

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

2012 ENGINE

Engine Mechanical (H4DOTC) - Forester

GENERAL DESCRIPTION

SPECIFICATION

GENERAL SPECIFICATIONS CHART

Engine	Model				2.5 L		
	Cylinder arrangement				Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine		
	Valve system mechanism				Belt driven, double overhead camshaft, 4-valve/cylinder		
	Bore x Stroke		mm (in)		99.5 x 79.0 (3.92 x 3.11)		
	Displacement		cm ³ (cu in)		2, 457 (149.94)		
	Compression ratio				8.4		
	Compression pressure (at 200 - 300 RPM)		kPa (kg/cm ² , psi)		Standard	981 - 1, 177 (10 - 12, 142 - 171)	
	Number of piston rings				Pressure ring: 2, Oil ring: 1		
	Intake valve timing		Open	Max. retard	ATDC 5°		
				Min. advance	BTDC 35°		
			Close	Max. retard	ABDC 65°		
				Min. advance	ABDC 25°		
	Exhaust valve timing		Open		BBDC 55°		
			Close		ATDC 5°		
	Valve clearance		Inspection value	Intake		0.20 ^{+0.04} _{-0.06} (0.0079 ^{+0.0016} ₋ 0.0024)	
				Exhaust		0.35±0.05 (0.0138±0.0020)	
			Adjustment value	Intake		0-20 ⁺⁰⁻⁰¹ _{-0.03} (0.0079 ^{+0.0004} ₋ 0.0012)	
Exhaust				0.35±0.02 (0.0138±0.0008)			
Idle RPM (select lever in "P" or "N" range)		RPM		No load	Standard	700±100	
		RPM		A/C ON	Standard	825±100	
Ignition order				1-->3-->2-->4			
Ignition timing				BTDC/RPM	Standard	17°±10°/700	

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

GENERAL SPECIFICATIONS CHART

Belt tension adjuster	Adjuster rod protrusion amount			mm (in)	5.2 - 6.2 (0.205 - 0.244)
Camshaft	Bending limit			mm (in)	0.020 (0.00079)
	Cam lobe height	mm (in)	Intake	Standard	46.55 - 46.65 (1.833 - 1.837)
			Exhaust	Standard	46.75 - 46.85 (1.841 - 1.844)
	Cam base circle diameter			mm (in)	Standard 37.0 (1.457)
	Journal O.D.	mm (in)	Front	Standard	37.946 - 37.963 (1.4939 - 1.4946)
			Center, rear	Standard	29.946 - 29.963 (1.1790 - 1.1796)
	Oil clearance			mm (in)	Standard 0.037 - 0.072 (0.0015 - 0.0028)
	Thrust clearance			mm (in)	Standard 0.068 - 0.116 (0.0027 - 0.0047)
Cylinder head	Warping limit (Mating surface with cylinder block)			mm (in)	0.035 (0.0014)
	Grinding limit			mm (in)	0.3 (0.012)
	Standard height			mm (in)	127.5 (5.02)
Valve seat	Seating angle between valve and valve seat				90°
	Contacting width between valve and valve seat	mm (in)	Intake	Standard	0.6 - 1.4 (0.024 - 0.055)
			Exhaust	Standard	1.2 - 1.8 (0.047 - 0.071)
Valve guide	Clearance between the valve guide and valve stem	mm (in)	Intake	Standard	0.030 - 0.057 (0.0012 - 0.0022)
			Exhaust	Standard	0.040 - 0.067 (0.0016 - 0.0026)
	Inside diameter			mm (in)	6.000 - 6.012 (0.2362 - 0.2367)
	Valve stem outer diameters	mm (in)	Intake		5.955 - 5.970 (0.2344 - 0.2350)
			Exhaust		5.945 - 5.960 (0.2341 - 0.2346)
	Valve guide protrusion amount			mm (in)	15.8 - 16.2 (0.622 - 0.638)
Valve	Head edge thickness	mm (in)	Intake	Standard	1.0 - 1.4 (0.039 - 0.055)
			Exhaust	Standard	1.3 - 1.7 (0.051 - 0.067)
	Overall length	mm (in)	Intake		104.4 (4.110)
			Exhaust		104.65 (4.1201)
	Free length			mm (in)	47.32 (1.863)
				Set	205 - 235 (20.9 - 24.0, 46.1 - 52.8)/36.0 (1.417)
				N (kgf,	

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

Valve spring	Tension/spring height		lb)/mm (in)	Lift	426 - 490 (43.4 - 50.0, 95.8 - 110)/26.50 (1.043)
	Squariness				2.5°, 2.1 mm (0.083 in) or less
Valve lifter	Outer diameter		mm (in)	Standard	34.959 - 34.975 (1.3763 - 1.3770)
	Valve lifter mating surface inner diameter		mm (in)	Standard	34.994 - 35.016 (1.3777 - 1.3786)
	Valve lifter and valve lifter mating surface clearance		mm (in)	Standard	0.019 - 0.057 (0.0007 - 0.0022)
Cylinder block	Warping limit (Mating surface with cylinder head)		mm (in)		0.025 (0.0098)
	Grinding limit		mm (in)		0.1 (0.004)
	Standard height		mm (in)		201.0 (7.91)
	Cylindricity		mm (in)	Standard	0.015 (0.0006)
	Out-of-roundness		mm (in)	Standard	0.010 (0.0004)
	Clearance between cylinder and piston at 20°C (68°F)		mm (in)	Standard	-0.010 - 0.010 (- 0.00039 - 0.00039)
	Cylinder inner diameter boring limit (diameter)		mm (in)		To 100.005 (3.9372)
Piston	Piston grade point		mm (in)		38.2 (1.50)
	Outer diameter	mm (in)	Standard	A	99.505 - 99.515 (3.9175 - 3.9179)
				B	99.495 - 99.505 (3.9171 - 3.9175)
				0.25 (0.0098) OS	99.745 - 99.765 (3.9270 - 3.9278)
				0.50 (0.0197) OS	99.995 - 100.015 (3.9368 - 3.9376)
Piston pin	Degree of fit			Piston pin must be fitted into position with thumb at 20°C (68°F).	
	Clearance between piston pin hole and piston pin		mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)
Piston ring	Piston ring gap	mm (in)	Top ring	Standard	0.20 - 0.25 (0.0079 - 0.0098)
			Second ring	Standard	0.37 - 0.52 (0.015 - 0.0203)
			Oil ring	Standard	0.20 - 0.50 (0.0079 - 0.0197)
	Clearance between piston ring and piston ring groove	mm (in)	Top ring	Standard	0.040 - 0.080 (0.0016 - 0.0031)
			Second ring	Standard	0.030 - 0.070 (0.0012 - 0.0028)
	Bend or twist per 100 mm (3.94 in) in				

2012 Subaru Forester X

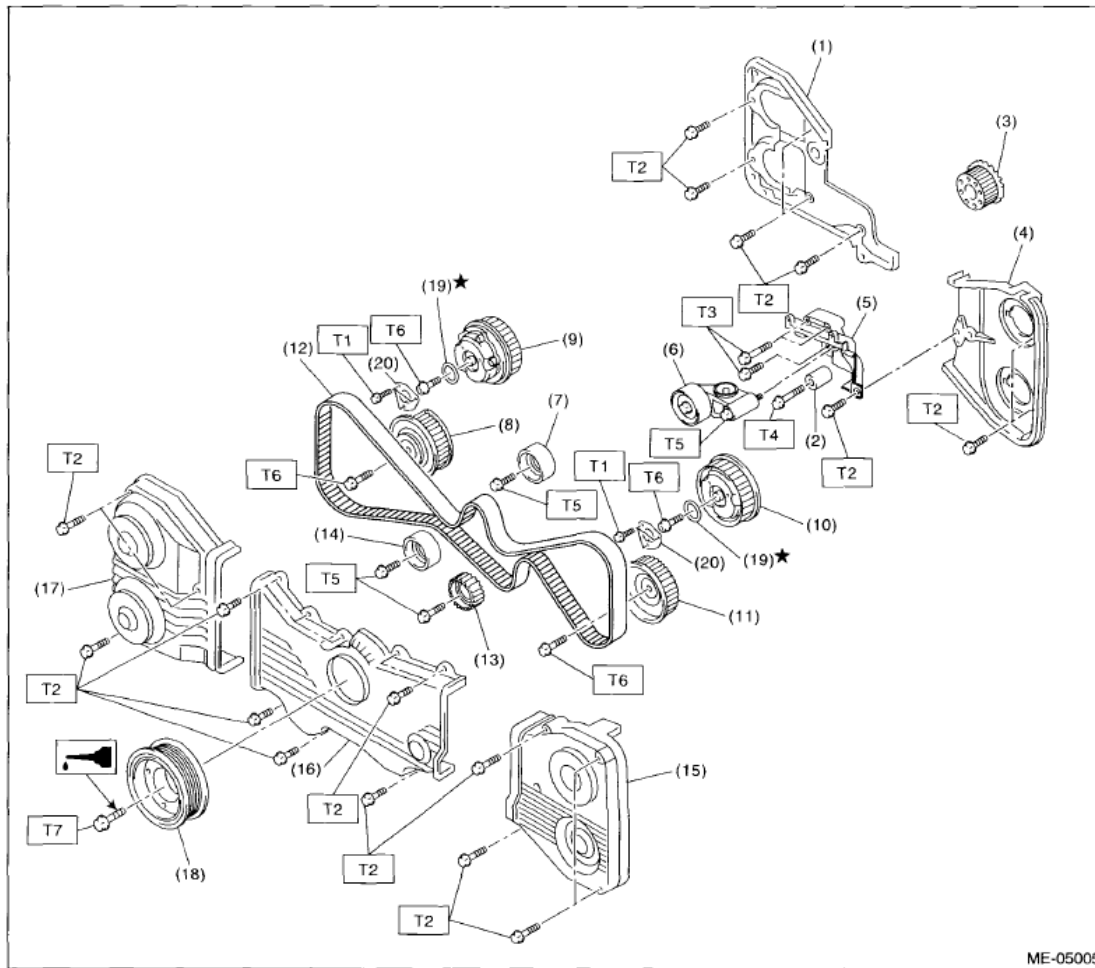
2012 ENGINE Engine Mechanical (H4DOTC) - Forester

Connecting rod and connecting rod bearing	length		mm (in)	Limit	0.10 (0.0039)	
	Thrust clearance		mm (in)	Standard	0.070 - 0.330 (0.0028 - 0.0130)	
	Oil clearance		mm (in)	Standard	0.017 - 0.045 (0.0007 - 0.0018)	
	Bearing size (Thickness at center)	mm (in)	Standard		1.490 - 1.506 (0.0587 - 0.0593)	
			0.03 (0.0012) US		1.504-1.512 (0.0592 - 0.0595)	
			0.05 (0.0020) US		1.514 - 1.522 (0.0596 - 0.0599)	
0.25 (0.0098) US			1.614 - 1.622 (0.0635 - 0.0639)			
Bushing of small end	Clearance between piston pin and bushing		mm (in)	Standard	0 - 0.022 (0 - 0.0009)	
Crankshaft and crankshaft bearing	Bending limit			mm (in)	0.035 (0.0014)	
	Crank pin	Out-of-roundness	mm (in)	Standard	0.003 (0.0001)	
			Cylindricity	mm (in)	Standard	0.004 (0.0002)
			Grinding limit (dia.)		mm (in)	To 51.750 (2.0374)
		Crank journal	Out-of-roundness	mm (in)	Standard	0.005 (0.0002)
	Cylindricity			mm (in)	Standard	0.006 (0.0002)
	Grinding limit (dia.)			mm (in)	To 59.758 (2.3527)	
	Crank pin outer diameter		mm (in)	Standard		51.976 - 52.000 (2.0463 - 2.0472)
		0.03 (0.0012) US		51.954 - 51.970 (2.0454 - 2.0461)		
		0.05 (0.0020) US		51.934 - 51.950 (2.0447 - 2.0453)		
		0.25 (0.0098) US		51.734 - 51.750 (2.0368 - 2.0374)		
	Crank journal outer diameter	mm (in)	Standard		59.984 - 60.008 (2.3616 - 2.3625)	
			0.03 (0.0012) US		59.962 - 59.978 (2.3607 - 2.3613)	
			0.05 (0.0020) US		59.942 - 59.958 (2.3599 - 2.3605)	
			0.25 (0.0098) US		59.742 - 59.758 (2.3520 - 2.3527)	
			Standard		1.998 - 2.015 (0.0787 - 0.0793)	
			0.03 (0.0012) US		2.017 - 2.020 (0.0794 - 0.0795)	

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Bearing size (Thickness at center)	mm (in)	#1, #3	0.05 (0.0020) US		2.027 - 2.030 (0.0798 - 0.0799)
			0.25 (0.0098) US		2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #5	Standard		2.000 - 2.017 (0.0787 - 0.0794)
			0.03 (0.0012) US		2.019 - 2.022 (0.0795 - 0.0796)
			0.05 (0.0020) US		2.029 - 2.032 (0.0799 - 0.0800)
			0.25 (0.0098) US		2.129 - 2.132 (0.0838 - 0.0839)
	Thrust clearance		mm (in)	Standard	0.030 - 0.115 (0.0012 - 0.0045)
	Oil clearance		mm (in)	Standard	0.010 - 0.030 (0.0004 - 0.0012)
NOTE: OS: Oversize US: Undersize					

COMPONENT**TIMING BELT**



ME-05005

- | | |
|--|------------------------------|
| (1) Timing belt cover No. 2 RH | (11) Exhaust cam sprocket LH |
| (2) Belt idler | (12) Timing belt |
| (3) Crank sprocket | (13) Belt idler No. 2 |
| (4) Timing belt cover No. 2 LH | (14) Belt idler |
| (5) Tensioner bracket | (15) Timing belt cover LH |
| (6) Automatic belt tension adjuster ASSY | (16) Front belt cover |
| (7) Belt idler | (17) Timing belt cover RH |
| (8) Exhaust cam sprocket RH | (18) Crank pulley |
| (9) Intake cam sprocket RH | (19) O-ring |
| (10) Intake cam sprocket LH | (20) Actuator cover |

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

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

T1: 3.4 (0.3, 2.5)

T2: 5 (0.5, 3.7)

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

T3: 24.5 (2.5, 18.1)

T4: 25 (2.5, 18.4)

T5: 39 (4.0, 28.8)

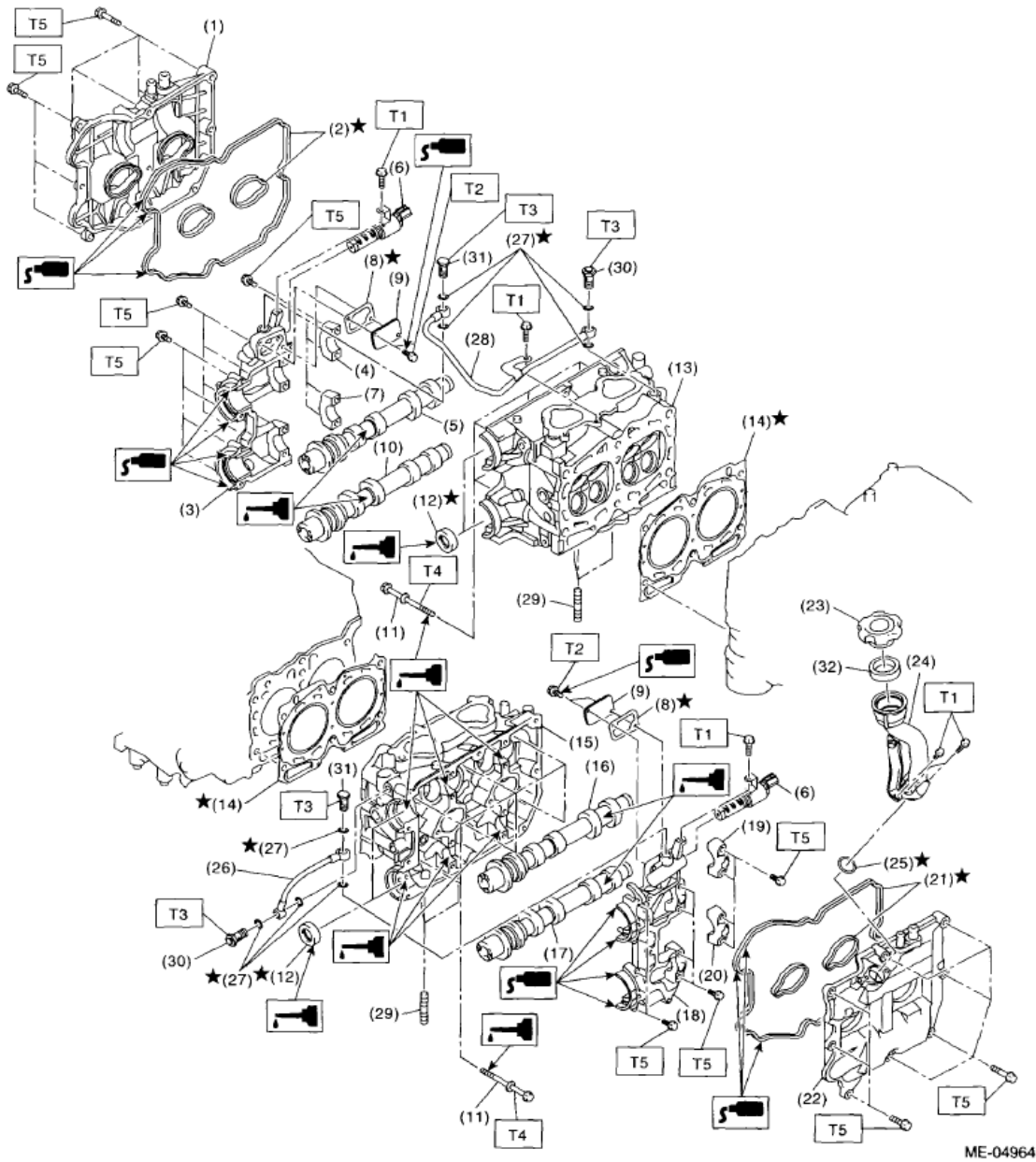
T6: < Ref. to INSTALLATION, Cam Sprocket. >

T7: < Ref. to INSTALLATION, Crank Pulley. >

CYLINDER HEAD AND CAMSHAFT

2012 Subaru Forester X

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ME-04964

- | | | |
|-------------------------------------|------------------------------|---|
| (1) Rocker cover RH | (14) Cylinder head gasket | (27) Gasket |
| (2) Rocker cover gasket RH | (15) Cylinder head LH | (28) Oil pipe RH |
| (3) Front camshaft cap RH | (16) Intake camshaft LH | (29) Stud bolt |
| (4) Intake camshaft cap RH | (17) Exhaust camshaft LH | (30) Union bolt with filter (with protrusion) |
| (5) Intake camshaft RH | (18) Front camshaft cap LH | (31) Union bolt without filter (without protrusion) |
| (6) Oil flow control solenoid valve | (19) Intake camshaft cap LH | (32) Gasket |
| (7) Exhaust camshaft cap RH | (20) Exhaust camshaft cap LH | |
| (8) Gasket | (21) Rocker cover gasket LH | |
| (9) Oil return cover | (22) Rocker cover LH | |
| (10) Exhaust camshaft RH | (23) Oil filler cap | |
| (11) Cylinder head bolt | (24) Oil filler duct | |
| (12) Oil seal | (25) O-ring | |

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

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

T1: 6.4 (0.7, 4.7)

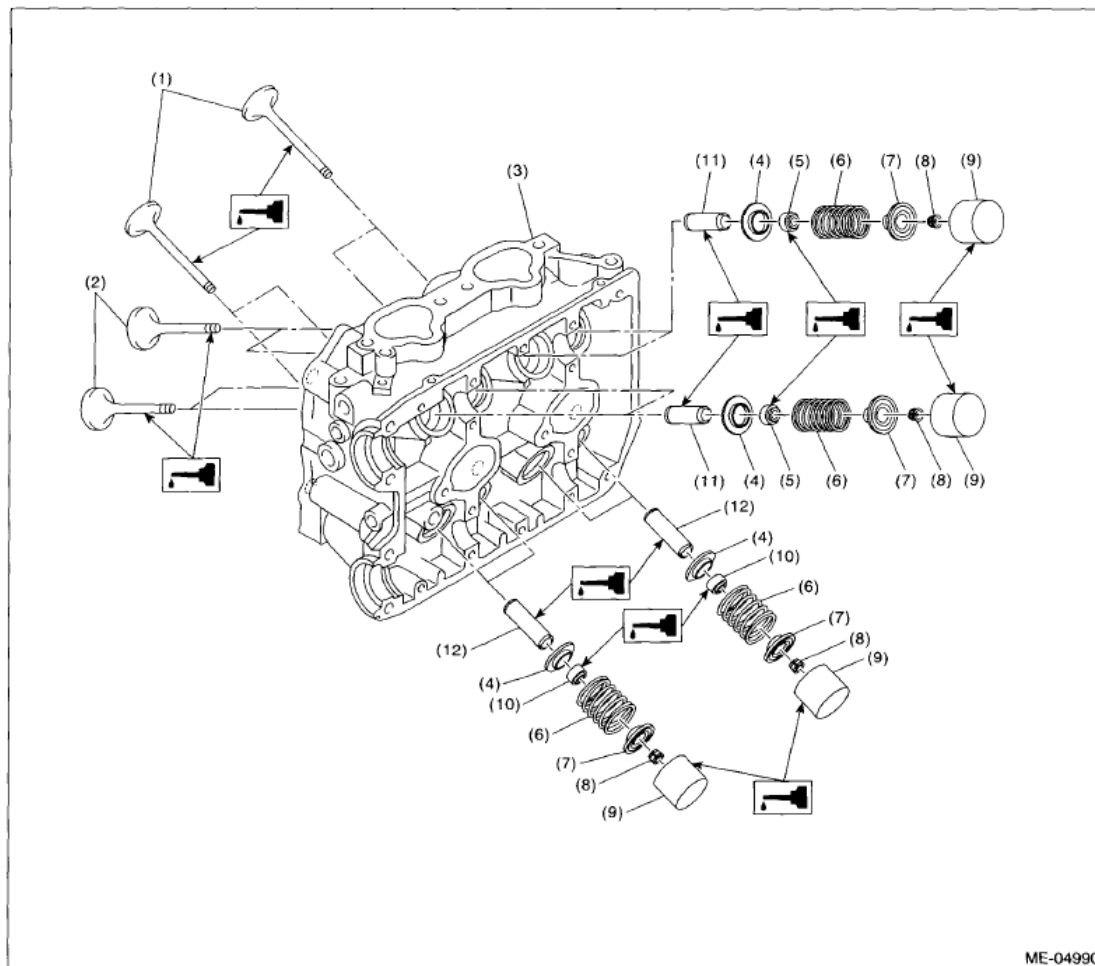
T2: 9 (0.9, 6.6)

T3: 29 (3.0, 21.4)

T4: < Ref. to INSTALLATION, Cylinder Head. >

T5: < Ref. to INSTALLATION, Camshaft. >

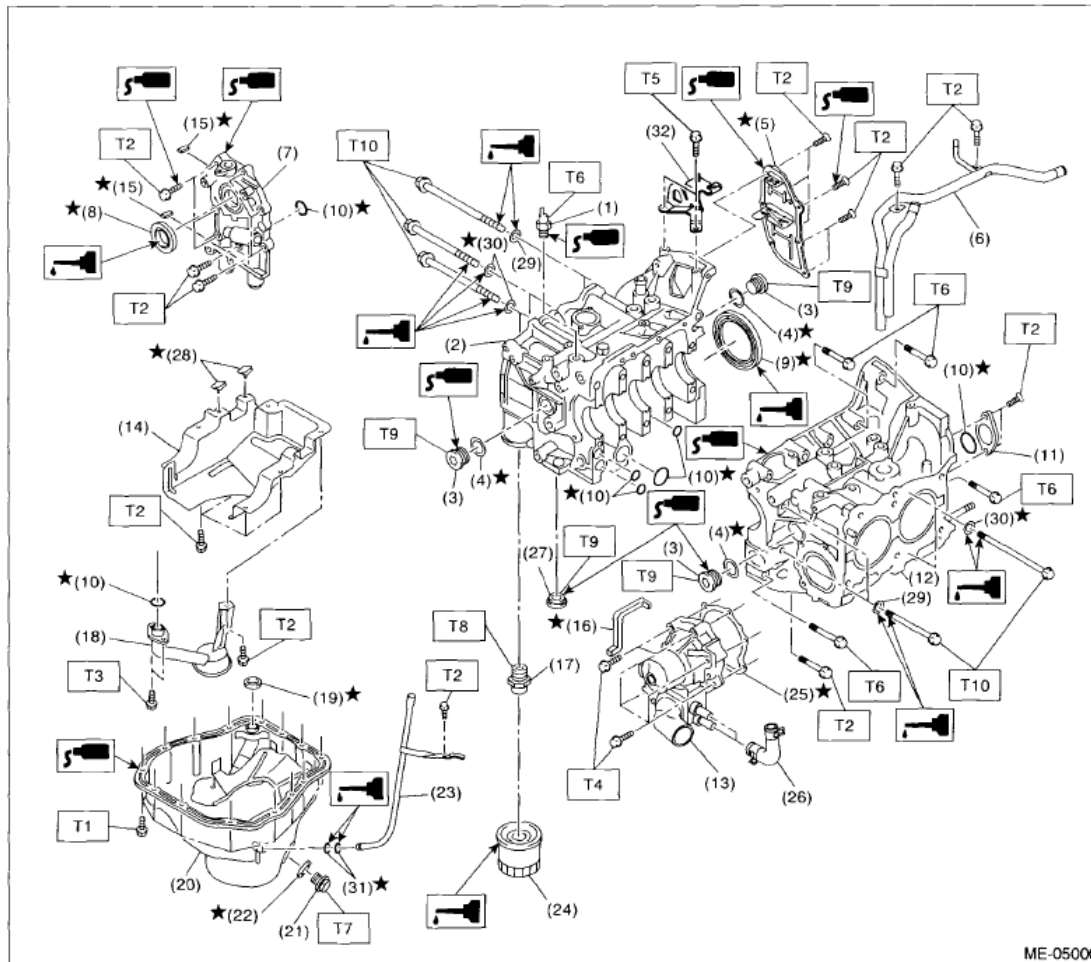
CYLINDER HEAD AND VALVE ASSEMBLY



- | | | |
|-----------------------|---------------------------|-----------------------------|
| (1) Exhaust valve | (5) Intake valve oil seal | (9) Valve lifter |
| (2) Intake valve | (6) Valve spring | (10) Exhaust valve oil seal |
| (3) Cylinder head | (7) Retainer | (11) Intake valve guide |
| (4) Valve spring seat | (8) Retainer key | (12) Exhaust valve guide |

Fig. 3: Identifying Cylinder Head, Valve Assembly And Related Components
 Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK



ME-05000

- | | | |
|-------------------------|----------------------------|-------------------------|
| (1) Oil pressure switch | (16) Water pump sealing | (31) O-ring |
| (2) Cylinder block RH | (17) Oil filter connector | (32) Engine rear hanger |
| (3) Service hole plug | (18) Oil strainer | |
| (4) Gasket | (19) Gasket | |
| (5) Oil separator cover | (20) Oil pan | |
| (6) Water by-pass pipe | (21) Drain plug | |
| (7) Oil pump | (22) Drain plug gasket | |
| (8) Front oil seal | (23) Oil level gauge guide | |
| (9) Rear oil seal | (24) Oil filter | |
| (10) O-ring | (25) Gasket | |
| (11) Service hole cover | (26) Water pump hose | |
| (12) Cylinder block LH | (27) Plug | |
| (13) Water pump | (28) Seal | |
| (14) Baffle plate | (29) Washer | |
| (15) Oil pump seal | (30) Seal washer | |

Fig. 4: Identifying Cylinder Block And Related Components With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 5 (0.5, 3.7)

T2: 6.4 (0.7, 4.7)

T3: 10 (1.0, 7.2)

T4: First 12 (1.2, 8.9)

Second 12 (1.2, 8.9)

T5: 16 (1.6, 11.8)

T6: 25 (2.5, 18.4)

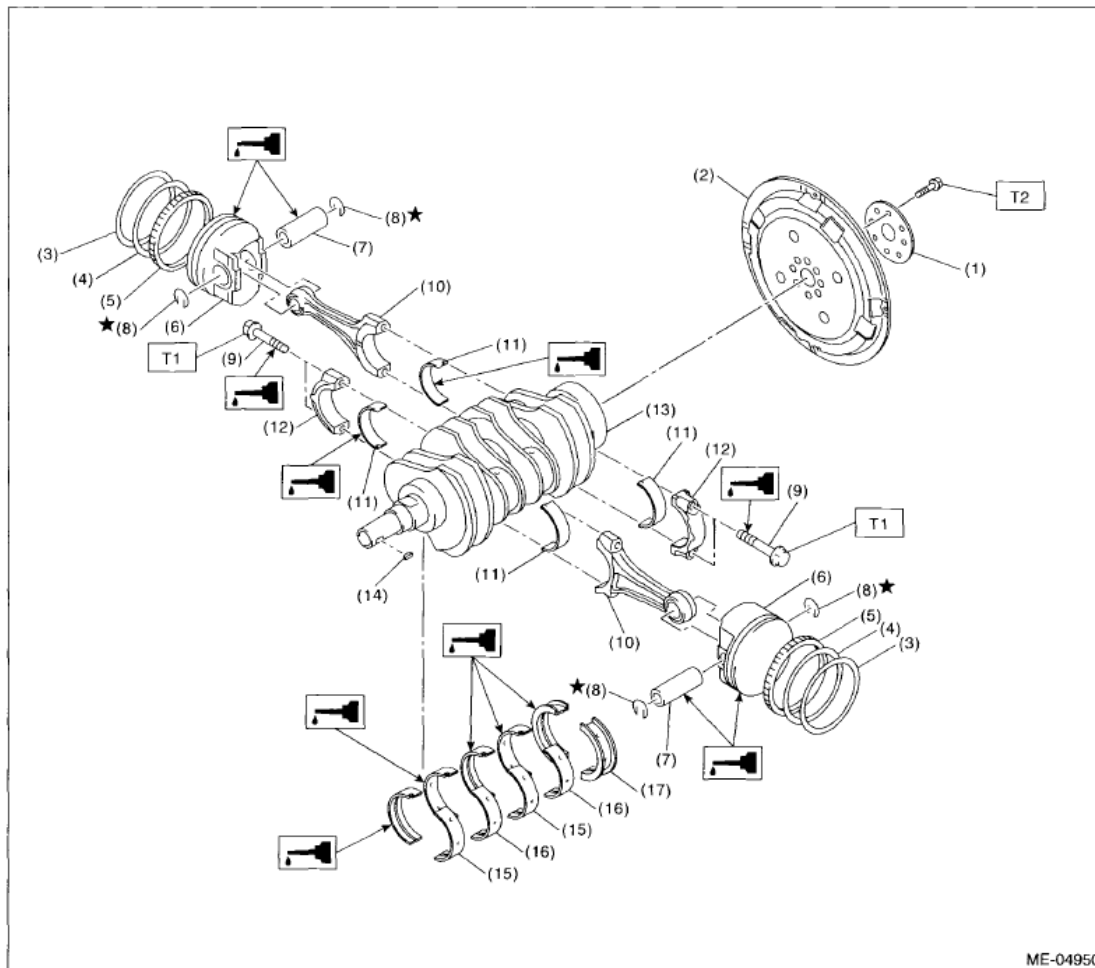
T7: 44 (4.5, 32.5)

T8: 45 (4.6, 33.2)

T9: 70 (7.1, 51.6)

T10: < Ref. to INSTALLATION, Cylinder Block. >

CRANKSHAFT AND PISTON



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

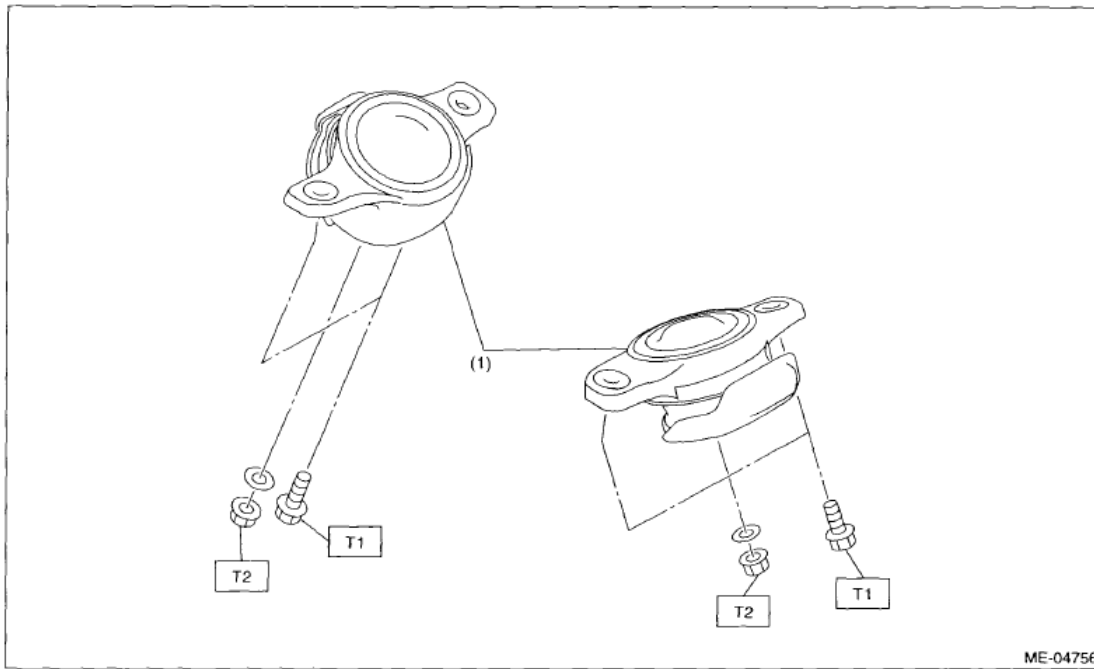
Fig. 5: Identifying Crankshaft, Piston And Related Components With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

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

T1: 52 (5.3, 38.4)

T2: < Ref. to INSTALLATION , Drive Plate. >

ENGINE MOUNTING



(1) Front cushion rubber

Fig. 6: Front Cushion Rubber And Mounting Bolts With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 35 (3.6, 25.8)

T2: 85 (8.7, 62.7)

CAUTION

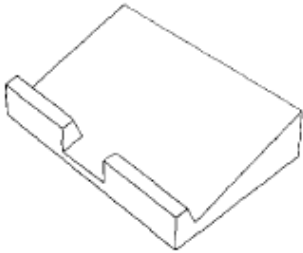
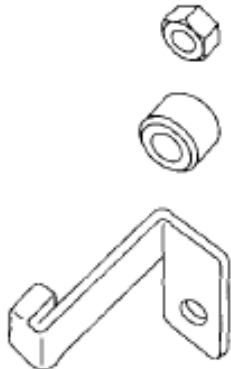
- Wear appropriate work clothing, including a cap, protective goggles and protective shoes when performing any work.
- Remove contamination including dirt and corrosion before removal, installation or disassembly.
- Keep the disassembled parts in order and protect them from dust and dirt.
- Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly and replacement.
- Vehicle components are extremely hot after driving. Be wary of receiving burns from heated parts.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or rigid racks at the specified points.
- Before disconnecting connectors of sensors or units, be sure to disconnect the ground cable from battery.
- All parts should be thoroughly cleaned, paying special attention to engine oil passages, pistons and bearings.
- Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.

- Be careful not to let oil, grease or coolant contact the timing belt.
- All removed parts, if to be reused, should be reinstalled in the original positions and directions.
- Bolts, nuts and washers should be replaced with new parts as required.
- Even if necessary inspections have been made in advance, proceed with assembly work while making rechecks.
- Remove or install the engine in an area where chain hoists, lifting devices, etc. are available for ready use.
- Be sure not to damage coated surfaces of body panels with tools, or not to stain seats and windows with coolant or oil. Place a cover over fender, as required, for protection.
- Prior to starting work, prepare the following: Service tools, clean cloth, containers to catch coolant and oil, wire ropes, chain hoist, transmission jacks, etc.
- Lift up or lower the vehicle when necessary. Make sure to support the correct positions.

PREPARATION TOOL

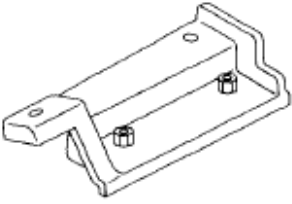
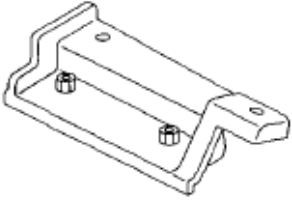
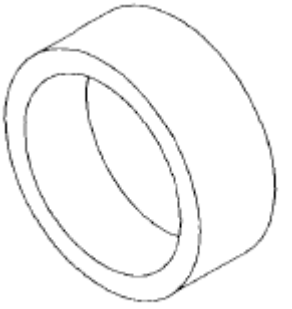
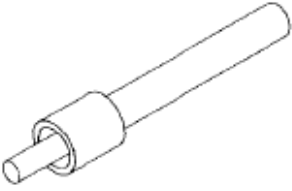
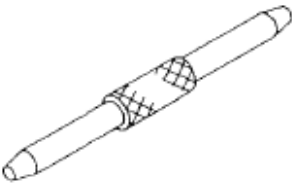
SPECIAL TOOL

SPECIAL TOOL REFERENCE CHART

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-498267600	498267600	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498277200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
		ENGINE STAND	Used together with ENGINE

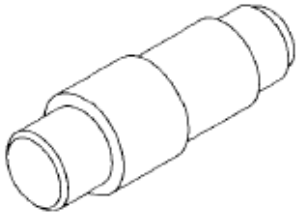
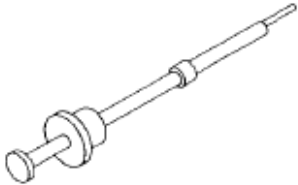
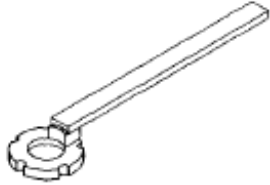
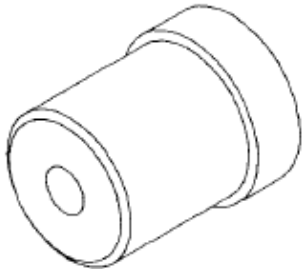
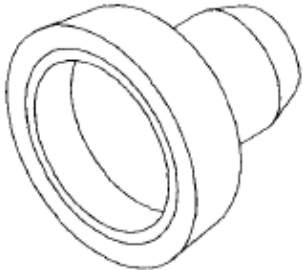
2012 Subaru Forester X

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 ST-498457000	498457000	ADAPTER RH	STAND (499817100).
 ST-498457100	498457100	ENGINE STAND ADAPTER LH	Used together with ENGINE STAND (499817100).
 ST-498747300	498747300	PISTON GUIDE	Used for installing the piston into the cylinder.
 ST-498857100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake valve guide oil seals and exhaust valve guide oil seals.
 ST-499017100	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.

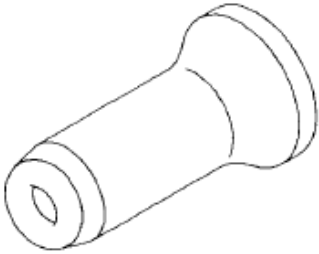
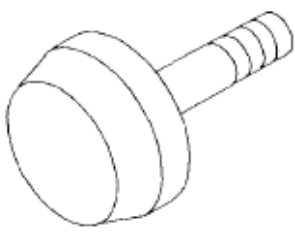
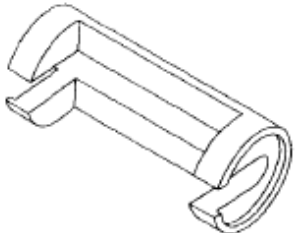
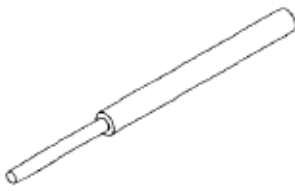
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 ST-499037100	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499097700	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499207400	499207400	CAM SPROCKET WRENCH	Used for removing and installing exhaust cam sprocket.
 ST-499587100	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).

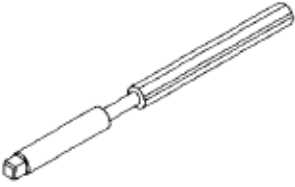
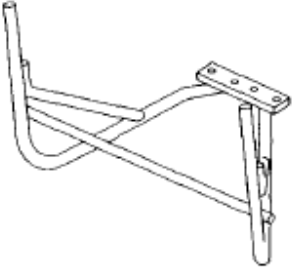
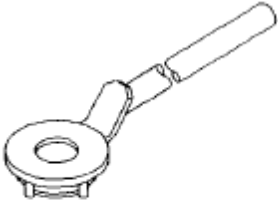
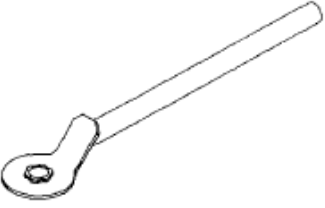
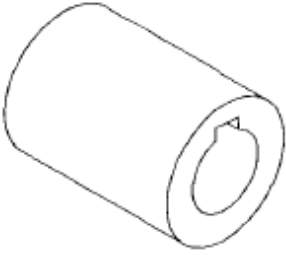
2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

 ST-499587600	499587600	OIL SEAL INSTALLER	Used for installing the camshaft oil seal.
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499597200	499597200	OIL SEAL GUIDE	• Used for installing the camshaft oil seal. • Used together with OIL SEAL INSTALLER (499587600).
 ST-499718000	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST-499767200	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.

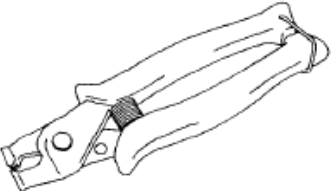
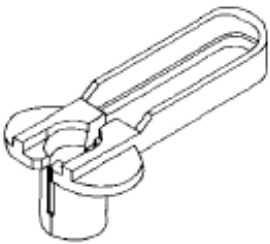
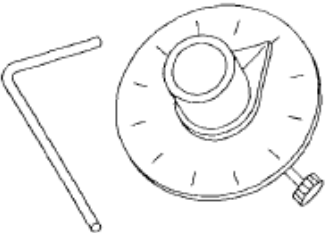
2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

 ST-499767400	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499817100	499817100	ENGINE STAND	• Used for disassembling and assembling engine. • Used together with ENGINE STAND ADAPTER RH (498457000) & LH (498457100).
 ST-499977400	499977400	CRANK PULLEY WRENCH	Used for removing and installing the crank pulley.
 ST-499977500	499977500	CAM SPROCKET WRENCH	Used for removing and installing intake cam sprocket.
 ST-499987500	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.

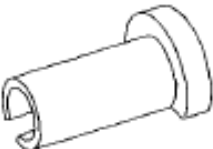
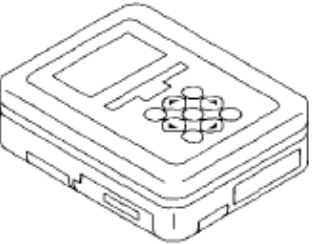
2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

 ST18251AA020	18251AA020	VALVE GUIDE ADJUSTER	Used for installing intake valve guides and exhaust valve guides.
 ST18353AA000	18353AA000	CLAMP PLIERS	• Used for removing and installing the PCV hose. • This tool is made by the French company CAILLAU. (code) 54.0.000.205 To make it easier to obtain, it has been provided with a tool number.
 ST18371AA000	18371AA000	CONNECTOR REMOVER	Used for disconnecting the quick connector on the fuel return hose side of the engine compartment (intake manifold).
 ST18854AA000	18854AA000	ANGLE GAUGE	Used for installing the crank pulley.
	42099AE000	QUICK CONNECTOR RELEASE	Used for removing the quick connector.

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

 ST42099AE000			
 ST1B022XU0	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for various inspections.

GENERAL TOOL

GENERAL TOOL REFERENCE CHART

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

COMPRESSION

INSPECTION

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

1. Remove the collector cover.
2. After warming-up the engine, turn the ignition switch to OFF.
3. Make sure that the battery is fully charged.
4. Remove the fuse of fuel pump from main fuse box.

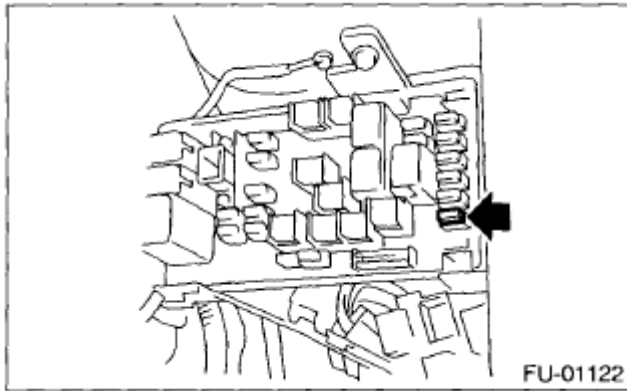


Fig. 7: Locating Fuel Pump Fuse
Courtesy of SUBARU OF AMERICA, INC.

5. Start the engine and run it until it stalls.
6. After the engine stalls, crank it for five more seconds.
7. Turn the ignition switch to OFF.
8. Remove all spark plugs. < Ref. to **REMOVAL** , Spark Plug. >
9. Fully open the throttle valve.
10. Check the starter motor for satisfactory performance and operation.
11. Install the compression gauge to the spark plug hole.

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

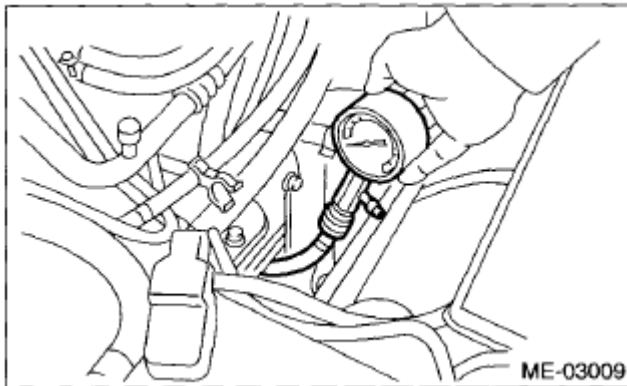


Fig. 8: Installing Compression Gauge To Spark Plug Hole
Courtesy of SUBARU OF AMERICA, INC.

12. Crank the engine by starter motor and read the value when the needle of the compression gauge becomes stable.

NOTE: • Perform at least two measurements per cylinder, and make sure that

the values are correct.

- If the compression pressure is out of standard, check or adjust the pistons, valves and cylinders.

Compression (fully open throttle):

Standard

981 - 1,177 kPa (10 - 12 kgf/cm² , 142 - 171 psi)

Difference between cylinders

49 kPa (0.5 kgf/cm² , 7 psi) or less

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

IDLE SPEED

INSPECTION

1. Before checking the idle speed, check the following item:
 1. Check the air cleaner element is free from clogging, ignition timing is correct, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. Read the engine idle speed using Subaru Select Monitor. < Ref. to **READ CURRENT DATA FOR ENGINE (NORMAL MODE)** , OPERATION, Subaru Select Monitor. >

NOTE:

- Idle speed cannot be adjusted manually, because the idle speed is automatically adjusted.
- If idle speed is out of standard, refer to the General Diagnosis Table under "Engine Control System". < Ref. to **BASIC DIAGNOSTIC PROCEDURE** . >

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

Idle RPM (no load and select lever in "P" or "N" range):

Standard

700±100 RPM

2. Check the idle speed when loaded. (Turn the A/C switch to "ON" and operate the compressor for at least

one minute before measurement.)

Idle speed (A/C ON and select lever in "P" or "N" range):

Standard

825±100 RPM

IGNITION TIMING

INSPECTION

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

METHOD WITH SUBARU SELECT MONITOR

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. Read the ignition timing using Subaru Select Monitor. < Ref. to **READ CURRENT DATA FOR ENGINE (NORMAL MODE)** , OPERATION, Subaru Select Monitor. >

NOTE: If ignition timing is out of standard, check the ignition control system. Refer to "Engine Control System". < Ref. to **BASIC DIAGNOSTIC PROCEDURE** . >

Ignition timing [BTDC/RPM]:

Standard

17°±10°/700

METHOD WITH TIMING LIGHT

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.
 2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. Stop the engine, and turn the ignition switch to OFF.
4. Remove the collector cover.
5. Disconnect the ground cable from battery.

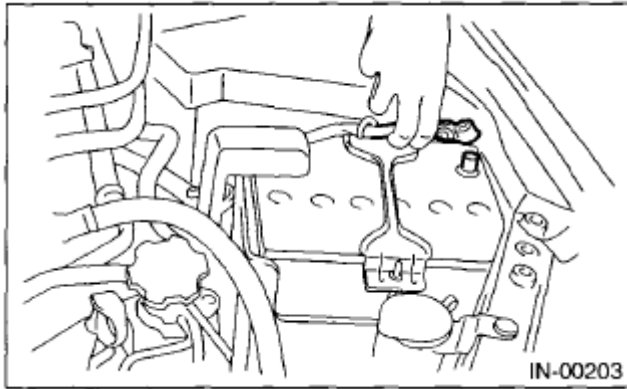


Fig. 9: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the air intake duct (Rear). < Ref. to **REMOVAL** , Air Intake Duct. >
7. Remove the air cleaner case. < Ref. to **REMOVAL** , Air Cleaner Case. >
8. Connect the timing light to the power wire of #1 ignition coil.
9. Install the air cleaner case. < Ref. to **INSTALLATION** , Air Cleaner Case. >
10. Connect the battery ground terminal.

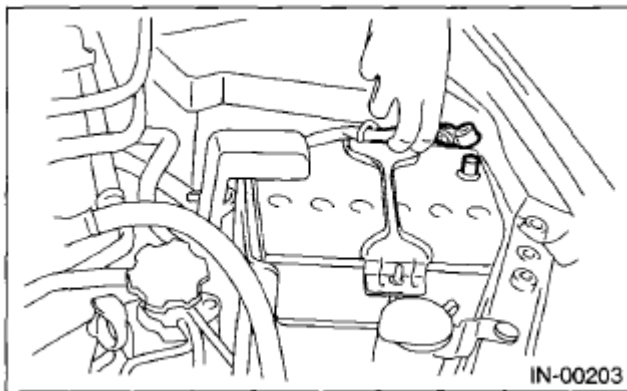


Fig. 10: Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

11. Start the engine, turn the timing light to the crank pulley, and check the ignition timing through the timing belt cover gauge.

NOTE: If ignition timing is out of standard, check the ignition control system. Refer to "Engine Control System". < Ref. to **BASIC DIAGNOSTIC PROCEDURE** . >

Ignition timing [BTDC/RPM]:

Standard

$17^{\circ}\pm 10^{\circ}/700$

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

INTAKE MANIFOLD VACUUM

INSPECTION

1. Warm up the engine.
2. Remove the collector cover.
3. Remove the intercooler. < Ref. to **REMOVAL** , Intercooler. >
4. Disconnect the brake booster vacuum hose from the intake manifold, and attach the vacuum gauge.

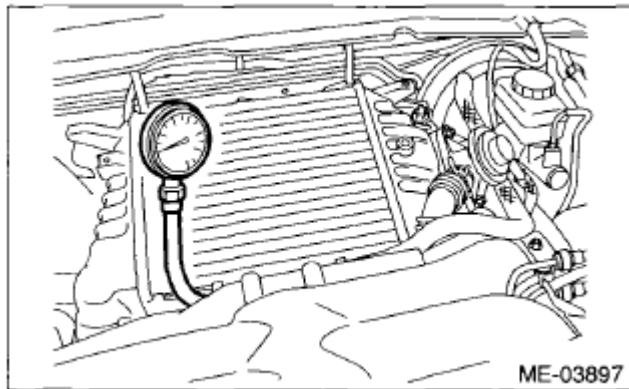


Fig. 11: Attaching Vacuum Gauge To Intake Manifold
Courtesy of SUBARU OF AMERICA, INC.

5. Install the intercooler. < Ref. to **INSTALLATION** , Intercooler. >
6. Keep the engine at idle speed and read the vacuum gauge indication.

NOTE: Condition of engine inside can be diagnosed by observing the behavior of the vacuum gauge needle as described in table below.

Intake manifold vacuum (at idling, A/C OFF):

Standard

-68.0 kPa (-510 mmHg, -20.08 inHg) or more

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

ENGINE CONDITION REFERENCE CHART

Diagnosis of engine condition by inspection of intake manifold vacuum	
Vacuum gauge needle behavior	Possible engine condition

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

ENGINE OIL PRESSURE

INSPECTION

1. Remove the collector cover.
2. Disconnect the ground cable from battery.

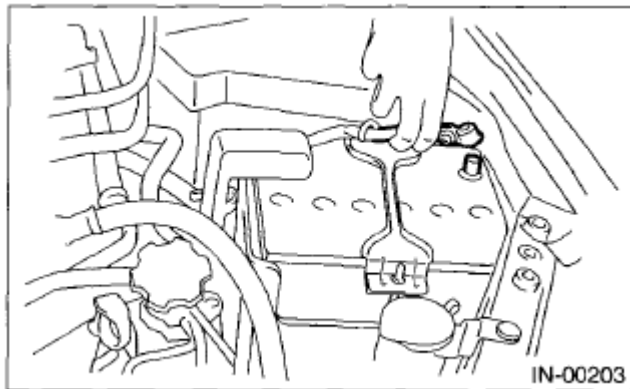


Fig. 12: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the oil pressure switch. < Ref. to **REMOVAL** , Oil Pressure Switch. >
4. Install the oil pressure gauge to cylinder block.

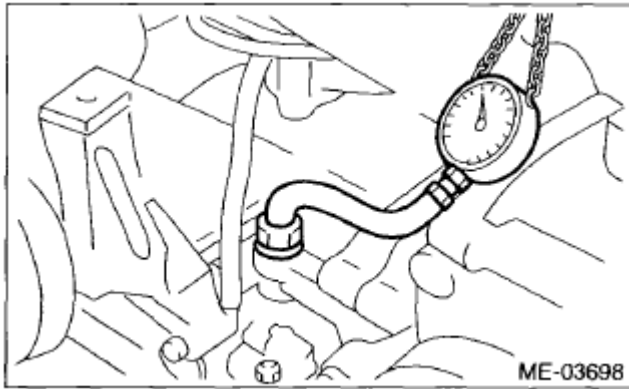


Fig. 13: Installing Oil Pressure Gauge To Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

5. Connect the battery ground terminal.

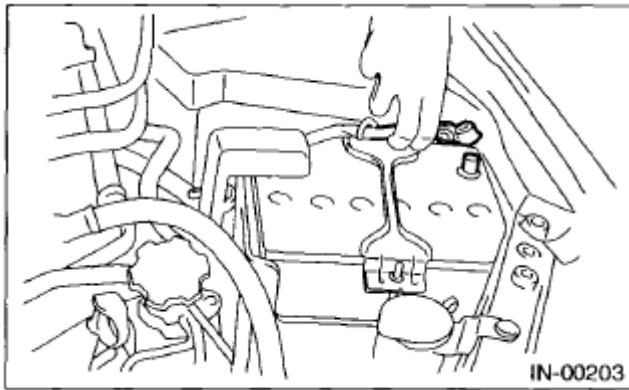


Fig. 14: Connecting Battery Ground Cable
Courtesy of SUBARU OF AMERICA, INC.

6. Start the engine, and check the oil pressure.

NOTE:

- Standard value is based on an engine oil temperature of 80°C (176°F).
- If the oil pressure is out of specification, check oil pump, oil filter and lubrication line. < Ref. to INSPECTION , Engine Lubrication System Trouble in General. >
- If the oil pressure warning light is ON and oil pressure is within specification, check the oil pressure switch. < Ref. to INSPECTION , Engine Lubrication System Trouble in General. >

Engine oil pressure:

Standard

98 kPa (1.0 kgf/cm² , 14 psi) or more (at 600 RPM)

294 kPa (3.0 kgf/cm² , 43 psi) or more (at 5, 000 RPM)

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

FUEL PRESSURE

INSPECTION

- CAUTION:**
- Before removing the fuel pressure gauge, release the fuel pressure.
 - Be careful not to spill fuel.
 - Catch the fuel from hoses using a container or cloth.

1. Remove the collector cover.
2. Release the fuel pressure. < Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel. >
3. Open the fuel filler lid and remove the fuel filler cap.
4. Disconnect the fuel delivery hose from fuel damper, and connect fuel pressure gauge.

- CAUTION:**
- Be careful not to spill fuel.
 - Catch the fuel from hoses using a container or cloth.
1. Attach ST to the fuel delivery pipe and push ST in the direction of arrow mark to disconnect the quick connector of the fuel delivery hose.

ST 42099AE000 QUICK CONNECTOR RELEASE

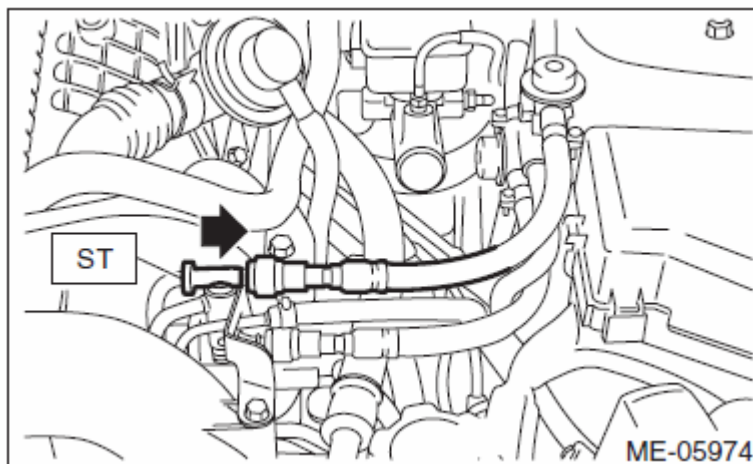


Fig. 15: Identifying Quick Connector Release
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the fuel pressure gauge with ST1 and ST2.

NOTE: ST1 is a SUBARU genuine part.
ST1 42075AG690 FUEL HOSE
ST2 18471AA000 FUEL PIPE ADAPTER

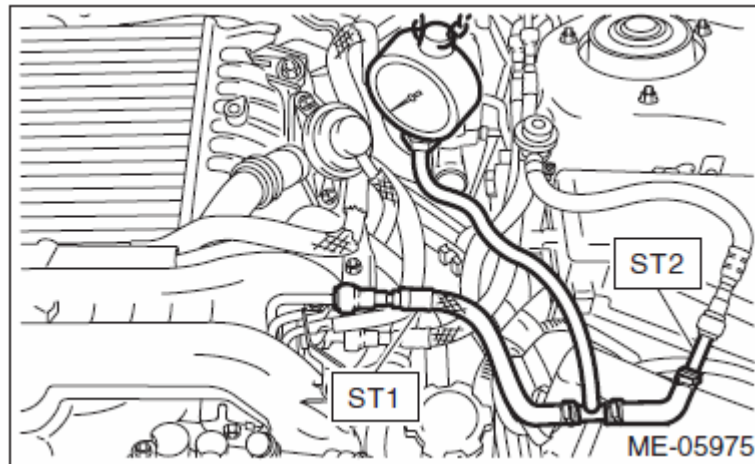


Fig. 16: Connecting Fuel Pressure Gauge To Fuel Damper
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kgf/cm² , 1 to 3 psi) higher than standard values during high-altitude operations.
- If the fuel pressure is out of specification, check or replace the fuel pump, fuel line, pressure regulator and pressure regulator vacuum hose.

Fuel pressure:***Standard***

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

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

NOTE:

- The fuel pressure gauge registers 10 to 20 kPa (0.1 to 0.2 kgf/cm² , 1 to 3 psi) higher than standard values during high-altitude operations.
- If the fuel pressure is out of specification, check or replace the fuel pump, fuel line, pressure regulator and pressure regulator vacuum

hose.

Fuel pressure:

Standard

230 - 260 kPa (2.35 - 2.65 kgf/cm² , 33 - 38 psi)

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

NOTE: For information about connecting fuel delivery hose, refer to "Fuel Delivery, Return & Evaporation Lines". < Ref. to CONNECTING THE FUEL DELIVERY HOSE, FUEL RETURN HOSE AND FUEL HOSE , INSTALLATION, Fuel Delivery, Return and Evaporation Lines. >

VALVE CLEARANCE

INSPECTION

1. Disconnect the ground cable from battery.

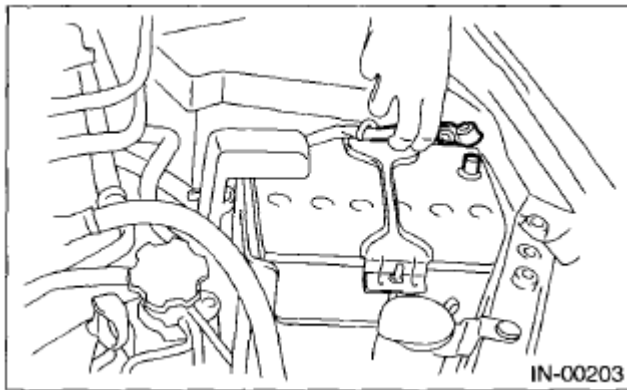


Fig. 17: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the engine from vehicle. < Ref. to REMOVAL, Engine Assembly. >
3. Remove the timing belt cover RH. < Ref. to REMOVAL, Timing Belt Cover. >
4. When inspecting #1 and #3 cylinders
 1. Remove the clip (A) and the stay (B) which hold the engine harness to the rocker cover.

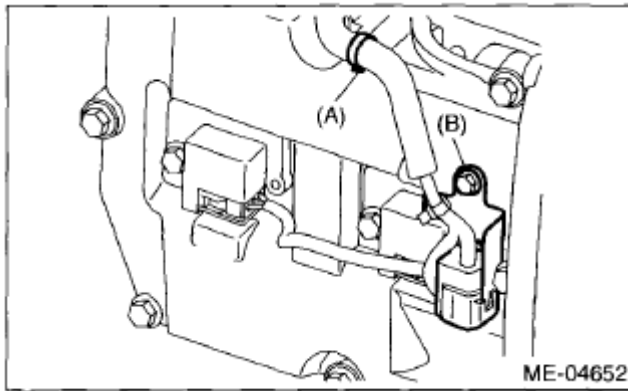


Fig. 18: Engine Harness Clip And Stay
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the ignition coil. < Ref. to **REMOVAL** , Ignition Coil. >
3. Disconnect the PCV hose (A) and PCV hose assembly (B) from the rocker cover RH.

NOTE: Pinch the clamp of the PCV hose by fitting the cut out in the ST with the protrusion on the clamp as shown in the illustration, and unlock the clamp.

ST 18353AA000 CLAMP PLIERS

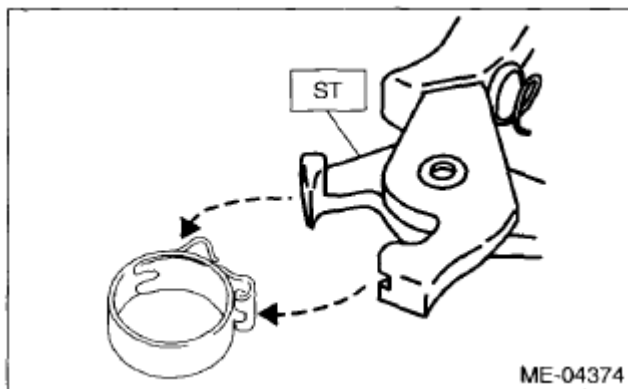


Fig. 19: Pinching Clamp Of PCV Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

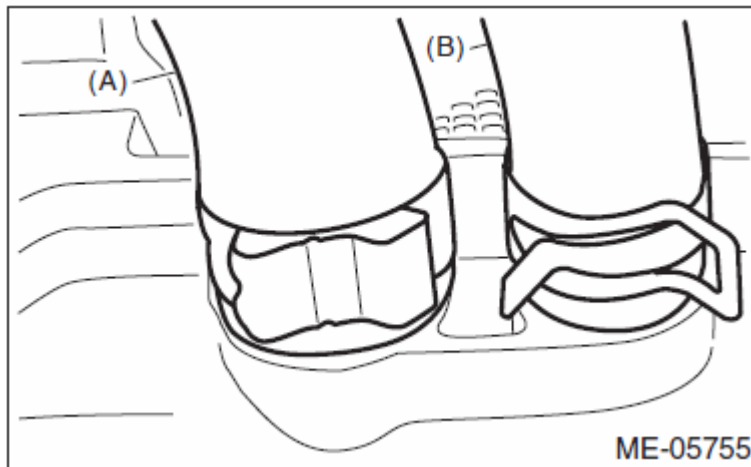


Fig. 20: Identifying PCV Hose And PCV Hose Assembly
 Courtesy of SUBARU OF AMERICA, INC.

4. Remove the rocker cover RH.
5. When inspecting #2 and #4 cylinders
 1. Remove the secondary air pump. < Ref. to **REMOVAL** , Secondary Air Pump. >
 2. Remove the air duct B (B) from the rocker cover LH and the air duct A (A).

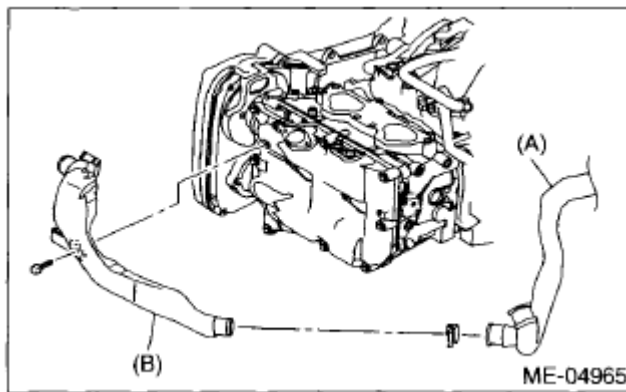


Fig. 21: Rocker Cover Air Ducts
 Courtesy of SUBARU OF AMERICA, INC.

3. Remove the ignition coil. < Ref. to **REMOVAL** , Ignition Coil. >
4. Disconnect the PCV hose (A) and PCV hose assembly (B) from the rocker cover LH

NOTE: Pinch the clamp of the PCV hose by fitting the cut out in the ST with the protrusion on the clamp as shown in the illustration, and unlock the clamp.

ST 18353AA000 CLAMP PLIERS

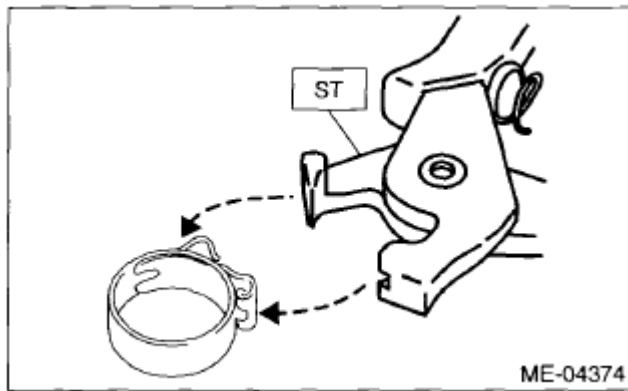


Fig. 22: Pinching Clamp Of PCV Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

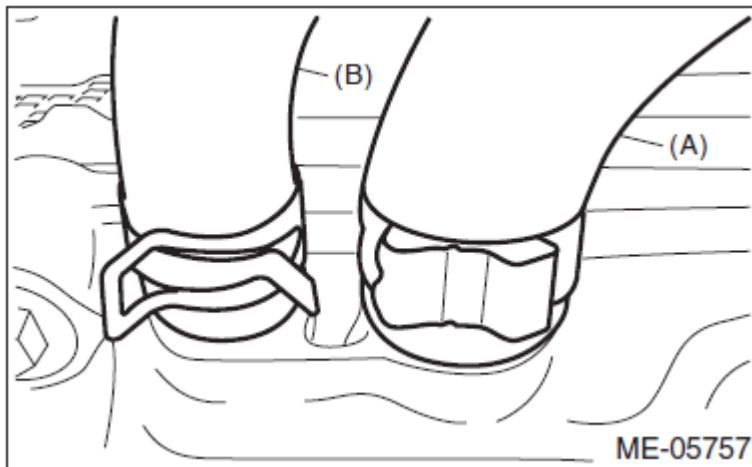


Fig. 23: Identifying PCV Hose And PCV Hose Assembly
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the rocker cover LH.
6. Turn the crank pulley clockwise until the round mark and arrow mark on the cam sprocket are set to position shown in the illustration.

NOTE: Turn the crank pulley using a socket wrench.

- Measurement of clearance of #1 cylinder intake valve and #3 cylinder exhaust valve

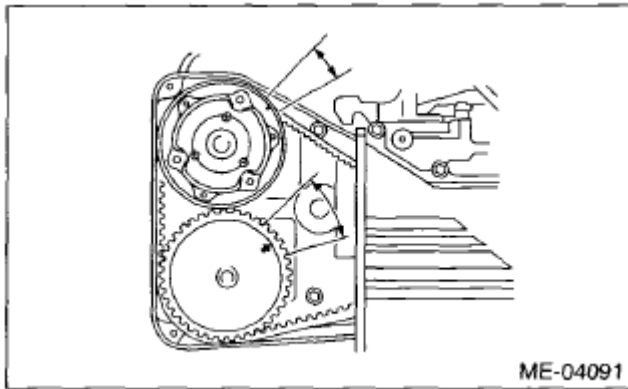


Fig. 24: Cam Sprocket Round And Arrow Mark
Courtesy of SUBARU OF AMERICA, INC.

- Measurement of clearance of #2 cylinder exhaust valve and #3 cylinder intake valve

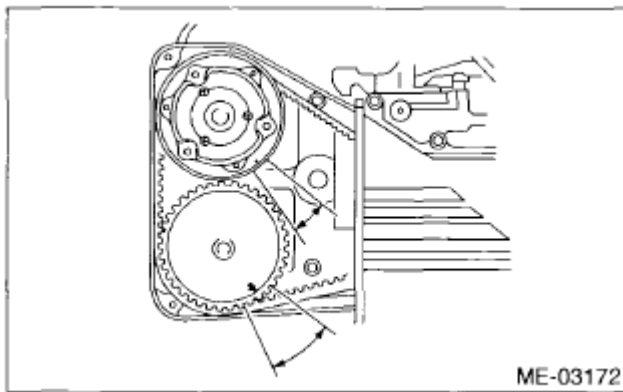


Fig. 25: Cylinder Exhaust And Intake Valve Round And Arrow Mark
Courtesy of SUBARU OF AMERICA, INC.

- Measurement of clearance of #2 cylinder intake valve and #4 cylinder exhaust valve

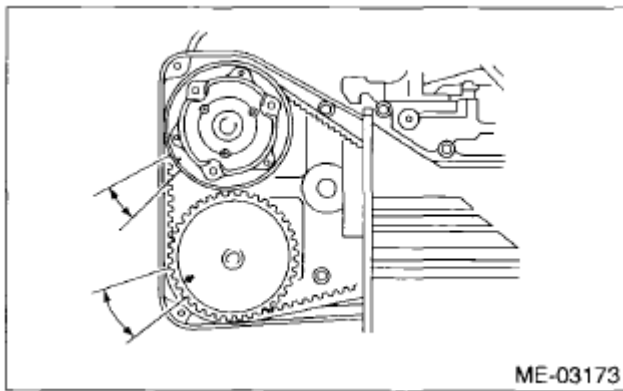


Fig. 26: Cylinder Exhaust And Intake Valve Round And Arrow Mark
Courtesy of SUBARU OF AMERICA, INC.

- Measurement of clearance of #1 cylinder exhaust valve and #4 cylinder intake valve

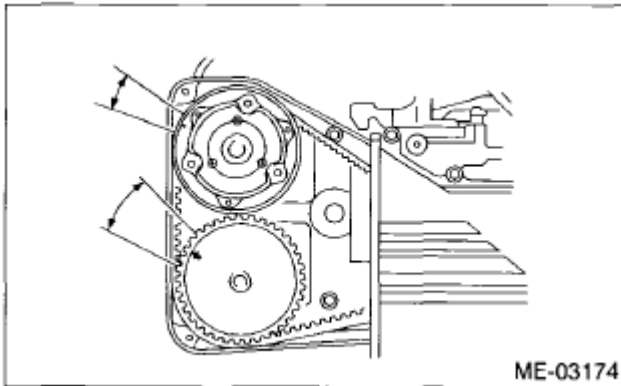


Fig. 27: Cylinder Exhaust And Intake Valve Round And Arrow Mark
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

- Insert a thickness gauge in a direction as horizontal as possible with respect to the valve lifter.
- Lift up the vehicle, and then measure the exhaust valve clearances.
- If the measured value is not within the inspection value, take notes of the value in order to adjust the valve clearance later on.

Valve clearance (inspection value):

Intake

$0.20^{+0.004}_{-0.06} \text{ mm } (0.0079^{+0.0016}_{-0.0024} \text{ in})$

Exhaust

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

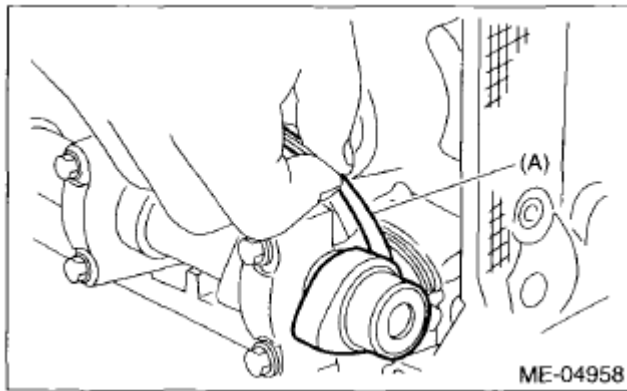


Fig. 28: Measuring Clearance Of Intake Valve And Exhaust Valve Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

8. If necessary, adjust the valve clearance. < Ref. to **ADJUSTMENT**, Valve Clearance. >
9. After inspection, install the related parts in the reverse order of removal.

NOTE:

- Refer to "Camshaft" when installing the rocker cover. < Ref. to **INSTALLATION**, Camshaft. >
- Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the illustration, and lock the clamp.

ST 18353AA000 CLAMP PLIERS

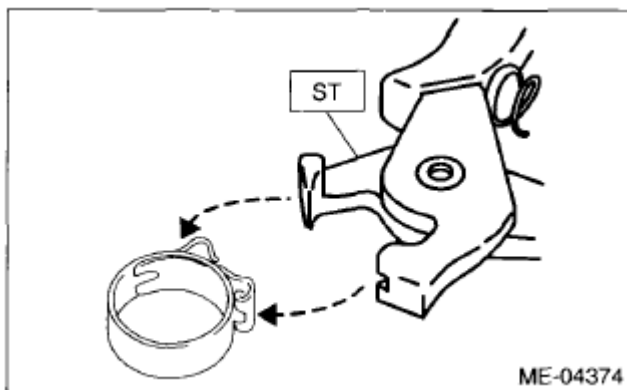


Fig. 29: Pinching Clamp Of PCV Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

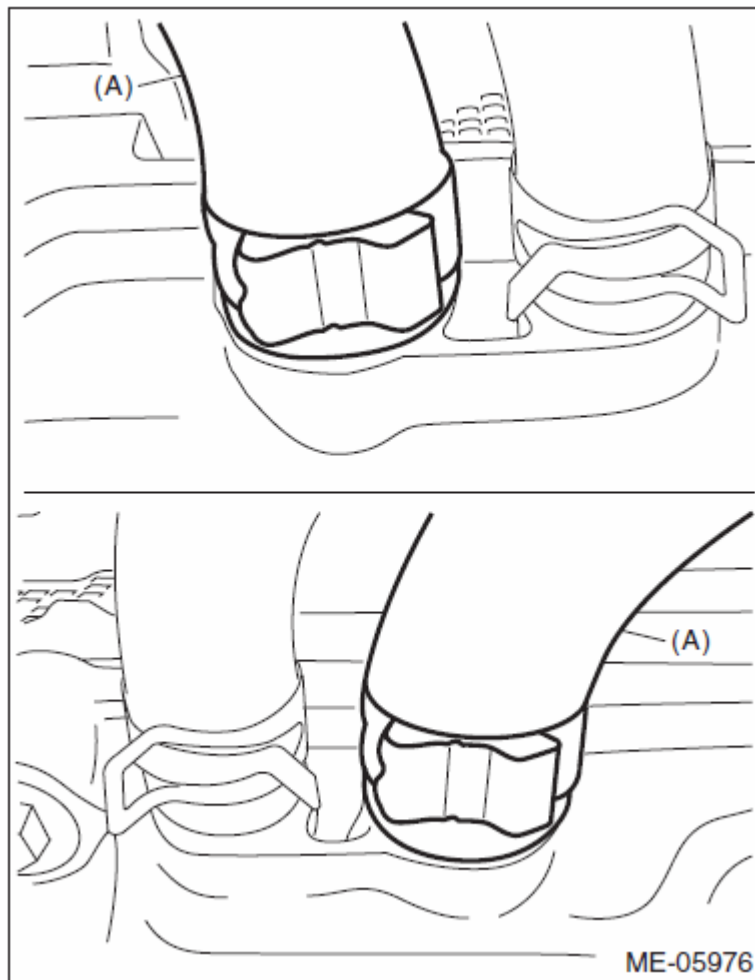


Fig. 30: Identifying PCV Hose Clamps
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

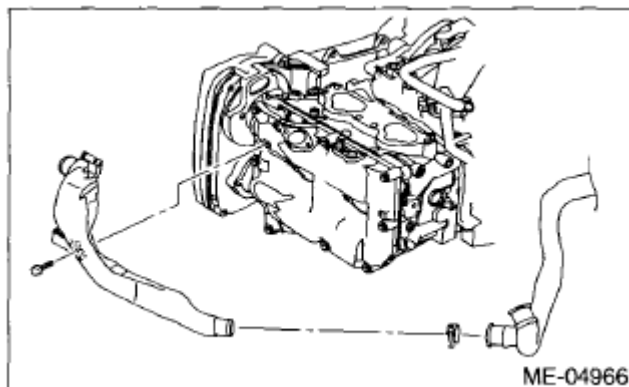
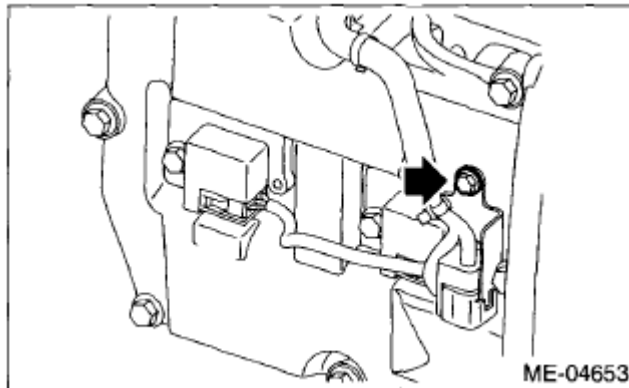


Fig. 31: PCV Hose

Courtesy of SUBARU OF AMERICA, INC.

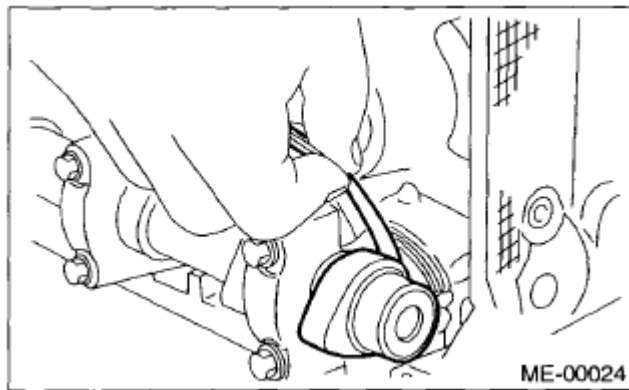
**Fig. 32: Locating PCV Hose Mounting Bolt**

Courtesy of SUBARU OF AMERICA, INC.

ADJUSTMENT

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

NOTE: Record the measured value of each valve clearance.

**Fig. 33: Measuring Valve Clearance Of Camshaft**

Courtesy of SUBARU OF AMERICA, INC.

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

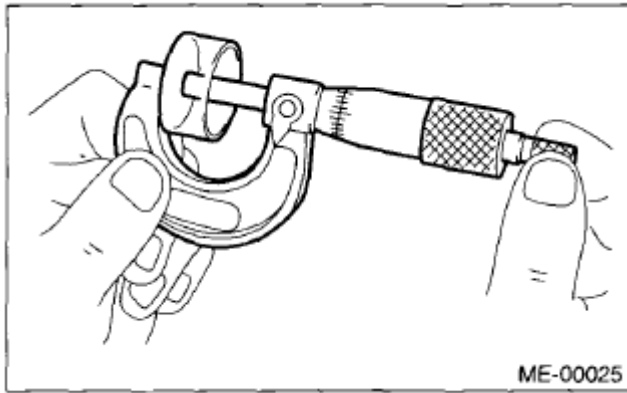


Fig. 34: Measuring Thickness Of Valve Lifter Using Micrometer
 Courtesy of SUBARU OF AMERICA, INC.

5. Select a valve lifter of suitable thickness using the measured valve clearance and valve lifter thickness, and install it.

NOTE: Use a new valve lifter.

VALVE LIFTER SPECIFICATIONS CHART

Unit: mm (in)
Intake valve: $S = (V + T) - 0.19 (0.0075)$
Exhaust valve: $S = (V + T) - 0.35 (0.0138)$
S: Valve lifter thickness required
V: Measured valve clearance
T: Valve lifter thickness to be used

6. Install the camshaft. < Ref. to **INSTALLATION**, Camshaft. >
7. Install the cam sprocket. < Ref. to **INSTALLATION**, Cam Sprocket. >
8. Install the timing belt. < Ref. to **TIMING BELT**, INSTALLATION, Timing Belt. >
9. Measure all valves for valve clearance again at this time. If the valve clearance is not within the adjustment value, repeat the procedure over again from step 2).

Valve clearance (adjustment value):

Intake

$0.20^{+0.01}_{-0.03} \text{ mm } (0.0079^{+0.0004}_{-0.0012} \text{ in})$

Exhaust

$0.35 \pm 0.02 \text{ mm } (0.0138 \pm 0.0008 \text{ in})$

10. After adjustment, install the related parts in the reverse order of removal.

ENGINE ASSEMBLY

REMOVAL

1. Change the bolt installation position from (A) to (B), then open the front hood completely.

Tightening torque:

7.5 N.m (0.8 kgf-m, 5.5 ft-lb)

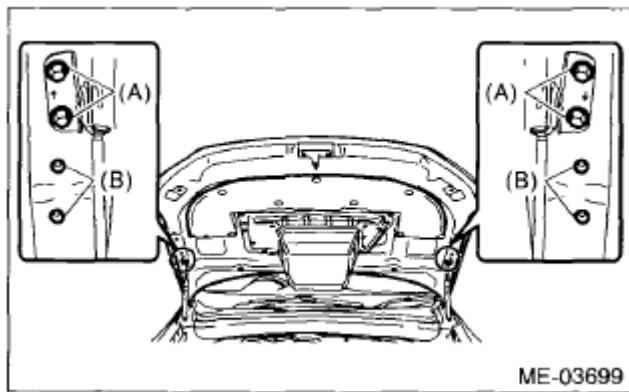


Fig. 35: Front Hood Bolts Installation Position
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the collector cover.
3. Collect the refrigerant from A/C system. < Ref. to **REFRIGERANT RECOVERY PROCEDURE** . >
4. Release the fuel pressure. < Ref. to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel. >
5. Remove the battery. < Ref. to **REMOVAL** , Battery. >
6. Open the fuel filler lid and remove the fuel filler cap.
7. Remove the air intake duct and air cleaner case. < Ref. to **REMOVAL** , Air Intake Duct. > < Ref. to **REMOVAL** , Air Cleaner Case. >
8. Remove the intercooler. < Ref. to **REMOVAL** , Intercooler. >
9. Remove the radiator. < Ref. to **REMOVAL** , Radiator. >
10. Remove the coolant filler tank. < Ref. to **REMOVAL** , Coolant Filler Tank. >
11. Disconnect the bulkhead harness connectors from the engine harness connectors.

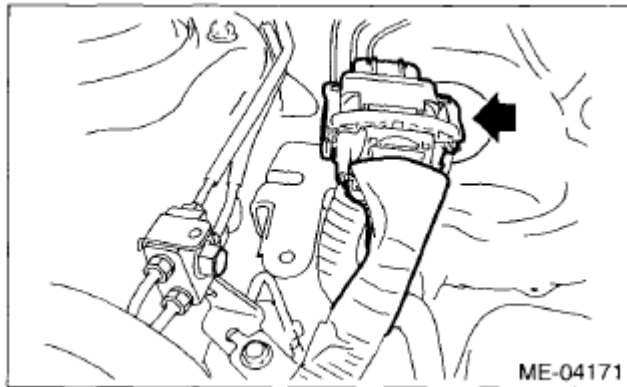


Fig. 36: Locating Bulkhead Harness And Engine Harness Connectors
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the engine harness connector from the engine harness bracket.

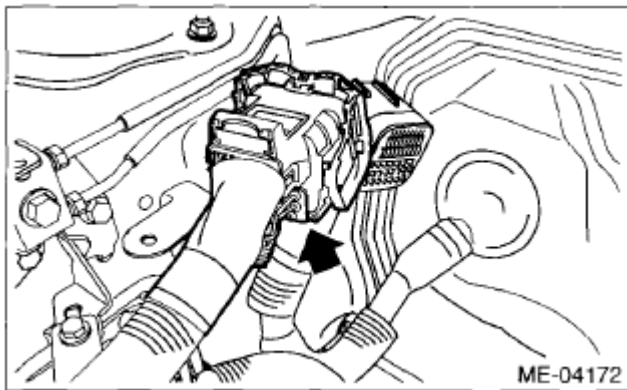


Fig. 37: Locating Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

13. Disconnect the following connectors and terminals.
 1. Generator connector and terminal

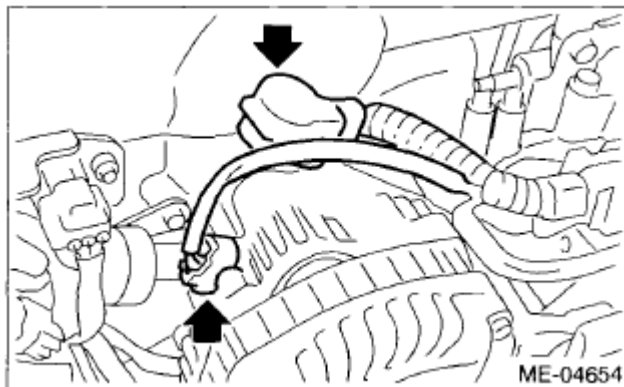


Fig. 38: Locating Generator Connector And Terminal
Courtesy of SUBARU OF AMERICA, INC.

2. Secondary air pump connector

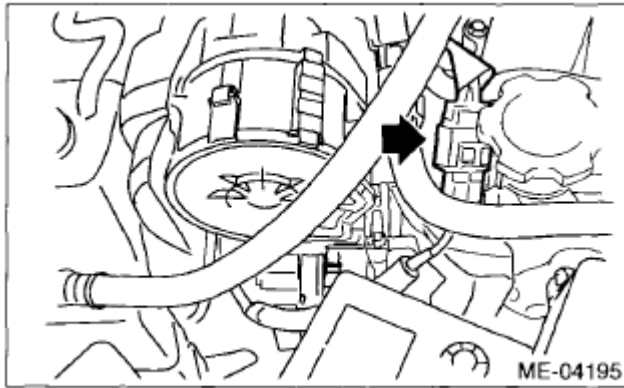


Fig. 39: Locating Secondary Air Pump Connector
Courtesy of SUBARU OF AMERICA, INC.

14. Disconnect the connector (A) from the A/C compressor, and remove the clip (B) securing the generator cord.

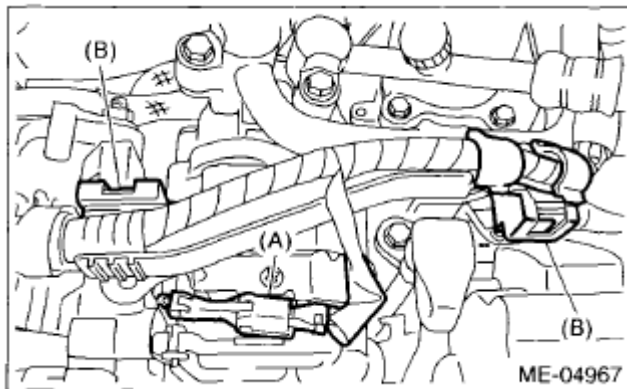


Fig. 40: A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

15. Disconnect the following hoses.
 1. A/C pressure hose < Ref. to **REMOVAL** , Hose and Pipe. >
 2. Brake booster vacuum hose

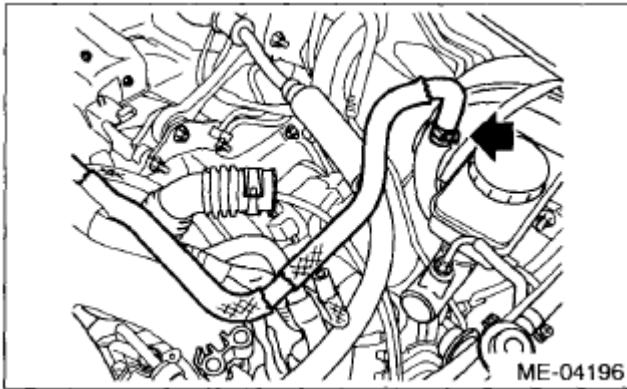


Fig. 41: Locating A/C Pressure Hose
Courtesy of SUBARU OF AMERICA, INC.

3. Heater inlet hose and heater outlet hose

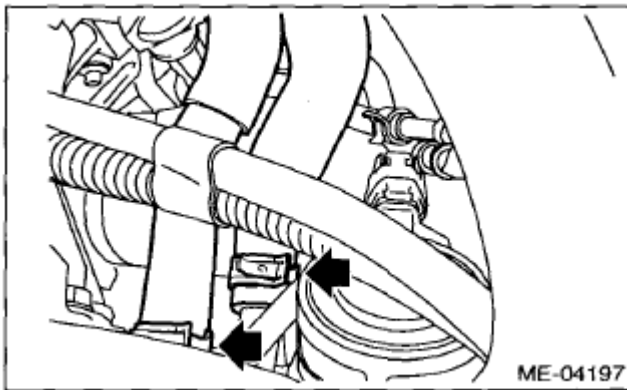


Fig. 42: Locating Heater Inlet Hose And Heater Outlet Hose
Courtesy of SUBARU OF AMERICA, INC.

16. Remove the power steering pump.
 1. Remove the front side belts. < Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt. >
 2. Disconnect the connector from power steering pump switch.

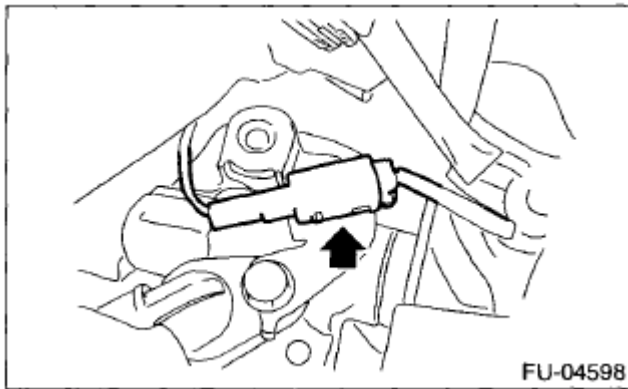


Fig. 43: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the power steering pump from the engine.

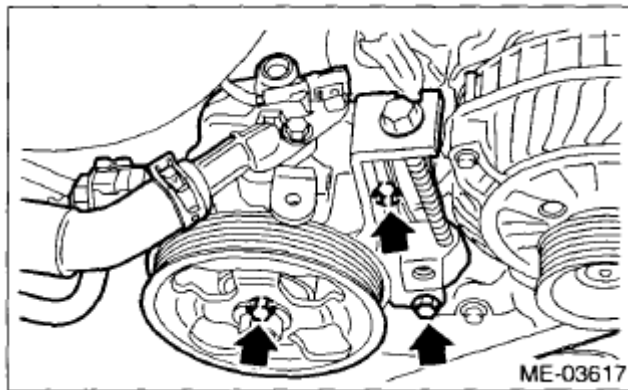


Fig. 44: Locating Power Steering Pump Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Place the power steering pump on the right side wheel apron.
17. Remove the center exhaust pipe. < Ref. to **REMOVAL** , Center Exhaust Pipe. >
18. Remove the turbocharger. < Ref. to **REMOVAL** , Turbocharger. >
19. Remove the joint pipe and front exhaust pipe. < Ref. to **REMOVAL** , Joint Pipe. > < Ref. to **REMOVAL** , Front Exhaust Pipe. >
20. Disconnect the ground cable on the engine side.

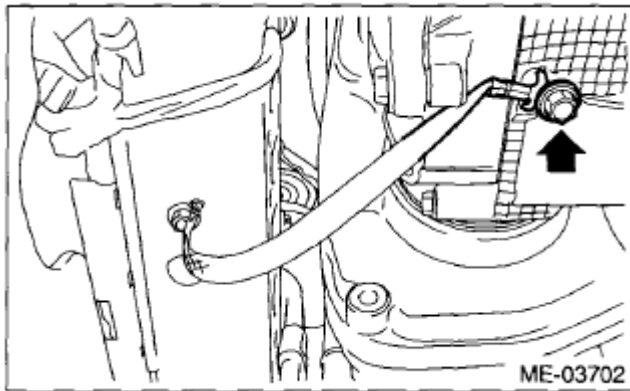


Fig. 45: Locating Ground Cable Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

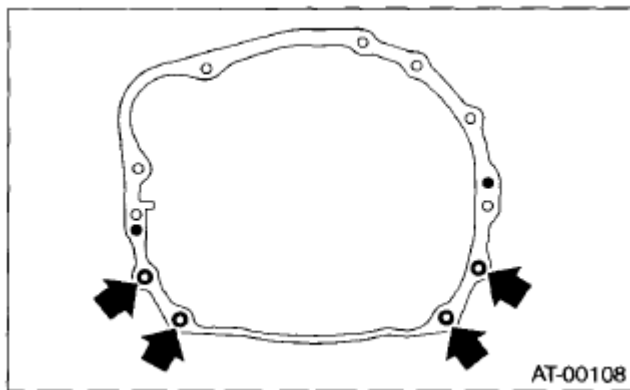


Fig. 46: Locating Transmission Lower Side Mounting Bolt And Nuts
Courtesy of SUBARU OF AMERICA, INC.

22. Remove the nuts which secure the engine mounting to the front crossmember.

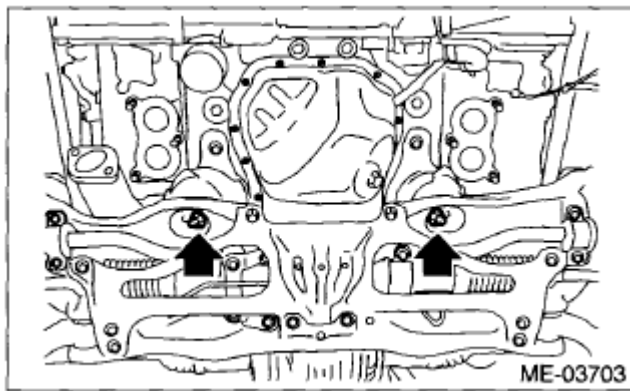


Fig. 47: Locating Front Crossmember Mounting Nuts
Courtesy of SUBARU OF AMERICA, INC.

23. Lower the vehicle.
24. Separate the torque converter clutch from the drive plate.
 1. Remove the service hole plug.
 2. Insert the wrench into the crank pulley bolt and rotate the crank pulley to remove the bolts which hold torque converter clutch to drive plate.

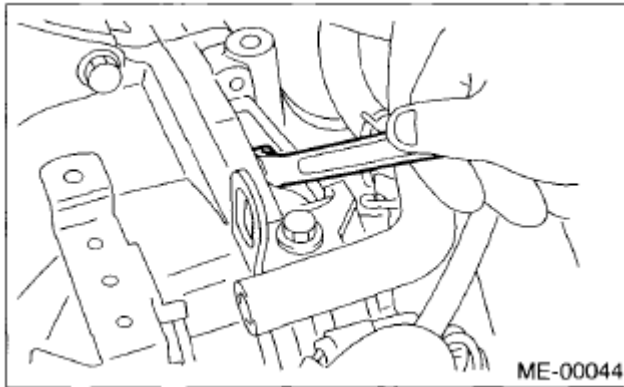


Fig. 48: Separating Torque Converter Clutch From Drive Plate
Courtesy of SUBARU OF AMERICA, INC.

25. Remove the pitching stopper.

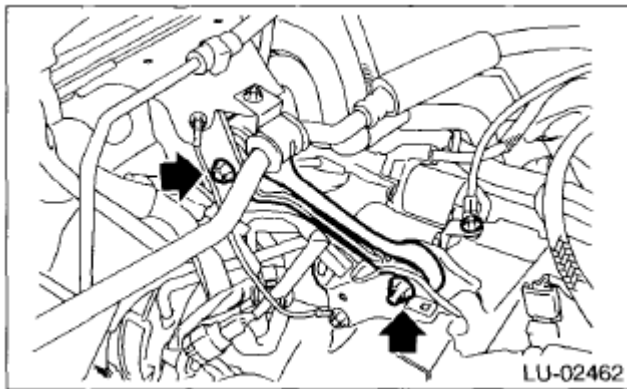


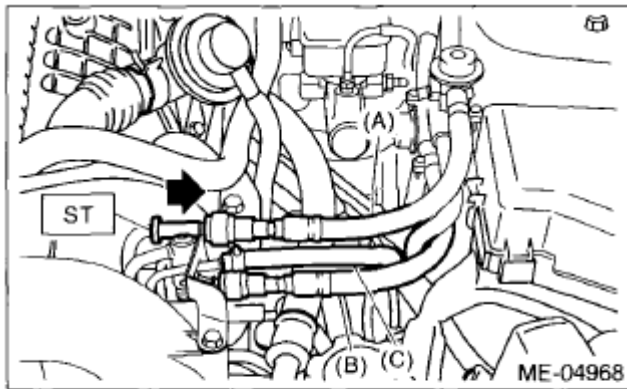
Fig. 49: Locating Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

26. Attach ST to the fuel delivery pipe and push ST in the direction of arrow mark to disconnect the fuel delivery hose.

ST 42099AE000 QUICK CONNECTOR RELEASE

CAUTION:

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



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

Fig. 50: Locating Evaporation Hose Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

27. Disconnect the fuel return hose using the ST.

ST 18371AA000 CONNECTOR REMOVER

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

1. Attach ST to the fuel return pipe as shown in the illustration.

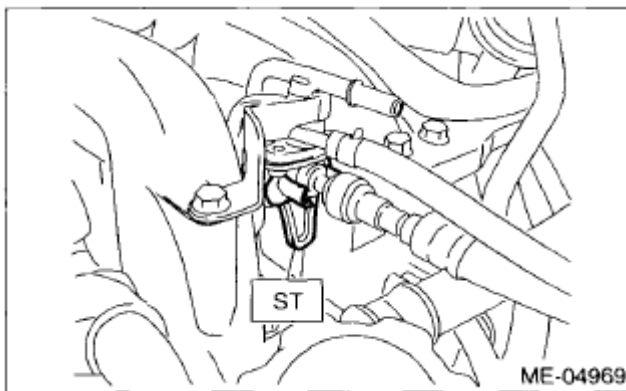


Fig. 51: Attaching ST To Fuel Return Pipe
Courtesy of SUBARU OF AMERICA, INC.

2. Insert the front side of ST into the quick connector.

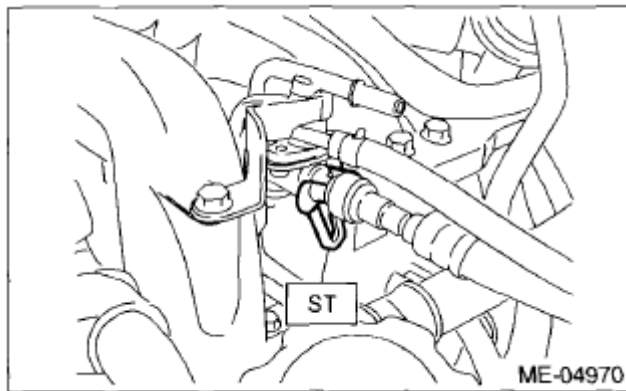


Fig. 52: Inserting Front Side Of Special Tool Into Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Insert the back side of ST into the quick connector and push ST in the direction of arrow mark to disconnect the fuel return hose.

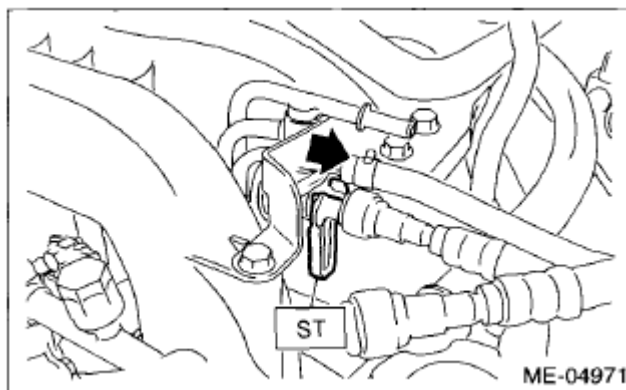


Fig. 53: Locating Fuel Return Hose
Courtesy of SUBARU OF AMERICA, INC.

28. Remove the clip and disconnect the evaporation hose from the fuel pipe.

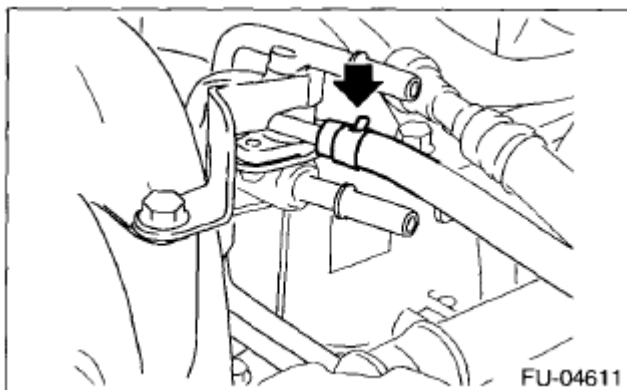


Fig. 54: Locating Evaporation Hose Mounting Clip

Courtesy of SUBARU OF AMERICA, INC.

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

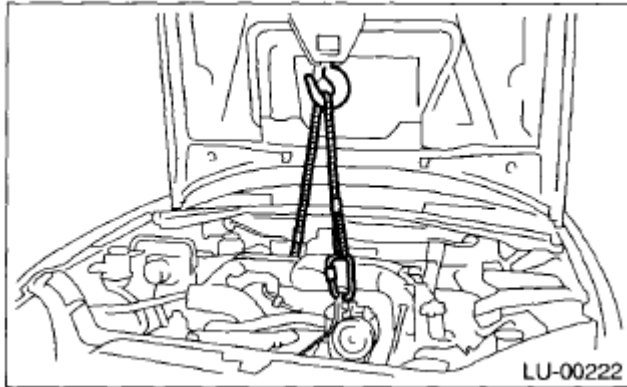
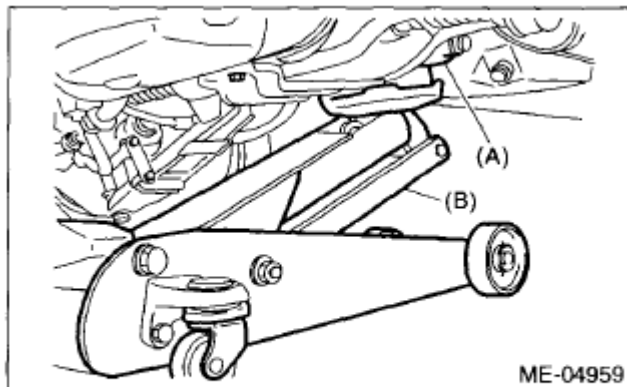


Fig. 55: Lifting Engine Using Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

30. Support the transmission with a garage jack.

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



- (A) Transmission
(B) Garage jack

Fig. 56: Supporting Transmission Using Garage Jack
Courtesy of SUBARU OF AMERICA, INC.

31. Separation of engine and transmission

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

1. Remove the starter. < Ref. to **REMOVAL** , Starter. >
2. Attach the ST to the torque converter clutch case.

ST 498277200 STOPPER SET

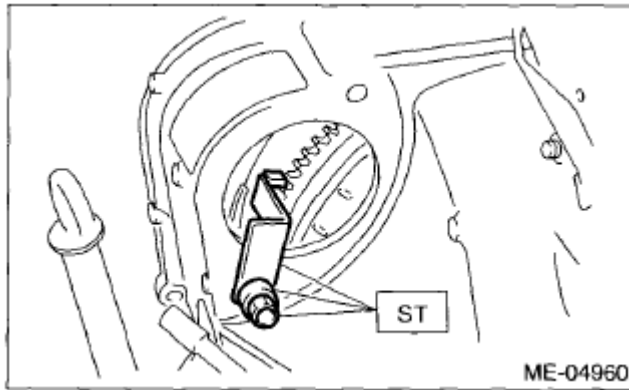


Fig. 57: Attaching ST To Torque Converter Clutch Case
 Courtesy of SUBARU OF AMERICA, INC.

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

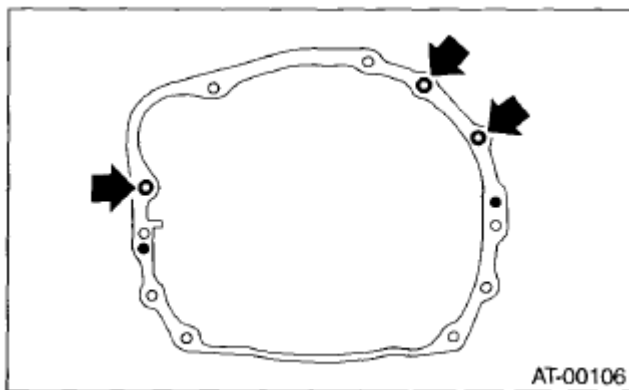


Fig. 58: Locating Mounting Bolts Of Upper Side Of Transmission
 Courtesy of SUBARU OF AMERICA, INC.

32. Remove the engine from vehicle.

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

1. Slightly raise the engine.
 2. Raise the transmission with garage jack.
 3. Slowly move the engine away from engine compartment.
33. Remove the engine mounting from the engine.

INSTALLATION

1. Install the engine mounting onto the engine.

Tightening torque:

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

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

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

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

Tightening torque:

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

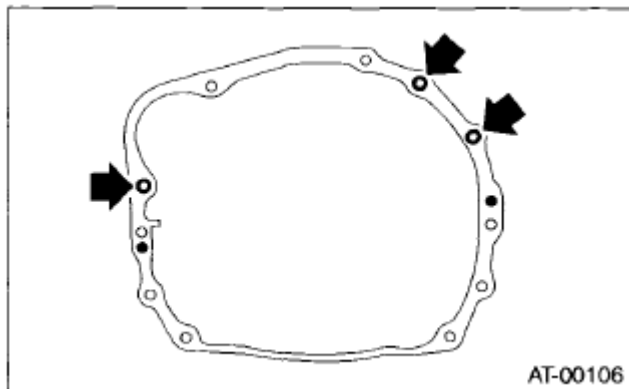


Fig. 59: Locating Mounting Bolts Of Upper Side Of Transmission
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the lifting device and wire ropes.

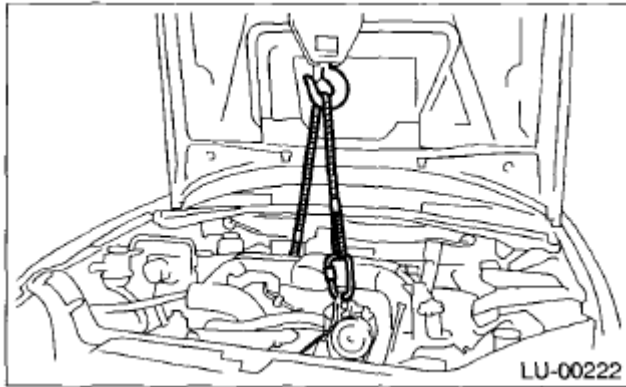


Fig. 60: Lifting Engine Using Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

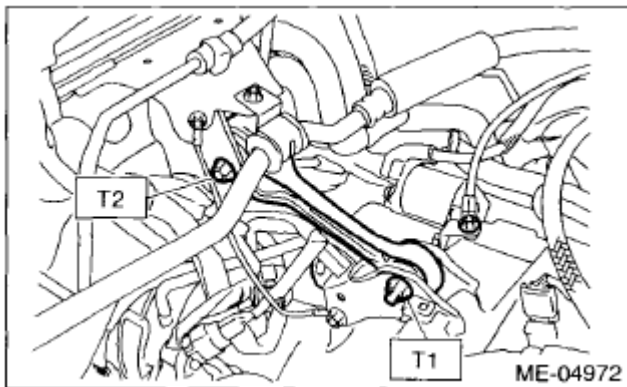


Fig. 61: Pitching Stopper
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the ST from torque converter clutch case.

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

ST 498277200 STOPPER SET

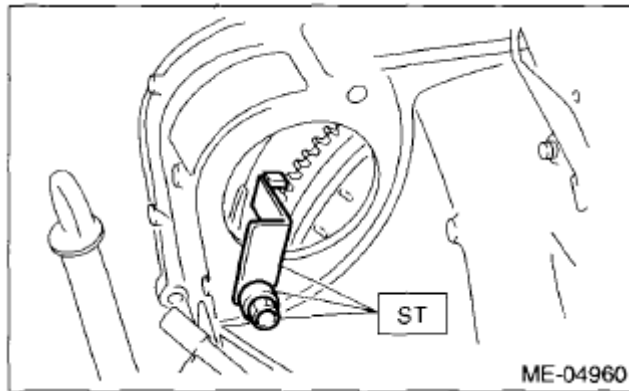


Fig. 62: Attaching ST To Torque Converter Clutch Case
Courtesy of SUBARU OF AMERICA, INC.

8. Install the starter. < Ref. to **INSTALLATION** , Starter. >
9. Install the torque converter clutch to drive plate.
 1. Insert the wrench into the crank pulley bolt and rotate the crank pulley to install the bolts which hold torque converter clutch to drive plate.

NOTE: Be careful not to drop bolts into the torque converter clutch case.

Tightening torque:

25 N.m (2.5 kgf-m, 18.4 ft-lb)

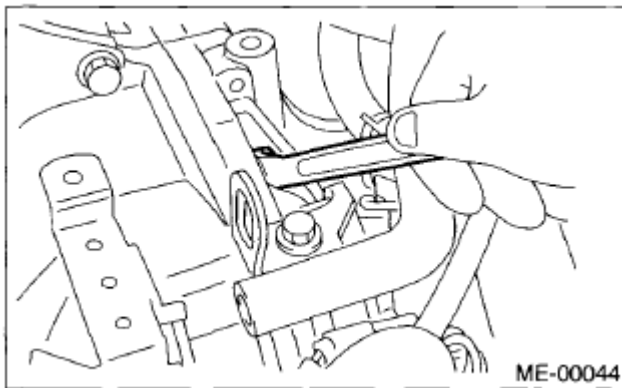


Fig. 63: Separating Torque Converter Clutch From Drive Plate
Courtesy of SUBARU OF AMERICA, INC.

2. Fit the plug to service hole.
10. Install the power steering pump.
 1. Install the power steering pump onto the engine.

Tightening torque:

Refer to "COMPONENT" of "Power Steering" for the tightening torque. < Ref. to COMPONENT , General Description. >

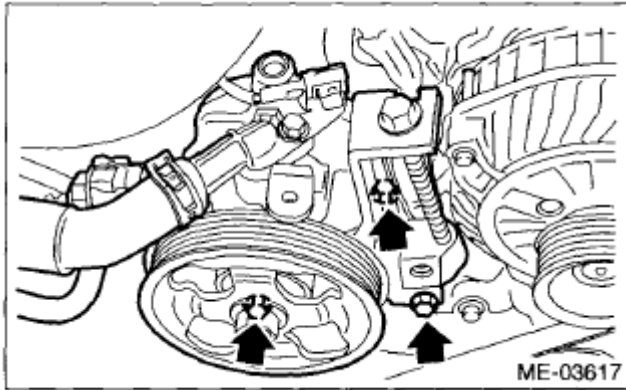


Fig. 64: Locating Power Steering Pump Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the connector to the power steering pump switch.

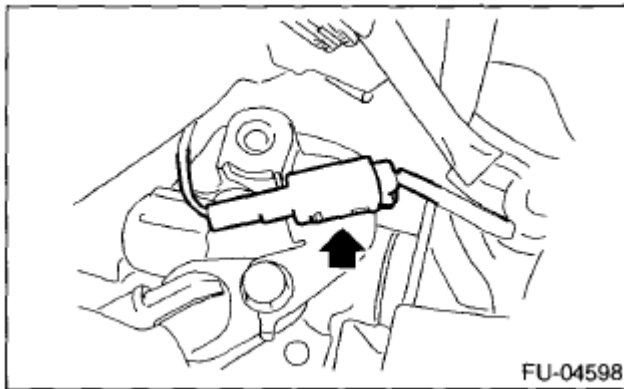


Fig. 65: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

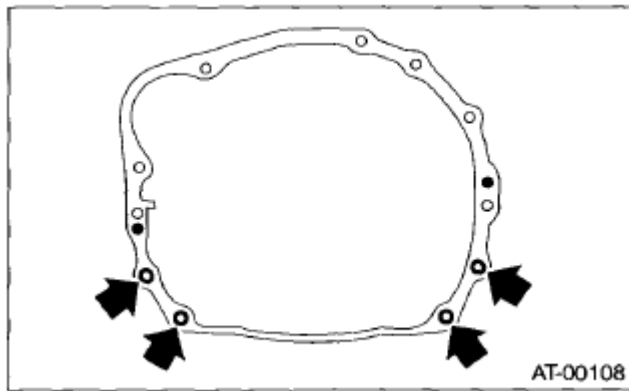


Fig. 66: Locating Transmission Lower Side Mounting Bolt And Nuts
Courtesy of SUBARU OF AMERICA, INC.

13. Install the nuts which hold the engine mounting to the crossmember.

NOTE: Make sure that the engine mounting nuts (A) and locator (B) are securely installed.

Tightening torque:

85 N.m (8.7 kgf-m, 62.7 ft-lb)

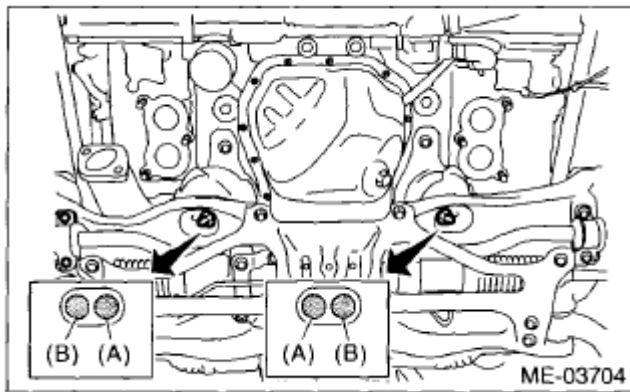


Fig. 67: Engine Mounting Crossmember Mounting Nuts
Courtesy of SUBARU OF AMERICA, INC.

14. Connect the ground cable.

Tightening torque:

7.5 N.m (0.8 kgf-m, 5.5 ft-lb)

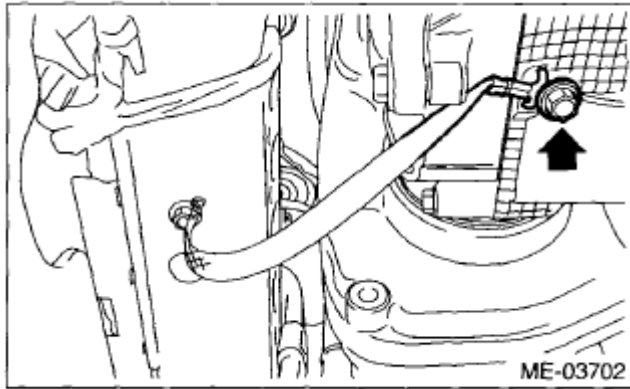


Fig. 68: Locating Ground Cable Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

15. Install the joint pipe and front exhaust pipe. < Ref. to **INSTALLATION** , Front Exhaust Pipe. > < Ref. to **INSTALLATION** , Joint Pipe. >
16. Install the turbocharger. < Ref. to **INSTALLATION** , Turbocharger. >
17. Install the center exhaust pipe. < Ref. to **INSTALLATION** , Center Exhaust Pipe. >
18. Connect the following hoses.
 1. Fuel delivery hose, fuel return hose and evaporation hose
 2. Heater inlet hose and heater outlet hose
 3. Brake booster vacuum hose
 4. A/C pressure hose < Ref. to **INSTALLATION** , Hose and Pipe. >
19. Secure the generator cord using the clip (B) and connect the connector (A) to A/C compressor.

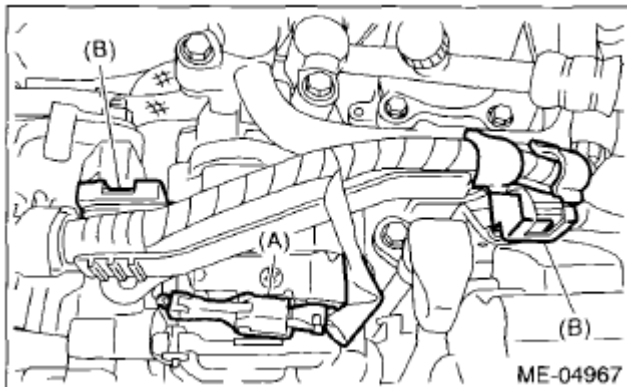


Fig. 69: A/C Compressor Connector
Courtesy of SUBARU OF AMERICA, INC.

20. Connect the following connectors and terminals.
 1. Generator connector and terminal

Tightening torque:

15 N.m (1.5 kgf-m, 11.1 ft-lb)

2. Secondary air pump connector

21. Install the engine harness connector to engine harness bracket, then connect the bulkhead harness connector to the engine harness connector.

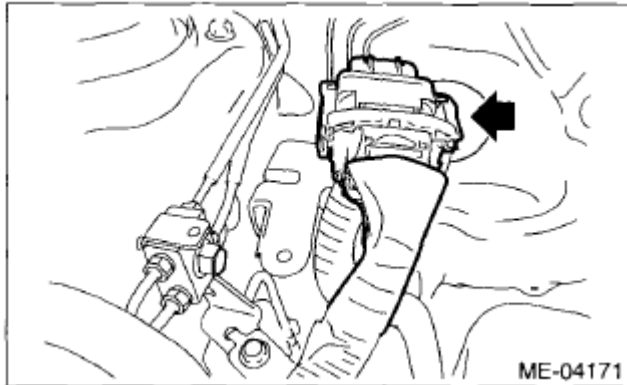


Fig. 70: Locating Bulkhead Harness And Engine Harness Connectors
Courtesy of SUBARU OF AMERICA, INC.

22. Install the intercooler. < Ref. to **INSTALLATION** , Intercooler. >
23. Install the radiator. < Ref. to **INSTALLATION** , Radiator. >
24. Install the coolant filler tank. < Ref. to **INSTALLATION** , Coolant Filler Tank. >
25. Install the air cleaner case and air intake duct. < Ref. to **INSTALLATION** , Air Cleaner Case. > < Ref. to **INSTALLATION** , Air Intake Duct. >
26. Install the battery. < Ref. to **INSTALLATION** , Battery. >
27. Fill engine coolant. < Ref. to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant. >
28. Charge the A/C system with refrigerant. < Ref. to **PROCEDURE** , Refrigerant Charging Procedure. >
29. Check the ATF level and replenish it if necessary. < Ref. to **INSPECTION** , Automatic Transmission Fluid. >
30. Install the collector cover.
31. Change the bolt installation position from (B) to (A), then close the front hood.

Tightening torque:

7.5 N.m (0.8 kgf-m, 5.5 ft-lb)

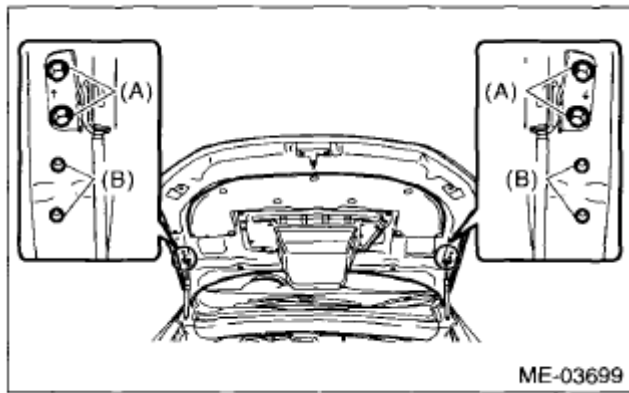


Fig. 71: Front Hood Bolts Installation Position
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Check that pipes, hoses, connectors and clamps are installed firmly.
2. Check the engine coolant is at specified level.
3. Check that the ATF is at specified level.
4. Start the engine and check for exhaust gas leakage, engine coolant leakage, fuel leakage, noise or vibration.

ENGINE MOUNTING

REMOVAL

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

INSTALLATION

Install in the reverse order of removal.

Tightening torque:

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

INSPECTION

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

PREPARATION FOR OVERHAUL

PROCEDURE

1. After removing the engine from vehicle body, attach the ST to the engine as shown in the illustration.

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 499817100 ENGINE STAND

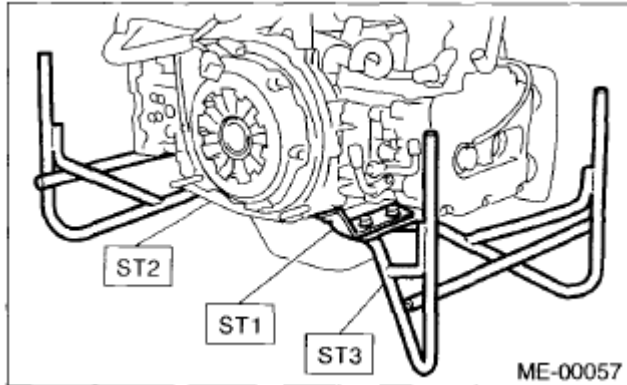


Fig. 72: Attaching Special Tool To Engine
Courtesy of SUBARU OF AMERICA, INC.

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

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

V-BELT

REMOVAL

NOTE: When replacing the single part, perform the work with the engine installed to vehicle body.

FRONT SIDE BELT

1. Remove the collector cover.
2. Remove the air intake duct (Rear). < Ref. to **REMOVAL** , Air Intake Duct. >
3. Remove the collector cover bracket.

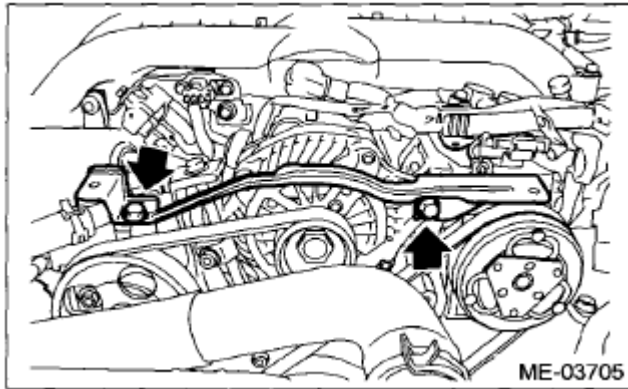


Fig. 73: Locating Collector Cover Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Loosen the bolt (A).
5. Loosen the slider bolt (B).
6. Remove the front side belt (C).

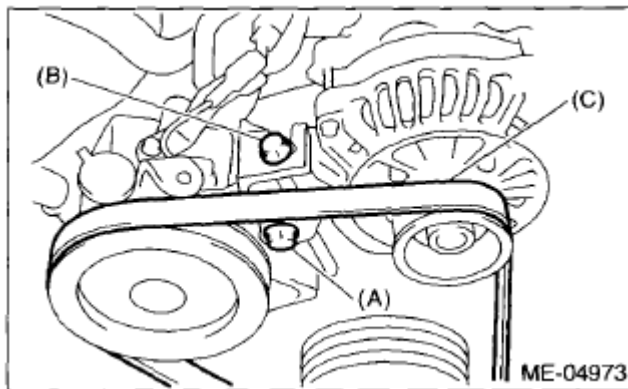


Fig. 74: Slider Bolt, Front Side Belt And Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

1. Remove the front side belts. < Ref. to **FRONT SIDE BELT**, REMOVAL, V-belt. >
2. Cut the rear side belt with a wire cutter, etc, and discard.

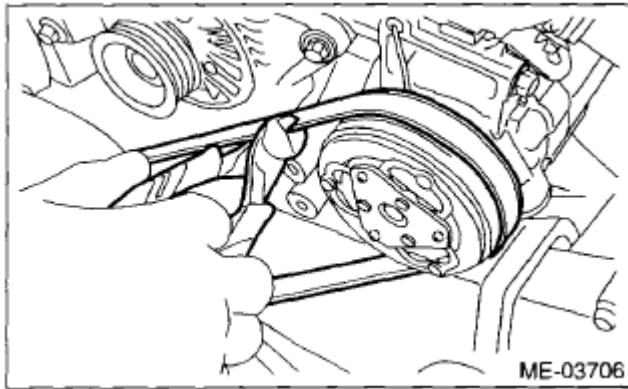


Fig. 75: Cutting Rear Side Belt Using Wire Cutter
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

FRONT SIDE BELT

CAUTION:

- When reusing the front side belt, wipe off dust and water with cloth.
- Do not use the front side belt if there is any oil, grease or coolant on the belt.
- Be careful not to rub the belt end surface with bare hands; exposed core may cause injury.

1. Wipe off any dust, oil and water on the groove of each pulley with cloth.
2. Install the front side belt (C), and adjust the slider bolt (B) so as to obtain the specified belt tension. < Ref. to **INSPECTION**, V-belt. >
3. Tighten the bolt (A).
4. Tighten the slider bolt (B).

Tightening torque:

Bolt (A)

25 N.m (2.5 kgf-m, 18.4 ft-lb)

Slider bolt (B)

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

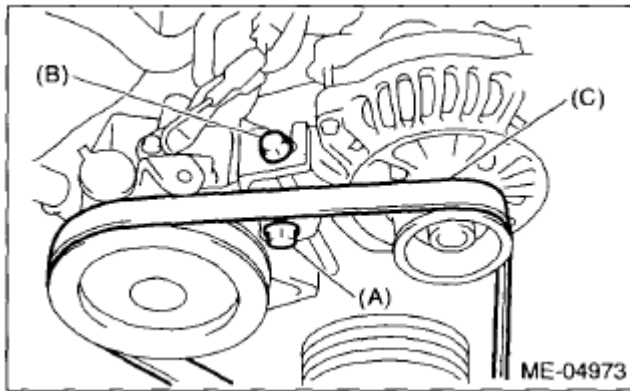


Fig. 76: Slider Bolt, Front Side Belt And Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Install the collector cover bracket.

Tightening torque:

T1: 8.5 N.m (0.9 kgf-m, 6.3 ft-lb)

T2: 25 N.m (2.5 kgf-m, 18.4 ft-lb)

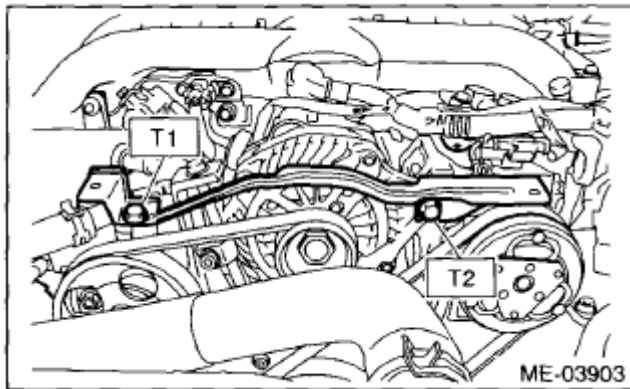


Fig. 77: Collector Cover Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Install the air intake duct (rear). < Ref. to **INSTALLATION** , Air Intake Duct. >
7. Install the collector cover.

REAR SIDE BELT

CAUTION:

- Do not re-use the rear side belt.
- Be careful not to let oil, grease or coolant contact a new rear side belt.

- Be careful not to rub the belt end surface with bare hands; exposed core may cause injury.
- To install the rear side belt, always use the provided tools (belt stopper, belt guide, belt guide holder, and bolt).

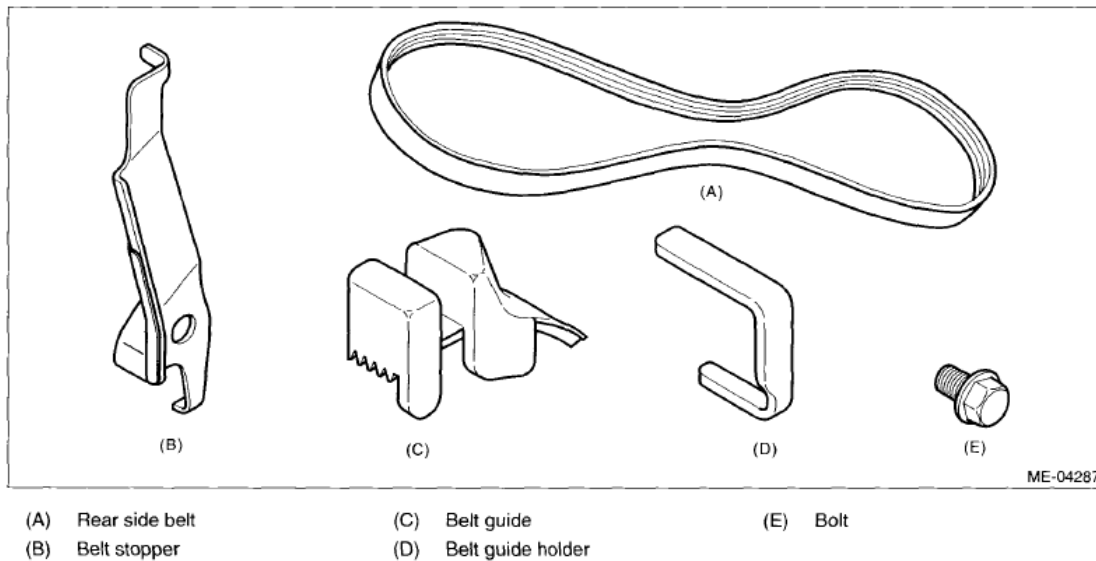


Fig. 78: Rear Side Belt, Belt Guide, Belt Stopper And Belt Guide Holder
Courtesy of SUBARU OF AMERICA, INC.

1. Wipe off any dust, oil and water on the groove of each pulley with cloth.
2. Wipe off any oil, water, dirt, and rust on the front of the crank pulley with cloth.
3. Slowly turn the crank pulley clockwise so that the service hole of the crank pulley comes around the top.

CAUTION: Do not turn the crank pulley counterclockwise.

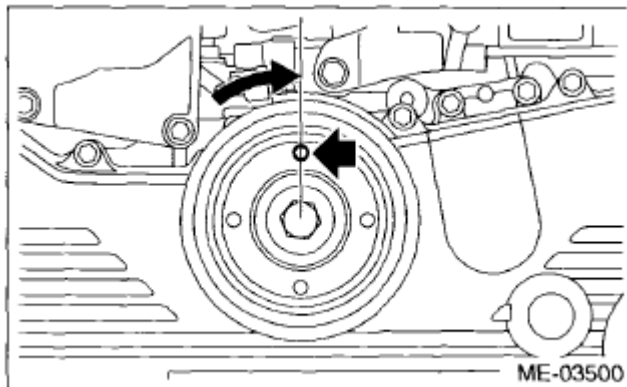


Fig. 79: Turning Crank Pulley Clockwise
Courtesy of SUBARU OF AMERICA, INC.

4. Hook a new rear side belt on the A/C compressor pulley.

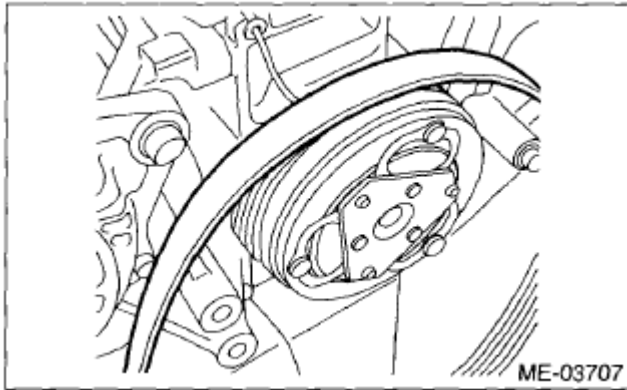


Fig. 80: A/C Compressor Pulley Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

5. As shown in the illustration, insert the claw of the belt stopper (A) to the lower hole (B) of the compressor bracket, then attach with bolt (C).

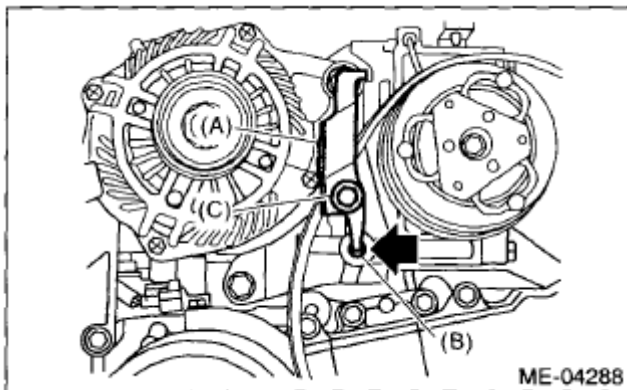


Fig. 81: Locating Claw Of Belt Stopper
Courtesy of SUBARU OF AMERICA, INC.

6. Place the belt guide while aligning it with the belt line of the crank pulley on the front side belt side.

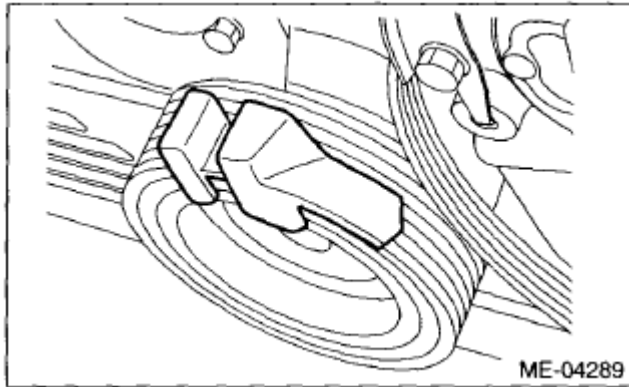


Fig. 82: Aligning Belt Line Of Crank Pulley On Front Side Belt Side
Courtesy of SUBARU OF AMERICA, INC.

7. Insert the belt guide holder into the service hole of the crank pulley so that the belt guide comes in between.

NOTE: Place the belt guide holder with the longer side up.

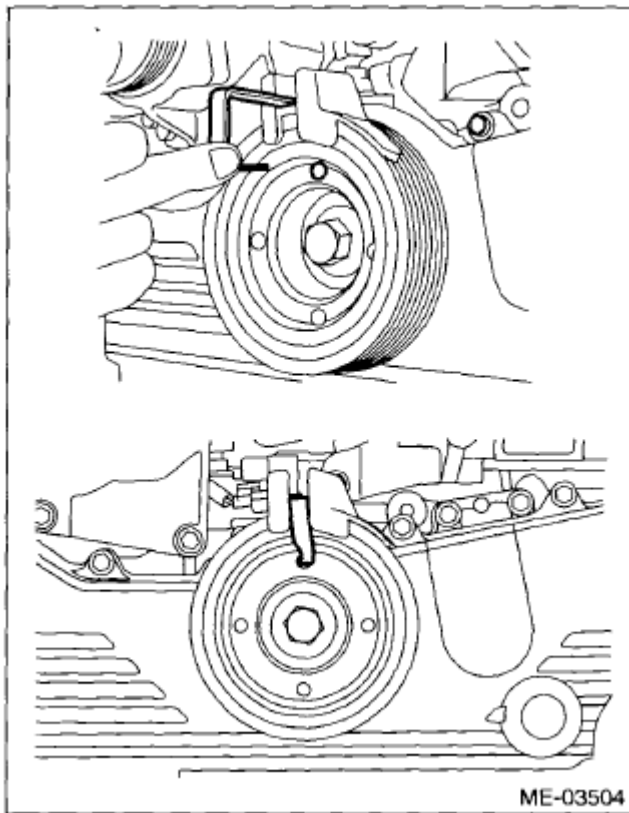


Fig. 83: Inserting Belt Guide Holder Into Service Hole Of Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

8. Slowly turn the crank pulley clockwise until the belt guide comes to approximately 45°.

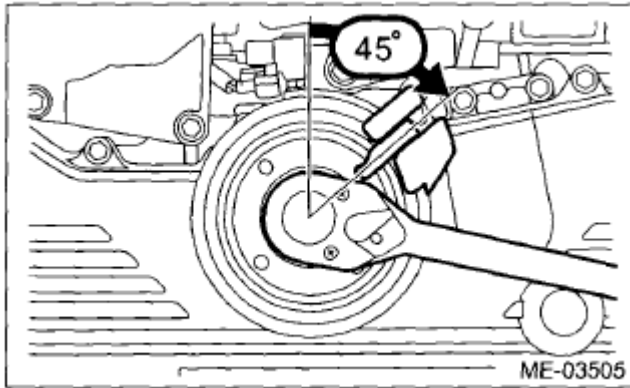


Fig. 84: Turning Crank Pulley Clockwise
Courtesy of SUBARU OF AMERICA, INC.

9. Place the rib surface of the rear side belt into the crank pulley groove, so that the rear side belt comes in between the belt guide holder.

CAUTION: When it is difficult to place the rear side belt to the crank pulley groove, pull out the belt guide holder half way, then place the rear side belt into the groove so that it comes in between the belt guide holder.

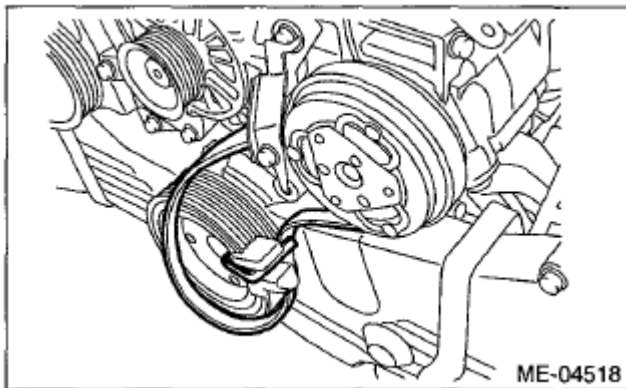


Fig. 85: Placing Rib Surface Of Rear Side Belt Into Crank Pulley Groove
Courtesy of SUBARU OF AMERICA, INC.

10. Place the tool through the loop of the rear side belt, and set on the crank pulley bolt.

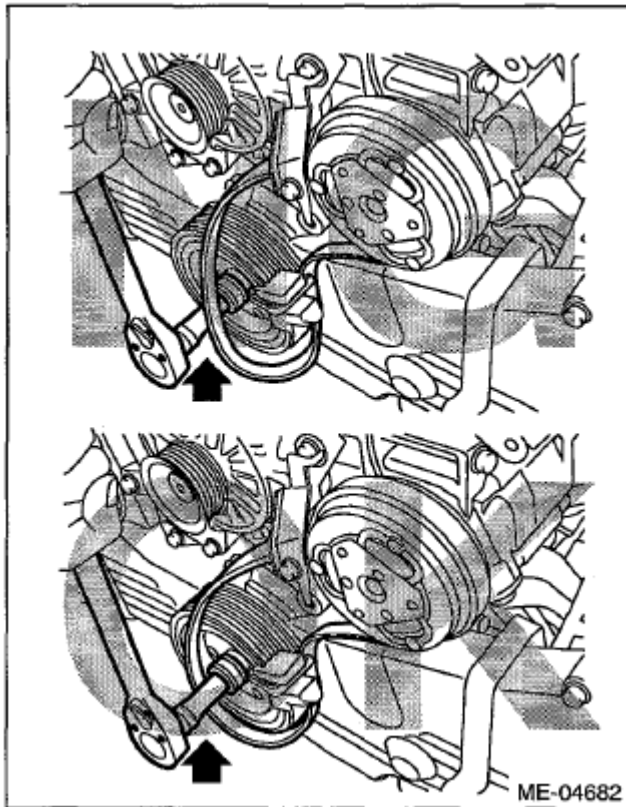


Fig. 86: Caution For Placing Tool Through Loop Of Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

11. While checking the following, slowly turn the crank pulley approximately 90° clockwise so that the belt guide comes to the position shown in the illustration.

CAUTION: When turning the crank pulley, always make sure that the belt guide is not off from the crank pulley groove.

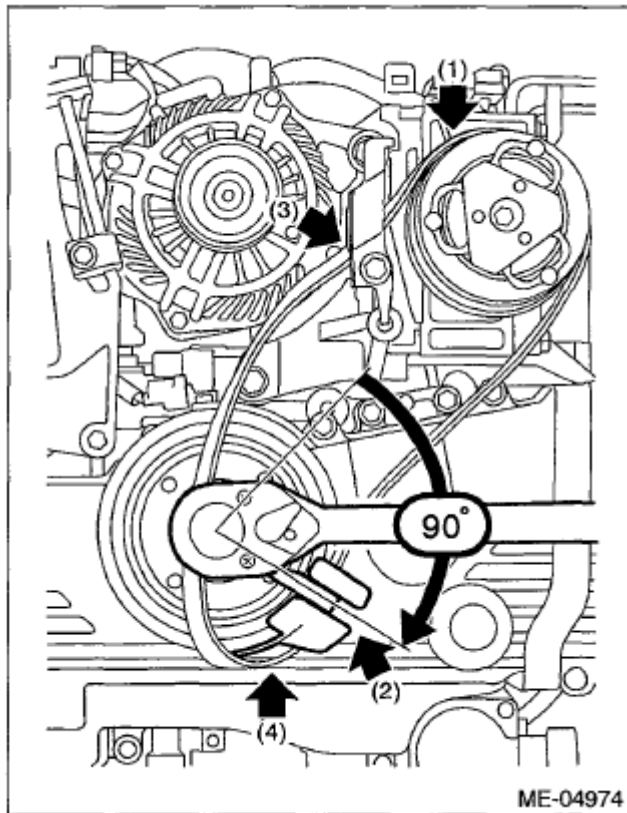


Fig. 87: Turning Crank Pulley Clockwise
 Courtesy of SUBARU OF AMERICA, INC.

1. The rib of the rear side belt is securely placed on the groove of the A/C compressor pulley.

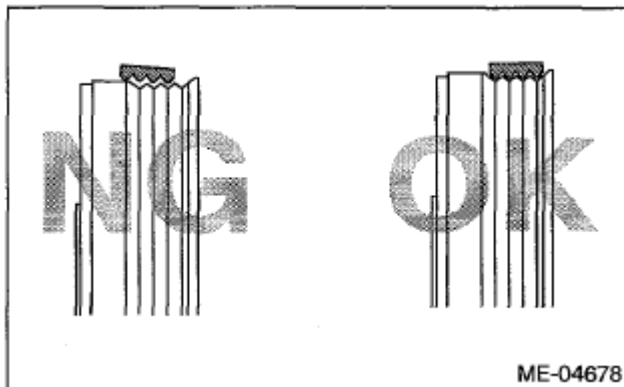


Fig. 88: Caution For Rib Of Rear Side Belt Of A/C Compressor Pulley
 Courtesy of SUBARU OF AMERICA, INC.

2. The rib of the rear side belt is securely placed on the groove of the crank pulley.

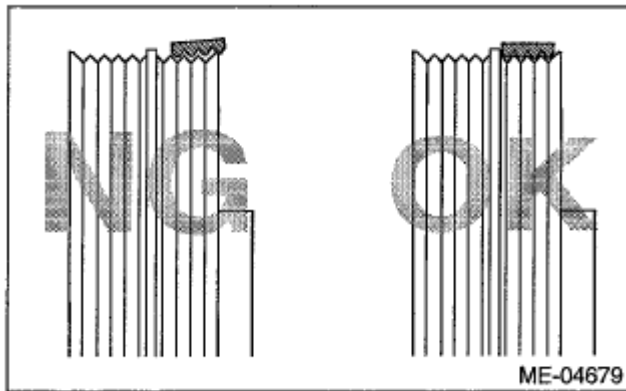


Fig. 89: Caution For Rib Of Rear Side Belt Of Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

3. The surface of the rear side belt is held by the belt stopper.

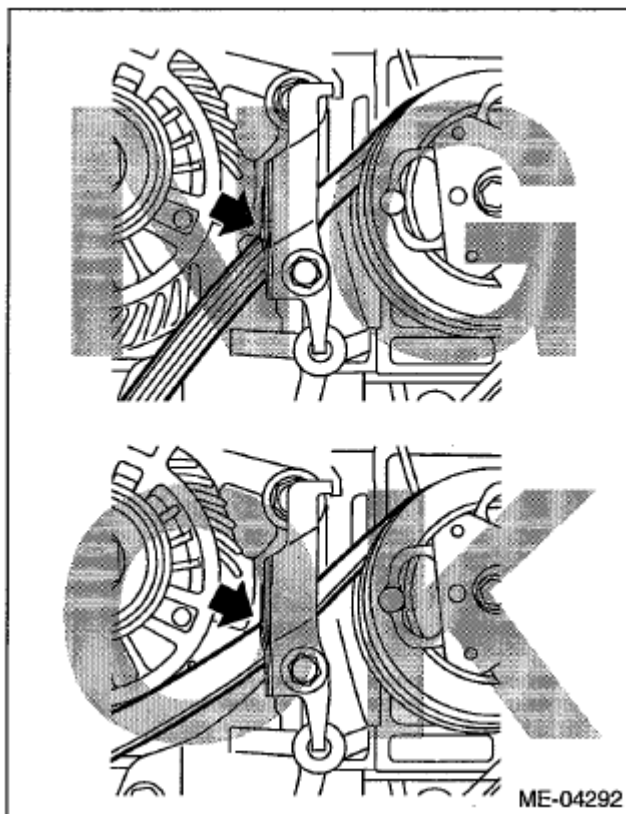


Fig. 90: Caution For Rear Side Belt Held By Belt Stopper
Courtesy of SUBARU OF AMERICA, INC.

4. The rear side belt is securely placed on the belt guide.

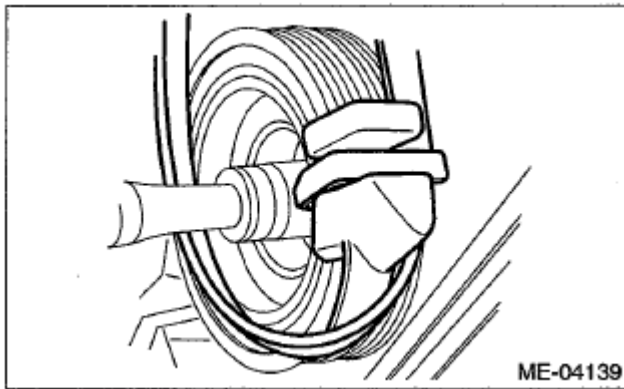


Fig. 91: Rear Side Belt Securely Placed On Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

12. While checking the following, slowly turn the crank pulley approximately 90° clockwise so that the belt guide comes to the position shown in the illustration.

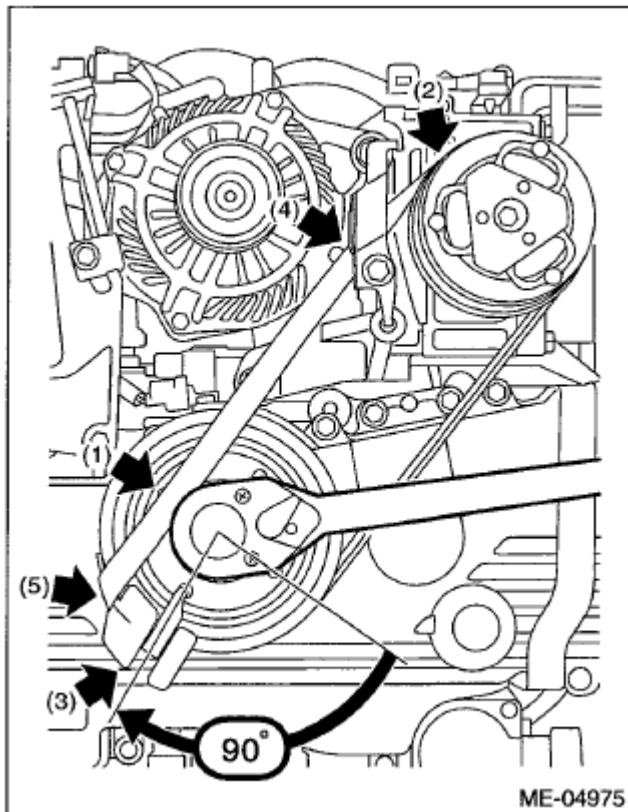


Fig. 92: Turning Crank Pulley Clockwise
Courtesy of SUBARU OF AMERICA, INC.

1. The rear side belt is not twisted.

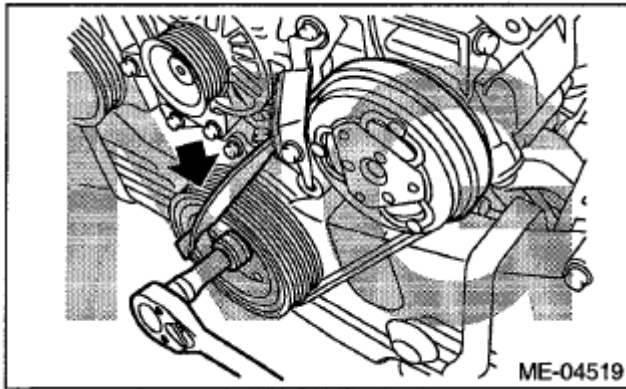


Fig. 93: Caution For Rear Side Belt
Courtesy of SUBARU OF AMERICA, INC.

2. The rib of the rear side belt is securely placed on the groove of the A/C compressor pulley.

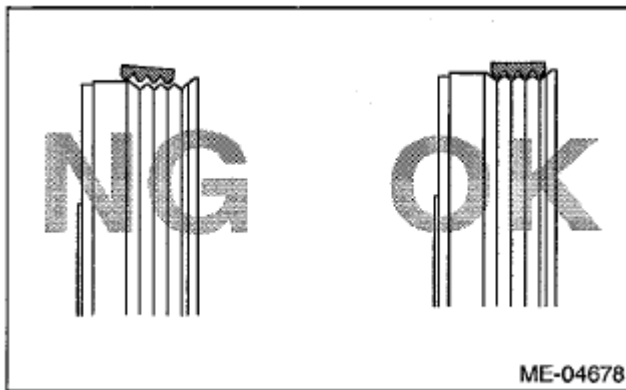


Fig. 94: Caution For Rib Of Rear Side Belt Of A/C Compressor Pulley
Courtesy of SUBARU OF AMERICA, INC.

3. The rib of the rear side belt is securely placed on the groove of the crank pulley.

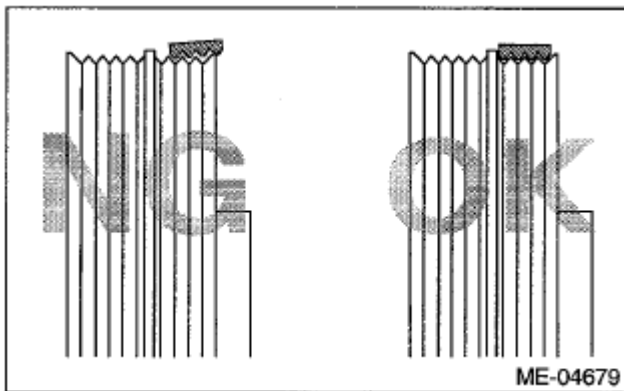


Fig. 95: Caution For Rib Of Rear Side Belt Of Crank Pulley
Courtesy of SUBARU OF AMERICA, INC.

4. The surface of the rear side belt is held by the belt stopper.

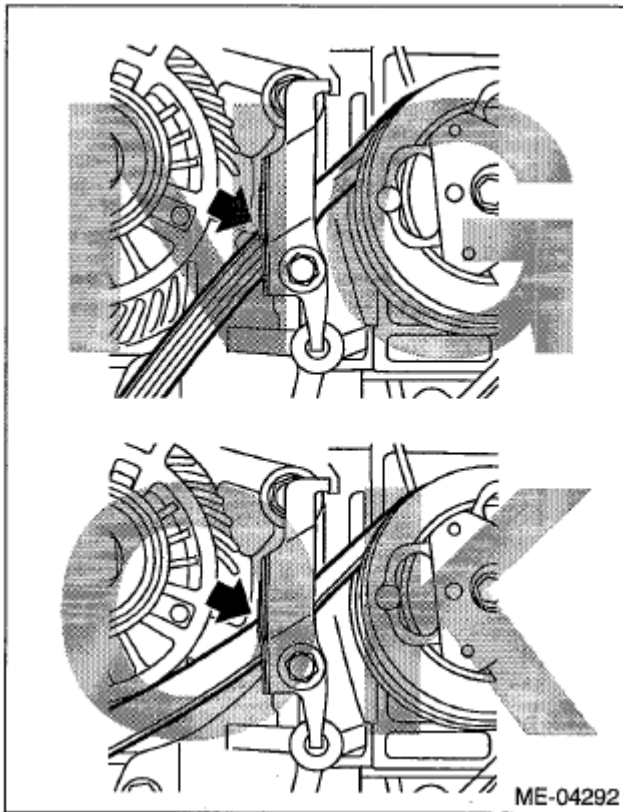


Fig. 96: Caution For Rear Side Belt Held By Belt Stopper
Courtesy of SUBARU OF AMERICA, INC.

5. The rear side belt is securely placed on the belt guide.

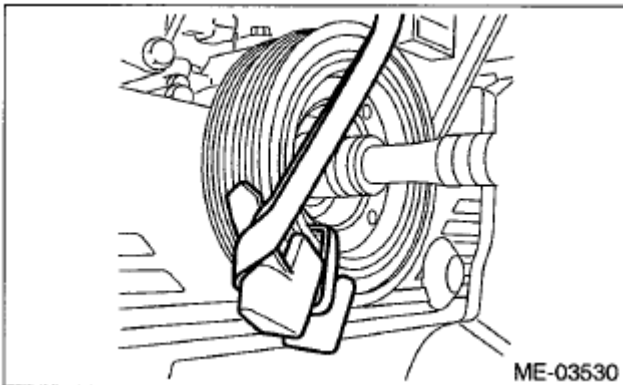


Fig. 97: Rear Side Belt Securely Placed On Belt Guide
Courtesy of SUBARU OF AMERICA, INC.

13. Slowly turn the crank pulley clockwise, and install the rear side belt.

CAUTION: Be careful that the total of procedures 8), 11), 12) and 13) does not exceed 330°; failure to do so may cause damage to the rear side belt and fall of the belt guide holder.

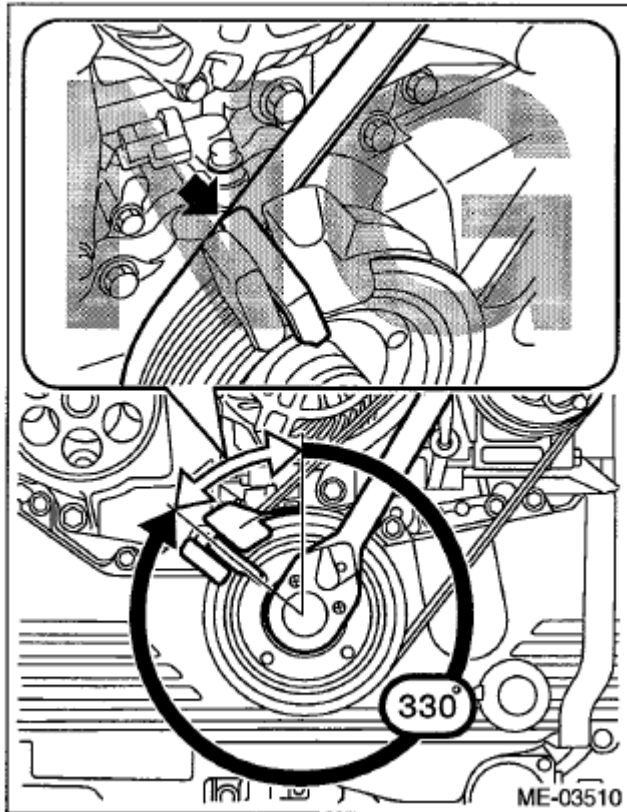


Fig. 98: Turning Crank Pulley Clockwise
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the belt guide and belt guide holder from the crank pulley.

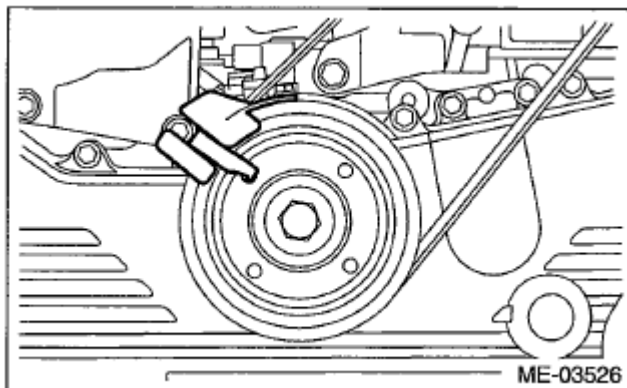


Fig. 99: Crank Pulley Belt Guide And Belt Guide Holder
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the belt stopper from the compressor bracket.

CAUTION: Always remove the belt stopper; failure to do so may cause smoke, fire, or belt cutting.

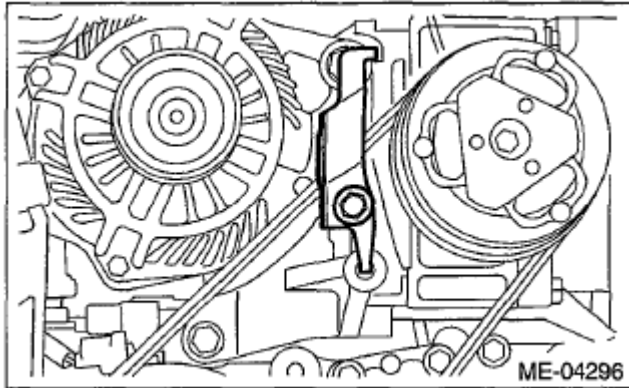


Fig. 100: Belt Stopper And Compressor Bracket
Courtesy of SUBARU OF AMERICA, INC.

16. Make sure that the belt rib is securely installed on the groove of each pulley, then turn the crank pulley slowly, twice in the clockwise direction, to seat the rear side belt properly.

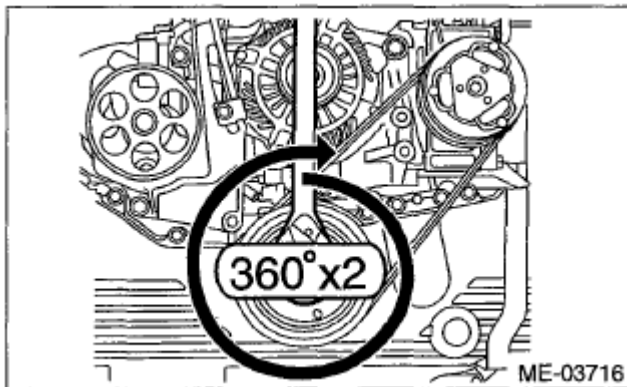


Fig. 101: Turning Crank Pulley Slowly In Clockwise Direction
Courtesy of SUBARU OF AMERICA, INC.

17. Discard the provided tools (belt stopper, belt guide, belt guide holder, and bolt) that are used.
18. Install the front side belt. < Ref. to **FRONT SIDE BELT**, INSTALLATION, V-belt. >

INSPECTION

FRONT SIDE BELT

CAUTION: Check and adjust the front side belt tension so that it is within the

specified range. Using the belt with a tension out of the specified range may result in a fault such as the following:

- If the front side belt tension is higher, unexpected force is generated at the power steering oil pump, generator and crankshaft bearing, causing abnormal noise due to abnormal wear of the bearing.
- If the front side belt tension is lower, the front side belt and crank pulley slip, causing abnormally high temperature on the crank pulley due to frictional heat. If this condition repeatedly occurs, the front side belt may abnormally wear, causing abnormal noise, front side belt damage or crank pulley damage.

1. Replace the front side belt, if crack, fraying or wear is found.
2. Check the front side belt tension and adjust it if necessary by changing the generator installing position.

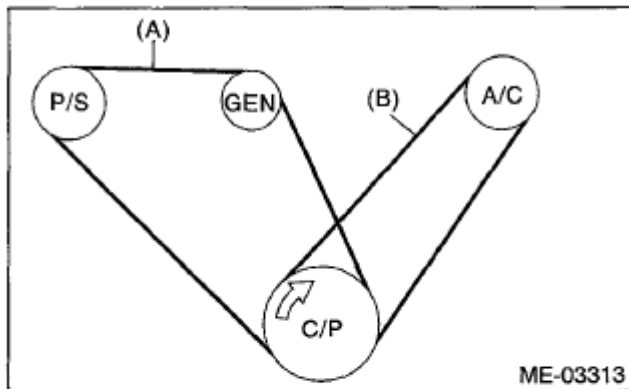
Front side belt tension (with belt tension gauge):

When installing new parts

640 - 780 N (65 - 80 kgf, 144 - 175 lbf)

At inspection

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



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

Fig. 102: Crank Pulley, Generator Pulley, Front And Rear Side Belt (With Belt Tension Gauge)
 Courtesy of SUBARU OF AMERICA, INC.

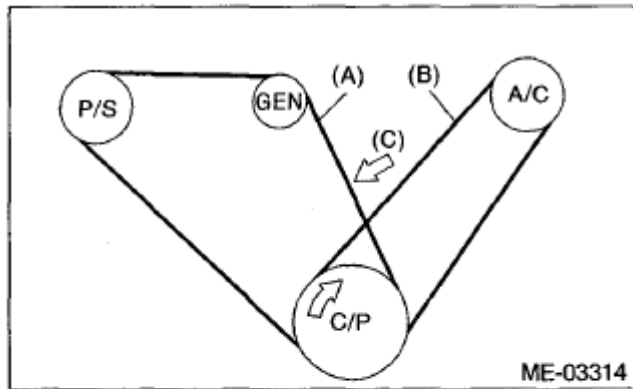
Front side belt tension (without belt tension gauge):

When installing new parts

7 - 9 mm (0.276 - 0.354 in)

At inspection

9 - 11 mm (0.354 - 0.433 in)



(A) Front side belt

(B) Rear side belt

(C) 98 N (10 kgf, 22 lbf)

C/P Crank pulley

GEN Generator pulley

P/S Power steering oil pump pulley

A/C A/C compressor pulley

Fig. 103: Crank Pulley, Generator Pulley, Front And Rear Side Belt (Without Belt Tension Gauge)

Courtesy of SUBARU OF AMERICA, INC.

REAR SIDE BELT

If cracks, fraying or wear is found, and when abnormal noise is produced, replace the rear side belt.

NOTE: Because the rear side belt is a stretch type belt, it is not necessary to check deflection and tension.

CRANK PULLEY

REMOVAL

NOTE: When replacing the single part, perform the work with the engine installed to vehicle body.

1. Remove the V-belts. < Ref. to **REMOVAL**, V-belt. >
2. Use the ST to lock the crank pulley, and remove the crank pulley bolts.

ST 499977400 CRANK PULLEY WRENCH

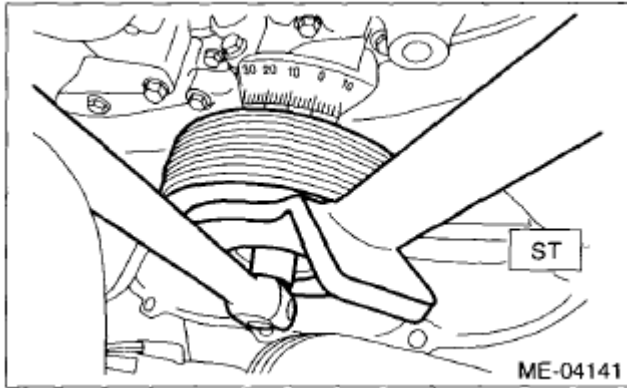


Fig. 104: Locking Crank Pulley Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the crank pulley.

INSTALLATION

METHOD WITHOUT ANGLE GAUGE

1. Clean the crankshaft thread using compressed air.
2. Install the crank pulley.
3. Apply engine oil to the crank pulley bolt seat and thread.
4. Tighten the crank pulley bolts.
 1. Use the ST to lock the crank pulley, and temporarily tighten the crank pulley bolt.

ST 499977400 CRANK PULLEY WRENCH

Tightening torque:

47 N.m (4.8 kgf-m, 34.7 ft-lb)

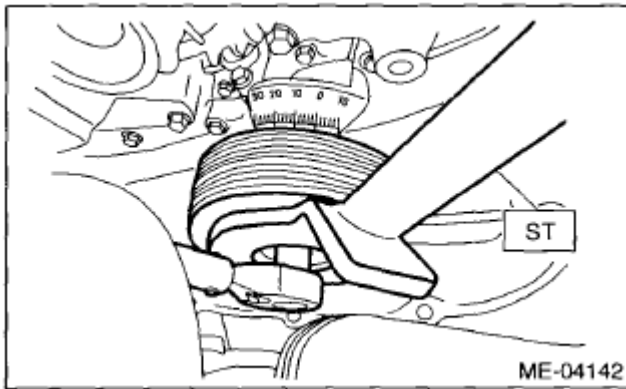
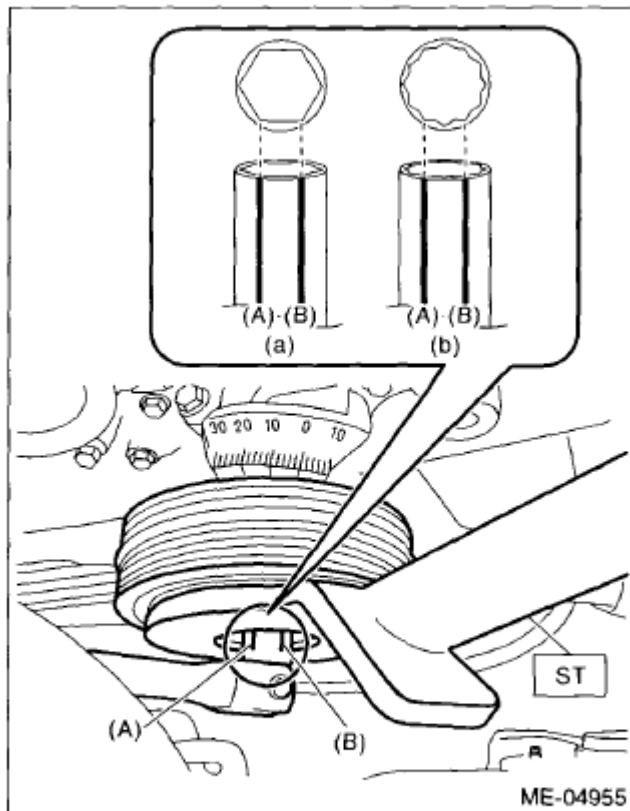


Fig. 105: Tightening Crank Pulley Bolt Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

2. Draw reference lines (A) and (B) using a marker to set the socket to the crank pulley bolt as shown in the illustration.

ST 499977400 CRANK PULLEY WRENCH

NOTE: Set the socket onto the crank pulley bolt so that reference lines (A) and (B) is visible.



- (a) When using 6-point socket
- (b) When using 12-point socket

Fig. 106: Positioning Socket Onto Crank Pulley Bolt
 Courtesy of SUBARU OF AMERICA, INC.

3. Draw end line (C) on ST using a marker at the same position as reference line (B) was drawn on the socket in step (2).

ST 499977400 CRANK PULLEY WRENCH

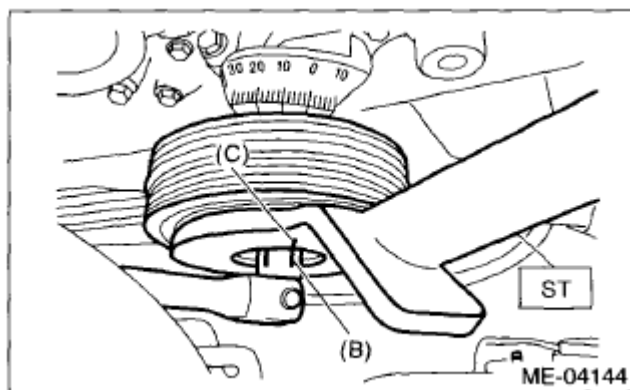


Fig. 107: Drawing End Line On ST Using Marker

Courtesy of SUBARU OF AMERICA, INC.

4. Use the ST to lock the crank pulley, and tighten the crank pulley bolt to the angle where reference line (A) and end line (C) are aligned.

ST 499977400 CRANK PULLEY WRENCH

NOTE: It should be approx. 60° when reference line (A) and end line (C) are aligned.

Tightening angle:

60°±5°

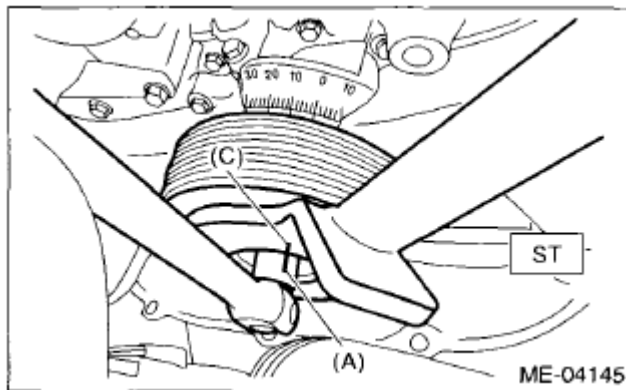


Fig. 108: Tightening Crank Pulley Bolt Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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

METHOD WITH ANGLE GAUGE

1. Clean the crankshaft thread using compressed air.
2. Install the crank pulley.
3. Apply engine oil to the crank pulley bolt seat and thread.
4. Tighten the crank pulley bolts.
 1. Remove the radiator main fan motor assembly and radiator sub motor assembly. < Ref. to REMOVAL , Radiator Main Fan and Fan Motor. > < Ref. to REMOVAL , Radiator Sub Fan and Fan Motor. >
 2. Use the ST1 to lock the crank pulley, and temporarily tighten the crank pulley bolt.

ST1 499977400 CRANK PULLEY WRENCH

Tightening torque:

47 N.m (4.8 kgf-m, 34.7 ft-lb)

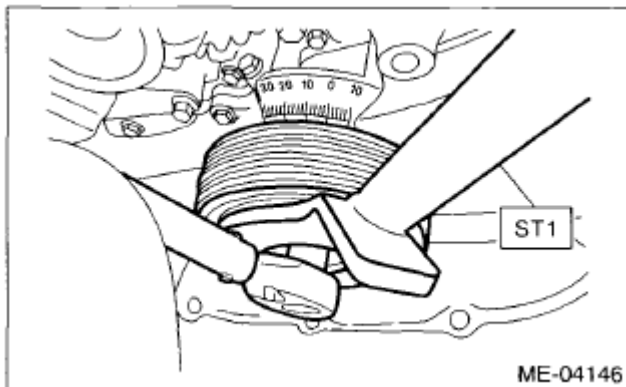


Fig. 109: Tightening Crank Pulley Bolt Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

3. Set the ST2, use the ST1 to lock the crank pulley, and tighten the crank pulley bolt to the specified angle.

ST1 499977400 CRANK PULLEY WRENCH

ST2 18854AA000 ANGLE GAUGE

NOTE: Attach the magnet used for securing the ST2 (ANGLE GAUGE) to ST1.

Tightening angle:

$60^{\circ} \pm 5^{\circ}$

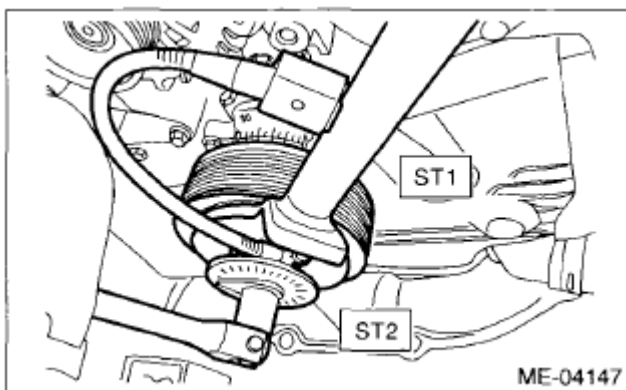


Fig. 110: Tightening Crank Pulley Bolt Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

4. Install the radiator main fan motor assembly and radiator sub motor assembly. < Ref. to

INSTALLATION , Radiator Main Fan and Fan Motor. > < Ref. to **INSTALLATION** , Radiator Sub Fan and Fan Motor. >

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

INSPECTION

1. Check that the crank pulley has no deformation, cracks or other damages.

TIMING BELT COVER

REMOVAL

NOTE: When replacing a single part, perform the work with the engine installed to body.

1. Remove the secondary air pump. < Ref. to **REMOVAL** , Secondary Air Pump. >
2. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
3. Remove the timing belt cover RH (A).
4. Remove the timing belt cover LH (B).
5. Remove the front timing belt cover (C).

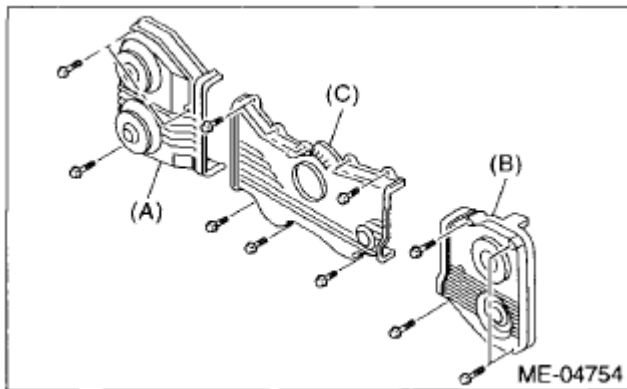


Fig. 111: Front Timing Belt Cover With Mounting Fasteners
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the front timing belt cover (C).

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)

2. Install the timing belt cover LH (B).

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)

3. Install the timing belt cover RH (A).

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)

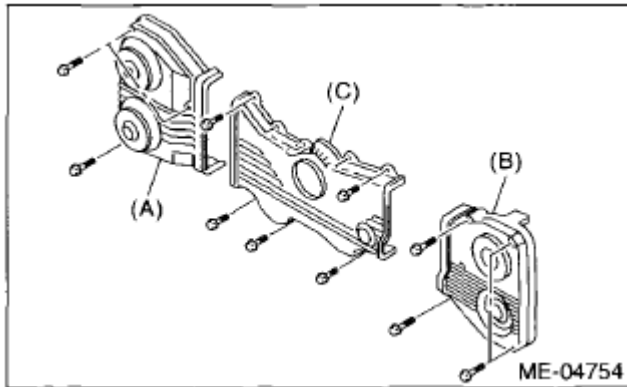


Fig. 112: Front Timing Belt Cover With Mounting Fasteners
Courtesy of SUBARU OF AMERICA, INC.

4. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >
5. Install the secondary air pump. < Ref. to **INSTALLATION** , Secondary Air Pump. >

INSPECTION

Check the timing belt cover for damage.

TIMING BELT

REMOVAL

NOTE:

- When replacing a single part, perform the work with the engine installed to body.
- When performing the work with the engine installed to body, the following parts must also be removed/installed.
- Radiator main fan motor assembly < Ref. to **REMOVAL** , Radiator Main Fan and Fan Motor. > < Ref. to **INSTALLATION** , Radiator Main Fan and Fan Motor. >
- Radiator sub fan motor assembly < Ref. to **REMOVAL** , Radiator Sub Fan and Fan Motor. > < Ref. to **INSTALLATION** , Radiator Sub Fan and Fan Motor. >

- When performing the work with the engine installed to body, protect the radiator with cardboards or blankets.

TIMING BELT

1. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
2. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
3. If the alignment mark or arrow mark (which indicates the direction of rotation) on timing belt fade away, put new marks before removing the timing belt as shown in procedures below.
 1. Turn the crankshaft using ST, and align the alignment marks on crank sprocket, intake cam sprocket LH, exhaust cam sprocket LH, intake cam sprocket RH and exhaust cam sprocket RH with marks on oil pump and notches of timing belt cover.

ST 499987500 CRANKSHAFT SOCKET

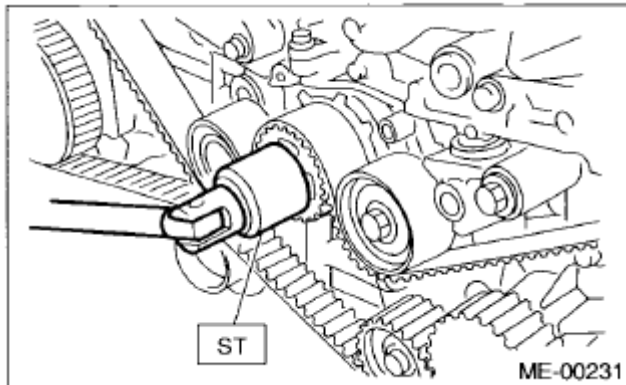


Fig. 113: Turning Crankshaft Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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

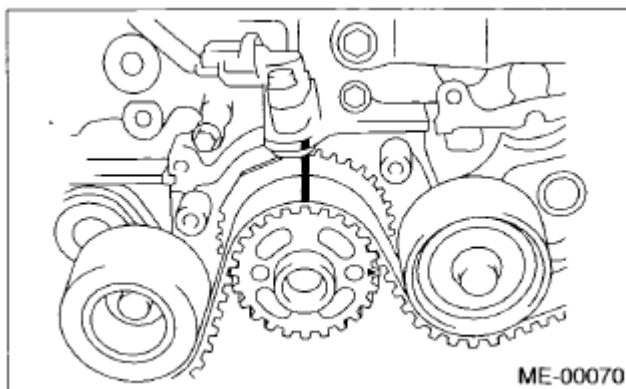


Fig. 114: Timing Belt Alignment Mark

Courtesy of SUBARU OF AMERICA, INC.

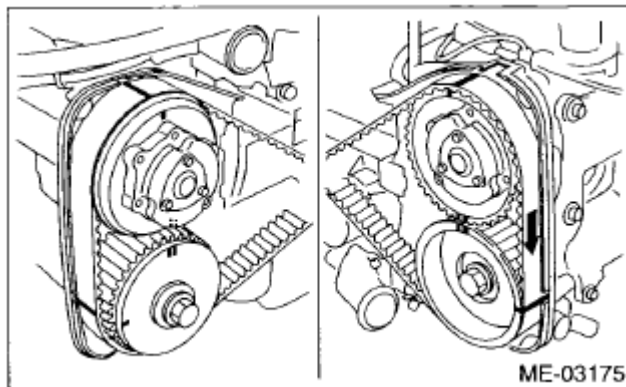


Fig. 115: Arrow Mark On Timing Belts
Courtesy of SUBARU OF AMERICA, INC.

Z_1 : 54.5 teeth

Z_2 : 51 teeth

Z_3 : 28 teeth

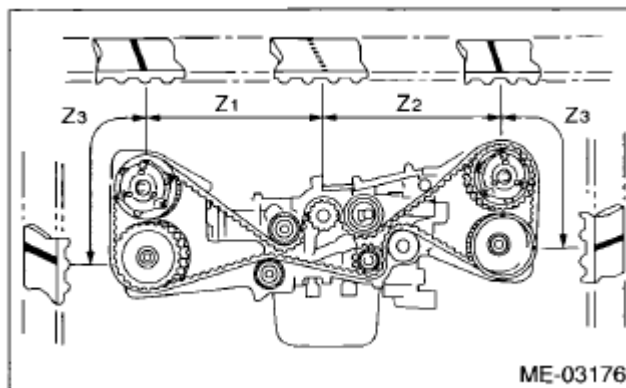


Fig. 116: Timing Belt Teeth Dimensions
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the belt idler (A).

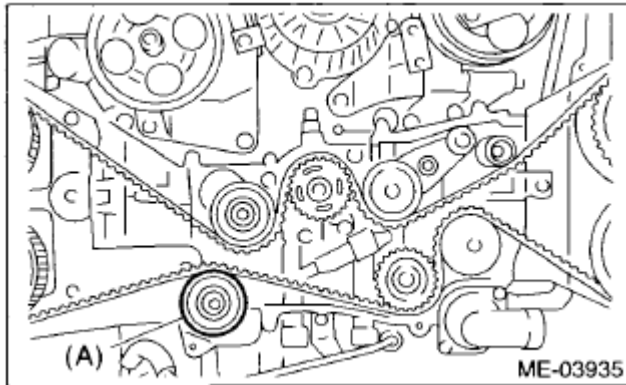


Fig. 117: Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

5. Remove the timing belt.

CAUTION: After the timing belt has been removed, never rotate the intake and exhaust sprocket. If the cam sprocket is rotated, the intake and exhaust valve heads strike together and valve stems are bent.

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

1. Remove the belt idler (A) and (B).

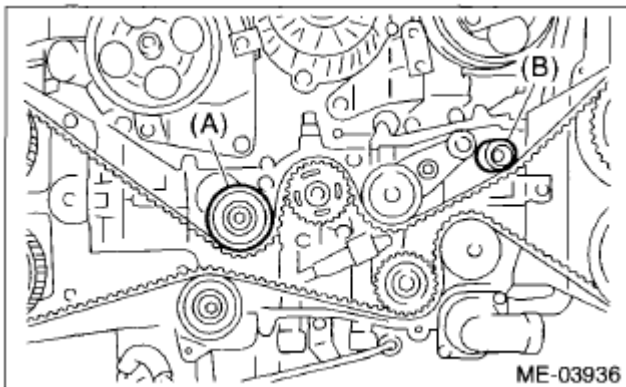


Fig. 118: Belt Idler

Courtesy of SUBARU OF AMERICA, INC.

2. Remove the belt idler No. 2.

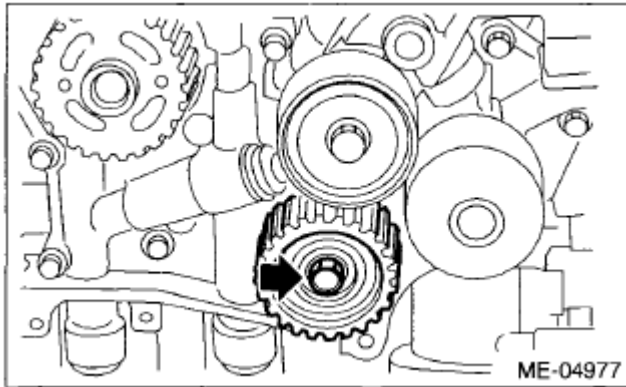


Fig. 119: Locating Belt Idler And Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the automatic belt tension adjuster assembly.

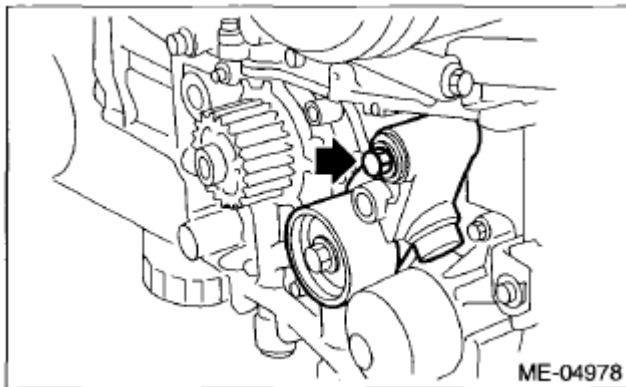


Fig. 120: Locating Automatic Belt Tension Adjuster Assembly Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

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

CAUTION:

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

- Push in the adjuster rod to the end face of the cylinder. However, do not press the adjuster rod below the end face of the cylinder. Doing so may damage the cylinder.
 - Do not release the press pressure until stopper pin is completely inserted.
1. Attach the automatic belt tension adjuster assembly to vertical pressing tool.
 2. Slowly push in the adjuster rod with a pressure of 165 N (16.8 kgf, 37.1 lbf) or more until the adjuster rod is aligned with the stopper pin hole in the cylinder.

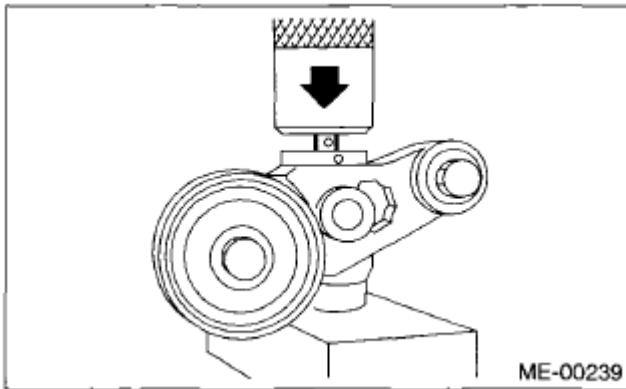


Fig. 121: Attaching Automatic Belt Tension Adjuster Assembly To Vertical Pressing Tool
Courtesy of SUBARU OF AMERICA, INC.

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

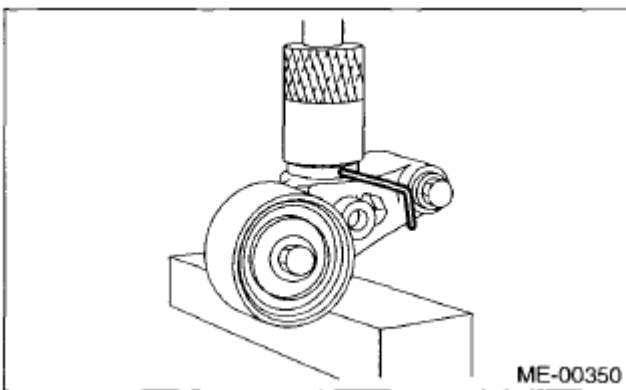


Fig. 122: Inserting Hex Wrench Into Stopper Pin Hole
Courtesy of SUBARU OF AMERICA, INC.

2. Install the automatic belt tension adjuster assembly.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)

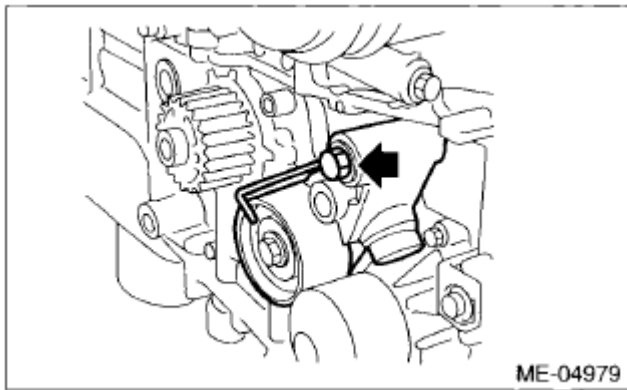


Fig. 123: Locating Automatic Belt Tension Adjuster Assembly Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Install the belt idler No. 2.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)

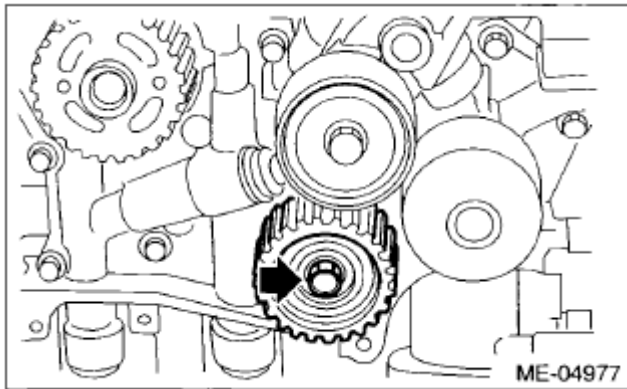


Fig. 124: Locating Belt Idler And Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Install the belt idlers.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)

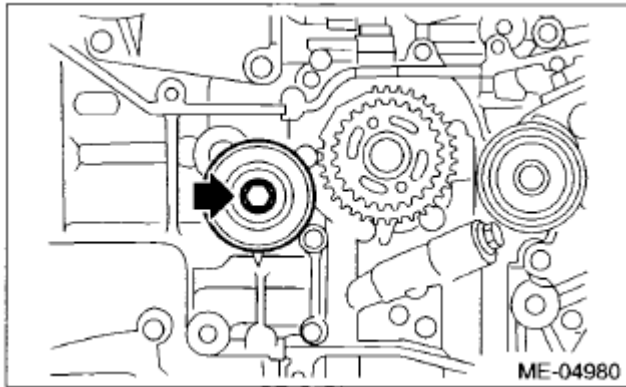


Fig. 125: Locating Belt Idler Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

25 N.m (2.5 kgf-m, 18.4 ft-lb)

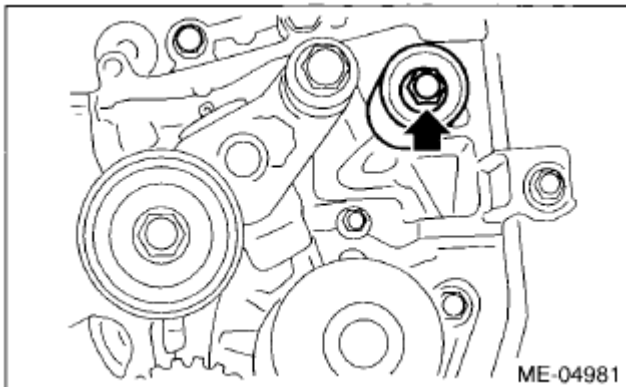


Fig. 126: Locating Belt Idler Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

TIMING BELT

1. Prepare for installation of the automatic belt tension adjuster assembly. < Ref. to **AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER**, INSTALLATION, Timing Belt. >
2. Align the mark (B) on crank sprocket with the mark (A) on oil pump.

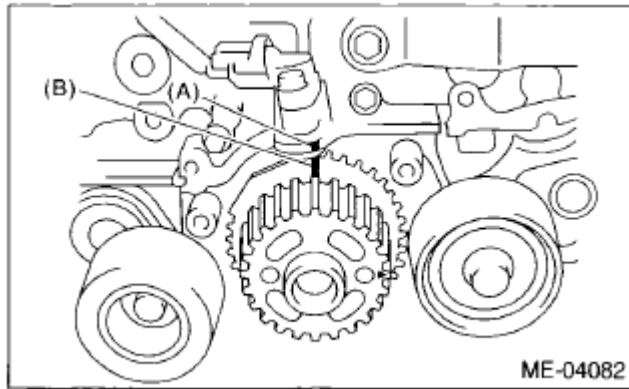


Fig. 127: Crank Sprocket Alignment Mark
Courtesy of SUBARU OF AMERICA, INC.

3. Align the single line mark (B) on the exhaust cam sprocket RH with notch (A) on the timing belt cover.

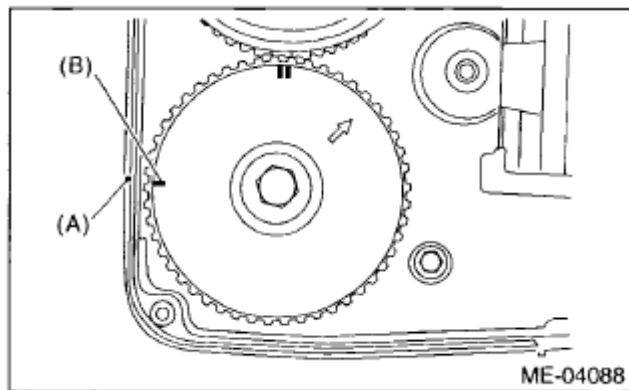


Fig. 128: Single Line Mark And Exhaust Cam Sprocket RH With Notch
Courtesy of SUBARU OF AMERICA, INC.

4. Align the single line mark (B) on the intake cam sprocket RH with notch (A) on the timing belt cover. Make sure that the double line marks (C) on intake and exhaust cam sprockets are aligned.

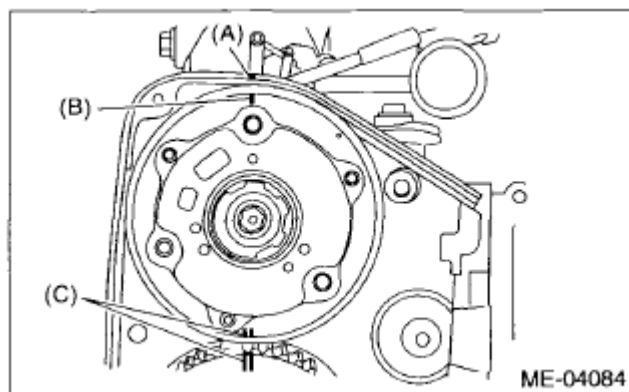


Fig. 129: Single, Double Line Mark And Notch

Courtesy of SUBARU OF AMERICA, INC.

5. Align the single line mark (B) on exhaust cam sprocket LH with notch (A) on the timing belt cover by turning the sprocket counterclockwise (as viewed from front of engine).

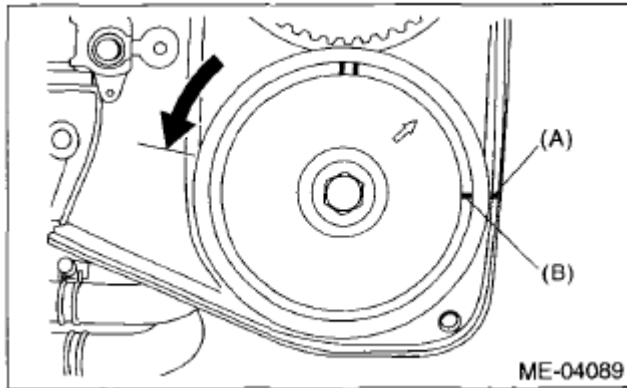


Fig. 130: Turning Sprocket Counterclockwise
Courtesy of SUBARU OF AMERICA, INC.

6. Align the single line mark (B) on intake cam sprocket LH with notch (A) on the timing belt cover by turning the sprocket clockwise (as viewed from front of engine). Make sure the double line marks (C) on the intake and exhaust cam sprockets are aligned.

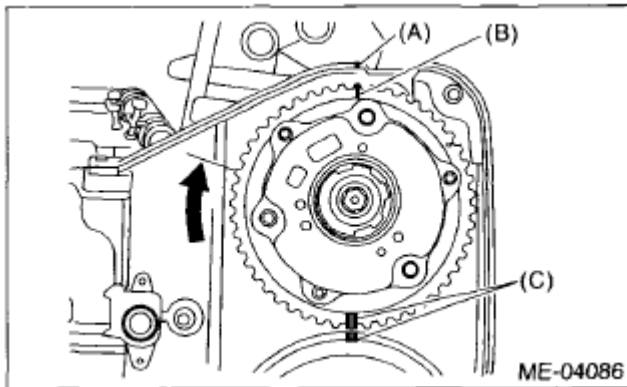
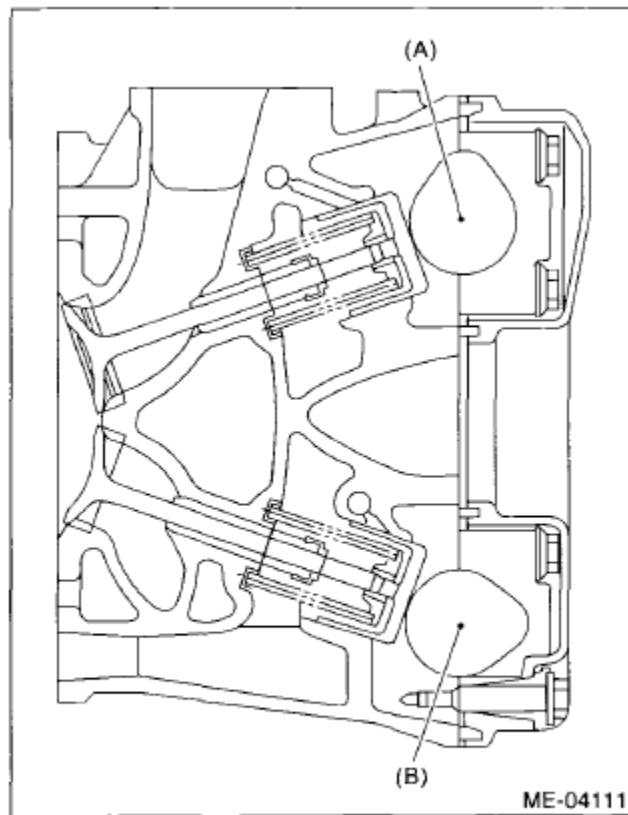


Fig. 131: Turning Sprocket Clockwise
Courtesy of SUBARU OF AMERICA, INC.

7. Make sure that the cam and crank sprockets are positioned properly.

CAUTION:

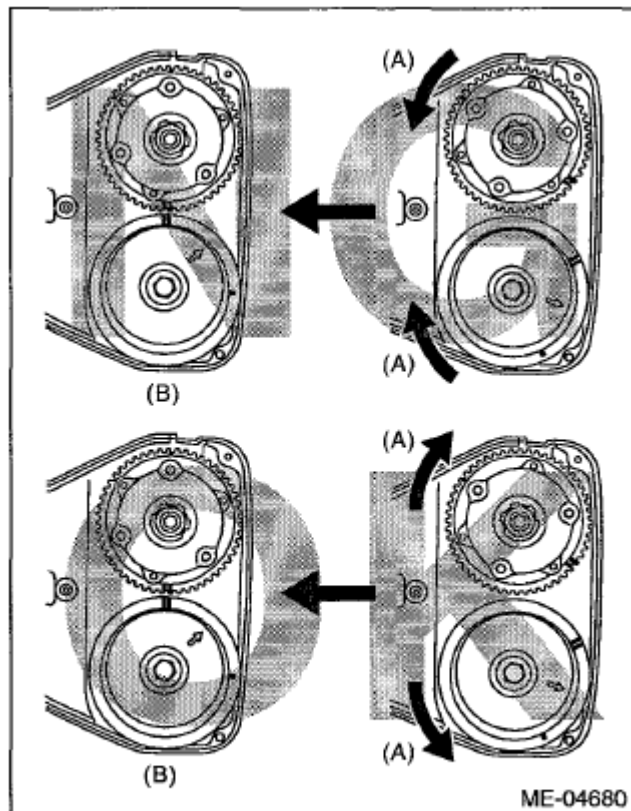
- Intake and exhaust camshafts for this DOHC engine can be independently rotated with the timing belts removed. As can be seen from the illustration, if the intake and exhaust valves are lifted simultaneously, heads will interfere with each other, resulting in bent valves.



(A) Intake camshaft
(B) Exhaust camshaft

Fig. 132: Intake And Exhaust Camshaft
Courtesy of SUBARU OF AMERICA, INC.

- When the timing belts are not installed, four camshafts are held at the "zero-lift" position, where all cams on camshafts are not pushing down on the intake and exhaust valves. (Under this condition, all valves remain unlifted.)
- When the camshafts are rotated to install the timing belts, #2 intake and #4 exhaust cam of camshaft LH are held, pushing their corresponding valves down. (Under this condition, these valves are held lifted.) Camshaft RH are held so that their cams do not push the valves down.
- Camshafts LH must be rotated from the zero-lift position to the position where the timing belt is to be installed with the smallest possible angle, in order to prevent mutual interference of intake and exhaust valve heads.
- Do not allow the camshafts to rotate in the direction shown in the upper illustration. Doing this may cause both the intake and exhaust valves to lift simultaneously, resulting in mutual interference of valve heads.



(A) Direction of rotation

(B) Timing belt installation position

Fig. 133: Camshaft Direction Of Rotation And Timing Belt Installation Position

Courtesy of SUBARU OF AMERICA, INC.

8. Align the alignment mark on the timing belt with marks on the sprockets in the alphabetical order shown in the illustration. While aligning marks, position the timing belt properly, and install the timing belt.

CAUTION:

- If the timing belt slips by 1 or more teeth, the valve and piston may hit each other.
- Make sure that the direction of belt rotation is correct.

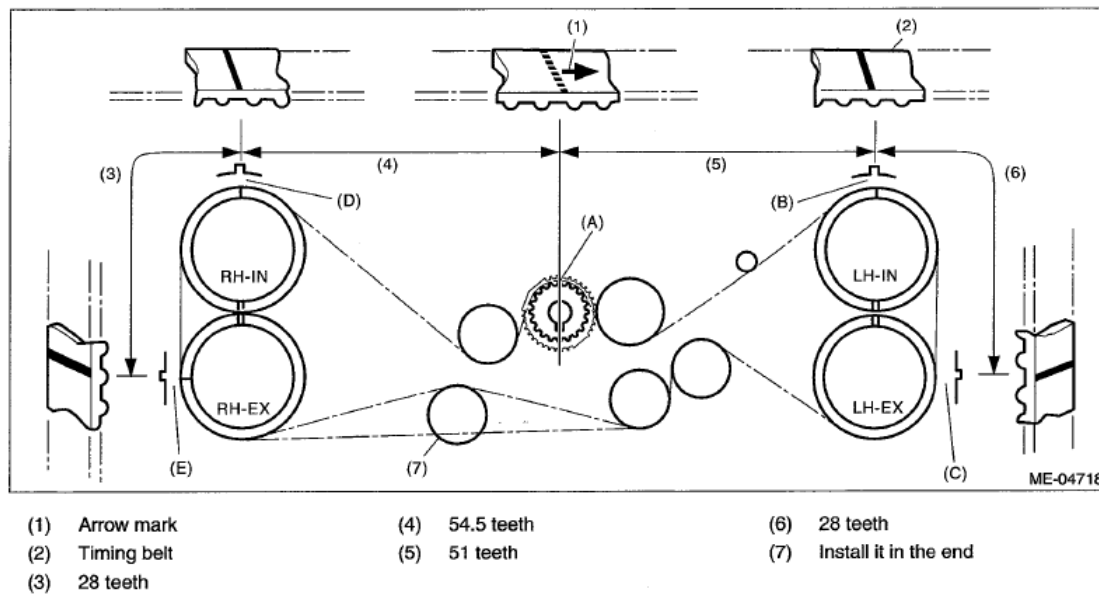


Fig. 134: Timing Belt Alignment Mark Aligning Sequence
Courtesy of SUBARU OF AMERICA, INC.

9. Install the belt idlers.

Tightening torque:

39 N.m (4.0 kgf-m, 28.8 ft-lb)

NOTE: Make sure that the marks on the timing belt and sprockets are aligned.

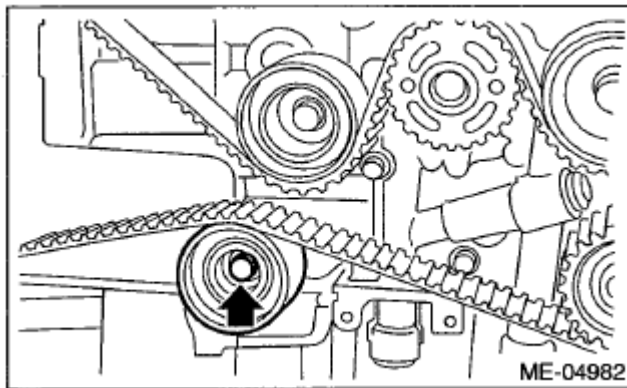


Fig. 135: Timing Belt And Sprockets Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

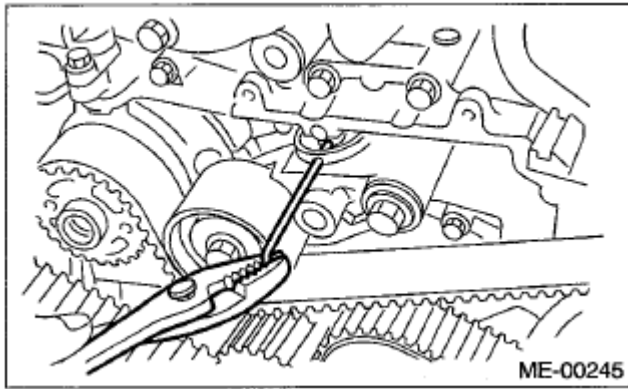


Fig. 136: Removing Stopper Pin From Tensioner Adjuster
Courtesy of SUBARU OF AMERICA, INC.

11. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
12. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >

INSPECTION

TIMING BELT

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

CAUTION:

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

In radial diameter h:

60 mm (2.36 in) or more

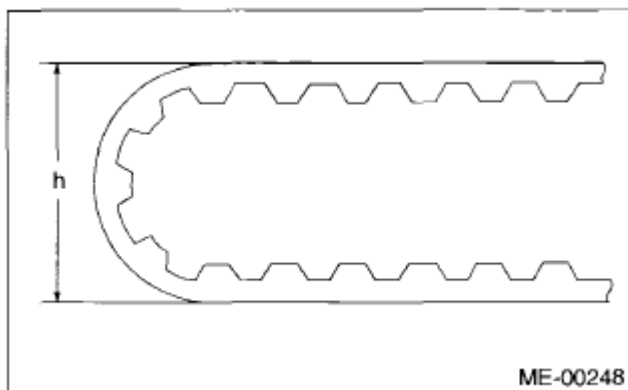


Fig. 137: Timing Belt Radial Diameter

Courtesy of SUBARU OF AMERICA, INC.

AUTOMATIC BELT TENSION ADJUSTER

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

NOTE: **Slight traces of oil on the oil seal of the rod does not indicate a problem.**

2. Check that the adjuster rod does not move when a pressure of 165 N (16.8 kgf, 37.1 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 165 N (16.8 kgf, 37.1 lb), check it using the following procedures:
 1. Slowly press the adjuster rod down to the end surface of cylinder. Repeat this operation two to three times.
 2. With the adjuster rod moved all the way up, apply a pressure of 165 N (16.8 kgf, 37.1 lb) to it, and check the adjuster rod stiffness.
 3. If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new part.

CAUTION:

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

4. Measure the amount of adjuster rod protrusion "L" from the end surface of the cylinder. If it is not within specifications, replace the automatic belt tension adjuster assembly with a new part.

Protrusion amount of adjuster rod L:

5.2 - 6.2 mm (0.205 - 0.244 in)

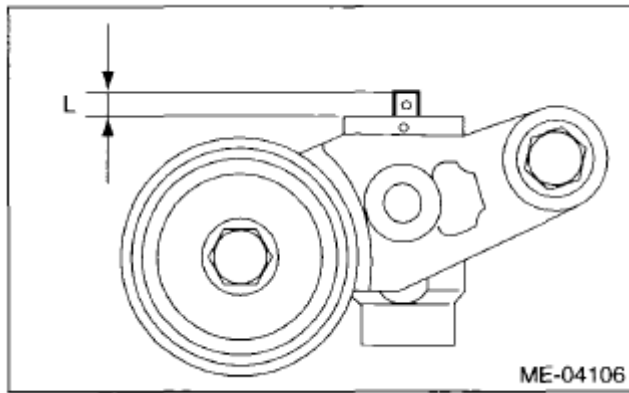


Fig. 138: Protrusion Amount Of Adjuster Rod
Courtesy of SUBARU OF AMERICA, INC.

BELT TENSION PULLEY

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

BELT IDLER

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

CAM SPROCKET

REMOVAL

NOTE: When replacing a single part, perform the work with the engine installed to body.

1. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
2. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
3. Remove the timing belt. < Ref. to **REMOVAL**, Timing Belt. >
4. Remove the actuator cover from intake cam sprocket.
5. Use the ST to lock the cam sprocket, and remove the cam sprocket bolt.

ST 499207400 CAM SPROCKET WRENCH

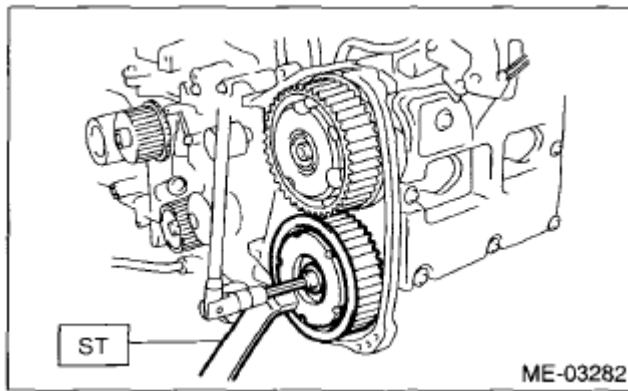


Fig. 139: Locking Cam Sprocket Using Cam Sprocket Wrench (499207400)
Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH

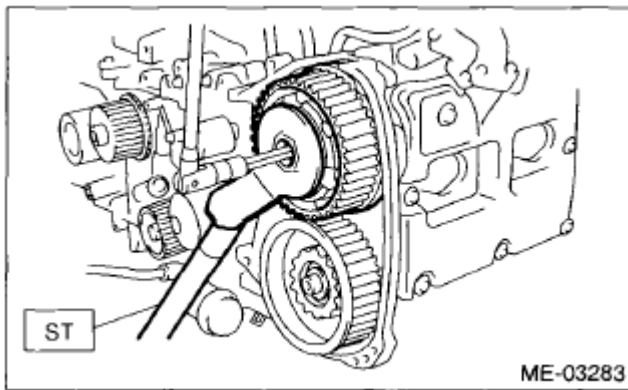


Fig. 140: Locking Cam Sprocket Using Cam Sprocket Wrench (4992077500)
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the cam sprocket.

INSTALLATION

1. Install the cam sprocket.
2. Use the ST to lock the cam sprocket, and install the cam sprocket bolt.

NOTE: Do not confuse cam sprockets (LH) and (RH) during installation.

ST 499207400 CAM SPROCKET WRENCH

Tightening torque:

Tighten to 30 N.m (3.1 kgf-m, 22.1 ft-lb) of torque, and then tighten further by 45°.

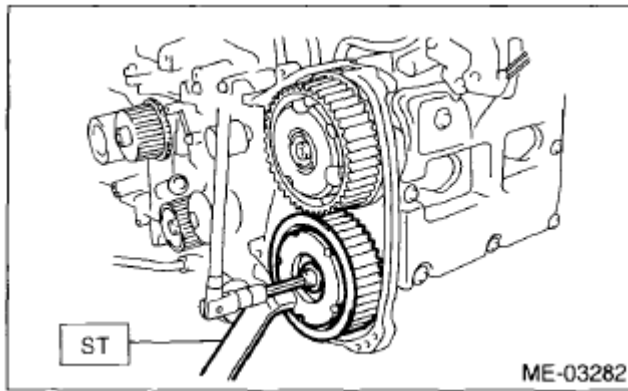


Fig. 141: Installing Cam Sprocket Bolt Using Special Tool
 Courtesy of SUBARU OF AMERICA, INC.

ST 499977500 CAM SPROCKET WRENCH

Tightening torque:

Tighten to 30 N.m (3.1 kgf-m, 22.1 ft-lb) of torque, and then tighten further by 45°.

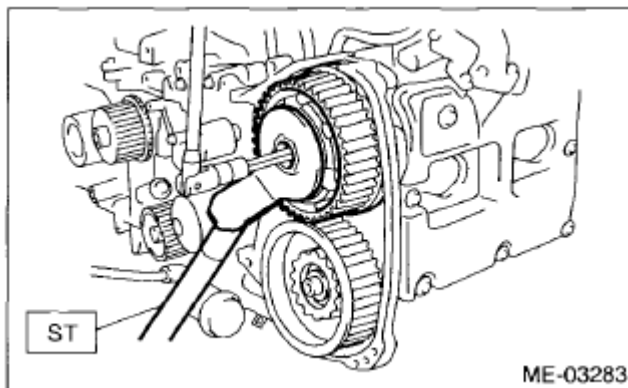


Fig. 142: Locking Cam Sprocket Using Cam Sprocket Wrench (4992077500)
 Courtesy of SUBARU OF AMERICA, INC.

3. Install the actuator cover to intake cam sprocket.

NOTE: Use new O-rings.

Tightening torque:

3.4 N.m (0.3 kgf-m, 2.5 ft-lb)

4. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt. >
5. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
6. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >

INSPECTION

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

CRANK SPROCKET

REMOVAL

NOTE: When replacing a single part, perform the work with the engine installed to body.

1. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
2. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
3. Remove the timing belt. < Ref. to **REMOVAL**, Timing Belt. >
4. Remove the crank sprocket.

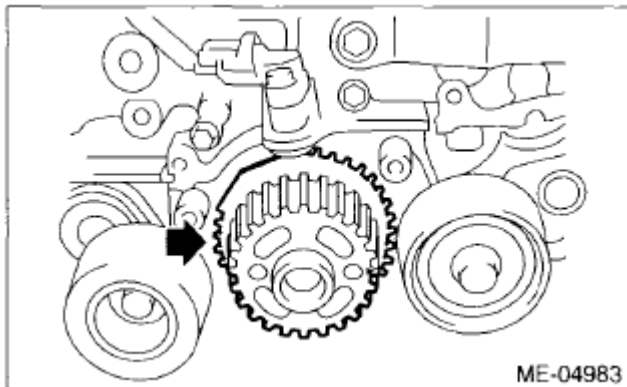


Fig. 143: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

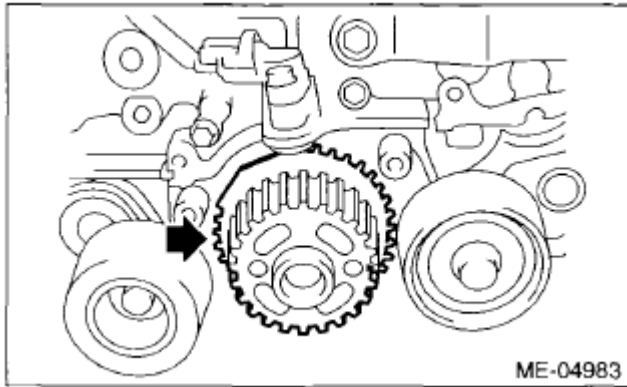


Fig. 144: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt. >
3. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
4. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >

INSPECTION

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

CAM SHAFT

REMOVAL

1. Remove the engine from the vehicle. < Ref. to **REMOVAL**, Engine Assembly. >
2. Remove the rear side belt. < Ref. to **REAR SIDE BELT**, REMOVAL, V-belt. >
3. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
4. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
5. Remove the timing belt. < Ref. to **REMOVAL**, Timing Belt. >
6. Remove the cam sprocket. < Ref. to **REMOVAL**, Cam Sprocket. >
7. Disconnect the connector from the oil flow control solenoid valve.

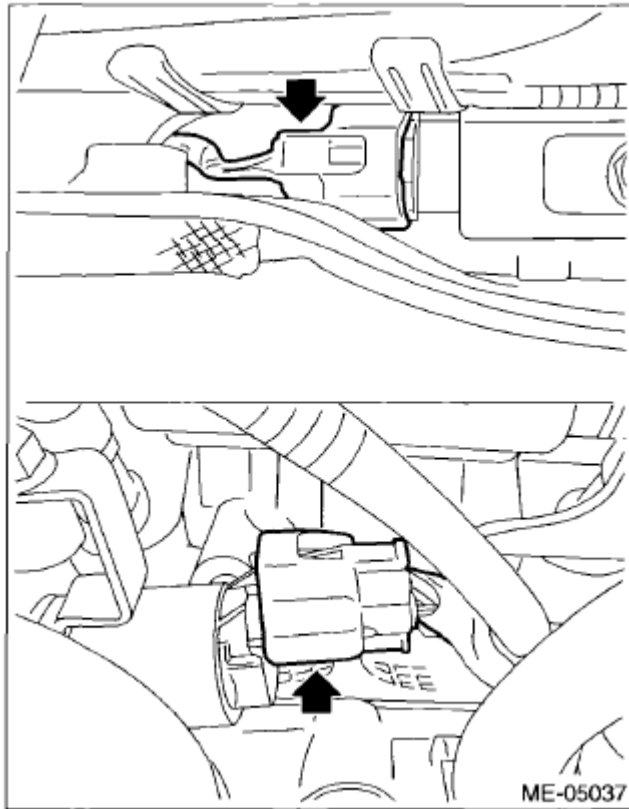


Fig. 145: Locating Oil Flow Control Solenoid Valve
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the timing belt cover No. 2 RH (A) and timing belt cover No. 2 LH (B).

NOTE: When removing the timing belt cover, be careful not to damage the seal rubber.

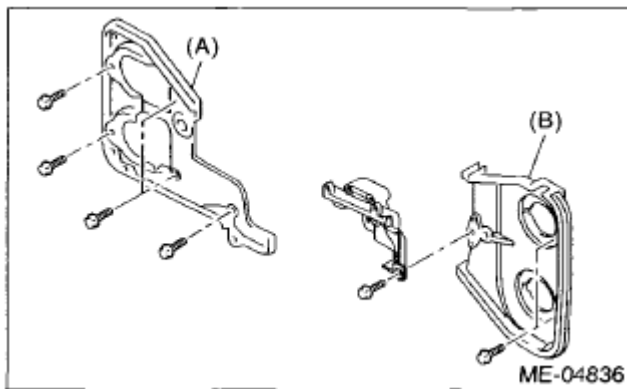


Fig. 146: LH And RH Timing Belt Cover Mounting Fasteners
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the tensioner bracket.

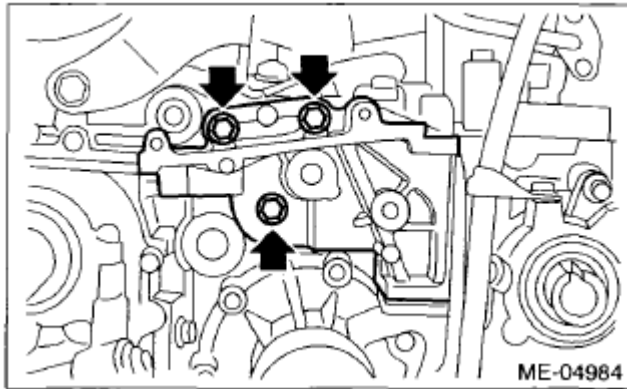


Fig. 147: Locating Tensioner Bracket Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

10. Remove the clip (A) and the stay (B) which hold the engine harness to the rocker cover.

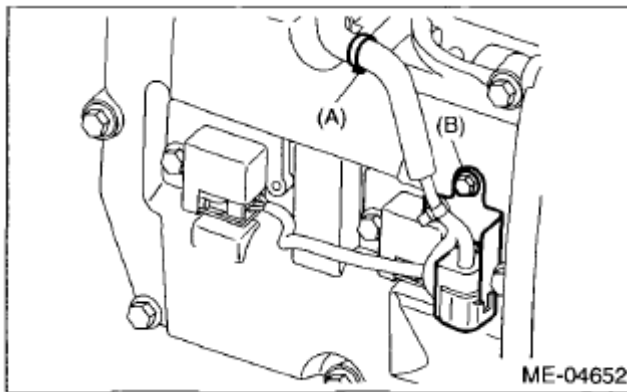


Fig. 148: Engine Harness Clip And Stay
 Courtesy of SUBARU OF AMERICA, INC.

11. Remove the air duct B (B) from the rocker cover LH and the air duct A (A).

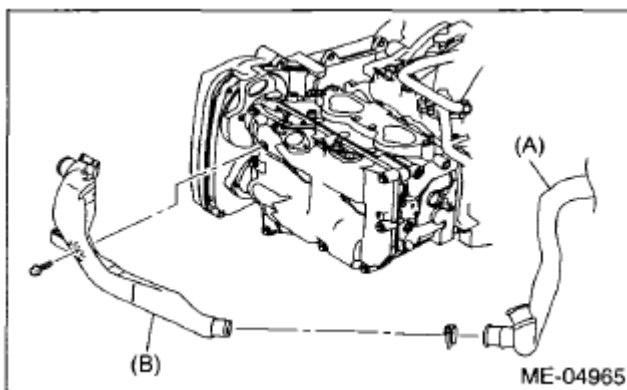


Fig. 149: Rocker Cover Air Ducts
 Courtesy of SUBARU OF AMERICA, INC.

12. Remove the ignition coil. < Ref. to **REMOVAL** , Ignition Coil. >
13. Disconnect the PCV hose (A) and PCV hose assembly (B) from the rocker cover.

NOTE: Pinch the clamp of the PCV hose (A) by fitting the cut out in the ST with the protrusion on the clamp as shown in the figure, and unlock the clamp.

ST 18353AA000 CLAMP PLIERS

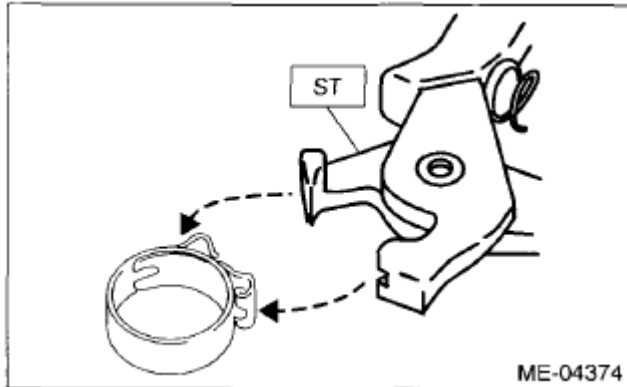


Fig. 150: Pinching Clamp Of PCV Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

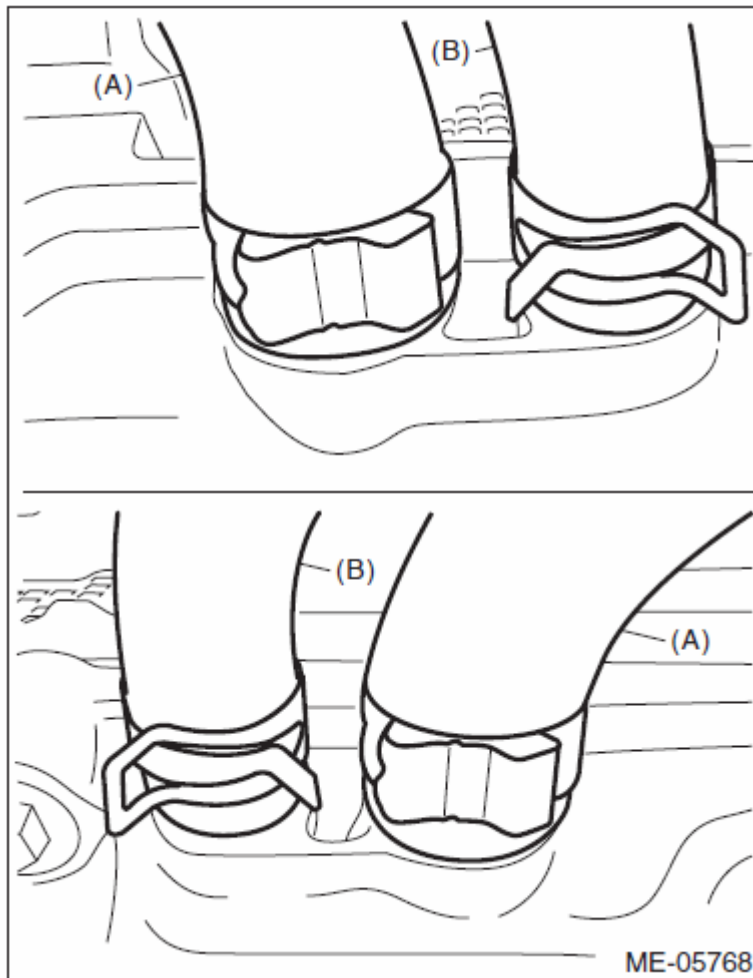
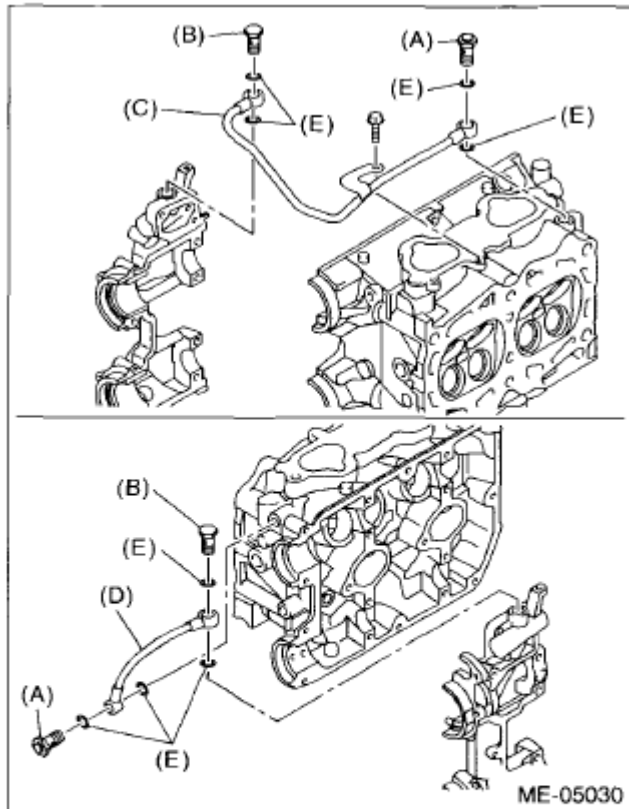


Fig. 151: Identifying PCV Hose And PCV Hose Assembly
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the rocker cover.
15. Remove the union bolt without filter (without protrusion) which secures the oil pipe to the front camshaft cap.



- (A) Union bolt with filter (with protrusion)
- (B) Union bolt without filter (without protrusion)
- (C) Oil pipe RH
- (D) Oil pipe LH
- (E) Gasket

Fig. 152: Front Camshaft Cap Mounting Screws
 Courtesy of SUBARU OF AMERICA, INC.

16. Loosen the upper side of the front camshaft cap and the intake camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the illustration.

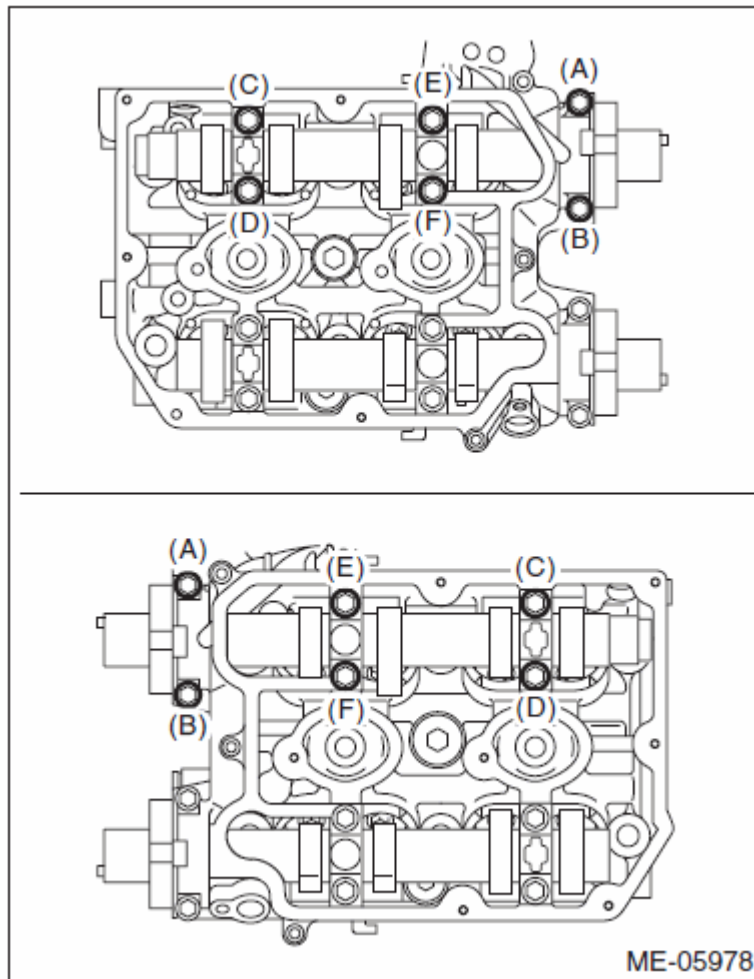


Fig. 153: Front Camshaft Cap And Intake Camshaft Cap Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

17. Loosen the lower side of the front camshaft cap and the exhaust camshaft cap bolts equally, a little at a time in alphabetical sequence shown in the illustration.

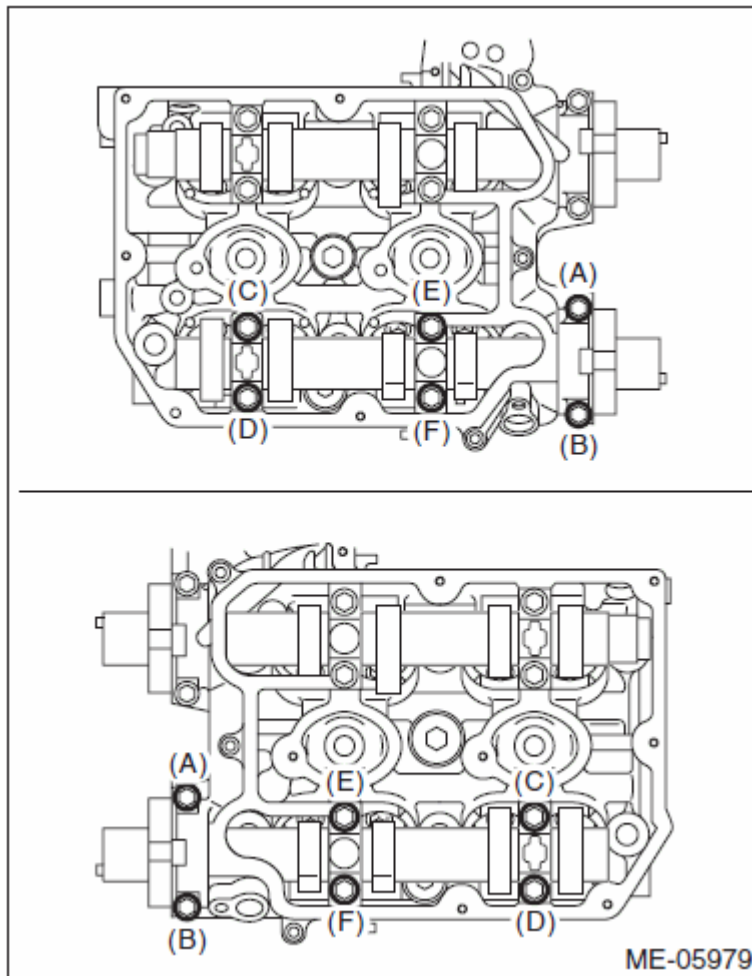


Fig. 154: Front Camshaft Cap And Exhaust Camshaft Cap Bolts Loosening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

18. Remove the front camshaft cap.
19. Remove the intake camshaft caps and intake camshaft.
20. Remove the exhaust camshaft caps and exhaust camshaft.

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

21. Remove the oil seal.

CAUTION: Do not scratch the journal surface when removing the oil seal.

22. Similarly, remove the camshaft RH.

INSTALLATION

1. Install the camshaft.

Apply engine oil to the cylinder head at camshaft bearing installation location before installing the camshaft. Install the camshaft so that each valve is close to or in contact with base circle of the cam lobe.

NOTE:

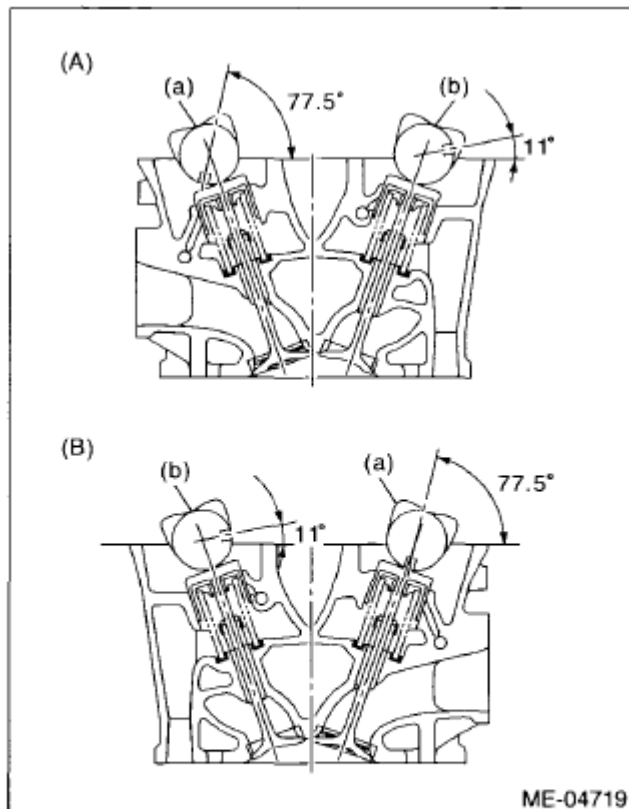
- Set the camshaft to the position shown in the illustration.
- When set at the position shown in the illustration, it is not necessary to rotate the camshaft RH when installing the timing belt, but it is necessary to rotate the camshaft LH slightly.

Intake camshaft LH:

Rotate 80° clockwise.

Exhaust camshaft LH:

Rotate 45° counterclockwise.



(A) Cylinder head LH

(B) Cylinder head RH

(a) Intake camshaft

(b) Exhaust camshaft

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

2. Install the camshaft cap.
 1. Apply small amount of liquid gasket to the mating surface of cap.

NOTE:

- **Install within 5 min. after applying liquid gasket.**
- **Do not apply liquid gasket excessively. Applying excessively may cause excess gasket to come out and flow toward oil seal, resulting in oil leak.**

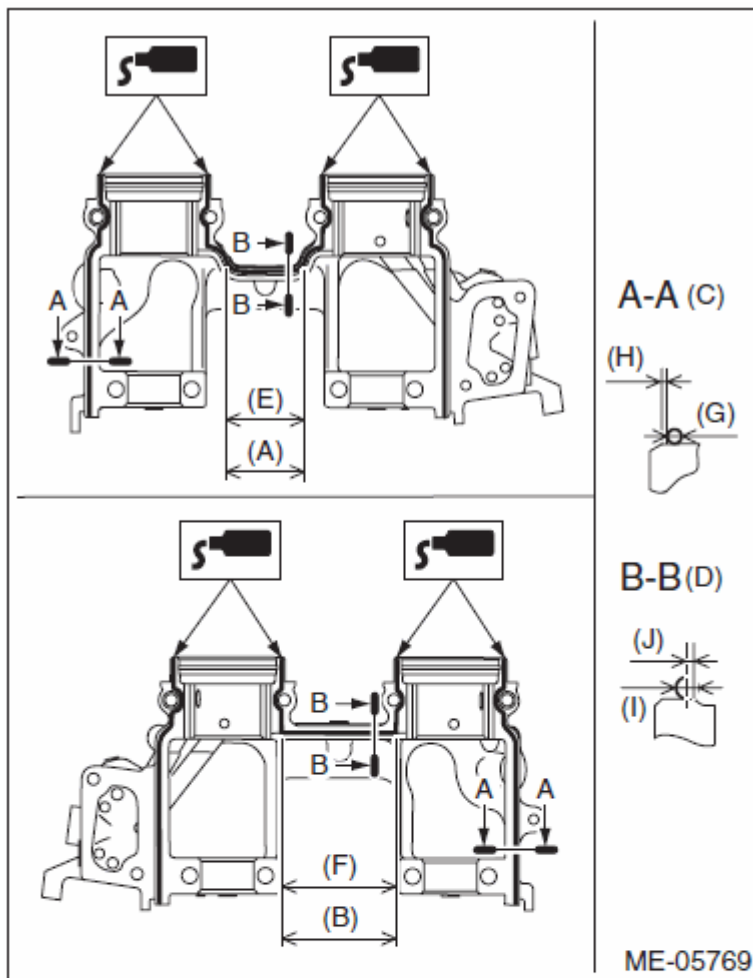
Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

Liquid gasket applying diameter:

Mating surfaces other than ranges A and B 2 ± 0.5 mm (0.0787 $\pm$ 0.0197 in)

Mating surfaces of ranges A and B 3 ± 1 mm (0.1181 $\pm$ 0.0394 in)



- (A) Range A
- (B) Range B
- (C) Liquid gasket applying position of mating surfaces of ranges other than A and B
- (D) Liquid gasket applying position of mating surfaces of ranges A and B
- (E) 44.8 mm (1.7638 in)
- (F) 65 mm (2.5591 in)
- (G) $\phi 2 \pm 0.5$ mm (0.0787 $\pm$ 0.0197 in)
- (H) 0.5 $\pm$ 0.5 mm (0.0197 $\pm$ 0.0197 in)
- (I) $\phi 3 \pm 1$ mm (0.1181 $\pm$ 0.0394 in)
- (J) 1 mm (0.0394 in) or less

Fig. 156: Cap Mating Surface Liquid Gasket Applying Area
 Courtesy of SUBARU OF AMERICA, INC.

2. Apply a thin coat of engine oil to the cap journal surface, and install the camshaft cap to the camshaft.
3. Gradually tighten the camshaft cap in at least two steps, in alphabetical order shown in the illustration, and then tighten to the specified torque.

Tightening torque:

T1: 9.75 N.m (1.0 kgf-m, 7.2 ft-lb)

T2: 20 N.m (2.0 kgf-m, 14.8 ft-lb)

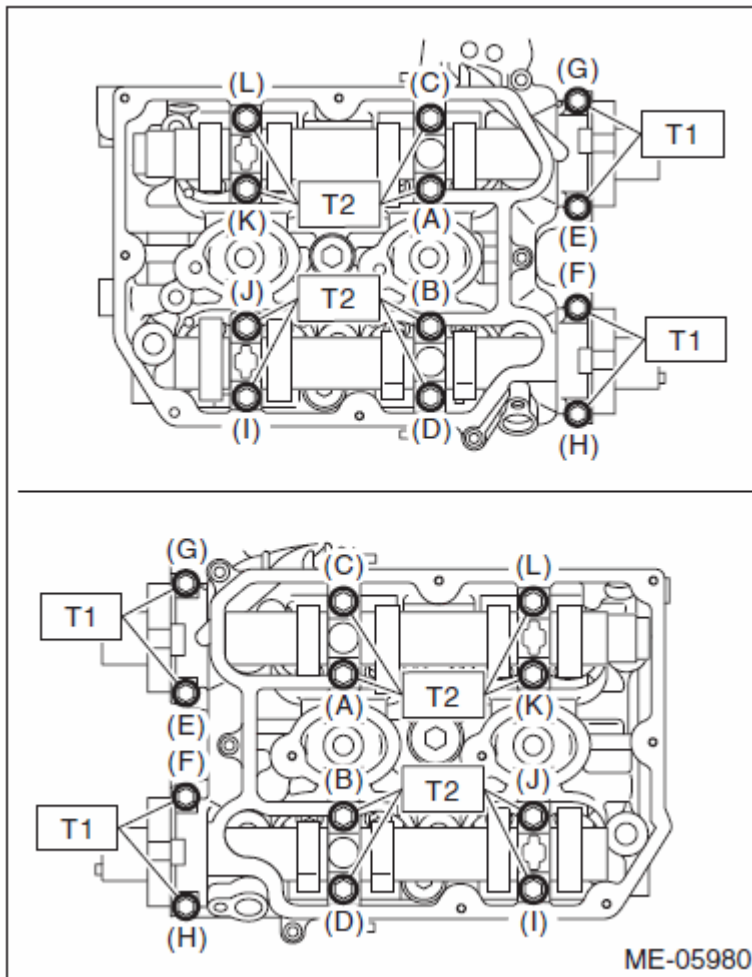


Fig. 157: Camshaft Cap Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. After tightening the camshaft cap, ensure the camshaft rotates only slightly while holding it at base circle.
3. Apply a thin coat of engine oil to the periphery of the camshaft oil seal and oil seal lip, and install the oil seal on the camshaft using ST1 and ST2.

NOTE: Use a new oil seal.

ST1 499587600 OIL SEAL INSTALLER

ST2 499597200 OIL SEAL GUIDE

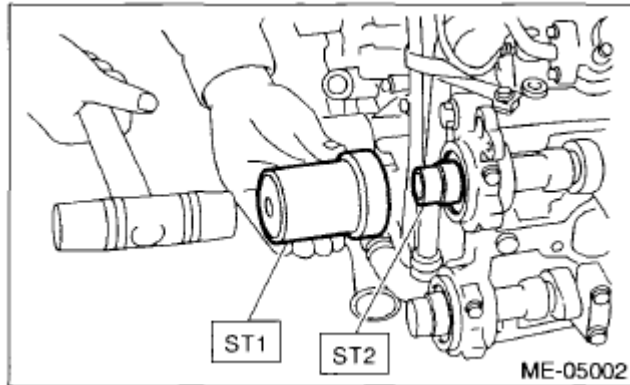


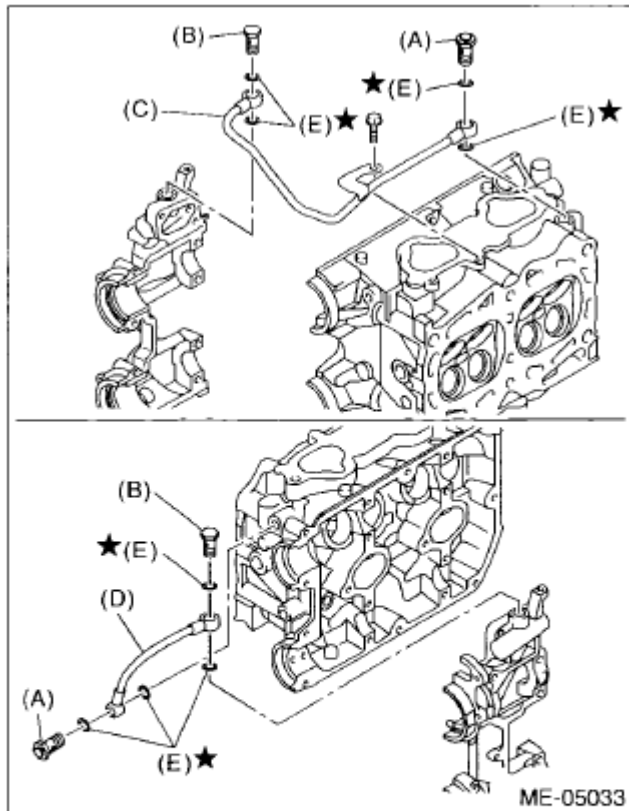
Fig. 158: Engine Oil Applying Area Of Camshaft Oil Seal And Oil Seal Lip
Courtesy of SUBARU OF AMERICA, INC.

4. Install the oil pipe to the front camshaft cap using the union bolt without filter (without protrusion).

NOTE: Use a new gasket.

Tightening torque:

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



- (A) Union bolt with filter (with protrusion)
- (B) Union bolt without filter (without protrusion)
- (C) Oil pipe RH
- (D) Oil pipe LH
- (E) Gasket

Fig. 159: Front Camshaft Cap Mounting Screws
 Courtesy of SUBARU OF AMERICA, INC.

5. Install the tensioner bracket.

Tightening torque:

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

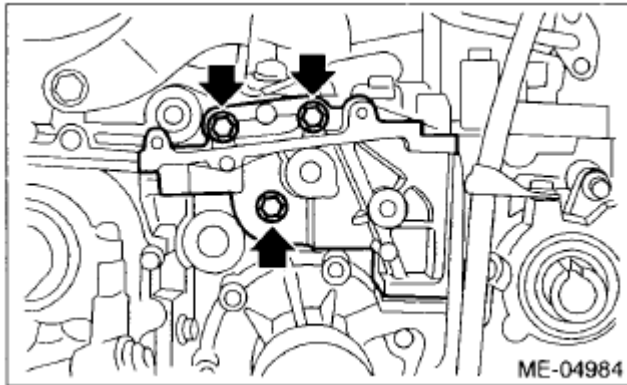


Fig. 160: Locating Tensioner Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Install the timing belt cover No. 2 RH (A) and timing belt cover No. 2 LH (B).

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)

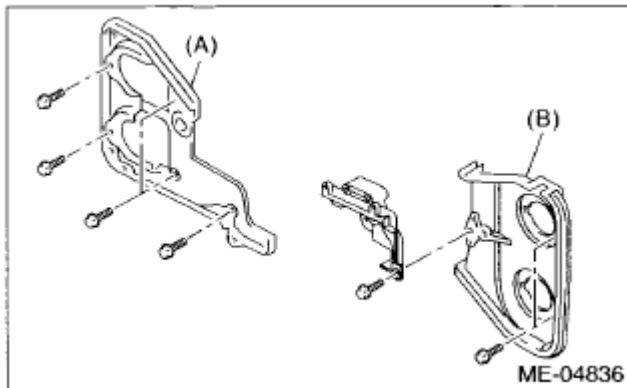


Fig. 161: LH And RH Timing Belt Cover Mounting Fasteners
Courtesy of SUBARU OF AMERICA, INC.

7. Install the cam sprocket. < Ref. to **INSTALLATION**, Cam Sprocket. >
8. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt. >
9. Adjust the valve clearance. < Ref. to **ADJUSTMENT**, Valve Clearance. >
10. Install the rocker cover.
 1. Install the rocker cover gasket to the rocker cover, (outer section and ignition coil section)

NOTE: Use a new rocker cover gasket.

2. Apply liquid gasket to the specified point of the cylinder head.

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

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

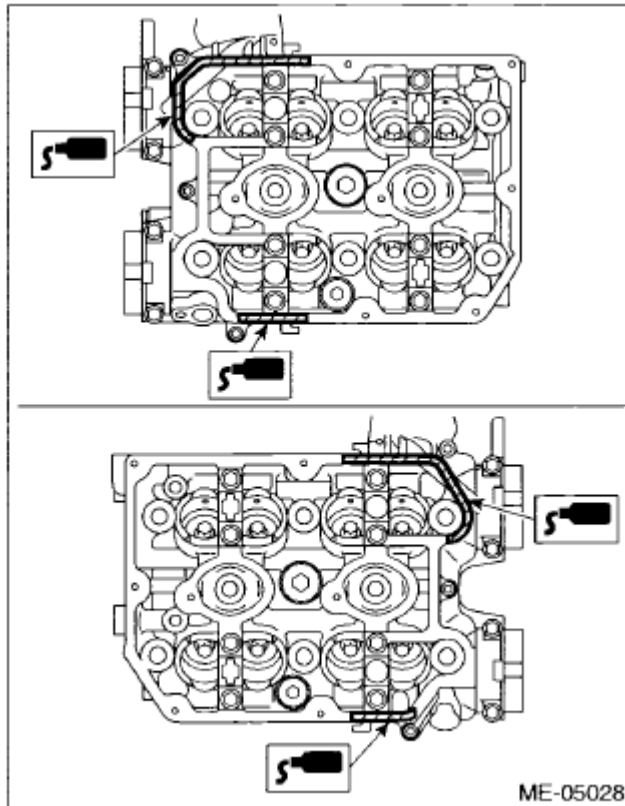


Fig. 162: Rocker Cover Liquid Gasket Applying Points
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover onto cylinder heads. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover bolts in alphabetical order shown in the illustration, and then tighten to specified torque in alphabetical order.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

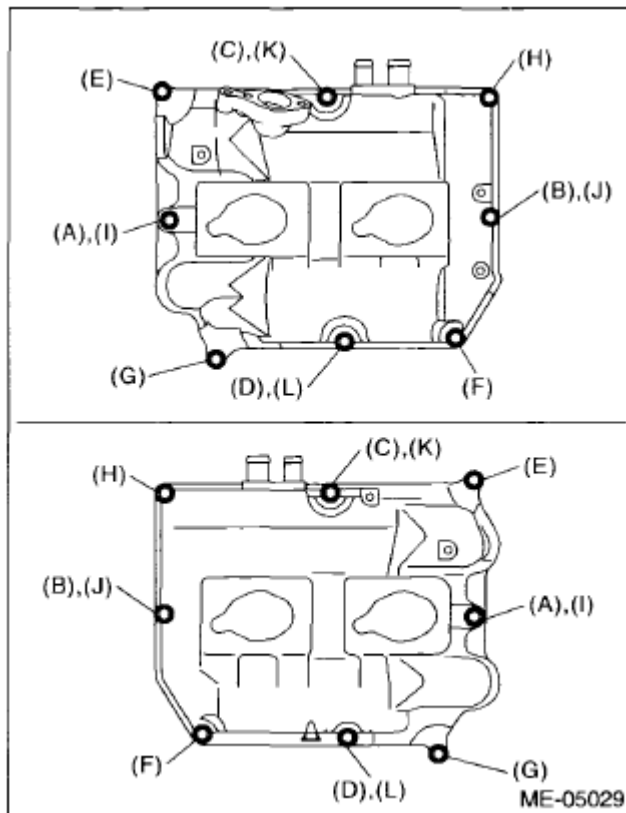


Fig. 163: Rocker Cover Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

11. Connect the PCV hose (A) and PCV hose assembly (B) to the rocker cover.

NOTE: Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the illustration, and lock the clamp.
ST 18353AA000 CLAMP PLIERS

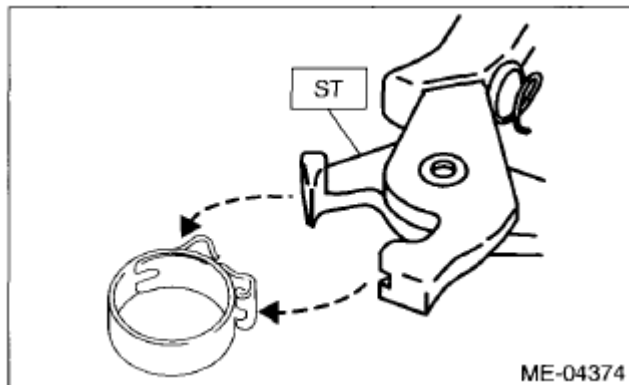


Fig. 164: Pinching Clamp Of PCV Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

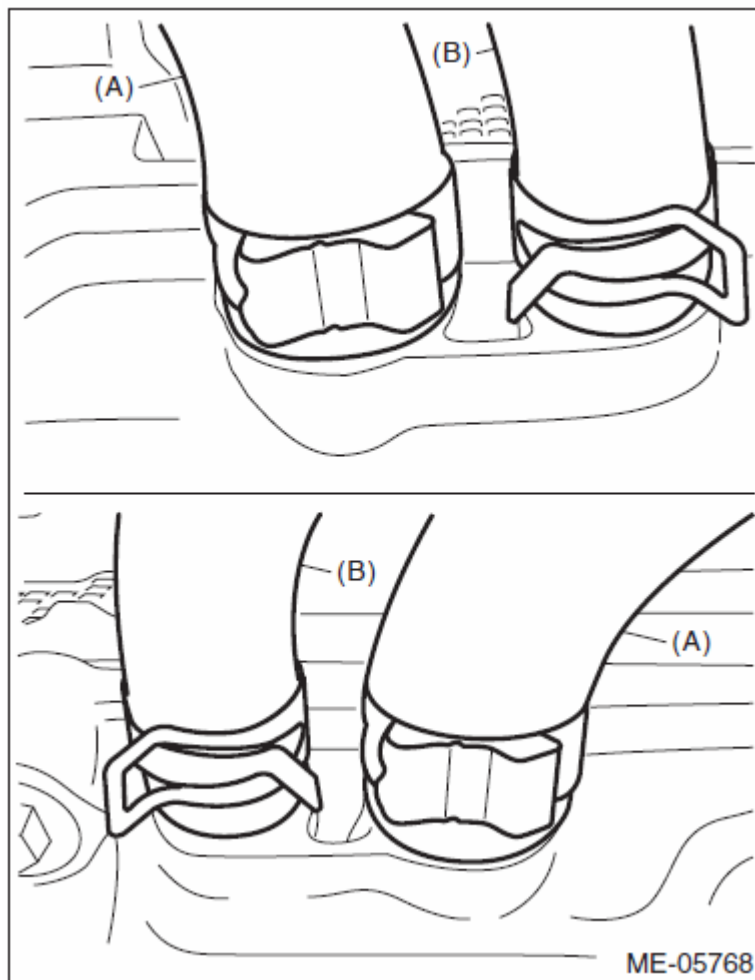


Fig. 165: Identifying PCV Hose And PCV Hose Assembly
Courtesy of SUBARU OF AMERICA, INC.

12. Connect the connector to oil flow control solenoid valve.

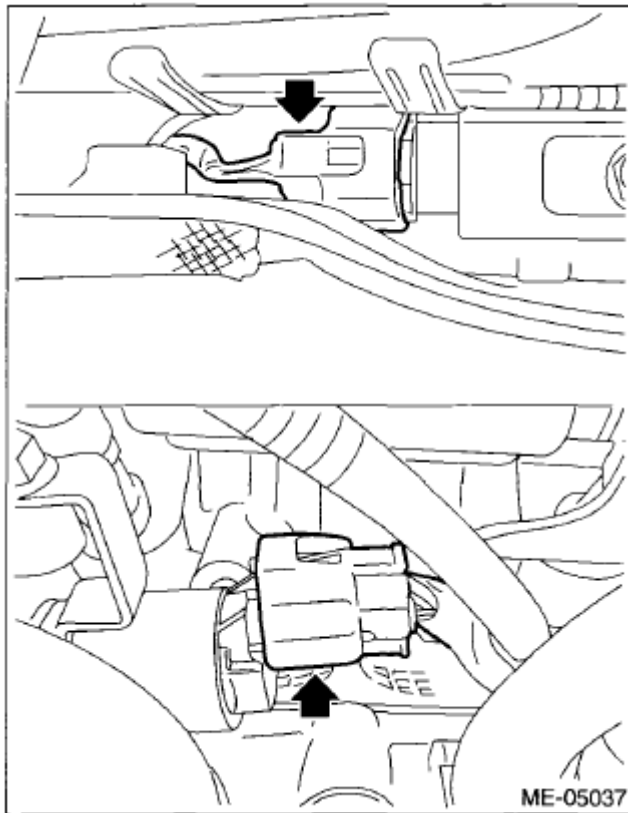


Fig. 166: Locating Oil Flow Control Solenoid Valve
Courtesy of SUBARU OF AMERICA, INC.

13. Install the ignition coil. < Ref. to **INSTALLATION** , Ignition Coil. >
14. Install the air duct B (B) to the rocker cover LH and the air duct A (A).

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

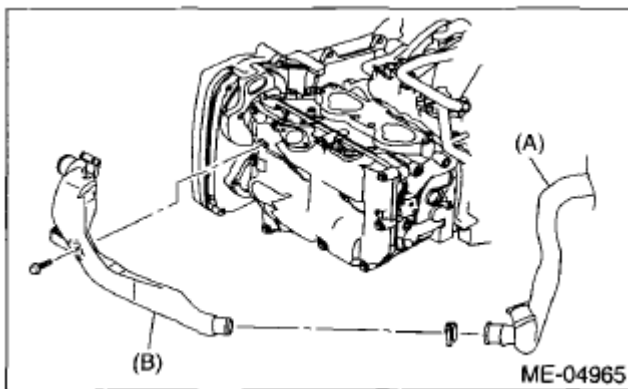


Fig. 167: Rocker Cover Air Ducts

Courtesy of SUBARU OF AMERICA, INC.

15. Securely install the engine harness with clip (A) and stay (B) to the rocker cover RH.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

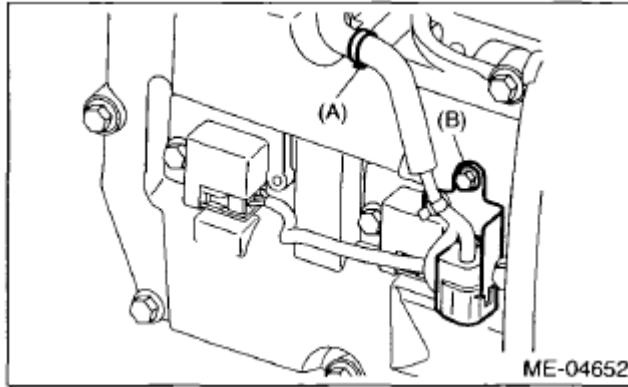


Fig. 168: Engine Harness Clip And Stay
Courtesy of SUBARU OF AMERICA, INC.

16. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
17. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >
18. Install the rear side belt. < Ref. to **REAR SIDE BELT**, INSTALLATION, V-belt. >
19. Install the engine to the vehicle. < Ref. to **INSTALLATION**, Engine Assembly. >

INSPECTION

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

Camshaft bend limit:

0.020 mm (0.00079 in)

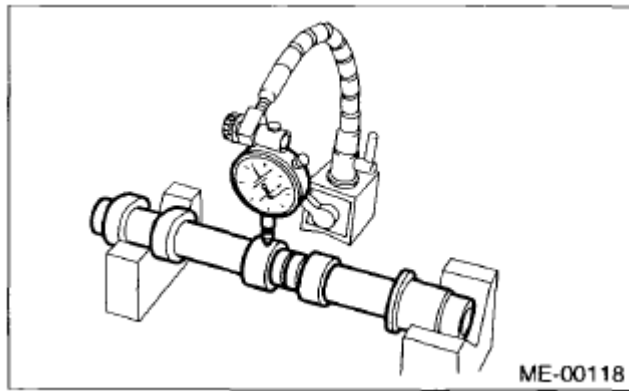


Fig. 169: Measuring Camshaft Journal Bend Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

2. Check the journal for damage and wear. place if faulty.
3. Check the cutout portion used for camshaft sensor for damage. Replace if faulty.
4. Check the cam face condition, and remove the minor faults by grinding with oil stone. Replace if there is uneven wear or others.
5. Measure the cam lobe height "H" and cam base circle diameter "A". If it exceeds the standard or offset wear occurs, replace it.

Cam lobe height H:

Standard

Intake

46.55 - 46.65 mm (1.833 - 1.837 in)

Exhaust

46.75 - 46.85 mm (1.841 - 1.844 in)

Cam base circle diameter A:

Standard

37.0 mm (1.457 in)

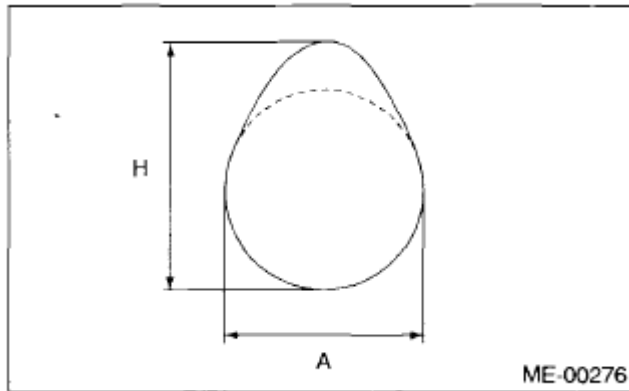


Fig. 170: Cam Base Circle Diameter And Cam Lobe Height
 Courtesy of SUBARU OF AMERICA, INC.

6. Measure the outside diameter of camshaft journal. If the journal diameter is not within specification, check the oil clearance.

CAMSHAFT JOURNAL SPECIFICATIONS CHART

	Camshaft journal	
	Front	Center, rear
Standard mm (in)	37.946 - 37.963 (1.4939 - 1.4946)	29.946 - 29.963 (1.1790 - 1.1796)

7. Measure the oil clearance of camshaft journal.
 1. Clean the camshaft cap and cylinder head camshaft journal.
 2. Place the camshaft on cylinder head. (Without installing the valve lifter)
 3. Place a plastigauge across each camshaft journals.
 4. Gradually tighten the camshaft cap in at least two steps, in alphabetical order shown in the illustration, and then tighten to the specified torque. Do not turn the camshaft.

Tightening torque:

T1 : 9.75 N.m (1.0 kgf-m, 7.2 ft-lb)

T2 : 20 N.m (2.0 kgf-m, 14.8 ft-lb)

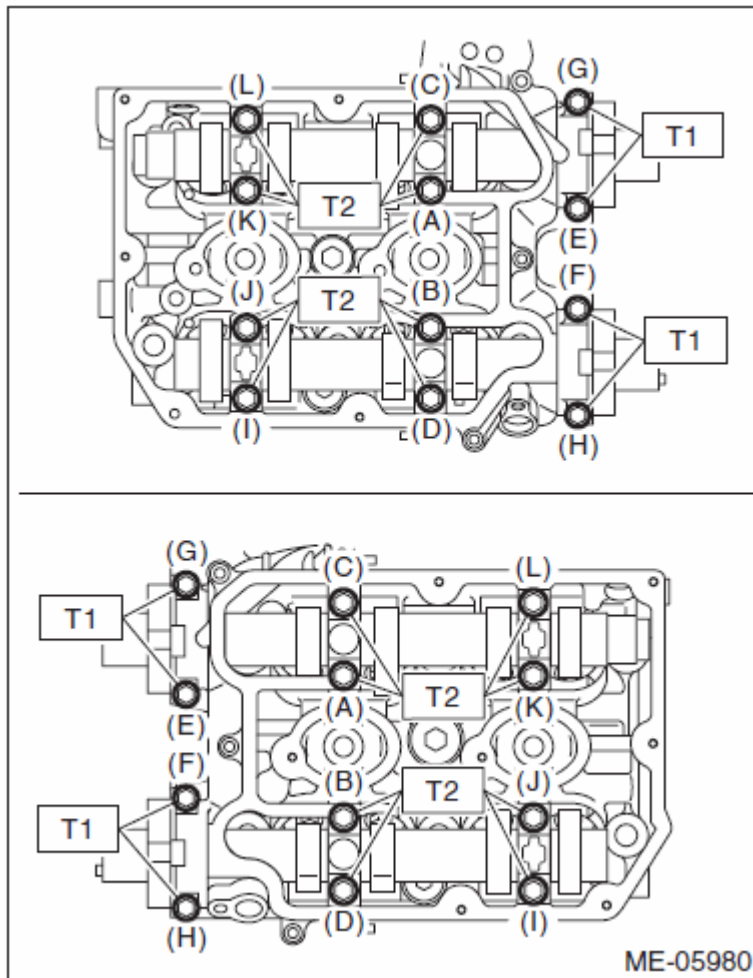


Fig. 171: Camshaft Cap Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Camshaft oil clearance:

Standard

0.037 - 0.072 mm (0.0015 - 0.0028 in)

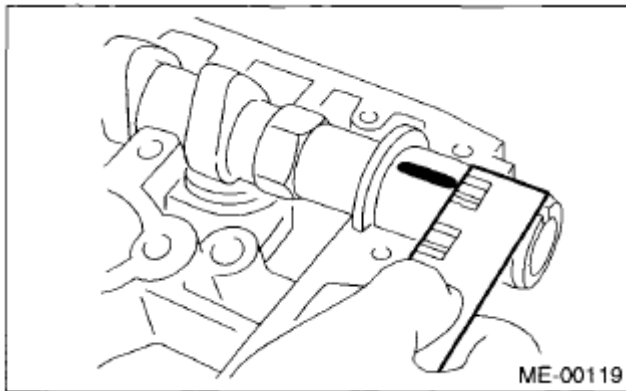


Fig. 172: Measuring Widest Point Of Plastigauge On Each Journal
Courtesy of SUBARU OF AMERICA, INC.

7. Completely remove the plastigauge.
8. Measure the thrust clearance of camshaft with the dial gauge set at end of camshaft. If the thrust clearance is not within the standard or there is offset wear, replace the camshaft caps and cylinder head as a set. If necessary replace the camshaft.

Camshaft thrust clearance:

Standard

0.068 - 0.116 mm (0.0027 - 0.0047 in)

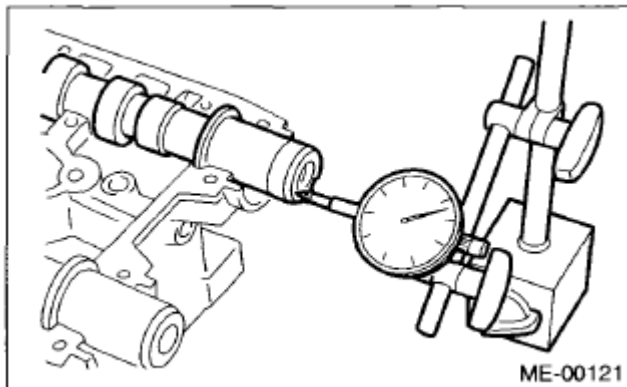


Fig. 173: Measuring Thrust Clearance Of Camshaft Using Dial Gauge Set At End Of Camshaft
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD

REMOVAL

1. Remove the engine from the vehicle. < Ref. to **REMOVAL**, Engine Assembly. >
2. Remove the rear side belt. < Ref. to **REAR SIDE BELT**, REMOVAL, V-belt. >

3. Remove the intake manifold. < Ref. to **REMOVAL** , Intake Manifold. >
4. Remove the crank pulley. < Ref. to **REMOVAL** , Crank Pulley. >
5. Remove the timing belt cover. < Ref. to **REMOVAL** , Timing Belt Cover. >
6. Remove the timing belt. < Ref. to **REMOVAL** , Timing Belt. >
7. Remove the cam sprocket. < Ref. to **REMOVAL** , Cam Sprocket. >
8. Remove the secondary air combination valve. < Ref. to **REMOVAL** , Secondary Air Combination Valve. >
9. Remove the bolts which secure A/C compressor bracket to cylinder head.
10. Remove the oil pipe. < Ref. to **REMOVAL** , Oil Pipe. >
11. Remove the camshaft. < Ref. to **REMOVAL** , Camshaft. >
12. Remove the oil level gauge guide. (LH side only)
13. Remove the cylinder head bolts in alphabetical order shown in the illustration.

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

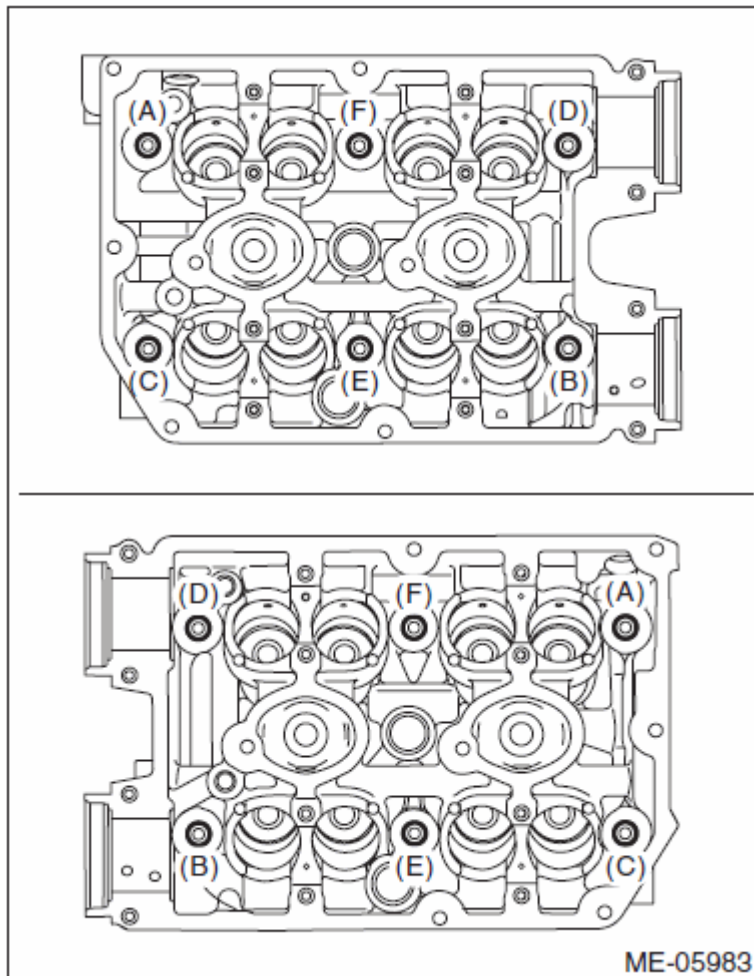
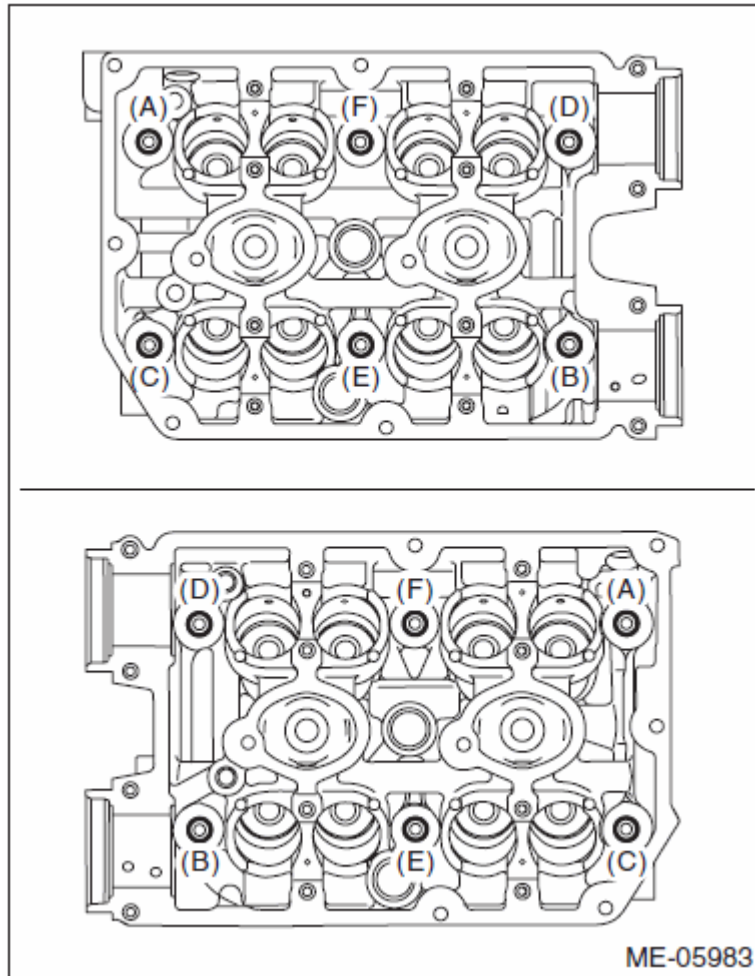


Fig. 174: Cylinder Head Bolts Removal Sequence

Courtesy of SUBARU OF AMERICA, INC.

14. While tapping the cylinder head with a plastic hammer, separate it from cylinder block. Remove the bolts (A) and (D) to remove cylinder head.

**Fig. 175: Cylinder Head Bolts Removal Sequence**

Courtesy of SUBARU OF AMERICA, INC.

15. Remove the cylinder head gasket.

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

16. Similarly, remove the right side cylinder head.

INSTALLATION

1. Install the cylinder head to the cylinder block.

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

NOTE: Use a new cylinder head gasket.

1. Clean the bolt threads and the bolt holes in the cylinder block

CAUTION: To avoid erroneous tightening of the bolts, clean out the bolt holes sufficiently by blowing with compressed air to eliminate engine coolant etc.

2. Apply a sufficient coat of engine oil to the washer and bolt thread.
3. Tighten all bolts to 40 N.m (4.1 kgf-m, 29.5 ft-lb) in alphabetical order.
4. Retighten all bolts to 95 N.m (9.7 kgf-m, 70.1 ft-lb) in alphabetical order.

CAUTION: If the bolt makes stick-slip sound during tightening, repeat the procedure from step (1). In this case, the cylinder head gasket can be reused.

5. Loosen all the bolts by 180° in the reverse order of installing, and loosen them further by 180°.
6. Tighten all bolts to 10 N.m (1.0 kgf-m, 7.4 ft-lb) in alphabetical order.
7. Retighten all bolts to 30 N.m (3.1 kgf-m, 22.1 ft-lb) in alphabetical order.
8. Retighten all bolts to 70 N.m (7.1 kgf-m, 51.6 ft-lb) in alphabetical order.
9. Retighten all bolts by 80 - 90° in alphabetical order.
10. Retighten all bolts by 40 - 45° in alphabetical order.

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

11. Retighten bolts (A) and (B) by 40 - 45°.

CAUTION: Make sure the total "tightening angle" of steps (10) and (11) does not exceed 90°.

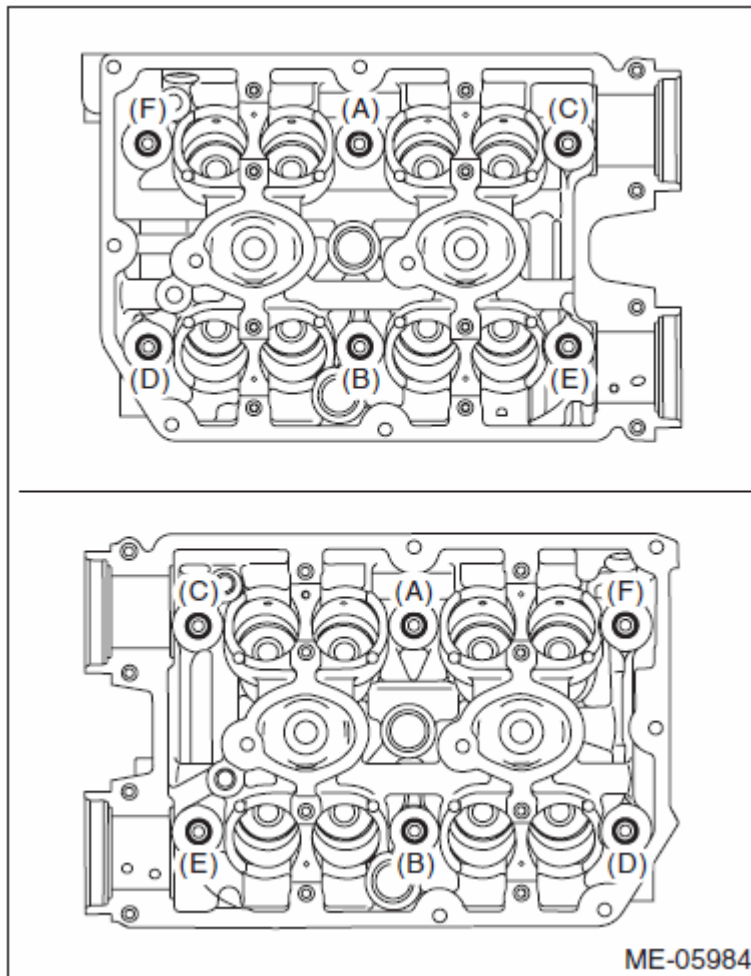


Fig. 176: Cylinder Head Gasket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Similarly, install the right side cylinder head.
3. Install the oil level gauge guide. (LH side only)

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

4. Install the camshaft. < Ref. to **INSTALLATION**, Camshaft. >
5. Install the oil pipe. < Ref. to **INSTALLATION**, Oil Pipe. >
6. Install the A/C compressor bracket on cylinder head.

Tightening torque:

36 N.m (3.7 kgf-m, 26.6 ft-lb)

7. Install the secondary air combination valve. < Ref. to **INSTALLATION**, Secondary Air Combination

Valve. >

8. Install the cam sprocket. < Ref. to **INSTALLATION**, Cam Sprocket. >
9. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt. >
10. Adjust the valve clearance. < Ref. to **ADJUSTMENT**, Valve Clearance. >
11. Install the rocker cover.
 1. Install the rocker cover gasket to the rocker cover, (outer section and ignition coil section)

NOTE: Use a new rocker cover gasket.

2. Apply liquid gasket to the specified point of the cylinder head.

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

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

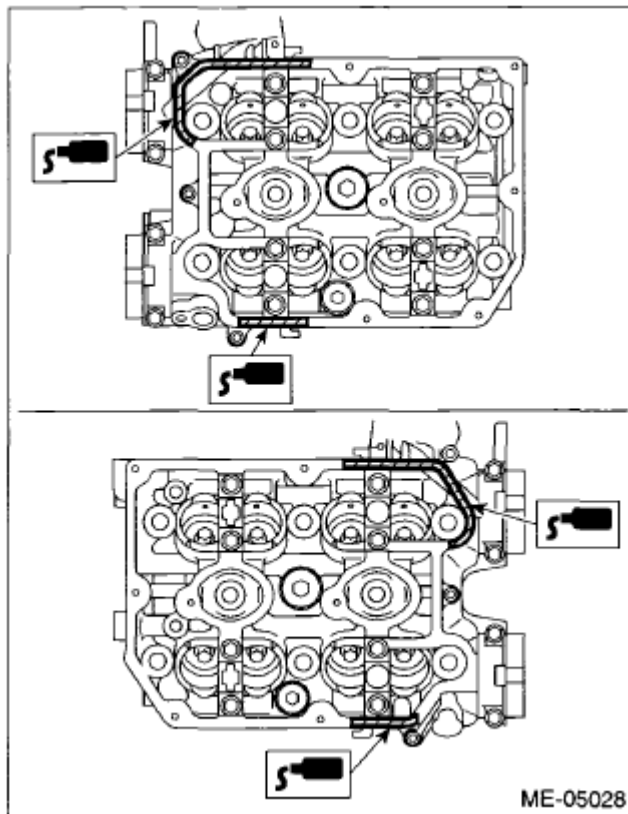


Fig. 177: Cylinder Head Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover onto cylinder heads. Ensure the gasket is properly positioned during installation.

4. Temporarily tighten the rocker cover bolts in alphabetical order shown in the illustration, and then tighten to specified torque in alphabetical order.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

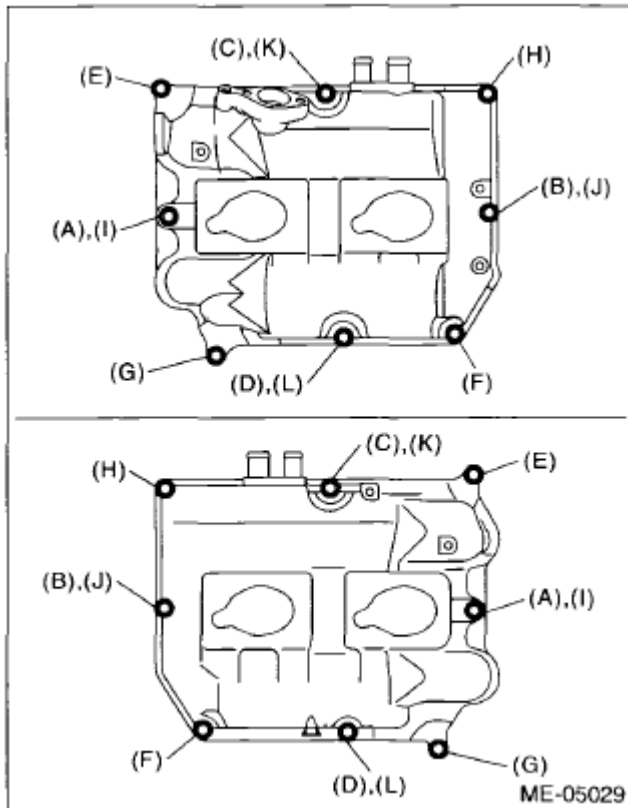


Fig. 178: Rocker Cover Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

12. Connect the PCV hose (A) and PCV hose assembly (B) to the rocker cover.

NOTE: Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the illustration, and lock the clamp.

ST 18353AA000 CLAMP PLIERS

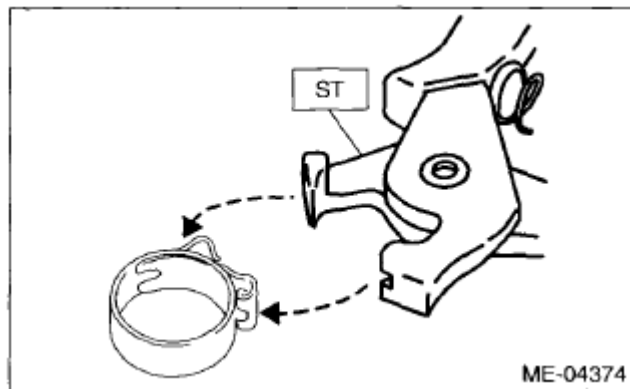


Fig. 179: Pinching Clamp Of PCV Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

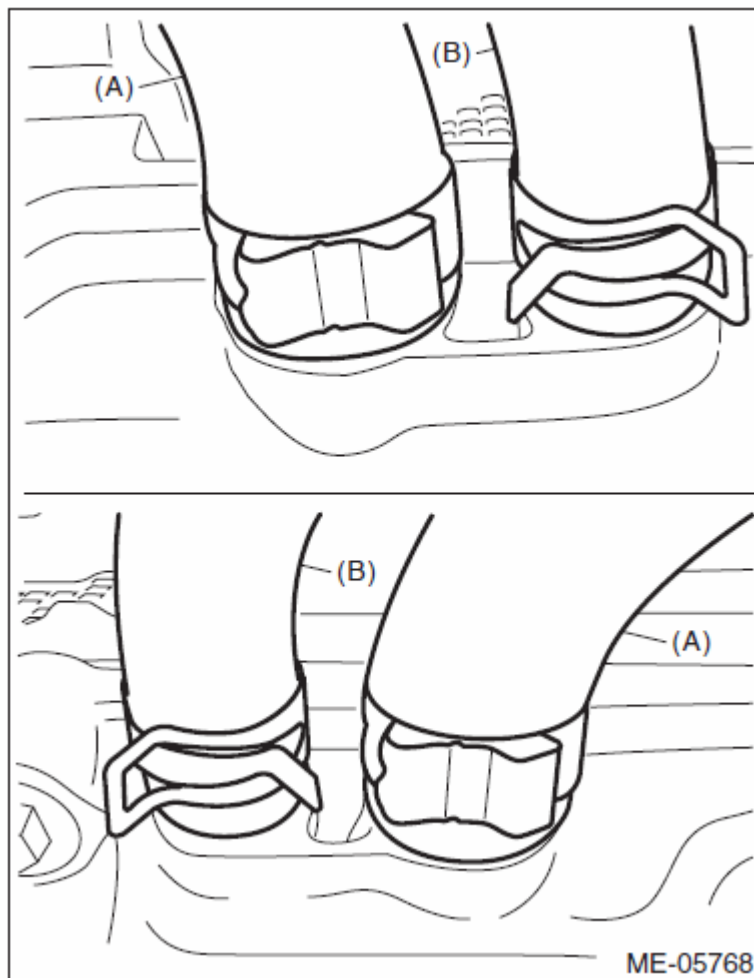


Fig. 180: Identifying PCV Hose And PCV Hose Assembly
Courtesy of SUBARU OF AMERICA, INC.

13. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >

14. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >
15. Install the intake manifold. < Ref. to **INSTALLATION** , Intake Manifold. >
16. Install the rear side belt. < Ref. to **REAR SIDE BELT**, **INSTALLATION**, V-belt. >
17. Install the engine to the vehicle. < Ref. to **INSTALLATION**, Engine Assembly. >

DISASSEMBLY

1. Remove the valve lifter.
2. Place the cylinder head on ST1.

ST1 498267600 CYLINDER HEAD TABLE

3. Using ST2, compress the valve spring and remove the valve spring retainer key. Remove each valve and valve spring.

ST2 499718000 VALVE SPRING REMOVER

NOTE:

- Mark each valve to prevent confusion.
- Pay careful attention not to damage the lips of intake valve oil seals and exhaust valve oil seals.
- Keep all the removed parts in order for re-installing in their original positions.
- For removal and installation procedures of the valve guide, intake valve oil seal and exhaust valve oil seal, refer to "INSPECTION". < Ref. to **VALVE GUIDE**, **INSPECTION**, Cylinder Head. > < Ref. to **INTAKE AND EXHAUST VALVE OIL SEAL**, **INSPECTION**, Cylinder Head. >

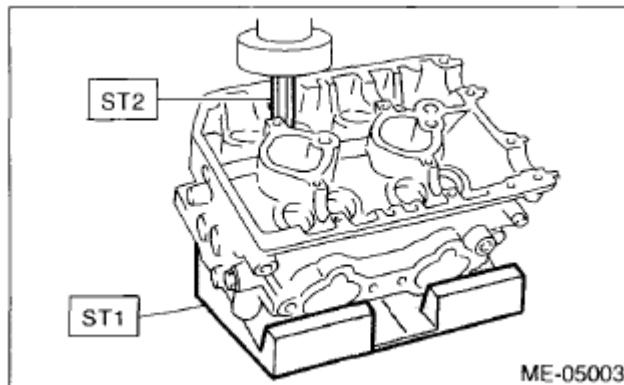
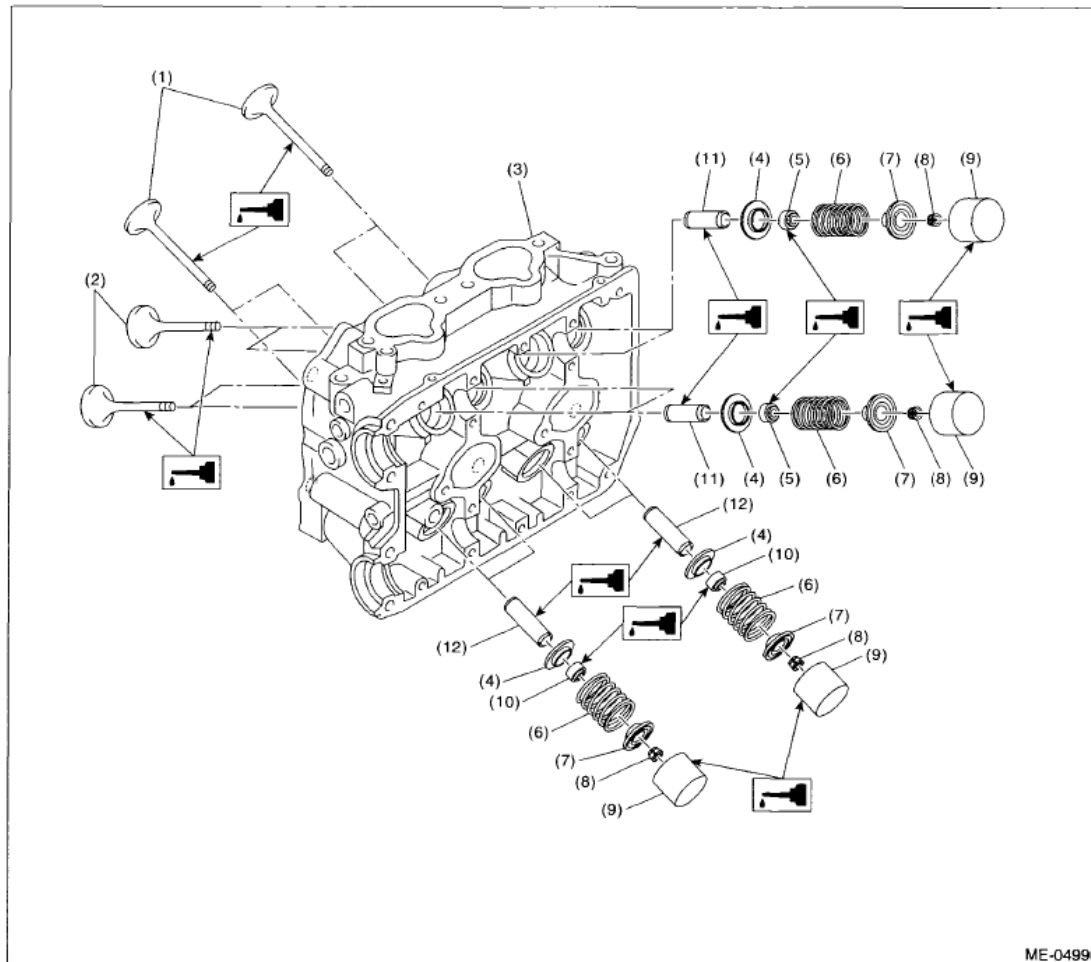


Fig. 181: Removing Valve Spring Retainer Key Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY



- | | | |
|-----------------------|---------------------------|-----------------------------|
| (1) Exhaust valve | (5) Intake valve oil seal | (9) Valve lifter |
| (2) Intake valve | (6) Valve spring | (10) Exhaust valve oil seal |
| (3) Cylinder head | (7) Retainer | (11) Intake valve guide |
| (4) Valve spring seat | (8) Retainer key | (12) Exhaust valve guide |

Fig. 182: Exploded View Of Cylinder Head Assembly
Courtesy of SUBARU OF AMERICA, INC.

1. Install the valve spring and valve.
 1. Coat the valve stem of each valve with engine oil and insert the valve into valve guide.

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

2. Set the cylinder head on ST1.

ST1 498267600 CYLINDER HEAD TABLE

3. Install the valve spring and retainer.

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

4. Set the ST2 on valve spring.

ST2 499718000 VALVE SPRING REMOVER

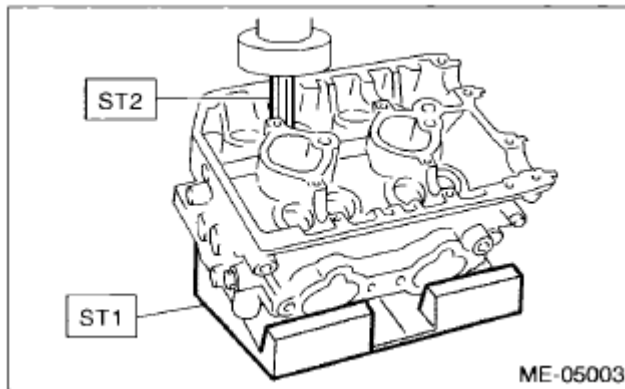


Fig. 183: Installing Valve Spring And Valve Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

CYLINDER HEAD

1. Check for cracks or damage. Use liquid penetrant tester on the important sections to check for fissures. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2. Measure the warping of the cylinder head surface that mates with cylinder block using a straight edge (A) and thickness gauge (B).

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

Warping limit:

0.035 mm (0.0014 in)

Grinding limit:

0.3 mm (0.012 in)

Standard height of cylinder head:

127.5 mm (5.02 in)

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

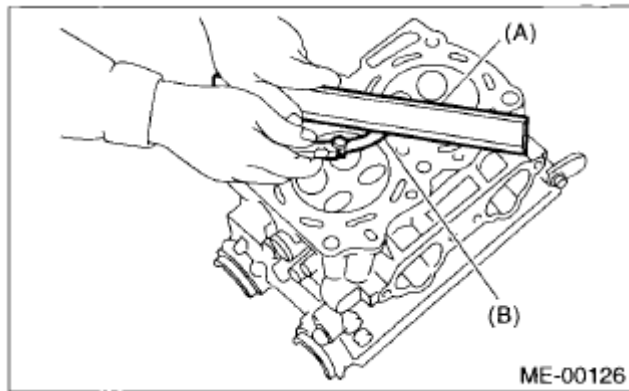


Fig. 184: Measuring Warping Of Cylinder Head Surface Using Straight Edge
Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

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

Contacting width W between valve and valve seat:

Standard

Intake

0.6 - 1.4 mm (0.024 - 0.055 in)

Exhaust

1.2 - 1.8 mm (0.047 - 0.071 in)

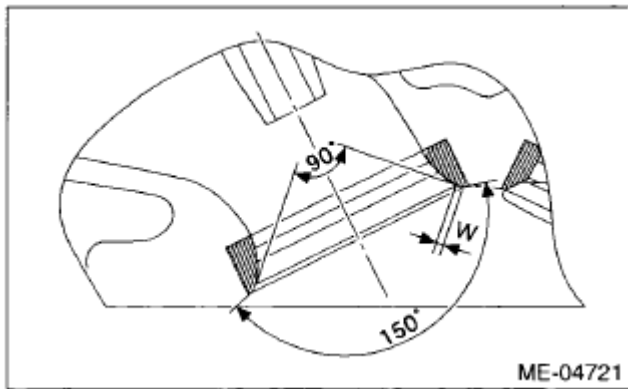


Fig. 185: Contacting Width W Between Valve And Valve Seat
Courtesy of SUBARU OF AMERICA, INC.

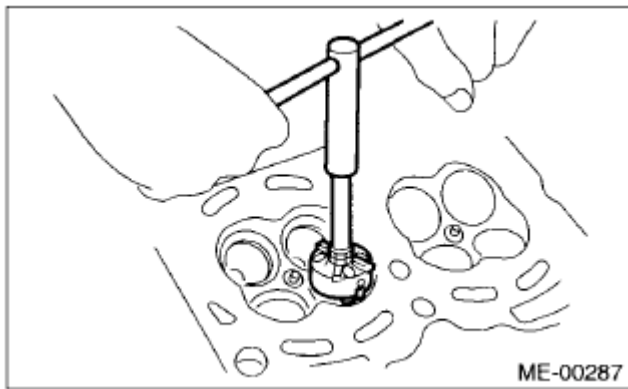


Fig. 186: Correcting Contact Surfaces Using Valve Seat Cutter
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

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

Clearance between the valve guide and valve stem:

Standard Intake

0.030 - 0.057 mm (0.0012 - 0.0022 in)

Exhaust

0.040 - 0.067 mm (0.0016 - 0.0026 in)

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

valve guide replacement.

Valve guide inner diameter:

6.000 - 6.012 mm (0.2362 - 0.2367 in)

Valve stem outer diameters:

Intake

5.955 - 5.970 mm (0.2344 - 0.2350 in)

Exhaust

5.945 - 5.960 mm (0.2341 - 0.2346 in)

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

ST1 498267600 CYLINDER HEAD TABLE

ST2 499767200 VALVE GUIDE REMOVER

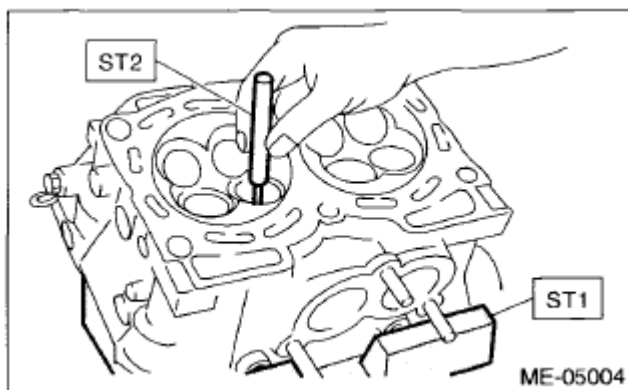


Fig. 187: Inserting ST2 Into Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

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

ST 18251AA020 VALVE GUIDE ADJUSTER

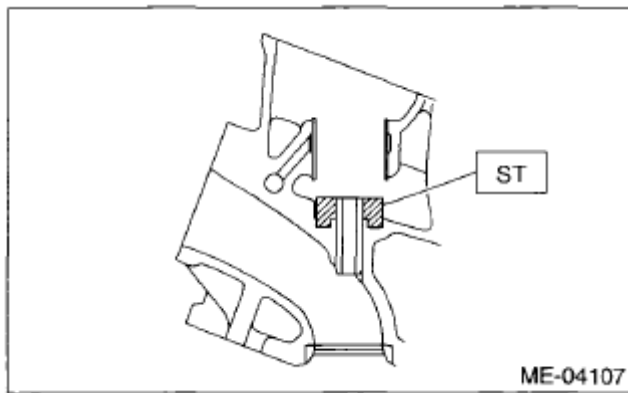


Fig. 188: Positioning Valve Guide Adjuster In Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

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

ST1 499767200 VALVE GUIDE REMOVER

ST2 18251AA020 VALVE GUIDE ADJUSTER

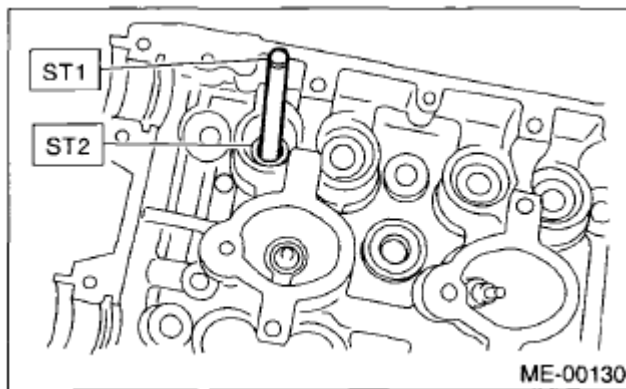


Fig. 189: Inserting Valve Guide Remover Into Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

6. Check the valve guide protrusion amount "L".

Valve guide protrusion amount L:

15.8 - 16.2 mm (0.622 - 0.638 in)

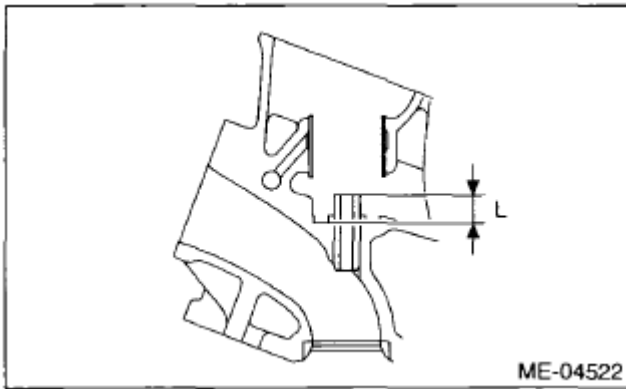


Fig. 190: Checking Valve Guide Protrusion Amount
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

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

ST 499767400 VALVE GUIDE REAMER

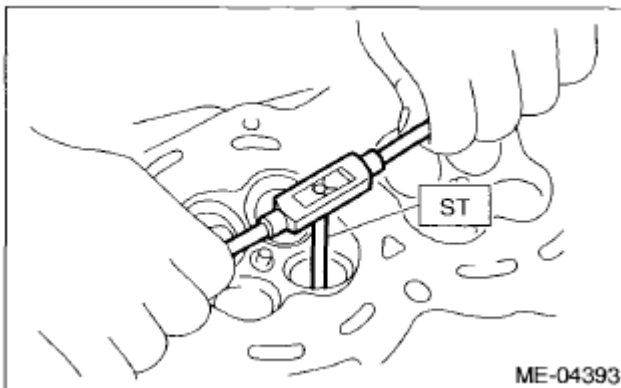


Fig. 191: Reaming Inside Of Valve Guide Using Valve Guide Reamer
Courtesy of SUBARU OF AMERICA, INC.

8. After reaming, clean the valve guide to remove chips.
9. Recheck the contact condition between valve and valve seat after replacing the valve guide.

INTAKE AND EXHAUST VALVE

1. Inspect the flange of valve and valve stem, and replace the valve with a new part if damaged, worn, deformed, or if dimension "H" in the illustration is outside of the specified limit.

Head edge thickness H:

Standard

Intake (A)

1.0 - 1.4 mm (0.039 - 0.055 in)

Exhaust (B)

1.3 - 1.7 mm (0.051 - 0.067 in)

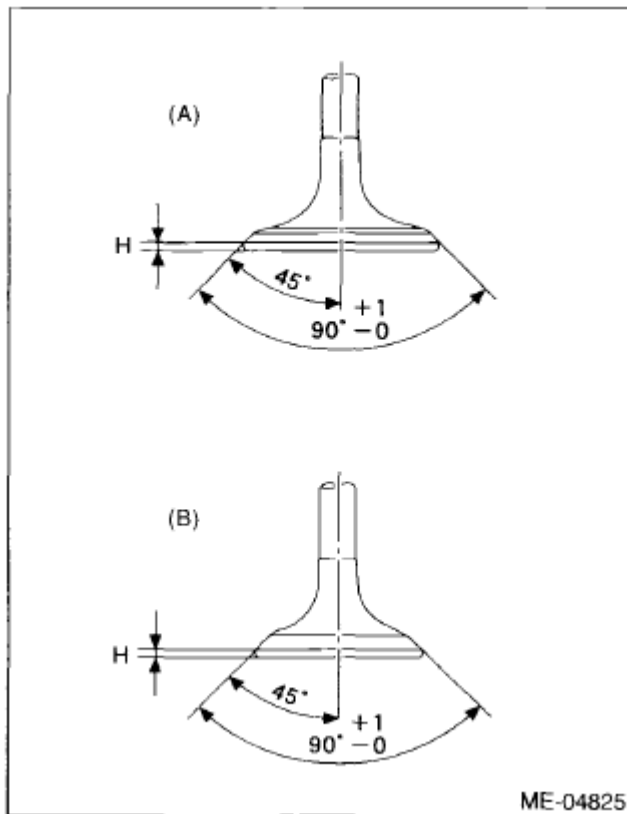


Fig. 192: Intake And Exhaust Valve Dimensions
Courtesy of SUBARU OF AMERICA, INC.

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

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

Valve overall length:

Intake

104.4 mm (4.110 in)

Exhaust

104.65 mm (4.1201 in)

VALVE SPRING

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

VALVE SPRING SPECIFICATIONS CHART

Free length	mm (in)	47.32 (1.863)
Tension/spring height N (kgf, lb)/mm (in)	Set	205 - 235 (20.9 - 24.0, 46.1 - 52.8)/36.0 (1.417)
	Lift	426 - 490 (43.4 - 50.0, 95.8 - 110)/26.50 (1.041)
Squareness		2.5°, 2.1 mm (0.083 in) or less

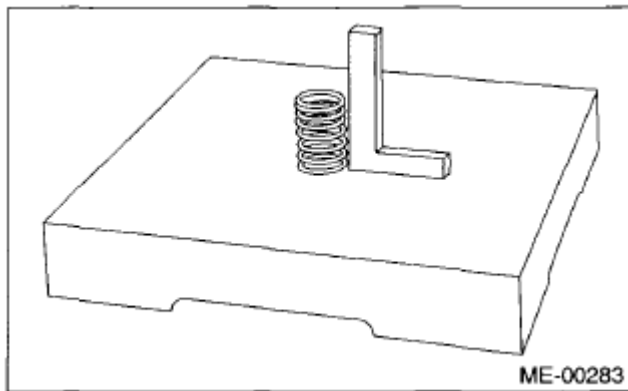


Fig. 193: Measuring Squareness Of Valve Spring Using Right Angle Gauge
 Courtesy of SUBARU OF AMERICA, INC.

INTAKE AND EXHAUST VALVE OIL SEAL

1. For the following, replace the oil seal with a new part. See below for replacement procedures.
 - When the lip is damaged.
 - When the spring is out of the specified position.
 - When readjusting the surfaces of valve and valve seat.
 - When replacing the valve guide.

2. Place the cylinder head on ST1, and use ST2 to press-fit the oil seal.

ST1 498267600 CYLINDER HEAD TABLE

ST2 498857100 VALVE OIL SEAL GUIDE

NOTE:

- Apply engine oil to oil seal before press-fitting.
- When press-fitting the oil seal, do not use a hammer to strike in.
- The intake valve oil seals and exhaust valve oil seals are distinguished by their colors.

Color of rubber part:

Intake [Gray]

Exhaust [Green]

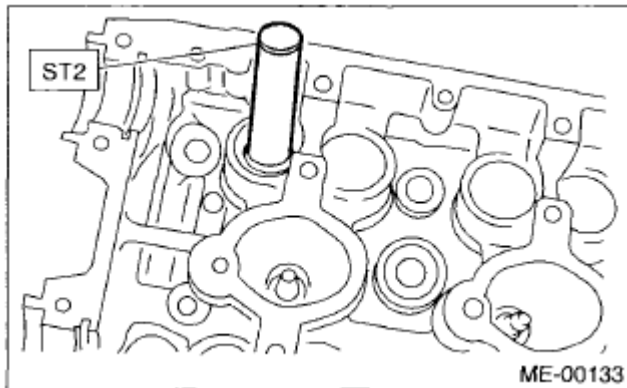


Fig. 194: Press-Fitting Oil Seal Using Cylinder Head Table And Valve Oil Seal Guide
Courtesy of SUBARU OF AMERICA, INC.

VALVE LIFTER

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

Outer diameter of valve lifter:

34.959 - 34.975 mm (1.3763 - 1.3770 in)

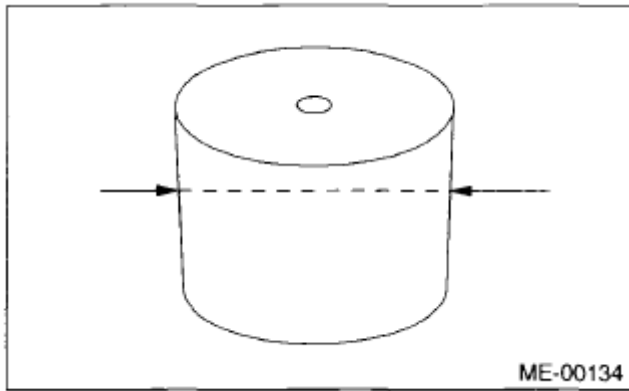


Fig. 195: Checking Valve Lifter

Courtesy of SUBARU OF AMERICA, INC.

3. Measure the inner diameter of valve lifter mating surface on cylinder head.

Inner diameter of valve lifter mating surface:

34.994 - 35.016 mm (1.3777 - 1.3786 in)

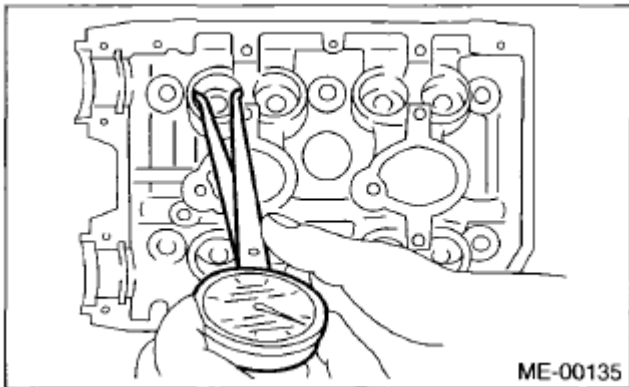


Fig. 196: Measuring Inner Diameter Of Valve Lifter Mating Surface On Cylinder Head

Courtesy of SUBARU OF AMERICA, INC.

4. Check the clearance between valve lifter and valve lifter mating surface. The clearance can be determined from the measured value of the valve lifter outer diameter and valve lifter mating surface inner diameter. If it is not within the standard or there is uneven wear in the inner surface, replace the cylinder head.

Clearance between valve lifter and valve lifter mating surface:

Standard

0.019 - 0.057 mm (0.0007 - 0.0022 in)

CYLINDER BLOCK

REMOVAL

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

1. Remove the engine from the vehicle. < Ref. to **REMOVAL**, Engine Assembly. >
2. Remove the rear side belt. < Ref. to **REAR SIDE BELT**, REMOVAL, V-belt. >
3. Remove the intake manifold. < Ref. to **REMOVAL**, Intake Manifold. >
4. Remove the crank pulley. < Ref. to **REMOVAL**, Crank Pulley. >
5. Remove the timing belt cover. < Ref. to **REMOVAL**, Timing Belt Cover. >
6. Remove the timing belt. < Ref. to **REMOVAL**, Timing Belt. >
7. Remove the cam sprocket. < Ref. to **REMOVAL**, Cam Sprocket. >
8. Remove the crank sprocket. < Ref. to **REMOVAL**, Crank Sprocket. >
9. Remove the generator and A/C compressor with their brackets.
10. Remove the camshaft. < Ref. to **REMOVAL**, Camshaft. >
11. Remove the cylinder head. < Ref. to **REMOVAL**, Cylinder Head. >
12. Remove the drive plate. < Ref. to **REMOVAL**, Drive Plate. >
13. Remove the oil separator cover.
14. Remove the water by-pass pipe for heater.
15. Remove the oil filter. < Ref. to **REMOVAL**, Engine Oil Filter. >
16. Remove the water pump. < Ref. to **REMOVAL**, Water Pump. >
17. Remove the bolts which secure oil pump to cylinder block.

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

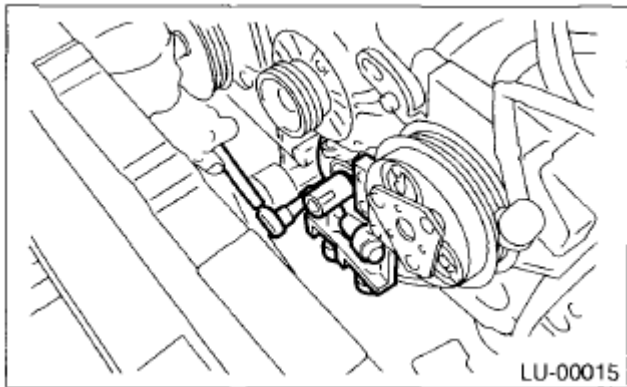


Fig. 197: Checking Oil Pump

Courtesy of SUBARU OF AMERICA, INC.

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

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

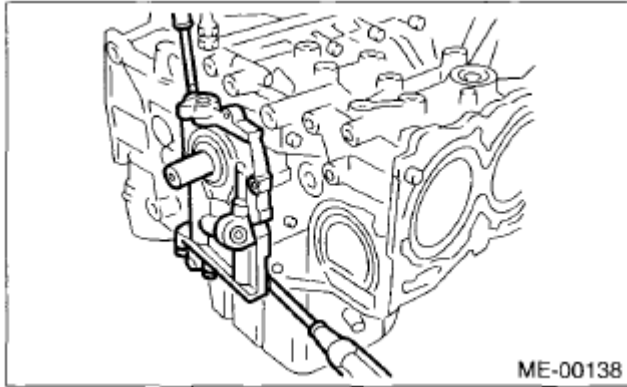


Fig. 198: Removing Oil Pump From Cylinder Block Using Flat Tip Screwdriver
Courtesy of SUBARU OF AMERICA, INC.

19. Remove the front oil seal from the oil pump.
20. Remove the oil pan.
 1. Set the part so that the cylinder block LH is on the upper side.
 2. Remove the bolts which secure oil pan to cylinder block.
 3. Insert an oil pan cutter blade between cylinder block-to-oil pan clearance and remove the oil pan.

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

21. Remove the oil strainer.
22. Remove the baffle plate.
23. Remove the water tank pipe assembly from the cylinder block RH.

NOTE: Pinch the clamp of the water tank pipe assembly by fitting the cut out in the ST with the protrusion on the clamp as shown in the illustration, and unlock the clamp.

ST 18353AA000 CLAMP PLIERS

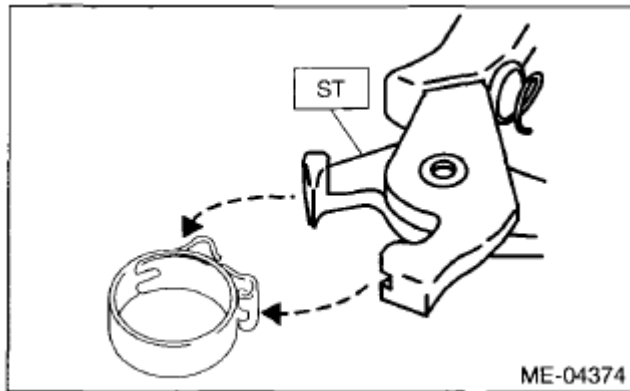
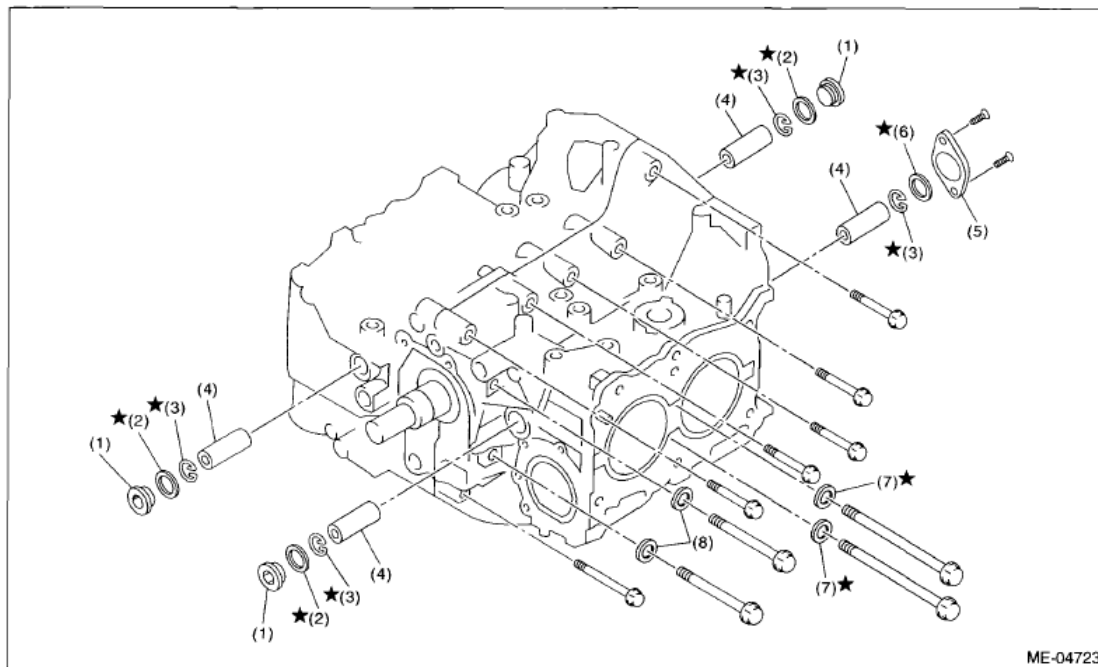


Fig. 199: Pinching Clamp Of Water Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 200: Service Hole Plug, Piston Pin, Seal Washer, Gasket, Service Hole Cover, Washer And Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

24. Remove the service hole plugs using a hexagon wrench [14 mm].

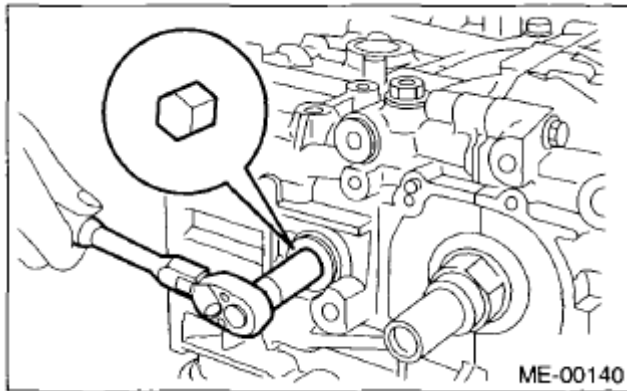


Fig. 201: Removing Service Hole Plugs Using Hexagon Wrench
Courtesy of SUBARU OF AMERICA, INC.

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

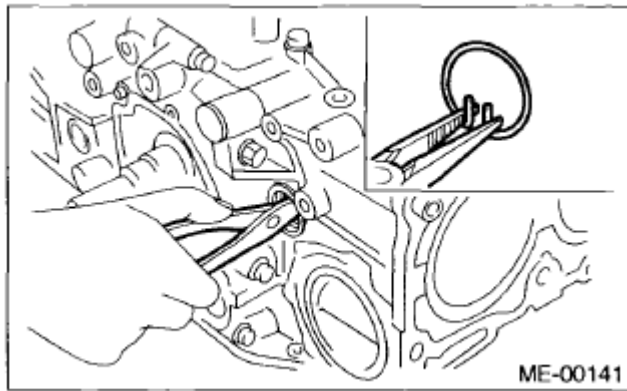


Fig. 202: Removing Piston Snap Ring Through Service Hole
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499097700 PISTON PIN REMOVER ASSY

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

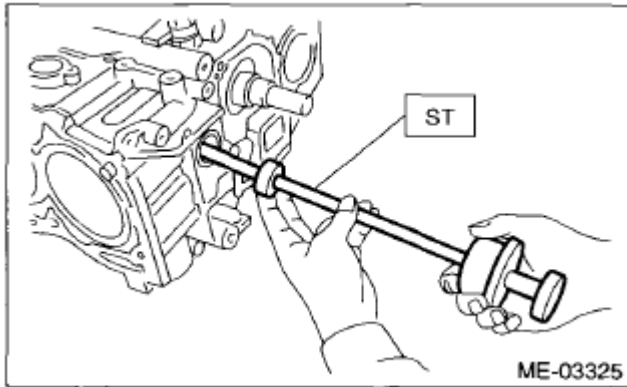


Fig. 203: Drawing Out Piston Pin From #1 And #2 Pistons Using ST
Courtesy of SUBARU OF AMERICA, INC.

28. Similarly draw out the piston pins from #3 and #4 pistons.
29. Remove the cylinder block connecting bolt on the RH side.
30. Loosen the cylinder block connecting bolt on the LH side by 2 to 3 turns.
31. Set the part so that the cylinder block LH is on the upper side, and remove the cylinder block connecting bolt.
32. Separate the cylinder block LH and RH.

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

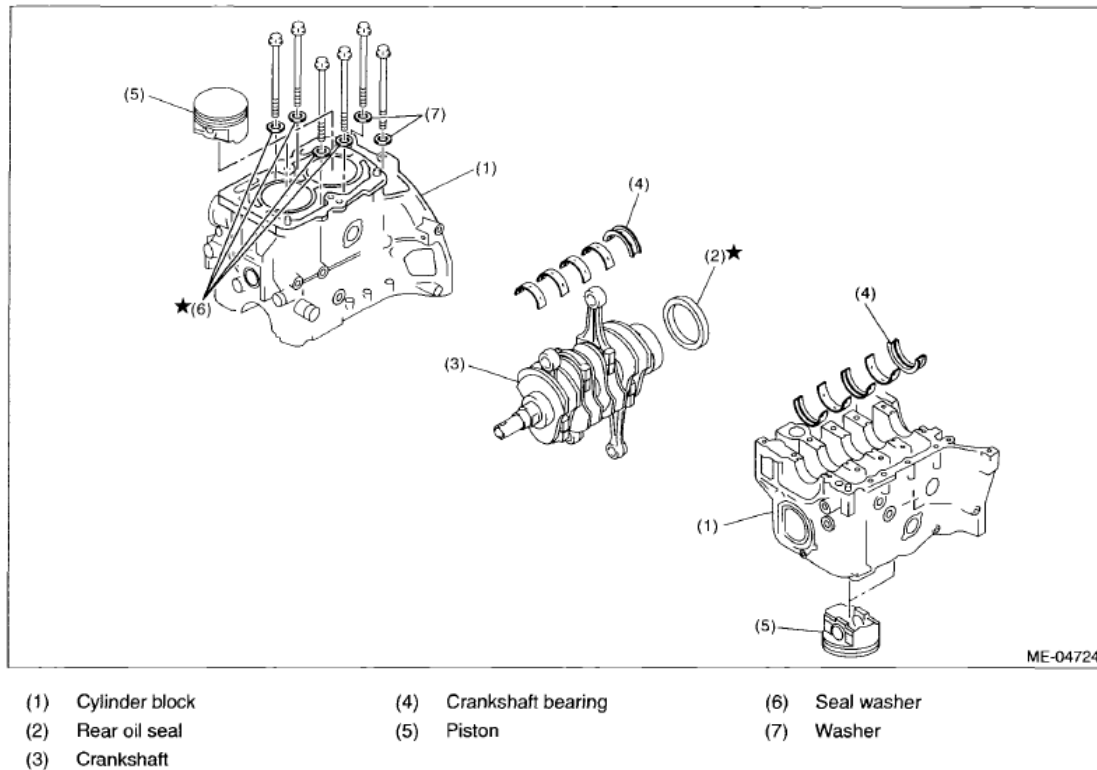


Fig. 204: Identifying Cylinder Block, Crankshaft Bearing, Seal Washer, Rear Oil Seal, Piston And Crankshaft

Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

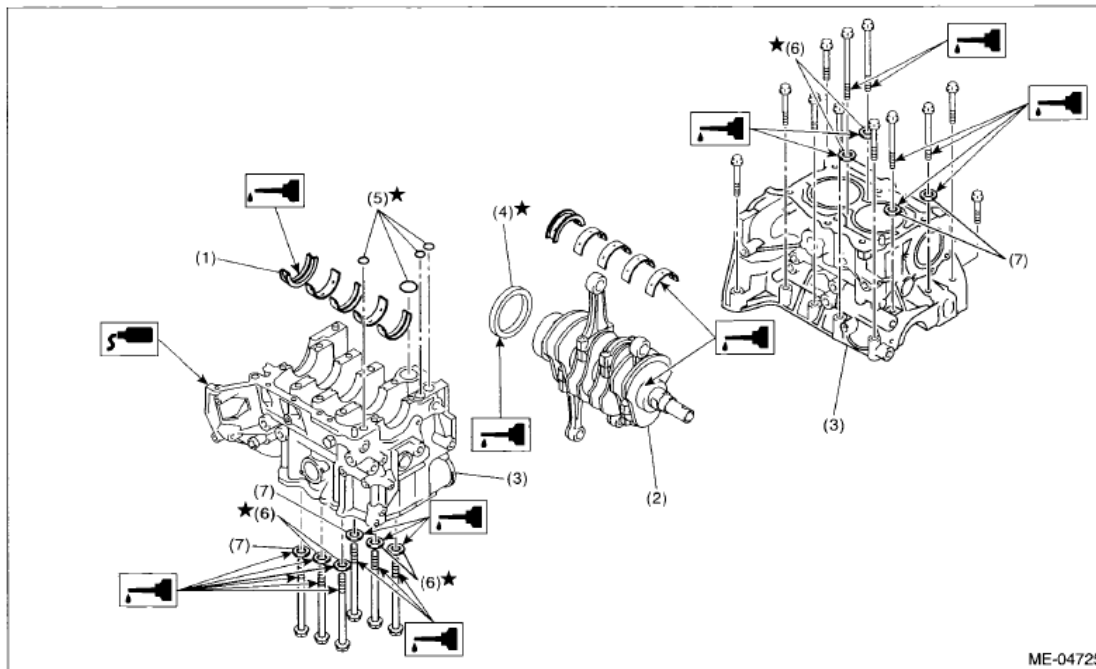
- Press the crankshaft bearing at the end opposite to locking lip to remove.
- Be careful not to confuse the crankshaft bearing combination.

36. Remove each piston from the cylinder block using a wooden bar or hammer handle.

NOTE:

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

INSTALLATION



- | | | |
|------------------------|-------------------|-----------------|
| (1) Crankshaft bearing | (4) Rear oil seal | (6) Seal washer |
| (2) Crankshaft | (5) O-ring | (7) Washer |
| (3) Cylinder block | | |

Fig. 205: Identifying Cylinder Block, Crankshaft Bearing, Seal Washer, Rear Oil Seal, O -Ring, And Crankshaft

Courtesy of SUBARU OF AMERICA, INC.

1. Remove oil on the mating surface of cylinder block before installation. Apply a coat of engine oil to the bearing and crankshaft journal.
2. Position the crankshaft and O-ring on cylinder block RH.

NOTE: Use new O-rings.

3. Apply liquid gasket to the mating surfaces of cylinder block RH, and position cylinder block LH.

NOTE:

- Install within 5 min. after applying liquid gasket.
- Do not allow liquid gasket to jut into O-ring grooves, oil passages, bearing grooves, etc.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

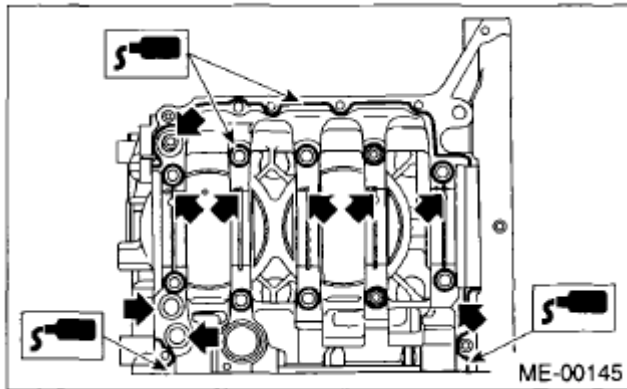


Fig. 206: Cylinder Block Mating Surfaces Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new seal washer.

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

Tightening torque:

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

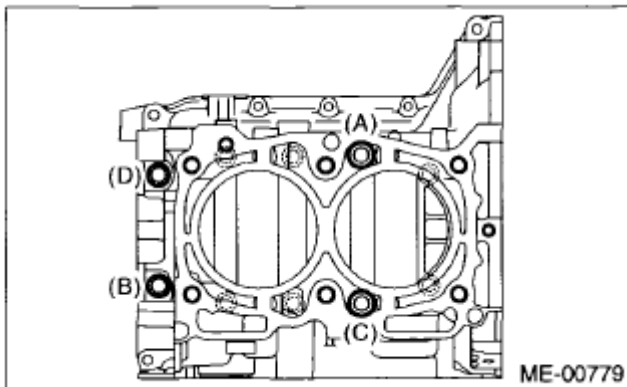


Fig. 207: Cylinder Block LH Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

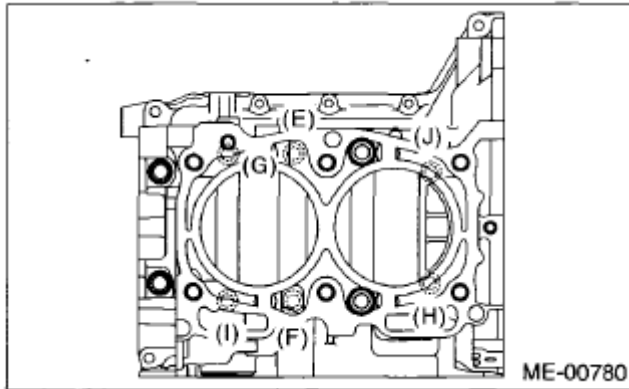


Fig. 208: Cylinder Block RH Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten the LH side cylinder block connecting bolts (A - D) further in alphabetical order.

Tightening torque:

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

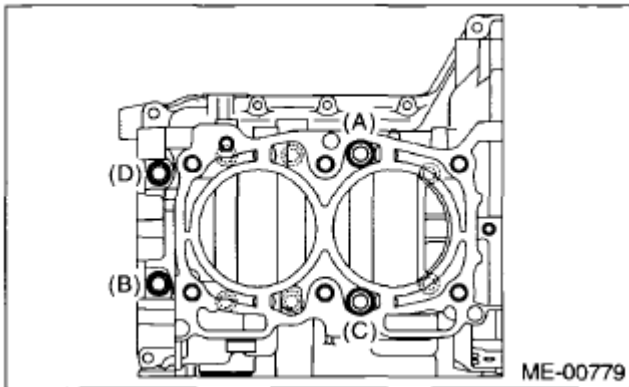


Fig. 209: Cylinder Block LH Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

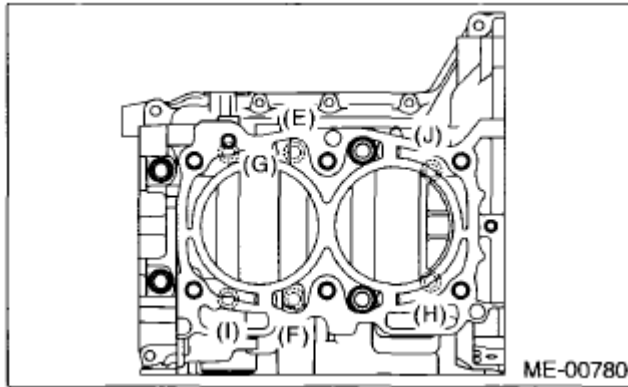


Fig. 210: Cylinder Block RH Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

9. Tighten the LH side cylinder block connecting bolts (A - D) further in alphabetical order.
 - (A), (C): Angle tightening

Tightening angle:

90°

- (B), (D): Torque tightening

Tightening torque:

40 N.m (4.1 kgf-m, 29.5 ft-lb)

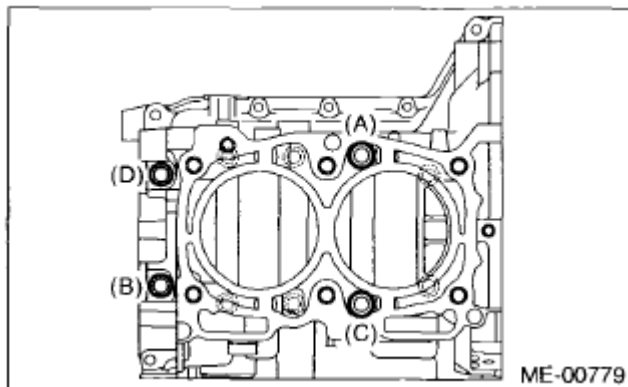


Fig. 211: Cylinder Block LH Connecting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening angle:

90°

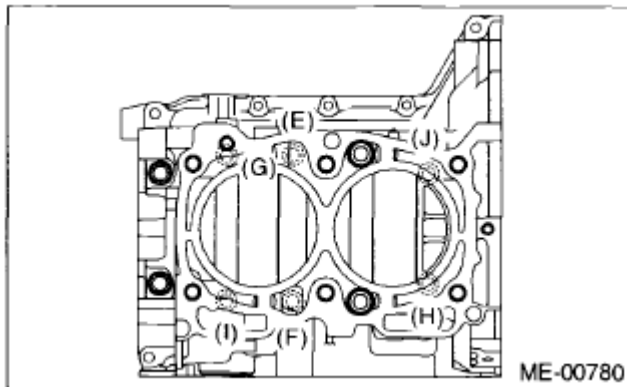


Fig. 212: Cylinder Block RH Connecting Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

(A) - (G): 25 N.m (2.5 kgf-m, 18.4 ft-lb)

(H): 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

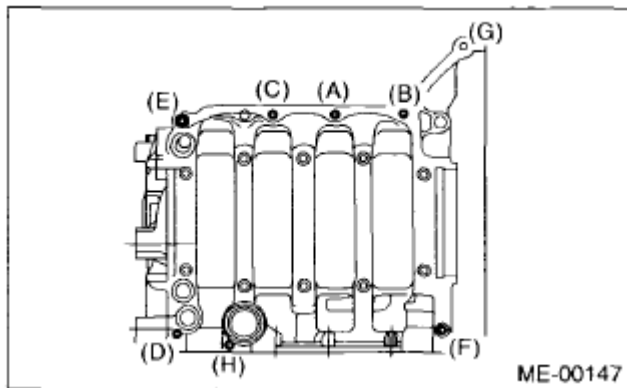


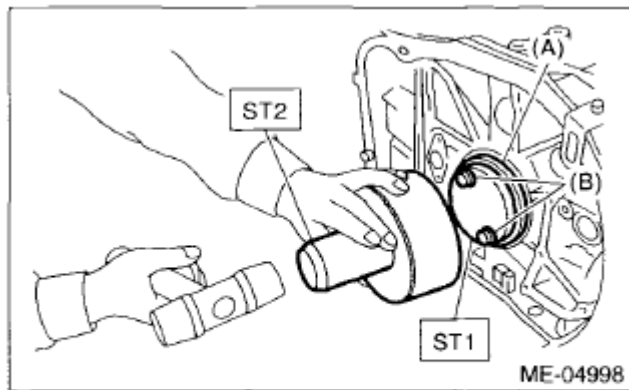
Fig. 213: Cylinder Block Connecting Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new rear oil seal.

ST1 499597100 CRANKSHAFT OIL SEAL GUIDE

ST2 499587200 CRANKSHAFT OIL SEAL INSTALLER



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

Fig. 214: Installing Rear Oil Seal Using Crankshaft Oil Seal Guide And Crankshaft Oil Seal Installer

Courtesy of SUBARU OF AMERICA, INC.

13. Position the top ring gap at (A) or (B) in the illustration.
14. Position the second ring gap at 180° on the reverse side the top ring gap.

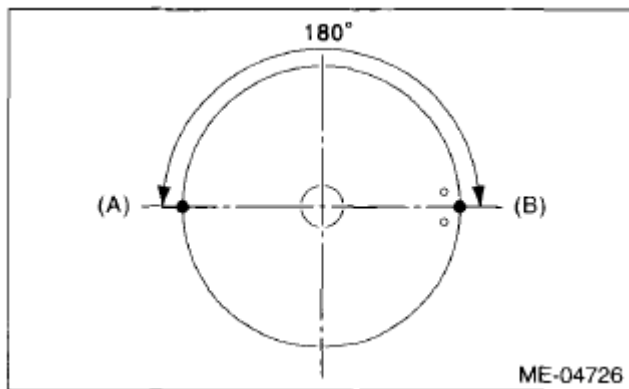


Fig. 215: Second Ring Gap Dimensions

Courtesy of SUBARU OF AMERICA, INC.

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

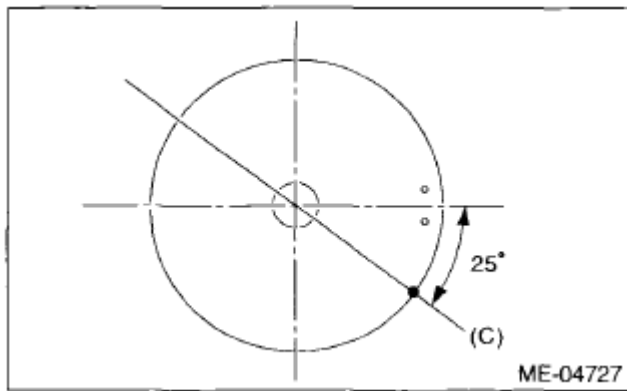


Fig. 216: Upper Rail Gap Dimensions
Courtesy of SUBARU OF AMERICA, INC.

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

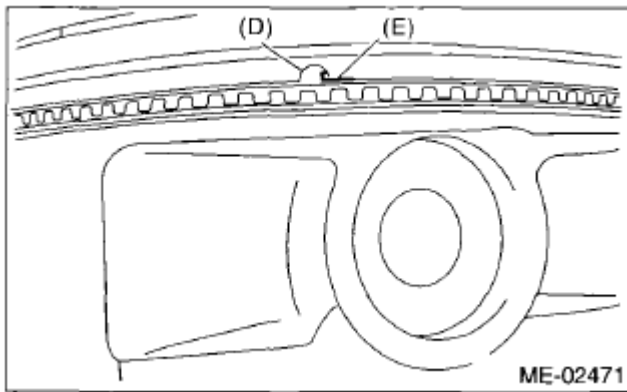


Fig. 217: Upper Rail Spin Stopper And Side Hole
Courtesy of SUBARU OF AMERICA, INC.

17. Position the expander gap at (F) in the illustration on the 180° opposite direction of (C).

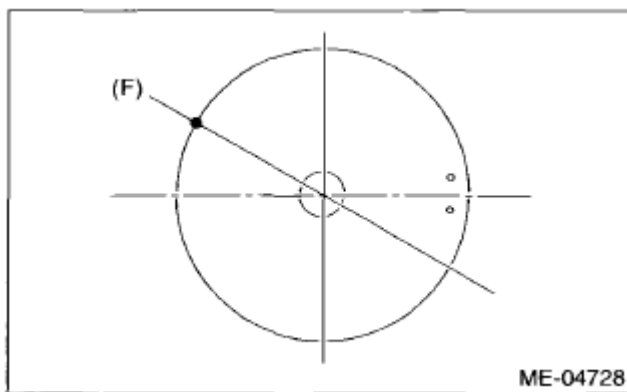


Fig. 218: Expander Gap
Courtesy of SUBARU OF AMERICA, INC.

18. Set the lower rail gap at position (G), located 120° clockwise from (C) in the illustration.

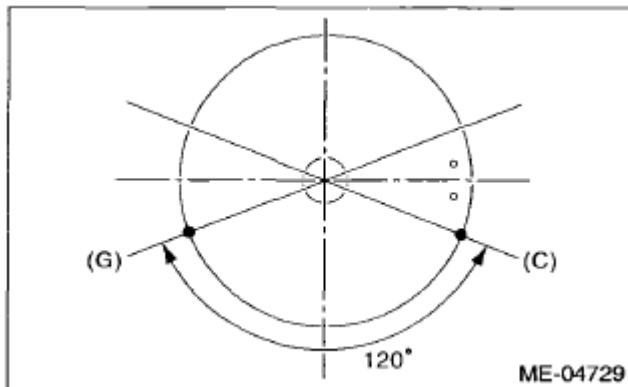


Fig. 219: Lower Rail Gap Dimensions
Courtesy of SUBARU OF AMERICA, INC.

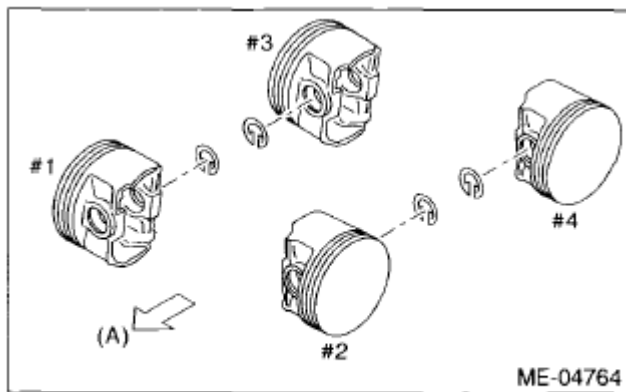
NOTE:

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

19. Install the snap ring.

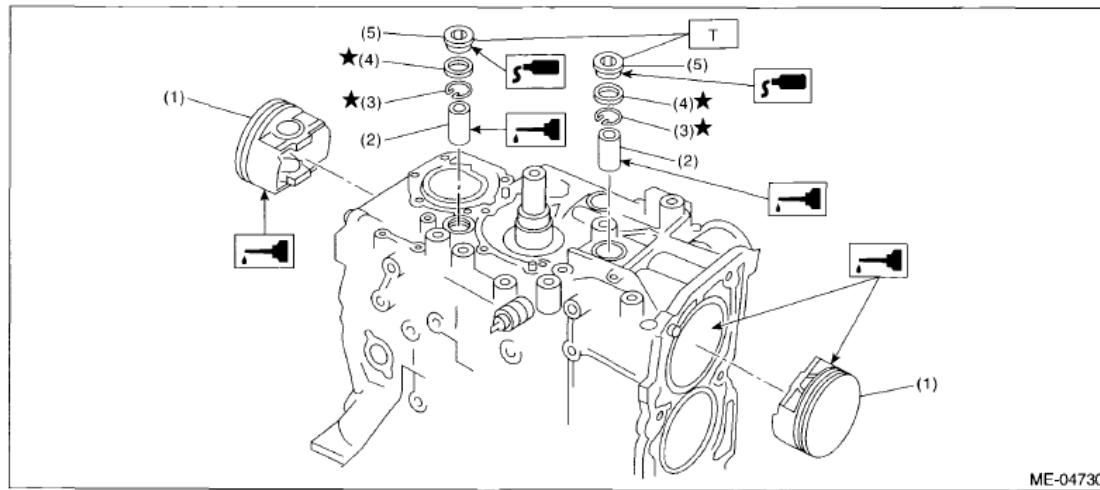
Before positioning the piston on the cylinder block, attach the snap ring in the service hole of the cylinder block, and the piston hole on the opposite side.

NOTE: Use new snap rings.



(A) Front side

Fig. 220: Cylinder Block Snap Ring Installation Position
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 221: Cylinder Block Oil Applying Points
Courtesy of SUBARU OF AMERICA, INC.

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

T: 70 (7.1, 51.6)

20. Install the piston.

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

ST1 499987500 CRANKSHAFT SOCKET

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

ST2 498747300 PISTON GUIDE

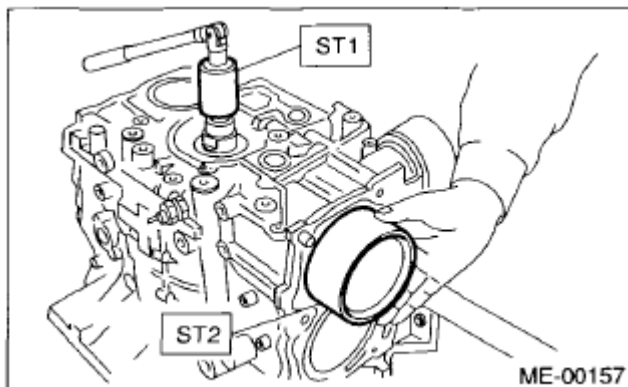
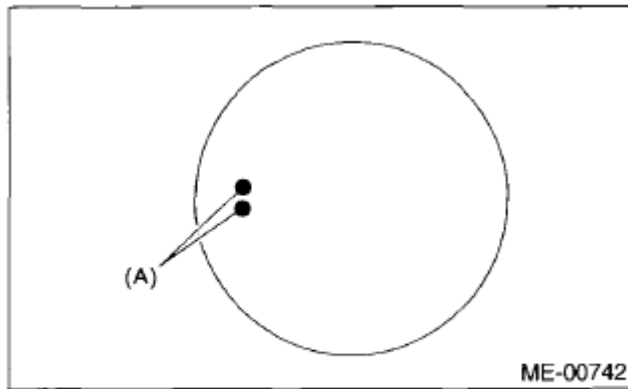


Fig. 222: Inserting Pistons In Cylinders Using ST2
Courtesy of SUBARU OF AMERICA, INC.

NOTE: Face the piston front mark towards the front of the engine.



(A) Front mark

Fig. 223: Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

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

ST3 499017100 PISTON PIN GUIDE

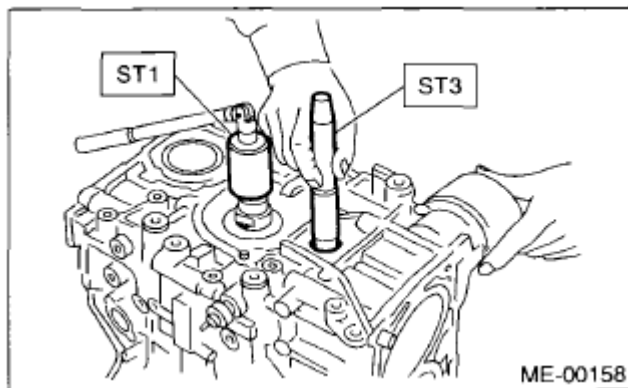


Fig. 224: Inserting Piston Pin Guide Into Service Hole
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new snap rings.

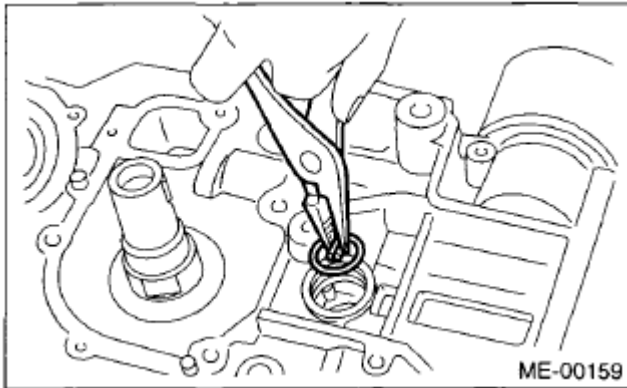


Fig. 225: Installing Snap Ring
Courtesy of SUBARU OF AMERICA, INC.

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

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

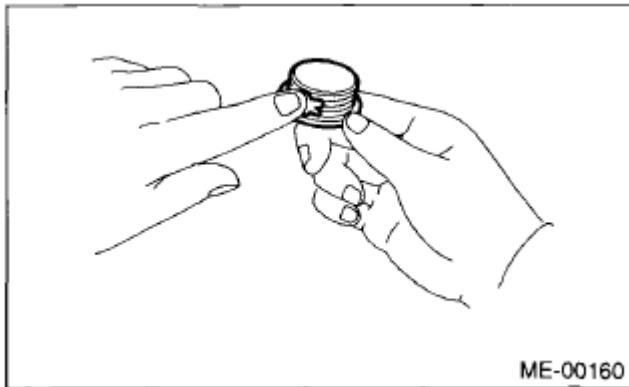


Fig. 226: Applying Liquid Gasket To Threaded Portion Of Service Hole Plug
Courtesy of SUBARU OF AMERICA, INC.

6. Install the service hole plug and gasket.

NOTE: Use a new gasket.

Tightening torque:

70 N.m (7.1 kgf-m, 51.6 ft-lb)

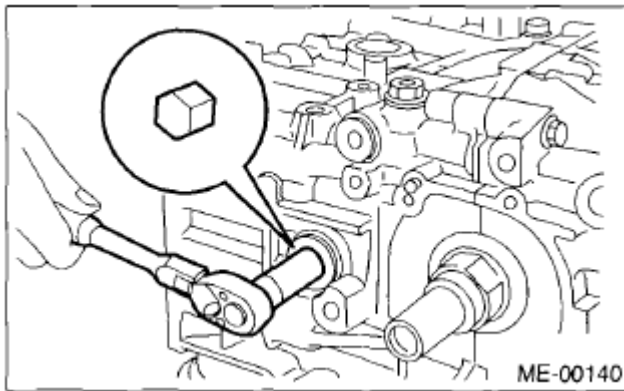
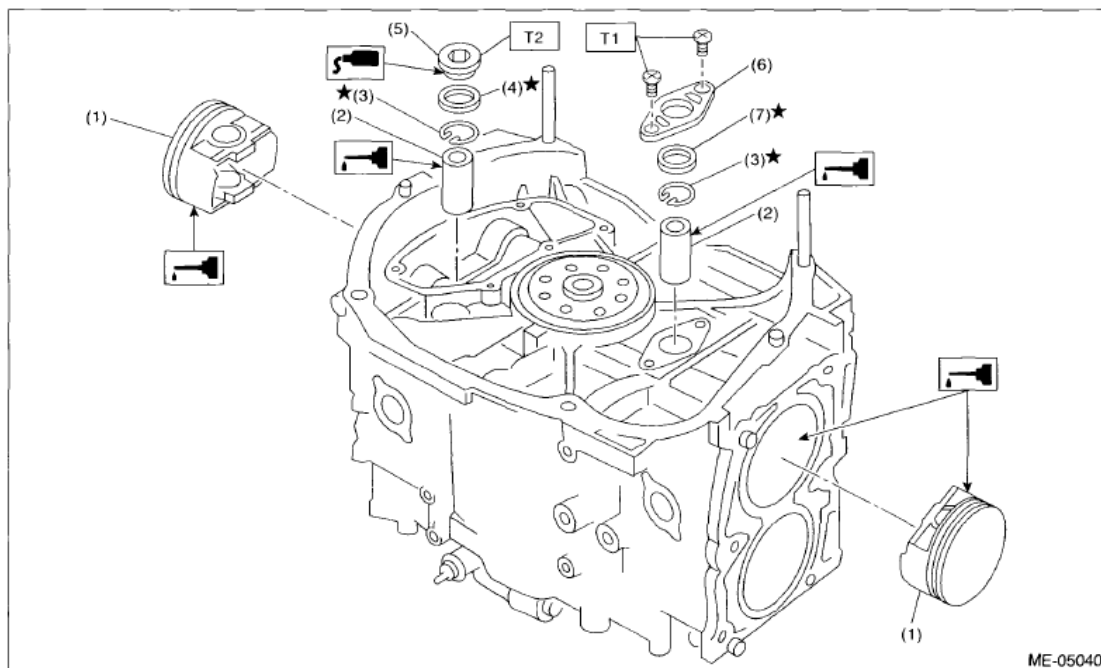


Fig. 227: Installing Service Hole Plug And Gasket
Courtesy of SUBARU OF AMERICA, INC.



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

Fig. 228: Cylinder Head Oil Applying Points
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7, 4.7)

T2: 70 (7.1, 51.6)

7. Set the parts so that the #3 and #4 cylinders are on the upper side. Following the same procedures

as used for #1 and #2 cylinders, install the pistons and piston pins.

8. Install the service hole cover.

NOTE: Use new O-rings.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

22. Install the water tank pipe assembly onto the cylinder block RH.

NOTE: Use a new clamp for the water tank pipe assembly clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the illustration, and lock the clamp.

ST 18353AA000 CLAMP PLIERS

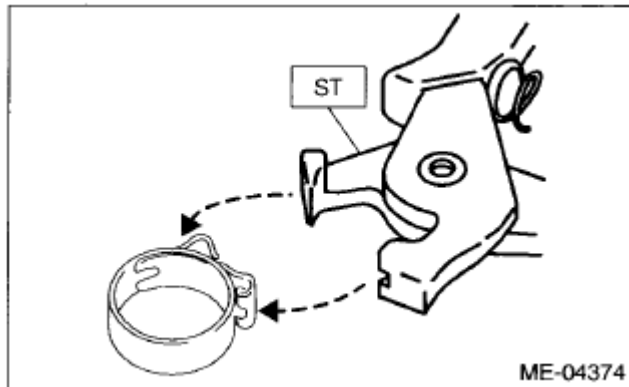


Fig. 229: Pinching Clamp Of PCV Hose Using Special Tool
Courtesy of SUBARU OF AMERICA, INC.

23. Install the baffle plate.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

24. Install the oil strainer.

NOTE: Use new O-rings.

Tightening torque:

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

25. Tighten the oil strainer stay together with the baffle plate.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

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

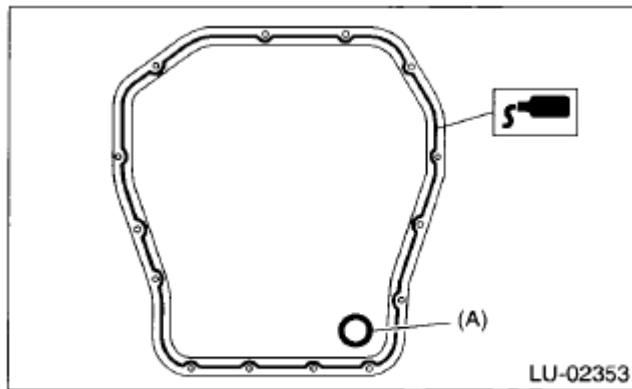
NOTE: Install within 5 min. after applying liquid gasket.

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

Tightening torque:

5 N.m (0.5 kgf-m, 3.7 ft-lb)



(A) Gasket

Fig. 230: Oil Pan Mating Surfaces Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

27. Apply liquid gasket to the mating surface of oil separator cover and the threaded portion of bolt (A) shown in the illustration (when reusing the bolt), and then install the oil separator cover.

NOTE:

- Install within 5 min. after applying liquid gasket.
- Use new oil separator cover.

Liquid gasket:

Mating surface

THREE BOND 1217G (Part No. K0677Y0100) or equivalent

Bolt thread (A) (when reusing the bolt)

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

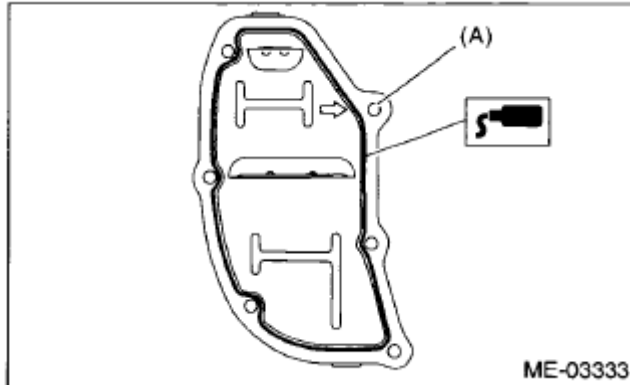


Fig. 231: Oil Separator Cover Mating Surface Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

28. Install the drive plate. < Ref. to **INSTALLATION** , Drive Plate. >
29. Install the oil pump.
 1. Using the ST, install the front oil seal.

ST 499587100 OIL SEAL INSTALLER

NOTE: Use a new front oil seal.

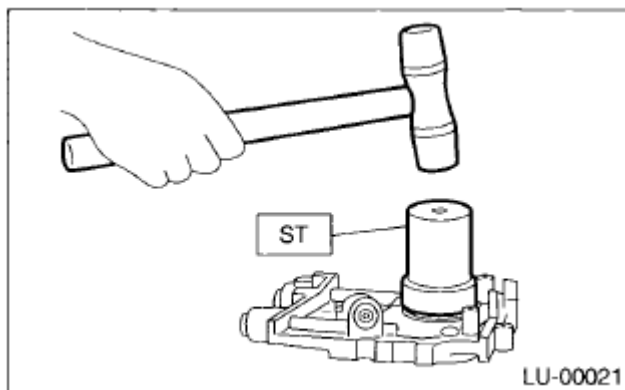


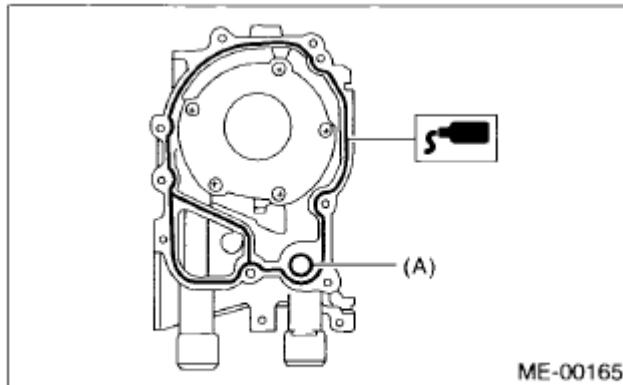
Fig. 232: Installing Front Oil Seal Using Oil Seal Installer
Courtesy of SUBARU OF AMERICA, INC.

2. Apply liquid gasket to the mating surfaces of oil pump.

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

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent



(A) O-ring

Fig. 233: Oil Pump Mating Surfaces Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

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

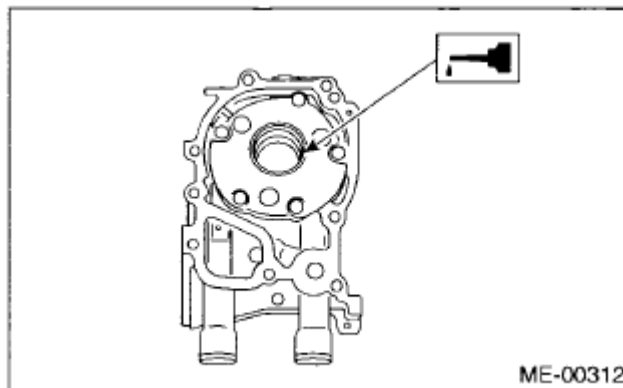


Fig. 234: Front Oil Seal Engine Oil Applying Area
Courtesy of SUBARU OF AMERICA, INC.

4. Install the oil pump to cylinder block.

CAUTION:

- Be careful not to damage the front oil seal during installation.
- Make sure the front oil seal lip is not folded.

NOTE:

- Align the flat surface of oil pump's inner rotor with that of crankshaft before installation.
- Use new O-rings.
- Do not forget to assemble O-rings.

5. Apply liquid gasket to the three bolts thread shown in illustration, (when reusing bolts)

Liquid gasket:

THREE BOND 1324 (Part No. 004403042) or equivalent

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

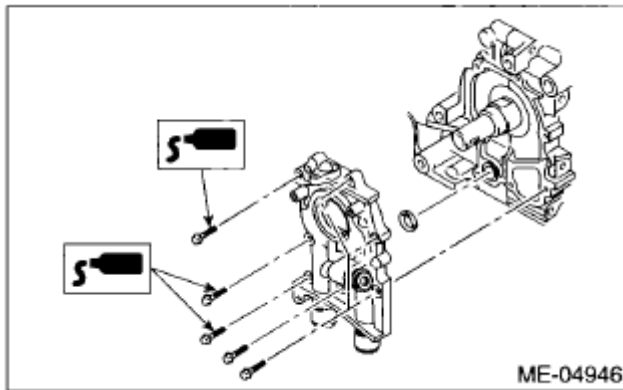


Fig. 235: Cylinder Block And Mounting Fasteners
Courtesy of SUBARU OF AMERICA, INC.

30. Install the water pump and gasket.

NOTE:

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

Tightening torque:

First:

12 N.m (1.2 kgf-m, 8.9 ft-lb)

Second:

12 N.m (1.2 kgf-m, 8.9 ft-lb)

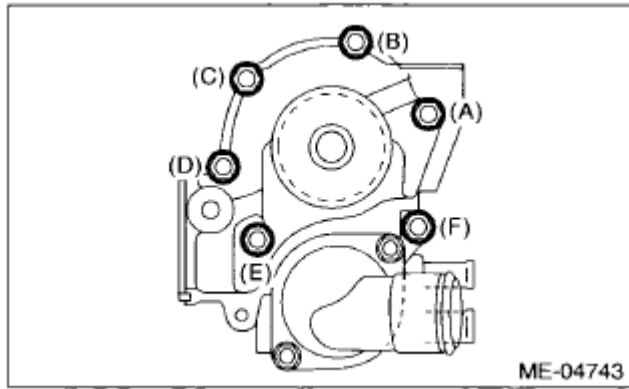


Fig. 236: Water Pump Mounting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

31. Install the water by-pass pipe for heater.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

32. Install the oil filter. < Ref. to **INSTALLATION**, Engine Oil Filter. >
33. Install the cylinder head. < Ref. to **INSTALLATION**, Cylinder Head. >
34. Install the camshaft. < Ref. to **INSTALLATION**, Camshaft. >
35. Install the generator and A/C compressor with their brackets.

Tightening torque:

36 N.m (3.7 kgf-m, 26.6 ft-lb)

36. Install the crank sprocket. < Ref. to **INSTALLATION**, Crank Sprocket. >
37. Install the cam sprocket. < Ref. to **INSTALLATION**, Cam Sprocket. >
38. Install the timing belt. < Ref. to **INSTALLATION**, Timing Belt. >
39. Adjust the valve clearance. < Ref. to **ADJUSTMENT**, Valve Clearance. >
40. Install the rocker cover.

1. Install the rocker cover gasket to the rocker cover, (outer section and ignition coil section)

NOTE: Use a new rocker cover gasket.

2. Apply liquid gasket to the specified point of the cylinder head.

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

Liquid gasket:

THREE BOND 1217G (Part No. K0877Y0100) or equivalent

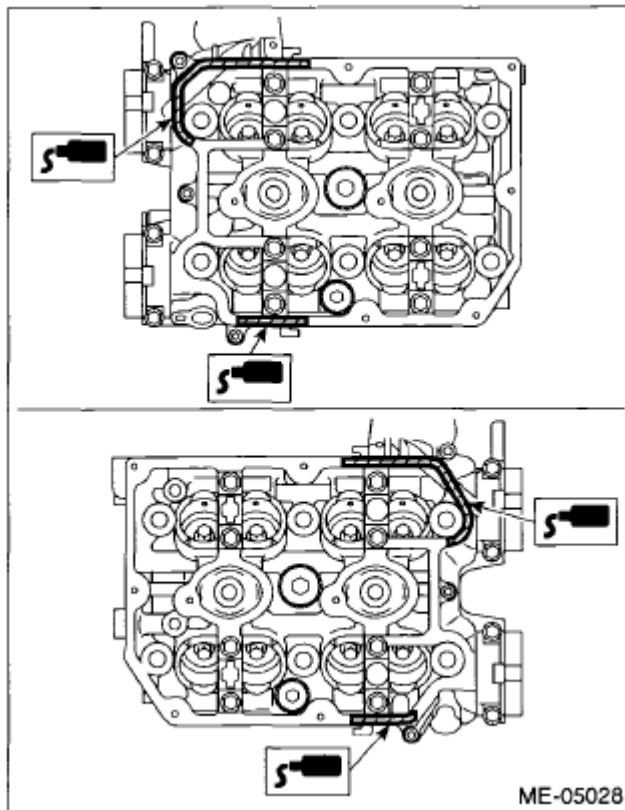


Fig. 237: Cylinder Head Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover onto cylinder heads. Ensure the gasket is properly positioned during installation.
4. Temporarily tighten the rocker cover bolts in alphabetical order shown in the illustration, and then tighten to specified torque in alphabetical order.

Tightening torque:

6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

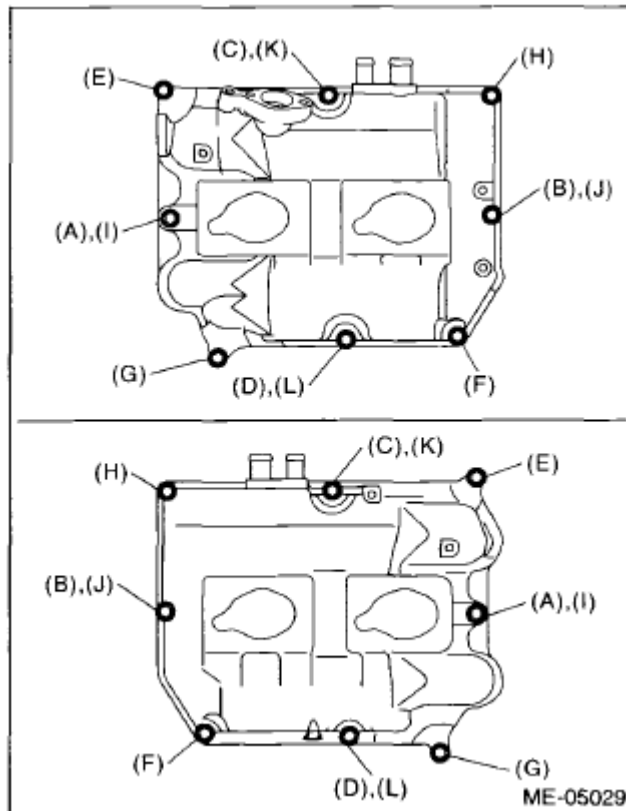


Fig. 238: Rocker Cover Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

41. Connect the PCV hose to the rocker cover.

NOTE: Use a new clamp for the PCV hose clamp, fit the cut out in the ST with the protrusion on the clamp as shown in the illustration, and lock the clamp.

ST 18353AA000 CLAMP PLIERS

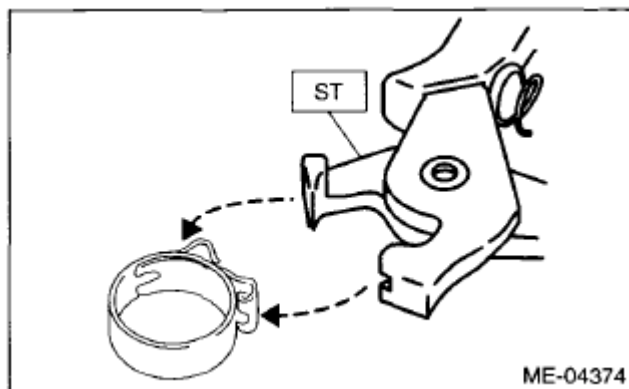


Fig. 239: Pinching Clamp Of PCV Hose Using Special Tool

Courtesy of SUBARU OF AMERICA, INC.

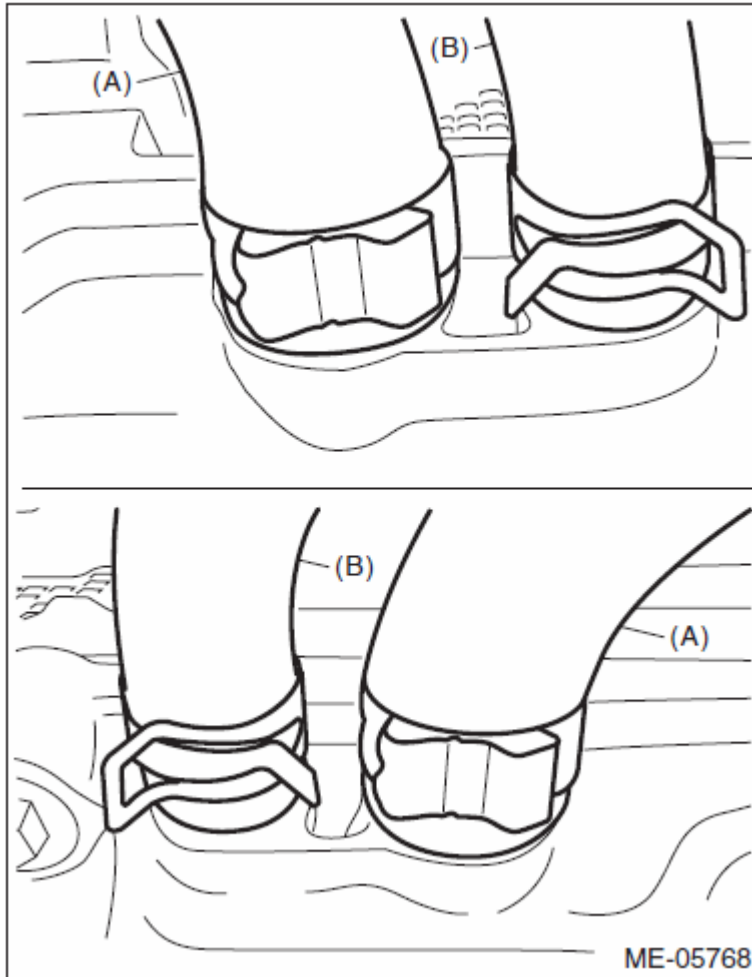
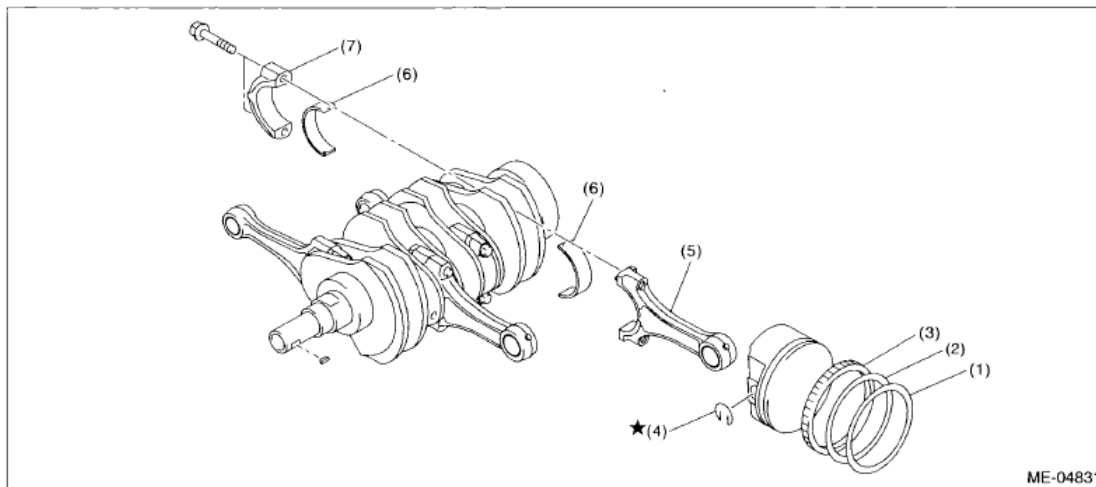


Fig. 240: Identifying PCV Hose And PCV Hose Assembly
Courtesy of SUBARU OF AMERICA, INC.

42. Install the timing belt cover. < Ref. to **INSTALLATION**, Timing Belt Cover. >
43. Install the crank pulley. < Ref. to **INSTALLATION**, Crank Pulley. >
44. Install the intake manifold. < Ref. to **INSTALLATION**, Intake Manifold. >
45. Install the rear side belt. < Ref. to **REAR SIDE BELT**, INSTALLATION, V-belt. >
46. Install the engine to the vehicle. < Ref. to **INSTALLATION**, Engine Assembly. >

DISASSEMBLY



- | | | |
|-----------------|--------------------|----------------------------|
| (1) Top ring | (4) Snap ring | (6) Connecting rod bearing |
| (2) Second ring | (5) Connecting rod | (7) Connecting rod cap |
| (3) Oil ring | | |

Fig. 241: Top Ring, Snap Ring, Connecting Rod Bearing, Connecting Rod Cap And Oil Ring
 Courtesy of SUBARU OF AMERICA, INC.

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

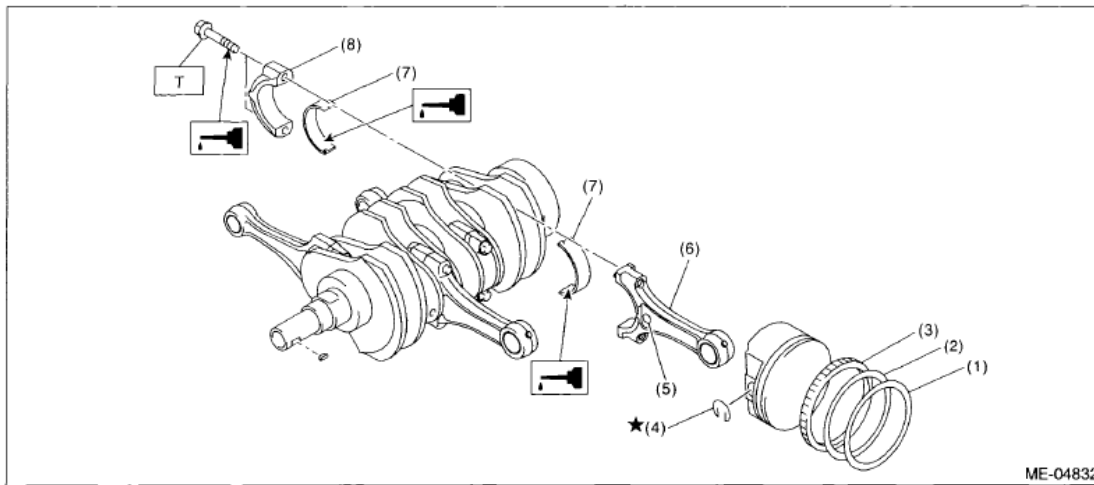
NOTE: Keep the removed connecting rods, connecting rod caps and bearings in order so that they are kept in their original combinations/groups, and not mixed together.

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

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

5. Remove the snap ring.

ASSEMBLY



- | | |
|-----------------|----------------------------|
| (1) Top ring | (5) Side mark |
| (2) Second ring | (6) Connecting rod |
| (3) Oil ring | (7) Connecting rod bearing |
| (4) Snap ring | (8) Connecting rod cap |

Fig. 242: Cylinder Block Oil Applying Points
 Courtesy of SUBARU OF AMERICA, INC.

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

T: 52 (5.3, 38.4)

1. Apply engine oil to the surface of the connecting rod bearings, and install the connecting rod bearings on connecting rods and connecting rod caps.
2. Position each connecting rod with the side with a side mark facing forward, and install it.
3. Attach the connecting rod cap and tighten it with connecting rod bolt. Make sure the arrow on connecting rod cap faces the front during installation.

NOTE:

- Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching number.
- When tightening the connecting rod bolts, apply oil on the threads.

Tightening torque:

52 N.m (5.3 kgf-m, 38.4 ft-lb)

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

NOTE:

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

INSPECTION

CYLINDER BLOCK

1. Check for cracks or damage. Use liquid penetrant tester on the important sections to check for fissures. Check that there are no marks of gas leaking or water leaking on gasket installing surface.
2. Check the oil passages for clogging.
3. Inspect the cylinder block surface that mates with cylinder head for warping by using a straight edge, and correct by grinding if necessary.

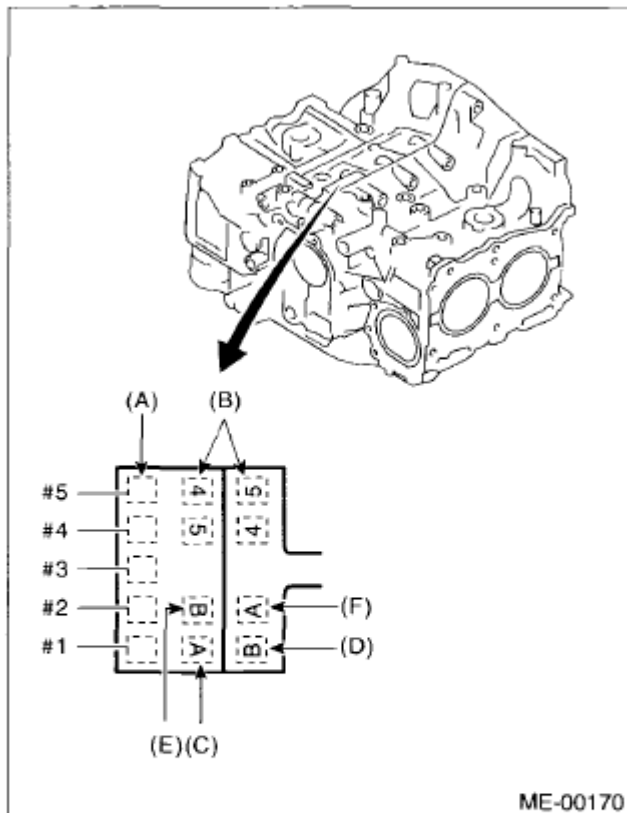
Warping limit:***0.025 mm (0.00098 in)******Grinding limit:******0.1 mm (0.004 in)******Standard height of cylinder block:******201.0 mm (7.91 in)*****CYLINDER AND PISTON**

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

NOTE:

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

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



ME-00170

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

Fig. 243: Journal Size Mark, Cylinder Block And Cylinder Bore Size Mark

Courtesy of SUBARU OF AMERICA, INC.

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

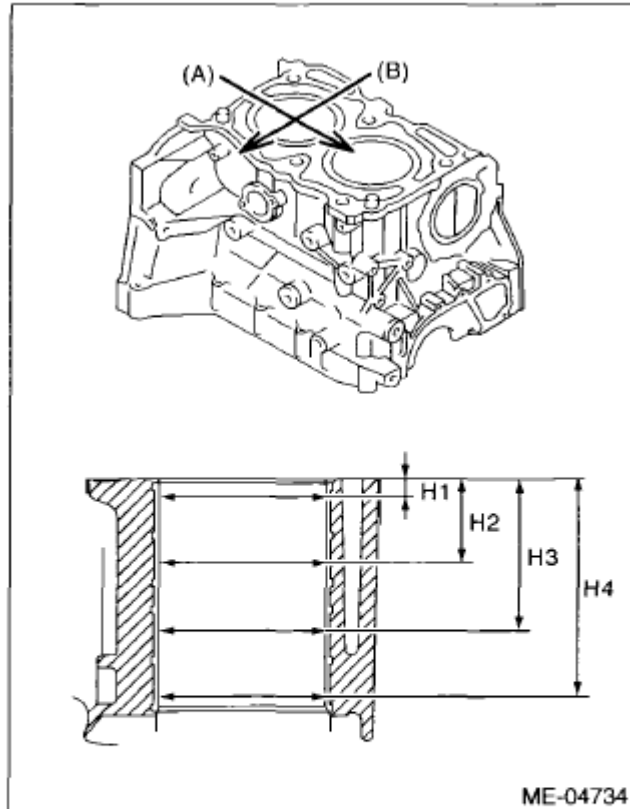
NOTE: Measurement should be performed at a temperature of 20°C (68°F).

Cylindricity:

Standard

0.015 mm (0.0006 in)

Out-of-roundness:

Standard**0.010 mm (0.0004 in)**

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

Fig. 244: Inner Diameter Of Each Cylinder In Both Thrust And Piston Pin
 Courtesy of SUBARU OF AMERICA, INC.

3. When the piston is to be replaced due to general or cylinder wear, select a suitable sized piston by measuring the piston clearance.
4. Measure outer diameter of each piston. Measure the outer diameter of each piston at the height as shown in the illustration. (Thrust direction)

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

Piston grade point H:

38.2 mm (1.50 in)

Piston outer diameter:

Standard

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

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

0.25 mm (0.0098 in) oversize

99.745 - 99.765 mm (3.9270 - 3.9278 in)

0.50 mm (0.0197 in) oversize

99.995 - 100.015 mm (3.9368 - 3.9376 in)

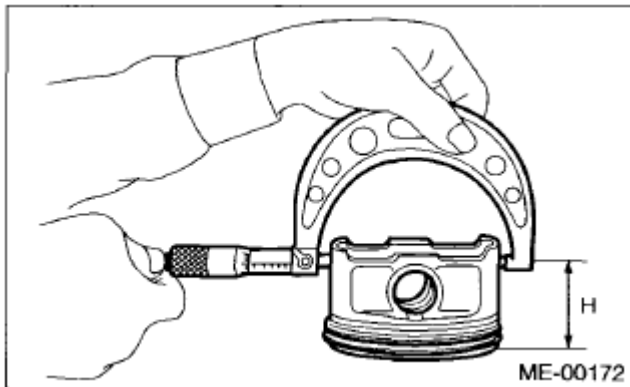


Fig. 245: Measuring Outer Diameter Of Each Piston Using Micrometer
 Courtesy of SUBARU OF AMERICA, INC.

5. Calculate the clearance between cylinder and piston.

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

Clearance between cylinder and piston at 20°C (68°F):

Standard

-0.010 - 0.010 mm (-0.00039 - 0.00039 in)

6. Boring and honing

1. If any of the measured value of cylindricality, out-of-roundness or cylinder-to-piston clearance is out of standard or if there is any damage on the cylinder wall, rebore it to replace with an oversize piston.

CAUTION: When any of the cylinders needs reboring, all other cylinders must be bored at the same time, and replaced with oversize pistons.

2. If the cylinder inner diameter exceeds the limit after boring and honing, replace the cylinder block.

NOTE: Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, when measuring the cylinder diameter, wait until it has cooled to room temperature.

Cylinder inner diameter boring limit (diameter):

To 100.005 mm (3.9372 in)

PISTON AND PISTON PIN

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

Clearance between piston pin hole and piston pin:

Standard

0.004 - 0.008 mm (0.0002 - 0.0003 in)

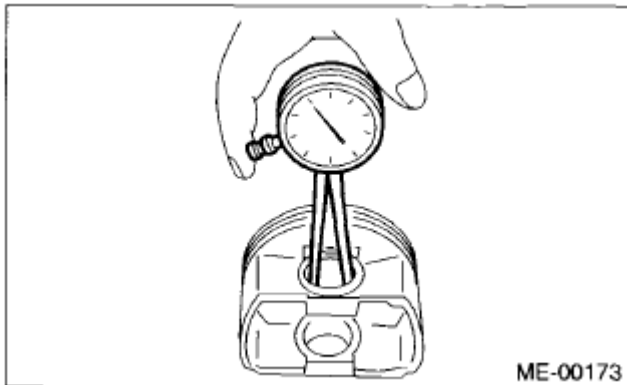


Fig. 246: Measuring Clearance Between Piston Pin Hole And Piston Pin Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

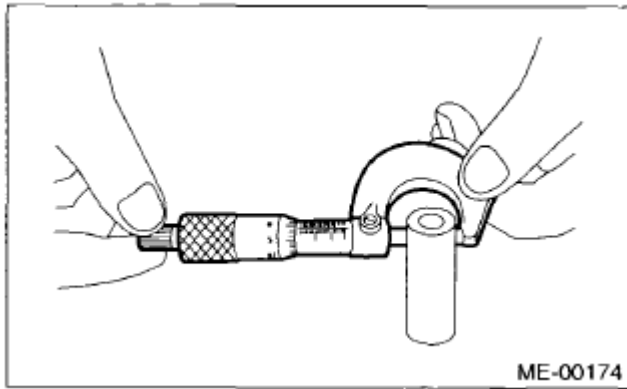


Fig. 247: Measuring Clearance Between Piston Pin Hole And Piston Pin Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

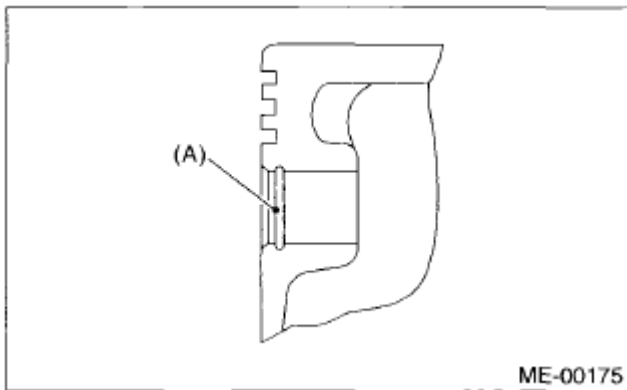


Fig. 248: Snap Ring Installation Groove
Courtesy of SUBARU OF AMERICA, INC.

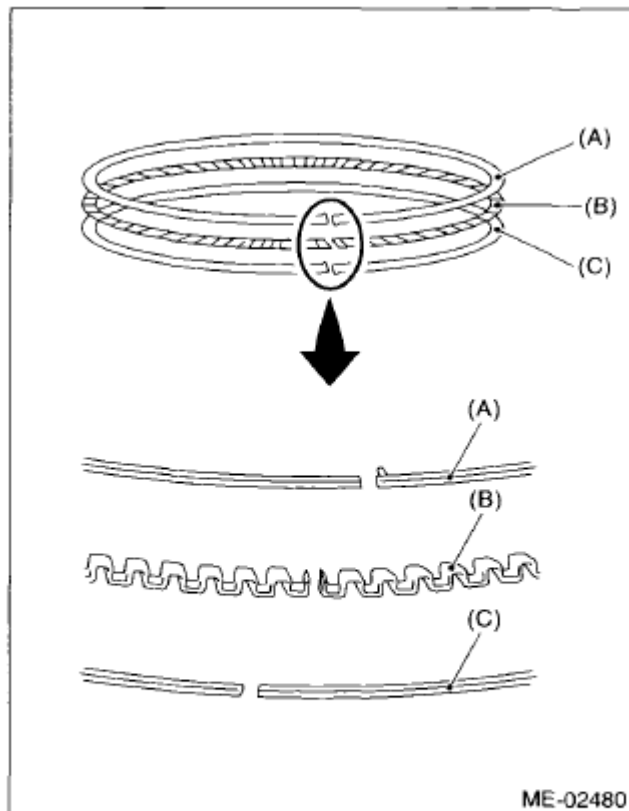
5. Check the piston pin snap ring for distortion, cracks and wear.

PISTON RING

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

NOTE:

- The top ring and second ring have the mark to determine the direction for installing. When attaching the ring to the piston, face these marks towards the top side.
- Oil ring consists of the upper rail, expander and lower rail. When attaching the oil ring to the piston, pay attention to the direction of each rail.



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

Fig. 249: Piston Ring Upper Rail, Expander And Lower Rail
Courtesy of SUBARU OF AMERICA, INC.

- Using the piston, insert the piston ring and oil ring into the cylinder so that they are perpendicular to the cylinder wall, and measure the piston ring gap with a thickness gauge.

PISTON RING GAP SPECIFICATIONS CHART

		Standard mm (in)
Piston ring gap	Top ring	0.20 - 0.25 (0.0079 - 0.0098)
	Second ring	0.37 - 0.52 (0.015 - 0.020)
	Oil ring rail	0.20 - 0.50 (0.0079 - 0.0197)

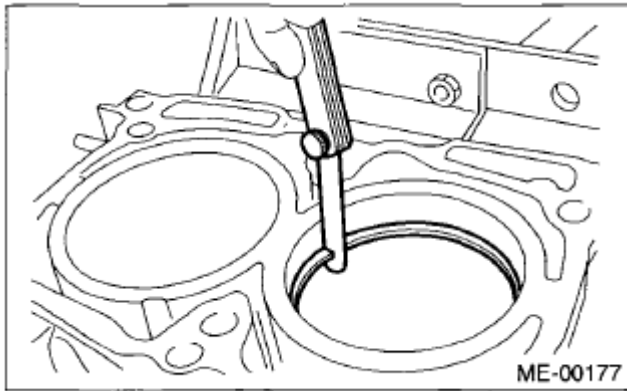


Fig. 250: Measuring Piston Ring Gap With Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Fit the piston ring straight into the piston ring groove, then measure the clearance between piston ring and piston ring groove with a thickness gauge.

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

PISTON RING GROOVE SPECIFICATIONS CHART

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

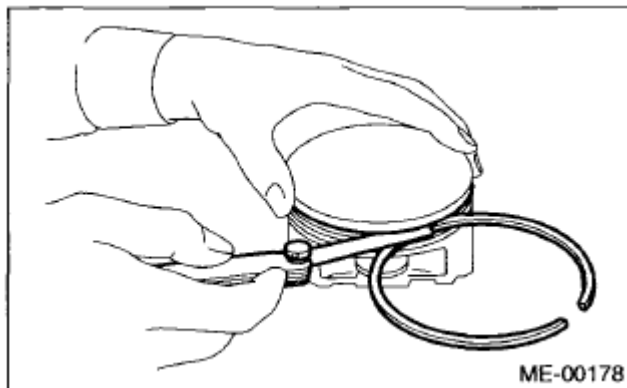


Fig. 251: Measuring Clearance Between Piston Ring And Piston Ring Groove
Courtesy of SUBARU OF AMERICA, INC.

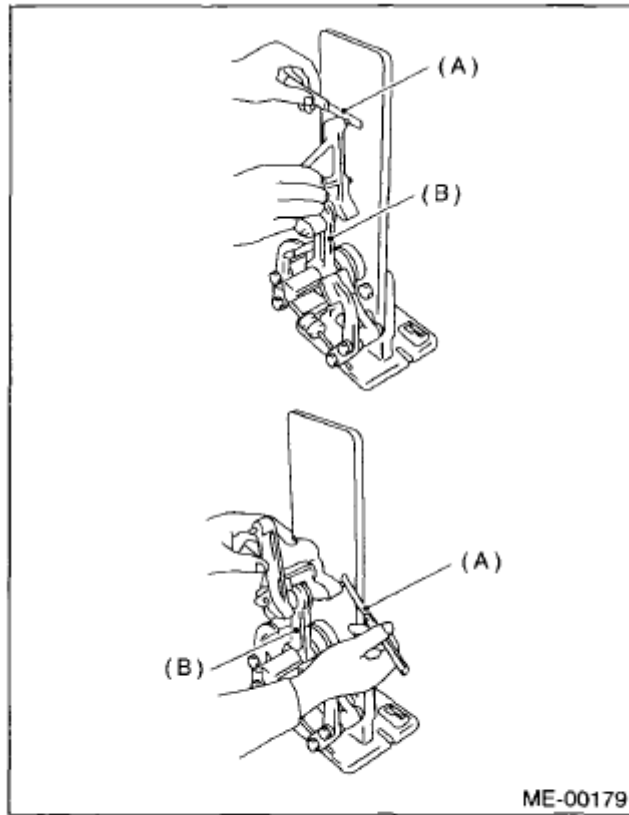
CONNECTING ROD

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

exceeds the limit.

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

0.10 mm (0.0039 in)



- (A) Thickness gauge
(B) Connecting rod

Fig. 252: Checking Connecting Rod For Bend And Twist Using Connecting Rod Aligner
Courtesy of SUBARU OF AMERICA, INC.

3. Install the connecting rod with bearings attached to the crankshaft, and using a thickness gauge, measure the thrust clearance. If the thrust clearance exceeds the standard or uneven wear is found, replace the connecting rod.

Connecting rod thrust clearance:

Standard

0.070 - 0.330 mm (0.0028 - 0.0130 in)

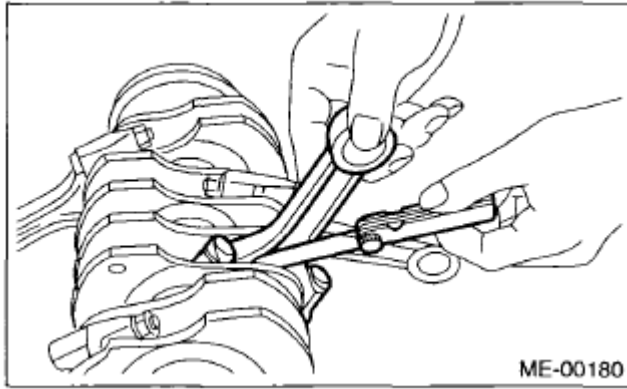


Fig. 253: Measuring Thrust Clearance Using Thickness Gauge
 Courtesy of SUBARU OF AMERICA, INC.

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

Connecting rod oil clearance:

Standard

0.017 - 0.045 mm (0.0007 - 0.0018 in)

CONNECTING ROD OIL CLEARANCE SPECIFICATIONS CHART

Unit: mm (in)		
Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.490 - 1.506 (0.0587 - 0.0593)	51.976 - 52.000 (2.0463 - 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 (2.0447 - 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 the bushing at connecting rod small end, and replace with a new part if worn or damaged.
7. Measure the piston pin clearance at connecting rod small end. If the measured value is not within the standard, replace it with a new part.

Clearance between piston pin and bushing:

Standard

0 - 0.022 mm (0 - 0.0009 in)

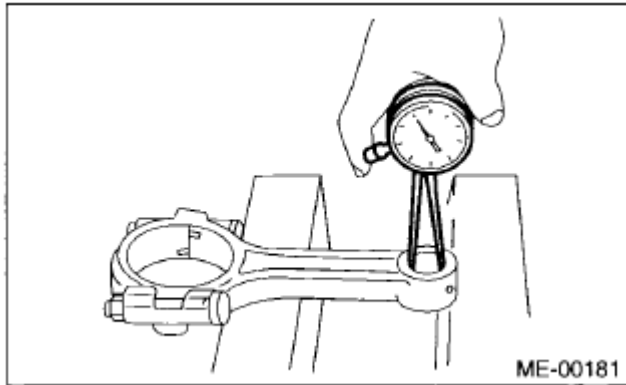


Fig. 254: Measuring Piston Pin Clearance At Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

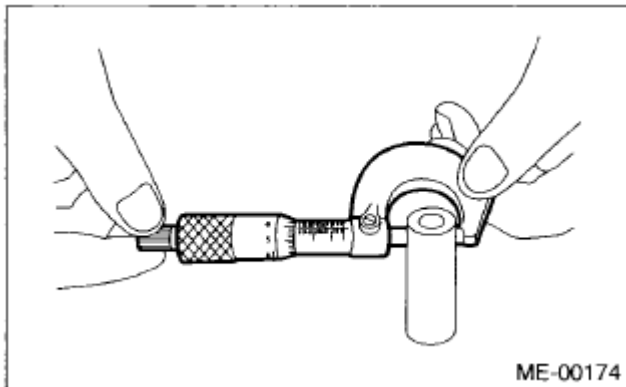


Fig. 255: Checking Clearance Between Piston Pin And Bushing
Courtesy of SUBARU OF AMERICA, INC.

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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER

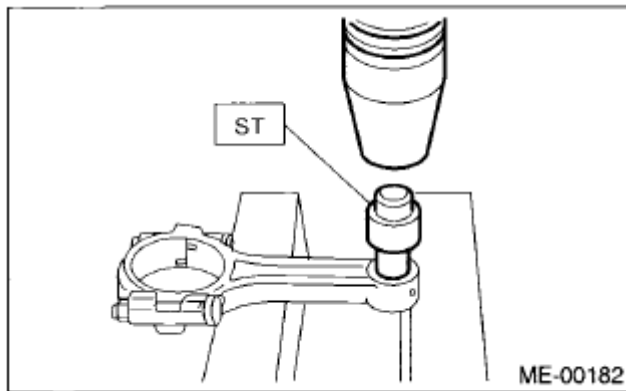


Fig. 256: Pressing Bushing Using Connecting Rod Bushing Remover And Installer
Courtesy of SUBARU OF AMERICA, INC.

3. Make two 3 mm (0.12 in) holes in the pressed bushing to match the pre-manufactured holes on the connecting rod, then ream the inside of the bushing.
4. After completion of reaming, clean the bushing to remove chips.

CRANKSHAFT AND CRANKSHAFT BEARING

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

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

Crankshaft bend limit:

0.035 mm (0.0014 in)

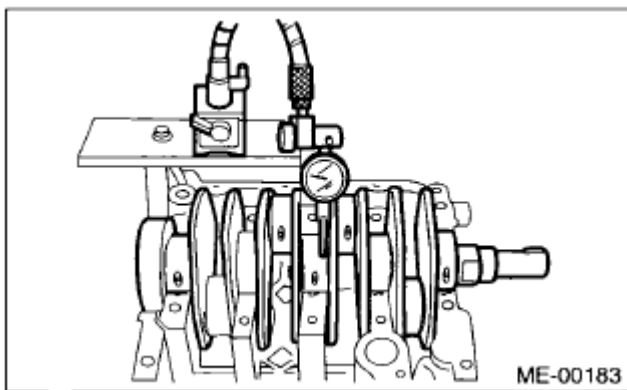


Fig. 257: Measuring Crankshaft Bend Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

Crank pin:***Out-of-roundness******Standard******0.003 mm (0.0001 in)******Cylindricality******Standard******0.004 mm (0.0002 in)******Grinding limit (dia.)******To 51.750 mm (2.0374 in)******Crank journal:******Out-of-roundness******Standard******0.005 mm (0.0002 in)******Cylindricality******Standard******0.006 mm (0.0002 in)******Grinding limit (dia.)******To 59.758 mm (2.3527 in)***

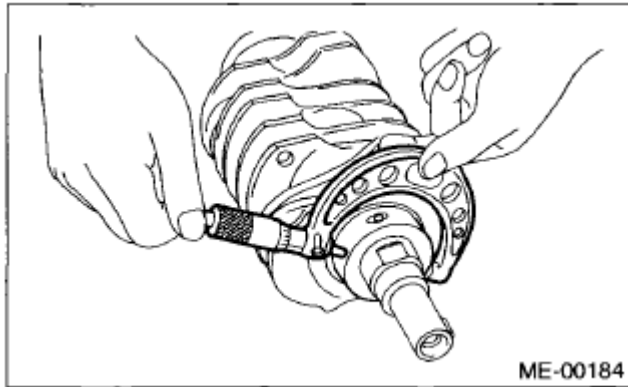


Fig. 258: Inspecting Crank Journal And Crank Pin For Wear
Courtesy of SUBARU OF AMERICA, INC.

CRANK JOURNAL DIAMETER SPECIFICATIONS CHART

		Unit: mm (in)		
		Crank journal diameter		Crank pin outer diameter
		#1, #3	#2, #4, #5	
Standard	Journal O.D.	59.984 - 60.008 (2.3616 - 2.3625)	59.984 - 60.008 (2.3616 - 2.3625)	51.976 - 52.000 (2.0463 - 2.0472)
	Bearing size (Thickness at center)	1.998 - 2.015 (0.0787 - 0.0793)	2.000 - 2.017 (0.0787 - 0.0794)	1.490 - 1.506 (0.0587 - 0.0593)
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)	1.504-1.512 (0.0592 - 0.0595)
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 (2.0447 - 2.0453)
	Bearing size (Thickness at center)	2.027 - 2.030 (0.0798 - 0.0799)	2.029 - 2.032 (0.0799 - 0.0800)	1.514-1.522 (0.0596 - 0.0599)
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)	1.614-1.622 (0.0635 - 0.0639)

4. Use a thickness gauge to measure the thrust clearance of crankshaft at #5 crank journal bearing. If clearance exceeds the standard, replace the bearing.

Crankshaft thrust clearance:

Standard

0.030 - 0.115 mm (0.0012 - 0.0045 in)

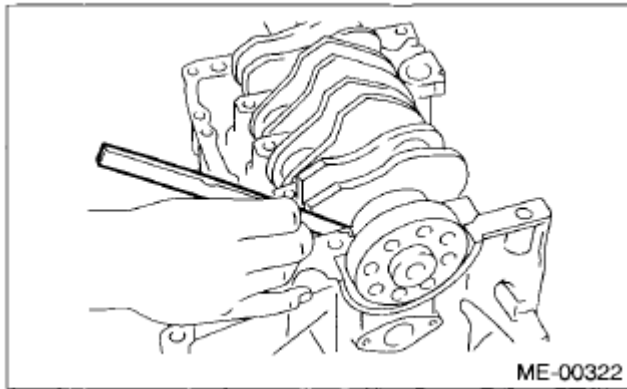


Fig. 259: Measuring Thrust Clearance Of Crankshaft Using Thickness Gauge
 Courtesy of SUBARU OF AMERICA, INC.

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

Crankshaft oil clearance:

Standard

0.010 - 0.030 mm (0.0004 - 0.0012 in)

INTAKE AND EXHAUST VALVE

SPECIFICATION

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

PISTON

SPECIFICATION

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

CONNECTING ROD

SPECIFICATION

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

CRANKSHAFT

SPECIFICATION

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

ENGINE TROUBLE IN GENERAL

INSPECTION

NOTE: The "RANK" shown in the chart shows the possibilities of the cause of trouble in order from "Very often" to "Rarely".

A - Very often

B - Sometimes

C - Rarely

SYMPTOM CHART

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

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

Initial combustion does not occur.	Timing belt	Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
Initial combustion occurs.	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		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 fuel or insufficient fuel	B
	Timing belt	Degradation, etc.	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		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 fuel or insufficient fuel	B

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

Engine stalls after initial combustion.	Timing belt	Degradation, etc.	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
2. Rough idle and engine stall	Engine control system < Ref. to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	C
		Loosened oil filler cap	B
		Dirty air cleaner element	C
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of fuel or insufficient fuel	B
	Timing belt	Defective timing	C
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective cylinder head gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Over-heating	C
		Evaporative emission control system	

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

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

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

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

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

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

		Incorrect valve timing	B
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C

ENGINE NOISE

INSPECTION

POSSIBLE CAUSE CONDITION CHART

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	- Valve mechanism is defective. - Incorrect valve clearance - Worn camshaft - Broken valve spring
Heavy and dull clank	Oil pressure is low.	- Worn crankshaft main bearing - Worn connecting rod bearing (large end)
	Oil pressure is normal.	- Loosened flywheel mounting bolt - Damaged engine mounting
High-pitched clank	Sound is noticeable when accelerating with an overload condition.	- Ignition timing advanced - Accumulation of carbon inside combustion chamber - Wrong heat range of spark plug - Improper octane value gasoline
Clank when engine speed is between 1, 000 and 2, 000 RPMs.	Sound is reduced when the fuel injector connector of the noisy cylinder is disconnected. ⁽¹⁾	- Worn crankshaft main bearing - Worn connecting rod bearing (large end)
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when the fuel injector connector of the noisy cylinder is disconnected. ⁽¹⁾	- Worn cylinder liner and piston ring - Broken or stuck piston ring - Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel	Unusually worn valve lifter

2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DOTC) - Forester

	injector connector is disconnected in turn. ⁽¹⁾	• Worn cam sprocket • Worn camshaft journal bore in cylinder head
Squeaky sound	-	• Insufficient generator lubrication
Rubbing sound	-	• Poor contact of generator brush and rotor
Gear scream when starting engine	-	• Defective ignition starter switch • Worn gear and starter pinion
Sound like polishing glass with a dry cloth	-	• Loose V-belt • Defective water pump shaft
Hissing sound	-	• Insufficient compression • Air leakage in air intake system, hose, connection or manifold
Timing belt noise	-	• Loose timing belt • Timing belt contacting with adjacent part
Valve noise	-	• Incorrect valve clearance

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