

2012 ENGINE

Engine Mechanical (H4DO) - Forester

GENERAL DESCRIPTION

SPECIFICATION

GENERAL SPECIFICATION CHART

Engine	Model		2.5 L
	Cylinder arrangement		Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve system mechanism		Chain driven, double overhead camshaft, 4-valve/cylinder
	Bore x Stroke mm (in)		94.0 x 90.0 (3.70 x 3.54)
	Displacement cm ³ (cu in)		2, 498 (152.43)
	Compression ratio		10
	Compression pressure (at 200 - 300 rpm)	kPa (kg/cm ² psi)	Standard
	Number of piston rings		Pressure ring: 2, Oil ring: 1
	Intake valve timing	Open	Max. retard
			Min. advance
		Close	Max. retard
			Min. advance
	Exhaust valve timing	Open	
		Close	
	Cam clearance mm (in)	Intake	
		Exhaust	
	Idling speed (Select lever is in "P" or "N" range on AT model; Gear shift lever is in neutral position on MT model.) rpm	No load	Standard
			Standard
		A/C ON	Standard

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Ignition order		1 --> 3 --> 2 --> 4	
Ignition timing	BTDC/rpm	Standard	AT model: 16° ±10°/675
			MT model: 16° 10°/650

NOTE: OS: Oversize US: Undersize

GENERAL SPECIFICATION CHART

Camshaft	Bending limit		mm (in)		0.020 (0.00079)
	Cam lobe height	mm (in)	Intake	Standard	40.89 - 40.99 (1.610 - 1.614)
			Exhaust	Standard	40.15 - 40.25 (1.581 - 1.585)
	Cam base circle diameter		mm (in)	Standard	34.0 (1.339)
	Journal O.D.		mm (in)	Standard	25.946 - 25.963 (1.0215 - 1.0222)
	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)	0.1 (0.004)
	Standard height			mm (in)	98.5 (3.878)
Valve seat	Seating angle between valve and valve seat				90°
	Contacting width between valve and valve seat	mm (in)	Intake	Standard	0.8 - 1.6 (0.031 - 0.063)
			Exhaust	Standard	1.1 - 1.7 (0.043 - 0.067)
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)	Standard	5.500 - 5.512 (0.2165 - 0.2170)
	Valve stem outer	mm (in)	Intake	Standard	5.455 - 5.470 (0.2148 - 0.2154)

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	diameters		Exhaust	Standard	5.445 - 5.460 (0.2144 - 0.2150)
	Valve guide protrusion amount		mm (in)	Standard	11.4 - 11.8 (0.449 - 0.465)
Valve	Head edge thickness	mm (in)	Intake	Standard	0.8 - 1.2 (0.031 - 0.047)
			Exhaust	Standard	1.0 - 1.4 (0.039 - 0.055)
	Overall length	mm (in)	Intake		103.8 (4.087)
			Exhaust		94.1 (3.705)
Valve spring	Free length		mm (in)	Standard	41.06 (1.617)
	Tension/spring height	N (kgf, lb)/mm (in)	Set	Standard	182 - 210 (18.56 - 21.41, 40.92 - 47.22)/33.0 (1.299)
			Lift	Standard	552 - 610 (56.29 - 62.20, 124.11 - 137.15)/22.0 (0.866)
	Squareness			Standard	2.5°, 2.1 mm (0.083 in) or less
Valve shim	Inside diameter		mm (in)	Standard	5.500 - 5.560 (0.2165 - 0.2189)
	Valve stem end outer diameters		mm (in)	Standard	5.455 - 5.470 (0.2148 - 0.2154)
	Clearance between the valve shim and valve stem end		mm (in)	Standard	0.030 - 0.105 (0.0012 - 0.0041)
Cylinder block	Warping limit (Mating surface with cylinder head)			mm (in)	0.025 (0.00098)
	Grinding limit			mm (in)	0.1 (0.004)
	Standard height			mm (in)	205.0 (8.07)
	Cylindrically		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	0.015 - 0.035 (0.00059 - 0.00138)
	Inner diameter of cylinder liner boring limit (diameter)			mm (in)	To 94.505 (3.7207)
	Piston grade point			mm (in)	13.3 (0.52)

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Piston	Outer diameter	mm (in)	Standard	A	93.980 - 93.990 (3.7000 - 3.7004)
				B	93.970 - 93.980 (3.6996 - 3.7000)
			0.25 (0.0098) OS		94.220 - 94.240 (3.7094 - 3.7102)
			0.50 (0.0197) OS		94.470 - 94.490 (3.7193 - 3.7201)
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 - 0.30 (0.0079 - 0.0118)
			Second ring	Standard	0.30 - 0.45 (0.0118 - 0.0177)
			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)
	Connecting rod and connecting	Bend or twist per 100 mm (3.94 in) in length		mm (in)	Limit
Thrust clearance		mm (in)	Standard	0.070 - 0.330 (0.0028 - 0.0130)	
Oil clearance		mm (in)	Standard	0.017 - 0.047 (0.0007 - 0.0019)	
			Standard		1.492 - 1.508 (0.0587 - 0.0594)

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rod bearing	Bearing size (Thickness at center)	mm (in)	0.03 (0.0012) US		1.511 - 1.515 (0.0595 - 0.0596)
			0.05 (0.0020) US		1.521 - 1.525 (0.0599 - 0.0600)
			0.25 (0.0098) US		1.621 - 1.625 (0.0638 - 0.0640)
Bushing of small end	Clearance between piston pin and bushing at connecting rod small end		mm (in)	Standard	0.004 - 0.026 (0.0002 - 0.0010)
Crankshaft and crankshaft	Bending limit			mm (in)	0.035 (0.0014)
	Crank pin	Out-of-roundness	mm (in)	Standard	0.005 (0.0002)
		Cylindrically	mm (in)	Standard	0.006 (0.0002)
		Grinding limit (dia.)		mm (in)	To 47.726 (1.8790)
	Crank journal	Out-of-roundness	mm (in)	Standard	0.005 (0.0002)
		Cylindrically	mm (in)	Standard	0.006 (0.0002)
		Grinding limit (dia.)		mm (in)	To 67.735 (2.6667)
	Crank pin outer diameter	mm (in)	Standard		47.976 - 48.000 (1.8888 - 1.8898)
			0.03 (0.0012) US		47.946 - 47.970 (1.8876 - 1.8886)
			0.05 (0.0020) US		47.926 - 47.950 (1.8868 - 1.8878)
			0.25 (0.0098) US		47.726 - 47.750 (1.8790 - 1.8799)
	Crank journal outer diameter	mm (in)	Standard		67.985 - 68.009 (2.6766 - 2.6775)
			0.03 (0.0012) US		67.955 - 67.979 (2.6754 - 2.6763)
			0.05 (0.0020) US		67.935 - 67.959 (2.6746 - 2.6755)
			0.25 (0.0098) US		67.735 - 67.759

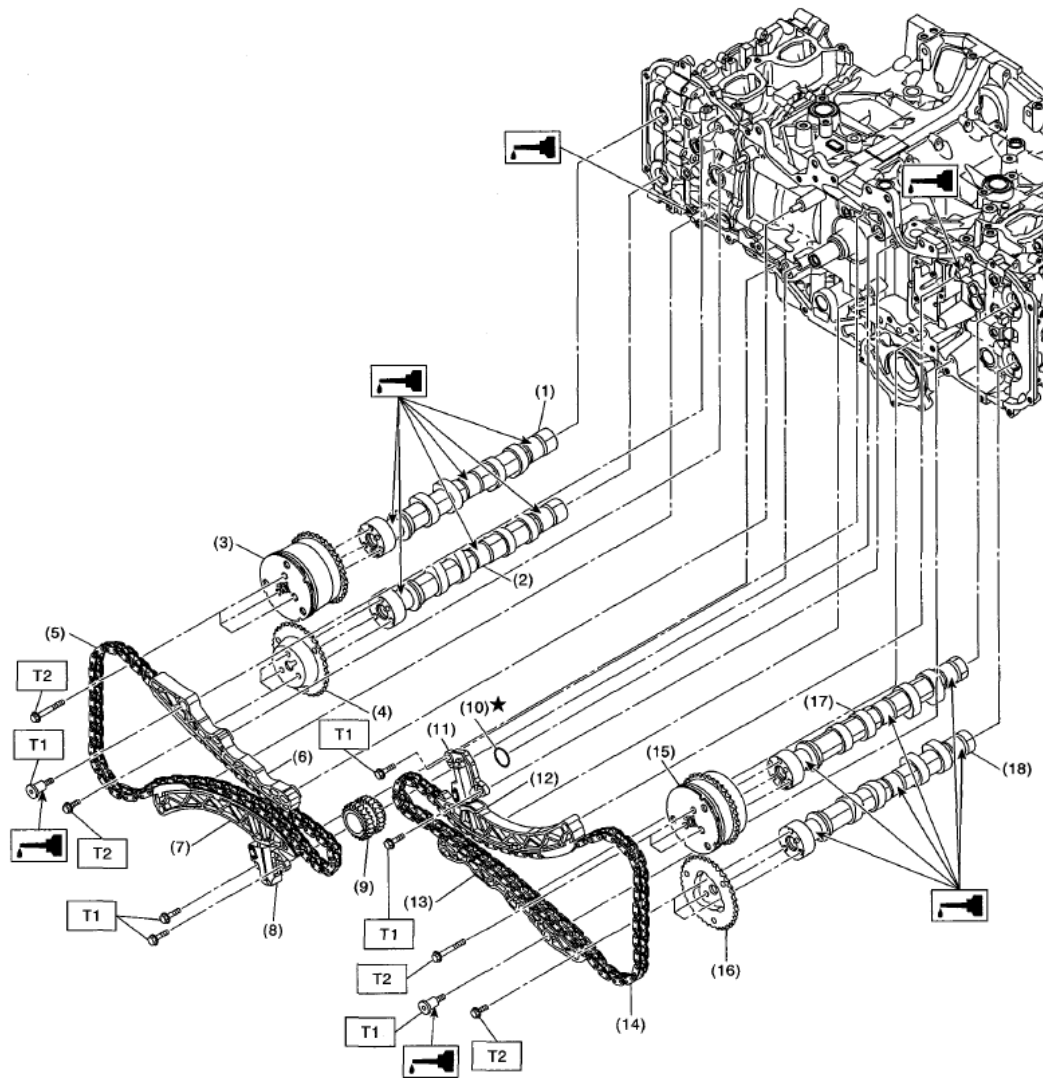
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bearing					(2.6667 - 2.6677)	
	Bearing size (Thickness at center)	mm (in)	#1,#2, #3, #4	Standard	2.495 - 2.513 (0.0982 - 0.0989)	
				0.03 (0.0012) US		2.519 - 2.522 (0.0992 - 0.0993)
				0.05 (0.0020) US		2.529 - 2.532 (0.0996 - 0.0997)
				0.25 (0.0098) US		2.629 - 2.632 (0.1035 - 0.1036)
		#5	Standard	2.493 - 2.511 (0.0981 - 0.0989)		
			0.03 (0.0012) US		2.517 - 2.520 (0.0991 - 0.0992)	
			0.05 (0.0020) US		2.527 - 2.530 (0.0995 - 0.0996)	
			0.25 (0.0098) US		2.627 - 2.630 (0.1034 - 0.1035)	
	Thrust clearance			mm (in)	Standard	0.130 - 0.308 (0.00512 - 0.01213)
	Oil clearance			mm (in)	Standard	0.013 - 0.031 (0.00051 - 0.00122)

COMPONENT

TIMING CHAIN



ME-05439

- | | | |
|------------------------------|-------------------------------|------------------------------|
| (1) Intake camshaft RH | (9) Crank sprocket | (16) Exhaust cam sprocket LH |
| (2) Exhaust camshaft RH | (10) O-ring | (17) Intake camshaft LH |
| (3) Intake cam sprocket RH | (11) Chain tensioner LH | (18) Exhaust camshaft LH |
| (4) Exhaust cam sprocket RH | (12) Chain tensioner lever LH | |
| (5) Timing chain RH | (13) Chain guide | |
| (6) Chain guide | (14) Timing chain LH | |
| (7) Chain tensioner lever RH | (15) Intake cam sprocket LH | |
| (8) Chain tensioner RH | | |

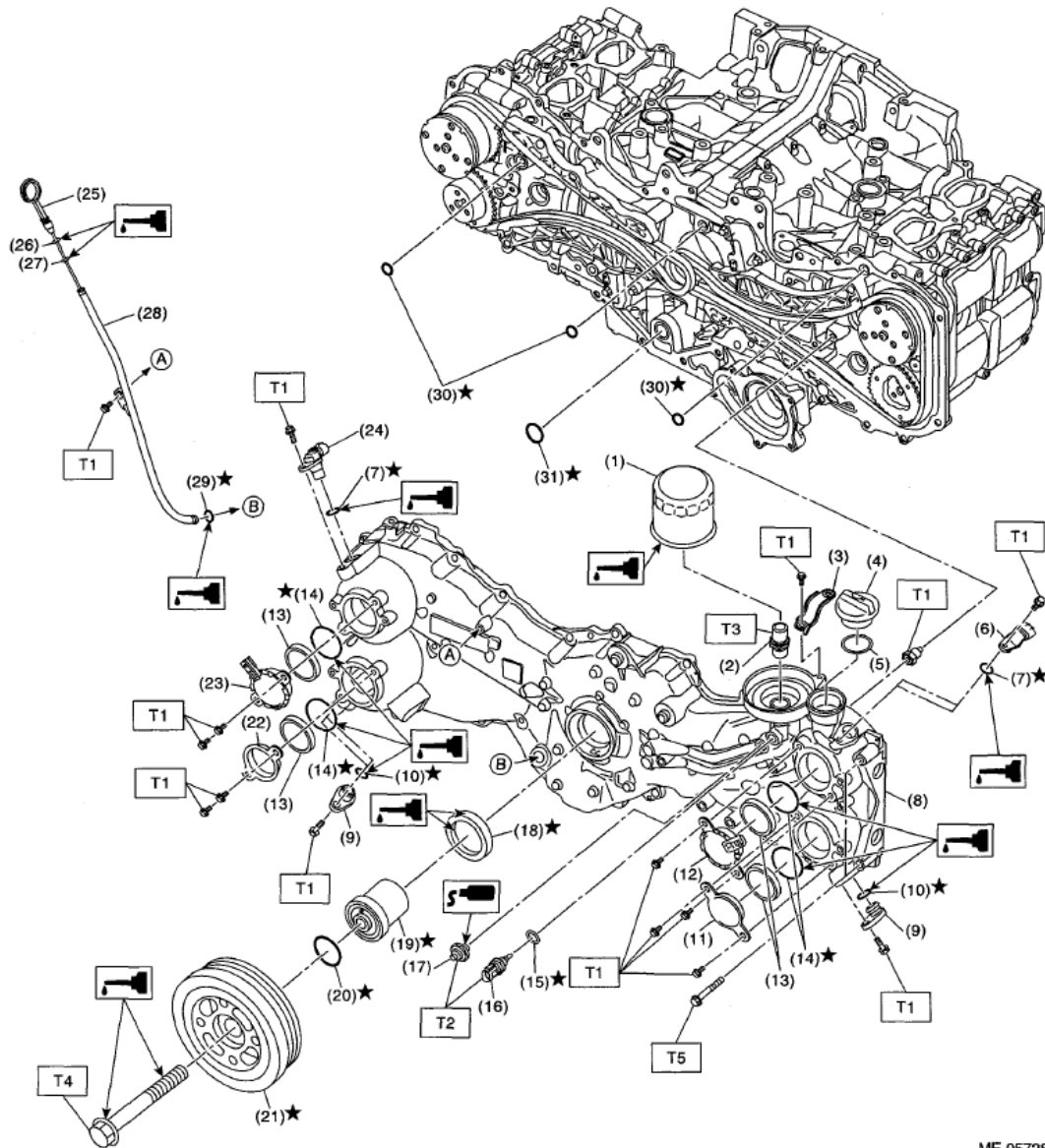
Fig. 1: Exploded View Of Timing Chains
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7, 4.7)

T2: 18 (1.8, 13.3)

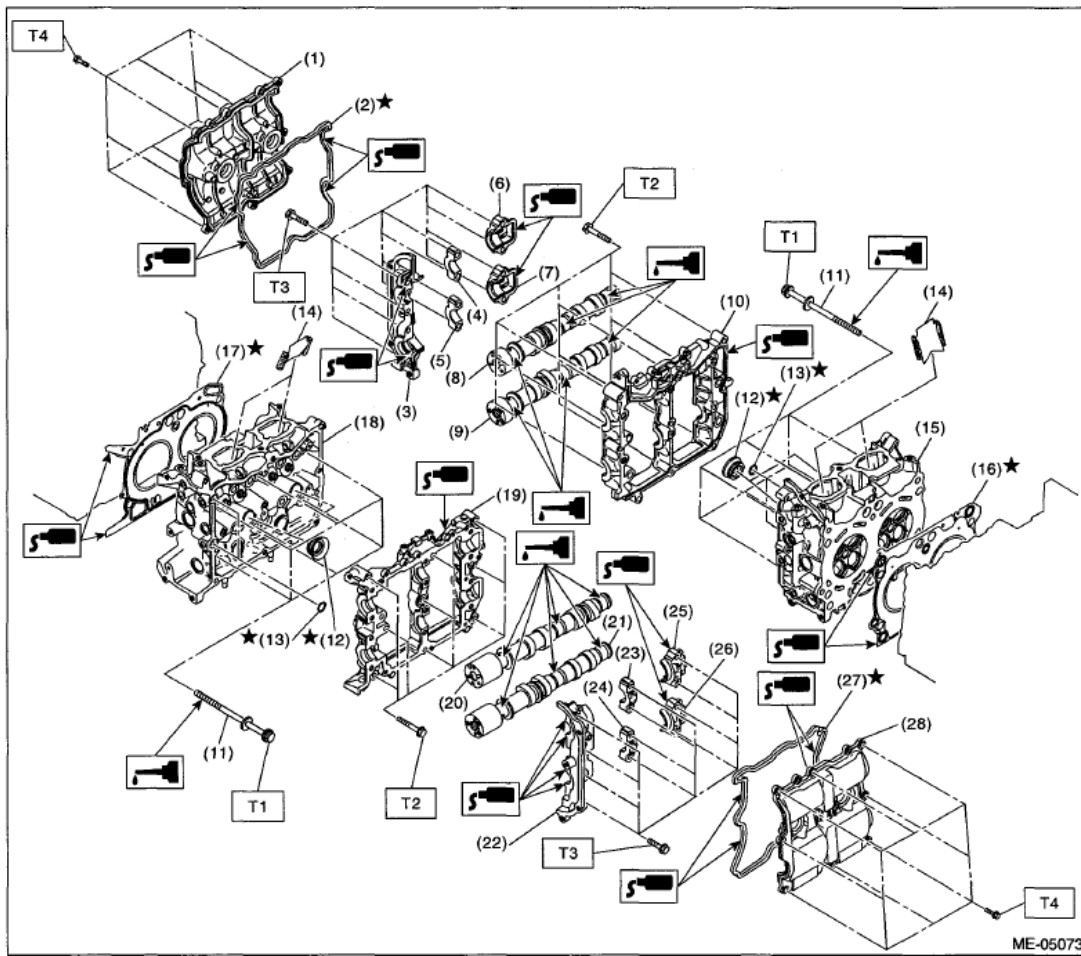
CHAIN COVER



ME-05728

- | | | |
|---------------------------------|------------------------------------|----------------------------|
| (1) Oil filter | (14) O-ring | (27) O-ring |
| (2) Oil pump union | (15) O-ring | (28) Oil level gauge guide |
| (3) Generator code stay | (16) Engine Oil Temperature Sensor | (29) O-ring |
| (4) Oil filler cap | (17) Oil pressure switch | (30) O-ring |
| (5) O-ring | (18) Front oil seal | (31) O-ring |
| (6) Camshaft position sensor LH | (19) Crank pulley boss | |
| (7) O-ring | (20) O-ring | |
| (8) Chain cover | (21) Crank pulley | |
| (9) Sensor cover | (22) Actuator cover RH | |
| (10) O-ring | (23) Oil control solenoid RH | |
| (11) Actuator cover LH | (24) Camshaft position sensor RH | |
| (12) Oil control solenoid LH | (25) Oil level gauge | |
| (13) Back-up ring | (26) O-ring | |

Fig. 2: Exploded View Of Chain Cover**Courtesy of SUBARU OF AMERICA, INC.*****Tightening torque: N.m (kgf-m, ft-lb)******T1: 6.4 (0.7, 4.7)******T2: 18 (1.8, 13.3)******T3: 45 (4.6, 33.2)******T4: < refer to INSTALLATION, Crank Pulley >******T5: < refer to INSTALLATION, Chain Cover >*****CYLINDER HEAD AND CAMSHAFT**



- | | | |
|------------------------------------|------------------------------------|-------------------------------------|
| (1) Rocker cover RH | (13) O-ring | (24) Exhaust center camshaft cap LH |
| (2) Rocker cover gasket RH | (14) Cylinder head plate | (25) Intake rear camshaft cap LH |
| (3) Front camshaft cap RH | (15) Cylinder head RH | (26) Exhaust rear camshaft cap LH |
| (4) Intake center camshaft cap RH | (16) Cylinder head gasket RH | (27) Rocker cover gasket LH |
| (5) Exhaust center camshaft cap RH | (17) Cylinder head gasket LH | (28) Rocker cover LH |
| (6) Intake camshaft cap RH | (18) Cylinder head LH | |
| (7) Exhaust rear camshaft cap RH | (19) Cam carrier LH | |
| (8) Intake camshaft RH | (20) Intake camshaft LH | |
| (9) Exhaust camshaft RH | (21) Exhaust camshaft LH | |
| (10) Cam carrier RH | (22) Front camshaft cap LH | |
| (11) Cylinder head bolt | (23) Intake center camshaft cap LH | |
| (12) Spark plug pipe gasket | | |

Fig. 3: Exploded View Of Cylinder Head And Camshaft
Courtesy of SUBARU OF AMERICA, INC.

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

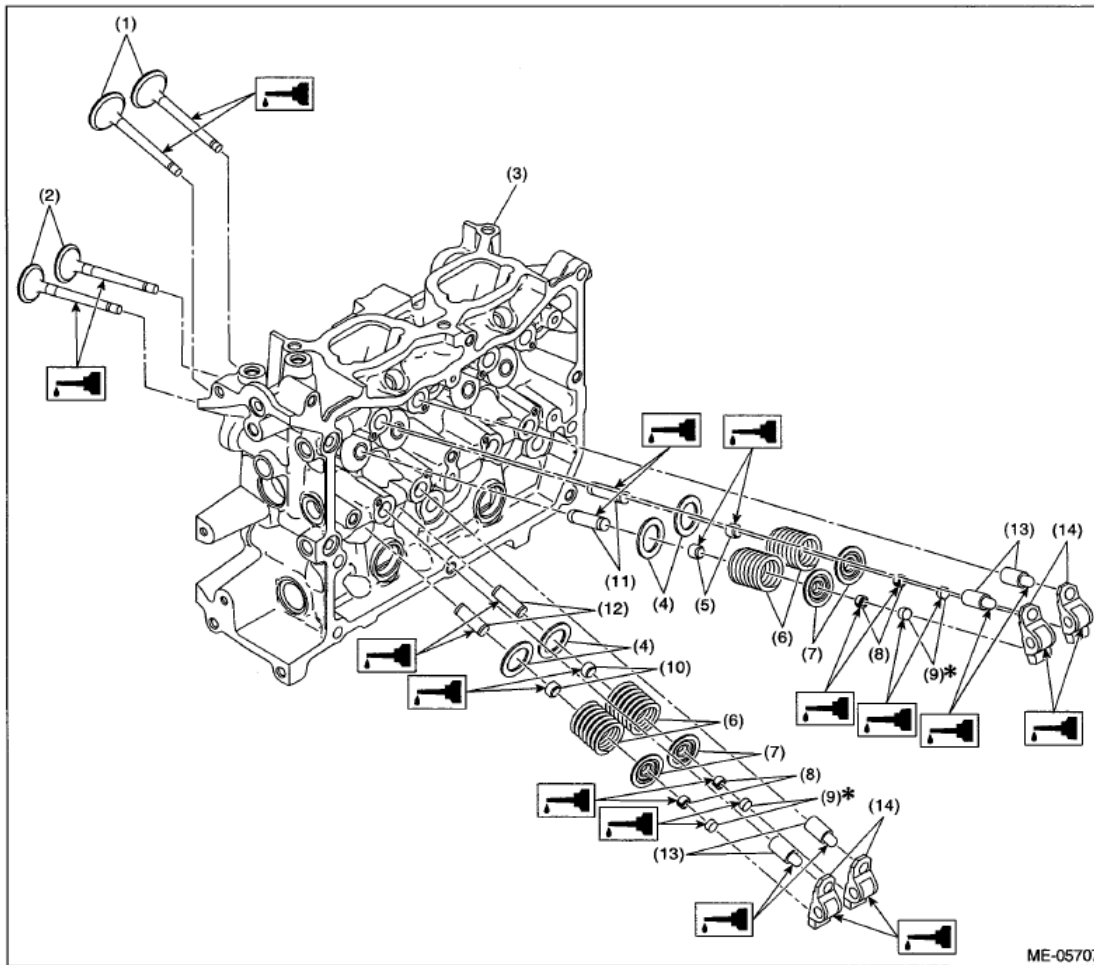
T1: < refer to INSTALLATION, Cylinder Head >

T2: < refer to INSTALLATION, Cam Carrier >

T3: < refer to ASSEMBLY, Cam Carrier >

T4: < refer to INSTALLATION, Rocker Cover >

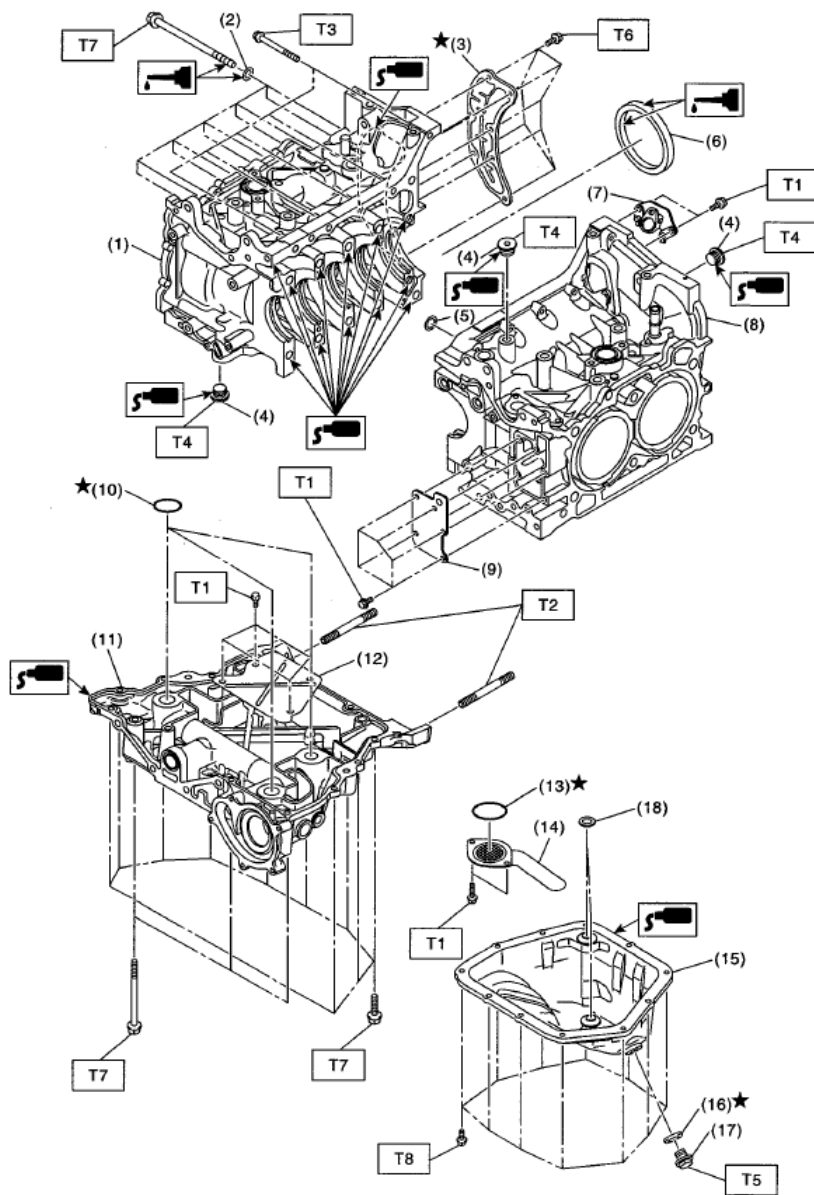
CYLINDER HEAD AND VALVE ASSEMBLY



- | | | |
|---------------------------|-----------------------------|------------------------------|
| (1) Exhaust valve | (6) Valve spring | (11) Intake valve guide |
| (2) Intake valve | (7) Valve spring retainer | (12) Exhaust valve guide |
| (3) Cylinder head | (8) Valve collet | (13) Roller rocker arm pivot |
| (4) Valve spring seat | (9) Valve shim | (14) Roller rocker arm |
| (5) Intake valve oil seal | (10) Exhaust valve oil seal | |

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

CYLINDER BLOCK



ME-05075

- | | |
|---------------------------------------|------------------------|
| (1) Cylinder block RH | (10) O-ring |
| (2) Washer | (11) Oil pan upper |
| (3) Oil separator cover | (12) Baffle plate |
| (4) Main gallery plug | (13) O-ring |
| (5) O-ring | (14) Oil strainer |
| (6) Rear oil seal | (15) Oil pan |
| (7) Crankshaft position sensor holder | (16) Drain plug gasket |
| (8) Cylinder block LH | (17) Drain plug |
| (9) Cylinder block plate | (18) Oil pan seal ring |

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

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

T1: 6.4 (0.7, 4.7)

T2: 18 (1.8, 13.3)

T3: 25 (2.5, 18.4)

T4: 37 (3.8, 27.3)

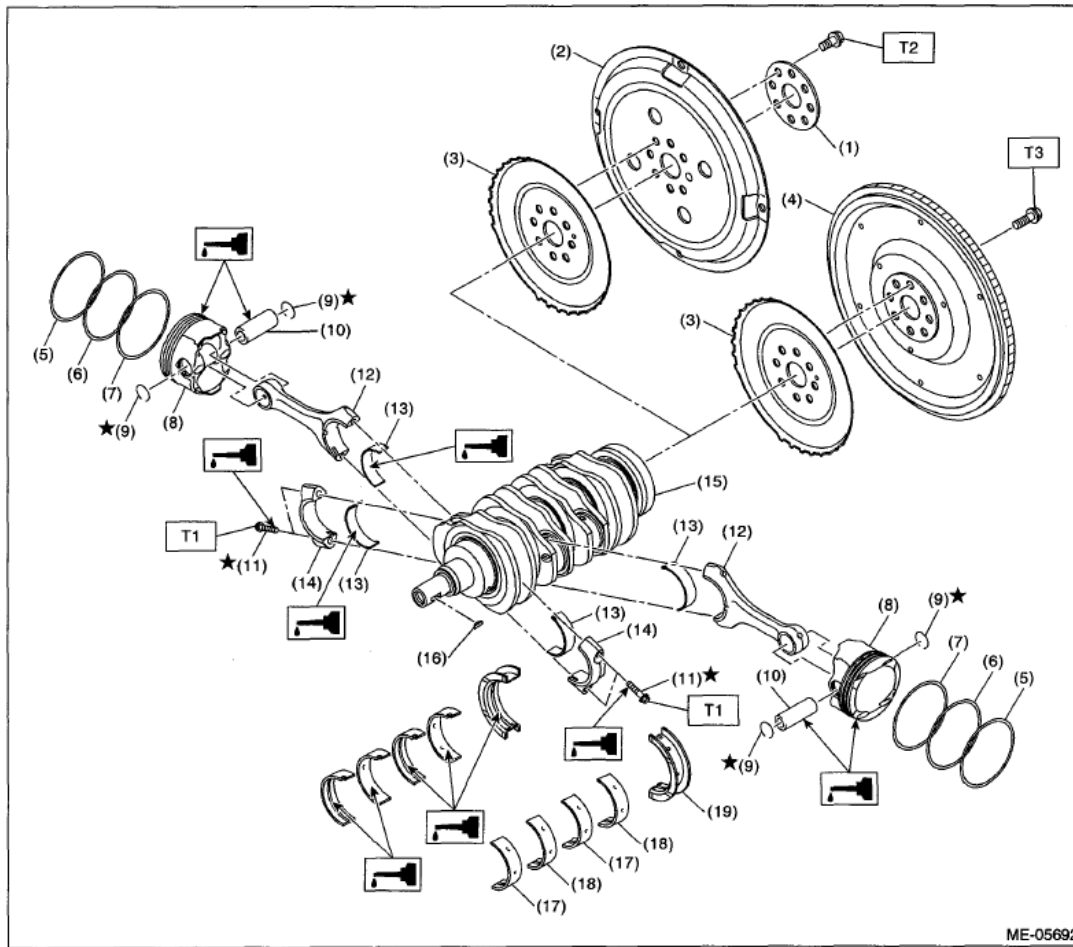
T5: 41.7 (4.3, 30.8)

T6: < refer to CYLINDER BLOCK, ASSEMBLY, Cylinder Block >

T7: < refer to INSTALLATION, Cylinder Block >

T8: < refer to OIL PAN , INSTALLATION, Oil Pan and Strainer >

CRANKSHAFT AND PISTON



- | | | |
|--------------------------------------|------------------------------|--------------------------------|
| (1) Reinforcement (AT model) | (9) Circlip | (17) Crankshaft bearing #1, #3 |
| (2) Drive plate (AT model) | (10) Piston pin | (18) Crankshaft bearing #2, #4 |
| (3) Crankshaft position sensor plate | (11) Connecting rod cap bolt | (19) Crankshaft bearing #5 |
| (4) Flywheel (MT model) | (12) Connecting rod | |
| (5) Top ring | (13) Connecting rod bearing | |
| (6) Second ring | (14) Connecting rod cap | |
| (7) Oil ring | (15) Crankshaft | |
| (8) Piston | (16) Woodruff key | |

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

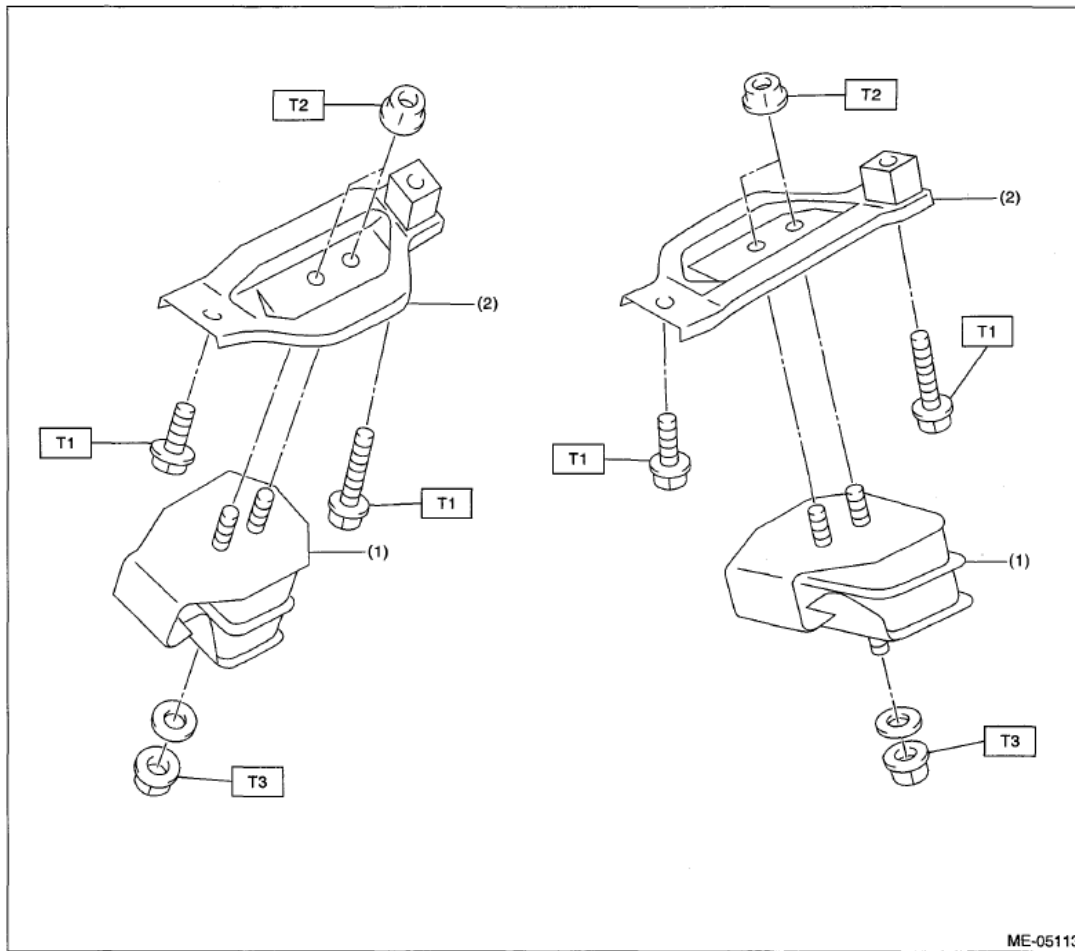
Tightening torque: N.m (kgf-m, ft-lb)

T1: < refer to INSTALLATION, Cylinder Block >

T2: < refer to INSTALLATION , Drive Plate >

T3: < refer to INSTALLATION , Flywheel >

ENGINE MOUNTING



(1) Front cushion rubber

(2) Front engine mounting bracket

Fig. 7: Identifying Front Cushion Rubber And Front Engine Mounting Bracket
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 35 (3.6, 25.8)

T2: 42 (4.3, 31.0)

T3: 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 clutch disc and flywheel.
- All removed parts, if to be reused, should be reinstalled in the original positions and directions.
- Bolts, nuts and washers should be replaced with new parts as required.
- Even if necessary inspections have been made in advance, proceed with assembly work while making re-checks.
- Remove or install the engine in an area where chain hoists, lifting devices, etc. are available for ready use.
- Be sure not to damage coated surfaces of body panels with tools, or not to stain seats and windows with coolant or oil. Place a cover over fender, as required, for protection.
- Prior to starting work, prepare the following:

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

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

PREPARATION TOOL

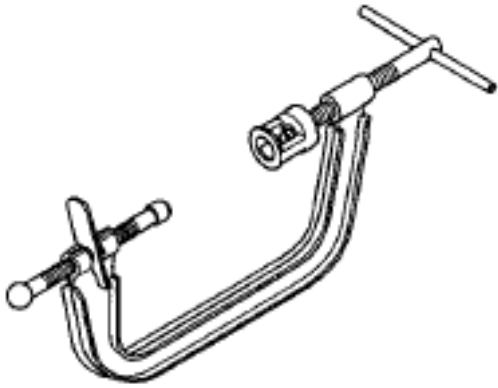
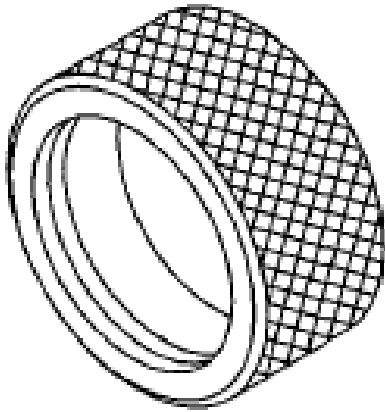
SPECIAL TOOL

SPECIAL TOOL DESCRIPTION CHART

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
	0920287002000 (Newly adopted tool)	REMOVER AND REPLACER	Used for removing and installing valve spring.

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**ST0920287002000****ST-398437700**

398437700

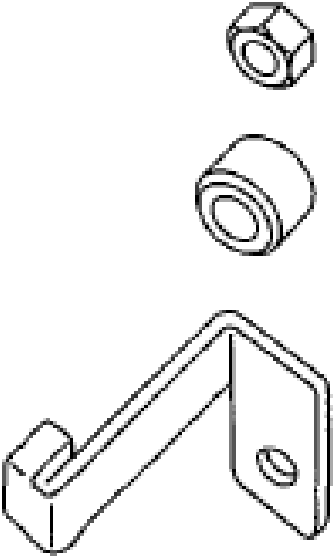
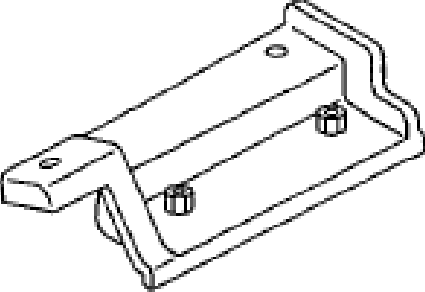
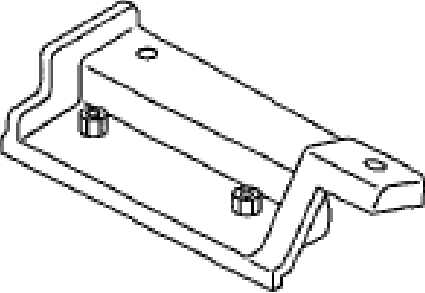
**OIL SEAL
INSTALLER**Used for installing the
front oil seal of engine.

498277200

STOPPER SETUsed for installing
automatic transmission
assembly to engine.

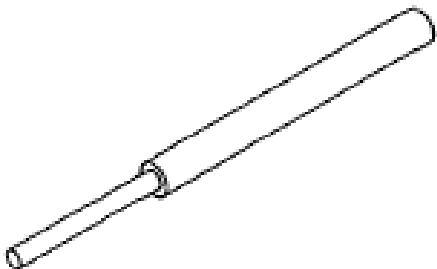
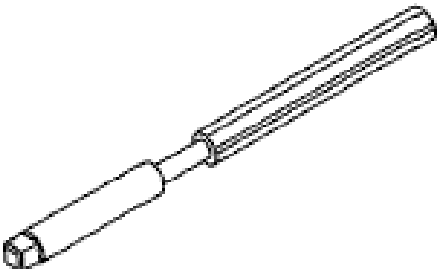
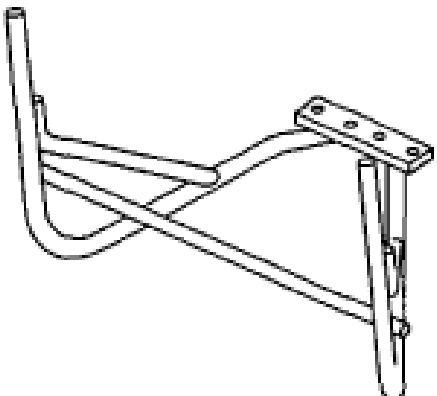
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 ST-498277200			
 ST-498457000	498457000	ENGINE STAND ADAPTER RH	• Used for disassembling and assembling engine. • Used together with ENGINE STAND (499817100) and ADAPTER (18362AA020).
 ST-498457100	498457100	ENGINE STAND ADAPTER LH	• Used for disassembling and assembling engine. • Used together with ENGINE STAND (499817100) and ADAPTER (18362AA020).
	499765700	VALVE GUIDE REMOVER AND	Used for removing and installing valve guide.

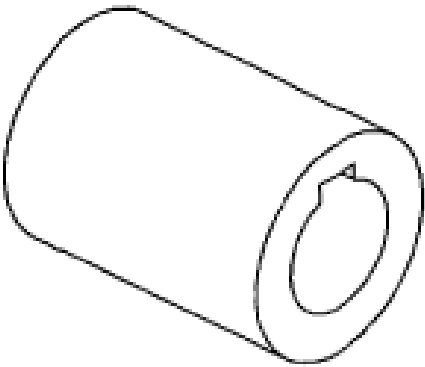
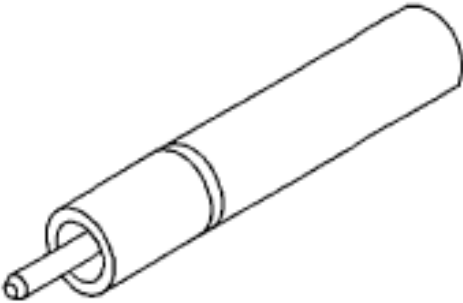
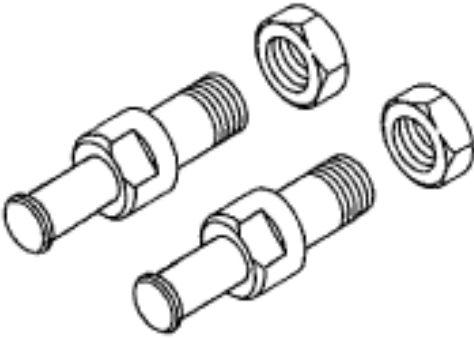
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 ST-499765700		INSTALLER	
 ST-499765900	499765900	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499817100	499817100	ENGINE STAND	• Used for disassembling and assembling engine. • Used together with ADAPTER (18362AA020), ENGINE STAND ADAPTER RH (498457000) and LH (498457100).
	18252AA000	CRANKSHAFT SOCKET	Used for rotating crankshaft.

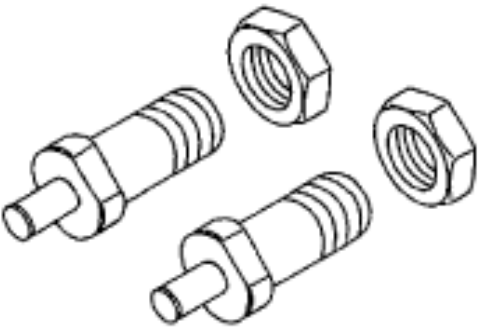
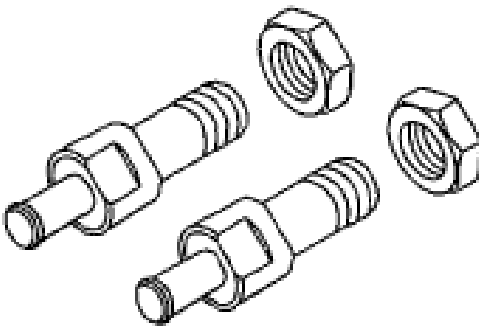
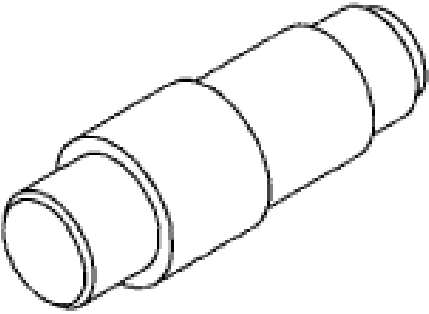
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 ST18252AA000			
 ST18261AA010	18261AA010	VALVE OIL SEAL GUIDE	Used for press-fitting of intake valve guide stem seals and exhaust valve guide stem seals.
 ST18334AA000	18334AA000	PULLEY WRENCH PIN SET	• Used for removing and installing the crank pulley. • Used together with PULLEY WRENCH (18355AA000).
	18334AA020 (Newly adopted tool)	PULLEY WRENCH PIN SET	• Used for removing and installing exhaust cam sprocket LH. • Used together

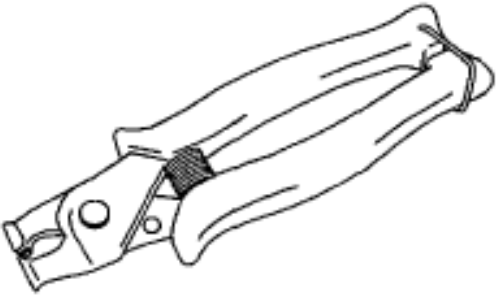
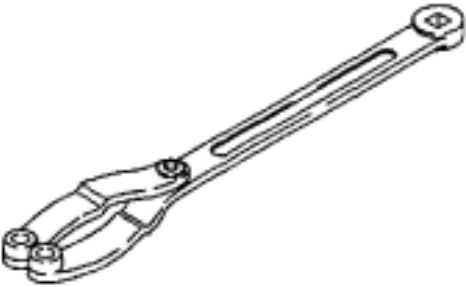
2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DO) - Forester

 ST18334AA020			with PULLEY WRENCH (18355AA000).
 ST18334AA030	18334AA030 (Newly adopted tool)	PULLEY WRENCH PIN SET	• Used for removing and installing water pump pulley and intake cam sprocket. • Used together with PULLEY WRENCH (18355AA000).
 ST18350AA000	18350AA000	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing bushing at connecting rod small end.
	18353AA000	CLAMP PLIERS	• Used for removing and installing the PCV hose. • This tool is made by the French company

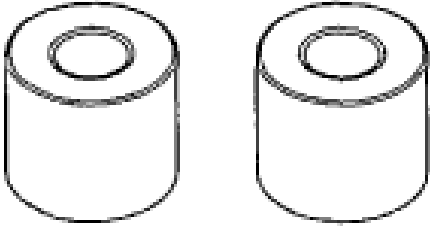
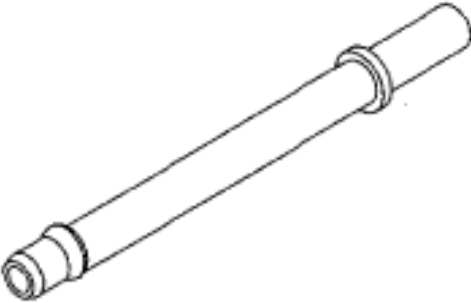
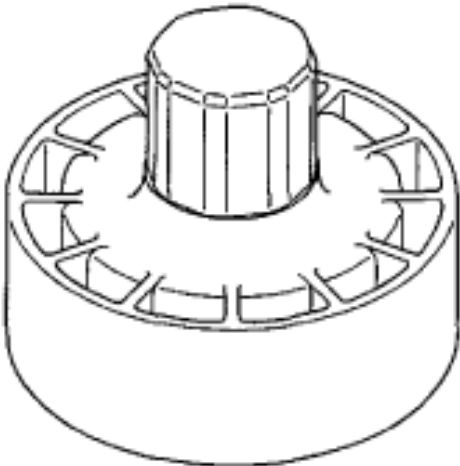
2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DO) - Forester

 ST18353AA000			CAILLAU. (code) 54.0.000.205 To make it easier to obtain, it has been provided with a tool number.
 ST18355AA000	18355AA000	PULLEY WRENCH	• Used for installing and removing the water pump pulley. • Used for removing and installing the crank pulley. • Used for removing and installing intake cam sprocket and exhaust cam sprocket LH. • Used together with PULLEY WRENCH PIN SET (18334AA030), PULLEY WRENCH PIN SET (18334AA000) or PULLEY WRENCH PIN SET (18334AA020).
	18362AA020 (Newly adopted tool)	ADAPTER	• Used for disassembling and assembling engine. • Used together with STAND

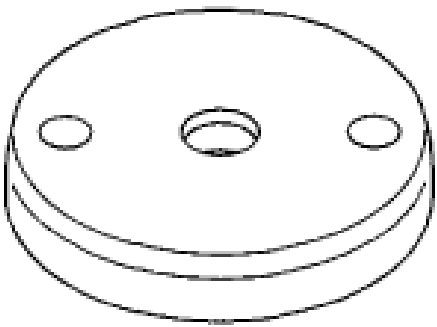
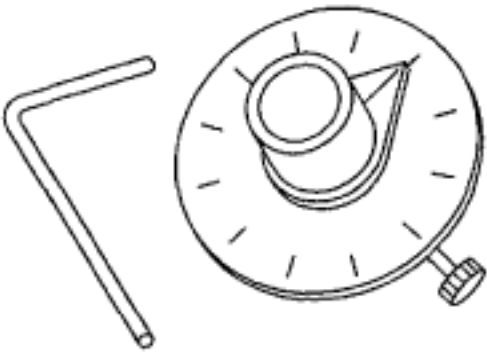
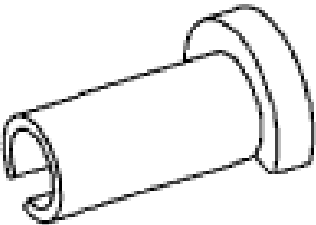
2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DO) - Forester

 ST18362AA020			(499817100), ENGINE STAND ADAPTER RH (498457000) and LH (498457100). • Bolt used: M10 x 50 (SUBARU genuine Part No 010410500)
 ST18471AA000	18471AA000	FUEL PIPE ADAPTER	Used for inspecting the fuel pressure.
 ST18657AA030	18657AA030 (Newly adopted tool)	OIL SEAL INSTALLER	• Used for installing the rear oil seal of engine. • Used together with OIL SEAL GUIDE (18671AA020).
	18671AA020 (Newly adopted tool)	OIL SEAL GUIDE	• Used for installing the rear oil seal of engine. • Used together with OIL SEAL

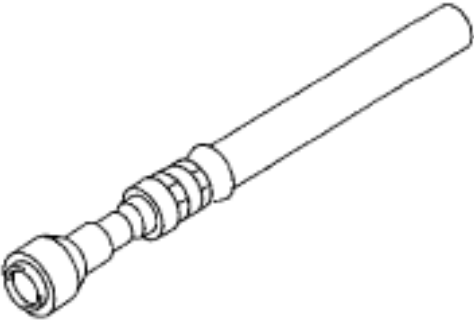
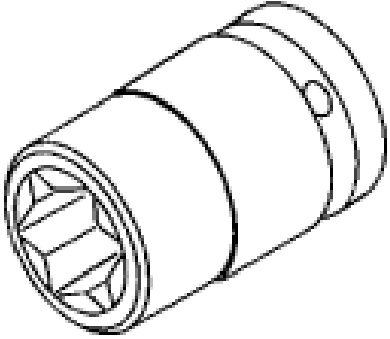
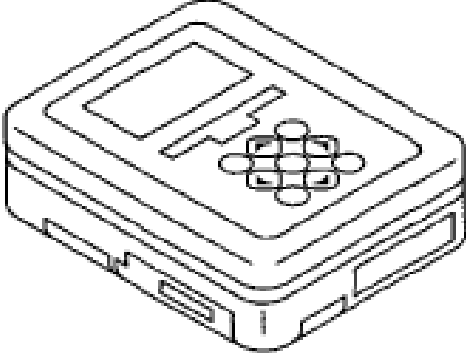
2012 Subaru Forester X

2012 ENGINE Engine Mechanical (H4DO) - Forester

 ST18671AA020			INSTALLER (18657AA030).
 ST18854AA000	18854AA000	ANGLE GAUGE	Used for angle tightening.
 ST42099AE000	42099AE000	QUICK CONNECTOR RELEASE	Used for removing the quick connector.
	42075AG690	FUEL HOSE	Used for inspecting the fuel pressure. NOTE: This is the SUBARU genuine part.

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2012 ENGINE Engine Mechanical (H4DO) - Forester

 ST42075AG690			
 ST18270KA010	18270KA010 (Newly adopted tool)	SOCKET	Used for installing and removing intake cam sprocket and exhaust cam sprocket.
 ST1B022XU0	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for various inspections.

GENERAL TOOL

SPECIAL TOOL DESCRIPTION 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.
TORX® socket E12	Used for removing and installing connecting rod cap bolt.
Piston ring compressor	Used for installing the piston into the cylinder block.
Thickness gauge	Used for various inspections.

COMPRESSION

INSPECTION

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

1. After warming-up the engine, turn the ignition switch to OFF.
2. Make sure that the battery is fully charged.
3. Check the starter motor for satisfactory performance and operation.
4. Remove the fuse of fuel pump from main fuse box.

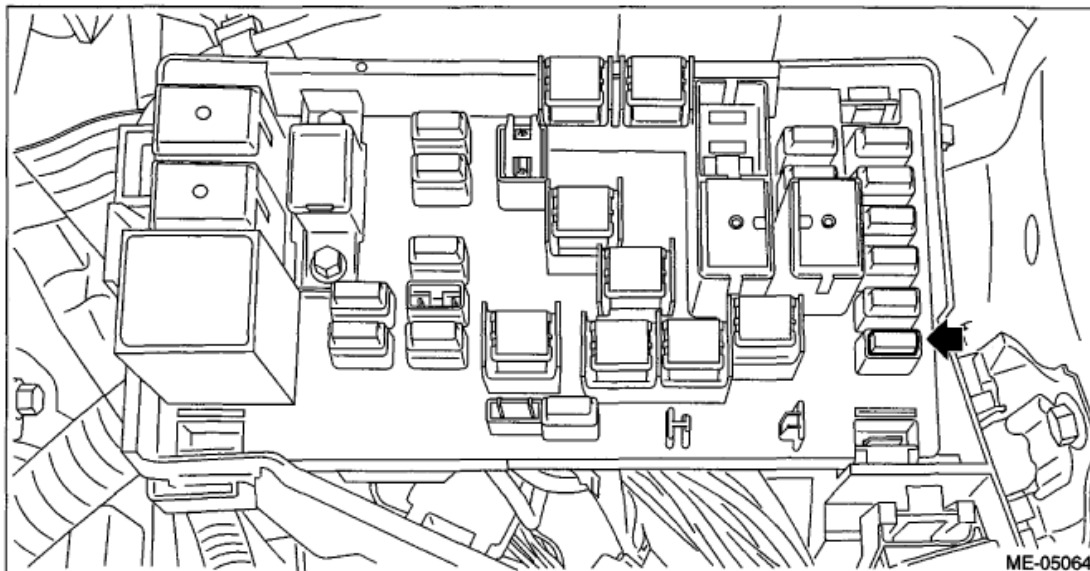


Fig. 8: Locating Fuse Of Fuel Pump Fuse Box
Courtesy of SUBARU OF AMERICA, INC.

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. < refer to **REMOVAL** , Spark Plug >
9. Connect the battery ground terminal.

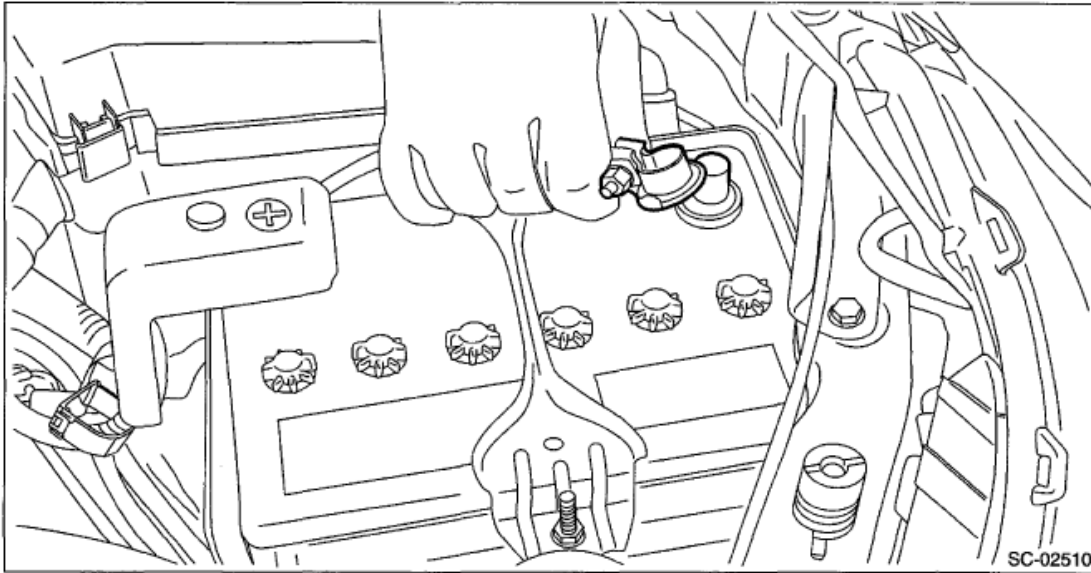


Fig. 9: Connecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

10. Install the compression gauge to the spark plug hole.

NOTE: When using a screw-in type compression gauge, the screw should be less than 25 mm (0.98 in) long.

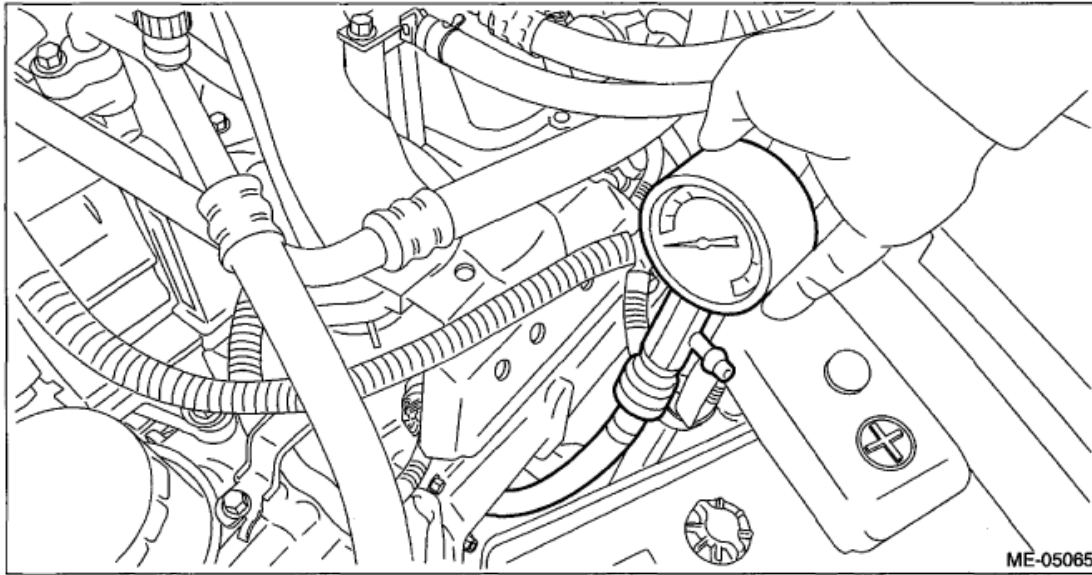


Fig. 10: Installing Compression Gauge To Spark Plug Hole
 Courtesy of SUBARU OF AMERICA, INC.

11. Turn the ignition switch to ON.
12. Fully open the throttle valve.
13. 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

1, 050 - 1, 400 kPa (11 - 14 kgf/cm² , 152 - 203 psi)

Difference between cylinders

100 kPa (1 kgf/cm² , 14 psi) or less

14. 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. < refer 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". < refer 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)

Idling speed (At no load; Select lever is in "P" or "N" range on AT model; Gear shift lever is in neutral position on MT model.):

Standard

675±100 rpm (AT model)

650±100 rpm (MT model)

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.)

Idling speed (With A/C ON; Select lever is in "P" or "N" range on AT model; Gear shift lever is in neutral position on MT model.):

Standard 850±100 rpm

IGNITION TIMING**INSPECTION**

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

1. Before checking the ignition timing, check the following item:
 1. Check the air cleaner element is free from clogging, spark plugs are in good condition, and hoses are connected properly.

2. Check the malfunction indicator light does not illuminate.
2. Warm up the engine.
3. Read the ignition timing using Subaru Select Monitor. < refer 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". < refer to **BASIC DIAGNOSTIC PROCEDURE** . >

Ignition timing [BTDC/rpm]:

Standard

16°±10°/675 (AT model)

16°±10°/650 (MT model)

INTAKE MANIFOLD VACUUM

INSPECTION

1. Warm up the engine.
2. Disconnect the brake booster vacuum hose from the intake manifold.

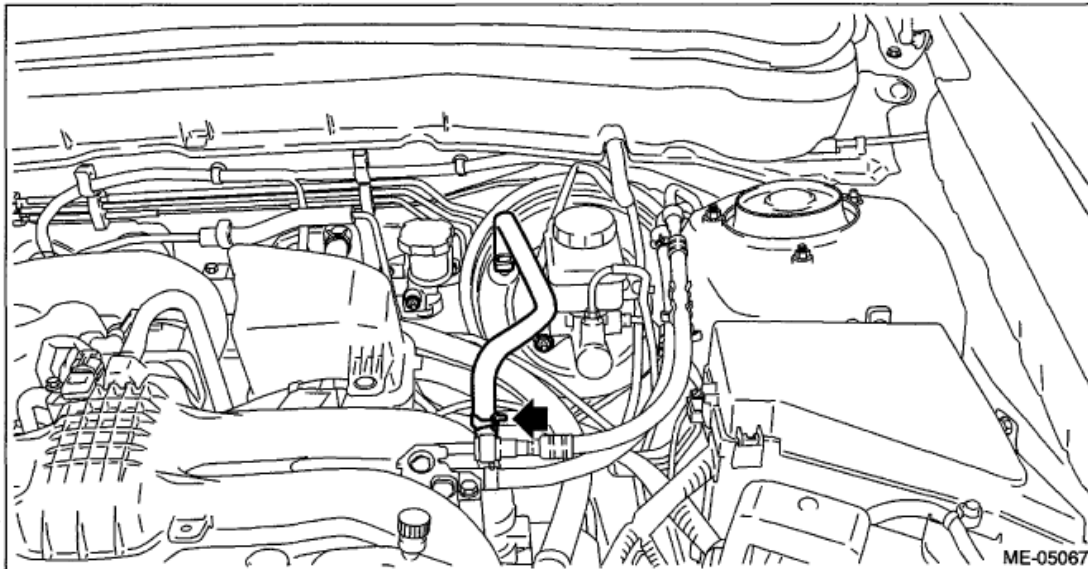


Fig. 11: Locating Brake Booster Vacuum Hose Of Intake Manifold
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the vacuum gauge to the intake manifold.

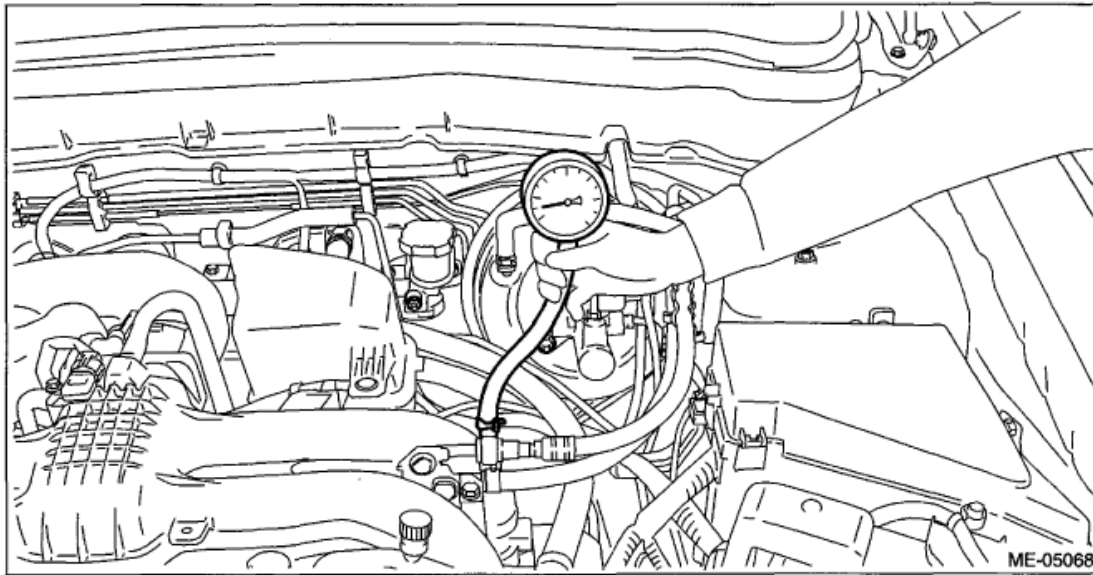


Fig. 12: Connecting Vacuum Gauge To Intake Manifold
 Courtesy of SUBARU OF AMERICA, INC.

4. 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 -60.0 kPa (-450 mmHg, -17.72 inHg) or more

INTAKE MANIFOLD 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

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

ENGINE OIL PRESSURE

INSPECTION

1. Disconnect the ground cable from battery.

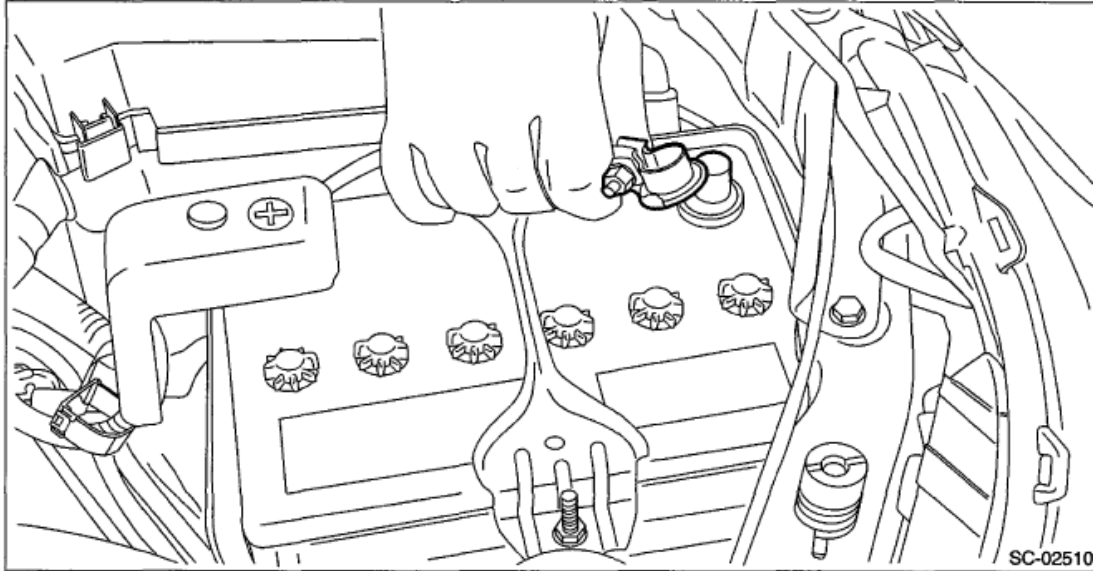


Fig. 13: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the oil pressure switch. < refer to **REMOVAL** , Oil Pressure Switch >
3. Install the oil pressure gauge to the chain cover.

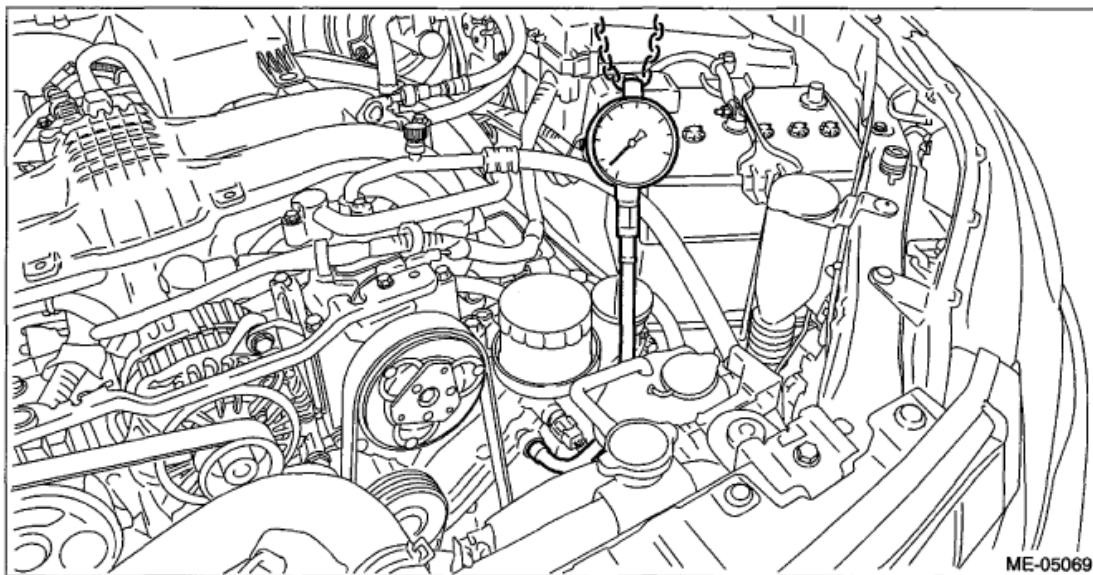


Fig. 14: Installing Oil Pressure Gauge To Chain Cover

Courtesy of SUBARU OF AMERICA, INC.

4. Connect the battery ground terminal.

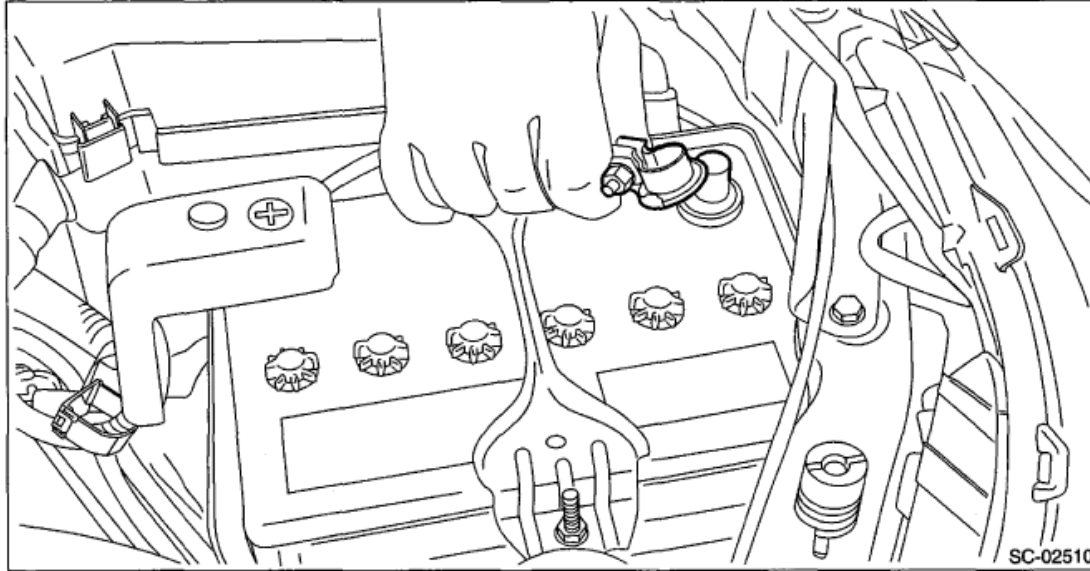


Fig. 15: Connecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

5. 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. < refer to INSPECTION , Engine Lubrication System Trouble in General >
- If the oil pressure warning light is ON and oil pressure is within standard, check the oil pressure switch. < refer to INSPECTION , Engine Lubrication System Trouble in General >

Engine oil pressure:

Standard

50 kPa (0.5 kgf/cm² , 7 psi) or more at 600 rpm

350 kPa (3.6 kgf/cm² , 51 psi) or more at 6, 000 rpm

6. 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. Release the fuel pressure. < refer to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel >
2. Open the fuel filler lid and remove the fuel filler cap.
3. Disconnect the fuel delivery hose from the fuel delivery pipe, and connect the 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

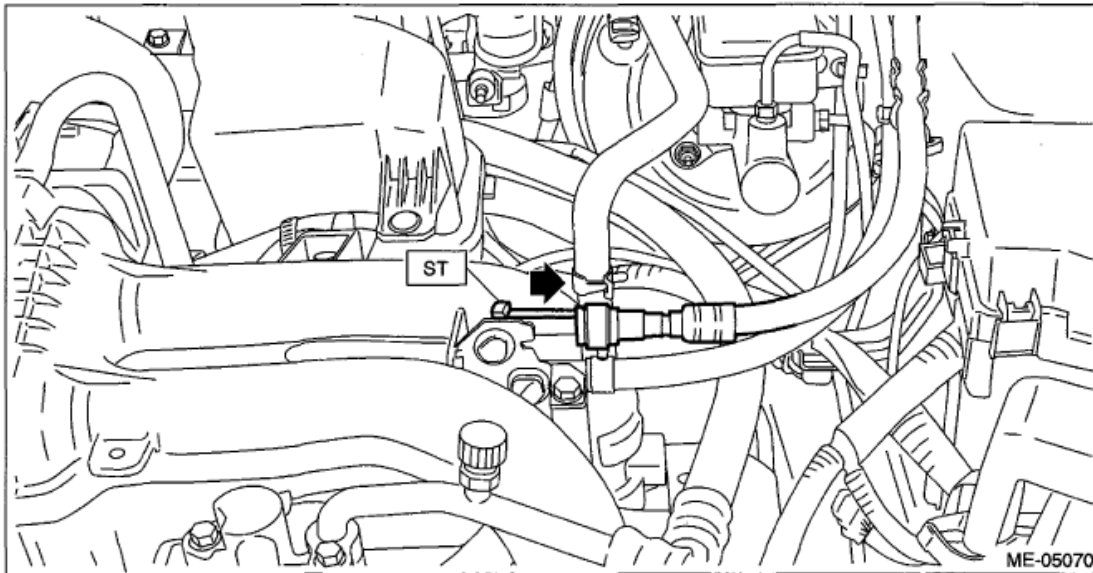


Fig. 16: Pushing ST In Quick Connector Of Fuel Delivery Hose
Courtesy of SUBARU OF AMERICA, INC.

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

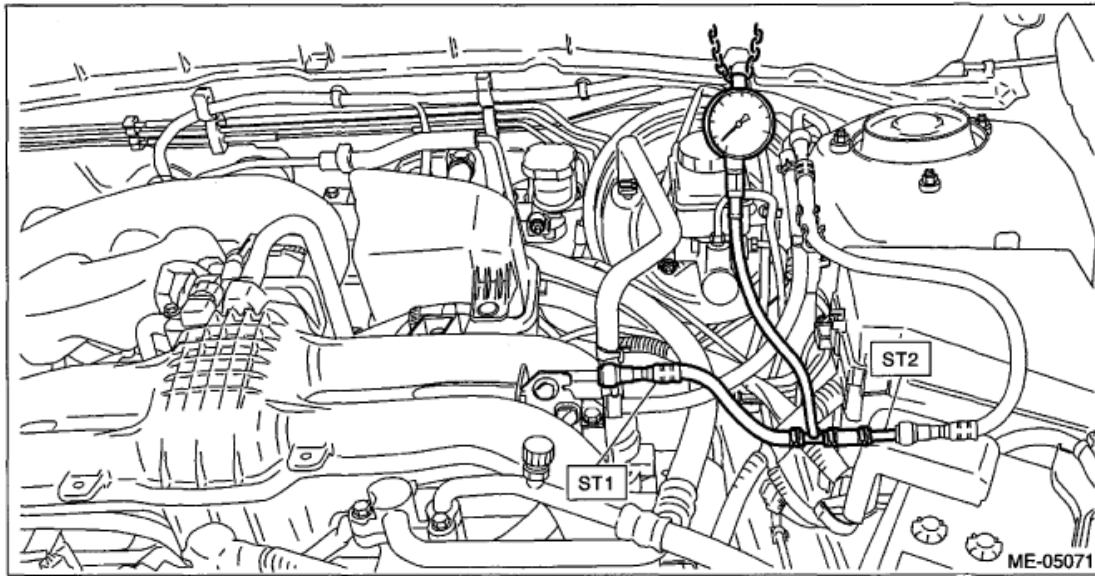


Fig. 17: Connecting Fuel Pressure Gauge With ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

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

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.
- Check or replace the fuel pump and fuel delivery line if the fuel pressure is out of the standard.

Fuel pressure:

Standard 340 - 400 kPa (3.5 - 4.1 kgf/cm² , 49 - 58 psi)

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

CAM CLEARANCE**INSPECTION****WHEN TIMING CHAIN ASSEMBLY IS NOT REMOVED**

CAUTION: When working on the vehicle, if engine oil is spilled onto the exhaust pipe, wipe it off with cloth to avoid emission of smoke or causing a fire.

NOTE:

- Inspection of cam clearance should be performed while engine is cold.
- If the engine is removed from vehicle, performing the step 1) and 2) is not necessary.

1. Disconnect the ground cable from battery.

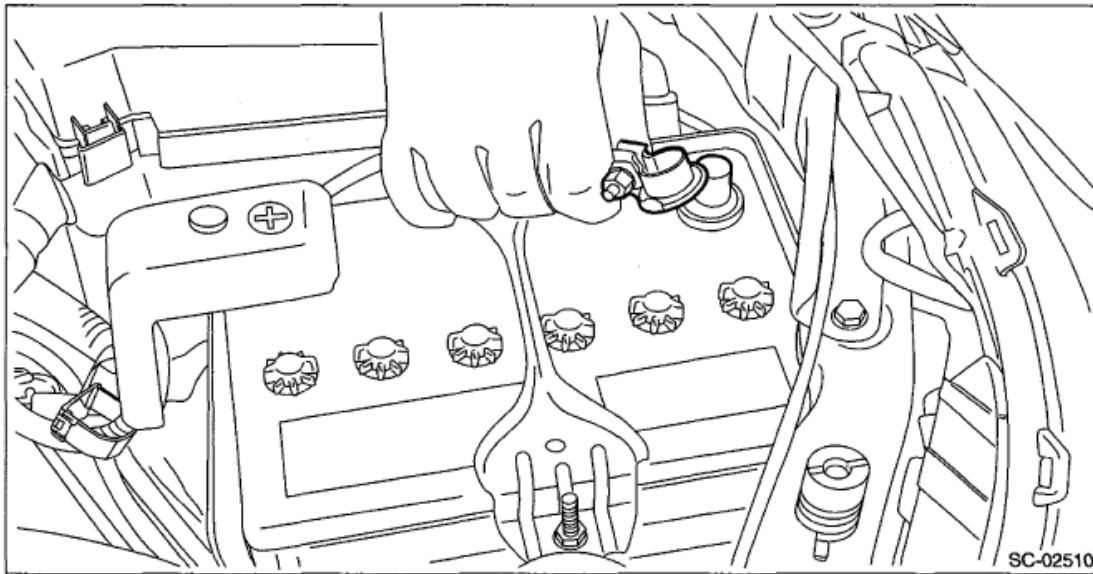


Fig. 18: Disconnecting Ground Cable From Battery
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake duct (Rear). < refer to **REMOVAL** , Air Intake Duct >
3. When inspecting #1 and #3 cylinders
 1. Remove the rocker cover RH. < refer to **ROCKER COVER RH**, REMOVAL, Rocker Cover >

NOTE: When working on the vehicle, place a suitable container under the vehicle.

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

NOTE: When the timing mark (A) on crank pulley is aligned to the 0° in timing gauge (B) on chain cover as shown in the figure, the #1 cylinder piston is located at TDC of compression stroke if the intake camshaft and exhaust camshaft does not depress the #1 cylinder intake side roller rocker arm (intake valve) and exhaust side roller rocker arm (exhaust valve). If roller rocker arm (valve) is depressed, turn the crank pulley by 360° in order to make #1 cylinder piston at TDC of compression stroke.

- When working on the vehicle

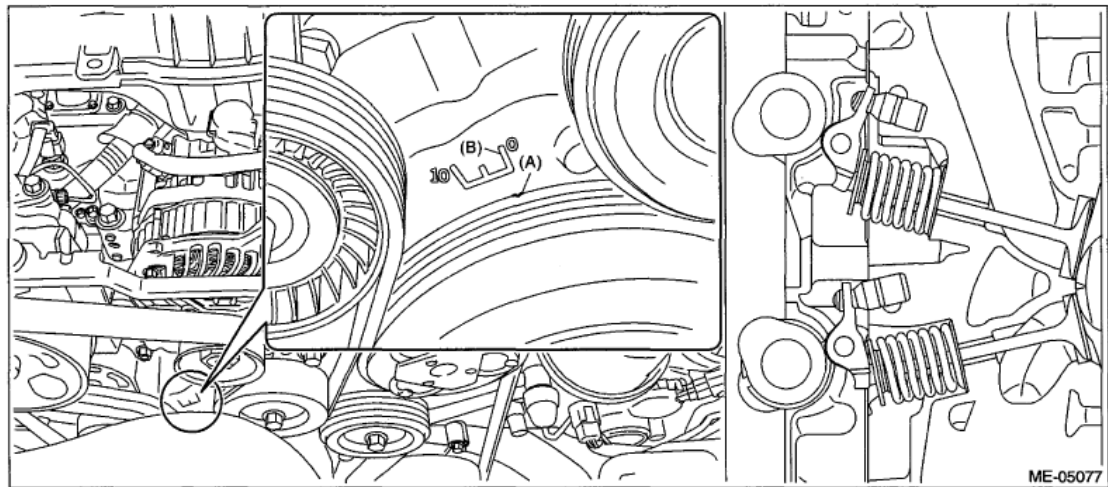


Fig. 19: Identifying Timing Mark On Crank Pulley (Working On Vehicle)
Courtesy of SUBARU OF AMERICA, INC.

- When working on the engine unit only

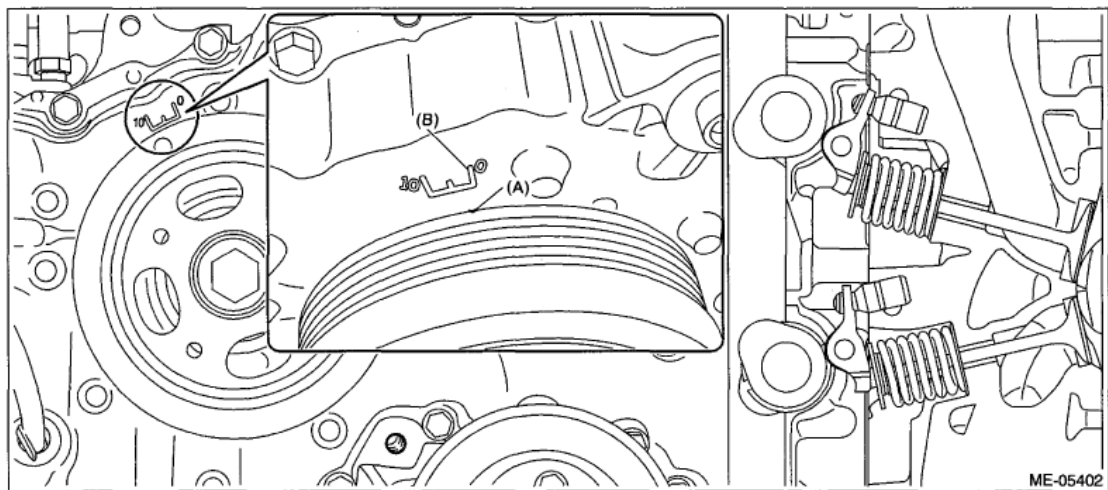


Fig. 20: Identifying Timing Mark On Crank Pulley (Working On Engine Unit)
Courtesy of SUBARU OF AMERICA, INC.

3. Check the cam clearance for #1 cylinder intake, #1 cylinder exhaust and #3 cylinder exhaust.

NOTE:

- Measure the roller surface of cam base circle and roller rocker arm using thickness gauge (A).
- If the measured value is out of standard, take notes of the value in order to adjust the cam clearance later on.

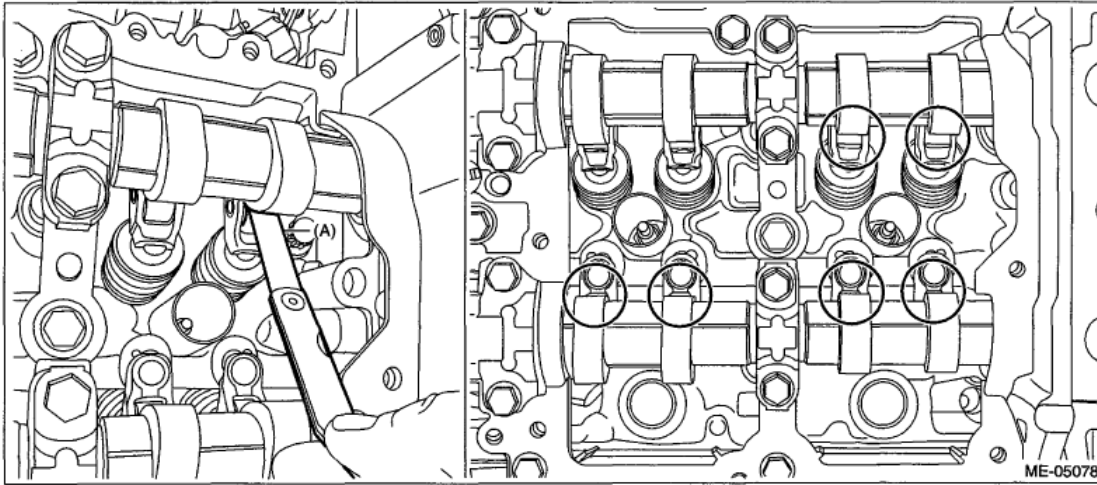
Cam clearance:***Intake******Standard 0.13 ± 0.03 mm (0.0051 ± 0.0012 in)******Exhaust******Standard 0.24 ± 0.03 mm (0.0094 ± 0.0012 in)***

Fig. 21: Measuring Roller Surface Of Cam Base Circle And Roller Rocker Arm Using Thickness Gauge

Courtesy of SUBARU OF AMERICA, INC.

4. Turn the crank pulley by 360°.
 - When working on the vehicle

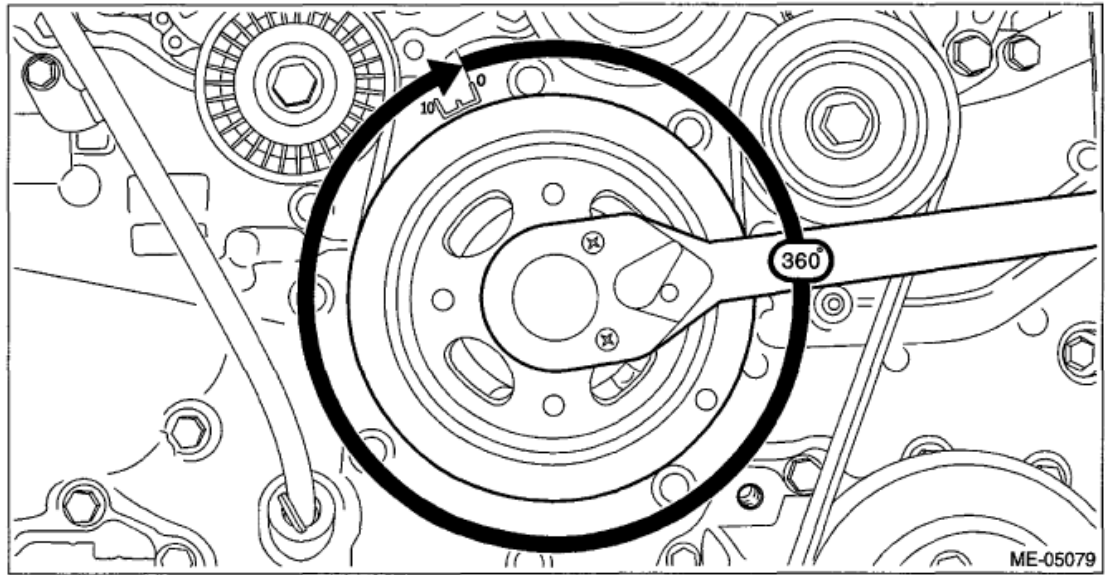


Fig. 22: Turning Crank Pulley (Working On Vehicle)
Courtesy of SUBARU OF AMERICA, INC.

- When working on the engine unit only

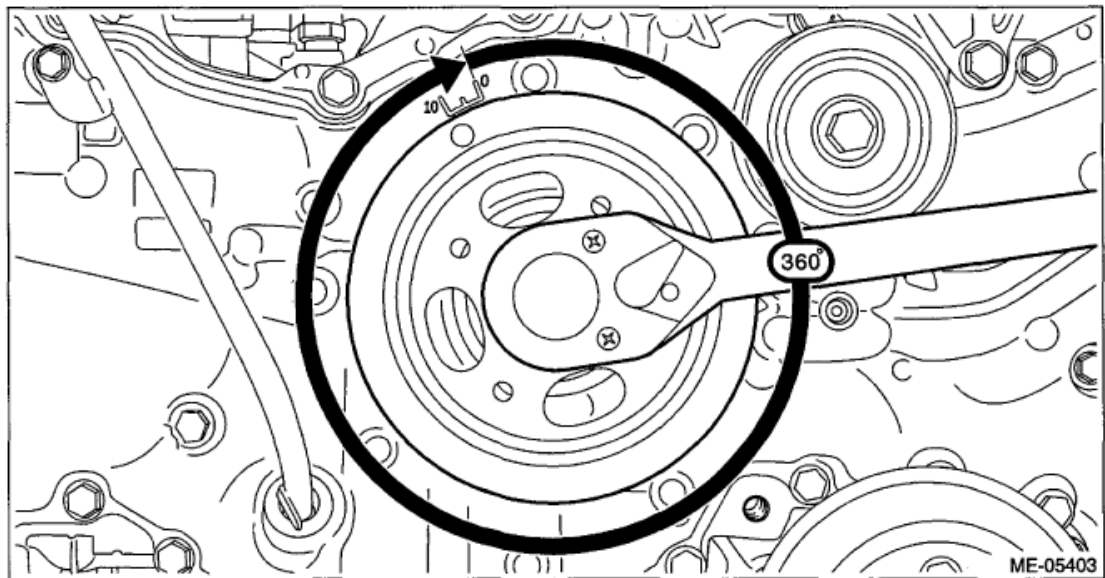


Fig. 23: Turning Crank Pulley (Working On Engine Unit)
Courtesy of SUBARU OF AMERICA, INC.

5. Check the clearance of #3 cylinder intake.

NOTE:

- Measure the roller surface of cam base circle and roller rocker arm using thickness gauge (A).
- If the measured value is out of standard, take notes of the value

in order to adjust the cam clearance later on.

Cam clearance:

Standard

0.13±0.03 mm (0.0051±0.0012 in)

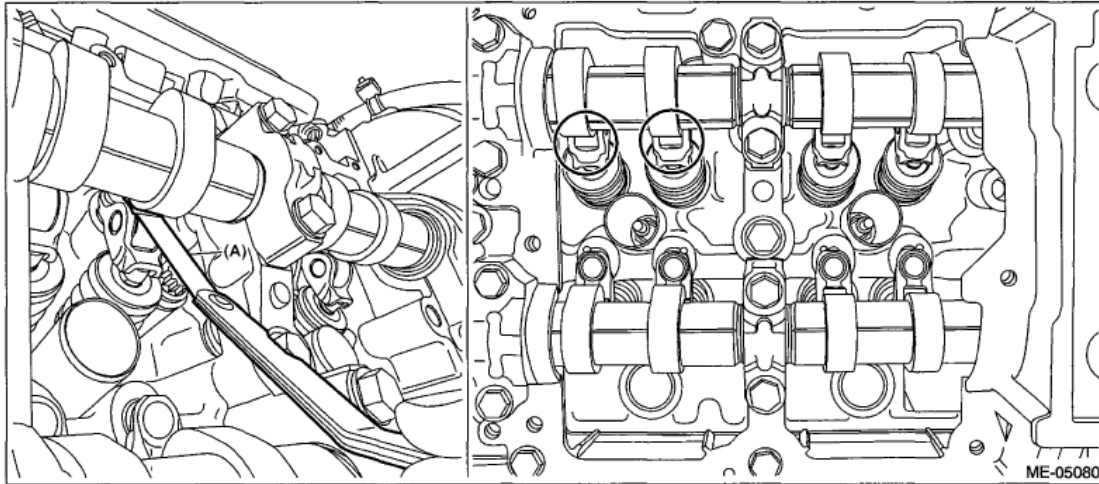


Fig. 24: Measuring Roller Surface Of Cam Base Circle And Roller Rocker Arm Using Thickness Gauge

Courtesy of SUBARU OF AMERICA, INC.

4. When inspecting #2 and #4 cylinders
 1. Remove the rocker cover LH. < refer to **ROCKER COVER LH, REMOVAL**, Rocker Cover >

NOTE: When working on the vehicle, place a suitable container under the vehicle.

2. Set #2 cylinder piston to top dead center of compression stroke by rotating the crank pulley clockwise using the socket wrench.

NOTE: When the timing mark (A) on crank pulley is aligned to the 0° in timing gauge (B) on chain cover as shown in the figure, the #2 cylinder piston is located at TDC of compression stroke if the intake camshaft and exhaust camshaft does not depress the #2 cylinder intake side roller rocker arm (intake valve) and exhaust side roller rocker arm (exhaust valve). If roller rocker arm (valve) is depressed, turn the crank pulley by 360° in order to make #2 cylinder piston at TDC of compression stroke.

- When working on the vehicle

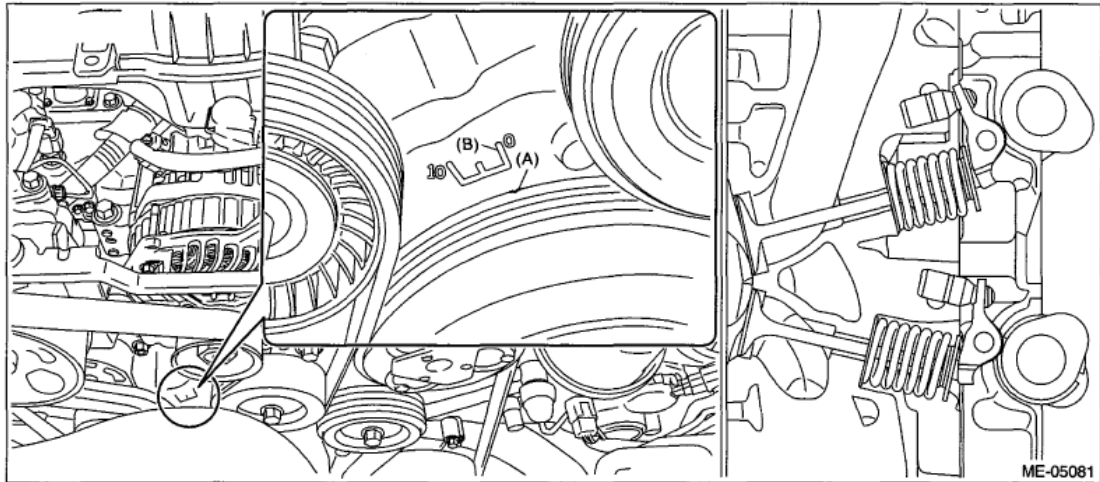


Fig. 25: Identifying Timing Mark On Crank Pulley (Working On Vehicle)
Courtesy of SUBARU OF AMERICA, INC.

- When working on the engine unit only

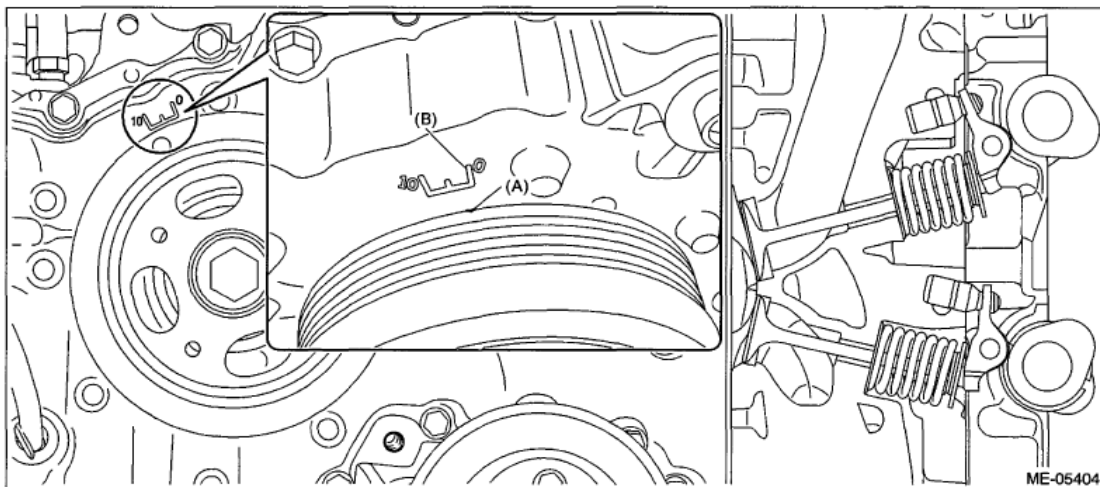


Fig. 26: Identifying Timing Mark On Crank Pulley (Working On Engine Unit)
Courtesy of SUBARU OF AMERICA, INC.

3. Check the cam clearance for #2 cylinder intake, #2 cylinder exhaust and #4 cylinder exhaust.

NOTE:

- Measure the roller surface of cam base circle and roller rocker arm using thickness gauge (A).
- If the measured value is out of standard, take notes of the value in order to adjust the cam clearance later on.

Cam clearance:

Intake

Standard 0.13±0.03 mm (0.0051±0.0012 in)

Exhaust

Standard

0.24±0.03 mm (0.0094±0.0012 in)

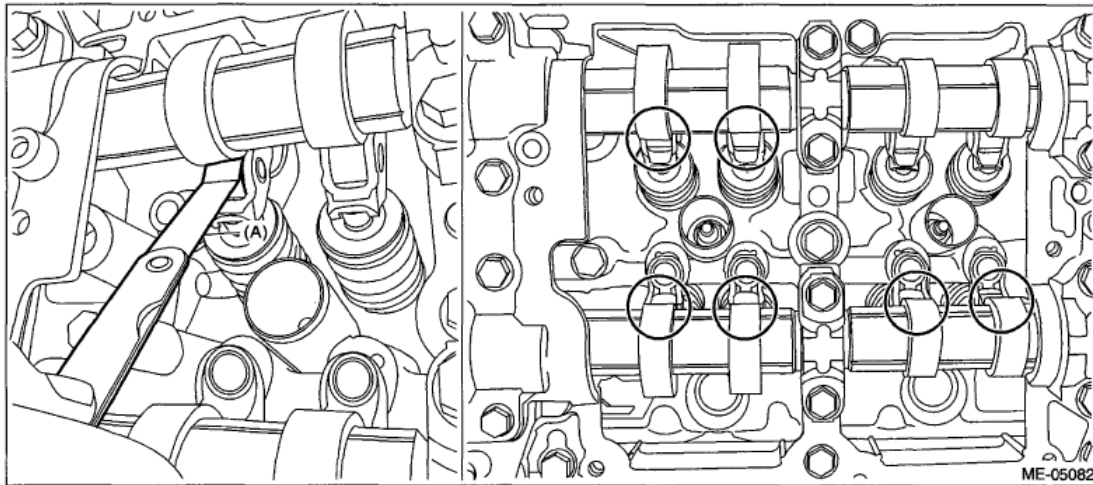


Fig. 27: Measuring Roller Surface Of Cam Base Circle And Roller Rocker Arm Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

4. Turn the crank pulley by 360°.
 - When working on the vehicle

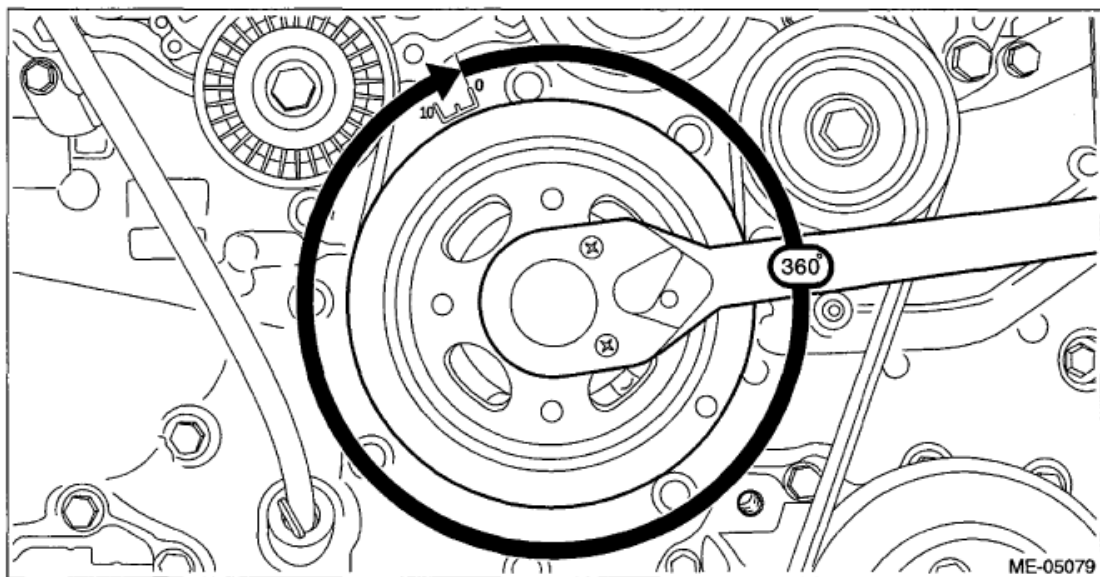


Fig. 28: Turning Crank Pulley (Working On Vehicle)

Courtesy of SUBARU OF AMERICA, INC.

- When working on the engine unit only

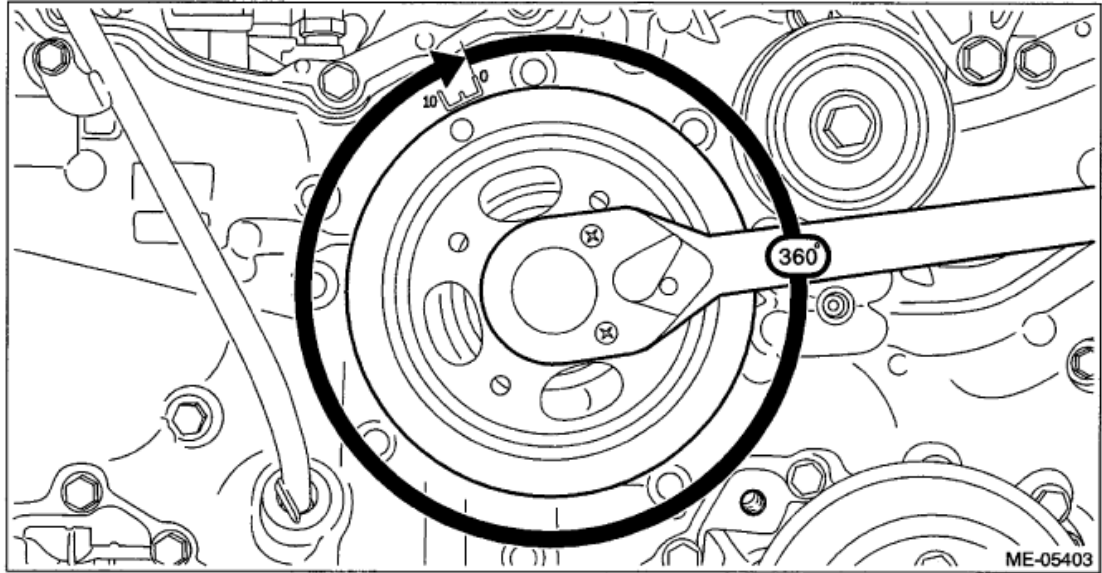


Fig. 29: Turning Crank Pulley (Working On Engine Unit)
Courtesy of SUBARU OF AMERICA, INC.

5. Check the clearance of #4 cylinder intake.

NOTE:

- Measure the roller surface of cam base circle and roller rocker arm using thickness gauge (A).
- If the measured value is out of standard, take notes of the value in order to adjust the cam clearance later on.

Cam clearance:

Standard

0.13±0.03 mm (0.0051±0.0012 in)

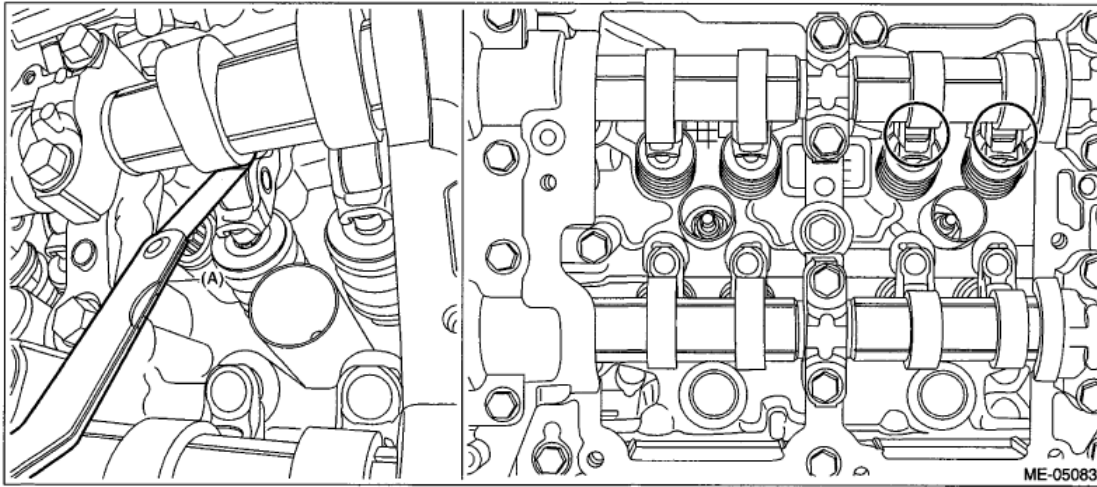


Fig. 30: Measuring Roller Surface Of Cam Base Circle And Roller Rocker Arm Using Thickness Gauge

Courtesy of SUBARU OF AMERICA, INC.

5. If necessary, adjust the cam clearance. < refer to ADJUSTMENT, Cam Clearance >
6. After inspection, install the related parts in the reverse order of removal.

WHEN TIMING CHAIN ASSEMBLY IS REMOVED

NOTE: Inspection of cam clearance should be performed while engine is cold.

1. When inspecting #1 and #3 cylinders
 1. Remove the rocker cover RH. < refer to ROCKER COVER RH, REMOVAL, Rocker Cover >

NOTE: When working on the vehicle, place a suitable container under the vehicle.

2. Check the #1 and #3 cylinder cam clearance.

CAUTION: Intake and exhaust camshafts can be independently rotated with the timing chain removed. When the intake valve and exhaust valve lift at the same time, the valve heads contact each other and valve stem may bend. Do not turn it to the outside of range of zero lift (cam base circle position) (in range where it can be turned lightly by hand).

- NOTE:**
- For cam clearance inspection, adjust the cam base circle position so that the thickness gauge (A) can be inserted easily by hand turning the camshaft (cam sprocket) to be measured.
 - Measure the roller surface of cam base circle and roller rocker arm using thickness gauge (A).

- If the measured value is out of standard, take notes of the value in order to adjust the cam clearance later on.

Cam clearance:

Intake

Standard

$0.13 \pm 0.03 \text{ mm } (0.0051 \pm 0.0012 \text{ in})$

Exhaust

Standard

$0.24 \pm 0.03 \text{ mm } (0.0094 \pm 0.0012 \text{ in})$

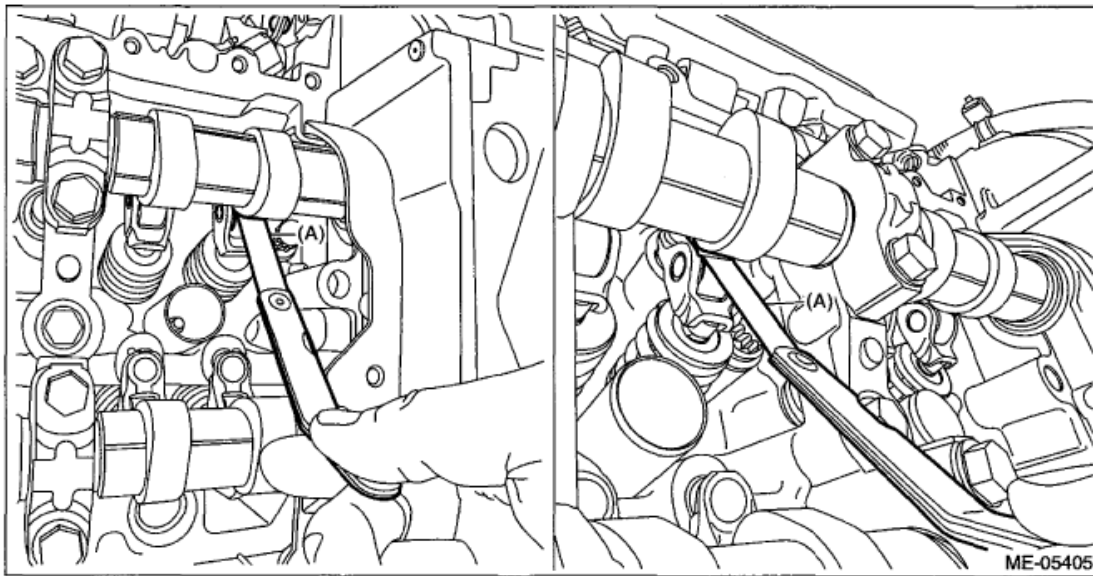


Fig. 31: Measuring Roller Surface Of Cam Base Circle And Roller Rocker Arm Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

2. When inspecting #2 and #4 cylinders
 1. Remove the rocker cover LH. < refer to **ROCKER COVER LH, REMOVAL**, Rocker Cover >

NOTE: When working on the vehicle, place a suitable container under the vehicle.

2. Check the #2 and #4 cylinder cam clearance.

CAUTION: Intake and exhaust camshafts can be independently rotated with the timing chain removed. When the intake valve and exhaust valve lift at the same time, the valve heads contact each other and valve stem may bend. Do not turn it to the outside of range of zero lift (cam base circle position) (in range where it can be turned lightly by hand).

NOTE:

- For cam clearance inspection, adjust the cam base circle position so that the thickness gauge (A) can be inserted easily by hand turning the camshaft (cam sprocket) to be measured.
- Measure the roller surface of cam base circle and roller rocker arm using thickness gauge (A).
- If the measured value is out of standard, take notes of the value in order to adjust the cam clearance later on.

Cam clearance:

Intake

Standard

$0.13 \pm 0.03 \text{ mm } (0.0051 \pm 0.0012 \text{ in})$

Exhaust

Standard

$0.24 \pm 0.03 \text{ mm } (0.0094 \pm 0.0012 \text{ in})$

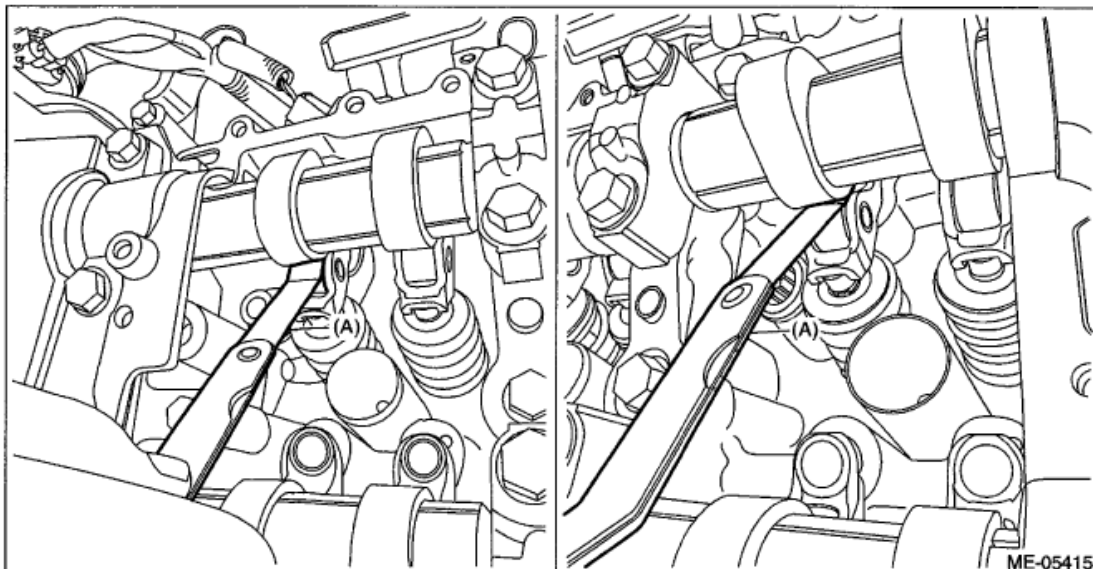


Fig. 32: Measuring Roller Surface Of Cam Base Circle And Roller Rocker Arm Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. If necessary, adjust the cam clearance. < refer to **ADJUSTMENT**, Cam Clearance >
4. After inspection, install the related parts in the reverse order of removal.

ADJUSTMENT

1. Remove the engine from the vehicle. < refer to **REMOVAL**, Engine Assembly >
2. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
3. When adjusting #1 and #3 cylinders
 1. Remove the timing chain RH. < refer to **TIMING CHAIN RH**, REMOVAL, Timing Chain Assembly >
 2. Remove the cam carrier RH. < refer to **CAM CARRIER RH**, REMOVAL, Cam Carrier >
 3. Measure the thickness of valve shim using micrometer.

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

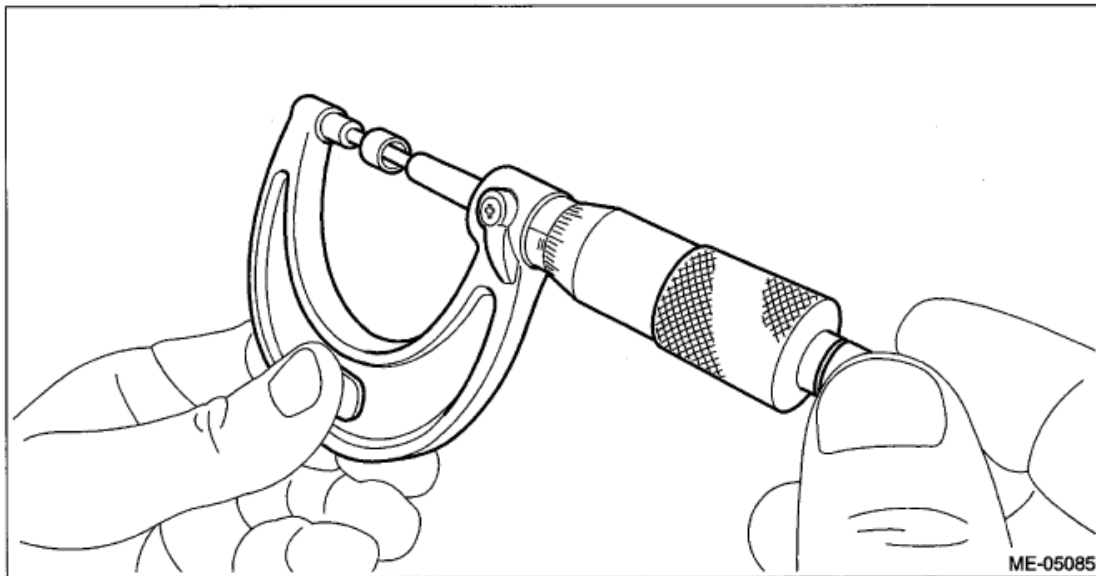


Fig. 33: Measuring Thickness Of Valve Shim Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

4. Select a valve shim of suitable thickness using the measured cam clearance and valve shim thickness.

NOTE: Use a new valve shim.

VALVE SHIM SPECIFICATION CHART

Formula
Intake side: $S = T + 1.54 \times (V - 0.13 \text{ mm (0.0051 in)})$
Exhaust side: $S = T + 1.69 \times (V - 0.24 \text{ mm (0.0094 in)})$
S: Valve shim thickness required
V: Measured cam clearance
T: Valve shim thickness to be used

5. Install the cam carrier RH. < refer to CAM CARRIER RH, INSTALLATION, Cam Carrier >
6. Check all the cam clearance of RH side at this time. If the cam clearance is not within the standard value, repeat the procedure over again from step 2).

NOTE: When the removing/installing of cam carrier RH has been performed, cam clearance may be outside the standard value. Checking of all cam clearance of RH side is necessary. Refer to INSPECTION of "Cam Clearance" for the cam clearance inspection. < refer to WHEN TIMING CHAIN ASSEMBLY IS REMOVED, INSPECTION, Cam Clearance >

Cam clearance:

Intake

Standard

0.13±0.03 mm (0.0051±0.0012 in)

Exhaust

Standard

0.24±0.03 mm (0.0094±0.0012 in)

4. When adjusting #2 and #4 cylinders
 1. Remove the timing chain LH. < refer to TIMING CHAIN LH, REMOVAL, Timing Chain Assembly >
 2. Remove the cam carrier LH. < refer to CAM CARRIER LH, REMOVAL, Cam Carrier >
 3. Measure the thickness of valve shim using micrometer.

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

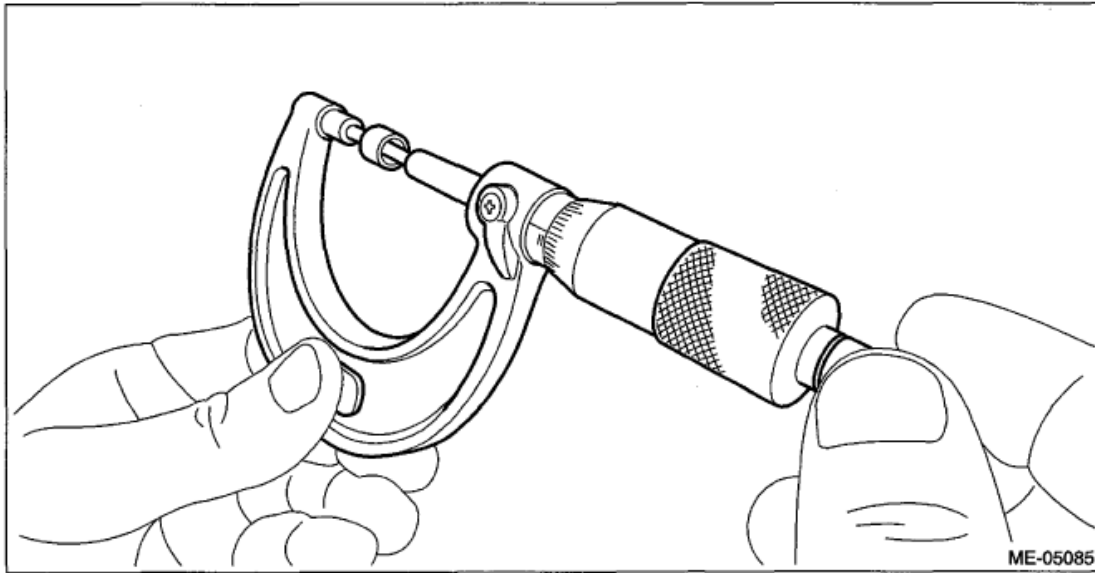


Fig. 34: Measuring Thickness Of Valve Shim Using Micrometer
 Courtesy of SUBARU OF AMERICA, INC.

4. Select a valve shim of suitable thickness using the measured cam clearance and valve shim thickness.

NOTE: Use a new valve shim.

VALVE SHIM SPECIFICATION CHART

Formula
Intake side: $S = T + 1.54 \times (V - 0.13 \text{ mm (0.0051 in)})$
Exhaust side: $S = T + 1.69 \times (V - 0.24 \text{ mm (0.0094 in)})$
S: Valve shim thickness required
V: Measured cam clearance
T: Valve shim thickness to be used

5. Install the cam carrier LH. < refer to **CAM CARRIER LH, INSTALLATION**, Cam Carrier >
6. Check all the cam clearance of LH side at this time. If the cam clearance is not within the standard value, repeat the procedure over again from step 2).

NOTE: When the removing/installing of cam carrier LH has been performed, cam clearance may be outside the standard value. Checking of all cam clearance of LH side is necessary. Refer to **INSPECTION of "Cam Clearance"** for the cam clearance inspection. < refer to **WHEN TIMING CHAIN ASSEMBLY IS REMOVED, INSPECTION, Cam Clearance** >

Cam clearance:

*Intake**Standard**0.13±0.03 mm (0.0051±0.0012 in)**Exhaust**Standard**0.24±0.03 mm (0.0094±0.0012 in)*

5. 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.

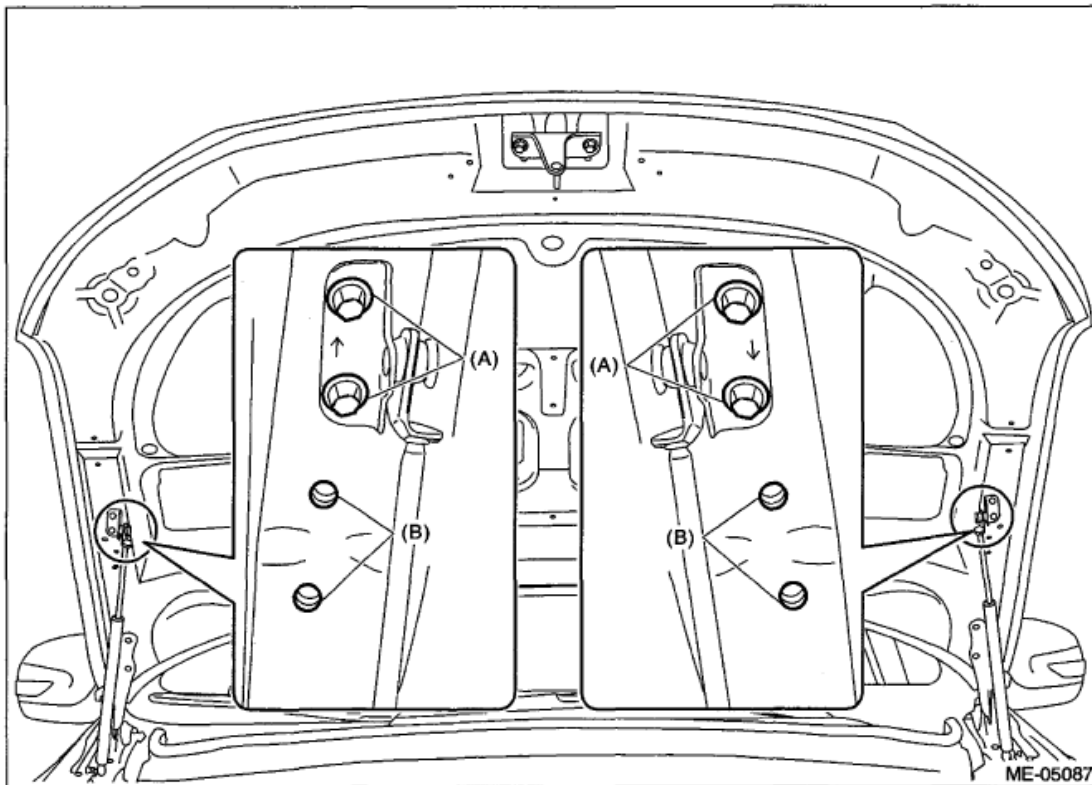
Tightening torque: 7.5 N.m (0.8 kgf-m, 5.5 ft-lb)

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

2. Remove the V-belt covers.

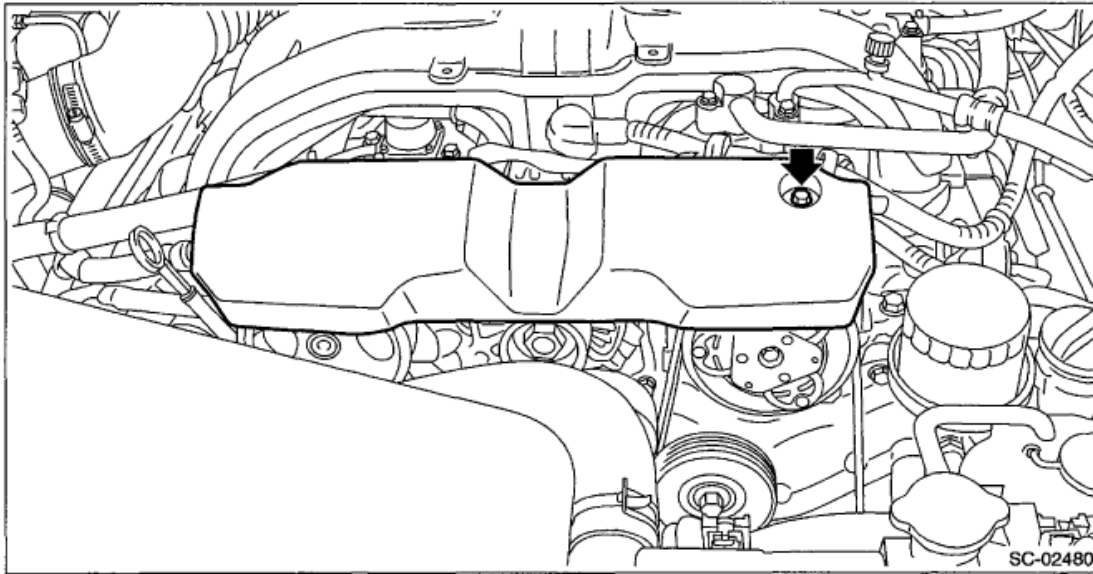


Fig. 36: Locating V-Belt Cover Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Collect the refrigerant from A/C system. < refer to **REFRIGERANT RECOVERY PROCEDURE** . >
4. Release the fuel pressure. < refer to **RELEASING OF FUEL PRESSURE** , PROCEDURE, Fuel >
5. Remove the battery. < refer to **REMOVAL** , Battery >
6. Remove the air intake duct (Rear). < refer to **REMOVAL** , Air Intake Duct >
7. Remove the air intake boot. < refer to **REMOVAL** , Air Intake Boot >
8. Disconnect the connector (A) from the mass air flow and intake air temperature sensor, and remove the clip (6) which holds the mass air flow and intake air temperature sensor harness.
9. Remove the suction hose (C) from the air cleaner case (rear).

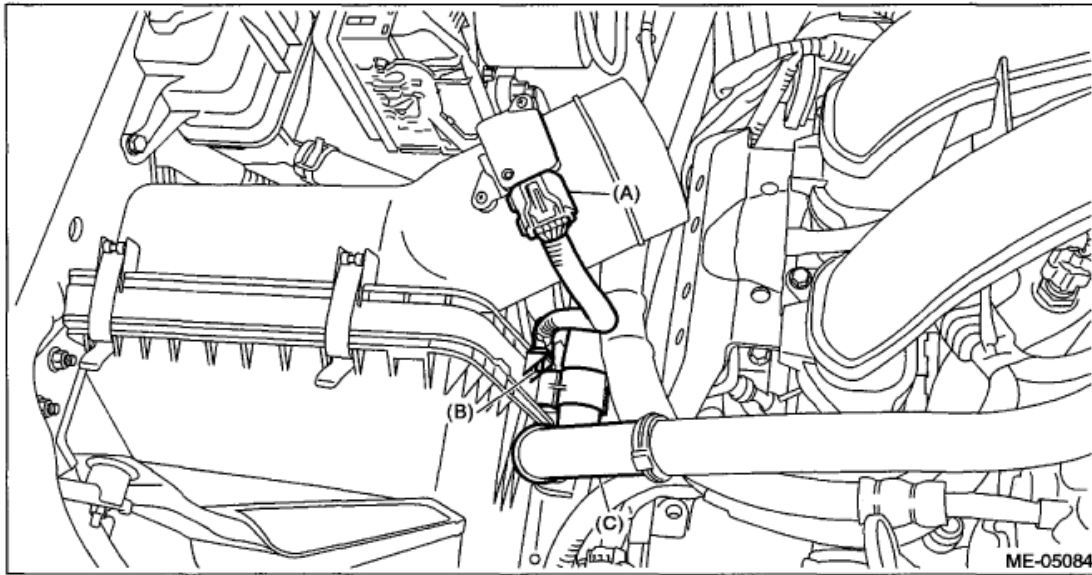


Fig. 37: Identifying Air Cleaner Case Suction Hose, Clip, Mass Air Flow And Intake Air Temperature Sensor Connector
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the air cleaner case (rear).

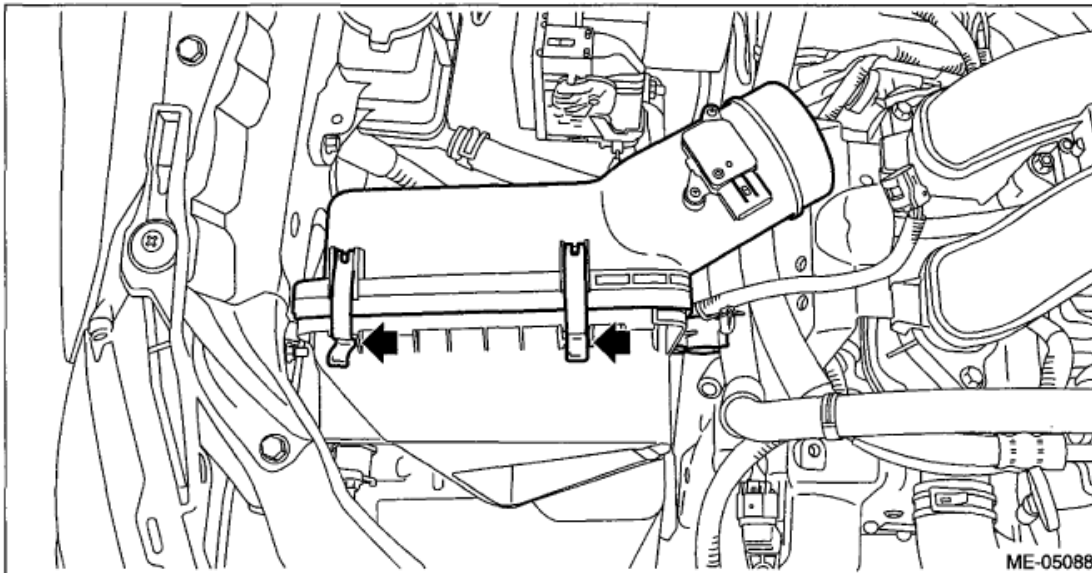


Fig. 38: Locating Air Cleaner Case Clamps (Rear)
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the radiator. < refer to **REMOVAL** , Radiator >
12. Disconnect the engine harness connector.
 1. Remove the bolt securing the bulkhead harness connector bracket.

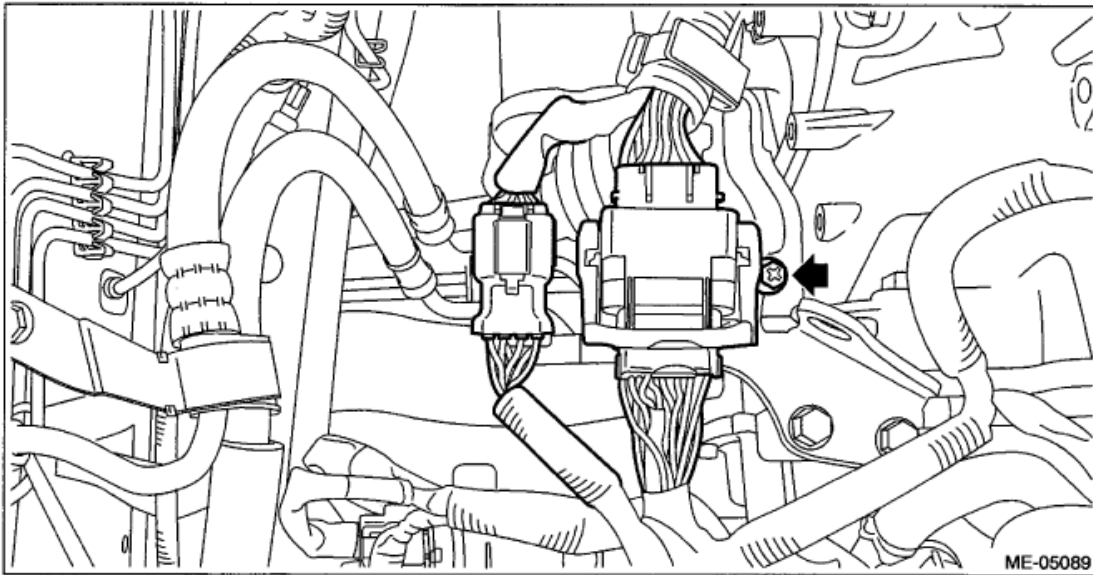


Fig. 39: Locating Bulkhead Harness Connector Bracket Bolt
Courtesy of SUBARU OF AMERICA, INC.

2. Disconnect the bulkhead harness connector from the engine harness connector (black) and engine harness connector (brown).

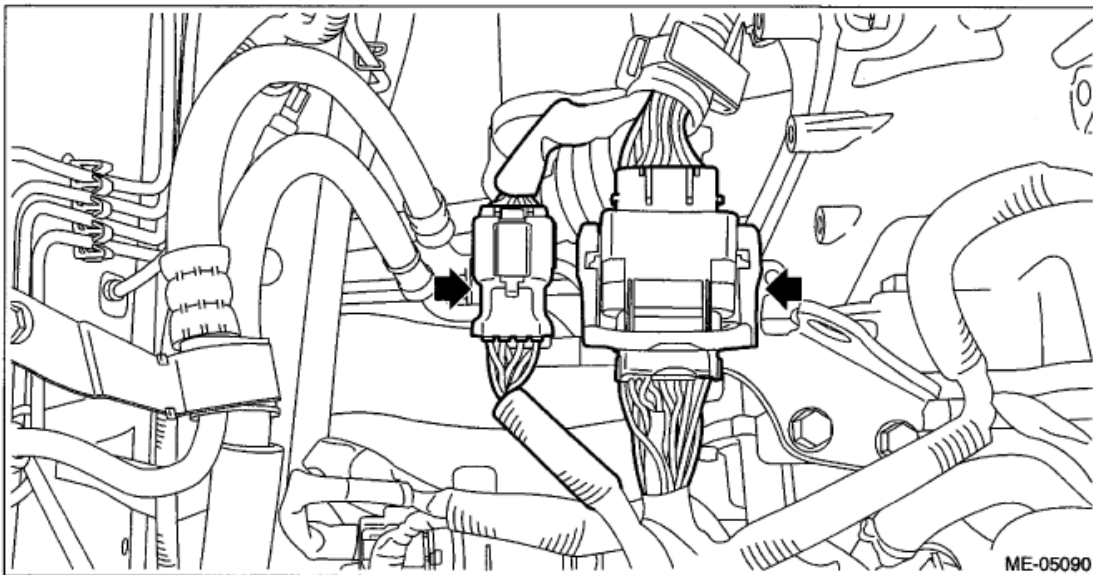


Fig. 40: Locating Bulkhead Harness Connector And Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the bolts which secure the generator cord stay to the chain cover.

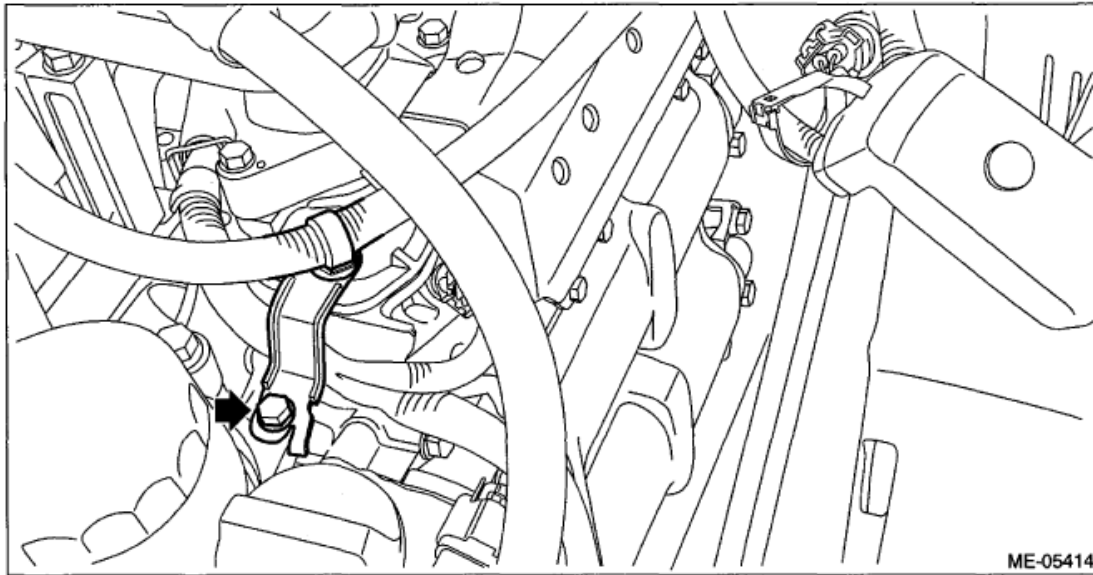


Fig. 41: Locating Generator Cord Stay Bolt
Courtesy of SUBARU OF AMERICA, INC.

14. Disconnect connector (A) and terminal (B) from the generator, and disconnect connector (C) from A/C compressor.
15. Remove the generator cord from the clip (D) and move the generator cord to the left side wheel apron.

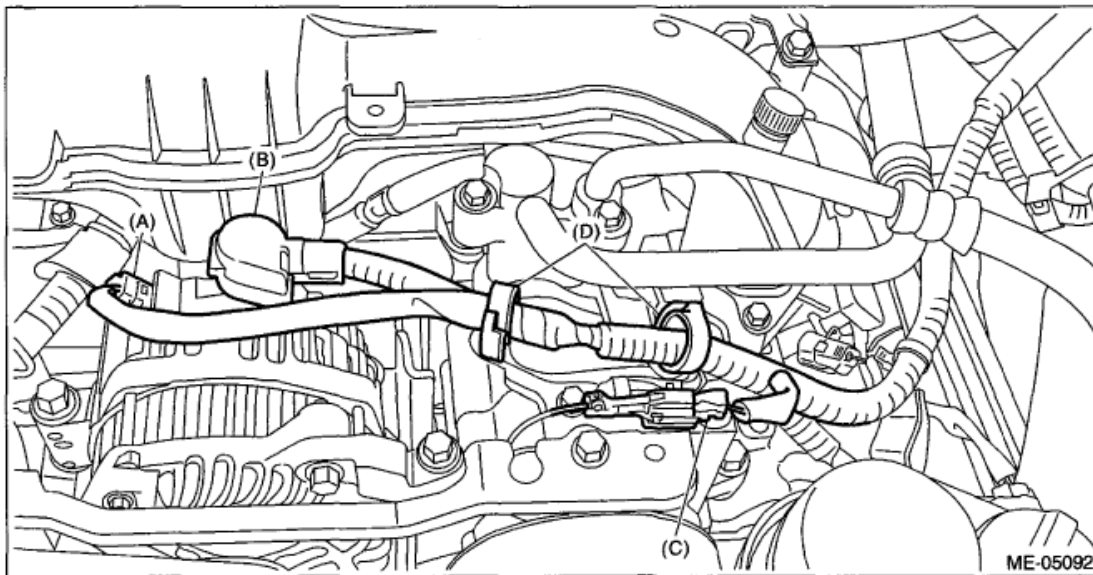


Fig. 42: Identifying Clip, A/C Compressor Connector, Generator Connector And Terminal
Courtesy of SUBARU OF AMERICA, INC.

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

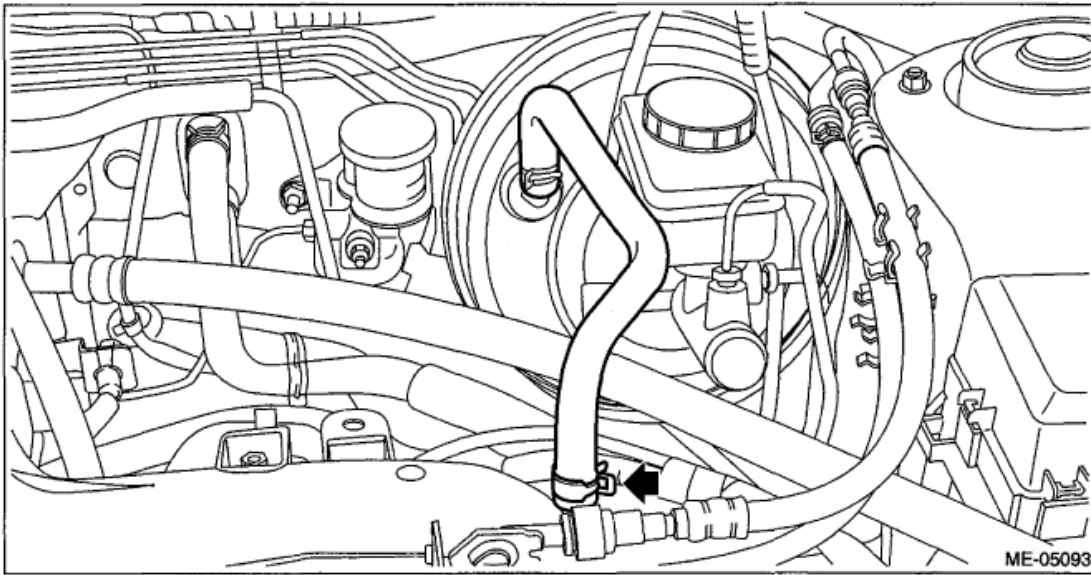


Fig. 43: Locating Brake Booster Vacuum Hose Clamp
Courtesy of SUBARU OF AMERICA, INC.

3. Heater inlet hose and heater outlet hose

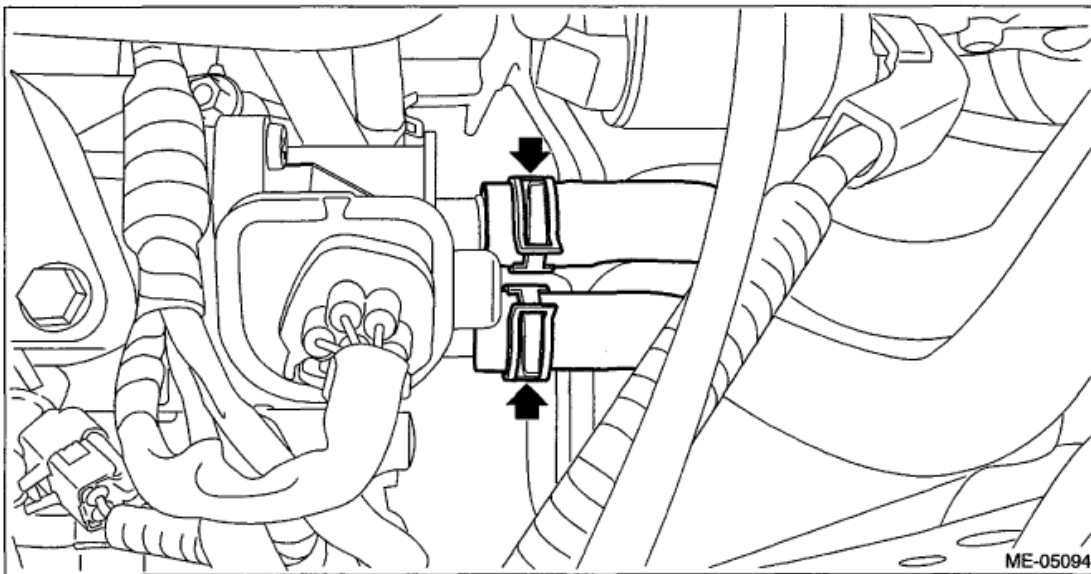


Fig. 44: Locating Inlet Hose And Heater Outlet Hose Clamps
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the power steering pump.
 1. Remove the V-belts. < refer to **REMOVAL**, V-belt >
 2. Remove the generator. < refer to **REMOVAL**, Generator >
 3. Disconnect the connector from power steering pump switch.

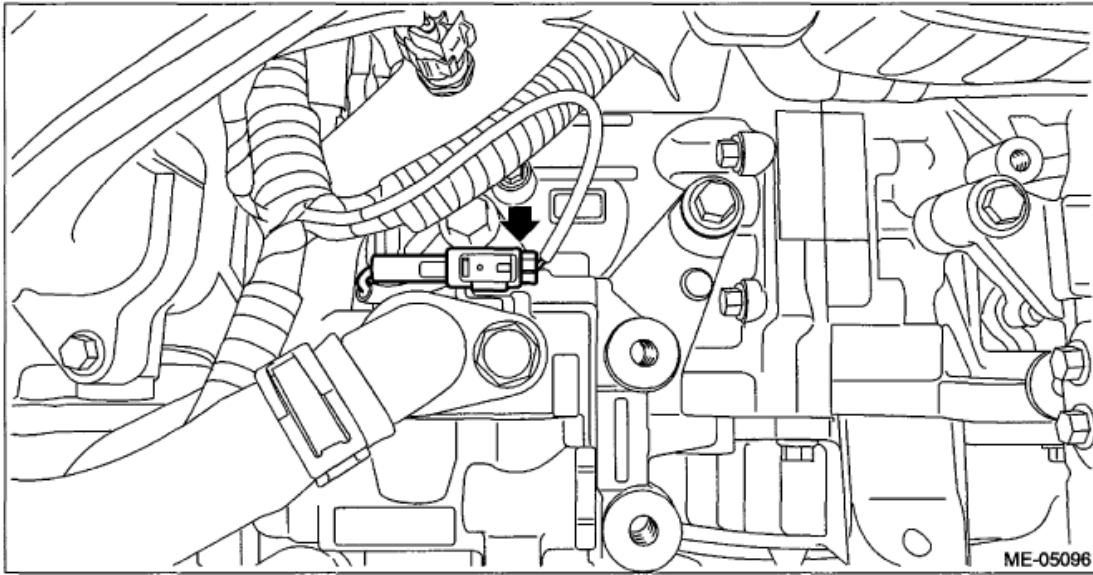


Fig. 45: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the power steering pump from the engine.

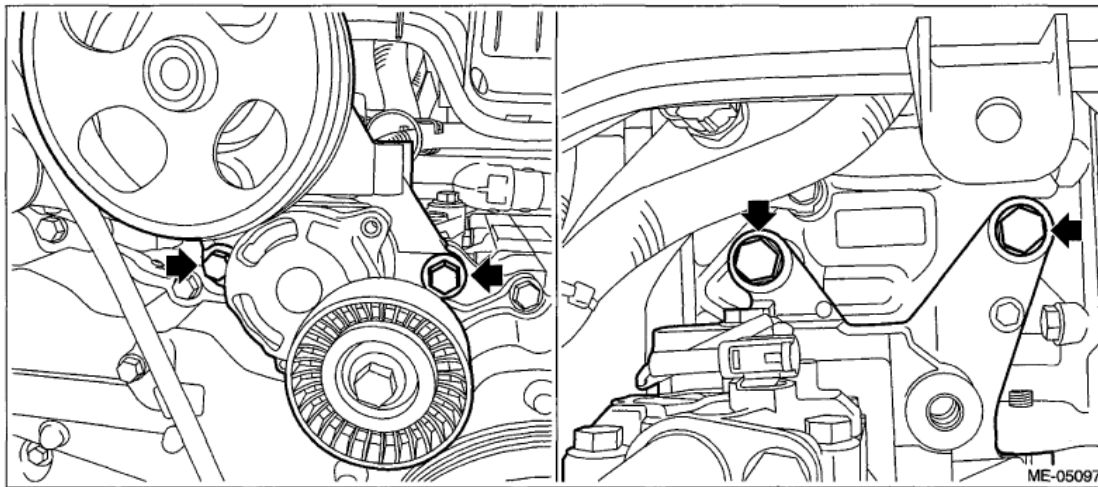


Fig. 46: Locating Engine Power Steering Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Place the power steering pump on the right side wheel apron.
18. Lift up the vehicle.
19. Remove the front exhaust pipe. < refer to **REMOVAL** , Front Exhaust Pipe >
20. Disconnect the ground cable on the engine side.

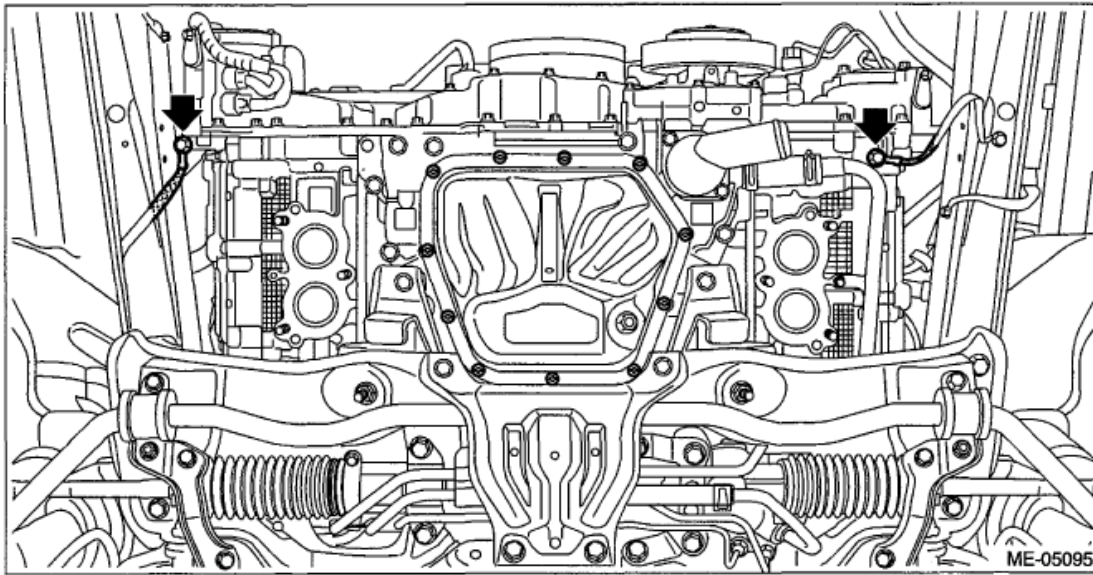


Fig. 47: Locating Ground Cable Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

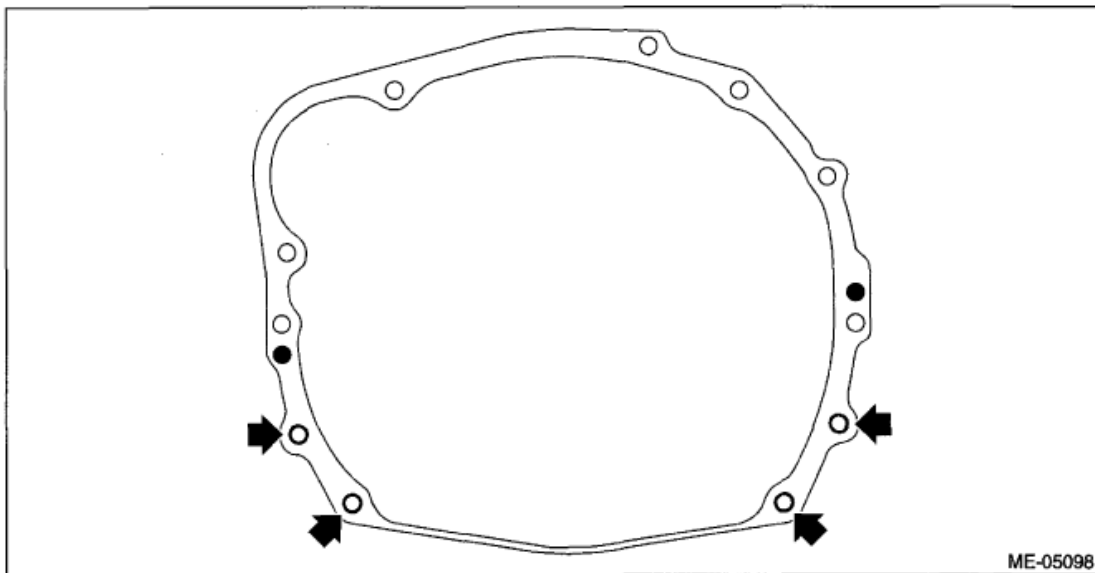


Fig. 48: Locating Lower Side Of Transmission Gasket Bolts And Nuts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

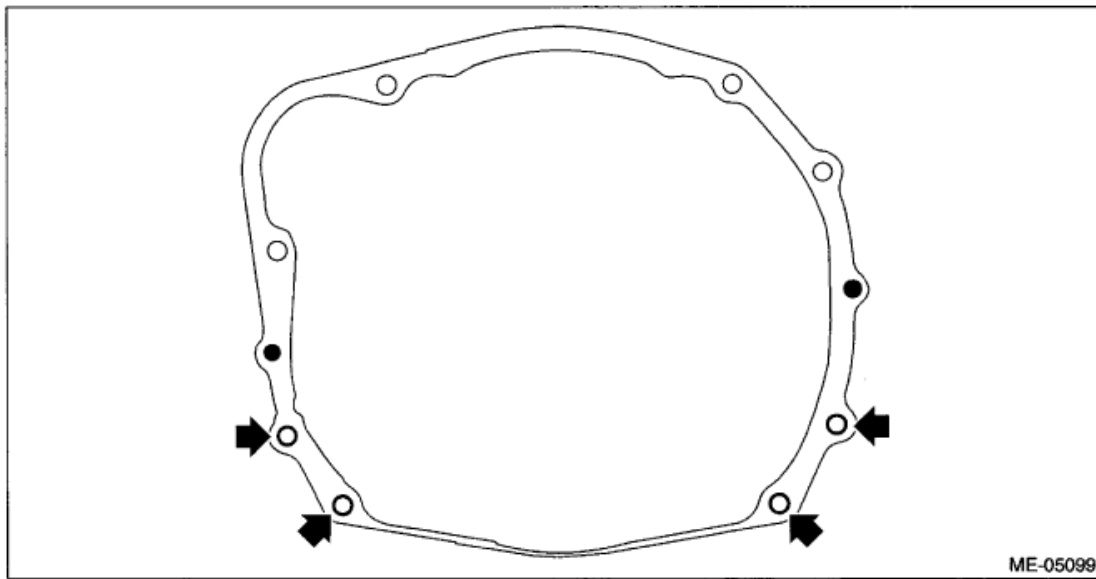


Fig. 49: Locating Lower Side Of Transmission Gasket Bolts And Nuts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

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

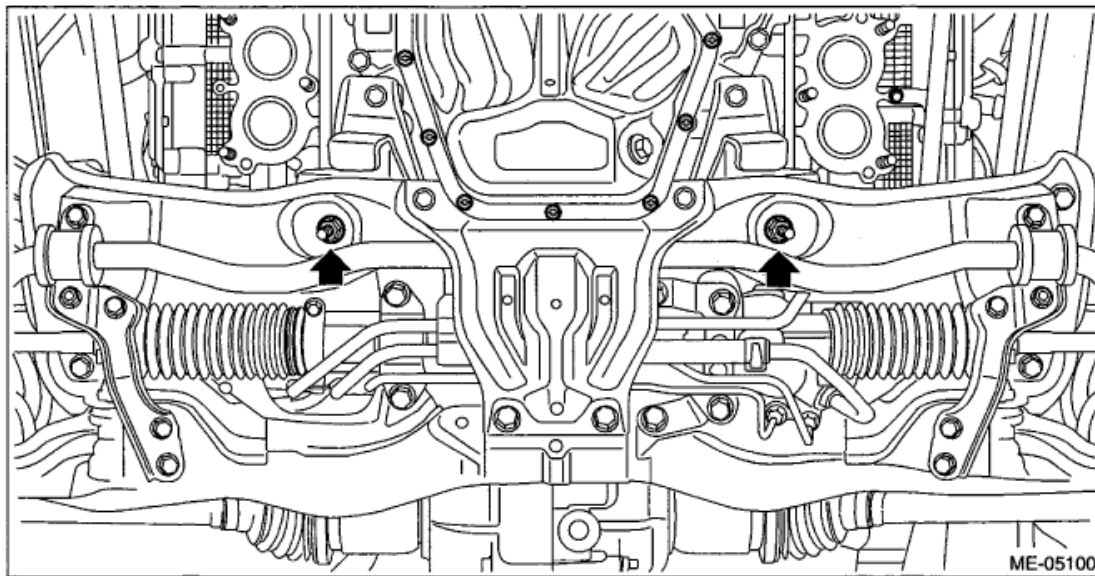


Fig. 50: Locating Front Crossmember Engine Mounting Nuts
Courtesy of SUBARU OF AMERICA, INC.

23. Separate the torque converter clutch from the drive plate. (AT model)
1. Lower the vehicle.
 2. Remove the service hole plug.
 3. 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.

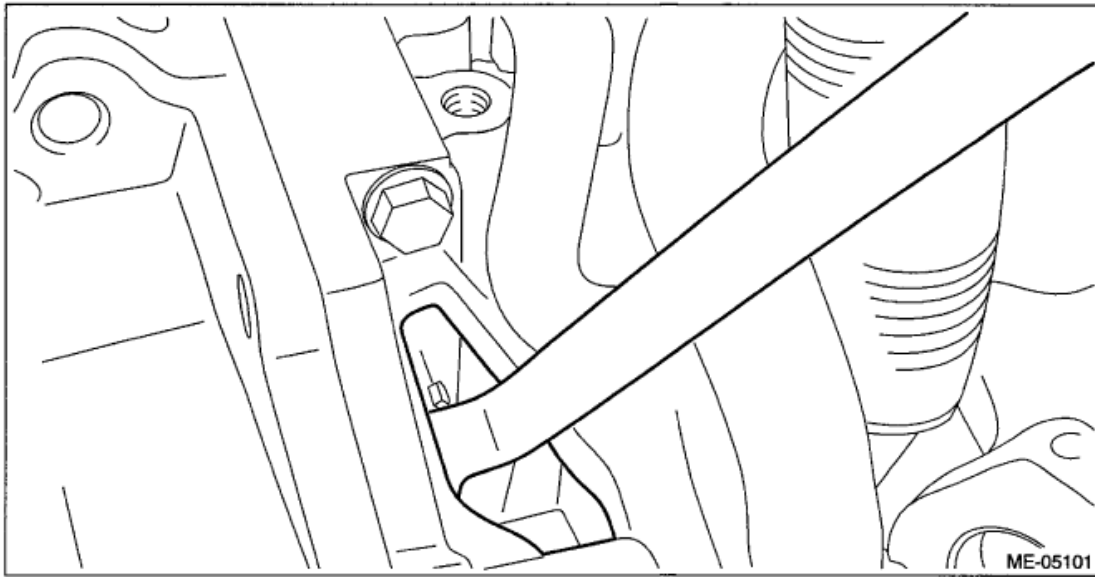


Fig. 51: Separating Torque Converter Clutch From Drive Plate (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

24. Remove the pitching stopper.

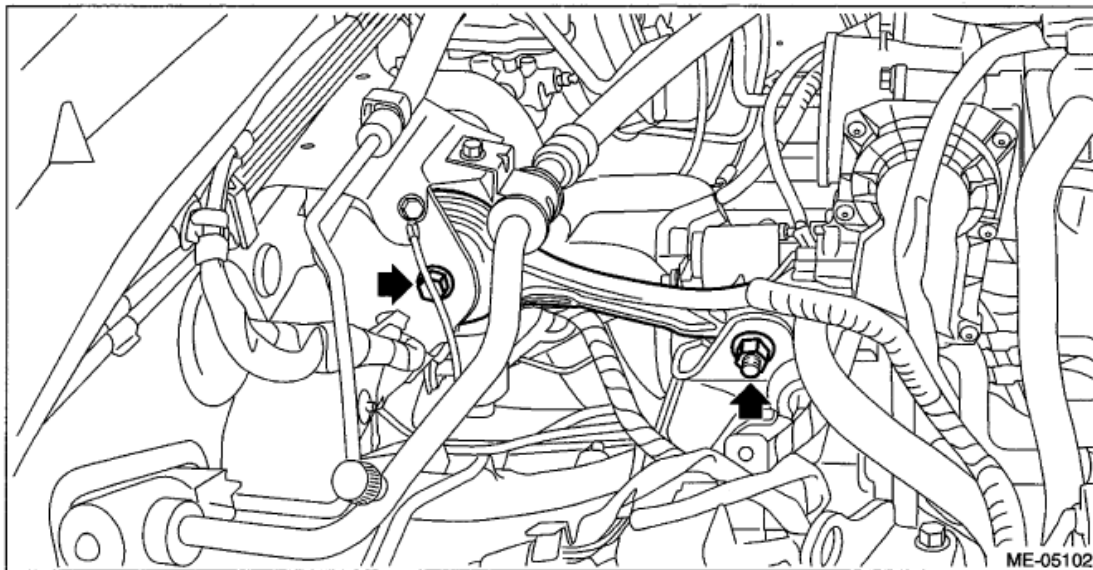


Fig. 52: Locating Pitching Stopper Bolt And Nut
Courtesy of SUBARU OF AMERICA, INC.

25. Disconnect the fuel delivery hose and evaporation hose.

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

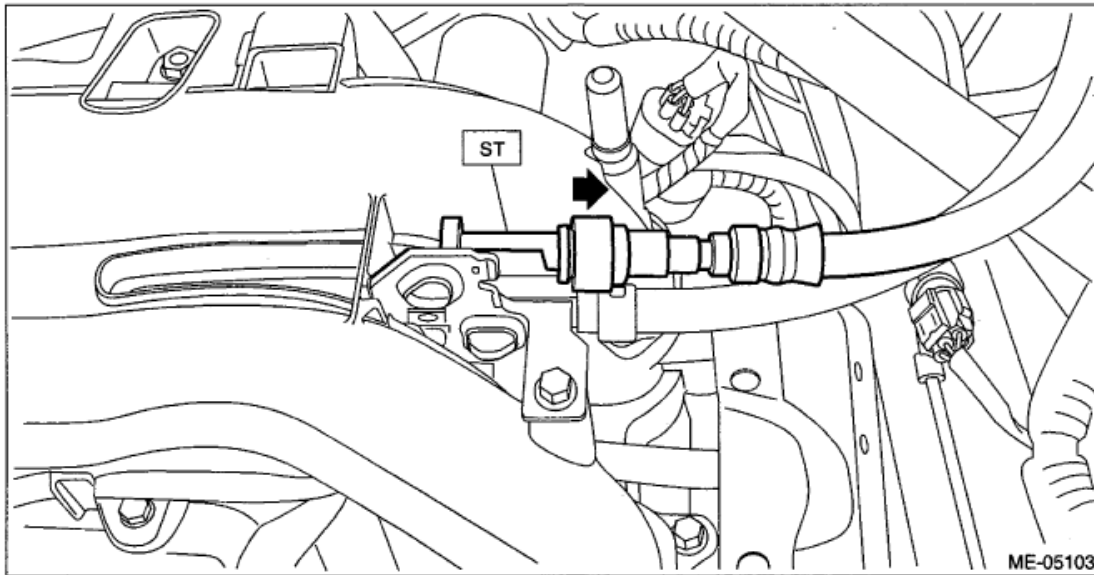


Fig. 53: Pushing ST In Quick Connector Of Fuel Delivery Hose
Courtesy of SUBARU OF AMERICA, INC.

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

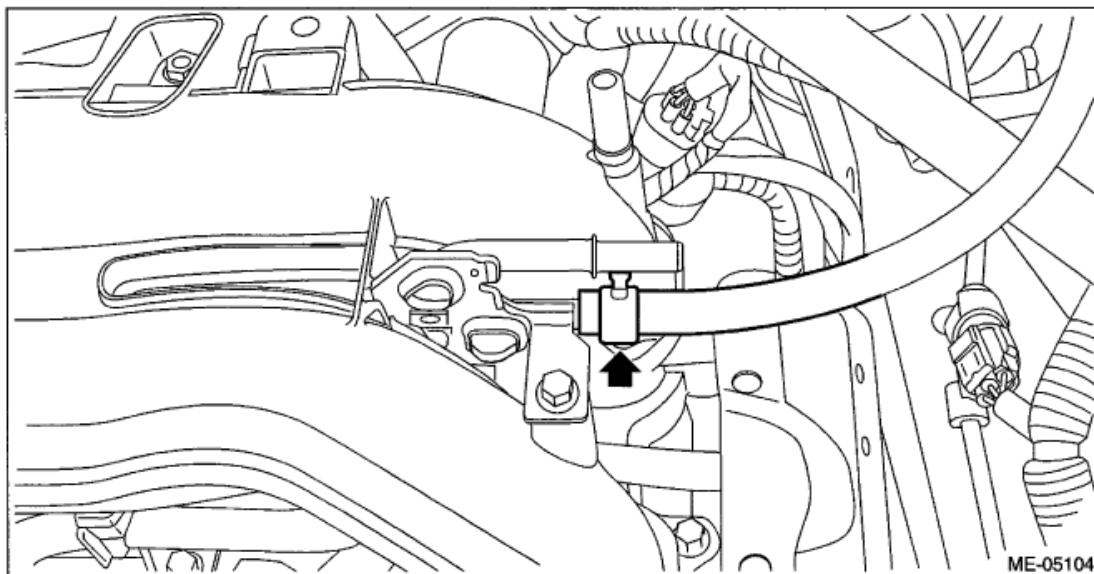


Fig. 54: Locating Evaporation Hose Clip
Courtesy of SUBARU OF AMERICA, INC.

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

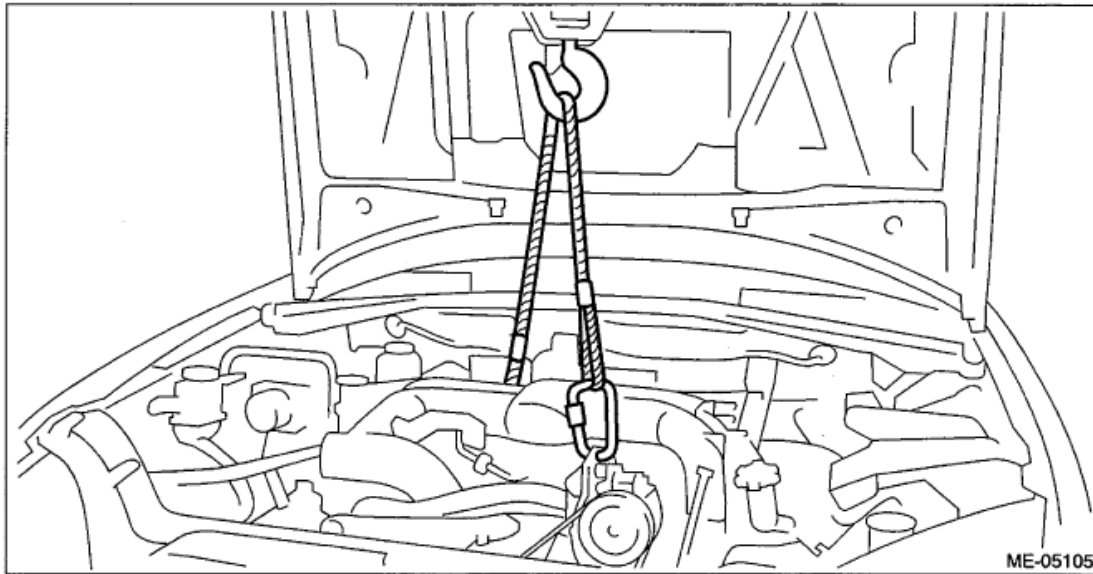
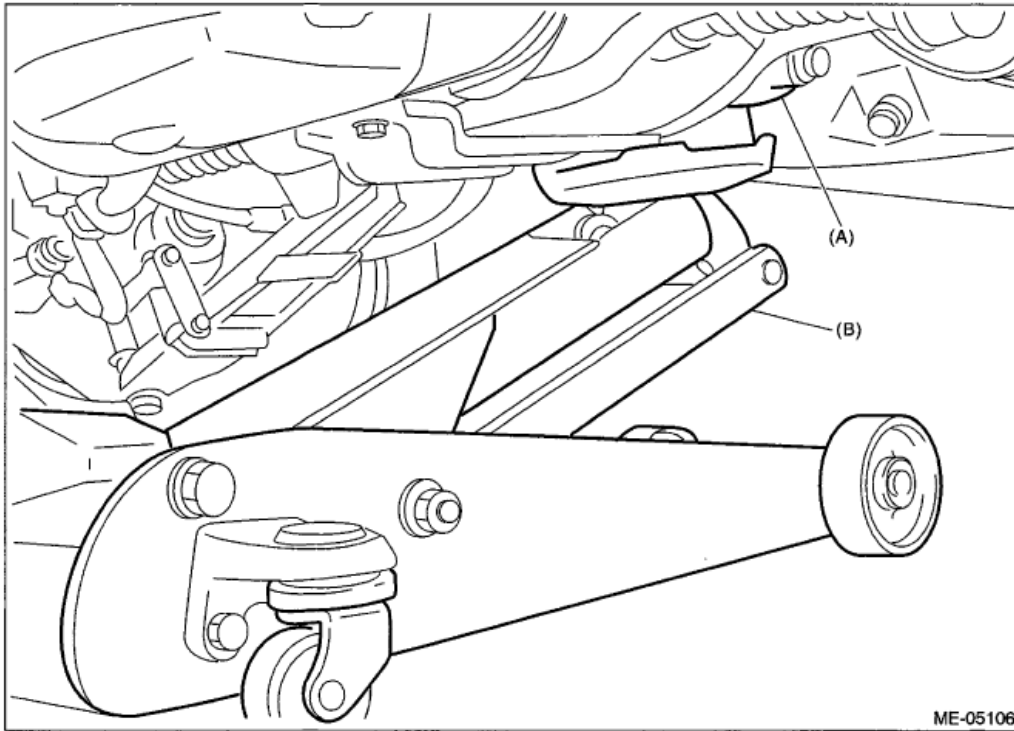


Fig. 55: Lifting Engine Using Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

27. 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 With Garage Jack
 Courtesy of SUBARU OF AMERICA, INC.

28. Separate the engine and transmission.

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

1. Remove the starter. < refer to **REMOVAL** , Starter >
2. Attach the ST to the torque converter clutch case. (AT model)

ST 498277200 STOPPER SET

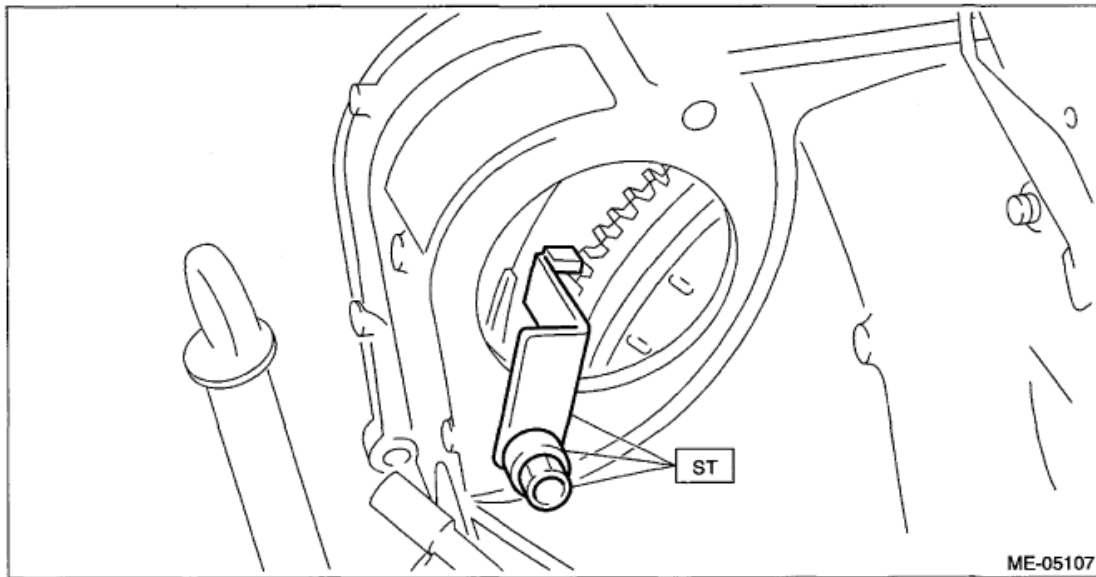


Fig. 57: Attaching ST To Torque Converter Clutch Case (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

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

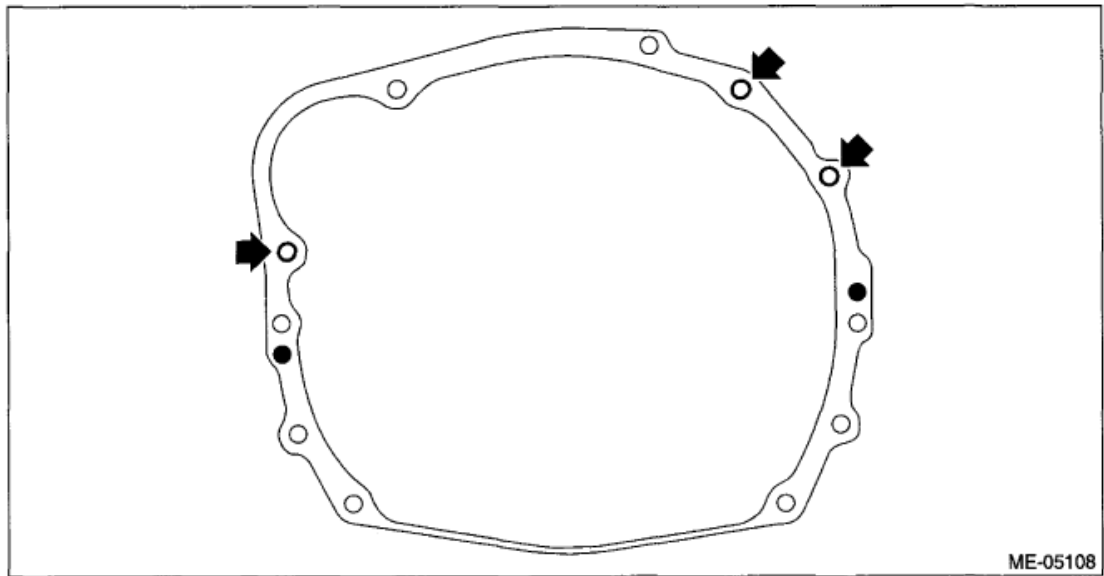


Fig. 58: Locating Upper Side Of Transmission Gasket Bolts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

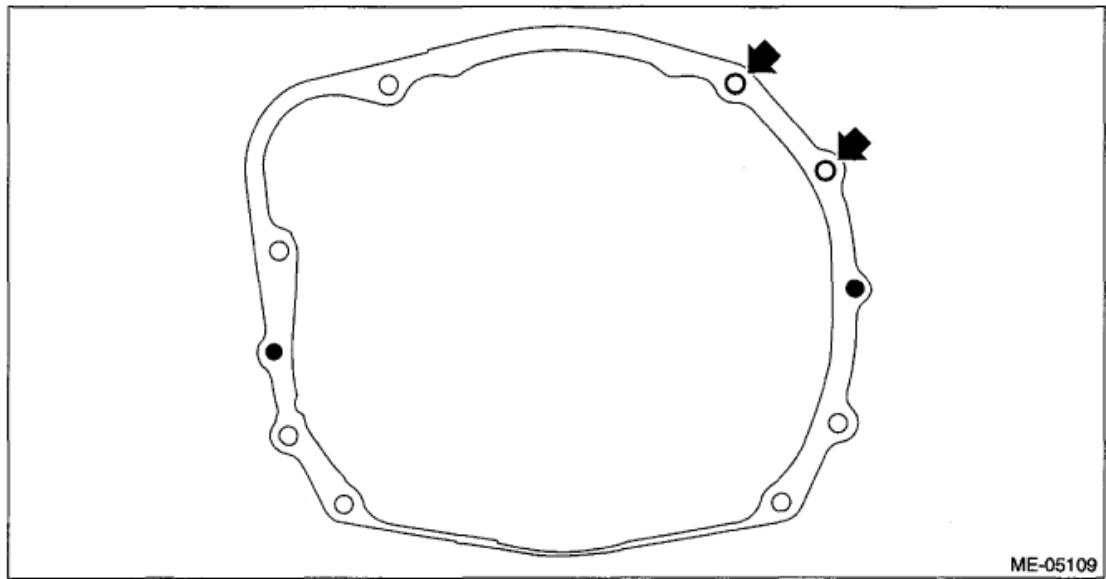


Fig. 59: Locating Upper Side Of Transmission Gasket Bolts (MT Model)
 Courtesy of SUBARU OF AMERICA, INC.

29. 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. Move the engine horizontally until main shaft is withdrawn from clutch cover. (MT model)
4. Slowly move the engine away from engine compartment.

30. 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. Apply a small amount of grease to splines of main shaft. (MT model)

Grease: NICHIMOLY N-130 or equivalent

3. 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.

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

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

- AT model

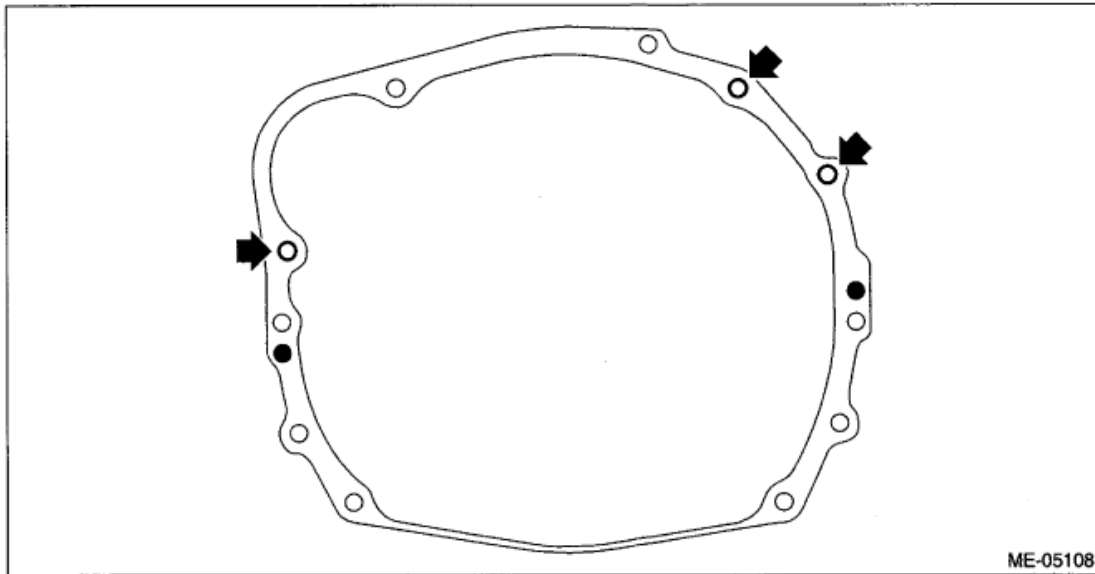


Fig. 60: Locating Upper Side Of Transmission Gasket Bolts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

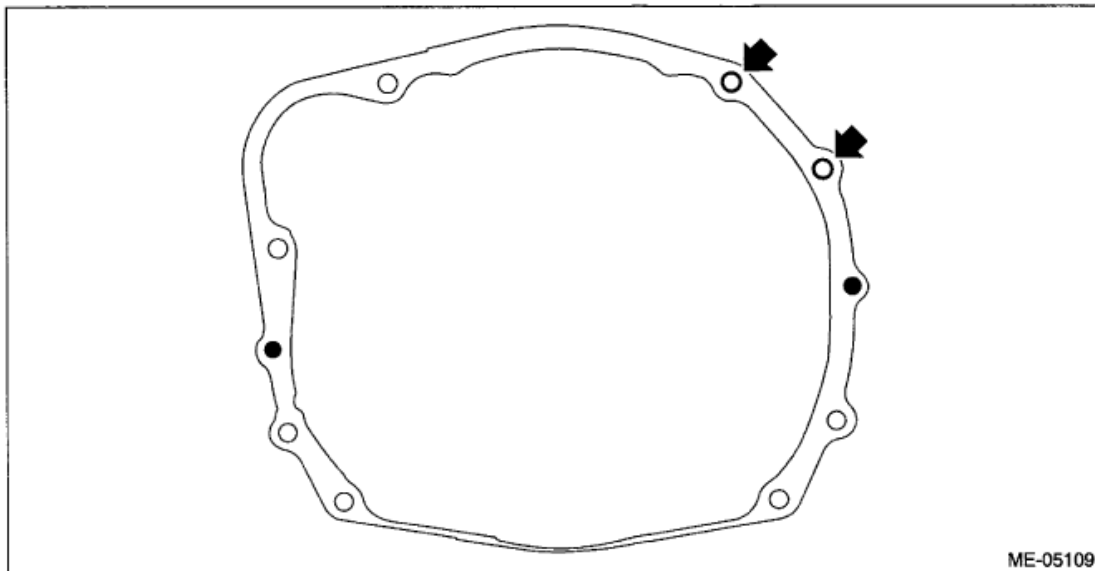


Fig. 61: Locating Upper Side Of Transmission Gasket Bolts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the lifting device and wire ropes.

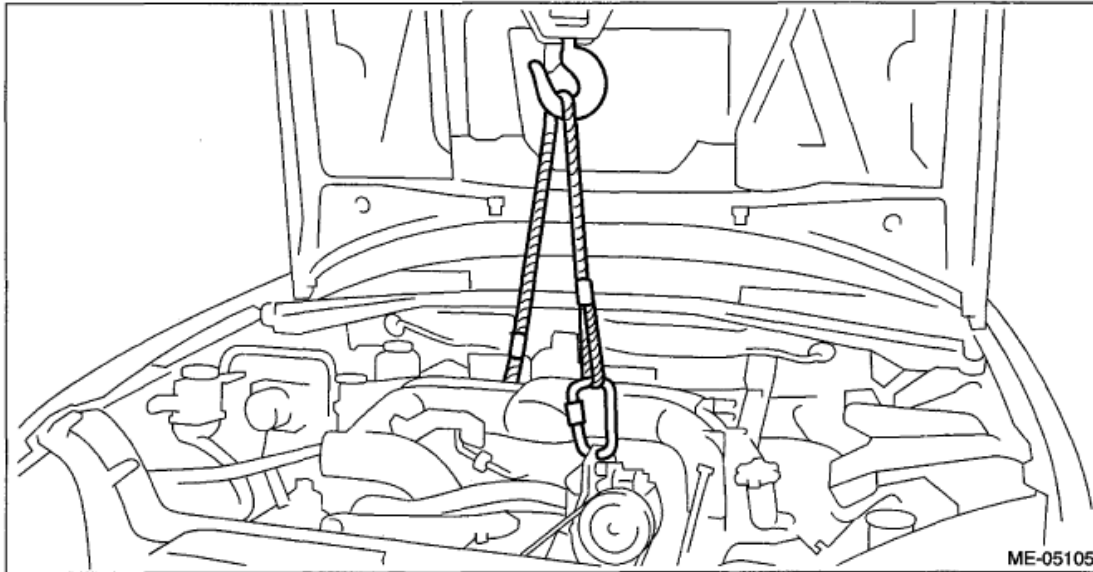


Fig. 62: Removing Lifting Device And Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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

Tightening torque:

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

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

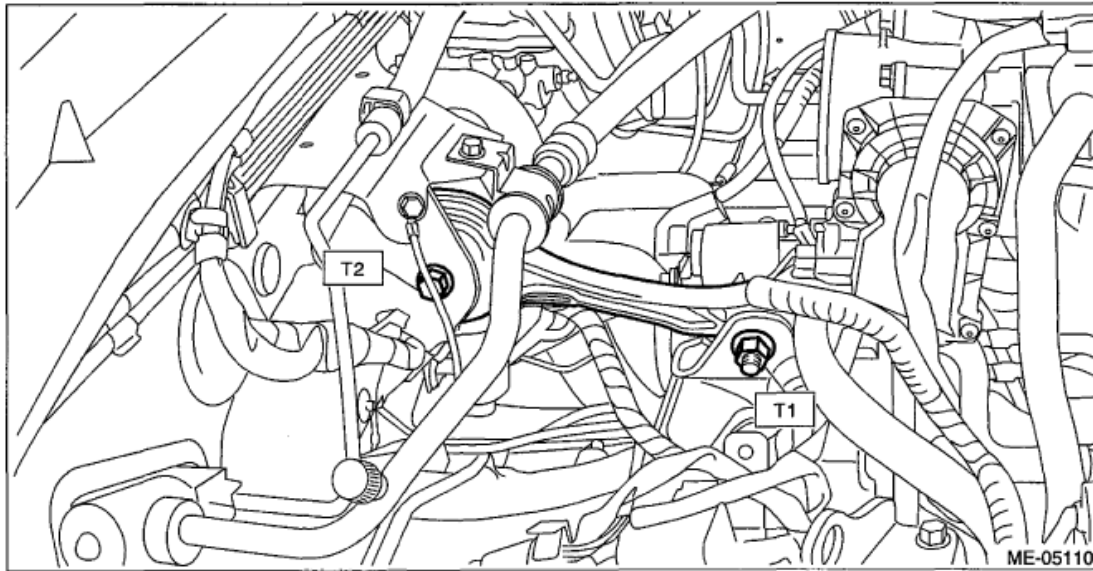


Fig. 63: Identifying Pitching Stopper Bolt And Nut
Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

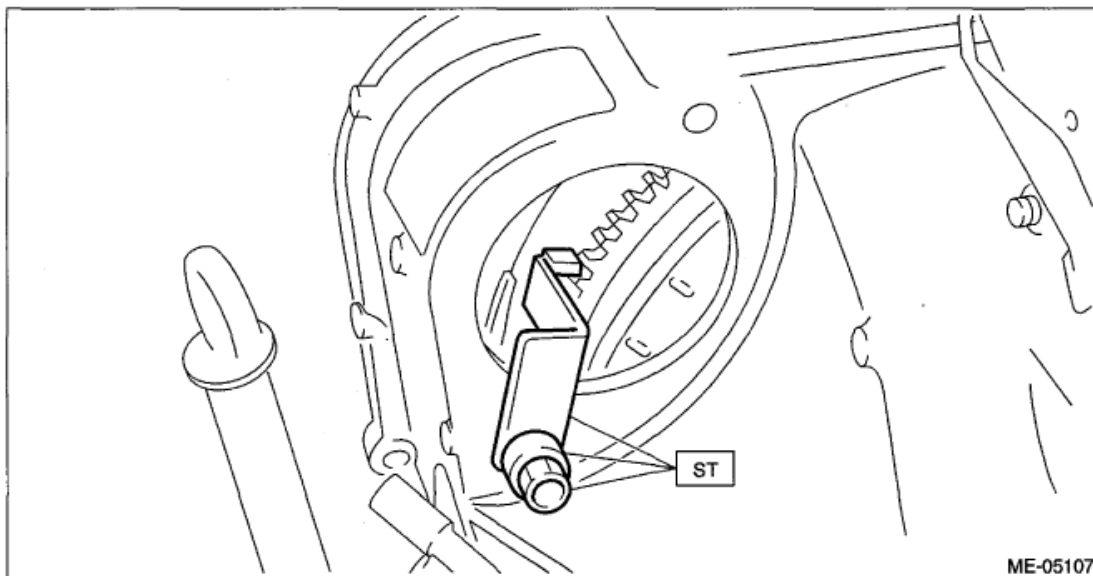


Fig. 64: Removing ST From Torque Converter Clutch Case (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

9. Install the starter. < refer to **INSTALLATION** , Starter >
10. Install the torque converter clutch to drive plate. (AT model)
 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)

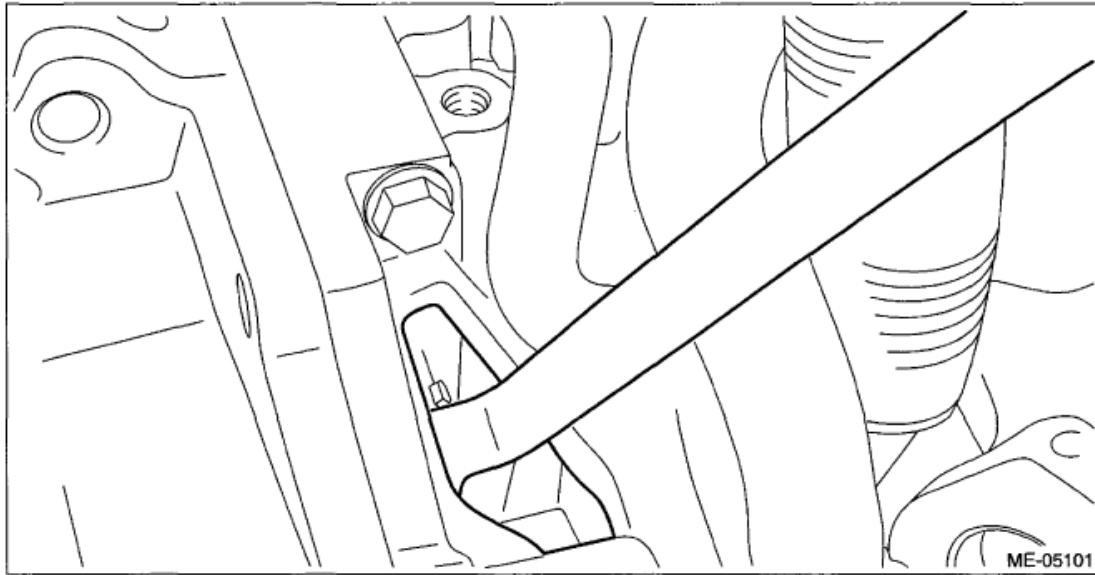


Fig. 65: Installing Torque Converter Clutch From Drive Plate (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

2. Fit the plug to service hole.
11. 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. < refer to **COMPONENT** , General Description >

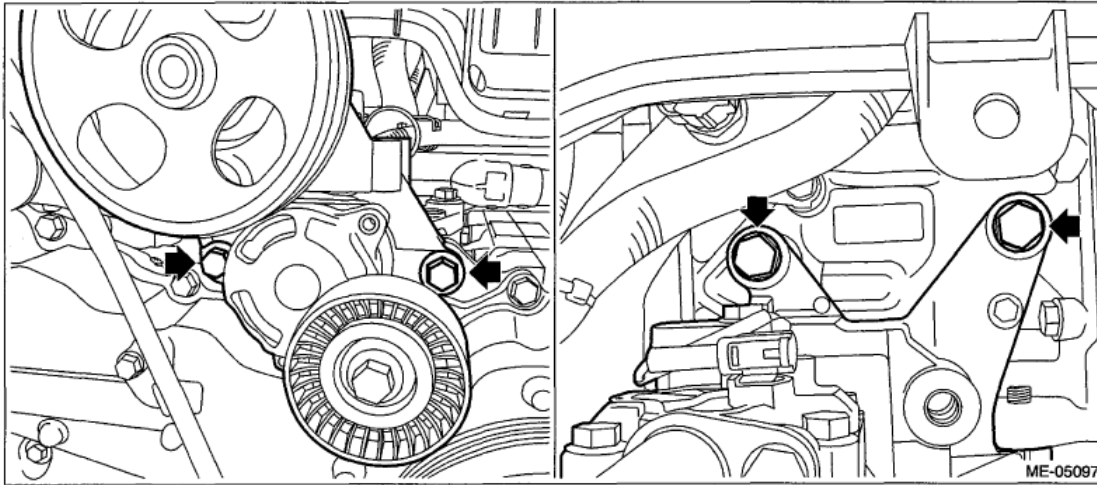


Fig. 66: Locating Engine Power Steering Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

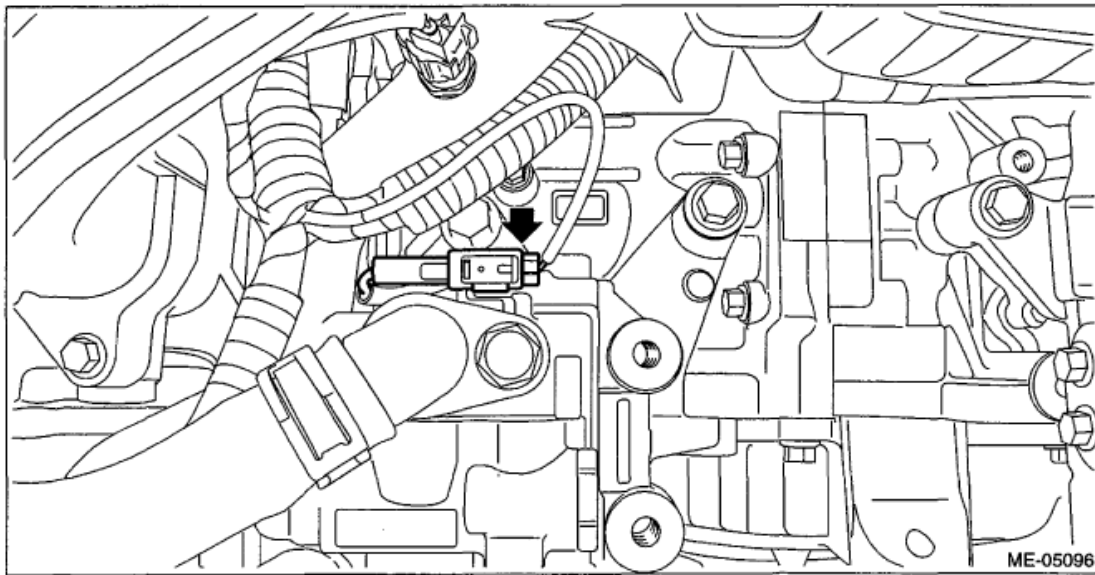


Fig. 67: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Install the generator. < refer to **INSTALLATION** , Generator >
4. Install the V-belts. < refer to **INSTALLATION**, V-belt >
12. Lift up the vehicle.
13. 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)

- AT model

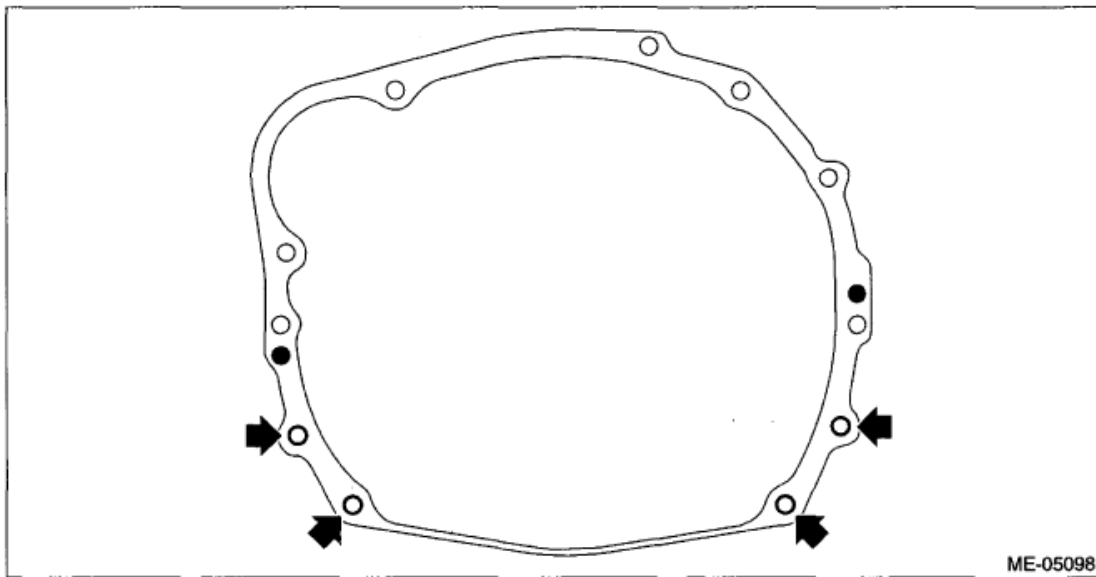


Fig. 68: Locating Lower Side Of Transmission Gasket Bolts And Nuts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

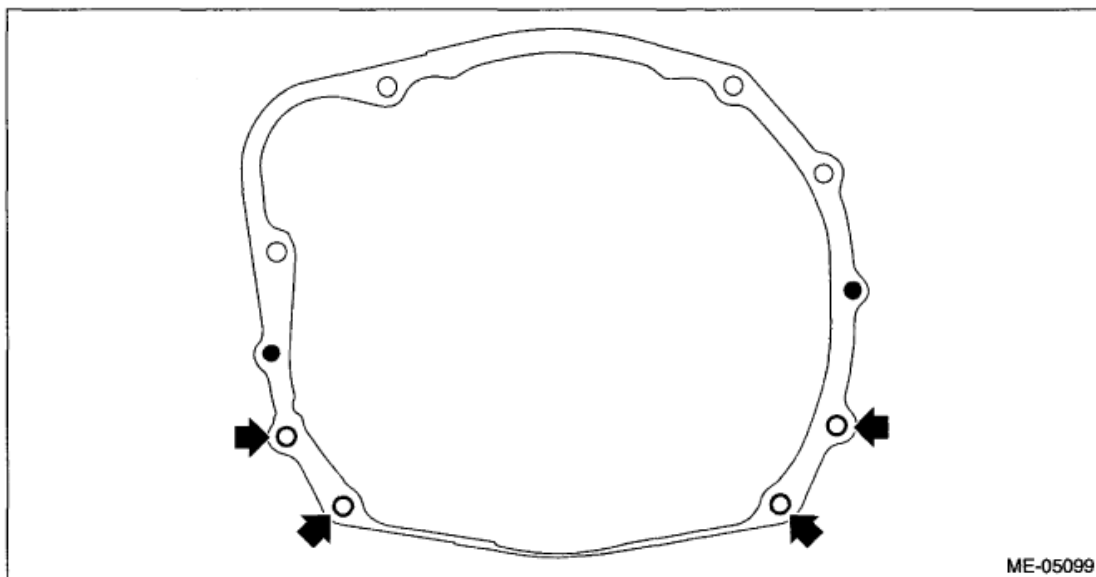


Fig. 69: Locating Lower Side Of Transmission Gasket Bolts And Nuts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

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

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

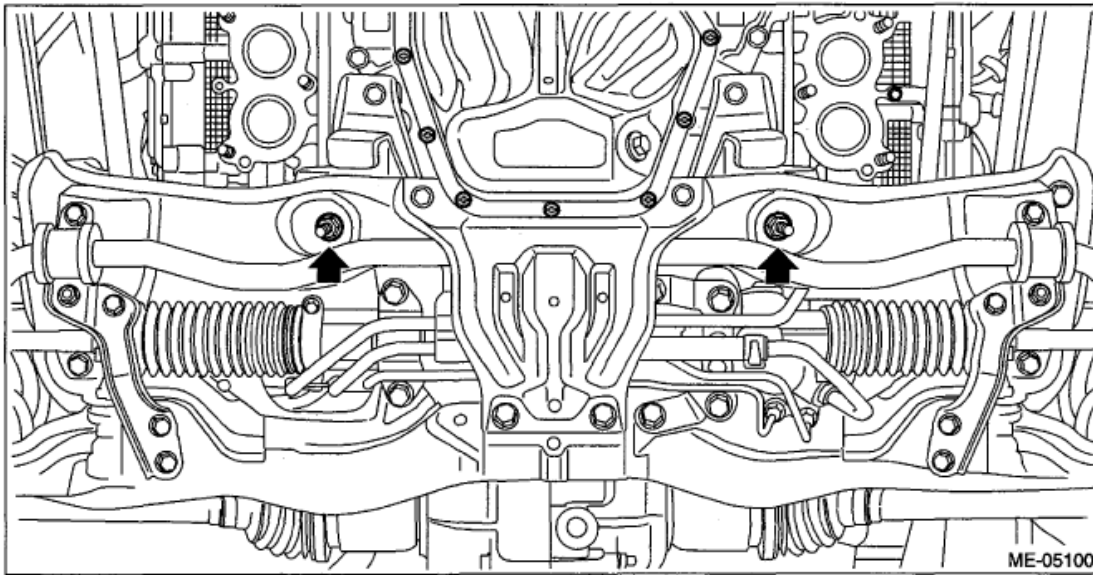


Fig. 70: Locating Front Crossmember Engine Mounting Nuts
Courtesy of SUBARU OF AMERICA, INC.

15. Connect the ground cable.

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

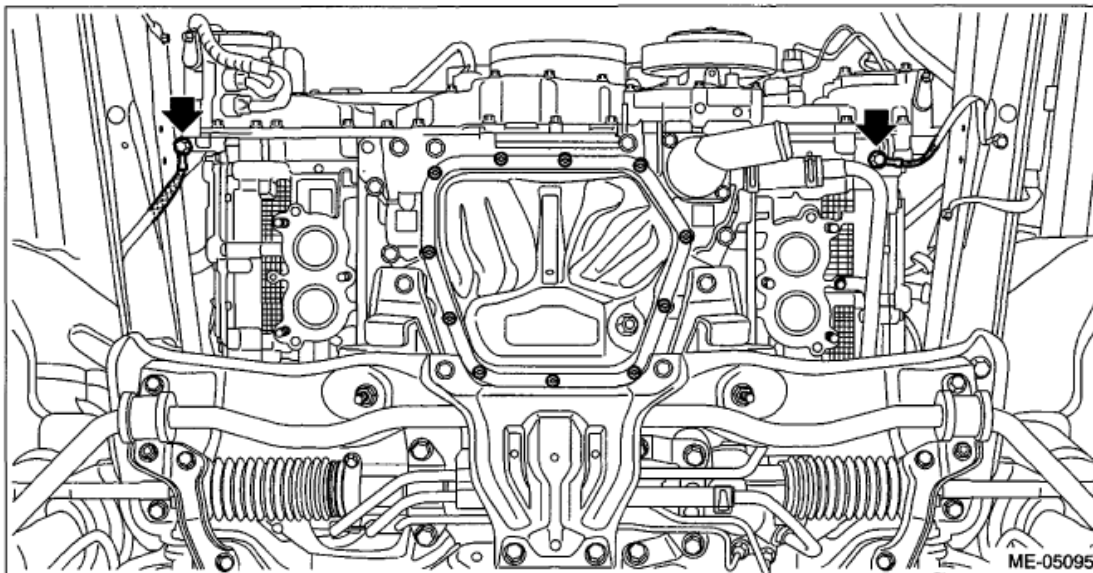


Fig. 71: Locating Ground Cable Bolts
Courtesy of SUBARU OF AMERICA, INC.

16. Install the front exhaust pipe. < refer to **INSTALLATION** , Front Exhaust Pipe >
17. Lower the vehicle.
18. Connect the following hoses.

1. Fuel delivery hose and evaporation hose
2. Heater inlet hose and heater outlet hose
3. Brake booster vacuum hose
4. A/C pressure hose < refer to **INSTALLATION** , Hose and Pipe >
19. Place the generator code and install the generator cord to the clip (D).
20. Connect connector (A) and terminal (B) to the generator, and connect connector (C) to A/C compressor.

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

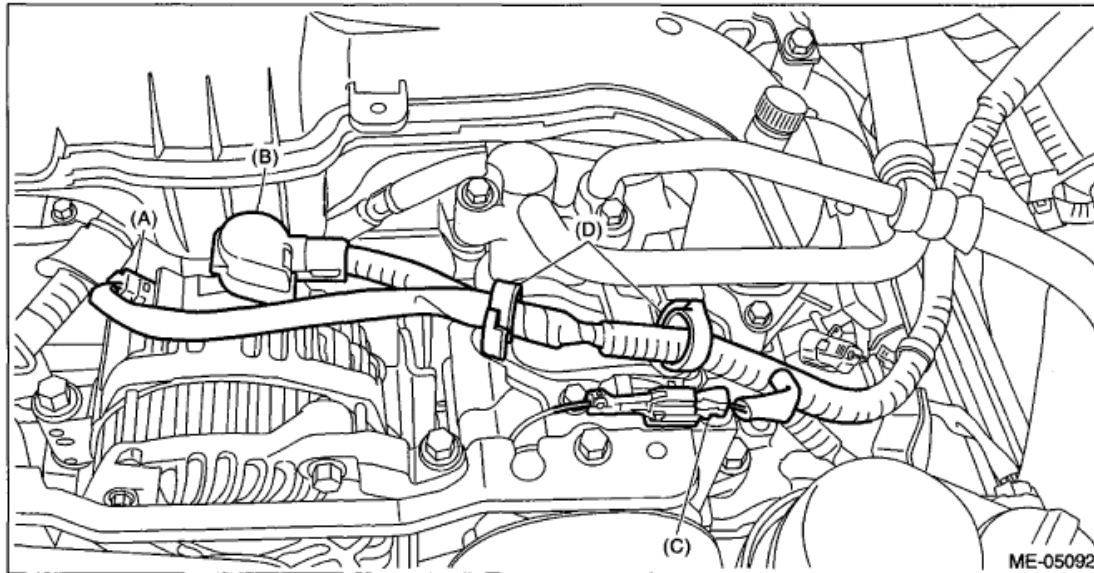


Fig. 72: Identifying Clip, A/C Compressor Connector, Generator Connector And Terminal
 Courtesy of SUBARU OF AMERICA, INC.

21. Install the generator cord stay to the chain cover.

NOTE: Install the generator cord stay so that the folded end (A) touches at the chain cover boss.

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



Fig. 73: Locating Generator Cord Stay Bolt
Courtesy of SUBARU OF AMERICA, INC.

22. Connect the engine harness connector.
 1. Connect the bulkhead harness connector to the engine harness connector (black) and engine harness connector (brown).

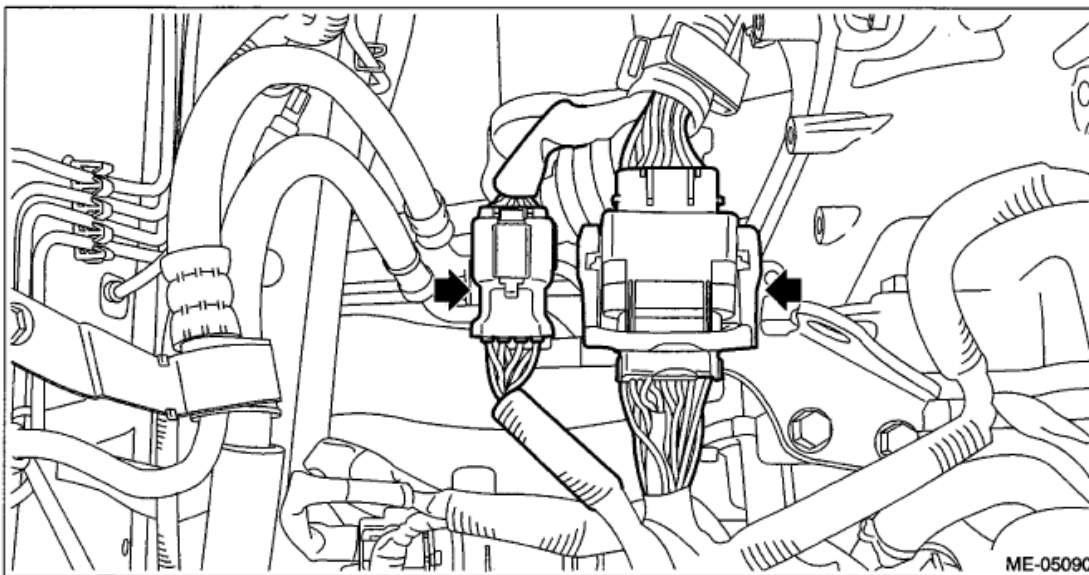


Fig. 74: Locating Bulkhead Harness Connector And Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

2. Install the bolt which secures the bulkhead harness connector bracket.

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

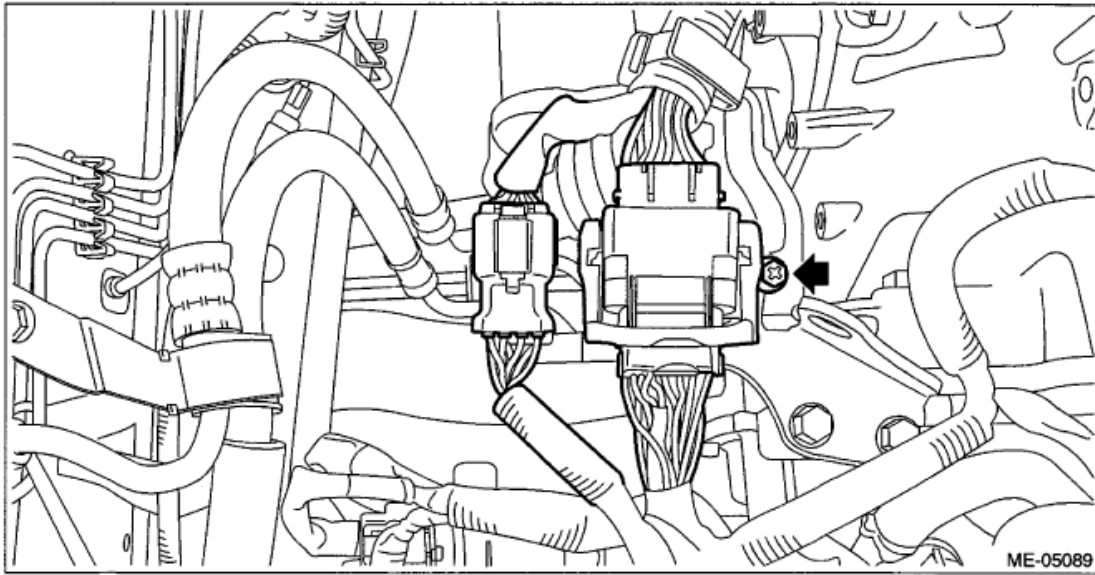


Fig. 75: Locating Bulkhead Harness Connector Bracket Bolt
 Courtesy of SUBARU OF AMERICA, INC.

23. Install the radiator. < refer to **INSTALLATION** , Radiator >
24. Install the air intake case (rear).

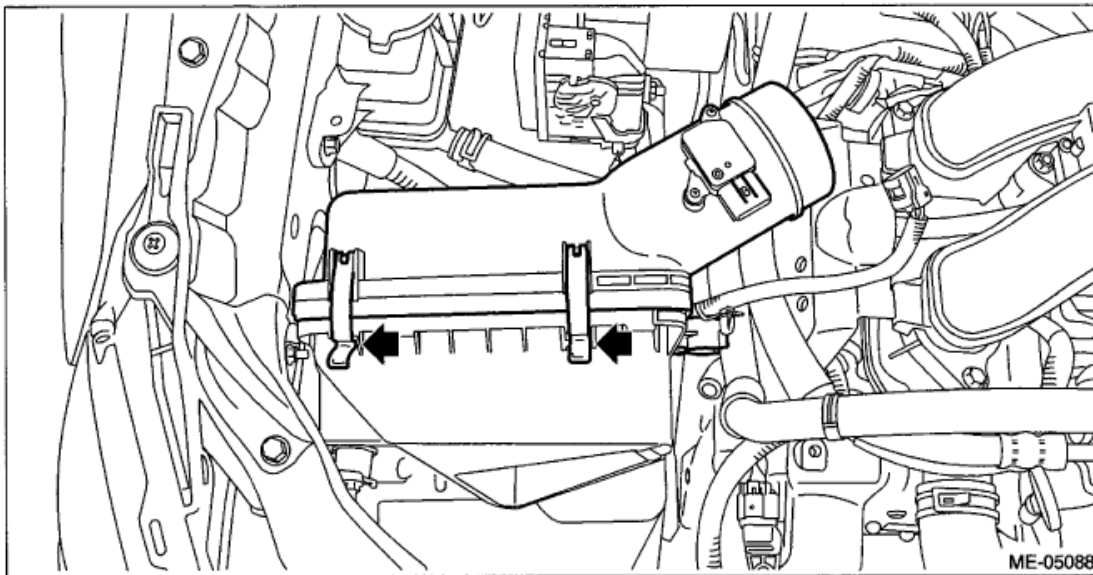


Fig. 76: Locating Air Cleaner Case Clamps (Rear)
 Courtesy of SUBARU OF AMERICA, INC.

25. Install the clip (B) which secures the mass air flow and intake air temperature sensor harness, and connect the connector (A) to the mass air flow and intake air temperature sensor.
26. Install the suction hose (C) to the air cleaner case (rear).

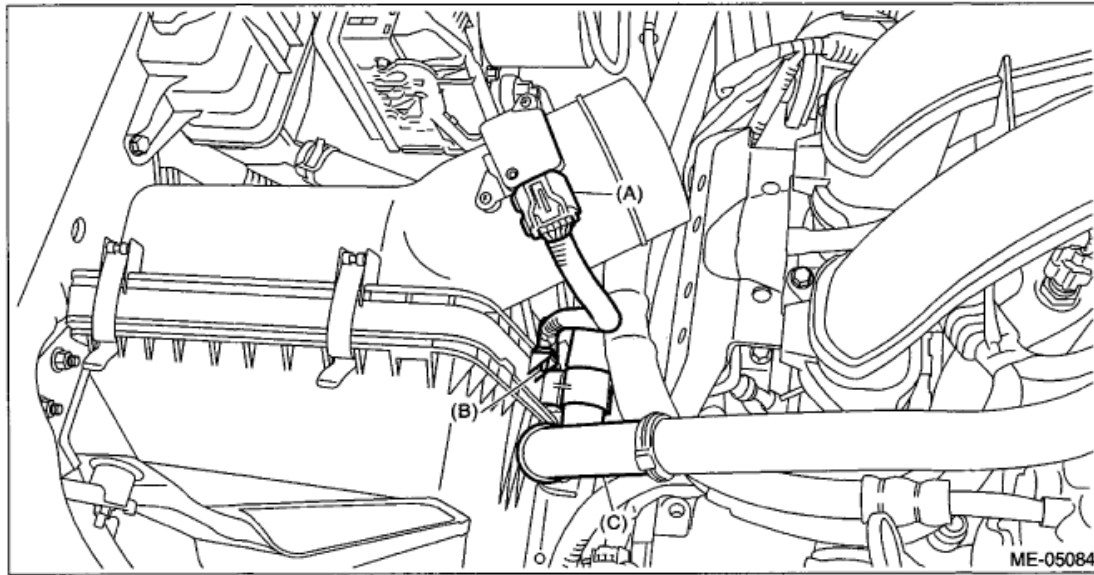


Fig. 77: Identifying Air Cleaner Case Suction Hose, Clip, Mass Air Flow And Intake Air Temperature Sensor Connector
Courtesy of SUBARU OF AMERICA, INC.

27. Install the air intake boot. < refer to **INSTALLATION** , Air Intake Boot >
28. Install the air intake duct (rear). < refer to **INSTALLATION** , Air Intake Duct >
29. Install the battery. < refer to **INSTALLATION** , Battery >
30. Fill engine coolant. < refer to **FILLING OF ENGINE COOLANT** , REPLACEMENT, Engine Coolant >
31. Check the ATF level and replenish it if necessary. (AT model) < refer to **INSPECTION** , Automatic Transmission Fluid >
32. Charge the A/C system with refrigerant. < refer to **PROCEDURE** , Refrigerant Charging Procedure >
33. Install the V-belt cover.

Tightening torque: 13 N.m (1.3 kgf-m, 9.6 ft-lb)

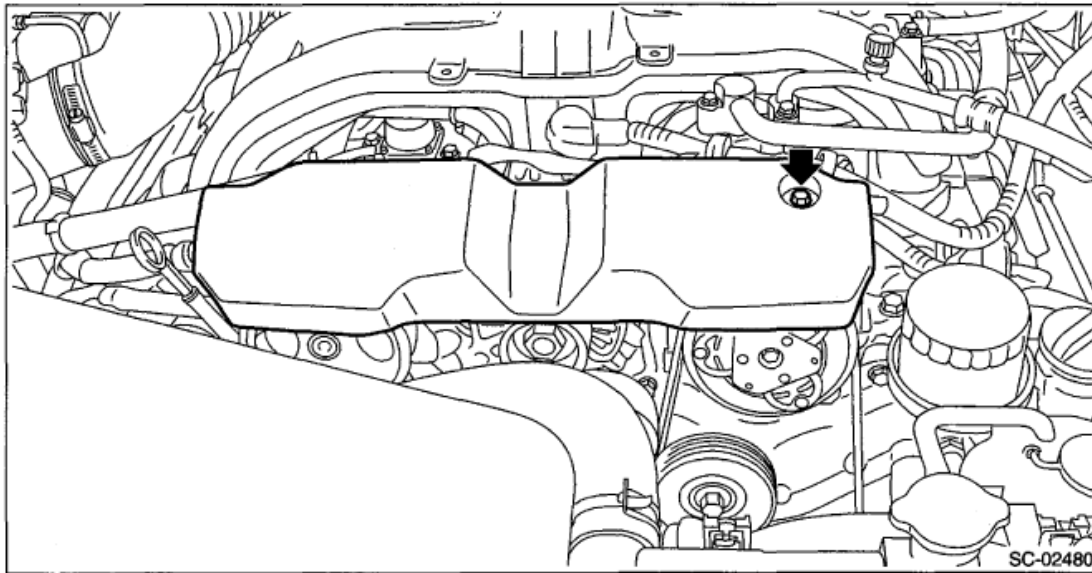


Fig. 78: Locating V-Belt Cover Bolt
 Courtesy of SUBARU OF AMERICA, INC.

34. 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)

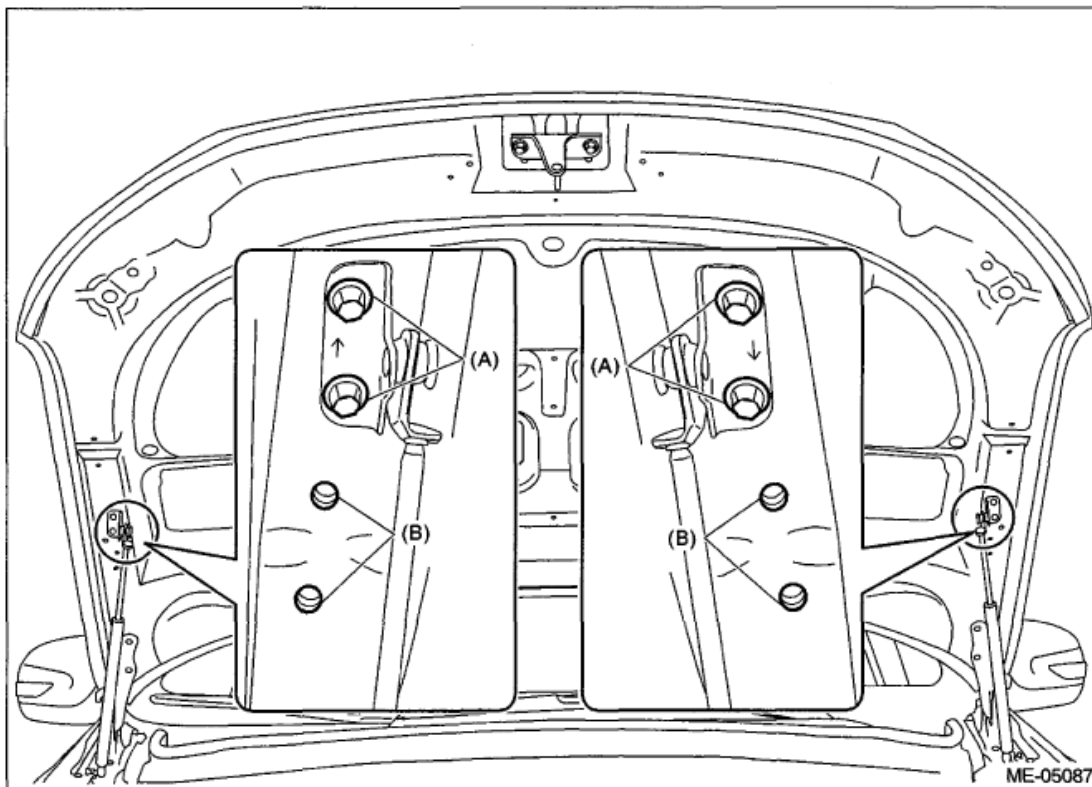


Fig. 79: Identifying Front Hood Bolts Installation Position

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. (AT model)
4. Start the engine and check for exhaust gas, engine coolant, leaks of fuel, etc. Also check for noise and vibrations.

ENGINE MOUNTING

REMOVAL

1. Remove the engine from the vehicle. < refer 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 there are no cracks or other damages.

PREPARATION FOR OVERHAUL

PROCEDURE

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

NOTE: When using a commercially sold engine stand, follow the instructions of engine stand used.

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

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 18362AA020 ADAPTER

ST4 499817100 ENGINE STAND

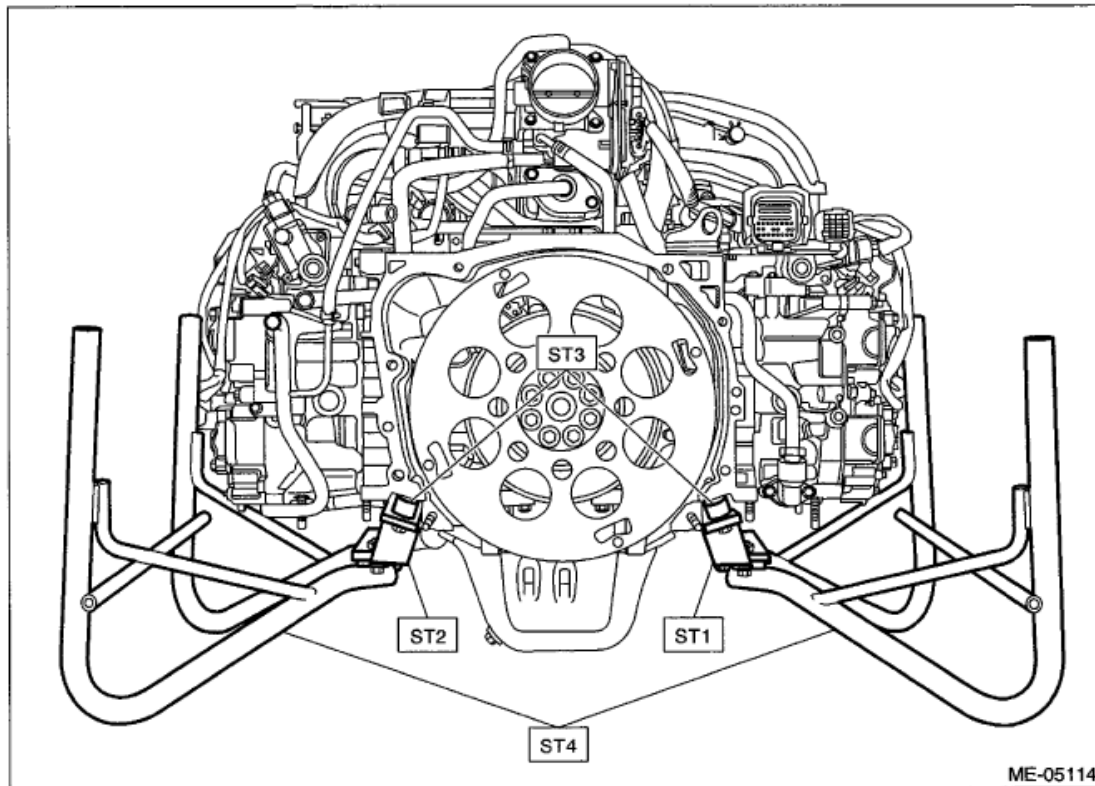


Fig. 80: Attaching ST To Engine
Courtesy of SUBARU OF AMERICA, INC.

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

V-BELT

REMOVAL

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

V-BELT

1. Remove the V-belt covers.

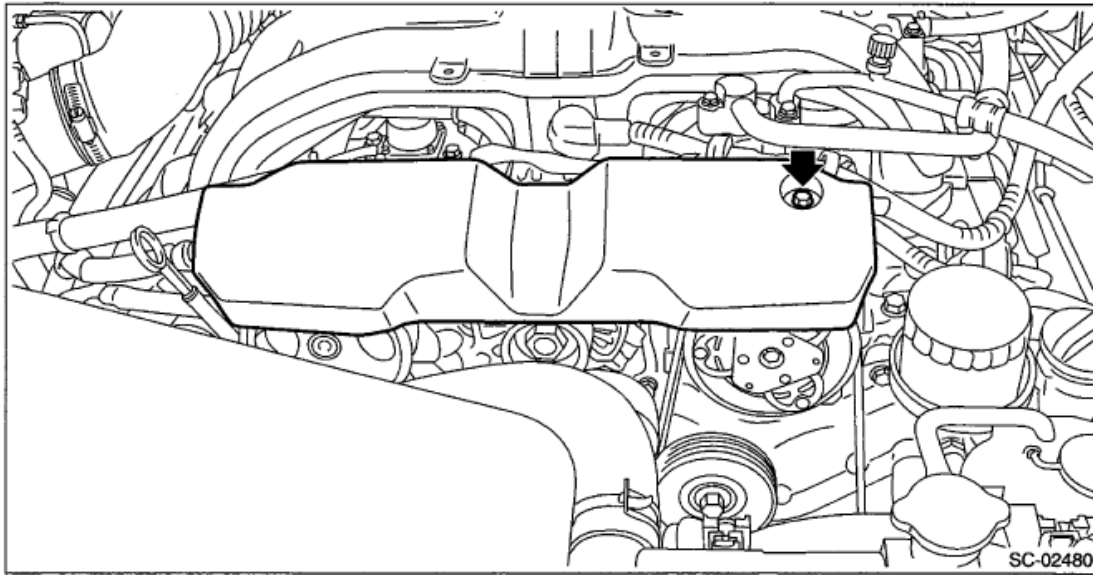


Fig. 81: Locating V-Belt Cover Bolt
 Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake duct (Rear). < refer to **REMOVAL** , Air Intake Duct >
3. Attach the tool to the V-belt tensioner assembly, and rotate the tool clockwise to loosen and remove the V-belt.

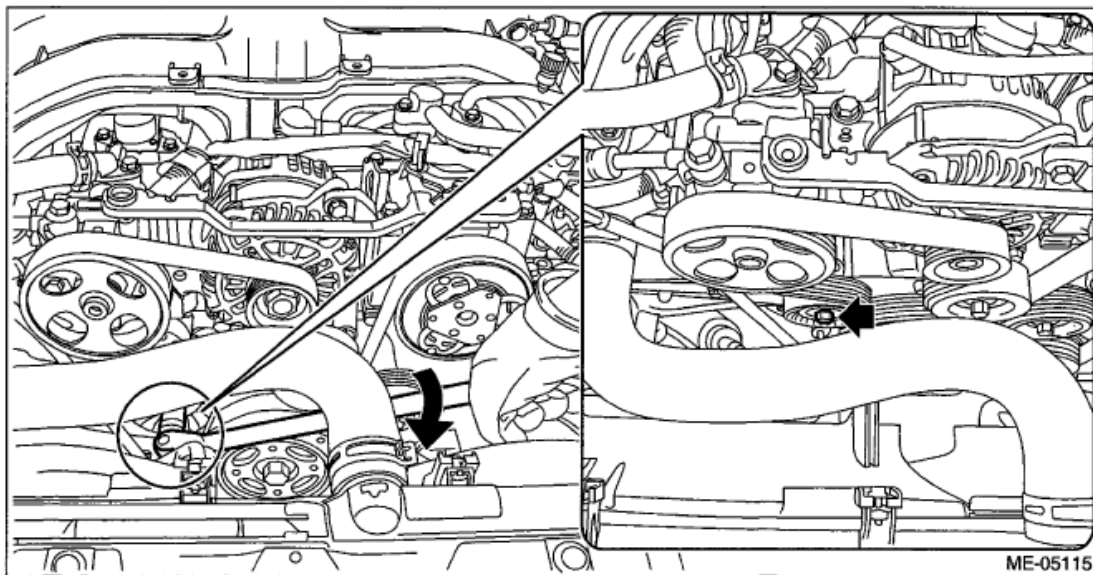


Fig. 82: Removing V-Belt With Tool
 Courtesy of SUBARU OF AMERICA, INC.

V-BELT TENSIONER ASSEMBLY AND IDLER PULLEY

1. Remove the V-belts. < refer to **V-BELT**, REMOVAL, V-belt >

2. Remove the cap from V-belt tensioner assembly.

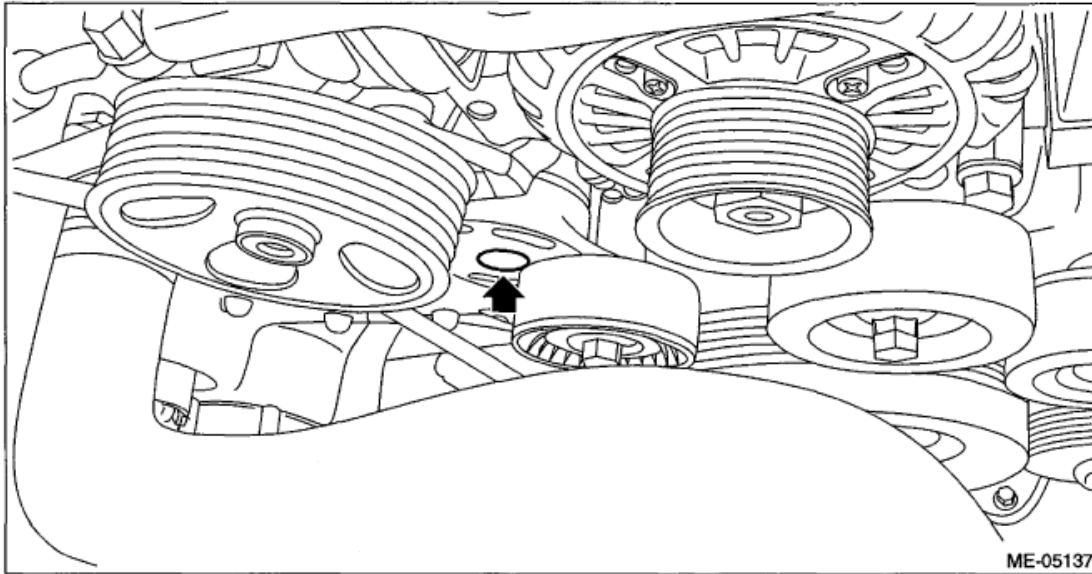


Fig. 83: Locating V-Belt Tensioner Assembly Cap
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the bolt securing the V-belt tensioner assembly to the power steering pump bracket, and remove the V-belt tensioner assembly.

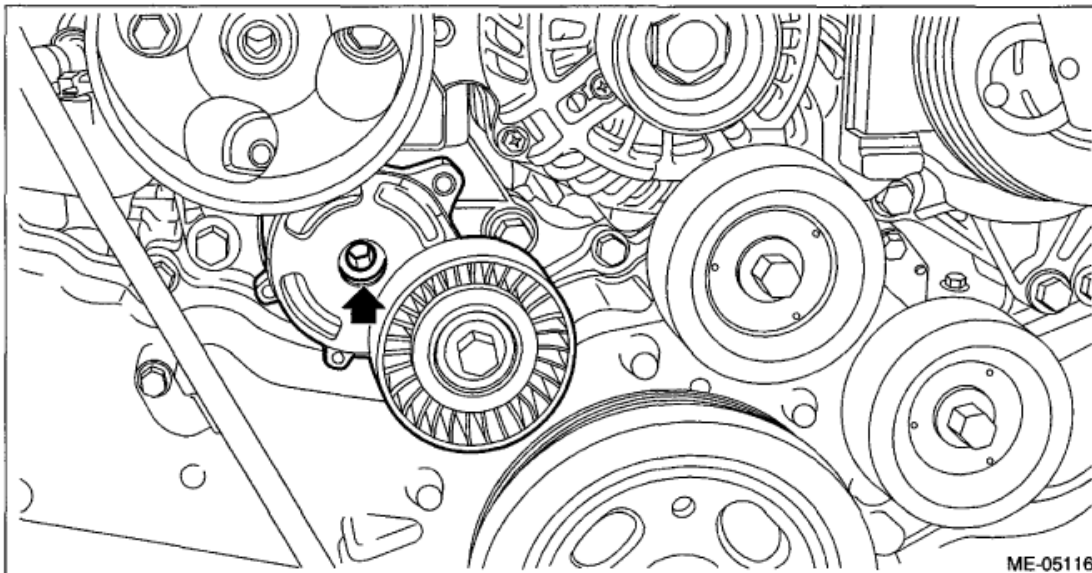
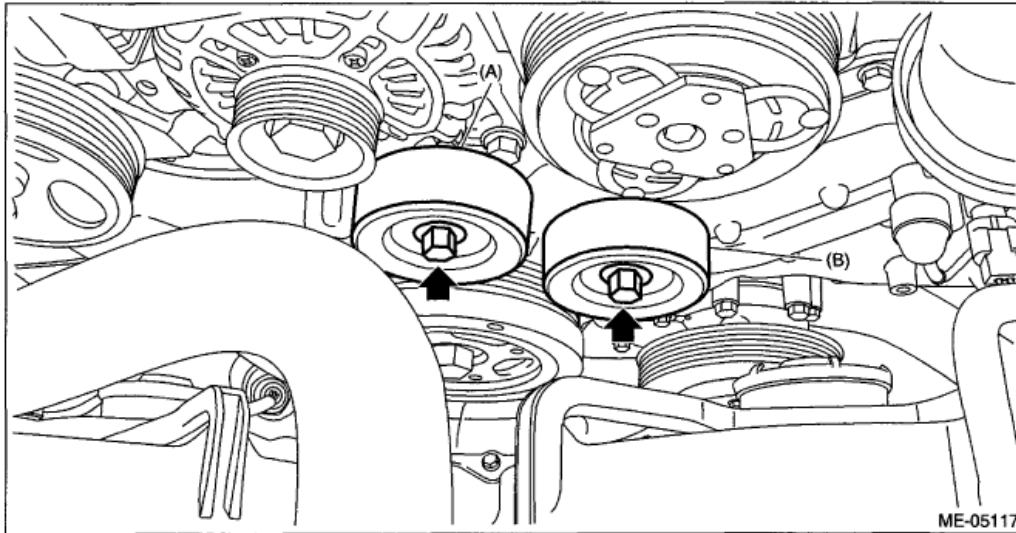


Fig. 84: Locating V-Belt Tensioner Assembly Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the bolts which secure the idler pulley to the chain cover, and remove the idler pulley.



(A) Idler pulley A

(B) Idler pulley B

Fig. 85: Locating Chain Cover Idler Pulley Bolts
Courtesy of SUBARU OF AMERICA, INC.

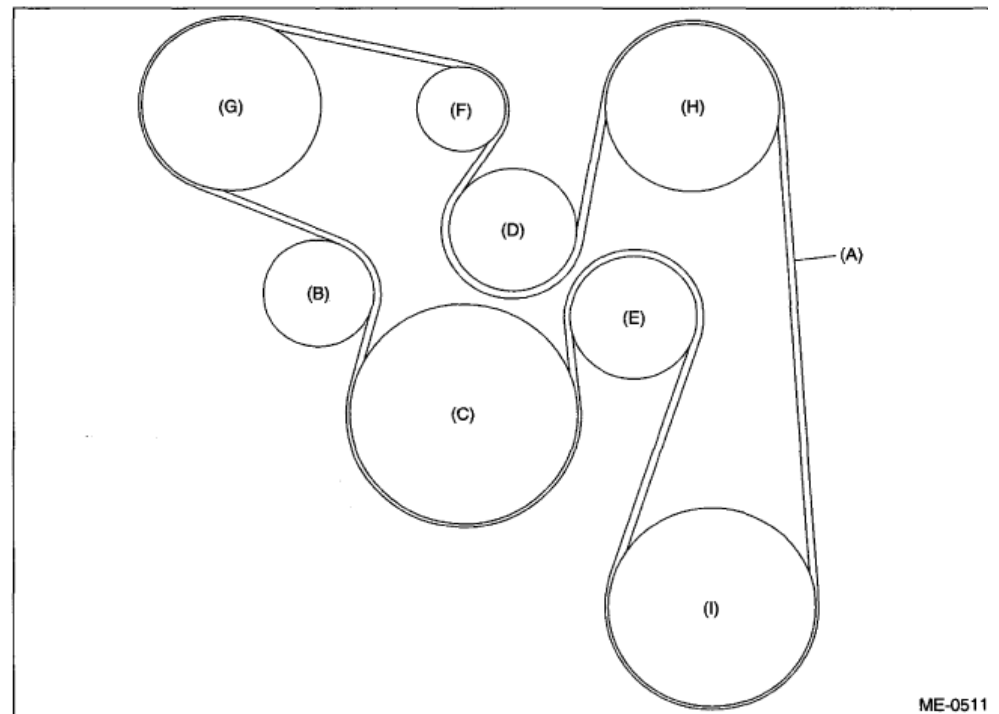
INSTALLATION

V-BELT

Install in the reverse order of removal.

CAUTION:

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



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- | | | |
|---------------------------|----------------------|--------------------------------|
| (A) V-belt | (D) Idler pulley A | (G) Power steering pump pulley |
| (B) V-belt tensioner ASSY | (E) Idler pulley B | (H) A/C compressor pulley |
| (C) Crank pulley | (F) Generator pulley | (I) Water pump pulley |

Fig. 86: V-Belt Routing Diagram
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque: 13 N.m (1.3 kgf-m, 9.6 ft-lb)

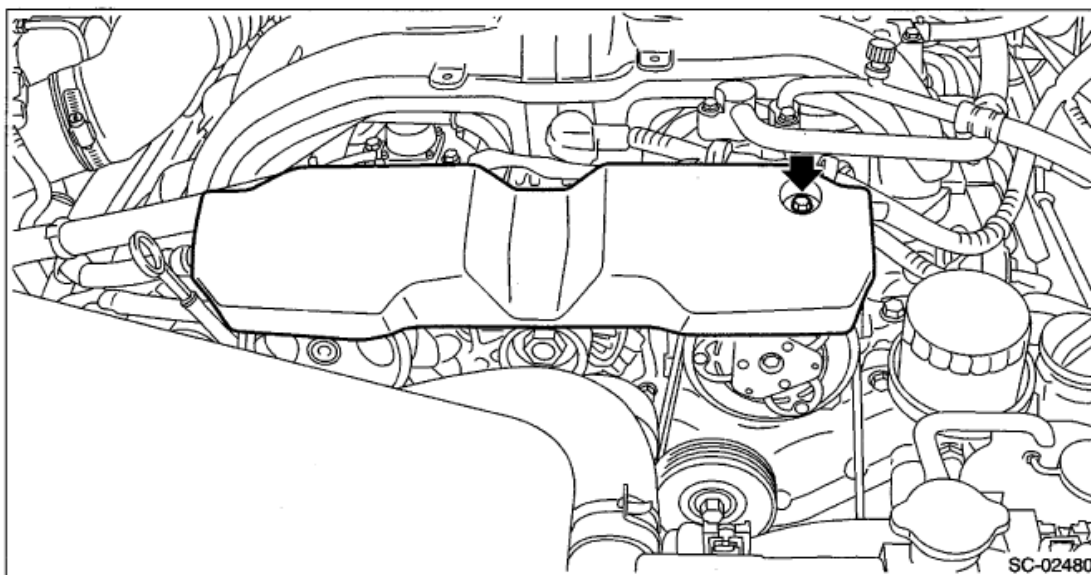


Fig. 87: Locating V-Belt Cover Bolt

Courtesy of SUBARU OF AMERICA, INC.

V-BELT TENSIONER ASSEMBLY AND IDLER PULLEY

1. Install the idler pulley to the chain cover.

NOTE: When installing the idler pulley, be careful of the idler pulley cover direction.

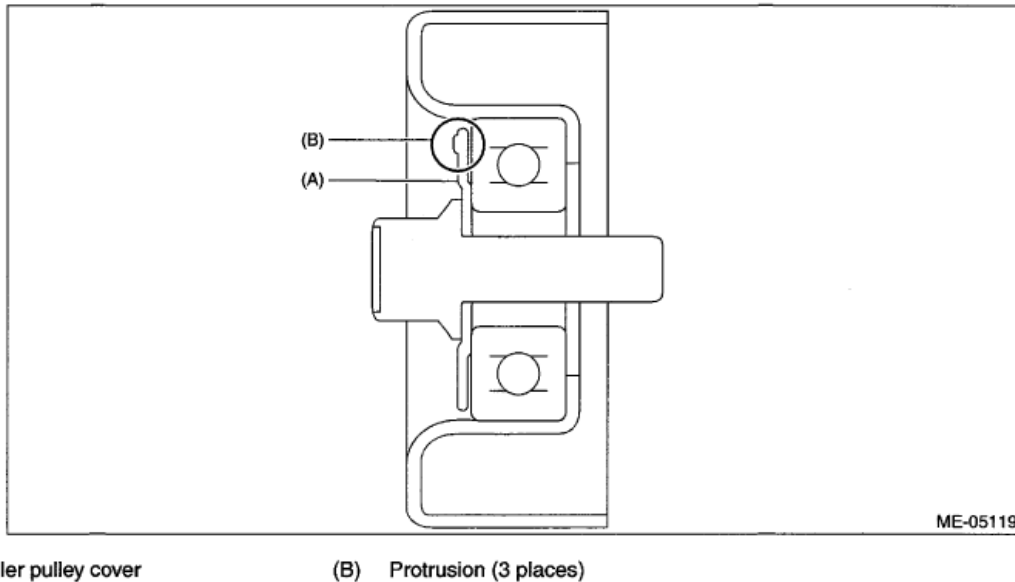
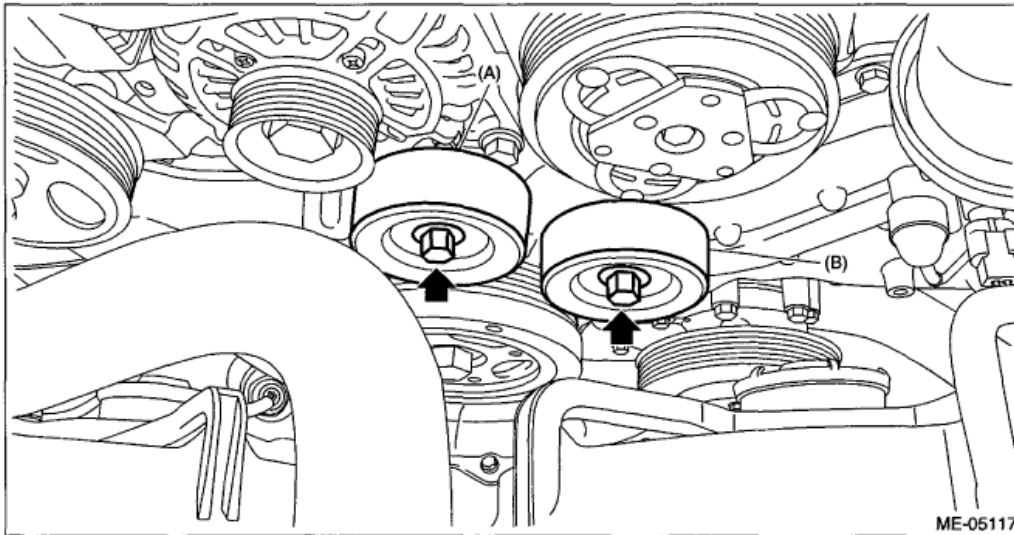


Fig. 88: Identifying Idler Pulley Cover And Protrusion
Courtesy of SUBARU OF AMERICA, INC.

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



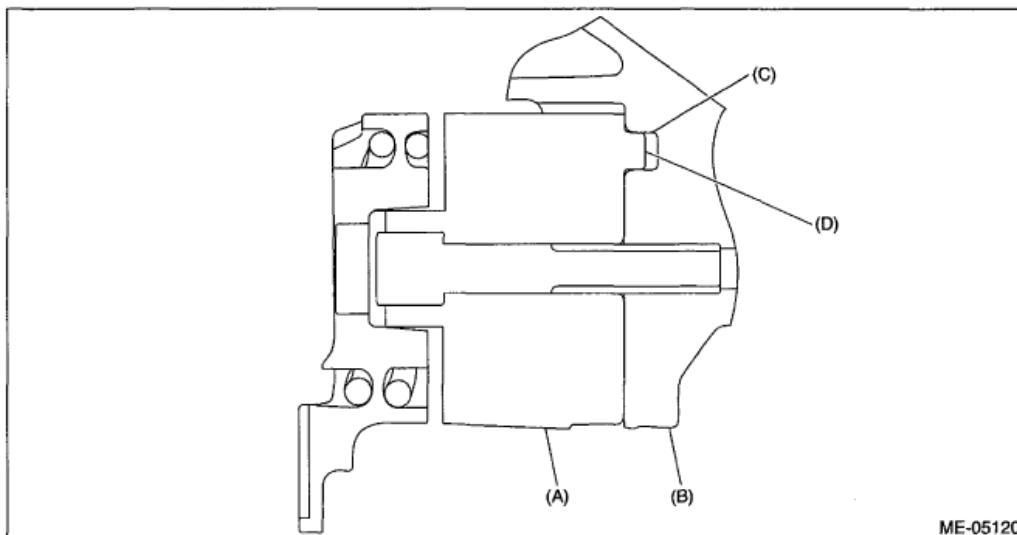
(A) Idler pulley A

(B) Idler pulley B

Fig. 89: Locating Chain Cover Idler Pulley Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Install the V-belt tensioner assembly onto the power steering pump bracket.

NOTE: When installing the V-belt tensioner assembly, insert the protrusion of V-belt tensioner assembly into the hole at the power steering pump bracket to prevent rotating.



(A) V-belt tensioner ASSY
(B) Power steering bracket

(C) Hole to prevent rotation

(D) Protrusion portion

Fig. 90: Identifying V-Belt Tensioner Assembly, Power Steering Pump Bracket And Protrusion Portion
Courtesy of SUBARU OF AMERICA, INC.

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

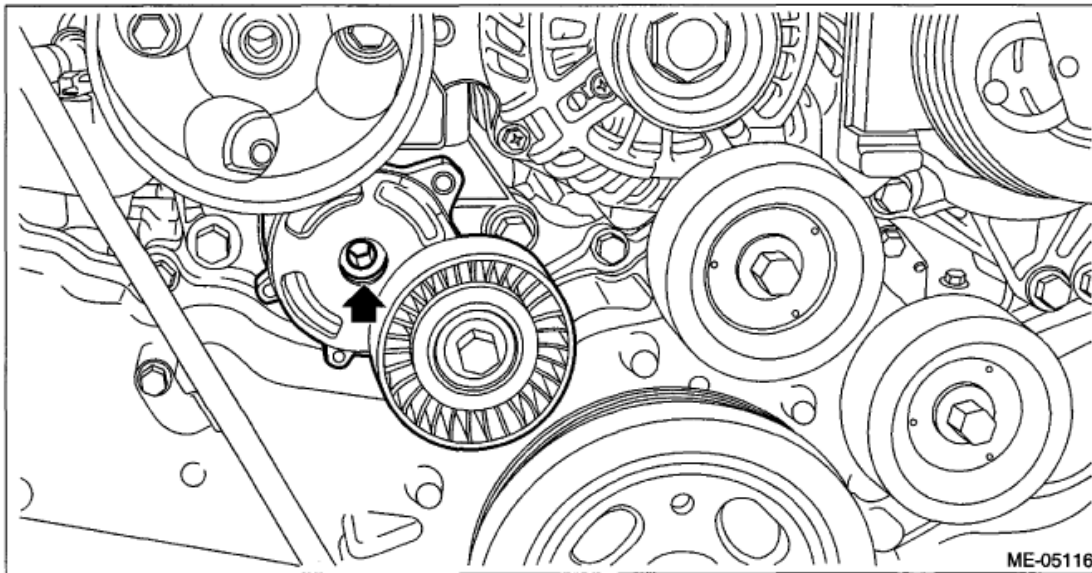


Fig. 91: Locating V-Belt Tensioner Assembly Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Install the cap to the V-belt tensioner assembly.

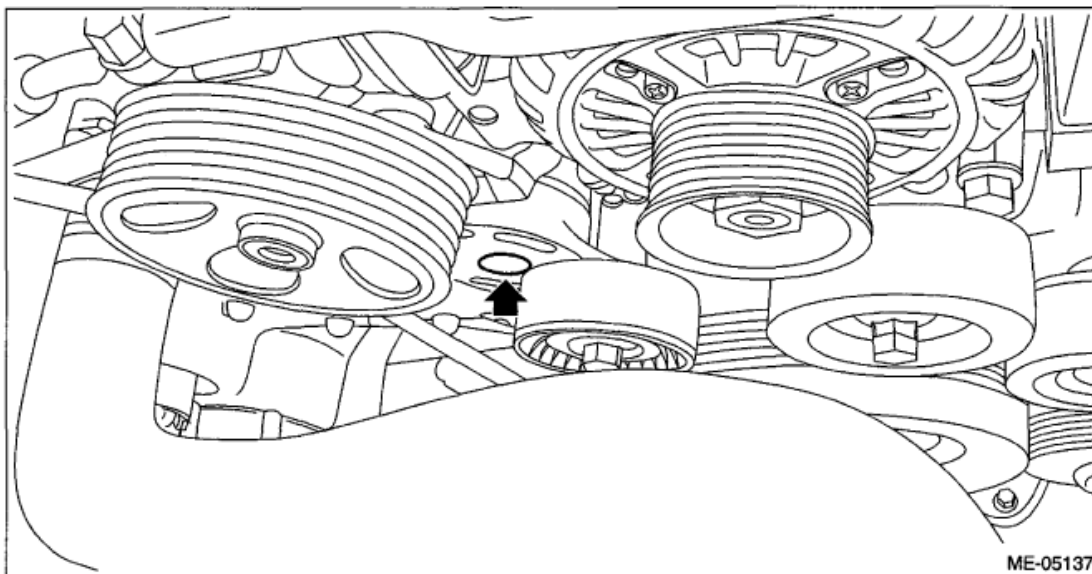


Fig. 92: Locating V-Belt Tensioner Assembly Cap
Courtesy of SUBARU OF AMERICA, INC.

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

INSPECTION

1. Check the V-belt for cracks, tear or wear.
2. Check the V-belt tensioner assembly and idler pulley for deformation, cracks or other damages.
3. Check that the V-belt ribs are securely placed on the rib grooves for each pulleys.

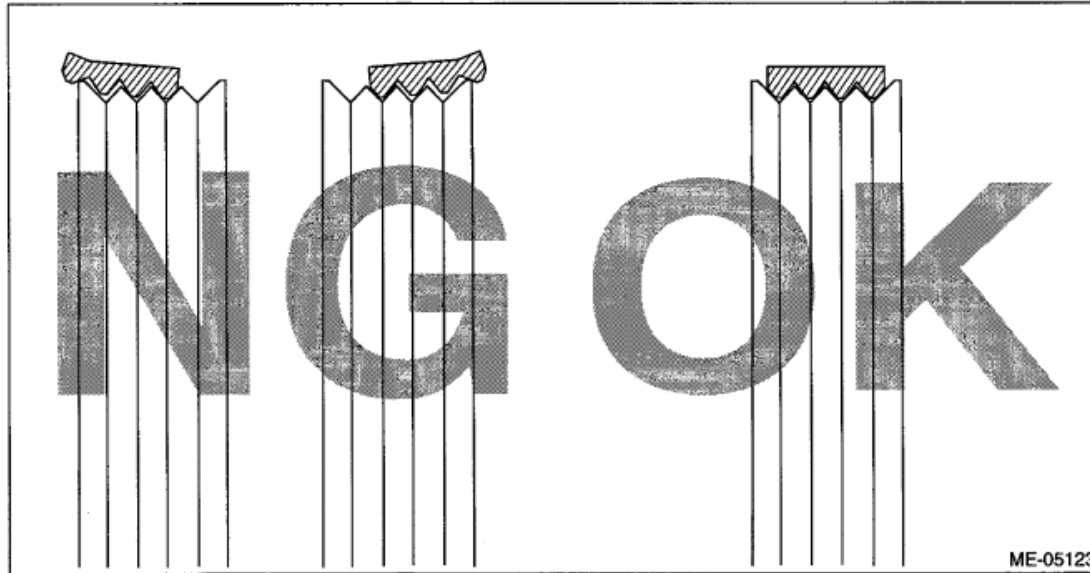


Fig. 93: Identifying Proper And Improper V-Belt Ribs
Courtesy of SUBARU OF AMERICA, INC.

4. Check that the V-belt tensioner assembly (C) moves in the direction of arrow (D), when the V-belt (A) is pushed in the direction of arrow (B) or released.

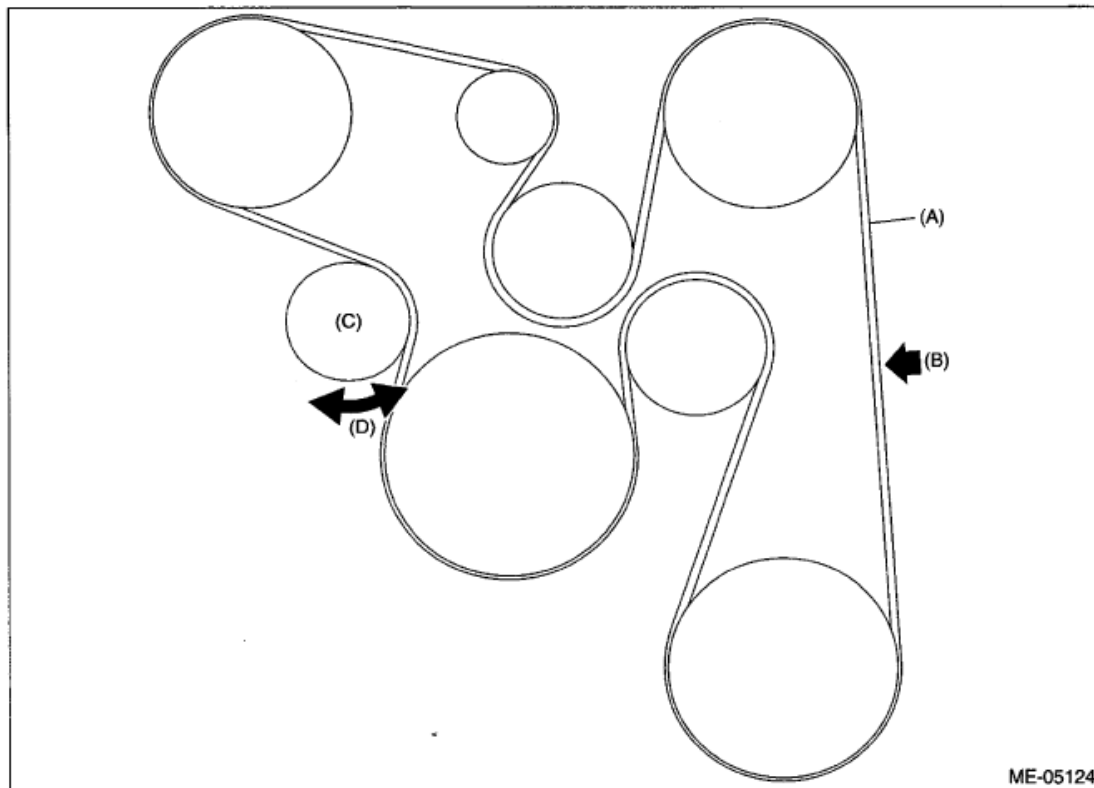


Fig. 94: Checking V-Belt Tensioner Assembly
Courtesy of SUBARU OF AMERICA, INC.

CRANK PULLEY

REMOVAL

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

1. Remove the V-belts. < refer to **REMOVAL**, V-belt >
2. Remove the radiator sub fan and fan motor. < refer to **REMOVAL** , Radiator Sub Fan and Fan Motor >
3. Use the ST to lock the crank pulley, and remove the crank pulley bolt.

NOTE: To prevent damaging ST1, attach the ST2 onto the ST1 as shown.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

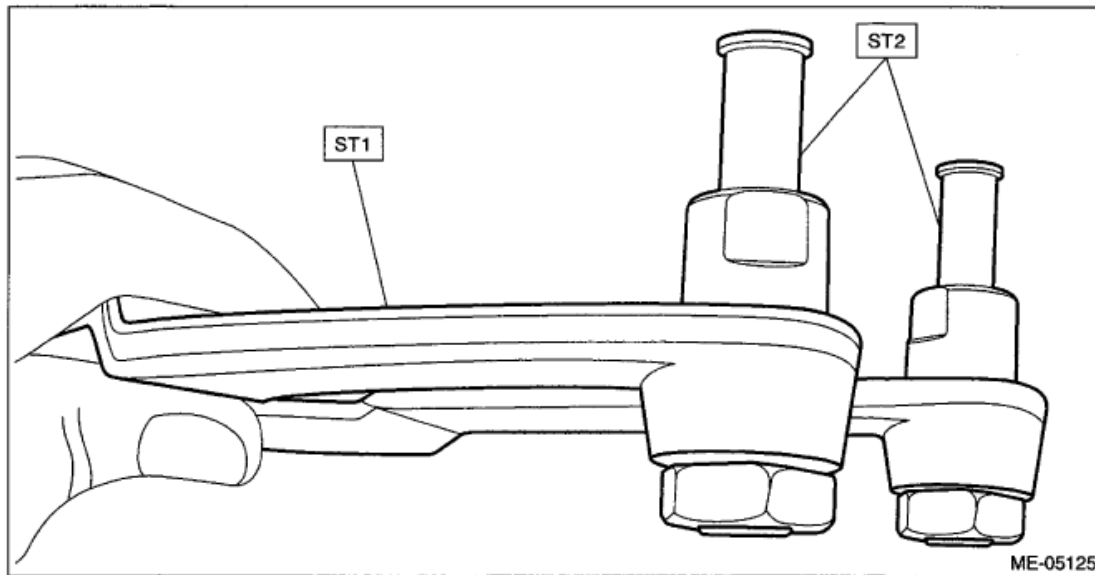


Fig. 95: Removing Crank Pulley Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

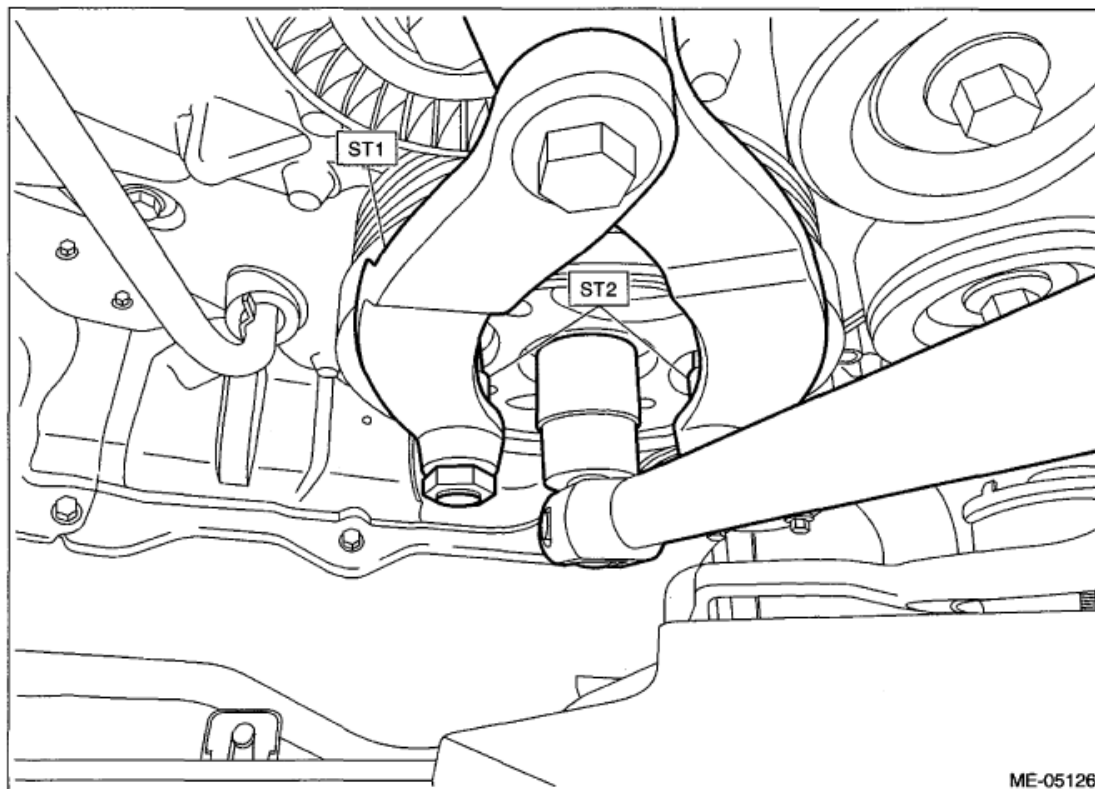


Fig. 96: Removing Crank Pulley Bolt Using ST

Courtesy of SUBARU OF AMERICA, INC.

4. Remove the crank pulley and remove the crank pulley boss.

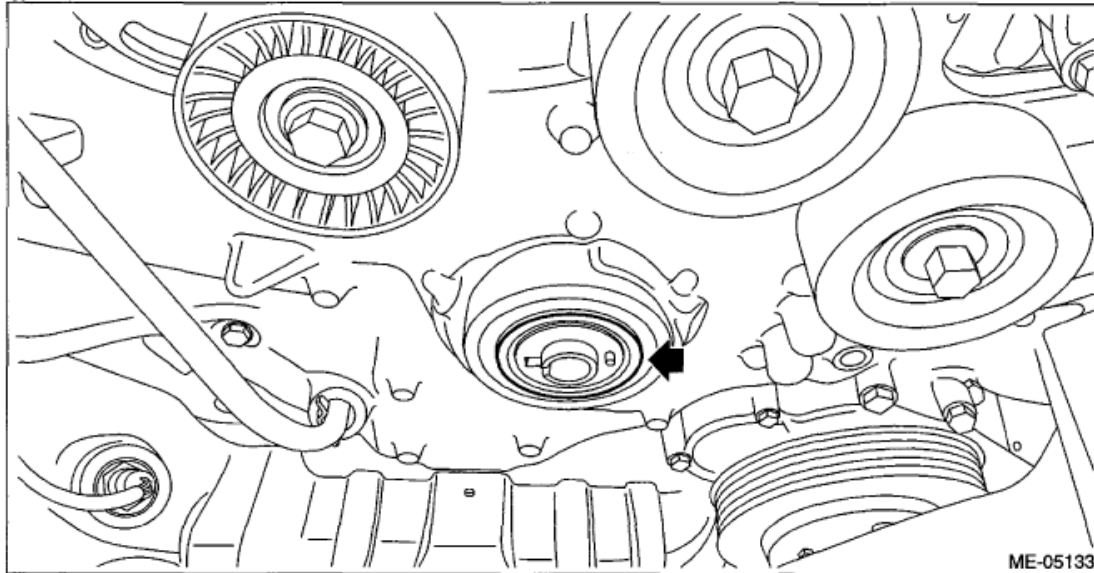


Fig. 97: Locating Crank Pulley Boss

Courtesy of SUBARU OF AMERICA, INC.

5. Remove the front oil seal.

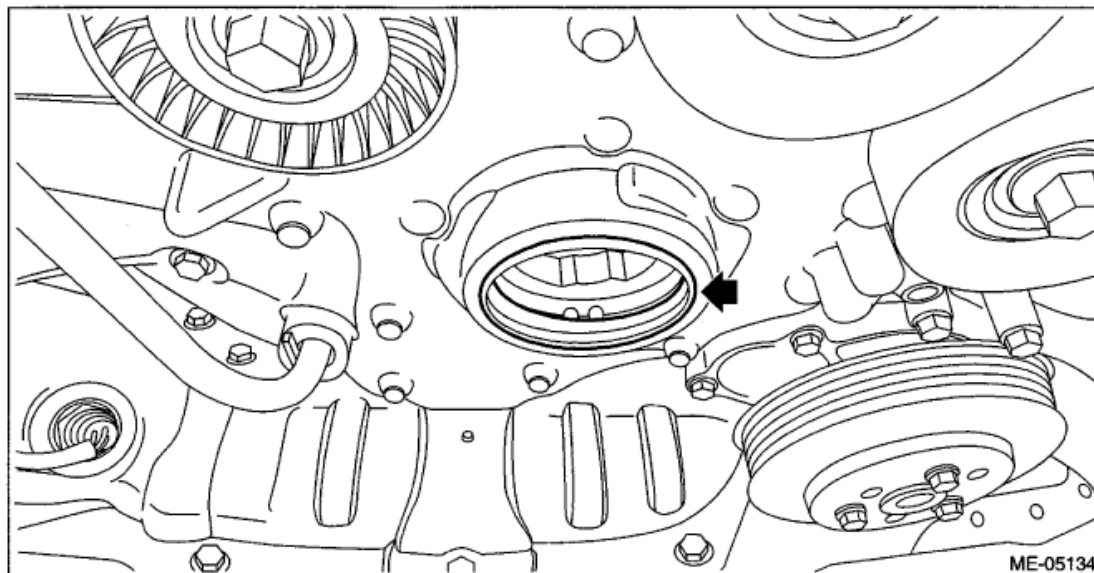


Fig. 98: Locating Front Oil Seal

Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

METHOD WITHOUT ANGLE GAUGE

1. Apply a light coat of engine oil to the front oil seal inner periphery and outer periphery, and install the front oil seal using ST.

NOTE:

- Use a new front oil seal.
- When tapping the front oil seal in, protect the radiator fin with cardboards etc. so as not to damage the radiator fin by the plastic hammer.

ST 398437700 OIL SEAL INSTALLER

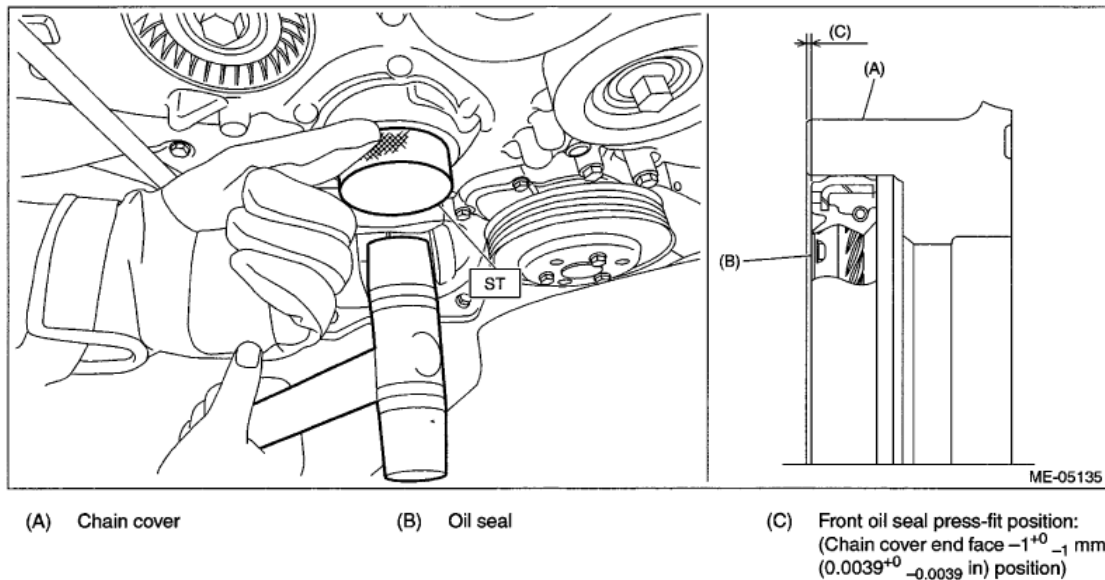
*Front oil seal press-fit position:**Chain cover end face -1^{+0}_{-1} mm ($0.0039^{+0}_{-0.0039}$ in) position*

Fig. 99: Installing Front Oil Seal Using ST
 Courtesy of SUBARU OF AMERICA, INC.

2. Clean the crankshaft thread using compressed air.
3. Install the crank pulley boss.

NOTE:**Use a new crank pulley boss and knock pins.**

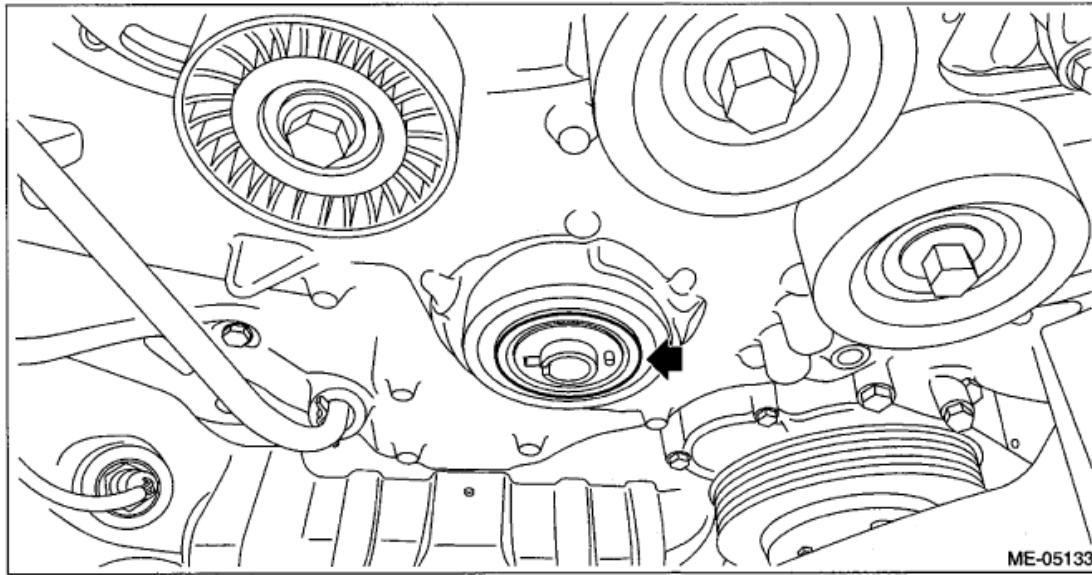


Fig. 100: Locating Crank Pulley Boss
Courtesy of SUBARU OF AMERICA, INC.

4. Apply engine oil to the crank pulley bolt seat and thread.
5. Install the crank pulley.
 1. Install the crank pulley to the crank pulley boss.

NOTE:

- Use new crank pulley and O-rings.
- Install the crank pulley by aligning the crank pulley knock hole (A) and crank pulley boss knock pin (B).

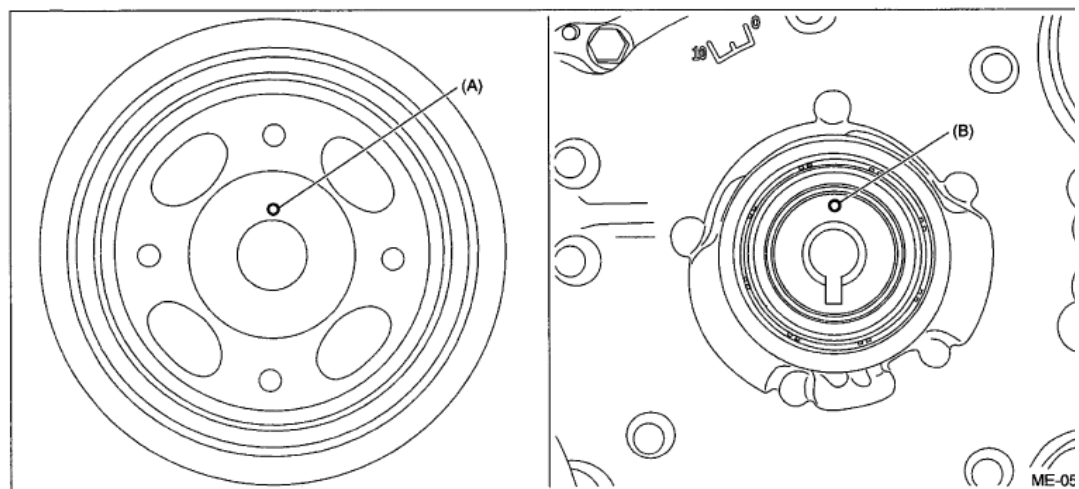


Fig. 101: Identifying Crank Pulley Knock Hole And Crank Pulley Boss Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

2. Use the ST to lock the crank pulley, and temporarily tighten the crank pulley bolt.

NOTE: To prevent damaging ST1, attach the ST2 onto the ST1 as shown.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

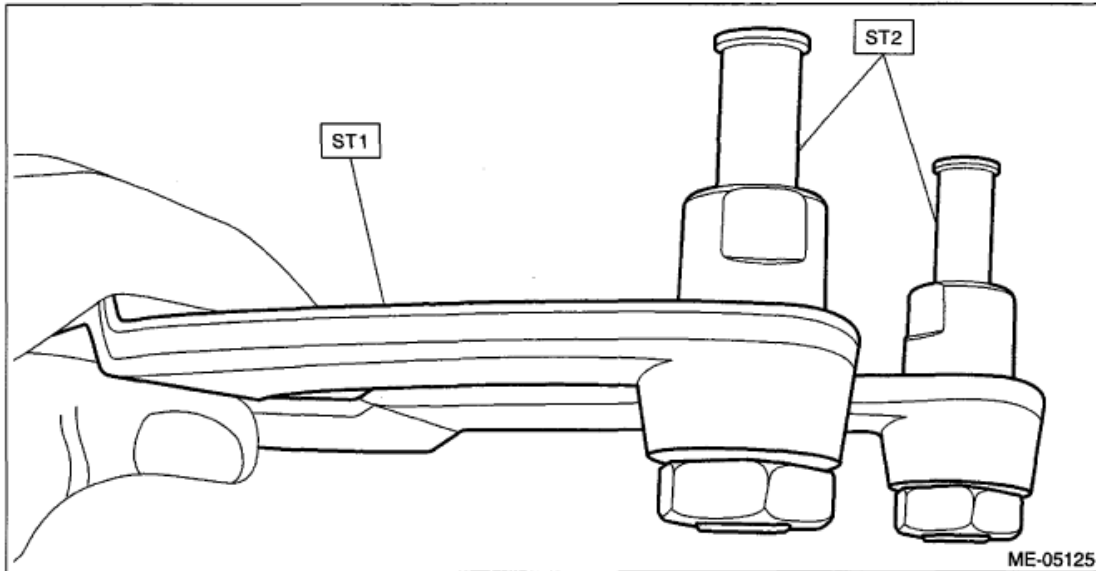


Fig. 102: Tightening Crank Pulley Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

Tightening torque: 60 N.m (6.1 kgf-m, 44.3 ft-lb)

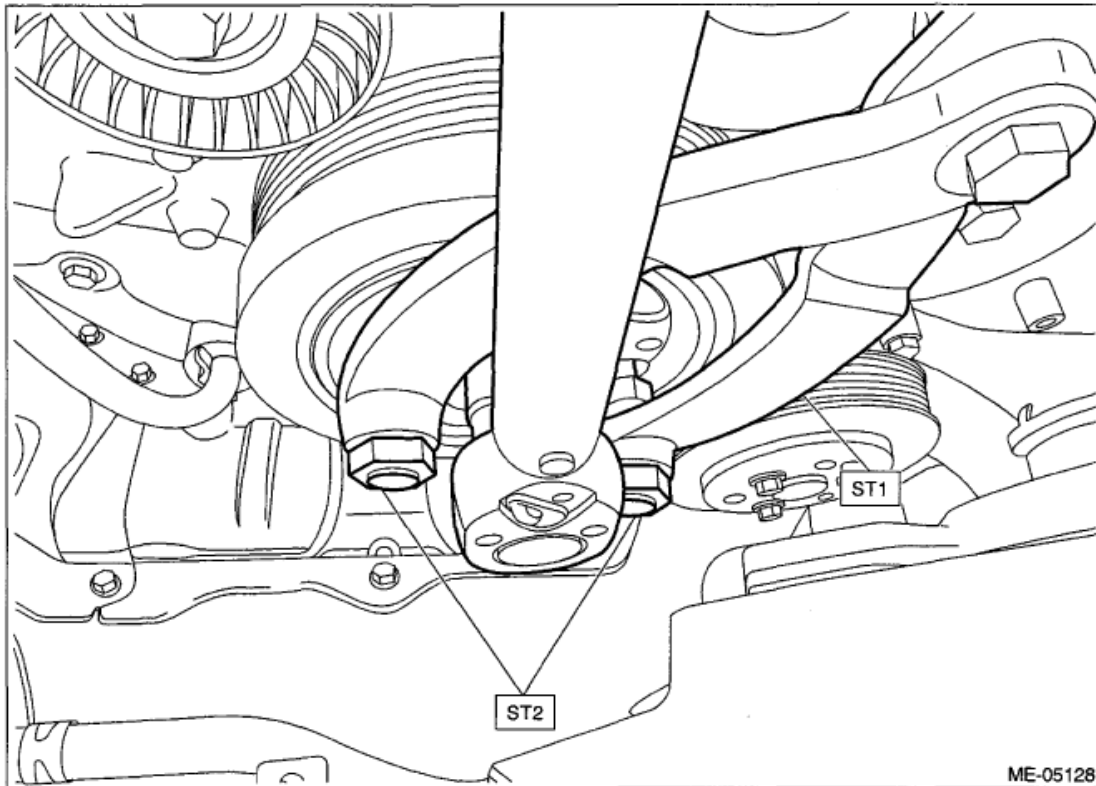
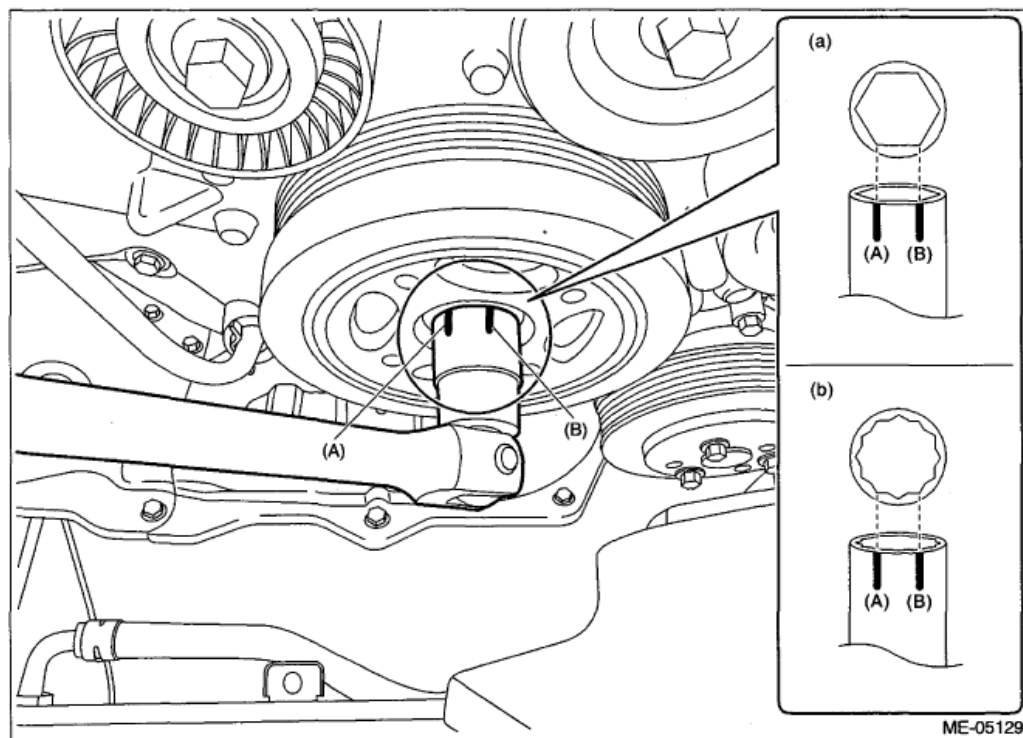


Fig. 103: Tightening Crank Pulley Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

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

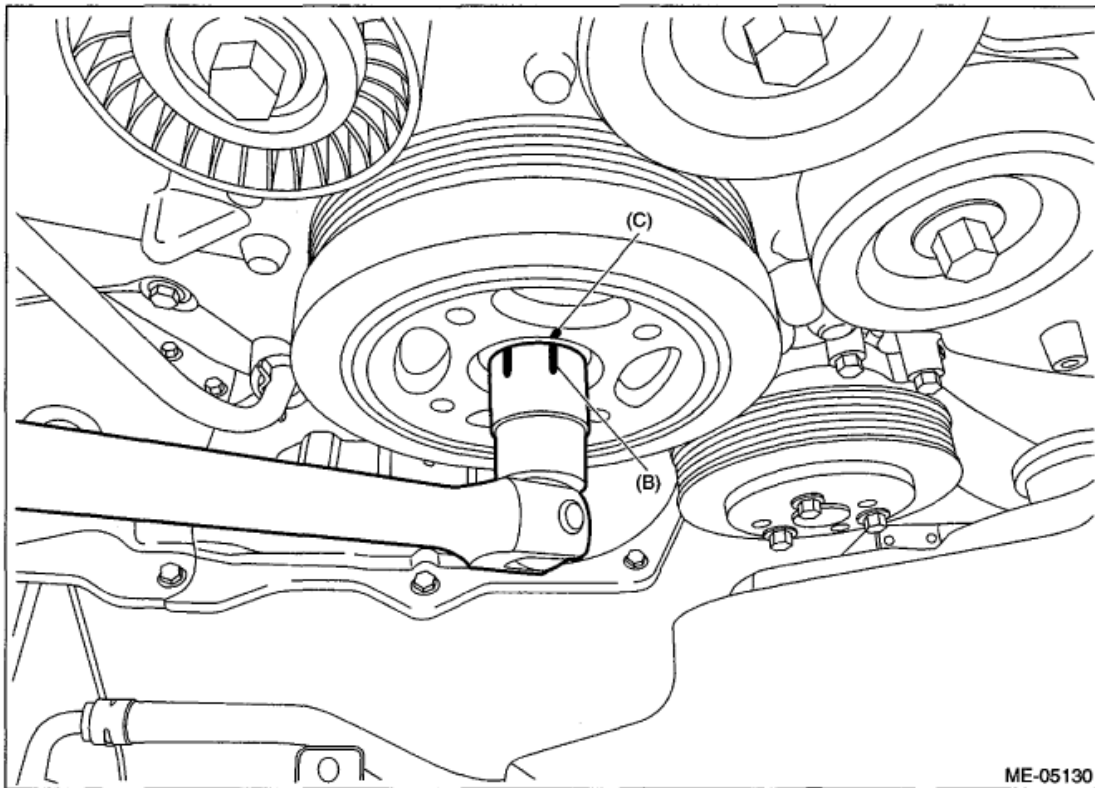


(a) When using 6-point socket

(b) When using 12-point socket

Fig. 104: Setting Socket Onto Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Draw end line (C) on crank pulley using a marker at the same position as reference line (B) drawn on the socket in step (2).



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Fig. 105: Identifying End Line On ST
Courtesy of SUBARU OF AMERICA, INC.

5. 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.

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

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

Tightening angle: 60°±5°

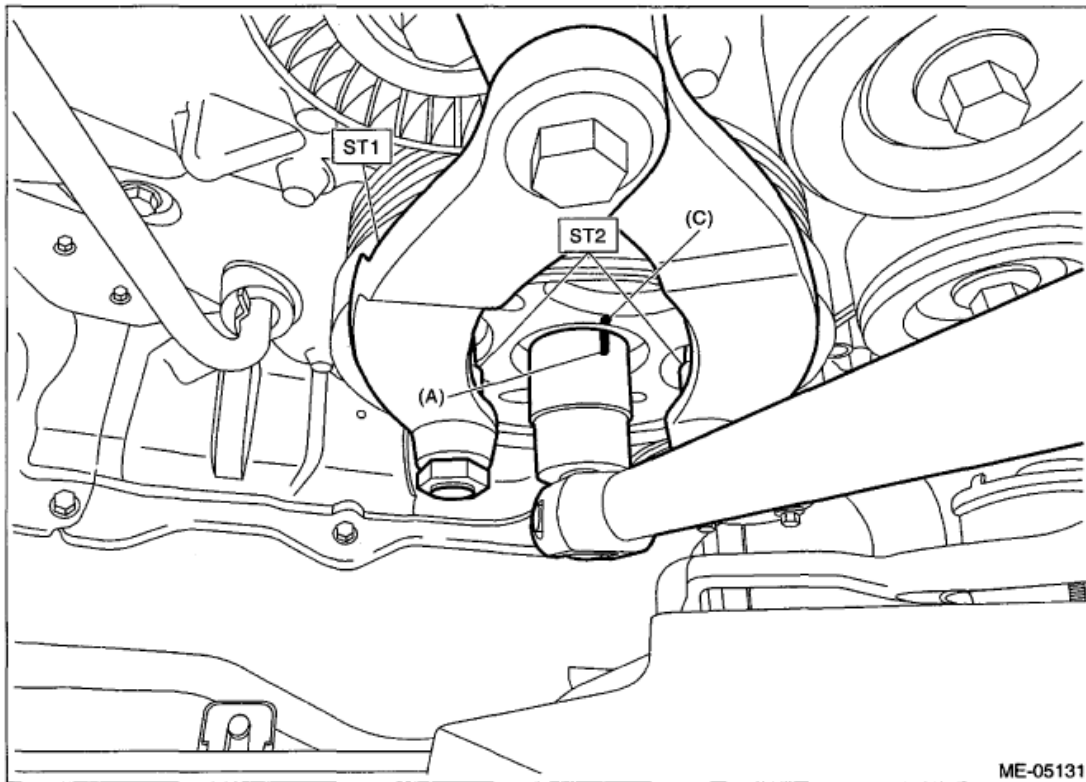


Fig. 106: Tightening Crank Pulley Bolt Using ST
 Courtesy of SUBARU OF AMERICA, INC.

6. Install the radiator sub fan and fan motor. < refer to **INSTALLATION** , Radiator Sub Fan and Fan Motor >
7. Install the V-belts. < refer to **INSTALLATION**, V-belt >

METHOD WITH ANGLE GAUGE

1. Apply a light coat of engine oil to the front oil seal inner periphery and outer periphery, and install the front oil seal using ST.

NOTE:

- Use a new front oil seal.
- When tapping the front oil seal in, protect the radiator fin with cardboards etc. so as not to damage the radiator fin by the plastic hammer.

ST 398437700 OIL SEAL INSTALLER

Front oil seal press-fit position: Chain cover end face -1^{+0}_{-1} mm ($0.0039^{+0}_{-0.0039}$ in) position

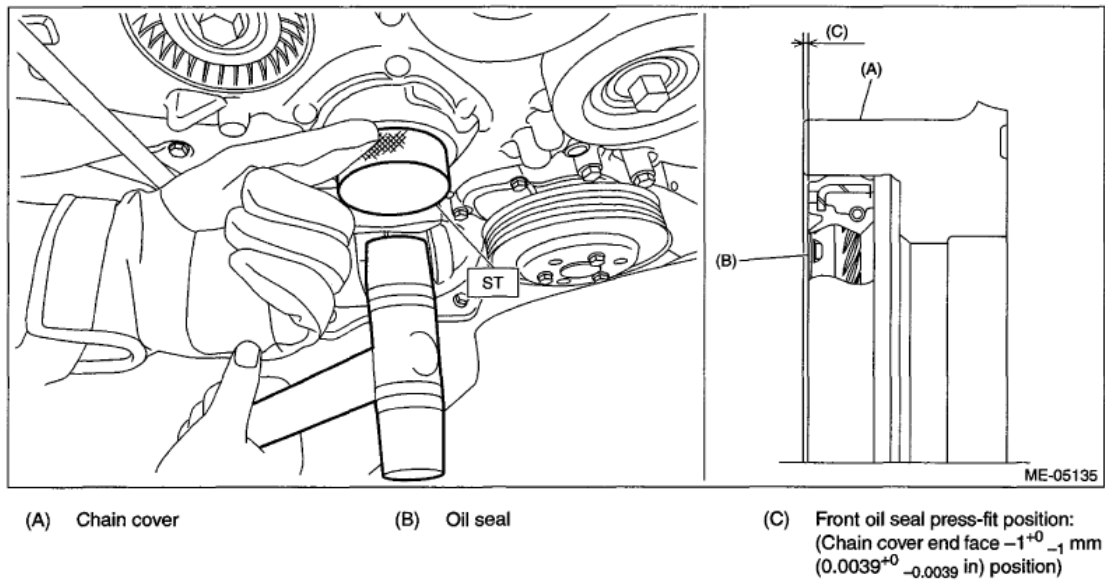


Fig. 107: Installing Front Oil Seal Using ST
Courtesy of SUBARU OF AMERICA, INC.

2. Clean the crankshaft thread using compressed air.
3. Install the crank pulley boss.

NOTE: Use a new crank pulley boss and knock pins.

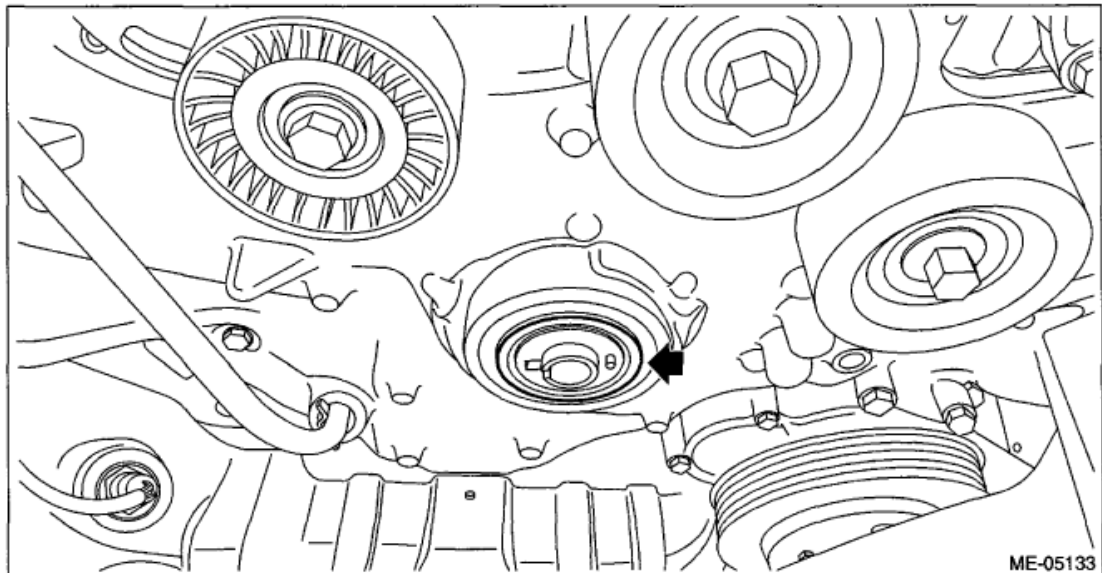


Fig. 108: Locating Crank Pulley Boss
Courtesy of SUBARU OF AMERICA, INC.

4. Apply engine oil to the crank pulley bolt seat and thread.
5. Install the crank pulley.

1. Install the crank pulley to the crank pulley boss.

NOTE:

- Use new crank pulley and O-rings.
- Install the crank pulley by aligning the crank pulley knock hole (A) and crank pulley boss knock pin (B).

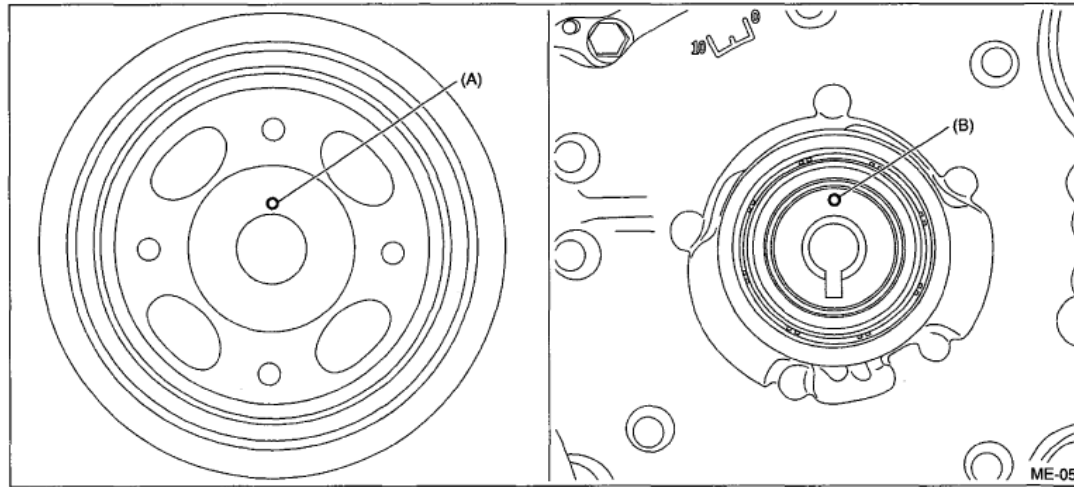


Fig. 109: Identifying Crank Pulley Knock Hole And Crank Pulley Boss Knock Pin

Courtesy of SUBARU OF AMERICA, INC.

2. Use the ST to lock the crank pulley, and temporarily tighten the crank pulley bolt.

NOTE: To prevent damaging ST1, attach the ST2 onto the ST1 as shown.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

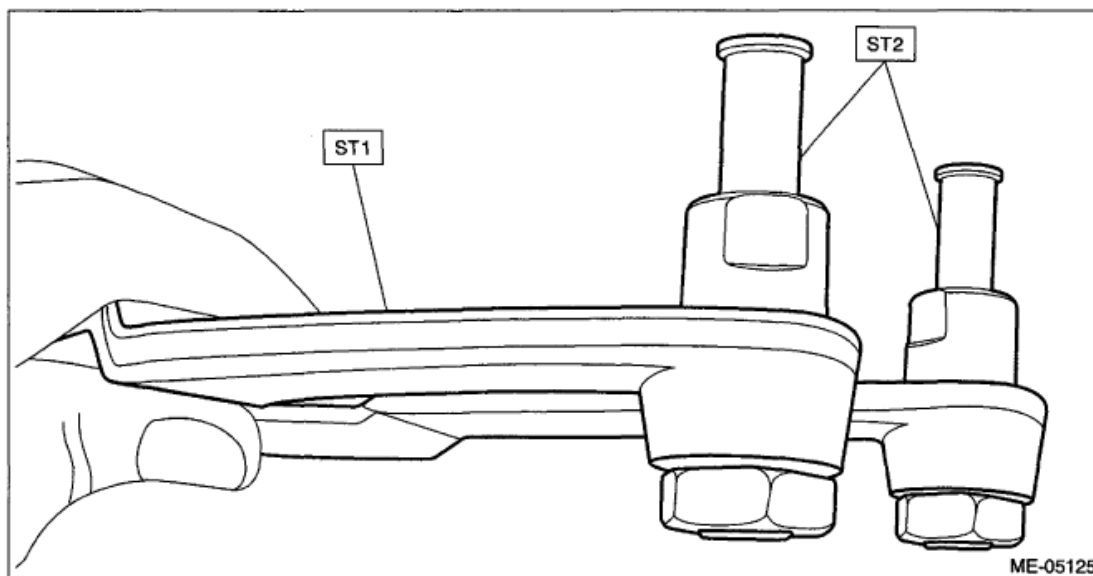


Fig. 110: Tightening Crank Pulley Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

Tightening torque: 60 N.m (6.1 kgf-m, 44.3 ft-lb)

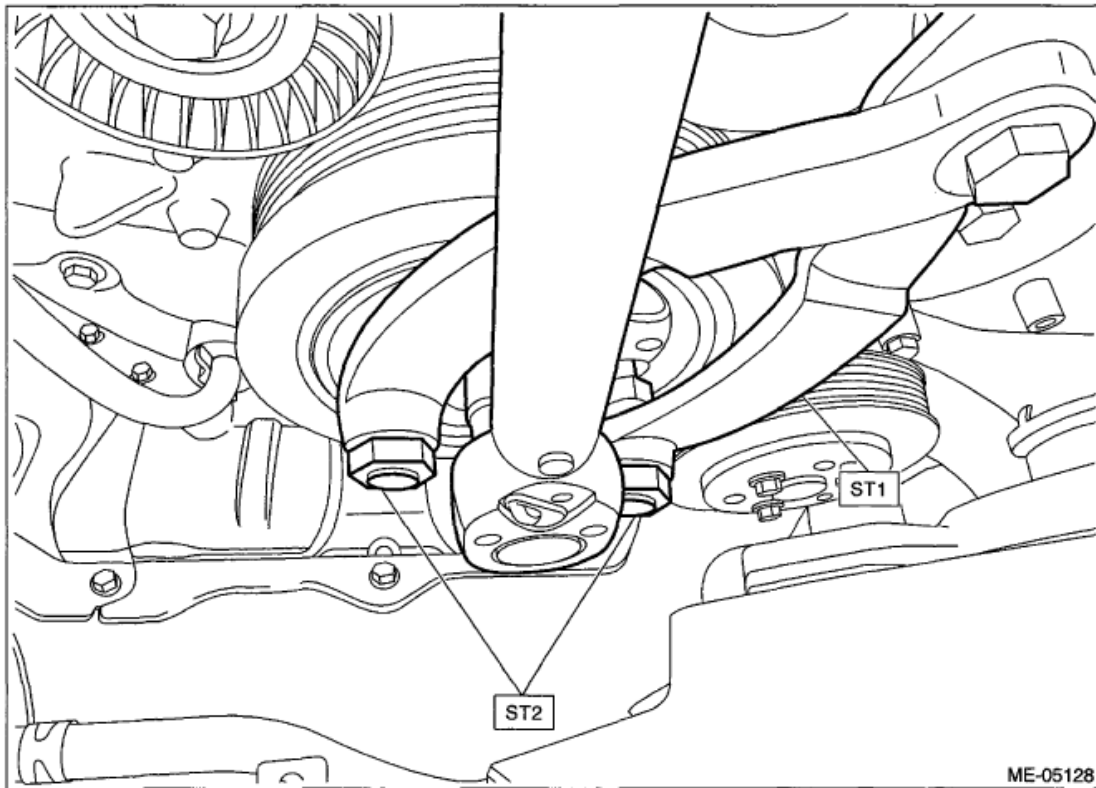


Fig. 111: Tightening Crank Pulley Bolt Using ST
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Attach the magnet used for securing the ST3 (ANGLE GAUGE) to ST1.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

ST3 18854AA000 ANGLE GAUGE

Tightening angle: $60^{\circ} \pm 5^{\circ}$

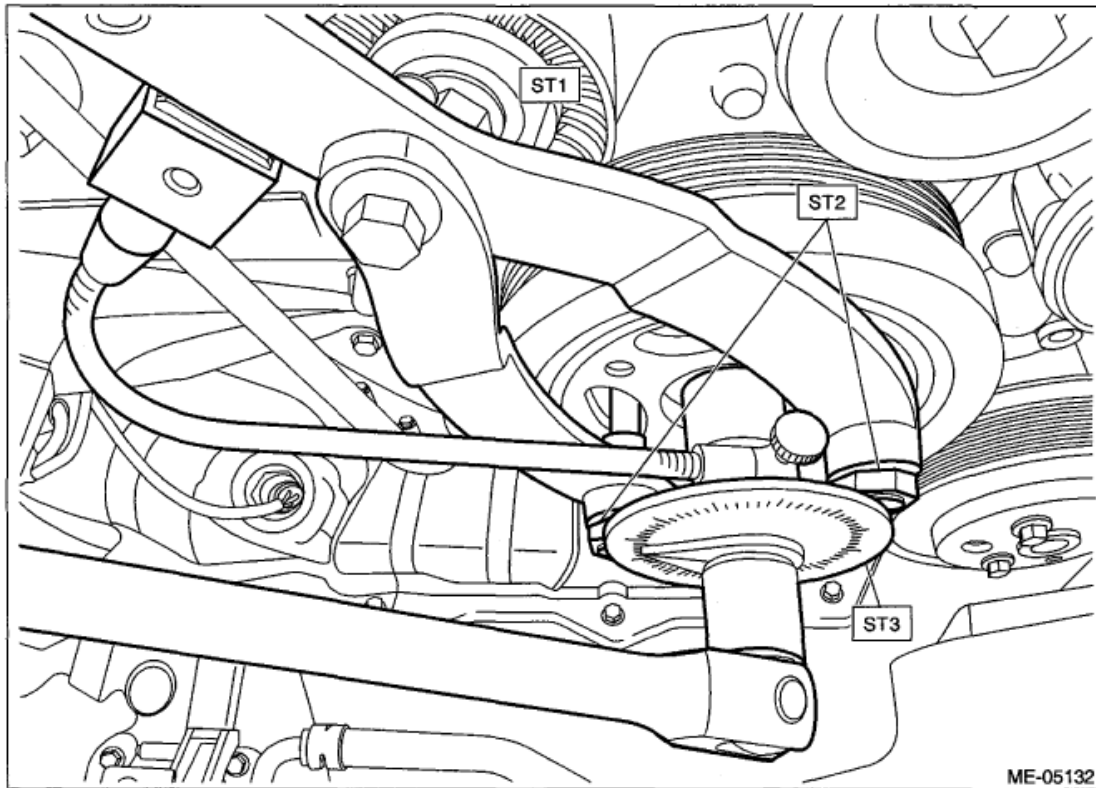


Fig. 112: Tightening Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

6. Install the radiator sub fan and fan motor. < refer to **INSTALLATION** , Radiator Sub Fan and Fan Motor >
7. Install the V-belts. < refer to **INSTALLATION**, V-belt >

INSPECTION

1. Check that the crank pulley has no deformation, cracks or other damages.
2. Inspect for oil leakage from the front oil seal. If there is an oil leak, replace the front oil seal with a new one. < refer to **REMOVAL**, Crank Pulley >

CHAIN COVER

REMOVAL

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

1. When working on the vehicle

NOTE: When working on the vehicle, perform the following steps also.

1. Remove the radiator. < refer to **REMOVAL** , Radiator >
2. Remove the front exhaust pipe. < refer to **REMOVAL** , Front Exhaust Pipe >
3. Remove the bolts which secure the generator cord stay to the chain cover.

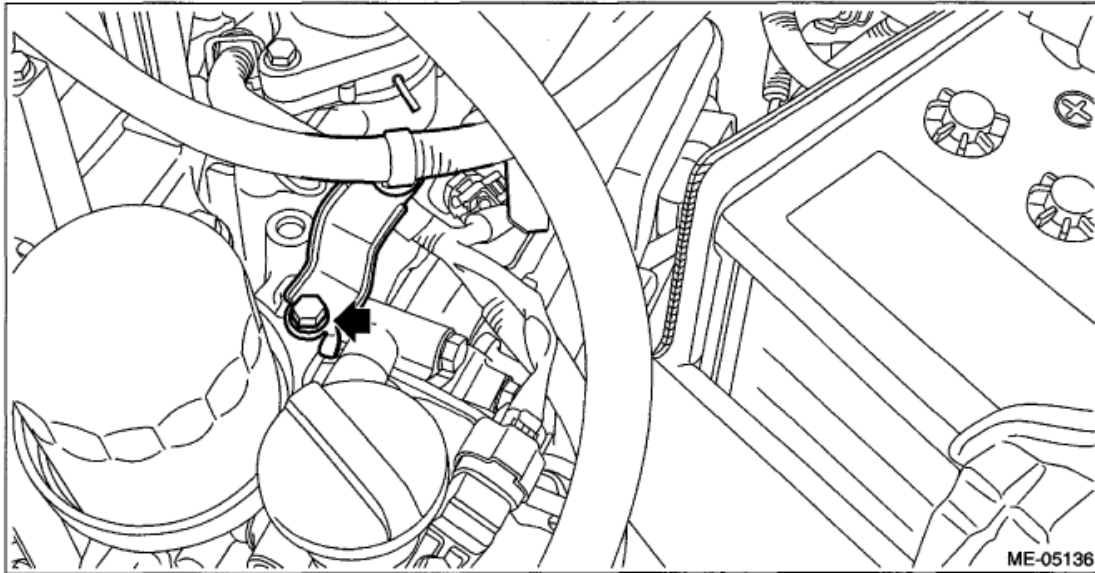


Fig. 113: Locating Generator Cord Stay Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the power steering pump.
 1. Remove the V-belts. < refer to **REMOVAL** , V-belt >
 2. Remove the generator. < refer to **REMOVAL** , Generator >
 3. Disconnect the connector from power steering pump switch.

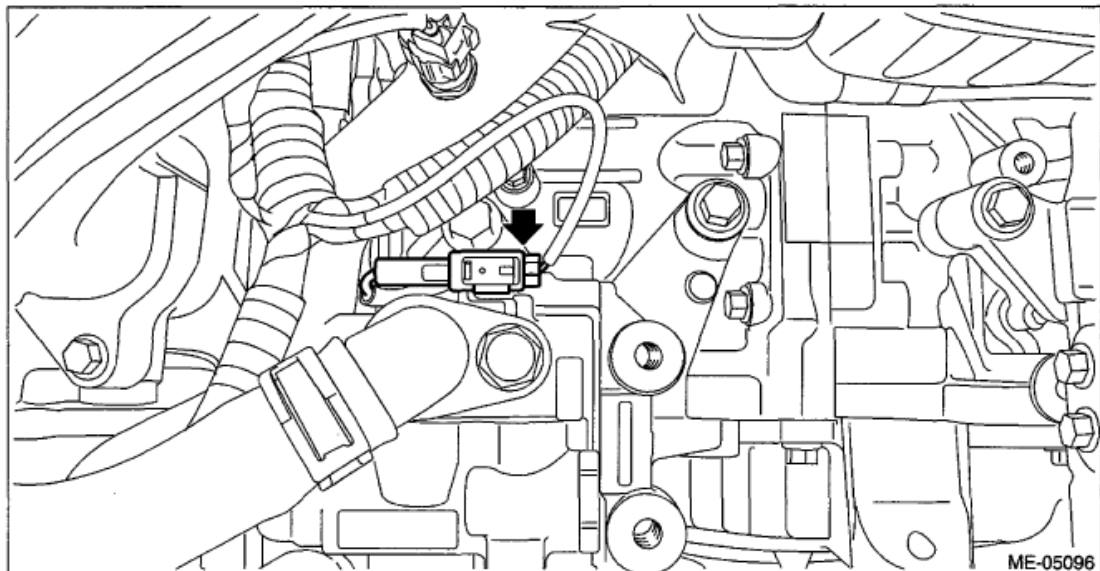


Fig. 114: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the power steering pump from the engine.

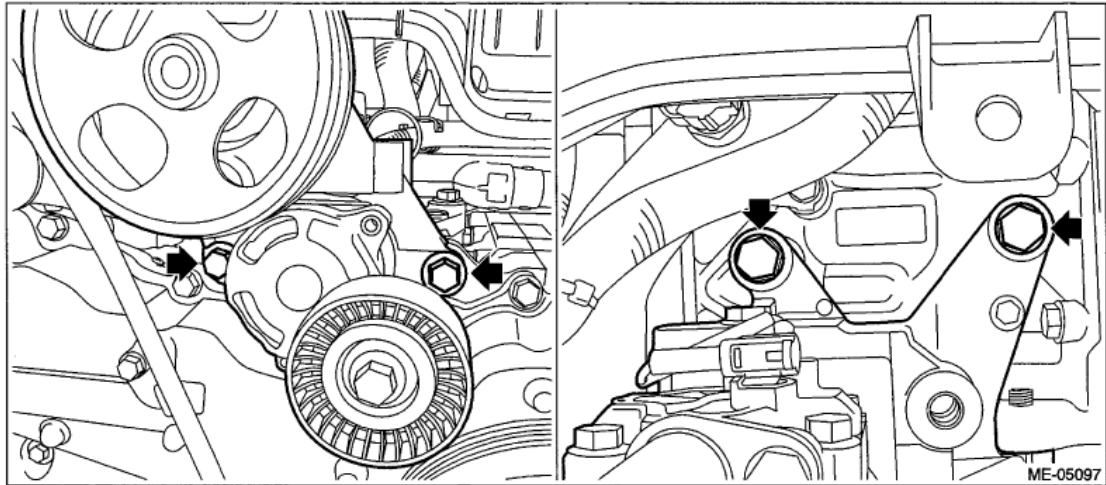


Fig. 115: Locating Engine Power Steering Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Place the power steering pump on the right side wheel apron.
2. Drain the engine oil. < refer to **REPLACEMENT** , Engine Oil >
3. Remove the water pump pulley. < refer to **WATER PUMP** , REMOVAL, Water Pump >
4. Remove the crank pulley. < refer to **REMOVAL**, Crank Pulley >
5. Remove the crank pulley boss.

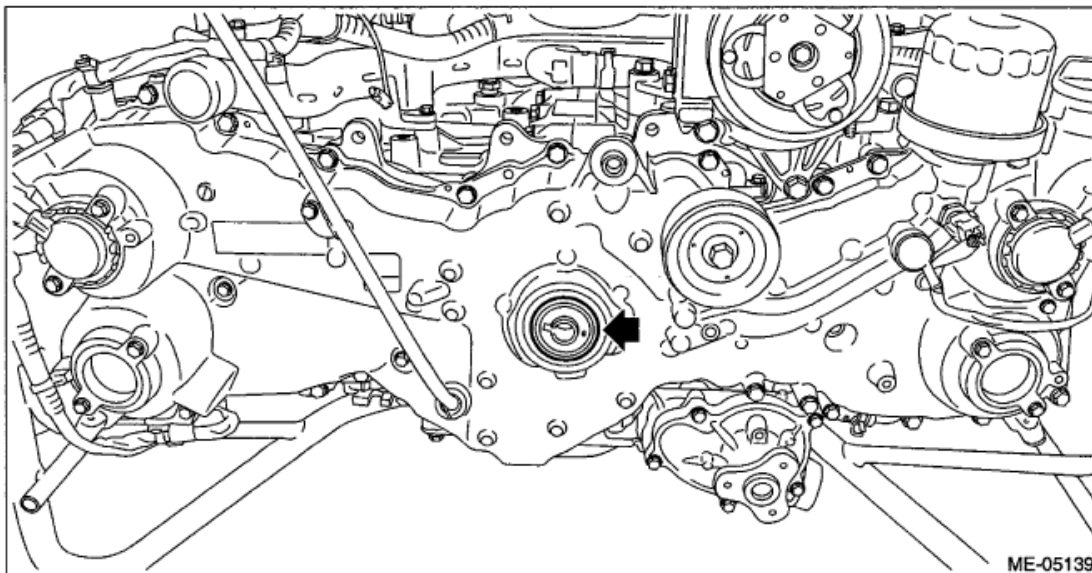


Fig. 116: Locating Crank Pulley Boss

Courtesy of SUBARU OF AMERICA, INC.

6. Remove the engine harness stay from the chain cover.

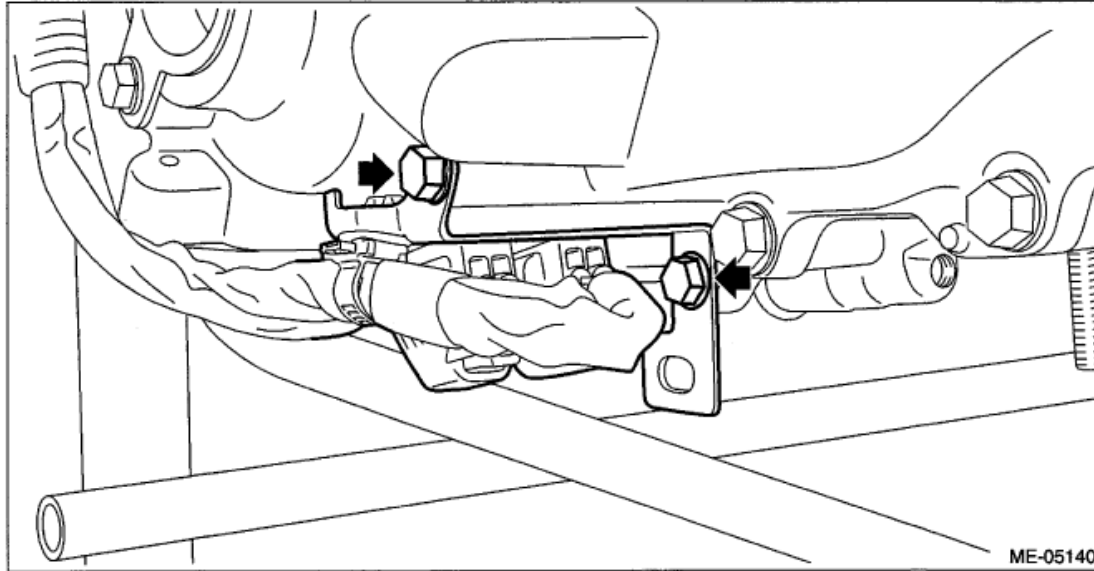


Fig. 117: Locating Chain Cover Engine Harness Stay Bolts
 Courtesy of SUBARU OF AMERICA, INC.

7. Disconnect the connector (A) from the oil control solenoid RH, and the connector (B) from the camshaft position sensor RH, and remove the clip (C) and clip (D) which secure the engine harness.

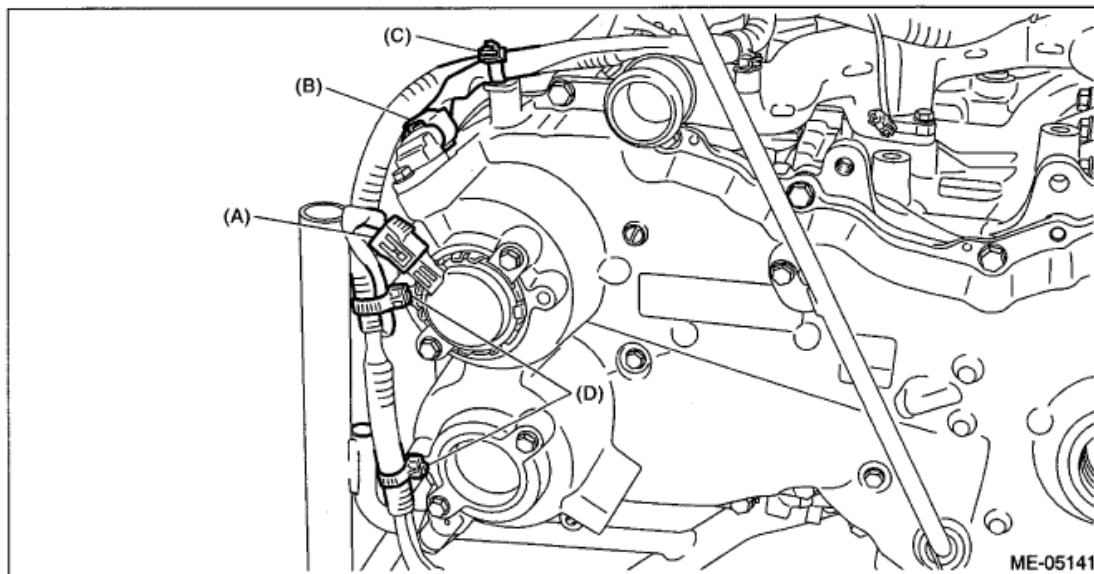


Fig. 118: Identifying Clips, Oil Control Solenoid RH Connector And Camshaft Position Sensor RH Connector
 Courtesy of SUBARU OF AMERICA, INC.

8. Remove the rubber cap from the oil pressure switch.

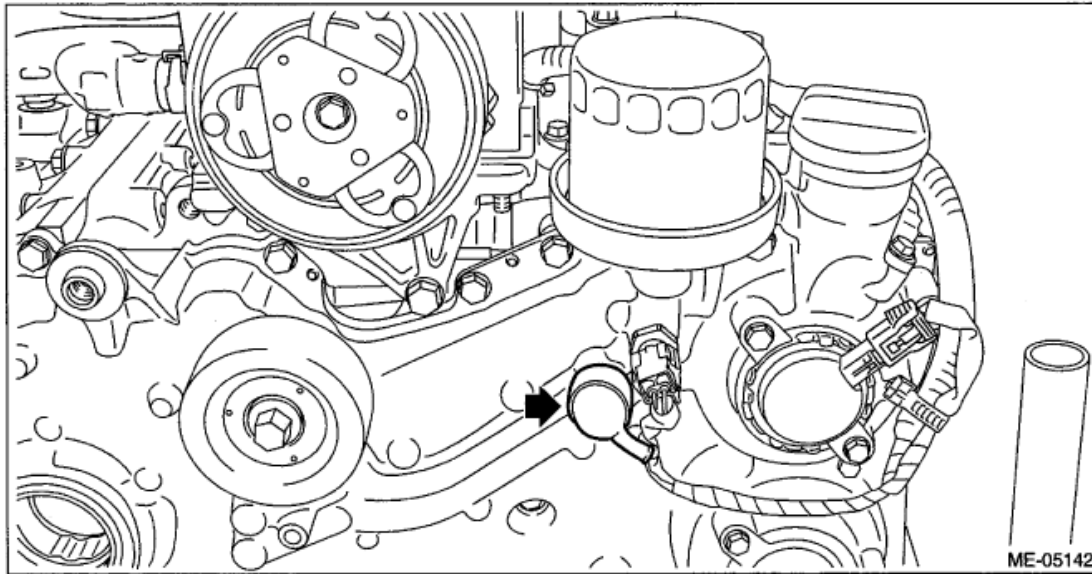


Fig. 119: Locating Oil Pressure Switch Rubber Cap
 Courtesy of SUBARU OF AMERICA, INC.

9. Disconnect the terminal (A) from the oil pressure switch, and connector (B) from the engine oil temperature sensor, and connector (C) from the oil control solenoid LH, and connector (D) from the camshaft position sensor LH, and remove the clip (E) and clip (F) which secure the engine harness.

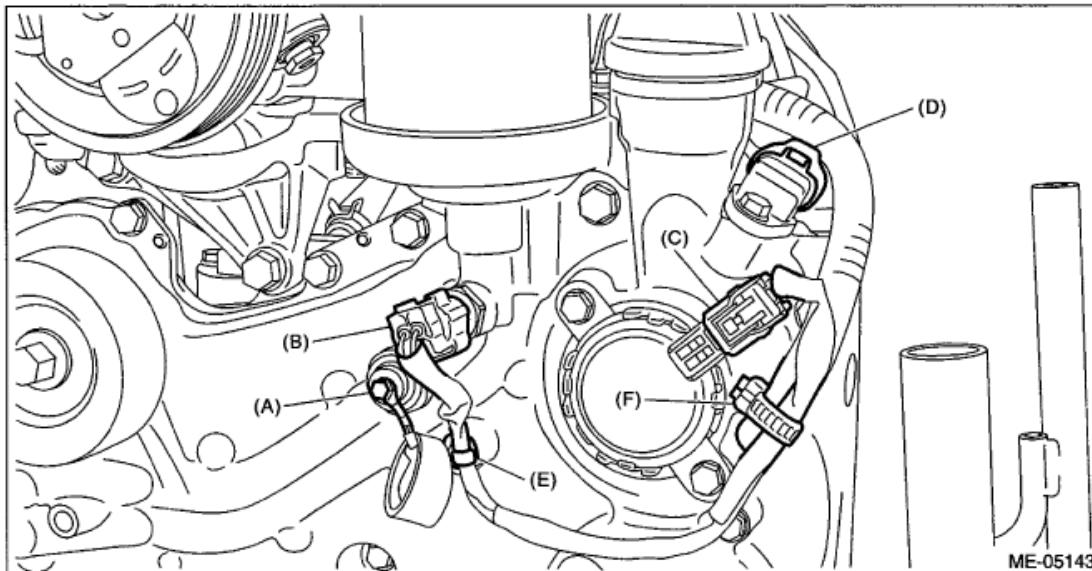


Fig. 120: Identifying Oil Pressure Switch Terminal, Engine Oil Temperature Sensor Connector, Oil Control Solenoid LH Connector And Clips
 Courtesy of SUBARU OF AMERICA, INC.

10. Pull out the oil level gauge (A), and remove the oil level gauge guide (B) and idler pulley (C).

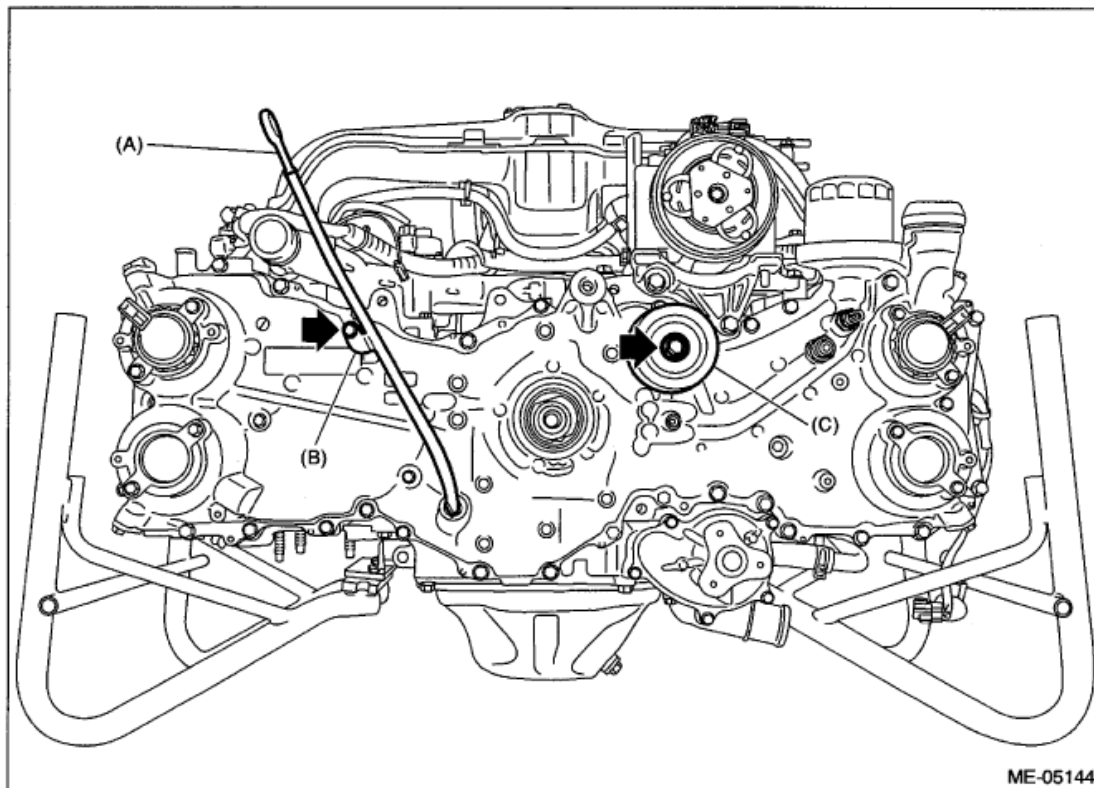


Fig. 121: Pulling Out Oil Level Gauge
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the chain cover.

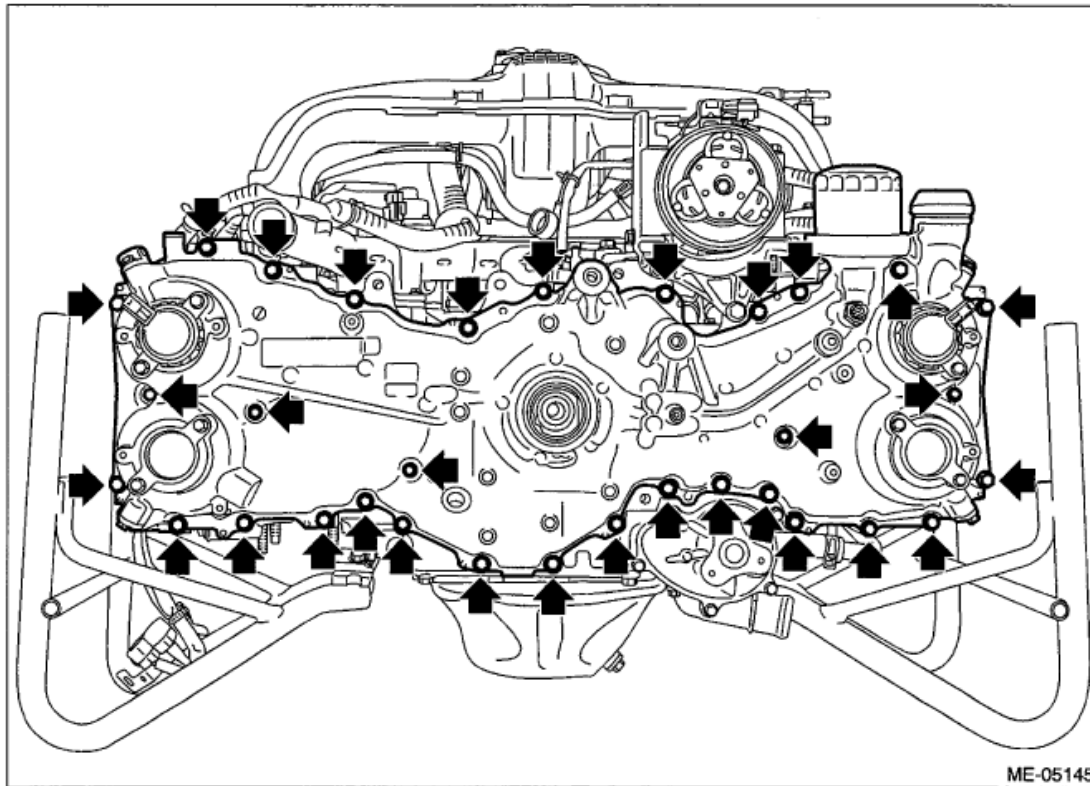


Fig. 122: Locating Chain Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the O-rings from cylinder head RH, cylinder head LH, cylinder block LH and oil pan upper.

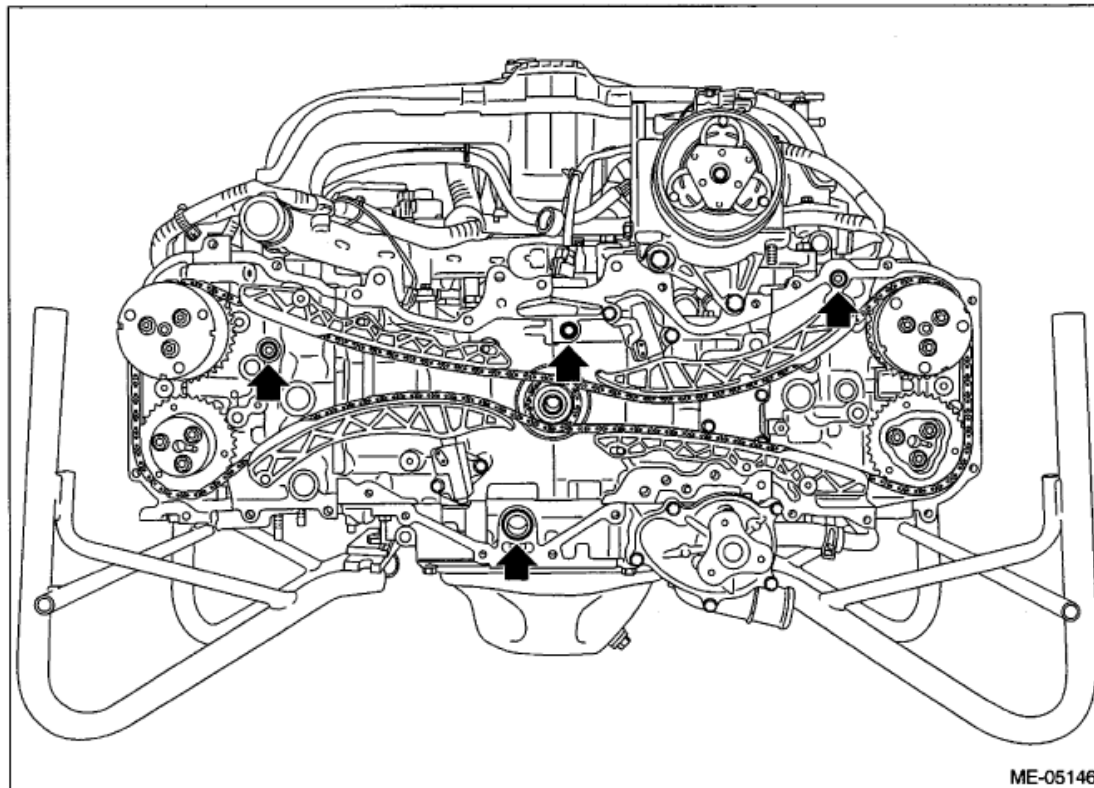


Fig. 123: Locating O-Rings Of Cylinder Head And Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the front oil seal from the chain cover.

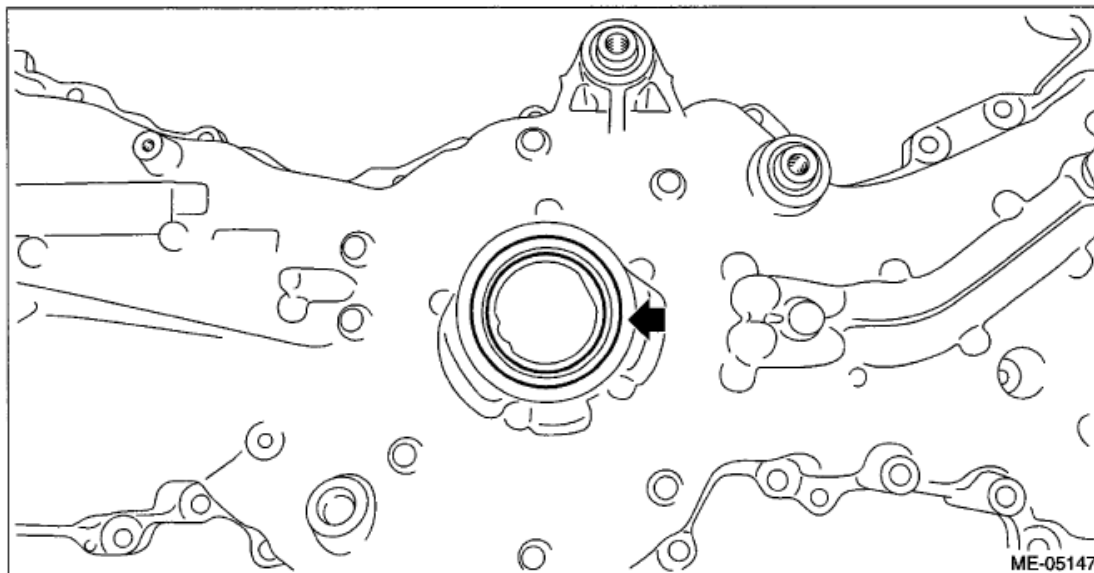


Fig. 124: Locating Front Oil Seal And Chain Cover
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the liquid gasket from the chain cover and engine unit.

INSTALLATION

1. Apply a light coat of engine oil to the front oil seal inner periphery and outer periphery, and install the front oil seal using ST.

ST 398437700 OIL SEAL INSTALLER

Front oil seal press-fit position: Chain cover end face -1^{+0}_{-1} mm ($0.0039^{+0}_{-0.0039}$ in) position

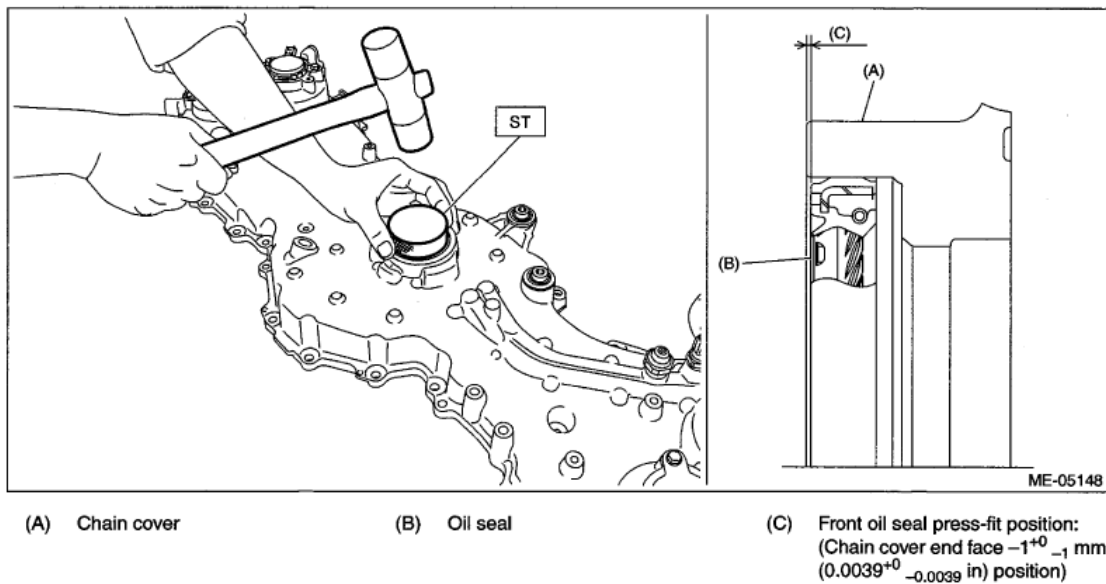


Fig. 125: Installing Front Oil Seal Using ST
Courtesy of SUBARU OF AMERICA, INC.

2. Install the O-rings to cylinder head RH, cylinder head LH, cylinder block LH and oil pan upper.

NOTE:

- Use new O-rings.
- Apply a coat of engine oil to the O-rings.

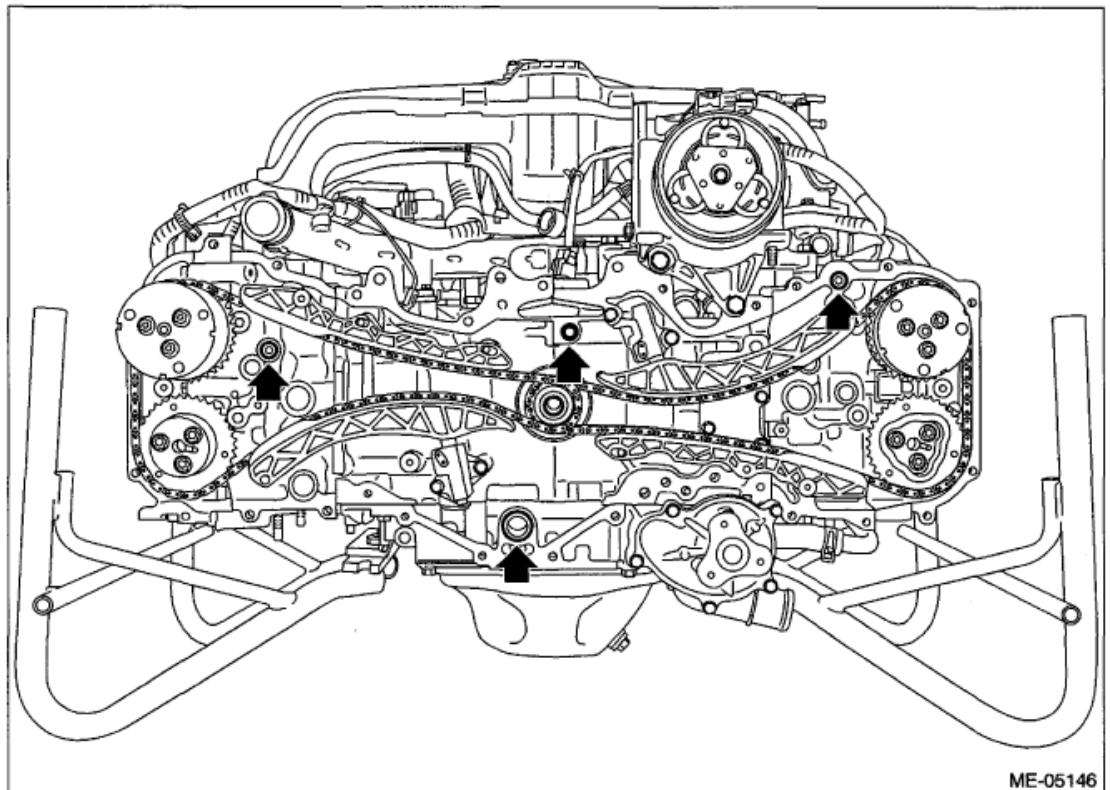


Fig. 126: Locating O-Rings Of Cylinder Head And Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

3. Apply liquid gasket if there are gaps between cylinder head and cylinder block (A) as shown.

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

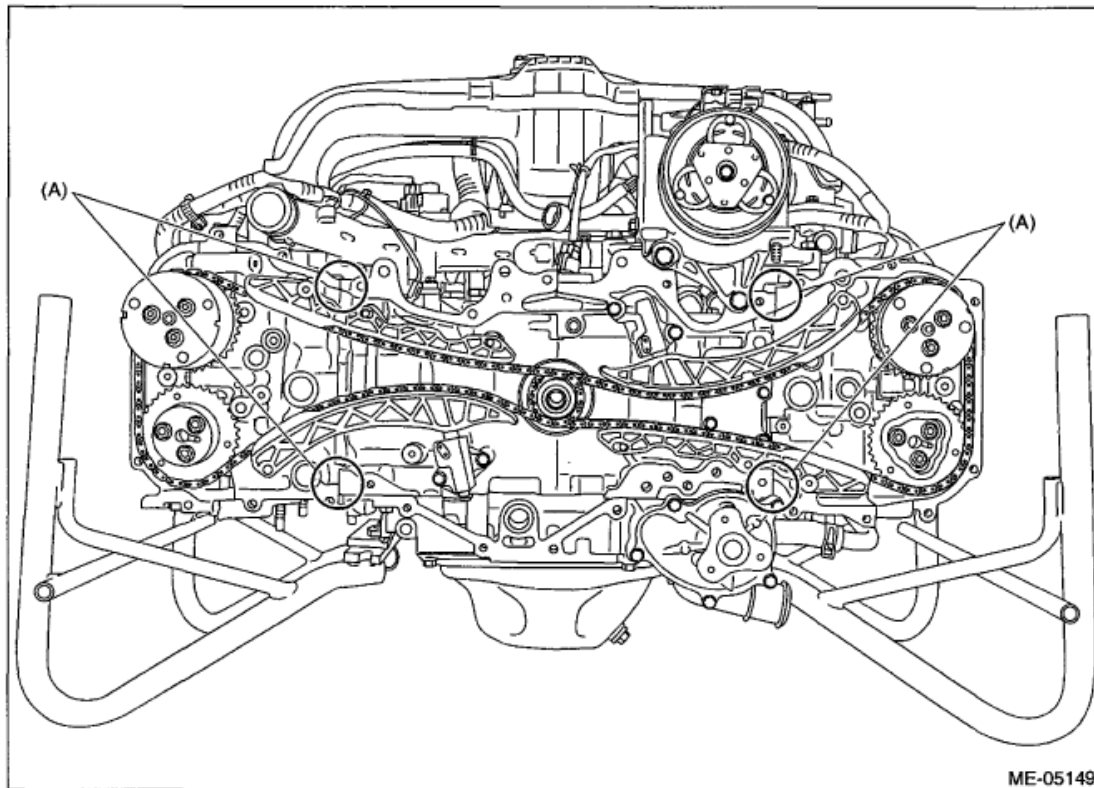


Fig. 127: Identifying Liquid Gasket Applying Area Between Cylinder Head And Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

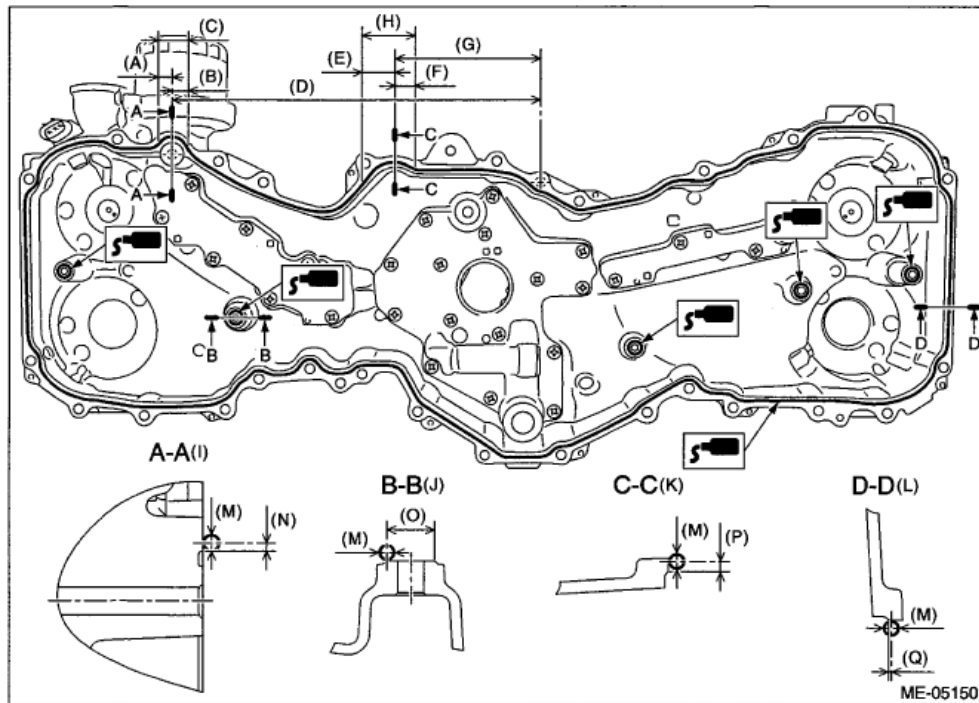
4. Apply liquid gasket to the chain cover mating surface and center boss (5 places) as shown in the figure.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the engine and the chain cover.
- Install within 5 min. after applying liquid gasket.

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

Liquid gasket applying diameter: 4 ± 0.5 mm (0.1575 ± 0.0197 in)



(A) 14.5 mm (0.5709 in)	(G) 127 mm (5.0000 in)	(M) 4±0.5 mm (0.1575±0.0197 in)
(B) 17.5 mm (0.6890 in)	(H) Range B	(N) 2 mm (0.0787 in)
(C) Range A	(I) Liquid gasket applying position of mating surfaces of range A	(O) φ12 mm (0.4724 in)
(D) 316.2 mm (12.4488 in)	(J) Liquid gasket applying position of center boss (5 places)	(P) 2.5 mm (0.0984 in)
(E) 24.5 mm (0.9646 in)	(K) Liquid gasket applying position of mating surfaces of range B	(Q) 0.5 mm (0.0197 in)
(F) 18.5 mm (0.7283 in)	(L) Liquid gasket applying position of mating surfaces other than range A and range B	

Fig. 128: Identifying Liquid Gasket Applying Area On Chain Cover Mating Surface And Center Boss

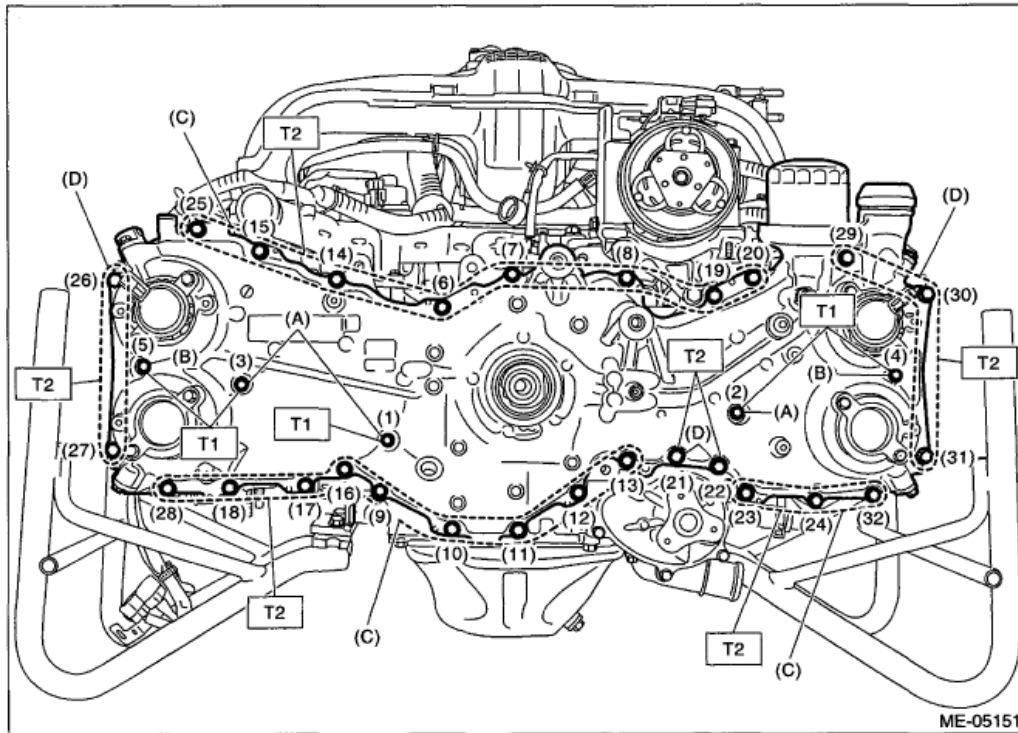
Courtesy of SUBARU OF AMERICA, INC.

- Set the chain cover, and tighten the bolts in numerical order as shown in the figure.

Tightening torque:

T1: 10 N.m (1.0 kgf-m, 7.4 ft-lb)

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



(A) M6 x 20
(B) M6 x 50

(C) M8 x 25

(D) M8 x 60

Fig. 129: Identifying Chain Cover Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Install the idler pulley (C) and oil level gauge guide (B), and insert the oil level gauge (A).

NOTE:

- Use a new O-ring to the oil level gauge guide.
- Apply a light coat of engine oil to the O-rings of the oil level gauge guide and the oil level gauge.

Tightening torque:

T1: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

T2: 36 N.m (3.7 kgf-m, 26.6 ft-lb)

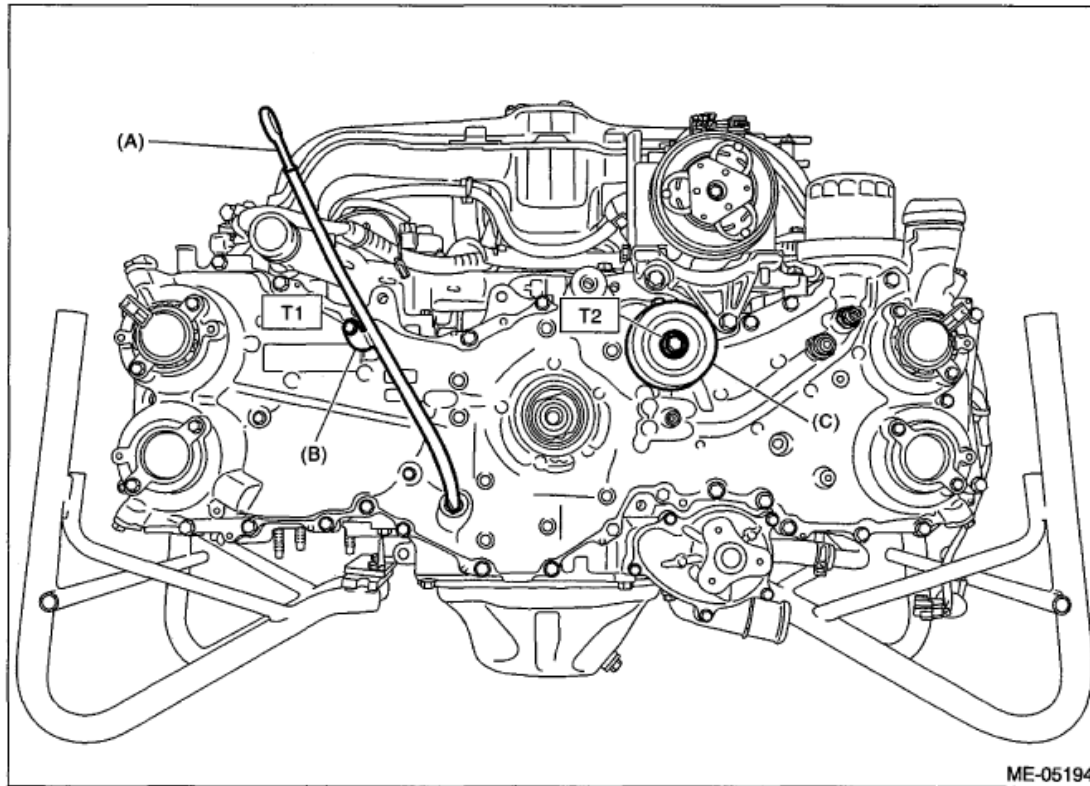
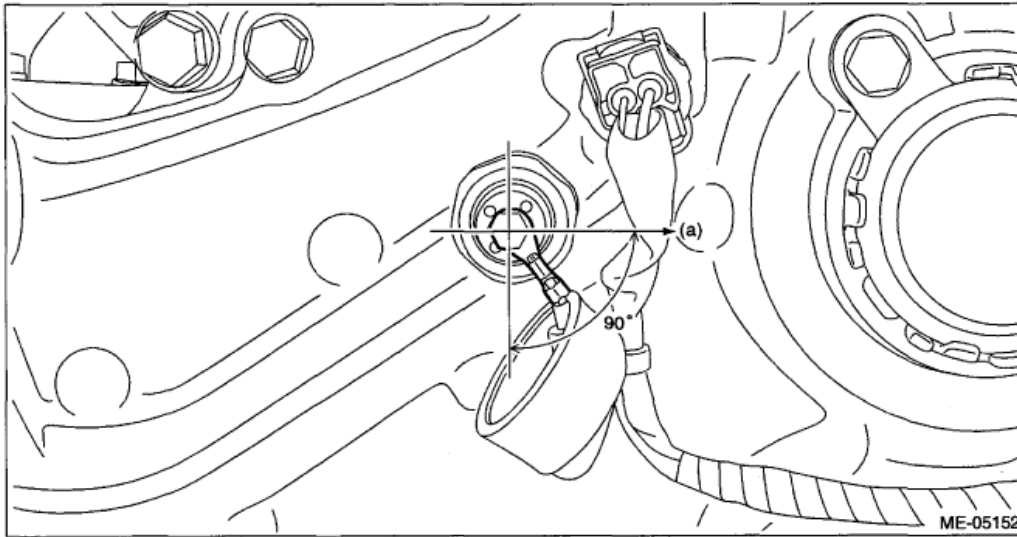


Fig. 130: Inserting Oil Level Gauge
Courtesy of SUBARU OF AMERICA, INC.

7. Connect the terminal (A) to the oil pressure switch, and connector (B) to the engine oil temperature sensor, and connector (C) to the oil control solenoid LH, and connector (D) to the camshaft position sensor LH, and secure the engine harness with clip (E) and clip (F).

NOTE: **The oil pressure switch harness must be positioned toward the left lower side of the vehicle within the range of 90°.**



(a) Left side of vehicle

Fig. 131: Identifying Oil Pressure Switch Harness Installation Angle
Courtesy of SUBARU OF AMERICA, INC.

Tightening torque: 1.5 N.m (0.2 kgf-m, 1.1 ft-lb)

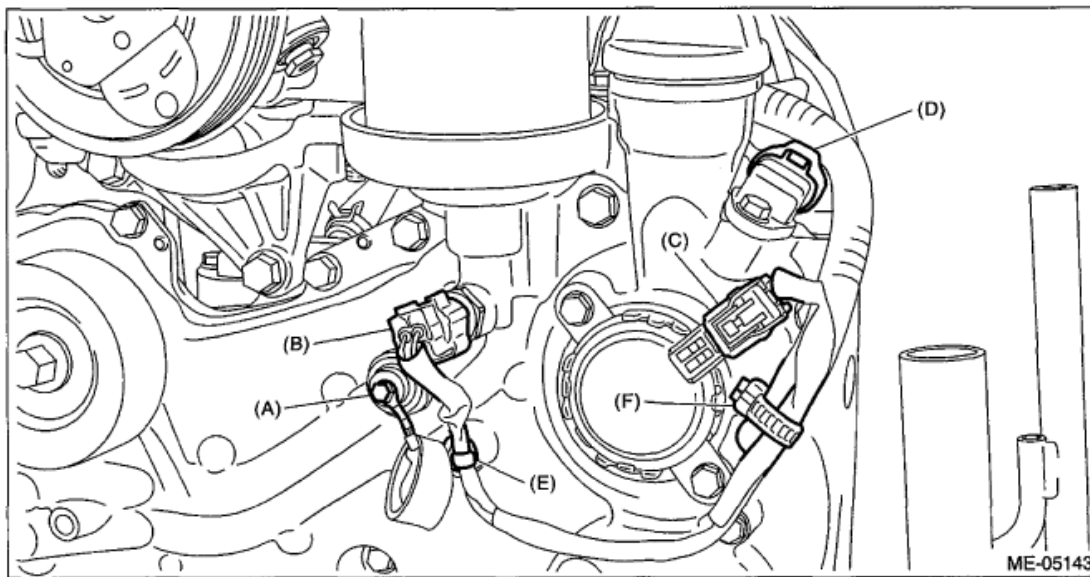


Fig. 132: Identifying Oil Pressure Switch Terminal, Engine Oil Temperature Sensor Connector, Oil Control Solenoid LH Connector And Clips
Courtesy of SUBARU OF AMERICA, INC.

8. Attach the rubber cap to the oil pressure switch.

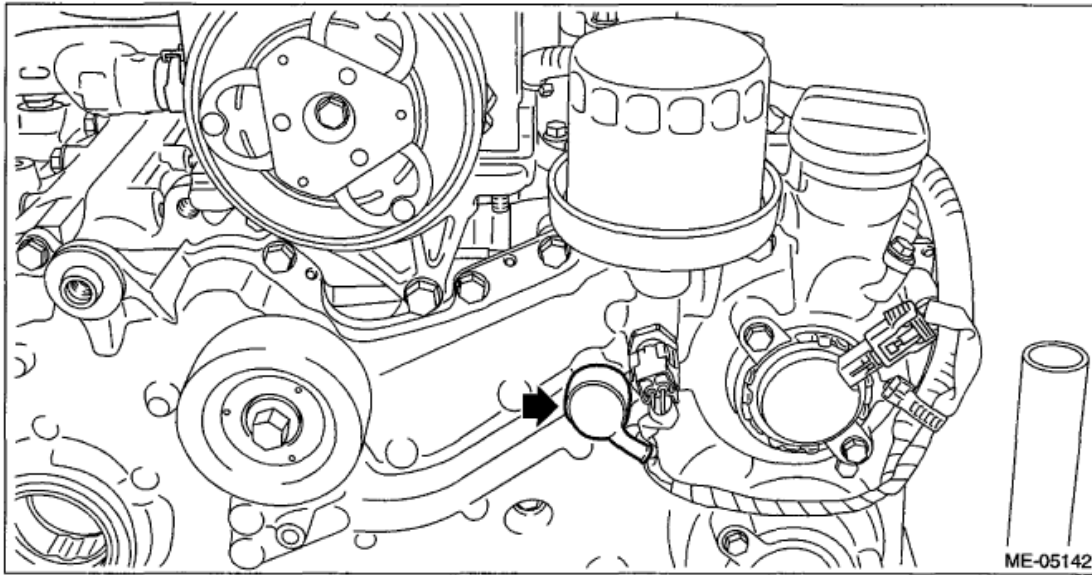


Fig. 133: Locating Oil Pressure Switch Rubber Cap
Courtesy of SUBARU OF AMERICA, INC.

9. Connect the connector (A) to the oil control solenoid RH, and the connector (B) to the camshaft position sensor RH, and secure the engine harness with clip (C) and clip (D).

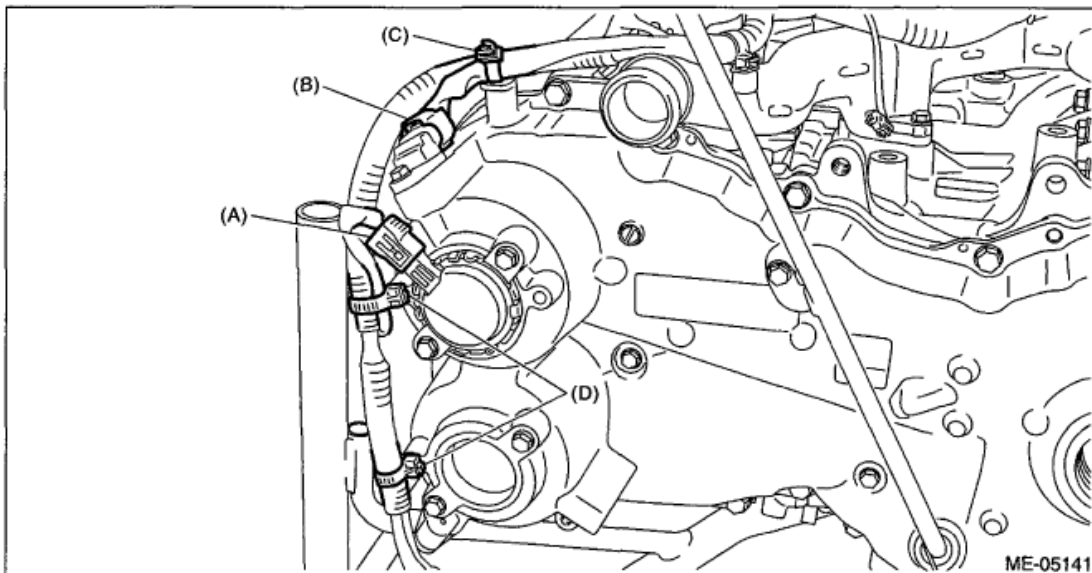


Fig. 134: Identifying Clips, Oil Control Solenoid RH Connector And Camshaft Position Sensor RH Connector
Courtesy of SUBARU OF AMERICA, INC.

10. Install the engine harness stay to the chain cover.

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

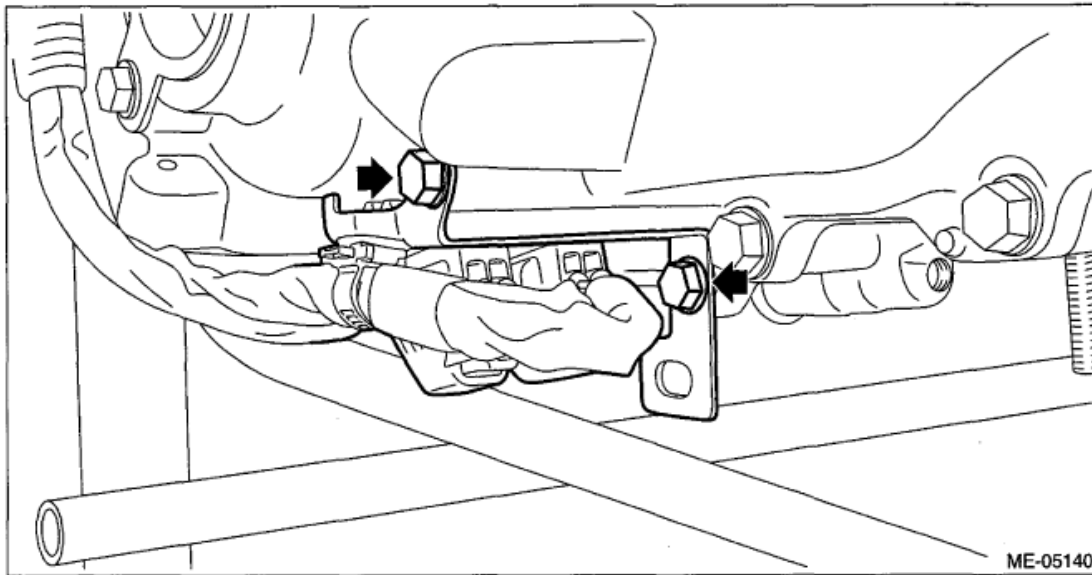


Fig. 135: Locating Chain Cover Engine Harness Stay Bolts
Courtesy of SUBARU OF AMERICA, INC.

11. Install the crank pulley boss.

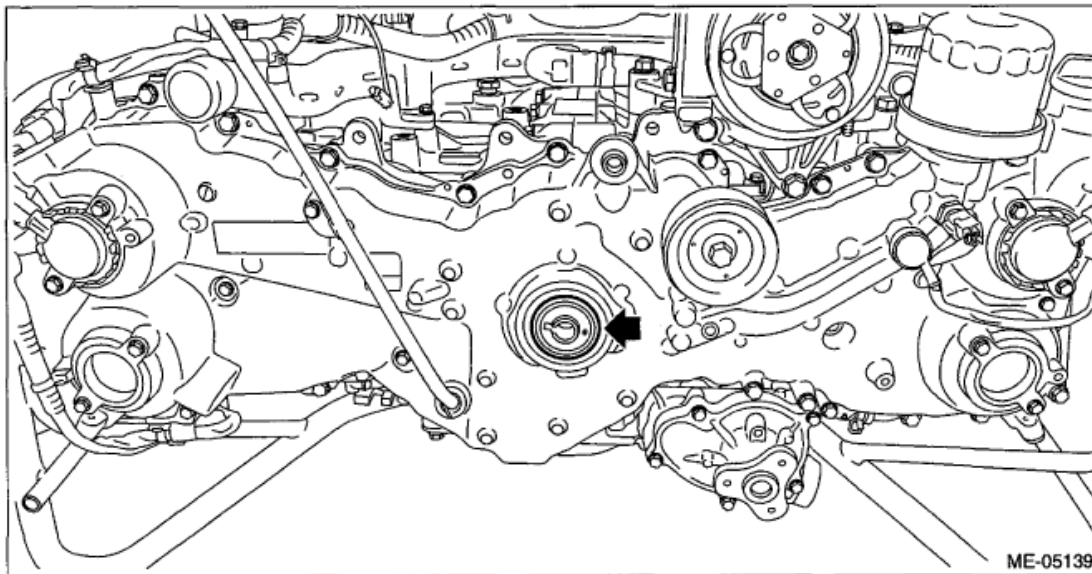


Fig. 136: Locating Crank Pulley Boss
Courtesy of SUBARU OF AMERICA, INC.

12. Install the crank pulley. < refer to **INSTALLATION**, Crank Pulley >
13. Install the water pump pulley. < refer to **WATER PUMP**, INSTALLATION, Water Pump >
14. Fill engine oil. < refer to **REPLACEMENT**, Engine Oil >
15. When working on the vehicle

NOTE: When working on the vehicle, perform the following steps also.

1. Install the radiator. < refer to **INSTALLATION** , Radiator >
2. Install the front exhaust pipe. < refer to **INSTALLATION** , Front Exhaust Pipe >
3. Install the generator cord stay to the chain cover.

NOTE: Install the generator cord stay so that the folded end (A) touches at the chain cover boss.

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

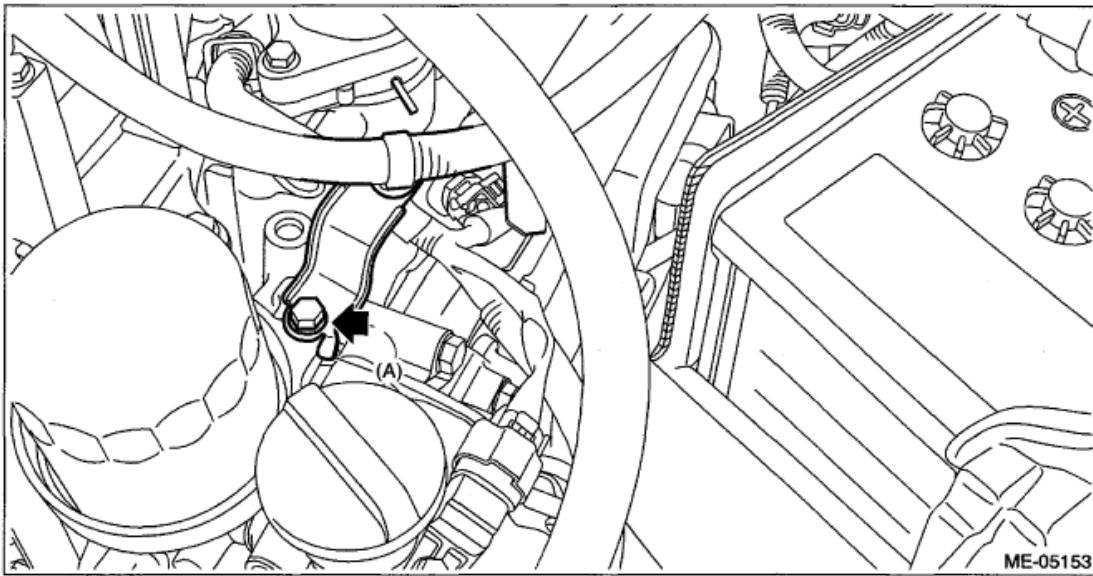


Fig. 137: Locating Generator Cord Stay Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. 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. < refer to **COMPONENT** , General Description >

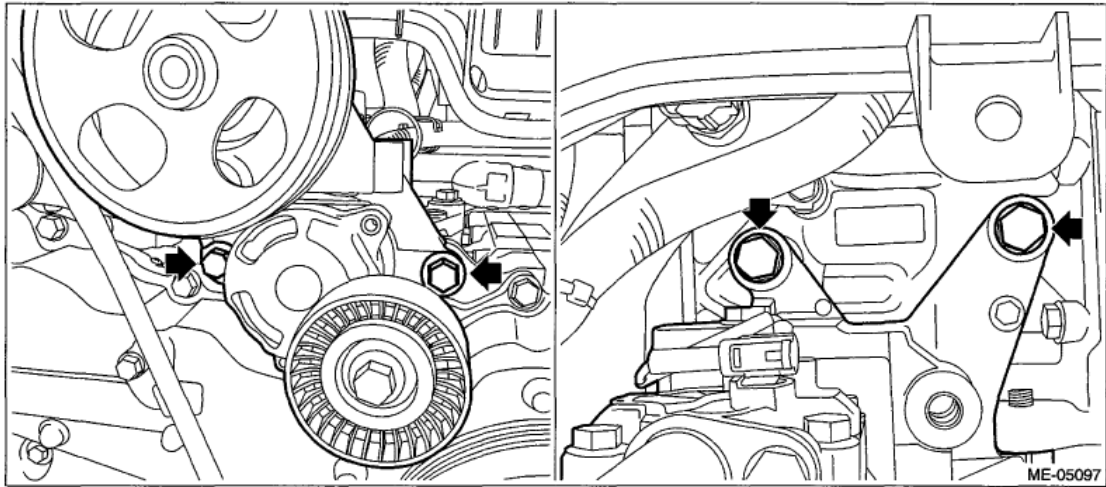


Fig. 138: Locating Engine Power Steering Pump Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

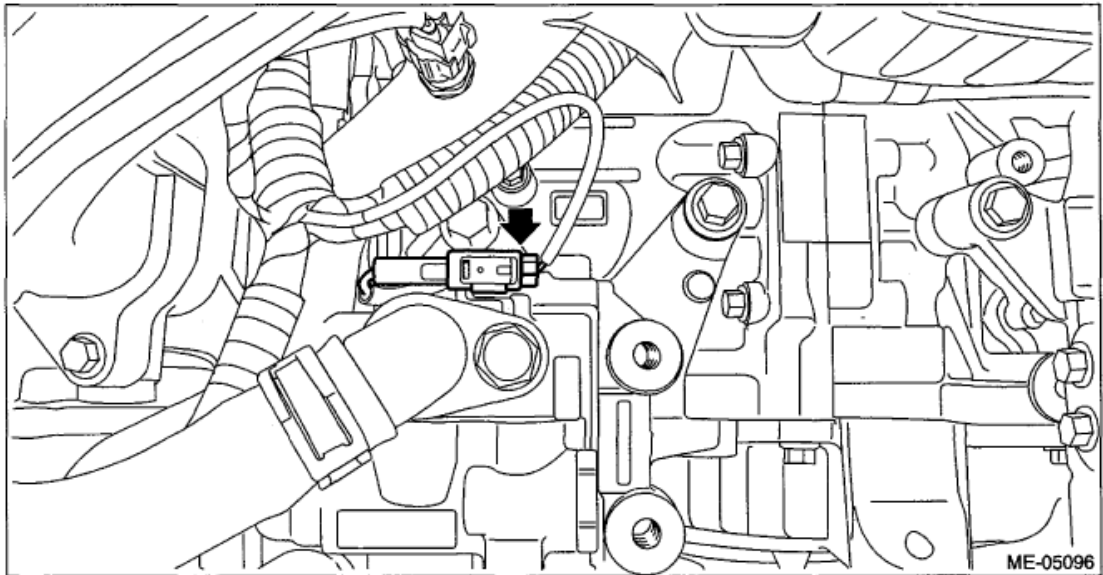


Fig. 139: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Install the generator. < refer to **INSTALLATION** , Generator >
4. Install the V-belts. < refer to **INSTALLATION**, V-belt >

DISASSEMBLY

1. Remove the oil filler cap.

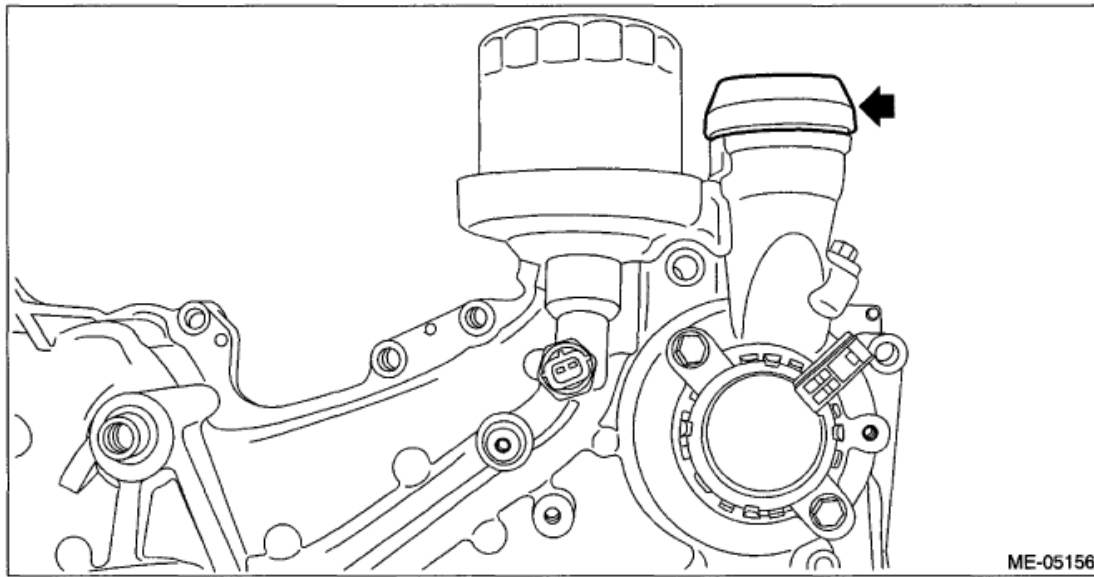


Fig. 140: Locating Oil Filler Cap
 Courtesy of SUBARU OF AMERICA, INC.

2. Remove the engine oil filter and the oil pump union. < refer to **REMOVAL** , Engine Oil Filter >
3. Remove the oil pressure switch. < refer to **REMOVAL** , Oil Pressure Switch >
4. Remove the engine oil temperature sensor. < refer to **REMOVAL** , Engine Oil Temperature Sensor >
5. Remove the oil control solenoid. < refer to **REMOVAL** , Oil Control Valve >
6. Remove the camshaft position sensor. < refer to **REMOVAL** , Camshaft Position Sensor >
7. Remove the actuator cover from chain cover.

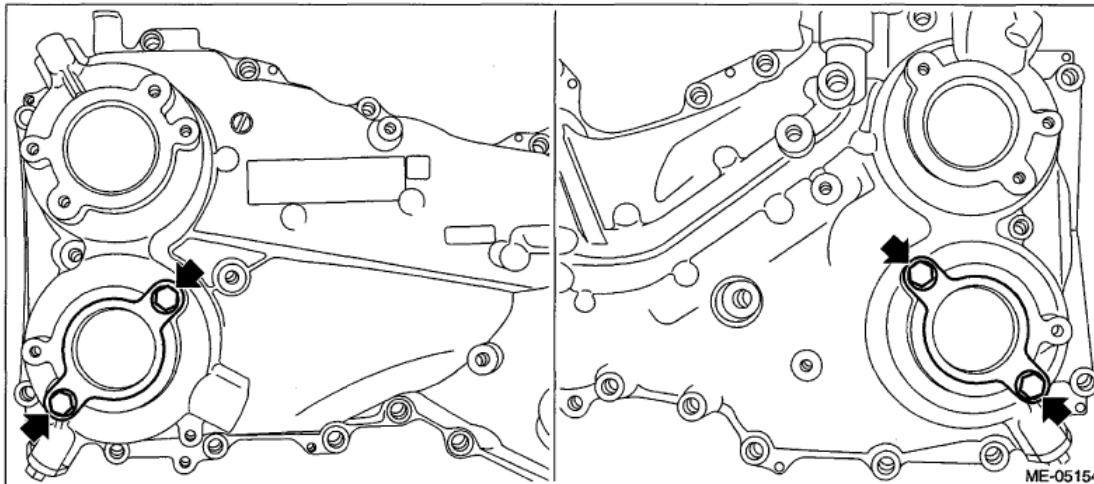


Fig. 141: Locating Actuator Cover Bolts
 Courtesy of SUBARU OF AMERICA, INC.

8. Remove the sensor cover from chain cover.

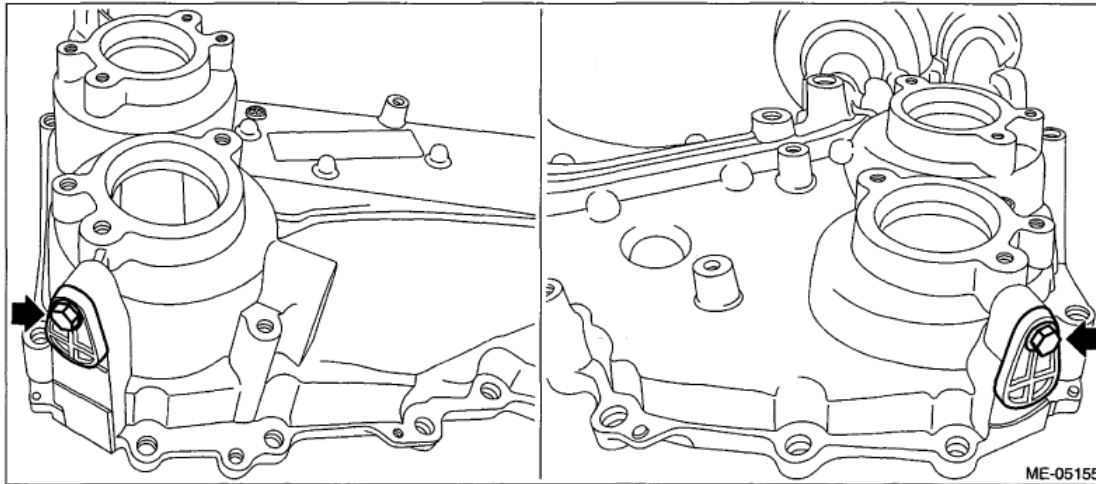


Fig. 142: Locating Sensor Cover Bolts
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY

1. Install the sensor cover to the chain cover.

NOTE:

- Use new O-rings.
- Apply a coat of engine oil to the O-rings.

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

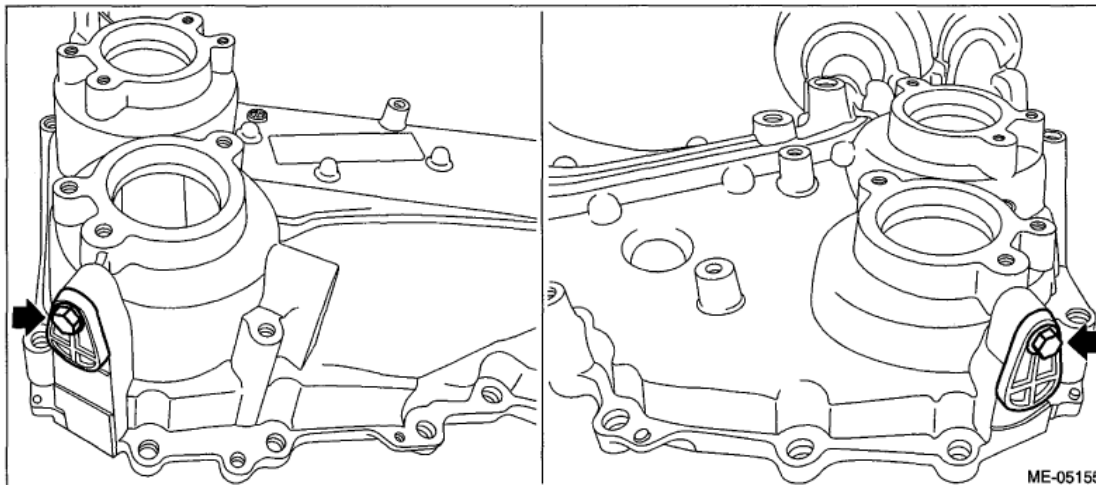


Fig. 143: Locating Sensor Cover Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Install the actuator cover to chain cover.

NOTE:

- Use new O-rings.
- Apply a coat of engine oil to the O-rings.

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

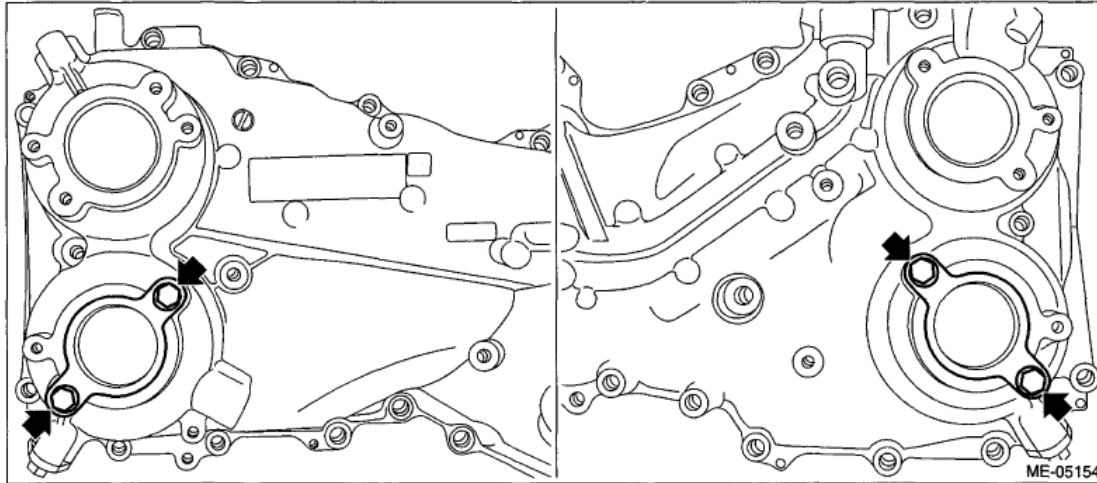


Fig. 144: Locating Actuator Cover Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install the camshaft position sensor. < refer to **INSTALLATION** , Camshaft Position Sensor >
4. Install the oil control solenoid. < refer to **INSTALLATION** , Oil Control Valve >
5. Install the engine oil temperature sensor. < refer to **INSTALLATION** , Engine Oil Temperature Sensor >
6. Install the oil pressure switch. < refer to **INSTALLATION** , Oil Pressure Switch >
7. Install the engine oil filter and the oil pump union. < refer to **INSTALLATION** , Engine Oil Filter >
8. Install the oil filler cap.

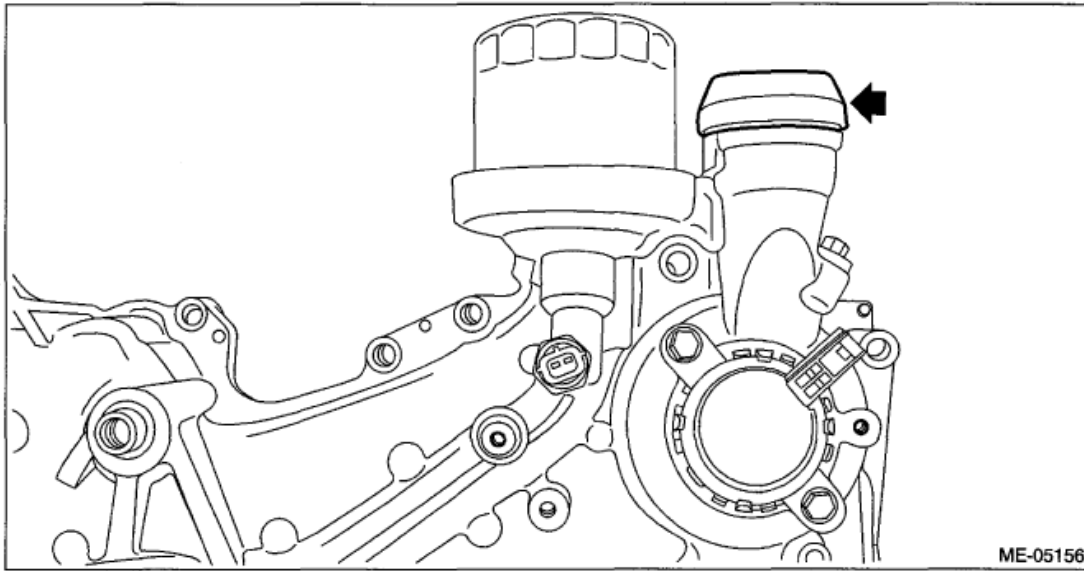


Fig. 145: Locating Oil Filler Cap
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

Check that the chain cover does not have deformation, cracks and any other damage.

TIMING CHAIN ASSEMBLY

REMOVAL

TIMING CHAIN RH

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

1. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
2. Using ST and by turning the crankshaft, align the alignment marks of crank sprocket, intake cam sprocket RH and exhaust cam sprocket RH to the positions as shown in the figure.

NOTE: If the alignment marks are aligned to the positions as shown in the figure, the crankshaft key is located at six o'clock position.

ST 18252AA000 CRANKSHAFT SOCKET

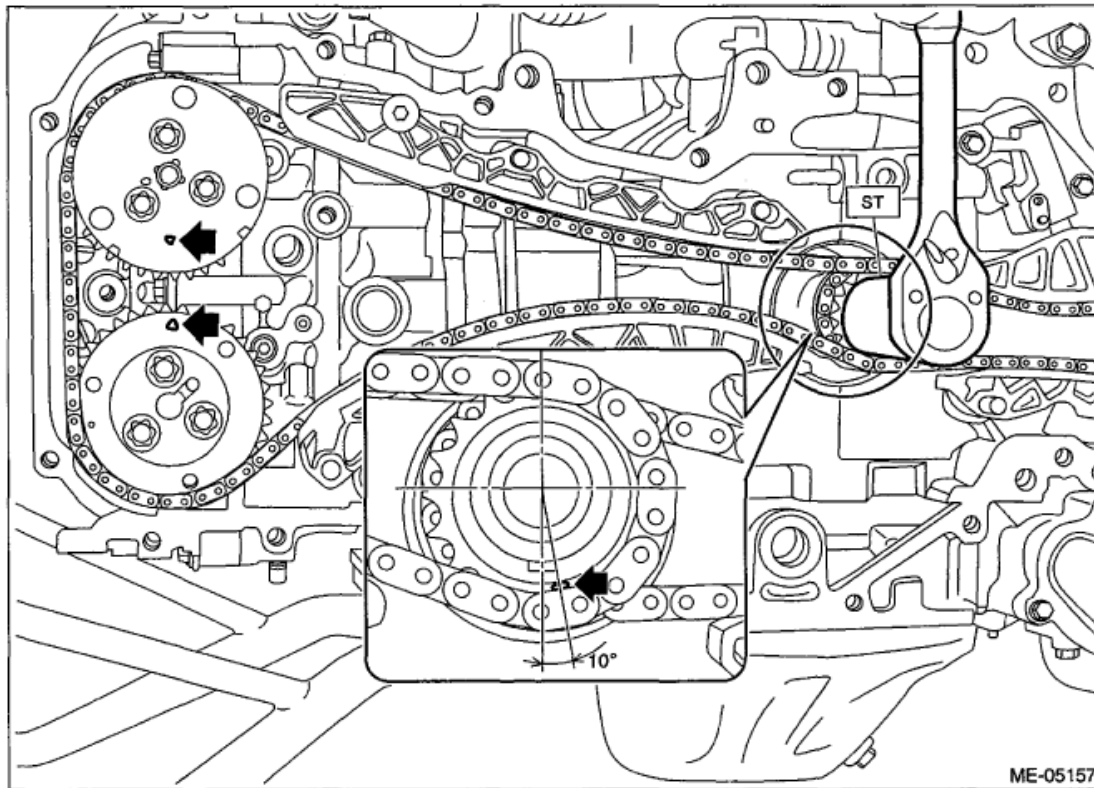


Fig. 146: Identifying Crankshaft Turning Angle
 Courtesy of SUBARU OF AMERICA, INC.

3. Push down the chain lever tensioner RH, and with a 2.5 mm (0.98 in) dia. stopper pin or a 2.5 mm (0.98 in) dia. hex wrench inserted into the stopper pin hole in the chain tensioner RH, secure the plunger (A).

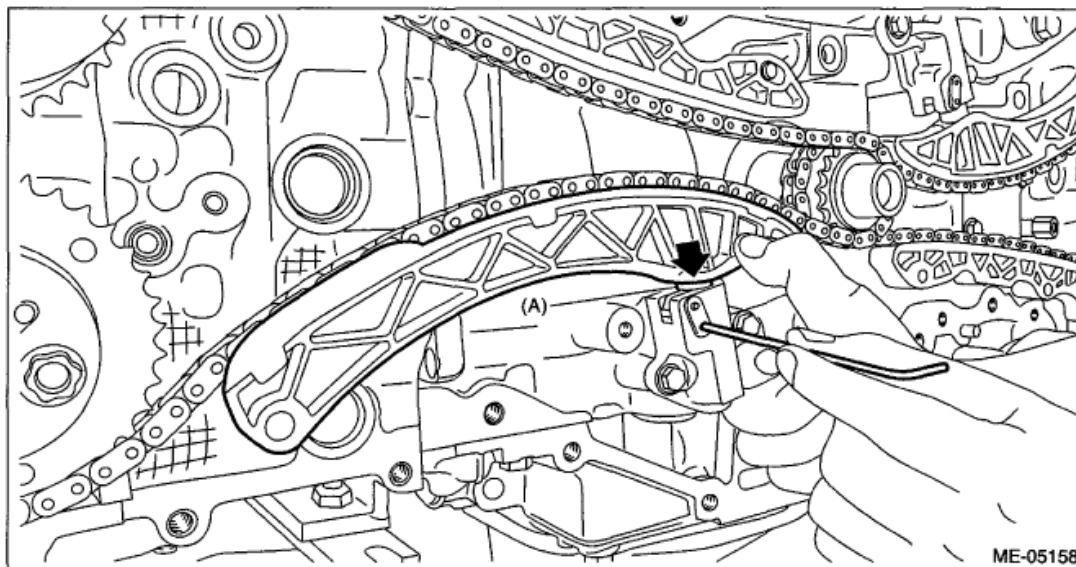


Fig. 147: Inserting Hex Wrench Into Stopper Pin Hole Of Chain Tensioner RH
 Courtesy of SUBARU OF AMERICA, INC.

4. Remove the chain tensioner RH, and remove the chain tensioner lever RH (A).

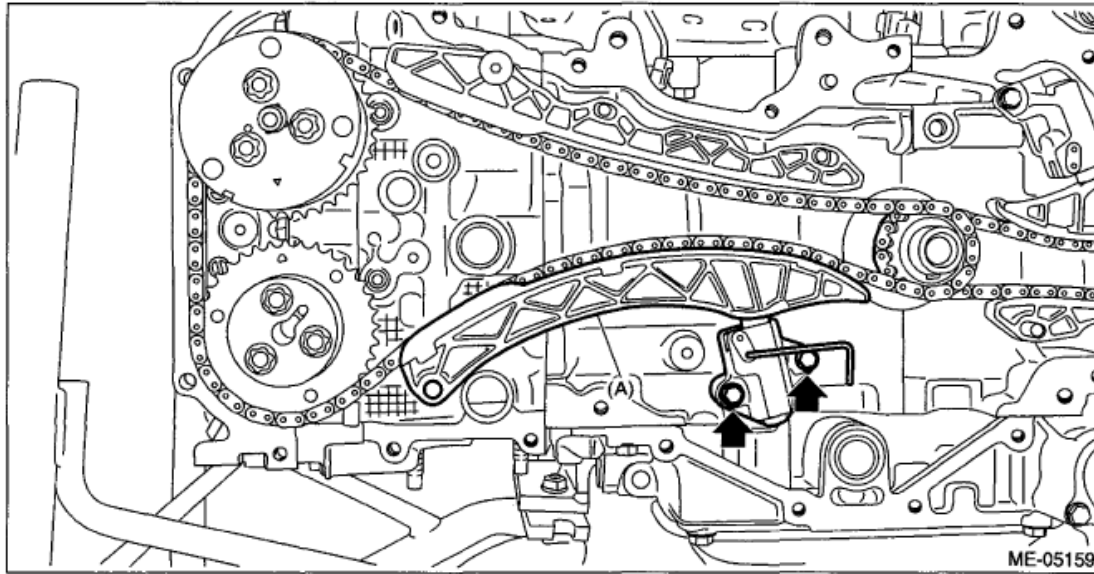


Fig. 148: Locating Chain Tensioner RH And Chain Tensioner Lever RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the chain guide RH, and remove the timing chain RH (A).

CAUTION:

- If the timing chain RH is not installed, the intake camshaft RH and exhaust camshaft RH are kept at zero-lift position. All cams on the camshaft are not pressing down the roller rocker arm (intake valve and exhaust valve). (Under this condition, all valves remain unlifted.)
- Intake camshaft RH and exhaust camshaft RH can be independently rotated with the timing chain RH removed. When the intake valve and exhaust valve lift at the same time, the valve heads contact each other and valve stem may bend. Do not turn it to the outside of range of zero-lift (in range where it can be turned lightly by hand).

NOTE:

To avoid mixing with LH side, keep the removed part in order.

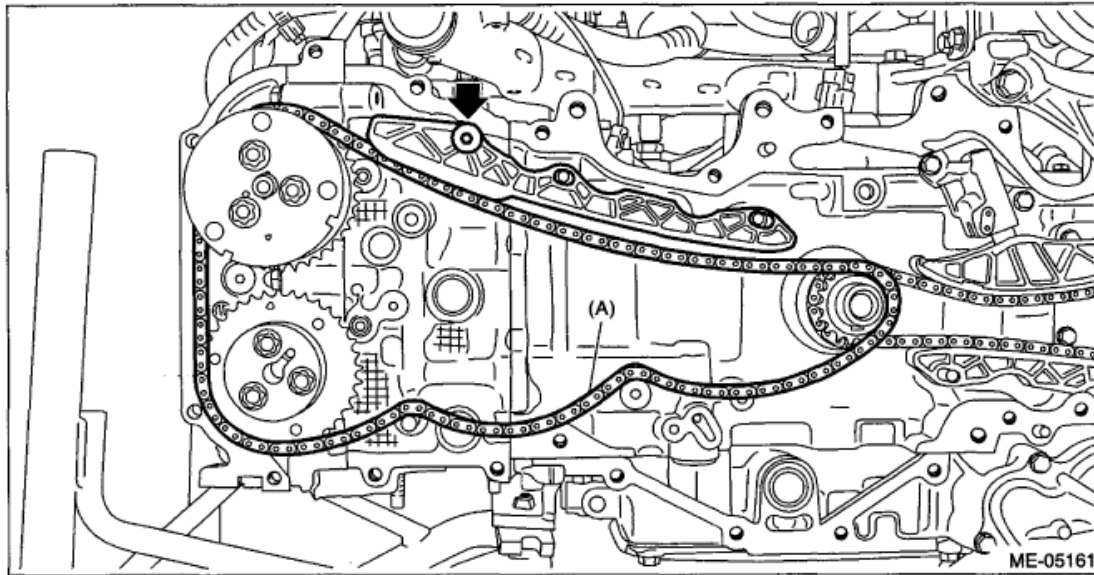


Fig. 149: Locating Chain Guide RH
Courtesy of SUBARU OF AMERICA, INC.

TIMING CHAIN LH

1. Remove the timing chain RH. < refer to **TIMING CHAIN RH**, REMOVAL, Timing Chain Assembly >
2. Using ST and by turning the crankshaft, align the alignment marks of crank sprocket, intake cam sprocket LH and exhaust cam sprocket LH to the positions as shown in the figure.

ST 18252AA000 CRANKSHAFT SOCKET

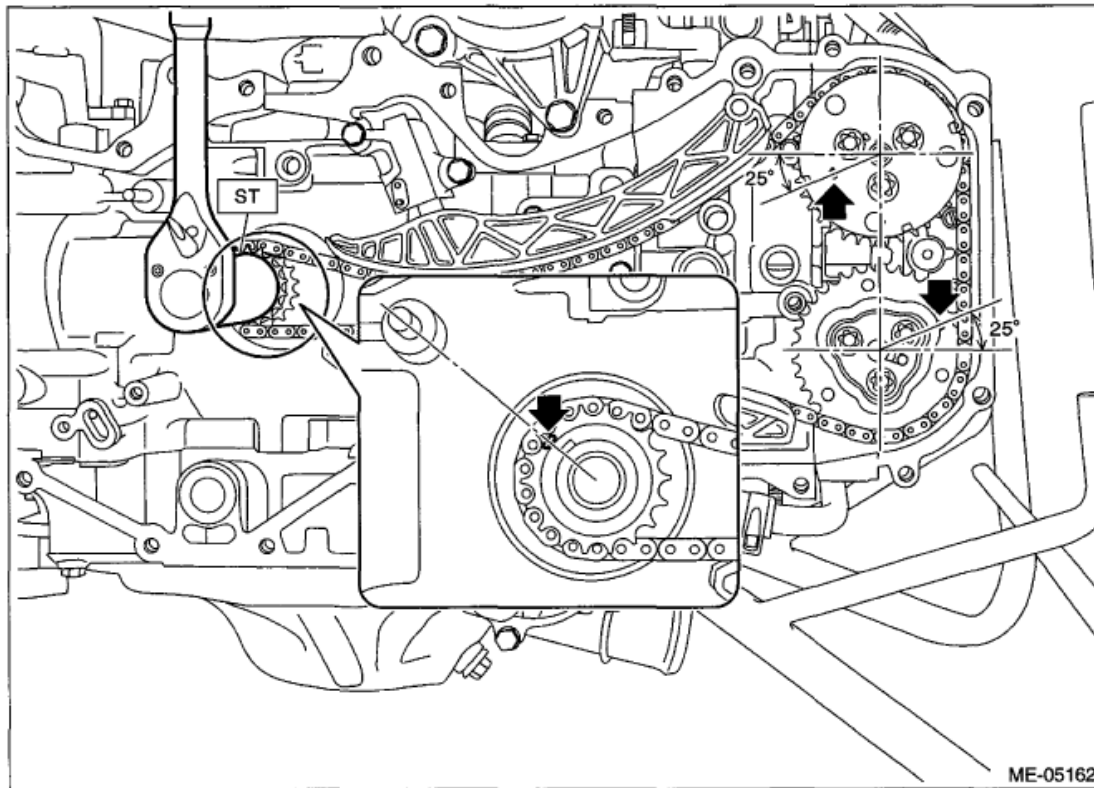


Fig. 150: Identifying Crankshaft Turning Angle
Courtesy of SUBARU OF AMERICA, INC.

3. Push down the chain lever tensioner LH, and with a 2.5 mm (0.98 in) dia. stopper pin or a 2.5 mm (0.98 in) dia. hex wrench inserted into the stopper pin hole in the chain tensioner LH, secure the plunger (A).

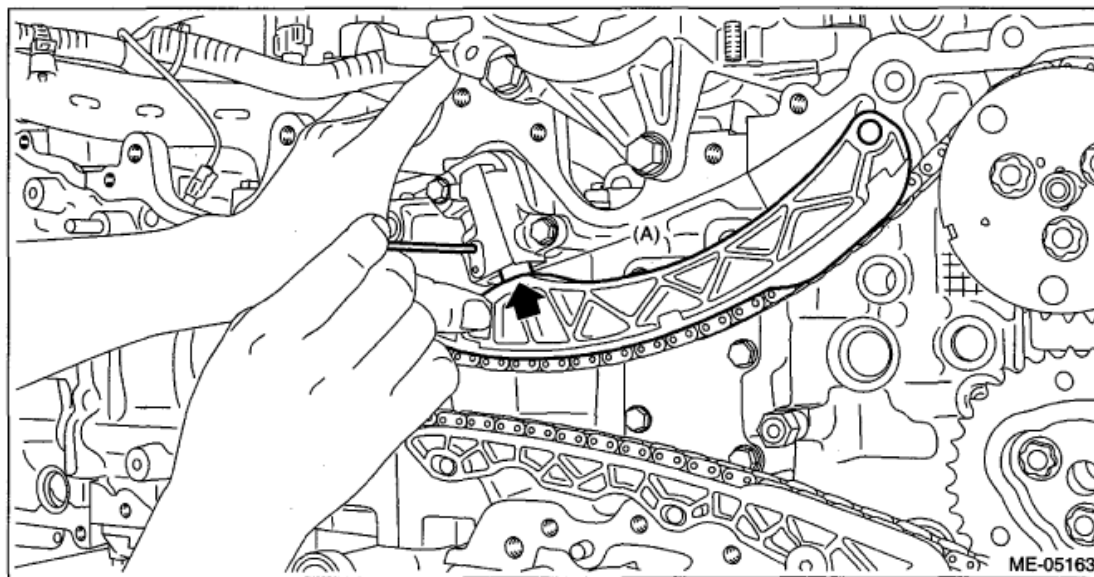


Fig. 151: Inserting Hex Wrench Into Stopper Pin Hole Of Chain Tensioner LH
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the chain tensioner LH, and remove the chain tensioner lever LH (A).

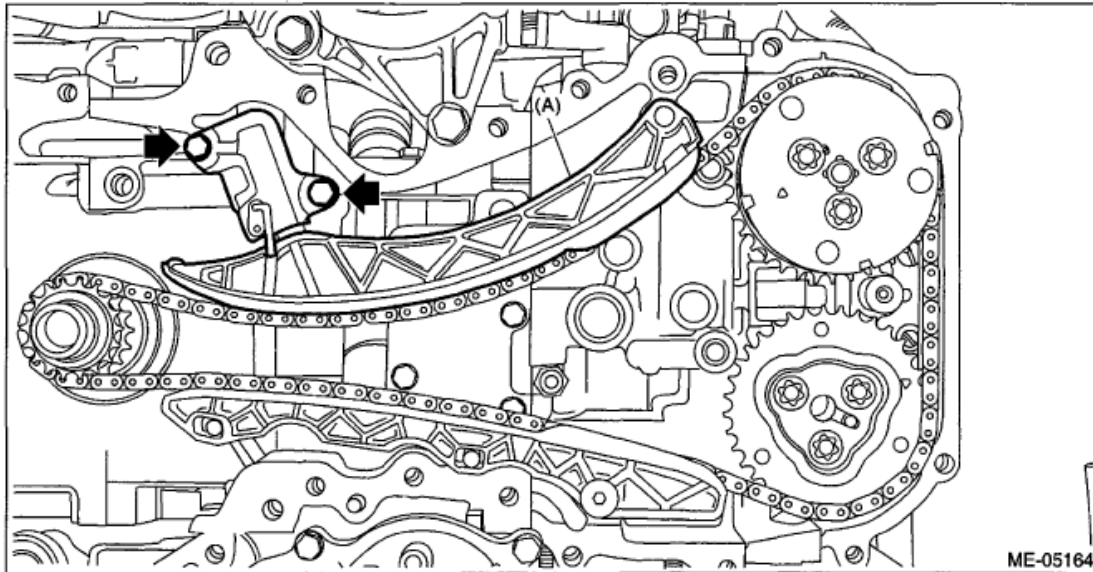


Fig. 152: Locating Chain Tensioner LH And Chain Tensioner Lever LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the O-ring from the cylinder block LH.

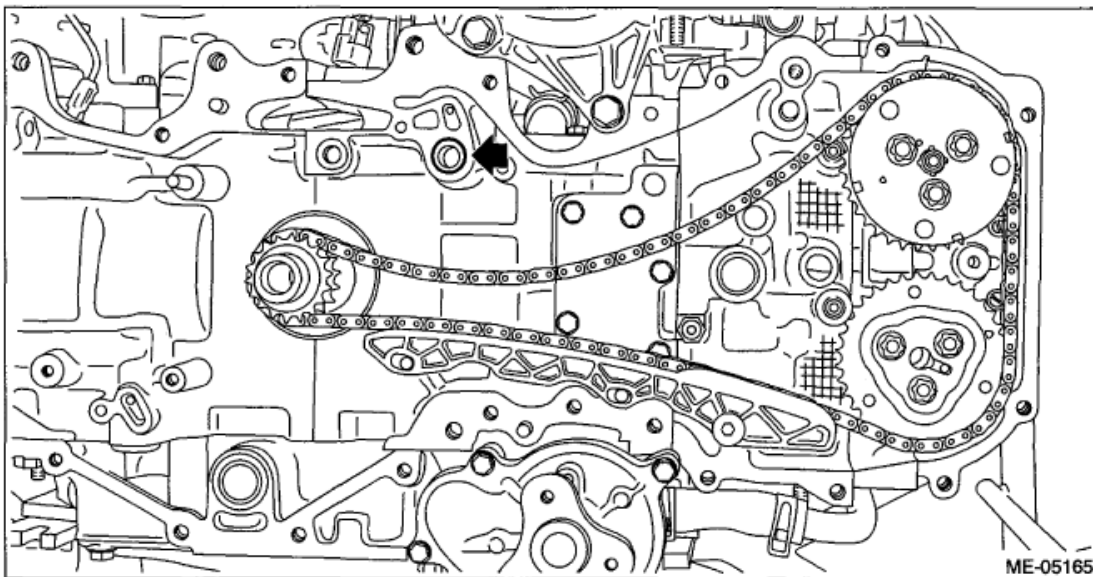


Fig. 153: Locating Cylinder Block LH O-Ring
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the chain guide LH, and remove the timing chain LH (A).

CAUTION:

- If the timing chain LH is not installed, the exhaust camshaft LH is kept at zero-lift position. All cams on the exhaust camshaft LH are not pressing down the roller rocker arm (exhaust valve). (Under this condition, exhaust valves remain unlifted.)
- Intake camshaft LH is kept at lift position. All cams on the intake camshaft LH are pressing down the roller rocker arm (intake valve). (Under this condition, intake valves remain lifted.)
- Intake camshaft LH and exhaust camshaft RH can be independently rotated with the timing chain LH removed. When the exhaust camshaft LH is turned, the valve heads contact each other and valve stem may bend as described in above. Do not turn the exhaust camshaft LH to the outside of range of zero-lift (in range where it can be turned lightly by hand).
- #1 piston and #4 piston are located near TDC. If the intake camshaft LH is turned, the valve and the piston may contact and valve stem may bend. Do not turn the intake camshaft LH at this time.

NOTE: To avoid mixing with RH side, keep the removed part in order.

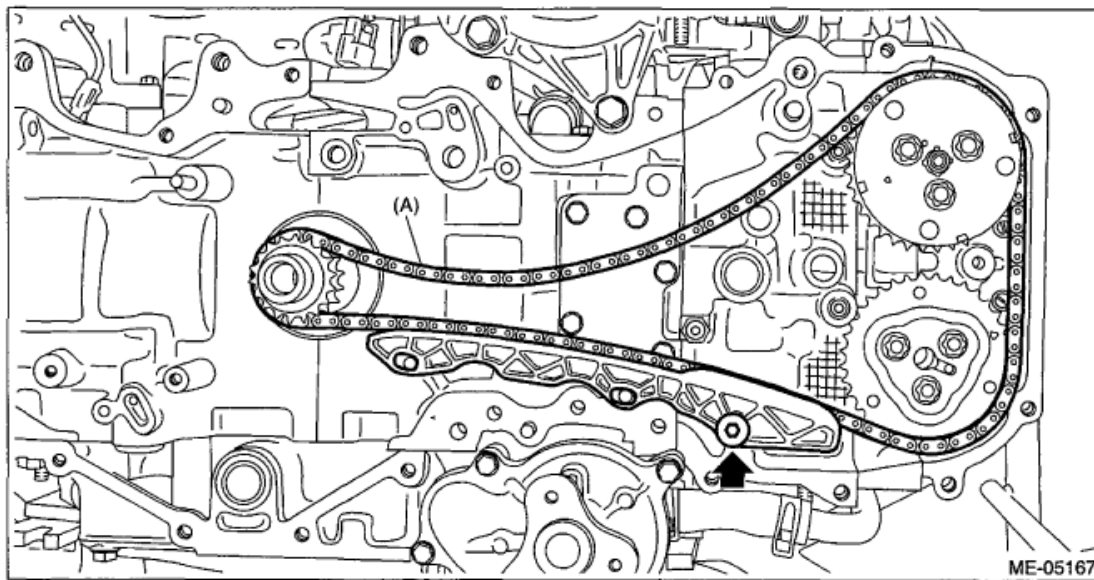


Fig. 154: Locating Chain Guide LH
Courtesy of SUBARU OF AMERICA, INC.

7. Using ST and by turning the crankshaft approximately 200° clockwise, align the alignment marks of crank sprocket to the positions as shown in the figure.

CAUTION:

- This procedure is required to prevent the valve and piston contacting with each other, by moving the all pistons to the

middle of the cylinders.

- **Never turn counterclockwise because the valve and piston may contact. Counterclockwise turn is allowed only when adjusting precisely the alignment marks, after turning the crank sprocket alignment mark clockwise near the position as shown in the figure.**

ST 18252AA000 CRANKSHAFT SOCKET

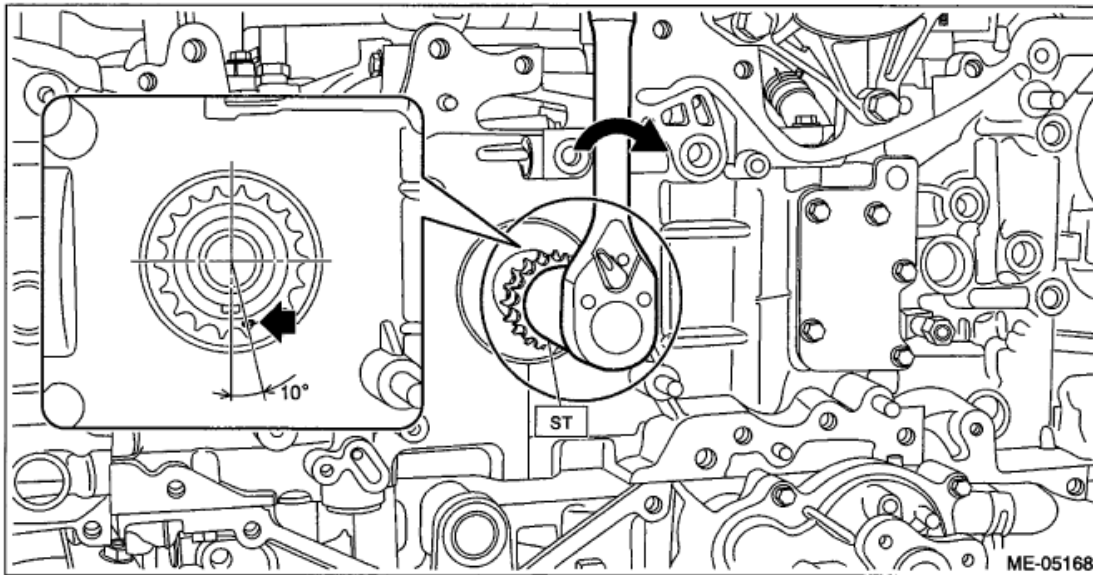


Fig. 155: Identifying Crankshaft Turning Angle
Courtesy of SUBARU OF AMERICA, INC.

8. Using ST and by turning the intake cam sprocket LH approximately 180°, align the alignment marks of intake cam sprocket LH to the positions (zero-lift position) as shown in the figure.

CAUTION: After this work, when the intake valve and exhaust valve lift at the same time, the valve heads contact each other and valve stem may bend. Do not turn the intake camshaft LH and exhaust camshaft LH to the outside of range of zero-lift (in range where it can be turned lightly by hand).

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA030 PULLEY WRENCH PIN SET

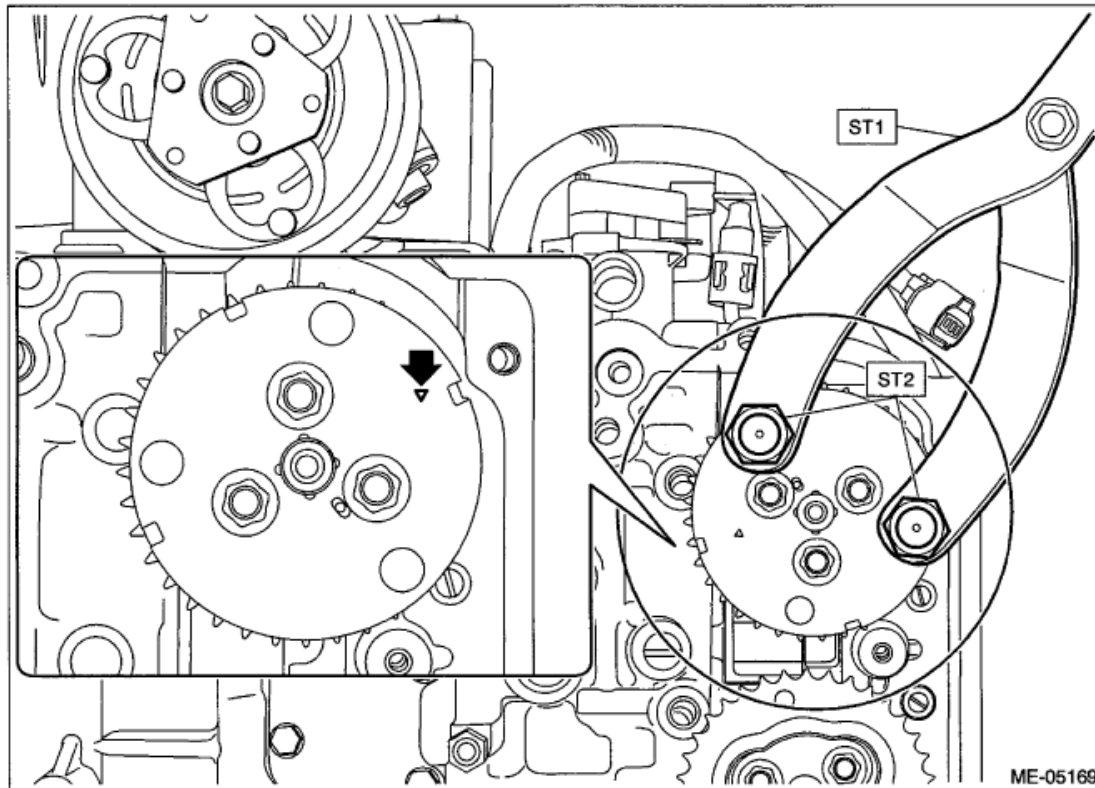


Fig. 156: Locating Marks On Intake Cam Sprocket LH

Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

TIMING CHAIN RH

NOTE:

- Be careful that the foreign matter is not into or onto the assembled component during installation.
- Apply engine oil to all component parts of the timing chain.

1. Install timing chain LH. < refer to **TIMING CHAIN LH**, INSTALLATION, Timing Chain Assembly >
2. Prepare to attach the chain tensioner RH.
 1. Move the link plate (A) in the direction of arrow to press in the plunger (B).

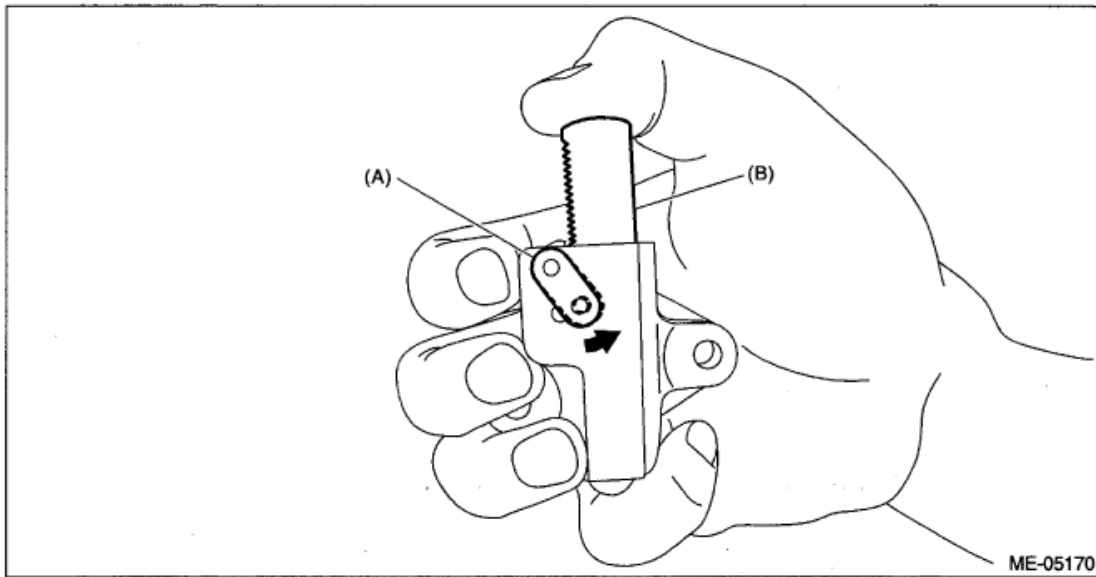


Fig. 157: Pressing Plunger

Courtesy of SUBARU OF AMERICA, INC.

2. With a 2.5 mm (0.98 in) dia. stopper pin or a 2.5 mm (0.98 in) (nominal) dia. hex wrench inserted into the stopper pin hole, secure the plunger.

NOTE: If the stopper pin hole on the link plate and the stopper pin hole on the chain tensioner are not aligned, check that the first notch of plunger rack (A) is engaged with the stopper tooth (B). If not engaged, retract the plunger a little so that the first notch of plunger rack (A) is engaged with the stopper tooth (B).

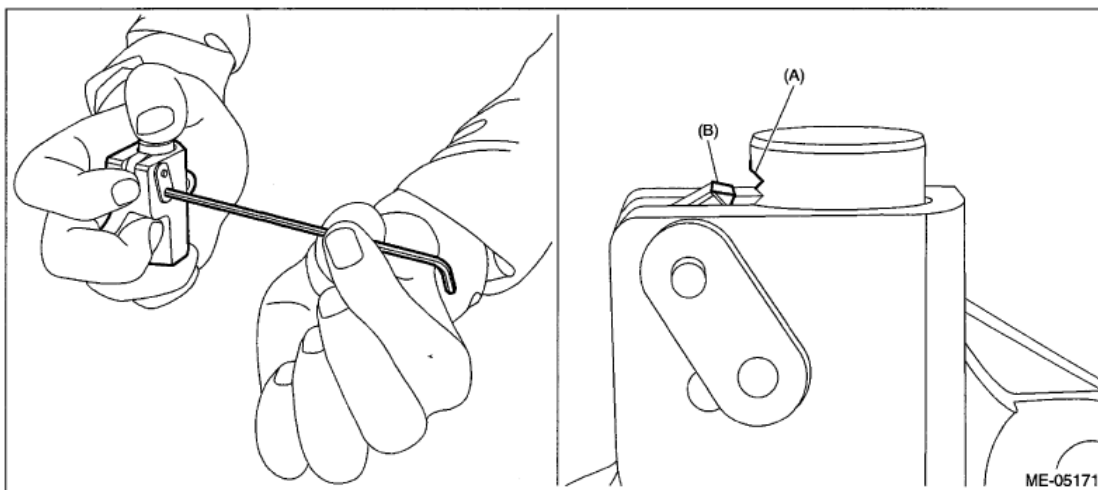


Fig. 158: Inserting Hex Wrench Into Stopper Pin Hole

Courtesy of SUBARU OF AMERICA, INC.

3. Using ST and by turning the crankshaft, align the alignment marks of crank sprocket, intake cam sprocket

LH and exhaust cam sprocket LH to the positions as shown in the figure.

NOTE: If the alignment marks are aligned to the positions as shown in the figure, the crankshaft key is located at six o'clock position.

ST 18252AA000 CRANKSHAFT SOCKET

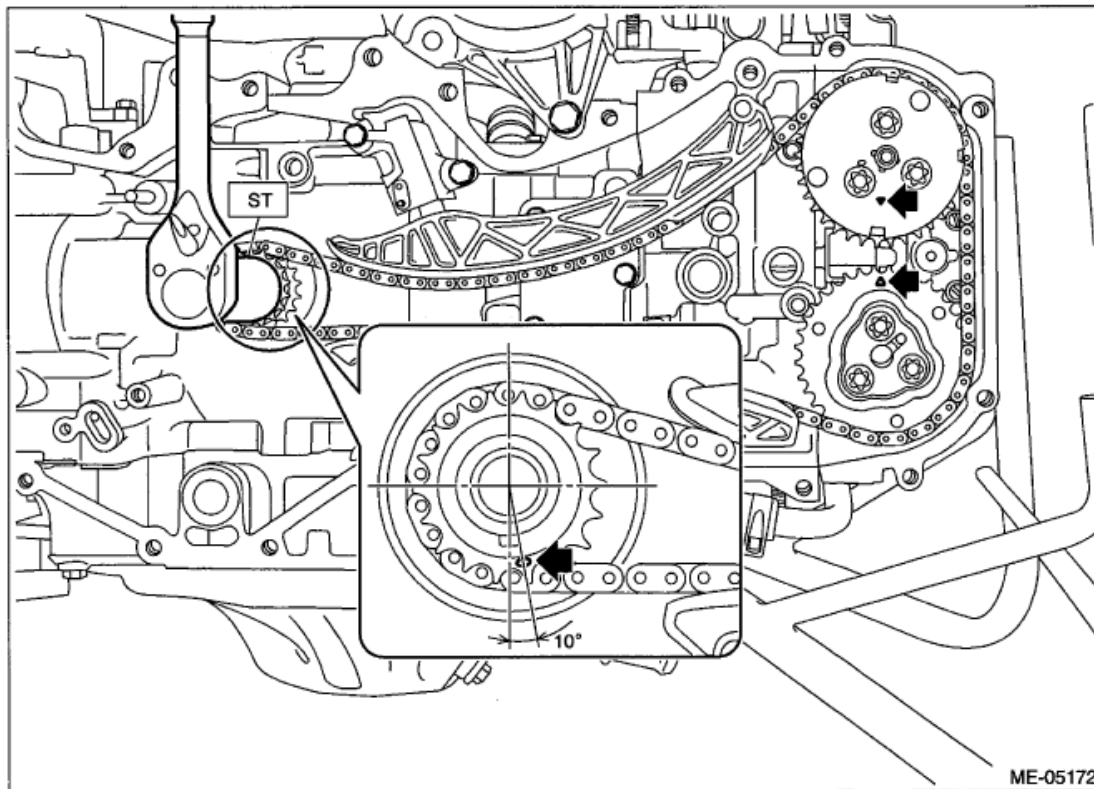


Fig. 159: Identifying Crankshaft Turning Angle
Courtesy of SUBARU OF AMERICA, INC.

4. Align the alignment marks of intake cam sprocket RH and exhaust cam sprocket RH to the positions as shown in the figure.

CAUTION: To prevent valve damage, turn the intake cam sprocket RH and exhaust cam sprocket RH only within the range of zero-lift (in range where it can be turned lightly by hand).

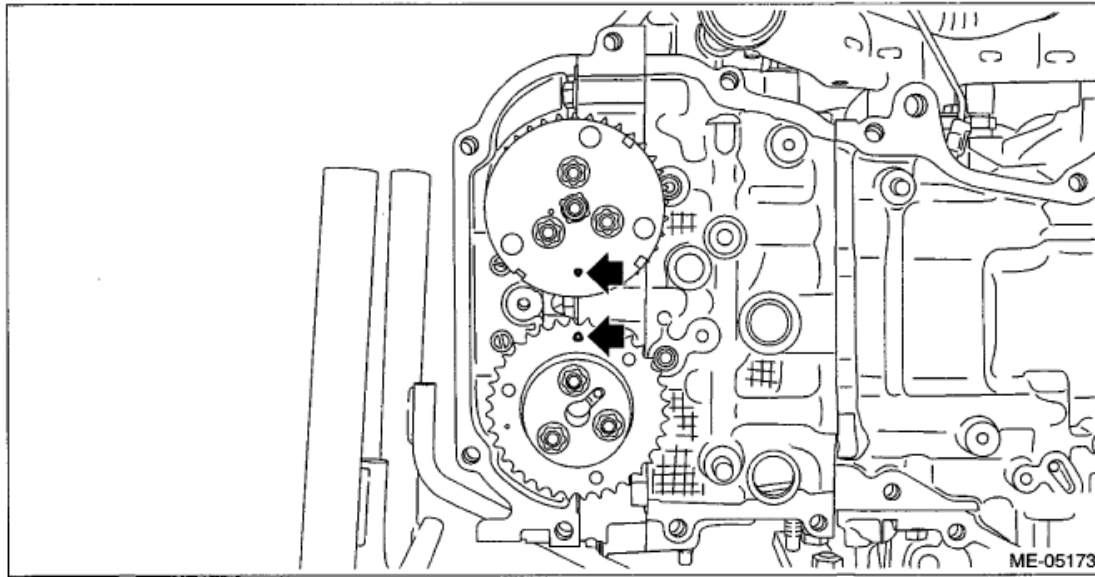
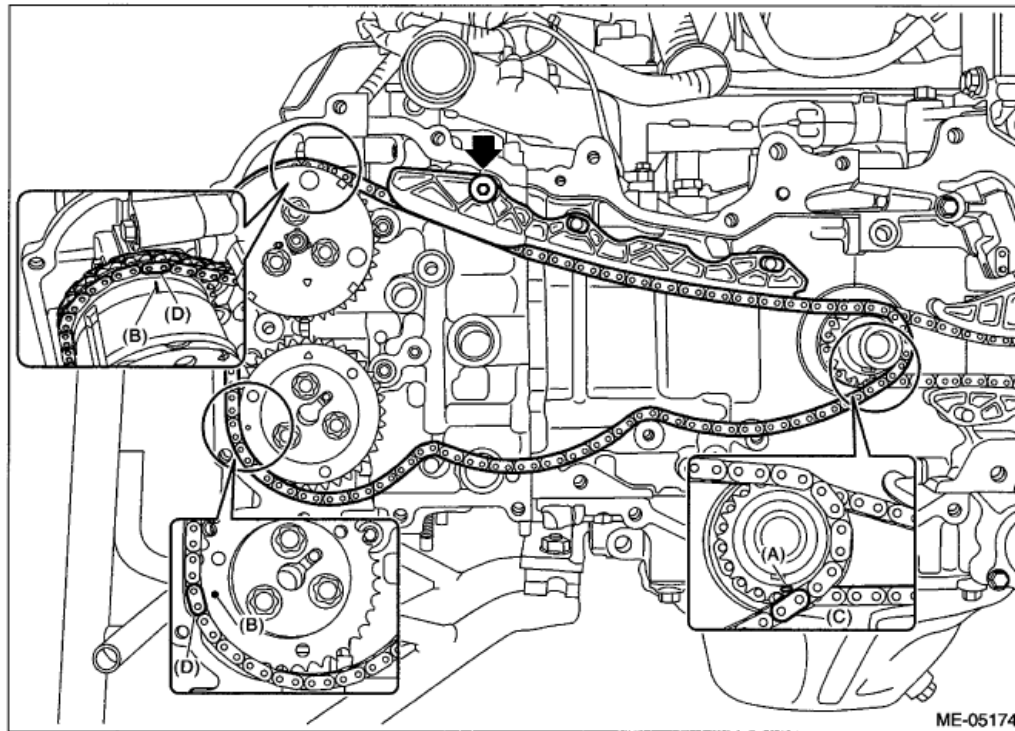


Fig. 160: Locating Alignment Marks On Intake Cam Sprocket RH And Exhaust Cam Sprocket RH
Courtesy of SUBARU OF AMERICA, INC.

5. Install the timing chain RH and the timing chain guide RH.
 1. Match the timing chain mark (yellow) to the alignment mark of the crank sprocket.
 2. Match the timing chain mark (orange) to the timing mark position of the intake cam sprocket RH.
 3. Match the timing chain mark (orange) to the timing mark position of the exhaust cam sprocket RH.
 4. Install the timing chain guide RH.

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



(A) Alignment mark
(B) Timing mark

(C) Yellow

(D) Orange

Fig. 161: Locating Timing Chain Guide RH
Courtesy of SUBARU OF AMERICA, INC.

6. Install the chain tensioner lever RH (A) and chain tensioner RH.

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

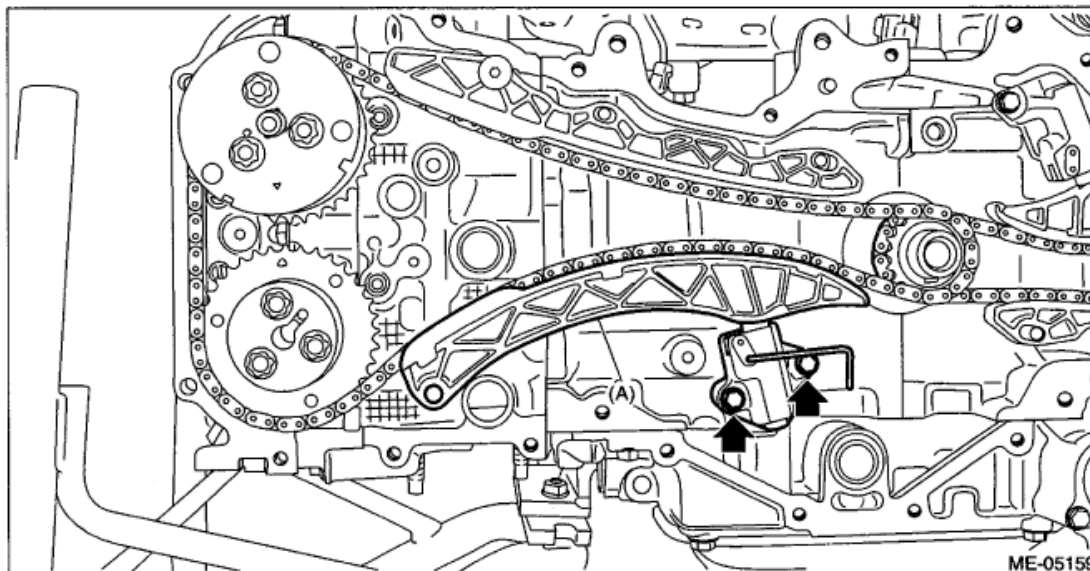
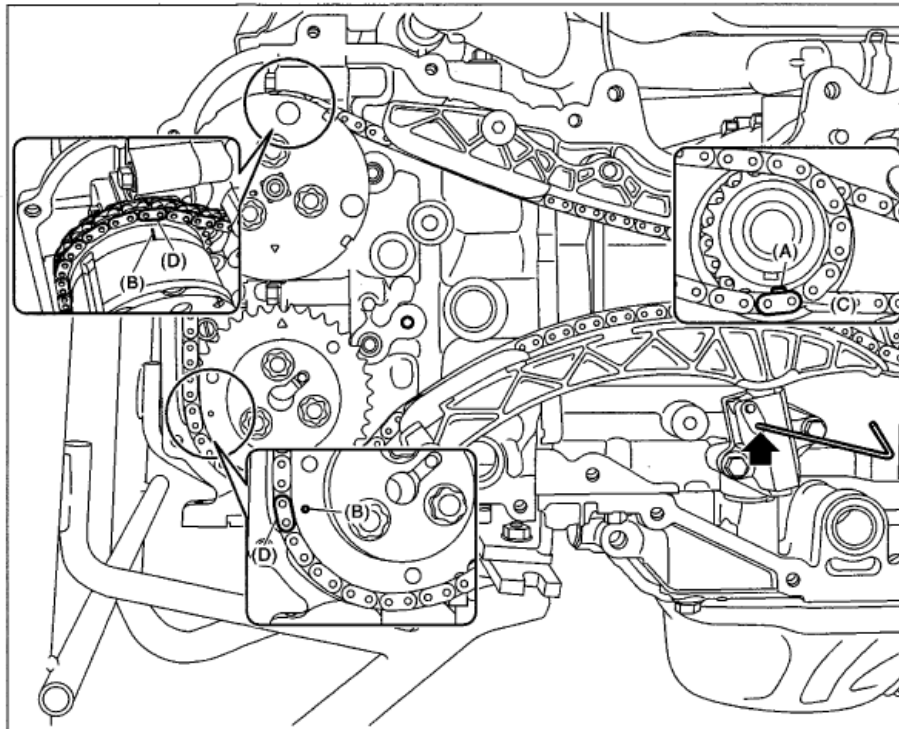


Fig. 162: Locating Chain Tensioner RH And Chain Tensioner Lever RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

7. Pull out the stopper pin from the chain tensioner RH.

CAUTION: Confirm the following before pulling out the stopper pin.

- Matching of the timing chain mark (yellow) to the alignment mark crank sprocket.
- Matching of the timing chain mark (orange) to the timing mark on the intake cam sprocket RH.
- Matching of the timing chain mark (orange) to the timing mark on the exhaust cam sprocket RH.



(A) Alignment mark
(B) Timing mark

(C) Yellow

(D) Orange

Fig. 163: Pulling Out Stopper Pin From Chain Tensioner RH
Courtesy of SUBARU OF AMERICA, INC.

8. Using the ST, turn the crankshaft clockwise, and make sure that there are no abnormal conditions.

CAUTION: Always make sure to perform this confirmation.

ST 18252AA000 CRANKSHAFT SOCKET

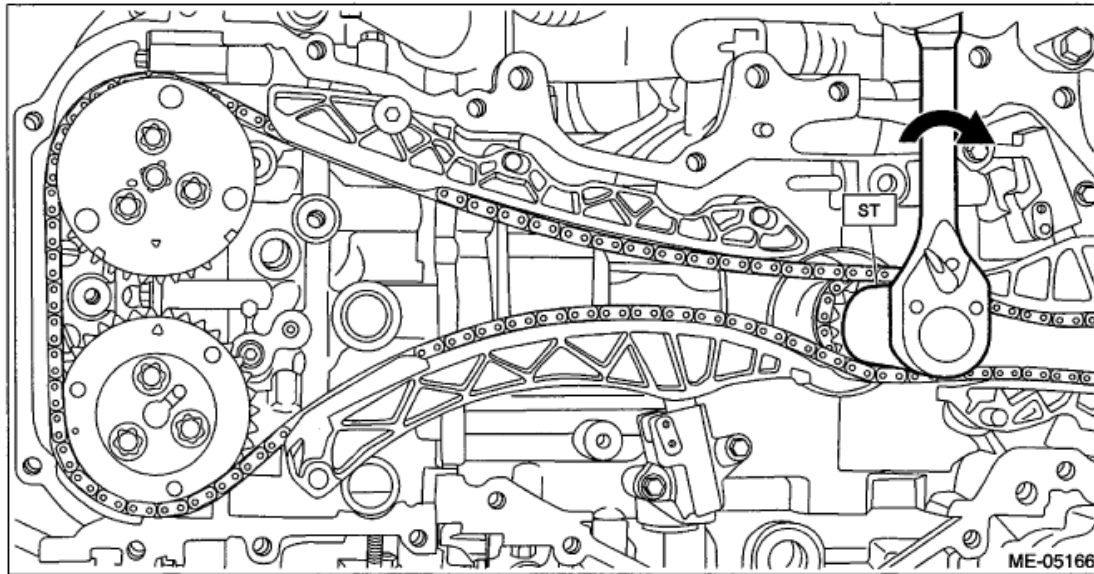


Fig. 164: Turning Crankshaft Using ST
Courtesy of SUBARU OF AMERICA, INC.

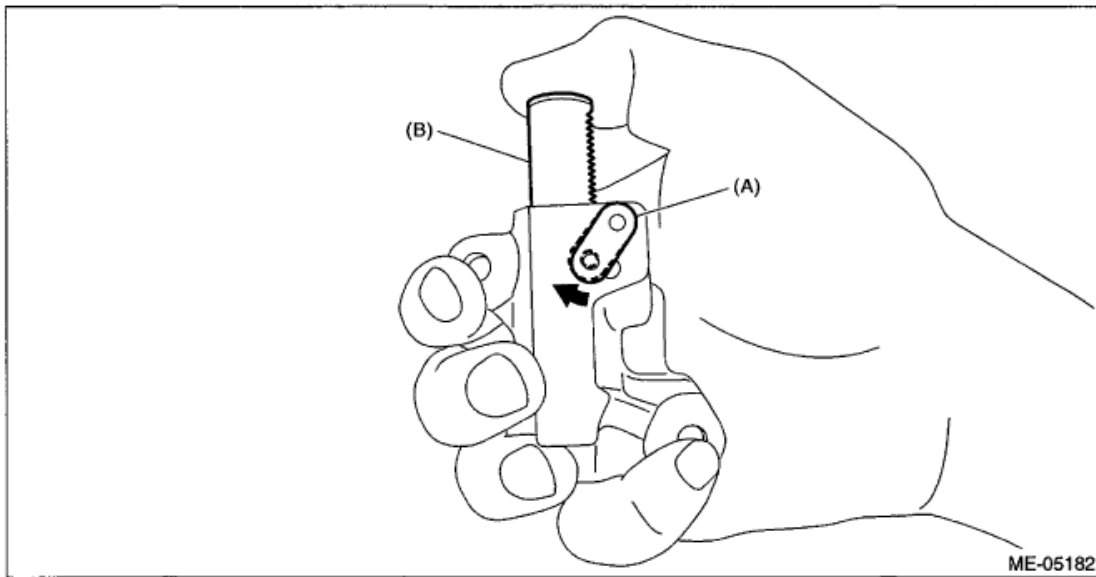
9. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >

TIMING CHAIN LH

NOTE:

- Be careful that the foreign matter is not into or onto the assembled component during installation.
- Apply engine oil to all component parts of the timing chain.

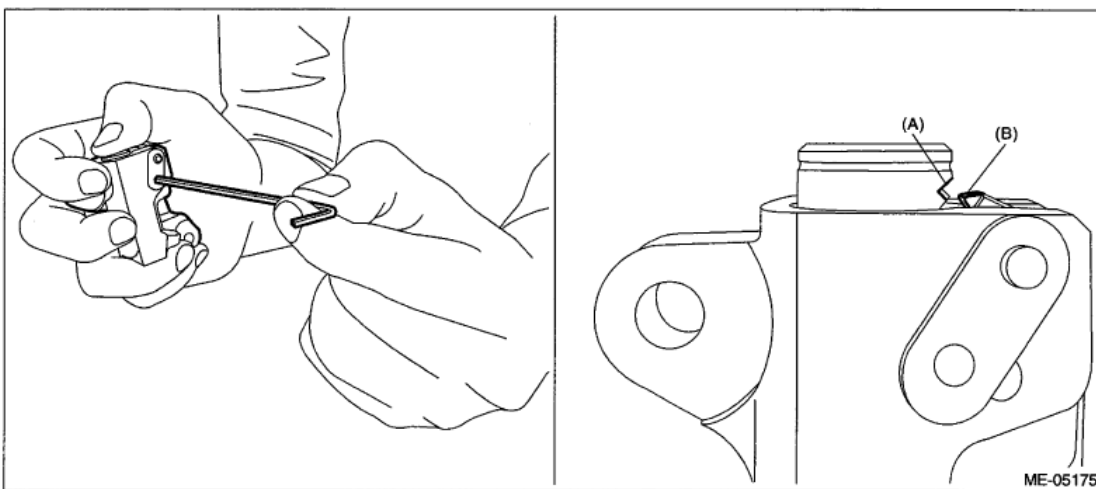
1. Prepare to attach the chain tensioner LH.
 1. Move the link plate (A) in the direction of arrow to press in the plunger (B).

**Fig. 165: Pressing Plunger**

Courtesy of SUBARU OF AMERICA, INC.

2. With a 2.5 mm (0.98 in) dia. stopper pin or a 2.5 mm (0.98 in) (nominal) dia. hex wrench inserted into the stopper pin hole, secure the plunger.

NOTE: If the stopper pin hole on the link plate and the stopper pin hole on the chain tensioner are not aligned, check that the first notch of plunger rack (A) is engaged with the stopper tooth (B). If not engaged, retract the plunger a little so that the first notch of plunger rack (A) is engaged with the stopper tooth (B).

**Fig. 166: Inserting Hex Wrench Into Stopper Pin Hole**

Courtesy of SUBARU OF AMERICA, INC.

2. Check that the crank sprocket is located at the position shown in the figure. If not aligned, using ST turn

the crankshaft to align the crank sprocket alignment mark to the position shown in the figure.

NOTE: This procedure is required to prevent the valve and piston contacting with each other in the next step.

ST 18252AA000 CRANKSHAFT SOCKET

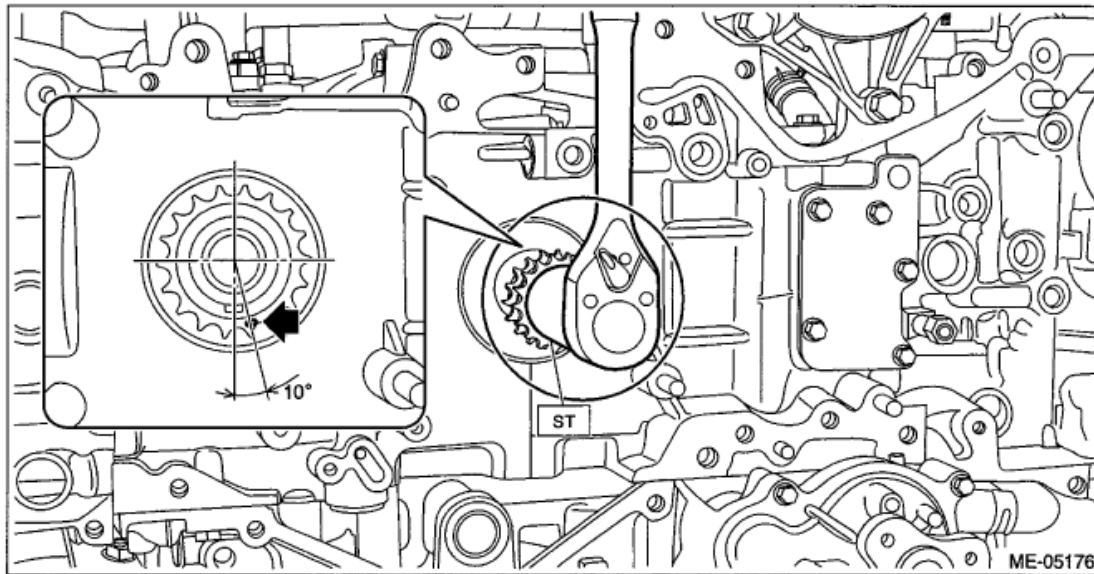


Fig. 167: Identifying Crankshaft Turning Angle
Courtesy of SUBARU OF AMERICA, INC.

3. Using ST and by turning the intake cam sprocket LH, align the alignment marks to the positions as shown in the figure.

CAUTION: When the intake valve and exhaust valve lift at the same time, the valve heads contact each other and valve stem may bend. Do not turn the exhaust camshaft LH.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA030 PULLEY WRENCH PIN SET

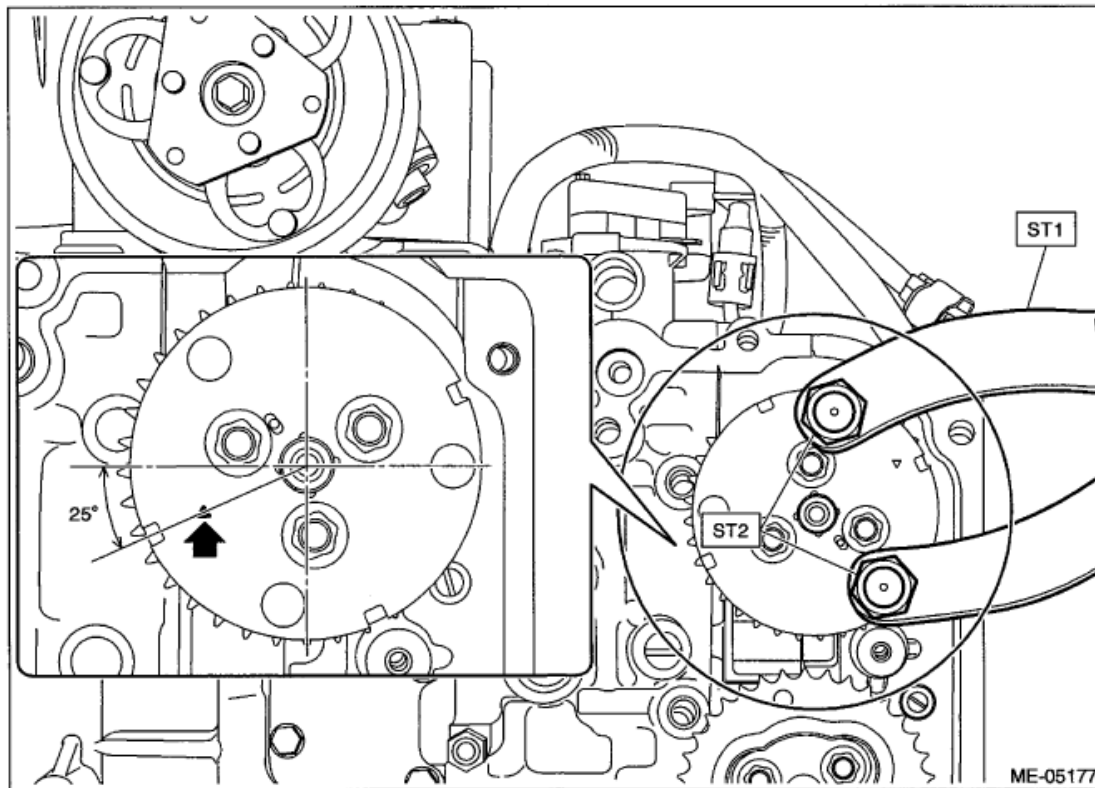


Fig. 168: Identifying Intake Cam Sprocket LH Turning Angle
Courtesy of SUBARU OF AMERICA, INC.

4. Using ST and by turning the crankshaft approximately 200° counterclockwise, align the alignment marks of crank sprocket to the positions as shown in the figure.

CAUTION: Never turn clockwise because the valve and piston may contact. Clockwise turn is allowed only when adjusting precisely the alignment marks, after turning the crank sprocket alignment mark counterclockwise near the position as shown in the figure.

ST 18252AA000 CRANKSHAFT SOCKET

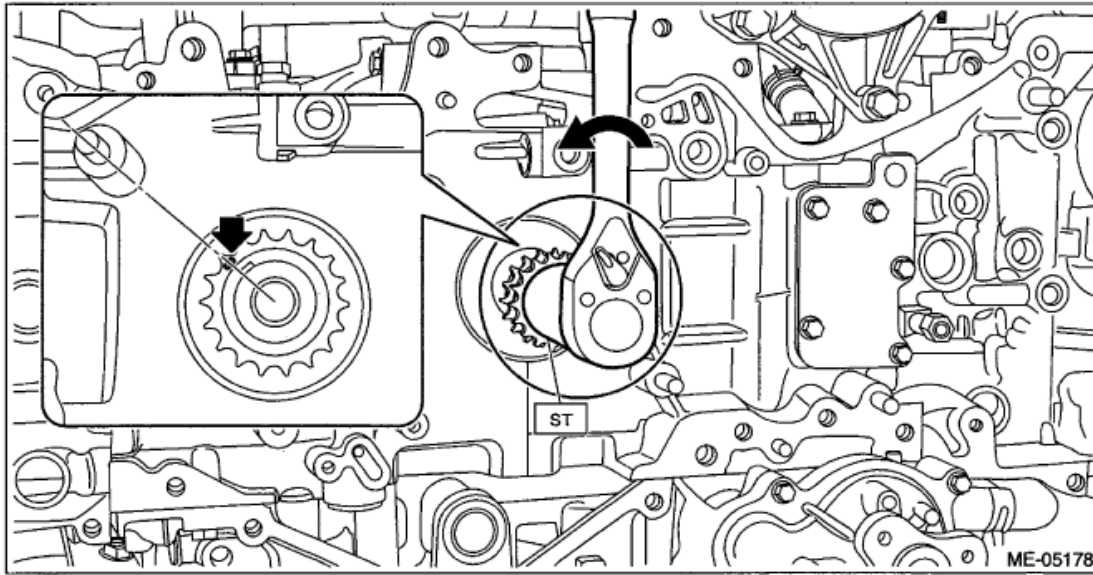


Fig. 169: Turning Crankshaft Using ST
Courtesy of SUBARU OF AMERICA, INC.

5. Align the alignment mark of exhaust cam sprocket LH to the position shown in the figure.

CAUTION: To prevent valve damage, turn the exhaust cam sprocket LH only within the range of zero-lift (in range where it can be turned lightly by hand).

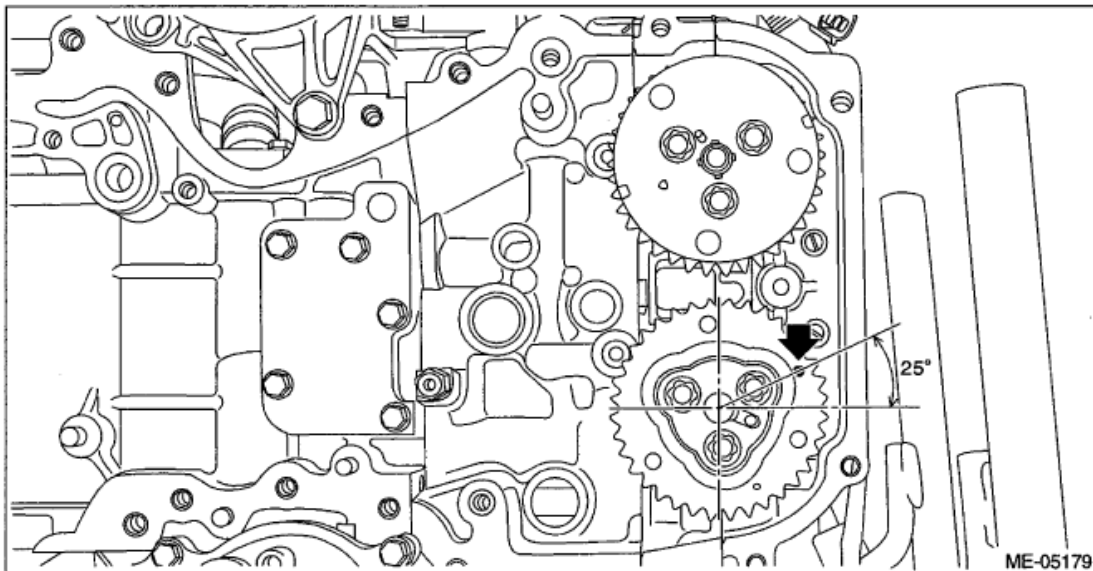
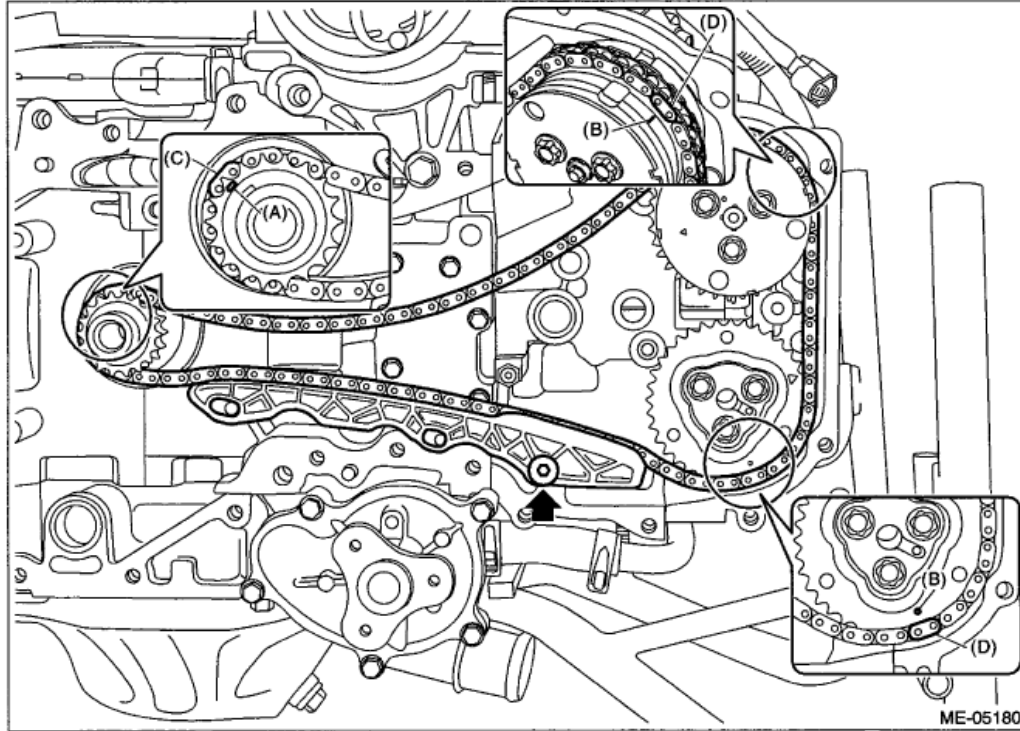


Fig. 170: Aligning Alignment Mark Of Exhaust Cam Sprocket LH
Courtesy of SUBARU OF AMERICA, INC.

6. Install the timing chain LH and the timing chain guide LH.

1. Match the timing chain mark (yellow) to the alignment mark of the crank sprocket.
2. Match the timing chain mark (orange) to the timing mark position of the intake cam sprocket LH.
3. Match the timing chain mark (orange) to the timing mark position of the exhaust cam sprocket LH.
4. Install timing chain guide LH.

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



(A) Alignment mark
(B) Timing mark

(C) Yellow

(D) Orange

Fig. 171: Locating Timing Chain Guide LH
Courtesy of SUBARU OF AMERICA, INC.

7. Install O-rings to the cylinder block LH.

NOTE: Use new O-rings.

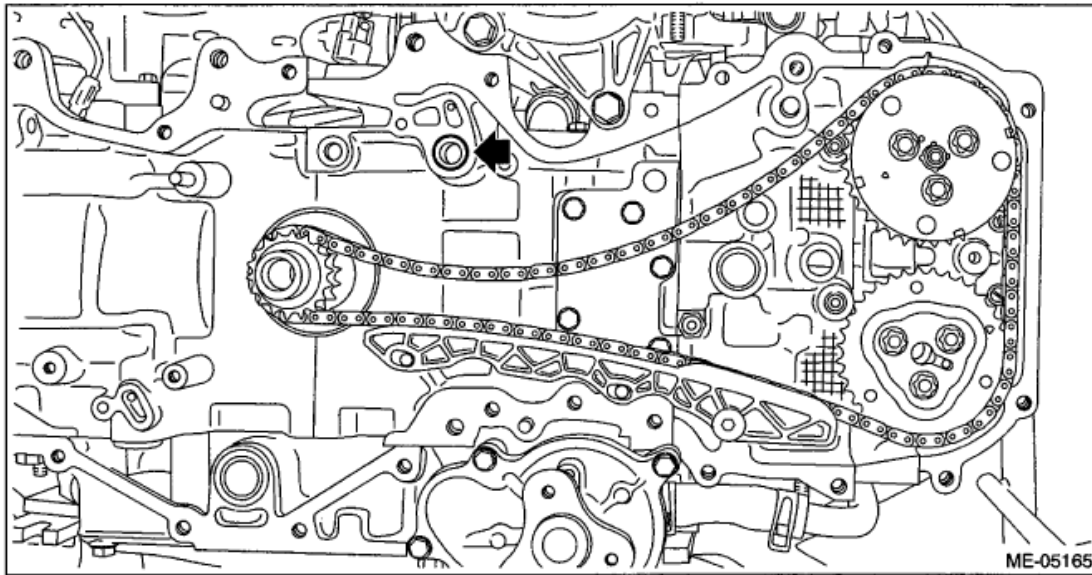


Fig. 172: Locating Cylinder Block LH O-Ring
Courtesy of SUBARU OF AMERICA, INC.

8. Install the chain tensioner lever LH (A) and chain tensioner LH.

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

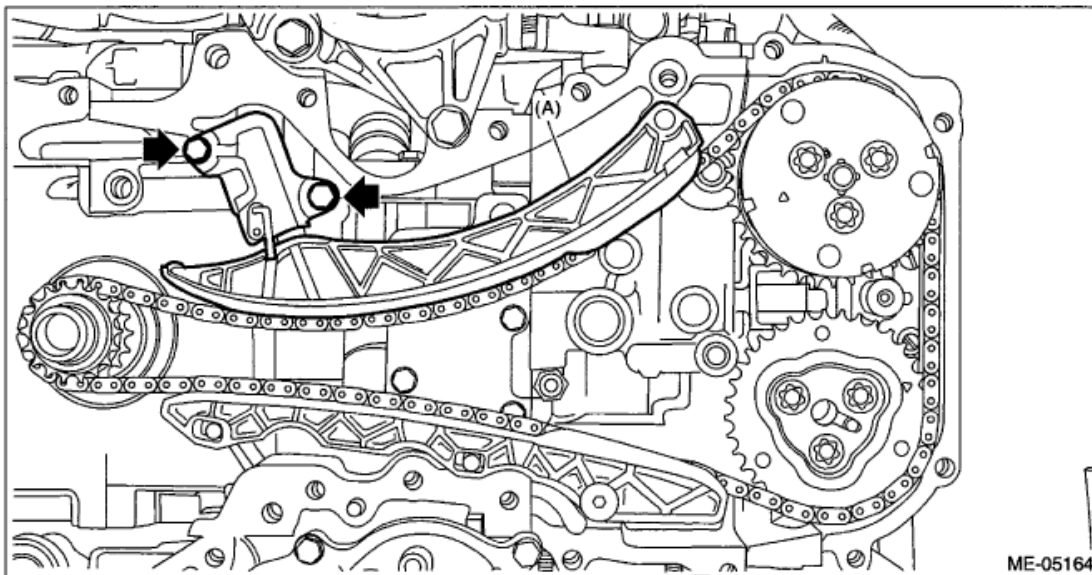
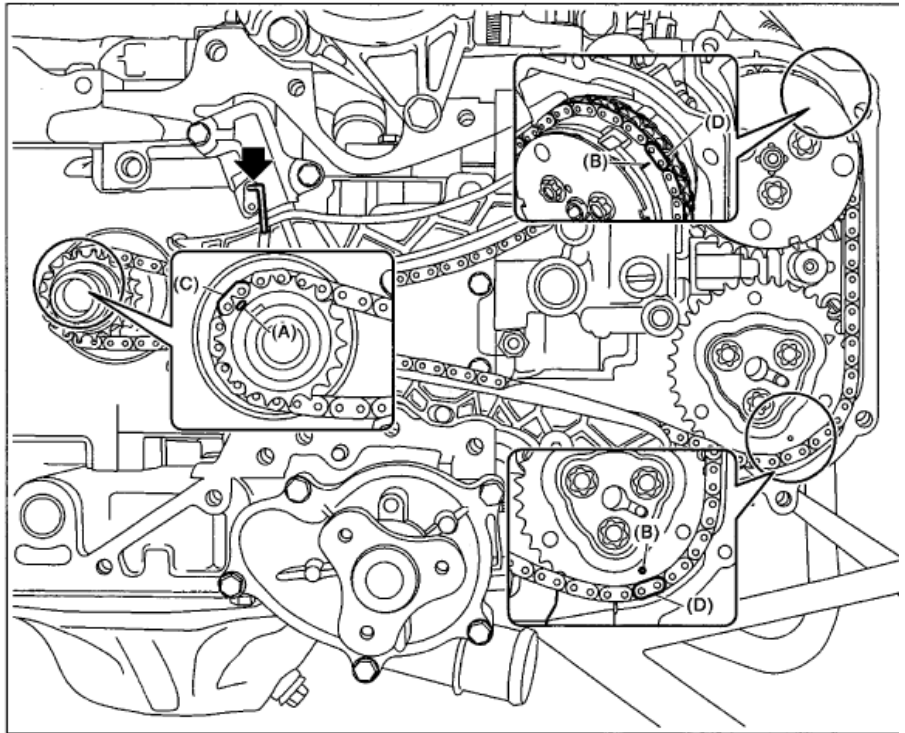


Fig. 173: Locating Chain Tensioner LH And Chain Tensioner Lever LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. Pull out the stopper pin from the chain tensioner LH.

CAUTION: Confirm the following before pulling out the stopper pin.

- Matching of the timing chain mark (yellow) to the alignment mark crank sprocket.
- Matching of the timing chain mark (orange) to the timing mark on the intake cam sprocket LH.
- Matching of the timing chain mark (orange) to the timing mark on the exhaust cam sprocket RH.



(A) Alignment mark
(B) Timing mark

(C) Yellow

(D) Orange

Fig. 174: Pulling Out Stopper Pin From Chain Tensioner LH
Courtesy of SUBARU OF AMERICA, INC.

10. Using the ST, turn the crankshaft clockwise, and make sure that there are no abnormal conditions.

CAUTION: Always make sure to perform this confirmation.

ST 18252AA000 CRANKSHAFT SOCKET

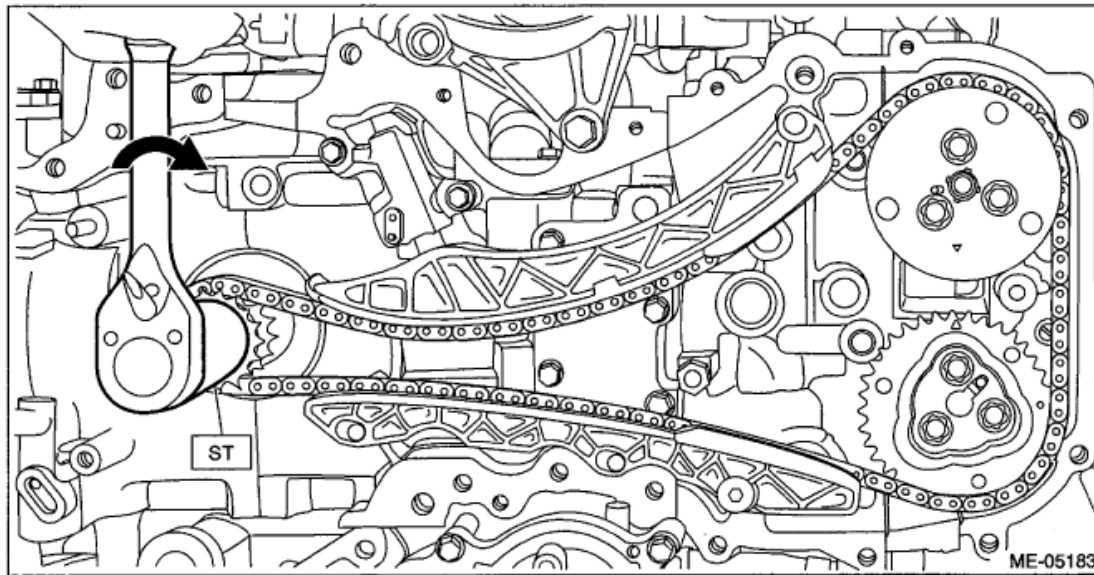


Fig. 175: Turning Crankshaft Using ST
 Courtesy of SUBARU OF AMERICA, INC.

11. Install the timing chain RH. < refer to **TIMING CHAIN RH**, INSTALLATION, Timing Chain Assembly >

INSPECTION

1. Check the timing chain, chain guide, chain tensioner lever and chain tensioner for deformation, cracks or other damages.
2. Check the chain guide and chain tensioner lever for abnormal wear.

CAM SPROCKET

REMOVAL

CAM SPROCKET RH

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

- **Intake cam sprocket RH**

1. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
2. Remove the timing chain RH. < refer to **TIMING CHAIN RH**, INSTALLATION, Timing Chain Assembly >
3. Hold the intake cam sprocket RH using the ST1 and ST2, and remove the bolts using the ST3.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA030 PULLEY WRENCH PIN SET

ST3 18270KA010 SOCKET

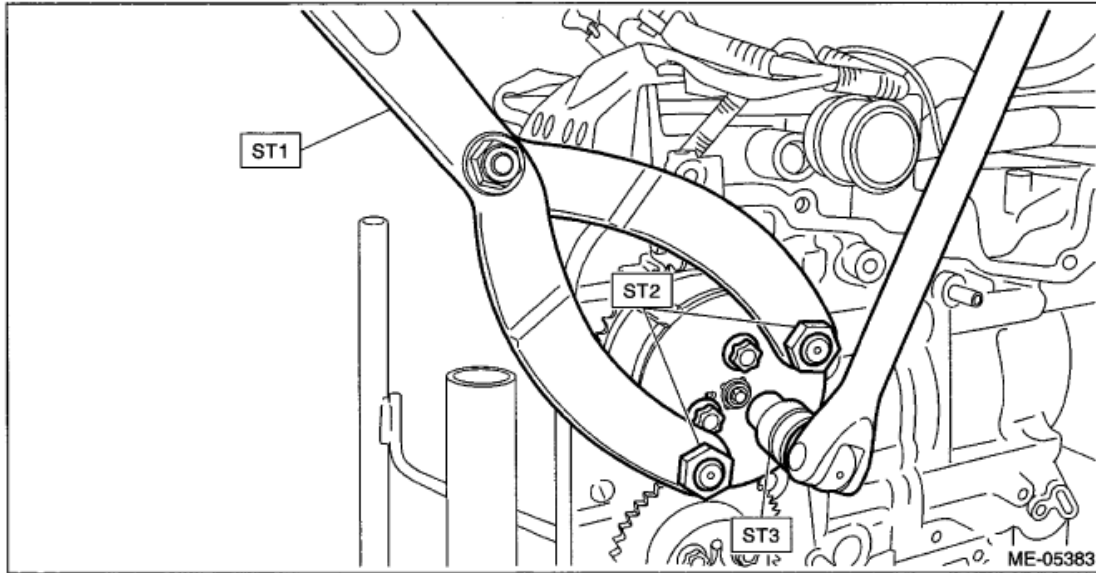


Fig. 176: Removing Intake Cam Sprocket RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the intake cam sprocket RH.

• **Exhaust cam sprocket RH**

1. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
2. Remove the timing chain RH. < refer to **TIMING CHAIN RH**, REMOVAL, Timing Chain Assembly >
3. Hold the exhaust cam sprocket RH by inserting the 6 mm (0.236 in) dia. steel rod into the exhaust cam sprocket RH hole as shown in the figure, and remove the bolts using the ST.

ST 18270KA010 SOCKET

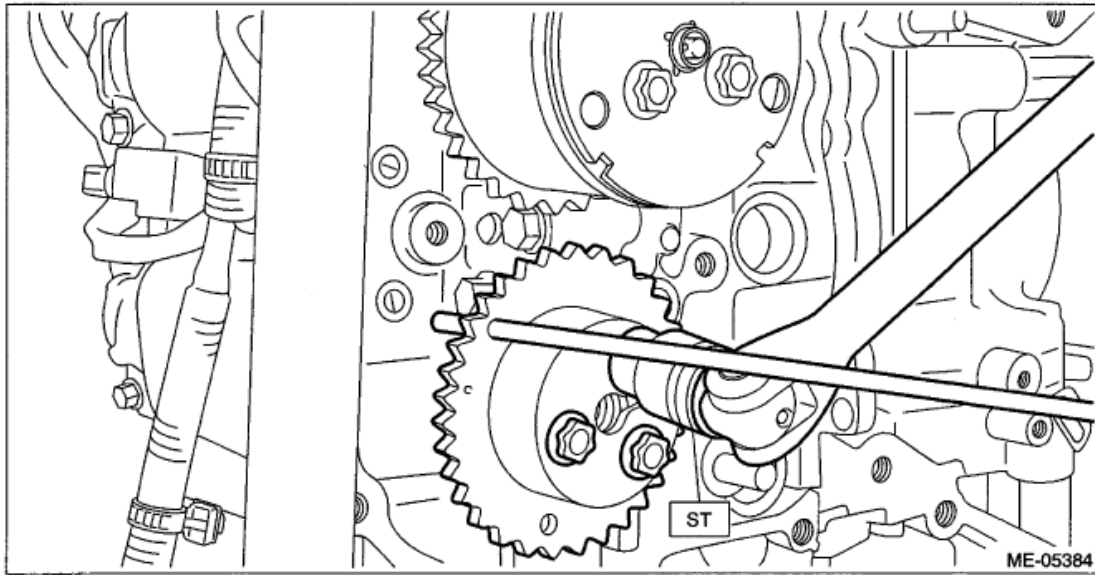


Fig. 177: Inserting Steel Rod Into Exhaust Cam Sprocket RH Hole
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the exhaust cam sprocket RH.

CAM SPROCKET LH

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

- Intake cam sprocket LH

1. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
2. Remove the timing chain LH. < refer to **TIMING CHAIN LH**, REMOVAL, Timing Chain Assembly >
3. Hold the intake cam sprocket LH using the ST1 and ST2, and remove the bolts using the ST3.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA030 PULLEY WRENCH PIN SET

ST3 18270KA010 SOCKET

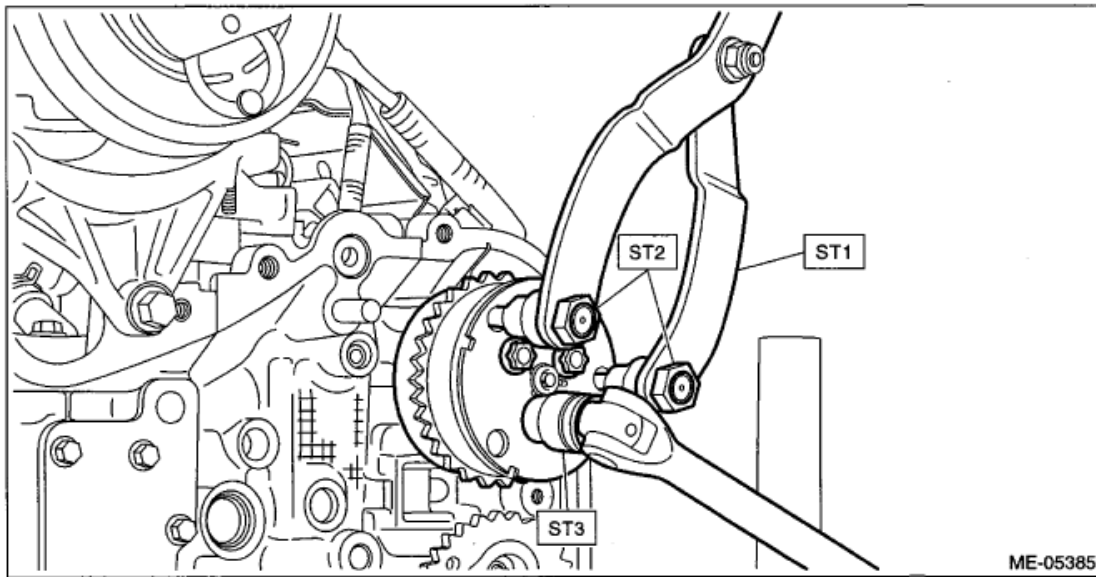


Fig. 178: Removing Intake Cam Sprocket LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the intake cam sprocket LH.

- **Exhaust cam sprocket LH**

1. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
2. Remove the timing chain LH. < refer to **TIMING CHAIN LH**, REMOVAL, Timing Chain Assembly >
3. Hold the exhaust cam sprocket LH using the ST1 and ST2, and remove the bolts using the ST3.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA020 PULLEY WRENCH PIN SET

ST3 18270KA010 SOCKET

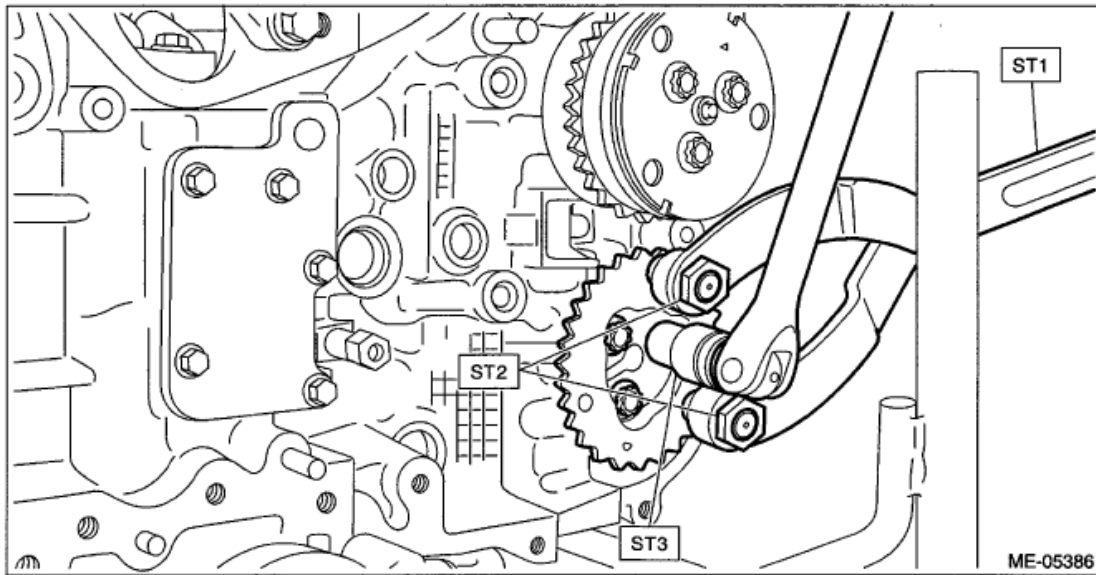


Fig. 179: Removing Exhaust Cam Sprocket LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the exhaust cam sprocket LH.

INSTALLATION

CAM SPROCKET RH

- Intake cam sprocket RH

1. Install the intake cam sprocket RH by aligning the knock hole (A) of intake cam sprocket RH and the knock pin (B) of intake camshaft RH.

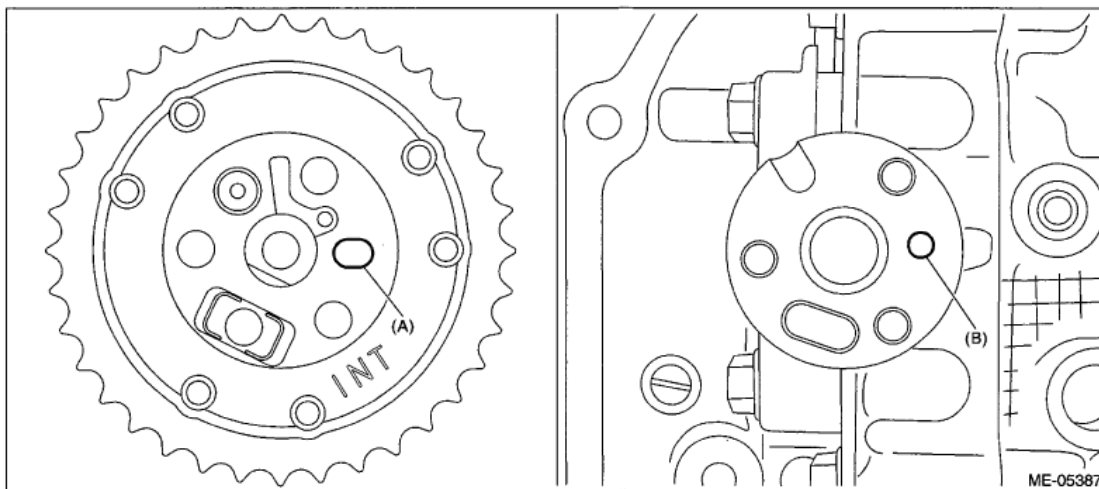


Fig. 180: Identifying Intake Cam Sprocket RH Knock Hole And Intake Camshaft RH Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

2. Hold the intake cam sprocket RH using the ST1 and ST2, and install the bolts using the ST3.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA030 PULLEY WRENCH PIN SET

ST3 18270KA010 SOCKET

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

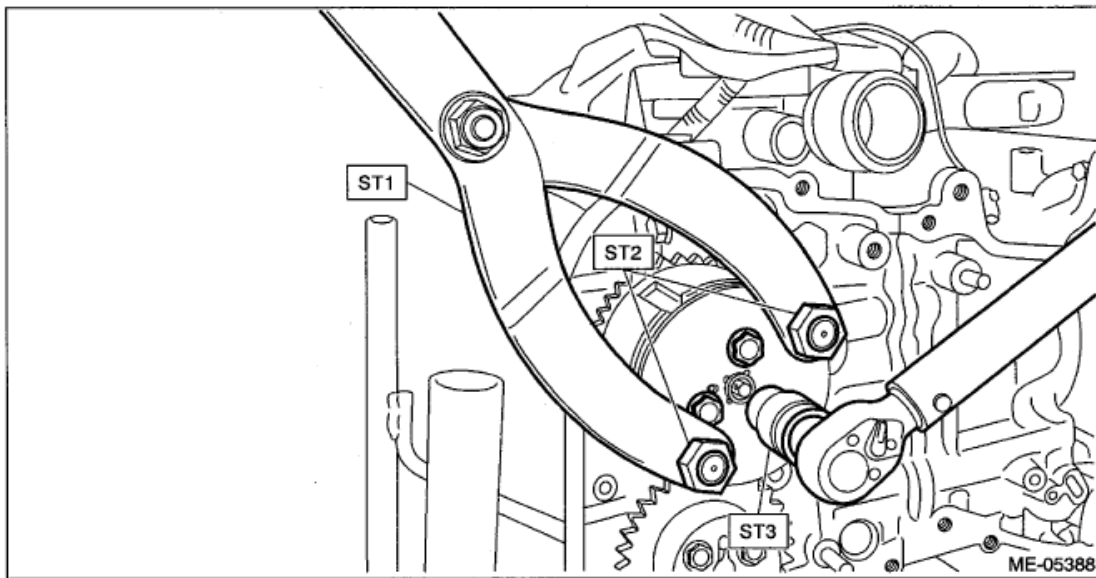


Fig. 181: Installing Intake Cam Sprocket RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install the timing chain RH. < refer to **TIMING CHAIN RH**, INSTALLATION, Timing Chain Assembly >
 4. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >
- **Exhaust cam sprocket RH**
 1. Install the exhaust cam sprocket RH by aligning the knock hole (A) of exhaust cam sprocket RH and the knock pin (B) of exhaust camshaft RH.

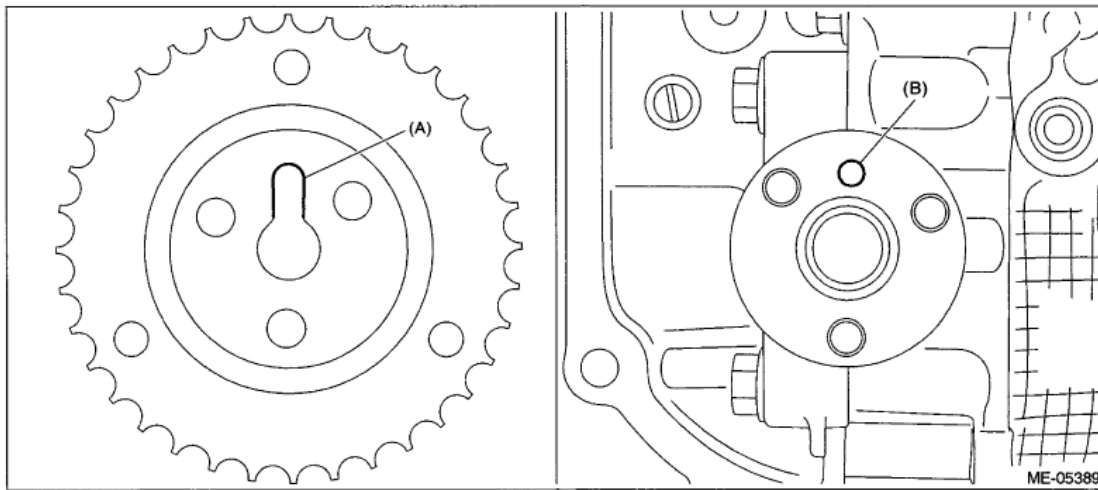


Fig. 182: Identifying Exhaust Cam Sprocket RH Knock Hole And Exhaust Camshaft RH Knock Pin

Courtesy of SUBARU OF AMERICA, INC.

2. Hold the exhaust cam sprocket RH by inserting the 6 mm (0.236 in) dia. steel rod into the exhaust cam sprocket RH hole as shown in the figure, and install the bolts using the ST.

ST 18270KA010 SOCKET

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

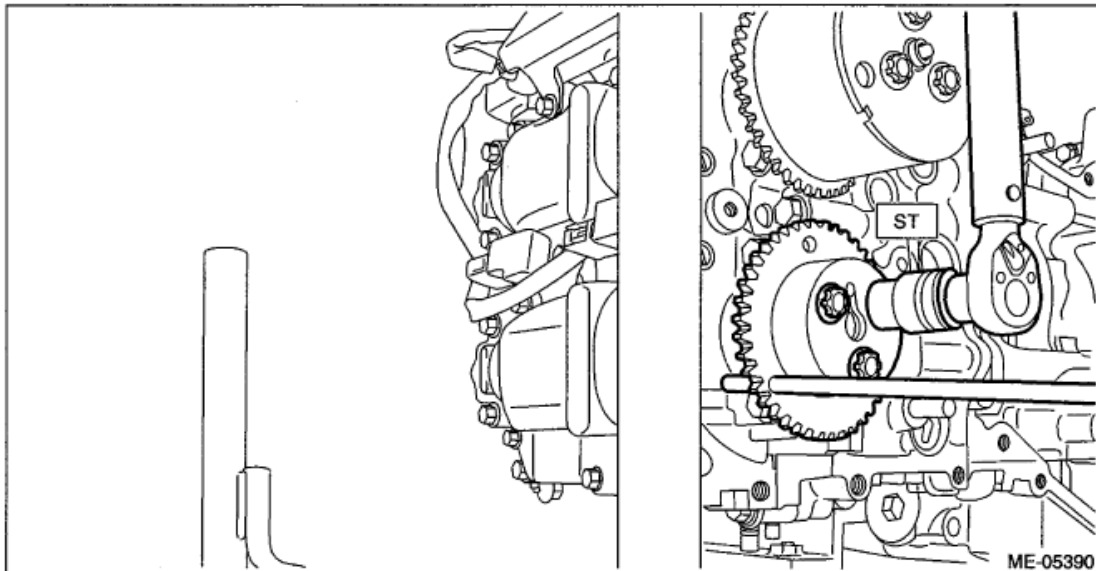


Fig. 183: Inserting Steel Rod Into Exhaust Cam Sprocket RH Hole

Courtesy of SUBARU OF AMERICA, INC.

3. Install the timing chain RH. < refer to **TIMING CHAIN RH, INSTALLATION**, Timing Chain Assembly >

4. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >

CAM SPROCKET LH

- **Intake cam sprocket LH**

1. Install the intake cam sprocket LH by aligning the knock hole (A) of intake cam sprocket LH and the knock pin (B) of intake camshaft LH.

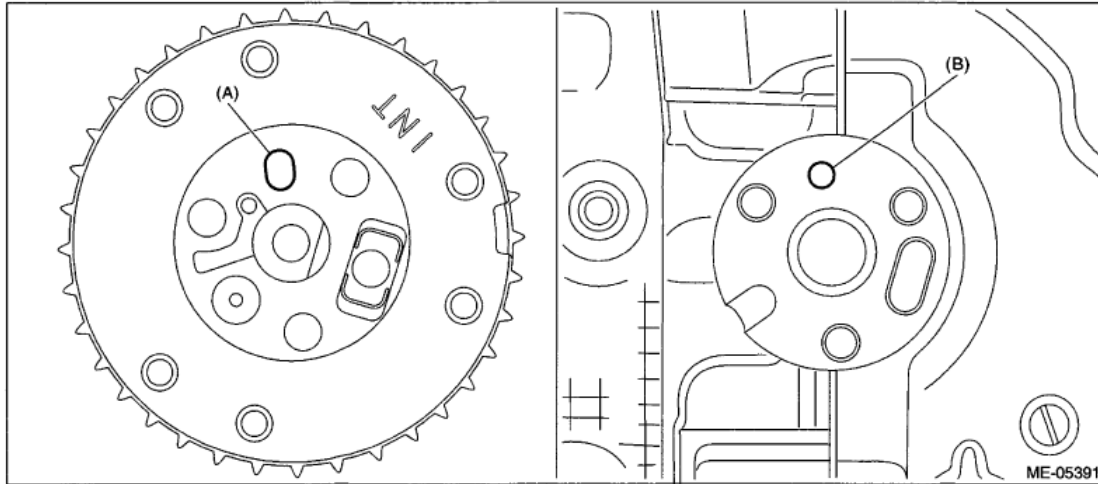


Fig. 184: Identifying Intake Cam Sprocket LH Knock Hole And Intake Camshaft LH Knock Pin

Courtesy of SUBARU OF AMERICA, INC.

2. Hold the intake cam sprocket LH using the ST1 and ST2, and install the bolts using the ST3.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA030 PULLEY WRENCH PIN SET

ST3 18270KA010 SOCKET

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

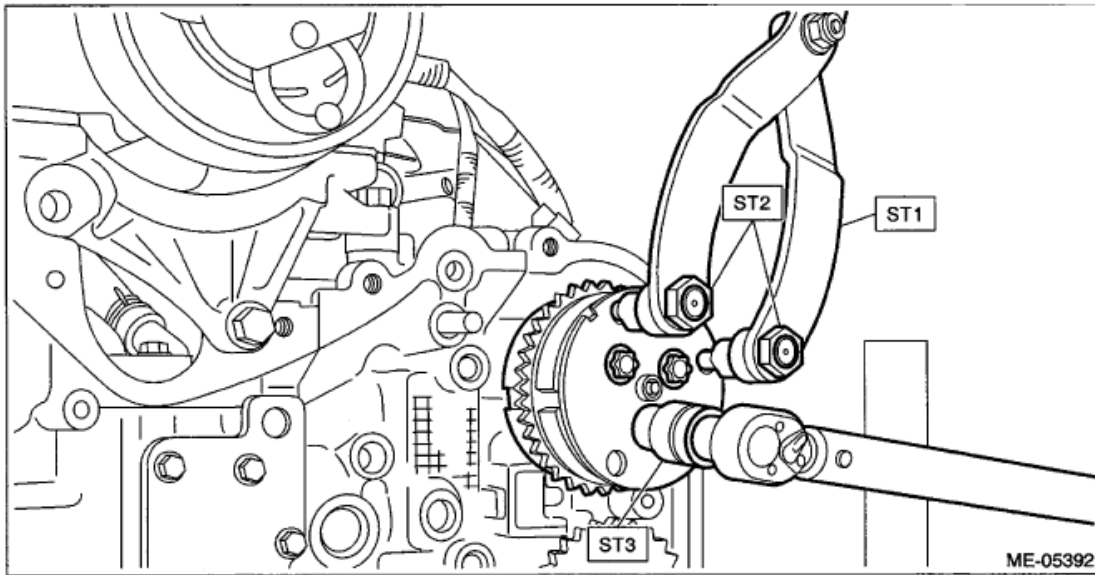


Fig. 185: Installing Intake Cam Sprocket LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install timing chain LH. < refer to **TIMING CHAIN LH**, INSTALLATION, Timing Chain Assembly >
4. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >

• **Exhaust cam sprocket LH**

1. Install the exhaust cam sprocket LH by aligning the knock hole (A) of exhaust cam sprocket LH and the knock pin (B) of exhaust camshaft LH.

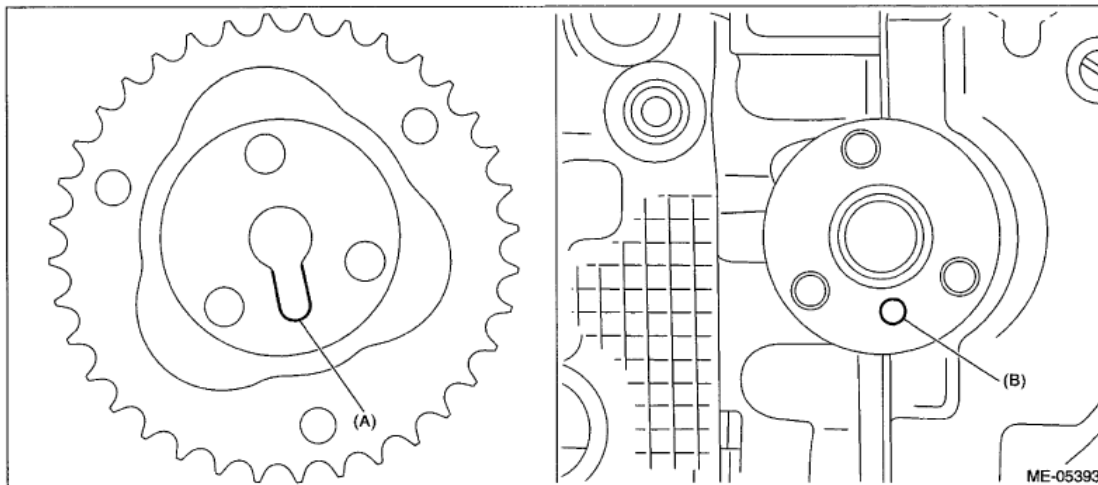


Fig. 186: Identifying Exhaust Cam Sprocket LH Knock Hole And Exhaust Camshaft LH Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

2. Hold the exhaust cam sprocket LH using the ST1 and ST2, and install the bolts using the ST3.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA020 PULLEY WRENCH PIN SET

ST3 18270KA010 SOCKET

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

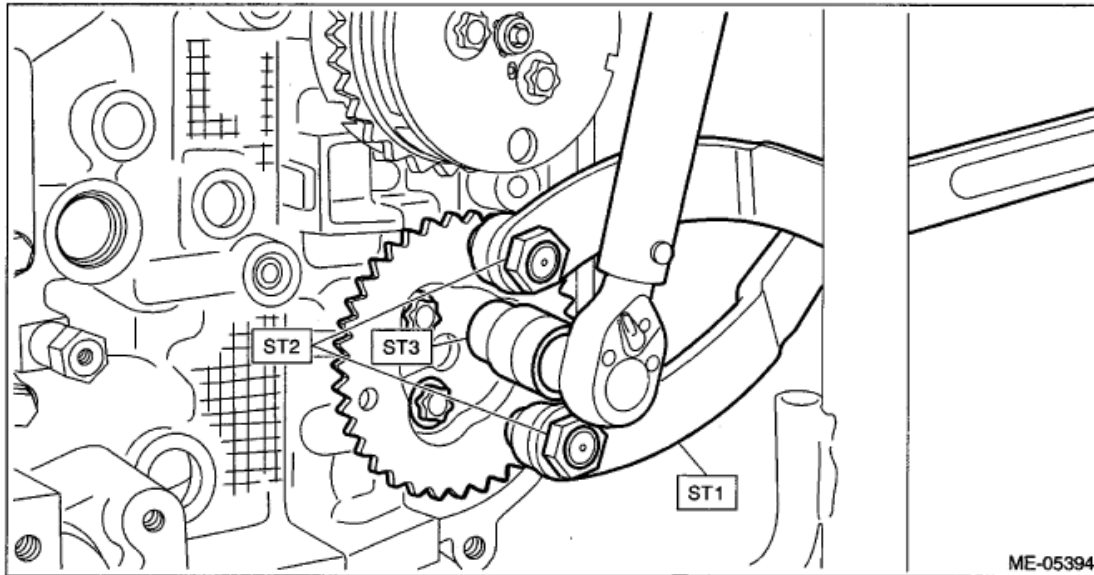


Fig. 187: Installing Exhaust Cam Sprocket LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Install timing chain LH. < refer to **TIMING CHAIN LH**, INSTALLATION, Timing Chain Assembly >
4. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >

INSPECTION

Check the cam sprocket teeth for abnormal wear and scratches.

CRANK SPROCKET

REMOVAL

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

1. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
2. Remove the timing chain. < refer to **REMOVAL**, Timing Chain Assembly >
3. Remove the crank sprocket.

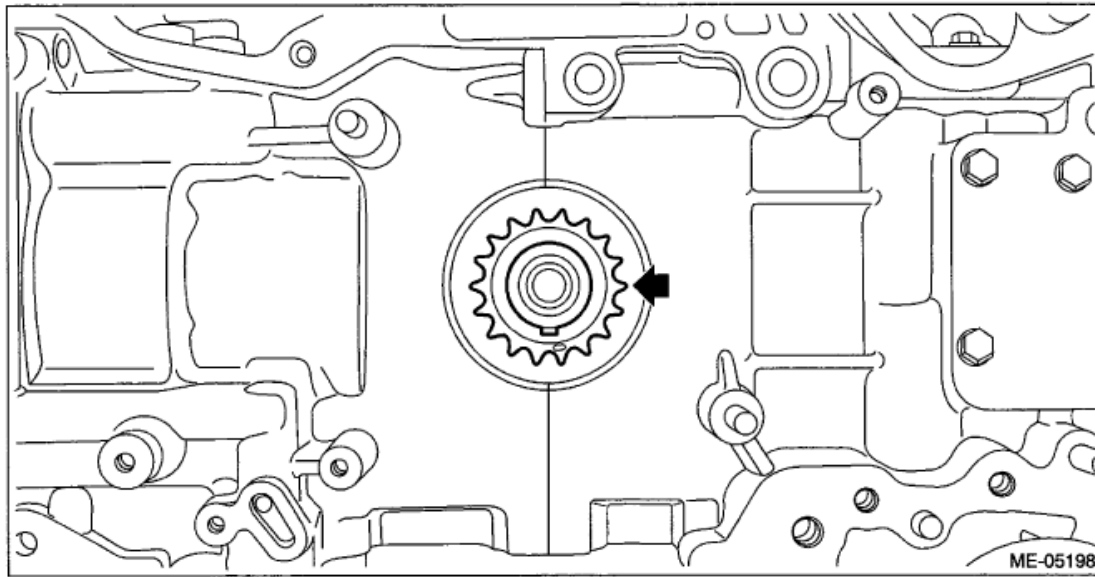


Fig. 188: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

NOTE: The direction of installation is not specified for the crank sprocket.

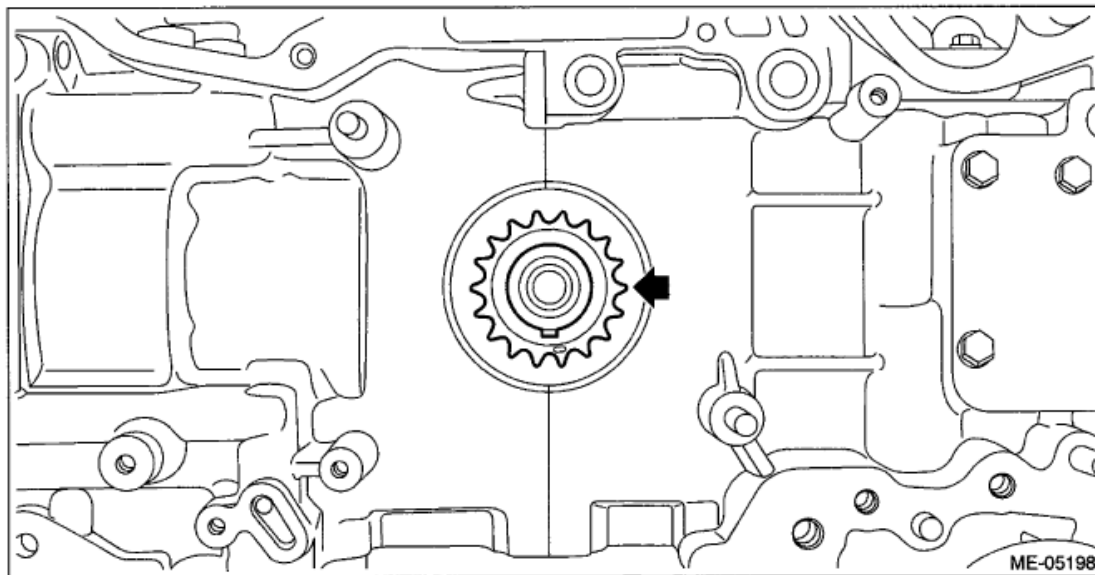


Fig. 189: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing chain. < refer to **INSTALLATION**, Timing Chain Assembly >

3. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >

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.

ROCKER COVER

REMOVAL

ROCKER COVER RH

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

1. When working on the vehicle

NOTE: When working on the vehicle, perform the following steps also.

1. Remove the air cleaner case. < refer to **REMOVAL** , Air Cleaner Case >
2. Remove the clip (A) from the air intake boot, and loosen the clamp (B) securing the air intake boot to the throttle body.

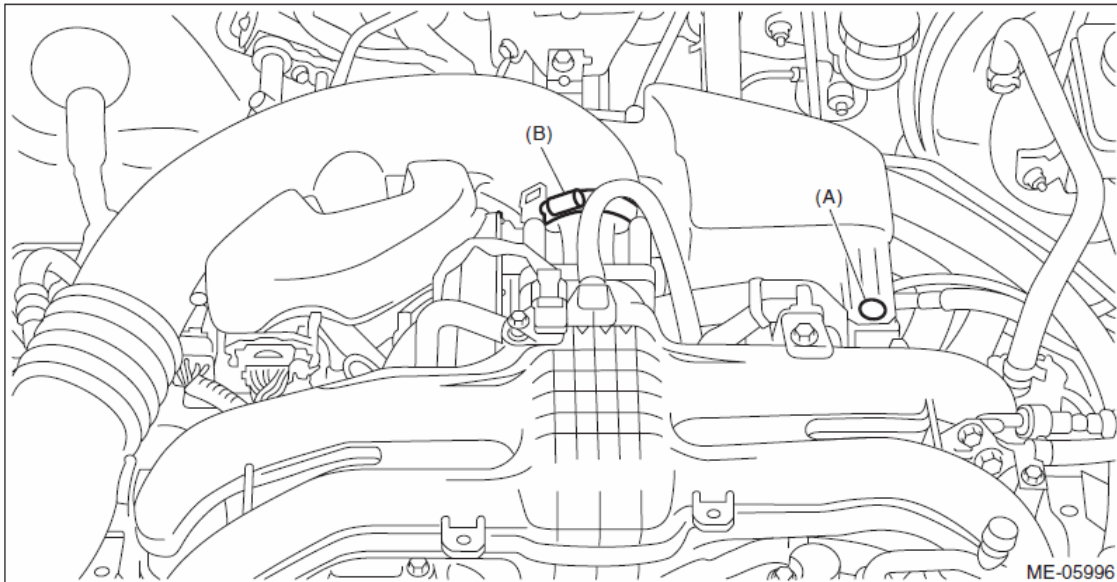


Fig. 190: Identifying Air Intake Boot Clip And Clamp
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the air intake boot from the throttle body, and move it to the left side wheel apron.

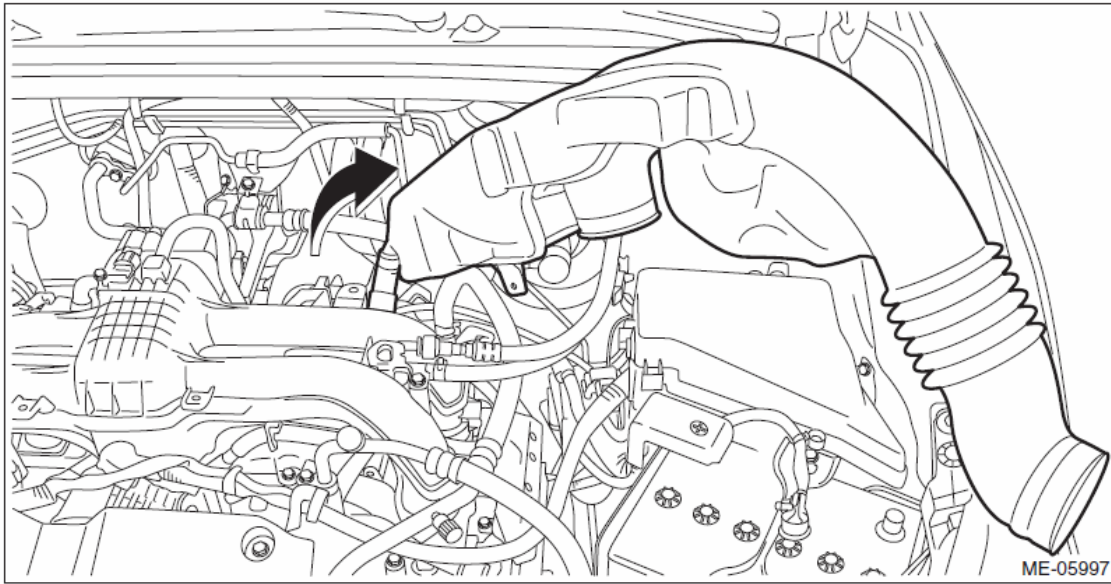


Fig. 191: Removing Air Intake Boot From Throttle Body
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the front exhaust pipe. < refer to **REMOVAL** , Front Exhaust Pipe >
2. Remove the #1 ignition coil and the #3 ignition coil. < refer to **REMOVAL** , Ignition Coil >
3. Remove the intake manifold protector RH.

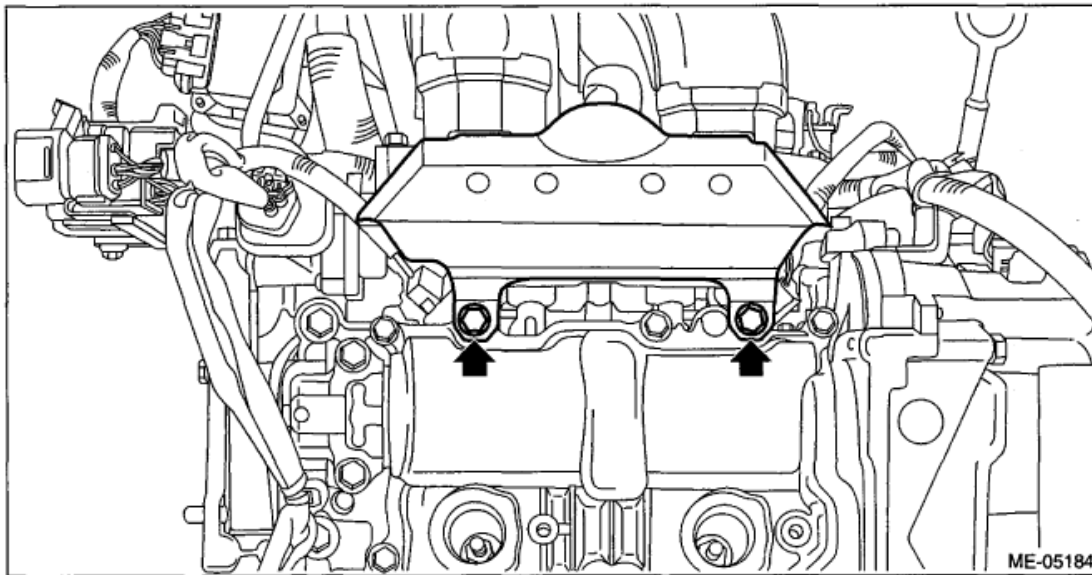


Fig. 192: Locating Intake Manifold Protector RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the rocker cover RH.

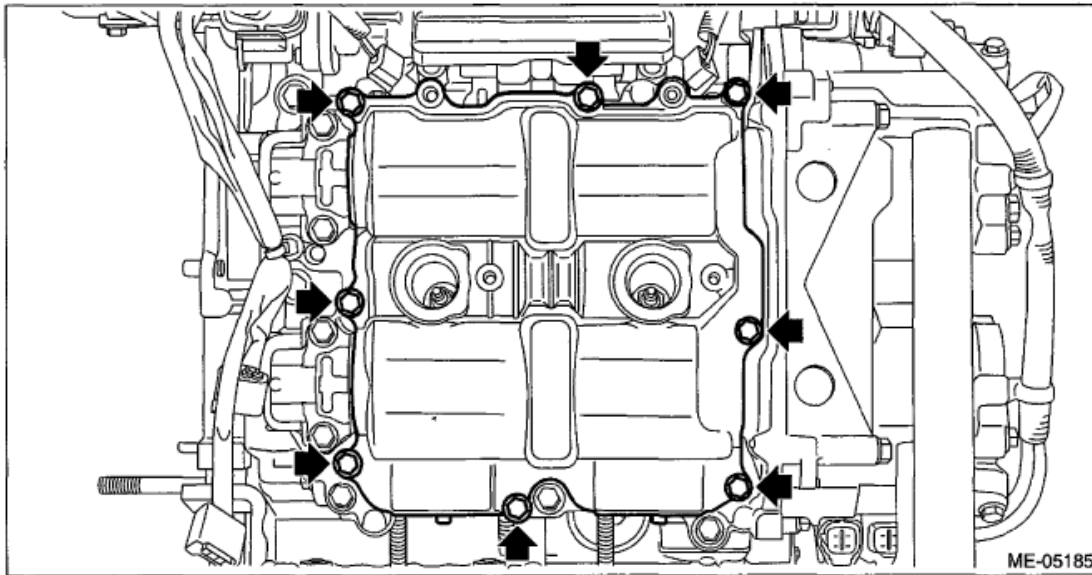


Fig. 193: Locating Rocker Cover RH Bolts
 Courtesy of SUBARU OF AMERICA, INC.

5. Remove the rocker cover gasket RH, #1 spark plug pipe gasket and #3 spark plug pipe gasket, and remove the liquid gasket.

CAUTION:

- When removing the liquid gasket from engine unit using scraper, special care not to damage the cam lobe of camshaft RH.
- If the cam lobe of camshaft RH interferes, turn the crankshaft to t position where the scraper does not touch.

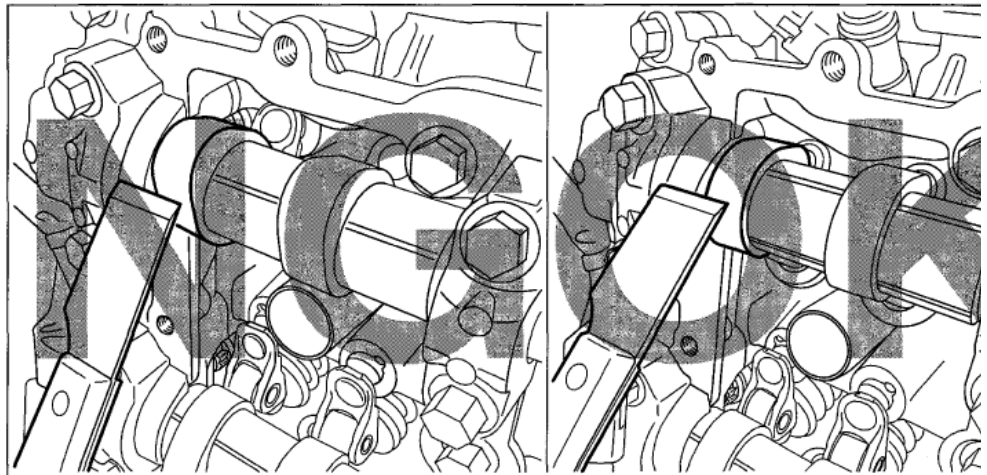


Fig. 194: Identifying Correct And Incorrect Method Of Removing Liquid Gasket
 Courtesy of SUBARU OF AMERICA, INC.

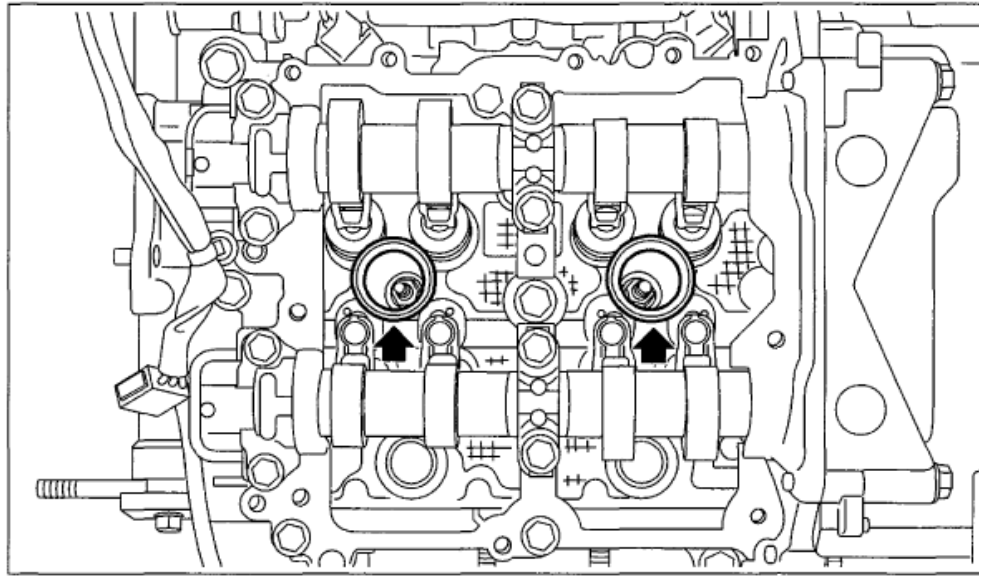


Fig. 195: Locating Rocker Cover Gasket RH
Courtesy of SUBARU OF AMERICA, INC.

ROCKER COVER LH

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

1. When working on the vehicle

NOTE: When working on the vehicle, perform the following steps also.

1. Remove the battery. < refer to **REMOVAL** , Battery >
2. Remove the V-belt covers.

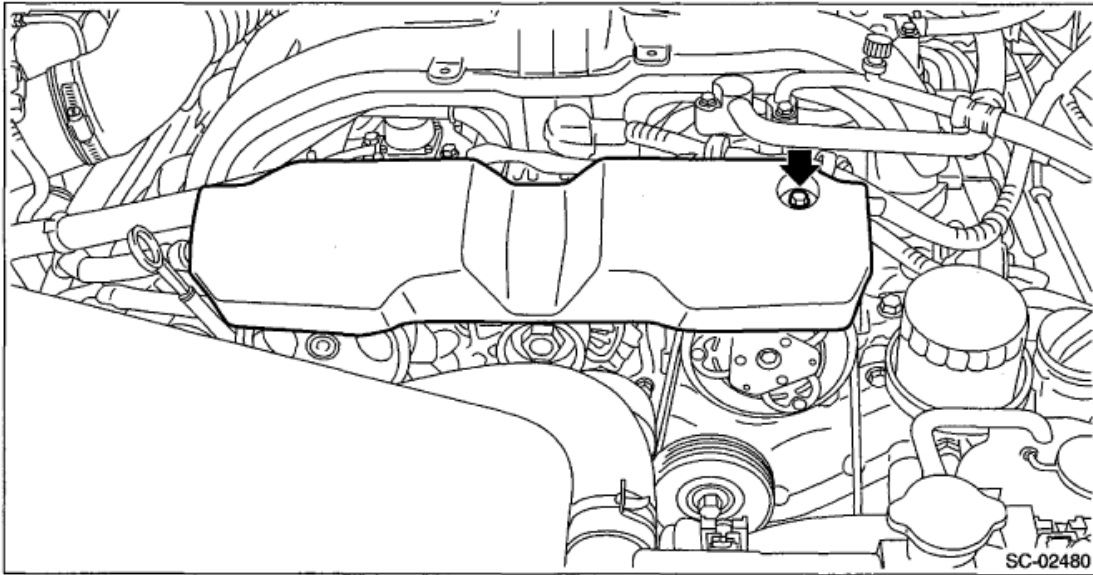


Fig. 196: Locating V-Belt Cover Bolt
 Courtesy of SUBARU OF AMERICA, INC.

3. Remove the air intake duct. < refer to **REMOVAL** , Air Intake Duct >
4. Align the timing mark (A) of crank pulley to the timing gauge (B) 0° of chain cover as shown in the figure, and turn the crankshaft by 180° clockwise from that position.

NOTE: This procedure is required to prevent the rocker cover LH and the cam lobe of camshaft LH contacting with each other when removing the rocker cover LH.

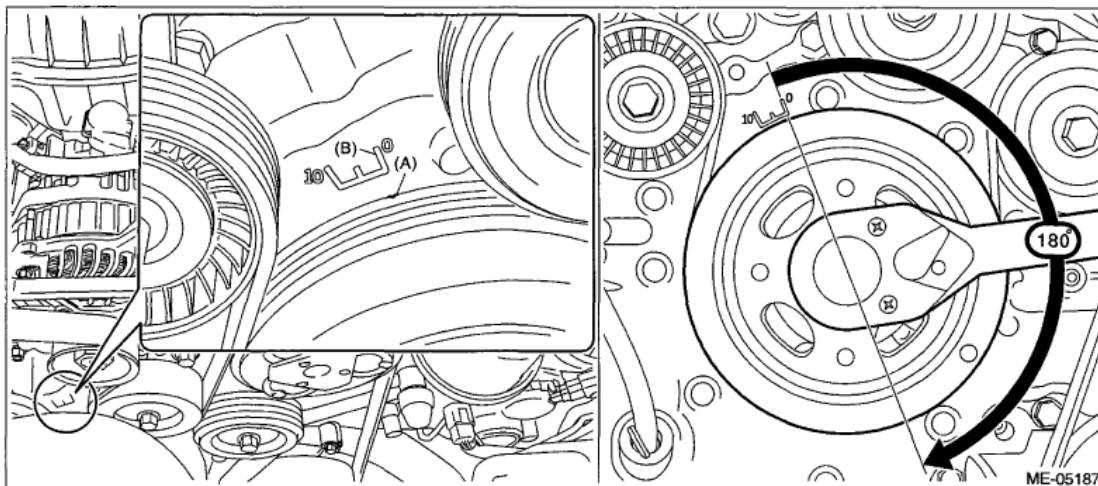


Fig. 197: Identifying Crankshaft Turning Angle
 Courtesy of SUBARU OF AMERICA, INC.

2. Remove the #2 ignition coil and the #4 ignition coil. < refer to **REMOVAL** , Ignition Coil >

3. Remove the intake manifold protector LH.

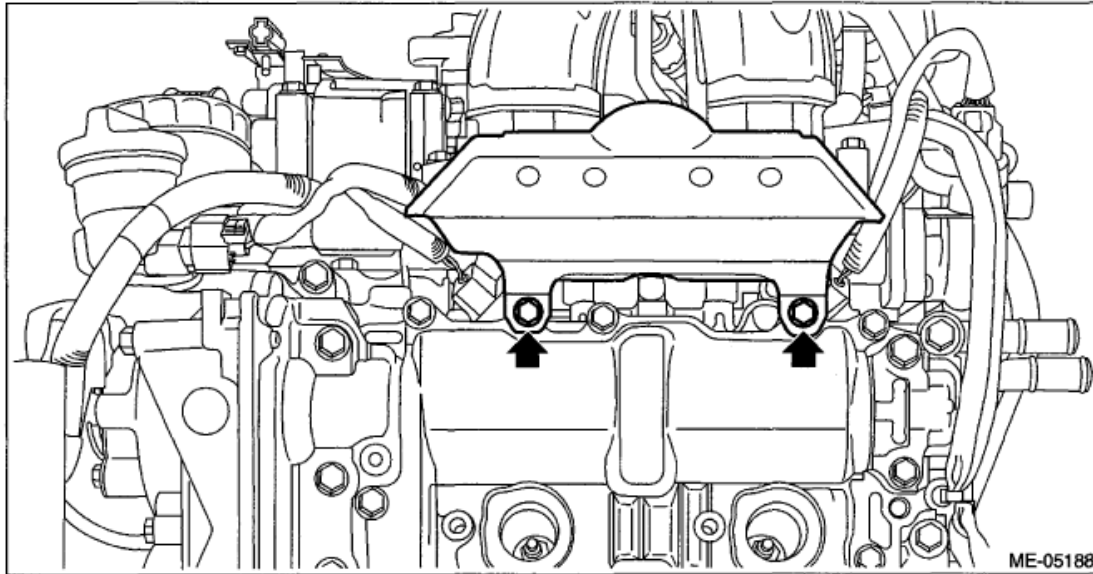


Fig. 198: Locating Intake Manifold Protector LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the rocker cover LH.

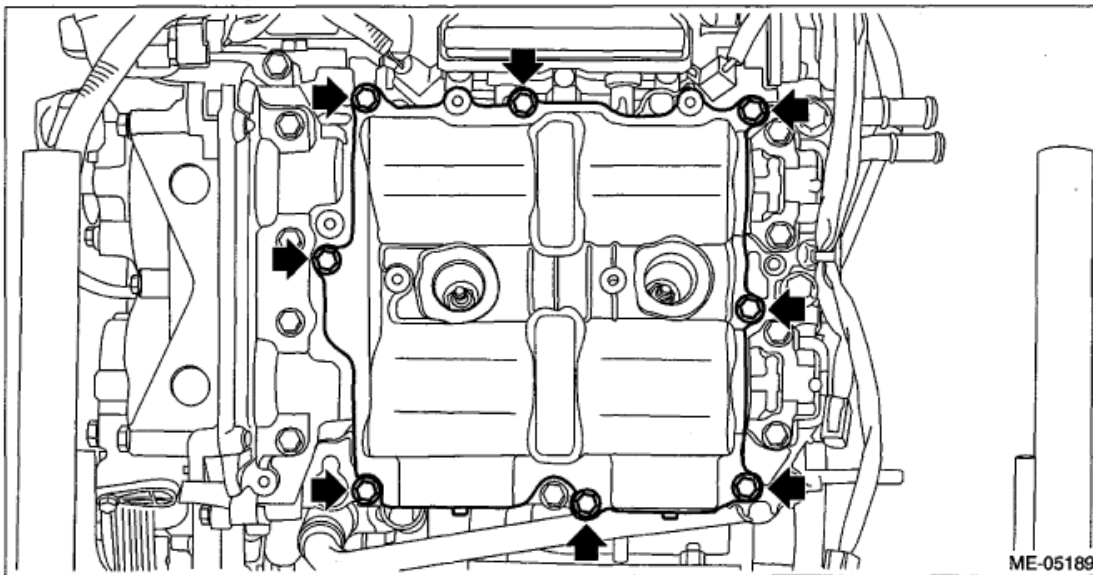


Fig. 199: Locating Rocker Cover LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the rocker cover gasket LH, #2 spark plug pipe gasket and #4 spark plug pipe gasket, and remove the liquid gasket.

CAUTION:

- When removing the liquid gasket from engine unit using scraper, special care not to damage the cam lobe of camshaft LH.
- If the cam lobe of camshaft LH interferes, turn the crankshaft to the position where the scraper does not touch.

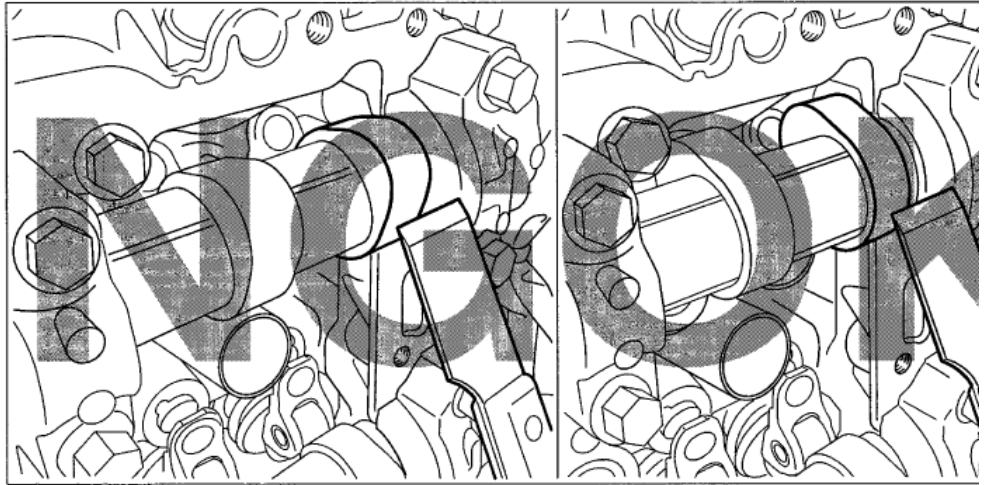


Fig. 200: Identifying Correct And Incorrect Method Of Removing Liquid Gasket

Courtesy of SUBARU OF AMERICA, INC.

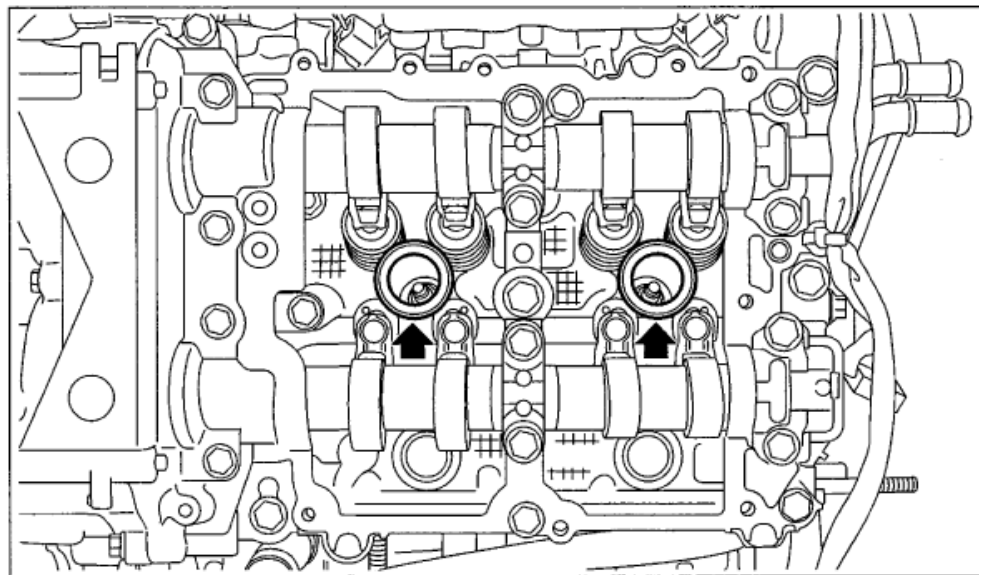


Fig. 201: Locating Rocker Cover Gasket LH

Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION**ROCKER COVER RH**

1. Install the #1 spark plug pipe gasket and #3 spark plug pipe gasket to the #1 spark plug pipe and #3 spark plug pipe.

NOTE:

- Use a new #1 spark plug pipe gasket and #3 spark plug pipe gasket.
- Apply a light coat of engine oil to the #1 spark plug pipe gasket and #3 spark plug pipe gasket, and insert them onto the spark plug pipe edge (A).

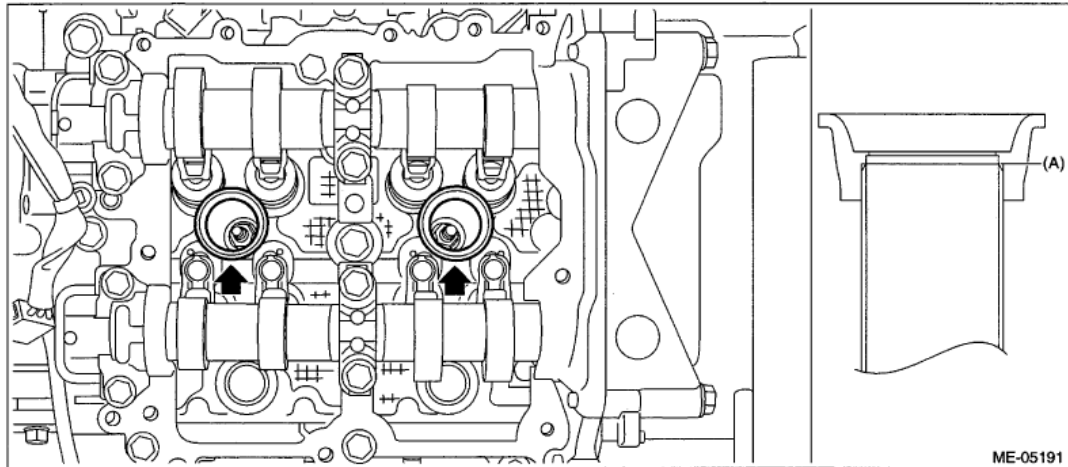


Fig. 202: Locating Spark Plug Pipe Gaskets
Courtesy of SUBARU OF AMERICA, INC.

2. Install the rocker cover gasket RH to the rocker cover RH.

NOTE:

Use a new rocker cover gasket RH.

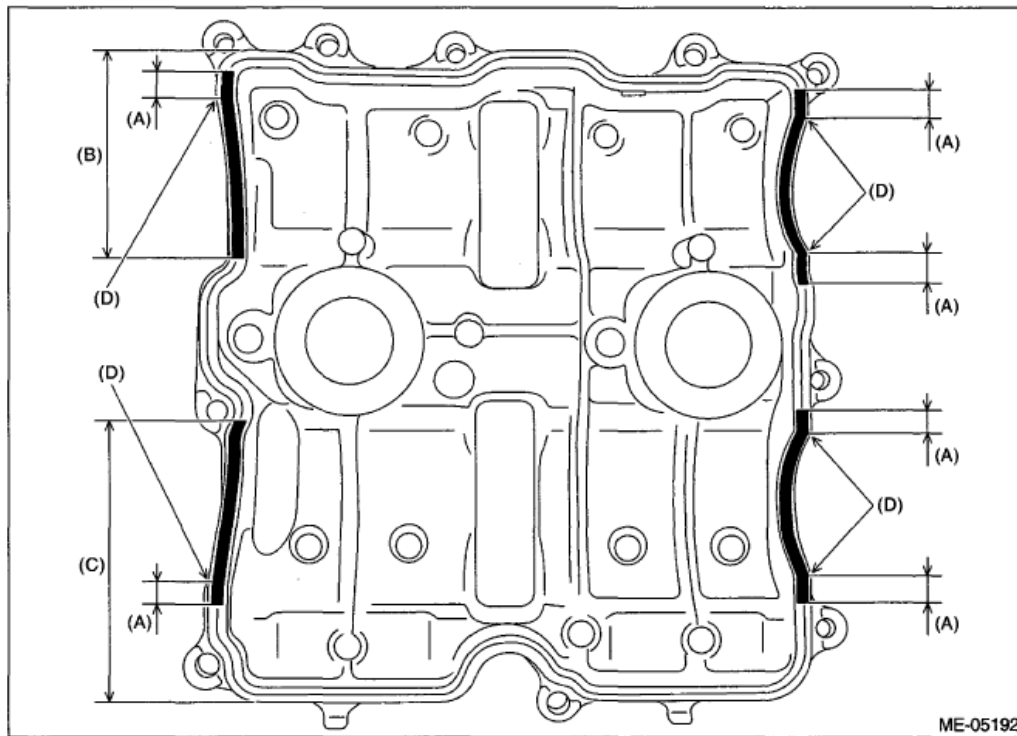
3. Apply liquid gasket to the mating surface of rocker cover RH as shown in the figure.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the engine.
- Be careful not to allow liquid gasket to be squeezed out from rocker cover RH.
- Install within 5 min. after applying liquid gasket.

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

Liquid gasket applying diameter: 3.5 ± 0.5 mm (0.1378 ± 0.0197 in)



(A) 10 mm (0.394 in) or more
(B) 68 mm (2.677 in) or more

(C) 89 mm (3.504 in) or more

(D) Arch starting point

Fig. 203: Identifying Liquid Gasket Applying Area On Mating Surface Of Rocker Cover RH
Courtesy of SUBARU OF AMERICA, INC.

4. Set the rocker cover RH, and tighten the bolts in numerical order as shown in the figure.

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

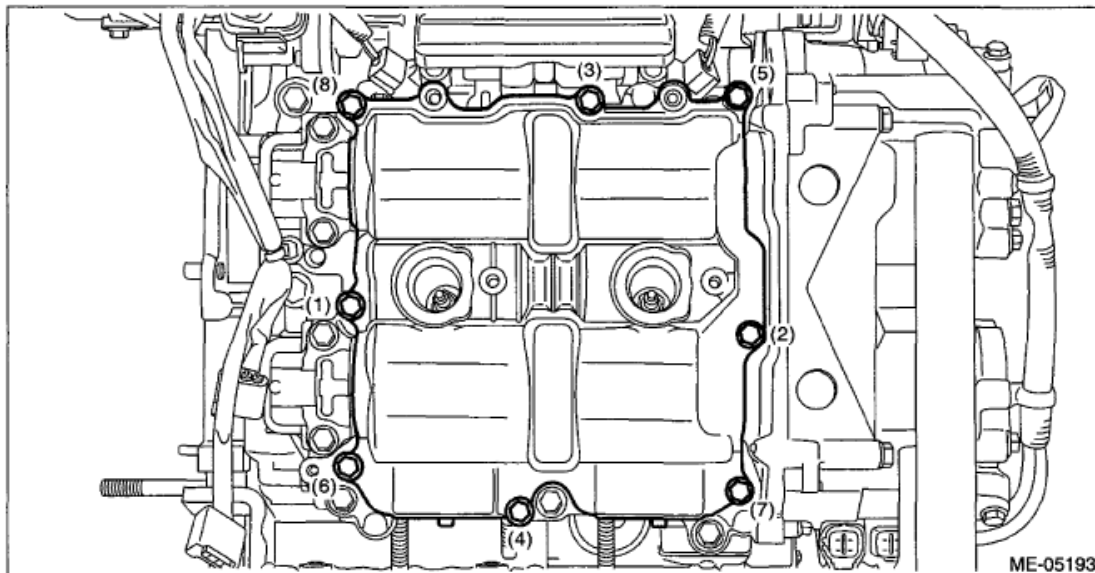


Fig. 204: Identifying Rocker Cover RH Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

5. Install the intake manifold protector RH.

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

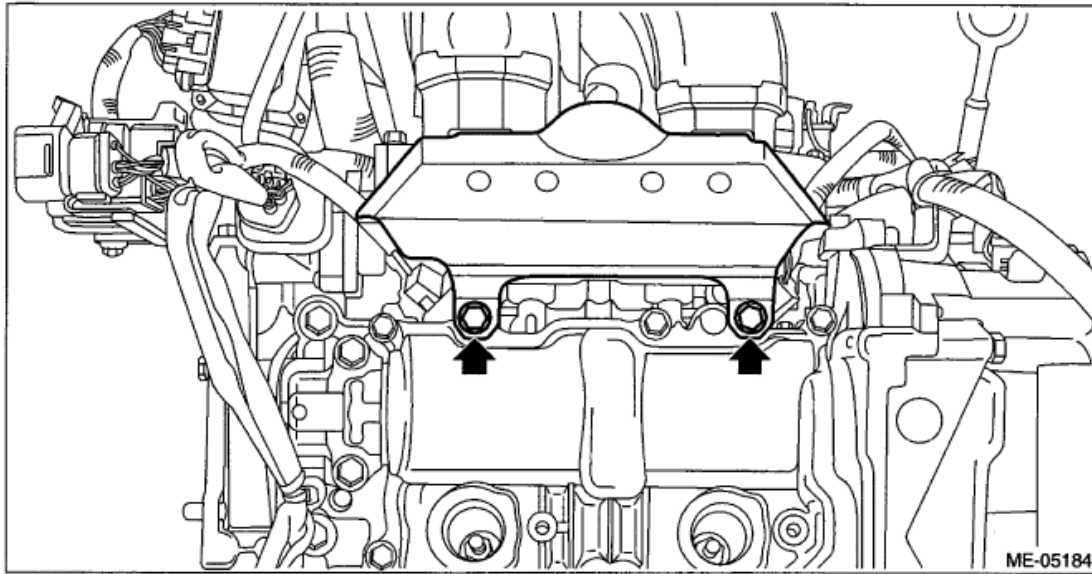


Fig. 205: Locating Intake Manifold Protector RH Bolts
 Courtesy of SUBARU OF AMERICA, INC.

6. Install the #1 ignition coil and the #3 ignition coil. < refer to **INSTALLATION** , Ignition Coil >
7. When working on the vehicle
 1. Install the front exhaust pipe. < refer to **INSTALLATION** , Front Exhaust Pipe >
 2. Install the air intake boot. < refer to **INSTALLATION** , Air Intake Boot >
 3. Install the air cleaner case. < refer to **INSTALLATION** , Air Cleaner Case >

ROCKER COVER LH

1. Align the timing mark (A) of crank pulley to the timing gauge (B) of chain cover as shown in the figure, and turn the crankshaft by 180° clockwise from that position.

NOTE:

- This procedure is required only when working on the vehicle.
- This procedure is required to prevent the rocker cover LH and the cam lobe of camshaft LH contacting with each other when installing the rocker cover LH.

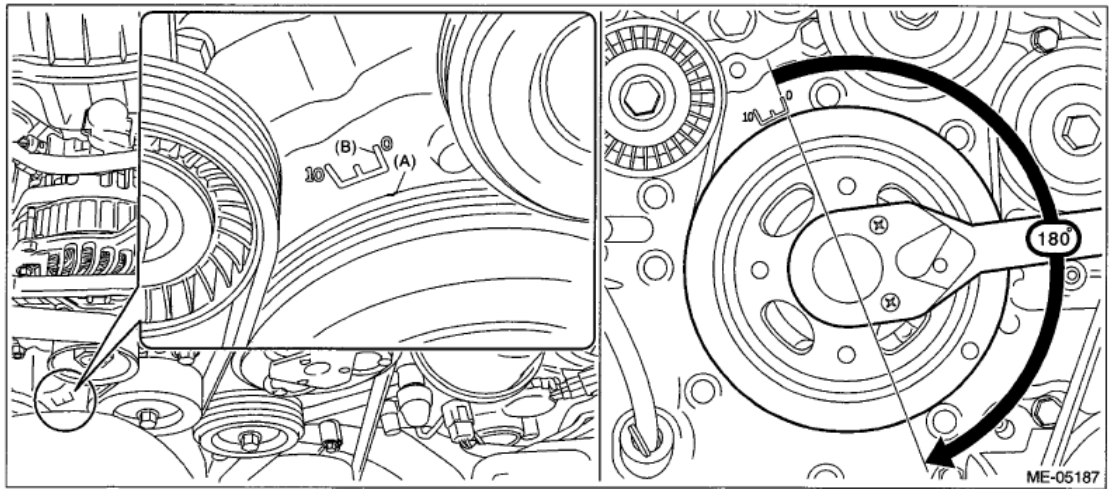


Fig. 206: Identifying Crankshaft Turning Angle
Courtesy of SUBARU OF AMERICA, INC.

2. Install the #2 spark plug pipe gasket and #4 spark plug pipe gasket to the #2 spark plug pipe and #4 spark plug pipe.

NOTE:

- Use a new #2 spark plug pipe gasket and #4 spark plug pipe gasket.
- Apply a light coat of engine oil to the #2 spark plug pipe gasket and #4 spark plug pipe gasket, and insert them onto the spark plug pipe edge (A).

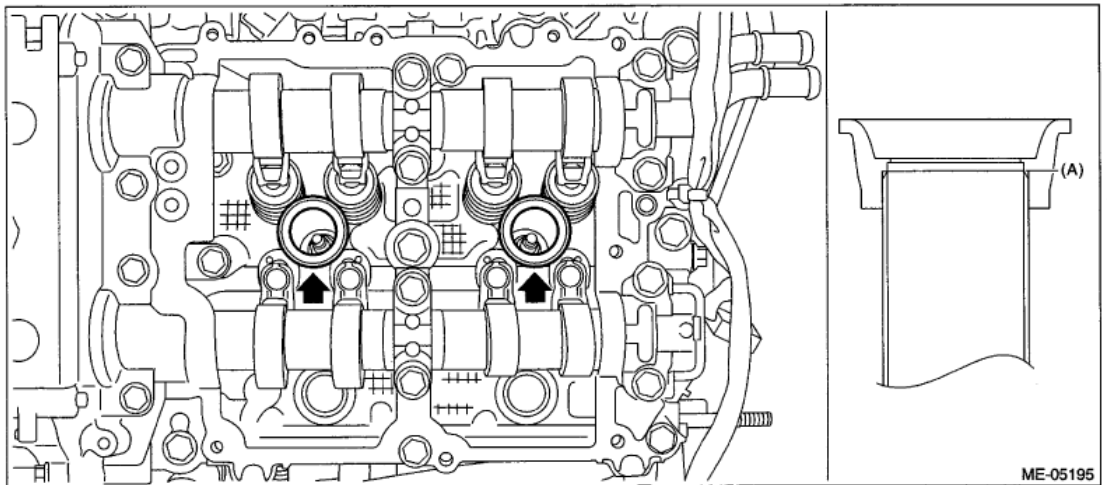


Fig. 207: Locating Spark Plug Pipe Gaskets
Courtesy of SUBARU OF AMERICA, INC.

3. Install the rocker cover gasket LH to the rocker cover LH.

NOTE:

Use a new rocker cover gasket LH.

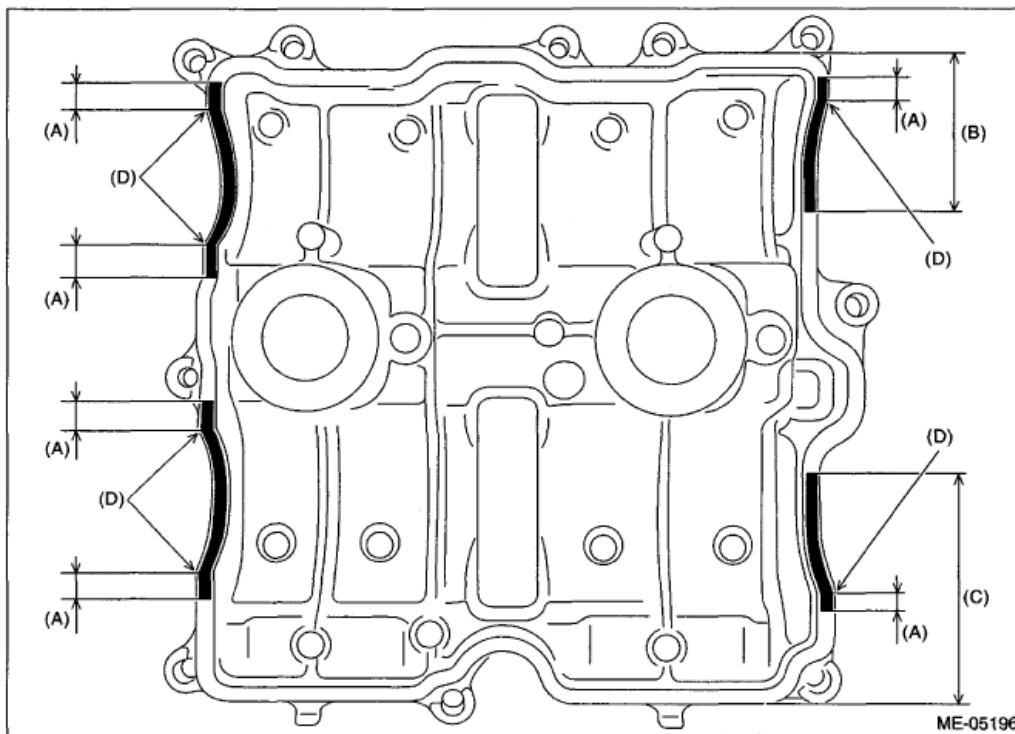
4. Apply liquid gasket to the mating surface of rocker cover LH as shown in the figure.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the engine.
- Be careful not to allow liquid gasket to be squeezed out from rocker cover LH.
- Install within 5 min. after applying liquid gasket.

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

Liquid gasket applying diameter: 3.5 ± 0.5 mm (0.1378 ± 0.0197 in)



(A) 10 mm (0.394 in) or more
(B) 51 mm (2.008 in) or more

(C) 73 mm (2.874 in) or more

(D) Arch starting point

Fig. 208: Identifying Liquid Gasket Applying Area On Mating Surface Of Rocker Cover LH
Courtesy of SUBARU OF AMERICA, INC.

5. Set the rocker cover LH, and tighten the bolts in numerical order as shown in the figure.

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

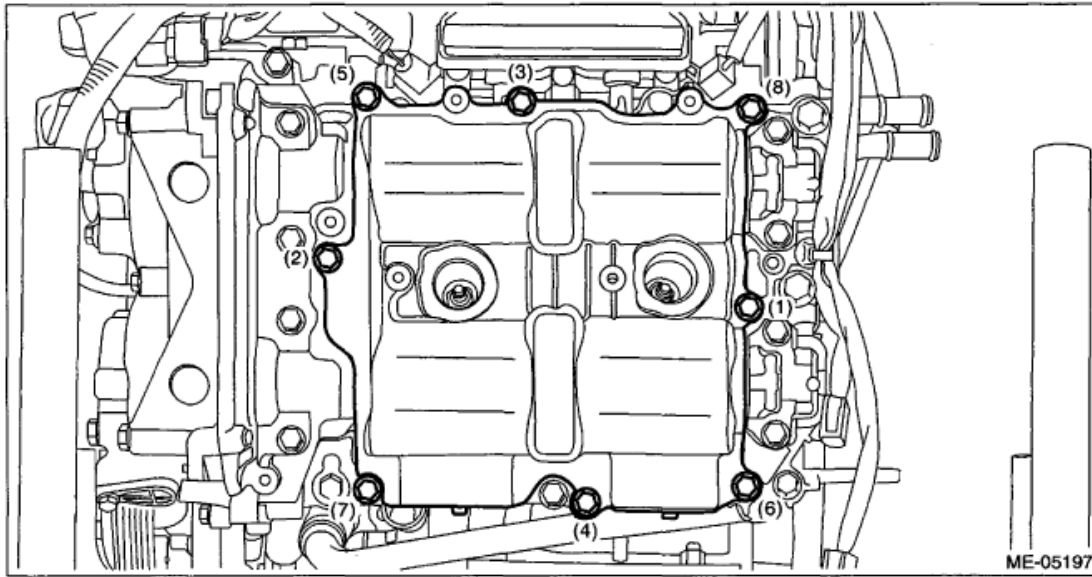


Fig. 209: Identifying Rocker Cover LH Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

6. Install the intake manifold protector LH.

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

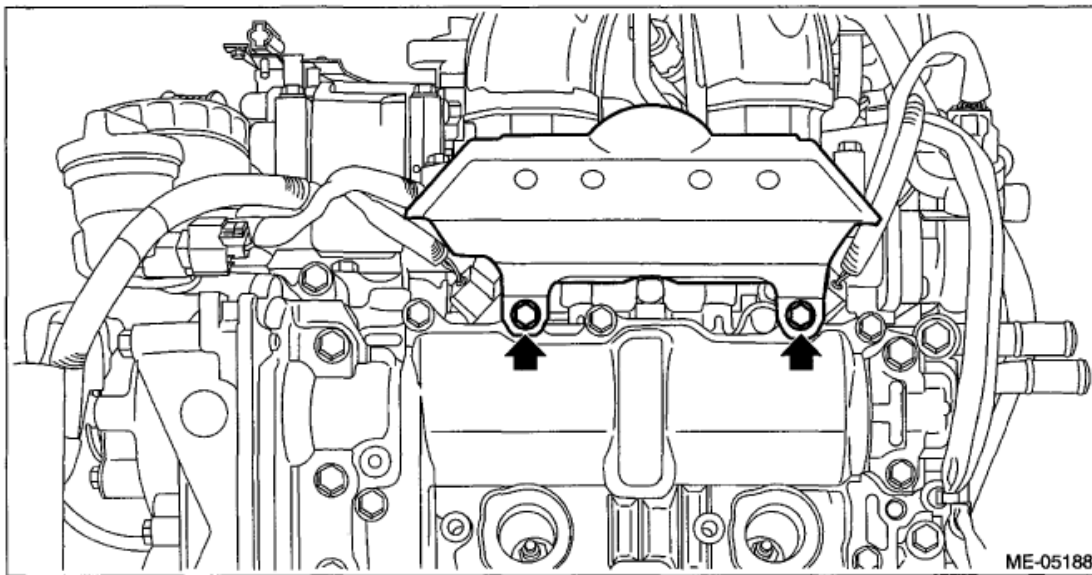


Fig. 210: Locating Intake Manifold Protector LH Bolts
 Courtesy of SUBARU OF AMERICA, INC.

7. Install the #2 ignition coil and the #4 ignition coil. < refer to **INSTALLATION** , Ignition Coil >
8. When working on the vehicle
 1. Install the air intake duct. < refer to **INSTALLATION** , Air Intake Duct >

2. Install the V-belt cover.

Tightening torque: 13 N.m (1.3 kgf-m, 9.6 ft-lb)

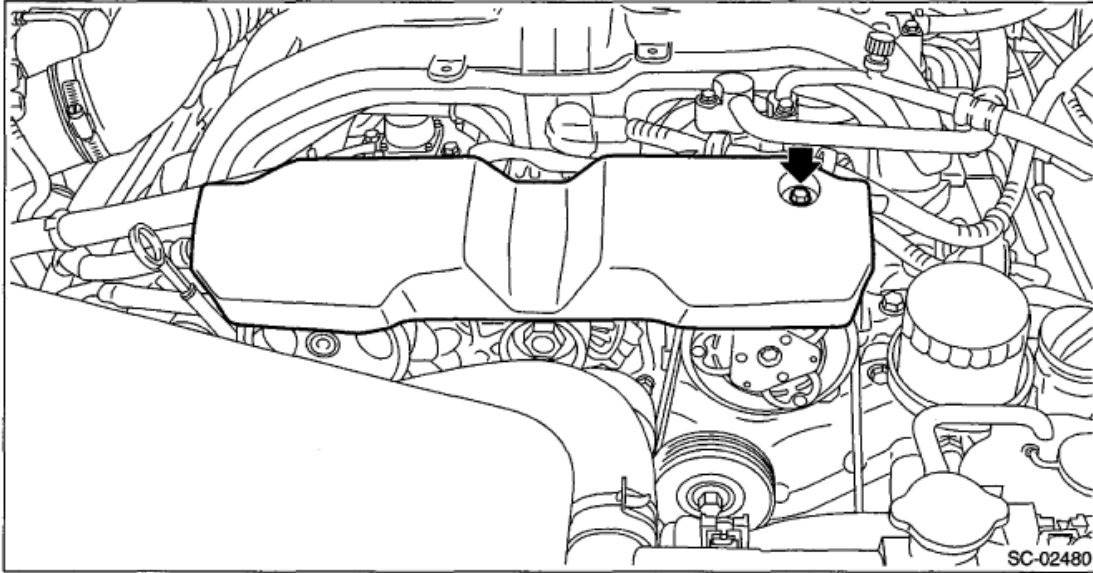


Fig. 211: Locating V-Belt Cover Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Install the battery. < refer to **INSTALLATION** , Battery >

INSPECTION

Check that the rocker cover does not have deformation, cracks and any other damage.

CAMSHAFT

REMOVAL

CAMSHAFT RH

The camshaft RH and cam carrier are designed as removing as a unit. Refer to "Cam Carrier" for removal procedures of camshaft RH. < refer to **CAM CARRIER RH**, REMOVAL, Cam Carrier > < refer to **CAM CARRIER RH**, DISASSEMBLY, Cam Carrier >

CAMSHAFT LH

The camshaft LH and cam carrier are designed as removing as a unit. Refer to "Cam Carrier" for removal procedures of camshaft LH. < refer to **CAM CARRIER LH**, REMOVAL, Cam Carrier > < refer to **CAM CARRIER LH**, DISASSEMBLY, Cam Carrier >

INSTALLATION

CAMSHAFT RH

The camshaft RH and cam carrier are designed as installing as a unit. Refer to "Cam Carrier" for installation procedures of camshaft RH. < refer to **CAM CARRIER RH**, ASSEMBLY, Cam Carrier > < refer to **CAM CARRIER RH**, INSTALLATION, Cam Carrier >

CAMSHAFT LH

The camshaft LH and cam carrier are designed as installing as a unit. Refer to "Cam Carrier" for installation procedures of camshaft LH. < refer to **CAM CARRIER LH**, ASSEMBLY, Cam Carrier > < refer to **CAM CARRIER LH**, INSTALLATION, Cam Carrier >

CAM CARRIER

REMOVAL

CAM CARRIER RH

1. Remove the engine from the vehicle. < refer to **REMOVAL**, Engine Assembly >
2. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
3. Remove the timing chain RH. < refer to **TIMING CHAIN RH**, REMOVAL, Timing Chain Assembly >
4. Remove the cam sprocket RH. < refer to **CAM SPROCKET RH**, REMOVAL, Cam Sprocket >

NOTE: This procedure is required only when disassembling the cam carrier RH.

5. Remove the rocker cover RH. < refer to **ROCKER COVER RH**, REMOVAL, Rocker Cover >
6. Remove the clip holding the engine harness from cam carrier RH.

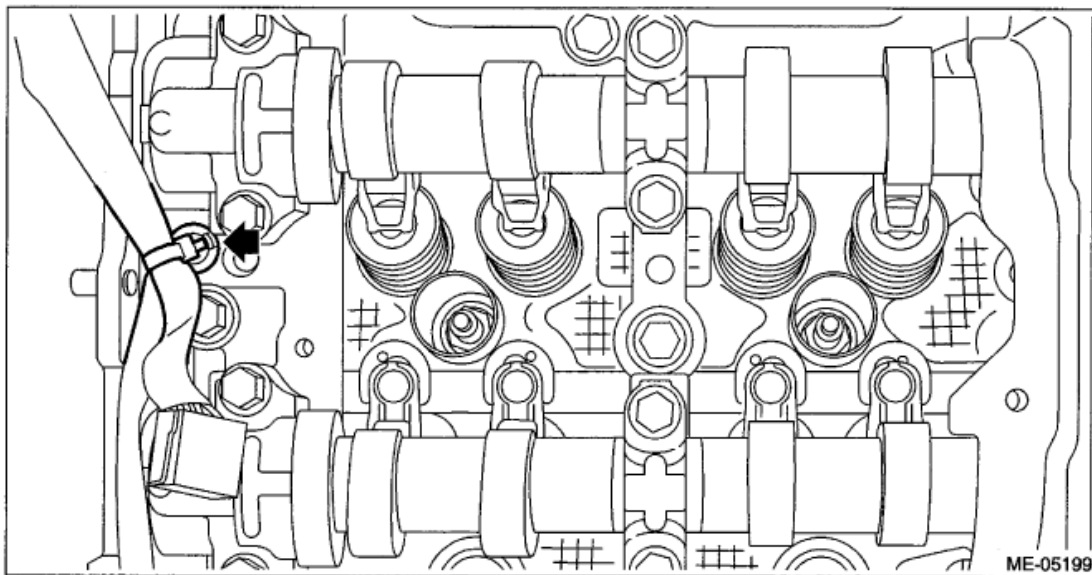


Fig. 212: Locating Cam Carrier RH Engine Harness Clip

Courtesy of SUBARU OF AMERICA, INC.

7. Remove the fuel pipe RH and the fuel injector RH.
 1. Disconnect the connector from fuel injector RH.

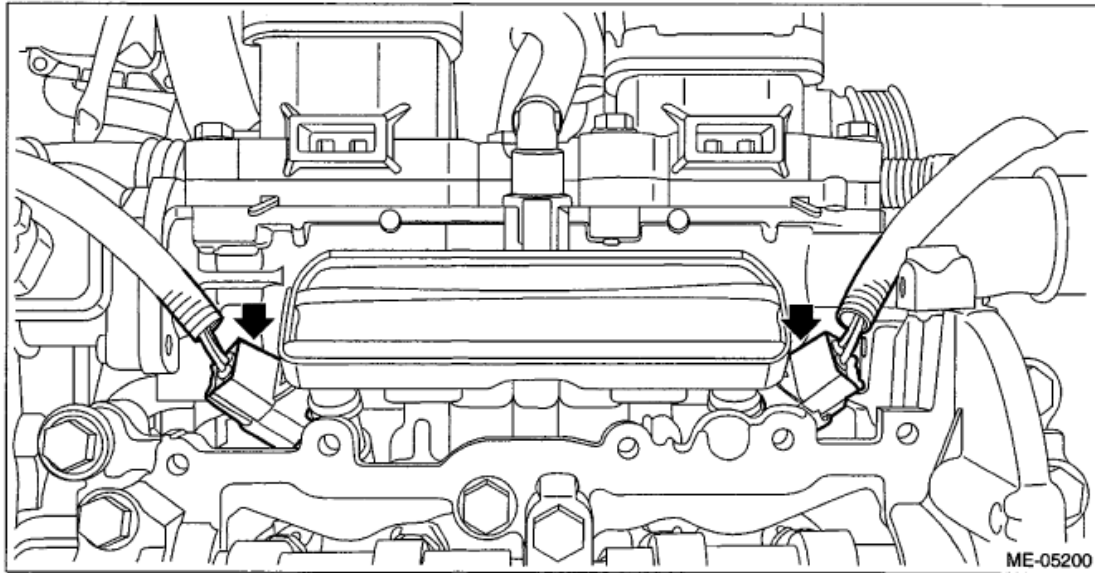
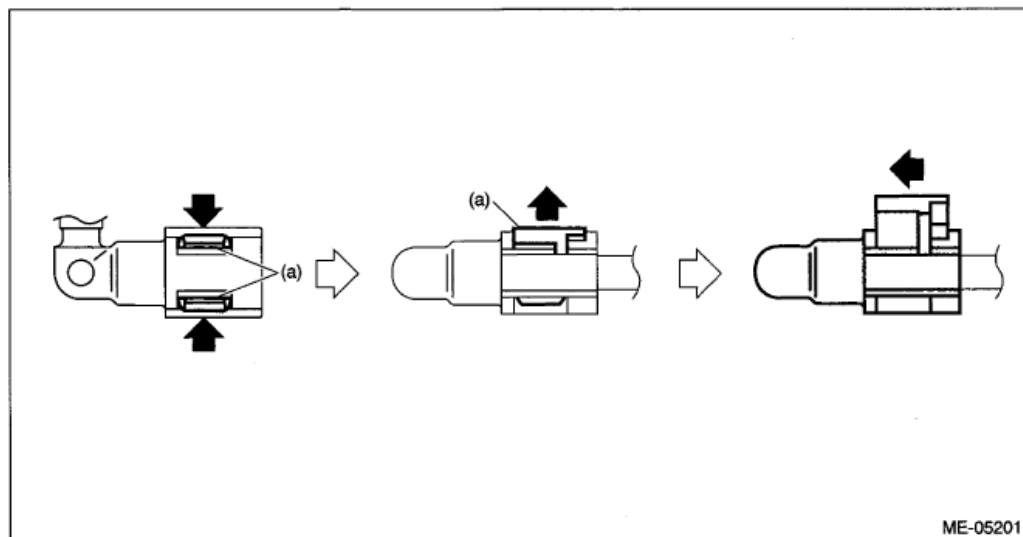


Fig. 213: Locating Fuel Injector RH Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Disconnect the quick connector from fuel pipe RH.

NOTE: Disconnect the quick connector as shown in the figure.



(a) Slider

Fig. 214: Disconnecting Quick Connector From Fuel Pipe RH

Courtesy of SUBARU OF AMERICA, INC.

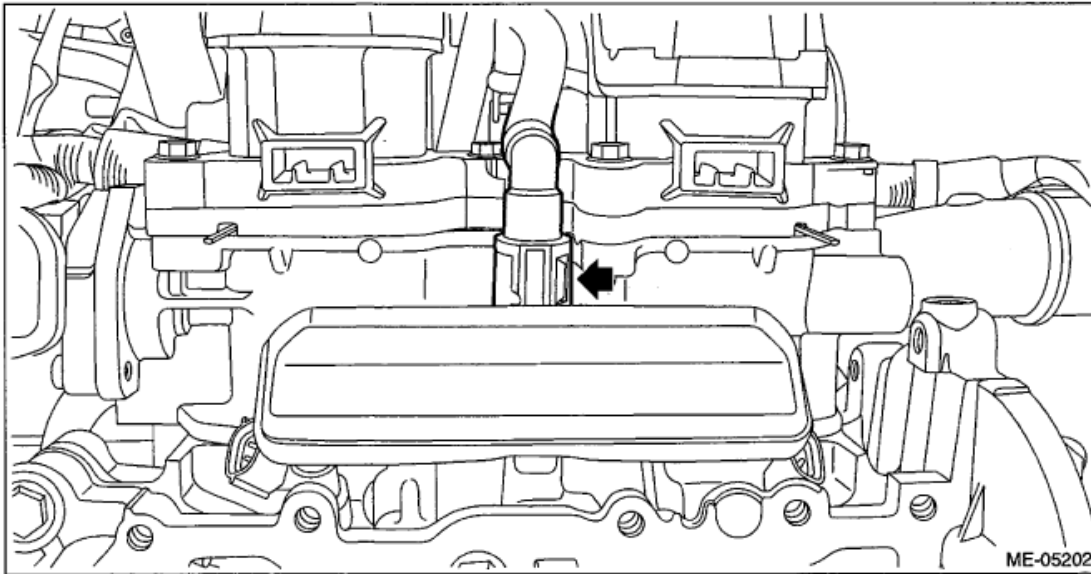


Fig. 215: Locating Fuel Pipe RH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the bolts securing the fuel pipe RH, and remove the fuel pipe RH and the fuel injector RH.

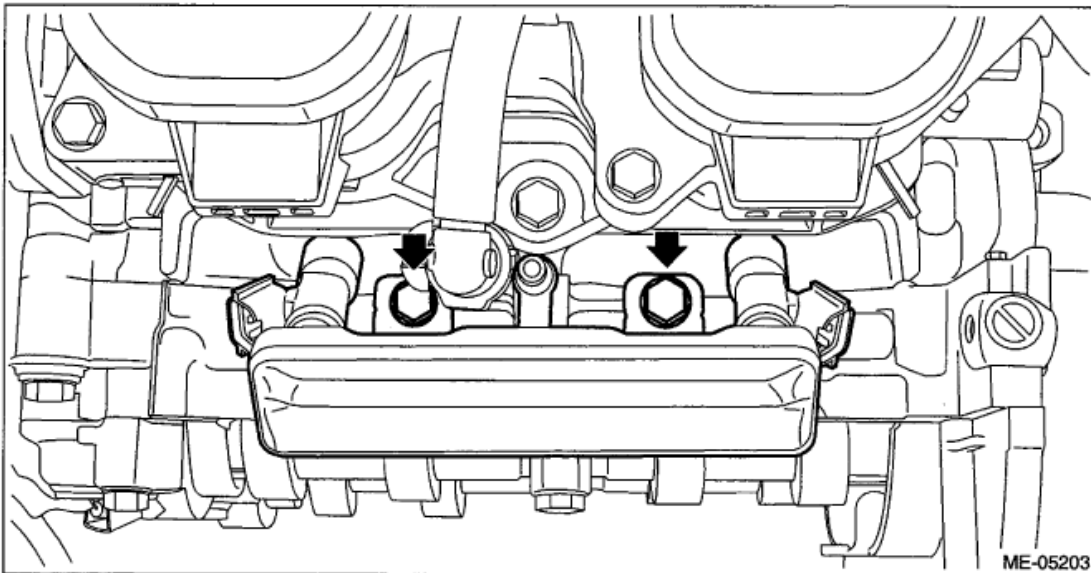


Fig. 216: Locating Fuel Pipe RH And Fuel Injector RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

8. Insert the steel rods into ST, and set the engine so that the camshaft RH is facing up.

CAUTION: • If the engine is standing on one side without inserting the steel

rod into ST, engine may lose balance and fall down. Be sure to insert the steel rod into ST to extend the length.

- Use the steel rod with enough strength.
- Be careful not to pinch the engine harness with ST.

ST 499817100 ENGINE STAND

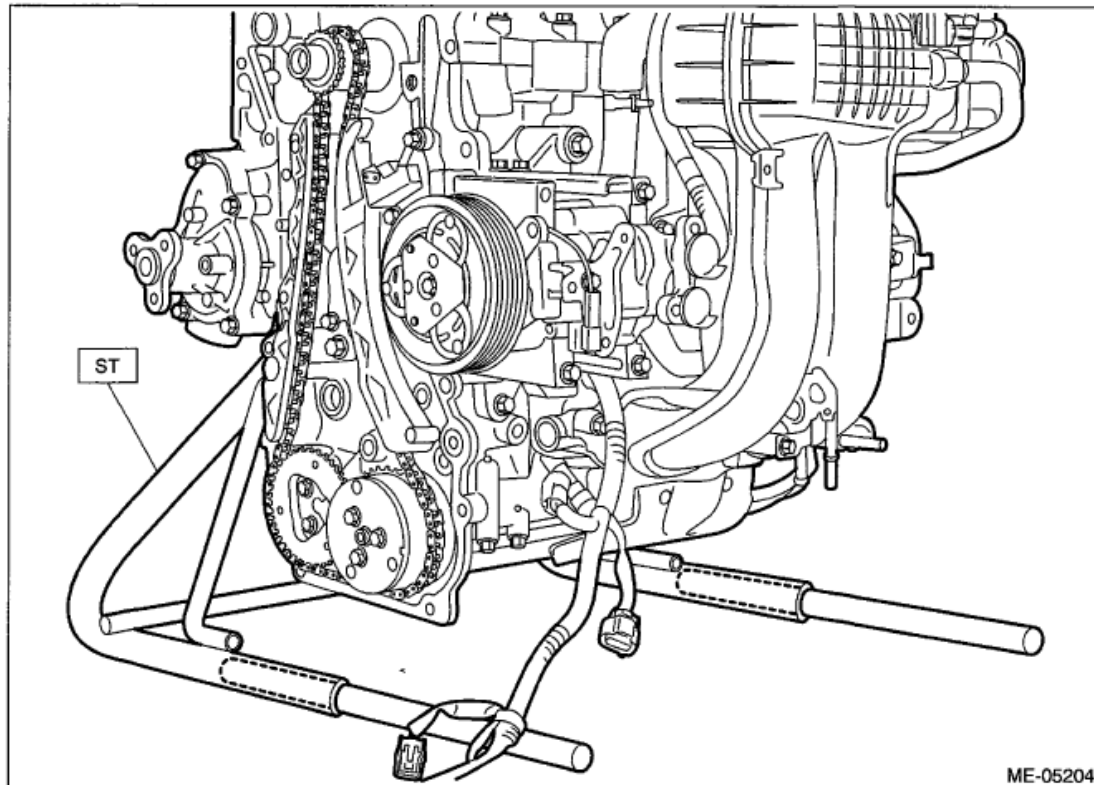


Fig. 217: Inserting Steel Rods Into ST
Courtesy of SUBARU OF AMERICA, INC.

9. Loosen the bolts holding the cam carrier RH equally, a little at a time in numerical sequence and remove the cam carrier RH.

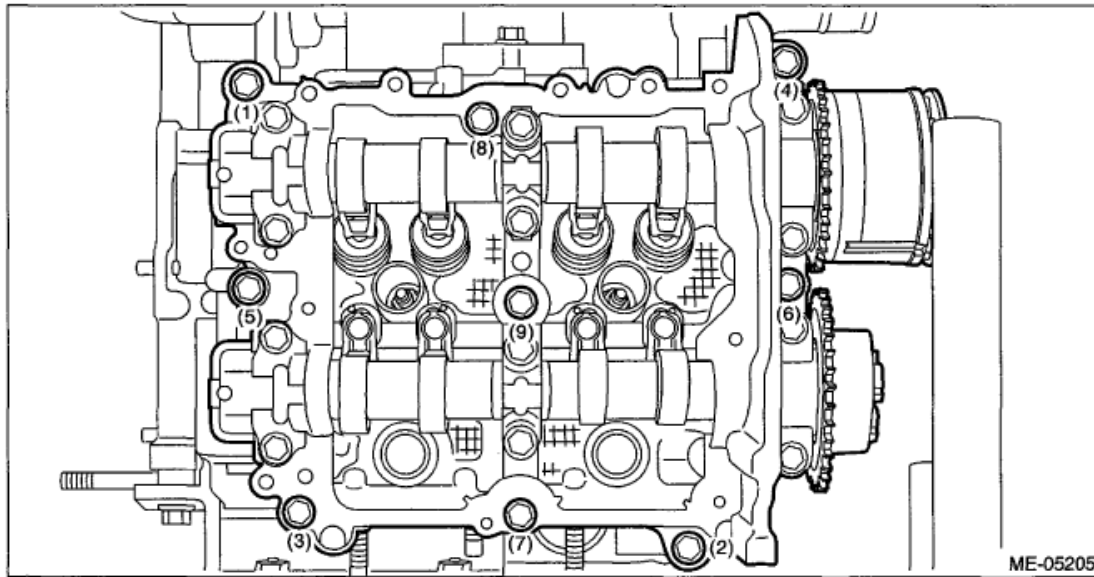


Fig. 218: Identifying Cam Carrier RH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the O-ring and the roller rocker arm from cylinder head RH.

NOTE: Be careful not to confuse the roller rocker arms.

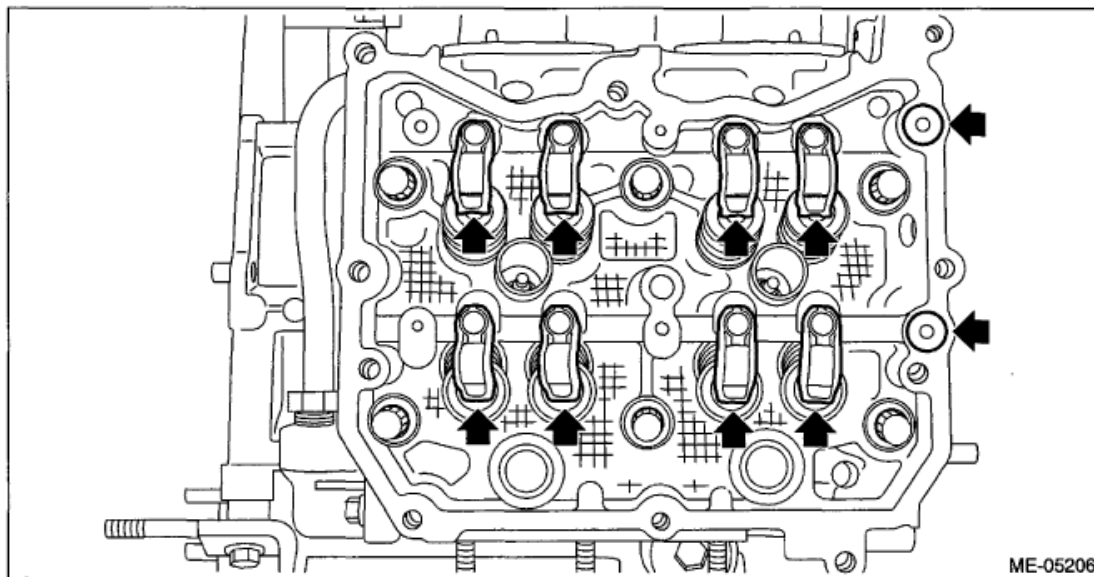


Fig. 219: Locating O-Ring And Roller Rocker Arm Of Cylinder Head RH
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the valve shim and the roller rocker arm pivot from cylinder head RH.

NOTE: Be careful not to confuse the valve shim and the roller rocker arm pivot.

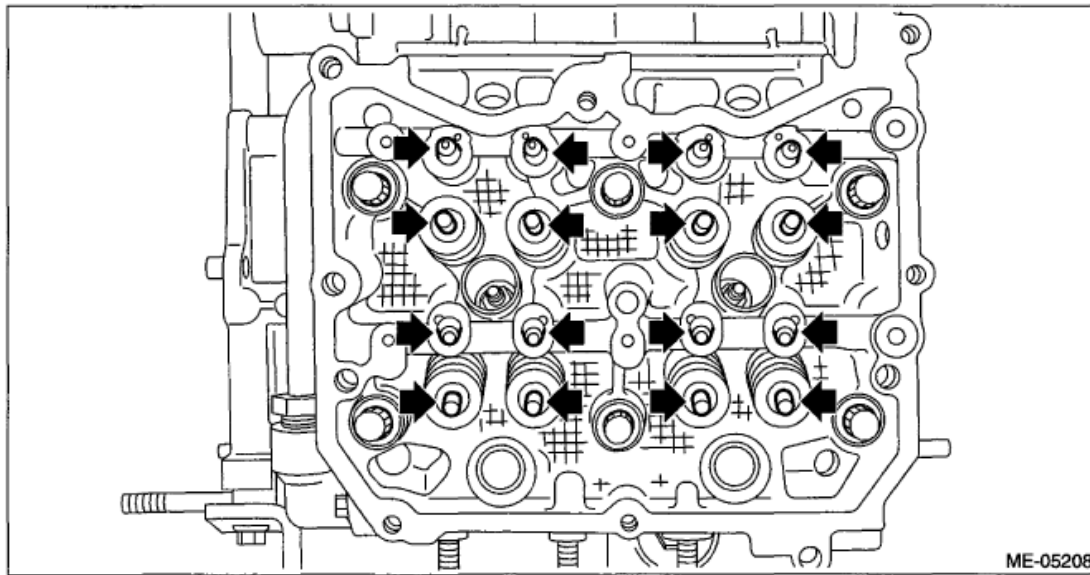


Fig. 220: Locating Valve Shim And Roller Rocker Arm Pivot Of Cylinder Head RH
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the liquid gasket from cam carrier RH and cylinder head RH.

CAM CARRIER LH

1. Remove the engine from the vehicle. < refer to **REMOVAL**, Engine Assembly >
2. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
3. Remove the timing chain LH. < refer to **TIMING CHAIN LH**, REMOVAL, Timing Chain Assembly >
4. Remove the cam sprocket LH. < refer to **CAM SPROCKET LH**, REMOVAL, Cam Sprocket >

NOTE: This procedure is required only when disassembling the cam carrier LH.

5. Remove the rocker cover LH. < refer to **ROCKER COVER LH**, REMOVAL, Rocker Cover >
6. Remove the clip holding the engine harness from cam carrier LH.

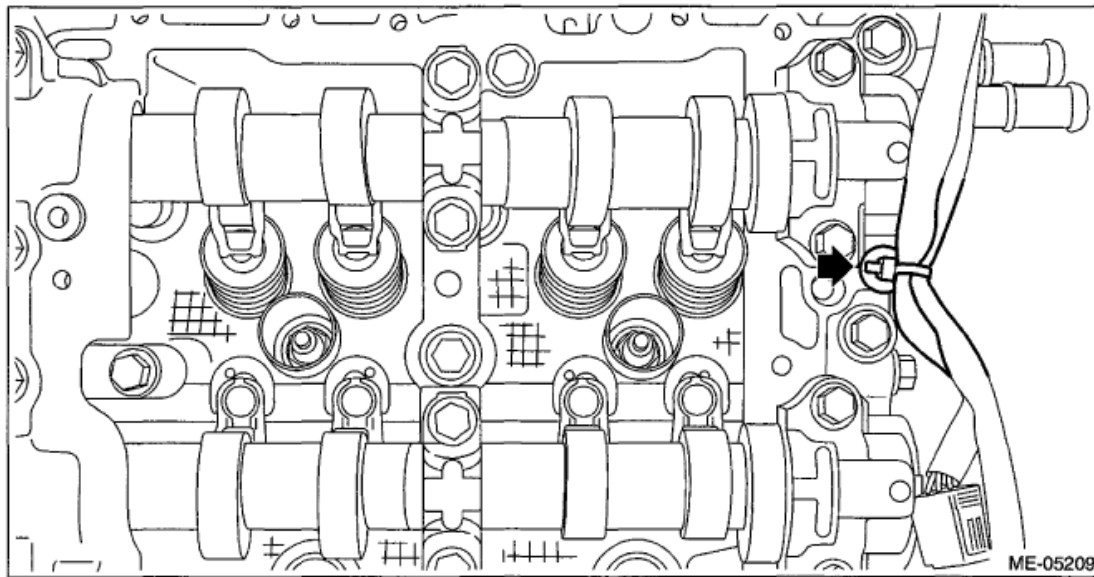


Fig. 221: Locating Cam Carrier LH Engine Harness Clip
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the preheater hose from intake manifold clip (A), and disconnect the preheater hose from throttle body.

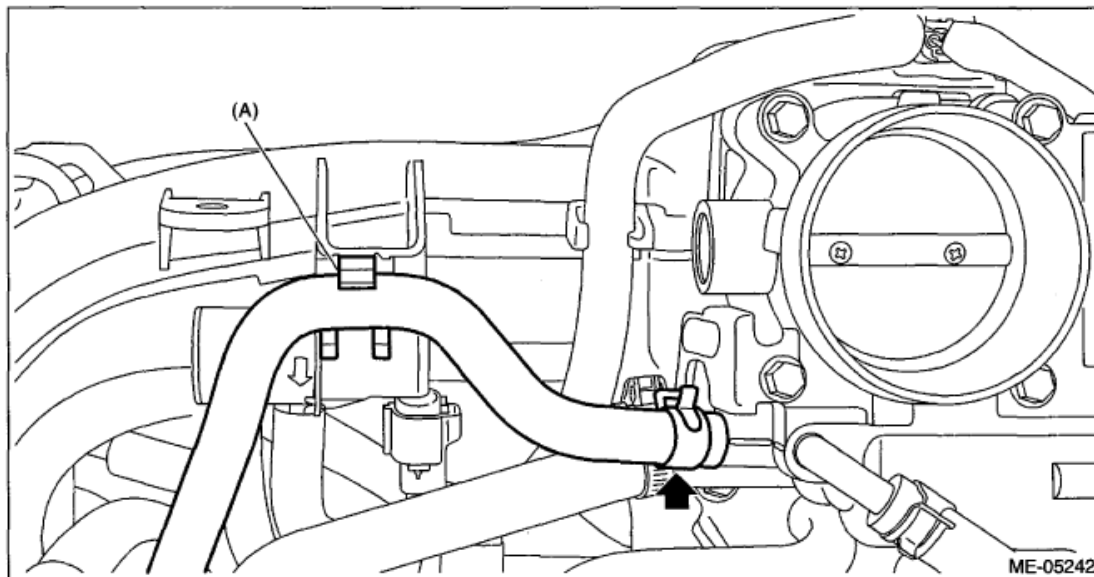


Fig. 222: Locating Intake Manifold Preheater Hose Clip
Courtesy of SUBARU OF AMERICA, INC.

8. Disconnect the water pipe hose from oil pan upper, and remove the water pipe assembly.

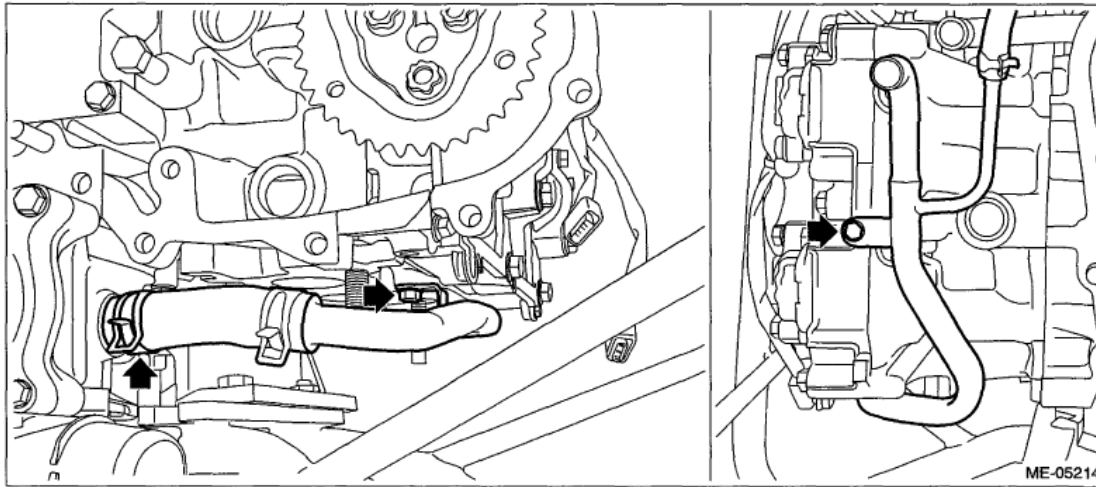


Fig. 223: Locating Water Pipe Hose Clamp And Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. Remove the fuel pipe LH and the fuel injector LH.
 1. Disconnect the connector from fuel injector LH.

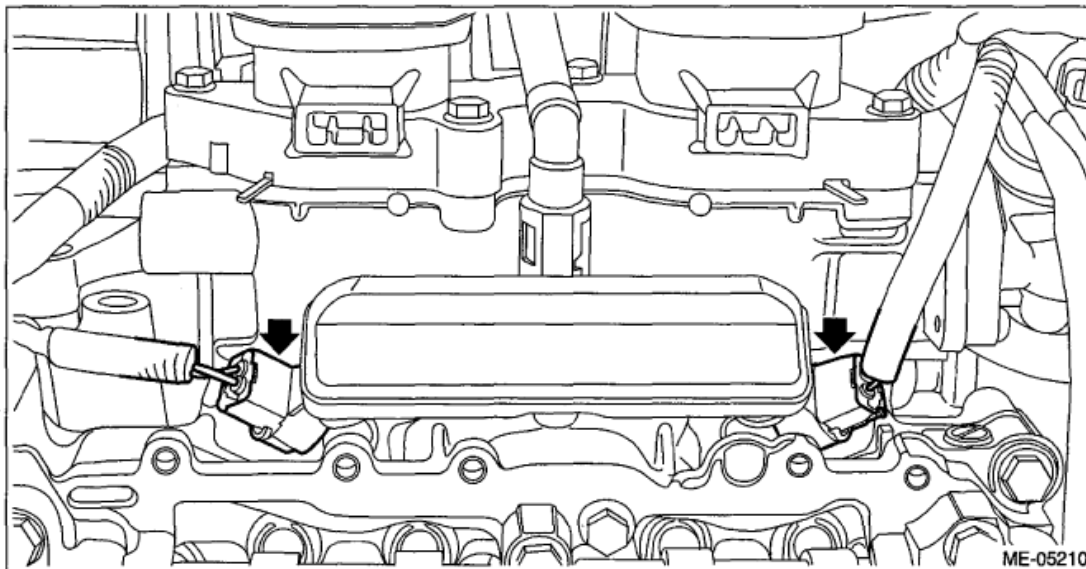
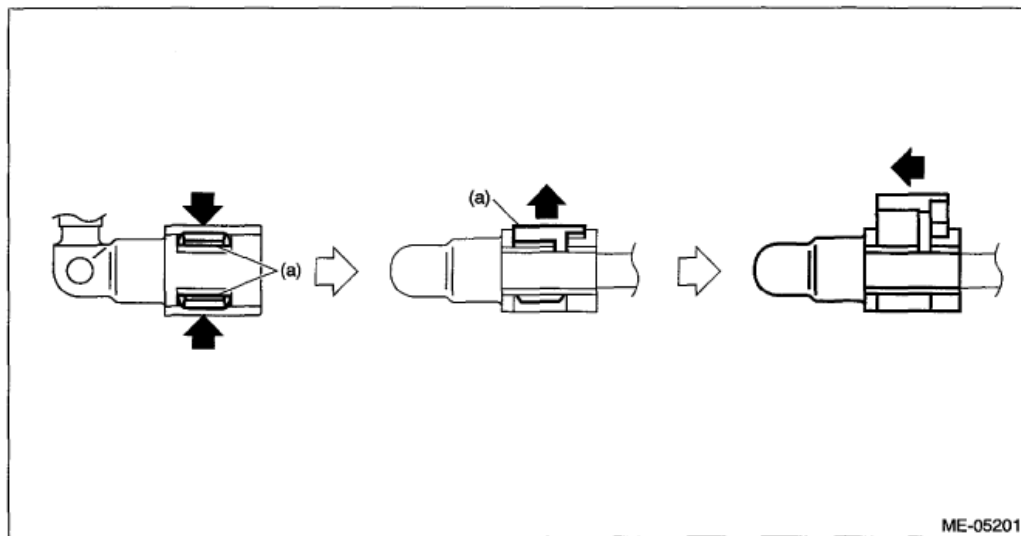


Fig. 224: Locating Fuel Injector LH Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Disconnect the quick connector from fuel pipe LH.

NOTE: **Disconnect the quick connector as shown in the figure.**



(a) Slider

Fig. 225: Disconnecting Fuel Pipe LH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

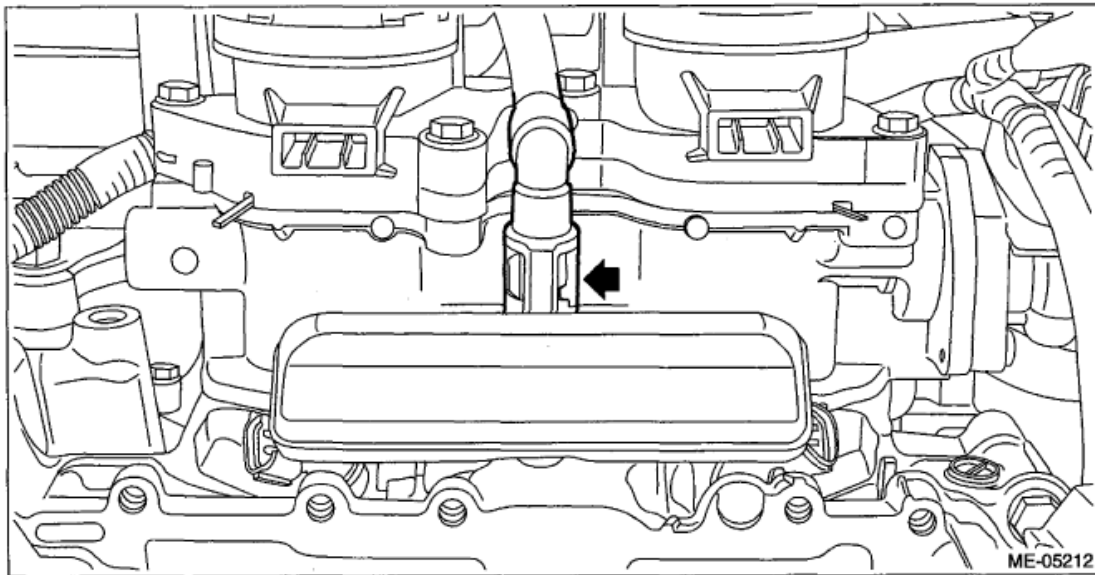


Fig. 226: Locating Fuel Pipe LH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the bolts securing the fuel pipe LH, and remove the fuel pipe LH and the fuel injector LH.

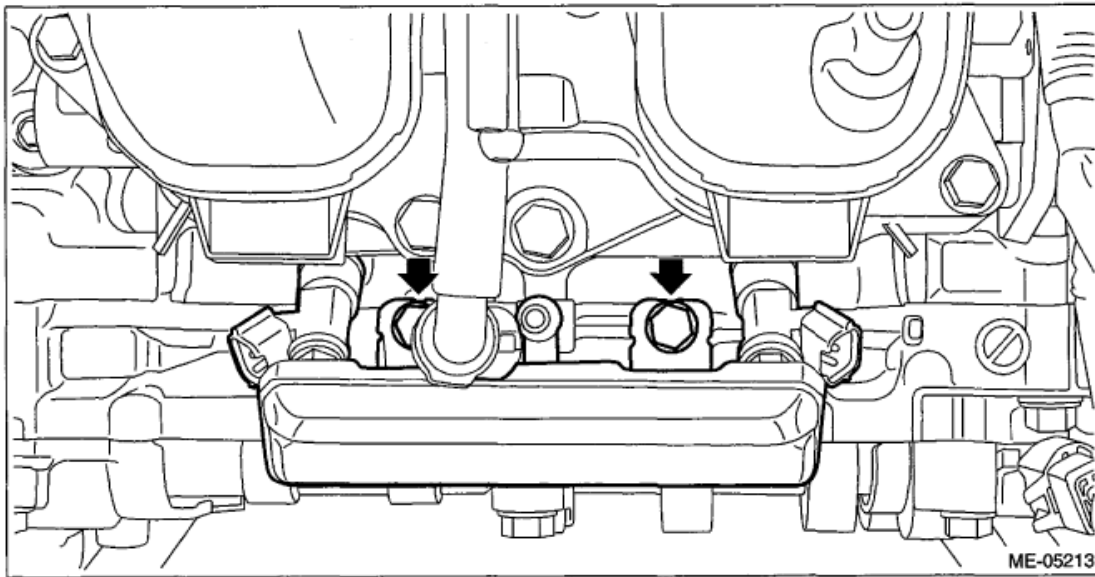


Fig. 227: Locating Fuel Pipe LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

10. Insert the steel rods into ST, and set the engine so that the camshaft LH is facing up.

CAUTION:

- If the engine is standing on one side without inserting the steel rod into ST, engine may lose balance and fall down. Be sure to insert the steel rod into ST to extend the length.
- Use the steel rod with enough strength.
- Be careful not to pinch the engine harness with ST.

ST 499817100 ENGINE STAND

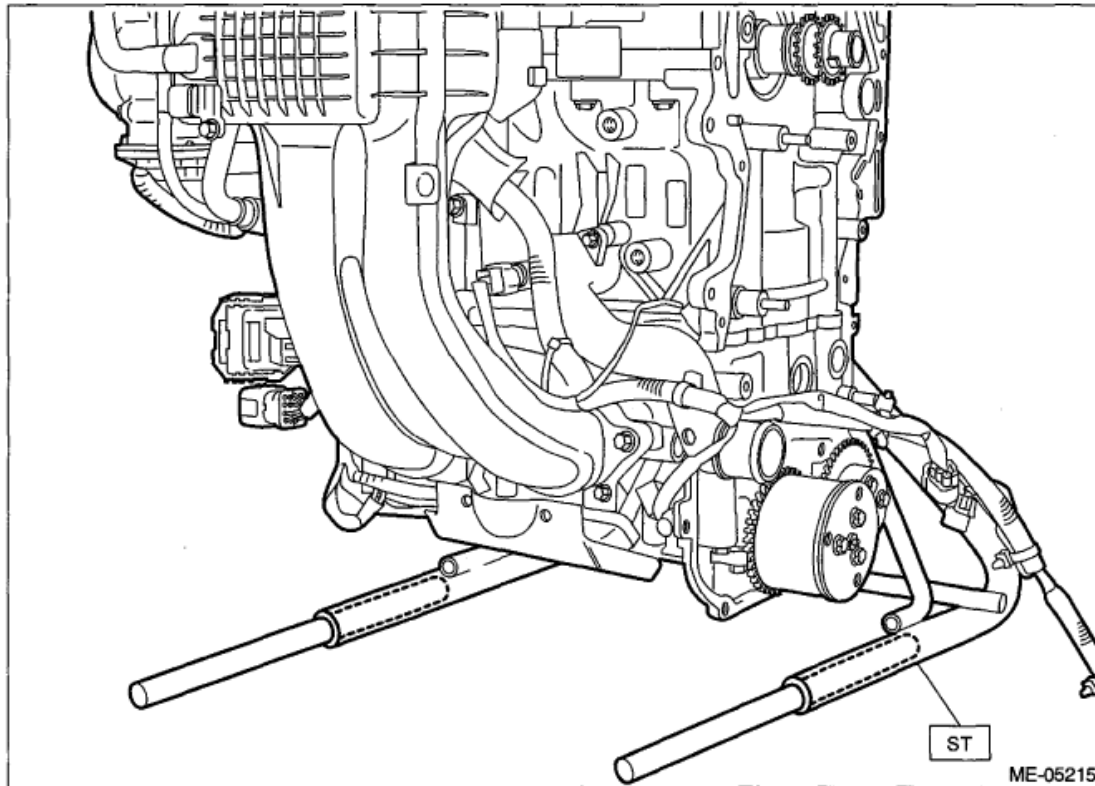


Fig. 228: Inserting Steel Rods Into ST
Courtesy of SUBARU OF AMERICA, INC.

11. Loosen the bolts holding the cam carrier LH equally, a little at a time in numerical sequence and remove the cam carrier LH.

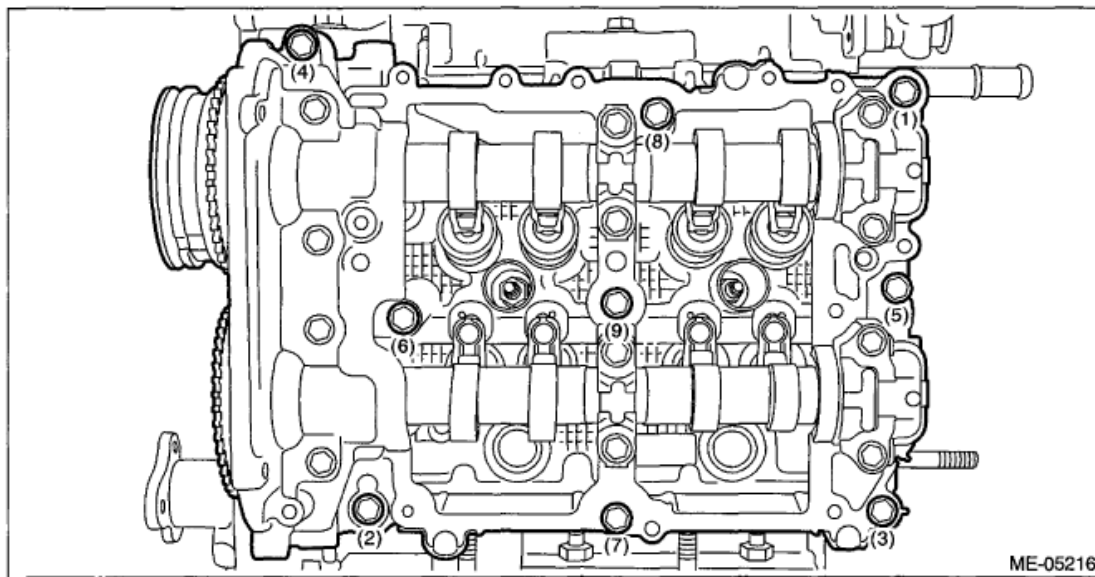


Fig. 229: Identifying Cam Carrier LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the O-ring and the roller rocker arm from cylinder head LH.

NOTE: Be careful not to confuse the roller rocker arms.

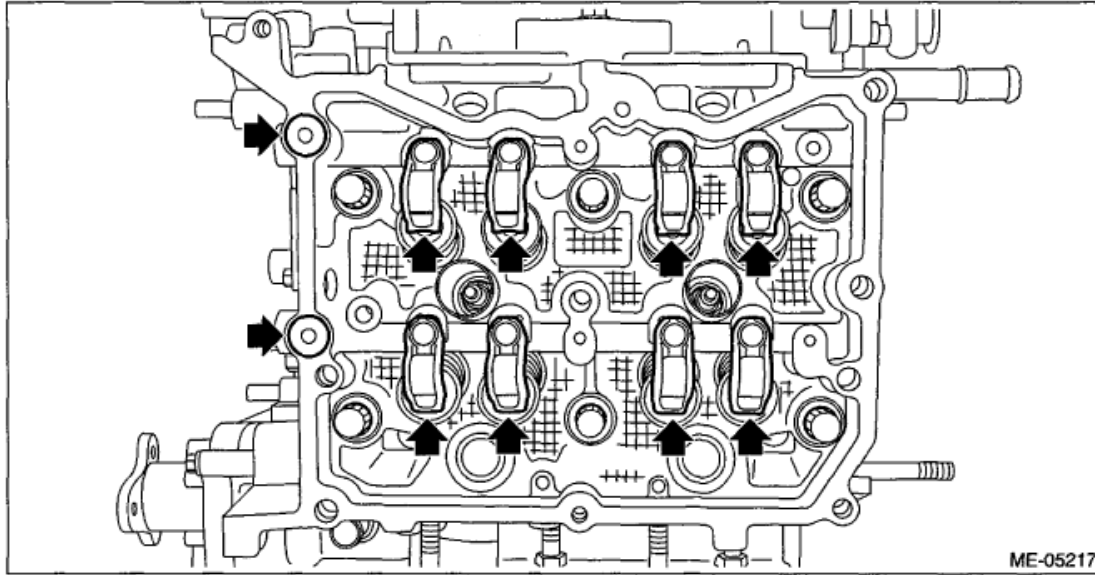


Fig. 230: Locating O-Ring And Roller Rocker Arm From Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the valve shim and the roller rocker arm pivot from cylinder head LH.

NOTE: Be careful not to confuse the valve shim and the roller rocker arm pivot.

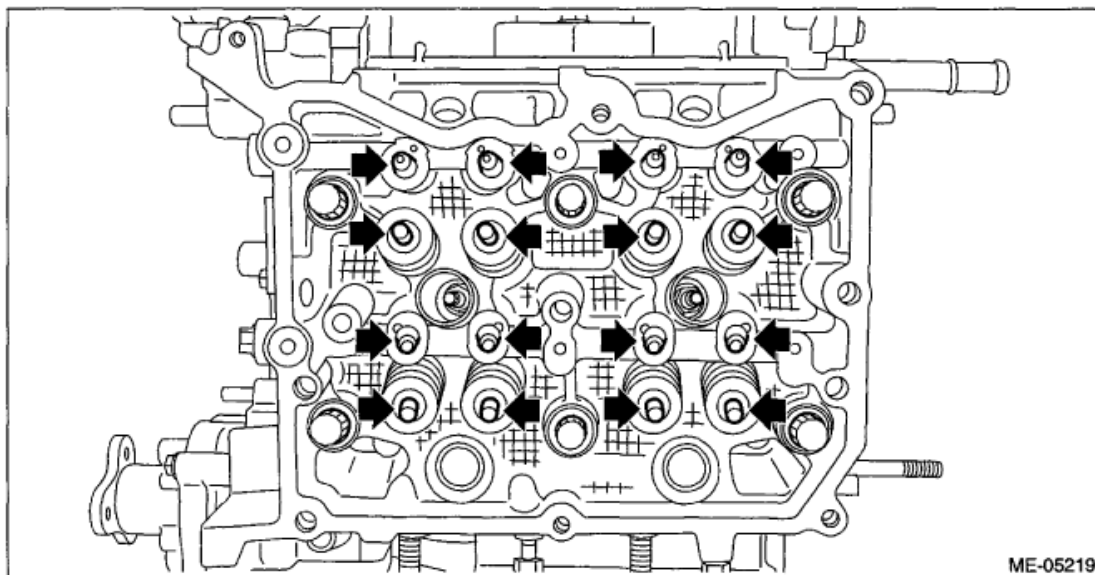


Fig. 231: Locating Valve Shim And Roller Rocker Arm Pivot Of Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the liquid gasket from cam carrier LH and cylinder head LH.

INSTALLATION

CAM CARRIER RH

1. Insert the steel rods into ST, and set the engine so that the camshaft RH is facing up.

CAUTION:

- If the engine is standing on one side without inserting the steel rod into ST, engine may lose balance and fall down. Be sure to insert the steel rod into ST to extend the length.
- Use the steel rod with enough strength.
- Be careful not to pinch the engine harness with ST.

ST 499817100 ENGINE STAND

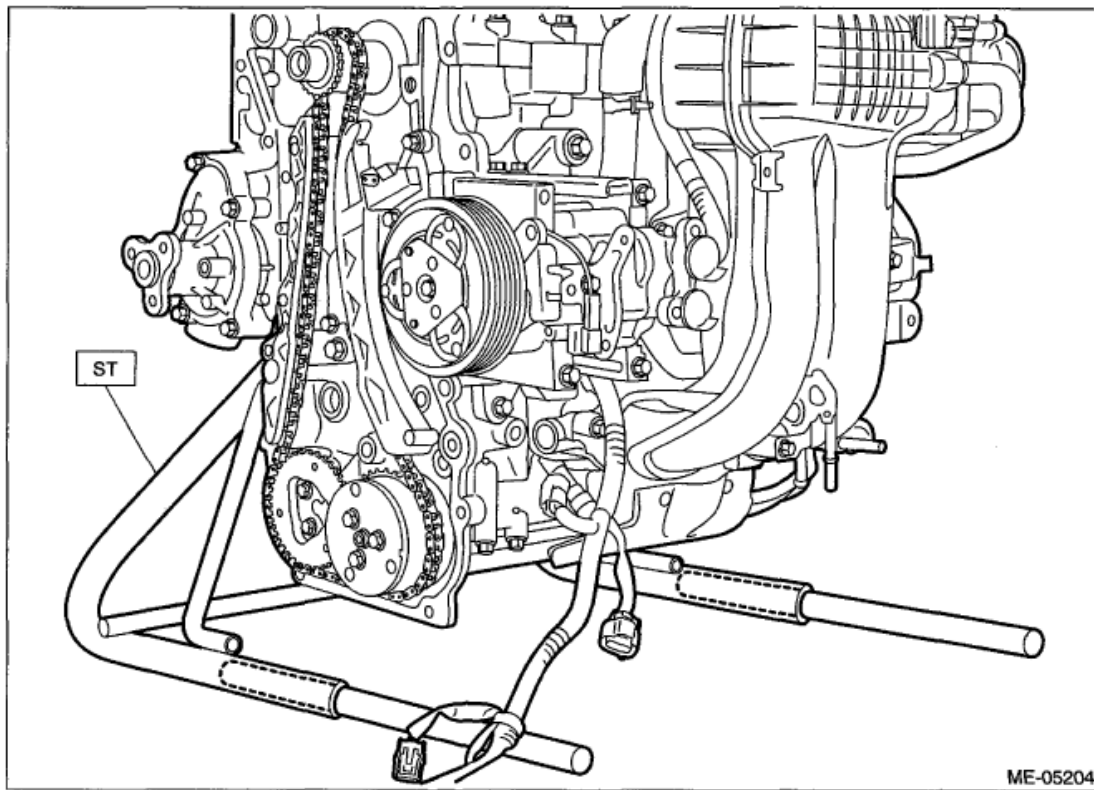


Fig. 232: Inserting Steel Rods Into ST
Courtesy of SUBARU OF AMERICA, INC.

2. Apply engine oil to the valve shim and the roller rocker arm pivot, and install the valve shim and the roller rocker arm pivot to the cylinder head RH.

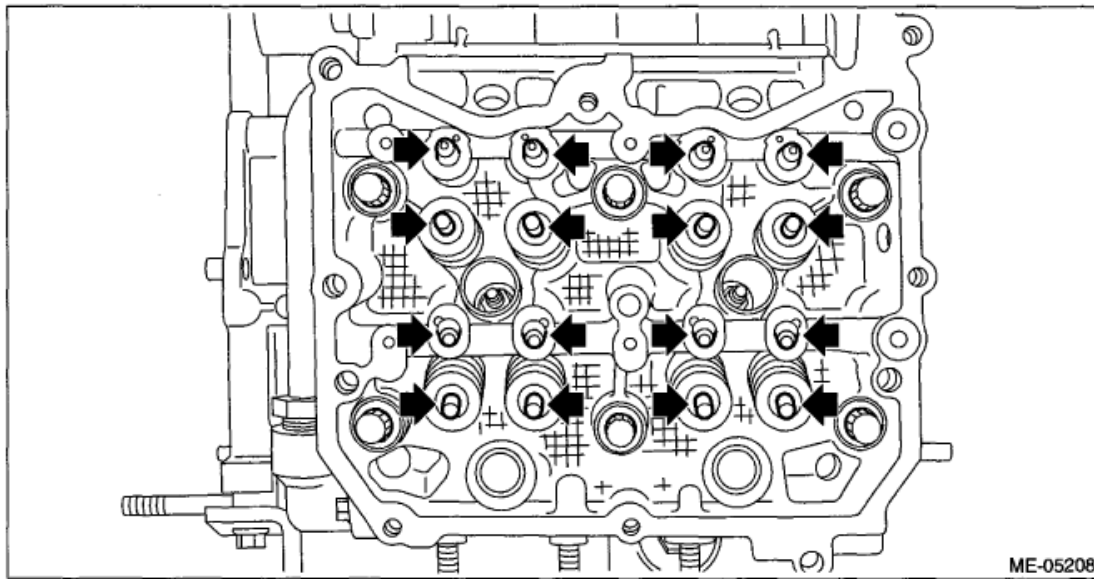


Fig. 233: Locating Valve Shim And Roller Rocker Arm Pivot Of Cylinder Head RH
Courtesy of SUBARU OF AMERICA, INC.

3. Apply engine oil to the O-ring and the roller rocker arm, and install the O-ring and the roller rocker arm to the cylinder head RH.

NOTE: Use new O-rings.

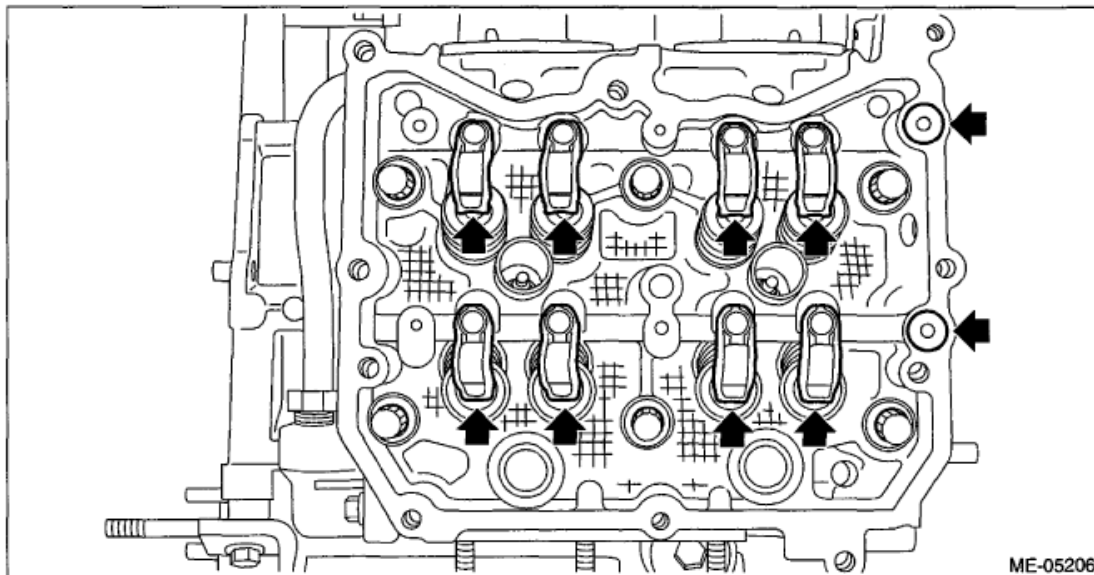


Fig. 234: Locating O-Ring And Roller Rocker Arm Of Cylinder Head RH
Courtesy of SUBARU OF AMERICA, INC.

4. Apply liquid gasket to the mating surface of cam carrier RH as shown in the figure.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the cylinder head RH and the cam carrier RH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket: THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter: 2.5 ± 0.5 mm (0.0984 ± 0.0197 in)

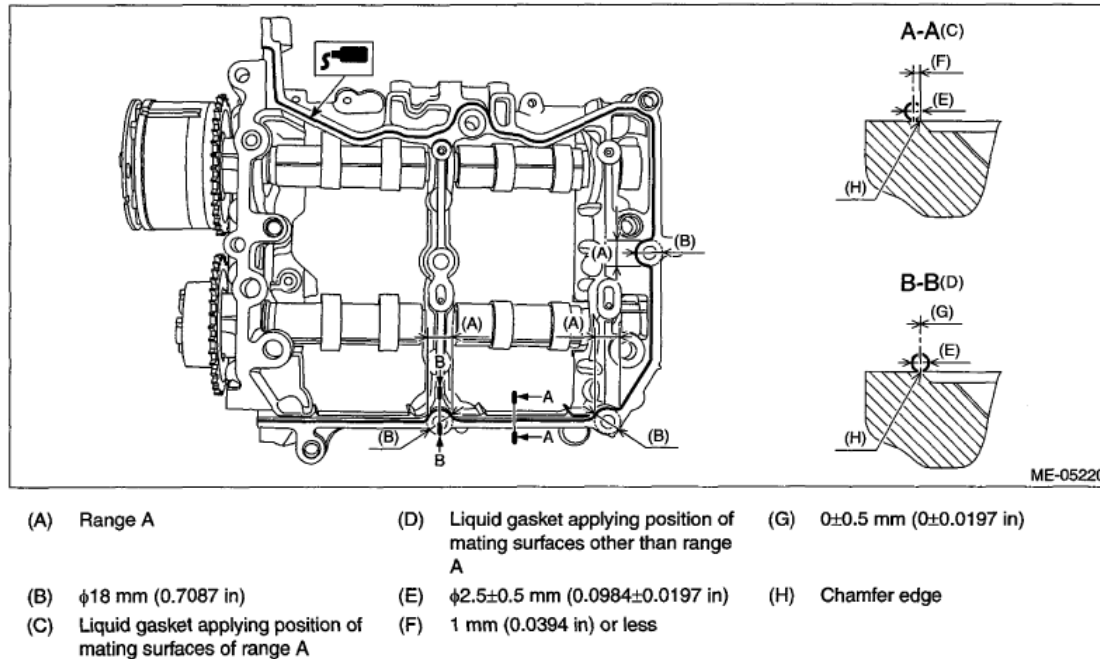


Fig. 235: Identifying Liquid Gasket Applying Area On Mating Surface Of Cam Carrier RH
Courtesy of SUBARU OF AMERICA, INC.

5. Install the cam carrier RH to the cylinder head RH.

1. Mount the cam carrier RH, then tighten all bolts with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

NOTE:

Set the intake camshaft RH and the exhaust camshaft RH to the zero-lift position.

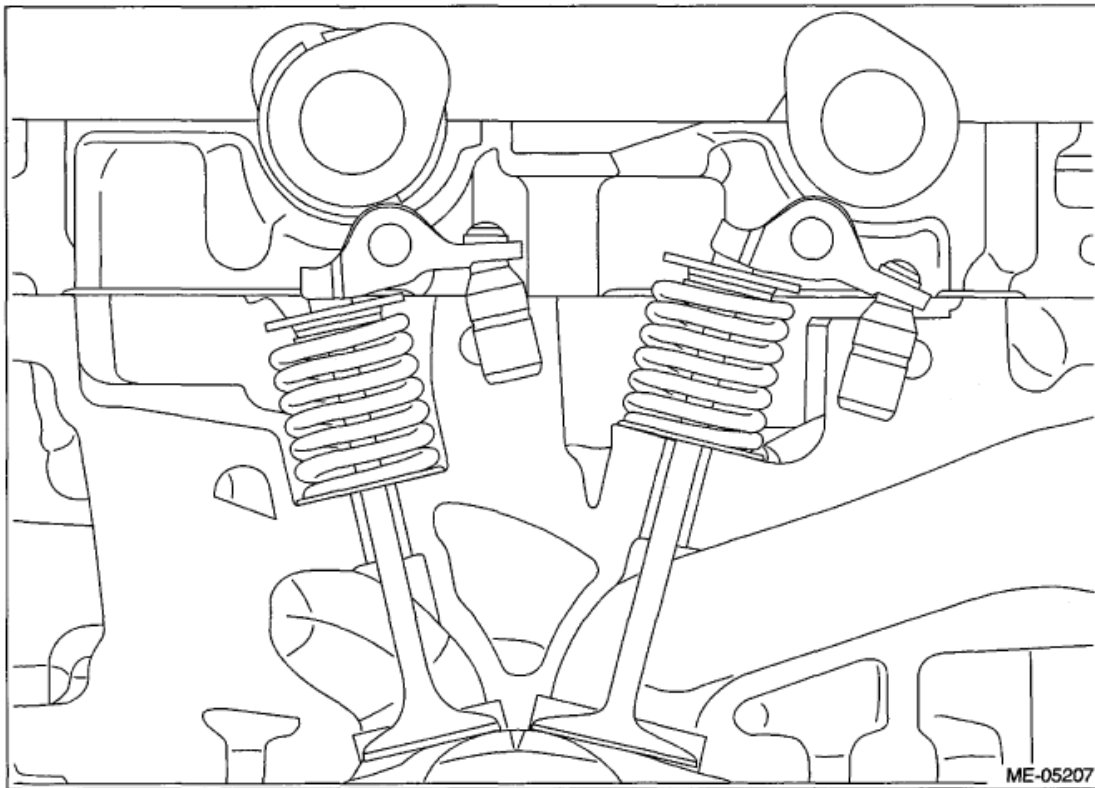


Fig. 236: Identifying Cam Carrier RH
 Courtesy of SUBARU OF AMERICA, INC.

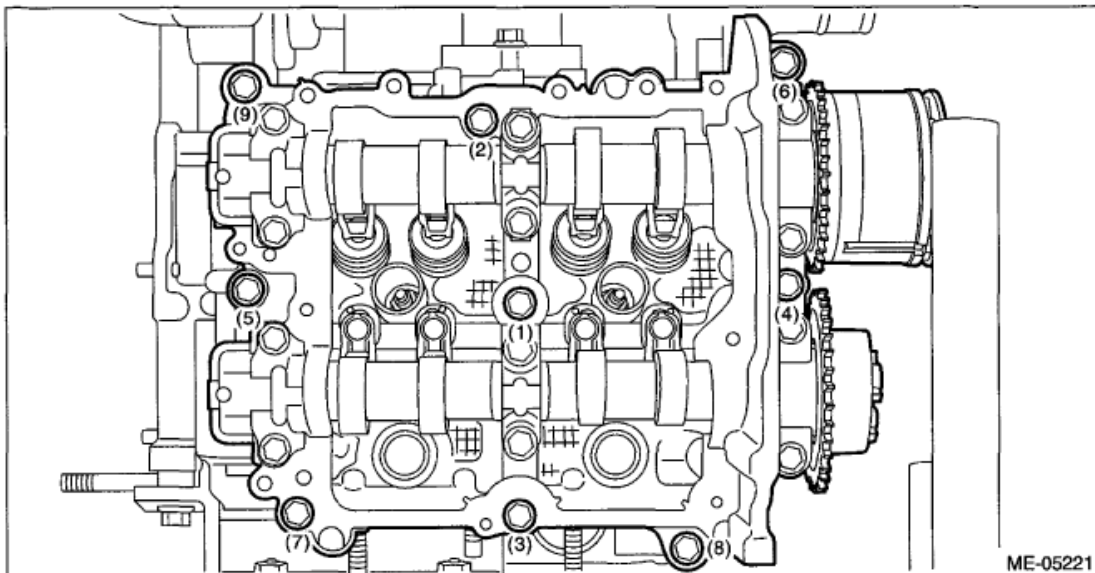


Fig. 237: Identifying Cam Carrier RH Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

2. Loosen the bolts (3 places) by 180° in numerical order as shown in the figure.

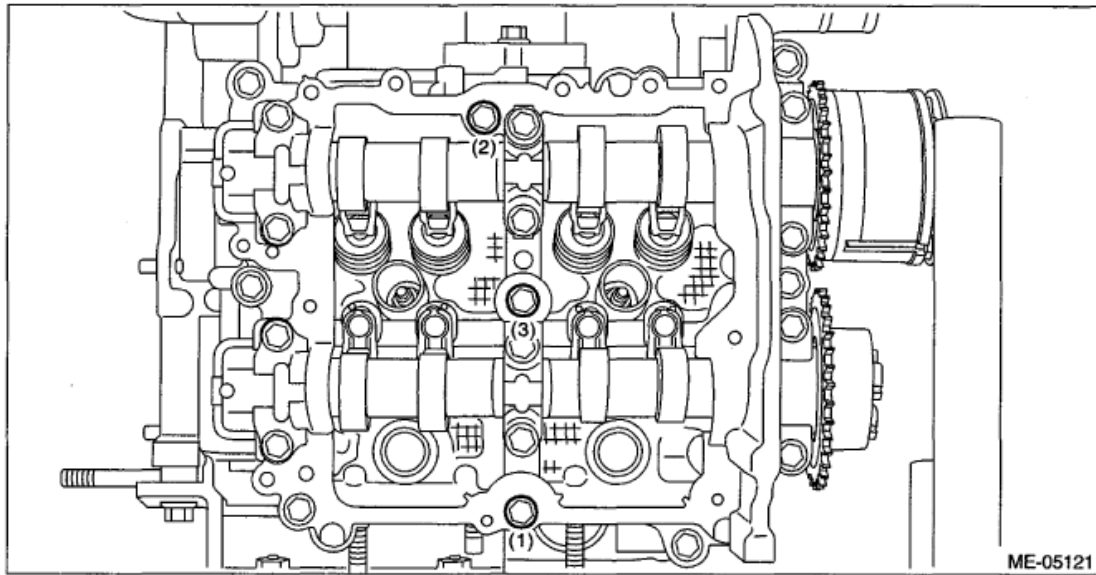


Fig. 238: Identifying Cam Carrier RH Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts (3 places) with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

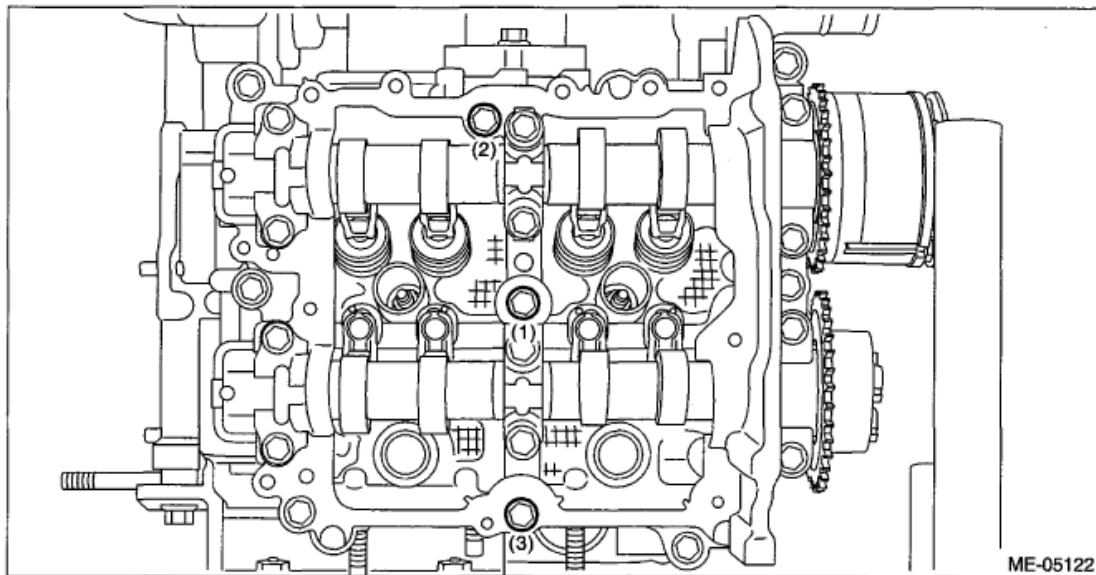


Fig. 239: Identifying Cam Carrier RH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. Loosen the bolts (3 places) by 180° in numerical order as shown in the figure.

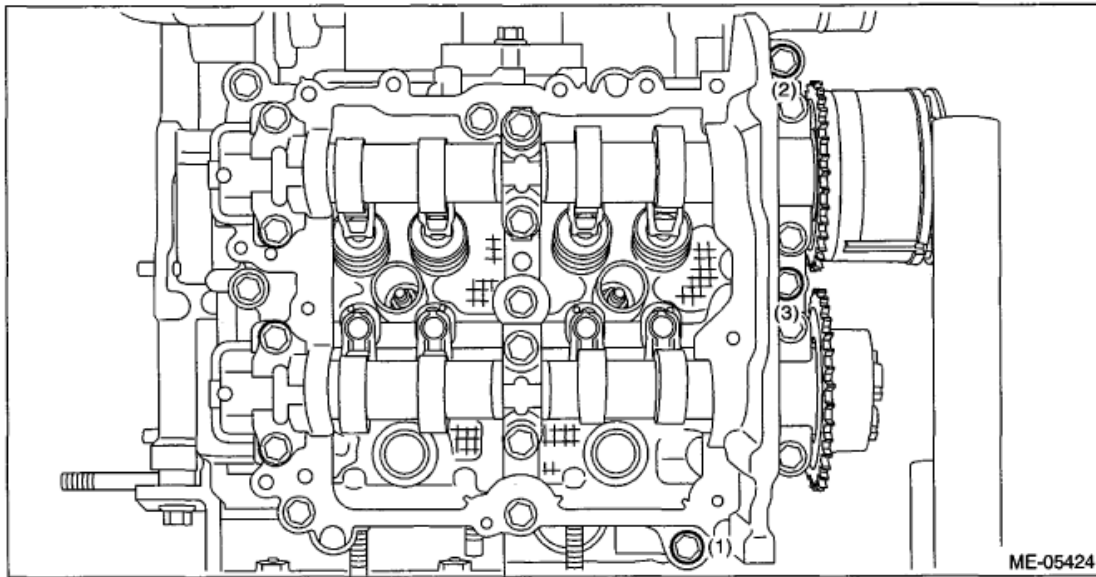


Fig. 240: Identifying Cam Carrier RH Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

5. Tighten the bolts (3 places) with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

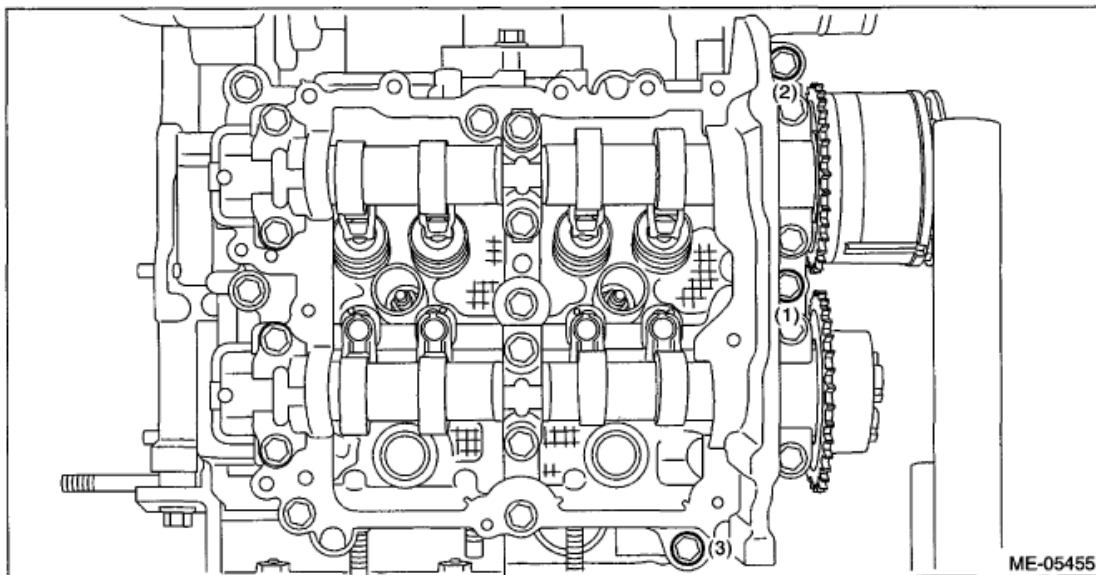


Fig. 241: Identifying Cam Carrier RH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Loosen the bolts (3 places) by 180° in numerical order as shown in the figure.

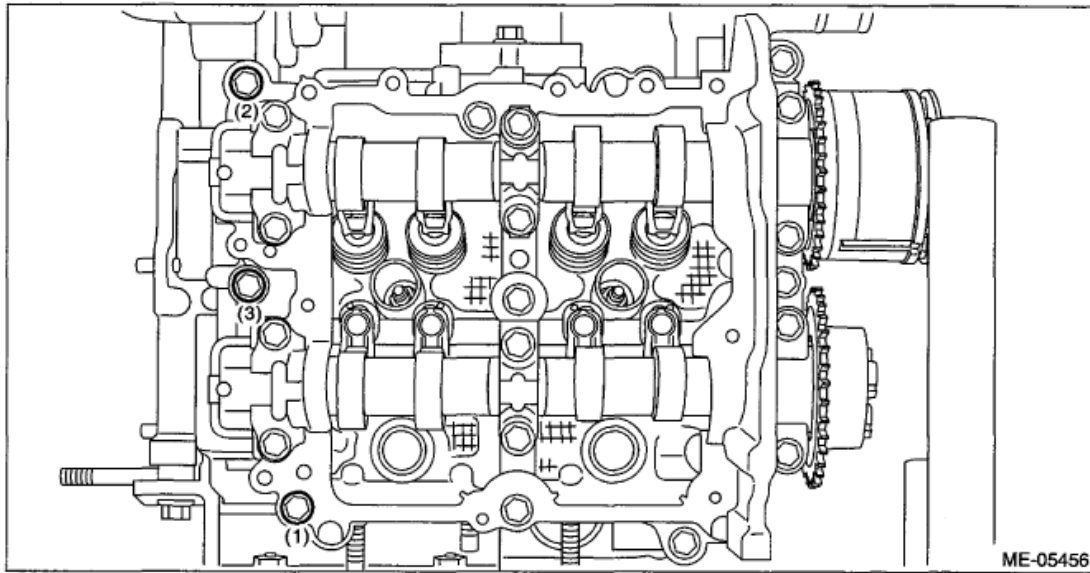


Fig. 242: Identifying Cam Carrier RH Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten the bolts (3 places) with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

NOTE: After tightening, if the liquid gasket is squeezed out onto the seal surface of the chain cover, completely remove any squeezed-out liquid gasket.

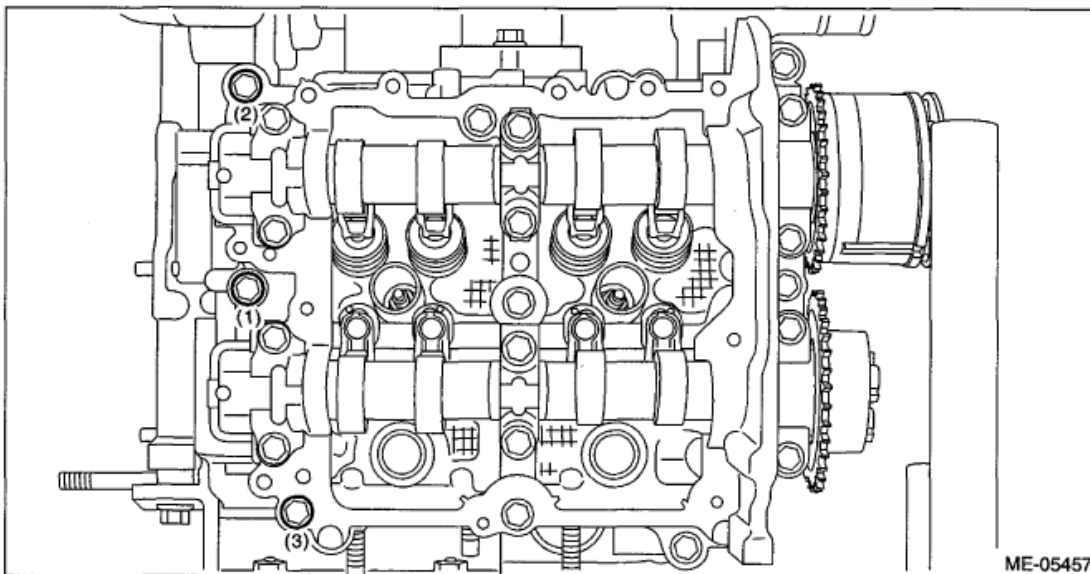


Fig. 243: Identifying Cam Carrier RH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Set the part so that the intake manifold is on the upper side.
7. Install the cam sprocket RH. < refer to **CAM SPROCKET RH**, INSTALLATION, Cam Sprocket >

NOTE: This procedure is required only when the cam carrier RH is removed for disassembly.

8. Check the cam clearance. < refer to **WHEN TIMING CHAIN ASSEMBLY IS REMOVED**, INSPECTION, Cam Clearance >
9. Install the timing chain RH. < refer to **TIMING CHAIN RH**, INSTALLATION, Timing Chain Assembly >
10. Install the fuel pipe RH and the fuel injector RH.
 1. Install the fuel pipe RH and the fuel injector RH, and install the bolts which secure the fuel pipe RH.

NOTE: Use new O-rings, rubbers and seal rings.

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

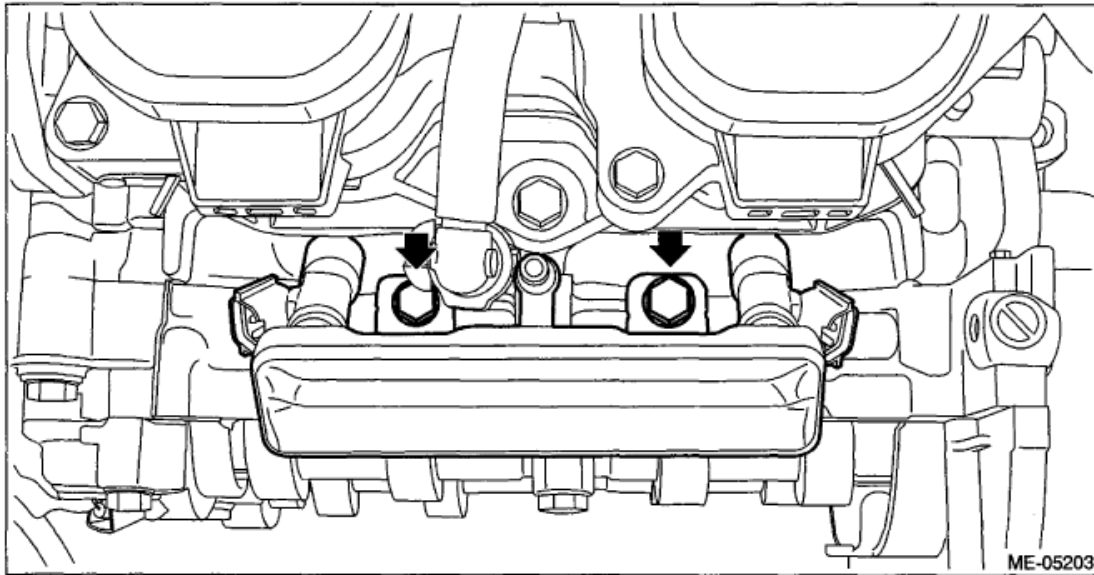


Fig. 244: Locating Fuel Pipe RH And Fuel Injector RH Bolts
Courtesy of SUBARU OF AMERICA, INC.

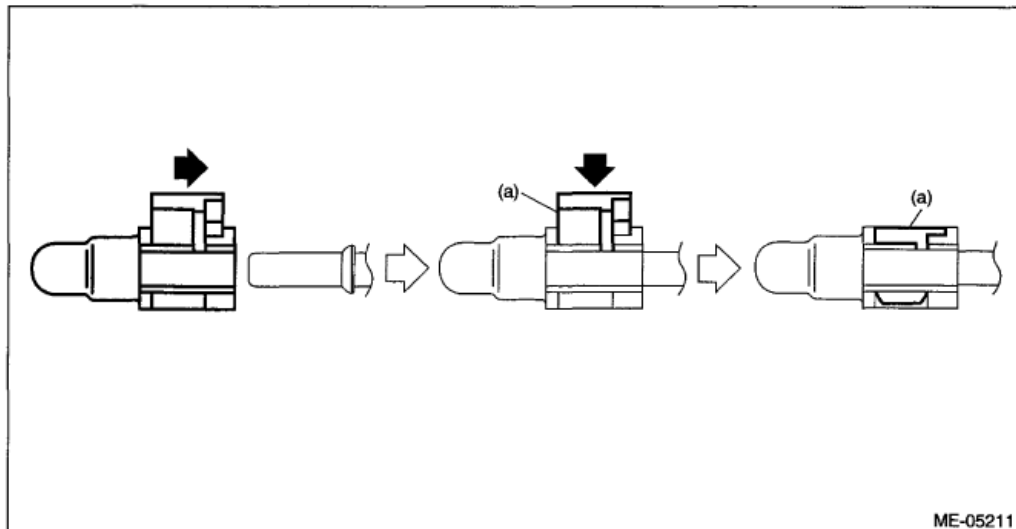
2. Connect the quick connector to the fuel pipe RH.

CAUTION:

- Check that there is no damage or dust on the quick connector. If necessary, clean the seal surface of the pipe.
- When connecting the quick connector, make sure to insert the pipe all the way in before locking the slider.

- If it is not possible to perform the push lock operation of the slider, recheck whether the pipe is securely inserted.
- Make sure that the quick connector is securely connected.

NOTE: Connect the quick connector as shown in the figure.



(a) Slider

Fig. 245: Connecting Quick Connector From Fuel Pipe RH
Courtesy of SUBARU OF AMERICA, INC.

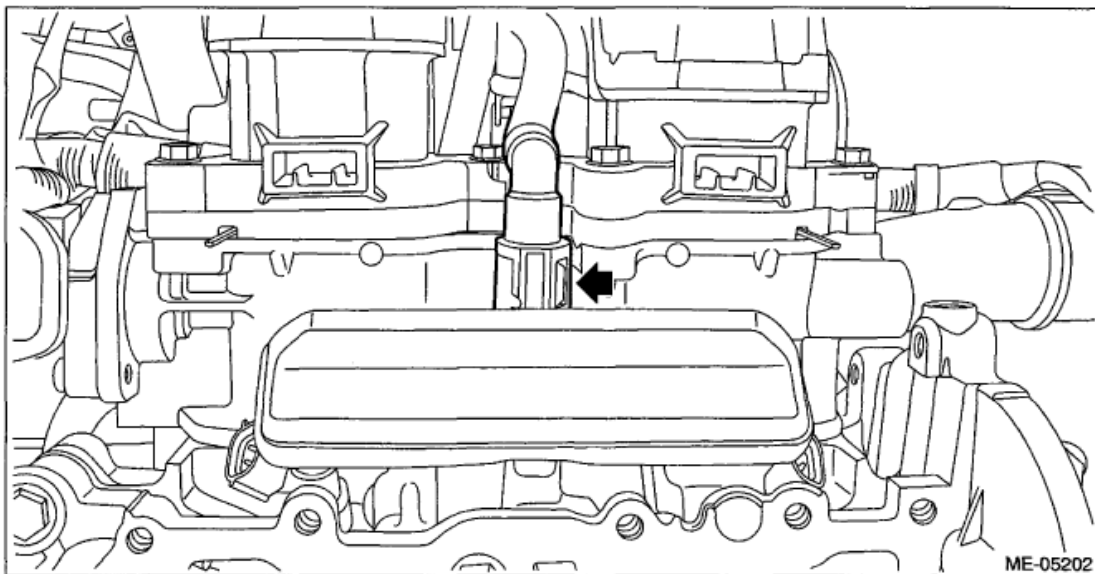


Fig. 246: Locating Fuel Pipe RH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the connectors to the fuel injector RH.

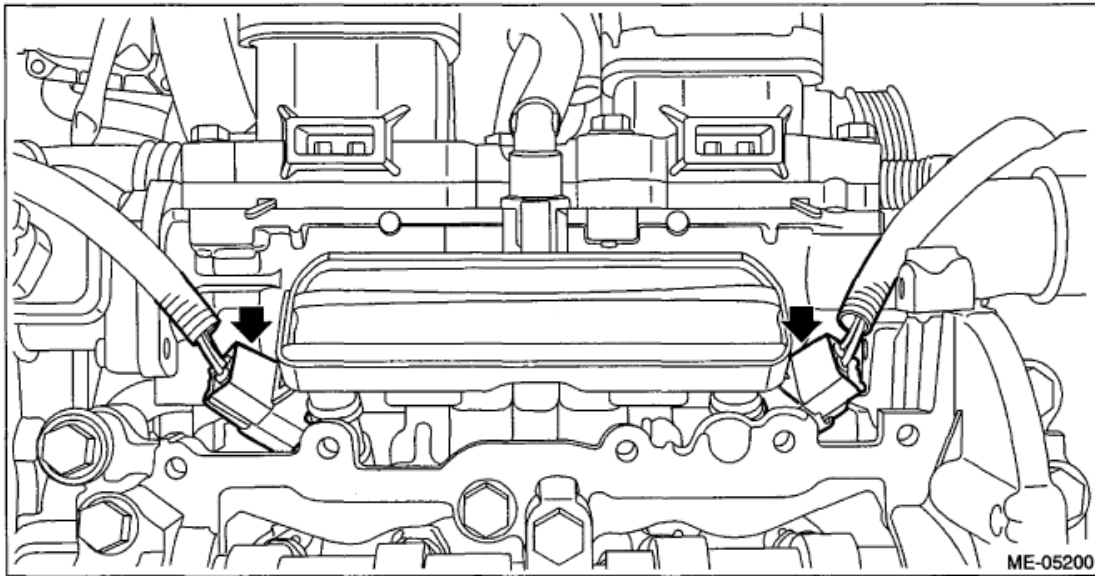


Fig. 247: Locating Fuel Injector RH Connectors
Courtesy of SUBARU OF AMERICA, INC.

11. Secure the engine harness to the cam carrier RH with a clip.

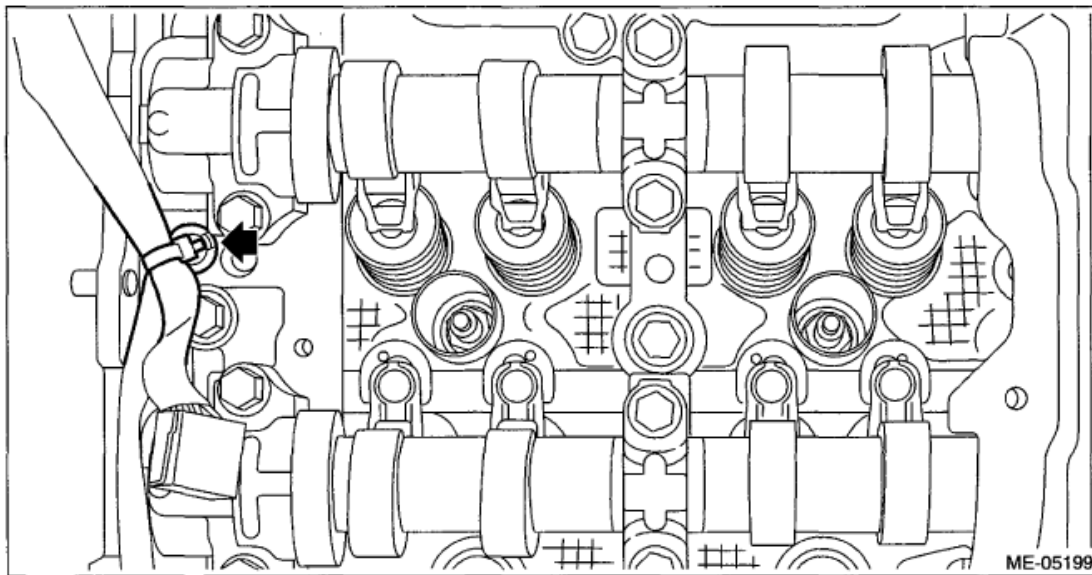


Fig. 248: Locating Cam Carrier RH Engine Harness Clip
Courtesy of SUBARU OF AMERICA, INC.

12. Install the rocker cover RH. < refer to **ROCKER COVER RH**, INSTALLATION, Rocker Cover >
13. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >
14. Install the engine to the vehicle. < refer to **INSTALLATION**, Engine Assembly >

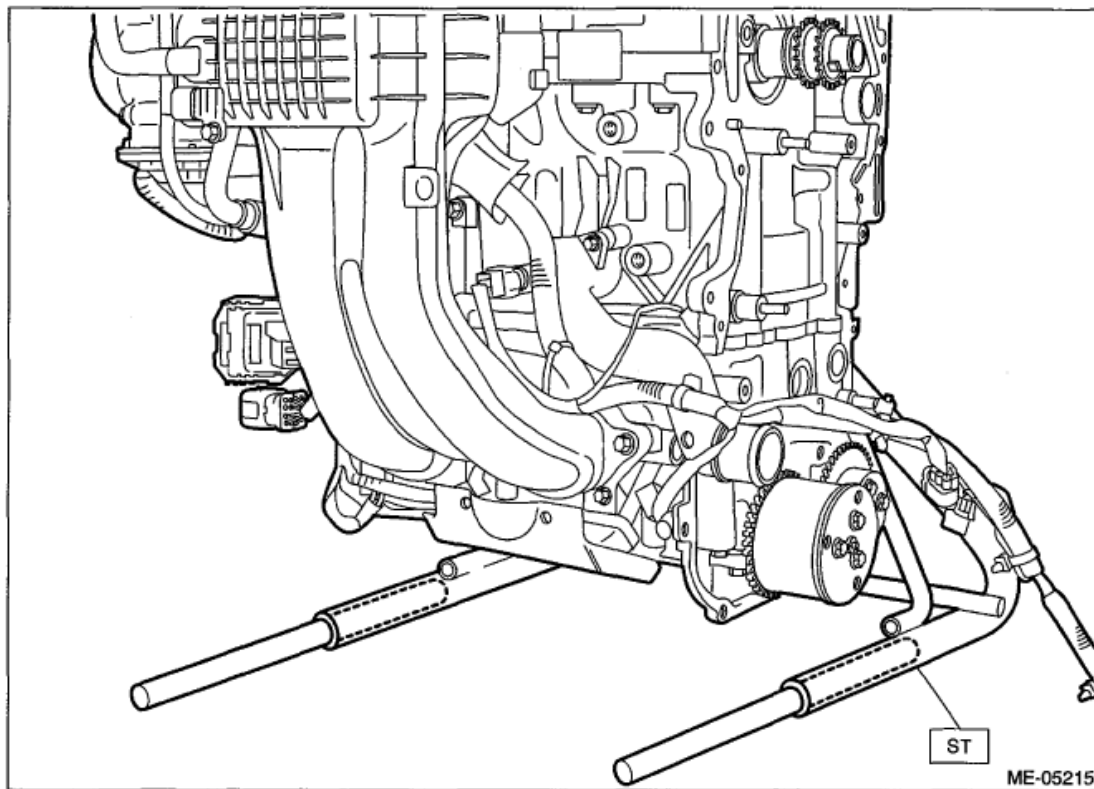
CAM CARRIER LH

1. Insert the steel rods into ST, and set the engine so that the camshaft LH is facing up.

CAUTION:

- If the engine is standing on one side without inserting the steel rod into ST, engine may lose balance and fall down. Be sure to insert the steel rod into ST to extend the length.
- Use the steel rod with enough strength.
- Be careful not to pinch the engine harness with ST.

ST 499817100 ENGINE STAND

**Fig. 249: Inserting Steel Rods Into ST**

Courtesy of SUBARU OF AMERICA, INC.

2. Apply engine oil to the valve shim and the roller rocker arm pivot, and install the valve shim and the roller rocker arm pivot to the cylinder head LH.

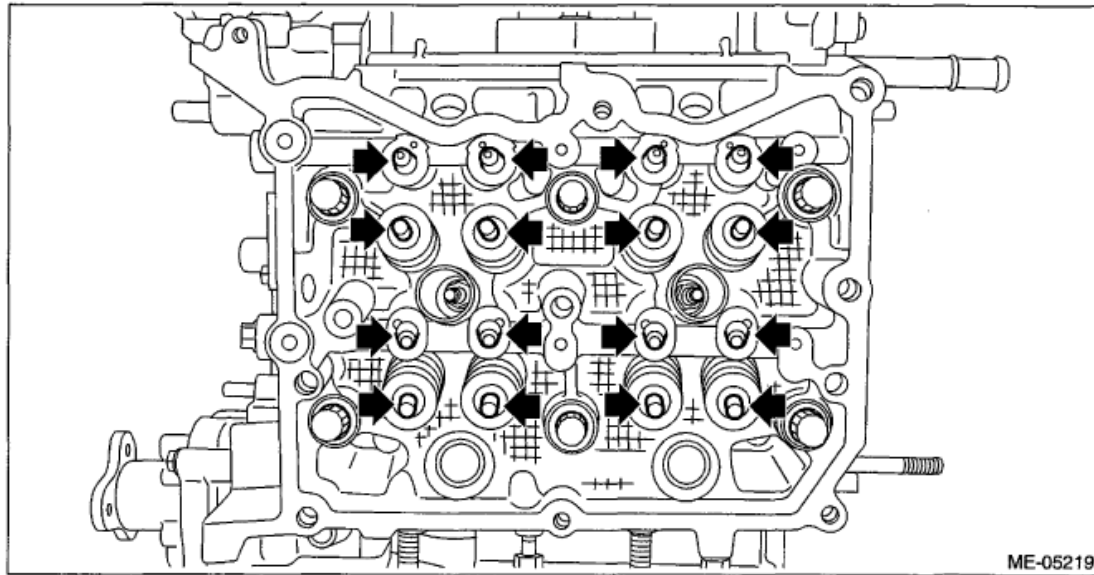


Fig. 250: Locating Valve Shim And Roller Rocker Arm Pivot Of Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

3. Apply engine oil to the O-ring and the roller rocker arm, and install the O-ring and the roller rocker arm to the cylinder head LH.

NOTE: Use new O-rings.

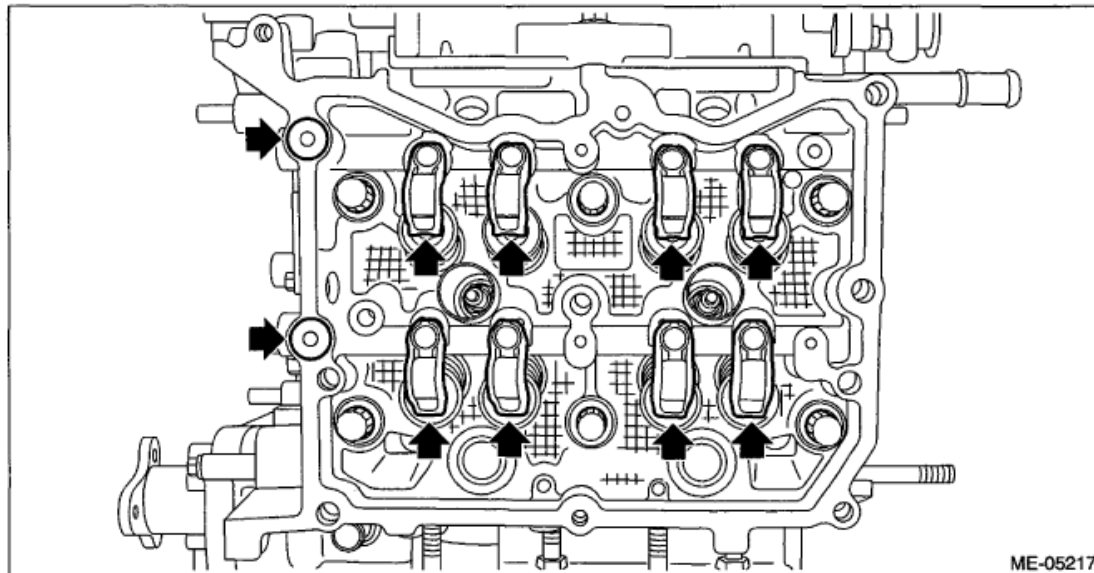


Fig. 251: Locating O-Ring And Roller Rocker Arm From Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

4. Apply liquid gasket to the mating surface of cam carrier LH as shown in the figure.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the cylinder head LH and the cam carrier LH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket: THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter: 2.5 ± 0.5 mm (0.0984 ± 0.0197 in)

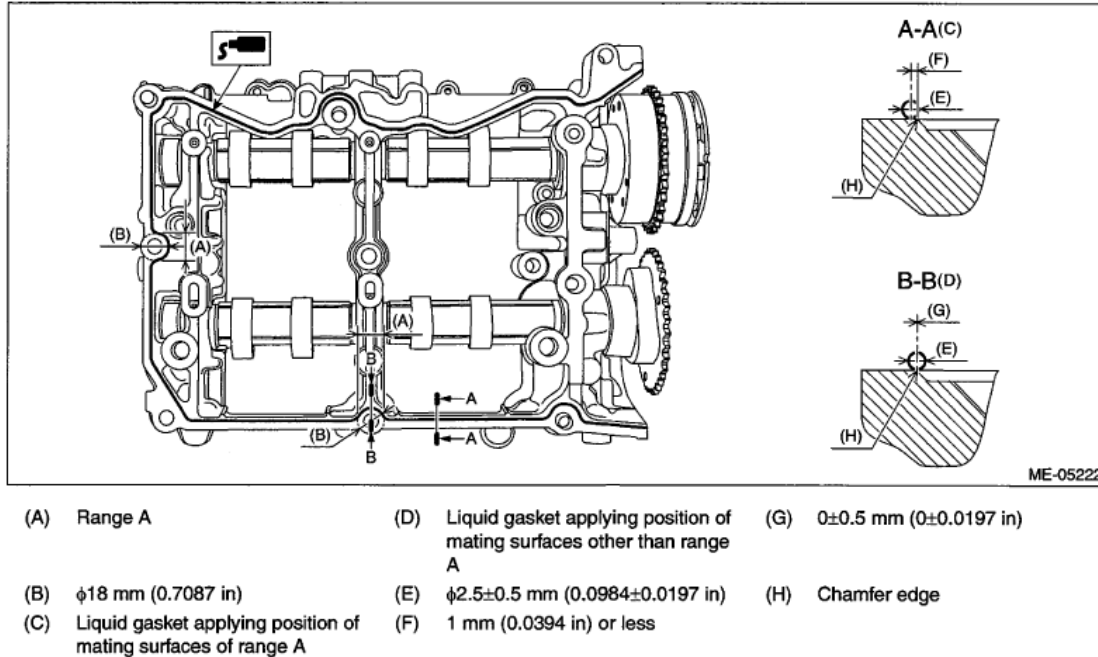


Fig. 252: Identifying Liquid Gasket Applying Area On Mating Surface Of Cam Carrier LH
Courtesy of SUBARU OF AMERICA, INC.

5. Install the cam carrier LH to the cylinder head LH.

1. Mount the cam carrier LH, then tighten all bolts with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

NOTE:

Set the intake camshaft LH and the exhaust camshaft LH to the zero-lift position.

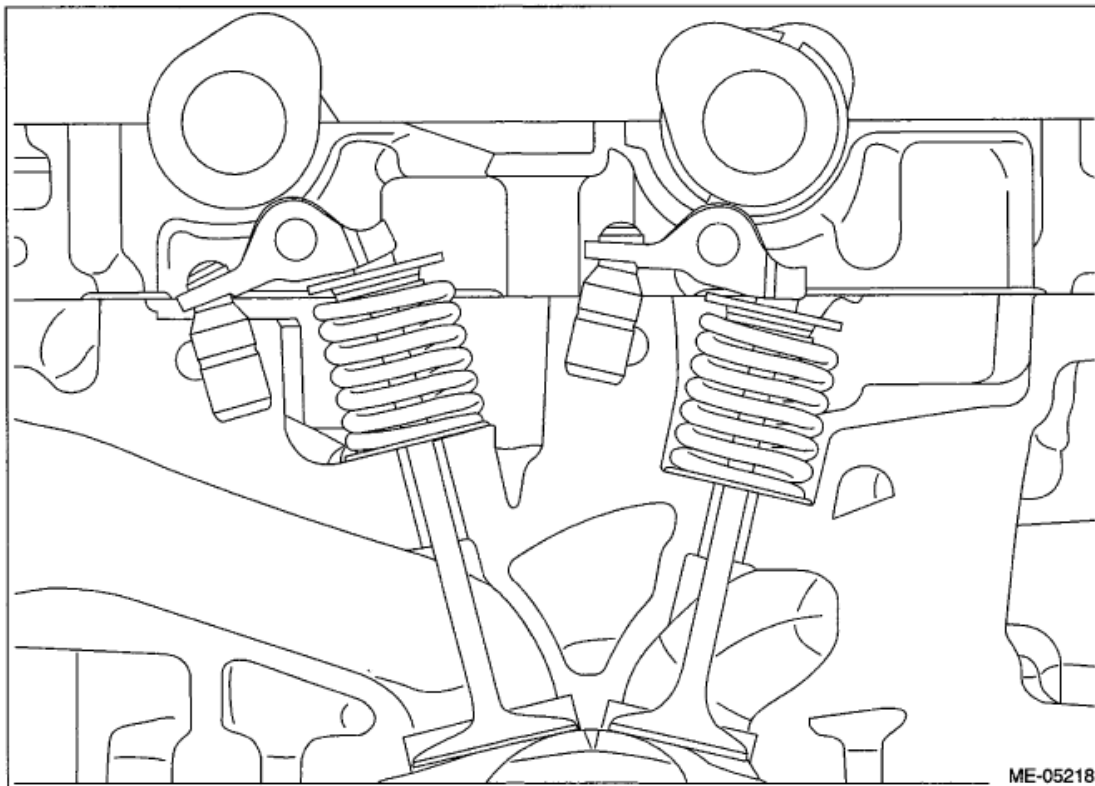


Fig. 253: Identifying Cam Carrier LH
Courtesy of SUBARU OF AMERICA, INC.

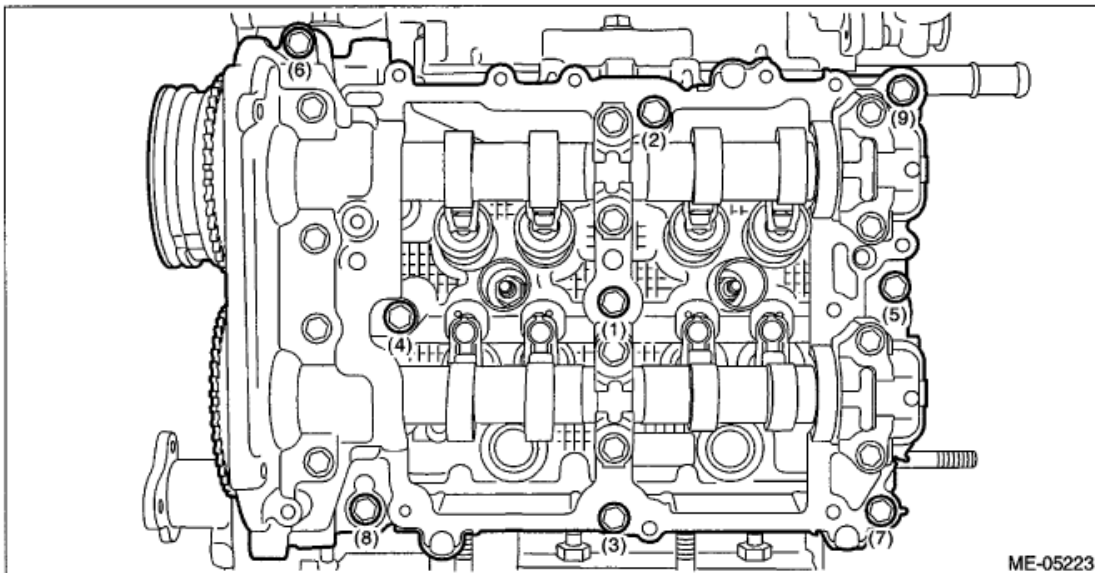


Fig. 254: Identifying Cam Carrier LH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

2. Loosen the bolts (3 places) by 180° in numerical order as shown in the figure.

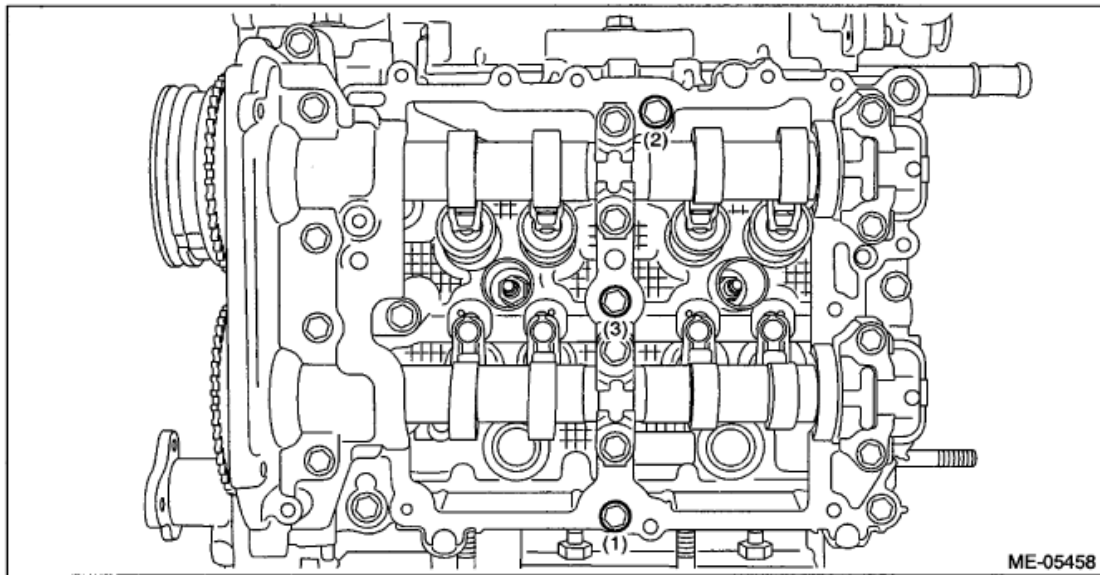


Fig. 255: Identifying Cam Carrier LH Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten the bolts (3 places) with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

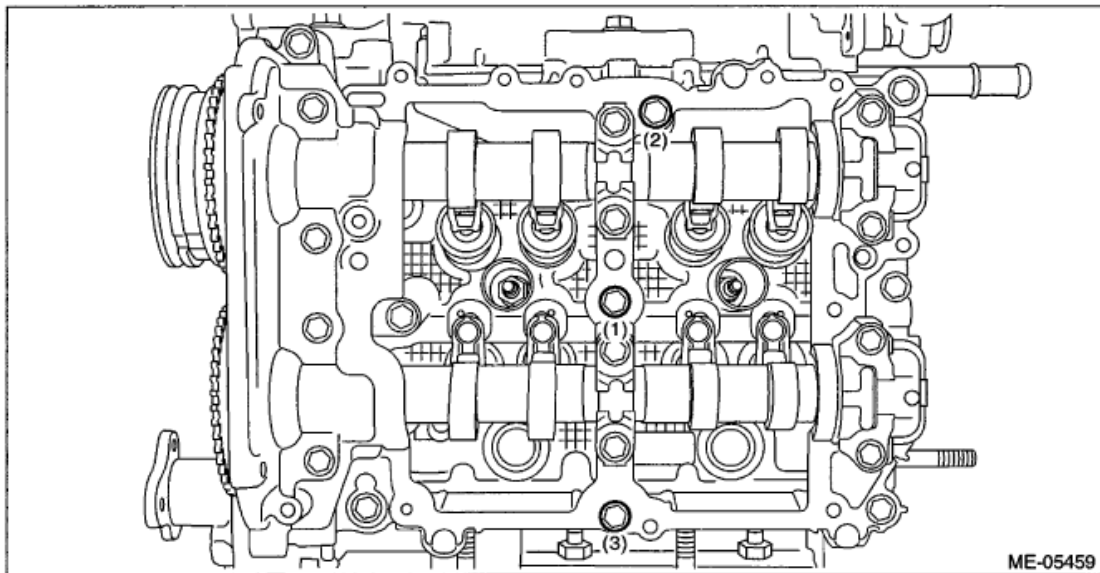


Fig. 256: Identifying Cam Carrier LH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. Loosen the bolts (3 places) by 180° in numerical order as shown in the figure.

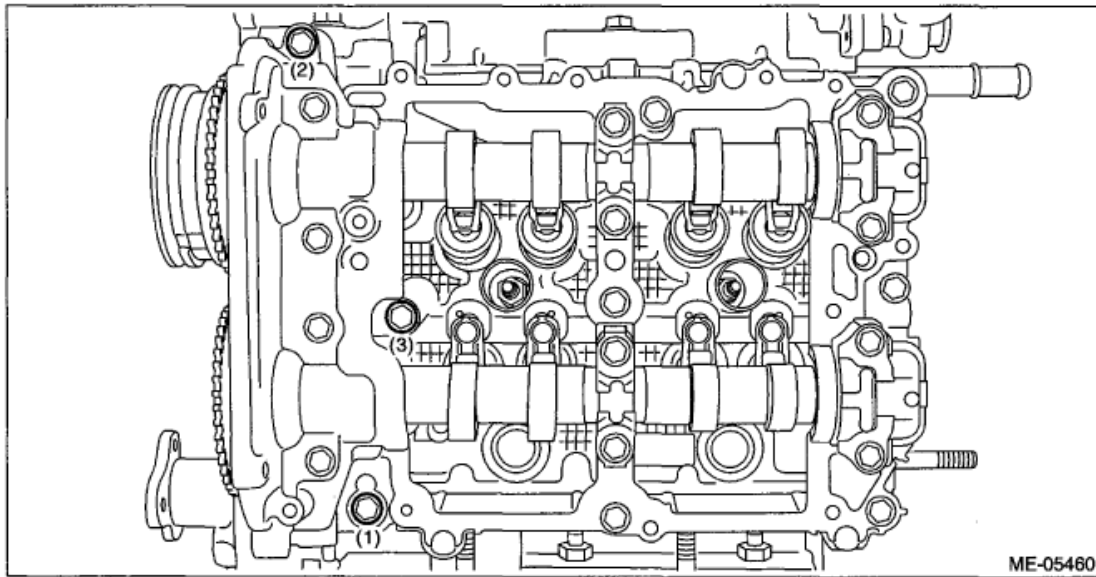


Fig. 257: Identifying Cam Carrier LH Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

5. Tighten the bolts (3 places) with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

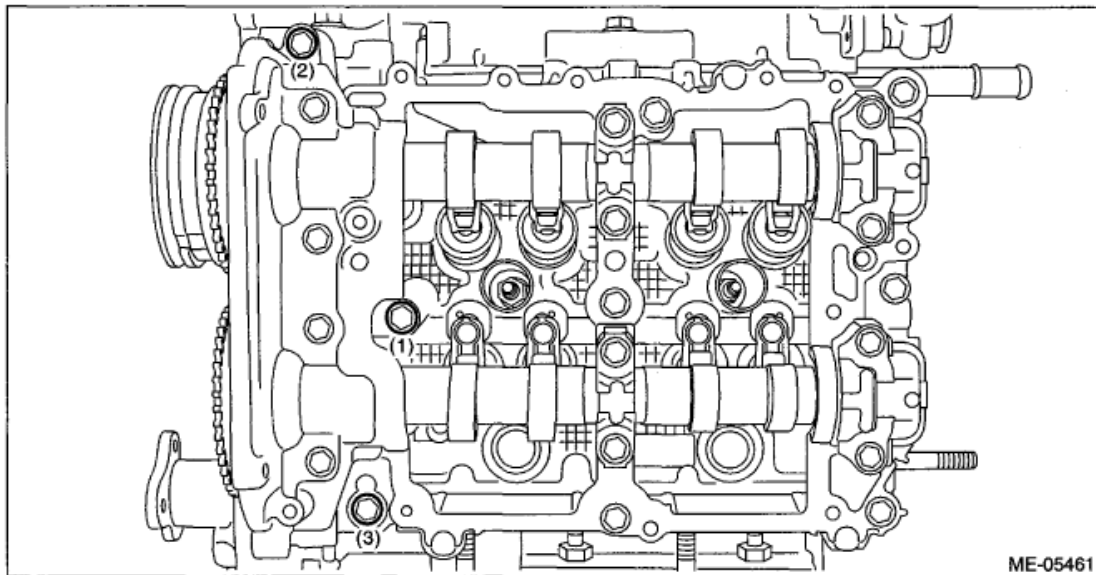


Fig. 258: Identifying Cam Carrier LH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Loosen the bolts (3 places) by 180° in numerical order as shown in the figure.

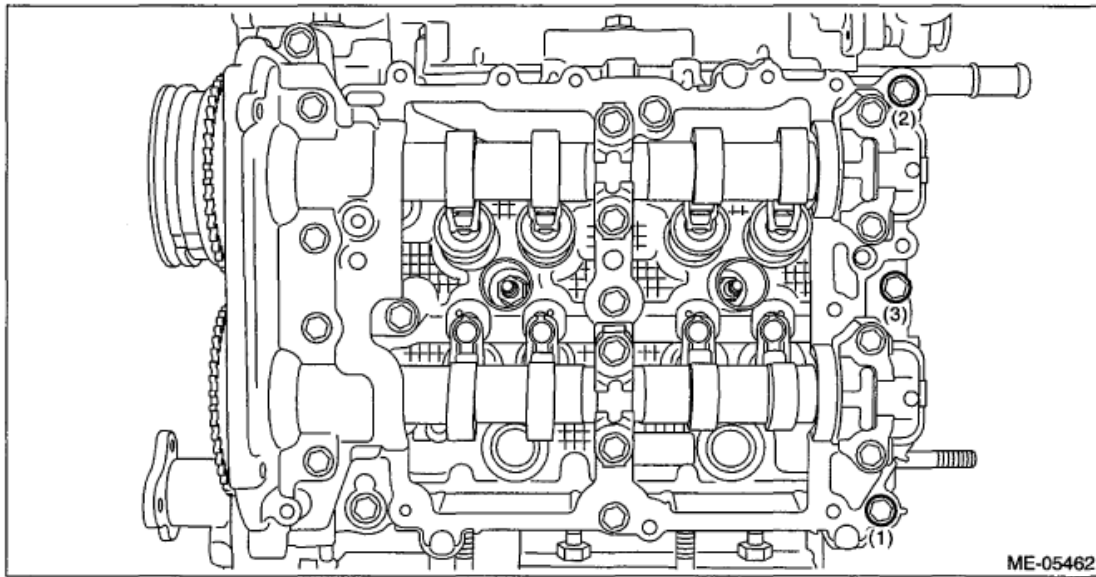


Fig. 259: Identifying Cam Carrier LH Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten the bolts (3 places) with a torque of 18 N.m (1.8 kgf-m, 13.3 ft-lb) in numerical order as shown in the figure.

NOTE: After tightening, if the liquid gasket is squeezed out onto the seal surface of the chain cover, completely remove any squeezed-out liquid gasket.

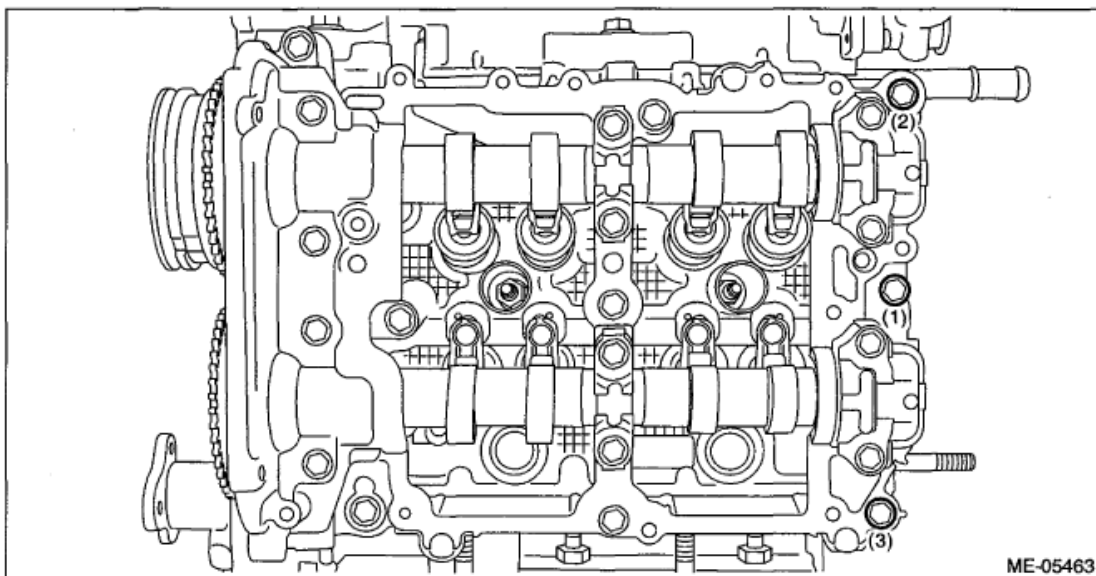


Fig. 260: Identifying Cam Carrier LH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Set the part so that the intake manifold is on the upper side.
7. Install the cam sprocket LH. < refer to **CAM SPROCKET LH**, INSTALLATION, Cam Sprocket >

NOTE: This procedure is required only when the cam carrier LH is removed for disassembly.

8. Check the cam clearance. < refer to **WHEN TIMING CHAIN ASSEMBLY IS REMOVED**, INSPECTION, Cam Clearance >
9. Install timing chain LH. < refer to **TIMING CHAIN LH**, INSTALLATION, Timing Chain Assembly >
10. Install the fuel pipe LH and the fuel injector LH.
 1. Install the fuel pipe LH and the fuel injector LH, and install the bolts which secure the fuel pipe LH.

NOTE: Use new O-rings, rubbers and seal rings.

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

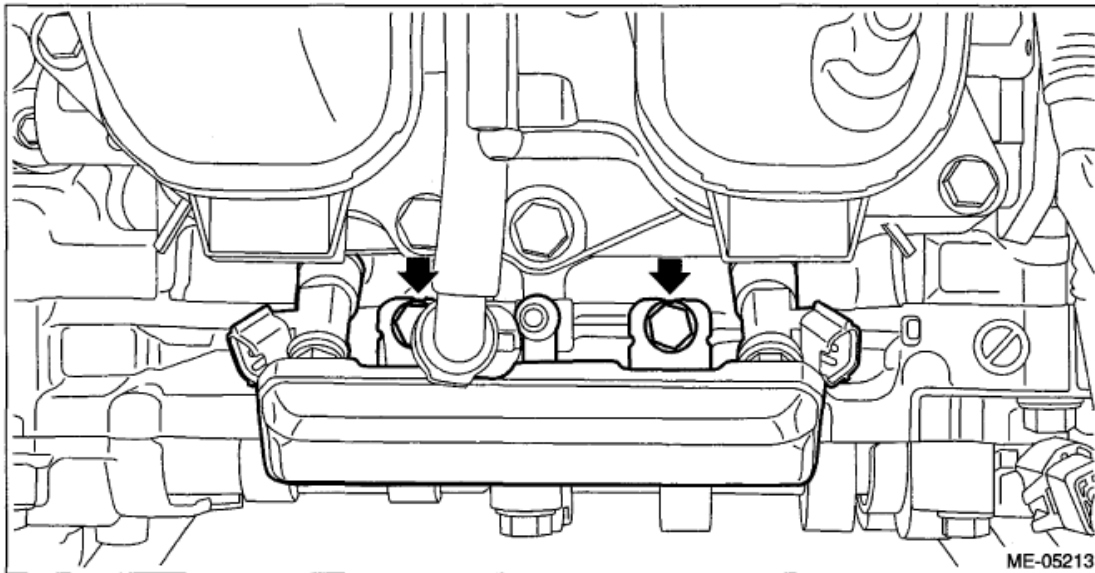


Fig. 261: Locating Fuel Pipe LH Bolts
Courtesy of SUBARU OF AMERICA, INC.

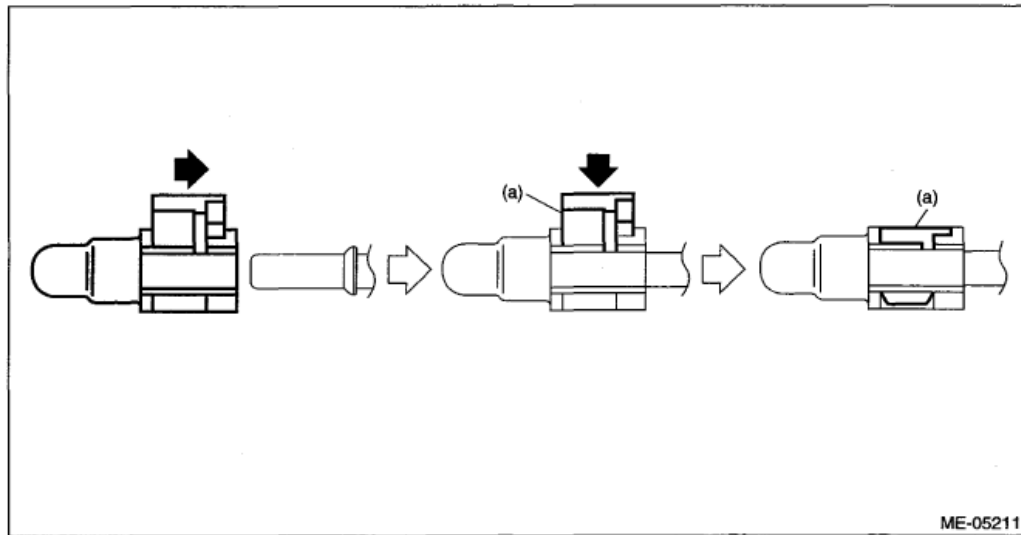
2. Connect the quick connector to the fuel pipe LH.

CAUTION:

- Check that there is no damage or dust on the quick connector. If necessary, clean the seal surface of the pipe.
- When connecting the quick connector, make sure to insert the pipe all the way in before locking the slider.
- If it is not possible to perform the push lock operation of

- the slider, recheck whether the pipe is securely inserted.
- Make sure that the quick connector is securely connected.

NOTE: Connect the quick connector as shown in the figure.



(a) Slider

Fig. 262: Connecting Fuel Pipe LH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

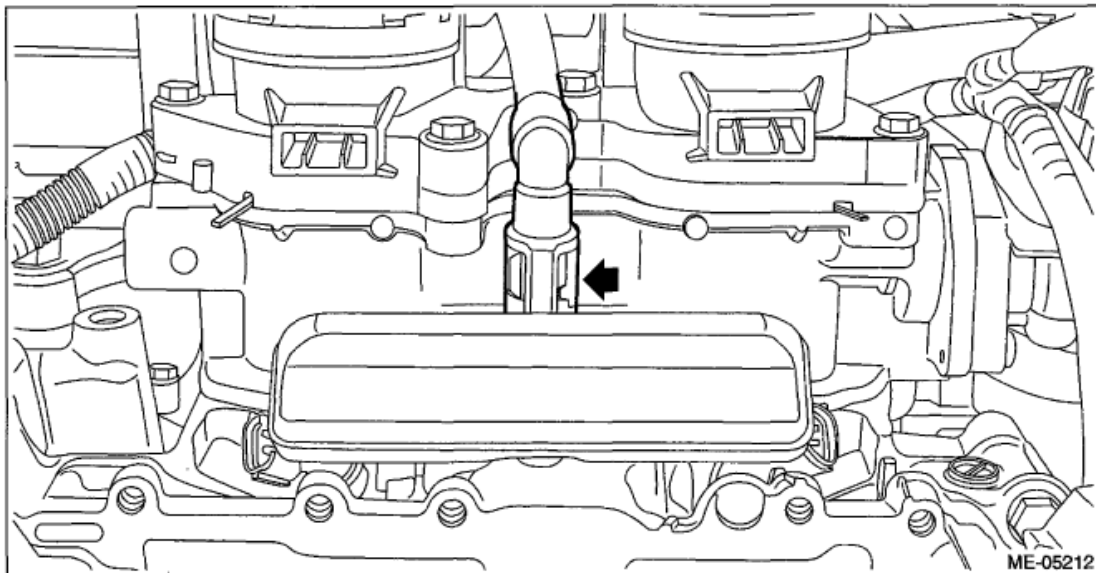


Fig. 263: Locating Fuel Pipe LH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the connectors to the fuel injector LH.

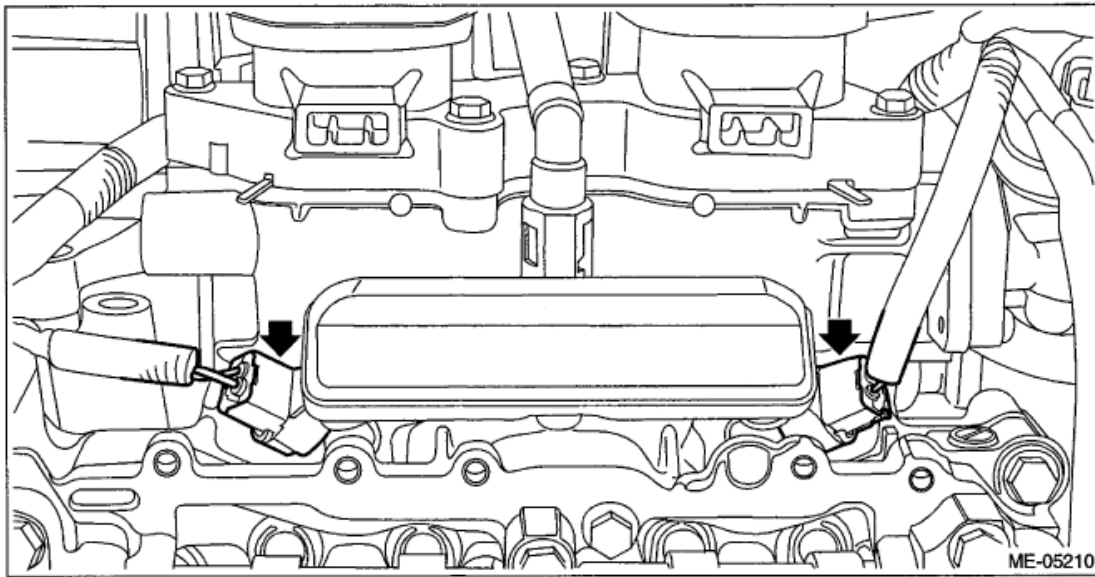


Fig. 264: Locating Fuel Injector LH Connectors
Courtesy of SUBARU OF AMERICA, INC.

11. Connect the water pipe hose to oil pan upper, and install the water pipe assembly.

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

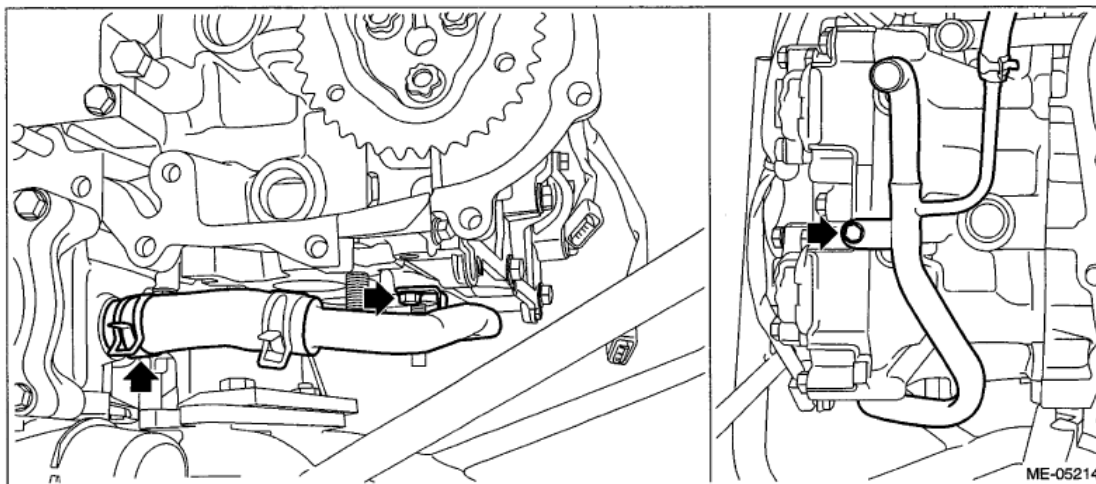


Fig. 265: Locating Water Pipe Hose Clamp And Bolts
Courtesy of SUBARU OF AMERICA, INC.

12. Connect the preheater hose to throttle body and install the preheater hose to intake manifold clip (A).

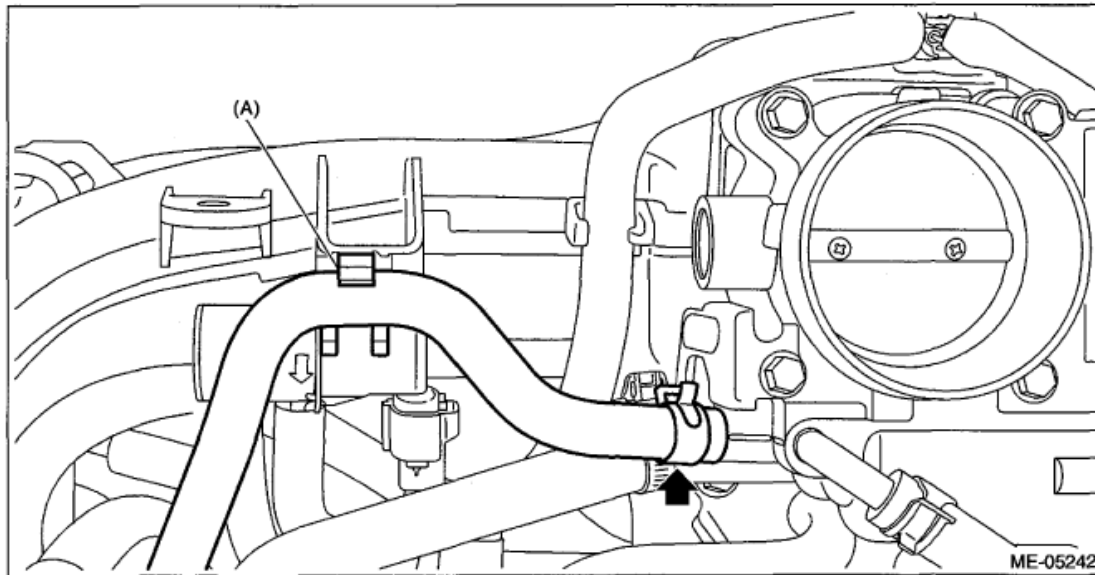


Fig. 266: Locating Intake Manifold Preheater Hose Clip
 Courtesy of SUBARU OF AMERICA, INC.

13. Secure the engine harness to the cam carrier LH with a clip.

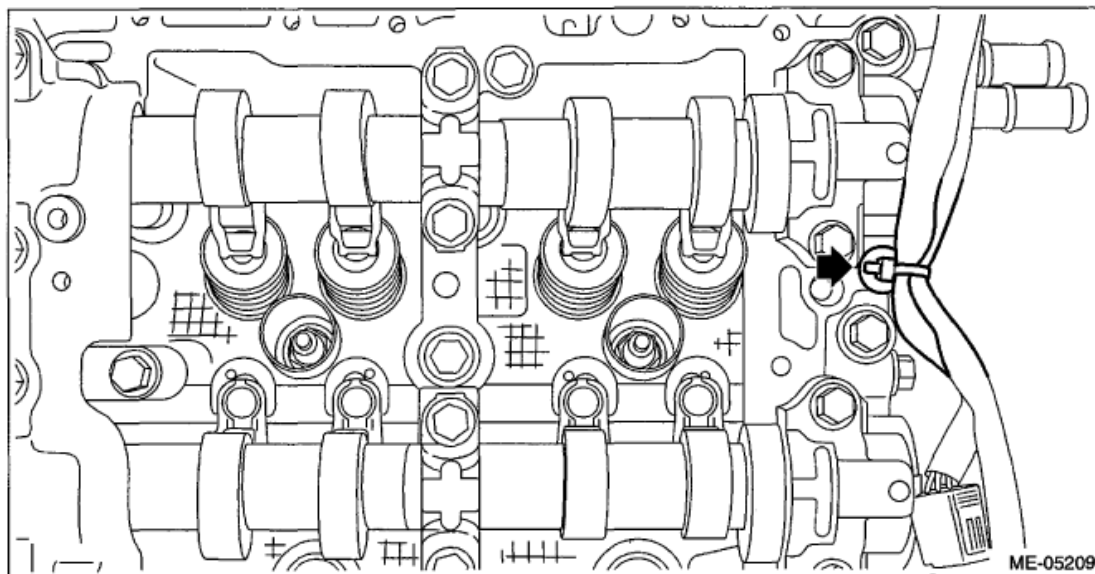


Fig. 267: Locating Cam Carrier LH Engine Harness Clip
 Courtesy of SUBARU OF AMERICA, INC.

14. Install the rocker cover LH. < refer to **ROCKER COVER LH**, INSTALLATION, Rocker Cover >
15. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >
16. Install the engine to the vehicle. < refer to **INSTALLATION**, Engine Assembly >

DISASSEMBLY

CAM CARRIER RH

1. Loosen the bolts (front camshaft cap RH, intake center camshaft cap RH, intake rear camshaft cap RH, exhaust center camshaft cap RH and exhaust rear camshaft cap RH) equally, a little at a time in numerical sequence as shown in the figure, and remove the camshaft cap.

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

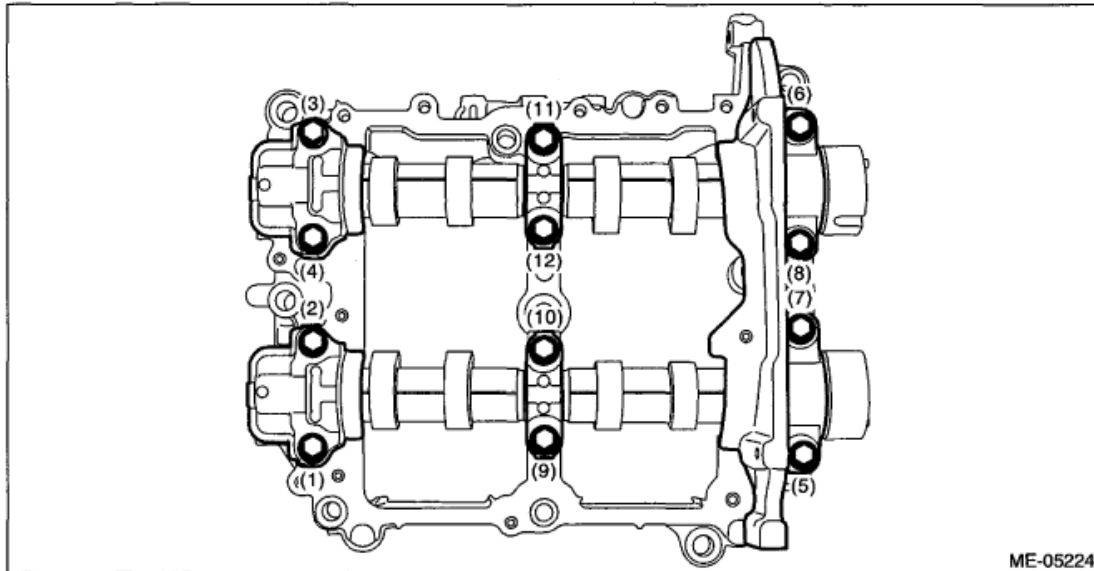


Fig. 268: Identifying Camshaft Caps Bolts Loosening Sequence (Cam Carrier RH)
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the intake camshaft RH and the exhaust camshaft RH from cam carrier RH.

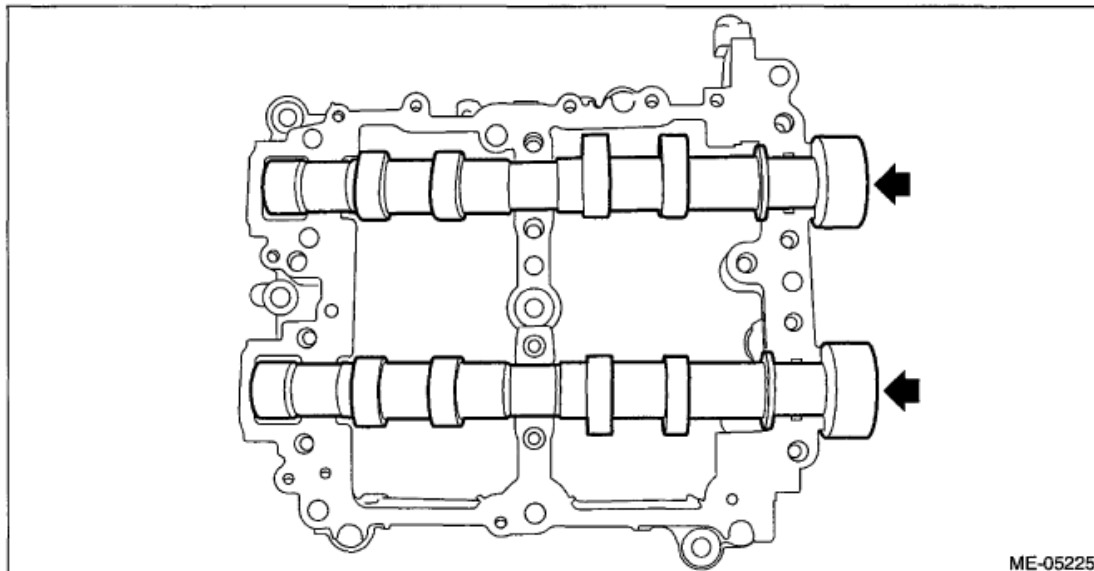


Fig. 269: Locating Intake Camshaft RH And Exhaust Camshaft RH
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the filter from cam carrier RH.

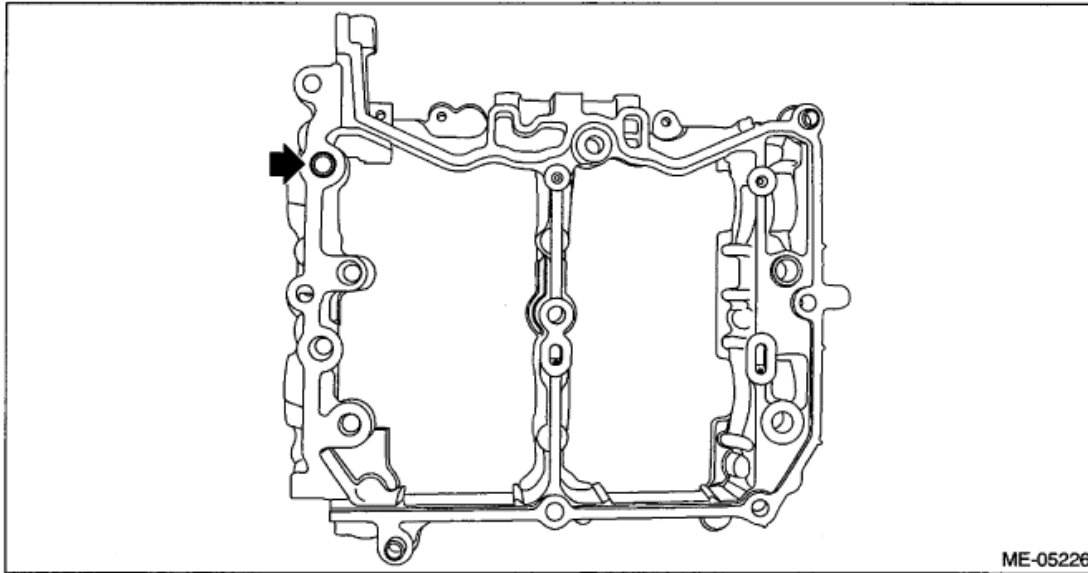


Fig. 270: Locating Filter Bolt Cam Carrier RH
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the liquid gasket from cam carrier RH and front camshaft cap RH, intake rear camshaft cap RH and exhaust rear camshaft cap RH.

CAM CARRIER LH

1. Loosen the bolts (front camshaft cap LH, intake center camshaft cap LH, intake rear camshaft cap LH, exhaust center camshaft cap LH and exhaust rear camshaft cap LH) equally, a little at a time in numerical sequence as shown in the figure, and remove the camshaft cap.

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

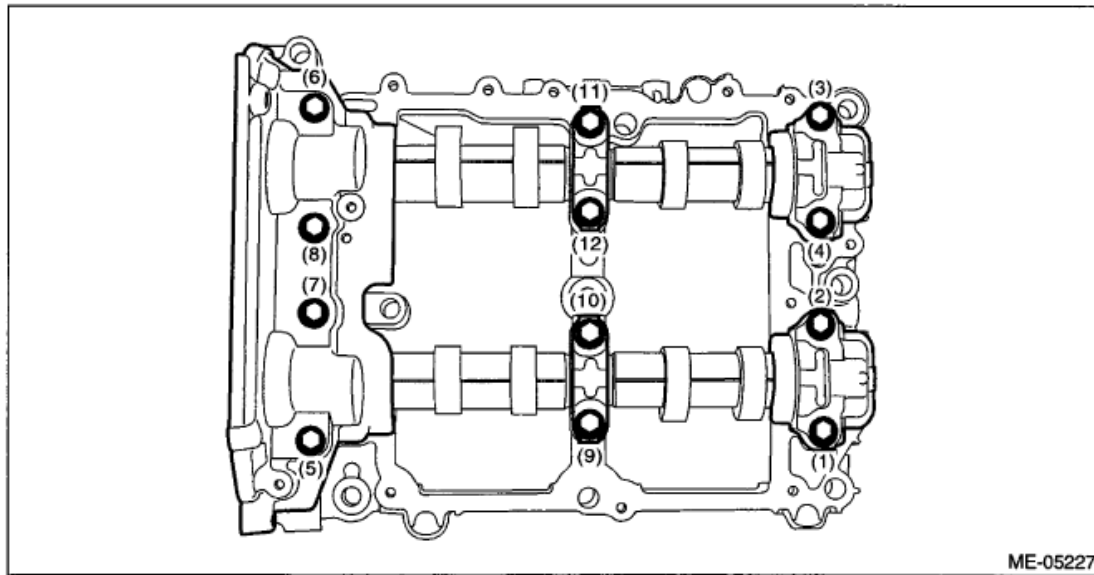


Fig. 271: Identifying Camshaft Caps Bolts Loosening Sequence (Cam Carrier LH)
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the intake camshaft LH and the exhaust camshaft LH from cam carrier LH.

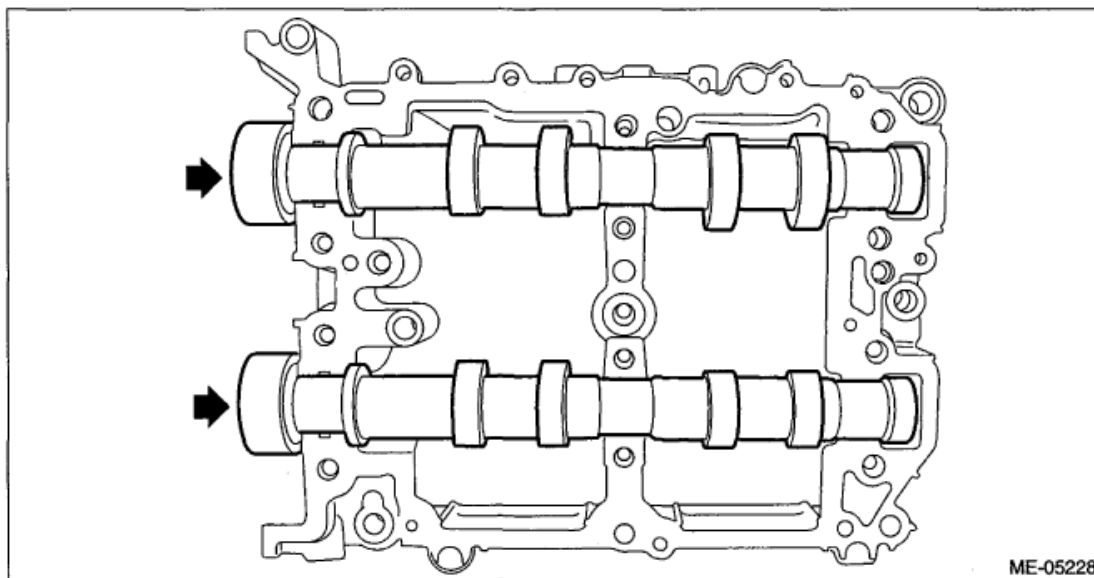


Fig. 272: Locating Intake Camshaft LH And Exhaust Camshaft LH
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the filter from cam carrier LH.

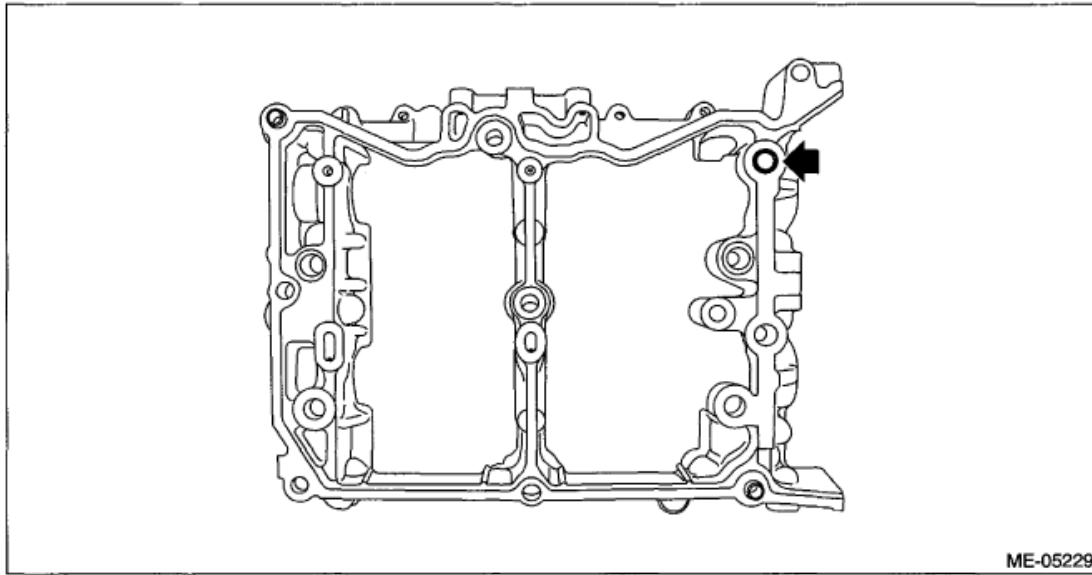


Fig. 273: Locating Filter Bolt Of Cam Carrier LH
 Courtesy of SUBARU OF AMERICA, INC.

4. Remove the liquid gasket from cam carrier LH and front camshaft cap LH, intake rear camshaft cap LH and exhaust rear camshaft cap LH.

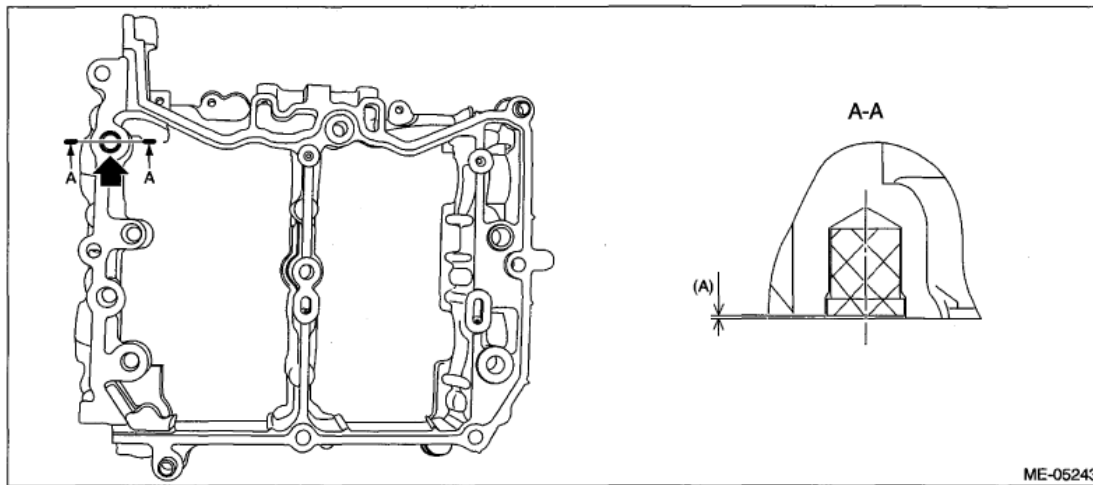
ASSEMBLY

CAM CARRIER RH

1. Install the filter to the cam carrier RH.

NOTE: Use a new filter.

Filter insert position: Cam carrier RH end face $0^{+0}_{-0.5} \text{ mm}$ ($0^{+0}_{-0.0197} \text{ in}$) position



(A) 0 — 0.5 mm (0 — 0.0197 in)

Fig. 274: Identifying Cam Carrier RH Filter Installation Position
 Courtesy of SUBARU OF AMERICA, INC.

2. Set the intake camshaft RH and the exhaust camshaft RH to the cam carrier RH.

NOTE: Apply engine oil to the journals of cam carrier RH before setting the intake camshaft RH and exhaust camshaft RH.

3. Install the front camshaft cap RH, intake center camshaft cap RH, intake rear camshaft cap RH, exhaust center camshaft cap RH and exhaust rear camshaft cap RH.
 1. Apply liquid gasket to the mating surface of front camshaft cap RH, intake rear camshaft cap RH and exhaust rear camshaft cap RH as shown in the + figure.

CAUTION:

- Do not apply liquid gasket excessively. Applying excessively may cause excess gasket to flow toward cam journal, resulting in engine seizure.
- Do not apply liquid gasket excessively to the intake center camshaft cap RH and exhaust center camshaft cap RH.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the front camshaft cap RH, intake rear camshaft cap RH, exhaust rear camshaft cap RH and cam carrier RH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket: THREE BOND 1217G (Part No. 0877Y0100) or equivalent

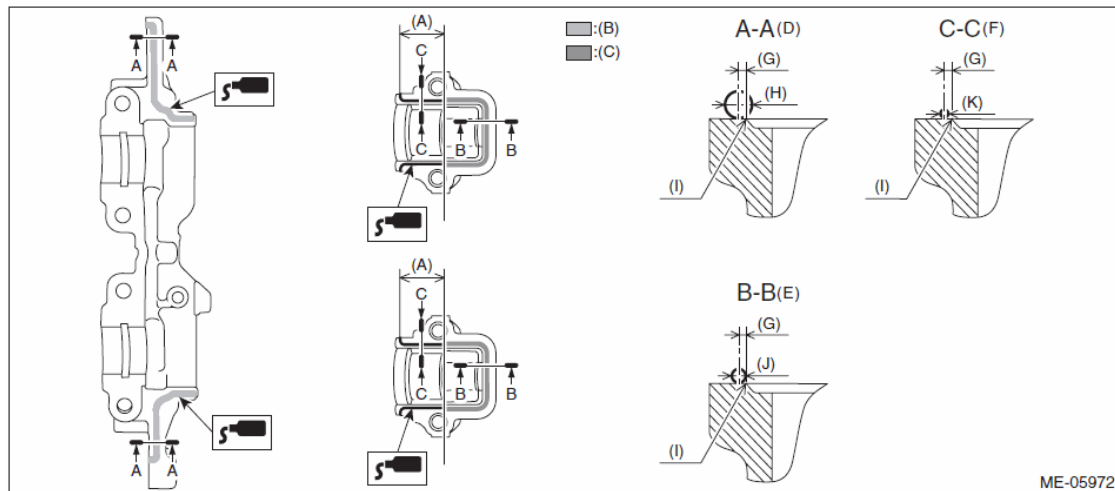
Liquid gasket applying diameter:

Mating surfaces other than range A

$1 \pm 0.5 \text{ mm}$ ($0.0394 \pm 0.0197 \text{ in}$)

Mating surfaces of range A

$2 \pm 0.5 \text{ mm}$ ($0.0787 \pm 0.0197 \text{ in}$)



- | | | |
|---|---|--|
| (A) 28.5 mm (1.122 in) | (E) Liquid gasket applying position of mating surfaces of range B | (I) Chamfer edge |
| (B) Range A | (F) Liquid gasket applying position of mating surfaces other than range A and range B | (J) $\phi 2 \pm 0.5 \text{ mm}$ ($0.0787 \pm 0.0197 \text{ in}$) |
| (C) Range B | (G) 1 mm (0.0394 in) or less | (K) $\phi 1 \pm 0.5 \text{ mm}$ ($0.0394 \pm 0.0197 \text{ in}$) |
| (D) Liquid gasket applying position of mating surfaces of range A | (H) $\phi 3.5 \pm 0.5 \text{ mm}$ ($0.1378 \pm 0.0197 \text{ in}$) | |

Fig. 275: Identifying Cam Carrier RH Mating Surfaces Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

2. Apply engine oil to the journals of each camshaft cap before setting the camshaft cap.
3. Tighten the bolts which secure front camshaft cap RH, intake center camshaft cap RH, intake rear camshaft cap RH, exhaust center camshaft cap RH and exhaust rear camshaft cap RH in numerical order as shown in the figure.

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

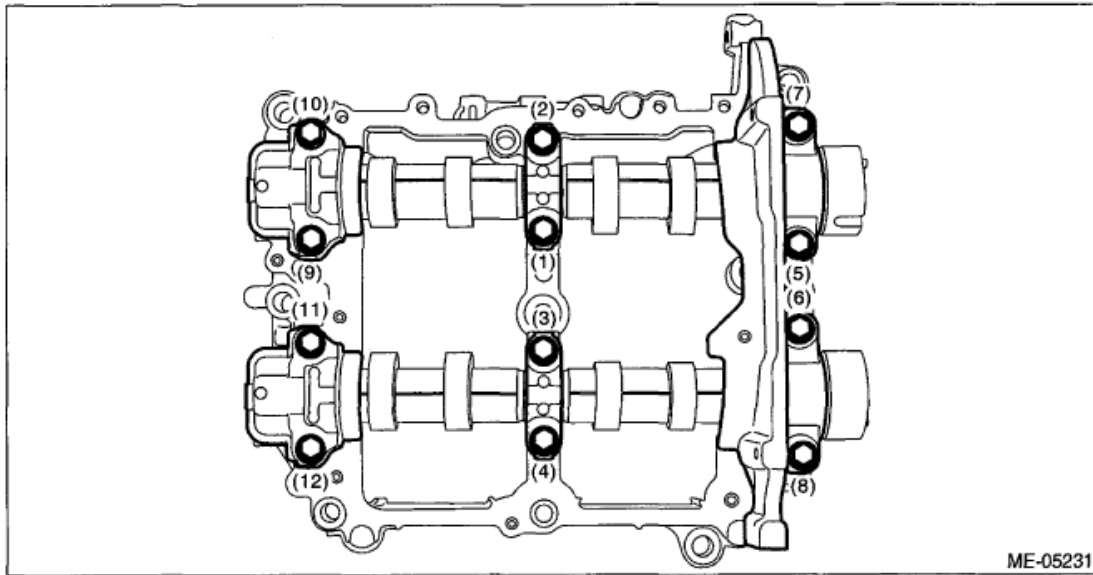


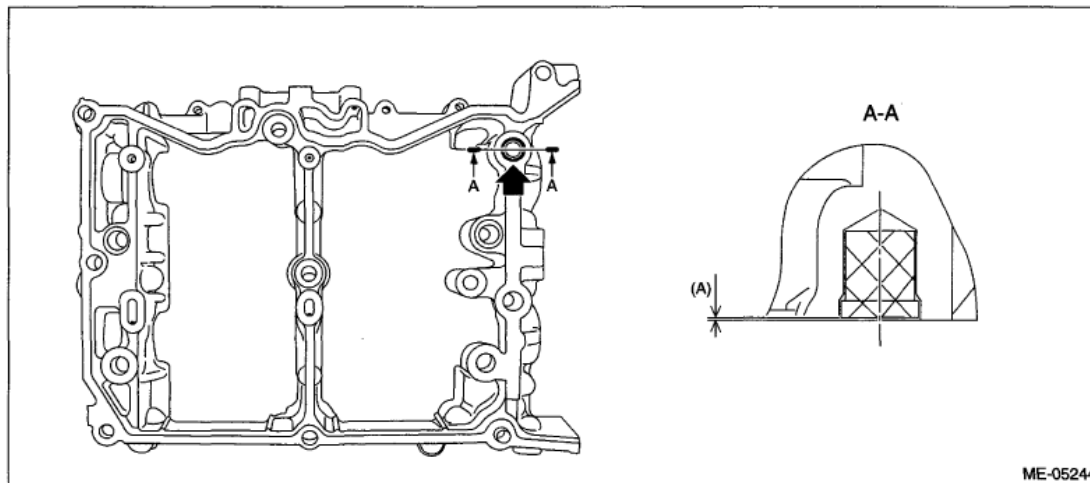
Fig. 276: Identifying Camshaft Caps Bolts Tightening Sequence (Cam Carrier RH)
Courtesy of SUBARU OF AMERICA, INC.

CAM CARRIER LH

1. Install the filter to the cam carrier LH.

NOTE: Use a new filter.

Filter insert position: Cam carrier LH end face $0^{+0}_{-0.5} \text{ mm}$ ($^{+0}_{-0.0197} \text{ in}$) position



(A) $0 - 0.5 \text{ mm}$ ($0 - 0.0197 \text{ in}$)

Fig. 277: Identifying Cam Carrier LH Filter Installation Position
Courtesy of SUBARU OF AMERICA, INC.

2. Set the intake camshaft LH and the exhaust camshaft LH to the cam carrier LH.

NOTE: **Apply engine oil to the journals of cam carrier LH before setting the intake camshaft LH and exhaust camshaft LH.**

3. Install the front camshaft cap LH, intake center camshaft cap LH, intake rear camshaft cap LH, exhaust center camshaft cap LH and exhaust rear camshaft cap LH.
 1. Apply liquid gasket to the mating surface of front camshaft cap LH, intake rear camshaft cap LH and exhaust rear camshaft cap LH as shown in the figure.

CAUTION:

- **Do not apply liquid gasket excessively. Applying excessively may cause excess gasket to flow toward cam journal, resulting in engine seizure.**
- **Do not apply liquid gasket excessively to the intake center camshaft cap LH and exhaust center camshaft cap LH.**

NOTE:

- **Before applying liquid gasket, remove oil from liquid gasket seal surface of the front camshaft cap LH, intake rear camshaft cap LH, exhaust rear camshaft cap LH and cam carrier LH.**
- **Install within 5 min. after applying liquid gasket.**

Liquid gasket: THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter:

Mating surfaces other than range A

1±0.5 mm (0.0394±0.0197 in)

Mating surfaces of range A

2±0.5 mm (0.0787±0.0197 in)

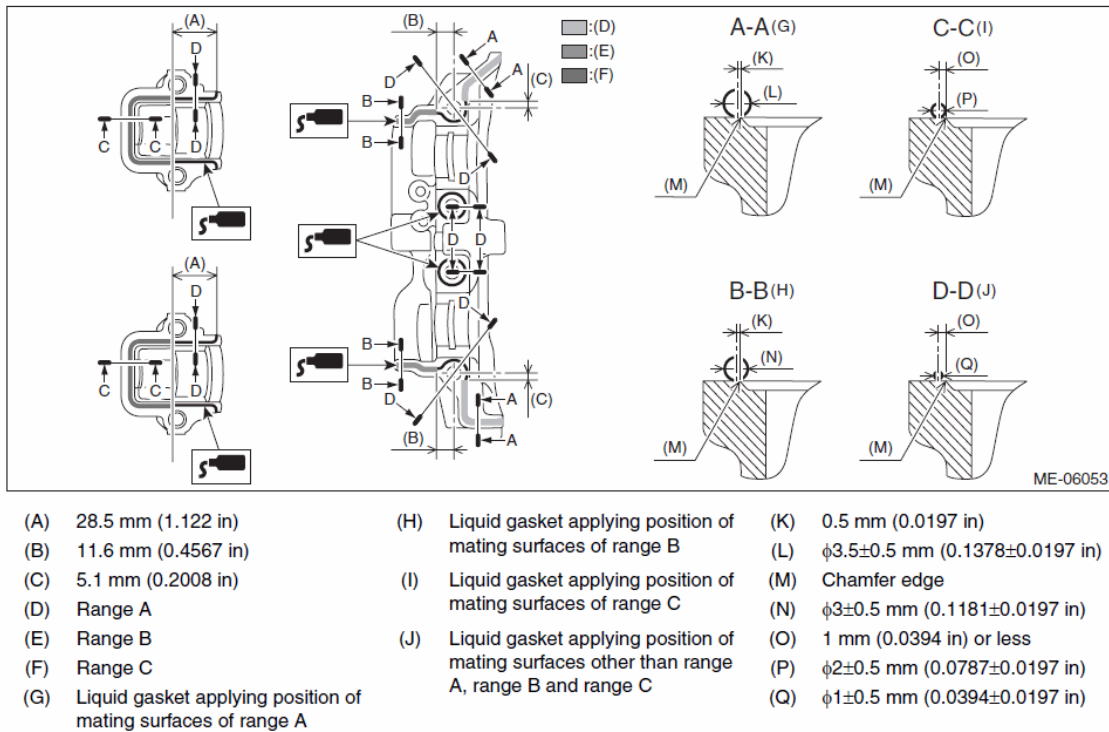


Fig. 278: Identifying Cam Carrier RH Mating Surfaces Liquid Gasket Applying Area
 Courtesy of SUBARU OF AMERICA, INC.

2. Apply engine oil to the journals of each camshaft cap before setting the camshaft cap.
3. Tighten the bolts which secure front camshaft cap LH, intake center camshaft cap LH, intake rear camshaft cap LH, exhaust center camshaft cap LH and exhaust rear camshaft cap LH in numerical order as shown in the figure.

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

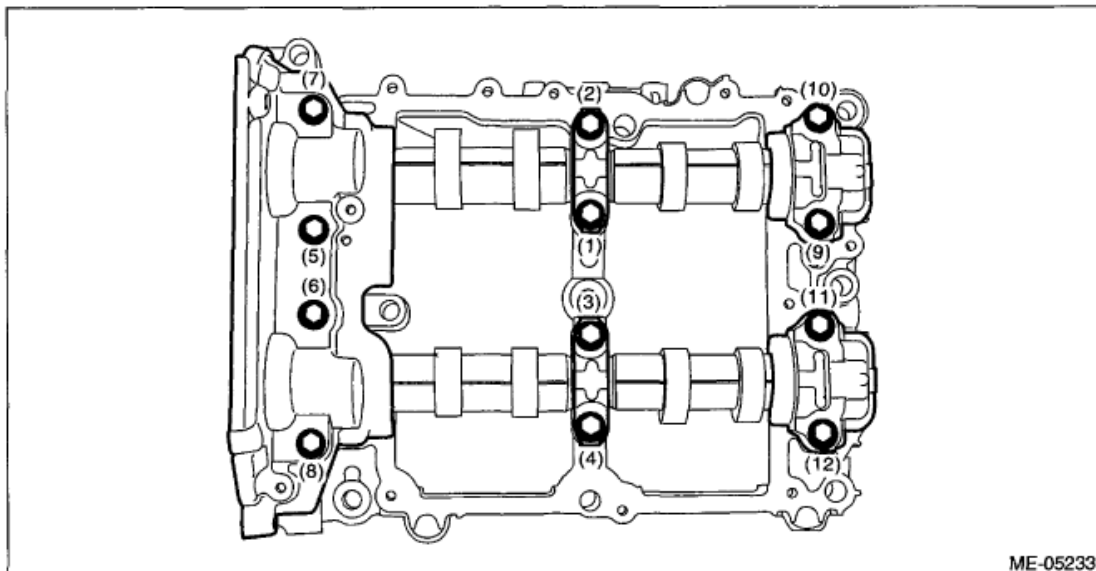


Fig. 279: Identifying Camshaft Caps Bolts Tightening Sequence (Cam Carrier LH)
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Visually check the cam carrier filter, and if clogging is found, replace with a new part.

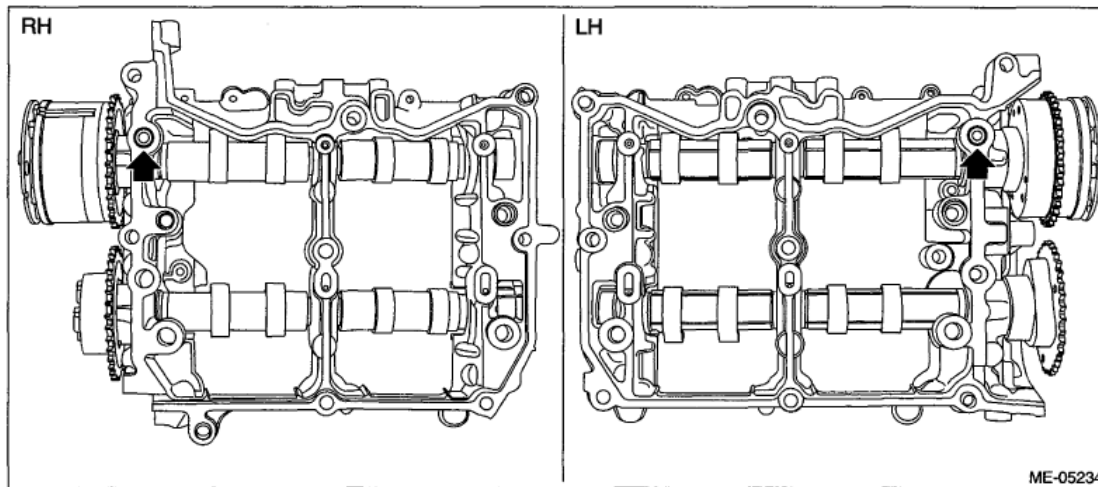


Fig. 280: Locating Cam Carrier Filter With Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Check the camshaft journals for damage and wear. Replace the camshaft if faulty.
3. Check the cam face condition of camshaft, and remove the minor faults by grinding with oil stone. Replace the camshaft if uneven wear is found.
4. Using a dial gauge, check the camshaft bend. If it exceeds the limit, replace the camshaft.

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

Camshaft bend limit: 0.020 mm (0.00079 in)

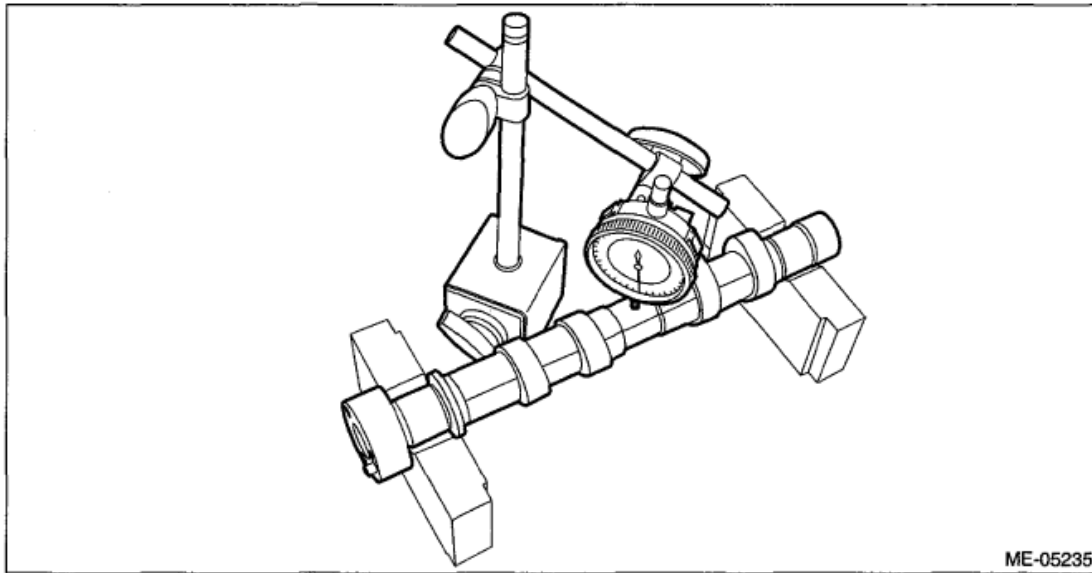


Fig. 281: Checking Camshaft Bend Using Dial Gauge
 Courtesy of SUBARU OF AMERICA, INC.

5. Check the cam lobe height "H" and cam base circle diameter "A" of camshaft using micrometer. If it is not within the standard, replace the camshaft.

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

Cam lobe height H:

Standard

Intake

40.89 - 40.99 mm (1.610 - 1.614 in)

Exhaust

40.15 - 40.25 mm (1.581 - 1.585 in)

Cam base circle diameter A:

Standard

34.0 mm (1.339 in)

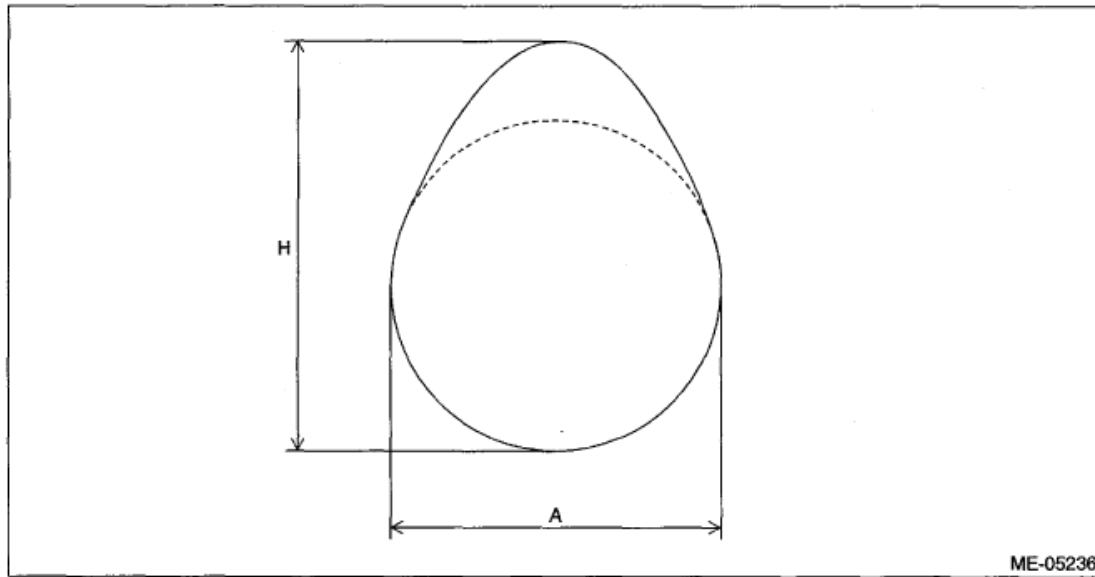


Fig. 282: Identifying Cam Lobe Height And Cam Base Circle Diameter Of Camshaft
Courtesy of SUBARU OF AMERICA, INC.

6. Check the camshaft journal outer diameter using micrometer. If it is not within the standard, check the oil clearance. Refer to step 7) for inspection procedure of oil clearance.

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

Camshaft journal O.D

Standard 25.946 - 25.963 mm (1.0215 - 1.0222 in)

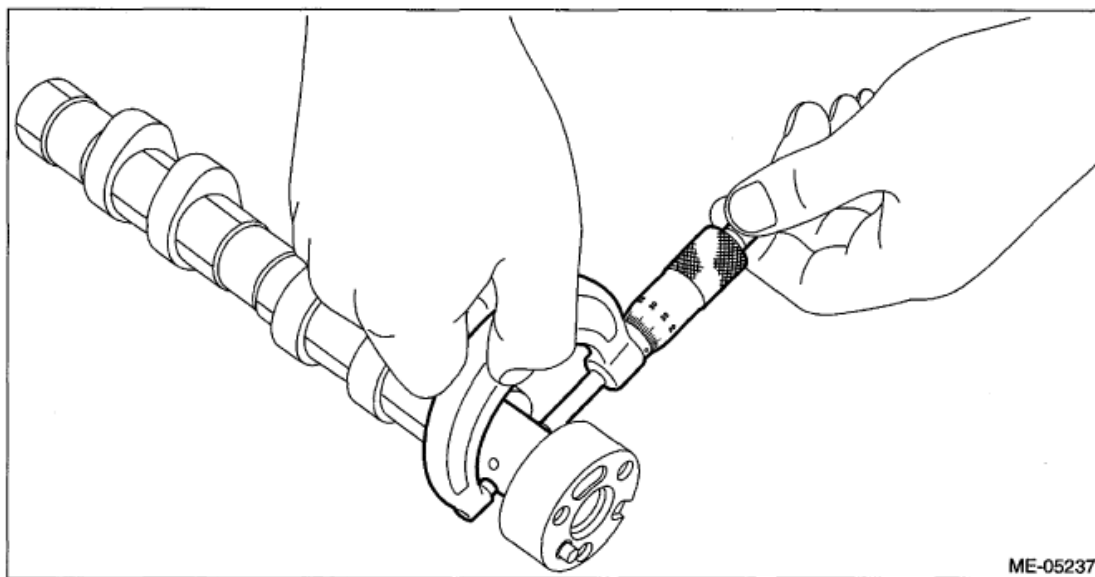


Fig. 283: Checking Camshaft Journal Outer Diameter Using Micrometer

Courtesy of SUBARU OF AMERICA, INC.

7. Check the oil clearance of camshaft journals using plastigage.

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

1. Remove the liquid gasket from cam carrier and front camshaft cap, intake rear camshaft cap and exhaust rear camshaft cap.
2. Clean each camshaft cap and cam carrier journals.
3. Set the camshaft to the cam carrier.
4. Place a plastigage across the camshaft journals of each camshaft and set the camshaft caps.
5. Tighten the bolts which secure front camshaft cap, intake center camshaft cap, intake rear camshaft cap, exhaust center camshaft cap and exhaust rear camshaft cap in numerical order as shown in the figure.

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

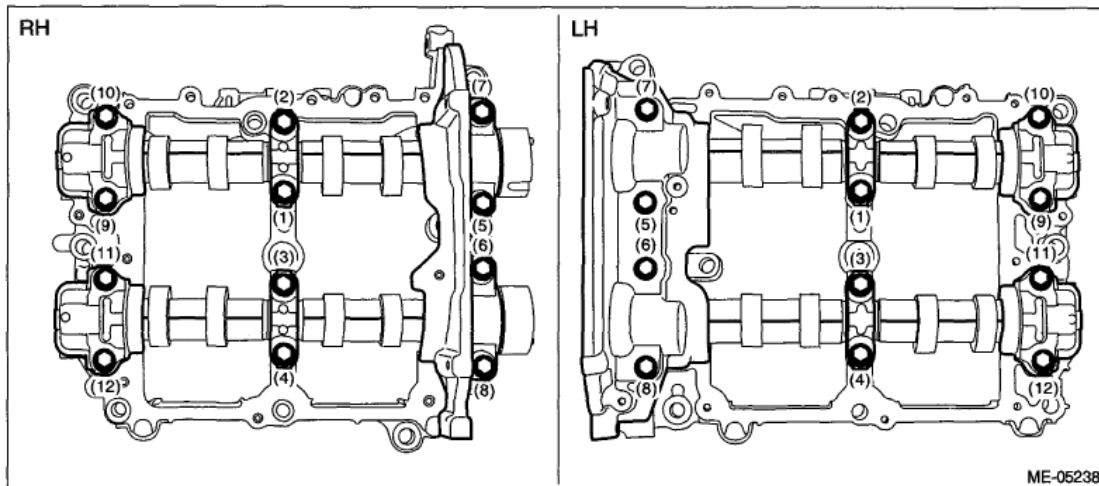


Fig. 284: Identifying Camshaft Caps Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Loosen the bolts (front camshaft cap, intake center camshaft cap, intake rear camshaft cap, exhaust center camshaft cap and exhaust rear camshaft cap) equally, a little at a time in numerical sequence as shown in the figure, and remove the camshaft cap.

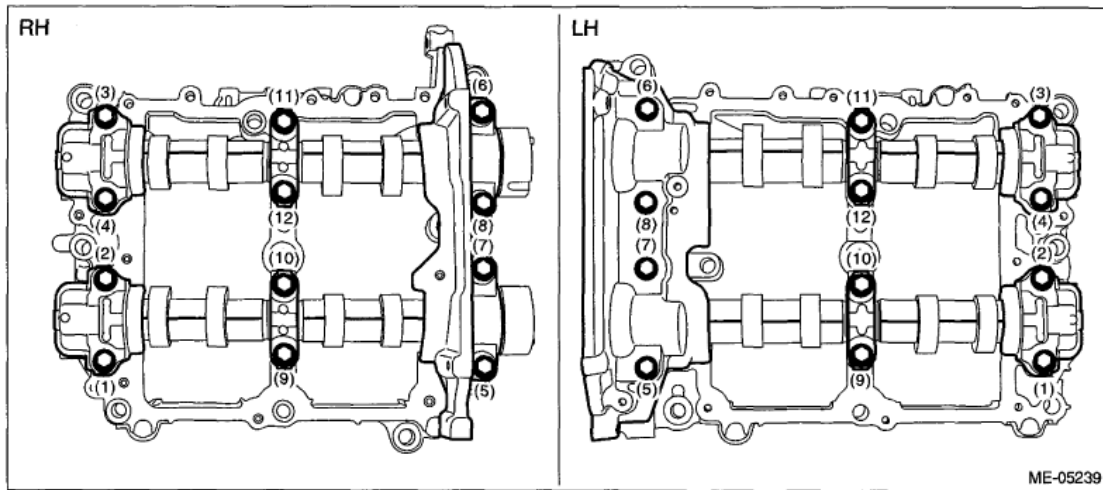


Fig. 285: Identifying Camshaft Caps Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

7. Measure the widest point of the plastigage on each journal. If it is not within the standard, replace the camshaft. If necessary, replace each camshaft cap and cam carrier as a set.

Oil clearance of camshaft journals:

Standard

0.037 - 0.072 mm (0.0015 - 0.0028 in)

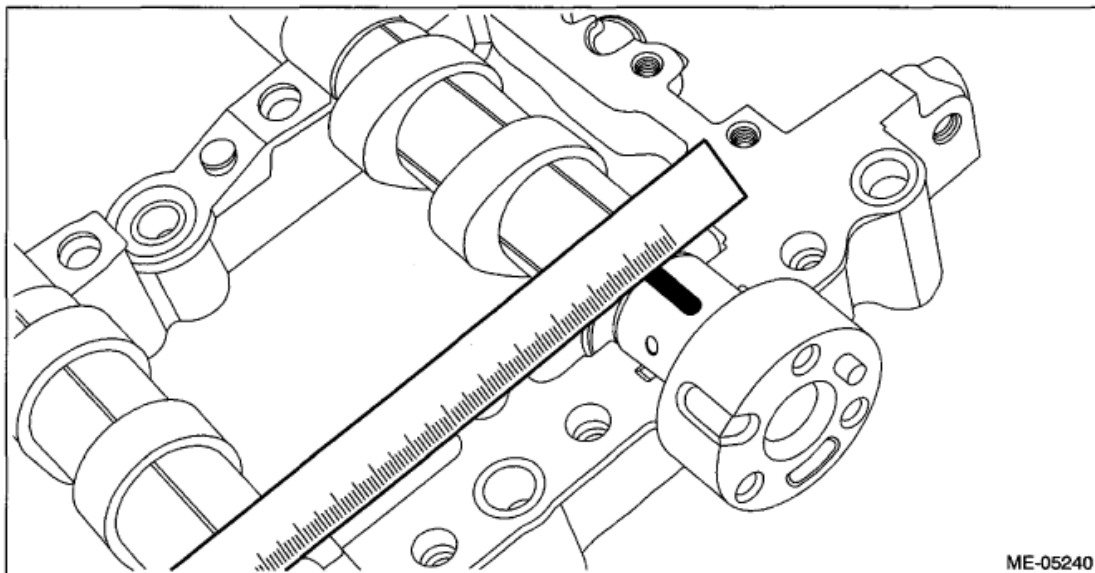


Fig. 286: Measuring Widest Point Of Plastigage On Camshaft Journal
Courtesy of SUBARU OF AMERICA, INC.

8. Completely remove the plastigage.

8. Using a dial gauge, check the thrust clearance. If it is not within the standard or if uneven wear is found, replace each camshaft cap and cam carrier as a set. If necessary replace the camshaft.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Set the dial gauge at end surface of camshaft.

Camshaft thrust clearance:***Standard***

0.068 - 0.116 mm (0.0027 - 0.0047 in)

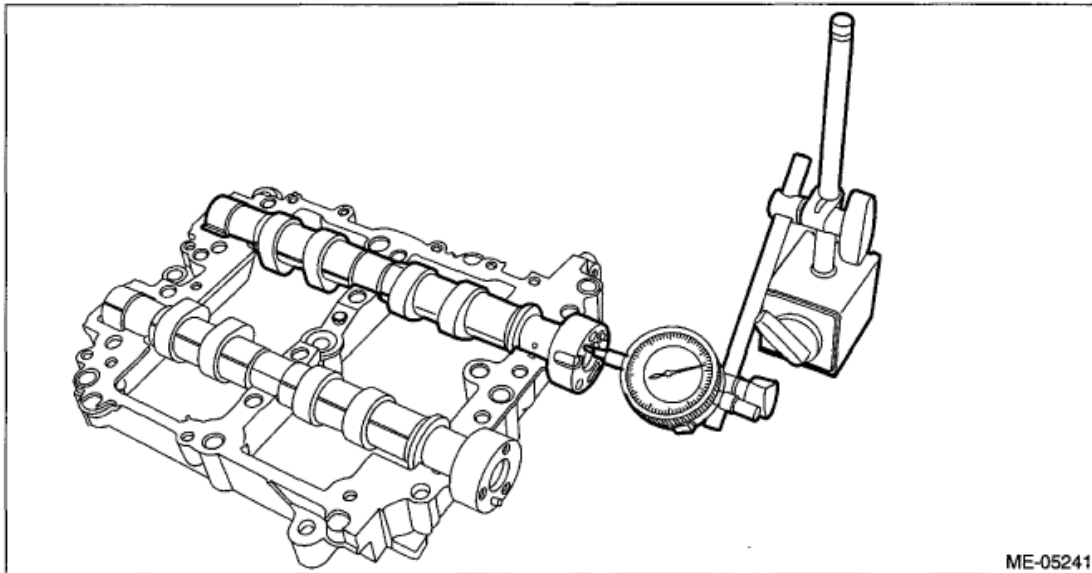


Fig. 287: Checking Camshaft Thrust Clearance Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

CYLINDER HEAD

REMOVAL

CYLINDER HEAD RH

1. Remove the engine from the vehicle. < refer to **REMOVAL**, Engine Assembly >
2. Remove the intake manifold. < refer to **REMOVAL**, Intake Manifold >
3. Remove the tumble generator valve assembly RH. < refer to **REMOVAL**, Tumble Generator Valve Assembly >
4. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
5. Remove the rocker cover RH. < refer to **ROCKER COVER RH**, REMOVAL, Rocker Cover >
6. Remove the cam carrier RH. < refer to **CAM CARRIER RH**, REMOVAL, Cam Carrier >

7. Remove the EGR pipe assembly from the water pipe assembly and the cylinder block RH.

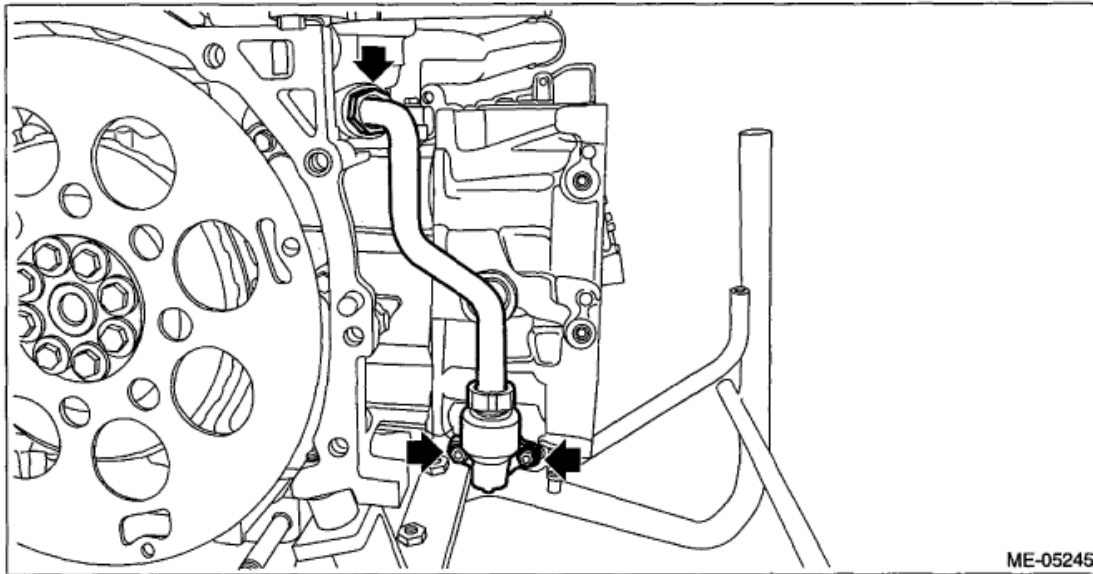


Fig. 288: Locating EGR Pipe Assembly With Bolts
Courtesy of SUBARU OF AMERICA, INC.

8. Loosen the bolts holding the cylinder head RH equally, a little at a time in numerical sequence and while leaving the cylinder head bolts (1) and (4) engaged by three or four threads, remove the other cylinder head bolts.

NOTE: Leave the cylinder head bolts (1) and (4) engaged by three or four threads to prevent the cylinder head RH from falling.

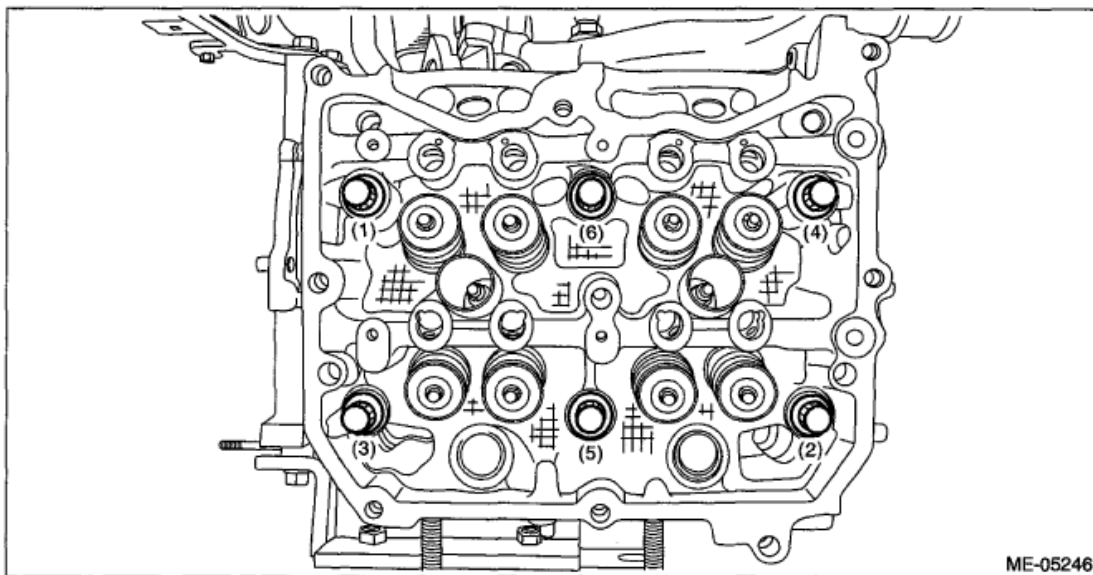


Fig. 289: Identifying Cylinder Head RH Bolts Loosening Bolts

Courtesy of SUBARU OF AMERICA, INC.

9. While tapping the cylinder head RH with a plastic hammer, separate it from cylinder block RH.
10. Remove the bolts (1) and (4) to remove cylinder head RH.
11. Remove the cylinder head gasket RH.

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

12. Remove the liquid gasket from cylinder head RH and cam carrier RH.

CYLINDER HEAD LH

1. Remove the engine from the vehicle. < refer to **REMOVAL**, Engine Assembly >
2. Remove the intake manifold. < refer to **REMOVAL**, Intake Manifold >
3. Remove the tumble generator valve assembly LH. < refer to **REMOVAL**, Tumble Generator Valve Assembly >
4. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
5. Remove the rocker cover LH. < refer to **ROCKER COVER LH**, REMOVAL, Rocker Cover >
6. Remove the cam carrier LH. < refer to **CAM CARRIER LH**, REMOVAL, Cam Carrier >
7. Remove the bolt securing the A/C compressor bracket to the cylinder head LH, and remove the A/C compressor bracket.

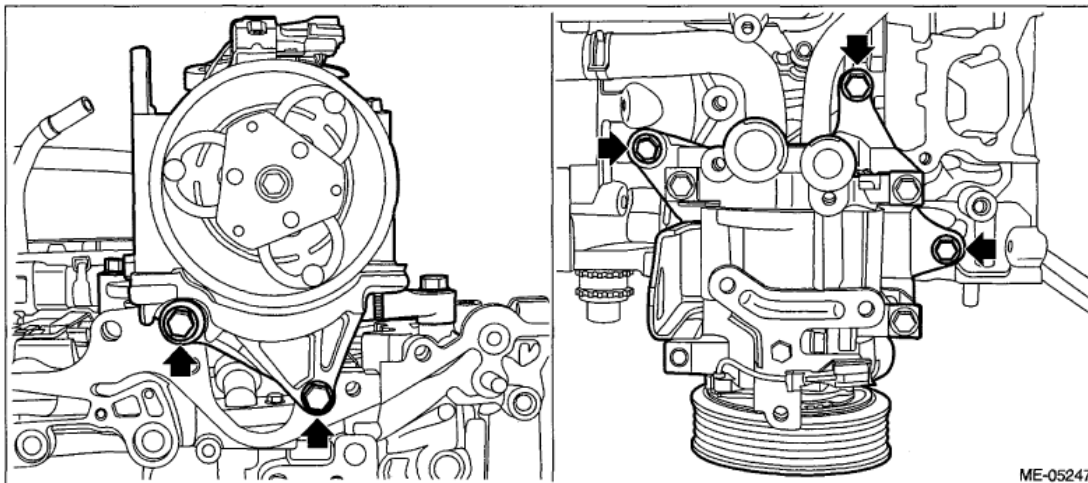


Fig. 290: Locating A/C Compressor Bracket Bolts Of Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

8. Loosen the bolts holding the cylinder head LH equally, a little at a time in numerical sequence and while leaving the cylinder head bolts (1) and (4) engaged by three or four threads, remove the other cylinder head bolts.

NOTE: Leave the cylinder head bolts (1) and (4) engaged by three or four threads to prevent the cylinder head LH from falling.

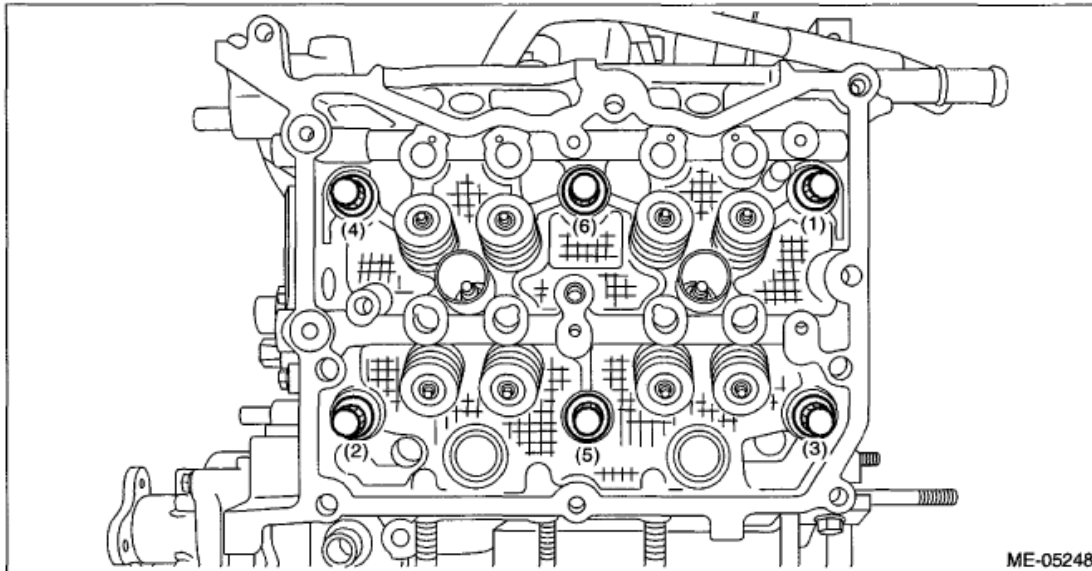


Fig. 291: Identifying Cylinder Head LH Bolts Loosening Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. While tapping the cylinder head LH with a plastic hammer, separate it from cylinder block LH.
10. Remove the cylinder head bolts (1) and (4) to remove cylinder head LH.
11. Remove the cylinder head gasket LH.

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

12. Remove the liquid gasket from cylinder head LH and cam carrier LH.

INSTALLATION

CYLINDER HEAD RH

1. Clean the bolt holes in the cylinder block RH.

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 liquid gasket to both sides of the cylinder head gasket RH as shown in the figure.

NOTE: • Use a new cylinder head gasket RH.

- Before applying liquid gasket, remove oil from the mating surface of the cylinder block RH and the cylinder head RH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket: THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter: 3 ± 1 mm (0.1181 ± 0.0394 in)

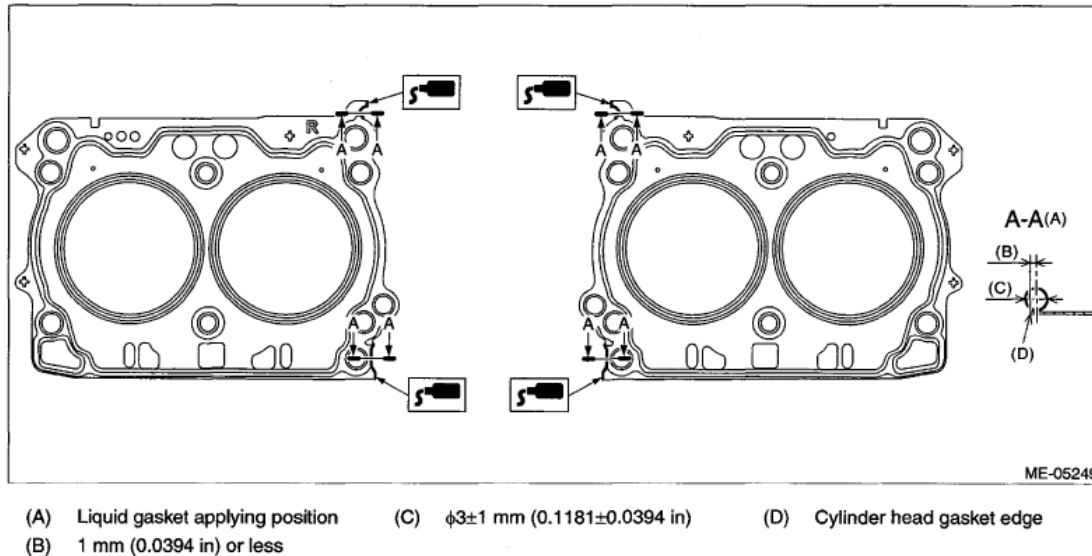


Fig. 292: Identifying Liquid Gasket Applying Area On Both Sides Of Cylinder Head Gasket RH
 Courtesy of SUBARU OF AMERICA, INC.

3. Attach the cylinder head gasket RH.

NOTE: Check that liquid gasket RH is squeezed out from the cylinder head gasket.

4. Install the cylinder head RH to the cylinder block RH.

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

1. Clean the cylinder head bolt threads and apply sufficient engine oil to the washer and cylinder head bolts threads.
2. Mount the cylinder head RH onto the cylinder block RH, then tighten all bolts with a torque of 29 N.m (3.0 kgf-m, 21.4 ft-lb) in numerical order as shown in the figure.

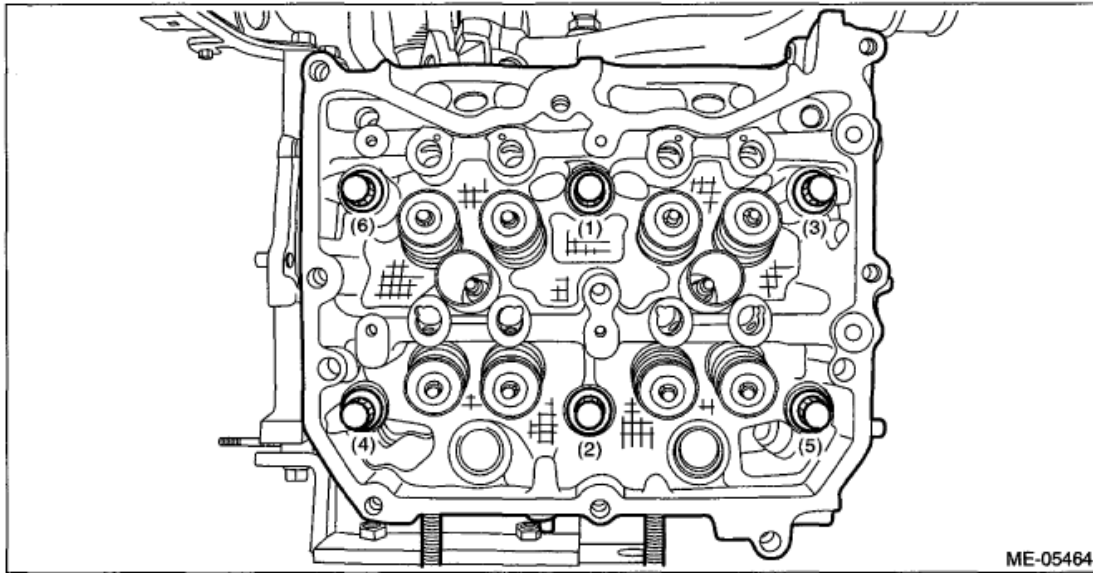


Fig. 293: Identifying Cylinder Head RH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten all cylinder head bolts further with a torque of 100 N.m (10.2 kgf-m, 73.8 ft-lb) in numerical order as shown in the figure.

CAUTION: If the bolt makes stick-slip sound during tightening, repeat the procedure from step 1). In that case, the cylinder head gasket RH can be reused. But it is necessary to remove liquid gasket completely from cylinder block RH, cylinder head RH and cylinder head gasket RH and re-apply to them.

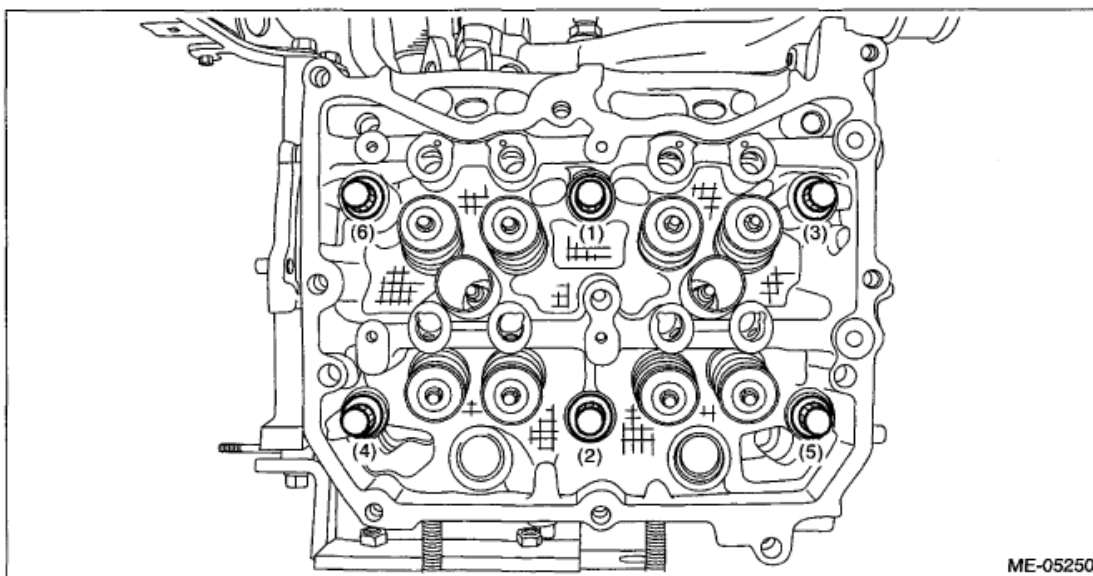


Fig. 294: Identifying Cylinder Head Bolts Tightening Sequence

Courtesy of SUBARU OF AMERICA, INC.

4. Loosen all cylinder head bolts 180° in numerical order as shown in the figure, and then loosen all cylinder head bolts 180° further in numerical order as shown in the figure.

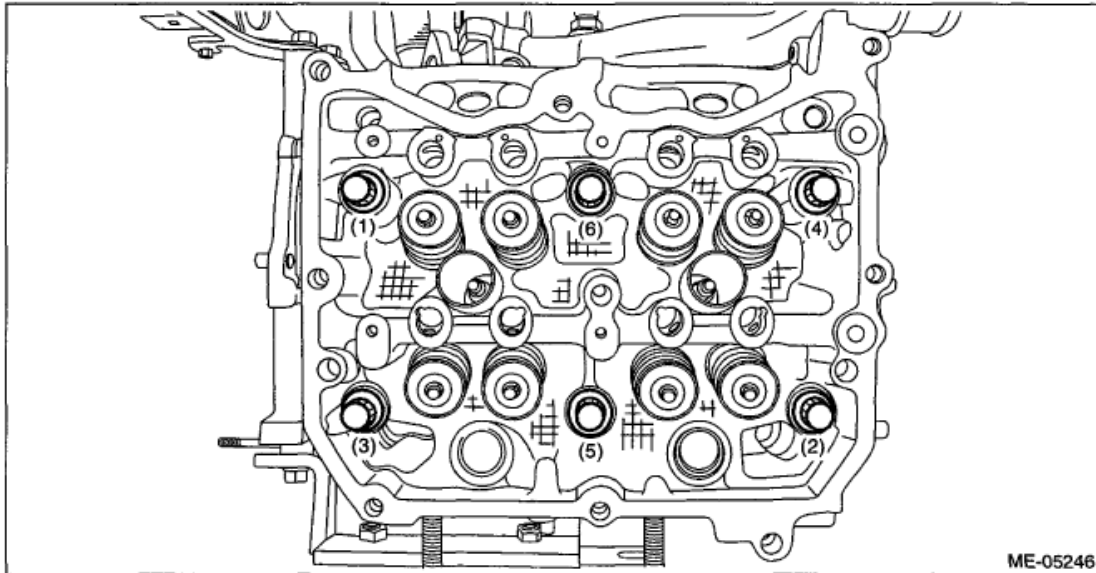


Fig. 295: Identifying Cylinder Head Bolts Loosening Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Tighten all cylinder head bolts with a torque of 42 N.m (4.3 kgf-m, 31.0 ft-lb) in numerical order as shown in the figure.

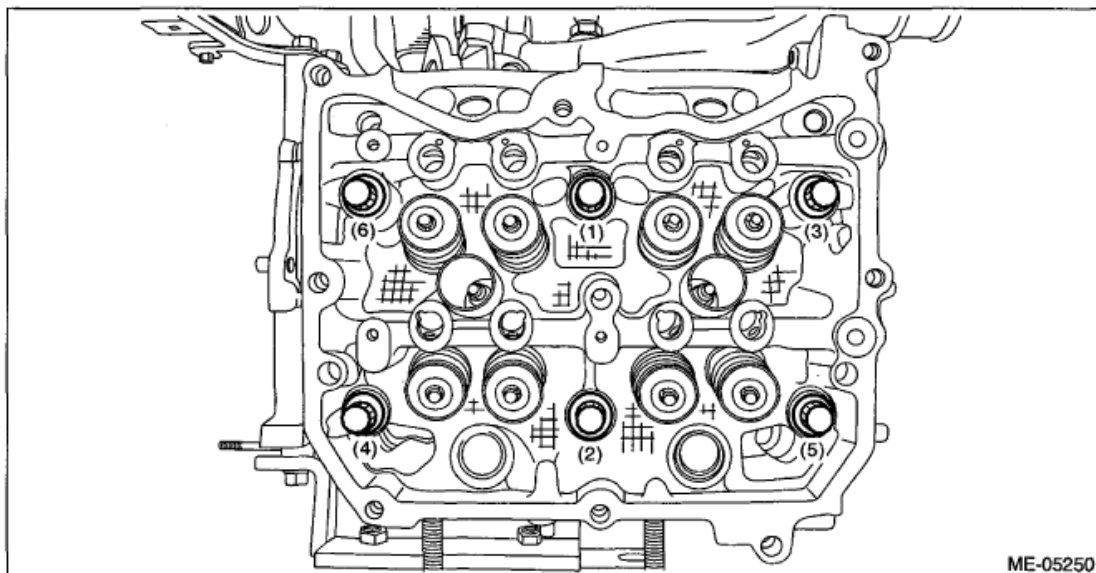


Fig. 296: Identifying Cylinder Head Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Tighten all cylinder head bolts with specified angle in numerical order as shown in the figure using ST2.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle: $80^{\circ} \pm 2^{\circ}$

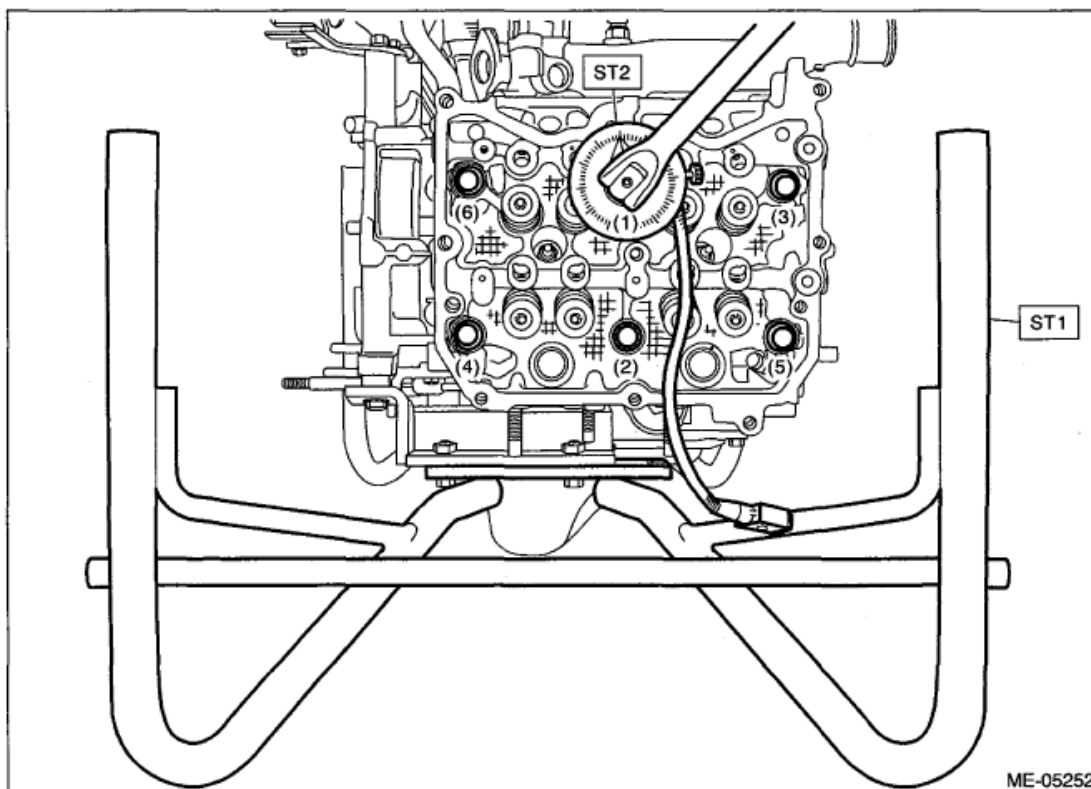


Fig. 297: Tightening Cylinder Head Bolts (Tightening Angle $80^{\circ} \pm 2^{\circ}$)
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten the cylinder head bolts (2 places) with specified angle in numerical order as shown in the figure using ST2.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle: $75^{\circ} \pm 2^{\circ}$

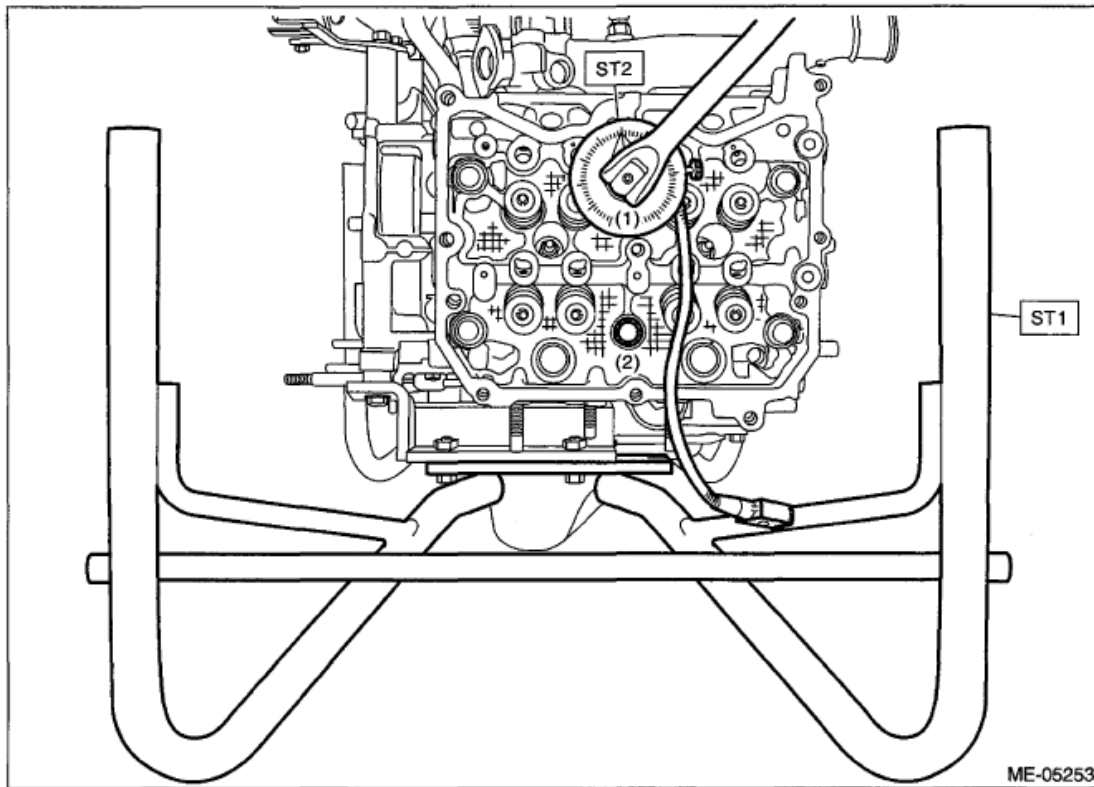


Fig. 298: Tightening Cylinder Head Bolts (Tightening Angle $75^{\circ} \pm 2^{\circ}$)
Courtesy of SUBARU OF AMERICA, INC.

8. Tighten the cylinder head bolts (4 places) with specified angle in numerical order as shown in the figure using ST2.

NOTE:

- After tightening, if the liquid gasket is squeezed out onto the seal surface of the chain cover, completely remove any squeezed-out liquid gasket.
- Attach the magnet used for securing the ST2 (ANGLE GAUGE) to ST1.

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle: $30^{\circ} \pm 2^{\circ}$

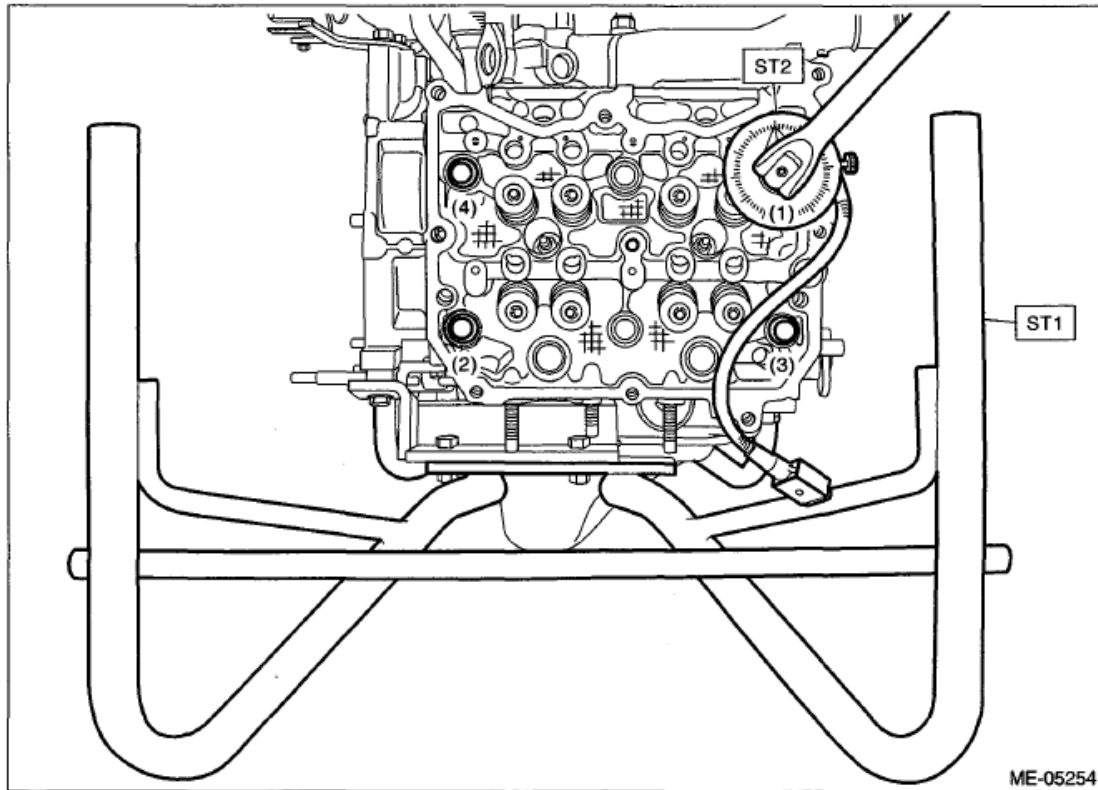


Fig. 299: Tightening Cylinder Head Bolts (Tightening Angle $30^{\circ} \pm 2^{\circ}$)
 Courtesy of SUBARU OF AMERICA, INC.

5. Install the EGR pipe assembly to the water pipe assembly and the cylinder block RH.

NOTE: Use a new gasket.

Tightening torque:

T1: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

T2: 51 N.m (5.2 kgf-m, 37.6 ft-lb)

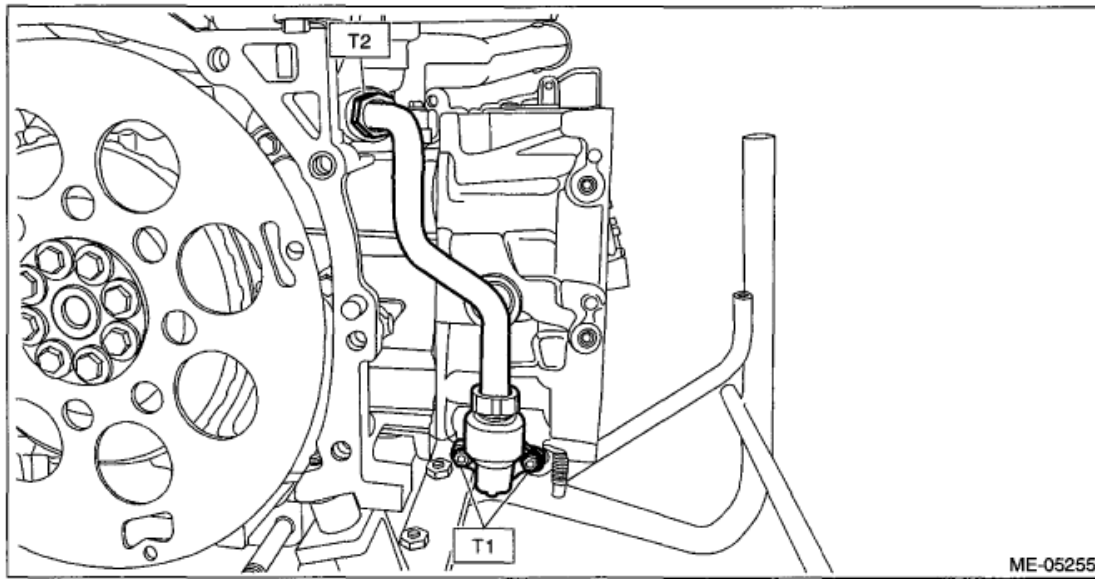


Fig. 300: Identifying EGR Pipe Assembly With Bolts
 Courtesy of SUBARU OF AMERICA, INC.

6. Install the cam carrier RH. < refer to CAM CARRIER RH, INSTALLATION, Cam Carrier >
7. Install the rocker cover RH. < refer to ROCKER COVER RH, INSTALLATION, Rocker Cover >
8. Install the chain cover. < refer to INSTALLATION, Chain Cover >
9. Install the tumble generator valve assembly RH. < refer to INSTALLATION , Tumble Generator Valve Assembly >
10. Install the intake manifold. < refer to INSTALLATION , Intake Manifold >
11. Install the engine to the vehicle. < refer to INSTALLATION, Engine Assembly >

CYLINDER HEAD LH

1. Clean the bolt holes in the cylinder block LH.

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

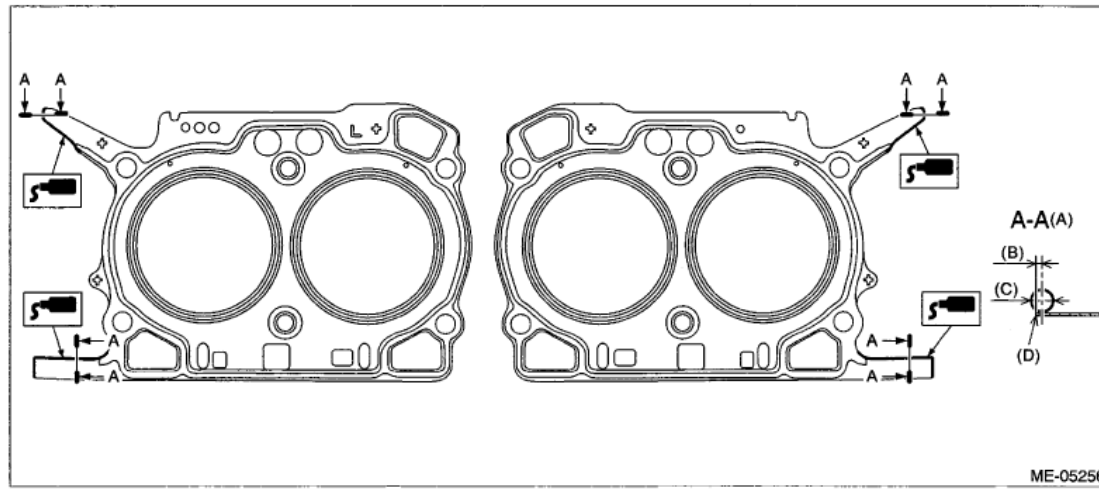
2. Apply liquid gasket to both sides of the cylinder head gasket LH as shown in the figure.

NOTE:

- Use a new cylinder head gasket LH.
- Before applying liquid gasket, remove oil from the mating surface of the cylinder block LH and the cylinder head LH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket: THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter: 3 ± 1 mm (0.1181 ± 0.0394 in)



- (A) Liquid gasket applying position (C) $\phi 3\pm1$ mm (0.1181 ± 0.0394 in) (D) Cylinder head gasket edge
 (B) 1 mm (0.0394 in) or less

Fig. 301: Identifying Liquid Gasket Applying Area On Both Sides Of Cylinder Head Gasket LH
 Courtesy of SUBARU OF AMERICA, INC.

3. Attach the cylinder head gasket LH.

NOTE: Check that liquid gasket is squeezed out from the cylinder head gasket LH.

4. Install the cylinder head LH to the cylinder block LH.

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

1. Clean the cylinder head bolt threads and apply sufficient engine oil to the washer and cylinder head bolts threads.
2. Mount the cylinder head LH onto the cylinder block LH, then tighten all bolts with a torque of 29 N.m (3.0 kgf-m, 21.4 ft-lb) in numerical order as shown in the figure.

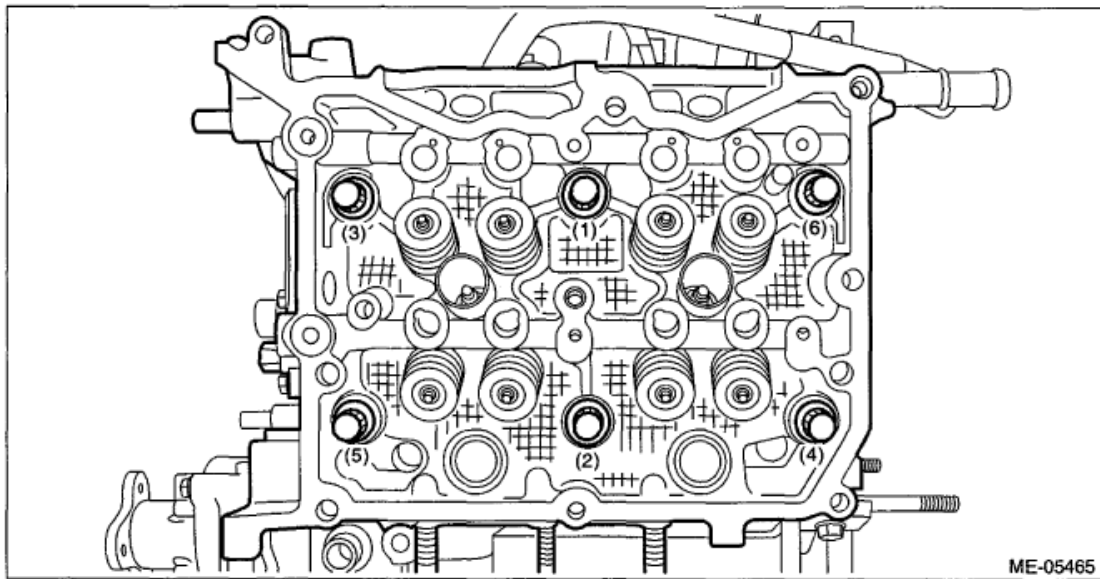


Fig. 302: Identifying Cylinder Head LH Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten all cylinder head bolts further with a torque of 100 N.m (10.2 kgf-m, 73.8 ft-lb) in numerical order as shown in the figure.

CAUTION: If the bolt makes stick-slip sound during tightening, repeat the procedure from step 1). In that case, the cylinder head gasket LH can be reused. But it is necessary to remove liquid gasket completely from cylinder block LH, cylinder head LH and cylinder head gasket LH and re-apply to them.

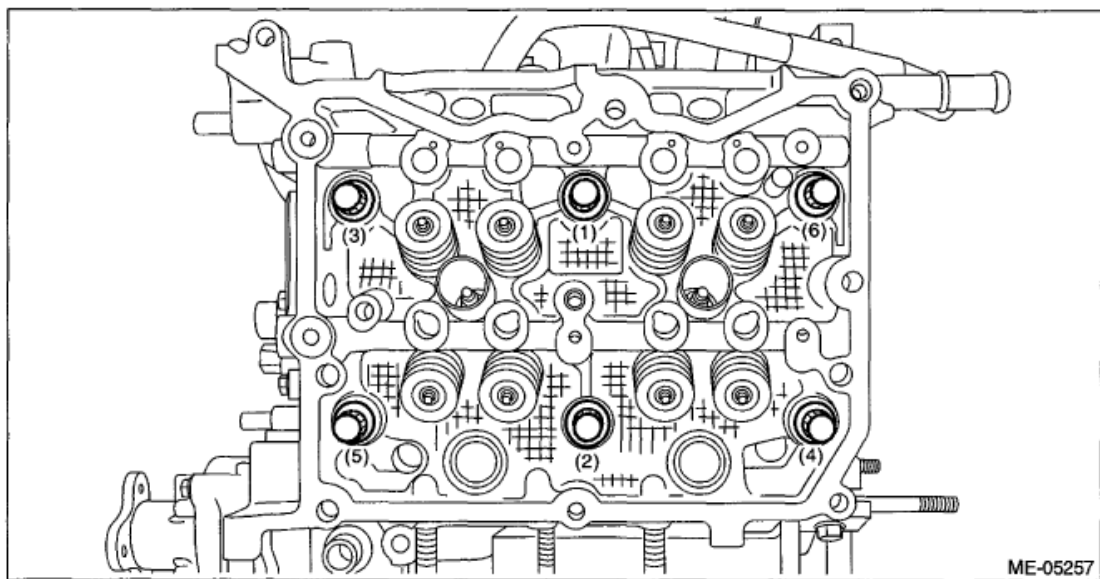


Fig. 303: Identifying Cylinder Head Bolts Tightening Sequence

Courtesy of SUBARU OF AMERICA, INC.

4. Loosen all cylinder head bolts 180° in numerical order as shown in the figure, and then loosen all cylinder head bolts 180° further in numerical order as shown in the figure.

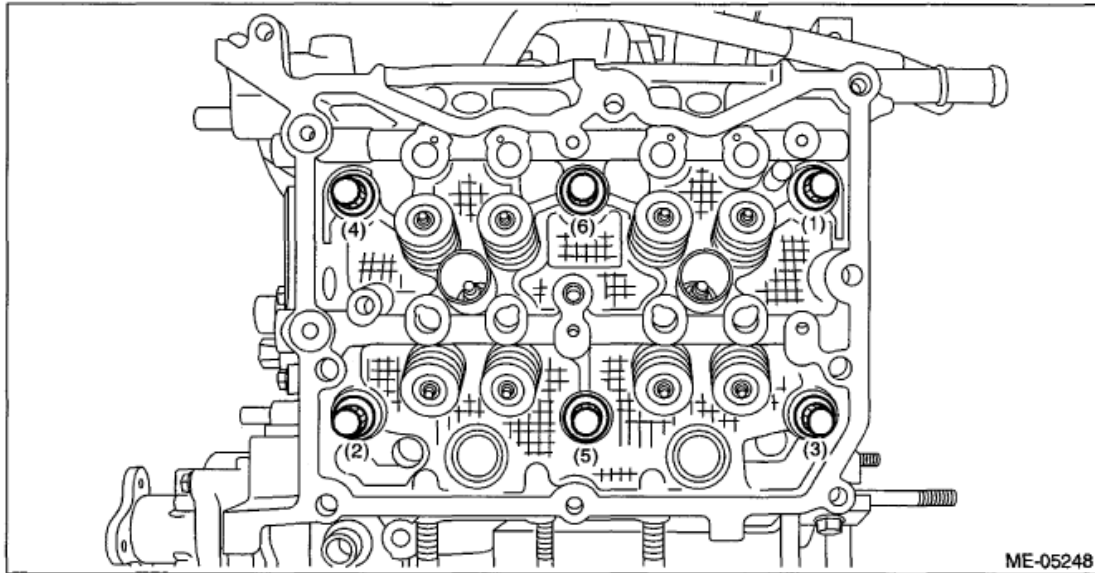


Fig. 304: Identifying Cylinder Head Bolts Loosening Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Tighten all cylinder head bolts with a torque of 42 N.m (4.3 kgf-m, 31.0 ft-lb) in numerical order as shown in the figure.

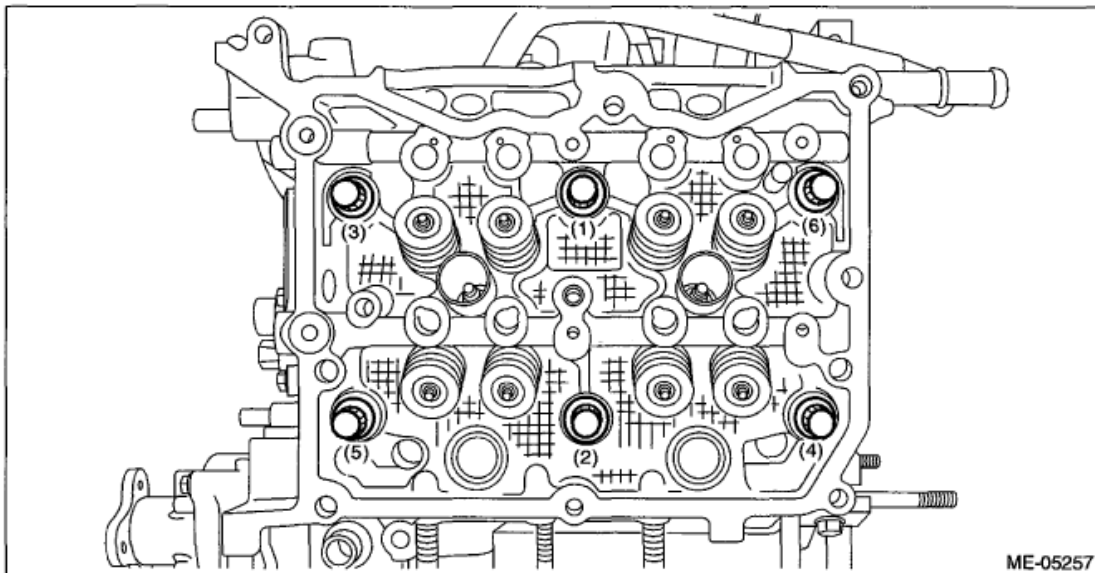


Fig. 305: Identifying Cylinder Head Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Tighten all cylinder head bolts with specified angle in numerical order as shown in the figure using ST2.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle: $80^{\circ} \pm 2^{\circ}$

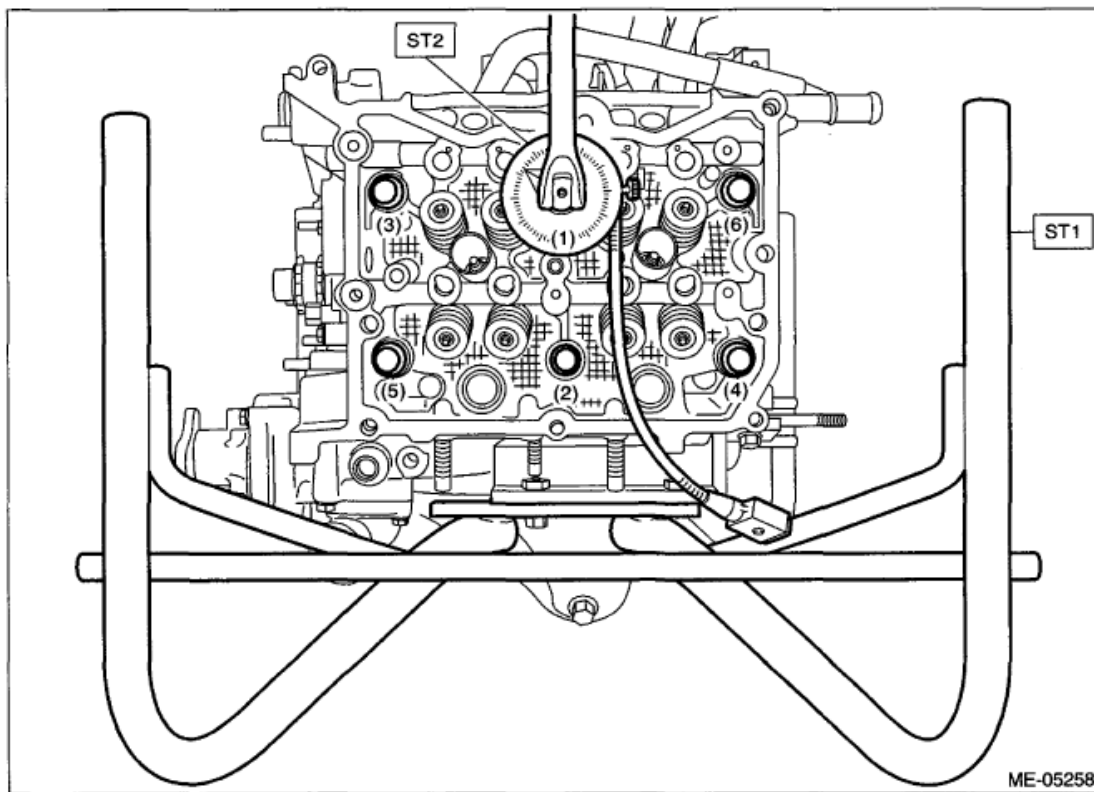


Fig. 306: Tightening Cylinder Head Bolts (Tightening Angle $80^{\circ} \pm 2^{\circ}$)
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten the cylinder head bolts (2 places) with specified angle in numerical order as shown in the figure using ST2.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle: $75^{\circ} \pm 2^{\circ}$

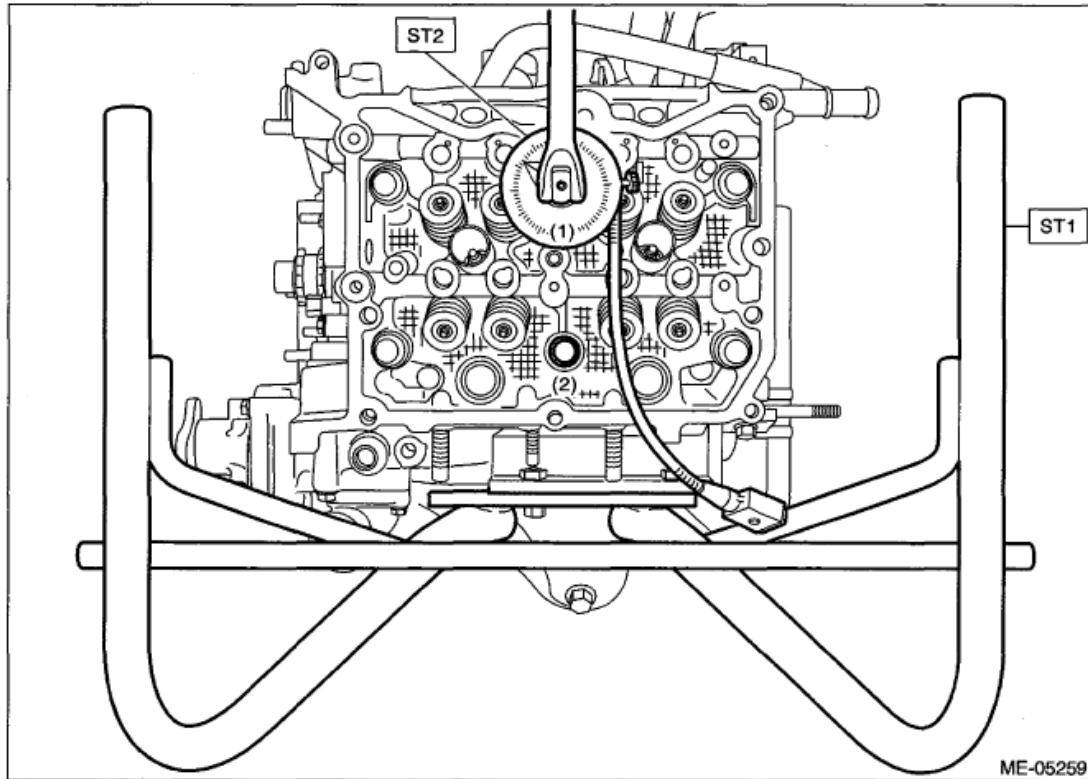


Fig. 307: Tightening Cylinder Head Bolts (Tightening Angle $75^{\circ} \pm 2^{\circ}$)
Courtesy of SUBARU OF AMERICA, INC.

8. Tighten the cylinder head bolts (4 places) with specified angle in numerical order as shown in the figure using ST2.

NOTE:

- After tightening, if the liquid gasket is squeezed out onto the seal surface of the chain cover, completely remove any squeezed-out liquid gasket.
- Attach the magnet used for securing the ST2 (ANGLE GAUGE) to ST1.

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle: $30^{\circ} \pm 2^{\circ}$

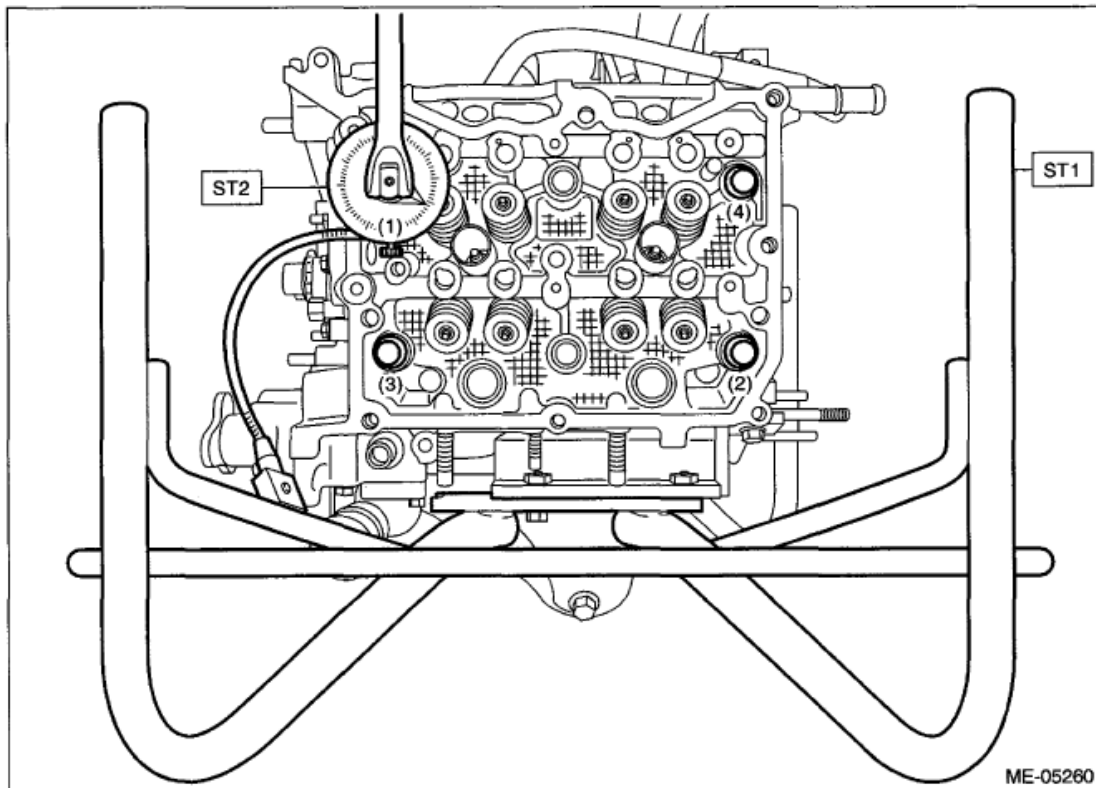


Fig. 308: Tightening Cylinder Head Bolts
Courtesy of SUBARU OF AMERICA, INC.

- Set the A/C compressor bracket to the cylinder head LH, and tighten the bolts in numerical order as shown in the figure.

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

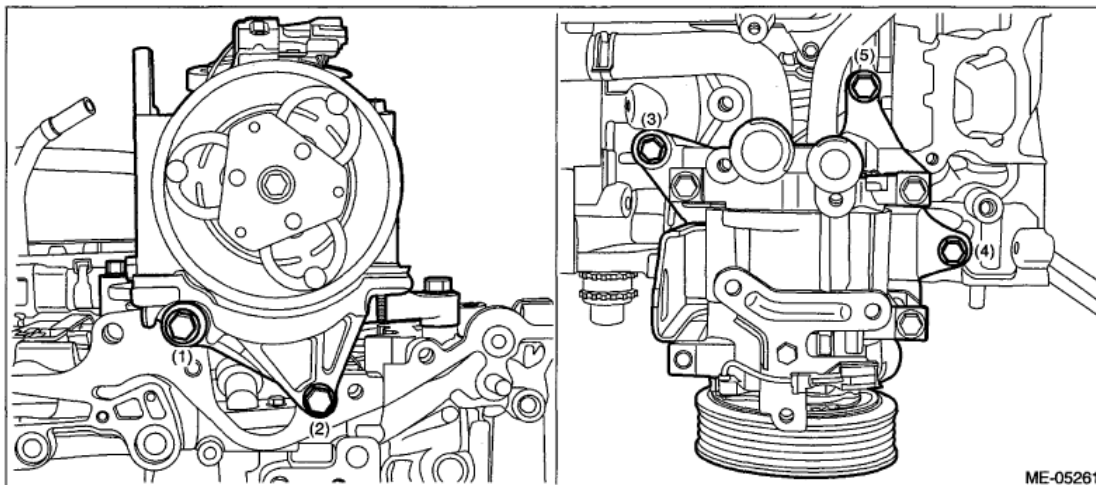


Fig. 309: Identifying A/C Compressor Bracket Bolts Of Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

6. Install the cam carrier LH. < refer to **CAM CARRIER LH, INSTALLATION**, Cam Carrier >
7. Install the rocker cover LH. < refer to **ROCKER COVER LH, INSTALLATION**, Rocker Cover >
8. Install the chain cover. < refer to **INSTALLATION**, Chain Cover >
9. Install the tumble generator valve assembly LH. < refer to **INSTALLATION** , Tumble Generator Valve Assembly >
10. Install the intake manifold. < refer to **INSTALLATION** , Intake Manifold >
11. Install the engine to the vehicle. < refer to **INSTALLATION**, Engine Assembly >

DISASSEMBLY

1. Remove the chain cover securing bolt from the cylinder head LH.

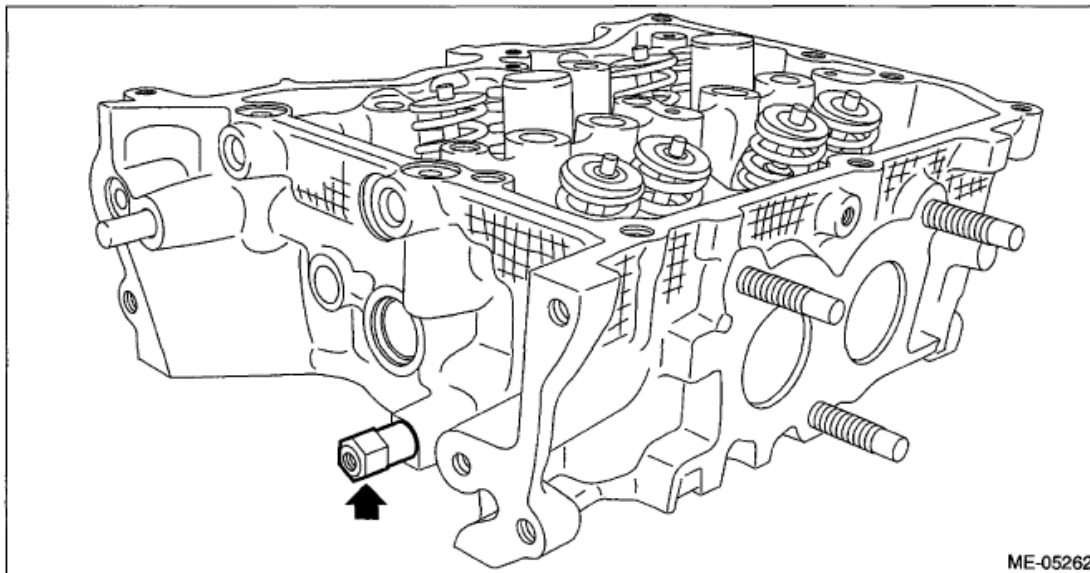


Fig. 310: Locating Chain Cover Securing Bolt Of Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the stud bolts from the cylinder head.

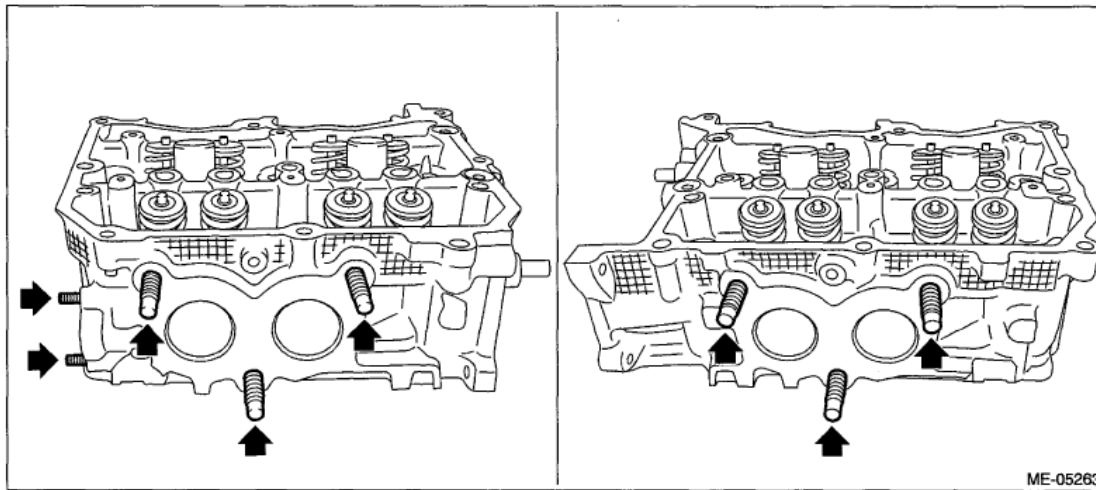


Fig. 311: Locating Stud Bolts Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the valve collet, valve, valve spring retainer, valve spring and valve spring seat from the cylinder head RH.

CAUTION: During work, place a waste cloth, etc. to avoid scratching the mating surface of the cylinder head.

NOTE:

- Mark each part to prevent confusion.
- Keep all the removed parts in order for re-installing in their original positions:
 1. Compress the valve spring and remove the valve collet using ST.

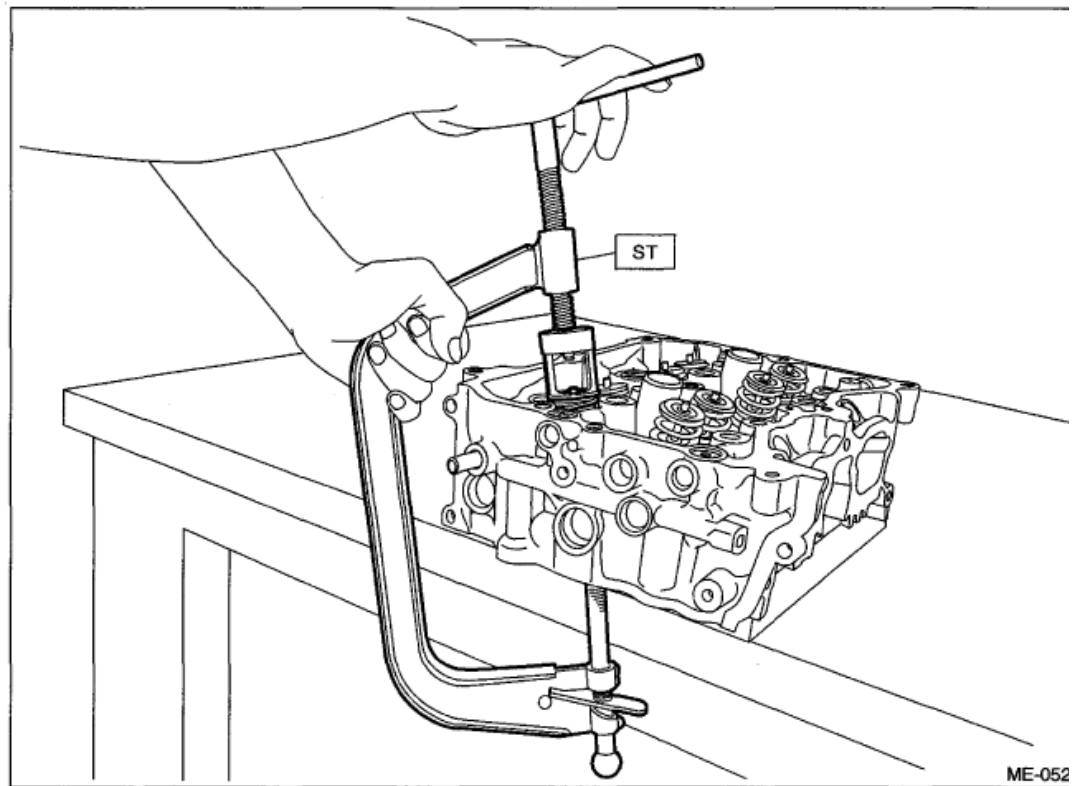


Fig. 312: Compressing Valve Spring Using ST
Courtesy of SUBARU OF AMERICA, INC.

2. Remove valve, valve spring retainer, valve spring and valve spring seat

4. Remove the valve collet, valve, valve spring retainer, valve spring and valve spring seat from the cylinder head LH.
5. Remove the valve oil seal from the valve guide.

CAUTION:

- During work, place a waste cloth, etc. to avoid scratching the mating surface of the cylinder head RH.
- Use special care not to damage the cylinder head RH and guide during work.

NOTE:

For removal of valve guide, refer to INSPECTION. Refer to VALVE GUIDE

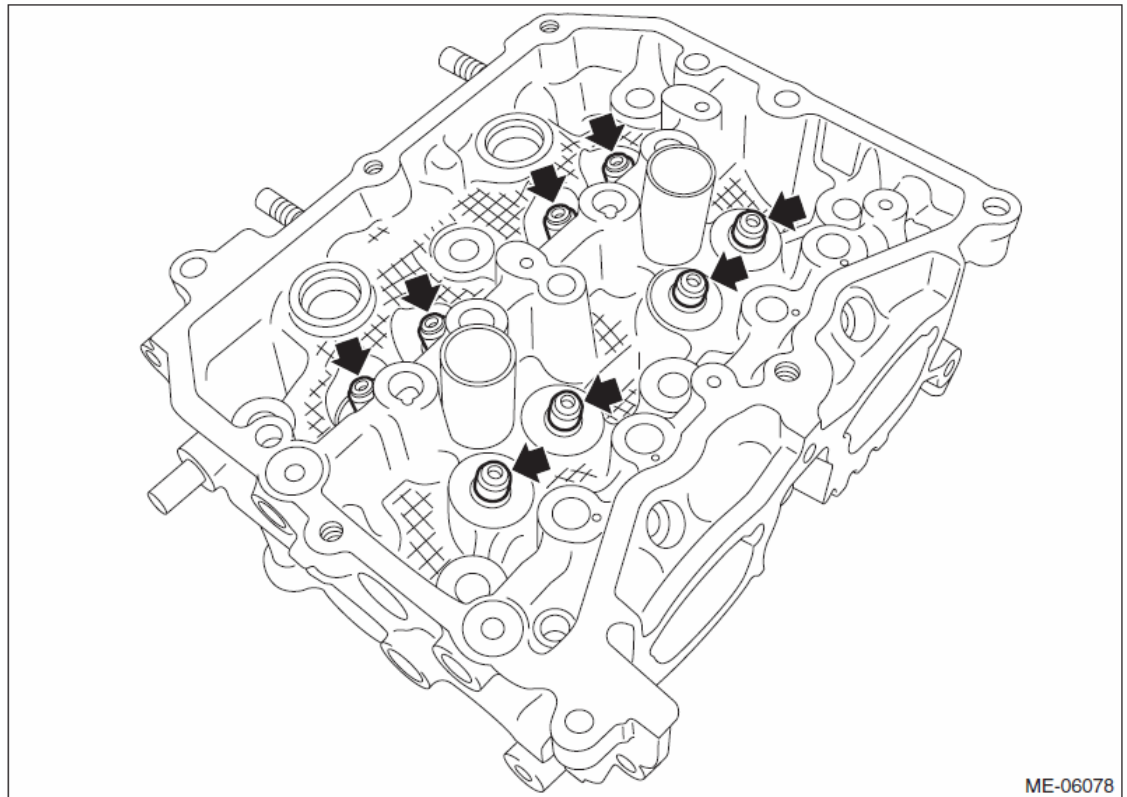
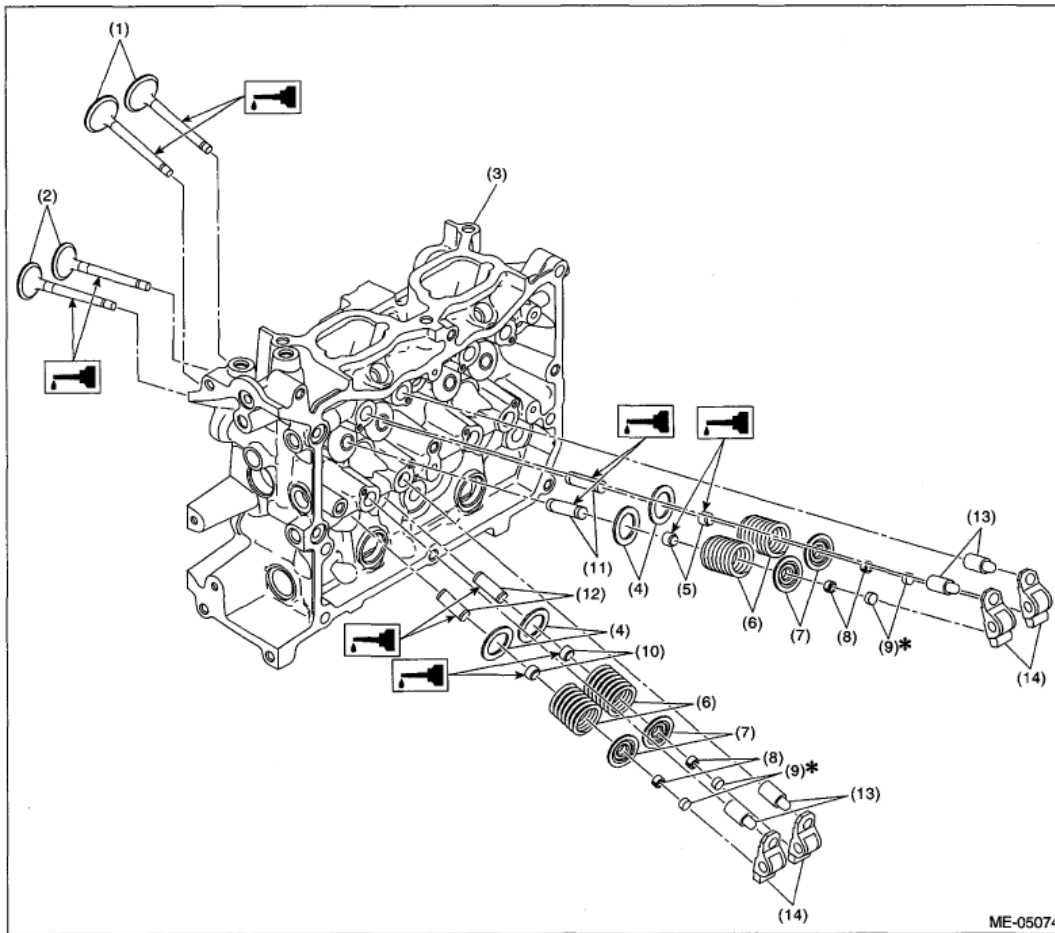


Fig. 313: Identifying Valve Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

6. For cylinder head LH, remove the valve oil seal in the same manner.

ASSEMBLY



- | | | |
|---------------------------|-----------------------------|------------------------------|
| (1) Exhaust valve | (6) Valve spring | (11) Intake valve guide |
| (2) Intake valve | (7) Valve spring retainer | (12) Exhaust valve guide |
| (3) Cylinder head | (8) Valve collet | (13) Roller rocker arm pivot |
| (4) Valve spring seat | (9) Valve shim | (14) Roller rocker arm |
| (5) Intake valve oil seal | (10) Exhaust valve oil seal | |

Fig. 314: Exploded View Of Cylinder Head
 Courtesy of SUBARU OF AMERICA, INC.

1. Using the ST, install the valve oil seal to the valve guide.

CAUTION:

- During work, place a waste cloth, etc. to avoid scratching the mat cylinder head RH.
- Use special care not to damage the cylinder head RH and guide c
- When installing the valve oil seal, press the ST with hands to inst the ST with a plastic hammer, otherwise the valve oil seal can be

NOTE:

- Use a new valve oil seal.
- Apply engine oil to valve oil seal before installing.
- The intake valve oil seals and exhaust valve oil seals are dis colors

Identification colors:

Intake [Gray]

Exhaust [Green]

- For installation of valve guide, refer to **INSPECTION**. Refer to **ST 18261AA010 VALVE OIL SEAL GUIDE**

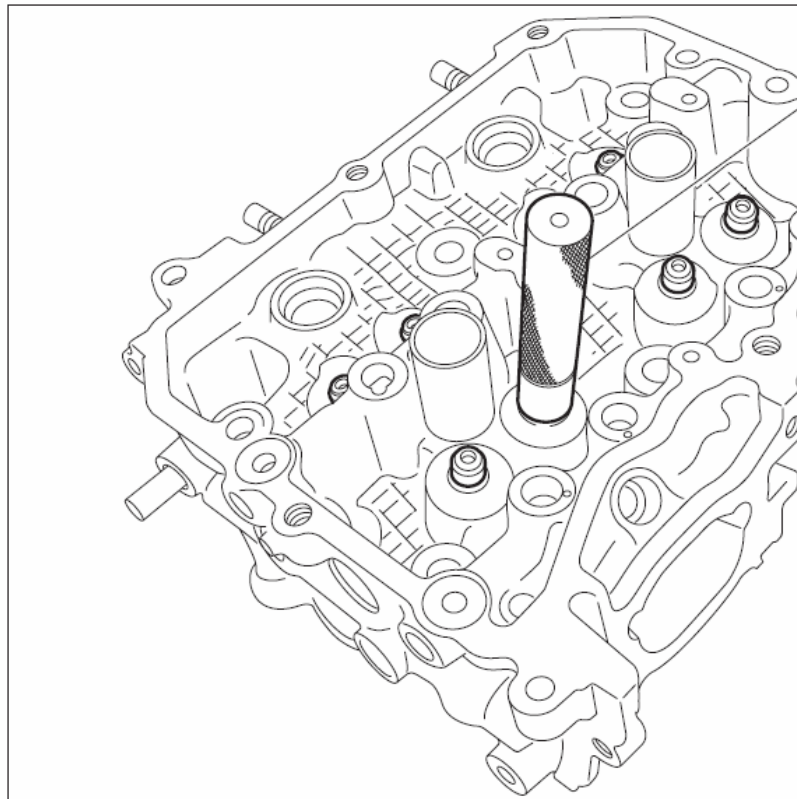


Fig. 315: Installing Valve Oil Seal Guide
Courtesy of SUBARU OF AMERICA, INC.

2. For cylinder head LH, install the valve oil seal in the same manner.
3. Install the valve spring seat, valve spring, valve spring retainer, valve and valve collet to the cylinder head RH.

CAUTION: During work, place a waste cloth, etc. to avoid scratching the mating surface of the cylinder head.

1. Set the valve seat, valve spring and retainer onto the cylinder head.

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

cylinder head side.

2. 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.

3. Compress the valve spring and install the valve collet using ST.

ST 0920287002000 REMOVER AND REPLACER

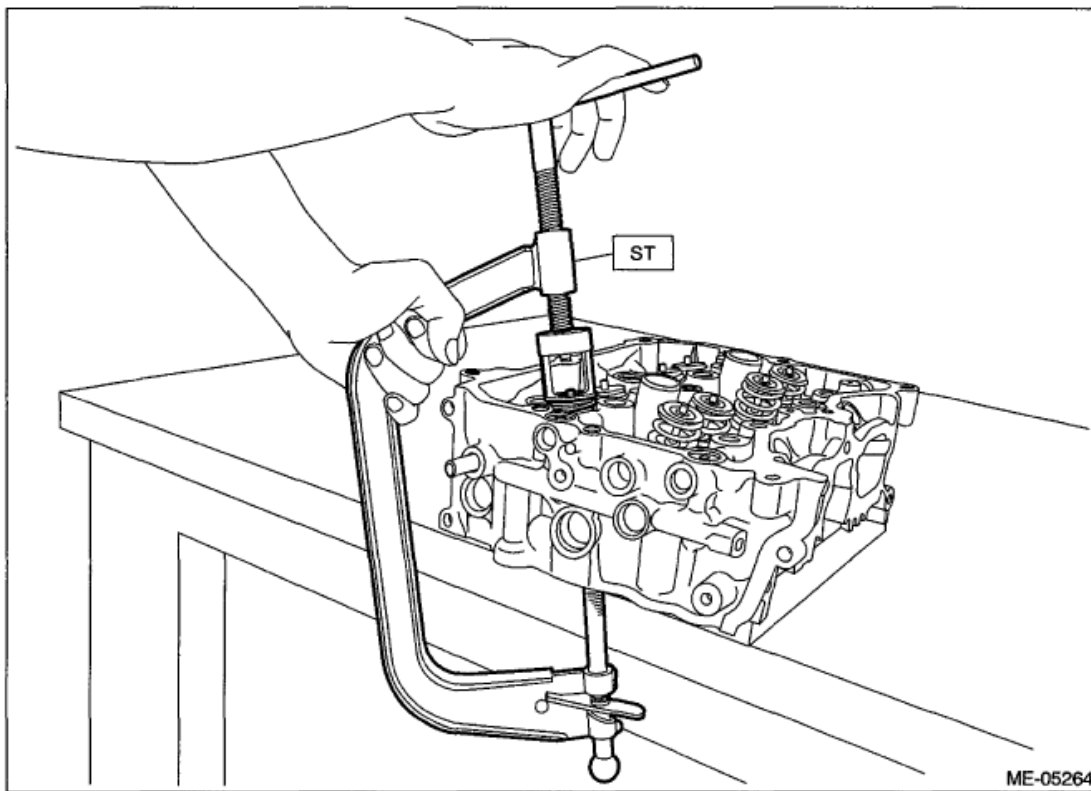


Fig. 316: Compressing Valve Spring Using ST
Courtesy of SUBARU OF AMERICA, INC.

4. Install the valve spring seat, valve spring, valve spring retainer, valve and valve collet to the cylinder head LH.
5. Lightly tap the valve spring retainer with a plastic hammer, and make sure that the valve collet is securely attached.
6. Install the stud bolts onto cylinder heads.

Tightening torque:

T1: 6.4 N.m (0.7 kgf-m, 4.7 ft-lb)

T2: 18 N.m (1.8 kgf-m, 13.3 ft-lb)

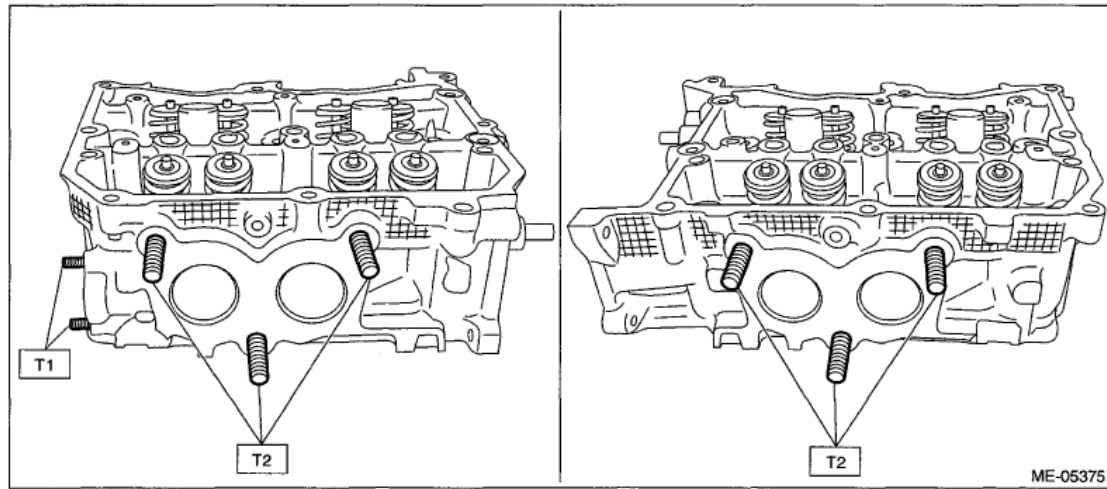


Fig. 317: Identifying Stud Bolts Of Cylinder Heads
Courtesy of SUBARU OF AMERICA, INC.

7. Install the chain cover securing bolt to the cylinder head LH.

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

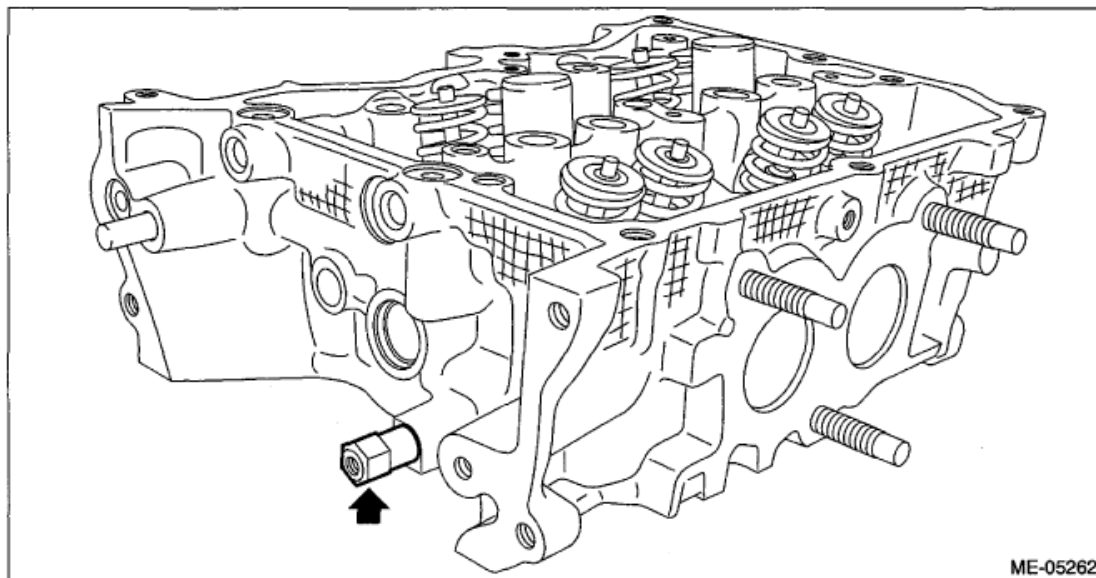


Fig. 318: Locating Chain Cover Securing Bolt Of Cylinder Head LH
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

CYLINDER HEAD

1. Visually inspect to make sure that there are no cracks, scratches or other damage.
2. Use liquid penetrant tester on the important sections to check for fissures.
3. Check that there are no marks of gas leaking or water leaking on gasket attachment surface.
4. Check the warping of the cylinder head mating surface that mates with cylinder block using a straight edge (A) and thickness gauge (B) at the locations shown in the figure. If it exceeds the limit, correct the surface by grinding it with a surface grinder or replace the cylinder head.

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

Warping limit:

0.035 mm (0.0014 in)

Grinding limit:

0.1 mm (0.004 in)

Standard height of cylinder head:

98.5 mm (3.878 in)

NOTE: **If the cylinder head bolt tightening torques and angle tightening is uneven, warpage of the cylinder head may occur. During installation work, make sure that tightening torque and angle tightening work is performed precisely so that it is tightened evenly.**

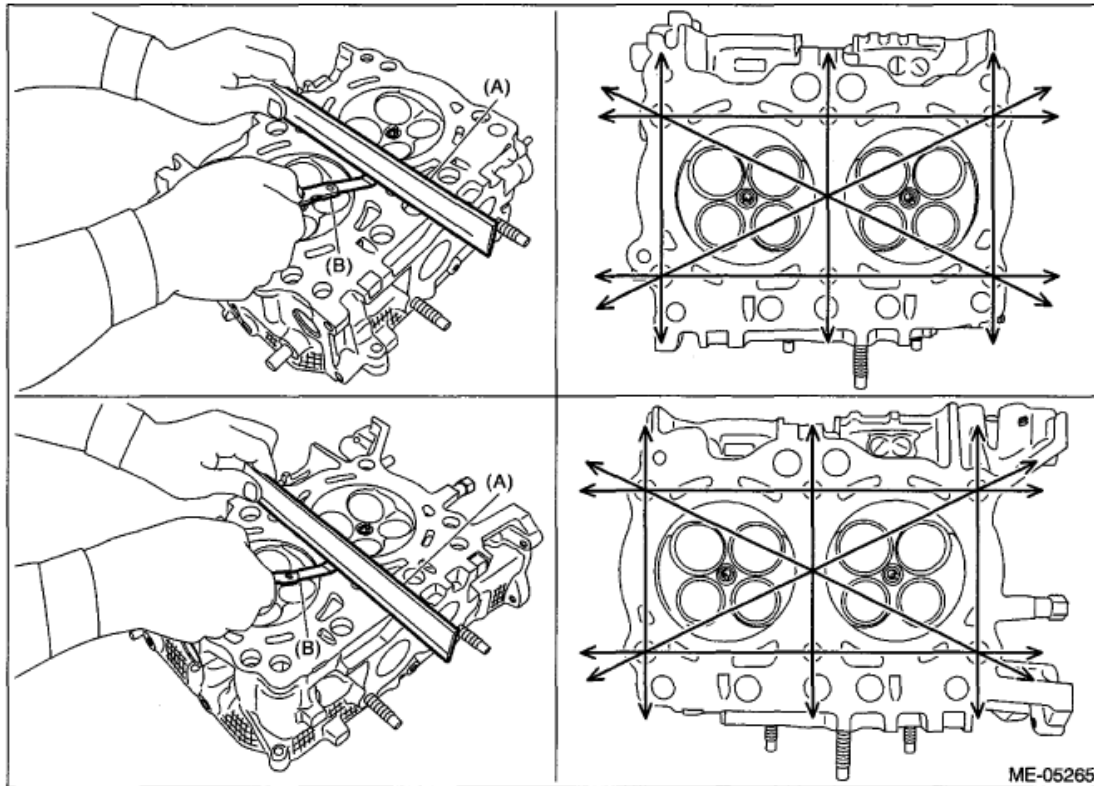


Fig. 319: Checking Warping Of Cylinder Head Mating Surface With Cylinder Block Using Straight Edge And Thickness Gauge

Courtesy of SUBARU OF AMERICA, INC.

VALVE SEAT

Inspect the intake and exhaust valve seats of cylinder head, 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

0.8 - 1.6 mm (0.031 - 0.063 in)

Exhaust

1.1 - 1.7 mm (0.043 - 0.067 in)

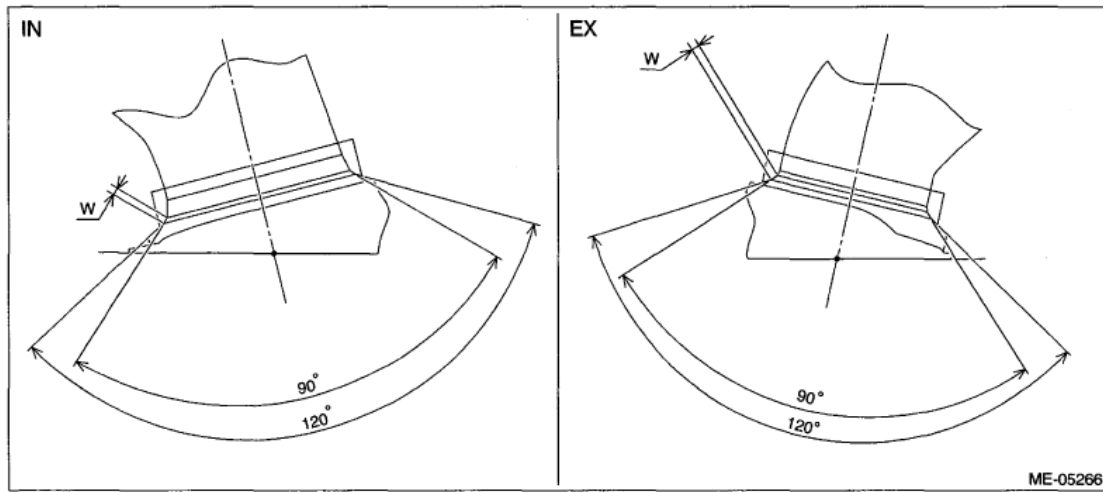


Fig. 320: Identifying Contacting Width Between Valve And Valve Seat
Courtesy of SUBARU OF AMERICA, INC.

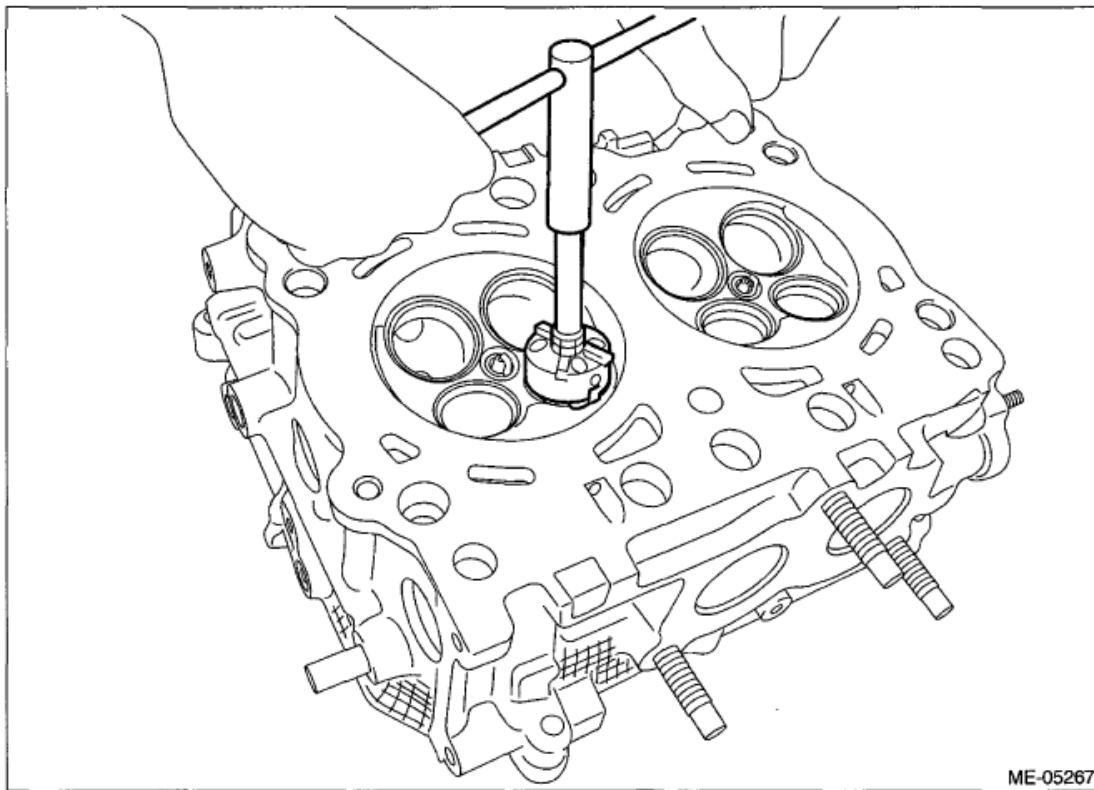


Fig. 321: Tightening Intake And Exhaust Valve Seats Of Cylinder Head
Courtesy of SUBARU OF AMERICA, INC.

VALVE GUIDE

1. Check the clearance between valve guide and valve stem. Check the clearance between valve guide and valve stem by measuring respectively the outer diameter of valve stem and the inner diameter of valve

guide.

1. Measure the outer diameter of valve stem with a micrometer. If it is not within the standard, replace the valve.

NOTE:

- Measurement should be performed at a temperature of 20°C (68° F).
- Measure the outer diameter of the valve stem at the three places as shown in the figure, and take the value of most worn location.
- If the valve is replaced, put a small amount of grinding compound on the valve seat surface of cylinder head, and lap the valve and valve seat surfaces. Replace with a new valve oil seal after lapping. For replacement of valve oil seal, refer to the "INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL". < refer to INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL, INSPECTION, Cylinder Head >

Valve stem outer diameters:

Standard

Intake

5.455 - 5.470 mm (0.2148 - 0.2154 in)

Exhaust

5.445 - 5.460 mm (0.2144 - 0.2150 in)

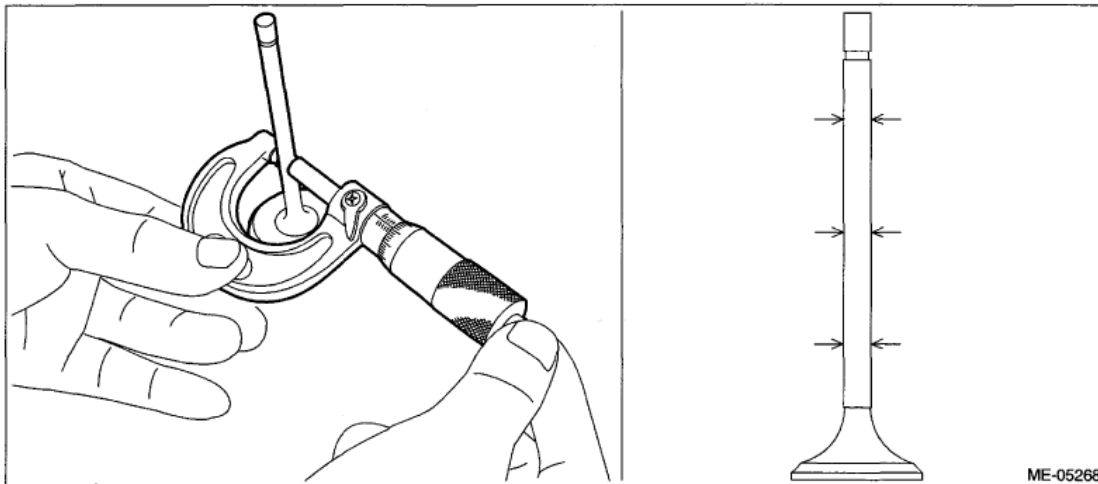


Fig. 322: Measuring Outer Diameter Of Valve Stem Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

2. Using a caliper gauge, measure the inner diameter of valve guide. If it is not within the standard, replace the valve guide. For replacement procedure, refer to step 2).

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

Valve guide inner diameter:

Standard

5.500 - 5.512 mm (0.2165 - 0.2770 in)

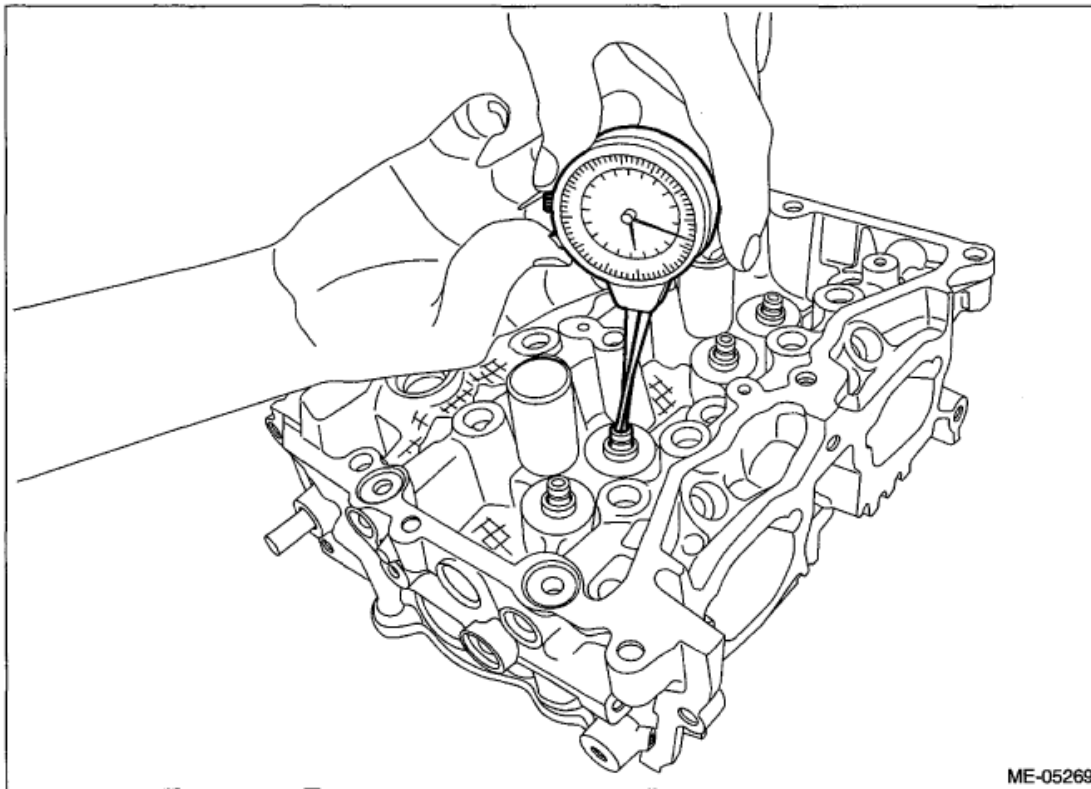


Fig. 323: Measuring Inner Diameter Of Valve Guide Using Caliper Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Calculate the clearance between valve guide and valve stem.

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, whichever shows the greater amount of wear or damage. For replacement procedure of valve guide, refer to the following.

NOTE: If the valve is replaced, put a small amount of grinding compound on the valve seat surface of cylinder head, and lap the valve and valve seat surfaces. Replace with a new valve oil seal after lapping. For replacement of valve oil seal, refer to the "INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL". < refer to INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL, INSPECTION, Cylinder Head >

1. Insert ST into the valve guide with the combustion chamber upward and remove the valve guide using plastic hammer.

CAUTION:

- Place a wood board wrapped with a waste cloth to stabilize the cylinder head before work.
- Use special care not to damage the cylinder head during work.

ST 499765700 VALVE GUIDE REMOVER AND INSTALLER

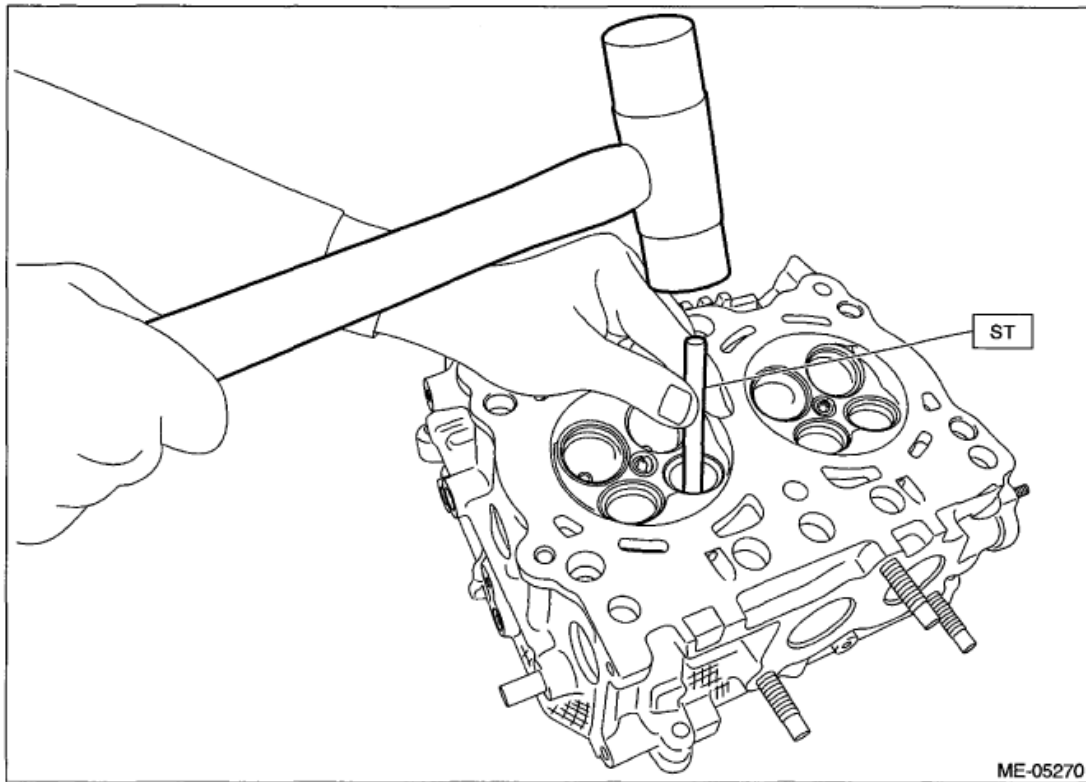


Fig. 324: Removing Valve Guide Using Plastic Hammer
Courtesy of SUBARU OF AMERICA, INC.

2. Before installing the valve guide, make sure that neither scratches nor damages exist on the inner surface of valve guide holes in cylinder head.
3. Draw a reference line (A) for insert on the valve guide using a marker as shown in the figure.

NOTE:

- Use a new valve guide.
- A reference line for insert is used as a guide when tapping-in the valve guide.

Valve guide inserting reference line position L: 15 mm (0.5906 in)

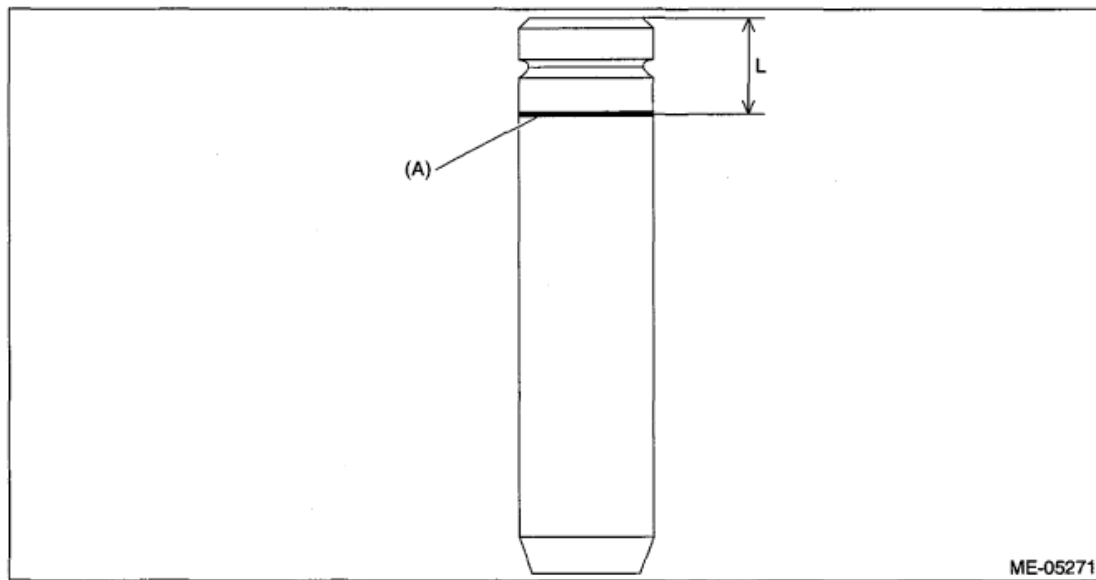


Fig. 325: Identifying Valve Guide Inserting Reference Line Position
Courtesy of SUBARU OF AMERICA, INC.

4. Apply a enough coat of engine oil to the valve guide, and set the valve guide on the cylinder head with the combustion chamber downward.
5. Insert the ST into the valve guide, and tap-in the valve guide to the reference line (A) for insert using plastic hammer.

CAUTION:

- During work, place a waste cloth, etc. to avoid scratching the mating surface of the cylinder head.
- Use special care not to damage the cylinder head during work.

ST 499765700 VALVE GUIDE REMOVER AND INSTALLER

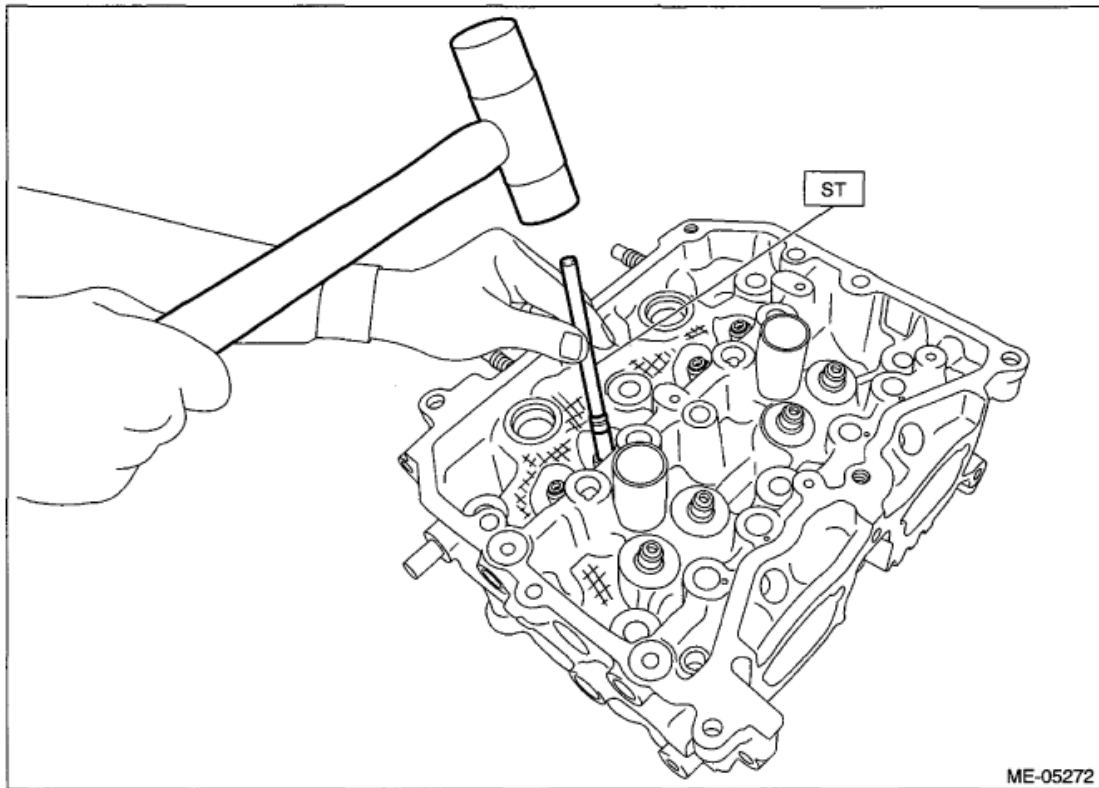


Fig. 326: Inserting ST Into Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

6. Measure the valve guide protrusion amount "L" as shown in the figure using a caliper gauge. Insert the ST into the valve guide again, and tap-in the valve guide so that it is positioned within standard by referring to the measured value using plastic hammer.

CAUTION:

- During work, place a waste cloth, etc. to avoid scratching the mating surface of the cylinder head.
- Use special care not to damage the cylinder head during work.

NOTE:

Be careful not to tap-in excessively by repeating the steps of Tapping-in --> Measurement --> Tapping-in --> Measurement... when installing the valve guide.

ST 499765700 VALVE GUIDE REMOVER AND INSTALLER

Valve guide protrusion amount L:

Standard

11.4 - 11.8 mm (0.449 - 0.465 in)

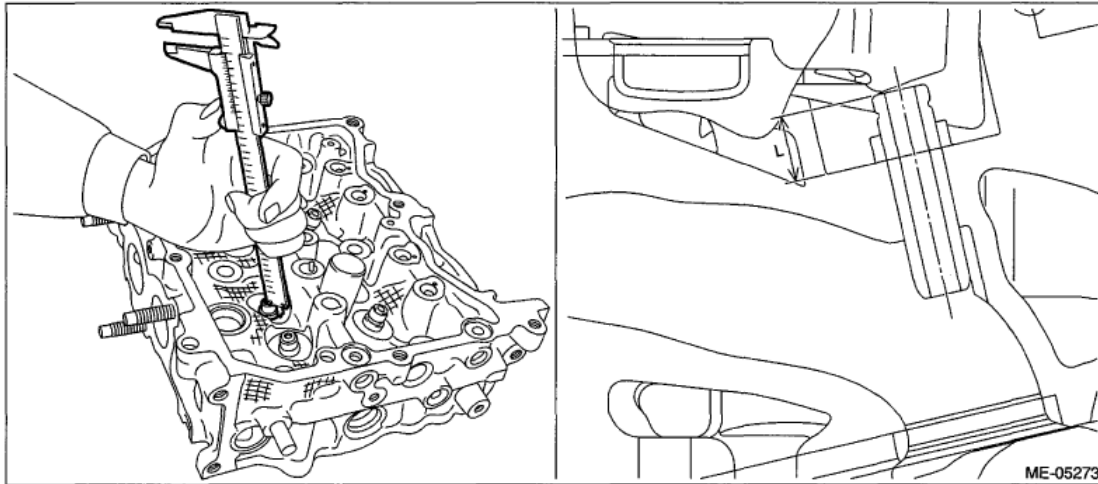


Fig. 327: Measuring Valve Guide Protrusion Amount Using Caliper Gauge
Courtesy of SUBARU OF AMERICA, INC.

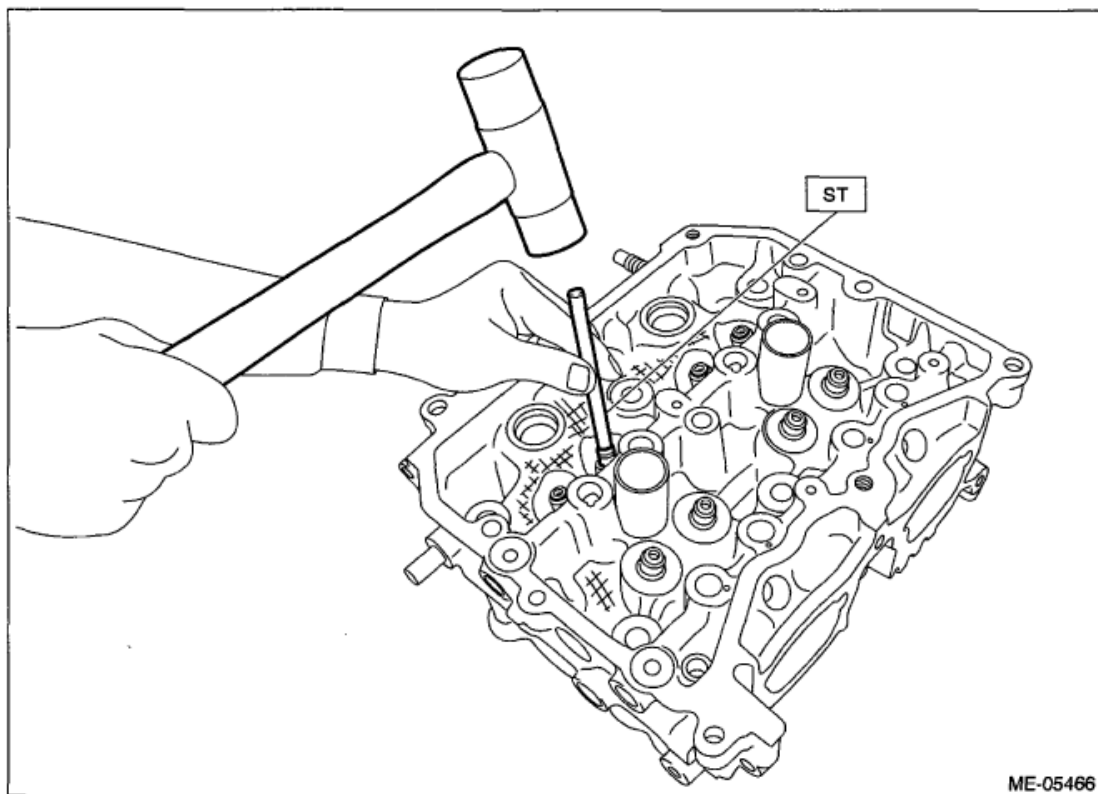


Fig. 328: Inserting ST Into Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

7. Ream the inside of valve guide with the combustion chamber upward 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.

CAUTION:

- Place a wood board wrapped with a waste cloth to stabilize the cylinder head before work.
- Use special care not to damage the cylinder head during work.

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 499765900 VALVE GUIDE REAMER

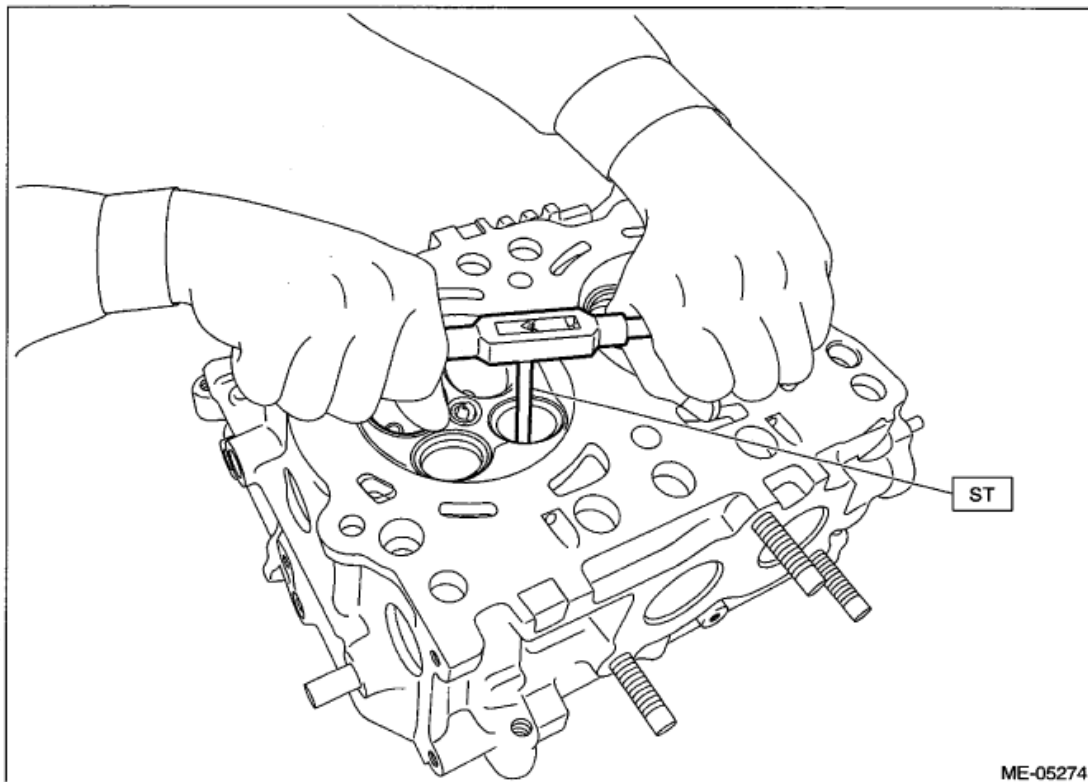


Fig. 329: Reaming Inside Of Valve Guide Using Valve Guide Reamer
Courtesy of SUBARU OF AMERICA, INC.

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 VALVE AND EXHAUST VALVE

1. Check the valve flange and valve stem for damage, wear or deformation.

2. Check the height "H" in the figure using a caliper gauge. If it is not within the standard, replace the valve.

NOTE:

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

Valve overall length:***Intake******103.8 mm (4.087 in)******Exhaust******94.1 mm (3.705 in)***

- If the valve is replaced, put a small amount of grinding compound on the valve seat surface of cylinder head, and lap the valve and valve seat surfaces. Replace with a new valve oil seal after lapping. For replacement of valve oil seal, refer to the "INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL". < refer to INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL, INSPECTION, Cylinder Head >

Head edge thickness H:***Standard******Intake (A)******0.8 - 1.2 mm (0.031 - 0.047 in)******Exhaust (B)******1.0 - 1.4 mm (0.039 - 0.055 in)***

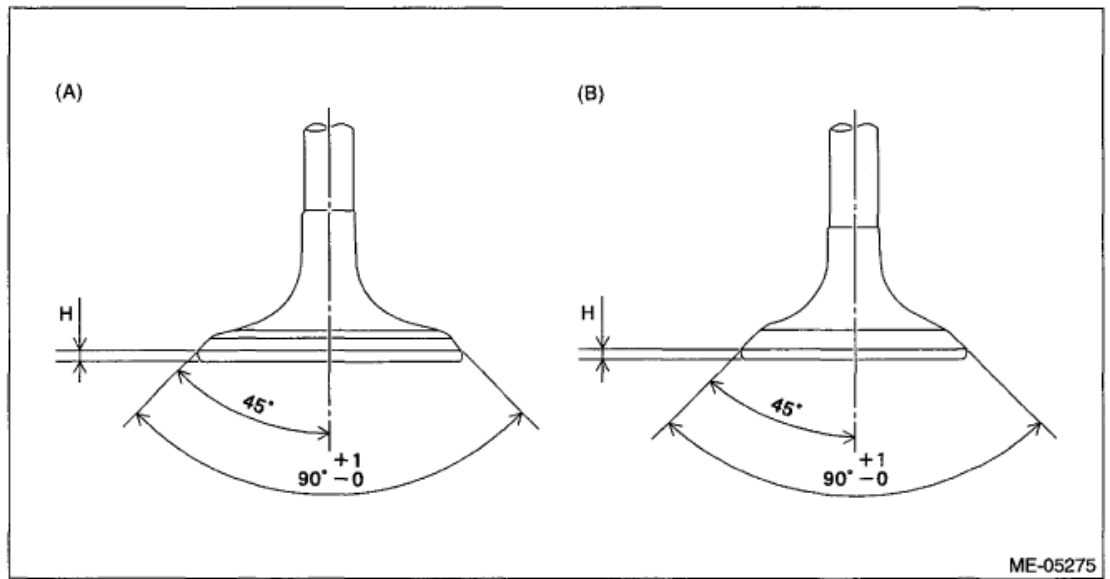


Fig. 330: Identifying Intake Valve And Exhaust Valve Dimension
Courtesy of SUBARU OF AMERICA, INC.

VALVE SPRING

1. Check the valve spring for damage and deformation.
2. Check the valve spring free length, tension and squareness. If it is not within the standard, replace the valve spring.

NOTE: To check the squareness of the valve spring, stand the valve spring on a surface plate and check its deflection at the top of the valve spring using a try square.

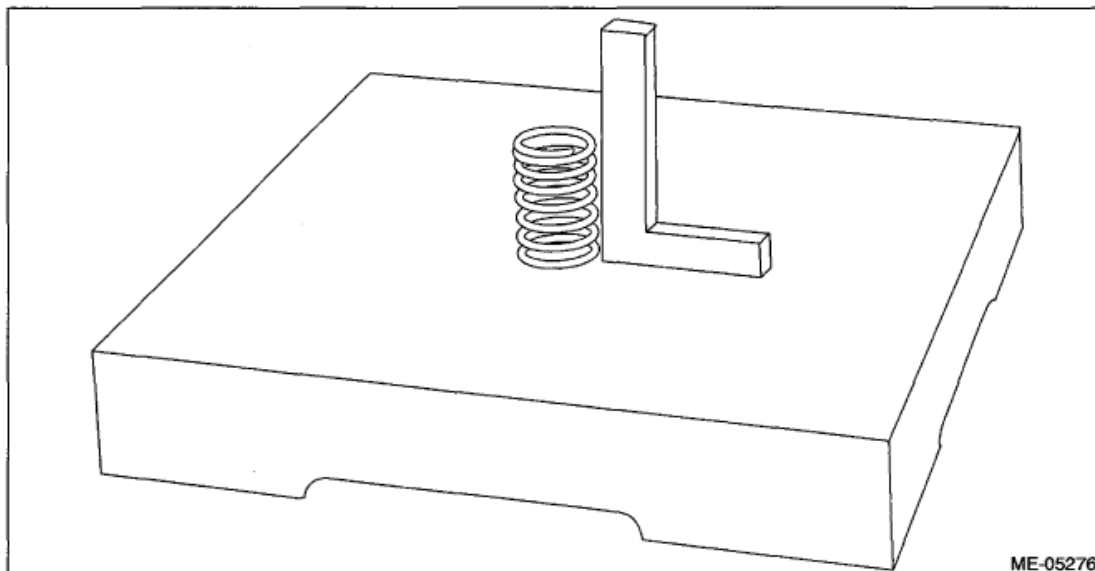


Fig. 331: Checking Valve Spring Free Length
Courtesy of SUBARU OF AMERICA, INC.

Free length:

Standard

41.06 mm (1.617 in)

Tension/spring height:

Standard

Set

182 - 210 N (18.56 - 21.41 kgf, 40.92 - 47.22 lbf)/33.0 mm (1.299 in)

Lift

552 - 61 ON (56.29 - 62.20 kgf, 124.11 - 137.15 lbf)/22.0 mm (0.866 in)

Squareness:

Standard

2.5°, 2.1 mm (0.083 in) or less

INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL

1. For the following, replace the oil seal with a new part. For replacement procedure, refer to the following.
 - 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. Remove the valve oil seal from the valve guide.

CAUTION:

- During work, place a waste cloth, etc. to avoid scratching the mat surface of the cylinder head.
- Use special care not to damage the cylinder head and guide during

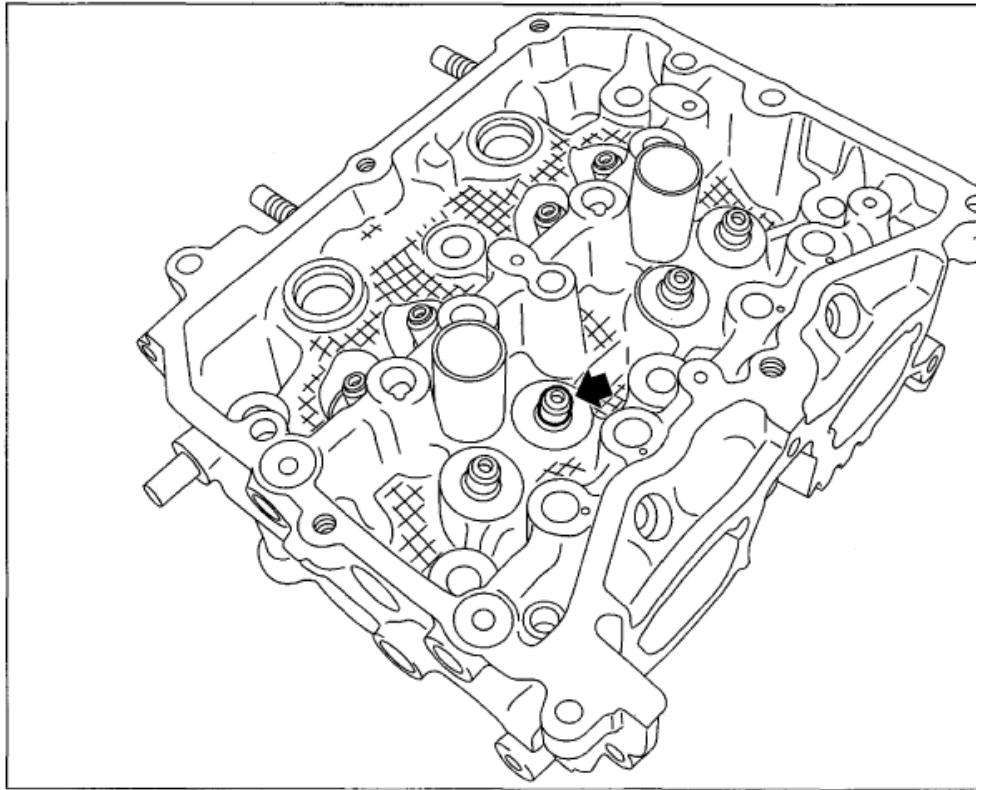


Fig. 332: Locating Valve Oil Seal Of Valve Guide
Courtesy of SUBARU OF AMERICA, INC.

3. Using the ST, insert the valve oil seal.

CAUTION:

- During work, place a waste cloth, etc. to avoid scratching the mating surface of the cylinder head.
- Use special care not to damage the cylinder head and guide during work.

NOTE:

- Apply engine oil to valve oil seal before inserting.
- The valve oil seal can be inserted by pressing ST with hand. Do not use a plastic 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]

ST 18261AA010 VALVE OIL SEAL GUIDE

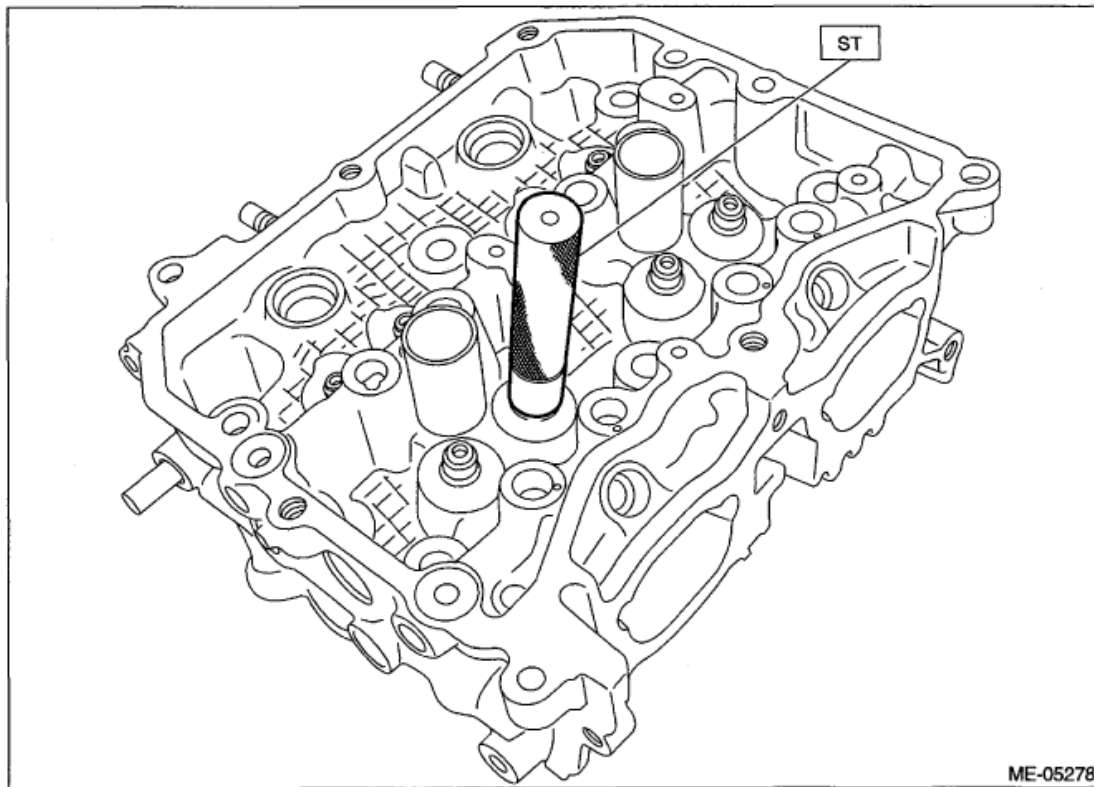


Fig. 333: Inserting Valve Oil Seal Using ST
Courtesy of SUBARU OF AMERICA, INC.

VALVE SHIM

1. Visually check the valve shim for damage.
2. Check the clearance between valve shim and valve stem end. Check the clearance between valve shim and valve stem end by measuring respectively the inner diameter of valve shim and the outer diameter of valve stem end.
 1. Using a caliper gauge, measure the inner diameter of valve shim. If it is not within the standard, replace the valve shim.

NOTE:

- Measurement should be performed at a temperature of 20°C (68° F).
- If the valve shim has to be replaced, check the cam clearance and replace with the suitable valve shim. < refer to **WHEN TIMING CHAIN ASSEMBLY IS REMOVED, INSPECTION, Cam Clearance** >

Valve shim inner diameter:

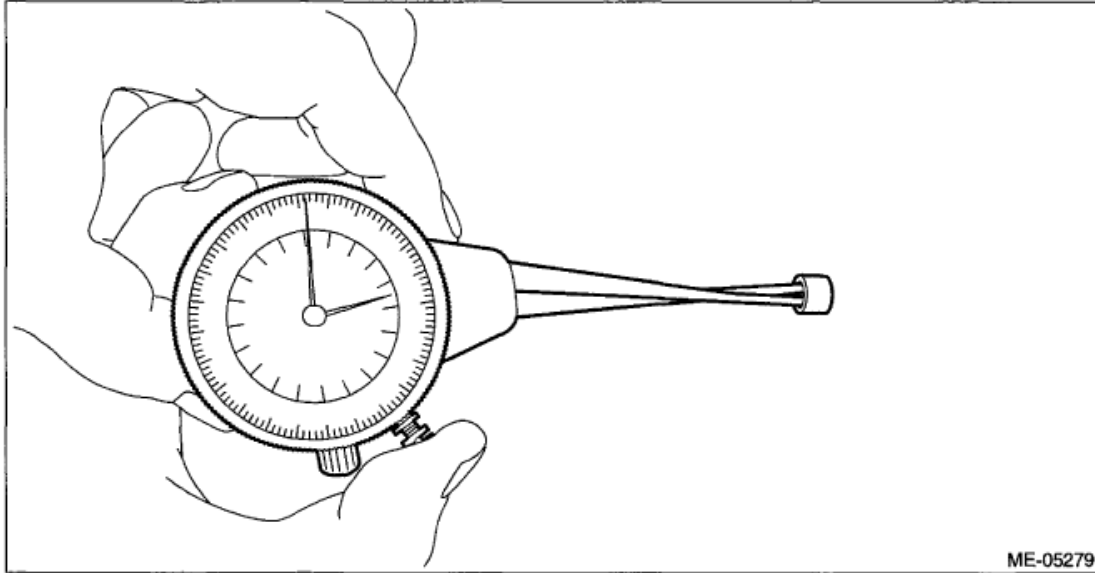
Standard**5.500 - 5.560 mm (0.2165 - 0.2189 in)**

Fig. 334: Measuring Inner Diameter Of Valve Shim Using Caliper Gauge
Courtesy of SUBARU OF AMERICA, INC.

2. Measure the outer diameter of valve stem end with a micrometer. If it is not within the standard, replace the valve.

NOTE:

- Measurement should be performed at a temperature of 20°C (68° F).
- If the valve is replaced, put a small amount of grinding compound on the valve seat surface of cylinder head, and lap the valve and valve seat surfaces. Replace with a new valve oil seal after lapping. For replacement of valve oil seal, refer to the "INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL". < refer to INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL, INSPECTION, Cylinder Head >

Valve stem end outer diameter:**Standard****5.455 - 5.470 mm (0.2148 - 0.2154 in)**

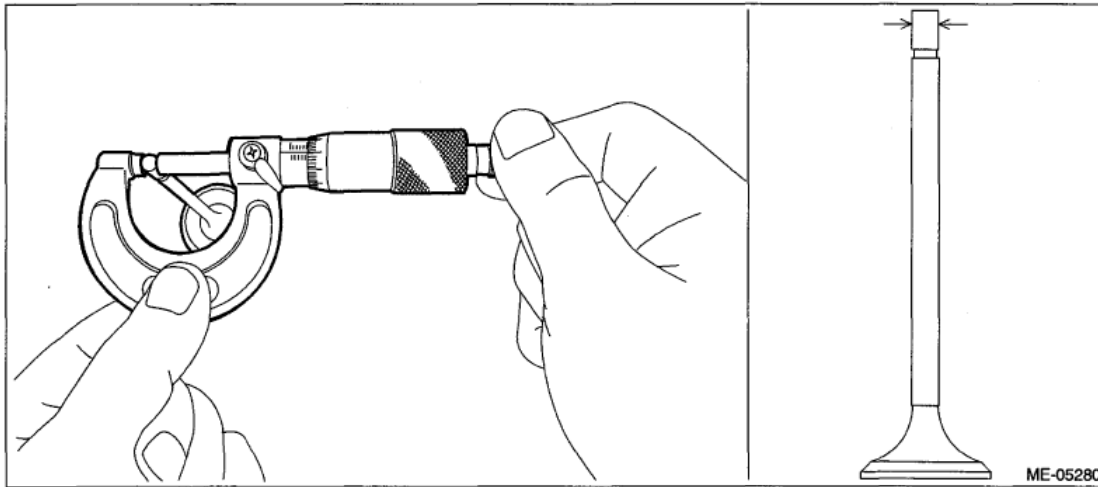


Fig. 335: Measuring Outer Diameter Of Valve Stem End With Micrometer
 Courtesy of SUBARU OF AMERICA, INC.

3. Calculate the clearance between valve shim and valve stem end. If the clearance exceeds the standard, replace the valve shim or valve, whichever shows the greater amount of wear or damage.

NOTE:

- If the valve is replaced, put a small amount of grinding compound on the valve seat surface of cylinder head, and lap the valve and valve seat surfaces. Replace with a new valve oil seal after lapping. For replacement of valve oil seal, refer to the "INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL". < refer to INTAKE VALVE OIL SEAL AND EXHAUST VALVE OIL SEAL, INSPECTION, Cylinder Head >
- If the valve shim has to be replaced, check the cam clearance and replace with the suitable valve shim. < refer to WHEN TIMING CHAIN ASSEMBLY IS REMOVED, INSPECTION, Cam Clearance >

Clearance between the valve shim and valve stem end:

Standard

0.030 - 0.105 mm (0.0012 - 0.0041 in)

CYLINDER BLOCK

REMOVAL

1. Remove the engine from the vehicle. < refer to REMOVAL, Engine Assembly >
2. Remove the intake manifold. < refer to REMOVAL, Intake Manifold >
3. Remove the tumble generator valve assembly. < refer to REMOVAL, Tumble Generator Valve

Assembly >

4. Remove the chain cover. < refer to **REMOVAL**, Chain Cover >
5. Remove the rocker cover. < refer to **REMOVAL**, Rocker Cover >
6. Remove the cam carrier. < refer to **REMOVAL**, Cam Carrier >
7. Remove the cylinder head. < refer to **REMOVAL**, Cylinder Head >
8. Remove the crank sprocket. < refer to **REMOVAL**, Crank Sprocket >
9. Remove the engine hanger from cylinder block RH.

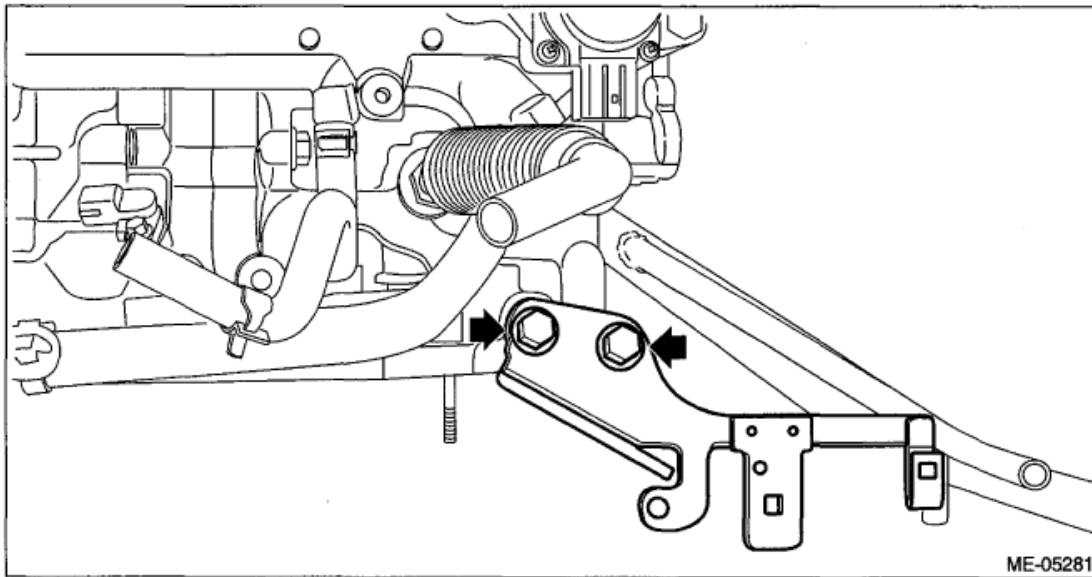


Fig. 336: Locating Engine Hanger Bolts Of Cylinder Block RH
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the bolts securing the water pipe assembly and PCV connector to the cylinder block, and remove the water pipe assembly and PCV connector as a set from cylinder block.

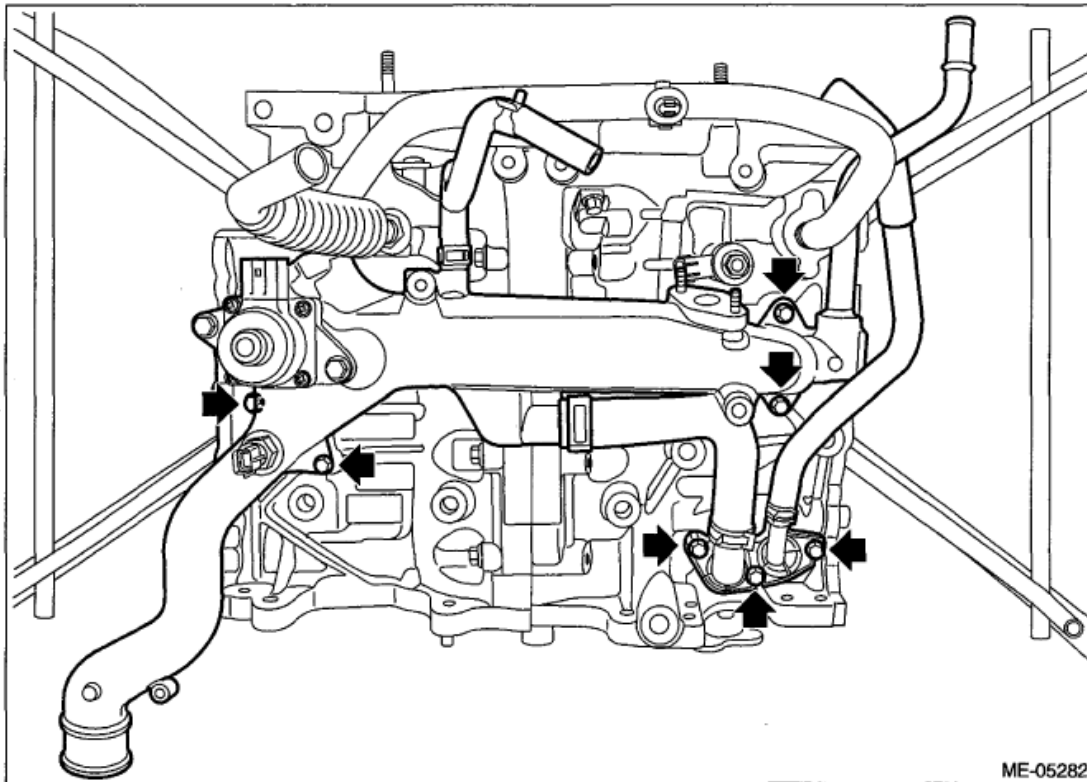


Fig. 337: Locating Water Pipe Assembly And PCV Connector Bolts
 Courtesy of SUBARU OF AMERICA, INC.

11. Remove the O-ring from the cylinder block and PCV connector.

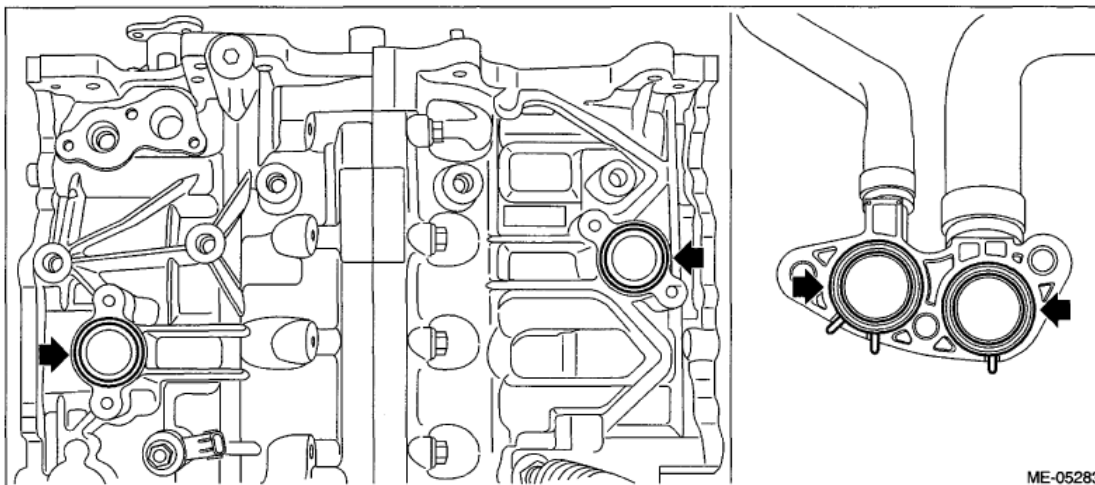


Fig. 338: Locating Cylinder Block And PCV Connector O-Ring
 Courtesy of SUBARU OF AMERICA, INC.

12. Remove the knock sensor from cylinder block LH.

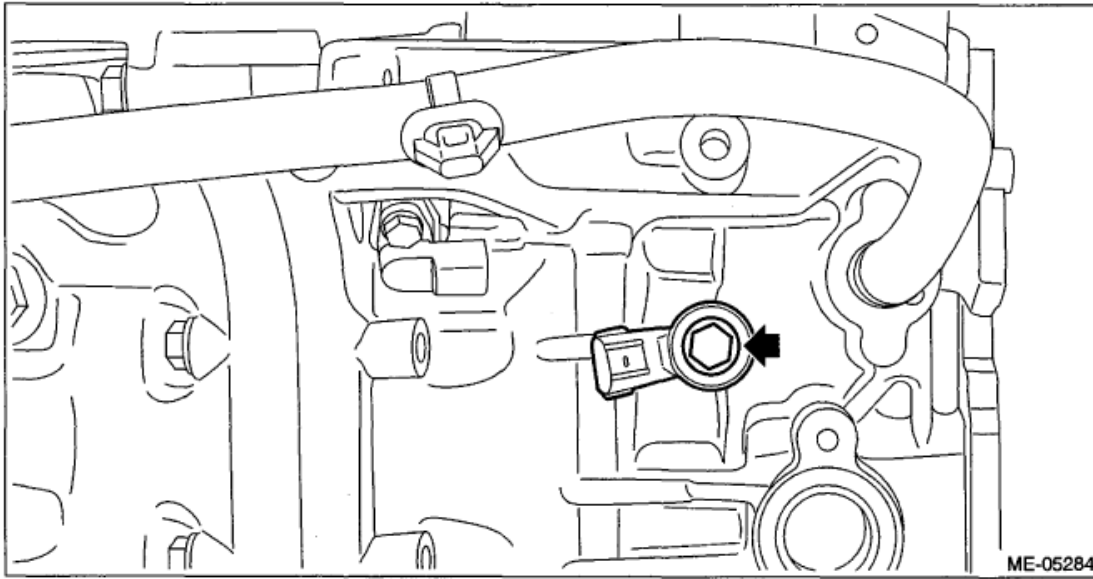


Fig. 339: Locating Knock Sensor Of Cylinder Block LH
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the PCV hose assembly (A) and the vacuum hose (B) from cylinder block and PCV valve.

NOTE: Pinch the clamp of the PCV hose assembly (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

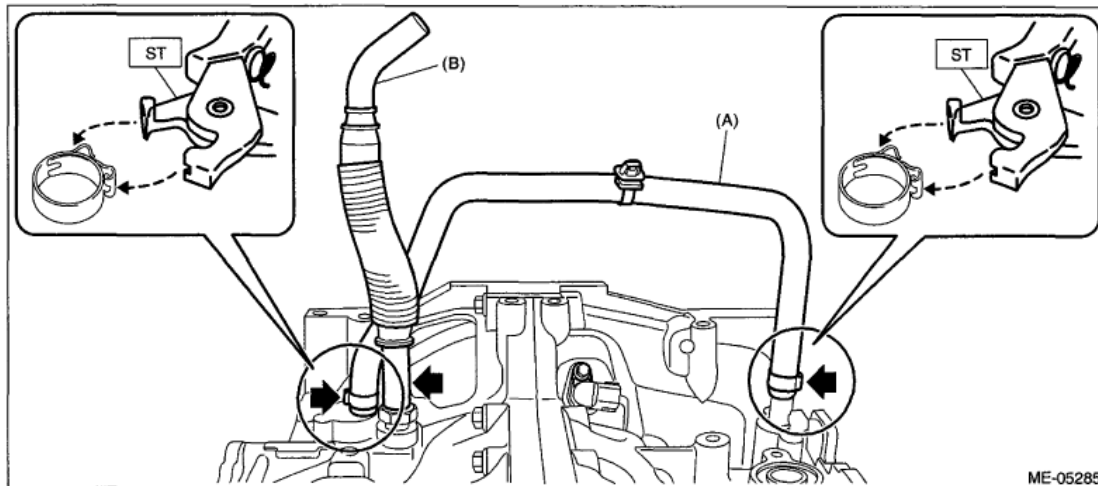


Fig. 340: Pinching Clamp Of PCV Hose Assembly
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the PCV valve from the cylinder block RH.

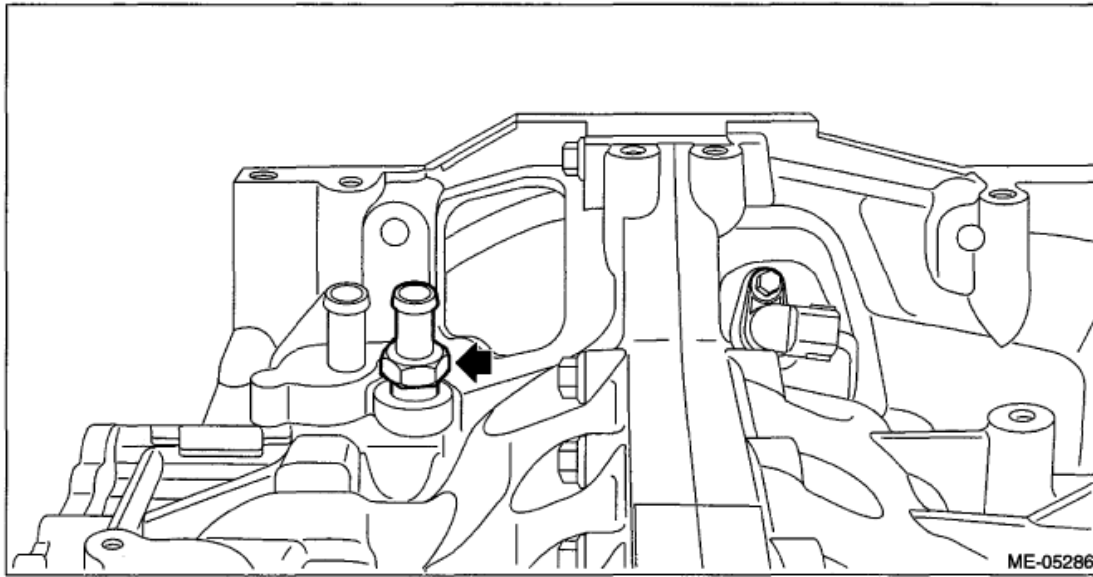


Fig. 341: Locating PCV Valve Bolt Of Cylinder Block RH
 Courtesy of SUBARU OF AMERICA, INC.

15. Remove the crankshaft position sensor plate with drive plate. (AT model) < refer to **REMOVAL** , Drive Plate >
16. Remove the clutch disc and cover. (MT model) < refer to **REMOVAL** , Clutch Disc and Cover >
17. Remove the crankshaft position sensor plate with flywheel. (MT model) < refer to **REMOVAL** , Flywheel >
18. Remove the bolts securing the crankshaft position sensor holder from the cylinder block LH, and remove the crankshaft position sensor with crankshaft position sensor holder.

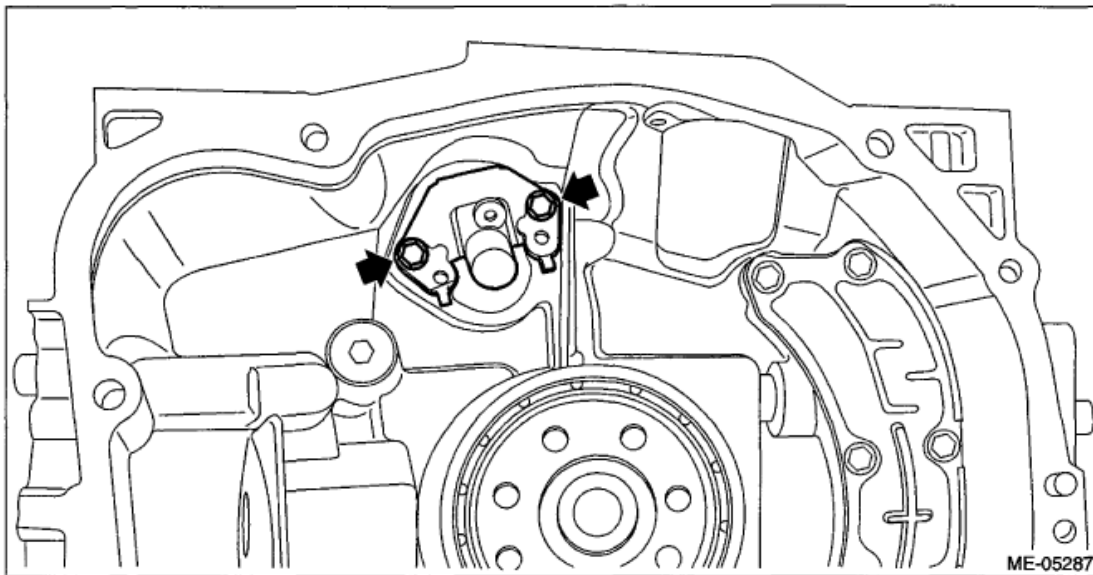


Fig. 342: Locating Crankshaft Position Sensor Holder Bolts
 Courtesy of SUBARU OF AMERICA, INC.

19. Set the cylinder block so that the oil pan is on the upper side, remove the ST1, ST2, ST3 and ST4 from cylinder block and oil pan upper.

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 18362AA020 ADAPTER

ST4 499817100 ENGINE STAND

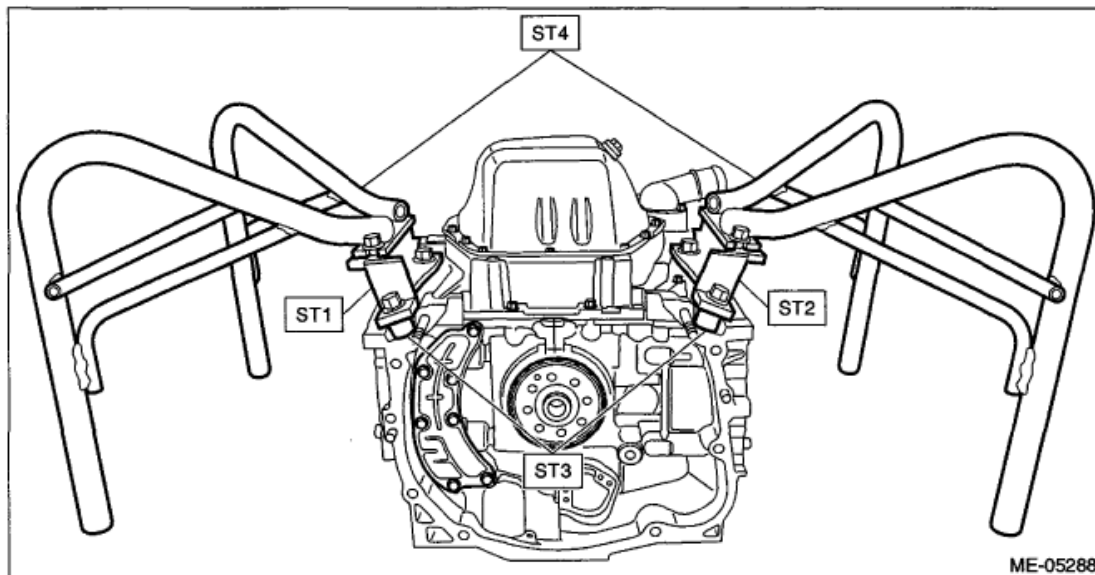


Fig. 343: Removing ST1, ST2, ST3 And ST4 From Cylinder Block And Oil Pan Upper
Courtesy of SUBARU OF AMERICA, INC.

20. Remove the thermostat cover from oil pan upper, and then remove the thermostat.

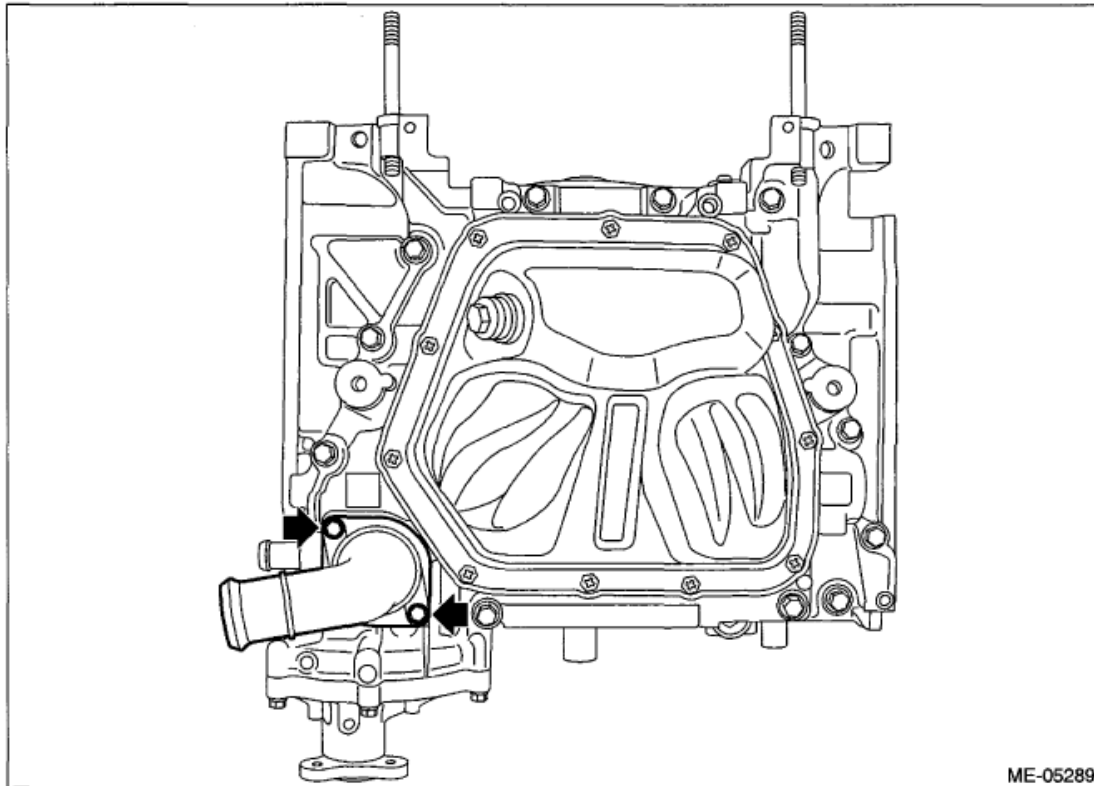


Fig. 344: Locating Thermostat Cover Bolts Of Oil Pan Upper
Courtesy of SUBARU OF AMERICA, INC.

21. Remove the oil pan upper with oil pan from cylinder block.

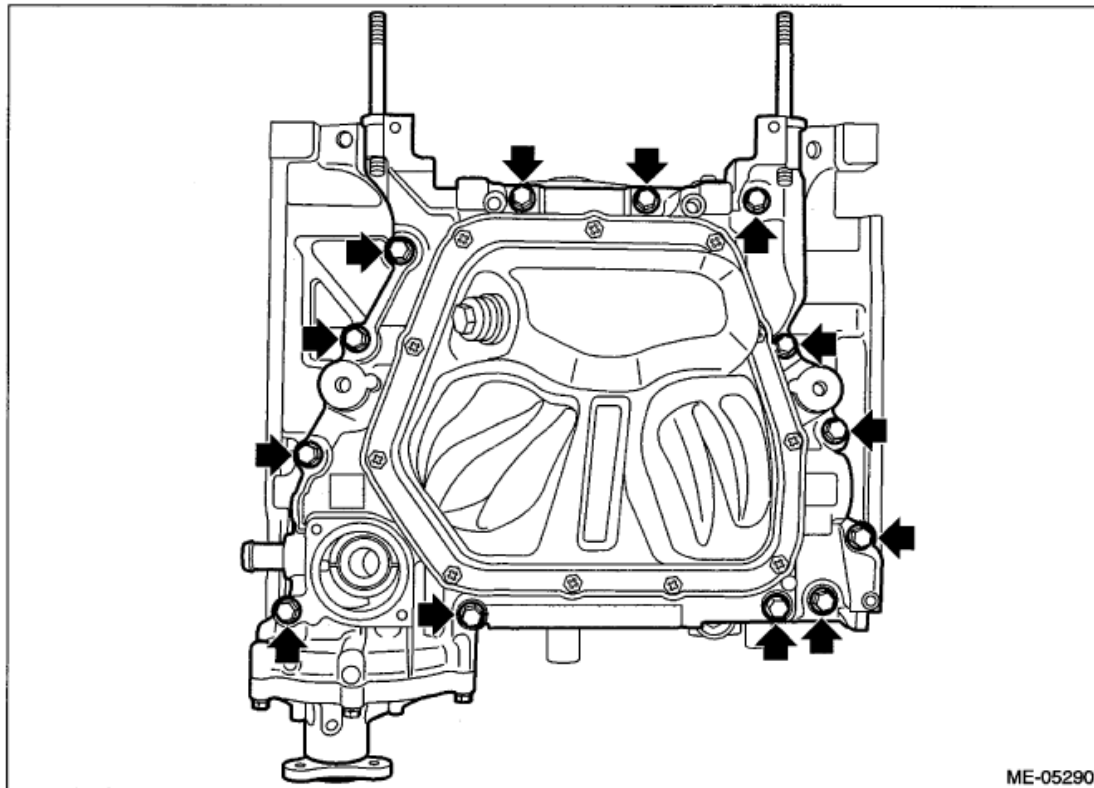


Fig. 345: Locating Oil Pan Bolts Of Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

22. Remove the O-ring from the cylinder block.

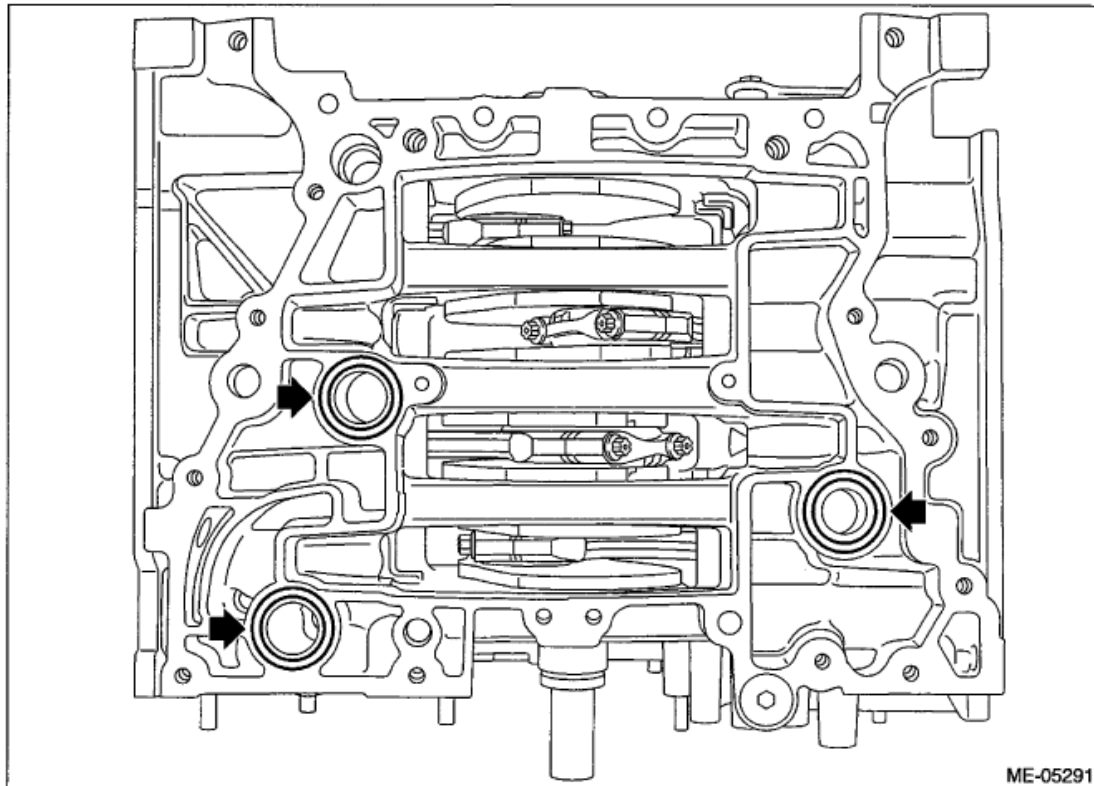


Fig. 346: Locating O-Ring Of Cylinder Block
 Courtesy of SUBARU OF AMERICA, INC.

23. Install the A/C compressor bracket bolts and the power steering pump bracket bolts at the locations shown in the figure.

NOTE:

- This procedure is required to prevent the knock pin damage when the cylinder block is raised in the next step.
- Use the same length bolt for the four bolts.

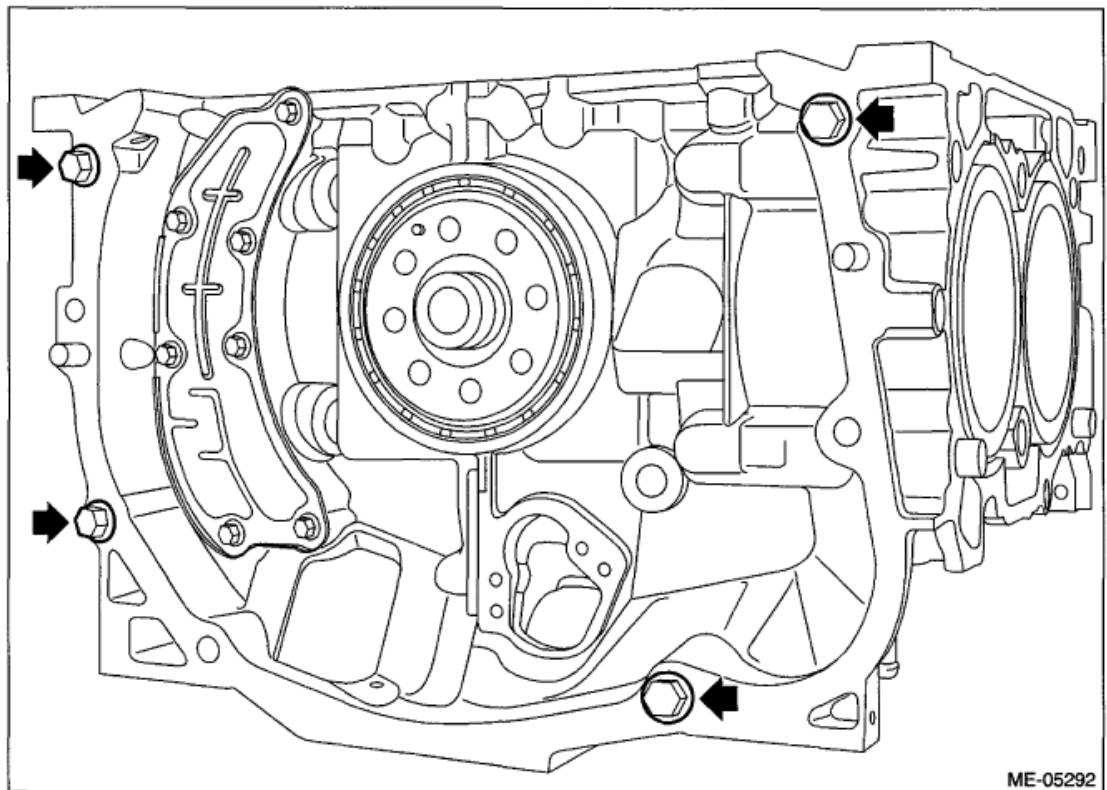


Fig. 347: Locating A/C Compressor Bracket And Power Steering Pump Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

24. Raise the cylinder block so that the rear oil seal is on the lower side.
25. Add a front mark on the piston using a marker as shown in the figure.

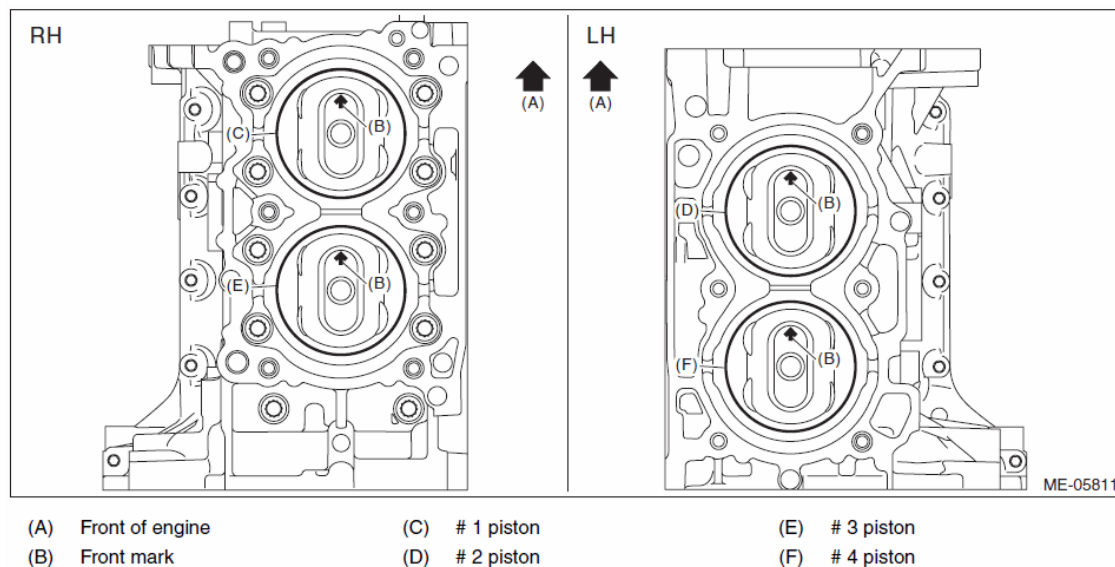


Fig. 348: Identifying Front Mark On Piston

Courtesy of SUBARU OF AMERICA, INC.

26. Remove the #1 and #4 connecting rod caps and pistons from the cylinder block.

NOTE: Mark each connecting rod cap and piston with a cylinder number.

1. Turn the crankshaft so that the #1 connecting rod cap (A) and #4 connecting rod cap (B) is located at the position shown in the figure using ST.

ST 18252AA000 CRANKSHAFT SOCKET

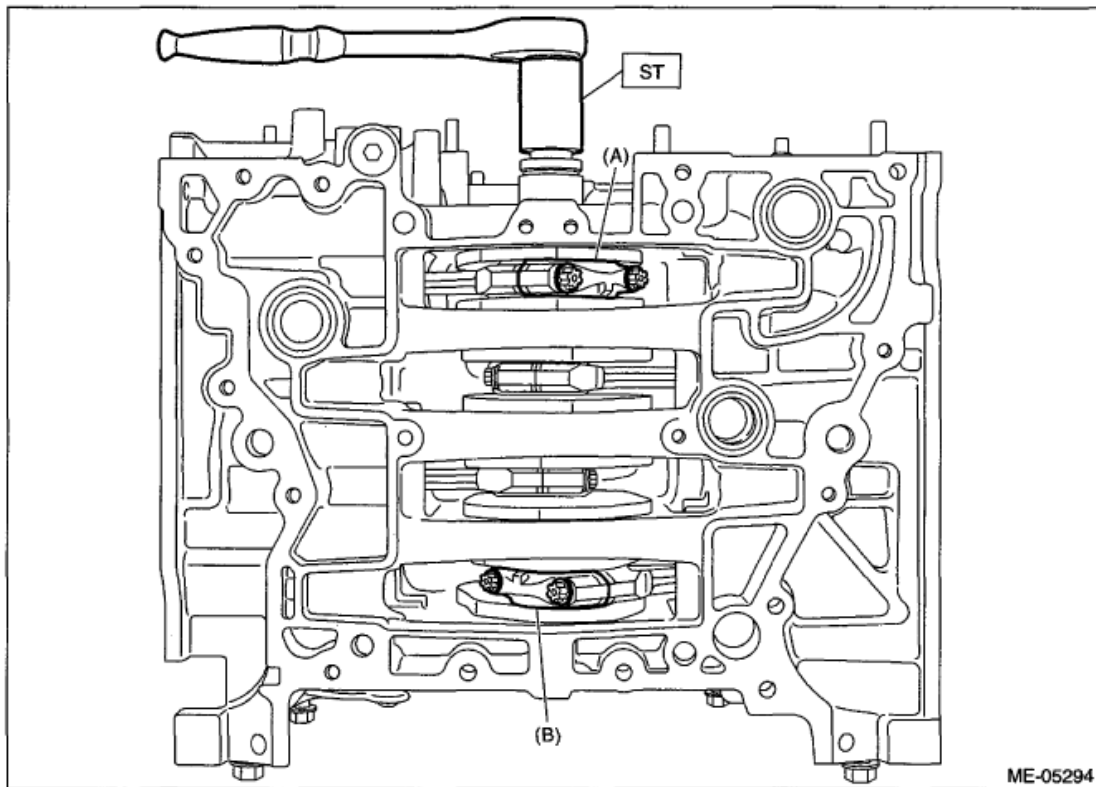


Fig. 349: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

2. Using TORX® socket E12, loosen the #1 connecting rod cap bolt, and remove the #1 connecting rod cap bolt and #1 connecting rod cap.

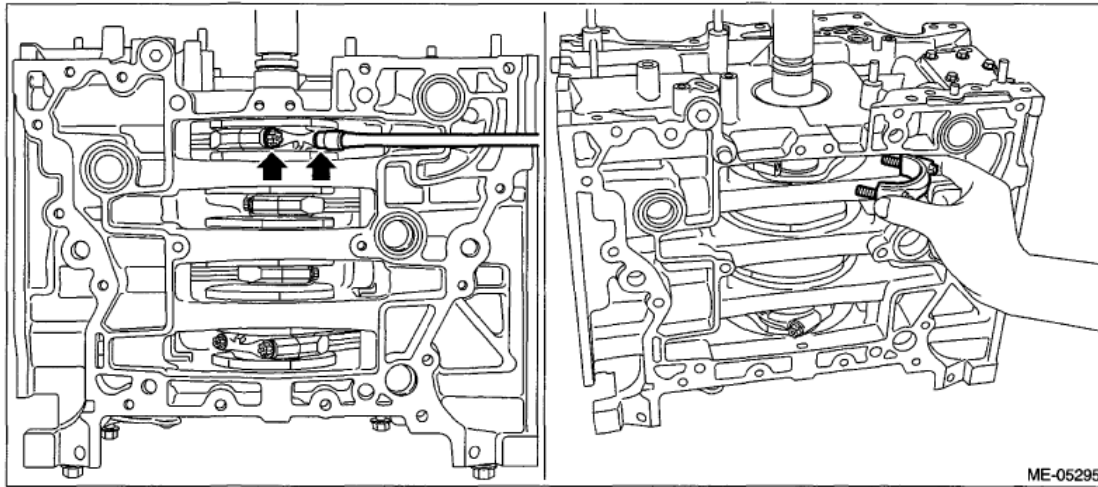


Fig. 350: Removing #1 Connecting Rod Cap And Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Using TORX® socket E12, loosen the #4 connecting rod cap bolt, and remove the #4 connecting rod cap bolt and #4 connecting rod cap.

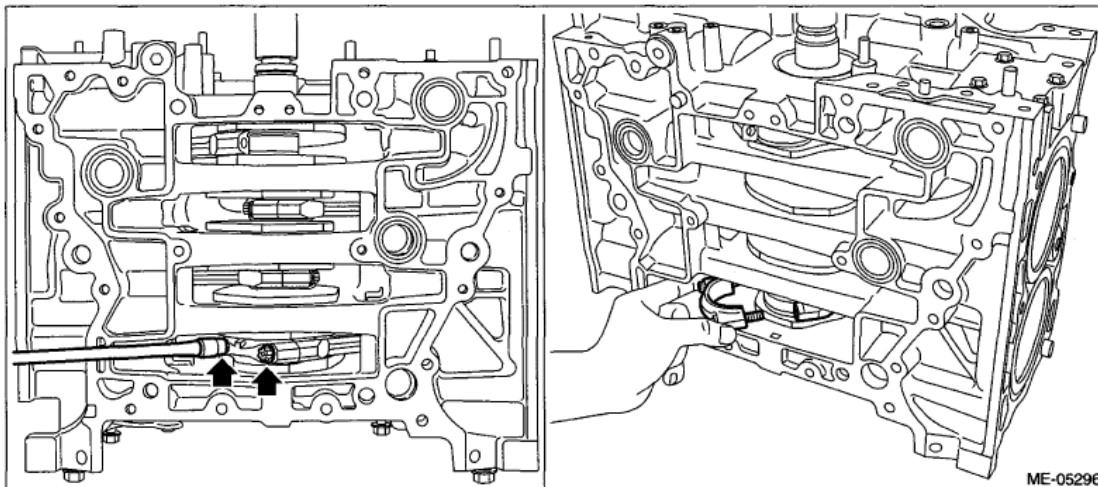


Fig. 351: Removing #4 Connecting Rod Cap And Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Using the ST, turn the crankshaft clockwise and separate the positions of the #1 crank pin (A) and the large end of the #1 connecting rod (B).

ST 18252AA000 CRANKSHAFT SOCKET

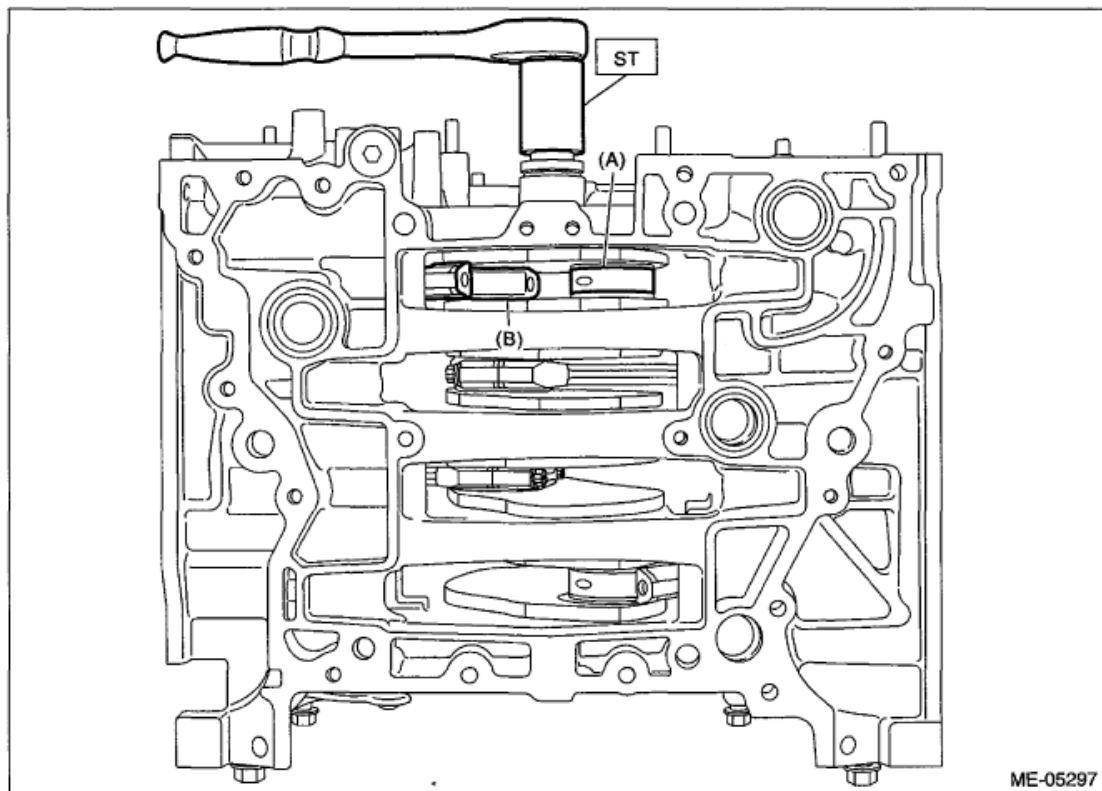


Fig. 352: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

5. Push the #1 connecting rod in the direction of the arrow, and remove the #1 piston with #1 connecting rod from the cylinder block.

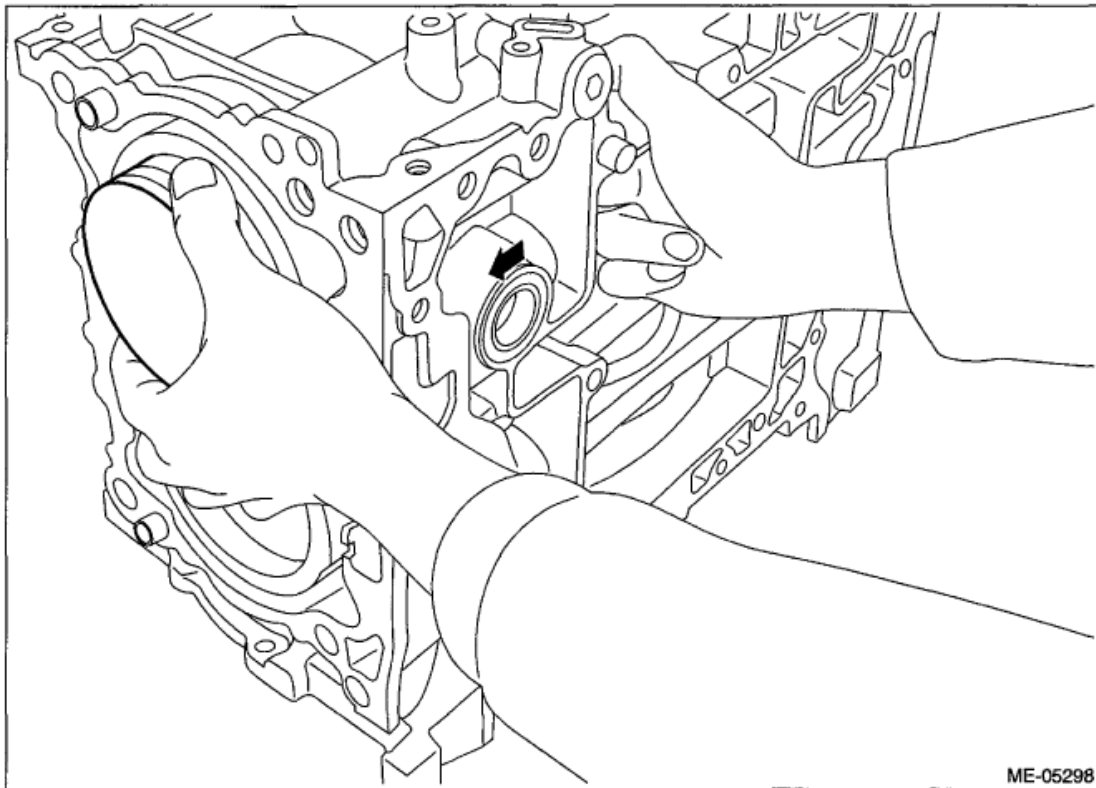


Fig. 353: Removing #1 Piston With #1 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

6. Using the ST, turn the crankshaft counterclockwise and separate the positions of the #4 crank pin (A) and the large end of the #4 connecting rod (B).

ST 18252AA000 CRANKSHAFT SOCKET

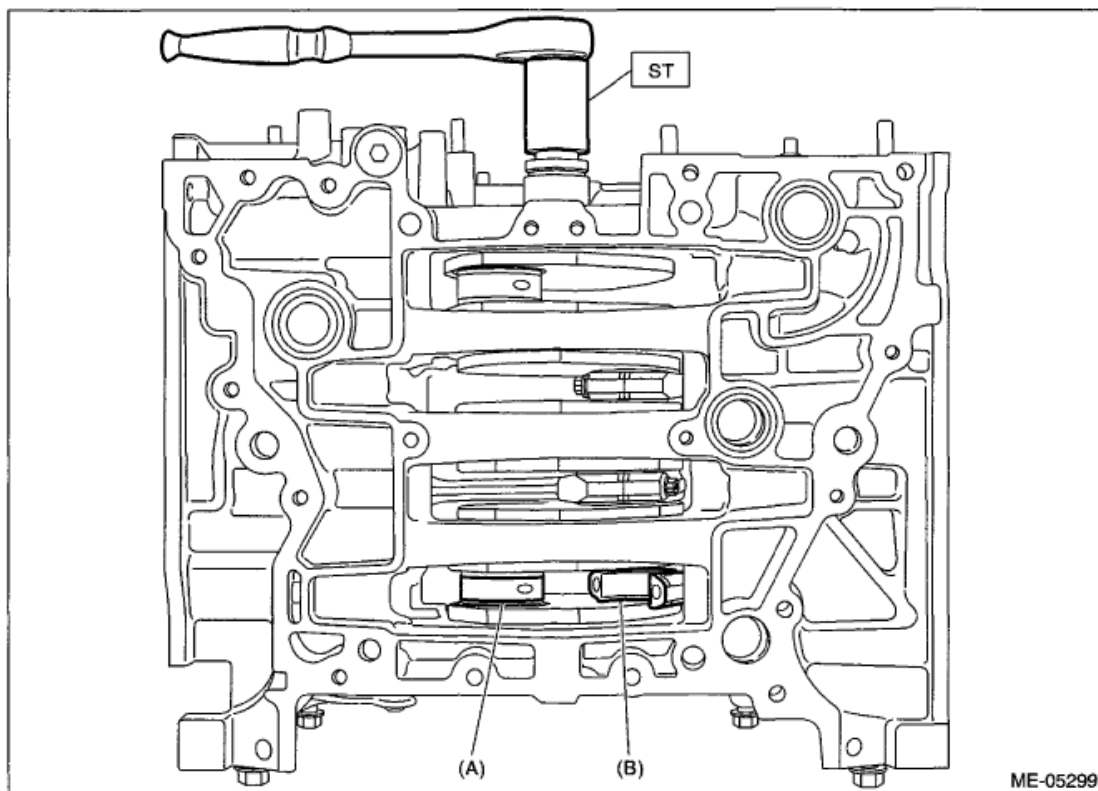


Fig. 354: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

7. Push the #4 connecting rod in the direction of the arrow, and remove the #4 piston with #4 connecting rod from the cylinder block.

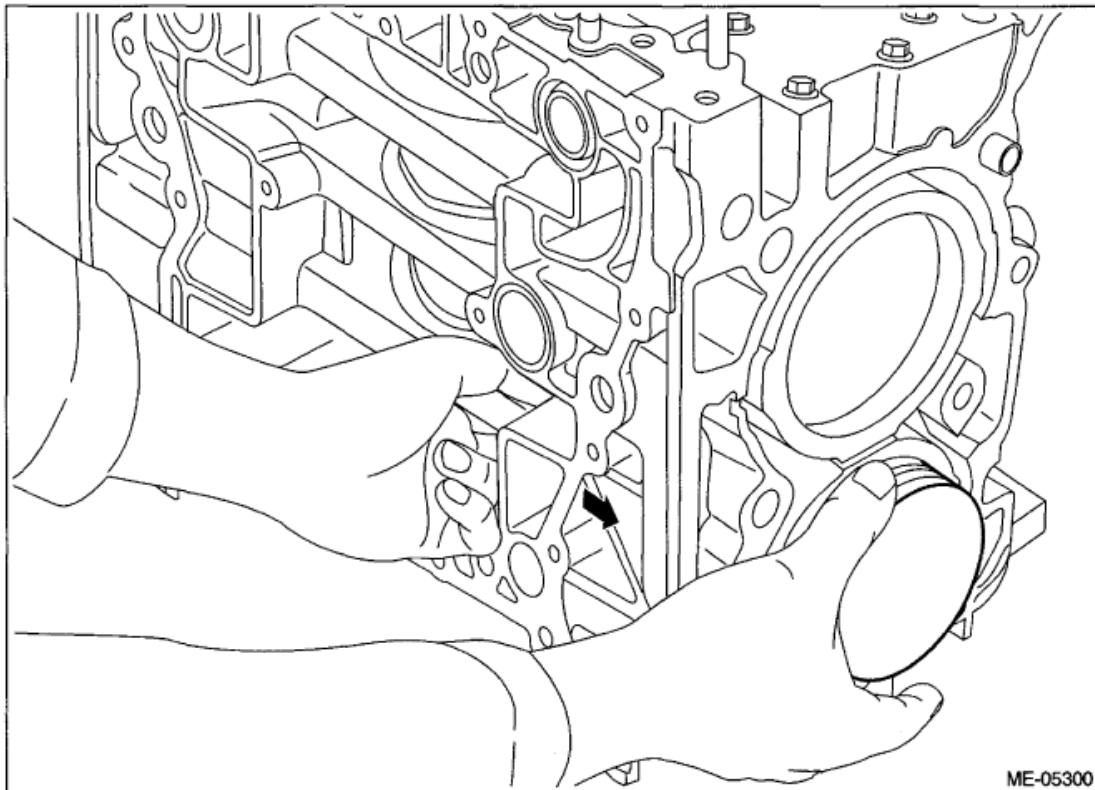


Fig. 355: Removing #4 Piston With #4 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

27. Remove the #2 and #3 connecting rod caps and pistons from the cylinder block.

NOTE: Mark each connecting rod cap and piston with a cylinder number.

1. Turn the crankshaft so that the #2 connecting rod cap (A) and #3 connecting rod cap (B) is located at the position shown in the figure using ST.

ST 18252AA000 CRANKSHAFT SOCKET

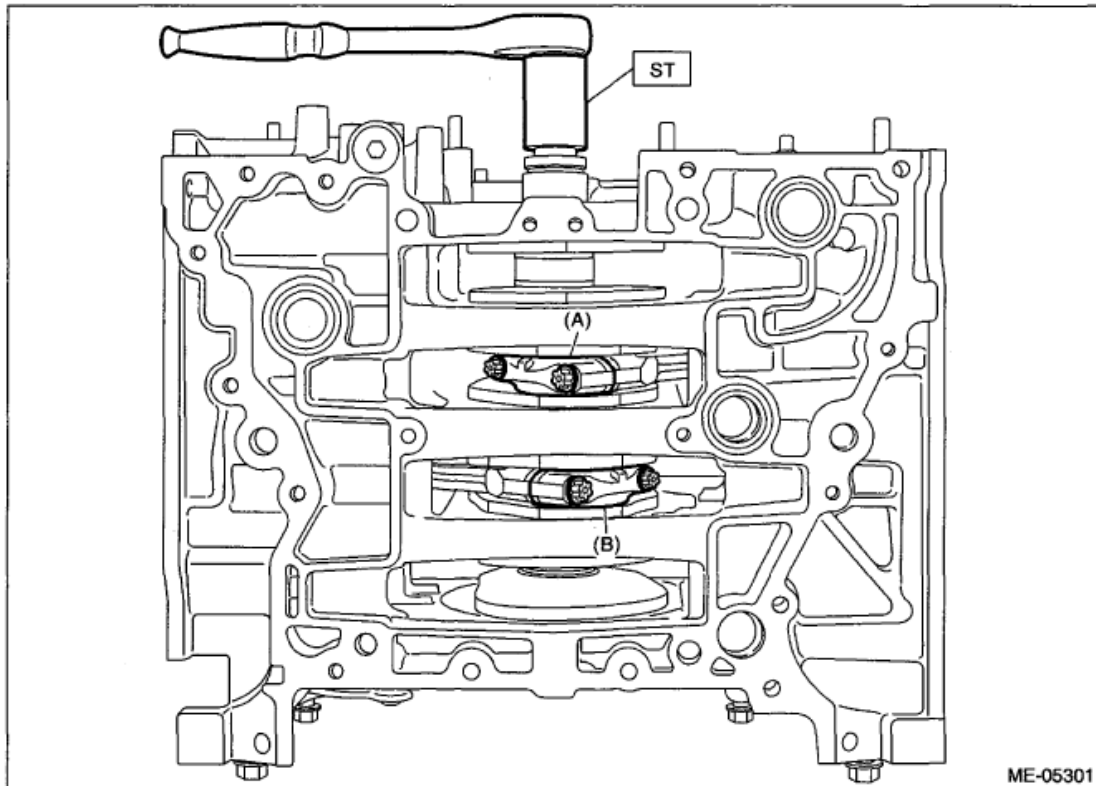


Fig. 356: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

2. Using TORX® socket E12, loosen the #2 connecting rod cap bolt, and remove the #2 connecting rod cap bolt and #2 connecting rod cap.

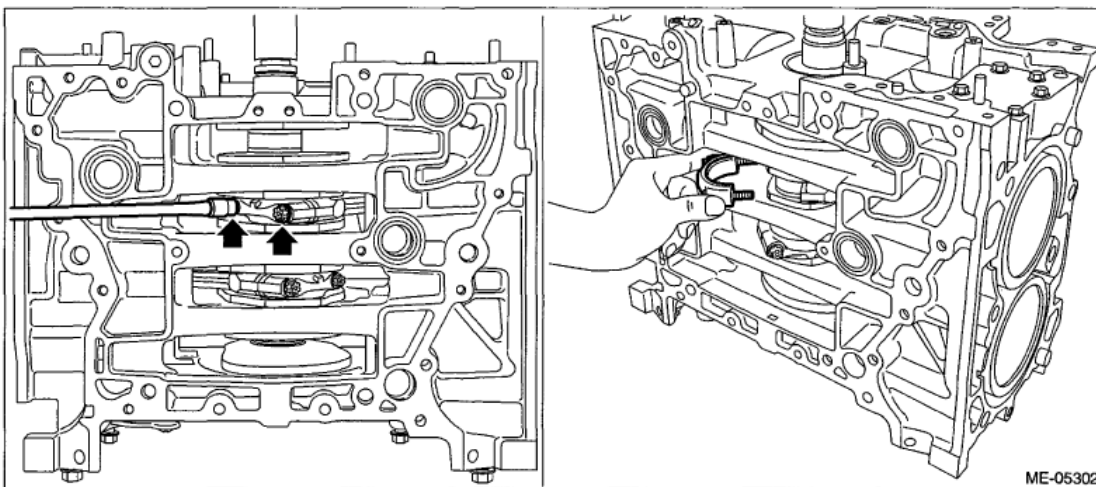


Fig. 357: Removing #2 Connecting Rod Cap And Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Using TORX® socket E12, loosen the #3 connecting rod cap bolt, and remove the #3 connecting

rod cap bolt and #3 connecting rod cap.

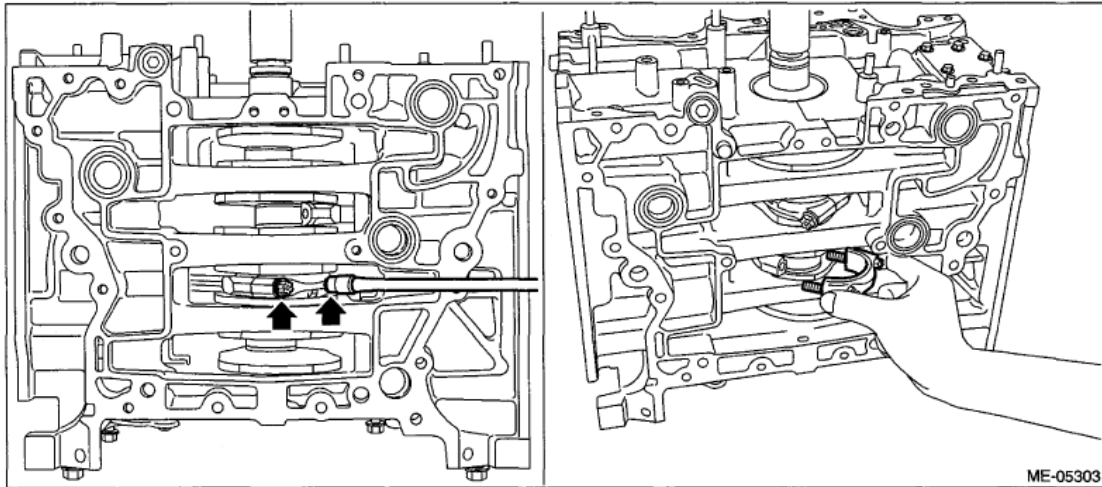


Fig. 358: Removing #3 Connecting Rod Cap And Bolt
Courtesy of SUBARU OF AMERICA, INC.

4. Using the ST, turn the crankshaft counterclockwise and separate the positions of the #2 crank pin (A) and the large end of the #2 connecting rod (B).

ST 18252AA000 CRANKSHAFT SOCKET

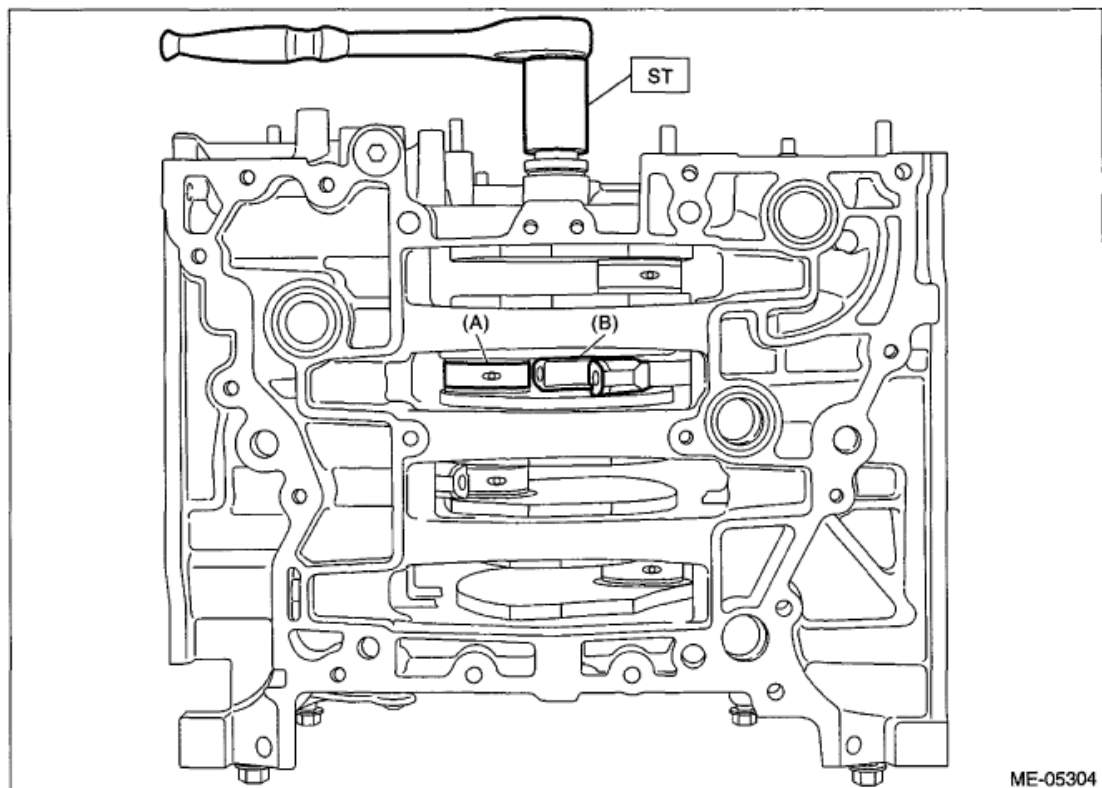


Fig. 359: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

5. Push the #2 connecting rod in the direction of the arrow, and remove the #2 piston with #2 connecting rod from the cylinder block.

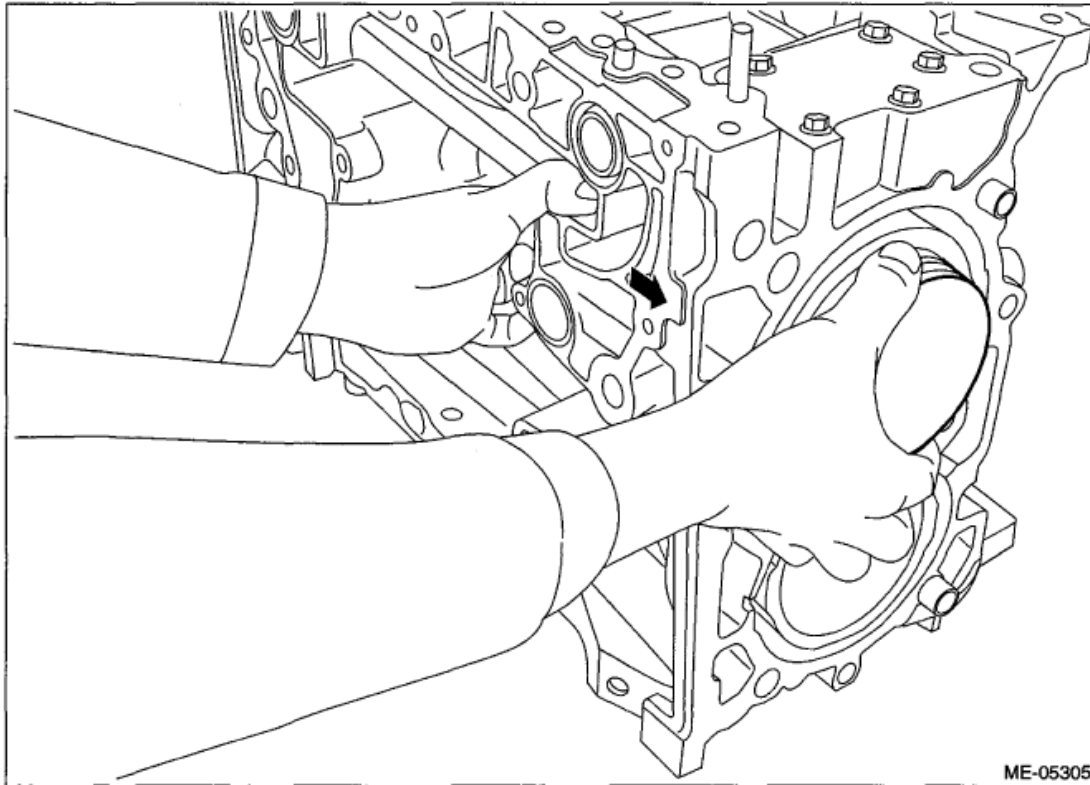


Fig. 360: Removing #2 Piston With #2 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

6. Using the ST, turn the crankshaft clockwise and separate the positions of the #3 crank pin (A) and the large end of the #3 connecting rod (B).

ST 18252AA000 CRANKSHAFT SOCKET

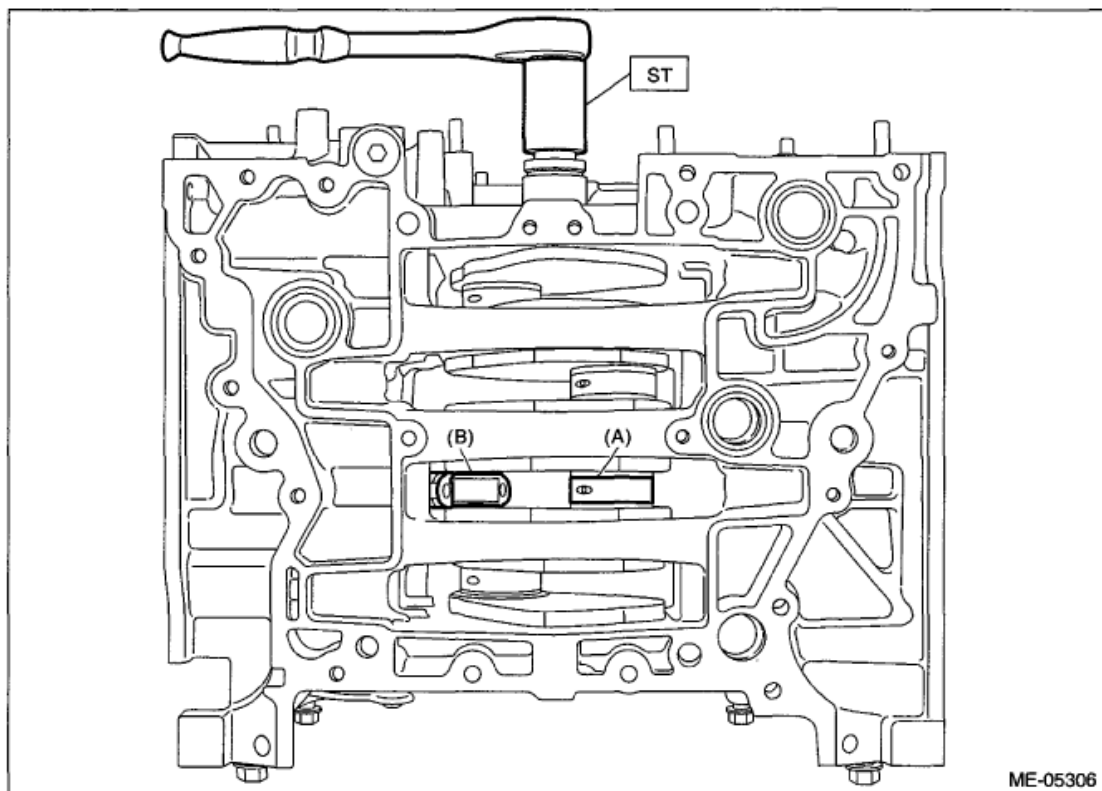


Fig. 361: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

7. Push the #3 connecting rod in the direction of the arrow, and remove the #3 piston with #3 connecting rod from the cylinder block.

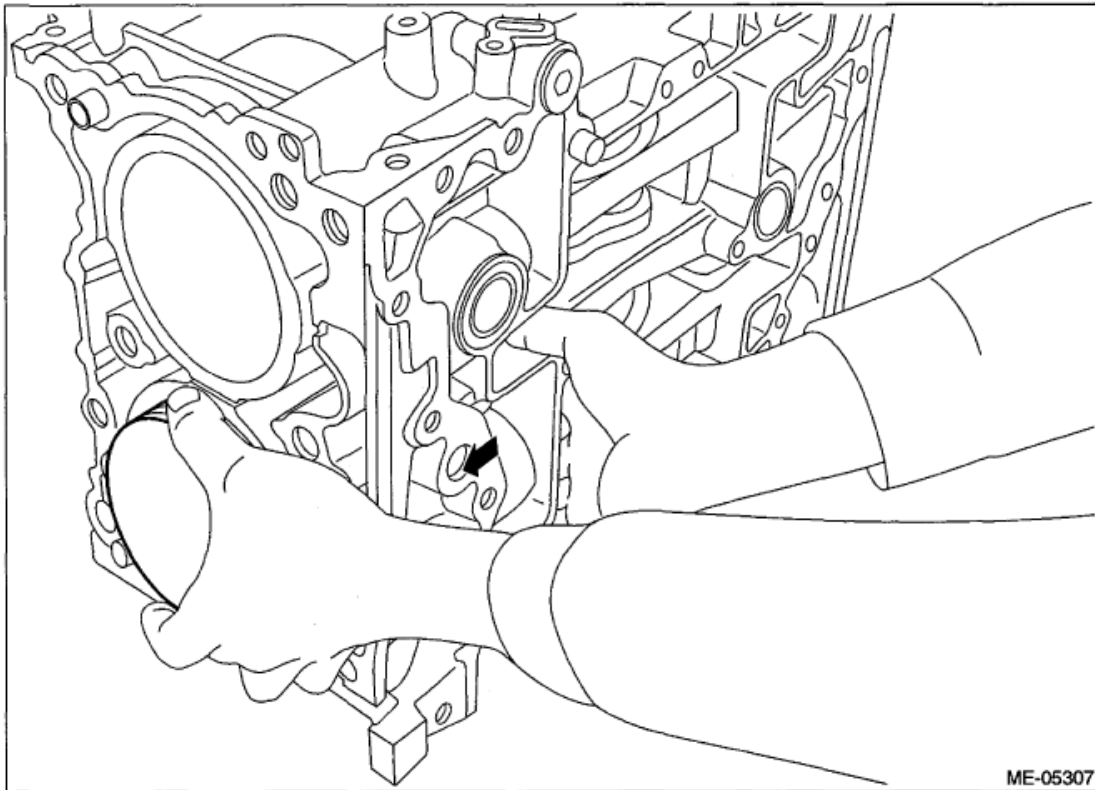


Fig. 362: Removing #3 Piston With #3 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

28. Set the cylinder block so that the oil pan side is on the upper side, and remove the A/C compressor bracket bolts and the power steering pump bracket bolts attached at the locations shown in the figure.

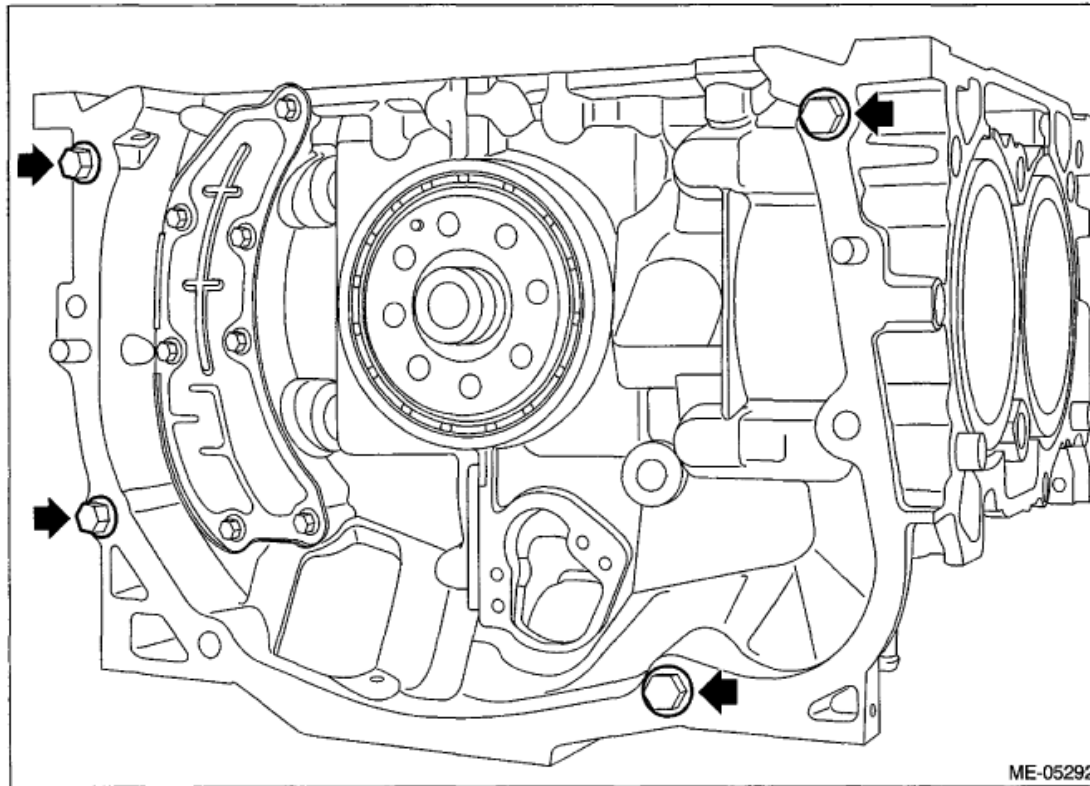


Fig. 363: Locating A/C Compressor Bracket And Power Steering Pump Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

29. Set the part so that the cylinder block RH is on the upper side, and separate the cylinder block.

CAUTION:

- Place a wood board wrapped with a waste cloth to prevent the knock pin damage and to stabilize the cylinder block before work.
- Be careful not to scratch the mating surface of cylinder block during work.

1. Remove the bolt shown in the figure.

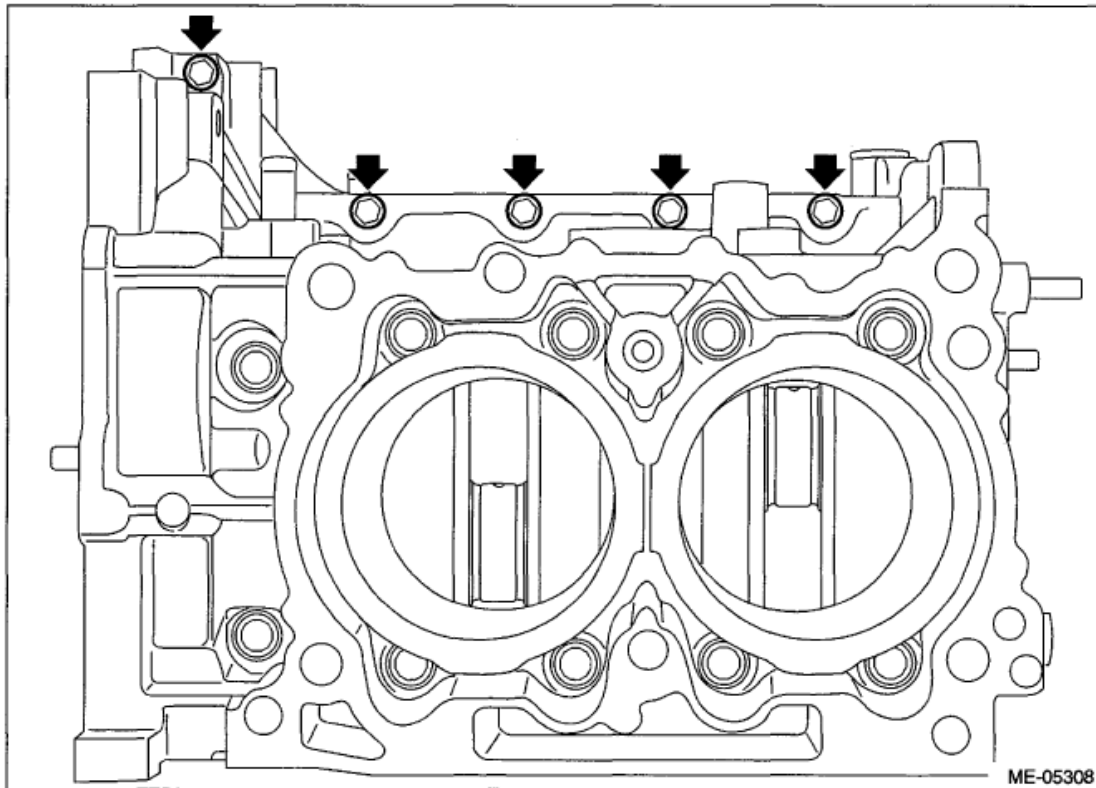


Fig. 364: Locating Cylinder Block RH Bolts (Upper Side)

Courtesy of SUBARU OF AMERICA, INC.

2. Loosen the cylinder block mounting bolts in numerical order as shown in the figure, and separate the cylinder block RH and LH.

NOTE: Lift the cylinder block RH slightly, and confirm that the crankshaft is remaining in the cylinder block LH. If the cylinder block RH is lifted carelessly when separating, the crankshaft may stick to cylinder block RH, then fall off.

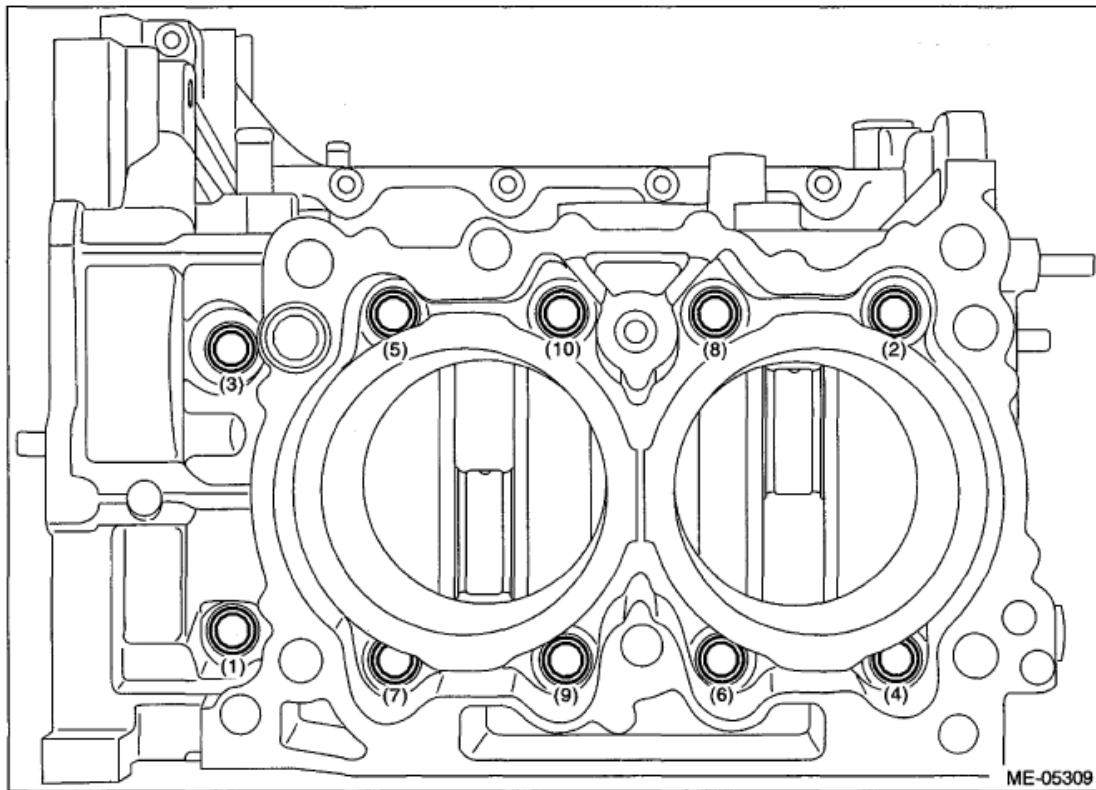


Fig. 365: Identifying Cylinder Block Mounting Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

30. Remove the crankshaft from cylinder block LH, and remove the rear oil seal.
31. Remove the O-ring from the cylinder block LH.

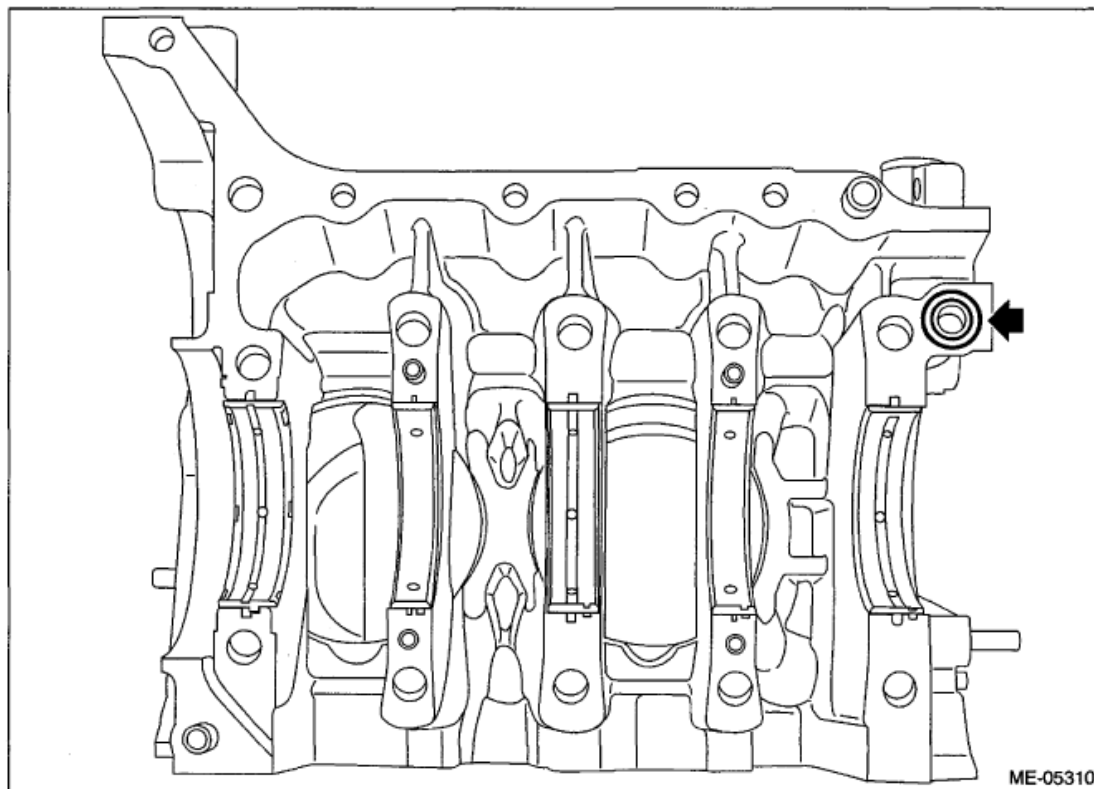


Fig. 366: Locating O-Ring Of Cylinder Block LH
 Courtesy of SUBARU OF AMERICA, INC.

32. Remove the crankshaft bearings from the cylinder block.

NOTE:

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

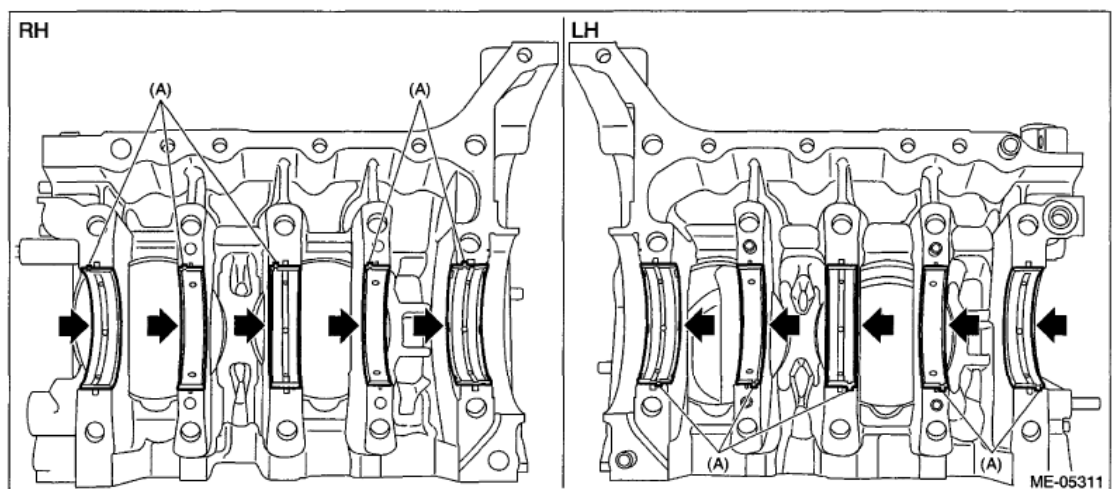


Fig. 367: Pressing Bearing At Opposite End Of Locking Lip

Courtesy of SUBARU OF AMERICA, INC.

33. Remove the liquid gasket from cylinder block.

INSTALLATION

1. Apply engine oil to the crankshaft bearing, and install the crankshaft bearing to the cylinder block.

CAUTION:

- Place a wood board wrapped with a waste cloth to prevent the kn damage and to stabilize the cylinder block before work.
- Be careful not to scratch the mating surface of cylinder block during work.

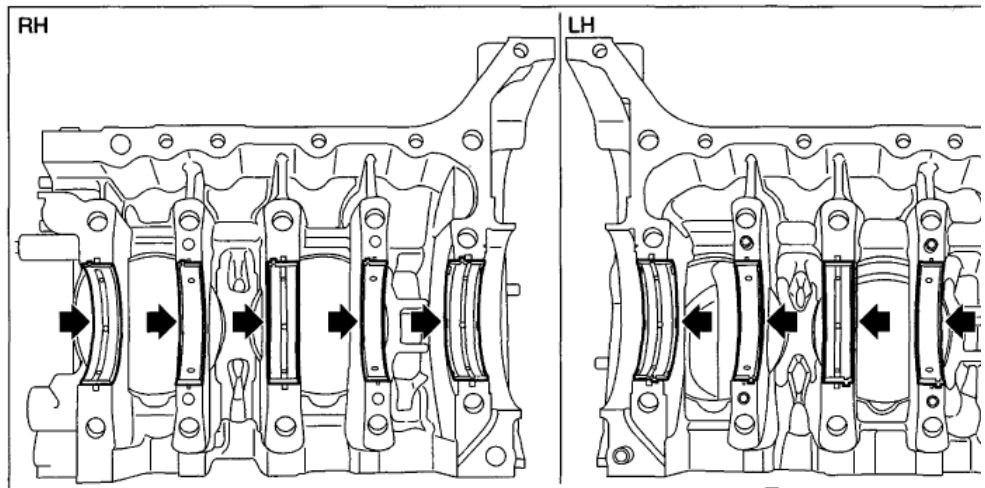


Fig. 368: Pressing Bearing At Opposite End Of Locking Lip
Courtesy of SUBARU OF AMERICA, INC.

2. Install O-rings to the cylinder block LH.

NOTE: Use new O-rings.

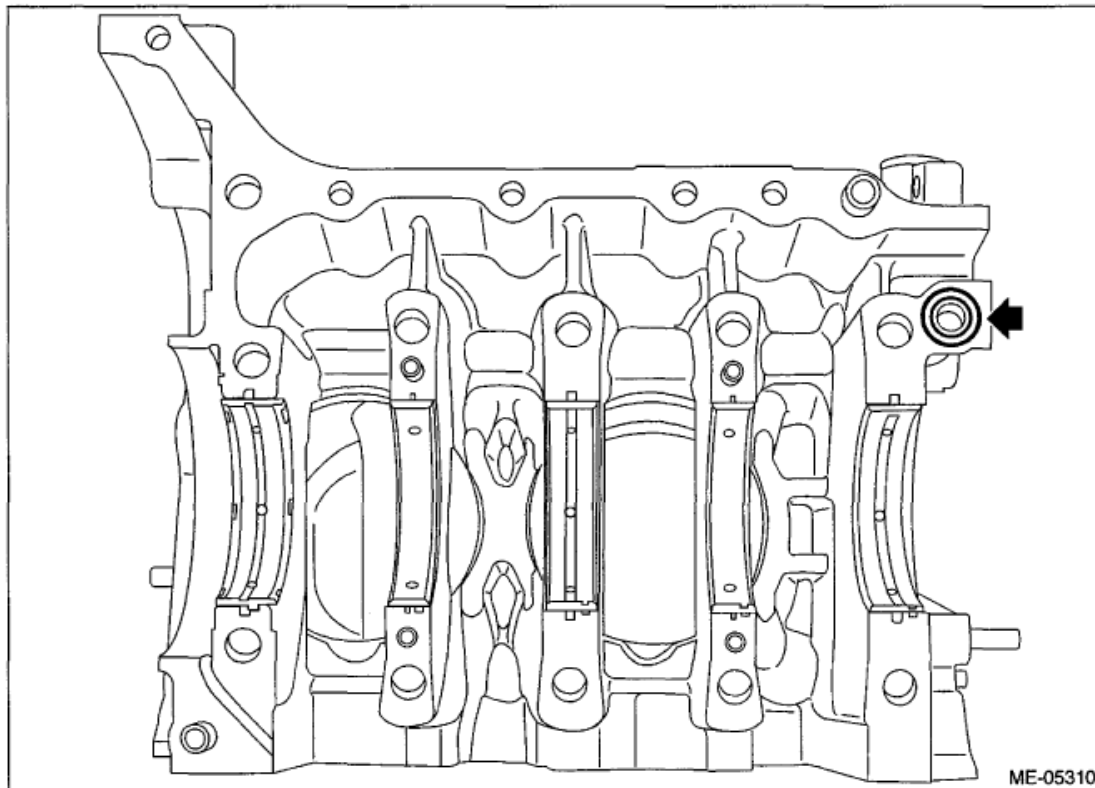


Fig. 369: Locating O-Ring Of Cylinder Block LH
Courtesy of SUBARU OF AMERICA, INC.

3. Apply engine oil to the crankshaft journal, and set the crankshaft to the cylinder block LH.

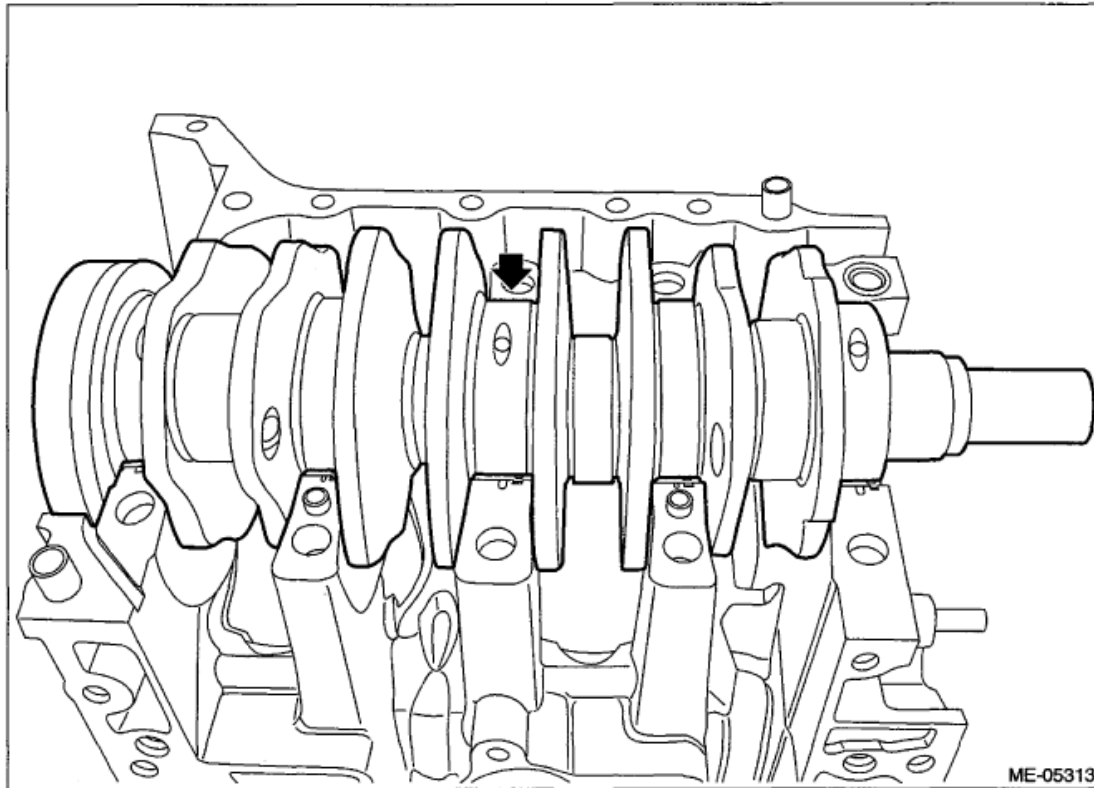


Fig. 370: Locating Crankshaft Journal
 Courtesy of SUBARU OF AMERICA, INC.

4. Apply liquid gasket to the mating surface of cylinder block RH as shown in the figure.

CAUTION: Do not let the liquid gasket overflow to the oil passage, journal groove, because the engine seizure may result.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the cylinder block RH and the cylinder block LH.
- Install within 5 min. after applying liquid gasket.

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

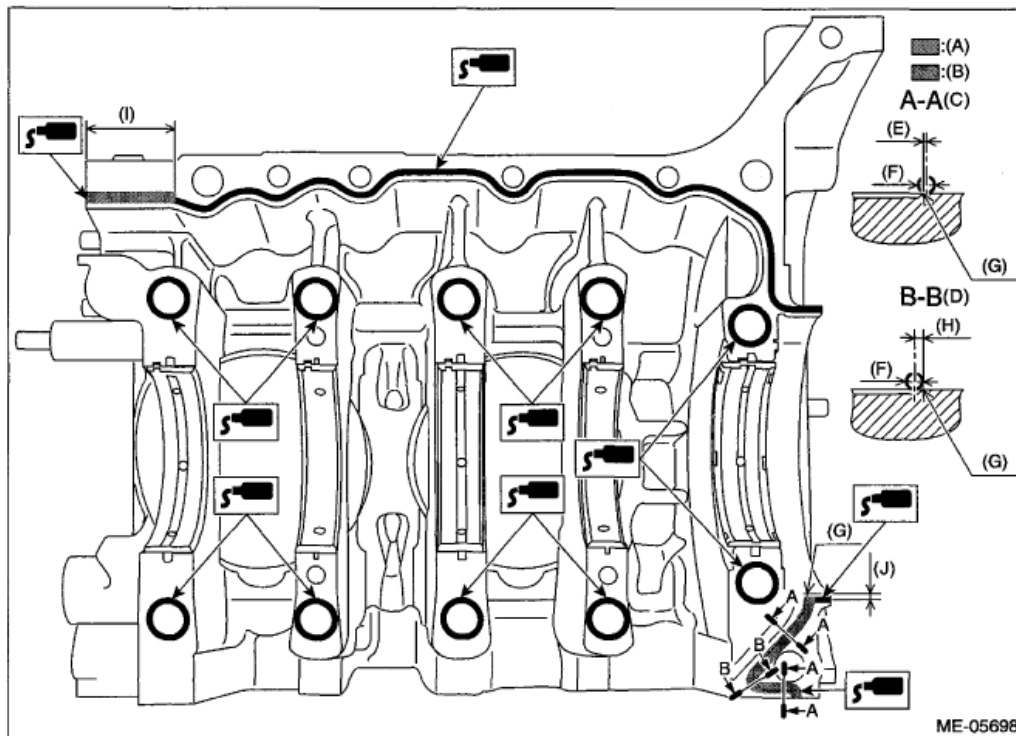
Liquid gasket applying diameter:

Mating surfaces other than ranges A and B

1±0.5 mm (0.0394±0.0197 in)

Mating surfaces of ranges A and B

4±0.5 mm (0.1575±0.0197 in)



- | | | |
|---|---|------------------------|
| (A) Range A | (E) 1 mm (0.0394 in) or less | (I) 36 mm (1.4173 in) |
| (B) Range B | (F) 4 ± 0.5 mm (0.1575 $\pm$ 0.0197 in) | (J) 2.5 mm (0.0984 in) |
| (C) Liquid gasket applying position of mating surfaces (other than the edge) of range B | (G) Chamfer edge | |
| (D) Liquid gasket applying position of mating surfaces (the edge) of range B | (H) 2 mm (0.0787 in) | |

Fig. 371: Applying Liquid Gasket To Mating Surface Of Cylinder Block RH
 Courtesy of SUBARU OF AMERICA, INC.

5. Install the cylinder block RH to the cylinder block LH.
6. Join the cylinder blocks.
 1. Apply a coat of engine oil to the washers and cylinder block mounting bolt threads.

NOTE: To prevent mixture of engine oil into the water jacket, do not apply a large amount.

2. Install the cylinder head bolt at the locations shown in the figure.

NOTE: This procedure is required to tighten the cylinder block mounting bolts with specified angle using ST.

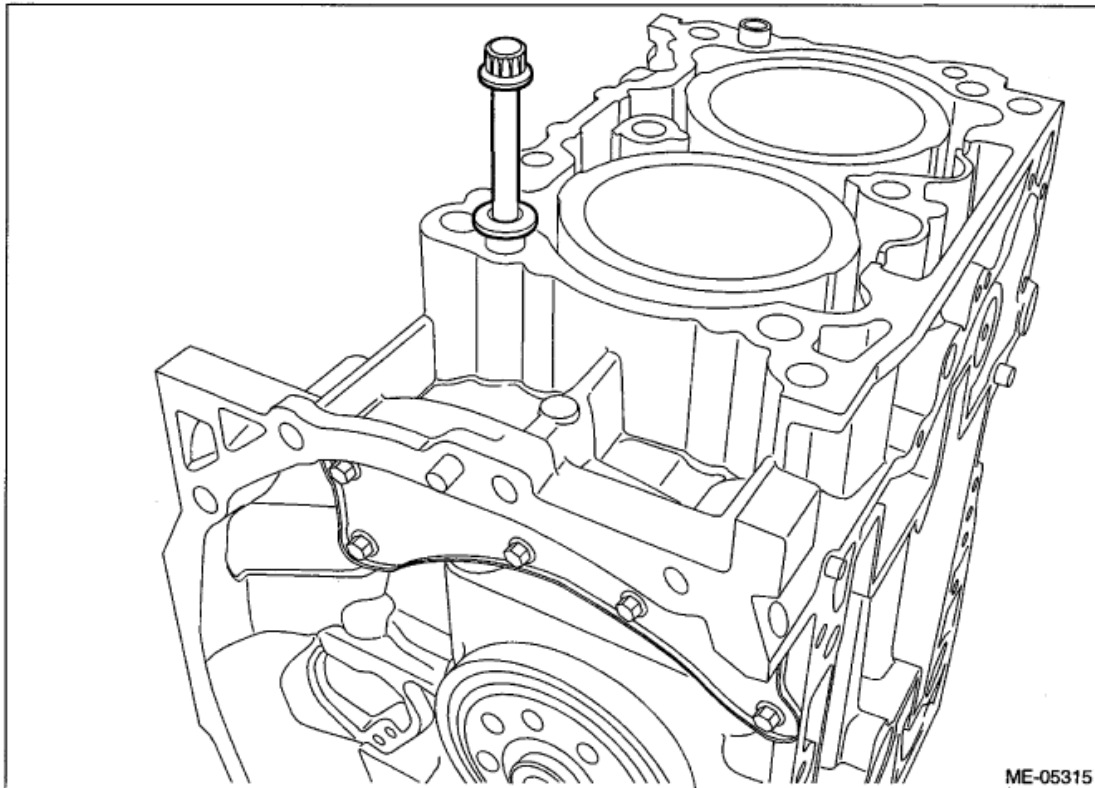


Fig. 372: Identifying Cylinder Head Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Tighten all mounting bolts with a torque of 35 N.m (3.6 kgf-m, 25.8 ft-lb) in numerical order as shown in the figure.

CAUTION: When tightening the mounting bolts with specified torque, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

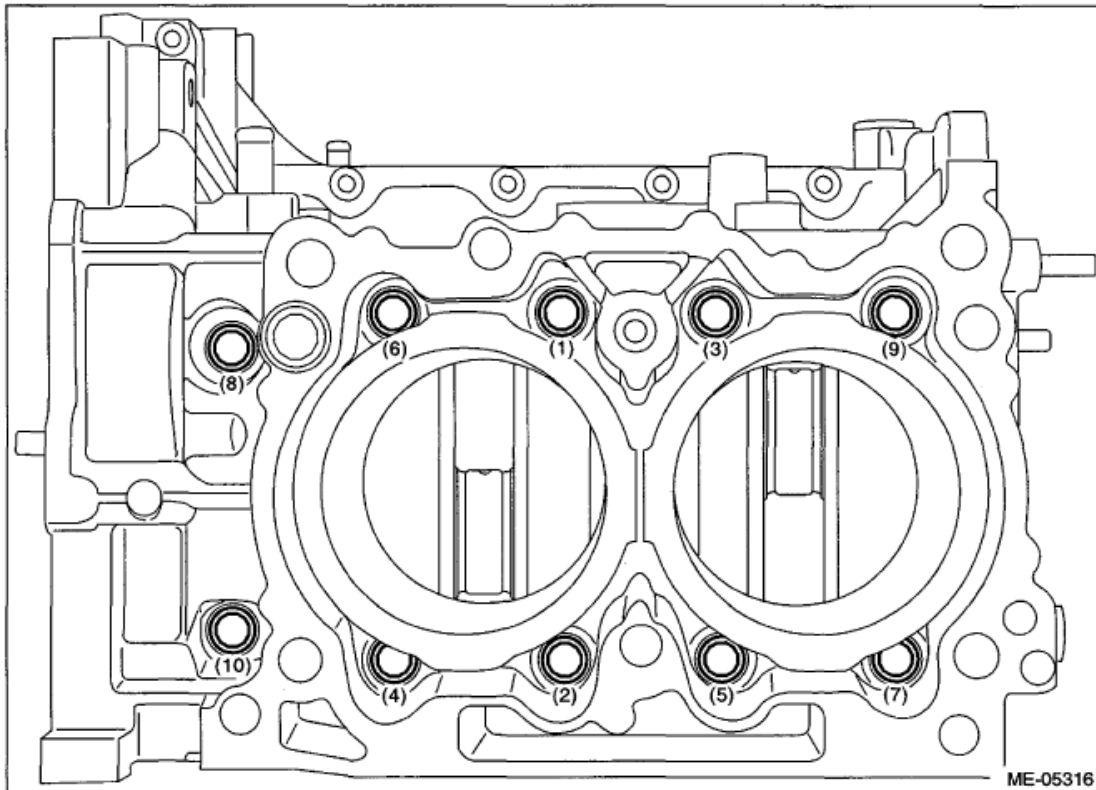


Fig. 373: Identifying Cylinder Block LH Mounting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

4. Loosen all mounting bolts by 180° in numerical order as shown in the figure.

CAUTION: When loosening the mounting bolts, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

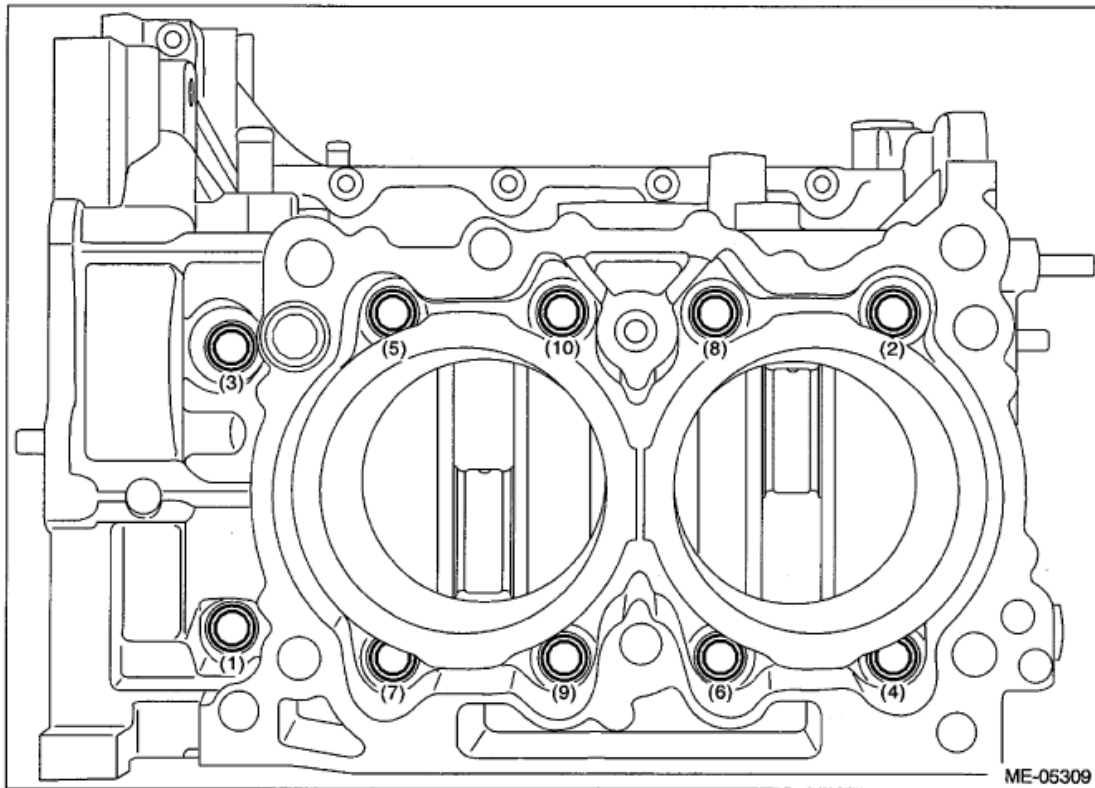


Fig. 374: Identifying Cylinder Block Mounting Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

5. Tighten all mounting bolts with a torque of 35 N.m (3.6 kgf-m, 25.8 ft-lb) in numerical order as shown in the figure.

CAUTION: When tightening the mounting bolts with specified torque, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

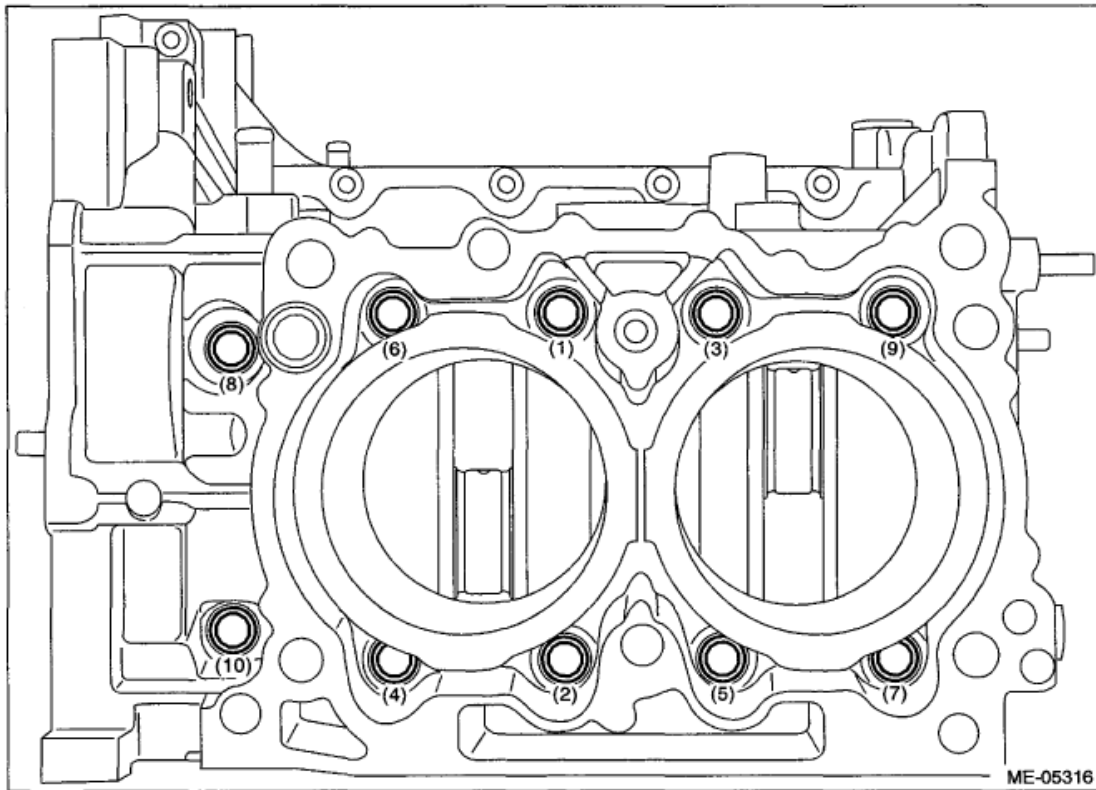


Fig. 375: Identifying Cylinder Block LH Mounting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

6. Loosen the mounting bolts (4 places) by 180° in numerical order as shown in the figure.

CAUTION: When loosening the mounting bolts, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

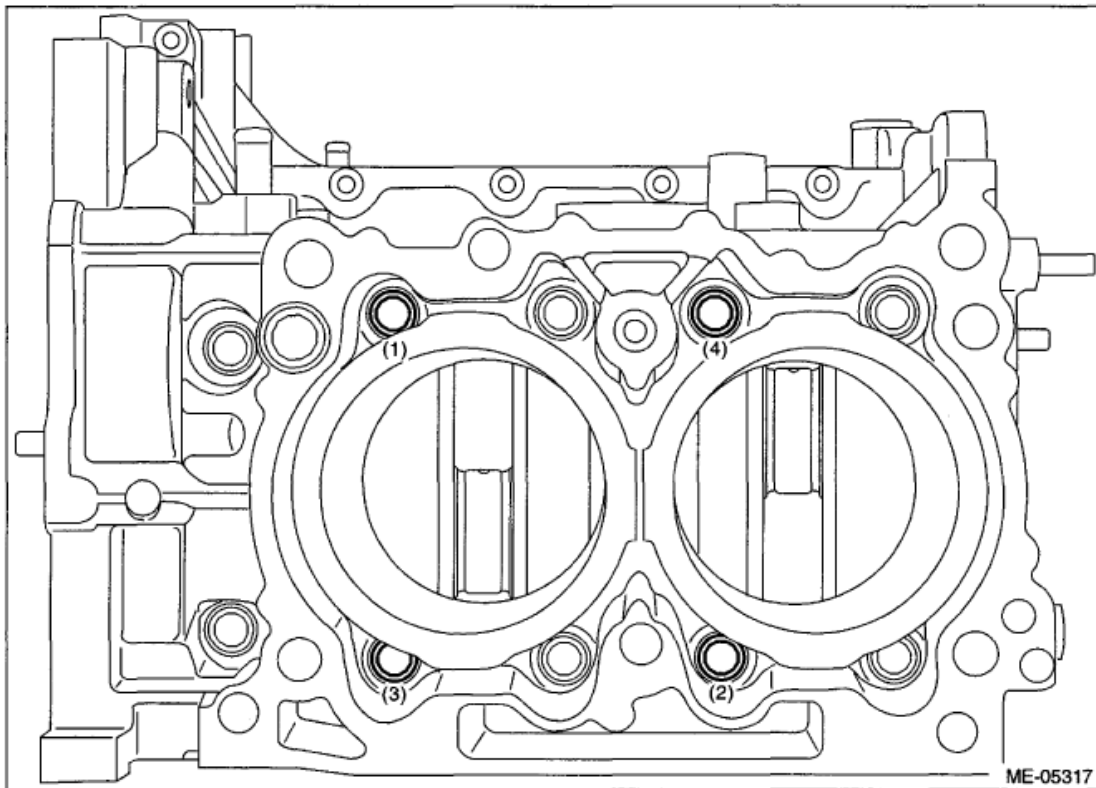


Fig. 376: Identifying Cylinder Block Mounting Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

7. Tighten the mounting bolts (4 places) with a torque of 17 N.m (1.7 kgf-m, 12.5 ft-lb) in numerical order as shown in the figure.

CAUTION: When tightening the mounting bolts with specified torque, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

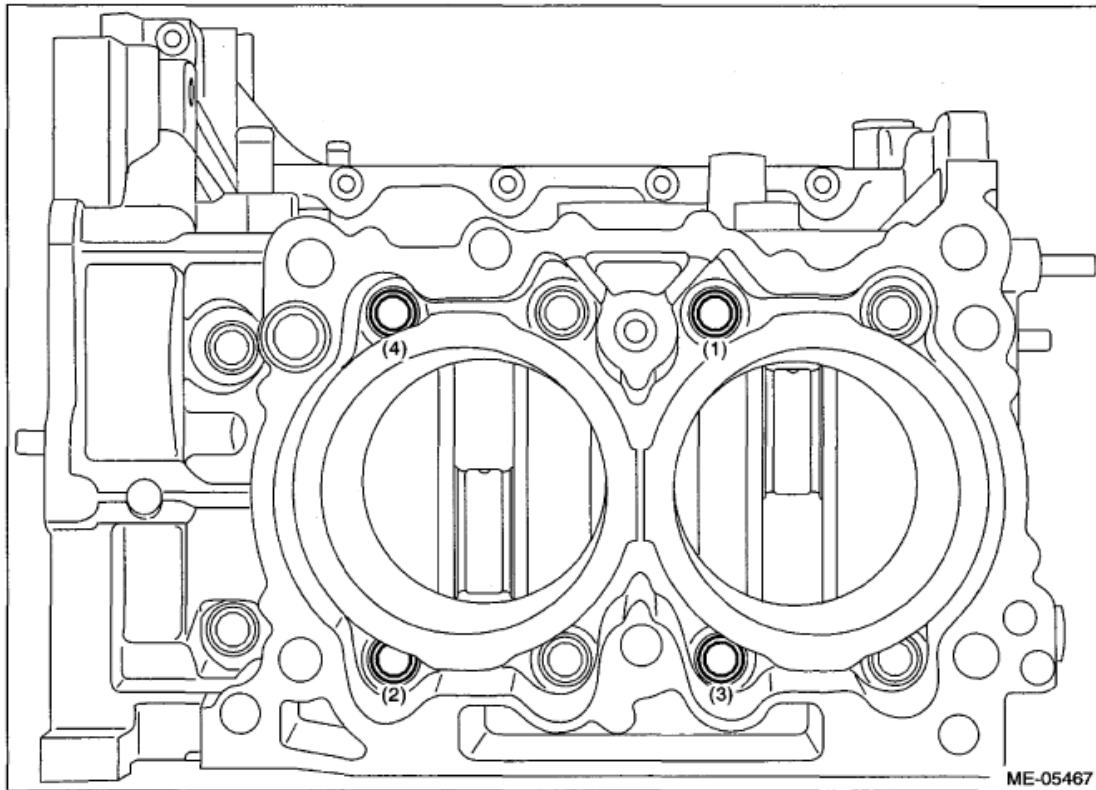


Fig. 377: Identifying Cylinder Block RH Mounting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

8. Tighten the mounting bolts (4 places) with specified angle in numerical order as shown in the figure using ST.

CAUTION: When tightening the mounting bolts with specified angle, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

NOTE: Attach the magnet used for securing the ST (ANGLE GAUGE) to the cylinder head bolt attached in step (2).

ST 18854AA000 ANGLE GAUGE

Tightening angle: $60^{\circ} \pm 2^{\circ}$

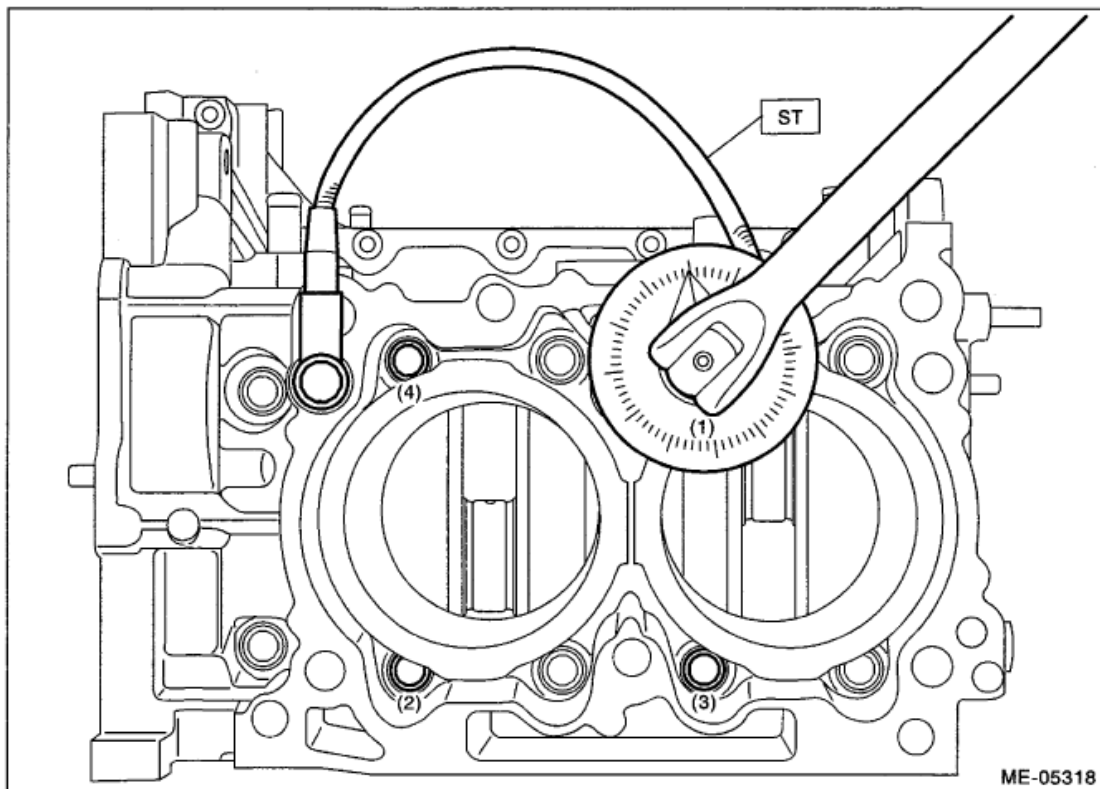


Fig. 378: Tightening Cylinder Block Mounting Bolts Using Angle Gauge
Courtesy of SUBARU OF AMERICA, INC.

9. Loosen the mounting bolts (6 places) by 180° in numerical order as shown in the figure.

CAUTION: When loosening the mounting bolts, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

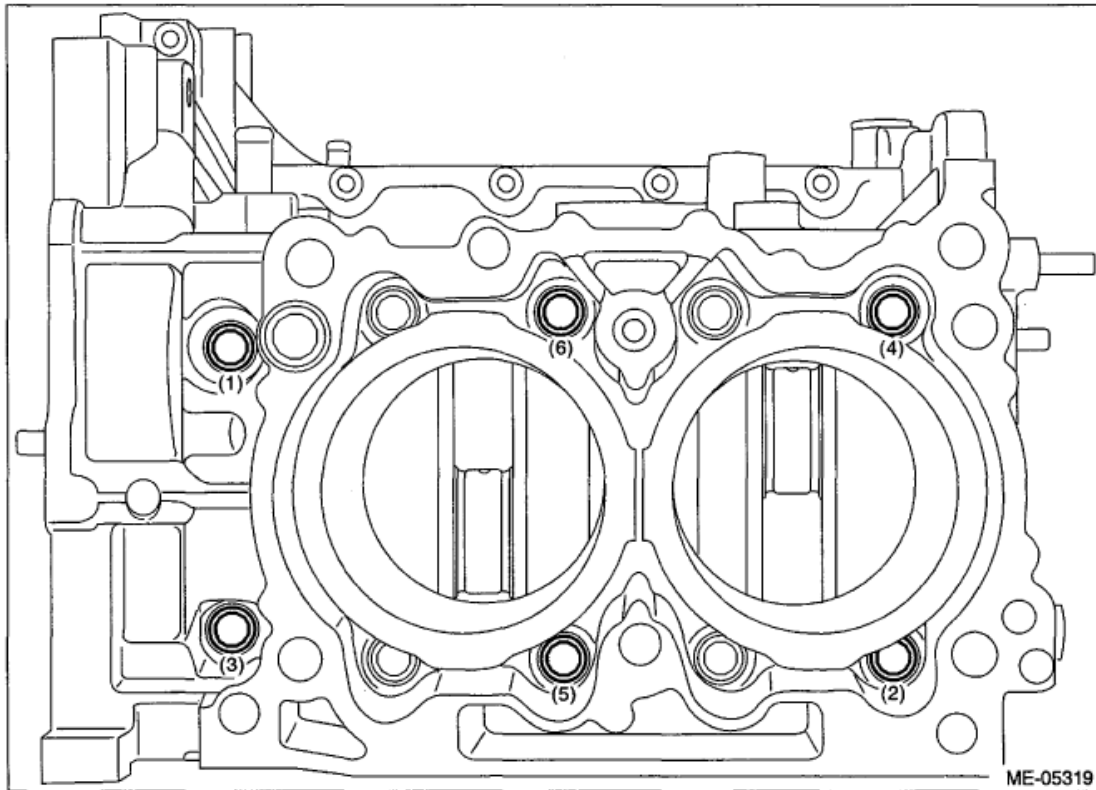


Fig. 379: Identifying Cylinder Block Mounting Bolts Loosening Sequence
Courtesy of SUBARU OF AMERICA, INC.

10. Tighten the mounting bolts (6 places) with a torque of 17 N.m (1.7 kgf-m, 12.5 ft-lb) in numerical order as shown in the figure.

CAUTION: When tightening the mounting bolts with specified torque, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

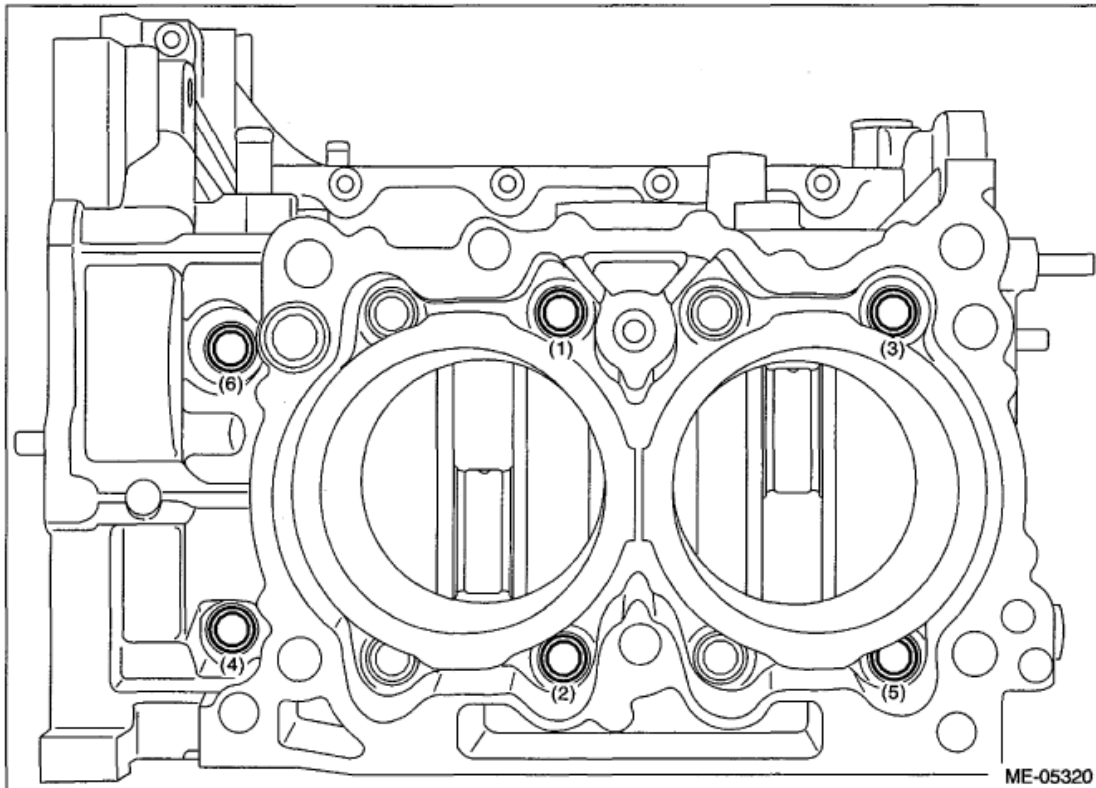


Fig. 380: Identifying Cylinder Block RH Mounting Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

11. Tighten the mounting bolts (6 places) with specified angle in numerical order as shown in the figure using ST.

CAUTION: When tightening the mounting bolts with specified angle, hold the cylinder block LH while not holding the cylinder block RH to ensure the joint accuracy of the cylinder block.

NOTE: Attach the magnet used for securing the ST (ANGLE GAUGE) to the cylinder head bolt attached in step (2).

ST 18854AA000 ANGLE GAUGE

Tightening angle: $60^{\circ} \pm 2^{\circ}$

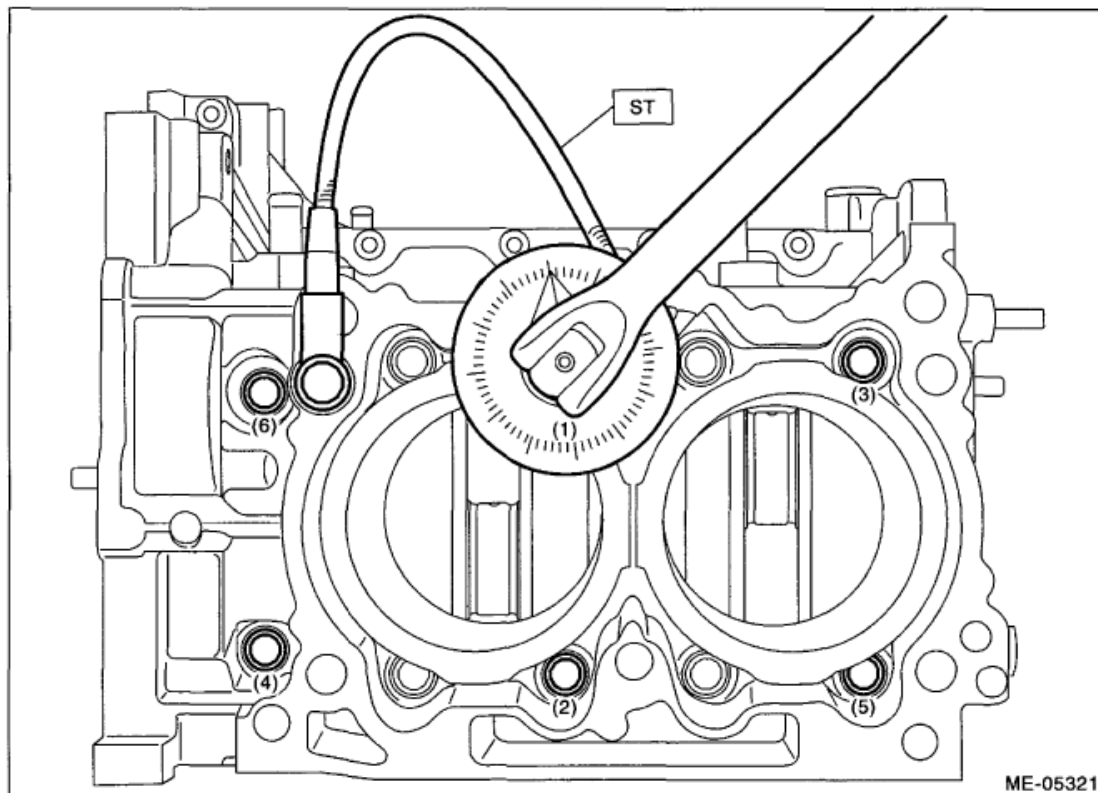


Fig. 381: Tightening Cylinder Block LH Mounting Bolts Using Angle Gauge
 Courtesy of SUBARU OF AMERICA, INC.

12. Remove the cylinder head bolt attached at the locations shown in the figure.

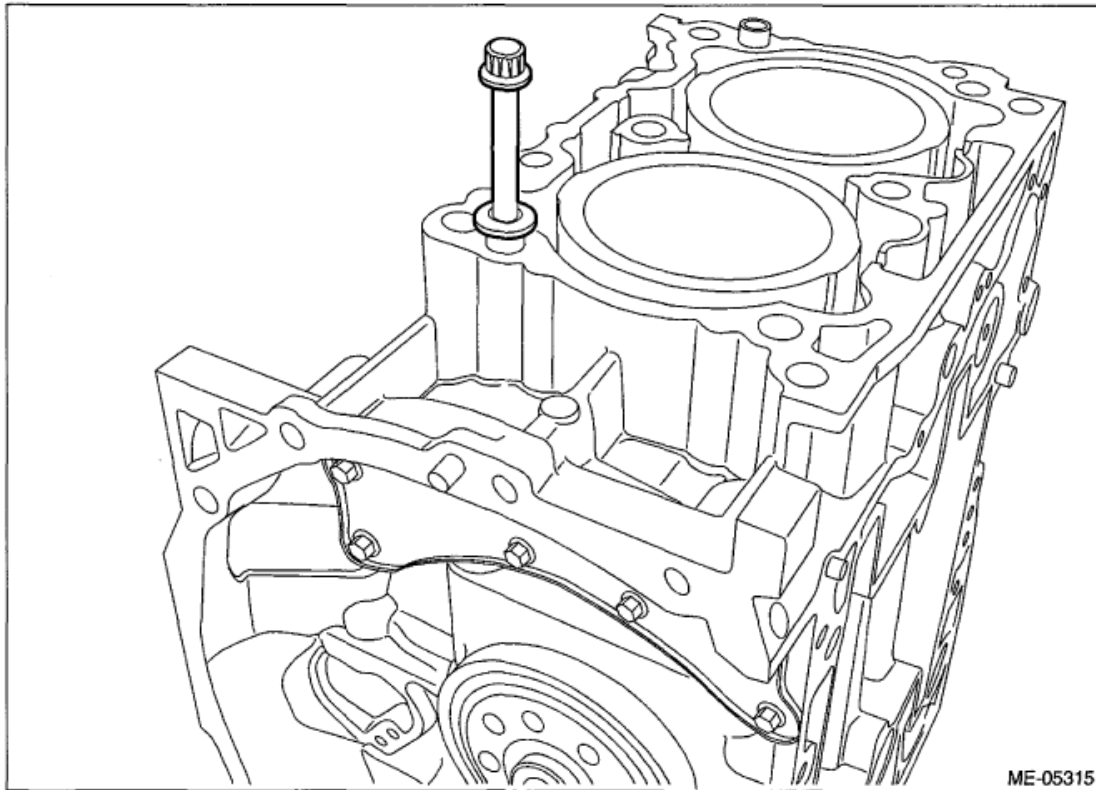


Fig. 382: Identifying Cylinder Head Bolt
Courtesy of SUBARU OF AMERICA, INC.

13. Install the bolt shown in the figure.

NOTE: After tightening, if the liquid gasket is squeezed out in the seal surface area of the chain cover and oil pan upper, completely remove any liquid gasket that is squeezed out.

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

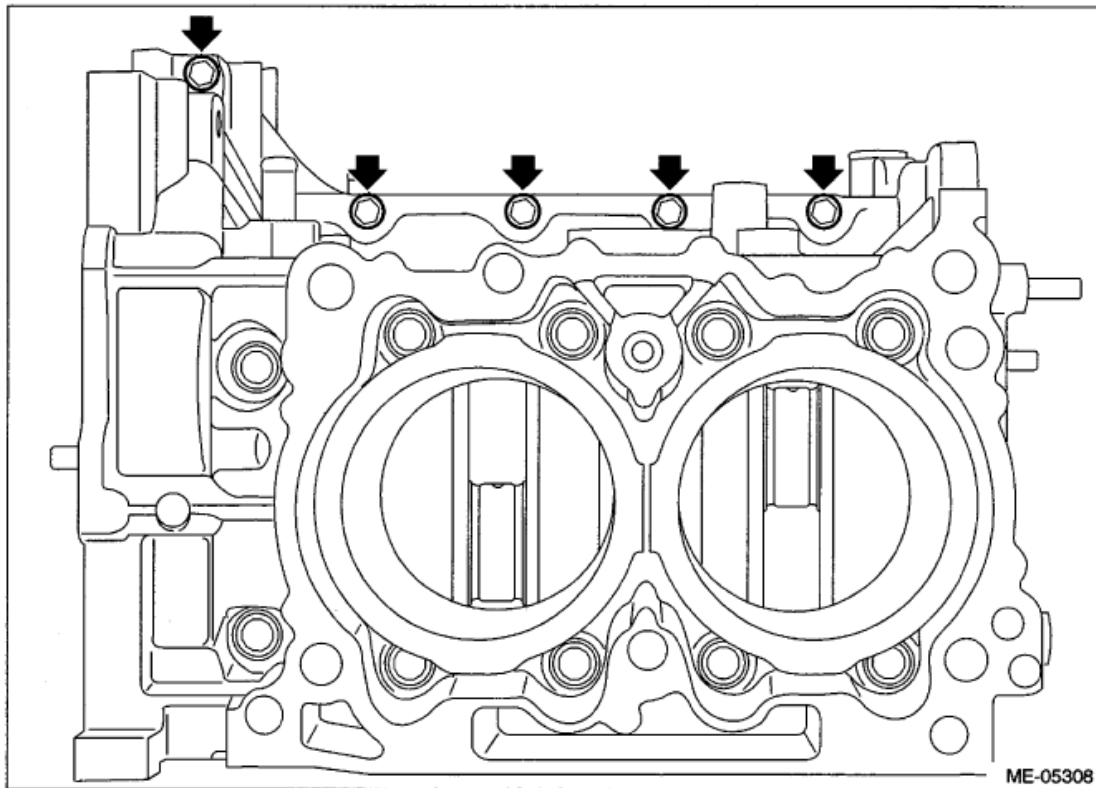


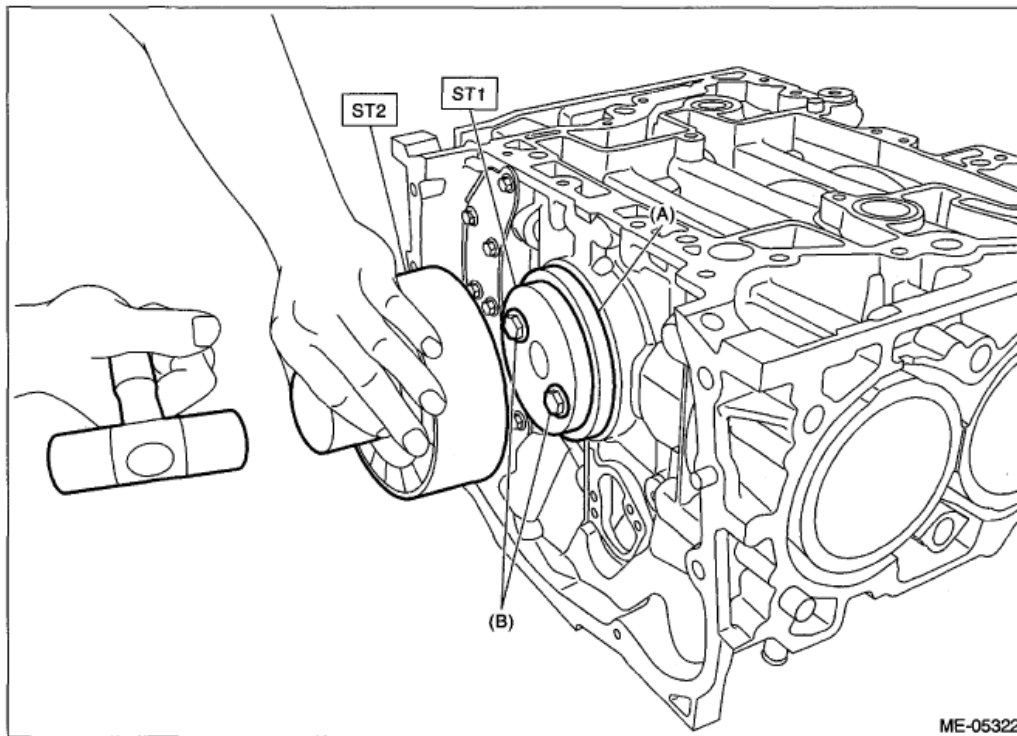
Fig. 383: Locating Cylinder Block RH Bolts (Upper Side)
 Courtesy of SUBARU OF AMERICA, INC.

7. Set the part so that the oil pan side of cylinder block is on the upper side.
8. 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 18671AA020 OIL SEAL GUIDE

ST2 18657AA030 OIL SEAL INSTALLER



(A) Rear oil seal

(B) Drive plate or flywheel mounting bolt

Fig. 384: Installing Rear Oil Seal Using ST1 And ST2
 Courtesy of SUBARU OF AMERICA, INC.

9. Install the A/C compressor bracket bolts and the power steering pump bracket bolts at the locations shown in the figure.

NOTE:

- This procedure is required to prevent the knock pin damage when the cylinder block is raised in the next step.
- Use the same length bolt for the four bolts.

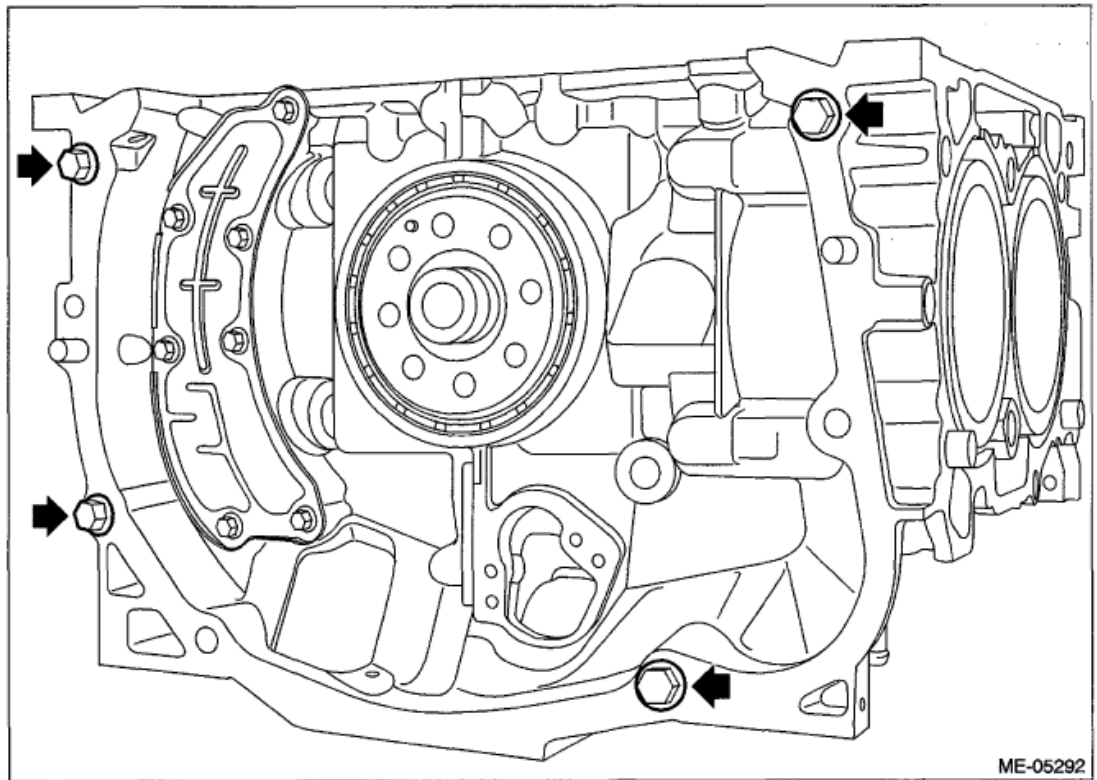


Fig. 385: Locating A/C Compressor Bracket And Power Steering Pump Bracket Bolts
 Courtesy of SUBARU OF AMERICA, INC.

10. Raise the cylinder block so that the rear oil seal is on the lower side.
11. Align the ring closed gaps of piston ring and oil ring for each piston.

NOTE:

- Make sure ring gaps do not face the same direction.
- Check that the piston ring mark of top ring and second ring faces the top side of the piston.
- Check that the ring gaps is not positioned within the range of piston skirt extended line.

1. Set the ring gap of the top ring to the position (A) in the figure.

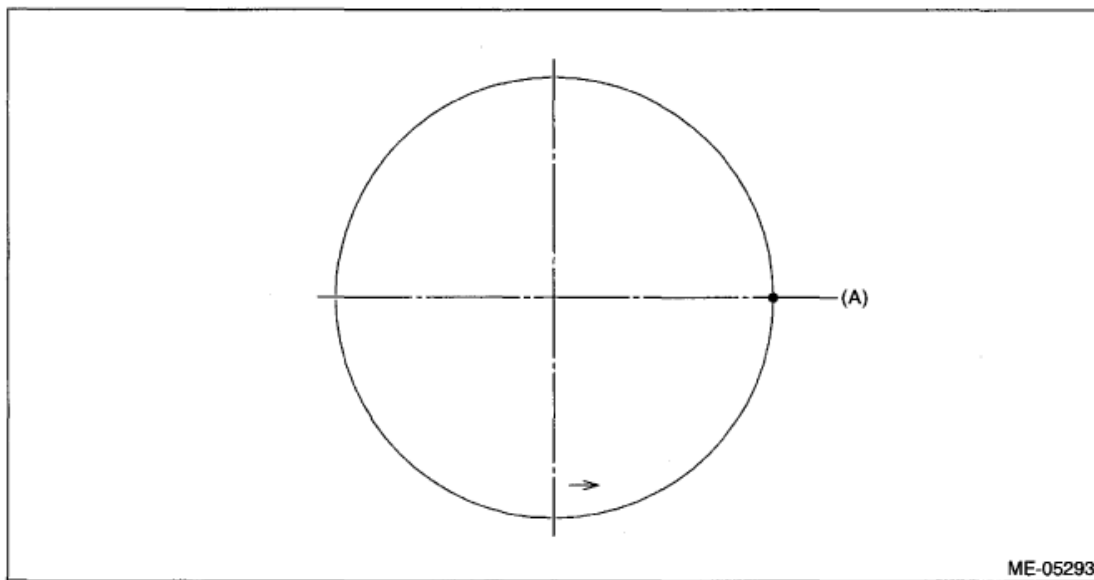


Fig. 386: Positioning Ring Gap Of Top Ring
Courtesy of SUBARU OF AMERICA, INC.

2. Position the ring gap of second ring at (B) in the figure on the 180° opposite direction of (A).

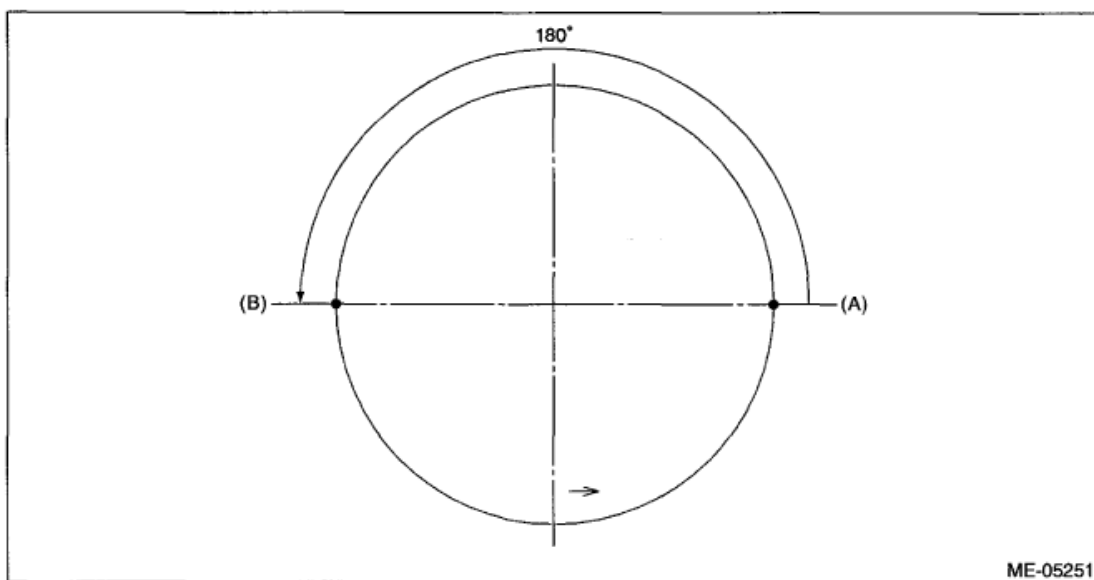


Fig. 387: Positioning Ring Gap Of Second Ring
Courtesy of SUBARU OF AMERICA, INC.

3. Set the ring gap of the upper rail to the position (C) in the figure.

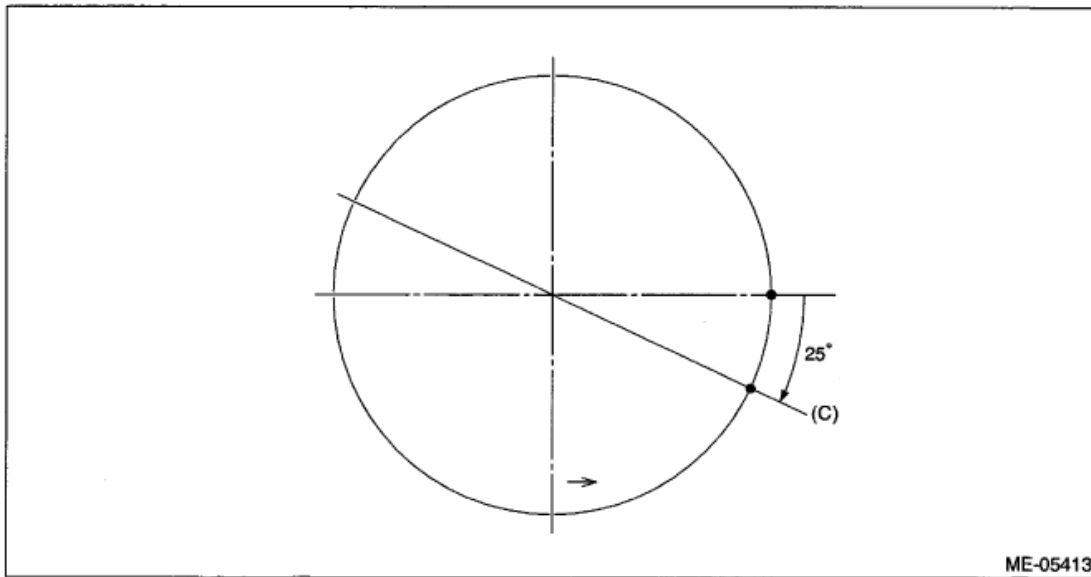


Fig. 388: Positioning Ring Gap Of Upper Rail
Courtesy of SUBARU OF AMERICA, INC.

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

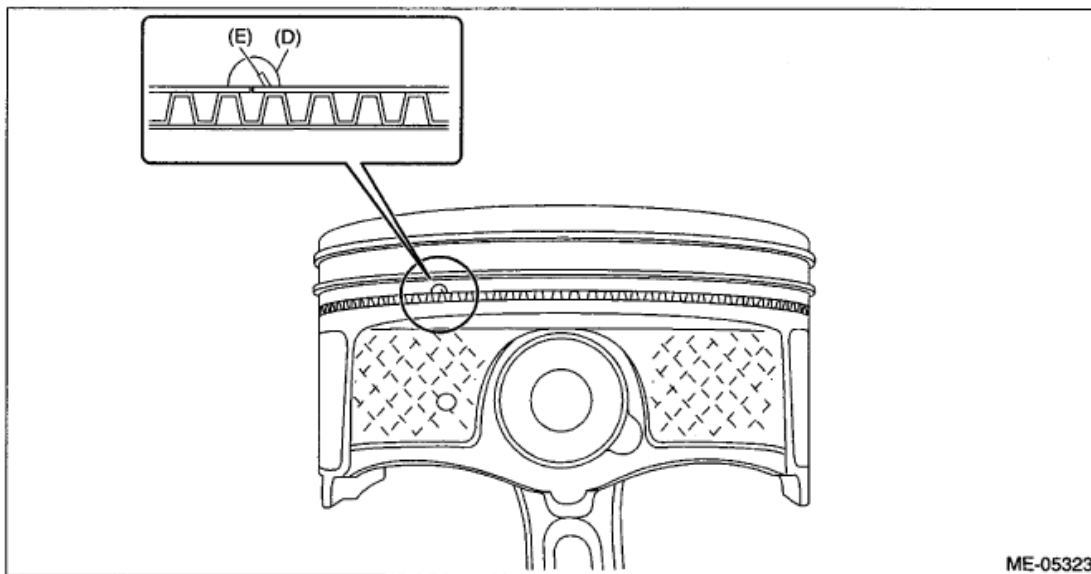


Fig. 389: Identifying Upper Rail Spin Stopper Alignment Position
Courtesy of SUBARU OF AMERICA, INC.

5. Position the ring gap of expander at (F) in the figure on the 180° opposite direction of (C).

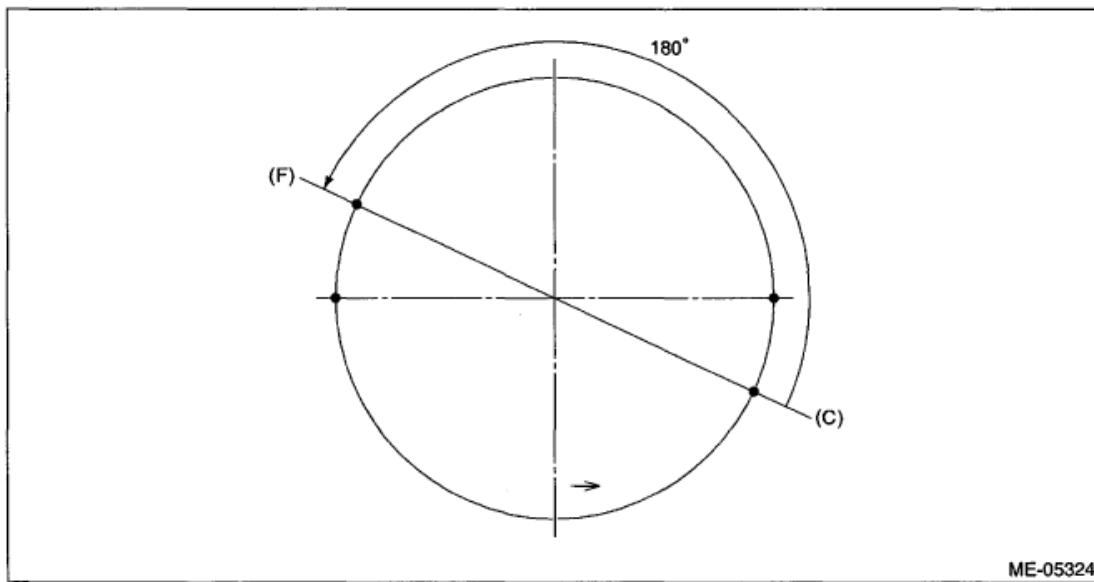


Fig. 390: Positioning Ring Gap Of Expander
Courtesy of SUBARU OF AMERICA, INC.

6. Set the ring gap of lower rail at position (G), located 120° clockwise from (C) in the figure.

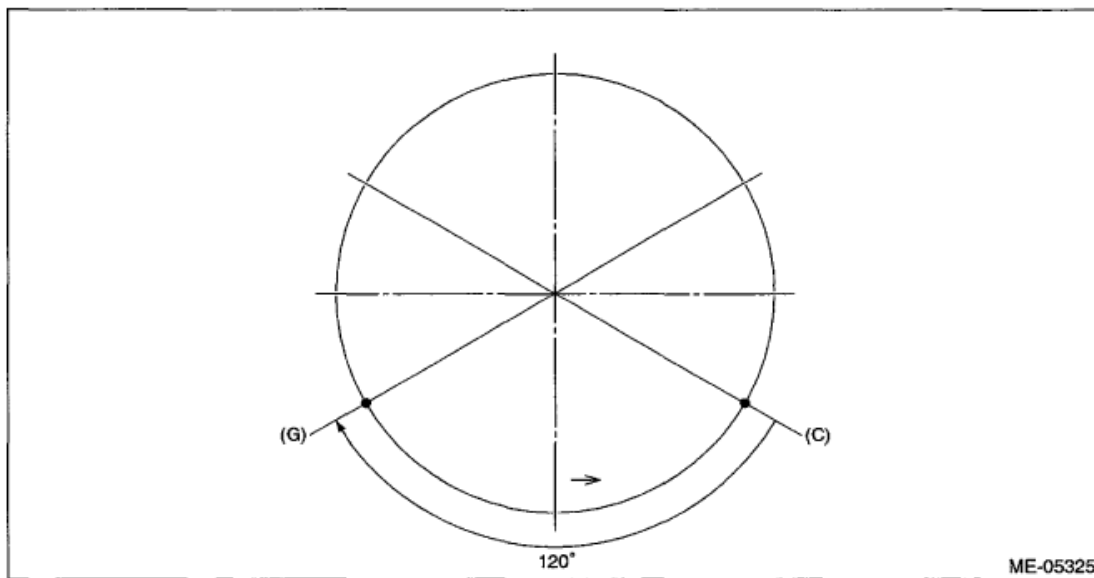


Fig. 391: Positioning Ring Gap Of Lower Rail
Courtesy of SUBARU OF AMERICA, INC.

12. Install the piston and connecting rod to the cylinder block.
 1. Apply engine oil to the outer circumference of each piston, crank pin, and in the cylinder block.
 2. Turn the crankshaft so that the #1 crank pin (A) is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

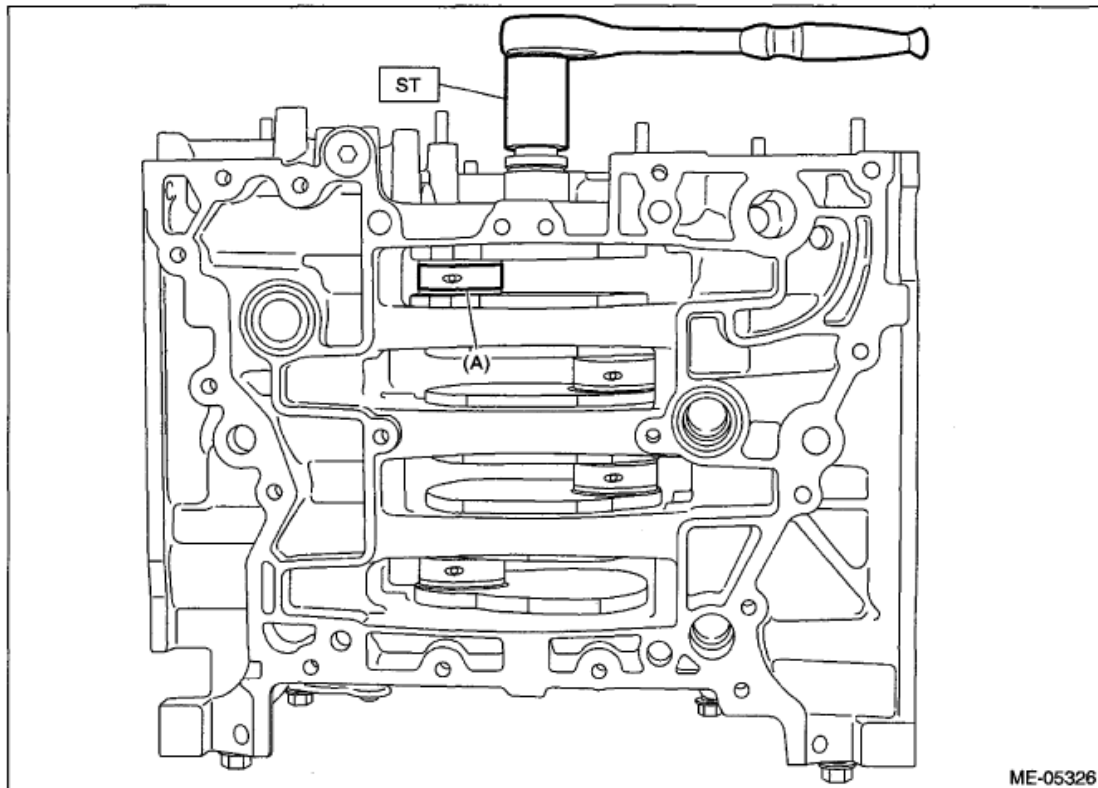


Fig. 392: Turning Crankshaft Using Crankshaft Socket
 Courtesy of SUBARU OF AMERICA, INC.

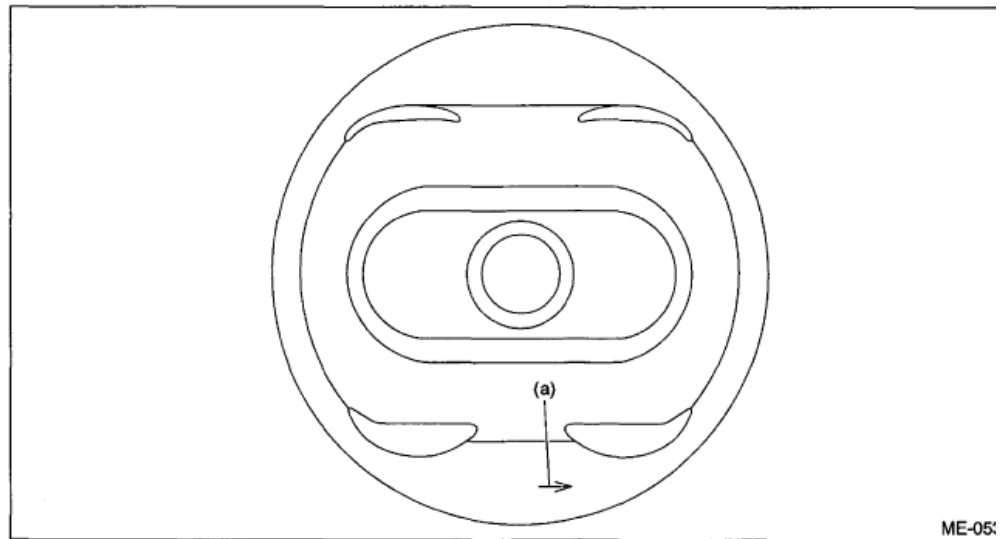
3. Compress the piston ring using piston ring compressor, and insert the #1 connecting rod with #1 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #1 crank pin by the #1 connecting rod large end.
- Be careful not to apply strong impact when inserting to prevent connecting rod bearing from falling off.

NOTE:

- Face the piston front mark (arrow) towards the front of the engine.

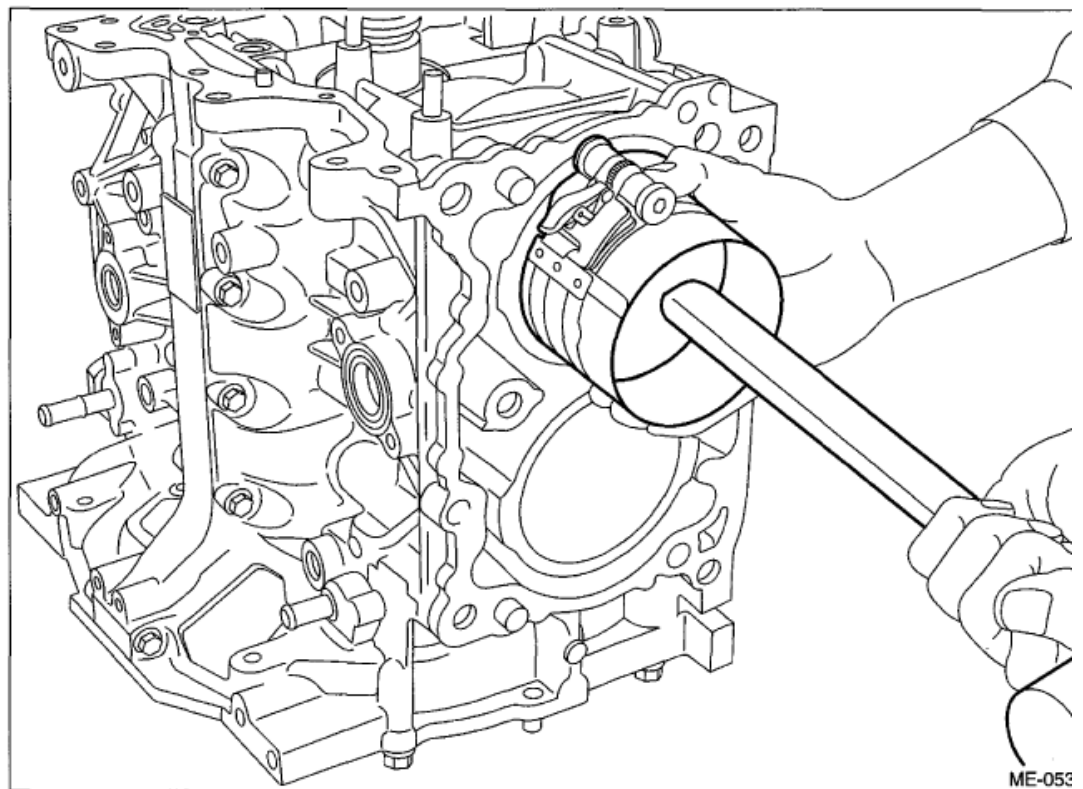


ME-053

(a) Front mark

Fig. 393: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

- Insert while lightly tapping the crown of the piston with the handle of a plastic hammer.



ME-053

Fig. 394: Tapping Crown Of Piston

Courtesy of SUBARU OF AMERICA, INC.

4. Turn the crankshaft counterclockwise so that the #1 crank pin and the large end of #1 connecting rod (A) are positioned as shown in the figure using ST, while pressing the #1 piston crown, and then set the #1 connecting rod cap and #1 connecting rod cap bolt.

NOTE:

- Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching symbol.
- Use a new connecting rod cap bolt.
- Apply a coat of engine oil to the #1 connecting rod cap seat and the connecting rod cap bolt threads.

ST 18252AA000 CRANKSHAFT SOCKET

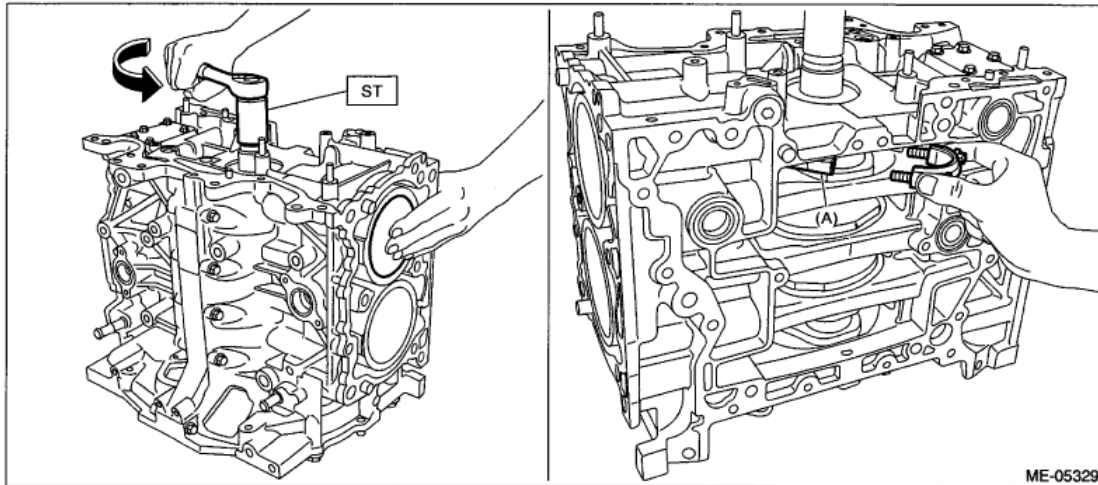


Fig. 395: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

5. Using TORX® socket E12, tighten the #1 connecting rod cap bolts to 10 N.m (1.0 kgf-m, 7.4 ft-lb) in numerical order as shown in the figure, then retighten the bolts to 22 N.m (2.2 kgf-m, 16.2 ft-lb) in numerical order as shown in the figure.

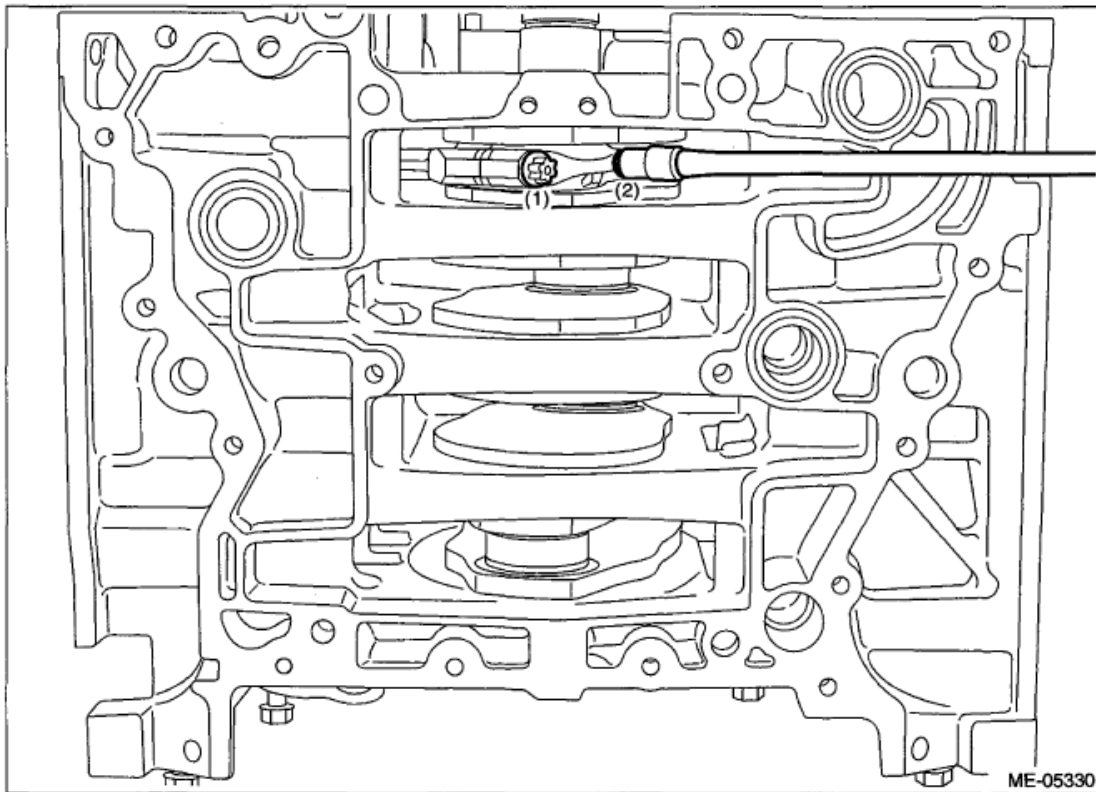


Fig. 396: Tighten #1 Connecting Rod Cap Bolt
Courtesy of SUBARU OF AMERICA, INC.

6. Turn the crankshaft clockwise so that the #2 crank pin (A) is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

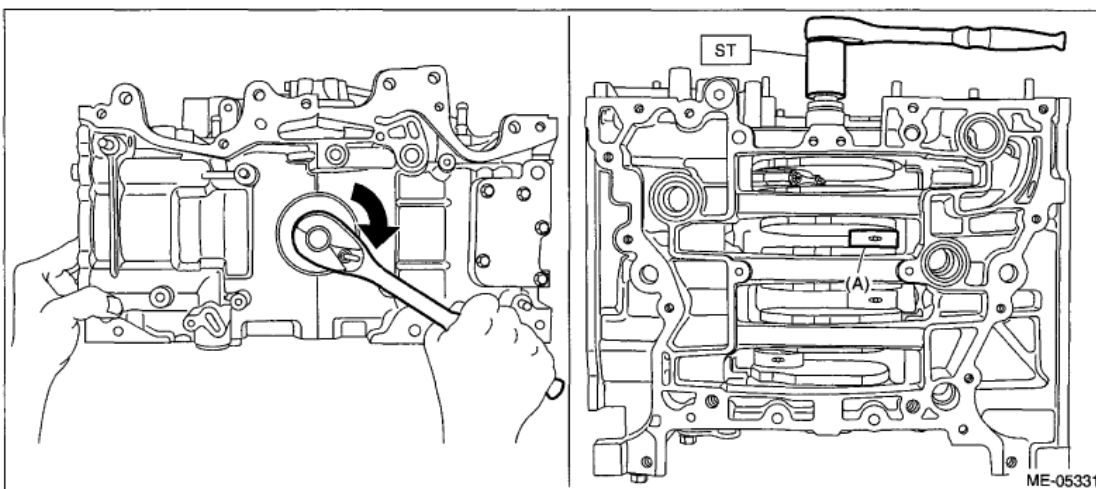


Fig. 397: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

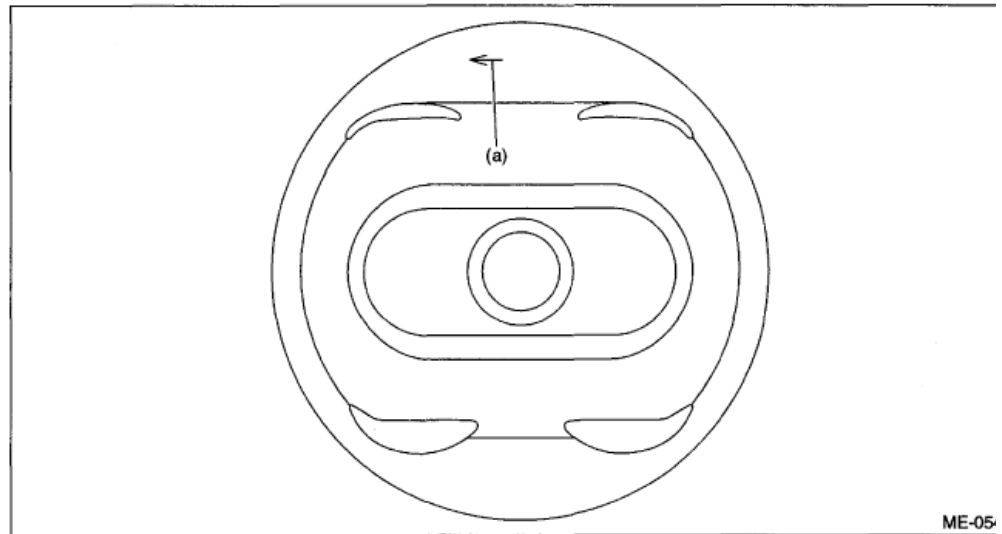
7. Compress the piston ring using piston ring compressor, and insert the #2 connecting rod with #2 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #2 crank pin by the #2 connecting rod large end.
- Be careful not to apply strong impact when inserting to prevent connecting rod bearing from falling off.

NOTE:

- Face the piston front mark (arrow) towards the front of the engine.



ME-05

(a) Front mark

Fig. 398: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

- Insert while lightly tapping the crown of the piston with the handle of a plastic hammer.

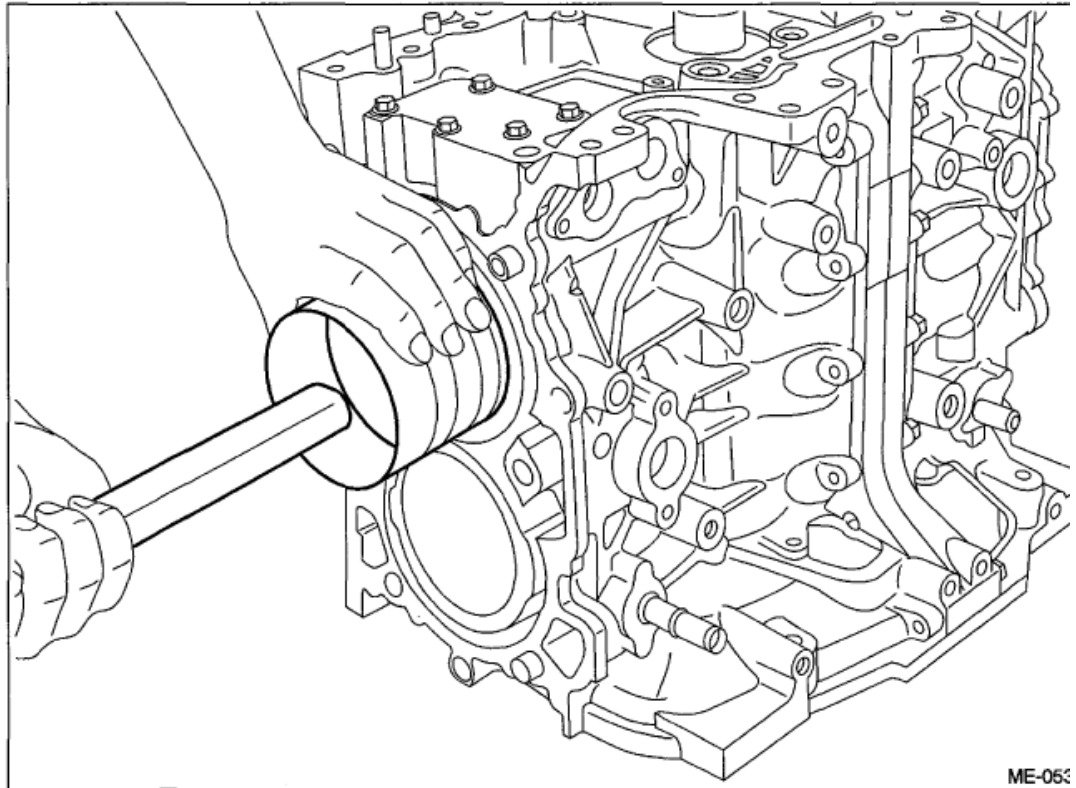


Fig. 399: Tapping Crown Of Piston
Courtesy of SUBARU OF AMERICA, INC.

8. Turn the crankshaft clockwise so that the #2 crank pin and the large end of #2 connecting rod (A) are positioned as shown in the figure using ST, while pressing the #2 piston crown, and then set the #2 connecting rod cap and #2 connecting rod cap bolt.

NOTE:

- Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching symbol.
- Use a new connecting rod cap bolt.
- Apply a coat of engine oil to the #2 connecting rod cap seat and the connecting rod cap bolt threads.

ST 18252AA000 CRANKSHAFT SOCKET

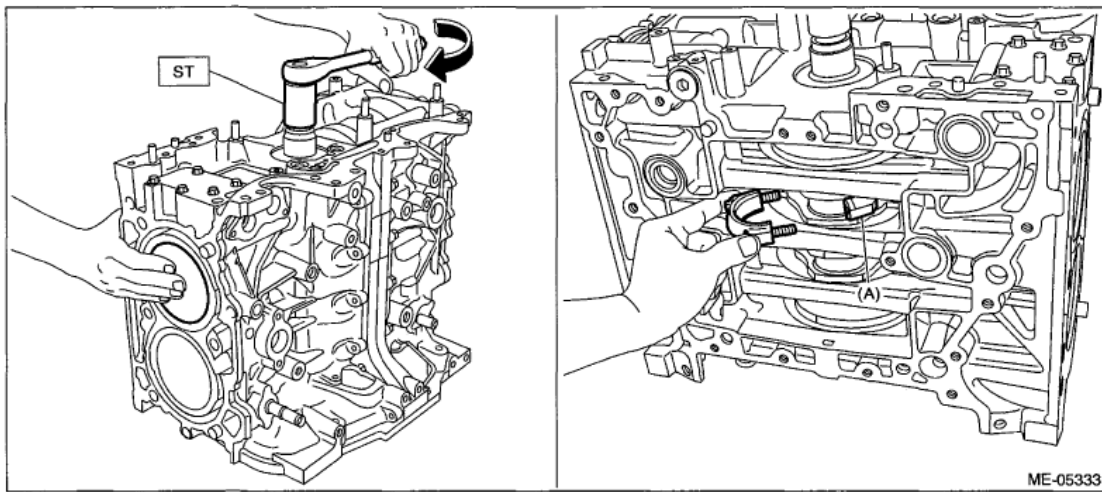


Fig. 400: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

9. Using TORX® socket E12, tighten the #2 connecting rod cap bolts to 10 N.m (1.0 kgf-m, 7.4 ft-lb) in numerical order as shown in the figure, then retighten the bolts to 22 N.m (2.2 kgf-m, 16.2 ft-lb) in numerical order as shown in the figure.

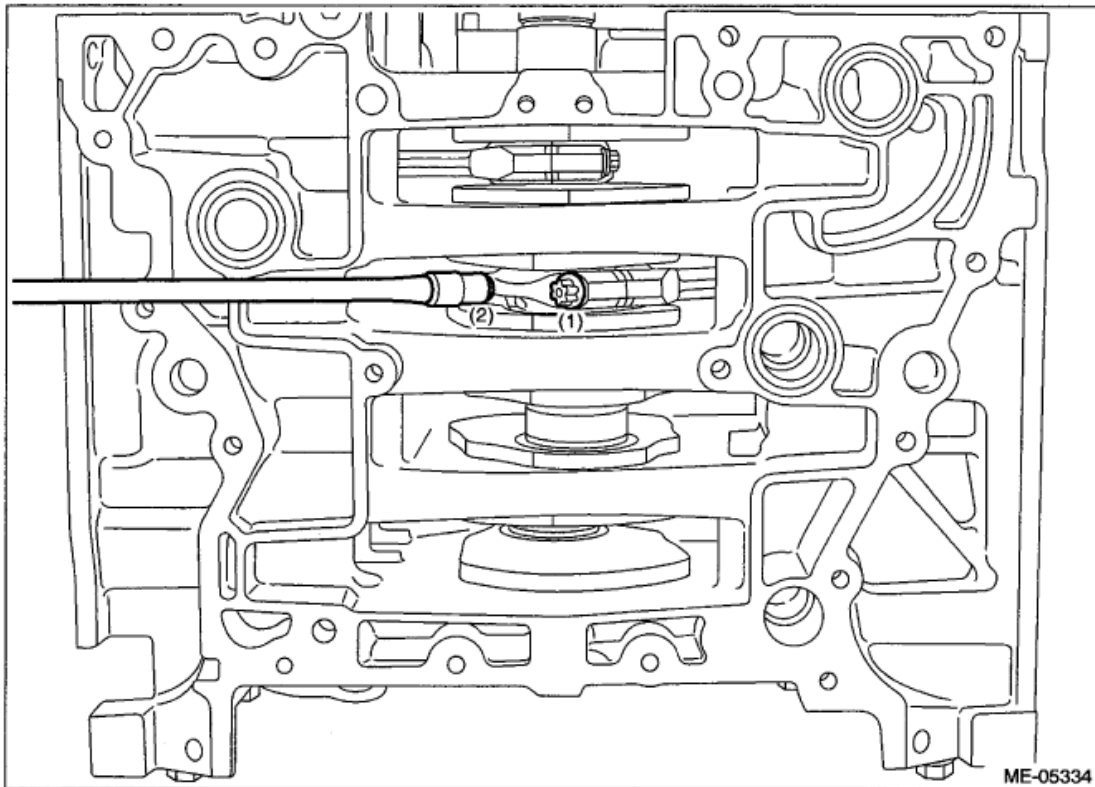


Fig. 401: Tightening #2 Connecting Rod Cap Bolt
Courtesy of SUBARU OF AMERICA, INC.

10. Turn the crankshaft clockwise so that the #3 crank pin (A) is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

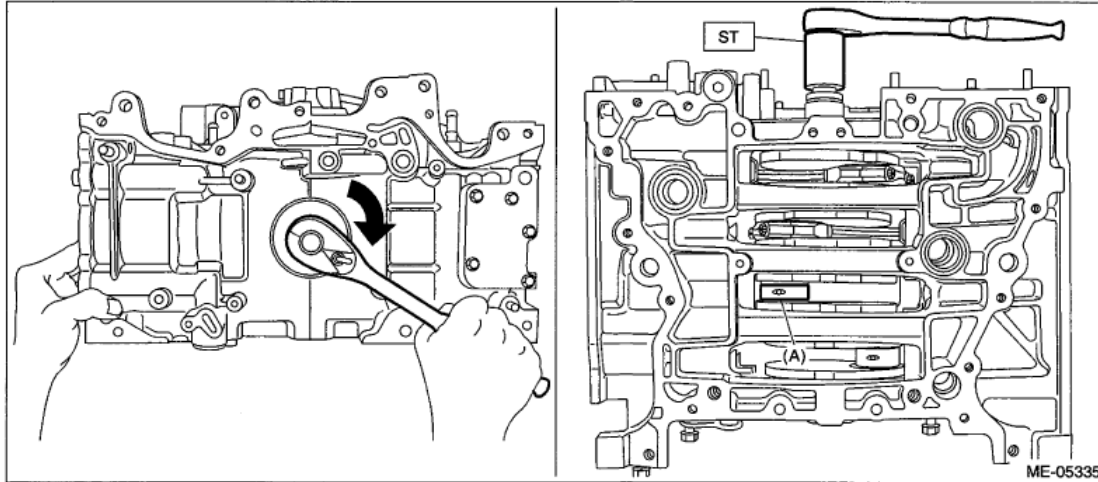


Fig. 402: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

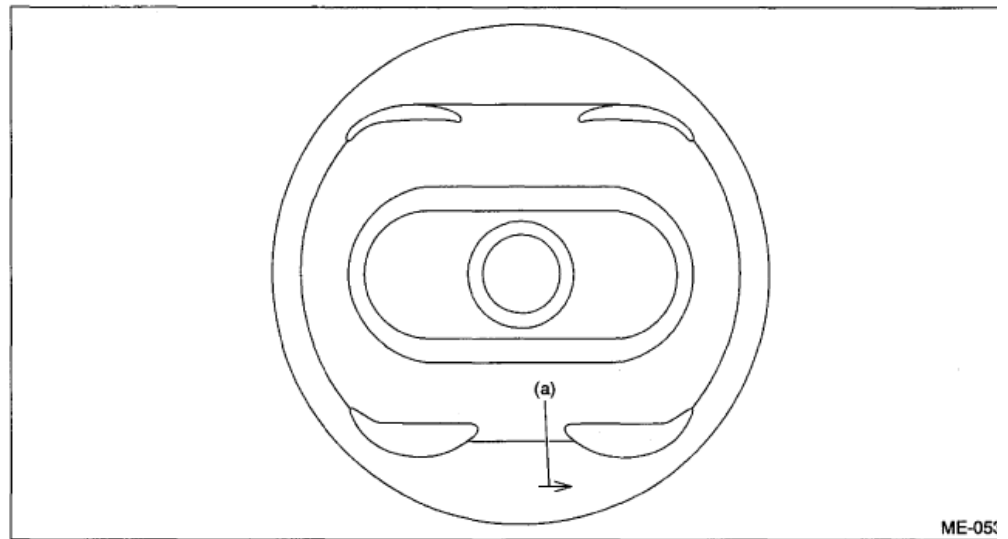
11. Compress the piston ring using piston ring compressor, and insert the #3 connecting rod with #3 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #3 crank pin by the #3 connecting rod large end.
- Be careful not to apply strong impact when inserting to prevent connecting rod bearing from falling off.

NOTE:

- Face the piston front mark (arrow) towards the front of the engine.

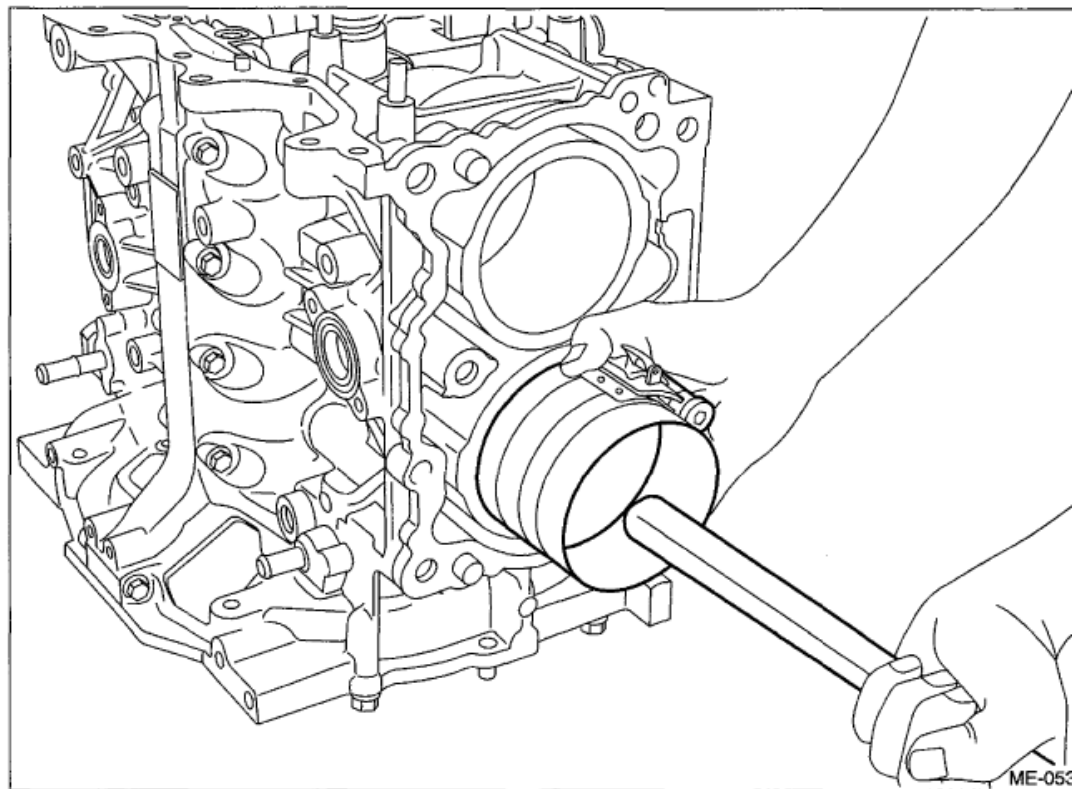


ME-053

(a) Front mark

Fig. 403: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

- Insert while lightly tapping the crown of the piston with the handle of a plastic hammer.



ME-053

Fig. 404: Tapping Crown Of Piston

Courtesy of SUBARU OF AMERICA, INC.

12. Turn the crankshaft counterclockwise so that the #3 crank pin and the large end of #3 connecting rod are positioned as shown in the figure using ST, while pressing the #3 piston crown, and then set the #3 connecting rod cap and #3 connecting rod cap bolt.

NOTE:

- Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching symbol.
- Use a new connecting rod cap bolt.
- Apply a coat of engine oil to the #3 connecting rod cap seat and the connecting rod cap bolt threads.

ST 18252AA000 CRANKSHAFT SOCKET

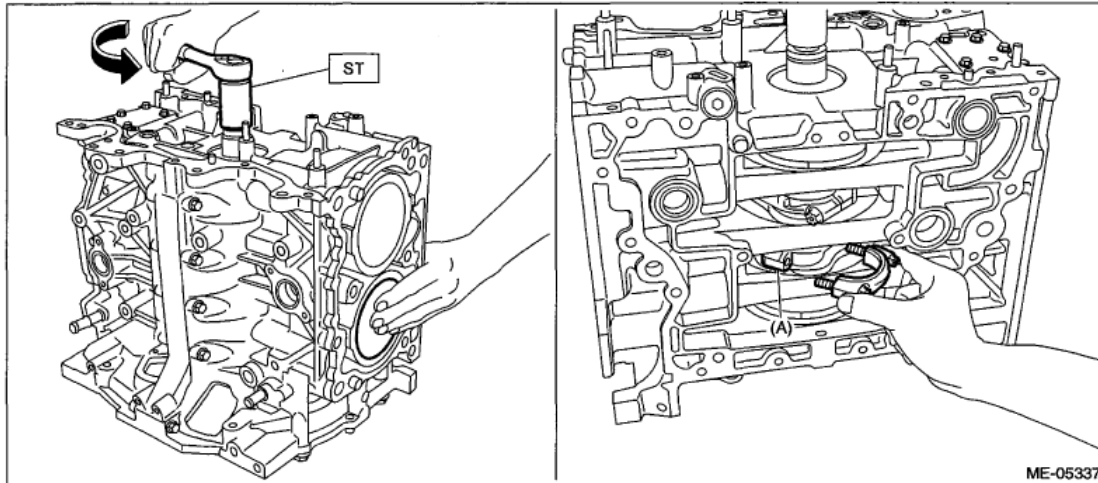


Fig. 405: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

13. Using TORX® socket E12, tighten the #3 connecting rod cap bolts to 10 N.m (1.0 kgf-m, 7.4 ft-lb) in numerical order as shown in the figure, then retighten the bolts to 22 N.m (2.2 kgf-m, 16.2 ft-lb) in numerical order as shown in the figure.

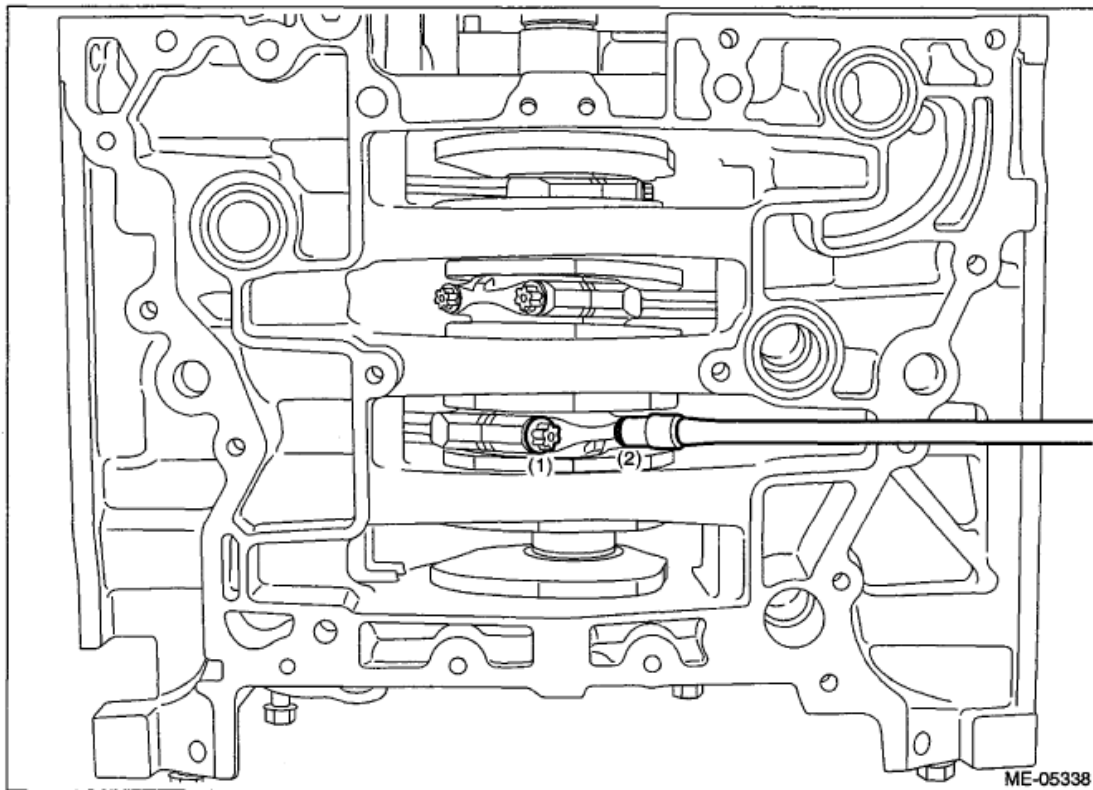


Fig. 406: Tightening #3 Connecting Rod Cap Bolt
Courtesy of SUBARU OF AMERICA, INC.

14. Turn the crankshaft clockwise so that the #4 crank pin (A) is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

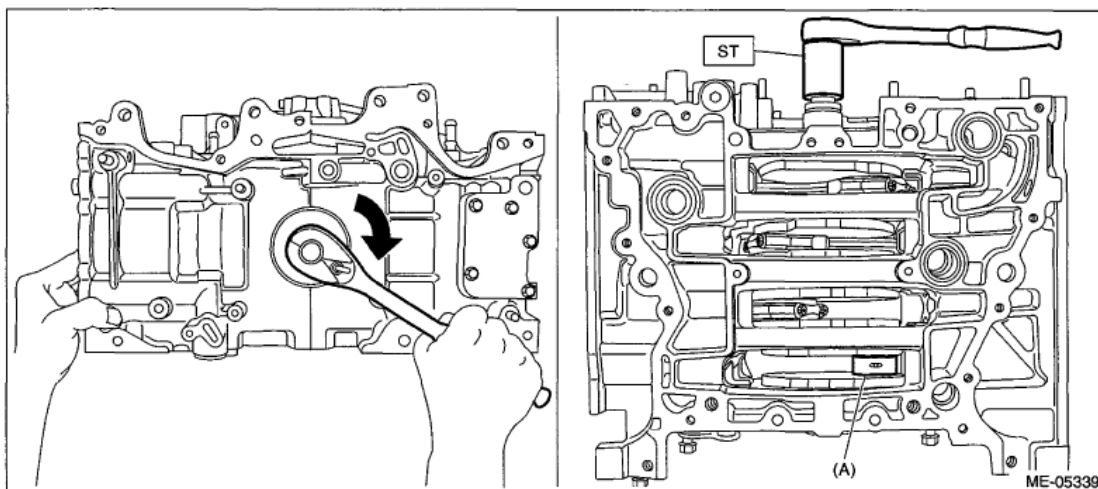


Fig. 407: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

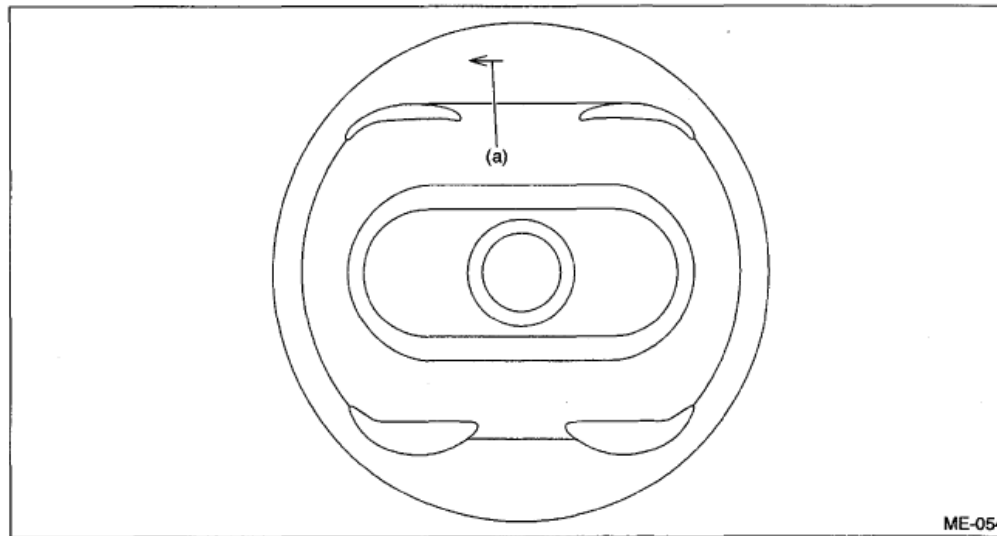
15. Compress the piston ring using piston ring compressor, and insert the #4 connecting rod with #4 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #4 crank pin by the #4 connecting rod large end.
- Be careful not to apply strong impact when inserting to prevent connecting rod bearing from falling off.

NOTE:

- Face the piston front mark (arrow) towards the front of the engine.



(a) Front mark

Fig. 408: Identifying Piston Front Mark
Courtesy of SUBARU OF AMERICA, INC.

- Insert while lightly tapping the crown of the piston with the handle of a plastic hammer.

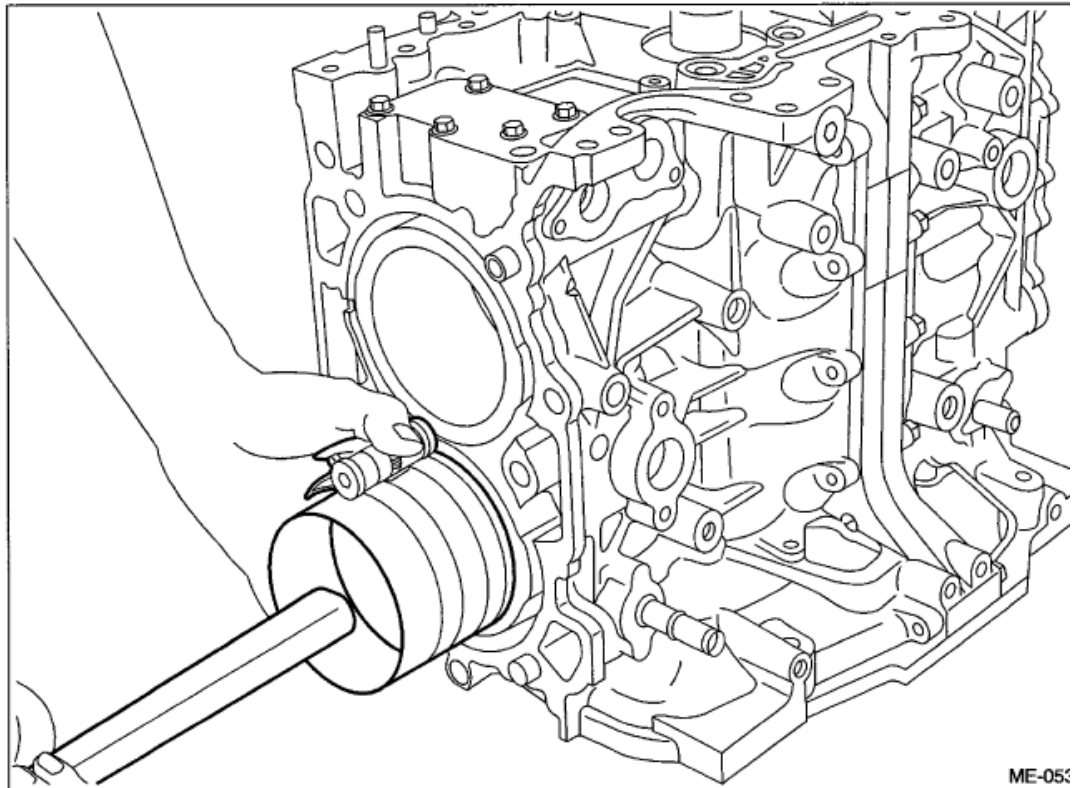


Fig. 409: Tapping Crown Of Piston
Courtesy of SUBARU OF AMERICA, INC.

16. Turn the crankshaft clockwise so that the #4 crank pin and the large end of #4 connecting rod (A) are positioned as shown in the figure using ST, while pressing the #4 piston crown, and then set the #4 connecting rod cap and #4 connecting rod cap bolt.

NOTE:

- Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching symbol.
- Use a new connecting rod cap bolt.
- Apply a coat of engine oil to the #4 connecting rod cap seat and the connecting rod cap bolt threads.

ST 18252AA000 CRANKSHAFT SOCKET

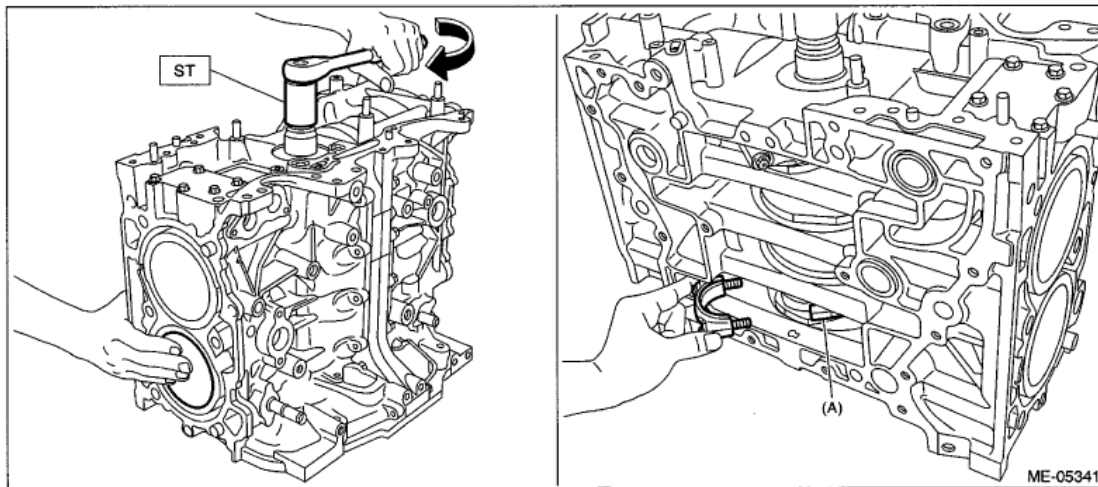


Fig. 410: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

17. Using TORX® socket E12, tighten the #4 connecting rod cap bolts to 10 N.m (1.0 kgf-m, 7.4 ft-lb) in numerical order as shown in the figure, then retighten the bolts to 22 N.m (2.2 kgf-m, 16.2 ft-lb) in numerical order as shown in the figure.

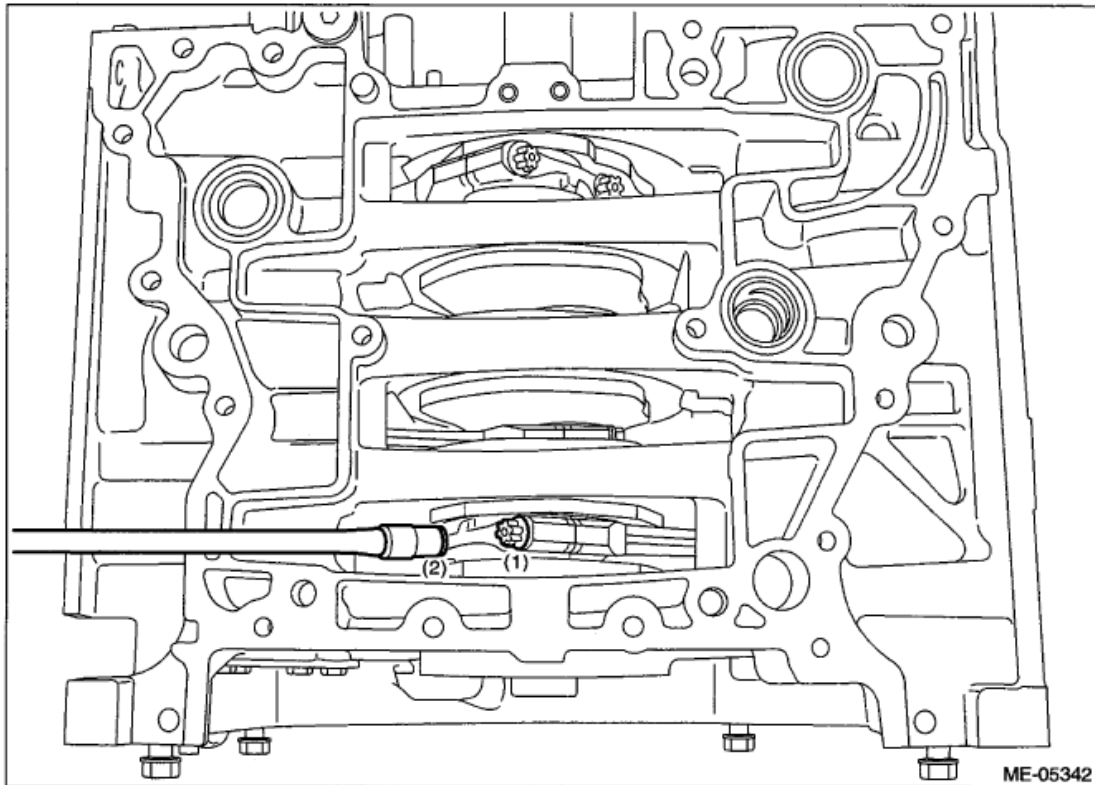


Fig. 411: Tightening #4 Connecting Rod Cap Bolt
Courtesy of SUBARU OF AMERICA, INC.

18. Install the cam carrier mounting bolts at the locations shown in the figure.

NOTE: This procedure is required to tighten the connecting rod cap bolts with specified angle using ST.

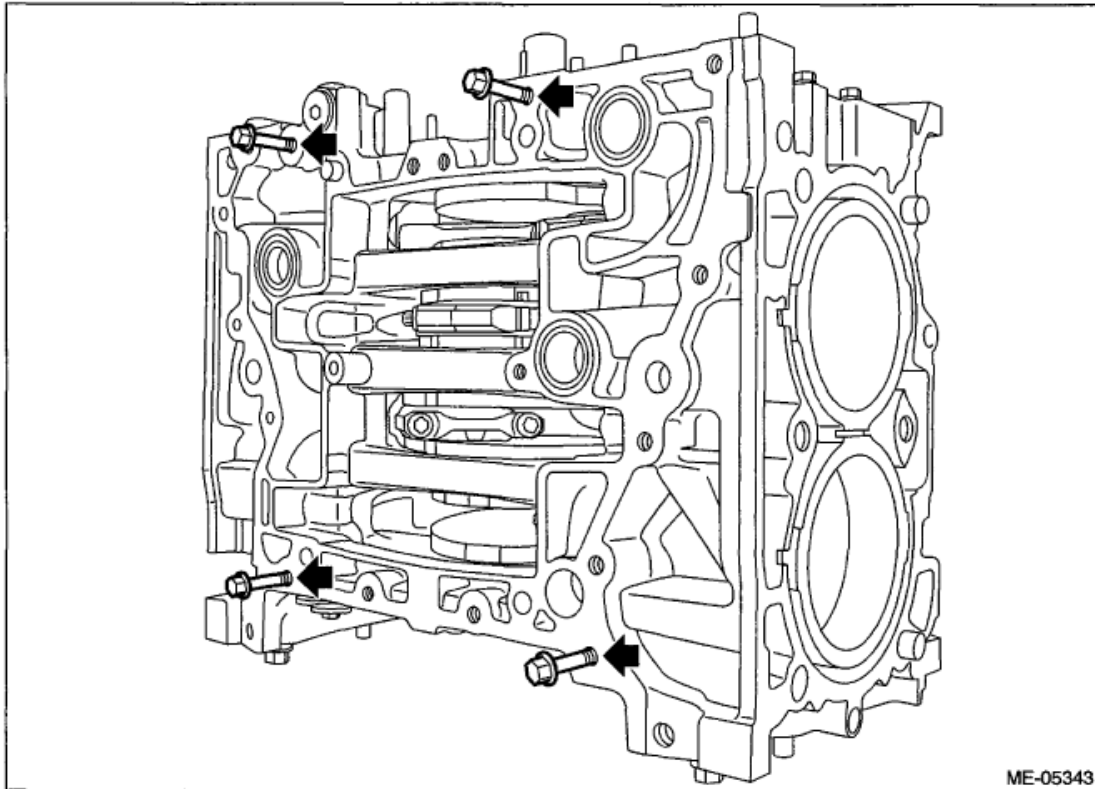


Fig. 412: Locating Cam Carrier Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

19. Turn the crankshaft so that the #1 connecting rod cap (A) and #4 connecting rod cap (B) is located at the position shown in the figure using ST.

ST 18252AA000 CRANKSHAFT SOCKET

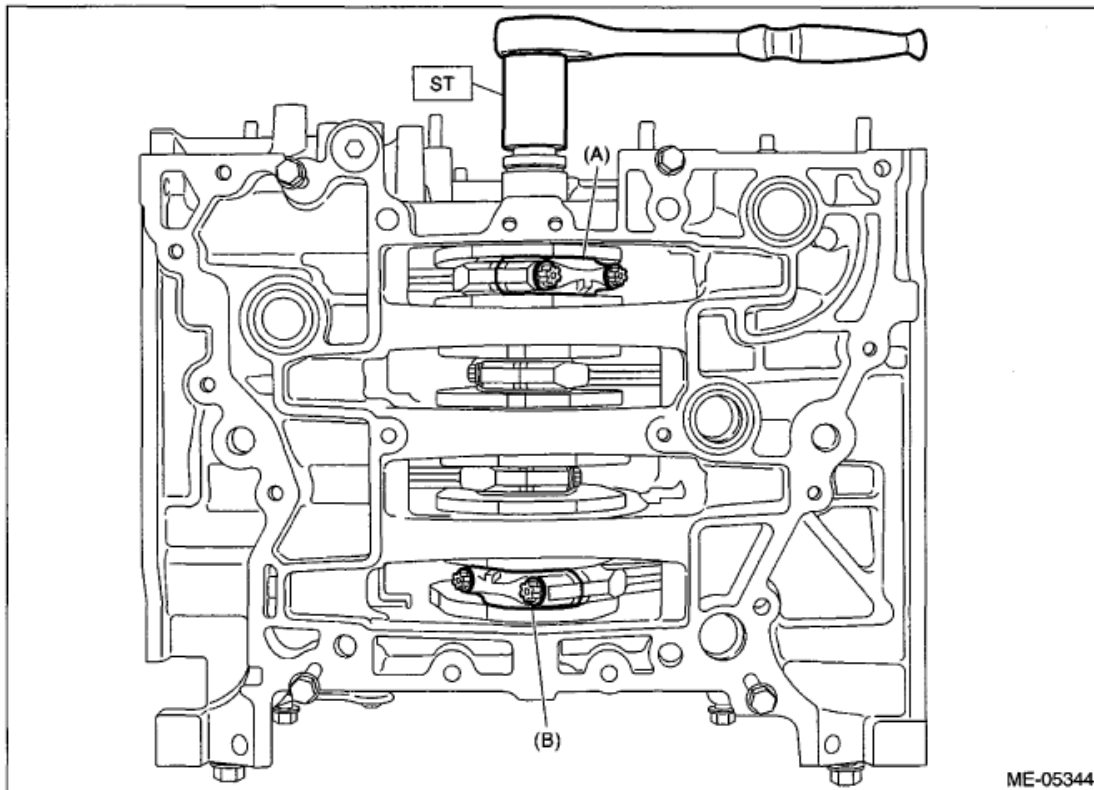


Fig. 413: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

20. Using ST and TORX® socket E12, tighten the #1 connecting rod cap bolts and #4 connecting rod cap bolts with specified angle in numerical order as shown in the figure.

NOTE: Attach the magnet used for securing the ST (ANGLE GAUGE) to the cam carrier mounting bolt attached in step (18).

ST 18854AA000 ANGLE GAUGE

Tightening angle: $137^{\circ} \pm 2^{\circ}$

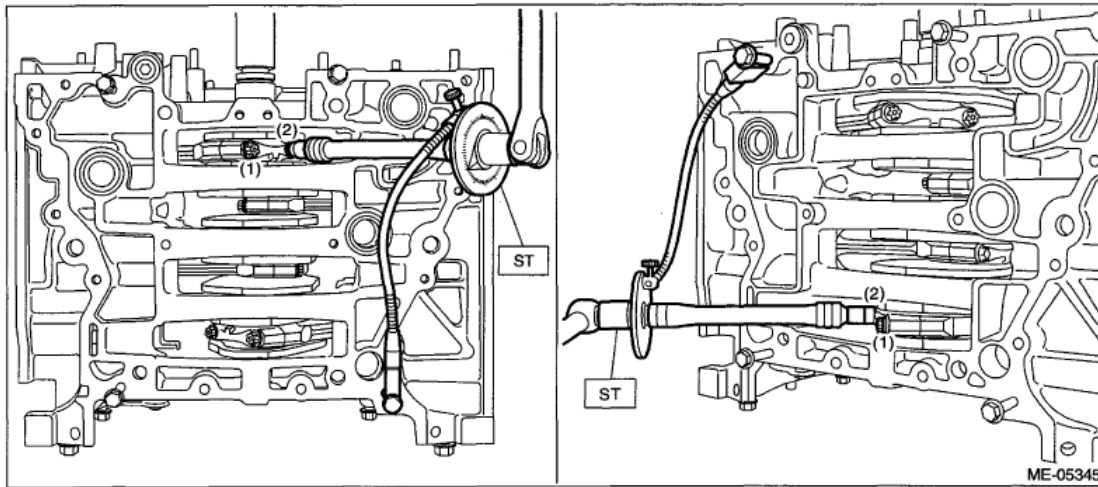


Fig. 414: Tightening #1 Connecting Rod Cap Bolts And #4 Connecting Rod Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

21. Turn the crankshaft so that the #2 connecting rod cap (A) and #3 connecting rod cap (B) is located at the position shown in the figure using ST.

ST 18252AA000 CRANKSHAFT SOCKET

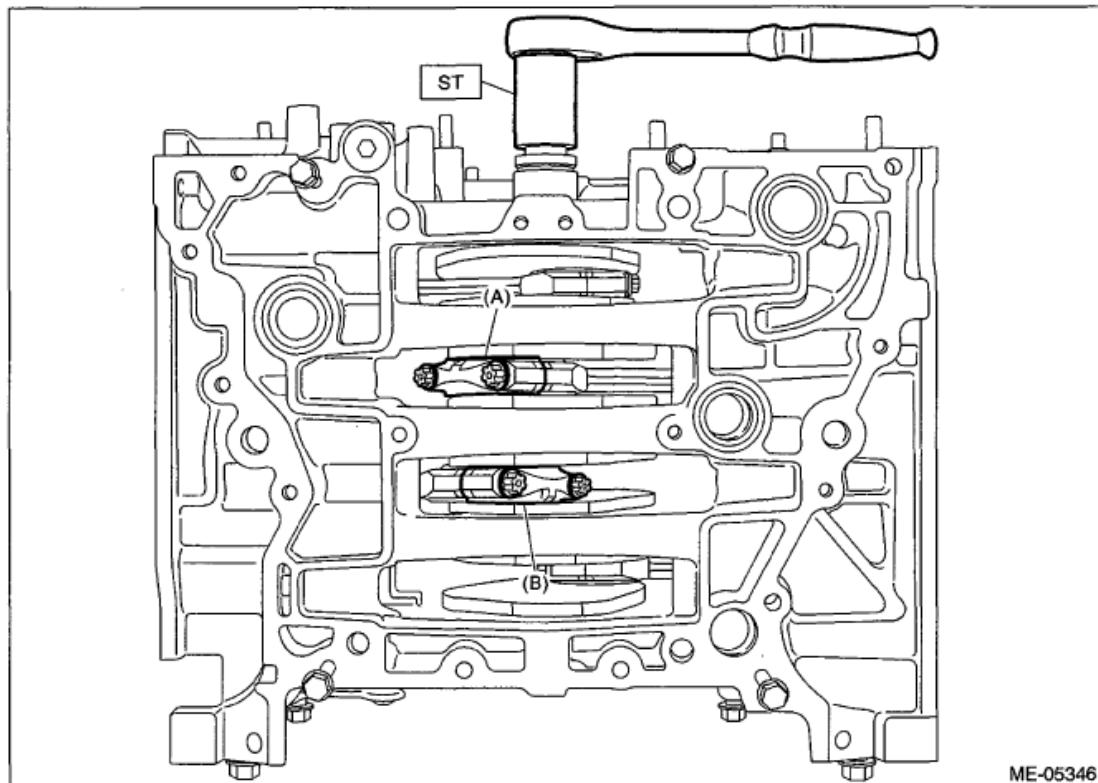


Fig. 415: Turning Crankshaft Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

22. Using ST and TORX® socket E12, tighten the #2 connecting rod cap bolts and #3 connecting rod cap bolts with specified angle in numerical order as shown in the figure.

NOTE: Attach the magnet used for securing the ST (ANGLE GAUGE) to the cam carrier mounting bolt attached in step (18).

ST 18854AA000 ANGLE GAUGE

Tightening angle: $137^{\circ} \pm 2^{\circ}$

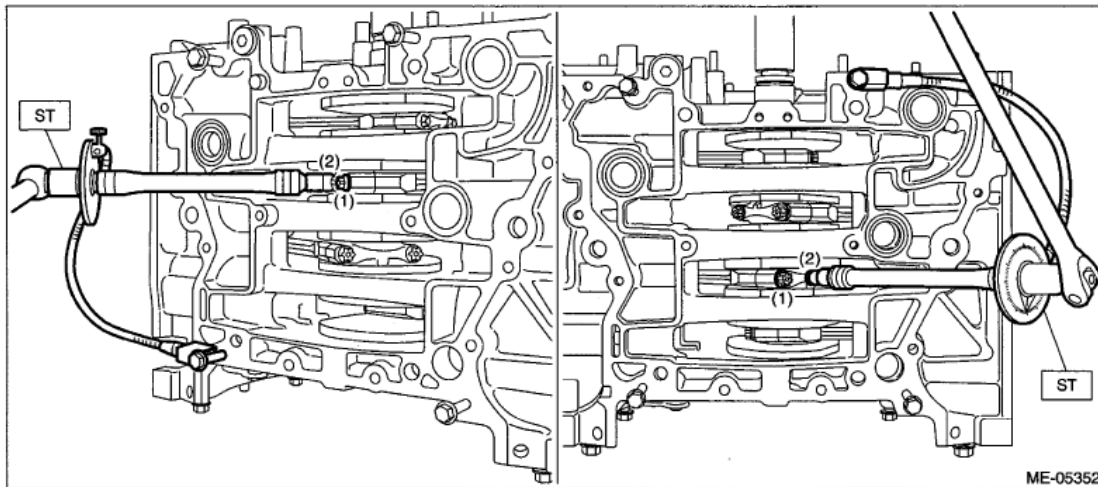


Fig. 416: Tightening #2 Connecting Rod Cap Bolts And #3 Connecting Rod Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

23. Remove the cam carrier mounting bolts attached at the locations shown in the figure.

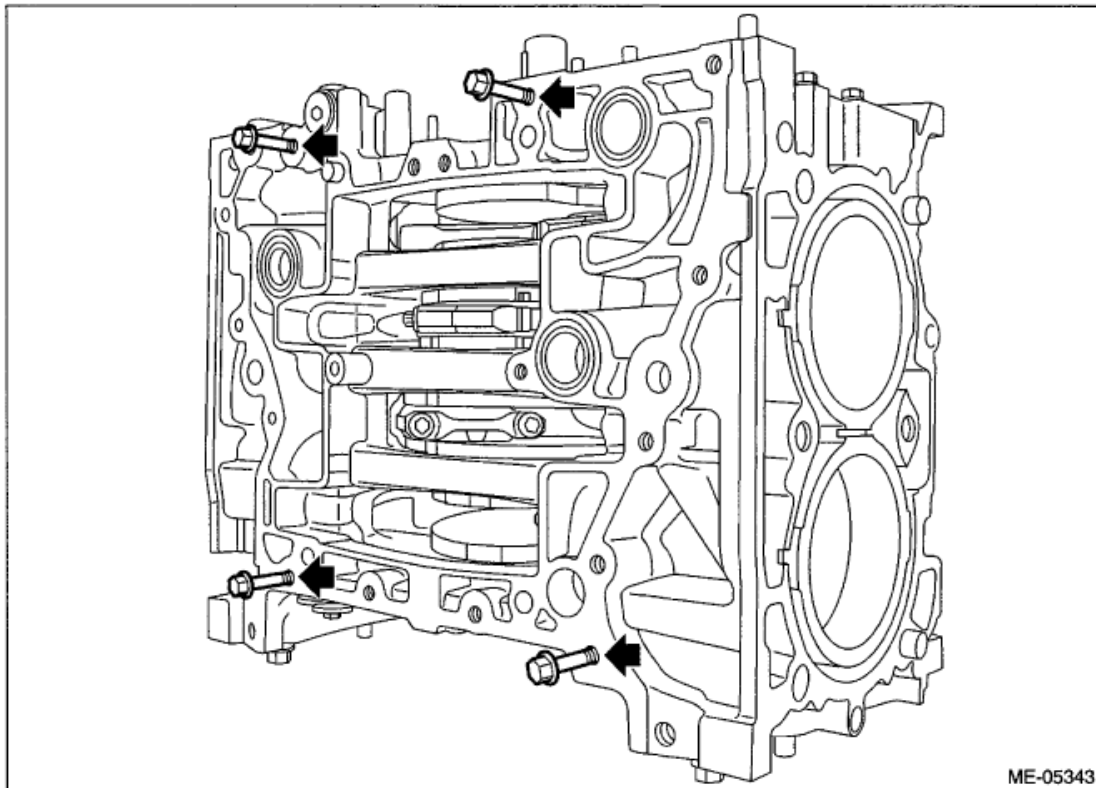


Fig. 417: Locating Cam Carrier Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

13. Set the cylinder block so that the oil pan side is on the upper side, and remove the A/C compressor bracket bolts and the power steering pump bracket bolts attached at the locations shown in the figure.

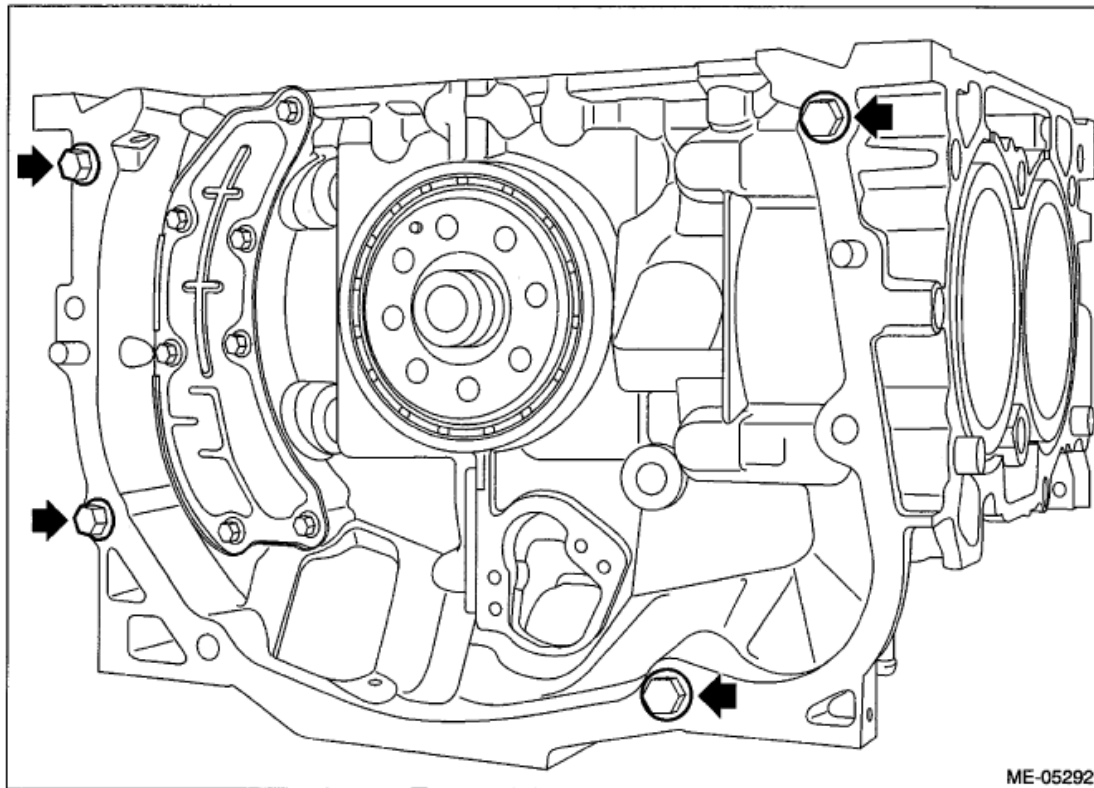


Fig. 418: Locating A/C Compressor Bracket And Power Steering Pump Bracket Bolts
Courtesy of SUBARU OF AMERICA, INC.

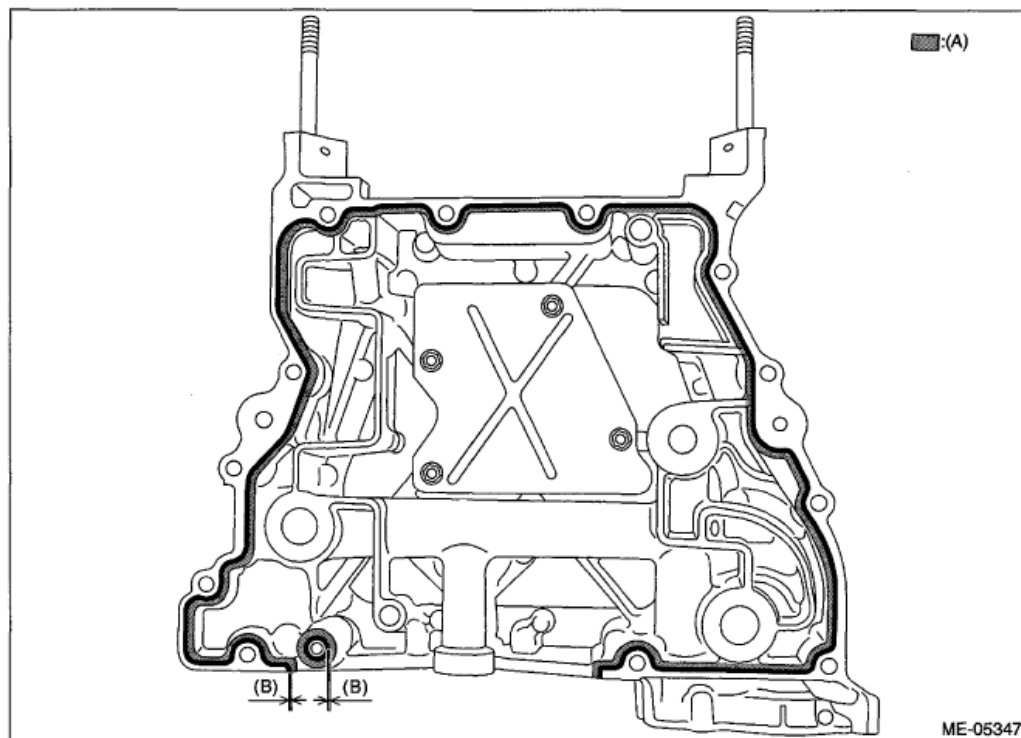
14. Install the oil pan upper with oil pan to the cylinder block.
 1. Apply liquid gasket to the mating surface of oil pan upper as shown in the figure.

NOTE:

- Before applying liquid gasket, remove oil from liquid gasket seal surface of the cylinder block and the oil pan upper.
- Install within 5 min. after applying liquid gasket.
- Apply liquid gasket 1.5 mm (0.0591 in) outside from the chamfer surface. However, application of liquid gasket on the chamfer surface around the bolt hole is allowed.

Liquid gasket: THREE BOND 1217G (Part No. 0877Y0100) or equivalent

Liquid gasket applying diameter: 5 ± 1 mm (0.1969 $\pm$ 0.0394 in)



(A) Chamfer surface

(B) 1.5 mm (0.0591 in)

Fig. 419: Identifying Mating Surface Of Oil Pan Upper Liquid Gasket Applying Area
 Courtesy of SUBARU OF AMERICA, INC.

2. Install the O-ring to the cylinder block.

NOTE: Use new O-rings.

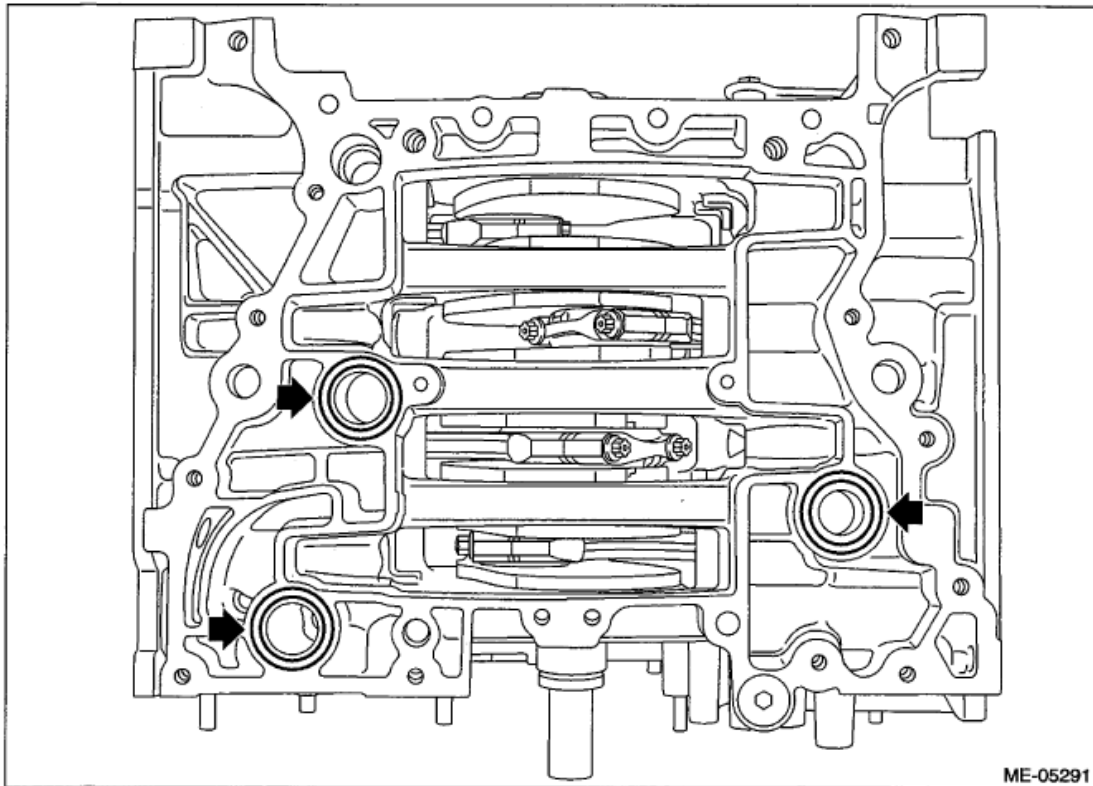
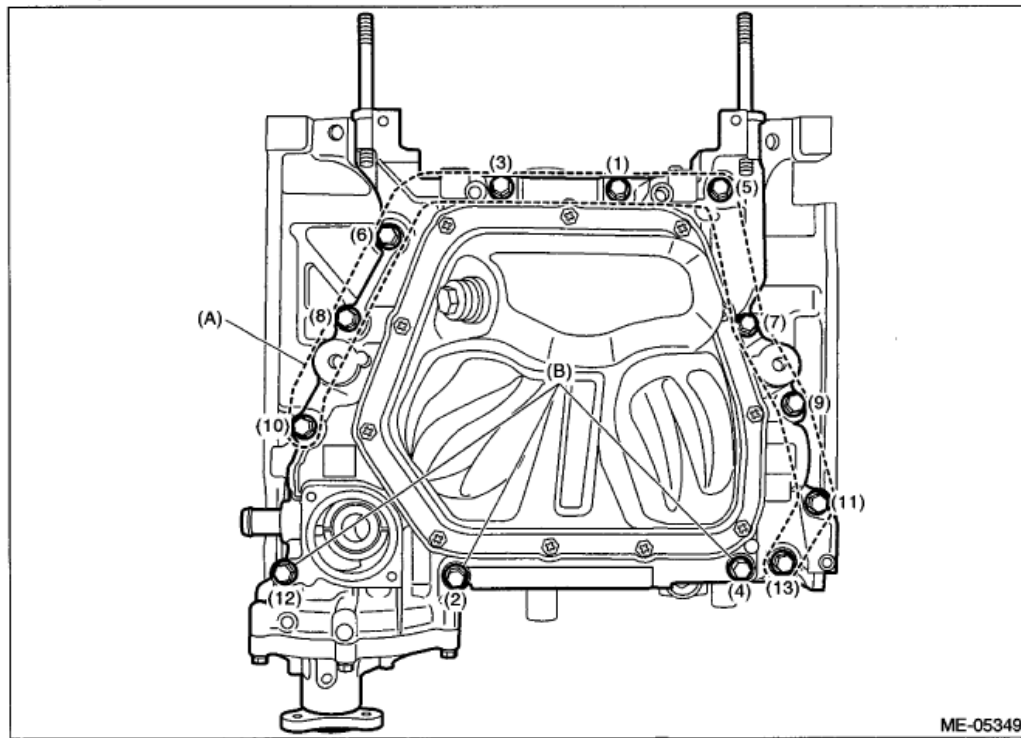


Fig. 420: Locating O-Ring Of Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

3. Set the oil pan with oil pan upper to the cylinder block, and tighten the bolts in numerical order as shown in the figure.

NOTE: After tightening, if the liquid gasket is squeezed out onto the seal surface of the chain cover, completely remove any squeezed-out liquid gasket.

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



(A) M8 x 25

(B) M8 x 75

Fig. 421: Identifying Cylinder Block Bolts Tightening Sequence
 Courtesy of SUBARU OF AMERICA, INC.

15. Set the thermostat to the oil pan upper, and install the thermostat cover.

NOTE: Use a new gasket.

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

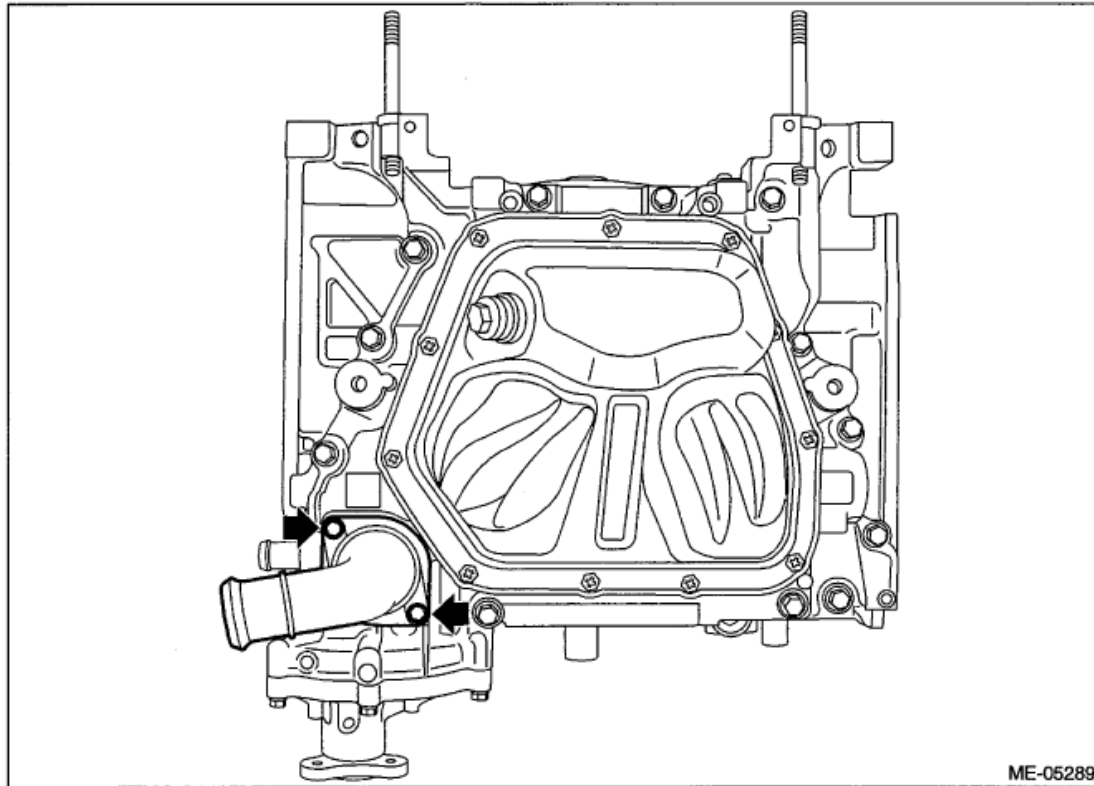


Fig. 422: Locating Thermostat Cover Bolts Of Oil Pan Upper
Courtesy of SUBARU OF AMERICA, INC.

16. Install the ST1, ST2, ST3 and ST4 to the cylinder block and oil pan upper.

ST1 498457000 ENGINE STAND ADAPTER RH

ST2 498457100 ENGINE STAND ADAPTER LH

ST3 18362AA020 ADAPTER

ST4 499817100 ENGINE STAND

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

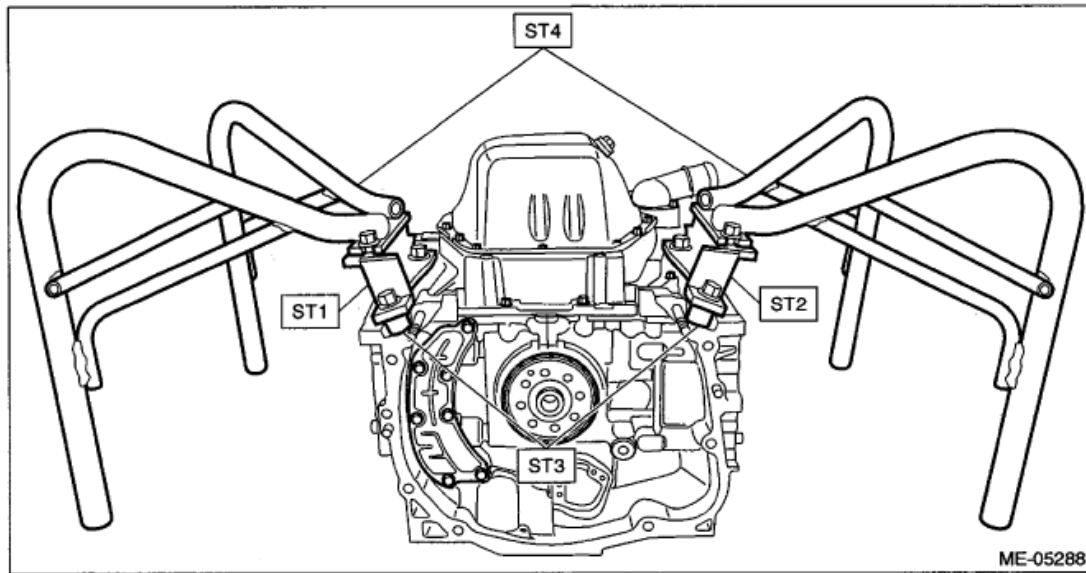


Fig. 423: Installing ST1, ST2, ST3 And ST4 From Cylinder Block And Oil Pan Upper
Courtesy of SUBARU OF AMERICA, INC.

17. Install the crankshaft position sensor with crankshaft position sensor holder to the cylinder block LH.

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

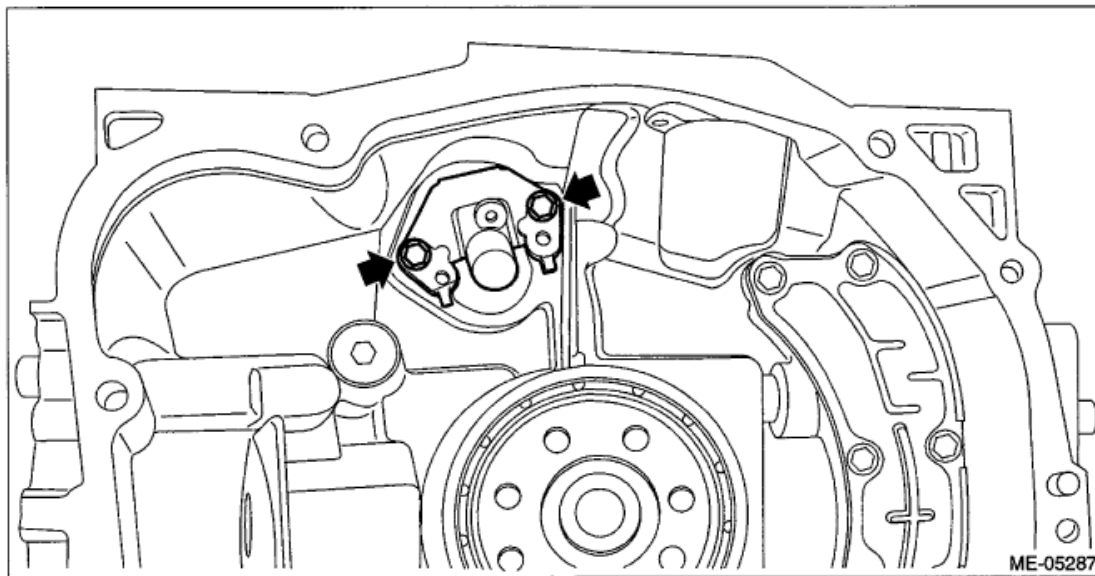


Fig. 424: Locating Crankshaft Position Sensor Holder Bolts
Courtesy of SUBARU OF AMERICA, INC.

18. Install the crankshaft position sensor plate with drive plate. (AT model) < refer to **INSTALLATION** , Drive Plate >
19. Install the crankshaft position sensor plate with flywheel. (MT model) < refer to **INSTALLATION** ,

Flywheel >

20. Install the clutch disc and cover. (MT model) < refer to **INSTALLATION** , Clutch Disc and Cover >
21. Install the PCV valve onto the cylinder block RH.

NOTE: Apply liquid gasket to the bolt threads of PCV valve.

Liquid gasket: THREE BOND 1141G or equivalent

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

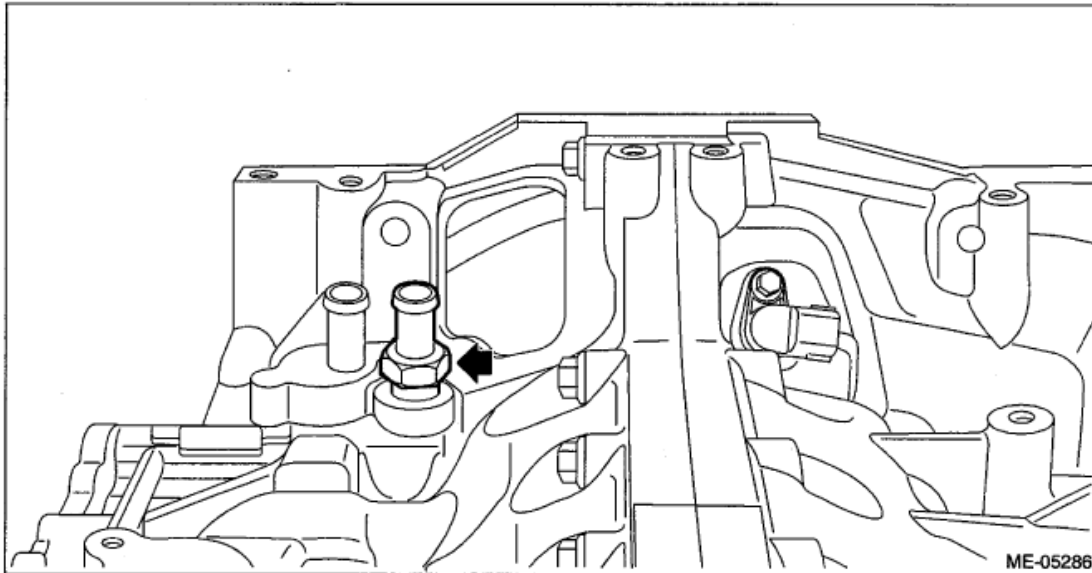


Fig. 425: Locating PCV Valve Bolt Of Cylinder Block RH
Courtesy of SUBARU OF AMERICA, INC.

22. Install the PCV hose assembly (A) and the vacuum hose (B) to cylinder block and PCV valve.

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

ST 18353AA000 CLAMP PLIERS

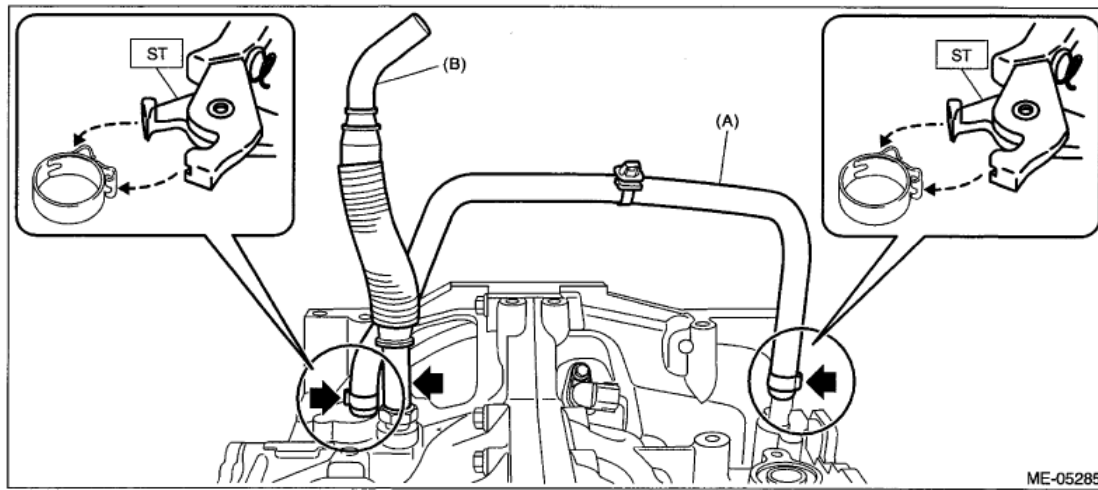


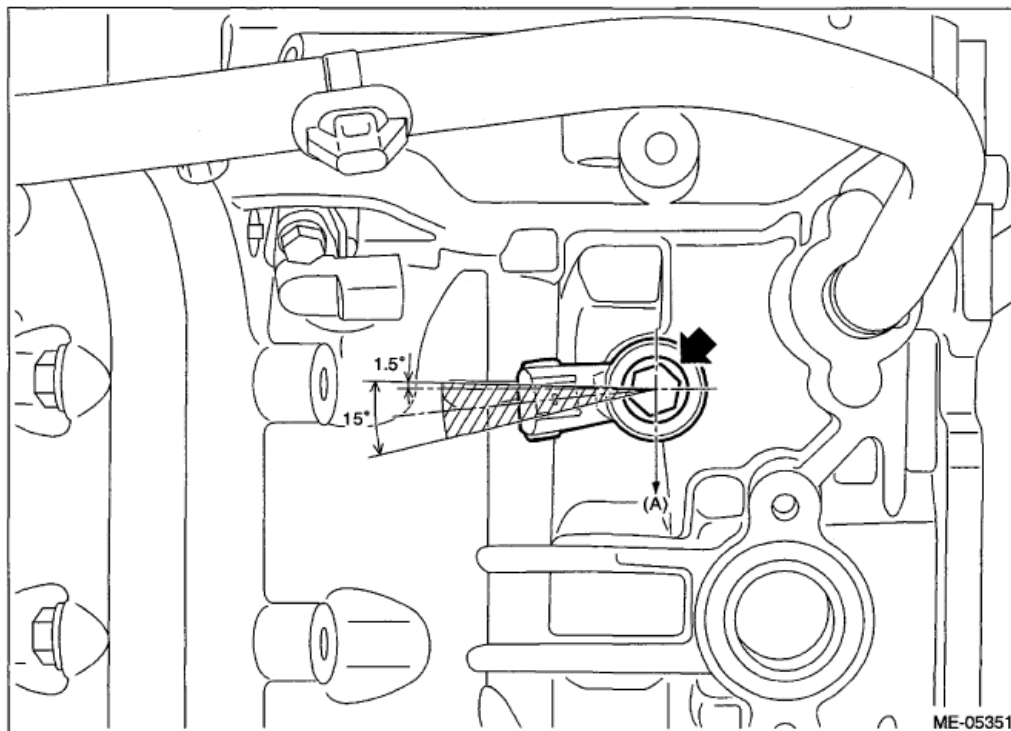
Fig. 426: Locking Clamp

Courtesy of SUBARU OF AMERICA, INC.

23. Install the knock sensor to the cylinder block LH.

NOTE: Knock sensor must be positioned toward engine front so that the connector center position is within the range of 76.5° - 91.5° (shaded area).

Tightening torque: 24 N.m (2.4 kgf-m, 17.7 ft-lb)



(A) Front of engine

Fig. 427: Identifying Knock Sensor Installation Dimension
Courtesy of SUBARU OF AMERICA, INC.

24. Install the O-ring to the cylinder block and PCV connector.

NOTE: Use new O-rings.

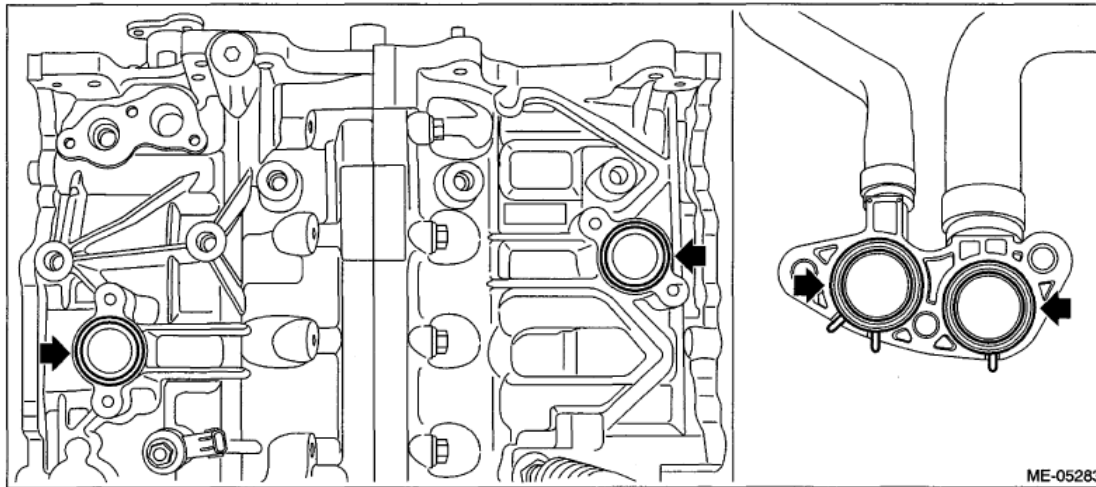


Fig. 428: Locating Cylinder Block And PCV Connector O-Ring
Courtesy of SUBARU OF AMERICA, INC.

25. Install the water pipe assembly and PCV connector to the cylinder block.

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

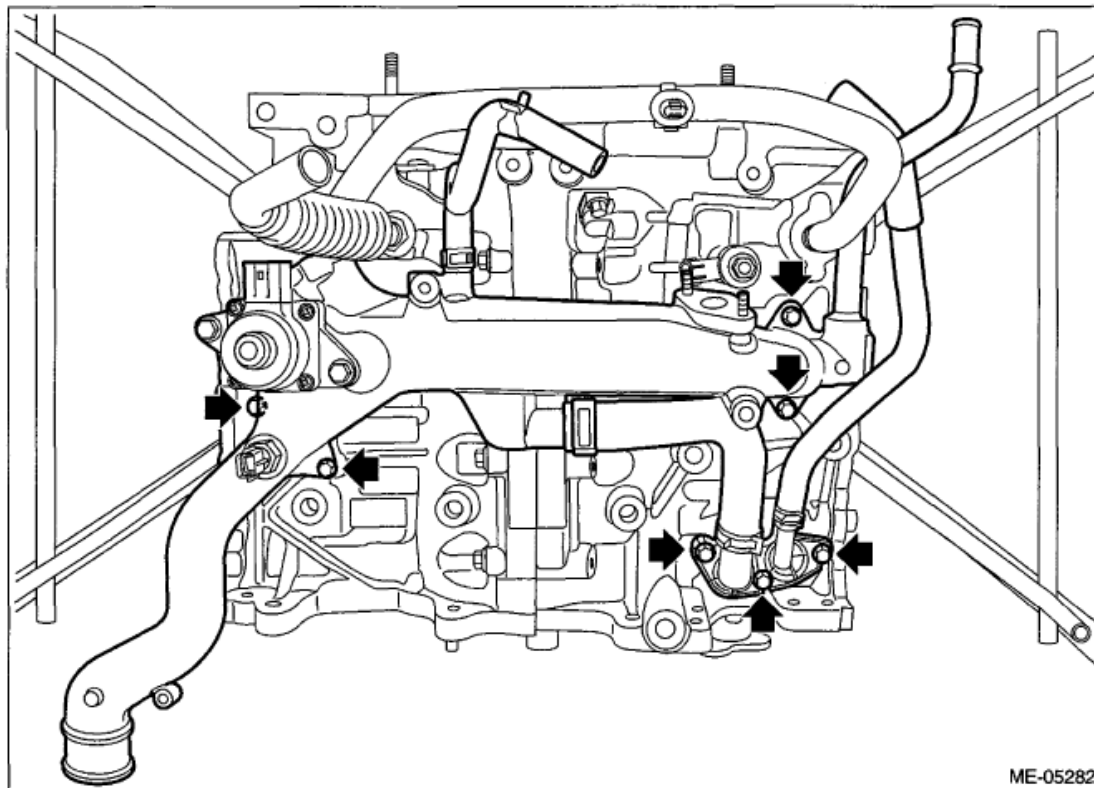


Fig. 429: Locating Water Pipe Assembly And PCV Connector Bolts
 Courtesy of SUBARU OF AMERICA, INC.

26. Install the engine hanger to the cylinder block RH.

Tightening torque: 21 N.m (2.1 kgf-m, 15.5 ft-lb)

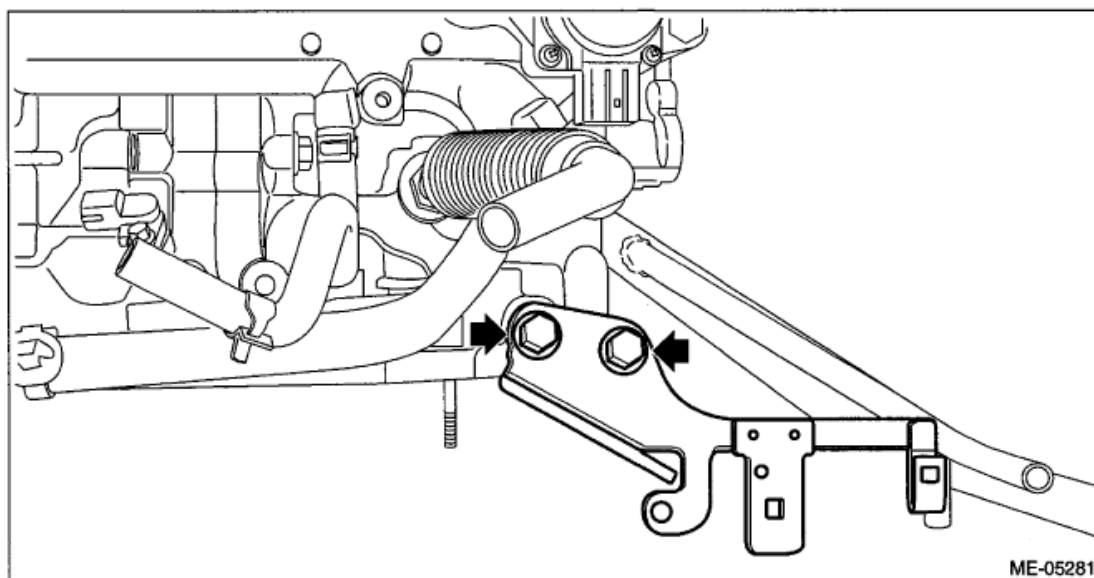


Fig. 430: Locating Engine Hanger Bolts Of Cylinder Block RH

Courtesy of SUBARU OF AMERICA, INC.

27. Install the crank sprocket. < refer to INSTALLATION, Crank Sprocket >
28. Install the cylinder head. < refer to INSTALLATION, Cylinder Head >
29. Install the cam carrier. < refer to INSTALLATION, Cam Carrier >
30. Install the rocker cover. < refer to INSTALLATION, Rocker Cover >
31. Install the chain cover. < refer to INSTALLATION, Chain Cover >
32. Install the tumble generator valve assembly. < refer to INSTALLATION, Tumble Generator Valve Assembly >
33. Install the intake manifold. < refer to INSTALLATION, Intake Manifold >
34. Install the engine to the vehicle. < refer to INSTALLATION, Engine Assembly >

DISASSEMBLY

CYLINDER BLOCK

1. Remove the oil separator cover from cylinder block RH.

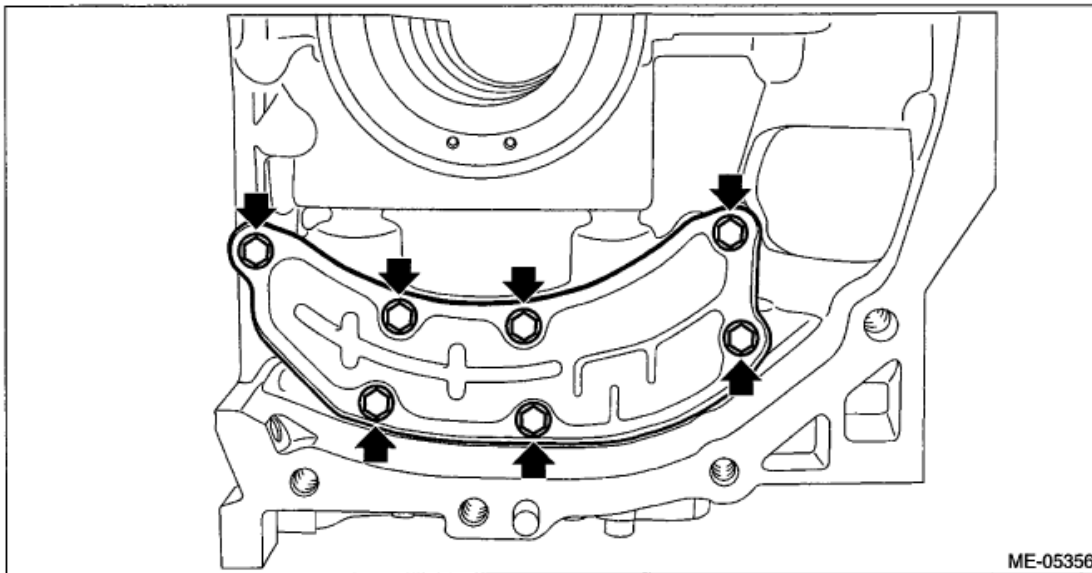


Fig. 431: Locating Oil Separator Cover Bolts Of Cylinder Block RH
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the liquid gasket from cylinder block RH.
3. Remove the main gallery plug from cylinder block RH.

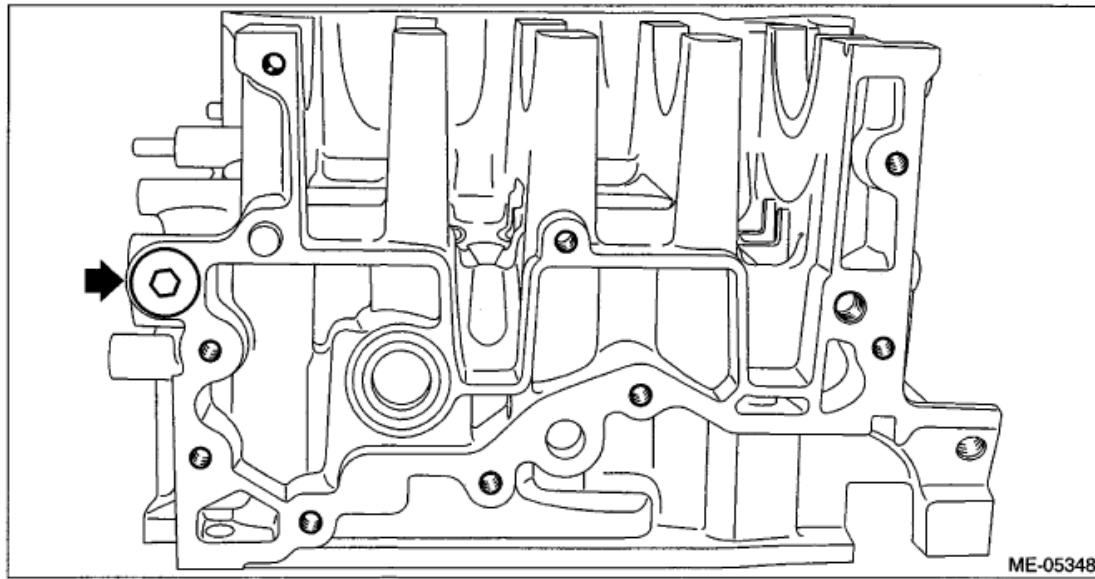


Fig. 432: Locating Main Gallery Plug From Cylinder Block RH
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the liquid gasket from the bolt holes in the cylinder block RH and the threaded portion of the main gallery plug.
5. Remove the cylinder block plate from cylinder block LH.

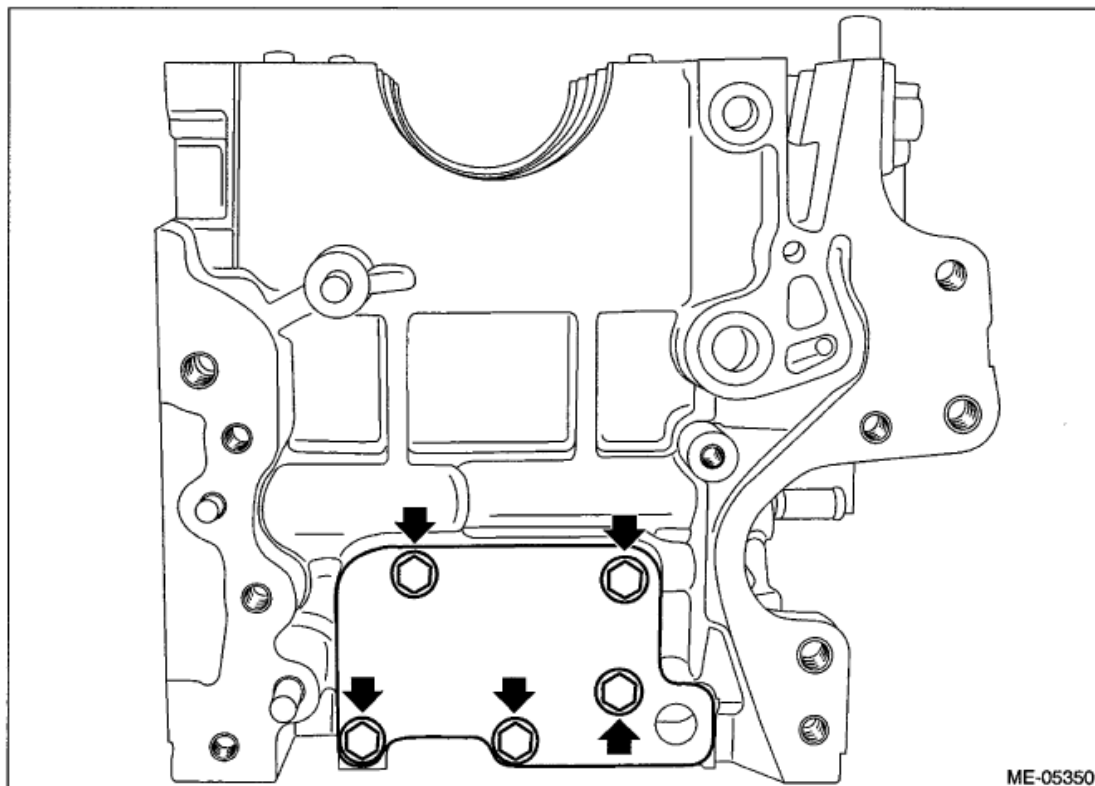


Fig. 433: Locating Cylinder Block Plate Bolts Of Cylinder Block LH
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the main gallery plug from cylinder block LH.

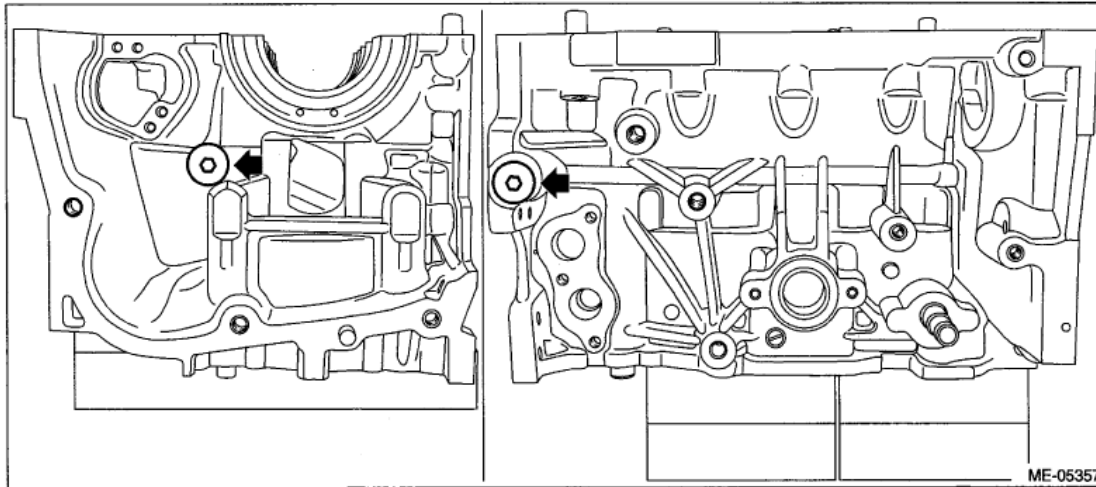
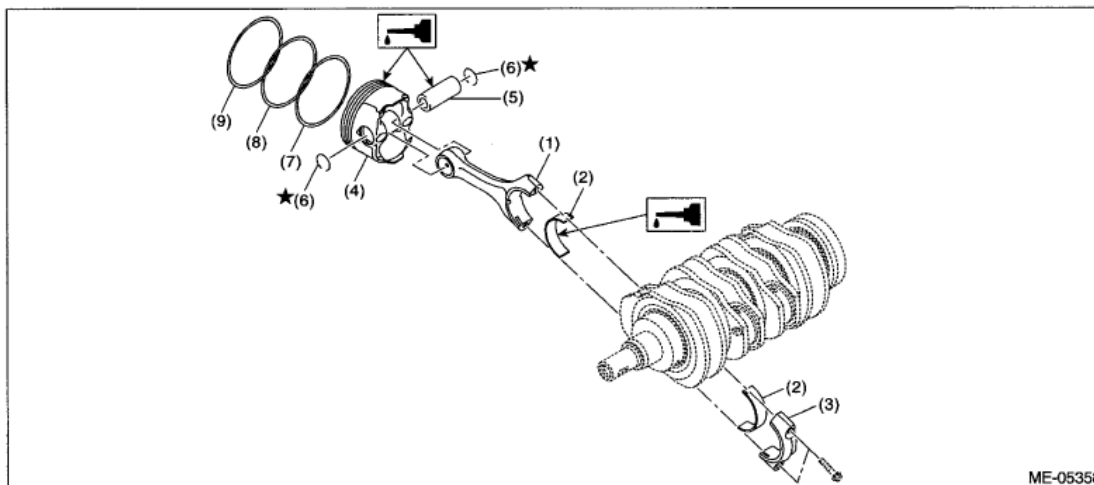


Fig. 434: Locating Main Gallery Plug Of Cylinder Block LH
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the liquid gasket from the bolt holes in the cylinder block LH and the threaded portion of the main gallery plug.

PISTON AND CONNECTING ROD



- | | | |
|----------------------------|----------------|-----------------|
| (1) Connecting rod | (4) Piston | (7) Oil ring |
| (2) Connecting rod bearing | (5) Piston pin | (8) Second ring |
| (3) Connecting rod cap | (6) Circlip | (9) Top ring |

Fig. 435: Exploded View Of Piston And Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

NOTE: To prevent confusion of various parts, mark each part.

1. Remove the connecting rod bearing from connecting rod and connecting rod cap.
2. Remove the piston rings using piston ring expander, and remove the oil ring by hand.

- NOTE:**
- Arrange the piston rings and oil rings in order so that they can be installed in their original positions.
 - Be careful not to confuse the piston rings and oil rings.

3. Remove the circlip on one end from the piston using a flat tip screwdriver.

NOTE: Be careful not damage the piston and piston pin, by wrapping the tip of flat tip screwdriver with tape.

4. Remove the piston pin from piston, and remove the connecting rod from piston.
5. Remove the circlip on other end from the piston using a flat tip screwdriver.

NOTE: Be careful not damage the piston and piston pin, by wrapping the tip of flat tip screwdriver with tape.

ASSEMBLY

CYLINDER BLOCK

1. Install the oil separator cover to the cylinder block RH.
 1. Apply liquid gasket to the mating surfaces of oil separator cover.

- NOTE:**
- Use new oil separator cover.
 - Before applying liquid gasket, remove oil from liquid gasket seal surface of the cylinder block RH.
 - Install within 5 min. after applying liquid gasket.

Liquid gasket:

Mating surface

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

Liquid gasket applying diameter: 4 ± 1 mm (0.1772 ± 0.0197 in)

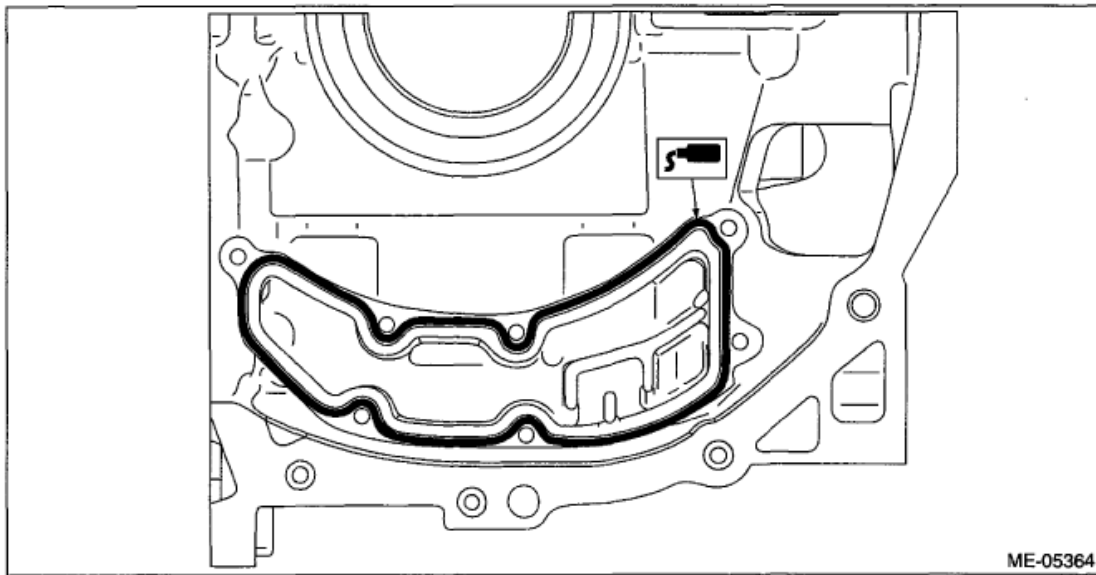


Fig. 436: Identifying Mating Surfaces Of Oil Separator Cover Liquid Gasket Applying Area
Courtesy of SUBARU OF AMERICA, INC.

2. Install the oil separator cover to the cylinder block RH, and tighten the oil separator cover bolts in numerical order as shown in the figure.

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

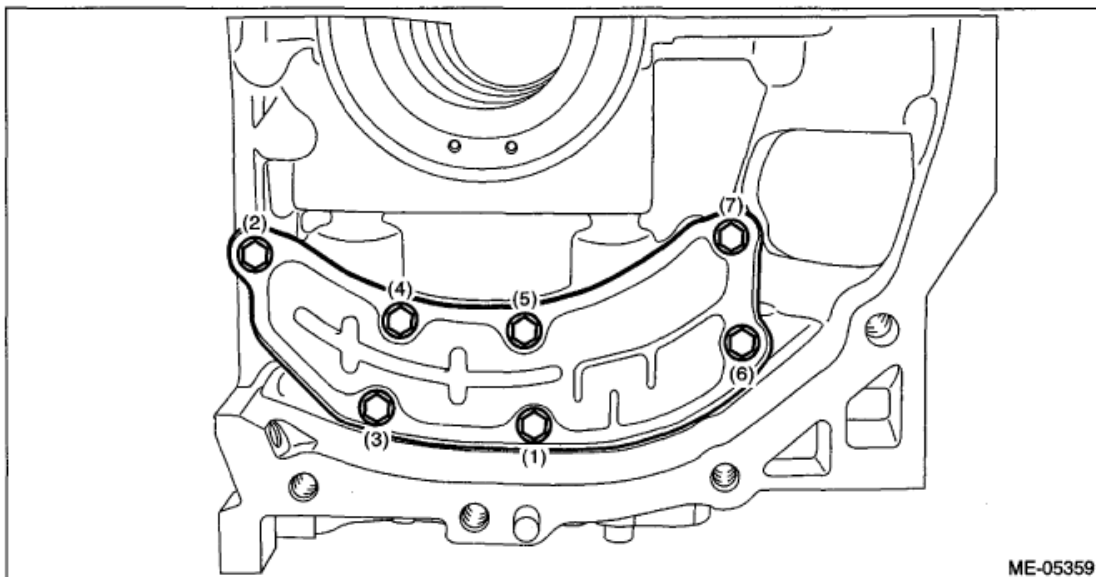


Fig. 437: Identifying Oil Separator Cover Bolts Tightening Sequence
Courtesy of SUBARU OF AMERICA, INC.

2. Apply liquid gasket to the threaded portion of the main gallery plug, and install the main gallery plug to the cylinder block RH.

NOTE: Before applying liquid gasket, remove oil from the bolt holes in the cylinder block RH and the threaded portion of the main gallery plug.

Liquid gasket: *THREE BOND 1105 (Part No. 004403010) or equivalent*

Tightening torque: *37 N.m (3.8 kgf-m, 27.3 ft-lb)*

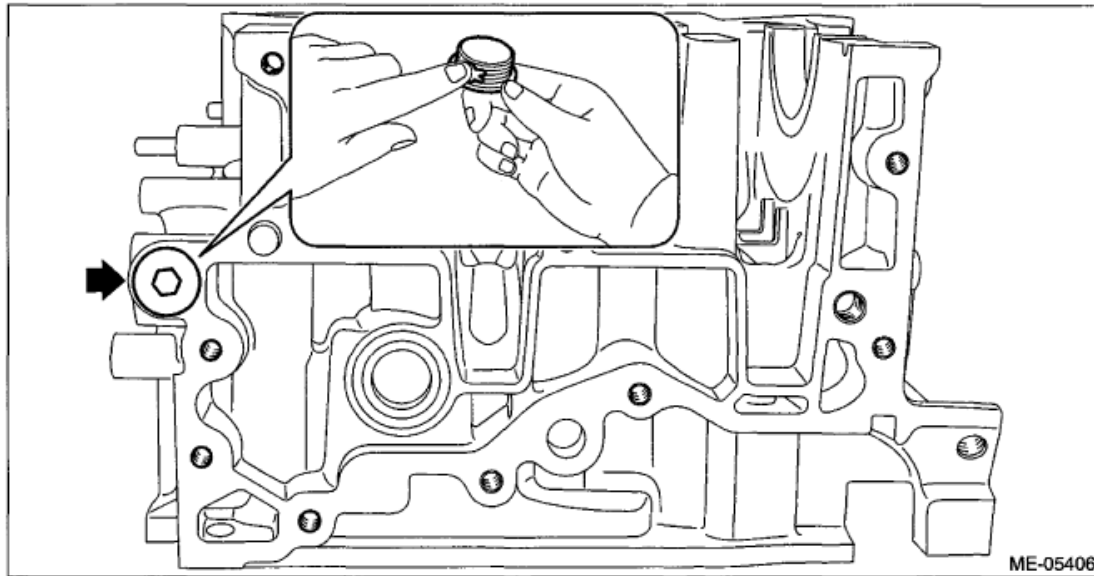


Fig. 438: Applying Liquid Gasket To Threaded Portion Of Main Gallery Plug
Courtesy of SUBARU OF AMERICA, INC.

3. Apply liquid gasket to the threaded portion of the main gallery plug, and install the main gallery plug to the cylinder block LH.

NOTE: Before applying liquid gasket, remove oil from the bolt holes in the cylinder block LH and the threaded portion of the main gallery plug.

Liquid gasket: *THREE BOND 1105 (Part No. 004403010) or equivalent*

Tightening torque: *37 N.m (3.8 kgf-m, 27.3 ft-lb)*

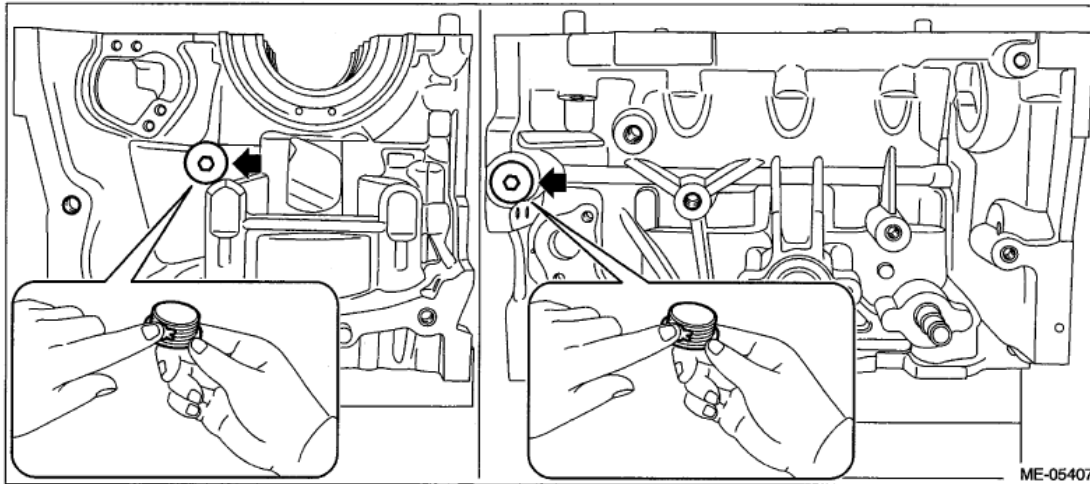


Fig. 439: Applying Liquid Gasket To Threaded Portion Of Main Gallery Plug
Courtesy of SUBARU OF AMERICA, INC.

4. Install the cylinder block plate onto cylinder block LH.

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

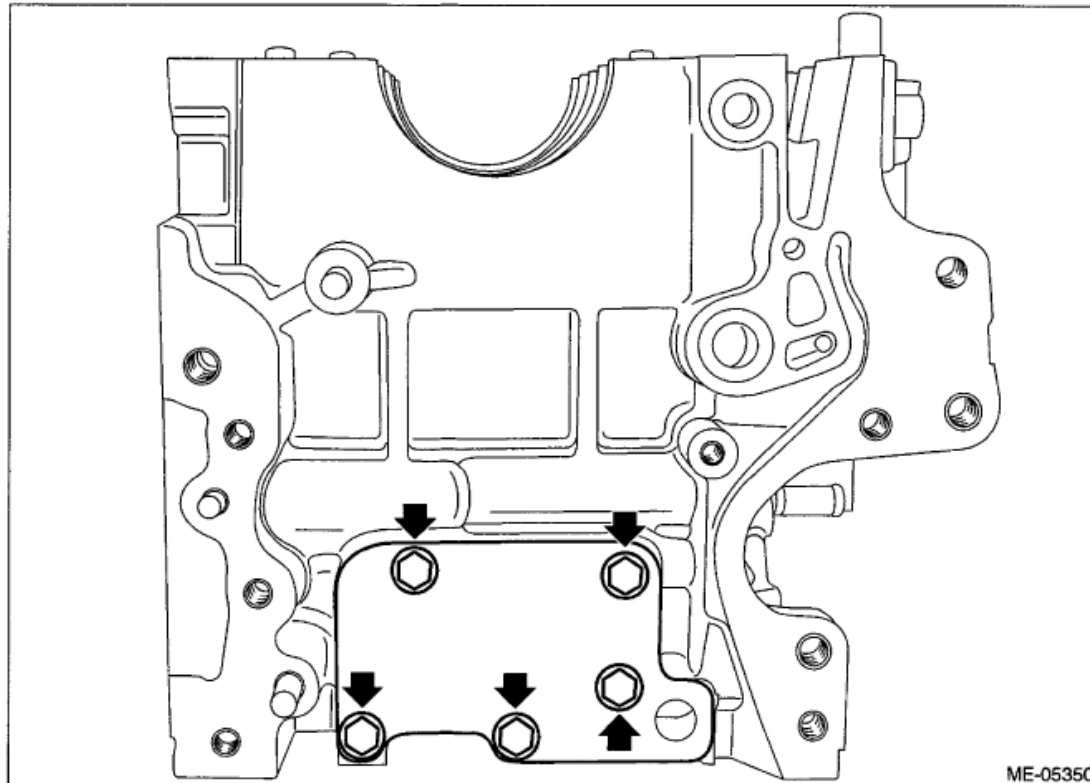
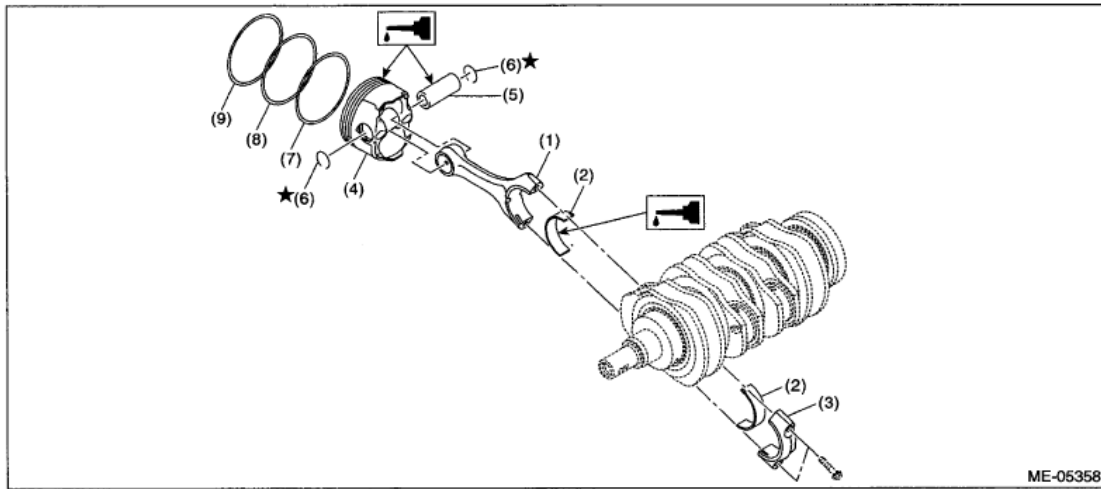


Fig. 440: Locating Cylinder Block Plate Bolts Of Cylinder Block LH
Courtesy of SUBARU OF AMERICA, INC.

PISTON AND CONNECTING ROD



- | | | |
|----------------------------|----------------|-----------------|
| (1) Connecting rod | (4) Piston | (7) Oil ring |
| (2) Connecting rod bearing | (5) Piston pin | (8) Second ring |
| (3) Connecting rod cap | (6) Circlip | (9) Top ring |

Fig. 441: Exploded View Of Piston And Connecting Rod
 Courtesy of SUBARU OF AMERICA, INC.

1. Install the connecting rod bearing to the connecting rod and connecting rod cap.
2. Install the circlip on one end of the piston using a flat tip screwdriver.

NOTE:

- Be careful not damage the piston, by wrapping the tip of flat tip screwdriver with tape.
- Make sure the circlip is firmly inserted into the circlip groove.
- After circlip installation, turn the circlip so that the ends of circlip (A) and the cutout portion of circlip (B) do not match.

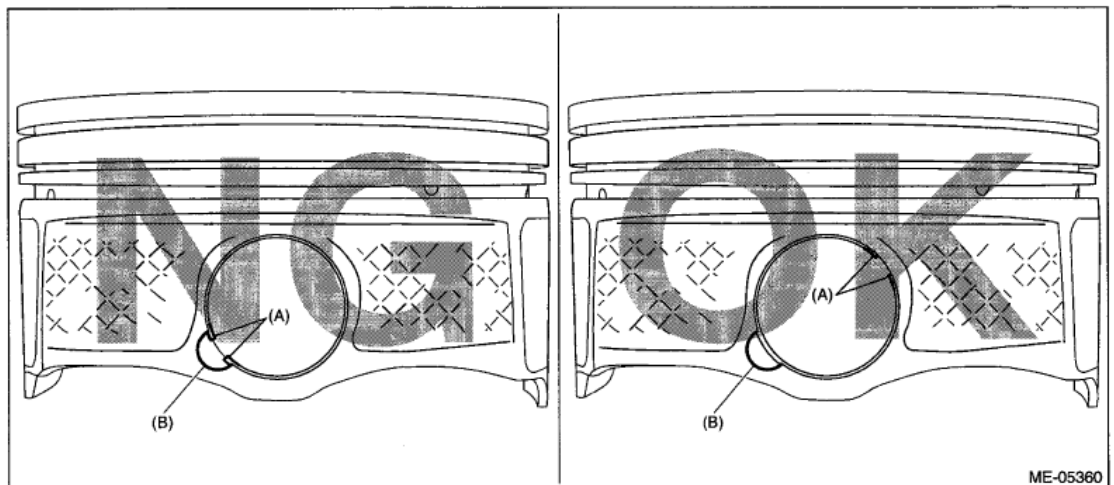
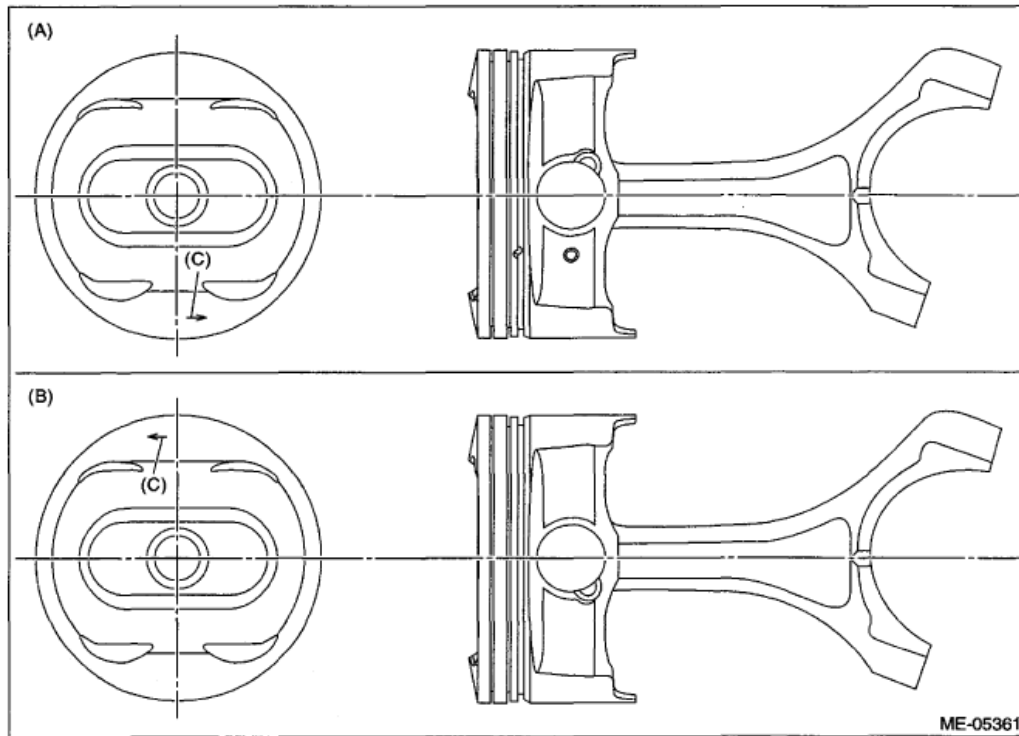


Fig. 442: Identifying Correct And Incorrect Circlip Installation Position
Courtesy of SUBARU OF AMERICA, INC.

3. Set the piston to the connecting rod.

NOTE: Align the front mark of piston and the connecting rod direction correctly as shown in the figure.



(A) RH side (#1 and #3)

(B) LH side (#2 and #4)

(C) Front mark

Fig. 443: Identifying Front Mark Of Piston And Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

4. Apply engine oil to the piston pin, and attach the piston pin.
5. Install the circlip on the piston using a flat tip screwdriver.

NOTE:

- Be careful not damage the piston and piston pin, by wrapping the tip of flat tip screwdriver with tape.
- Make sure the circlip is firmly inserted into the circlip groove.
- After circlip installation, turn the circlip so that the ends of circlip (A) and the cutout portion of circlip (B) do not match.

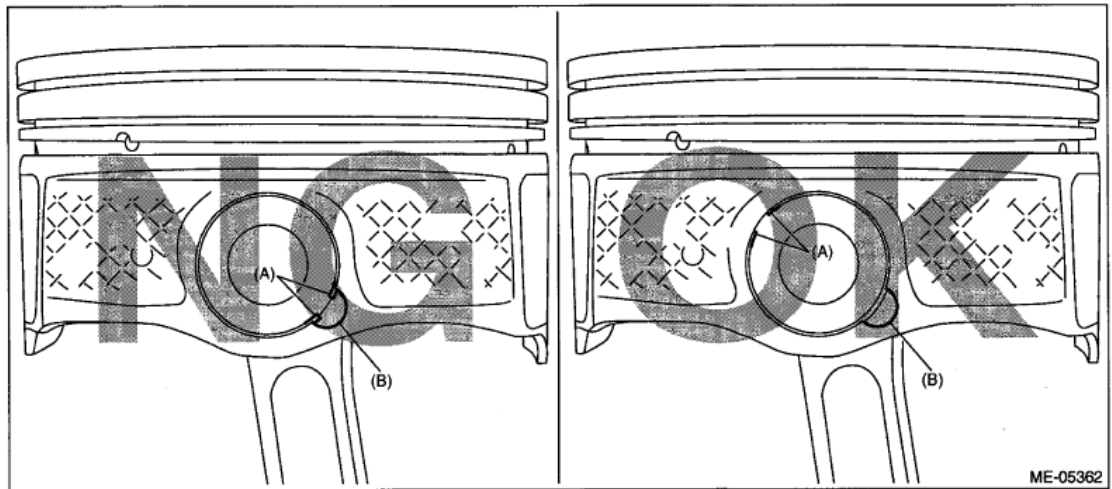
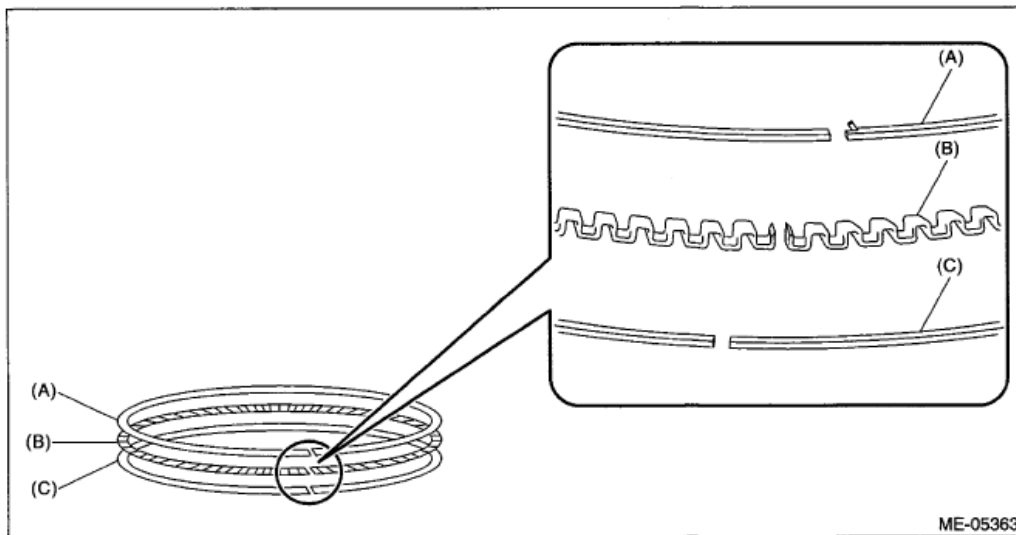


Fig. 444: Identifying Correct And Incorrect Circlip Installation Position
Courtesy of SUBARU OF AMERICA, INC.

6. Install the oil ring upper rail, expander and lower rail by hand.

NOTE: Oil ring consists of the upper rail, expander and lower rail.



(A) Upper rail

(B) Expander

(C) Lower rail

Fig. 445: Identifying Oil Ring Upper Rail, Expander And Lower Rail
Courtesy of SUBARU OF AMERICA, INC.

7. Install the second ring and top ring using piston ring expander.

NOTE: Install so that the piston ring mark faces the top side of the piston.

INSPECTION

CYLINDER BLOCK

1. Visually inspect to make sure that there are no cracks, scratches or other damage.
2. Use liquid penetrant tester on the important sections to check for fissures.
3. Check that there are no traces of gas leaking or water leaking on the gasket attachment surface.
4. Check the oil passages for clogging.
5. Check for warpage of mating surfaces of the cylinder block that contacts cylinder head using a straight edge and thickness gauge. If it exceeds the limit, correct the surface by grinding it with a surface grinder or replace the cylinder block.

Warping limit:***0.025 mm (0.00098 in)******Grinding limit:******0.1 mm (0.004 in)******Standard height of cylinder block:******205.0 mm (8.07 in)*****CYLINDER AND PISTON**

1. Using a cylinder bore gauge, check the inner diameter of cylinder liner, cylindrically, out-of-roundness. If it is not within the standard, perform boring and honing, or replace the cylinder block and piston as a set. For boring and honing procedure, refer to step 3).

NOTE:

- **Measurement should be performed at a temperature of 20°C (68°F).**
- **Measure the inner diameter of each cylinder liner in both the thrust and piston pin directions at the heights as shown in the figure.**
- **The cylinder bore size is stamped on the upper face of the cylinder block.**

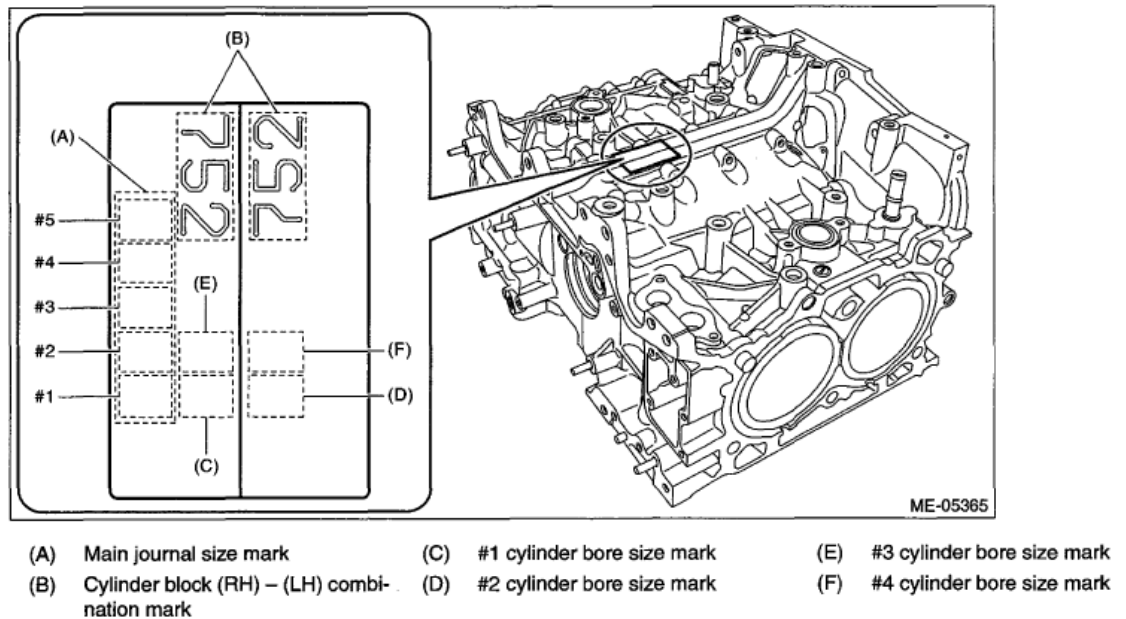


Fig. 446: Identifying Cylinder Bore Size
 Courtesy of SUBARU OF AMERICA, INC.

Inner diameter of cylinder liner:

Standard

- A. 94.005 - 94.015 mm (3.7010 - 3.7014 in)
- B. 93.995 - 94.005 mm (3.7006 - 3.7010 in)

Cylindrically:

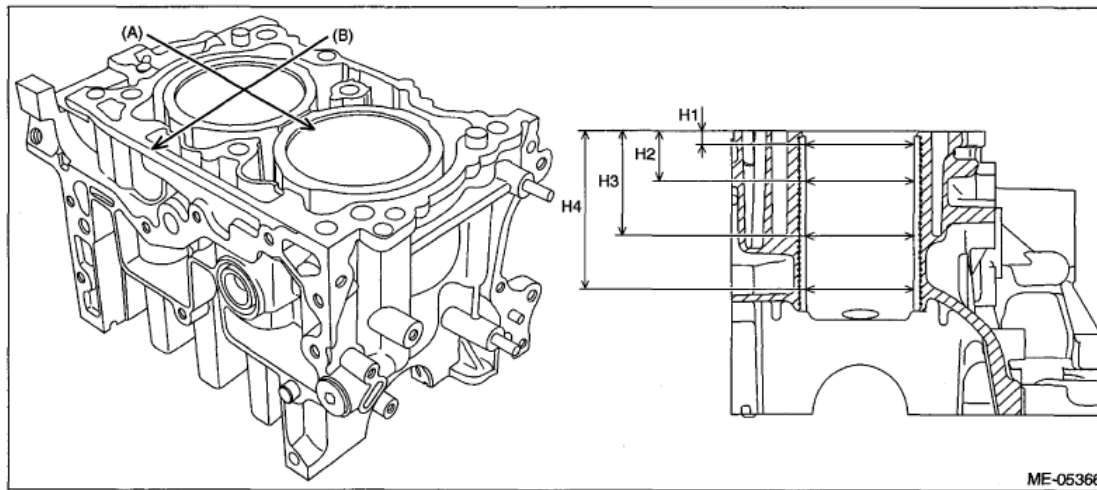
Standard

0.015 mm (0.0006 in)

Out-of-roundness:

Standard

0.010 mm (0.0004 in)



(A) Thrust direction

(B) Piston pin direction

H1: 10 mm (0.3937 in)

H2: 45 mm (1.7717 in)

H3: 80 mm (3.1496 in)

H4: 115 mm (4.5276 in)

Fig. 447: Checking Inner Diameter Of Cylinder Liner, Cylindrically And Out-Of-Roundness Using Cylinder Bore Gauge

Courtesy of SUBARU OF AMERICA, INC.

2. Check the clearance between cylinder liner and piston. Check the clearance between cylinder liner and piston by measuring respectively the inner diameter of cylinder liner and the outer diameter of piston.

NOTE: For the measurement of the inner diameter of cylinder liner, refer to step 1).

1. Check the outer diameter of piston with a micrometer. If it is not within the standard, replace the piston.

NOTE:

- Measurement should be performed at a temperature of 20°C (68° F).
- Measure the outer diameter of each piston in thrust direction at the height as shown in the figure.
- Standard sized pistons are classified into two grades, "A" and "B". These grades should be used as guide lines in selecting a standard piston.
- If the piston is replaced, check the clearance between cylinder liner and piston in the step (2), and select a suitable sized piston.

Piston grade point H:

13.3 mm (0.52 in)

Piston outer diameter:

Standard size

Standard

- A. 93.980 - 93.990 mm (3.7000 - 3.7004 in)
- B. 93.970 - 93.980 mm (3.6996 - 3.7000 in) 0.25 mm (0.0098 in) oversize

Standard

94.220 - 94.240 mm (3.7094 - 3.7702 in) 0.50 mm (0.0197 in) oversize

Standard

94.470 - 94.490 mm (3.7193 - 3.7201 in)

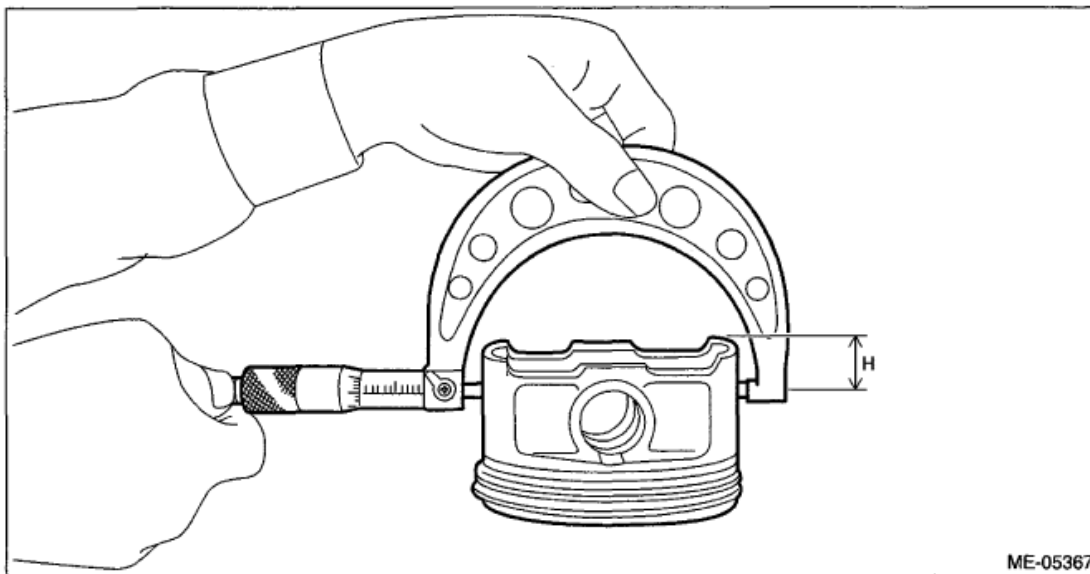


Fig. 448: Measuring Outer Diameter Of Piston With Micrometer
 Courtesy of SUBARU OF AMERICA, INC.

2. Calculate the clearance between cylinder liner and piston. If it is not within the standard, perform boring and honing, or replace the cylinder block and piston as a set. For boring and honing procedure, refer to step [3](#)).

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

Standard

0.015 - 0.035 mm (0.00059 - 0.00138 in)

3. Boring and honing

1. If any of the inner diameter, cylindrically, out-of-roundness or cylinder-to-piston clearance is out of standard or if there is any damage on the cylinder liner, rebore it to replace with an oversize piston.

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

2. If the inner diameter of cylinder liner exceeds the limit after boring and honing, replace the cylinder block and piston as a set.

NOTE:

- Immediately after reboring, the inner diameter of cylinder liner may differ from its real diameter due to temperature rise. Thus, when measuring the inner diameter of cylinder liner, wait until it has cooled to normal temperature.
- For the measurement of the inner diameter of cylinder liner, refer to step 1).

Inner diameter of cylinder liner boring limit (diameter):

To 94.505 mm (3.7207 in)

PISTON AND PISTON PIN

1. Check the piston and piston pin for wear or crack.
2. Check the snap ring for distortion or wear.
3. Check the piston ring groove for damage.
4. Check the circlip groove (A) for burr.

NOTE: If the burr is found, remove the burr from groove.

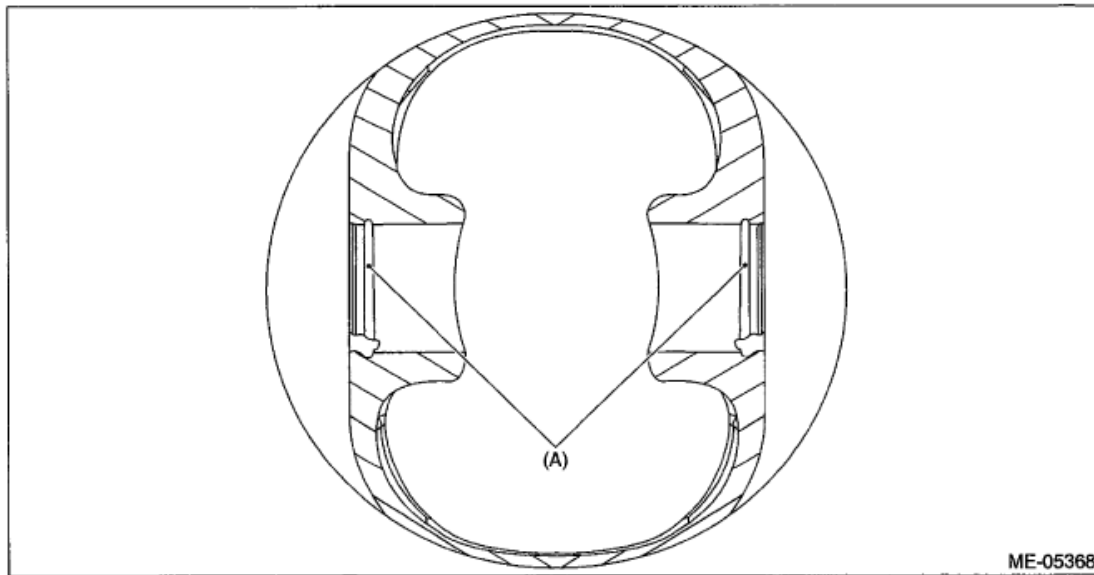


Fig. 449: Identifying Circlip Groove
Courtesy of SUBARU OF AMERICA, INC.

5. Check that the piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F).
6. Check the clearance between piston pin hole and piston pin. Check the clearance between piston pin hole and piston pin by measuring respectively the inner diameter of piston pin hole and the outer diameter of piston pin.
 1. Using a caliper gauge, measure the inner diameter of piston pin hole.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Record the measured value.

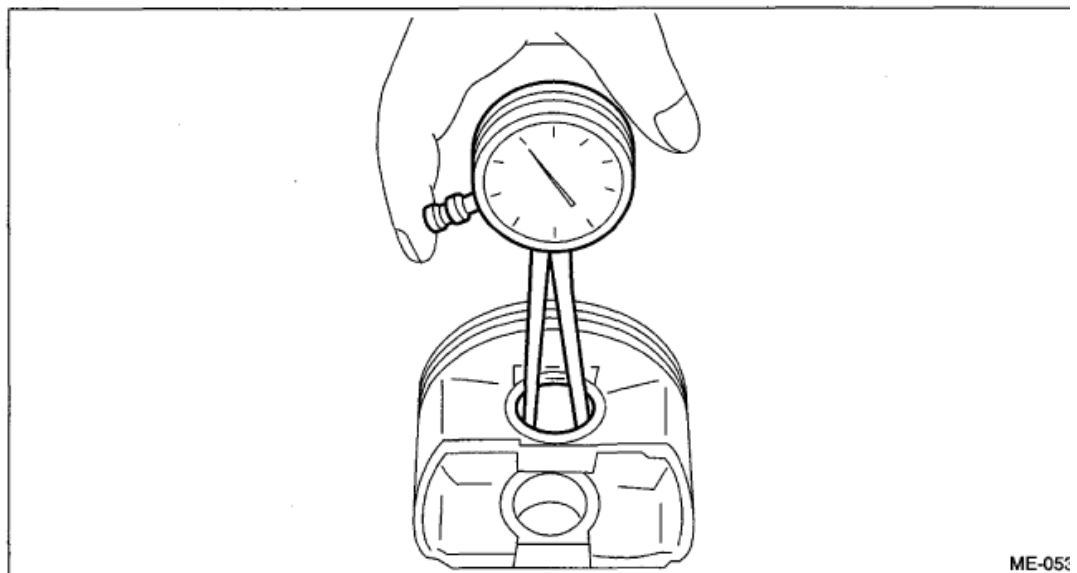


Fig. 450: Measuring Inner Diameter Of Piston Pin Hole Using Caliper Gauge

Courtesy of SUBARU OF AMERICA, INC.

2. Measure the outer diameter of piston pin with a micrometer.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Record the measured value.

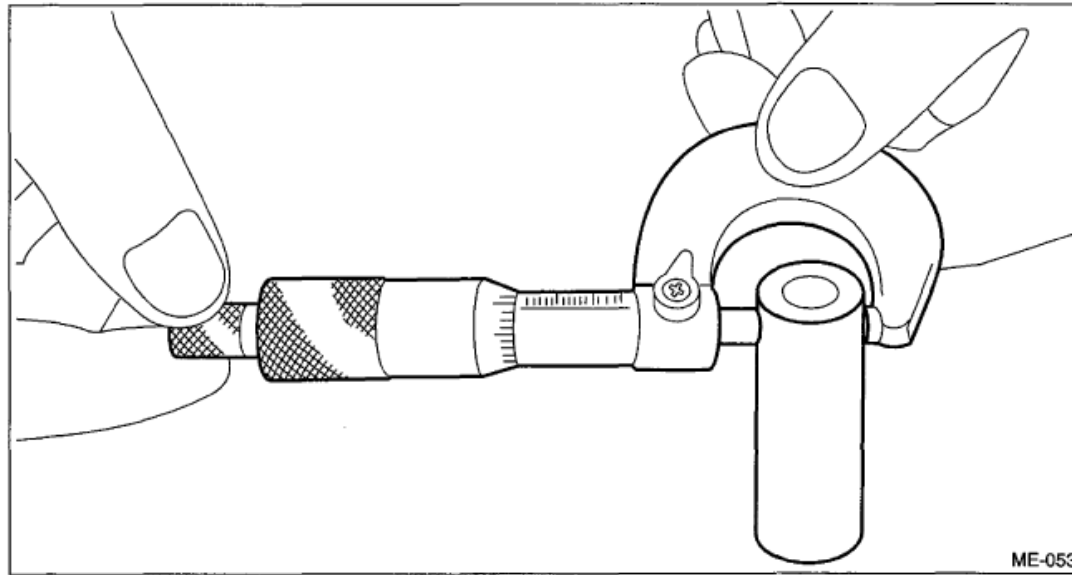


Fig. 451: Measuring Outer Diameter Of Piston Pin With Micrometer

Courtesy of SUBARU OF AMERICA, INC.

3. Calculate the clearance between piston pin hole and piston pin. If it is not within the standard, replace the piston and piston pin as a set.

Clearance between piston pin hole and piston pin:

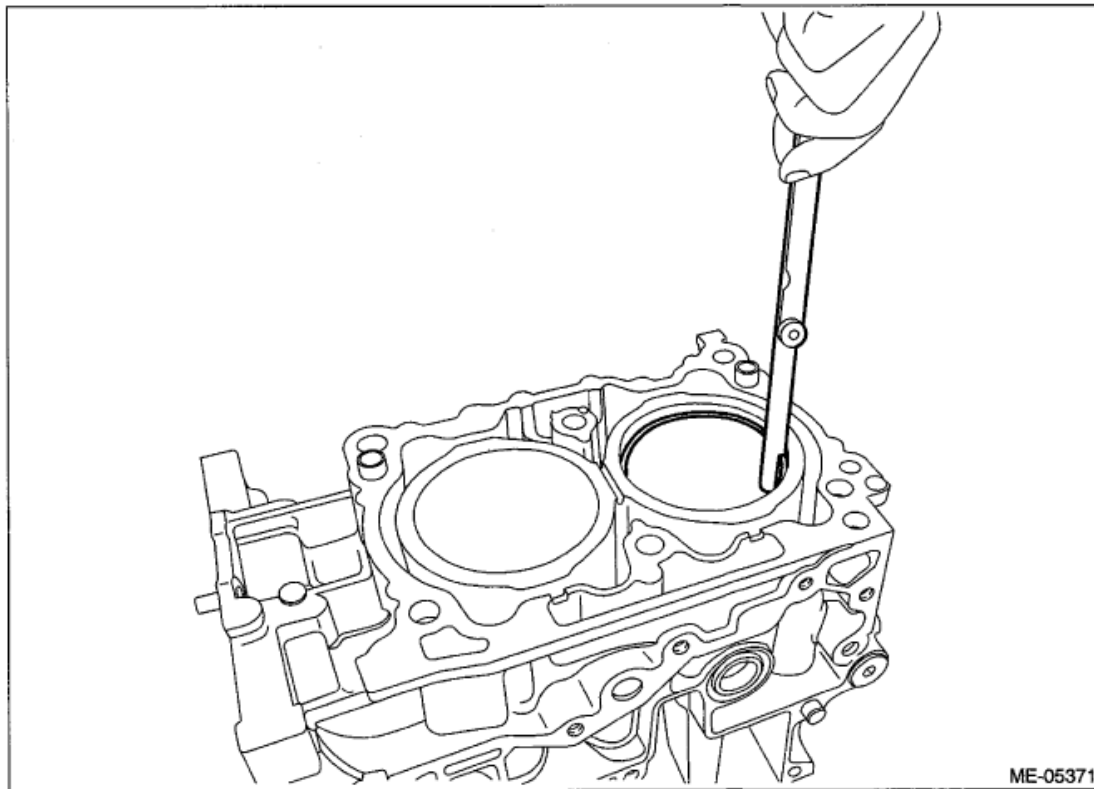
Standard

0.004 - 0.008 mm (0.0002 - 0.0003 in)

PISTON RING

1. Make sure the piston ring is not broken or damaged.
2. Using a cylindrical guide, insert the piston ring and oil ring into the cylinder liner so that they are perpendicular to the cylinder wall, and check the piston ring gap using a thickness gauge. If it is not within the standard, replace the piston ring or oil ring.

NOTE: Use piston ring with same size as piston when replacing piston ring.

Piston ring gap:***Standard******Top ring******0.20 - 0.30 mm (0.0079 - 0.0118 in)******Second ring******0.30 - 0.45 mm (0.0118 - 0.0177 in)******Oil ring rail******0.20 - 0.50 mm (0.0079 - 0.0197 in)***

ME-05371

Fig. 452: Checking Piston Ring Gap Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Fit the piston ring straight into the piston ring groove, then check the clearance between piston ring and piston ring groove with a thickness gauge. If it is not within the standard, replace the piston ring or oil ring.

NOTE:

- Before measuring the clearance, clean the piston ring groove and

piston ring.

- Use piston ring with same size as piston when replacing piston ring.

Clearance between piston ring and piston ring groove:

Standard

Top ring

0.040 - 0.080 mm (0.0016 - 0.0031 in)

Second ring

0.030 - 0.070 mm (0.0012 - 0.0028 in)

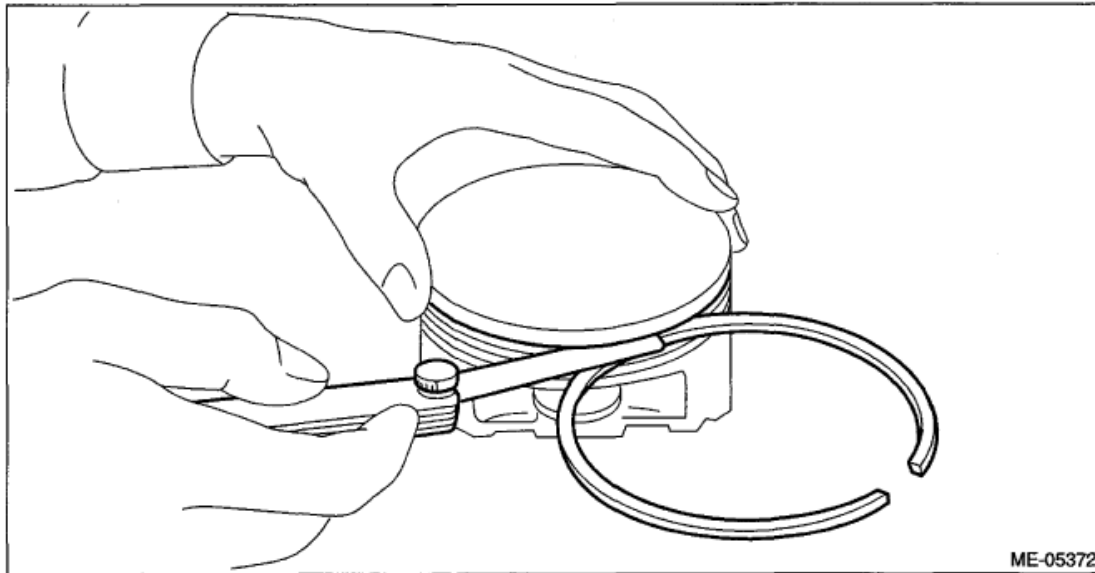


Fig. 453: Checking Clearance Between Piston Ring And Piston Ring Groove With Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD

1. Check that the large or small end thrust surface is not damaged.
2. Install the connecting rod to the crankshaft, and check the thrust clearance using a thickness gauge. If it is not within the standard, replace the connecting rod.

NOTE:

- Do not forget to install the connecting rod bearing and the connecting rod cap bearing, when installing the connecting rod to the crankshaft.
- Measurement should be performed at a temperature of 20°C (68°F).

- **Measure the thrust clearance of each connecting rod at several points, and replace the connecting rod if there is uneven wear.**

Connecting rod thrust clearance:

Standard

0.070 - 0.330 mm (0.0028 - 0.0130 in)

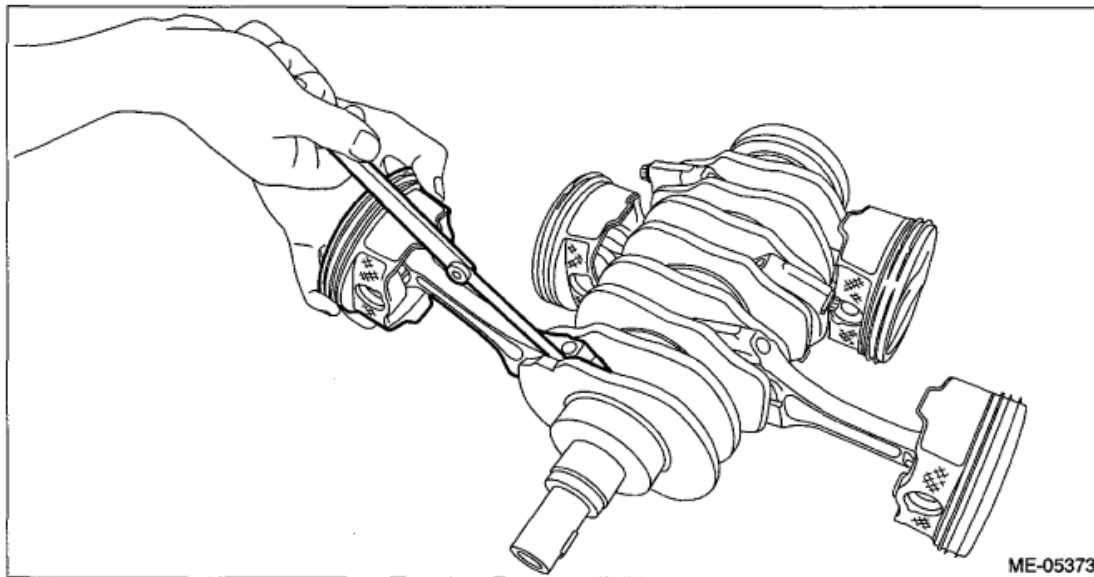
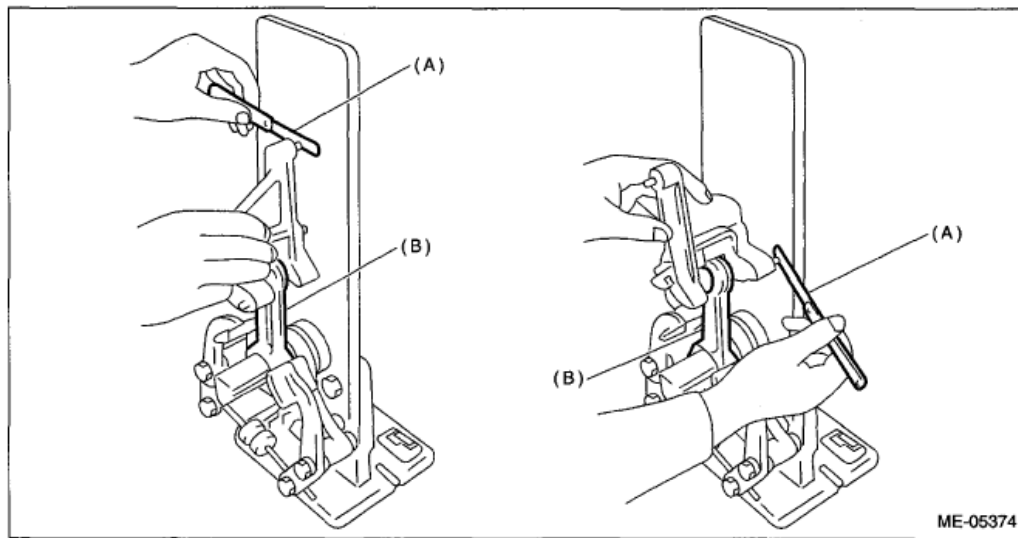


Fig. 454: Checking Connecting Rod Thrust Clearance
Courtesy of SUBARU OF AMERICA, INC.

3. Check for bend or twist using a connecting rod aligner. If it exceeds the limit, replace the connecting rod.

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. 455: Checking Connecting Rod For Bend Or Twist Using Connecting Rod Aligner
Courtesy of SUBARU OF AMERICA, INC.

4. Inspect the connecting rod bearing for scar, peeling, seizure, melting or wear, etc.
5. Check the oil clearance on each connecting rod bearing using plastigage. If it is not within the standard, replace the connecting rod bearing.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Measure the outer diameter of crank pin using micrometer, and select the suitable size connecting rod bearing when replacing the connecting rod bearing.

BEARING SPECIFICATION CHART

Unit: mm (in)		
Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.492 - 1.508 (0.0587 - 0.0594)	47.976 - 48.000 (1.8888 - 1.8898)
0.03 (0.0012) Undersize	1.511 - 1.515 (0.0595 - 0.0596)	47.946 - 47.970 (1.8876 - 1.8886)
0.05 (0.0020) Undersize	1.521 - 1.525 (0.0599 - 0.0600)	47.926 - 47.950 (1.8868 - 1.8878)
0.25 (0.0098) Undersize	1.621 - 1.625 (0.0638 - 0.0640)	47.726 - 47.750 (1.8790 - 1.8799)

Connecting rod oil clearance:

Standard

0.017 - 0.047 mm (0.0007 - 0.0019 in)

6. Check the bushing at connecting rod small end for damage.

7. Check the clearance between piston pin and bushing at connecting rod small end. Check the clearance between the piston pin and bushing at connecting rod small end by measuring respectively the outer diameter of piston pin and the inner diameter of bushing at connecting rod small end.
 1. Measure the outer diameter of piston pin with a micrometer.

- NOTE:**
- **Measurement should be performed at a temperature of 20°C (68°F).**
 - **Record the measured value.**

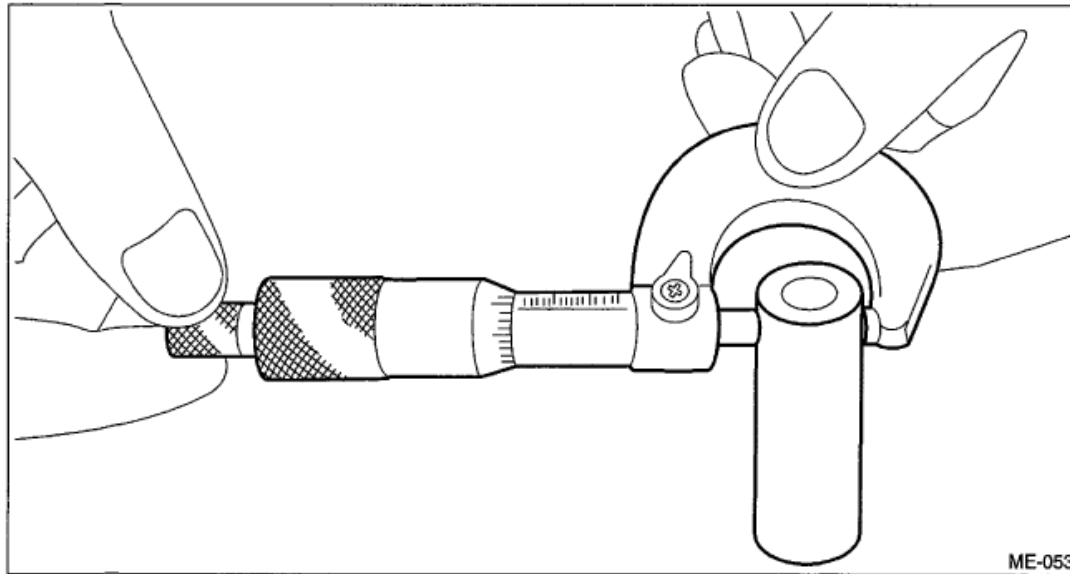


Fig. 456: Measuring Outer Diameter Of Piston Pin With Micrometer
Courtesy of SUBARU OF AMERICA, INC.

2. Using a caliper gauge, measure the inner diameter of bushing at connecting rod small end.

- NOTE:**
- **Measurement should be performed at a temperature of 20°C (68°F).**
 - **Record the measured value.**

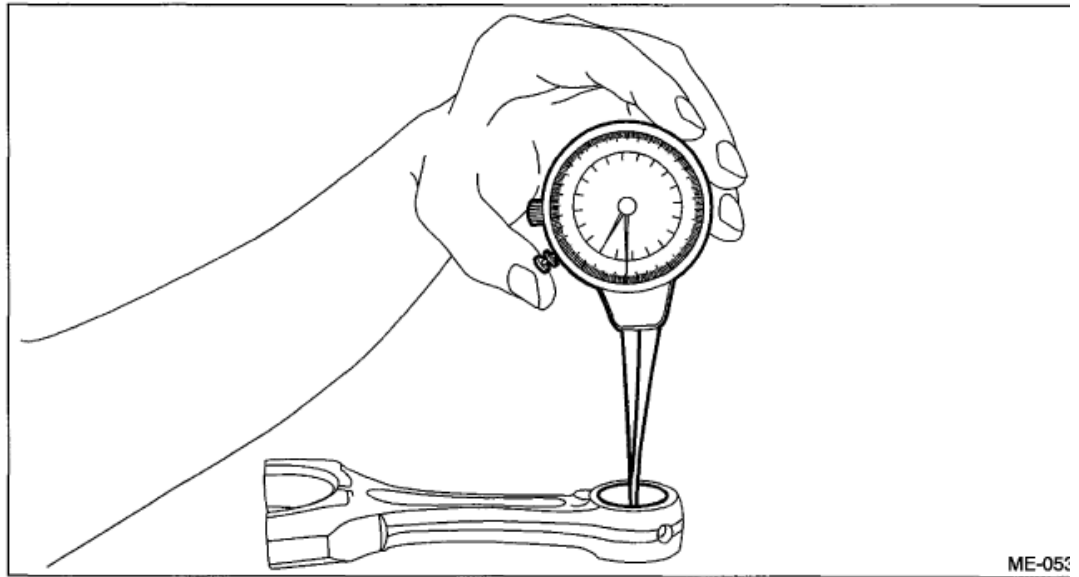


Fig. 457: Measuring Inner Diameter Of Bushing Using Caliper Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Calculate the clearance between piston pin and bushing at connecting rod small end.

Clearance between piston pin and bushing at connecting rod small end:

Standard

0.004 - 0.026 mm (0.0002 - 0.0010 in)

8. If the clearance between piston pin and bushing at connecting rod small end exceeds the standard, replace the piston pin and bushing at connecting rod small end as a set. For replacement procedure of bushing at connecting rod small end, refer to the following.
 1. Using the ST and a press, pull out the connecting rod bushing from the small end of the connecting rod.

NOTE: The direction of ST for pulling out and for press fitting is different. Therefore, attention must be paid to the direction of usage for ST.

ST 18350AA000 CONNECTING ROD BUSHING REMOVER AND INSTALLER

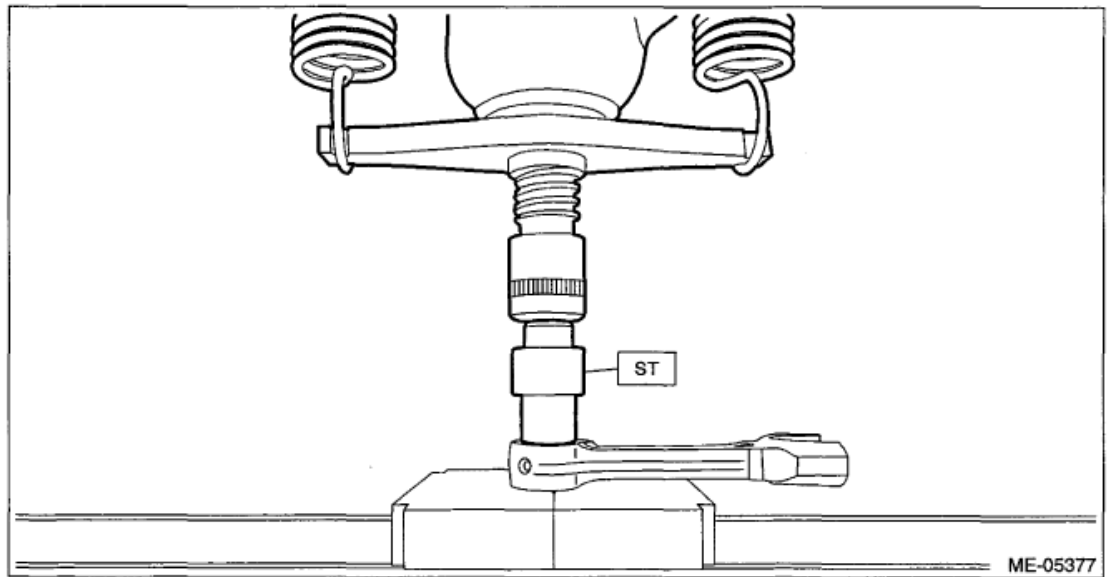
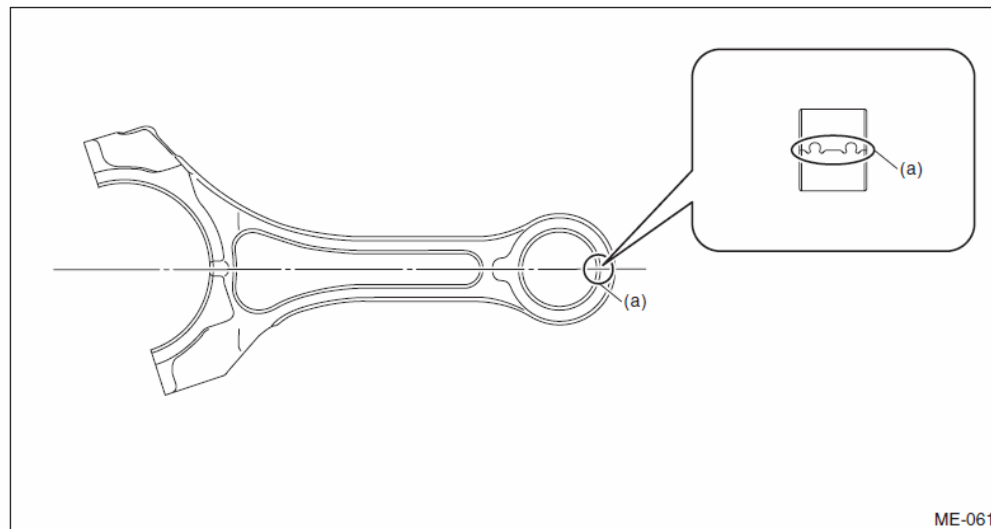


Fig. 458: Pressing Bushing With ST
Courtesy of SUBARU OF AMERICA, INC.

2. Press the connecting rod bushing with ST and the press, after applying engine oil on the periphery of connecting rod bushing.

NOTE: • Clinch area of the connecting rod bushing is as shown in the figure.



(a) Clinch area of connecting rod bushing

Fig. 459: Identifying Clinch Area Of Connecting Rod Bushing
Courtesy of SUBARU OF AMERICA, INC.

- The direction of ST for pulling out and for press fitting is different. Therefore, attention must be paid to the direction of usage for ST.

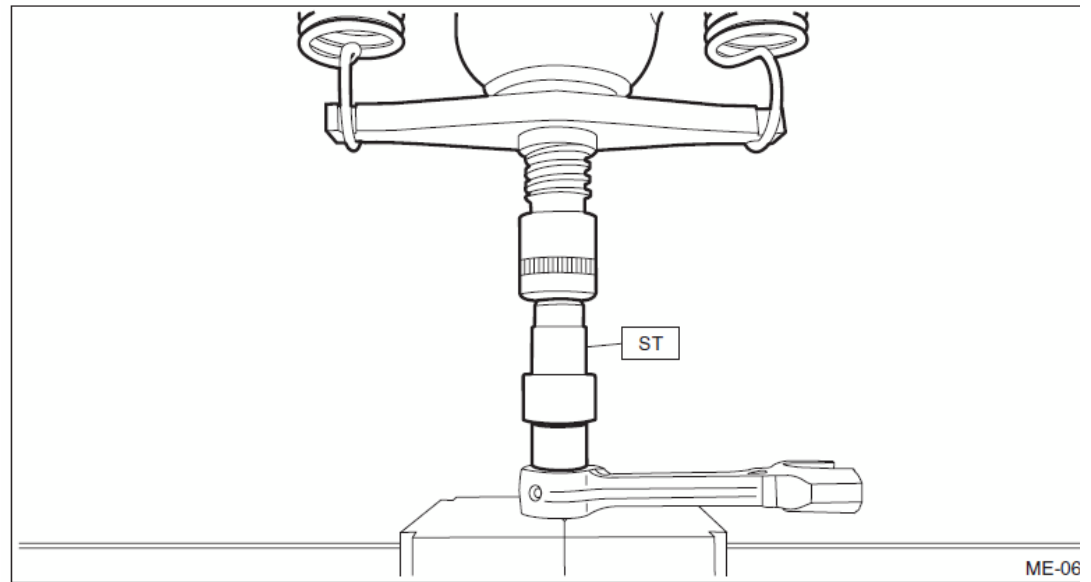
ST 18350AA000 CONNECTING ROD BUSHING REMOVER AND INSTALLER

Fig. 460: Pressing Bushing With ST
Courtesy of SUBARU OF AMERICA, INC.

3. Make two 3 mm (0.12 in) holes in the pressed connecting rod bushing by aligning with the pre-manufactured holes provided on the small end of the connecting rod.
4. Using a reamer, ream the inside surface of the connecting rod bushing. Insert the reamer in the connecting rod bushing, and turn slowly clockwise while pushing lightly. Bring the reamer back while rotating it clockwise.

NOTE:

- Use a reamer with a diameter of Ø22.
- Apply engine oil to the reamer.
- If the inner surface of valve guide is damaged, the edge of reamer should be slightly ground with oil stone.
- If the inner surface of connecting rod bushing becomes lustrous and the reamer does not chip, use a new reamer or remedy the reamer.

5. After completion of reaming, clean the connecting rod bushing to remove chips.

CRANKSHAFT AND CRANKSHAFT BEARING

1. Clean the crankshaft completely, and check it for cracks using liquid penetrant tester.
2. Using a dial gauge, check the crankshaft bend. If it exceeds the limit, grind to correct or replace the crankshaft.

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.
- Measurement should be performed at a temperature of 20°C (68°F).
- When grinding to correct the crankshaft, refer to step 3).

Crankshaft bend limit: 0.035 mm (0.0014 in)

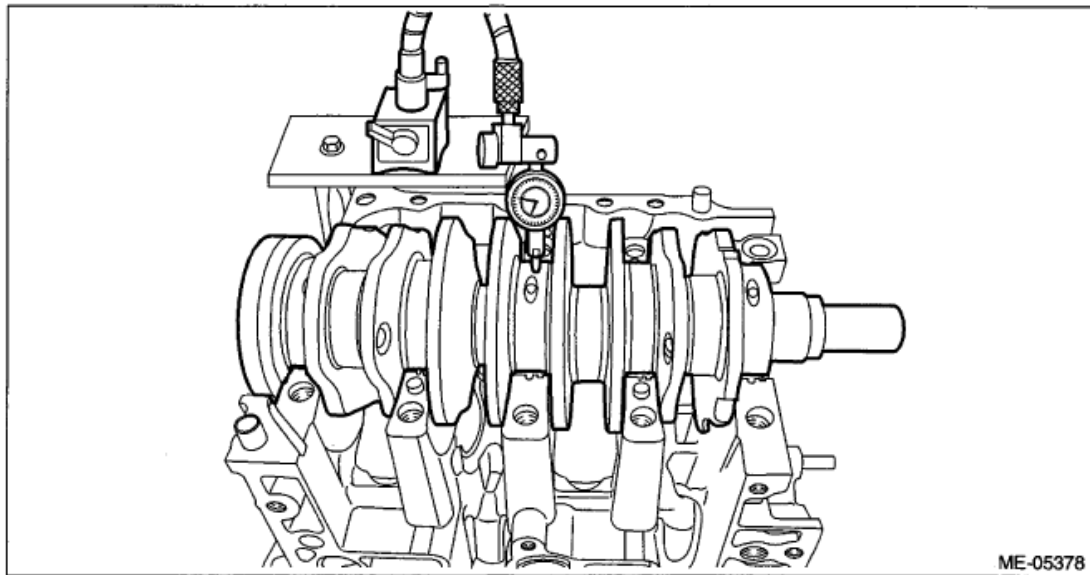


Fig. 461: Checking Crankshaft Bend Using Dial Gauge

Courtesy of SUBARU OF AMERICA, INC.

- Using micrometer, check the outer diameter of crank journal and crank pin, cylindrically, out-of-roundness. If it is not within the standard, replace the connecting rod bearing or crankshaft bearing, and grind to correct or replace the crankshaft as required.
 - Measurement should be performed at a temperature of 20°C (68°F).
 - Select the suitable size connecting rod bearing or crankshaft bearing when replacing the connecting rod bearing or crankshaft bearing.
 - When grinding to correct the crank journal or crank pin, finish them to the suitable dimensions as shown in the table below according to the undersize bearing to be used.

CRANKSHAFT AND CRANKSHAFT BEARING SPECIFICATION CHART

		Unit: mm (in)		
		Crank journal diameter		Crank pin outer diameter
		#1,#2, #3, #4	#5	
Standard	Journal O.D.	67.985 - 68.009 (2.6766 - 2.6775)	67.985 - 68.009 (2.6766 - 2.6775)	47.976 - 48.000 (1.8888 - 1.8898)
	Bearing size	2.495 - 2.513	2.493 - 2.511	1.492 - 1.508

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	(Thickness at center)	(0.0982 - 0.0989)	(0.0981 - 0.0989)	(0.0587 - 0.0594)
0.03 (0.0012) Undersize	Journal O.D.	67.955 - 67.979 (2.6754 - 2.6763)	67.955 - 67.979 (2.6754 - 2.6763)	47.946 - 47.970 (1.8876 - 1.8886)
	Bearing size (Thickness at center)	2.519 - 2.522 (0.0992 - 0.0993)	2.517 - 2.520 (0.0991 - 0.0992)	1.511 - 1.515 (0.0595 - 0.0596)
0.05 (0.0020) Undersize	Journal O.D.	67.935 - 67.959 (2.6746 - 2.6755)	67.935 - 67.959 (2.6746 - 2.6755)	47.926 - 47.950 (1.8868 - 1.8878)
	Bearing size (Thickness at center)	2.529 - 2.532 (0.0996 - 0.0997)	2.527 - 2.530 (0.0995 - 0.0996)	1.521 - 1.525 (0.0599 - 0.0600)
0.25 (0.0098) Undersize	Journal O.D.	67.735 - 67.759 (2.6667 - 2.6677)	67.735 - 67.759 (2.6667 - 2.6677)	47.726 - 47.750 (1.8790 - 1.8799)
	Bearing size (Thickness at center)	2.629 - 2.632 (0.1035 - 0.1036)	2.627 - 2.630 (0.1034 - 0.1035)	1.621 - 1.625 (0.0638 - 0.0640)

Crank pin and crank journal:

Out-of-roundness

Standard

0.005 mm (0.0002 in)

Cylindrically

Standard

0.006 mm (0.0002 in)

Grinding limit (dia.)

Crank pin: To 47.726 mm (1.8790 in)

Crank journal: To 67.735 mm (2.6667 in)

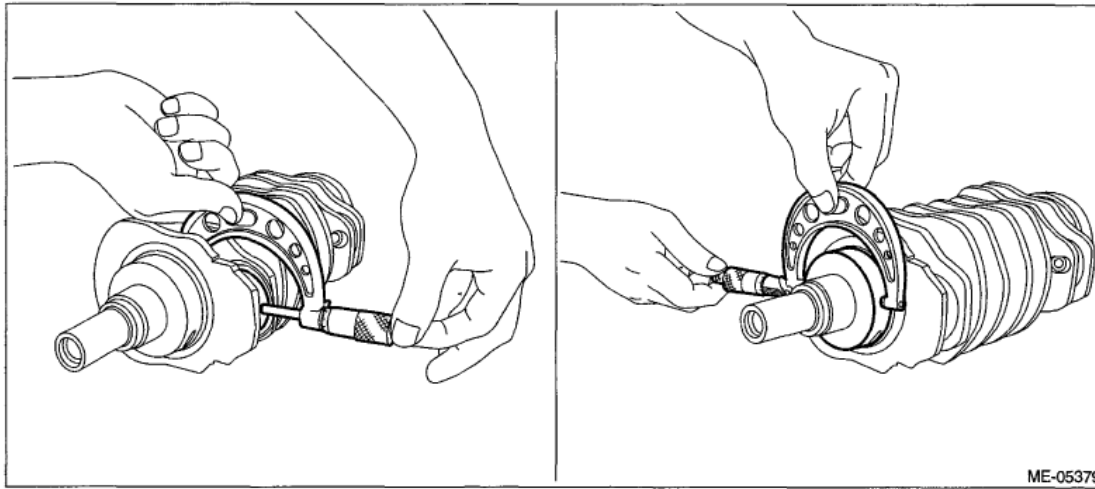


Fig. 462: Checking Outer Diameter Of Crank Journal And Crank Pin, Cylindrically And Out-Of-Round-Ness Using Micrometer

Courtesy of SUBARU OF AMERICA, INC.

4. Inspect the crankshaft bearing for scar, peeling, seizure, melting or wear, etc.
5. Use a thickness gauge to check the thrust clearance of crankshaft at #5 crankshaft bearing. If it is not within the standard, replace the #5 crankshaft bearing.
 - Measurement should be performed at a temperature of 20°C (68°F).
 - Select the suitable size by referring to step 3) when replacing #5 crankshaft bearing.

Crankshaft thrust clearance:

Standard

0.130 - 0.308 mm (0.00512 - 0.01213 in)

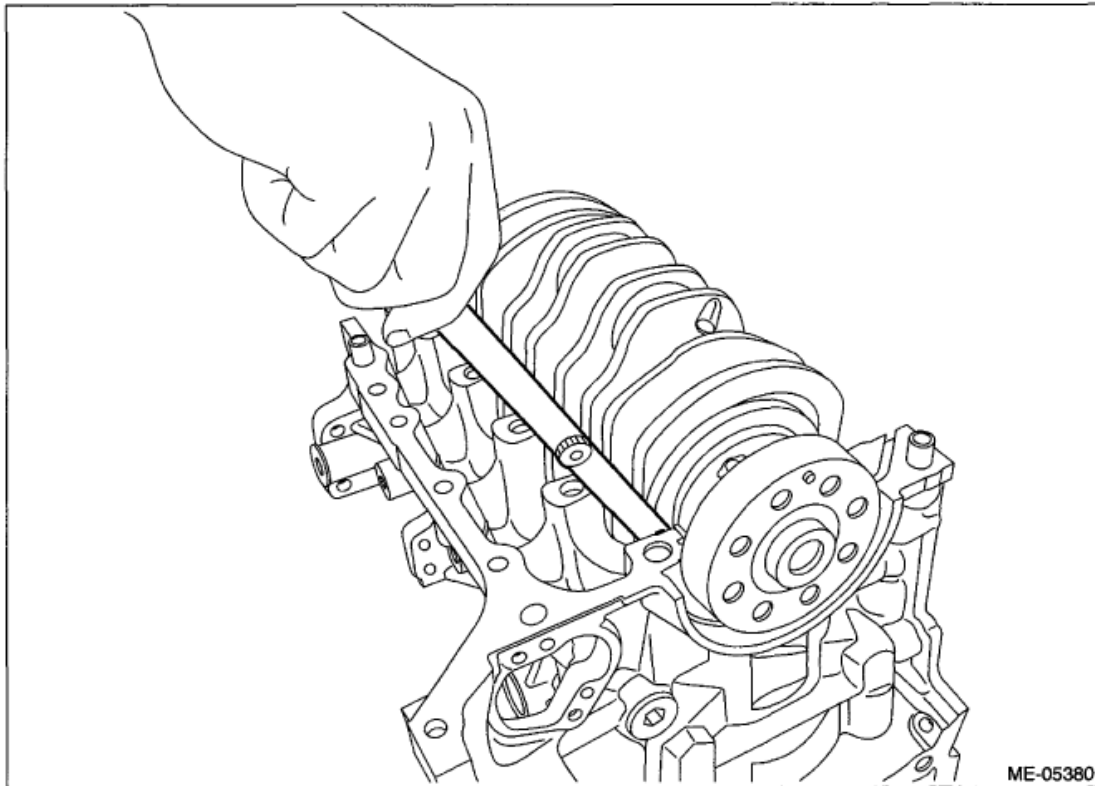


Fig. 463: Checking Thrust Clearance Of Crankshaft At #5 Crankshaft Bearing Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

6. Check the oil clearance on each crankshaft bearing using plastigage. If it is not within the standard, replace the crankshaft bearing, and grind to correct or replace the crankshaft as required.
 - Measurement should be performed at a temperature of 20°C (68°F).
 - Select the suitable size by referring to step 3) when replacing crankshaft bearing.
 - When grinding to correct the crank journal, finish it to the suitable dimensions by referring to step 3) according to the undersize bearing to be used.

Crankshaft oil clearance:

Standard

0.013 - 0.031 mm (0.00051 - 0.00122 in)

INTAKE AND EXHAUST VALVE

SPECIFICATION

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

PISTON

SPECIFICATION

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

CONNECTING ROD

SPECIFICATION

Refer to "Cylinder Block" for removal and installation procedures of connecting rod.

< refer to **REMOVAL**, Cylinder Block > < refer to **INSTALLATION**, Cylinder Block >

CRANKSHAFT

SPECIFICATION

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

POSSIBLE CAUSE REFERENCE 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

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		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 < refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system < refer 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
	Timing chain	Trouble	B
		Defective timing	B
	Compression	Incorrect cam 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 liner and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
Initial combustion occurs.	Engine control system < refer 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

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		Lack of fuel or insufficient fuel	B
	Timing chain	Trouble	B
		Defective timing	B
	Compression	Incorrect cam 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 liner and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
	Engine control system < refer 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
Engine stalls after initial combustion.	Fuel line	Clogged fuel line	C
		Lack of fuel or insufficient fuel	B
	Timing chain	Trouble	B
		Defective timing	B
	Compression	Incorrect cam clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder head gasket	C

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2. Rough idle and engine stall		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 < refer to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	C
		Loosened oil filler cap	B
		Dirty air cleaner element	C
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of fuel or insufficient fuel	B
	Timing chain	Defective timing	C
	Compression	Incorrect cam 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

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		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Over-heating	C
	Others	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
3. Low output, hesitation and poor acceleration	Engine control system < refer 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 chain	Defective timing	B
	Compression	Incorrect cam 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

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		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
4. Surging	Engine control system < refer to BASIC DIAGNOSTIC PROCEDURE . >		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	B
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of fuel or insufficient fuel	C
	Timing chain	Defective timing	B
	Compression	Incorrect cam 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

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		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 < refer 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 < refer 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 < refer 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 chain	Defective timing	B
	Compression	Incorrect cam 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	C
		Incorrect valve timing	A
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C

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	Others	Evaporative emission control system malfunction	C
8. Knocking	Engine control system < refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Loosened oil filler cap	B
	Timing chain	Defective timing	B
	Compression	Incorrect cam 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 mounting bolt or defective oil pan	B
10. Excessive fuel consumption	Engine control system < refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> . >		A
	Intake system	Dirty air cleaner element	A
	Timing chain	Defective timing	B
	Compression	Incorrect cam clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective cylinder 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 REFERENCE CHART

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	- Valve mechanism is defective. - Incorrect cam clearance - Worn camshaft - Broken valve spring - Defective valve shim
Heavy and dull clank	Oil pressure is low.	- Worn crankshaft bearing - Worn connecting rod bearing and connecting rod cap bearing at connecting rod 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 bearing - Worn connecting rod bearing and connecting rod cap bearing at connecting rod 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 piston pin hole of piston
		Unusually worn valve rocker

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	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	• Unusually worn valve shim • Worn cam sprocket • Worn camshaft journal of cam carrier and camshaft cap
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	-	• Defective automatic belt tensioner adjuster assembly (Loose V-belt) • Defective water pump shaft
Hissing sound	-	• Insufficient compression • Air leakage in air intake system, hose, connection or manifold
Timing chain noise	-	• Loose timing chain • Timing chain contacting with adjacent part
Valve noise	-	• Incorrect cam 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 < refer to <u>OPERATION</u> , Clear Memory Mode > and Inspection Mode < refer to <u>PROCEDURE</u> , Inspection Mode > after connecting the fuel injector connector.		