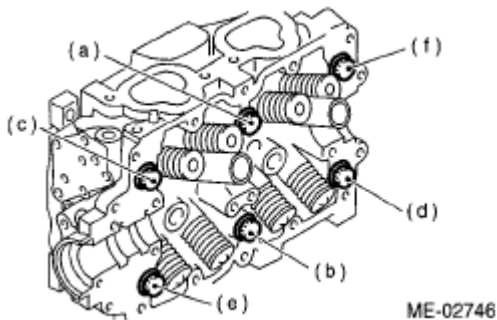


Fig. 127: Identifying Tightening Sequence Of Cylinder Head Bolts

3. Install the camshaft. <Ref. to INSTALLATION, CAMSHAFT. >
4. Install the valve rocker assembly. <Ref. to INSTALLATION, VALVE ROCKER ASSEMBLY. >
5. Install the A/C compressor bracket on cylinder head.
6. Install the intake manifold.

<Ref. to INSTALLATION , Intake Manifold. >

7. Install the cam sprocket. <Ref. to INSTALLATION, CAM SPROCKET. >
8. Install the timing belt. <Ref. to INSTALLATION, TIMING BELT. >

9. Install the timing belt cover.

<Ref. to **INSTALLATION**, TIMING BELT COVER. >

10. Install the crank pulley. <Ref. to **INSTALLATION**, CRANK PULLEY. >

11. Install the V-belts. <Ref. to **INSTALLATION**, V-BELT. >

DISASSEMBLY

1. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

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

ST 499718000 VALVE SPRING REMOVER

NOTE:

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

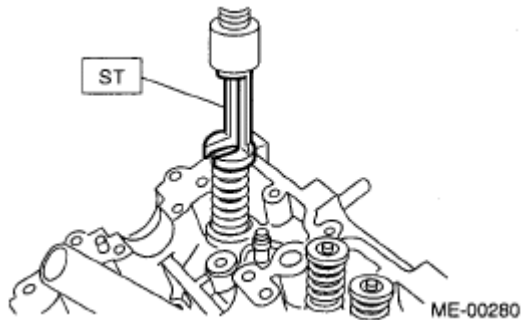
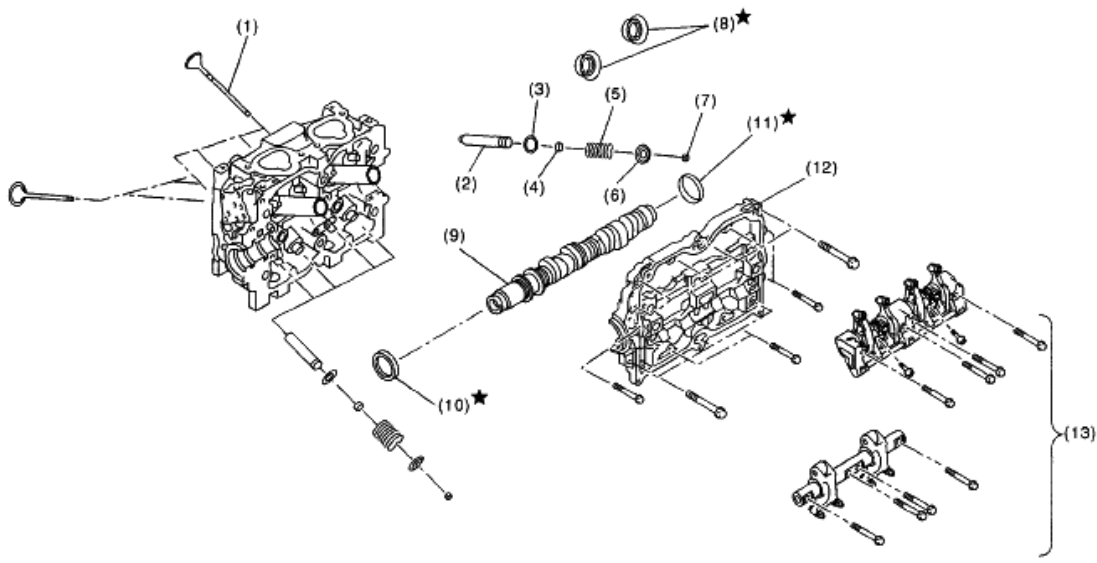


Fig. 128: Identifying Valve Spring Remover ST 499718000

ASSEMBLY



ME-02718

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

Fig. 129: Identifying Cylinder Head Assembly Components

1. Installation of valve spring and valve:

1. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

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

CAUTION: Use extreme care not to damage the oil seal lips when inserting the valve into valve guide.

3. Install the valve spring and retainer.

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

4. Set the ST on valve spring.

ST 499718000 VALVE SPRING REMOVER

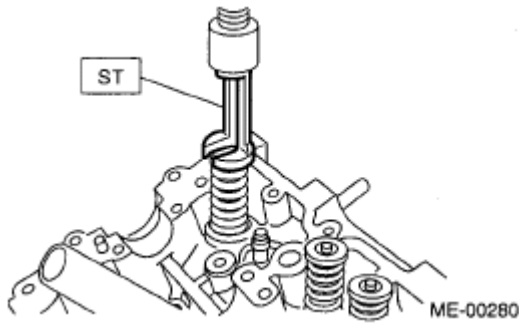
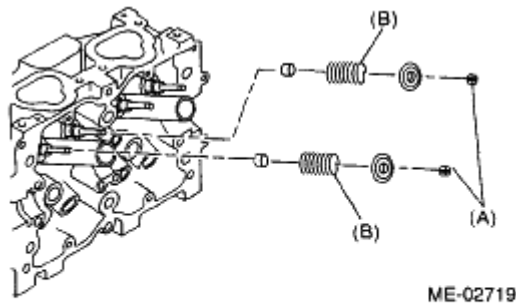


Fig. 130: Identifying Valve Spring Remover ST 499718000

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



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

Fig. 131: Identifying Valve Spring And Valve Spring Retainer Key

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

INSPECTION

CYLINDER HEAD

1. Make sure that no crack or other damage do not exists. In addition to visual inspection, inspect important areas using liquid penetrant tester.

Also make sure the gasket installing surface shows no trace of gas and water leaks.

2. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

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

If the warping exceeds the limit, regrind the surface with a surface grinder.

Warping limit:

0.03 mm (0.0012 in)

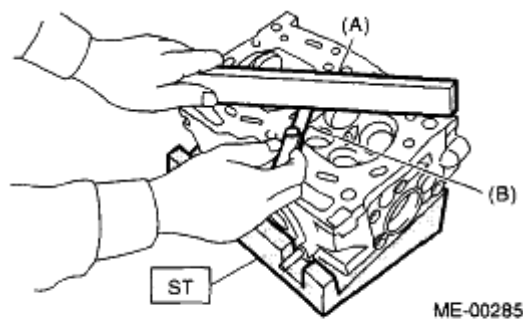
Grinding limit:

0.1 mm (0.004 in)

Standard height of cylinder head:

97.5 mm (3.839 in)

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



- (A) Straight edge
(B) Thickness gauge

Fig. 132: Measuring Warping Of Cylinder Head Surface

VALVE SEAT

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

Valve seat width W:

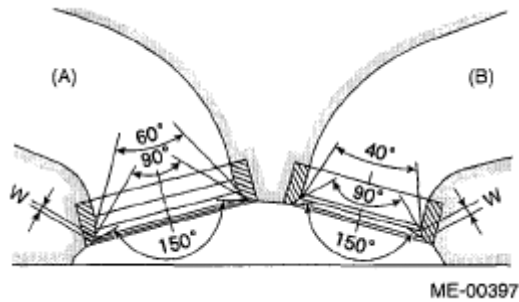
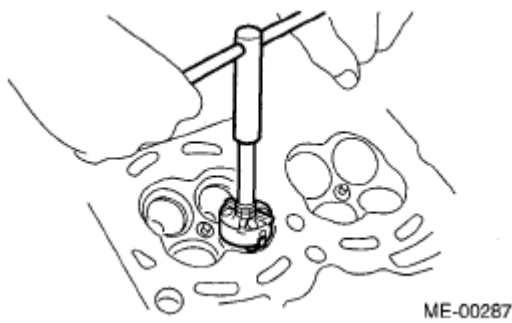
Standard:

Intake (A)

0.8 - 1.4 mm (0.03 - 0.055 in) Exhaust (B)

1.2 - 1.8 mm (0.047 - 0.071 in)

Service limit:

Intake (A)***1.7 mm (0.067 in)******Exhaust (B)******2.2 mm (0.087 in)*****Fig. 133: Identifying Valve Seat Width****Fig. 134: Applying Valve Seat Cutter In Valve Seats****VALVE GUIDE**

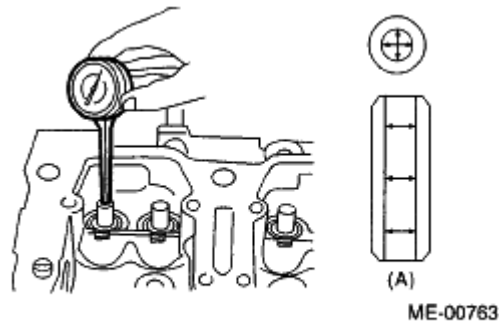
1. Check the clearance between valve guide and stem. The clearance can be checked by measuring respectively the outer diameter of valve stem with a micrometer and the inner diameter of valve guide with a caliper gauge.

Clearance between the valve guide and valve stem:***Standard:******Intake******0.035 - 0.062 mm (0.0014 - 0.0024 in)******Exhaust***

0.040 - 0.067 mm (0.0016 - 0.0026 in)

Service limit:

0.15 mm (0.0059 in)



(A) Valve guide

Fig. 135: Checking Clearance Between Valve Guide And Stem

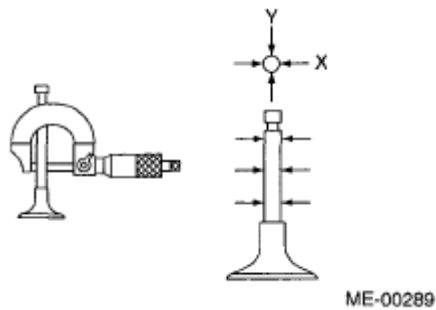


Fig. 136: Measuring Outer Diameter Of Valve Stem With Micrometer

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

Valve guide inner diameter:

6.000 - 6.012 mm (0.2362 - 0.2367 in)

Valve stem outer diameters:

Intake

5.950 - 5.965 mm (0.2343 - 0.2348 in)

Exhaust

5.945 - 5.960 mm (0.2341 - 0.2346 in)

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

ST1 498267800 CYLINDER HEAD TABLE

ST2 499767200 VALVE GUIDE REMOVER

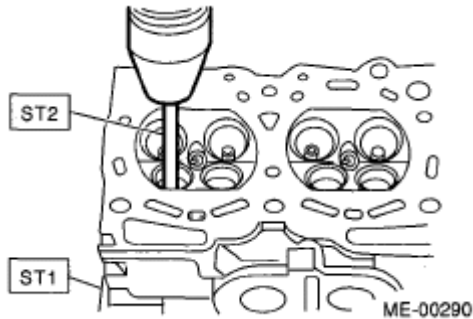


Fig. 137: Measuring Valve Guide Inner Diameter

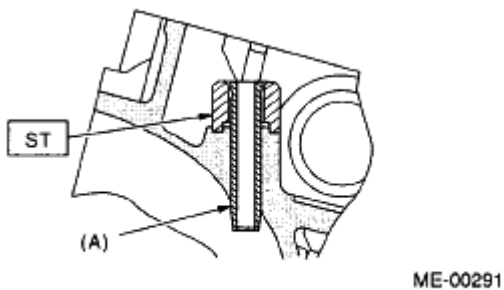
3. Turn the cylinder head upside down and place the ST as shown in the figure.

Intake side

ST 499767700 VALVE GUIDE ADJUSTER

Exhaust side

ST 499767800 VALVE GUIDE ADJUSTER



(A) Valve guide

Fig. 138: Identifying Valve Guide

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

ST1 499767200 VALVE GUIDE REMOVER

Intake side

ST2 499767700 VALVE GUIDE ADJUSTER

Exhaust side

ST2 499767800 VALVE GUIDE ADJUSTER

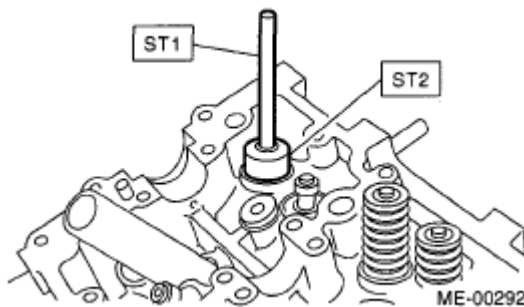


Fig. 139: Identifying Valve Guide Adjuster ST2 499767700 And Valve Guide Remover ST1 499767200

6. Check the valve guide protrusion.

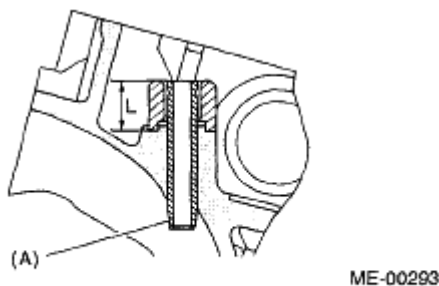
Valve guide protrusion L:

Intake

20.0 - 21.0 mm (0.787 - 0.827 in)

Exhaust

16.5 - 22.5 mm (0.650 - 0.886 in)



(A) Valve guide

Fig. 140: Identifying Valve Guide Protrusion

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

CAUTION:

- Apply engine oil to the reamer when reaming.
- If the inner surface of the valve guide is torn, the edge of the reamer should be slightly ground with an 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.

ST 499767400 VALVE GUIDE REAMER



Fig. 141: Reaming Inside Of Valve Guide

8. 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 H is outside of the specified limit.

H:

Intake

Standard:

0.8 - 1.2 mm (0.03 - 0.047 in)

Limit:

0.6 mm (0.024 in)

Exhaust

Standard:

1.0 - 1.4 mm (0.039 - 0.055 in)

Limit:

0.6 mm (0.024 in)

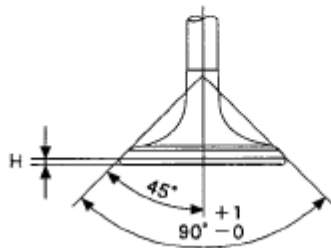
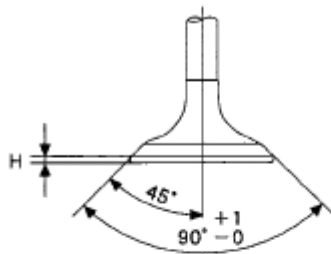
Valve overall length:

Intake

120.6 mm (4.75 in)

Exhaust

121.7 mm (4.79 in)



ME-00295

Fig. 142: Identifying Intake And Exhaust Valve Dimension

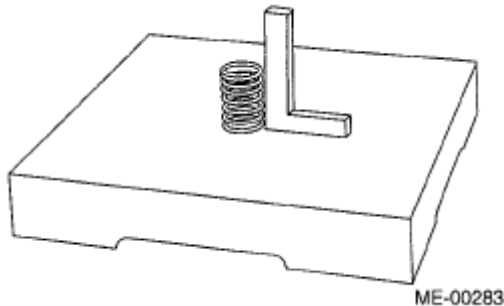
2. Put a small amount of grinding compound on the seat surface, and lap the valve seat.

VALVE SPRING

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

VALVE SPRING FREE LENGTH AND TENSION/SPRING HEIGHT SPECIFICATION

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

**Fig. 143: Measuring Squareness Of Valve Spring****INTAKE AND EXHAUST VALVE OIL SEAL**

In the following case, pinch and remove the oil seal from valve using pliers, and then replace it with a new one.

- 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. Place the cylinder head on ST1.
2. Using the ST2, press-fit the oil seal.

CAUTION:

- Apply engine oil to oil seal before press-fitting.
- When press-fitting the oil seal, do not use a hammer or strike in.
- Differentiate between the intake valve oil seal and exhaust valve oil seal by noting their difference in color.

ST1 498267800 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

Color of rubber part:

Intake [Gray]

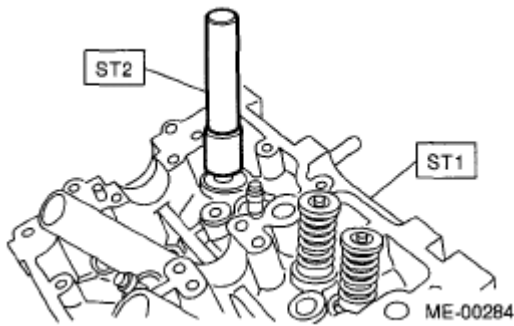
Exhaust [Green]

Fig. 144: Installing Valve Oil Seal Using Valve Oil Seal Guide ST2 498857100

CYLINDER BLOCK

REMOVAL

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

1. Remove the intake manifold. <Ref. to **REMOVAL**, Intake Manifold. >
2. Remove the V-belts. <Ref. to **REMOVAL**, V-BELT. >
3. Remove the crank pulley. <Ref. to **REMOVAL**, CRANK PULLEY. >
4. Remove the timing belt cover. <Ref. to **REMOVAL**, TIMING BELT COVER. >
5. Remove the timing belt. <Ref. to **REMOVAL**, TIMING BELT. >
6. Remove the cam sprocket. <Ref. to **REMOVAL**, CAM SPROCKET. >
7. Remove the crank sprocket. <Ref. to **REMOVAL**, CRANK PULLEY. >
8. Remove the generator and A/C compressor with their brackets.
9. Remove the rocker cover.
10. Remove the cylinder head bolts in alphabetical sequence shown in the figure.

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

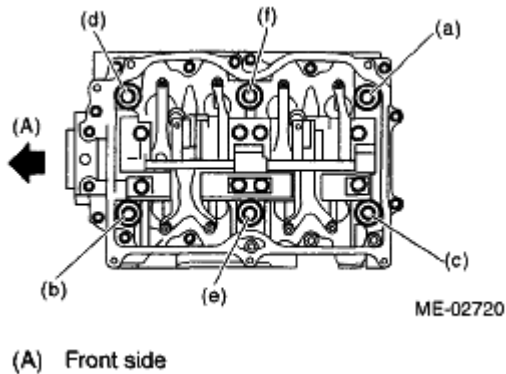


Fig. 145: Identifying Removal Sequence Of Cylinder Head Bolts

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

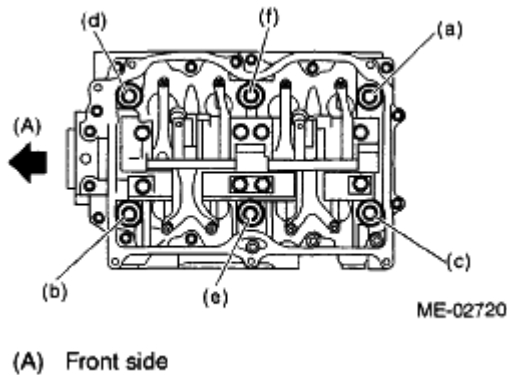


Fig. 146: Identifying Removal Sequence Of Cylinder Head Bolts

13. Remove the cylinder head gasket.

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

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

Using the ST, lock the crankshaft.

ST 498497100 CRANKSHAFT STOPPER

- MT model

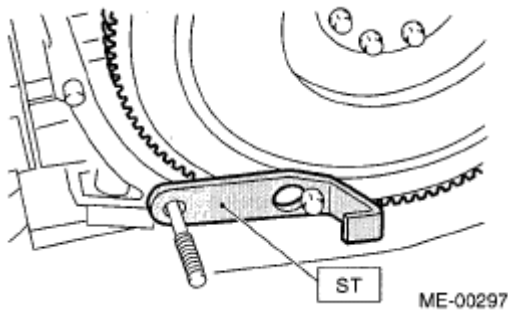


Fig. 147: Locking Crankshaft Using Crankshaft Stopper ST498497100 - MT Model

- AT model

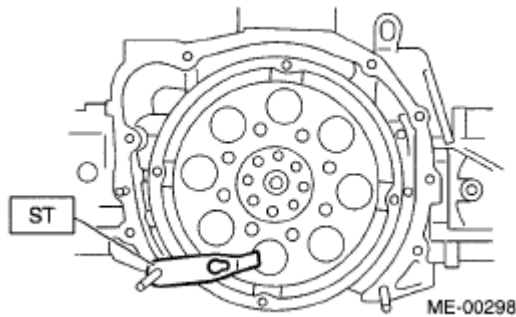


Fig. 148: Locking Crankshaft Using Crankshaft Stopper ST498497100 - AT Model

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

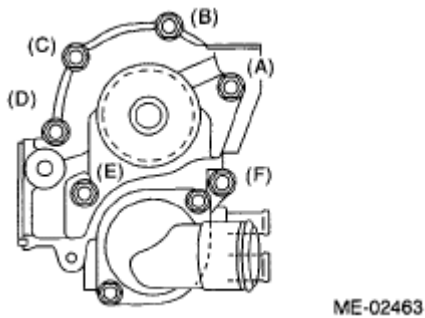


Fig. 149: Identifying Loosening Sequence Of Water Pump Bolts

20. Remove the bolts which install oil pump onto cylinder block.

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

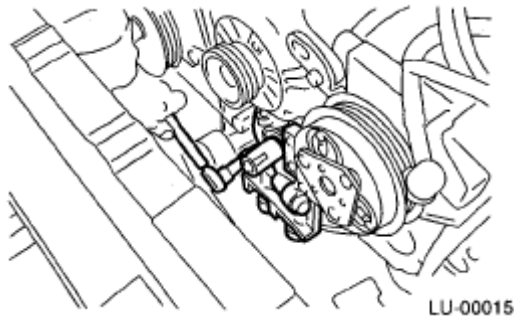


Fig. 150: Locating Oil Pump Bolts

21. Remove the oil pump from cylinder block using flat tip screwdriver.

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

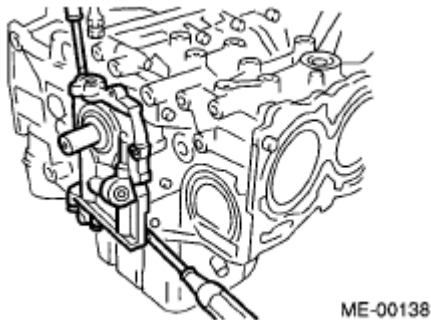


Fig. 151: Locating Oil Pump

22. Remove the oil pan.
 1. Place the cylinder block to face the #2 and #4 piston side upward.
 2. Remove the bolts which secure oil pan to cylinder block.
 3. Insert an oil pan cutter blade between cylinder block-to-oil pan clearance and remove the oil pan.

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

23. Remove the oil strainer stay.
24. Remove the oil strainer.
25. Remove the baffle plate.
26. Remove the oil filter. <Ref. to **REMOVAL** , Engine Oil Filter. >
27. Remove the water pipe.

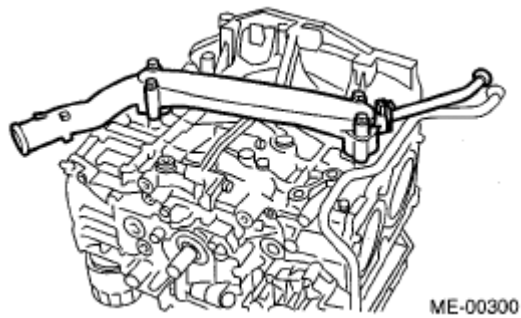
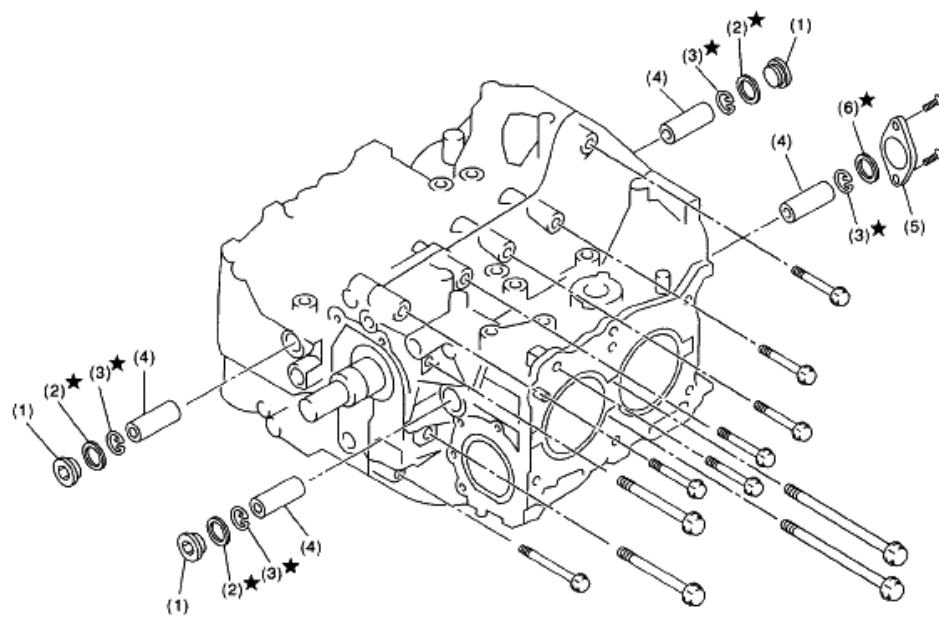


Fig. 152: Identifying Water Pipe



(1) Service hole plug
(2) Gasket

(3) Snap ring
(4) Piston pin

(5) Service hole cover
(6) O-ring

Fig. 153: Identifying Service Hole Plug, Snap Ring, Piston Pin And Service Hole Cover

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

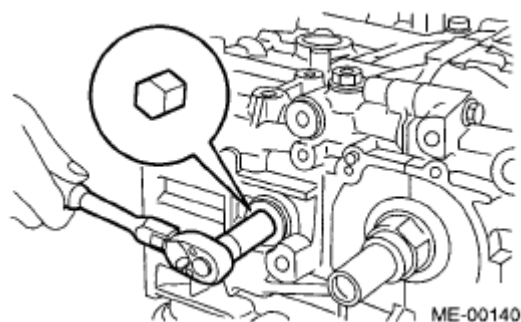


Fig. 154: Locating Service Hole Plug

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

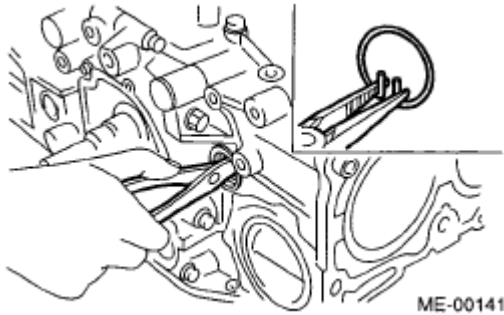


Fig. 155: Locating Piston Snap Ring

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

ST 499097700 PISTON PIN REMOVER

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

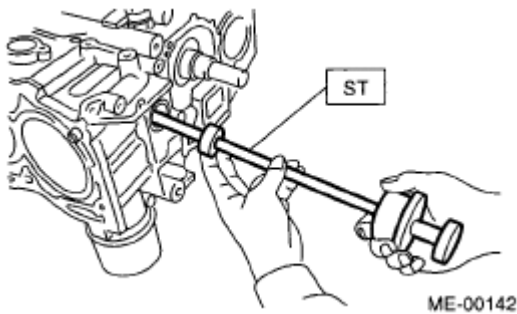


Fig. 156: Removing Piston Pin Using Piston Pin Remover ST 499097700

31. Similarly remove the piston pins from #3 and #4 pistons.
32. Remove the bolts which connect cylinder block on the side of #2 and #4 cylinders.
33. Back off the bolts which connect cylinder block on the side of #1 and #3 cylinders two or three turns.
34. Set up the cylinder block so that #1 and #3 cylinders are on the upper side, then remove the cylinder block connecting bolts.
35. Separate the cylinder block (RH) and (LH).

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

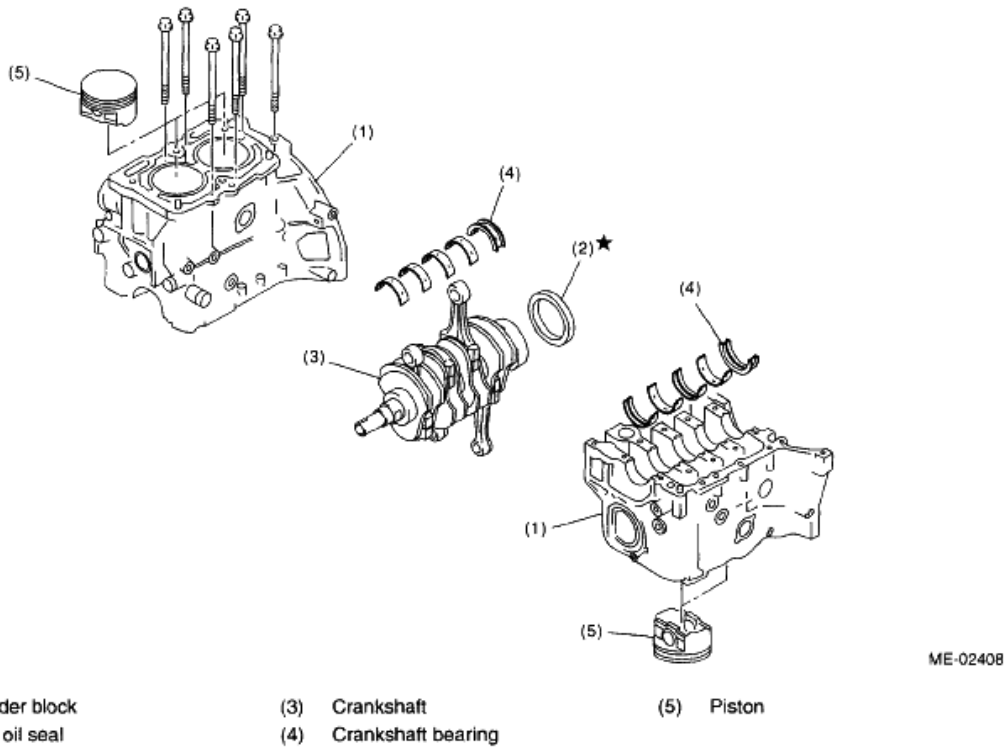


Fig. 157: Identifying Rear Oil Seal, Crankshaft, Crankshaft Bearing And Piston

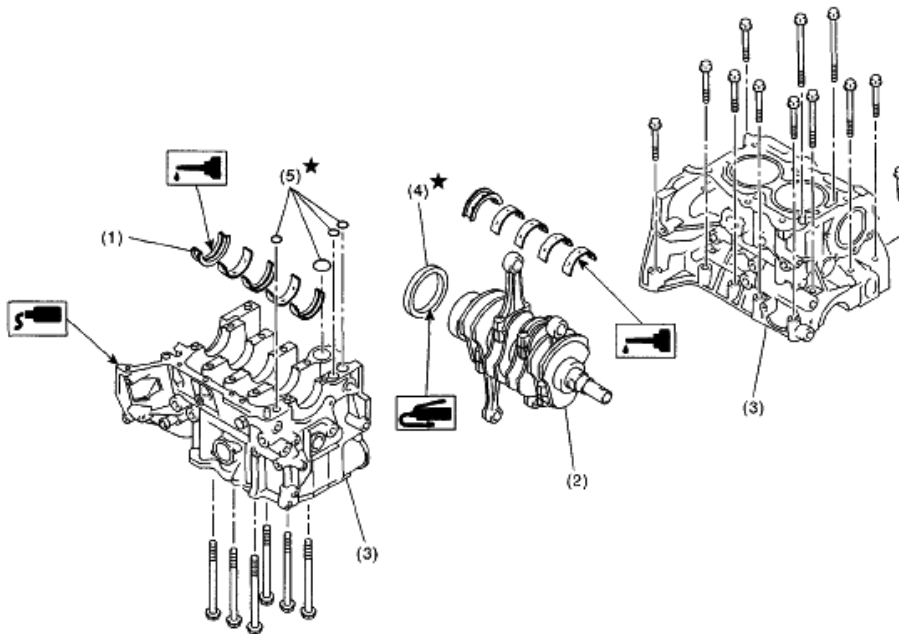
36. Remove the rear oil seal.
37. Remove the crankshaft together with connecting rod.
38. Remove the crankshaft bearings from cylinder block using a hammer handle.

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

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

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

INSTALLATION



ME-02458

- | | | |
|------------------------|--------------------|------------|
| (1) Crankshaft bearing | (3) Cylinder block | (5) O-ring |
| (2) Crankshaft | (4) Rear oil seal | |

Fig. 158: Identifying Rear Oil Seal, Crankshaft, Crankshaft Bearing And O-Ring

NOTE: Remove oil on the mating surface of bearing and cylinder block before installation. Apply a coat of engine oil to crankshaft pins.

1. Position the crankshaft on the #2 and #4 cylinder block.
2. Apply liquid gasket to the mating surface of #1 and #3 cylinder block, and position it on #2 and #4 cylinder block.

Liquid gasket:

Three bond 1215 (Part Number 004403007) or equivalent

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

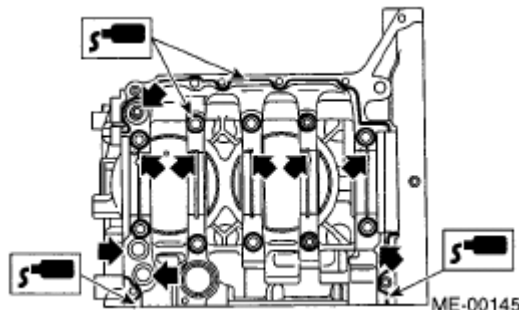


Fig. 159: Identifying Liquid Gasket Applying Area Of Cylinder Block

3. Apply a coat of engine oil to the washer and bolt thread.
4. Tighten the 10 mm cylinder block connecting bolts on LH side (A - D) in alphabetical sequence.

Tightening torque:

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

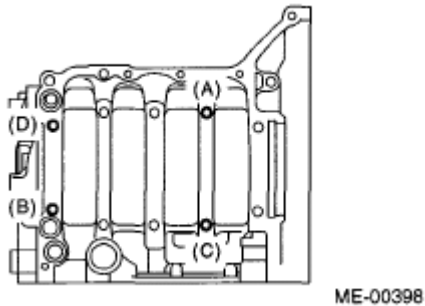


Fig. 160: Identifying Tightening Sequence Of Cylinder Block Connecting Bolts

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

Tightening torque:

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

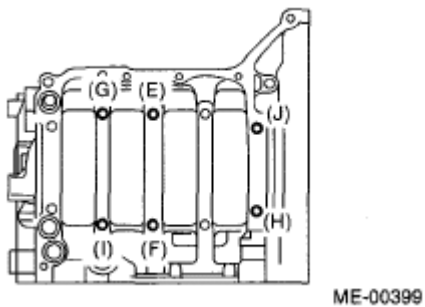


Fig. 161: Identifying Tightening Sequence Of Cylinder Block Connecting Bolts

6. Further tighten the LH side bolts (A - D) in alphabetical sequence.

Tightening torque:

18 N.m (1.8 kgf-m, 13 ft-lb)

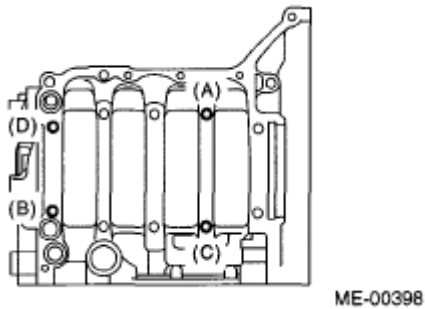


Fig. 162: Identifying Tightening Sequence Of Cylinder Block Connecting Bolts

7. Further tighten the RH side bolts (E - J) in alphabetical sequence.

Tightening torque:

18 N.m (1.8 kgf-m, 13 ft-lb)

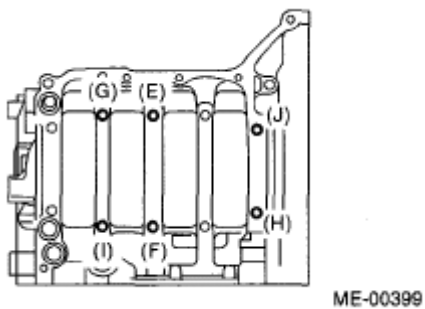


Fig. 163: Identifying Tightening Sequence Of Cylinder Block Connecting Bolts

8. Further tighten the LH side bolts (A - D) in alphabetical sequence.
 - (A), (C): Angle tightening

Tightening angle:

90°

- (B), (D): Torque tightening

Tightening torque:

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

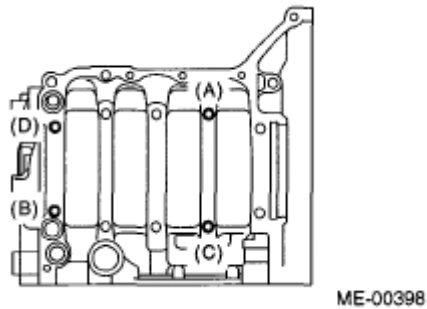


Fig. 164: Identifying Tightening Sequence Of Cylinder Block Connecting Bolts

9. Tighten the RH side bolts (E - J) 90° further in alphabetical sequence.

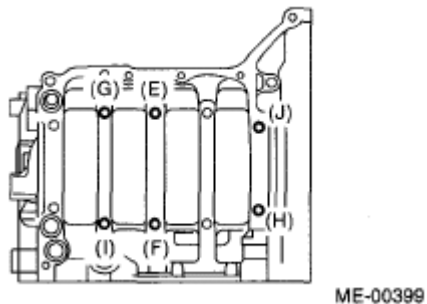


Fig. 165: Identifying Tightening Sequence Of Cylinder Block Connecting Bolts

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

Tightening torque:

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

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

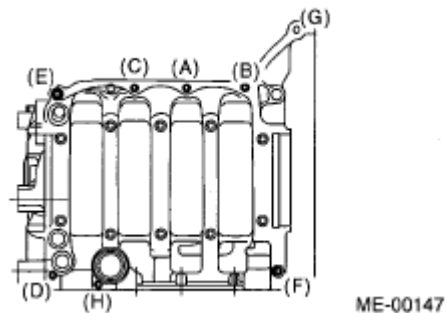
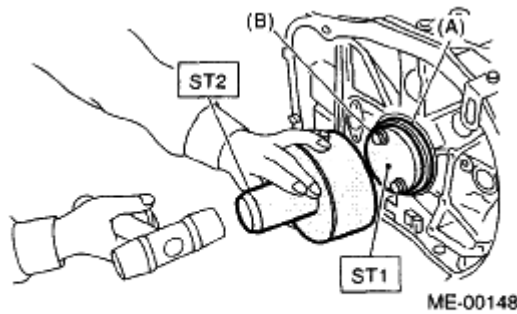


Fig. 166: Identifying Tightening Sequence Of Cylinder Block Connecting Bolts

11. Install the rear oil seal using ST1 and ST2.

ST1 499597100 OIL SEAL GUIDE

ST2 499587200 OIL SEAL INSTALLER



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

Fig. 167: Installing Rear Oil Seal Using Oil Seal Installer ST2 499587200

NOTE: Use a new rear oil seal.

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

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

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

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

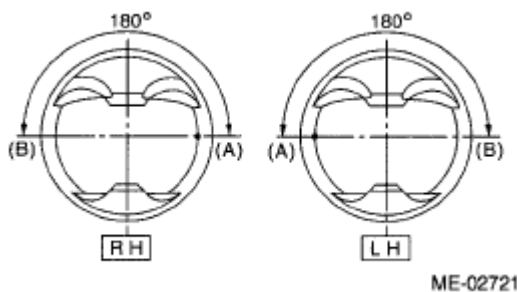


Fig. 168: Identifying Second Ring Gap

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

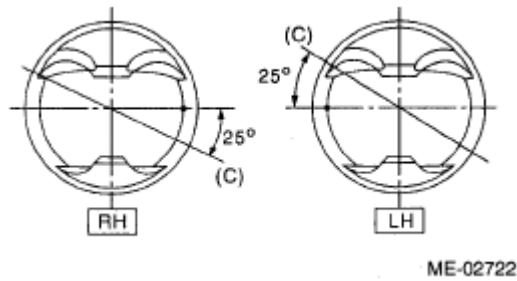


Fig. 169: Identifying Upper Rail Gap

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

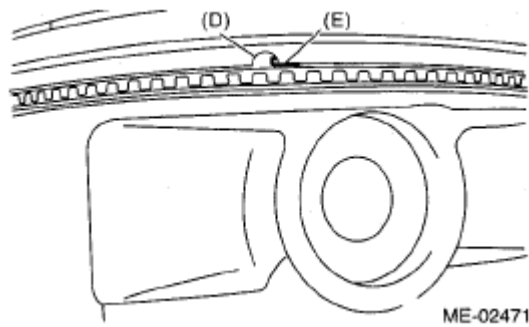


Fig. 170: Identifying Upper Rail Spin Stopper

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

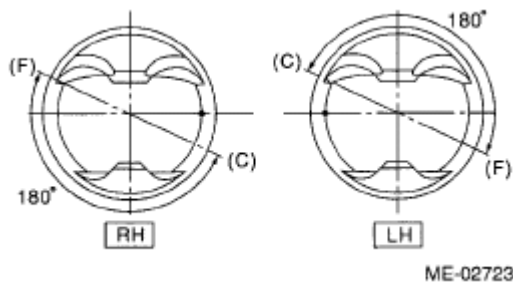


Fig. 171: Identifying Expander Gap

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

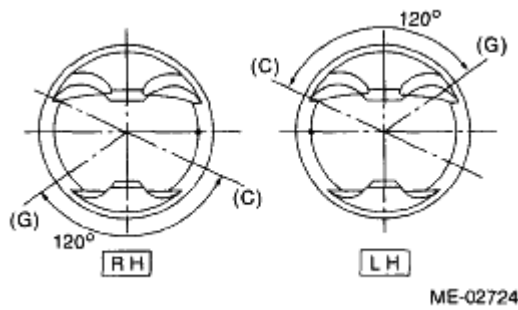


Fig. 172: Identifying Lower Rail Gap

CAUTION:

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

18. 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.

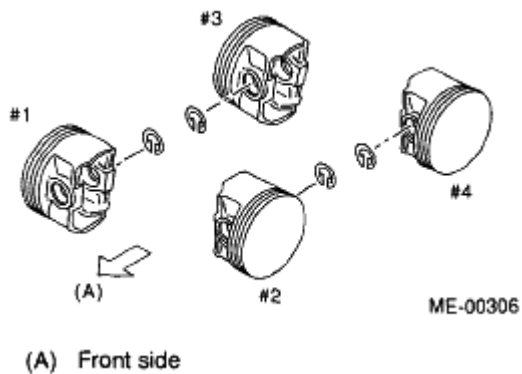
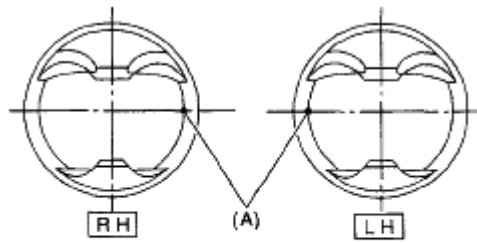


Fig. 173: Identifying Piston Position

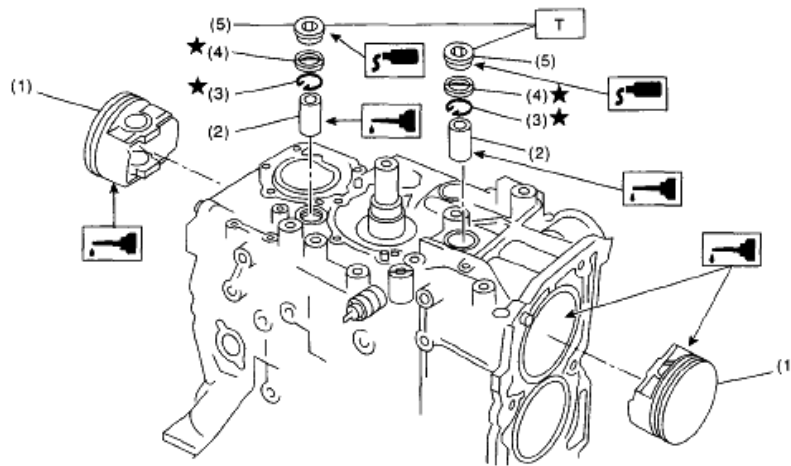
CAUTION: Piston front mark faces towards the front of engine.



ME-02725

(A) Front mark

Fig. 174: Identifying Front Mark On Piston



ME-02426

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

Tightening torque: N·m (kgf-m, ft-lb)
T: 70 (7.1, 50.6)

Fig. 175: Identifying Piston, Piston Pin, Piston Ring And Service Hole Plug

19. Install the piston.
 1. Place the cylinder block to face the #1 and #2 cylinder side upward.
 2. Using the ST1, turn the crankshaft so that #1 and #2 connecting rods are set at bottom dead center.

ST1 499987500 CRANKSHAFT SOCKET

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

ST2 498747300 PISTON GUIDE

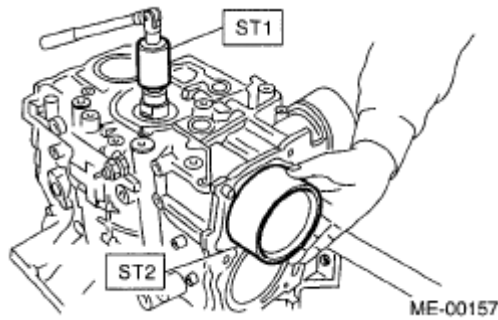


Fig. 176: Inserting Pistons In Cylinder Using Piston Guide ST2 498747300

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

ST3 499017100 PISTON PIN GUIDE

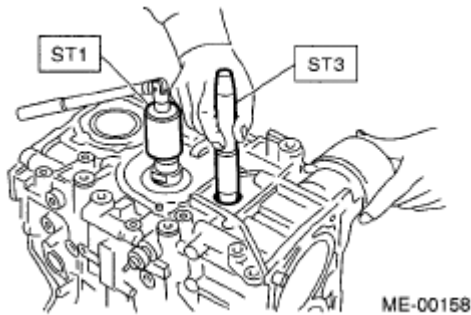


Fig. 177: Inserting ST3 Into Service Hole

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

NOTE: Use new snap rings.

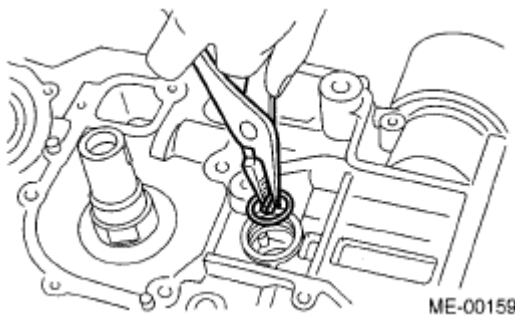
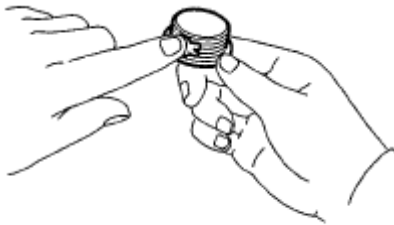


Fig. 178: Installing Snap Ring

5. Apply liquid gasket around the service hole plug.

Liquid gasket:

Three bond 1215 (Part Number 004403007) or equivalent

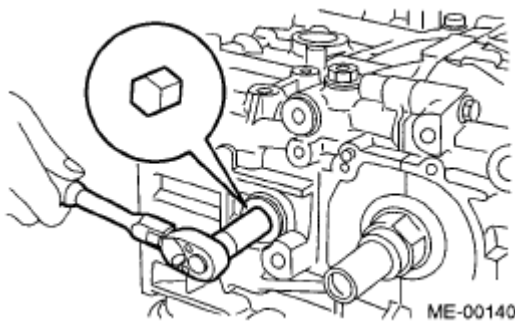


ME-00160

Fig. 179: Applying Liquid Gasket Around Service Hole Plug

6. Install the service hole plug and gasket.

NOTE: Use a new gasket.



ME-00140

Fig. 180: Installing Service Hole Plug

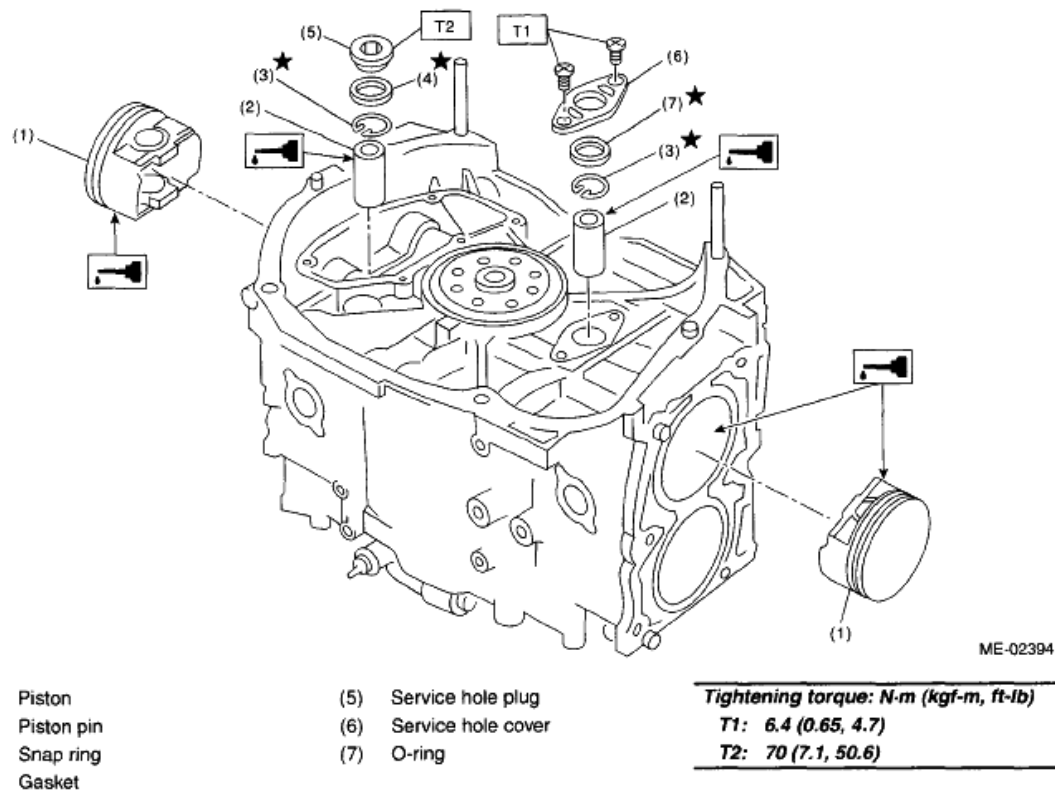


Fig. 181: Identifying Piston, Piston Pin, Piston Ring And Service Hole Plug

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

21. Install the water pipe.

Tightening torque:

6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

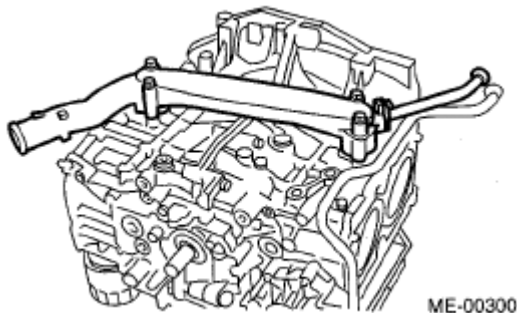


Fig. 182: Identifying Water Pipe

22. Install the baffle plate.

Tightening torque:

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

23. Install the oil strainer and O-ring.

Tightening torque:

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

24. Install the oil strainer stay.
25. Apply liquid gasket to the mating surfaces, and install the oil pan.

Liquid gasket:

Three bond 1207C (Part No.004403012) or equivalent

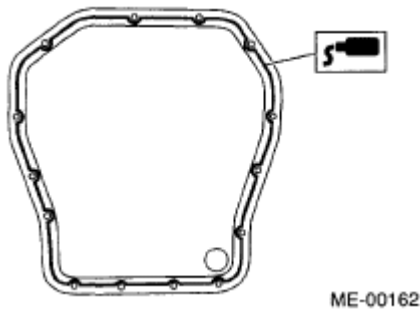


Fig. 183: Identifying Liquid Gasket Applying Area Of Oil Pan

26. Apply liquid gasket to the mating surfaces and the threaded portion of bolt (A) shown in the figure, and then install the oil separator cover.

Liquid gasket:

- **Mating surface**

Three bond 1207C (Part No.004403012) or equivalent

- **(A) bolt threads**

Three bond 1324 (Part Number004403042) or equivalent

Tightening torque:

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

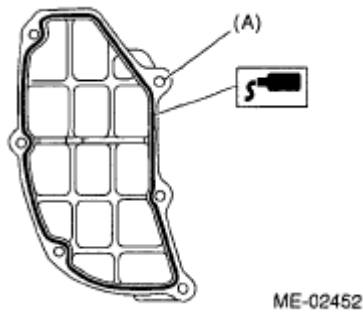


Fig. 184: Identifying Liquid Gasket Applying Area Of Bolt

27. Install the flywheel. (MT model)

<Ref. to **INSTALLATION** , Flywheel. >

To lock the crankshaft, use the ST.

ST 498497100 CRANKSHAFT STOPPER

Tightening torque:

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

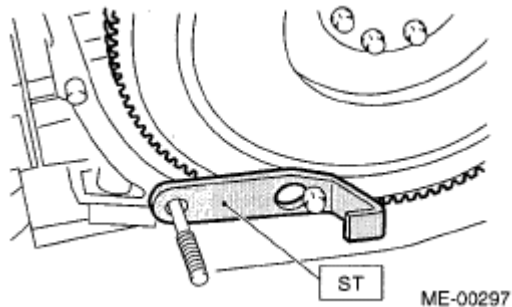


Fig. 185: Locking Crankshaft Using Crankshaft Stopper ST498497100 - MT Model

28. Install the drive plate.

To lock the crankshaft, use the ST.

ST 498497100 CRANKSHAFT STOPPER

Tightening torque:

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

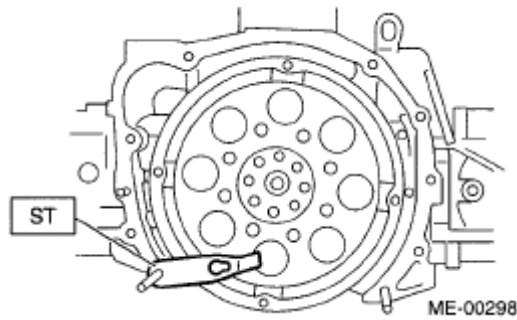


Fig. 186: Locking Crankshaft Using Crankshaft Stopper ST498497100 - AT Model

29. Install the housing cover.
30. Installation of oil pump:
 1. Discard the front oil seal after removal. Replace with a new one using ST.

ST 499587100 OIL SEAL INSTALLER

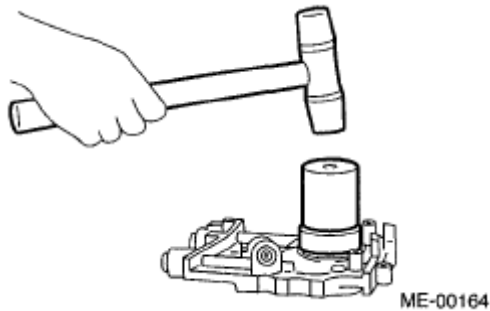
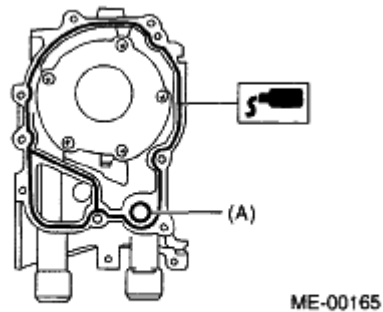


Fig. 187: Installing Oil Seal Using Oil Seal Installer ST499587100

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

Liquid gasket:

Three bond 1215 (Part Number004403007) or equivalent



(A) O-ring

Fig. 188: Identifying Liquid Gasket Applying Area Of Oil Pump

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

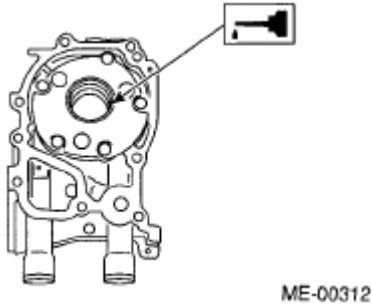


Fig. 189: Identifying Liquid Gasket Applying Area Of Oil Seal

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

CAUTION:

- Make sure the oil seal lip is not folded.
- Do not forget to install the O-ring and seal when installing oil pump.

5. Apply liquid gasket to the three bolts thread shown in figure.

Liquid gasket:

Three bond 1324 (Part Number 004403042) or equivalent

Tightening torque:

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

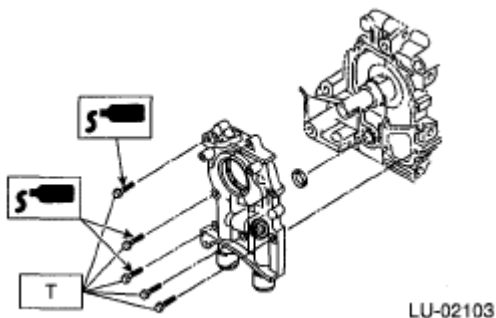


Fig. 190: Identifying Liquid Gasket Applying Area Of Bolts

31. Install the service hole plug and gasket.

Tightening torque:

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

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

CAUTION:

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

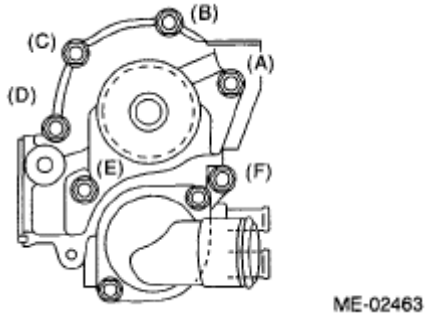


Fig. 191: Identifying Tightening Sequence Of Water Pump Bolts

32. Install the water by-pass pipe for heater.
33. Install the oil filter.

<Ref. to **INSTALLATION** , Engine Oil Filter. >

34. Tighten the cylinder head bolts. <Ref. to **INSTALLATION**, CYLINDER HEAD. >
35. Install the oil level gauge guide and tighten the bolts. (LH side only)
36. Install the rocker cover and rocker cover gasket.

NOTE: Use a new rocker cover gasket.

37. Install the crank sprocket.

<Ref. to **INSTALLATION**, CRANK SPROCKET. >

38. Install the cam sprocket. <Ref. to **INSTALLATION**, CAM SPROCKET. >
39. Install the timing belt. <Ref. to **INSTALLATION**, TIMING BELT. >
40. Install the timing belt cover.
41. <Ref. to **INSTALLATION**, TIMING BELT COVER. >
42. Install the crank pulley. <Ref. to **INSTALLATION**, CRANK PULLEY. >
43. Install the generator and A/C compressor brackets on cylinder head.
44. Install the V-belts. <Ref. to **INSTALLATION**, V-BELT. >
45. Install the intake manifold.

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

DISASSEMBLY

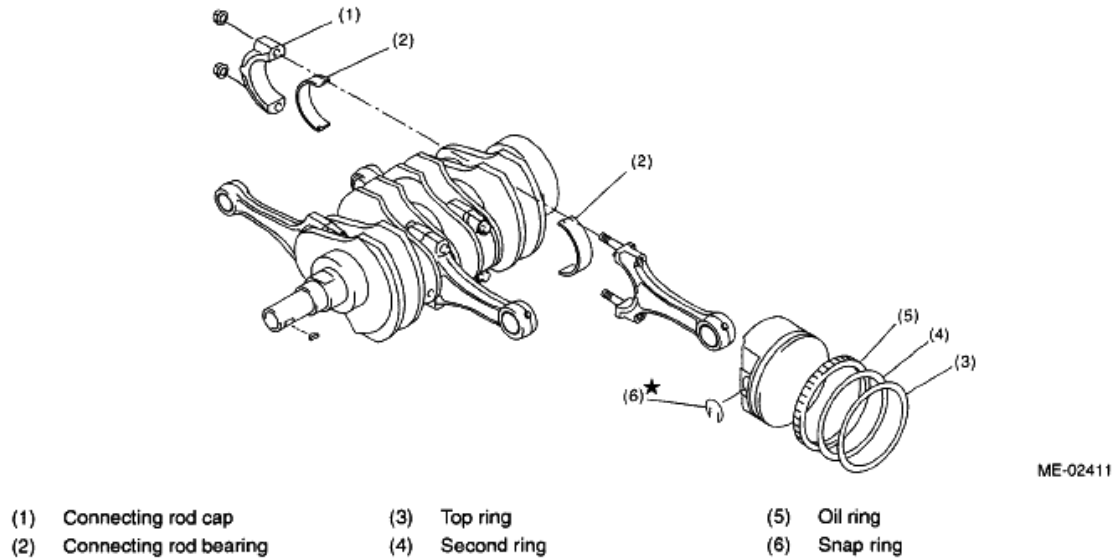


Fig. 192: Identifying Connecting Rod Cap, Top Ring, Oil Ring, Snap Ring And Connecting Rod Bearing

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

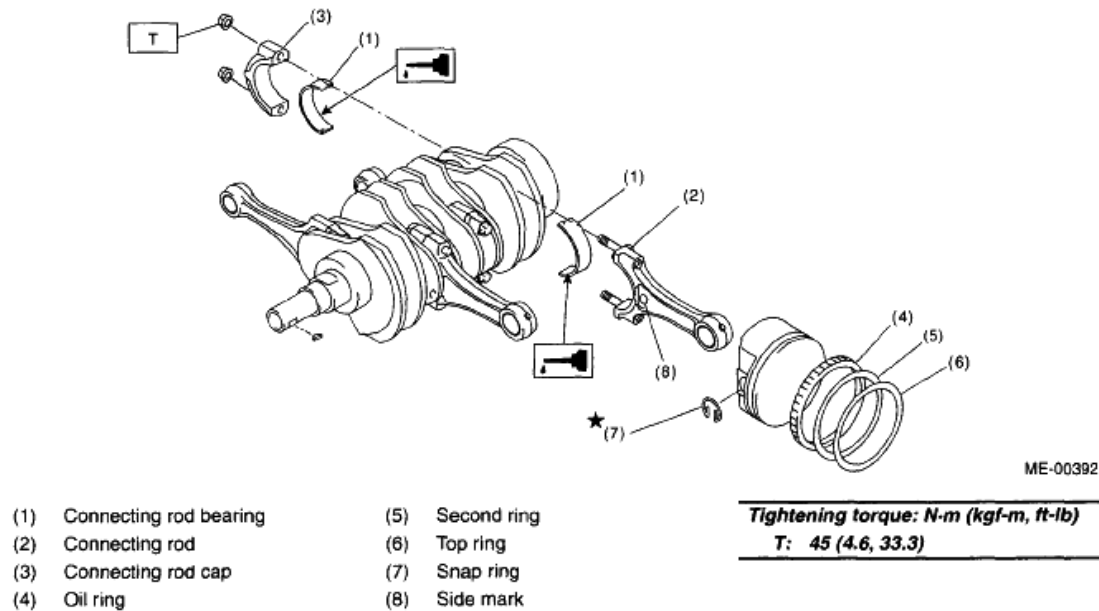


Fig. 193: Identifying Connecting Rod Cap, Top Ring, Oil Ring, Snap Ring And Connecting Rod Bearing

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

Make sure the arrow on connecting rod cap faces toward front during installation.

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 nuts, apply oil on the threads.

5. Install the expander, lower rail and upper rail in this order by hand. Install the second ring and top ring along with the 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, and correct by grinding if necessary.

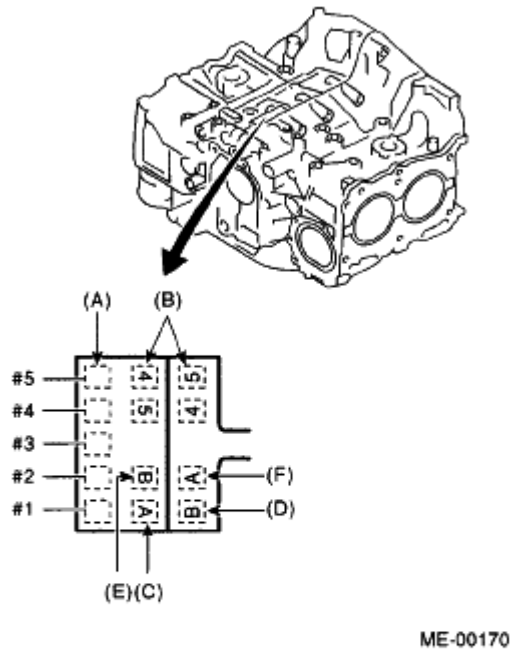
Warping limit:***0.025 mm (0.00098 in)******Grinding limit:******0.1 mm (0.004 in)******Standard height of cylinder block:******201.0 mm (7.91 in)*****CYLINDER AND PISTON**

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

NOTE:

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

Standard diameter:***A: 99.505 - 99.515 mm (3.9175 - 3.9179 in)******B: 99.495 - 99.505 mm (3.9171 - 3.9175 in)***



- (A) Main journal size mark
- (B) Cylinder block (RH)-(LH) combination mark
- (C) #1 cylinder bore size mark
- (D) #2 cylinder bore size mark
- (E) #3 cylinder bore size mark
- (F) #4 cylinder bore size mark

Fig. 194: Identifying Cylinder Bore Size Stamped On Cylinder Block Front Upper Surface

2. How to measure the inner diameter of each cylinder

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

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

Taper:

Standard:

0.015 mm (0.0006 in)

Service limit:

0.050 mm (0.0020 in)

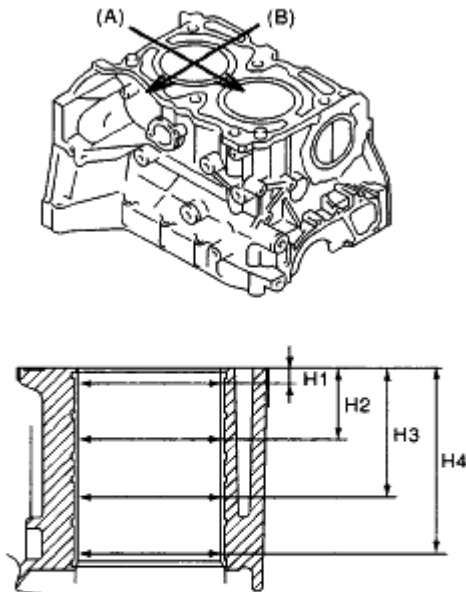
Out-of-roundness:

Standard:

0.010 mm (0.0004 in)

Service limit:

0.050 mm (0.0020 in)



ME-00171

- (A) Piston pin direction
- (B) Thrust direction
- H1 10 mm (0.39 in)
- H2 45 mm (1.77 in)
- H3 80 mm (3.15 in)
- H4 115 mm (4.53 in)

Fig. 195: Identifying Inner Diameter Of Cylinder

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

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

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

Piston grade point H:

38.2 mm (1.504 in)

Standard:

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

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

0.25 mm (0.0098 in) oversize:

99.745 - 99.765 mm (3.9270 - 3.9278 in)

0.50 mm (0.0197 in) oversize:

99.995 - 100.015 mm (3.9368 - 3.9376 in)

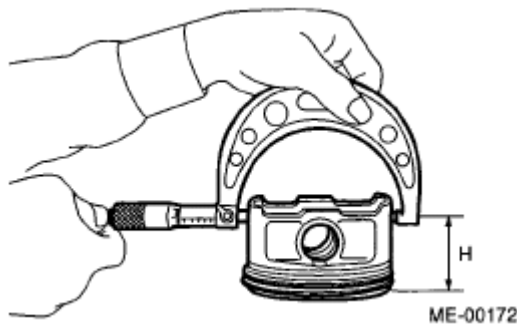


Fig. 196: Measuring Outer Diameter Of Piston

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)

Service limit:

0.030 mm (0.0012 in)

6. Boring and honing

1. If any of the measured value of taper, out-of-roundness or cylinder-to-piston clearance is not 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 the limit after boring and honing, replace the cylinder block.

Limit of cylinder inner diameter:***100.015 mm (3.9376 in)***

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

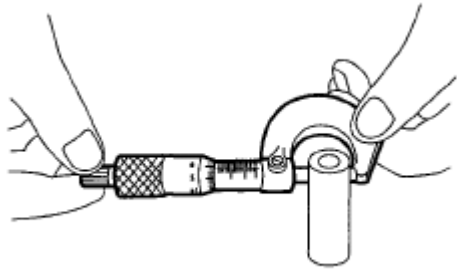
PISTON AND PISTON PIN

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 the standard value, replace the piston and bore the cylinder to enable use of the 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.

Clearance between piston hole and piston pin:***Standard:******0.004 - 0.008 mm (0.0002 - 0.0003 in)******Service limit:******0.020 mm (0.0008 in)***

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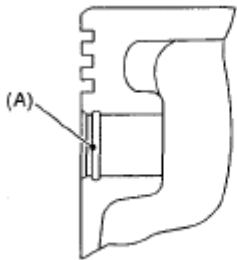
Fig. 197: Measuring Inner Diameter Of Piston Hole



ME-00174

Fig. 198: Measuring Piston Pin Diameter

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. 199: Identifying Snap Ring Installation Groove

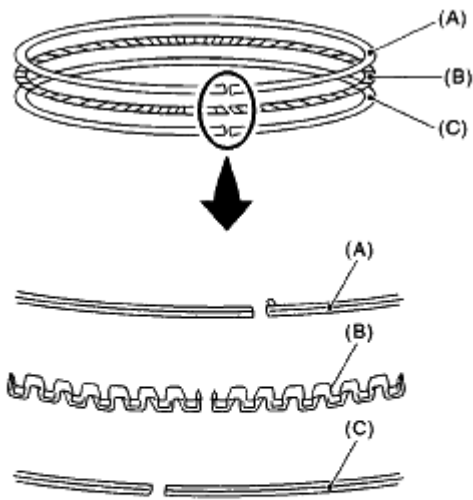
5. Check the piston pin snap ring for distortion, cracks and wear.

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 one of the same size as piston.

CAUTION:

- Marks are displayed on the end of top and second rings. When installing the rings to piston, face these marks upward.
- Oil ring consists of the upper rail, expander and lower rail. Be careful about the direction of rail when installing the oil ring to piston.



ME-02472

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

Fig. 200: Identifying Oil Rings

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

PISTON RING GAP SPECIFICATION

mm (in)			
		Standard	Limit
Piston ring gap	Top ring	0.20 - 0.35 (0.0079 - 0.0138)	1.0 (0.039)
	Second ring	0.37 - 0.52 (0.0144 - 0.0203)	
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)	1.5 (0.059)

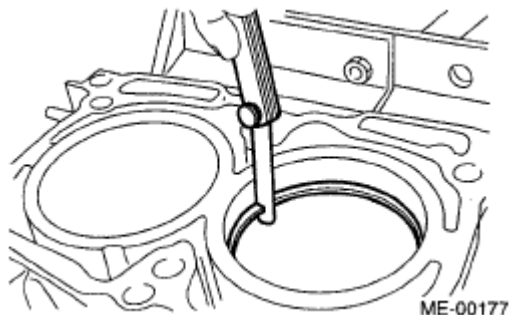
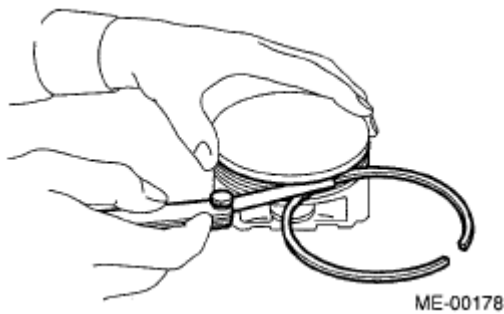


Fig. 201: Measuring Piston Ring Gap

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

CLEARANCE SPECIFICATION BETWEEN PISTON RING AND PISTON RING GROOVE

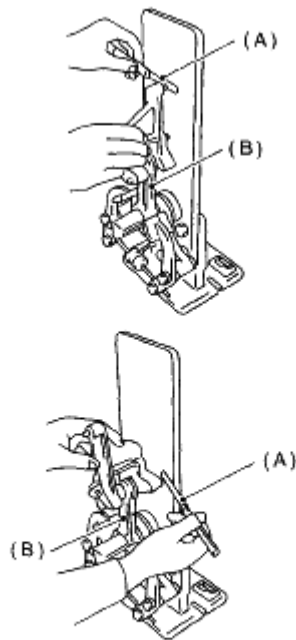
mm (in)			
		Standard	Limit
Clearance between piston ring and piston ring groove	Top ring	0.040 - 0.080 (0.0016 - 0.0031)	0.15 (0.059)
	Second ring	0.030 - 0.070 (0.0012 - 0.0028)	

**Fig. 202: Measuring Clearance Between Piston Ring And Piston Ring Groove****CONNECTING ROD**

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

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

0.10 mm (0.0039 in)



ME-00179

- (A) Thickness gauge
(B) Connecting rod

Fig. 203: Checking Connecting Rod For Bend Or Twist

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

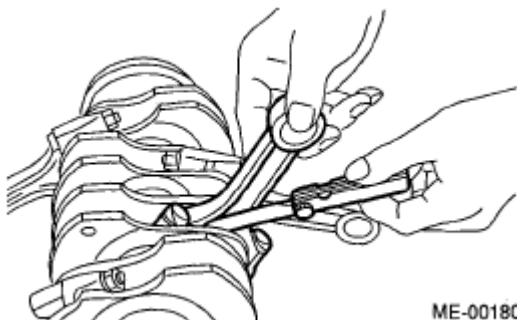
Connecting rod side clearance:

Standard:

0.070 - 0.330 mm (0.0028 - 0.0130 in)

Service limit:

0.4 mm (0.016 in)



ME-00180

Fig. 204: Measuring Connecting Rod Side Clearance

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

Connecting rod oil clearance:***Standard:******0.016 - 0.044 mm (0.00063 - 0.0017 in)******Service limit:******0.05 mm (0.0020 in)*****BEARING THICKNESS AND CRANK PIN OUTER DIAMETER SPECIFICATION**

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

6. Inspect the bushing at connecting rod small end, and replace if worn or damaged. 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)******Service limit:******0.030 mm (0.0012 in)***

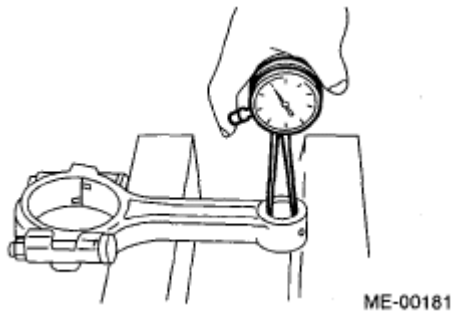


Fig. 205: Measuring Connecting Rod Small End Diameter

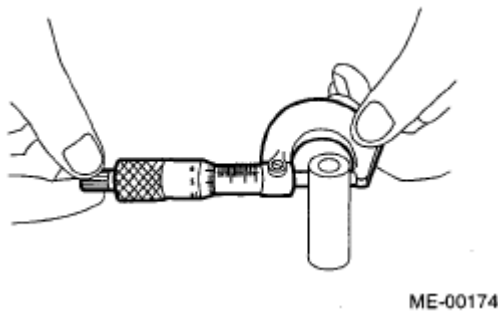


Fig. 206: Measuring Piston Pin Diameter

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 bushing.

ST 499037100 CONNECTING ROD BUSHING REMOVER & INSTALLER

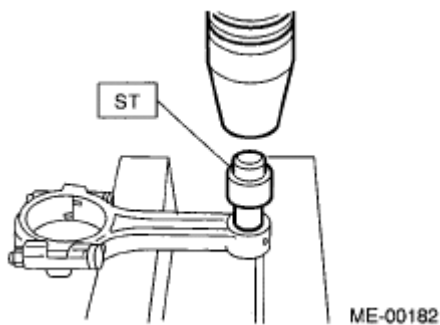


Fig. 207: Pressing Bushing With Connecting Rod Bushing Remover & Installer ST499037100

3. Make two 3 mm (0.12 in) holes in bushing. Ream the inside of bushing.
4. After completion of reaming, clean the bushing to remove chips.

CRANKSHAFT AND CRANKSHAFT BEARING

1. Clean the crankshaft completely, and check it for cracks using liquid penetrant tester. Replace if faulty.

2. Measure the bend of crankshaft. If it exceeds the limit, repair or replace it.

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

Crankshaft bend limit:

0.035 mm (0.0014 in)

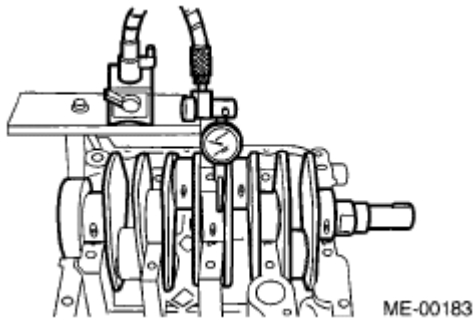


Fig. 208: Measuring Bend Of Crankshaft

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

Out-of-roundness:

0.003 mm (0.0001 in)

Cylindricity:

0.004 mm (0.0002 in)

Grinding limit:

To 51.750 mm (2.0374 in) dia.

Crank journal

Out-of-roundness:

0.005 mm (0.0002 in)

Cylindricity:

0.006 mm (0.0002 in)

Grinding limit:

To 59.750 mm (2.3524 in) dia.

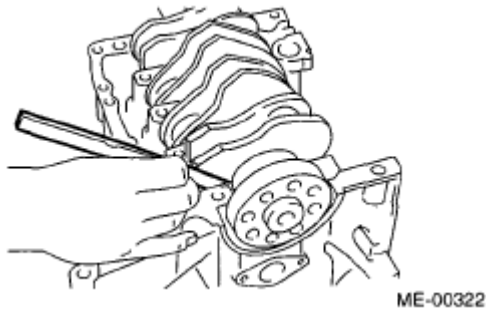


Fig. 209: Inspecting Crank Journal

CRANK JOURNAL AND CRANK PIN OUTER DIAMETER SPECIFICATION

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

4. Measure the thrust clearance of crankshaft at center bearing. If clearance outside of standard value, replace the bearing.

Crankshaft thrust clearance:***Standard:******0.030 - 0.115 mm (0.0012 - 0.0045 in)******Service limit:******0.25 mm (0.0098 in)*****Fig. 210: Measuring Thrust Clearance Of Crankshaft**

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

Crankshaft oil clearance:***Standard:******0.010 - 0.030 mm (0.0004 - 0.0012 in)******Service limit:******0.040 mm (0.0016 in)*****OIL SWITCHING SOLENOID VALVE****REMOVAL****RH SIDE**

1. Disconnect the ground cable from battery.

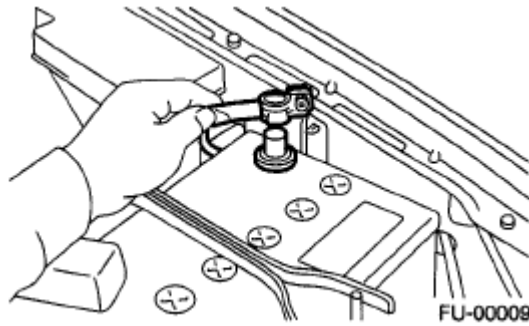


Fig. 211: Disconnecting Battery Ground Cable

2. Remove the air intake chamber.

<Ref. to **REMOVAL** , Air Intake Chamber. >

3. Remove the engine harness connector from the bracket.

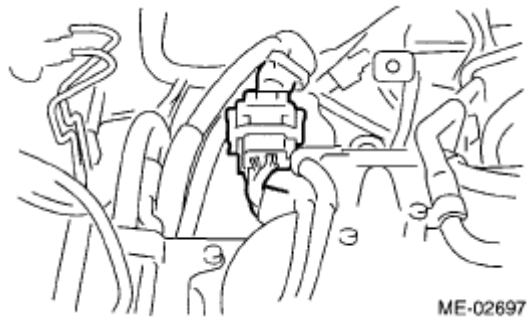


Fig. 212: Identifying Engine Harness Connector

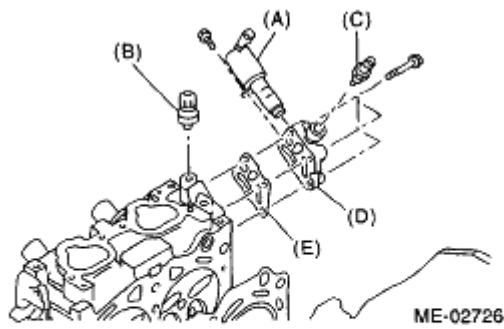
4. Disconnect the connector from the oil switching solenoid valve.
5. Remove the oil switching solenoid valve.
6. Remove the variable valve lift diagnosis oil pressure switch.

<Ref. to **REMOVAL** , Variable Valve Lift Diagnosis Oil Pressure Switch. >

7. Remove the oil temperature sensor.

<Ref. to **REMOVAL** , Oil Temperature Sensor. >

8. Remove the oil switching solenoid valve holder from the cylinder head.



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

Fig. 213: Identifying Oil Temperature Sensor And Oil Switching Solenoid Valve

LH SIDE

1. Disconnect the ground cable from battery.

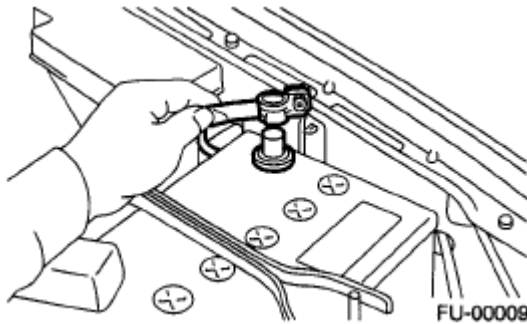


Fig. 214: Disconnecting Battery Ground Cable

2. Remove the V-belts.
<Ref. to **REMOVAL**, V-BELT. >
3. Remove the crank pulley.
<Ref. to **REMOVAL**, CRANK PULLEY. >
4. Remove the timing belt cover.
<Ref. to **REMOVAL**, TIMING BELT COVER. >
5. Remove the timing belt.

<Ref. to **REMOVAL**, TIMING BELT. >

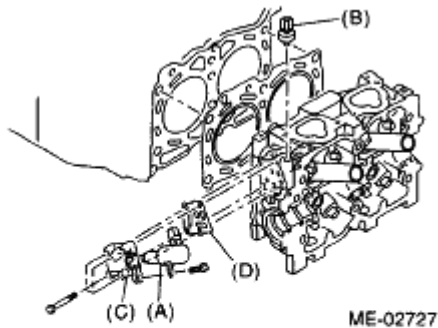
6. Remove the cam sprocket.

<Ref. to **REMOVAL**, CAM SPROCKET. >

7. Remove the timing belt cover No. 2 (LH).
8. Disconnect the connector from the oil switching solenoid valve.
9. Remove the oil switching solenoid valve.
10. Remove the variable valve lift diagnosis oil pressure switch.

<Ref. to **REMOVAL** , Variable Valve Lift Diagnosis Oil Pressure Switch. >

11. Remove the oil switching solenoid valve holder from the cylinder head.



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

Fig. 215: Identifying Variable Valve Lift Diagnostic Oil Pressure Switch And Oil Switching Solenoid Valve

INSTALLATION

RH SIDE

Install in the reverse order of removal.

NOTE: Use a new gasket.

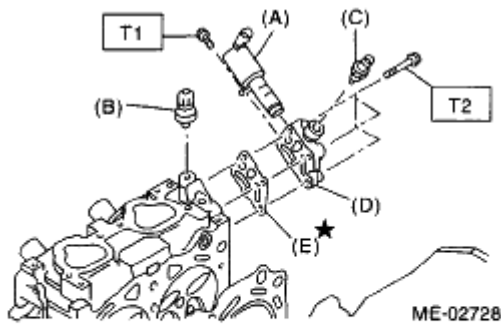
Tightening torque:

T1

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

T2

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



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

Fig. 216: Identifying Variable Valve Lift Diagnostic Oil Pressure Switch And Oil Switching Solenoid Valve

LH SIDE

Install in the reverse order of removal.

NOTE: Use a new gasket.

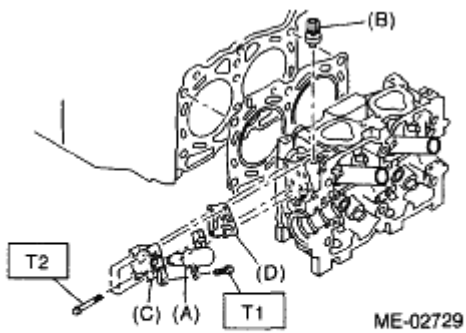
Tightening torque:

T1

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

T2

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



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

Fig. 217: Identifying Oil Switching Solenoid Valve Holder And Oil Switching Solenoid Valve

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 HEAD**" for removal and installation procedures of pistons. <Ref. to **REMOVAL**, CYLINDER BLOCK. > <Ref. to **INSTALLATION**, CYLINDER BLOCK. >

CONNECTING ROD

SPECIFICATION

Refer to "**CYLINDER HEAD**" for removal and installation procedures of connecting rod.

<Ref. to **REMOVAL**, CYLINDER BLOCK. > <Ref. to **INSTALLATION**, CYLINDER BLOCK. >

CRANKSHAFT

SPECIFICATION

Refer to "**CYLINDER HEAD**" for removal and installation procedures of crankshaft. <Ref. to **REMOVAL**, CYLINDER BLOCK. > <Ref. to **INSTALLATION**, CYLINDER BLOCK. >

ENGINE TROUBLE IN GENERAL

INSPECTION

NOTE: "RANK" shown in the chart refers to the possibility of the cause of trouble in order "Very often" to "Rarely"

A - Very often

B - Sometimes

C - Rarely

PROBLEM SYMPTOMS CHART

Symptom	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
1) Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective inhibitor switch	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
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Fuel line	Defective fuel pump and relay	A
		Lack of or insufficient fuel	B
	Belt	Trouble	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head	C

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		bolt or defective gasket	
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
3) Initial combustion occurs.	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Defective intake manifold gasket	B
		Defective throttle body gasket	B
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of or insufficient fuel	B
	Belt	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
4) Engine stalls after initial combustion.	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Loosened or cracked intake duct	B
		Loosened or cracked PCV hose	C

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		Loosened or cracked vacuum hose	C
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Dirty air cleaner element	C
	Fuel line	Clogged fuel line	C
		Lack of or insufficient fuel	B
	Belt	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
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

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		Clogged fuel line	C
		Lack of or insufficient fuel	B
	Belt	Defective timing	C
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Overheating	C
	Others	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
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

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

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		fuel	
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Cooling system	Overheating	B
	Others	Evaporative emission control system malfunction	C
5. Engine does not return to idle.	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Loosened or cracked vacuum hose	A
	Others	Stuck or damaged throttle valve	A
6. Dieseling (Run-on)	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Cooling system	Overheating	B
	Others	Evaporative emission control system malfunction	B
7. After burning in exhaust system	Engine control system <Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Loosened or cracked intake duct	C
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	B
		Defective PCV valve	B
		Loosened oil filler cap	C
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	B

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		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C
	Others	Evaporative emission control system malfunction	C
8. Knocking	Engine control system <Ref. to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Loosened oil filler cap	B
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
	Cooling system	Overheating	A
9. Excessive engine oil consumption	Intake system	Loosened or cracked PCV hose	A
		Defective PCV valve	B
		Loosened oil filler cap	C
	Compression	Defective valve stem	A
		Worn or stuck piston rings, cylinder and piston	A
	Lubrication system	Loosened oil pump attaching bolts and defective gasket	B
		Defective oil filter seal	B
		Defective crankshaft oil seal	B
		Defective rocker cover gasket	B
		Loosened oil drain plug or defective gasket	B
		Loosened oil pan fitting bolts or defective oil pan	B
10. Excessive fuel	Engine control system <Ref. to BASIC		A

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consumption

DIAGNOSTIC PROCEDURE . >

Intake system	Dirty air cleaner element	A
Belt	Defective timing	B
Compression	Incorrect valve clearance	B
	Loosened spark plug or defective gasket	C
	Loosened cylinder head bolt or defective gasket	C
	Improper valve sealing	B
	Defective valve stem	C
	Worn or broken valve spring	C
	Worn or stuck piston rings, cylinder and piston	B
	Incorrect valve timing	B
Lubrication system	Incorrect oil pressure	C
Cooling system	Over-cooling	C

ENGINE NOISE**INSPECTION****PROBLEM SYMPTOMS CHART - ENGINE NOISE**

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

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to 2,000 rpm	injector connector of noisy cylinder is disconnected. ⁽¹⁾	bearing Worn bearing at crankshaft end of connecting rod
Knocking sound when engine is operating under idling speed and engine is warm	Noise is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	- Worn cylinder liner and piston ring - Broken or stuck piston ring - Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	- Worn cam sprocket - Worn camshaft journal bore in cylinder head assembly
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Poor contact of generator brush and rotor
Gear scream when starting engine	-	- Defective ignition starter switch - Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	- Loose drive belt - Defective water pump shaft
Hissing sound	-	- Insufficient compression - Air leakage in air intake system, hose, connection or manifold
Timing belt noise	-	- Loose timing belt - Belt contacting with case/adjacent part
Valve noise	-	Incorrect valve clearance

NOTE:

(1) When disconnecting the fuel injector connector, the malfunction indicator light illuminates and DTC is stored in ECM memory. Therefore, carry out the Clear Memory Mode <Ref. to OPERATION , Clear Memory Mode. > and Inspection Mode <Ref. to PROCEDURE , Inspection Mode. > after connecting the fuel injector connector.