

2005 Subaru Impreza RS

2005 ENGINE Mechanical - H4SO - Impreza

2005 ENGINE**Mechanical - H4SO - Impreza****GENERAL DESCRIPTION****SPECIFICATION****GENERAL DESCRIPTION**

Application			Specification
Cylinder arrangement			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
Valve system mechanism			Belt driven, single over-head camshaft, 4-valve/cylinder
Bore x Stroke	mm (in)	99.5 x 79.0(3.917x3.110)	
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	Open	BTDC 2°	
	Close	ABDC 56°	
Exhaust valve timing	Open	BBDC 40°	
	Close	ATDC 8°	
Valve clearance	mm (in)	Intake	0.20+/-0.04 (0.0079+/-0.0016)
		Exhaust	0.25+/-0.04 (0.0098+/-0.0016)
Idle speed [at neutral position on MT, or "P" or "N" range on AT]	rpm	650+/-100 (No load) 850+/-100 (A/C ON)	
Ignition order			1 --> 3 --> 2 --> 4
Ignition timing	BTDC/rpm	MT	10°+/-8°/650
		AT	15°+/-8°/700

NOTE: US: undersize OS: oversize**BELT TENSION 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)
				Standard

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	Side clearance of spacer		mm (in)	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)
Camshaft	Bend limit			mm (in)	0.025 (0.0010)
	Side clearance		mm (in)	Standard	0.030 - 0.090 (0.0012 - 0.0035)
				Limit	0.10 (0.0039)
	Cam lobe height	mm (in)	Intake	Standard	39.485 - 39.585 (1.5545 - 1.5585)
				Limit	39.385(1.5506)
			Exhaust	Standard	39.720 - 39.820 (1.5491 - 1.5530)
				Limit	39.620 (1.5598)
	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 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)
Valve	Head edge thickness	mm (in)	Intake	Standard	0.8 - 1.2 (0.03 - 0.047)
				Limit	0.6 (0.024)
			Exhaust	Standard	1.0 - 1.4 (0.039 - 0.055)
				Limit	0.6 (0.024)
	Stem outer diameters		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 springs	Free length			mm (in)	54.30(2.1378)
	Squareness				2.5°, 2.4 (0.094) or less
	Tension/spring height	N (kgf, lb)/mm	Set	214 - 246 (22 - 25, 48 - 55)/45.0 (1.772)	

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			(in)	Lift	526 - 582 (54 - 59, 119 - 130)/34.7 (1.366)
Cylinder block	Surface warpage limit (mating with cylinder head)			mm (in)	0.025 (0.00098)
	Grinding limit			mm (in)	0.1 (0.004)
	Standard height			mm (in)	201.0(7.91)
	Cylinder inner diameter	mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)
				B	99.495 - 99.505 (3.9171 - 3.9175)
	Taper		mm (in)	Standard	0.015(0.0006)
				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 standard diameter			mm (in)	23.000 - 23.006 (0.9055 - 0.9057)
Piston pin	Outer diameter			mm (in)	22.994 - 23.000 (0.9053 - 0.9055)
	Clearance between piston and piston pin		mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)
				Limit	0.020 (0.0008)
Degree of fit					Piston pin must be fitted into position with thumb at 20°C (68° F).
Piston Ring	Ring closed gap	mm (in)	Top ring	Standard	0.20 - 0.35 (0.0079 - 0.0138)
				Limit	1.0 (0.039)
			Second ring	Standard	0.37 - 0.52 (0.0144 - 0.0203)
				Limit	1.0 (0.039)
			Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)
				Limit	1.5(0.059)
	Ring groove gap	mm (in)	Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)
				Limit	0.15(0.0059)
Second ring			Standard	0.030 - 0.070 (0.0012 - 0.0028)	
			Limit	0.15 (0.0059)	
Connecting Rod	Bend twist per 100 mm (3.94 in) in length	mm (in)	Limit		0.10 (0.0039)
	Side clearance of large end	mm (in)	Standard		0.070 - 0.330 (0.0028 - 0.0130)
			Limit		0.4(0.016)

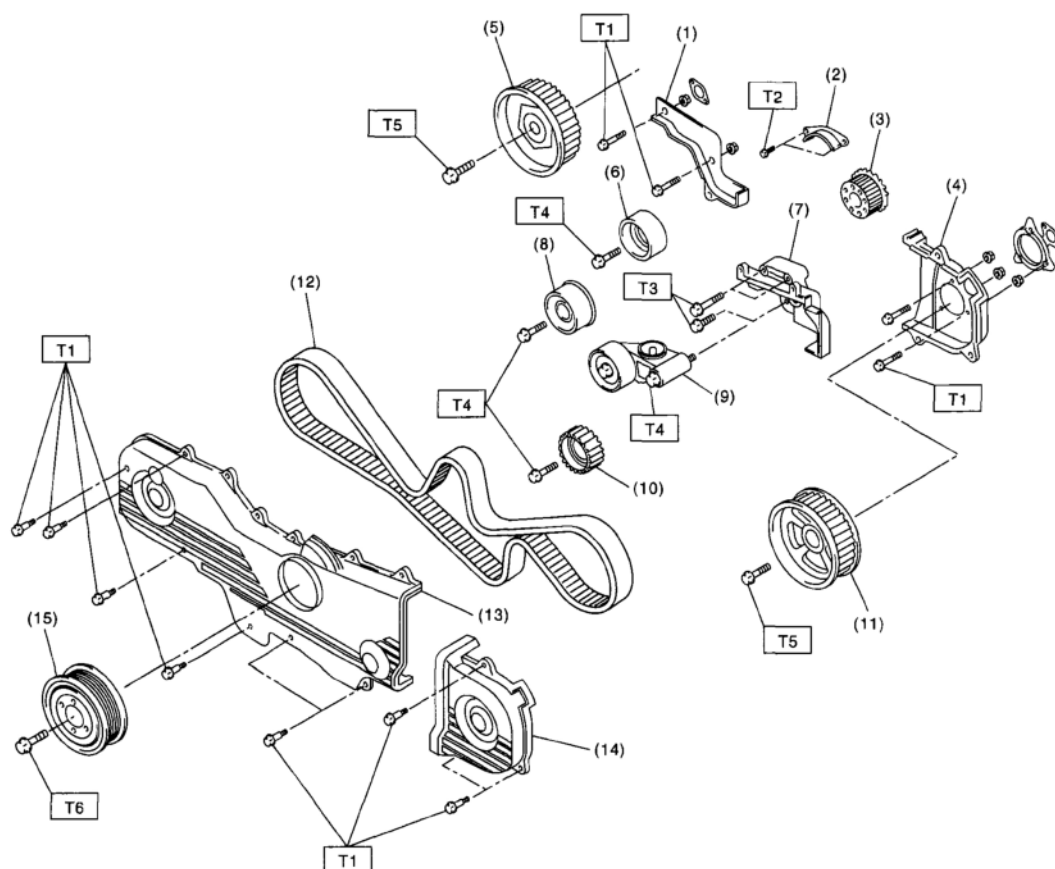
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Bearing of large end	Oil clearance	mm (in)	Standard	0.016 - 0.044 (0.00063 - 0.0017)
			Limit	0.05 (0.0020)
	Bearing size (Thickness at center)	mm (in)	Standard	1.492 - 1.501 (0.0587 - 0.0591)
			0.03 (0.0012) US	1.510-1.513 (0.0594 - 0.0596)
			0.05 (0.0020) US	1.520 - 1.523 (0.0598 - 0.0600)
			0.25 (0.0098) US	1.620 - 1.623 (0.0638 - 0.0639)
Bush of small end	Clearance between piston pin and bushing	mm (in)	Standard	0 - 0.022 (0 - 0.0009)
			Limit	0.030(0.0012)
Crankshaft	Bend limit		mm (in)	0.035(0.0014)
	Crank pin	Out-of-roundness	mm (in)	0.003(0.0001)
		Cylindrically	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)
		Cylindrically	mm (in)	0.006 (0.0002)
		Grinding limit (dia.)	mm (in)	To 59.750 (2.3524)
	Crank pin outer diameter	mm (in)	Standard	51.984 - 52.000 (2.0466 - 2.0472)
			0.03 (0.0012) US	51.954 - 51.970 (2.0454 - 2.0461)
			0.05 (0.0020) US	51.934 - 51.950 (2.0446 - 2.0453)
			0.25 (0.0098) US	51.734 - 51.750 (2.0368 - 2.0374)
	Crank journal outer diameter	mm (in)	Standard	59.992 - 60.008 (2.3619 - 2.3625)
			0.03 (0.0012) US	59.962 - 59.978 (2.3607 - 2.3613)
			0.05 (0.0020) US	59.942 - 59.958 (2.3599 - 2.3605)
			0.25 (0.0098) US	59.742 - 59.758 (2.3520 - 2.3527)
	Side clearance	mm (in)	Standard	0.030 - 0.115 (0.0012 - 0.0045)
			Limit	0.25 (0.0098)
	Oil clearance	mm (in)	Standard	0.010 - 0.030 (0.0001 - 0.0012)
			Limit	0.40 (0.016)
Main bearing	Main bearing mm (in)	#1, #3	Standard	1.998 - 2.011 (0.0787 - 0.0792)
			0.03 (0.0012) US	2.017 - 2.020 (0.0794 - 0.0795)
			0.05 (0.0020) US	2.027 - 2.030 (0.0798 - 0.0799)
			0.25 (0.0098) US	2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #5	Standard	2.000 - 2.013 (0.0787 - 0.0793)
			0.03 (0.0012) US	2.019 - 2.022 (0.0795 - 0.0796)
			0.05 (0.0020) US	2.029 - 2.032 (0.0799 - 0.0800)
			0.25 (0.0098) US	2.129 - 2.132 (0.0838 - 0.0839)

COMPONENT

TIMING BELT



- | | |
|----------------------------------|--|
| (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.>

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Fig. 1: Exploded View Of Timing Belt With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD AND CAMSHAFT

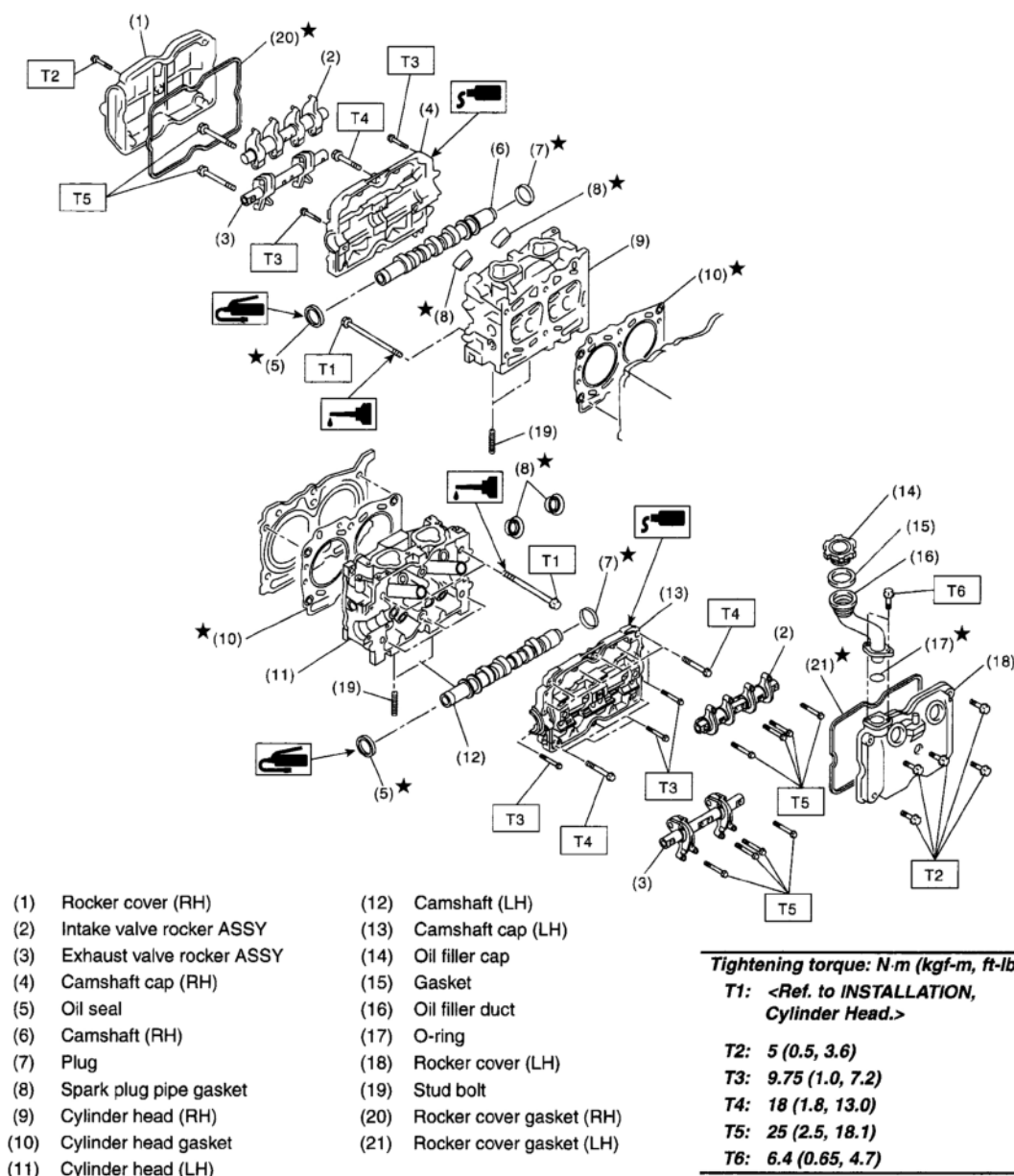
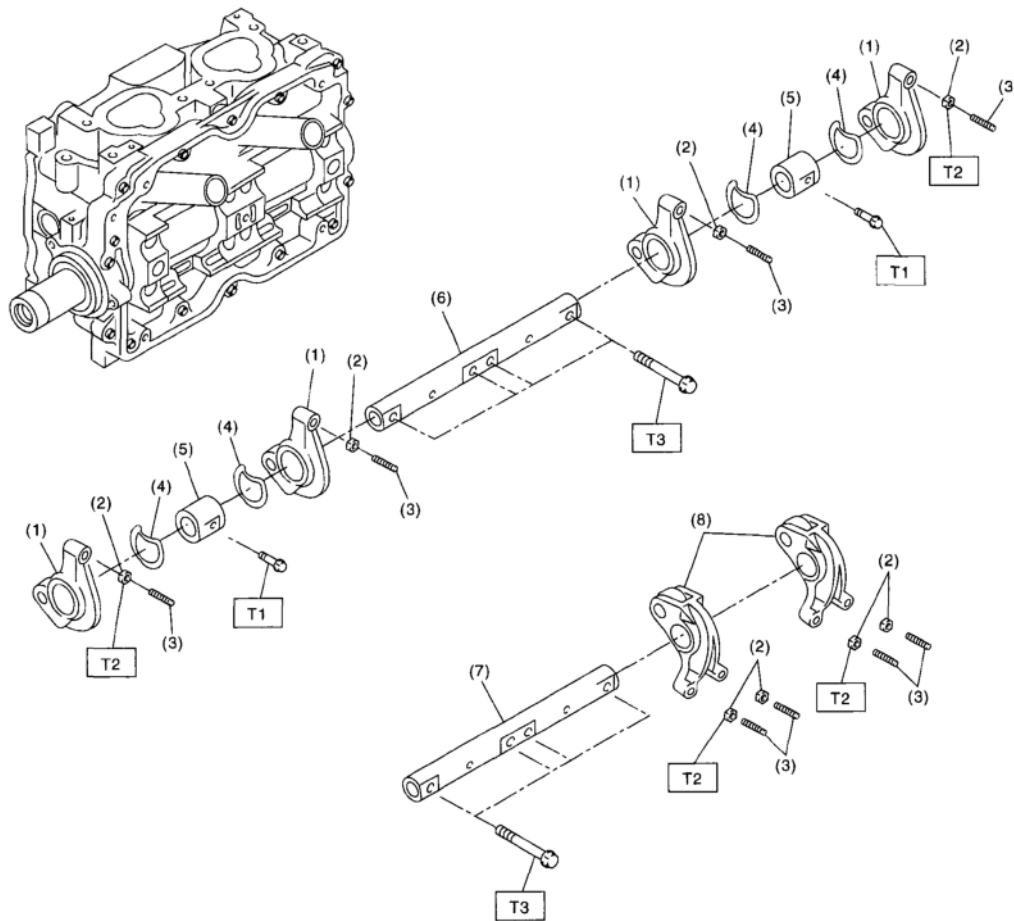


Fig. 2: Exploded View Of Cylinder Head And Camshaft With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

VALVE ROCKER ASSEMBLY



- (1) Intake valve rocker arm
- (2) Valve rocker nut
- (3) Valve rocker adjust screw
- (4) Spring

- (5) Rocker shaft support
- (6) Intake rocker shaft
- (7) Exhaust rocker shaft
- (8) Exhaust valve rocker arm

Tightening torque: N·m (kgf-m, ft-lb)

T1: 5 (0.5, 3.6)

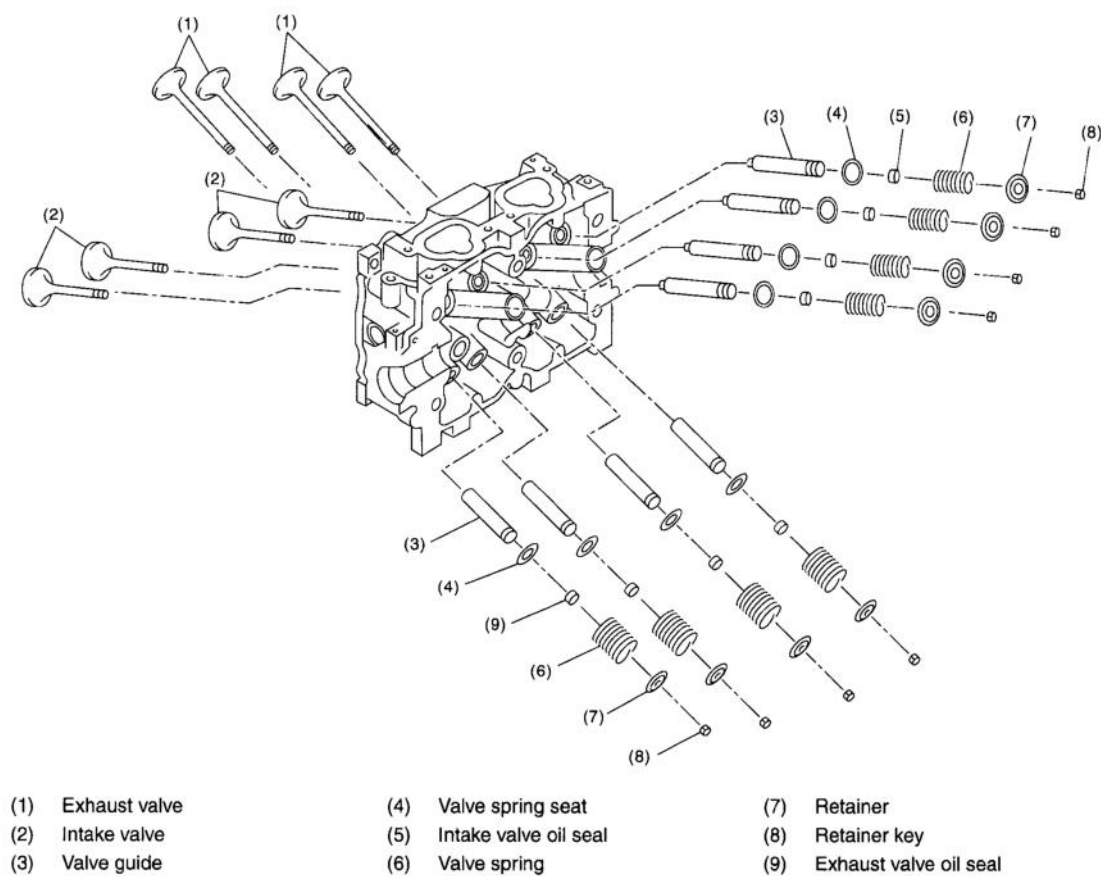
T2: 9.75 (1.0, 7.2)

T3: 25 (2.5, 18.1)

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Fig. 3: Exploded View Of Valve Rocker Assembly With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD AND VALVE ASSEMBLY



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Fig. 4: Exploded View Of Cylinder Head And Valve Assembly
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK

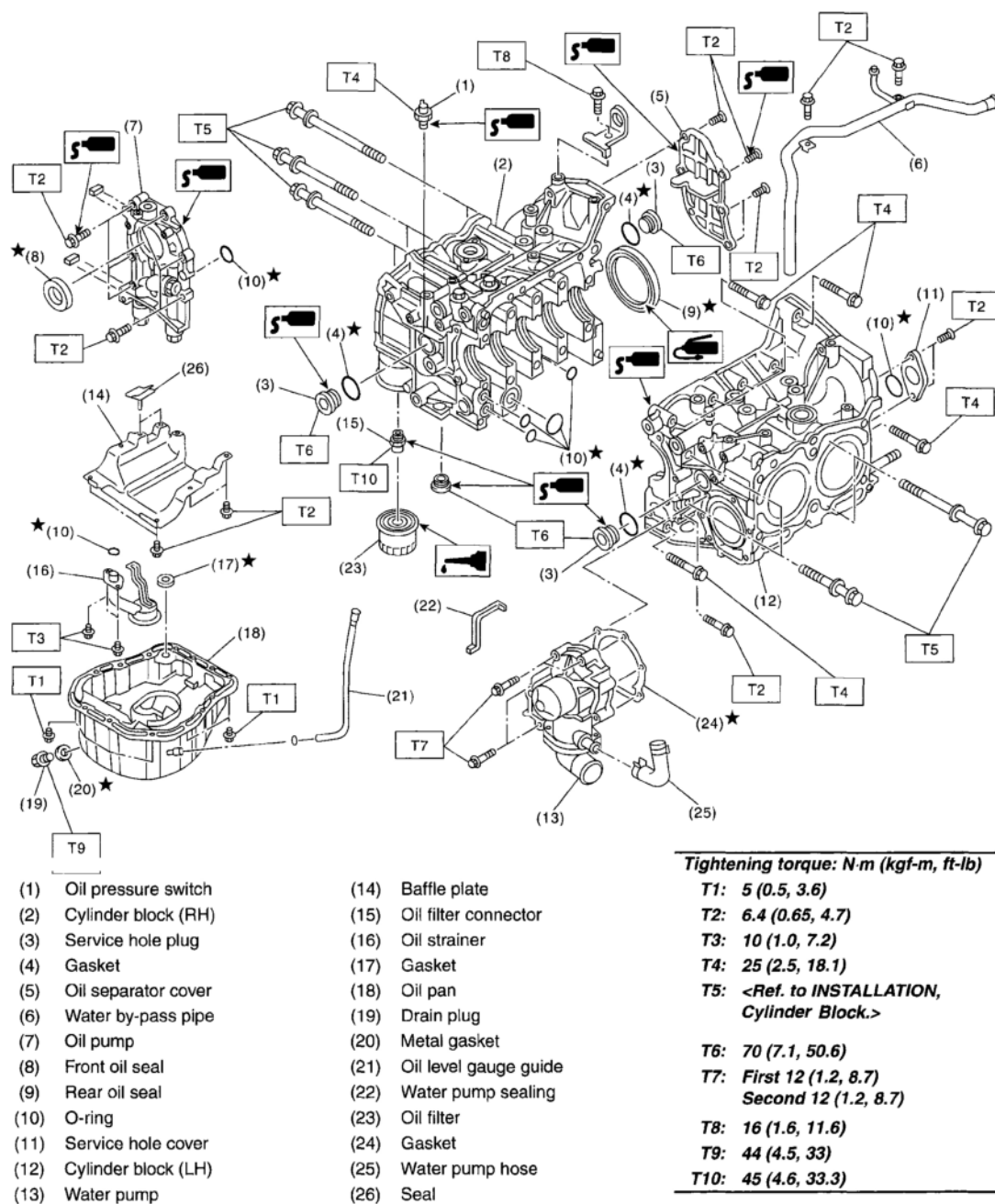
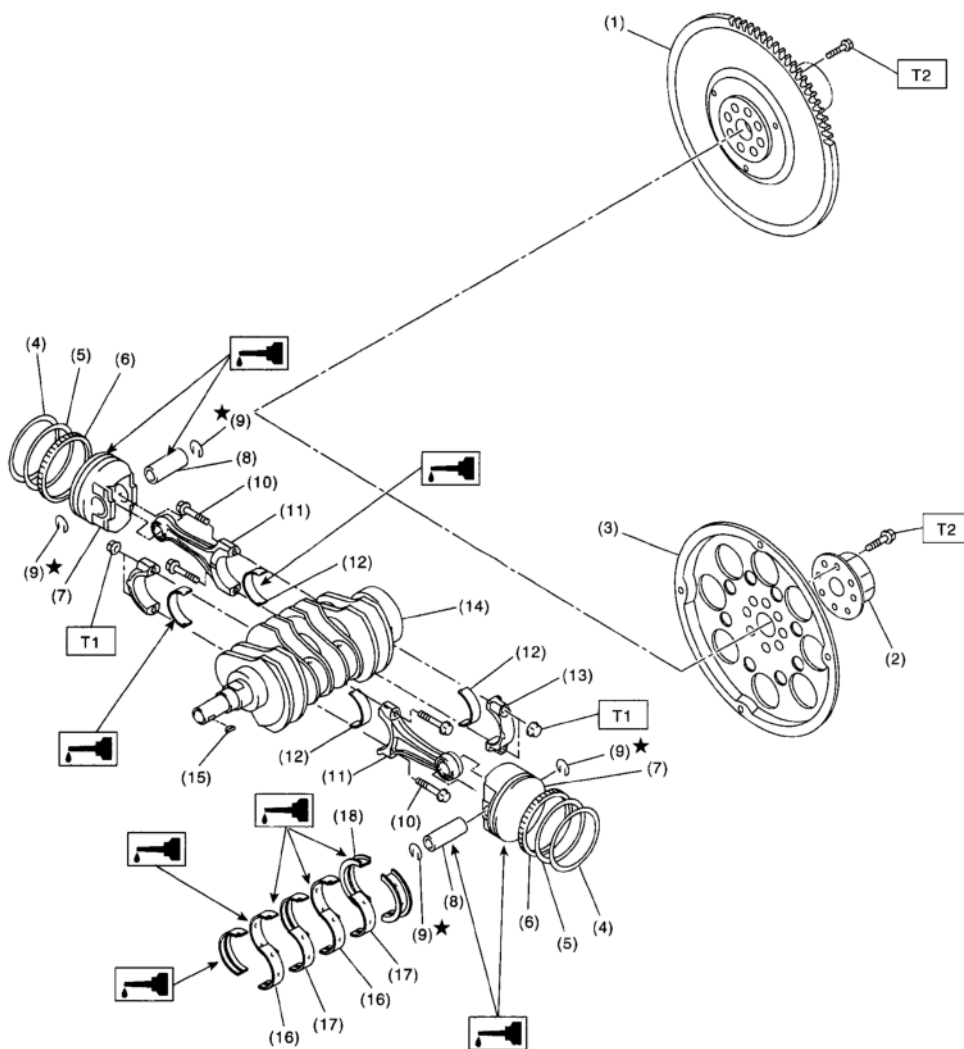


Fig. 5: Exploded View Of Cylinder Block With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

CRANKSHAFT AND PISTON

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- (1) Flywheel (MT model)
- (2) Reinforcement (AT model)
- (3) Drive plate (AT model)
- (4) Top ring
- (5) Second ring
- (6) Oil ring
- (7) Piston

- (8) Piston pin
- (9) Snap ring
- (10) Connecting rod bolt
- (11) Connecting rod
- (12) Connecting rod bearing
- (13) Connecting rod cap
- (14) Crankshaft

- (15) Woodruff key
- (16) Crankshaft bearing #1, #3
- (17) Crankshaft bearing #2, #4
- (18) Crankshaft bearing #5

Tightening torque: N·m (kgf-m, ft-lb)

T1: 45 (4.6, 33.3)

T2: 72 (7.3, 52.8)

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Fig. 6: Exploded View Of Crankshaft And Piston With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

ENGINE MOUNTING

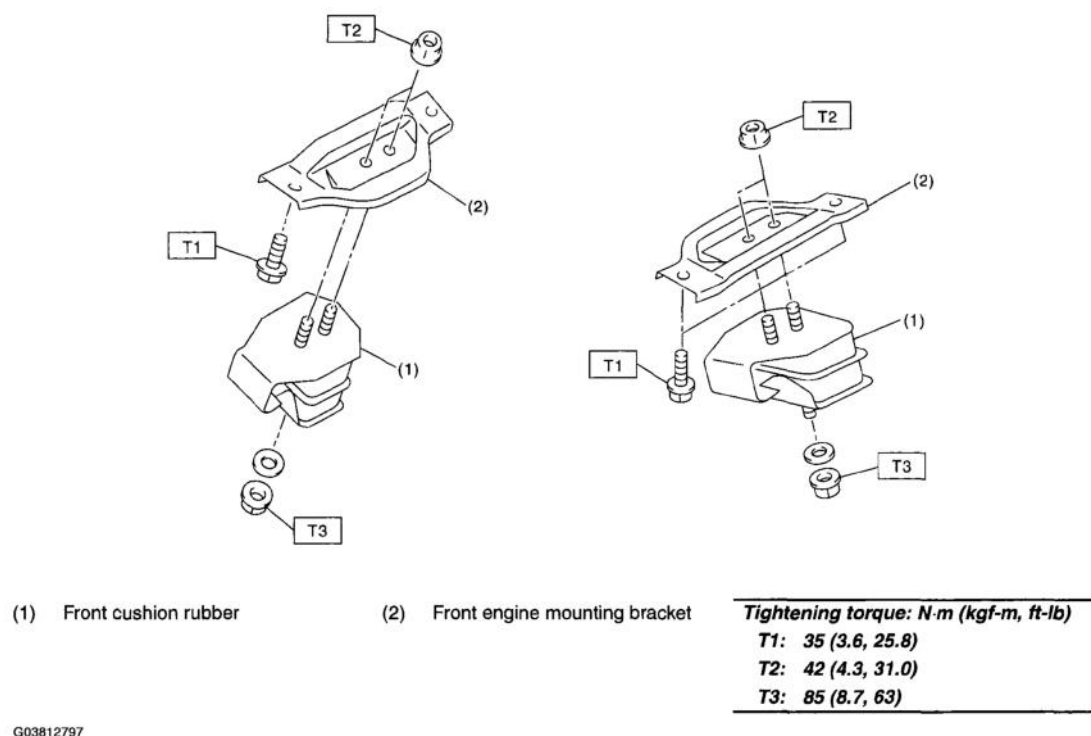


Fig. 7: Exploded View Of Engine Mounting With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

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

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

PREPARATION TOOL

SPECIAL TOOL

SPECIAL TOOL

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
<u>Fig. 8</u>	18231AA010	CAM SPROCKET WRENCH	• Used for removing and installing cam sprocket. (LH side) • CAM SPROCKET WRENCH (499207100) can also be used.
<u>Fig. 9</u>	24082AA230	CARTRIDGE	Troubleshooting for electrical system.
<u>Fig. 10</u>	22771AA030	SUBARU SELECT MONITOR KIT	Troubleshooting for electrical system.
<u>Fig. 11</u>	498267800	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
<u>Fig. 12</u>	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
<u>Fig. 13</u>	498457000	ENGINE STAND ADAPTER RH	Used with ENGINE STAND (499817100)
<u>Fig. 14</u>	498457100	ENGINE STAND ADAPTER LH	Used with ENGINE STAND (499817100).
<u>Fig. 15</u>	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of flywheel when loosening/tightening crank pulley bolt.
<u>Fig. 16</u>	498747300	PISTON GUIDE	Used for installing piston in cylinder.
<u>Fig. 17</u>	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.

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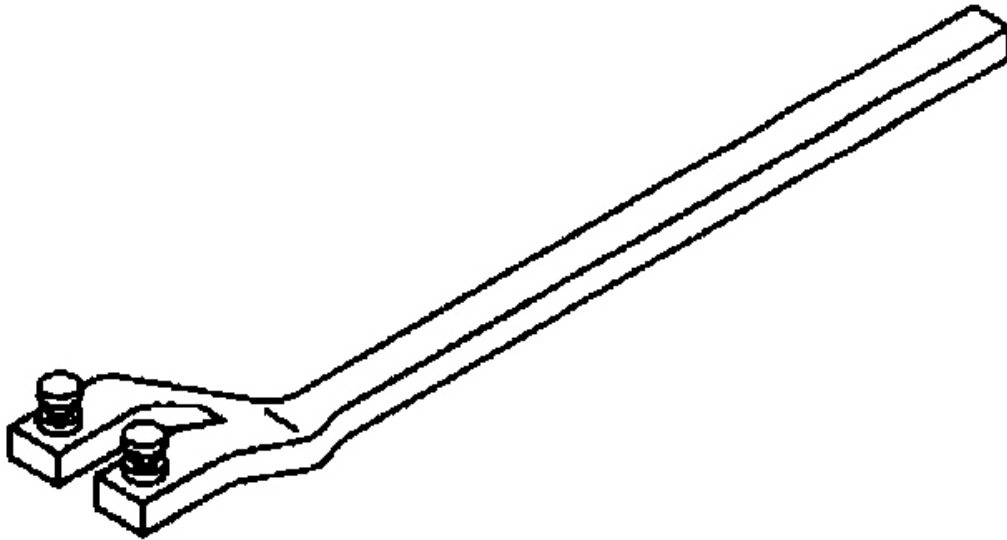
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<u>Fig. 18</u>	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
<u>Fig. 19</u>	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
<u>Fig. 20</u>	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL GUIDE (499597100).
<u>Fig. 21</u>	499587500	OIL SEAL INSTALLER	• Used for installing camshaft oil seal. • Used with OIL SEAL GUIDE (499597000).
<u>Fig. 22</u>	4995877004	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.
<u>Fig. 23</u>	4990977004	PISTON PIN REMOVER ASSY	Used for removing piston pin.
<u>Fig. 24</u>	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (RH side)
<u>Fig. 25</u>	499497000	TORX® PLUS	Used for removing and installing camshaft cap.
<u>Fig. 26</u>	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
<u>Fig. 27</u>	4995970004	OIL SEAL GUIDE	• Used for installing camshaft oil seal. • Used with CAMSHAFT OIL SEAL INSTALLER (499587500).
<u>Fig. 28</u>	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL INSTALLER (499587200).
<u>Fig. 29</u>	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
<u>Fig. 30</u>	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
<u>Fig. 31</u>	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
<u>Fig. 32</u>	499767700	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Intake side)

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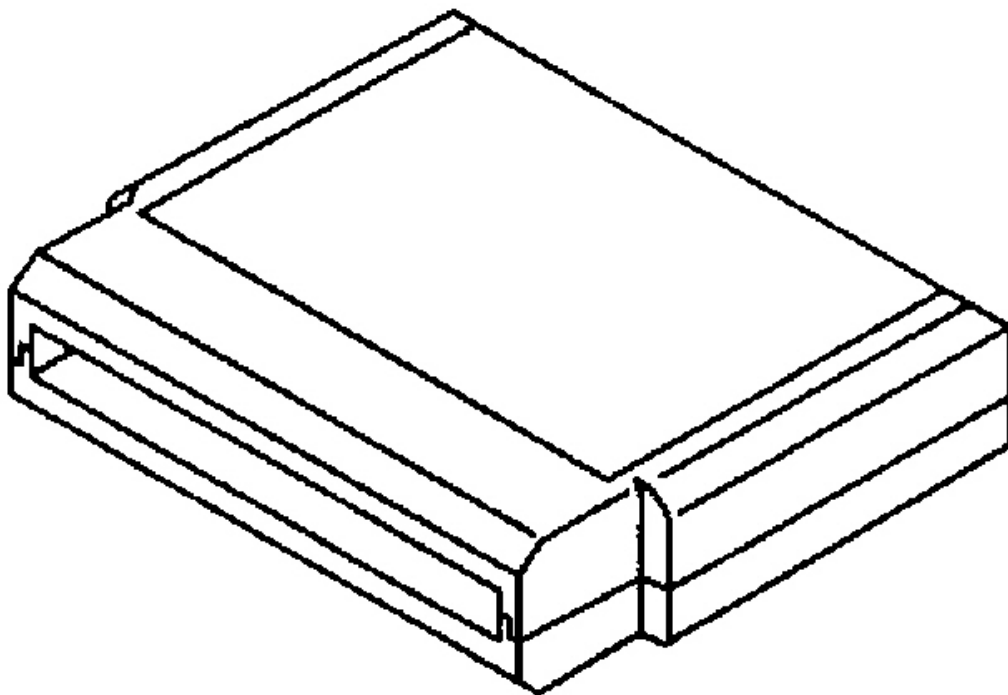
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<u>Fig. 33</u>	499767800	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Exhaust side)
<u>Fig. 34</u>	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used with ENGINE STAND ADAPTER RH (498457000) & LH (498457100).
<u>Fig. 35</u>	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when loosening/tightening crank pulley bolt.
<u>Fig. 36</u>	498547000	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 80 mm (3.15 in))
<u>Fig. 37</u>	18332AA000	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 68 mm (2.68 in))
<u>Fig. 38</u>	18332AA010	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 65 mm (2.56 in))
<u>Fig. 39</u>	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
<u>Fig. 40</u>	42099AE000	CONNECTOR REMOVER	Used for removing quick connector.



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Fig. 8: Identifying Special Tool ST18231AA010
Courtesy of SUBARU OF AMERICA, INC.



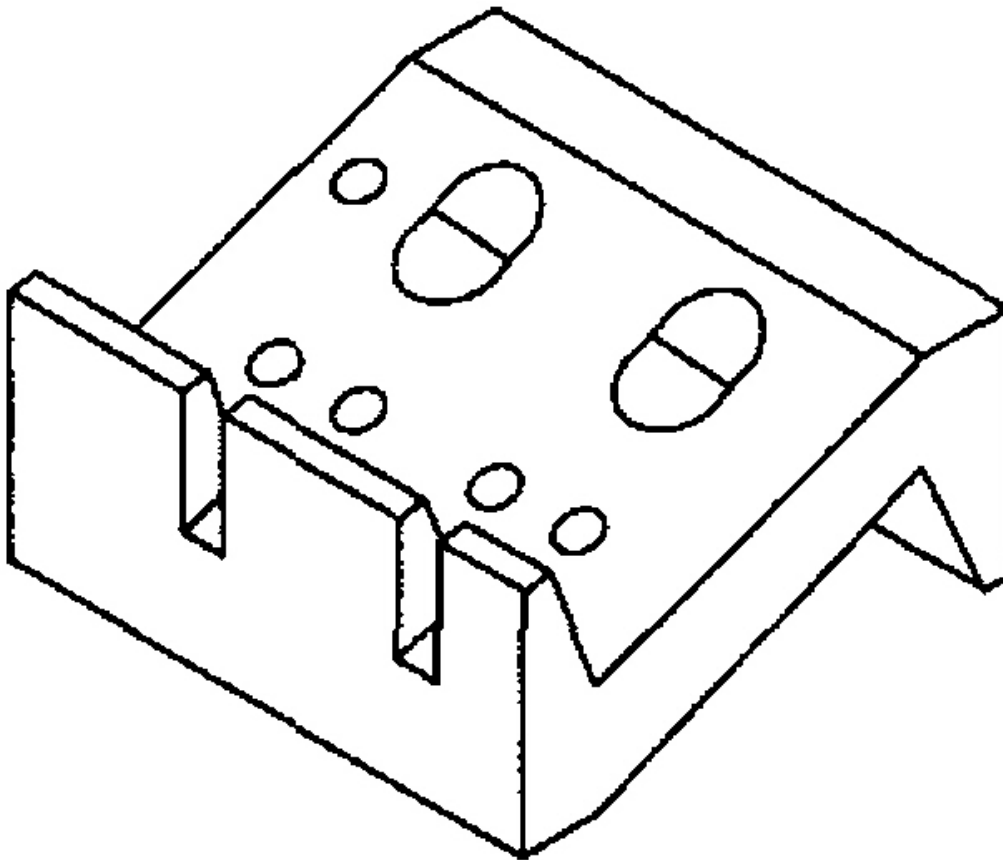
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Fig. 9: Identifying Special Tool ST24082AA230
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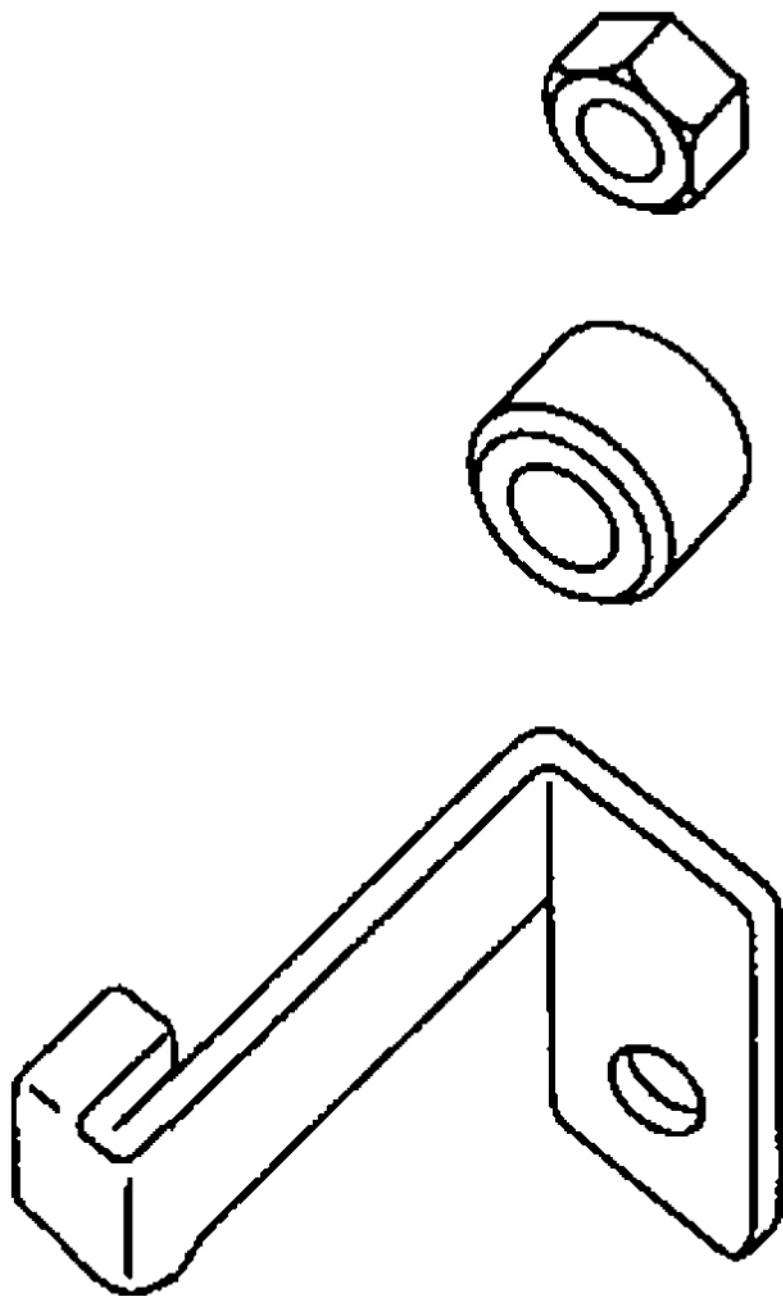
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Fig. 10: Identifying Special Tool ST22771AA030
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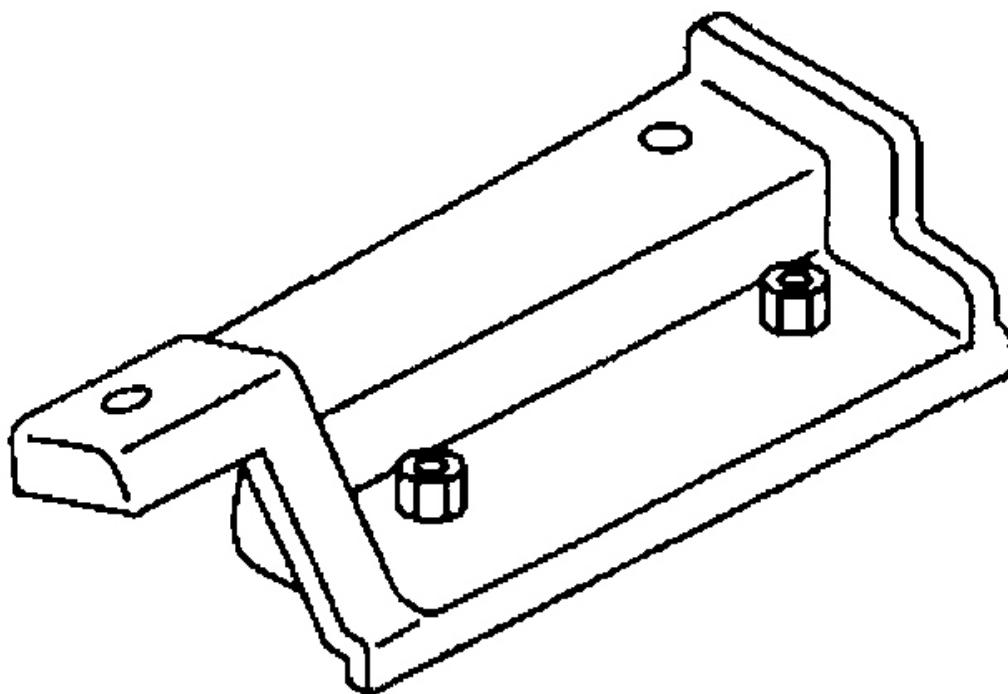
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Fig. 11: Identifying Special Tool ST498267800
Courtesy of SUBARU OF AMERICA, INC.



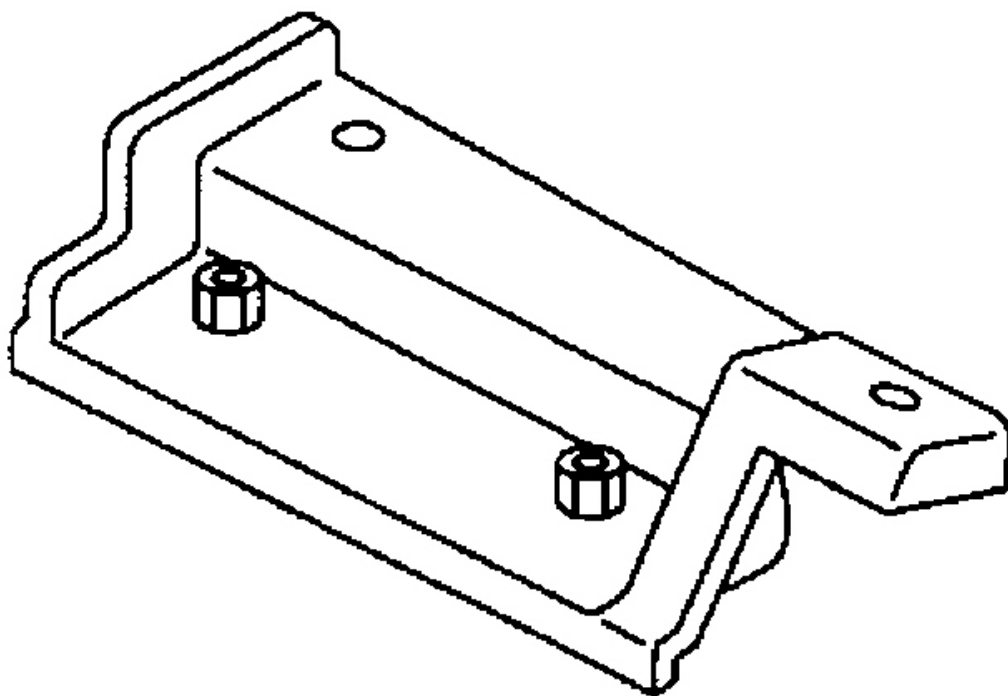
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Fig. 12: Identifying Special Tool ST-498277200
Courtesy of SUBARU OF AMERICA, INC.



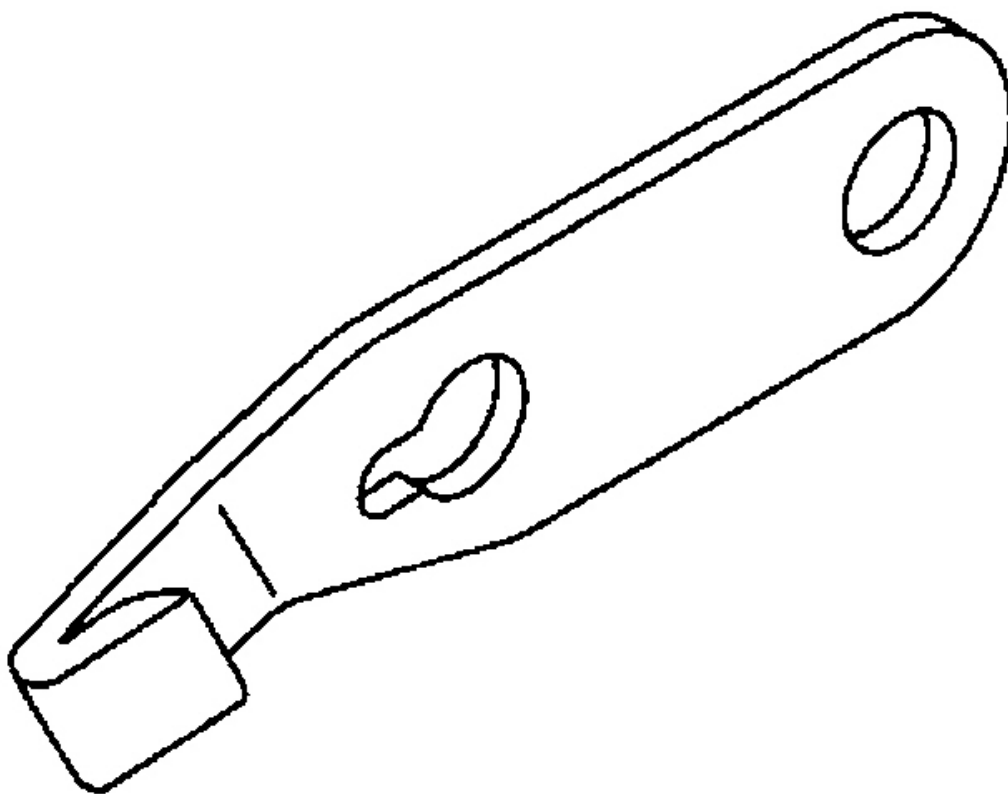
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Fig. 13: Identifying Special Tool ST-498457000
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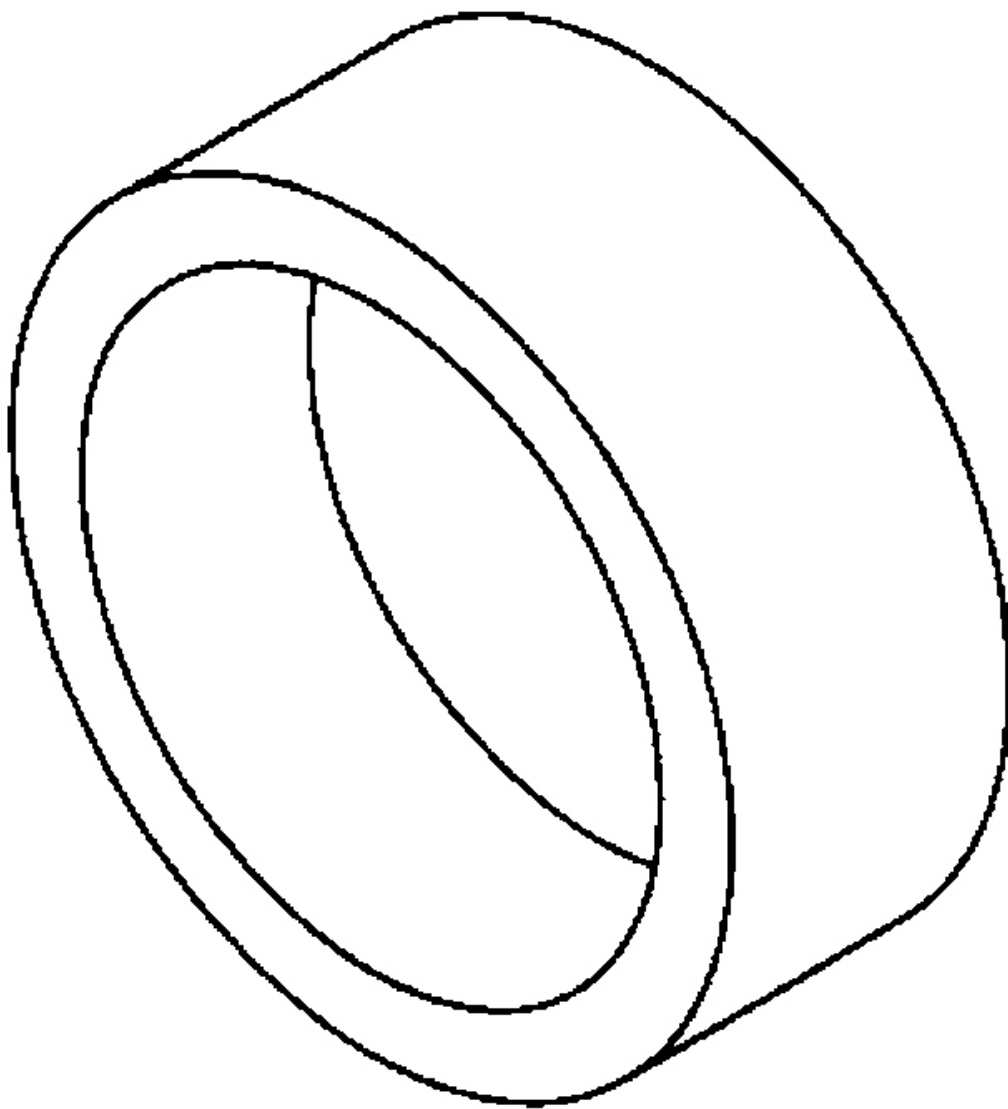
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Fig. 14: Identifying Special Tool ST-498457100
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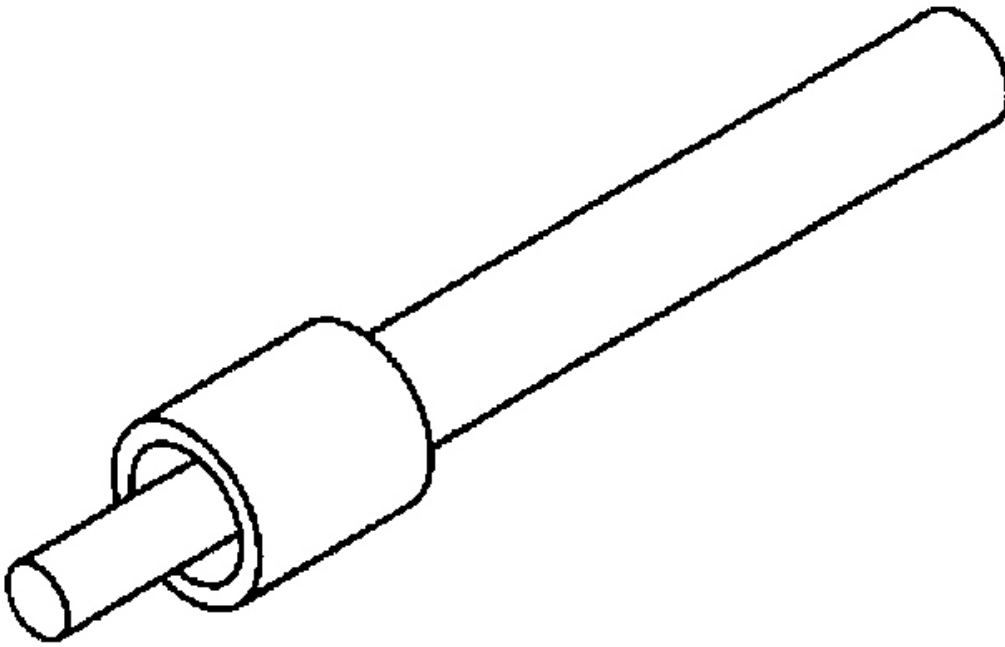
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Fig. 15: Identifying Special Tool ST-498497100
Courtesy of SUBARU OF AMERICA, INC.



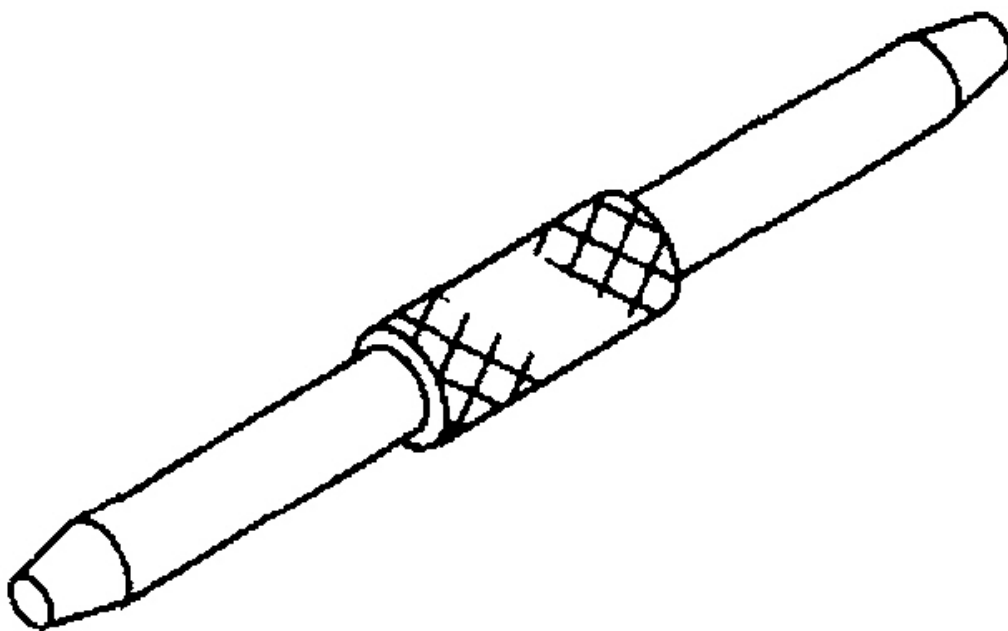
G03812806

Fig. 16: Identifying Special Tool ST-498747300
Courtesy of SUBARU OF AMERICA, INC.



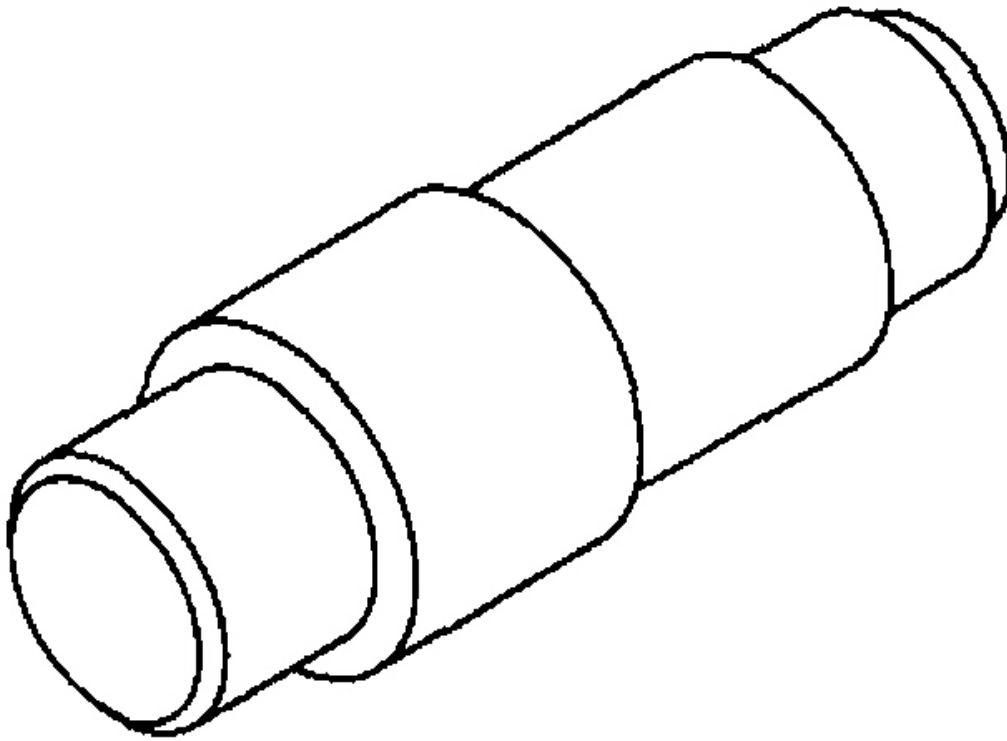
G03812807

Fig. 17: Identifying Special Tool ST-498857100
Courtesy of SUBARU OF AMERICA, INC.



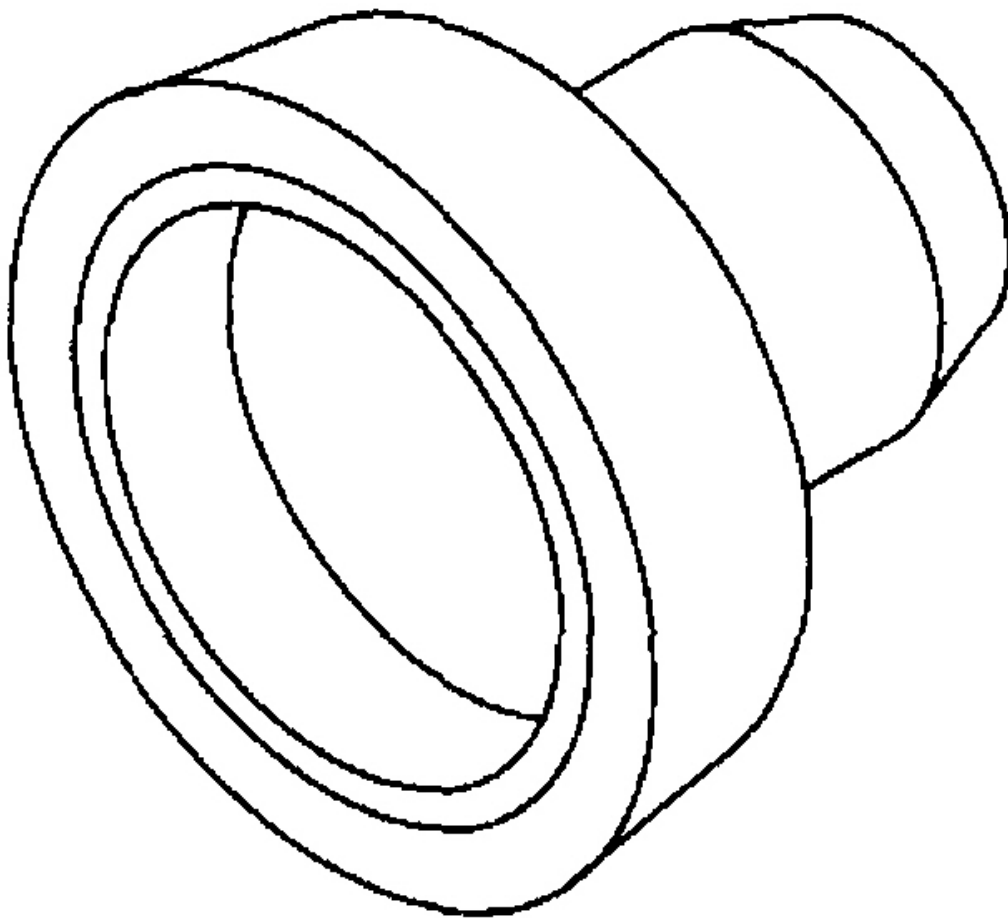
G03812808

Fig. 18: Identifying Special Tool ST-499017100
Courtesy of SUBARU OF AMERICA, INC.



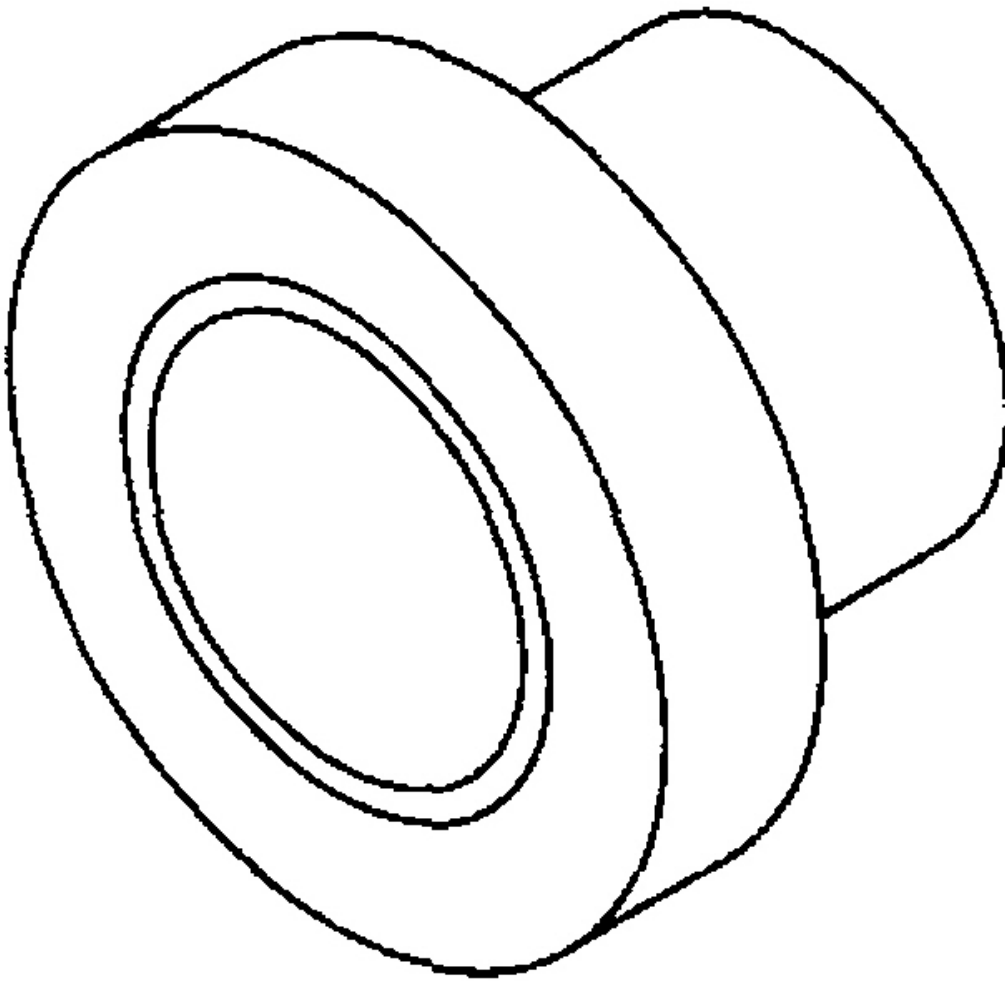
G03812809

Fig. 19: Identifying Special Tool ST-499037100
Courtesy of SUBARU OF AMERICA, INC.



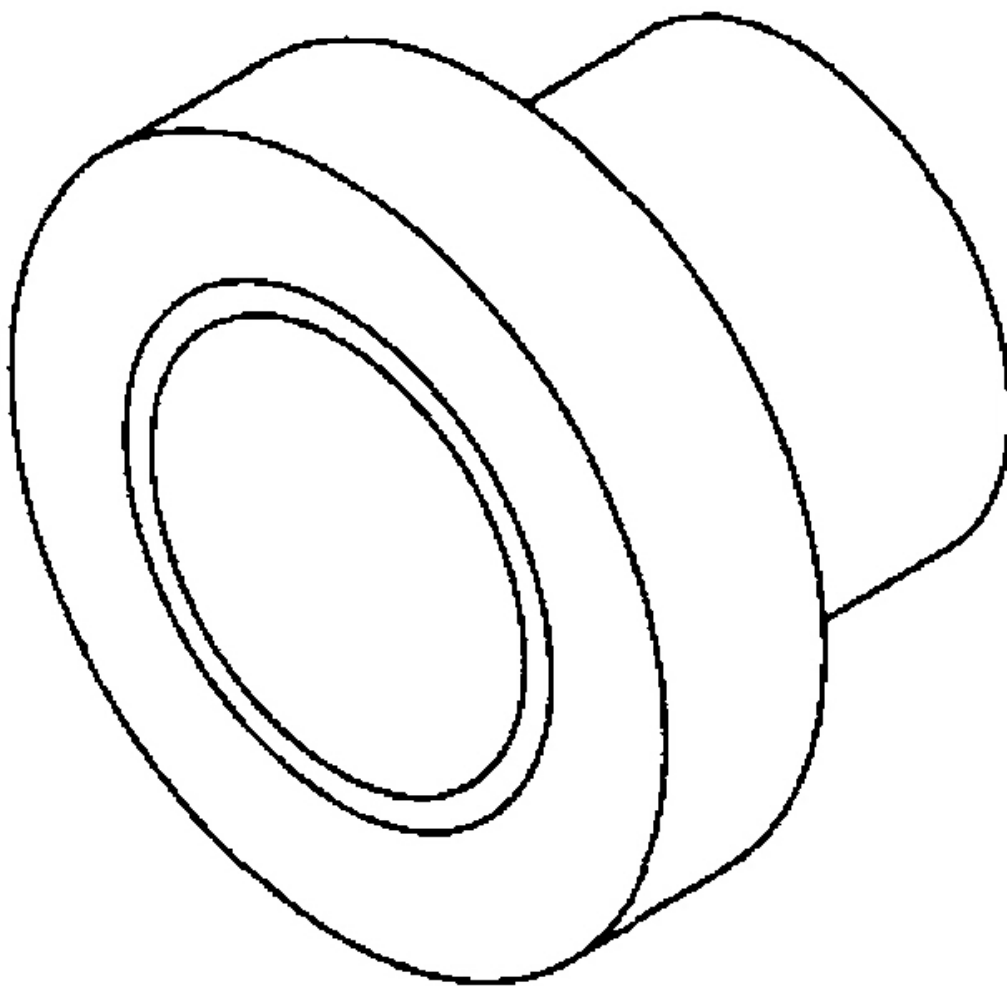
G03812810

Fig. 20: Identifying Special Tool ST-499587200
Courtesy of SUBARU OF AMERICA, INC.



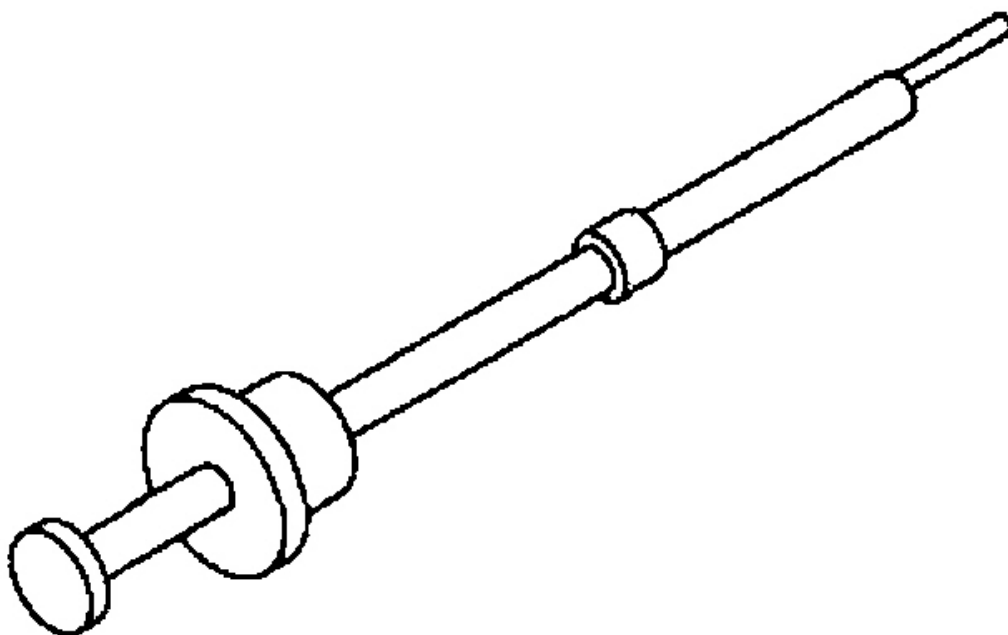
G03812811

Fig. 21: Identifying Special Tool ST-499587500
Courtesy of SUBARU OF AMERICA, INC.



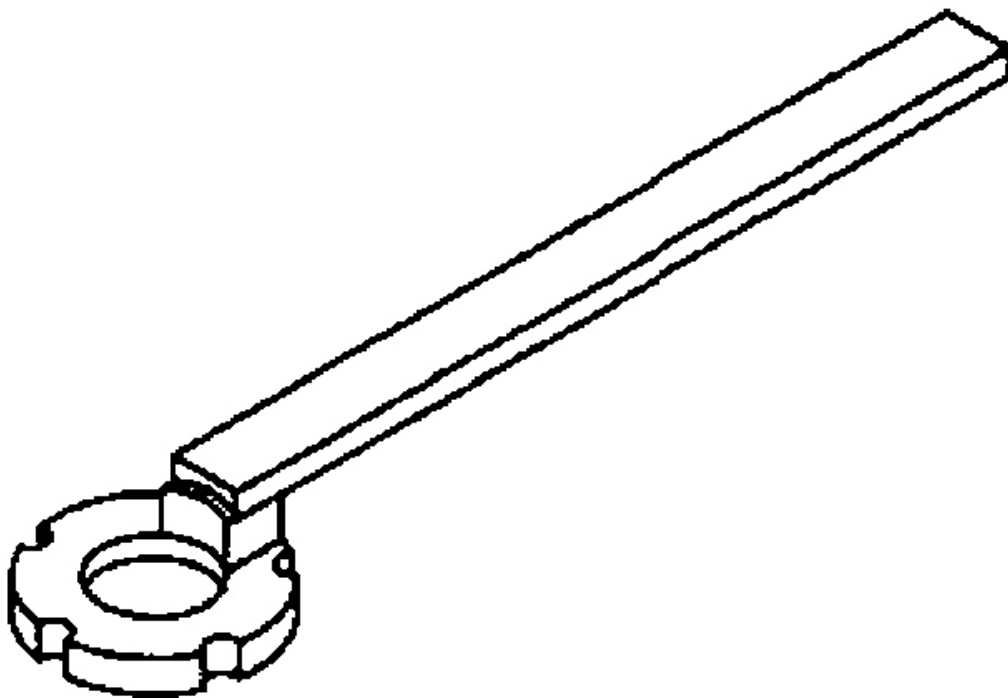
G03812812

Fig. 22: Identifying Special Tool ST-499587700
Courtesy of SUBARU OF AMERICA, INC.



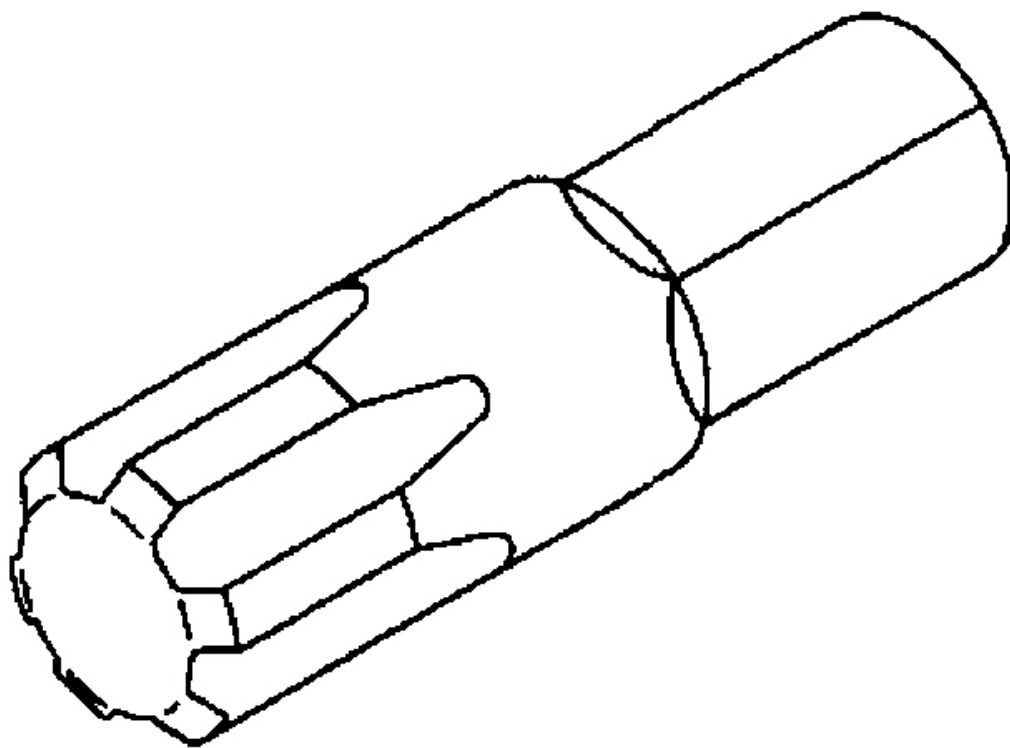
G03812813

Fig. 23: Identifying Special Tool ST-499097700
Courtesy of SUBARU OF AMERICA, INC.



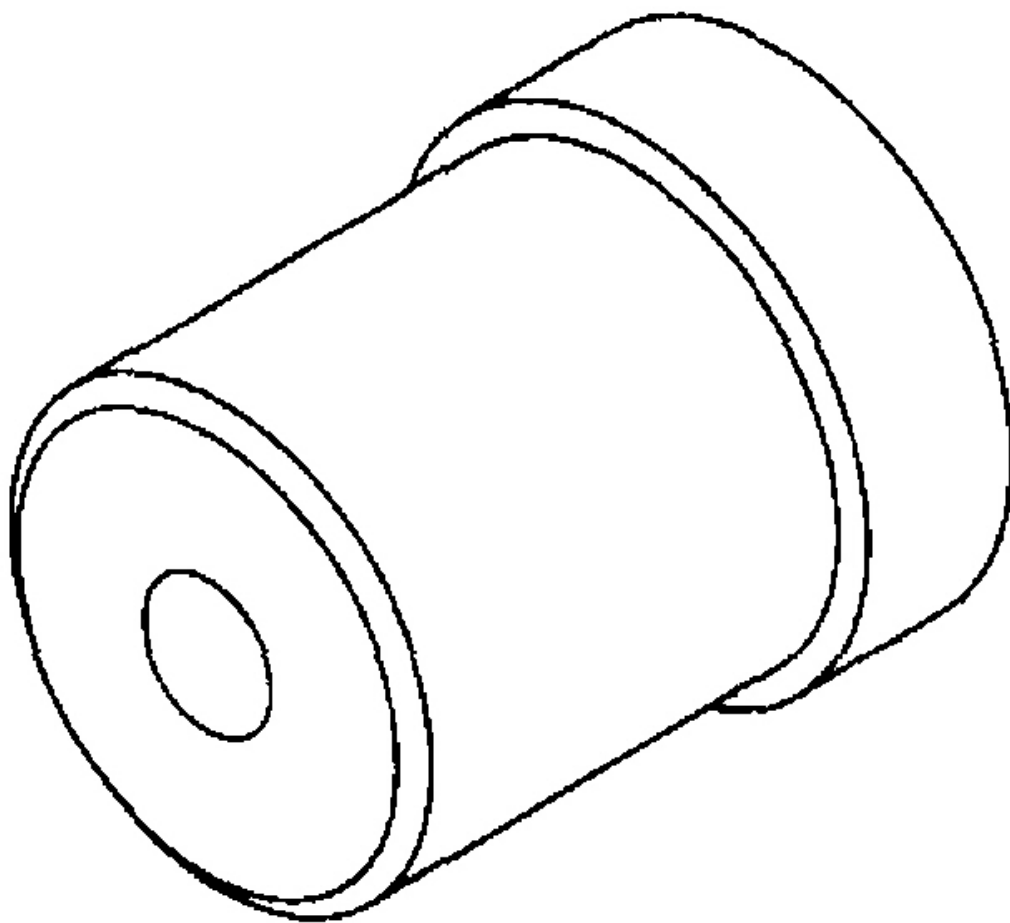
G03812814

Fig. 24: Identifying Special Tool ST-499207400
Courtesy of SUBARU OF AMERICA, INC.



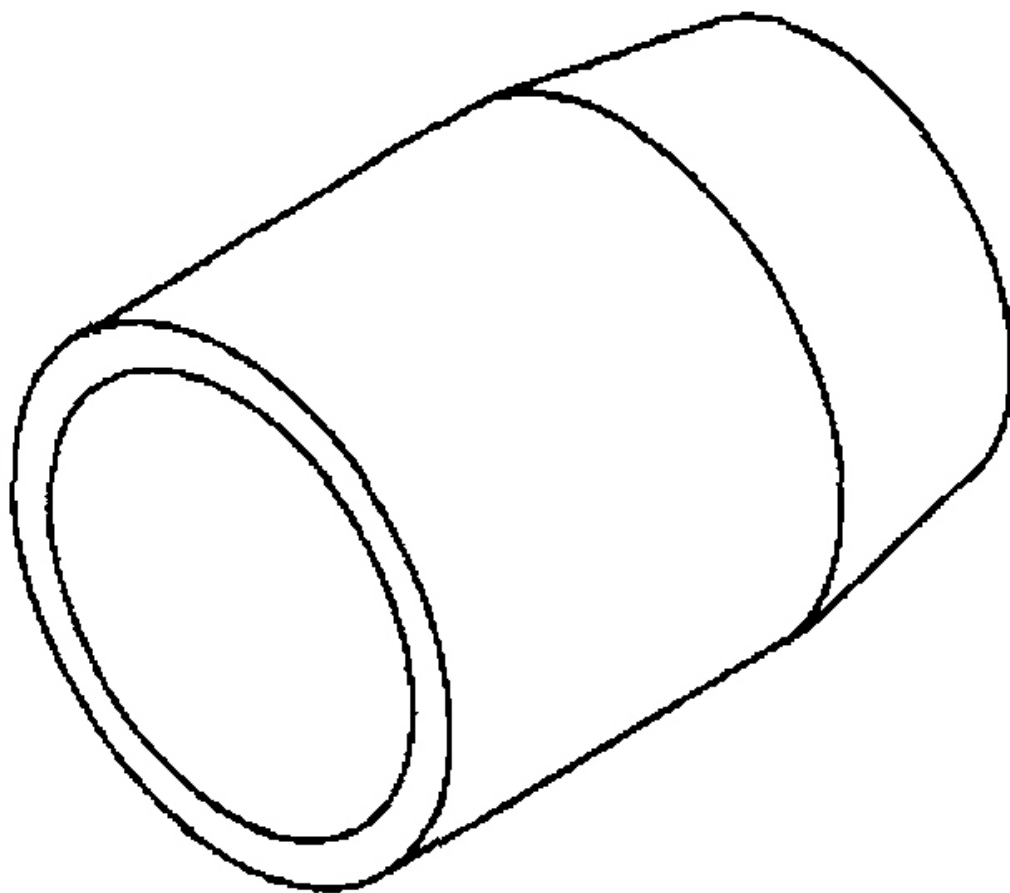
G03812815

Fig. 25: Identifying Special Tool ST-499207400
Courtesy of SUBARU OF AMERICA, INC.



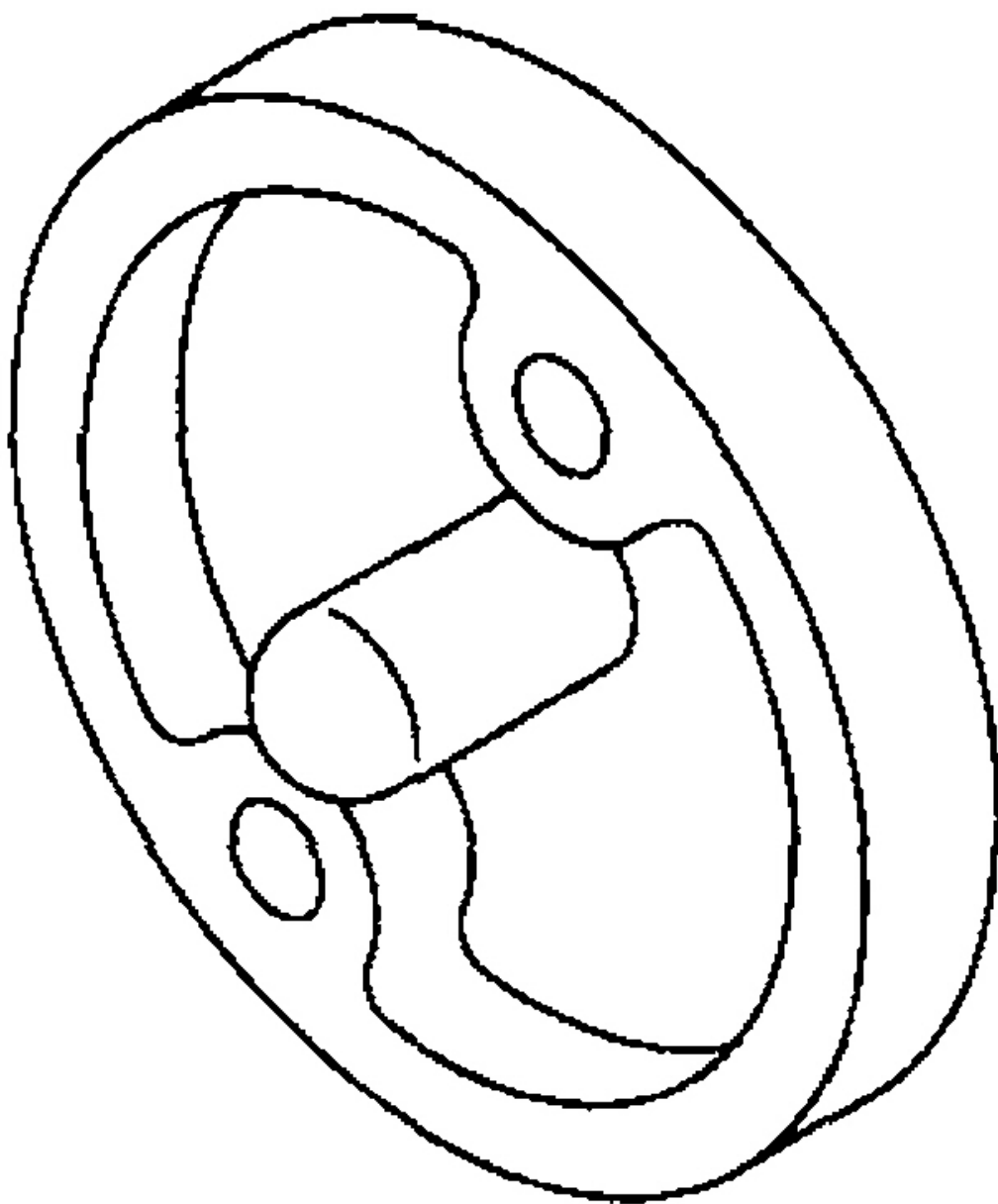
G03812816

Fig. 26: Identifying Special Tool ST-499587100
Courtesy of SUBARU OF AMERICA, INC.



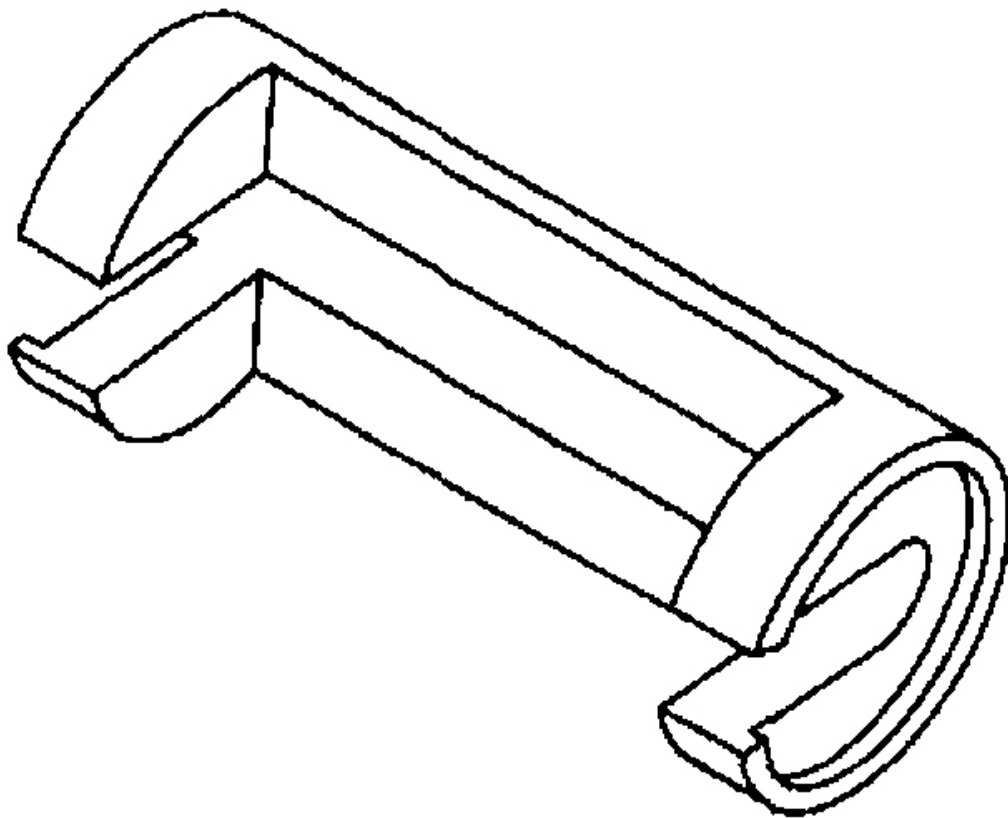
G03812817

Fig. 27: Identifying Special Tool ST-499597000
Courtesy of SUBARU OF AMERICA, INC.



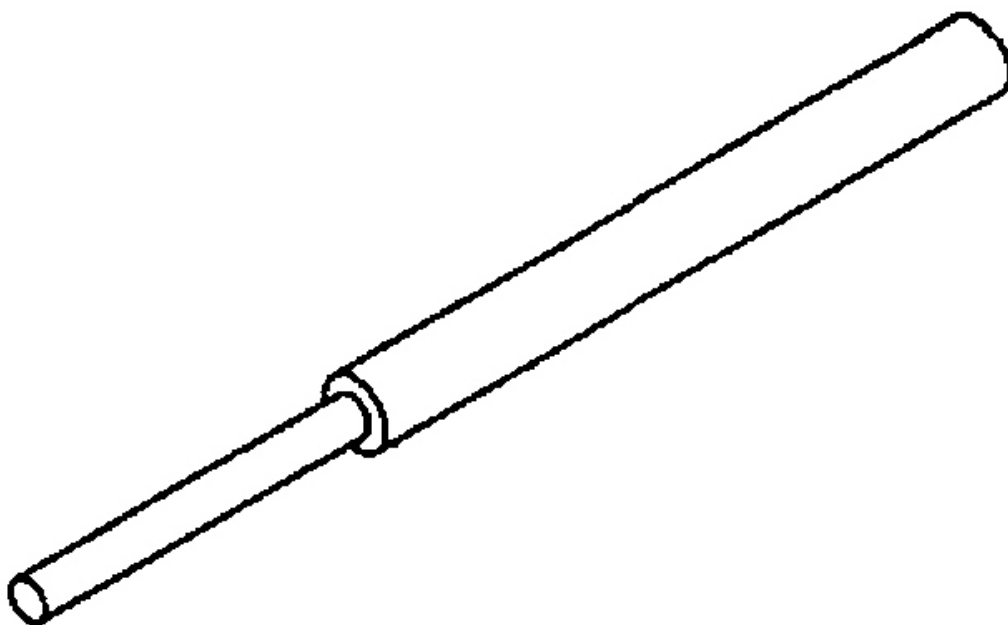
G03812818

Fig. 28: Identifying Special Tool ST-499597100
Courtesy of SUBARU OF AMERICA, INC.



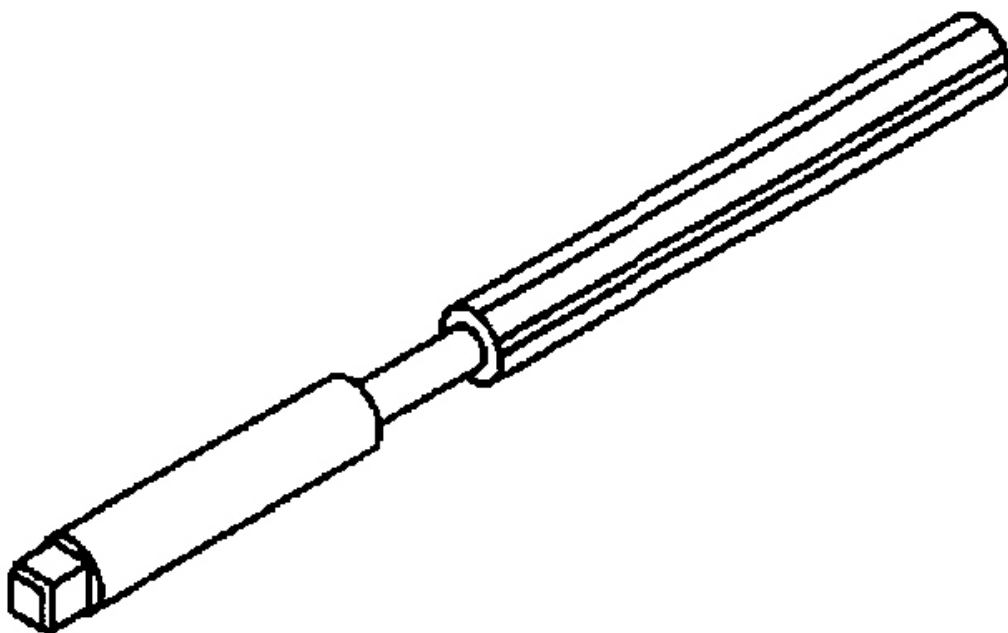
G03812819

Fig. 29: Identifying Special Tool ST-499718000
Courtesy of SUBARU OF AMERICA, INC.



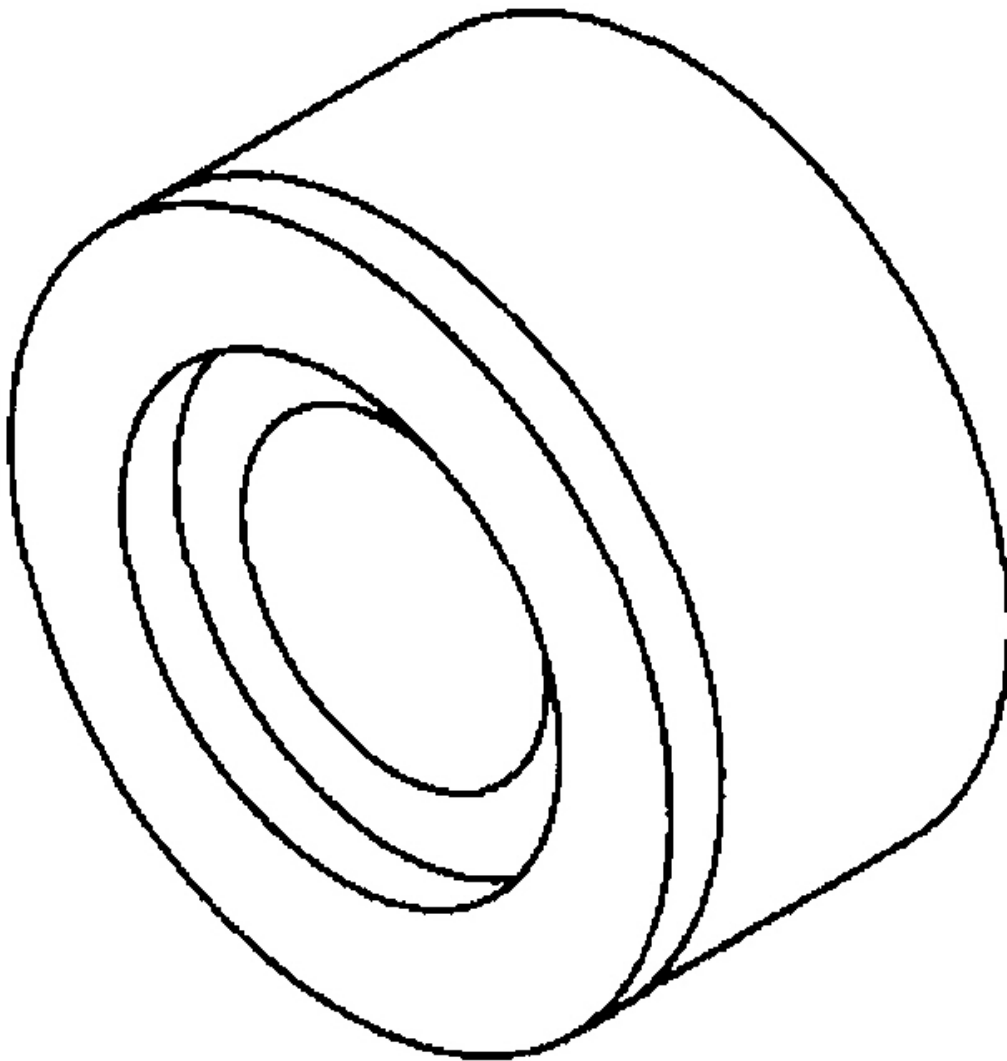
G03812820

Fig. 30: Identifying Special Tool ST-499767200
Courtesy of SUBARU OF AMERICA, INC.



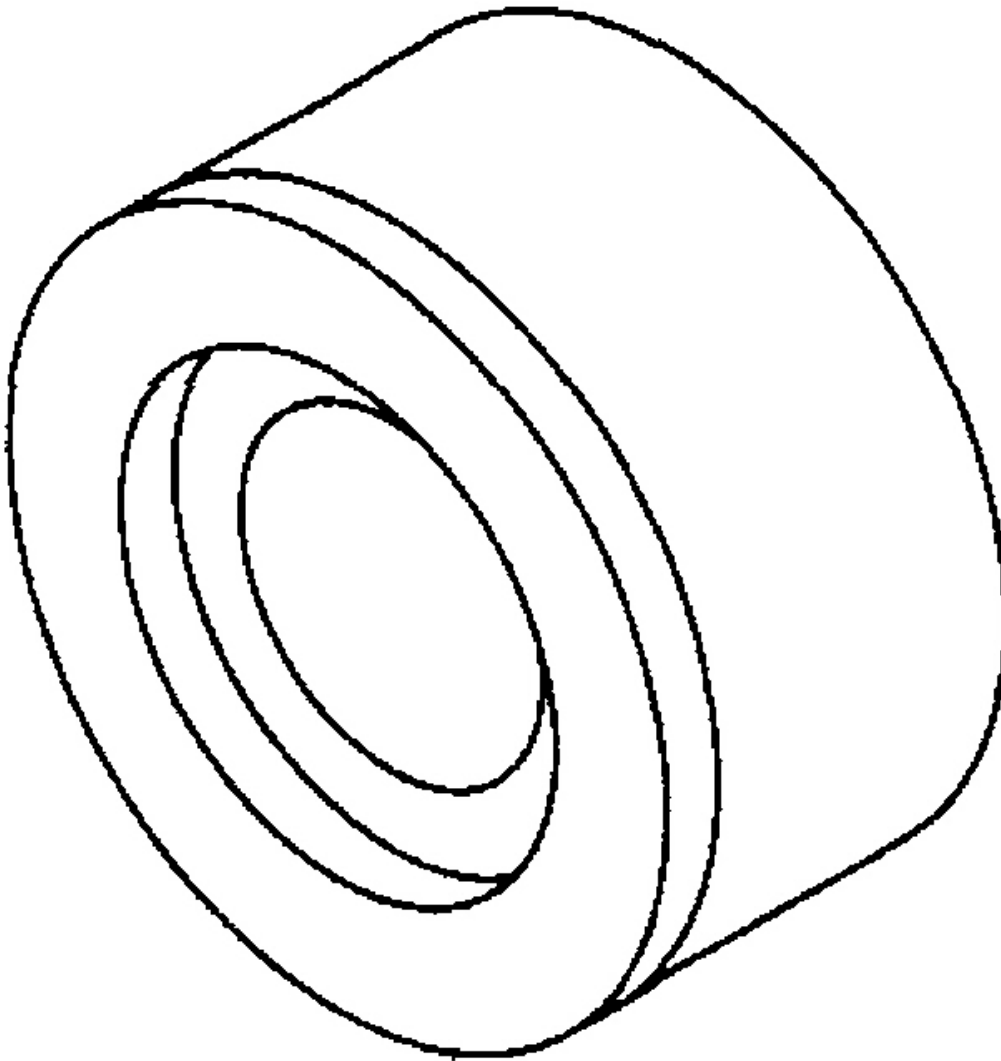
G03812821

Fig. 31: Identifying Special Tool ST-499767400
Courtesy of SUBARU OF AMERICA, INC.



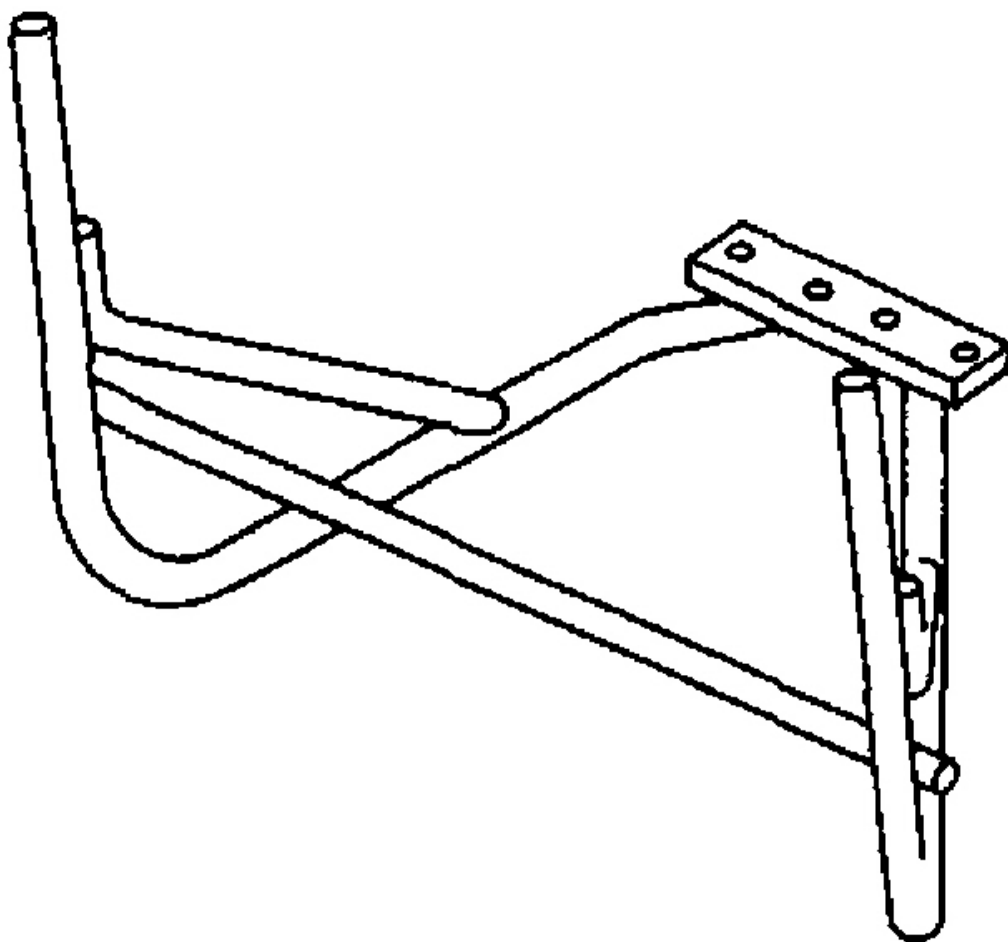
G03812822

Fig. 32: Identifying Special Tool ST-499767700
Courtesy of SUBARU OF AMERICA, INC.



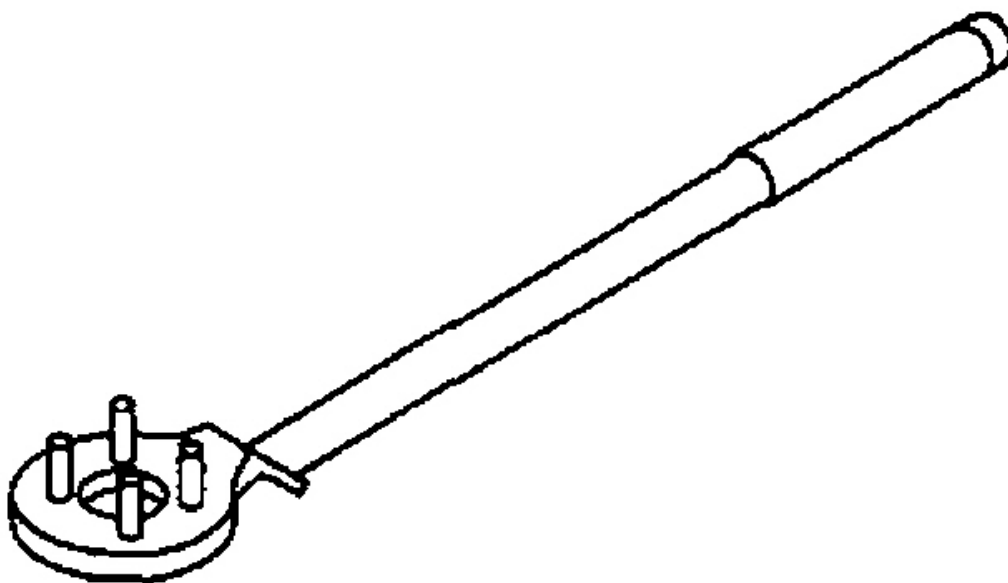
G03812823

Fig. 33: Identifying Special Tool ST-499767800
Courtesy of SUBARU OF AMERICA, INC.



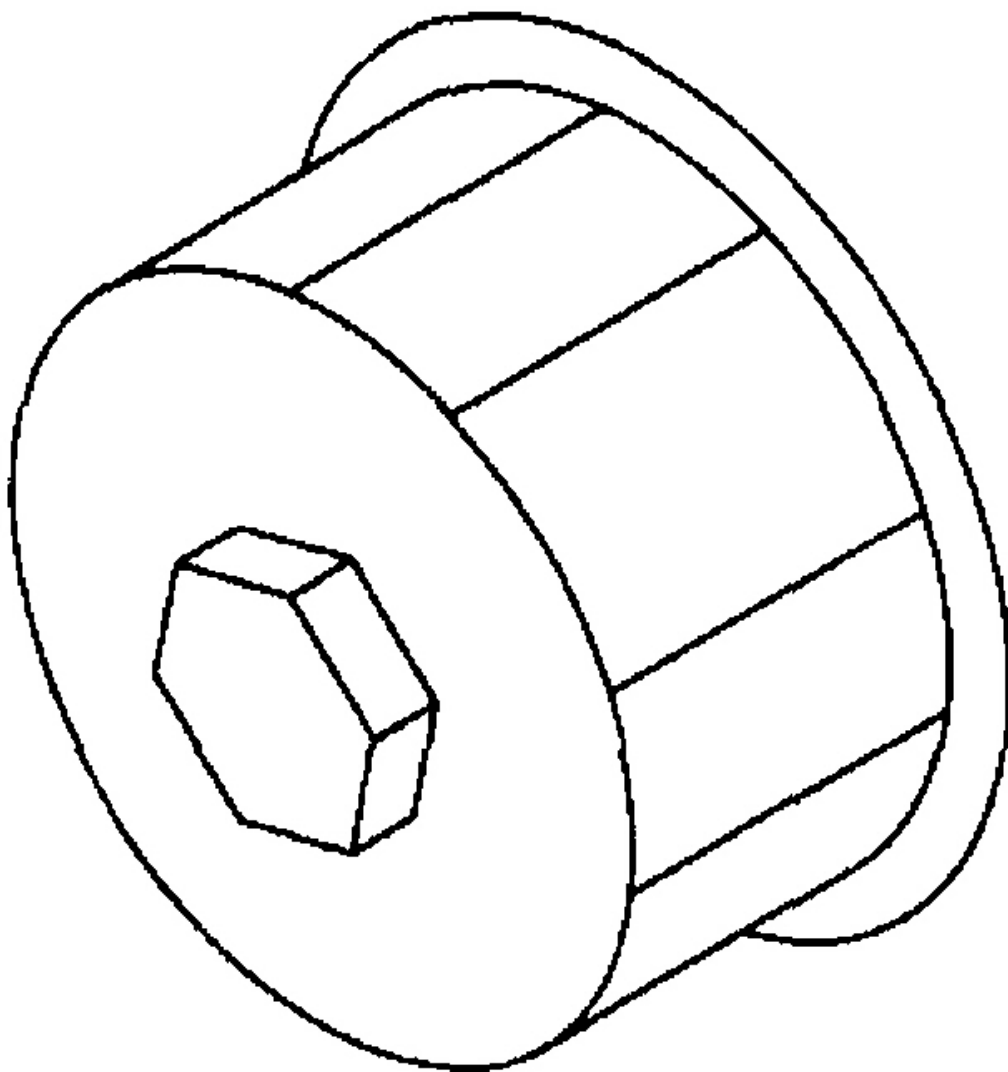
G03812824

Fig. 34: Identifying Special Tool ST-499817100
Courtesy of SUBARU OF AMERICA, INC.



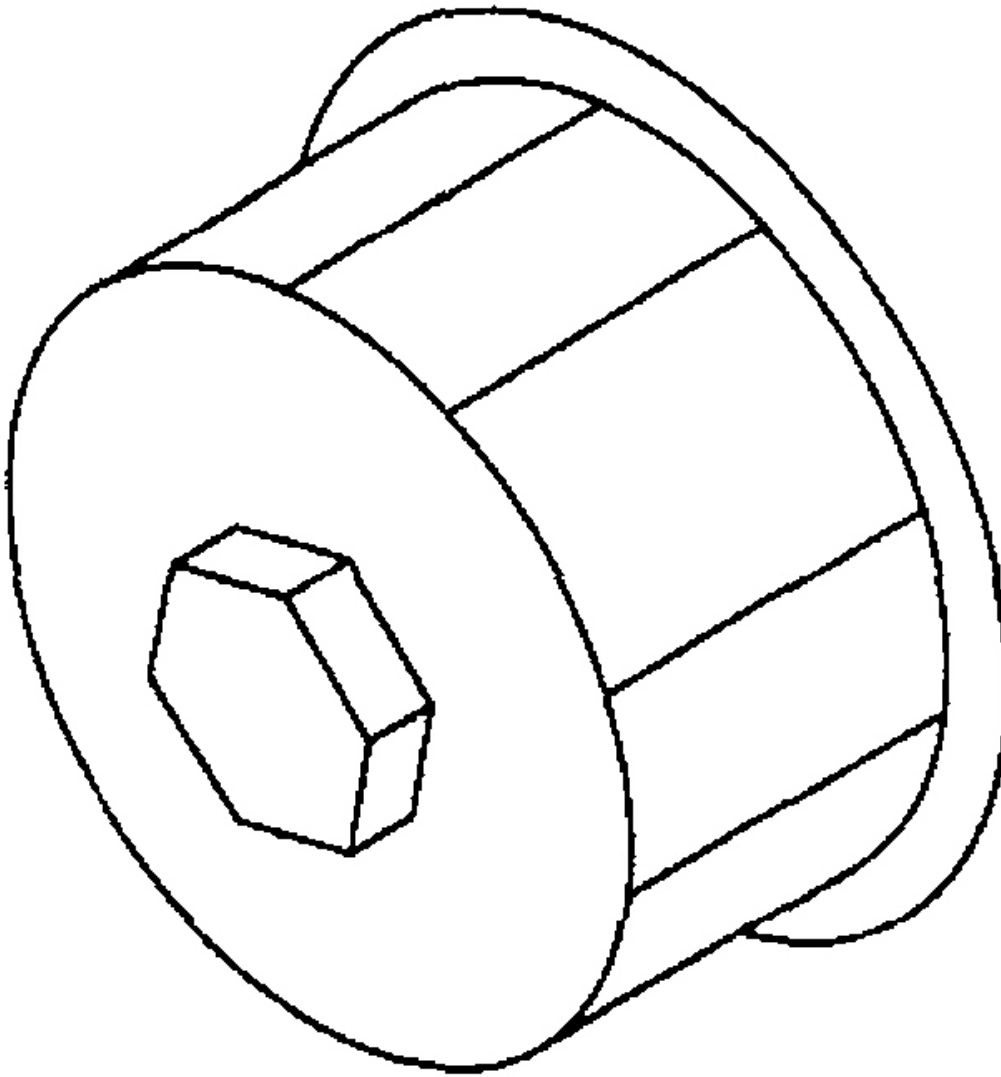
G03812825

Fig. 35: Identifying Special Tool ST-499977100
Courtesy of SUBARU OF AMERICA, INC.



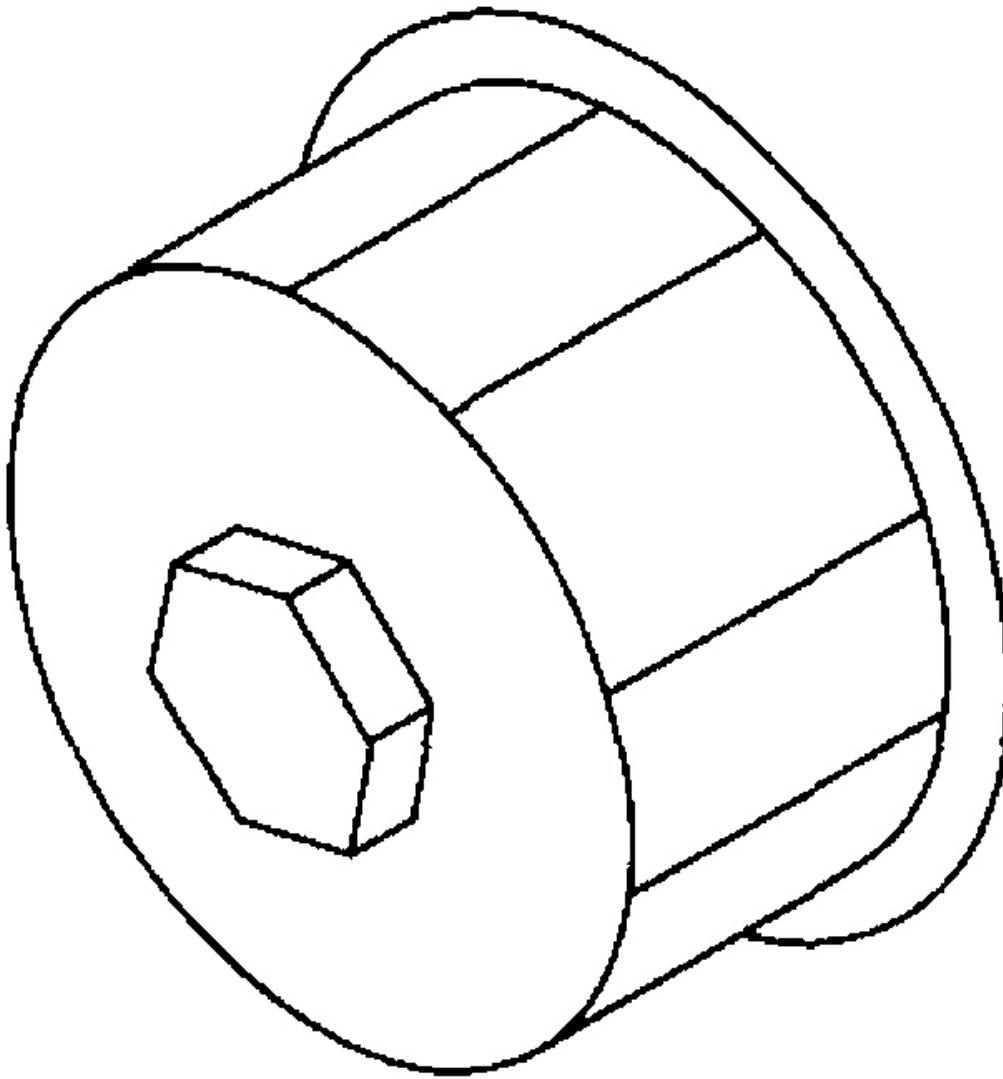
G03812826

Fig. 36: Identifying Special Tool ST-498547000
Courtesy of SUBARU OF AMERICA, INC.



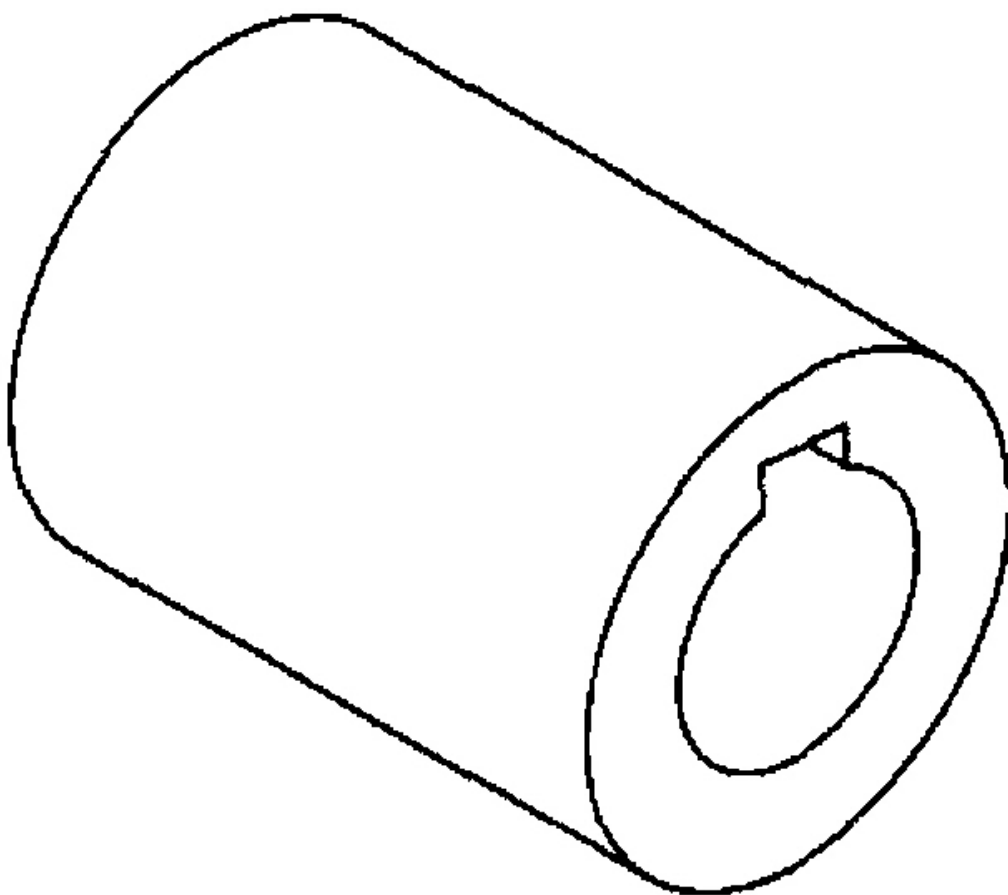
G03812827

Fig. 37: Identifying Special Tool ST-18332AA000
Courtesy of SUBARU OF AMERICA, INC.



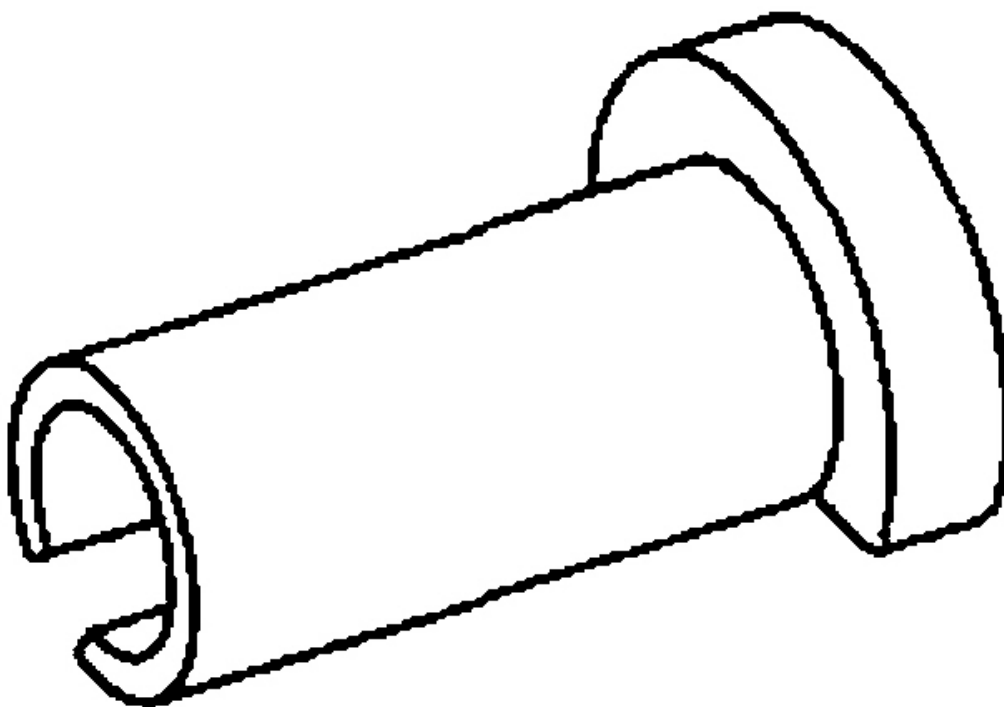
G03812828

Fig. 38: Identifying Special Tool ST18332AA010
Courtesy of SUBARU OF AMERICA, INC.



G03812829

Fig. 39: Identifying Special Tool ST-499987500
Courtesy of SUBARU OF AMERICA, INC.



G03812830

Fig. 40: Identifying Special Tool ST-42099AE000
Courtesy of SUBARU OF AMERICA, INC.

GENERAL TOOL

GENERAL TOOL SPECIFICATION

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
Tachometer (Secondary pick-up type)	Used for measuring idle speed.
Timing light	Used for measuring ignition timing.

PROCEDURE

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

- V-belt
- Timing belt

- Valve rocker assembly
- Camshaft
- Cylinder head

COMPRESSION

INSPECTION

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

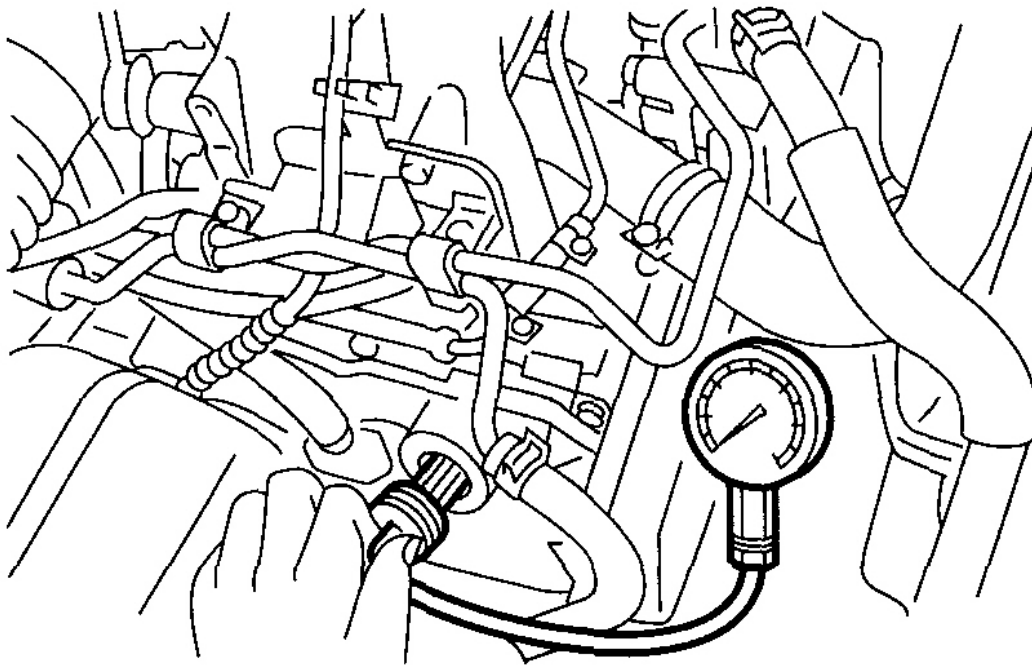
1. After warming-up the engine, turn the ignition switch to OFF.
2. Make sure that the battery is fully charged.
3. Release the fuel pressure.

< 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 tight 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.



G03812831

Fig. 41: Checking Starter Motor Performance And Operation
Courtesy of SUBARU OF AMERICA, INC.

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

Compression (350 rpm and fully open throttle):

Standard:

1,275 kPa (13.0 kgf/cm² , 185 psi) Limit:

1,020 kPa (10.4 kgf/cm² , 148 psi)

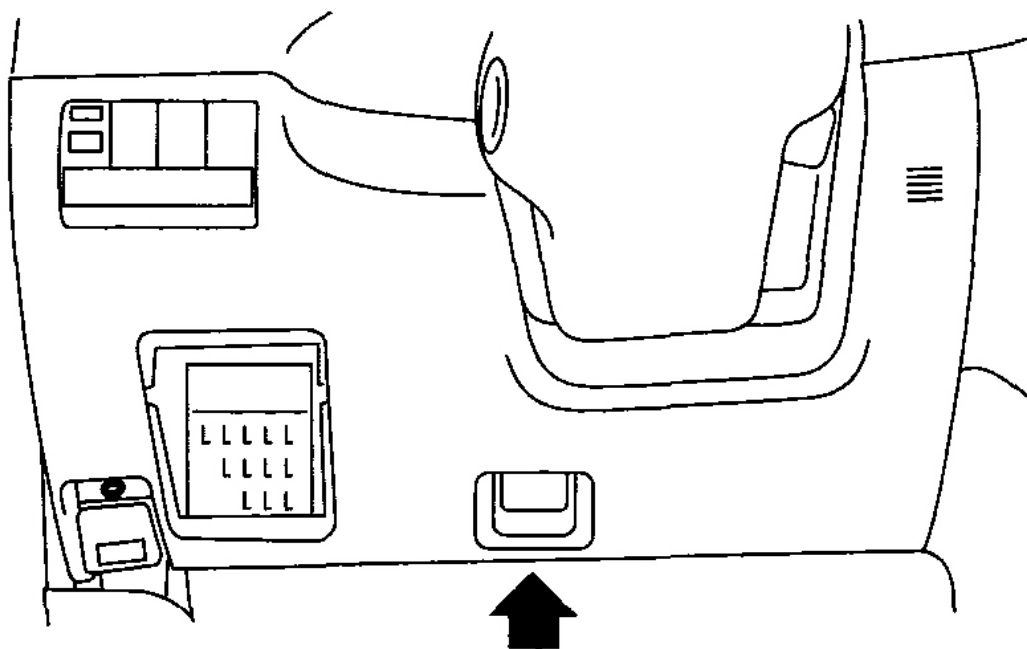
Difference between cylinders:

49 kPa (0.5 kgf/cm² , 7 psi) or less

IDLE SPEED

INSPECTION

1. Before checking the idle speed, check the following:
 - a. Ensure the air cleaner element is free from clogging, ignition timing is correct, spark plugs are in good condition, and hoses are connected properly.
 - b. Ensure the malfunction indicator light does not illuminate.
2. Idle the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. When using Subaru Select Monitor, refer to the following. < Ref. to **PREPARATION TOOL**, General Description. >
 - a. Insert the cartridge to the Subaru Select Monitor.
 - b. Connect the Subaru Select Monitor to data link connector.

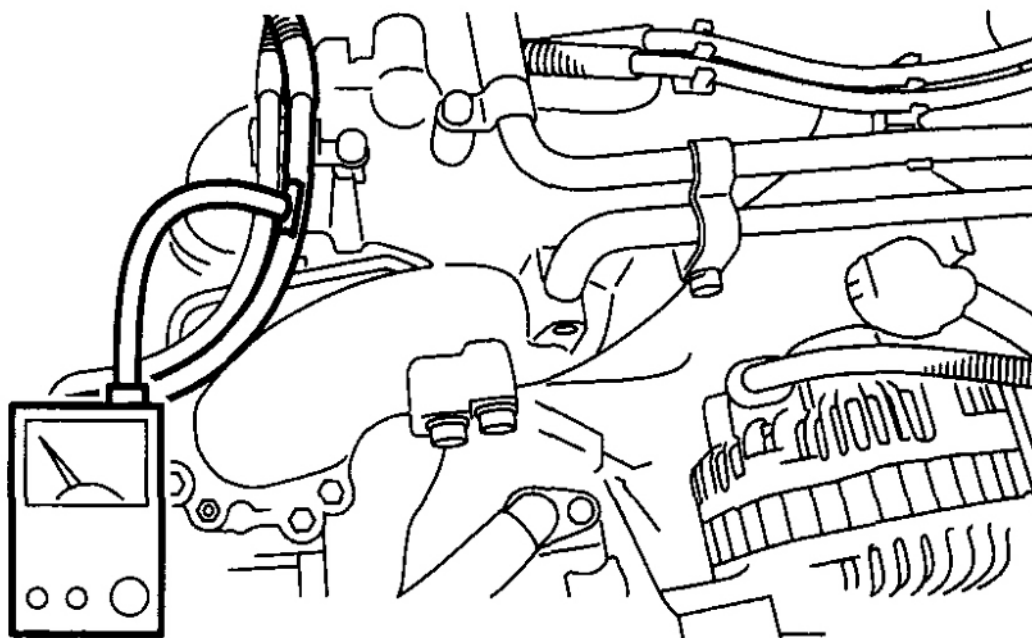


G03812832

Fig. 42: Connecting Subaru Select Monitor To Data Link Connector
Courtesy of SUBARU OF AMERICA, INC.

- c. Turn the ignition switch to ON, and Subaru select monitor switch to ON.
- d. Select {Each System Check} in the Main Menu.
- e. Select {Engine} in the Selection Menu.
- f. Select {Current Data Display & Save} in the Engine Control System Diagnosis.
- g. Select {Data Display} in the Data Display Menu.

- h. Start the engine, and read engine idle speed.
5. When using the tachometer (Secondary pick-up type):
 - a. Attach the pick-up clip to No. 1 cylinder spark plug cord.
 - b. Start the engine, and read engine idle speed.



G03812833

Fig. 43: Attaching Pick-Up Clip To No. 1 Cylinder Spark Plug Cord
Courtesy of SUBARU OF AMERICA, INC.

NOTE: This ignition system provides simultaneous ignition for #1 and #2 plugs. It must be noted that some tachometers may register twice that of actual engine speed.

6. Check the idle speed when unloaded. (With headlights, heater fan, rear defroster, radiator fan, A/C, etc. OFF)

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

650+/-100 rpm

7. 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 idle speed is out of specifications, refer to General Diagnosis Table under "Engine Control System". < Ref. to BASIC DIAGNOSTIC PROCEDURE . >

IGNITION TIMING

INSPECTION

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

1. Idle the engine.
2. To check the ignition timing, connect a timing light to #1 cylinder spark plug cord, and illuminate the timing mark with the timing light.
3. Start the engine and check the ignition timing at the following idle speed.

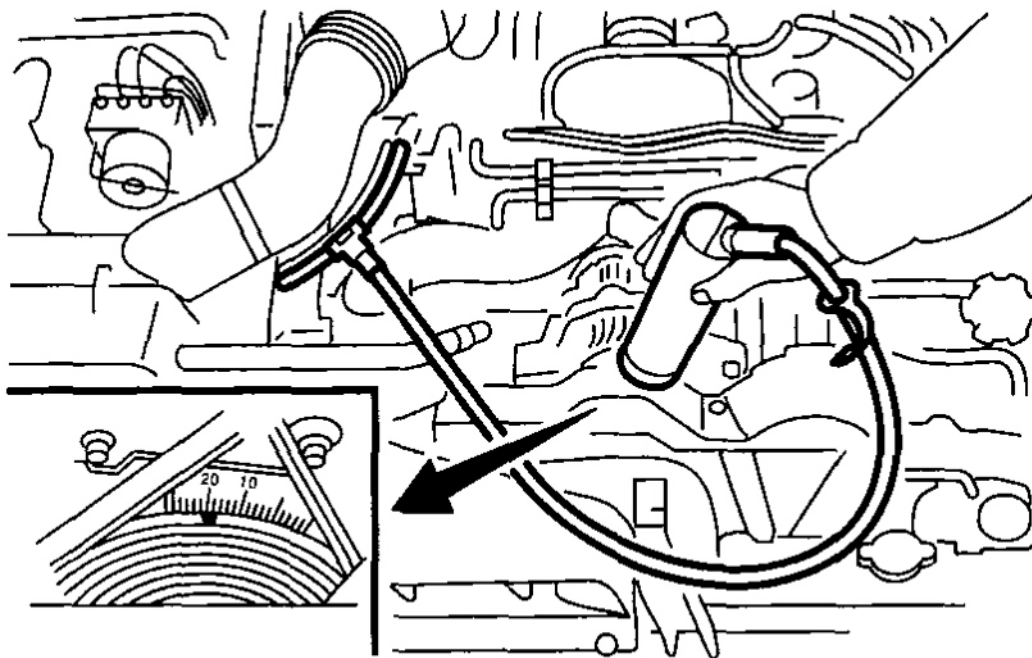
Ignition timing(BTDC/rpm):

MT

10°+/-8°/650

AT

15°+/-8°/700



G03812834

Fig. 44: Inspecting Ignition Timing

Courtesy of SUBARU OF AMERICA, INC.

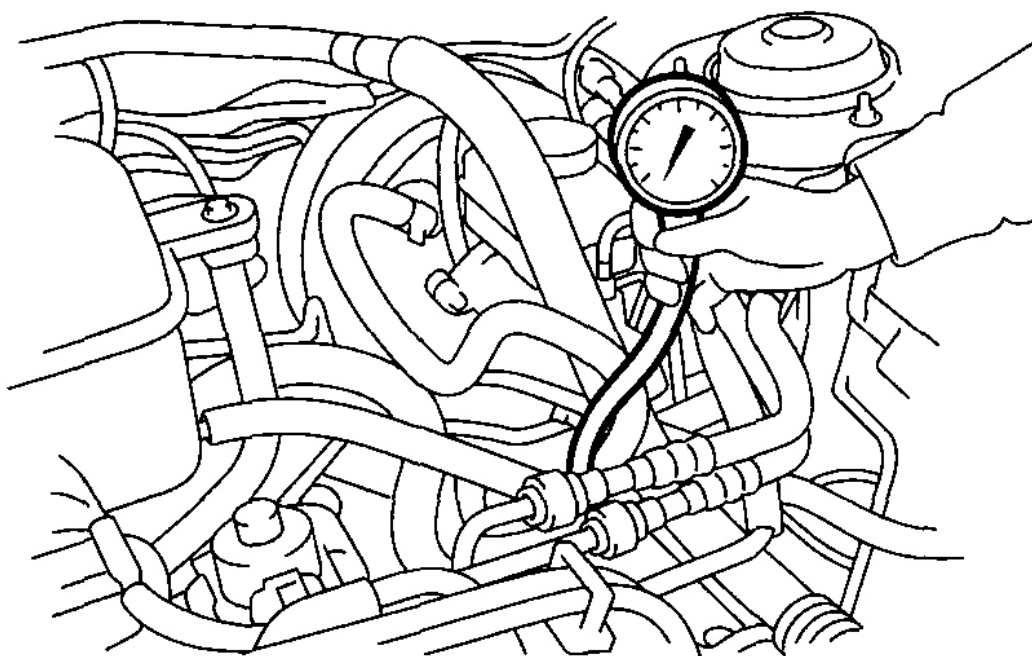
If the timing is not correct, check the ignition control system. < Ref. to **BASIC DIAGNOSTIC PROCEDURE** . >

INTAKE MANIFOLD VACUUM

INSPECTION

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

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



G03812835

Fig. 45: Inspecting Intake Manifold Vacuum
 Courtesy of SUBARU OF AMERICA, INC.

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

Less than -60.0 kPa (-450 mmHg, -17.72 in-Hg)

DIAGNOSIS OF ENGINE CONDITION CHART

Diagnosis of engine condition by measurement of intake manifold vacuum	
Vacuum gauge indication	Possible engine condition
1. Needle is steady but lower than normal position. This tendency becomes more evident as engine temperature rises.	Air leakage around intake manifold gasket, disconnection or damage of vacuum hose
2. When engine speed is reduced slowly from higher speed, needle stops temporarily when it is lowering or becomes steady above normal position.	Exhaust pressure is too high, or exhaust system is clogged.
3. Needle intermittently drops to position lower than normal position.	Leakage around cylinder
4. Needle drops suddenly and intermittently from normal position.	Valve anchoring
5. 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

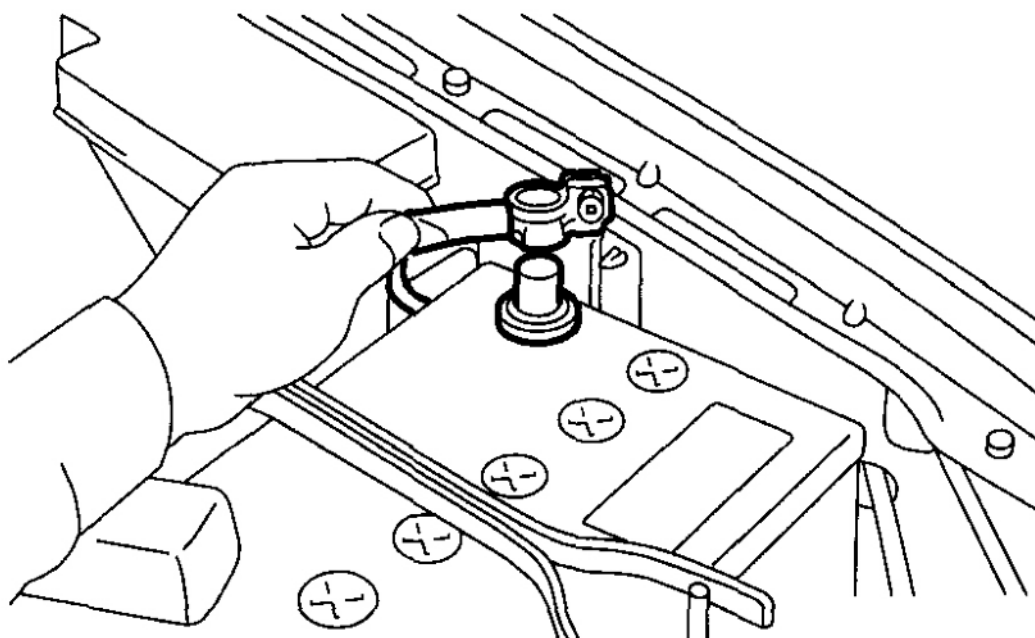
6. Needle vibrates above and below normal position in narrow range.

Defective ignition system

ENGINE OIL PRESSURE

INSPECTION

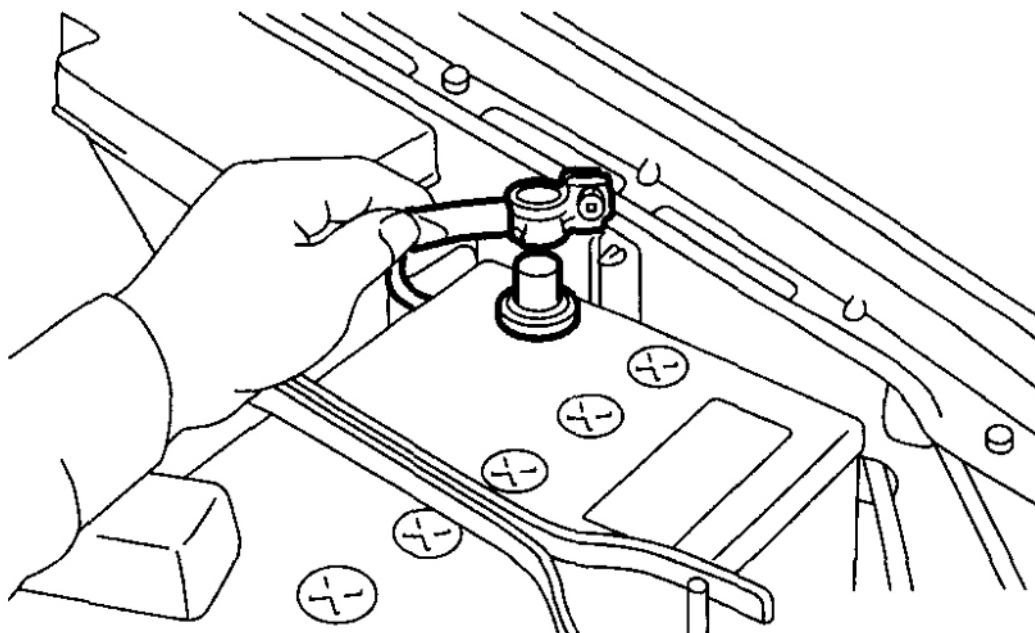
1. Disconnect the ground cable from battery.



G03812836

Fig. 46: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

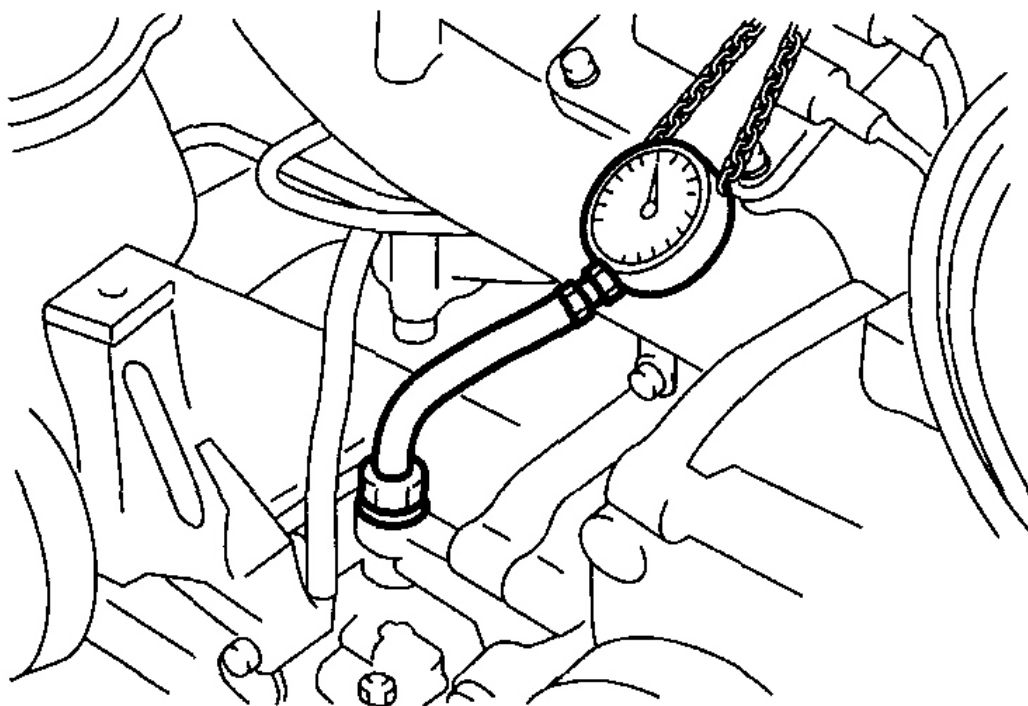
2. Remove the generator from bracket. < Ref. to **REMOVAL** , Generator. >
3. Disconnect the connector from oil pressure switch.
4. Remove the pressure switch from cylinder block. < Ref. to **REMOVAL** , Oil Pressure Switch. >
5. Connect the oil pressure gauge hose to cylinder block.
6. Connect the battery ground cable to battery.



G03812837

Fig. 47: Connecting Battery Ground Cable To Battery
Courtesy of SUBARU OF AMERICA, INC.

7. Start the engine, and measure oil pressure.



G03812838

Fig. 48: Measuring Oil Pressure

Courtesy of SUBARU OF AMERICA, INC.

Oil pressure:**Standard:**88 kPa (0.9 kg/cm² , 13 psi) or more at 800 rpm294 kPa (3.0 kg/cm² , 43 psi) or more at 5,000 rpm**CAUTION:**

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

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

8. 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

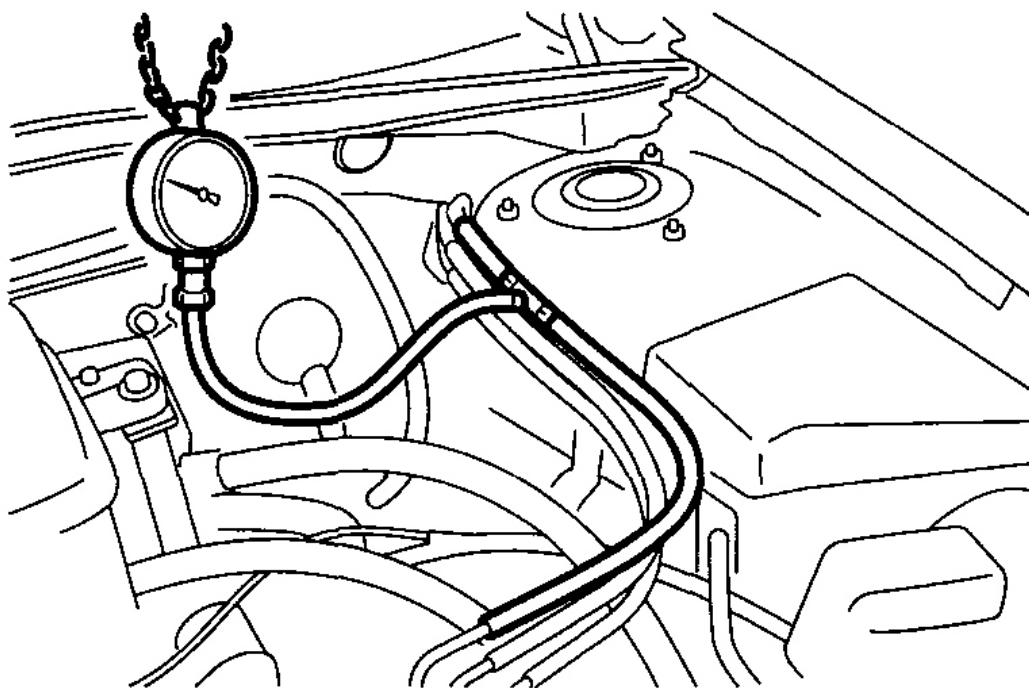
WARNING: Before removing the fuel pressure gauge, release fuel pressure.

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

1. Release the fuel pressure.

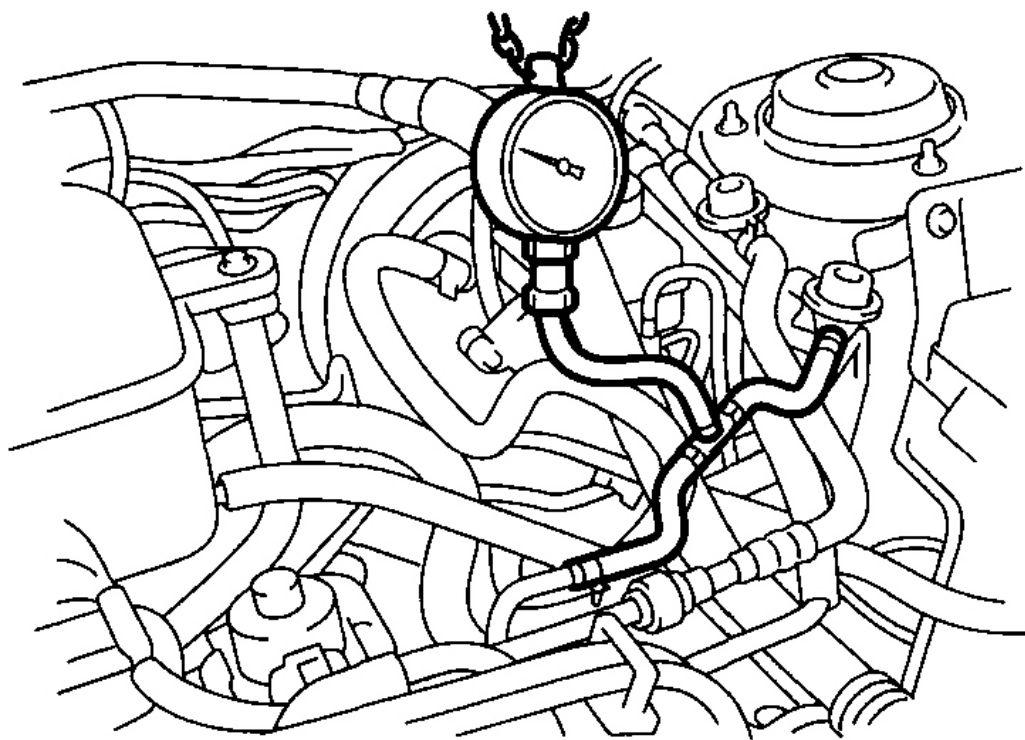
< Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel. >

2. Open the fuel filler flap lid, and remove the fuel filler cap.
3. Disconnect the fuel delivery hose from fuel damper, and connect a fuel pressure gauge.



G03812839

Fig. 49: Releasing Of Fuel Pressure
Courtesy of SUBARU OF AMERICA, INC.



G03812840

Fig. 50: Disconnecting Fuel Delivery Hose From Fuel Damper
Courtesy of SUBARU OF AMERICA, INC.

4. Connect the connector of fuel pump relay.



G03812841

Fig. 51: Connecting Connector Of Fuel Pump Relay
Courtesy of SUBARU OF AMERICA, INC.

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

Fuel pressure:

Standard:

284 - 314 kPa (2.9 - 3.2 kg/cm² , 41-46 psi)

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

Fuel pressure:

Standard:

206 - 235 kPa (2.1 - 2.4 kg/cm² , 30 - 34 psi)

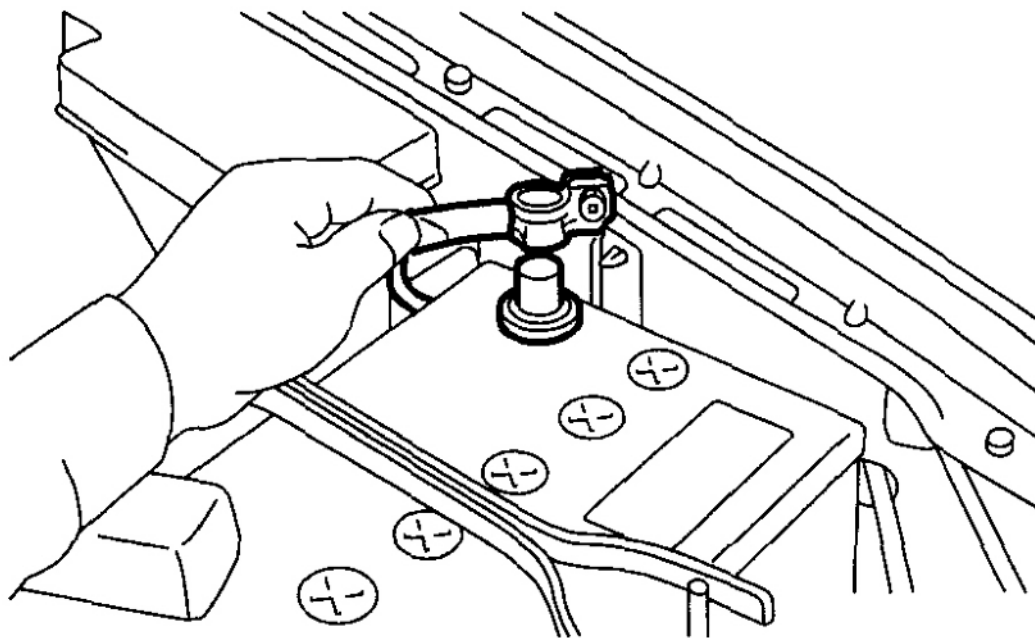
NOTE: The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kg/cm² , 1 to 3 psi) higher than standard values during high-altitude operations.

VALVE CLEARANCE

INSPECTION

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

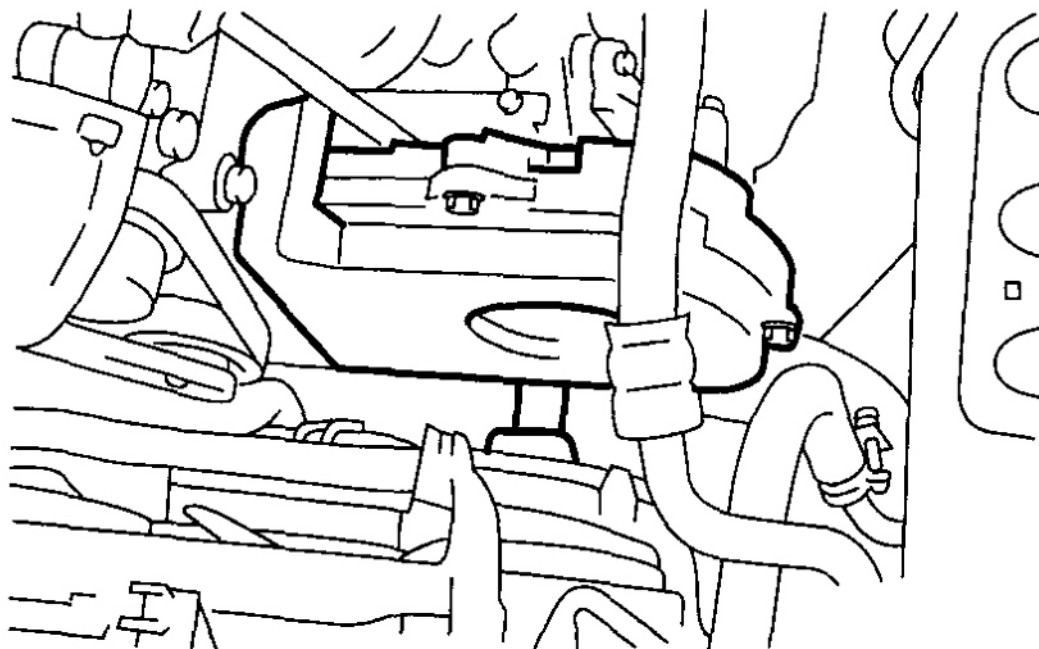
1. Set the vehicle on a lift.
2. Lift-up the vehicle.
3. Remove the under cover.
4. Lower the vehicle.
5. Disconnect the ground cable from battery.



G03812842

Fig. 52: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the timing belt cover (LH).



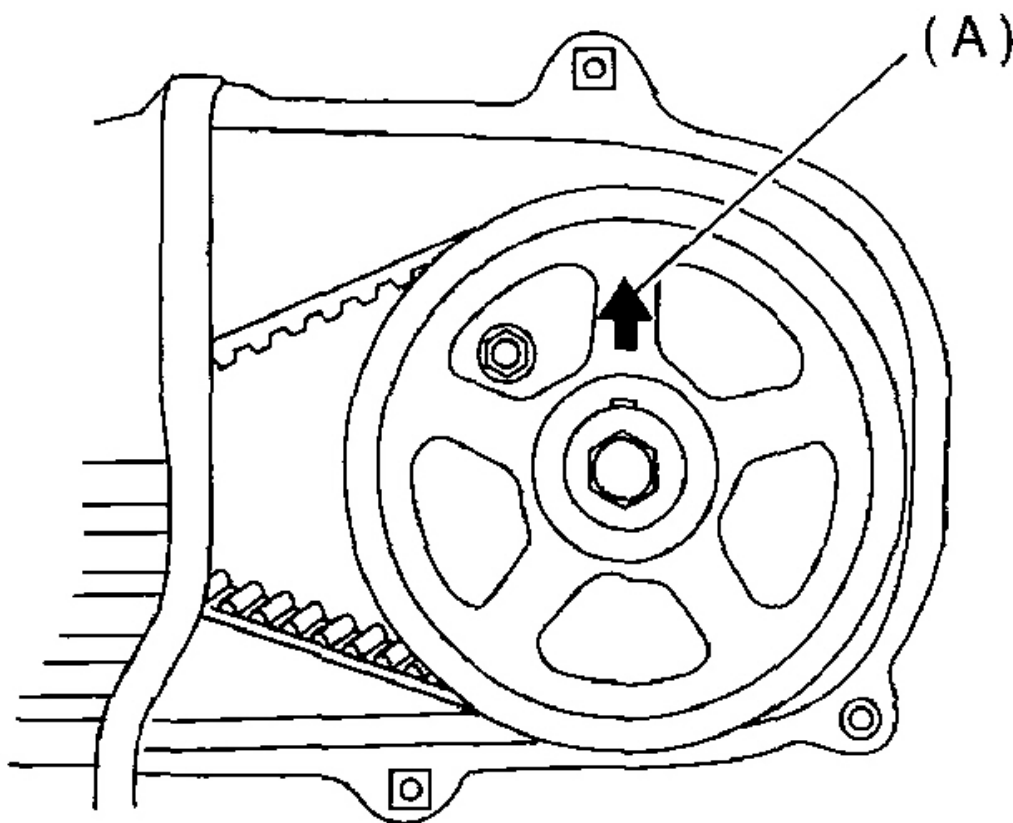
G03812843

Fig. 53: Removing Timing Belt Cover (LH)
Courtesy of SUBARU OF AMERICA, INC.

7. When inspecting #1 and #3 cylinders:
- Disconnect the spark plug cords from spark plugs RH side. < Ref. to **RH SIDE** , REMOVAL, Spark Plug. >
 - Disconnect the PCV hose from rocker cover (RH).
 - Remove the bolts, then remove the rocker cover (RH).
8. When inspecting #2 and #4 cylinders:
- Disconnect the spark plug cords from spark plugs (LH Side). < Ref. to **LH SIDE** , REMOVAL, Spark Plug. >
 - Disconnect the PCV hose from rocker cover (LH).
 - Remove the bolts, then remove the rocker cover (LH).
9. 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.



G03812844

Fig. 54: Identifying #1 Cylinder Piston Dead Center
Courtesy of SUBARU OF AMERICA, INC.

10. Measure #1 cylinder valve clearance using thickness gauge.

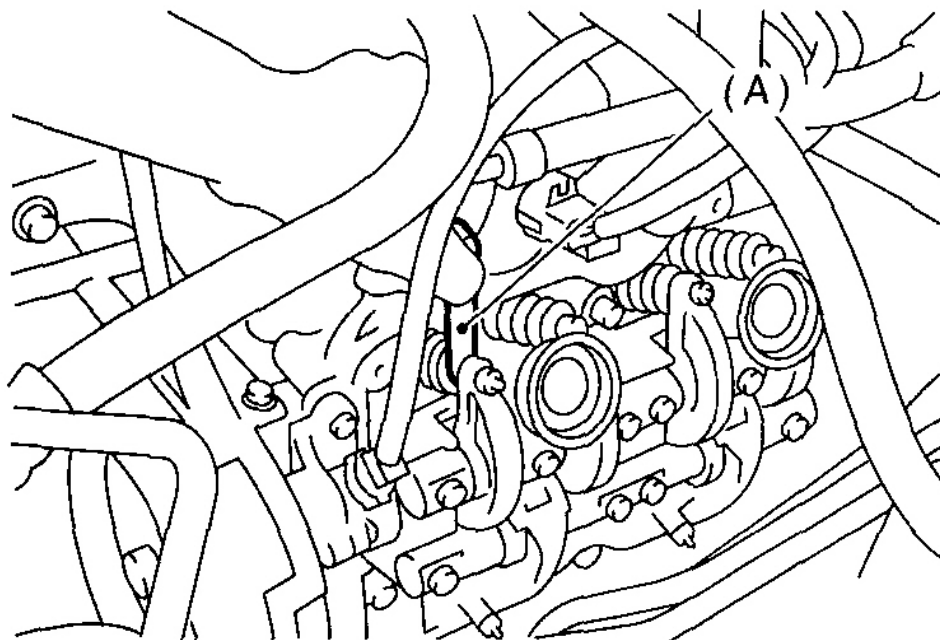
CAUTION:

- Insert the thickness gauge (A) in as horizontally as possible with to the valve stem end face.
- Measure the exhaust valve clearances 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)



G03812845

Fig. 55: Measuring Cylinder Valve Clearance Using Thickness Ga
Courtesy of SUBARU OF AMERICA, INC.

11. If necessary, adjust the valve clearance. < Ref. to , **ADJUSTMENT**, Valve Clearance. >
12. 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.

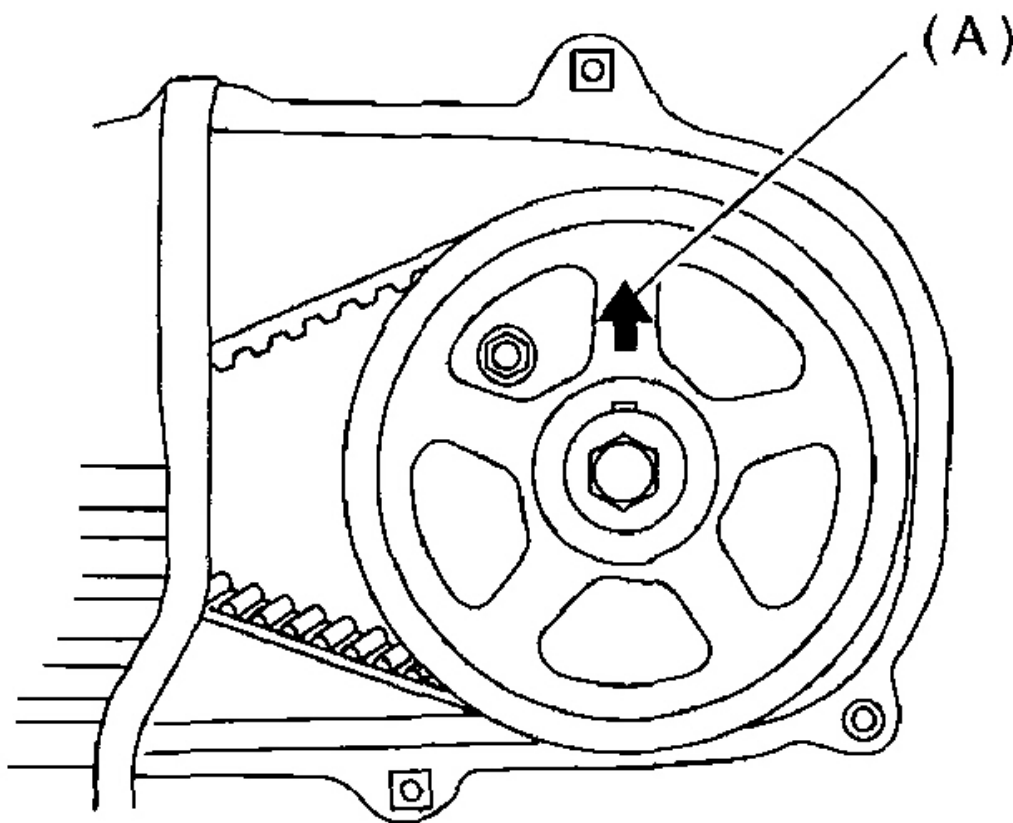
13. After inspection, install the related parts in the reverse order of removal.

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.



G03812846

Fig. 56: Identifying Cylinder Piston To Top Dead Center Of Compression
Courtesy of SUBARU OF AMERICA, INC.

2. Adjust the #1 cylinder valve clearance.
 - a. Loosen the valve rocker nut and screw.
 - b. Place a suitable thickness gauge.
 - c. While noting the valve clearance, tighten the valve rocker adjusting screw.

- d. When the specified valve clearance is obtained, tighten the valve rocker nut.

Tightening torque:

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

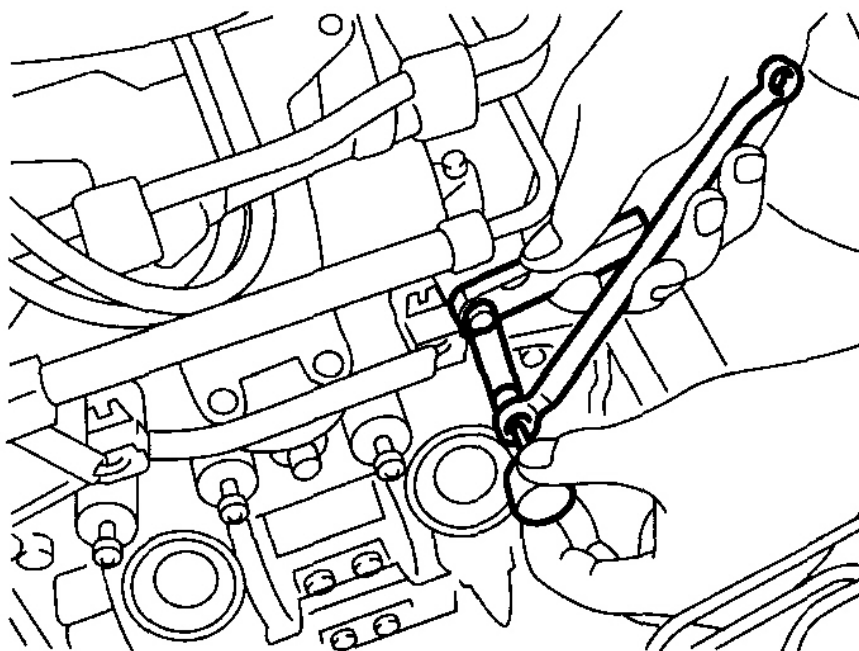
CAUTION:

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

Valve clearance Intake:

0.20+/-0.04 mm (0.0079+/-0.0016 in) Exhaust:

0.25+/-0.04 mm (0.0098+/-0.0016 in)



G03812847

Fig. 57: Inserting Thickness Gauge In Horizontally As Possible
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

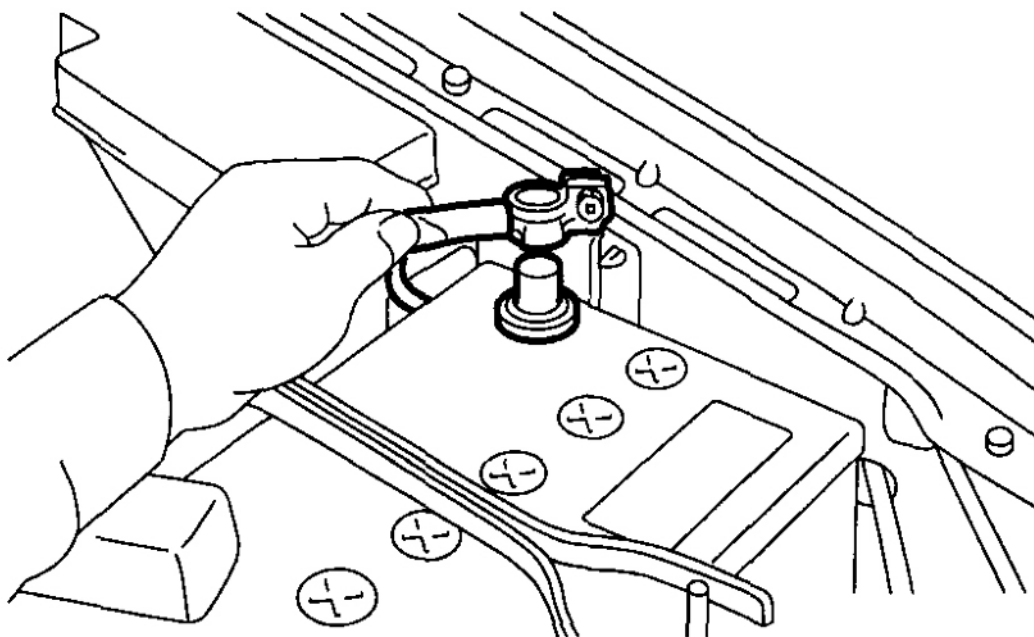
- Be sure to set the cylinder pistons to their respective top dead centers on compression stroke before measuring valve clearances.
- By rotating the crank pulley clockwise every 180° from the state that #1 cylinder piston is on the top dead center of compression stroke, #3, #2 and #4 cylinder pistons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

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 hood 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. Remove the fuel filler cap.
6. Disconnect the ground cable from battery.



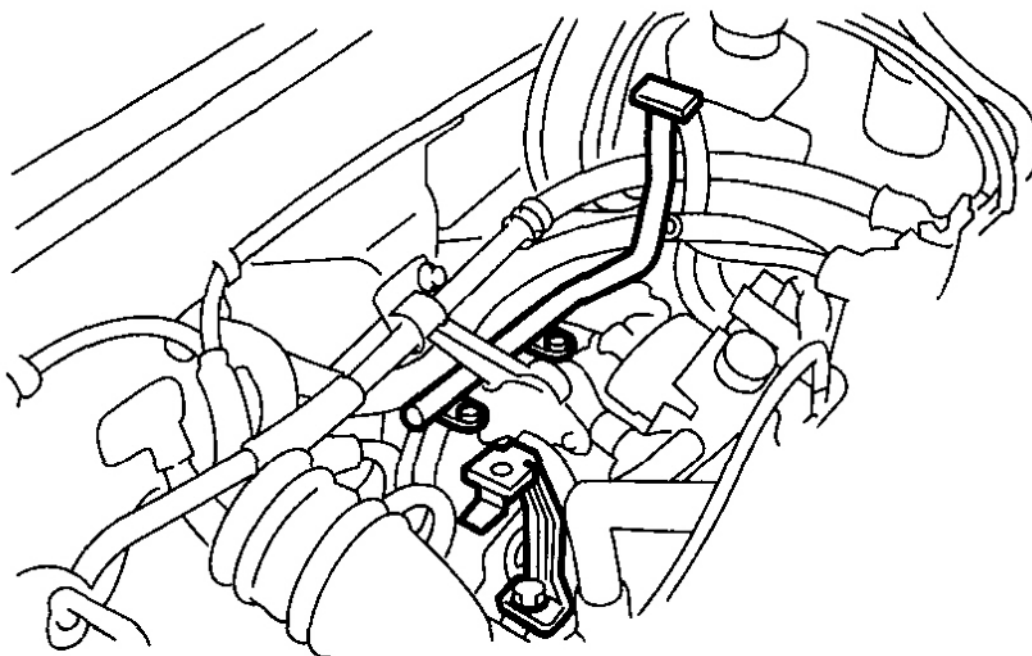
G03812848

Fig. 58: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

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. >

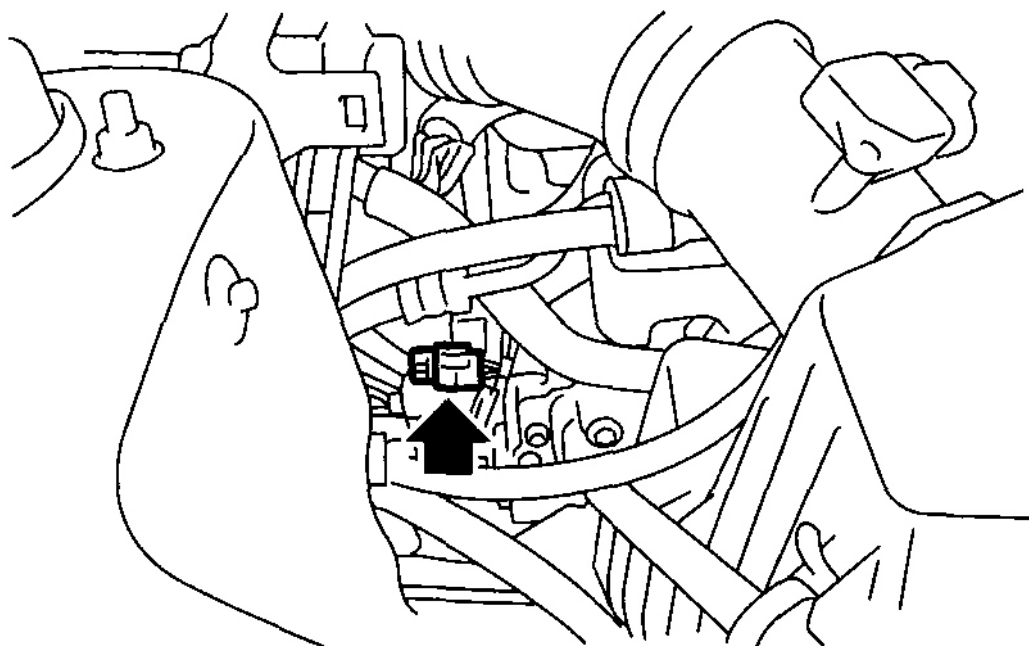
8. Remove the under cover.
9. Remove the radiator from vehicle. < Ref. to **REMOVAL** , Radiator. >
10. Disconnect the A/C pressure hoses from A/C compressor.
11. Remove the air intake chamber stay.



G03812849

Fig. 59: Removing Air Intake Chamber Stay
Courtesy of SUBARU OF AMERICA, INC.

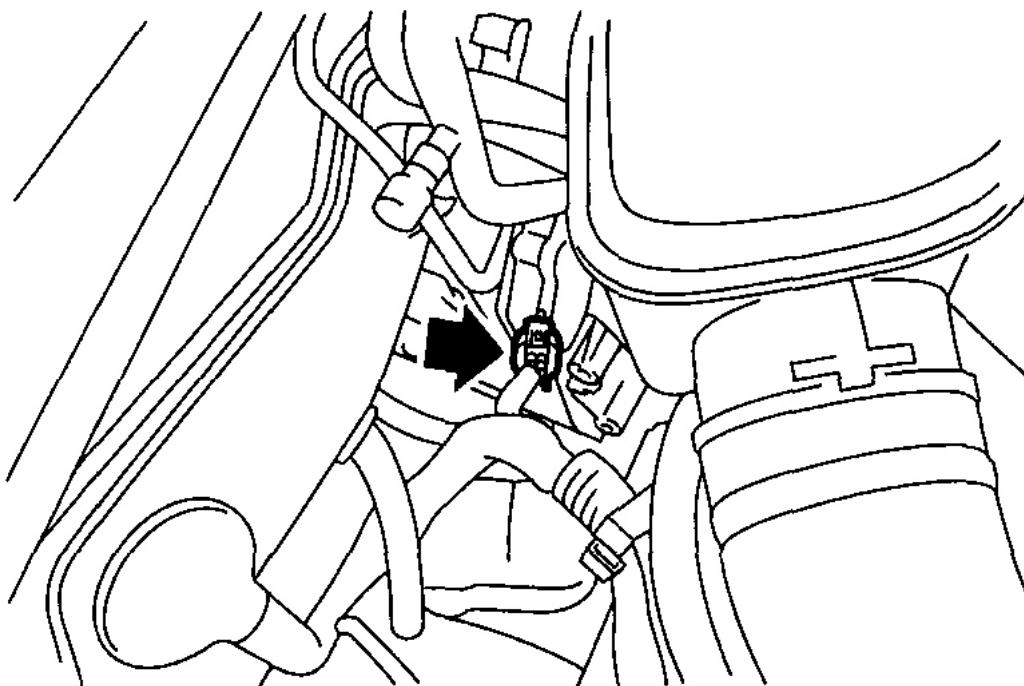
12. Disconnect the following connectors and cables.
 - a. Front oxygen (A/F) sensor connector



G03812850

Fig. 60: Identifying Front Oxygen (A/F) Sensor Connector
Courtesy of SUBARU OF AMERICA, INC.

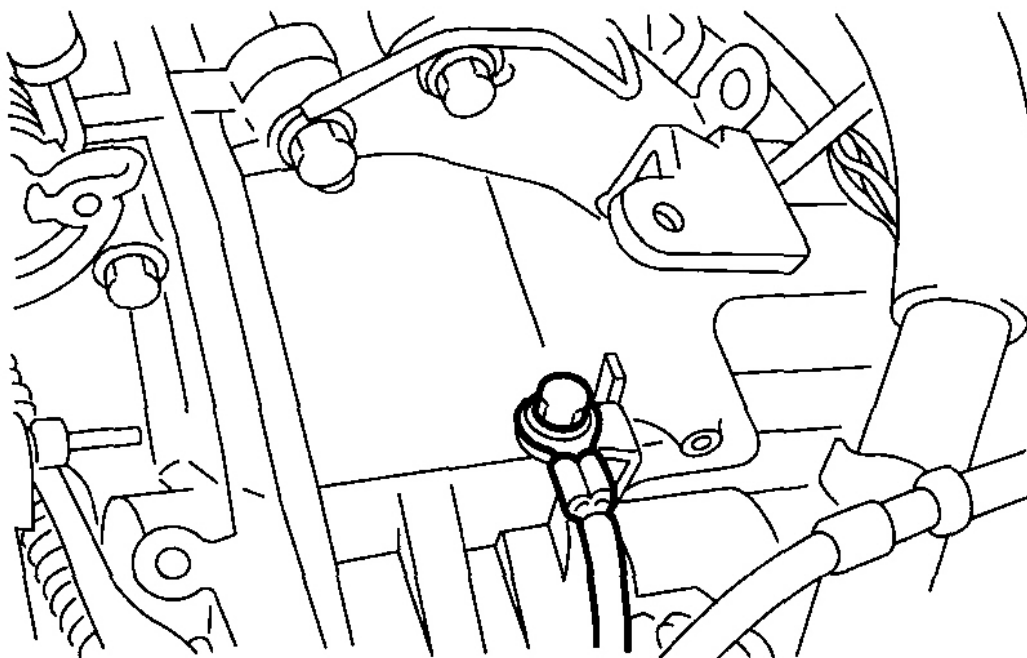
- b. Rear oxygen sensor connector



G03812851

Fig. 61: Identifying Rear Oxygen Sensor Connector
Courtesy of SUBARU OF AMERICA, INC.

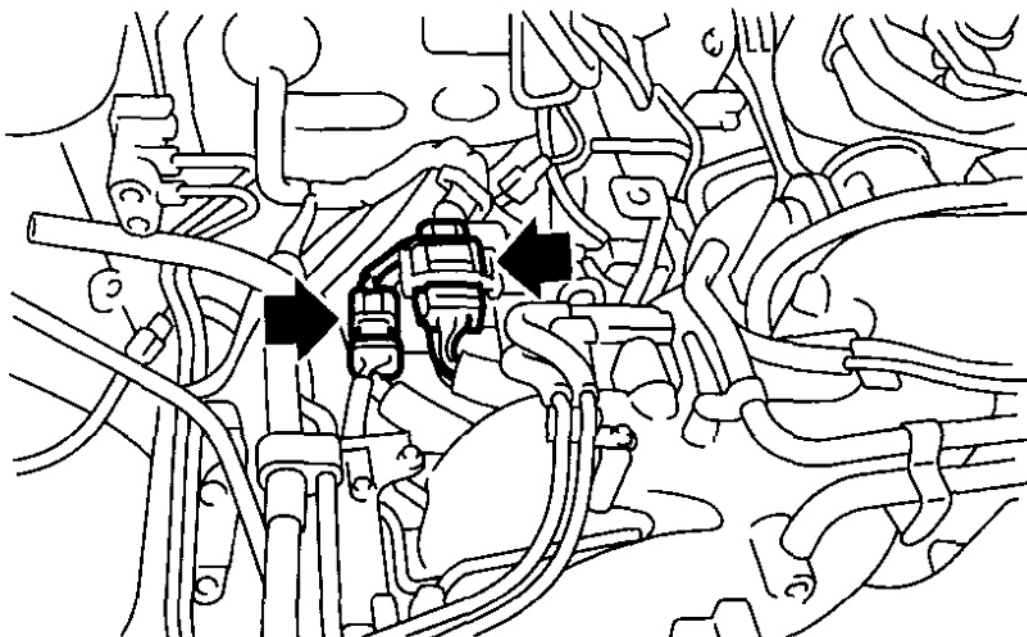
- c. Engine ground cable



G03812852

Fig. 62: Identifying Engine Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

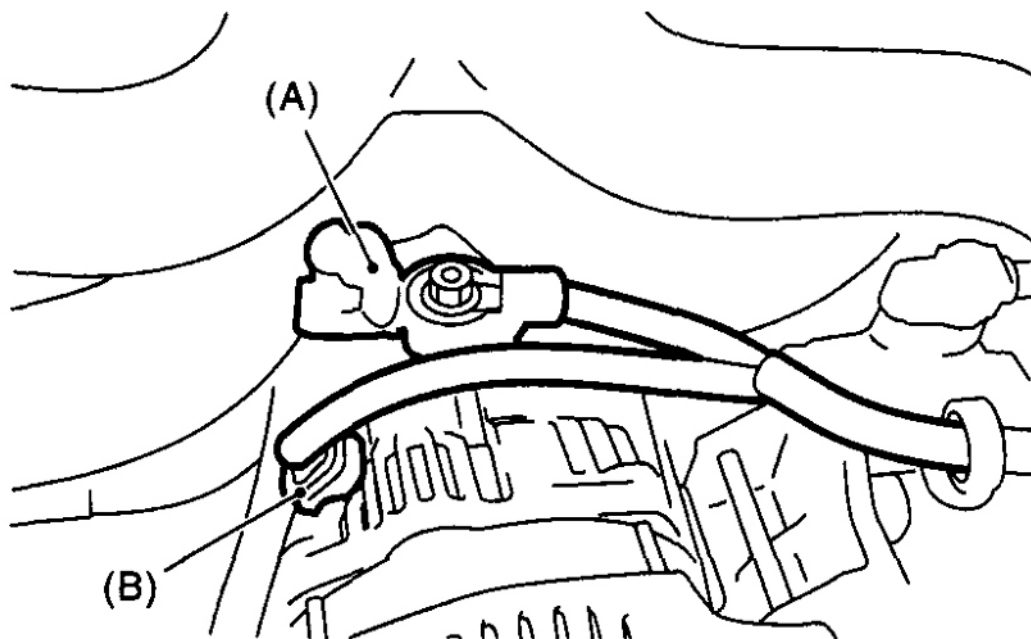
- d. Engine harness connectors



G03812853

Fig. 63: Identifying Engine Harness Connectors
Courtesy of SUBARU OF AMERICA, INC.

- e. Generator connector and terminal



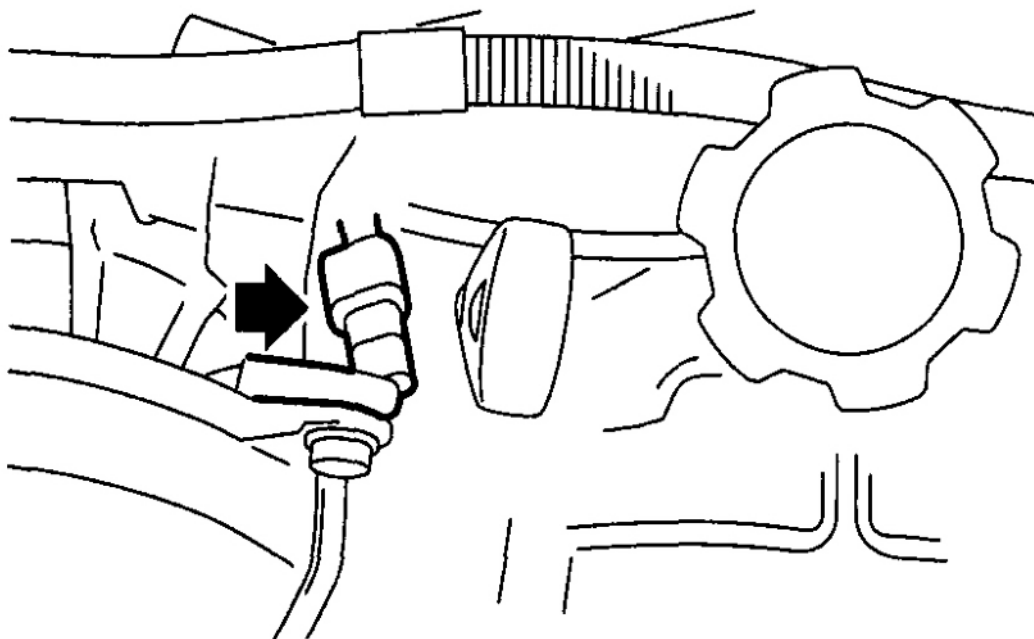
(A) Terminal

(B) Generator connector

G03812854

Fig. 64: Identifying Generator Connector And Terminal
Courtesy of SUBARU OF AMERICA, INC.

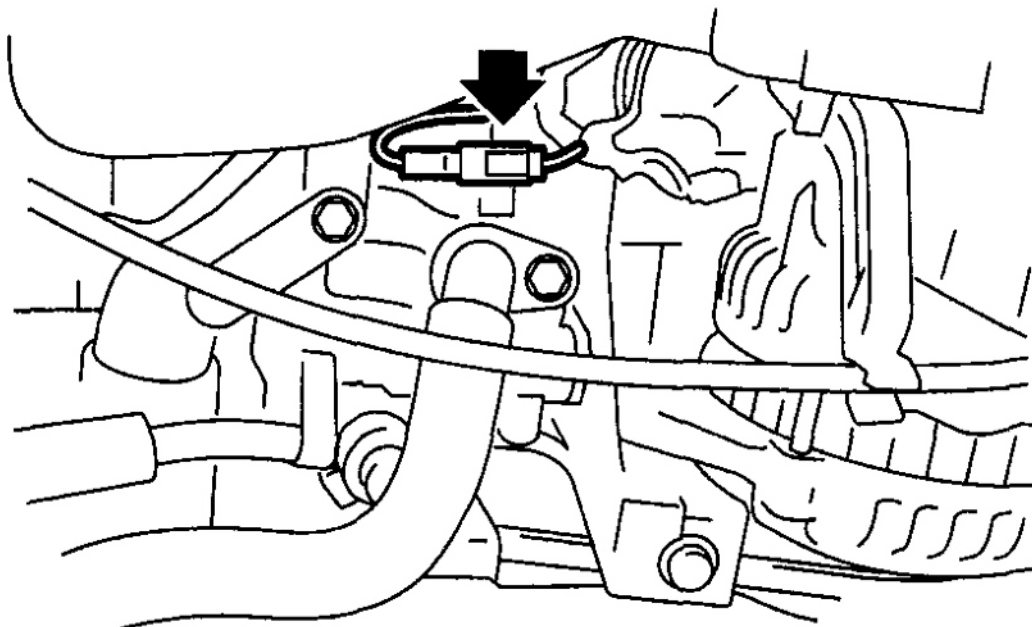
- f. A/C compressor connectors



G03812855

Fig. 65: Identifying A/C Compressor Connectors
Courtesy of SUBARU OF AMERICA, INC.

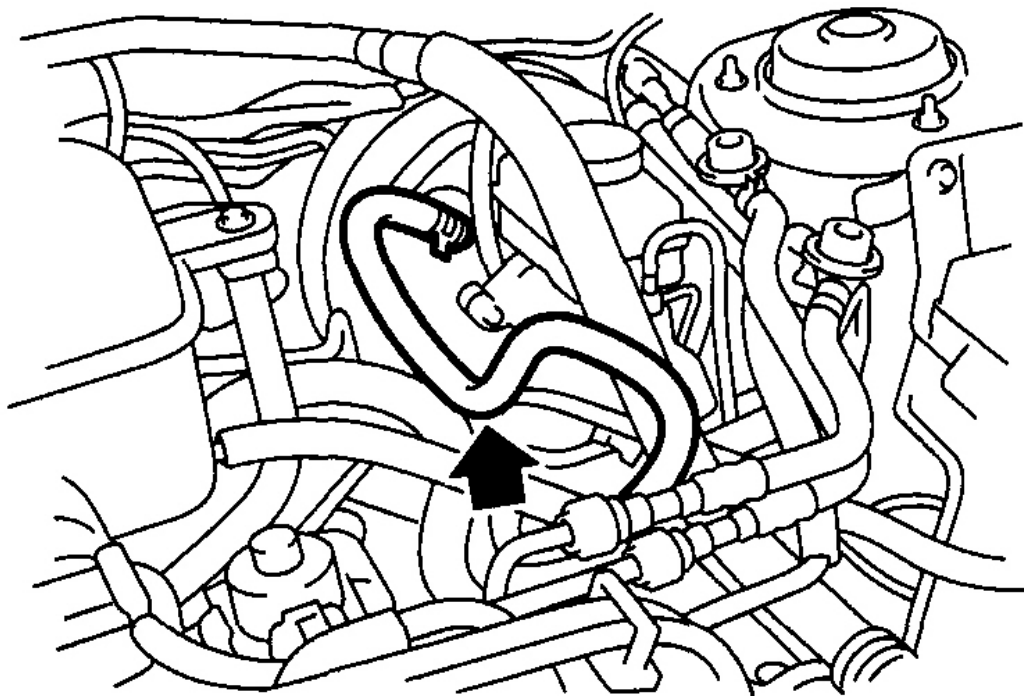
- g. Power steering switch connector



G03812856

Fig. 66: Identifying Power Steering Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

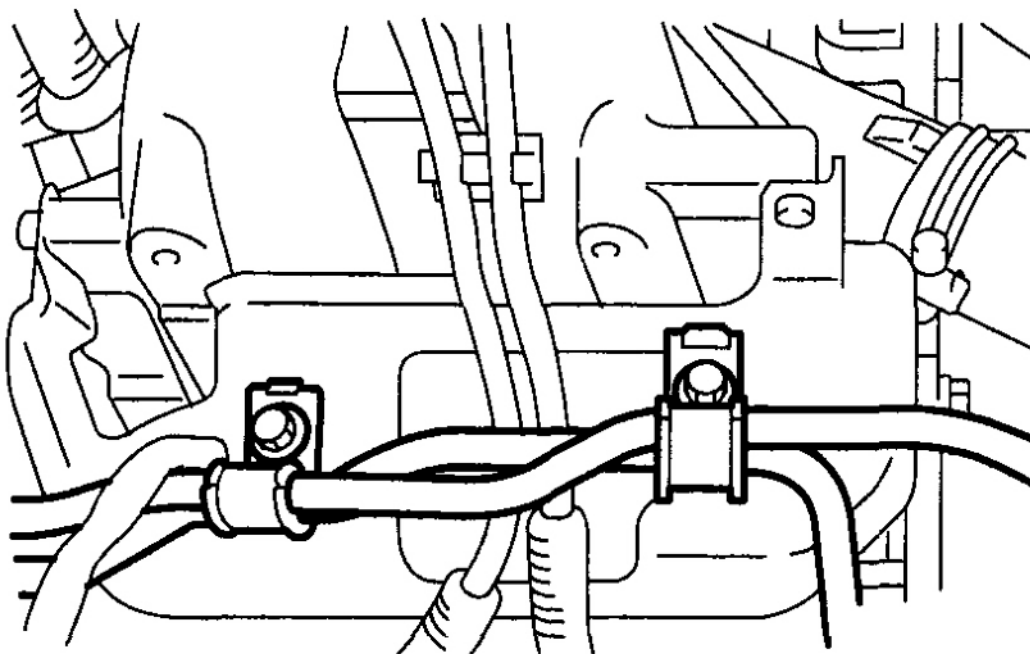
13. Disconnect the following hoses.
 - a. Brake booster vacuum hose



G03812857

Fig. 67: Disconnecting Brake Booster Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

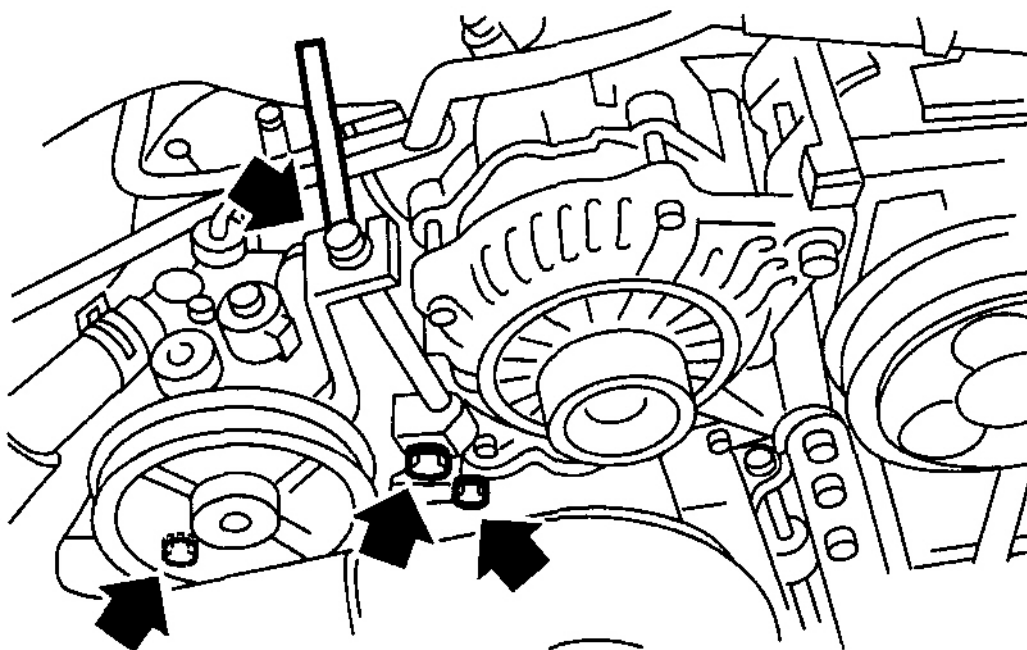
- b. Heater inlet and outlet hoses
- 14. Remove the power steering pump from bracket.
 - a. Loosen the lock bolt and slider bolt, and then remove the front side V-belt. < Ref. to , **FRONT SIDE BELT**, REMOVAL, V-belt. >
 - b. Remove the pipe with bracket.



G03812858

Fig. 68: Removing Pipe With Bracket
Courtesy of SUBARU OF AMERICA, INC.

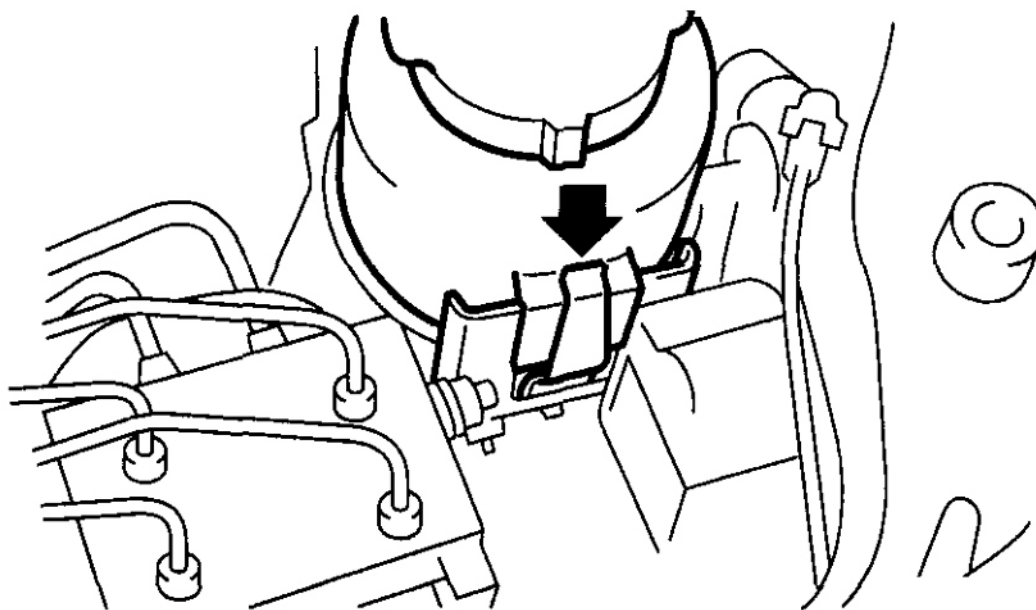
- c. Remove the bolts which install the power steering pump to bracket.



G03812859

Fig. 69: Removing Bolts Which Install Power Steering Pump To Bracket
Courtesy of SUBARU OF AMERICA, INC.

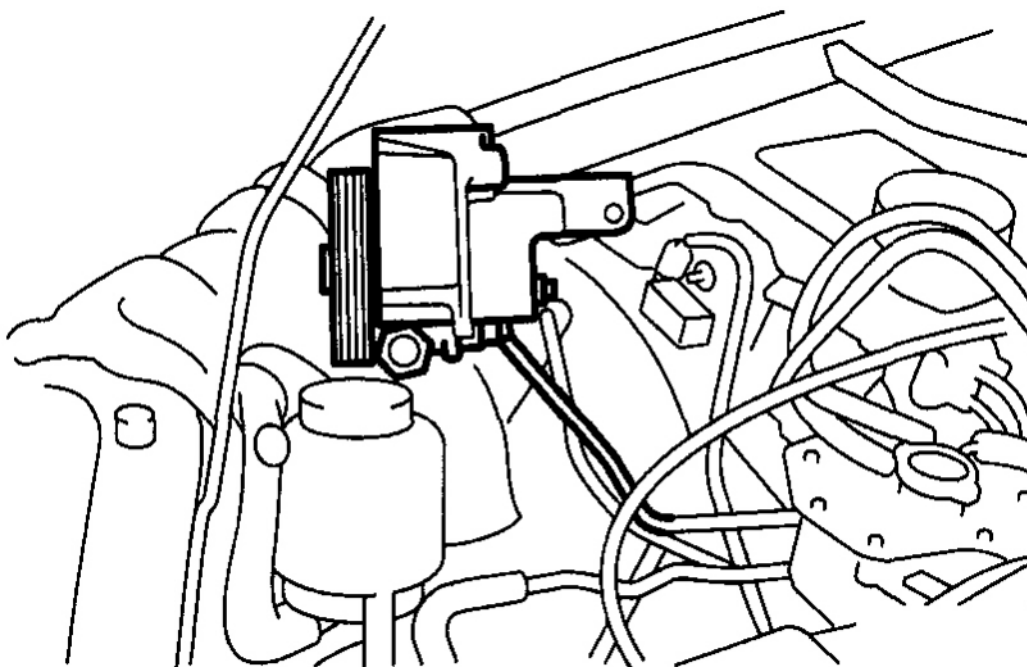
- d. Remove the power steering tank from bracket by pulling it upward.



G03812860

Fig. 70: Removing Power Steering Tank From Bracket
Courtesy of SUBARU OF AMERICA, INC.

- e. Place the power steering pump on right side wheel apron.



G03812861

Fig. 71: Placing Power Steering Pump On Right Side Wheel Apron
Courtesy of SUBARU OF AMERICA, INC.

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

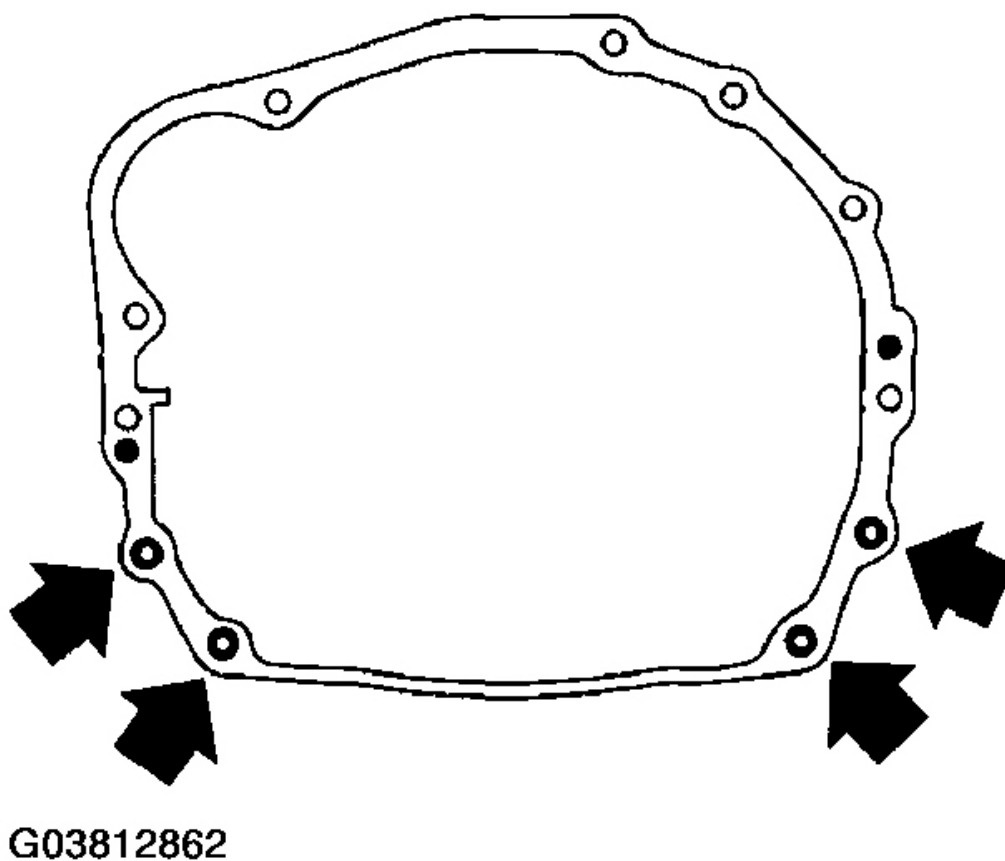
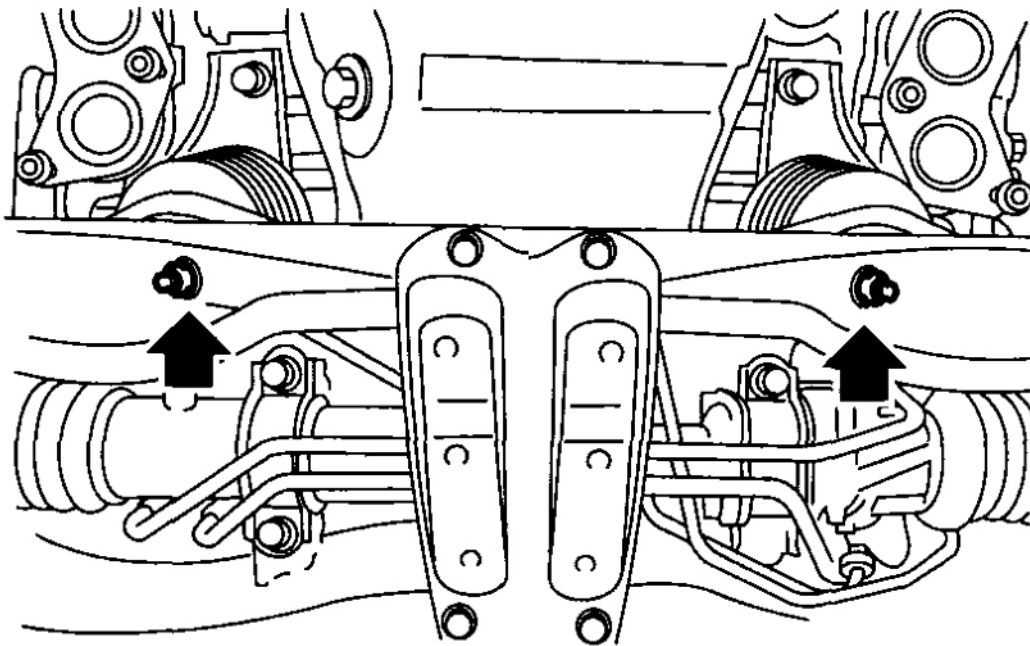


Fig. 72: Removing Nuts Which Hold Lower Side Of Transmission To Engine
Courtesy of SUBARU OF AMERICA, INC.

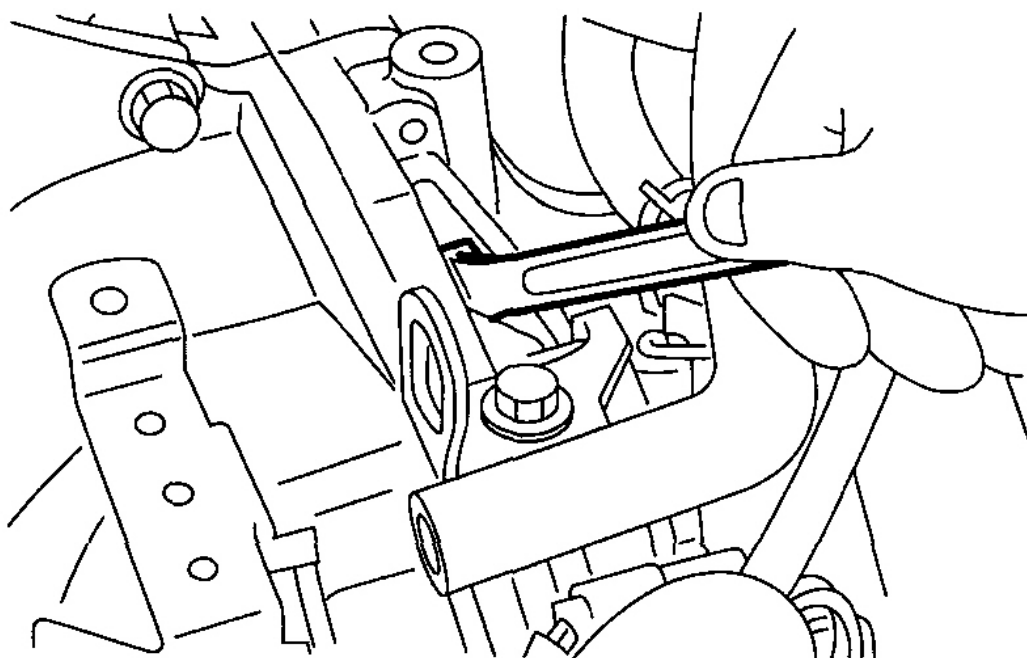
17. Remove the nuts which install front cushion rubber onto front crossmember.



G03812863

Fig. 73: Removing Front Cushion Rubber Onto Front Crossmember
Courtesy of SUBARU OF AMERICA, INC.

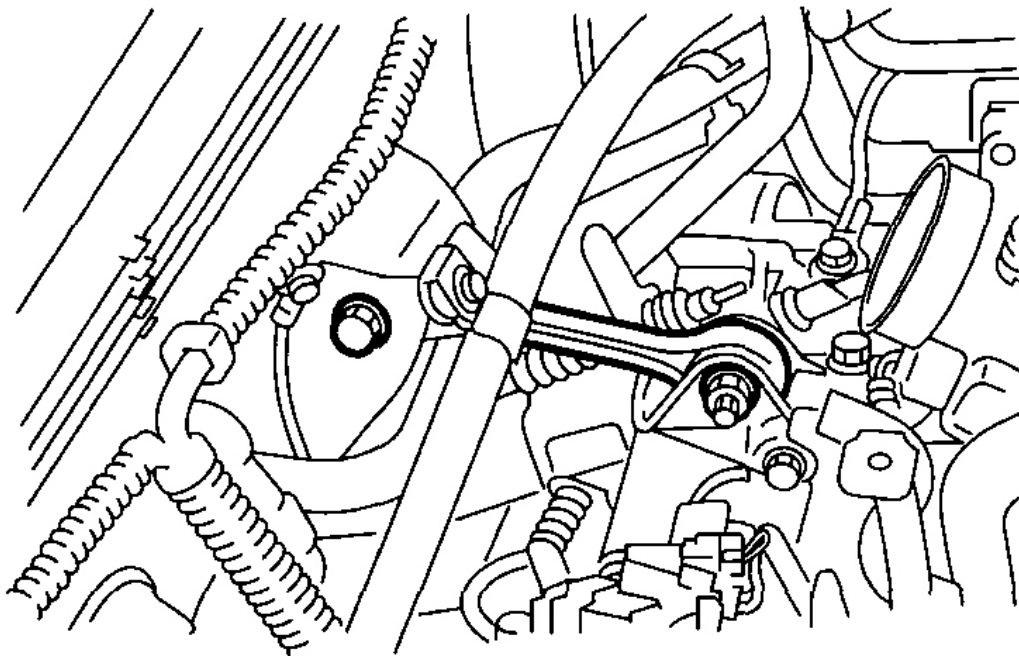
18. Separate the torque converter clutch from drive plate. (AT model)
 - a. Lower the vehicle.
 - b. Remove the service hole plug.
 - c. Remove the bolts which hold torque converter clutch to drive plate.
 - d. Remove other bolts while rotating the engine using a socket wrench.



G03812864

Fig. 74: Removing Bolts While Rotating Engine Using A Socket Wrench
Courtesy of SUBARU OF AMERICA, INC.

19. Remove the pitching stopper.



G03812865

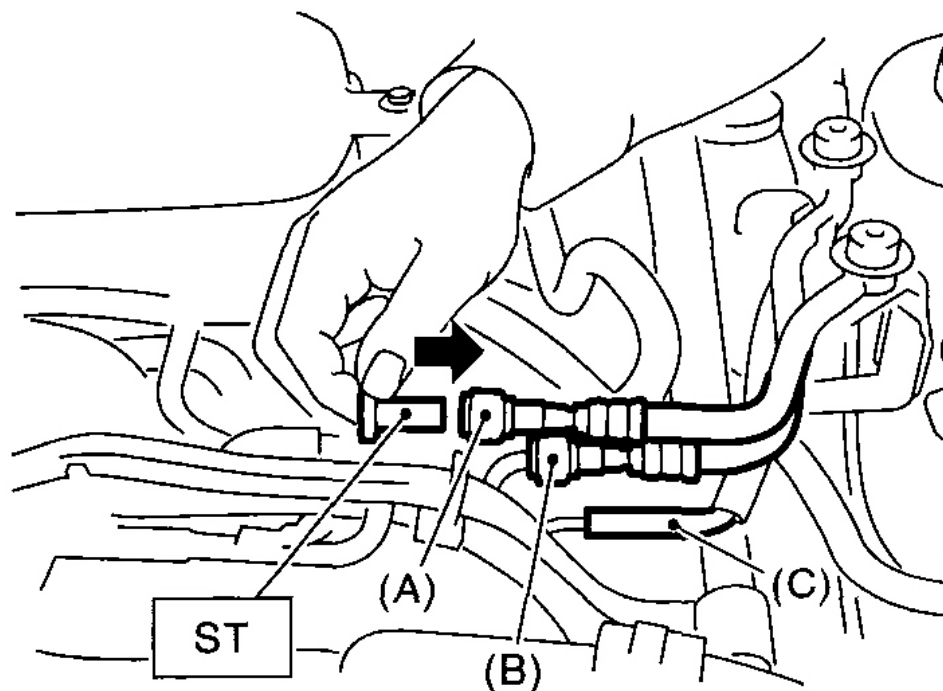
Fig. 75: Removing Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

20. Disconnect the fuel delivery hose (A), return hose (B) and evaporation hose (C). < Ref. to **REMOVAL** , Fuel Delivery, Return and Evaporation Lines. >

CAUTION:

- Catch fuel from the hose into container.
- Disconnect the hose with its end wrapped with cloth to prevent fuel splashing.

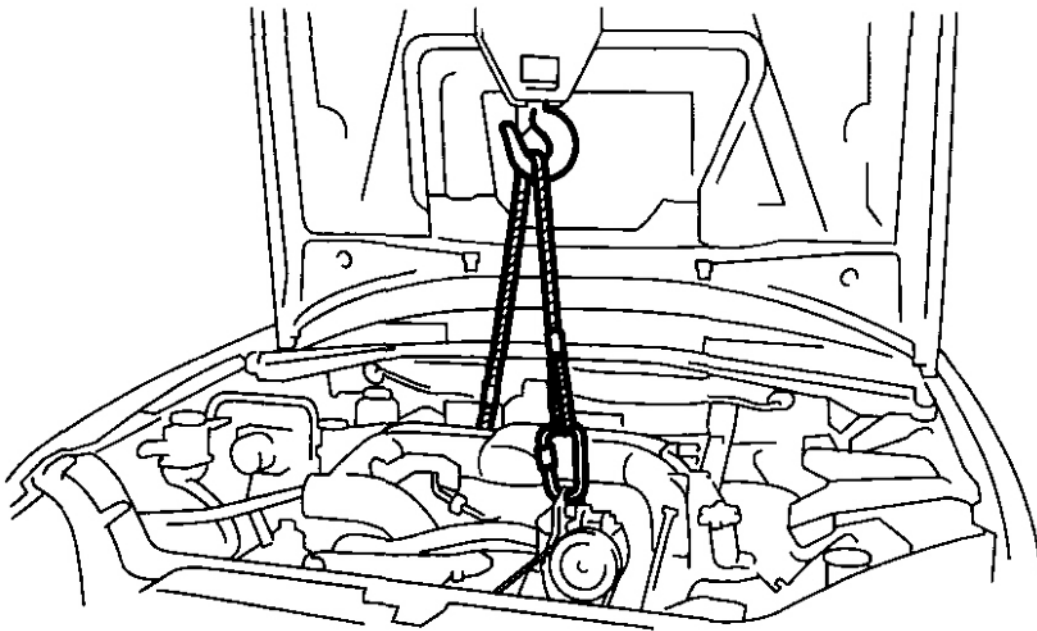
ST 42099AE000 CONNECTOR REMOVER



G03812866

Fig. 76: Disconnecting Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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



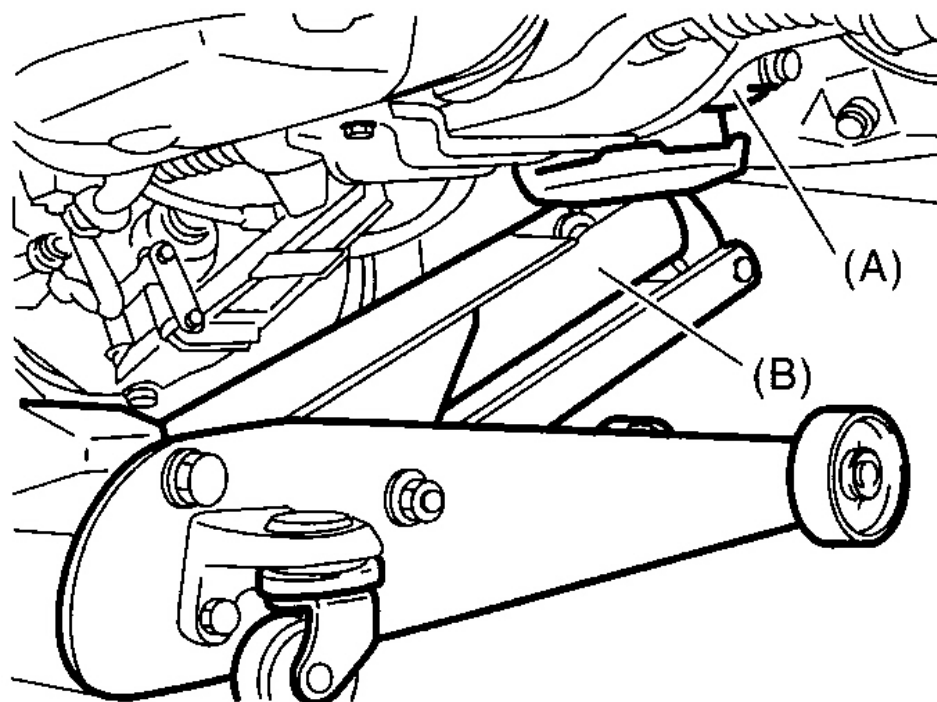
G03812867

Fig. 77: Supporting Engine With A Lifting Devices And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

22. Support the transmission with a garage jack.

CAUTION:

- Doing this is very important because the transmission lowers for weight. This work is also of great importance for facilitating reins



(A) Transmission

(B) Garage jack

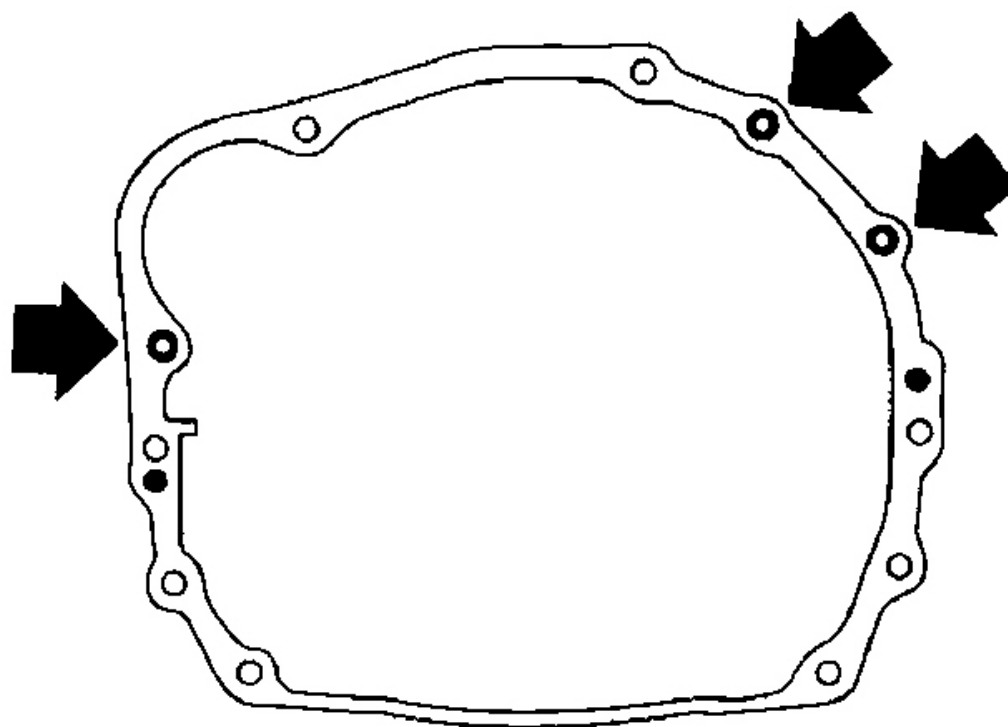
G03812868

Fig. 78: Supporting Transmission With A Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

- Before removing the engine away from transmission, check to be work has been overlooked.

23. Separation of engine and transmission.

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

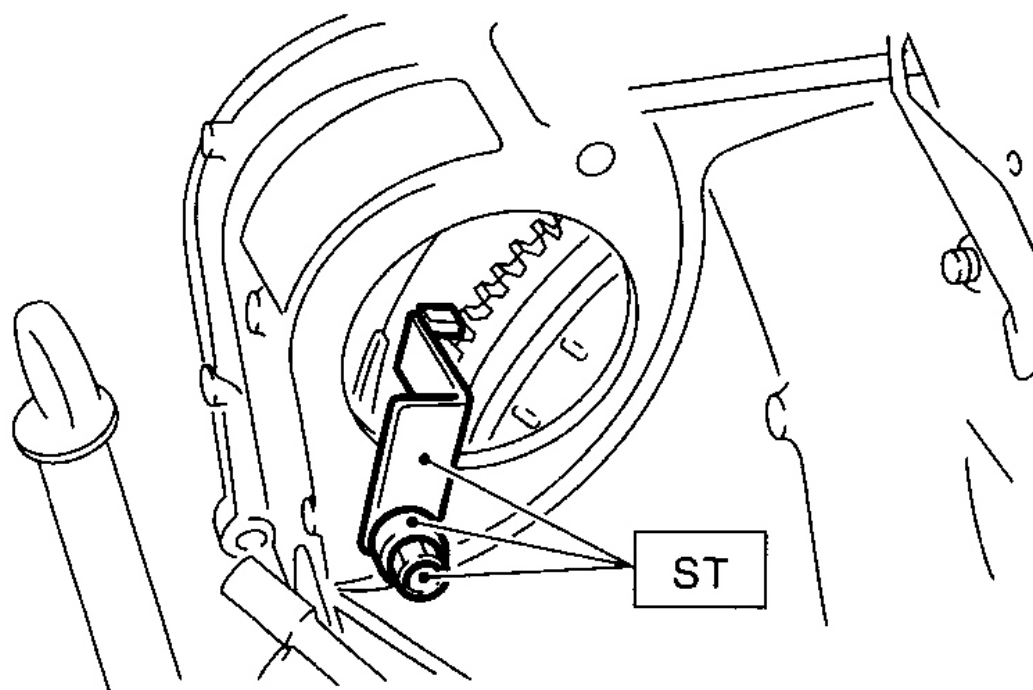


G03812869

Fig. 79: Removing Bolts Which Hold Upper Side Of Transmission To Engine
Courtesy of SUBARU OF AMERICA, INC.

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

ST 498277200 STOPPER SET



G03812870

Fig. 80: Setting Special Tool To Converter Case
Courtesy of SUBARU OF AMERICA, INC.

25. Remove the engine from vehicle.
 - a. Slightly raise the engine.
 - b. Raise the transmission with garage jack.
 - c. Move the engine horizontally until main shaft is withdrawn from clutch cover.
 - d. 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

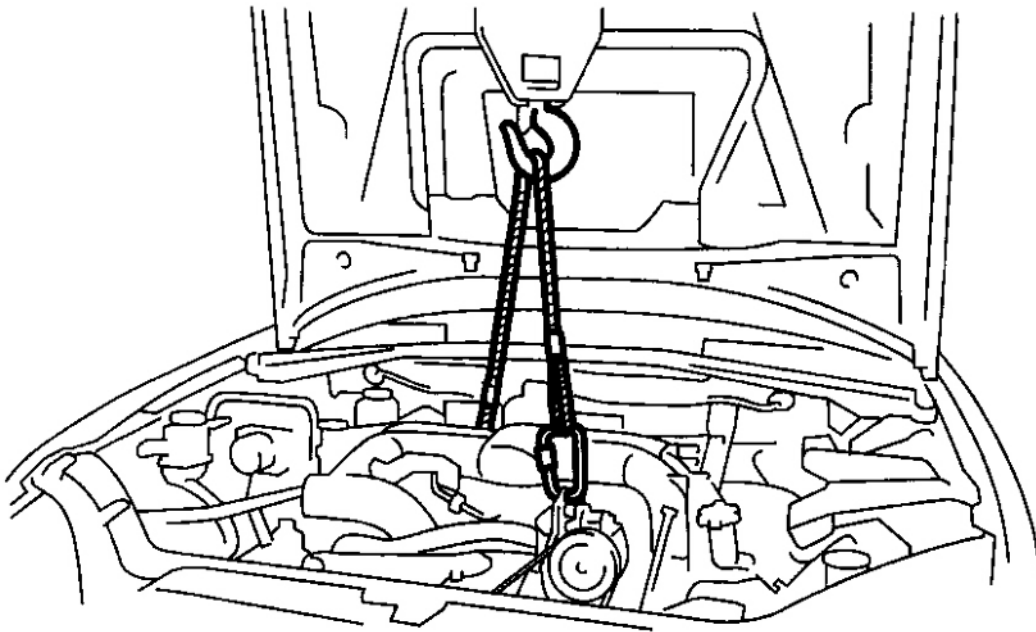
1. Install the front cushion rubbers.

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.



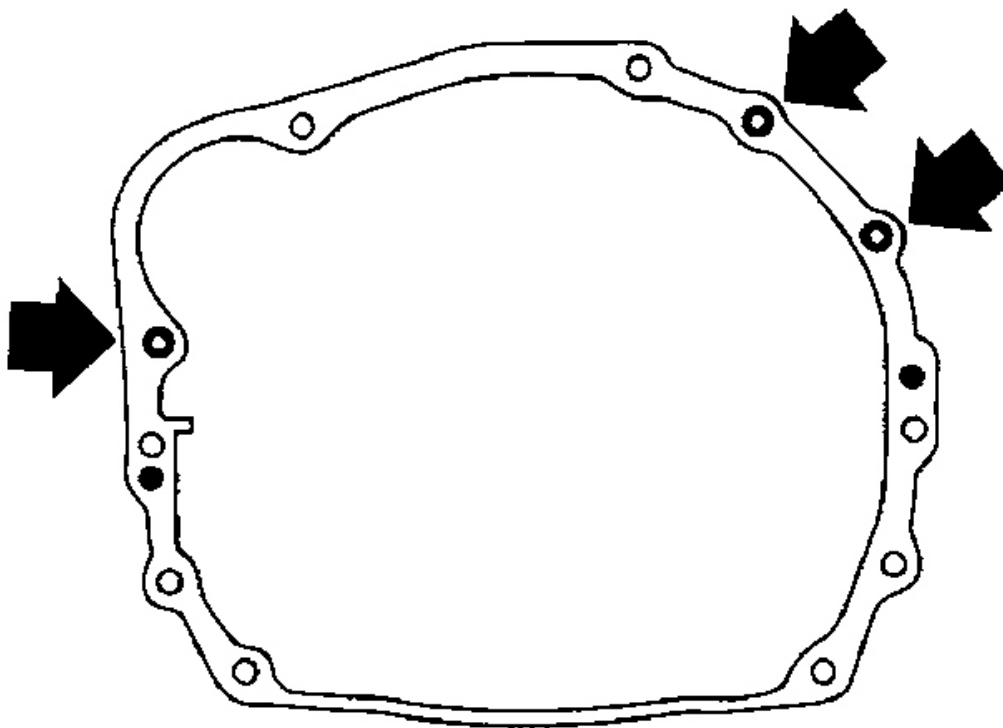
G03812871

Fig. 81: Positioning Engine In Engine Compartment
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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



G03812872

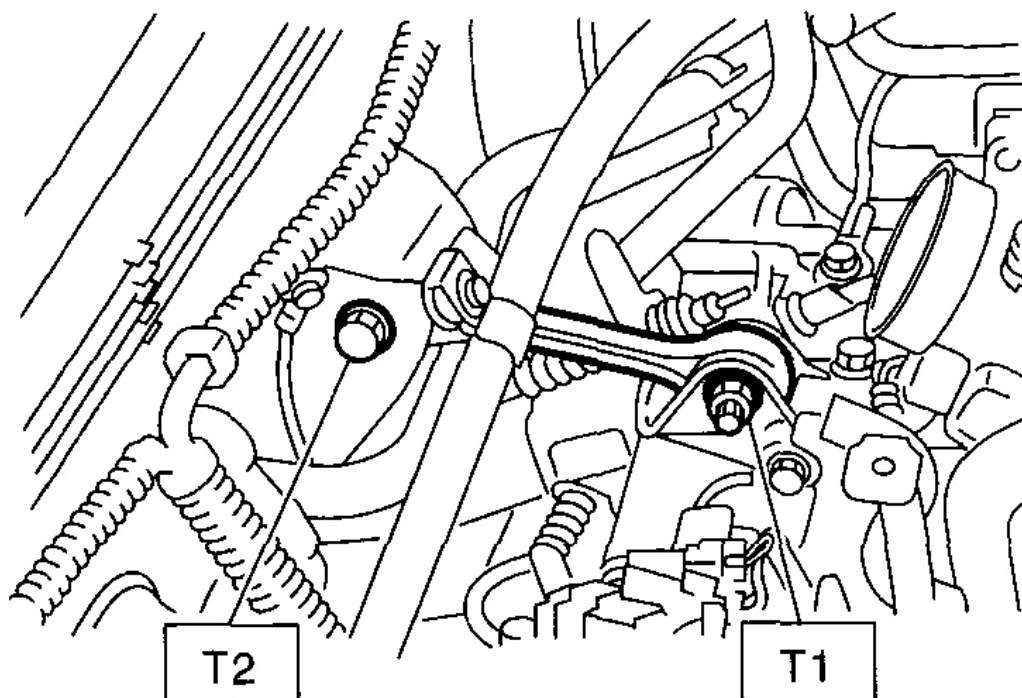
Fig. 82: Tightening Bolts Which Hold Upper Side Of Transmission To Engine
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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



G03812873

Fig. 83: Installing Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

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

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

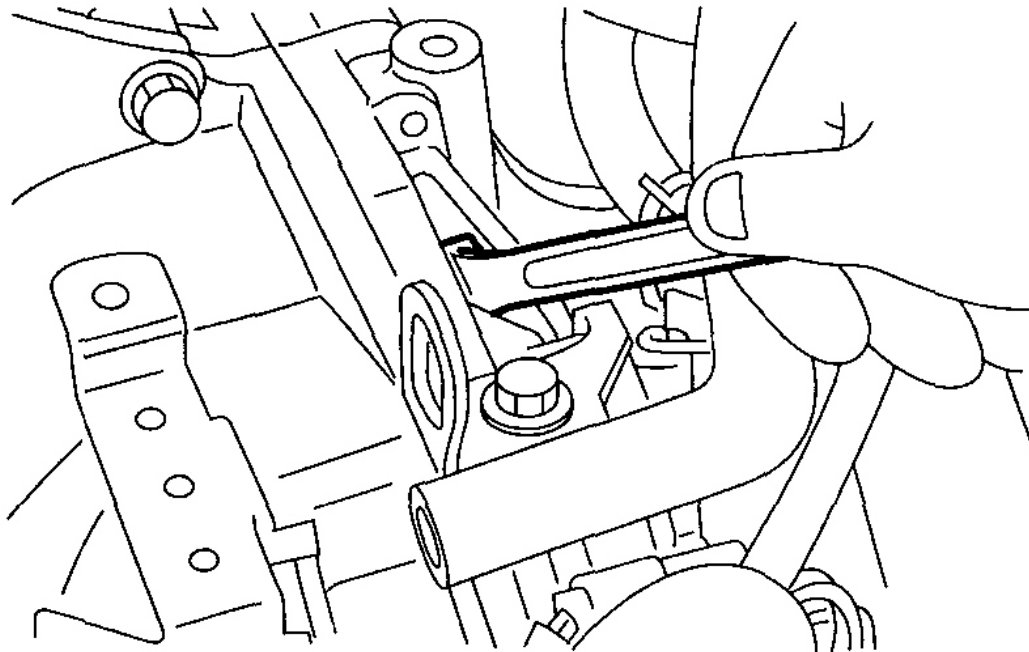
ST 498277200 STOPPER SET

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

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

Tightening torque:

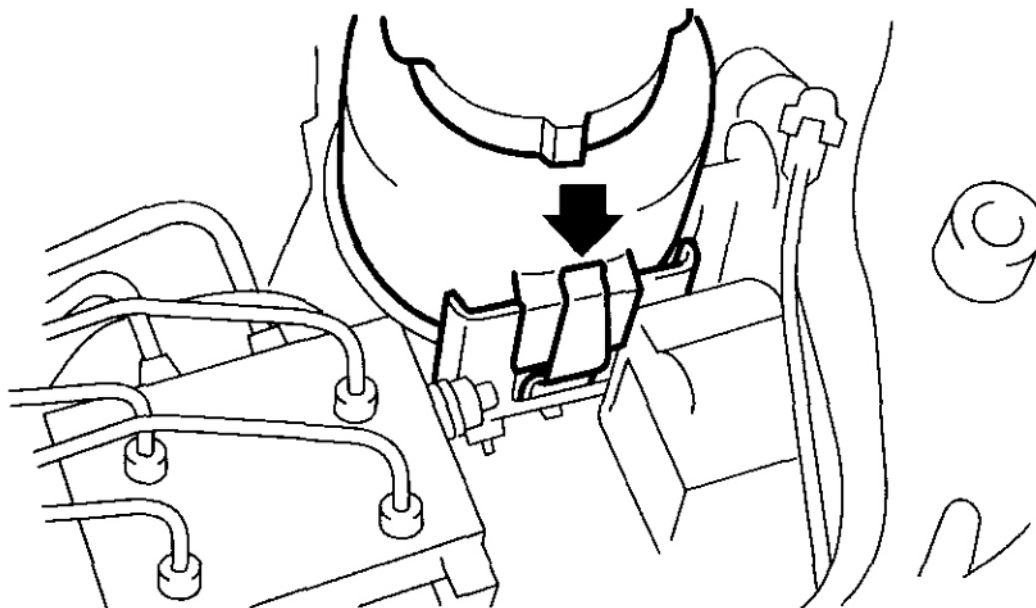
25 N.m (2.5 kgf-m, 18.1 ft-lb)



G03812874

Fig. 84: Installing Torque Converter Clutch To Drive Plate
Courtesy of SUBARU OF AMERICA, INC.

- c. Clog the service hole plug and prevent foreign matters from being mixed.
- 11. Install the power steering pump on bracket.
 - a. Install the power steering tank to bracket.



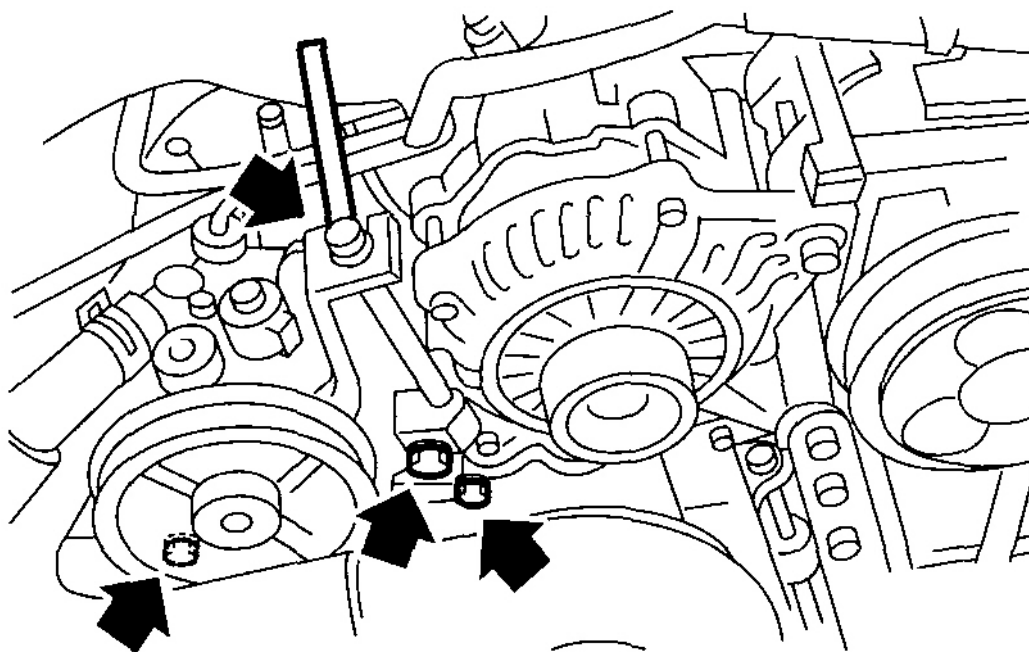
G03812875

Fig. 85: Installing Power Steering Tank To Bracket
Courtesy of SUBARU OF AMERICA, INC.

- b. Install the power steering pump on bracket, and tighten the bolts.

Tightening torque:

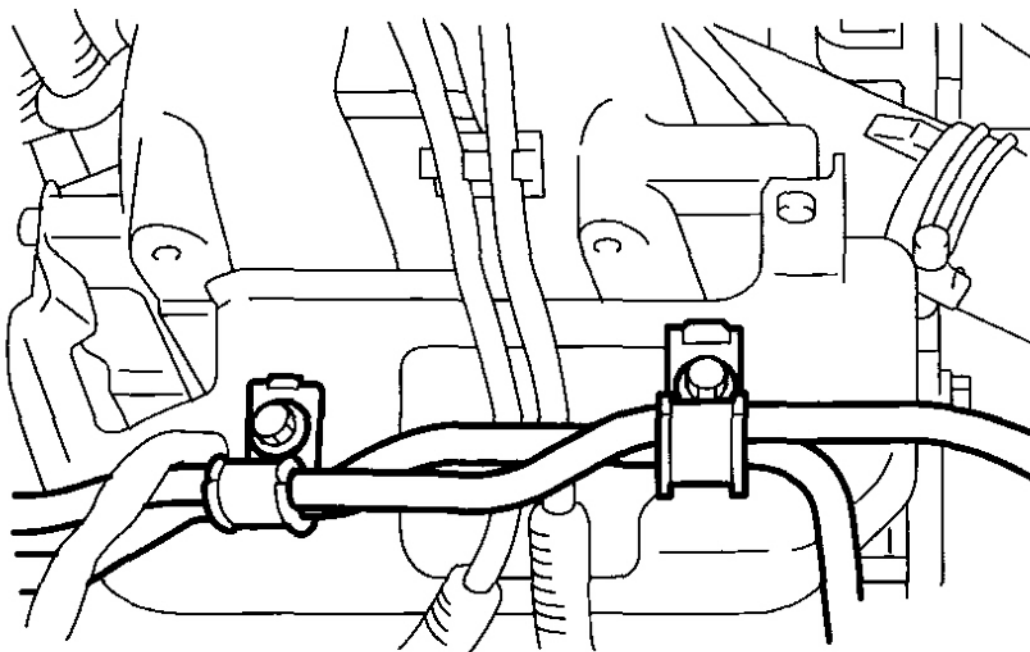
22 N.m (2.2 kgf-m, 16 ft-lb)



G03812876

Fig. 86: Installing Power Steering Pump On Bracket
Courtesy of SUBARU OF AMERICA, INC.

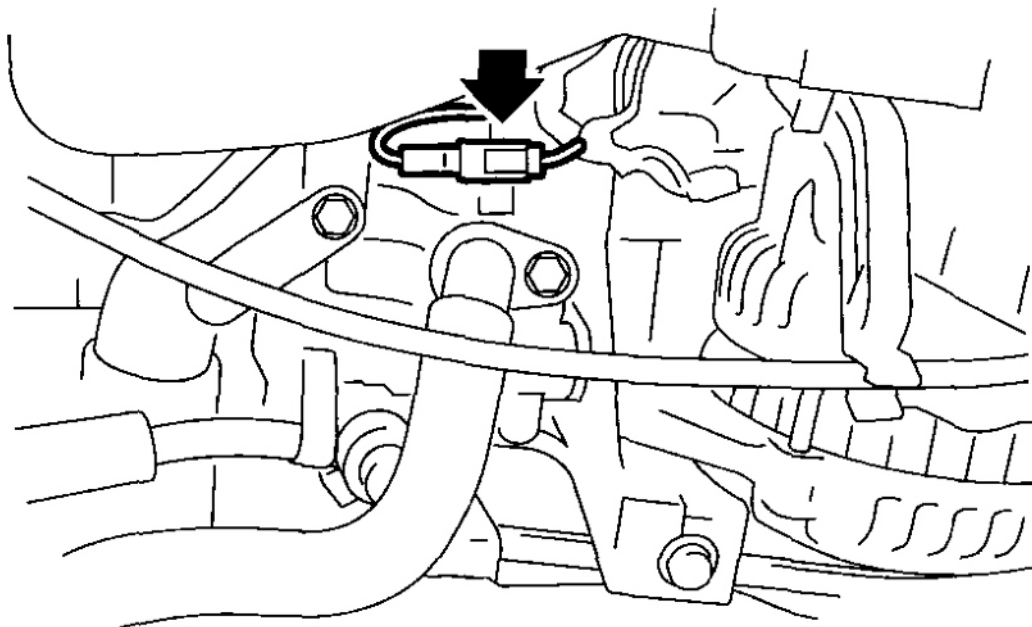
- c. Install the pipe with the bracket.



G03812877

Fig. 87: Installing Pipe With Bracket
Courtesy of SUBARU OF AMERICA, INC.

- d. Connect the power steering switch connector.



G03812878

Fig. 88: Connecting Power Steering Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

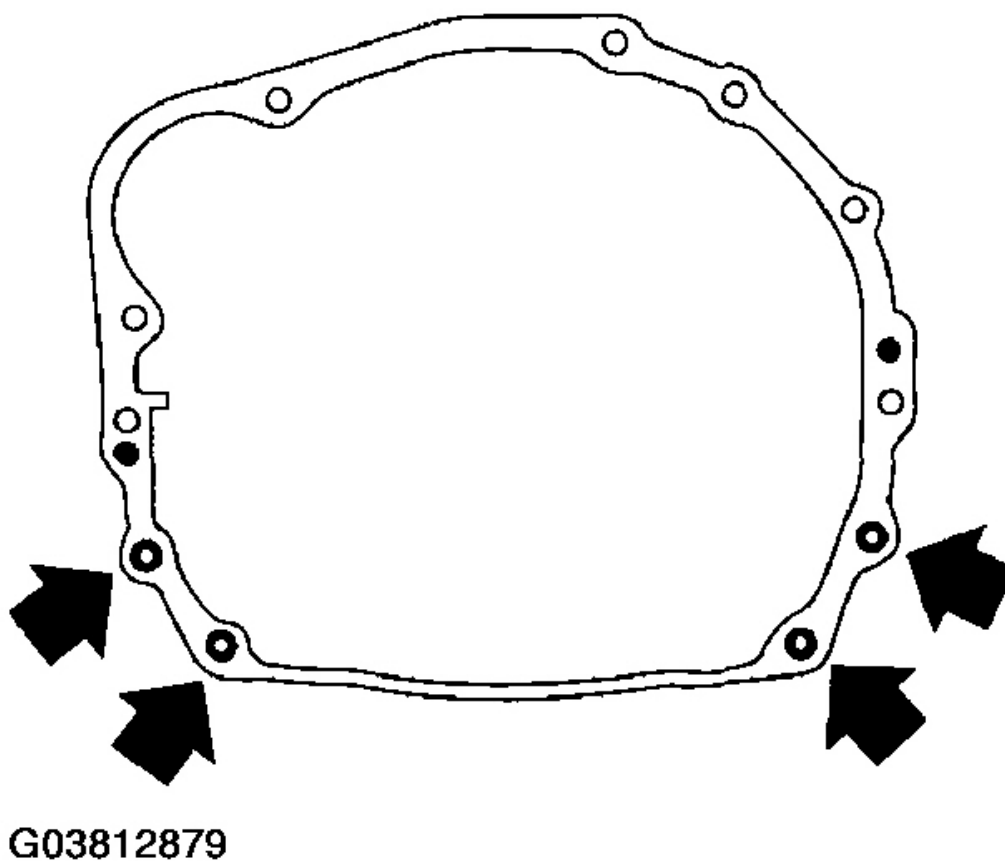


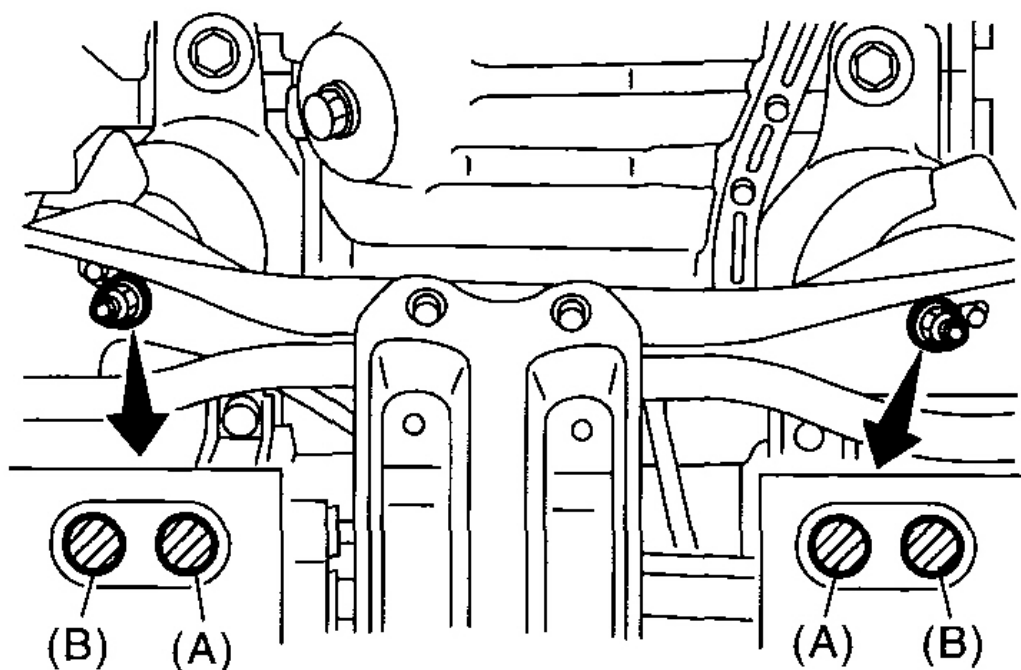
Fig. 89: Tightening Nuts Which Hold Lower Side Of Transmission To Engine
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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.**



G03812880

Fig. 90: Installing Front Cushion Rubber Onto Crossmember
Courtesy of SUBARU OF AMERICA, INC.

15. Install the front and center exhaust pipe. < Ref. to **INSTALLATION** , Front Exhaust Pipe. >
16. Lower the vehicle.
17. Connect the following hoses:
 - a. Fuel delivery hose, return hose and evaporation hose
 - b. Heater inlet and outlet hoses
 - c. Brake booster vacuum hose
18. Connect the following connectors:
 - a. Front oxygen (A/F) sensor connector
 - b. Rear oxygen sensor connector
 - c. Engine ground cable

Tightening torque:

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

- d. Engine harness connectors

- e. Generator connector and terminal
 - f. 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. Install the A/C pressure hoses. < Ref. to **INSTALLATION** , Hose and Tube. >
21. Install the radiator to vehicle. < Ref. to **INSTALLATION** , Radiator. >
22. 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. >
23. Install the under cover.
24. Install the battery in the vehicle, and connect cables.
25. Fill engine coolant. < Ref. to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant. >
26. Check the ATF level and replenish it if necessary. < Ref. to **INSPECTION** , Automatic Transmission Fluid. >
27. Charge the A/C system with refrigerant. < Ref. to **PROCEDURE** , Refrigerant Charging Procedure. >
28. Remove the front hood stay, and close the front hood.
29. Take off the vehicle from a lift.

INSPECTION

- 1. Check pipes, hoses, connectors and clamps are installed firmly.
- 2. Check that the engine coolant and ATF are at specified levels.
- 3. Start the engine, and make sure that no leaks of exhaust gas, engine coolant and fuel, noise and vibrations.

ENGINE MOUNTING**REMOVAL**

- 1. Remove the engine assembly. < 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

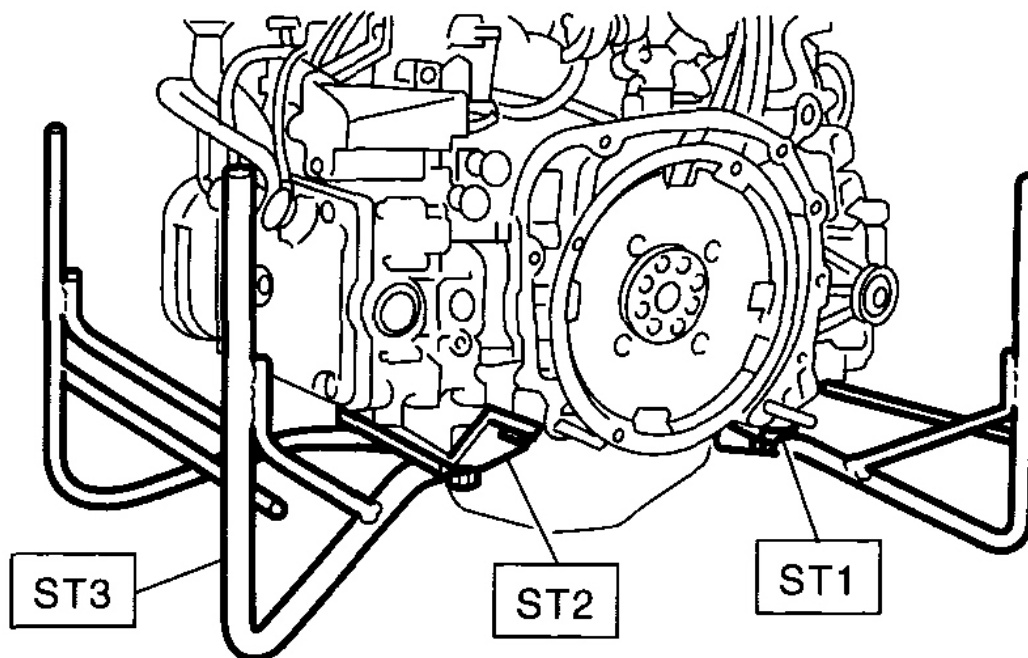
PROCEDURE

1. After removing the engine from the body, secure it in the ST as shown in **Fig. 91**.

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 499817100 ENGINE STAND



G03812881

Fig. 91: Securing Engine Assembly In Special Tool
Courtesy of SUBARU OF AMERICA, INC.

2. In this section the procedures described under each index are all connected and stated in order. The

procedure for overhauling of the engine will be completed when you go through all steps in the process.

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

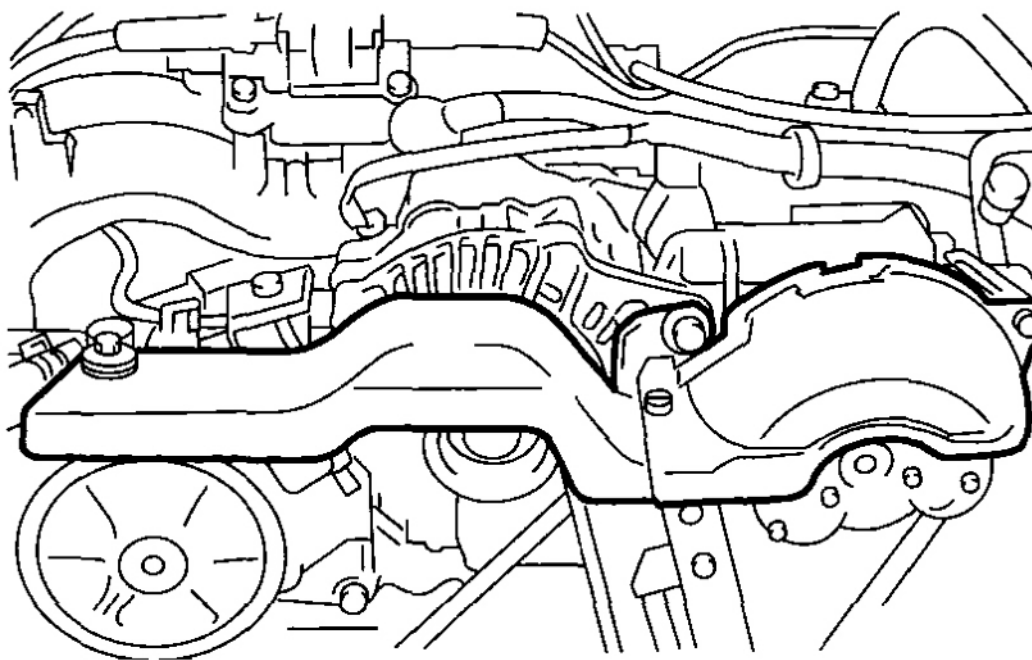
V-BELT

REMOVAL

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

FRONT SIDE BELT

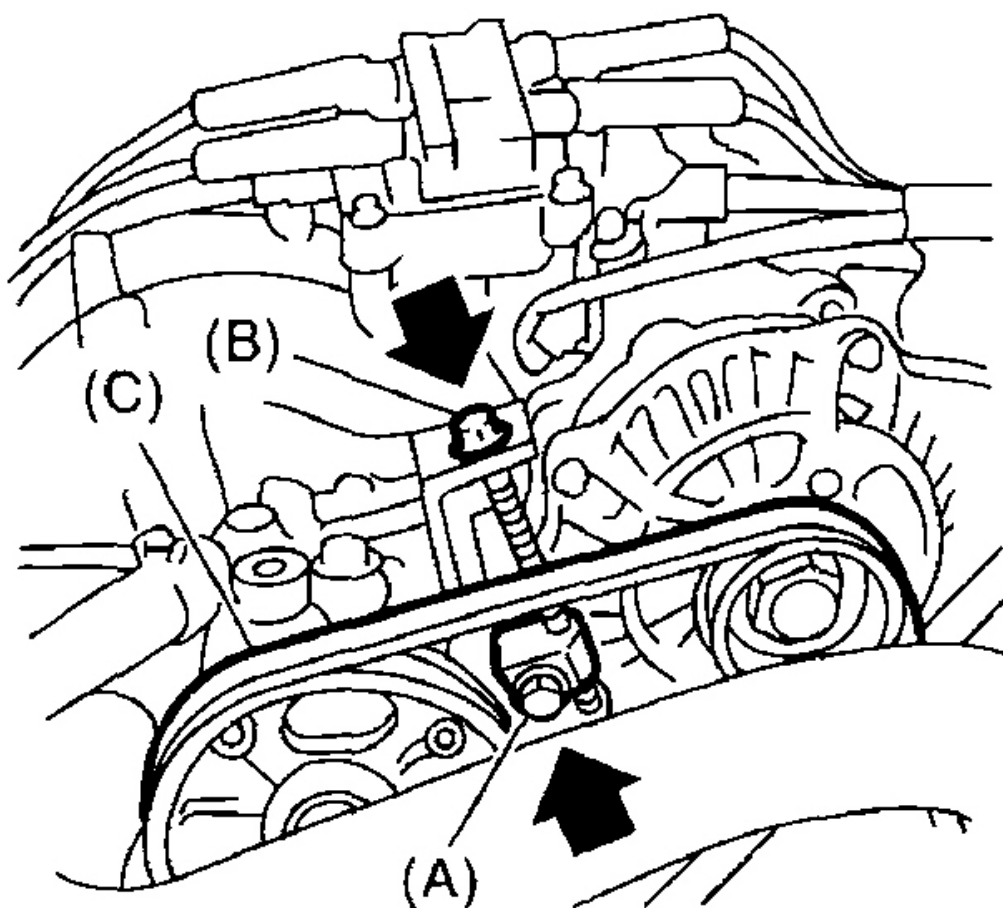
1. Remove the V-belt covers.



G03812882

Fig. 92: Removing V-Belt Covers
Courtesy of SUBARU OF AMERICA, INC.

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



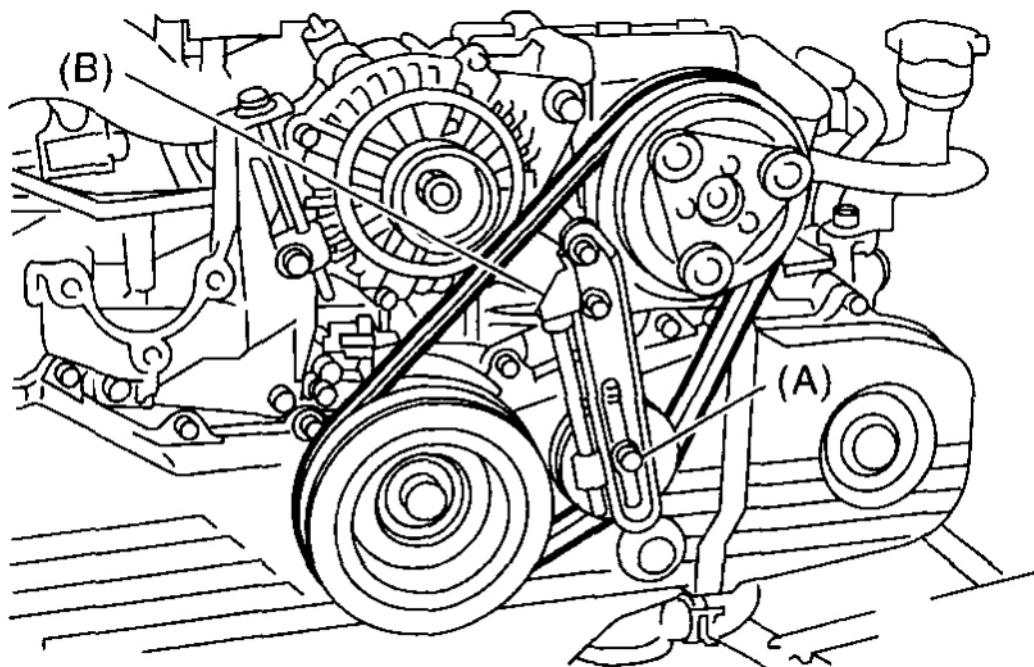
G03812883

Fig. 93: Removing Front Side Belt
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the front side belt (C).

REAR SIDE BELT

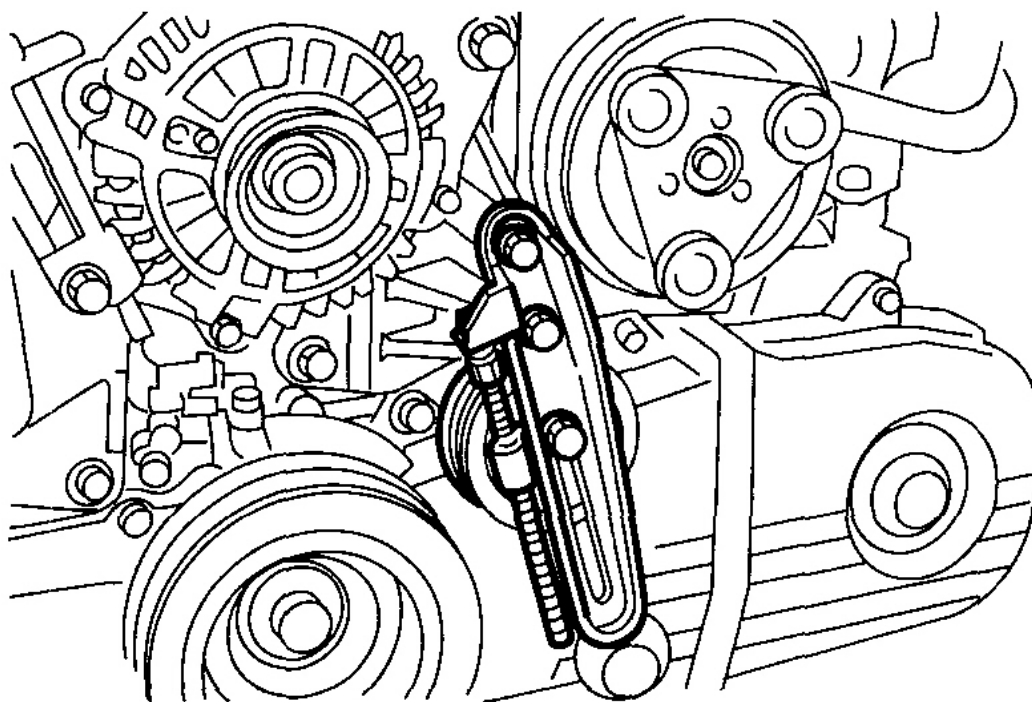
1. Loosen the lock nut (A).
2. Loosen the slider bolt (B).



G03812884

Fig. 94: Removing Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

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



G03812885

Fig. 95: Removing Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

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

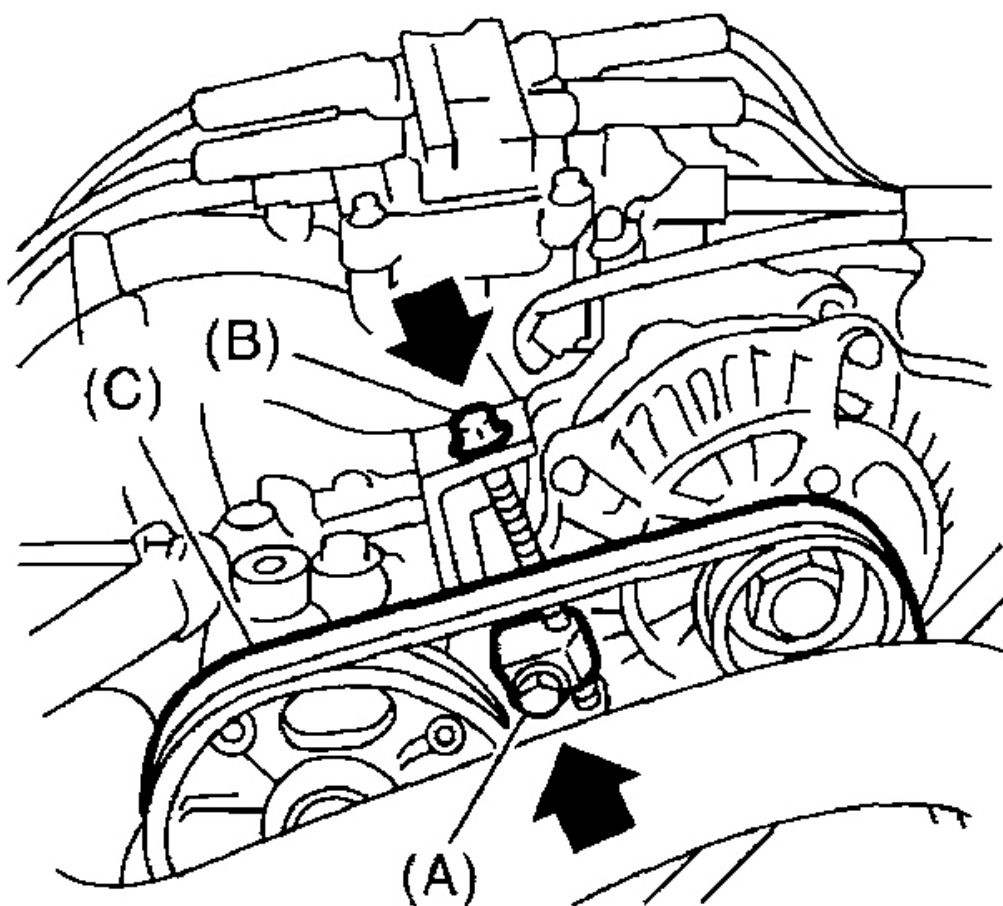
FRONT SIDE BELT

1. Install 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)



G03812886

Fig. 96: Installing Front Side Belt
Courtesy of SUBARU OF AMERICA, INC.

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.

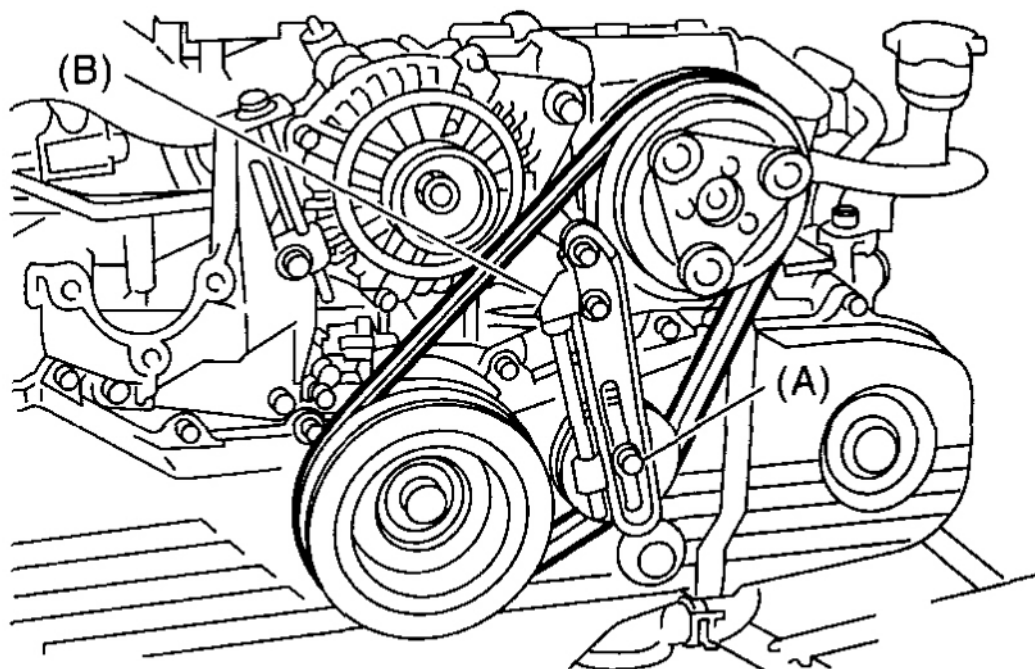
< Ref. to , **INSPECTION**, V-belt. >

3. Tighten the lock nut (A).

Tightening torque:

Lock nut (A):

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



G03812887

Fig. 97: Installing V Belt
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Replace the belts, if cracks, 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:

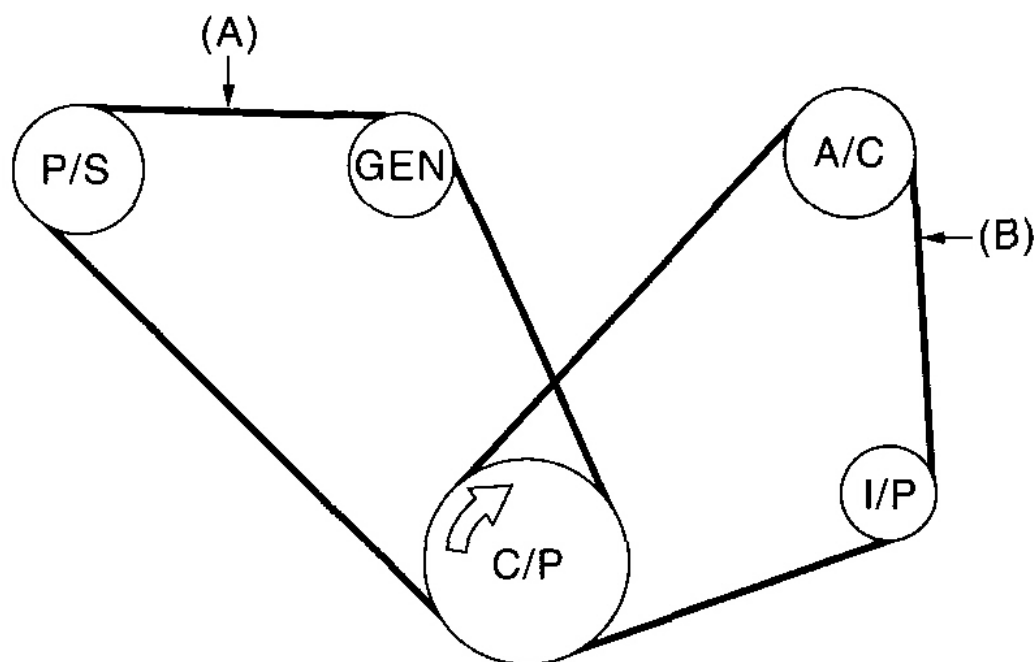
490 --640 N (50.0-65.3 kgf, 110.2-- 143.9 lb)

(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

G03812888

Fig. 98: Checking V-Belt Tension (With Belt Tension Gauge)

Courtesy of SUBARU OF AMERICA, INC.

Belt tension (without belt tension gauge)

(A)

When installing new parts:

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

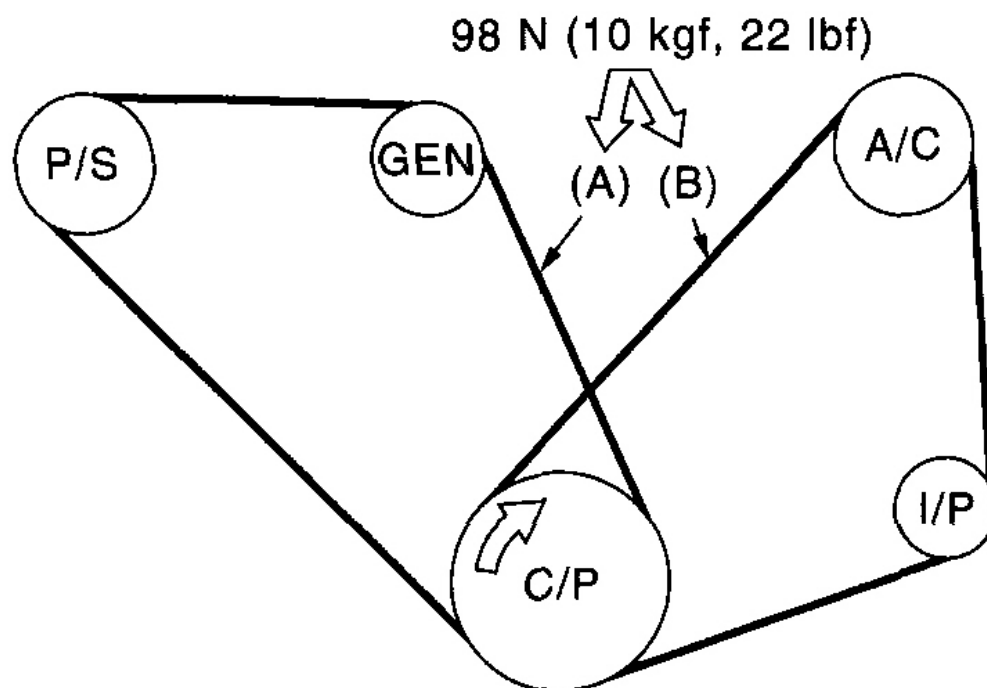
9-11 mm (0.354 - 0.433 in)

(B)

When installing new parts:

7.5 - 8.5 mm (0.295 - 0.335 in) At inspection:

9.0-- 10.0 mm (0.354 - 0.394 in)



(A) Front side belt

(B) Rear side belt

C/P Crank pulley

GEN Generator

P/S Power steering oil pump pulley

A/C Air conditioning compressor pulley

I/P Idler pulley

G03812889

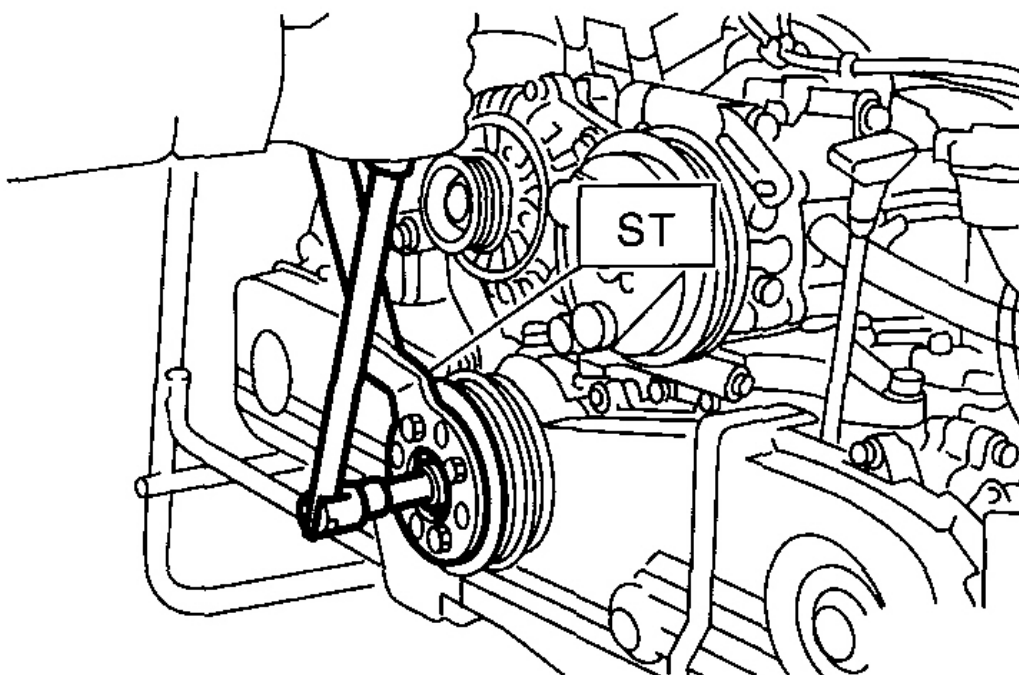
Fig. 99: Checking V-Belt Tension (Without Belt Tension Gauge)
Courtesy of SUBARU OF AMERICA, INC.

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



G03812890

Fig. 100: Removing Crank Pulley Bolt Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION

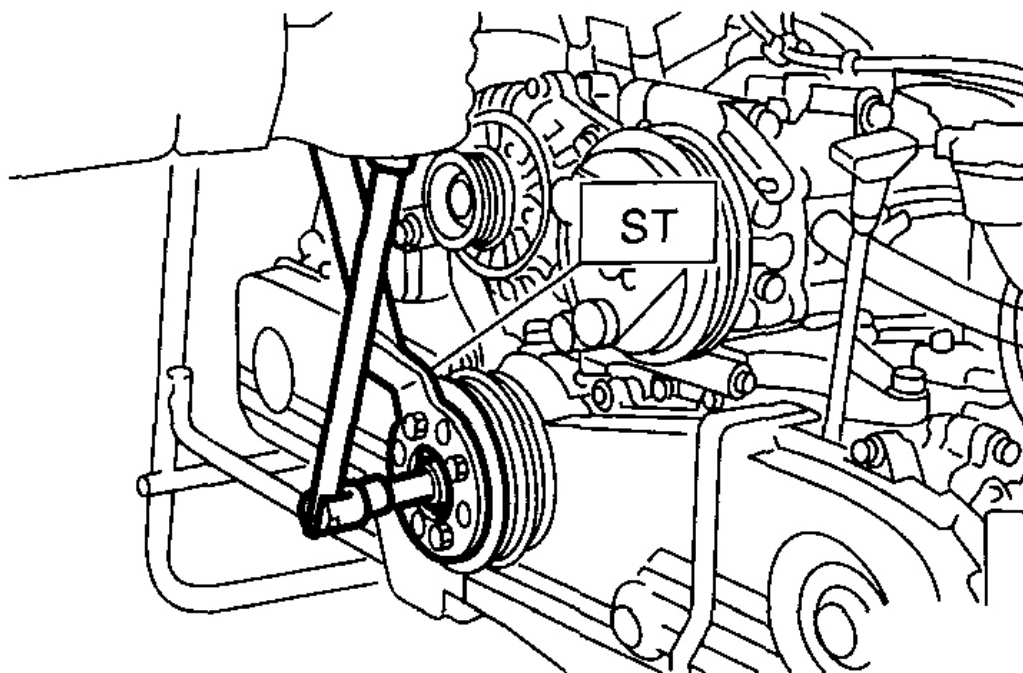
1. Install the crank pulley.
2. Install the pulley bolt.

To lock the crankshaft, use ST.

ST 499977100 CRANK PULLEY WRENCH

- a. Clean the crankshaft thread using compressed air.

- b. Apply engine oil to the crank pulley bolt seat and thread.
- c. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 33 ft-lb).
- d. Tighten the crank pulley bolts.

Tightening torque:**180 N.m (18.4 kgf-m, 132.8 ft-lb)****G03812891****Fig. 101: Installing Crank Pulley****Courtesy of SUBARU OF AMERICA, INC.**

- 3. Confirm that the tightening angle of crank pulley bolt is 65 degrees or more. If the tightening angle of crank pulley bolt is less than 65 degrees, conduct the following procedures.
 - a. Replace the crank pulley bolts and clean them.

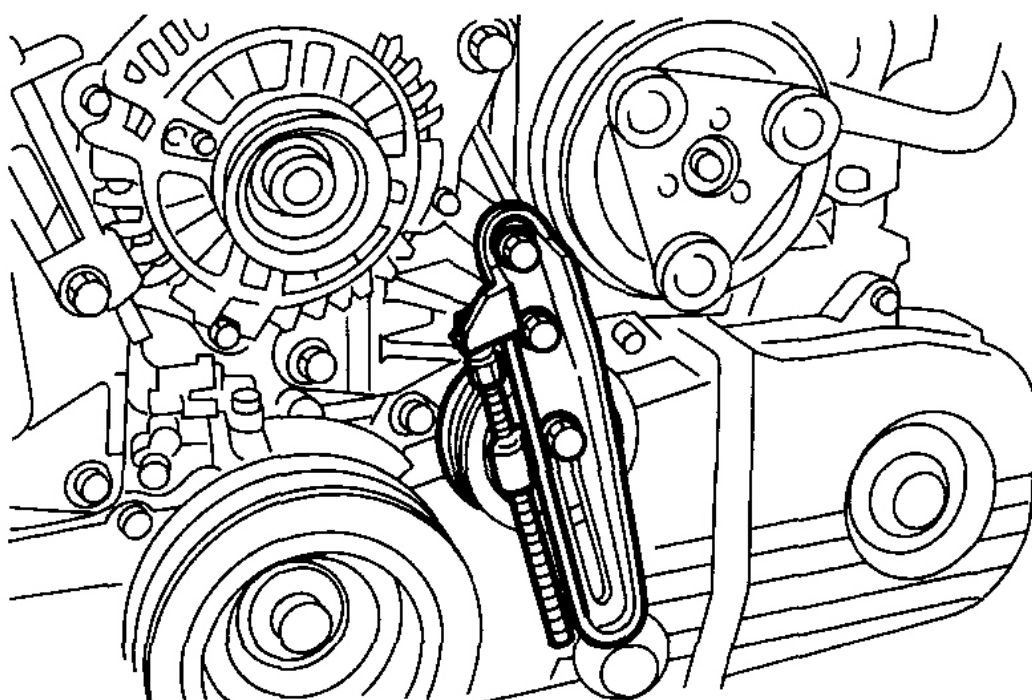
Crank pulley bolt: 12369AA011

- b. Clean the crankshaft thread using compressed air.
- c. Apply engine oil to the crank pulley bolt seal and thread.

- d. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 33 ft-lb).
- e. Tighten the crank pulley bolts keeping them in an angle between 65 degrees and 75 degrees.

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.



G03812892

Fig. 102: Installing Belt Tensioner
Courtesy of SUBARU OF AMERICA, INC.

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

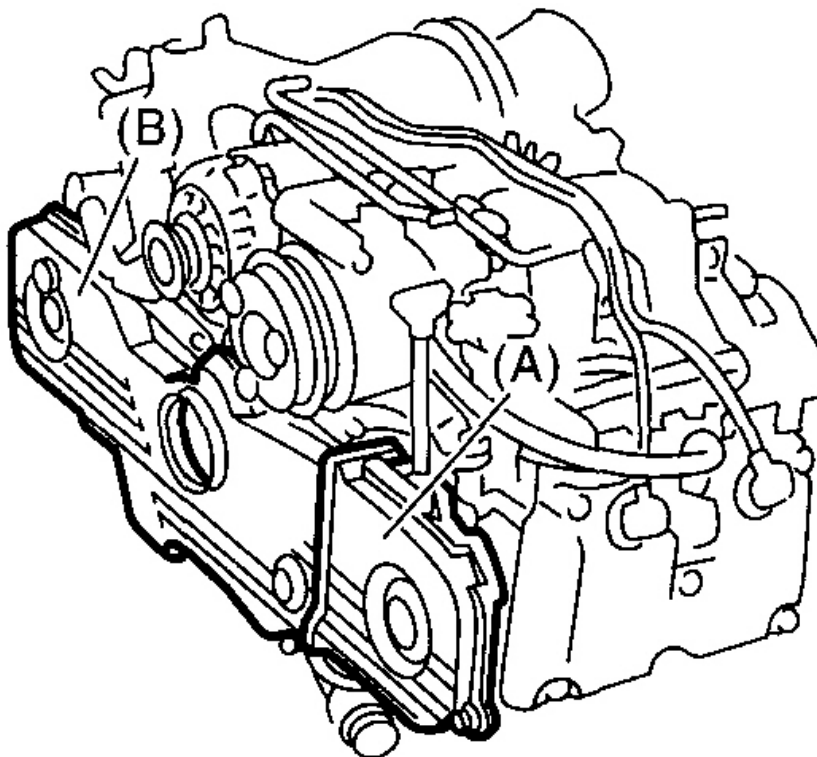
INSPECTION

- 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.



(A) Timing belt cover (LH)

(B) Front timing belt cover

G03812893

Fig. 103: Removing Timing Belt Cover
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the front timing belt cover.

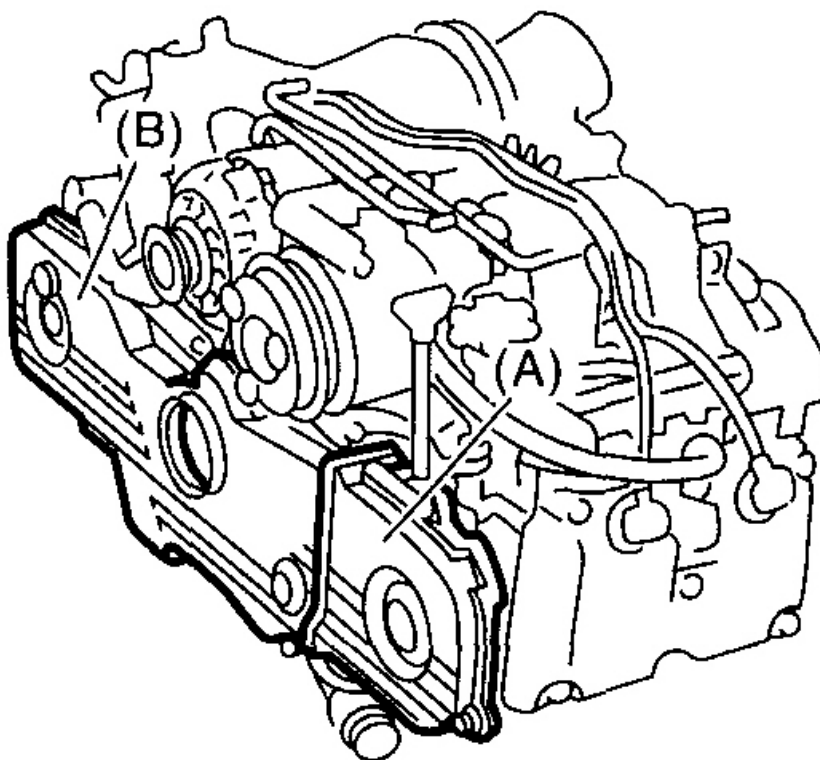
Tightening torque:

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

2. Install the timing belt cover (LH).

Tightening torque:

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



(A) Timing belt cover (LH)

(B) Front timing belt cover

G03812894

Fig. 104: Installing Timing Belt Cover (LH)

Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

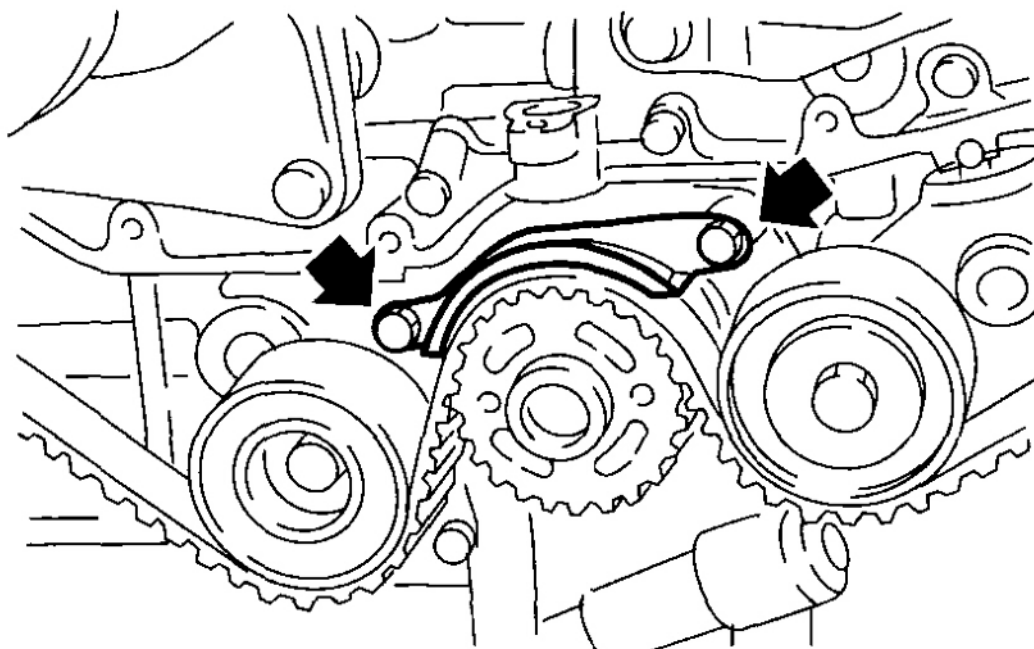
Check the cover for damage.

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)

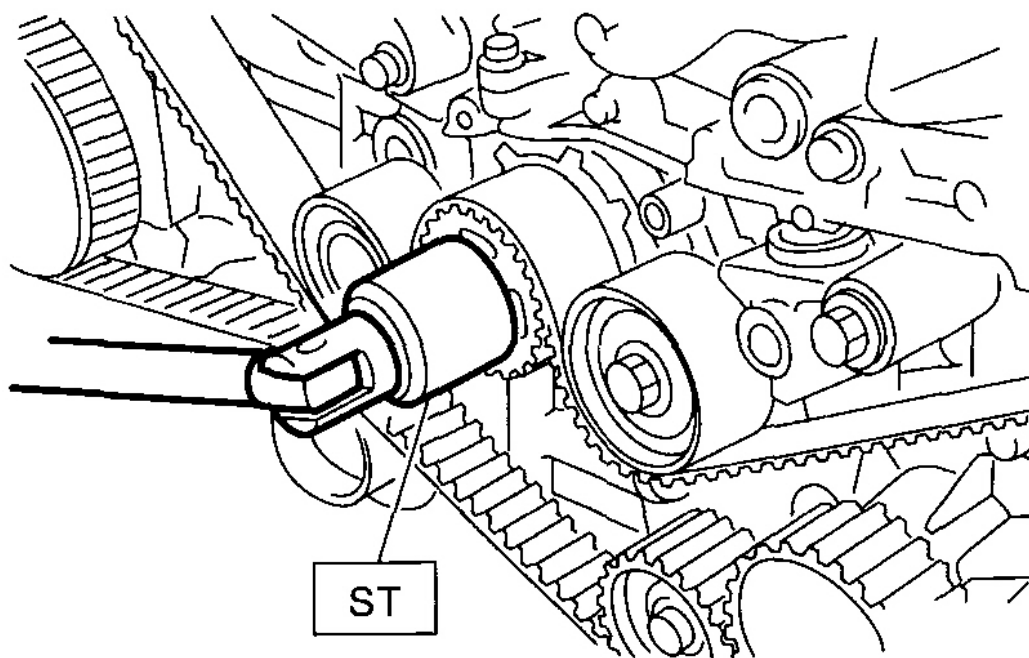


G03812895

Fig. 105: Removing Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

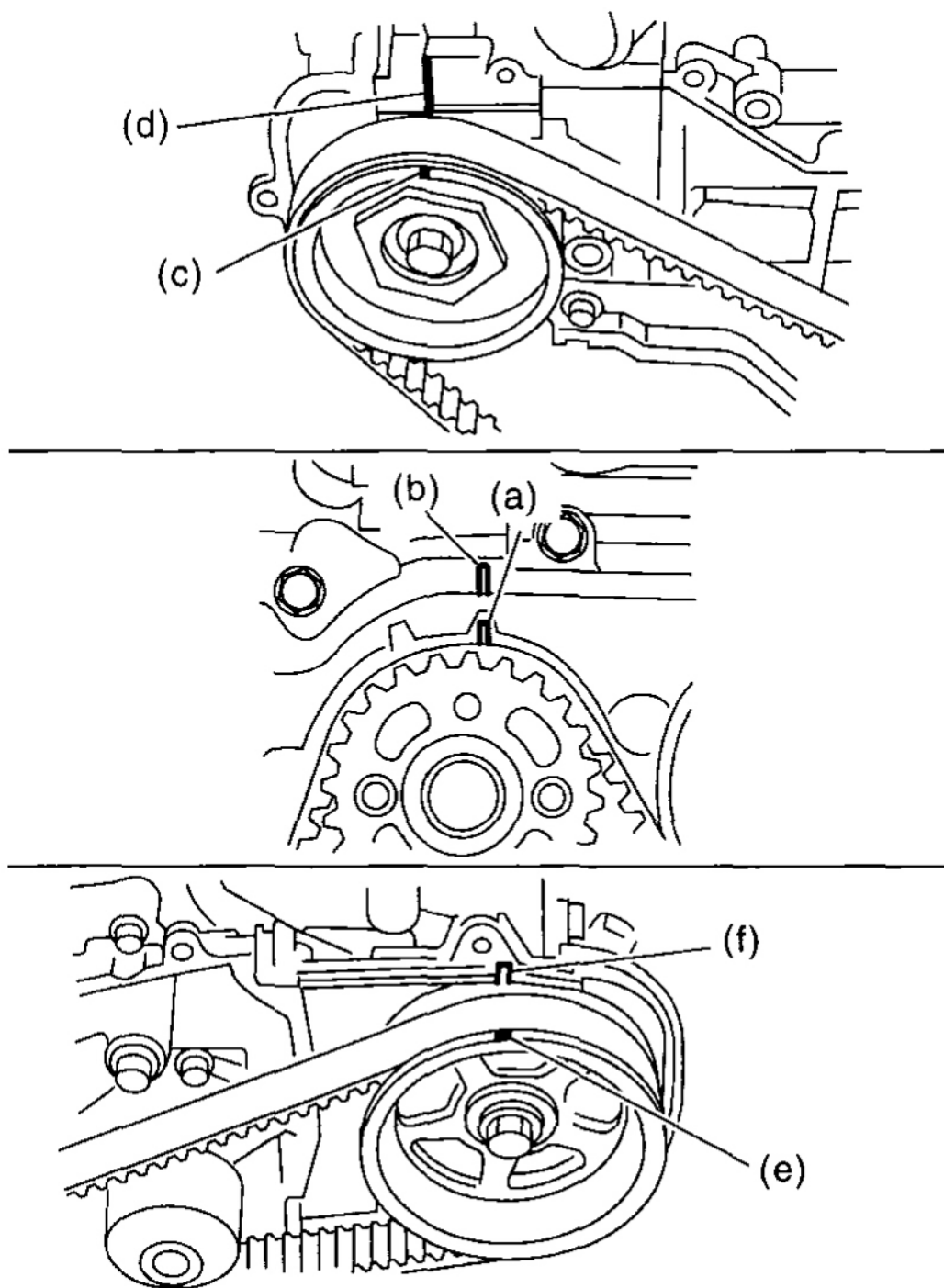
5. If the alignment mark or arrow mark (which indicates rotation direction) on timing belt fade away, put new marks before removing the timing belt as shown in **Fig. 106**.
 - a. To turn crankshaft, use the ST: Align the mark (a) of sprocket to the cylinder block notch (b), and then ensure the right 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



G03812896

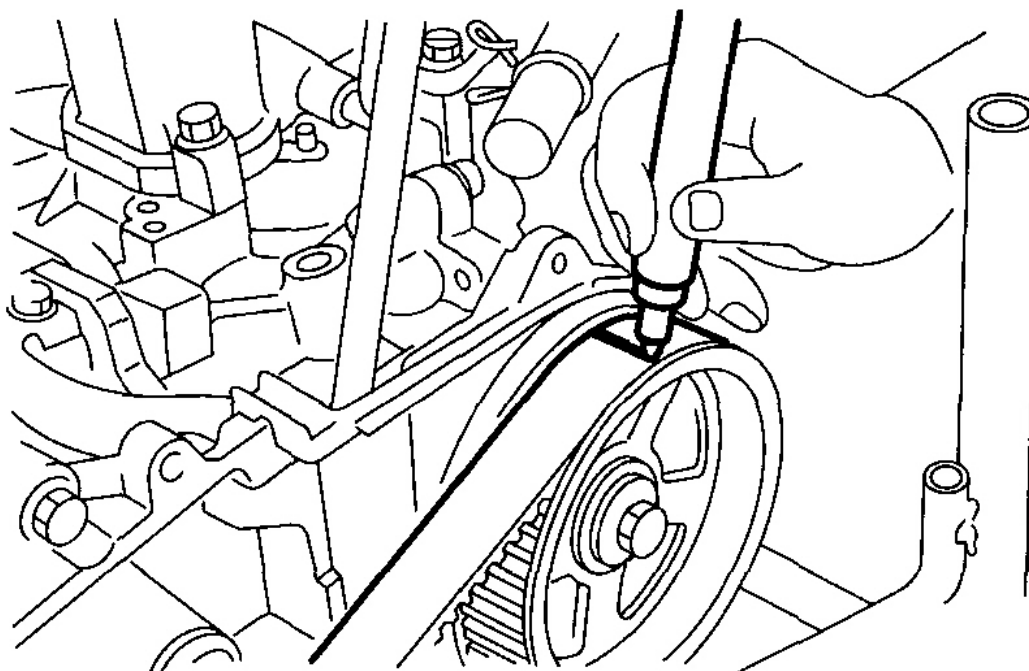
Fig. 106: Aligning Mark (A) Of Sprocket To Cylinder Block Using Special Tool (1 Of 2)
Courtesy of SUBARU OF AMERICA, INC.



G03812897

Fig. 107: Aligning Mark (A) Of Sprocket To Cylinder Block Using Special Tool (2 Of 2)
 Courtesy of SUBARU OF AMERICA, INC.

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



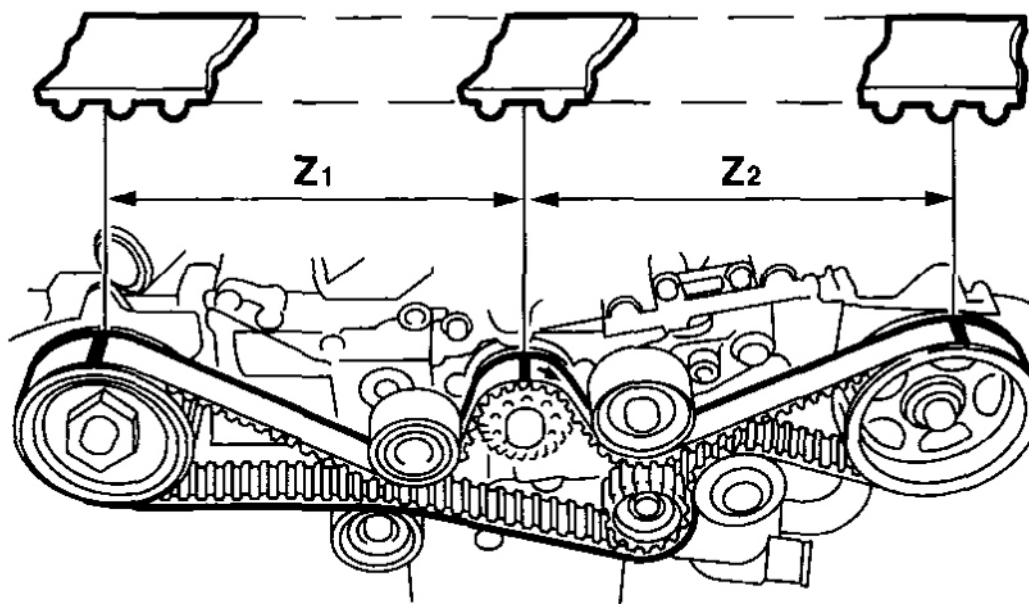
G03812898

Fig. 108: Putting Alignment Marks Or Arrow Marks On Timing Belts
Courtesy of SUBARU OF AMERICA, INC.

Specified data:

Z_1 : Length of 46.8 teeth

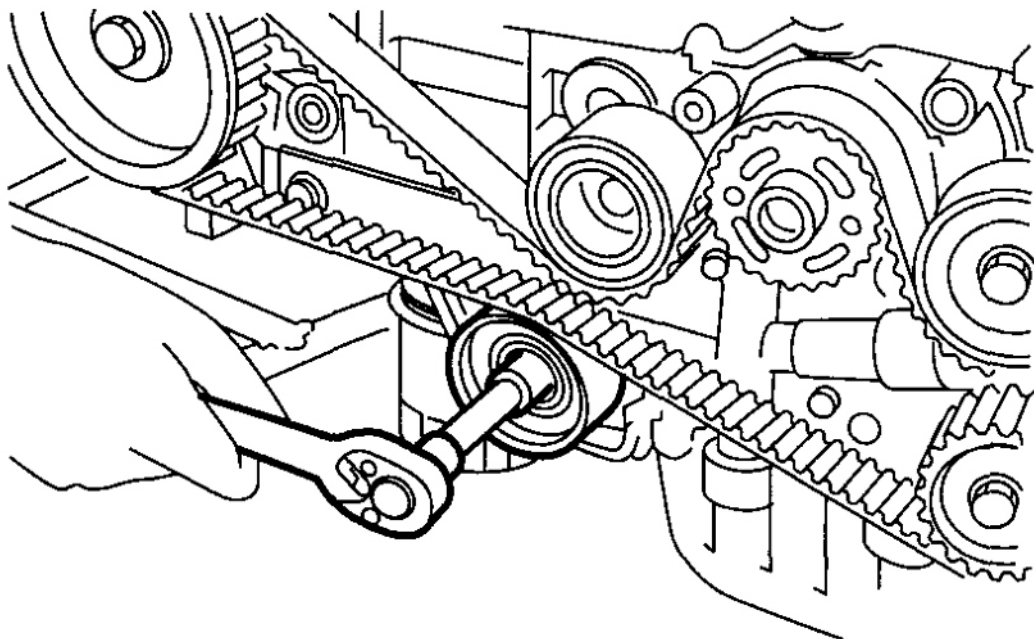
Z_2 : Length of 43.7 teeth



G03812899

Fig. 109: Identifying Length Of Teeth
Courtesy of SUBARU OF AMERICA, INC.

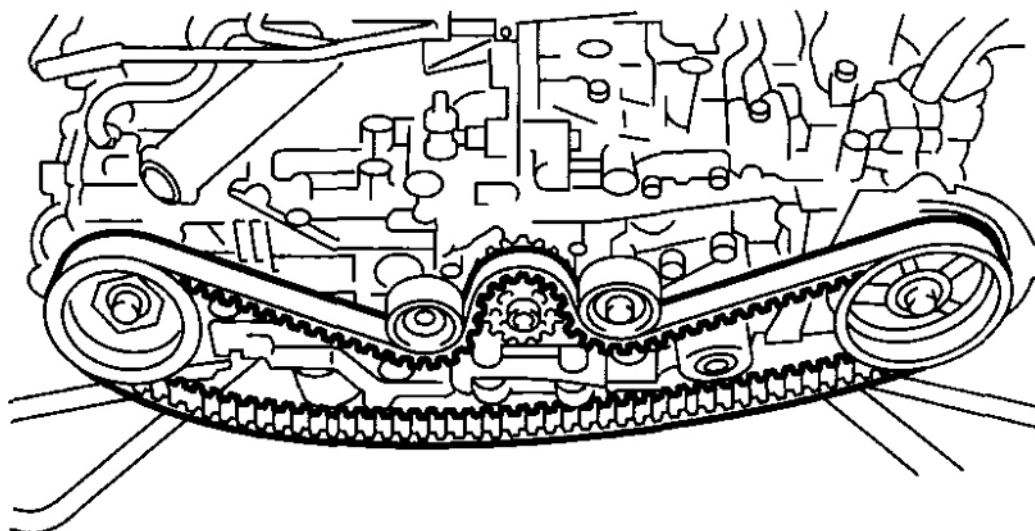
6. Remove the belt idler (No. 2).
7. Remove the belt idler No. 2.



G03812900

Fig. 110: Removing Belt Idler No. 2
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt.

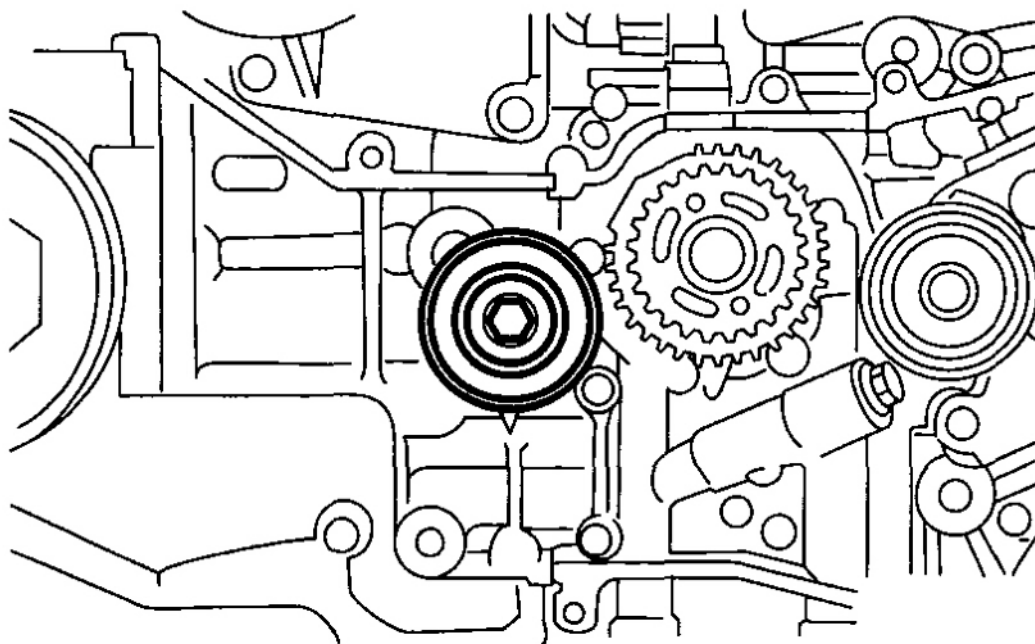


G03812901

Fig. 111: Removing Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY

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

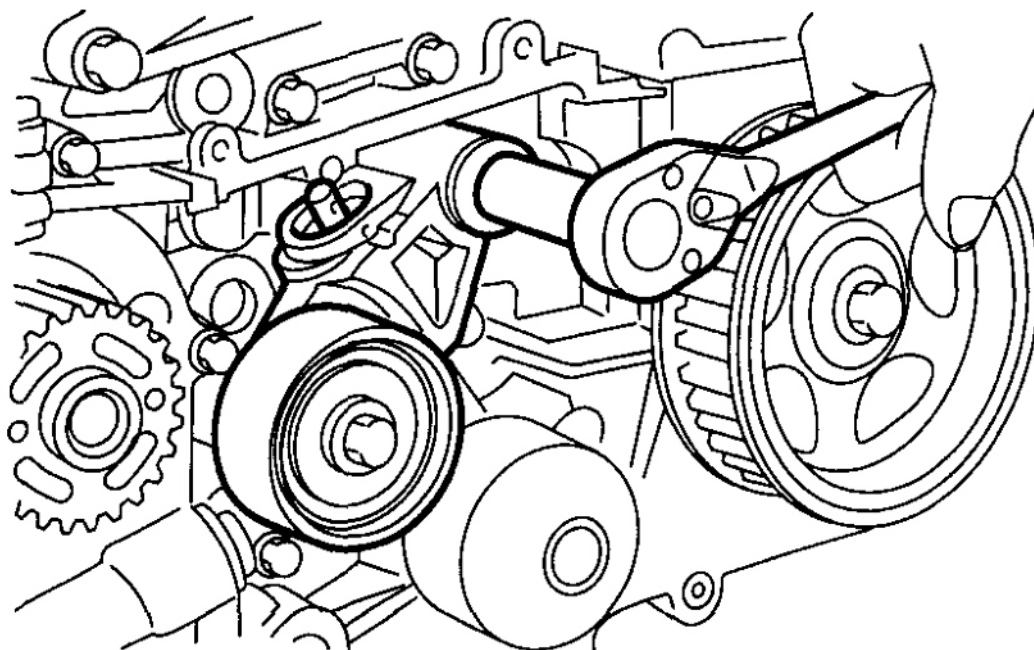


G03812902

Fig. 112: Removing Belt Idler (No. 1)

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the automatic belt tension adjuster assembly.



G03812903

Fig. 113: Removing Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

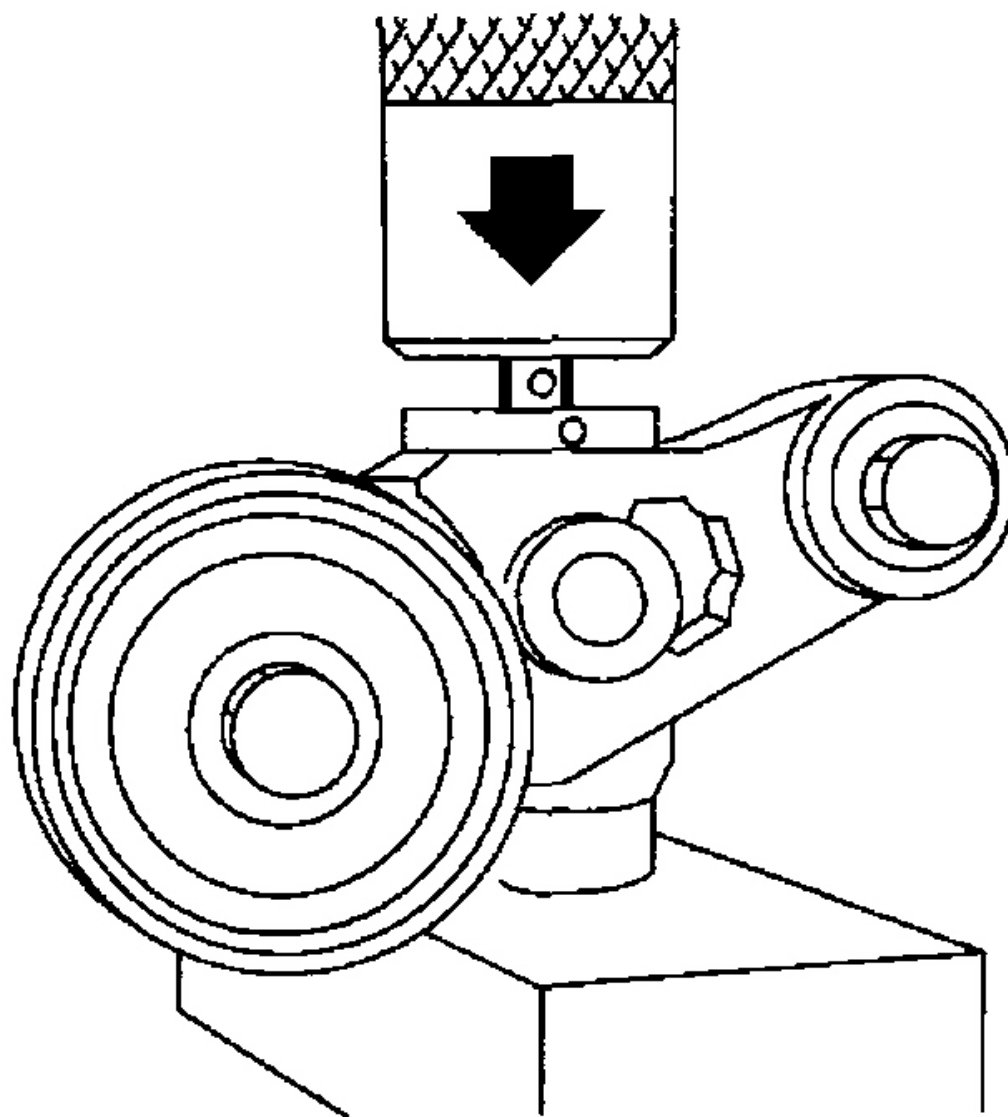
1. Preparation for installation of automatic belt tension adjuster assembly.

CAUTION:

- Always use a vertical type pressing tool to move the adjuster rod down.
- Do not use a lateral type vise.
- Push the adjuster rod vertically.
- Be sure to move the adjuster rod down slowly applying a pressure of 294 N (30 kgf, 66 lb).
- 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.

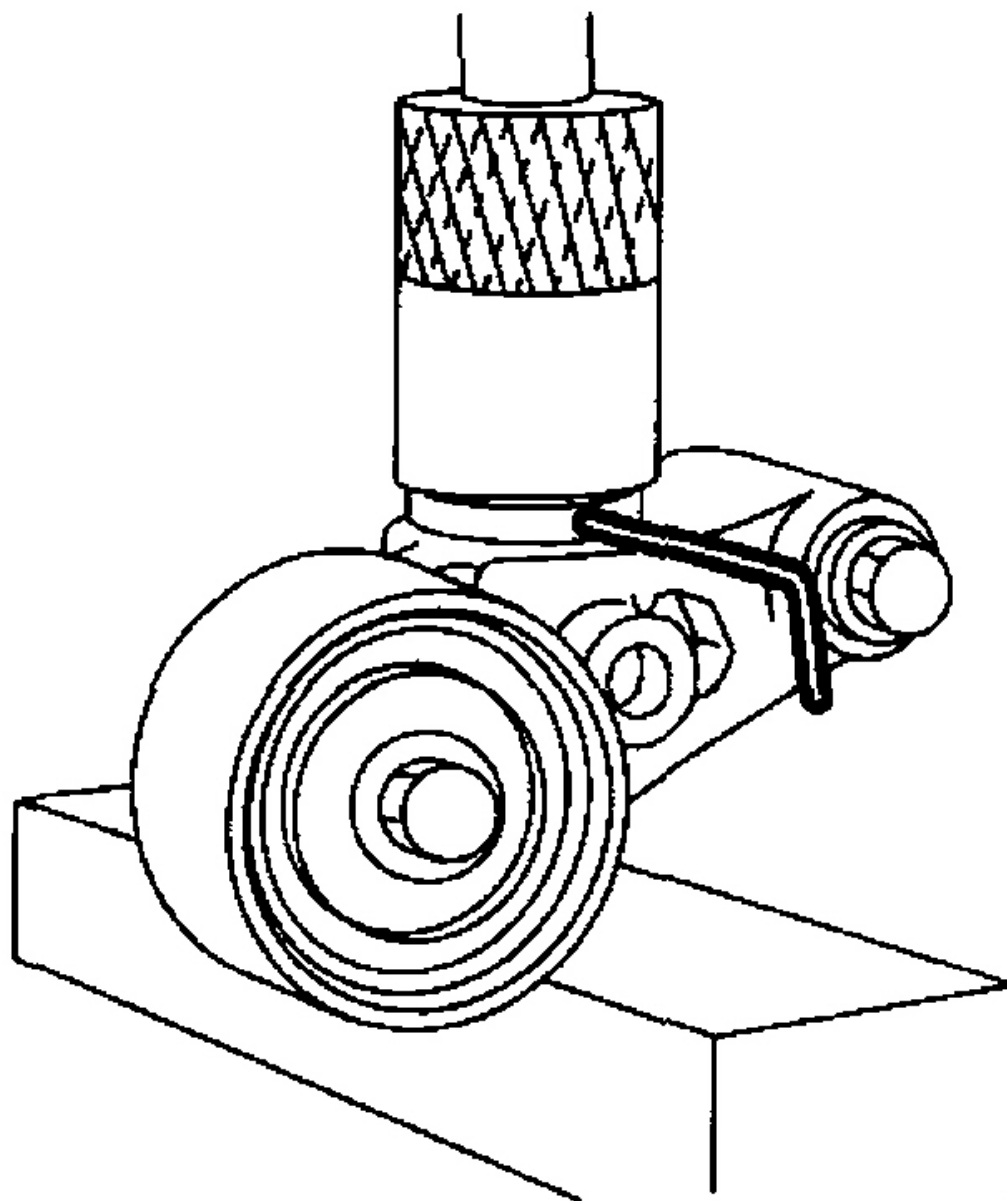
- **Do not release the press pressure until stopper pin is completely inserted.**
- a. Attach the automatic belt tension adjuster assembly to the vertical pressing tool.
 - b. Slowly move the adjuster rod down with a pressure of more than 294 N (30 kgf, 66 lb) until the adjuster rod is aligned with the stopper pin hole in the cylinder.



G03812904

Fig. 114: Attaching Automatic Belt Tension (1 Of 2)
Courtesy of SUBARU OF AMERICA, INC.

- c. 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.



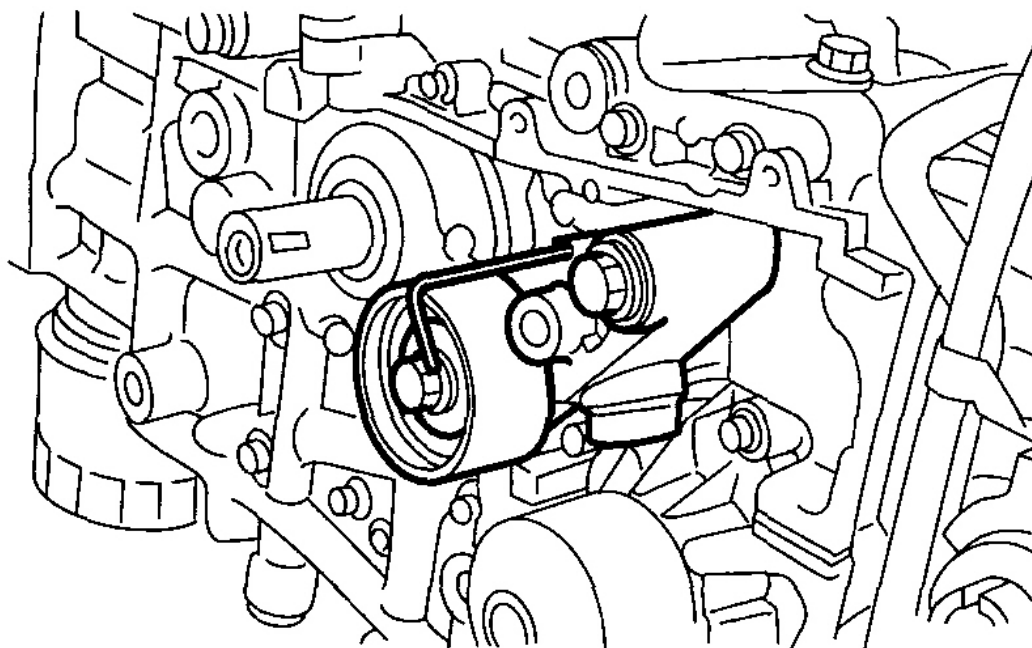
G03812905

Fig. 115: Attaching Automatic Belt Tension (2 Of 2)
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

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



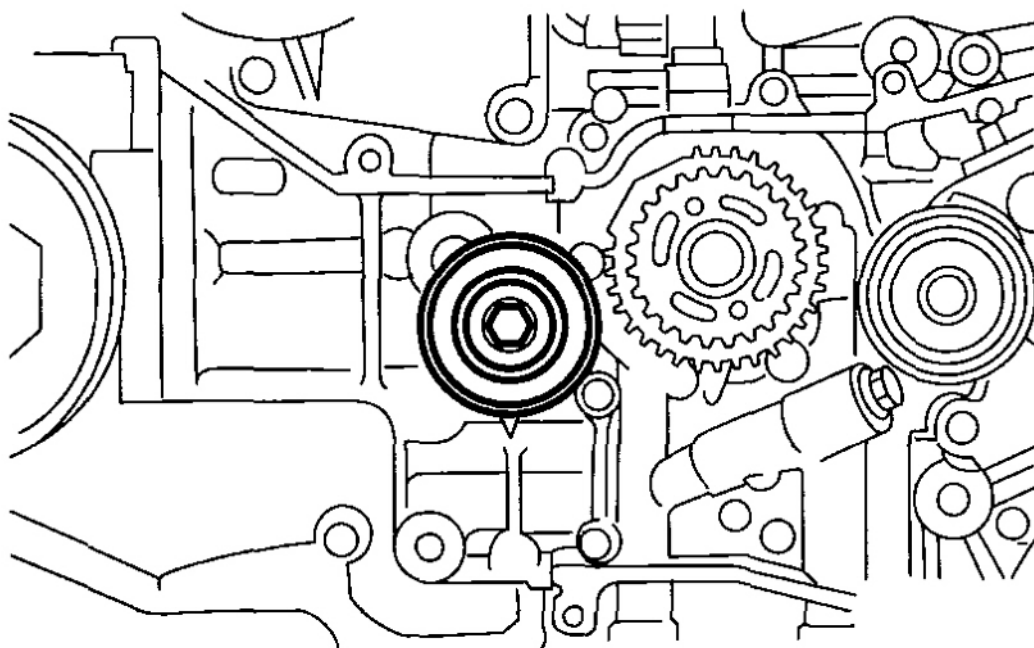
G03812906

Fig. 116: Installing Automatic Belt Tension Adjuster Assembly
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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



G03812907

Fig. 117: Installing Belt Idler (No. 1)

Courtesy of SUBARU OF AMERICA, INC.

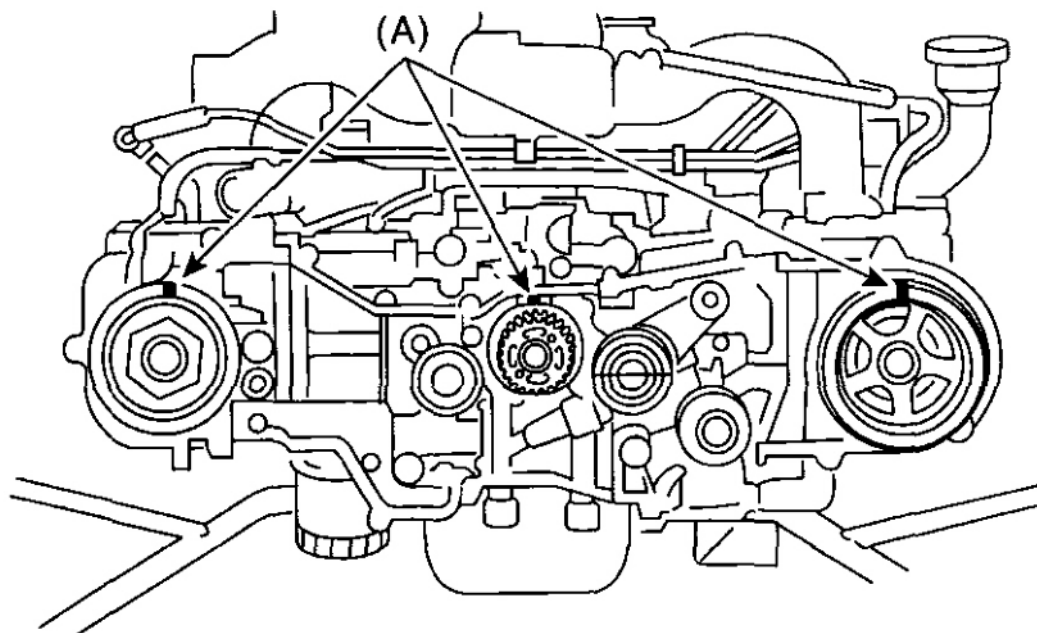
TIMING BELT

1. Prepare for installation of automatic belt tension adjuster assembly. < Ref. to , **AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER**, INSTALLATION, Timing Belt. >
2. Installation of timing belt:
 - a. Turn the cam sprocket No. 2 using ST1, and turn the cam 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.

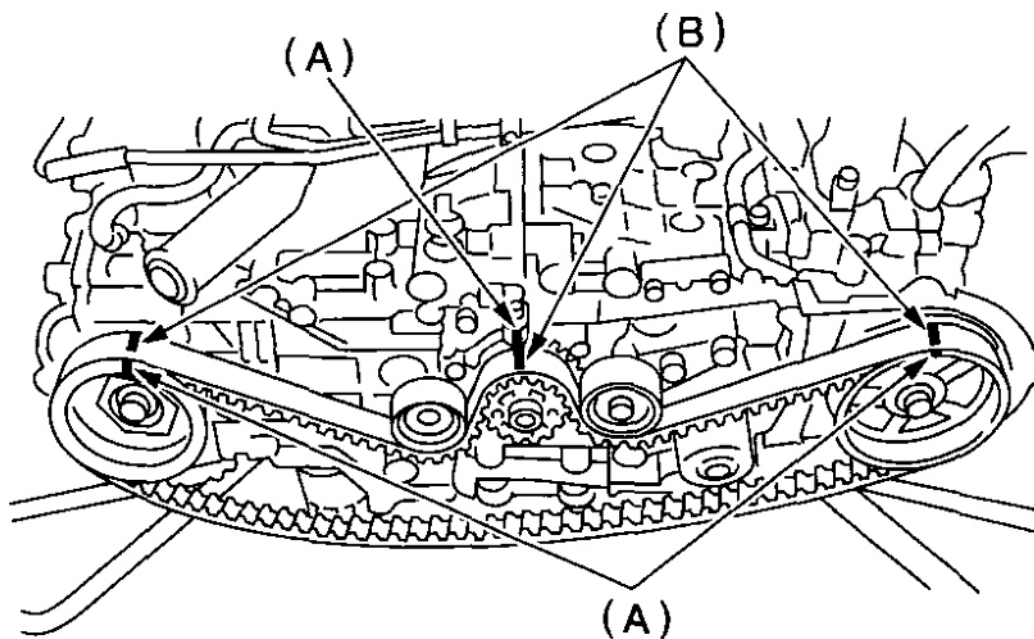
ST2 499207400 CAM SPROCKET WRENCH



G03812908

Fig. 118: Installing Of Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

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



G03812909

Fig. 119: Aligning Alignment Mark (B) On Timing Belt
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idler No. 2.

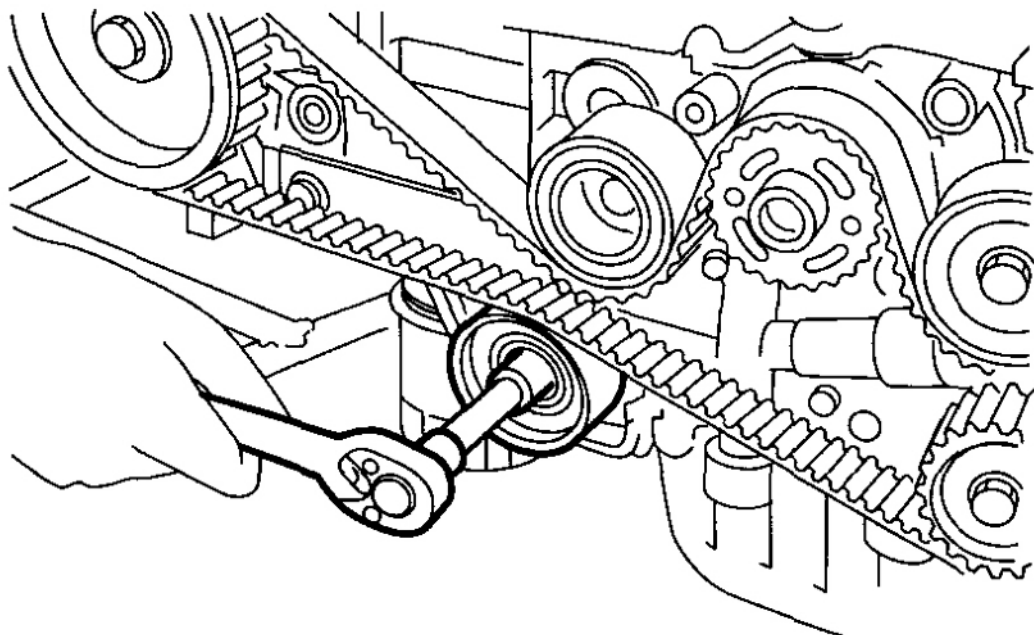
Tightening torque:

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

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

Tightening torque:

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

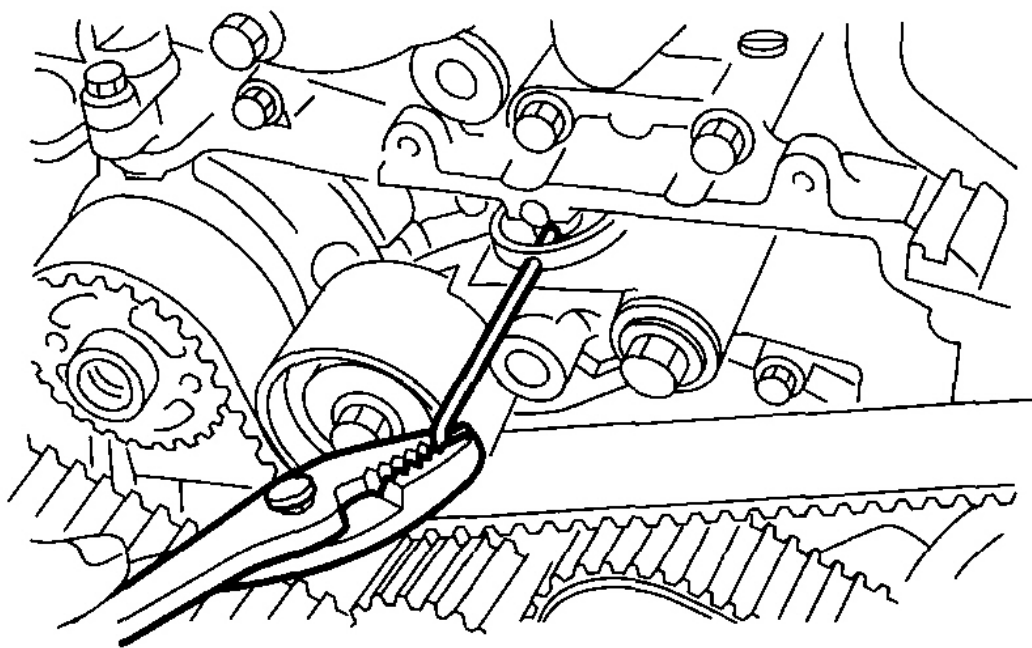


G03812910

Fig. 120: Installing Belt Idler (No. 2)

Courtesy of SUBARU OF AMERICA, INC.

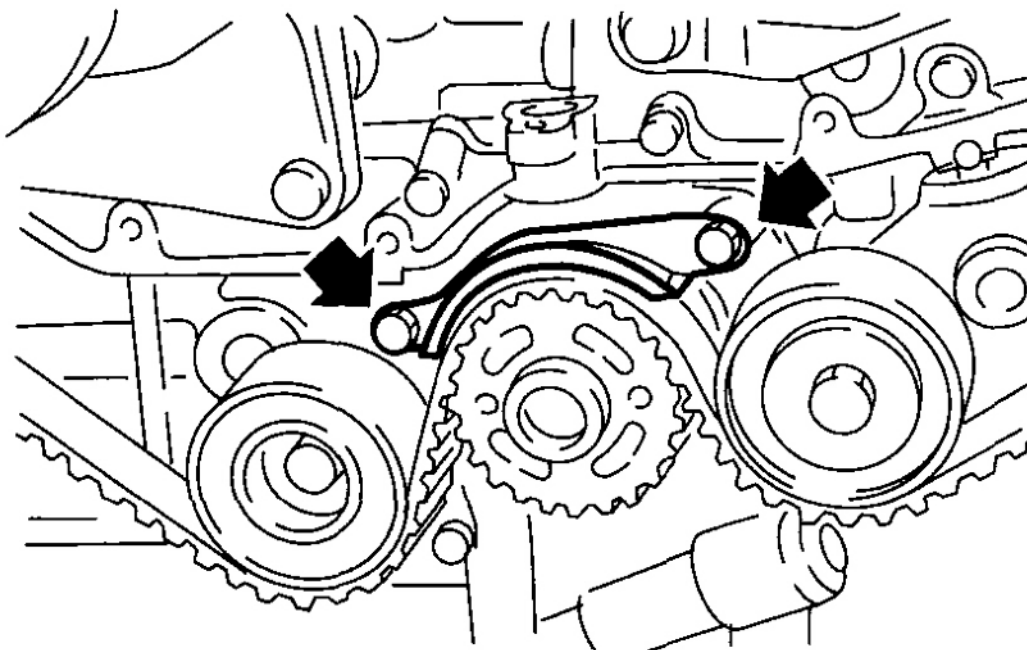
5. After ensuring the marks on timing belt and cam sprockets are aligned, remove the stopper pin from belt tension adjuster.



G03812911

Fig. 121: Removing Stopper Pin From Belt Tension Adjuster
Courtesy of SUBARU OF AMERICA, INC.

6. Install the timing belt guide. (MT model)
 - a. Temporarily tighten the timing belt guide mounting bolts.



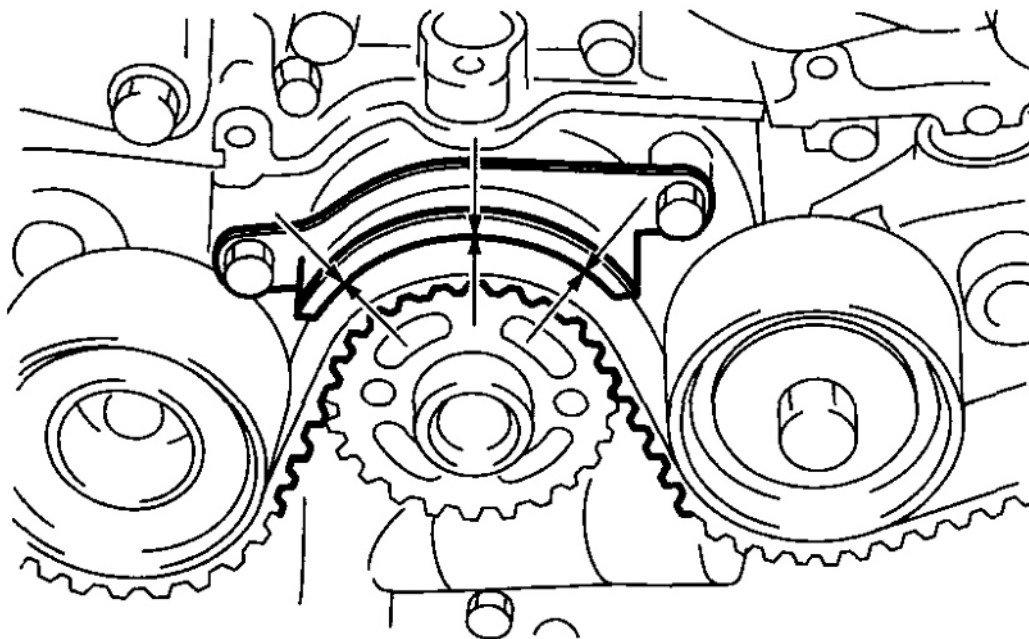
G03812912

Fig. 122: Tightening Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

- b. 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)



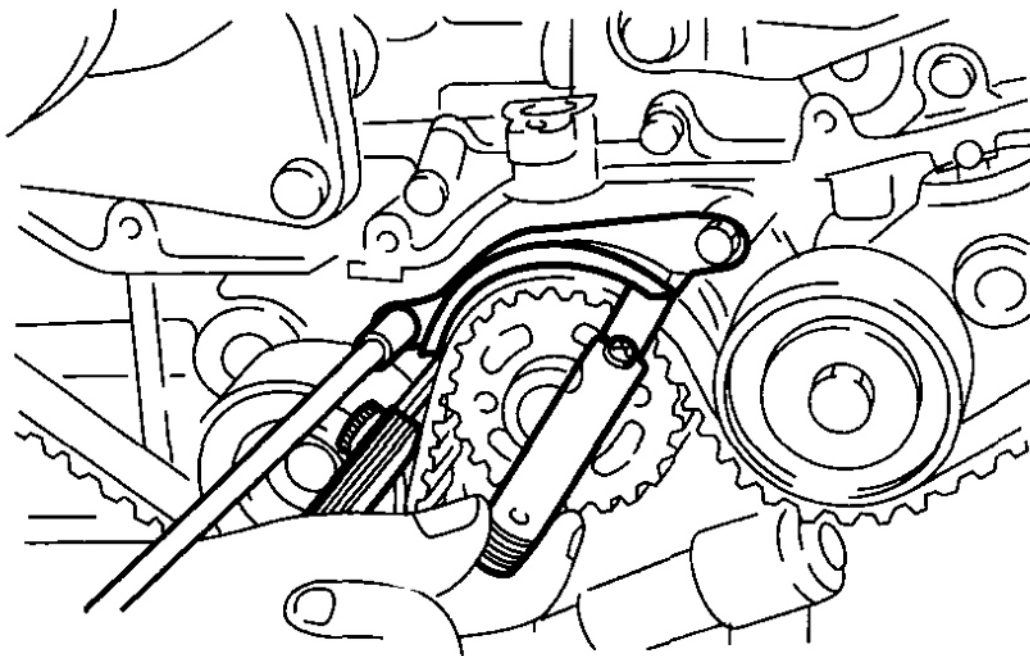
G03812913

Fig. 123: Checking Clearance Between Timing Belt And Timing Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

- c. Tighten the timing belt guide mounting bolts.

Tightening torque:

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



G03812914

Fig. 124: Tightening Timing Belt Guide Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

7. Install the timing belt cover. < Ref. to , **INSTALLATION**, Timing Belt Cover. >
8. Install the crank pulley. < Ref. to , **INSTALLATION**, Crank Pulley. >
9. Install the V-belts. < Ref. to , **INSTALLATION**, V-belt. >

INSPECTION

TIMING BELT

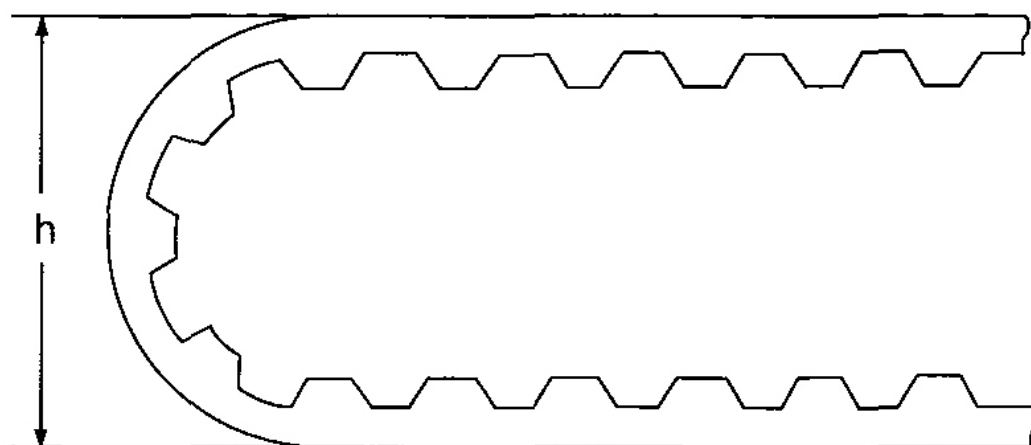
1. Check the timing belt teeth for breaks, cracks and wear. If any fault is found, replace the belt.
2. Check the condition of the backside of belt. If cracks are found, replace the belt.

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



G03812915

Fig. 125: Inspecting Timing Belt

Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

1. Visually check the oil seals for leaks, and rod ends for abnormal wear or 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:
 - a. Slowly press the adjuster rod down to the end surface of the cylinder. Repeat this operation two to three times.
 - b. 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.
 - c. If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new one.

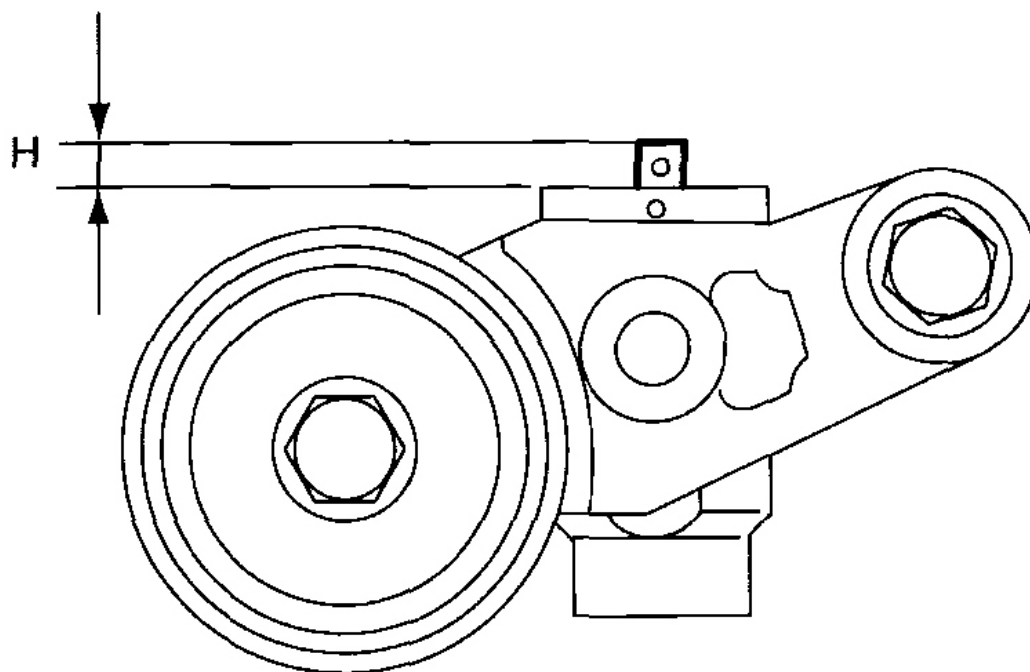
CAUTION:

- **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 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 specifications, replace with a new one.

Amount of rod protrusion H:

5.7+/-0.5 mm (0.224+/-0.050 in)



G03812916

Fig. 126: Measuring Amount Of Rod Protrusion
Courtesy of SUBARU OF AMERICA, INC.

BELT TENSION PULLEY

1. Check the mating surfaces of timing belt and contact point of adjuster rod for abnormal wear or scratches. 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

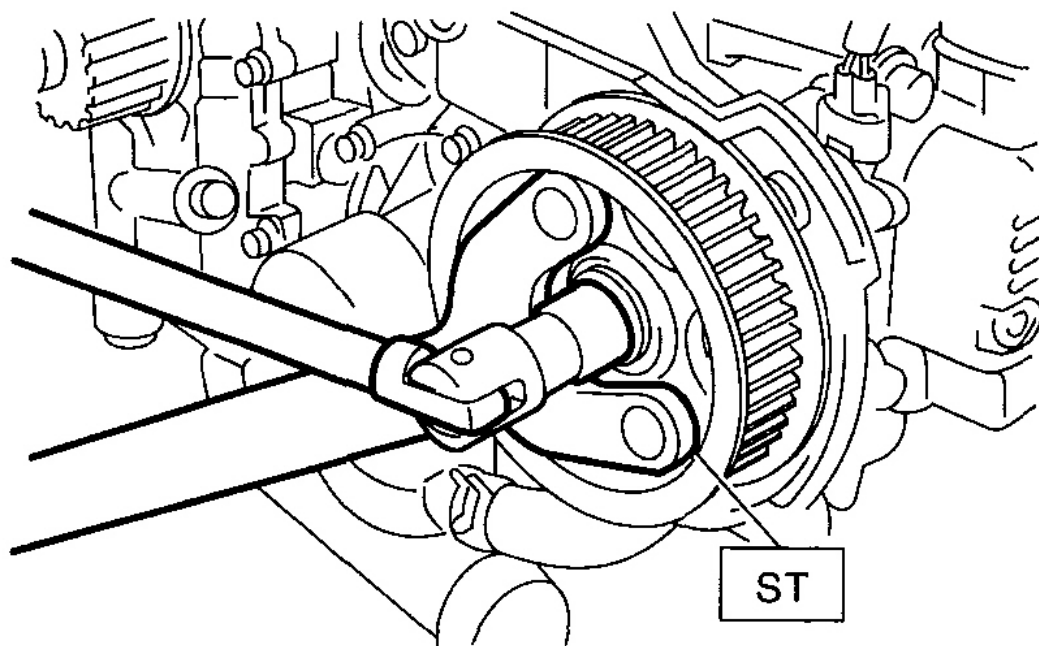
1. Check the belt idler for smooth rotation. Replace if noise or excessive play occurs.
2. Check the outer contacting surfaces of idler pulley for abnormal wear and scratches.
3. Check the belt idler for grease leakage.

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 ST.

ST 18231AA010 CAM SPROCKET WRENCH

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

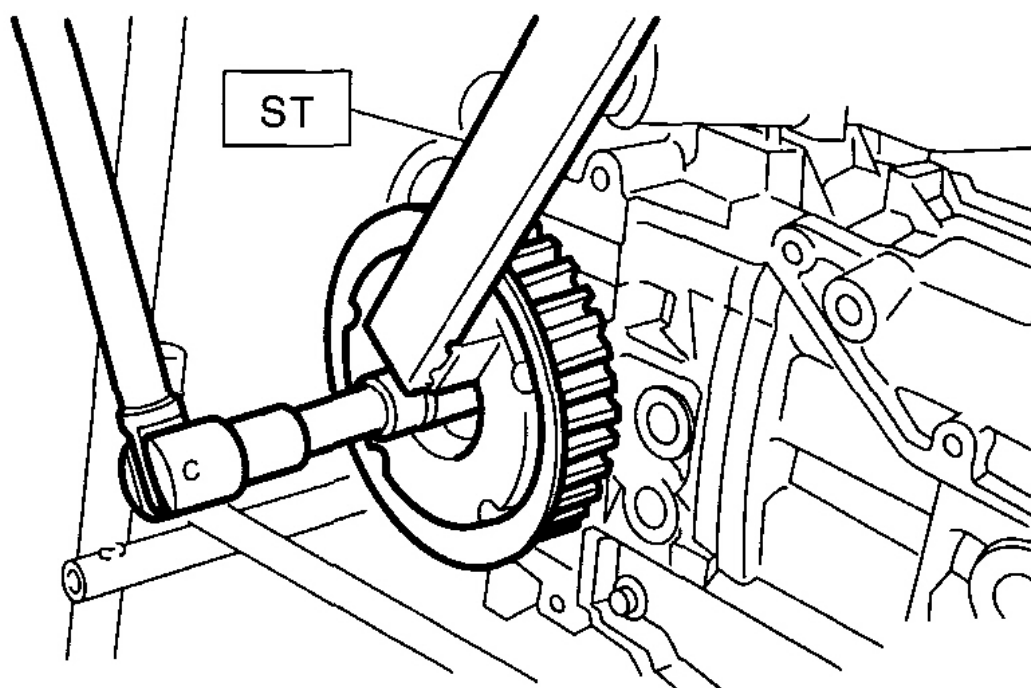


G03812917

Fig. 127: Removing CAM Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499207400 CAM SPROCKET WRENCH



G03812918

Fig. 128: Removing CAM Sprocket No. 1.
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

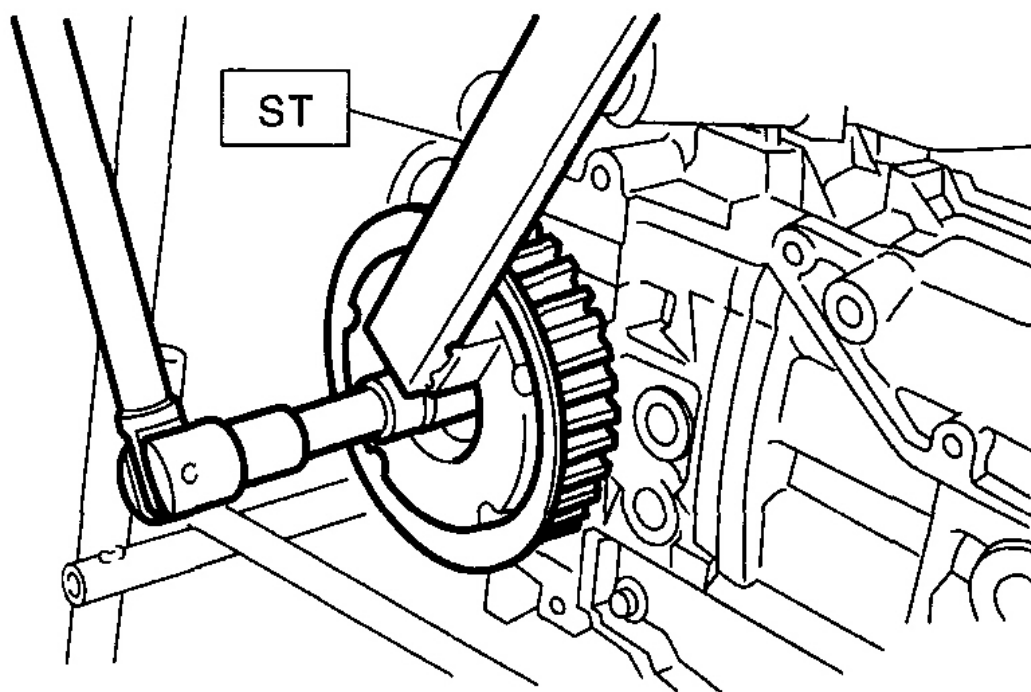
1. Install the cam sprocket No. 1. To lock the camshaft, use ST.

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. Cam sprocket No. 2 is identified by a protrusion used to monitor the camshaft position sensor.



G03812919

Fig. 129: Installing CAM Sprocket No. 1
Courtesy of SUBARU OF AMERICA, INC.

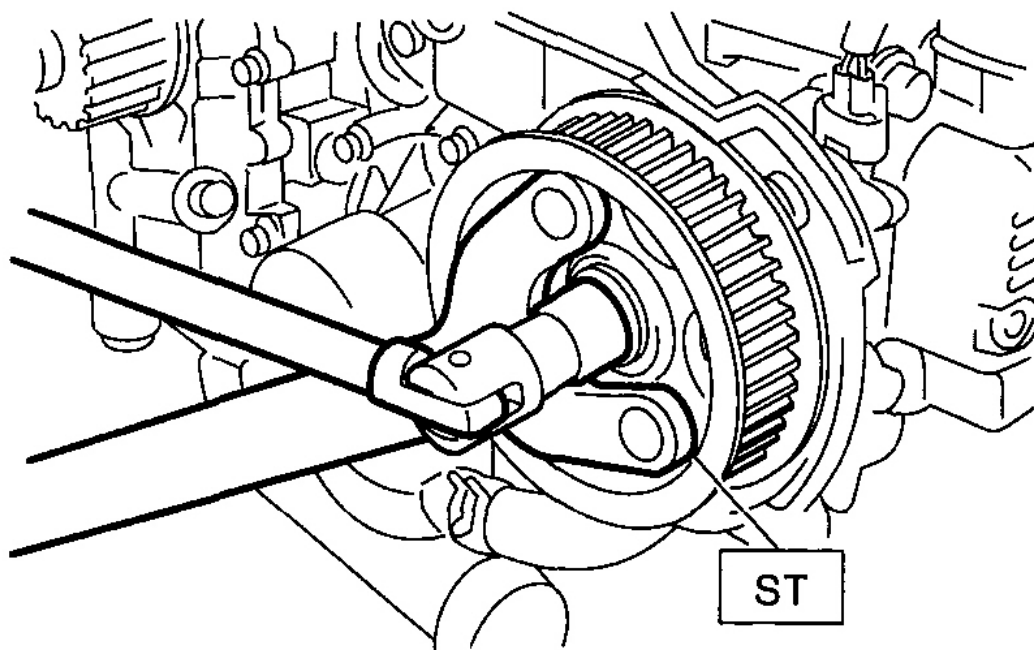
2. Install the cam sprocket No. 2. To lock the camshaft, use ST.

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)



G03812920

Fig. 130: Installing CAM Sprocket No. 2
Courtesy of SUBARU OF AMERICA, INC.

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 cam sprocket. < Ref. to , **REMOVAL**, Cam Sprocket. >
6. Remove the crank sprocket.

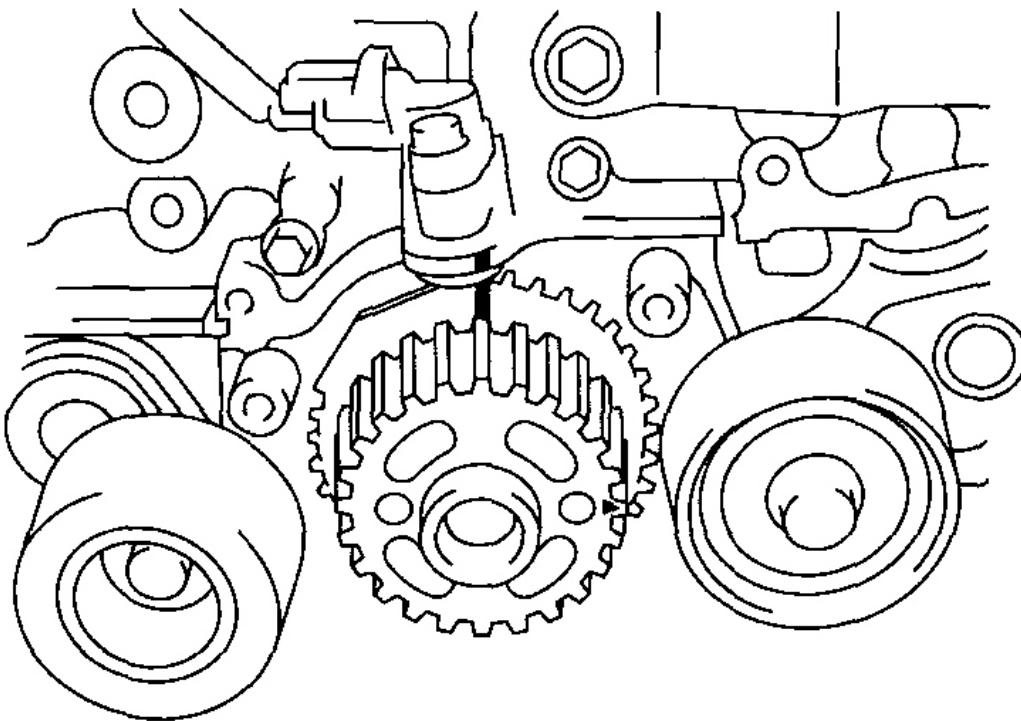
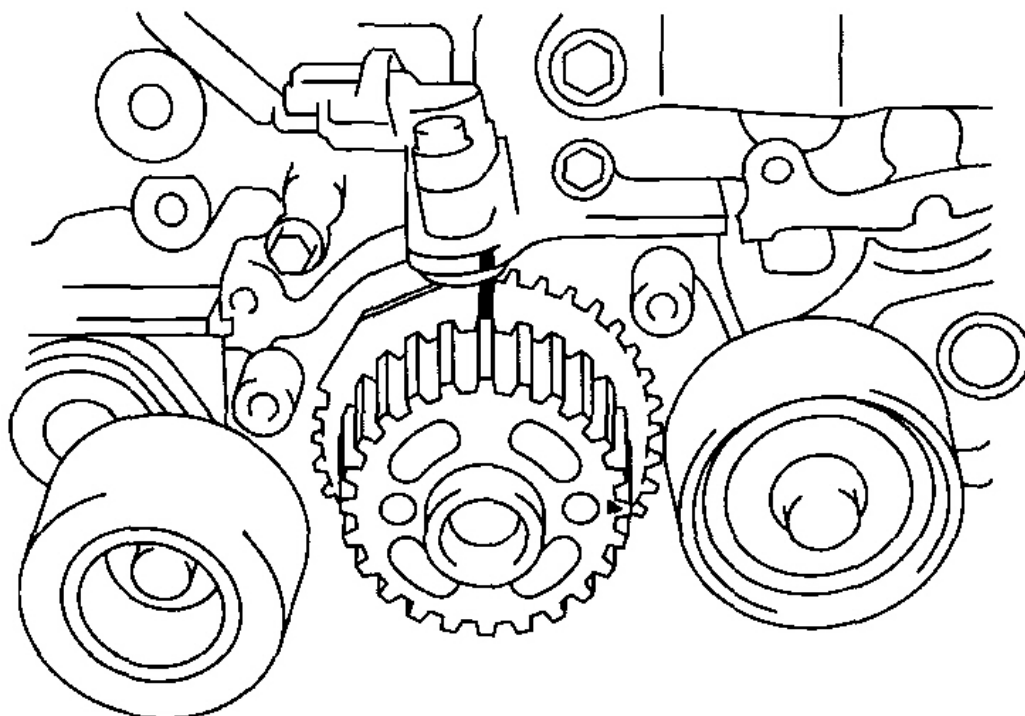
**G03812921**

Fig. 131: Removing Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.



G03812922

Fig. 132: Installing Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

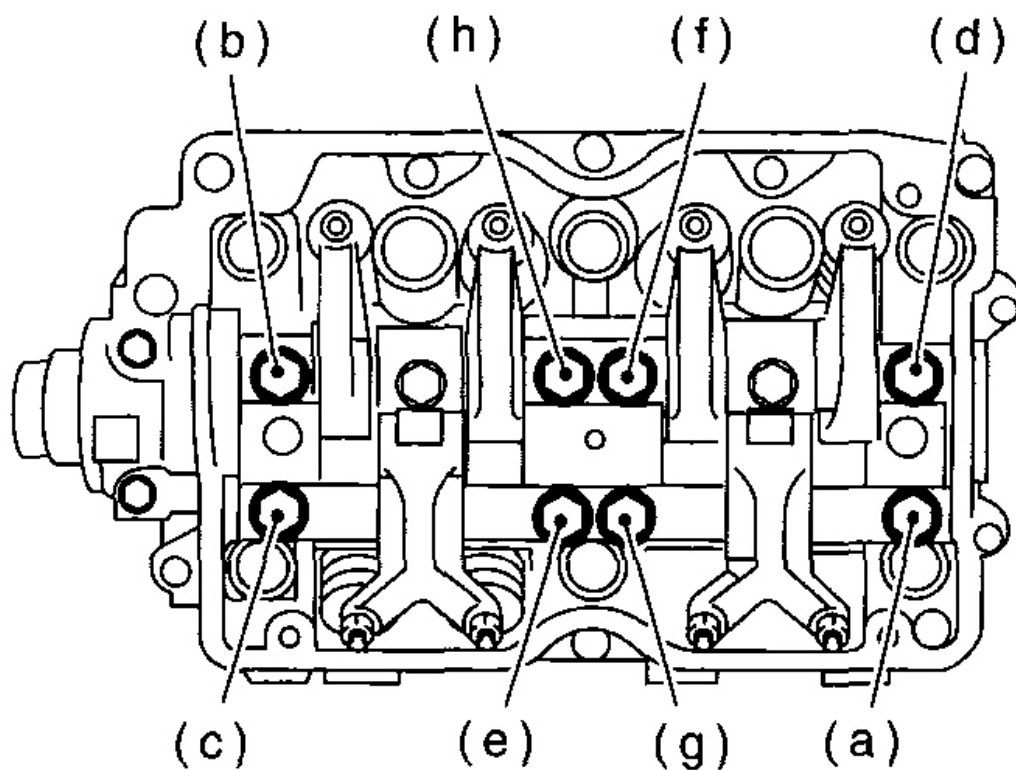
1. Check the crank sprocket teeth for abnormal wear and scratches.
2. Make sure there is no free play between crank sprocket and key.
3. Check the crank sprocket protrusion used for sensor for damage and contamination of foreign matter.

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. Removal of valve rocker assembly
 - a. Remove the bolts (a) through (h) shown in **Fig. 133**, in alphabetical sequence.

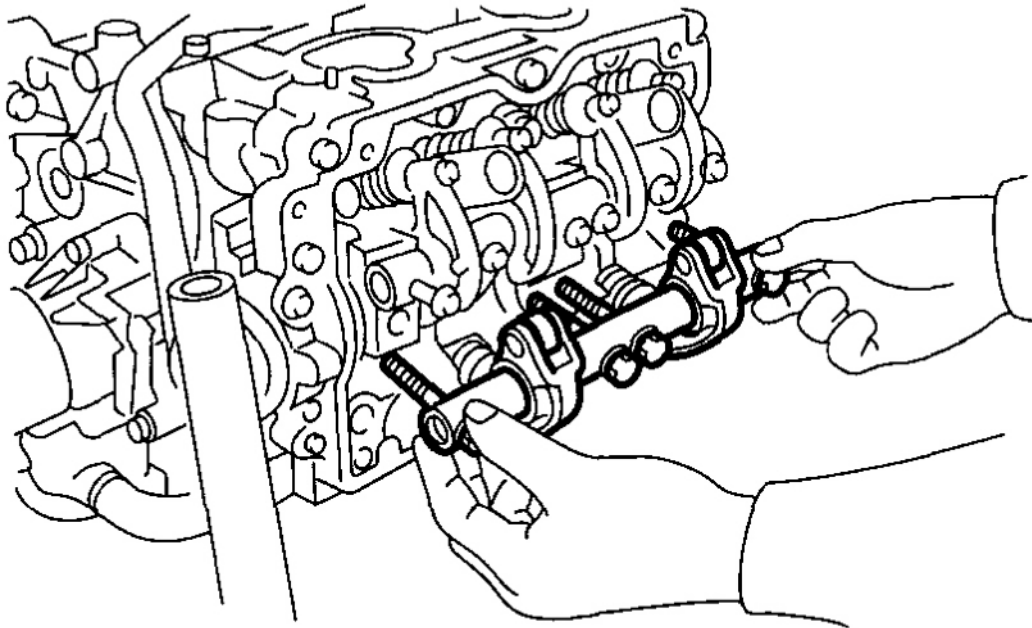
NOTE: Leave two or three threads of bolts (g) and (h) engaged in order to retain the valve rocker assembly.



G03812923

Fig. 133: Removing Bolts Of Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

- b. Remove the valve rocker assembly.



G03812924

Fig. 134: Removing Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

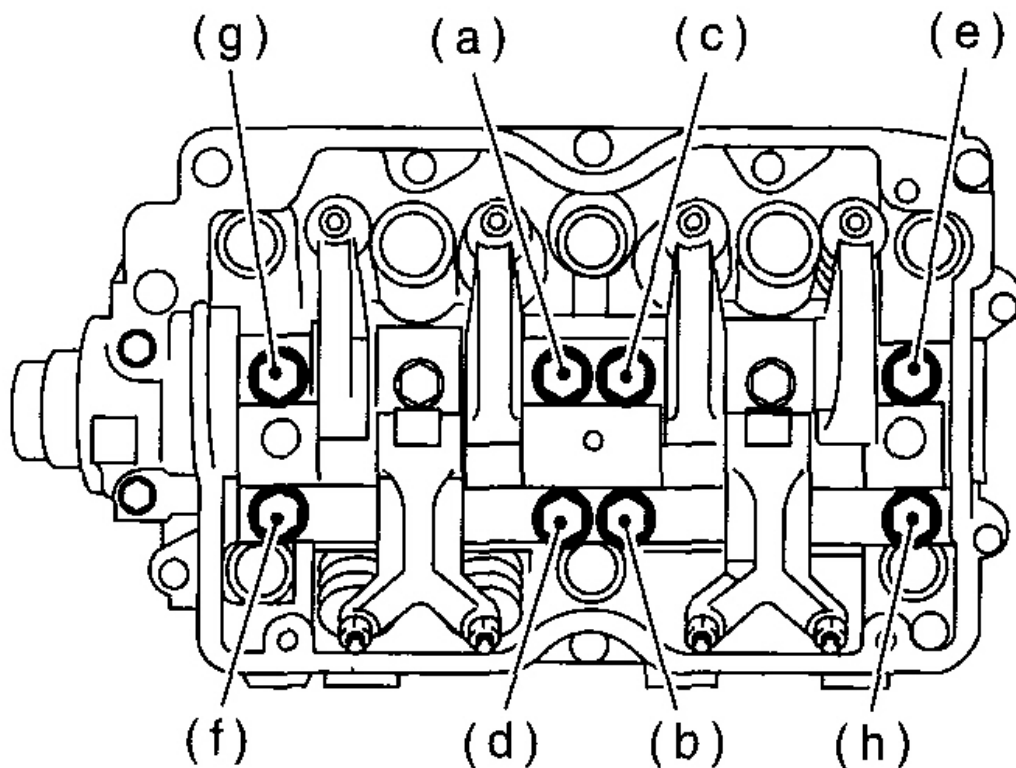
1. Install the valve rocker assembly.
 - a. Temporarily tighten the bolts (a) through (d) equally in order as shown in **Fig. 135** .

NOTE: **Do not allow the valve rocker assembly to damage knock pins.**

- b. Tighten the bolts (e) through (h) to specified torque.
 - c. Tighten the bolts (a) through (d) to specified torque.

Tightening torque:

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



G03812925

Fig. 135: Installing Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new rocker cover gasket.

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

1. Remove the bolts which secure the rocker shaft.
2. Extract the rocker shaft. Remove the valve rocker arms, springs and shaft supports from rocker shaft.

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

3. Remove the nut and adjusting screw from valve rocker.

ASSEMBLY

1. Install the adjusting screw and nut to valve rocker.
2. Arrange the valve rocker arms, springs and shaft supports in assembly order, and then insert the valve rocker shaft.

Tightening torque (Shaft supports installing bolts):

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

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

3. Install the valve rocker shaft securing bolts.

INSPECTION

VALVE ROCKER ARM AND ROCKER SHAFT

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

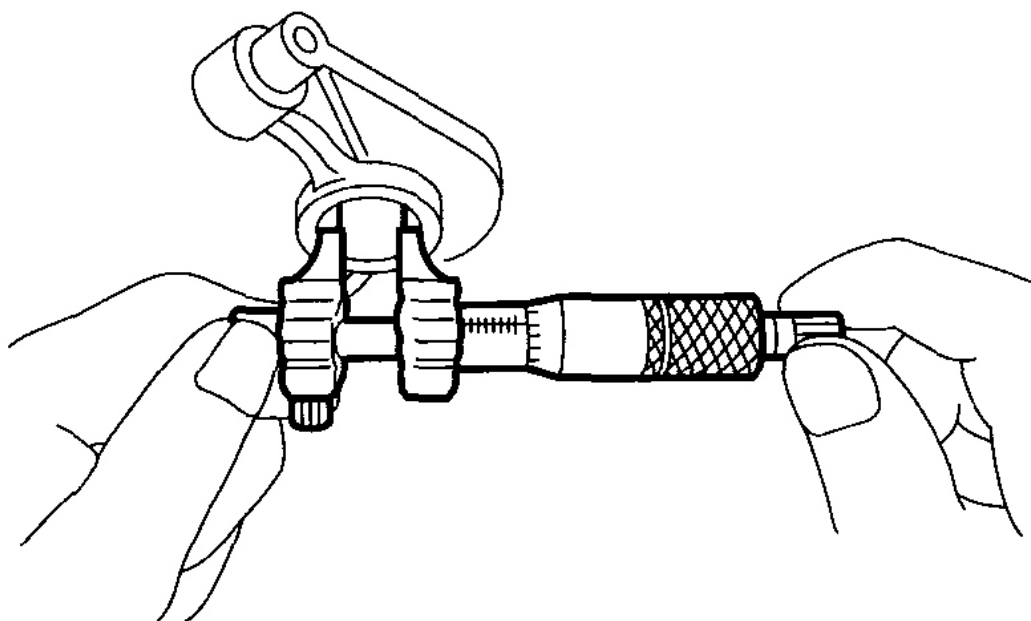
Clearance between arm and shaft:

Standard:

0.020 - 0.054 mm (0.0008 - 0.0021 in)

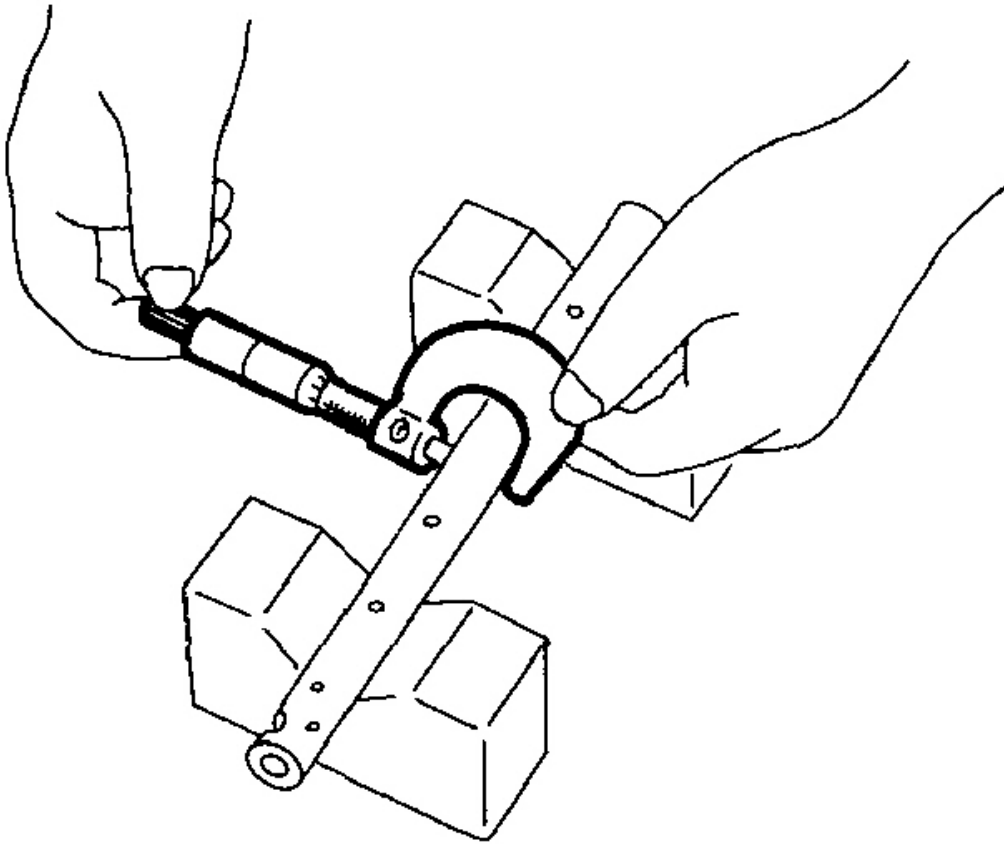
Limit:

0.10 mm (0.0039 in)



G03812926

Fig. 136: Inspecting Valve Rocker Arm And Rocker Shaft (1 Of 2)
Courtesy of SUBARU OF AMERICA, INC.



G03812927

Fig. 137: Inspecting Valve Rocker Arm And Rocker Shaft (2 Of 2)

Courtesy of SUBARU OF AMERICA, INC.

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 cam or valve contact surface of valve rocker arm is worn or dented excessively, replace the valve

rocker arm.

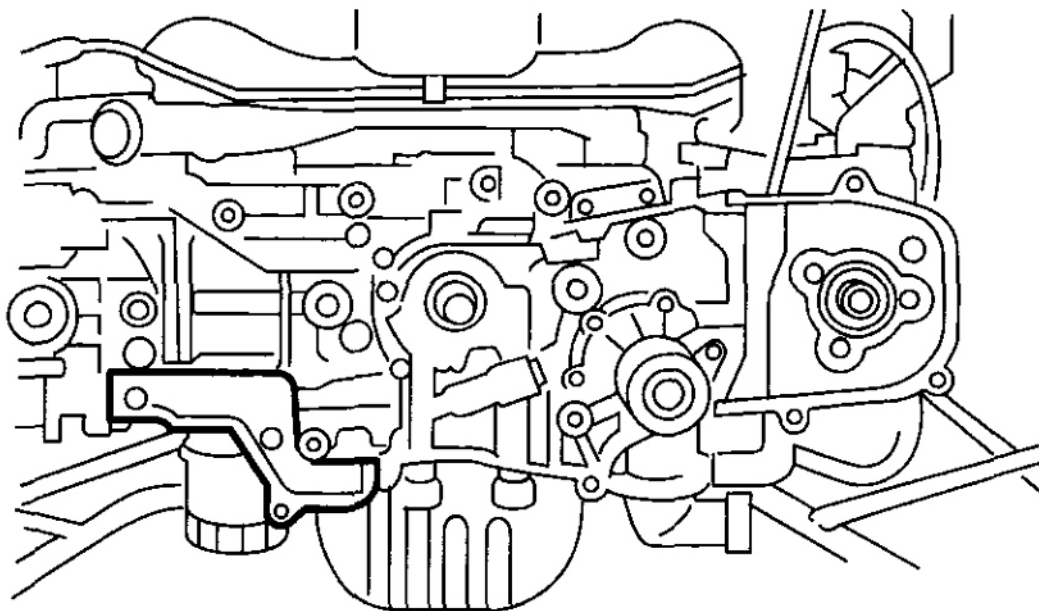
4. Check that the valve rocker arm roller rotates smoothly. If not, replace the valve rocker arm.

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 crank sprocket. < Ref. to , **REMOVAL**, Crank Sprocket. >
7. Remove the timing belt cover No. 2 (LH).
8. Remove the timing belt cover No. 2 (RH).

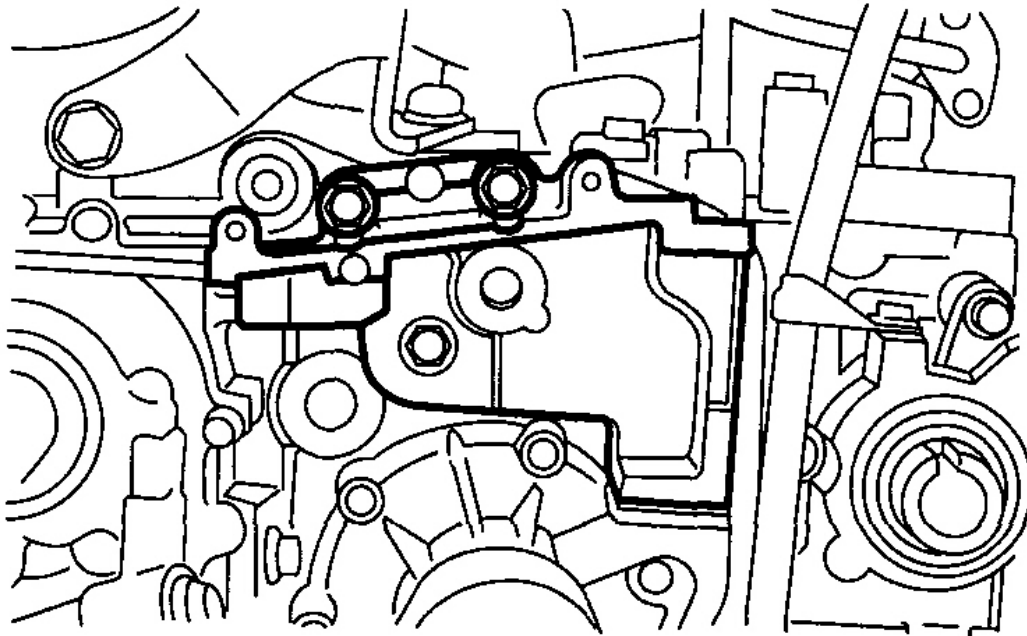
NOTE: Do not damage or lose the seal rubber when removing the timing belt covers.



G03812928

Fig. 138: Removing Camshaft
Courtesy of SUBARU OF AMERICA, INC.

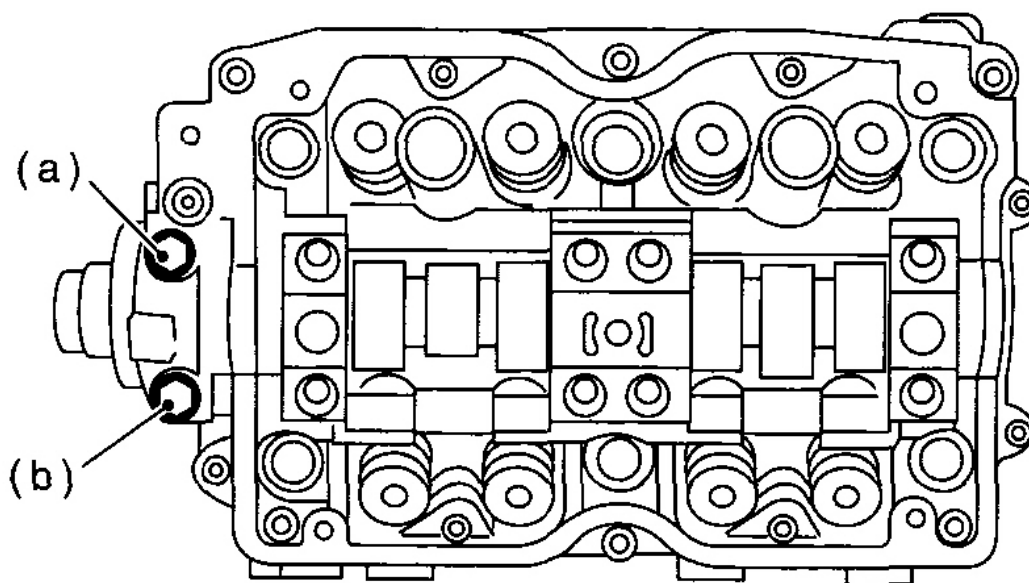
9. Remove the tensioner bracket.



G03812929

Fig. 139: Removing Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

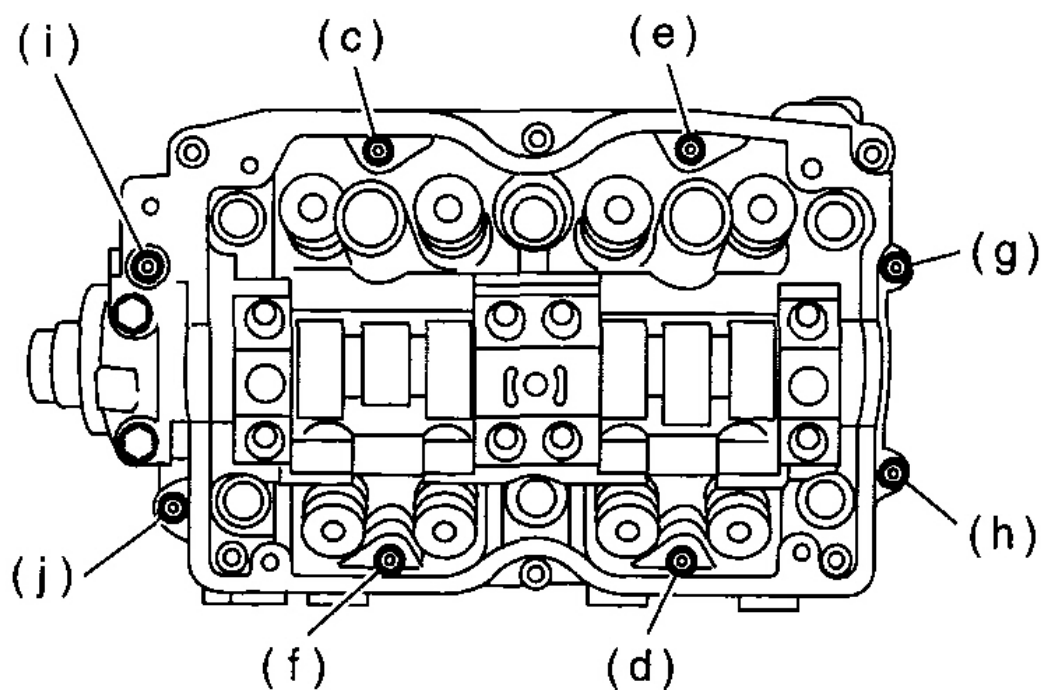
10. Remove the camshaft position sensor support. (LH side only)
11. Remove the oil level gauge guide. (LH side only)
12. Remove the valve rocker assembly. < Ref. to , **REMOVAL**, Valve Rocker Assembly. >
13. Remove the camshaft cap.
 - a. Remove the bolts (a) and (b) in alphabetical sequence.



G03812930

Fig. 140: Removing Camshaft Position Sensor Support
Courtesy of SUBARU OF AMERICA, INC.

- b. Equally loosen the bolts (c) through (j) all the way in alphabetical sequence shown in **Fig. 141**.



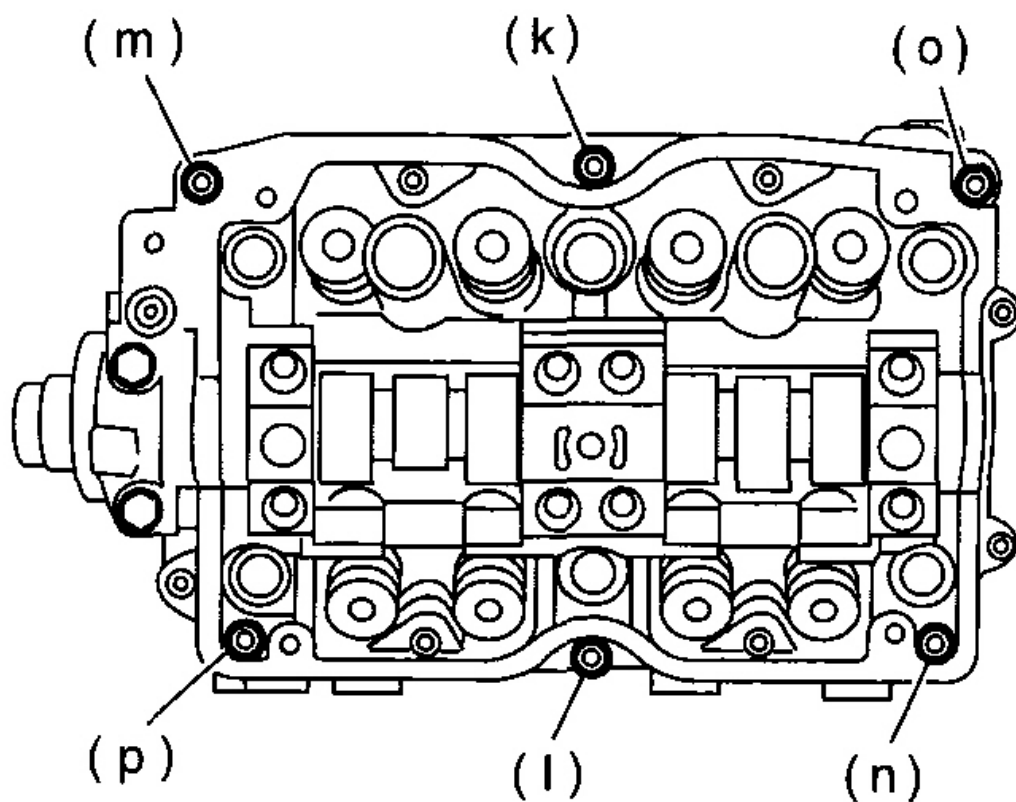
G03812931

Fig. 141: Loosening Bolts

Courtesy of SUBARU OF AMERICA, INC.

- c. Remove the bolts (k) through (p) in alphabetical sequence using ST shown in **Fig. 142**.

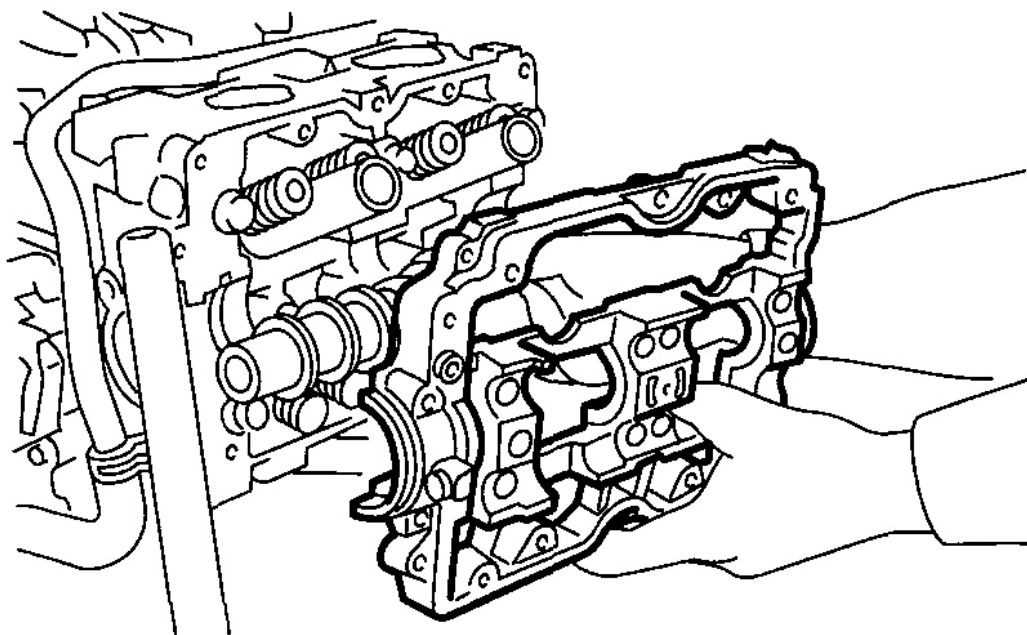
ST 499497000 TORX® PLUS



G03812932

Fig. 142: Removing Bolts Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

- d. Remove the camshaft cap.



G03812933

Fig. 143: Removing Camshaft Cap
Courtesy of SUBARU OF AMERICA, INC.

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

CAUTION:

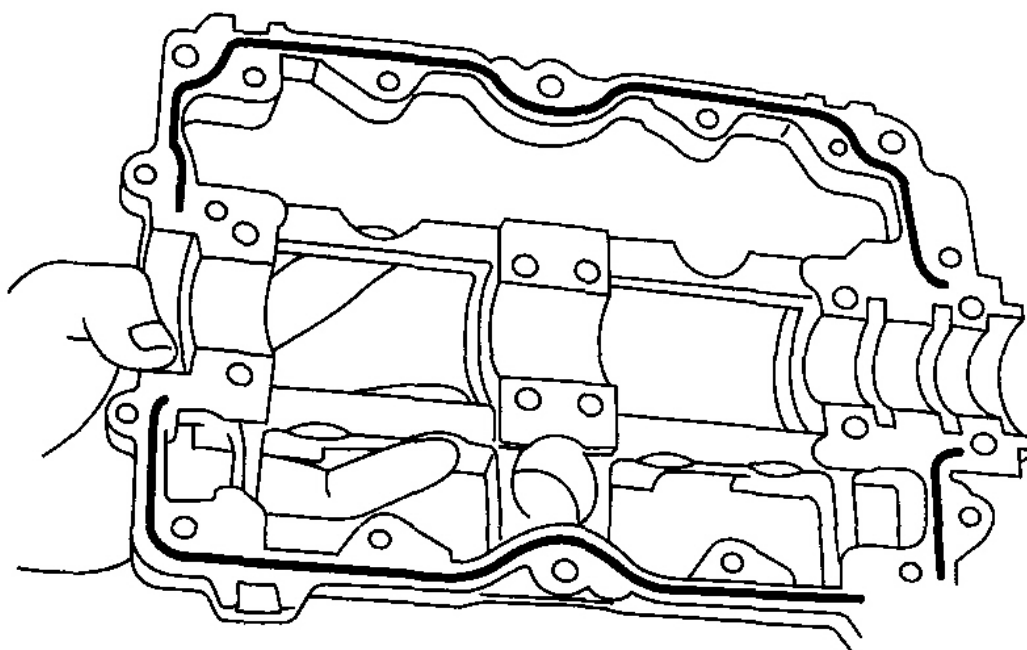
- Do not remove the oil seal unless necessary.
- Do not scratch the journal surface when removing the oil seal.

INSTALLATION

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

Liquid gasket:

THREE BOND 1280B (Part No. K0877YA018)

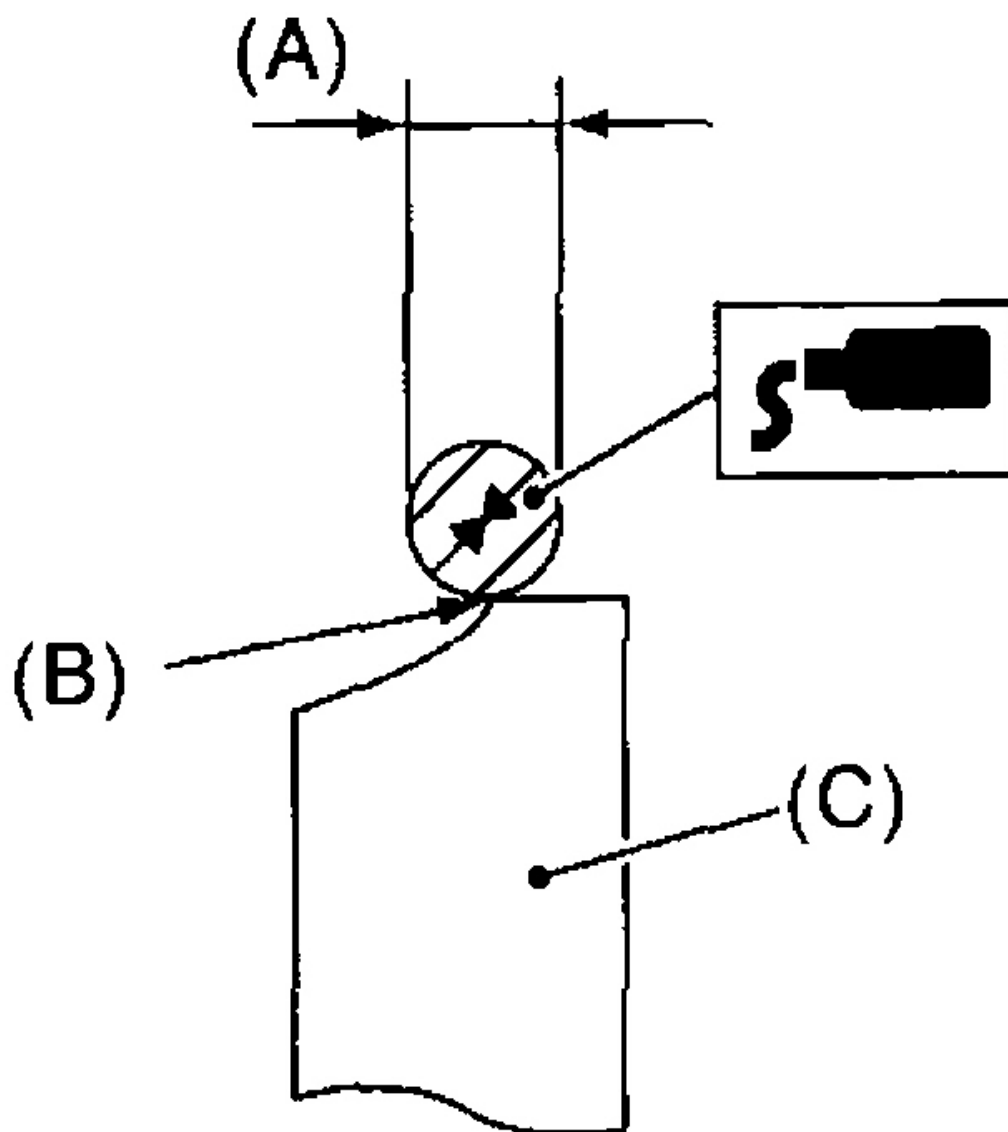


G03812934

Fig. 144: Applying Liquid Gasket To Mating Surfaces Of Camshaft Cap
Courtesy of SUBARU OF AMERICA, INC.

NOTE:

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



G03812935

Fig. 145: Applying A Coat Of Liquid Gasket
Courtesy of SUBARU OF AMERICA, INC.

- b. Temporarily tighten the bolts (g) through (j) in alphabetical sequence shown in **Fig. 146**.

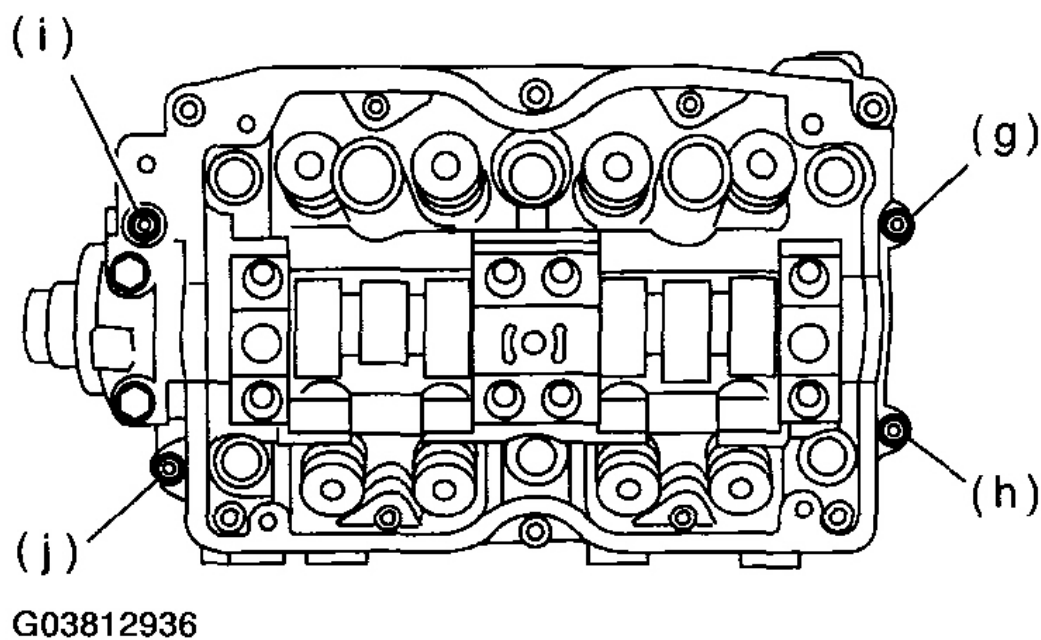
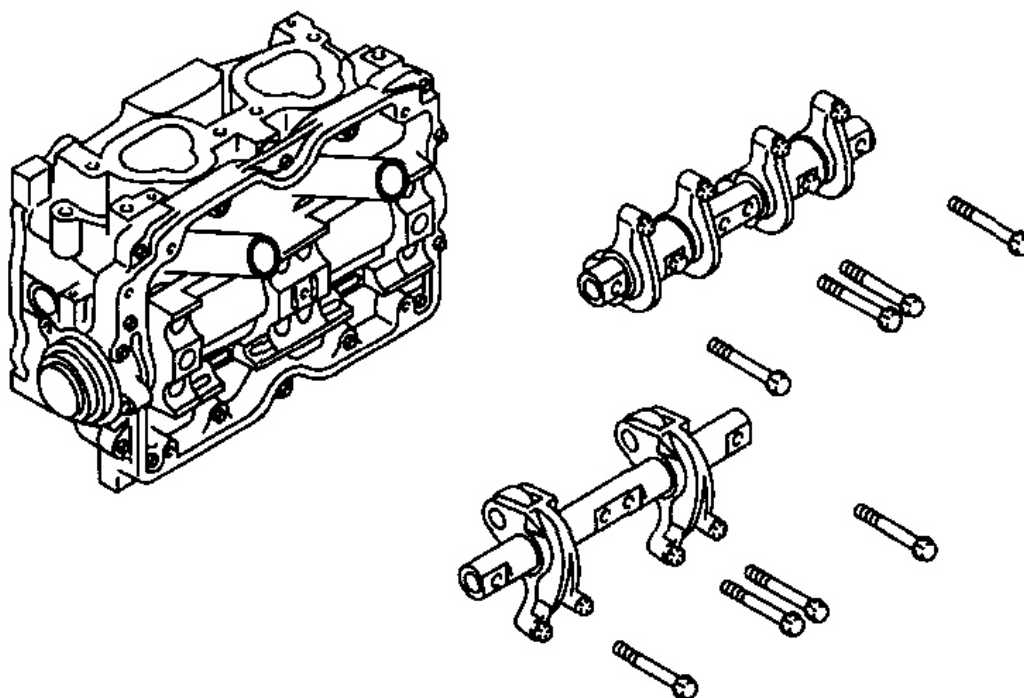


Fig. 146: Tightening Bolts

Courtesy of SUBARU OF AMERICA, INC.

- c. Install the valve rocker assembly.



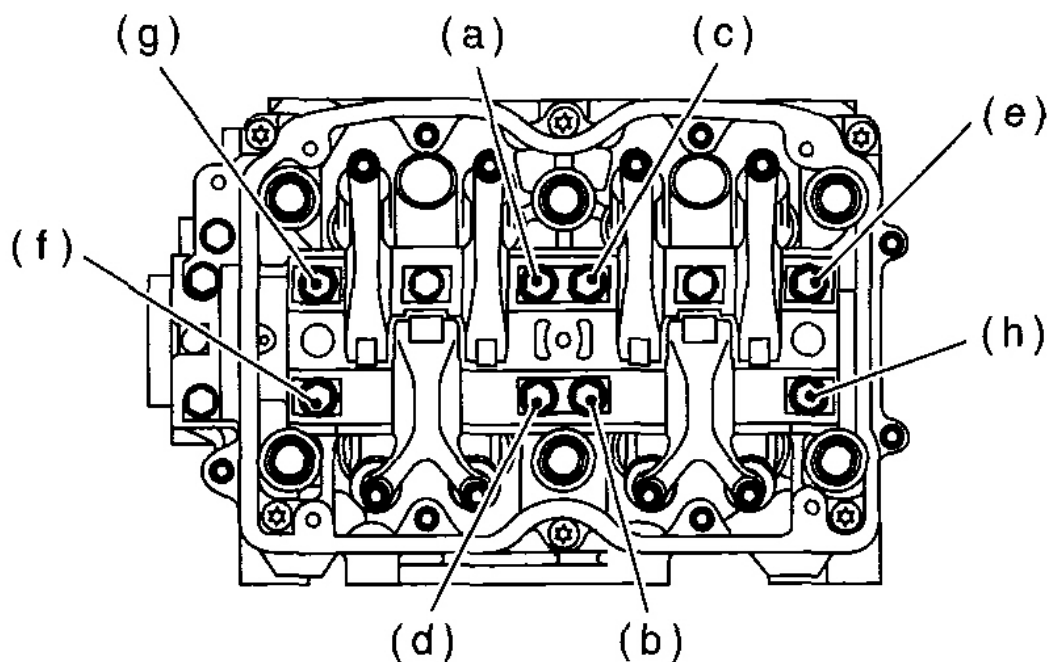
G03812937

Fig. 147: Installing Valve Rocker Assembly
Courtesy of SUBARU OF AMERICA, INC.

- d. Tighten the bolts (a) through (h) in alphabetical sequence shown in **Fig. 148**.

Tightening torque:

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



G03812938

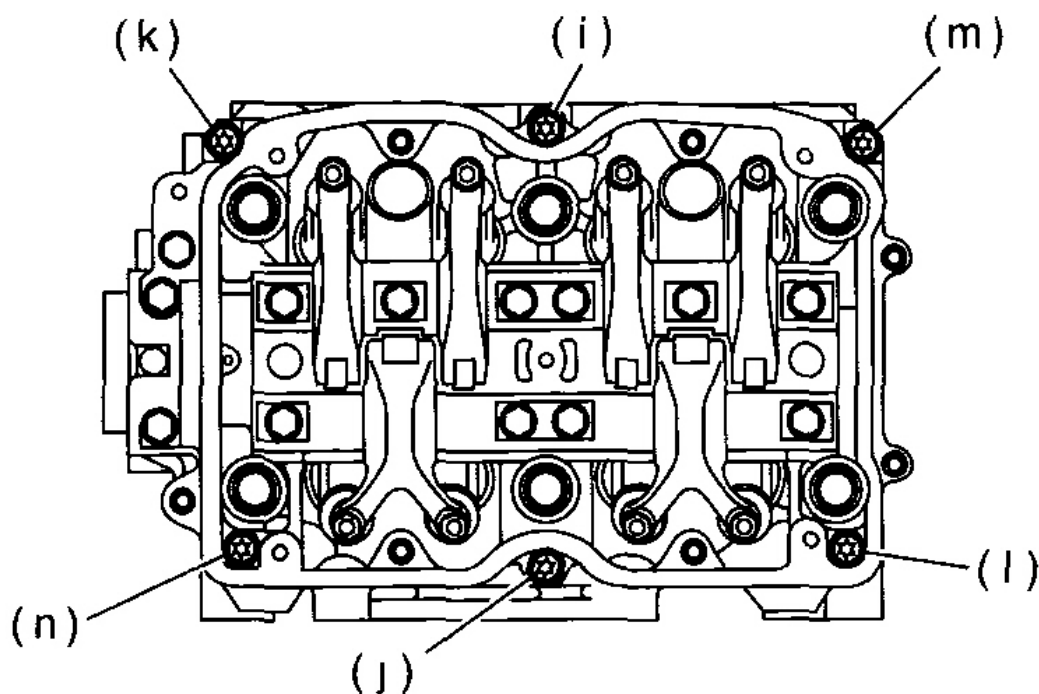
Fig. 148: Tightening Torque Specification (1 Of 4)

Courtesy of SUBARU OF AMERICA, INC.

- e. Tighten the TORX® bolts (i) through (n) in alphabetical sequence shown in **Fig. 149**, using ST .

ST 499497000 TORX® PLUS

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



G03812939

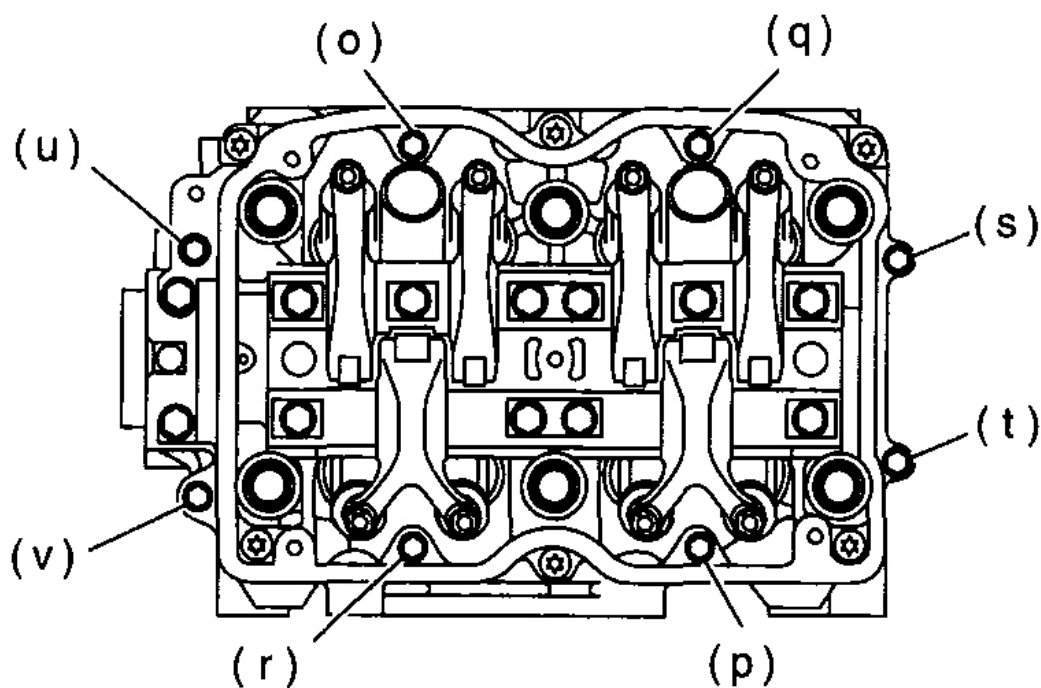
Fig. 149: Tightening Torque Specification (2 Of 4)

Courtesy of SUBARU OF AMERICA, INC.

- f. Tighten the bolts (o) through (v) in alphabetical sequence shown in **Fig. 150**.

Tightening torque:

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



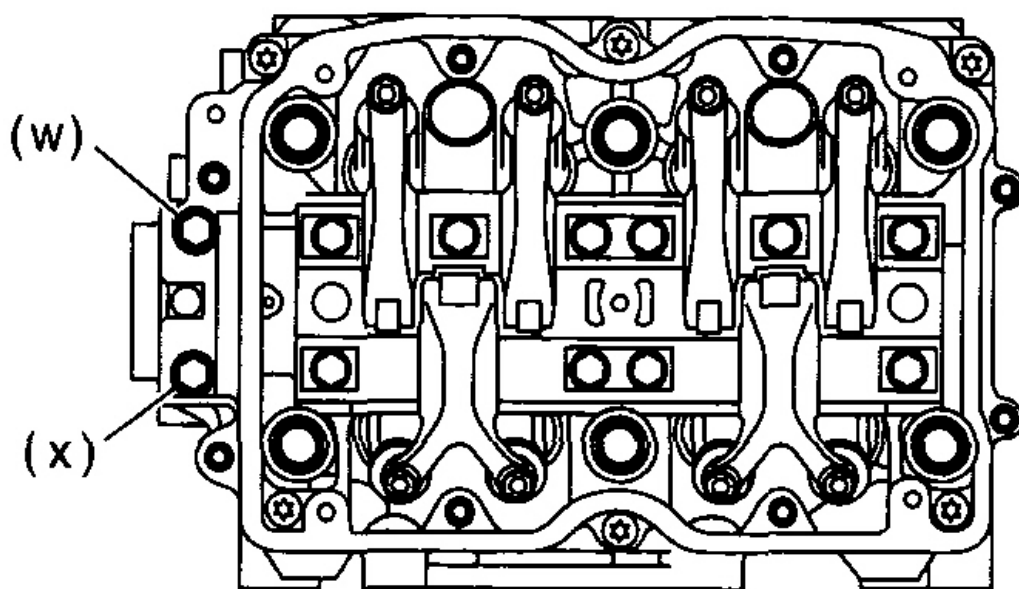
G03812940

Fig. 150: Tightening Torque Specification (3 Of 4)
Courtesy of SUBARU OF AMERICA, INC.

- g. Tighten the bolts (w) and (x) in alphabetical sequence shown in **Fig. 151**.

Tightening torque:

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



G03812941

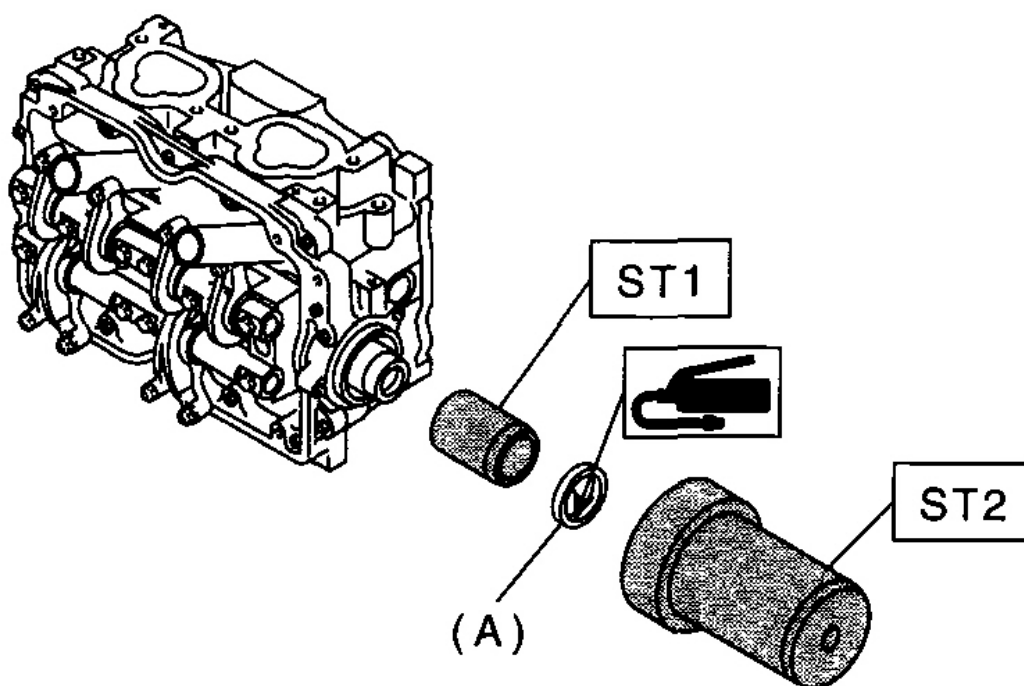
Fig. 151: Tightening Torque Specification (4 Of 4)
 Courtesy of SUBARU OF AMERICA, INC.

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



G03812942

Fig. 152: Applying A Coat Of Grease To Oil Seal Lips
Courtesy of SUBARU OF AMERICA, INC.

4. Install the plug using ST.

ST 499587700 CAMSHAFT OIL SEAL INSTALLER

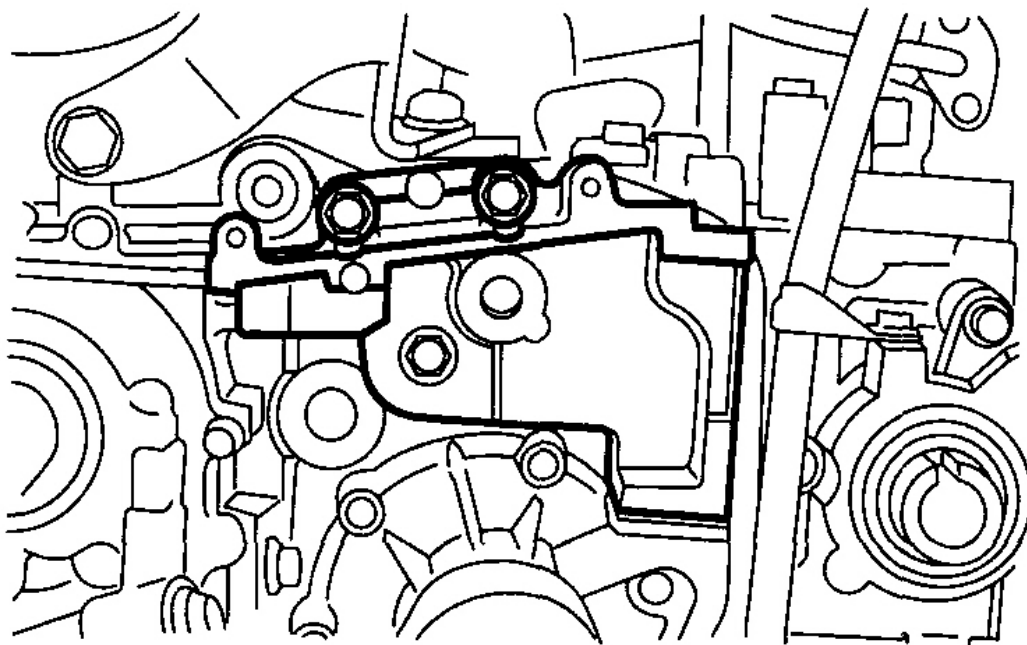
5. Adjust the valve clearance. < Ref. to , ADJUSTMENT, Valve Clearance. >
6. Install the rocker cover, rocker cover gasket and connect PCV hose.

NOTE: Use new rocker cover gasket.

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)



G03812943

Fig. 153: Installing Tensioner Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

Tightening torque:

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

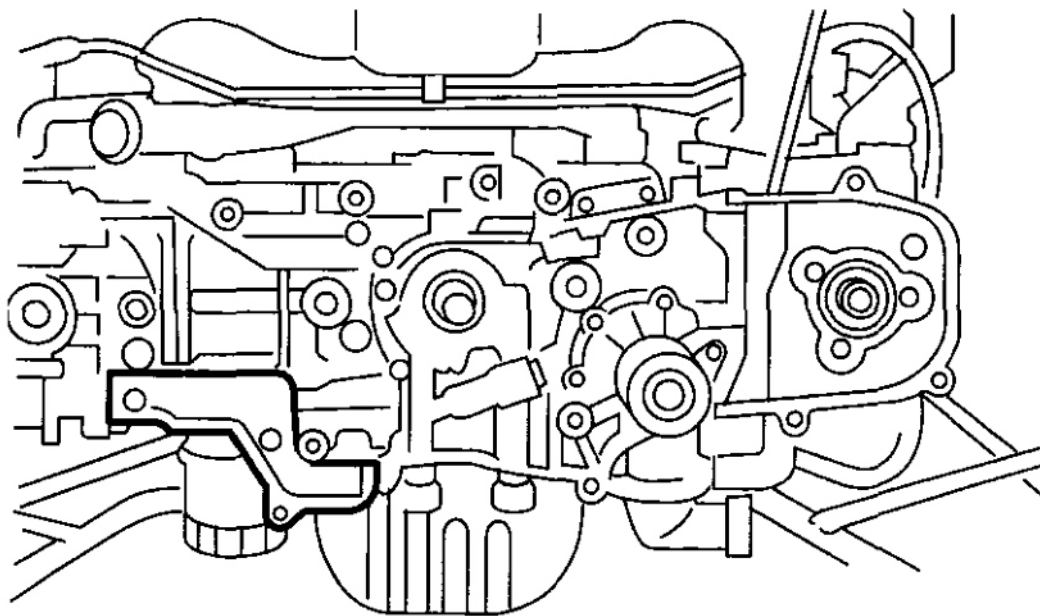
**G03812944**

Fig. 154: Installing Timing Belt Cover No. 2 (LH)

Courtesy of SUBARU OF AMERICA, INC.

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

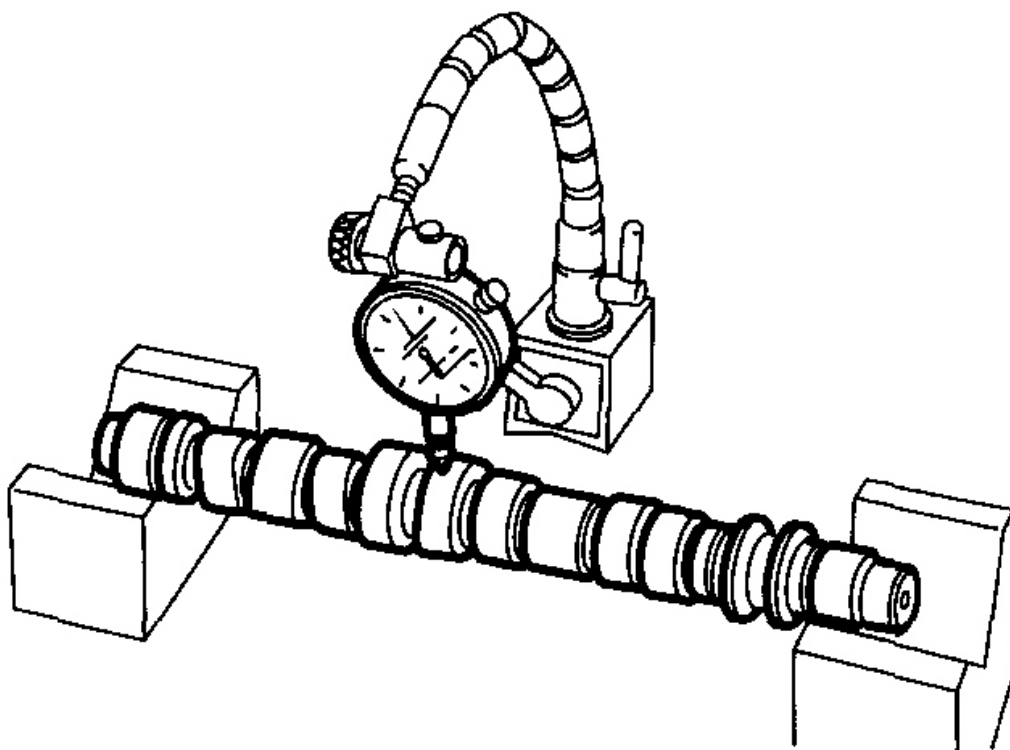
INSPECTION

CAMSHAFT

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

Service limit:

0.025 mm (0.00098 in)



G03812945

Fig. 155: Inspecting Camshaft
 Courtesy of SUBARU OF AMERICA, INC.

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

CLEARANCE AT JOURNAL SPECIFICATION

Unit: mm (in)		
Clearance at journal	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.

2005 Subaru Impreza RS

2005 ENGINE Mechanical - H4SO - Impreza

Cam height H:

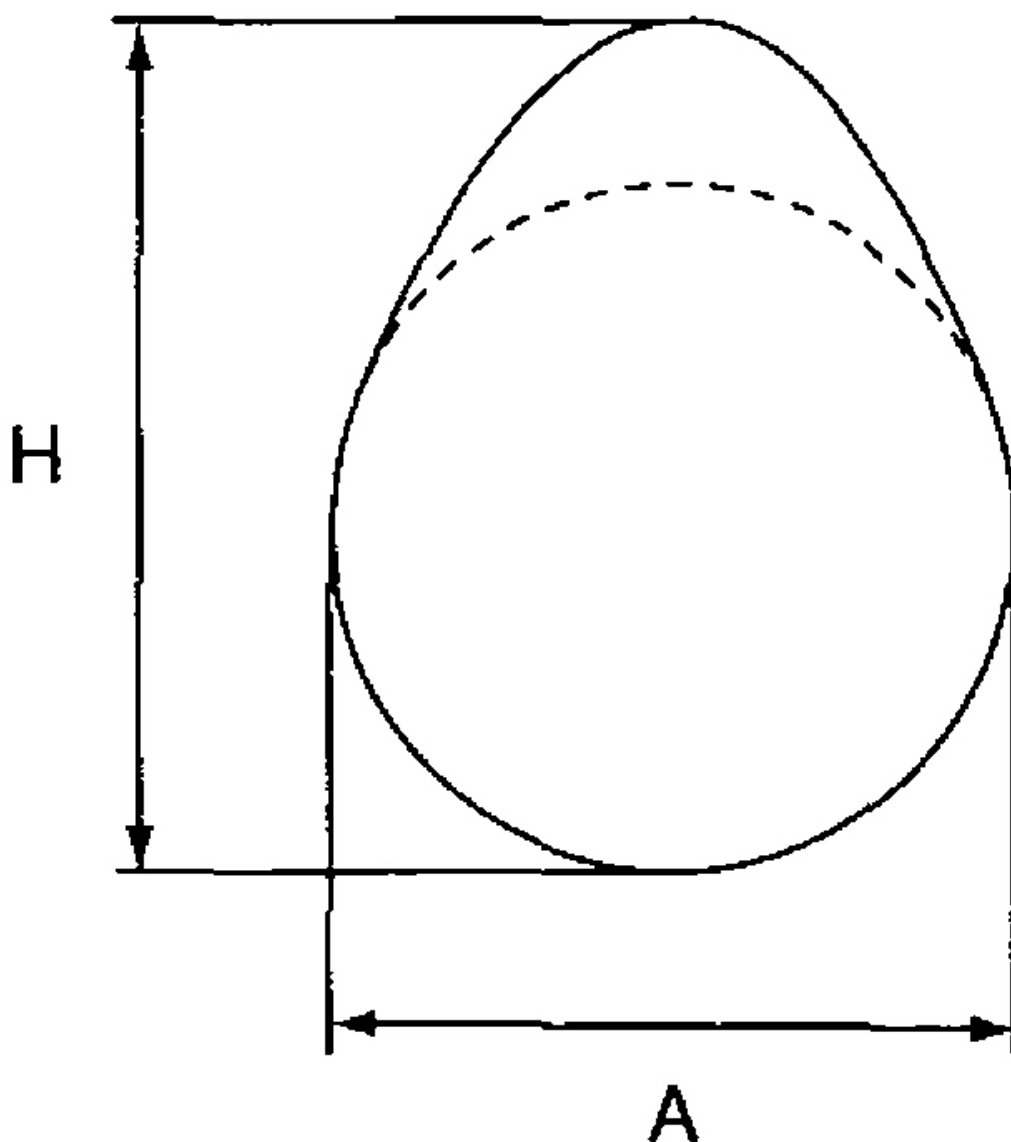
PARTS SPECIFICATION

Parts		Unit: mm (in)
Intake	Standard	39.485 - 39.585 (1.5545 - 1.5585)
	Limit	39.385(1.5506)
Exhaust	Standard	39.720 - 39.820 (1.5491 --1.5530)
	Limit	39.620(1.5598)

Cam base circle diameter A:

Intake: 34.00 mm (1.3386 in)

Exhaust: 34.00 mm (1.3386 in)



G03812946

Fig. 156: Measuring Camshaft
Courtesy of SUBARU OF AMERICA, INC.

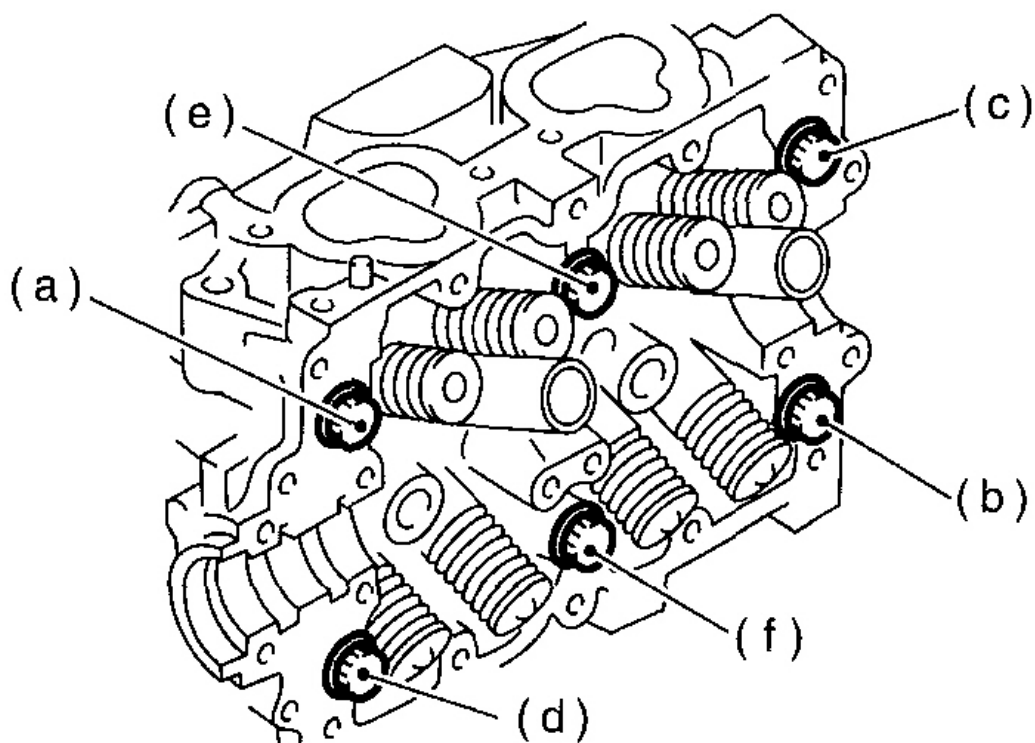
CAMSHAFT SUPPORT

Measure the side clearance of camshaft with setting the dial gauge at end of camshaft. If side clearance exceeds the limit, replace the camshaft support.

Standard:**0.030 - 0.090 mm (0.0012 - 0.0035 in)****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 **Fig. 157** .

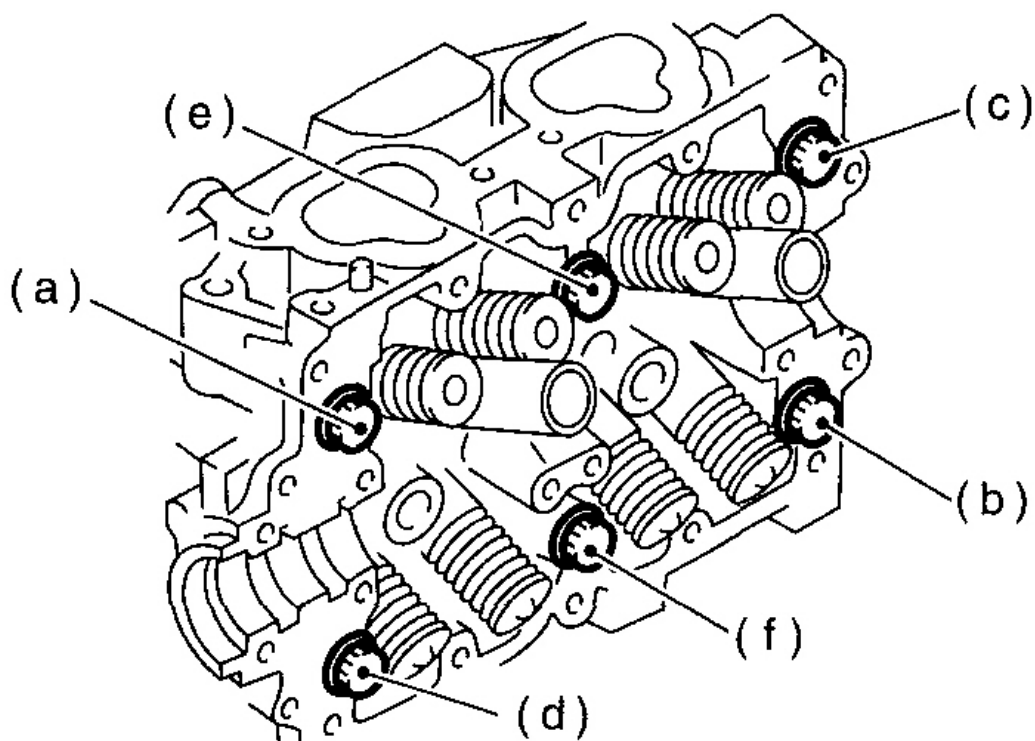
NOTE: **Leave bolts (a) and (c) engaged by three or four threads to prevent the cylinder head from falling.**



G03812947

Fig. 157: Removing Cylinder Head Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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



G03812948

Fig. 158: Removing Cylinder Head

Courtesy of SUBARU OF AMERICA, INC.

13. Remove the cylinder head gasket.

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

14. Similarly, remove the right side cylinder head.

INSTALLATION

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

CAUTION:

- 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.

- a. Apply a coat of engine oil to washers and bolt threads.
- b. Tighten all bolts to 29 N.m (3.0 kgf-m, 22 ft-lb) in alphabetical sequence.

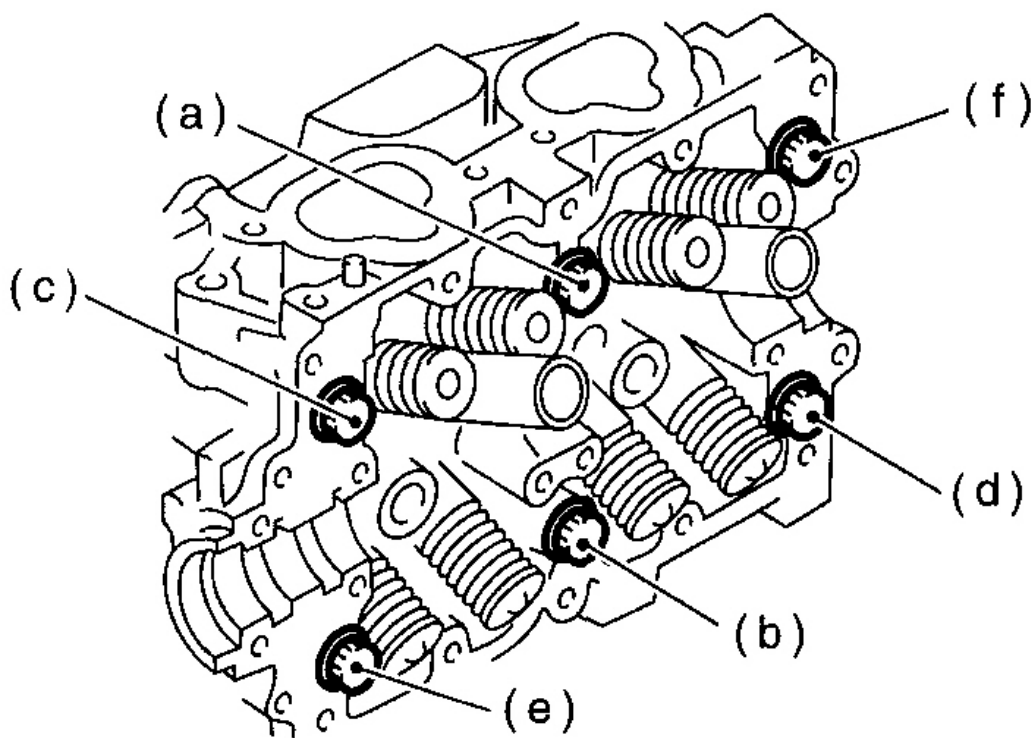
Then tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.

- c. Back off all bolts by 180° in reverse order of installation, and back them off again by 180°.
- d. Tighten all bolts to 42 N.m (3.9 kgf-m, 31 ft-lb) in alphabetical sequence.
- e. Tighten all bolts by 80° - 90° in alphabetical sequence.
- f. Tighten all bolts by 40° - 45° in alphabetical sequence.

NOTE: **Do not tighten the bolts more than 45°.**

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

NOTE: **Ensure the total +"re-tightening angle" in the [former two steps], do not exceed 90°.**



G03812949

Fig. 159: Applying A Coat Of Engine Oil To Washers
Courtesy of SUBARU OF AMERICA, INC.

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.
- Use extreme care not to damage the lips of the intake valve oil seals and exhaust valve oil seals.

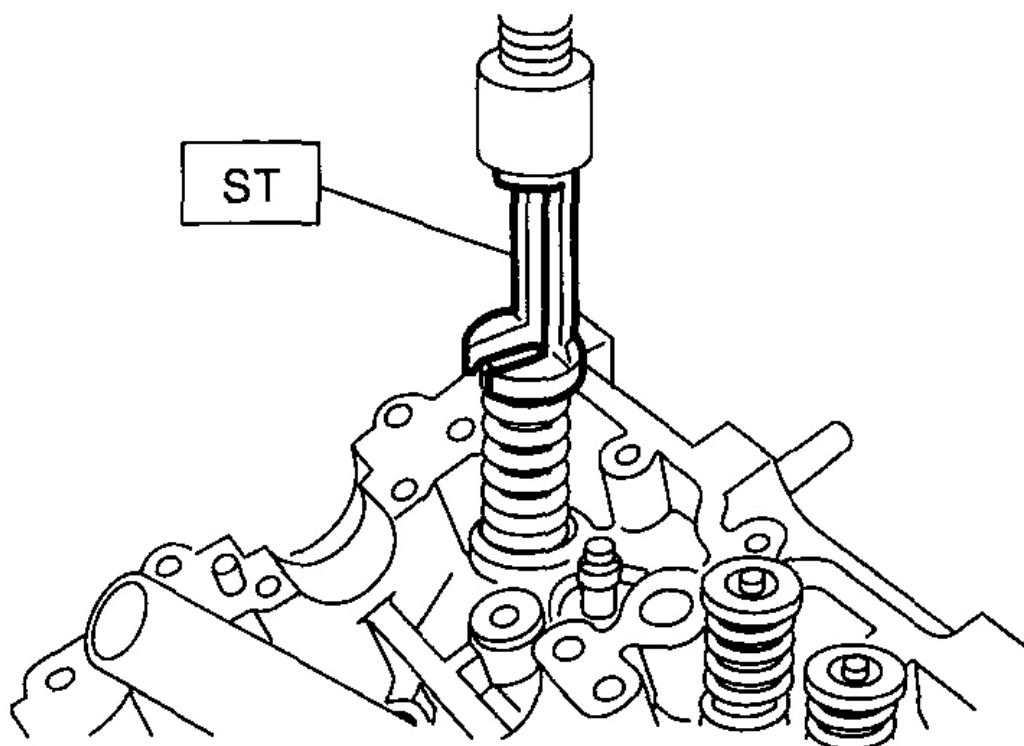
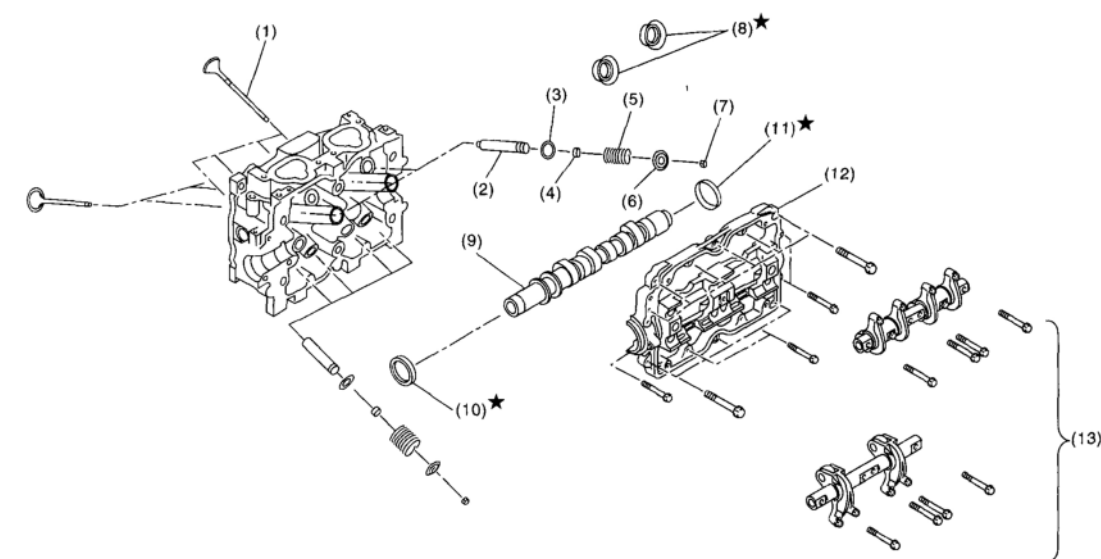
**G03812950**

Fig. 160: Removing Valve And Valve Spring Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



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

G03812951

Fig. 161: Exploded View Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

1. Installation of valve spring and valve:
 - a. Place the cylinder head on the ST.

ST 498267800 CYLINDER HEAD TABLE

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

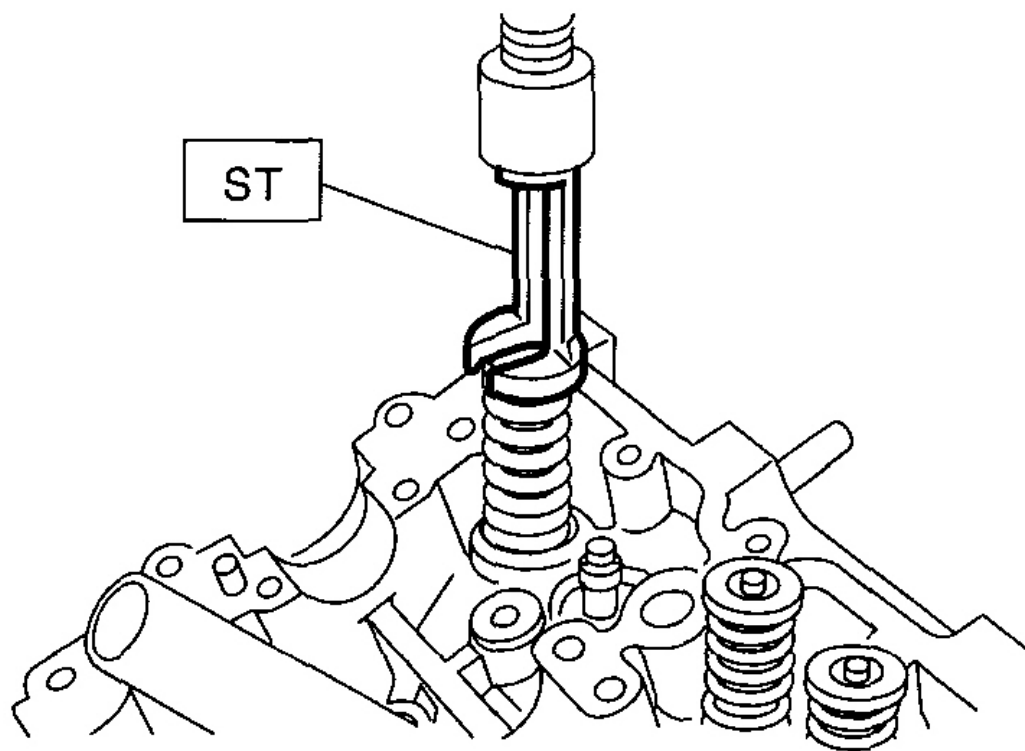
CAUTION: Use extreme care not to damage the oil lips when inserting the valve into valve guide.

- c. Install the valve spring and retainer.

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

- d. Set the ST on valve spring.

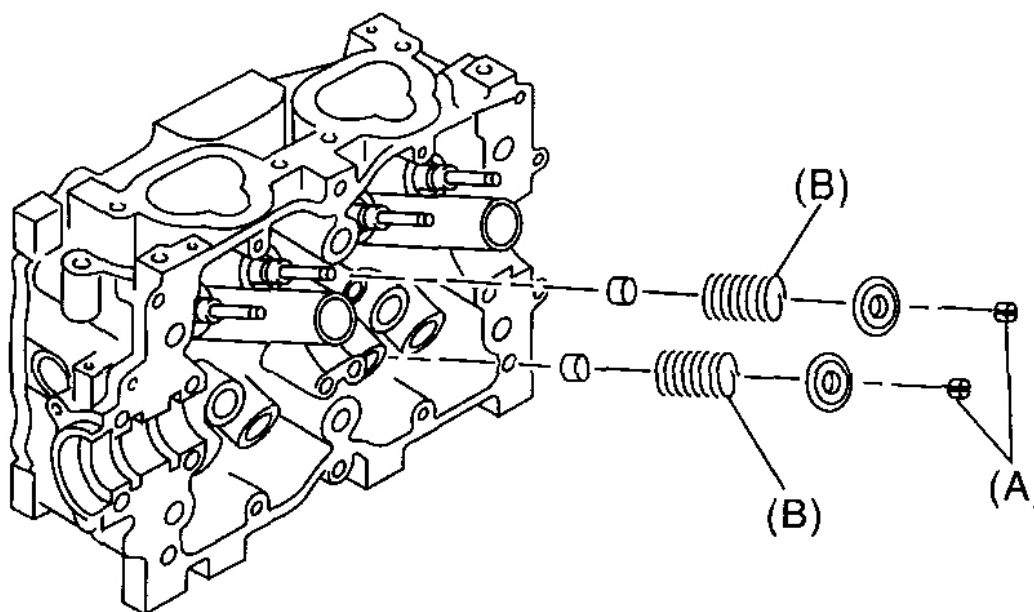
ST 499718000 VALVE SPRING REMOVER



G03812952

Fig. 162: Installing Valve Spring And Retainer Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

- e. Compress the valve spring and fit the valve spring retainer key.



(A) Retainer key

(B) Valve springs

G03812953

Fig. 163: Compressing Valve Spring And Fit Valve Spring Retainer Key
Courtesy of SUBARU OF AMERICA, INC.

- f. 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 exist. In addition to visual inspection, inspect important areas by means of red lead check.

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)

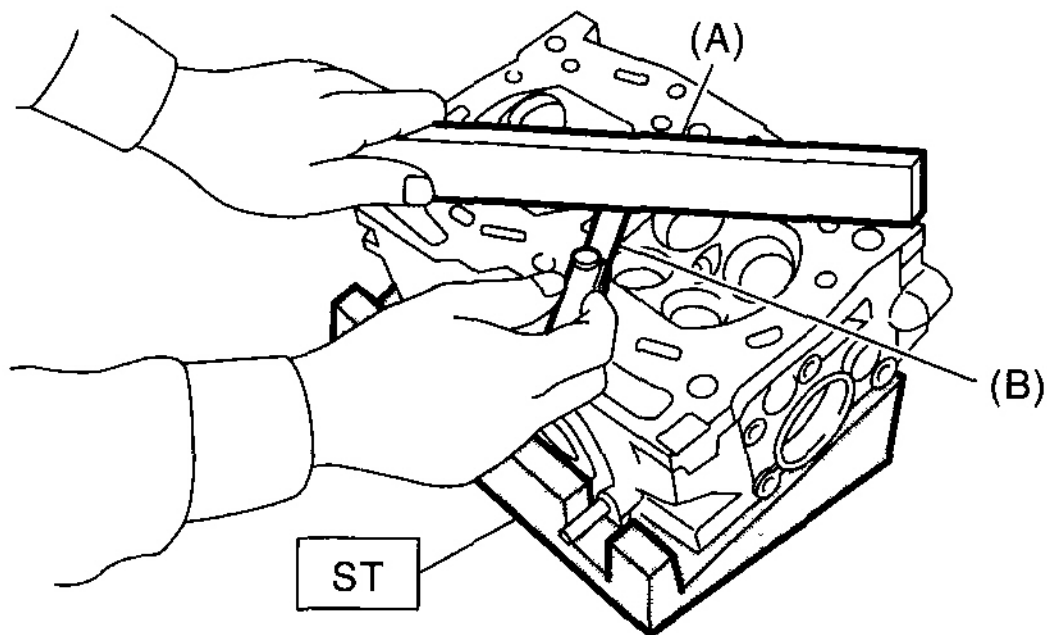
Grinding limit:

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

G03812954

Fig. 164: Measuring Warping Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Valve seat width W:

Standard

Intake (A)

0.8 - 1.4 mm (0.03 - 0.055 in)

Exhaust (B)

1.2 - 1.8 mm (0.047-- 0.071 in)

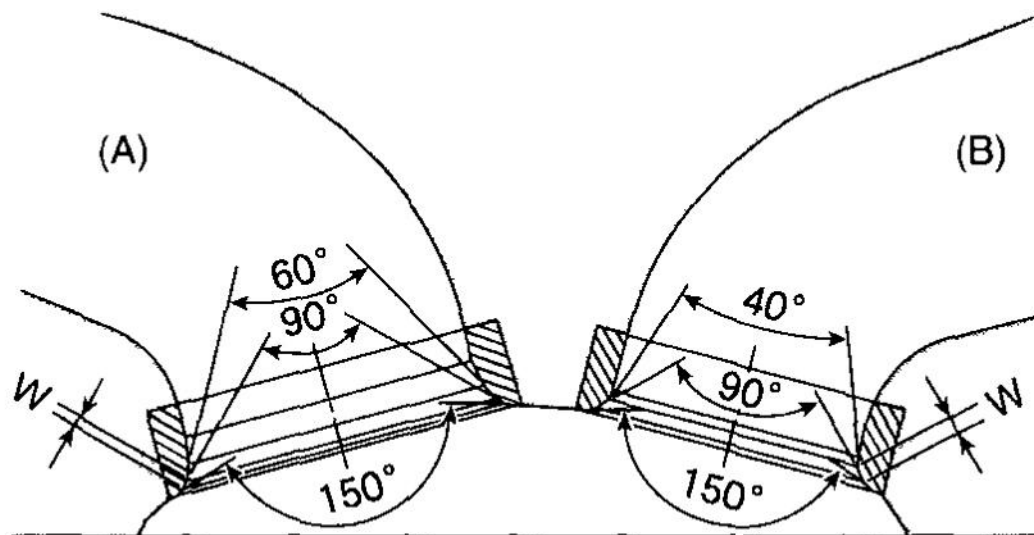
Limit

Intake (A)

1.7 mm (0.067 in)

Exhaust (B)

2.2 mm (0.087 in)



G03812955

Fig. 165: Identifying Valve Seat Width
Courtesy of SUBARU OF AMERICA, INC.

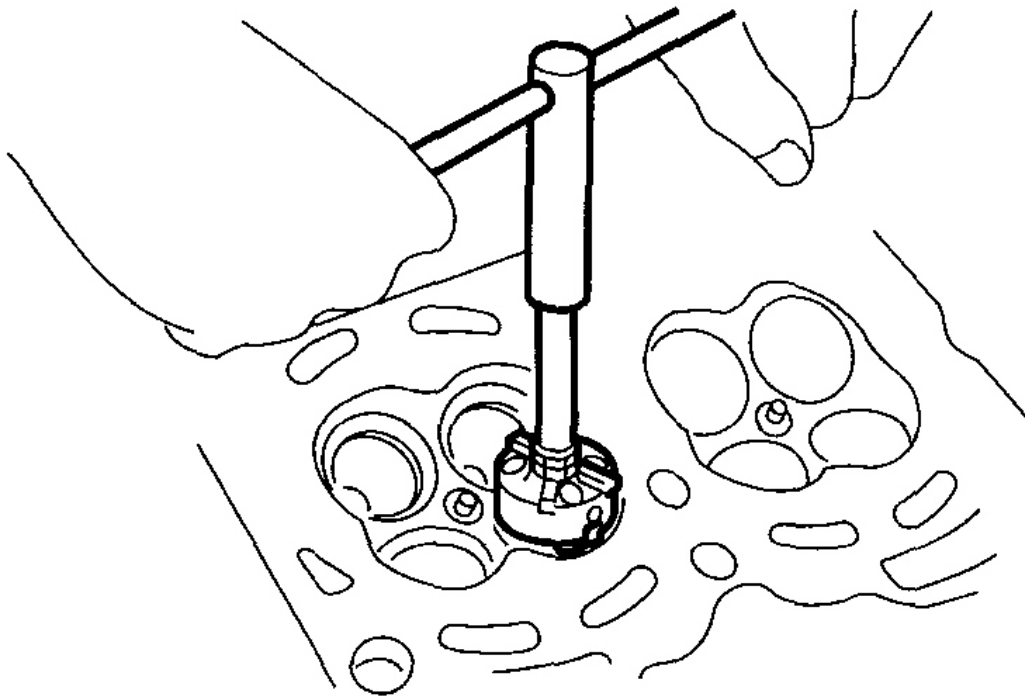
**G03812956**

Fig. 166: Identifying Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

Clearance between the valve guide and valve stem:

Standard

Intake

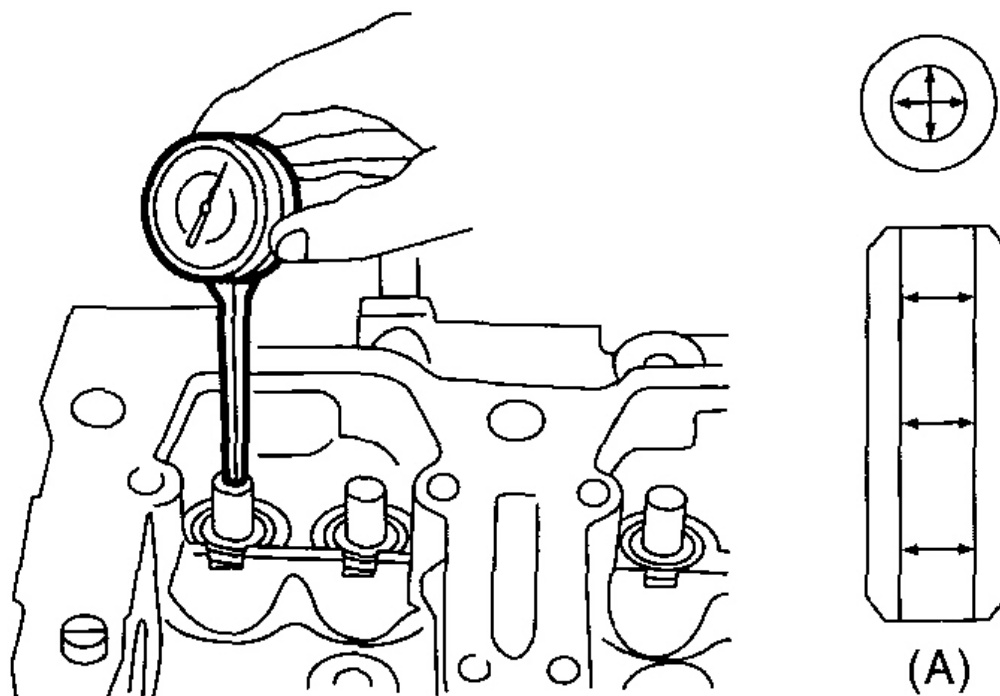
0.035 - 0.062 mm (0.0014 - 0.0024 in)

Exhaust

0.040 - 0.067 mm (0.0016 - 0.0026 in)

Limit

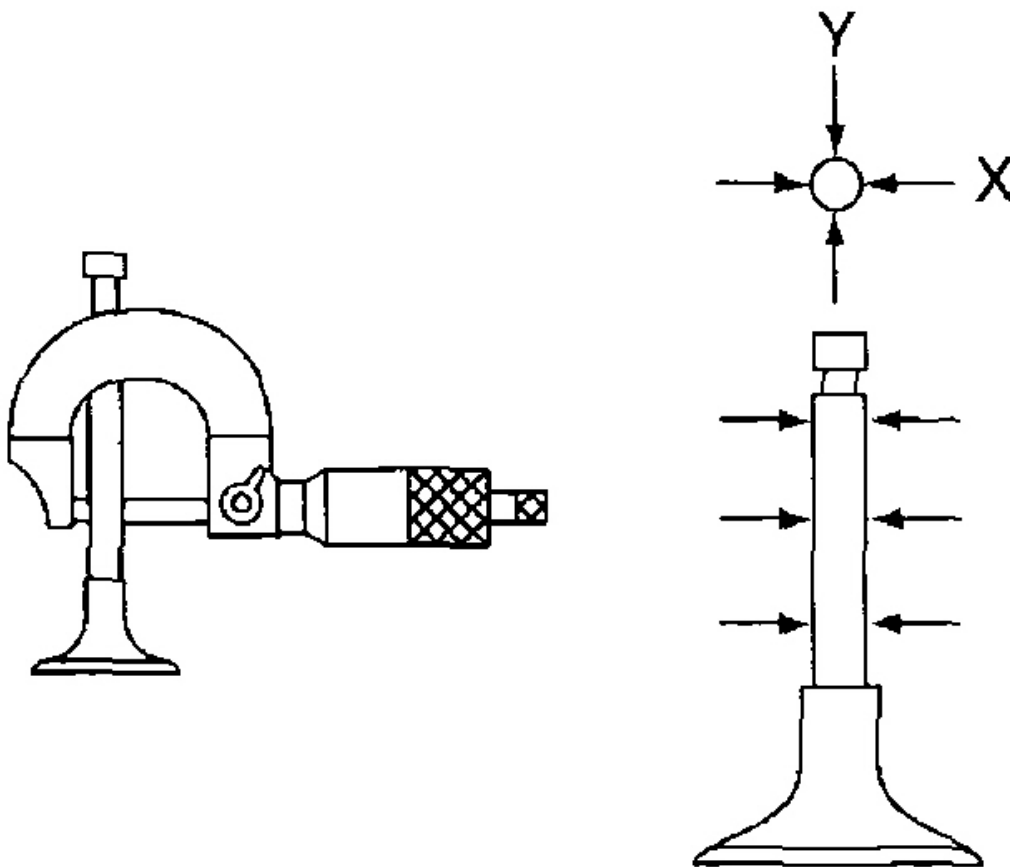
0.15 mm (0.059 in)



(A) Valve guide

G03812957

Fig. 167: Checking Clearance Between Valve Guide And Stem
Courtesy of SUBARU OF AMERICA, INC.



G03812958

Fig. 168: Measuring Valve Width
Courtesy of SUBARU OF AMERICA, INC.

2. If the clearance between valve guide and stem exceeds the standard value, 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

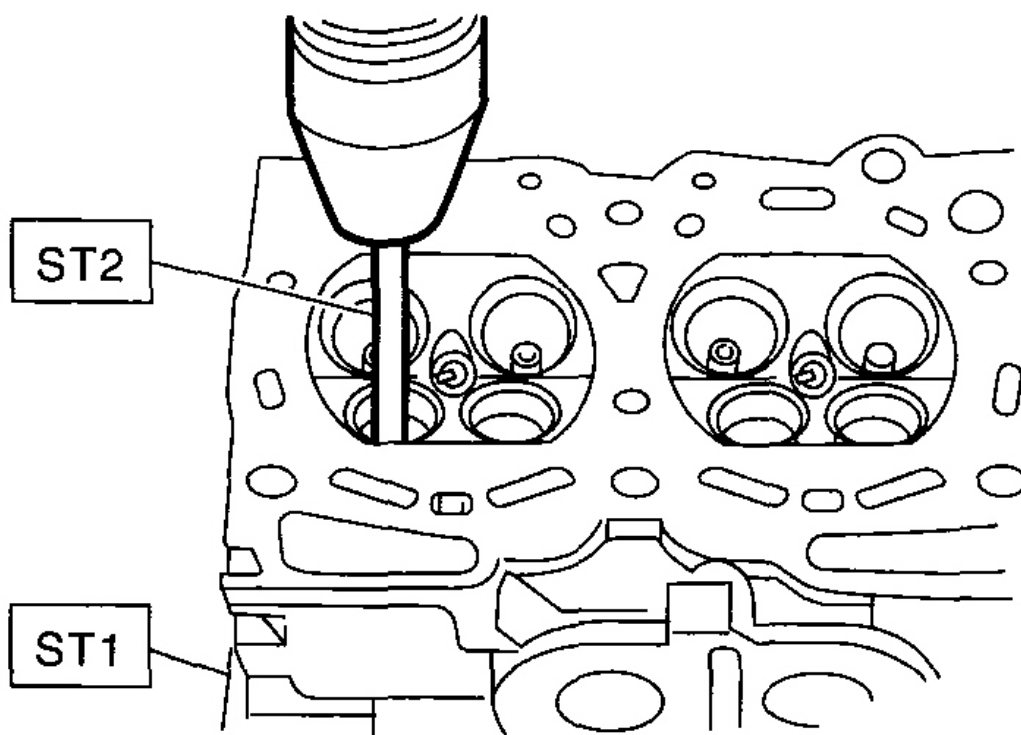
5.950 - 5.965 mm (0.2343 - 0.2348 in) Exhaust

5.945 - 5.960 mm (0.2341 - 0.2346 in)

- a. Place the cylinder head on ST1 with the combustion chamber upward so that valve guides enter the holes in ST1.
- b. Insert ST2 into the valve guide and press it down to remove the valve guide.

ST1 498267800 CYLINDER HEAD TABLE

ST2 499767200 VALVE GUIDE REMOVER



G03812959

Fig. 169: Removing Valve Guide Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

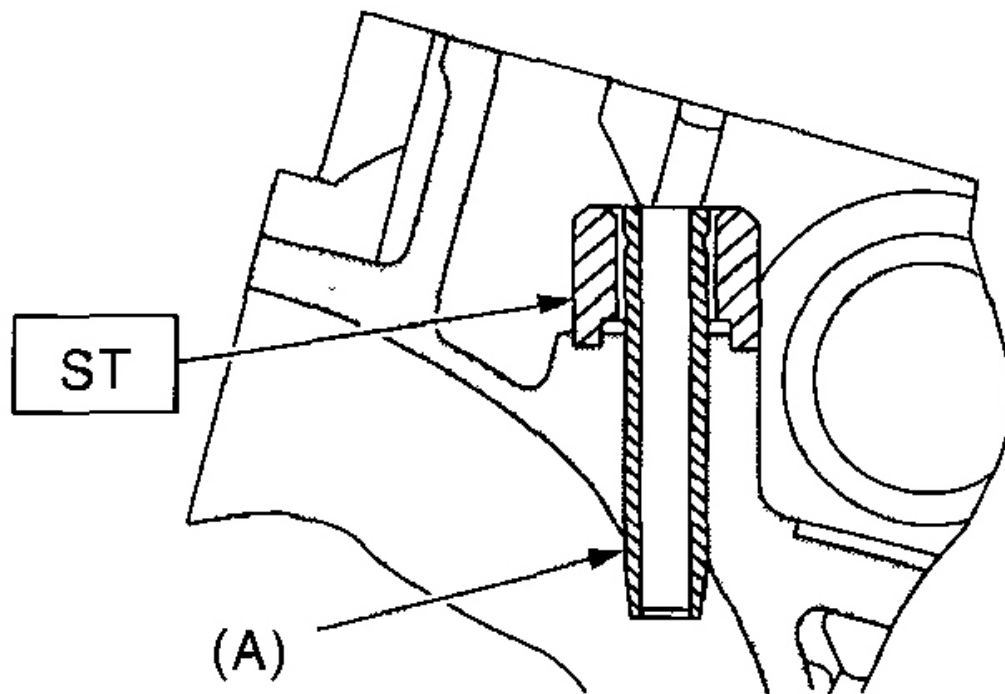
- c. Turn the cylinder head upside down and place the ST as shown in **Fig. 170**.

Intake side:

ST 499767700 VALVE GUIDE ADJUSTER

Exhaust side:

ST 499767800 VALVE GUIDE ADJUSTER



(A) Valve guide

G03812960

Fig. 170: Turning Cylinder Head Upside Down Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

- d. Before installing a new valve guide, make sure that neither scratches nor damages exist on the inside surface of the valve guide holes in cylinder head.
- e. 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

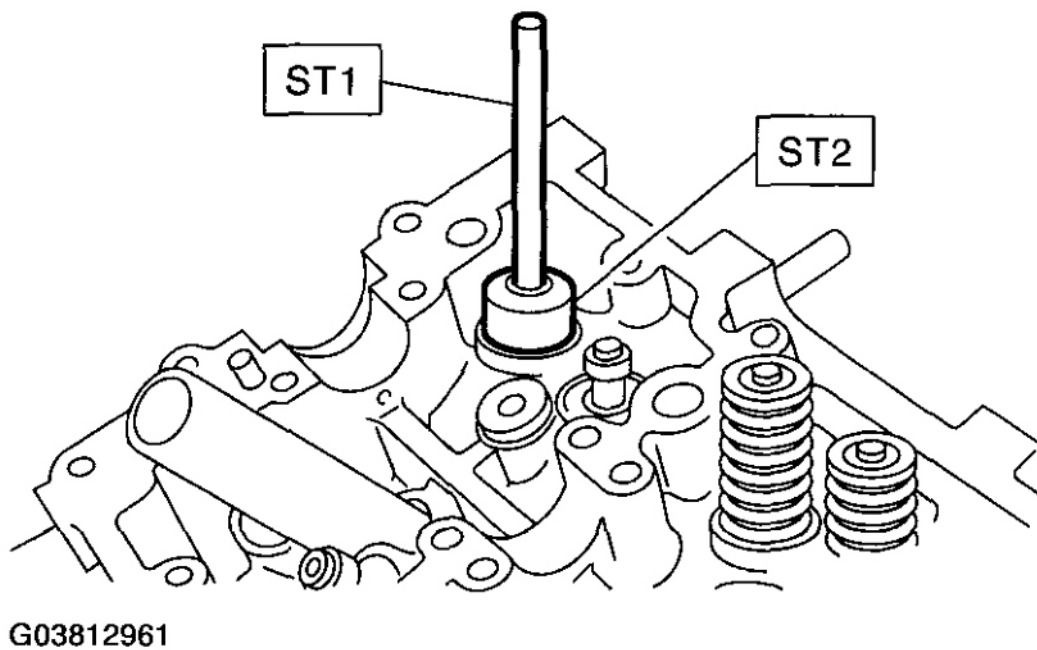


Fig. 171: Installing A New Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

- f. Check the valve guide protrusion.

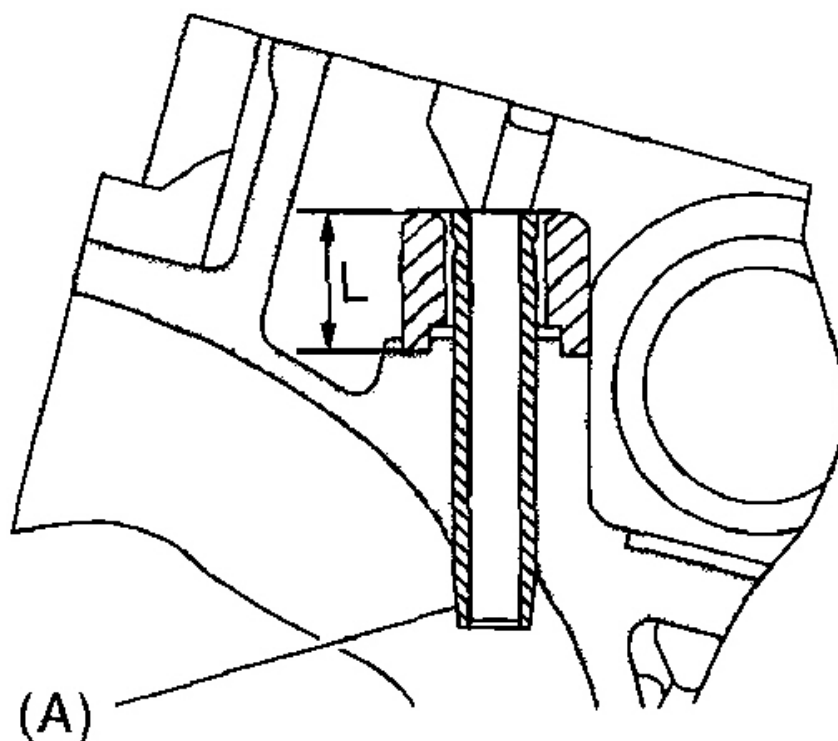
Valve guide protrusion L:

Intake

20.0 - 21.0 mm (0.787 - 0.827 in)

Exhaust

16.5 - 17.5 mm (0.650 - 0.689 in)



(A) Valve guide

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Fig. 172: Checking Valve Guide Protrusion
Courtesy of SUBARU OF AMERICA, INC.

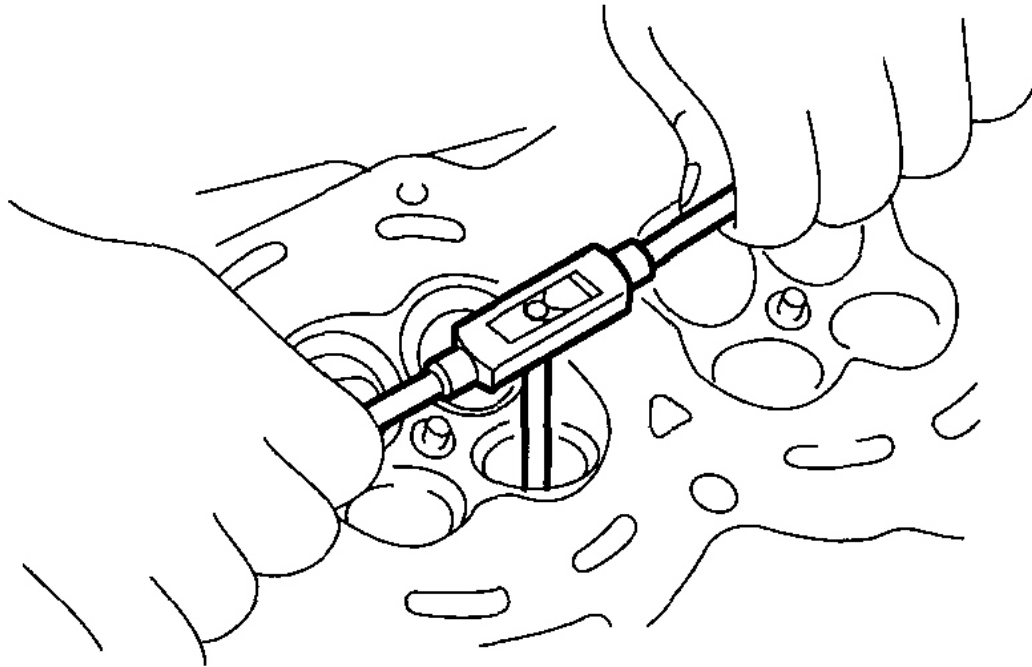
- g. Ream the inside of valve guide using ST. Put the reamer in valve guide, and rotate the reamer slowly clockwise while pushing it lightly. Bring the reamer back while rotating it clockwise. After reaming, clean the valve guide to remove chips.

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 the valve guide becomes lustrous and the reamer does not chip, use a new reamer or remedy

the reamer.

ST 499767400 VALVE GUIDE REAMER



G03812963

Fig. 173: Reaming Inside Of Valve Guide Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

- h. 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" exceed the standard value.

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)

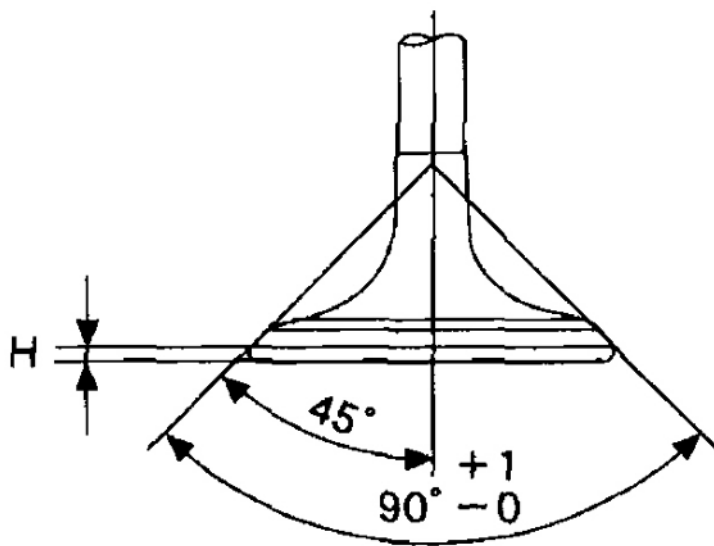
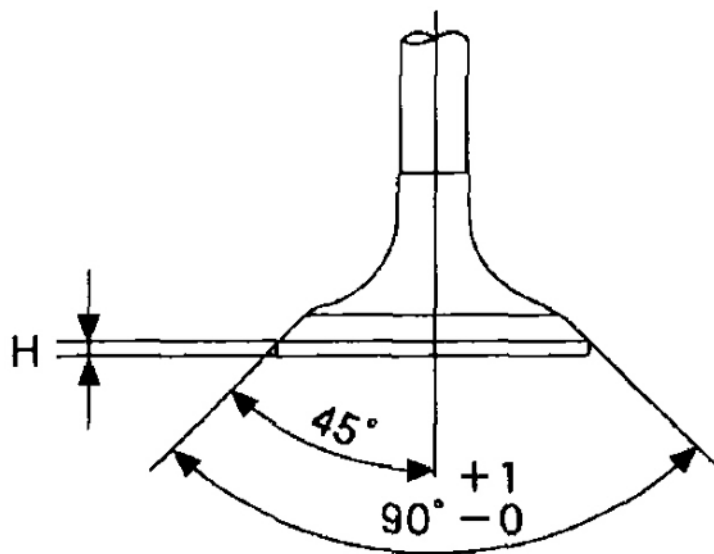
Valve overall length:

Intake

120.6 mm (4.75 in)

Exhaust

121.7 mm (4.79 in)



G03812964

Fig. 174: Inspecting Intake And Exhaust Valve
Courtesy of SUBARU OF AMERICA, INC.

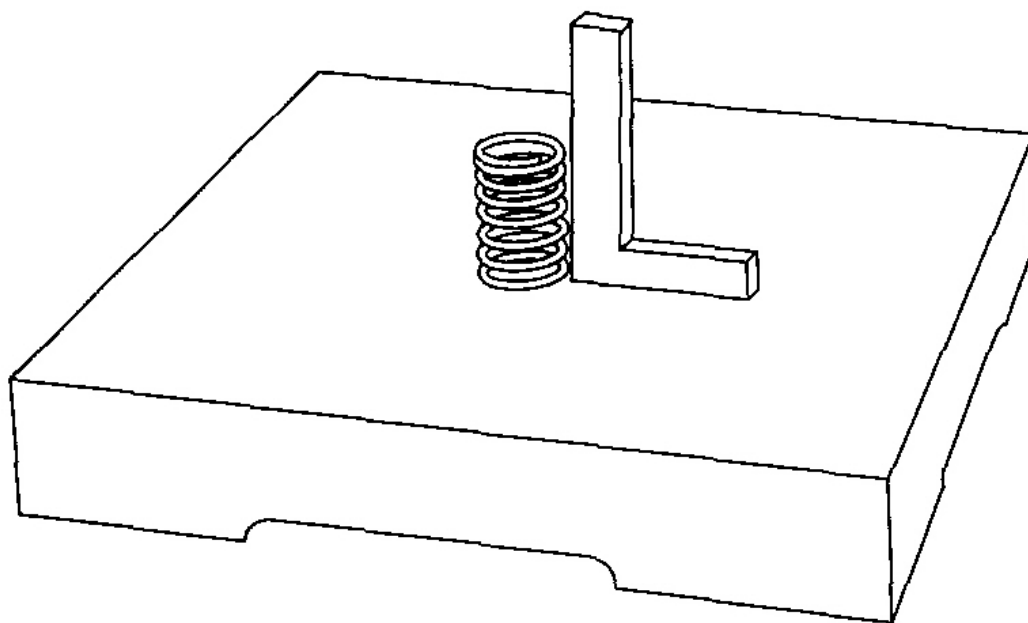
- Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. < Ref. to , **VALVE SEAT**, INSPECTION, Cylinder Head. > Install a new intake valve oil seal after lapping.

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.

FREE LENGTH SPECIFICATION

Free length	mm (in)	54.30 (2.1378)
Tension/spring height	Set	214 - 246 (22 - 25, 48 - 55)/45.0 (1.772)
N (kgf, lb)/mm (in)	Lift	526 - 582 (54 - 59, 119 --130)/34.7 (1.366)
Squareness		2.5°, 2.4 mm (0.094 in) or less



G03812965

Fig. 175: Checking Valve Springs
 Courtesy of SUBARU OF AMERICA, INC.

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 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.**

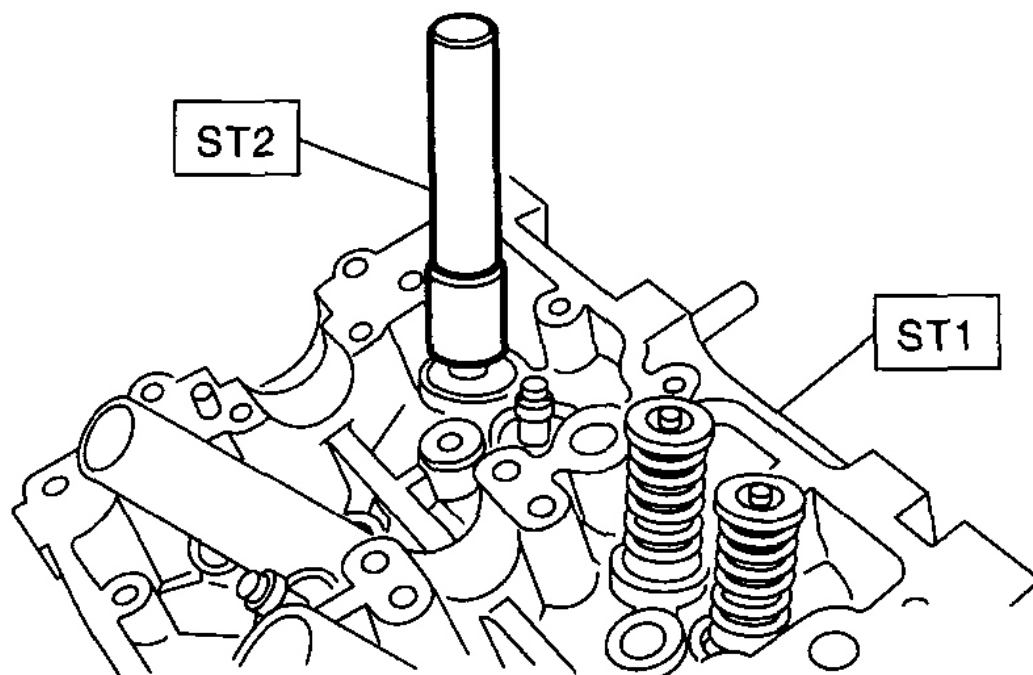
ST1 498267800 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

Color of rubber part:

Intake [Black] or [Gray]

Exhaust [Brown] or [Green]



G03812966

Fig. 176: Identifying Intake

Courtesy of SUBARU OF AMERICA, INC.

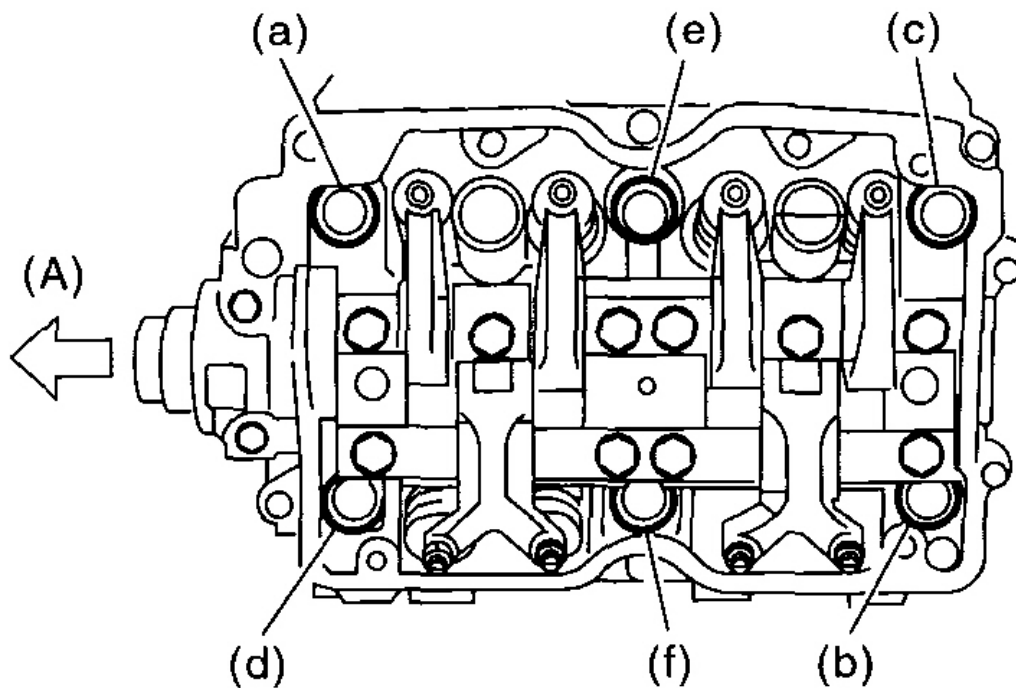
CYLINDER BLOCK

REMOVAL

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

1. Remove the intake manifold. < Ref. to **REMOVAL**, Intake Manifold. >
2. Remove the V-belts. < Ref. to , **REMOVAL**, 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 as shown in **Fig. 177** .

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

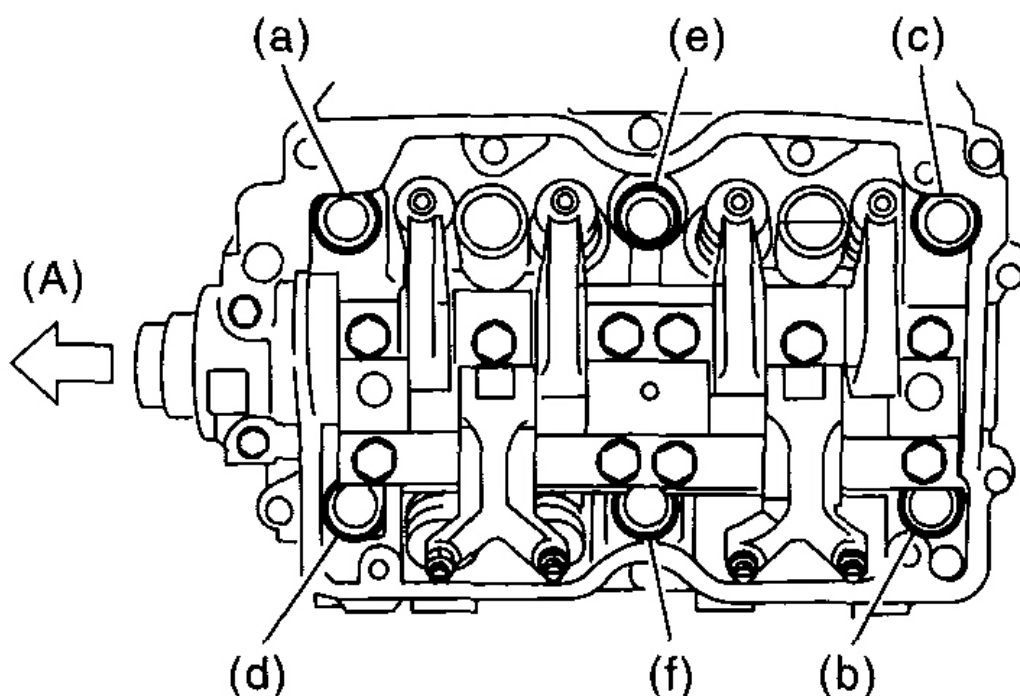


(A) Front side

G03812967

Fig. 177: Removing Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front side

G03812968

Fig. 178: Removing Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the cylinder head gasket.

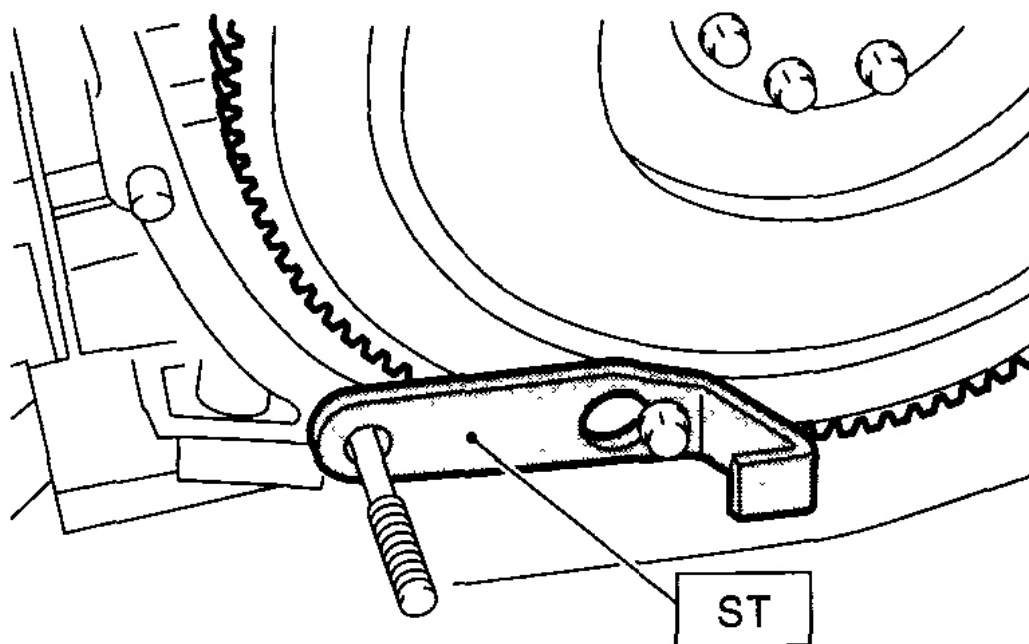
NOTE: Do not scratch the mating surface of cylinder head and cylinder block.

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

Lock the crankshaft using ST.

ST 498497100 CRANKSHAFT STOPPER

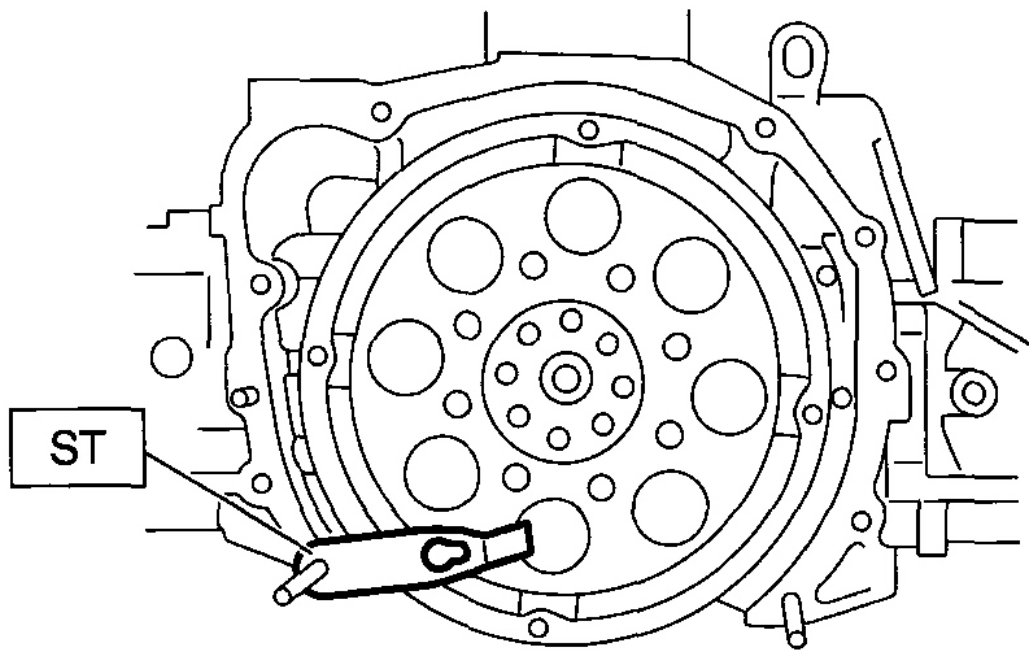
- MT model



G03812969

Fig. 179: Locking Crankshaft Using Special Tool (MT)
Courtesy of SUBARU OF AMERICA, INC.

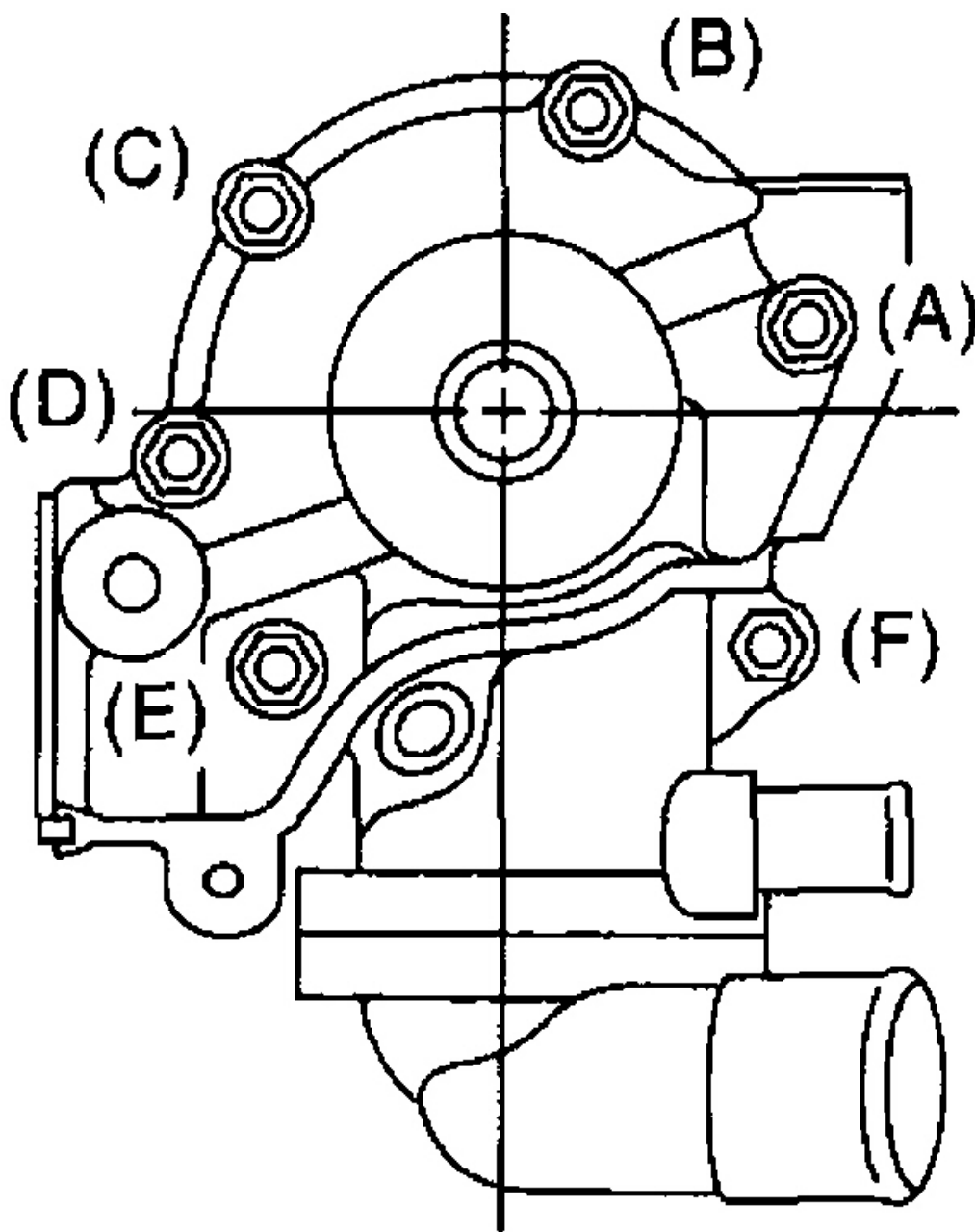
- AT model



G03812970

Fig. 180: Locking Crankshaft Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the oil separator cover.
18. Remove the water by-pass pipe for heater.
19. Remove the water pump after loosening the bolts in alphabetical sequence as shown in **Fig. 181** .

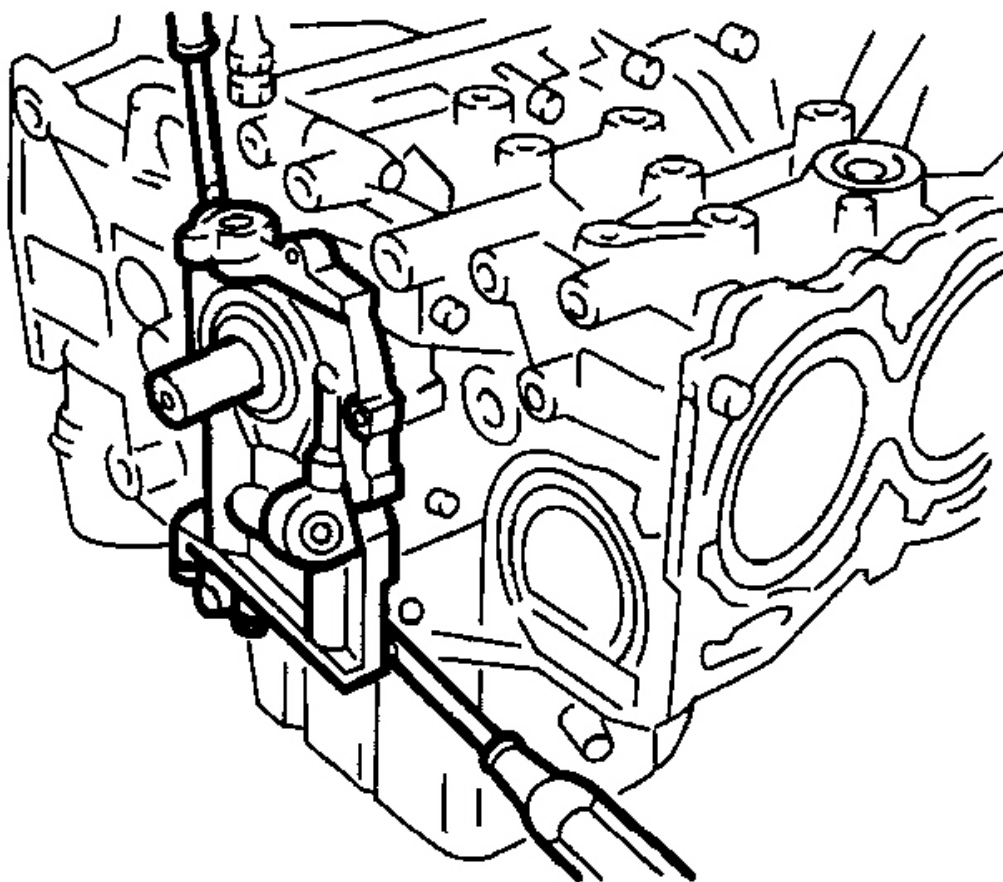


G03812971

Fig. 181: Removing Water Pump
Courtesy of SUBARU OF AMERICA, INC.

20. Remove the oil pump from cylinder block. Use a flat tip screwdriver as shown in **Fig. 182** when removing the oil pump.

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



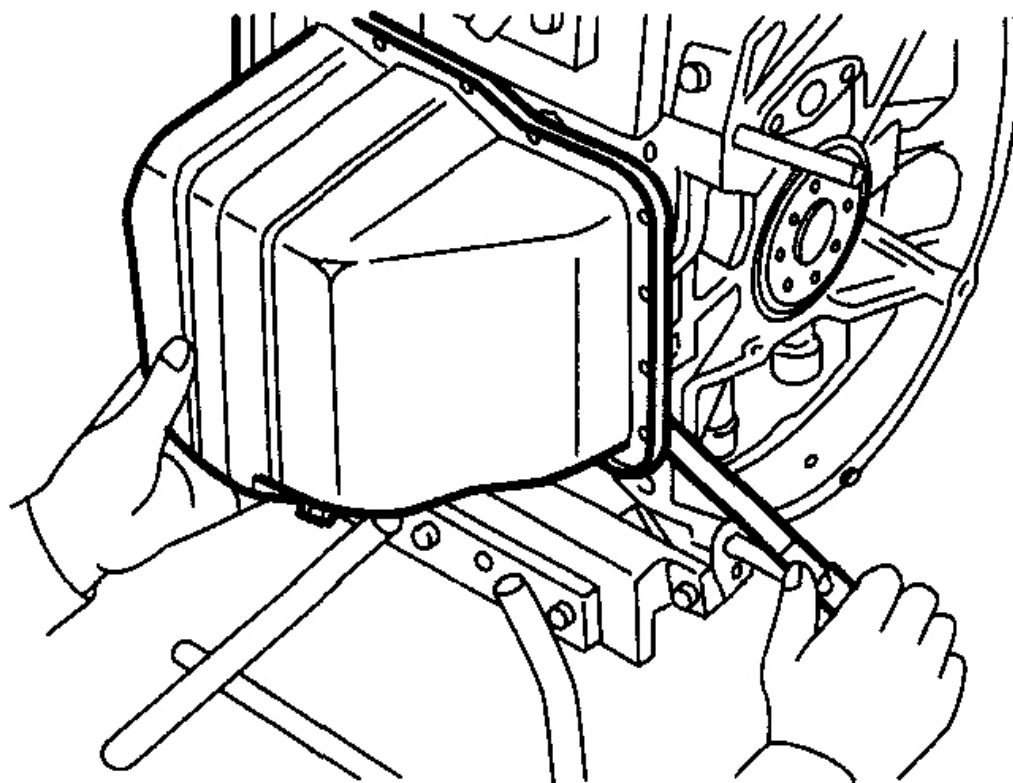
G03812972

Fig. 182: Removing Oil Pump From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

21. Remove the oil pan.
- Place the cylinder block to face the #2 and #4 piston side upward.
 - Remove the bolts which secure oil pan to cylinder block.

- c. Insert a 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.



G03812973

Fig. 183: Removing Bolts Which Secure Oil Pan To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

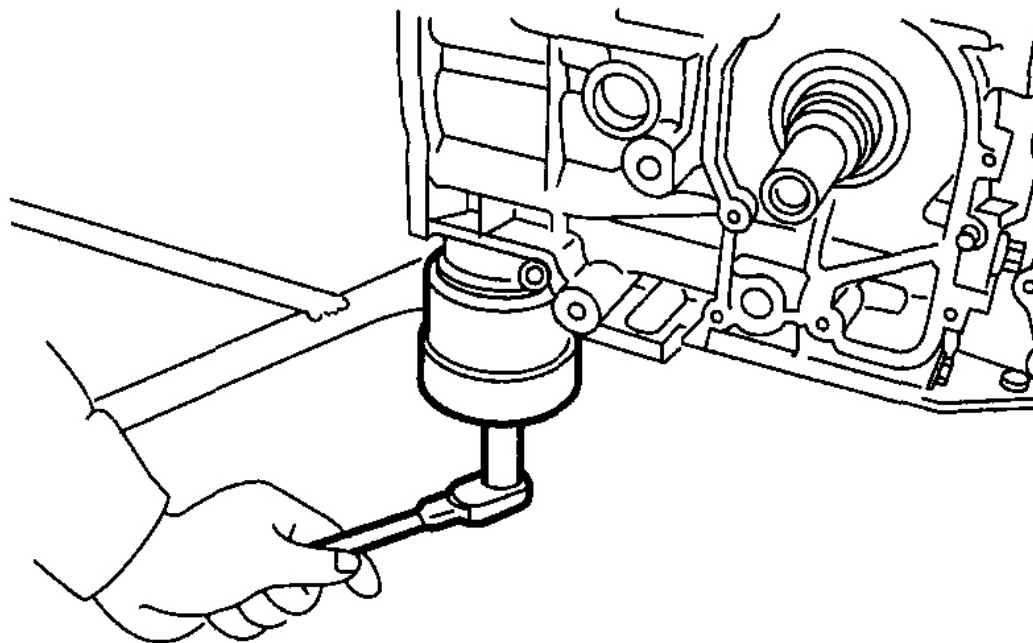
22. Remove the oil strainer stay.
23. Remove the oil strainer.
24. Remove the baffle plate.
25. Remove the oil filter using ST.

ST 18332AA000 OIL FILTER WRENCH (Outer diameter: 68 mm (2.68 in))

ST 18332AA010 OIL FILTER WRENCH (Outer diameter: 65 mm (2.56 in))

ST 498547000 OIL FILTER WRENCH (Outer diameter: 80 mm (3.15 in))

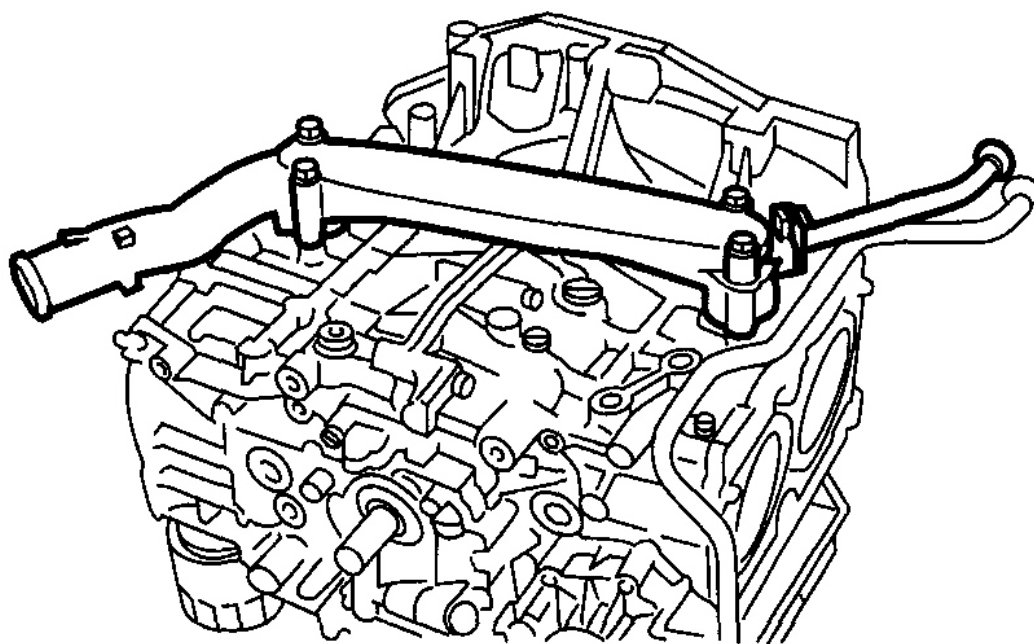
NOTE: Standard oil filter is outer diameter of 68 mm (2.68 in). However, SUBARU genuine oil filter having outer diameter of 65 mm (2.56 in) or 80 mm (3.15 in) can also be used.



G03812974

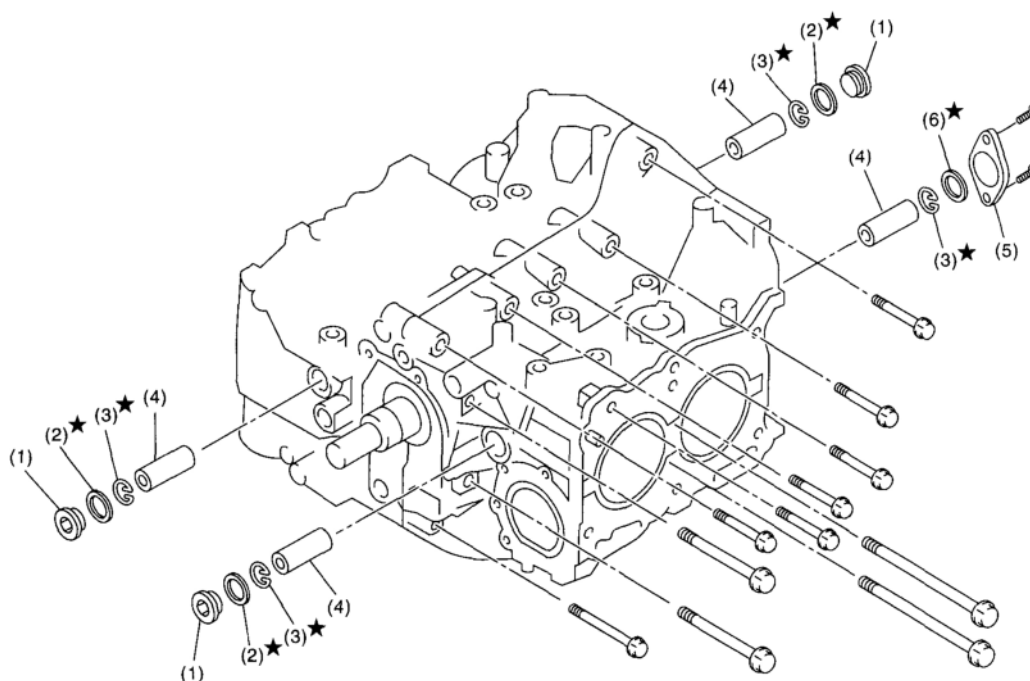
Fig. 184: Removing Oil Filter Using Special Tools
Courtesy of SUBARU OF AMERICA, INC.

26. Remove the water pipe.



G03812975

Fig. 185: Removing Water Pipe
Courtesy of SUBARU OF AMERICA, INC.



(1) Service hole plug
(2) Gasket

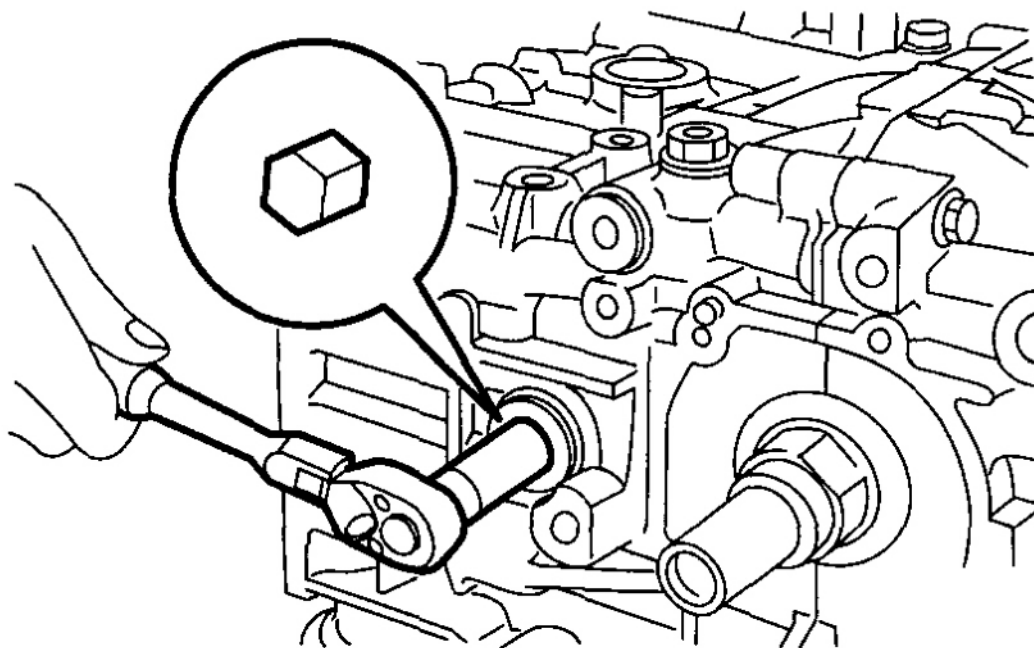
(3) Snap ring
(4) Piston pin

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

G03812976

Fig. 186: Exploded View Of Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

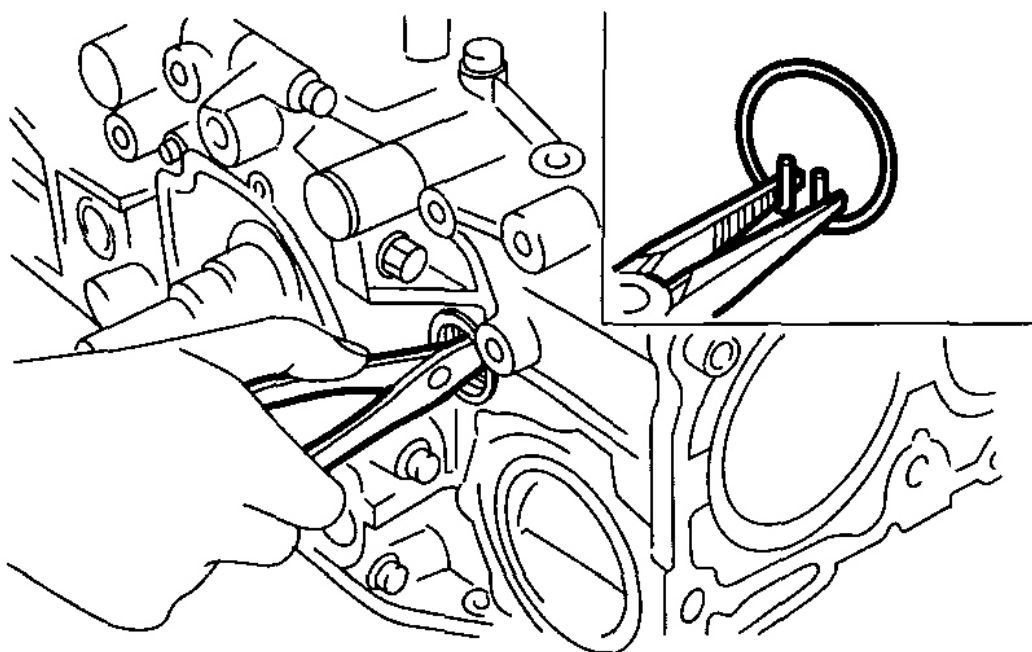
27. Remove the service hole cover and service hole plugs using a hexagon wrench (14 mm).



G03812977

Fig. 187: Removing Service Hole Cover And Service Hole Plugs
Courtesy of SUBARU OF AMERICA, INC.

28. 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.



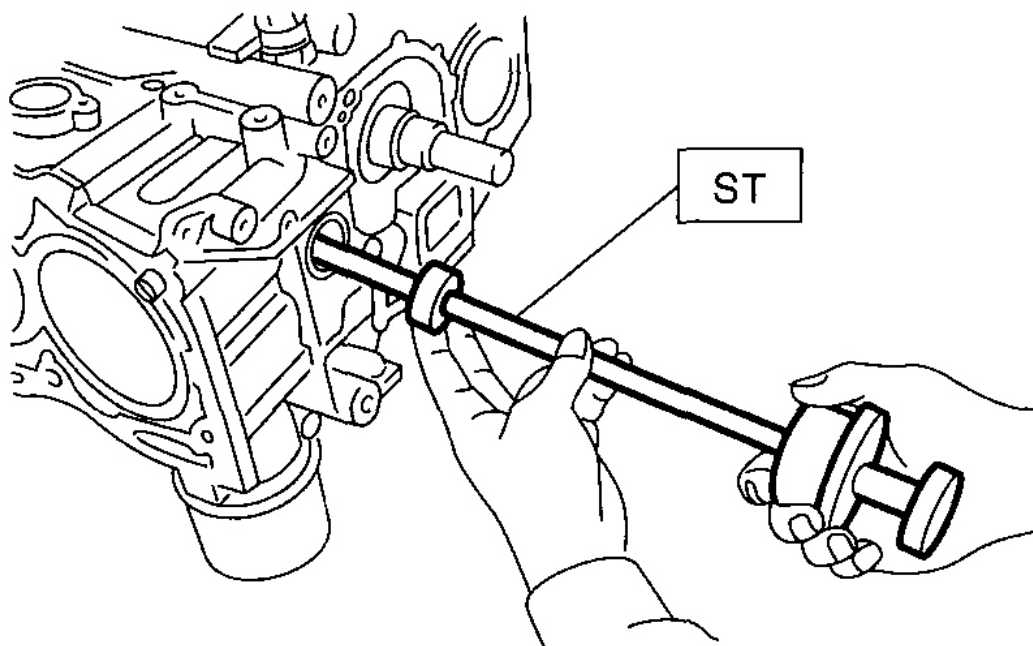
G03812978

Fig. 188: Removing Piston Snap Ring Through Service Holes
Courtesy of SUBARU OF AMERICA, INC.

29. 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.



G03812979

Fig. 189: Removing Piston Pin From #1 And #2 Pistons Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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

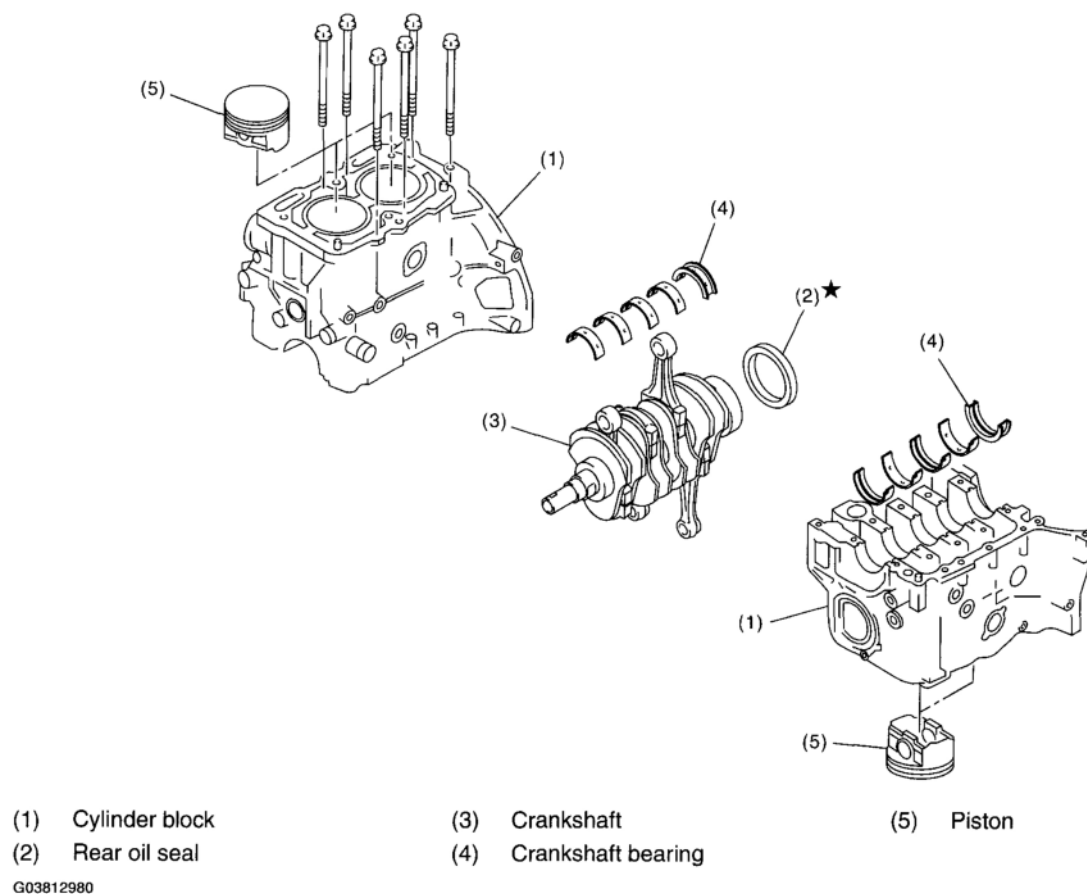


Fig. 190: Separating Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

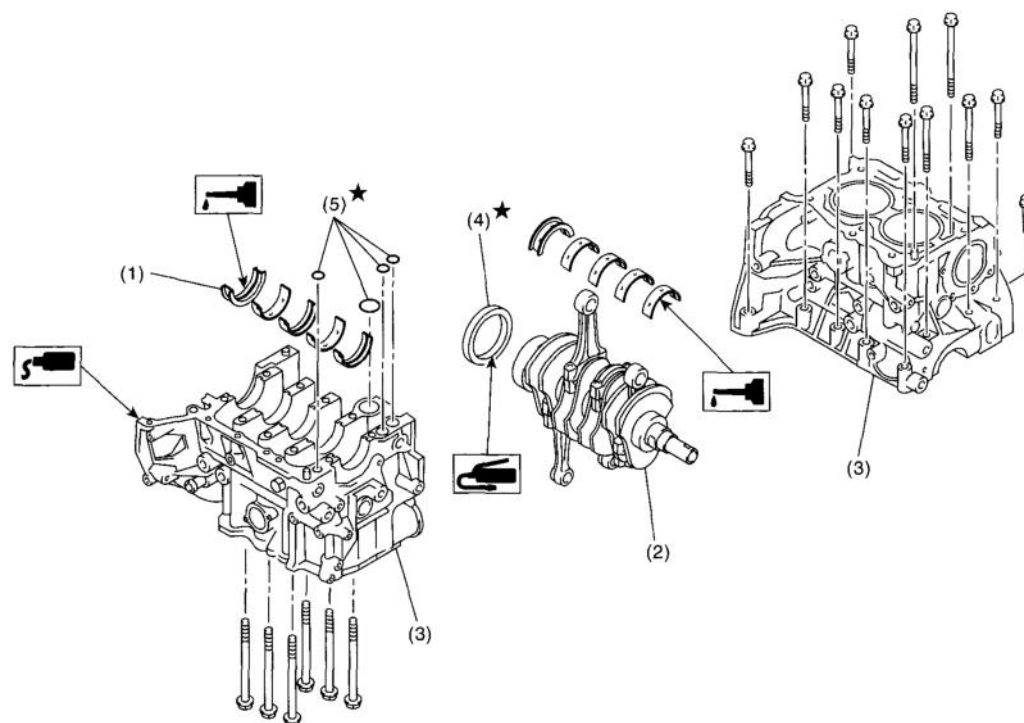
35. Remove the rear oil seal.
36. Remove the crankshaft together with connecting rod.
37. Remove the crankshaft bearings from cylinder block using a hammer handle.

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

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

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

INSTALLATION



(1) Crankshaft bearing

(2) Crankshaft

(3) Cylinder block

(4) Rear oil seal

(5) O-ring

G03812981

Fig. 191: Installing Cylinder Block

Courtesy of SUBARU OF AMERICA, INC.

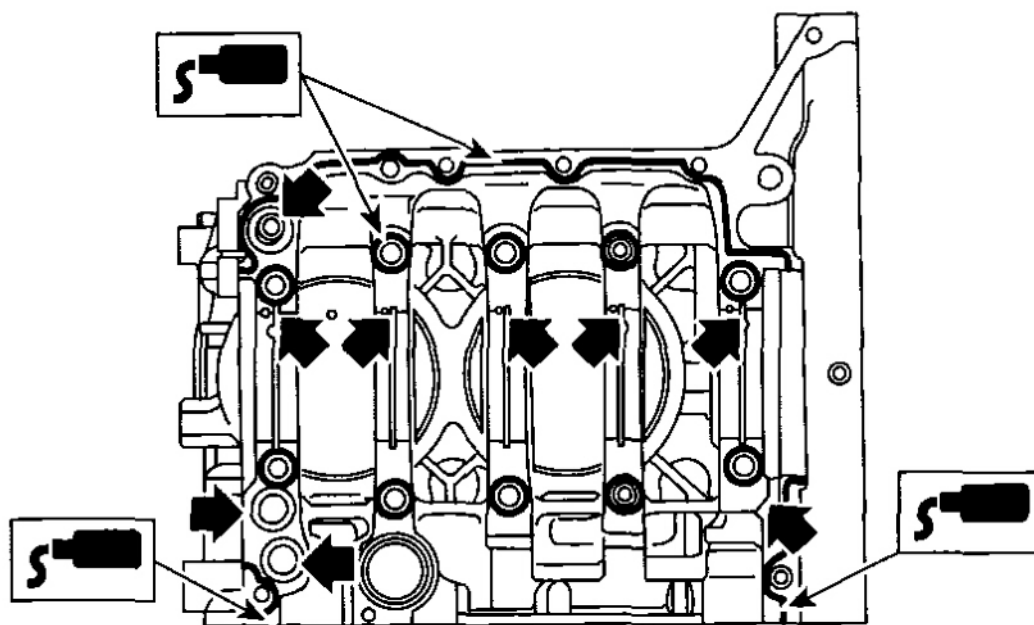
NOTE: Remove oil on the mating surface of bearing and cylinder block before installation. Apply a coat of engine oil to crankshaft pins.

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 No. 004403007) or equivalent

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



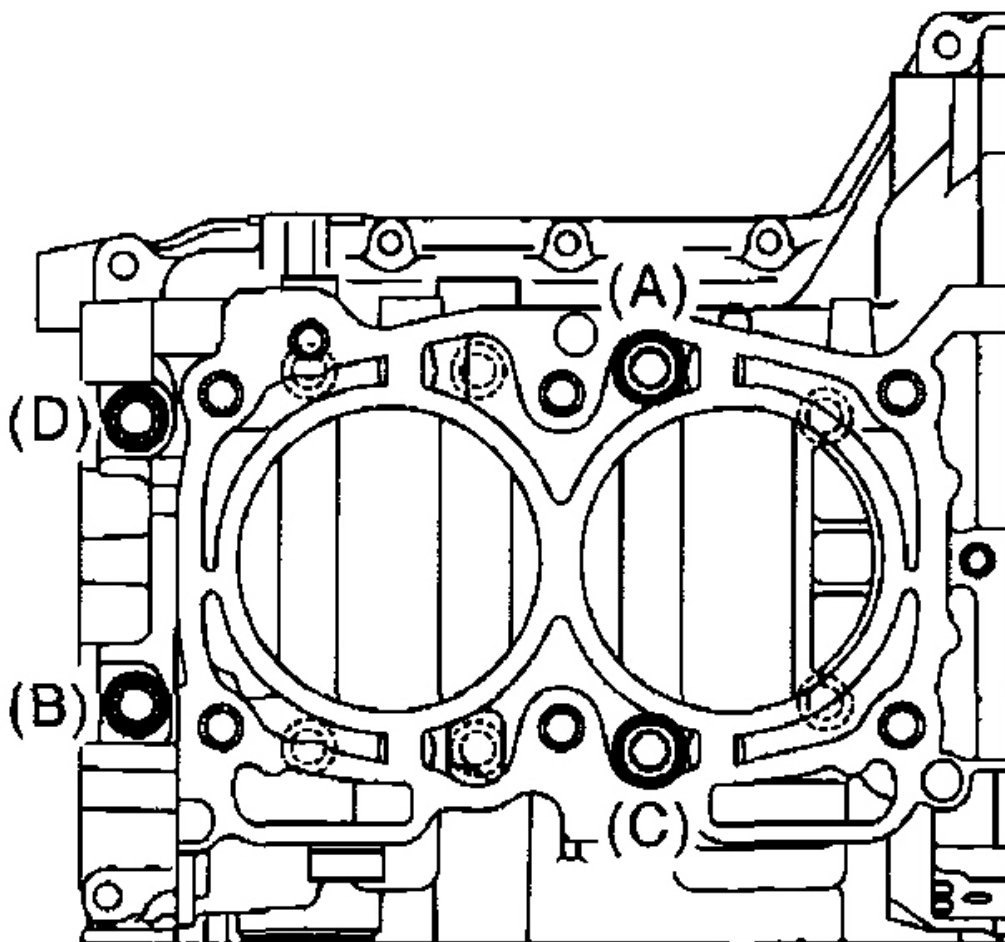
G03812982

Fig. 192: Applying Liquid Gasket To Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

3. 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, 7.4 ft-lb)



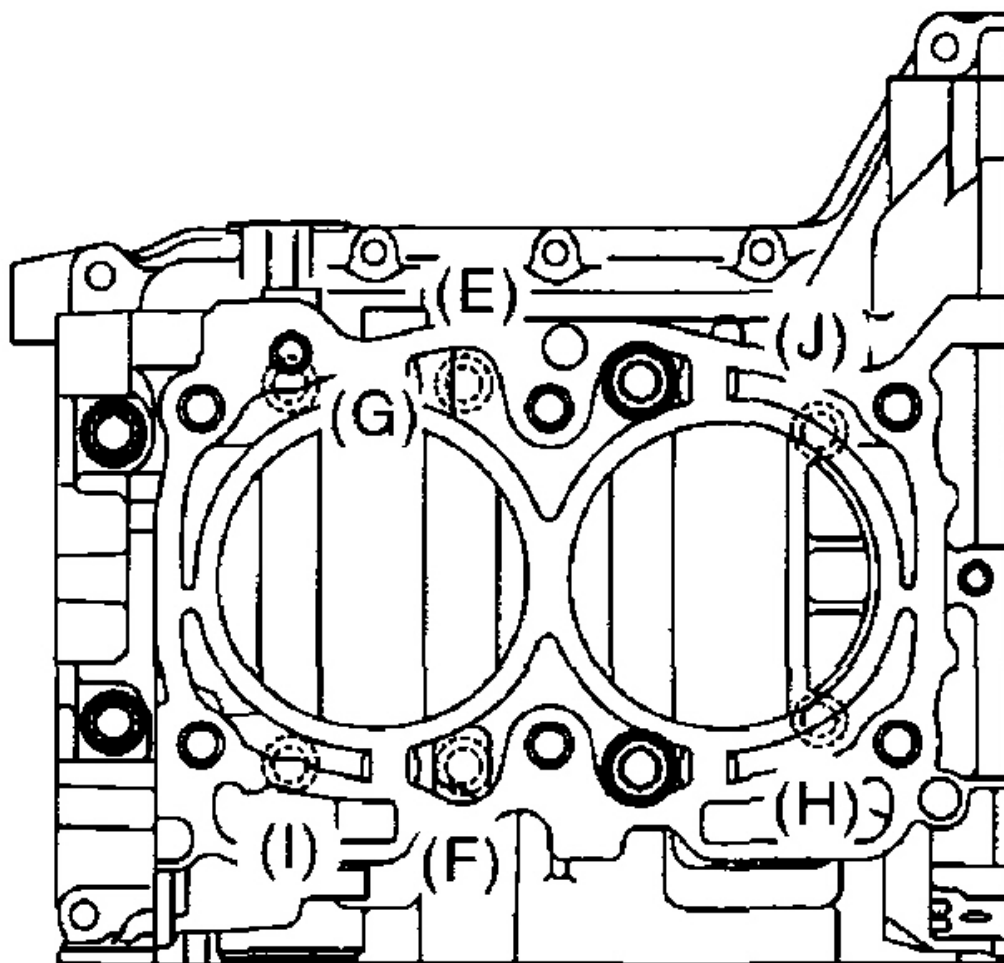
G03812983

Fig. 193: Tightening Sequence Cylinder Block Connecting Bolts On Rh
Courtesy of SUBARU OF AMERICA, INC.

4. 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, 7.4 ft-lb)



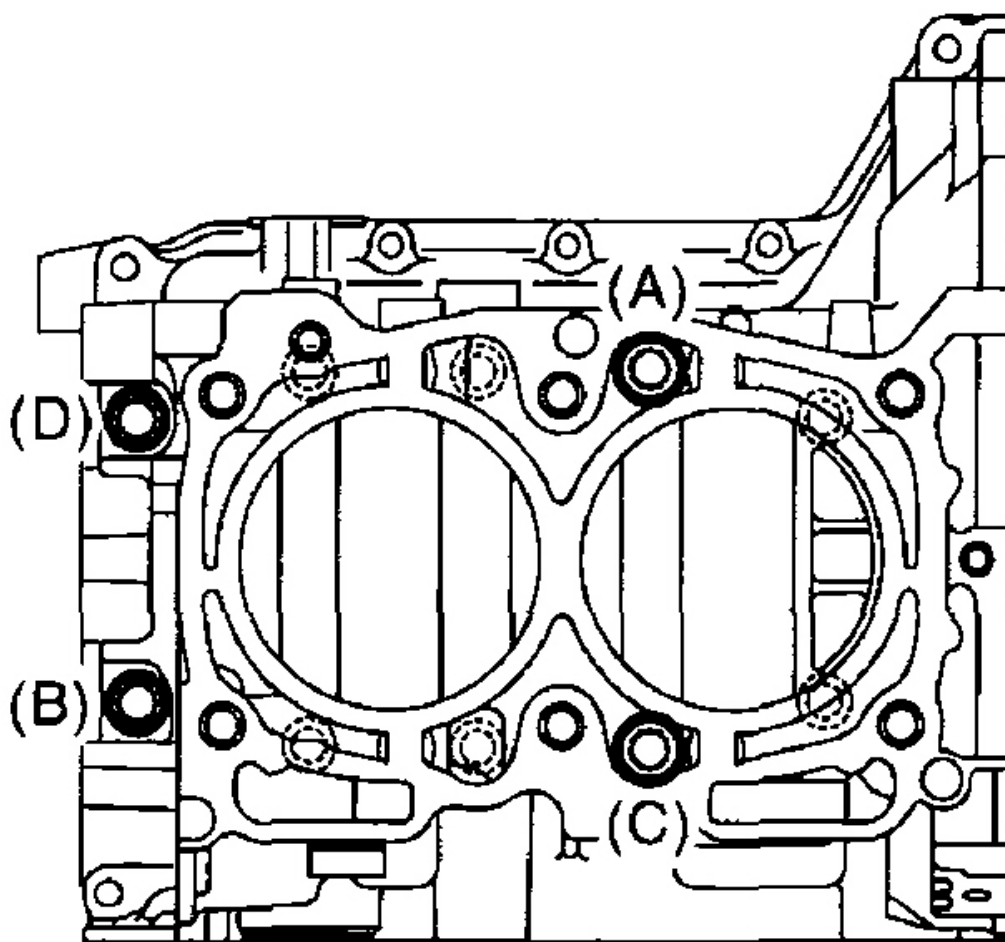
G03812984

Fig. 194: Tightening Sequence Cylinder Block Connecting Bolts On LH
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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



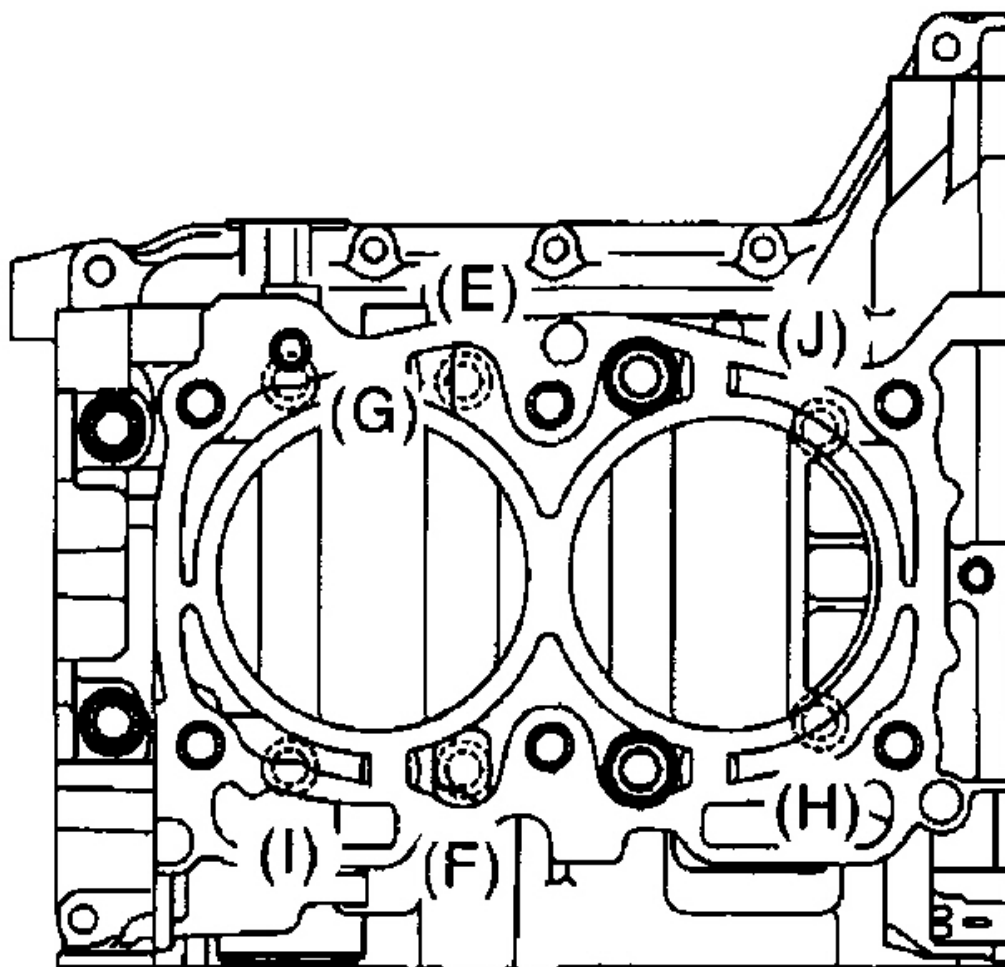
G03812985

Fig. 195: Tightening Sequence LH Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

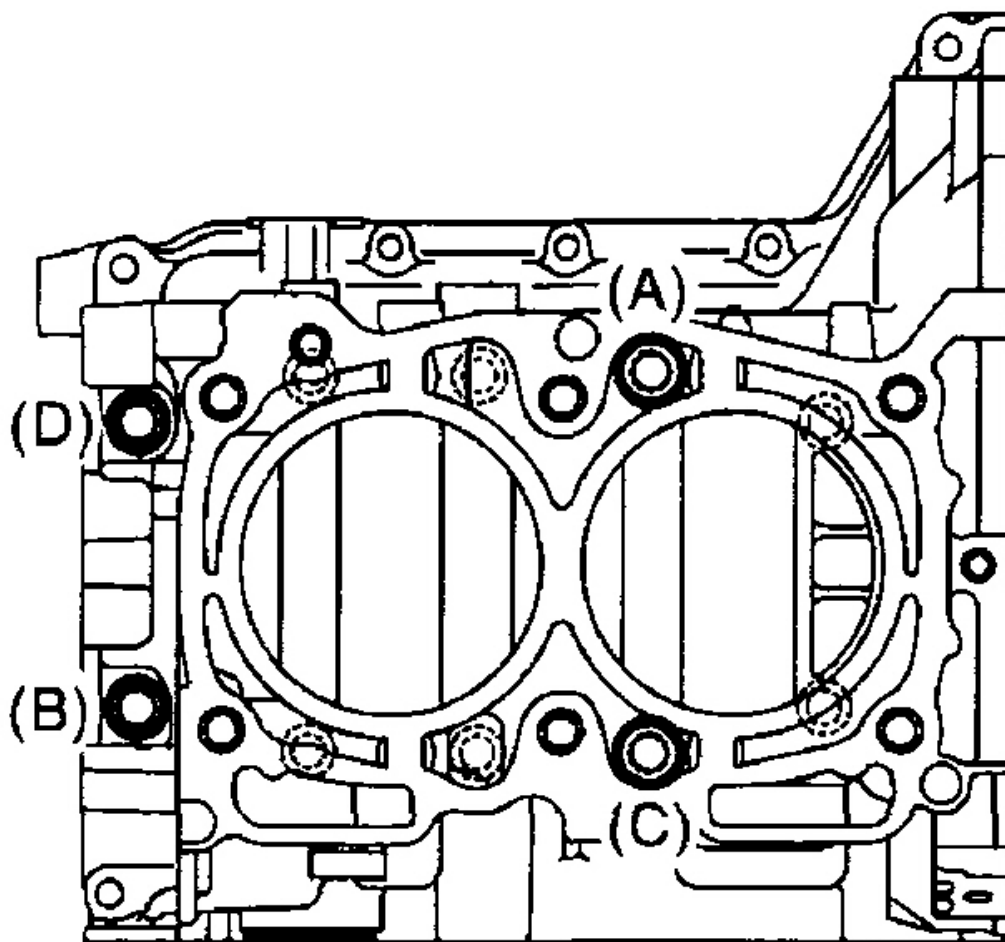
18 N.m (1.8 kgf-m, 13.3 ft-lb)



G03812986

Fig. 196: Tightening Sequence RH Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

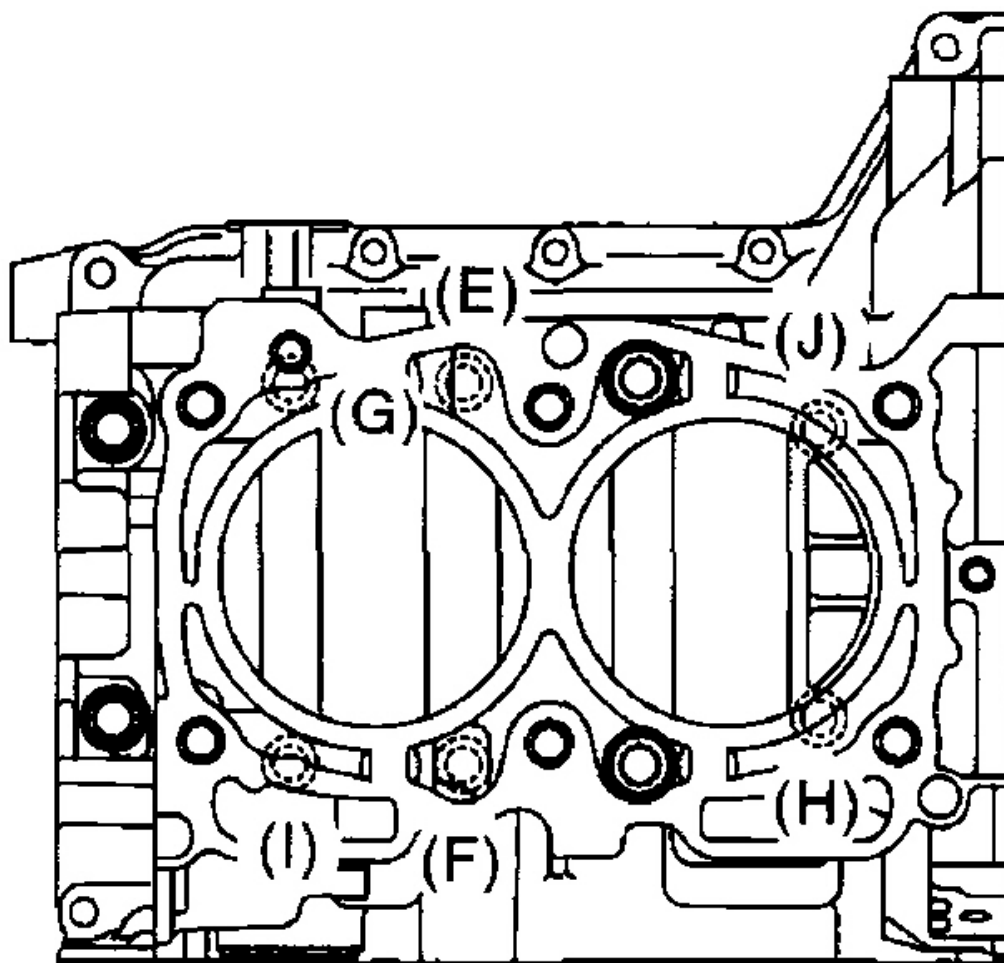
7. Further tighten the LH side bolts (A), (C) to 90°, (B), (D) 40 N.m (4.1 kgf-m, 29.5 ft-lb) in alphabetical sequence.



G03812987

Fig. 197: Tightening Sequence LH Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

8. Further tighten the RH side bolts (E - J) to 90° in alphabetical sequence.



G03812988

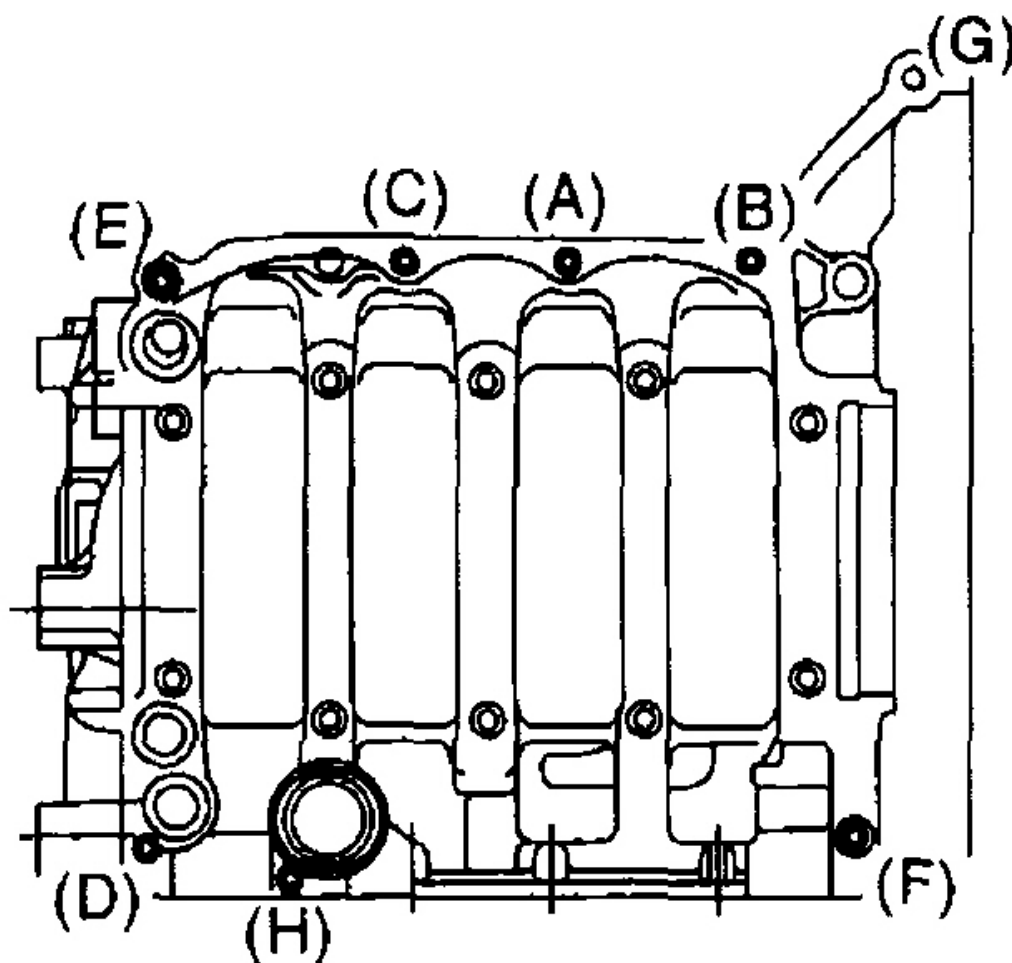
Fig. 198: Tightening Sequence RH Side Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. 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)



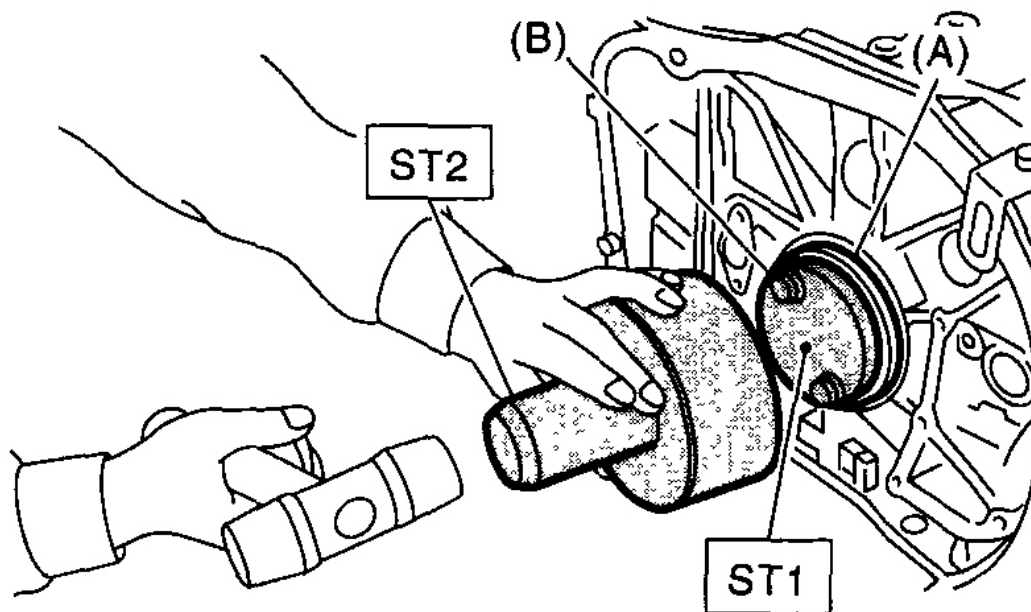
G03812989

Fig. 199: Tightening Sequence Cylinder Block Connecting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

ST1 499597100 OIL SEAL GUIDE

ST2 499587200 OIL SEAL INSTALLER

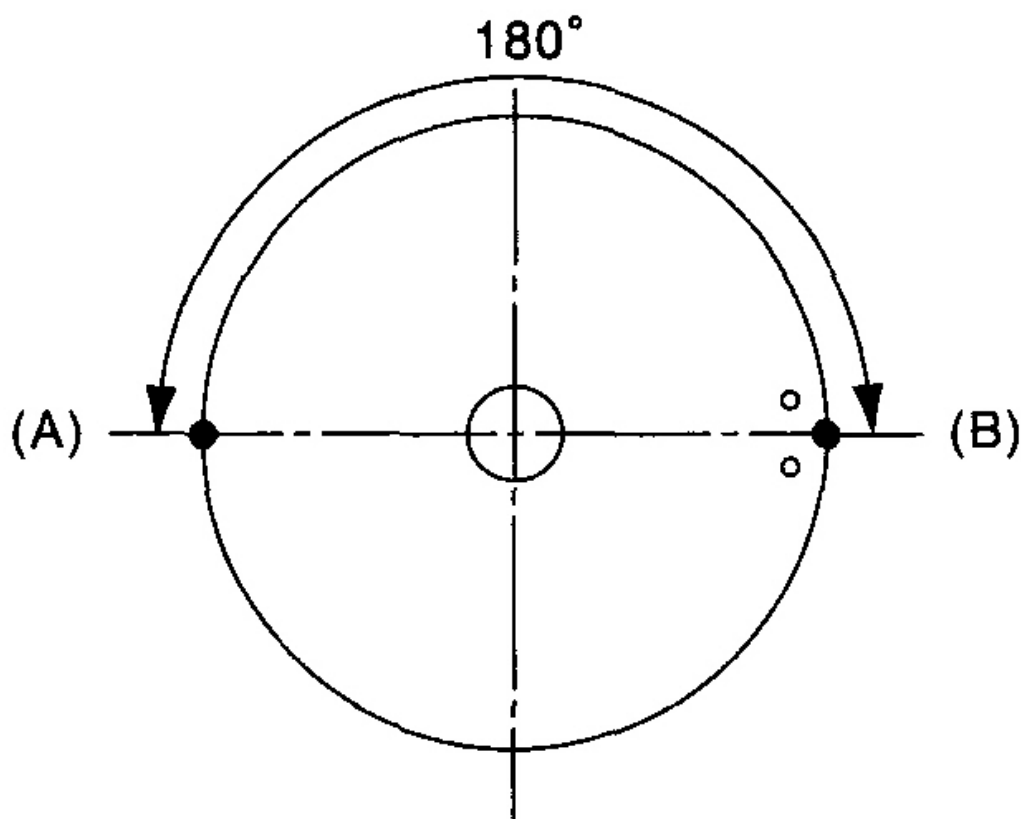


- (A) Rear oil seal
- (B) Flywheel attaching bolt

G03812990

Fig. 200: Installing Rear Oil Seal Using Special Tools
 Courtesy of SUBARU OF AMERICA, INC.

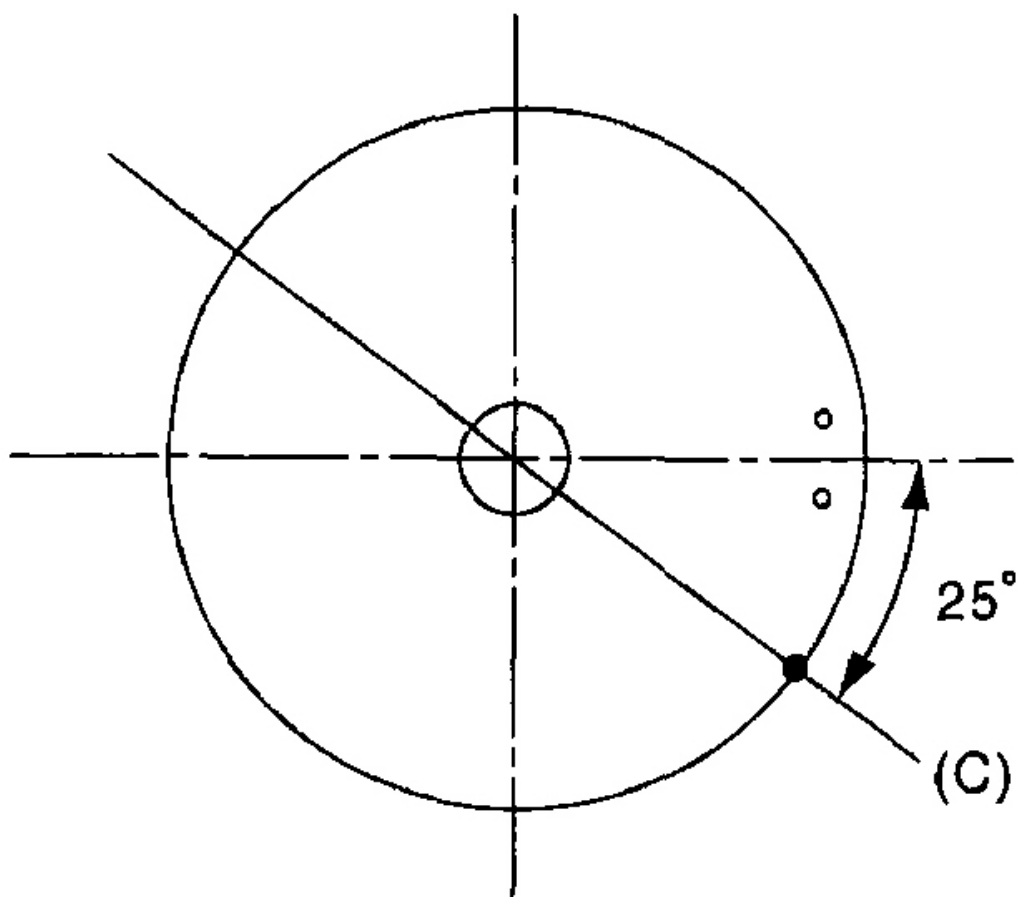
11. Position the top ring gap at (A) or (B) shown in **Fig. 201** .
12. Position the second ring gap at 180° on the reverse side of the top ring gap.



G03812991

Fig. 201: Positioning Top Ring Gap At (A) Or (B)
Courtesy of SUBARU OF AMERICA, INC.

13. Position the upper rail gap at (C) shown in **Fig. 202** .

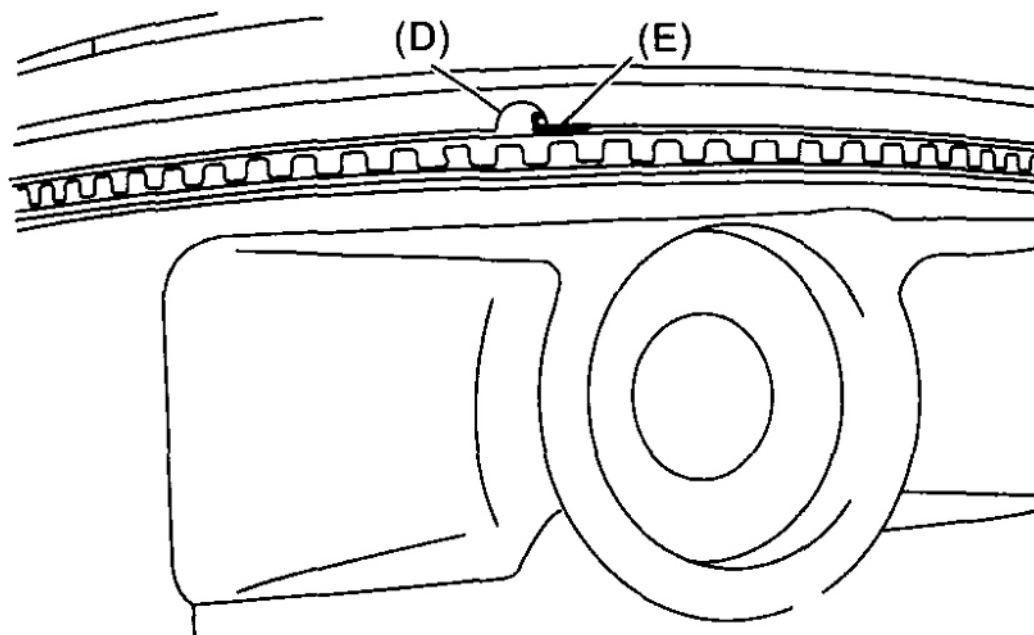


G03812992

Fig. 202: Positioning Upper Rail Gap

Courtesy of SUBARU OF AMERICA, INC.

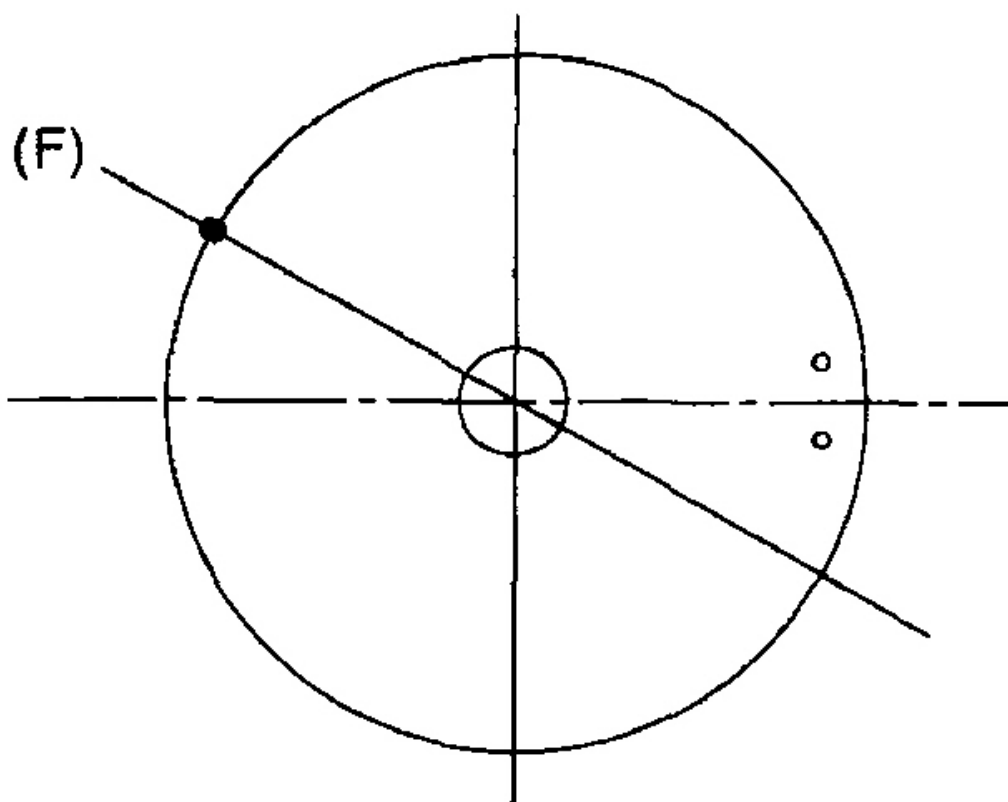
14. Align the upper rail spin stopper (E) to the side hole (D) on the piston.



G03812993

Fig. 203: Aligning Upper Rail Spin Stopper To Side Hole (D) On Piston
Courtesy of SUBARU OF AMERICA, INC.

15. Position the expander gap at 180° on the reverse side of (C), shown as (F), in **Fig. 204** .

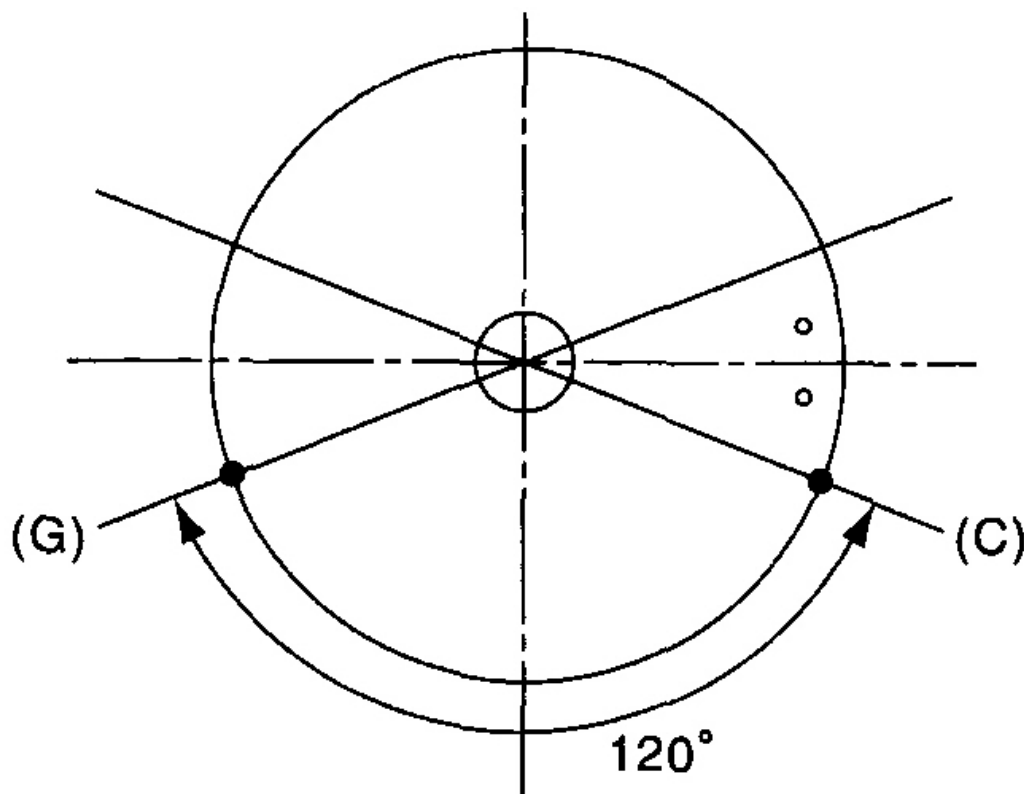


G03812994

Fig. 204: Positioning Expander Gap

Courtesy of SUBARU OF AMERICA, INC.

16. Position the lower rail gap at 120° on counterclockwise of (C), shown as (G), in **Fig. 205** .



G03812995

Fig. 205: Positioning Lower Rail Gap
Courtesy of SUBARU OF AMERICA, INC.

CAUTION:

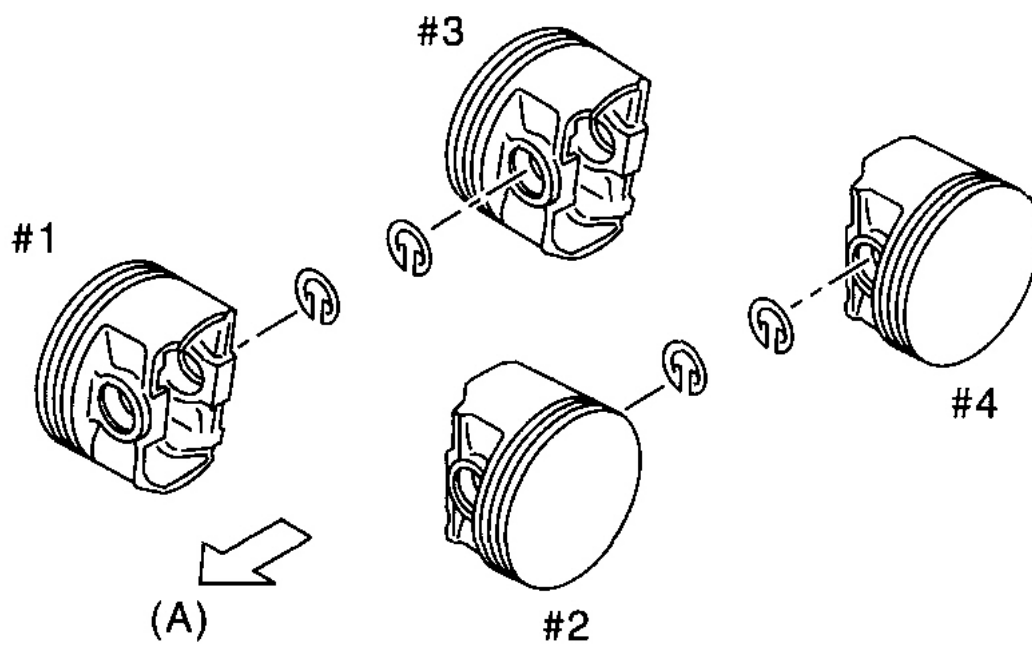
- Ensure ring gaps do not face the same direction.
- Ensure ring gaps are not within the piston skirt area.

17. Install the snap ring.

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

NOTE:

Use new snap rings.

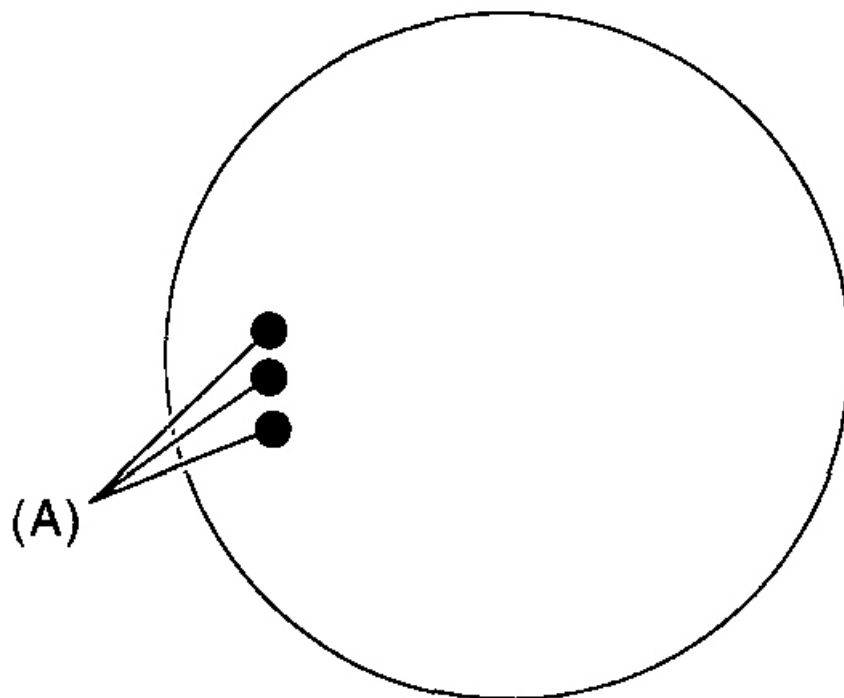


(A) Front side

G03812996

Fig. 206: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Front mark

G03812997

Fig. 207: Identifying Piston Front Towards Front Of Engine
Courtesy of SUBARU OF AMERICA, INC.

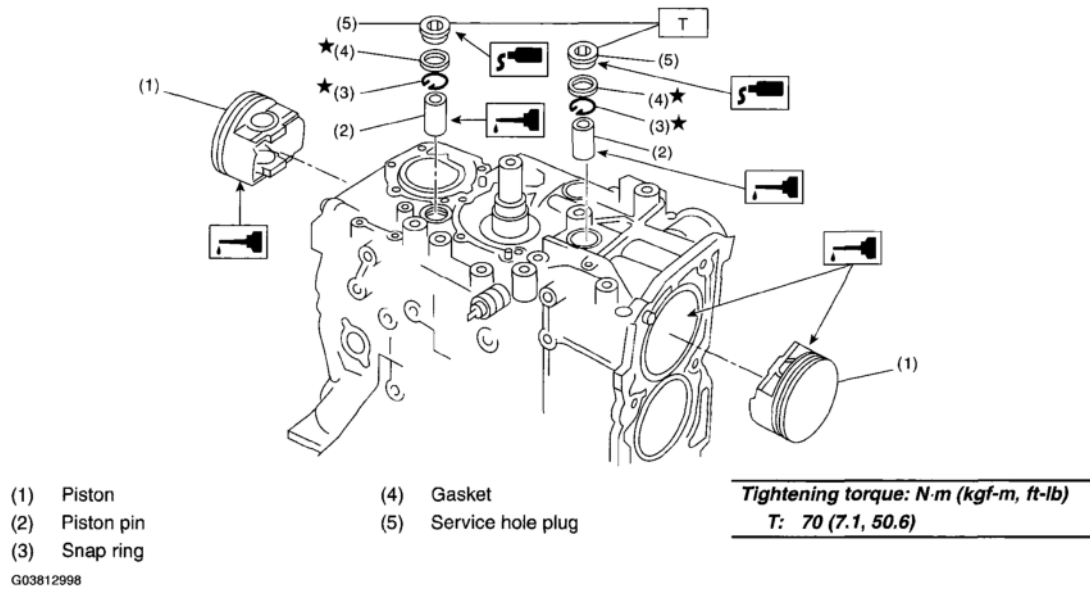


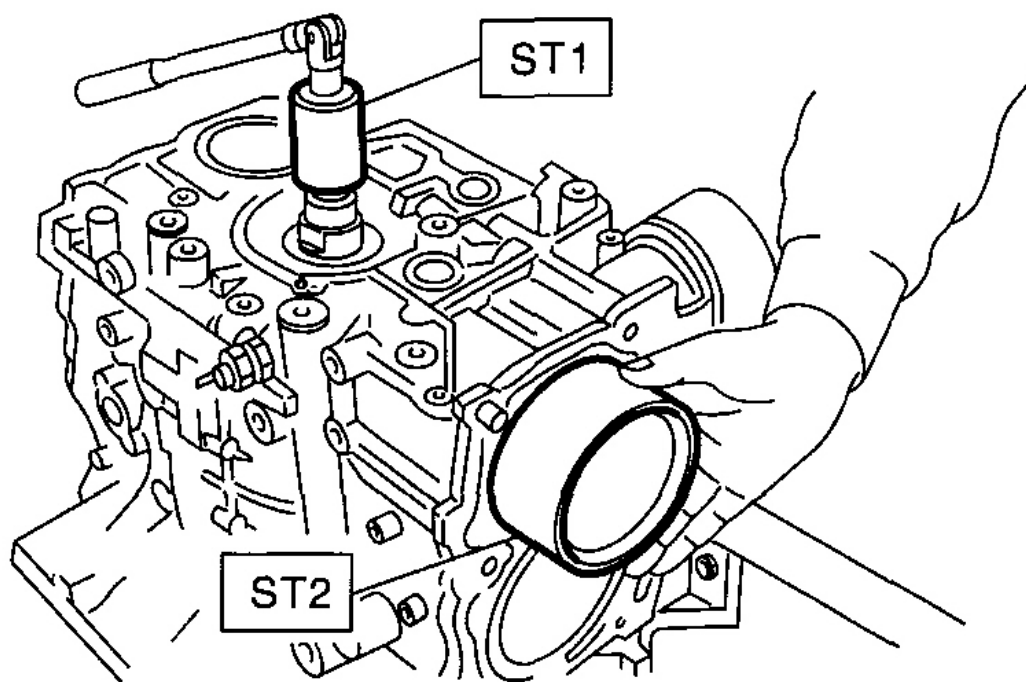
Fig. 208: Exploded View Of Pistons And Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

ST1 499987500 CRANKSHAFT SOCKET

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

ST2 498747300 PISTON GUIDE

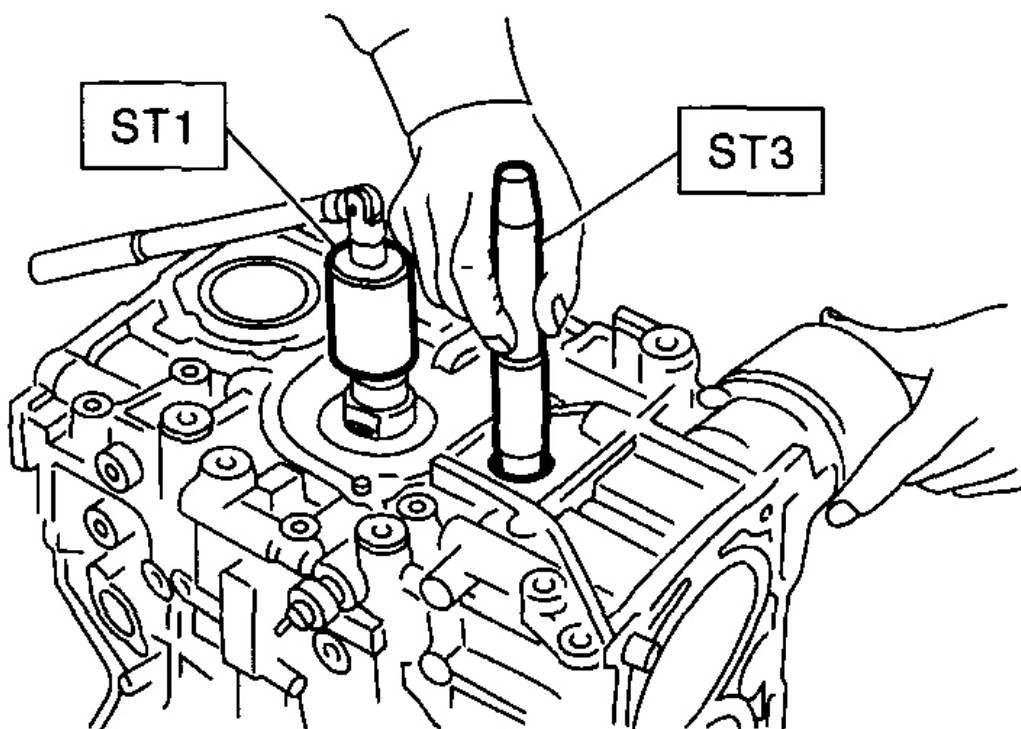


G03812999

Fig. 209: Applying A Coat Of Engine Oil
Courtesy of SUBARU OF AMERICA, INC.

19. Install the piston pin.
 - a. Apply a coat of engine oil to ST3.
 - b. Insert ST3 into the service hole to align piston pin hole with connecting rod small end.

ST3 499017100 PISTON PIN GUIDE



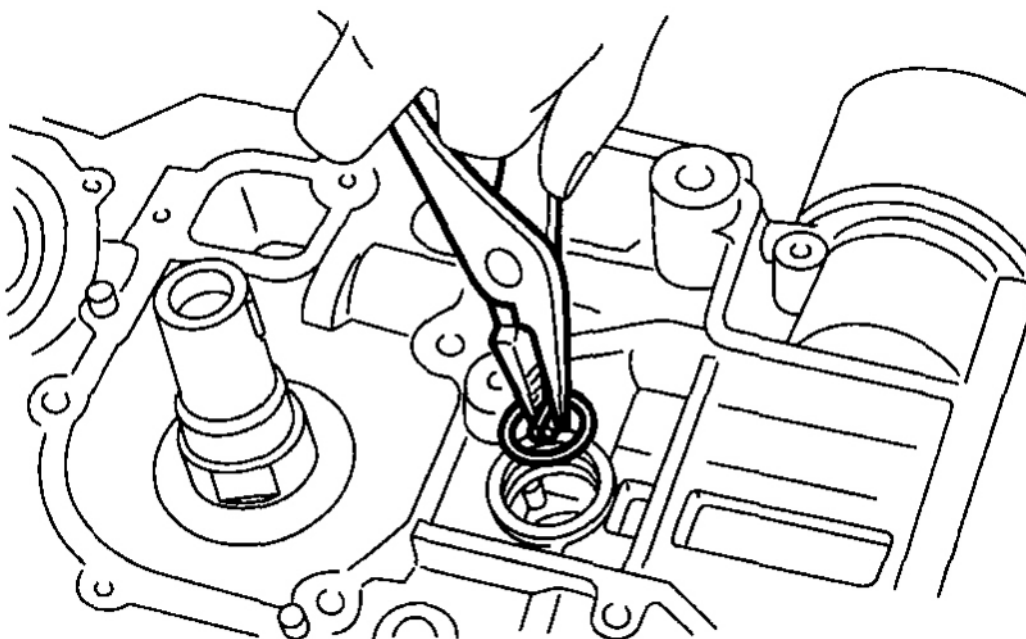
G03813000

Fig. 210: Installing Piston Pin

Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.



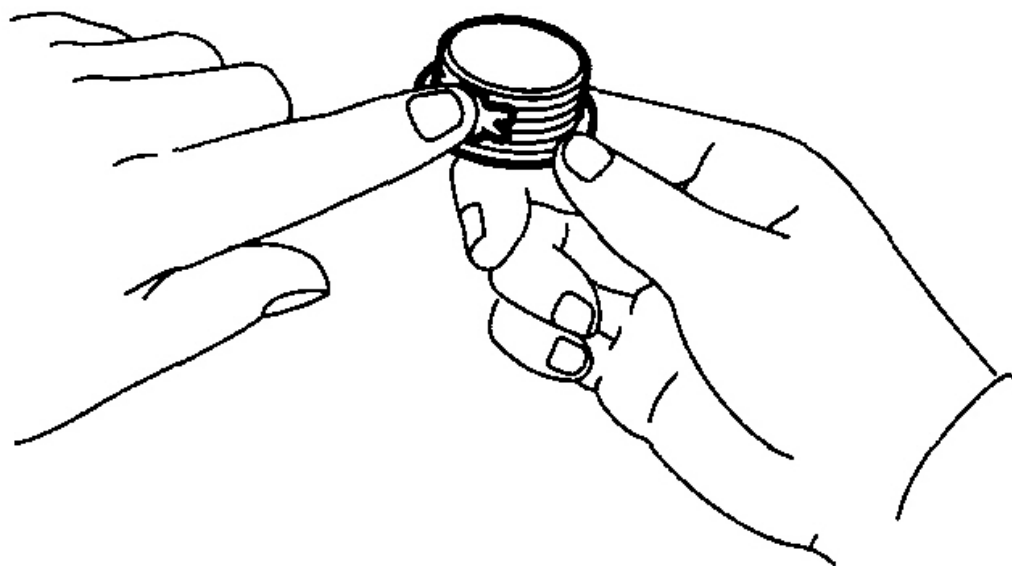
G03813001

Fig. 211: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

- e. Apply liquid gasket around the service hole plug.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent

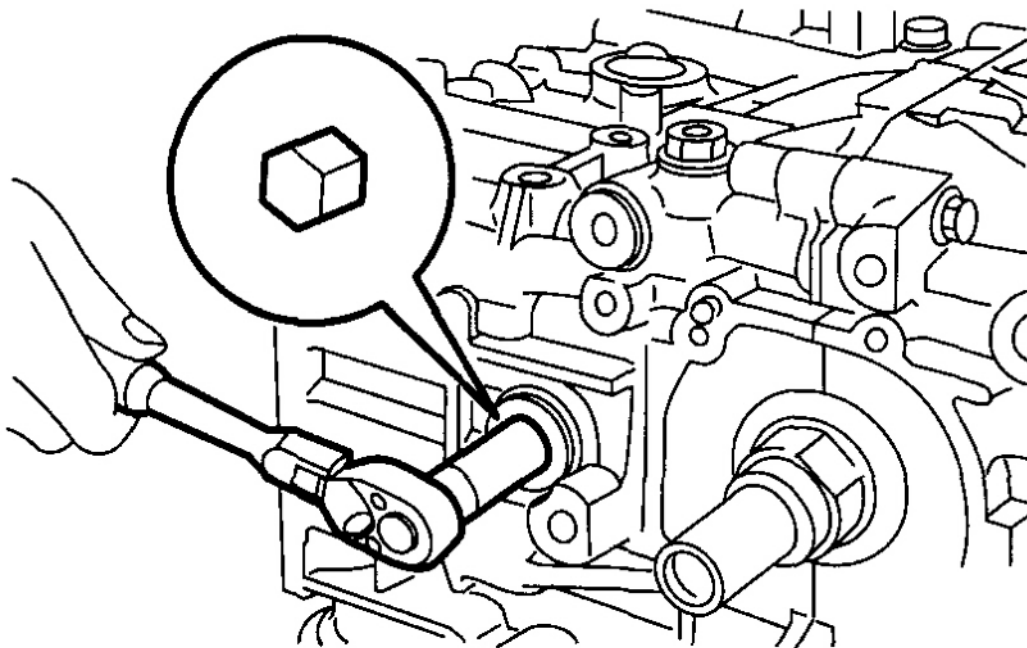


G03813002

Fig. 212: Applying Liquid Gasket Around Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

- f. Install the service hole plug and gasket.

NOTE: **Use a new gasket.**



G03813003

Fig. 213: Installing Service Hole Plug And Gasket
Courtesy of SUBARU OF AMERICA, INC.

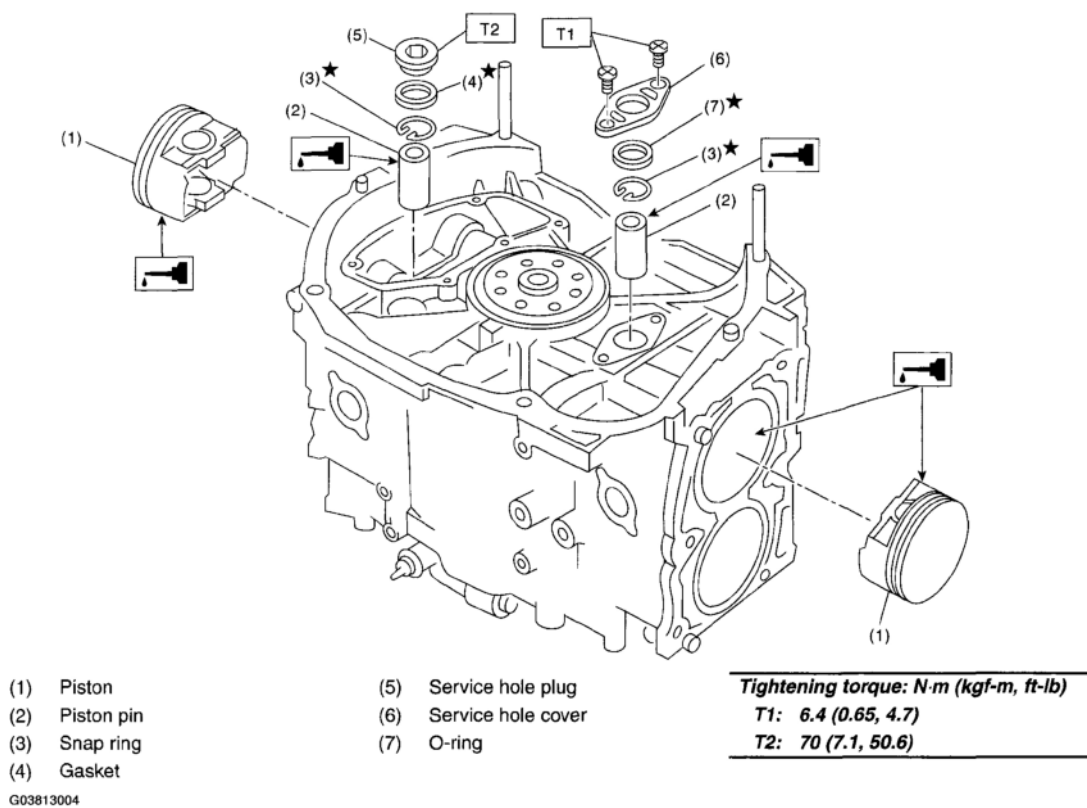
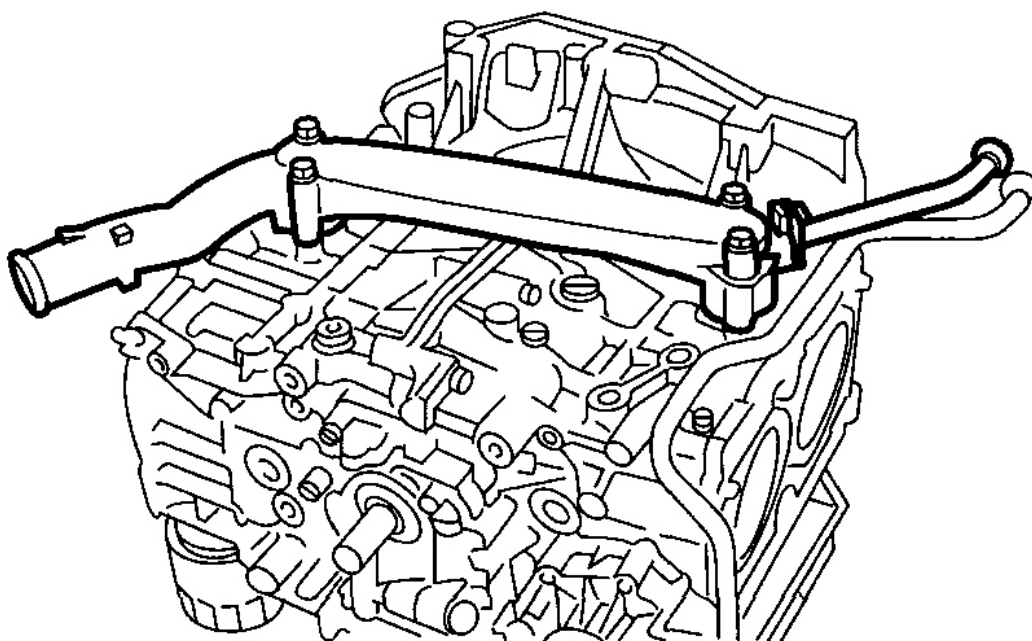


Fig. 214: Exploded View Of Cylinder Block
 Courtesy of SUBARU OF AMERICA, INC.

- g. 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.
20. Install the water pipe.



G03813005

Fig. 215: Installing Water Pipe

Courtesy of SUBARU OF AMERICA, INC.

21. Install the baffle plate.

Tightening torque:

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

22. Install the oil strainer and O-ring.

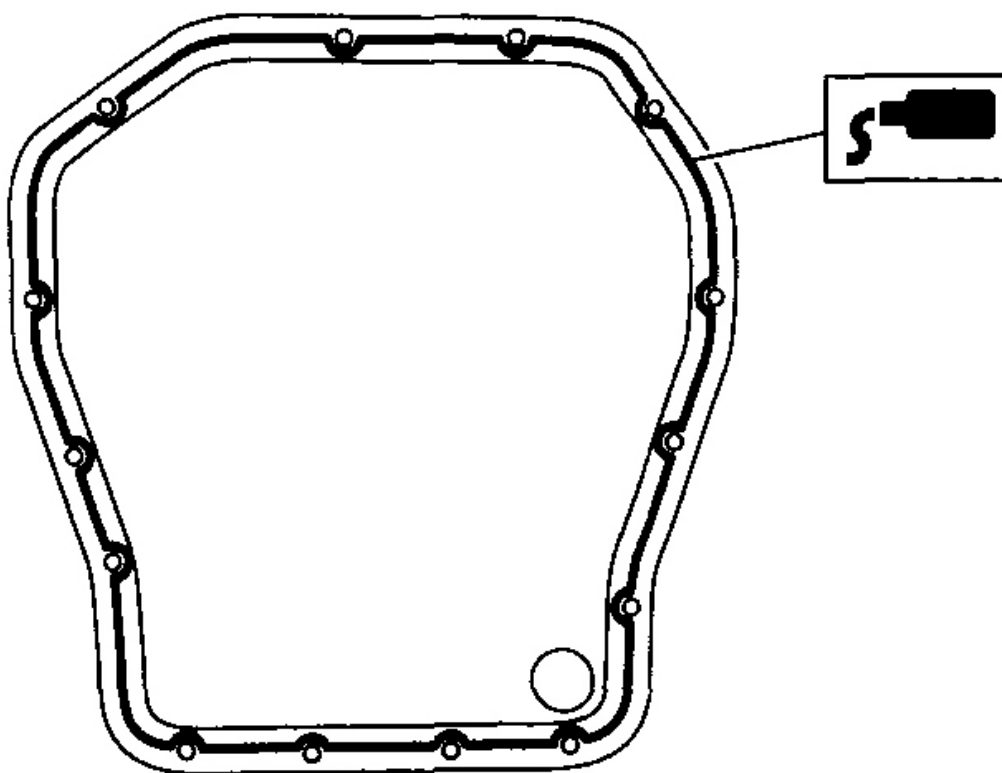
Tightening torque:

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

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

Liquid gasket:

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



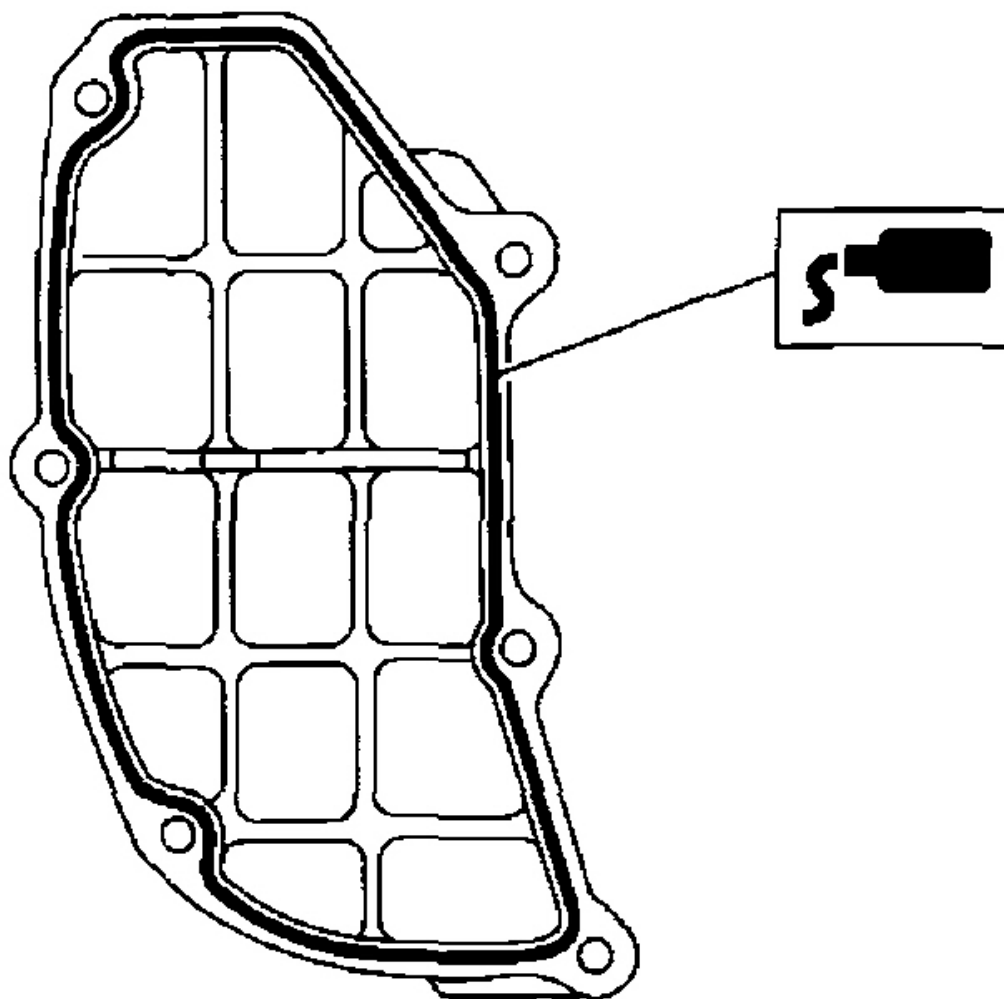
G03813006

Fig. 216: Applying Liquid Gasket To Mating Surfaces
Courtesy of SUBARU OF AMERICA, INC.

25. Apply liquid gasket to mating surfaces and install the oil separator cover.

Liquid gasket:

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



G03813007

Fig. 217: Installing Oil Separator Cover
Courtesy of SUBARU OF AMERICA, INC.

26. Install the flywheel. (MT model)

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

To lock the crankshaft, use the ST.

ST 498497100 CRANKSHAFT STOPPER

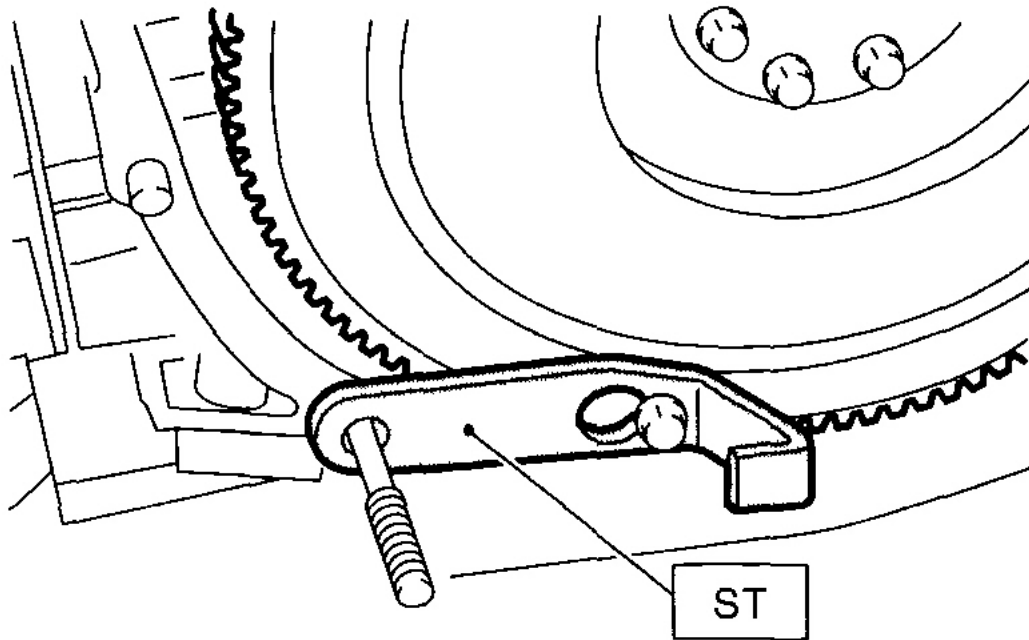
Tightening torque:**72 N.m (7.3 kgf-m, 52.8 ft-lb)****G03813008**

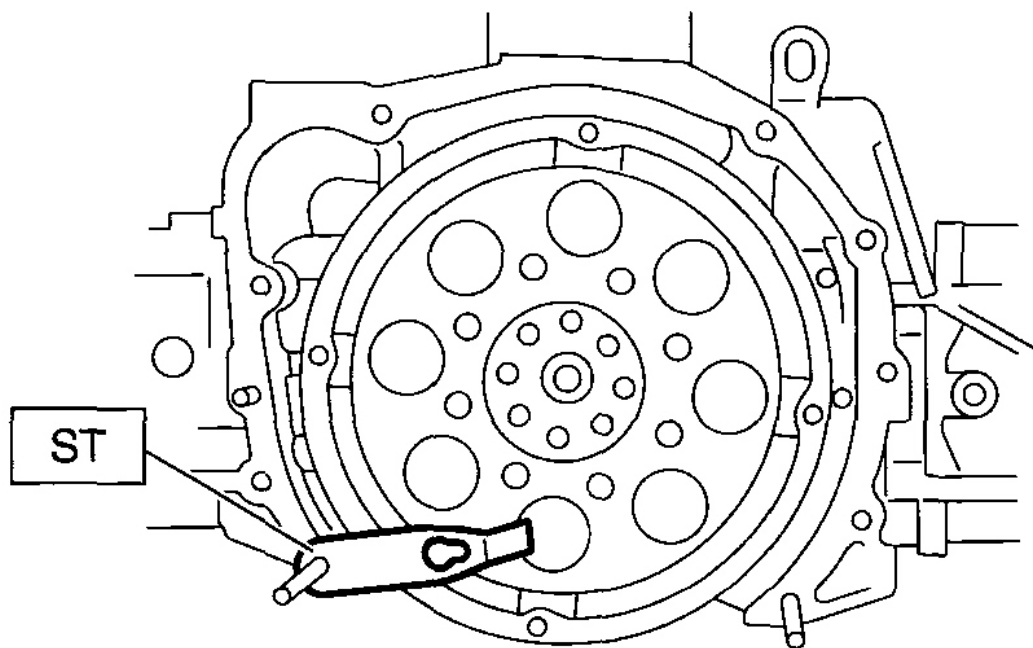
Fig. 218: Locking Crankshaft Using Special Tool (MT)
Courtesy of SUBARU OF AMERICA, INC.

27. 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)**

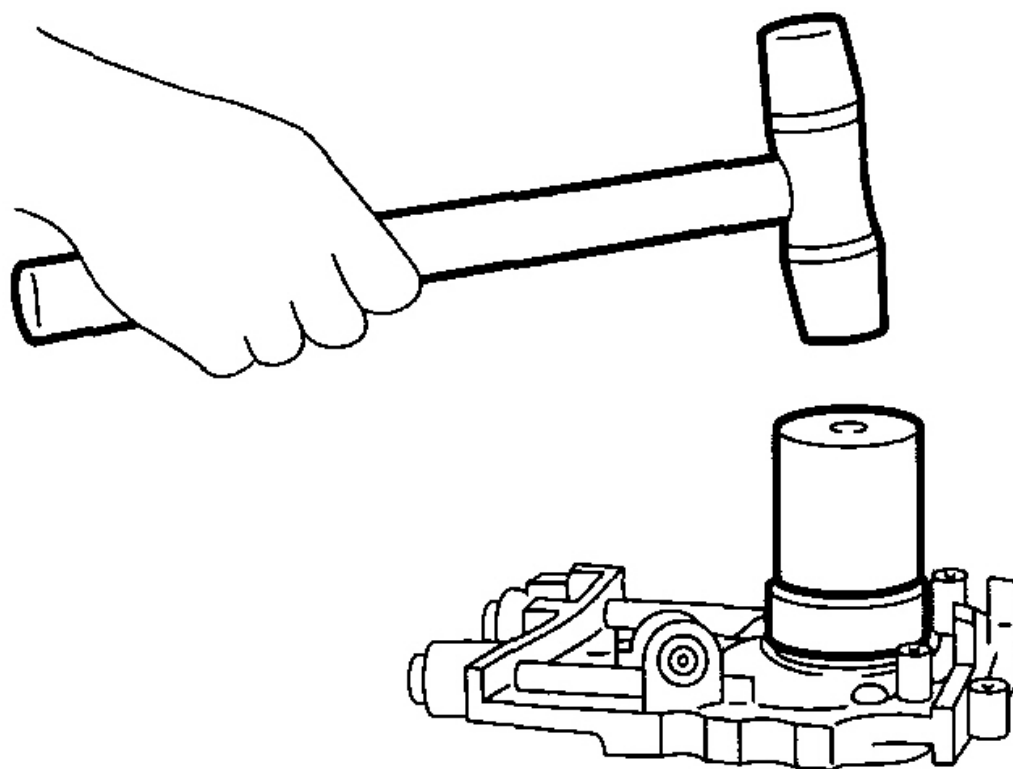


G03813009

Fig. 219: Installing Drive Plate Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499587100 OIL SEAL INSTALLER



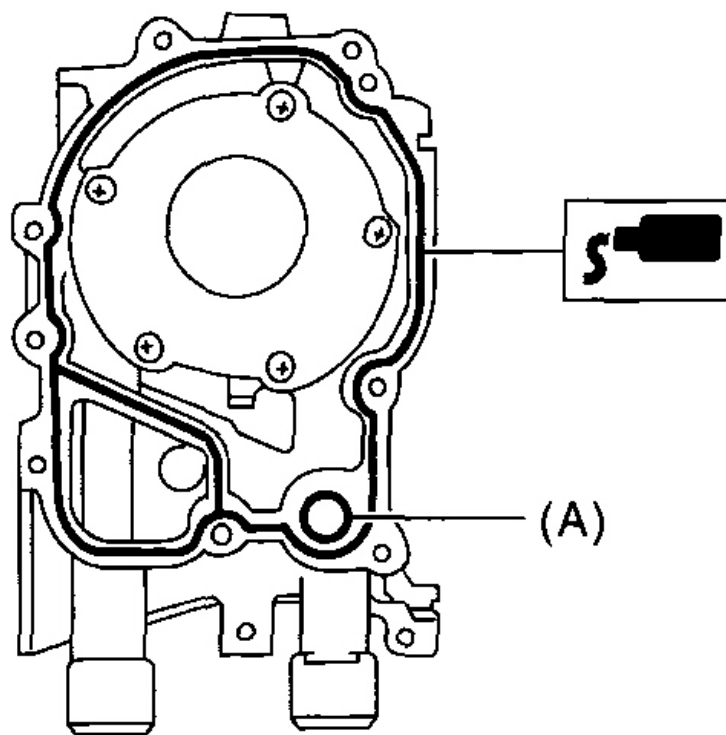
G03813010

Fig. 220: Installing Housing Cover Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

- b. Apply liquid gasket to the matching surface of oil pump.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent



(A) O-ring

G03813011

Fig. 221: Applying Liquid Gasket To Matching Surface Of Oil Pump
Courtesy of SUBARU OF AMERICA, INC.

- c. Apply a coat of engine oil to the inside of oil seal.

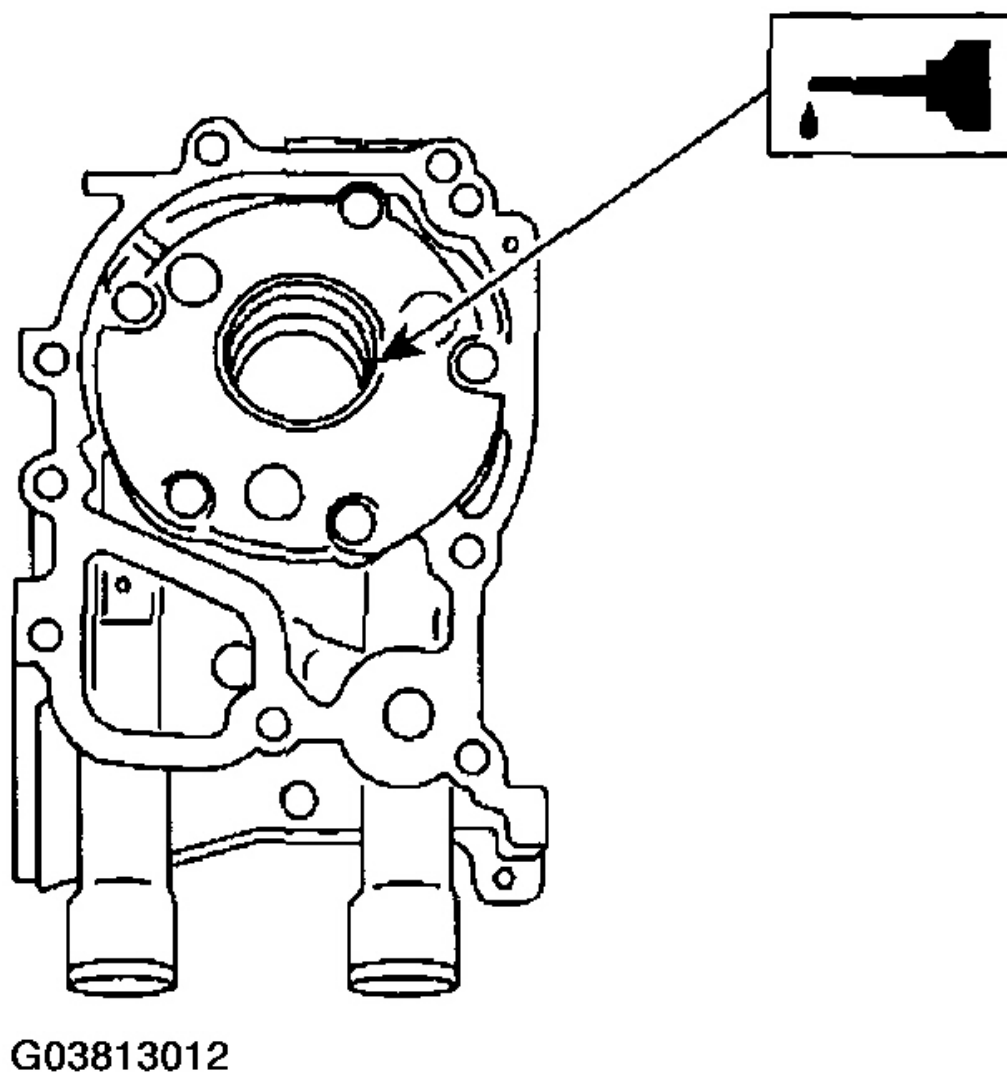


Fig. 222: Applying A Coat Of Engine Oil To Inside Of Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

- d. Install the oil pump on cylinder block. Be careful not to damage the oil seal during installation.
- e. Position the oil pump, aligning the notched area with crankshaft, and push the oil pump straight.

CAUTION:

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

- f. Install the oil pump.
- g. Apply liquid gasket to the threaded portion of three bolts.

Liquid gasket:

THREE BOND 1215 (Part No. 004403007) or equivalent

Tightening torque:

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

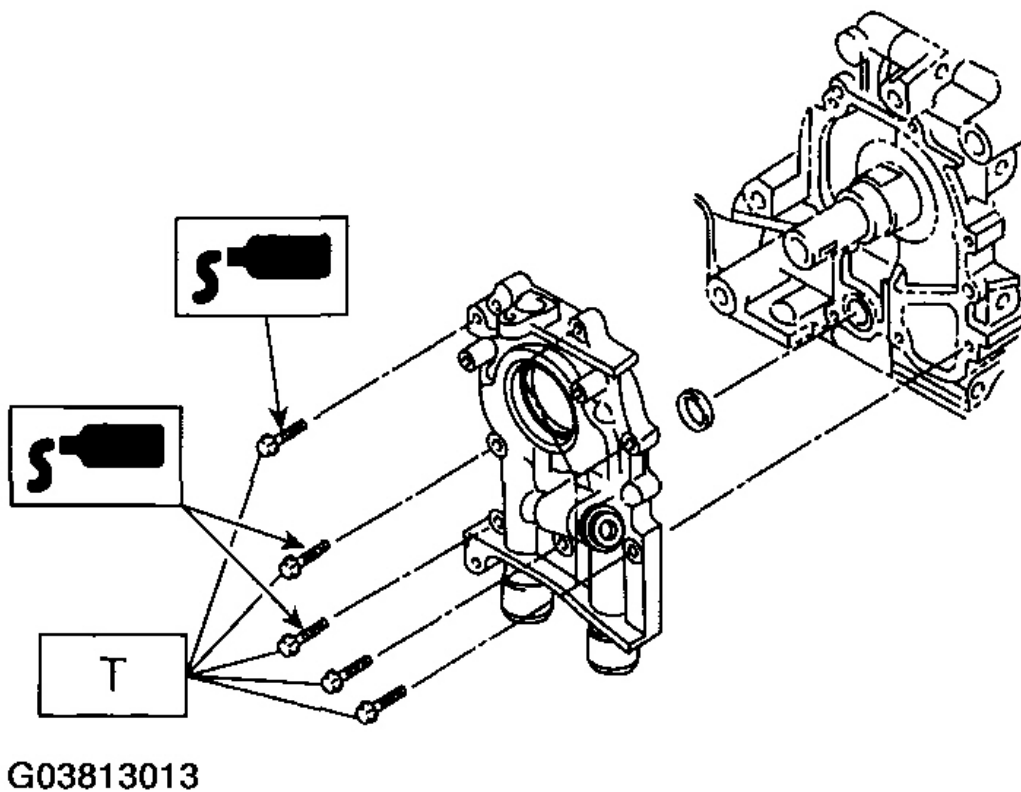


Fig. 223: Applying Liquid Gasket To Threaded Portion Of Three Bolts
Courtesy of SUBARU OF AMERICA, INC.

- 30. Install the water pump and gasket.

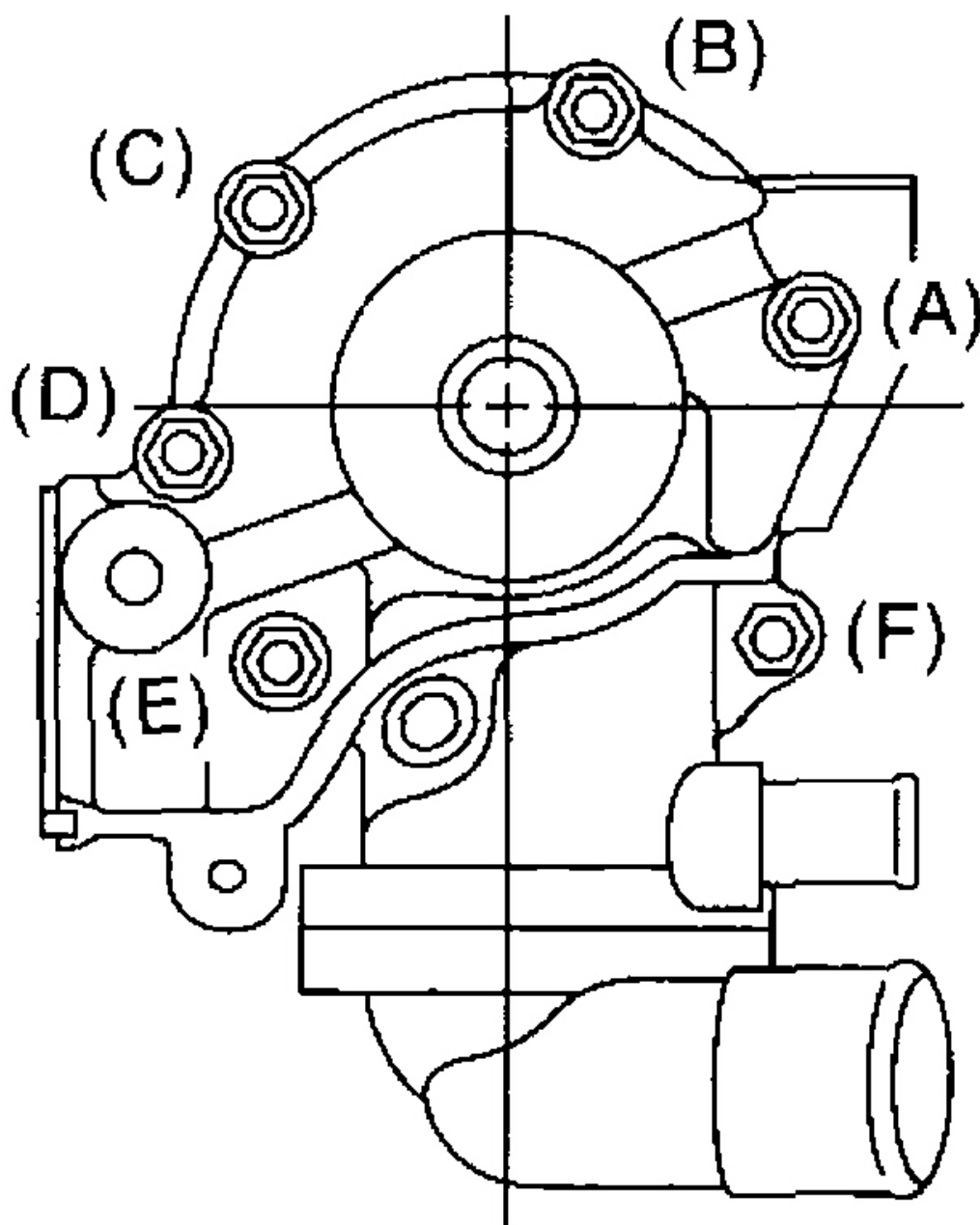
Tightening torque:

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

Second: 12N.m (1.2kgf-m, 8.7ft-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 Fig. 224 .**



G03813014

Fig. 224: Installing Water Pump And Gasket
Courtesy of SUBARU OF AMERICA, INC.

31. Install the water by-pass pipe for heater.
32. Install the oil filter using ST.

ST 18332AA000 OIL FILTER WRENCH (Outer diameter: 68 mm (2.68 in))

ST 18332AA010 OIL FILTER WRENCH (Outer diameter: 65 mm (2.56 in))

ST 498547000 OIL FILTER WRENCH (Outer diameter: 80 mm (3.15 in))

NOTE: **Standard oil filter is outer diameter of 68 mm (2.68 in). However, SUBARU genuine oil filter having outer diameter of 65 mm (2.56 in) or 80 mm (3.15 in) can also be used.**

Install the oil filter by turning it by hand, being careful not to damage the seal rubber.

Tighten the oil filter 68 mm (2.68 in) in diameter by approx. 1 rotation more after the seal rubber of oil filter comes in contact with cylinder block.

Tighten the oil filter 65 mm (2.56 in) in diameter by approx. 2/3 - 3/4 rotation more after the seal rubber of oil filter comes in contact with cylinder block or oil cooler.

CAUTION: Do not tighten excessively, or oil may leak.

33. Tighten the cylinder head bolts.
 - a. Apply a coat of engine oil to washers and bolt threads.
 - b. Tighten all bolts to 29 N.m (3.0 kgf-m, 22 ft-lb) in alphabetical sequence.

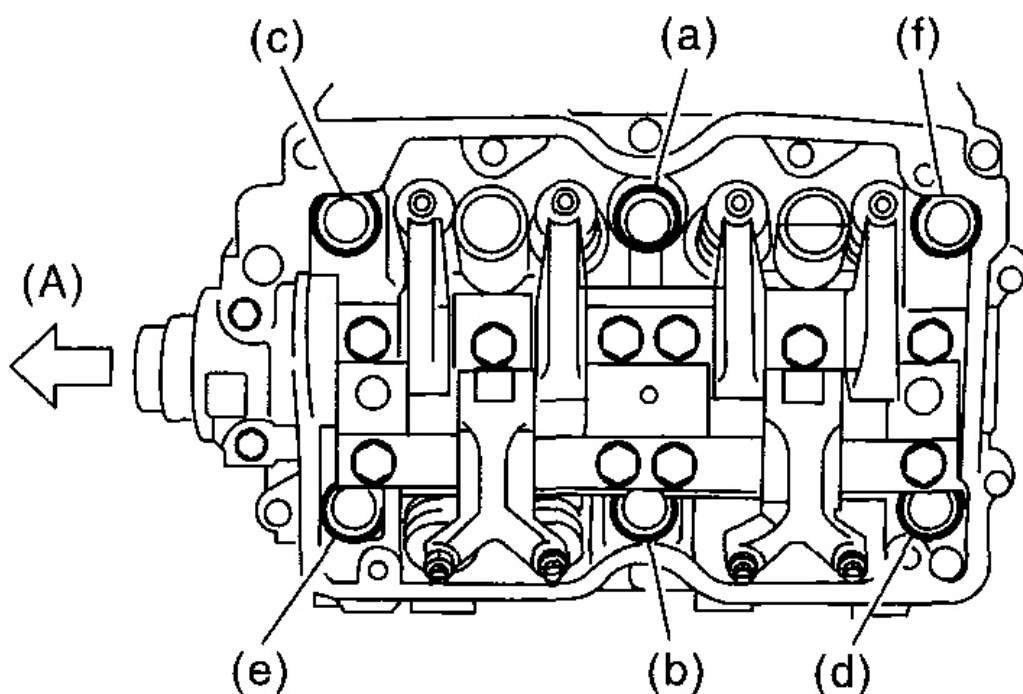
Then tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.

- c. Back off all bolts by 180° first, and back them off again by 180°.
- d. Tighten the bolts (a) and (b) to 34 N.m (3.5 kgf-m, 25 ft-lb).
- e. Tighten the bolts (c), (d), (e) and (f) to 15 N.m (1.5 kgf-m, 11 ft-lb).
- f. Tighten all bolts by 80° - 90° in alphabetical sequence.

CAUTION: Do not tighten the bolts more than 90°.

- g. Further tighten all bolts by 80° - 90° in alphabetical sequence.

CAUTION: Ensure the total "re-tightening angle" of the step (f) and g does not exceed 180°.



(A) Front side

G03813015

Fig. 225: Tightening Bolts Sequence
Courtesy of SUBARU OF AMERICA, INC.

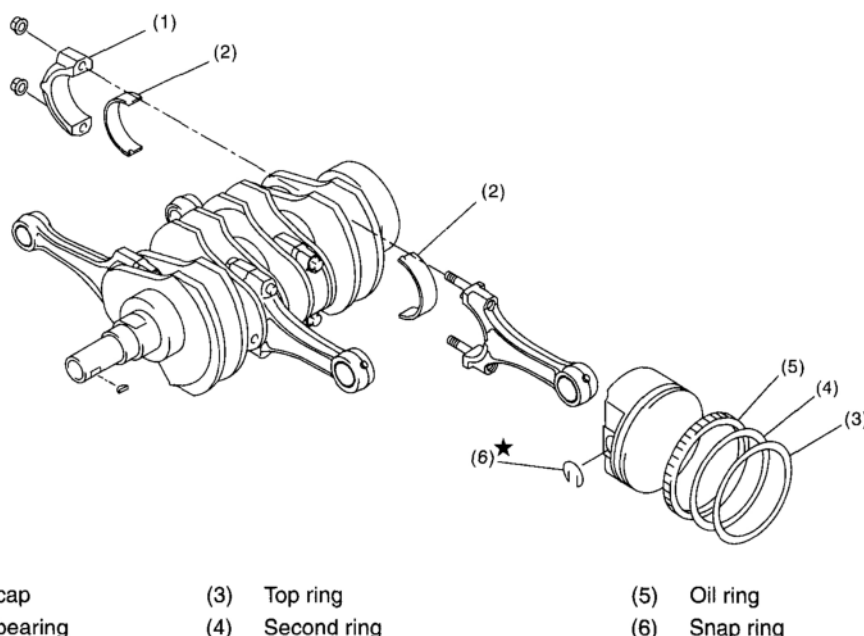
34. Install the oil level gauge guide and tighten the bolt (left side only).
35. Install the rocker cover and rocker cover gasket.

NOTE: Use new rocker cover gasket.

36. Install the crank sprocket. < Ref. to , **INSTALLATION**, Crank Sprocket. >
37. Install the cam sprocket. < Ref. to , **INSTALLATION**, Cam Sprocket. >
38. Install the timing belt. < Ref. to , **INSTALLATION**, Timing Belt. >
39. Install the timing belt cover. < Ref. to , **INSTALLATION**, Timing Belt Cover. >
40. Install the crank pulley. < Ref. to , **INSTALLATION**, Crank Pulley. >
41. Install the generator and A/C compressor brackets on cylinder head.
42. Install the V-belts. < Ref. to , **INSTALLATION**, V-belt. >

43. Install the intake manifold. < Ref. to **INSTALLATION** , Intake Manifold. >

DISASSEMBLY



G03813016

Fig. 226: Removing Connecting Rod Cap
Courtesy of SUBARU OF AMERICA, INC.

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

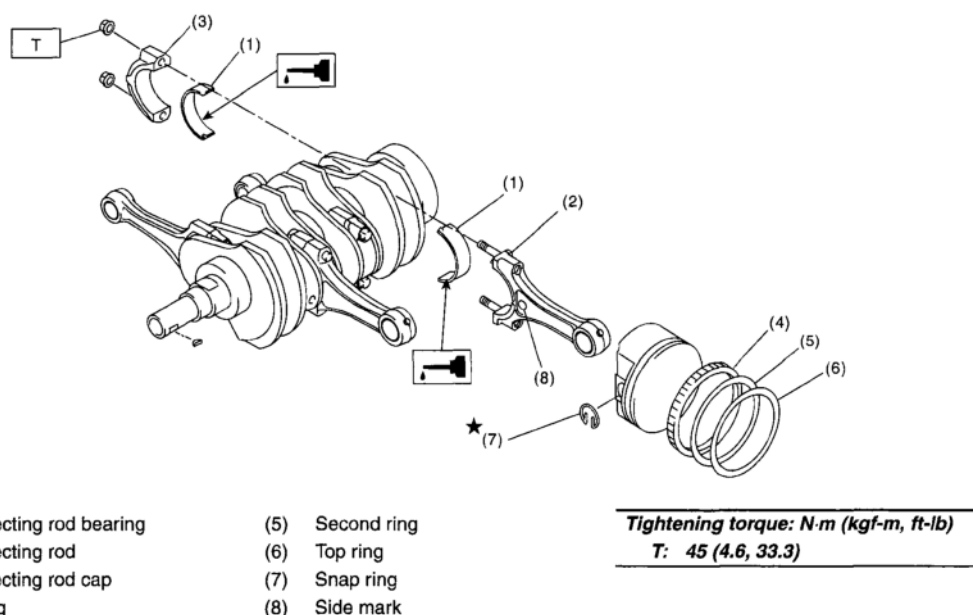
NOTE: Arrange the removed connecting rod, connecting rod cap and bearing in order, to prevent confusion.

3. Remove the piston rings using the 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



G03813017

Fig. 227: Applying Oil To Surfaces Of Connecting Rod Bearings
Courtesy of SUBARU OF AMERICA, INC.

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

Ensure 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 with a piston ring expander.

INSPECTION

CYLINDER BLOCK

1. Visually check for cracks and damage. Especially, inspect the important parts by means of red lead check.
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's front upper surface.

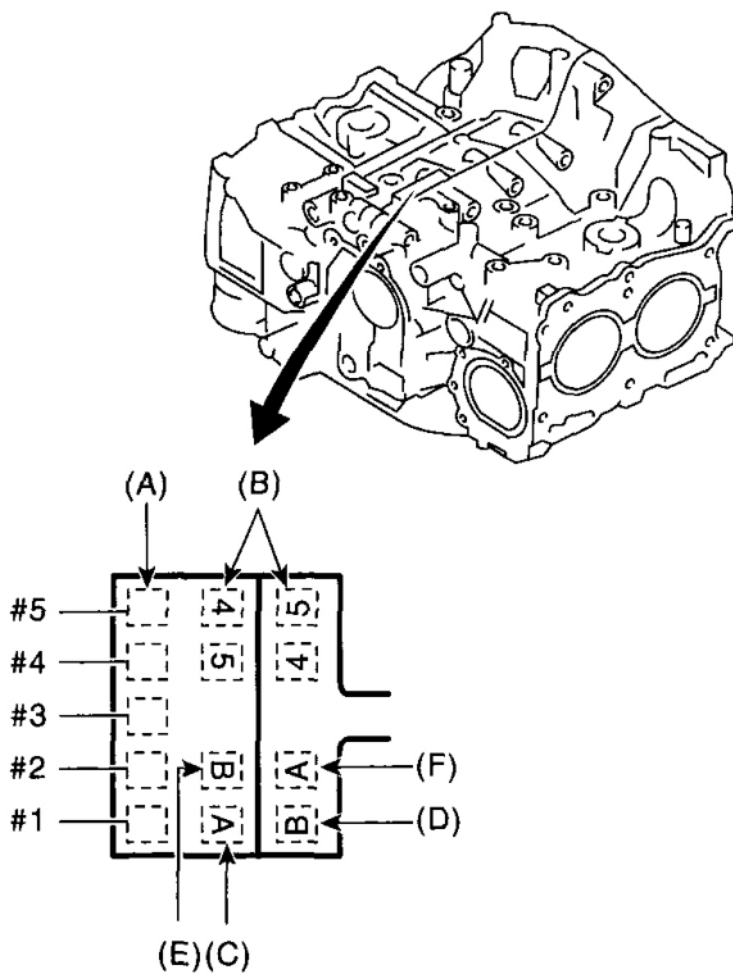
NOTE: **Measurement should be performed at a temperature of 20°C (68°F).**

2. 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

G03813018

Fig. 228: Identifying Cylinder Bore Size Mark
 Courtesy of SUBARU OF AMERICA, INC.

3. 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 **Fig. 229** , 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)

Limit

0.050 mm (0.0020 in)

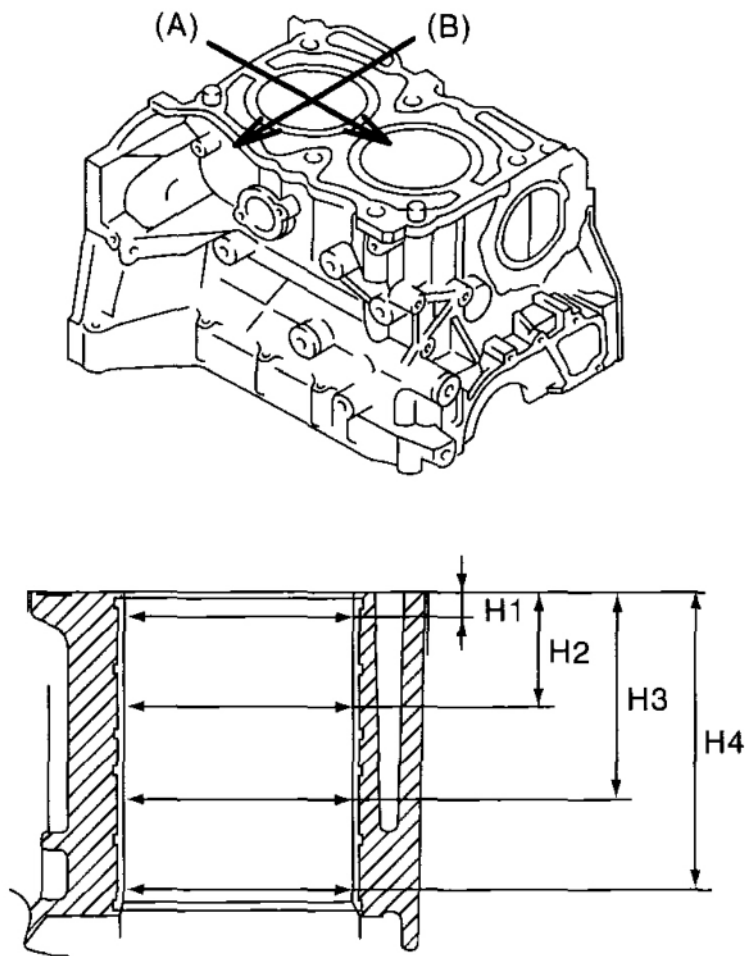
Out-of-roundness:

Standard

0.010 mm (0.0004 in)

Limit

0.050 mm (0.0020 in)



(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)

G03813019

Fig. 229: Measuring Inner Diameter Of Cylinder
 Courtesy of SUBARU OF AMERICA, INC.

4. When the piston is to be replaced due to general or cylinder wear, determine a suitable sized piston by measuring the piston clearance.

5. How to measure the outer diameter of each piston:

Measure the outer diameter of each piston at the height as shown in **Fig. 230** . (Thrust direction)

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

Piston grade point H:

37.0 mm (1.457 in)

Standard

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

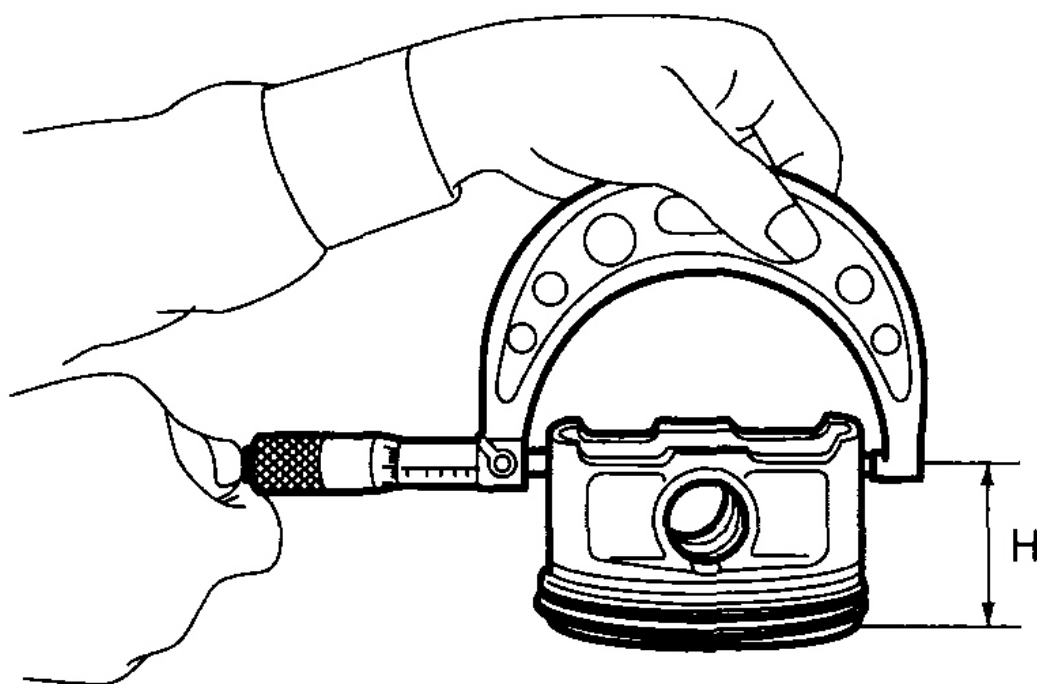
B: 99.495 - 99.505 mm (3.9171 - 3.9175 in)

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)



G03813020

Fig. 230: Measuring Piston Diameter
Courtesy of SUBARU OF AMERICA, INC.

6. 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)

Limit

0.030 mm (0.0012 in)

7. Boring and honing
 - a. If the value of taper, out-of-roundness, or cylinder-to-piston clearance measured exceeds the standard value 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.

- b. If the cylinder inner diameter exceeds 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 defective.
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. Or bore the cylinder to use an oversize piston.
3. Make sure that the piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F). Replace if defective.

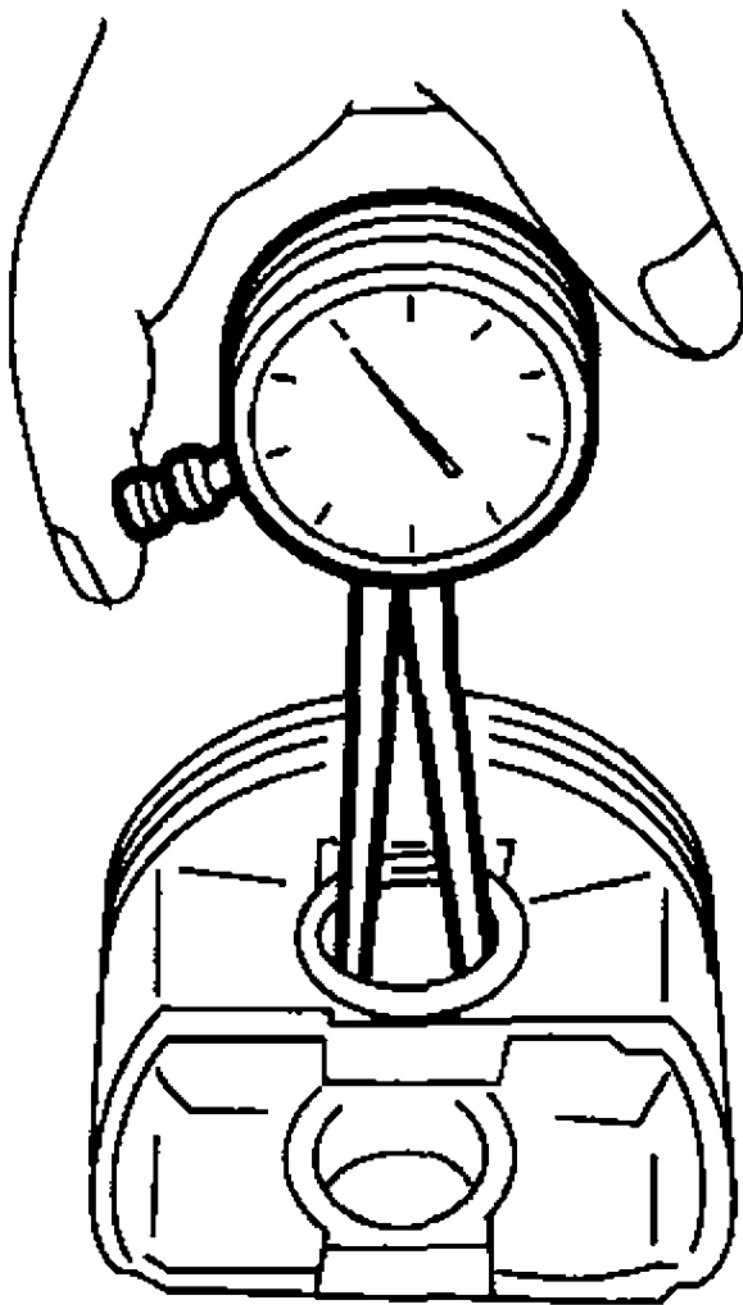
Clearance between piston hole and piston pin:

Standard

0.004 - 0.008 mm (0.0002 - 0.0003 in)

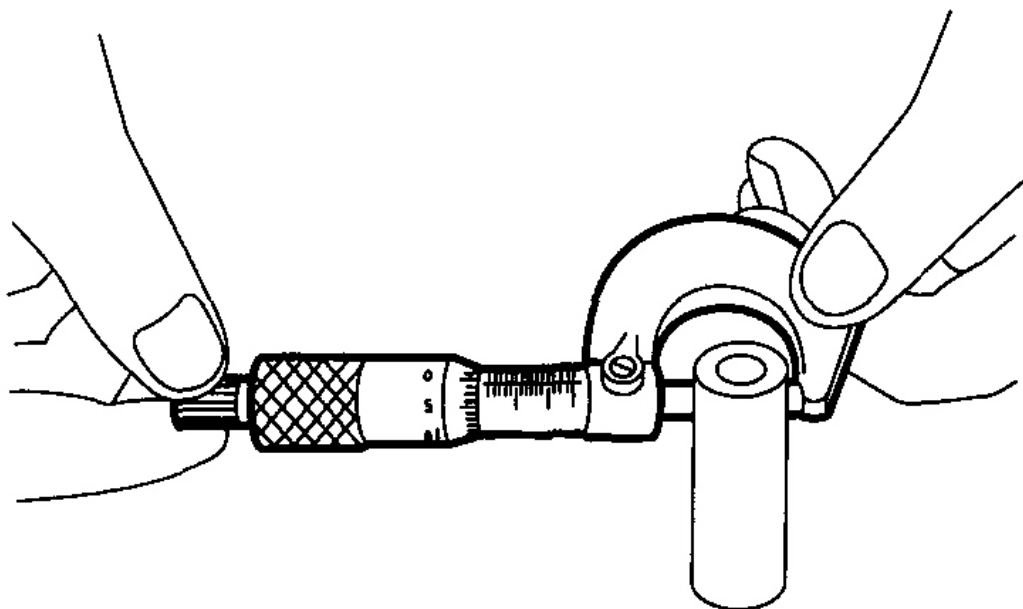
Limit

0.020 mm (0.0008 in)



G03813021

Fig. 231: Measuring Piston Hole Inner Diameter
Courtesy of SUBARU OF AMERICA, INC.

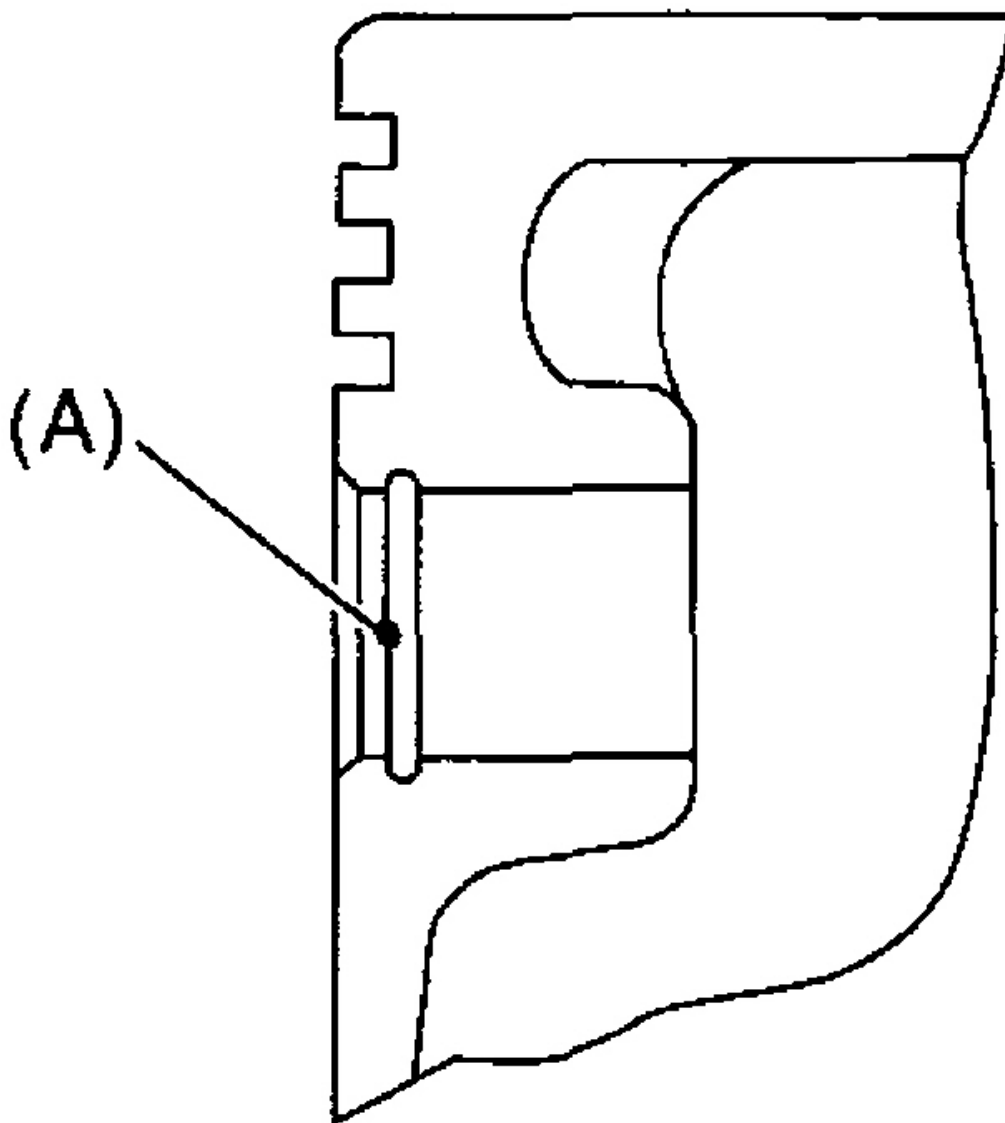


G03813022

Fig. 232: Measuring Piston Pin

Courtesy of SUBARU OF AMERICA, INC.

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



G03813023

Fig. 233: Checking Snap Ring Installation Groove (A) On Piston For Burr
Courtesy of SUBARU OF AMERICA, INC.

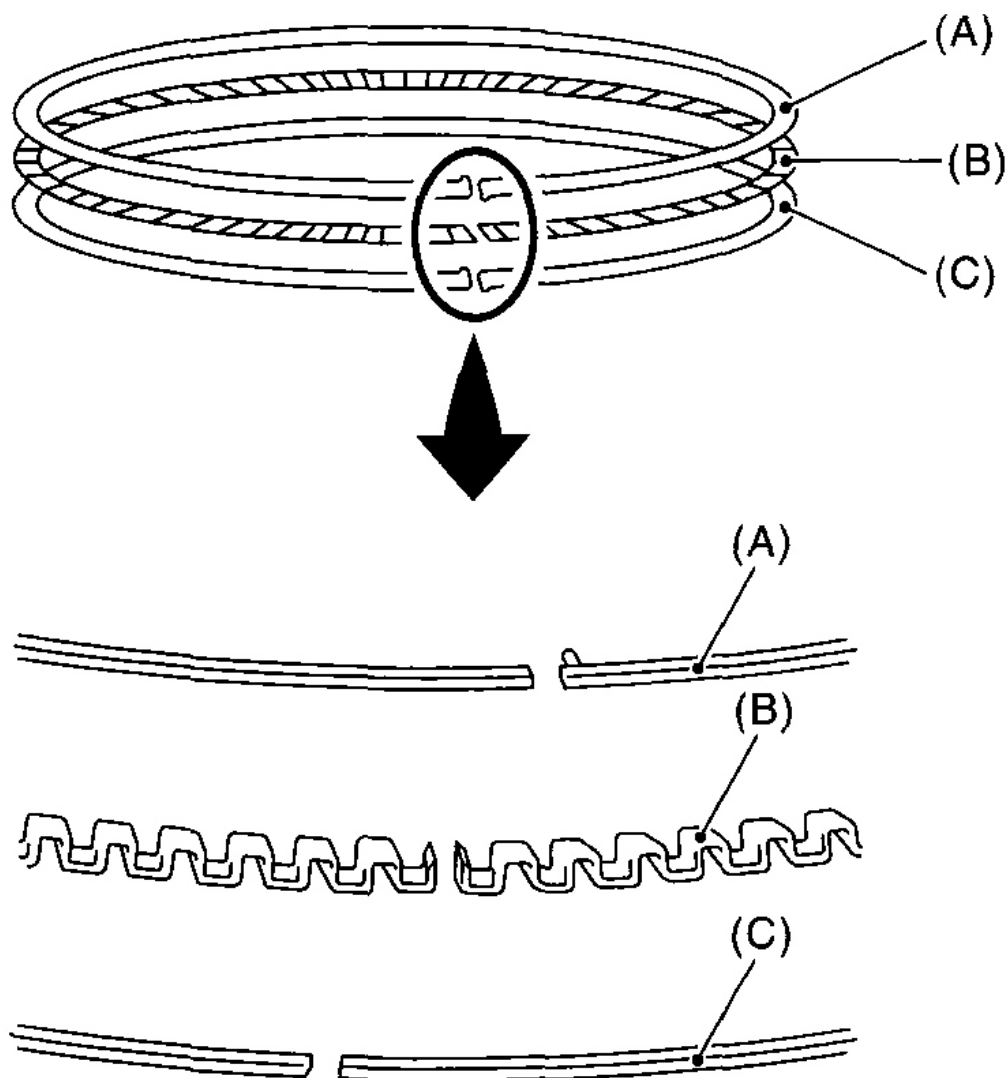
5. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

CAUTION:

- **Mark is displayed on the end of top and second rings. When installing the rings to the 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.**



(A) Upper rail

(B) Expander

(C) Lower rail

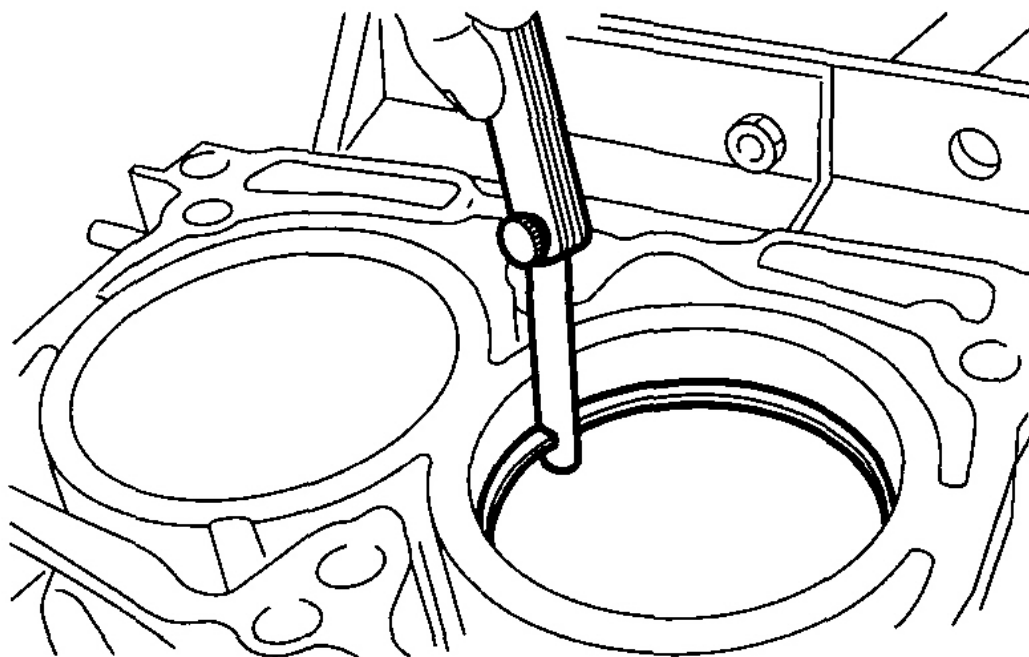
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Fig. 234: Checking Piston Ring
Courtesy of SUBARU OF AMERICA, INC.

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

STANDARD MM (IN) SPECIFICATION

		Standard mm (in)	Limit mm (in)
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 - 0.020)	1.0 (0.039)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)	1.5(0.059)



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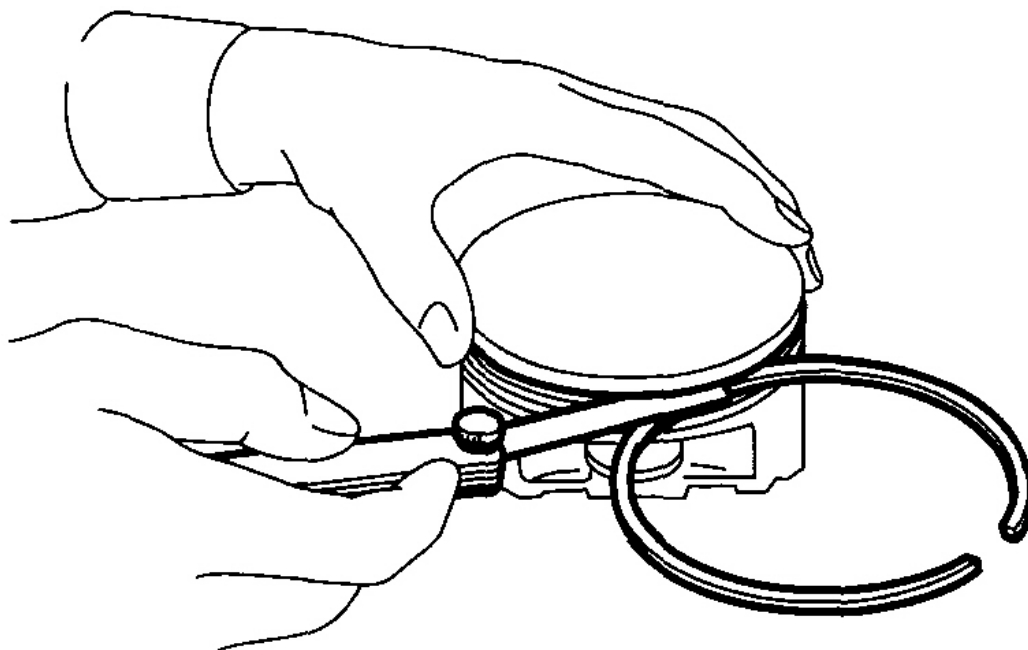
Fig. 235: Cleaning Piston Ring Groove And Piston Ring
 Courtesy of SUBARU OF AMERICA, INC.

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

LIMIT MM (IN) SPECIFICATION

		Standard mm (in)	Limit mm (in)
Clearance between piston ring and piston ring	Top ring	0.040 - 0.080 (0.0016 - 0.0031)	0.15(0.0059)

groove	Second ring	0.030 - 0.070 (0.0012 - 0.0028)	0.15(0.0059)
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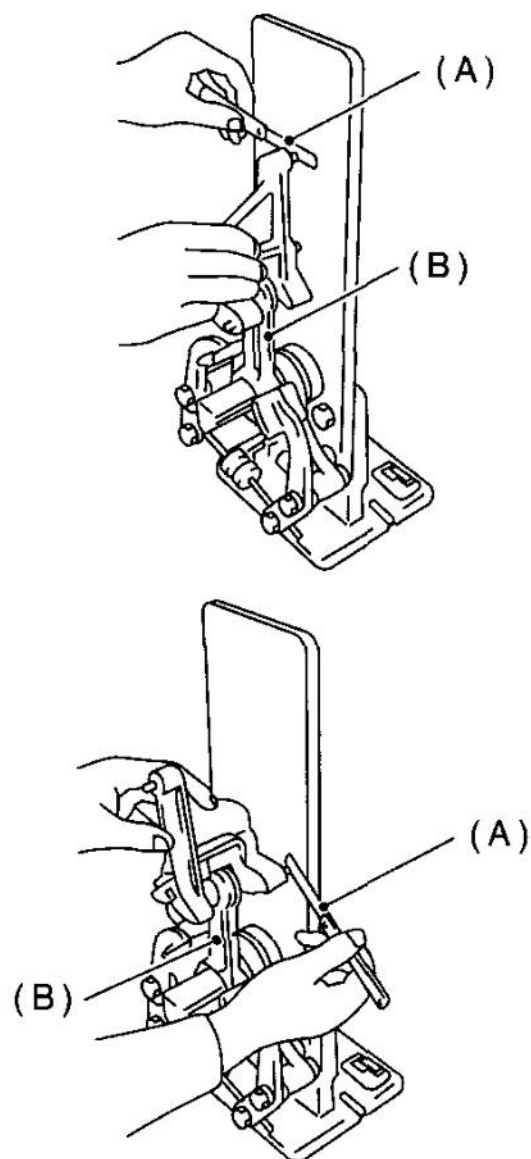
Fig. 236: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

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

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

0.10 mm (0.0039 in)



(A) Thickness gauge

(B) Connecting rod

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Fig. 237: Identifying Connecting Rod
 Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod fitted with bearing to crankshaft and measure the side clearance (thrust clearance). If side clearance exceeds the limit, replace the connecting rod.

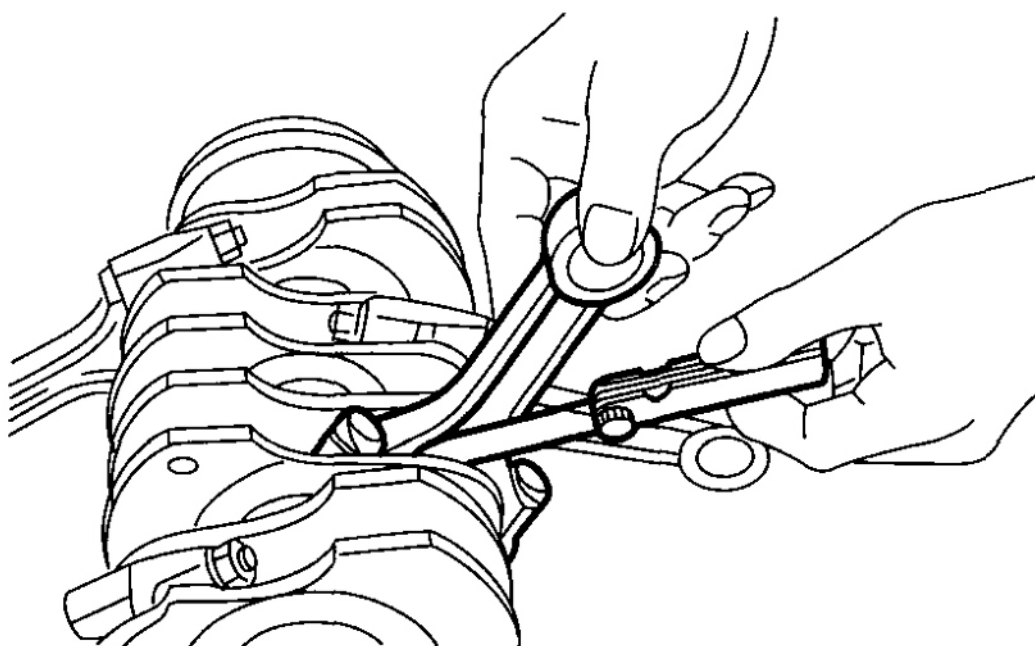
Connecting rod side clearance:**Standard****0.070 - 0.330 mm (0.0028 - 0.0130 in)****Limit****0.4 mm (0.016 in)****G03813028**

Fig. 238: Installing Connecting Rod Fitted With Bearing To Crankshaft
Courtesy of SUBARU OF AMERICA, INC.

4. Inspect the connecting rod bearing for scar, peeling, seizure, melting, wear, etc.
5. Measure the oil clearance on individual connecting rod bearings by means of plastigage. If any oil clearance is not within the specification, replace the defective bearing with a new one of standard size or undersize as necessary. (See **OUTER DIAMETER OF CRANK PIN SPECIFICATION** .)

Connecting rod oil clearance:**Standard**

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0.016 - 0.044 mm (0.00063 - 0.0017 in)

Limit

0.05 mm (0.0020 in)

OUTER DIAMETER OF CRANK PIN SPECIFICATION

Unit: mm (in)		
Bearings	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 the connecting rod small end.

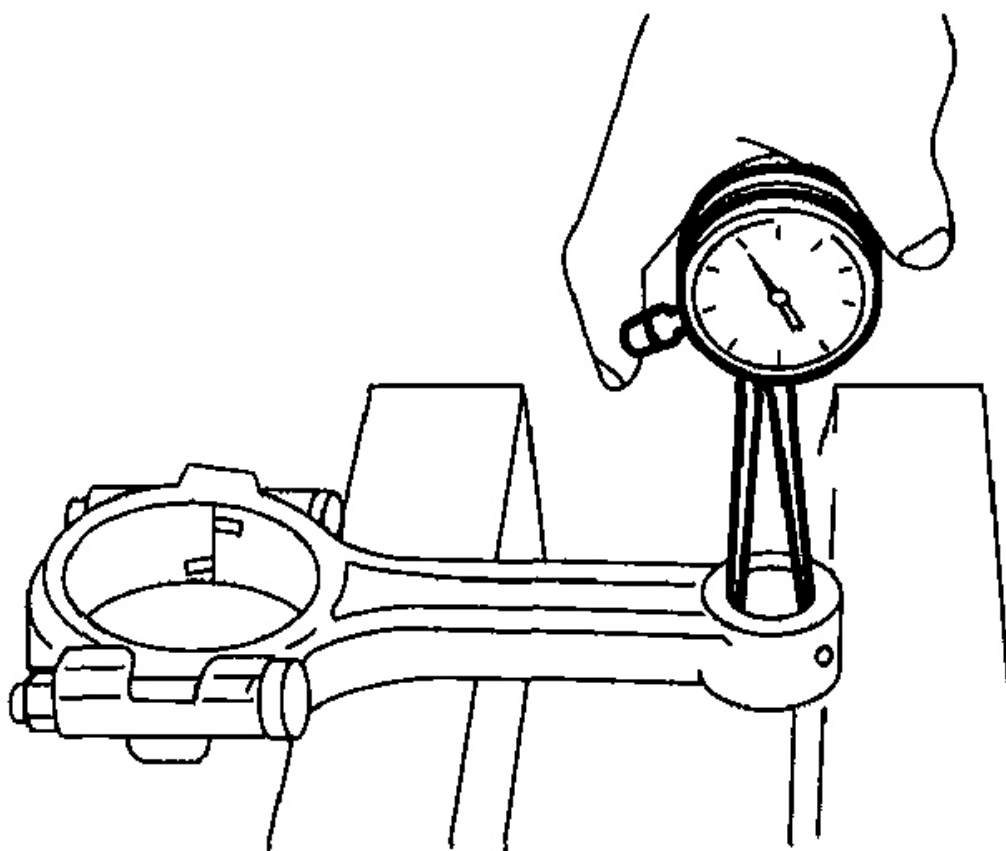
Clearance between piston pin and bushing:

Standard

0 - 0.022 mm (0 - 0.0009 in)

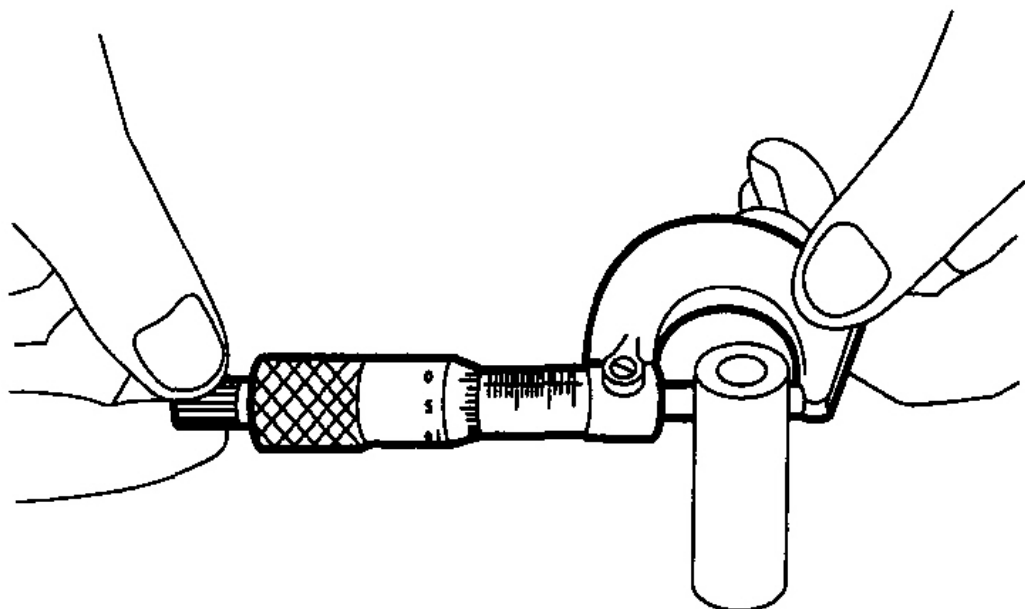
Limit

0.030 mm (0.0012 in)



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Fig. 239: Inspecting Bushing At Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

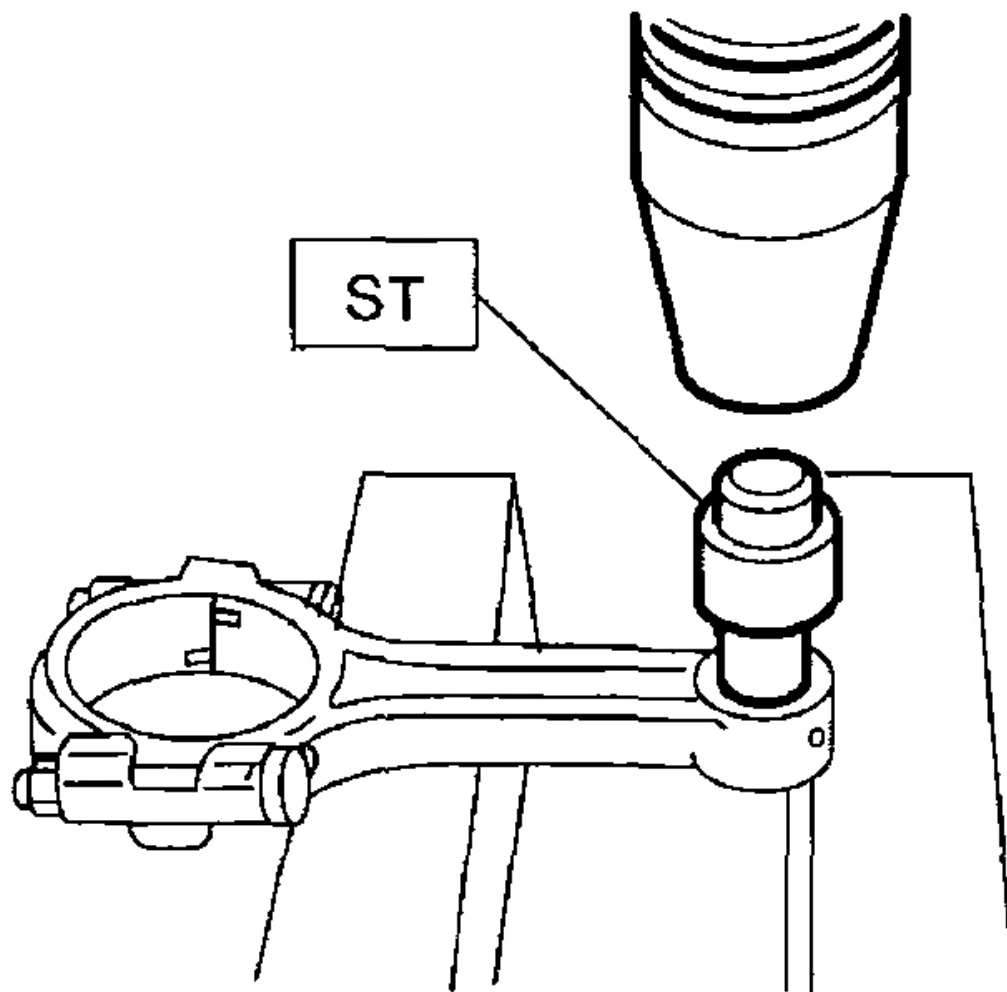


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Fig. 240: Measuring Piston Pin Clearance At Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

7. Replacement procedure is as follows.
 - a. Remove the bushing from connecting rod with ST and press.
 - b. Press the bushing with ST after applying oil on the periphery of bushing.

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER



G03813031

Fig. 241: Pressing Bush Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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

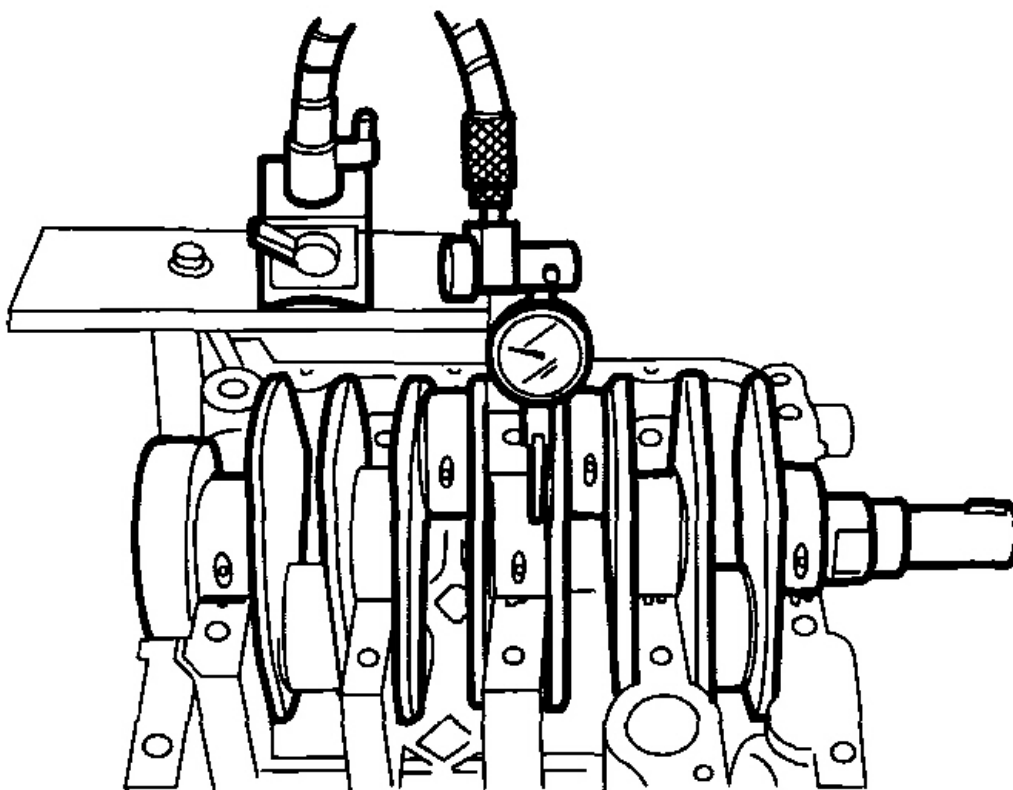
CRANKSHAFT AND CRANKSHAFT BEARING

- 1. Clean the crankshaft completely, and check it for cracks using red lead. 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)



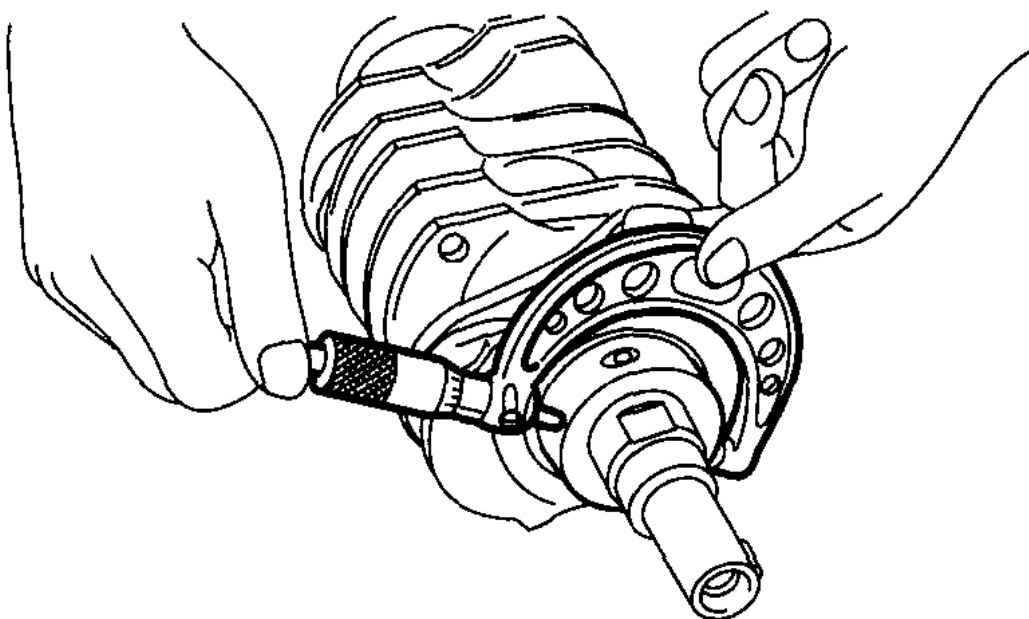
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Fig. 242: Measuring Crankshaft And Crankshaft Bearing
Courtesy of SUBARU OF AMERICA, INC.

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

Crank pin:

Out-of-roundness**0.003 mm (0.0001 in)****Cylindrically****0.004 mm (0.0002 in)****Grinding limit****To 51.750 mm (2.0374 in) dia.****Crank journal:****Out-of-roundness****0.005 mm (0.0002 in)****Cylindrically****0.006 mm (0.0002 in)****Grinding limit****To 59.750 mm (2.3524 in) dia**



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Fig. 243: Inspecting Crank Journal And Crank Pin For Wear
 Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL OUTER DIAMETER SPECIFICATION

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

Bearing size (Thickness at center)	2.127 - 2.130 (0.0837 - 0.0839)	2.129 - 2.132 (0.0838 - 0.0839)	1.620 - 1.623 (0.0638 - 0.0639)
---------------------------------------	------------------------------------	------------------------------------	------------------------------------

4. Measure the side clearance of crankshaft at center bearing. If clearance exceeds the limit, replace the bearing.

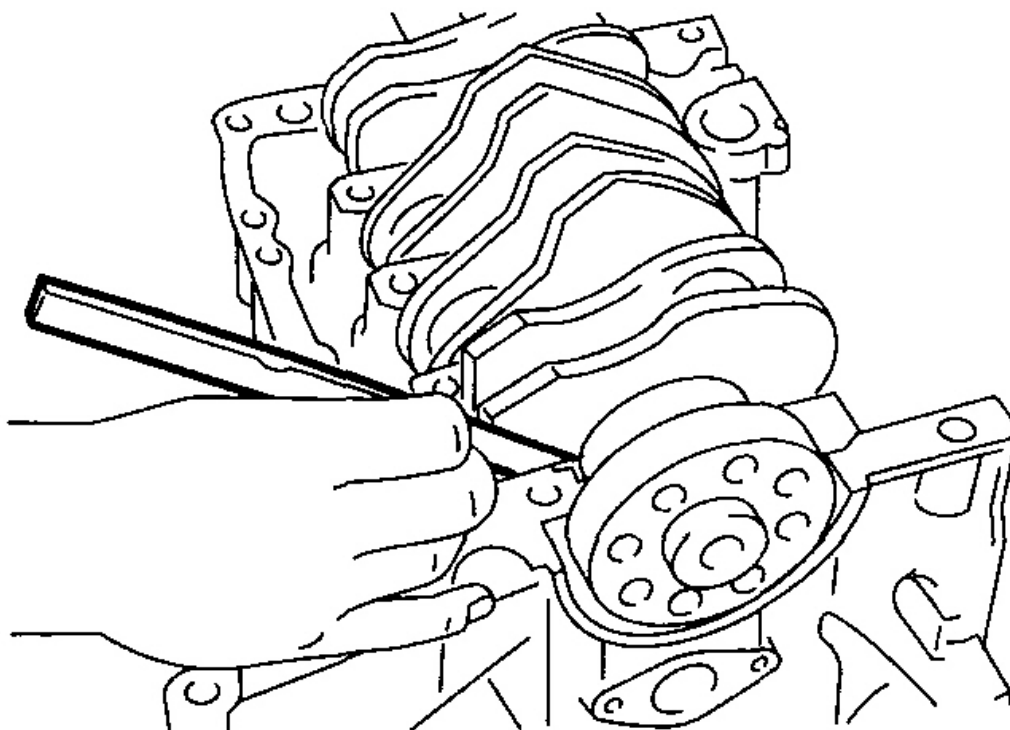
Crankshaft side clearance:

Standard

0.030 - 0.115 mm (0.0012 - 0.0045 in)

Limit

0.25 mm (0.0098 in)



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Fig. 244: Measuring Side Clearance Of Crankshaft At Center Bearing
Courtesy of SUBARU OF AMERICA, INC.

5. Inspect individual crankshaft bearings for signs of flaking, seizure, melting and wear.
6. Measure the oil clearance on each crankshaft bearing by means of plastigage. If the measurement is not within the specification, 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)

Limit

0.040 mm (0.0016 in)

ENGINE TROUBLE IN GENERAL

INSPECTION

NOTE: "RANK" shown in SYMPTOM CHART, refers to the possibility of reason for the trouble in order ("Very often" to "Rarely")

SYMPTOM CHART

Symptom	Problem parts, etc.	Possible cause	RANK
1. Engine does not start.			
a) Starter does not turn.	Starter	Defective battery-to-starter harness	(2)
		Defective starter switch	(3)
		Defective inhibitor switch	(3)
		Defective starter	(2)
	Battery	Poor terminal connection	(1)
		Run-down battery	(1)
		Defective charging system	(2)
	Friction	Seizure of crankshaft and connecting rod bearing	(3)
		Seized camshaft	(3)
		Seized or stuck piston and cylinder	(3)
	Starter	Defective starter	(3)
	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURE		(1)

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b) Initial combustion does not occur.	Fuel line	Defective fuel pump and relay	(1)
		Lack of or insufficient fuel	(2)
	Belt	Trouble	(2)
		Defective timing	(2)
	Compression	Incorrect valve clearance	(3)
		Loosened spark plug or defective gasket	(3)
		Loosened cylinder head bolt or defective gasket	(3)
		Improper valve sealing	(3)
		Defective valve stem	(3)
		Worn or broken valve spring	(2)
		Worn or stuck piston rings, cylinder and piston	(3)
		Incorrect valve timing	(2)
		Improper engine oil (low viscosity)	(2)
c) Initial combustion occurs.	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u>		(1)
	Intake system	Defective intake manifold gasket	(2)
		Defective throttle body gasket	(2)
	Fuel line	Defective fuel pump and relay	(3)
		Clogged fuel line	(3)
		Lack of or insufficient fuel	(2)
	Belt	Trouble	(2)
		Defective timing	(2)
	Compression	Incorrect valve clearance	(3)
		Loosened spark plug or defective gasket	(3)
		Loosened cylinder head bolt or defective gasket	(3)
		Improper valve sealing	(3)
		Defective valve stem	(3)
		Worn or broken valve	

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d) Engine stalls after initial combustion.		spring	(2)
		Worn or stuck piston rings, cylinder and piston	(3)
		Incorrect valve timing	(2)
		Improper engine oil (low viscosity)	(2)
	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		(1)
	Intake system	Loosened or cracked intake duct	(2)
		Loosened or cracked PCV hose	(3)
		Loosened or cracked vacuum hose	(3)
		Defective intake manifold gasket	(2)
		Defective throttle body gasket	(2)
		Dirty air cleaner element	(3)
	Fuel line	Clogged fuel line	(3)
		Lack of or insufficient fuel	(2)
	Belt	Trouble	(2)
		Defective timing	(2)
	Compression	Incorrect valve clearance	(3)
		Loosened spark plug or defective gasket	(3)
		Loosened cylinder head bolt or defective gasket	(3)
		Improper valve sealing	(3)
		Defective valve stem	(3)
		Worn or broken valve spring	(2)
		Worn or stuck piston rings, cylinder and piston	(3)
		Incorrect valve timing	(2)
		Improper engine oil (low viscosity)	(2)
	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		(1)
		Loosened or cracked intake duct	(1)

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2. Rough idle and engine stall	Intake system	Loosened or cracked PCV hose	(1)
		Loosened or cracked vacuum hose	(1)
		Defective intake manifold gasket	(2)
		Defective throttle body gasket	(2)
		Defective PCV valve	(3)
		Loosened oil filler cap	(2)
		Dirty air cleaner element	(3)
	Fuel line	Defective fuel pump and relay	(3)
		Clogged fuel line	(3)
		Lack of or insufficient fuel	(2)
	Belt	Defective timing	(3)
	Compression	Incorrect valve clearance	(2)
		Loosened spark plug or defective gasket	(2)
		Loosened cylinder head bolt or defective gasket	(2)
		Improper valve sealing	(2)
		Defective valve stem	(3)
		Worn or broken valve spring	(2)
		Worn or stuck piston rings, cylinder and piston	(2)
		Incorrect valve timing	(1)
		Improper engine oil (low viscosity)	(2)
	Lubrication system	Incorrect oil pressure	(2)
		Defective rocker cover gasket	(3)
	Cooling system	Over-heating	(3)
	Other	Evaporative emission control system malfunction	(1)
		Stuck or damaged throttle valve	(2)
	Engine control system < Ref. to BASIC		(1)

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3. Low output, hesitation and poor acceleration	DIAGNOSTIC PROCEDURE . >	
	Intake system	Loosened or cracked intake duct (1)
		Loosened or cracked PCV hose (1)
		Loosened or cracked vacuum hose (2)
		Defective intake manifold gasket (2)
		Defective throttle body gasket (2)
		Defective PCV valve (2)
		Loosened oil filler cap (2)
		Dirty air cleaner element (1)
	Fuel line	Defective fuel pump and relay (2)
		Clogged fuel line (2)
		Lack of or insufficient fuel (3)
	Belt	Defective timing (2)
	Compression	Incorrect valve clearance (2)
		Loosened spark plug or defective gasket (2)
		Loosened cylinder head bolt or defective gasket (2)
		Improper valve sealing (2)
		Defective valve stem (3)
		Worn or broken valve spring (2)
		Worn or stuck piston rings, cylinder and piston (3)
		Incorrect valve timing (1)
		Improper engine oil (low viscosity) (2)
	Lubrication system	Incorrect oil pressure (2)
	Cooling system	Over-heating (3)
		Over-cooling (3)
	Other	Evaporative emission control system malfunction (1)
	Engine control system < Ref. to BASIC	

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4. Surging	DIAGNOSTIC PROCEDURE . >		(1)
	Intake system	Loosened or cracked intake duct	(1)
		Loosened or cracked PCV hose	(1)
		Loosened or cracked vacuum hose	(1)
		Defective intake manifold gasket	(2)
		Defective throttle body gasket	(2)
		Defective PCV valve	(2)
		Loosened oil filler cap	(2)
		Dirty air cleaner element	(2)
	Fuel line	Defective fuel pump and relay	(2)
		Clogged fuel line	(2)
		Lack of or insufficient fuel	(3)
	Belt	Defective timing	(2)
	Compression	Incorrect valve clearance	(2)
		Loosened spark plug or defective gasket	(3)
		Loosened cylinder head bolt or defective gasket	(3)
		Improper valve sealing	(3)
		Defective valve stem	(3)
		Worn or broken valve spring	(3)
		Worn or stuck piston rings, cylinder and piston	(3)
		Incorrect valve timing	(1)
		Improper engine oil (low viscosity)	(2)
	Cooling system	Over-heating	(2)
	Other	Evaporative emission control system malfunction	(3)
5. Engine does not return	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURE . >		(1)
	Intake system	Loosened or cracked	(1)

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to idle.		vacuum hose	
	Other	Stuck or damaged throttle valve	(1)
6. Dieseling (Run-on)	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURE . >		(1)
	Cooling system	Over-heating	(2)
	Other	Evaporative emission control system malfunction	(2)
7. After burning in exhaust system	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURE . >		(1)
	Intake system	Loosened or cracked intake duct	(3)
		Loosened or cracked PCV hose	(3)
		Loosened or cracked vacuum hose	(2)
		Defective PCV valve	(2)
		Loosened oil filler cap	(3)
	Belt	Defective timing	(2)
	Compression	Incorrect valve clearance	(2)
		Loosened spark plug or defective gasket	(3)
		Loosened cylinder head bolt or defective gasket	(3)
		Improper valve sealing	(2)
		Defective valve stem	(3)
		Worn or broken valve spring	(3)
		Worn or stuck piston rings, cylinder and piston	(3)
		Incorrect valve timing	(1)
	Lubrication system	Incorrect oil pressure	(3)
	Cooling system	Over-cooling	(3)
	Other	Evaporative emission control system malfunction	(3)
8. Knocking	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURE . >		(1)
	Intake system	Loosened oil filler cap	(2)
	Belt	Defective timing	(2)

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	Compression	Incorrect valve clearance	(3)
		Incorrect valve timing	(2)
	Cooling system	Over-heating	(1)
9. Excessive engine oil consumption	Intake system	Loosened or cracked PCV hose	(1)
		Defective PCV valve	(2)
		Loosened oil filler cap	(3)
	Compression	Defective valve stem	(1)
		Worn or stuck piston rings, cylinder and piston	(1)
	Lubrication system	Loosened oil pump attaching bolts and defective gasket	(2)
		Defective oil filter seal	(2)
		Defective crankshaft oil seal	(2)
		Defective rocker cover gasket	(2)
		Loosened oil drain plug or defective gasket	(2)
		Loosened oil pan fitting bolts or defective oil pan	(2)
10. Excessive fuel consumption	Engine control system < Ref. to BASIC DIAGNOSTIC PROCEDURE . >		(1)
	Intake system	Dirty air cleaner element	(1)
	Belt	Defective timing	(2)
	Compression	Incorrect valve clearance	(2)
		Loosened spark plug or defective gasket	(3)
		Loosened cylinder head bolt or defective gasket	(3)
		Improper valve sealing	(2)
		Defective valve stem	(3)
		Worn or broken valve spring	(3)
		Worn or stuck piston rings, cylinder and piston	(2)
		Incorrect valve timing	(2)
	Lubrication system	Incorrect oil pressure	(3)
	Cooling system	Over-cooling	(3)

(1) Very often

(2) Sometimes

(3) Rarely

ENGINE NOISE

INSPECTION

POSSIBLE CAUSE CONDITION CHART

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 (big end)
	Oil pressure is normal.	Damaged engine mounting
High-pitched clank (Spark knock)	Sound is noticeable when accelerating with an overload.	- Ignition timing advanced - Accumulation of carbon inside combustion chamber - Wrong spark plug - Improper gasoline
Clank when engine speed is 1,000 to 2,000 rpm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	- Worn camshaft main bearing - Worn bearing at crankshaft end of connecting rod
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. ⁽¹⁾	- Worn cylinder liner and piston ring - Broken or stuck piston ring - Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	- Worn cam sprocket - Worn camshaft journal bore in crankcase
Squeaky sound	-	Insufficient generator lubrication
Rubbing sound	-	Defective generator brush and rotor contact

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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	-	• Loss of compression • Air leakage in air intake system, hoses, connections or manifolds
Timing belt noise	-	• Loose timing belt • Belt contacting with case/adjacent part
Valve tappet noise	-	Incorrect valve clearance
(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 <u>OPERATION</u> , Clear Memory Mode. > and inspection mode < Ref. to <u>PROCEDURE</u> , Basic Diagnostic Procedure. > after connecting the fuel injector connector.		