

## 2002 ENGINE

## Mechanical - Legacy &amp; Outback

## GENERAL DESCRIPTION

## SPECIFICATIONS

**NOTE:**

**STD:** Standard

**I.D.:** Inner Diameter

**O.D.:** Outer Diameter

**US:** Undersize

**OS:** Oversize

## MECHANICAL GENERAL SPECIFICATIONS

Engine	Type		Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve arrangement		Belt driven, single over-head camshaft, 4-valve/cylinder
	Bore x Stroke	mm (in)	99.5 x 79.0 (3.917 x 3.110)
	Displacement	cm <sup>3</sup> (cu in)	2,457 (150)
	Compression ratio		10.0
	Compression pressure (at 200 - 300 rpm) kPa (kg/cm <sup>2</sup> , psi)		1,020 - 1,275 (10.4 - 13.0, 148 - 185)
	Number of piston rings		Pressure ring: 2, Oil ring: 1
	Intake valve timing	Opening	1° BTDC
		Closing	51° ABDC
	Exhaust valve timing	Opening	50° BBDC
		Closing	6° ATDC
	Valve clearance	Intake mm (in)	0.20 ± 0.02 (0.0079 ± 0.0008)
		Exhaust mm (in)	0.25 ± 0.02 (0.0098 ± 0.0008)
Idling speed [At neutral position on MT, or "P" or "N" position on AT]  rpm		MT: 650 ± 100 (No load) AT: 700 ± 100 (No load)	

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

			850 ± 100 (A/C switch ON)	
	Firing order		1 --> 3 --> 2 --> 4	
	Ignition timing	BTDC/rpm	MT: 10° ± 8°/650 AT: 15° ± 8°/700	
Belt tensioner adjuster	Protrusion of adjuster rod		5.2 - 6.2 mm (0.205 - 0.244 in)	
Belt tensioner	Spacer O.D.		17.955 - 17.975 mm (0.7069 - 0.7077 in)	
	Tensioner bush I.D.		18.00 - 18.08 mm (0.7087 - 0.7118 in)	
	Clearance between spacer and bush	STD	0.025 - 0.125 mm (0.0010 - 0.0049 in)	
		Limit	0.175 mm (0.0069 in)	
	Side clearance of spacer	STD	0.20 - 0.55 mm (0.0079 - 0.0217 in)	
		Limit	0.81 mm (0.0319 in)	
Valve rocker arm	Clearance between shaft and arm	STD	0.020 - 0.054 mm (0.0008 - 0.0021 in)	
		Limit	0.10 mm (0.0039 in)	
Camshaft	Bend limit		0.025 mm (0.0010 in)	
	Thrust clearance	STD	0.030 - 0.090 mm (0.0012 - 0.0035 in)	
		Limit	0.10 mm (0.0039 in)	
	Cam lobe height	Intake	STD	39.485 - 39.585 mm (1.5545 - 1.5585 in)
			Limit	39.385 mm (1.5506 in)
		Exhaust	STD	39.257 - 39.357 mm (1.5455 - 1.5495 in)
			Limit	39.157 mm (1.5416 in)
	Camshaft journal O.D.		31.928 - 31.945 mm (1.2570 - 1.2577 in)	
	Camshaft journal hole I.D.		32.000 - 32.018 mm (1.2598 - 1.2605 in)	
	Oil clearance	STD	0.055 - 0.090 mm (0.0022 - 0.0035 in)	
		Limit	0.10 mm (0.0039 in)	
Cylinder head	Surface warpage limit		0.05 mm (0.0020 in)	
	Surface grinding limit		0.1 mm (0.004 in)	
	Standard height		97.5 mm (3.839 in)	

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

Valve set	Refacing angle			90°
	Contacting width	Intake	STD	1.0 mm (0.039 in)
			Limit	1.7 mm (0.067 in)
		Exhaust	STD	1.4 mm (0.055 in)
			Limit	2.1 mm (0.083 in)
Valve guide	Inner diameter			6.000 - 6.012 mm (0.2362 - 0.2367 in)
	Protrusion above head		Intake	20.0 - 20.5 mm (0.787 - 0.807 in)
			Exhaust	16.5 - 17.0 mm (0.650 - 0.669 in)
Valve	Head edge thickness	Intake	STD	1.0 mm (0.039 in)
			Limit	0.6 mm (0.024 in)
		Exhaust	STD	1.2 mm (0.047 in)
			Limit	0.6 mm (0.024 in)
	Stem diameter		Intake	5.950 - 5.965 mm (0.2343 - 0.2348 in)
			Exhaust	5.945 - 5.960 mm (0.2341 - 0.2346 in)
	Stem oil clearance	STD	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 (0.0059 in)
	Overall length		Intake	120.6 mm (4.75 in)
			Exhaust	121.7 mm (4.79 in)
Valve spring	Free length			54.30 mm (2.1378 in)
	Squareness			2.5°, 2.4 mm (0.094 in)
	Tension/spring height			214.8 - 246.2 N (21.9 - 25.1 kgf, 48.3 - 55.3 lb)/ 45.0 mm (1.772 in) 526.6 - 581.6 N (53.7 - 59.3 kgf, 118.4 - 130.8 lb)/34.7 mm (1.366 in)
	Surface warpage limit (mating with cylinder head)			0.05 mm (0.0020 in)
	Surface grinding limit			0.1 mm (0.004 in)
	Cylinder bore	STD	A	99.505 - 99.515 mm (3.9175 - 3.9179 in)
			B	99.495 - 99.505 mm (3.9171 - 3.9175 in)

# 2002 Subaru Legacy L

## 2002 ENGINE Mechanical - Legacy & Outback

Cylinder block	Taper		STD	0.015 mm (0.0006 in)
			Limit	0.050 mm (0.0020 in)
	Out-of-roundness		STD	0.010 mm (0.0004 in)
			Limit	0.050 mm (0.0020 in)
	Piston clearance		STD	0.010 - 0.030 mm (0.0004 - 0.0012 in)
			Limit	0.050 mm (0.0020 in)
	Enlarging (boring) limit			
Piston	Outer diameter	STD	A	99.485 - 99.495 mm (3.9167 - 3.9171 in)
			B	99.475 - 99.485 mm (3.9163 - 3.9167 in)
		0.25 mm (0.0098 in) OS		99.725 - 99.735 mm (3.9262 - 3.9266 in)
		0.50 mm (0.0197 in) OS		99.975 - 99.985 mm (3.9360 - 3.9364 in)
	Standard inner diameter of piston pin hole			
Piston pin	Outer diameter			22.994 - 23.000 mm (0.9053 - 0.9055 in)
	Standard clearance between piston pin and hole in piston			0.004 - 0.008 mm (0.0002 - 0.0003 in)
	Degree of fit			Piston pin must be fitted into position with thumb at 20°C (68°F).
Piston ring	Piston ring gap	Top ring	STD	0.20 - 0.35 mm (0.0079 - 0.0138 in)
			Limit	1.0 mm (0.039 in)
		Second ring	STD	0.35 - 0.50 mm (0.0138 - 0.0197 in)
			Limit	1.0 mm (0.039 in)
		Oil ring	STD	0.20 - 0.70 mm (0.0079 - 0.0276 in)
			Limit	1.5 mm (0.059 in)
	Clearance between piston ring and piston ring groove	Top ring	STD	0.040 - 0.080 mm (0.0016 - 0.0031 in)
			Limit	0.15 mm (0.0059 in)
		STD	0.030 - 0.070 mm	



# 2002 Subaru Legacy L

## 2002 ENGINE Mechanical - Legacy & Outback

Connecting rod		Second ring		(0.0012 - 0.0028 in)
			Limit	0.15 mm (0.0059 in)
			Bend twist per 100 mm (3.94 in) in length	Limit
			Limit	0.10 mm (0.0039 in)
Connecting rod bearing	Oil clearance	Side clearance	STD	0.070 - 0.330 mm (0.0028 - 0.0130 in)
			Limit	0.4 mm (0.016 in)
			STD	0.020 - 0.046 mm (0.0008 - 0.0018 in)
			Limit	0.05 mm (0.0020 in)
Connecting rod bushing	Clearance between piston pin and bushing	Thickness at center portion	STD	1.486 - 1.498 mm (0.0585 - 0.0590 in)
			0.03 mm (0.0012 in) US	1.504 - 1.512 mm (0.0592 - 0.0595 in)
			0.05 mm (0.0020 in) US	1.514 - 1.522 mm (0.0596 - 0.0599 in)
			0.25 mm (0.0098 in) US	1.614 - 1.622 mm (0.0635 - 0.0639 in)
Crankshaft	Bend limit	Crank pin and crank journal	STD	0 - 0.022 mm (0 - 0.0009 in)
			Limit	0.030 mm (0.0012 in)
	Out-of-roundness	Grinding limit		0.035 mm (0.0014 in)
				0.020 mm (0.0008 in) or less
	Crank pin outer diameter			0.250 mm (0.0098 in)
			STD	51.984 - 52.000 mm (2.0466 - 2.0472 in)
			0.03 mm (0.0012 in) US	51.954 - 51.970 mm (2.0454 - 2.0461 in)
			0.05 mm (0.0020 in) US	51.934 - 51.950 mm (2.0446 - 2.0453 in)
			0.25 mm (0.0098 in) US	51.734 - 51.750 mm (2.0368 - 2.0374 in)
	Crank journal outer diameter	#1, #5, #3	STD	59.992 - 60.008 mm (2.3619 - 2.3625 in)
			0.03 mm (0.0012 in) US	59.962 - 59.978 mm (2.3607 - 2.3613 in)
			0.05 mm (0.0020 in) US	59.942 - 59.958 mm (2.3599 - 2.3605 in)
			0.25 mm (0.0098 in) US	59.742 - 59.758 mm (2.3520 - 2.3527 in)
			STD	59.992 - 60.008 mm

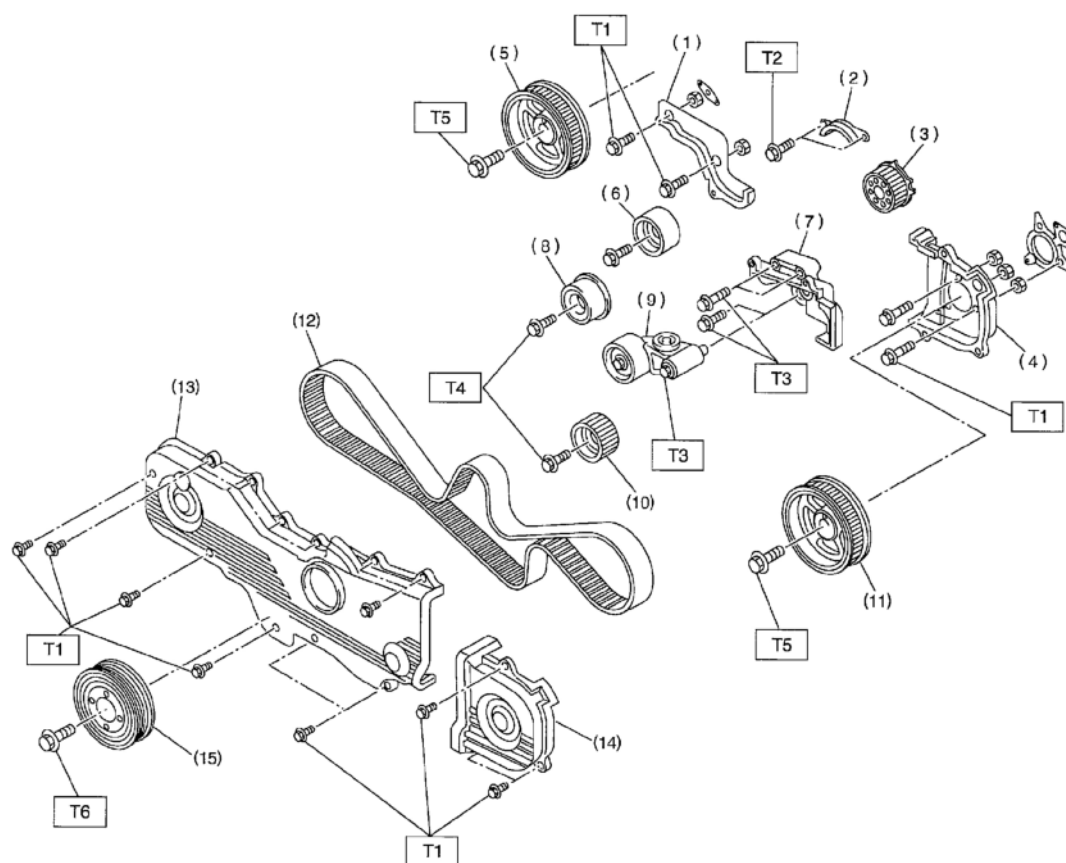
## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

		#2, #4		(2.3619 - 2.3625 in)
			0.03 mm (0.0012 in) US	59.962 - 59.978 mm (2.3607 - 2.3613 in)
			0.05 mm (0.0020 in) US	59.942 - 59.958 mm (2.3599 - 2.3605 in)
			0.25 mm (0.0098 in) US	59.742 - 59.758 mm (2.3520 - 2.3527 in)
	Thrust clearance		STD	0.030 - 0.115 mm (0.0012 - 0.0045 in)
			Limit	0.25 mm (0.0098 in)
	Oil clearance		STD	0.010 - 0.030 mm (0.0004 - 0.0012 in)
			Limit	0.040 mm (0.0016 in)
Crankshaft bearing	Crankshaft bearing thickness	#1, #3	STD	1.998 - 2.011 mm (0.0787 - 0.0792 in)
			0.03 mm (0.0012 in) US	2.017 - 2.020 mm (0.0794 - 0.0795 in)
			0.05 mm (0.0020 in) US	2.027 - 2.030 mm (0.0798 - 0.0799 in)
			0.25 mm (0.0098 in) US	2.127 - 2.130 mm (0.0837 - 0.0839 in)
		#2, #4, #5	STD	2.000 - 2.013 mm (0.0787 - 0.0793 in)
			0.03 mm (0.0012 in) US	2.019 - 2.022 mm (0.0795 - 0.0796 in)
			0.05 mm (0.0020 in) US	2.029 - 2.032 mm (0.0799 - 0.0800 in)
			0.25 mm (0.0098 in) US	2.129 - 2.132 mm (0.0838 - 0.0839 in)

#### COMPONENT

#### TIMING BELT



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

G02960035

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

***T1: 5 (0.5, 3.6)***

***T2: 9.8 (1.0, 7.2)***

***T3: 25 (2.5, 18.1)***

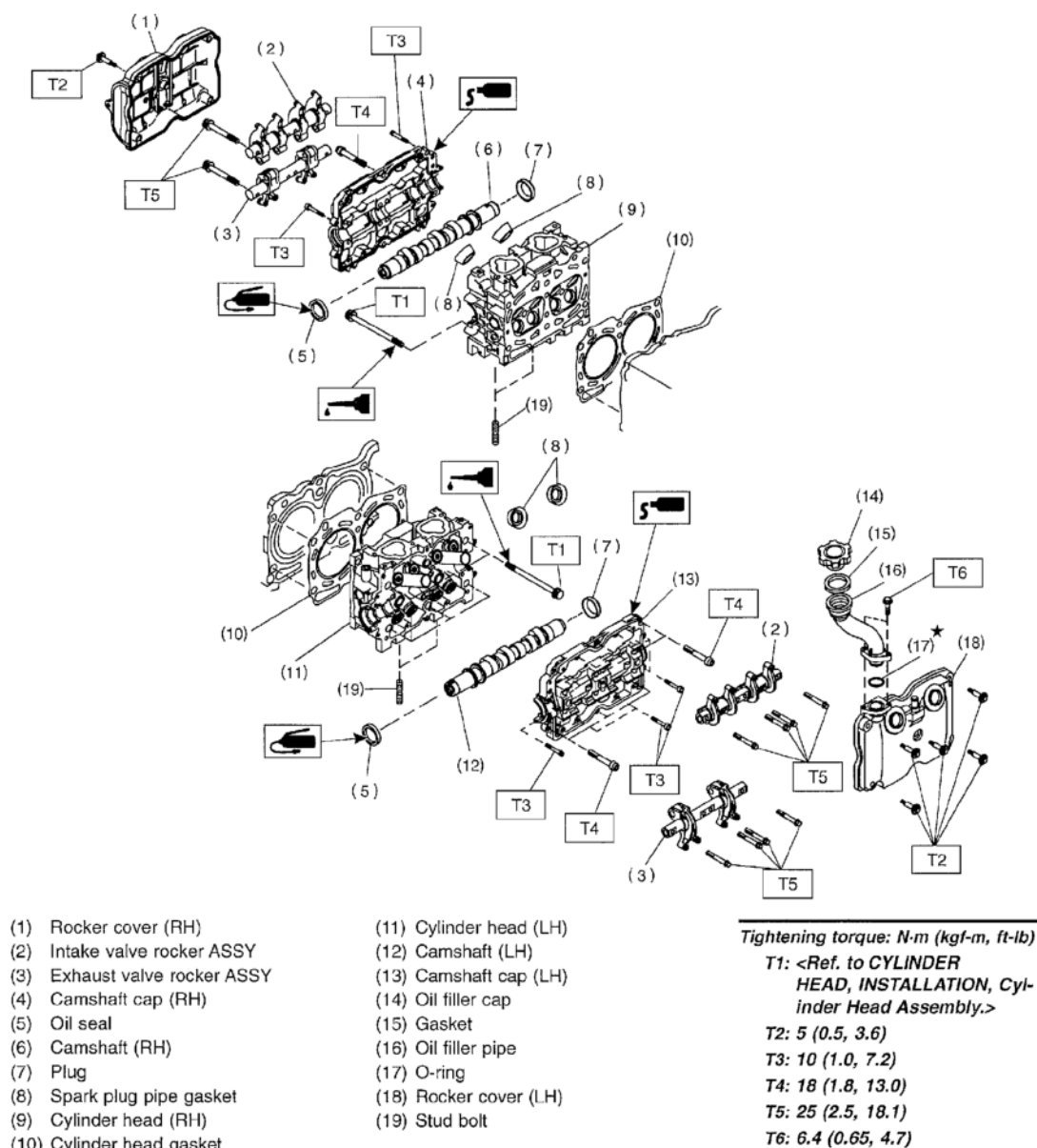
***T4: 39 (4.0, 28.9)***

***T5: 78 (8.0, 57.9)***

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

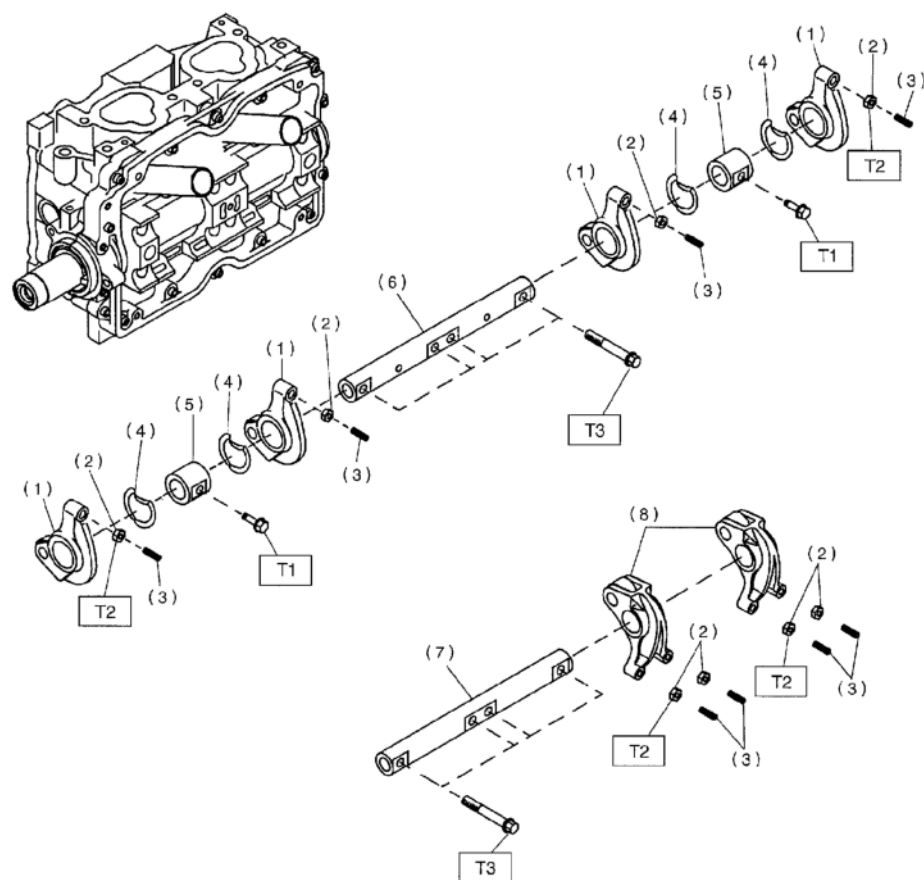
**Fig. 1: Identifying Timing Belt Components**  
Courtesy of SUBARU OF AMERICA, INC.

### **CYLINDER HEAD AND CAMSHAFT**



**Fig. 2: Identifying Cylinder Head & Camshaft Components**  
 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)**

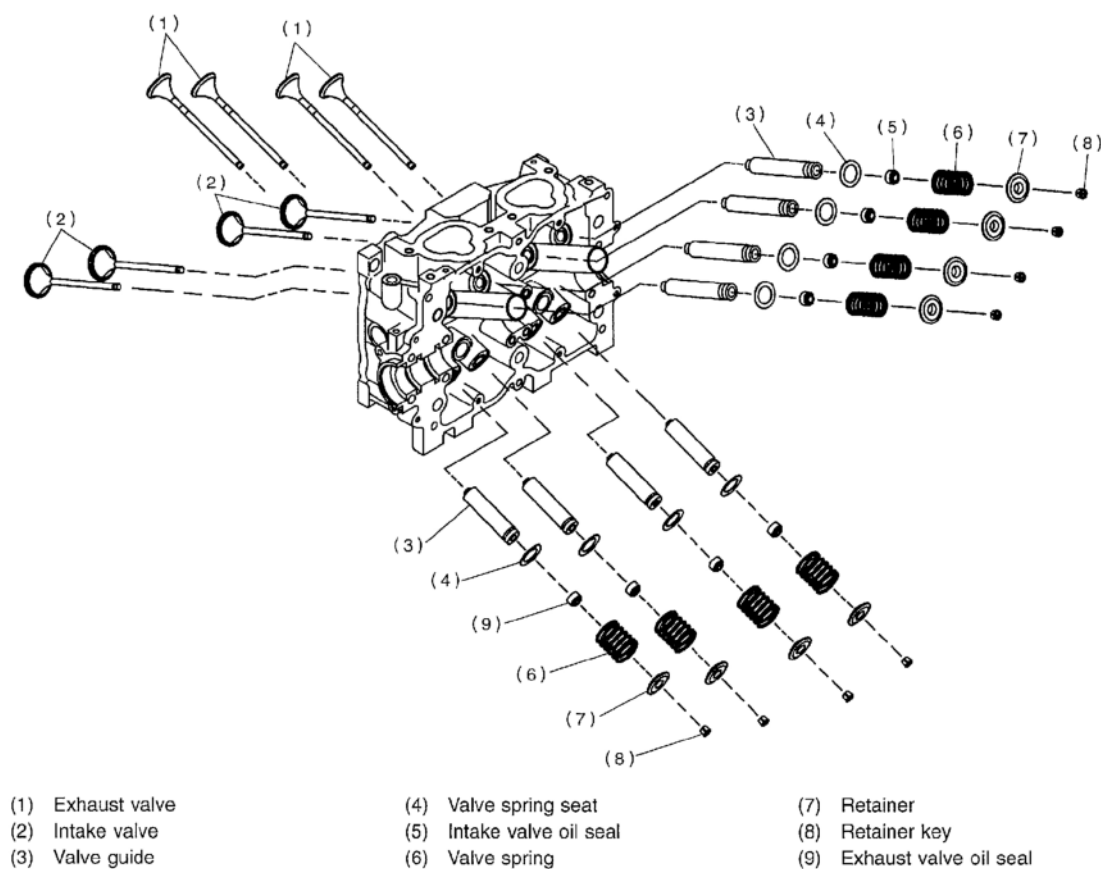
**T2: 10 (1.0, 7.2)**

**T3: 25 (2.5, 18.1)**

G02960037

**Fig. 3: Identifying Valve Rocker Assembly Components**  
**Courtesy of SUBARU OF AMERICA, INC.**

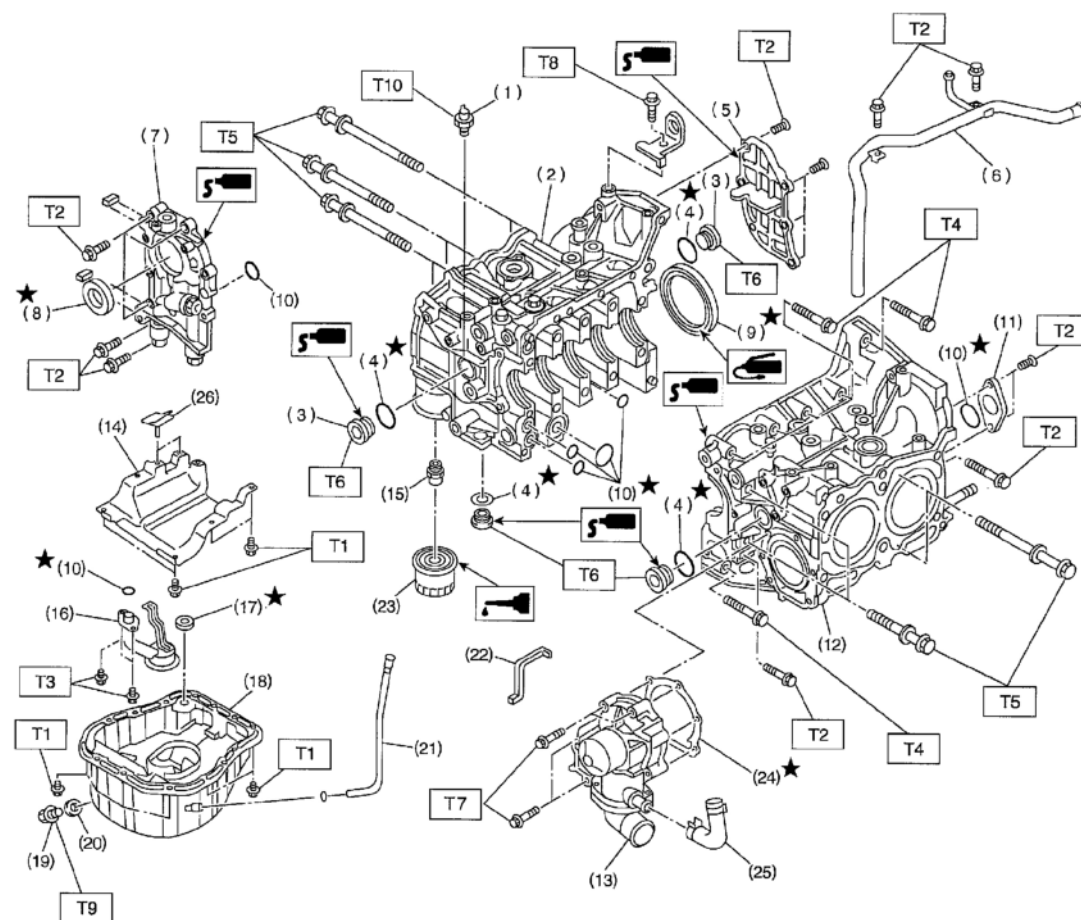
### CYLINDER HEAD AND VALVE ASSEMBLY



G02960038

**Fig. 4: Identifying Cylinder Head & Valve Assembly Components**  
 Courtesy of SUBARU OF AMERICA, INC.

### CYLINDER BLOCK



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

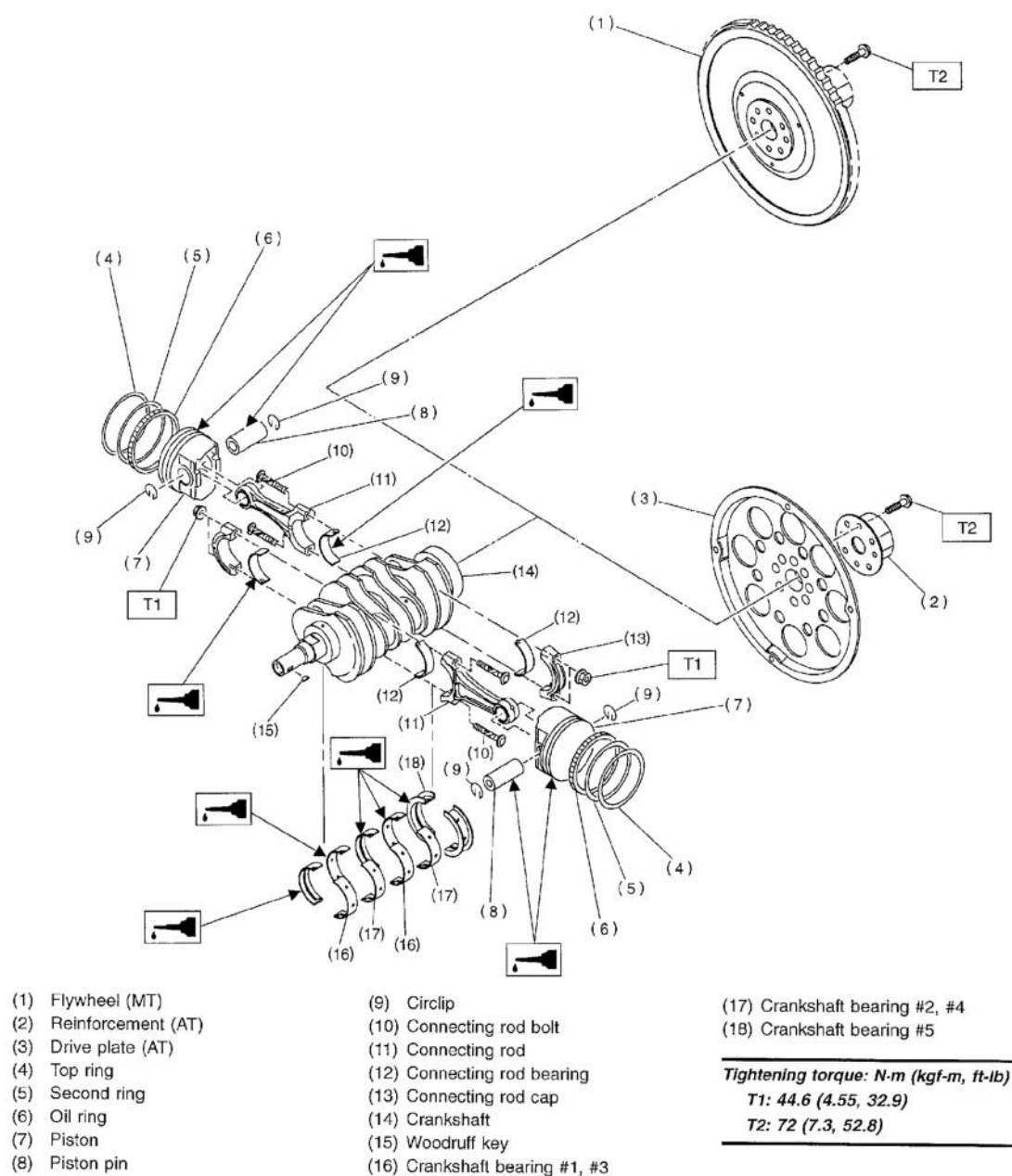
### Tightening torque: N-m (kgf-m, ft-lb)

- |                         |
|-------------------------|
| T1: 5 (0.5, 3.6)        |
| T2: 6.4 (0.65, 4.7)     |
| T3: 10 (1.0, 7)         |
| T4: 25 (2.5, 18.1)      |
| T5: 47 (4.8, 34.7)      |
| T6: 69 (7.0, 50.6)      |
| T7: First 12 (1.2, 8.7) |
| Second 12 (1.2, 8.7)    |
| T8: 16 (1.6, 11.6)      |
| T9: 44 (4.5, 33)        |
| T10: 25 (2.5, 18.1)     |

G02960039

**Fig. 5: Identifying Cylinder Block Assembly Components**  
Courtesy of SUBARU OF AMERICA, INC.

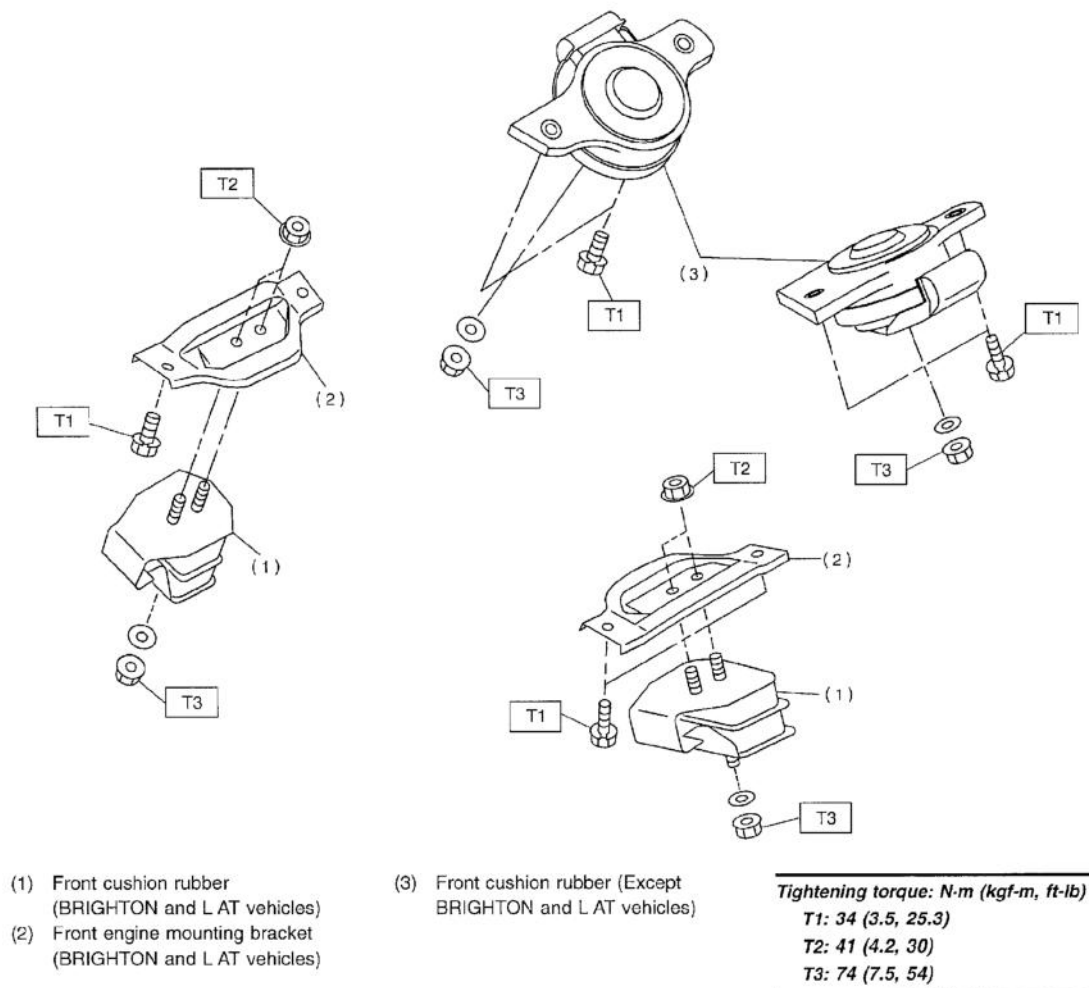
### CRANKSHAFT AND PISTON



**Fig. 6: Identifying Crankshaft & Piston Components**  
 Courtesy of SUBARU OF AMERICA, INC.

### ENGINE MOUNTING





G02960041

**Fig. 7: Identifying Engine Mounting Components**  
Courtesy of SUBARU OF AMERICA, INC.

### CAUTION

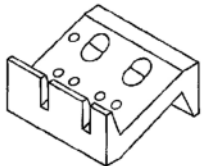
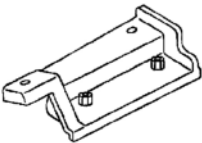
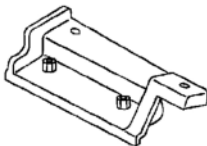
- Wear working clothing, including a cap, protective goggles, and protective shoes during operation.
- Remove contamination including dirt and corrosion before removal, installation or disassembly.
- Keep the disassembled parts in order and protect them from dust or dirt.
- Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly, and replacement.
- Be careful not to burn your hands, because each part in the vehicle is hot after running.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or safety stands at the specified points.
- Before disconnecting electrical connectors of sensors or units, be sure to disconnect 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 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 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 TOOLS**

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

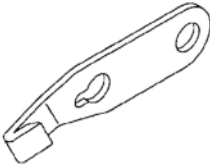
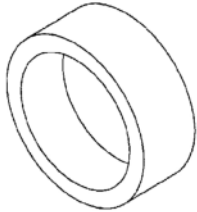
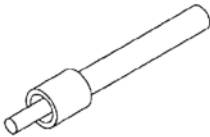
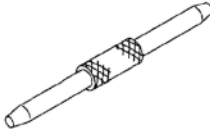
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	498267800	CYLINDER HEAD TABLE	<ul style="list-style-type: none"><li>• Used for replacing valve guides.</li><li>• Used for removing and installing valve springs.</li></ul>
	498457000	ENGINE STAND ADAPTER RH	Used with ENGINE STAND (499817000).
	498457100	ENGINE STAND ADAPTER LH	Used with ENGINE STAND (499817000).

G02960042

**Fig. 8: Identifying Special Tools (1 Of 8)**  
Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

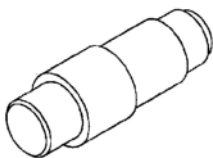
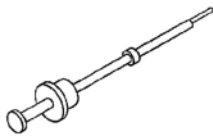
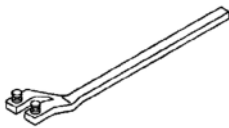
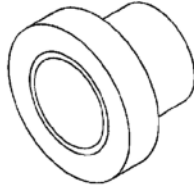
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of flywheel when loosening and tightening crankshaft pulley bolt, etc.
	498747300	PISTON GUIDE	Used for installing piston in cylinder.
	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.

G02960043

**Fig. 9: Identifying Special Tools (2 Of 8)**  
Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

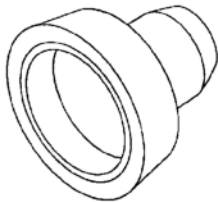
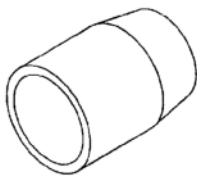

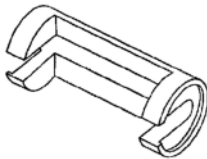
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	499037100	CONNECTING ROD BUSHING REMOVER & INSTALLER	Used for removing and installing connecting rod bushing.
	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
	499207100	CAMSHAFT SPROCKET WRENCH	Used for removing and installing camshaft sprocket.
	499587700	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.

G02960044

**Fig. 10: Identifying Special Tools (3 Of 8)**  
Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

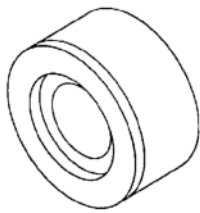
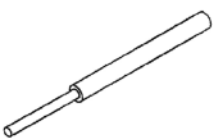
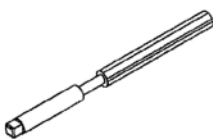
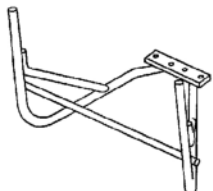
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	499587200	CRANKSHAFT OIL SEAL INSTALLER	<ul style="list-style-type: none"> <li>Used for installing crankshaft oil seal.</li> <li>Used with CRANKSHAFT OIL SEAL GUIDE (499597100).</li> </ul>
	499597000	OIL SEAL GUIDE	<ul style="list-style-type: none"> <li>Used for installing camshaft oil seal.</li> <li>Used with CAMSHAFT OIL SEAL INSTALLER (499587100).</li> </ul>
	499597100	CRANKSHAFT OIL SEAL GUIDE	<ul style="list-style-type: none"> <li>Used for installing crankshaft oil seal.</li> <li>Used with CRANKSHAFT OIL SEAL INSTALLER (499587200).</li> </ul>
	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.

G02960045

**Fig. 11: Identifying Special Tools (4 Of 8)**  
 Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

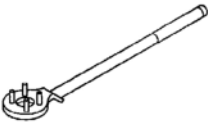
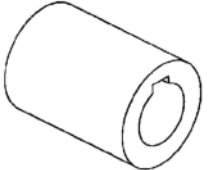
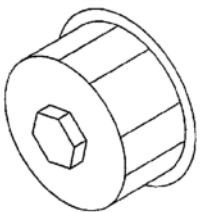
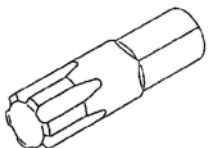
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	499767700 (Intake side) 499767800 (Exhaust side)	VALVE GUIDE ADJUSTER	Used for installing valve guides.
	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
	499817100	ENGINE STAND	<ul style="list-style-type: none"> <li>• Stand used for engine disassembly and assembly.</li> <li>• Used with ENGINE STAND ADAPTER RH (498457000) &amp; LH (498457100).</li> </ul>

G02960046

**Fig. 12: Identifying Special Tools (5 Of 8)**  
Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crankshaft pulley when loosening and tightening crankshaft pulley bolts.
	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
	498547000	OIL FILTER WRENCH	Used for removing and installing oil filter.
	499497000	TORX PLUS	Used for removing and installing camshaft cap.

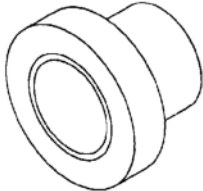
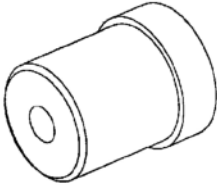
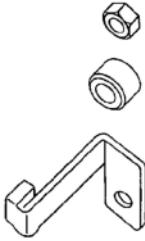
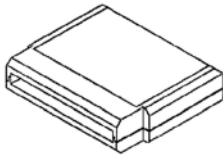
G02960047

**Fig. 13: Identifying Special Tools (6 Of 8)**  
Courtesy of SUBARU OF AMERICA, INC.



## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback


ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	499587500	OIL SEAL INSTALLER	Used for installing front camshaft oil seal.
	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
	24082AA190 (Newly adopted tool)	CARTRIDGE	Troubleshooting for electrical systems.

G02960048

**Fig. 14: Identifying Special Tools (7 Of 8)**  
**Courtesy of SUBARU OF AMERICA, INC.**

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	22771AA030	SELECT MONITOR KIT	Troubleshooting for electrical systems. <ul style="list-style-type: none"><li>• English: 22771AA030 (Without printer)</li><li>• German: 22771AA070 (Without printer)</li><li>• French: 22771AA080 (Without printer)</li><li>• Spanish: 22771AA090 (Without printer)</li></ul>

G02960049

#### **Fig. 15: Identifying Special Tools (8 Of 8)**

Courtesy of SUBARU OF AMERICA, INC.

#### **GENERAL PURPOSE TOOLS**

#### **GENERAL PURPOSE TOOLS CHART**

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.

- Timing Belt
- Valve Rocker Assembly
- Camshaft
- Cylinder Head

#### **COMPRESSION**

#### **INSPECTION**

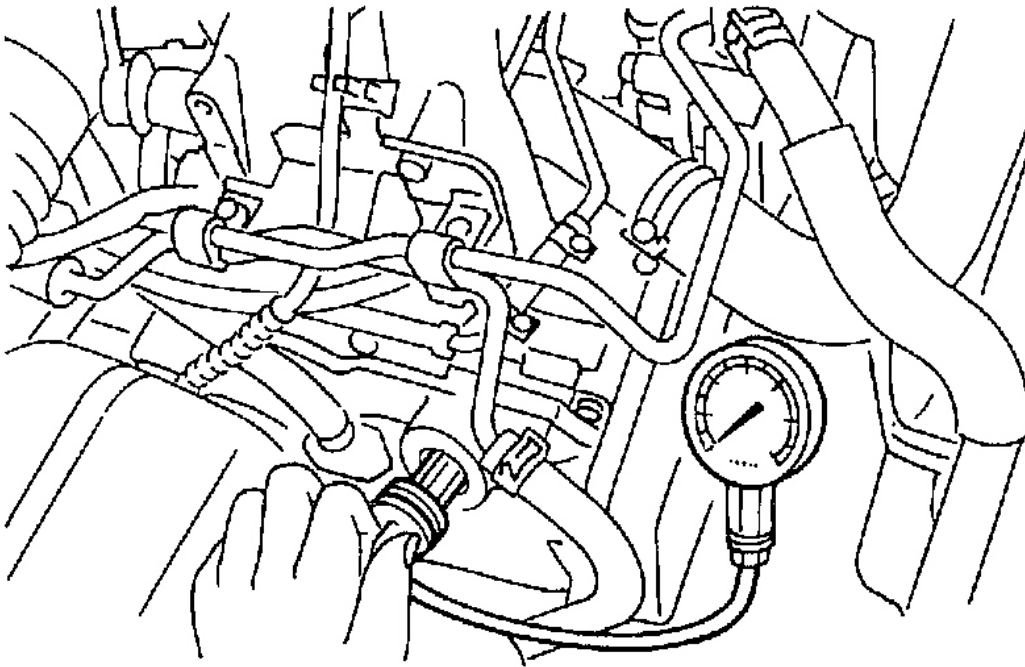
**CAUTION:** After warming-up, engine becomes very hot. Be careful not to burn yourself during measurement.

1. After warming-up the engine, turn ignition switch to OFF.
2. Make sure that the battery is fully charged.
3. Release fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** , OPERATION, Fuel.
4. Remove all the spark plugs.

5. Fully open throttle valve.
6. Check the starter motor for satisfactory performance and operation.
7. Hold the compression gauge tight against the spark plug hole.

**CAUTION:** 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.



G02960050

**Fig. 16: Inspecting Compression**  
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 kg/cm<sup>2</sup> , 185 psi)

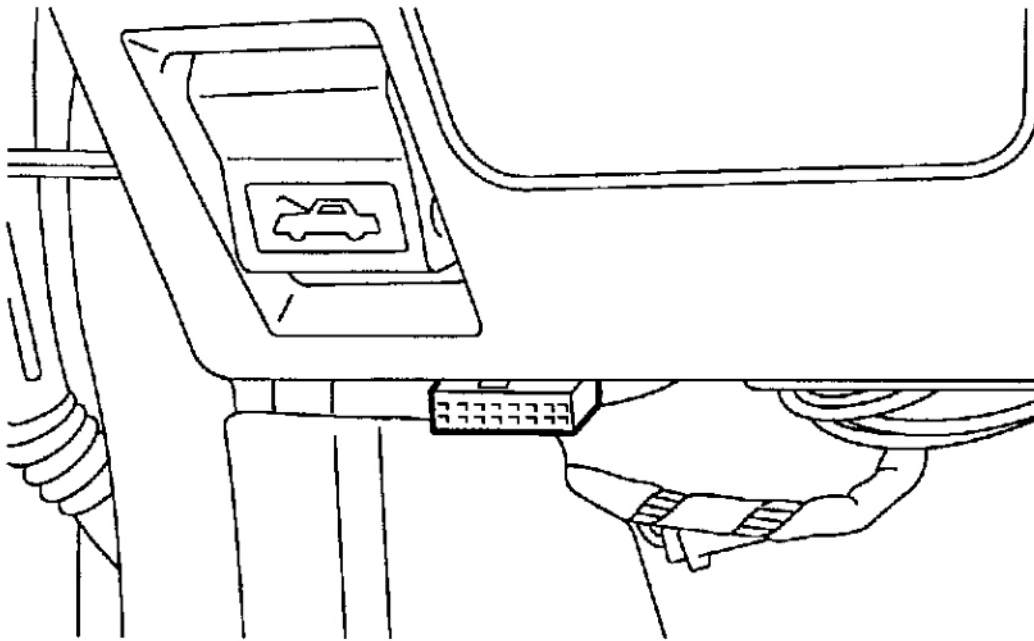
**Limit;** 1,020 kPa (10.4 kg/cm<sup>2</sup> , 148 psi)

Difference between cylinders; 49 kPa (0.5 kg/cm<sup>2</sup> , 7 psi), or less

## IDLE SPEED

### INSPECTION

1. Before checking idle speed, check the following:
  1. Ensure that air cleaner element is free from clogging, ignition timing is correct, spark plugs are in good condition, and that hoses are connected properly.
  2. Ensure that malfunction indicator light (CHECK ENGINE light) does not illuminate.
2. Warm-up the engine.
3. Stop the engine, and turn ignition switch to OFF.
4. When using SUBARU SELECT MONITOR. Refer to **SPECIAL TOOLS**, PREPARATION TOOL, General Descriptions.
  1. Insert the cartridge to SUBARU SELECT MONITOR.
  2. Connect SUBARU SELECT MONITOR to the data link connector.

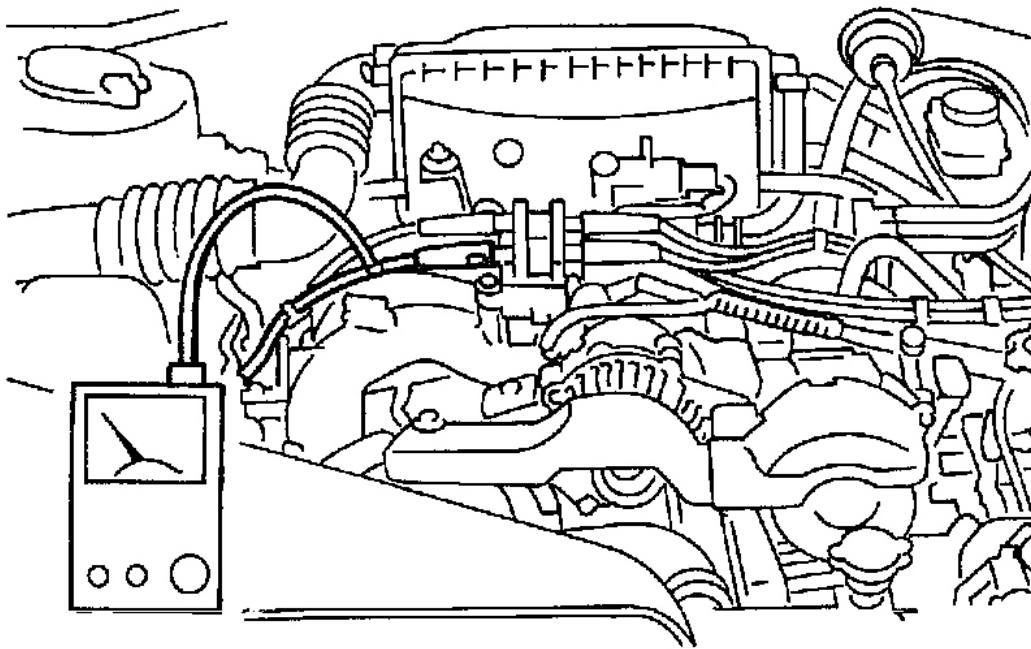


G02960051

**Fig. 17: Connecting Subaru Select Monitor To Data Link Connector**  
Courtesy of SUBARU OF AMERICA, INC.

3. Turn ignition switch to ON, and SUBARU SELECT MONITOR switch to ON.

4. Select {2. Each System Check} in Main Menu.
  5. Select {Engine Control System} in Selection Menu.
  6. Select {1. Current Data Display & Save} in Engine Control System Diagnosis.
  7. Select {1.12 Data Display} in Data Display Menu.
  8. Start the engine, and read engine idle speed.
5. When using tachometer (Secondary pick-up type).
1. Attach the pick-up clip to No. 1 cylinder spark plug cord.
  2. Start the engine, and read engine idle speed.



G02960052

**Fig. 18: Inspecting Engine Idle Speed**  
Courtesy of SUBARU OF AMERICA, INC.

**NOTE:**

- When using the OBD-II general scan tool, carefully read its operation manual.
- 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 idle speed when unloaded. (With headlights, heater fan, rear defroster, radiator fan, air conditioning, etc. OFF)

**Idle speed (No load and gears in neutral (MT), or N or P (AT) position):****MT vehicle:** 650+/-100 rpm**AT vehicle:** 700+/-100 rpm

7. Check idle speed when loaded. (Turn air conditioning switch to "ON" and operate compressor for at least one minute before measurement.)

**Idle speed [A/C "ON", no load and gears in neutral (MT) or N or P (AT) position]:** 850+/-100 rpm

**CAUTION:** Never rotate idle adjusting screw. If idle speed is out of specifications, refer to BASIC DIAGNOSTIC PROCEDURES .

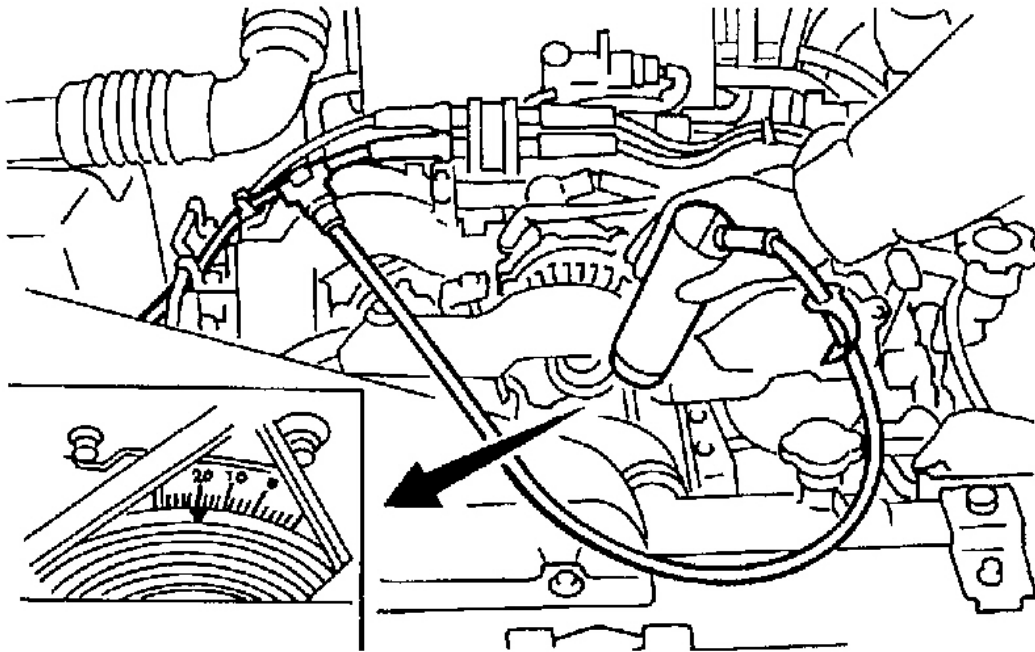
## IGNITION TIMING

### INSPECTION

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

1. Warm-up 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 at idle speed and check the ignition timing.

**Ignition timing [BTDC/rpm]:****MT vehicle:** 10°+/-8°/650**AT vehicle:** 15°+/-8°/700



G02960053

**Fig. 19: Inspecting Ignition Timing**

Courtesy of SUBARU OF AMERICA, INC.

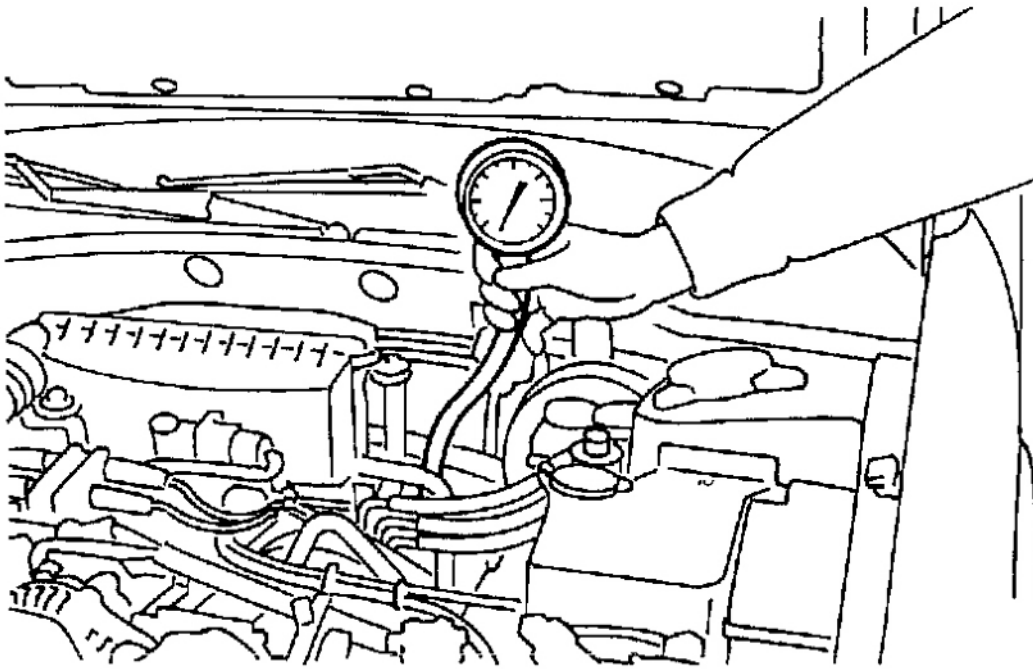
If the timing is not correct, check the ignition control system. Refer to **BASIC DIAGNOSTIC PROCEDURES**

## INTAKE MANIFOLD VACUUM

### INSPECTION

1. Warm-up the engine.
2. Disconnect the brake vacuum hose and install the vacuum gauge to the hose fitting on the manifold.
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.



G02960054

**Fig. 20: 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 inHg)

#### ENGINE CONDITION DIAGNOSIS BY MEASUREMENT OF MANIFOLD VACUUM

Vacuum gauge indication	Possible engine condition
1. Needle is steady but lower than normal position. This tendency becomes more evident as engine temperature rises.	Leakage around intake manifold gasket or disconnection or damaged 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.	Back pressure too high, or exhaust system clogged
3. Needle intermittently drops to position lower than normal position.	Leakage around cylinder
4. Needle drops suddenly and intermittently from normal position.	Sticky valves
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	Defective ignition system or throttle



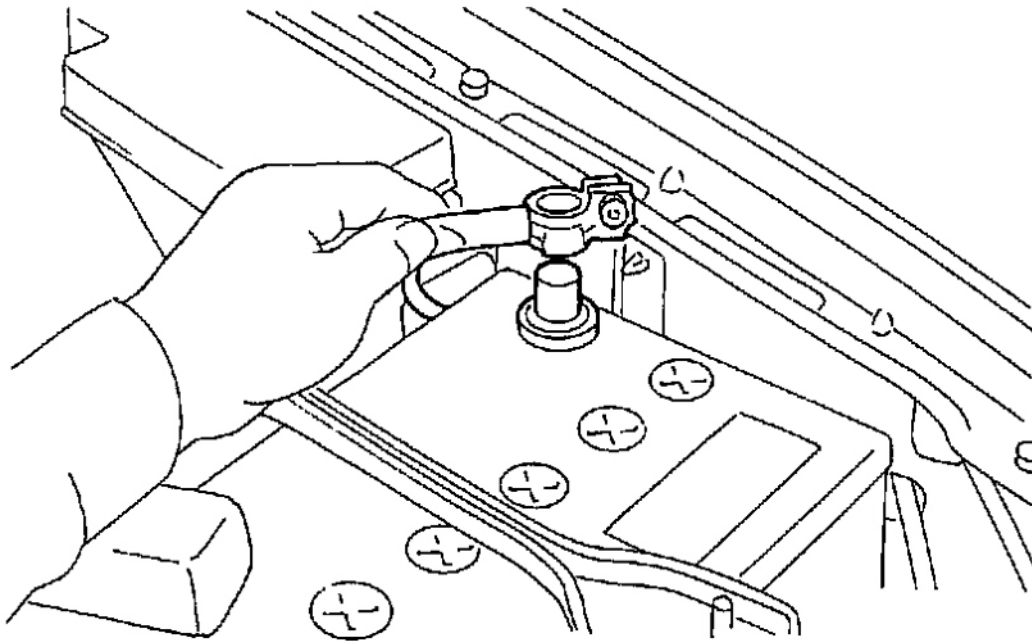
range.

chamber idle adjustment

## ENGINE OIL PRESSURE

### INSPECTION

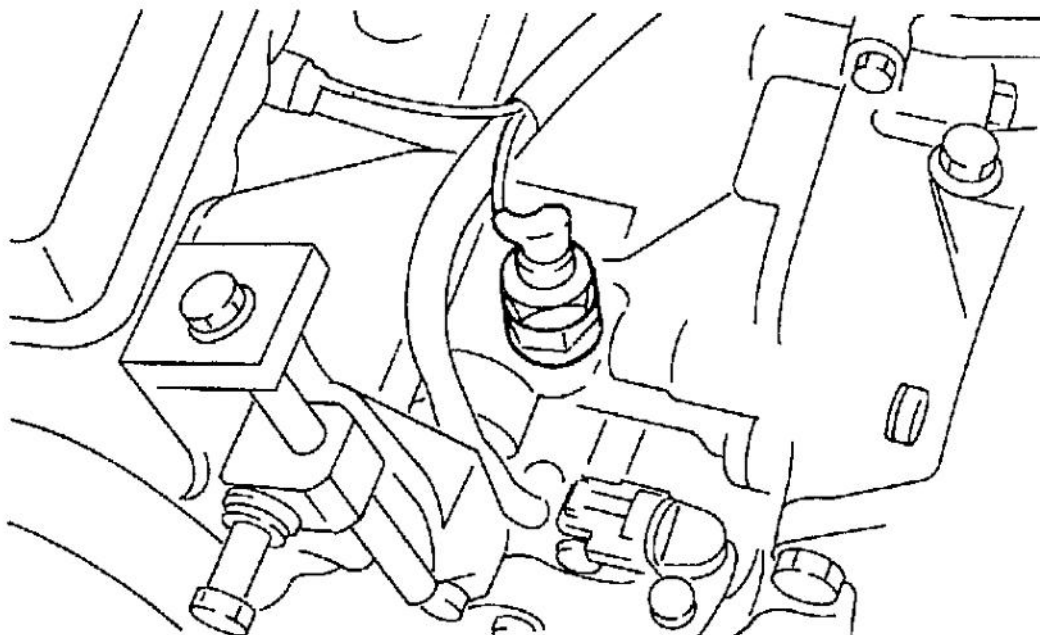
1. Disconnect battery ground cable.



G02960055

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

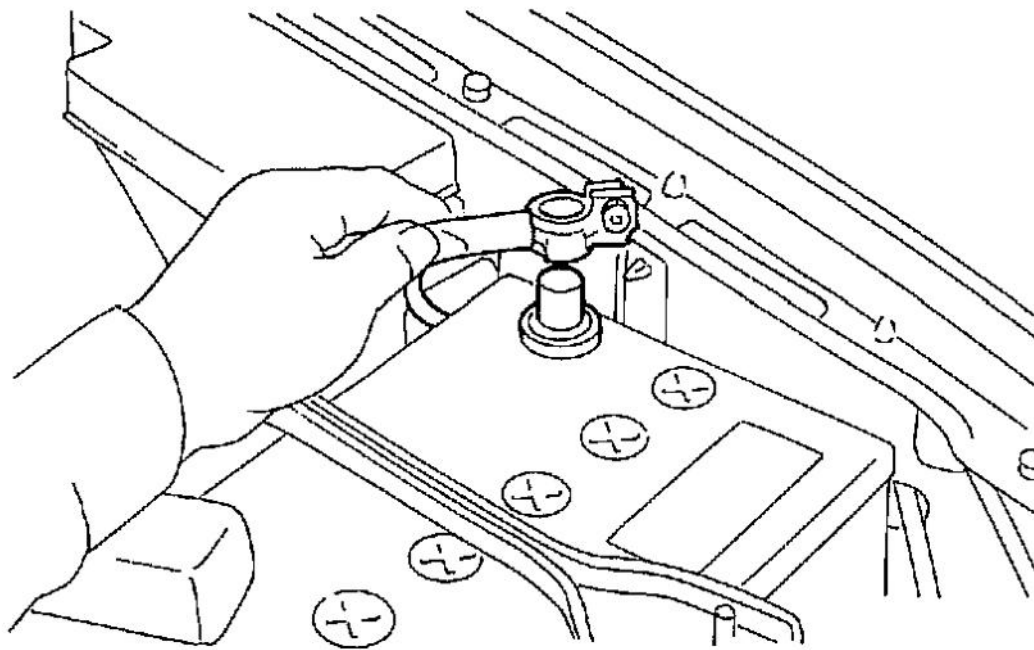
2. Remove generator from bracket. Refer to **REMOVAL** , Generators.
3. Disconnect connector from oil pressure switch.
4. Remove oil pressure switch from engine cylinder block. Refer to **REMOVAL** , Oil Pressure Switch.



G02960056

**Fig. 22: Removing Oil Pressure Switch From Engine Cylinder Block**  
Courtesy of SUBARU OF AMERICA, INC.

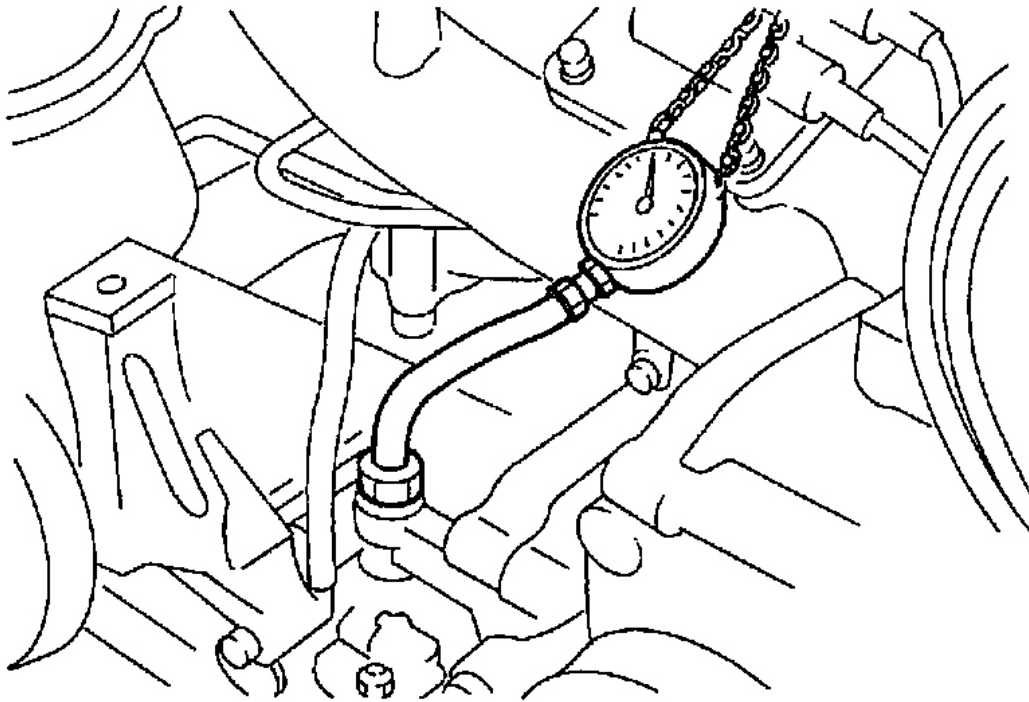
5. Connect oil pressure gauge hose to cylinder block.
6. Connect battery ground cable.



G02960057

**Fig. 23: Connecting Battery Ground Cable**  
Courtesy of SUBARU OF AMERICA, INC.

7. Start the engine, and measure oil pressure.



G02960058

**Fig. 24: Measuring Oil Pressure**  
Courtesy of SUBARU OF AMERICA, INC.

Oil pressure:

98 kPa (1.0 kg/cm<sup>2</sup> , 14 psi) or more at 800 rpm

294 kPa (3.0 kg/cm<sup>2</sup> , 43 psi) or more at 5,000 rpm

**CAUTION:**

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

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

8. After measuring oil pressure, install oil pressure switch. Refer to INSTALLATION , Oil Pressure Switch.

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

9. Install generator and V-belt in the reverse order of removal, and adjust the V-belt deflection. Refer to **INSTALLATION**, V-belts

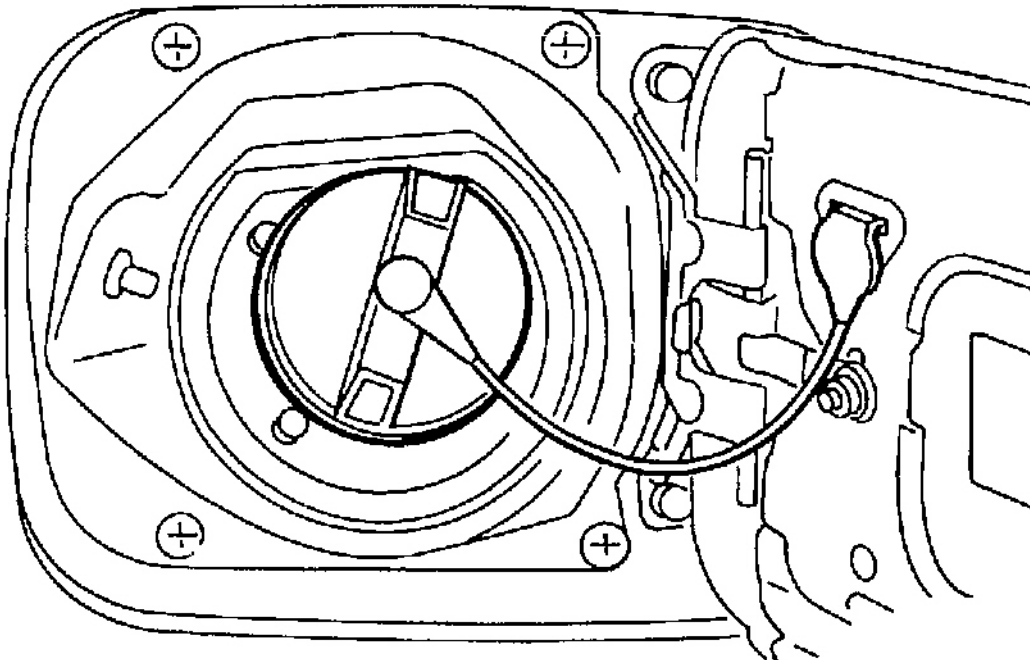
## FUEL PRESSURE

### INSPECTION

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

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

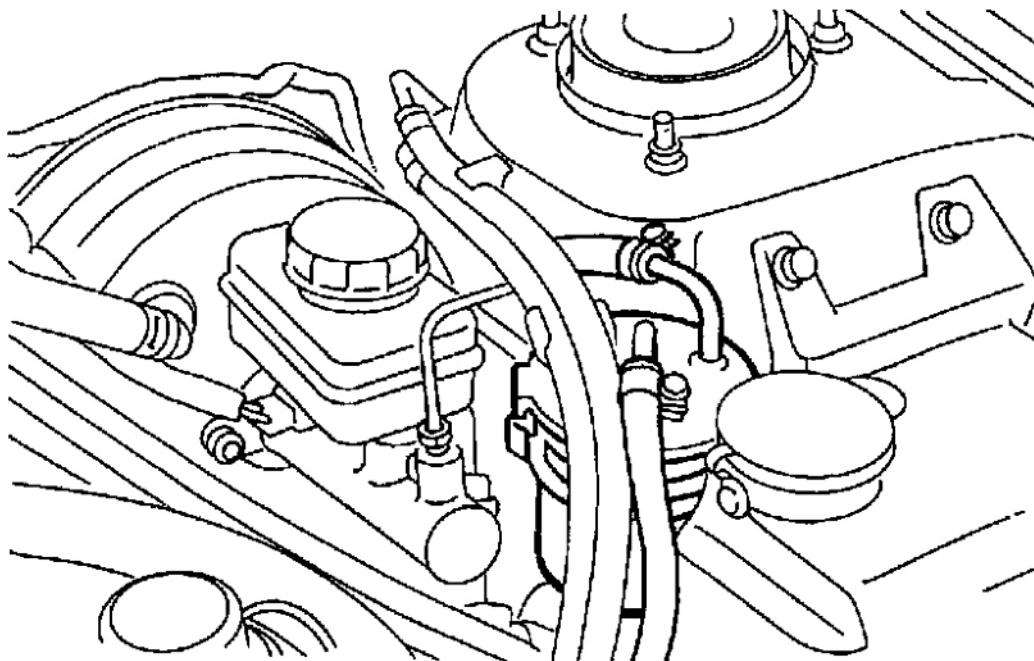
1. Release fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** , OPERATION, Fuel.
2. Open fuel flap lid, and remove fuel filler cap.



G02960059

**Fig. 25: Removing Fuel Filler Cap**  
Courtesy of SUBARU OF AMERICA, INC.

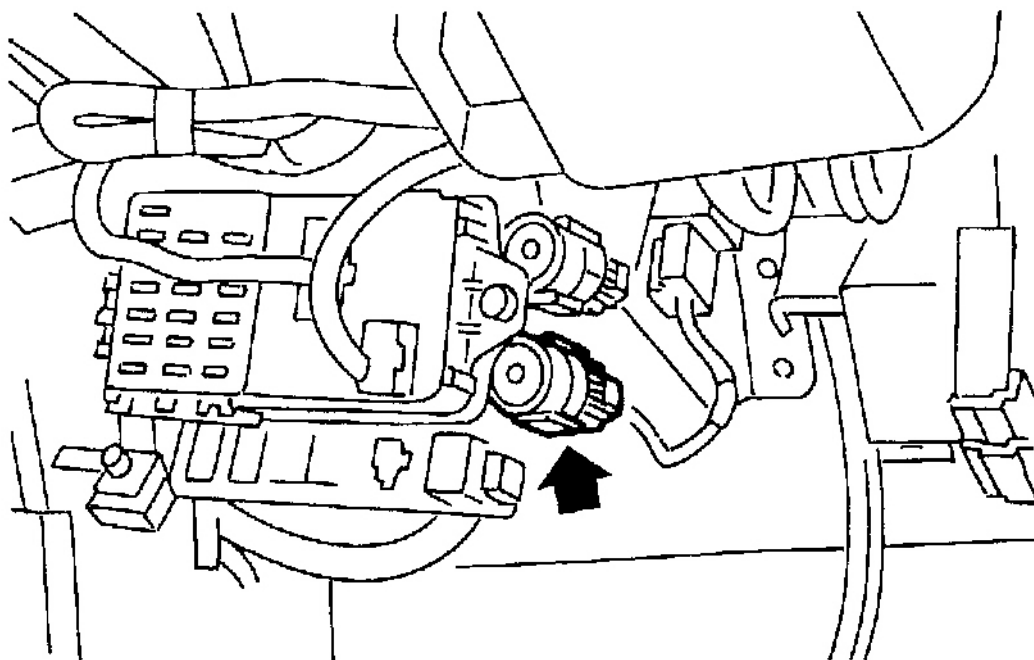
3. Disconnect fuel delivery hoses from fuel filter, and connect fuel pressure gauge.



G02960060

**Fig. 26: Disconnecting Fuel Delivery Hoses From Fuel Filter**  
Courtesy of SUBARU OF AMERICA, INC.

4. Connect connector of fuel pump relay.



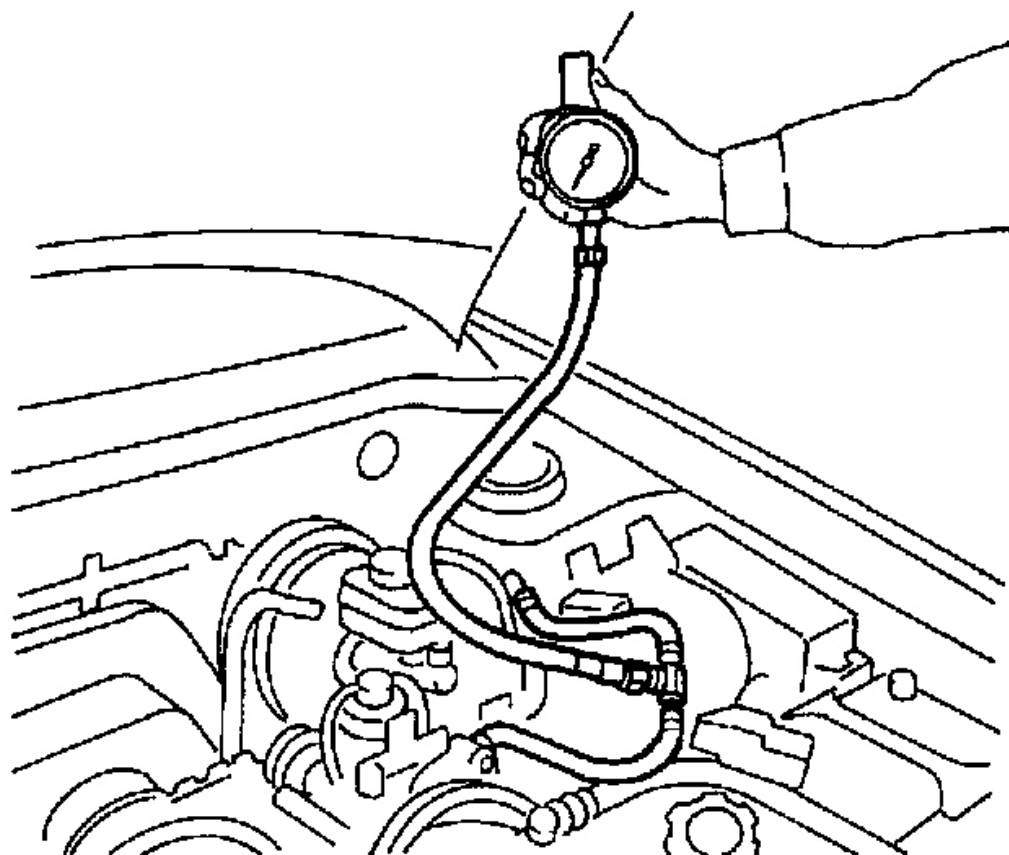
G02960061

**Fig. 27: Connecting Connector Of Fuel Pump Relay**  
Courtesy of SUBARU OF AMERICA, INC.

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

**Fuel pressure:**

**Standard;** 284 - 314 kPa (2.9 - 3.2 kg/cm<sup>2</sup> , 41 - 46 psi)



G02960062

**Fig. 28: Measuring Fuel Pressure While Disconnecting Pressure Regulator Vacuum Hose From Intake Manifold**

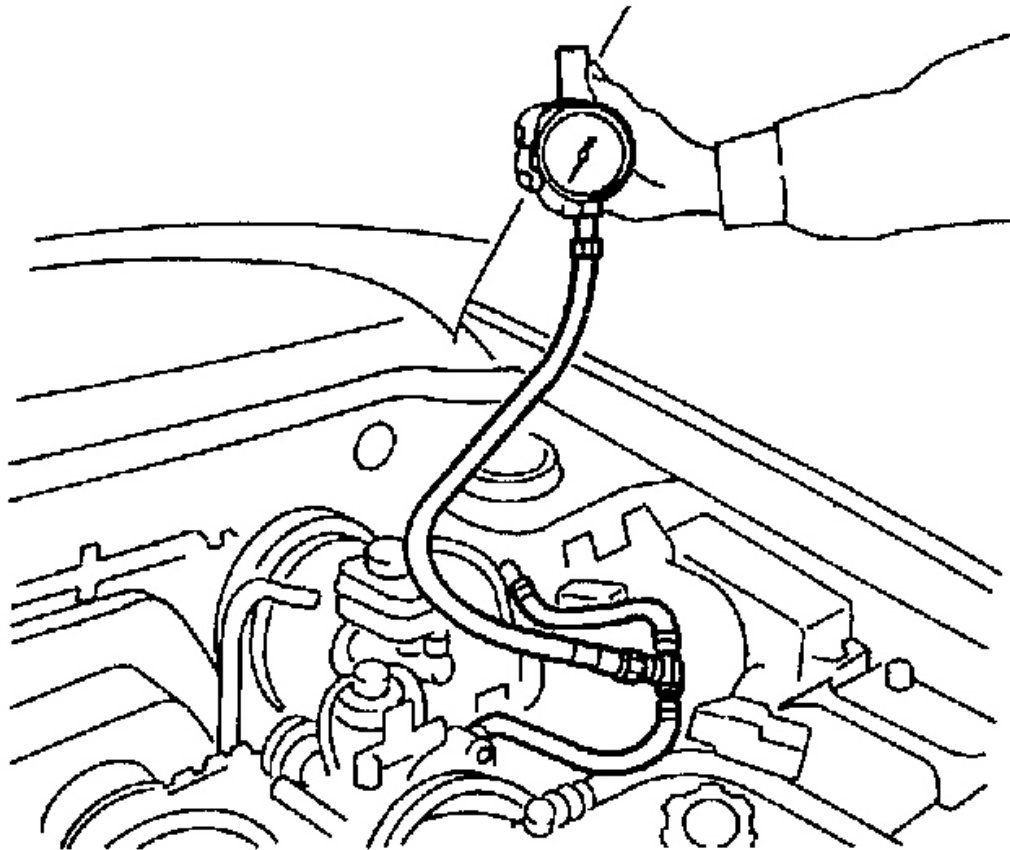
Courtesy of SUBARU OF AMERICA, INC.

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

**Fuel pressure:**

**Standard;** 206 - 235 kPa (2.1 - 2.4 kg/cm<sup>2</sup> , 30 - 34 psi)





G02960063

**Fig. 29: Measuring Fuel Pressure After Connecting Pressure Regulator Vacuum Hose**  
Courtesy of SUBARU OF AMERICA, INC.

**NOTE:** The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kg/cm<sup>2</sup> , 1 to 3 psi) higher than standard values during high-altitude operations.

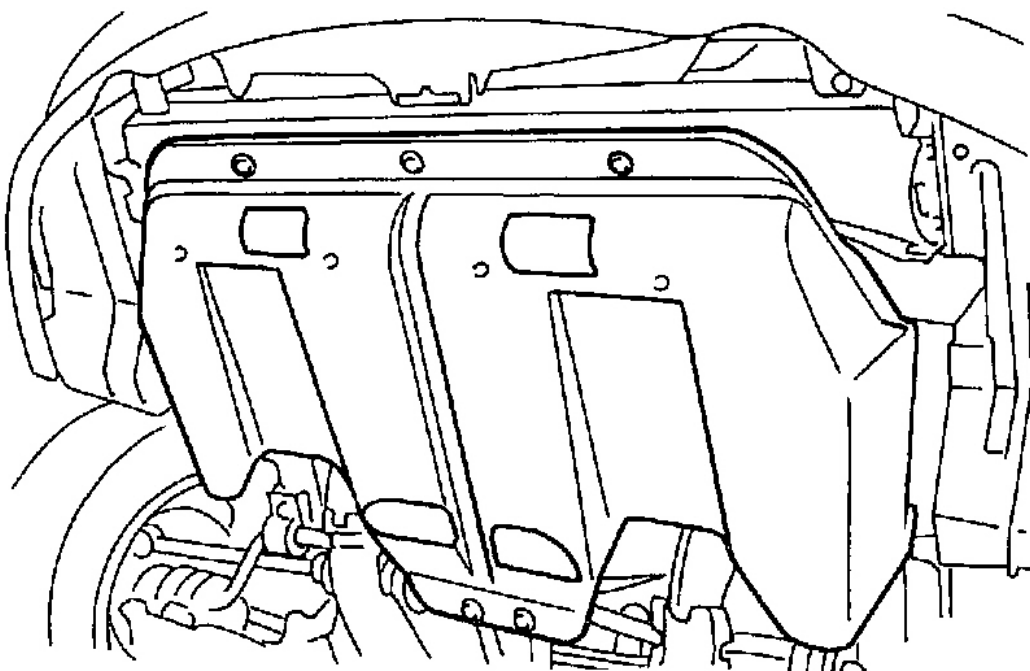
## VALVE CLEARANCE

### INSPECTION

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

1. Set the vehicle onto the lift.

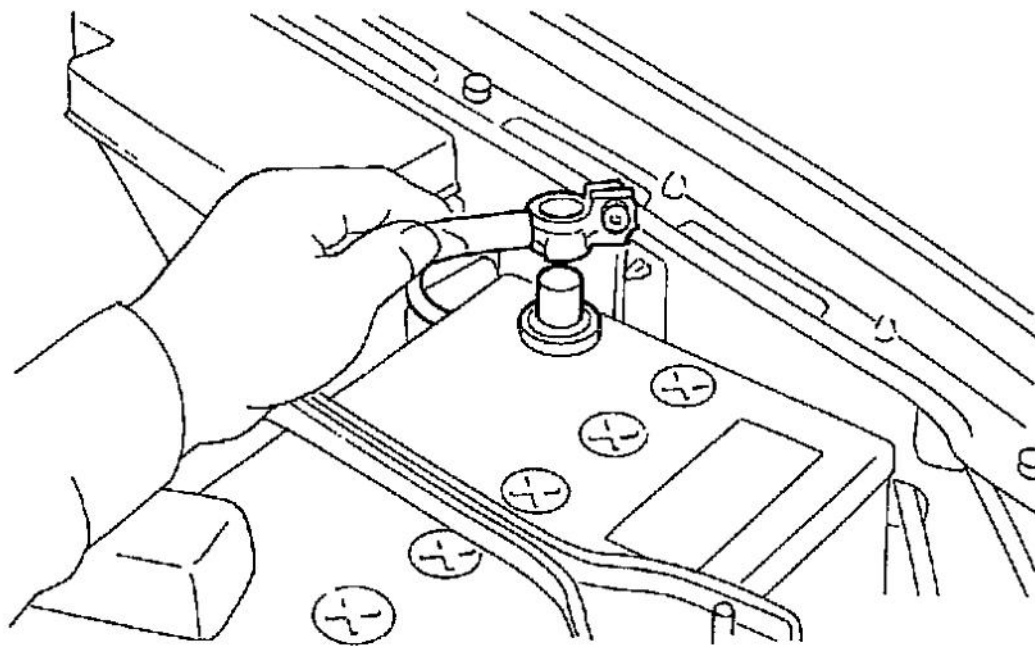
2. Lift-up the vehicle.
3. Remove under cover.



G02960064

**Fig. 30: Removing Under Cover**  
Courtesy of SUBARU OF AMERICA, INC.

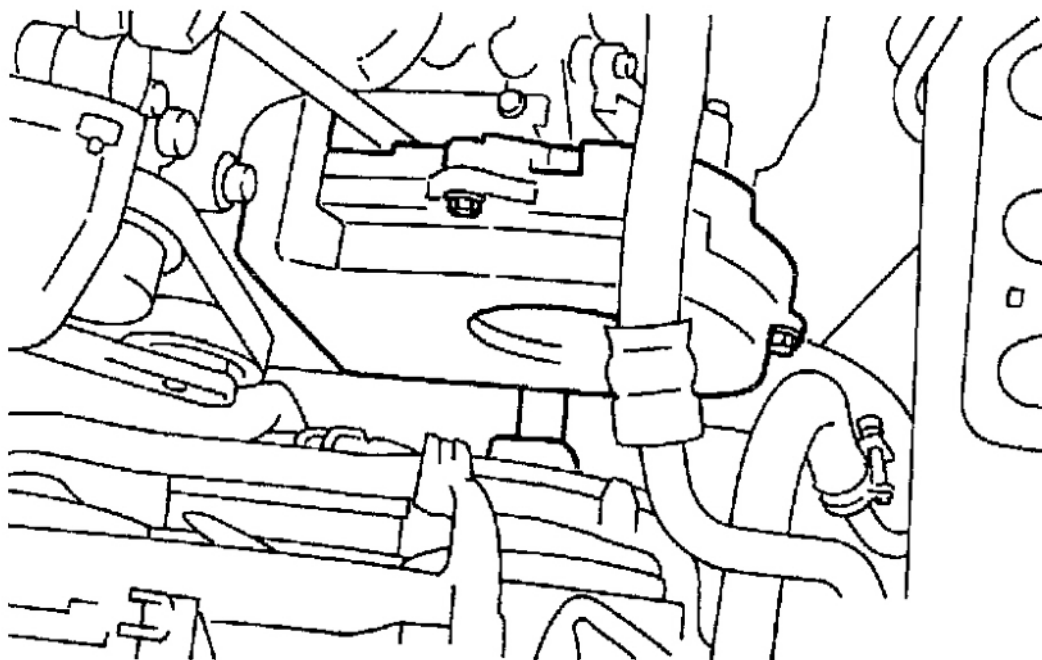
4. Disconnect battery ground cable.



G02960065

**Fig. 31: Disconnecting Battery Ground Cable**  
Courtesy of SUBARU OF AMERICA, INC.

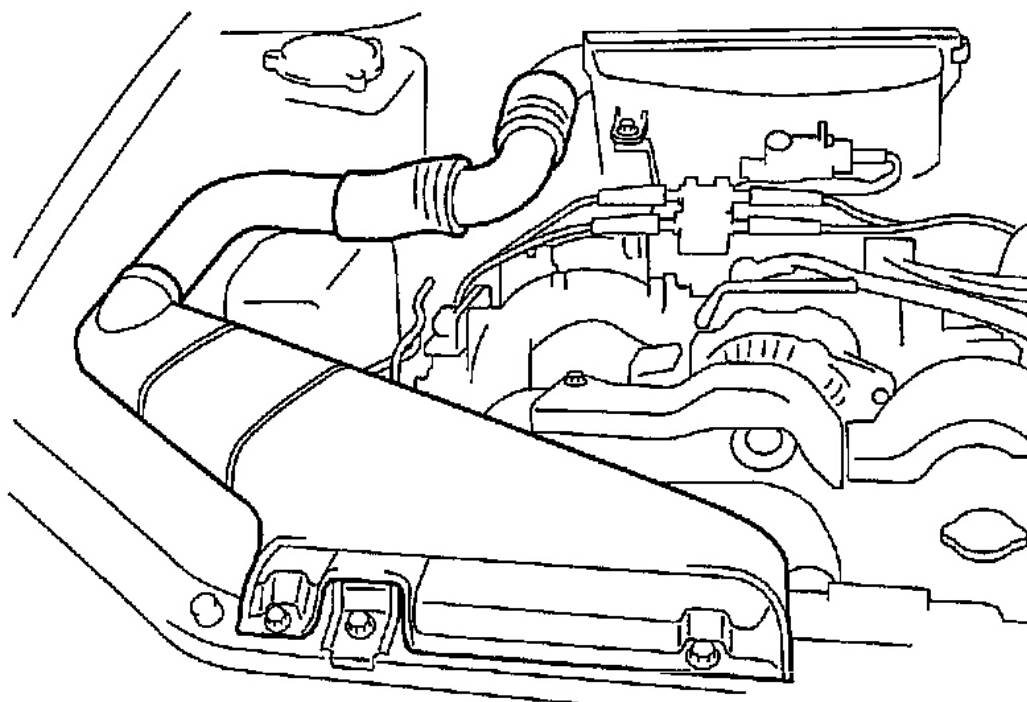
5. Lower the vehicle.
6. Remove timing belt cover (LH).



G02960066

**Fig. 32: Removing Timing Belt Cover (LH)**  
Courtesy of SUBARU OF AMERICA, INC.

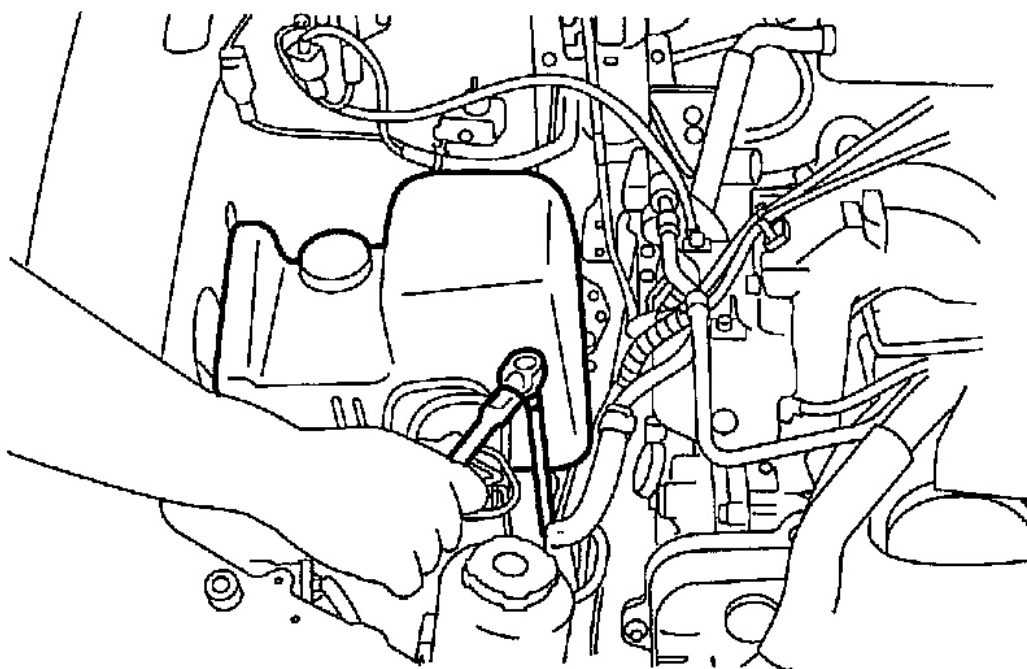
7. Remove rocker cover.
8. When inspecting #1 and #3 cylinders;
  1. Remove bolt which secures air intake duct to radiator panel side.
  2. Remove air intake duct as a unit.



G02960067

**Fig. 33: Removing Air Intake Duct**  
Courtesy of SUBARU OF AMERICA, INC.

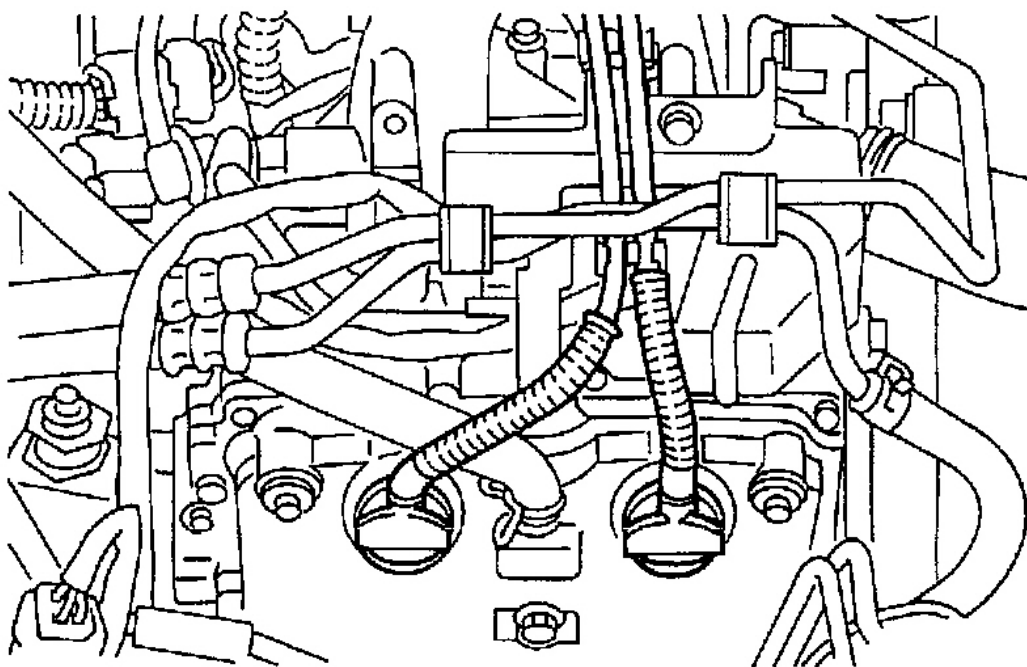
3. Remove bolt, and then remove resonator chamber.



G02960068

**Fig. 34: Removing Resonator Chamber**  
Courtesy of SUBARU OF AMERICA, INC.

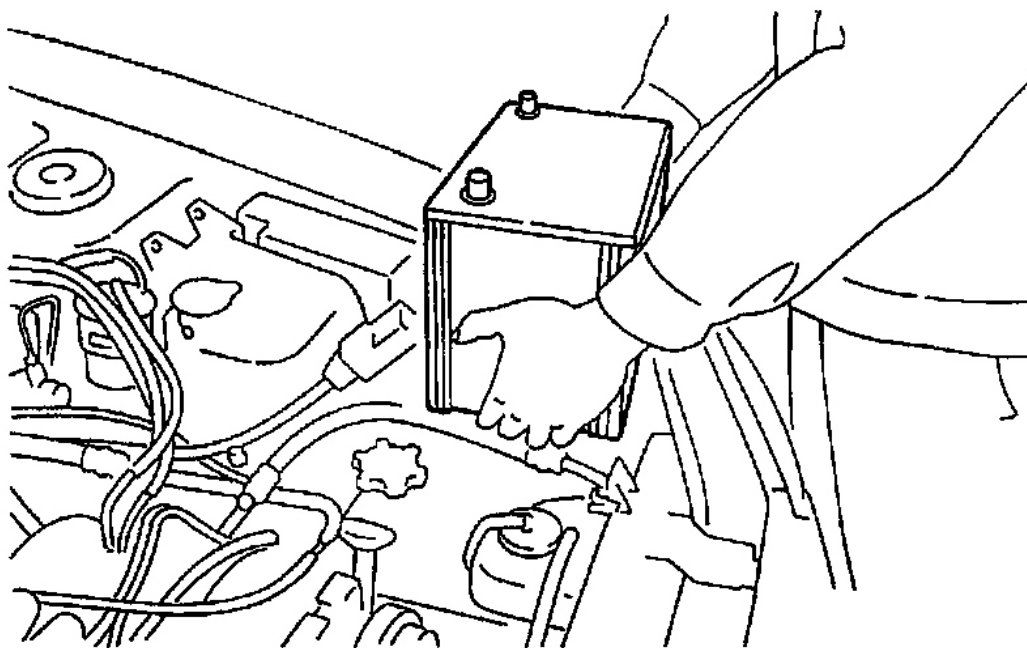
4. Disconnect spark plug cords from spark plugs (#1 and #3 cylinders).



G02960069

**Fig. 35: Disconnecting Spark Plug Cords From Spark Plugs**  
Courtesy of SUBARU OF AMERICA, INC.

5. Disconnect PCV hose from rocker cover (RH).
6. Remove bolts, then remove rocker cover (RH).
9. When inspecting #2 and #4 cylinders;
  1. Disconnect battery cables, and then remove battery and battery carrier.

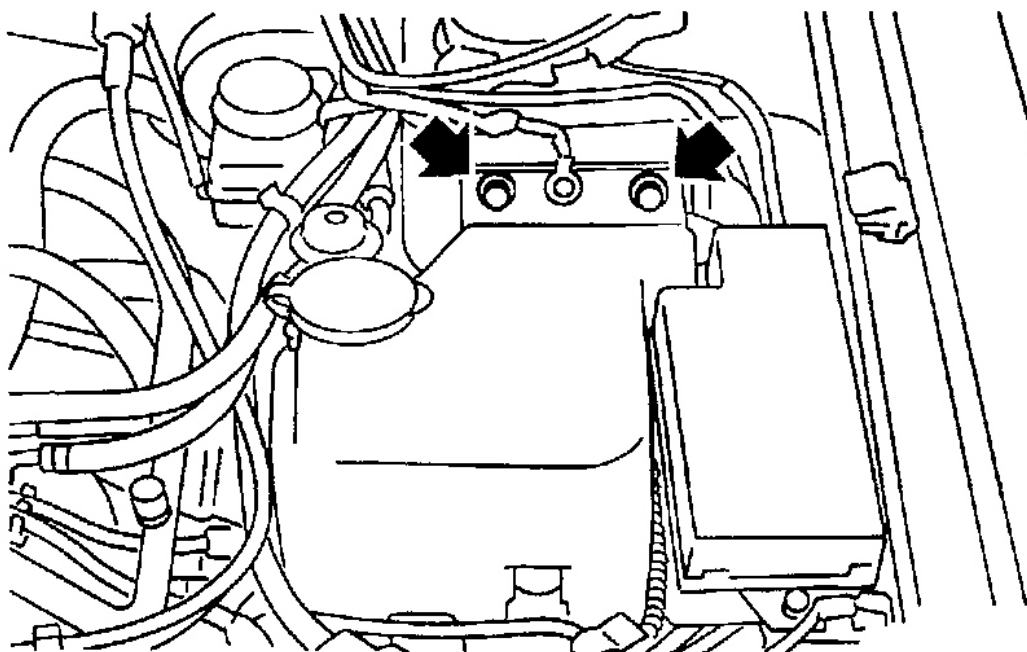


G02960070

**Fig. 36: Removing Battery & Battery Carrier**  
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the two bolts which hold washer tank.

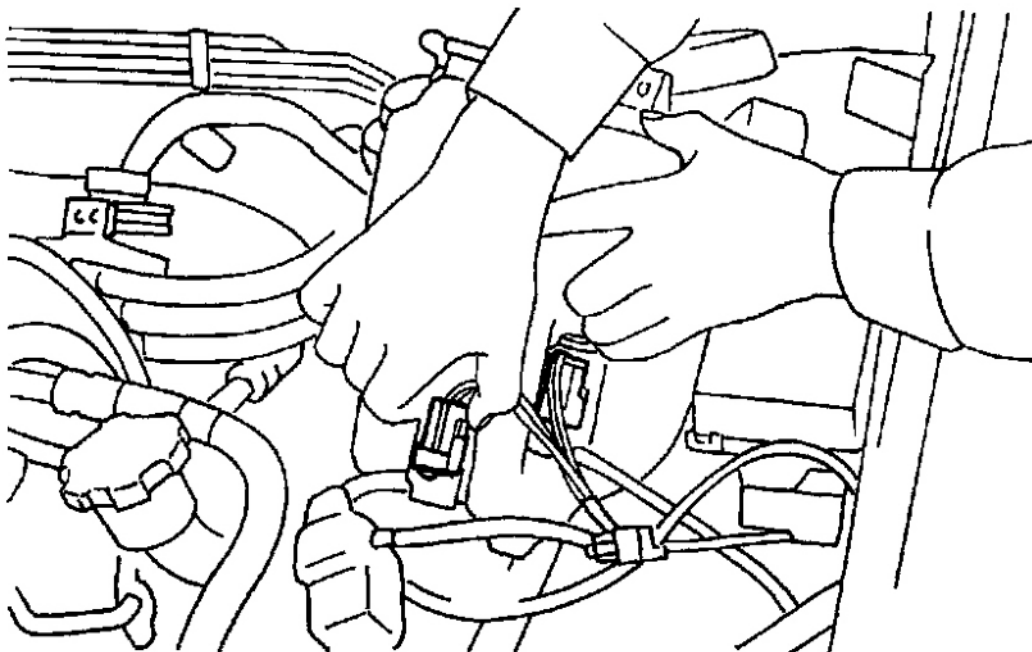




G02960071

**Fig. 37: Removing Bolts Holding Washer Tank**  
Courtesy of SUBARU OF AMERICA, INC.

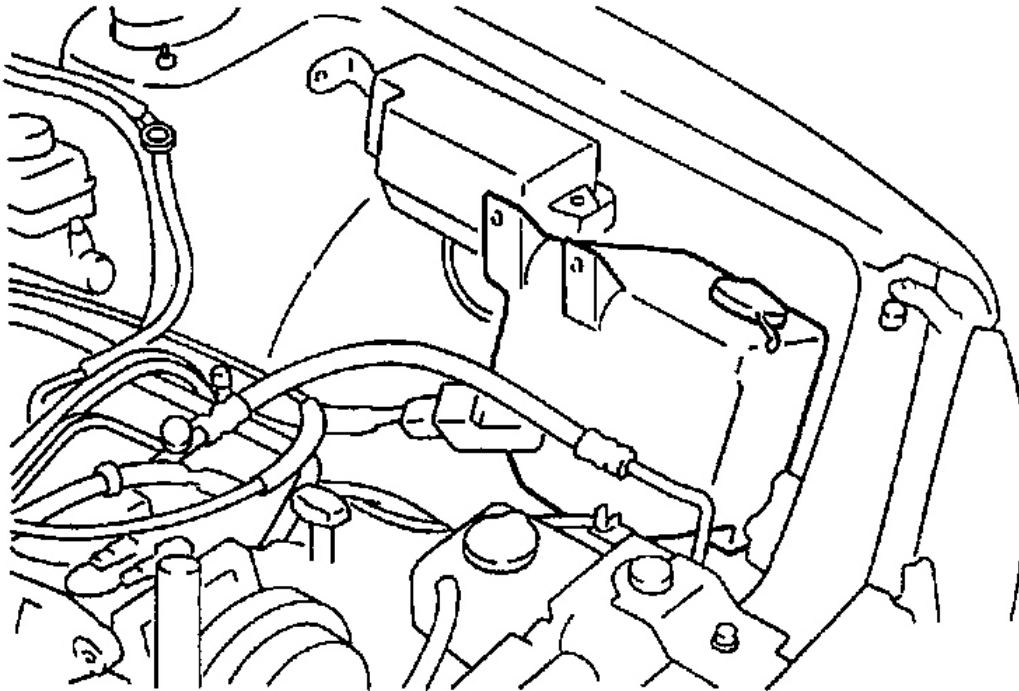
3. Disconnect washer motor connectors.



G02960072

**Fig. 38: Disconnecting Washer Motor Connectors**  
Courtesy of SUBARU OF AMERICA, INC.

4. Move washer tank to forward.



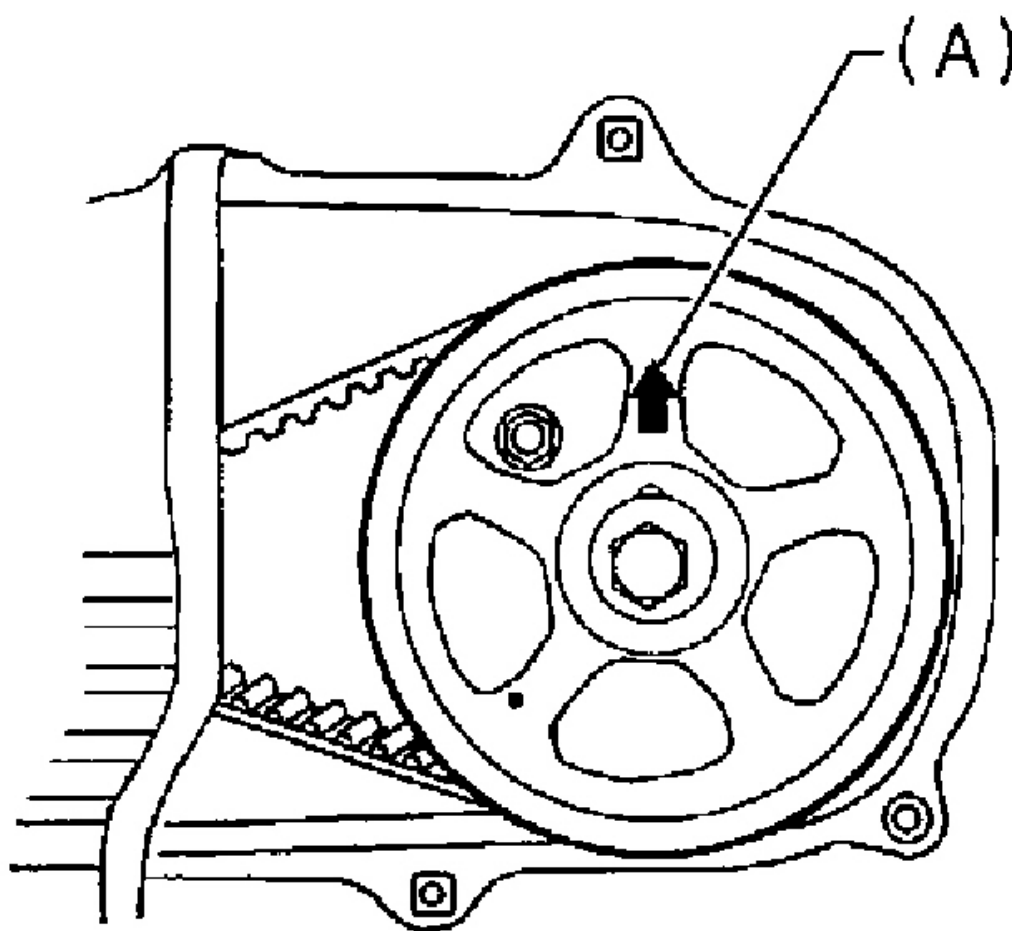
G02960073

**Fig. 39: Moving Washer Tank To Forward**  
Courtesy of SUBARU OF AMERICA, INC.

5. Disconnect spark plug cords from spark plugs (#2 and #4 cylinders).
6. Disconnect PCV hose from rocker cover (LH).
7. Remove bolts, then remove rocker cover (LH).
10. Set #1 cylinder piston to top dead center of compression stroke by rotating crankshaft pulley clockwise using ST.

ST 499977100 CRANKSHAFT PULLEY WRENCH

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



G02960074

**Fig. 40: Identifying Arrow Mark On Camshaft Sprocket (LH)**  
Courtesy of SUBARU OF AMERICA, INC.

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

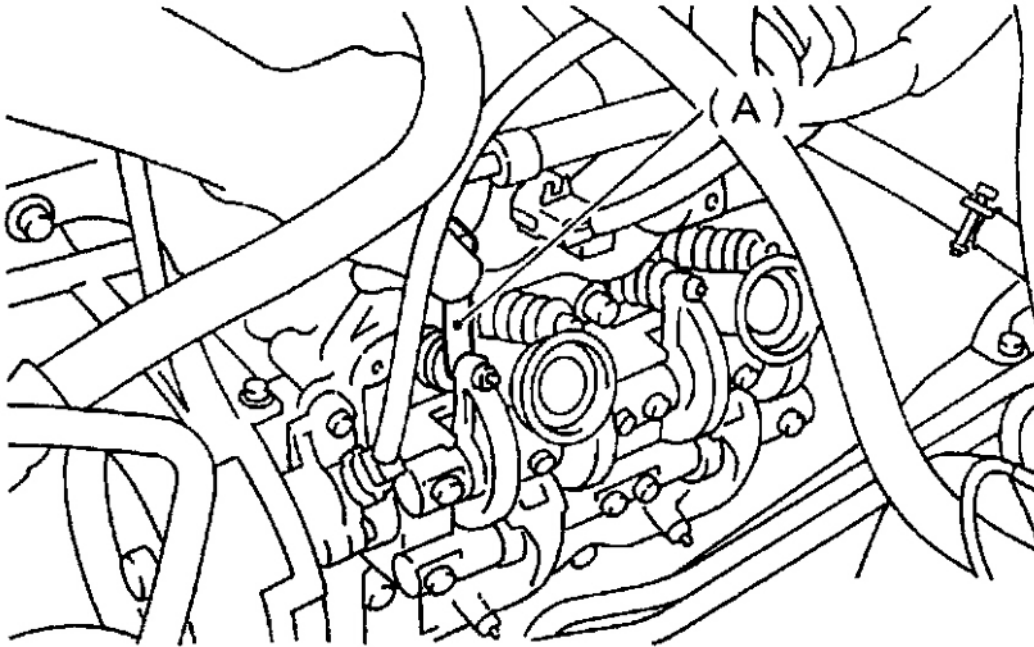
**CAUTION:**

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

**Valve clearance:**

**Intake;** 0.2+/-0.02 mm (0.0079+/-0.0008 in)

**Exhaust;** 0.25+/-0.02 mm (0.0098+/-0.0008 in)



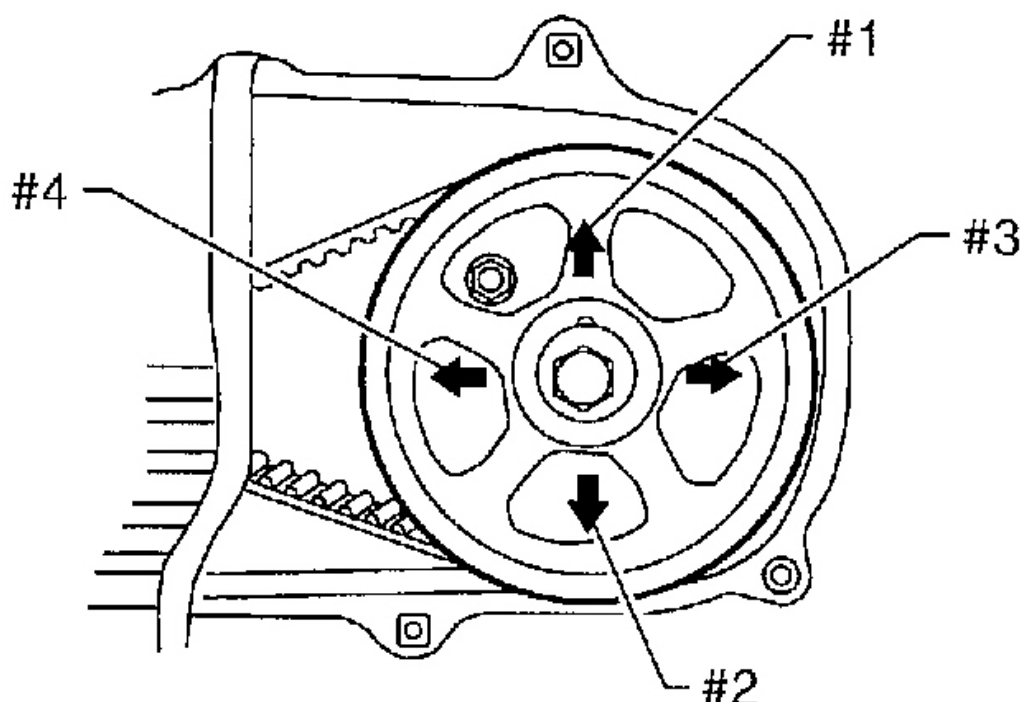
G02960075

**Fig. 41: Measuring No. 1 Cylinder Valve Clearance By Using Thickness Gauge**  
Courtesy of SUBARU OF AMERICA, INC.

12. If necessary, adjust the valve clearance. Refer to ADJUSTMENT, Valve Clearances.
13. Similar to measurement procedures used for #1 cylinder, measure #2, #3 and #4 cylinder valve, clearances.

**NOTE:**

- Be sure to set cylinder pistons to their respective top dead centers on compression stroke before measuring valve clearances.
- To set #3, #2 and #4 cylinder pistons to their top dead centers on compression stroke, turn crankshaft pulley clockwise 90° at a time starting with arrow mark on left-hand camshaft sprocket facing up.



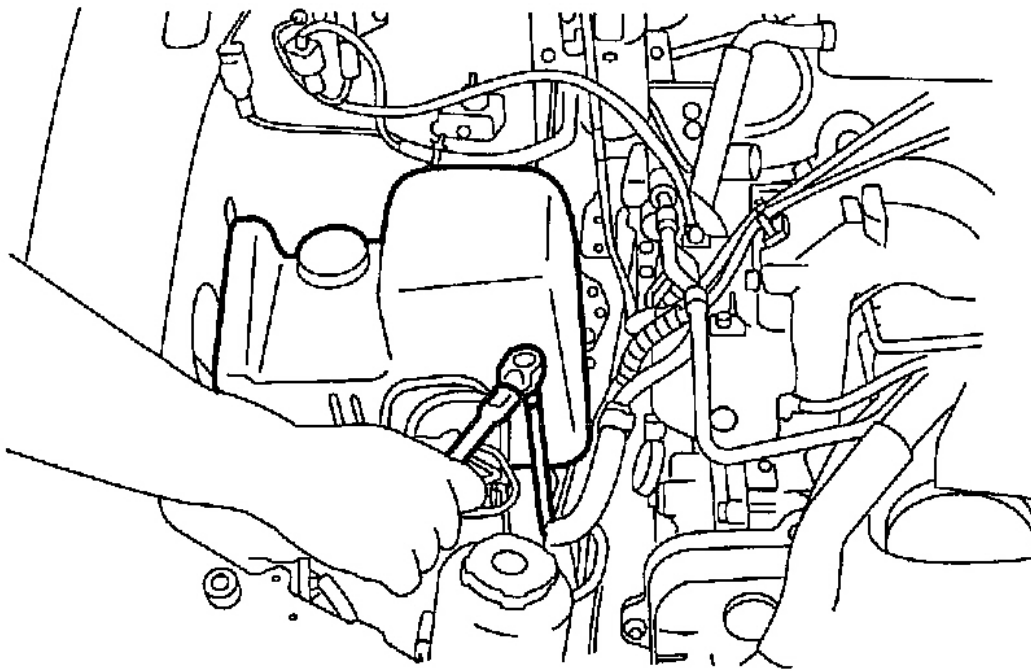
G02960076

**Fig. 42: Identifying Arrow Mark On Left-Hand Camshaft Sprocket Facing Up**  
Courtesy of SUBARU OF AMERICA, INC.

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

**Tightening torque:**

**Resonator chamber; 32 N.m (3.3 kgf-m, 24 ft-lb)**



G02960077

**Fig. 43: Tightening Resonator Chamber Bolts**  
Courtesy of SUBARU OF AMERICA, INC.

## ADJUSTMENT

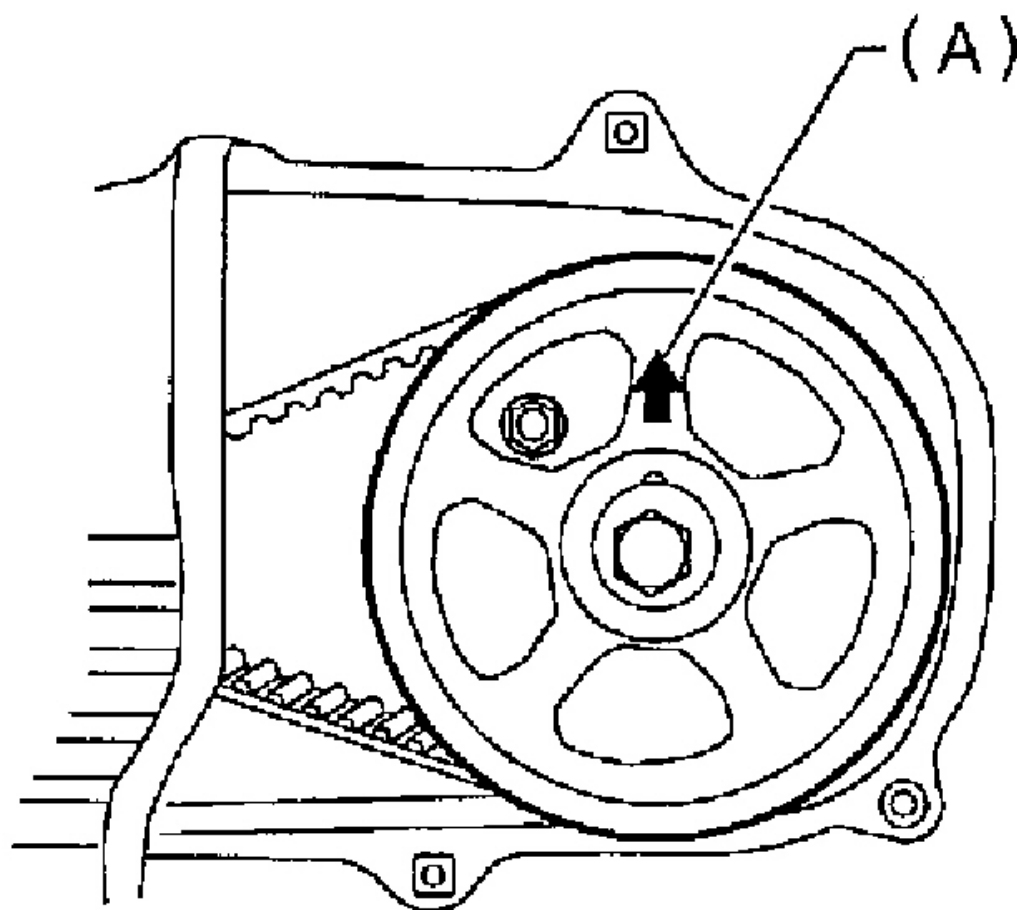
**CAUTION:** Adjustment of valve clearance should be performed while engine is cold.

1. Set #1 cylinder piston to top dead center of compression stroke by rotating crankshaft pulley clockwise using ST.

ST 499977100 CRANKSHAFT PULLEY WRENCH

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

2. Adjust the #1 cylinder valve clearance.
  1. Loosen the valve rocker nut and screw.



G02960078

**Fig. 44: Identifying Arrow Mark On Camshaft Sprocket (LH)**  
Courtesy of SUBARU OF AMERICA, INC.

2. Place suitable thickness gauge.
3. While noting valve clearance, tighten valve rocker adjust screw.
4. When specified valve clearance is obtained, tighten valve rocker nut.

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

**CAUTION:**

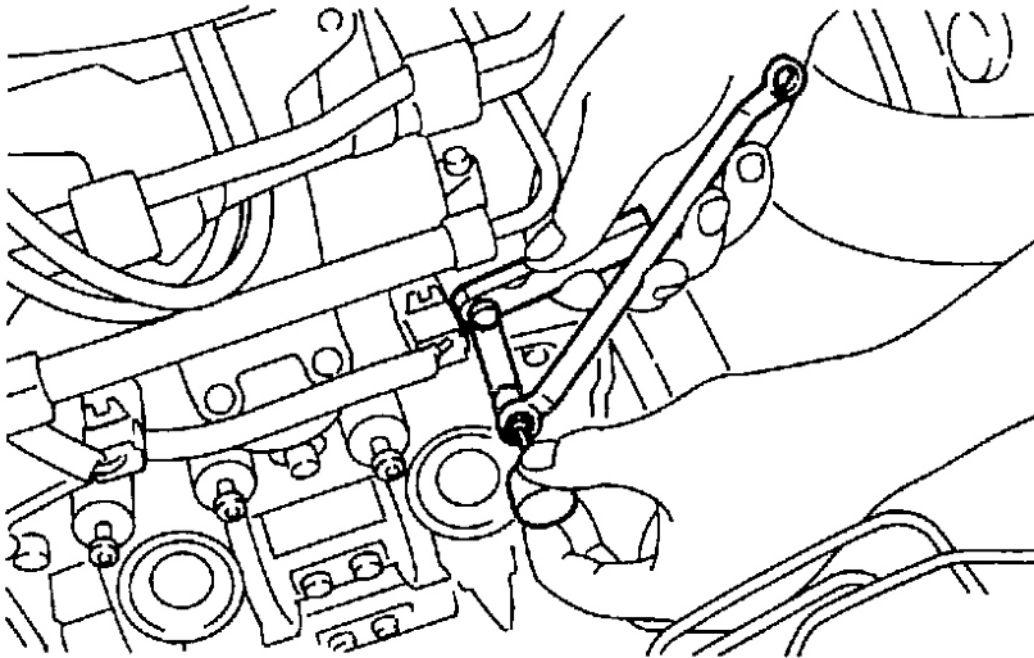
- Insert the thickness gauge in as horizontal a direction as possible with respect to the valve stem end face.
- Adjust exhaust valve clearances while lifting-up the vehicle.



**Valve clearance:**

**Intake;** 0.20+/-0.02 mm (0.0079+/-0.0008 in)

**Exhaust;** 0.25+/-0.02 mm (0.0098+/-0.0008 in)



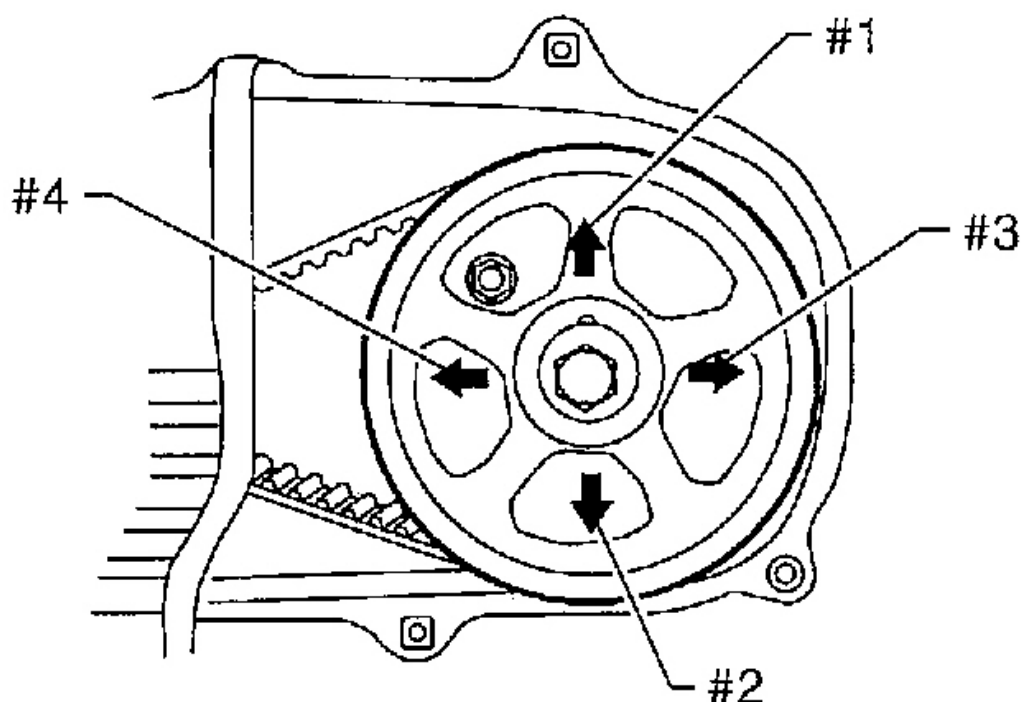
G02960079

**Fig. 45: Measuring Intake/Exhaust Valve Clearance**  
Courtesy of SUBARU OF AMERICA, INC.

3. Ensure that valve clearances are within specifications.
4. Turn crankshaft two complete rotations until #1 cylinder piston is again set to top dead center on compression stroke.
5. Ensure that valve clearances are within specifications. If necessary, readjust valve clearances.
6. Similar to adjustment procedures used for #1 cylinder, adjust #2, #3 and #4 cylinder valve clearances.

**NOTE:**

- **Be sure to set cylinder pistons to their respective top dead centers on compression stroke before adjusting valve clearances.**
- **To set #3, #2 and #4 cylinder pistons to their top dead centers on compression stroke, turn crankshaft pulley clockwise 90° at a time starting with arrow mark on left-hand camshaft sprocket facing up.**



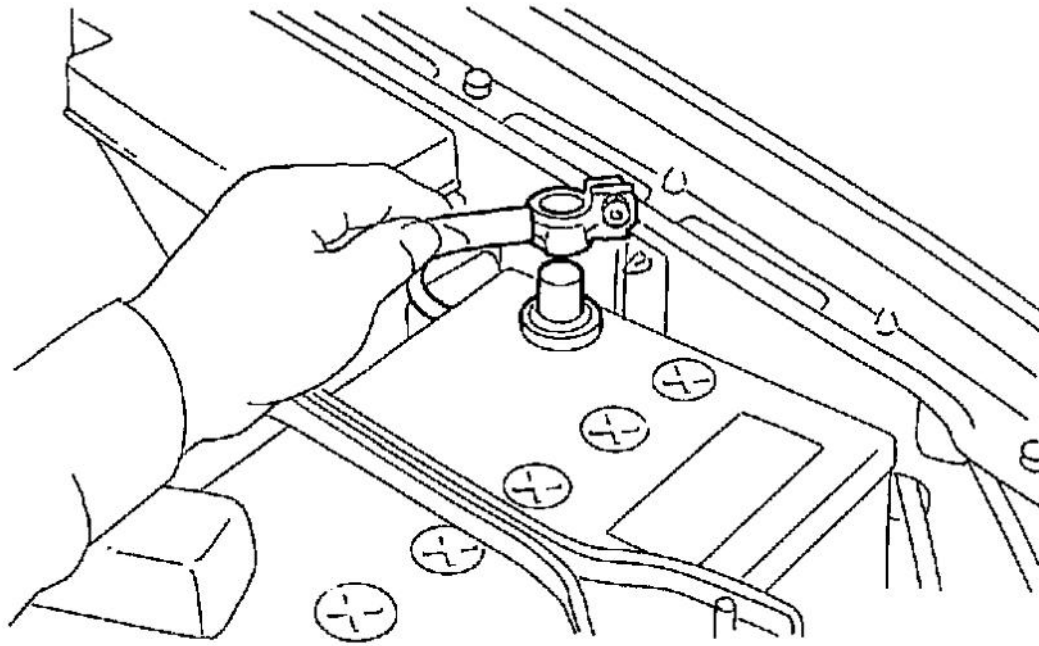
G02960080

**Fig. 46: Identifying Arrow Mark On Left-Hand Camshaft Sprocket Facing Up**  
Courtesy of SUBARU OF AMERICA, INC.

## ENGINE ASSEMBLY

### REMOVAL

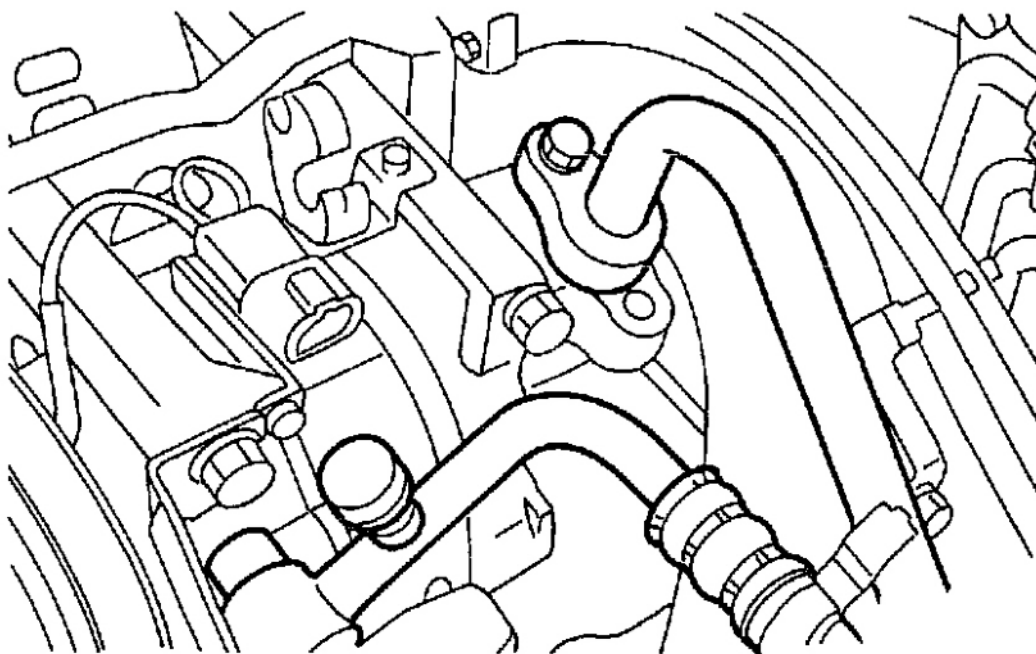
1. Set the vehicle on lift arms.
2. Open front hood fully and support with stay.
3. Raise rear seat, and turn floor mat up.
4. Release fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** , OPERATION, Fuel.
5. Remove filler cap.
6. Disconnect battery ground cable.



G02960081

**Fig. 47: Disconnecting Battery Ground Cable**  
 Courtesy of SUBARU OF AMERICA, INC.

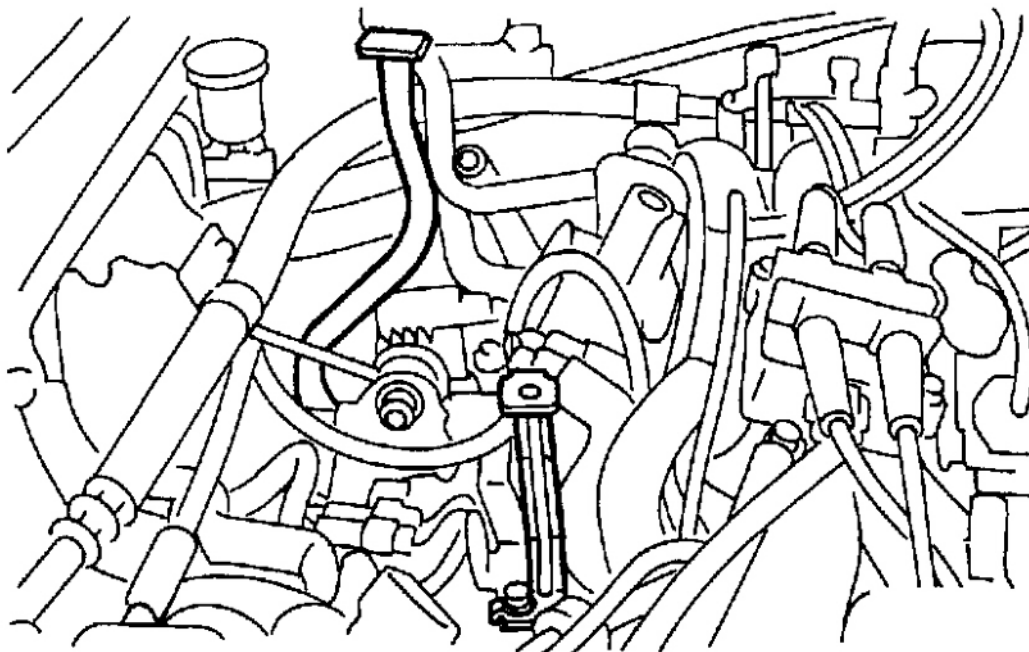
7. Remove air intake duct and air cleaner case. Refer to **REMOVAL** , Air Intake Duct and **REMOVAL** , Air Cleaner Case.
8. Remove under cover.
9. Remove radiator from vehicle. Refer to **REMOVAL** , Radiator.
10. Remove ATF cooler pipe from body. Refer to **REMOVAL** , ATF Cooler Pipe and Hose.
11. Collect refrigerant, and remove pressure hoses. (With A/O)
  1. Place and connect the attachment hose to the refrigerant recycle system.
  2. Collect refrigerant from A/C system.
  3. Disconnect A/C pressure hoses from A/C compressor.



G02960082

**Fig. 48: Disconnecting A/C Pressure Hoses From A/C Compressor**  
Courtesy of SUBARU OF AMERICA, INC.

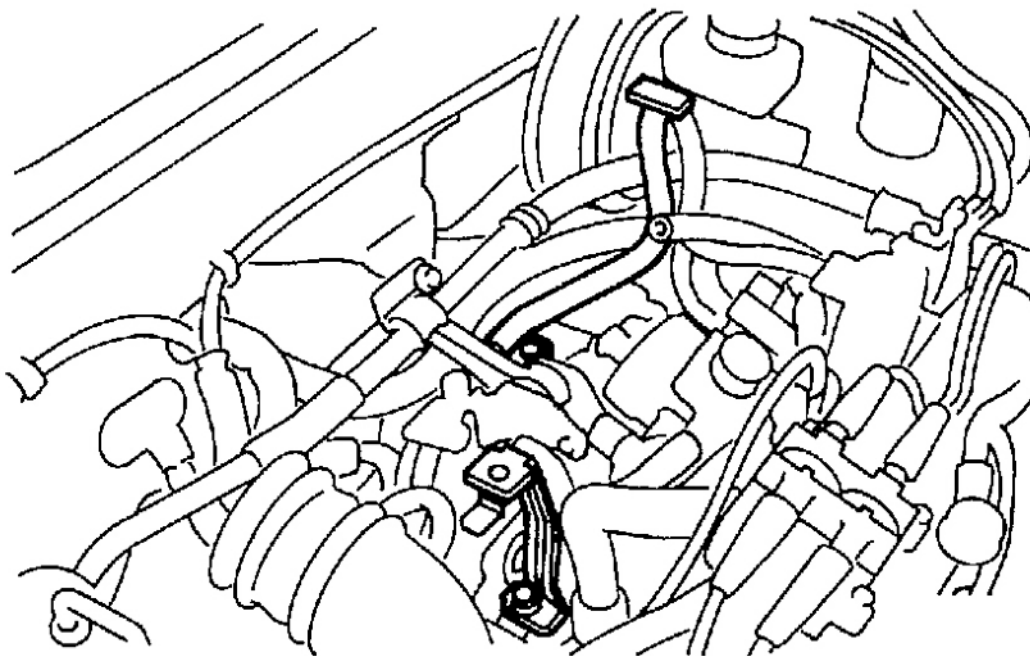
12. Remove air cleaner case stay.
  - MT model



G02960083

**Fig. 49: Removing Air Cleaner Case Stay (MT Model)**  
Courtesy of SUBARU OF AMERICA, INC.

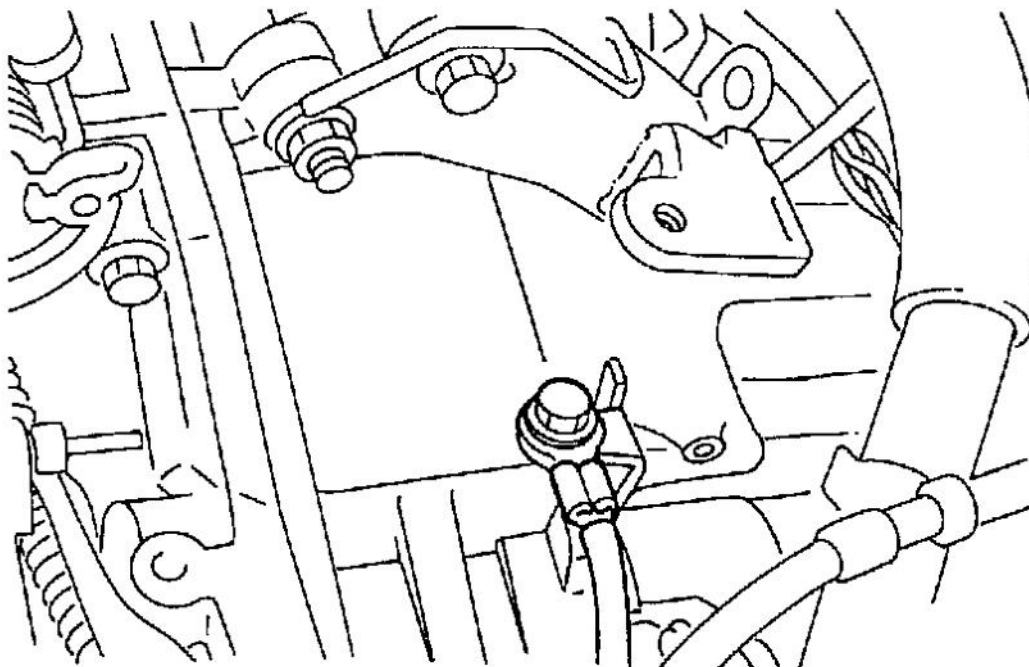
- AT model



G02960084

**Fig. 50: Removing Air Cleaner Case Stay (AT Model)**  
Courtesy of SUBARU OF AMERICA, INC.

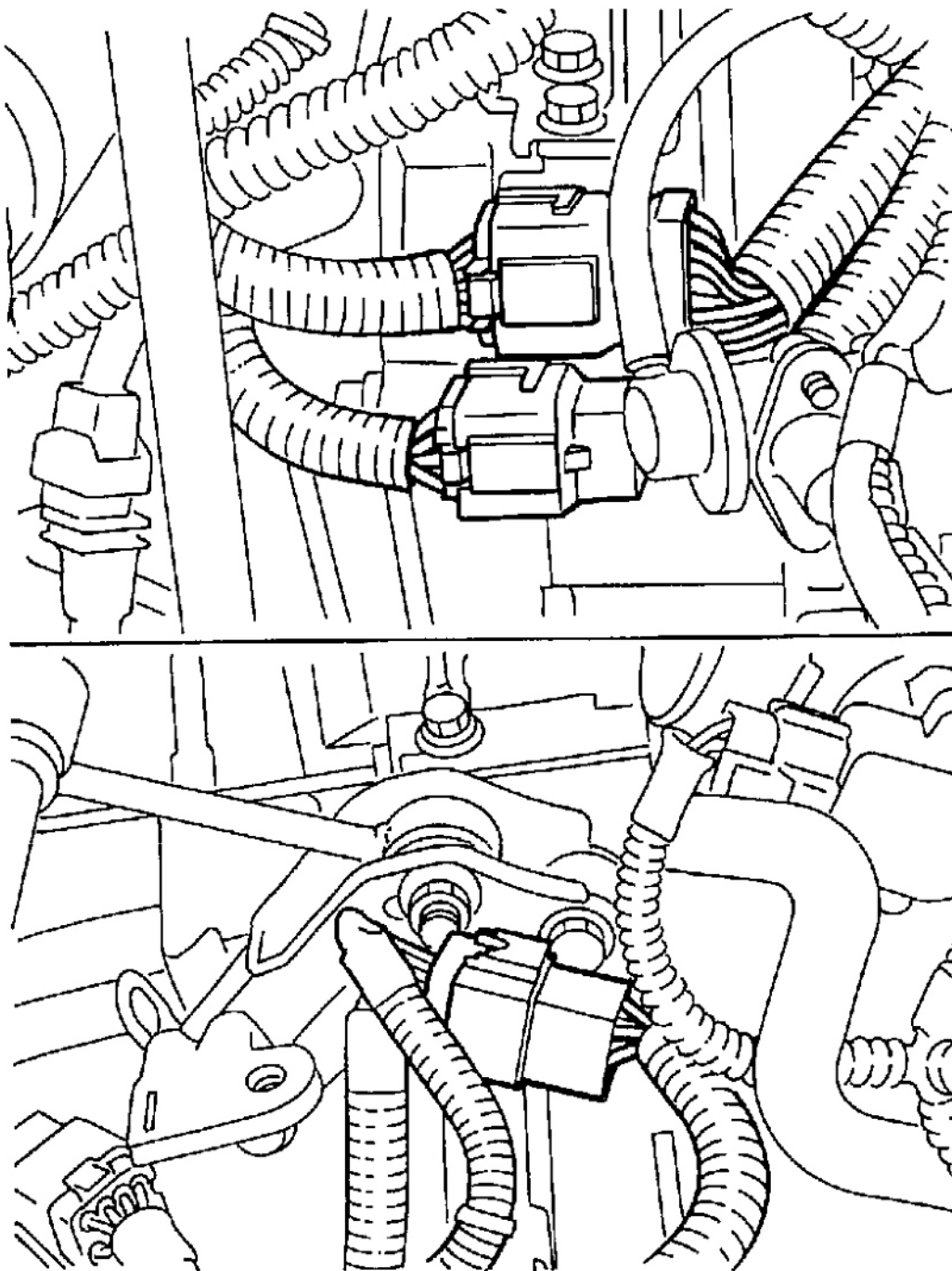
13. Disconnect the following connectors and cables.
  1. Engine ground terminal



G02960085

**Fig. 51: Disconnecting Engine Ground Terminal**  
Courtesy of SUBARU OF AMERICA, INC.

2. Engine harness connectors

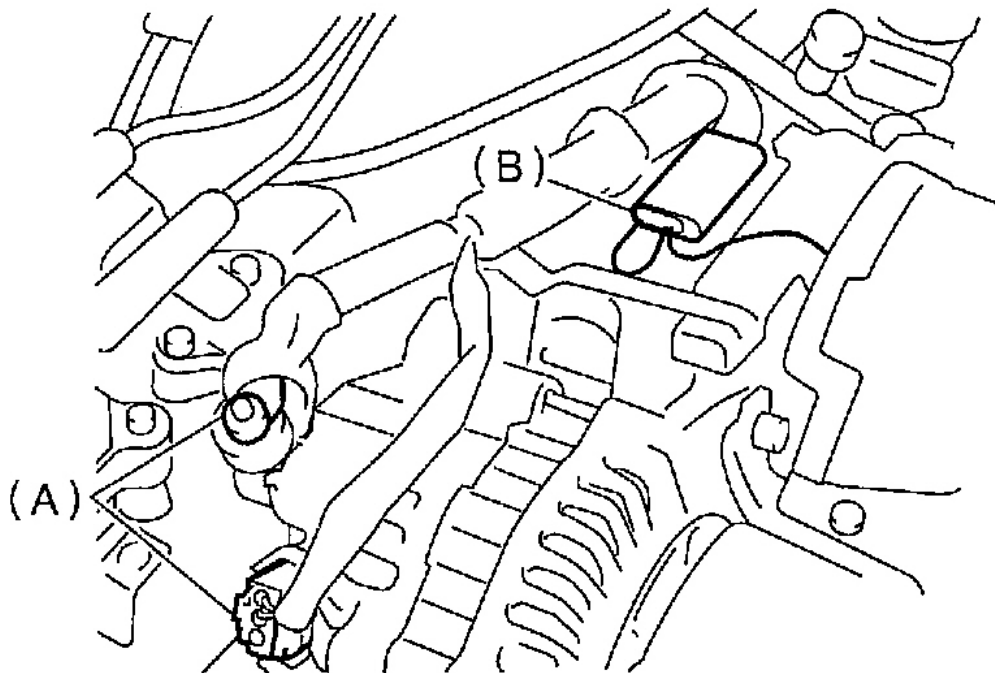


G02960086

**Fig. 52: Disconnecting Engine Harness Connectors**  
Courtesy of SUBARU OF AMERICA, INC.



3. Alternator connector, terminal and A/C compressor connector

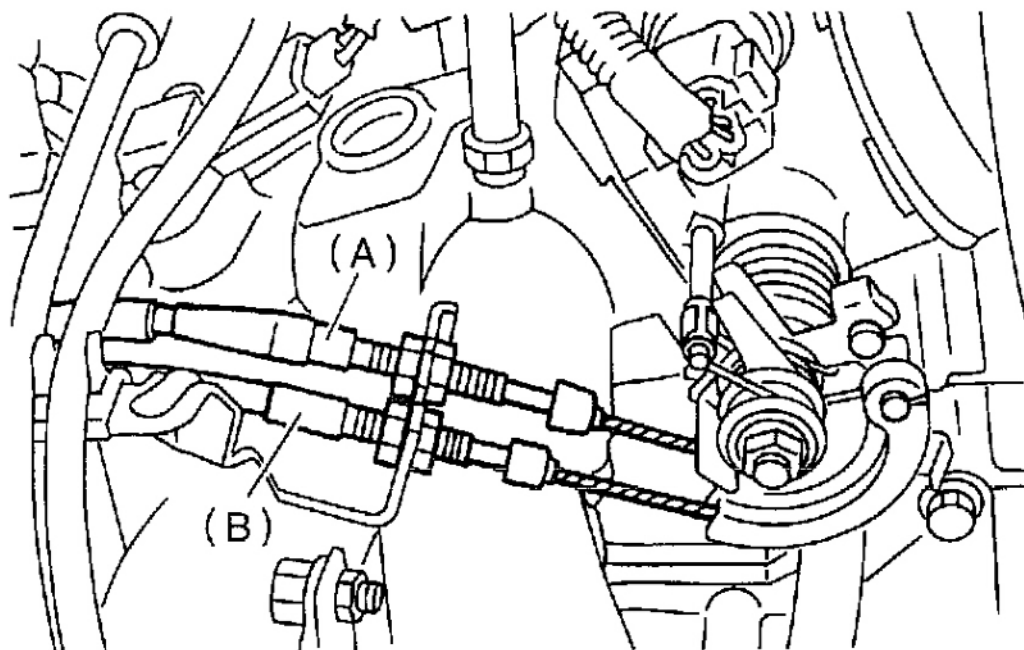


- (A) Alternator connector and terminal  
(B) A/C compressor connector

G02960087

**Fig. 53: Disconnecting Alternator Connector, Terminal & A/C Compressor Connector**  
Courtesy of SUBARU OF AMERICA, INC.

4. Accelerator cable and cruise control cable

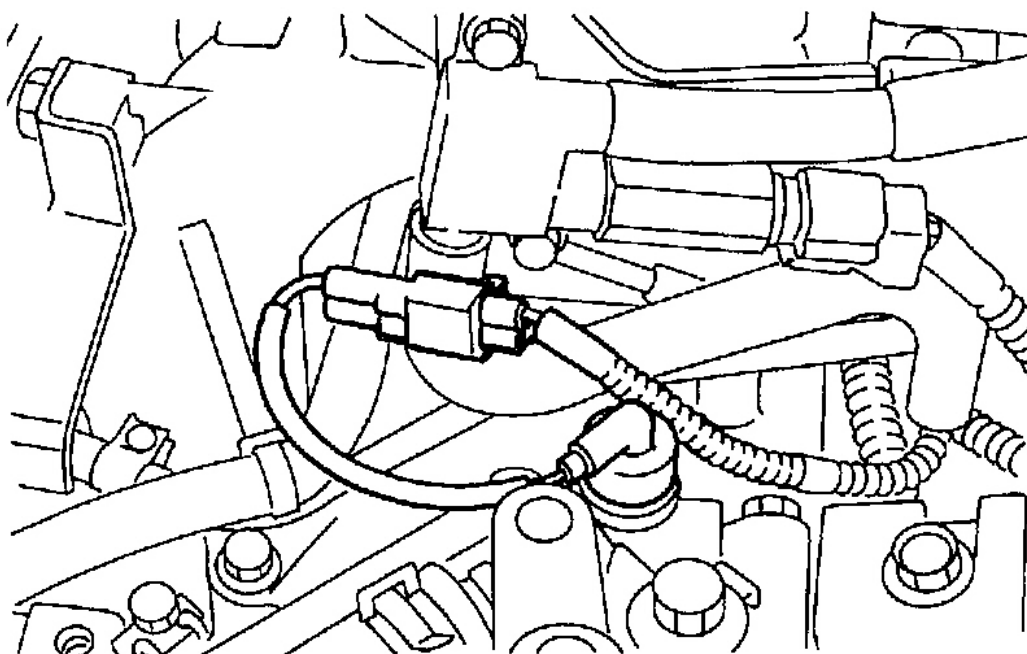


- (A) Accelerator cable  
(B) Cruise control cable

G02960088

**Fig. 54: Disconnecting Accelerator Cable & Cruise Control Cable**  
Courtesy of SUBARU OF AMERICA, INC.

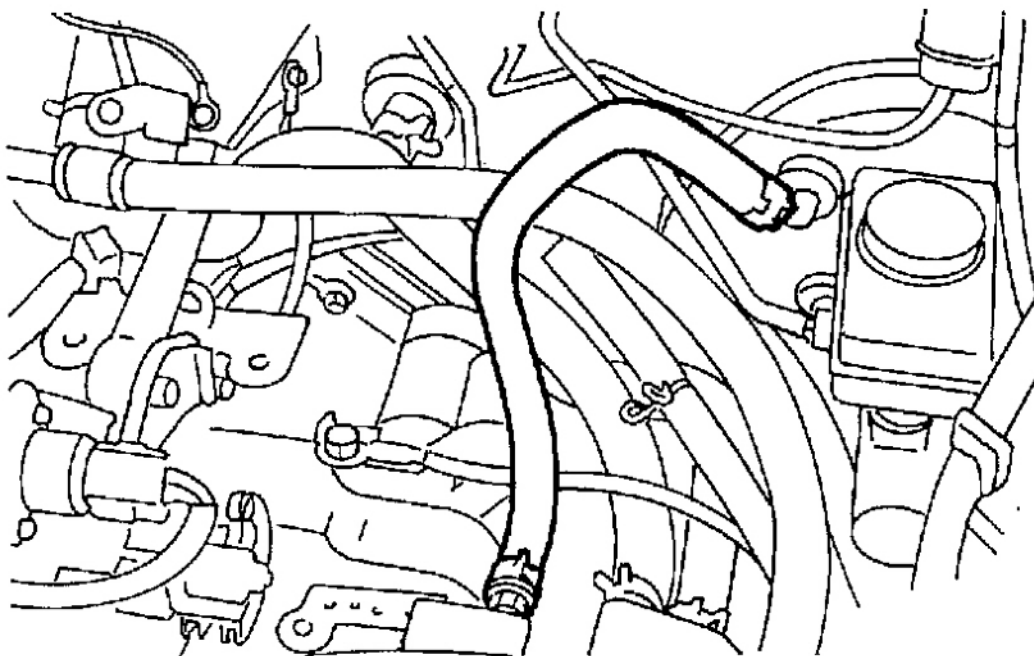
5. Pressure switch



G02960089

**Fig. 55: Disconnecting Pressure Switch**  
Courtesy of SUBARU OF AMERICA, INC.

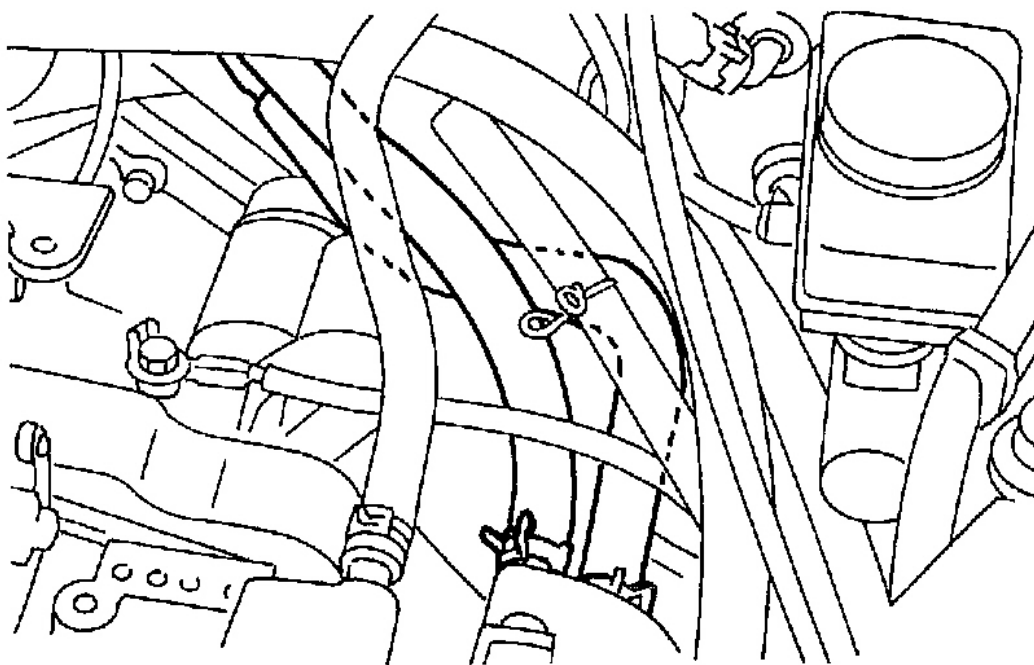
14. Disconnect the following hoses.
  1. Brake booster vacuum hose



G02960090

**Fig. 56: Disconnecting Brake Booster Vacuum Hose**  
Courtesy of SUBARU OF AMERICA, INC.

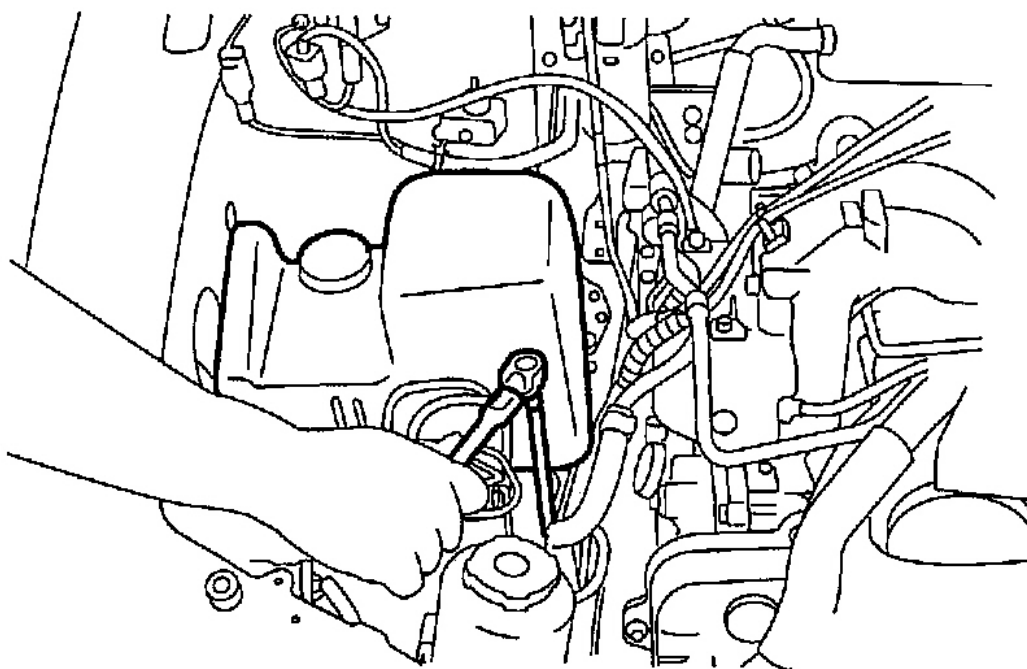
2. Heater inlet outlet hose



G02960091

**Fig. 57: Disconnecting Heater Inlet Outlet Hose**  
Courtesy of SUBARU OF AMERICA, INC.

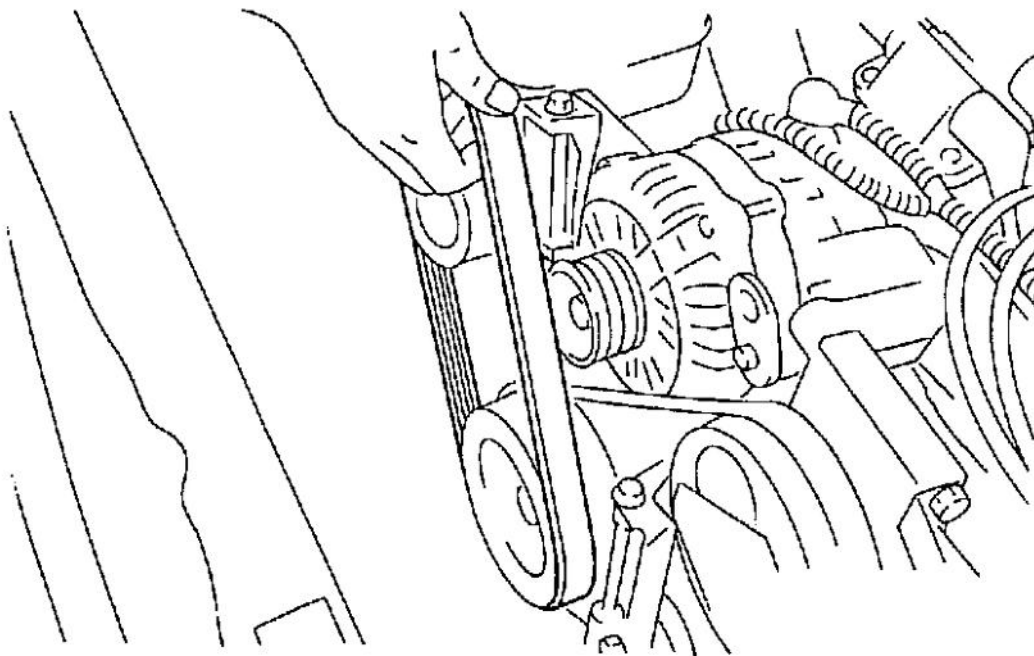
15. Remove power steering pump from bracket.
  1. Remove resonator chamber.



G02960092

**Fig. 58: Removing Resonator Chamber**  
Courtesy of SUBARU OF AMERICA, INC.

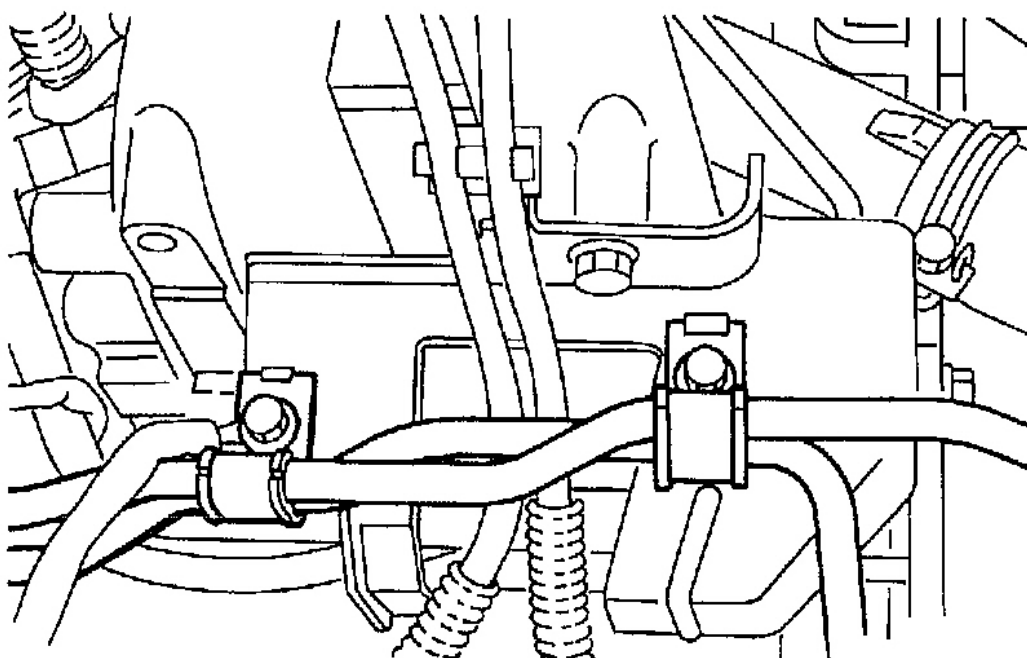
2. Loosen lock bolt and slider bolt, and remove front side V-belt.



G02960093

**Fig. 59: Removing Front Side V-Belt**  
Courtesy of SUBARU OF AMERICA, INC.

3. Remove pipe with bracket.

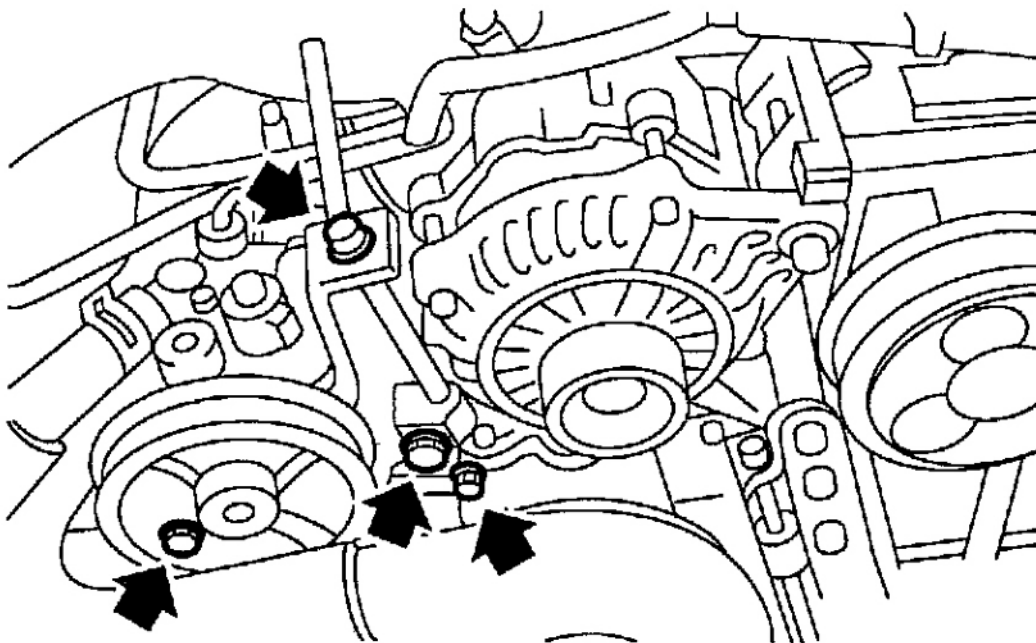


G02960094

**Fig. 60: Removing Pipe With Bracket**  
Courtesy of SUBARU OF AMERICA, INC.

4. Remove bolts which install power steering pump bracket.

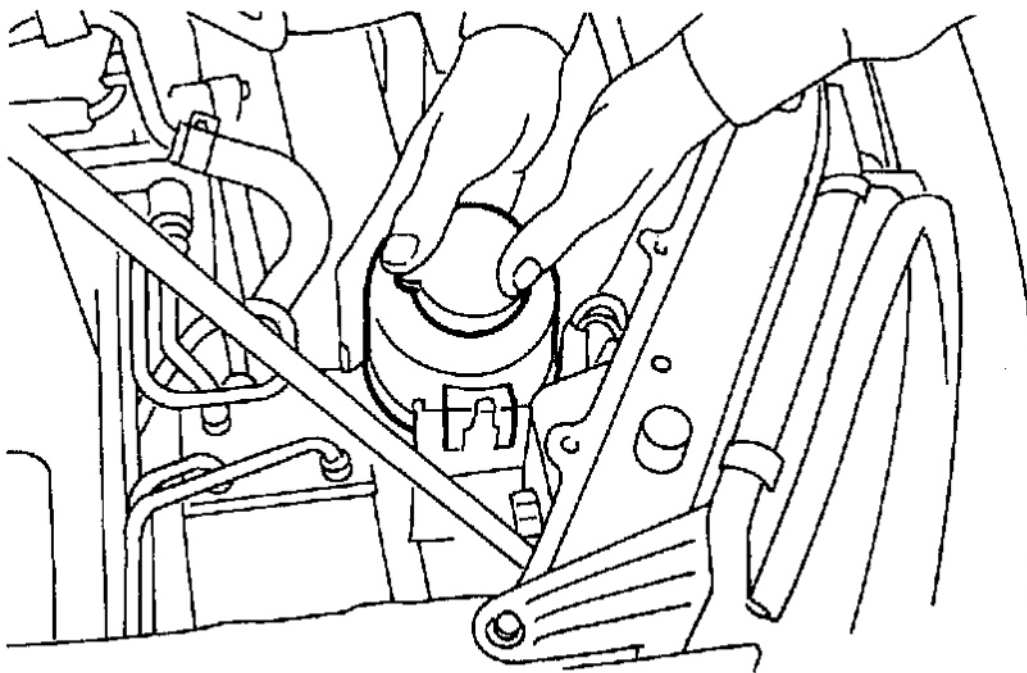




G02960095

**Fig. 61: Removing Power Steering Pump Bracket Bolts**  
Courtesy of SUBARU OF AMERICA, INC.

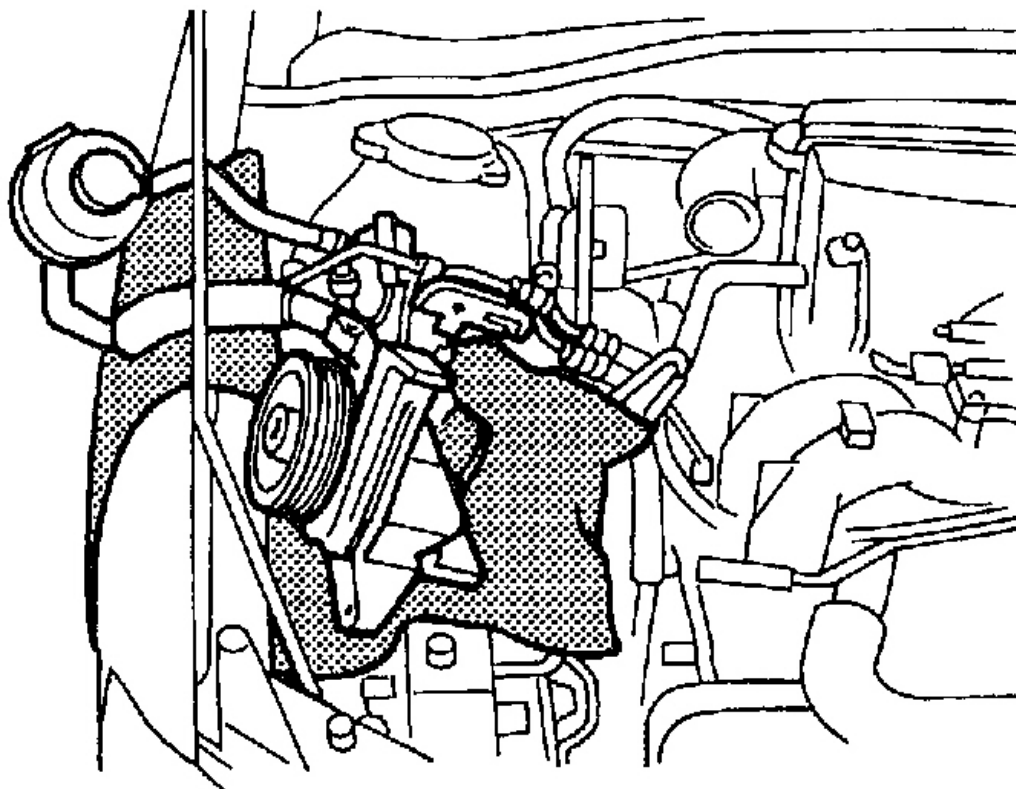
5. Remove power steering tank from the bracket by pulling it upward.



G02960096

**Fig. 62: Removing Power Steering Tank From Bracket**  
Courtesy of SUBARU OF AMERICA, INC.

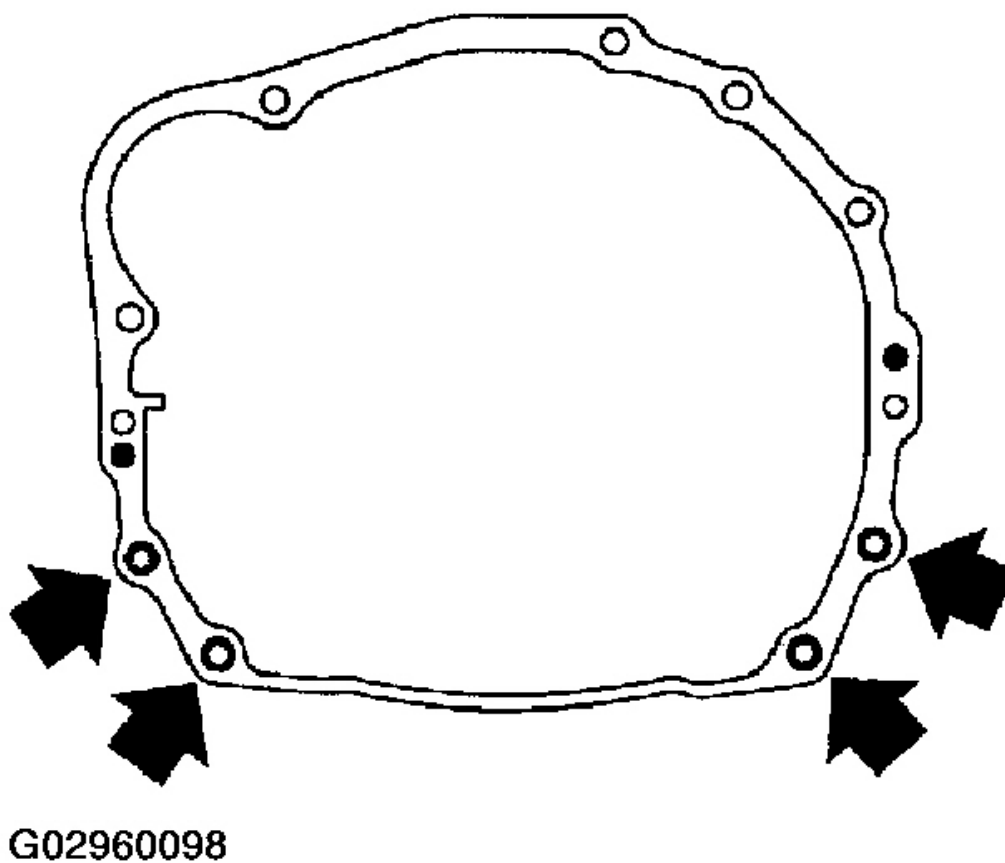
6. Place power steering pump on the right side wheel apron.



G02960097

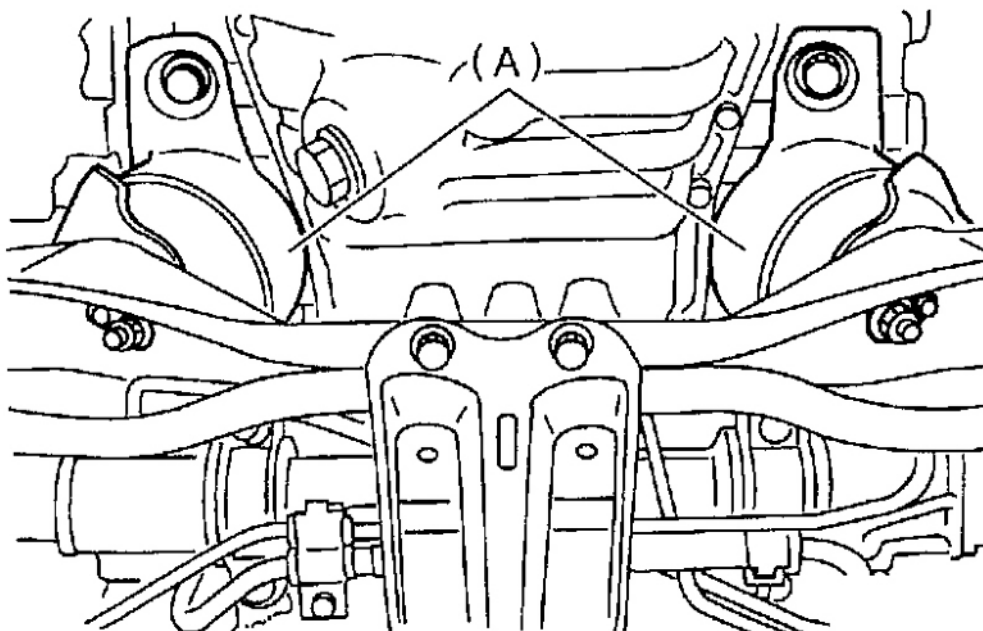
**Fig. 63: Placing Power Steering Pump On Right Side Wheel Apron**  
Courtesy of SUBARU OF AMERICA, INC.

16. Remove front and center exhaust pipe. Refer to **REMOVAL** , Front Exhaust pipe and **REMOVAL** , Center Exhaust Pipe.
17. Remove nuts which hold lower side of transmission to engine.



**Fig. 64: Removing Nuts Holding Lower Side Of Transmission To Engine**  
Courtesy of SUBARU OF AMERICA, INC.

18. Remove nuts which install front cushion rubber onto front crossmember.



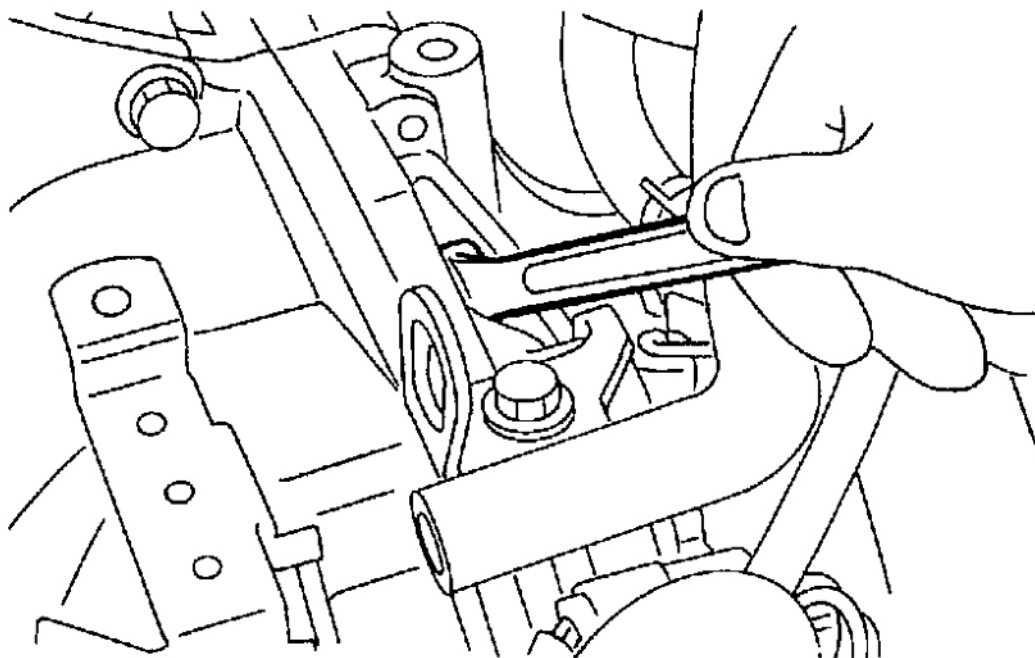
(A) Engine mount

G02960099

**Fig. 65: Removing Front Cushion Rubber Nuts Onto Front Crossmember**  
Courtesy of SUBARU OF AMERICA, INC.

19. Separate torque converter clutch from drive plate. (AT model)
  1. Lower the vehicle.
  2. Remove service hole plug.
  3. Remove bolts which hold torque converter clutch to drive plate.
  4. Remove other bolts while rotating the crankshaft pulley using ST.

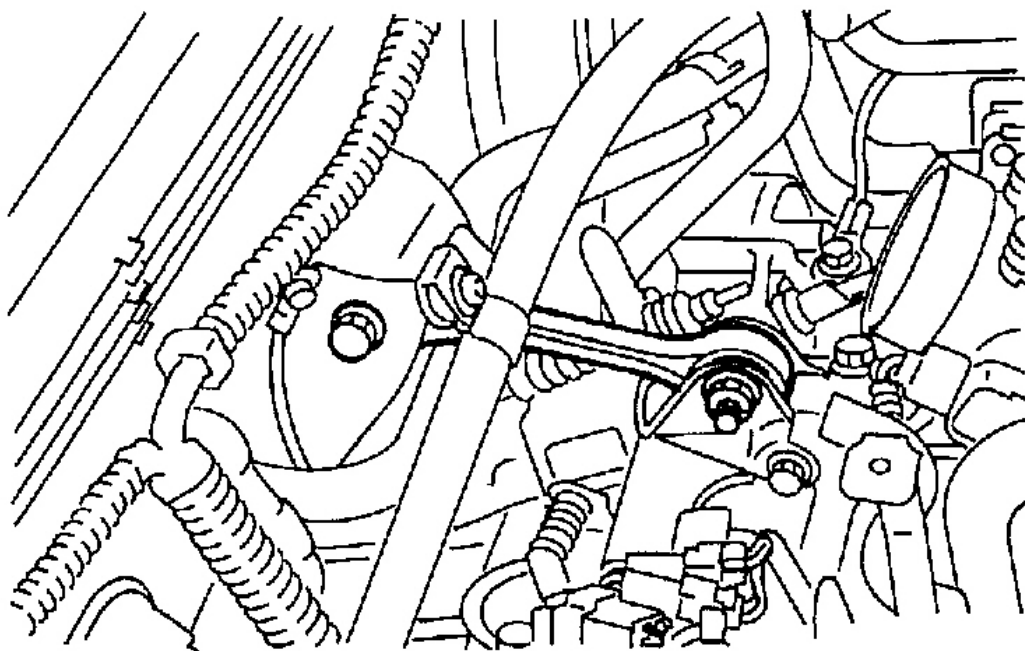
ST 499977100 CRANK PULLEY WRENCH



G02960100

**Fig. 66: Separating Torque Converter Clutch From Drive Plate**  
Courtesy of SUBARU OF AMERICA, INC.

20. Remove pitching stopper.



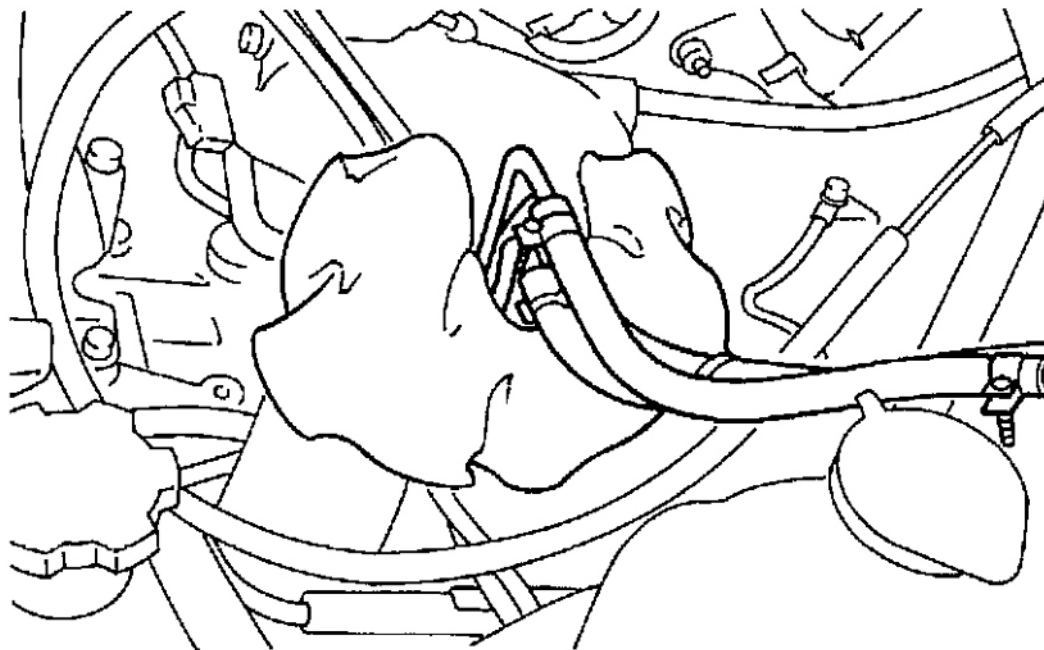
G02960101

**Fig. 67: Removing Pitching Stopper**  
Courtesy of SUBARU OF AMERICA, INC.

21. Disconnect fuel delivery hose, return hose and evaporation hose.

**CAUTION:**

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

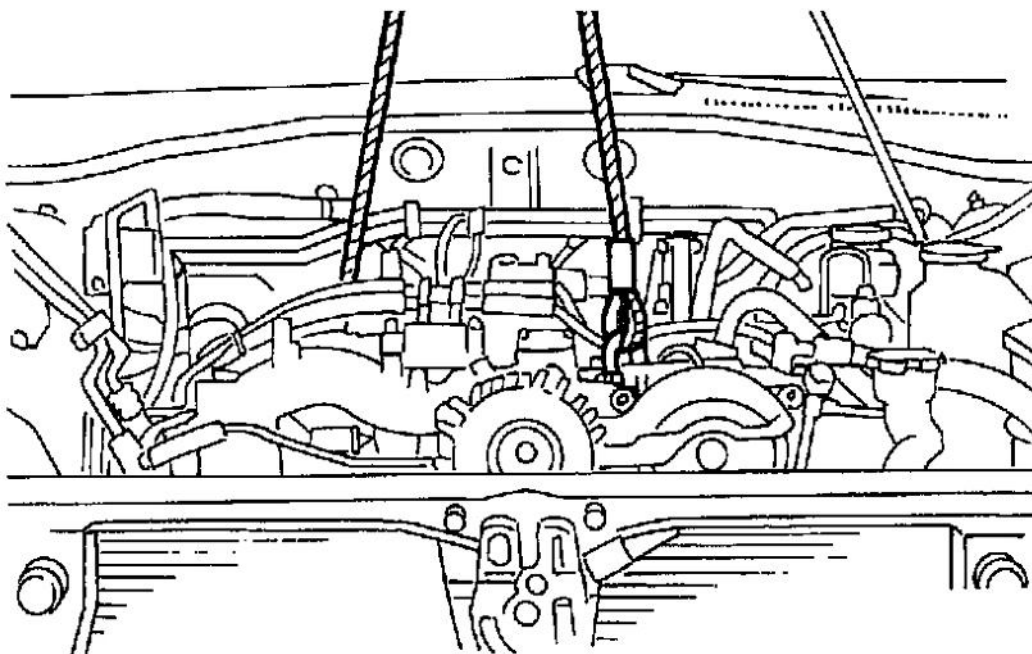


G02960102

**Fig. 68: Disconnecting Fuel Delivery Hose, Return Hose & Evaporation Hose**  
Courtesy of SUBARU OF AMERICA, INC.

22. Support engine with a lifting device and wire ropes.



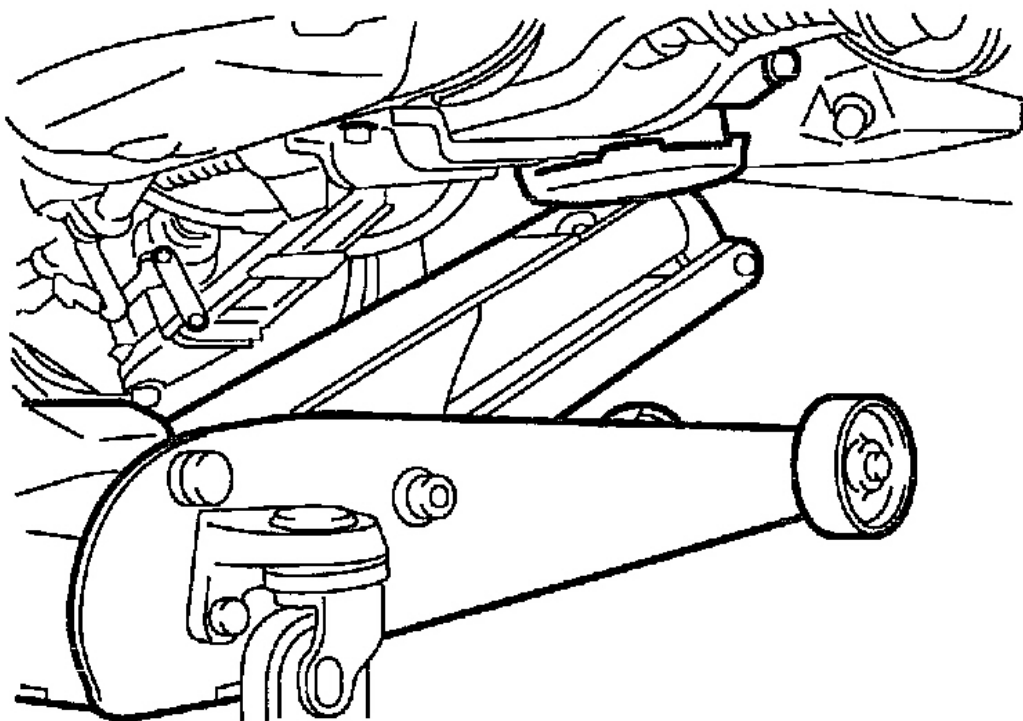


G02960103

**Fig. 69: Supporting Engine With Lifting Device & Wire Ropes**  
Courtesy of SUBARU OF AMERICA, INC.

23. Support transmission with a garage jack.

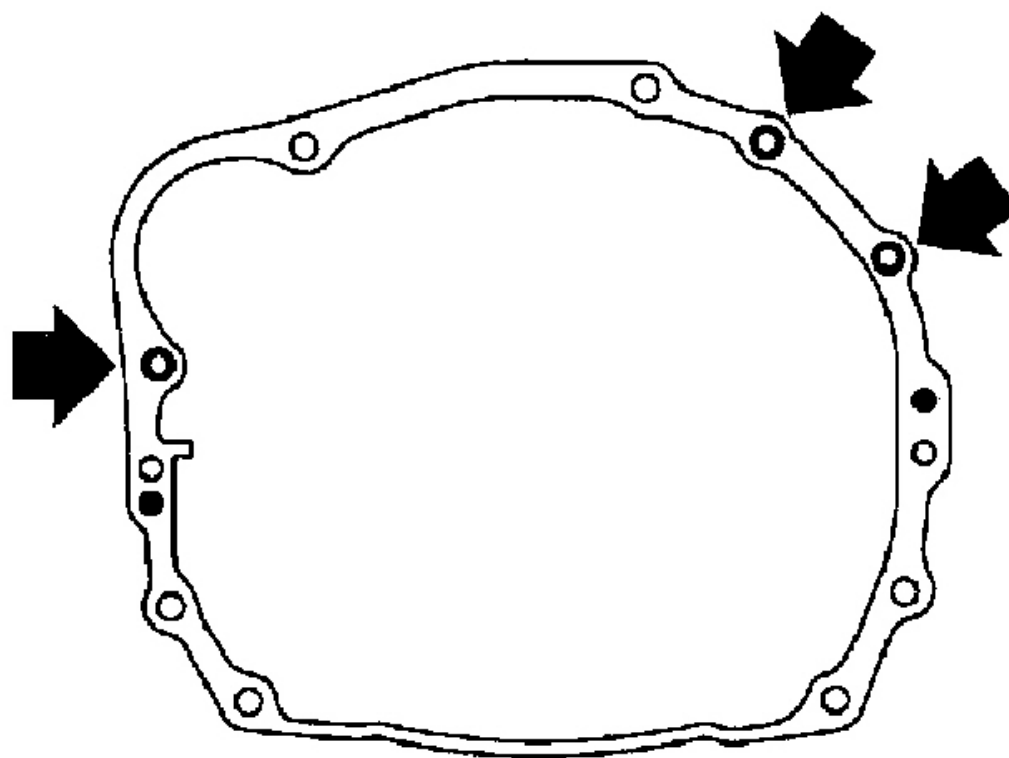
**CAUTION:** Before moving engine away from transmission, check to be sure no work has been overlooked. Doing this is very important in order to facilitate re-installation and because transmission lowers under its own weight.



G02960104

**Fig. 70: Supporting Transmission With Garage Jack**  
Courtesy of SUBARU OF AMERICA, INC.

24. Separation of engine and transmission.
  1. Remove starter. Refer to **REMOVAL** , Starter.
  2. Remove bolts which hold upper side of transmission to engine.

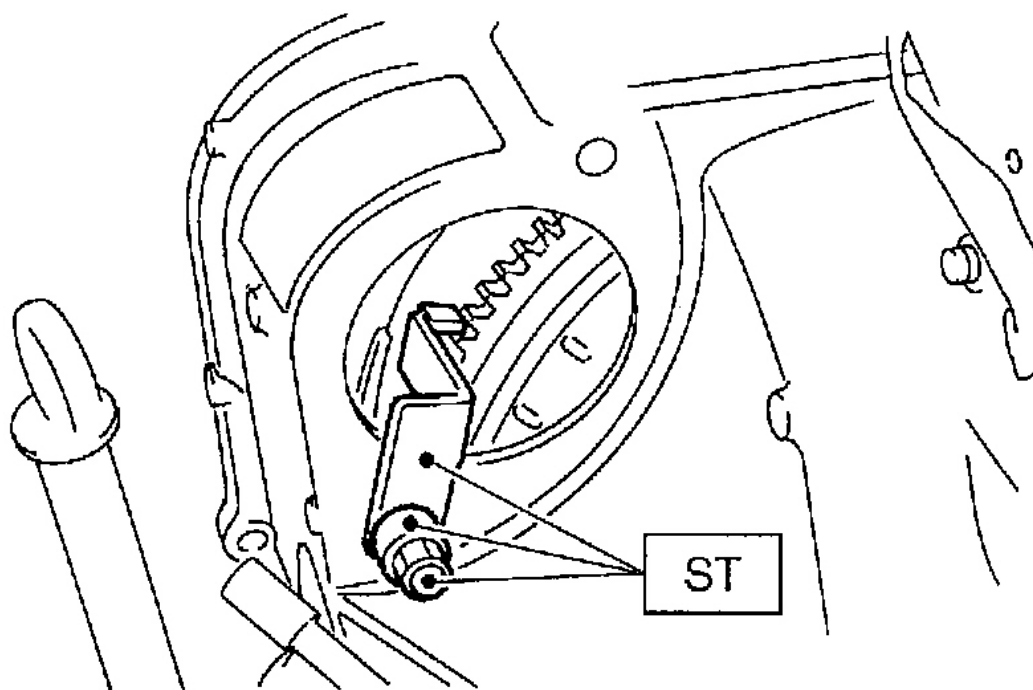


G02960105

**Fig. 71: Removing Bolts Holding Upper Side Of Transmission To Engine**  
Courtesy of SUBARU OF AMERICA, INC.

25. Install ST to torque converter clutch case. (AT model)

ST 498277200 STOPPER SET

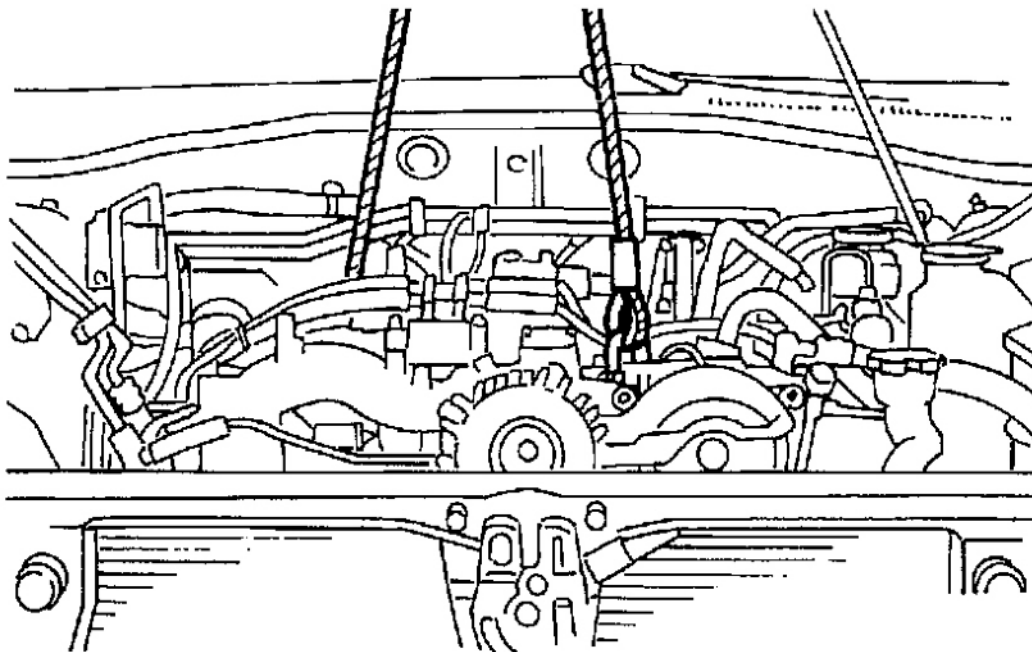


G02960106

**Fig. 72: Installing ST To Torque Converter Clutch Case**  
Courtesy of SUBARU OF AMERICA, INC.

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

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



G02960107

**Fig. 73: Removing Engine From Vehicle**  
Courtesy of SUBARU OF AMERICA, INC.

27. Remove front cushion rubbers.

## INSTALLATION

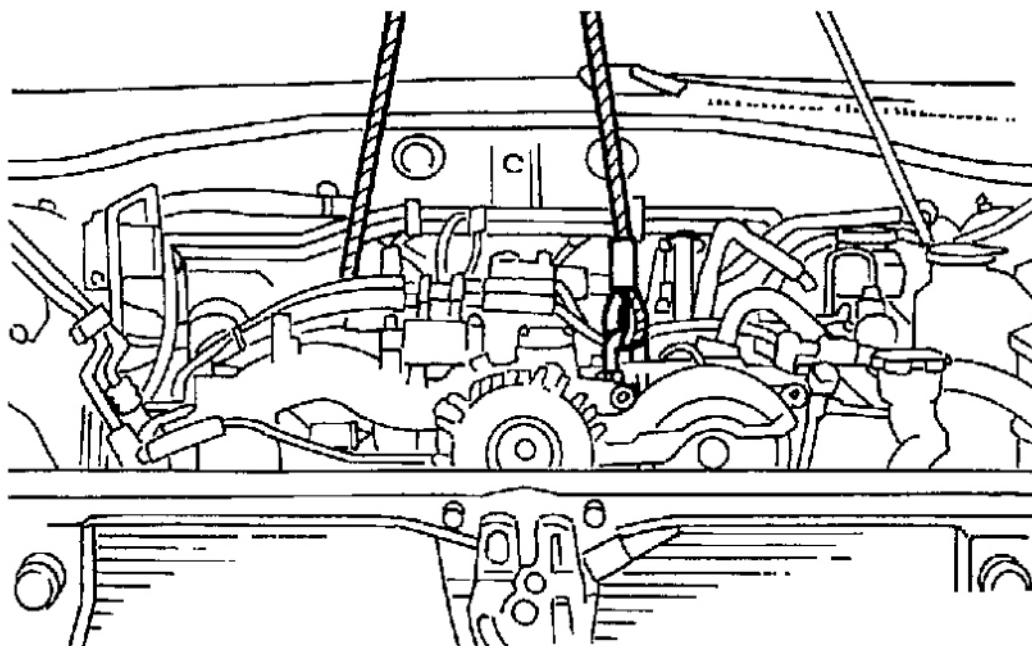
1. Install front cushion rubbers.

**Tightening torque:** 34 N.m (3.5 kgf-m, 25.3 ft-lb)

2. Install engine onto transmission.

1. Position engine in engine compartment and align it with transmission.

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

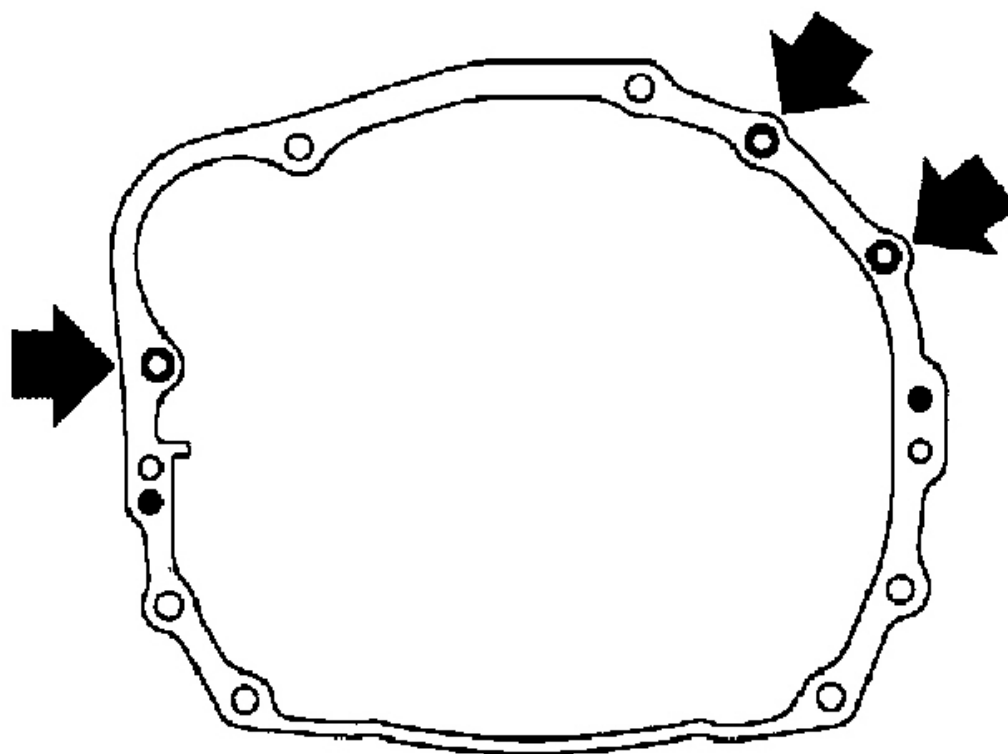


G02960108

**Fig. 74: Installing Engine Onto Transmission**  
Courtesy of SUBARU OF AMERICA, INC.

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

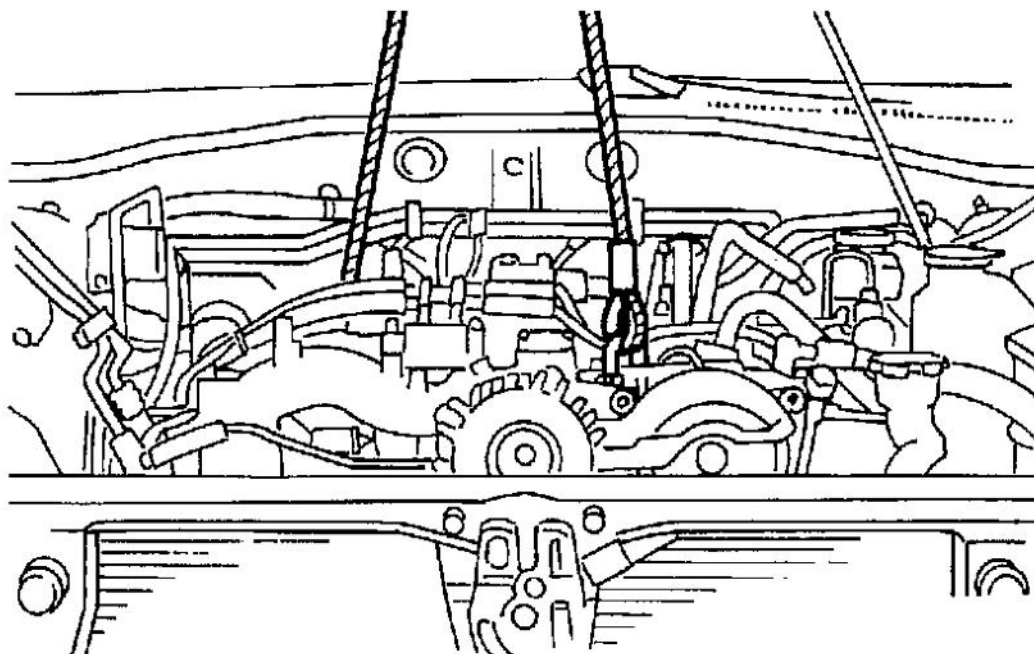
**Tightening torque:** 50 N.m (5.1 kgf-m, 36.9 ft-lb)



G02960109

**Fig. 75: Tightening Bolts Holding Upper Side Of Transmission To Engine**  
Courtesy of SUBARU OF AMERICA, INC.

4. Remove lifting device and wire ropes.



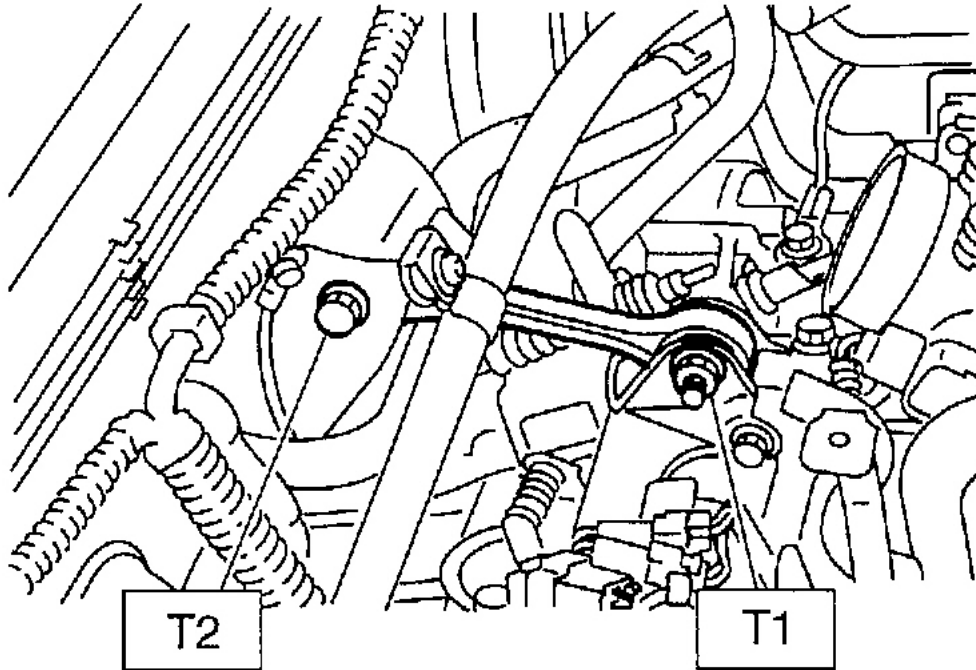
G02960110

**Fig. 76: Removing Lifting Device & Wire Ropes**  
Courtesy of SUBARU OF AMERICA, INC.

5. Remove garage jack.
6. Install pitching stopper.



**T1: 50 N·m (5.1 kgf-m, 36.9 ft-lb)**  
**T2: 58 N·m (5.9 kgf-m, 43 ft-lb)**



G02960111

**Fig. 77: Installing Pitching Stopper**

Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

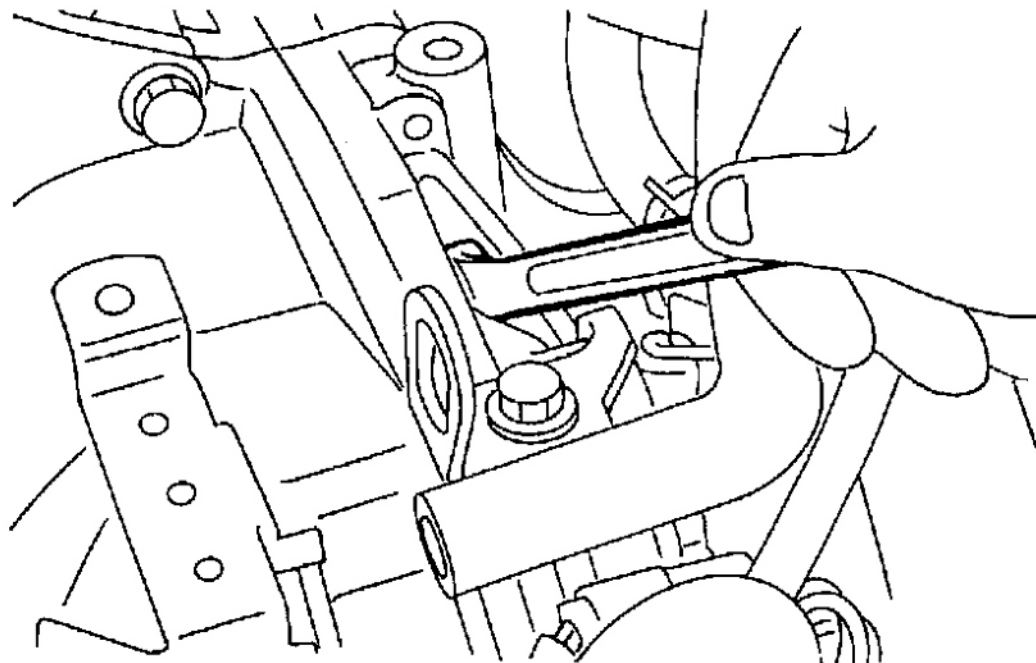
8. Install starter. Refer to **INSTALLATION**, Starter.
9. Install torque converter clutch onto drive plate. (AT model)
  1. Tighten bolts which hold torque converter clutch to drive plate.
  2. Tighten other bolts while rotating the crankshaft pulley by using ST.

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

housing.

ST 499977100 CRANK PULLEY WRENCH

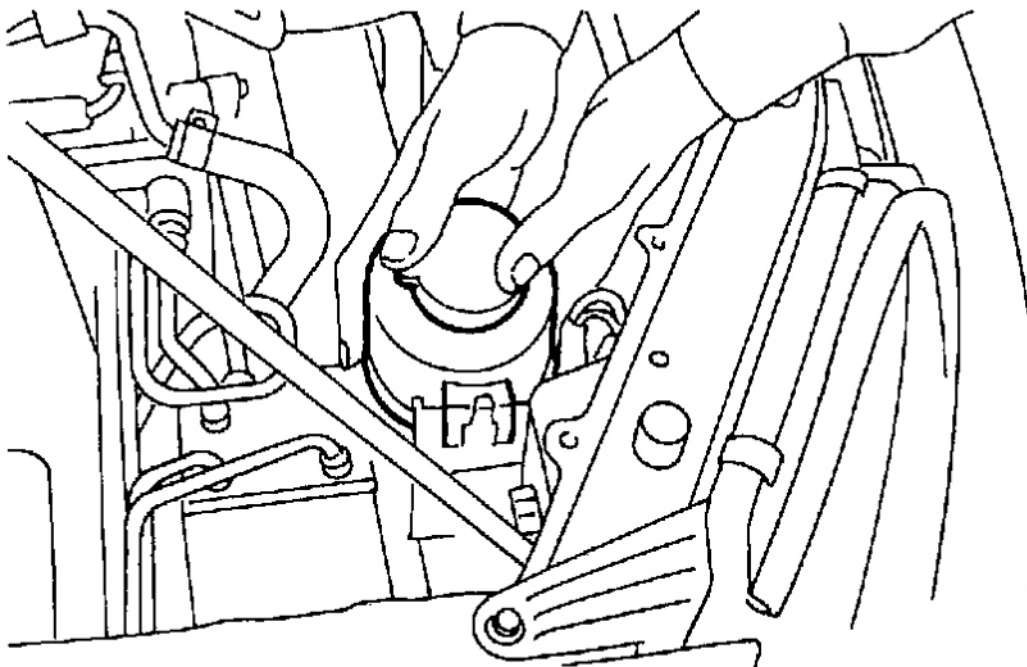
**Tightening torque:** 25 N.m (2.5 kgf-m, 18.1 ft-lb)



G02960112

**Fig. 78: Installing Torque Converter Clutch Onto Drive Plate**  
Courtesy of SUBARU OF AMERICA, INC.

3. Clog plug onto service hole.
10. Install power steering pump on bracket.
  1. Install power steering tank on bracket.

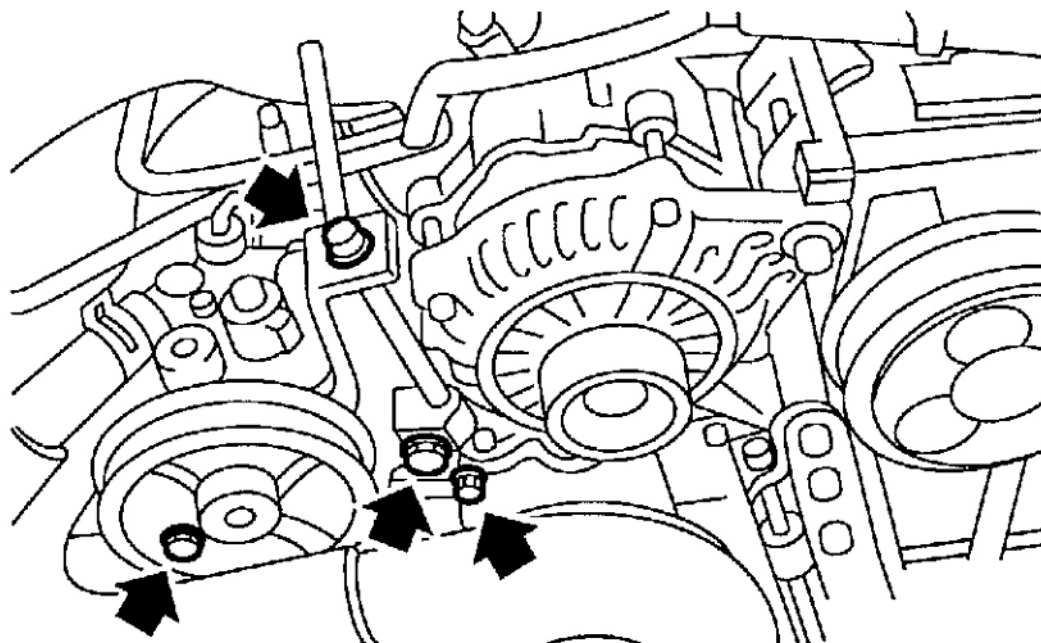


G02960113

**Fig. 79: Installing Power Steering Tank On Bracket**  
Courtesy of SUBARU OF AMERICA, INC.

2. Install power steering pump on bracket, and tighten bolts.

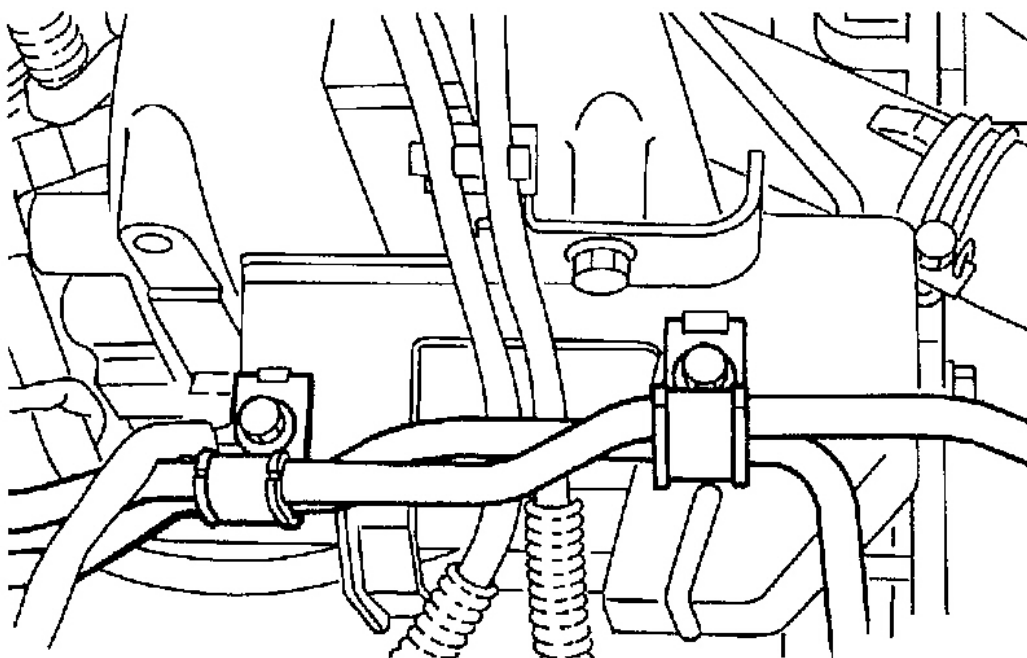
**Tightening torque:** 20.1 N.m (2.05 kgf-m, 14.8 ft-lb)



G02960114

**Fig. 80: Installing Power Steering Pump On Bracket**  
Courtesy of SUBARU OF AMERICA, INC.

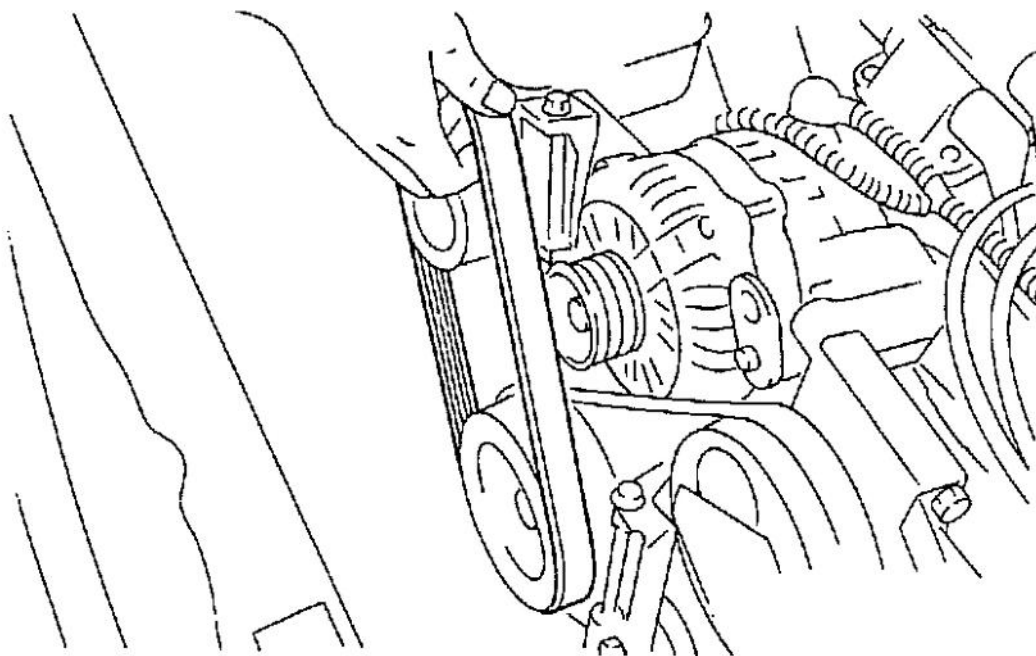
3. Tighten bolt which installs power steering pump bracket, and install spark plug codes.



G02960115

**Fig. 81: Tightening Power Steering Pump Bracket Bolt**  
Courtesy of SUBARU OF AMERICA, INC.

4. Intake front side V-belt, and adjust it.

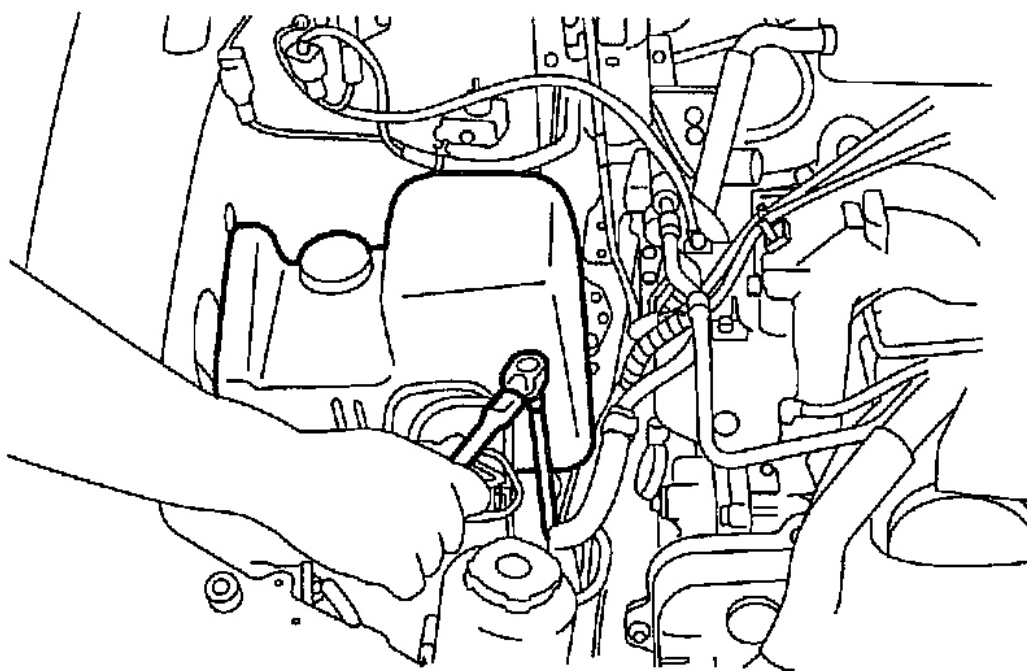


G02960116

**Fig. 82: Installing Intake Front Side V-Belt**  
Courtesy of SUBARU OF AMERICA, INC.

5. Install resonator chamber.

**Tightening torque:** 32 N.m (3.3 kgf-m, 24 ft-lb)

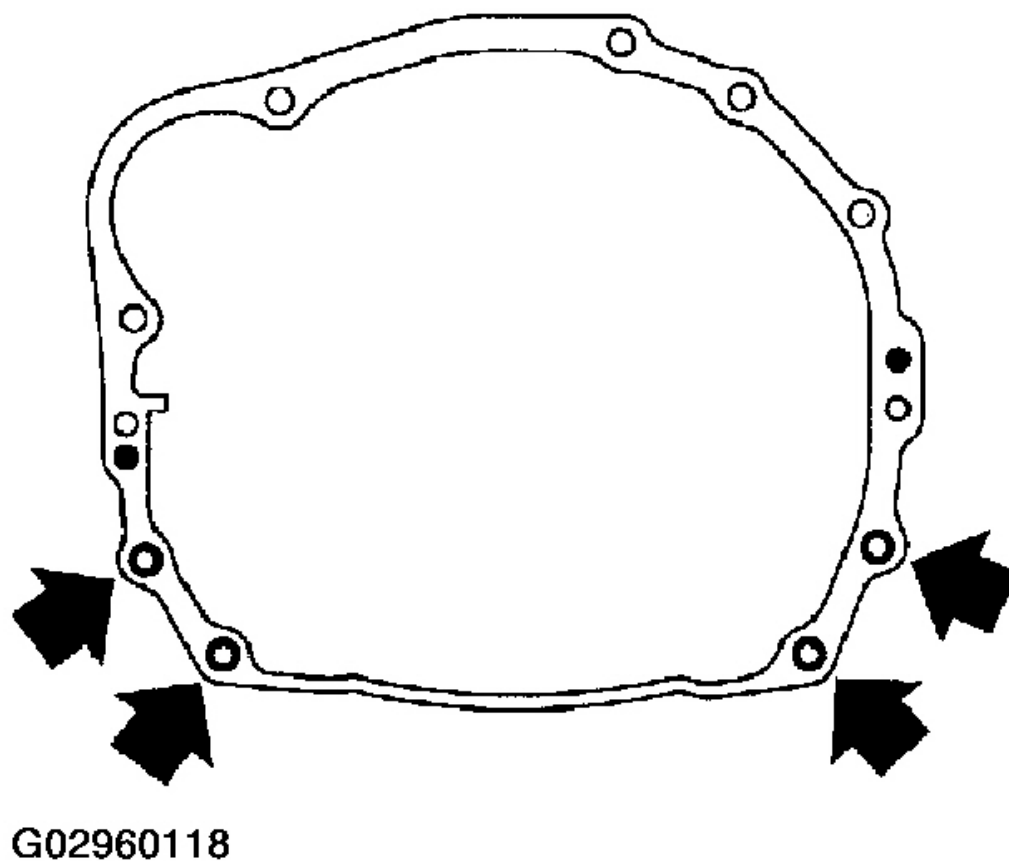


G02960117

**Fig. 83: Installing Resonator Chamber**  
Courtesy of SUBARU OF AMERICA, INC.

11. Tighten nuts which hold lower side of transmission to engine.

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



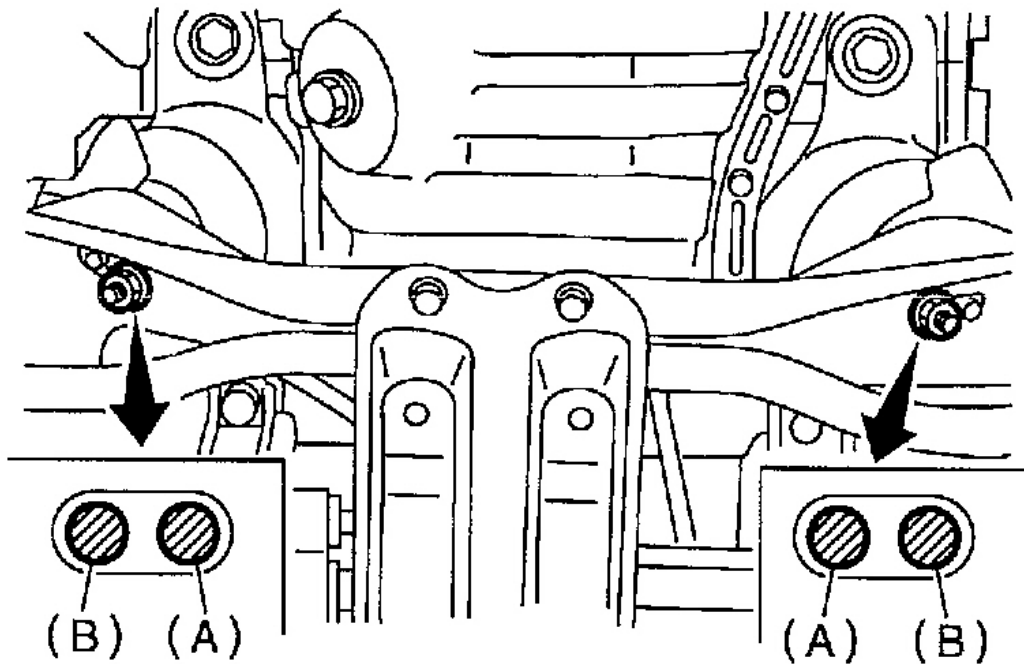
**Fig. 84: Tightening Nuts Holding Lower Side Of Transmission To Engine**  
Courtesy of SUBARU OF AMERICA, INC.

12. Tighten nuts which install front cushion rubber onto crossmember.

**Tightening torque:** 85 N.m (8.7kgf-m, 63 ft-lb)

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





G02960119

**Fig. 85: Tightening Front Cushion Rubber Nuts Onto Crossmember**  
 Courtesy of SUBARU OF AMERICA, INC.

13. Install front and center exhaust pipe. Refer to **INSTALLATION** , Front Exhaust Pipe and **INSTALLATION** , Center Exhaust Pipe.
14. Connect the following hoses.
  1. Fuel delivery hose, return hose and evaporation hose
  2. Heater inlet and outlet hoses
  3. Brake booster vacuum hose
15. Connect the following connectors.
  1. Engine ground terminals
 

**Tightening torque:** 14 N.m (1.4 kgf-m, 10.1 ft-lb)
  2. Engine harness connectors
  3. Alternator connector and terminal
  4. A/C compressor connectors
  5. Power steering pressure switch
16. Connect the following cables.
  1. Accelerator cable

2. Cruise control cables (With cruise control)

**CAUTION: After connecting each cable, adjust them.**

17. Install air cleaner case stay.

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

18. Install A/C pressure hoses. Refer to **INSTALLATION** , Flexible Hose.
19. Install radiator to vehicle. Refer to **INSTALLATION** , Radiator.
20. Install ATF cooler pipe to body. Refer to **INSTALLATION** , ATF Cooler Pipe and Hose.
21. Install air intake duct and cleaner case. Refer to **INSTALLATION** , Air Intake Duct and **INSTALLATION** , Air Cleaner Case.
22. Install under cover.
23. Install battery in the vehicle, and connect cables.
24. Fill coolant. Refer to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant.
25. Check ATF level and correct if necessary. (AT model) Refer to **AUTOMATIC TRANSMISSION FLUID** .
26. Charge A/C system with refrigerant. Refer to **OPERATION** , Refrigerant Charging Procedures.
27. Remove front hood stay, and close front hood.
28. Take off the vehicle from lift arms.

## INSPECTION

1. Make sure pipes and hoses are installed correctly.
2. Make sure the engine coolant and ATF are at specified levels.

## ENGINE MOUNTING

### REMOVAL

1. Remove engine assembly. Refer to **REMOVAL**, Engine Assembly.
2. Remove engine mounting from engine assembly.

### INSTALLATION

Install in the reverse order of removal.

#### **Tightening torque:**

**Engine mounting;** 35 N.m (3.6 kgf-m, 26 ft-lb)

### INSPECTION

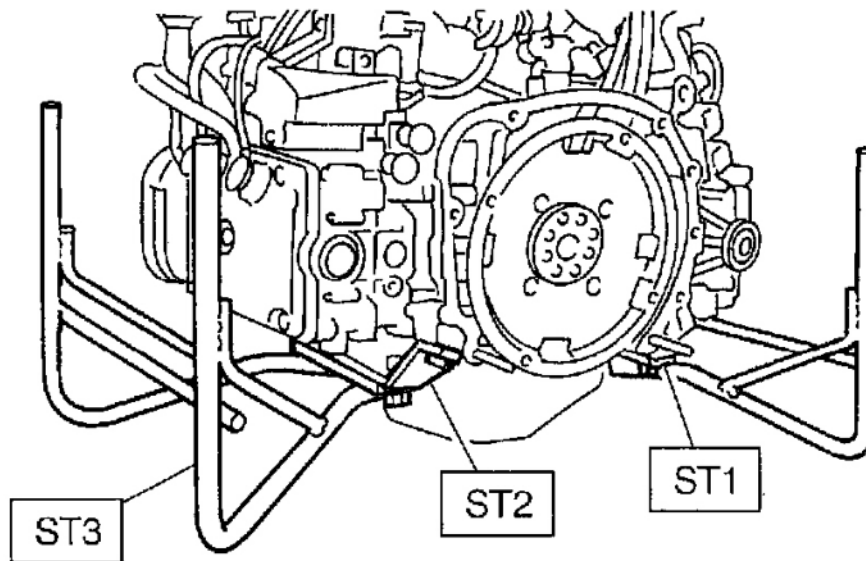
Make sure there are no cracks or other damage.

## PREPARATION FOR OVERHAUL

### PROCEDURE

1. After removing the engine from the body, secure it in the ST shown below.

ST1	498457000	ENGINE STAND ADAPTER RH
ST2	498457100	ENGINE STAND ADAPTER LH
ST3	499817100	ENGINE STAND



G02960120

**Fig. 86: Securing Engine In ST**  
Courtesy of SUBARU OF AMERICA, INC.

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

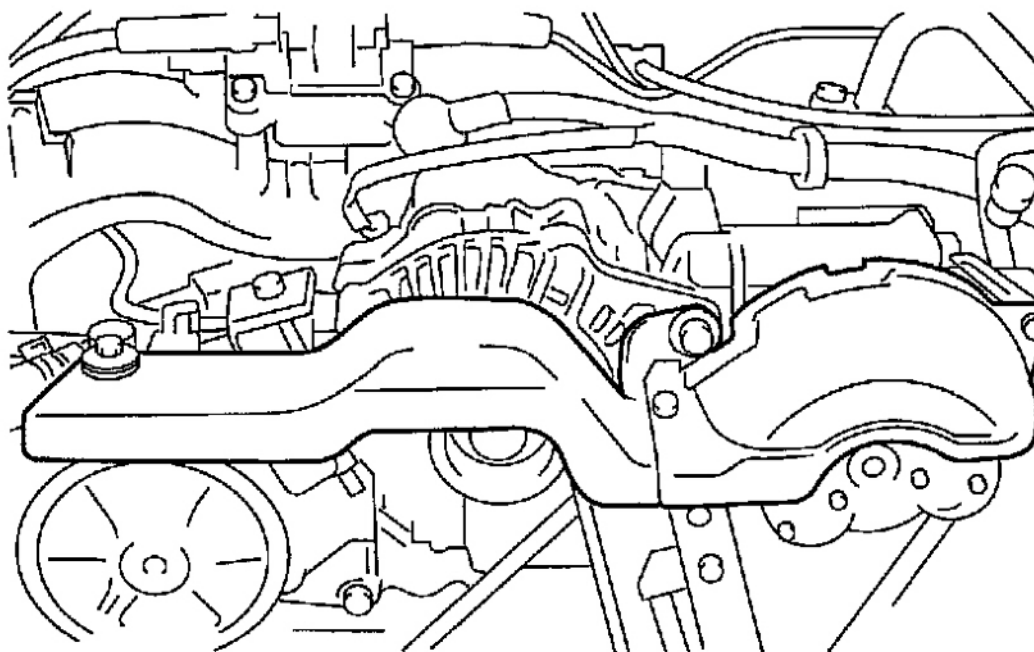
Therefore, in this section, to conduct the particular procedure within the flow of a section, you need to go back and conduct the procedure described previously in order to do that particular procedure.

## V-BELT

**REMOVAL****FRONT SIDE BELT**

**NOTE:** Perform the following procedures 1) to 4) with the engine installed to the body.

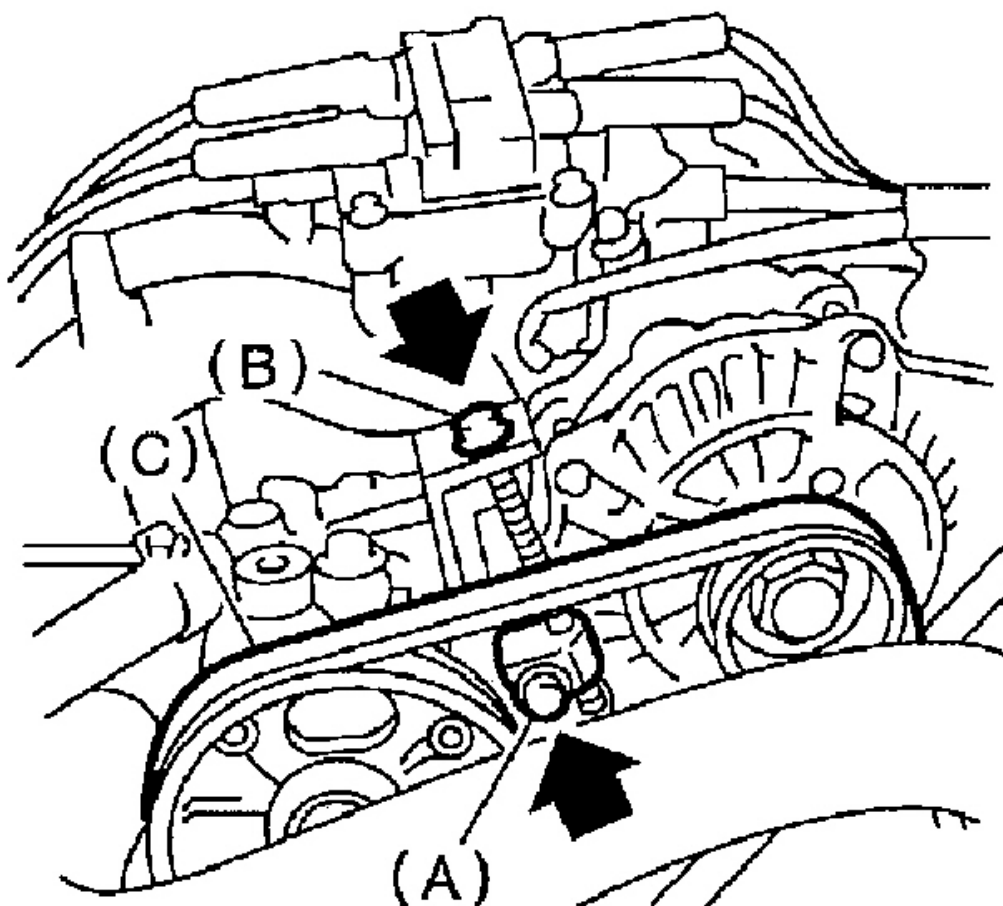
1. Remove V-belt cover.



G02960121

**Fig. 87: Removing V-Belt Cover**  
Courtesy of SUBARU OF AMERICA, INC.

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

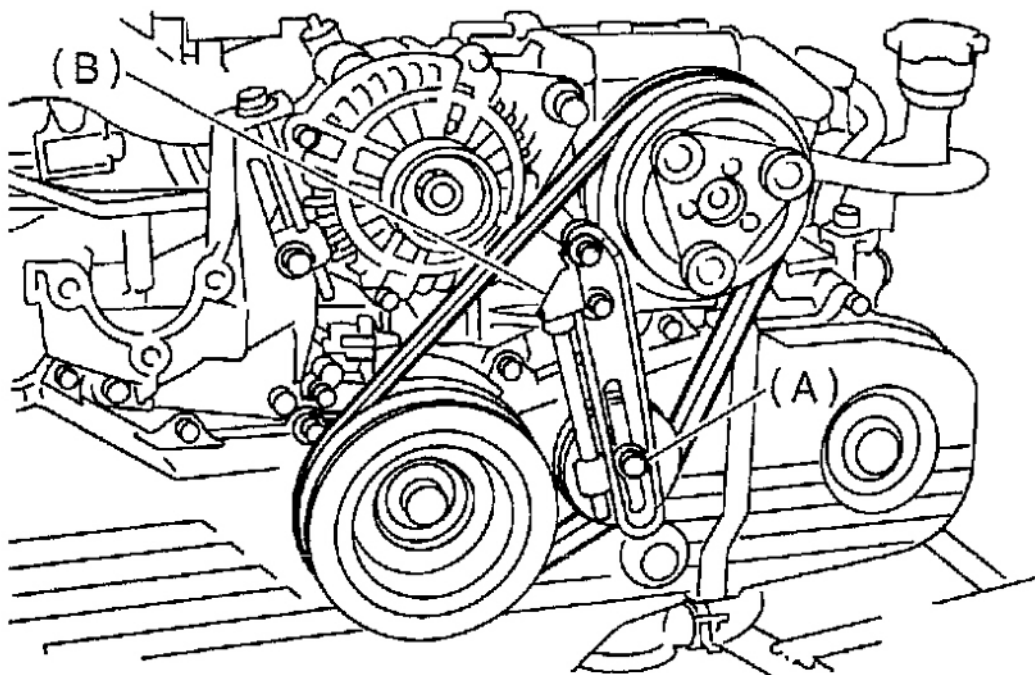


G02960122

**Fig. 88: Removing Front Side Belt**  
Courtesy of SUBARU OF AMERICA, INC.

#### REAR SIDE BELT

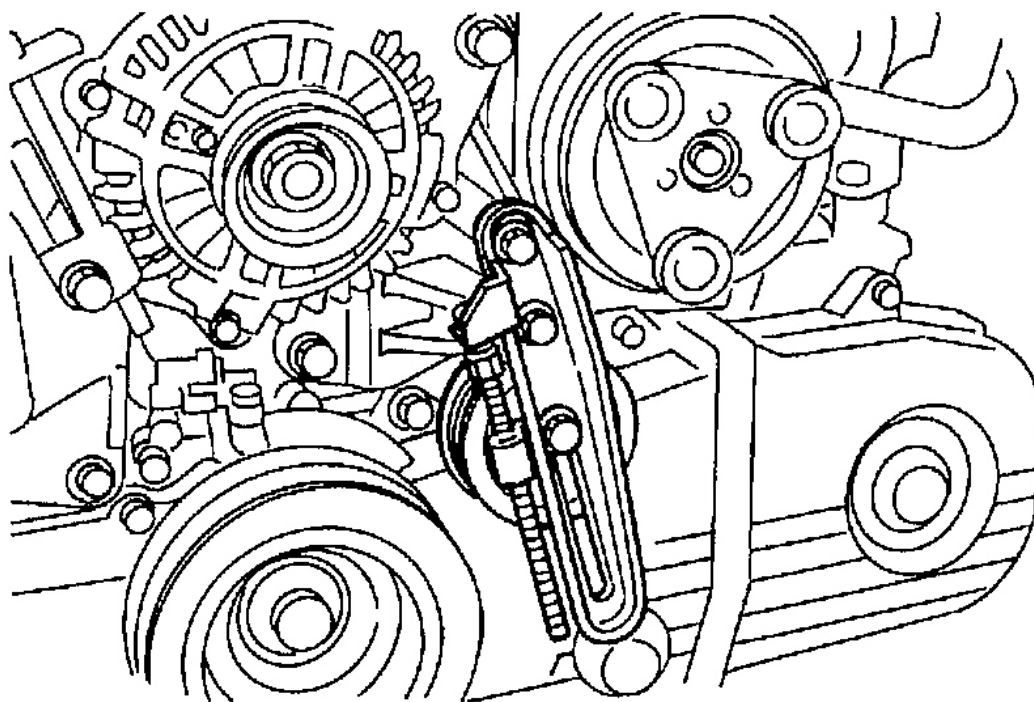
1. Loosen the lock nut (A).
2. Loosen the slider bolt (B).



G02960123

**Fig. 89: Loosening Lock Nut & Slider Bolt**  
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the A/C belt.
4. Remove the A/C belt tensioner.



G02960124

**Fig. 90: Removing A/C Belt Tensioner**  
Courtesy of SUBARU OF AMERICA, INC.

## INSTALLATION

### FRONT SIDE BELT

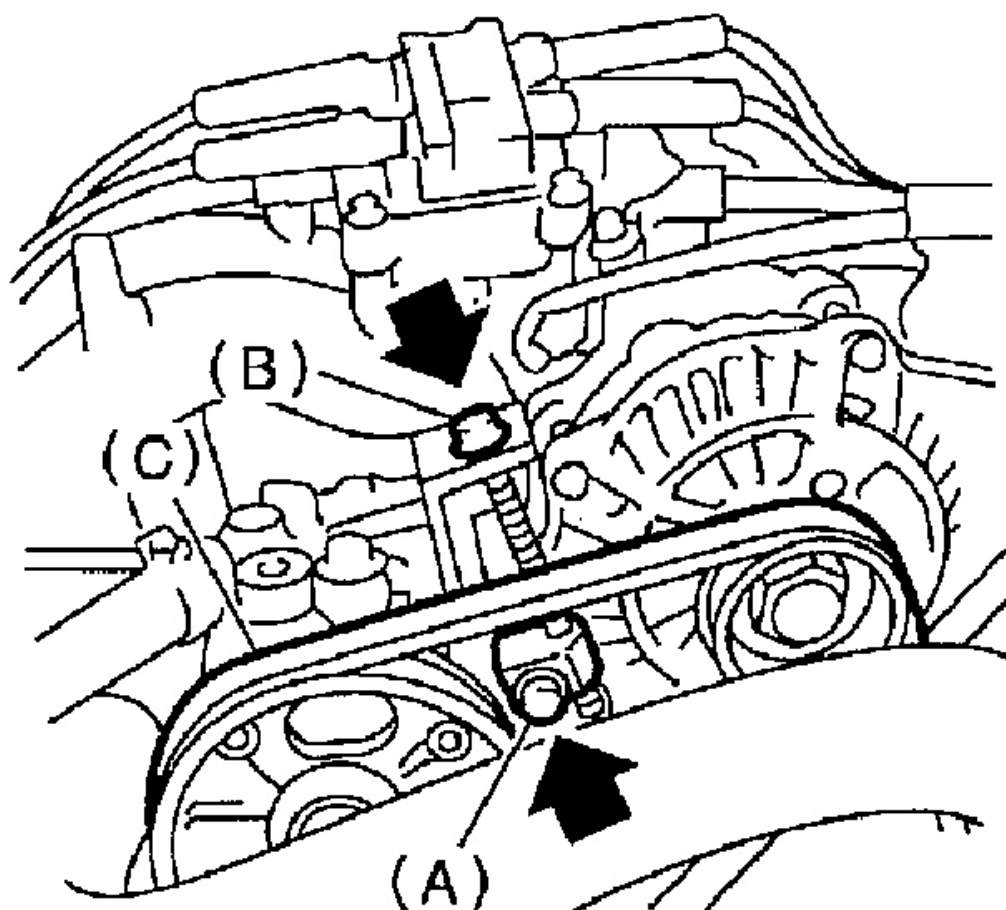
**CAUTION:** Wipe off any oil or water on the belt and pulley.

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

#### Tightening torque:

**Lock bolt through bolt:** 25 N.m (2.5 kgf-m, 18 ft-lb)

**Slider bolt:** 8 N.m (0.8 kgf-m, 5.8 ft-lb)



G02960125

**Fig. 91: Tightening Lock Bolt & Slider Bolt**  
Courtesy of SUBARU OF AMERICA, INC.

4. Install V-belt cover.

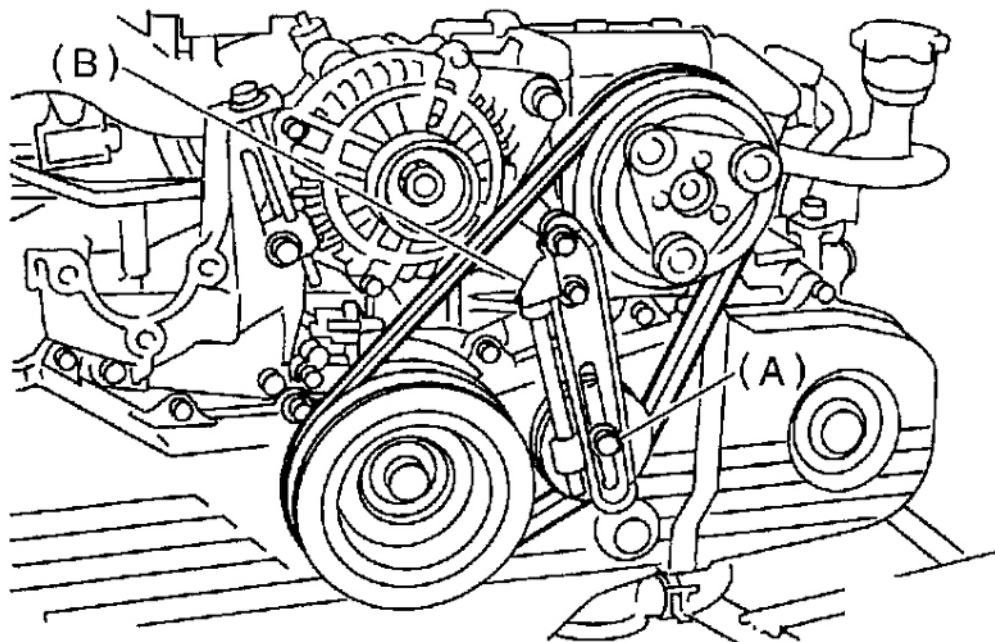
#### REAR SIDE BELT

1. Install a belt, and tighten the slider bolt (B) so as to obtain the specified belt tension. Refer to **INSPECTION**, V-belt.
2. Tighten the lock nut (A).

**Tightening torque:** 22.6 N.m (2.3 kgf-m, 16.6 ft-lb)



**Lock nut (A);**  
**22.6 N·m (2.3 kgf-m, 16.6 ft-lb)**

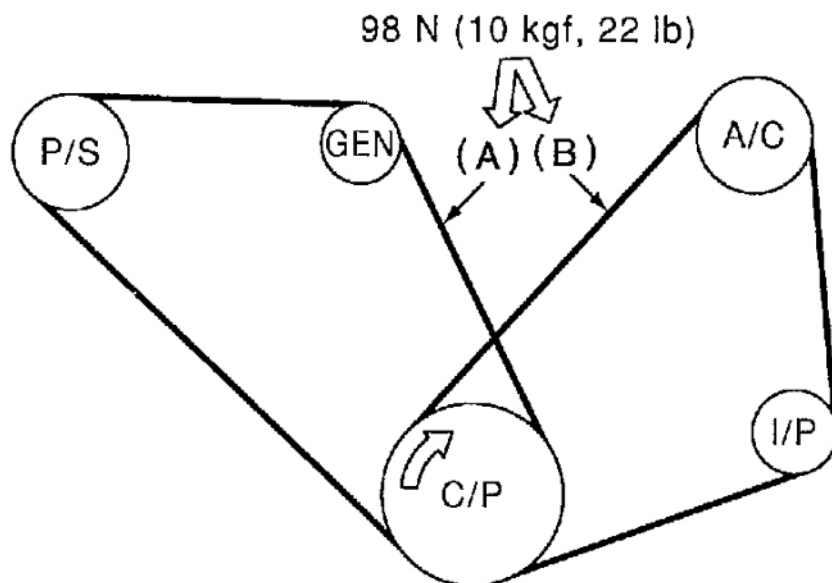


G02960126

**Fig. 92: Tightening Lock Nut**  
Courtesy of SUBARU OF AMERICA, INC.

## INSPECTION

1. Replace belts, if cracks, fraying or wear is found.
2. Check drive belt tension and adjust it if necessary by changing generator installing position and/or idler pulley installing position.

**(A)****replaced: 7 — 9 mm (0.276 — 0.354 in)****reused: 9 — 11 mm (0.354 — 0.433 in)****(B)\*****replaced: 7.5 — 8.5 mm (0.295 — 0.335****in)****reused: 9.0 — 10.0 mm (0.354 — 0.394 in)**

C/P Crankshaft pulley

GEN Generator

P/S Power steering oil pump pulley

A/C Air conditioning compressor pulley

I/P Idler pulley

G02960127

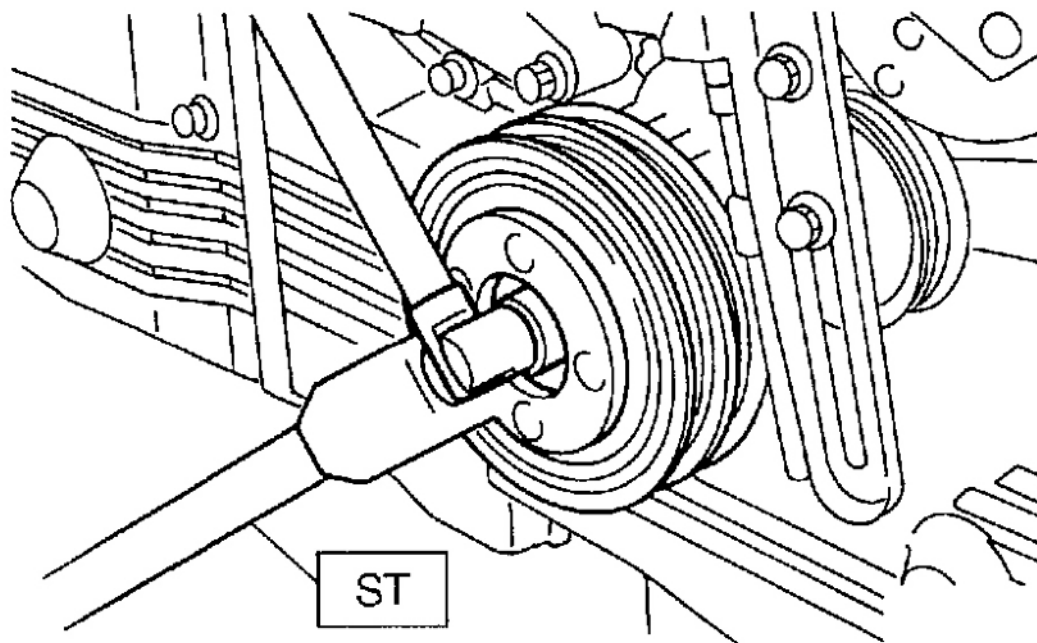
**Fig. 93: Checking Drive Belt Tension & Adjusting It**  
 Courtesy of SUBARU OF AMERICA, INC.

## CRANKSHAFT PULLEY

**REMOVAL**

1. Remove V-belt. Refer to **REMOVAL**, V-belt.
2. Remove crankshaft pulley bolt. To lock crankshaft, use ST.

ST 499977100 CRANKSHAFT PULLEY WRENCH



G02960128

**Fig. 94: Removing Crankshaft Pulley Bolt**  
Courtesy of SUBARU OF AMERICA, INC.

3. Remove crankshaft pulley.

**INSTALLATION**

1. Install crankshaft pulley.
2. Install pulley bolt.

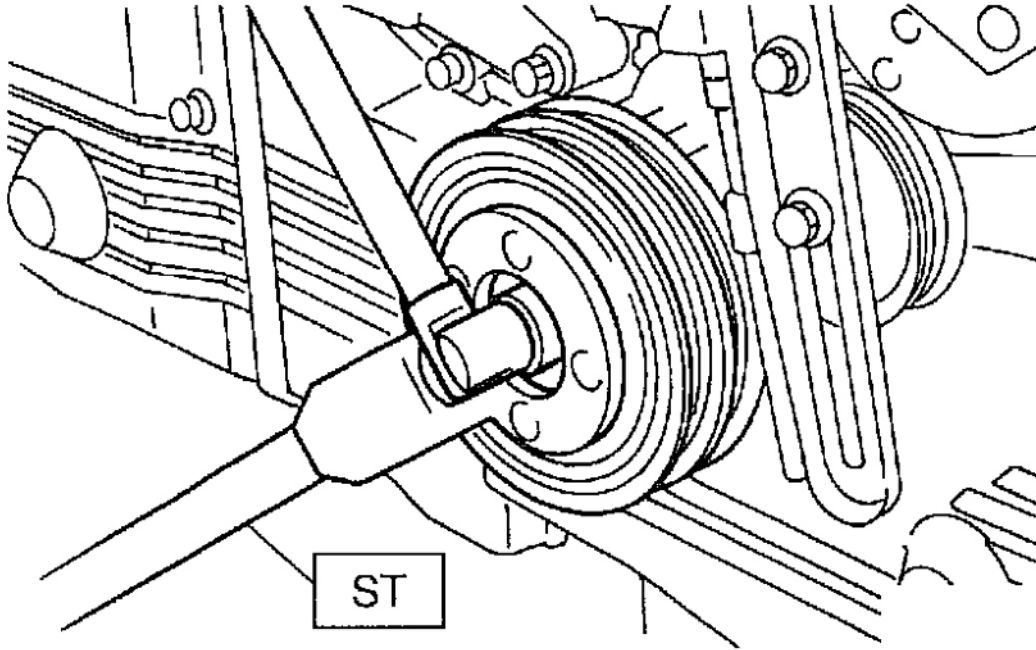
To lock crankshaft, use ST.

ST 499977100 CRANKSHAFT PULLEY WRENCH

1. Clean the crankshaft pulley thread using an air gun.

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

**Tightening torque:** 177 N.m (18.0 kgf-m, 130.2 ft-lb)



G02960129

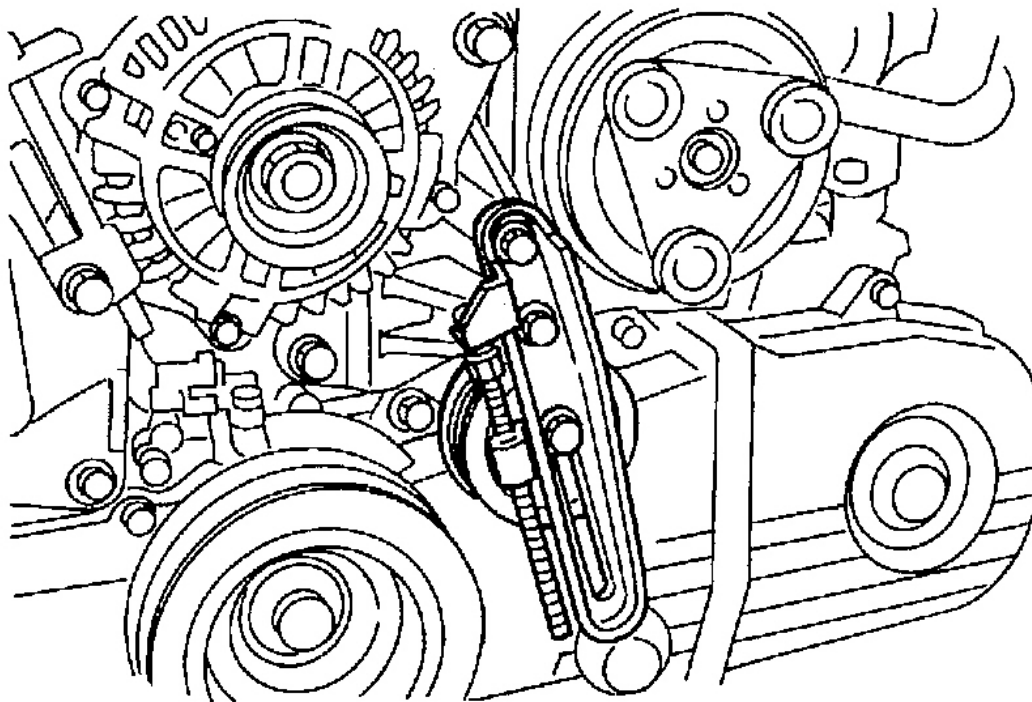
**Fig. 95: Tightening Crankshaft Pulley Bolt**  
Courtesy of SUBARU OF AMERICA, INC.

3. Confirm that the tightening angle of the crankshaft pulley bolt is 65 degrees or more. If not, conduct the following procedures (1) through (4).
  1. Replace the crankshaft pulley bolts and clean them.

**Crankshaft pulley bolt:** 12369AA011
  2. Clean the crankshaft thread using an air gun.
  3. Tighten the bolts temporarily with tightening torque of 44 N.m (4.5 kgf-m, 33 ft-lb).
  4. Tighten the crankshaft pulley bolts keeping them in an angle between 65 degrees and 75 degrees.

**CAUTION:** Conduct the tightening procedures by confirming the turning angle of the crankshaft pulley bolt referring to the gauge indicated on the belt cover.

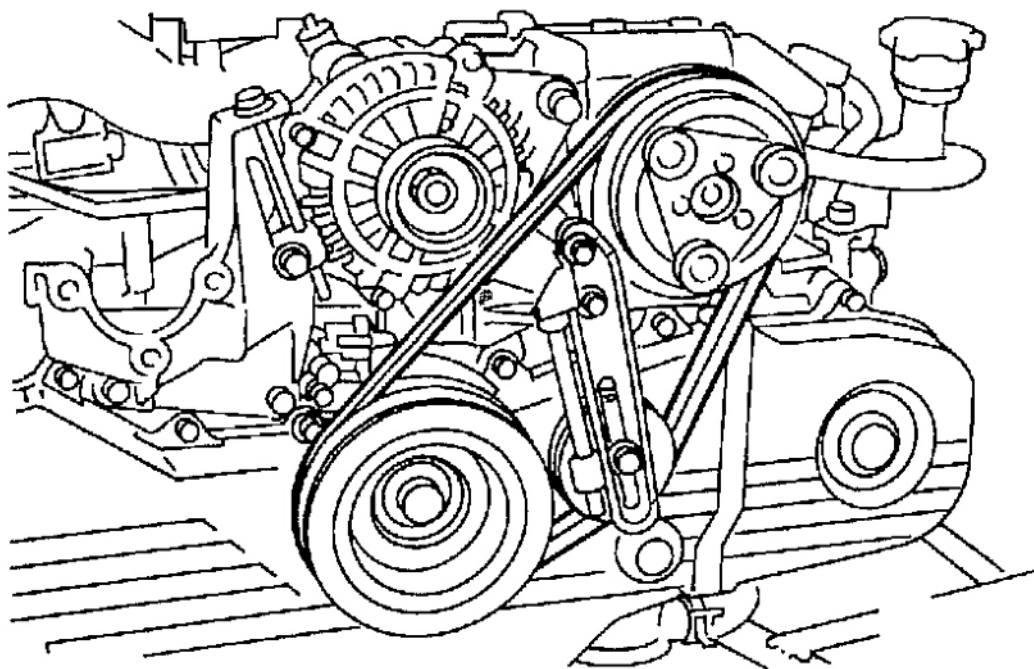
4. Install A/C belt tensioner.



G02960130

**Fig. 96: Installing A/C Belt Tensioner**  
Courtesy of SUBARU OF AMERICA, INC.

5. Install A/C belt.



G02960131

**Fig. 97: Installing A/C Belt**

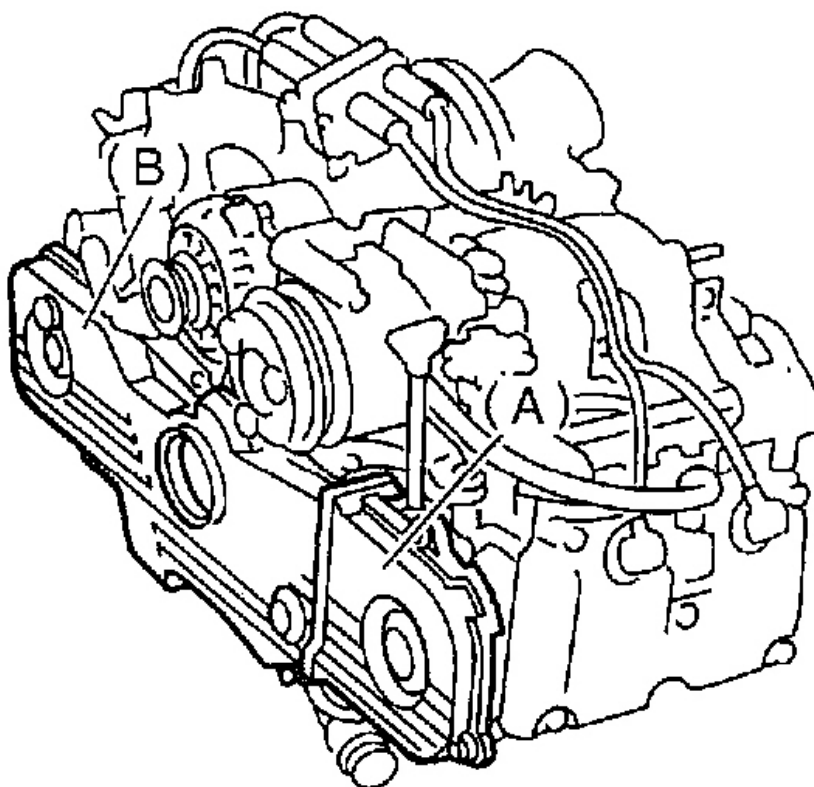
Courtesy of SUBARU OF AMERICA, INC.

**INSPECTION**

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

**BELT COVER****REMOVAL**

1. Remove V-belt. Refer to **REMOVAL**, V-belt.
2. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
3. Remove belt cover (LH).
4. Remove front belt cover.



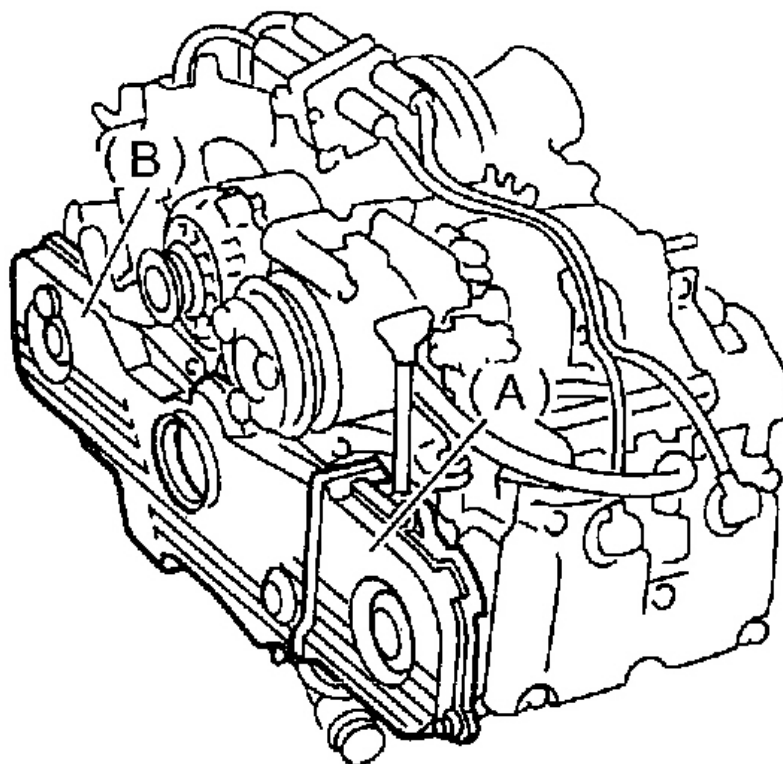
- (A) Belt cover (LH)
- (B) Front belt cover

G02960132

**Fig. 98: Removing Front Belt Cover**  
Courtesy of SUBARU OF AMERICA, INC.

#### INSTALLATION

1. Install front belt cover.  
**Tightening torque:** 5 N.m (0.5 kgf-m, 3.6 ft-lb)
2. Install belt cover (LH).  
**Tightening torque:** 5 N.m (0.5 kgf-m, 3.6 ft-lb)



(A) Belt cover (LH)

(B) Front belt cover

G02960133

**Fig. 99: Installing Front Belt Cover (LH)**  
Courtesy of SUBARU OF AMERICA, INC.

3. Install crankshaft pulley. Refer to **INSTALLATION**, Crankshaft Pulley.
4. Install V-belt. Refer to **INSTALLATION**, V-belt.

## INSPECTION

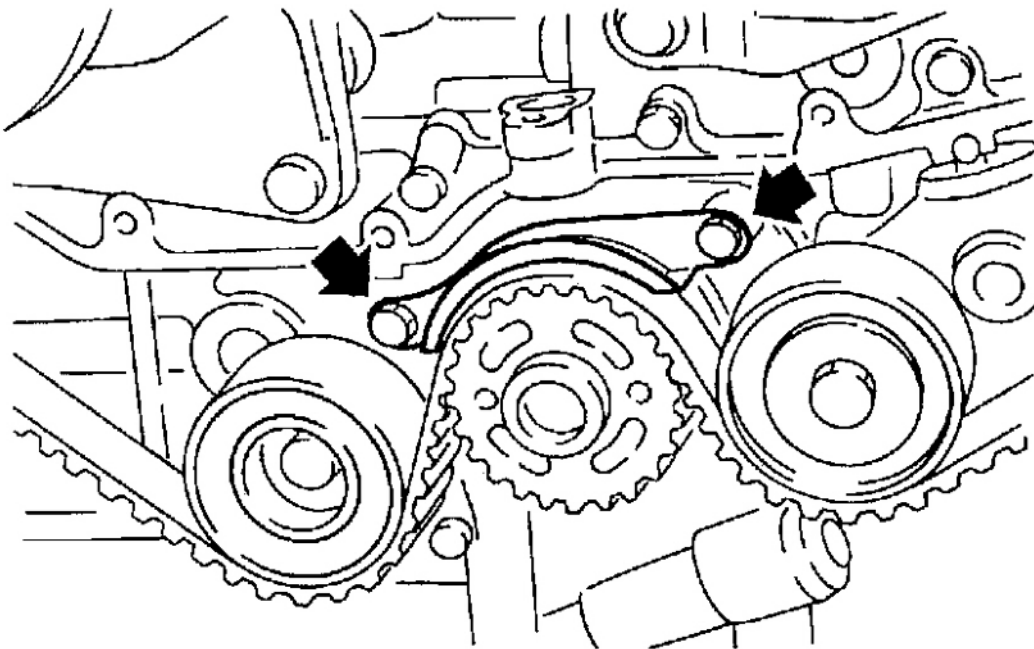
Make sure the cover is not damaged.

## TIMING BELT ASSEMBLY



**REMOVAL****TIMING BELT**

1. Remove V-belt. Refer to **REMOVAL**, V-belt.
2. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
3. Remove belt cover. Refer to **REMOVAL**, Belt Cover.
4. Remove timing belt guide. (MT vehicle only)

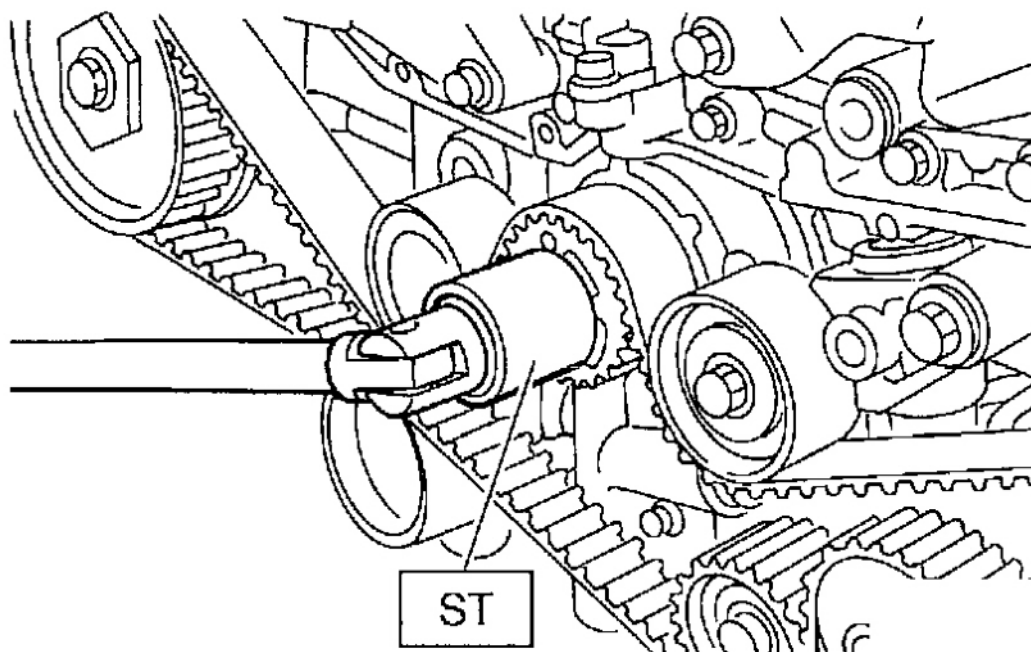


G02960134

**Fig. 100: Removing Timing Belt Guide (MT Vehicle Only)**  
**Courtesy of SUBARU OF AMERICA, INC.**

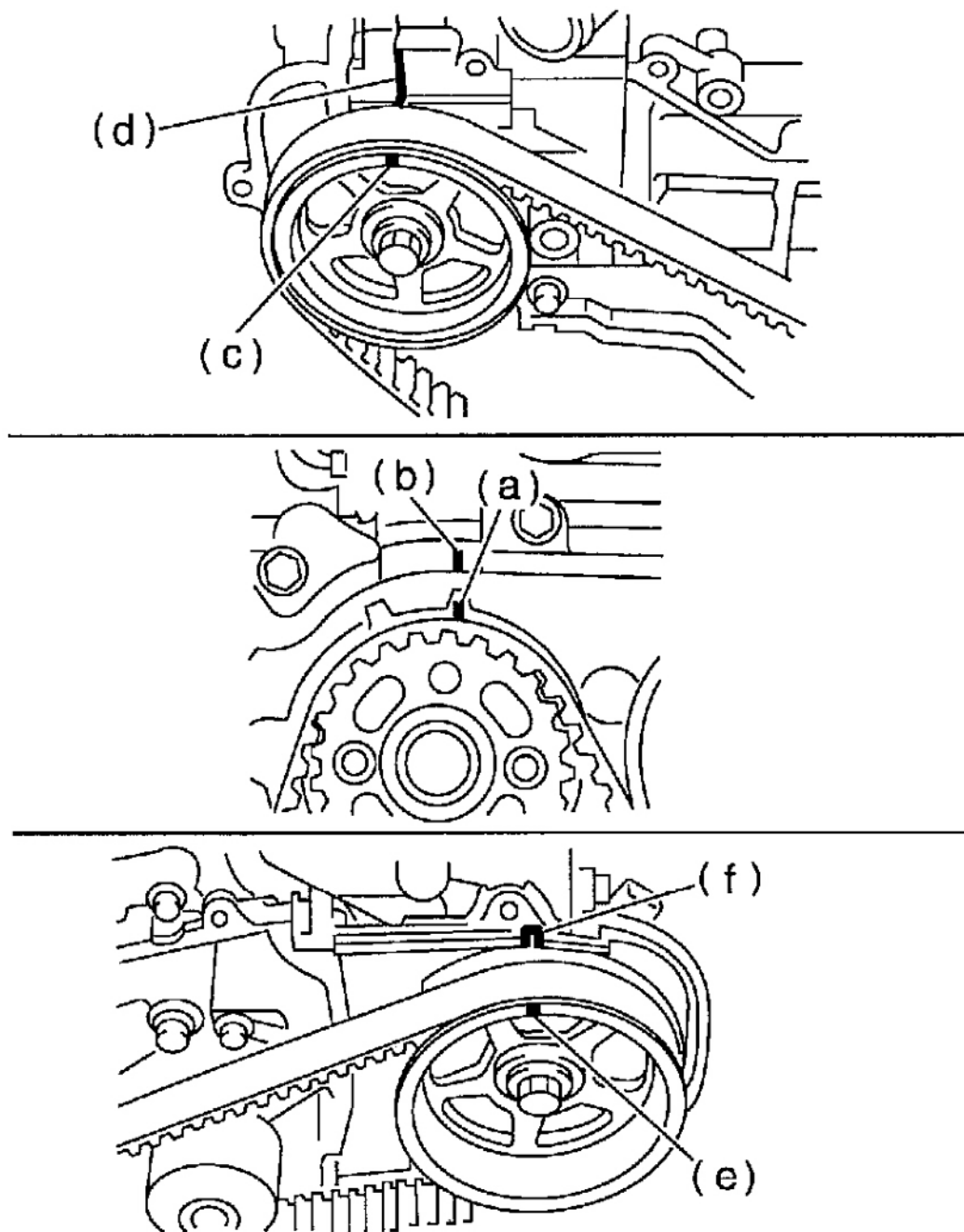
5. If alignment mark (a) and/or arrow mark (which indicates rotation direction) on timing belt fade away, put new marks before removing timing belt as shown in procedures below.
  1. Turn crankshaft using ST. Align mark (a) of sprocket to cylinder block notch (b) and ensure that right side cam sprocket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

ST 499987500 CRANKSHAFT SOCKET



G02960135

**Fig. 101: Turning Camshaft Using ST**  
Courtesy of SUBARU OF AMERICA, INC.

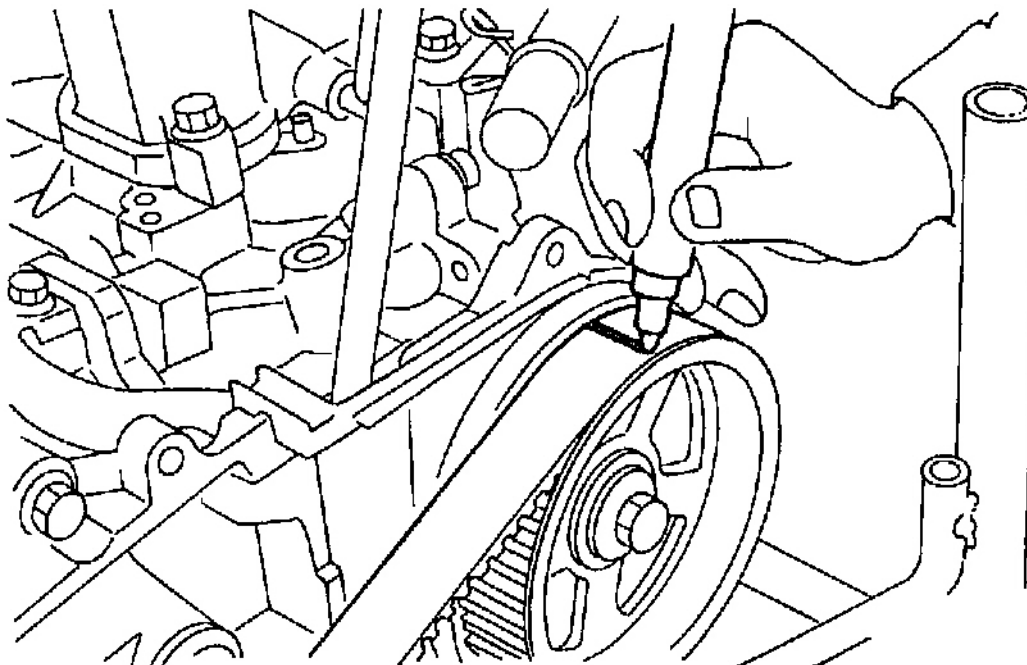


G02960136

**Fig. 102: Adjusting Aligning Mark Of Sprocket To Cylinder Block Notch**  
Courtesy of SUBARU OF AMERICA, INC.

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

sprocket and cam sprockets.



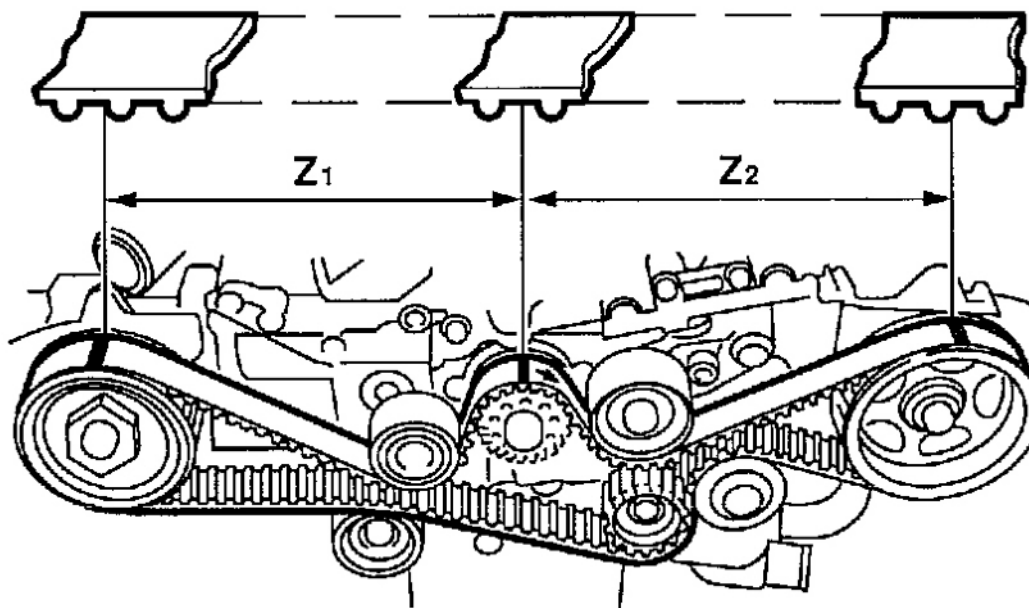
G02960137

**Fig. 103: Putting Alignment And/Or Arrow Marks On Timing Belts**  
Courtesy of SUBARU OF AMERICA, INC.

**Specified data:**

$Z_1$  : 46.8 tooth length

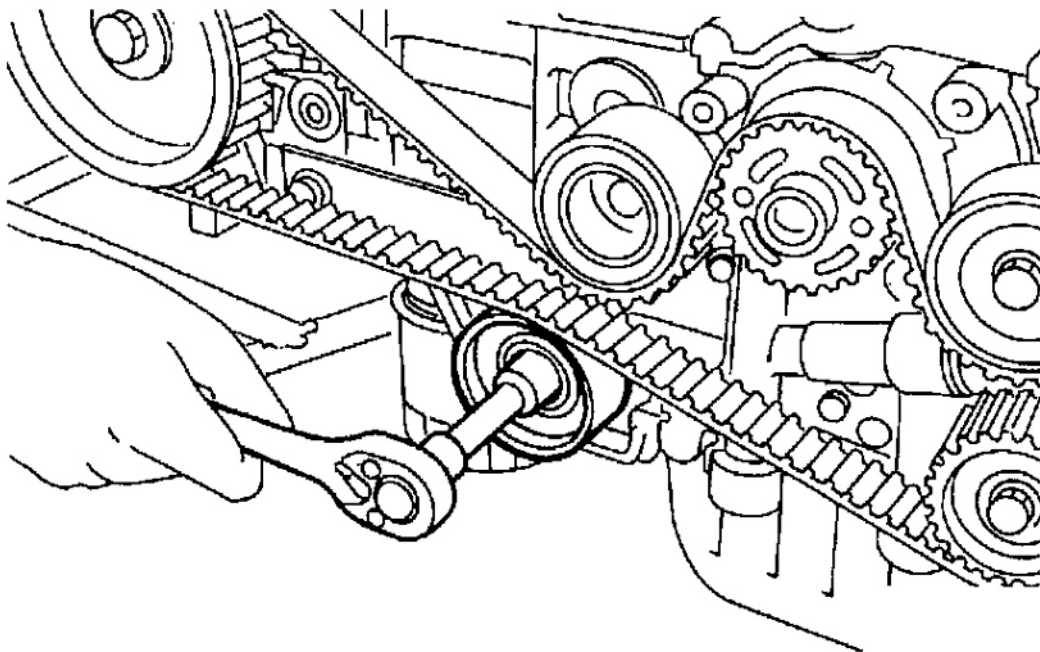
$Z_2$  : 43.7 tooth



G02960138

**Fig. 104: Identifying Tooth Length**  
Courtesy of SUBARU OF AMERICA, INC.

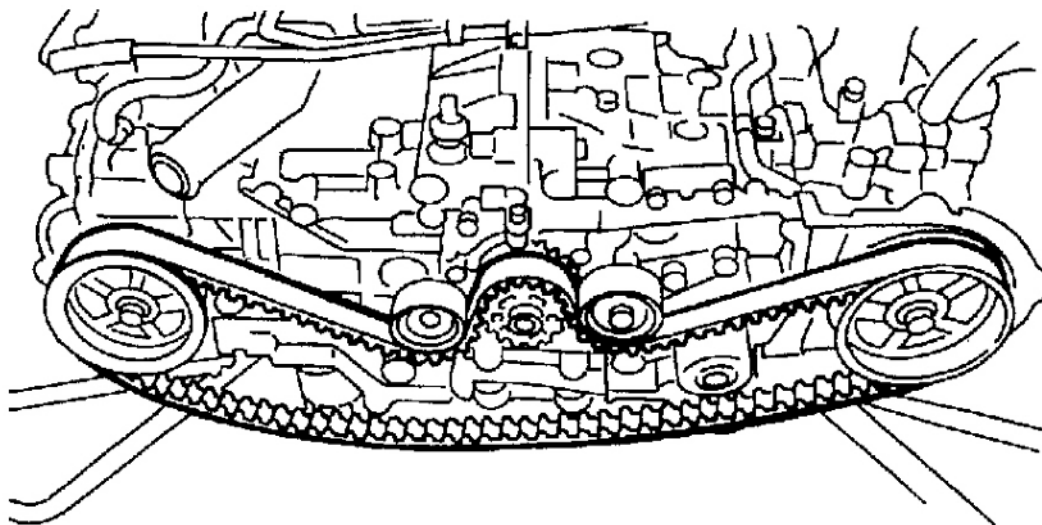
6. Remove belt idler (No. 2).
7. Remove belt idler No. 2.



G02960139

**Fig. 105: Removing Belt Idler No. 2**  
**Courtesy of SUBARU OF AMERICA, INC.**

8. Remove timing belt.

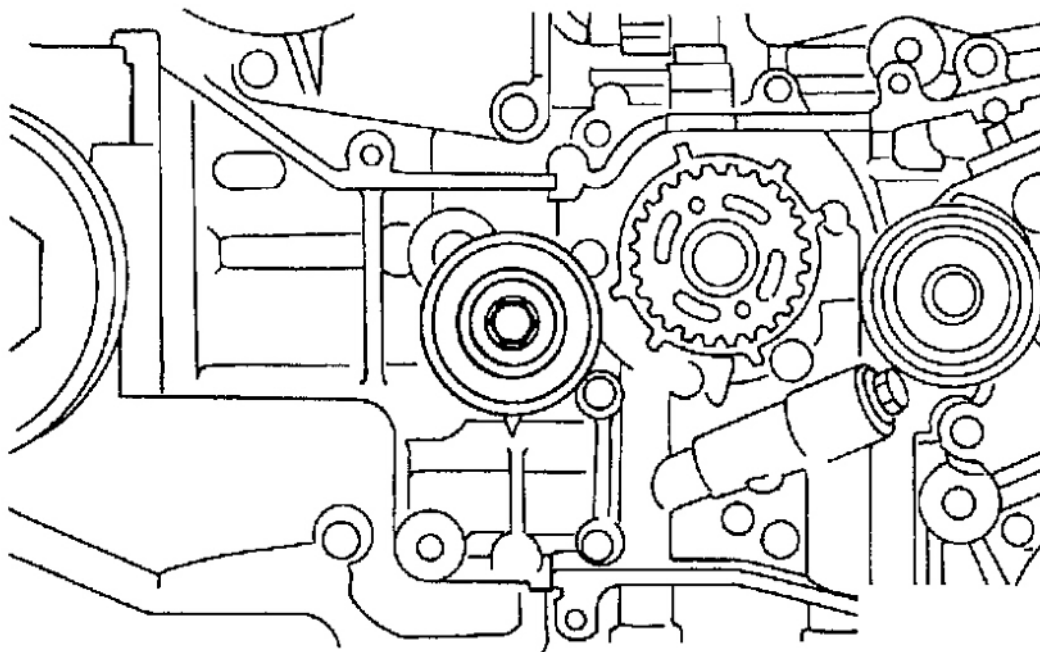


G02960140

**Fig. 106: Removing Timing Belt**  
Courtesy of SUBARU OF AMERICA, INC.

**BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY**

1. Remove belt idler (No. 1).



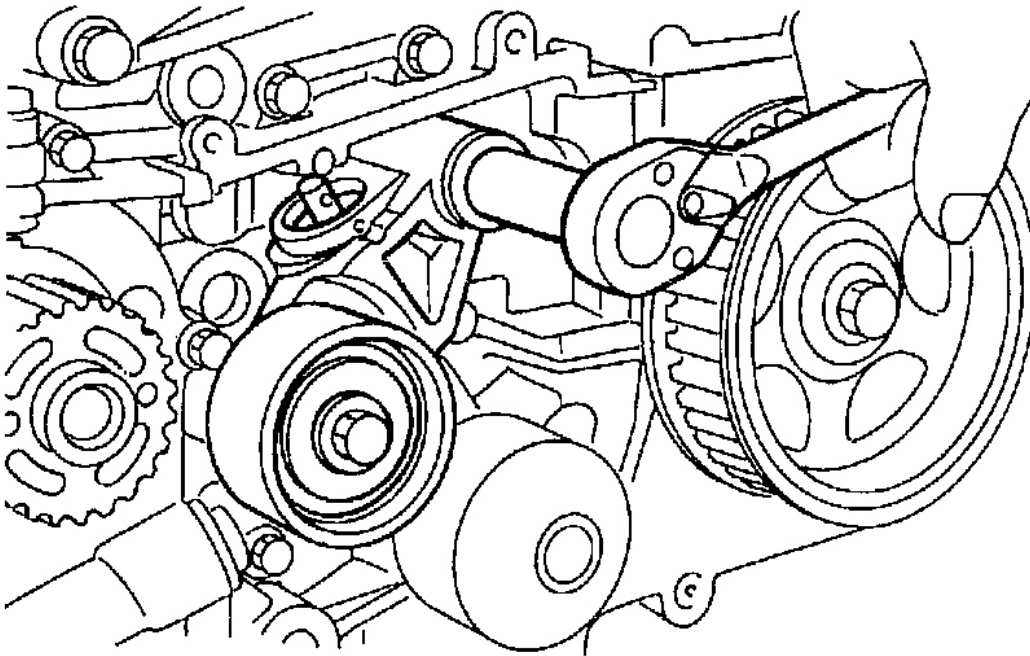
G02960141

**Fig. 107: Removing Belt Idler No. 1**

Courtesy of SUBARU OF AMERICA, INC.

2. Remove automatic belt tension adjuster assembly.





G02960142

**Fig. 108: 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;

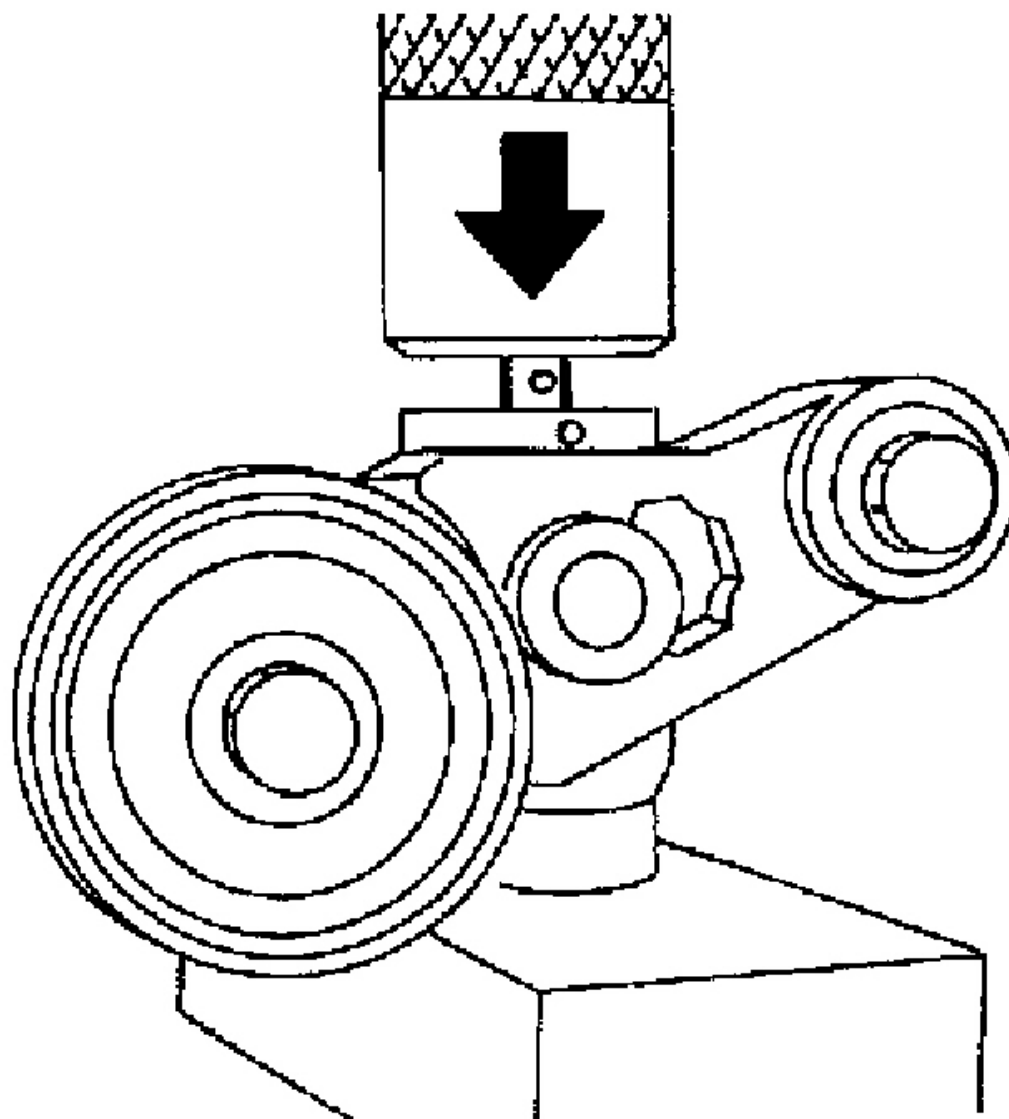
**CAUTION:**

- Always use a vertical type pressing tool to move the adjuster rod down.
- Do not use a lateral type vise.
- Push adjuster rod vertically.
- Be sure to slowly move the adjuster rod down applying a pressure of 294 H (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 the cylinder. Doing so may damage the cylinder.**

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

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

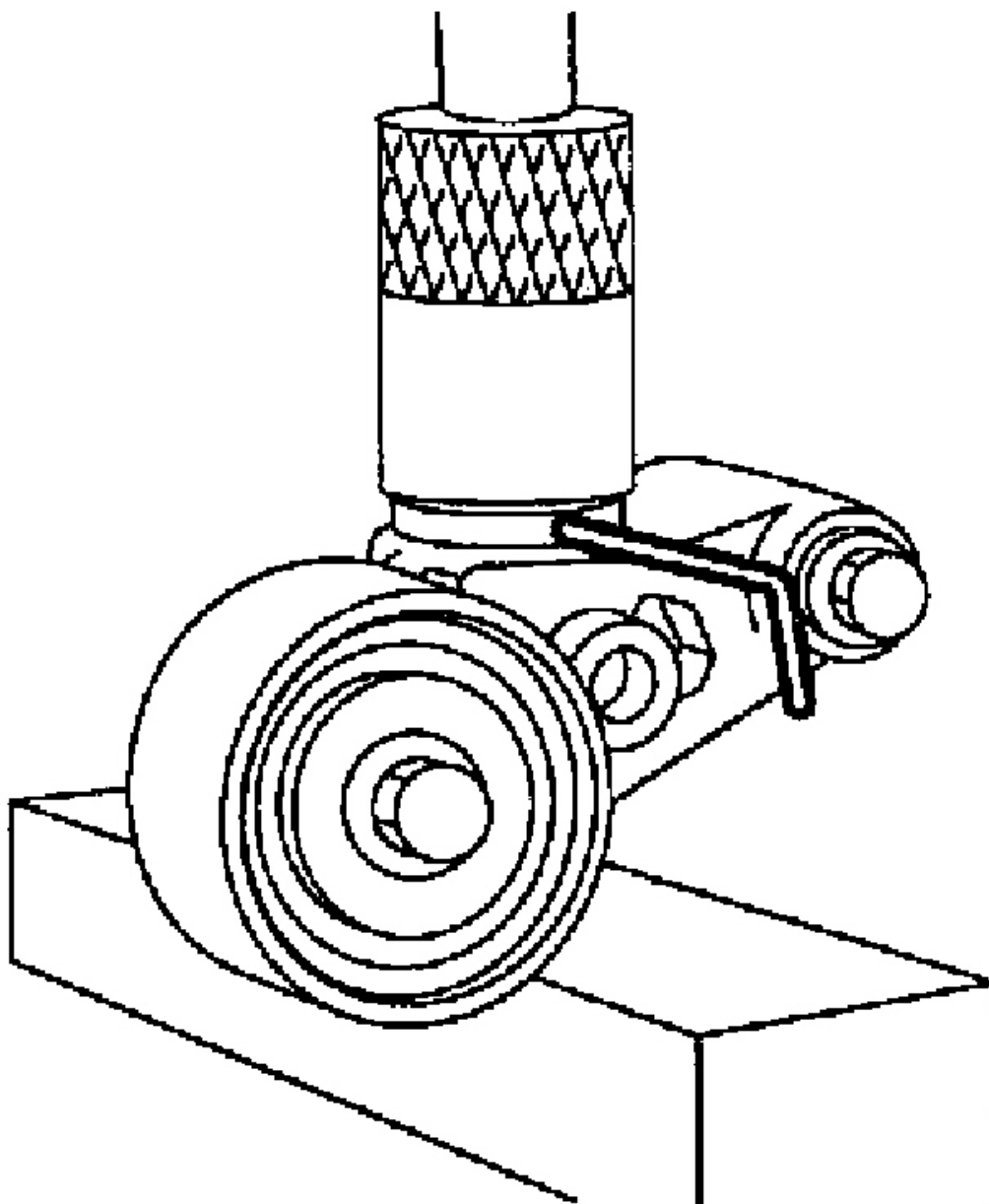


G02960143

**Fig. 109: Aligning Adjuster Rod Down Until Adjuster Is Aligned With Stopper Pin Hole In Cylinder**

Courtesy of SUBARU OF AMERICA, INC.

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

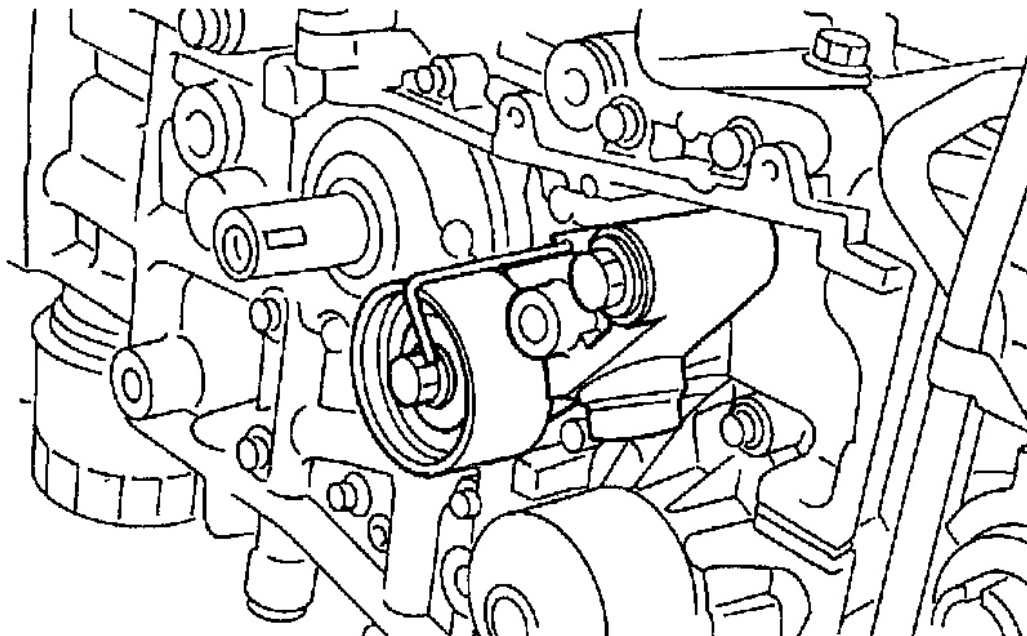


G02960144

**Fig. 110: Inserting Hex Bar Wrench Into Stopper Pin Hole**  
Courtesy of SUBARU OF AMERICA, INC.

2. Install automatic belt tension adjuster assembly.

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

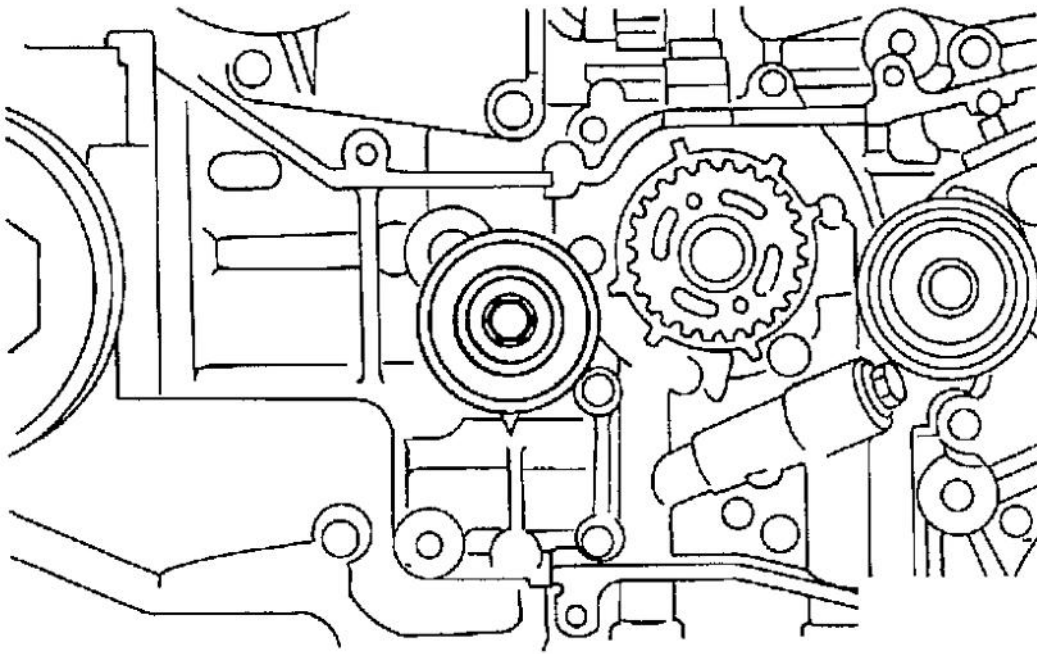


G02960145

**Fig. 111: Installing Automatic Belt Tension Adjuster Assembly**  
Courtesy of SUBARU OF AMERICA, INC.

3. Install belt idler (No. 1).

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



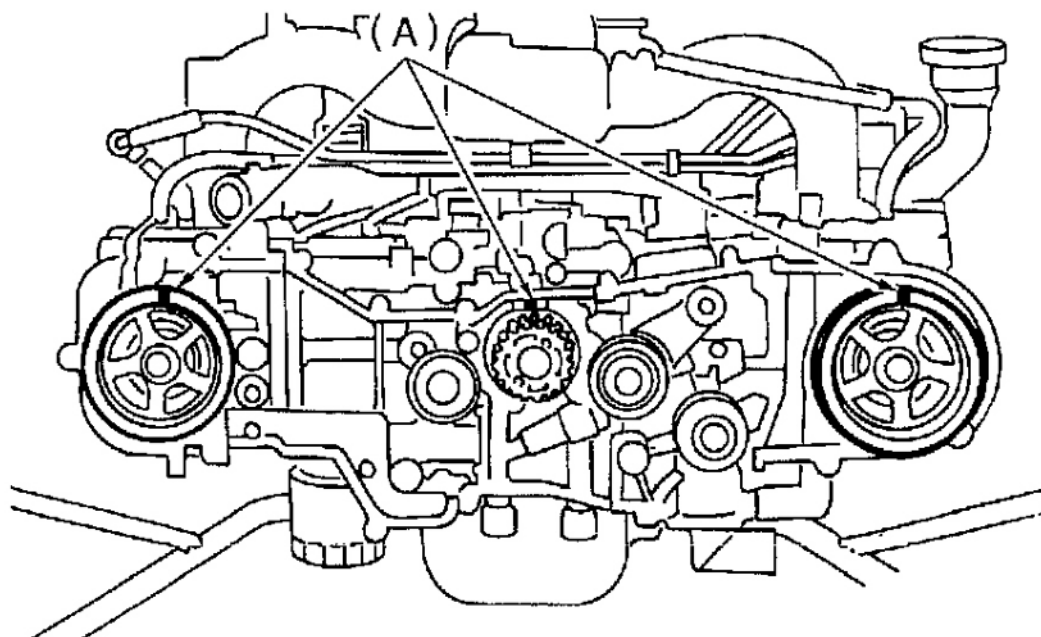
G02960146

**Fig. 112: Installing Belt Idler (No. 1)**  
Courtesy of SUBARU OF AMERICA, INC.

#### TIMING BELT

1. Preparation for installation of automatic belt tension adjuster assembly. Refer to **AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER**, INSTALLATION, Timing Belt Assembly.
2. Installation of timing belt
  1. Turn camshaft sprocket No. 2 using ST1, and turn camshaft sprocket No. 1 using ST2 so that their alignment marks (A) come to top positions.

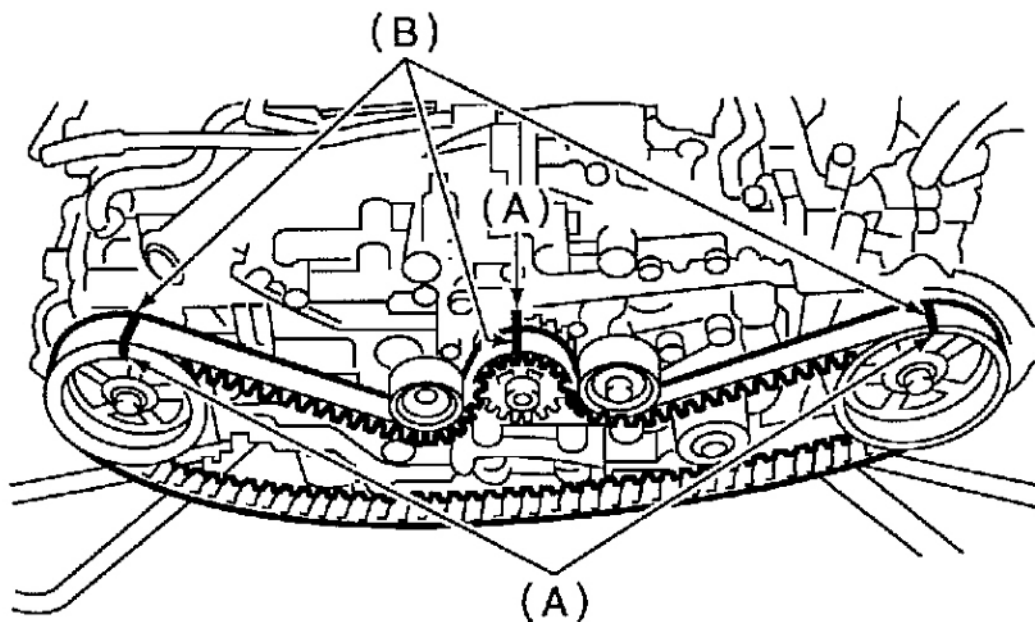
ST1 499207100 CAMSHAFT SPROCKET WRENCH



**Fig. 113: Turning Camshaft Sprockets Using ST**  
Courtesy of SUBARU OF AMERICA, INC.

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

**CAUTION: Ensure belt's rotating direction is correct.**



G02960148

**Fig. 114: Aligning Alignment Mark On Timing Belt With Marks On Sprockets**  
Courtesy of SUBARU OF AMERICA, INC.

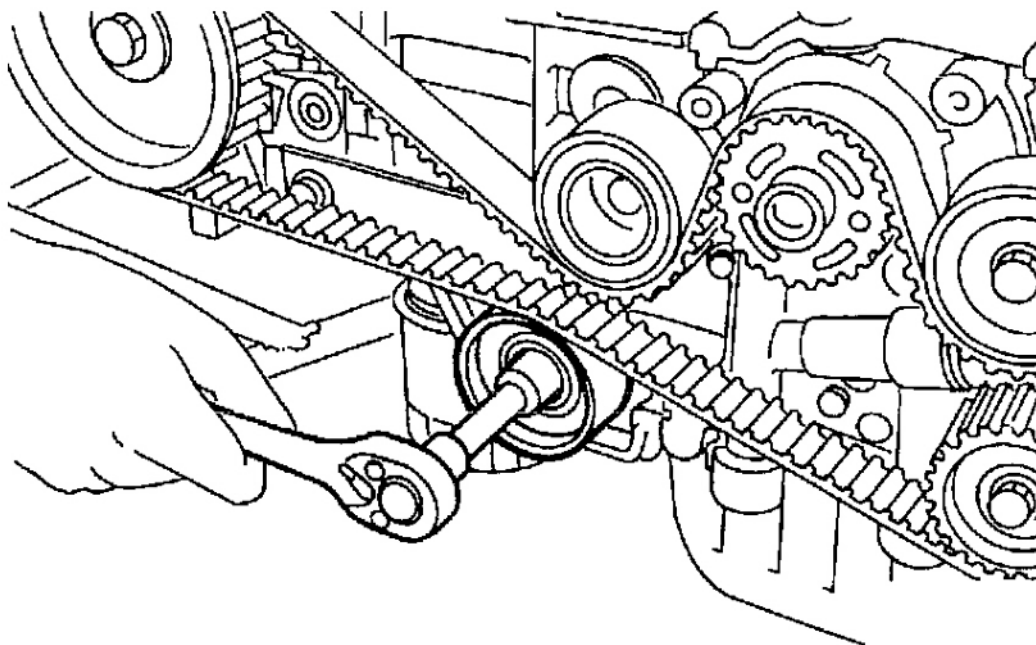
3. Install belt idler No. 2.

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

4. Install belt idler (No. 2).

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



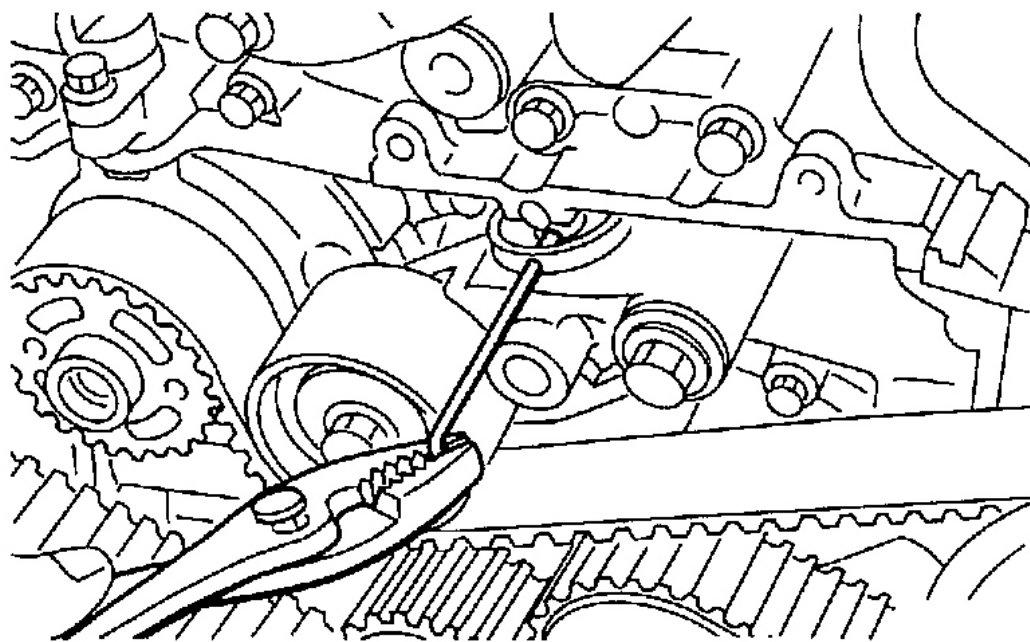


G02960149

**Fig. 115: Installing Belt Idler (No. 2)**  
Courtesy of SUBARU OF AMERICA, INC.

5. After ensuring that the marks on timing belt and camshaft sprockets are aligned, remove stopper pin from belt tensioner adjuster.

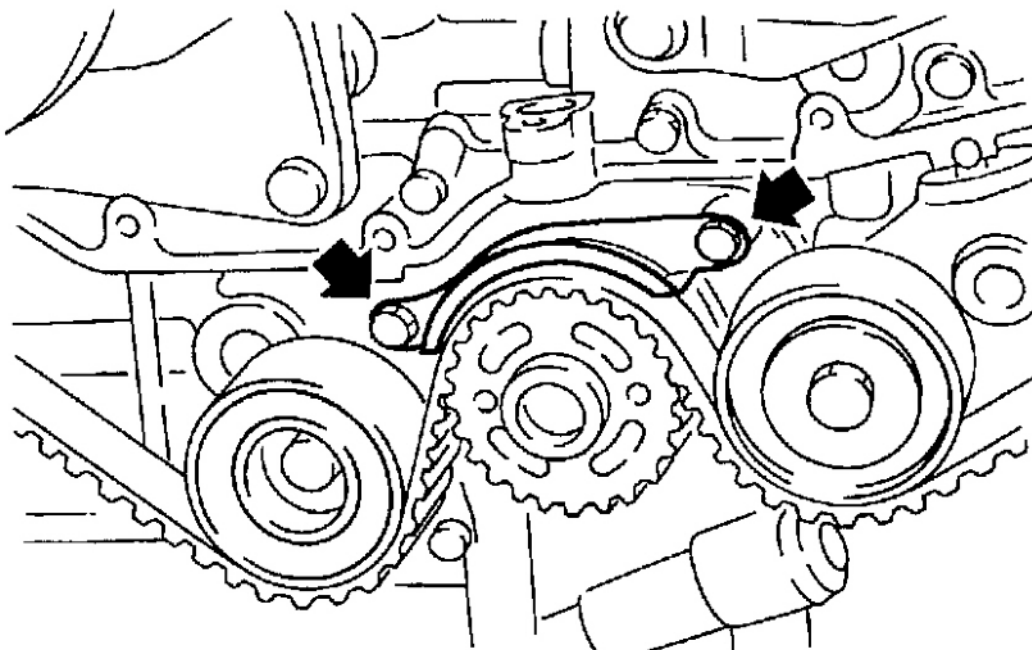
**CAUTION:** After properly installing timing belt, remove rocker cover and ensure that the valve lash adjuster contains no air.



G02960150

**Fig. 116: Removing Stopper Pin From Belt Tensioner Adjuster**  
Courtesy of SUBARU OF AMERICA, INC.

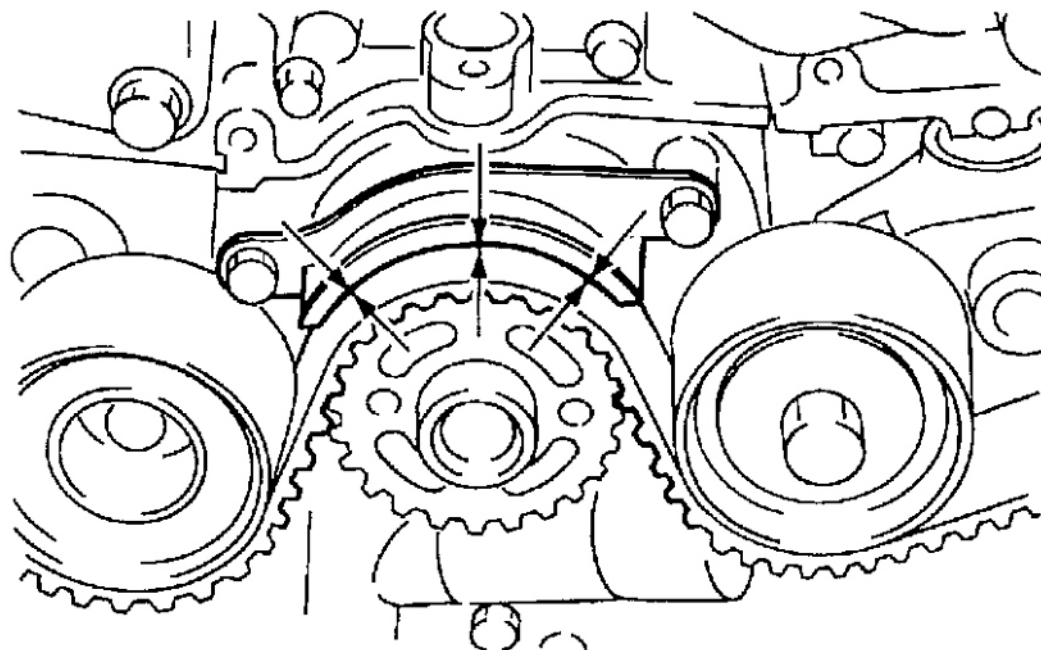
6. Install timing belt guide. (MT vehicles only)
  1. Temporarily tighten remaining bolts.



G02960151

**Fig. 117: Temporarily Tightening Remaining Bolts**  
Courtesy of SUBARU OF AMERICA, INC.

2. Check and adjust clearance between timing belt and timing belt guide by using thickness gauge.  
**Clearance:** 1.0+/-0.5 mm (0.039+/-0.020 in)

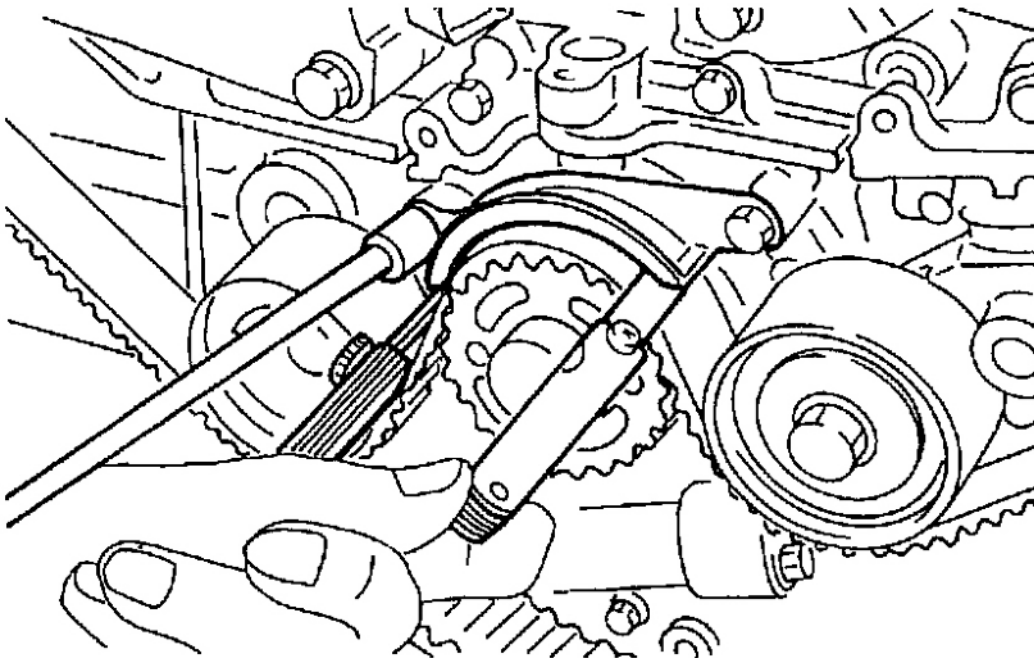


G02960152

**Fig. 118: Checking & Adjusting Clearance Between Timing Belt & Timing Belt Guide**  
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten remaining bolts.

**Tightening torque:** 9.8 N.m (1.0 kgf-m, 7.2 ft-lb)



G02960153

**Fig. 119: Tightening Remaining Bolts**  
Courtesy of SUBARU OF AMERICA, INC.

7. Install belt cover. Refer to **INSTALLATION**, Belt Cover.
8. Install crankshaft pulley. Refer to **INSTALLATION**, Crankshaft Pulley.
9. Install V-belt. Refer to **INSTALLATION**, V-belt.

## INSPECTION

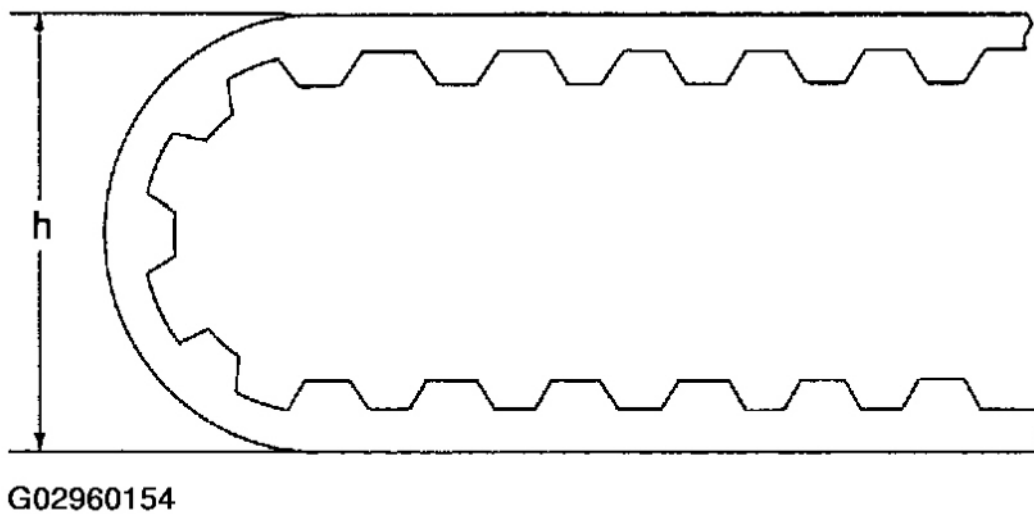
### TIMING BELT

1. Check timing belt teeth for breaks, cracks, and wear. If any fault is found, replace belt.
2. Check the condition of back side of belt; if any crack is found, replace 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 belt sharply.

**Bending radius:** h 60 mm (2.36 in) or more



**Fig. 120: Bending Radius "h"**

Courtesy of SUBARU OF AMERICA, INC.

#### AUTOMATIC BELT TENSION ADJUSTER

1. Visually check oil seals for leaks, and rod ends for abnormal wear or scratches. If necessary, replace faulty parts.

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

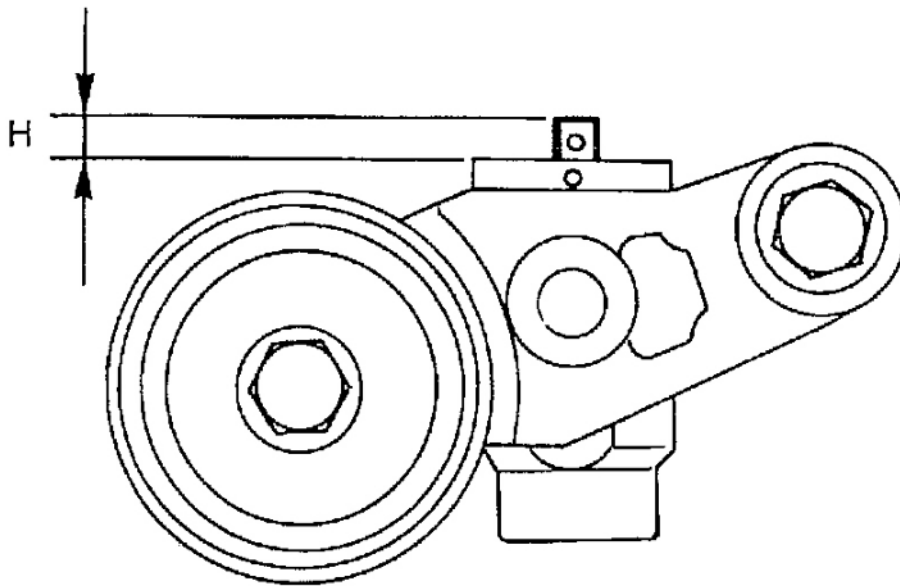
2. Check that the adjuster rod does not move when a pressure of 294 N (30 kgf, 66 lb) is applied to it. This is to check adjuster rod stiffness.
3. If the adjuster rod is not stiff and moves freely when applying 294 N (30 kgf, 66 lb), check it using the following procedures:
  1. Slowly press the adjuster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

**CAUTION:**

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

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

**Rod extension:  $H$**   
 **$5.7 \pm 0.5$  mm ( $0.224 \pm 0.020$  in)**



G02960155

**Fig. 121: Measuring Extension Of Rod Beyond Body**  
Courtesy of SUBARU OF AMERICA, INC.

#### BELT TENSION PULLEY

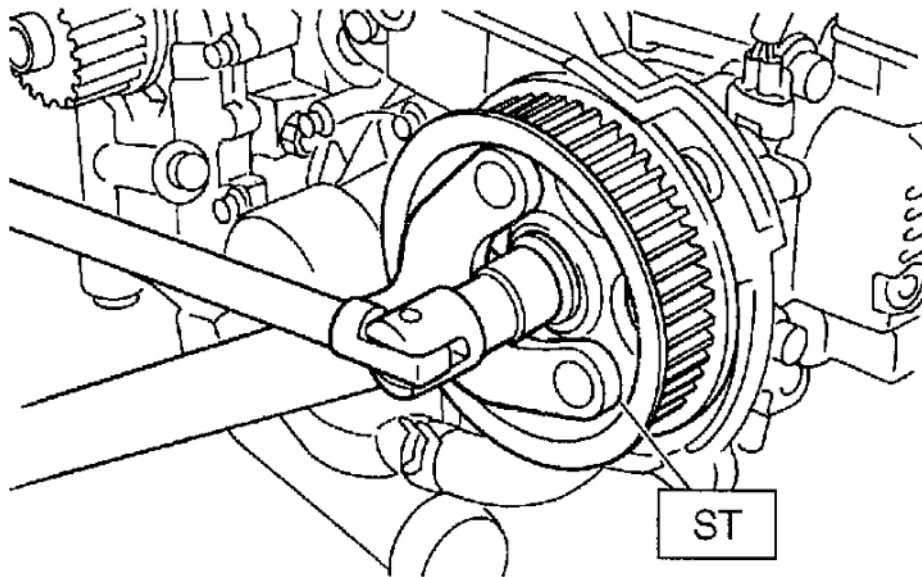
1. Check mating surfaces of timing belt and contact point of adjuster rod for abnormal wear or scratches. Replace automatic belt tensioner assembly if faulty.
2. Check tension pulley for smooth rotation. Replace if noise or excessive play is noted.
3. Check tension pulley for grease leakage.

**BELT IDLER**

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

**CAMSHAFT SPROCKET****REMOVAL**

1. Remove V-belt. Refer to **REMOVAL**, V-belt.
2. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
3. Remove belt cover. Refer to **REMOVAL**, Belt Cover.
4. Remove timing belt assembly. Refer to **REMOVAL**, Timing Belt Assembly.
5. Remove camshaft sprocket No. 1 and No. 2. To lock camshaft, use ST.

**ST 499207100 CAMSHAFT SPROCKET  
WRENCH**

G02960156

**Fig. 122: Removing Camshaft Sprocket**  
Courtesy of SUBARU OF AMERICA, INC.



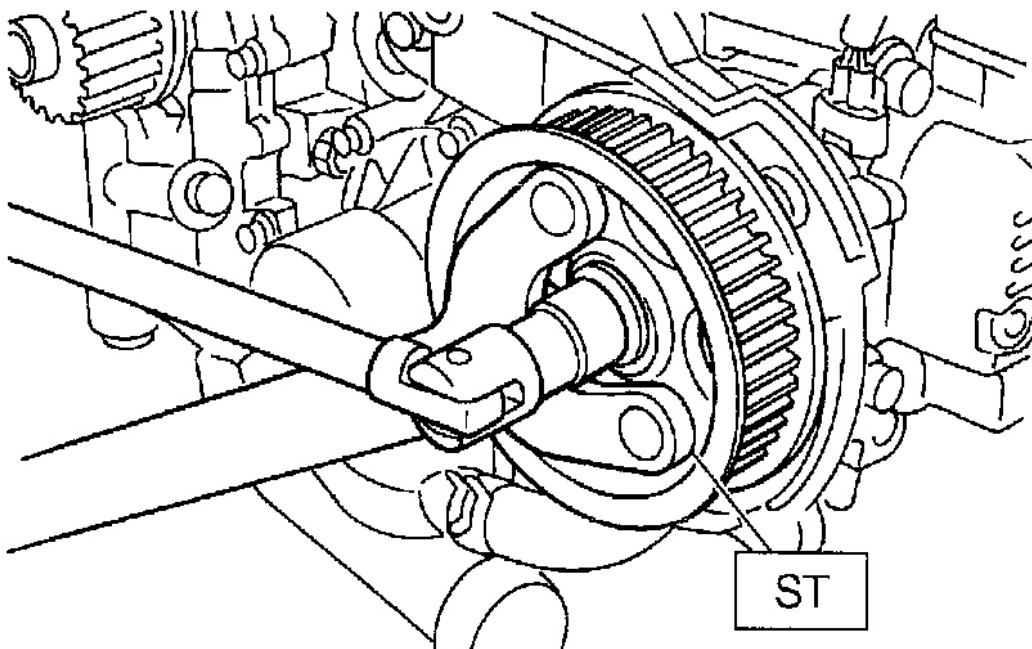
## INSTALLATION

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

ST 499207100 CAMSHAFT SPROCKET WRENCH

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

**CAUTION:** Do not confuse left and right side camshaft sprockets during installation. The camshaft sprocket No. 2 is identified by a projection used to monitor camshaft position sensor.



G02960157

**Fig. 123: Installing Camshaft Sprocket**  
Courtesy of SUBARU OF AMERICA, INC.

2. Install timing belt assembly. Refer to **INSTALLATION**, Timing Belt Assembly.
3. Install belt cover. Refer to **INSTALLATION**, Belt Cover.
4. Install crankshaft pulley. Refer to **INSTALLATION**, Crankshaft Pulley.
5. Install V-belt. Refer to **INSTALLATION**, V-belt.

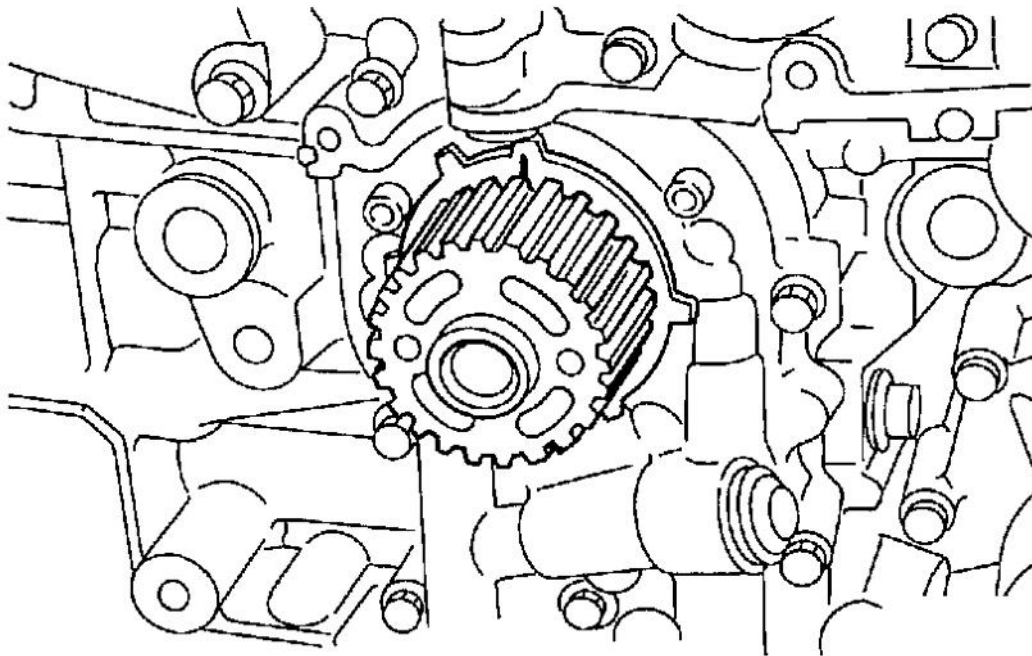
## INSPECTION

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

## CRANKSHAFT SPROCKET

### REMOVAL

1. Remove V-belt. Refer to **REMOVAL**, V-belt.
2. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
3. Remove belt cover. Refer to **REMOVAL**, Belt Cover.
4. Remove timing belt assembly. Refer to **REMOVAL**, Timing Belt Assembly.
5. Remove camshaft sprocket. Refer to **REMOVAL**, Camshaft Sprockets.
6. Remove crankshaft sprocket.

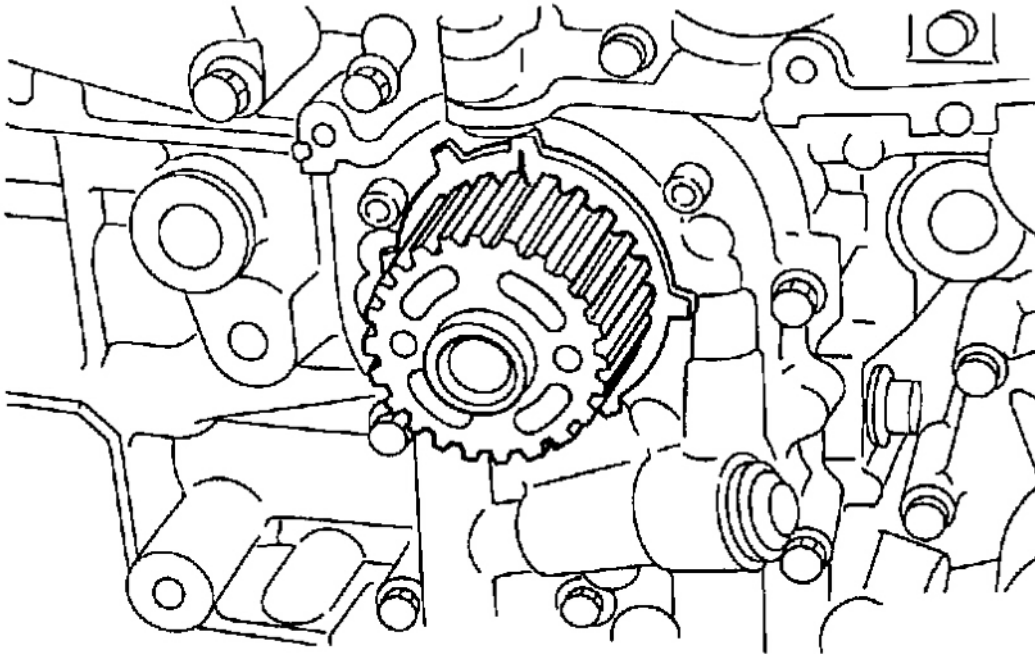


G02960158

**Fig. 124: Removing Crankshaft Sprocket**  
Courtesy of SUBARU OF AMERICA, INC.

### INSTALLATION

1. Install crankshaft sprocket.



G02960159

**Fig. 125: Installing Crankshaft Sprocket**  
Courtesy of SUBARU OF AMERICA, INC.

2. Install camshaft sprocket. Refer to **INSTALLATION**, Camshaft Sprockets.
3. Install timing belt assembly. Refer to **INSTALLATION**, Timing Belt Assembly.
4. Install belt cover. Refer to **INSTALLATION**, Belt Cover.
5. Install crankshaft pulley. Refer to **INSTALLATION**, Camshaft Pulley.
6. Install V-belt. Refer to **INSTALLATION**, V-belt.

## INSPECTION

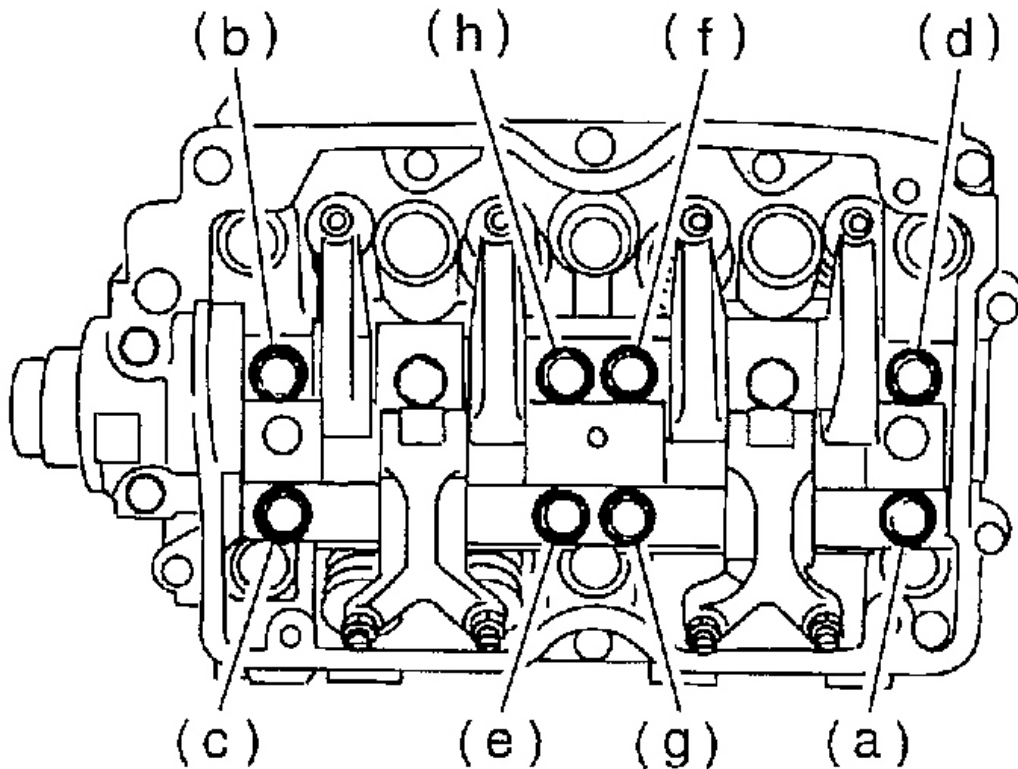
1. Check sprocket teeth for abnormal wear and scratches.
2. Make sure there is no free play between sprocket and key.
3. Check crankshaft sprocket notch for sensor for damage and contamination of foreign matter.

## VALVE ROCKER ASSEMBLY

### REMOVAL

1. Remove V-belt. Refer to **REMOVAL**, V-belt.
2. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
3. Remove belt cover. Refer to **REMOVAL**, Belt Cover.
4. Remove timing belt assembly. Refer to **REMOVAL**, Timing Belt Assembly.
5. Remove camshaft sprocket. Refer to **REMOVAL**, Camshaft Sprockets.
6. Disconnect PCV hose and remove rocker cover.
7. Removal of valve rocker assembly
  1. Remove bolts (a) through (h) in alphabetical sequence.

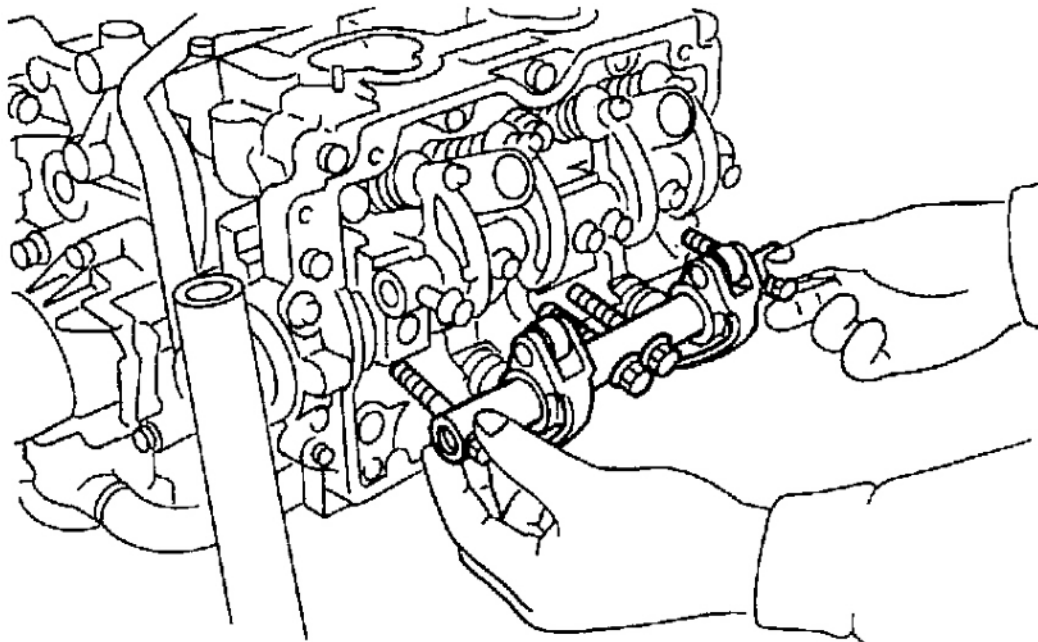
**CAUTION:** Leave two or three threads of bolts (g and h) engaged to retain valve rocker assembly.



G02960160

**Fig. 126: Removing Valve Rocker Bolts In Sequence (a-h)**  
Courtesy of SUBARU OF AMERICA, INC.

2. Remove valve rocker assembly.



G02960161

**Fig. 127: Removing Valve Rocker Assembly**  
Courtesy of SUBARU OF AMERICA, INC.

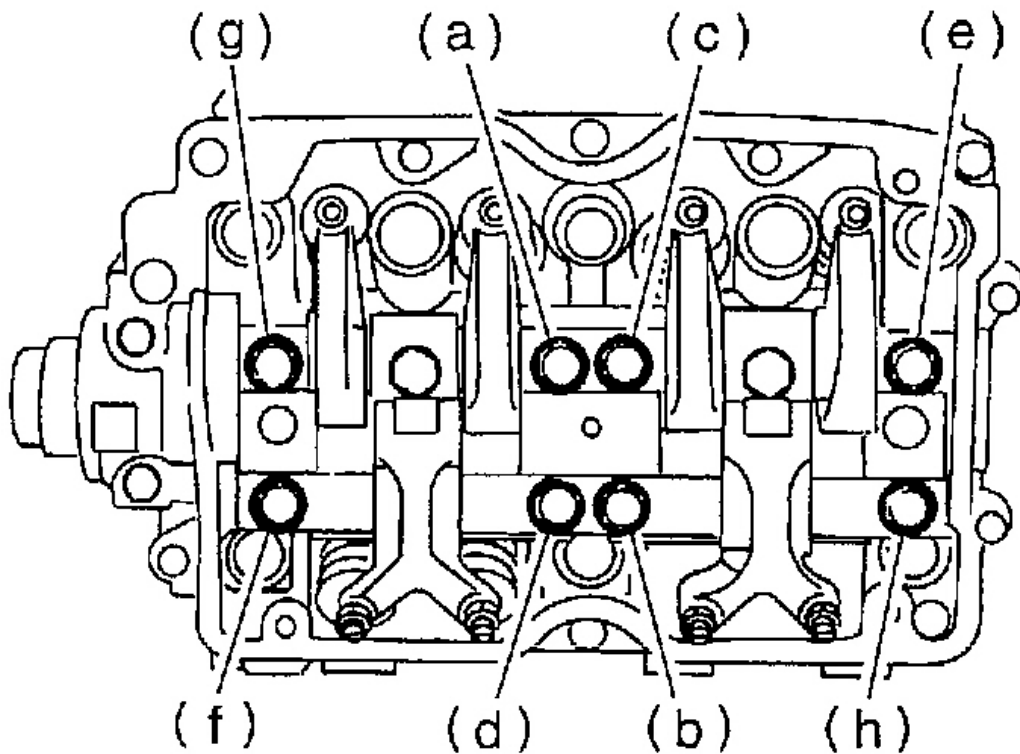
## INSTALLATION

1. Installation of valve rocker assembly
  1. Temporarily tighten bolts (a) through (d) equally as shown in figure.

**CAUTION: Do not allow valve rocker assembly to gouge knock pins.**

2. Tighten bolts (e) through (h) to specified torque.
3. Tighten bolts (a) through (d) to specified torque.

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



G02960162

**Fig. 128: Installing Valve Rocker Assembly In Sequence**  
Courtesy of SUBARU OF AMERICA, INC.

2. Adjust the valve clearances. Refer to ADJUSTMENT, Valve Clearances.
3. Install rocker cover and connect PCV hose.
4. Install camshaft sprocket. Refer to INSTALLATION, Camshaft Sprockets.
5. Install timing belt assembly. Refer to INSTALLATION, Timing Belt Assembly.
6. Install belt cover. Refer to INSTALLATION, Belt Cover.
7. Install crankshaft pulley. Refer to INSTALLATION, Crankshaft Pulley.
8. Install V-belt. Refer to INSTALLATION, V-belts.

## DISASSEMBLY

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

**CAUTION: Arrange all removed parts in order so that they can be installed in their original positions.**

3. Remove nut and adjuster screw from valve rocker.

## **ASSEMBLY**

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

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

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

3. Install valve rocker shaft securing bolts.

## **INSPECTION**

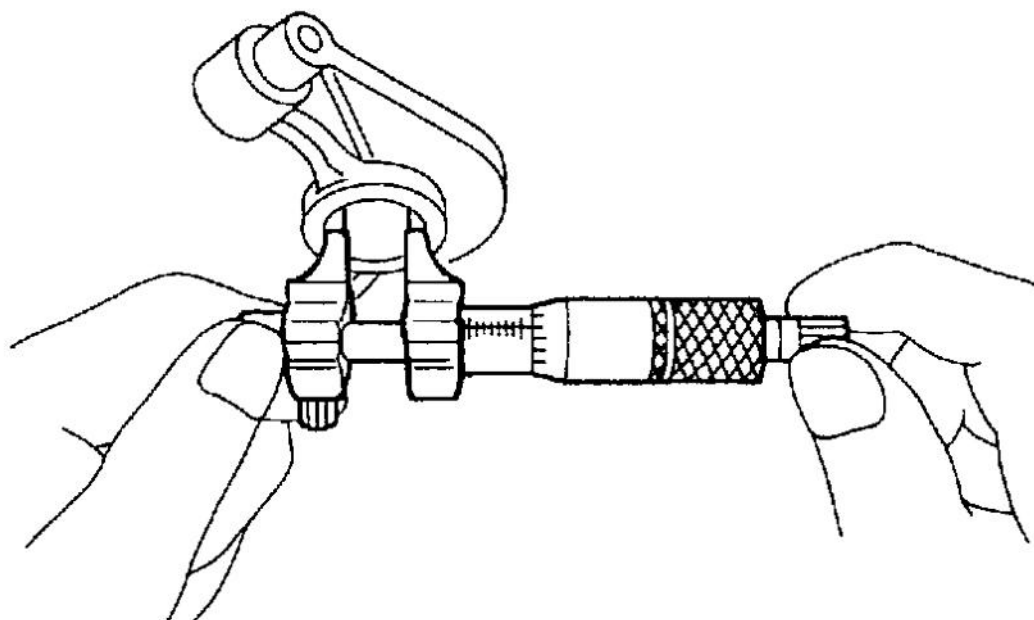
### **VALVE ROCKER ARM**

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

**Clearance between arm and shaft:**

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

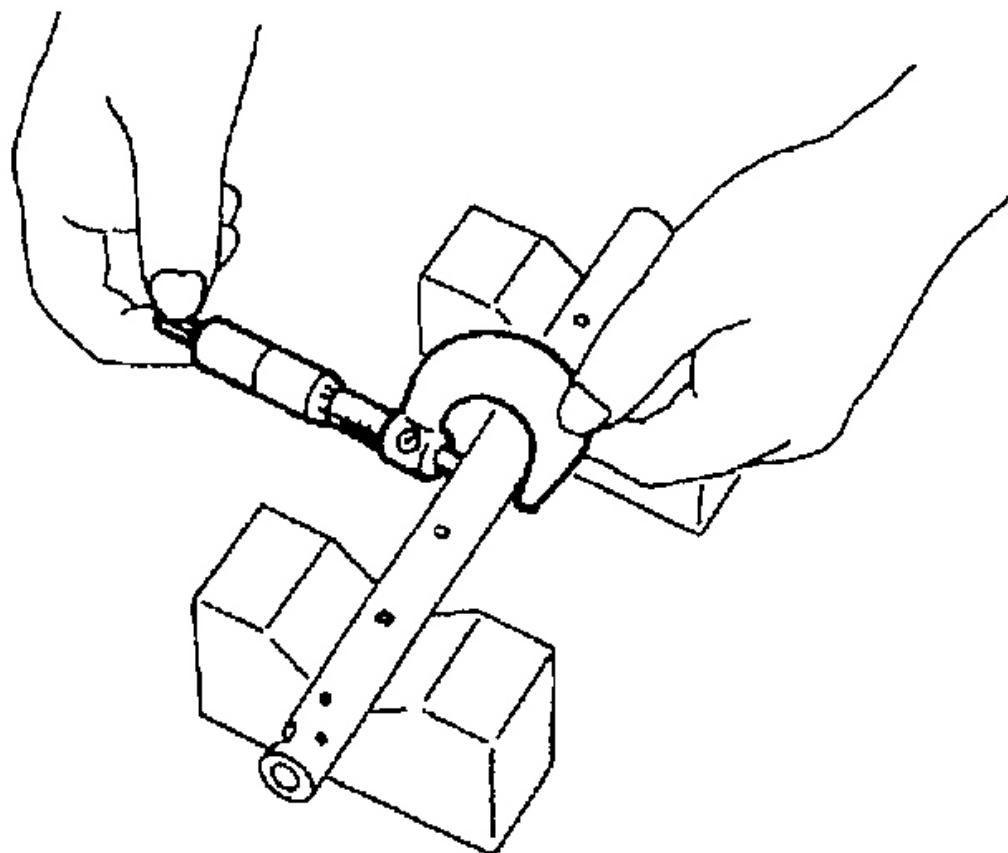
**Limit:** 0.10 mm (0.0039 in)



G02960163

**Fig. 129: Measuring Inside Diameter Of Valve Rocker Arm**  
Courtesy of SUBARU OF AMERICA, INC.





G02960164

**Fig. 130: Measuring Outside Diameter Of Valve Rocker Shaft**  
Courtesy of SUBARU OF AMERICA, INC.

2. If oil clearance exceeds the limit, replace 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. Measure inside diameter of rocker shaft support and outside diameter of valve rocker shaft, and determine the difference between the two (= oil clearance).

**Clearance between support and shaft:**

**Standard:** 0.005 - 0.039 mm (0.0002 - 0.0015 in)

**Limit:** 0.05 mm (0.0020 in)

4. If oil clearance exceeds the limit, replace rocker shaft support or shaft, whichever shows greater amount of wear.

**Rocker shaft support inside diameter:** 22.005 - 22.026 mm (0.8663 - 0.8672 in)

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

5. If cam or valve contact surface of valve rocker arm is worn or dented excessively, replace valve rocker arm.
6. Check that valve rocker arm roller rotates smoothly. If not, replace valve rocker arm.

#### **INTAKE AND EXHAUST VALVE ROCKER SHAFT**

Visually check oil relief valve of shaft end for any of the following abnormalities.

- Breaks in check ball body
- Foreign particles caught in valve spring
- Oil leakage at check ball

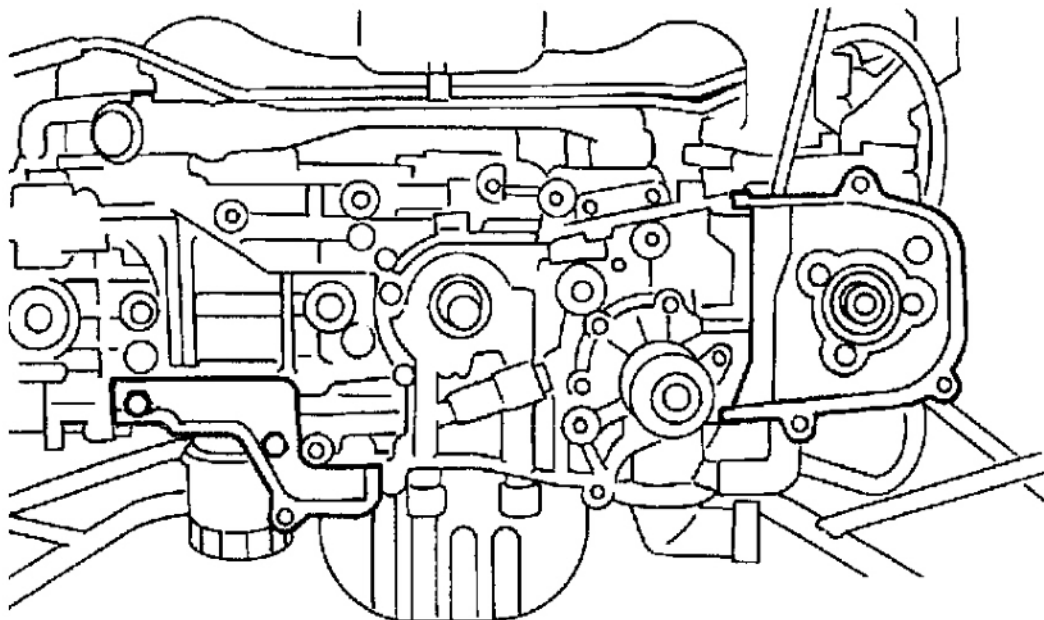
**CAUTION: Repair or replace valve rocker shaft as necessary.**

## **CAMSHAFT**

### **REMOVAL**

1. Remove V-belt. Refer to **INSTALLATION**, V-belt.
2. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
3. Remove belt cover. Refer to **REMOVAL**, Belt Cover.
4. Remove timing belt assembly. Refer to **REMOVAL**, Timing Belt Assembly.
5. Remove camshaft sprocket. Refer to **REMOVAL**, Camshaft Sprockets.
6. Remove crankshaft sprocket. Refer to **REMOVAL**, Crankshaft Sprockets.
7. Remove belt cover No. 2 (LH).
8. Remove belt cover No. 2 (RH).

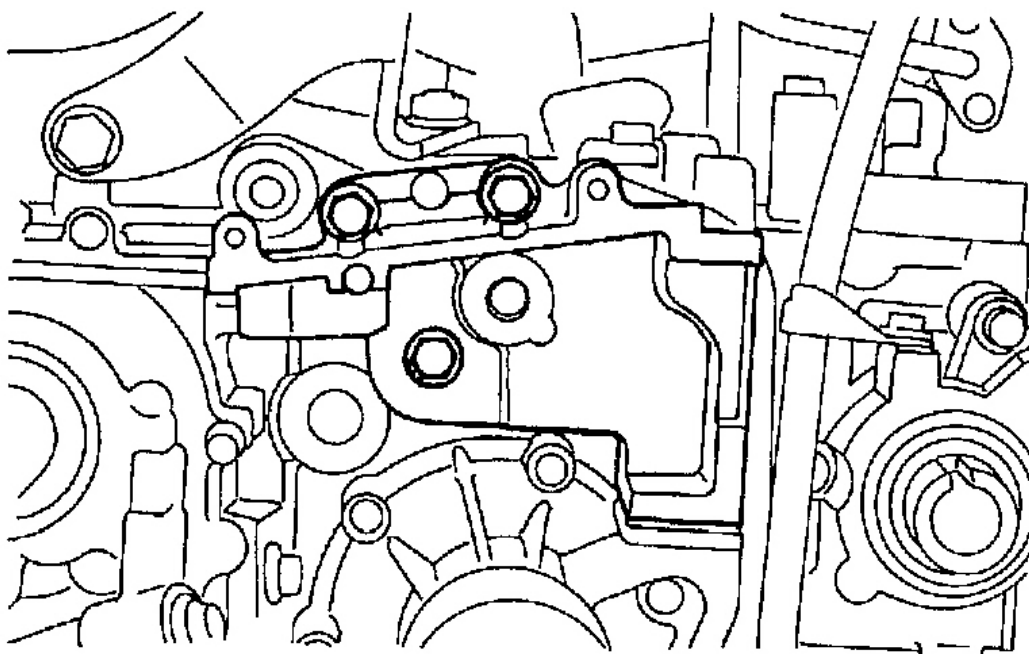
**CAUTION: Do not damage or lose the seal rubber when removing belt covers.**



G02960165

**Fig. 131: Removing Belt Cover No. 2 (RH/LH)**  
Courtesy of SUBARU OF AMERICA, INC.

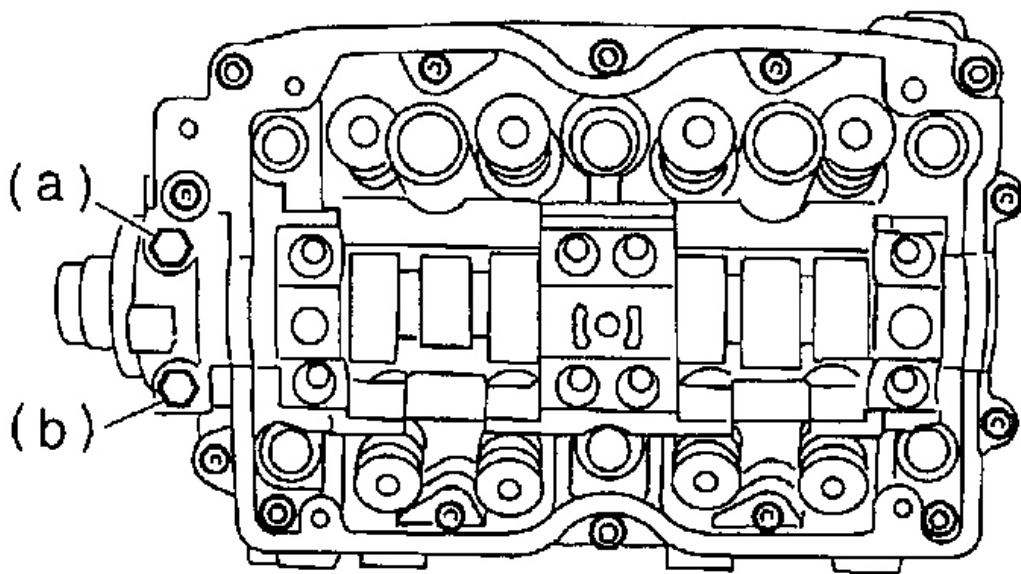
9. Remove tensioner bracket.



G02960166

**Fig. 132: Removing Tensioner Bracket**  
Courtesy of SUBARU OF AMERICA, INC.

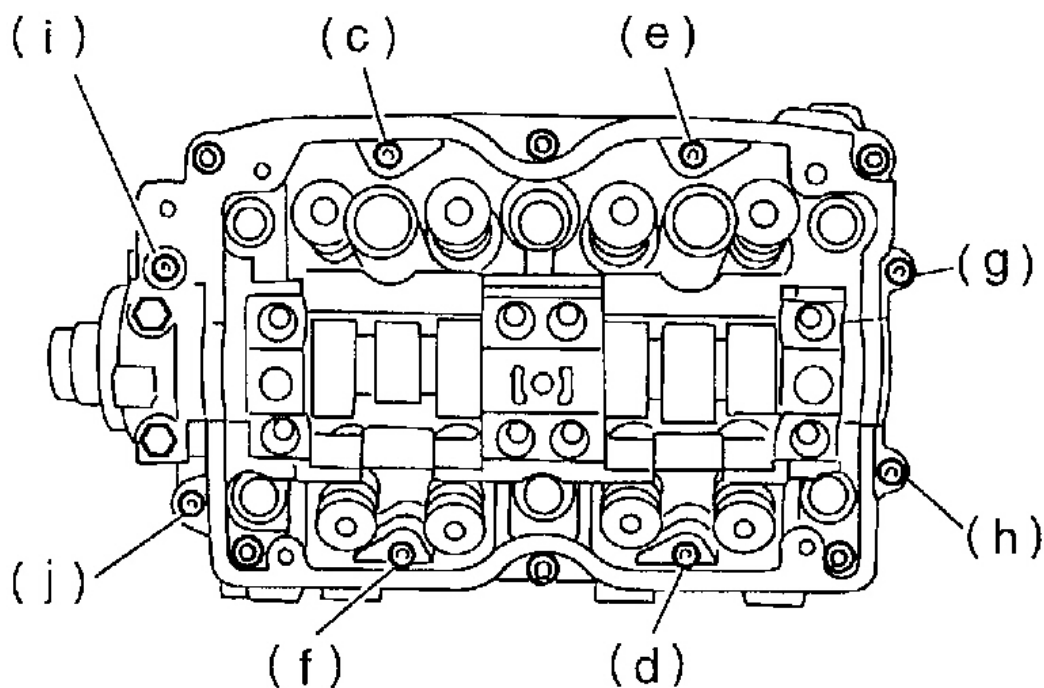
10. Remove camshaft position sensor support. (LH side only)
11. Remove oil level gauge guide. (LH side only)
12. Remove valve rocker assembly. Refer to **REMOVAL**, Valve Rocker Assembly.
13. Remove camshaft cap.
  1. Remove bolts (a) through (b) in alphabetical sequence.



G02960167

**Fig. 133: Removing Camshaft Cap In Sequence (a-b)**  
Courtesy of SUBARU OF AMERICA, INC.

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

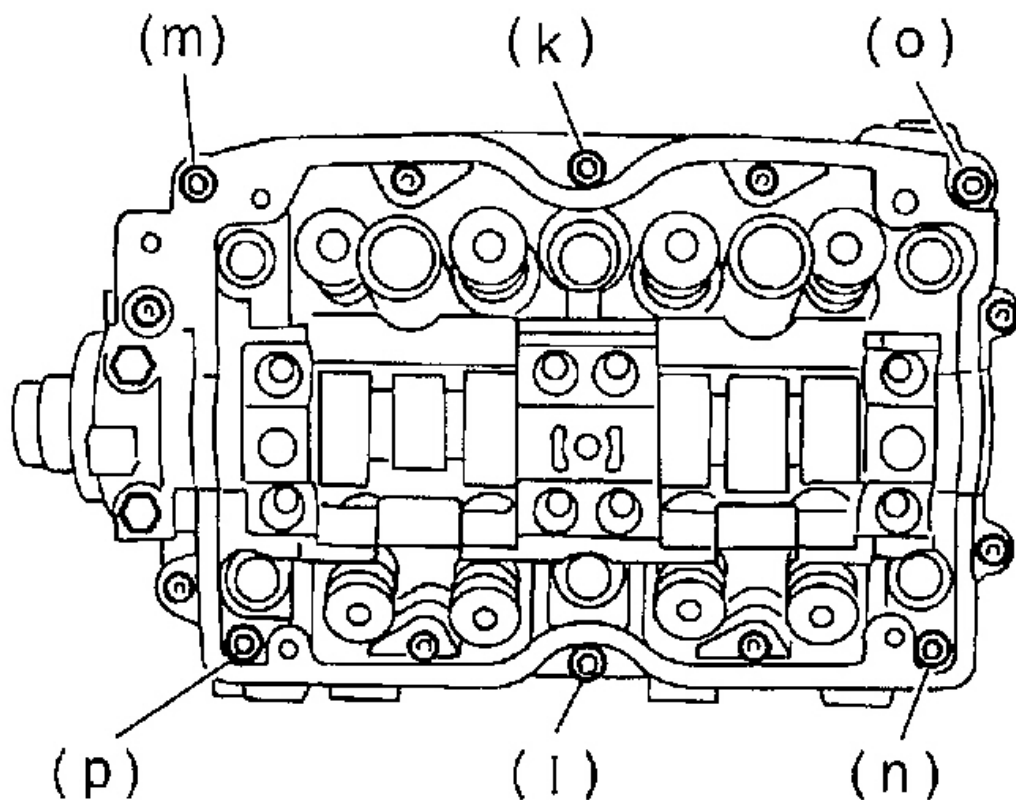


G02960168

**Fig. 134: Removing Camshaft Cap In Sequence (c-j)**  
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499497000 TORX PLUS

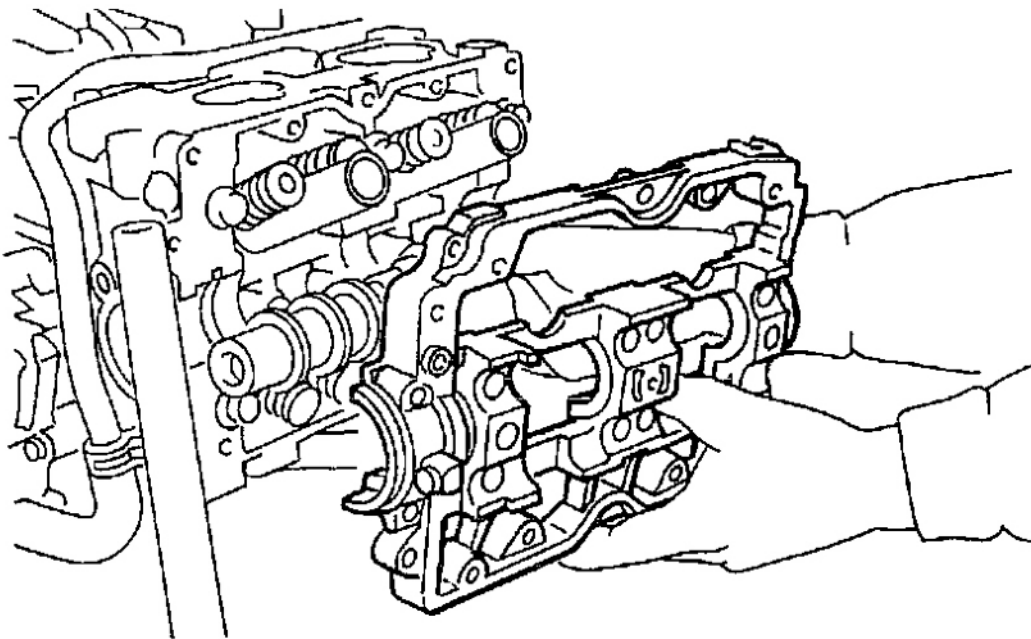


G02960169

**Fig. 135: Removing Camshaft Cap In Sequence (k-p)**

Courtesy of SUBARU OF AMERICA, INC.

4. Remove camshaft cap.



G02960170

**Fig. 136: Removing Camshaft Cap**  
Courtesy of SUBARU OF AMERICA, INC.

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

**CAUTION:**

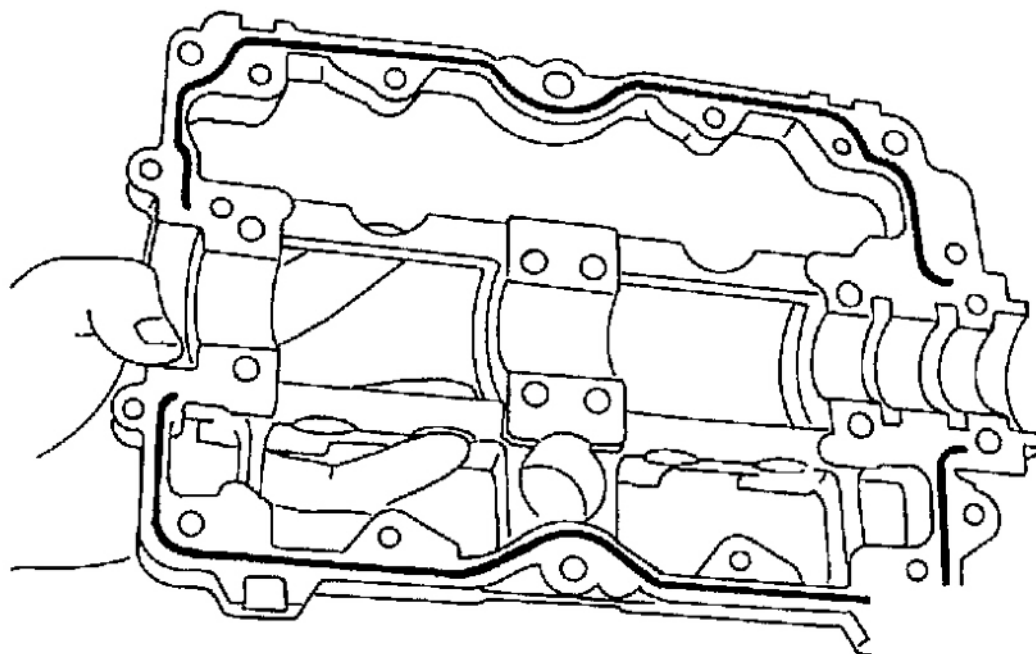
- Do not remove oil seal unless necessary.
- Do not scratch journal surface when removing oil seal.

**INSTALLATION**

1. Apply a coat of engine oil to camshaft journals and install camshaft.
2. Install camshaft cap.
  1. Apply liquid gasket on the around of camshaft cap.

**Liquid gasket:****THREE BOND 1280B****P/N K0877YA018**

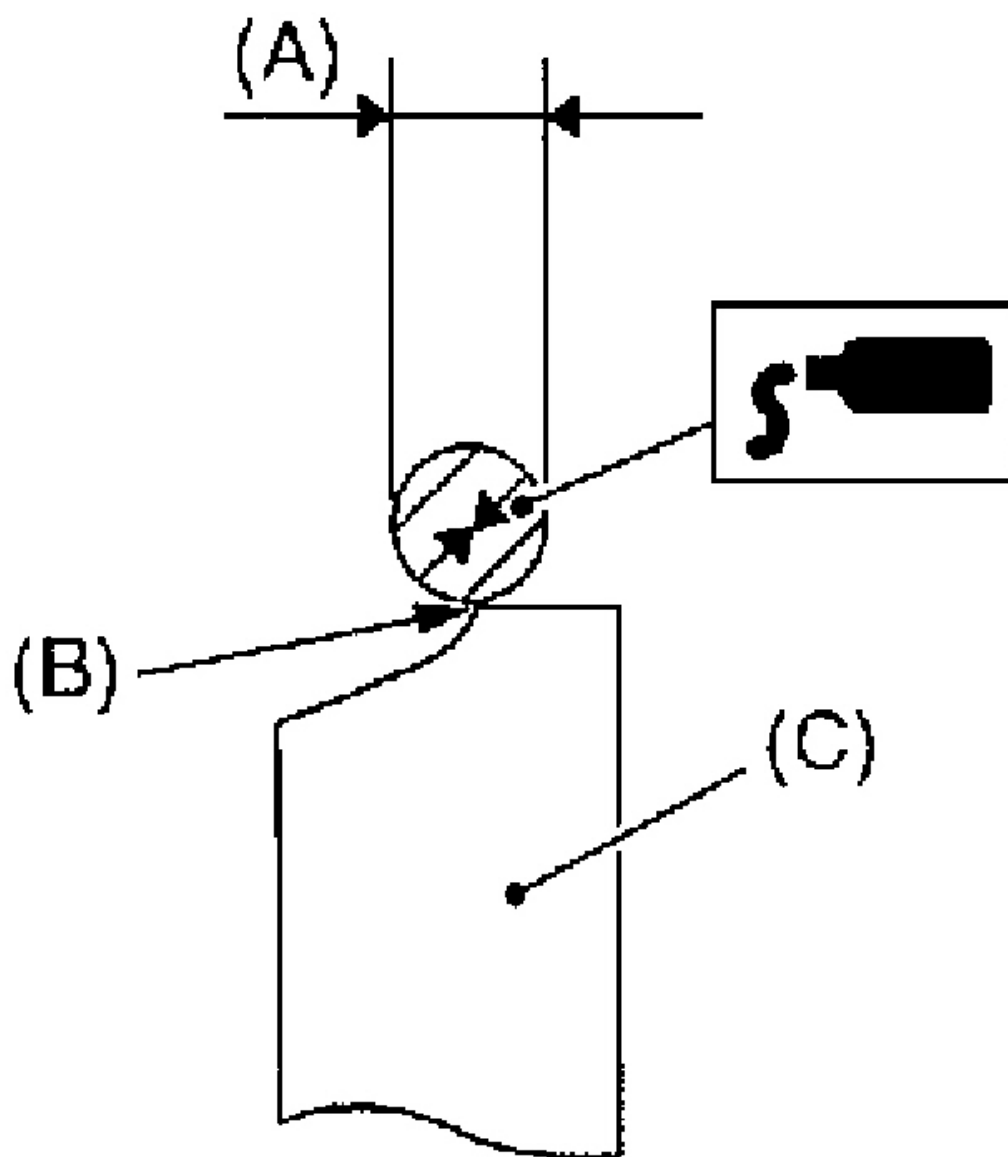




G02960171

**Fig. 137: Applying Liquid Gasket Around Of Camshaft Cap**  
Courtesy of SUBARU OF AMERICA, INC.

**NOTE:** Apply a 3 mm (0.12 in) diameter (A) continuous strip of liquid gasket along edge (B) of camshaft cap (C) mating surface.

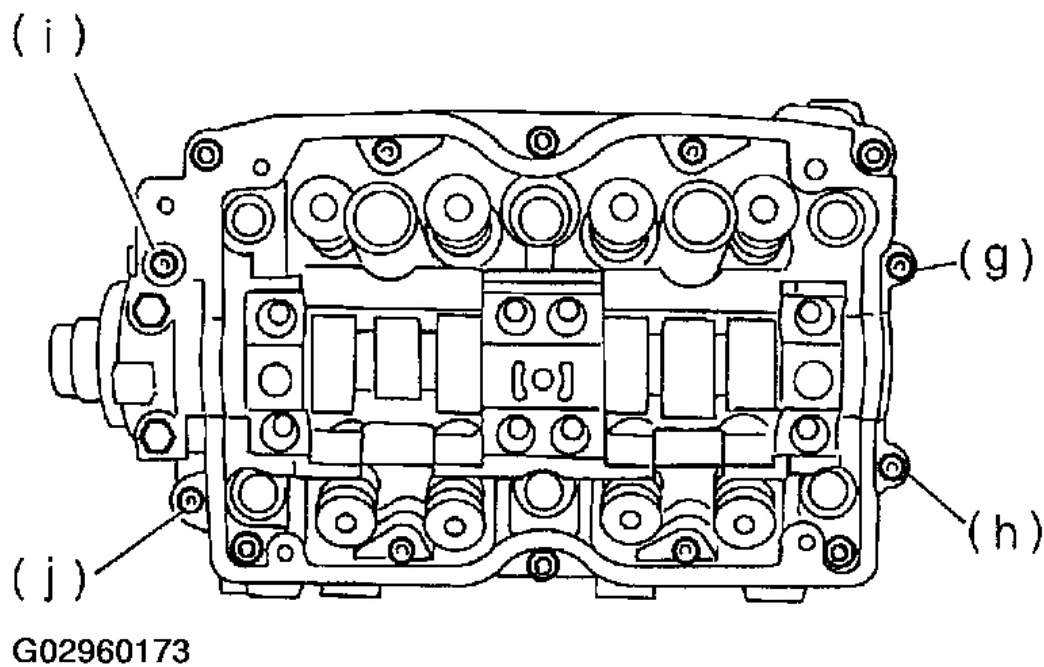


G02960172

**Fig. 138: Applying Continuous Strip Of Liquid Gasket Along Edge Of Camshaft Cap Mating Surface**

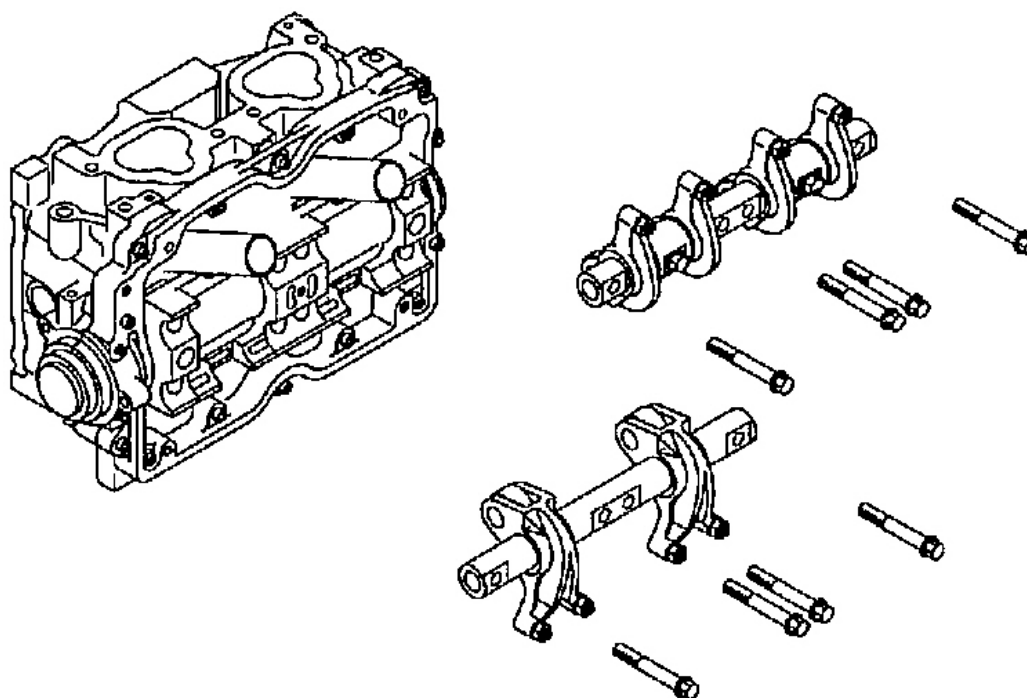
Courtesy of SUBARU OF AMERICA, INC.

2. Temporarily tighten bolts (g) through (j) in alphabetical sequence.



**Fig. 139: Temporarily Tightening Camshaft Bolts In Sequence (g-j)**  
Courtesy of SUBARU OF AMERICA, INC.

3. Install valve rocker assembly.

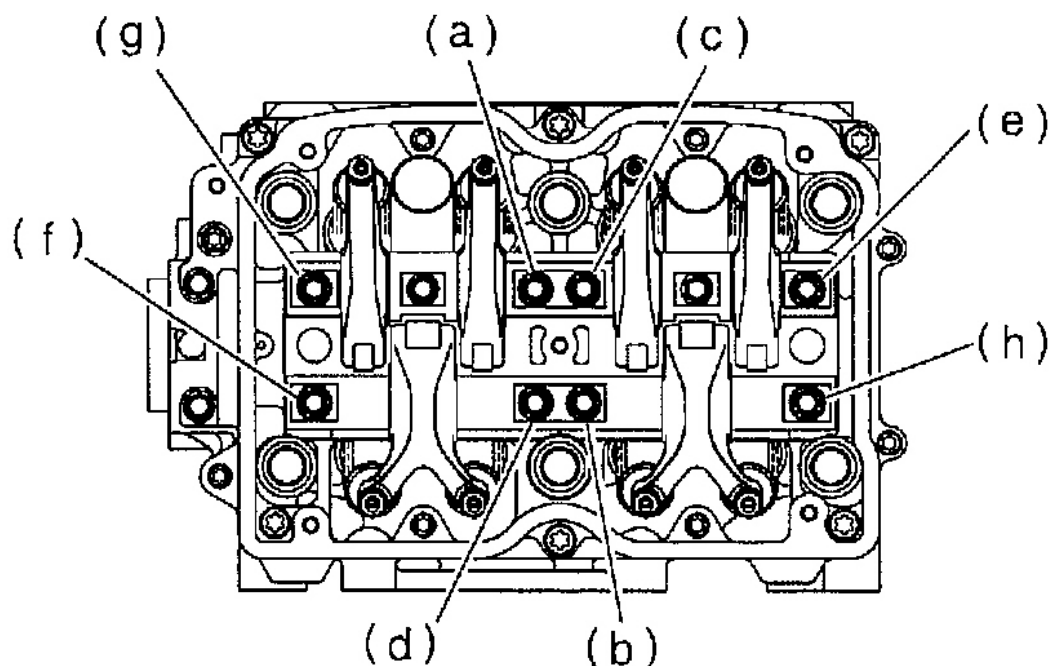


G02960174

**Fig. 140: Installing Valve Rocker Assembly**  
 Courtesy of SUBARU OF AMERICA, INC.

4. Tighten bolts (a) through (h) in alphabetical sequence.

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



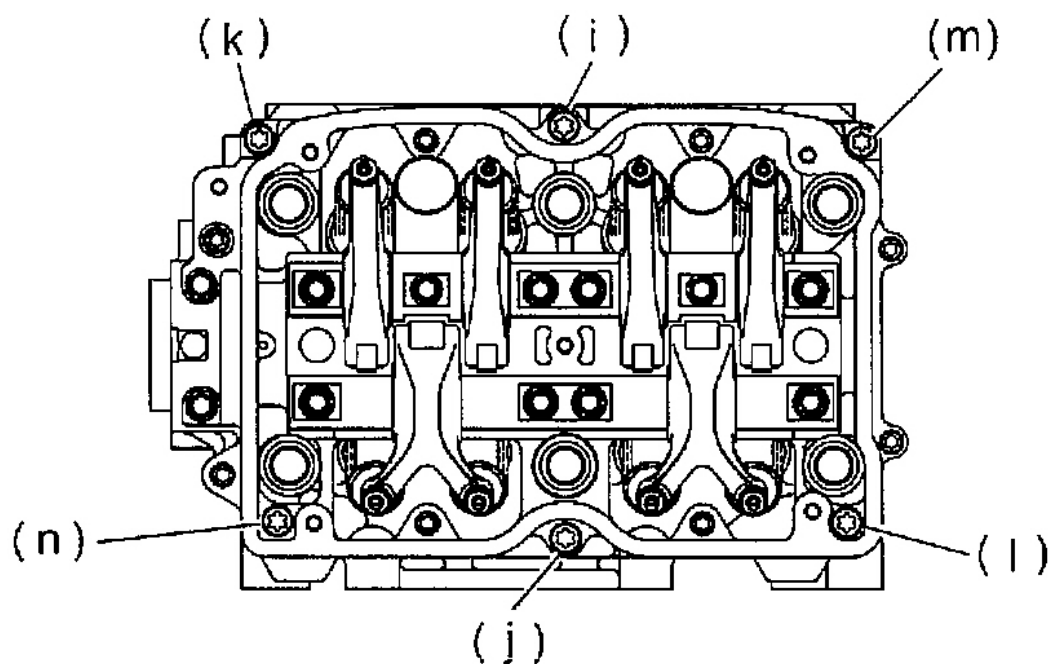
G02960175

**Fig. 141: Tightening Camshaft Bolts In Sequence (a-h)**  
 Courtesy of SUBARU OF AMERICA, INC.

5. Tighten TORX bolts (i) through (n) in alphabetical sequence using ST.

ST 499427000 TORX PLUS

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

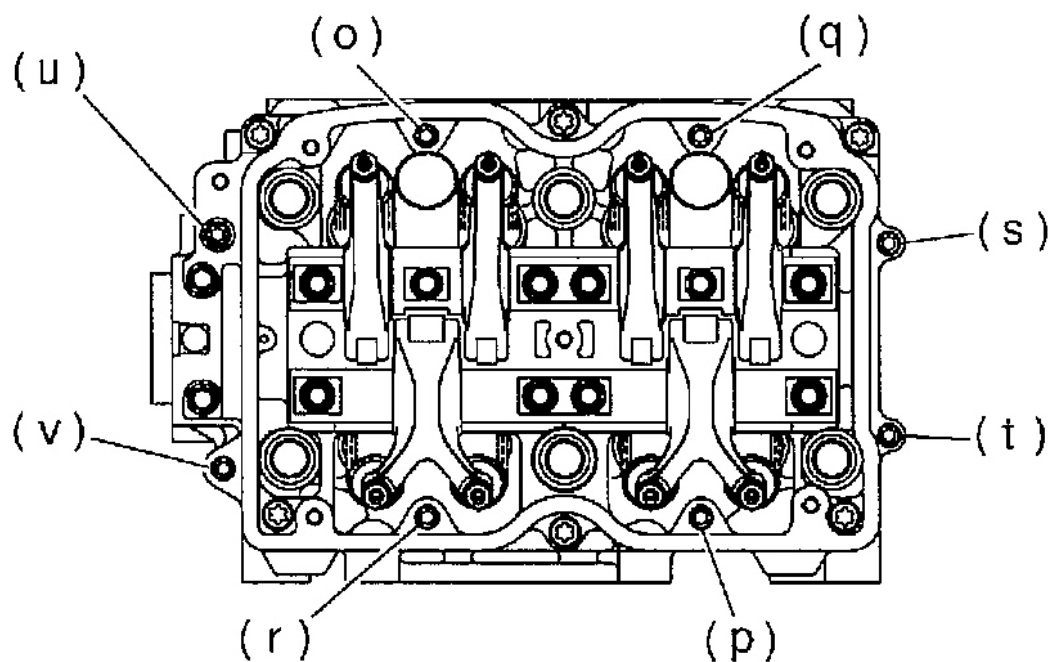


G02960176

**Fig. 142: Tightening Camshaft In Sequence (i-n)**  
Courtesy of SUBARU OF AMERICA, INC.

6. Tighten bolts (o) through (v) in alphabetical sequence.

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

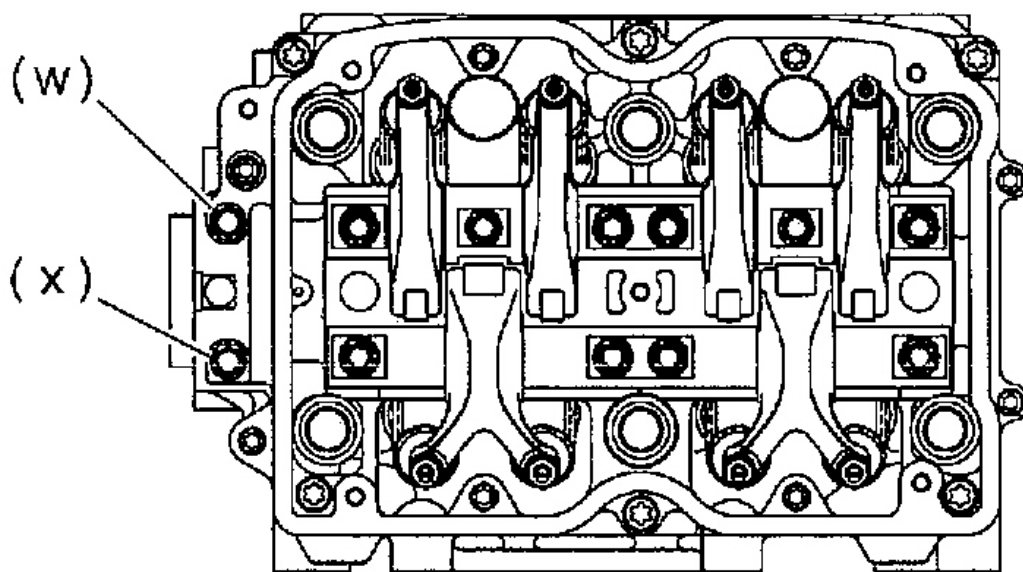


G02960177

**Fig. 143: Tightening Camshaft Bolt In Sequence (o-v)**  
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten bolts (w) through (x) in alphabetical sequence.

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



G02960178

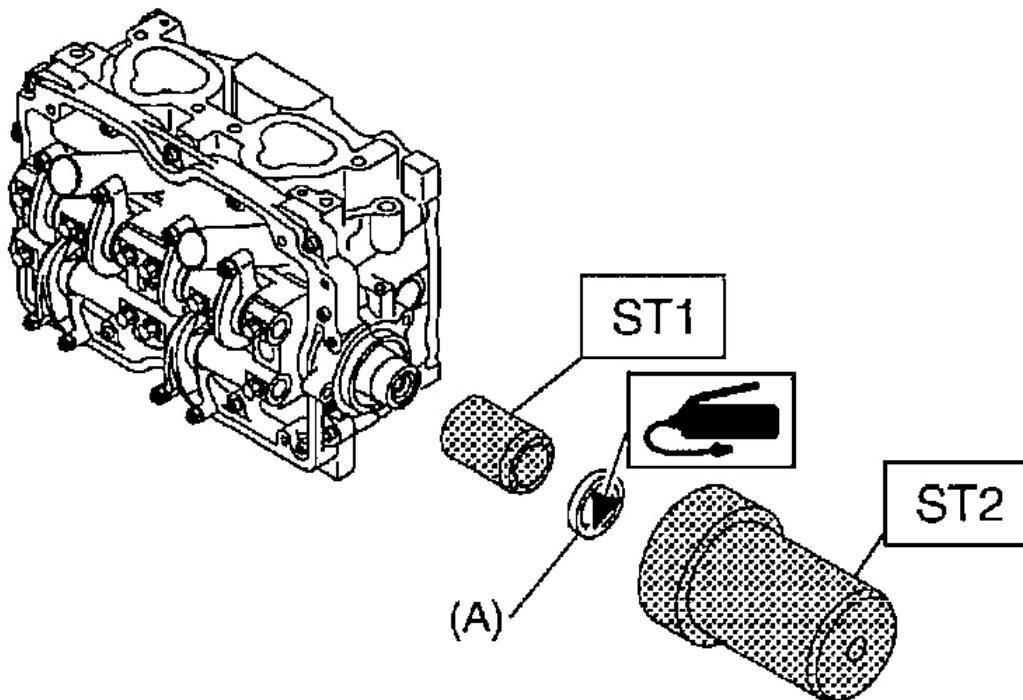
**Fig. 144: Tightening Camshaft Bolts In Sequence (w-x)**

Courtesy of SUBARU OF AMERICA, INC.

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

**CAUTION: Use a new oil seal.**





G02960179

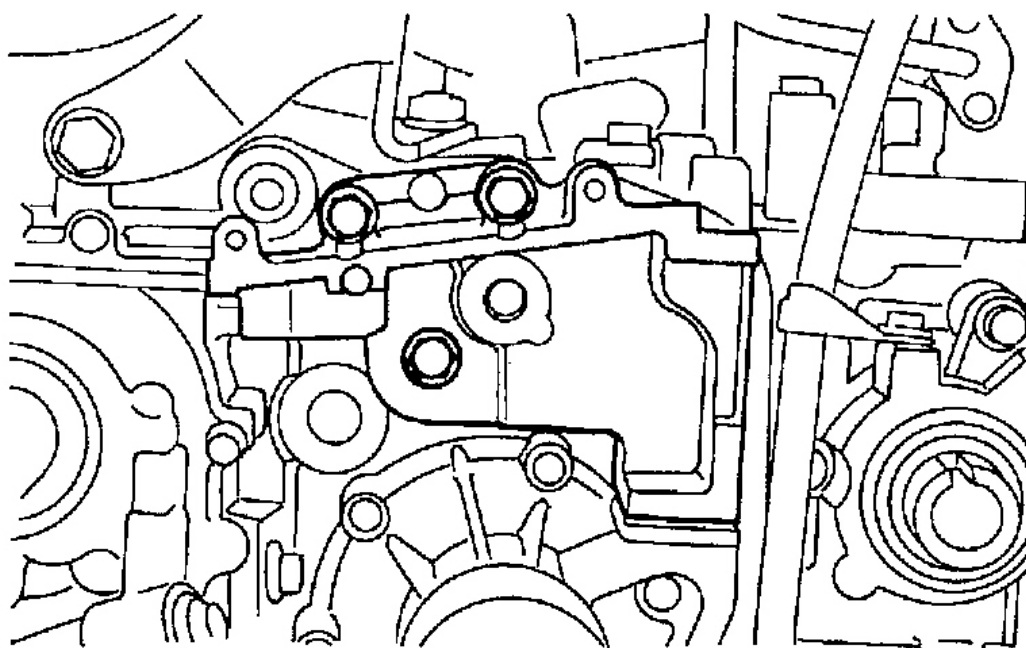
**Fig. 145: Applying Coat Of Grease To Oil Seal Lips**  
Courtesy of SUBARU OF AMERICA, INC.

4. Install plug using ST.

ST 499587700 OIL SEAL INSTALLER

5. Adjust the valve clearance. Refer to **ADJUSTMENT**, Valve Clearances.
6. Install rocker cover and connect PCV hose.
7. Install oil level gauge guide. (LH side only)
8. Install camshaft position sensor support. (LH side only)
9. Install tensioner bracket.

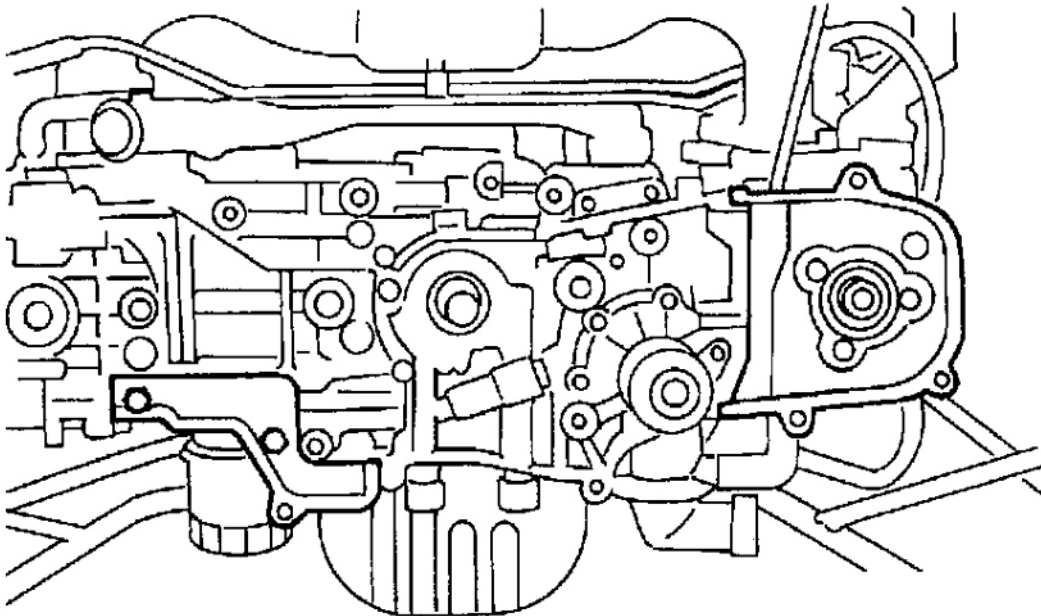
**Tightening torque:** 25 N.m (2.5 kgf-m, 18.1 ft-lb)



G02960180

**Fig. 146: Installing Tensioner Bracket**  
Courtesy of SUBARU OF AMERICA, INC.

10. Install belt cover No. 2 (RH).  
**Tightening torque:** 5 N.m (0.5 kgf-m, 3.6 ft-lb)
11. Install belt cover No. 2 (LH).  
**Tightening torque:** 5 N.m (0.5 kgf-m, 3.6 ft-lb)



G02960181

**Fig. 147: Installing Belt Cover No. 2 (LH)**  
Courtesy of SUBARU OF AMERICA, INC.

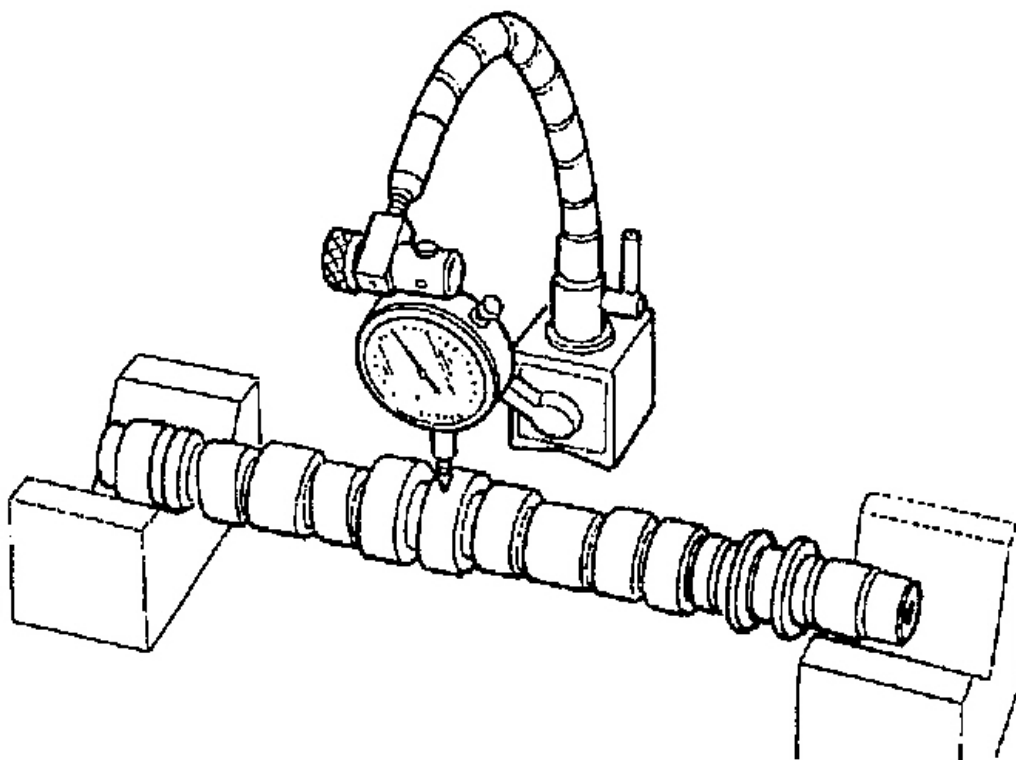
12. Install timing belt assembly. Refer to **INSTALLATION**, Timing Belt Assembly.
13. Install belt cover. Refer to **INSTALLATION**, Belt Cover.
14. Install crankshaft pulley. Refer to **INSTALLATION**, Crankshaft Pulley.
15. Install V-belt. Refer to **INSTALLATION**, V-belt.

## INSPECTION

### CAMSHAFT

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

**Limit:** 0.025 mm (0.0010 in)

**G02960182**

**Fig. 148: Measuring Camshaft Bend**  
**Courtesy of SUBARU OF AMERICA, INC.**

2. Check journal for damage and wear. Replace if faulty.
3. Measure outside diameter of camshaft journal and inside diameter of cylinder head journal, and determine the difference between the two (= oil clearance). If oil clearance exceeds specifications, replace camshaft or cylinder head as necessary.

		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)

G02960183

**Fig. 149: Camshaft Journal Clearance Specification Chart**

Courtesy of SUBARU OF AMERICA, INC.

4. Check cam face condition; remove minor faults by grinding with oil stone. Measure the cam height H; replace if the limit has been exceeded.

**Cam height: H**

Item	Unit: mm (in)	
Intake	STD	39.485 — 39.585 (1.5545 — 1.5585)
	Limit	39.385 (1.5506)
Exhaust	STD	39.257 — 39.357 (1.5455 — 1.5495)
	Limit	39.157 (1.5416)

G02960184

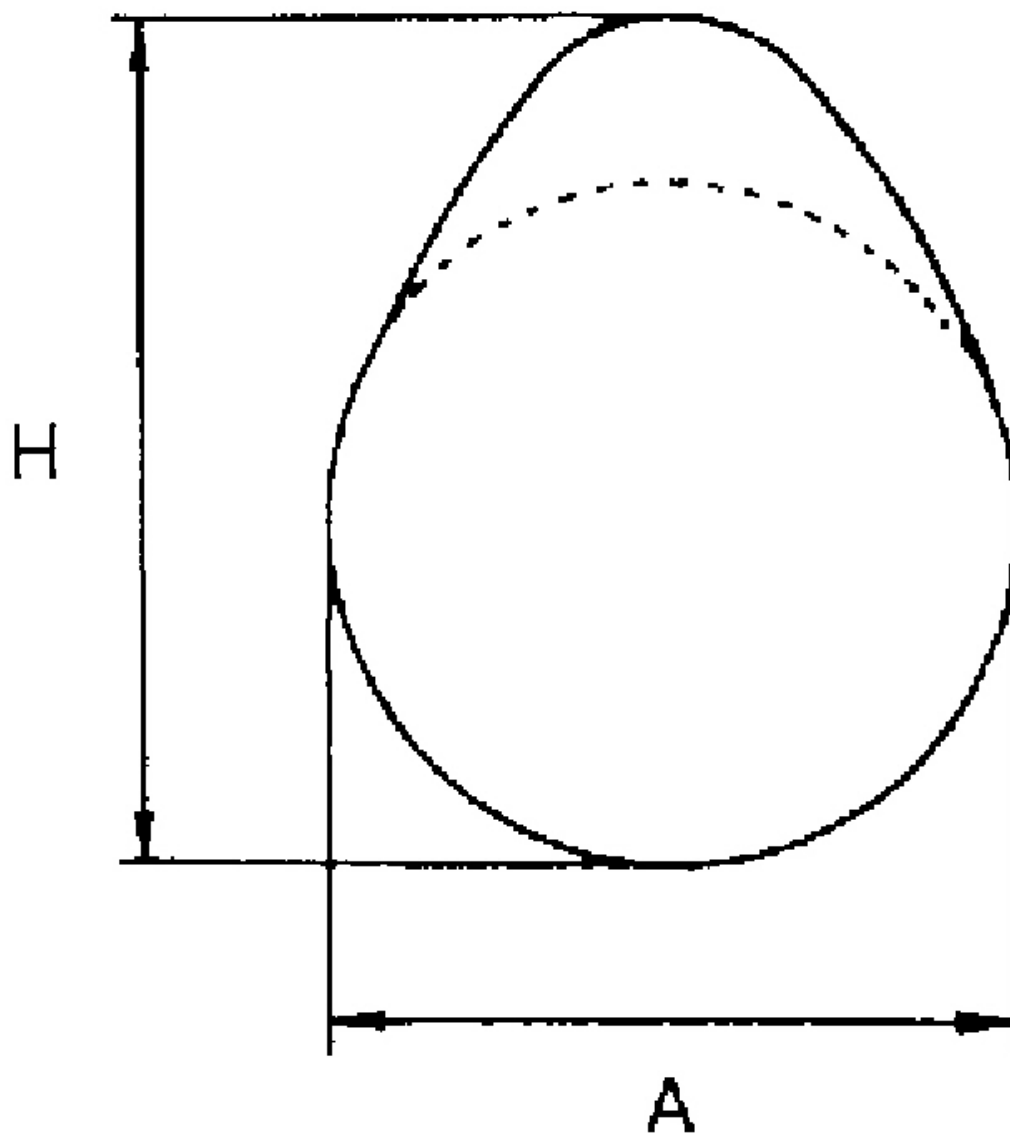
**Fig. 150: Cam Height Specification Chart**

Courtesy of SUBARU OF AMERICA, INC.

**Cam base circle diameter A:**

IN: 34.00 mm (1.3386 in)

**EX:** 34.00 mm (1.3386 in)



**G02960185**

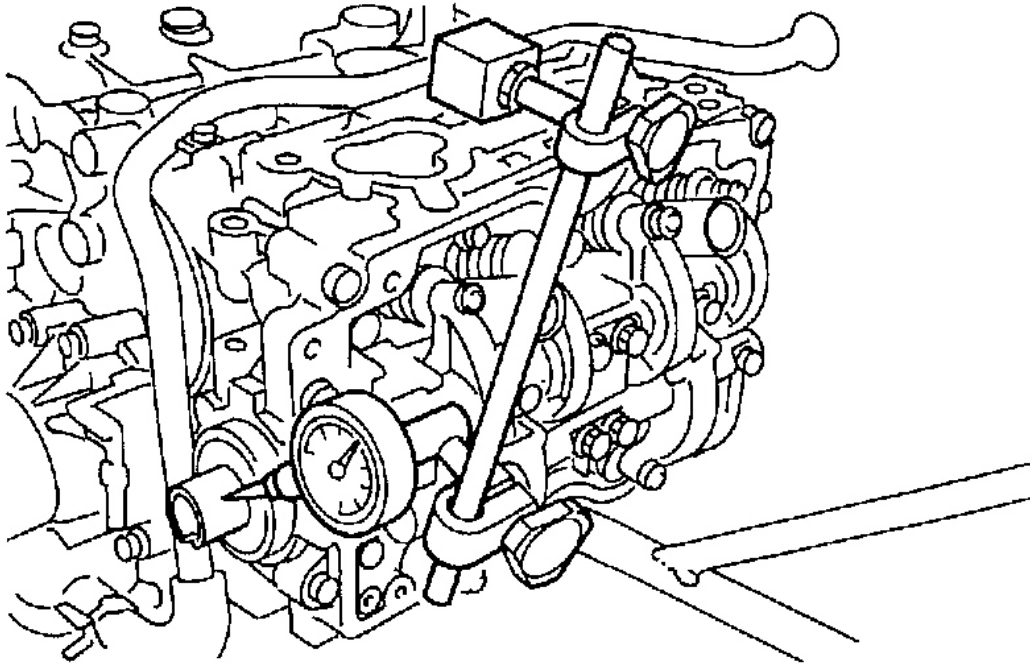
**Fig. 151: Installing Cam Base Circle Diameter**  
**Courtesy of SUBARU OF AMERICA, INC.**

**CAMSHAFT SUPPORT**

Measure the thrust clearance of camshaft with dial gauge. If the clearance exceeds the limit, replace camshaft support.

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

**Limit:** 0.10 mm (0.0039 in)



G02960186

**Fig. 152: Measuring Thrust Clearance Of Camshaft With Dial Gauge**  
Courtesy of SUBARU OF AMERICA, INC.

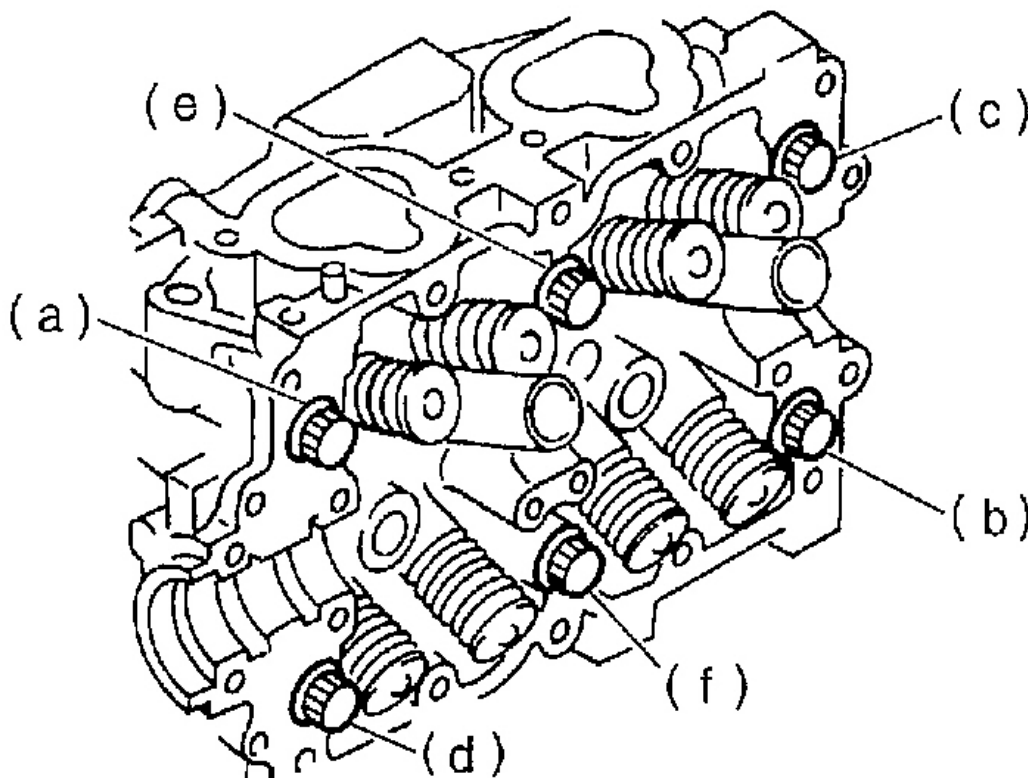
## CYLINDER HEAD ASSEMBLY

### REMOVAL

1. Remove V-belt. Refer to **REMOVAL**, V-belt.
2. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
3. Remove belt cover. Refer to **REMOVAL**, Belt Cover.
4. Remove timing belt assembly. Refer to **REMOVAL**, Timing Belt Assembly.
5. Remove camshaft sprocket. Refer to **REMOVAL**, Camshaft Sprockets.
6. Remove intake manifold. Refer to **REMOVAL**, Intake Manifold.
7. Remove bolt which installs A/C compressor bracket on cylinder head.

8. Remove valve rocker assembly. Refer to **REMOVAL**, Valve Rocker Assembly.
9. Remove camshaft. Refer to **REMOVAL**, Camshaft.
10. Remove cylinder head bolts in alphabetical sequence shown in figure.

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

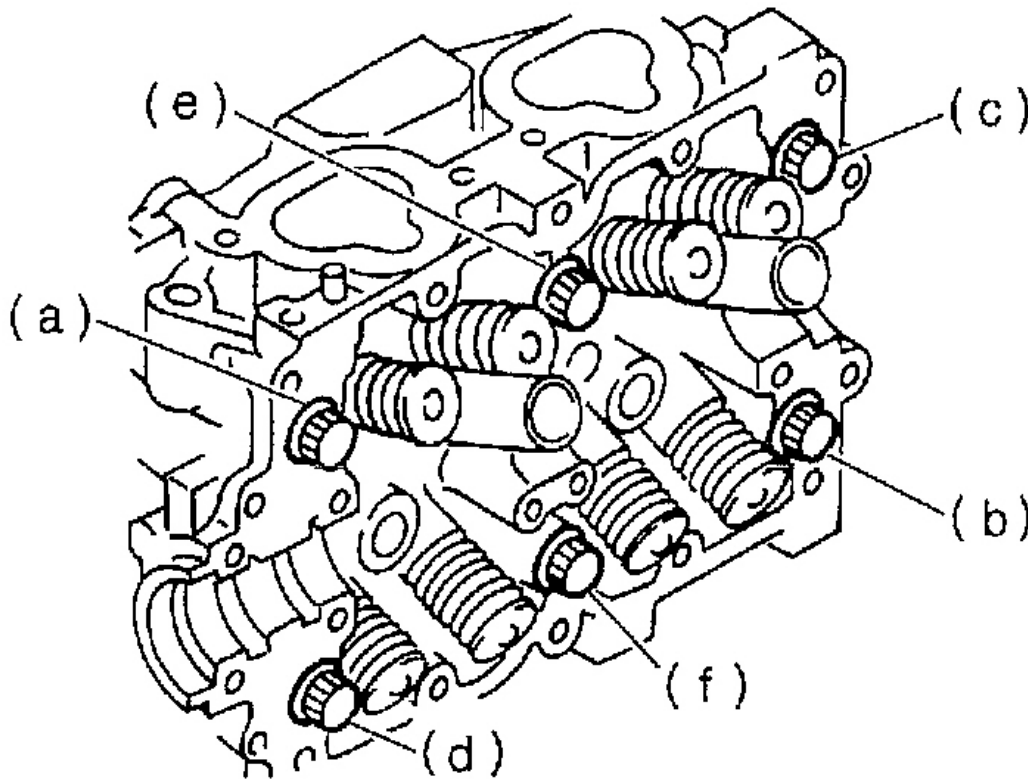


G02960187

**Fig. 153: Removing Cylinder Head Bolts In Sequence**  
Courtesy of SUBARU OF AMERICA, INC.

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





G02960188

**Fig. 154: Removing Cylinder Head Bolts (a & b)**  
Courtesy of SUBARU OF AMERICA, INC.

13. Remove cylinder head gasket.

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

14. Similarly, remove right side cylinder head.

## INSTALLATION

### CYLINDER HEAD

1. Install 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 oil pump.**

2. Tighten cylinder head bolts.

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

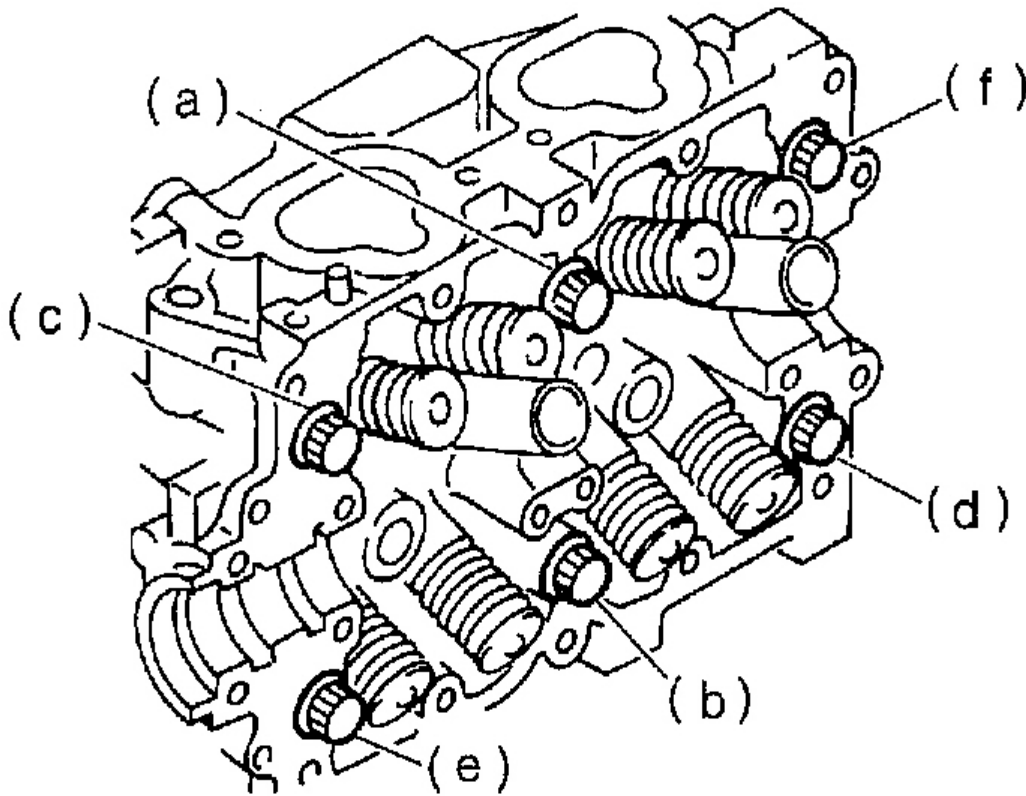
Then tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.

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

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

7. Further tighten all bolts by 80 to 90° in alphabetical sequence shown in figure below.

**CAUTION: Ensure that the total "re-tightening angle" [in the former two steps], do not exceed 180°.**



G02960189

**Fig. 155: Tightening Bolts Additional 80°-90°**  
Courtesy of SUBARU OF AMERICA, INC.

3. Install camshaft. Refer to **INSTALLATION**, Camshaft.
4. Install valve rocker assembly. Refer to **INSTALLATION**, Valve Rocker Assembly.
5. Install A/C compressor bracket on cylinder head.
6. Install intake manifold. Refer to **INSTALLATION**, Intake Manifold.
7. Install camshaft sprocket. Refer to **INSTALLATION**, Camshaft Sprockets.
8. Install timing belt assembly. Refer to **INSTALLATION**, Timing Belt Assembly.
9. Install belt cover. Refer to **INSTALLATION**, Belt Cover.
10. Install crankshaft pulley. Refer to **INSTALLATION**, Crankshaft Pulley.
11. Install V-belt. Refer to **INSTALLATION**, V-belt.

## DISASSEMBLY

1. Place cylinder head on ST.

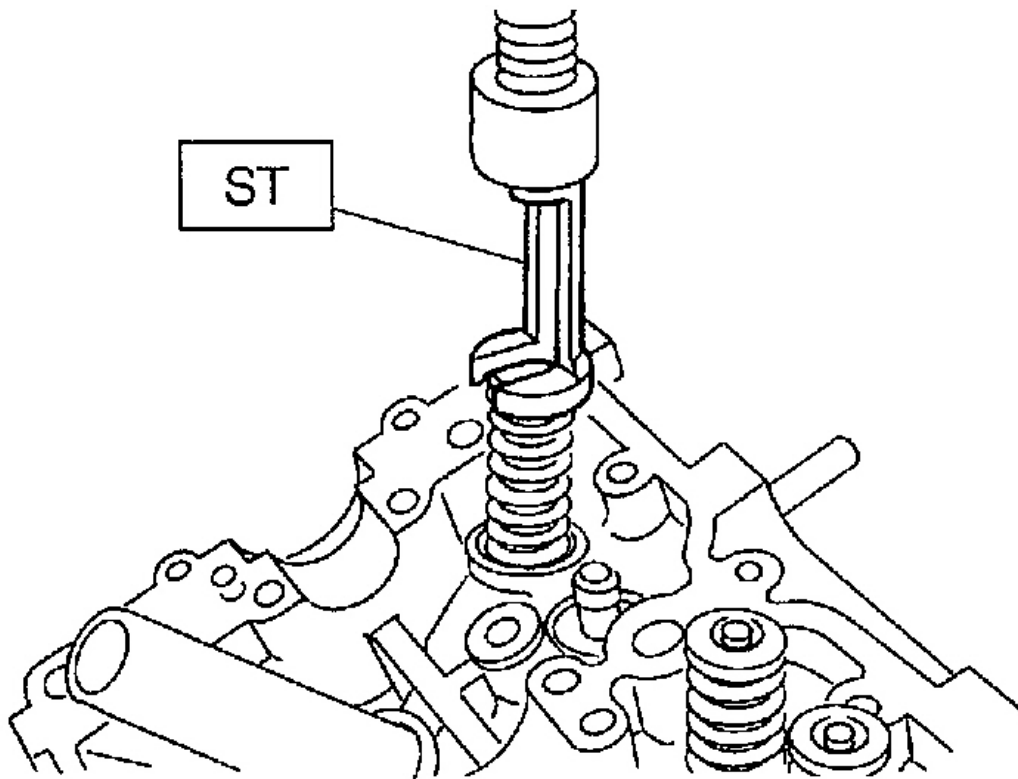
ST 498267800 CYLINDER HEAD TABLE

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

ST 499718000 VALVE SPRING REMOVER

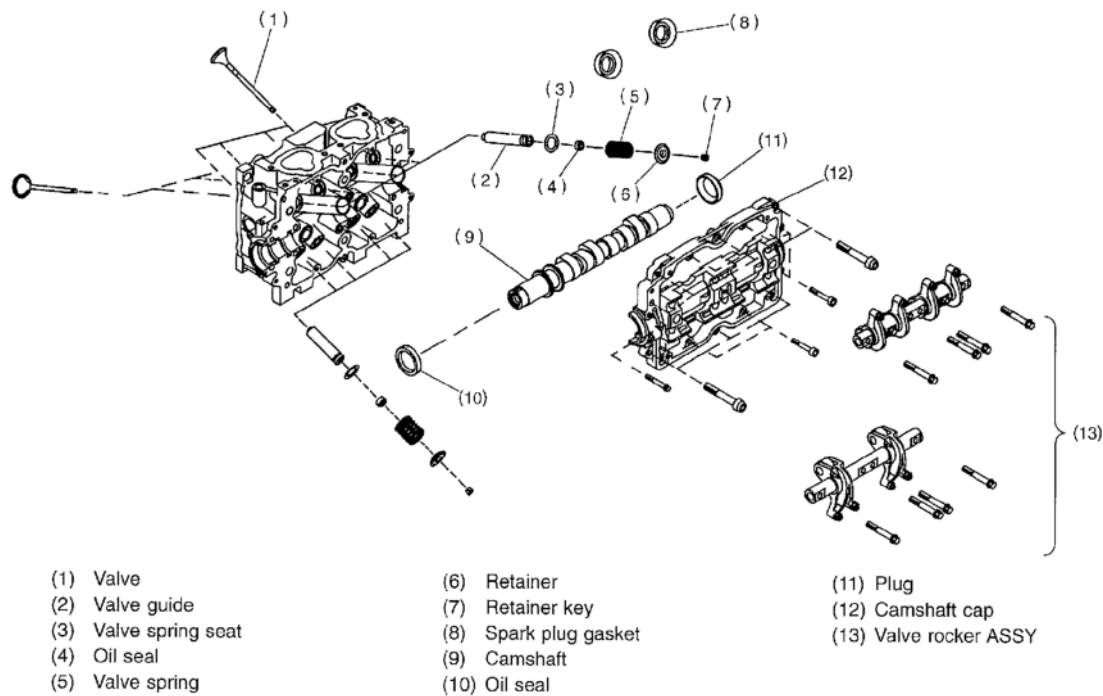
**CAUTION:**

- 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.



G02960190

**Fig. 156: Setting ST On Valve Spring**  
Courtesy of SUBARU OF AMERICA, INC.



G02960191

**Fig. 157: Identifying Cylinder Head Assembly Components**  
Courtesy of SUBARU OF AMERICA, INC.

### ASSEMBLY

#### 1. Installation of valve spring and valve

1. Place cylinder head on ST.

ST 498267800 CYLINDER HEAD TABLE

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

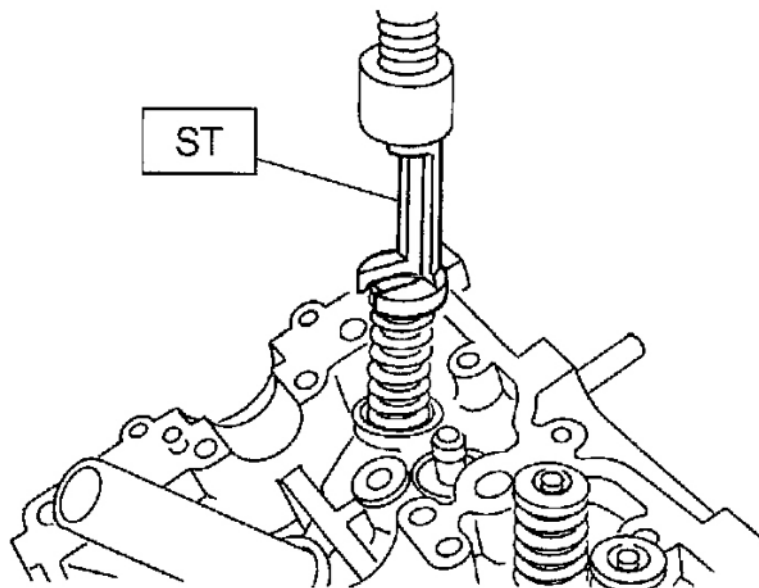
**CAUTION:** When inserting valve into valve guide, use special care not to damage the oil seal lip.

3. Install valve spring and retainer.

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

4. Set ST on valve spring.

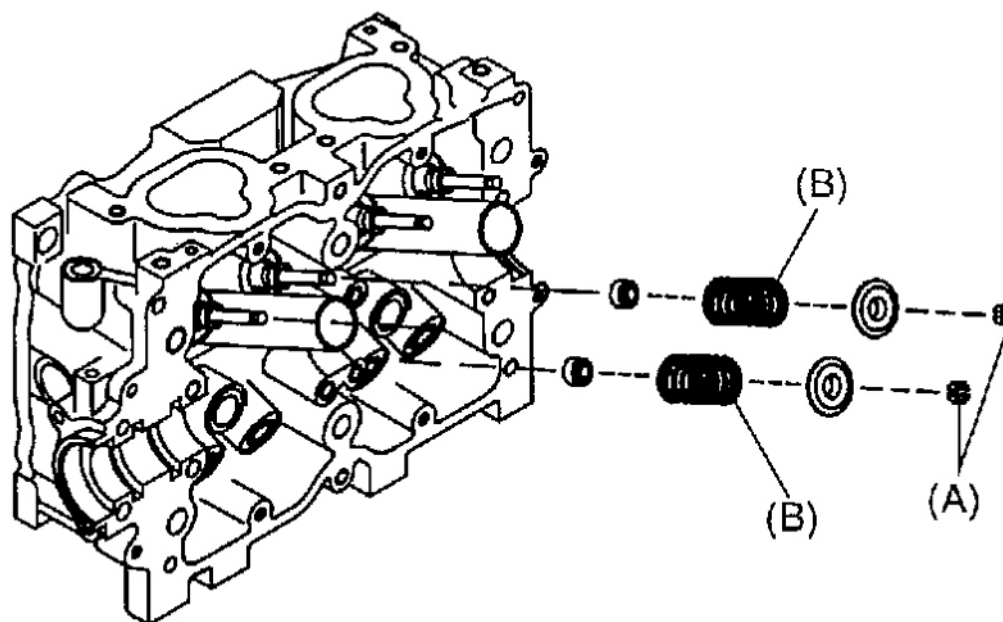
## ST 499718000 VALVE SPRING REMOVER



G02960192

**Fig. 158: Setting ST On Valve Spring**  
Courtesy of SUBARU OF AMERICA, INC.

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



(A) Retainer key

(B) Painted face

G02960193

**Fig. 159: Fitting Valve Spring Retainer Key**  
Courtesy of SUBARU OF AMERICA, INC.

6. After installing, tap valve spring retainers lightly with wooden hammer for better seating.

## INSPECTION

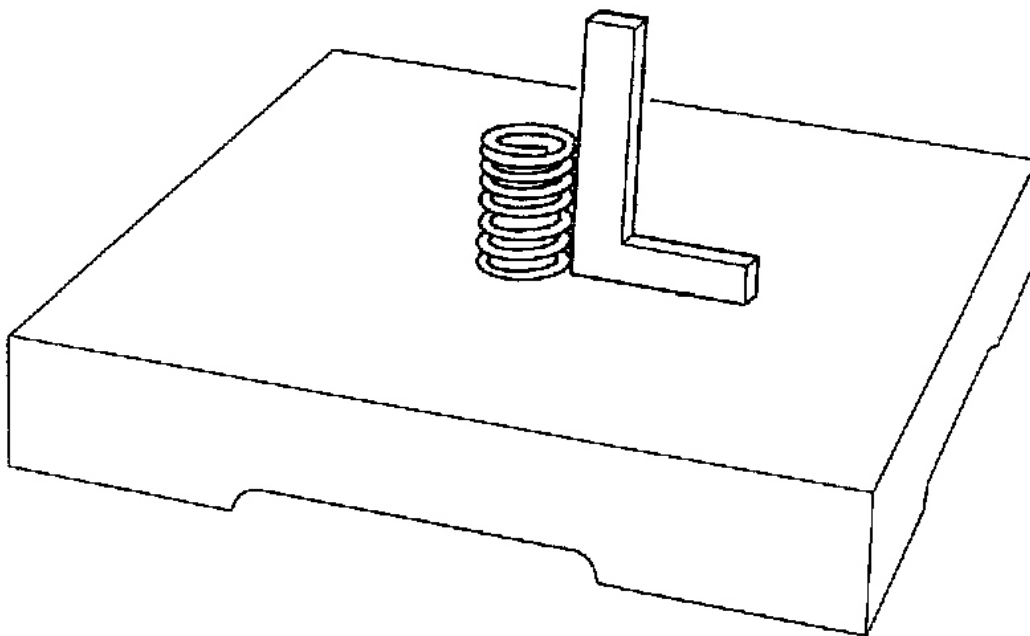
### VALVE SPRING

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

Free length	54.30 mm (2.1378 in)
Squareness	2.5°, 2.4 mm (0.094 in)
Tension/spring height	214.8 — 246.2 N (21.9 — 25.1 kgf, 48.3 — 55.3 lb)/ 45.0 mm (1.772 in)
	526.6 — 581.6 N (53.7 — 59.3 kgf, 118.4 — 130.8 lb)/34.7 mm (1.366 in)

G02960194

**Fig. 160: Measuring Squareness Of Valve Spring**  
 Courtesy of SUBARU OF AMERICA, INC.



G02960195

**Fig. 161: Measuring Deflection At Top Using Try Square**  
 Courtesy of SUBARU OF AMERICA, INC.



**INTAKE AND EXHAUST VALVE OIL SEAL**

Replace oil seal with new one, if lip is damaged or spring out of place, or when the surfaces of intake valve and valve seat are reconditioned or intake valve guide is replaced. Use pliers to pinch and remove oil seal from valve.

1. Place cylinder head on ST1.
2. Press-fit oil seal to the specified dimension indicated in the figure using ST2.

**CAUTION:**

- **Apply engine oil to oil seal before press-fitting.**
- **When press-fitting oil seal, do not use hammer or strike in.**
- **Differentiate between 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:**

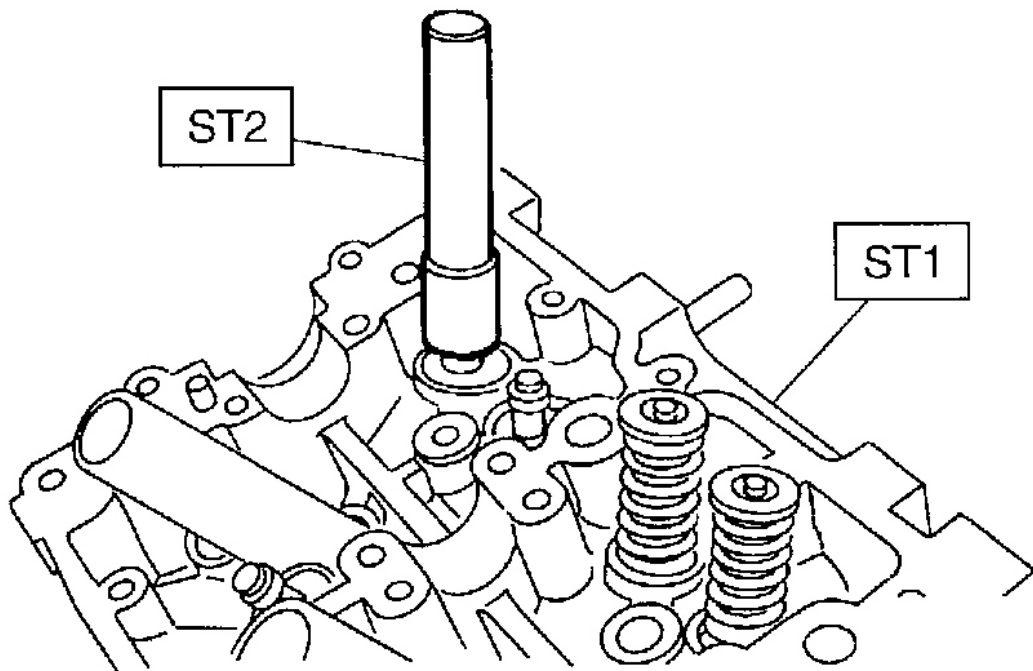
**Intake [Black]**

**Exhaust [Brown]**

**Color of spring part:**

**Intake [Silver]**

**Exhaust [Silver]**



G02960196

**Fig. 162: Installing Oil Seal**

Courtesy of SUBARU OF AMERICA, INC.

**ADJUSTMENT****CYLINDER**

1. Make sure that no crack or other damage exists. In addition to visual inspection, inspect important areas by means of red lead check. Also make sure that gasket installing surface shows no trace of gas and water leaks.
2. Place cylinder head on 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.

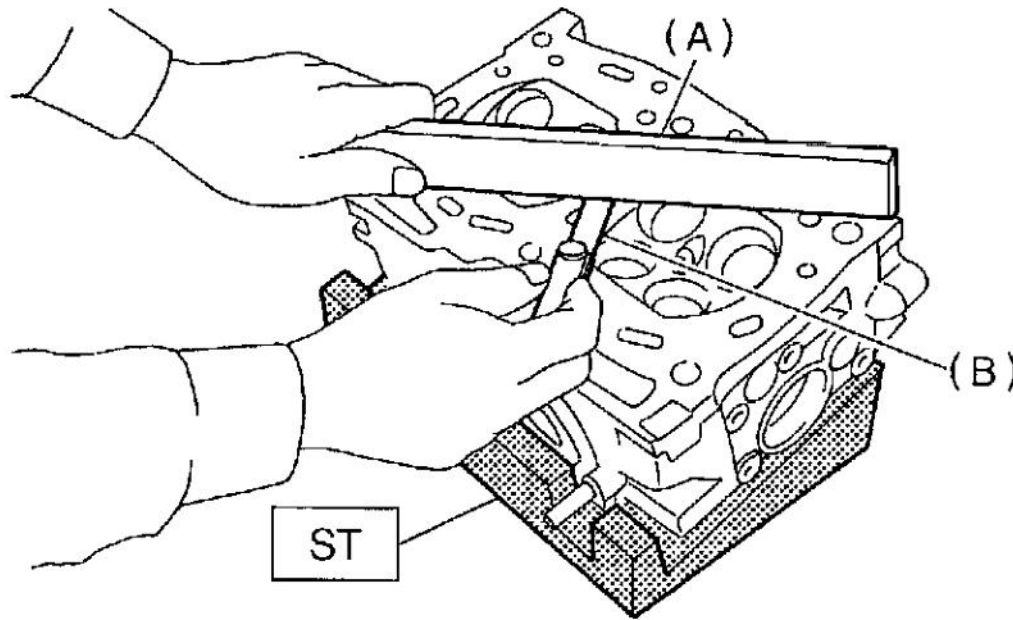
If the warping exceeds 0.05 mm (0.0020 in), regrind the surface with a surface grinder.

**Warping limit:** 0.05 mm (0.0020 in)

**Grinding limit:** 0.1 mm (0.004 in)

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

**CAUTION:** 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

G02960197

**Fig. 163: Measure Warping Of Cylinder Head Surface Using Straight Edge & Thickness Gauge**  
Courtesy of SUBARU OF AMERICA, INC.

#### VALVE SEAT

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

#### Valve seat width: W

##### Intake

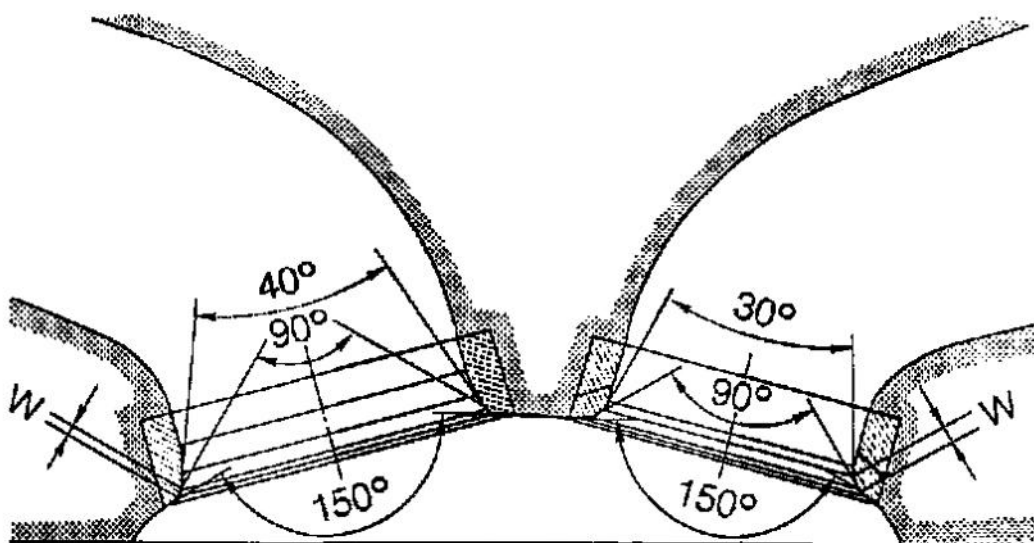
**Standard:** 1.0 mm (0.039 in)

**Limit:** 1.7 mm (0.067 in)

**Exhaust**

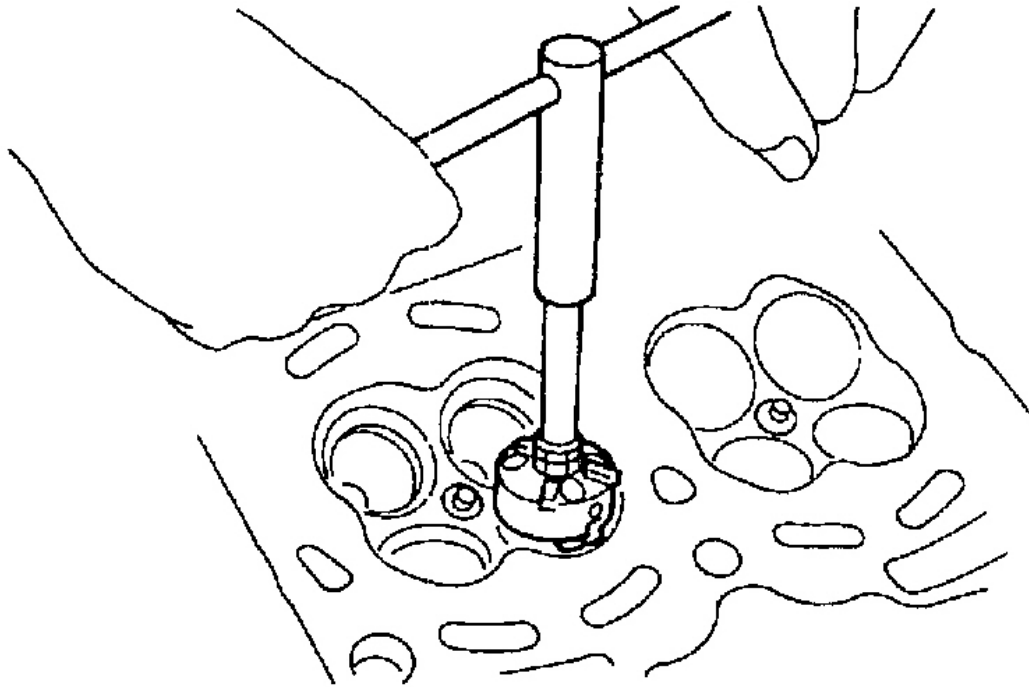
**Standard:** 1.4 mm (0.055 in)

**Limit:** 2.1 mm (0.083 in)



G02960198

**Fig. 164: Inspecting Intake & Exhaust Valve Seats**  
Courtesy of SUBARU OF AMERICA, INC.



G02960199

**Fig. 165: Correcting Contact Surfaces With Valve Seat Cutter**  
Courtesy of SUBARU OF AMERICA, INC.

#### VALVE GUIDE

1. Check the clearance between valve guide and stem. The clearance can be checked by measuring the outside diameter of valve stem and the inside diameter of valve guide with outside and inside micrometers respectively.

#### **Clearance between the valve guide and valve stem:**

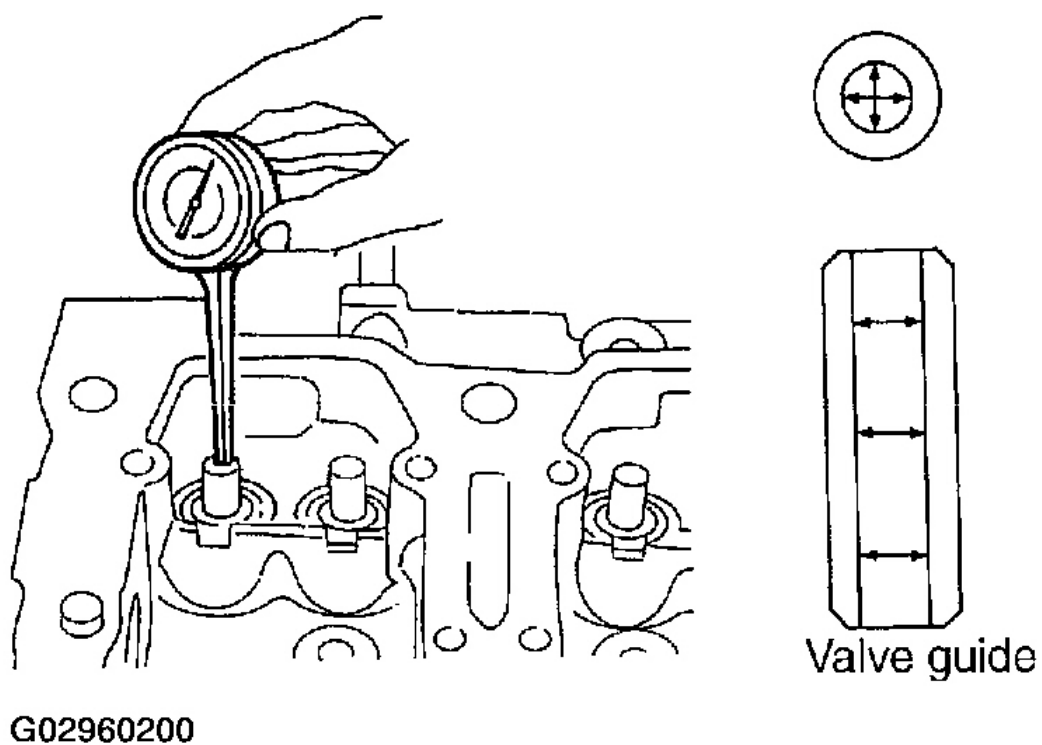
##### **Standard**

**Intake:** 0.035 - 0.062 mm (0.0014 - 0.0024 in)

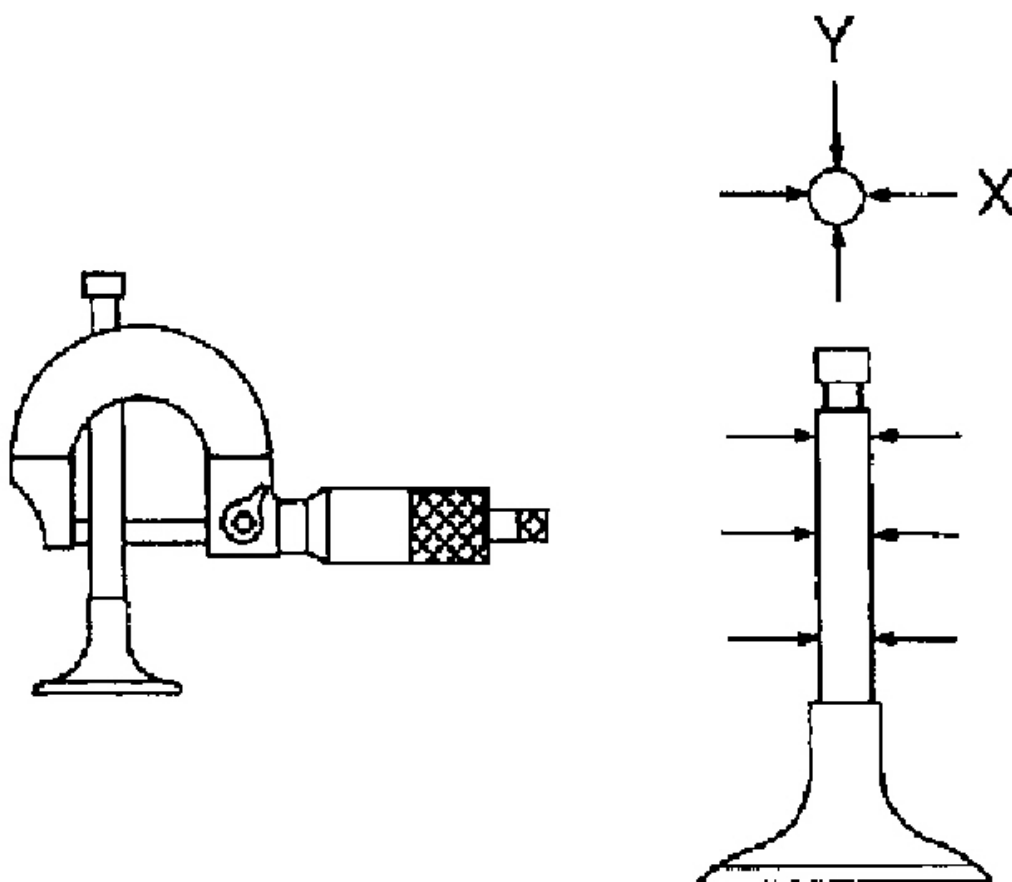
**Exhaust:** 0.040 - 0.067 mm (0.0016 - 0.0026 in)

**Limit:** 0.15 mm (0.0059 in)

**NOTE:** Measure the top, center, and bottom diameters of valve and valve guide respectively to check each clearance.



**Fig. 166: Measuring Top, Center & Bottom diameters Of Valve**  
Courtesy of SUBARU OF AMERICA, INC.



G02960201

**Fig. 167: Measuring Valve Guide**

Courtesy of SUBARU OF AMERICA, INC.

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

**Valve guide inner diameter:** 6.000 - 6.012 mm (0.2362 - 0.2367 in)

**Valve stem outer diameters:**

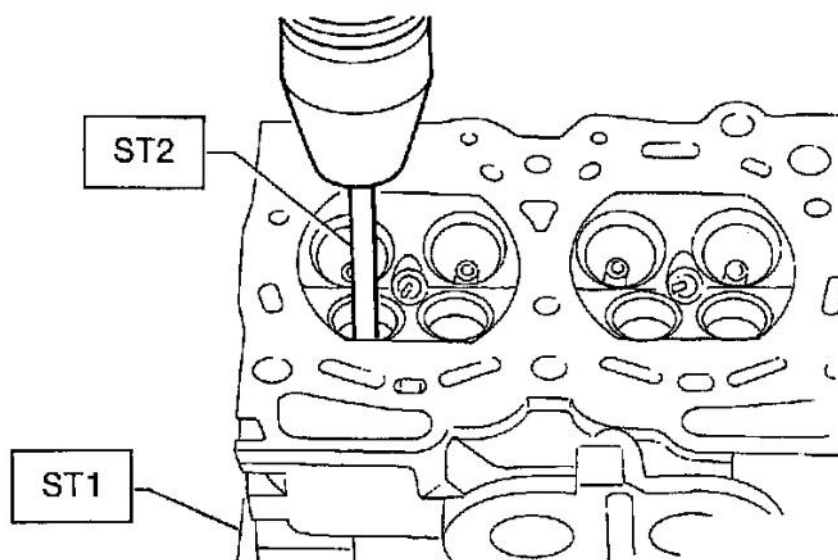
**Intake:** 5.950 - 5.965 mm (0.2343 - 0.2348 in)

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

1. Place cylinder head on ST1 with the combustion chamber upward so that valve guides enter the holes in ST1.

2. Insert ST2 into valve guide and press it down to remove valve guide.

ST1 498267800 CYLINDER HEAD TABLE  
ST2 499767200 VALVE GUIDE REMOVER



G02960202

**Fig. 168: Placing Cylinder Head On ST1 With Combustion Chamber Upward**  
Courtesy of SUBARU OF AMERICA, INC.

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

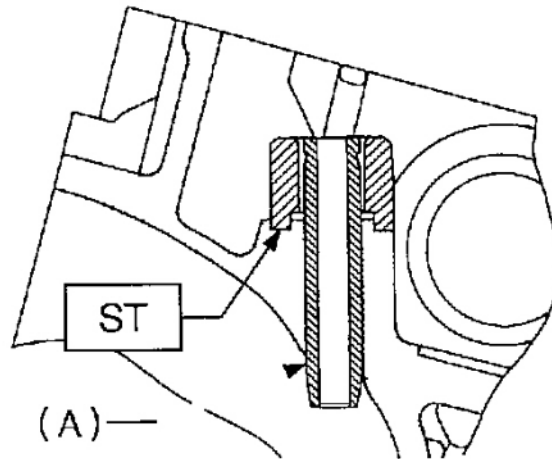


Intake side:

ST 499767700 VALVE GUIDE ADJUSTER

Exhaust side:

ST 499767800 VALVE GUIDE ADJUSTER



(A) Valve guide

G02960203

**Fig. 169: Turning Cylinder Head Upside Down & Placing ST**  
Courtesy of SUBARU OF AMERICA, INC.

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

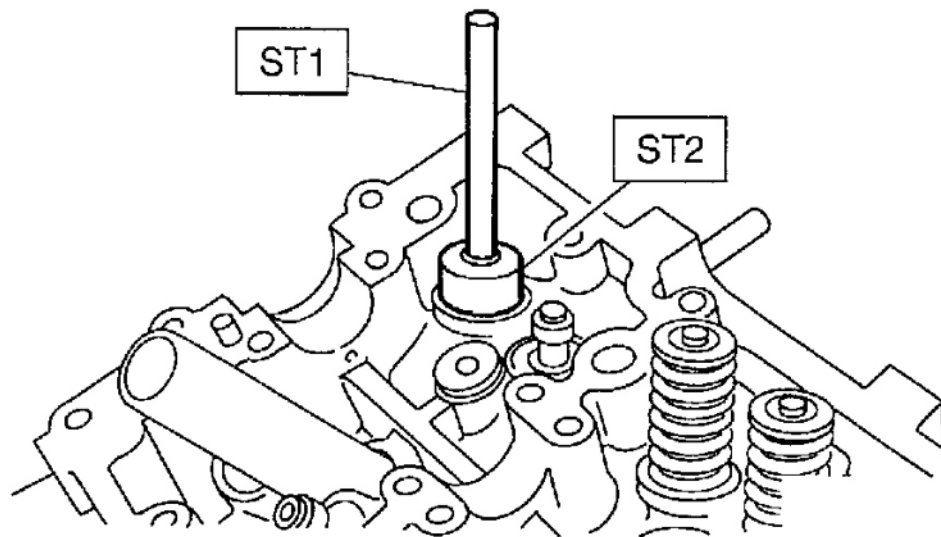
ST1 499767200 VALVE GUIDE REMOVER

Intake side:

ST2 499767700 VALVE GUIDE ADJUSTER

Exhaust side:

ST2 499767800 VALVE GUIDE ADJUSTER



G02960204

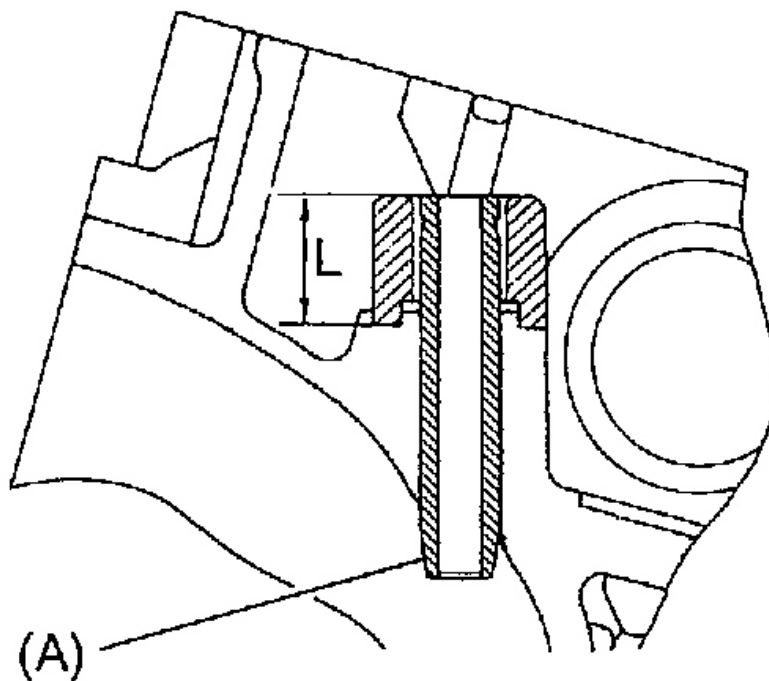
**Fig. 170: Inserting ST1 Into Valve Guide**  
Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion.

**Valve guide protrusion: L**

**Intake:** 20.0 - 20.5 mm (0.787 - 0.807 in)

**Exhaust:** 16.5 - 17.0 mm (0.650 - 0.669 in)



(A) Valve guide

G02960205

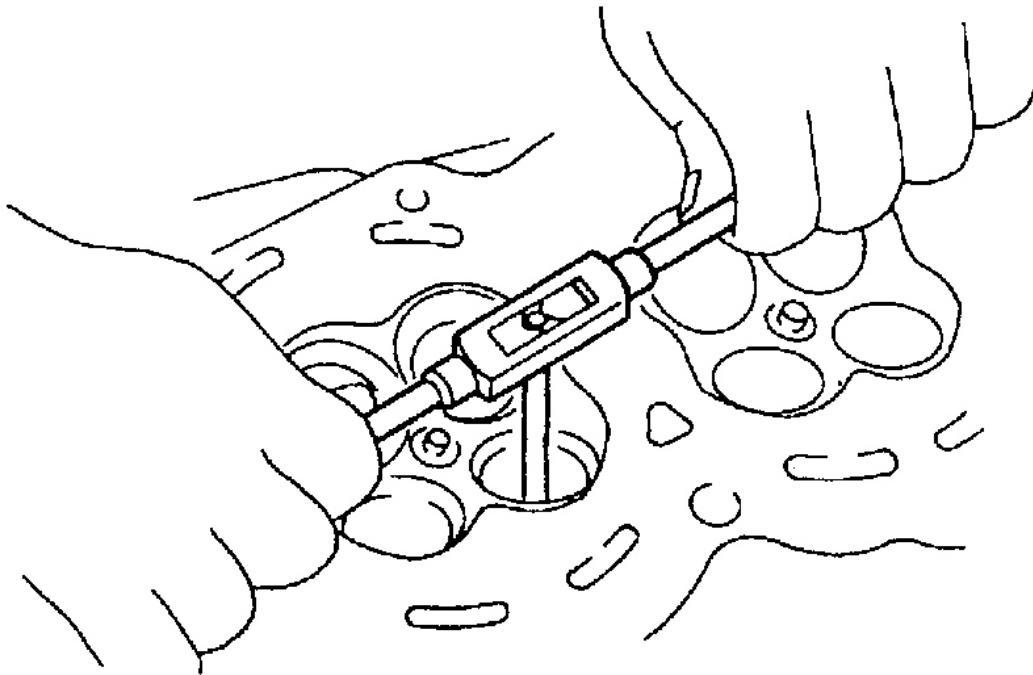
**Fig. 171: Checking Valve Guide Protrusion**  
Courtesy of SUBARU OF AMERICA, INC.

7. Ream the inside of valve guide with ST. Gently rotate the reamer clockwise while pressing it lightly into valve guide, and return it also rotating clockwise. After reaming, clean 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 chips, use a new reamer or remedy the reamer.

ST 499767400 VALVE GUIDE REAMER



G02960206

**Fig. 172: Reaming Inside Of Valve Guide With ST**  
Courtesy of SUBARU OF AMERICA, INC.

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

#### INTAKE AND EXHAUST VALVE

1. Inspect the flange and stem of valve, and replace if damaged, worn, or deformed, or if "H" is less than the specified limit.

**H:**

##### **Intake**

**Standard:** 1.0 mm (0.039 in)

**Limit:** 0.6 mm (0.024 in)

##### **Exhaust**

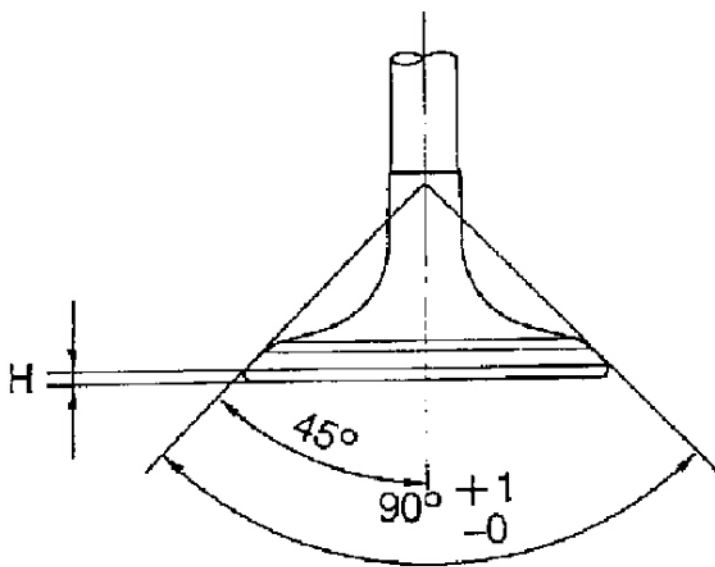
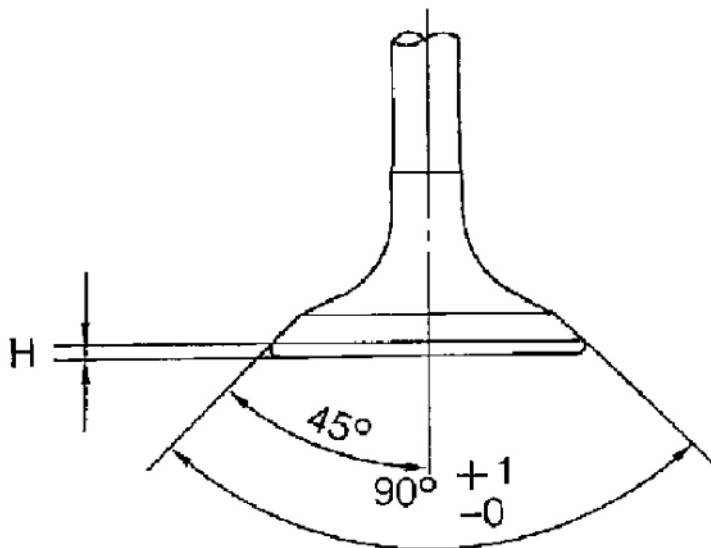
**Standard:** 1.2 mm (0.047 in)

**Limit:** 0.6 mm (0.024 in)

##### **Valve overall length:**

**Intake:** 120.6 mm (4.75 in)

**Exhaust:** 121.7 mm (4.79 in)



G02960207

**Fig. 173: Inspecting Flange & Stem Of Valve**  
Courtesy of SUBARU OF AMERICA, INC.

2. Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. Refer to **VALVE SEAT**, ADJUSTMENT, Cylinder Head Assembly. Install a new intake valve oil seal after lapping.

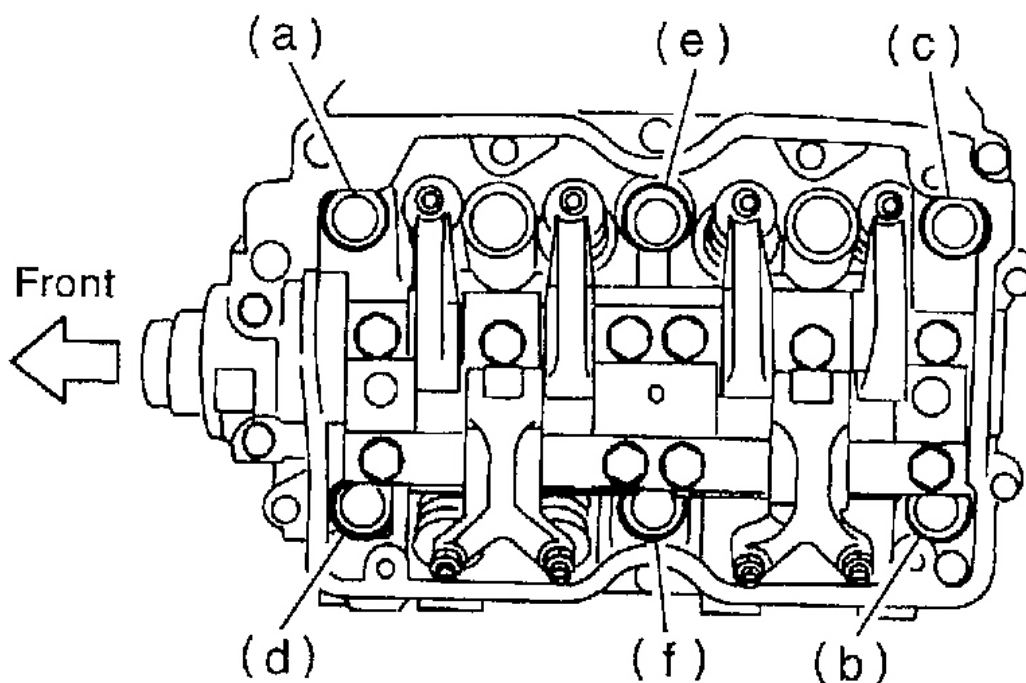
## CYLINDER BLOCK

### REMOVAL

**NOTE:** Before conducting this procedure, drain engine oil completely if applicable.

1. Remove intake manifold. Refer to **REMOVAL** , Intake Manifold.
2. Remove V-belt. Refer to **REMOVAL**, V-belt.
3. Remove crankshaft pulley. Refer to **REMOVAL**, Crankshaft Pulley.
4. Remove belt cover. Refer to **REMOVAL**, Belt Cover.
5. Remove timing belt assembly, Refer to **REMOVAL**, Timing Belt Assembly.
6. Remove camshaft sprocket. Refer to **REMOVAL**, Camshaft Sprockets.
7. Remove crankshaft sprocket. Refer to **REMOVAL**, Crankshaft Sprockets.
8. Remove generator and A/C compressor with their brackets.
9. Remove rocker cover.
10. Remove cylinder head bolts in alphabetical sequence shown in figure.

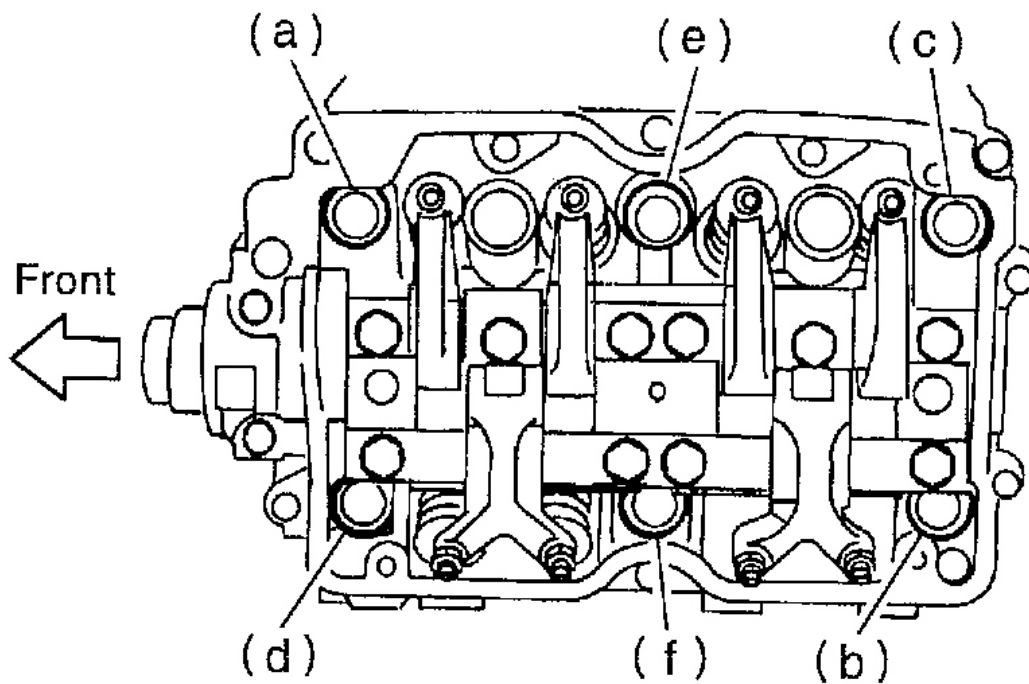
**CAUTION:** Leave bolts (a) and (b) engaged by three or four threads to prevent cylinder head from failing.



G02960208

**Fig. 174: Removing Cylinder Head Bolts In Sequence**  
Courtesy of SUBARU OF AMERICA, INC.

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



G02960209

**Fig. 175: Removing Cylinder Head Bolts (a & b)**  
Courtesy of SUBARU OF AMERICA, INC.

13. Remove cylinder head gasket.

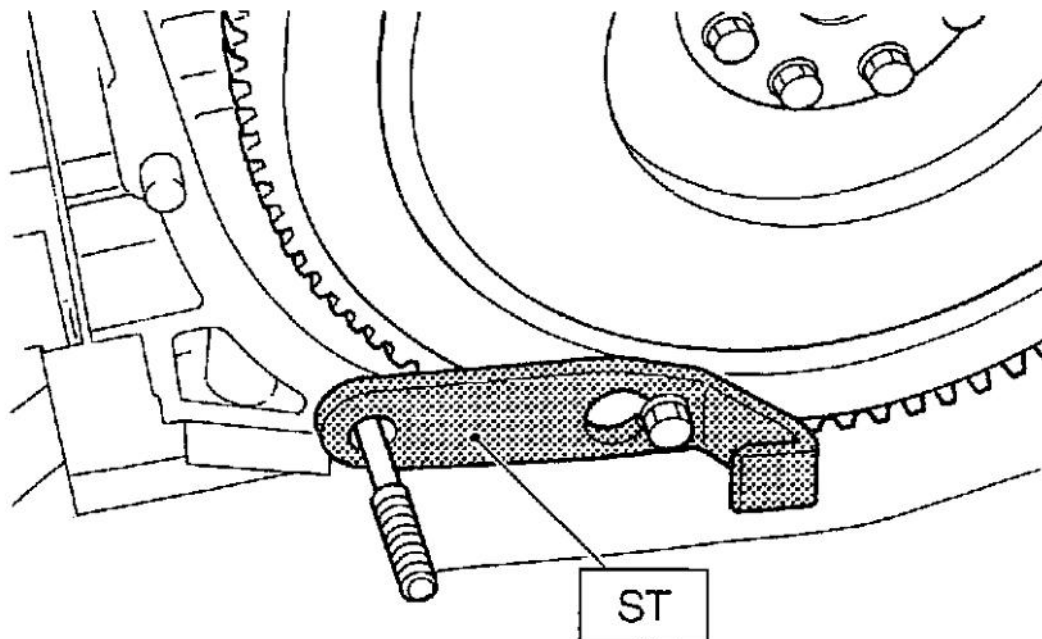
**CAUTION: Do not scratch the mating surface of cylinder head and cylinder block.**

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

Using ST, lock crankshaft.

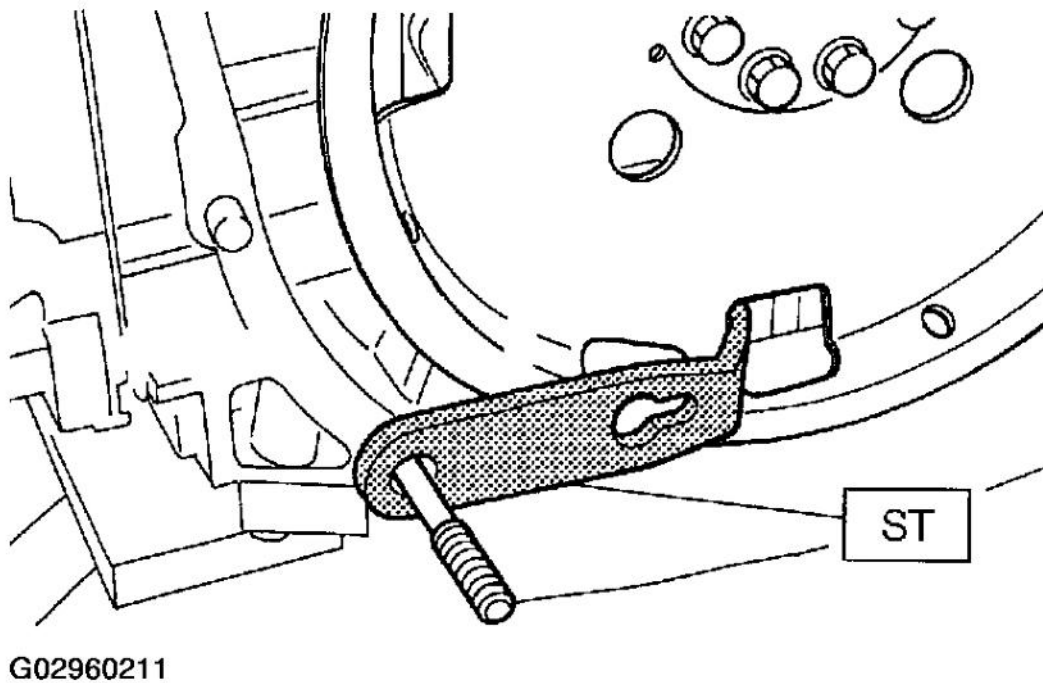
ST 498497100 CRANKSHAFT STOPPER





G02960210

**Fig. 176: Removing Flywheel (MT Vehicles Only)**  
Courtesy of SUBARU OF AMERICA, INC.

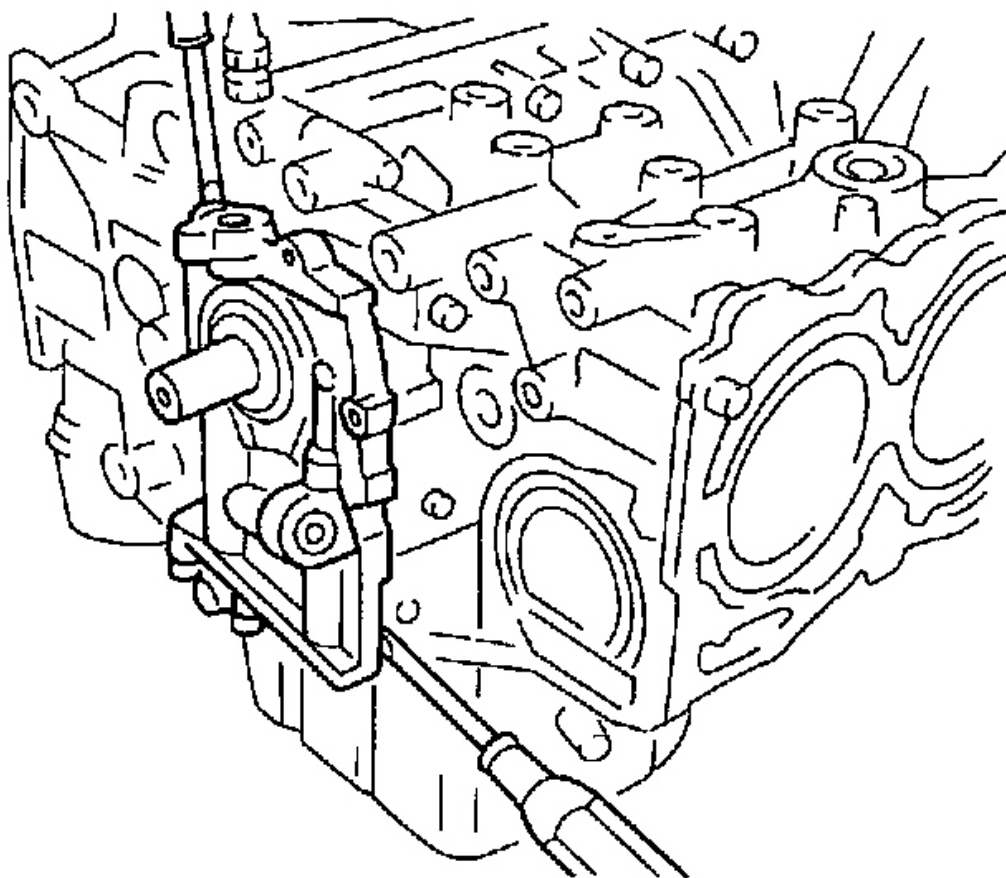


**Fig. 177: Removing Drive Plate (AT Vehicles Only)**  
Courtesy of SUBARU OF AMERICA, INC.

17. Remove oil separator cover.
18. Remove water by-pass pipe for heater.
19. Remove water pump.
20. Remove oil pump from cylinder block.

Use a flat-bladed screwdriver as shown in figure when removing oil pump.

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



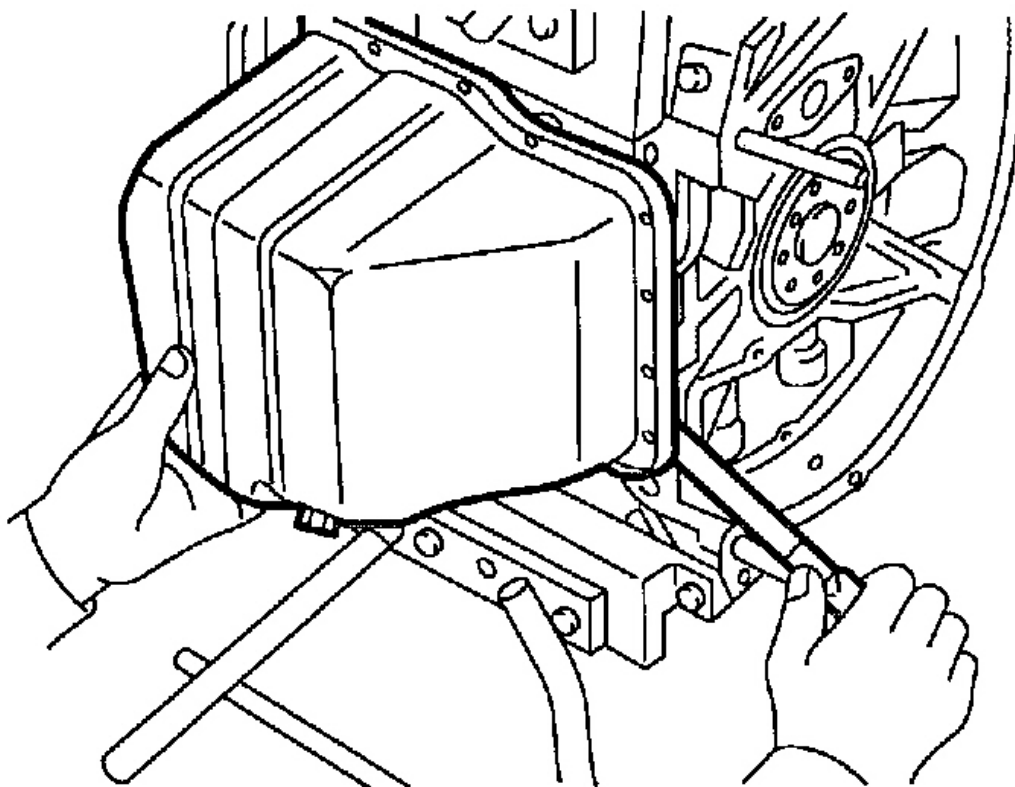
G02960212

**Fig. 178: Removing Oil Pump From Cylinder Block**  
Courtesy of SUBARU OF AMERICA, INC.

21. Removal of oil pan

1. Turn cylinder block with #2 and #4 piston sides facing upward.
2. Remove bolts which secure oil pan to cylinder block.
3. Insert a oil pan cutter blade between cylinder block-to-oil pan clearance and remove oil pan.

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

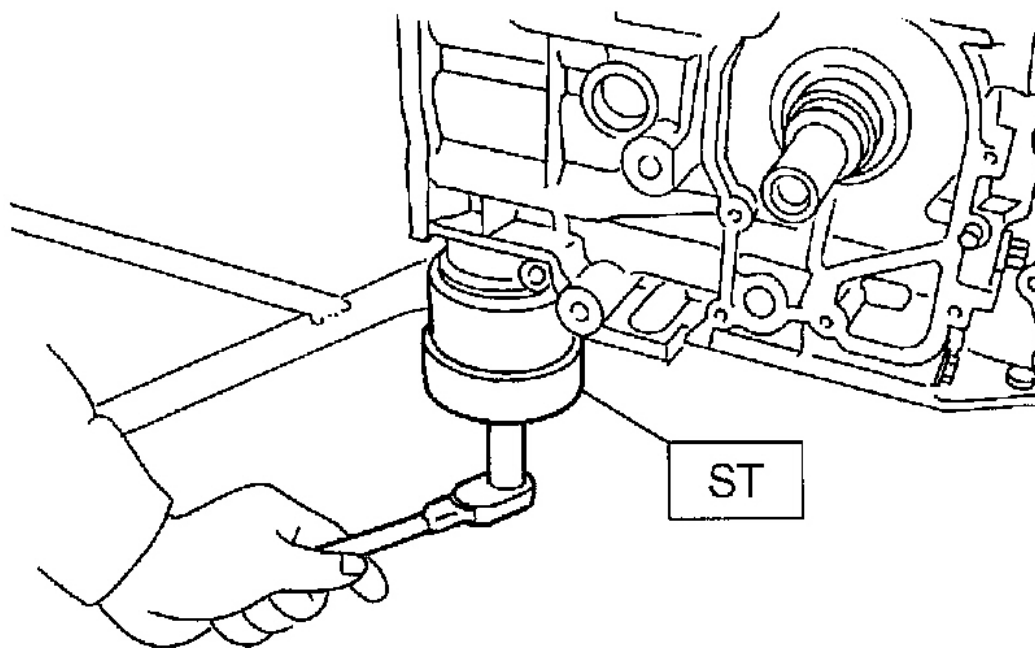


G02960213

**Fig. 179: Removing Oil Pan**

Courtesy of SUBARU OF AMERICA, INC.

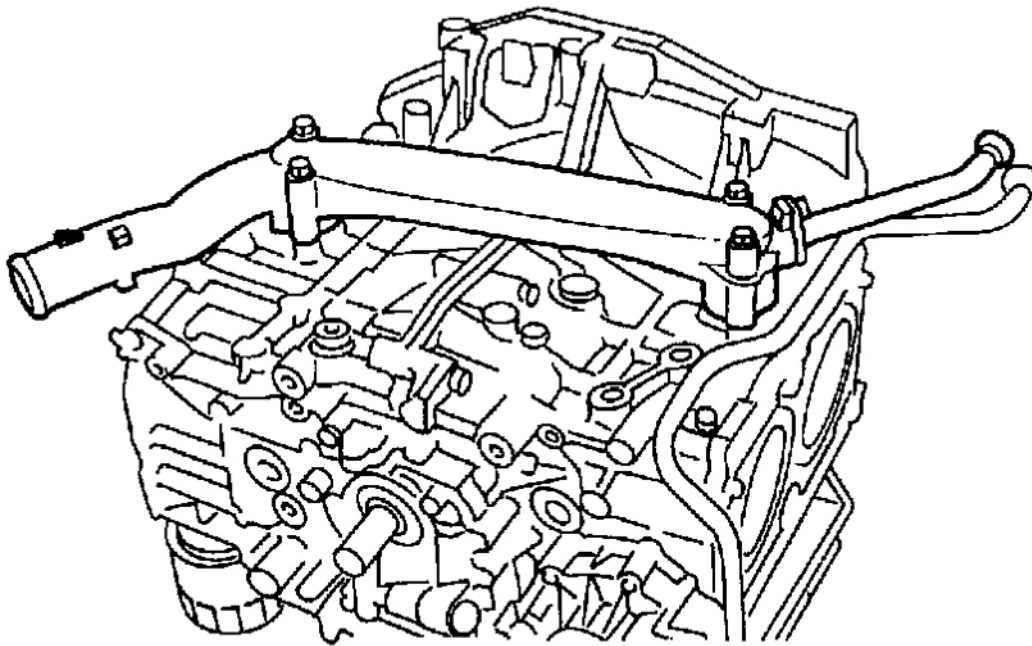
22. Remove oil strainer stay.
23. Remove oil strainer.
24. Remove baffle plate.
25. Remove oil filter using ST.



G02960214

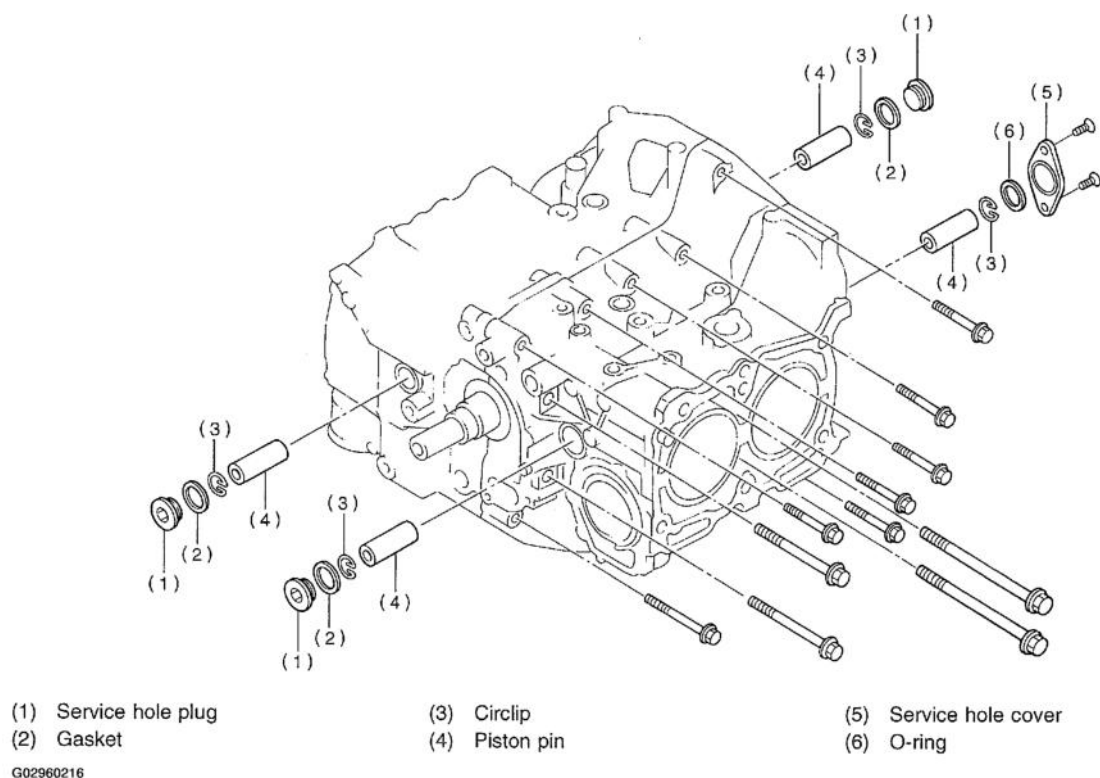
**Fig. 180: Removing Oil Filter Using ST**  
Courtesy of SUBARU OF AMERICA, INC.

26. Remove water pipe.



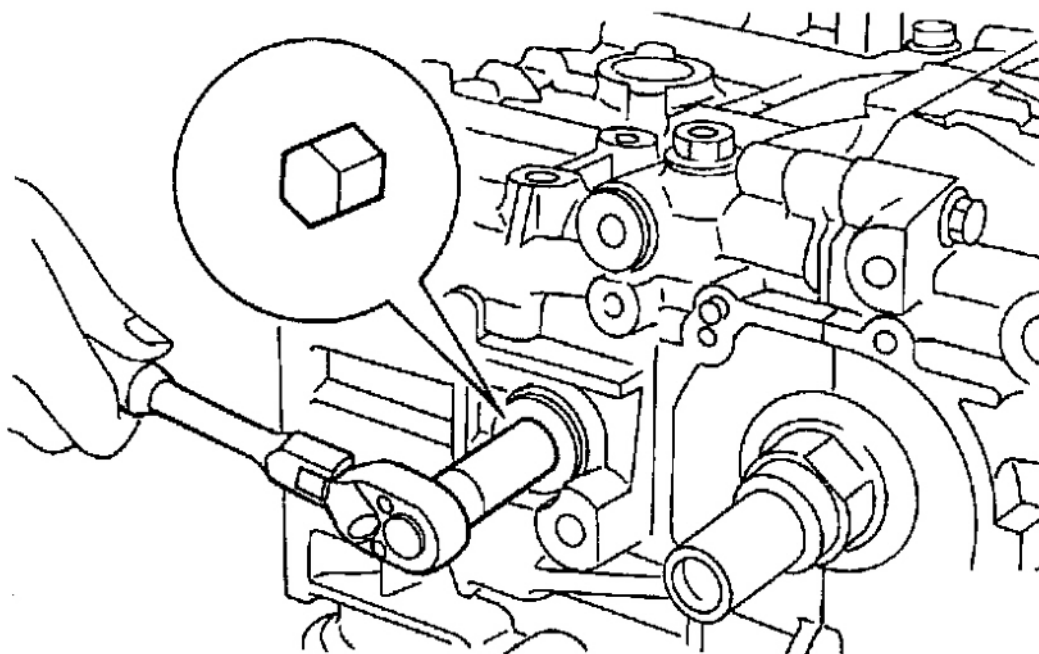
G02960215

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



**Fig. 182: Identifying Cylinder Block Components**  
 Courtesy of SUBARU OF AMERICA, INC.

27. Remove service hole cover and service hole plugs using hexagon wrench [14 mm (0.55 in)].

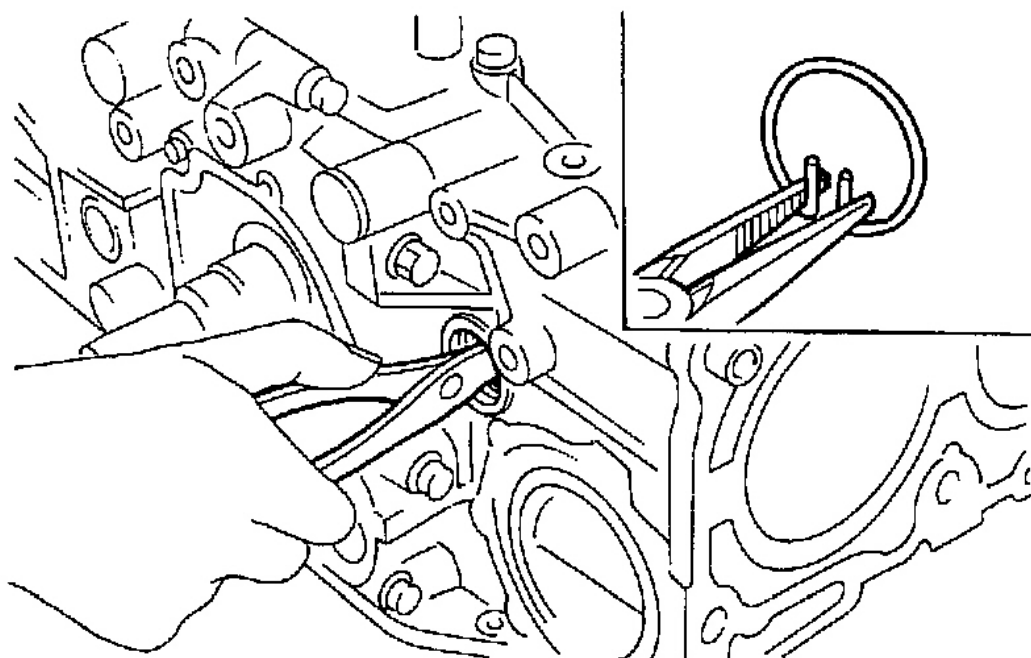


G02960217

**Fig. 183: Removing Service Hole Cover & Service Hole Plug**  
Courtesy of SUBARU OF AMERICA, INC.

28. Rotate crankshaft to bring #1 and #2 pistons to bottom dead center position, then remove piston circlip through service hole of #1 and #2 cylinders.





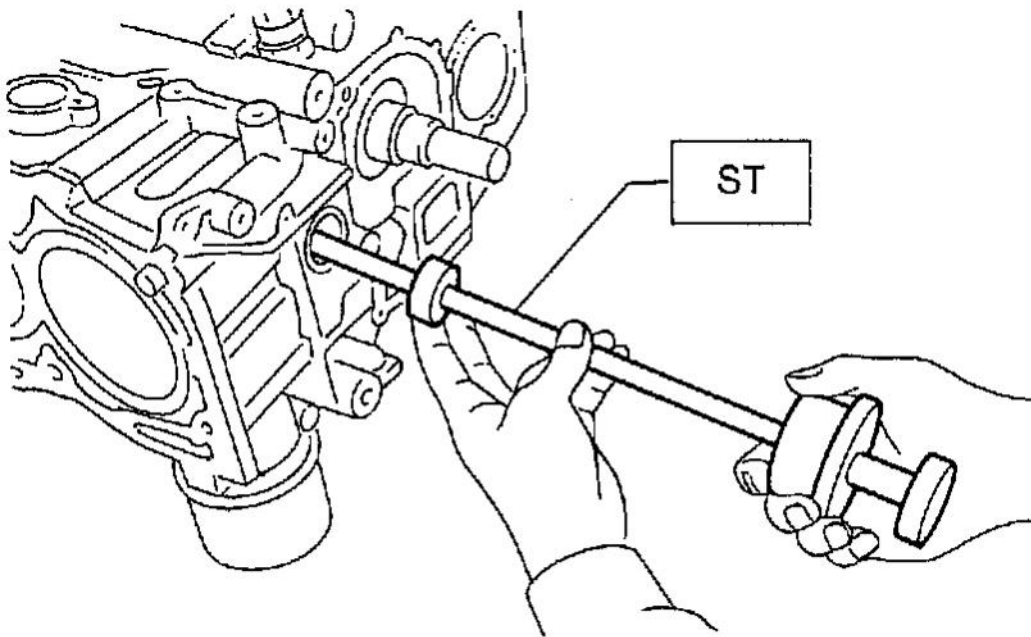
G02960218

**Fig. 184: Removing Piston Circlip**  
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499097700 PISTON PIN REMOVER

**CAUTION:** Be careful not to confuse original combination of piston, piston pin and cylinder.



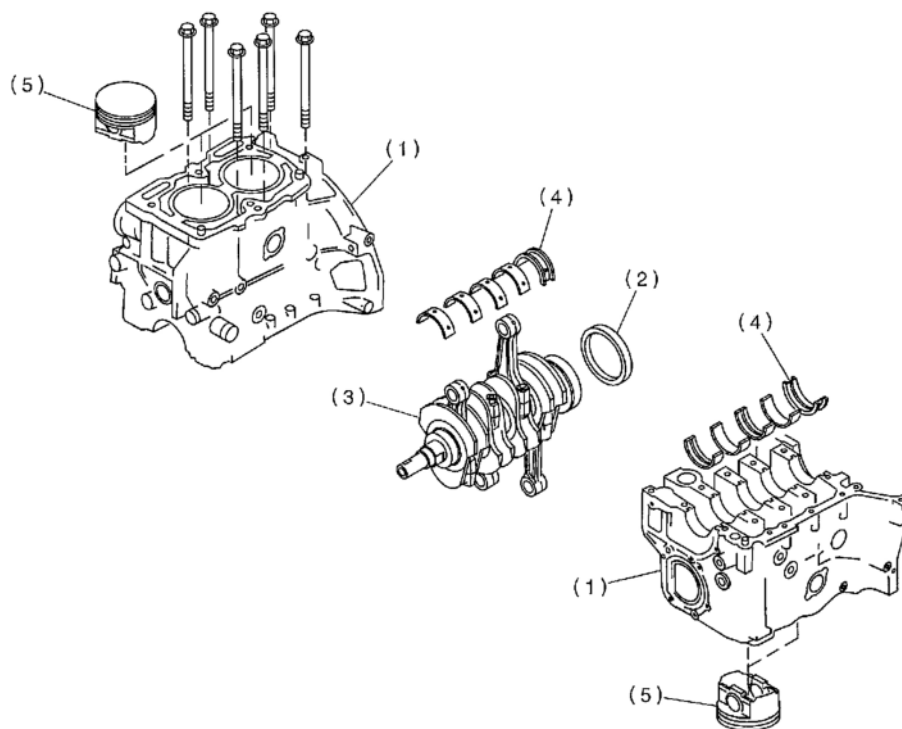
G02960219

**Fig. 185: Removing Piston pin**

Courtesy of SUBARU OF AMERICA, INC.

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

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



(1) Cylinder block

(2) Rear oil seal

G02960220

(3) Crankshaft

(4) Crankshaft bearing

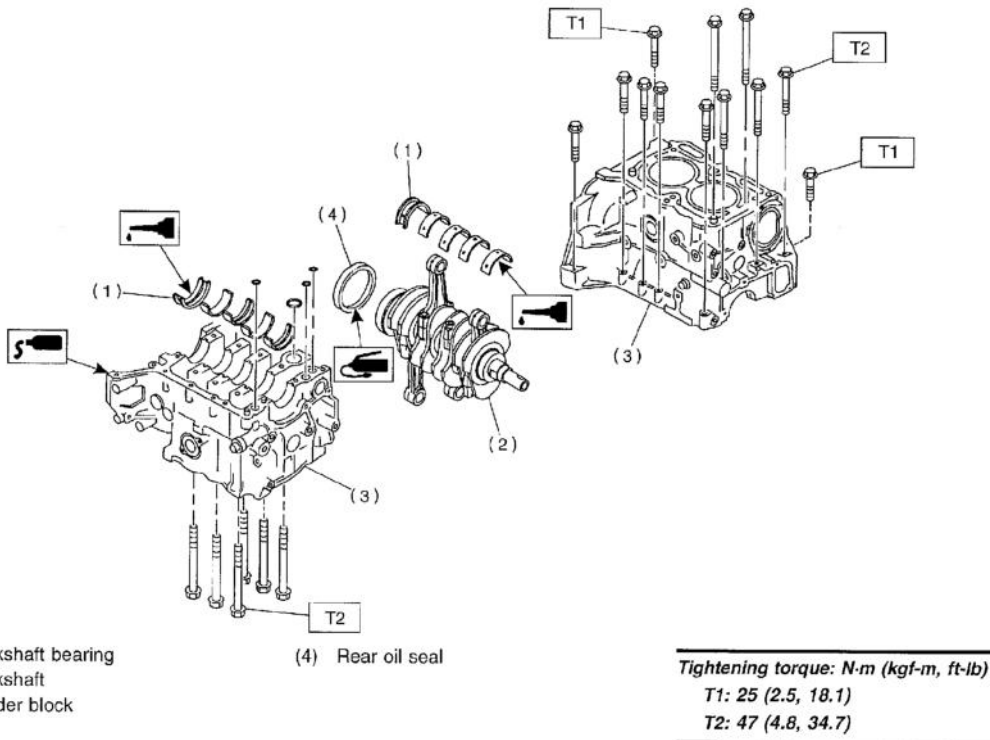
(5) Piston

**Fig. 186: Separating Left & Right Hand Cylinder Blocks**  
**Courtesy of SUBARU OF AMERICA, INC.**

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

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

### INSTALLATION



G02960221

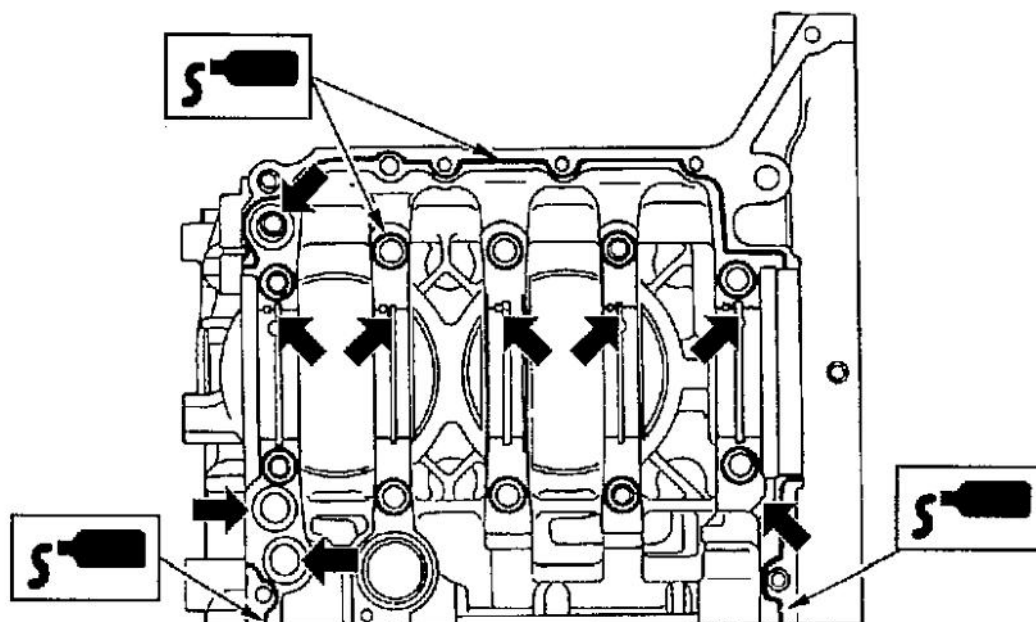
**Fig. 187: Installing Cylinder Block**  
Courtesy of SUBARU OF AMERICA, INC.

**CAUTION:** Remove oil in the mating surface of bearing and cylinder block before installation. Also apply a coat of engine oil to crankshaft pins.

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

**Fluid packing:** THREE BOND 1215 or equivalent

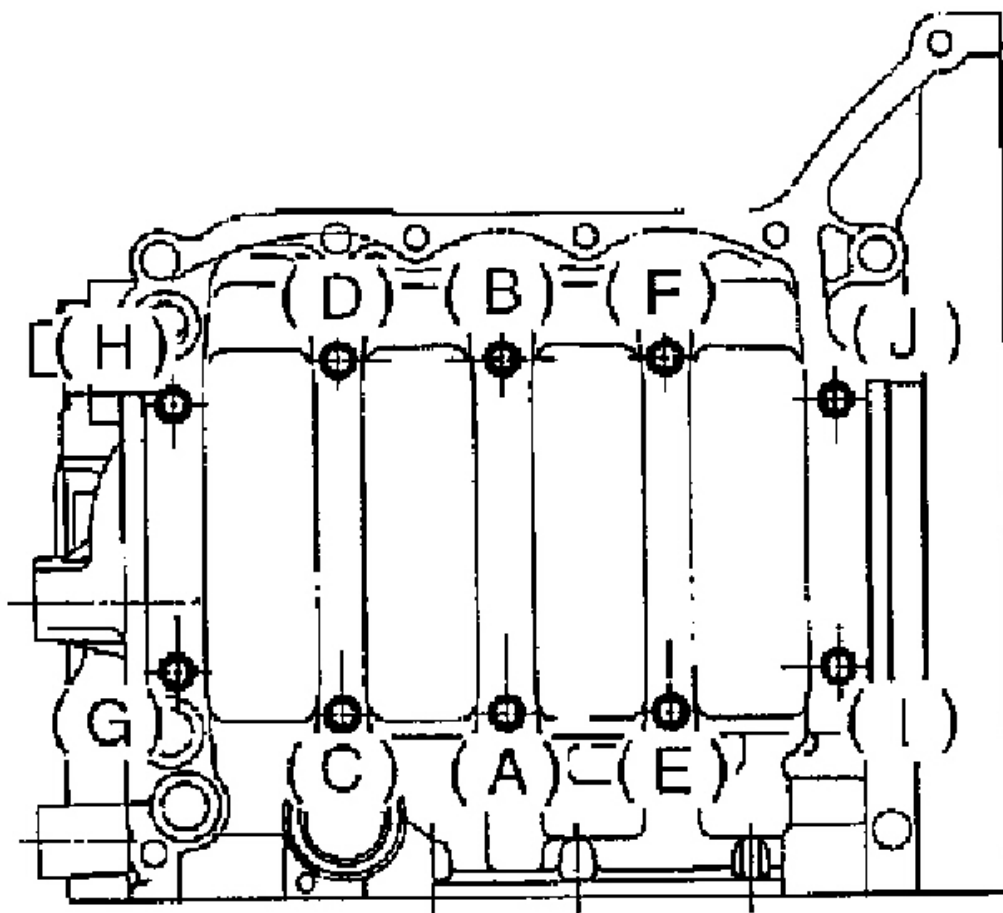
**CAUTION:** Do not allow fluid packing to jut into O-ring grooves, oil passages, bearing grooves, etc.



G02960222

**Fig. 188: Applying Fluid Packing To Mating Surface Of Cylinder Block**  
Courtesy of SUBARU OF AMERICA, INC.

3. Temporarily tighten 10 mm cylinder block connecting bolts in alphabetical sequence shown in figure.

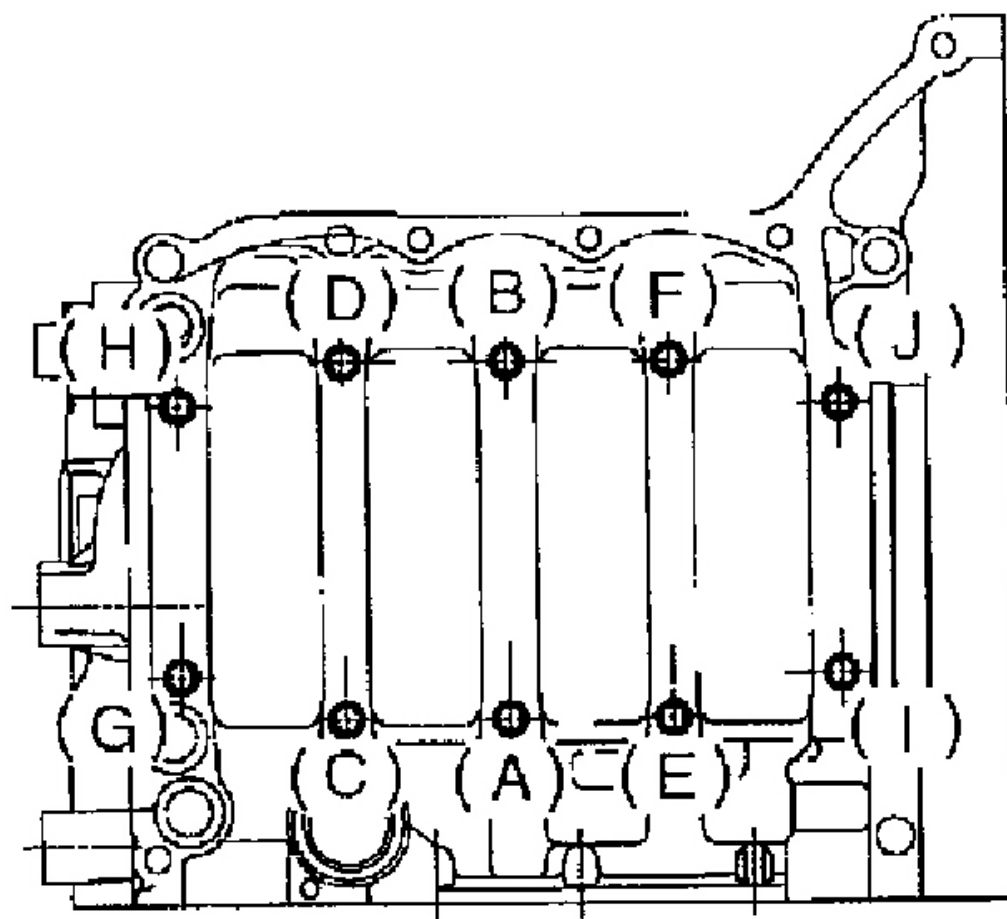


G02960223

**Fig. 189: Temporarily Tightening 10mm Cylinder Block Connecting Bolts In Sequence**  
Courtesy of SUBARU OF AMERICA, INC.

4. Tighten 10 mm cylinder block connecting bolts in alphabetical sequence.

**Tightening torque:** 47+/-3 N.m (4.8+/-0.3 kgf-m, 34.7+/-2.2 ft-lb)



G02960224

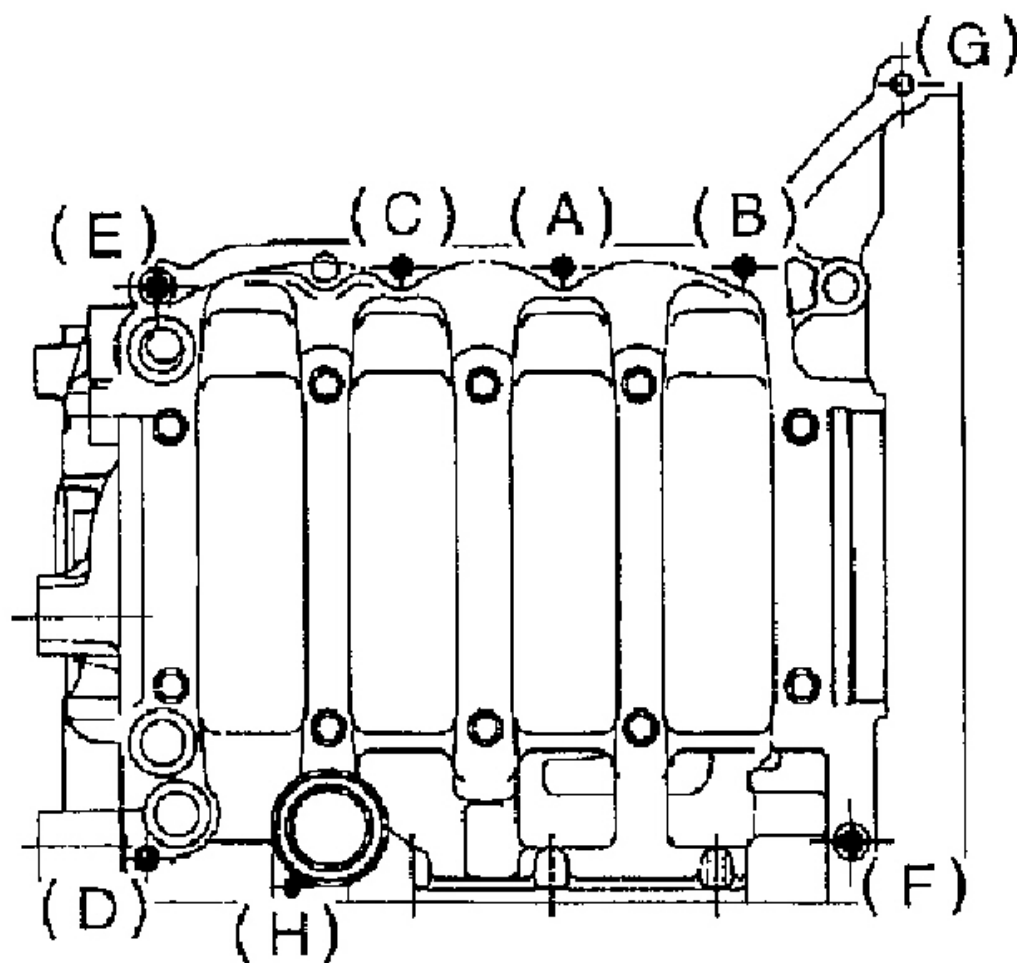
**Fig. 190: Tightening 10mm Cylinder Block Connecting Bolts in Sequence**  
Courtesy of SUBARU OF AMERICA, INC.

5. Tighten 8 mm and 6 mm cylinder block connecting bolts in alphabetical sequence shown in figure.

**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)

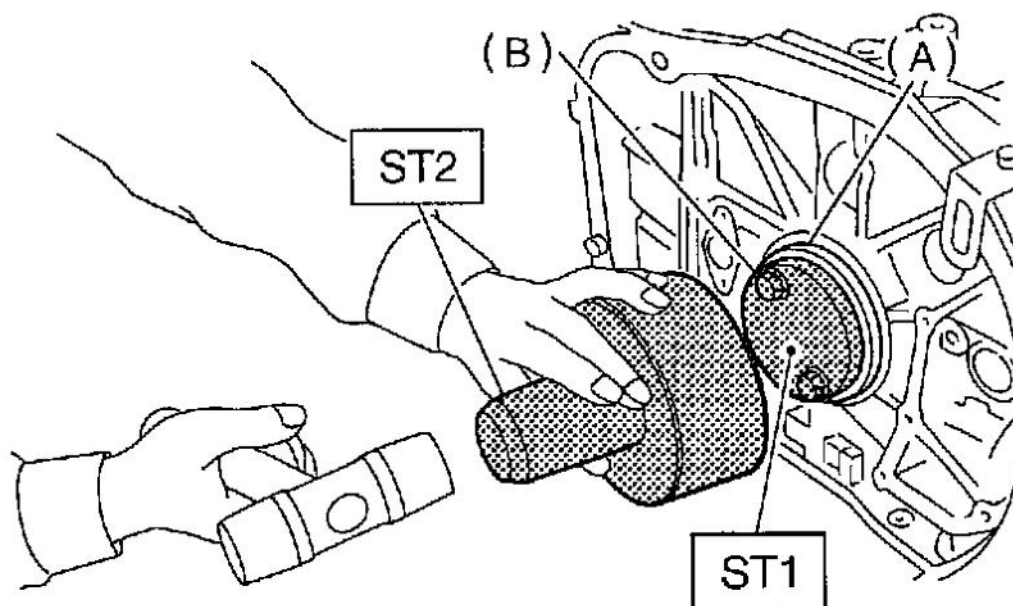


G02960225

**Fig. 191: Tightening 8mm & 6mm Cylinder Block Connecting Bolts In Sequence**  
Courtesy of SUBARU OF AMERICA, INC.

6. Install rear oil seal using ST1 and ST2.





(A) Rear oil seal

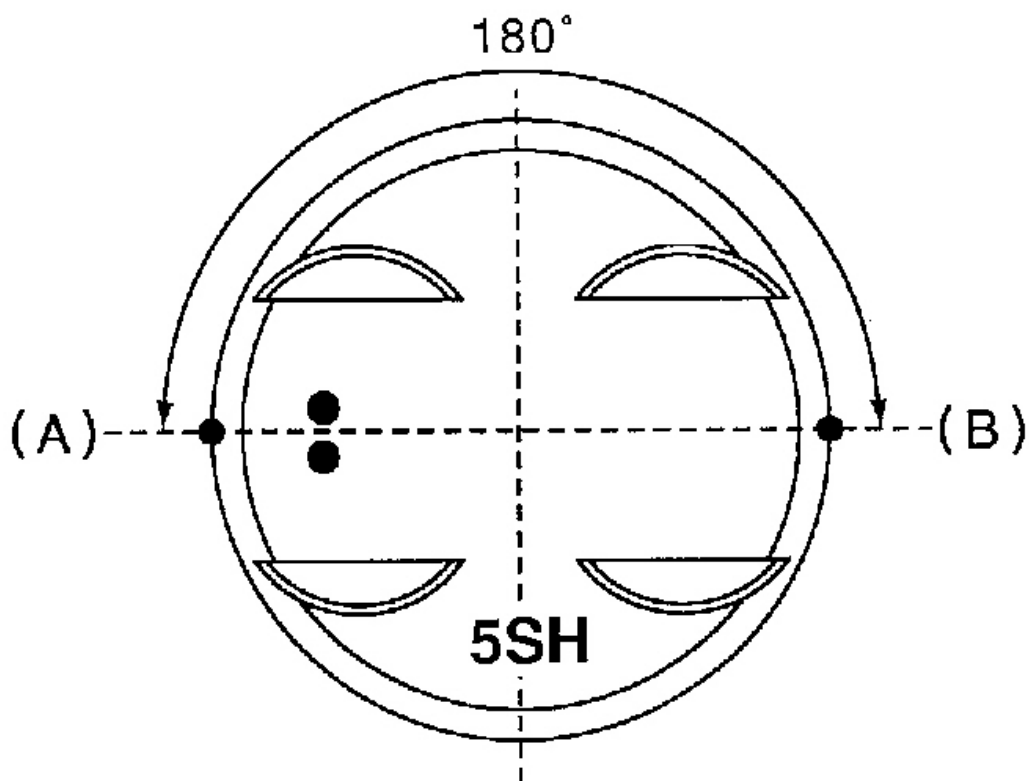
(B) Flywheel attaching bolt

G02960226

**Fig. 192: Installing Rear Oil Seal**

Courtesy of SUBARU OF AMERICA, INC.

7. Position the top ring gap at (A) or (B) in the figure.
8. Position the second ring gap at 180° on the reverse side for the top ring gap.

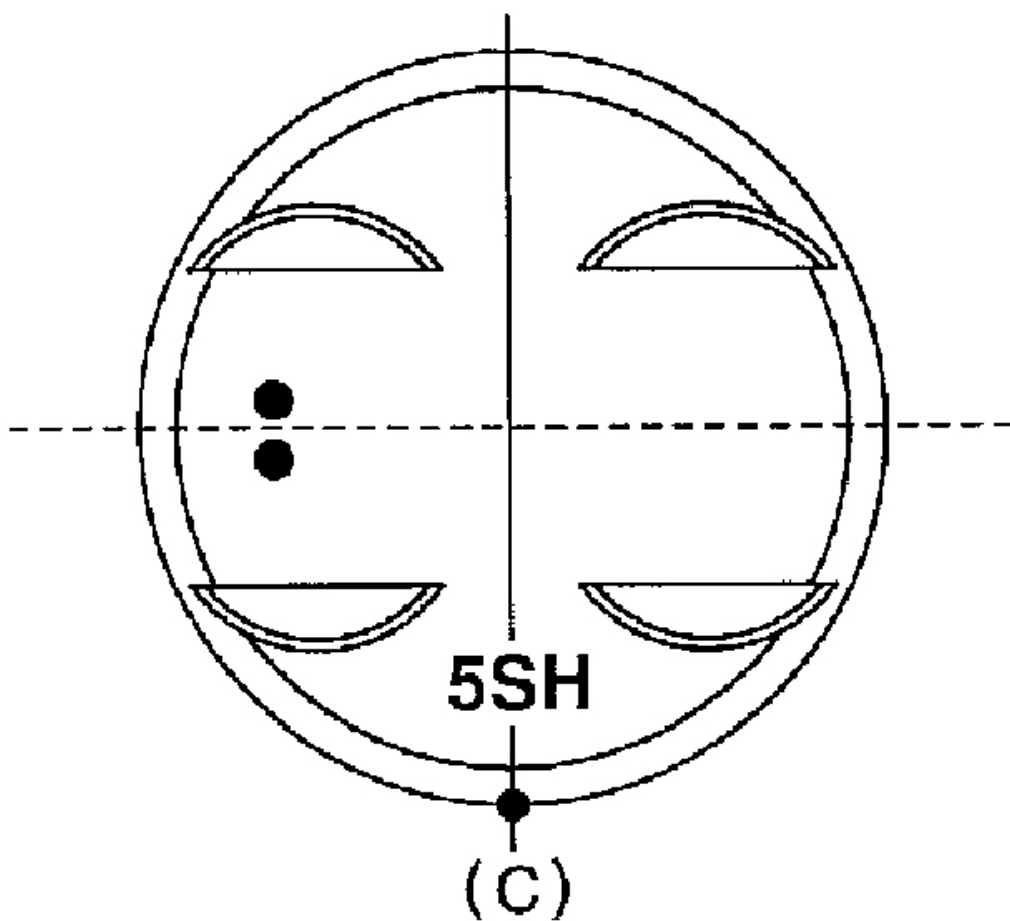


G02960227

**Fig. 193: Positioning Top Ring Gap**

Courtesy of SUBARU OF AMERICA, INC.

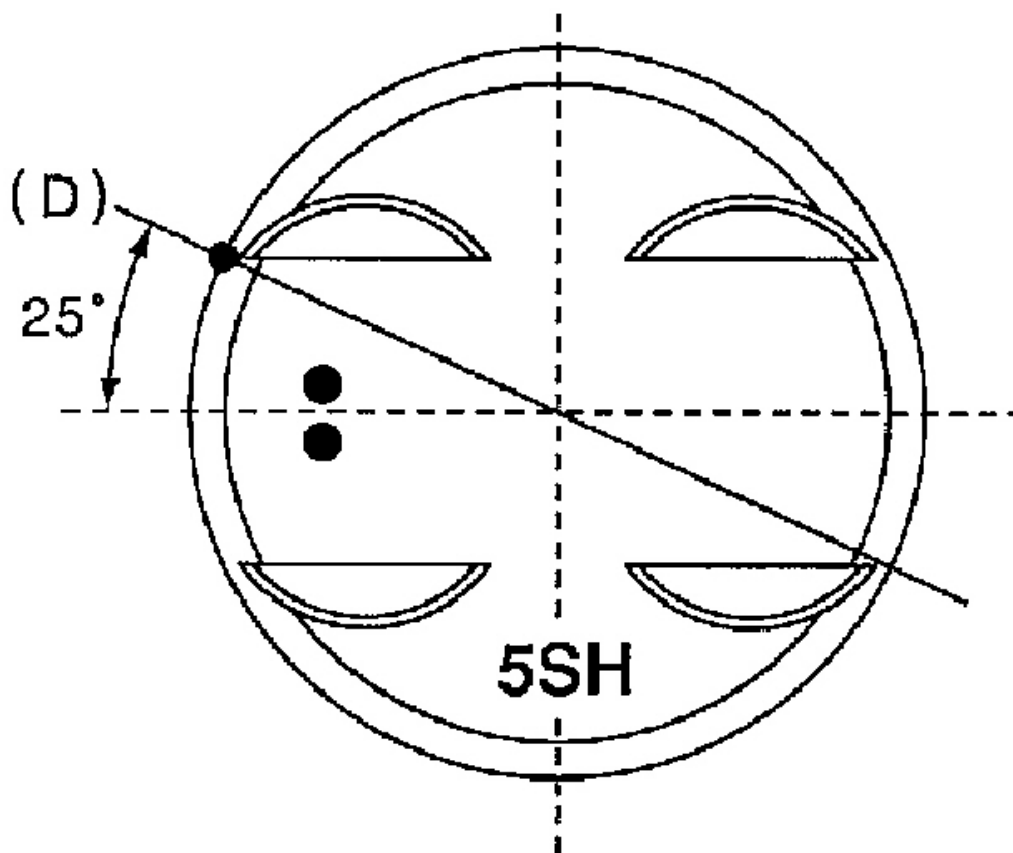
9. Position the expander gap at (C) in the figure.



G02960228

**Fig. 194: Positioning Expander Gap**  
Courtesy of SUBARU OF AMERICA, INC.

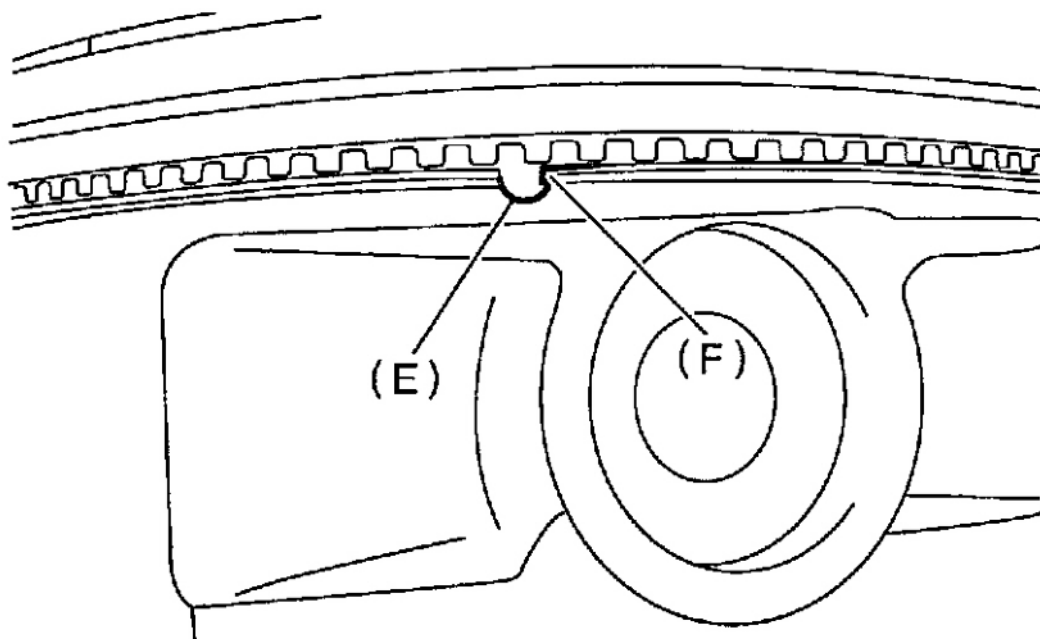
10. Position the lower rail gap at (D) in the figure.



G02960229

**Fig. 195: Identifying Lower Rail Gap**  
Courtesy of SUBARU OF AMERICA, INC.

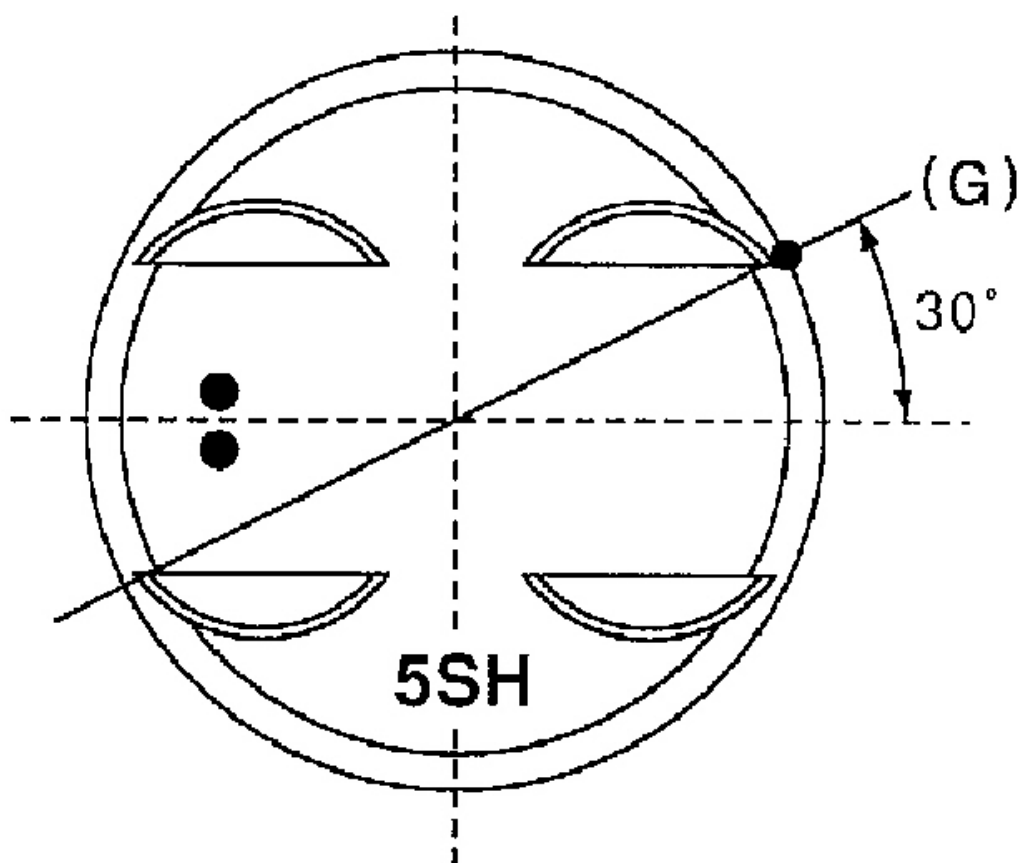
**NOTE:** Align lower rail spin stopper (F) with piston side surface hole (E).



G02960230

**Fig. 196: Aligning Lower Rail Spin Stopper With Piston Side Surface Hole**  
Courtesy of SUBARU OF AMERICA, INC.

11. Position the upper rail gap at (G) in the figure.



G02960231

**Fig. 197: Positioning Upper Rail Gap**  
Courtesy of SUBARU OF AMERICA, INC.

**CAUTION:**

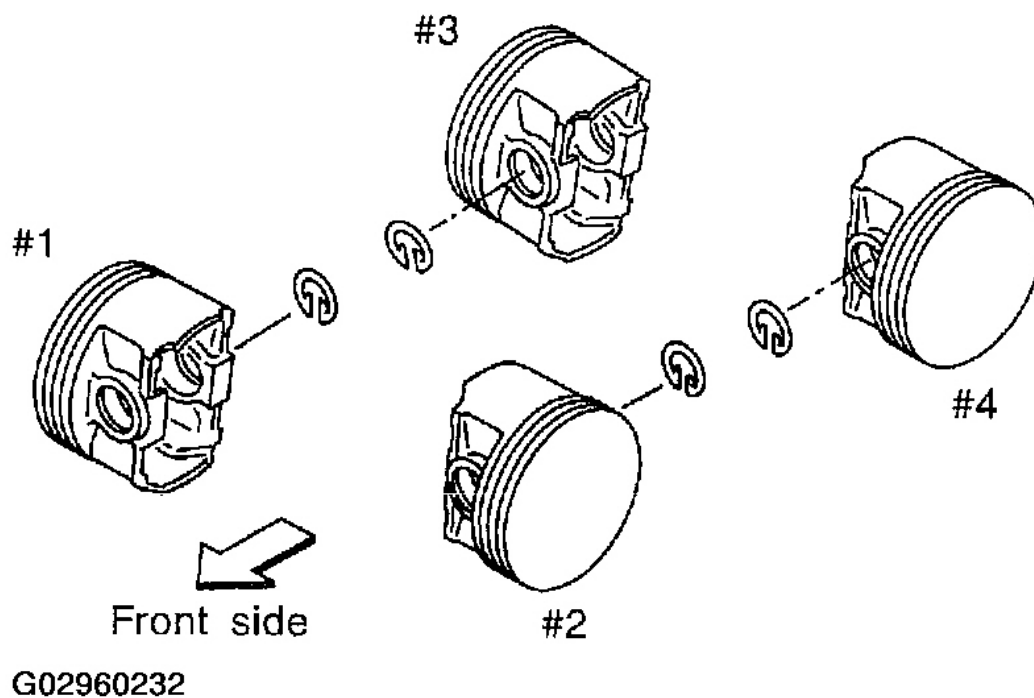
- Ensure ring gaps do not face the same direction.
- Ensure ring gaps are not within the piston skirt area.

## 12. Install circlip.

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

**NOTE:**

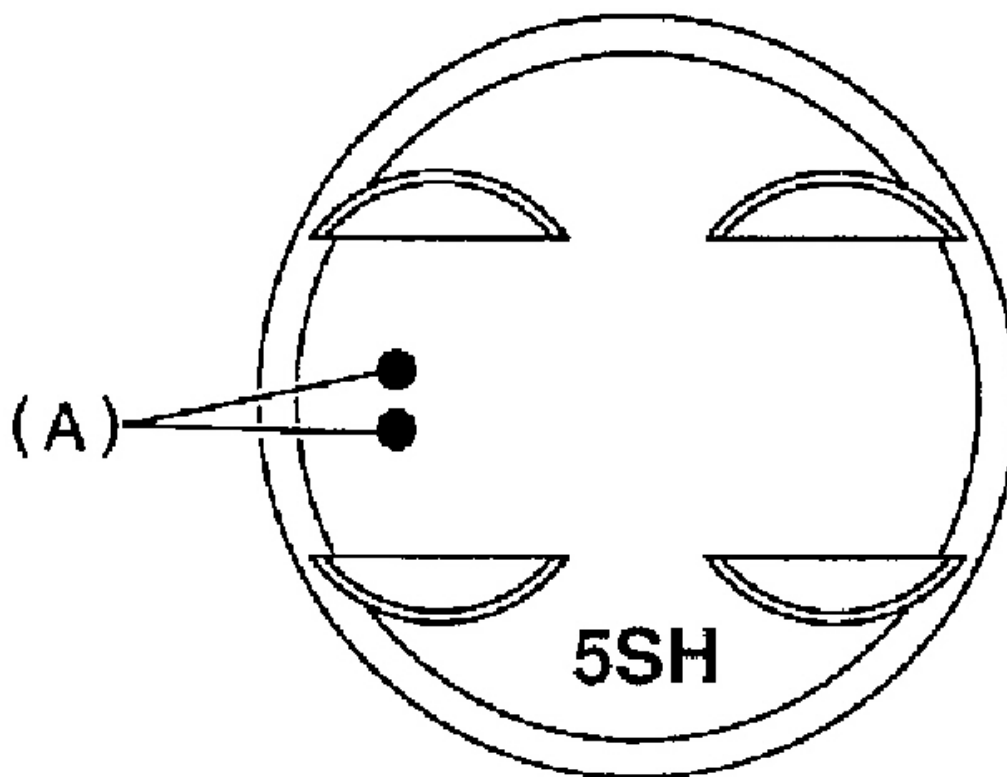
**Use new circlips.**



**Fig. 198: Installing Circlip**

Courtesy of SUBARU OF AMERICA, INC.

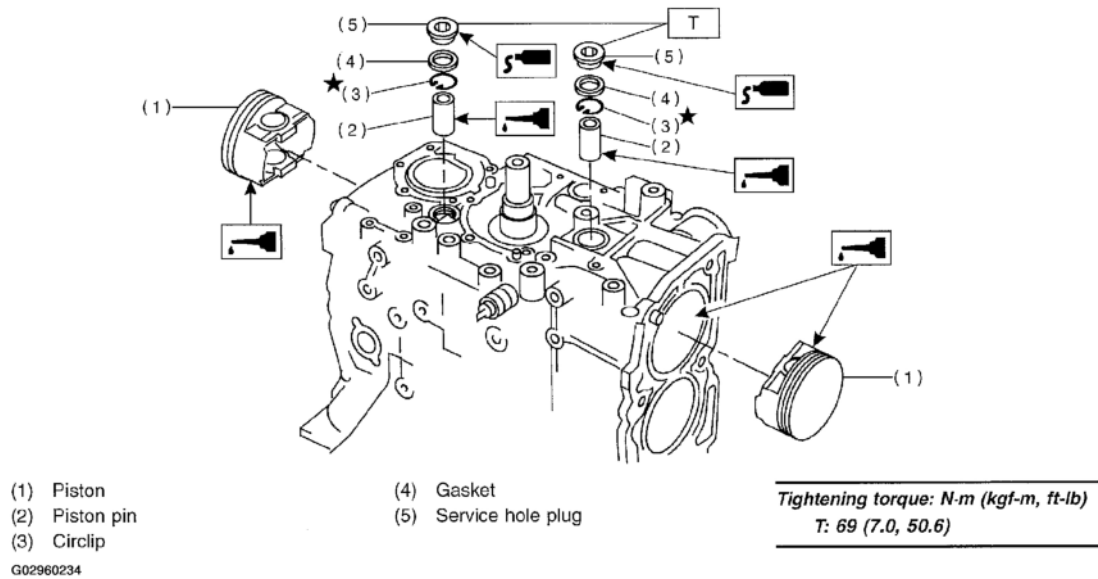
**CAUTION:** Piston front mark faces towards the front of the engine.



G02960233

**Fig. 199: Identifying Front Mark On Piston**  
Courtesy of SUBARU OF AMERICA, INC.





**Fig. 200: Applying Fluid Packing To Piston, Piston Pin & Service Hole Plug**  
Courtesy of SUBARU OF AMERICA, INC.

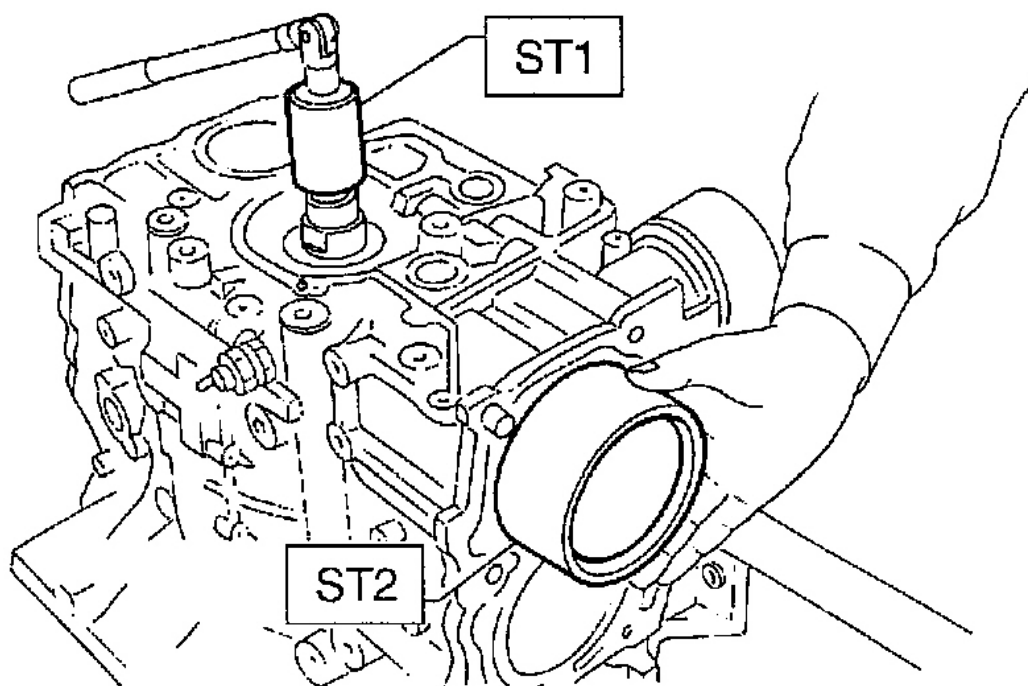
### 13. Installing piston

1. Turn cylinder block so that #1 and #2 cylinders face upward.
2. Using ST1, turn crankshaft so that #1 and #2 connecting rods are set at bottom dead center.

ST1 499987500 CRANKSHAFT SOCKET

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

ST2 498747300 PISTON GUIDE



G02960235

**Fig. 201: Installing Piston**

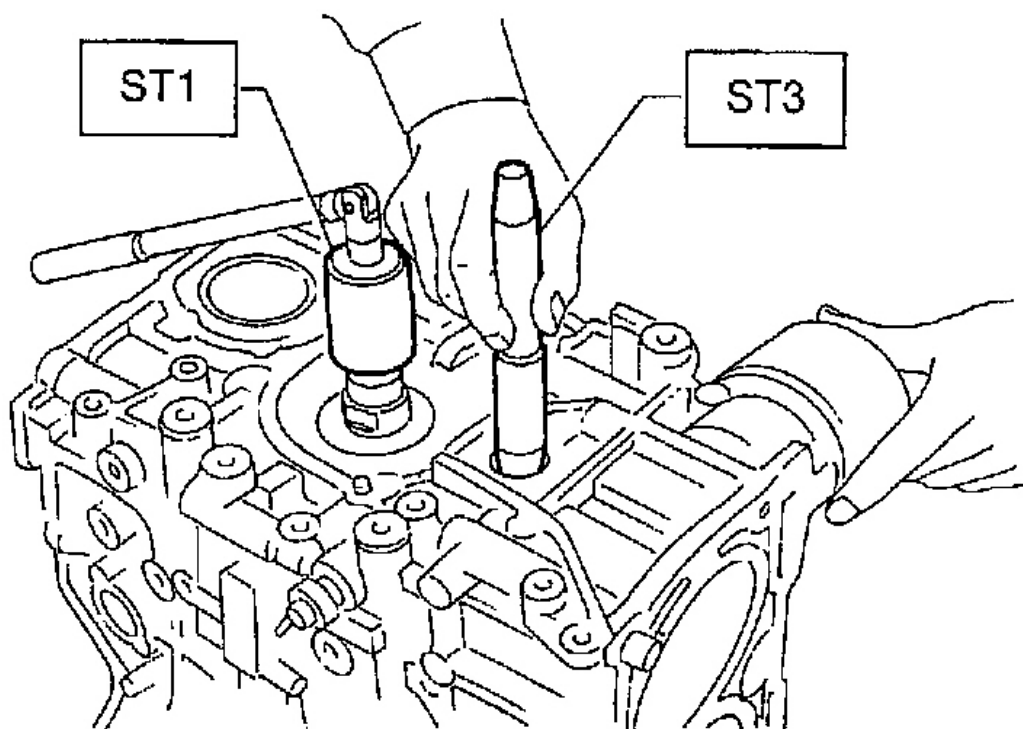
Courtesy of SUBARU OF AMERICA, INC.

## 14. Installing piston pin

1. Insert ST3 into service hole to align piston pin hole with connecting rod small end.

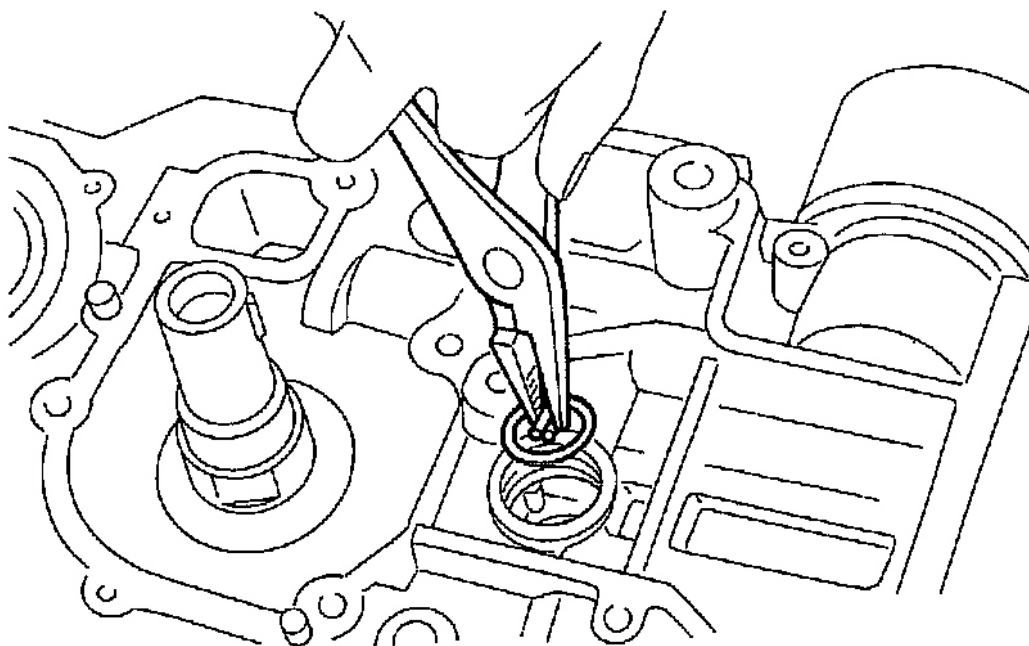
**CAUTION: Apply a coat of engine oil to ST3 before insertion.**

ST3 499017100 PISTON PIN GUIDE

**G02960236****Fig. 202: Installing Piston Pin****Courtesy of SUBARU OF AMERICA, INC.**

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

**CAUTION: Use new circlips.**



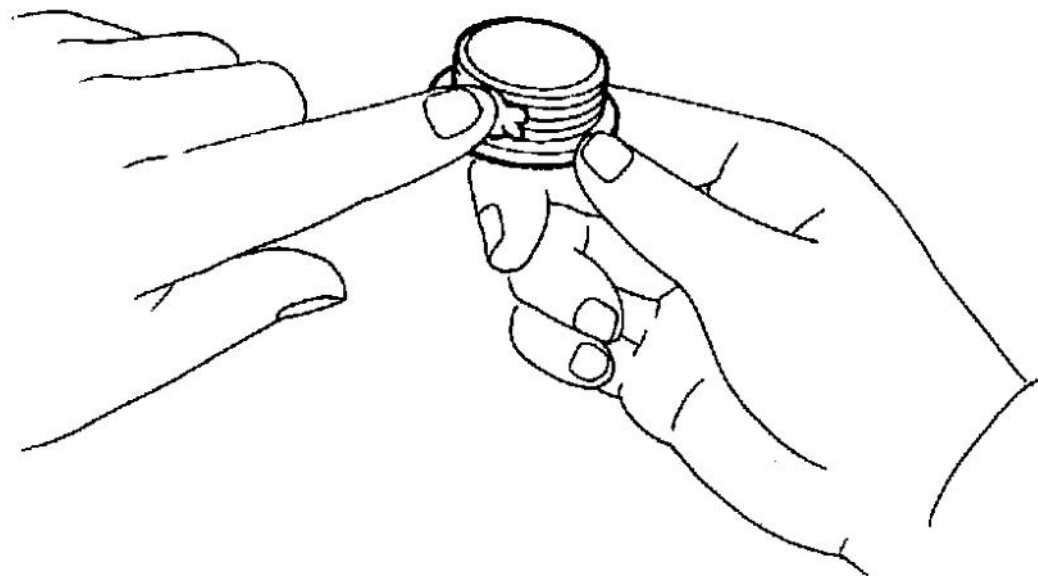
G02960237

**Fig. 203: Installing Circlip**

Courtesy of SUBARU OF AMERICA, INC.

4. Apply fluid packing around the service hole plug.

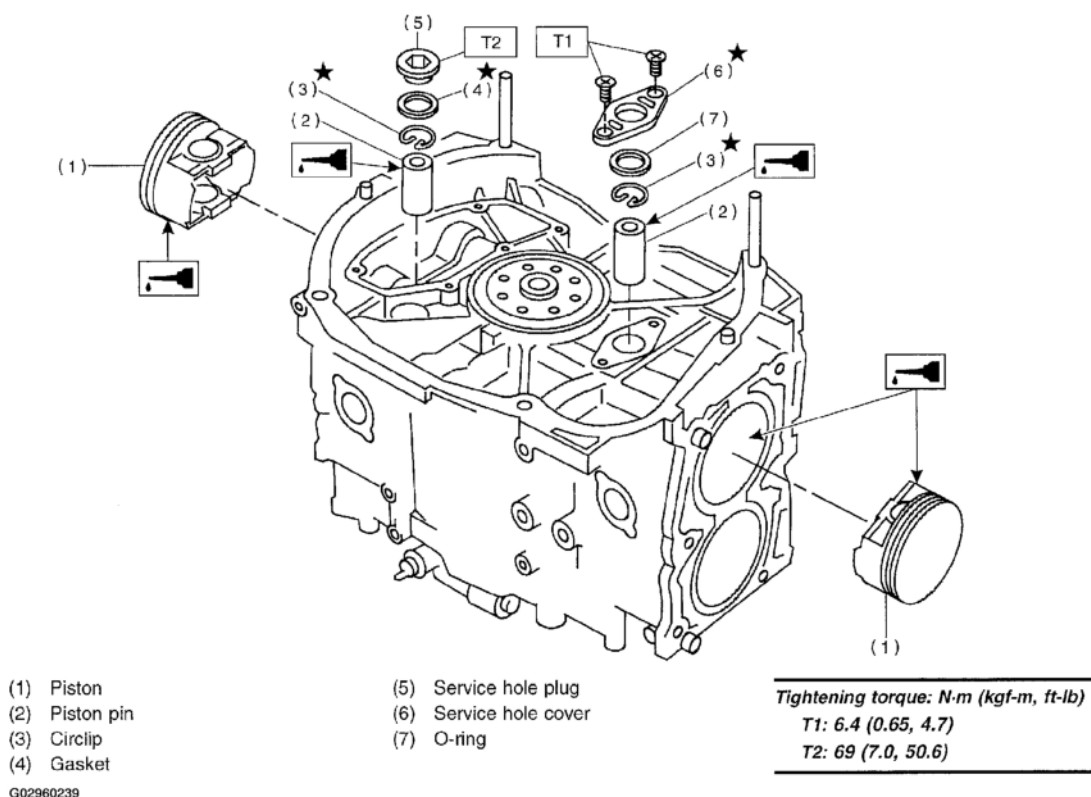
**Fluid packing:** THREE BOND 1215 or equivalent



G02960238

**Fig. 204: Applying Fluid Packing Around Service Hole Plug**  
Courtesy of SUBARU OF AMERICA, INC.

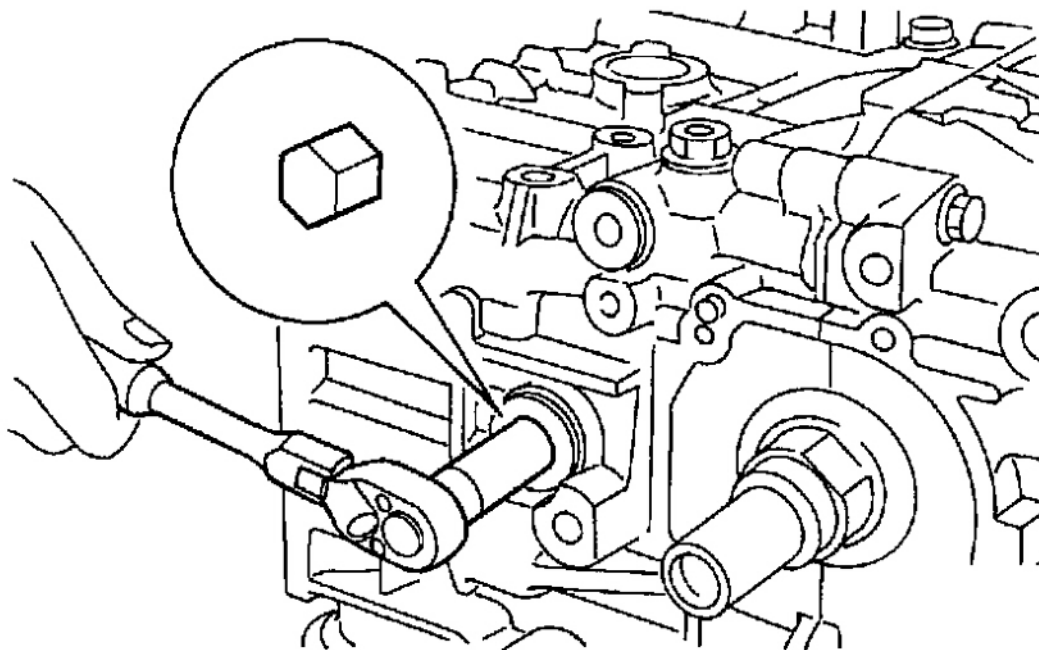
5. Install service hole plug and gasket.



**Fig. 205: Installing Service Hole Plug & Gasket**  
 Courtesy of SUBARU OF AMERICA, INC.

- Turn cylinder block so that #3 and #4 cylinders face upward. Using the same procedures as used for #1 and #2 cylinders, install pistons and piston pins.

**CAUTION: Use a new gasket.**

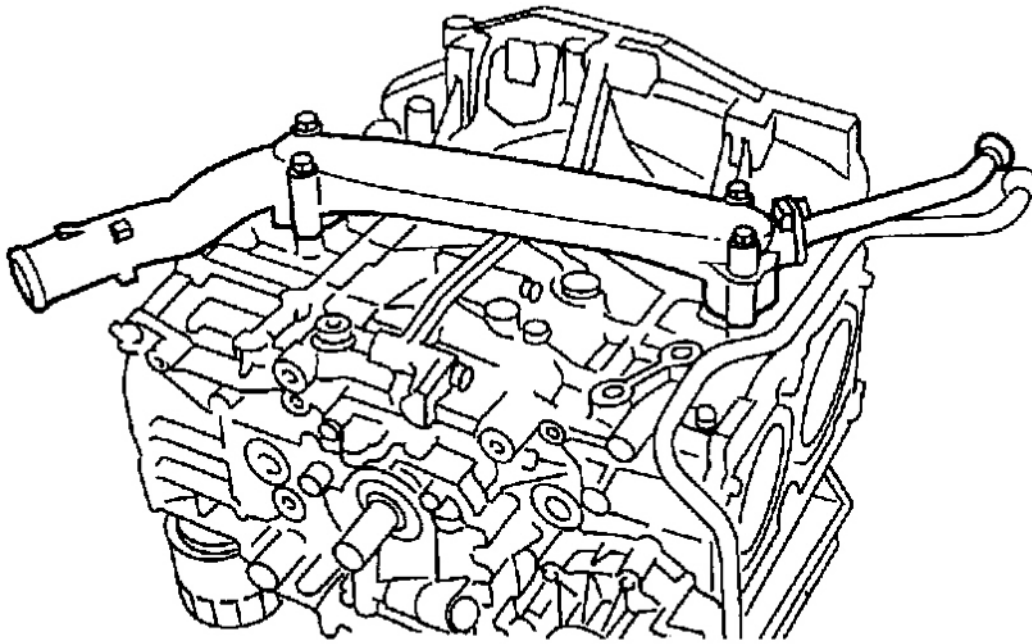


G02960240

**Fig. 206: Installing Piston Pin**

Courtesy of SUBARU OF AMERICA, INC.

15. Install water pipe.



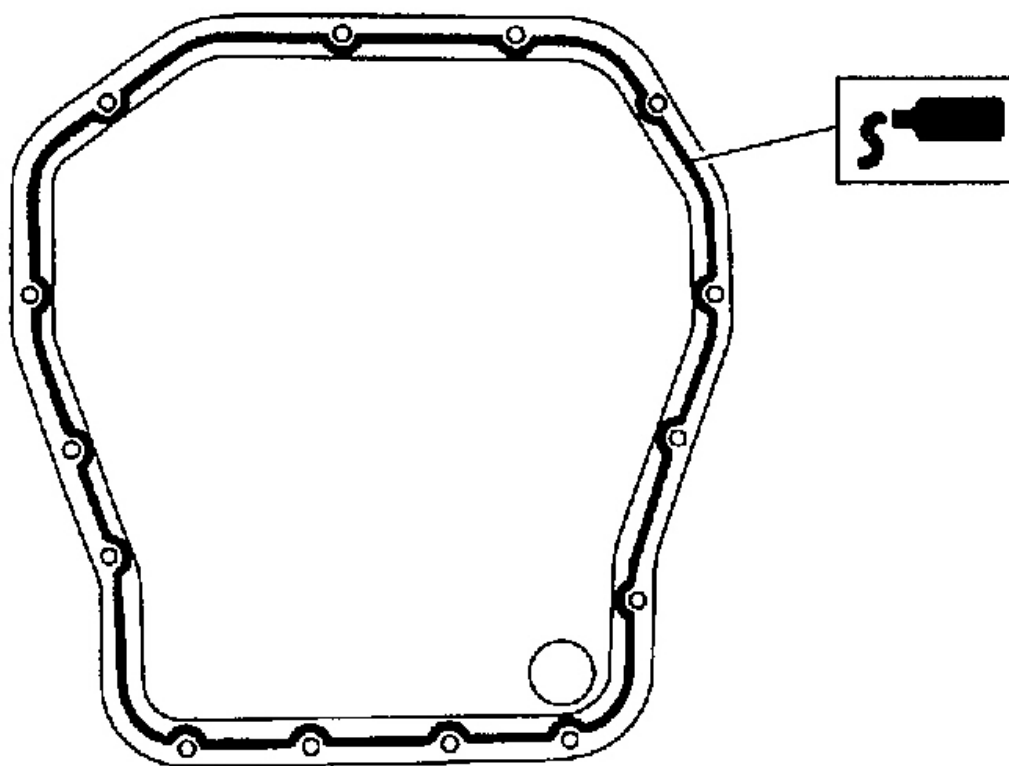
G02960241

**Fig. 207: Installing Water Pipe**

Courtesy of SUBARU OF AMERICA, INC.

16. Install baffle plate.  
**Tightening torque:** 6.4 N.m (0.65 kgf-m, 4.7 ft-lb)
17. Install oil strainer and O-ring  
**Tightening torque:** 10 N.m (1.0 kgf-m, 7 ft-lb)
18. Install oil strainer stay.
19. Apply fluid packing to matching surfaces and install oil pan.  
**Fluid packing:** THREE BOND 1215 or equivalent



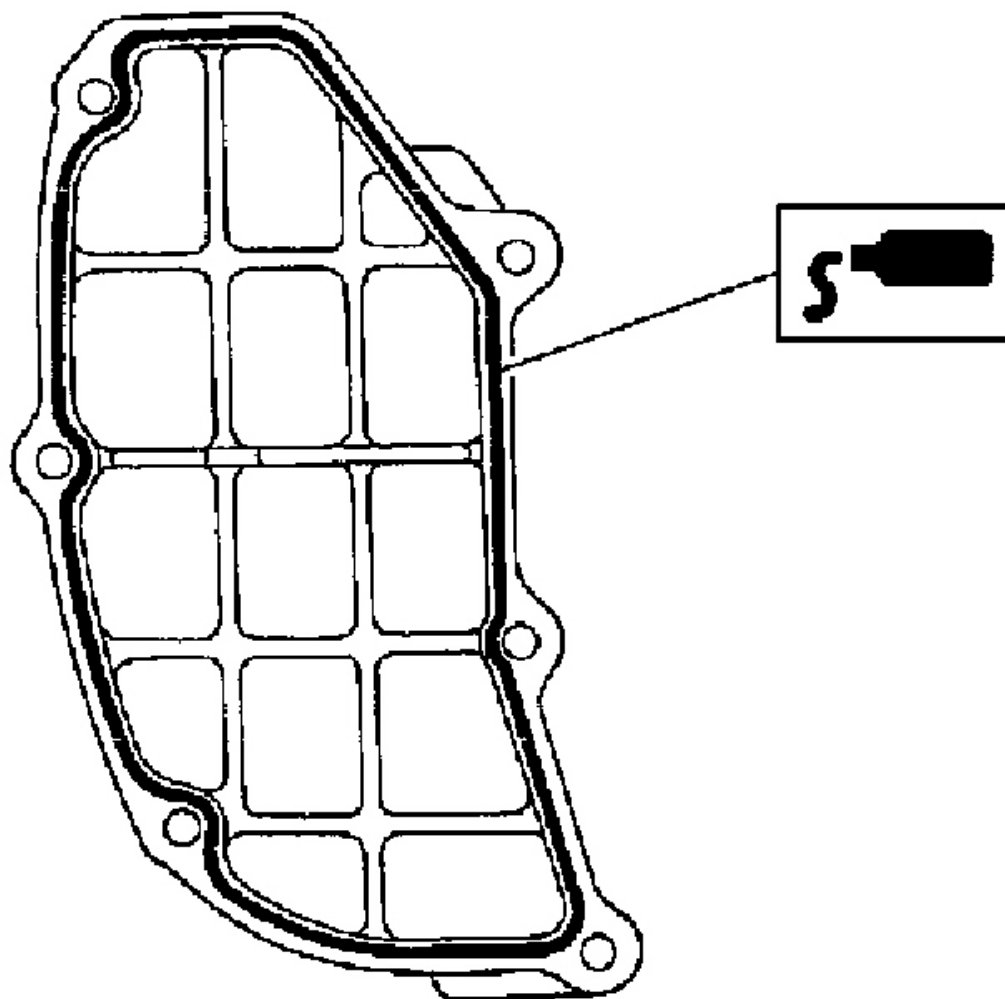


G02960242

**Fig. 208: Applying Fluid Packing To Matching Surfaces Of Oil Pan**  
Courtesy of SUBARU OF AMERICA, INC.

20. Apply fluid packing to matching surfaces and install oil separator cover.

**Fluid packing:** THREE BOND 1215 or equivalent



G02960243

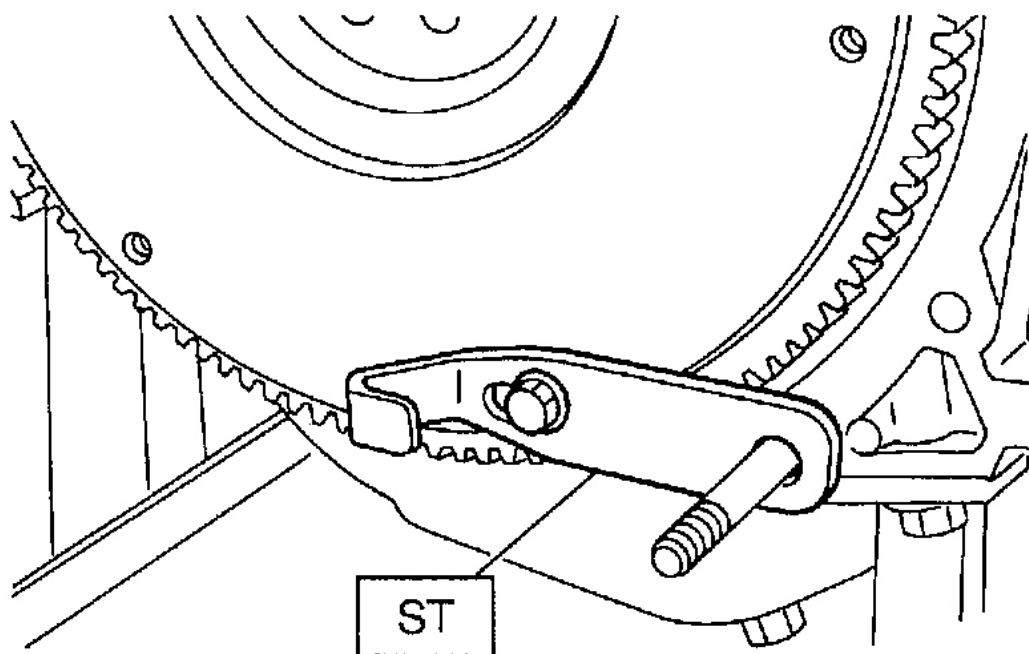
**Fig. 209: Applying Fluid Packing To Matching Surfaces Of Oil Separator Cover**  
Courtesy of SUBARU OF AMERICA, INC.

21. Install flywheel or drive plate.

To lock crankshaft, use ST.

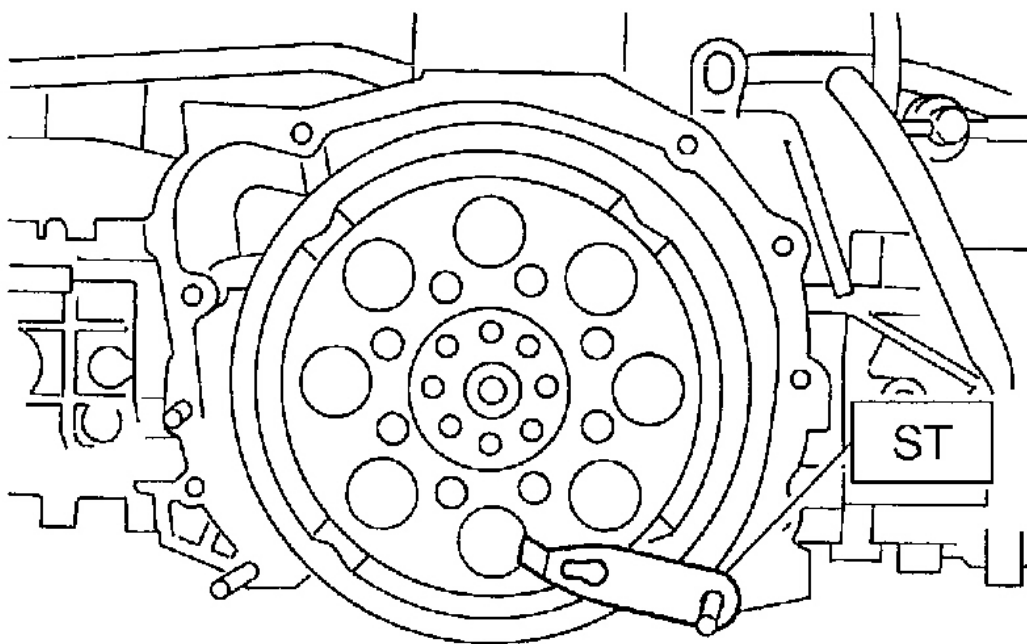
ST 498497100 CRANKSHAFT STOPPER

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



G02960244

**Fig. 210: Installing Flywheel (MT Model)**  
Courtesy of SUBARU OF AMERICA, INC.

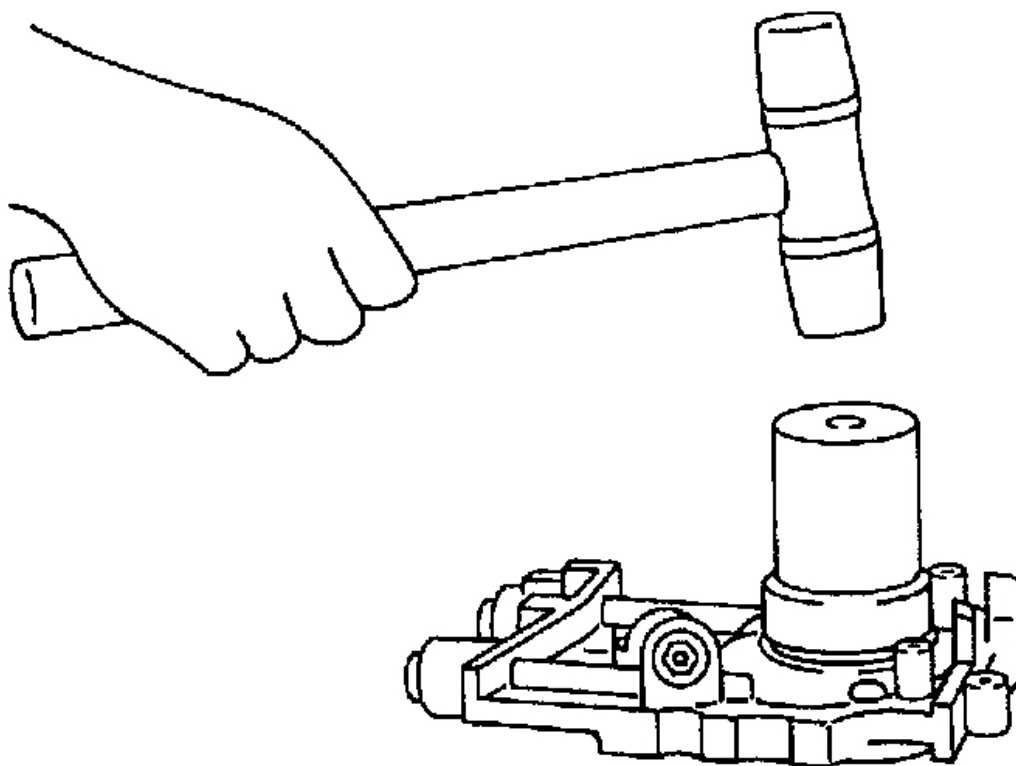


G02960245

**Fig. 211: Installing Drive Plate (AT Model)**  
Courtesy of SUBARU OF AMERICA, INC.

22. Install housing cover.
23. Installation of oil pump
  1. Discard front oil seal after removal. Replace with a new one using ST.

ST 499587100 OIL SEAL INSTALLER



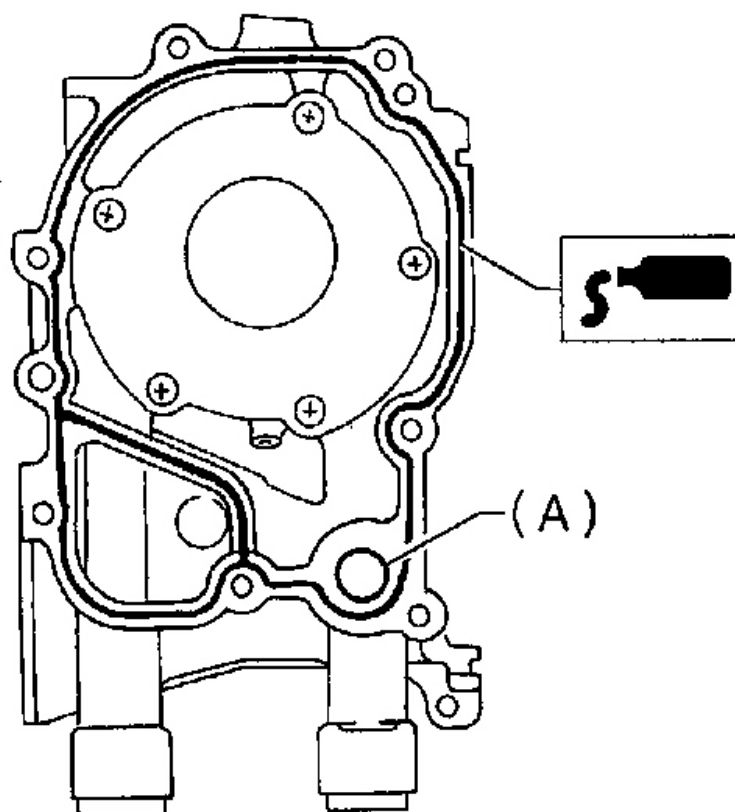
G02960246

**Fig. 212: Installing Oil Seal**

Courtesy of SUBARU OF AMERICA, INC.

2. Apply fluid packing to matching surface of oil pump.

**Fluid packing:** THREE BOND 1215 or equivalent

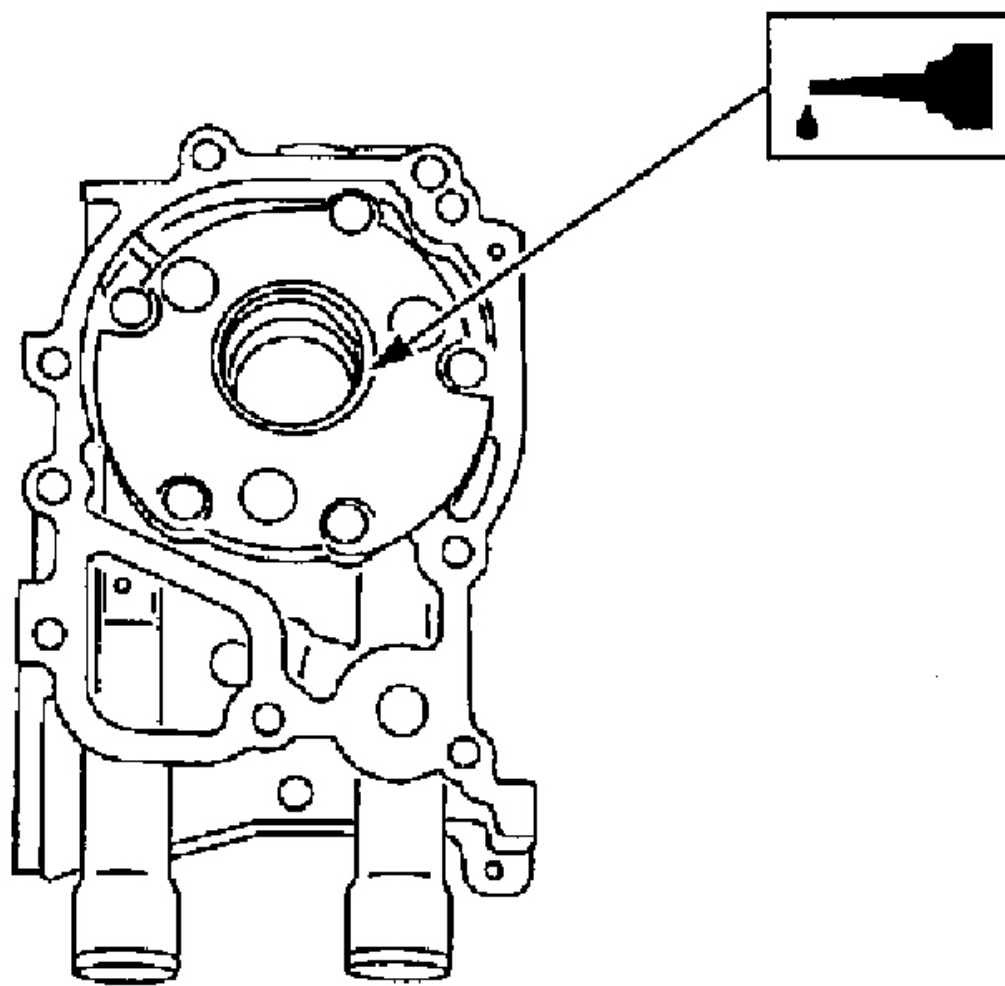


(A) O-ring

G02960247

**Fig. 213: Applying Fluid Packing To Matching Surface Of Oil Pump**  
Courtesy of SUBARU OF AMERICA, INC.

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



G02960248

**Fig. 214: Applying Coat Of Engine Oil To Inside Of Oil Seal**  
Courtesy of SUBARU OF AMERICA, INC.

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

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

**CAUTION:**

- Do not forget to install O-ring and seal when installing oil pump.
- Align flat surface of oil pump's inner rotor with crankshaft before installation.

24. Install water pump and gasket.

**Tightening torque:**

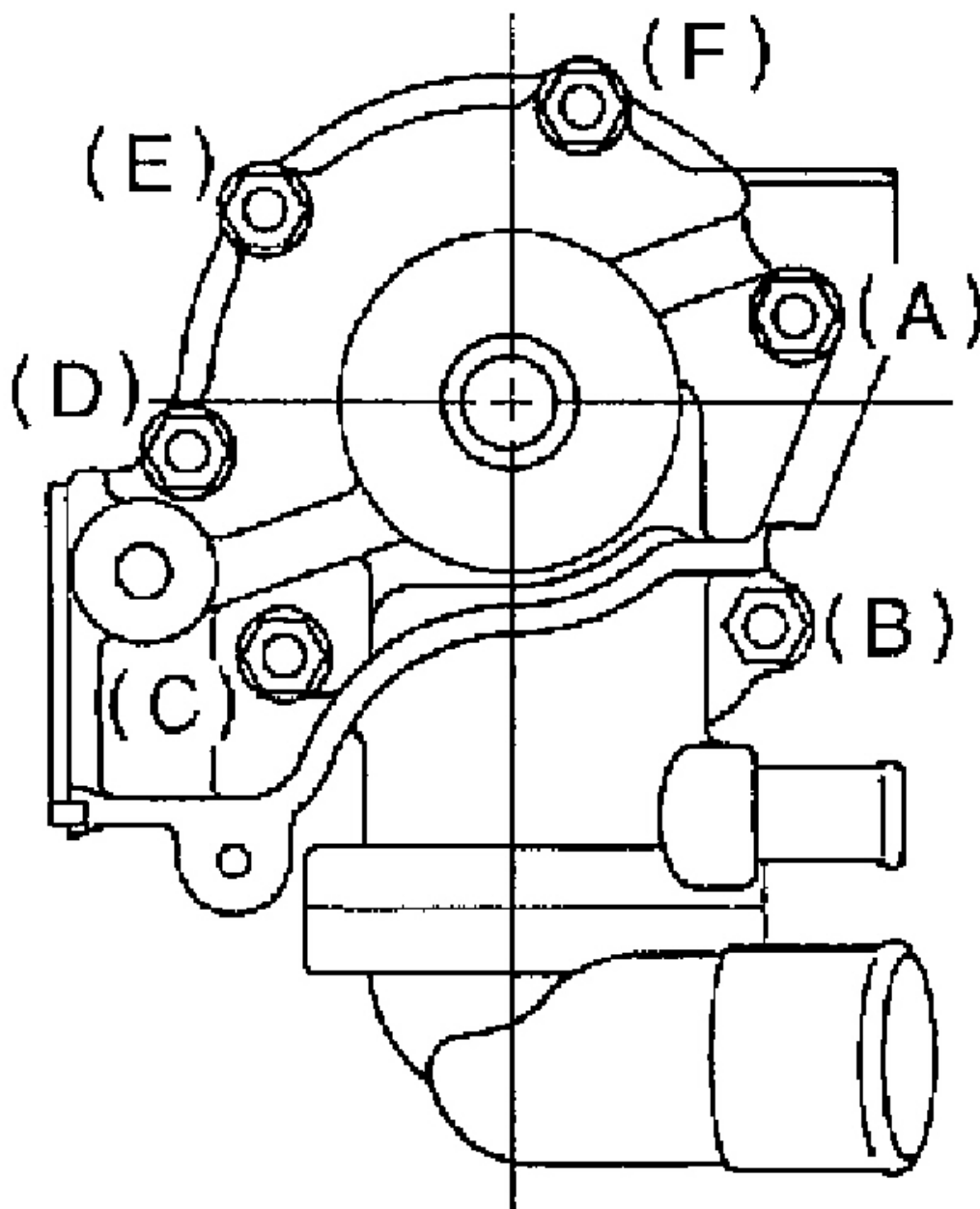
**First;** 12 N.m (1.2 kgf-m, 8.7 ft-lb)

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

**CAUTION:**

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



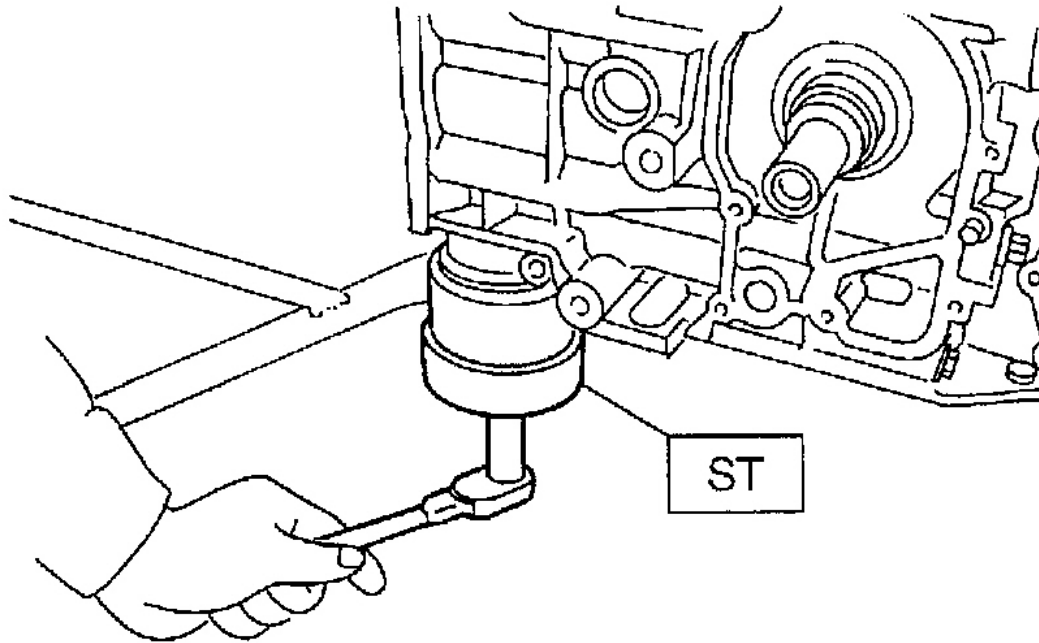


G02960249

**Fig. 215: Installing Water Pump & Gasket**  
Courtesy of SUBARU OF AMERICA, INC.

25. Install water by-pass pipe for heater.

26. Install oil filter using ST.



G02960250

**Fig. 216: Installing Oil Filter Using ST**  
Courtesy of SUBARU OF AMERICA, INC.

27. Tighten cylinder head bolts.

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

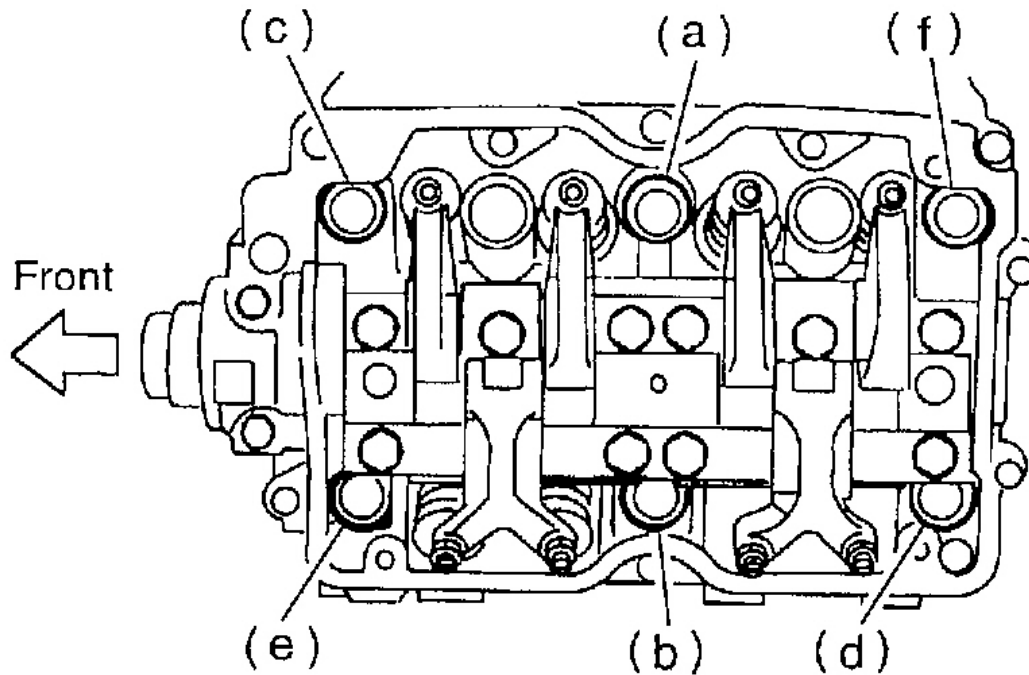
Then tighten all bolts to 69 N.m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.

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

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

7. Further tighten all bolts by 80 to 90° in alphabetical sequence.

**CAUTION:** Ensure that the total "re-tightening angle" [in the former two steps], do not exceed 180°.

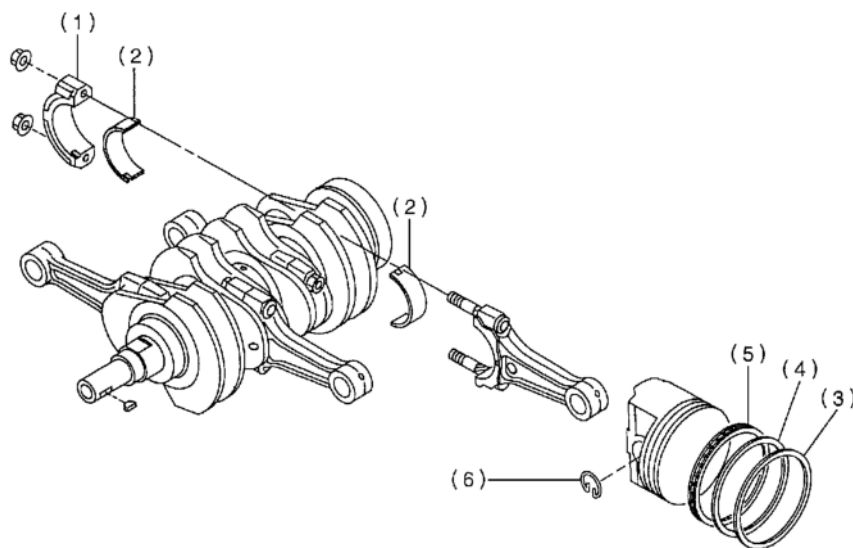


G02960251

**Fig. 217: Tightening Bolts Additional 80°-90°**  
Courtesy of SUBARU OF AMERICA, INC.

28. Install oil level gauge guide and tighten attaching bolt (left side only).
29. Install rocker cover.
30. Install crankshaft sprocket. Refer to **INSTALLATION**, Crankshaft Sprockets.
31. Install camshaft sprocket. Refer to **INSTALLATION**, Camshaft Sprockets.
32. Install timing belt assembly. Refer to **INSTALLATION**, Timing Belt Assembly.
33. Install belt cover. Refer to **INSTALLATION**, Belt Cover.
34. Install crankshaft pulley. Refer to **INSTALLATION**, Crankshaft Pulley.
35. Install generator and A/C compressor brackets on cylinder head.
36. Install V-belt. Refer to **INSTALLATION**, V-belt.
37. Install intake manifold. Refer to **INSTALLATION**, Intake Manifold.

## DISASSEMBLY



(1) Connecting rod cap  
(2) Connecting rod bearing

(3) Top ring  
(4) Second ring

(5) Oil ring  
(6) Circlip

G02960252

**Fig. 218: Disassembling Connecting Rod And Piston Rings**  
Courtesy of SUBARU OF AMERICA, INC.

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

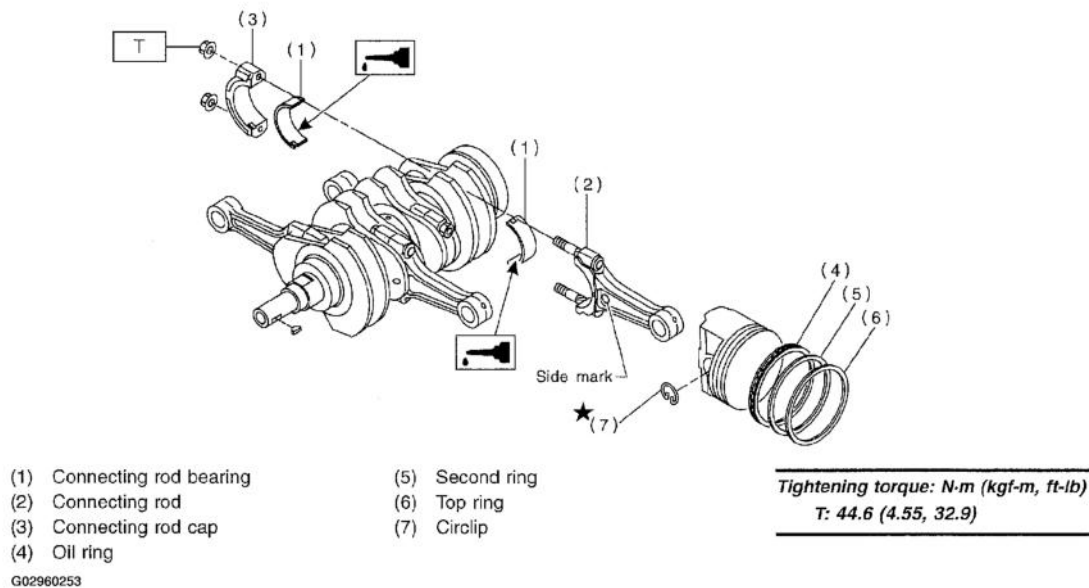
**CAUTION:** Arrange removed connecting rod, connecting rod cap and bearing in order to prevent confusion.

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

**CAUTION:** Arrange the removed piston rings in good order to prevent confusion.

5. Remove circlip.

### ASSEMBLY



**Fig. 219: Assembling Connecting Rod & Piston Rings**  
Courtesy of SUBARU OF AMERICA, INC.

1. Install connecting rod bearings on connecting rods and connecting rod caps.

**CAUTION:** Apply oil to the surfaces of the connecting rod bearings.

2. Install connecting rod on crankshaft.

**CAUTION:** Position each connecting rod with the side marked facing forward.

3. Install connecting rod cap with connecting rod nut.

Ensure the arrow on connecting rod cap faces the 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.

4. Install oil ring spacer, lower rail and upper rail in this order by hand. Then install second ring and top ring with a piston ring expander.

## INSPECTION

**CYLINDER BLOCK**

1. Visually check for cracks and damage. Especially, inspect important parts by means of red lead check.
2. Check the oil passages for clogging.
3. Inspect crankcase surface that mates with cylinder head for warping by using a straight edge, and correct by grinding if necessary.

**Warping limit:** 0.05 mm (0.0020 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.

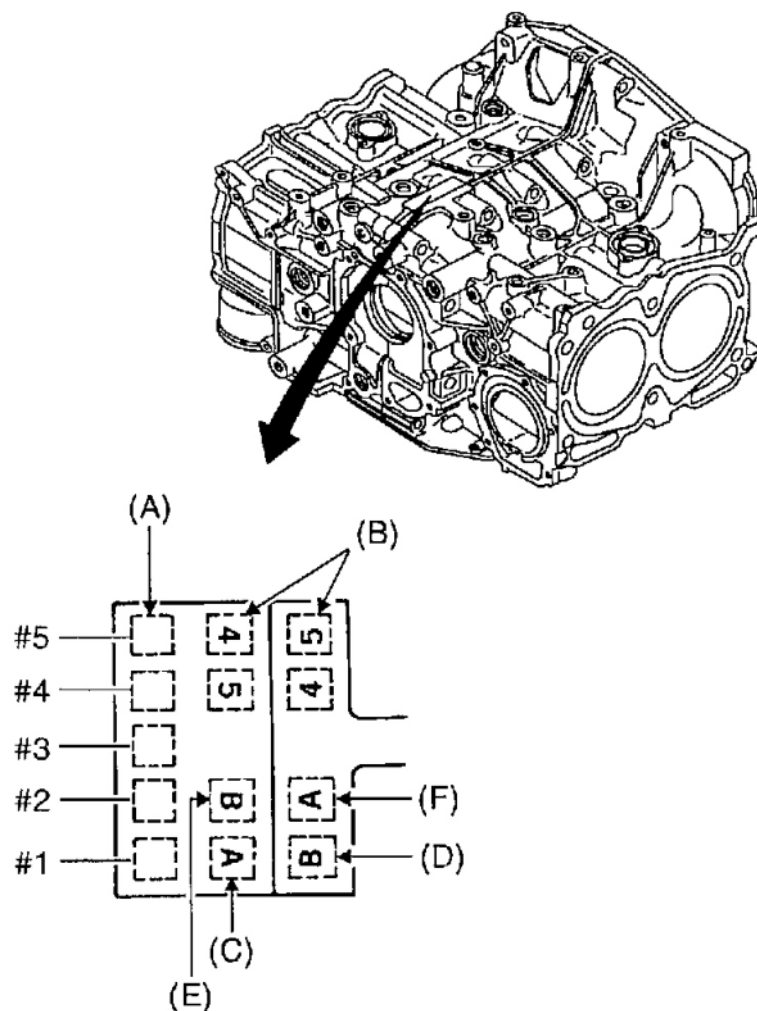
**CAUTION:** Measurement should be performed at a temperature 20°C (68°F).

**NOTE:** Standard sized pistons are classified into two grades, "A" and "B". These grades should be used as a guide line 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

G02960254

**Fig. 220: Identifying Cylinder & Piston Stamp**  
 Courtesy of SUBARU OF AMERICA, INC.

2. How to measure the inner diameter of each cylinder

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

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

**Taper:**

**Standard:** 0.015 mm (0.0006 in)

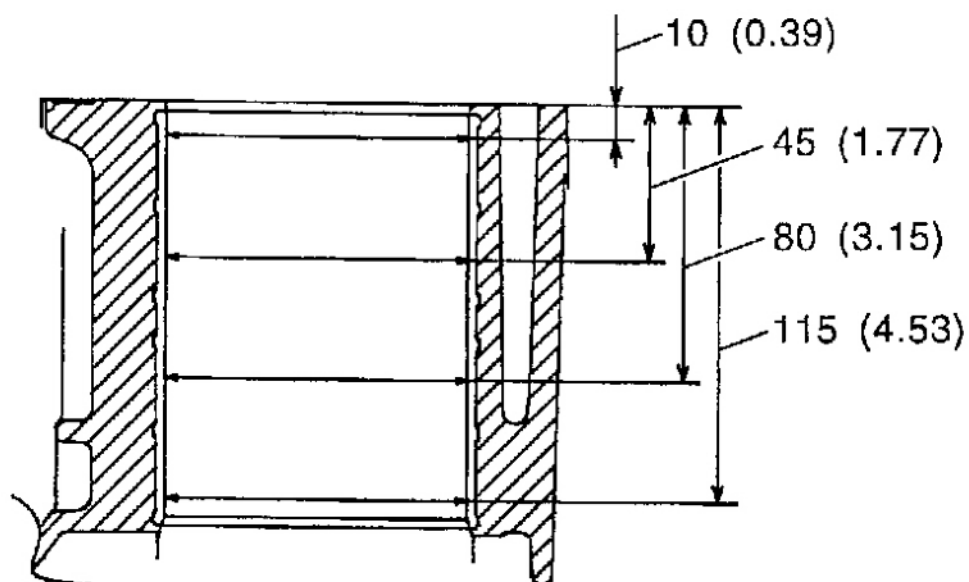
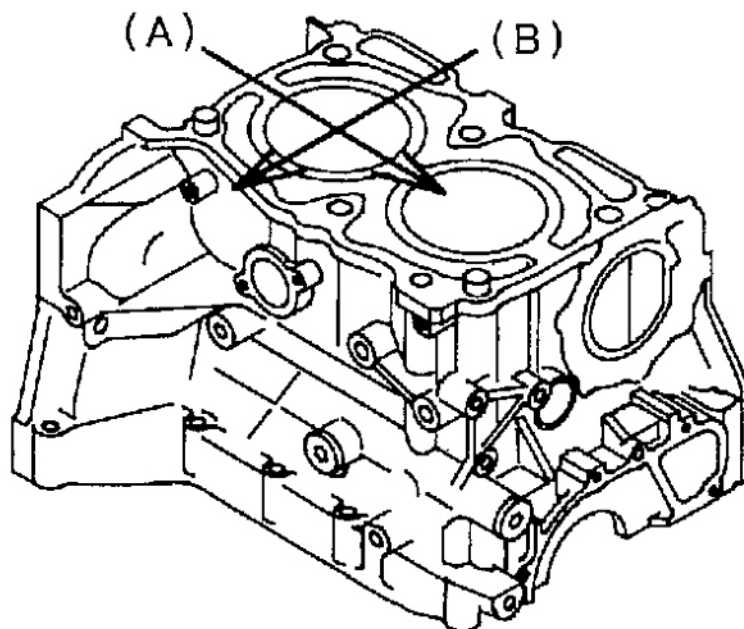
**Limit** 0.050 mm (0.0020 in)

**Out-of-roundness:**

**Standard** 0.010 mm (0.0004 in)

**Limit** 0.050 mm (0.0020 in)





Unit: mm (in)

(A) Piston pin direction

(B) Thrust direction

G02960255

**Fig. 221: Measuring Inner Diameter Of Each Cylinder In Both Thrust & Piston Pin Directions****Courtesy of SUBARU OF AMERICA, INC.**

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

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

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

**Piston grade point H: 37.0 mm (1.457 in)**

**Piston outer diameter:**

**Standard**

**A:** 99.485 - 99.495 mm (3.9167-3.9171 in)

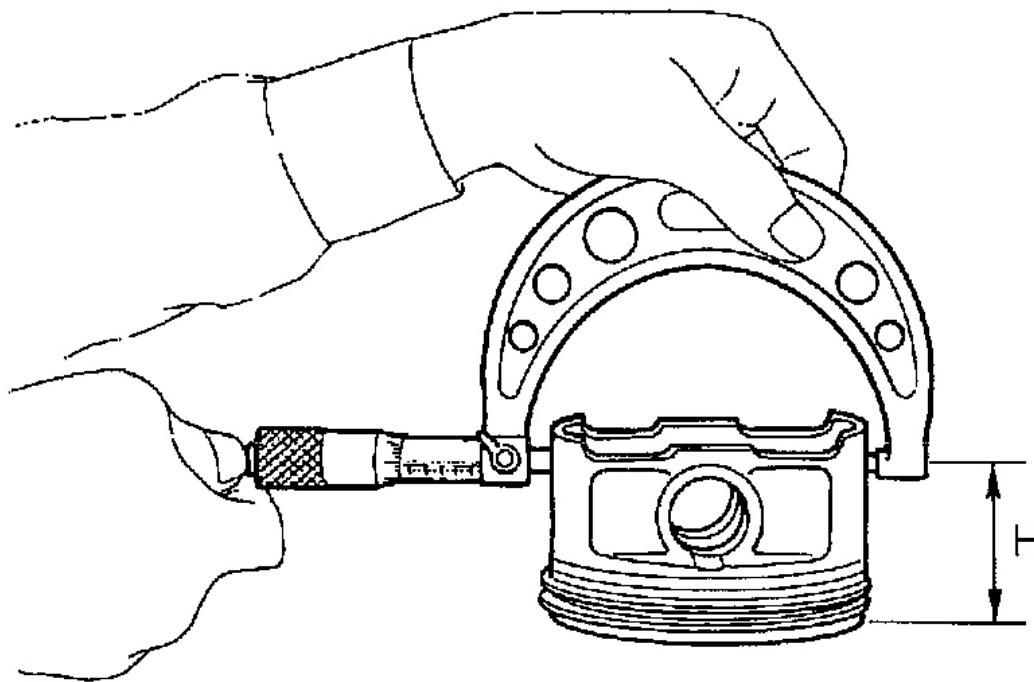
**B:** 99.475 - 99.485 mm (3.9163 - 3.9167 in)

**0.25 mm (0.0098 in) oversize**

99.725 - 99.735 mm (3.9262 - 3.9266 in)

**0.50 mm (0.0197 in) oversize**

99.975 - 99.985 mm (3.9360 - 3.9364 in)



G02960256

**Fig. 222: Measuring Outer Diameter Of Piston**  
Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

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

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

**Limit** 0.050 mm (0.0020 in)

6. Boring and honing
  1. If the value of taper, out-of-roundness, or cylinder-to-piston clearance measured exceeds the specified limit or if there is any damage on the cylinder wall, rebore it to use an oversize piston.

**CAUTION:** When any of the cylinders needs reboring, all other cylinders must be bored at the same time, and use oversize pistons. Do not perform boring on one cylinder only, nor use an oversize

**piston for one cylinder only.**

2. If the cylinder inner diameter exceeds the limit after boring and honing, replace the crank-case.

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

**Limit of cylinder enlarging (boring):** 0.5 mm (0.020 in)

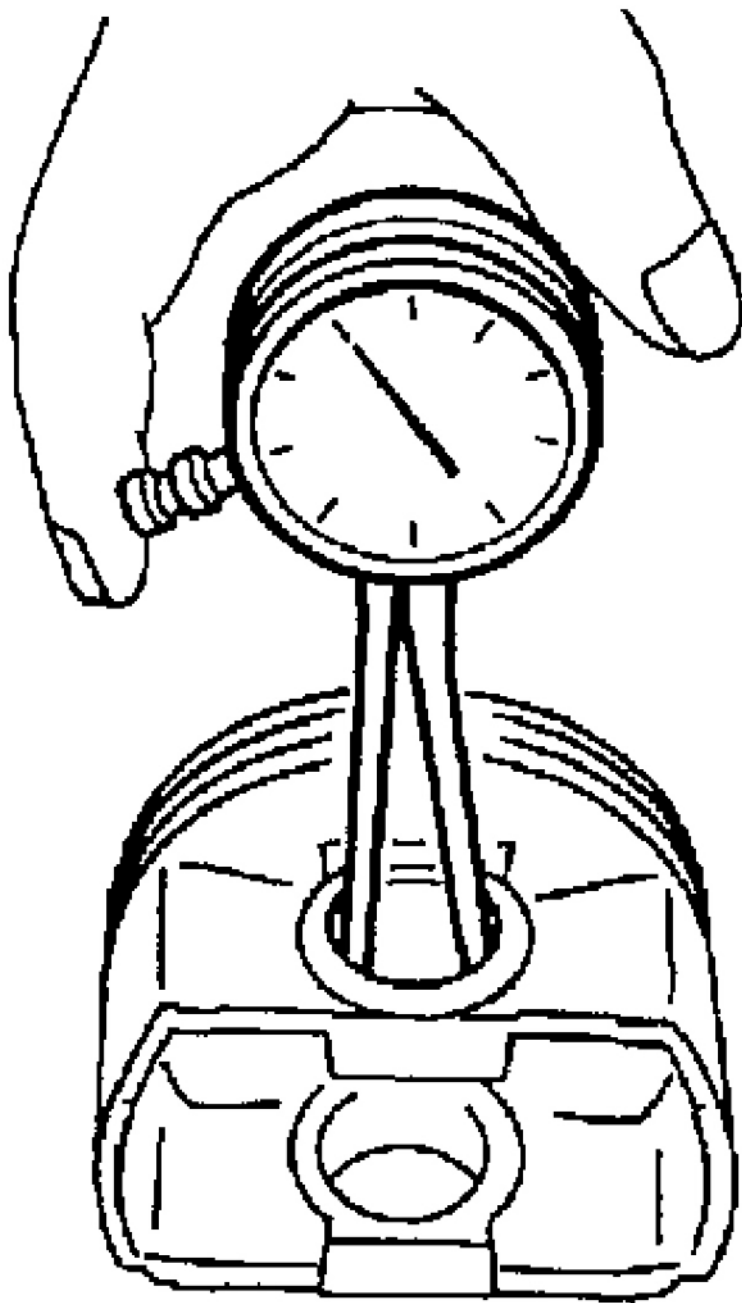
**PISTON AND PISTON PIN**

1. Check 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. Refer to **CYLINDER AND PISTON, INSPECTION**, Cylinder Block. If any of the clearances is not to specification, replace the piston or bore the cylinder to use an oversize piston.
3. Make sure that piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F). Replace if defective.

**Standard clearance between piston pin and hole in piston:**

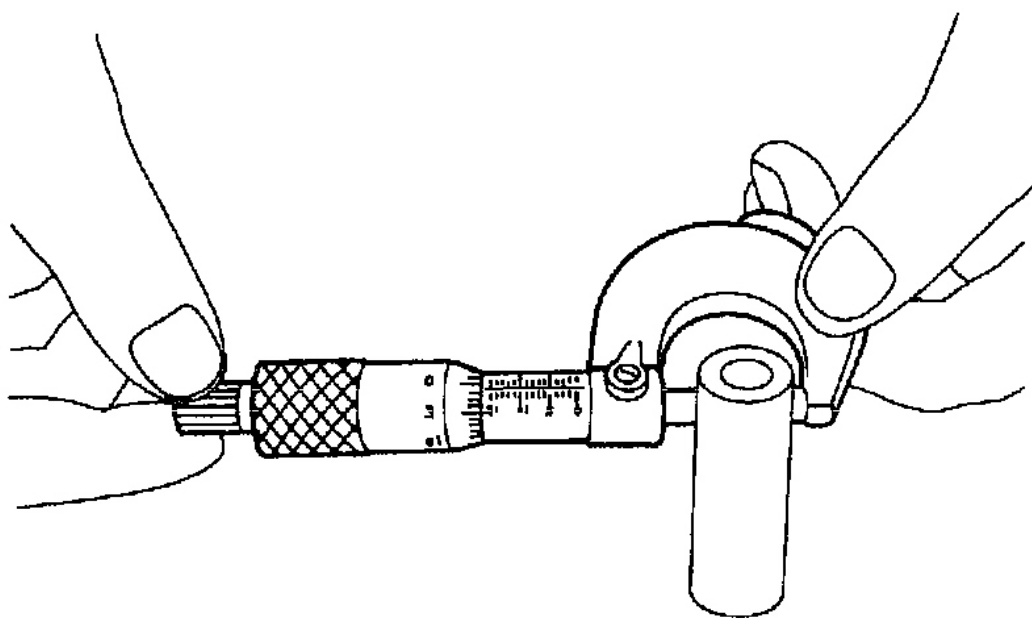
**Standard:** 0.004 - 0.008 mm (0.0002 - 0.0003 in)

**Limit:** 0.020 mm (0.0008 in)



G02960257

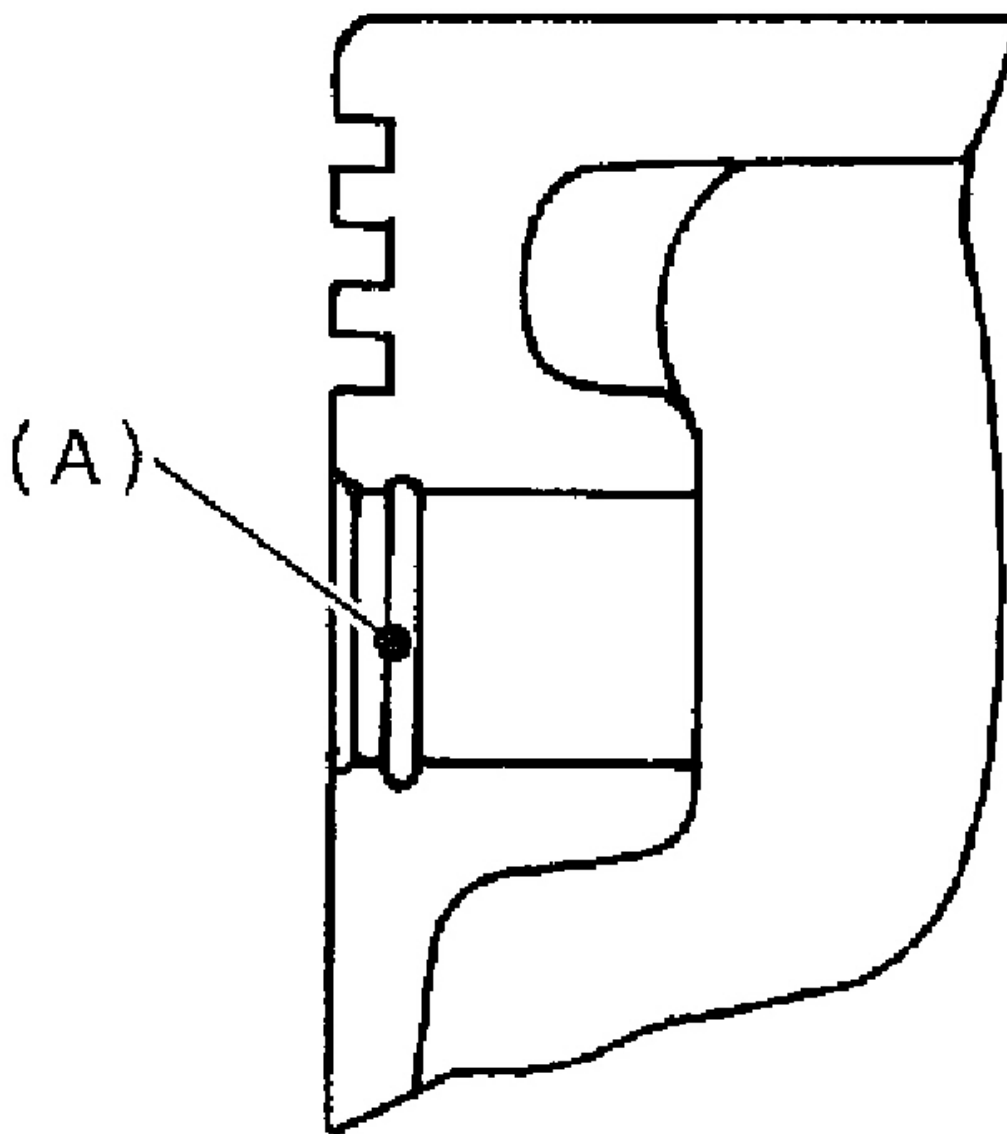
**Fig. 223: Measuring Inner Diameter Of Piston Pin Hole**  
Courtesy of SUBARU OF AMERICA, INC.



G02960258

**Fig. 224: Measuring Outer Diameter Of Piston Pin**  
**Courtesy of SUBARU OF AMERICA, INC.**

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



G02960259

**Fig. 225: Removing Burr From Groove**  
 Courtesy of SUBARU OF AMERICA, INC.

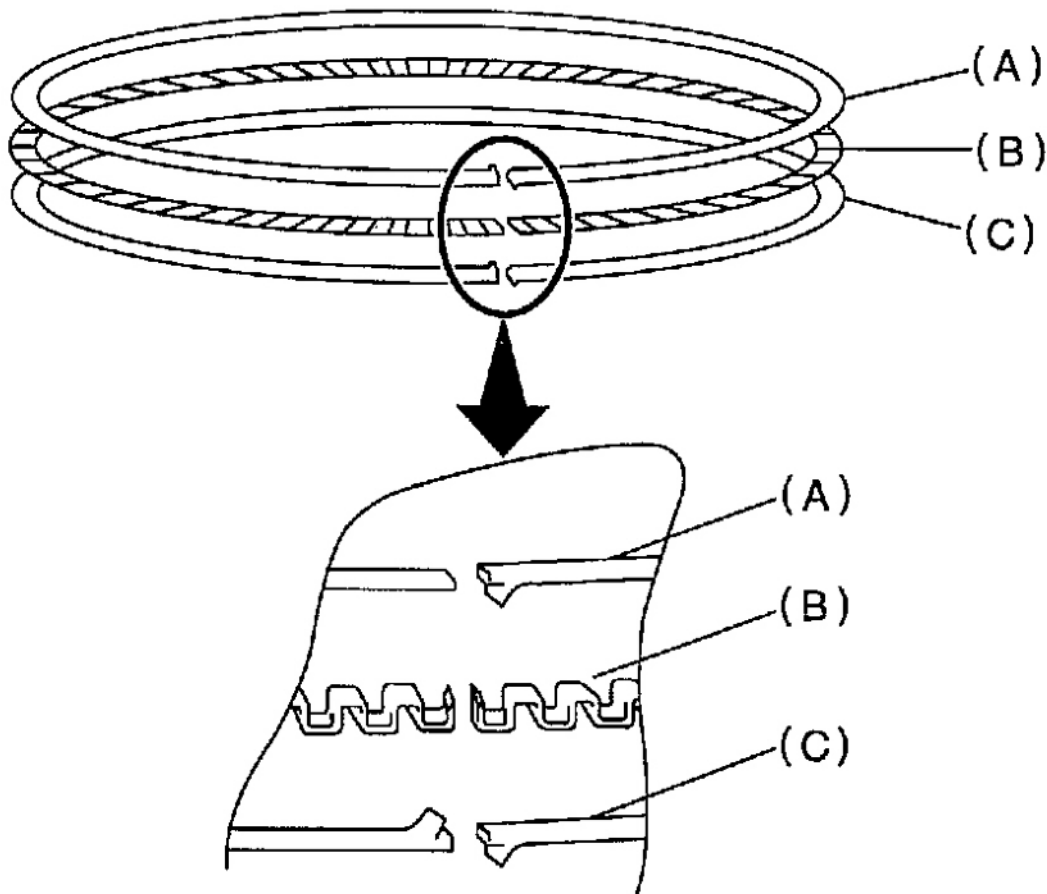
5. Check piston pin circlip for distortion, cracks and wear.

#### PISTON RING

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

**CAUTION:**

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



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

G02960260

**Fig. 226: Checking Piston Rings**



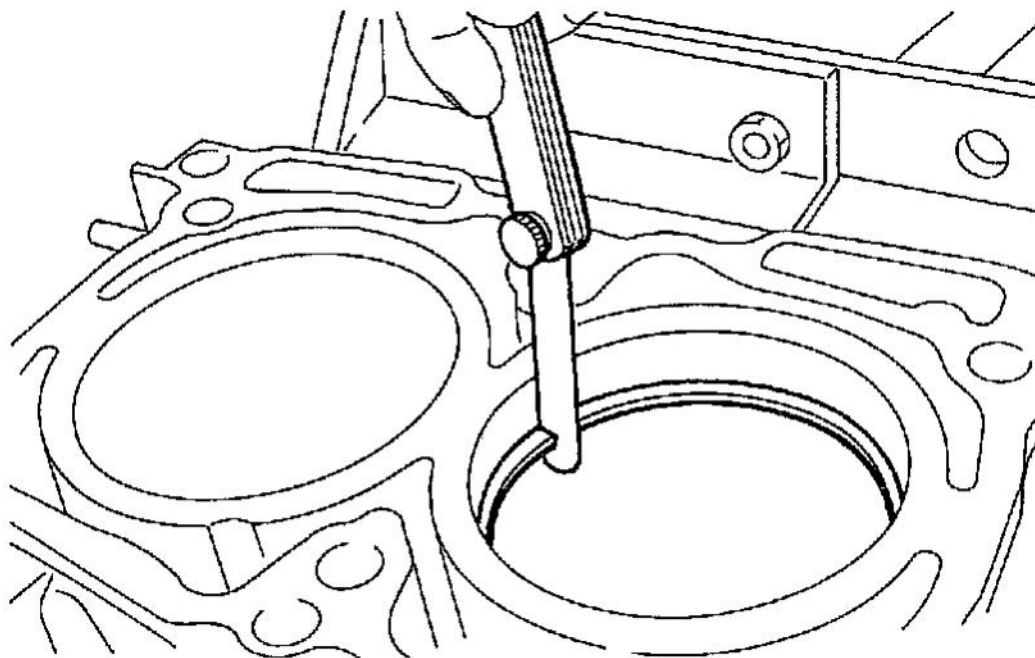
Courtesy of SUBARU OF AMERICA, INC.

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

Unit: mm (in)			
		Standard	Limit
Piston ring gap	Top ring	0.20 — 0.35 (0.0079 — 0.0138)	1.0 (0.039)
	Second ring	0.35 — 0.50 (0.0138 — 0.0197)	1.0 (0.039)
	Oil ring rail	0.20 — 0.70 (0.0079 — 0.0276)	1.5 (0.059)

G02960261

**Fig. 227: Piston Ring Gap Specification Chart**  
Courtesy of SUBARU OF AMERICA, INC.



G02960262

**Fig. 228: Measuring Piston Ring Gap With Thickness Gauge**  
Courtesy of SUBARU OF AMERICA, INC.

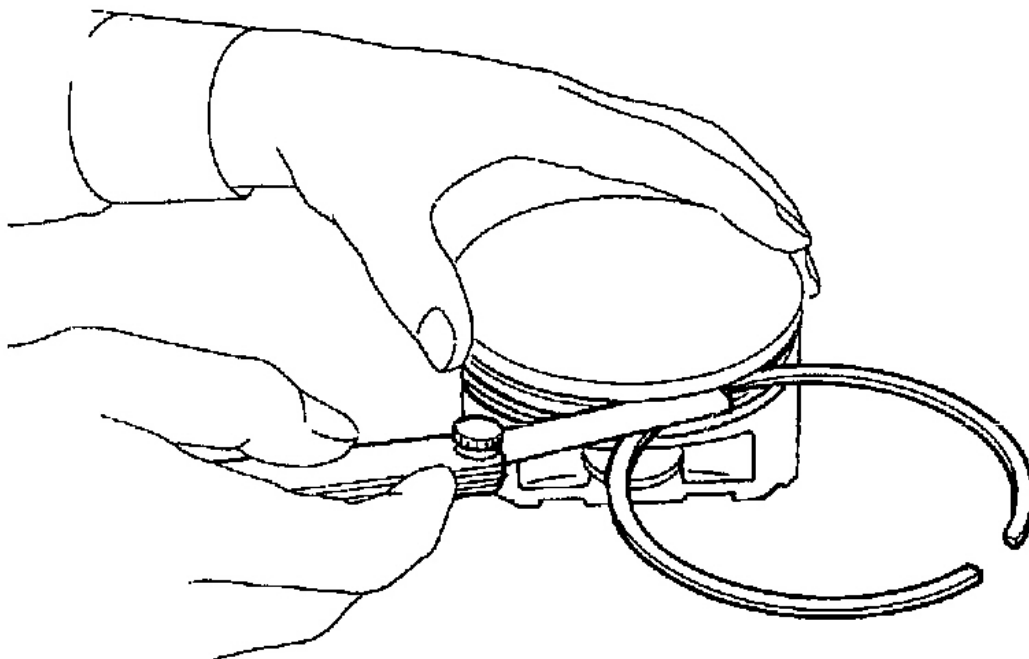
3. Measure the clearance between piston ring and piston ring groove with a thickness gauge.

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

		Unit: mm (in)	
		Standard	Limit
Clearance between piston ring and piston ring groove	Top ring	0.040 — 0.080 (0.0016 — 0.0031)	0.15 (0.0059)
	Second ring	0.030 — 0.070 (0.0012 — 0.0028)	0.15 (0.0059)

G02960263

**Fig. 229: Piston Ring & Piston Ring Groove Clearance Specification Chart**  
Courtesy of SUBARU OF AMERICA, INC.



G02960264

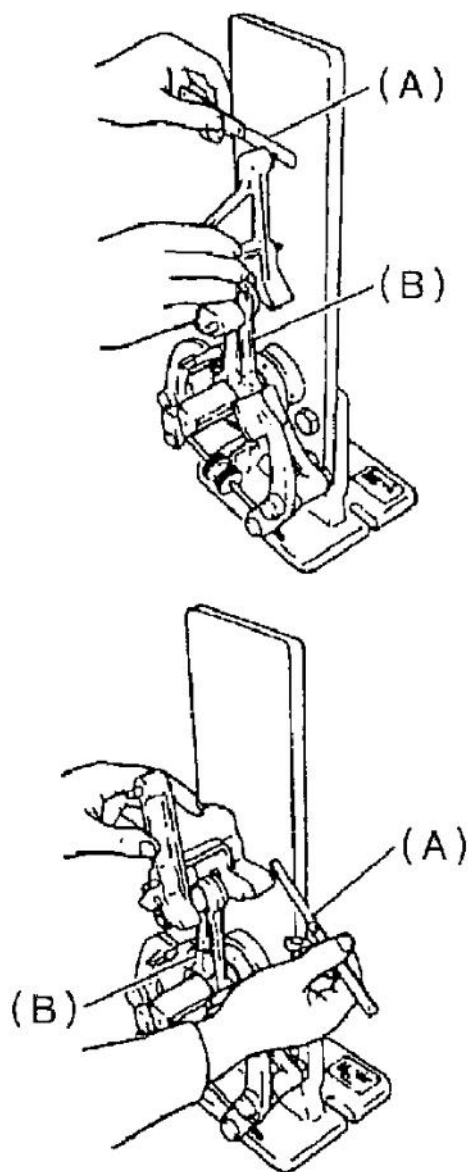
**Fig. 230: Measuring Clearance Between Piston Ring & Piston Ring Groove With Thickness Gauge**

**Courtesy of SUBARU OF AMERICA, INC.**

**CONNECTING ROD**

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



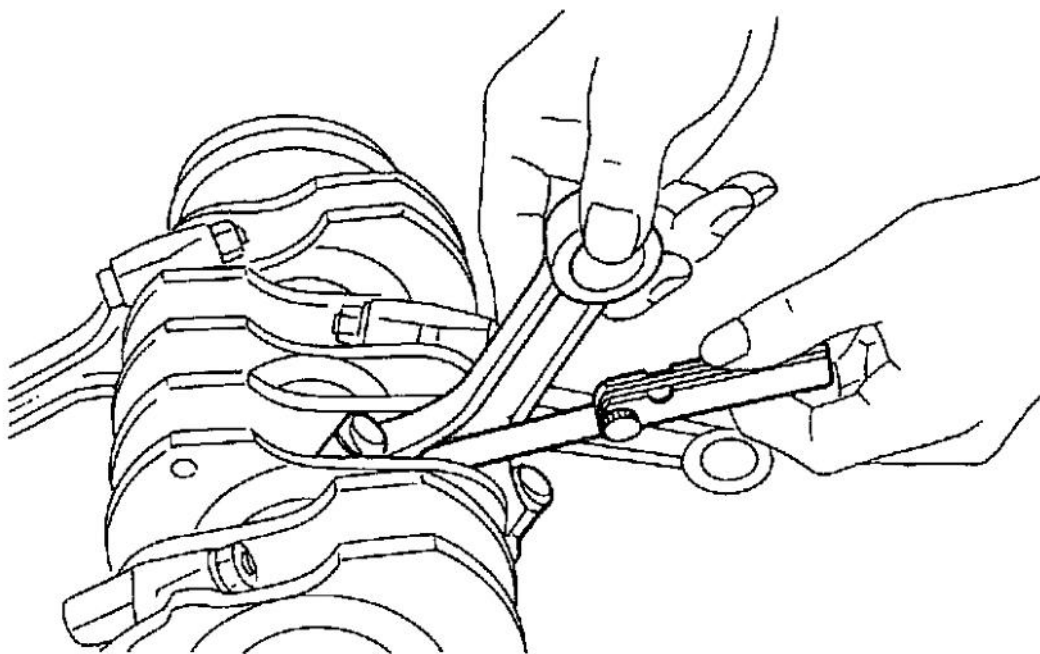
(A) Thickness gauge

(B) Connecting rod

G02960265

**Fig. 231: Checking Connecting Rod For Bending Or Twisting**  
Courtesy of SUBARU OF AMERICA, INC.

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

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

G02960266

**Fig. 232: Measuring Thrust Clearance Of Connecting Rod**

Courtesy of SUBARU OF AMERICA, INC.

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

**Connecting rod oil clearance:****Standard:** 0.012 - 0.038 mm (0.0005 - 0.0015 in)**Limit:** 0.050 mm (0.0020 in)**BEARING SIZE THICKNESS AND OUTER DIAMETER OF CRANK PIN SPECIFICATION**

Unit: mm (in)		

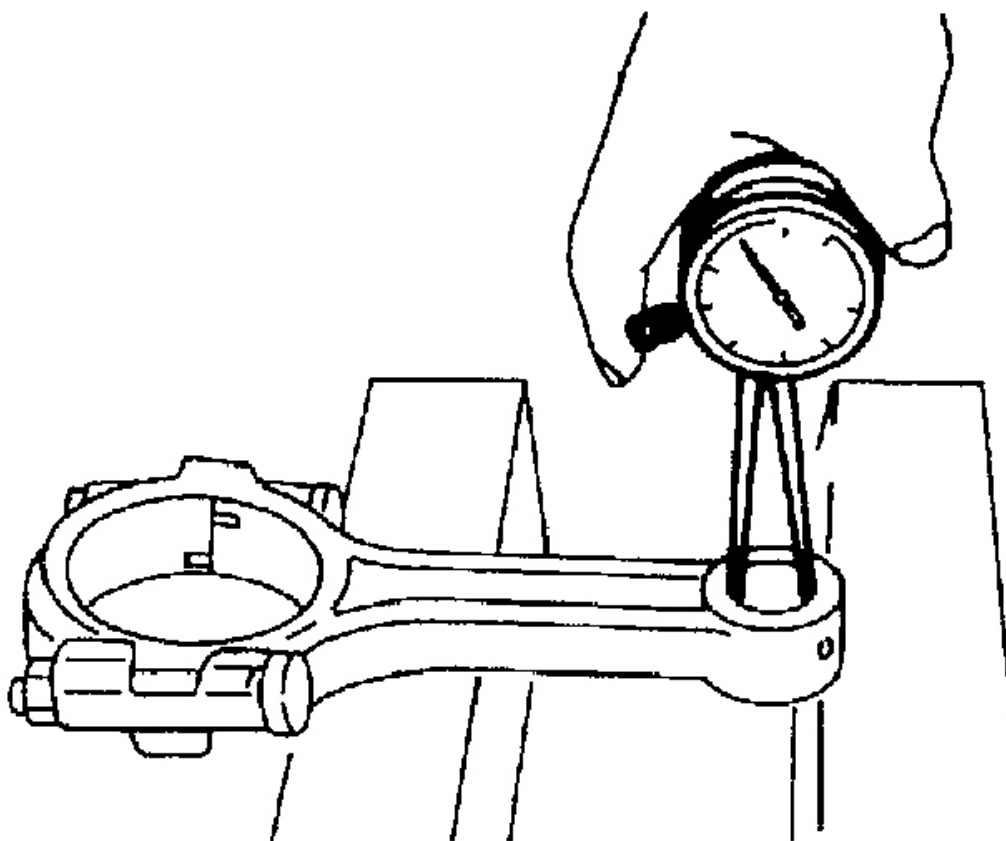
Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.490 - 1.502 (0.0587 - 0.0591)	51.984 - 52.000 (2.0466 - 2.0472)
0.03 (0.0012) undersize	1.504 - 1.512 (0.0592 - 0.0595)	51.954 - 51.970 (2.0454 - 2.0461)
0.05 (0.0020) undersize	1.514 - 1.522 (0.0596 - 0.0599)	51.934 - 51.950 (2.0446 - 2.0453)
0.25 (0.0098) undersize	1.614 - 1.622 (0.0635 - 0.0639)	51.734 - 51.750 (2.0368 - 2.0374)

6. Inspect 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:**

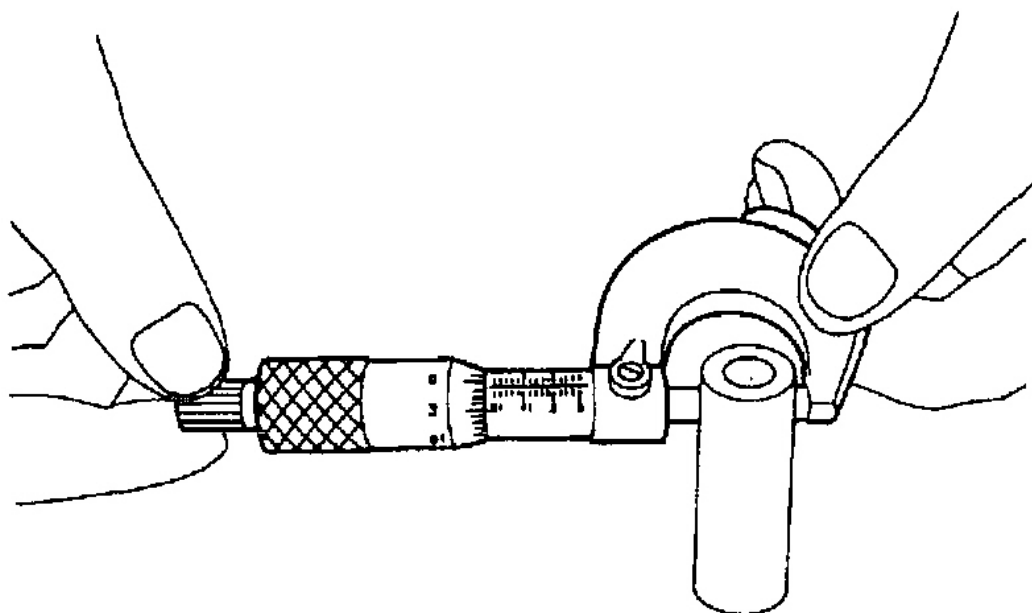
**Standard:** 0 - 0.022 mm (0 - 0.0009 in)

**Limit:** 0.030 mm (0.0012 in)



**G02960267**

**Fig. 233: Measuring Piston Pin Clearance At Connecting Rod Small End**  
Courtesy of SUBARU OF AMERICA, INC.



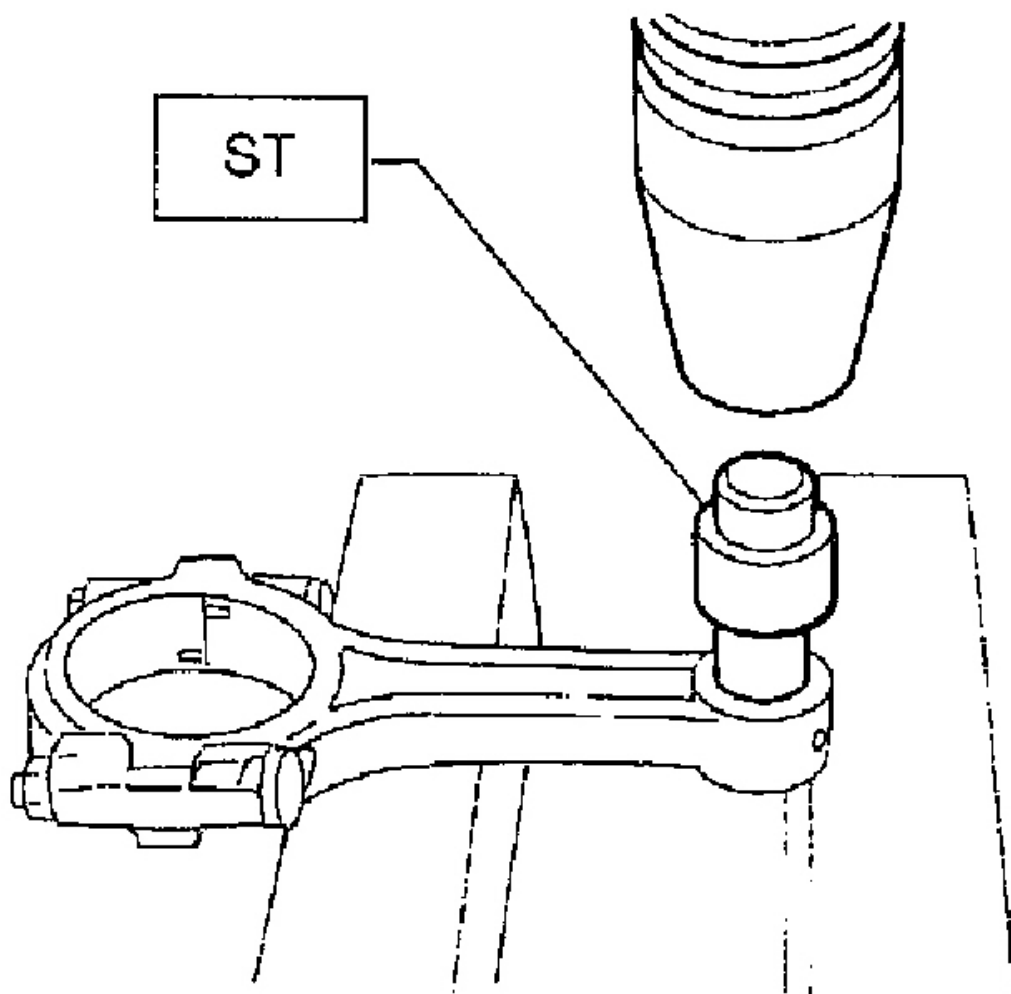
G02960268

**Fig. 234: Measuring Outer Diameter Of Piston Pin**  
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER





G02960269

**Fig. 235: Installing Connecting Rod Bushing**  
Courtesy of SUBARU OF AMERICA, INC.

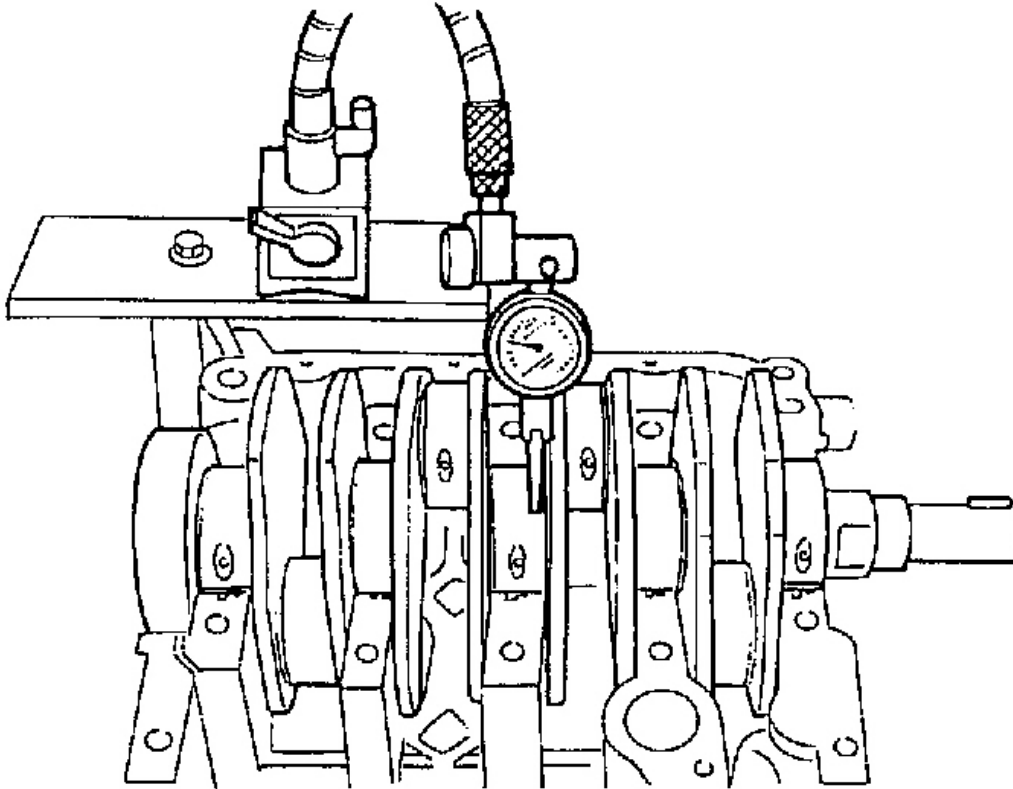
8. Make two 3 mm (0.12 in) holes in bushing. Ream the inside of bushing.
9. After completion of reaming, clean bushing to remove chips.

#### CRANKSHAFT AND CRANKSHAFT BEARING

1. Clean crankshaft completely and check for cracks by means of red lead check etc., and replace if defective.
2. Measure the crankshaft bend, and correct or replace if it exceeds the limit.

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

**Crankshaft bend limit:** 0.035 mm (0.0014 in)



G02960270

**Fig. 236: Measuring Crankshaft Bend**  
Courtesy of SUBARU OF AMERICA, INC.

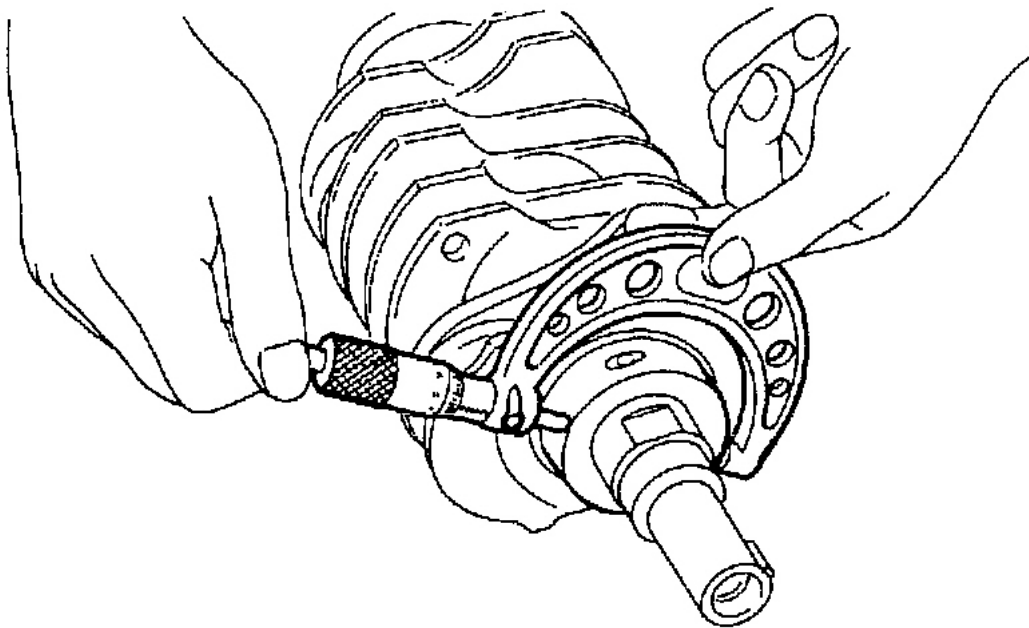
3. Inspect the crank journal and crank pin for wear. If they are not within the specifications, replace bearing with a suitable (undersize) one, and replace or recondition crankshaft as necessary. When grinding crank journal or crank pin, finish them to the specified dimensions according to the undersize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

**Crank pin and crank journal:**

**Out-of-roundness:** 0.020 mm (0.0008 in) or less

**Taper limit:** 0.07 mm (0.0028 in)

**Grinding limit:** 0.250 mm (0.0098 in)



**G02960271**

**Fig. 237: Measuring Crank Journal Diameter**  
Courtesy of SUBARU OF AMERICA, INC.

# 2002 Subaru Legacy L

## 2002 ENGINE Mechanical - Legacy & Outback

		Unit: mm (in)		
		Crank journal diameter		Crank pin 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)

O.D. ... Outer Diameter  
G02960272

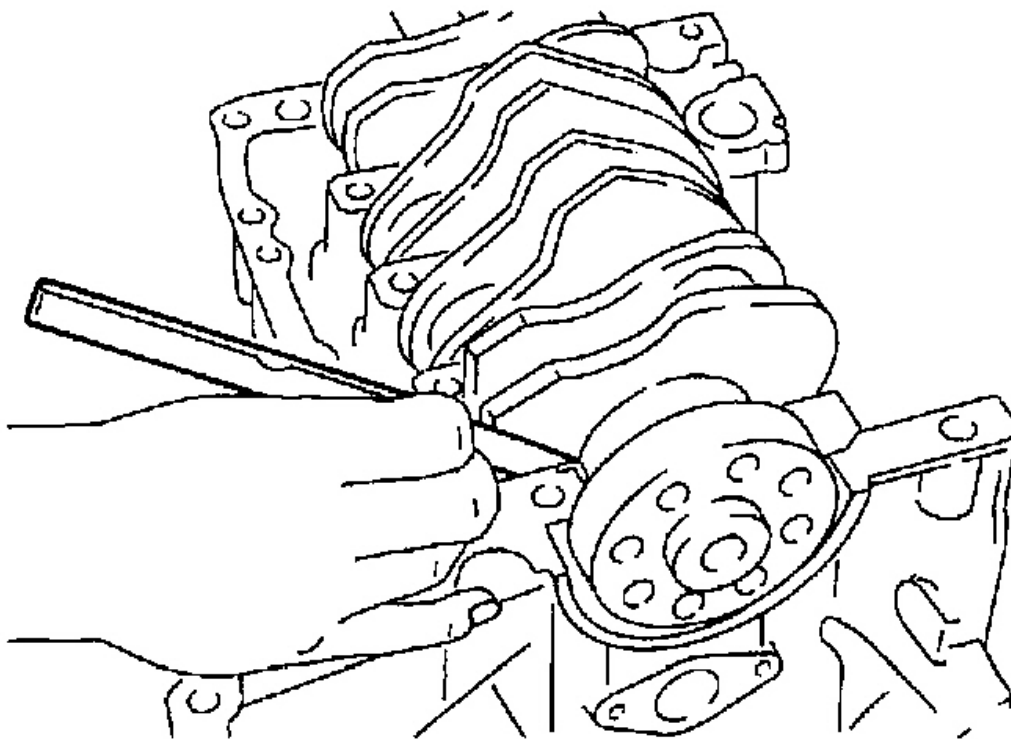
**Fig. 238: Crank Journal & Crank Pin Diameter Specification Chart**  
Courtesy of SUBARU OF AMERICA, INC.

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

### Crankshaft thrust clearance:

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

**Limit:** 0.25 mm (0.0098 in)



G02960273

**Fig. 239: Measuring Thrust 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 plastigauge. If the measurement is not within the specification, replace defective bearing with an undersize one, and replace or recondition crankshaft as necessary.

#### CRANKSHAFT OIL SPECIFICATION

Unit: mm (in)	
Crankshaft oil clearance	
Standard	0.010 - 0.030 (0.0004 - 0.0012)
Limit	0.040 (0.0016)

## ENGINE TROUBLE IN GENERAL

### INSPECTION

# 2002 Subaru Legacy L

## 2002 ENGINE Mechanical - Legacy & Outback

**NOTE:** "RANK" shown in the chart refer to the possibility of reason for the trouble in order ("Very often" to "Rarely")

A — Very often  
B — Sometimes  
C — Rarely

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
1. Engine will not start.			
1) Starter does not turn.	● Starter	● Defective battery-to-starter harness	B
		● Defective starter switch	C
		● Defective inhibitor switch or neutral switch	C
		● Defective starter	B
	● Battery	● Poor terminal connection	A
		● Run-down battery	A
		● Defective charging system	B
	● Friction	● Seizure of crankshaft and connecting rod bearing	C
		● Seized camshaft	C
		● Seized or stuck piston and cylinder	C
2) Initial combustion does not occur.	● Starter	● Defective starter	C
	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Fuel line	● Defective fuel pump and relay	A
		● Lack of or insufficient fuel	B
	● Belt	● Defective	B
		● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	B
		● Improper engine oil (low viscosity)	B

G02960274

**Fig. 240: Engine Trouble Inspection Chart (1 Of 6)**  
Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
3) Initial combustion occur.	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
	● Fuel line	● Defective fuel pump and relay	C
		● Clogged fuel line	C
		● Lack of or insufficient fuel	B
	● Belt	● Defective	B
		● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	B
		● Improper engine oil (low viscosity)	B
4) Engine stalls after initial combustion.	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Loosened or cracked intake duct	B
		● Loosened or cracked PCV hose	C
		● Loosened or cracked vacuum hose	C
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Dirty air cleaner element	C
	● Fuel line	● Clogged fuel line	C
		● Lack of or insufficient fuel	B
	● Belt	● Defective	B
		● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	B
		● Improper engine oil (low viscosity)	B

G02960275

**Fig. 241: Engine Trouble Inspection Chart (2 Of 6)**  
**Courtesy of SUBARU OF AMERICA, INC.**

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
2. Rough idle and engine stall	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Loosened or cracked intake duct	A
		● Loosened or cracked PCV hose	A
		● Loosened or cracked vacuum hose	A
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Defective PCV valve	C
		● Loosened oil filler cap	B
		● Dirty air cleaner element	C
	● Fuel line	● Defective fuel pump and relay	C
		● Clogged fuel line	C
		● Lack of or insufficient fuel	B
	● Belt	● Defective timing	C
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	B
		● Loosened cylinder head bolts or defective gasket	B
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	B
		● Incorrect valve timing	A
		● Improper engine oil (low viscosity)	B
	● Lubrication system	● Incorrect oil pressure	B
		● Defective rocker cover gasket	C
	● Cooling system	● Overheating	C
	● Others	● Malfunction of evaporative emission control system	A
		● Stuck or damaged throttle valve	B
		● Accelerator cable out of adjustment	C

G02960276

**Fig. 242: Engine Trouble Inspection Chart (3 Of 6)**  
**Courtesy of SUBARU OF AMERICA, INC.**



## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
3. Low output, hesitation and poor acceleration	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Loosened or cracked intake duct	A
		● Loosened or cracked PCV hose	A
		● Loosened or cracked vacuum hose	B
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Defective PCV valve	B
		● Loosened oil filler cap	B
		● Dirty air cleaner element	A
	● Fuel line	● Defective fuel pump and relay	B
		● Clogged fuel line	B
		● Lack of or insufficient fuel	C
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	B
		● Loosened cylinder head bolts or defective gasket	B
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	A
		● Improper engine oil (low viscosity)	B
	● Lubrication system	● Incorrect oil pressure	B
	● Cooling system	● Overheating	C
		● Over cooling	C
	● Others	● Malfunction of evaporative emission control system	A
4. Surging	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Loosened or cracked intake duct	A
		● Loosened or cracked PCV hose	A
		● Loosened or cracked vacuum hose	A
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Defective PCV valve	B
		● Loosened oil filler cap	B
		● Dirty air cleaner element	B
	● Fuel line	● Defective fuel pump and relay	B
		● Clogged fuel line	B
		● Lack of or insufficient fuel	C
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	C
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	A
		● Improper engine oil (low viscosity)	B
	● Cooling system	● Overheating	B
	● Others	● Malfunction of evaporative emission control system	C

G02960277

**Fig. 243: Engine Trouble Inspection Chart (4 Of 6)**  
 Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
5. Engine does not return to idle.	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Loosened or cracked vacuum hose	A
	● Others	● Stuck or damaged throttle valve	A
		● Accelerator cable out of adjustment	B
6. Dieseling (Run-on)	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Cooling system	● Overheating	B
	● Others	● Malfunction of evaporative emission control system	B
7. After burning in exhaust system	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Loosened or cracked intake duct	C
		● Loosened or cracked PCV hose	C
		● Loosened or cracked vacuum hose	B
		● Defective PCV valve	B
		● Loosened oil filler cap	C
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken valve spring	C
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	A
	● Lubrication system	● Incorrect oil pressure	C
	● Cooling system	● Over cooling	C
	● Others	● Malfunction of evaporative emission control system	C
8. Knocking	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Loosened oil filler cap	B
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Incorrect valve timing	B
	● Cooling system	● Overheating	A
9. Excessive engine oil consumption	● Intake system	● Loosened or cracked PCV hose	A
		● Defective PCV valve	B
		● Loosened oil filler cap	C
	● Compression	● Defective valve stem	A
		● Worn or stuck piston rings, cylinder and piston	A
	● Lubrication system	● Loosened oil pump attaching bolts and defective gasket	B
		● Defective oil filler seal	B
		● Defective crankshaft oil seal	B
		● Defective rocker cover gasket	B
		● Loosened oil drain plug or defective gasket	B
		● Loosened oil pan fitting bolts or defective oil pan	B

G02960278

**Fig. 244: Engine Trouble Inspection Chart (5 Of 6)**  
 Courtesy of SUBARU OF AMERICA, INC.

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
10. Excessive fuel consumption	● Engine control system <Ref. to Basic Diagnostic Procedure.>		A
	● Intake system	● Dirty air cleaner element	A
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken valve spring	C
		● Worn or stuck piston rings, cylinder and piston	B
		● Incorrect valve timing	B
	● Lubrication system	● Incorrect oil pressure	C
	● Cooling system	● Over cooling	C
	● Others	● Accelerator cable out of adjustment	B

G02960279

**Fig. 245: Engine Trouble Inspection Chart (6 Of 6)**  
Courtesy of SUBARU OF AMERICA, INC.

## ENGINE NOISE

### INSPECTION

## 2002 Subaru Legacy L

### 2002 ENGINE Mechanical - Legacy & Outback

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	<ul style="list-style-type: none"> <li>● Valve mechanism is defective.</li> <li>● Incorrect valve clearance</li> <li>● Worn valve rocker</li> <li>● Worn camshaft</li> <li>● Broken valve spring</li> </ul>
Heavy and dull clank	Oil pressure is low.	<ul style="list-style-type: none"> <li>● Worn crankshaft main bearing</li> <li>● Worn connecting rod bearing (big end)</li> </ul>
	Oil pressure is normal.	<ul style="list-style-type: none"> <li>● Loose flywheel mounting bolts</li> <li>● Damaged engine mounting</li> </ul>
High-pitched clank (Spark knock)	Sound is noticeable when accelerating with an overload.	<ul style="list-style-type: none"> <li>● Ignition timing advanced</li> <li>● Accumulation of carbon inside combustion chamber</li> <li>● Wrong spark plug</li> <li>● Improper gasoline</li> </ul>
Clank when engine speed is medium (1,000 to 2,000 rpm).	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. (NOTE*)	<ul style="list-style-type: none"> <li>● Worn crankshaft main bearing</li> <li>● Worn bearing at crankshaft end of connecting rod</li> </ul>
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. (NOTE*)	<ul style="list-style-type: none"> <li>● Worn cylinder liner and piston ring</li> <li>● Broken or stuck piston ring</li> <li>● Worn piston pin and hole at piston end of connecting rod</li> </ul>
	Sound is not reduced if each fuel injector connector is disconnected in turn. (NOTE*)	<ul style="list-style-type: none"> <li>● Unusually worn valve lifter</li> <li>● Worn cam gear</li> <li>● Worn camshaft journal bore in crankcase</li> </ul>
Squeaky sound	—	<ul style="list-style-type: none"> <li>● Insufficient generator lubrication</li> </ul>
Rubbing sound	—	<ul style="list-style-type: none"> <li>● Defective generator brush and rotor contact</li> </ul>
Gear scream when starting engine	—	<ul style="list-style-type: none"> <li>● Defective ignition starter switch</li> <li>● Worn gear and starter pinion</li> </ul>
Sound like polishing glass with a dry cloth	—	<ul style="list-style-type: none"> <li>● Loose drive belt</li> <li>● Defective water pump shaft</li> </ul>
Hissing sound	—	<ul style="list-style-type: none"> <li>● Loss of compression</li> <li>● Air leakage in air intake system, hoses, connections or manifolds</li> </ul>
Timing belt noise	—	<ul style="list-style-type: none"> <li>● Loose timing belt</li> <li>● Belt contacting case/adjacent part</li> </ul>
Valve tappet noise	—	<ul style="list-style-type: none"> <li>● Incorrect valve clearance</li> </ul>

NOTE\*:

When disconnecting fuel injector connector, Malfunction Indicator Light (CHECK ENGINE light) illuminates and trouble code is stored in ECM memory.

Therefore, carry out the CLEAR MEMORY MODE <Ref. to Clear Memory Mode.> and INSPECTION MODE <Ref. to Inspection Mode.> after connecting fuel injector connector.

G02960280

**Fig. 246: Engine Noise Inspection Chart**  
Courtesy of SUBARU OF AMERICA, INC.