

2013 Subaru Legacy

2013 ENGINE Engine Mechanical (H4DO) - Legacy/Outback

2013 ENGINE

Engine Mechanical (H4DO) - Legacy/Outback

GENERAL DESCRIPTION

SPECIFICATION

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	1, 050 - 1, 400 (11 - 14, 152 - 203)
	Number of piston rings			Compression ring: 2 Oil ring: 1
	Intake valve timing	Open	Max. retard	ATDC 16°
			Min. advance	BTDC 39°
		Close	Max. retard	ABDC 80°
			Min. advance	ABDC 25°
	Exhaust valve timing		Open	BBDC 35°
			Open	ATDC 13°
	Cam clearance	mm (in)	Intake	Standard 0.13±0.03 (0.0051±0.0012)
			Exhaust	Standard 0.24±0.03 (0.0094±0.0012)
	Idle speed (For CVT model, select lever in "P" or "N" range. For MT model, gear shift lever in neutral position.)	rpm	No load	Standard CVT model: 675±100
				MT model: 650±100
			A/C ON	Standard CVT model: 700±100
	Ignition order			1 --> 3 --> 2 --> 4
	Ignition timing		BTDC/rpm	Standard CVT model: 16°±10°/675
				MT model: 16°±10°/650

NOTE: OS: Oversize US: Undersize

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Camshaft	Bending		mm (in)	Limit	0.020 (0.00079)
	Cam lobe height	mm (in)	Intake	Standard	40.77 - 40.87 (1.605 - 1.609)
			Exhaust	Standard	40.15 - 40.25 (1.581 - 1.585)
	Cam base circle diameter		mm (in)	Standard	34.0 (1.339)
	Journal outer diameter		mm (in)	Standard	25.946 - 25.963 (1.0215 - 1.0222)
	Thrust clearance		mm (in)	Standard	0.068 - 0.116 (0.0027 - 0.0047)
	Oil clearance		mm (in)	Standard	0.037 - 0.072 (0.0015 - 0.0028)
Cylinder head	Warpage (mating surface with cylinder block)		mm (in)	Limit	0.035 (0.0014)
	Grinding limit			mm (in)	To 98.4 (3.874)
	Height		mm (in)	Standard	98.5 (3.878)
Valve & valve guide	Valve overall length		mm (in)	Intake	103.3 (4.067)
				Exhaust	94.1 (3.705)
	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)
	Valve stem outer diameter	mm (in)	Intake	Standard	5.455 - 5.470 (0.2148 - 0.2154)
			Exhaust	Standard	5.445 - 5.460 (0.2144 - 0.2150)
	Valve guide inner diameter		mm (in)	Standard	5.500 - 5.512 (0.2165 - 0.2170)
	Clearance between valve and valve guide	mm (in)	Intake	Standard	0.030 - 0.057 (0.0012 - 0.0022)
			Exhaust	Standard	0.040 - 0.067 (0.0016 - 0.0026)
Valve guide protrusion amount		mm (in)	Standard	11.4 - 11.8 (0.449 - 0.465)	
Valve & valve shim	Valve stem end outer diameter	mm (in)	Intake	Standard	5.455 - 5.470 (0.2148 - 0.2154)
			Exhaust	Standard	5.445 - 5.460 (0.2148 - 0.2150)
	Valve shim inner diameter		mm (in)	Standard	5.500 - 5.560 (0.2165 - 0.2189)
	Clearance between valve and valve shim	mm (in)	Intake	Standard	0.030 - 0.105 (0.0012 - 0.0041)
					0.040 - 0.115 (0.0016 - 0.0045)

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		Exhaust	Standard	0.0045)		
Valve seat	Seating width between valve and valve seat	mm	Intake	Standard	0.8 - 1.6 (0.031 - 0.063)	
		(in)	Exhaust	Standard	1.1 - 1.7 (0.043 - 0.067)	
	Seating angle between valve and valve seat			45°		
	Seating position between valve and valve seat			Valve face center		
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°, 1.8 mm (0.071 in) or less	
Cylinder block & piston	Cylinder block warpage (Mating surface with cylinder head)		mm (in)	Limit	0.025 (0.00098)	
	Grinding limit of cylinder block			mm (in)	To 204.9 (8.067)	
	Height of cylinder block		mm (in)	Standard	205.0 (8.071)	
	Inner diameter of cylinder liner	mm (in)	Cylinder bore size mark A	Standard	94.005 - 94.015 (3.7010 - 3.7014)	
			Cylinder bore size mark B	Standard	93.995 - 94.005 (3.7006 - 3.7010)	
	Cylindricity of cylinder liner		mm (in)	Limit	0.015 (0.0006)	
	Out-of-roundness of cylinder liner		mm (in)	Limit	0.010 (0.0004)	
	Piston grade point			mm (in)	13.3 (0.52)	
	Piston outer diameter	mm (in)	Standard Size	Grade A	Standard	93.980 - 93.990 (3.7000 - 3.7004)
				Grade B	Standard	93.970 - 93.980 (3.6996 - 3.7000)
			0.25 (0.0098) OS		Standard	94.220 - 94.240 (3.7094 - 3.7102)
			0.50 (0.0197) OS		Standard	94.470 - 94.490 (3.7193 - 3.7201)
	Clearance between cylinder liner and piston		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 and piston	Degree of fit			Piston pin must be fitted into position with thumb at 20°C (68°F).		

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pin	Clearance between piston and piston pin			mm (in)	Standard	0.004 - 0.008 (0.0002 - 0.0003)
Piston ring	Closed gap	mm (in)	Compression ring	Top ring	Standard	0.20 - 0.30 (0.0079 - 0.0118)
				Second ring	Standard	0.30 - 0.45 (0.0118 - 0.0177)
			Oil ring (upper rail and lower rail)		Standard	0.20 - 0.50 (0.0079 - 0.0197)
	Clearance between compression ring and piston		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 rod bearing	Bend or twist per 100 mm (3.94 in) in length			mm (in)	Limit	0.10 (0.0039)
	Thrust clearance			mm (in)	Standard	0.070 - 0.330 (0.0028 - 0.0130)
	Connecting rod bearing thickness (at center)		mm (in)	Standard size	Standard	1.492 - 1.508 (0.0587 - 0.0594)
				0.03 (0.0012) US	Standard	1.511 - 1.515 (0.0595 - 0.0596)
				0.05 (0.0020) US	Standard	1.521 - 1.525 (0.0599 - 0.0600)
				0.25 (0.0098) US	Standard	1.621 - 1.625 (0.0638 - 0.0640)
	Oil clearance			mm (in)	Standard	0.017 - 0.047 (0.0007 - 0.0019)
Piston pin & connecting rod bushing	Clearance between piston pin and connecting rod bushing			mm (in)	Standard	0.004 - 0.026 (0.0002 - 0.0010)
	Bending			mm (in)	Limit	0.035 (0.0014)
	Crankshaft pin	Cylindricity		mm (in)	Limit	0.006 (0.0002)
		Out-of-roundness		mm (in)	Limit	0.005 (0.0002)
		Grinding limit (dia.)		mm (in)		To 47.726 (1.8790)
	Crankshaft journal	Cylindricity		mm (in)	Limit	0.006 (0.0002)
		Out-of-roundness		mm (in)	Limit	0.005 (0.0002)
		Grinding limit (dia.)		mm (in)		To 67.735 (2.6667)
			Standard size	Standard	47.976 - 48.000 (1.8888 - 1.8898)	
			0.03 (0.0012) US	Standard	47.946 - 47.970 (1.8876 - 1.8898)	

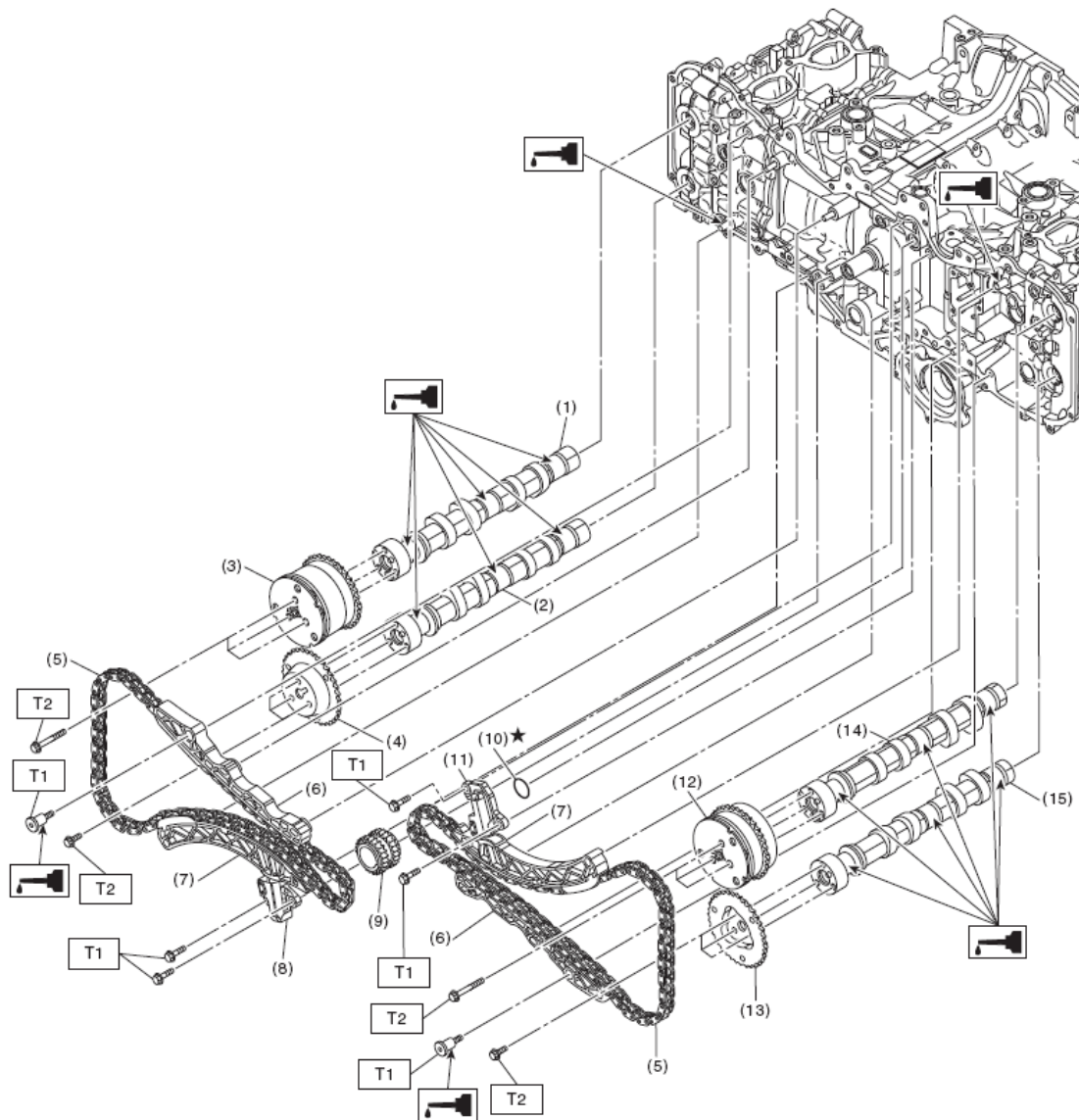
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Crankshaft and crankshaft bearing	Crankshaft pin outer diameter		mm (in)			- 1.8886)
				0.05 (0.0020) US	Standard	47.926 - 47.950 (1.8868 - 1.8878)
				0.25 (0.0098) US	Standard	47.726 - 47.750 (1.8790 - 1.8799)
	Crankshaft journal outer diameter		mm (in)	Standard size	Standard	67.985 - 68.009 (2.6766 - 2.6775)
				0.03 (0.0012) US	Standard	67.955 - 67.979 (2.6754 - 2.6763)
				0.05 (0.0020) US	Standard	67.935 - 67.959 (2.6746 - 2.6755)
				0.25 (0.0098) US	Standard	67.735 - 67.759 (2.6667 - 2.6677)
	Crankshaft bearing thickness (at center)	mm (in)	#1, #2, #3, #4	Standard size	Standard	2.495 - 2.513 (0.0982 - 0.0989)
				0.03 (0.0012) US	Standard	2.519 - 2.522 (0.0992 - 0.0993)
				0.05 (0.0020) US	Standard	2.529 - 2.532 (0.0996 - 0.0997)
				0.25 (0.0098) US	Standard	2.629 - 2.632 (0.1035 - 0.1036)
		#5	Standard size	Standard	2.493 - 2.511 (0.0981 - 0.0989)	
			0.03 (0.0012) US	Standard	2.517 - 2.520 (0.0991 - 0.0992)	
0.05 (0.0020) US			Standard	2.527 - 2.530 (0.0995 - 0.0996)		
0.25 (0.0098) US			Standard	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 & CAMSHAFT



ME-07071

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

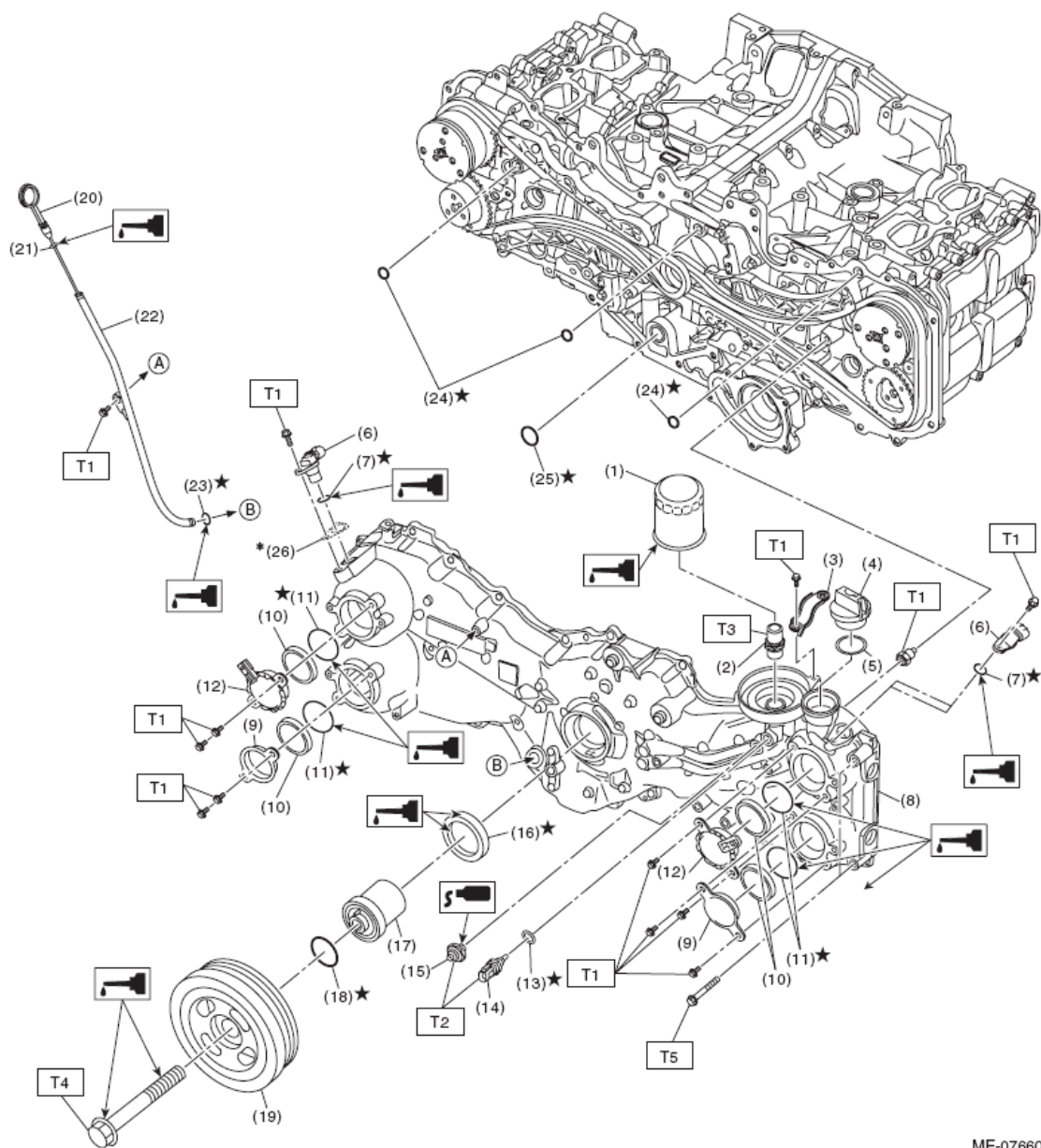
Fig. 1: Exploded View Of Timing Chain & Camshaft With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7, 4.7)

T2: 18 (1.8, 13.3)

CHAIN COVER



ME-07660

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

* Use one or no spacer to adjust the gap.

Fig. 2: Identifying Chain Cover And Related Component With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7, 4.7)

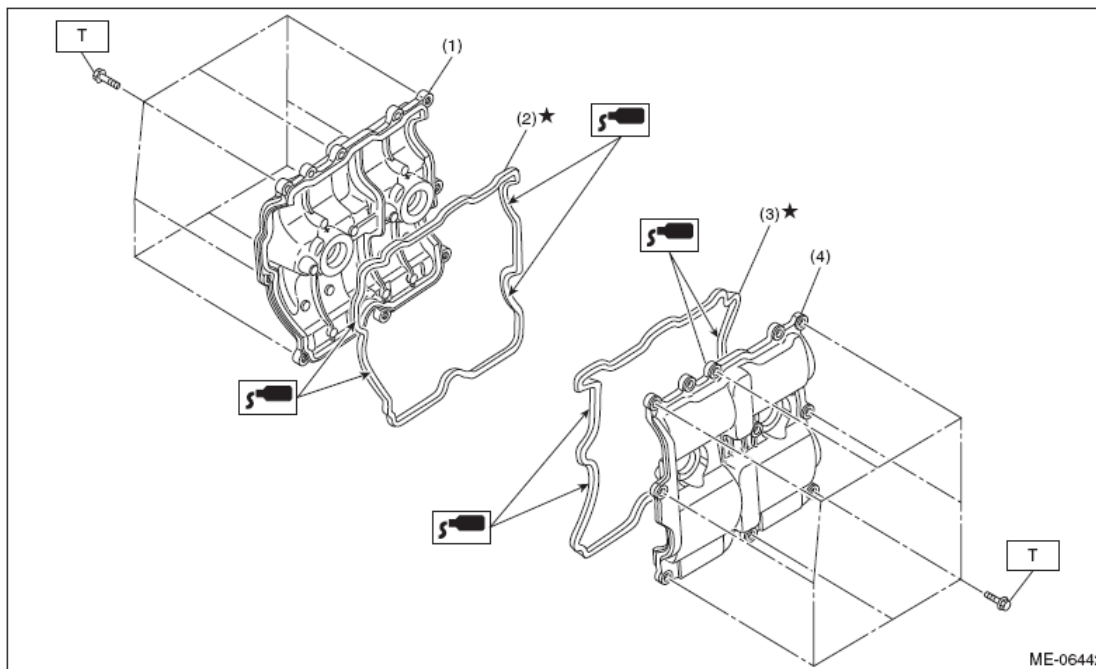
T2: 18 (1.8, 13.3)

T3: 45 (4.6, 33.2)

T4: Refer to INSTALLATION.

T5: Refer to INSTALLATION.

ROCKER COVER



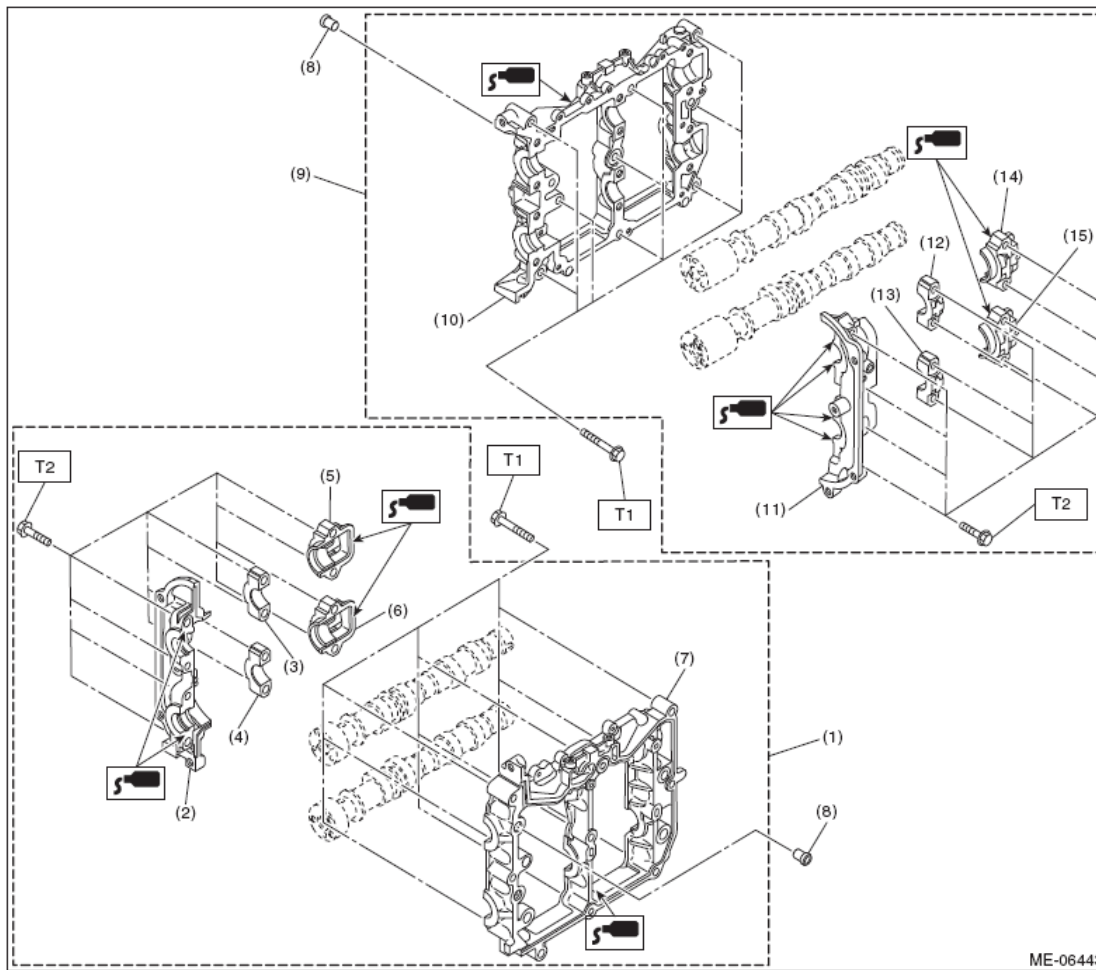
- | | |
|----------------------------|----------------------------|
| (1) Rocker cover RH | (3) Rocker cover gasket LH |
| (2) Rocker cover gasket RH | (4) Rocker cover LH |

Fig. 3: Identifying Rocker Cover And Gasket (LH And RH)
Courtesy of SUBARU OF AMERICA, INC.

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

T: Refer to INSTALLATION.

CAM CARRIER



ME-06443

- | | | |
|------------------------------------|-------------------------------------|-----------------------------------|
| (1) Cam carrier ASSY | (8) Filter | (15) Exhaust rear camshaft cap LH |
| (2) Front camshaft cap RH | (9) Cam carrier ASSY | |
| (3) Intake center camshaft cap RH | (10) Cam carrier LH | |
| (4) Exhaust center camshaft cap RH | (11) Front camshaft cap LH | |
| (5) Intake rear camshaft cap RH | (12) Intake center camshaft cap LH | |
| (6) Exhaust rear camshaft cap RH | (13) Exhaust center camshaft cap LH | |
| (7) Cam carrier RH | (14) Intake rear camshaft cap LH | |

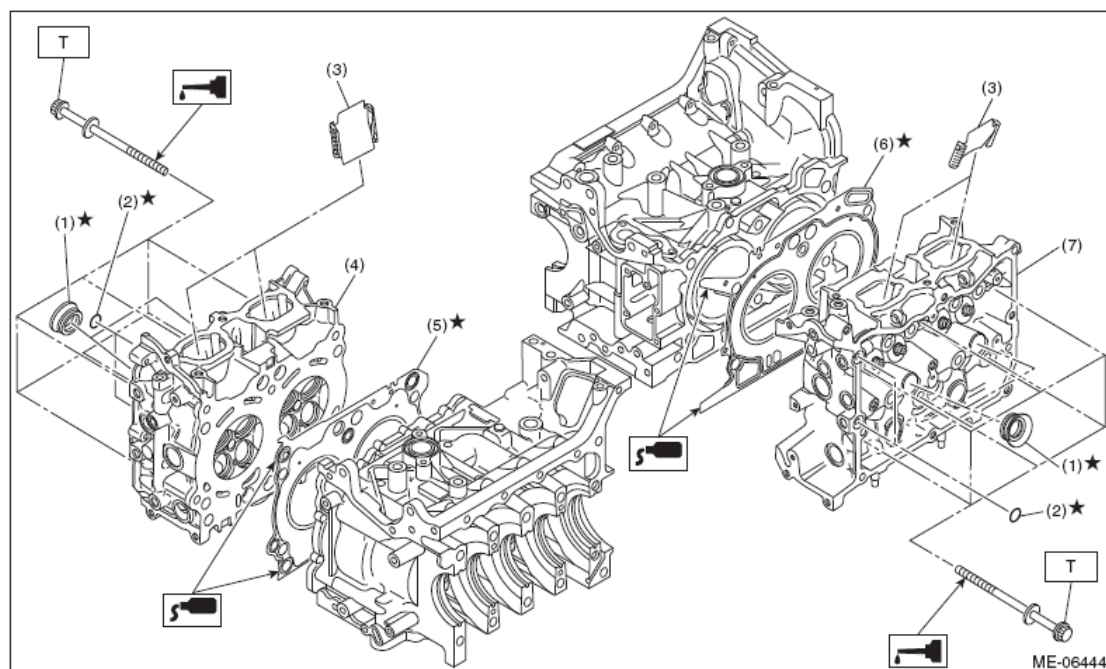
Fig. 4: Identifying Cam Carrier And Related Components
 Courtesy of SUBARU OF AMERICA, INC.

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

T1: Refer to ASSEMBLY.

T2: Refer to INSTALLATION.

CYLINDER HEAD



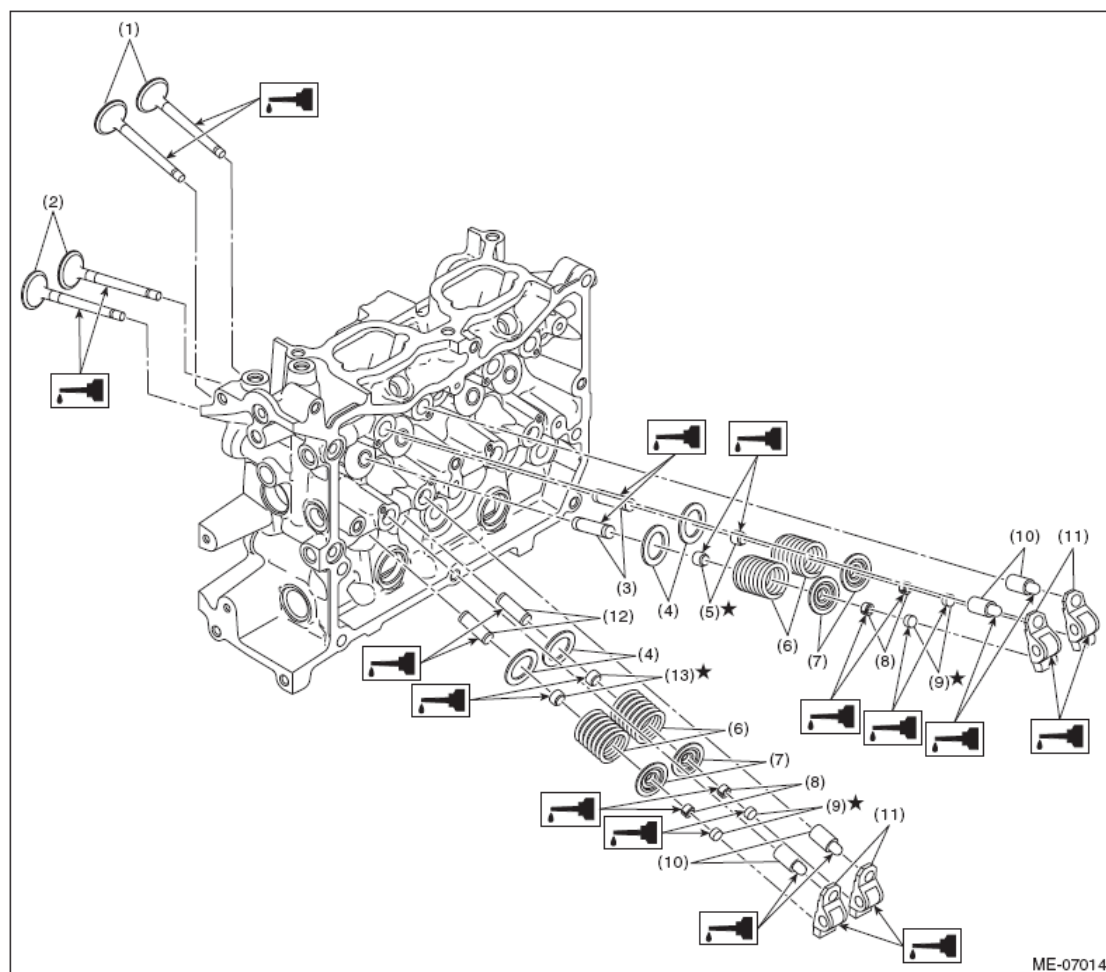
- | | |
|----------------------------|-----------------------------|
| (1) Spark plug pipe gasket | (5) Cylinder head gasket RH |
| (2) O-ring | (6) Cylinder head gasket LH |
| (3) Cylinder head plate | (7) Cylinder head LH |
| (4) Cylinder head RH | |

Fig. 5: Identifying Cylinder Head And Related Components
 Courtesy of SUBARU OF AMERICA, INC.

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

T: Refer to INSTALLATION.

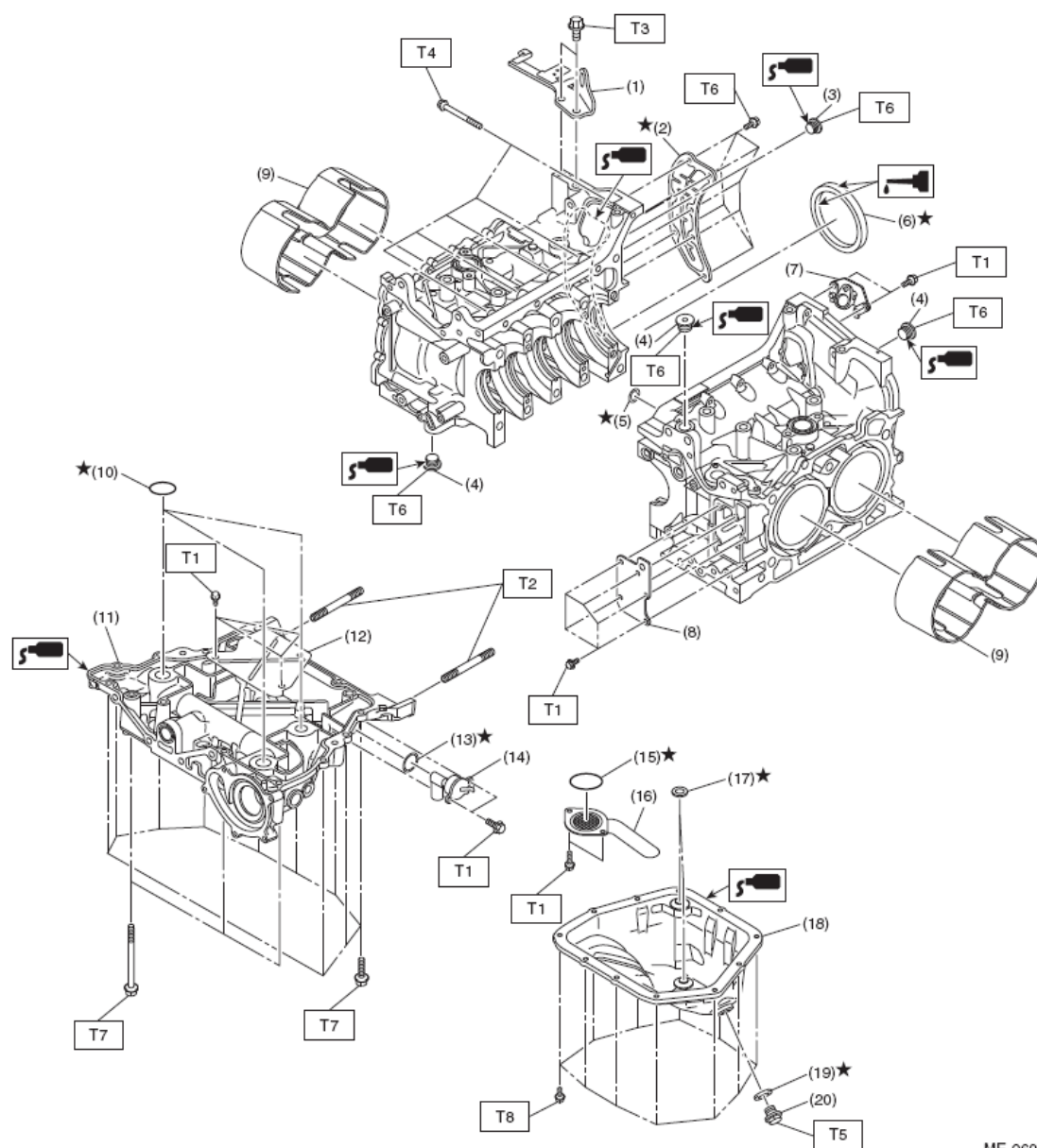
VALVE ASSY



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

Fig. 6: Exploded View Of Valve Assembly And Related Components
 Courtesy of SUBARU OF AMERICA, INC.

CYLINDER BLOCK 1



ME-06990

- | | |
|---------------------------------------|------------------------|
| (1) Engine rear hanger | (11) Oil pan upper |
| (2) Oil separator cover | (12) Baffle plate |
| (3) Cylinder block plug | (13) O-ring |
| (4) Main gallery plug | (14) Oil level switch |
| (5) O-ring | (15) O-ring |
| (6) Rear oil seal | (16) Oil strainer |
| (7) Crankshaft position sensor holder | (17) Oil pan seal ring |
| (8) Cylinder block plate | (18) Oil pan |
| (9) Water jacket spacer | (19) Drain plug gasket |
| (10) O-ring | (20) Drain plug |

Fig. 7: Identifying Cylinder Block 1 And Related Components
 Courtesy of SUBARU OF AMERICA, INC.

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

T1: 6.4 (0.7, 4.7)

T2: 10 (1.0, 7.4)

T3: 21 (2.1, 15.5)

T4: 25 (2.5, 18.4)

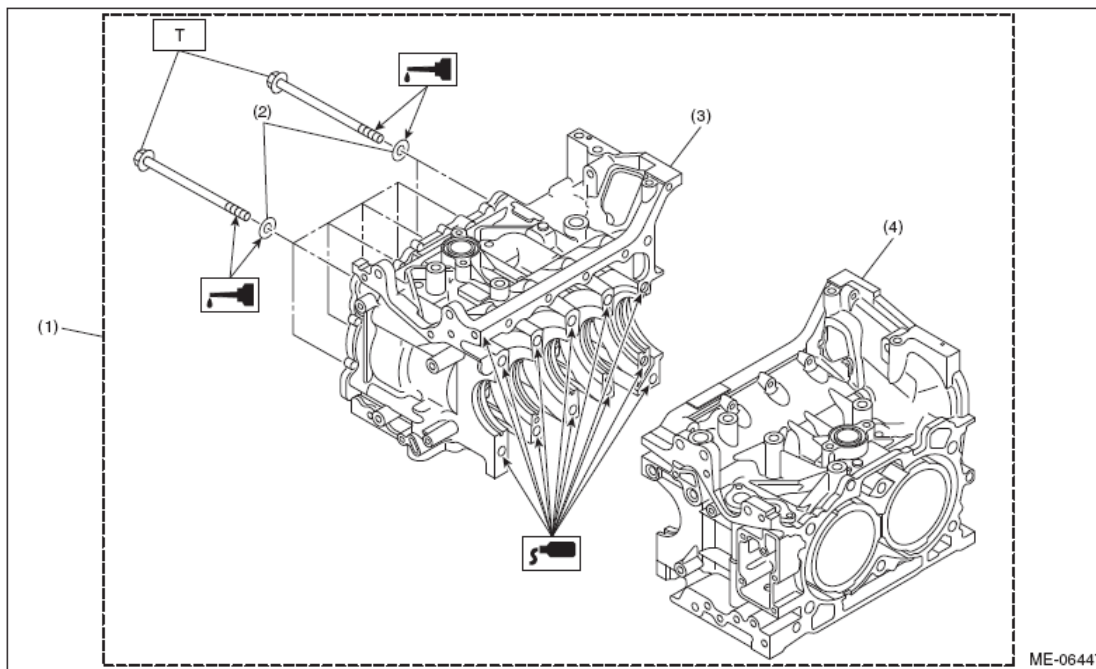
T5: 41.7 (4.3, 30.8)

T6: Refer to CYLINDER BLOCK.

T7: Refer to INSTALLATION.

T8: Refer to OIL PAN.

CYLINDER BLOCK 2



(1) Cylinder block ASSY

(2) Washer

(3) Cylinder block RH

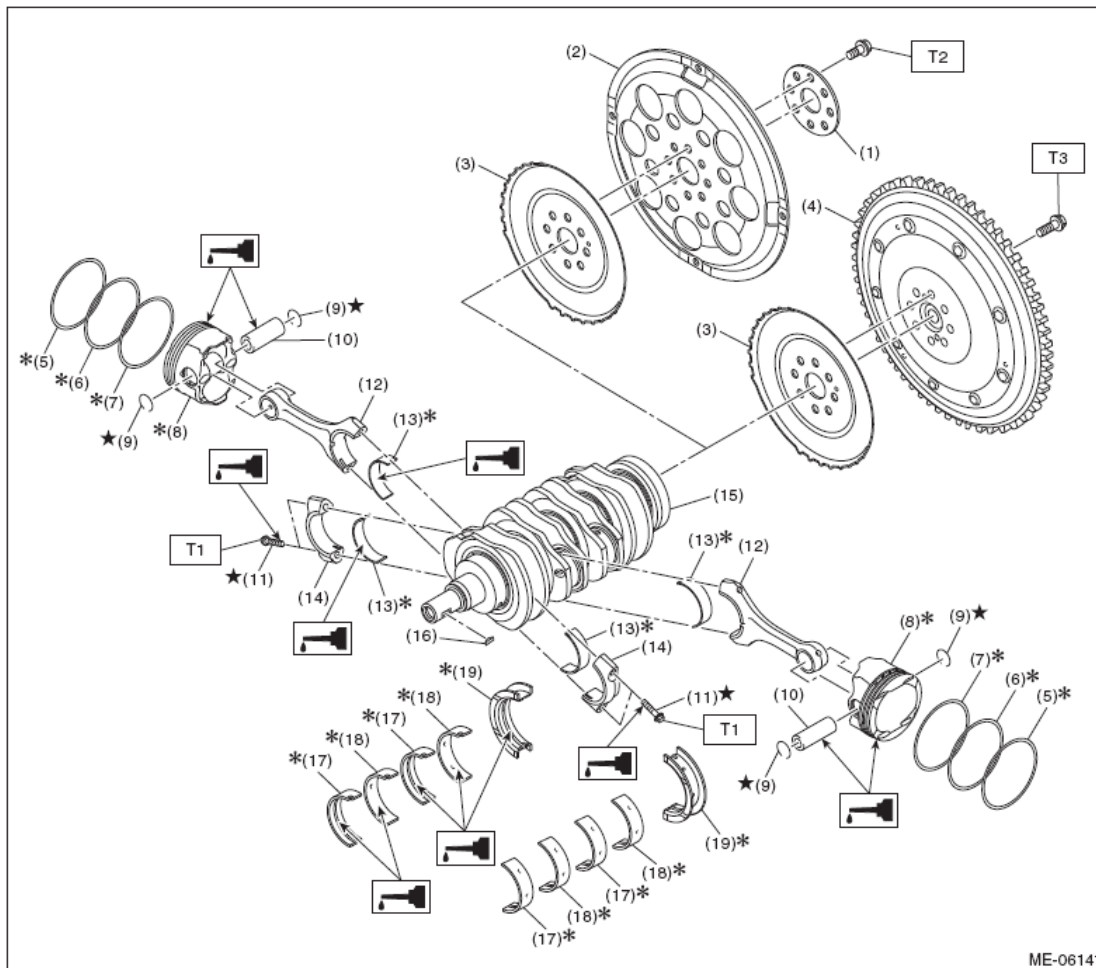
(4) Cylinder block LH

Fig. 8: Identifying Cylinder Block 2 And Related Components
Courtesy of SUBARU OF AMERICA, INC.

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

T: Refer to INSTALLATION.

CRANKSHAFT AND PISTON



- | | | |
|--------------------------------------|------------------------------|--------------------------------|
| (1) Reinforcement (CVT model) | (9) Circlip | (17) Crankshaft bearing #1, #3 |
| (2) Drive plate (CVT 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. 9: Identifying Crankshaft, Piston And Related Components
 Courtesy of SUBARU OF AMERICA, INC.

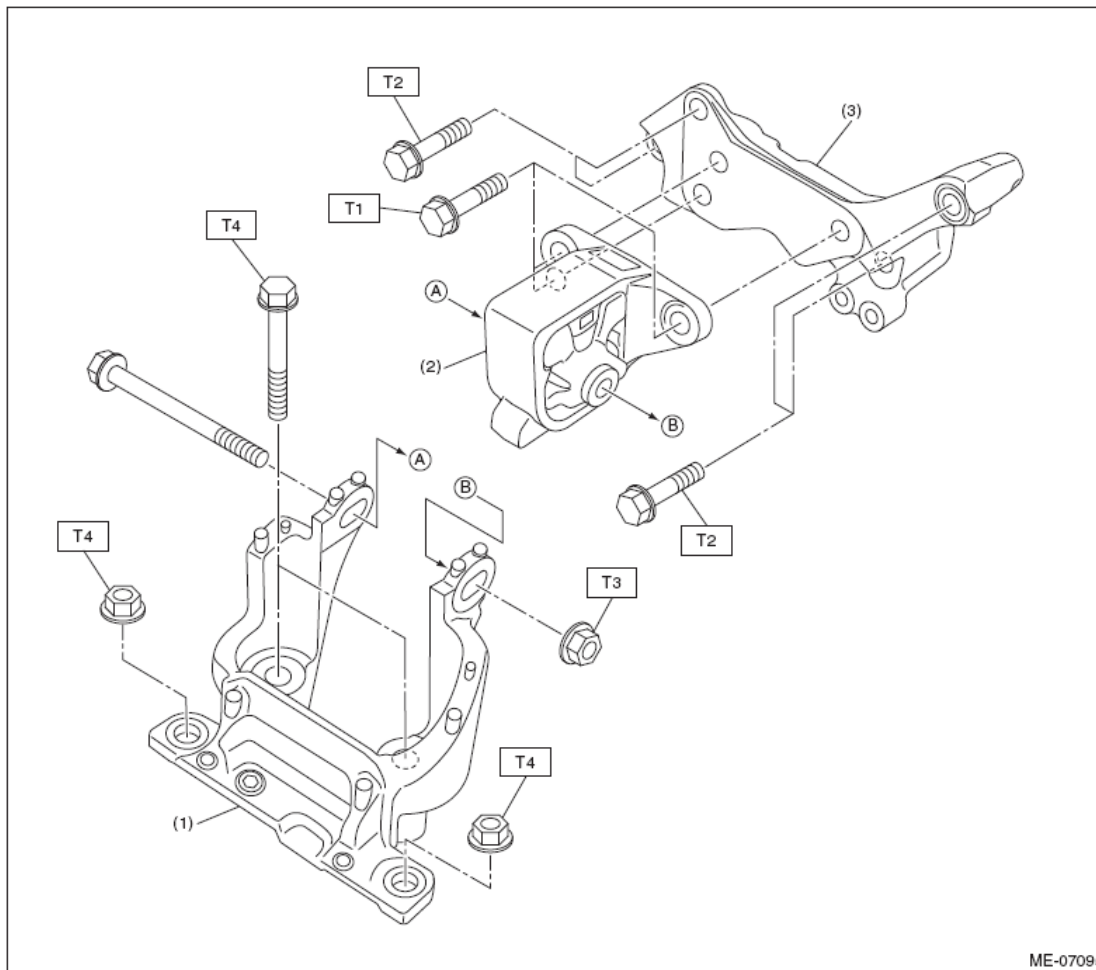
Tightening torque: N.m (kgf-m, ft-lb)

T1: Refer to INSTALLATION.

T2: Refer to INSTALLATION.

T3: Refer to INSTALLATION.

ENGINE MOUNTING



- (1) Front mounting bracket (3) Engine mounting bracket
(2) Front cushion rubber

Fig. 10: Identifying Front Mounting Bracket, Engine Mounting Bracket And Front Cushion Rubber
Courtesy of SUBARU OF AMERICA, INC.

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

T1: 25 (2.5, 18.4)

T2: 30 (3.1, 22.1)

T3: 45 (4.6, 33.2)

T4: 60 (6.1, 44.3)

CAUTION

- Prior to starting work, pay special attention to the following:
 1. Always wear work clothes, a safety cap, protective shoes. Additionally, wear a helmet, protective

goggles, etc. if necessary.

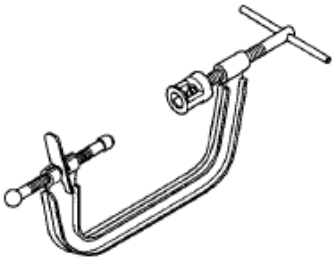
2. Protect the vehicle using a seat cover, fender cover, etc.

3. Prepare the service tools, clean cloth, containers to catch grease and oil, etc.

- Vehicle components are extremely hot immediately after driving. Be wary of receiving burns from heated parts.
- When performing a repair, identify the cause of trouble and avoid unnecessary removal, disassembly and replacement.
- Before disconnecting connectors of sensors or units, be sure to disconnect the ground cable from battery.
- Always use the jack-up point when the shop jacks or rigid racks are used to support the vehicle.
- Remove or install the engine in an area where chain hoists, lifting devices, etc. are available for ready use. When lifting up the vehicle, make sure to support the vehicle at the jack-up points.
- Be careful not to let any oil or grease contact the clutch disc or flywheel.
- Remove contamination including dirt and corrosion before removal, installation, disassembly or assembly.
- Keep the removed parts in order and protect them from dust and dirt.
- All removed parts, if to be reused, should be reinstalled in the original positions with attention to the correct directions, etc.
- Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil when being assembled.
- Bolts, nuts and washers should be replaced with new parts as required.
- Be sure to tighten the fasteners including bolts and nuts to the specified torque.

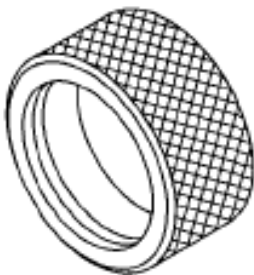
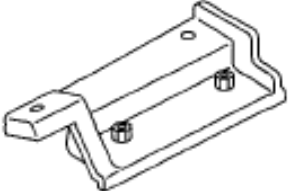
PREPARATION TOOL

SPECIAL TOOL

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST0920287002000	0920287002000	REMOVER AND REPLACER	Used for removing and installing valve spring.
	398437700	OIL SEAL INSTALLER	Used for installing the front oil seal of engine.

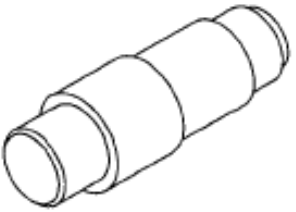
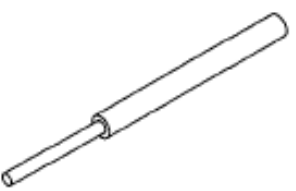
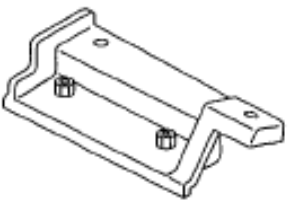
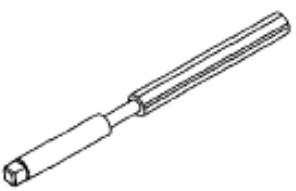
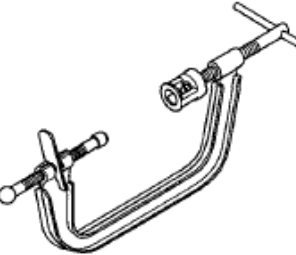
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 ST-398437700			
 ST-498277200	498277200	STOPPER SET	Used for preventing the torque converter from falling when removing and installing the engine.
 ST-498277200	498457000	ENGINE STAND ADAPTER RH	• Used for disassembling and assembling engine. • Used together with ENGINE STAND (499817100) and ADAPTER (18362AA020).
 ST-498457000	498457100	ENGINE STAND ADAPTER LH	• Used for disassembling and assembling engine. • Used together with ENGINE STAND (499817100) and ADAPTER (18362AA020).

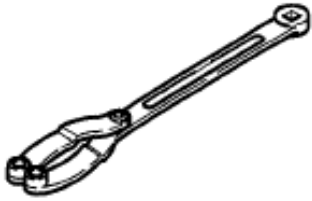
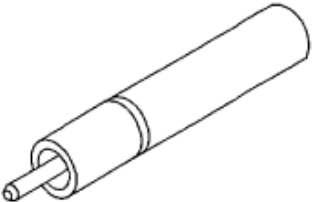
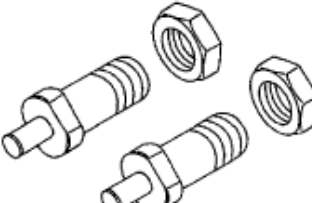
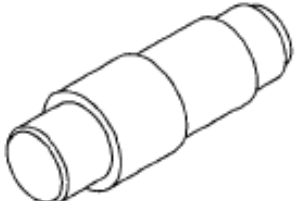
2013 Subaru Legacy

2013 ENGINE Engine Mechanical (H4DO) - Legacy/Outback

 ST18350AA000	499765700	VALVE GUIDE REMOVER AND INSTALLER	Used for removing and installing valve guide.
 ST-499765700	499765900	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-498457100	499817100	ENGINE STAND	• Used for disassembling and assembling engine. • Used together with ADAPTER (18362AA020), ENGINE STAND ADAPTER RH (498457000) and LH (498457100).
 ST-499765900	18252AA000	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST0920287002000	18261AA010	VALVE OIL SEAL GUIDE	Used for press-fitting of intake valve guide stem seals and exhaust valve guide stem seals.

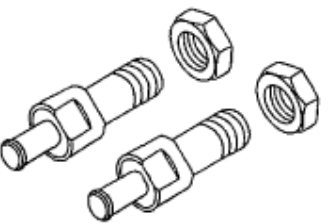
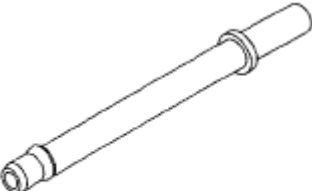
2013 Subaru Legacy

2013 ENGINE Engine Mechanical (H4DO) - Legacy/Outback

 ST18270AA020	18270AA020	SOCKET	Used for removing and installing connecting rod.
 ST18355AA000	18334AA000	PULLEY WRENCH PIN SET	• Used for removing and installing the crank pulley. • Used together with PULLEY WRENCH (18355AA000).
 ST18261AA010	18334AA020	PULLEY WRENCH PIN SET	• Used for removing and installing exhaust cam sprocket. • Used together with PULLEY WRENCH (18355AA000).
 ST18334AA020	18334AA030	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 the connecting rod bushing at connecting rod small end.
			• Used for installing and removing the water pump

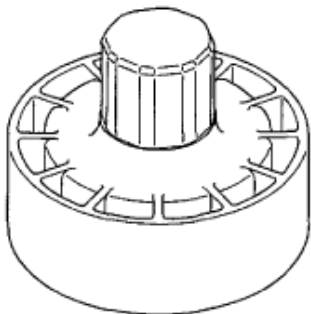
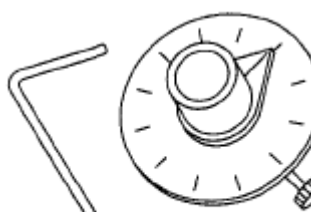
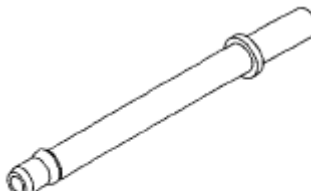
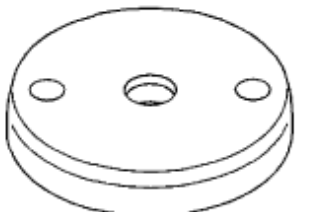
2013 Subaru Legacy

2013 ENGINE Engine Mechanical (H4DO) - Legacy/Outback

 ST18355AA000	18355AA000	PULLEY WRENCH	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 (18334AA000), PULLEY WRENCH PIN SET (18334AA020) or PULLEY WRENCH PIN SET (18334AA030).
 ST18334AA030	18362AA020	ADAPTER	• Used for disassembling and assembling engine. • Used together with STAND (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.
 ST18362AA020	18657AA030	OIL SEAL INSTALLER	• Used for installing the rear oil seal of engine. • Used together with OIL SEAL GUIDE (18671AA020).
	18671AA020	OIL SEAL GUIDE	• Used for installing the rear oil seal of engine.

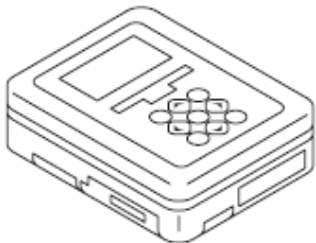
2013 Subaru Legacy

2013 ENGINE Engine Mechanical (H4DO) - Legacy/Outback

 ST18657AA030			Used together with OIL SEAL INSTALLER (18657AA030).
 ST18854AA000	18854AA000	ANGLE GAUGE	Used for angle tightening.
 ST42099AE000	42099AE000	QUICK CONNECTOR RELEASE	Used for removing the quick connector.
 ST18471AA000	42075AG690	FUEL HOSE	Used for inspecting the fuel pressure. NOTE: This is the SUBARU genuine part.
 ST18671AA020	18270KA010	SOCKET	Used for installing and removing intake cam sprocket and exhaust cam sprocket.

2013 Subaru Legacy

2013 ENGINE Engine Mechanical (H4DO) - Legacy/Outback

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

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
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.
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.

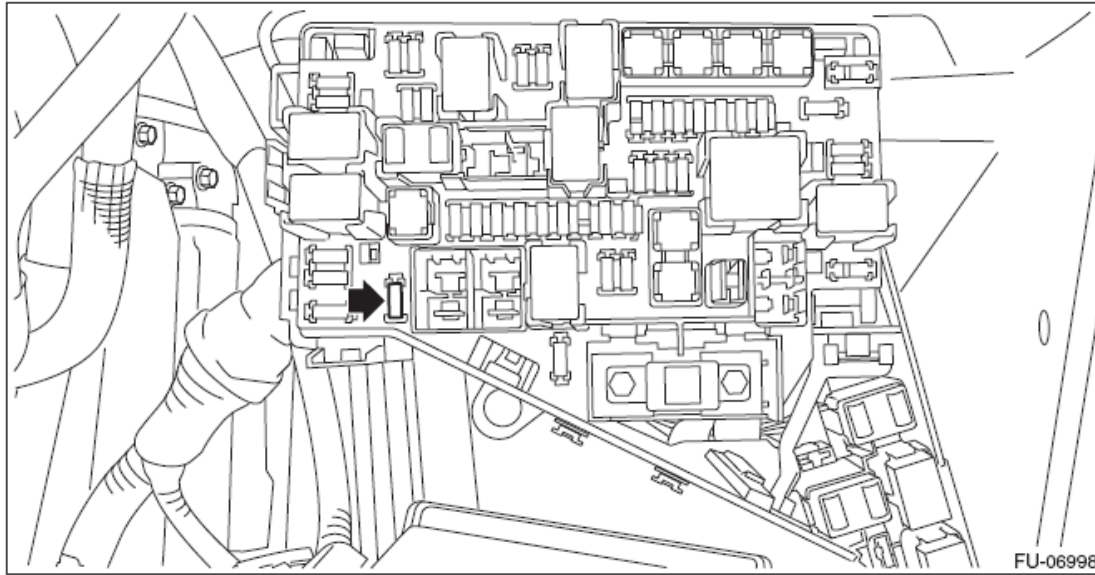


Fig. 11: Locating Main Fuse Box Fuse
Courtesy of SUBARU OF AMERICA, INC.

5. Start the engine and run it until it stalls.
6. After the engine stalls, crank it for five more seconds.
7. Turn the ignition switch to OFF.
8. Remove all spark plugs. Refer to **REMOVAL** .
9. Connect the battery ground terminal.

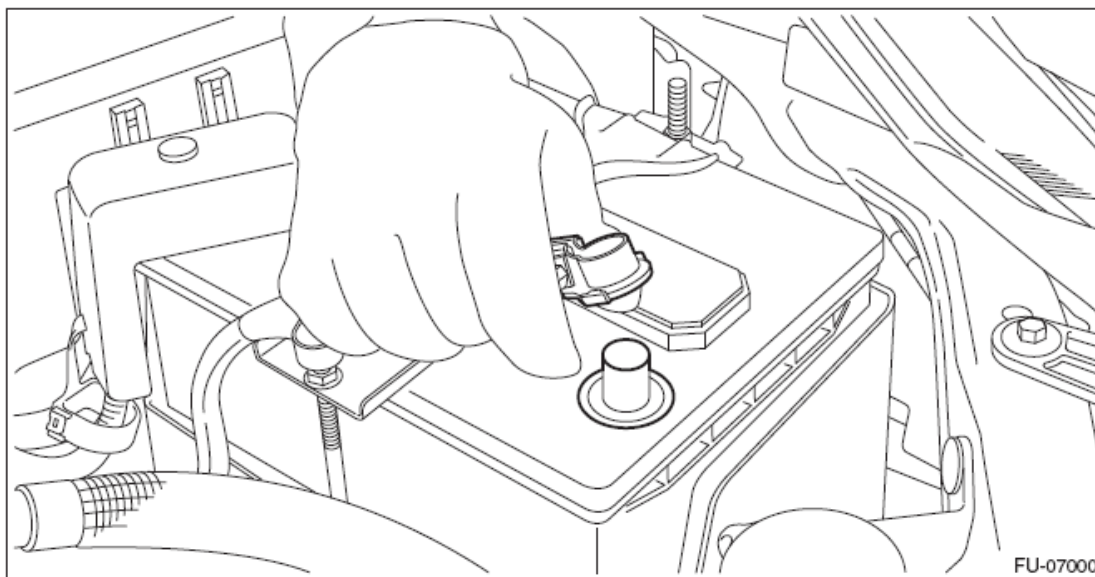


Fig. 12: Connecting/Disconnecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

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.

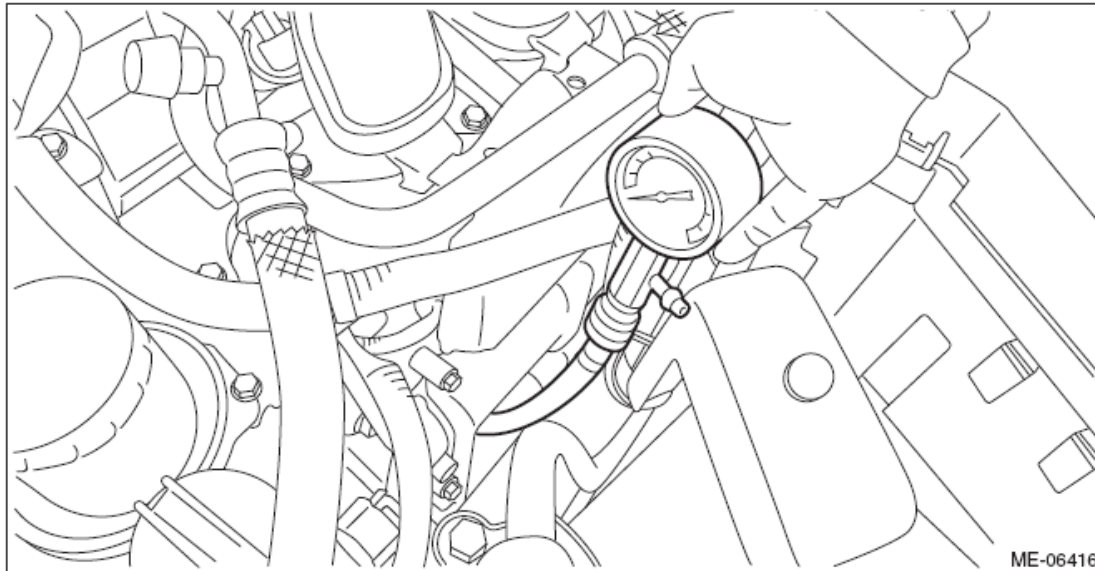


Fig. 13: Installing Compression Gauge To Spark Plug Hole
Courtesy of SUBARU OF AMERICA, INC.

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 **DISPLAY OF ENGINE FREEZE FRAME DATA**.

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 in **BASIC DIAGNOSTIC PROCEDURE**

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

Idle speed (No load, and for CVT model, select lever in "P" or "N" range, for MT model, gear shift lever in neutral position.):

Standard

675±100 rpm (CVT 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.)

Idle speed (A/C on, and for CVT model, select lever in "P" or "N" range, for MT model, gear shift lever in neutral position.):

Standard

700±100 rpm (CVT model)

800 - 850±100 rpm (MT model)

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 **DISPLAY OF ENGINE FREEZE FRAME DATA**.

NOTE: If ignition timing is out of standard, check the ignition control system. Refer to **BASIC DIAGNOSTIC PROCEDURE**.

Ignition timing [BTDC/rpm]:

Standard

16°±10°/675 (CVT 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.

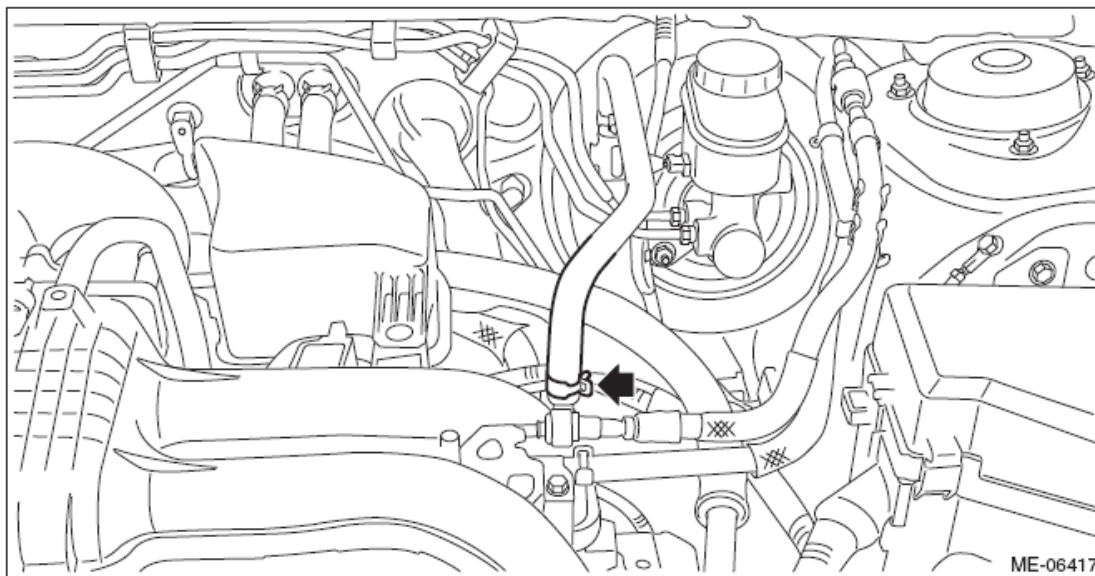


Fig. 14: Locating Brake Booster Vacuum Hose Clip
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the vacuum gauge to the intake manifold.

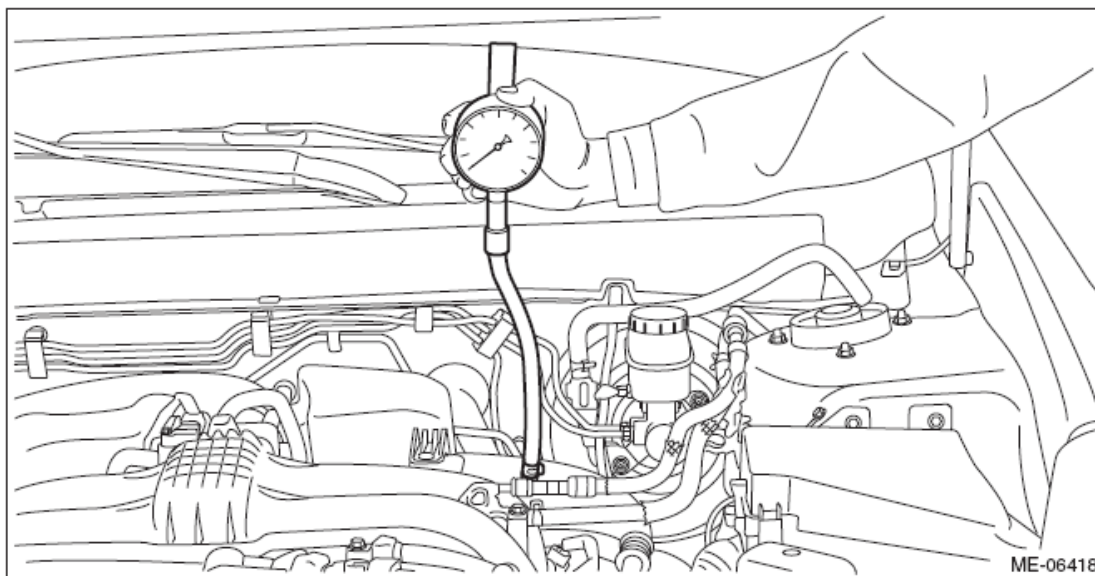


Fig. 15: Connecting Vacuum Gauge To Intake Manifold
Courtesy of SUBARU OF AMERICA, INC.

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

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, disconnection or damage of 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

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

ENGINE OIL PRESSURE

INSPECTION

- Disconnect the ground cable from battery.

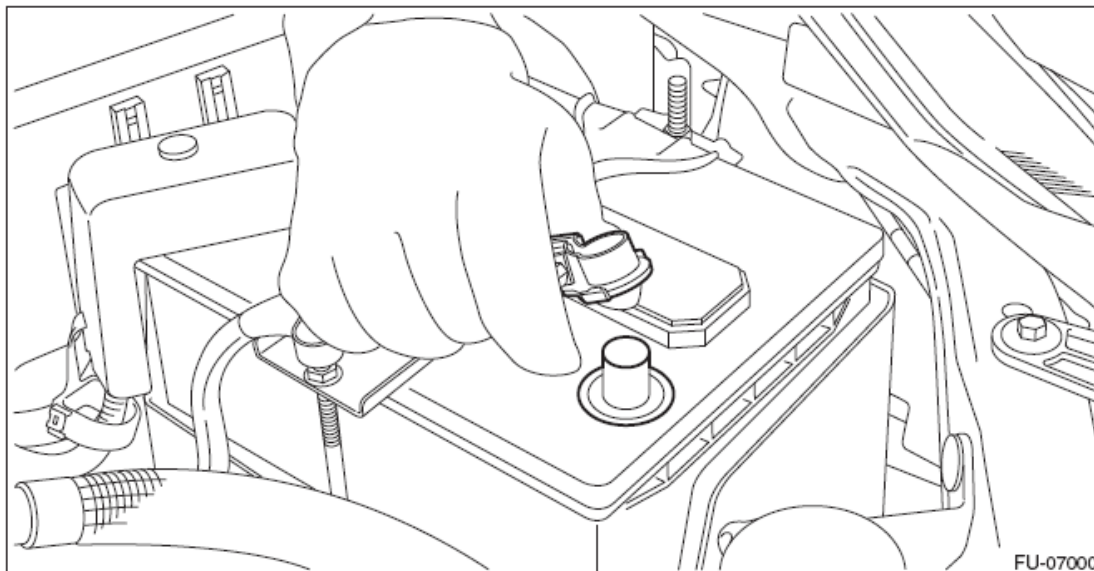


Fig. 16: Connecting/Disconnecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the oil pressure switch. Refer to **REMOVAL** .
3. Install the oil pressure gauge to the chain cover.

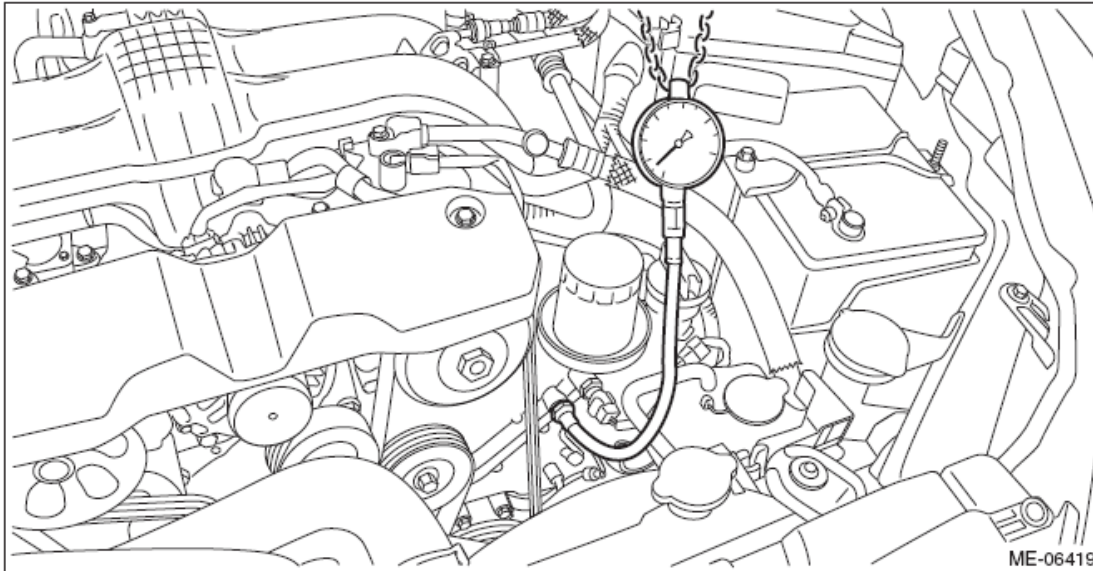


Fig. 17: Installing Oil Pressure Gauge To Chain Cover
Courtesy of SUBARU OF AMERICA, INC.

4. Connect the battery ground terminal.

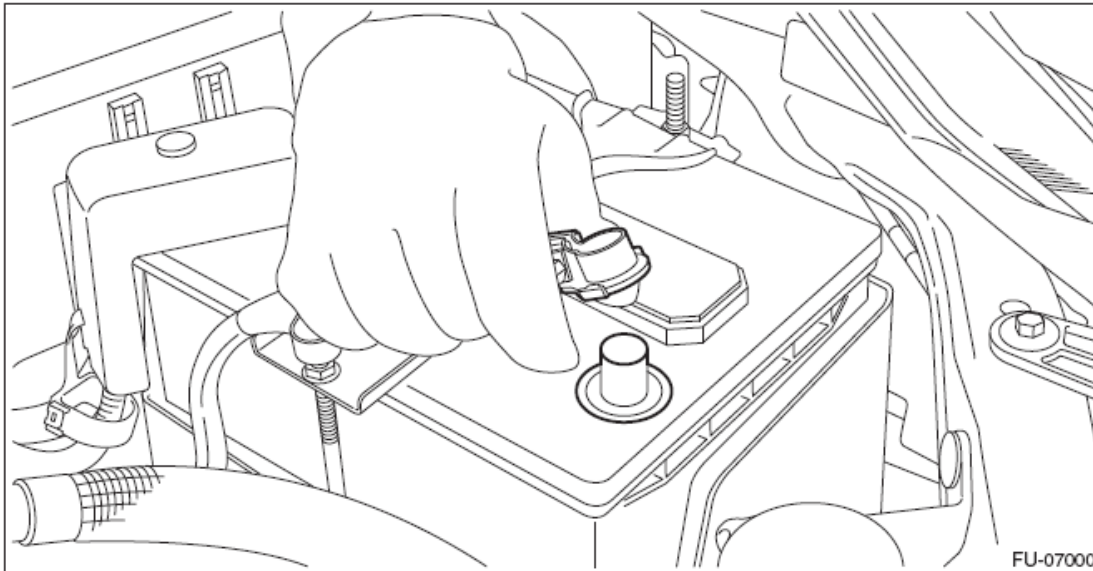


Fig. 18: Connecting/Disconnecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

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 .
- If the oil pressure warning light is ON and oil pressure is within standard, check the oil pressure switch. Refer to INSPECTION .

*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 .
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

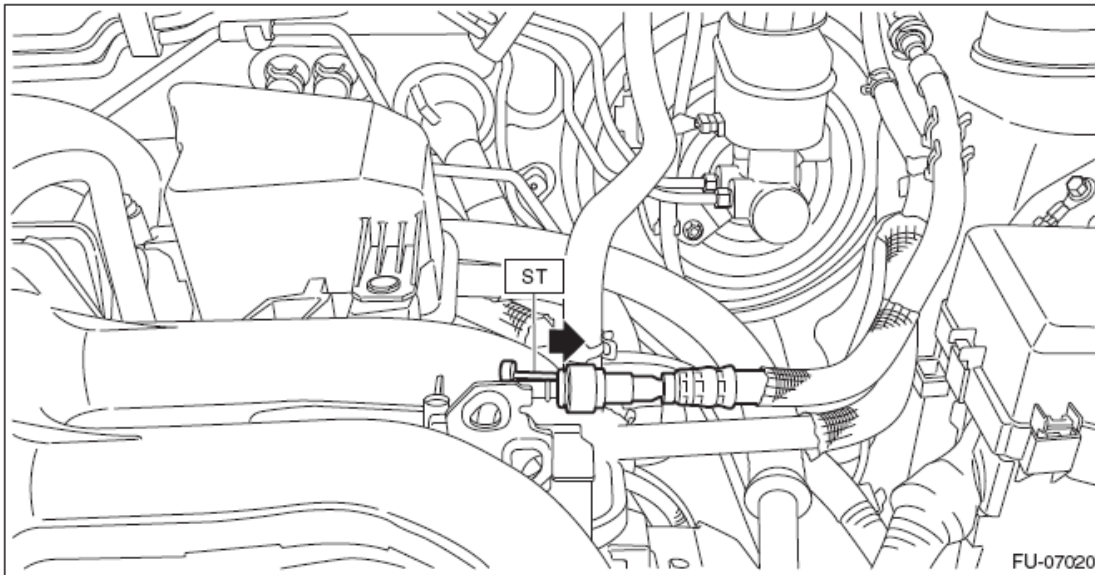


Fig. 19: Disconnecting Fuel Delivery Hose Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

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

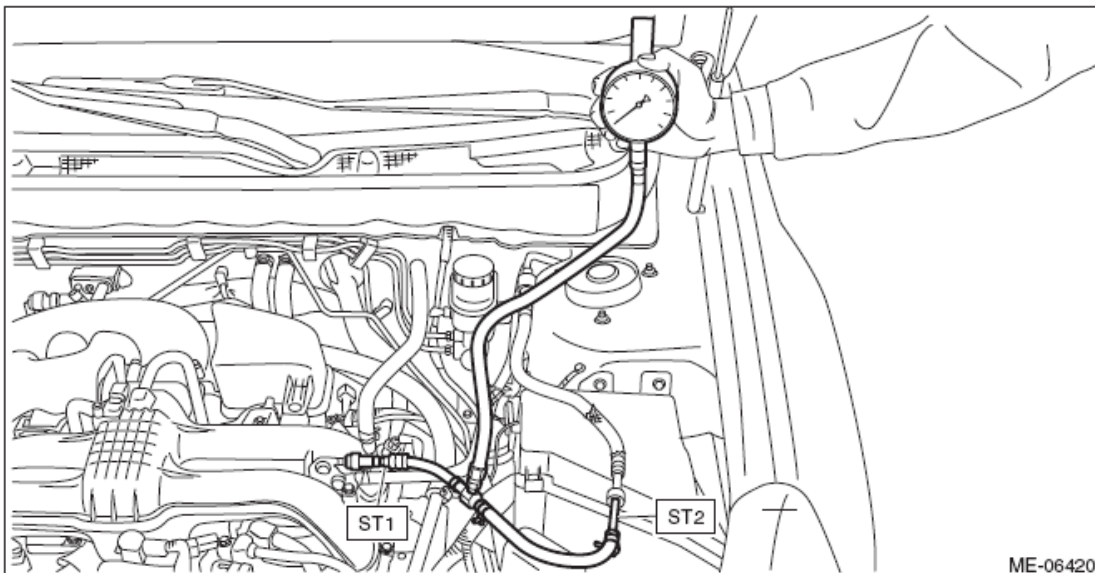


Fig. 20: Connecting Fuel Pressure Gauge Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

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 spilt 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.

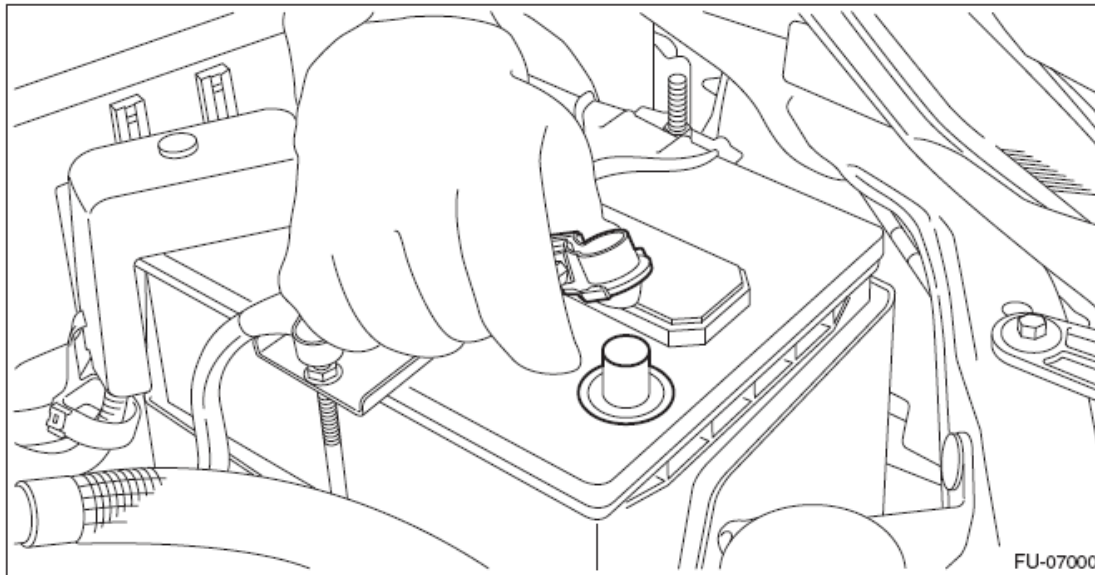


Fig. 21: Connecting/Disconnecting Battery Ground Terminal
 Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake duct. Refer to **REMOVAL**.
3. When inspecting #1 and #3 cylinders
 1. Remove the rocker cover RH. Refer to **ROCKER COVER RH**.

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.

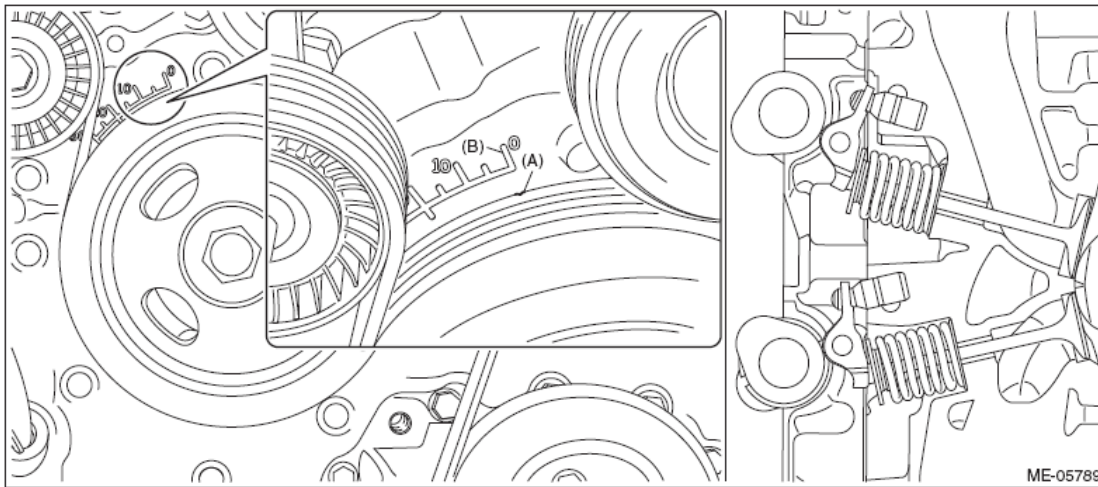


Fig. 22: Identifying Crank Pulley Timing Mark And Chain Cover Timing Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

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

Exhaust

Standard

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

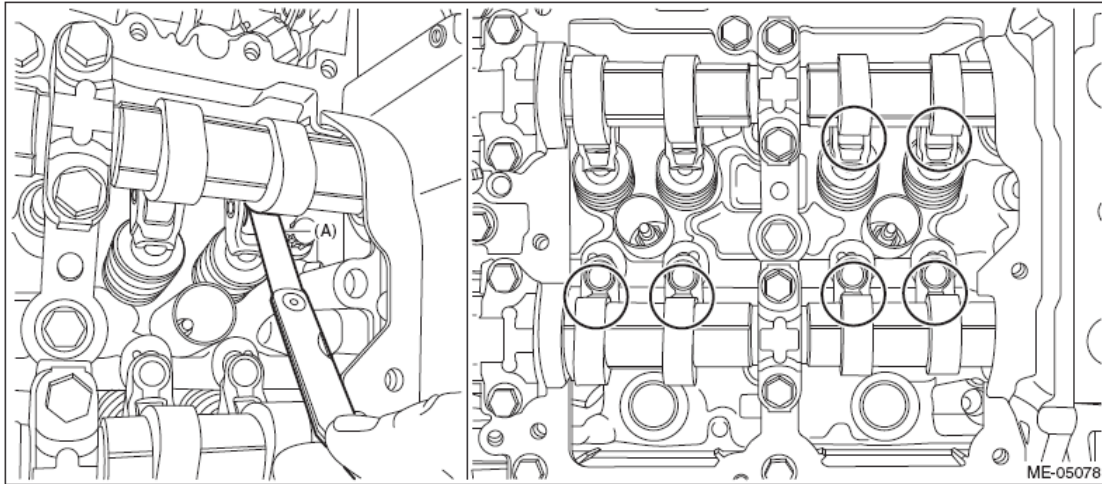


Fig. 23: Checking Cam Clearance For No. 1 Cylinder Intake, No. 1 And No. 3 Cylinder Exhaust

Courtesy of SUBARU OF AMERICA, INC.

4. Turn the crank pulley by 360°.

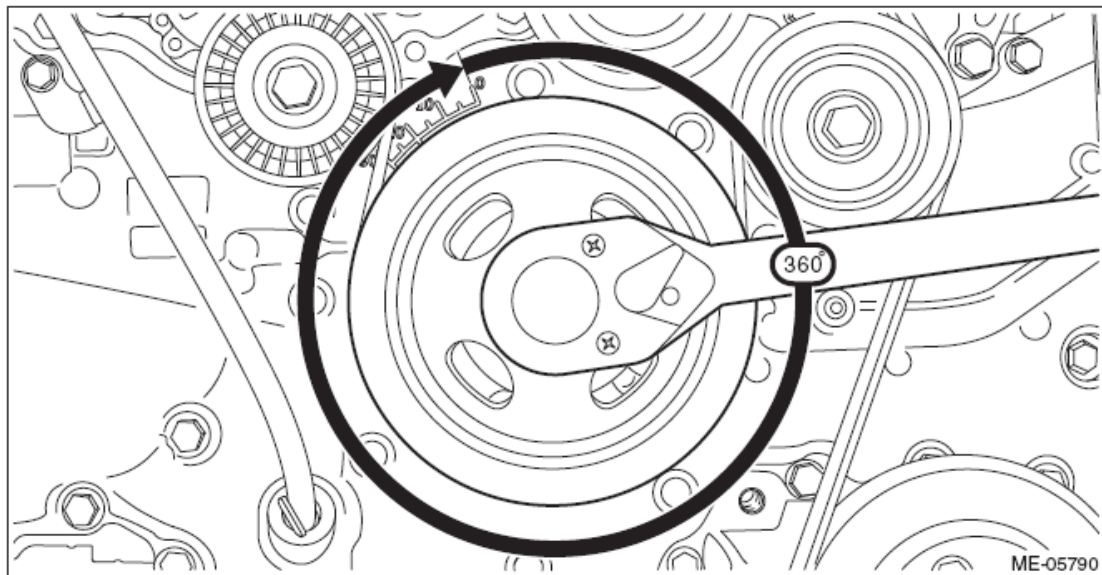


Fig. 24: Turning Crank Pulley

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)

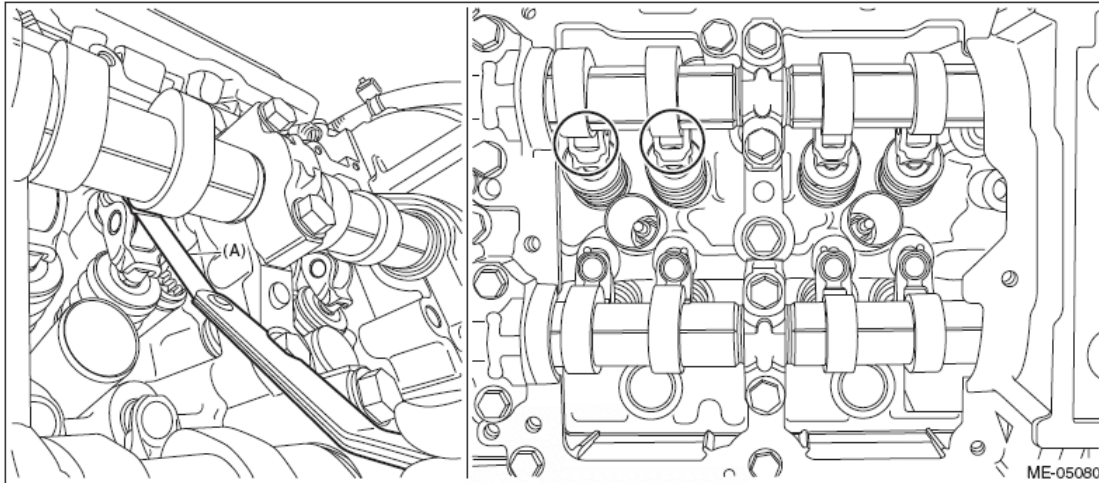


Fig. 25: Checking Clearance Of No. 3 Cylinder Intake
Courtesy of SUBARU OF AMERICA, INC.

4. When inspecting #2 and #4 cylinders

1. Remove the rocker cover LH. Refer to **ROCKER COVER LH.**

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.

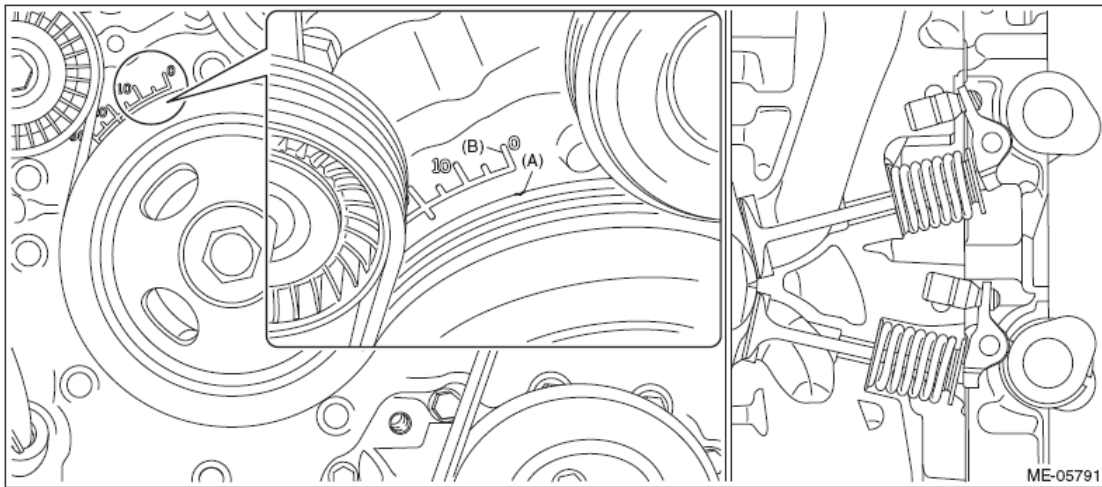


Fig. 26: Identifying Crank Pulley Timing Mark And Chain Cover Timing Gauge
Courtesy of SUBARU OF AMERICA, INC.

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

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

Exhaust

Standard

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

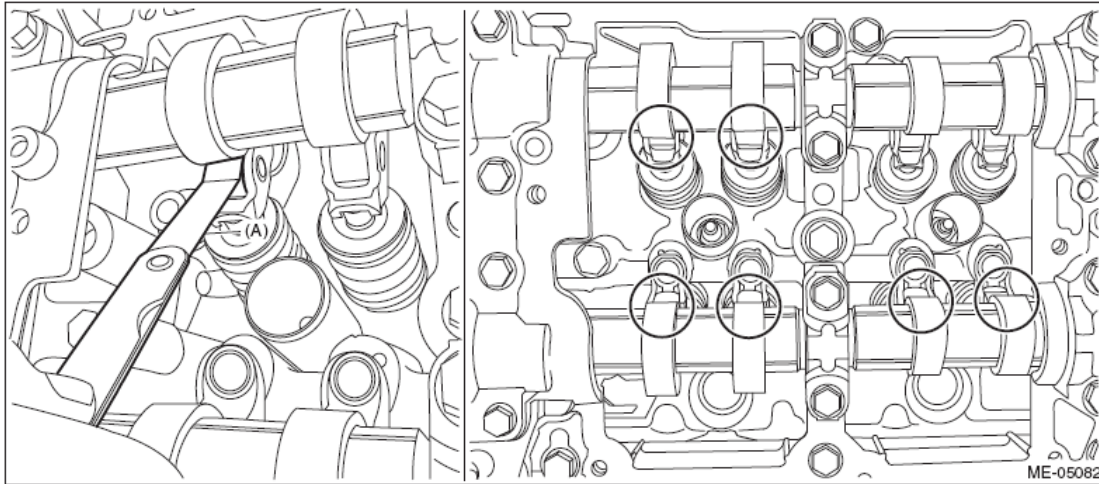


Fig. 27: Checking Cam Clearance For No. 2 Cylinder Intake, No. 2 And No. 4 Cylinder Exhaust

Courtesy of SUBARU OF AMERICA, INC.

4. Turn the crank pulley by 360°.

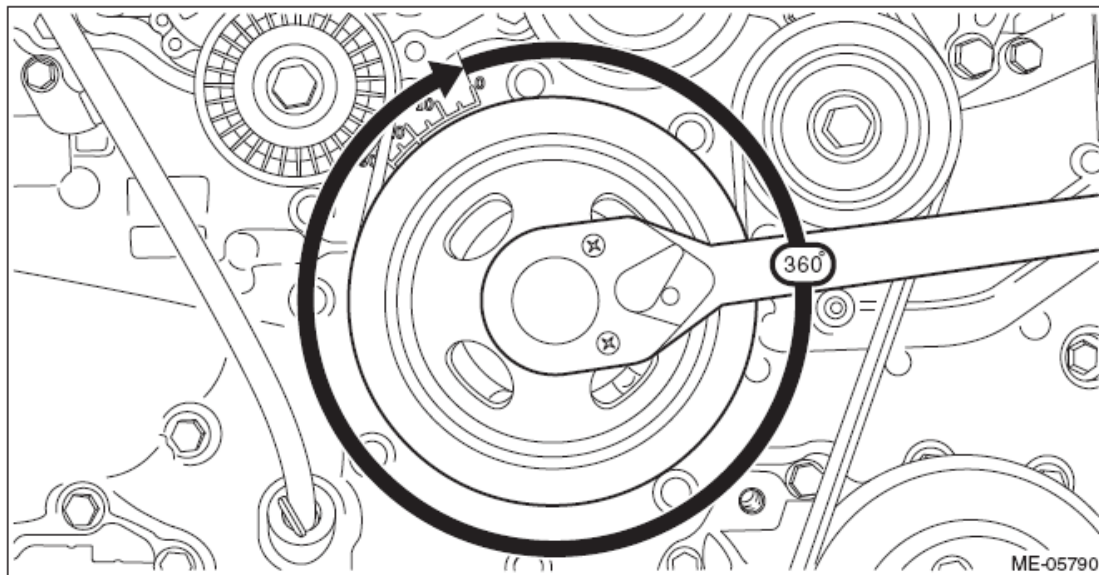


Fig. 28: Turning Crank Pulley

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.

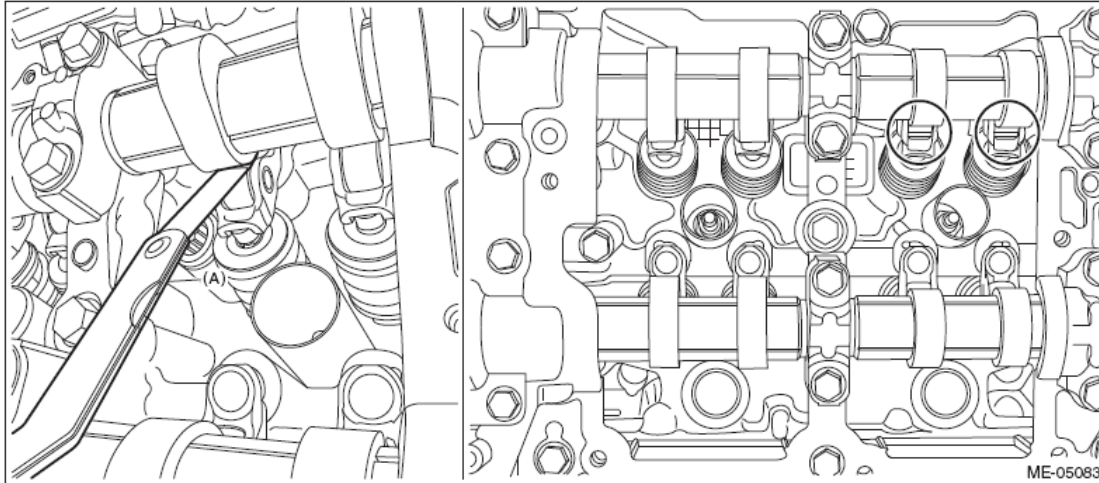
Cam clearance:**Standard** **0.13 ± 0.03 mm (0.0051 ± 0.0012 in)**

Fig. 29: Checking Clearance Of No. 4 Cylinder Intake
Courtesy of SUBARU OF AMERICA, INC.

5. If necessary, adjust the cam clearance. Refer to **ADJUSTMENT**.
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**.

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*

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

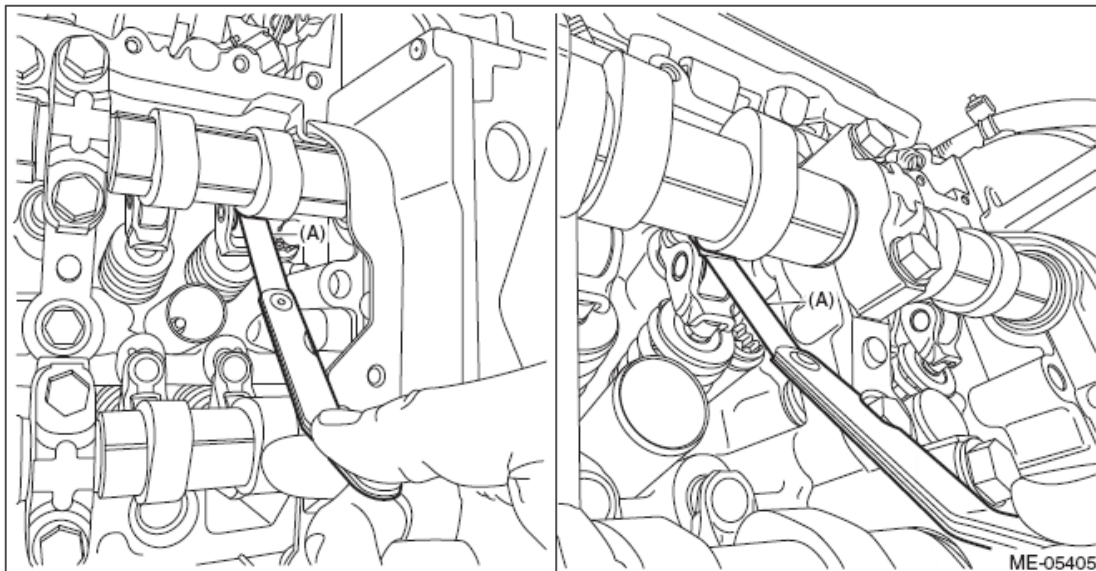


Fig. 30: Checking Clearance Of No. 1 And No. 3 Cylinder Cam
Courtesy of SUBARU OF AMERICA, INC.

2. When inspecting #2 and #4 cylinders
 1. Remove the rocker cover LH. Refer to **ROCKER COVER LH.**

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±0.03 mm (0.0051±0.0012 in)

Exhaust

Standard

0.24±0.03 mm (0.0094±0.0012 in)

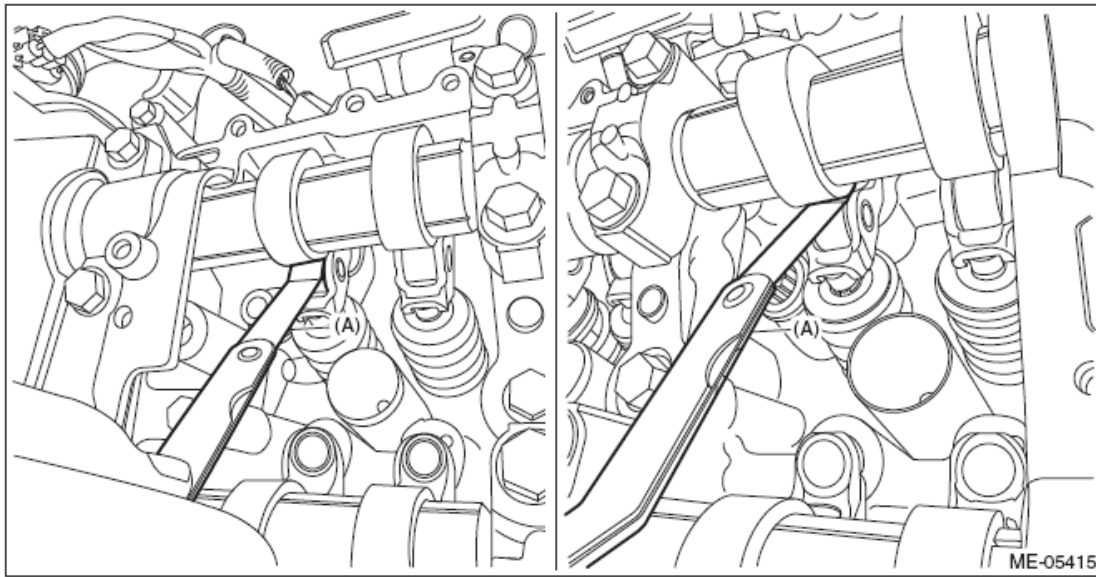


Fig. 31: Checking Clearance Of No. 2 And No. 4 Cylinder Cam
Courtesy of SUBARU OF AMERICA, INC.

3. If necessary, adjust the cam clearance. Refer to **ADJUSTMENT**.
4. After inspection, install the related parts in the reverse order of removal.

ADJUSTMENT

1. Remove the engine from the vehicle. Refer to **REMOVAL**.
2. Remove the chain cover. Refer to **REMOVAL**.
3. When adjusting #1 and #3 cylinders
 1. Remove the timing chain RH. Refer to **TIMING CHAIN RH**.
 2. Remove the cam carrier RH. Refer to **CAM CARRIER RH**.
 3. Measure the thickness of valve shim using micrometer.

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

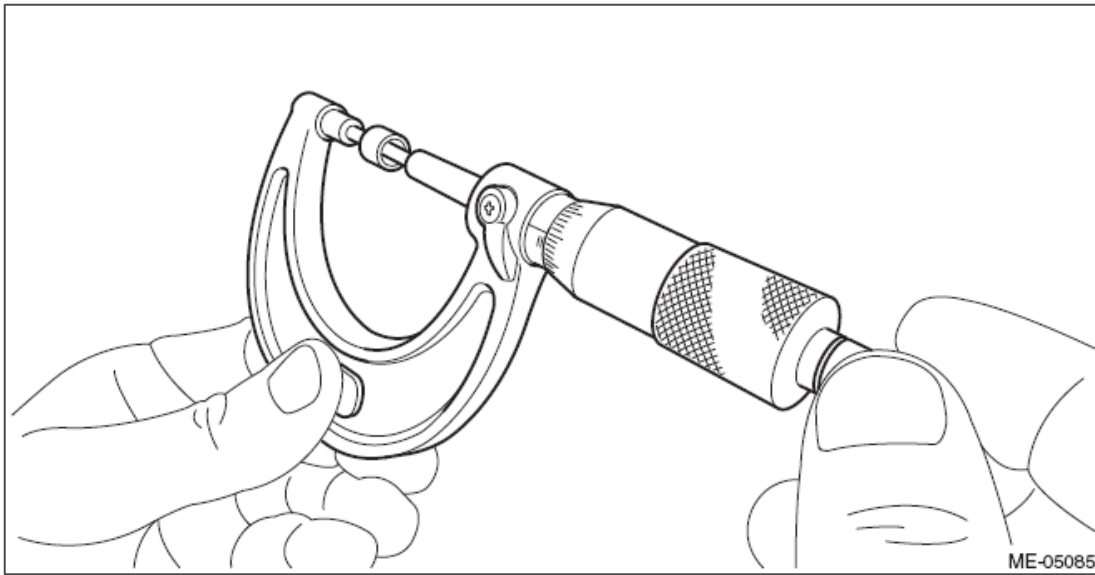


Fig. 32: Measuring Thickness Of Valve Shim Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use a new valve shim.

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: Current valve shim thickness

5. Install the cam carrier RH. Refer to **CAM CARRIER RH**.
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 **WHEN TIMING CHAIN ASSEMBLY IS REMOVED** for the cam clearance inspection.

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.**
 2. Remove the cam carrier LH. Refer to **CAM CARRIER LH.**
 3. Measure the thickness of valve shim using micrometer.

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

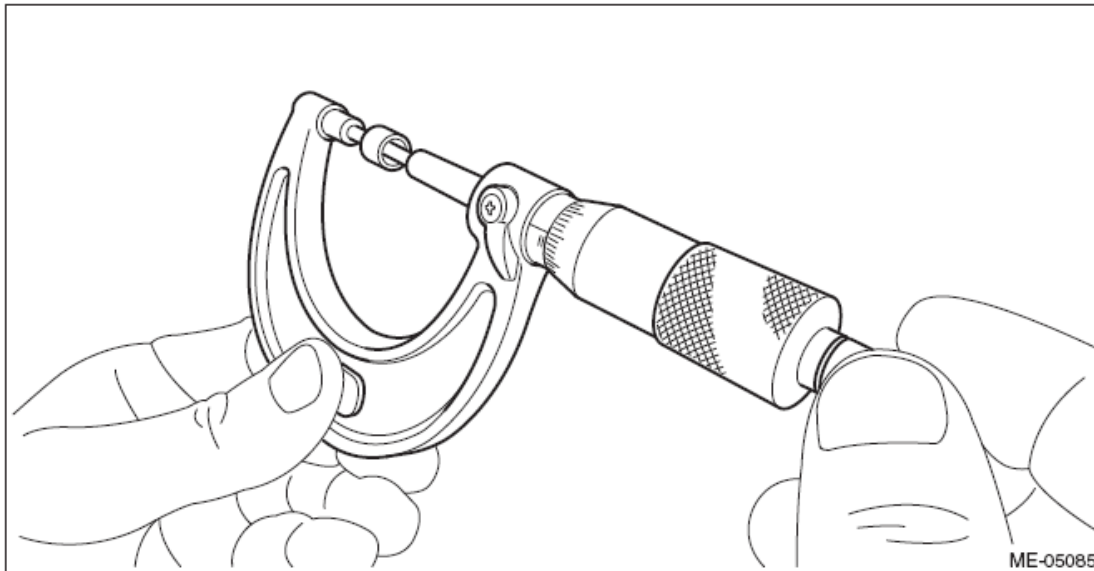


Fig. 33: Measuring Thickness Of Valve Shim Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: **Use a new valve shim.**

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: Current valve shim thickness

5. Install the cam carrier LH. Refer to **CAM CARRIER LH**.
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 **WHEN TIMING CHAIN ASSEMBLY IS REMOVED** for the cam clearance inspection.

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 front hood damper mounting position from (A) to (B), and completely open the front hood.

Tightening torque:

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

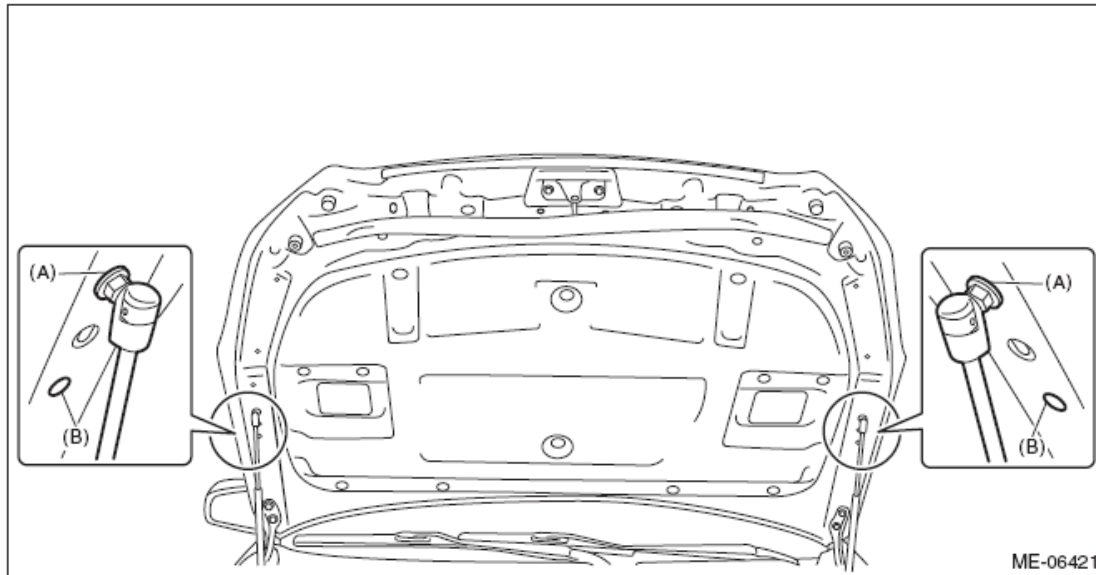


Fig. 34: Identifying Front Hood Damper Mounting Positions
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the V-belt covers.

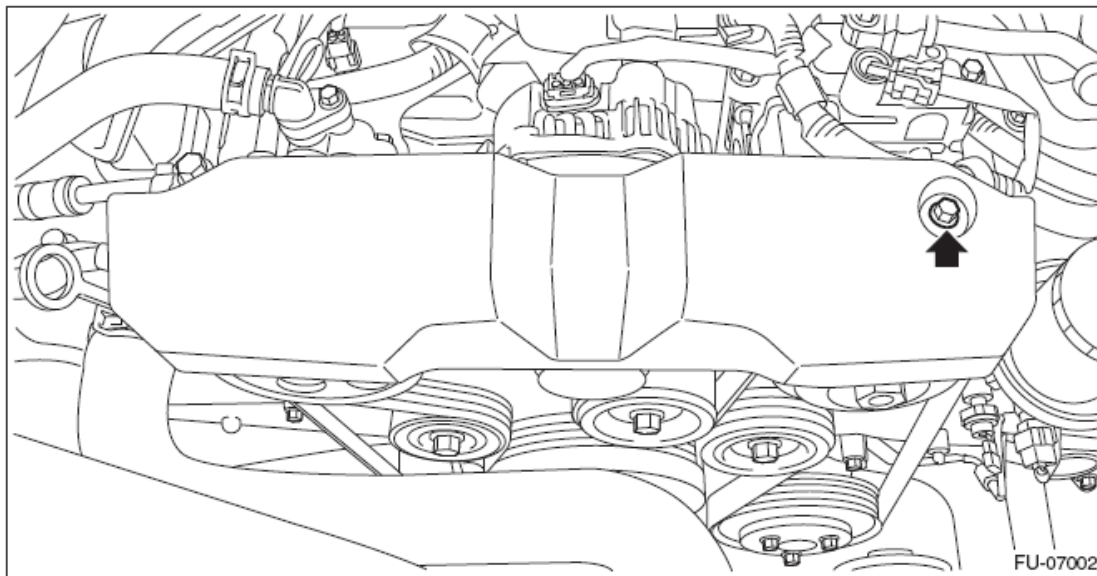


Fig. 35: Locating V-Belt Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Collect the refrigerant from A/C system. Refer to **REFRIGERANT RECOVERY PROCEDURE** .
4. Release the fuel pressure. Refer to **RELEASING OF FUEL PRESSURE** .
5. Disconnect the ground cable from battery.

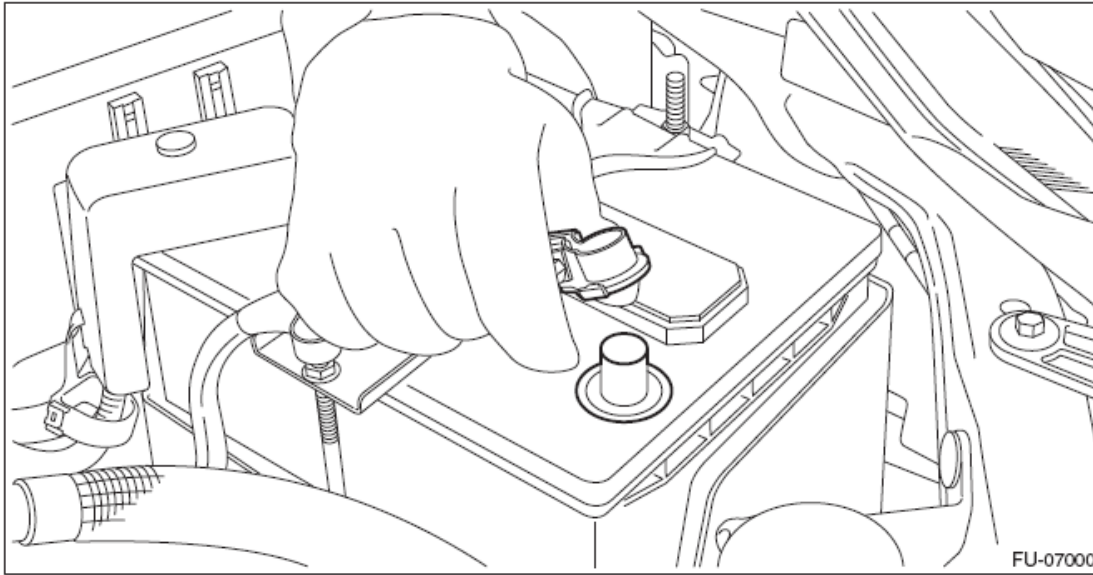


Fig. 36: Connecting/Disconnecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the air intake duct. Refer to **REMOVAL** .
7. Remove the air intake boot. Refer to **REMOVAL** .
8. Disconnect the connector (A) from the mass air flow and intake air temperature sensor, and remove the clip (B) which holds the mass air flow and intake air temperature sensor harness.
9. Remove the suction hose (C) from the air cleaner case (rear).

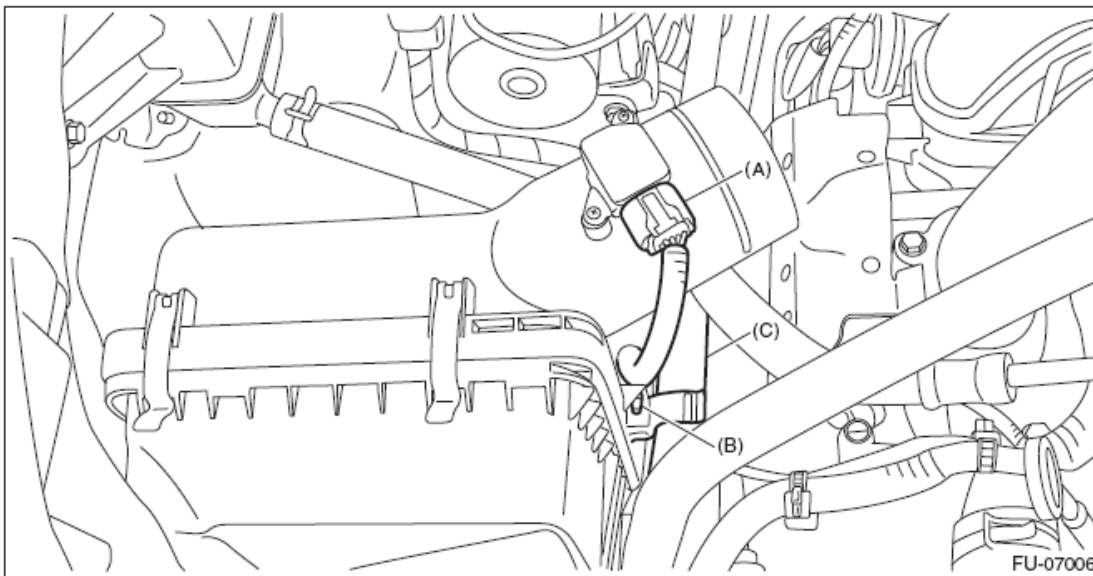


Fig. 37: Identifying Mass Air Flow Connector, Suction Hose And Clip
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the air cleaner case (rear).

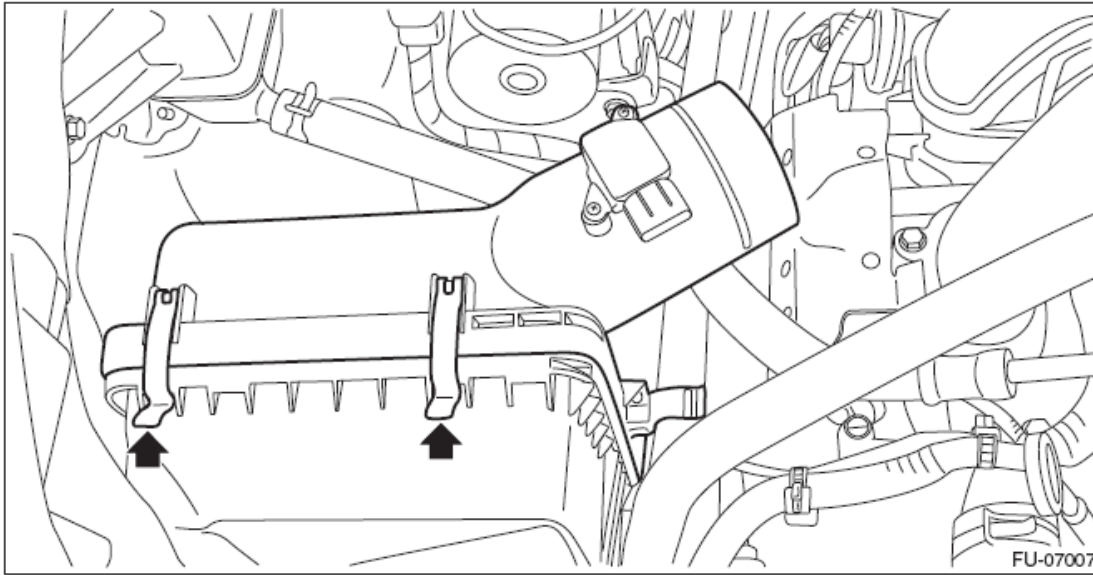


Fig. 38: Locating Rear Air Cleaner Case Mounting Clips
Courtesy of SUBARU OF AMERICA, INC.

11. Remove the radiator. Refer to **REMOVAL**.
12. Disconnect the brake booster vacuum hose from the intake manifold.

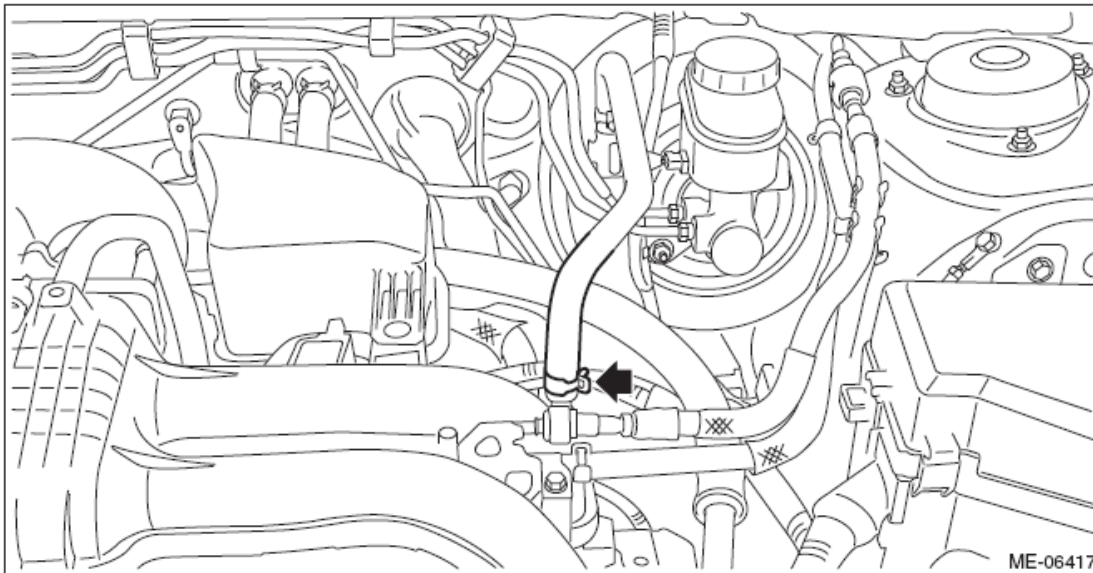


Fig. 39: Locating Brake Booster Vacuum Hose Clip
Courtesy of SUBARU OF AMERICA, INC.

13. Disconnect the engine harness connector.
 1. Remove the bolt securing the bulkhead harness connector bracket.

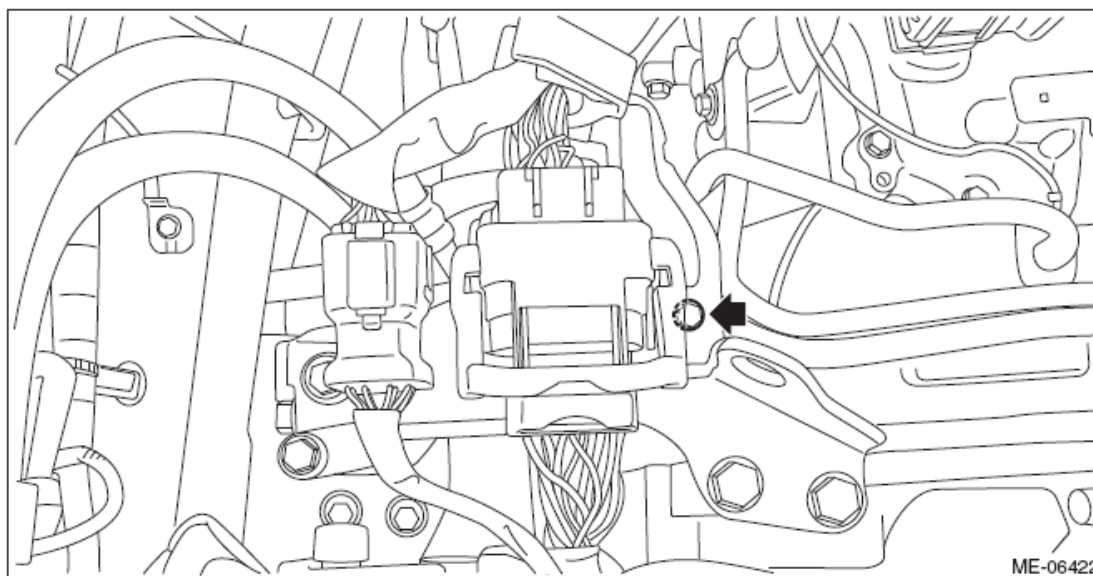


Fig. 40: Locating Bulkhead Harness Connector Bracket Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

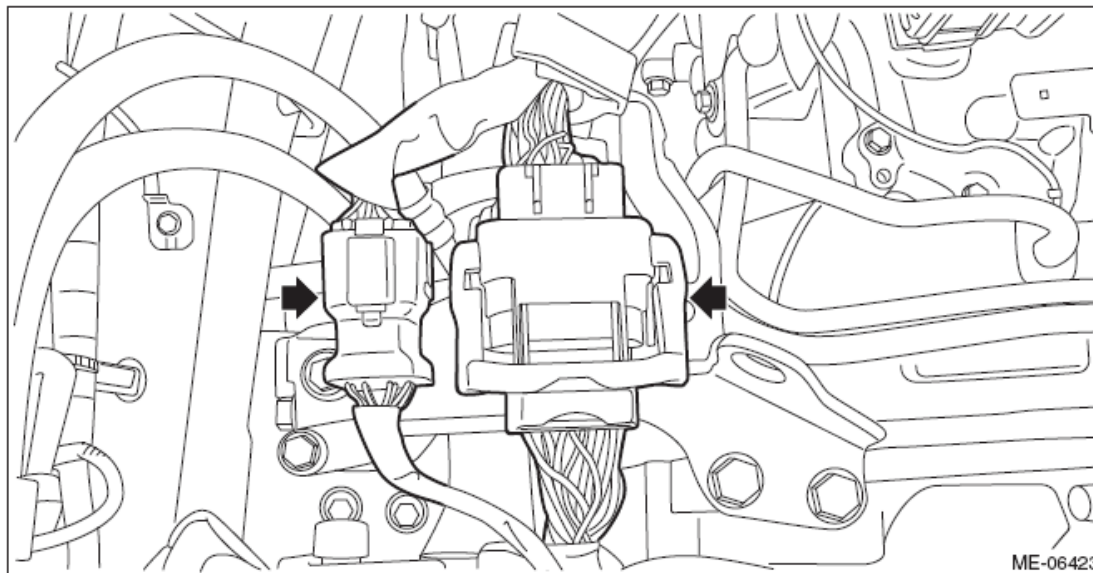


Fig. 41: Locating Bulkhead Harness Connector And Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

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

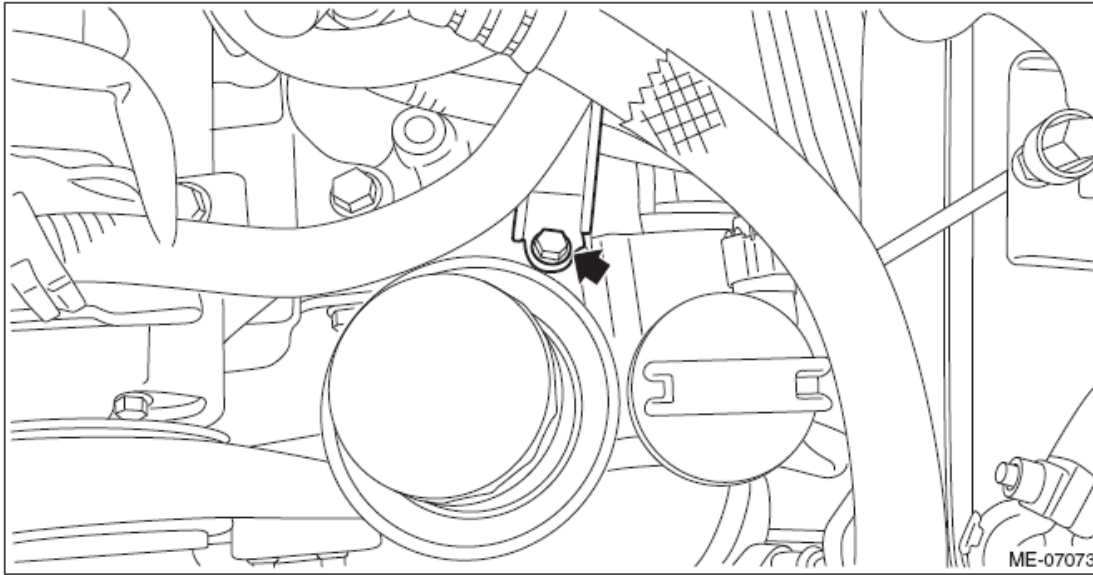


Fig. 42: Locating Generator Cord Stay Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

15. Disconnect the connectors (A) and (B) from the A/C compressor.

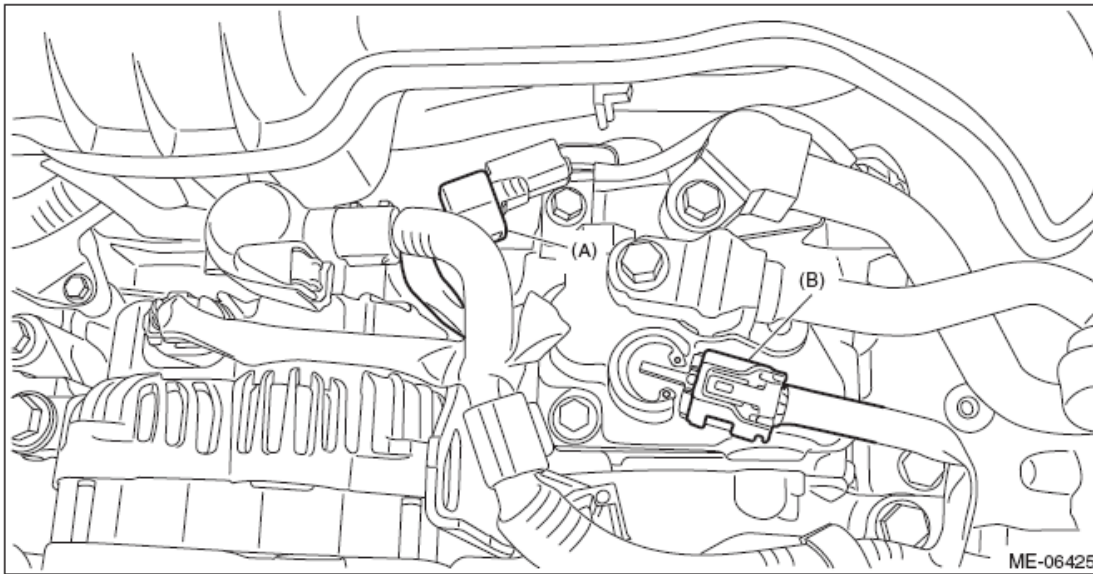


Fig. 43: Identifying A/C Compressor Connectors
Courtesy of SUBARU OF AMERICA, INC.

16. Disconnect the connector (A) and the terminal (B) from the generator, and disconnect the clip (C) which secures to the stay of the A/C compressor.
17. Remove the generator cord from the clip (D) and move the generator cord to the left side wheel apron.

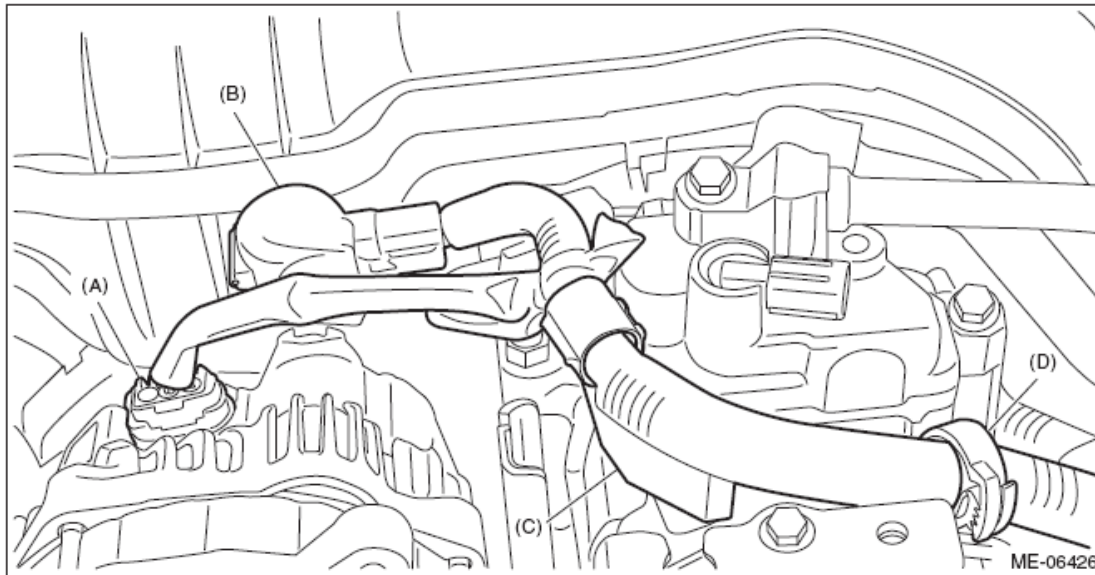


Fig. 44: Identifying A/C Compressor Connector, Terminal And Clips
Courtesy of SUBARU OF AMERICA, INC.

18. Disconnect the following hoses.
 1. A/C pressure hose Refer to **REMOVAL** .
 2. Heater inlet hose and heater outlet hose

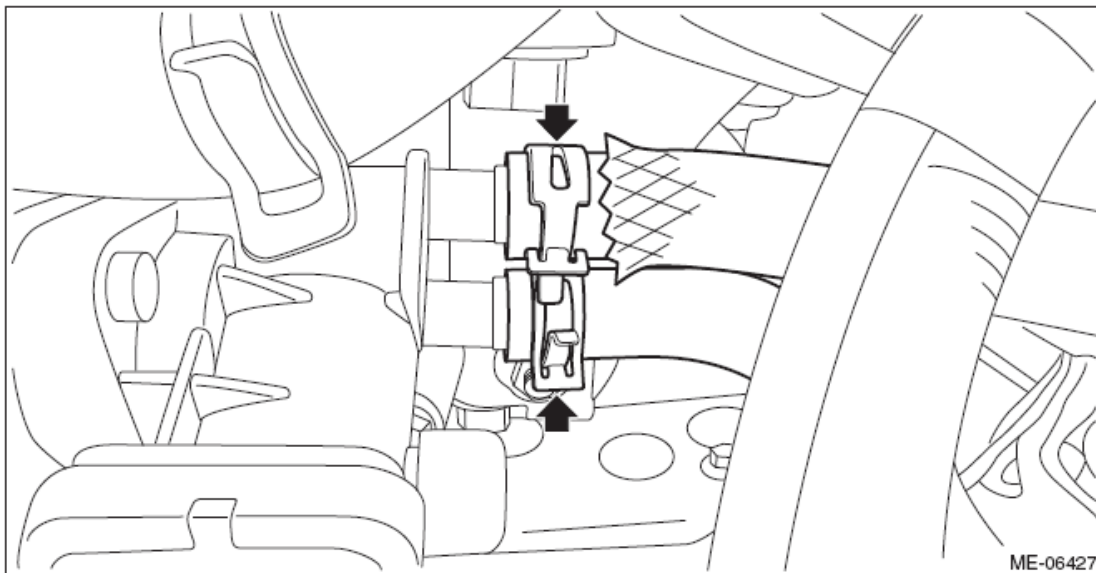


Fig. 45: Locating Heater Inlet And Outlet Hose Clamps
Courtesy of SUBARU OF AMERICA, INC.

19. Remove the V-belts. Refer to **REMOVAL**.
20. Remove the generator. Refer to **REMOVAL** .
21. Remove the power steering pump.

1. Disconnect the connector from power steering pump.

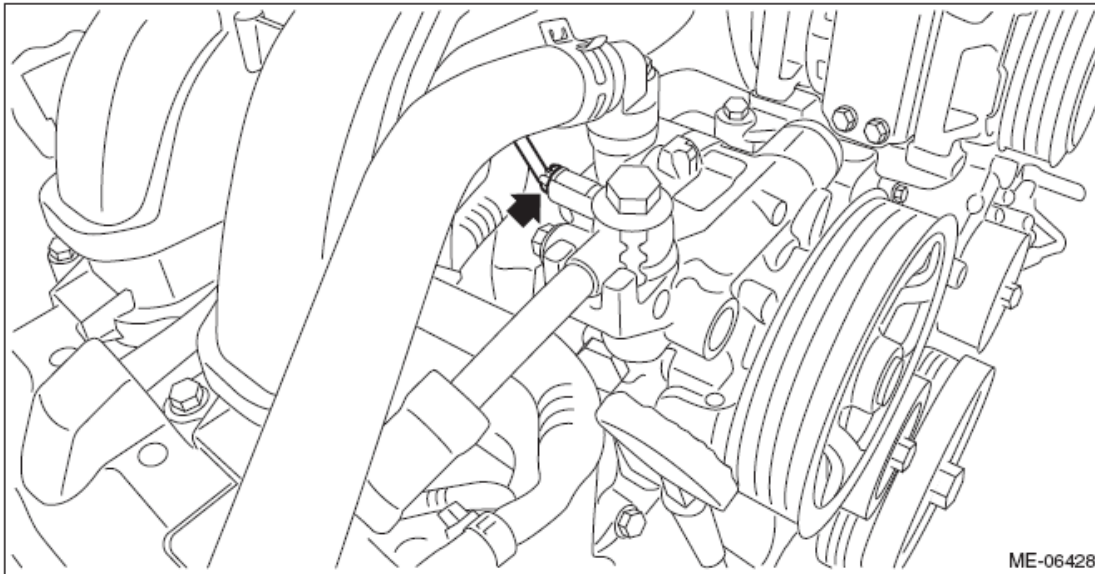


Fig. 46: Locating Power Steering Pump Connector
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the power steering pump together with the power steering pump bracket from the engine.

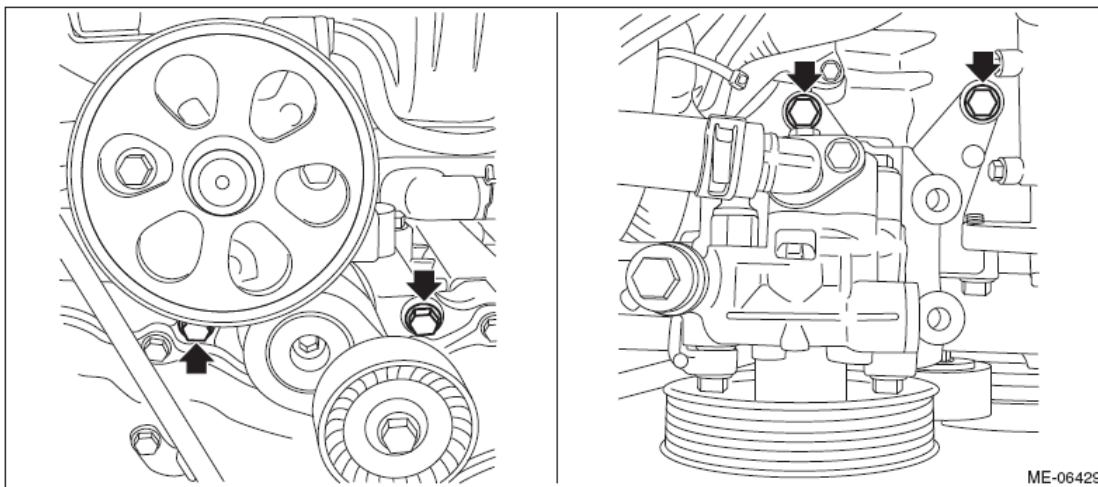


Fig. 47: Locating Power Steering Pump Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Mount the power steering pump together with the power steering pump bracket on RH side wheel apron.
22. Lift up the vehicle.
23. Remove the front exhaust pipe. Refer to **REMOVAL** .
24. Disconnect the ground cable on the engine side.

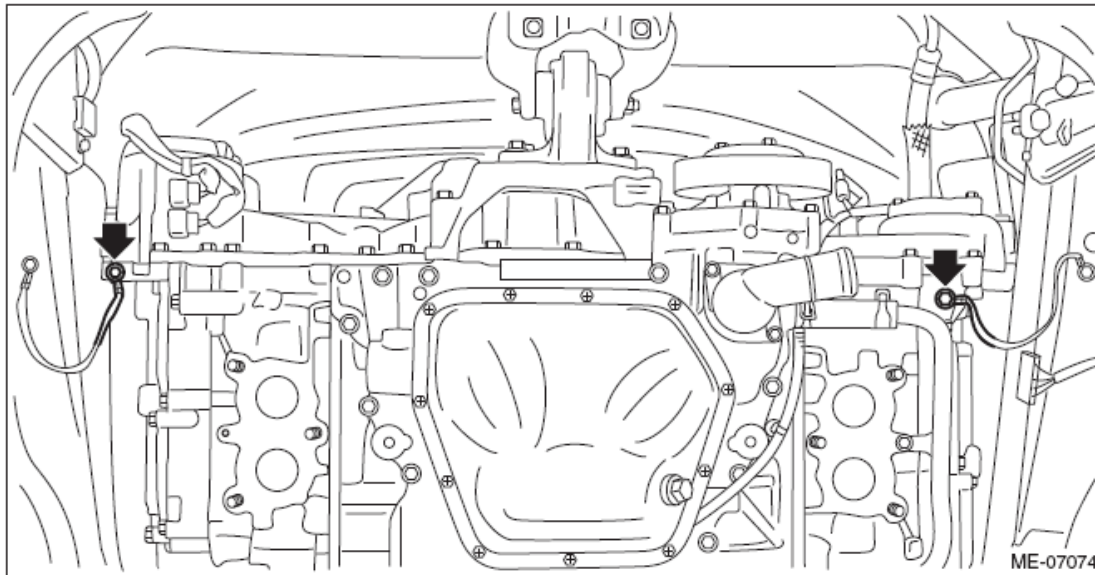


Fig. 48: Locating Engine Side Ground Cables
Courtesy of SUBARU OF AMERICA, INC.

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

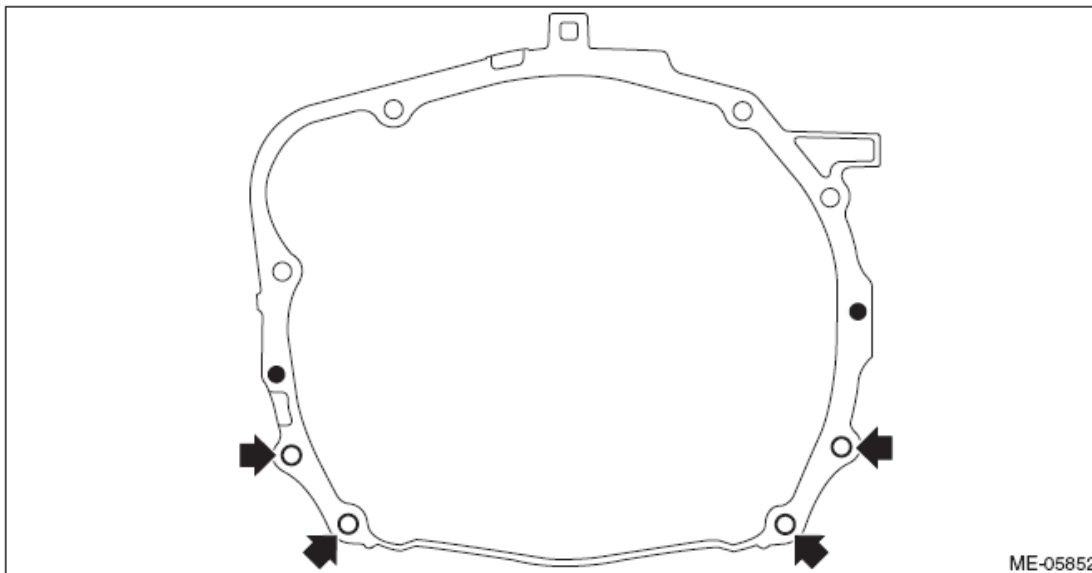


Fig. 49: Locating Transmission To Engine Lower Side Mounting Bolts And Nuts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

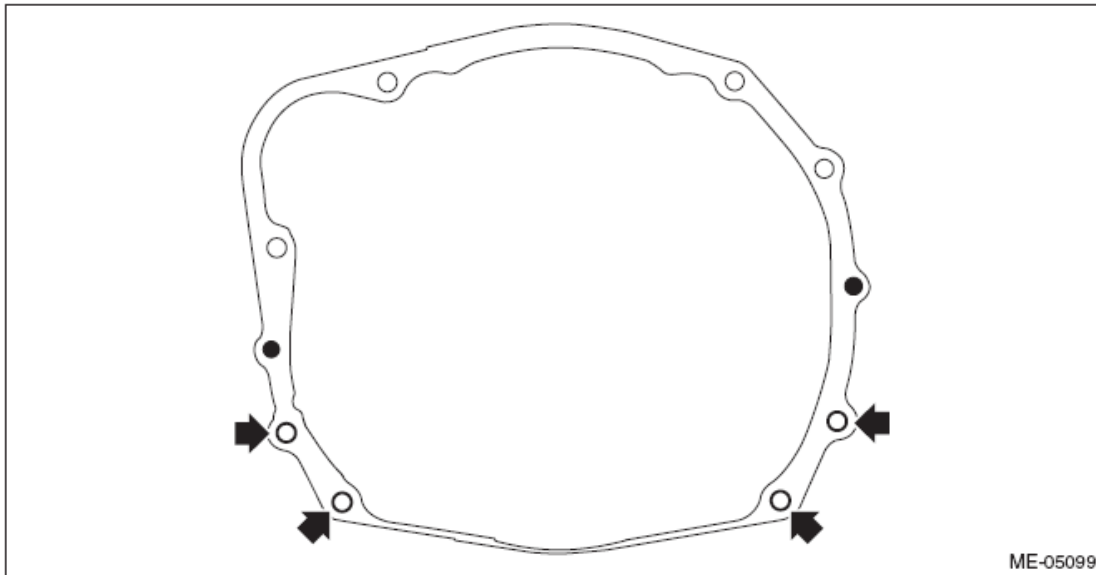


Fig. 50: Locating Transmission To Engine Lower Side Mounting Bolts And Nuts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

26. Remove the starter. Refer to **REMOVAL**.
27. Separate the torque converter clutch from the drive plate. (CVT model)
 1. Remove the service hole plug.
 2. Insert the wrench into the crank pulley bolt and rotate the crank pulley to remove the bolts which hold torque converter clutch to drive plate.

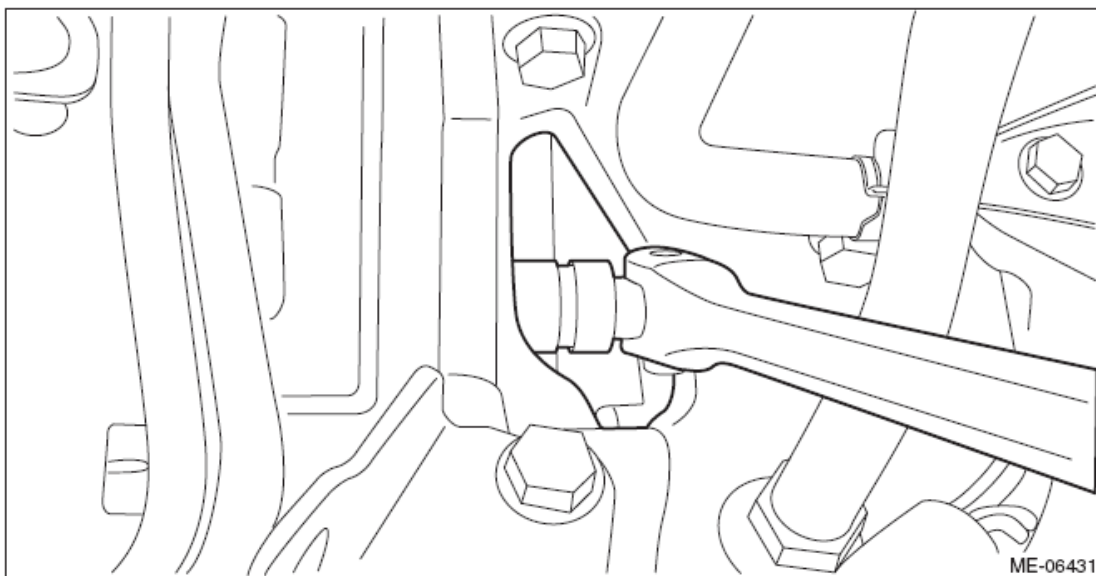


Fig. 51: Separating Torque Converter Clutch From Drive Plate (CVT Model)
Courtesy of SUBARU OF AMERICA, INC.

28. 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

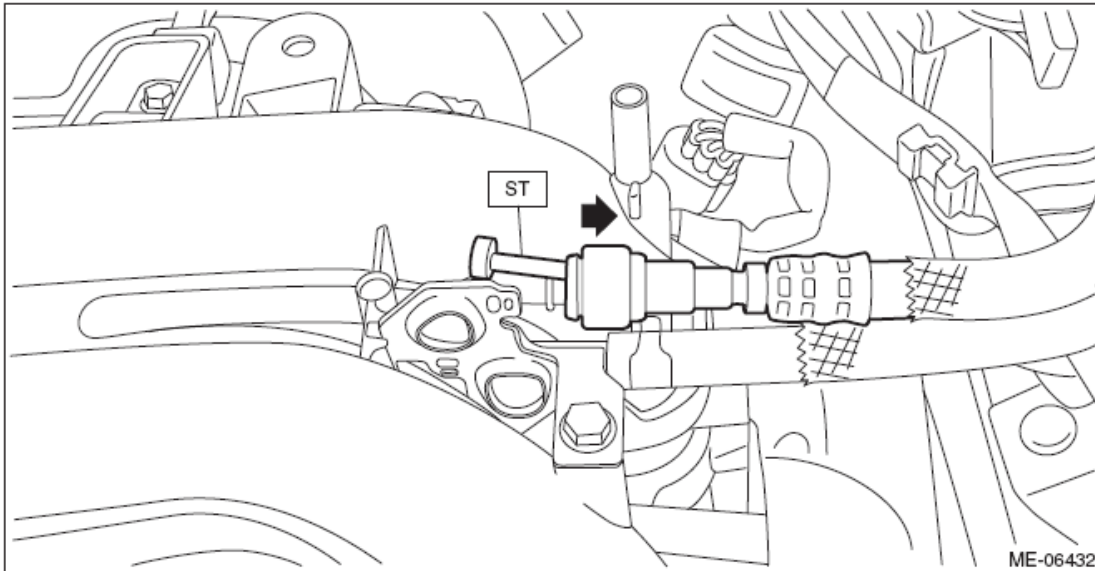


Fig. 52: Disconnecting Fuel Delivery Hose And Evaporation Hose
Courtesy of SUBARU OF AMERICA, INC.

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

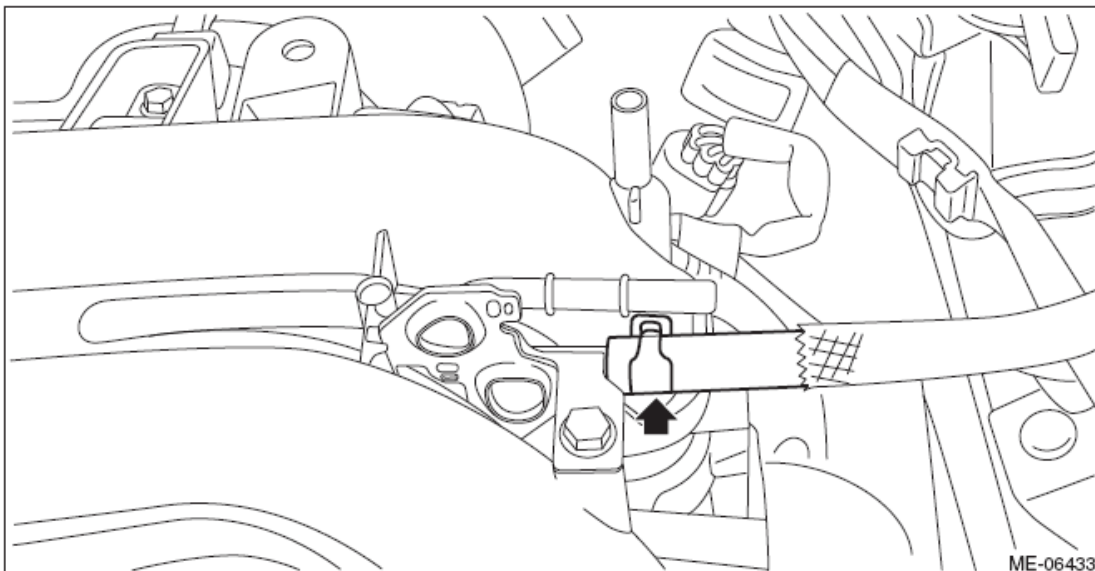


Fig. 53: Locating Evaporation Hose Mounting Clip
Courtesy of SUBARU OF AMERICA, INC.

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

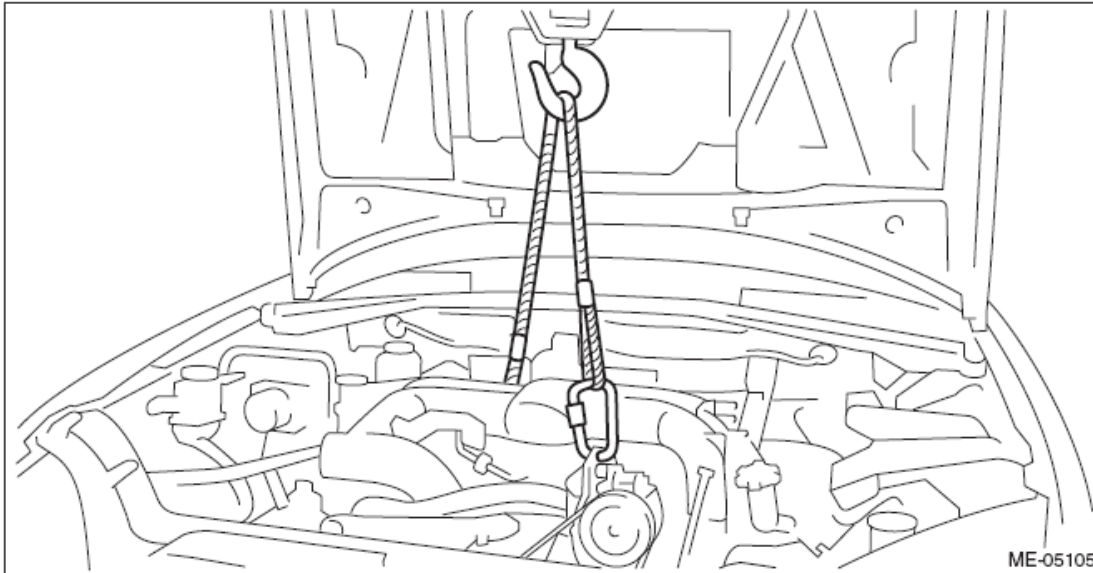


Fig. 54: Lifting Engine Using Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

30. Remove the bolt and nut which secure engine mounting to the cradle.

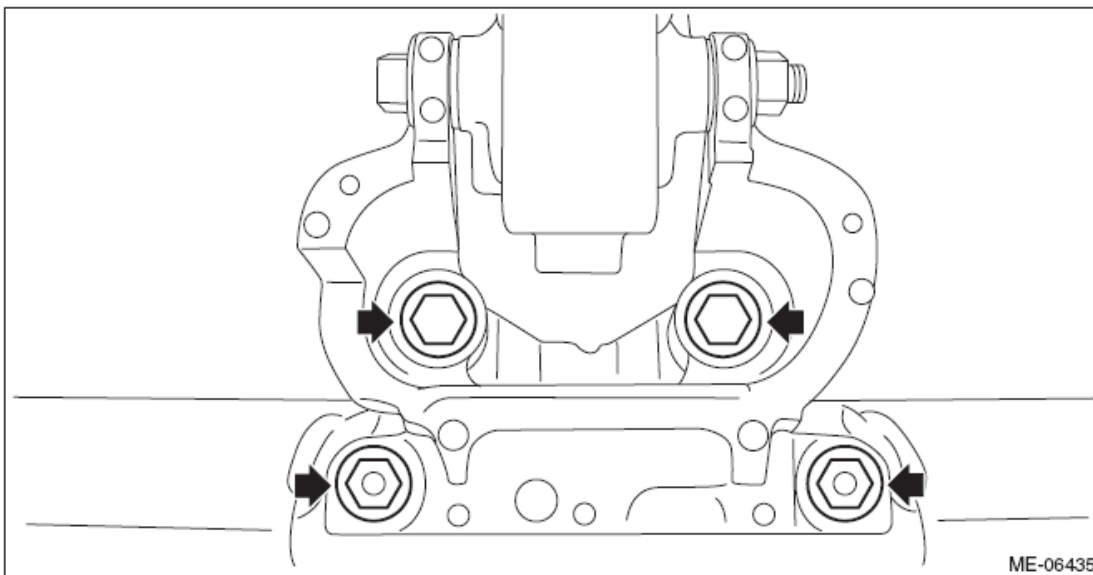


Fig. 55: Locating Engine Mounting To Cradle Mounting Bolts And Nuts
Courtesy of SUBARU OF AMERICA, INC.

31. Remove the bolts which hold the engine mounting to the engine mounting bracket.

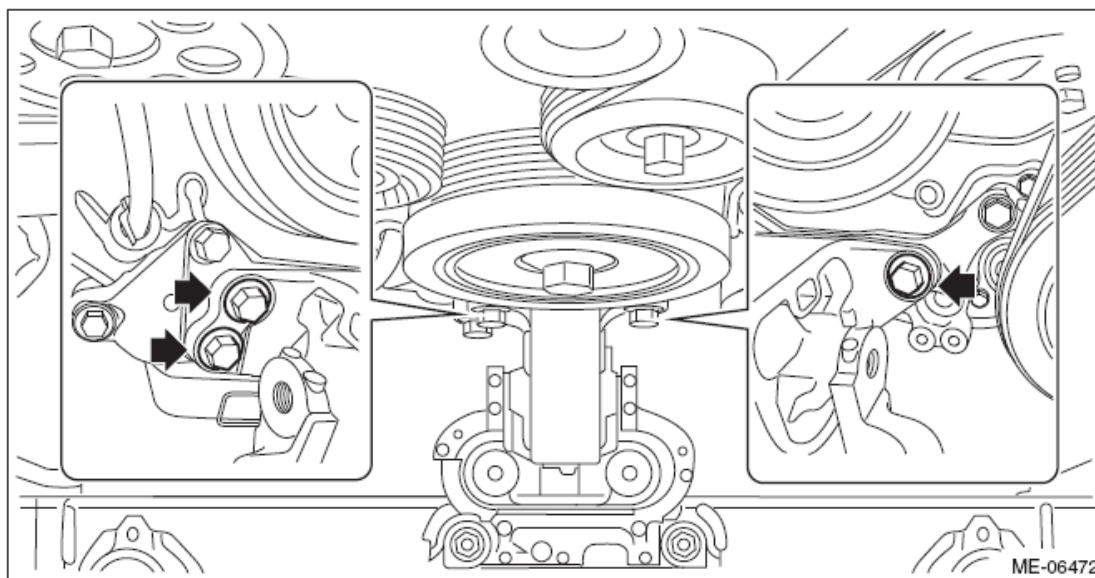


Fig. 56: Locating Engine Mounting To Engine Mounting Bracket Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

32. 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** .
2. Attach the ST to the torque converter clutch case. (CVT model)

ST 498277200 STOPPER SET

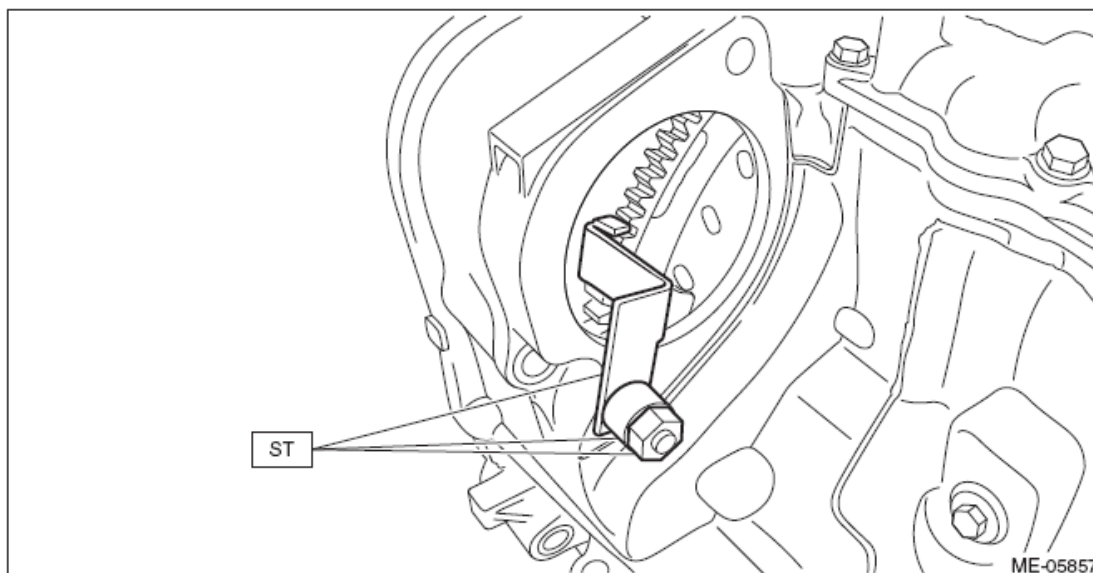


Fig. 57: Separating Engine And Transmission Using Stopper Set
Courtesy of SUBARU OF AMERICA, INC.

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

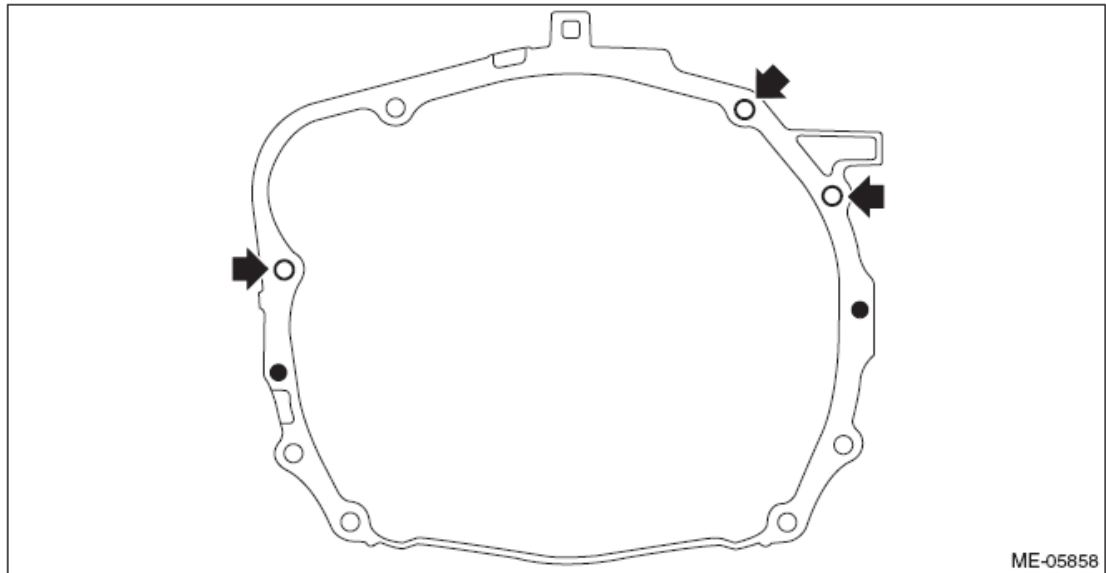


Fig. 58: Locating Transmission To Engine Upper Side Mounting Bolts (CVT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

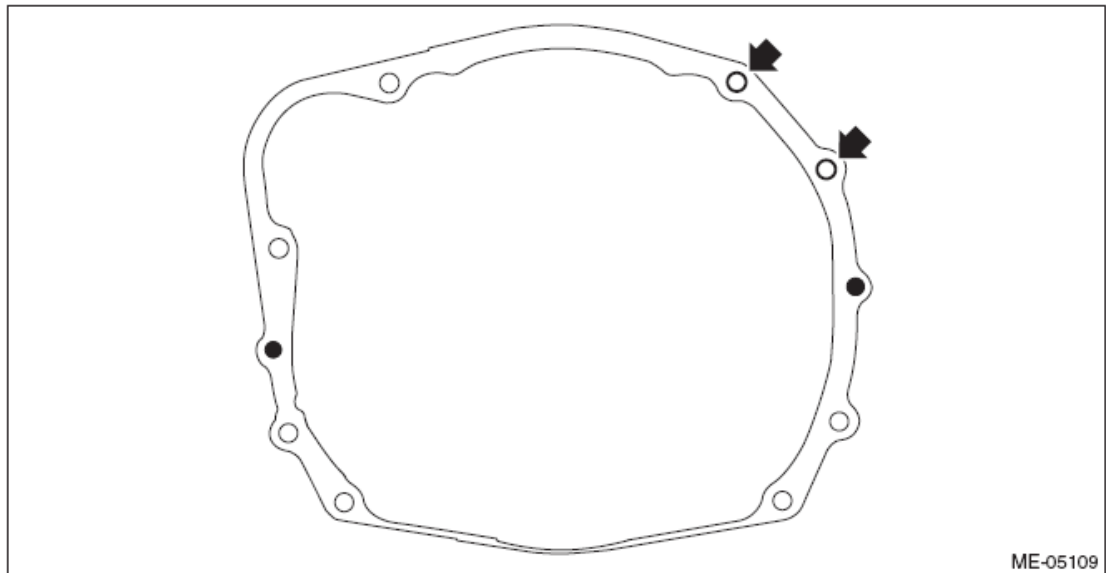


Fig. 59: Locating Transmission To Engine Upper Side Mounting Bolts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

33. Remove the engine from the 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. Move the engine horizontally until main shaft is withdrawn from clutch cover. (MT model)
 3. Slowly move the engine away from engine compartment.
34. Remove the engine mounting bracket from the engine.

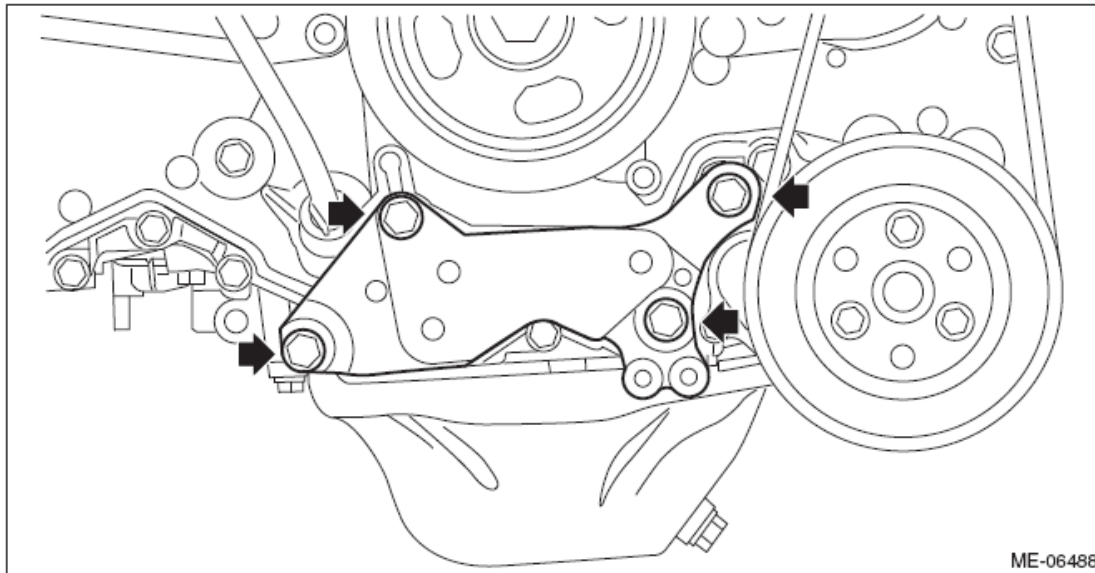


Fig. 60: Locating Engine Mounting Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the engine mounting bracket onto the engine.

Tightening torque:

30 N.m (3.1 kgf-m, 22.1 ft-lb)

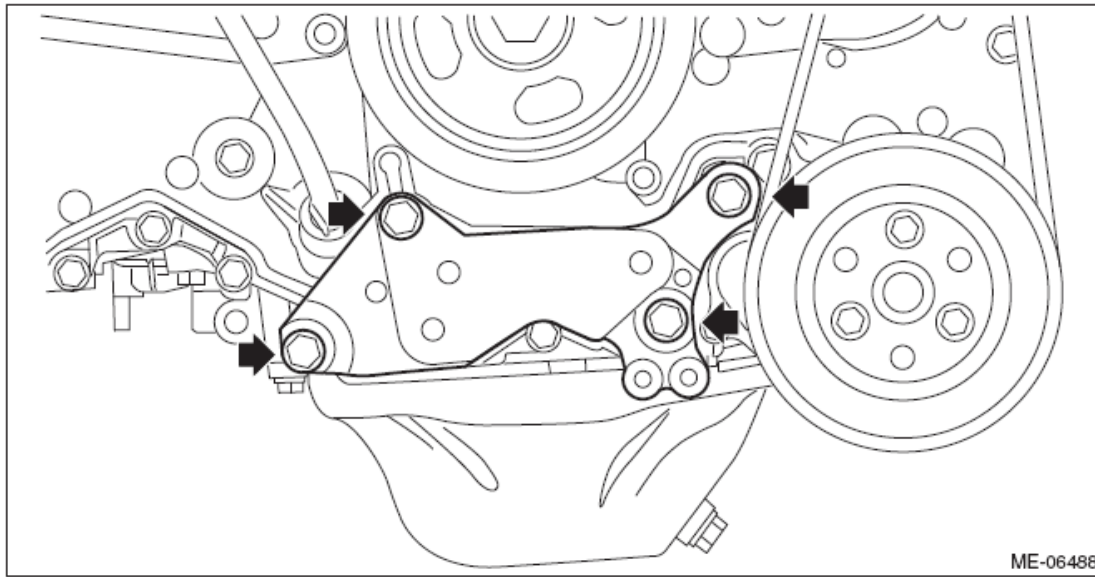


Fig. 61: Locating Engine Mounting Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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)

- CVT model

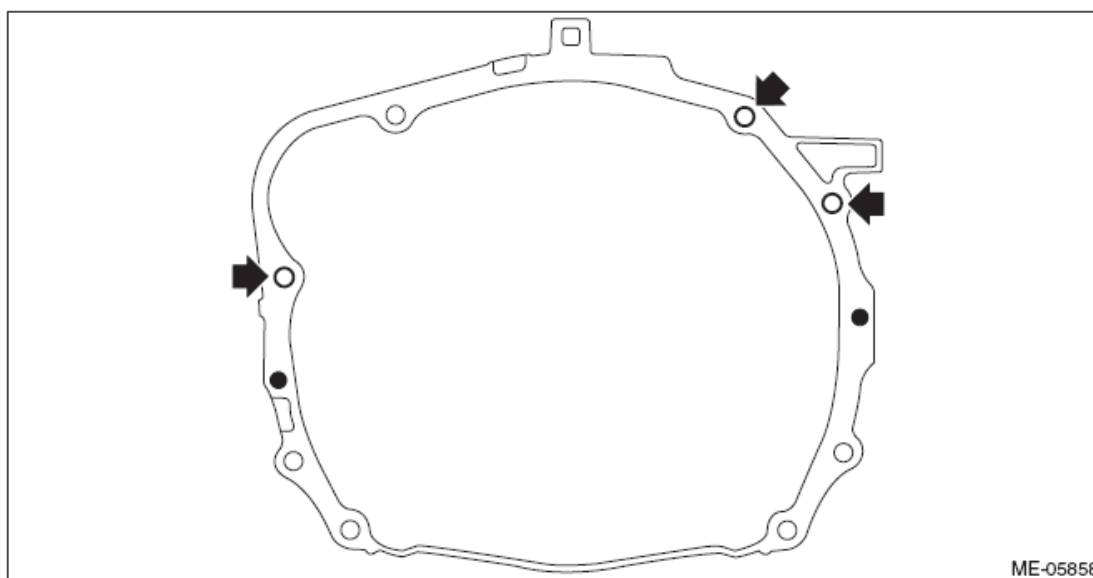


Fig. 62: Locating Transmission To Engine Upper Side Mounting Bolts (CVT Model)
 Courtesy of SUBARU OF AMERICA, INC.

- MT model

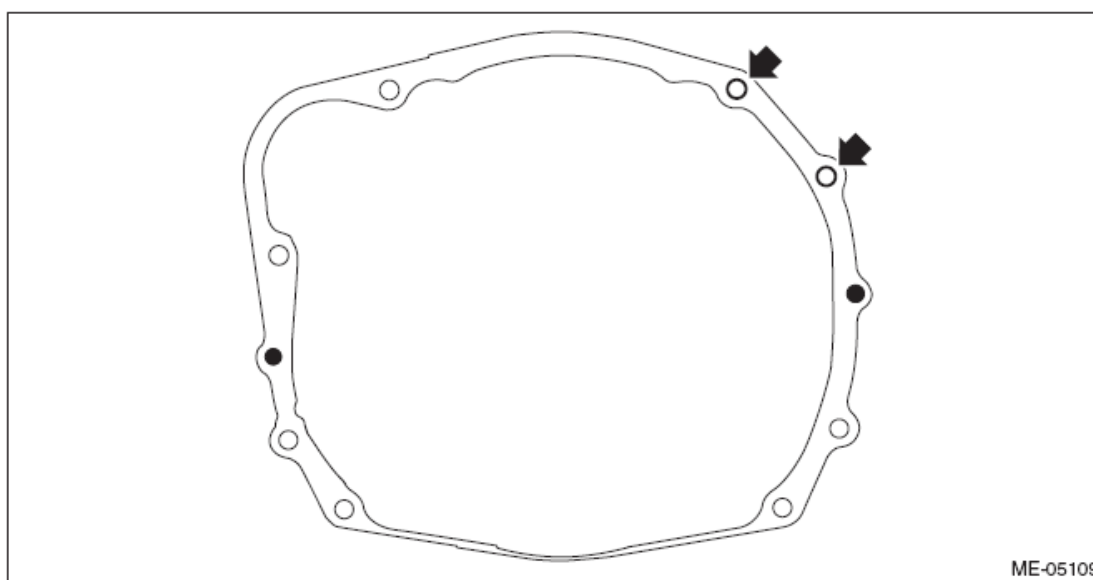


Fig. 63: Locating Transmission To Engine Upper Side Mounting Bolts (MT Model)
 Courtesy of SUBARU OF AMERICA, INC.

5. Attach the bolts which secure the engine mounting to the engine mounting bracket.

Tightening torque:

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

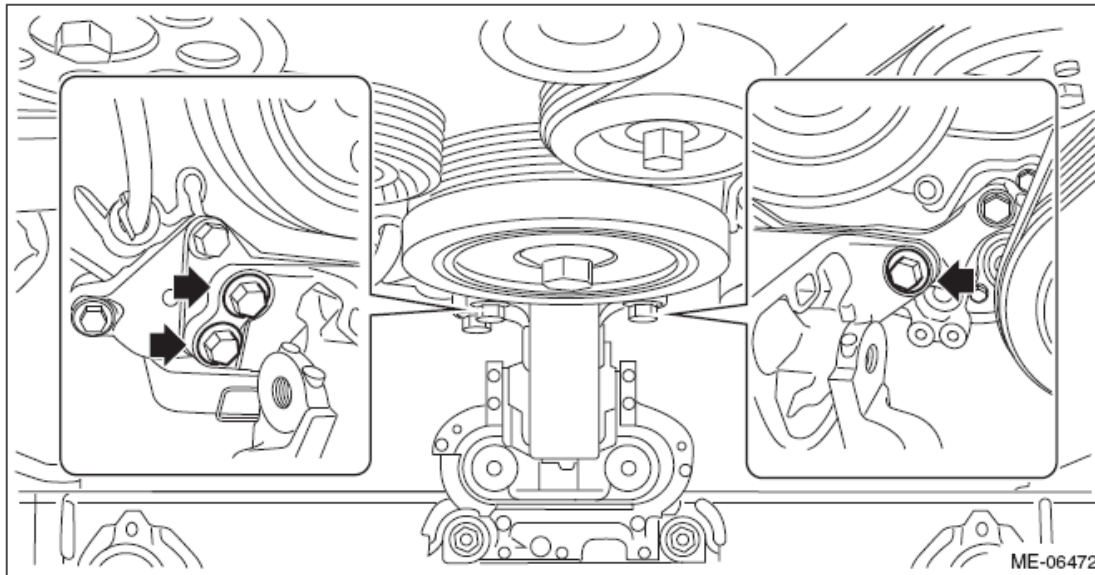


Fig. 64: Locating Engine Mounting To Engine Mounting Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Attach the bolts and nuts which secure engine mounting to the cradle.

Tightening torque:

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

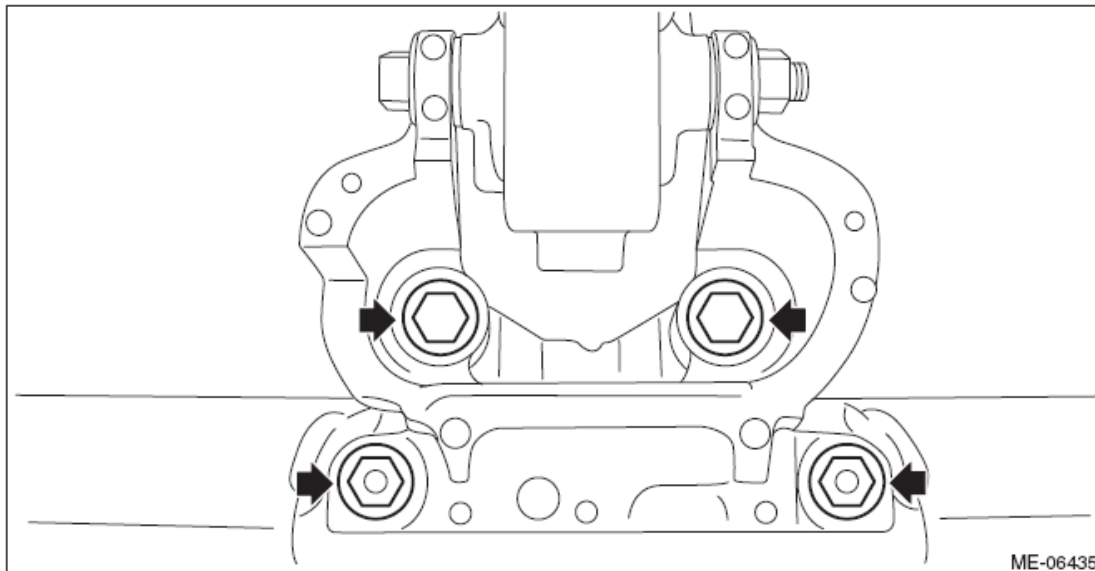


Fig. 65: Locating Engine Mounting To Cradle Mounting Bolts And Nuts
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the lifting device and wire ropes.

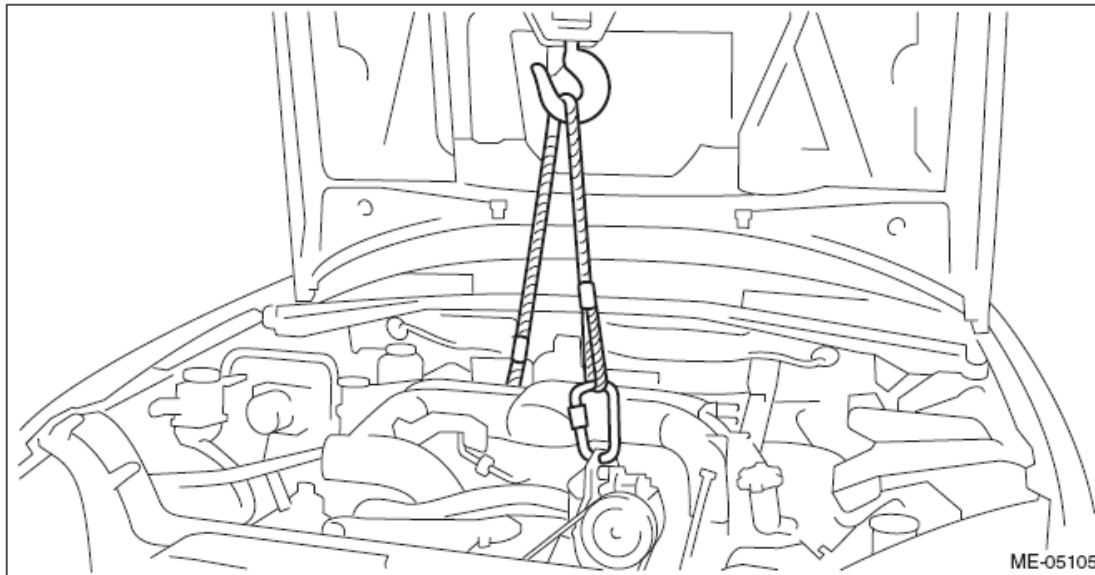


Fig. 66: Lifting Engine Using Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

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

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

ST 498277200 STOPPER SET

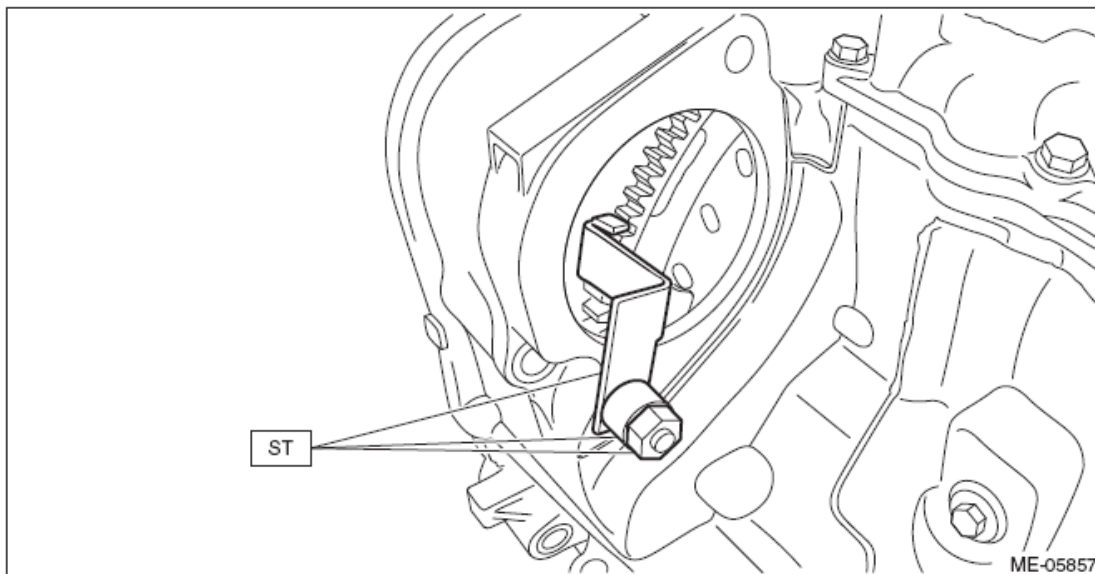


Fig. 67: Separating Engine And Transmission Using Stopper Set
Courtesy of SUBARU OF AMERICA, INC.

9. Install the torque converter clutch to drive plate. (CVT 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)

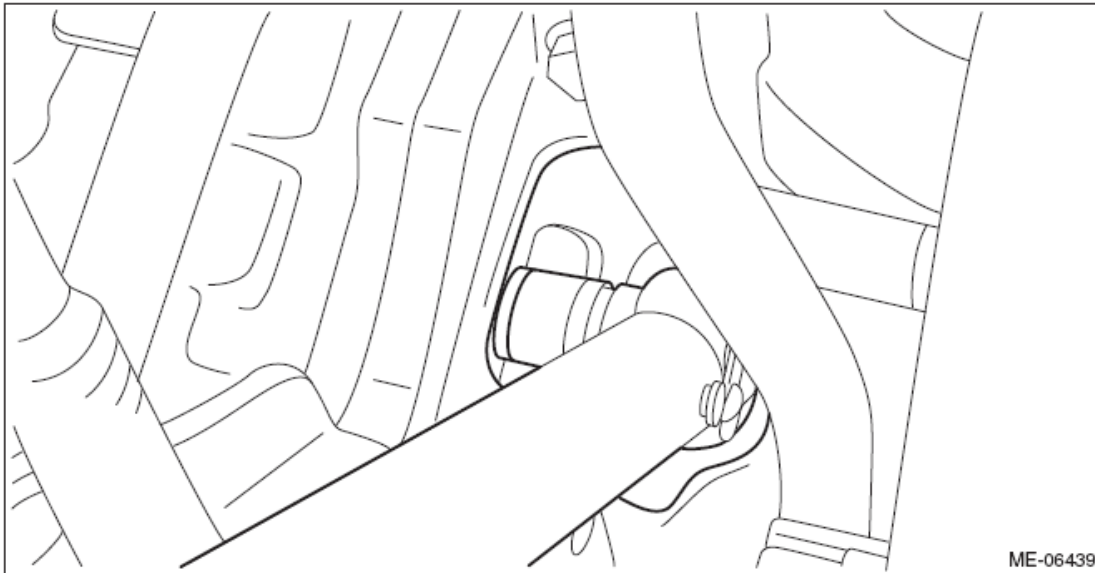


Fig. 68: Installing Torque Converter Clutch To Drive Plate (CVT Model)
Courtesy of SUBARU OF AMERICA, INC.

2. Fit the plug to service hole.
10. Install the starter. Refer to **INSTALLATION**.
11. Lift up the vehicle.
12. Install the bolts and nuts which hold lower side of the transmission to engine.

Tightening torque:

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

- CVT model

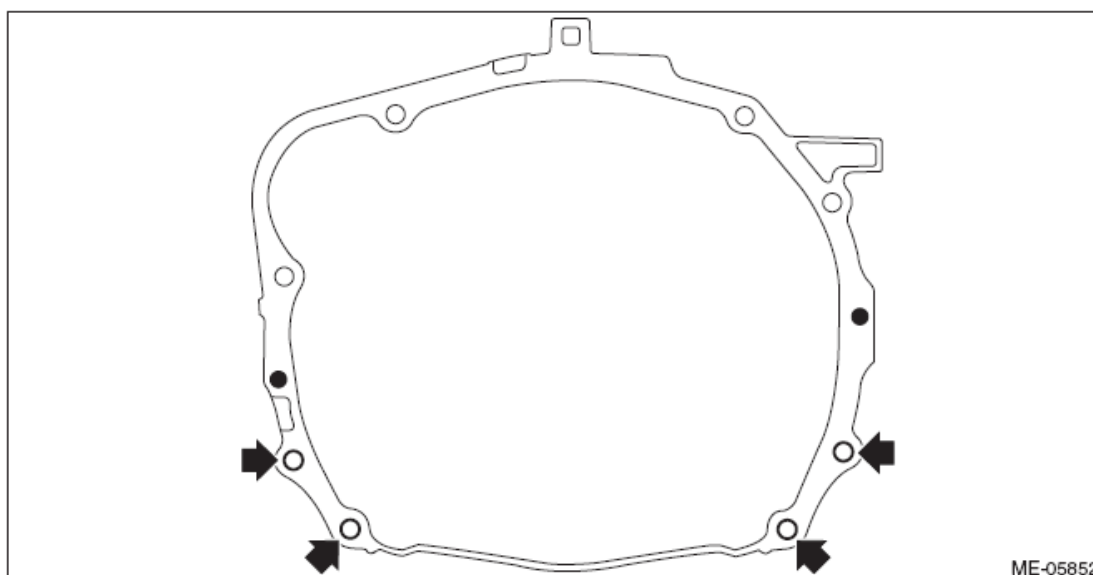


Fig. 69: Locating Transmission To Engine Lower Side Mounting Bolts And Nuts (AT Model)
Courtesy of SUBARU OF AMERICA, INC.

- MT model

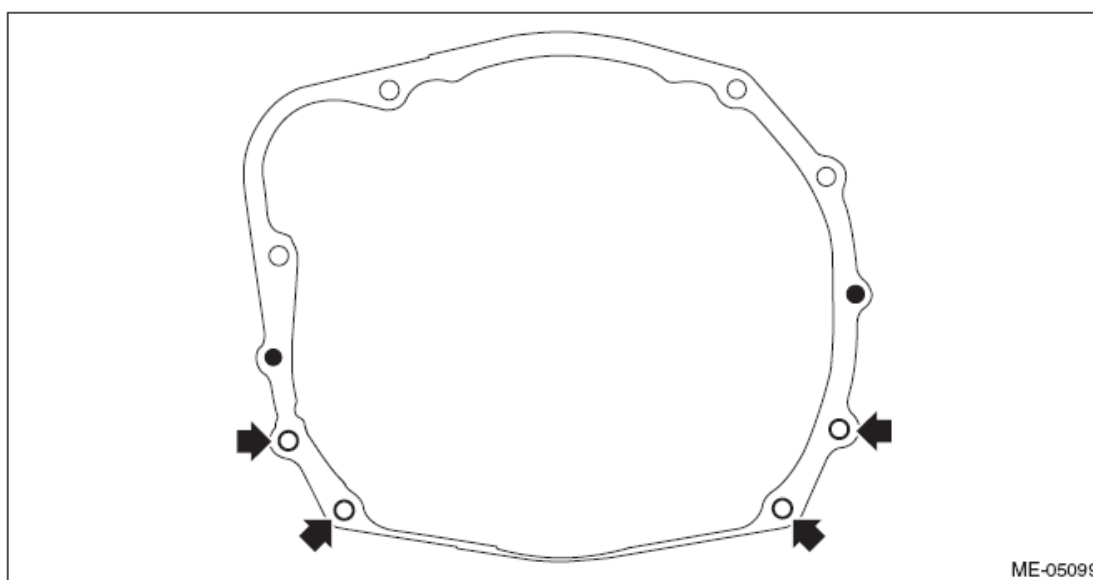


Fig. 70: Locating Transmission To Engine Lower Side Mounting Bolts And Nuts (MT Model)
Courtesy of SUBARU OF AMERICA, INC.

13. Connect the ground cable.

Tightening torque:

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

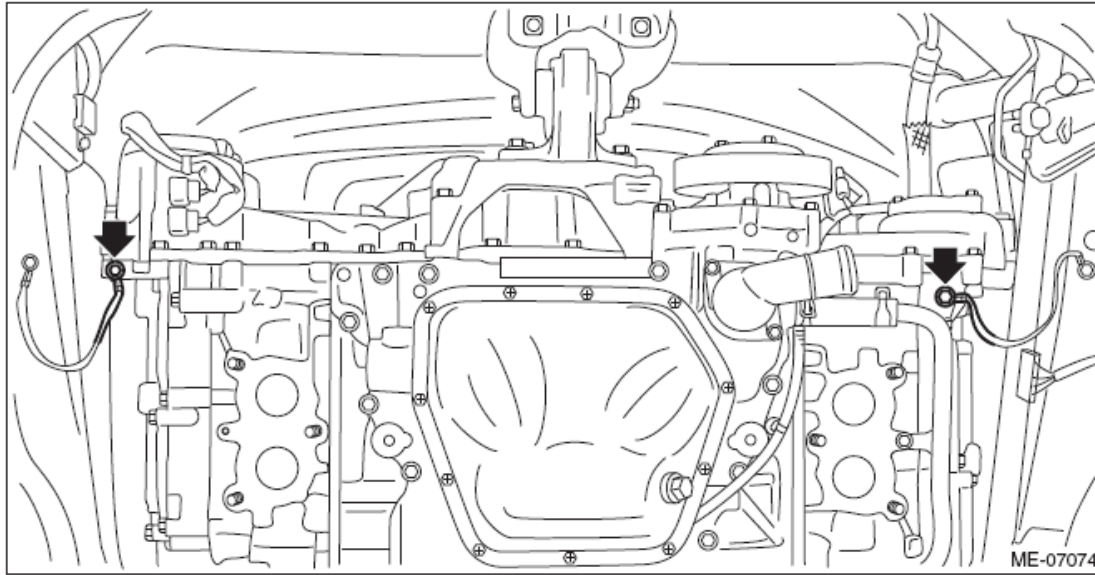


Fig. 71: Locating Engine Side Ground Cables
Courtesy of SUBARU OF AMERICA, INC.

14. Install the front exhaust pipe. Refer to **INSTALLATION** .
15. Lower the vehicle.
16. 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** .
17. Install the power steering pump.
 1. Install the power steering pump together with the power steering pump bracket onto the engine.

Tightening torque:

Refer to GENERATOR BRACKET.

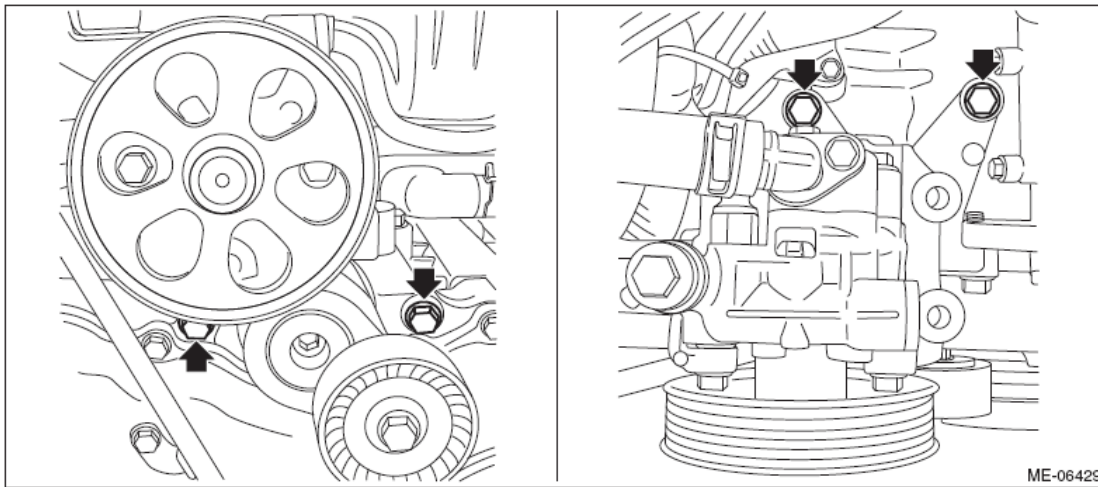


Fig. 72: Locating Power Steering Pump Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Connect the connector to the power steering pump.

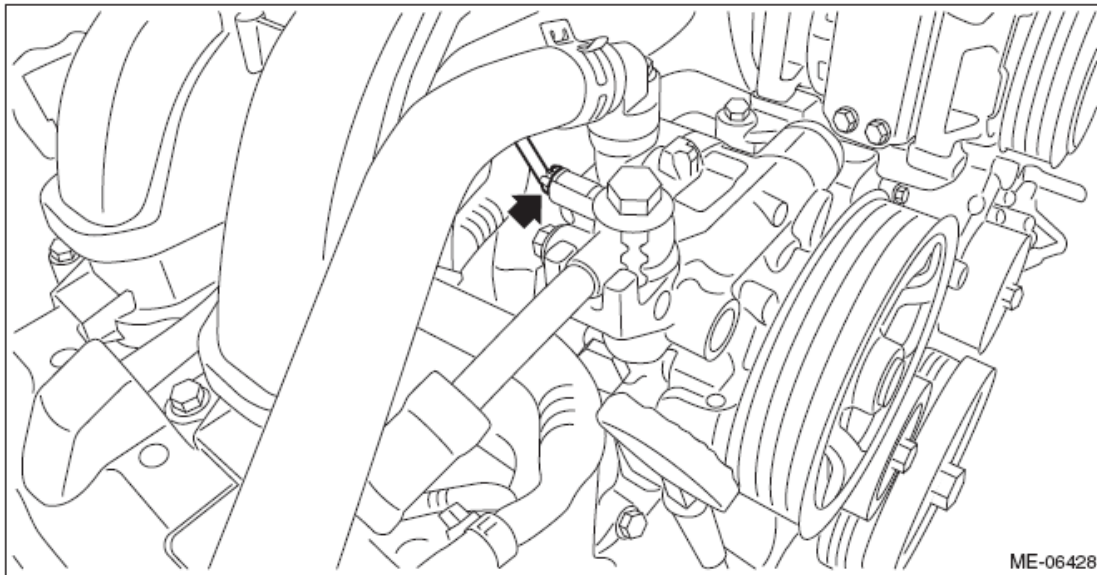


Fig. 73: Locating Power Steering Pump Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Install the generator. Refer to **INSTALLATION**.
4. Install the V-belts. Refer to **INSTALLATION**.
18. Place the generator code and install the generator cord to the clip (D).
19. Connect connector (A) and terminal (B) to the generator, and secure them to the stay of the A/C compressor with the clip (C).

Tightening torque:

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

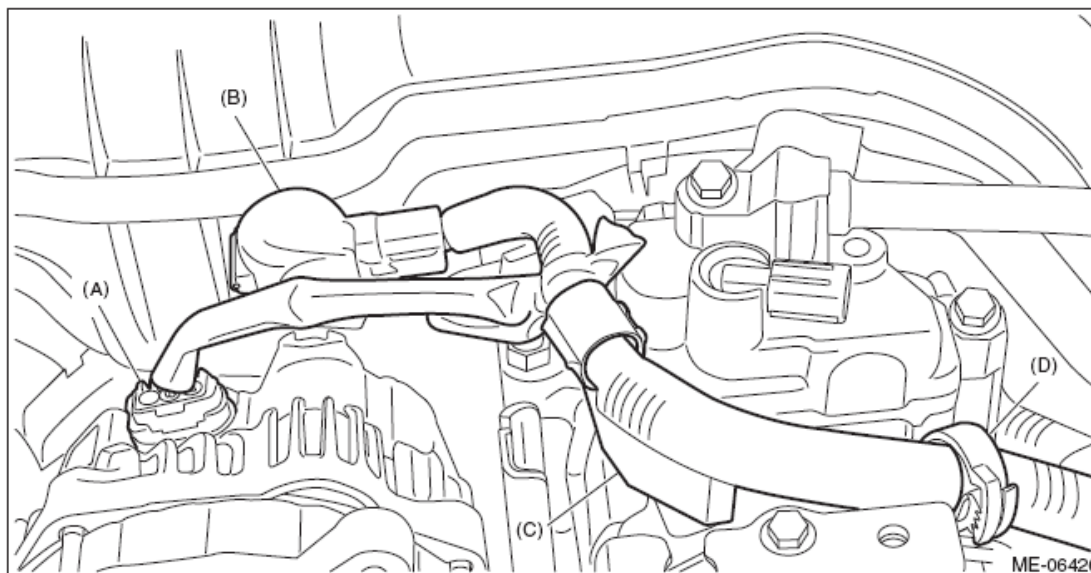


Fig. 74: Identifying A/C Compressor Connector, Terminal And Clips
 Courtesy of SUBARU OF AMERICA, INC.

20. Connect the connectors (A) and (B) to the A/C compressor.

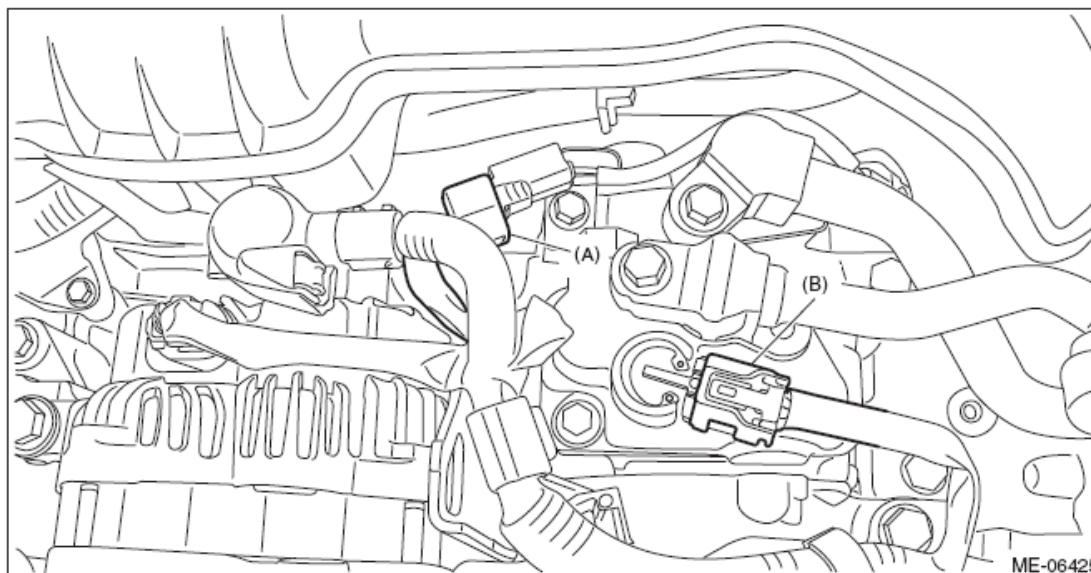


Fig. 75: Identifying A/C Compressor Connectors
 Courtesy of SUBARU OF AMERICA, INC.

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)

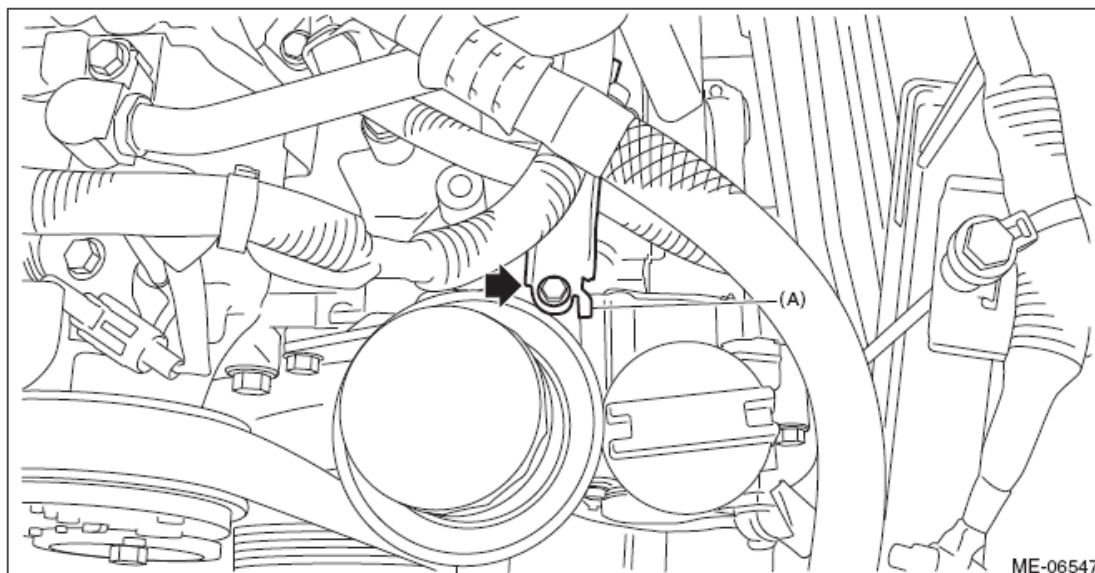


Fig. 76: Locating Generator Cord Stay Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

22. Connect the engine harness connector.

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

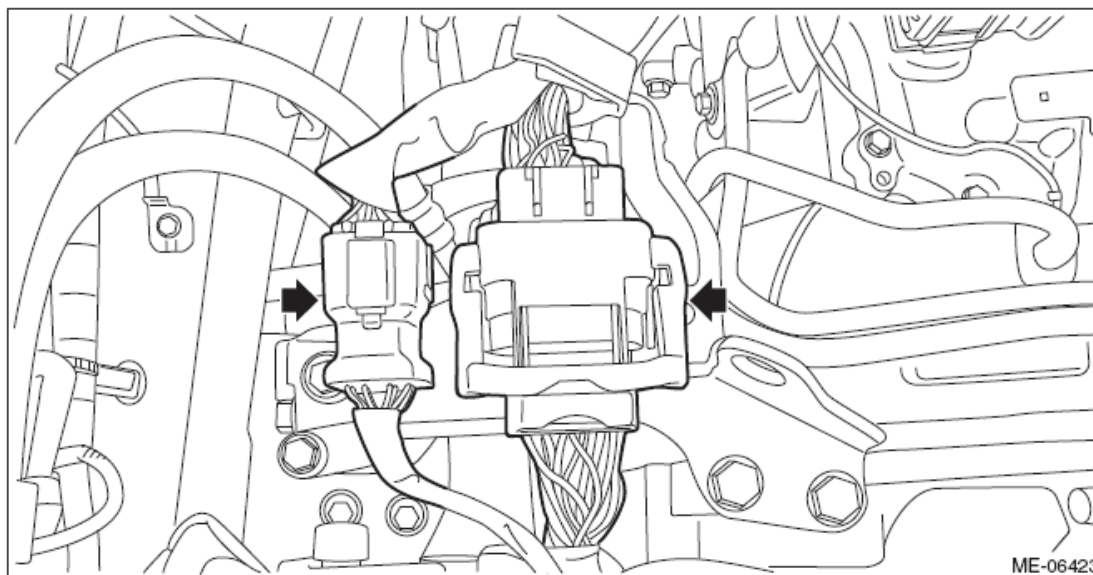


Fig. 77: Locating Bulkhead Harness Connector And Engine Harness Connector
Courtesy of SUBARU OF AMERICA, INC.

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)

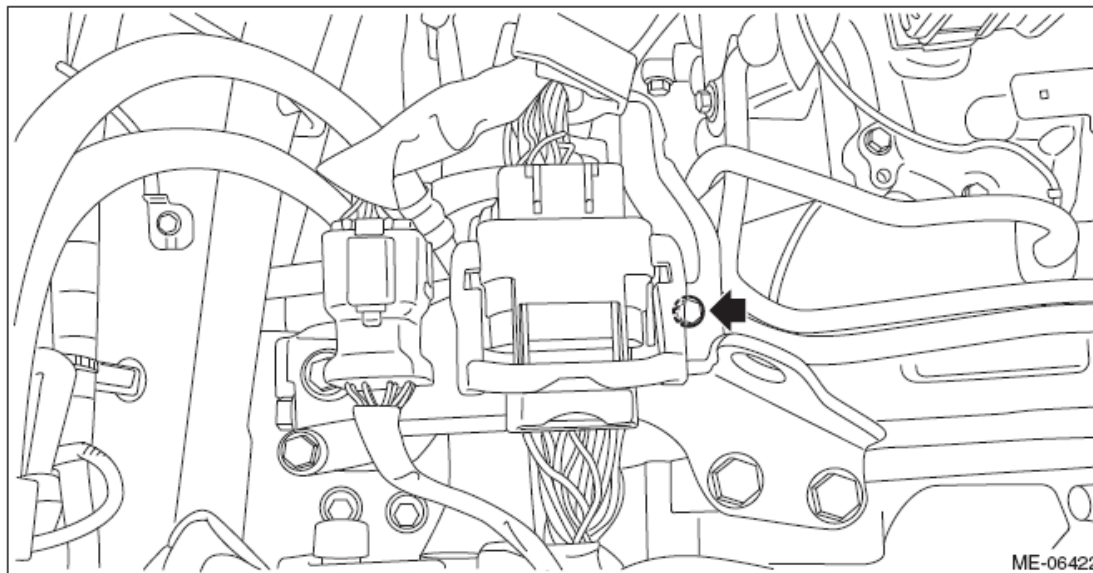


Fig. 78: Locating Bulkhead Harness Connector Bracket Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

23. Install the radiator. Refer to **INSTALLATION** .
24. Install the air intake case (rear).

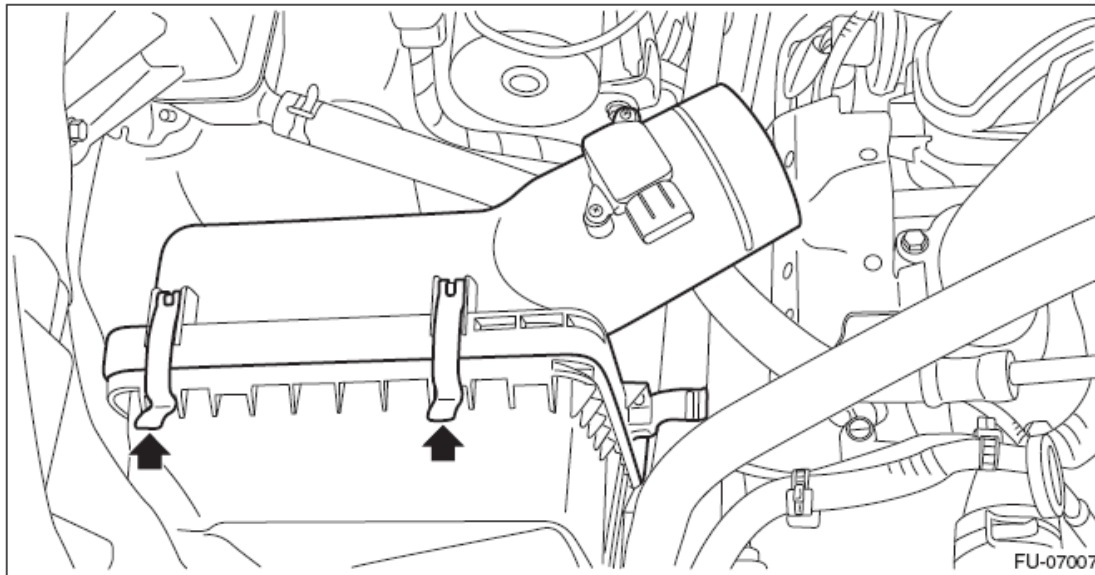


Fig. 79: Locating Rear Air Cleaner Case Mounting Clips
 Courtesy of SUBARU OF AMERICA, INC.

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

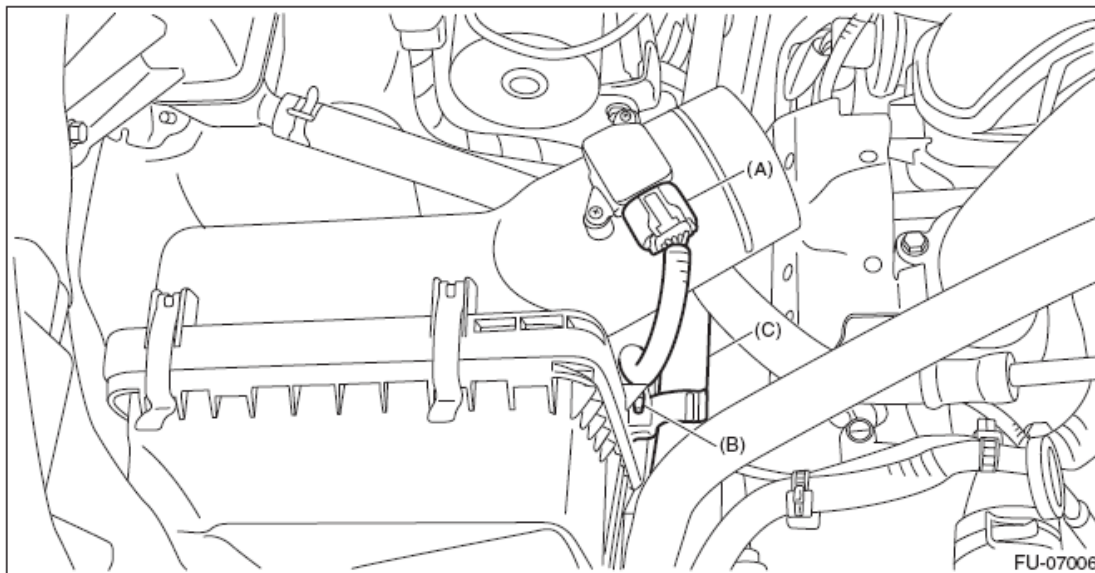


Fig. 80: Identifying Mass Air Flow Connector, Suction Hose And Clip
 Courtesy of SUBARU OF AMERICA, INC.

27. Install the air intake boot. Refer to **INSTALLATION** .
28. Install the air intake duct. Refer to **INSTALLATION** .
29. Connect the battery ground terminal.

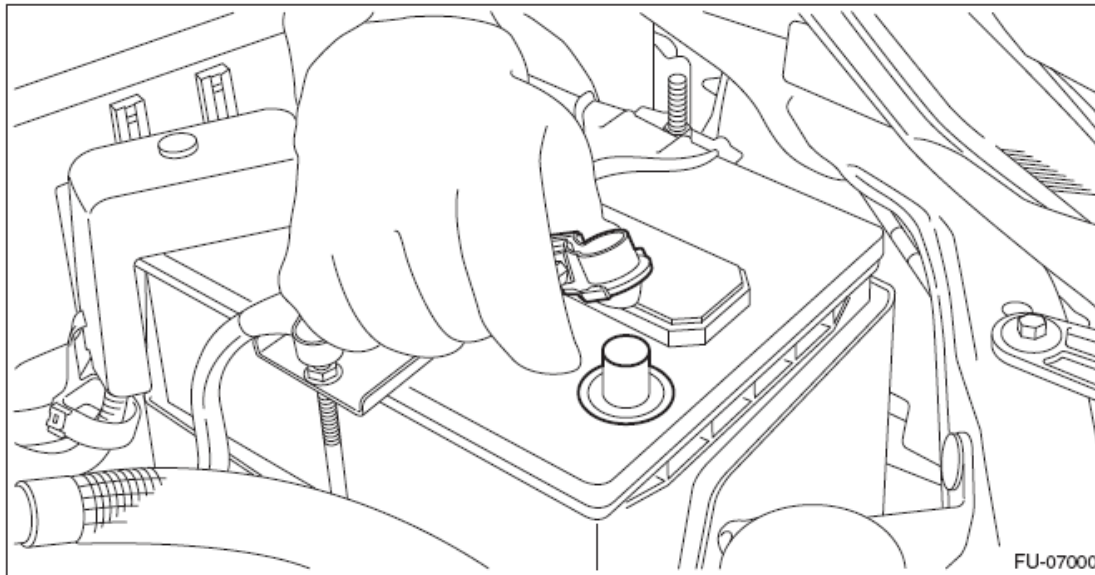


Fig. 81: Connecting/Disconnecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

30. Fill engine coolant. Refer to **FILLING OF ENGINE COOLANT** .
31. Check the CVTF level and replenish it if necessary. (CVT model) Refer to **ADJUSTMENT** .
32. Charge the A/C system with refrigerant. Refer to **PROCEDURE** .
33. Install the V-belt cover.

Tightening torque:

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

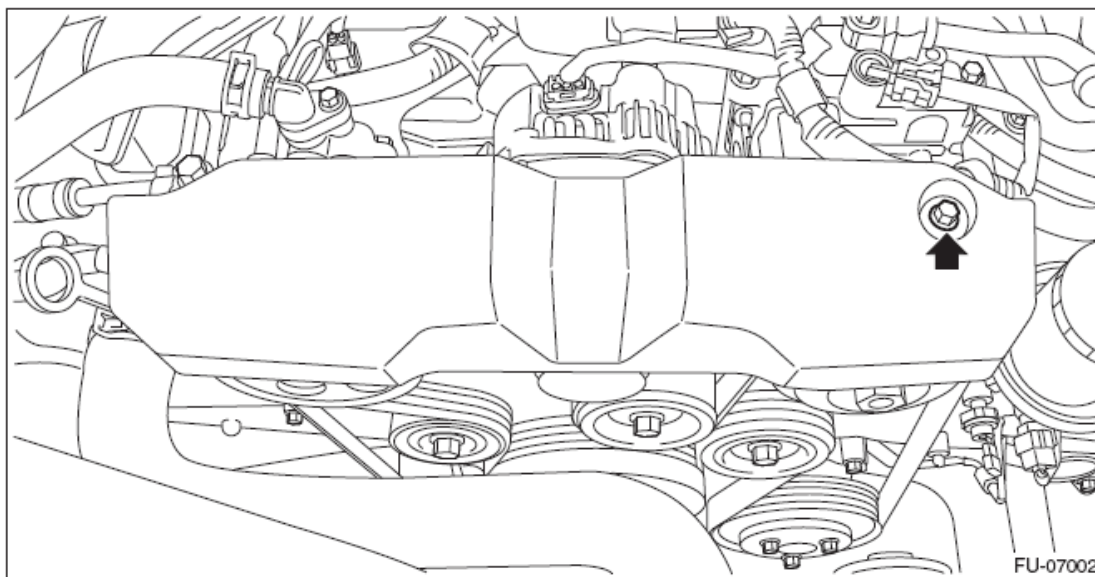


Fig. 82: Locating V-Belt Cover Mounting Bolts

Courtesy of SUBARU OF AMERICA, INC.

34. Change the front hood damper mounting position from (B) to (A), and close the front hood.

Tightening torque:

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

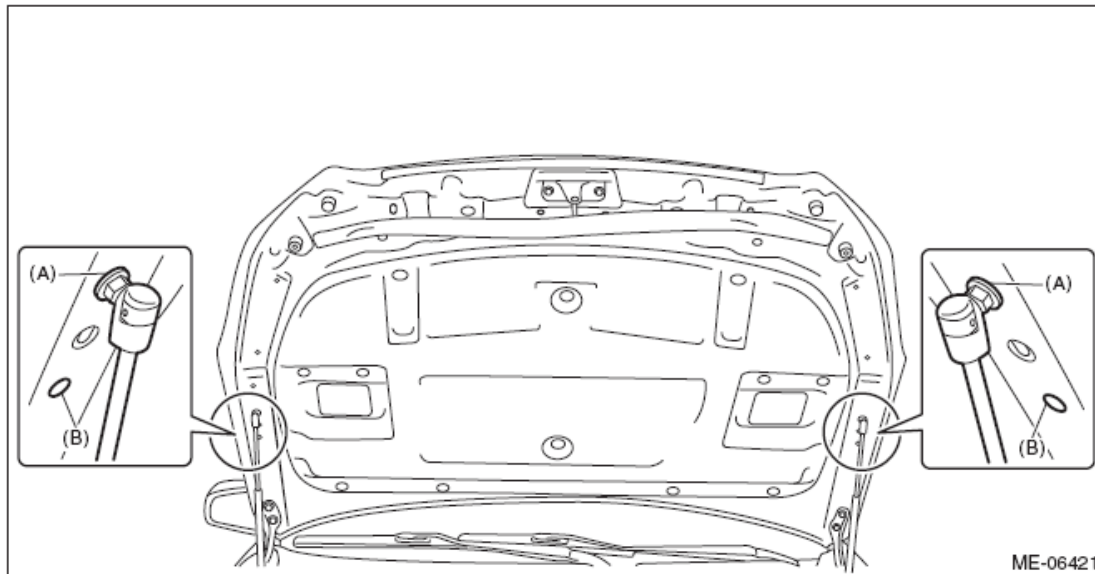


Fig. 83: Identifying Front Hood Damper Mounting Positions
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

1. Check that pipes, hoses, connectors and clamps are installed firmly.
2. Check the engine coolant is at specified level.
3. Check CVTF is at the specified level. (CVT 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. Change the front hood damper mounting position from (A) to (B), and completely open the front hood.

Tightening torque:

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

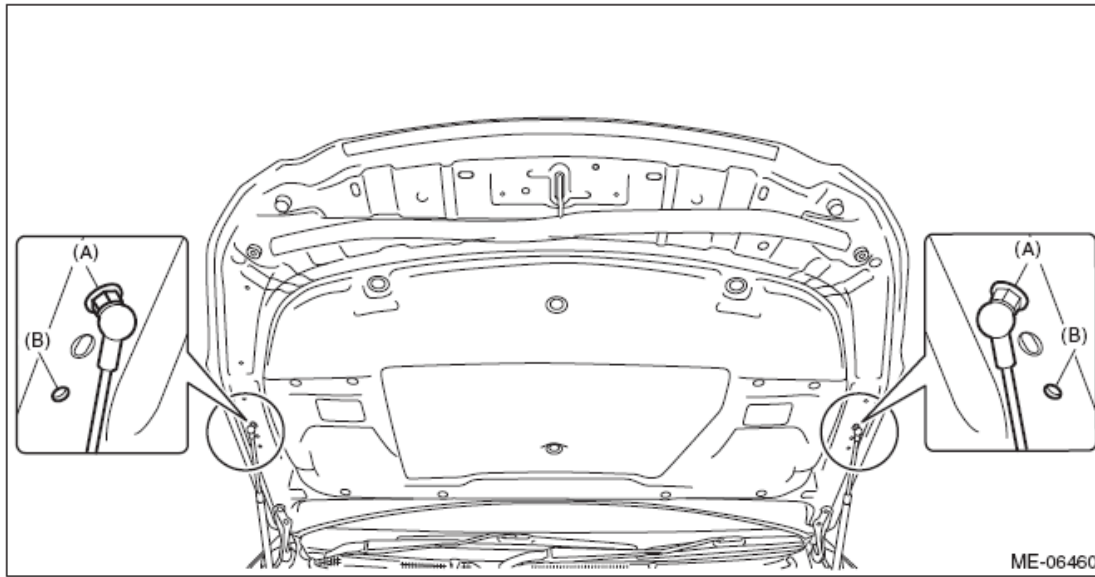


Fig. 84: Identifying Front Hood Damper Mounting Positions
Courtesy of SUBARU OF AMERICA, INC.

2. Disconnect the ground cable from battery.

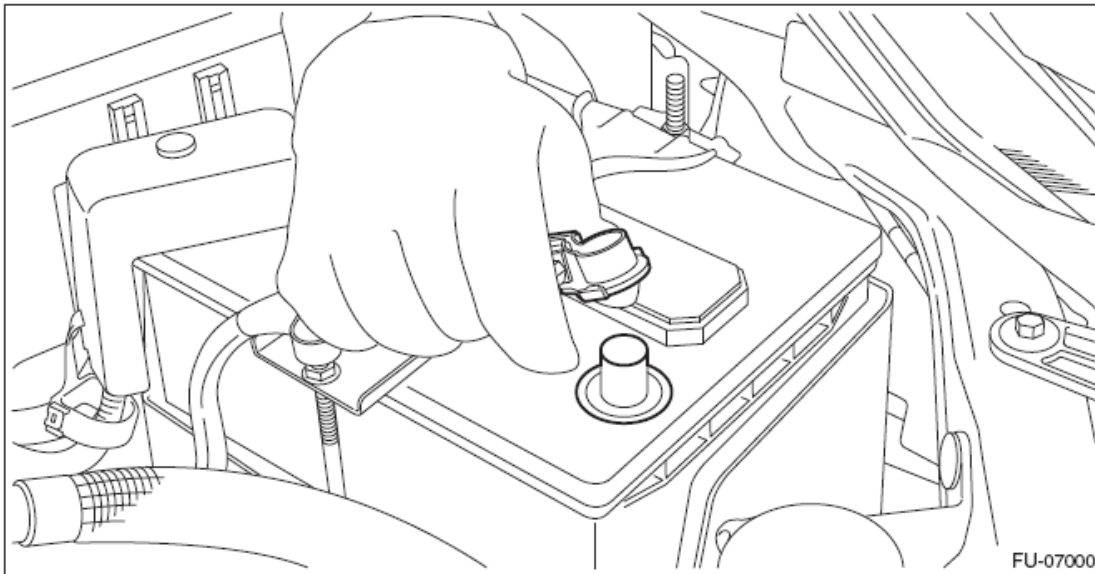
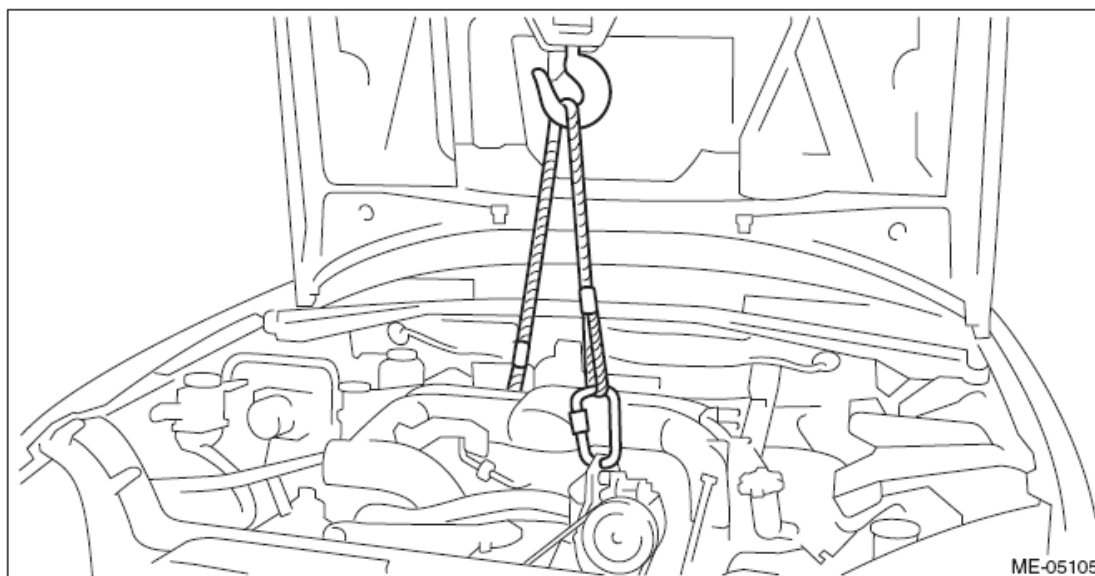


Fig. 85: Connecting/Disconnecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

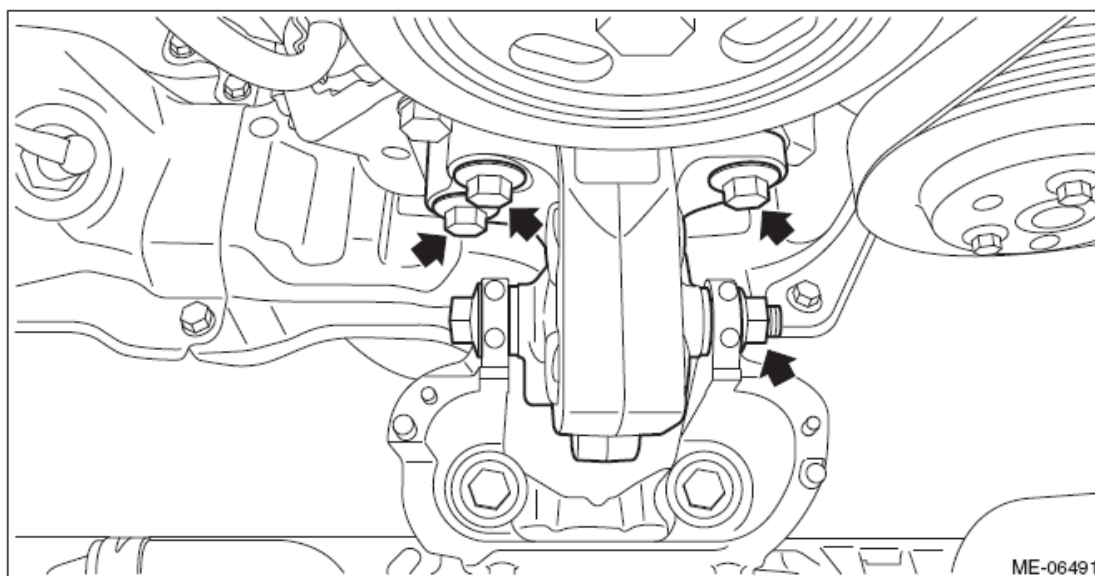
3. Remove the radiator main fan motor assembly and radiator sub fan motor assembly. Refer to **REMOVAL** and **REMOVAL** .
4. Support the engine with a lifting device and wire ropes.



ME-05105

Fig. 86: Lifting Engine Using Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the front cushion rubber from the front mounting bracket and engine mounting bracket.



ME-06491

Fig. 87: Locating Front Cushion Rubber And Engine Mounting Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Remove the engine mounting bracket from the engine assembly.

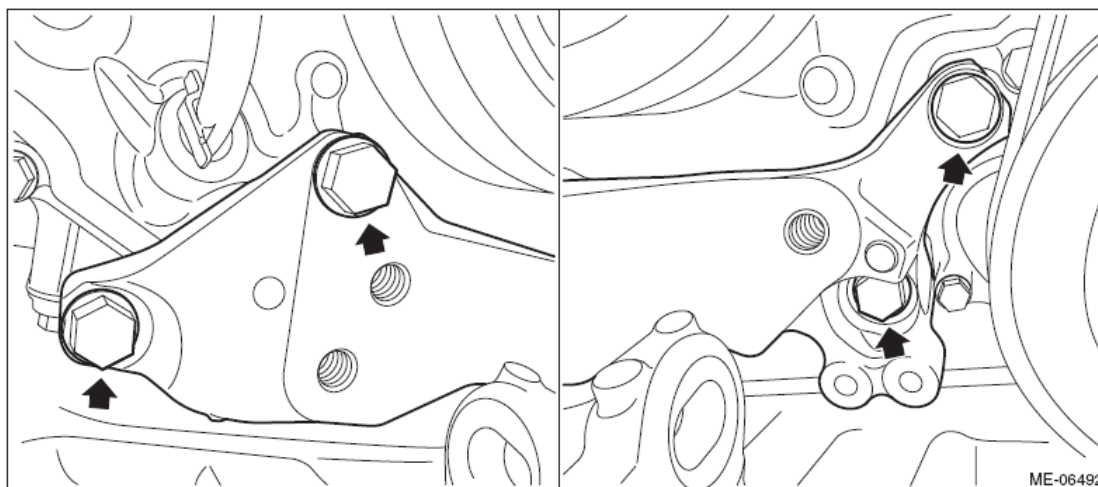


Fig. 88: Locating Engine Mounting Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the grille bracket.

NOTE: Remove ten clips when removing the grille bracket.

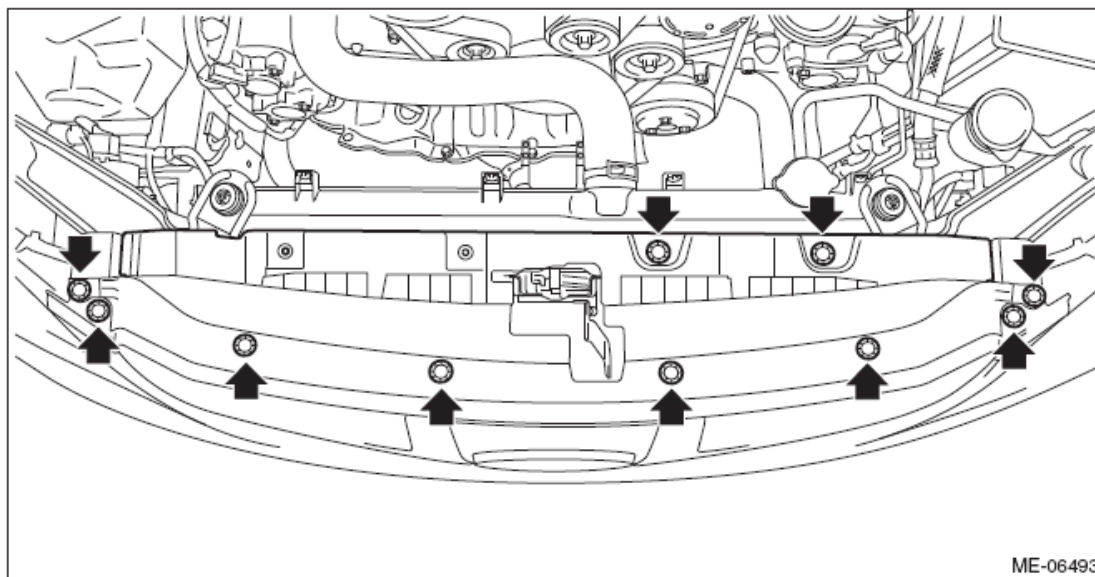


Fig. 89: Locating Grille Bracket Clips
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the radiator upper brackets.

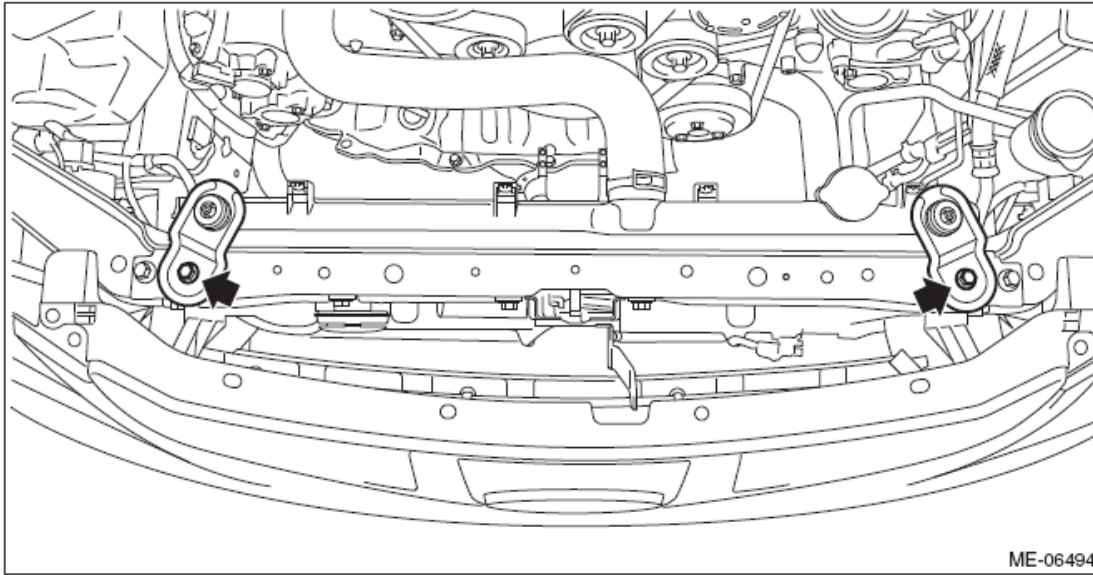


Fig. 90: Locating Radiator Upper Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. Slide the radiator to the right and left, and remove the front mounting bracket.

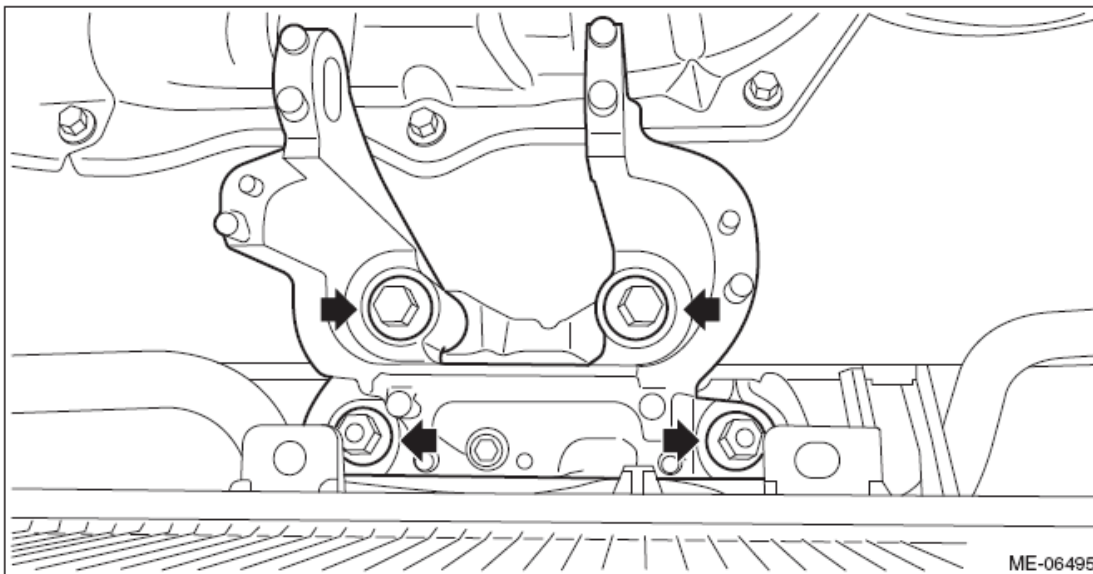


Fig. 91: Locating Front Mounting Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Slide the radiator to the right and left, and install the front mounting bracket.

Tightening torque:

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

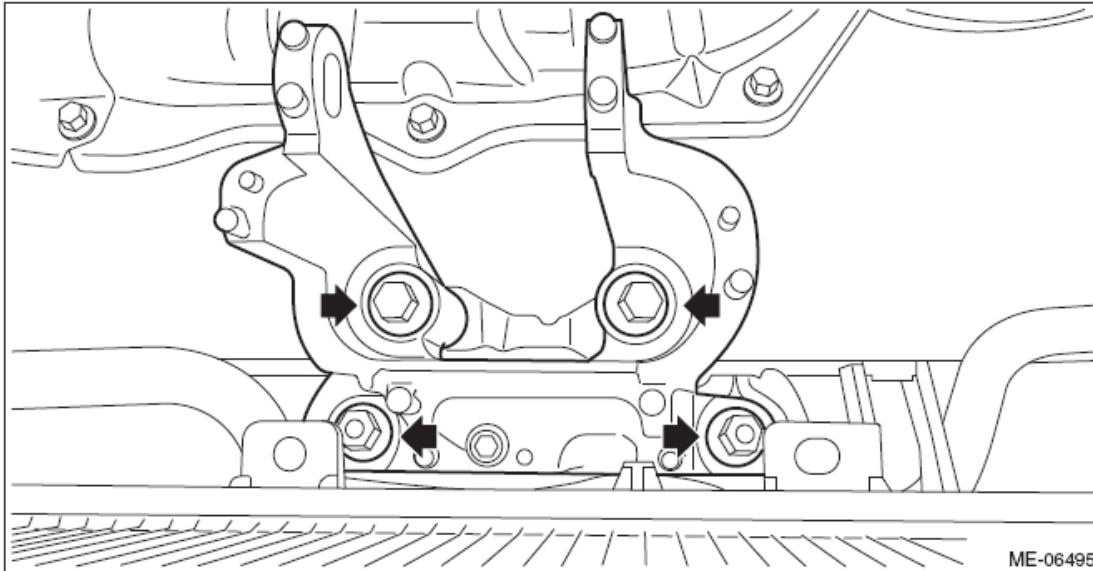


Fig. 92: Locating Front Mounting Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Make pins on the lower side of radiator be fitted into the radiator lower cushions.
3. Install the radiator upper brackets.

Tightening torque:

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

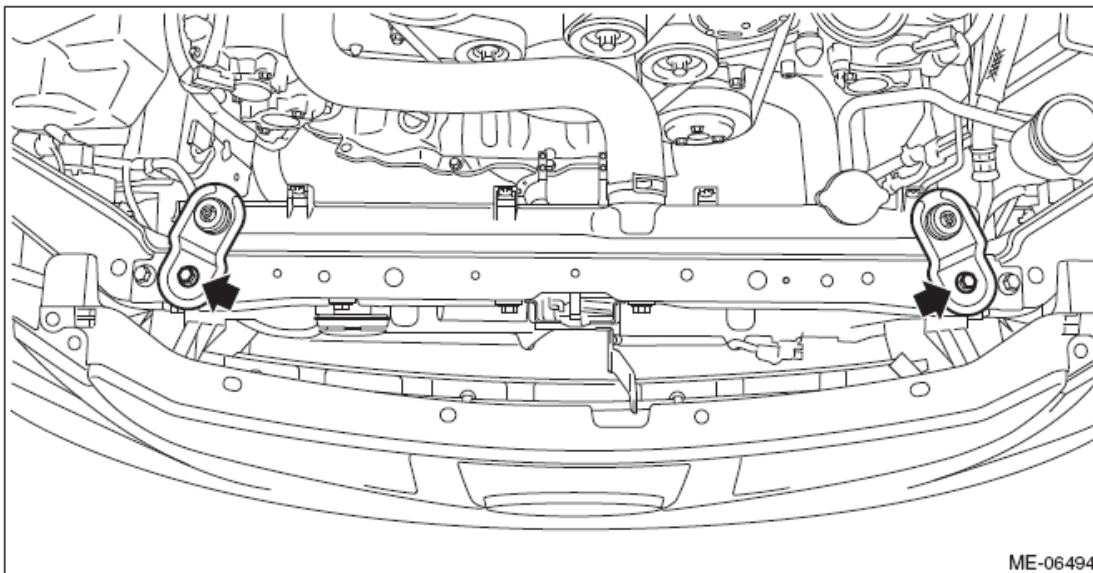


Fig. 93: Locating Radiator Upper Bracket Mounting Bolts

Courtesy of SUBARU OF AMERICA, INC.

4. Attach the grille bracket.

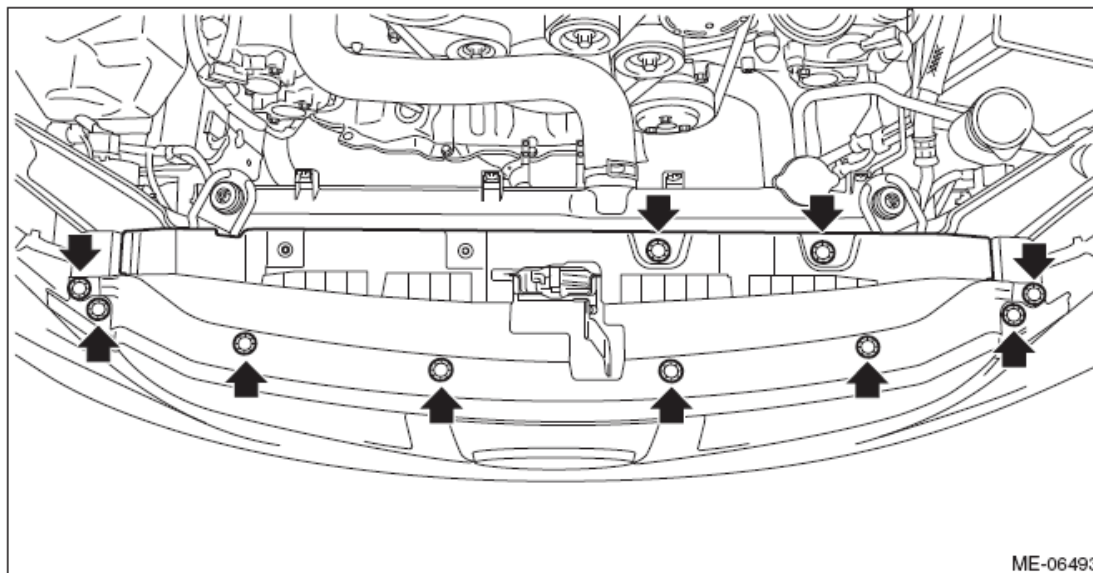


Fig. 94: Locating Grille Bracket Clips

Courtesy of SUBARU OF AMERICA, INC.

5. Install the engine mounting bracket onto the engine.

Tightening torque:

30 N.m (3.1 kgf-m, 22.1 ft-lb)

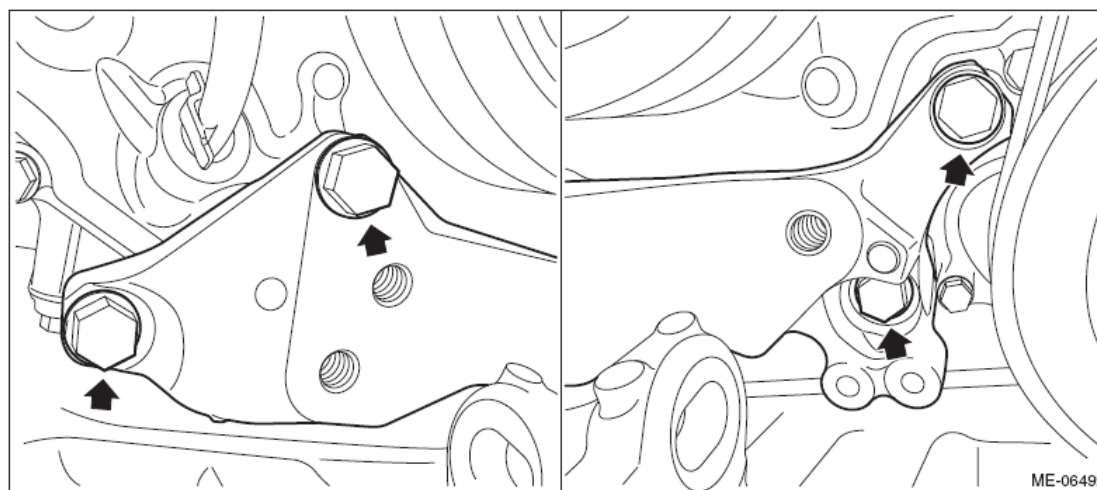


Fig. 95: Locating Engine Mounting Bracket Mounting Bolts

Courtesy of SUBARU OF AMERICA, INC.

6. Install the front cushion rubber to the front mounting bracket and engine mounting bracket.

Tightening torque:

T1: 25 N.m (2.5 kgf-m, 18.4 ft-lb)

T2: 45 N.m (4.6 kgf-m, 33.2 ft-lb)

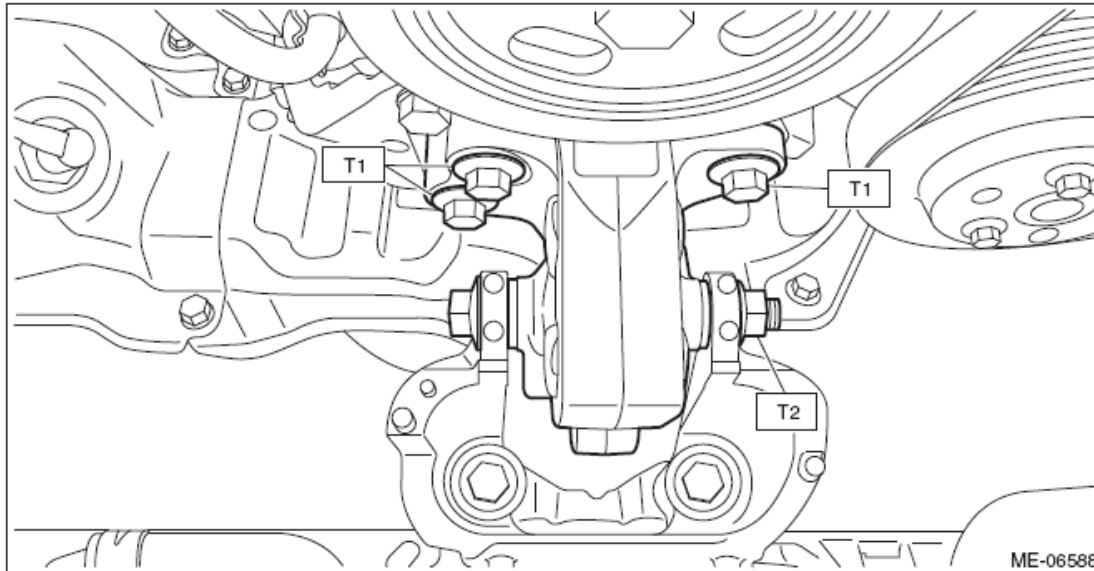


Fig. 96: Identifying Front Cushion Rubber And Engine Mounting Bracket Mounting Bolts With Torque Specifications

Courtesy of SUBARU OF AMERICA, INC.

7. Remove the lifting device and wire ropes.

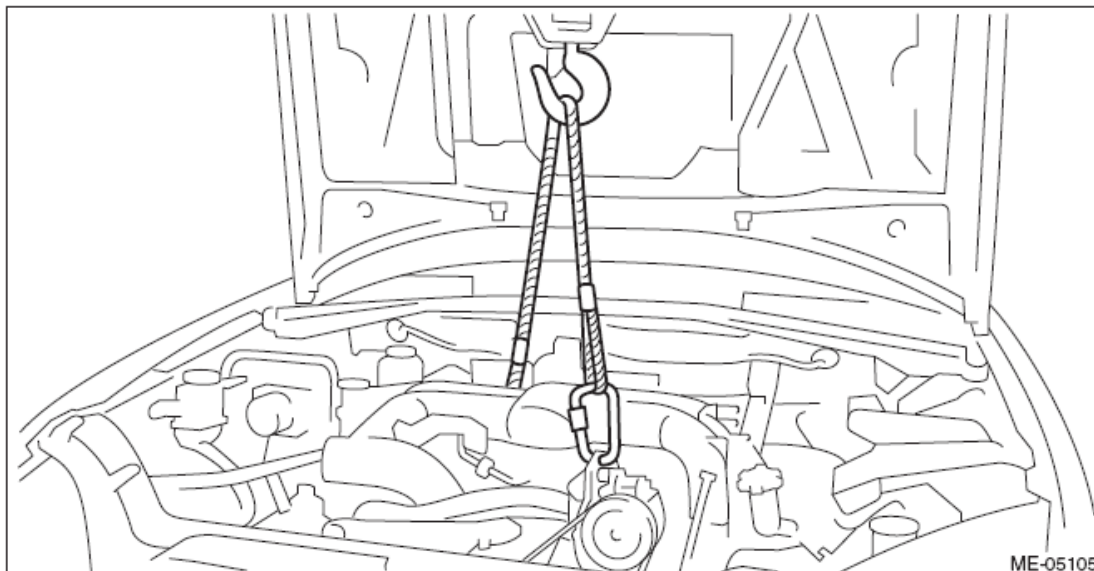


Fig. 97: Lifting Engine Using Wire Ropes
Courtesy of SUBARU OF AMERICA, INC.

8. Install the radiator main fan motor assembly and radiator sub fan motor assembly. Refer to **INSTALLATION** and **INSTALLATION**.
9. Connect the battery ground terminal.

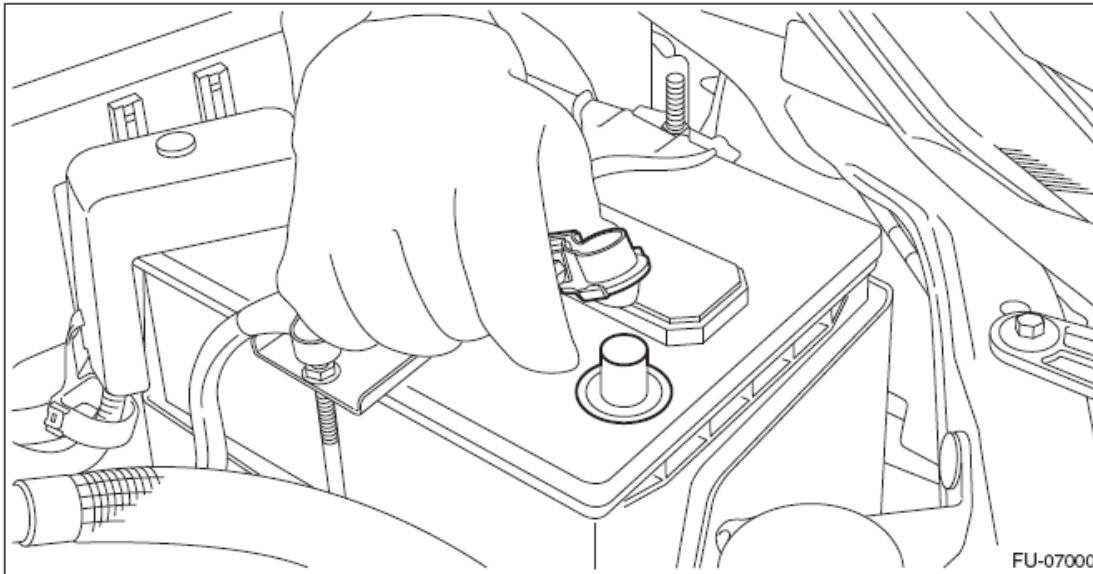


Fig. 98: Connecting/Disconnecting Battery Ground Terminal
Courtesy of SUBARU OF AMERICA, INC.

10. Change the front hood damper mounting position from (B) to (A), and close the front hood.

Tightening torque:

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

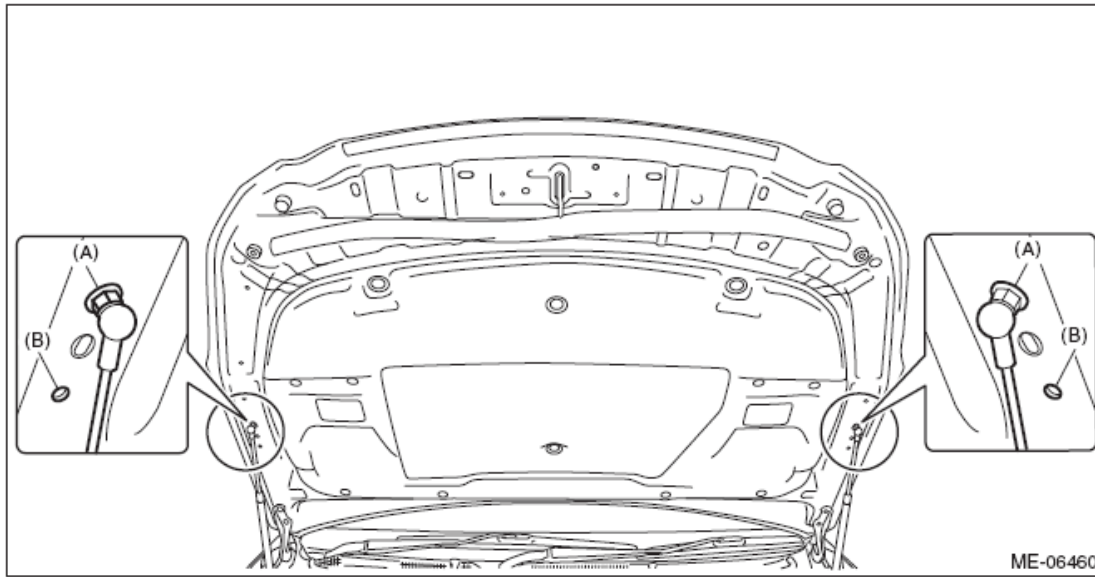


Fig. 99: Identifying Front Hood Damper Mounting Positions
 Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

Check that the engine mounting does not have deformation, cracks and any other damage.

PREPARATION FOR OVERHAUL

PROCEDURE

1. After removing the engine from the 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

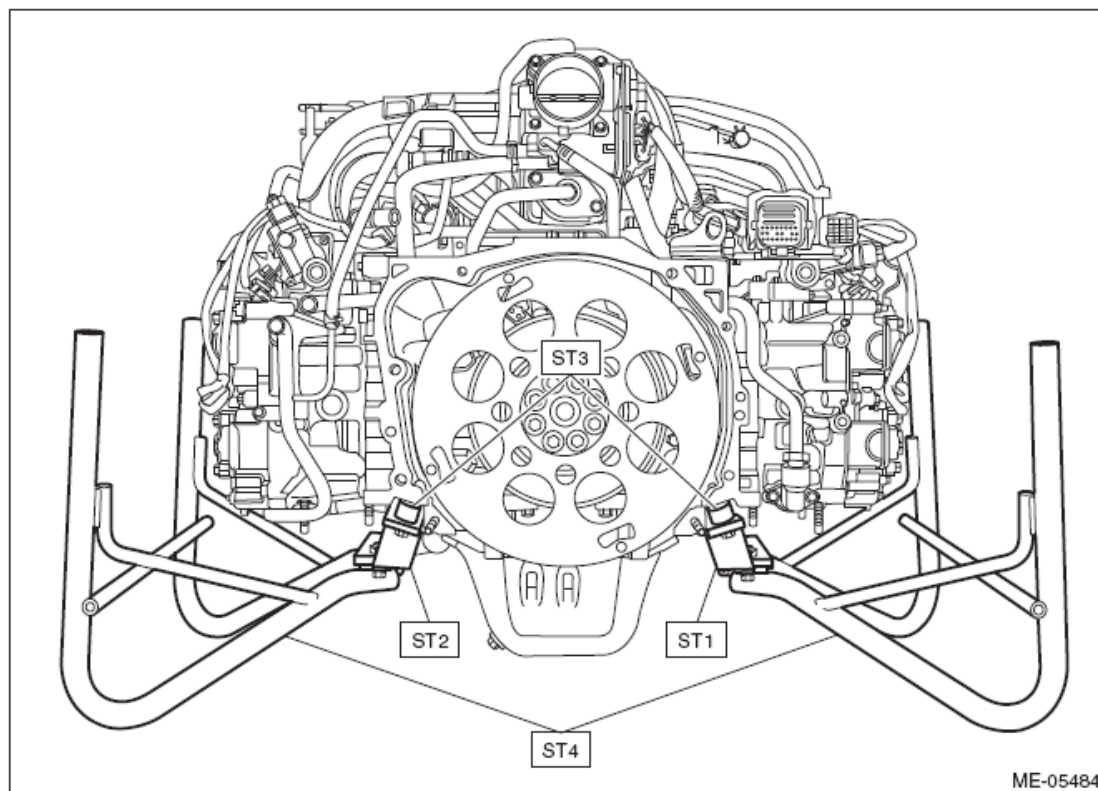


Fig. 100: Removing Engine From Vehicle Body Using Special Tools
Courtesy of SUBARU OF AMERICA, INC.

2. In this article the procedures described under each index are all connected and stated in order. The procedure for overhauling of the engine will be completed when you go through all steps in the process. Therefore, in this article, to conduct the particular procedure within the flow of a 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 assembly installed to body.

V-BELT

1. Remove the V-belt covers.

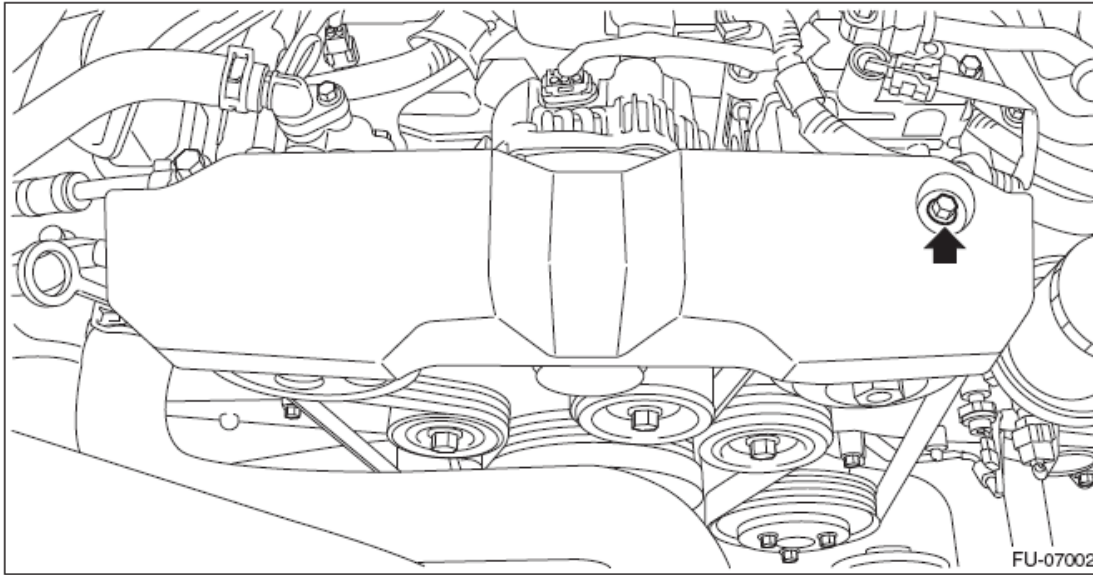


Fig. 101: Locating V-Belt Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the air intake duct. Refer to **REMOVAL**.
3. Attach the tool to the V-belt tensioner assembly, and rotate the tool clockwise to loosen and remove the V-belt.

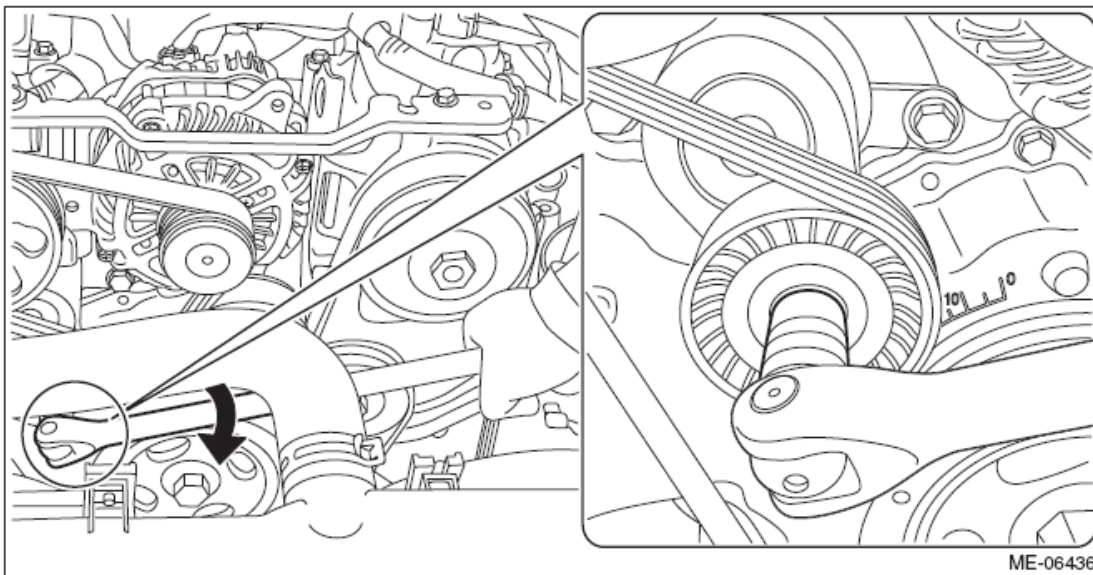


Fig. 102: Removing V-Belt Using Tool
Courtesy of SUBARU OF AMERICA, INC.

V-BELT TENSIONER ASSEMBLY AND IDLER PULLEY

1. Remove the V-belts. Refer to **V-BELT**.

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

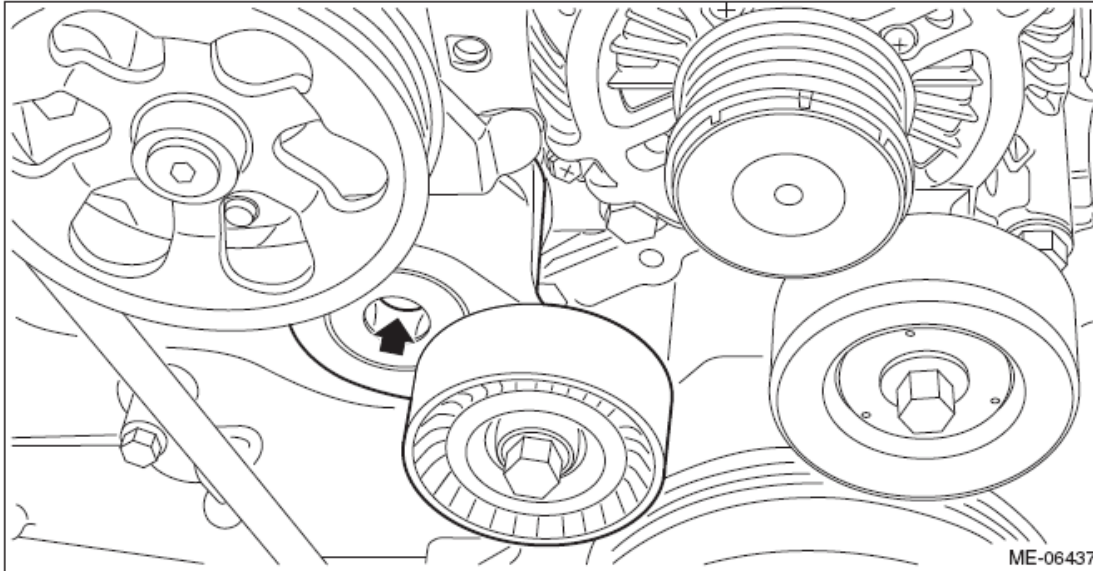


Fig. 103: Locating V-Belt Tensioner Assembly And Idler Pulley
Courtesy of SUBARU OF AMERICA, INC.

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

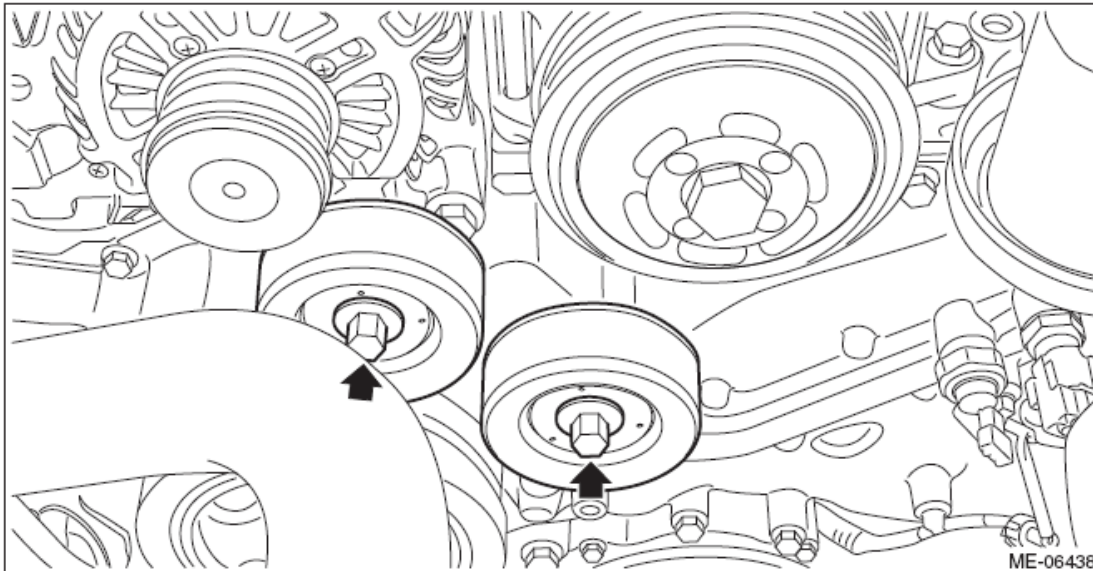


Fig. 104: Locating Idler Pulley To Chain Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

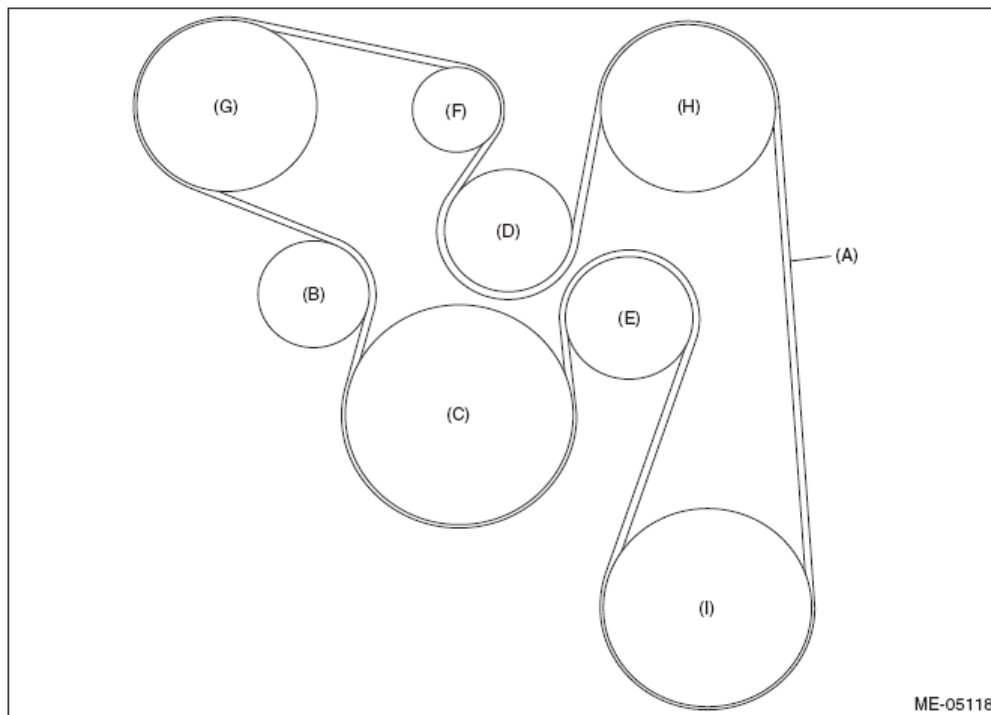
INSTALLATION

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.



- | | | |
|---------------------------|----------------------|--------------------------------|
| (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. 105: V-Belt Routing Diagram

Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

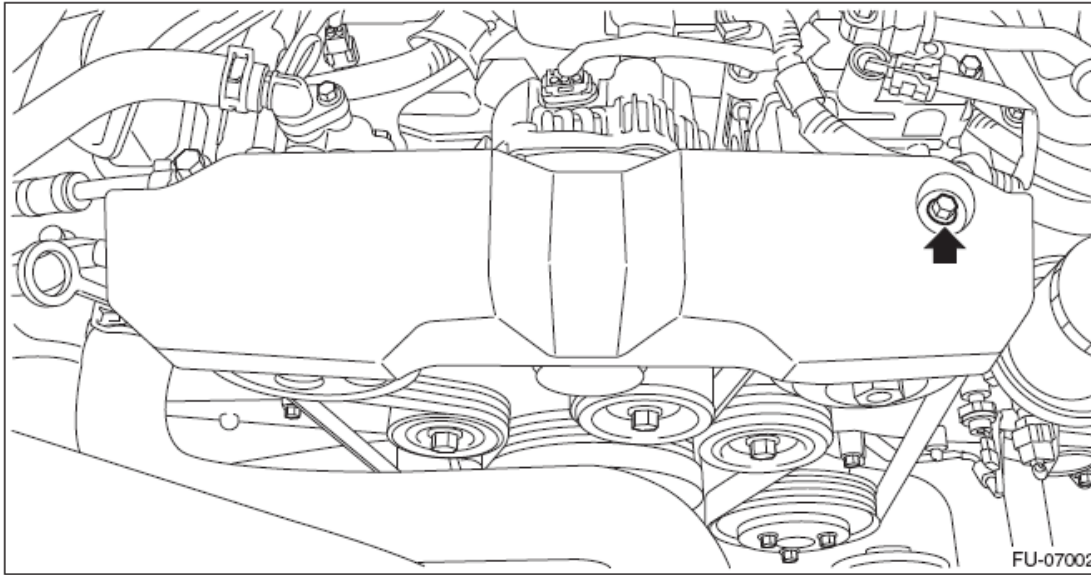
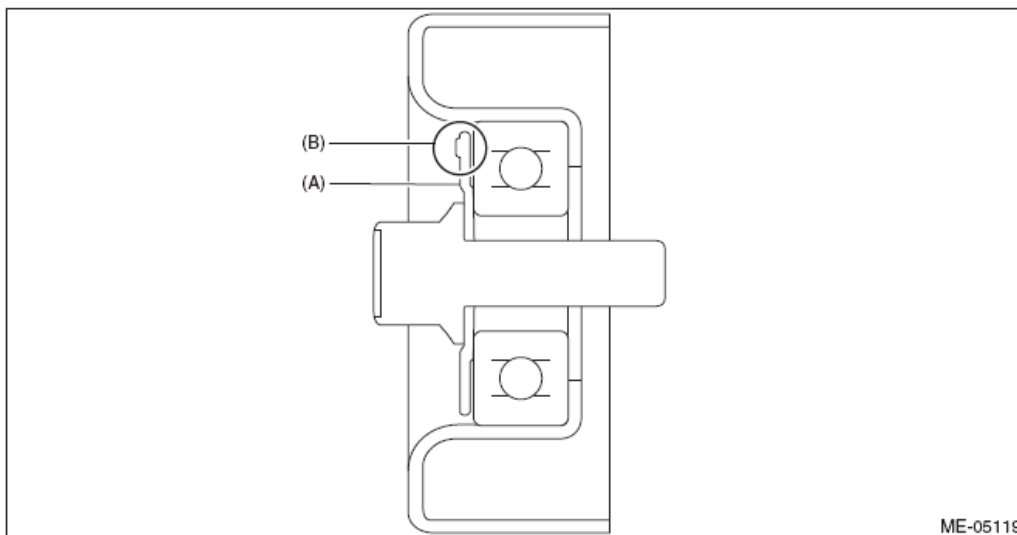


Fig. 106: Locating V-Belt Cover Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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.



- (A) Idler pulley cover (B) Protrusion (3 places)

Fig. 107: Identifying Idler Pulley Cover And Protrusion
 Courtesy of SUBARU OF AMERICA, INC.

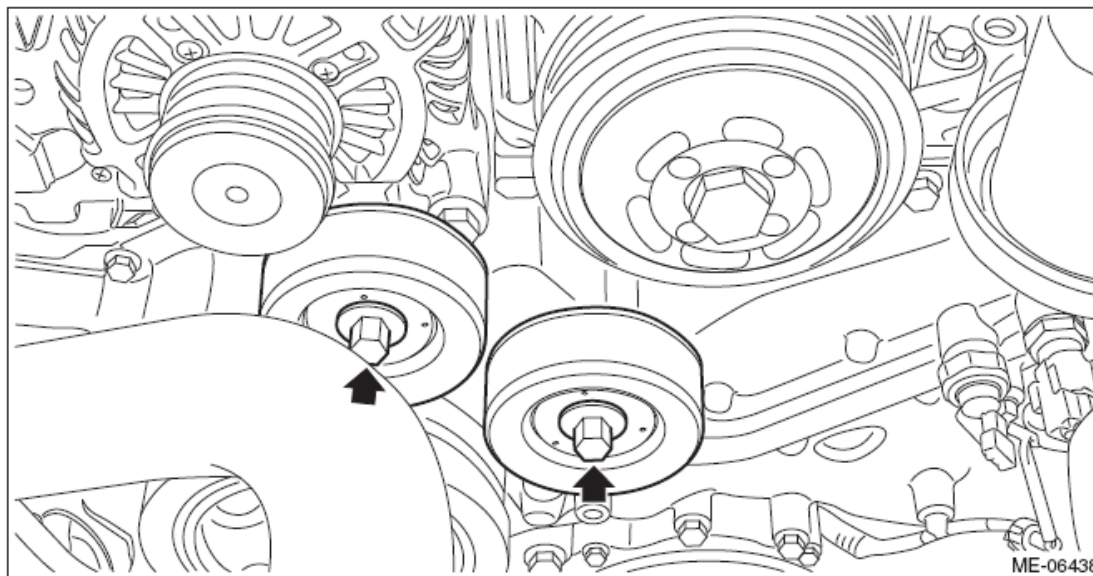
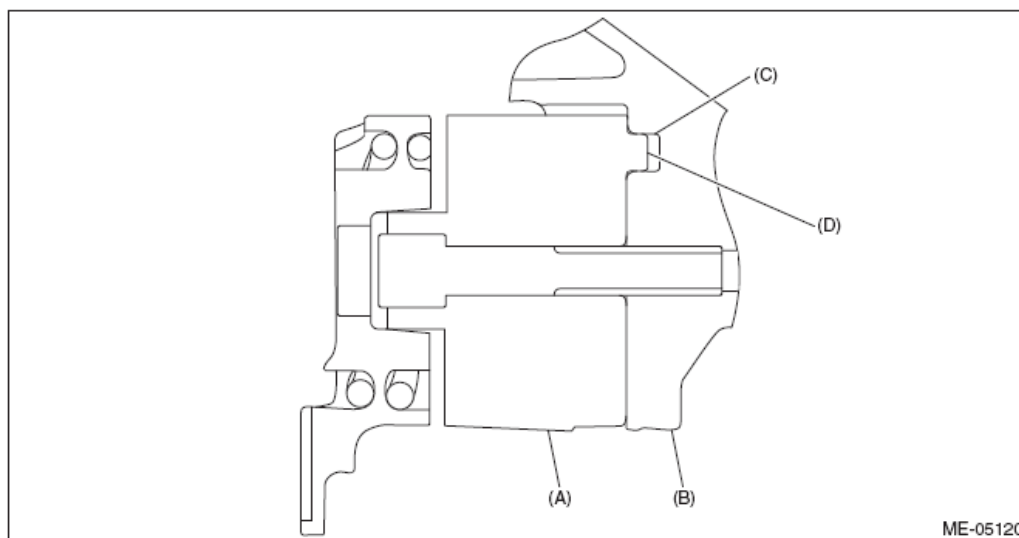
Tightening torque:***36 N.m (3.7 kgf-m, 26.6 ft-lb)***

Fig. 108: Locating Idler Pulley To Chain Cover Mounting 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. 109: Identifying V-Belt Tensioner Assembly, Hole, Protrusion Portion And Power Steering Bracket

Courtesy of SUBARU OF AMERICA, INC.

Tightening torque:

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

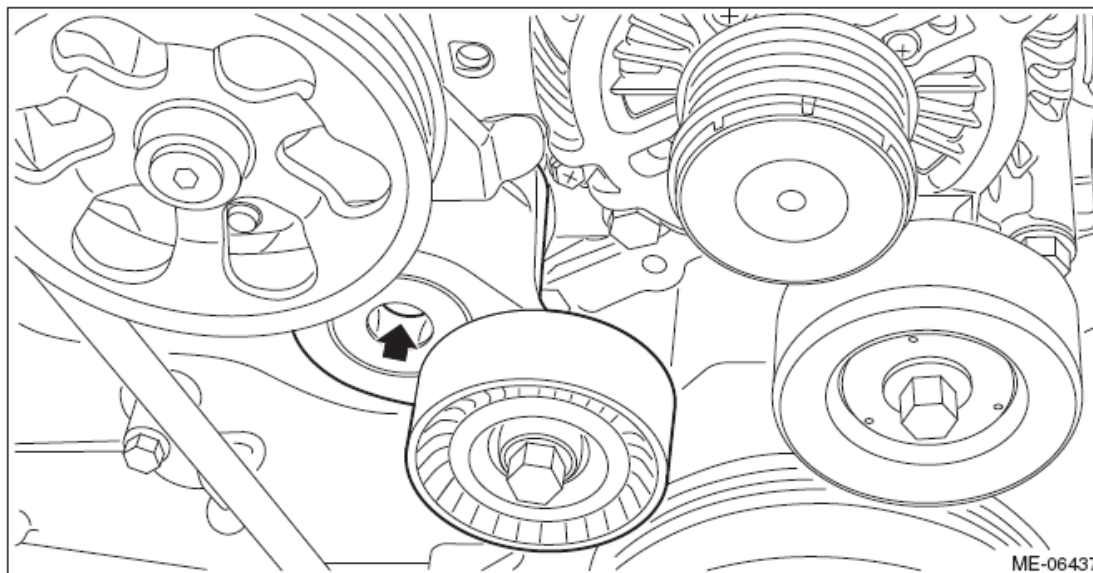


Fig. 110: Locating V-Belt Tensioner Assembly And Idler Pulley

Courtesy of SUBARU OF AMERICA, INC.

3. Install the V-belts. Refer to **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.

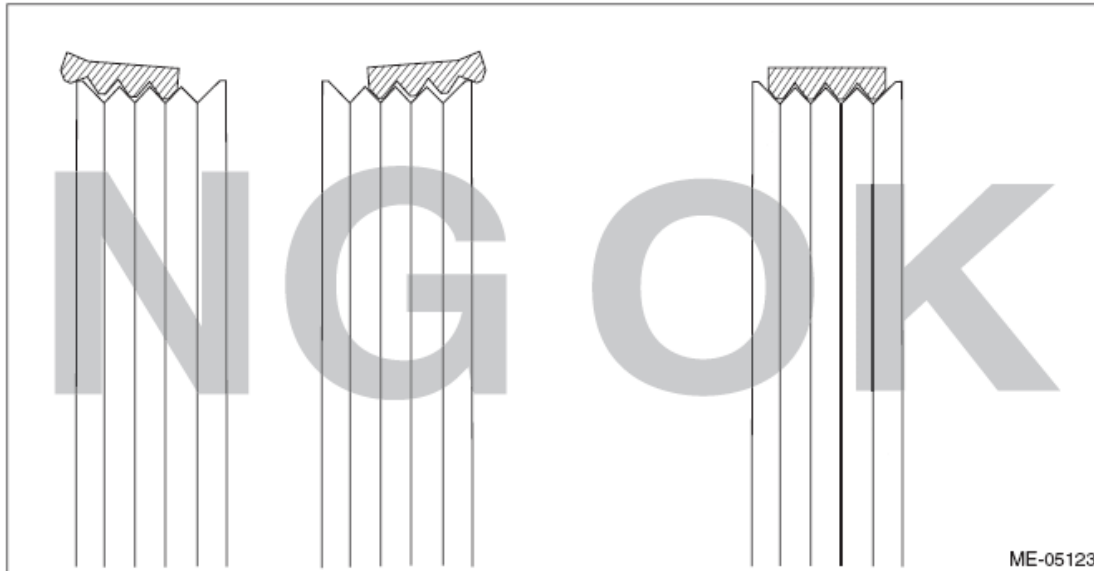


Fig. 111: Identifying Proper And Improper Condition Of V-Belt
Courtesy of SUBARU OF AMERICA, INC.

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

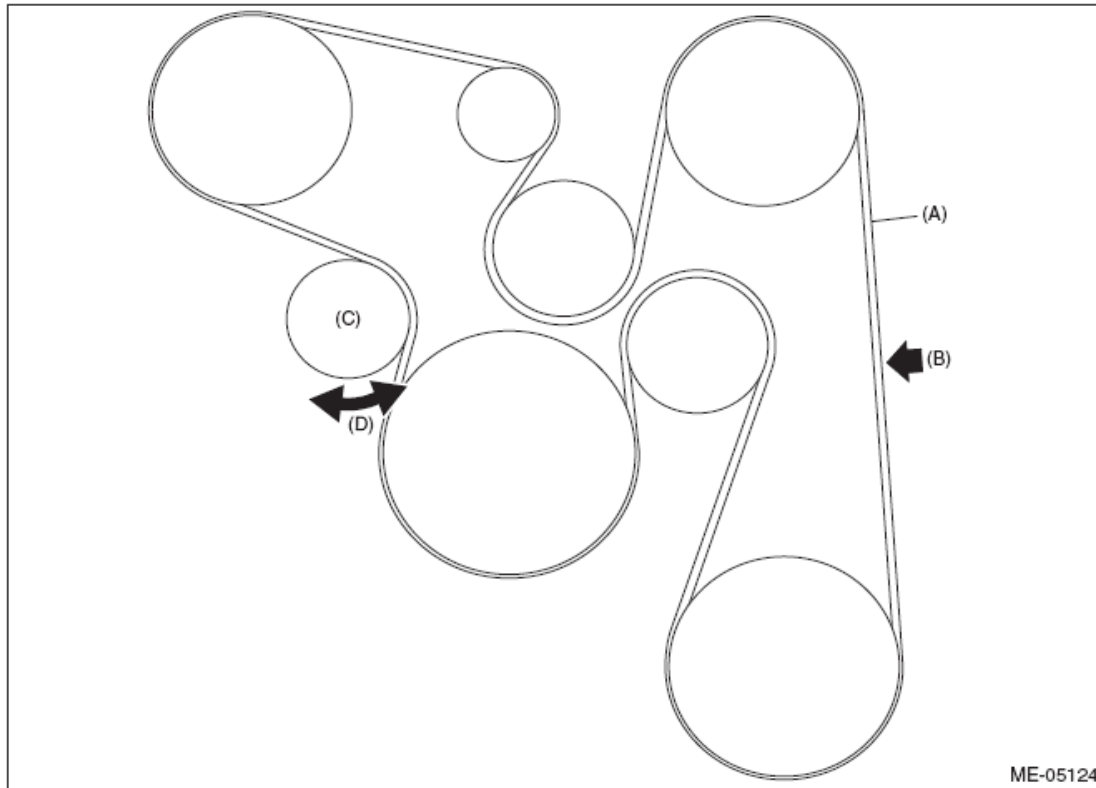


Fig. 112: V-Belt Routing Diagram
Courtesy of SUBARU OF AMERICA, INC.

CRANK PULLEY

REMOVAL

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

1. Remove the V-belts. Refer to **REMOVAL**.
2. 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

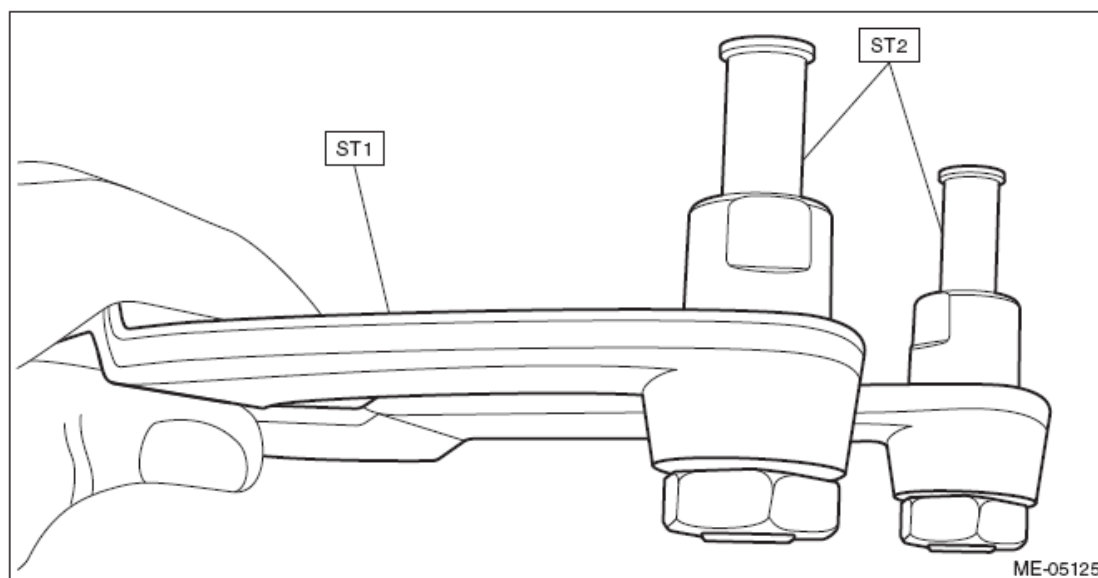


Fig. 113: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

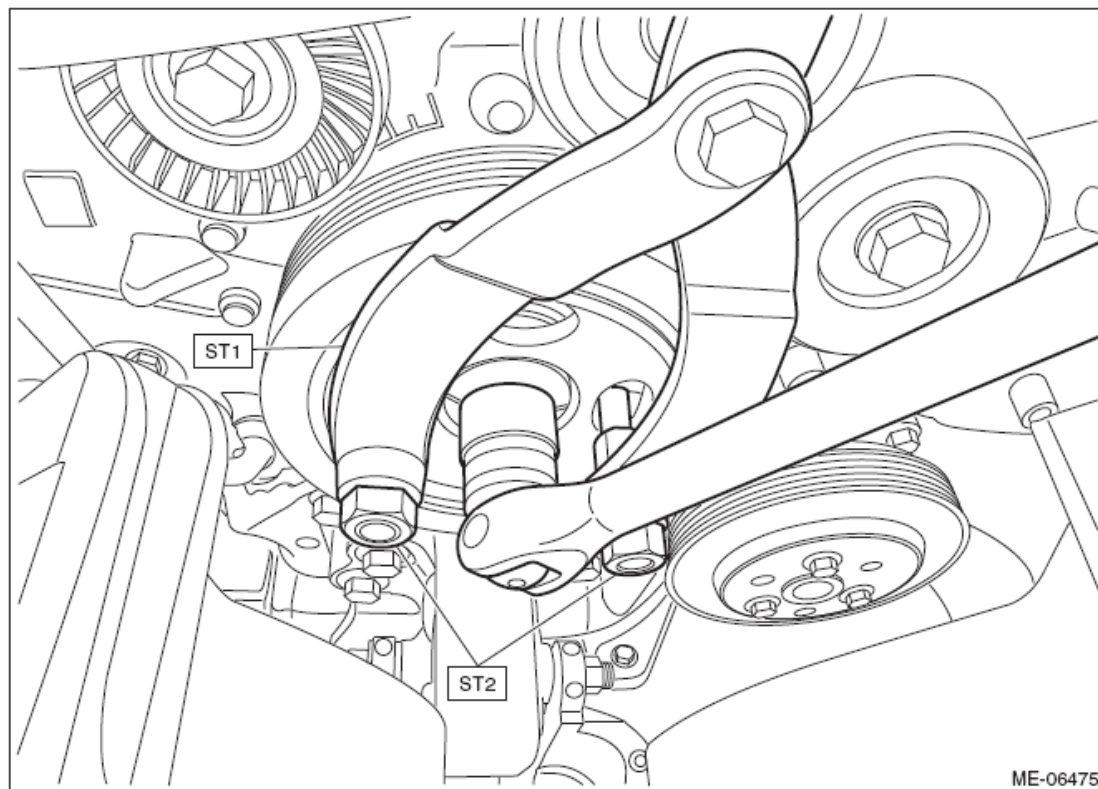


Fig. 114: Tightening Crank Pulley Bolt Using Tool

Courtesy of SUBARU OF AMERICA, INC.

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

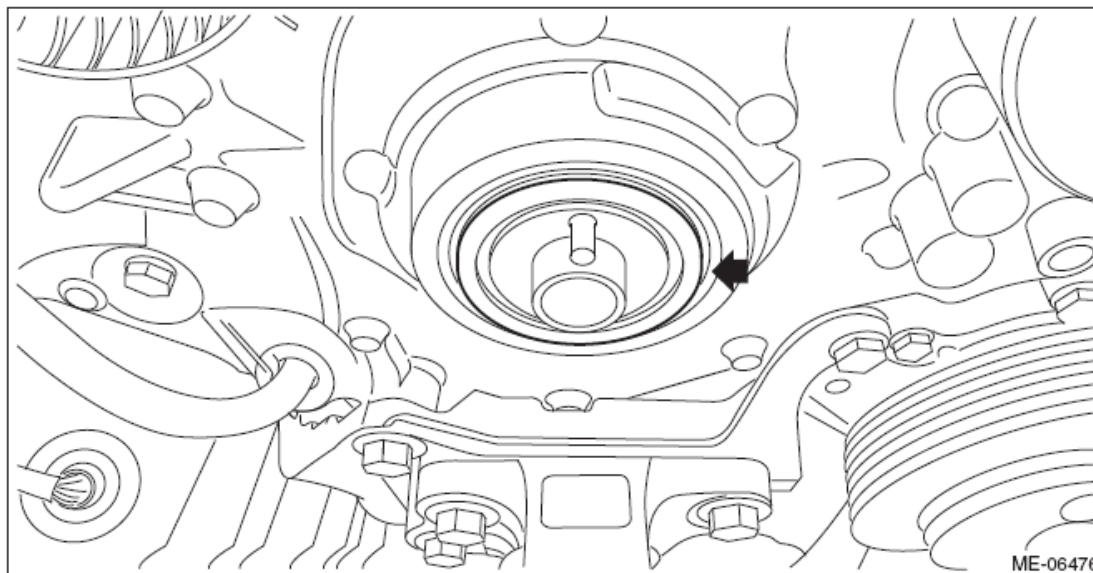


Fig. 115: Locating Crank Pulley Boss
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the front oil seal.

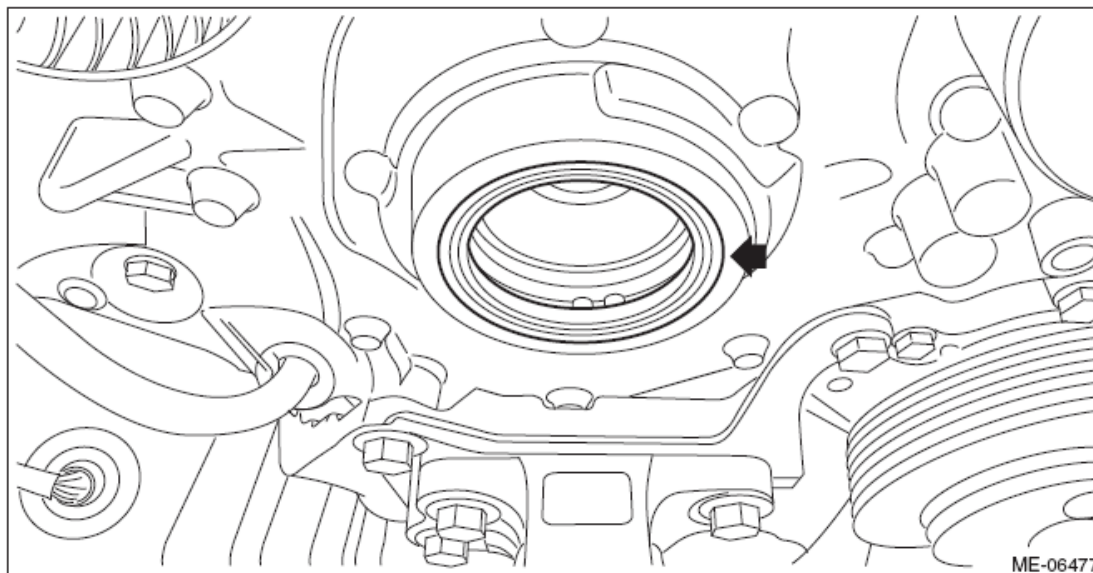


Fig. 116: Locating Front Oil Seal
Courtesy of SUBARU OF AMERICA, INC.

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.

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:

1^{+0}_{-1} mm ($0.0039^{+0}_{-0.0039}$ in) position from chain cover end face

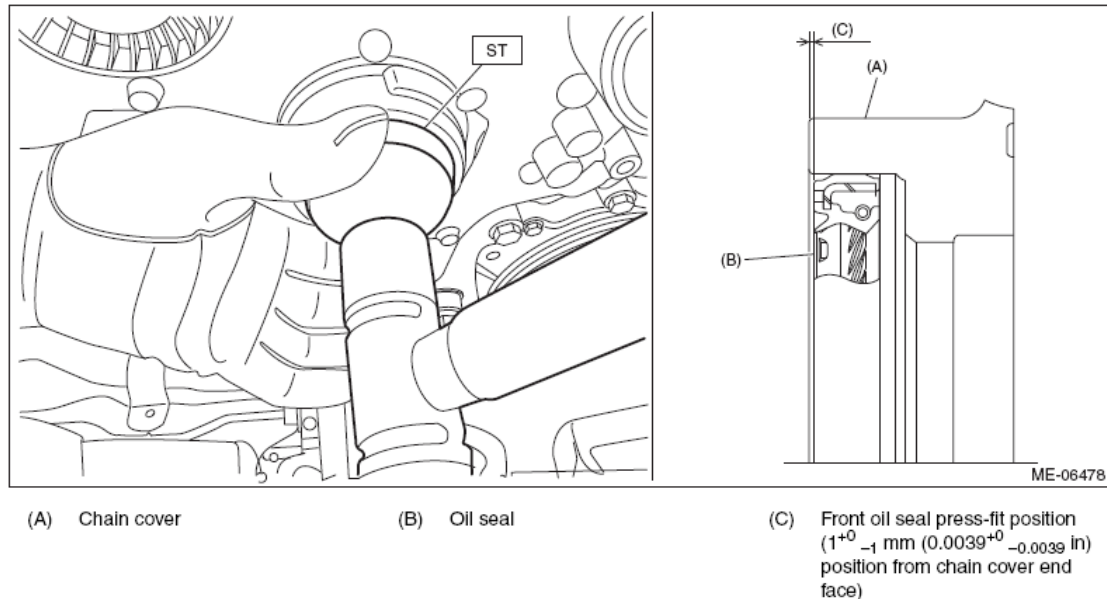


Fig. 117: Installing Front Oil Seal Using Tool
Courtesy of SUBARU OF AMERICA, INC.

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

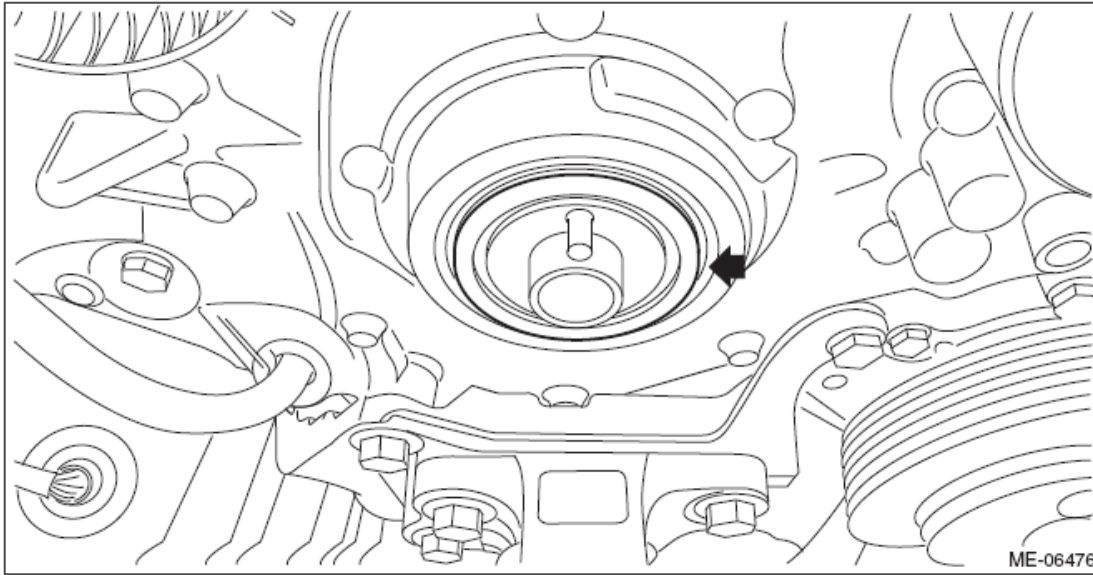


Fig. 118: Locating Crank Pulley Boss
Courtesy of SUBARU OF AMERICA, INC.

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

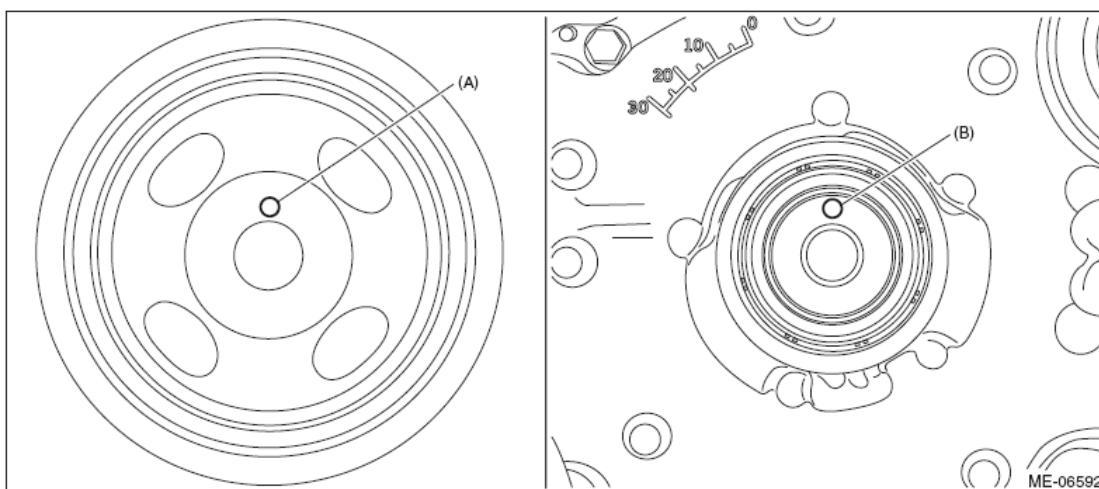


Fig. 119: Identifying Crank Pulley Knock Hole And Crank Pulley Boss Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

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

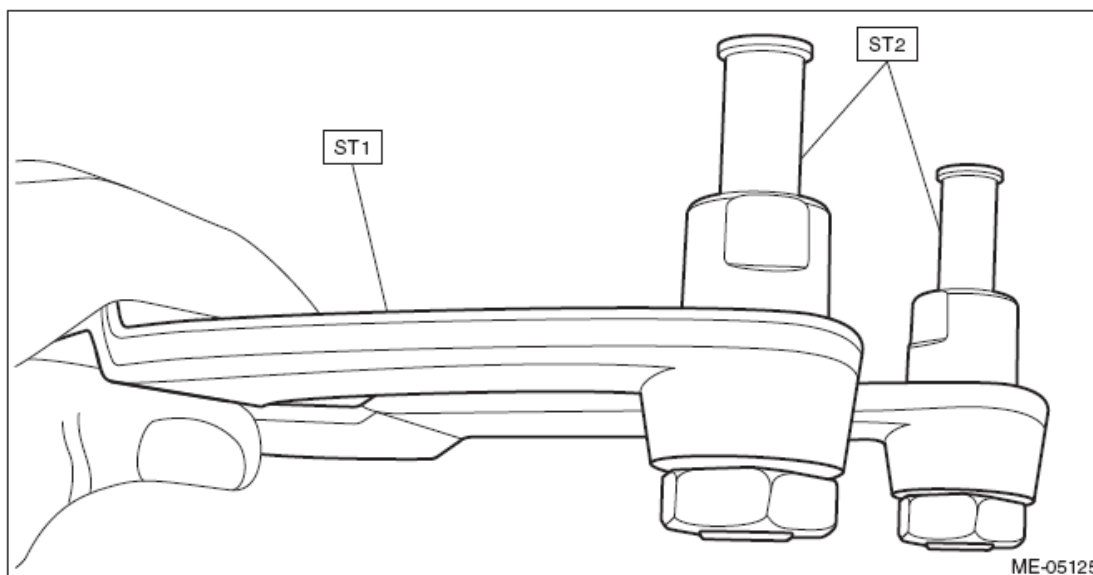


Fig. 120: Removing Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

ST1 18355AA000 PULLEY WRENCH

ST2 18334AA000 PULLEY WRENCH PIN SET

Tightening torque:

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

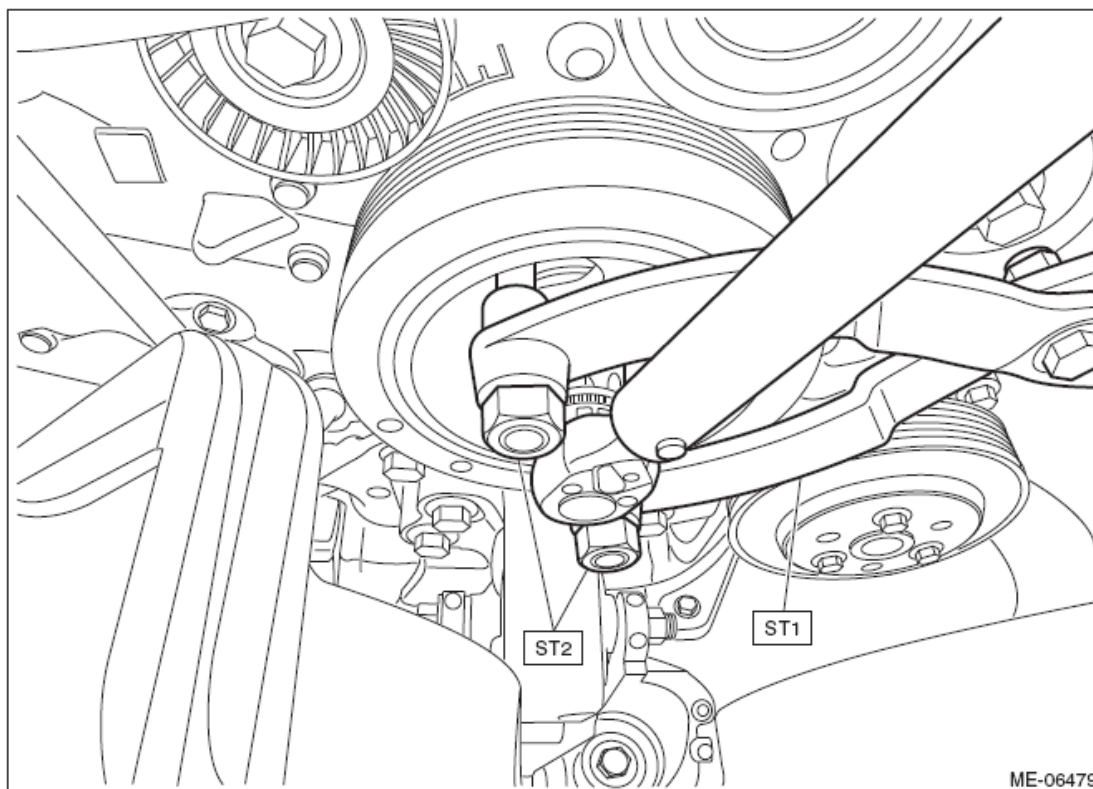
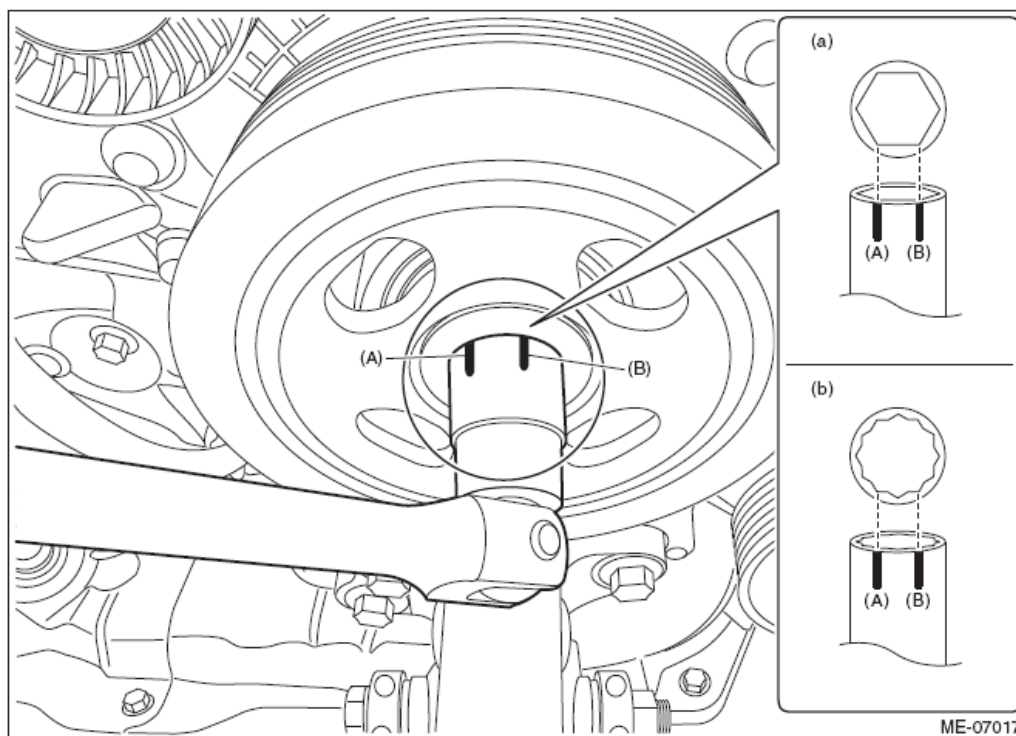


Fig. 121: Tightening Crank Pulley Bolt
Courtesy of SUBARU OF AMERICA, INC.

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. 122: Drawing Reference Lines (A) And (B) Using Marker
 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).

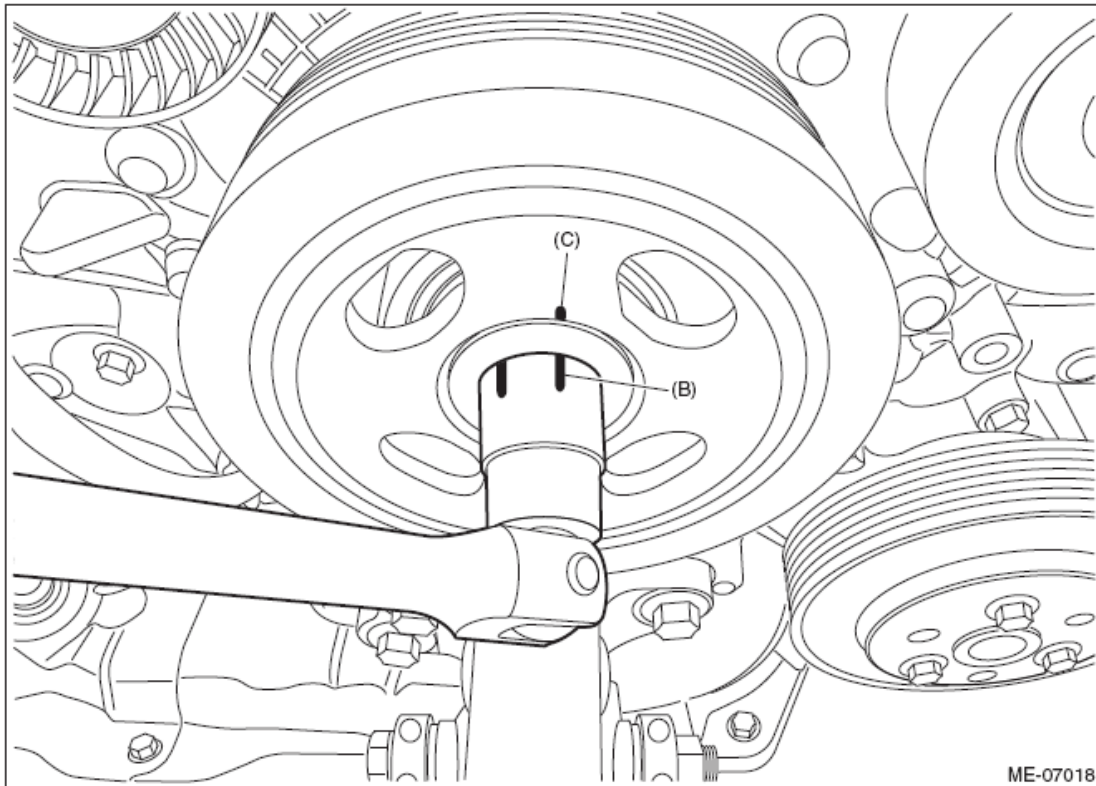


Fig. 123: Drawing End Line (C) On Crank Pulley Using Marker
Courtesy of SUBARU OF AMERICA, INC.

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°

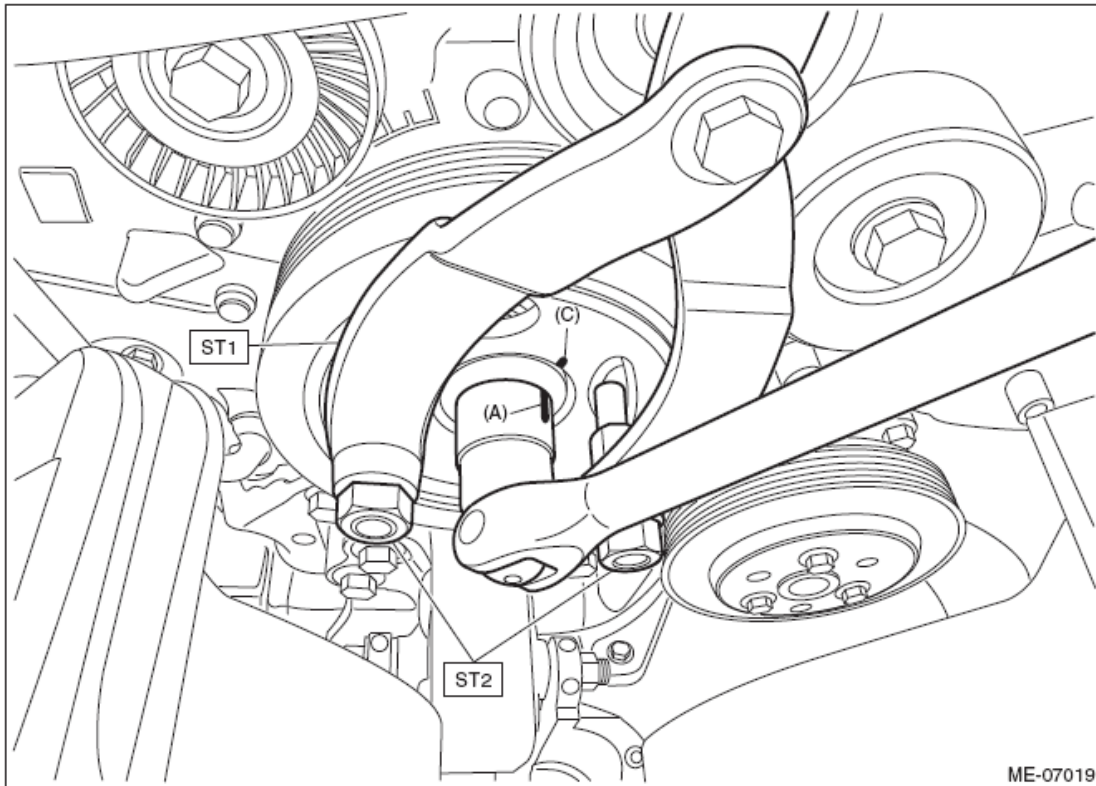


Fig. 124: Tightening Crank Pulley Bolt Using Tool
Courtesy of SUBARU OF AMERICA, INC.

6. Install the V-belts. Refer to **INSTALLATION**.

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**.

CHAIN COVER

REMOVAL

NOTE: When replacing a single part, perform the work with the engine assembly 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**.

2. Remove the front exhaust pipe. Refer to **REMOVAL** .
3. Remove the engine mounting. Refer to **REMOVAL**.
4. Remove the bolts which secure the generator cord stay to the chain cover.

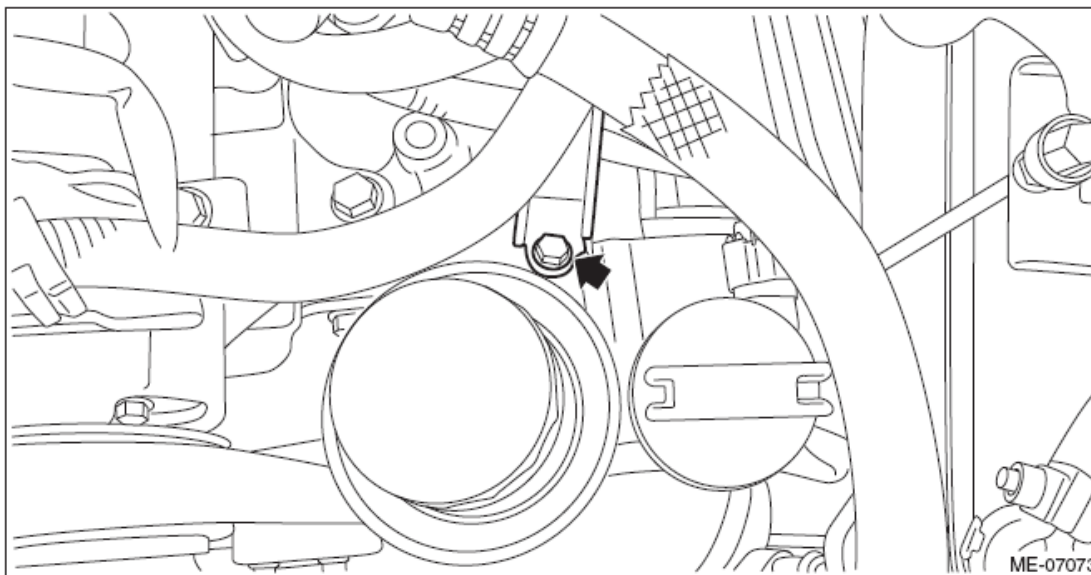


Fig. 125: Locating Generator Cord Stay Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the power steering pump.
1. Remove the V-belts. Refer to **REMOVAL**.
2. Remove the generator. Refer to **REMOVAL** .
3. Disconnect the connector from the power steering pump switch.

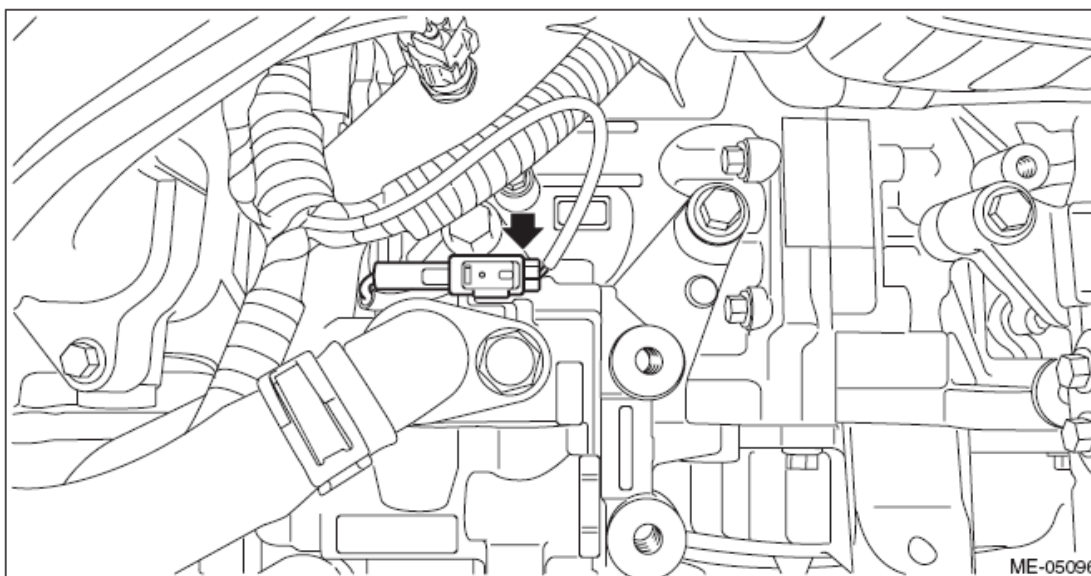


Fig. 126: Locating Power Steering Pump Switch Connector
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the power steering pump from the engine.

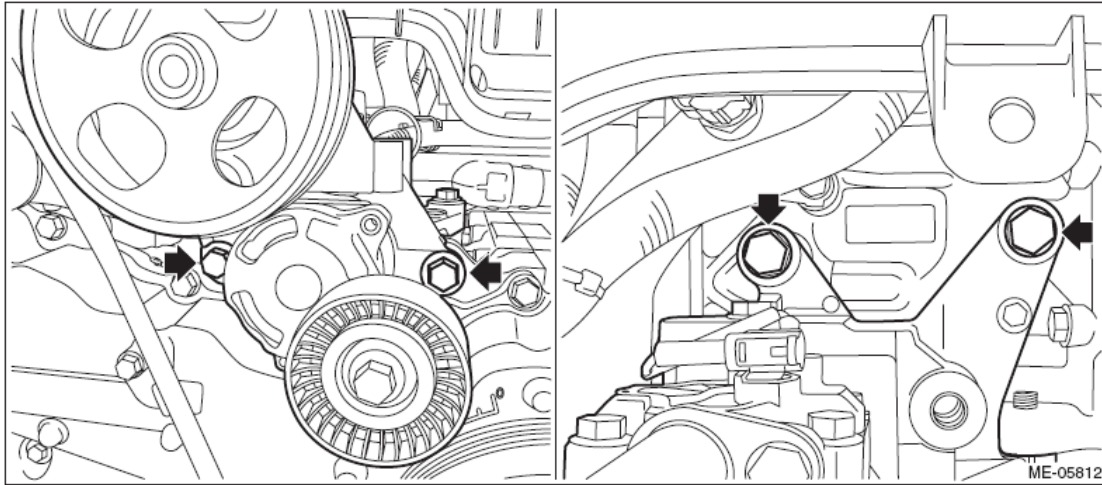


Fig. 127: Locating Engine Power Steering Pump Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Place the power steering pump on the right side wheel apron.
2. Drain the engine oil. Refer to **REPLACEMENT**.
3. Remove the water pump pulley. Refer to **WATER PUMP**.
4. Remove the crank pulley. Refer to **REMOVAL**.
5. Remove the engine harness stay from the chain cover.

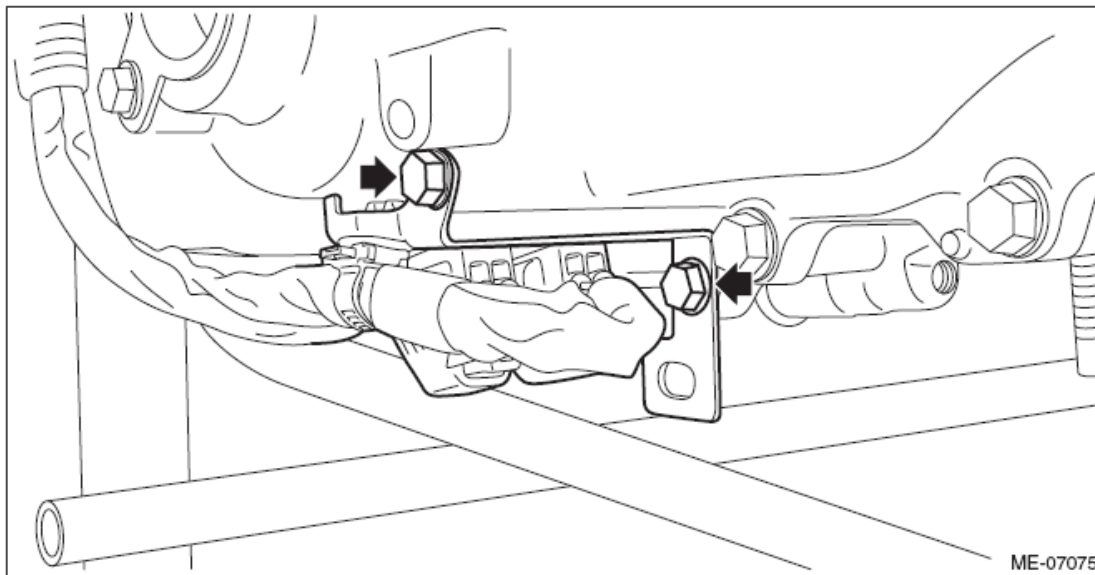


Fig. 128: Locating Engine Harness Stay Mounting Bolts

Courtesy of SUBARU OF AMERICA, INC.

6. 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.

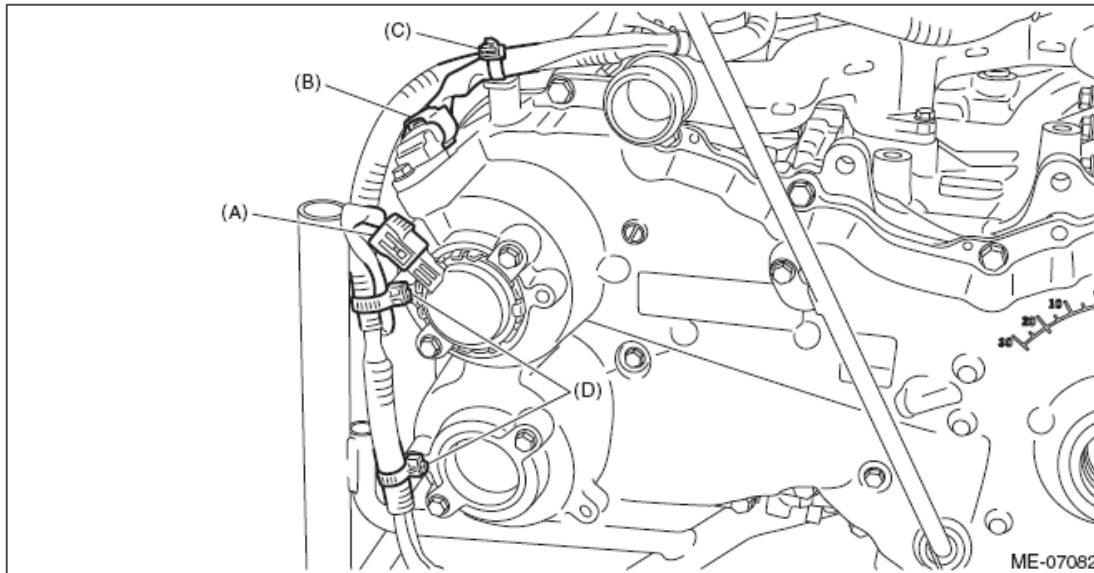


Fig. 129: Identifying Oil Control Solenoid And Camshaft Position Sensor RH Connectors With Harness Mounting Clips

Courtesy of SUBARU OF AMERICA, INC.

7. Disconnect the connectors from the oil level switch, and remove the clip (A) which secure the oil level switch harness.

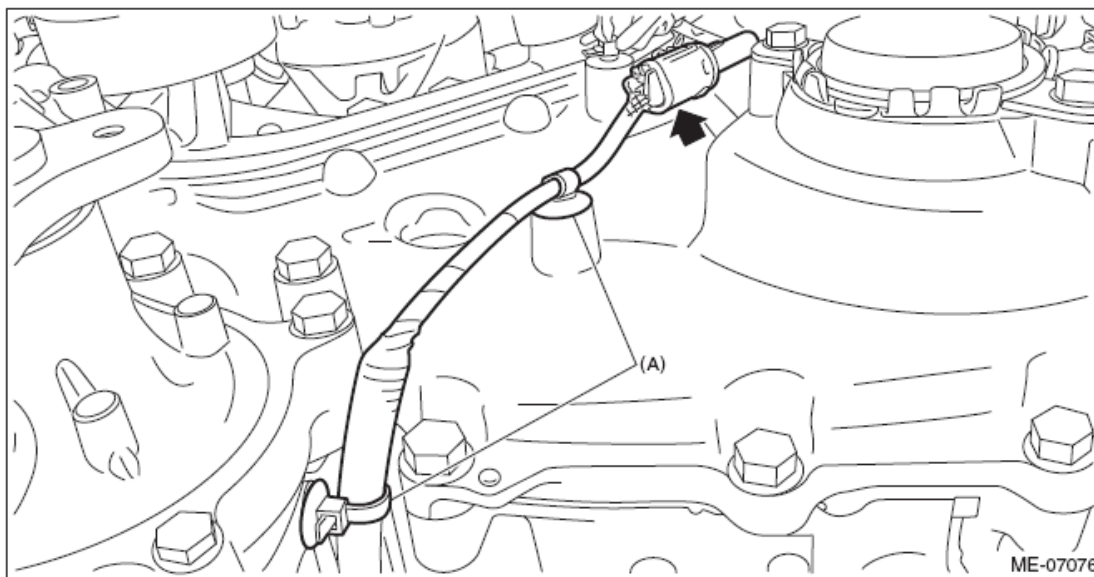


Fig. 130: Locating Oil Level Switch Connector

Courtesy of SUBARU OF AMERICA, INC.

8. 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.

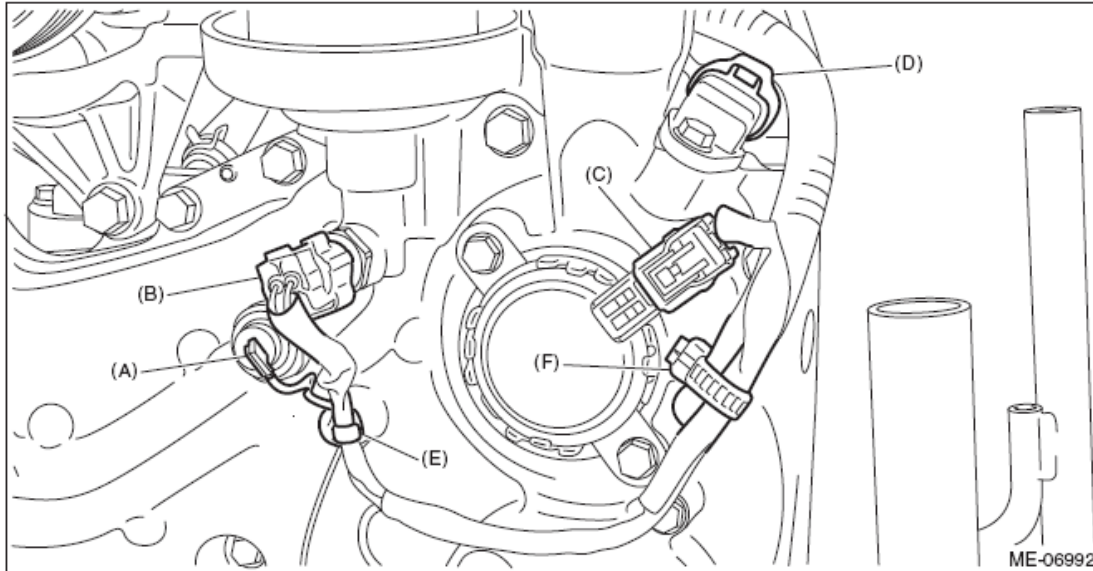


Fig. 131: Identifying Oil Pressure Switch And Oil Control Solenoid LH Connectors, Terminals And Clips
Courtesy of SUBARU OF AMERICA, INC.

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

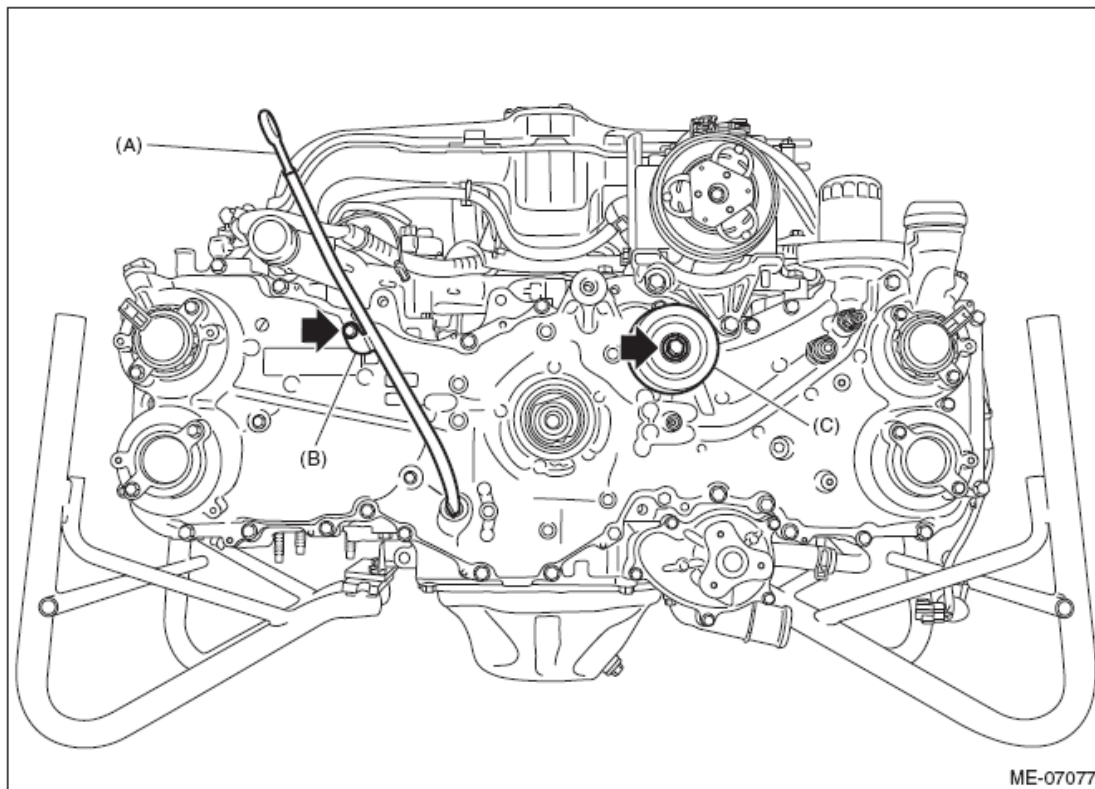


Fig. 132: Locating Oil Level Gauge Guide And Idler Pulley Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

10. Remove the chain cover.

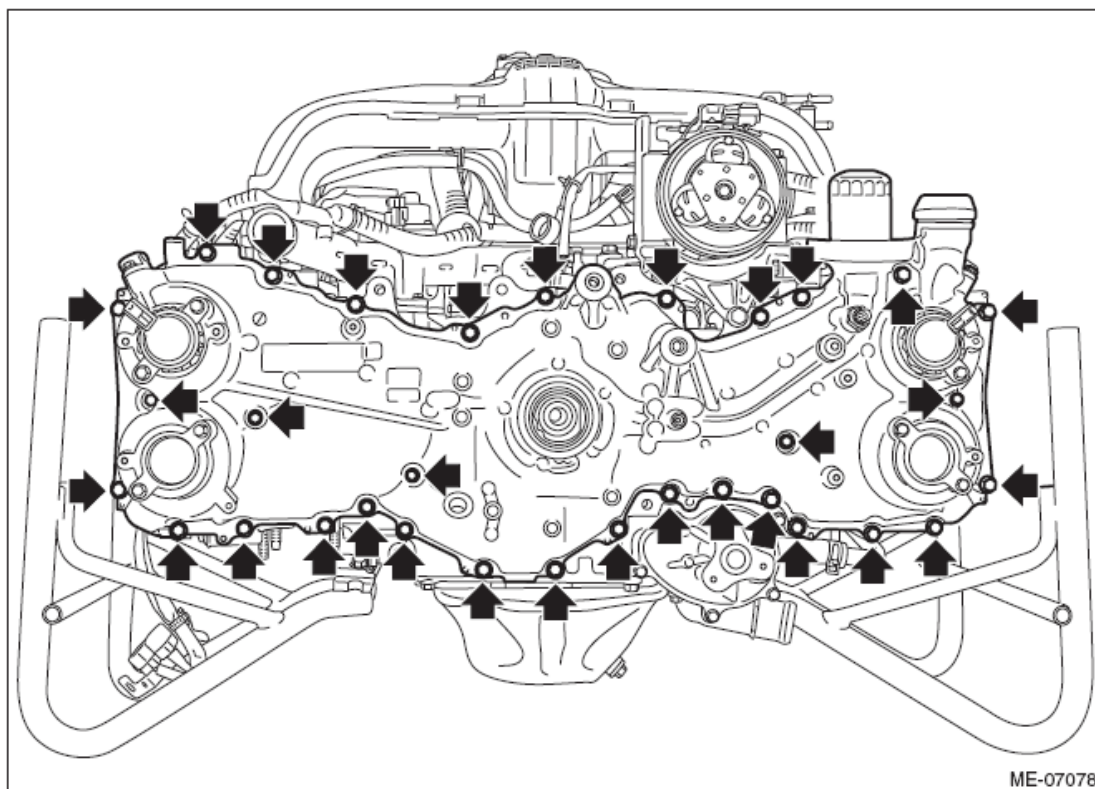


Fig. 133: Locating Chain Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

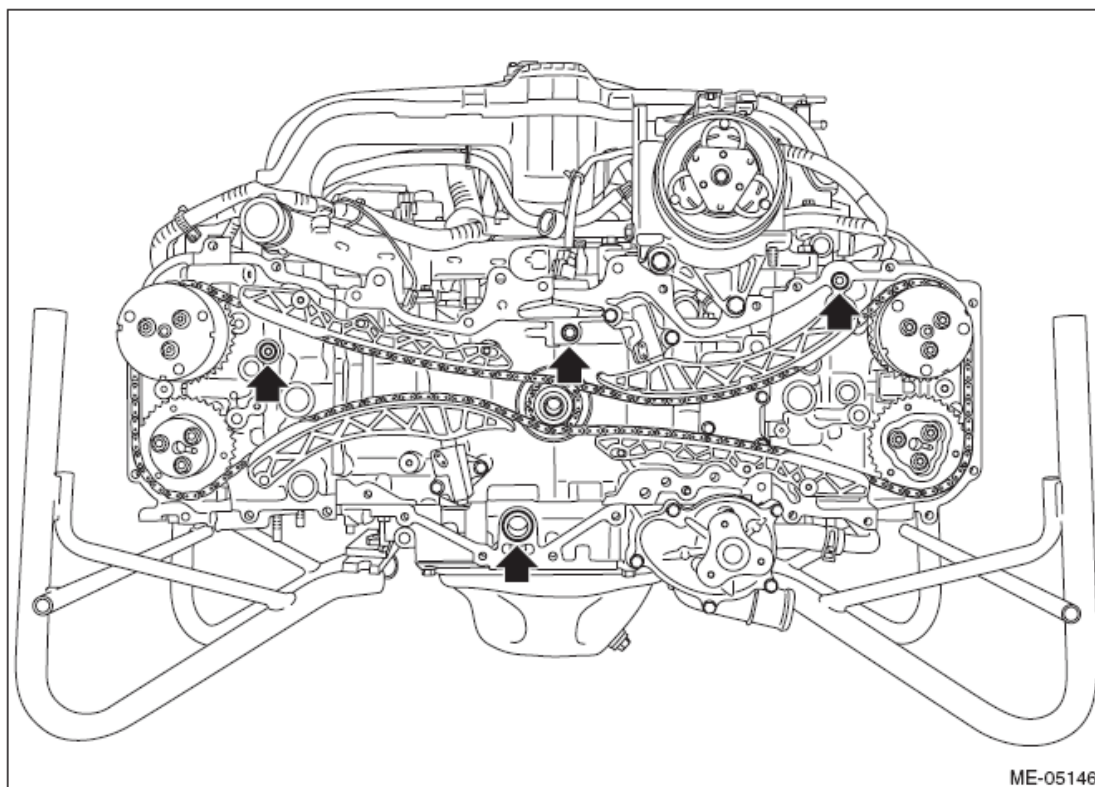


Fig. 134: Removing/Installing Cylinder Head, Block And O-Rings
Courtesy of SUBARU OF AMERICA, INC.

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

INSTALLATION

1. 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.

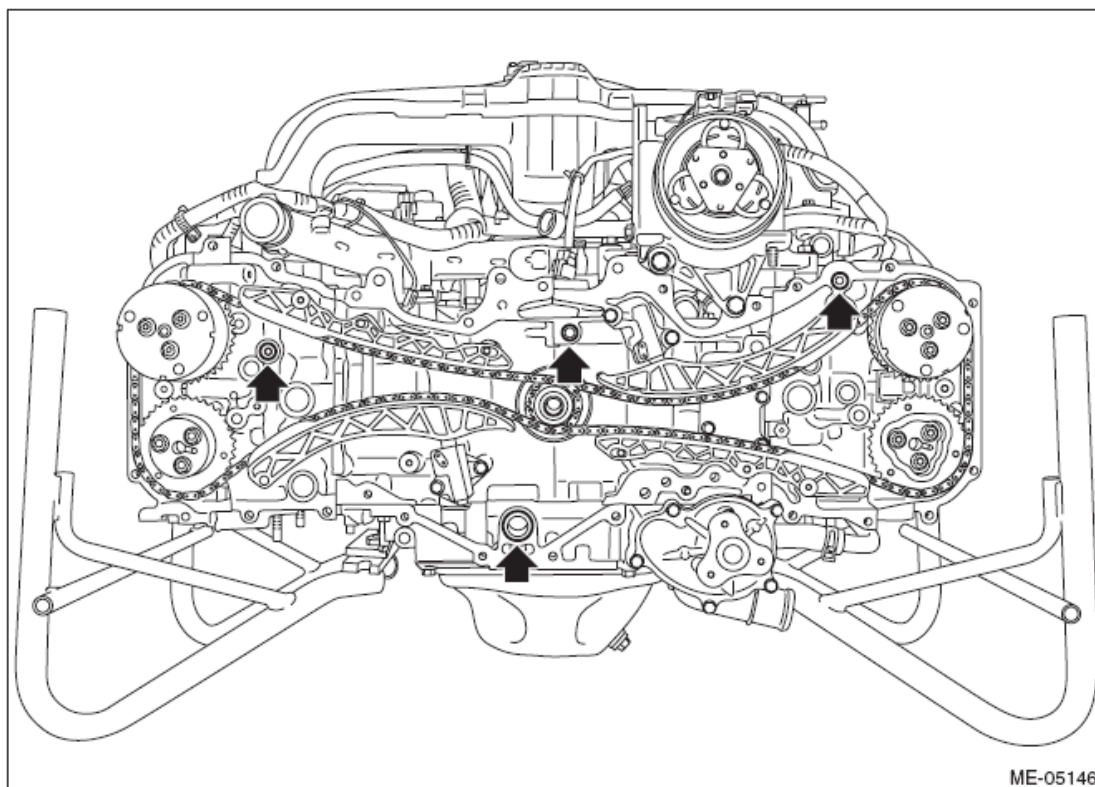


Fig. 135: Removing/Installing Cylinder Head, Block And O-Rings
Courtesy of SUBARU OF AMERICA, INC.

2. Apply liquid gasket if there are gaps between front camshaft cap and cam carrier (A), cam carrier and cylinder head (B), and cylinder head and cylinder block (C) as shown in the figure.

Liquid gasket:

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

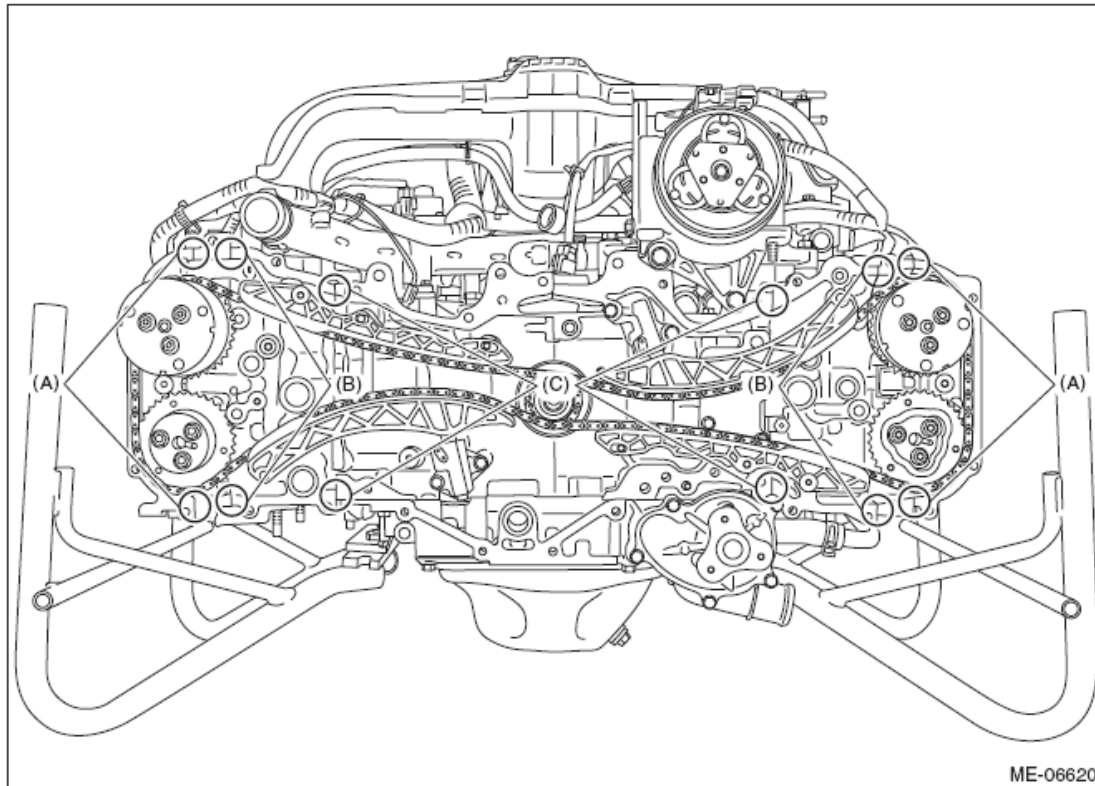


Fig. 136: Identifying Liquid Gasket Applying Area On Gaps Between Front Camshaft Cap And Cam Carrier, Cam Carrier And Cylinder Head And Cylinder Head And Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

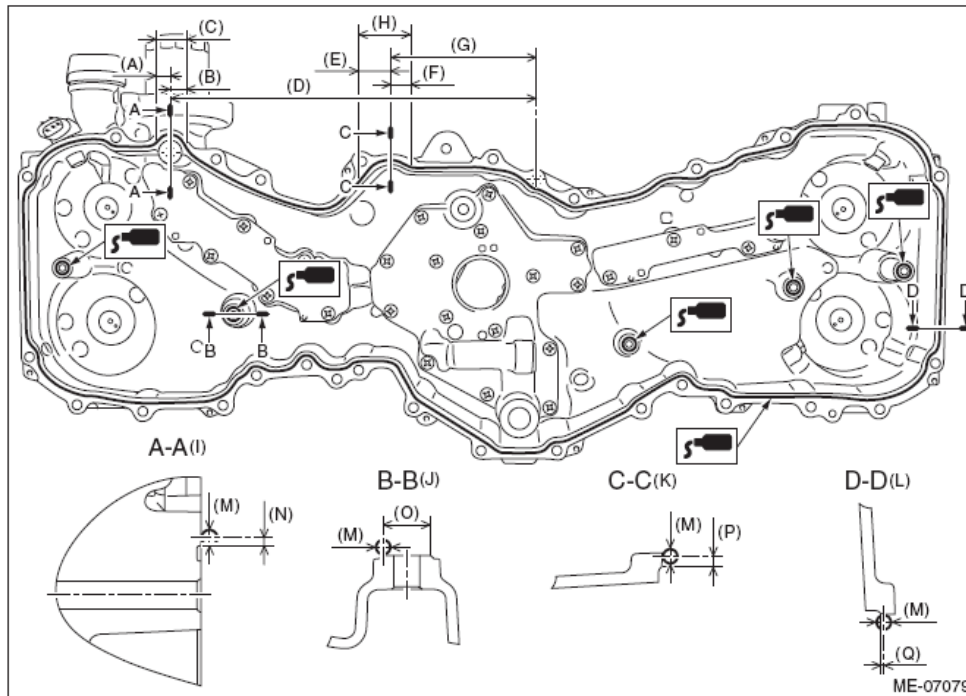
- Before applying liquid gasket, degrease the old liquid gasket seal surface of the engine and chain cover.
- Install within 5 min. after applying liquid gasket.

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) $\phi 4 \pm 0.5$ mm (0.1575 $\pm$ 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) $\phi 12$ 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. 137: Identifying Liquid Gasket Applying Area On Chain Cover Mating Surface And Center Boss

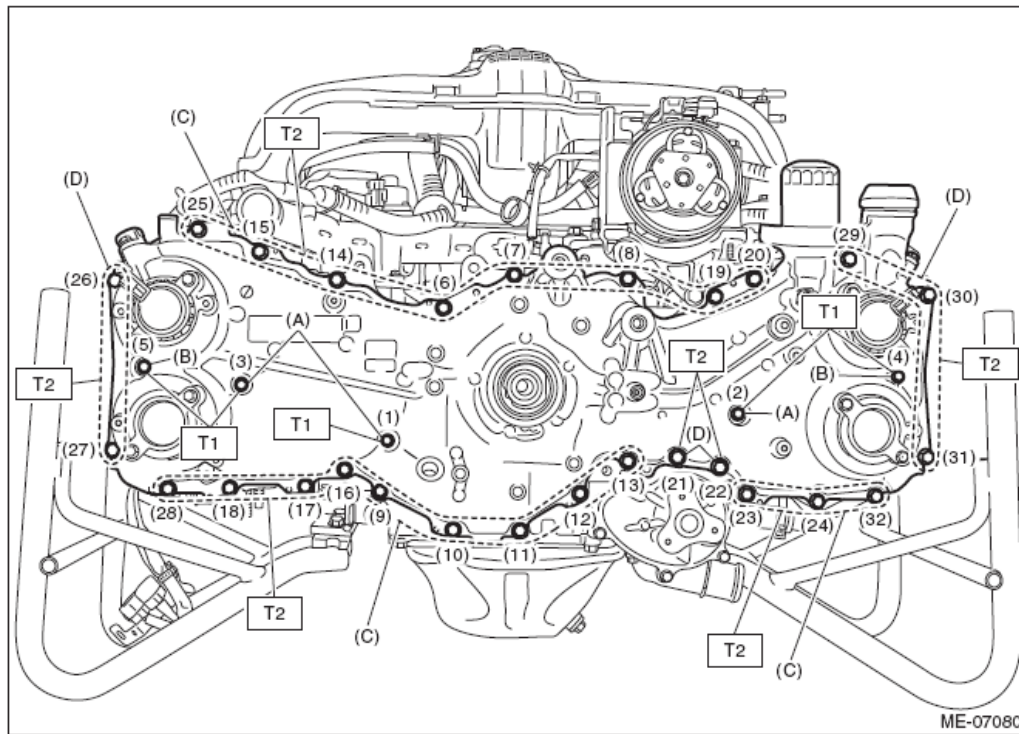
Courtesy of SUBARU OF AMERICA, INC.

- 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 × 20
(B) M6 × 50

(C) M8 × 25

(D) M8 × 60

Fig. 138: Identifying Tightening Sequence Of Chain Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. 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)

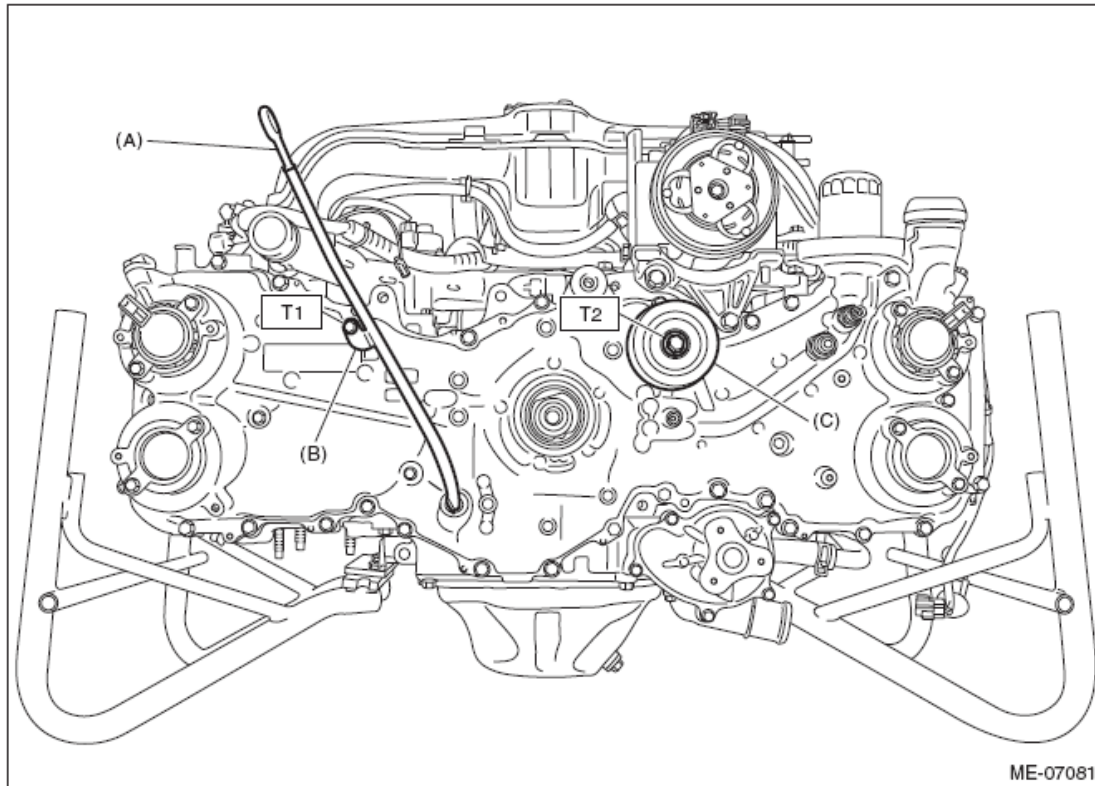


Fig. 139: Locating Oil Level Gauge Guide And Oil Level Gauge Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

6. 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).

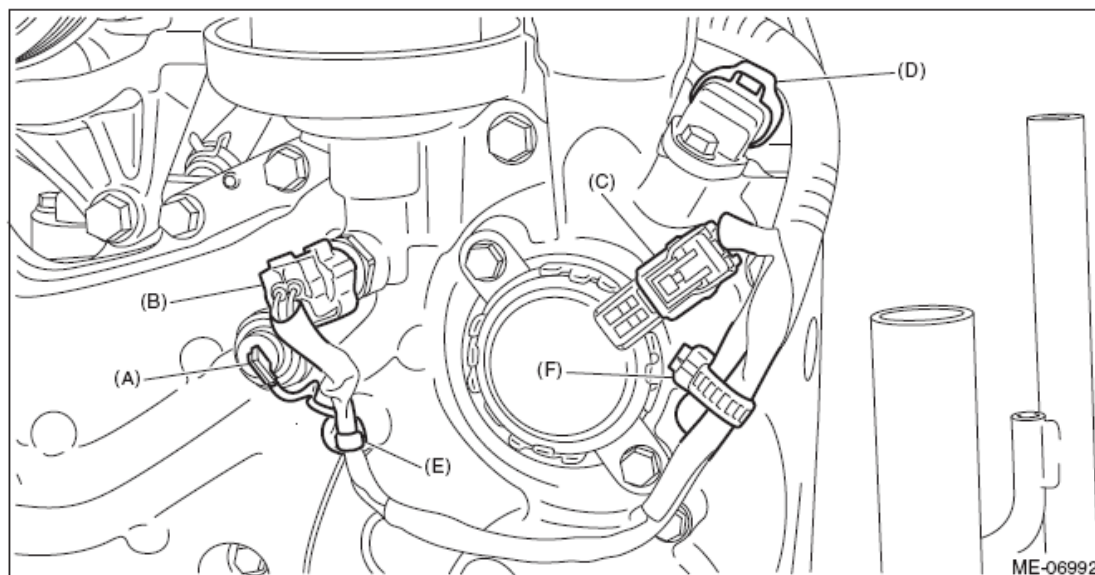
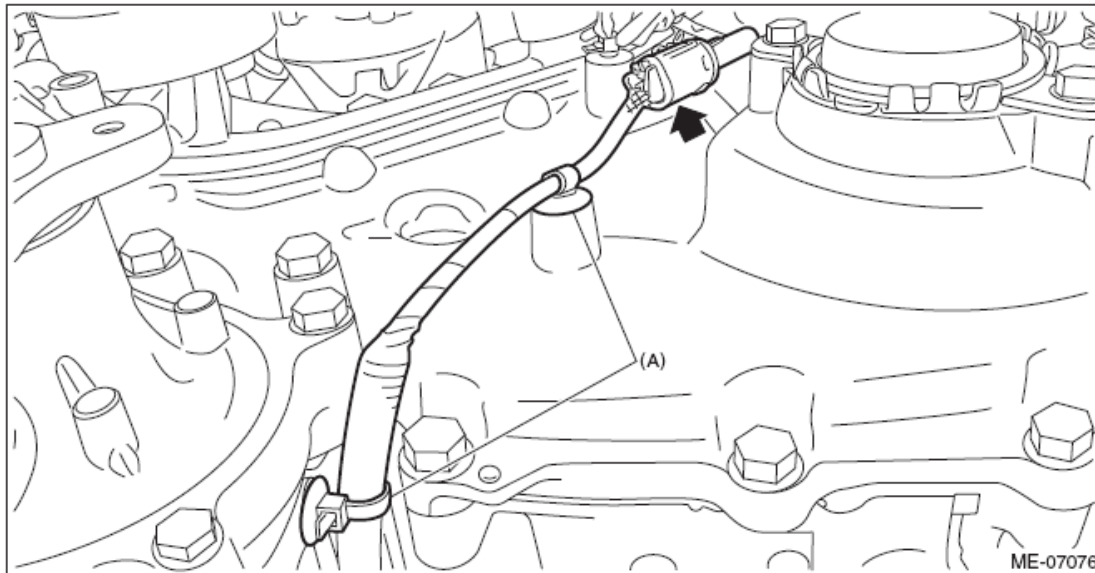


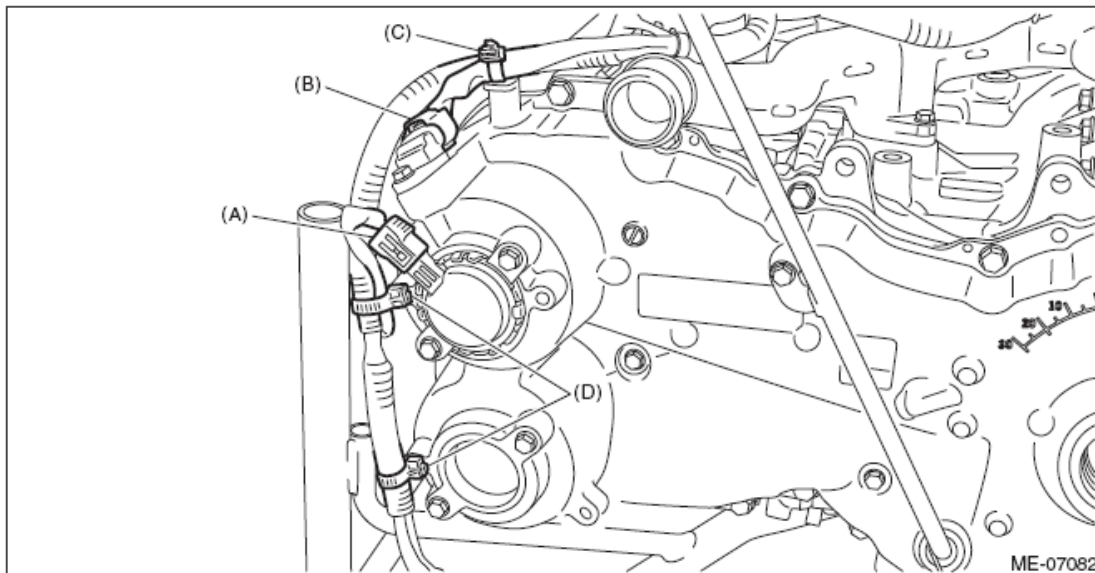
Fig. 140: Identifying Oil Pressure Switch And Oil Control Solenoid LH Connectors, Terminals And

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

7. Secure the oil level switch harness with clips (A), and connect the connectors to the oil level switch.

**Fig. 141: Locating Oil Level Switch Connector****Courtesy of SUBARU OF AMERICA, INC.**

8. 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. 142: Identifying Oil Control Solenoid And Camshaft Position Sensor RH Connectors With Harness Mounting Clips****Courtesy of SUBARU OF AMERICA, INC.**

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

Tightening torque:

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

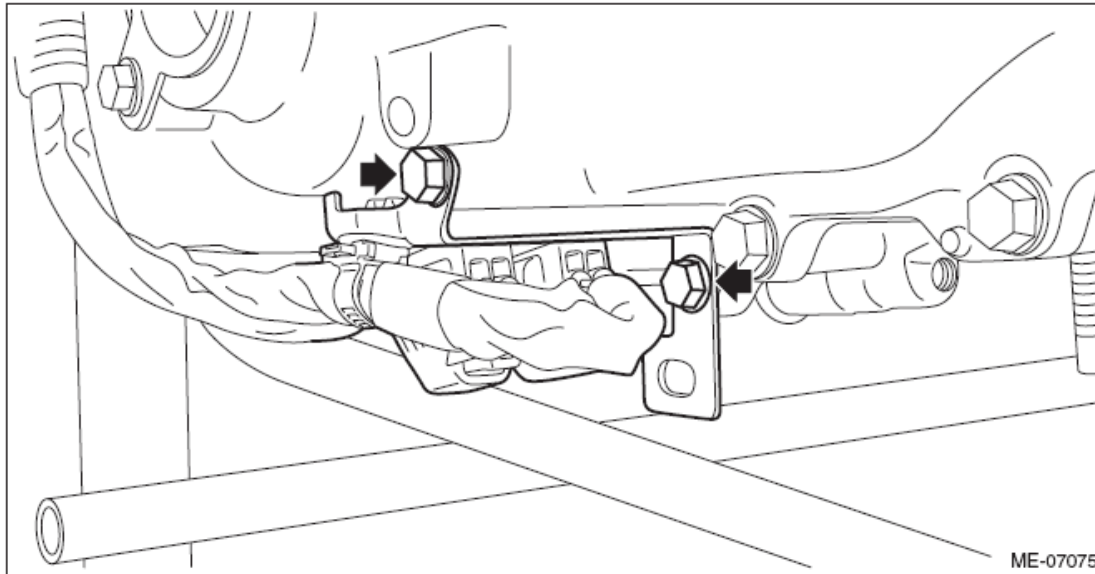


Fig. 143: Locating Engine Harness Stay Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

10. Install the crank pulley. Refer to **INSTALLATION**.
11. Install the water pump pulley. Refer to **WATER PUMP**.
12. Fill engine oil. Refer to **REPLACEMENT**.
13. Install the generator bracket.
 1. Set the generator bracket to the engine, 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)

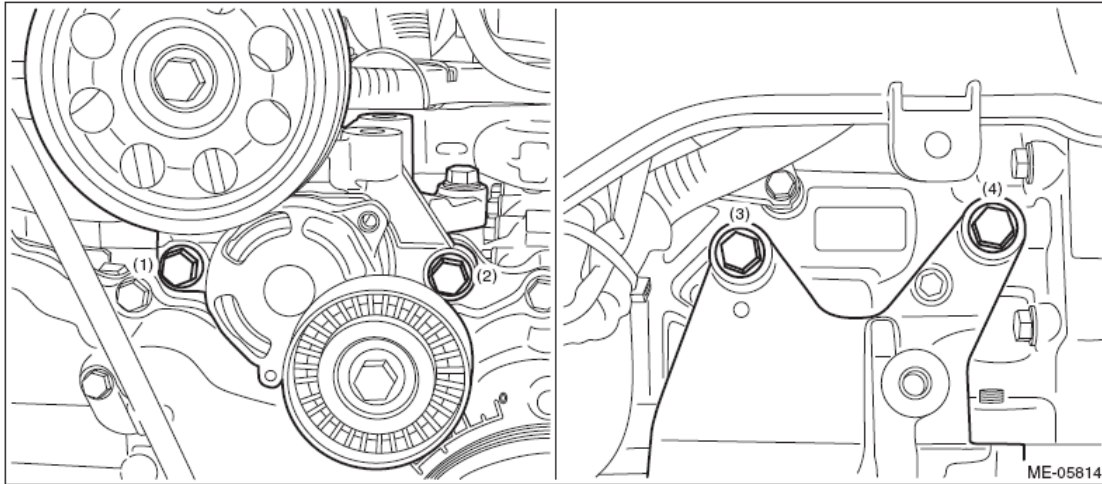


Fig. 144: Identifying Tightening Sequence Of Generator Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Install the generator. Refer to **INSTALLATION** .
3. Install the V-belts. Refer to **INSTALLATION** .
14. When working on the vehicle

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

1. Install the radiator. Refer to **INSTALLATION** .
2. Install the front exhaust pipe. Refer to **INSTALLATION** .
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)

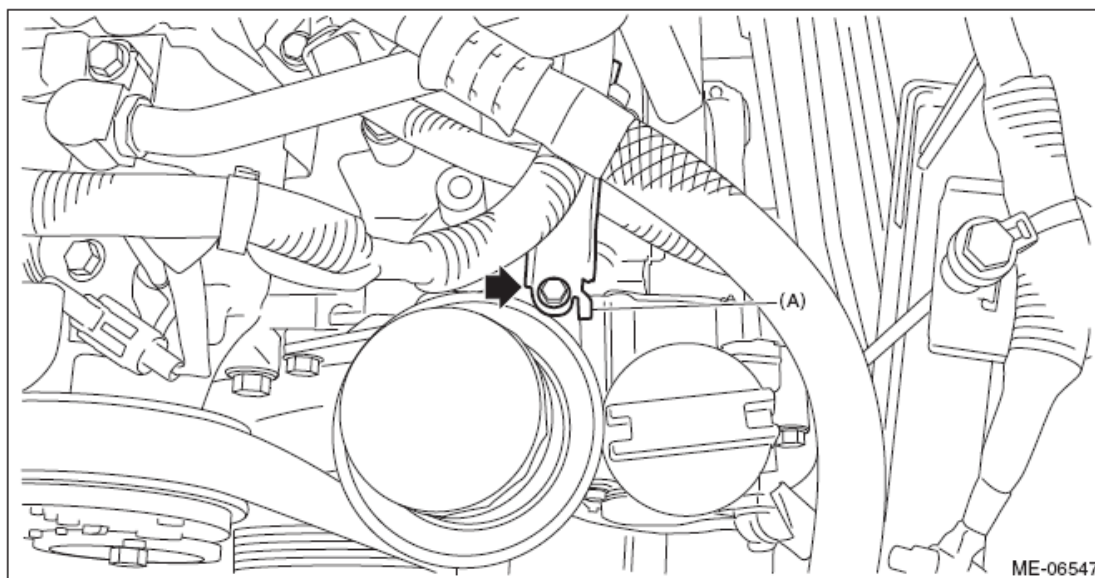


Fig. 145: Locating Generator Cord Stay Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

DISASSEMBLY

1. Remove the oil filler cap.

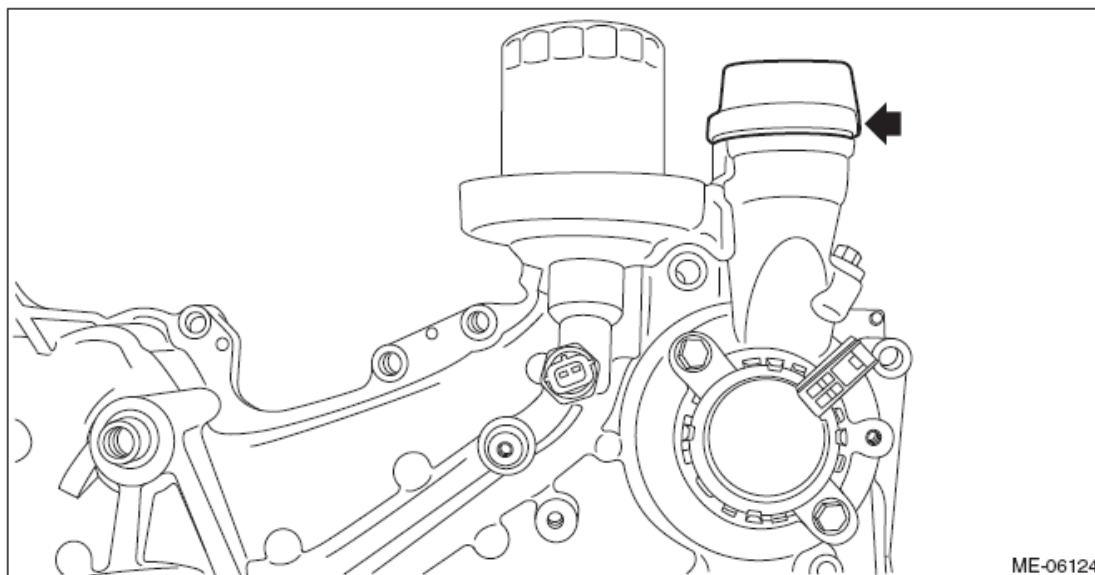


Fig. 146: Locating Oil Filler Cap
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the engine oil filter and the oil pump union. Refer to **REMOVAL** .
3. Remove the oil pressure switch. Refer to **REMOVAL** .
4. Remove the engine oil temperature sensor. Refer to **REMOVAL** .

5. Remove the oil control solenoid. Refer to **REMOVAL** .
6. Remove the camshaft position sensor. Refer to **REMOVAL** .
7. Remove the actuator cover from chain cover.

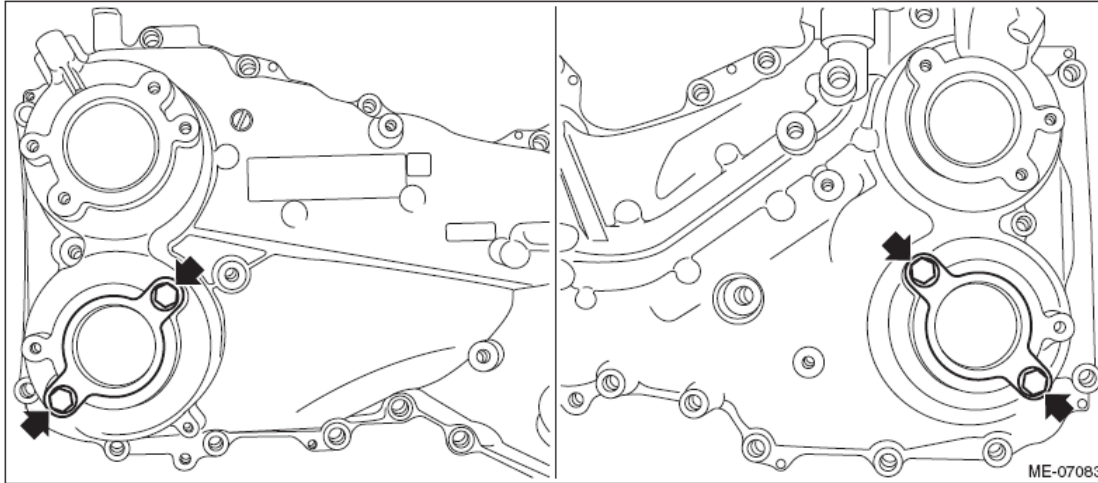


Fig. 147: Locating Actuator Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

ASSEMBLY

1. 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)

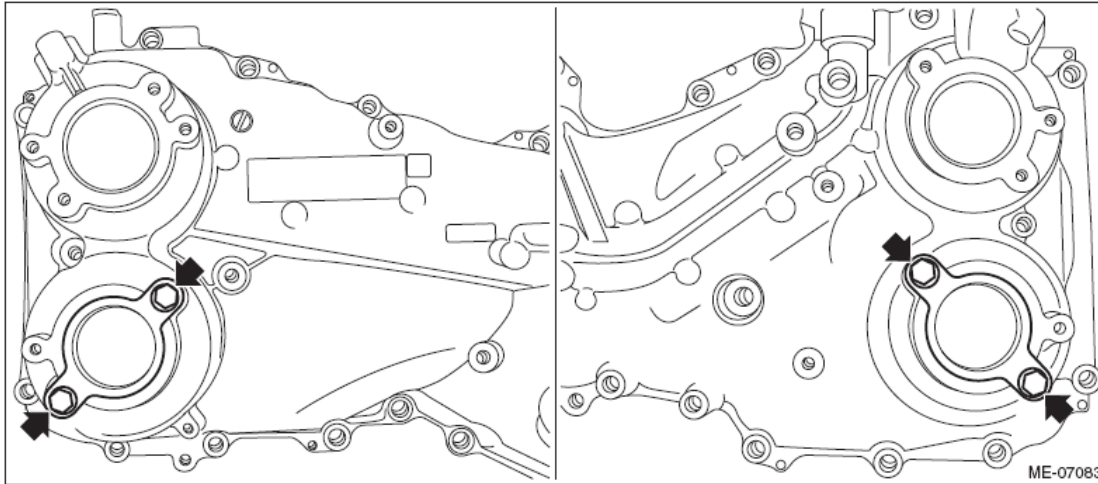


Fig. 148: Locating Actuator Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

2. Install the camshaft position sensor. Refer to **INSTALLATION** .
3. Install the oil control solenoid. Refer to **INSTALLATION** .
4. Install the engine oil temperature sensor. Refer to **INSTALLATION** .
5. Install the oil pressure switch. Refer to **INSTALLATION** .
6. Install the engine oil filter and the oil pump union. Refer to **INSTALLATION** .
7. Install the oil filler cap.

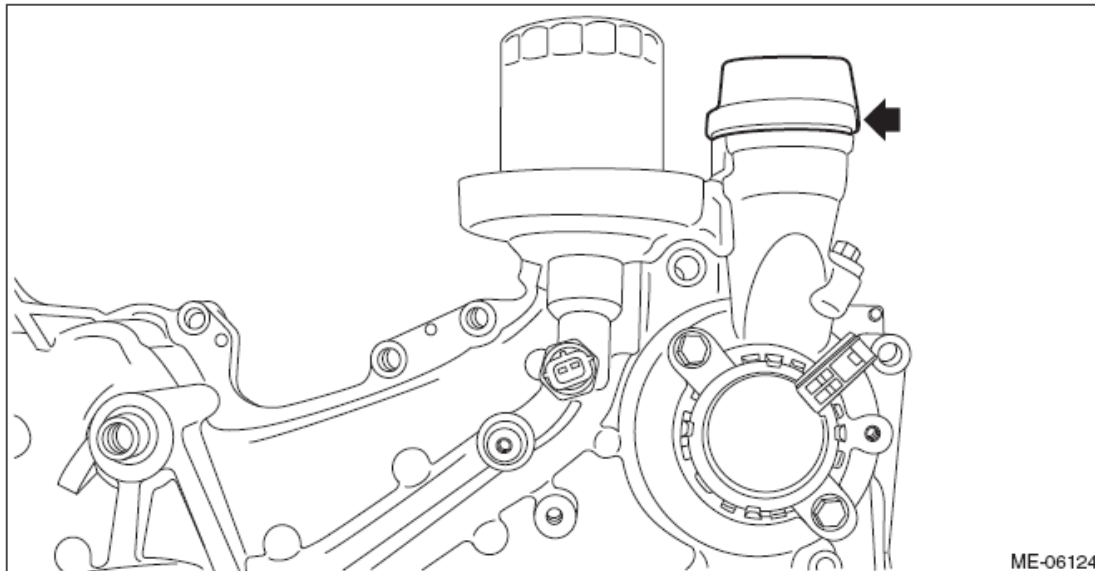


Fig. 149: Locating Oil Filler Cap
Courtesy of SUBARU OF AMERICA, INC.

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 assembly installed to body.

1. Remove the chain cover. Refer to **REMOVAL**.
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

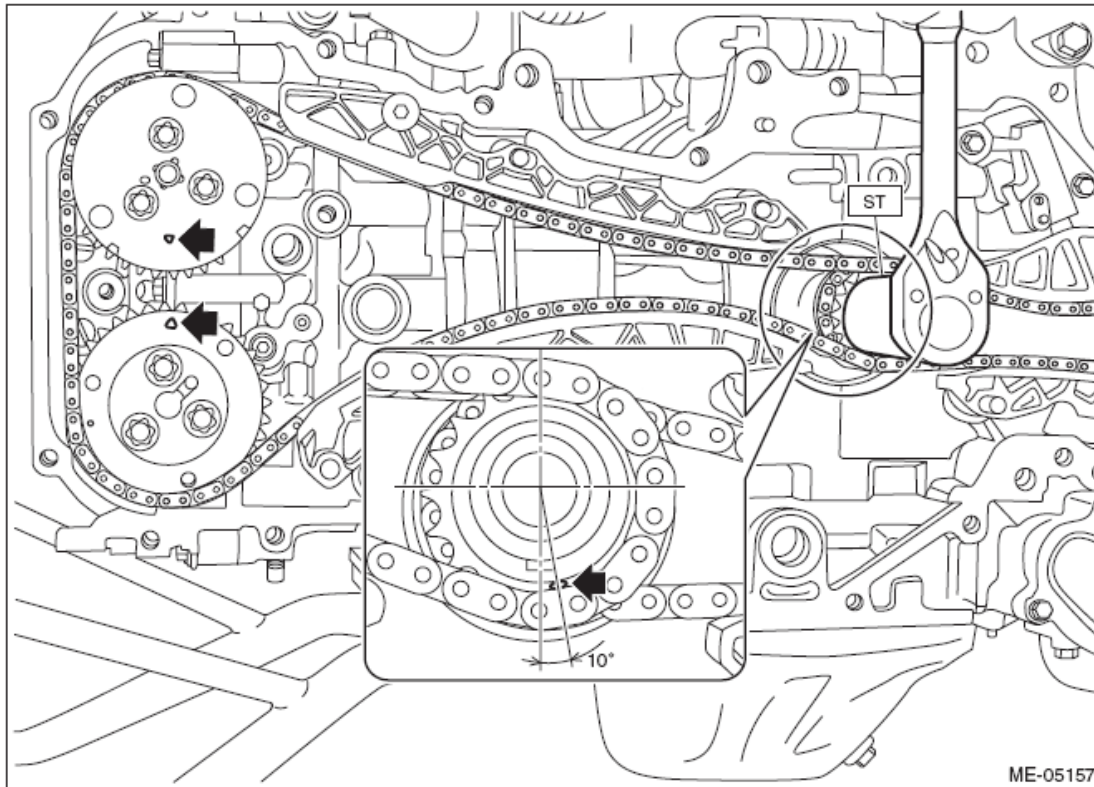


Fig. 150: Aligning Alignment Marks Of Crank Sprocket, Intake And Exhaust Cam Sprocket RH Using Tool

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).

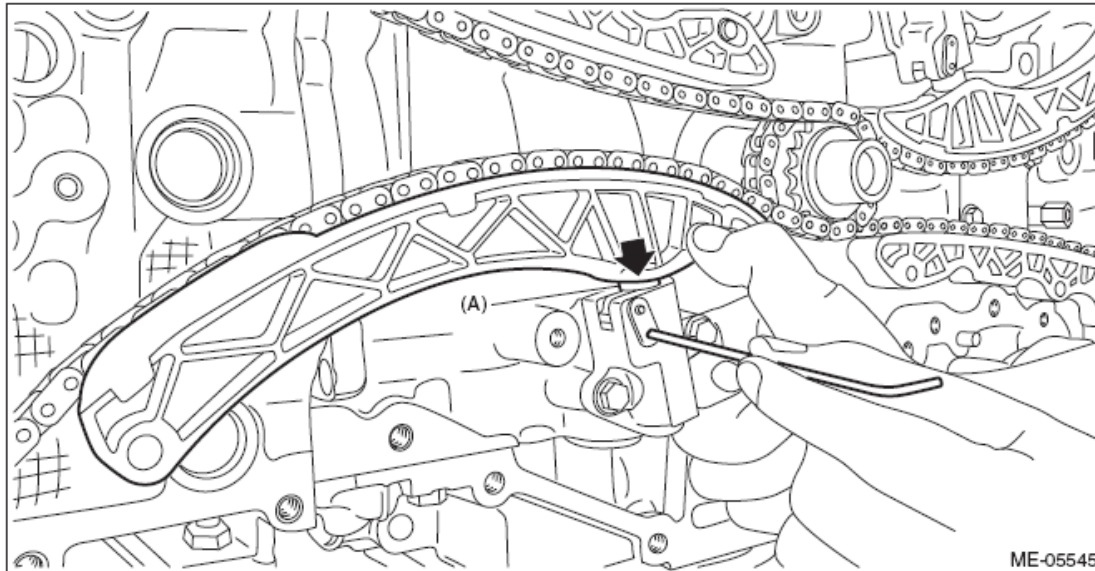


Fig. 151: Inserting Hex Wrench Into Chain Tensioner RH Stopper Pin Hole
Courtesy of SUBARU OF AMERICA, INC.

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

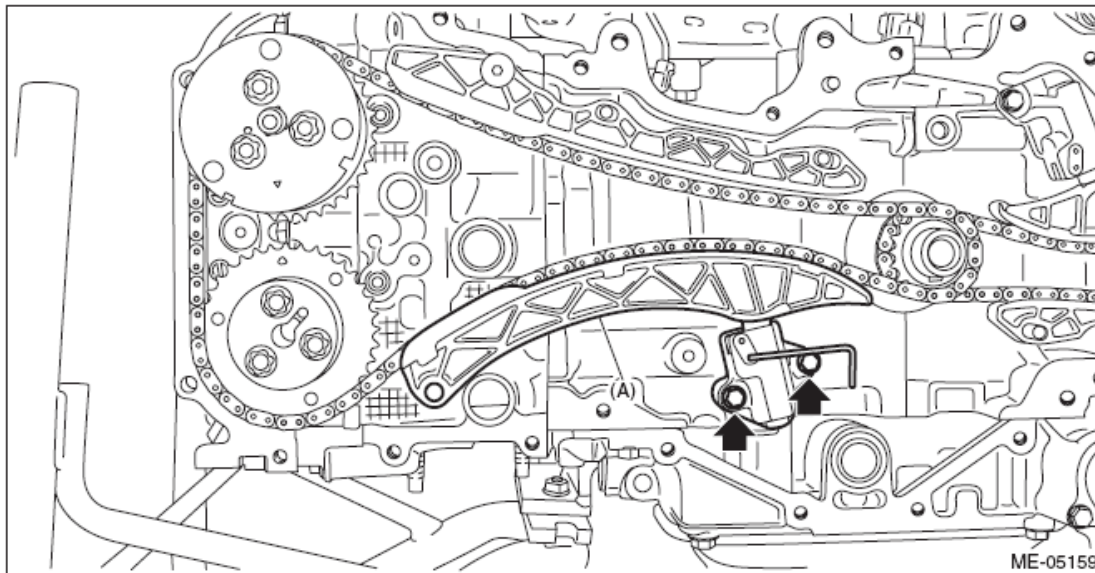


Fig. 152: Locating Chain Tensioner Lever RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

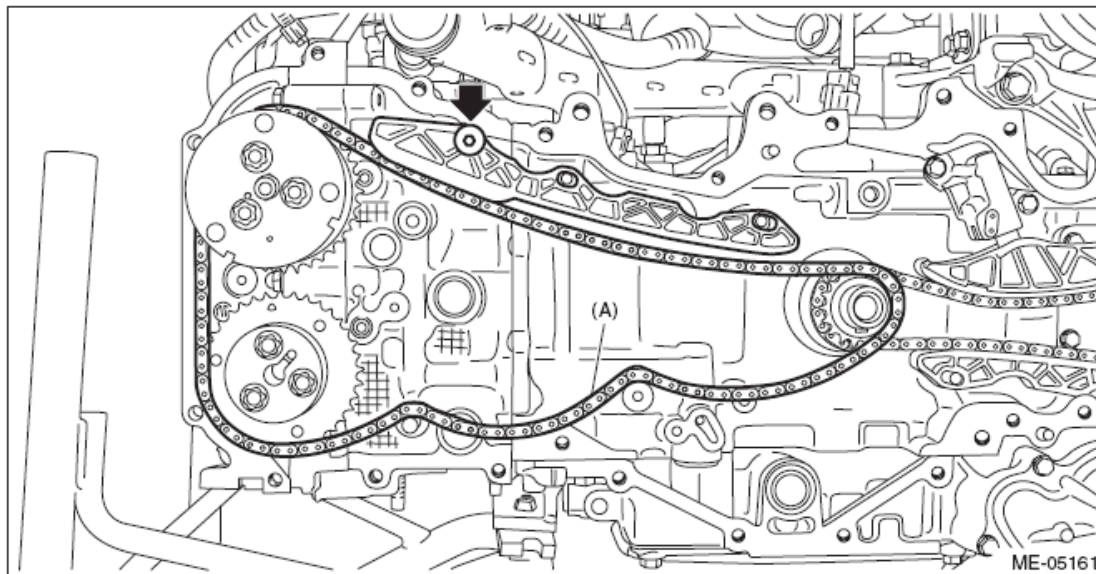


Fig. 153: Locating Timing Chain LH Chain Guide Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

TIMING CHAIN LH

1. Remove the timing chain RH. Refer to **TIMING CHAIN RH**.
2. Using ST and by turning the crankshaft, align the alignment marks of crankshaft key, intake cam sprocket LH and exhaust cam sprocket LH to the positions as shown in the figure.

ST 18252AA000 CRANKSHAFT SOCKET

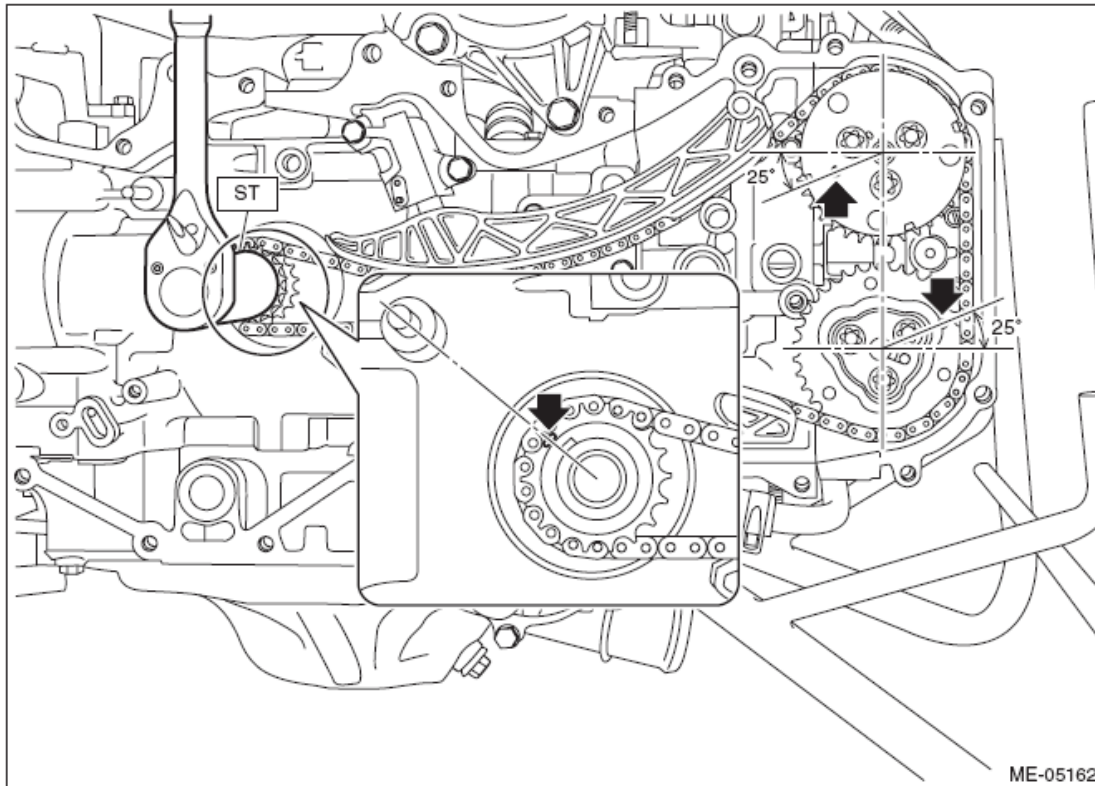


Fig. 154: Aligning Alignment Marks Of Crankshaft Key, Intake And Exhaust Cam Sprocket LH Using Tool
Courtesy of SUBARU OF AMERICA, INC.

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).

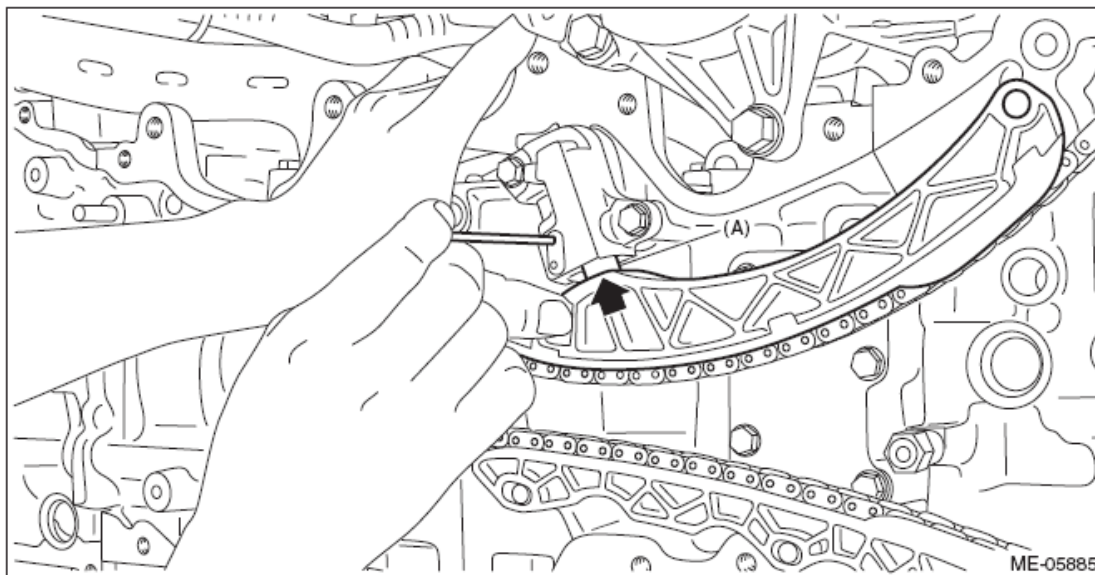


Fig. 155: Inserting Hex Wrench Into Chain Tensioner LH Stopper Pin Hole

Courtesy of SUBARU OF AMERICA, INC.

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

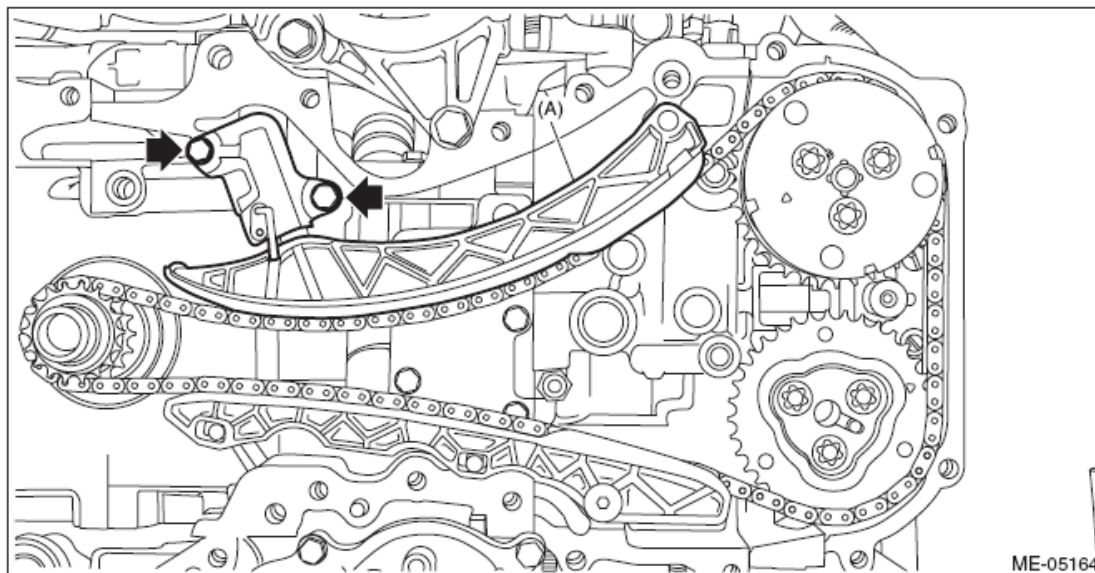


Fig. 156: Locating Chain Tensioner Lever LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

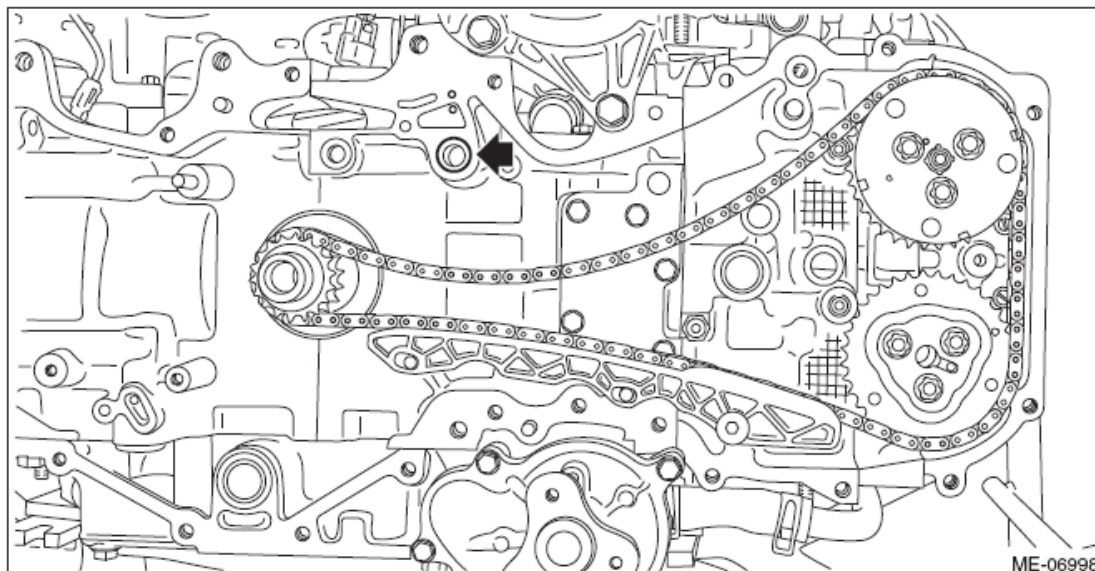


Fig. 157: Locating Cylinder Block LH O-Ring
Courtesy of SUBARU OF AMERICA, INC.

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.

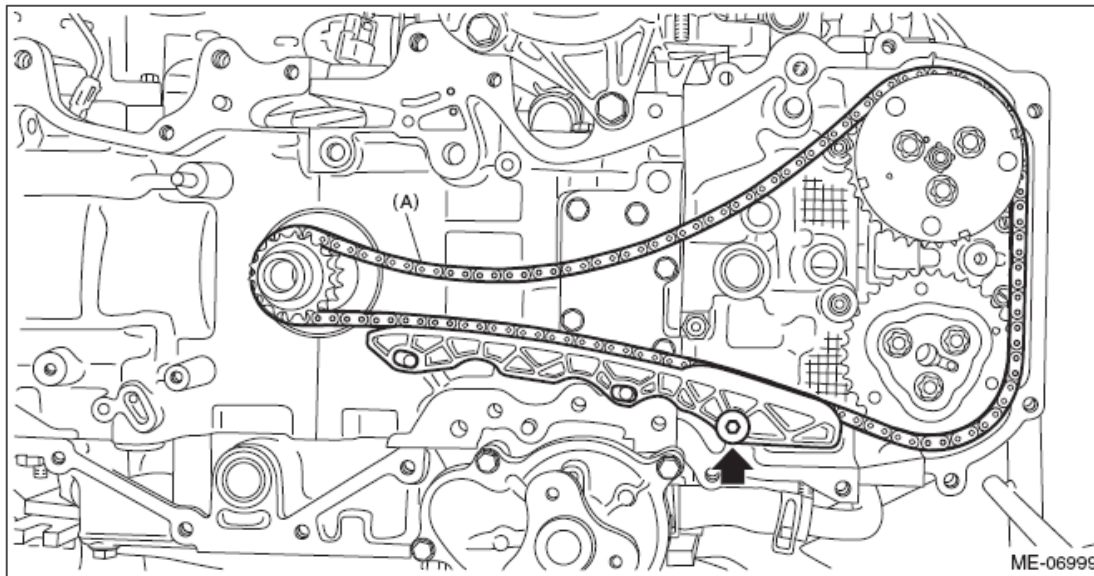


Fig. 158: Locating Chain Guide LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

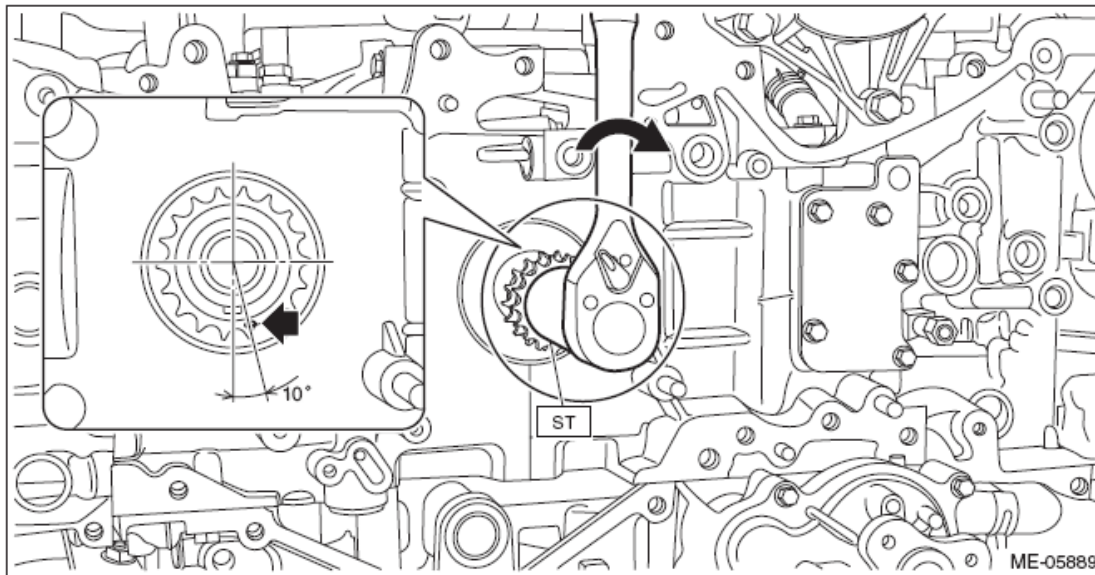


Fig. 159: Turning Crankshaft Using Tool
Courtesy of SUBARU OF AMERICA, INC.

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

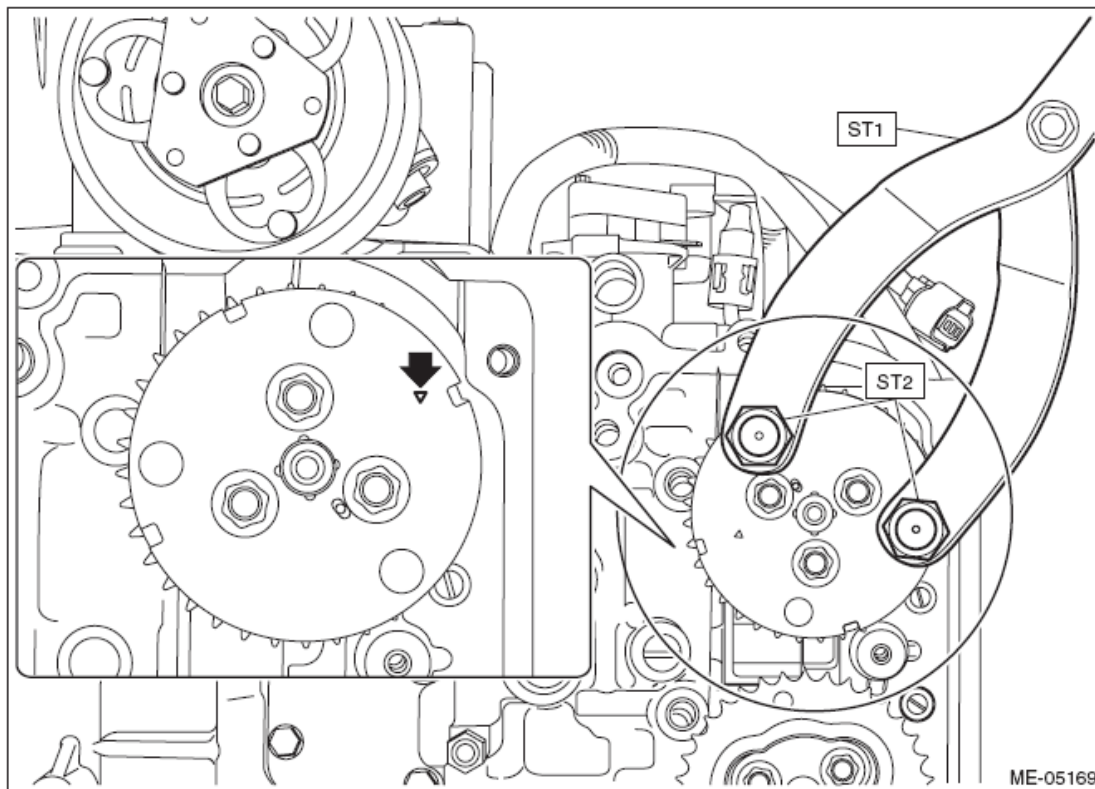


Fig. 160: Aligning Alignment Marks Of Intake Cam Sprocket LH To Zero-Lift Position Using Tools

Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

CAUTION: Before installing the timing chain RH, be sure to install the timing chain LH first.

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**.
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).

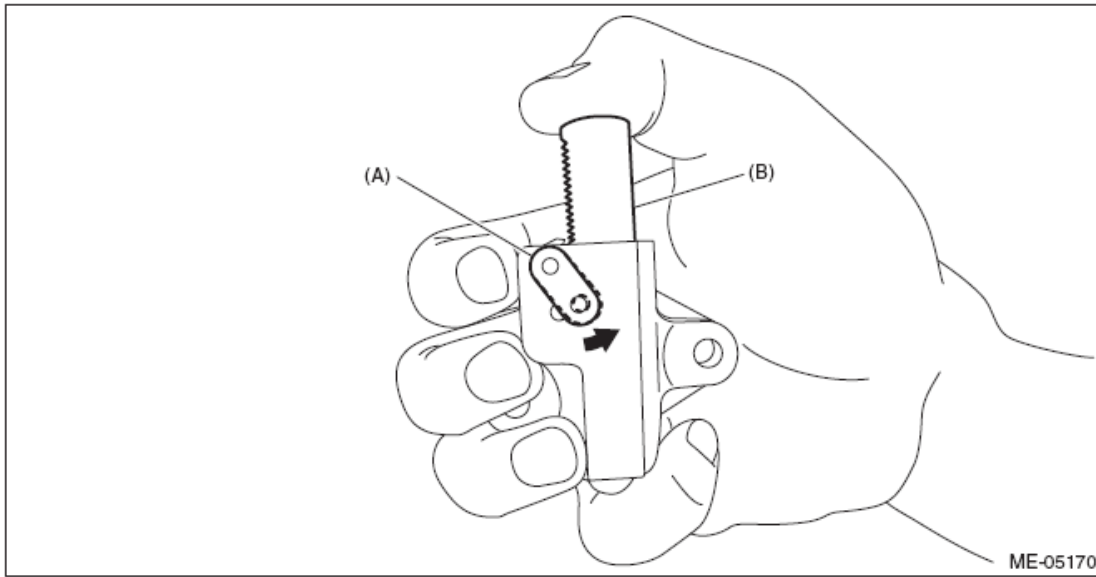


Fig. 161: Pressing Link Plate Plunger
Courtesy of SUBARU OF AMERICA, INC.

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).

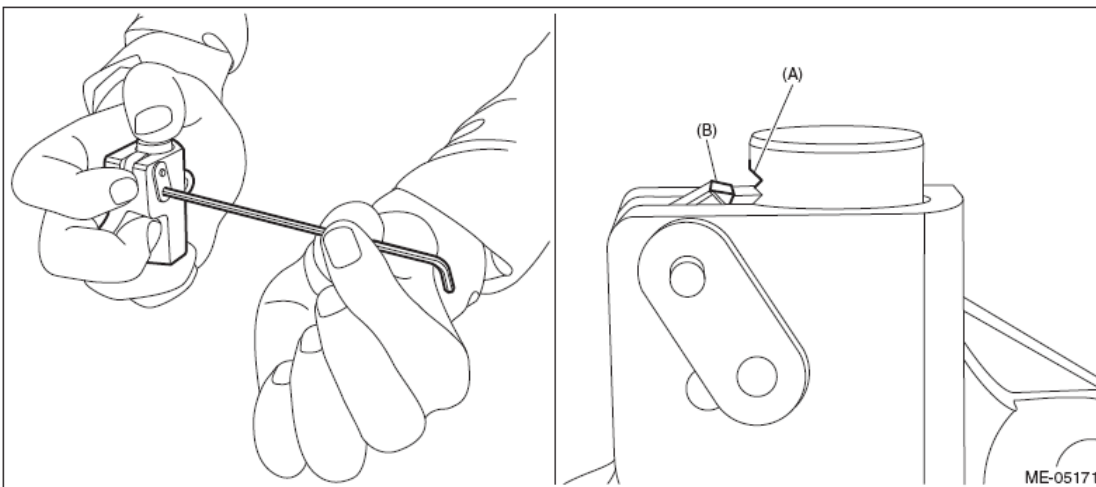


Fig. 162: Inserting Hex Wrench Into Stopper Pin Hole
Courtesy of SUBARU OF AMERICA, INC.

3. Make sure that the alignment marks of the crank sprocket, intake cam sprocket LH and exhaust cam

sprocket LH are aligned to the positions as shown in the figure.

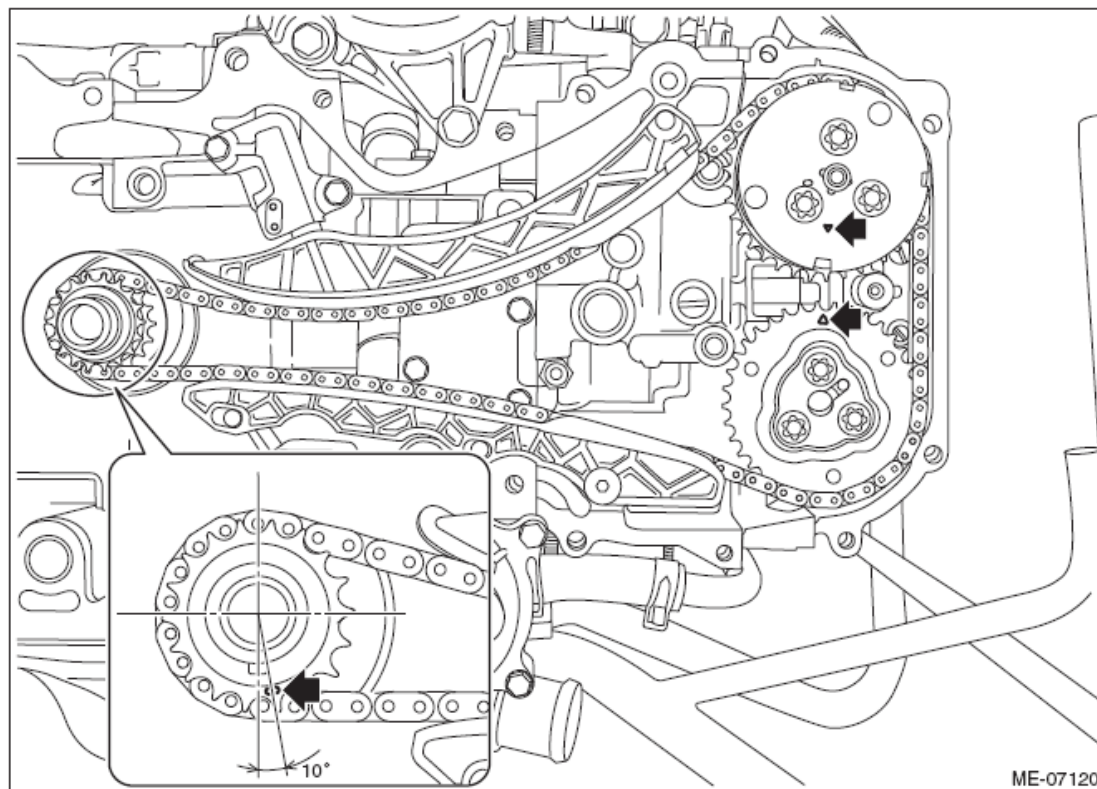


Fig. 163: Identifying Alignment Marks On Crank Sprocket, Intake And Exhaust Cam Sprocket LH
Courtesy of SUBARU OF AMERICA, INC.

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).

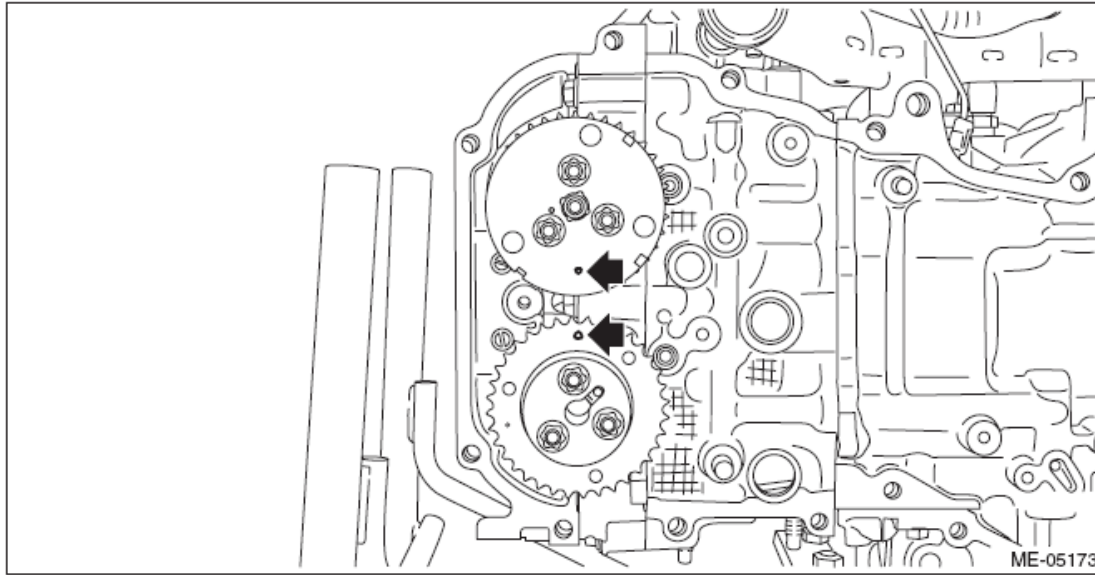
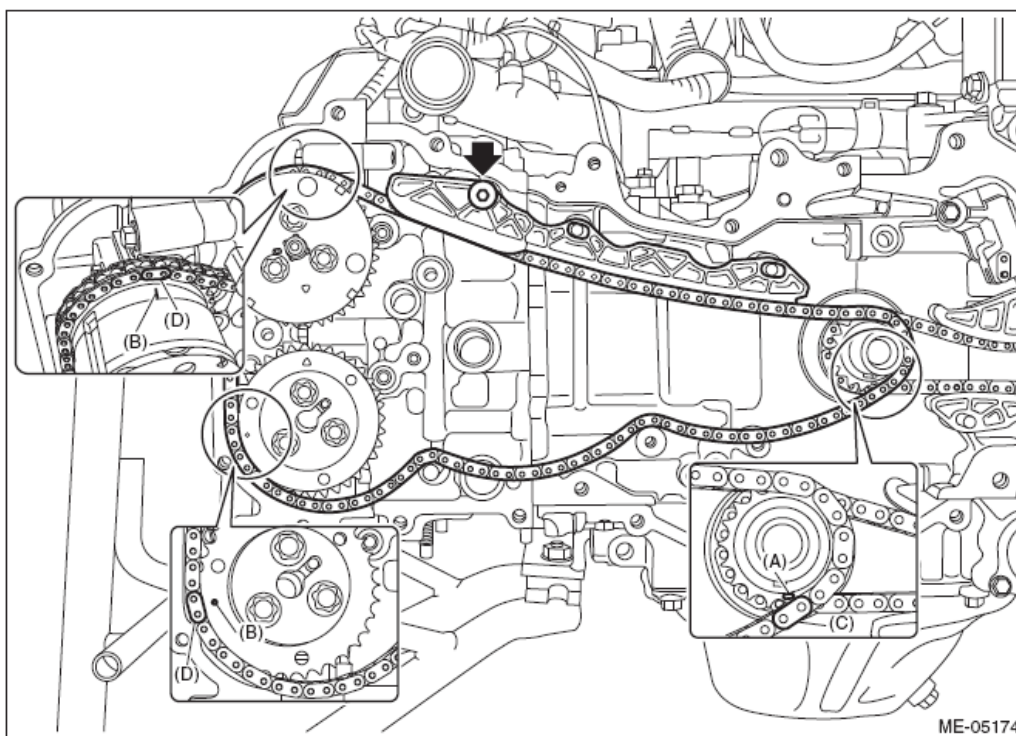


Fig. 164: Locating Alignment Marks On Intake And Exhaust Cam Sprocket RH
Courtesy of SUBARU OF AMERICA, INC.

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

(C) Blue

(D) Pink

(B) Timing mark

Fig. 165: Locating Timing Chain Guide RH Mounting Bolt
 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)

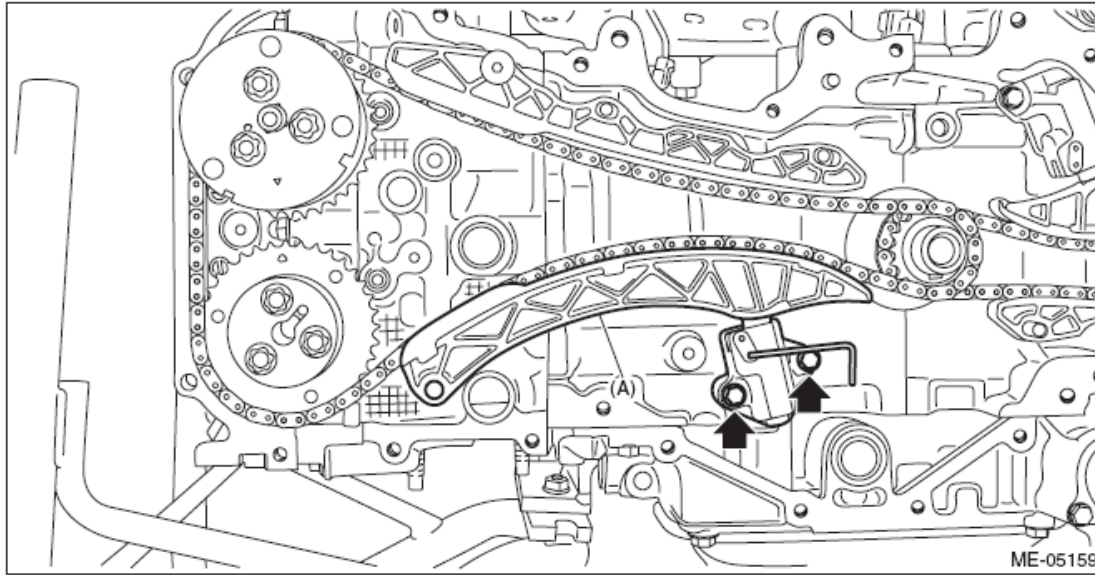
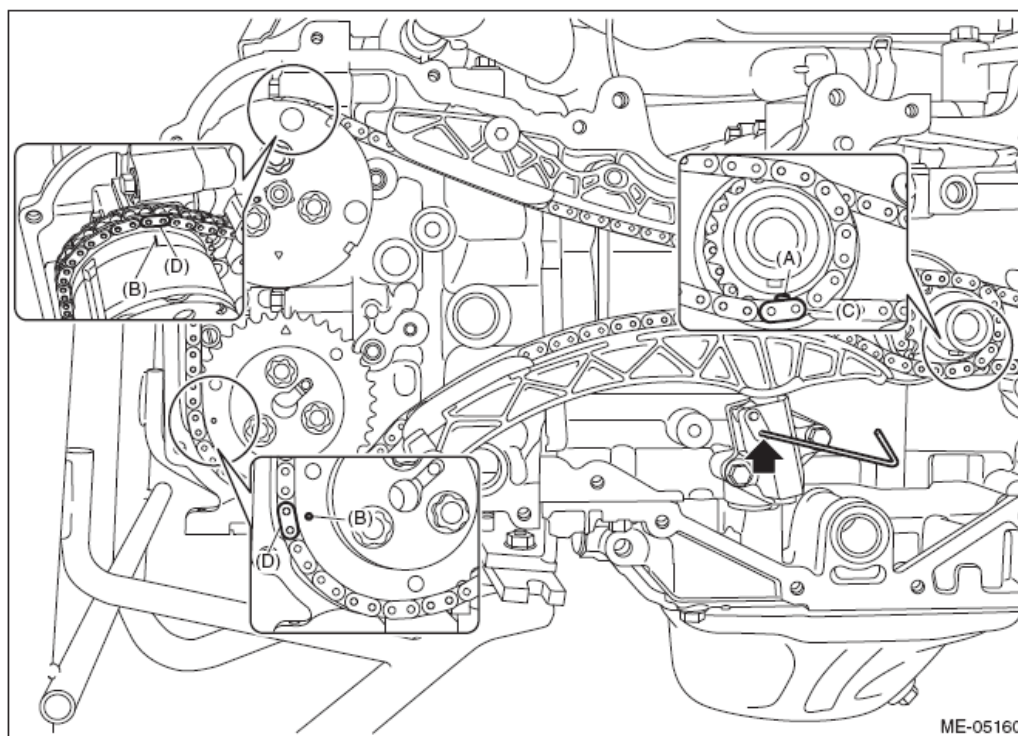


Fig. 166: Locating Chain Tensioner Lever RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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 (blue) to the alignment mark of the crank sprocket.
- Matching of the timing chain mark (pink) to the timing mark position of the intake cam sprocket RH.
- Matching of the timing chain mark (pink) to the timing mark position of the exhaust cam sprocket RH.



(A) Alignment mark
(B) Timing mark

(C) Blue

(D) Pink

Fig. 167: Locating Chain Tensioner RH Stopper Pin
Courtesy of SUBARU OF AMERICA, INC.

8. Make sure that the alignment marks of the cam sprocket and crank sprocket are aligned to the positions as shown in the figure.

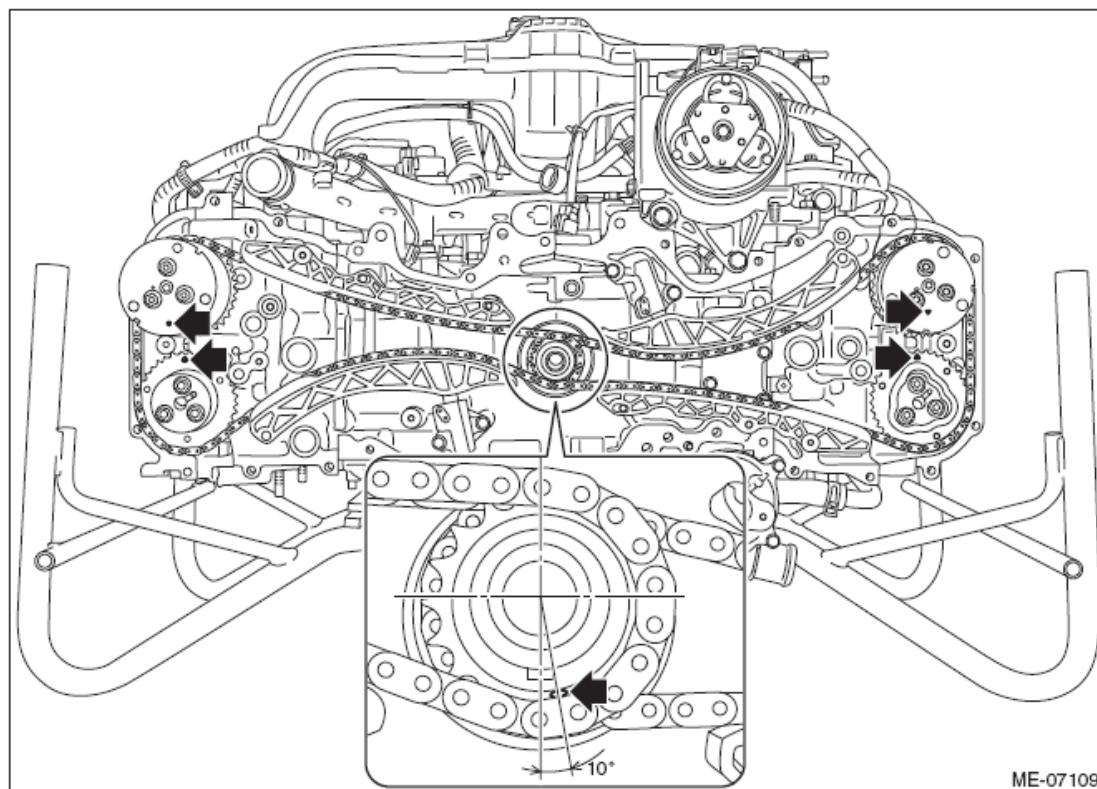


Fig. 168: Locating Alignment Marks On Cam Sprocket And Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

9. 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

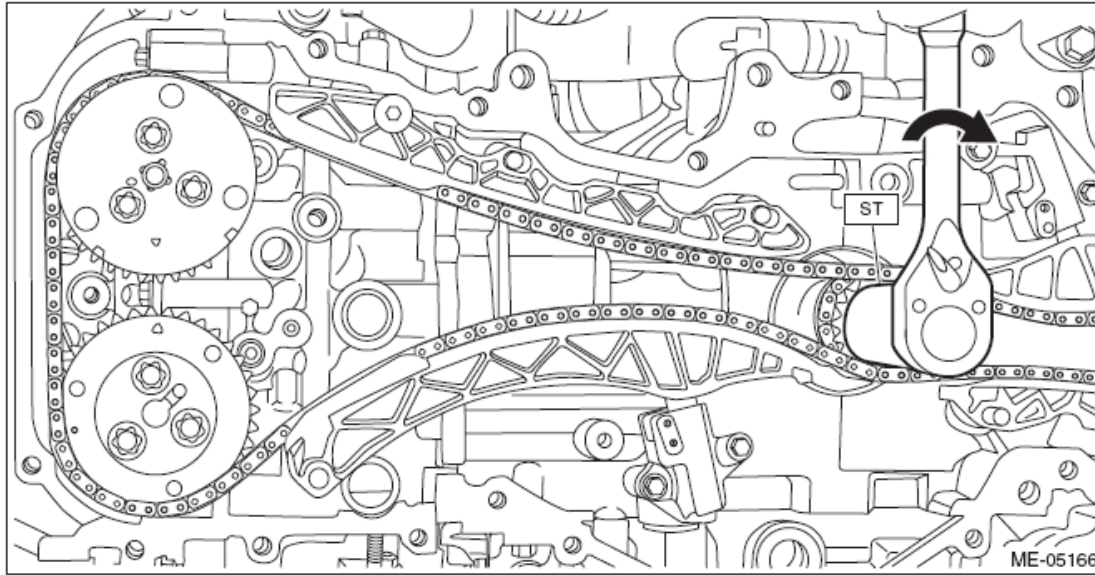


Fig. 169: Turning Crankshaft To Clockwise Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

10. Install the chain cover. Refer to **INSTALLATION**.

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).

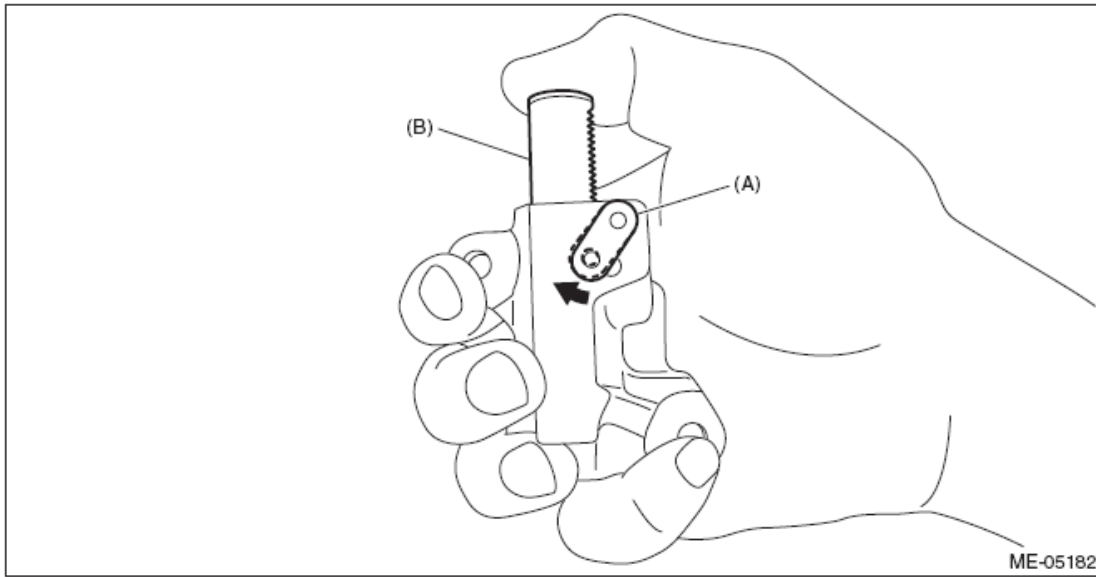


Fig. 170: Pressing Link Plate Plunger
Courtesy of SUBARU OF AMERICA, INC.

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).

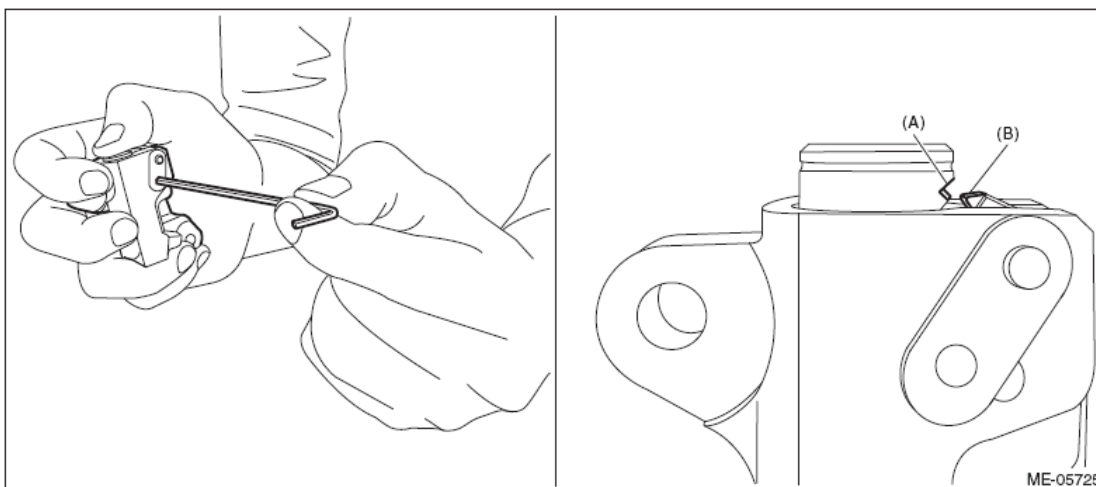


Fig. 171: Inserting Hex Wrench Into Stopper Pin Hole
Courtesy of SUBARU OF AMERICA, INC.

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

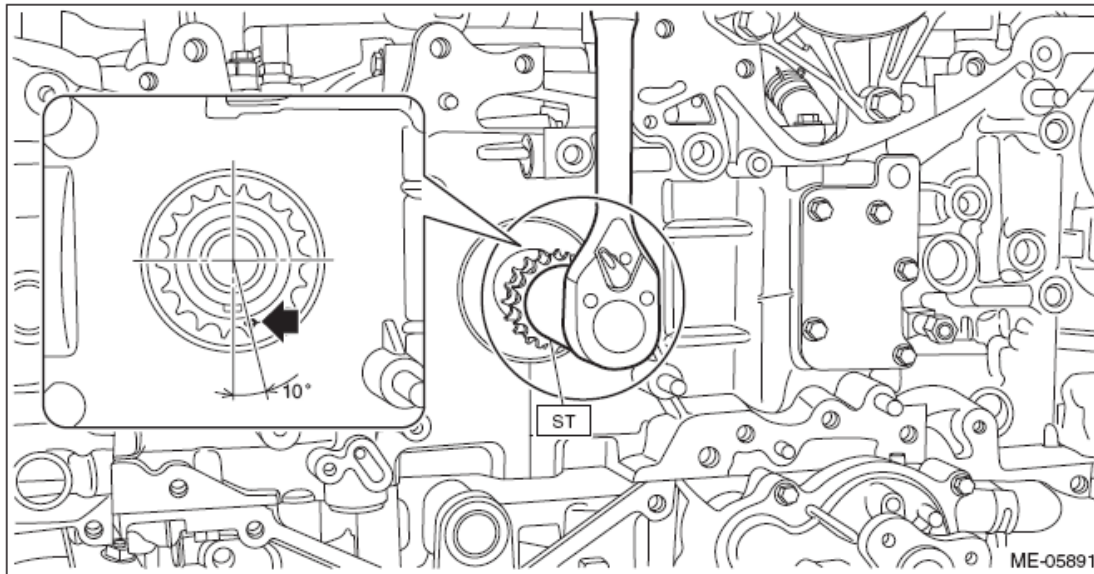


Fig. 172: Aligning Crankshaft With Crank Sprocket Alignment Mark
Courtesy of SUBARU OF AMERICA, INC.

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

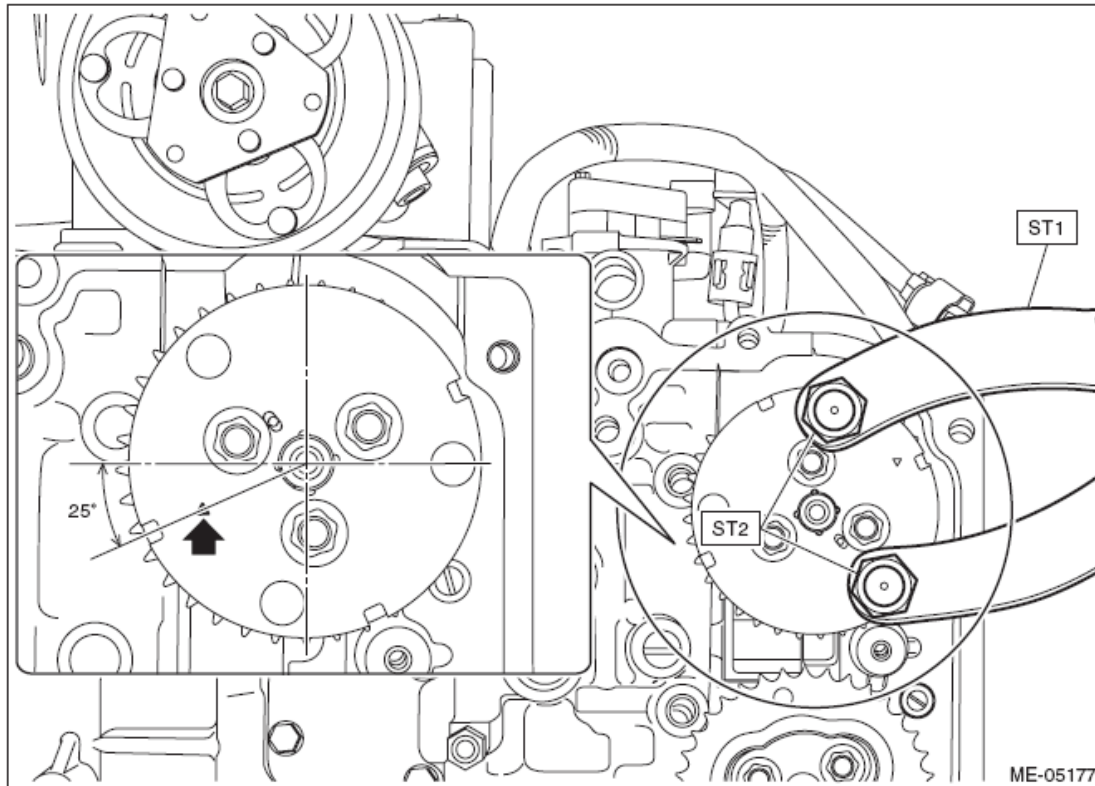


Fig. 173: Turning Intake Cam Sprocket LH Using Tool
 Courtesy of SUBARU OF AMERICA, INC.

4. Using ST and by turning the crankshaft approximately 200° counterclockwise, align the alignment marks of crankshaft key 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 the key position precisely, after turning the crankshaft counterclockwise to bring the key near the position as shown in the figure.

ST 18252AA000 CRANKSHAFT SOCKET

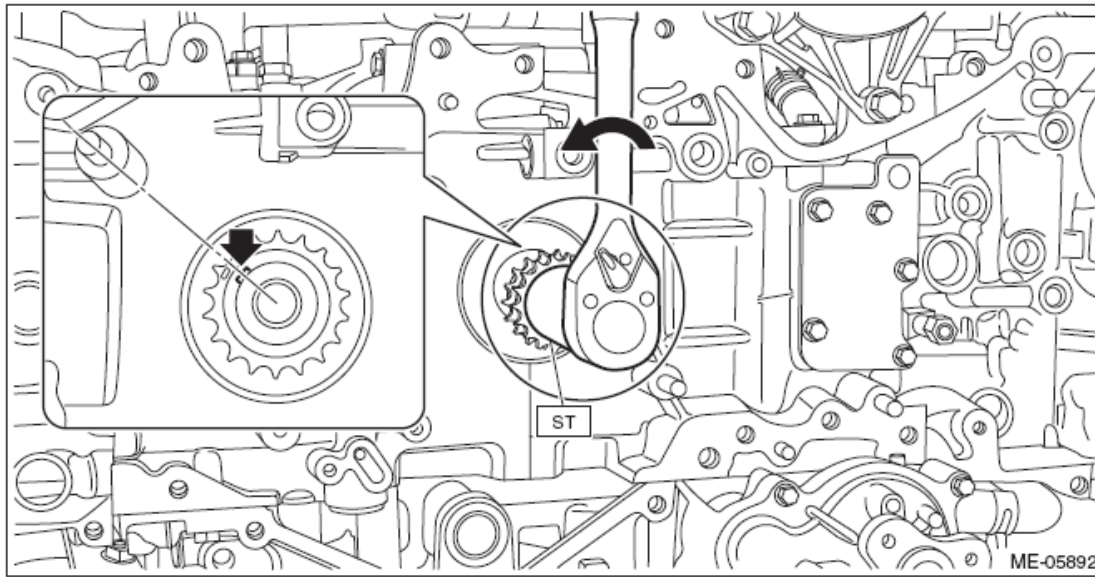


Fig. 174: Turning Crankshaft To Counterclockwise
Courtesy of SUBARU OF AMERICA, INC.

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).

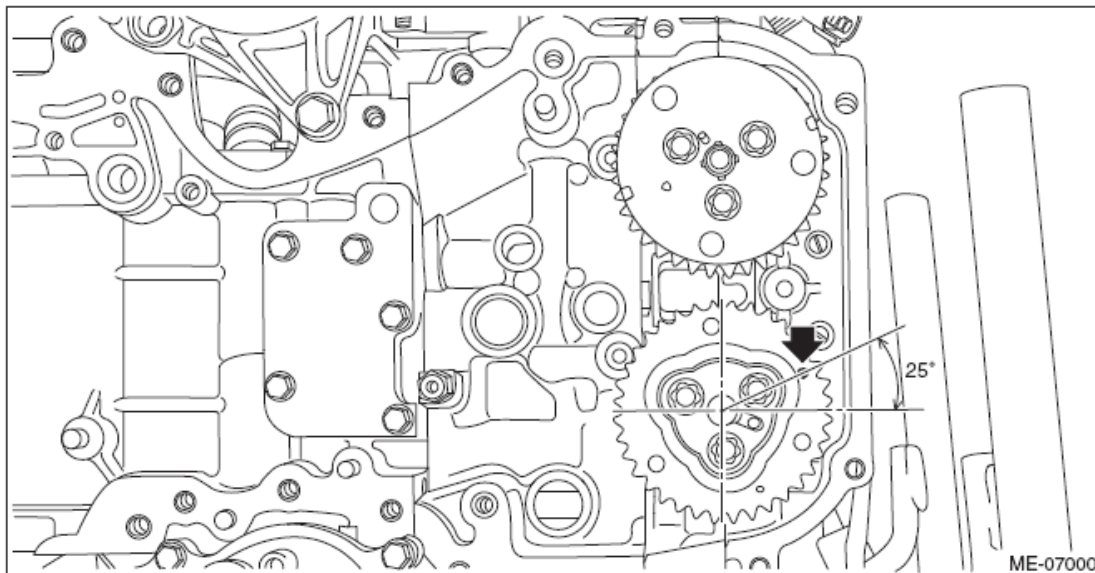


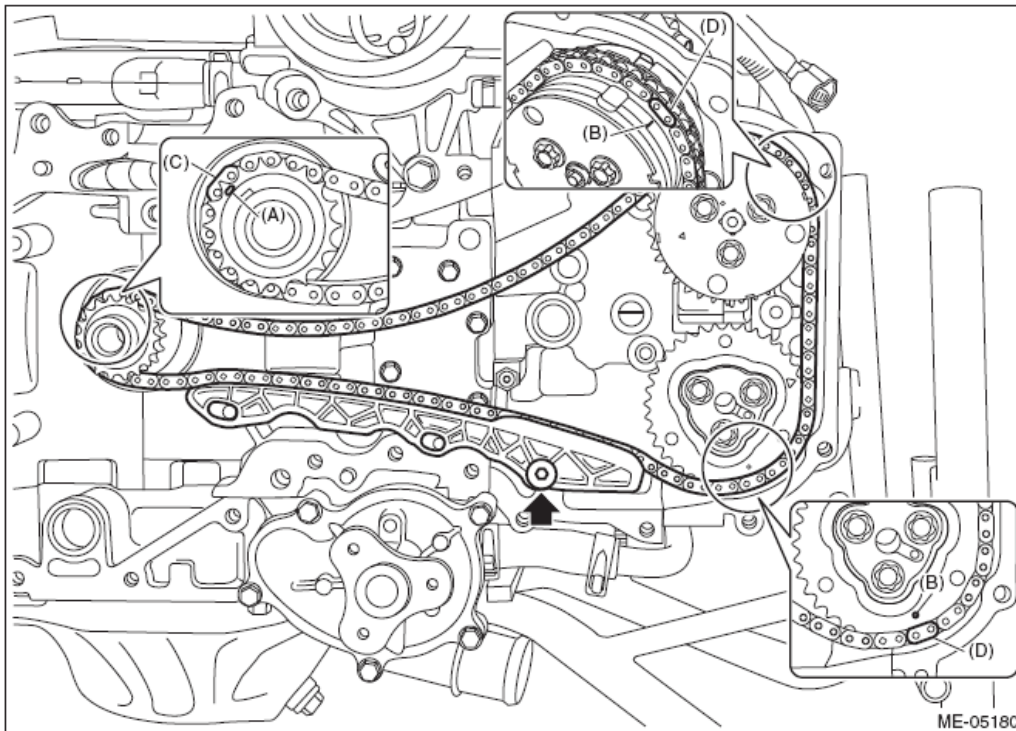
Fig. 175: Aligning Alignment Mark Of Exhaust Cam Sprocket LH
Courtesy of SUBARU OF AMERICA, INC.

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

1. Match the timing chain mark (blue) to the alignment mark of the crank sprocket.
2. Match the timing chain mark (pink) to the timing mark position of the intake cam sprocket LH.
3. Match the timing chain mark (pink) 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

(C) Blue

(D) Pink

(B) Timing mark

Fig. 176: Locating Timing Chain Guide LH Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new O-rings.

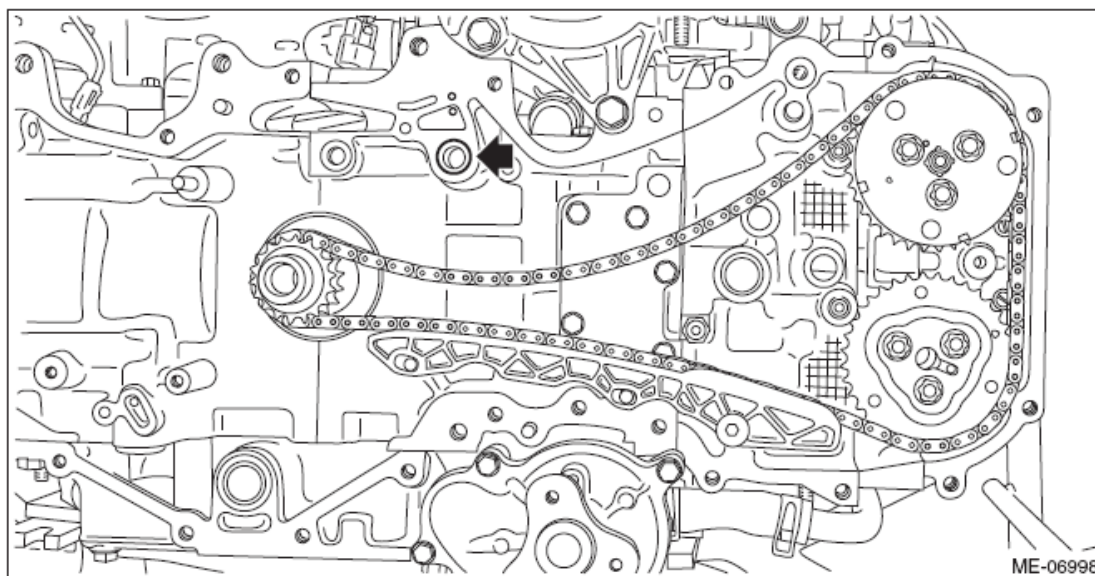


Fig. 177: Locating Cylinder Block LH O-Ring
Courtesy of SUBARU OF AMERICA, INC.

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)

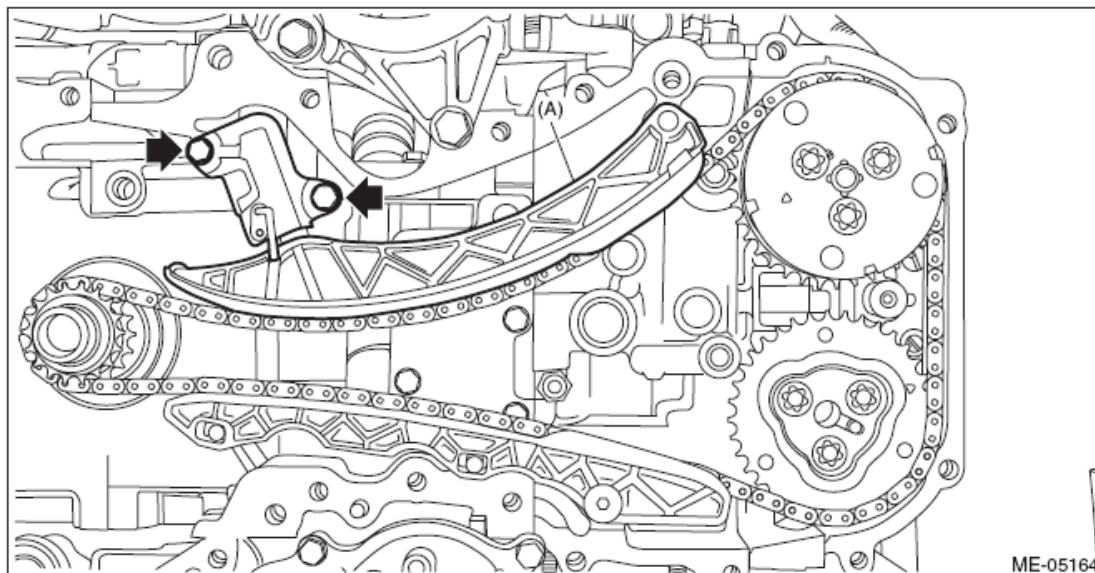
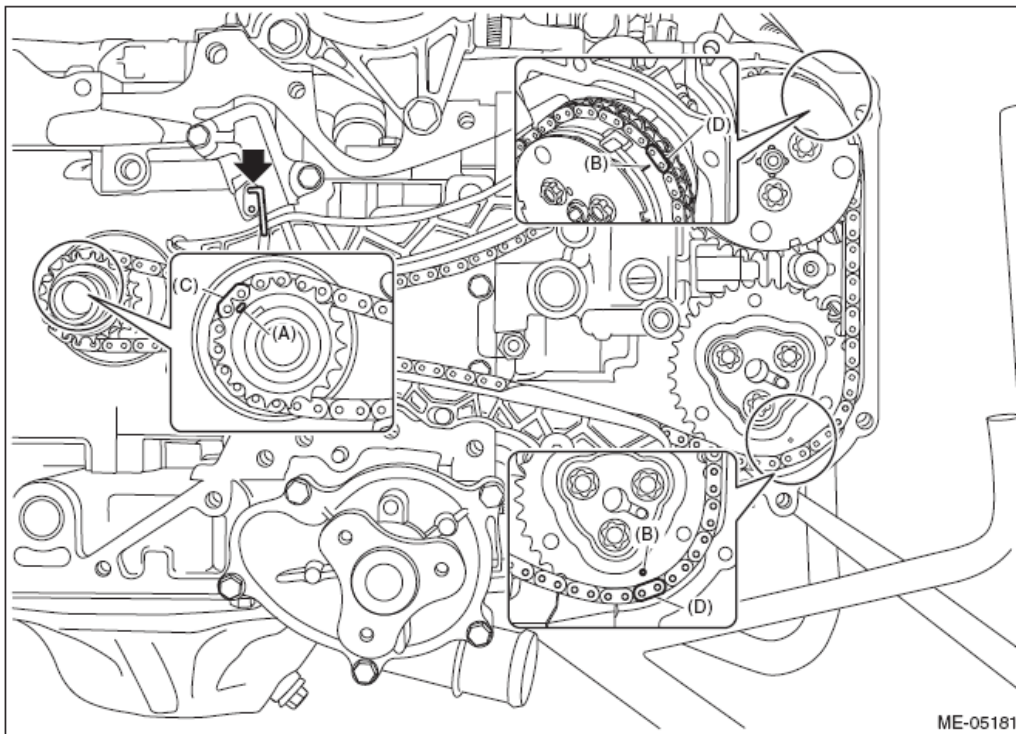


Fig. 178: Locating Chain Tensioner Lever LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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 (blue) to the alignment mark of the crank sprocket.
- Matching of the timing chain mark (pink) to the timing mark position of the intake cam sprocket LH.
- Matching of the timing chain mark (pink) to the timing mark position of the exhaust cam sprocket LH.



(A) Alignment mark
(B) Timing mark

(C) Blue

(D) Pink

Fig. 179: Locating Chain Tensioner LH Stopper Pin
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

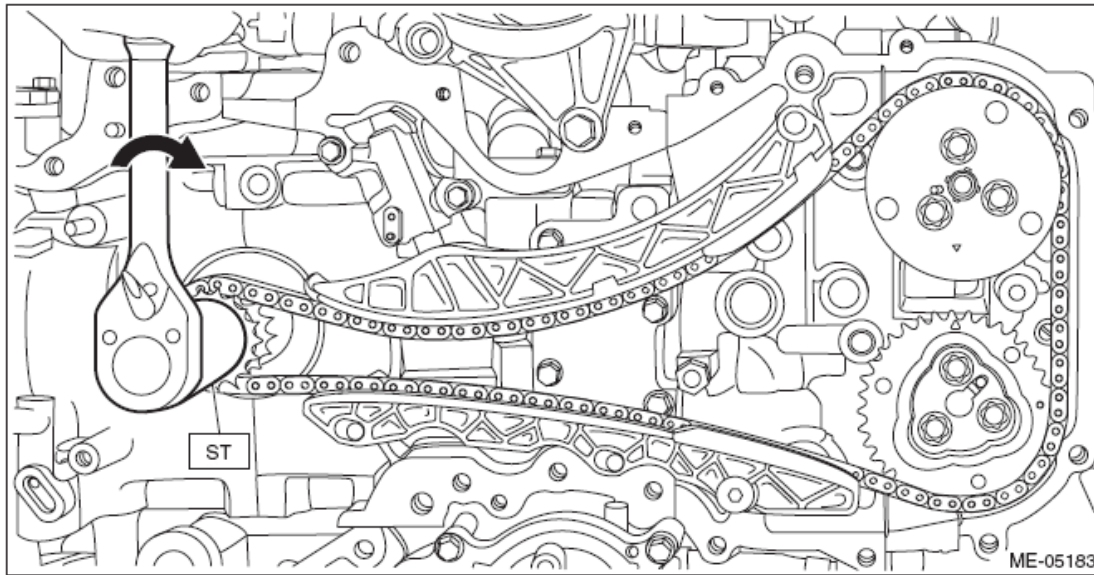


Fig. 180: Turning Crankshaft To Clockwise Using Crankshaft Socket
Courtesy of SUBARU OF AMERICA, INC.

11. 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

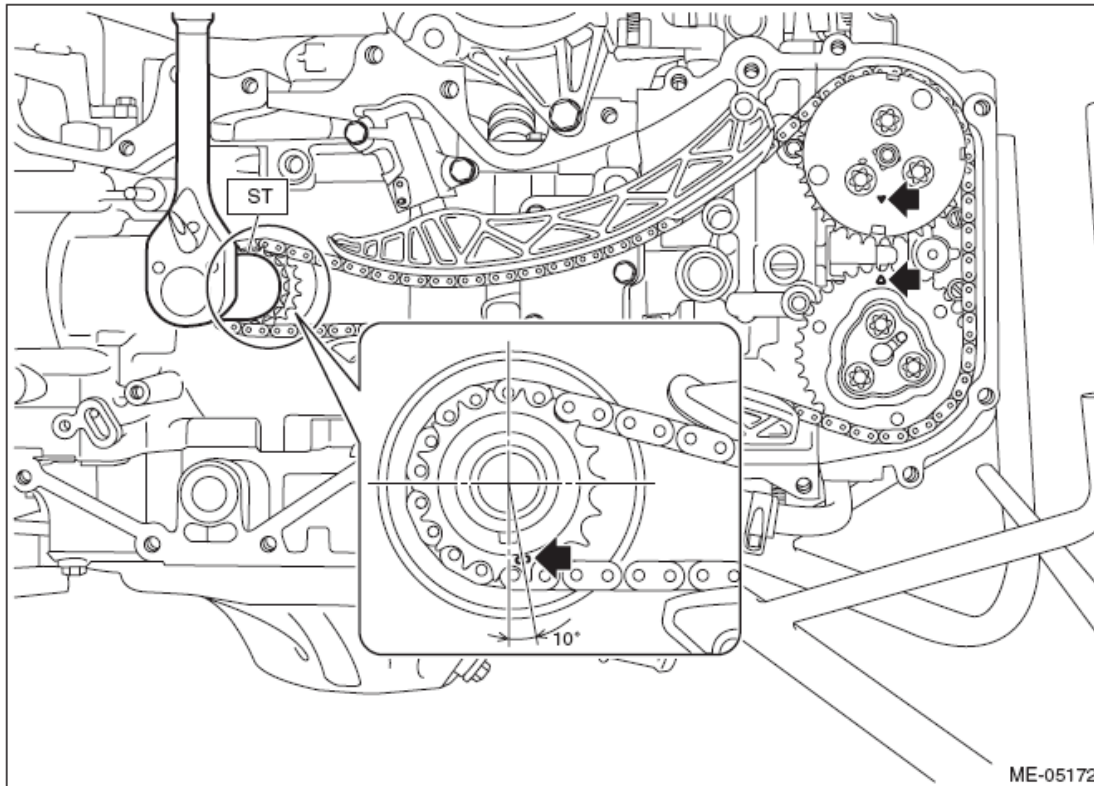


Fig. 181: Aligning Alignment Marks Of Crank Sprocket, Intake And Exhaust Cam Sprocket LH Using Crankshaft Socket
 Courtesy of SUBARU OF AMERICA, INC.

12. Install the timing chain RH. Refer to **TIMING CHAIN RH**.

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 assembly installed to body.

- Intake cam sprocket RH

1. Remove the chain cover. Refer to **REMOVAL**.

2. Remove the timing chain RH. Refer to **TIMING CHAIN RH**.
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

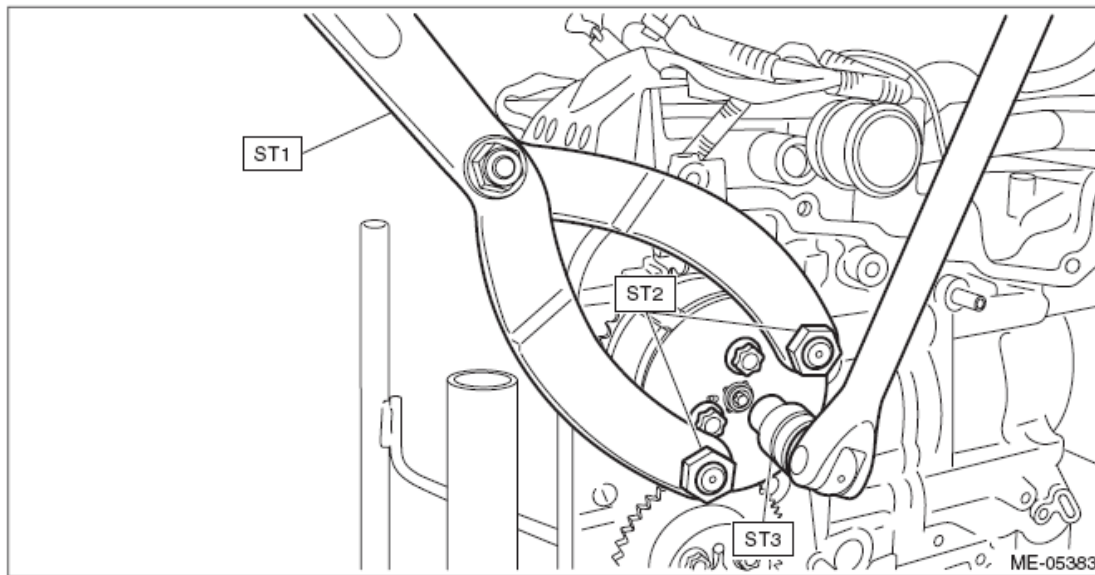


Fig. 182: Removing Intake Cam Sprocket RH Mounting Bolt Using Tools
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the intake cam sprocket RH.
 - **Exhaust cam sprocket RH**
1. Remove the chain cover. Refer to **REMOVAL**.
2. Remove the timing chain RH. Refer to **TIMING CHAIN RH**.
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

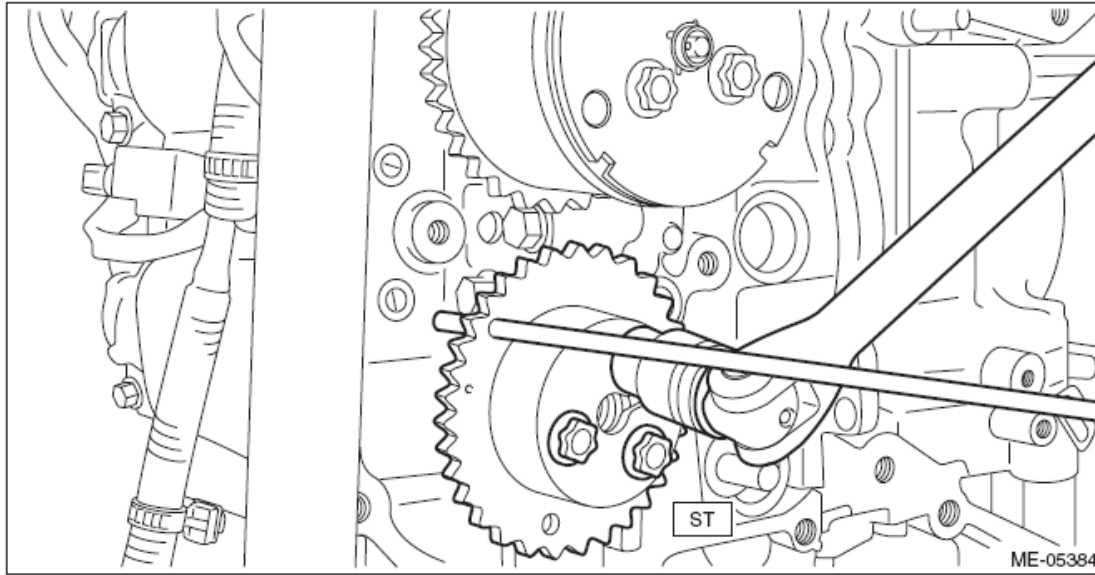


Fig. 183: Inserting Steel Rod Into Exhaust Cam Sprocket RH Hole
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the exhaust cam sprocket RH.

CAM SPROCKET LH

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

- **Intake cam sprocket LH**

1. Remove the chain cover. Refer to **REMOVAL**.
2. Remove the timing chain LH. Refer to **TIMING CHAIN LH**.
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

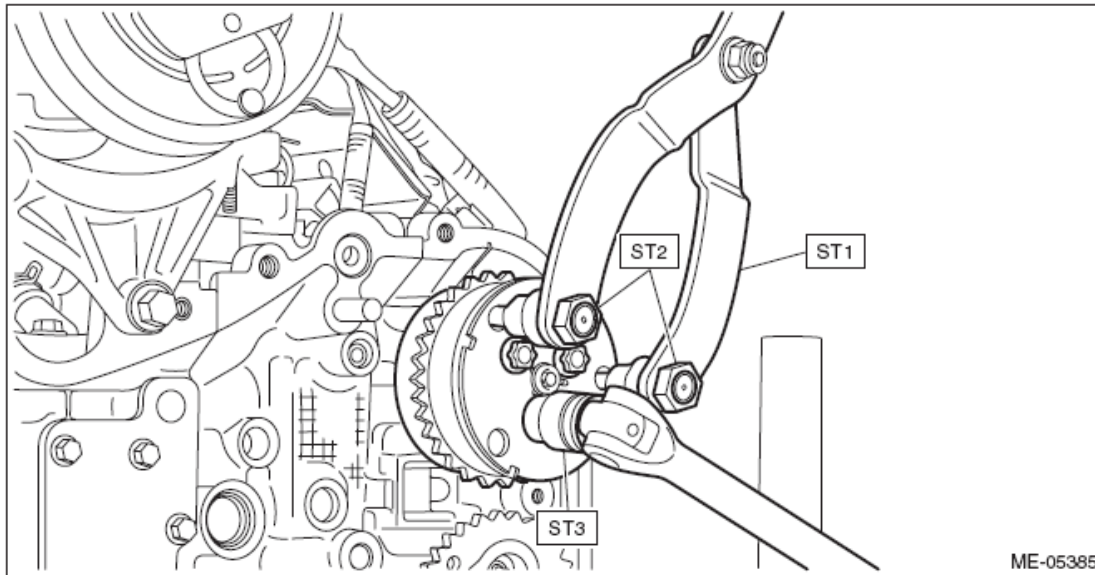


Fig. 184: Removing Intake Cam Sprocket LH Mounting Bolt Using Tools
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the intake cam sprocket LH.

- **Exhaust cam sprocket LH**

1. Remove the chain cover. Refer to **REMOVAL**.
2. Remove the timing chain LH. Refer to **TIMING CHAIN LH**.
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

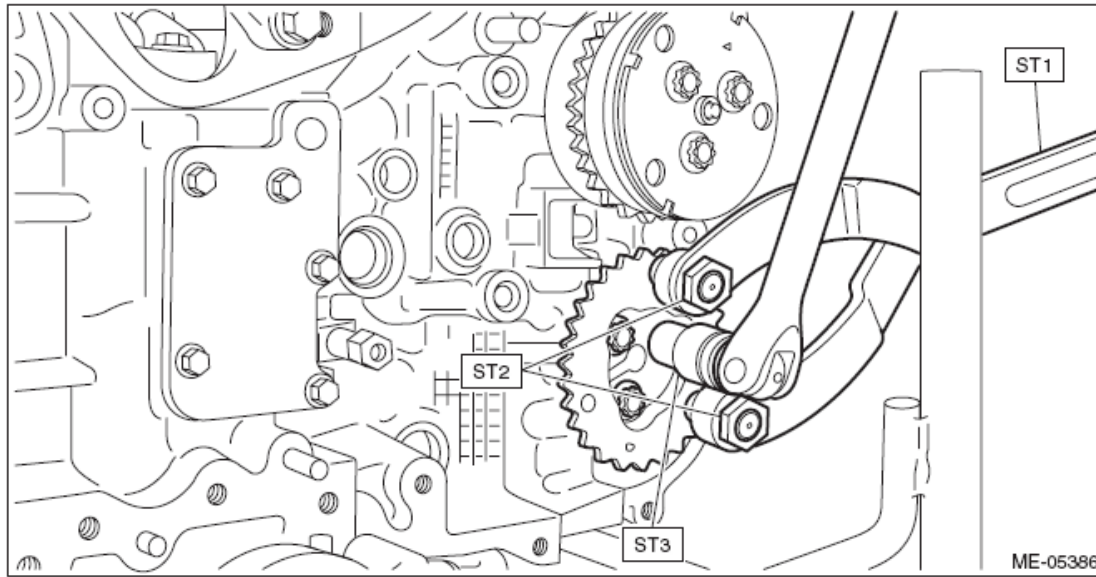


Fig. 185: Removing Exhaust Cam Sprocket LH Mounting Bolt Using Tools
Courtesy of SUBARU OF AMERICA, INC.

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.

NOTE: Before installation, check that there is no foreign matter on the intake cam sprocket RH and intake camshaft RH.

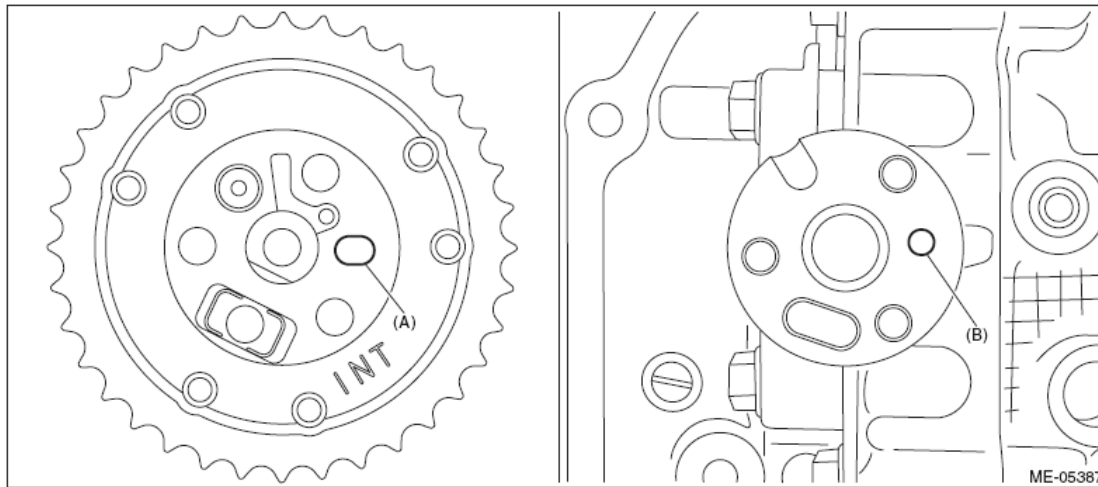


Fig. 186: Identifying Intake Cam Sprocket RH Knock Hole And Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

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)

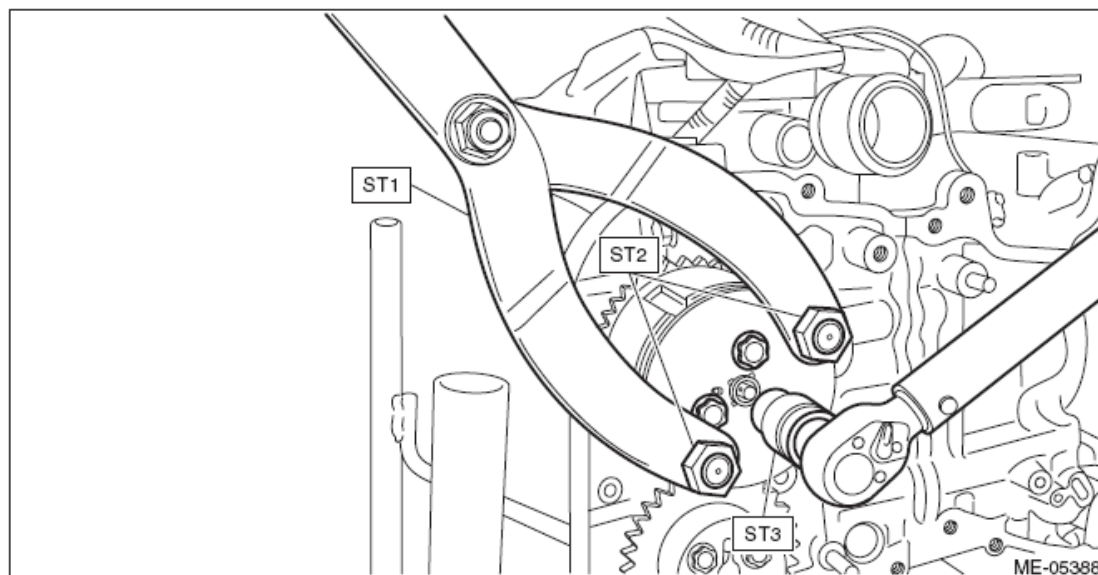


Fig. 187: Installing Intake Cam Sprocket RH Mounting Bolt Using Tools

Courtesy of SUBARU OF AMERICA, INC.

3. Install the timing chain RH. Refer to **TIMING CHAIN RH**.
4. Install the chain cover. Refer to **INSTALLATION**.

- **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.

NOTE: Before installation, check that there is no foreign matter on the exhaust cam sprocket RH and exhaust camshaft RH.

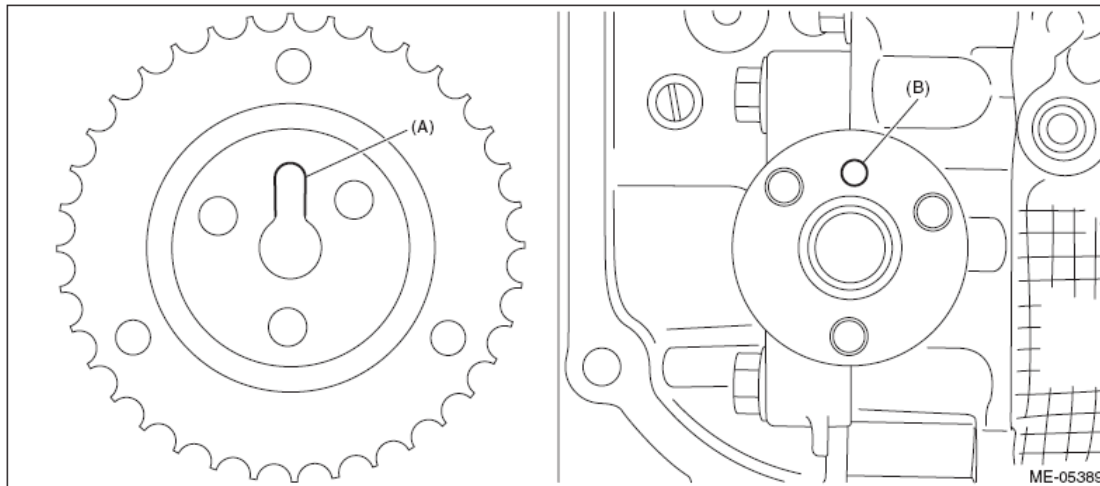


Fig. 188: Identifying Exhaust Cam Sprocket RH Knock Hole And Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

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)

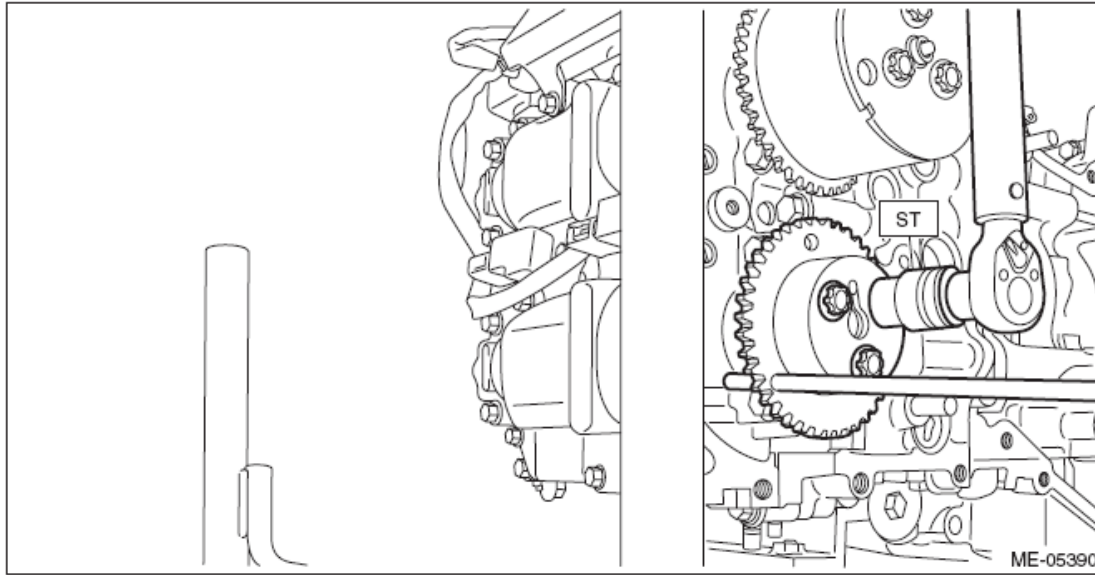


Fig. 189: Inserting Steel Rod Into Exhaust Cam Sprocket RH Hole
Courtesy of SUBARU OF AMERICA, INC.

3. Install the timing chain RH. Refer to **TIMING CHAIN RH**.
4. Install the chain cover. Refer to **INSTALLATION**.

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.

NOTE: Before installation, check that there is no foreign matter on the intake cam sprocket LH and intake camshaft LH.

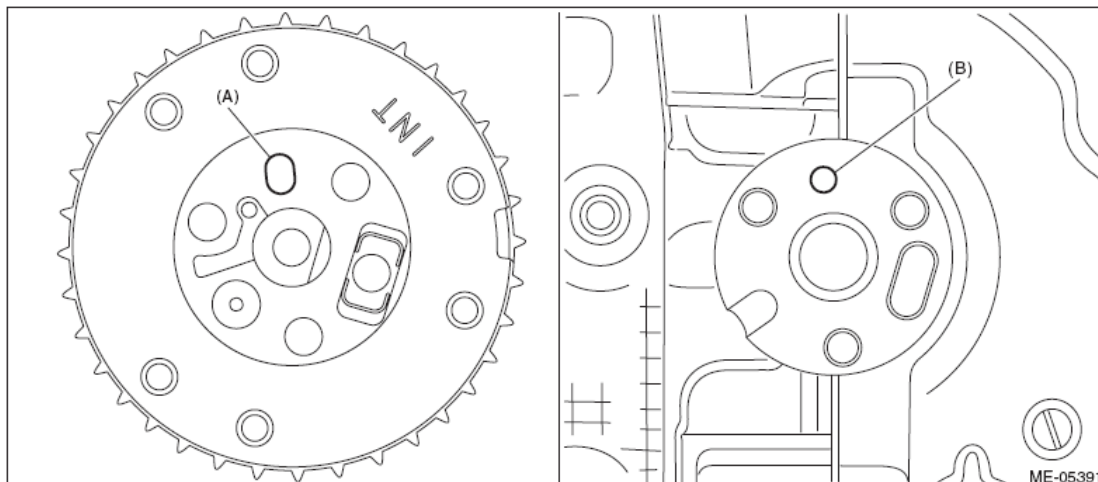


Fig. 190: Identifying Intake Cam Sprocket LH Knock Hole And Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

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)

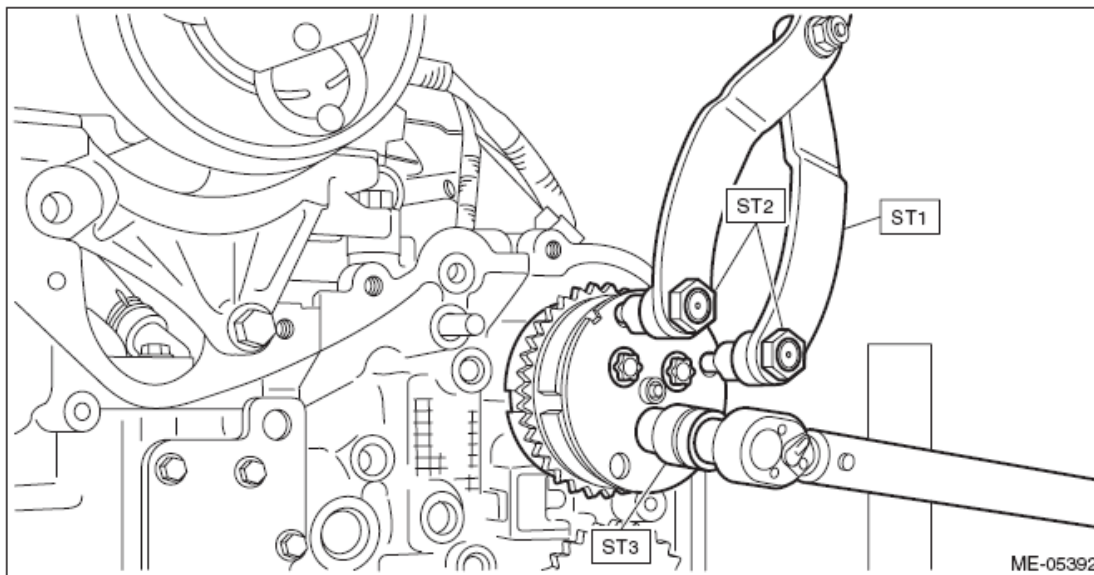


Fig. 191: Installing Intake Cam Sprocket LH Mounting Bolt Using Tools
Courtesy of SUBARU OF AMERICA, INC.

3. Install timing chain LH. Refer to **TIMING CHAIN LH**.
4. Install the chain cover. Refer to **INSTALLATION**.

- **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.

NOTE: Before installation, check that there is no foreign matter on the exhaust cam sprocket LH and exhaust camshaft LH.

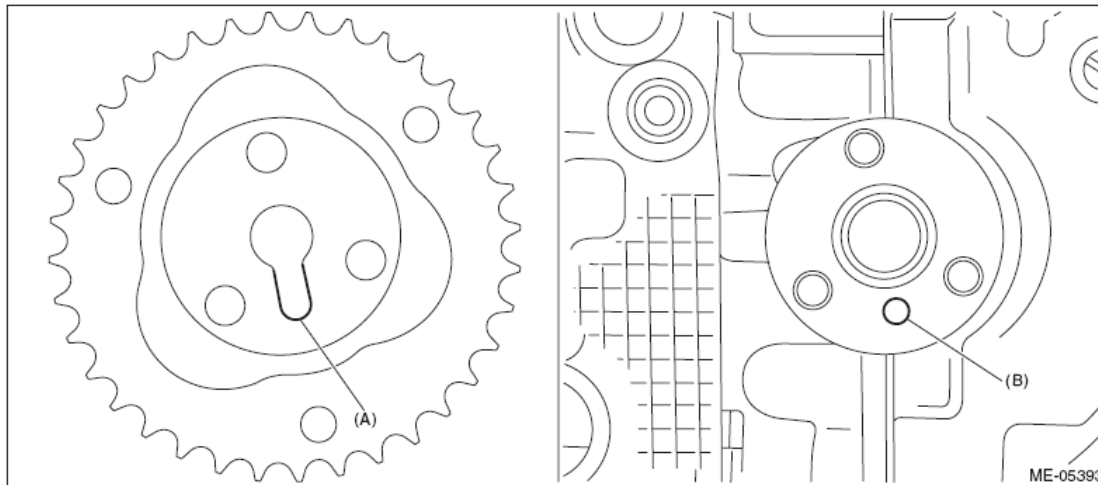


Fig. 192: Identifying Exhaust Cam Sprocket LH Knock Hole And Knock Pin
Courtesy of SUBARU OF AMERICA, INC.

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)

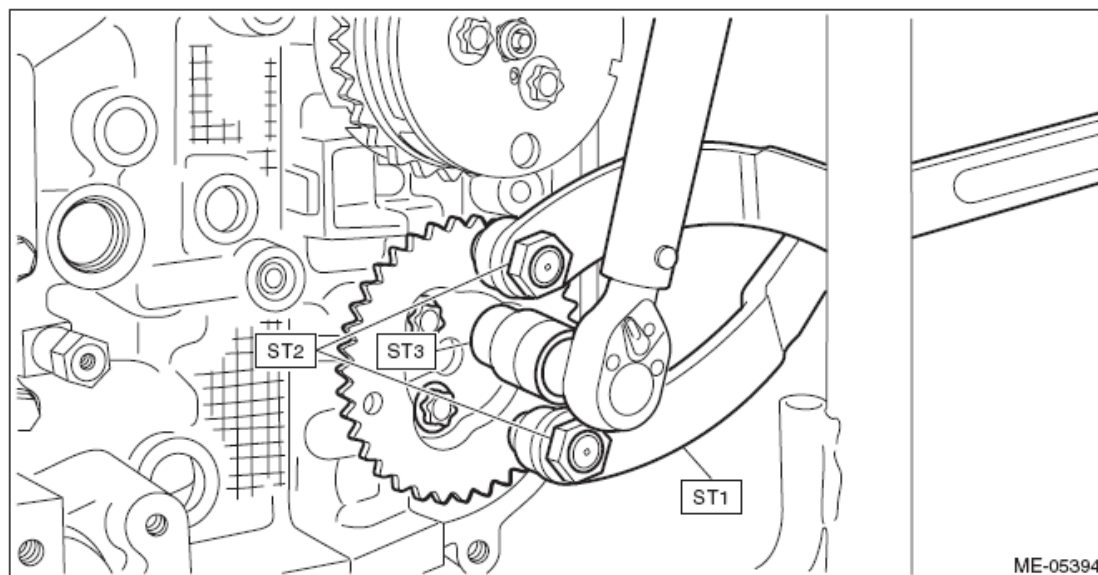


Fig. 193: Installing Exhaust Cam Sprocket LH Mounting Bolt Using Tools

Courtesy of SUBARU OF AMERICA, INC.

3. Install timing chain LH. Refer to **TIMING CHAIN LH**.
4. Install the chain cover. Refer to **INSTALLATION**.

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 assembly installed to body.

1. Remove the chain cover. Refer to **REMOVAL**.
2. Remove the timing chain. Refer to **REMOVAL**.
3. Remove the crank sprocket.

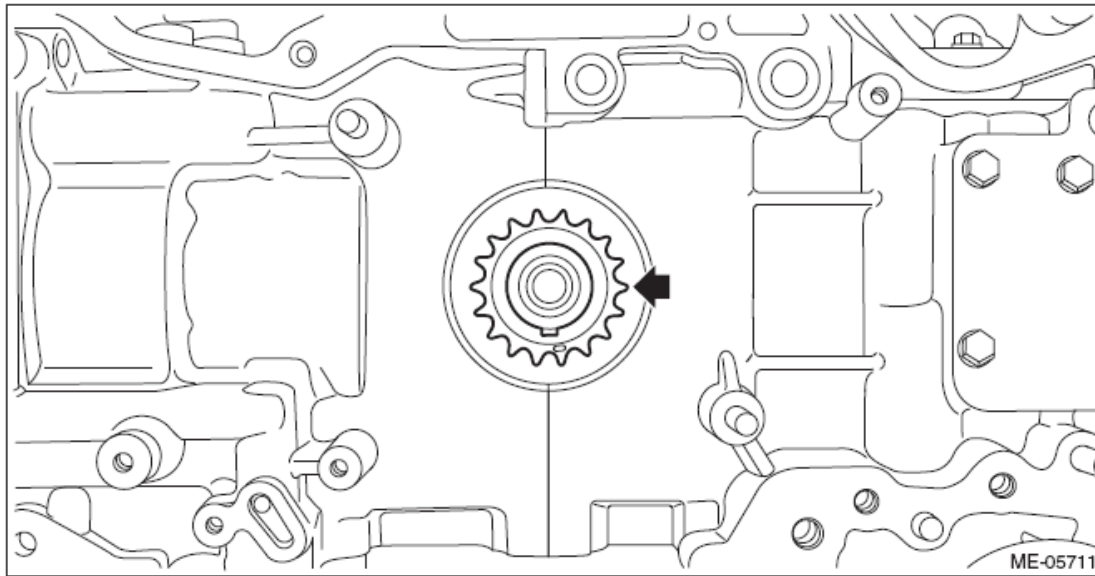


Fig. 194: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

INSTALLATION

1. Install the crank sprocket.

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

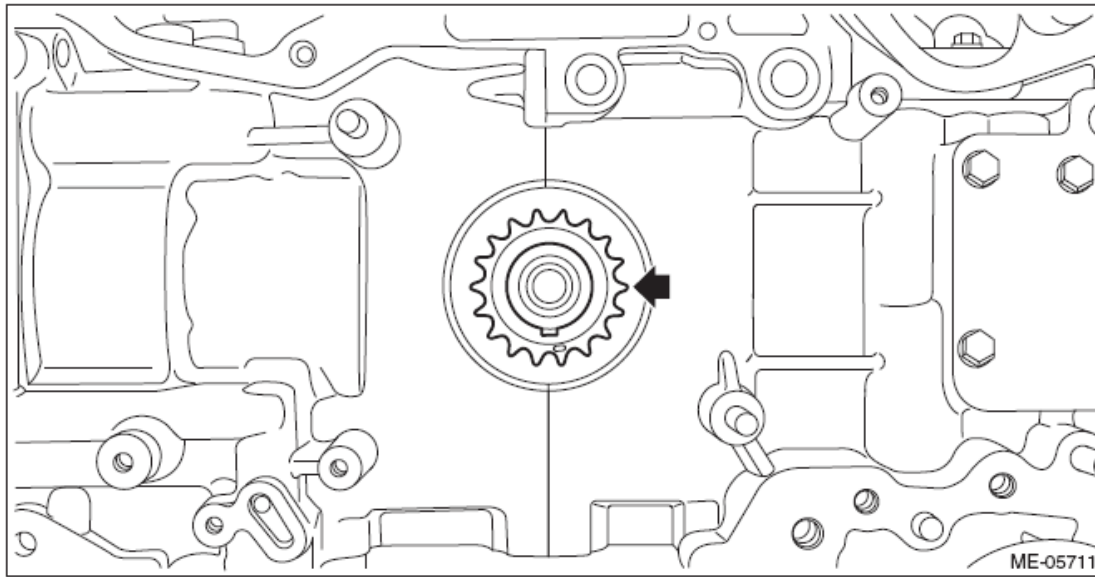


Fig. 195: Locating Crank Sprocket
Courtesy of SUBARU OF AMERICA, INC.

2. Install the timing chain. Refer to **INSTALLATION**.
3. Install the chain cover. Refer to **INSTALLATION**.

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 assembly 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**.
2. Remove the clip (A) from the air intake boot, and loosen the clamps (B) and (C) securing the air intake boot to the throttle body.

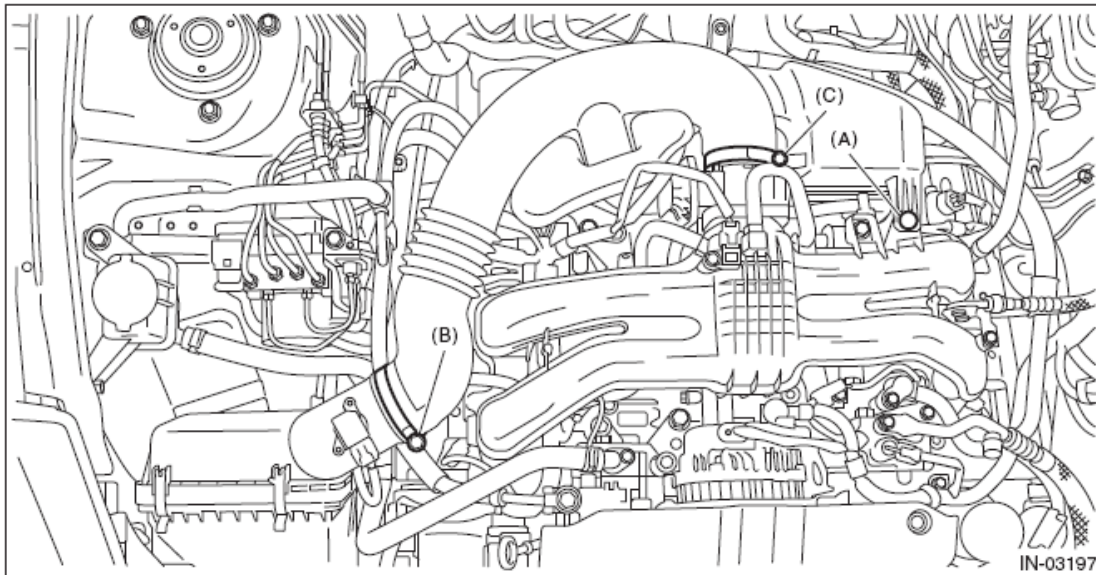


Fig. 196: Identifying Air Intake Boot Clip And Clamps
Courtesy of SUBARU OF AMERICA, INC.

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

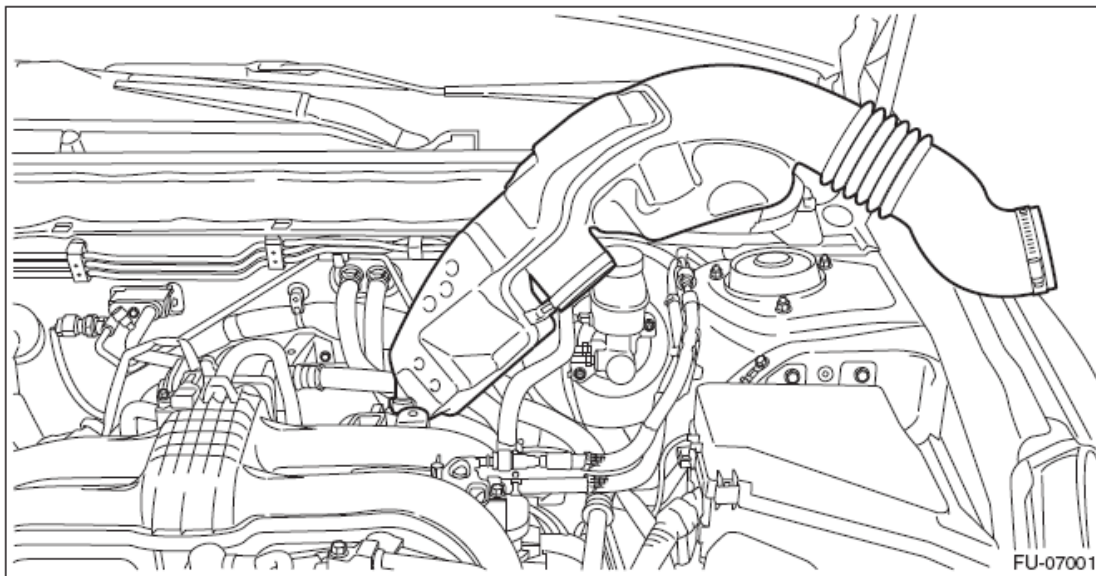


Fig. 197: Identifying Throttle Body Air Intake Boot
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the front exhaust pipe. Refer to **REMOVAL** .
2. Remove the #1 ignition coil and the #3 ignition coil. Refer to **REMOVAL** .
3. Remove the intake manifold protector RH.

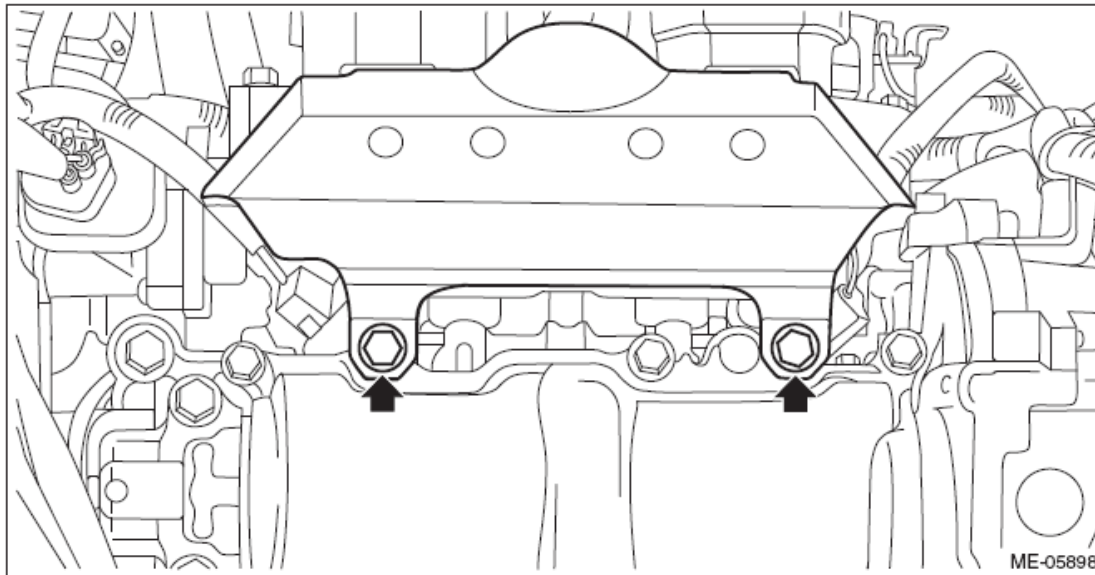


Fig. 198: Locating Intake Manifold Protector RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the rocker cover RH.

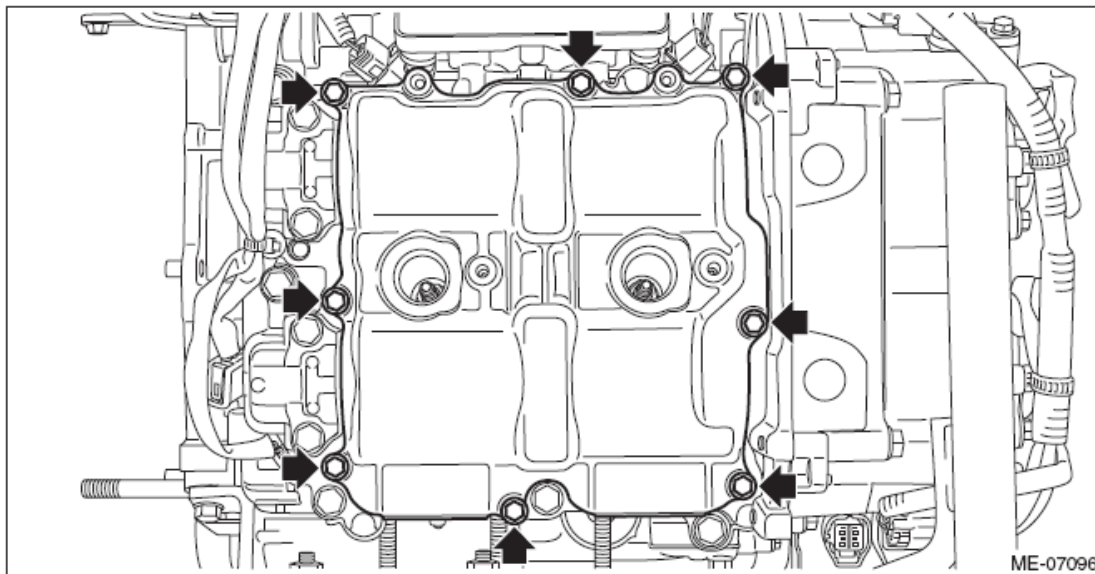


Fig. 199: Locating Rocker Cover RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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, use special care not to damage the cam lobe of

camshaft RH.

- If the cam lobe of camshaft RH interferes, turn the crankshaft to the position where the scraper does not touch.

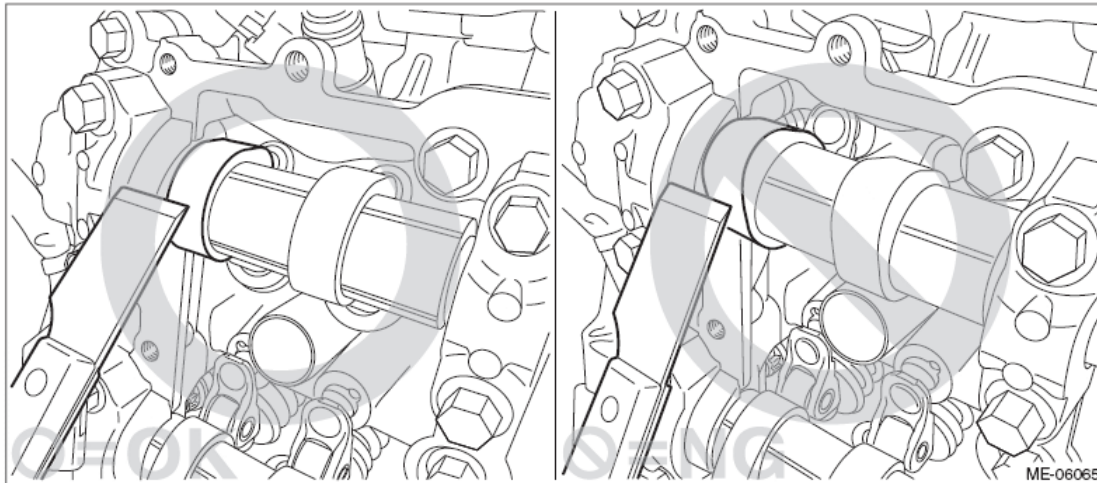


Fig. 200: Caution For Removing Liquid Gasket From Camshaft Cam Lobe Using Scraper
Courtesy of SUBARU OF AMERICA, INC.

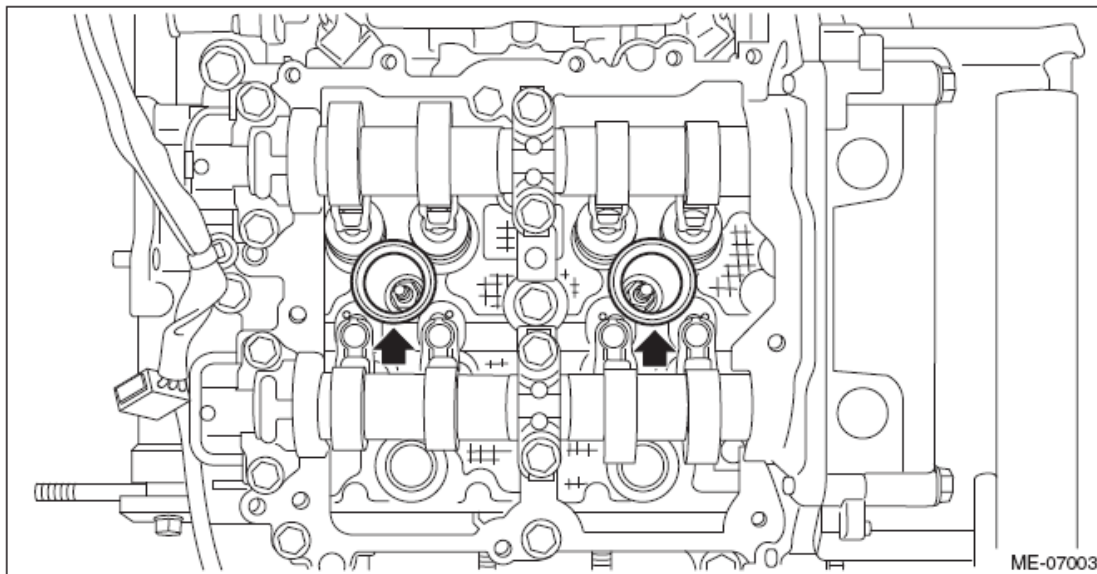


Fig. 201: Locating Spark Plug Pipe Gasket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

ROCKER COVER LH

NOTE: When replacing a single part, perform the work with the engine assembly 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**.
2. Remove the V-belt covers.

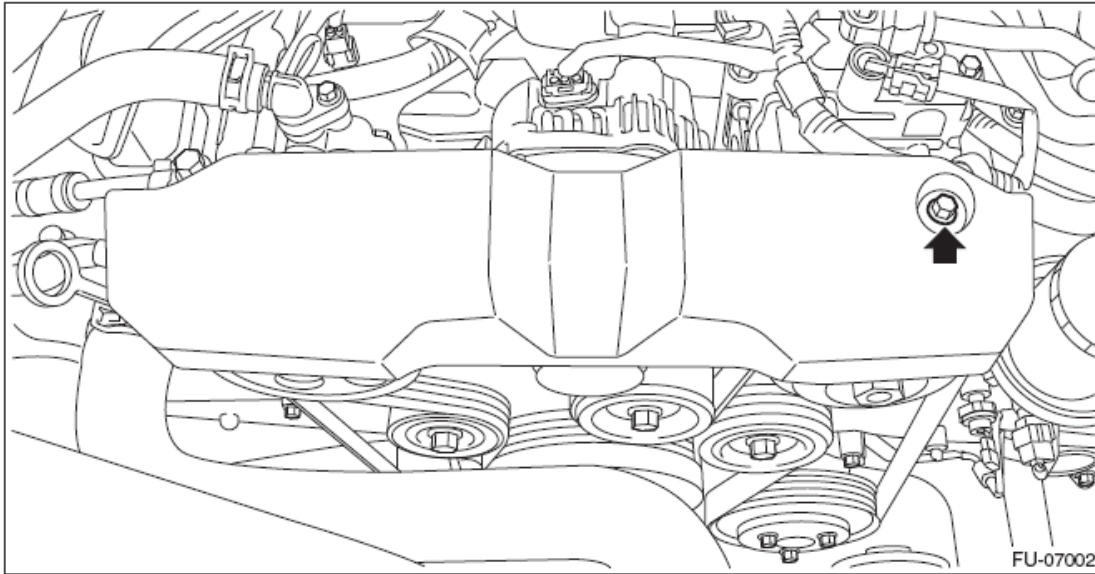


Fig. 202: Locating V-Belt Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the air intake duct. Refer to **REMOVAL**.
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.

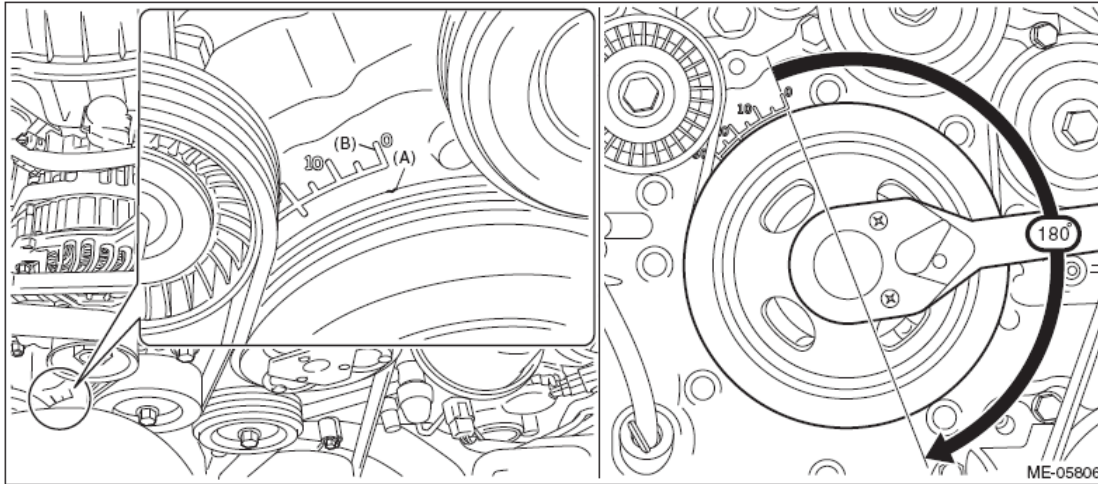


Fig. 203: Turning Crankshaft To Clockwise
Courtesy of SUBARU OF AMERICA, INC.

2. Remove the #2 ignition coil and the #4 ignition coil. Refer to **REMOVAL**.
3. Remove the intake manifold protector LH.

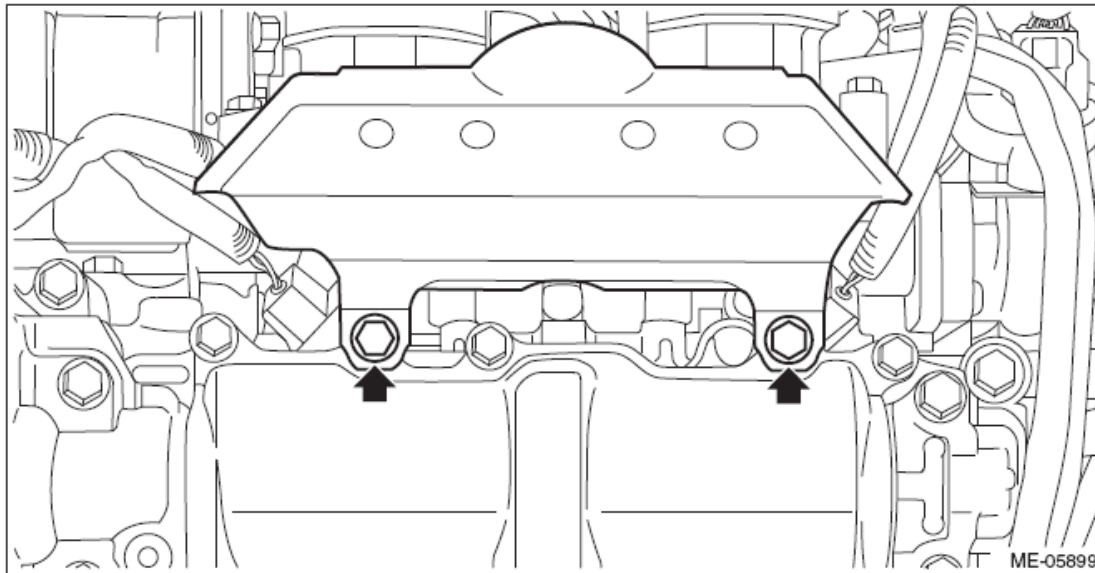


Fig. 204: Locating Intake Manifold Protector LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

4. Remove the rocker cover LH.

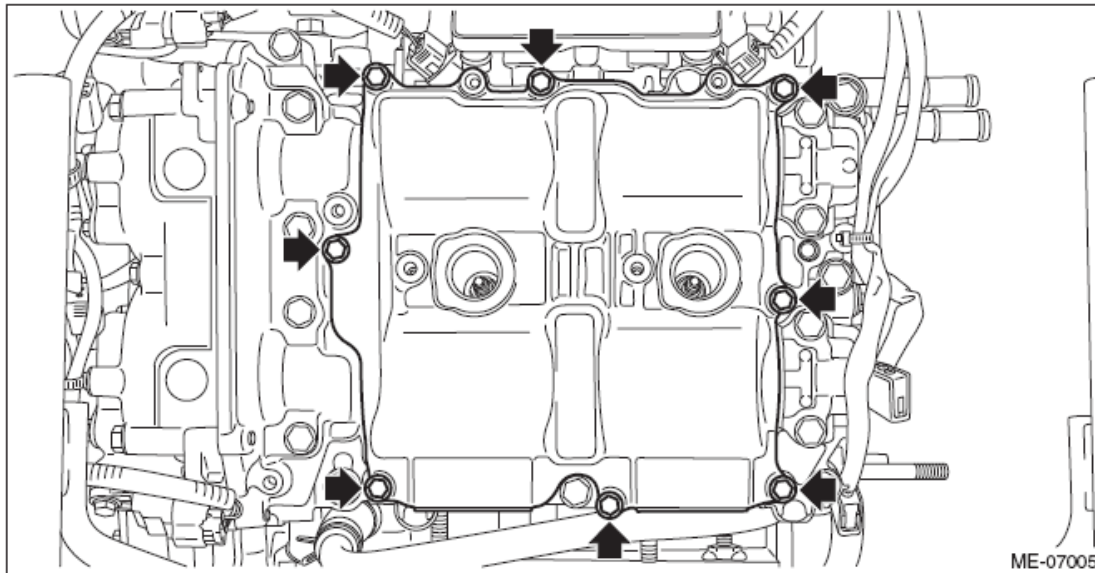


Fig. 205: Locating Rocker Cover LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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, use 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.

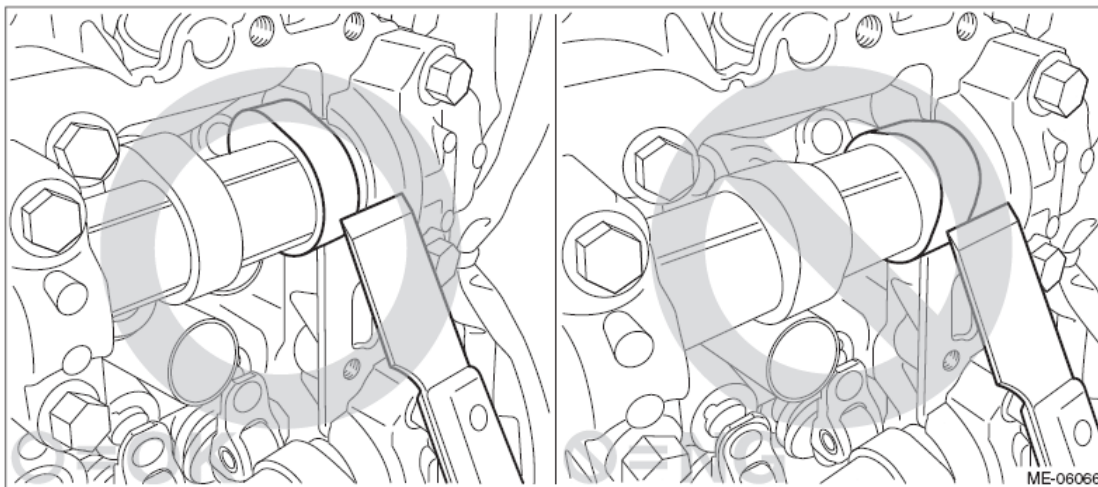


Fig. 206: Caution For Removing Liquid Gasket From Camshaft Cam Lobe Using Scraper
Courtesy of SUBARU OF AMERICA, INC.

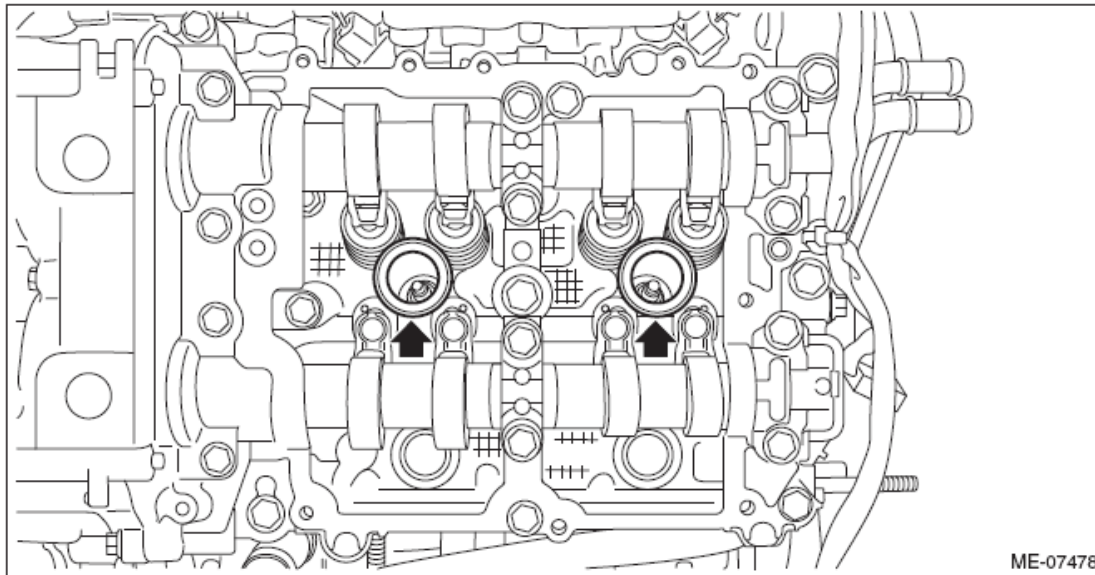


Fig. 207: Locating Spark Plug Pipe Gaskets
Courtesy of SUBARU OF AMERICA, INC.

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).

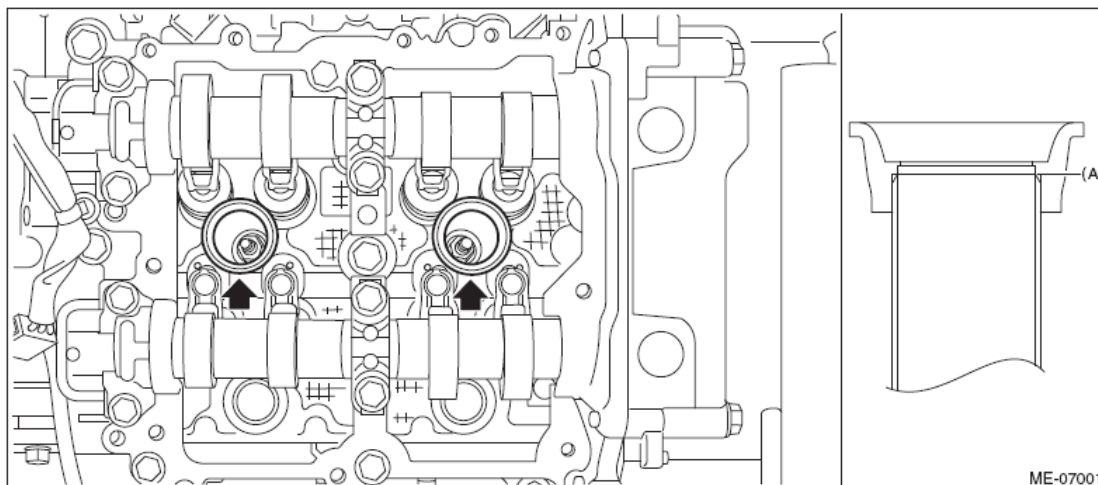


Fig. 208: Locating Spark Plug Pipe Gasket Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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.

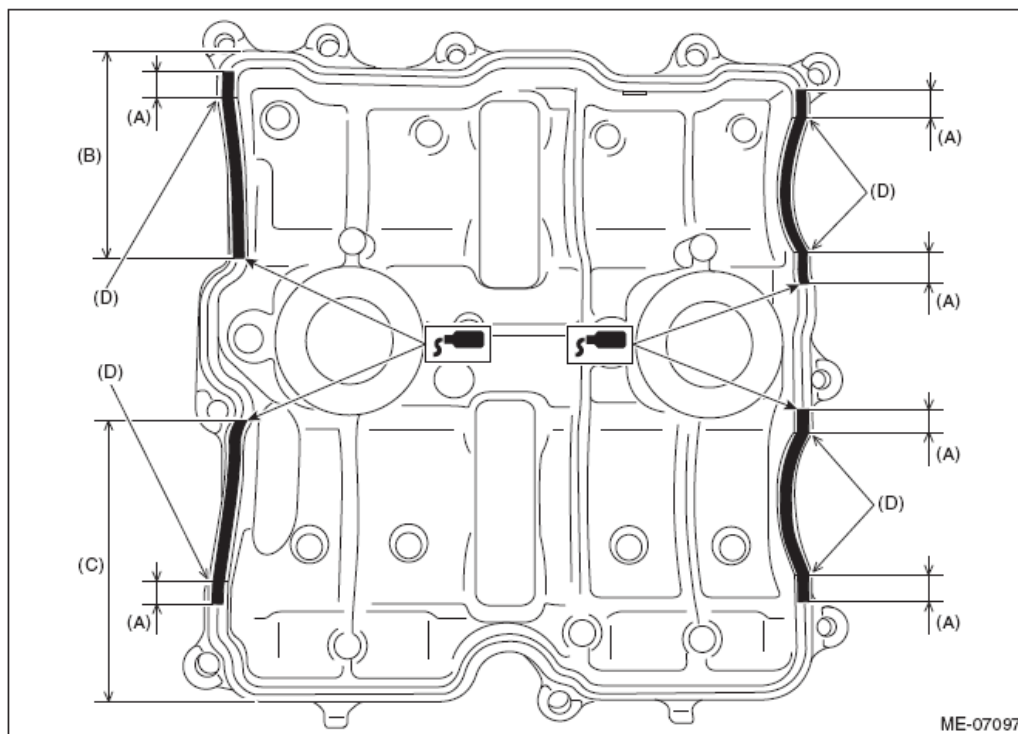
- NOTE:**
- Before applying liquid gasket, degrease the old liquid gasket seal surface of the engine.
 - Be careful not to allow liquid gasket to be squeezed out from rocker cover RH.
 - Install within 5 min. after applying liquid gasket.

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. 209: 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)

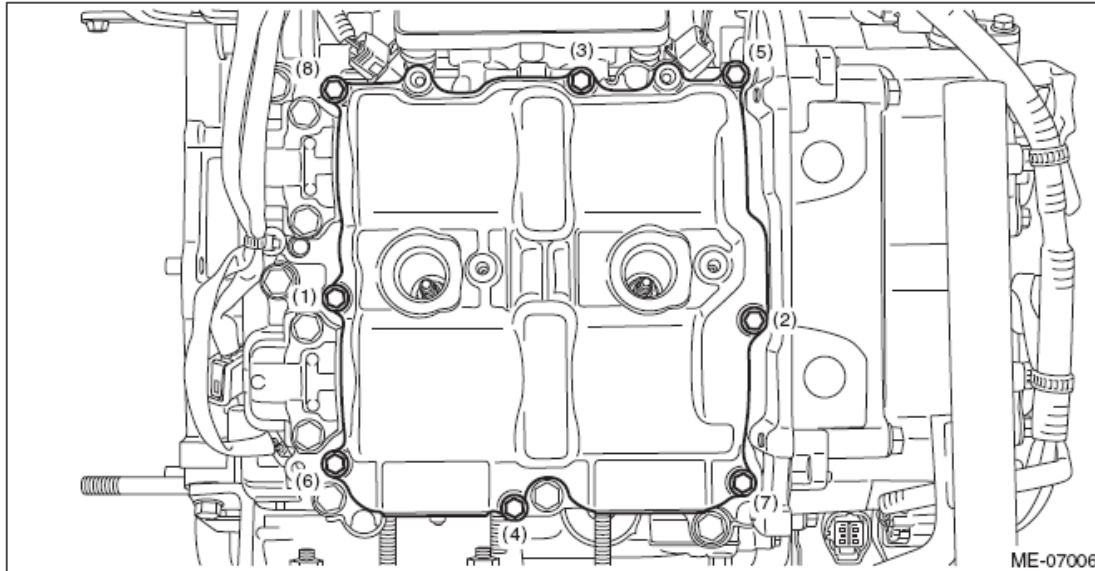


Fig. 210: Identifying Tightening Sequence Of Rocker Cover RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Install the intake manifold protector RH.

Tightening torque:

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

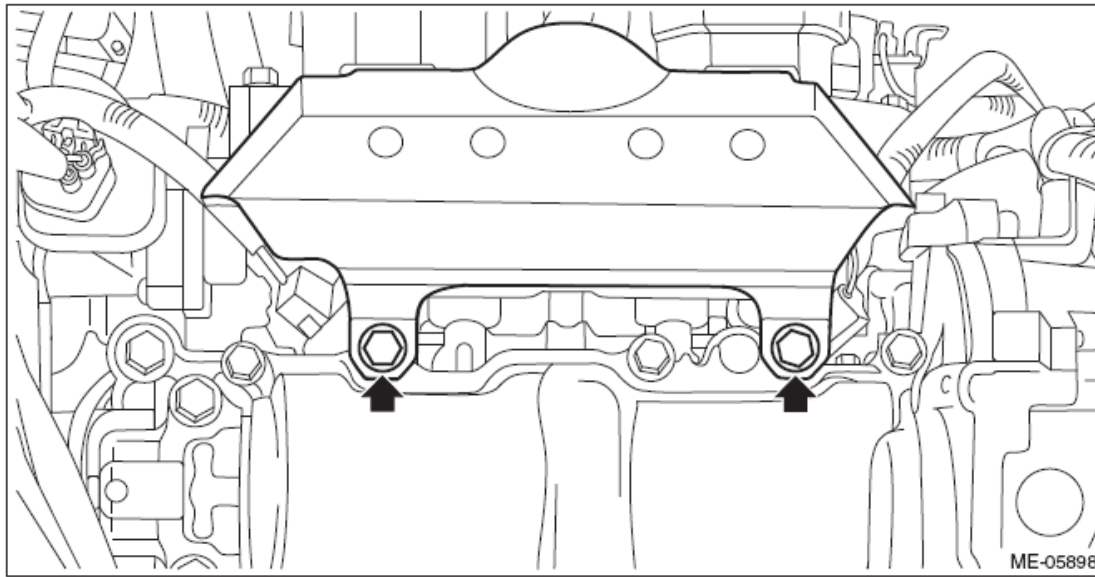


Fig. 211: Identifying Intake Manifold Protector RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Install the #1 ignition coil and the #3 ignition coil. Refer to **INSTALLATION** .
7. When working on the vehicle
 1. Install the front exhaust pipe. Refer to **INSTALLATION** .
 2. Install the air intake boot. Refer to **INSTALLATION** .
 3. Install the air cleaner case. Refer to **INSTALLATION** .

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.

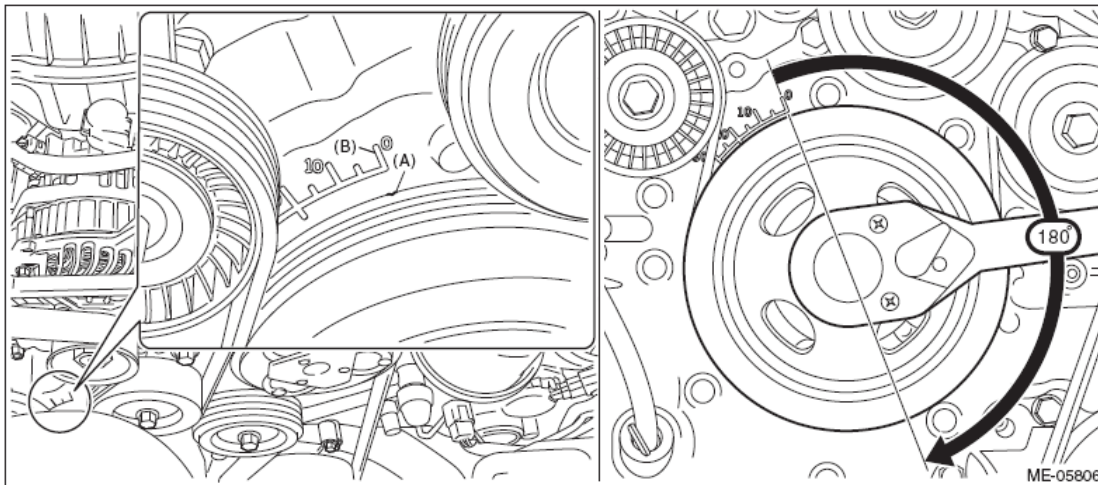


Fig. 212: Turning Crankshaft To Clockwise
Courtesy of SUBARU OF AMERICA, INC.

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).

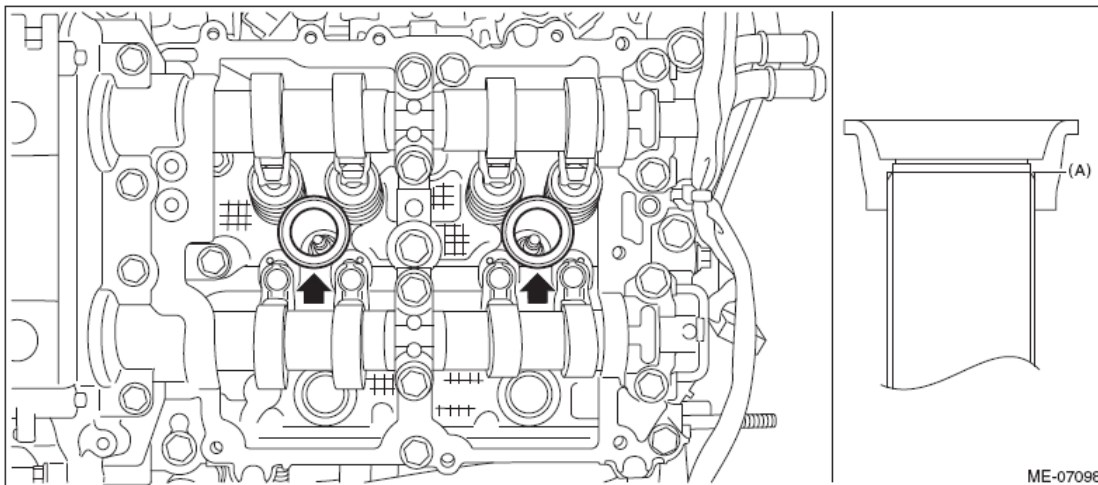


Fig. 213: Locating Spark Plug Pipe Gasket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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:

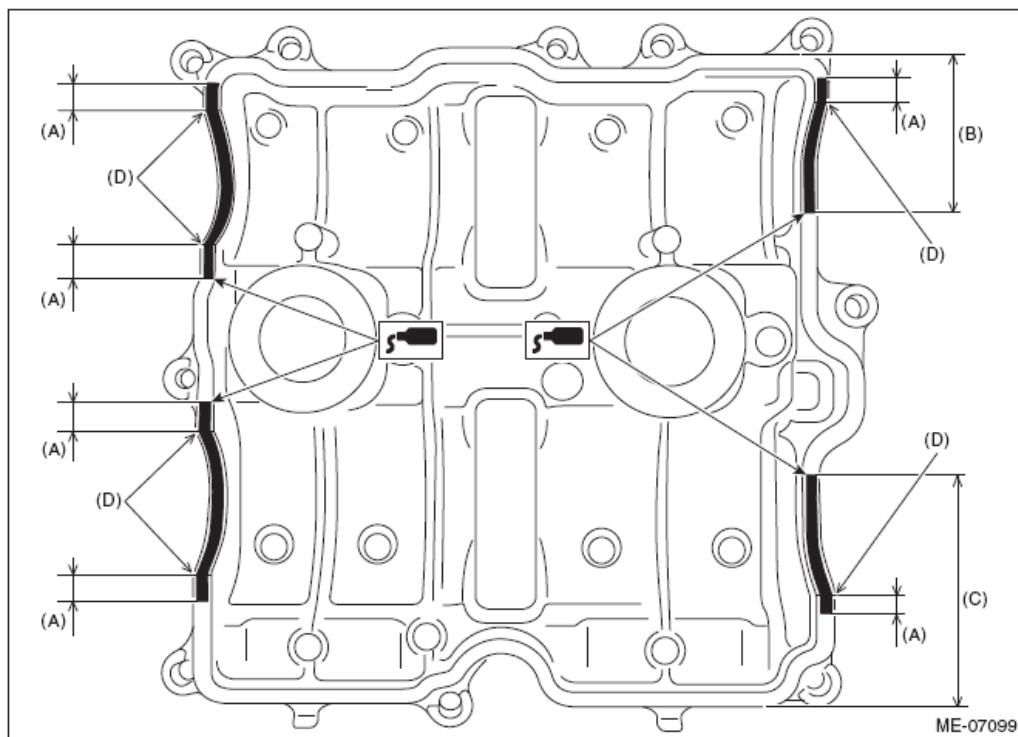
- Before applying liquid gasket, degrease the old liquid gasket seal surface of the engine.
- Be careful not to allow liquid gasket to be squeezed out from rocker cover LH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket:

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

Liquid gasket applying diameter:

$3.5 \pm 0.5 \text{ mm}$ ($0.1378 \pm 0.0197 \text{ in}$)



(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. 214: 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)

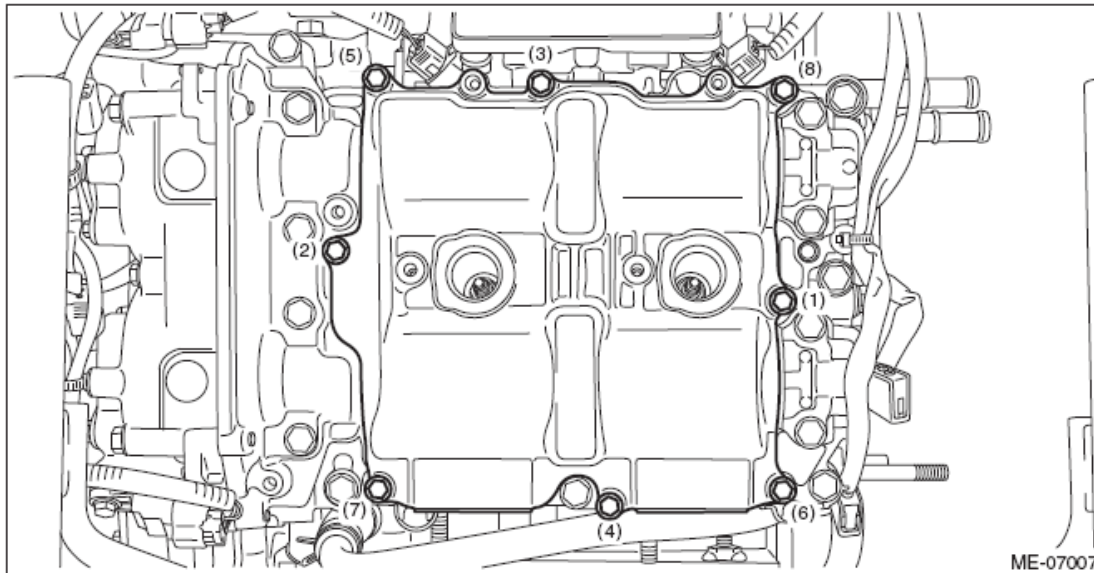


Fig. 215: Identifying Tightening Sequence Of Rocker Cover LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Install the intake manifold protector LH.

Tightening torque:

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

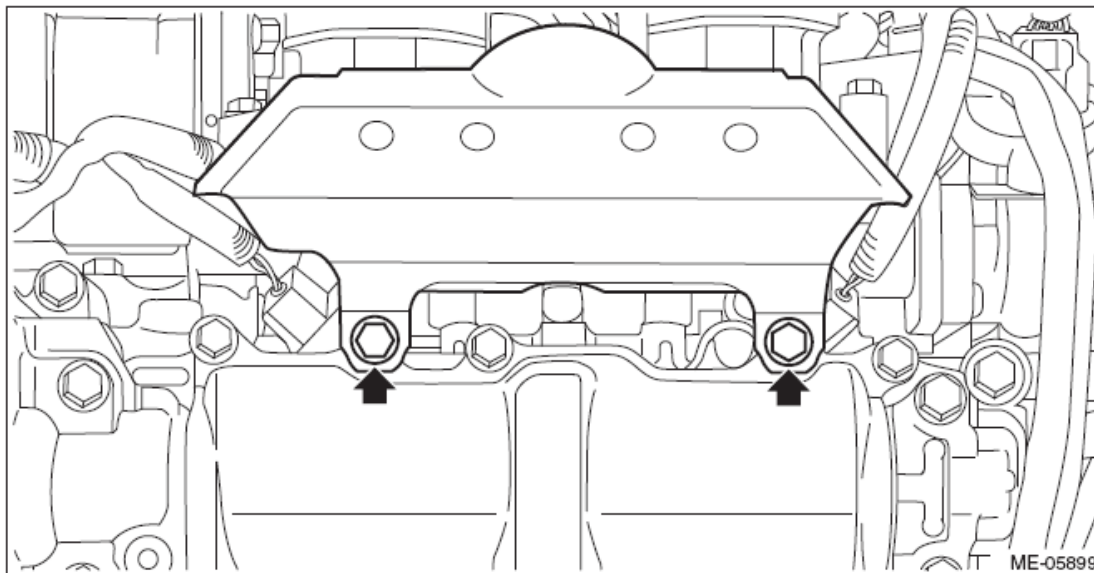


Fig. 216: Locating Intake Manifold Protector LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

7. Install the #2 ignition coil and the #4 ignition coil. Refer to **INSTALLATION** .
8. When working on the vehicle
 1. Install the air intake duct. Refer to **INSTALLATION** .
 2. Install the V-belt cover.

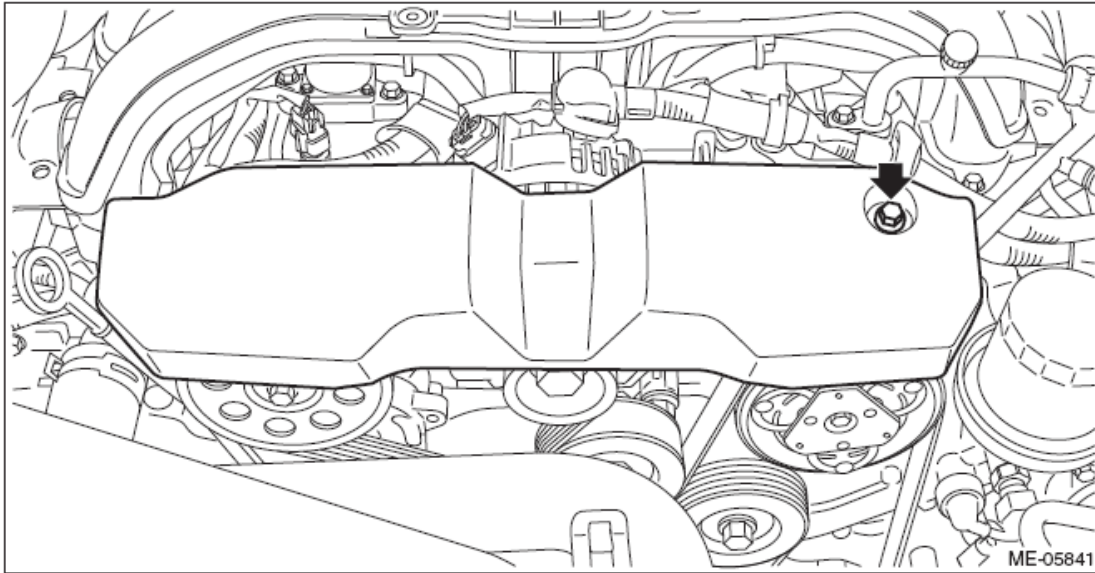
Tightening torque:***13 N.m (1.3 kgf-m, 9.6 ft-lb)***

Fig. 217: Locating V-Belt Cover Mounting Bolt
Courtesy of SUBARU OF AMERICA, INC.

3. Install the battery. Refer to **INSTALLATION** .

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 RH** and **CAM CARRIER RH** for removal procedures of camshaft RH.

CAMSHAFT LH

The camshaft LH and cam carrier are designed as removing as a unit. Refer to **CAM CARRIER LH** and **CAM CARRIER LH** for removal procedures of camshaft LH.

INSTALLATION

CAMSHAFT RH

The camshaft RH and cam carrier are designed as installing as a unit. Refer to **CAM CARRIER RH** and **CAM CARRIER RH** for installation procedures of camshaft RH.

CAMSHAFT LH

The camshaft LH and cam carrier are designed as installing as a unit. Refer to **CAM CARRIER LH** and **CAM CARRIER LH** for installation procedures of camshaft LH.

CAM CARRIER

REMOVAL

CAM CARRIER RH

1. Remove the engine from the vehicle. Refer to **REMOVAL**.
2. Remove the chain cover. Refer to **REMOVAL**.
3. Remove the timing chain RH. Refer to **TIMING CHAIN RH**.
4. Remove the cam sprocket RH. Refer to **CAM SPROCKET RH**.

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

5. Remove the rocker cover RH. Refer to **ROCKER COVER RH**.
6. Remove the clip holding the engine harness from cam carrier RH.

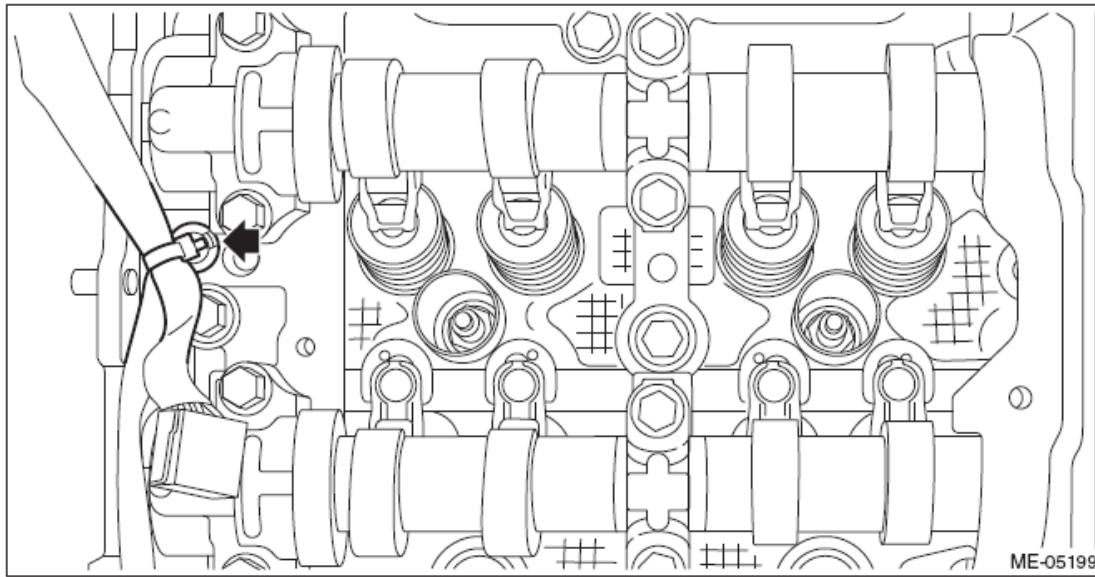


Fig. 218: Locating Engine Harness Holding Clip
Courtesy of SUBARU OF AMERICA, INC.

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

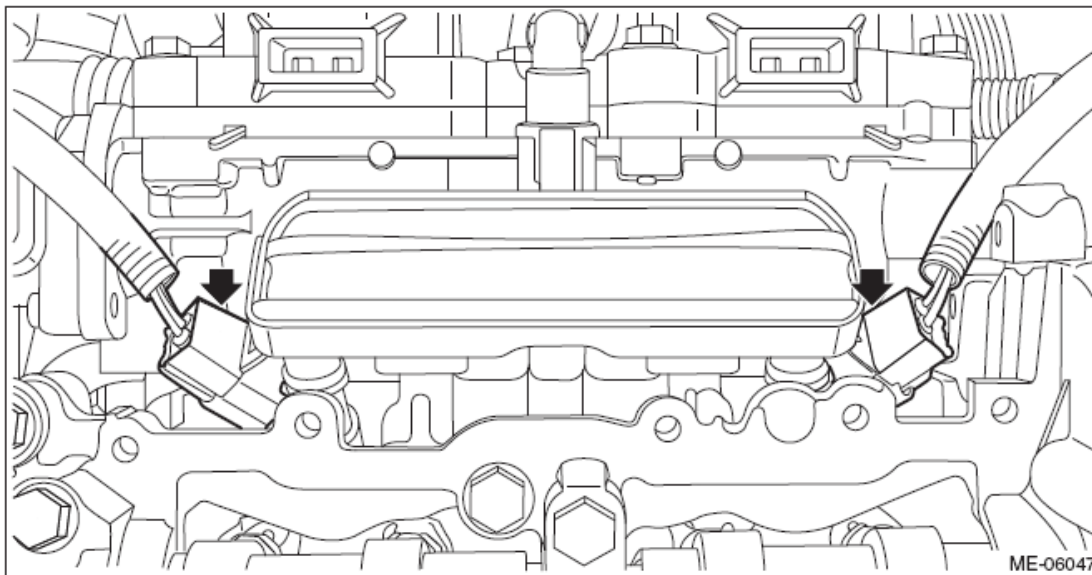
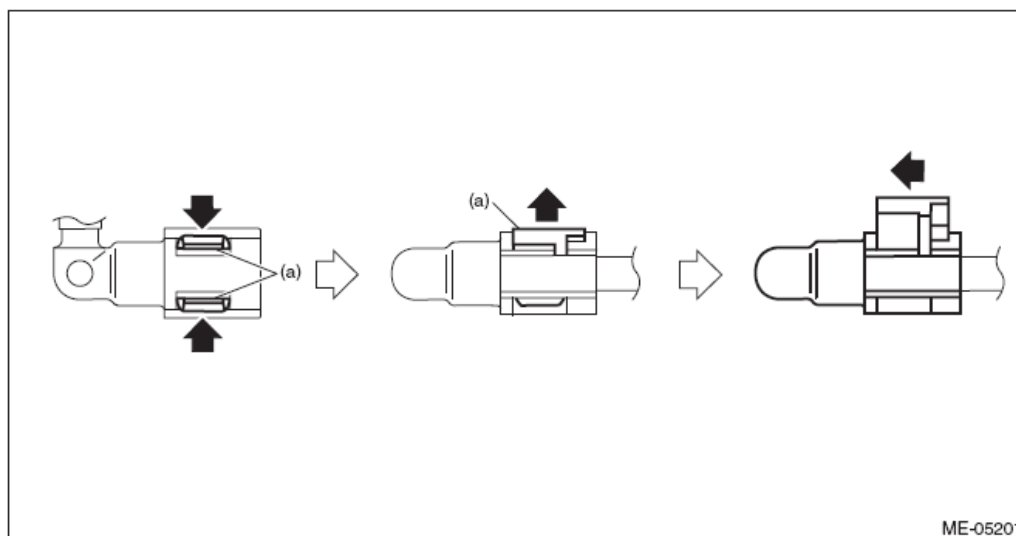


Fig. 219: Locating Fuel Injector RH Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Disconnect the quick connector from fuel pipe RH.

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



(a) Slider

Fig. 220: Disconnecting Fuel Pipe RH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

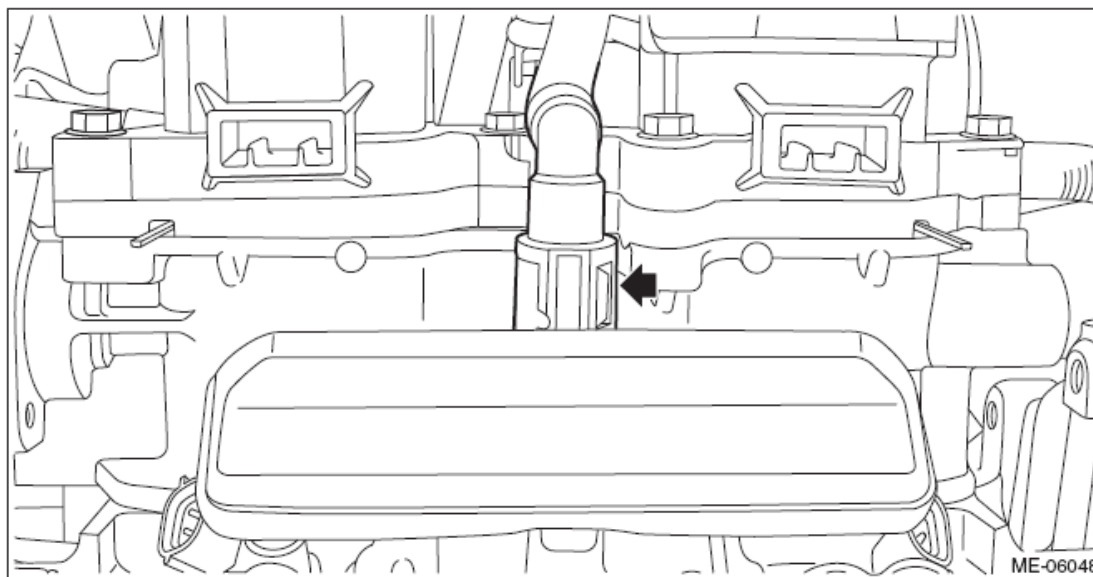


Fig. 221: Locating Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

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

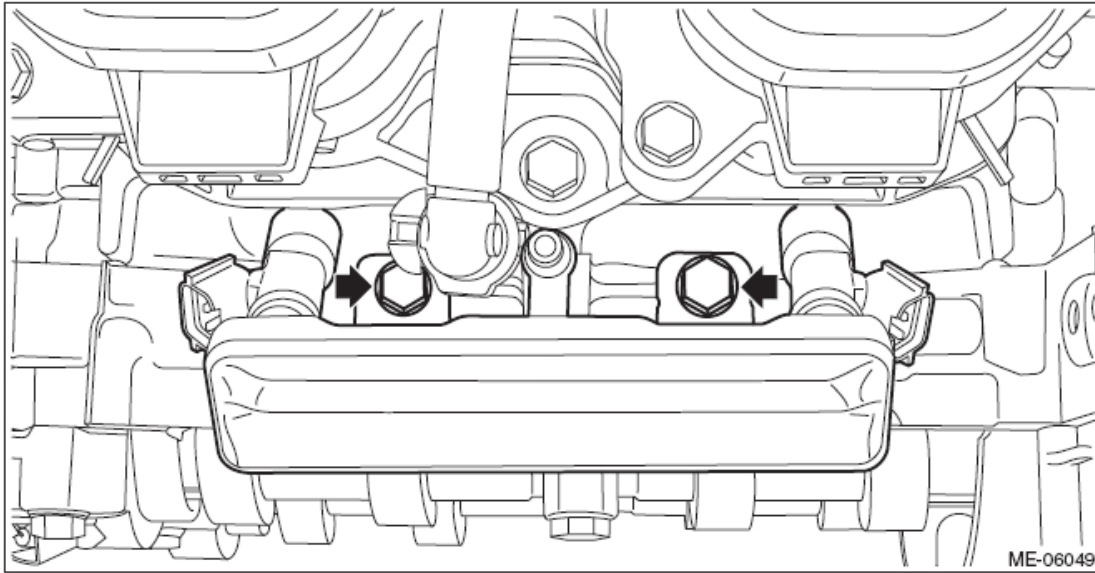


Fig. 222: Locating Tightening Sequence Of Fuel Pipe RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

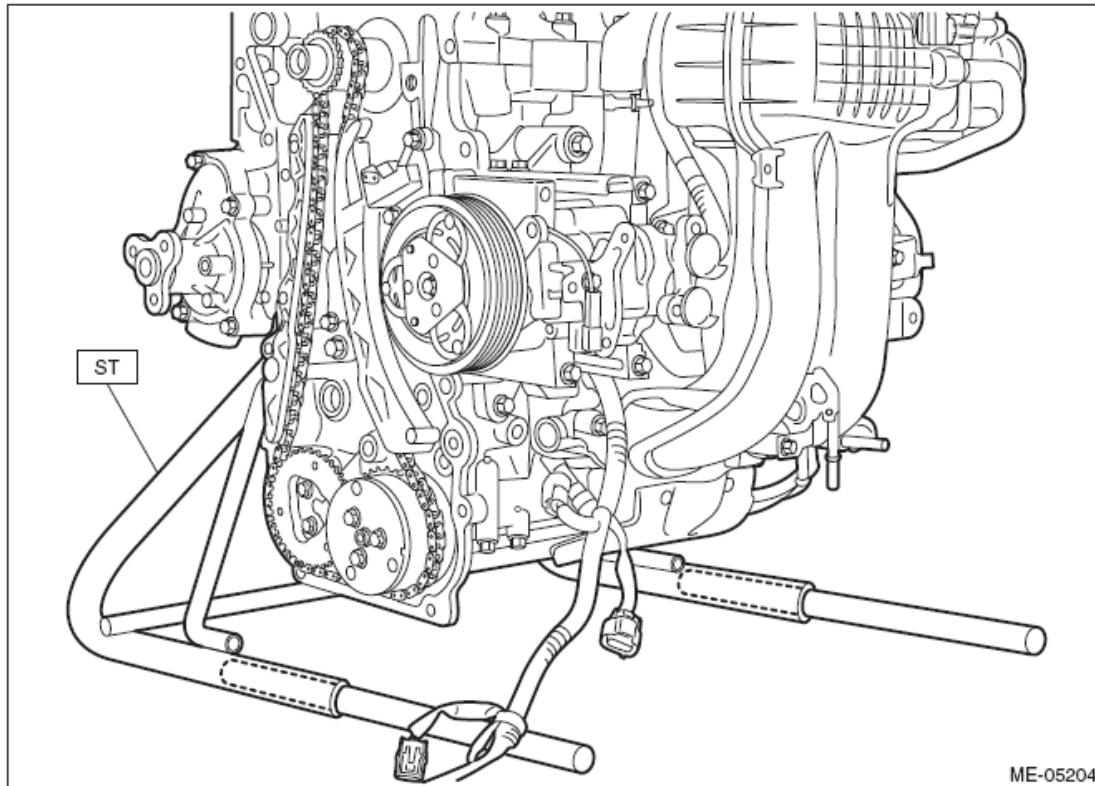


Fig. 223: Supporting Engine Using Engine Stand
Courtesy of SUBARU OF AMERICA, INC.

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

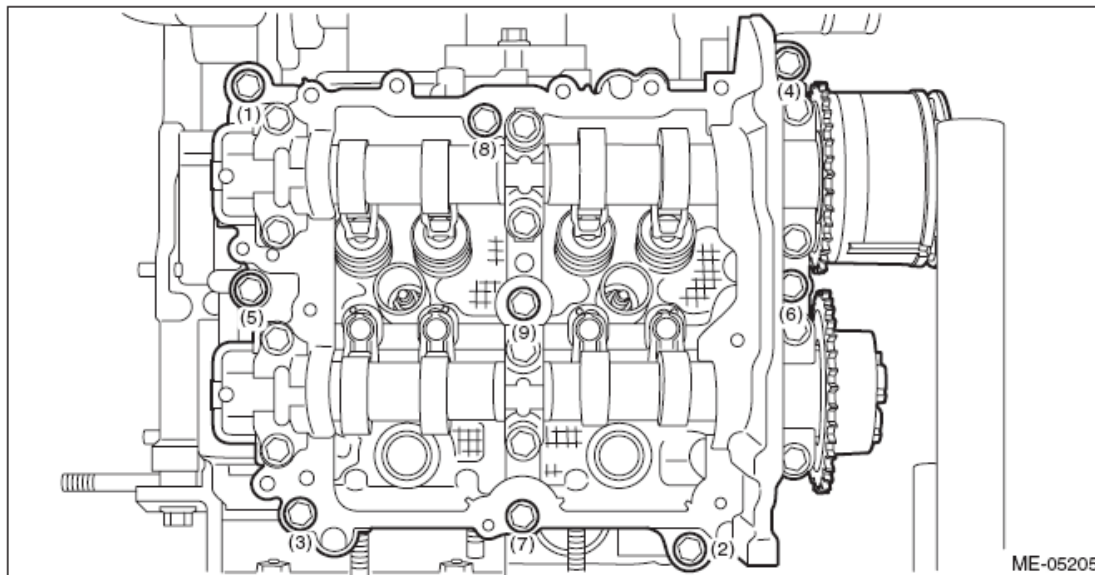


Fig. 224: Identifying Loosening Sequence Of Cam Carrier RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

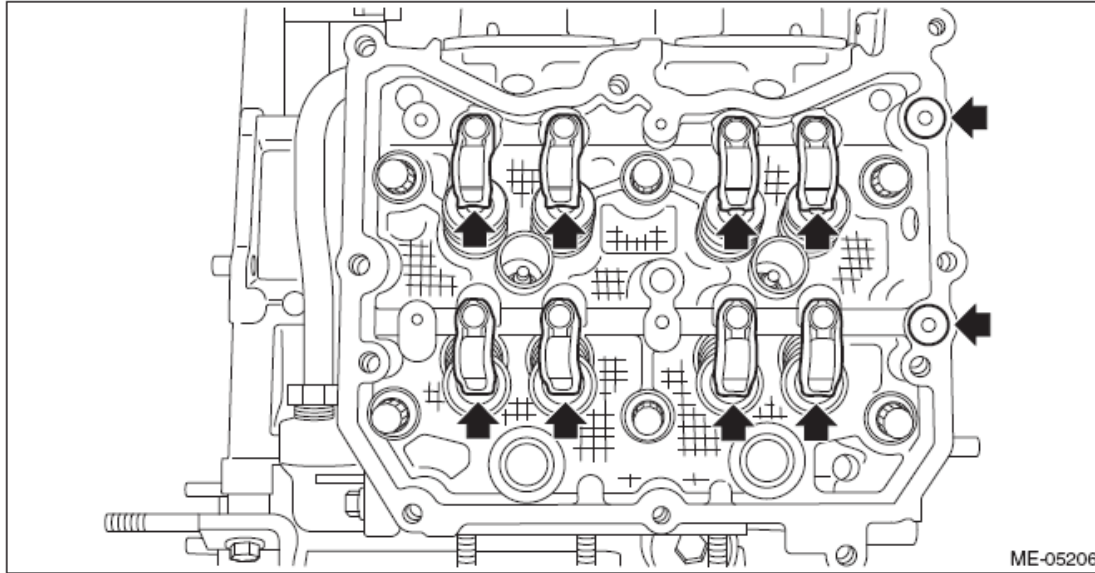


Fig. 225: Locating Cylinder Head RH O-Ring And Roller Rocker Arms
Courtesy of SUBARU OF AMERICA, INC.

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.

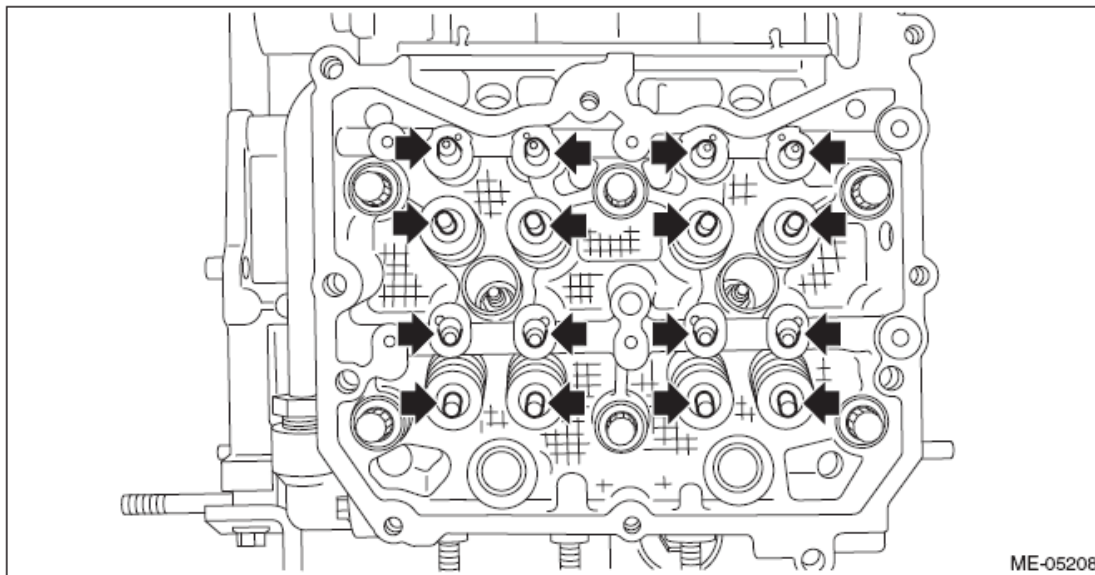


Fig. 226: Locating Cylinder Head RH Valve Shims And Roller Arm Pivots
Courtesy of SUBARU OF AMERICA, INC.

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**.
2. Remove the chain cover. Refer to **REMOVAL**.
3. Remove the timing chain LH. Refer to **TIMING CHAIN LH**.
4. Remove the cam sprocket LH. Refer to **CAM SPROCKET LH**.

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

5. Remove the rocker cover LH. Refer to **ROCKER COVER LH**.
6. Remove the clip holding the engine harness from cam carrier LH.

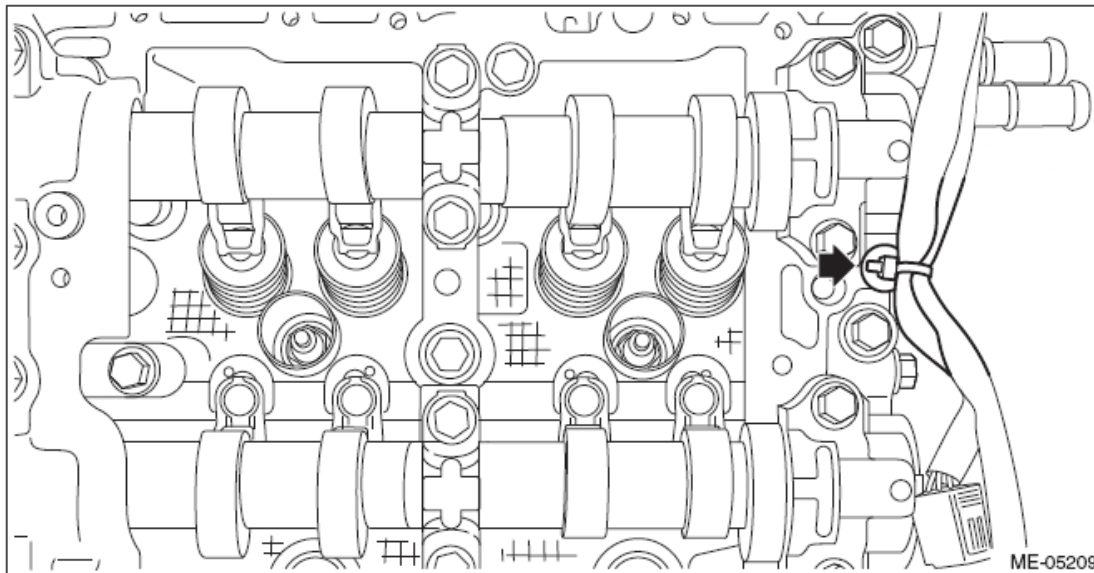


Fig. 227: Locating Cam Carrier LH Engine Harness Mounting Clip
Courtesy of SUBARU OF AMERICA, INC.

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

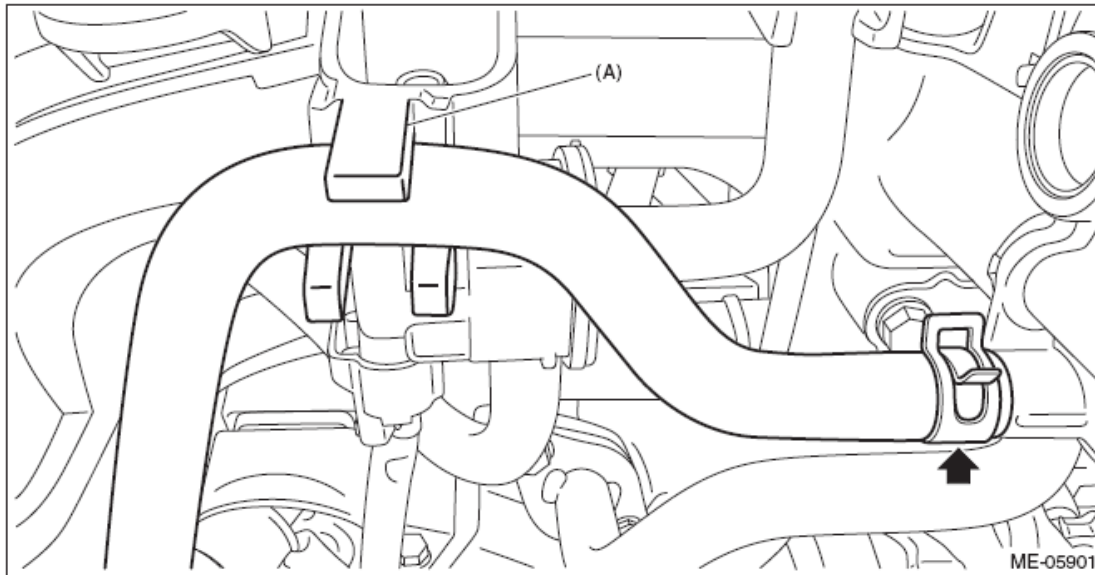


Fig. 228: Locating Preheater Hose Mounting Clip
Courtesy of SUBARU OF AMERICA, INC.

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

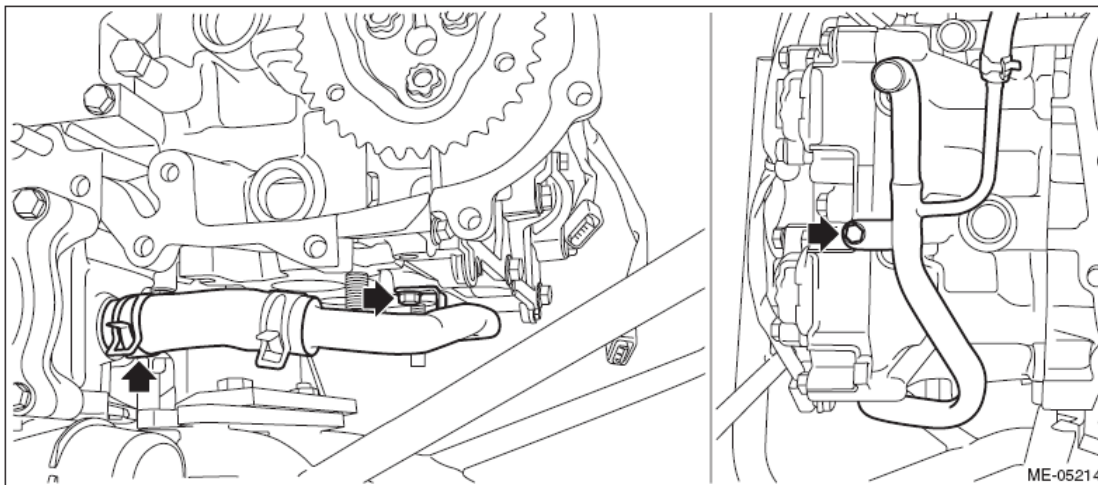


Fig. 229: Locating Water Pipe Hose To Oil Pan Upper Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

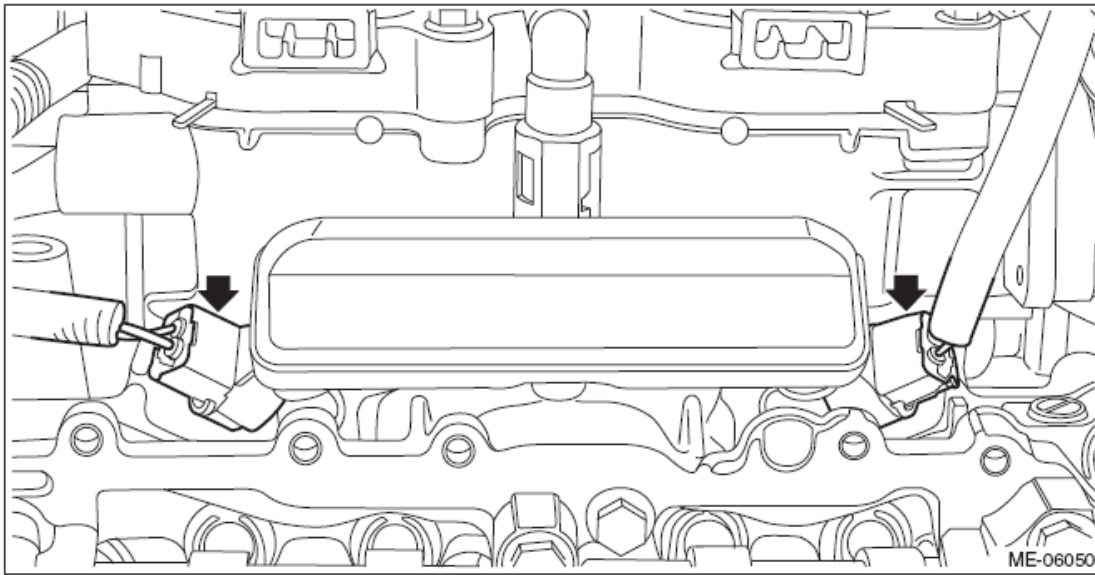
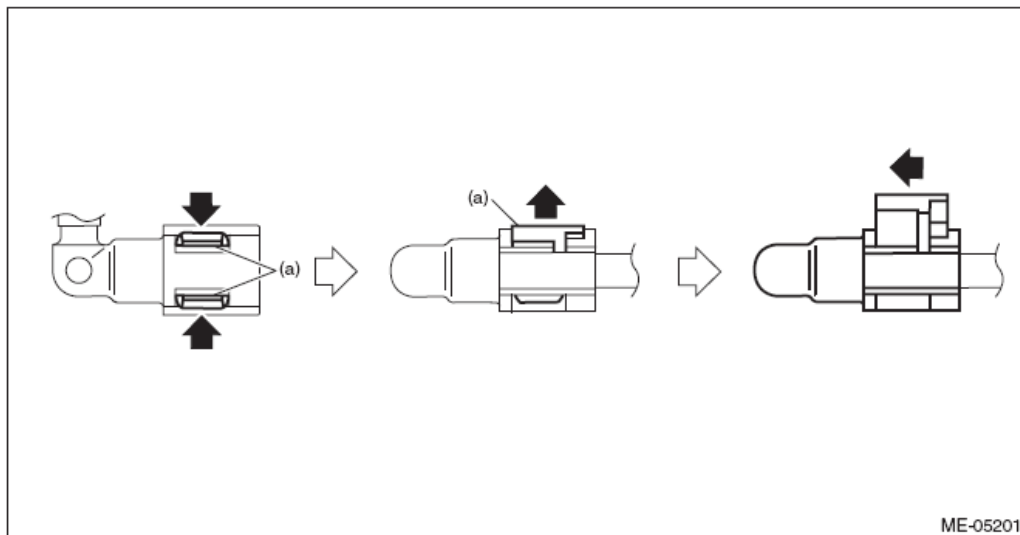


Fig. 230: Locating Fuel Injector LH Connectors
Courtesy of SUBARU OF AMERICA, INC.

2. Disconnect the quick connector from fuel pipe LH.

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



(a) Slider

Fig. 231: Disconnecting Quick Connector From Fuel Pipe LH
Courtesy of SUBARU OF AMERICA, INC.

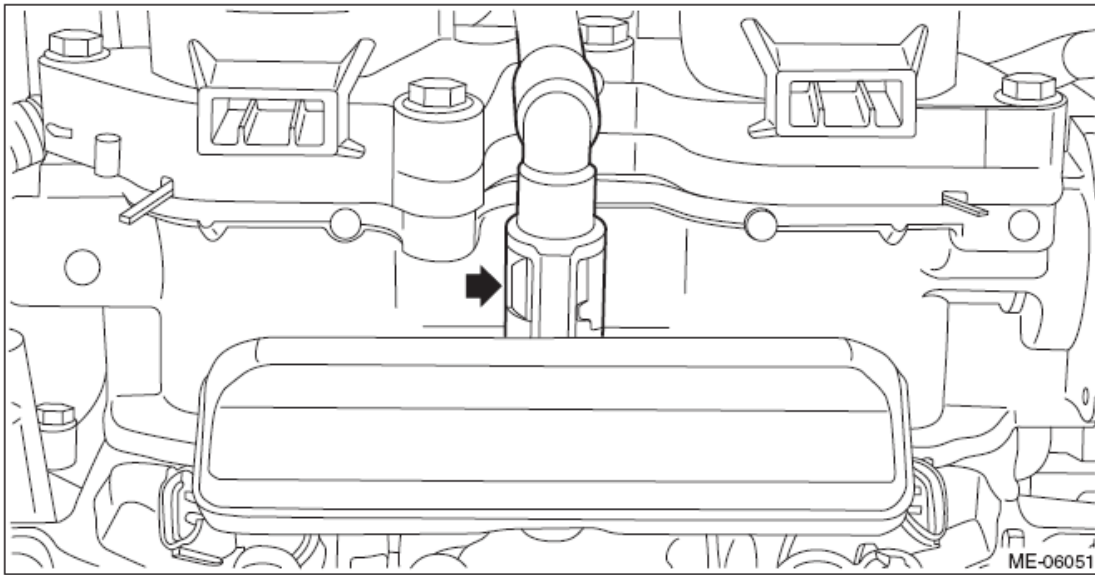


Fig. 232: Locating Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

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

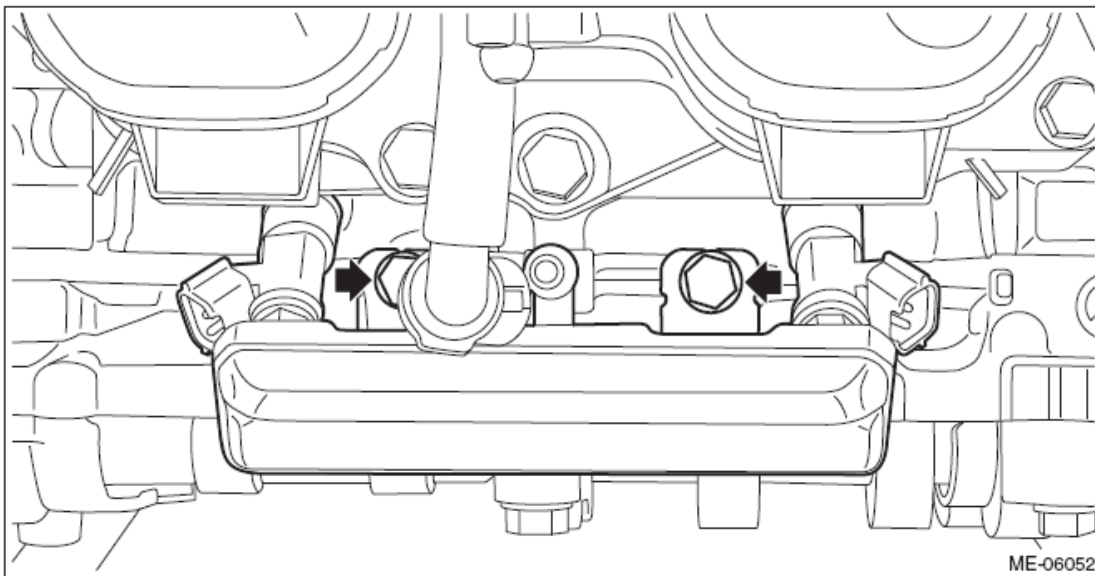


Fig. 233: Locating Fuel Pipe LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

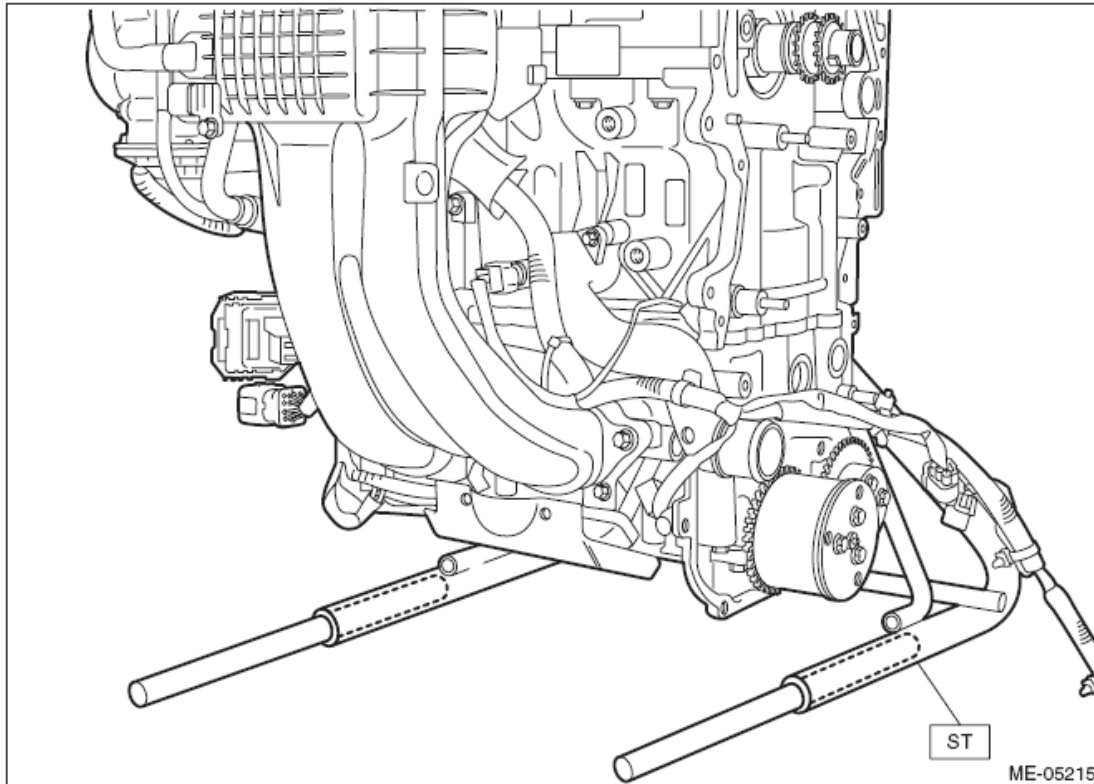


Fig. 234: Inserting Steel Rods Into Engine Stand
Courtesy of SUBARU OF AMERICA, INC.

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

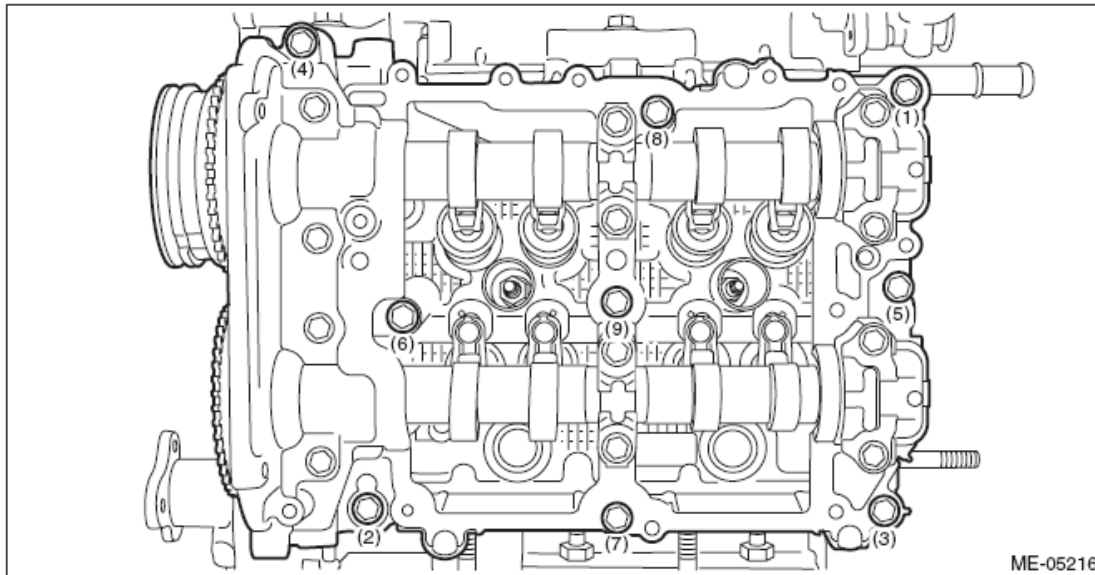


Fig. 235: Identifying Loosening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

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

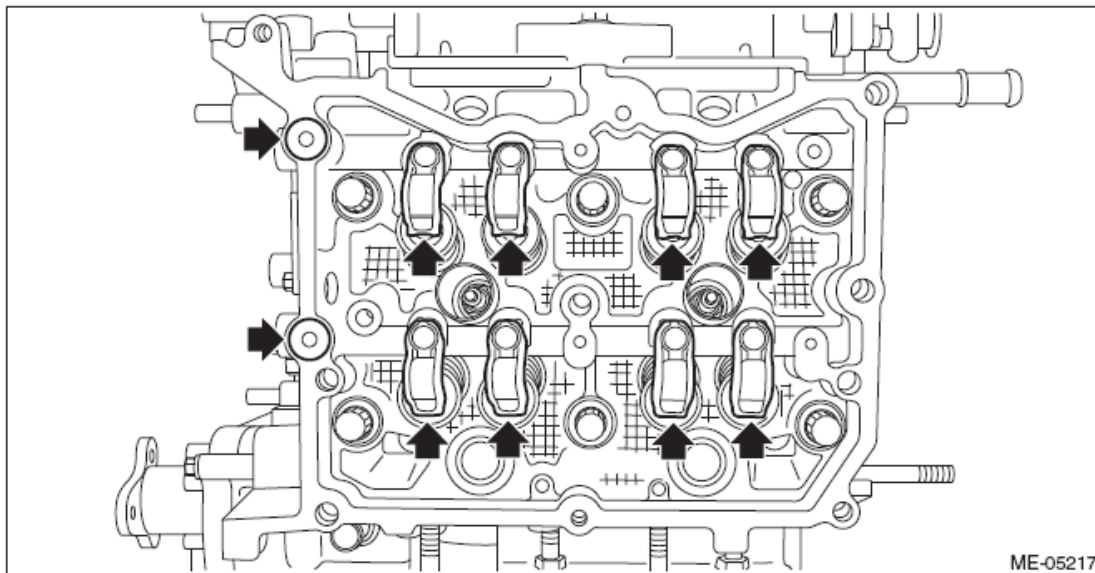


Fig. 236: Locating Cylinder Head LH O-Ring And Roller Rocker Arms
Courtesy of SUBARU OF AMERICA, INC.

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.

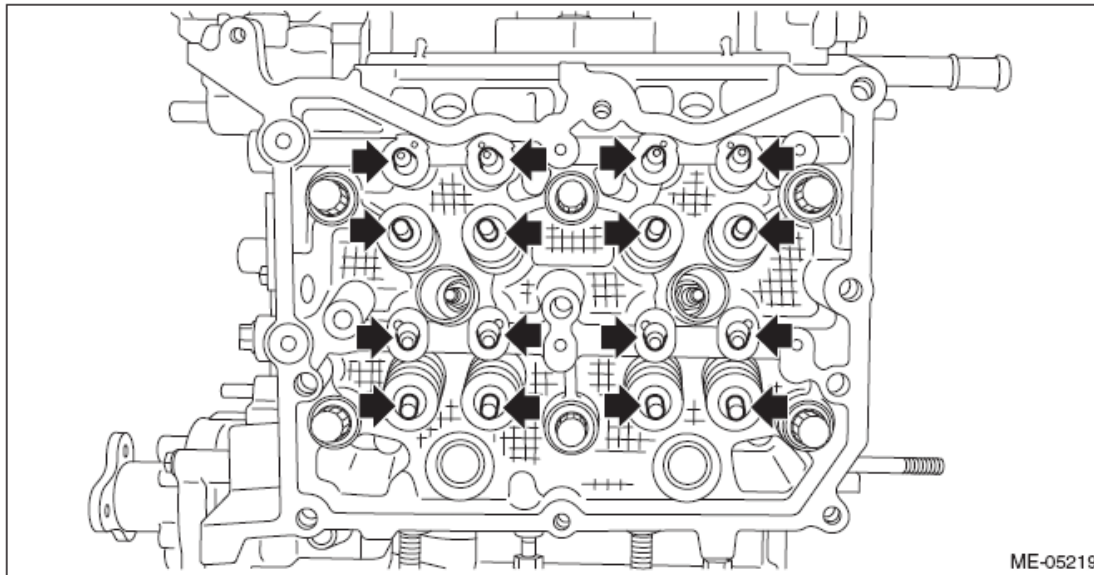


Fig. 237: Locating Cylinder Head LH Valve Shims And Roller Rocker Arm Pivots
Courtesy of SUBARU OF AMERICA, INC.

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

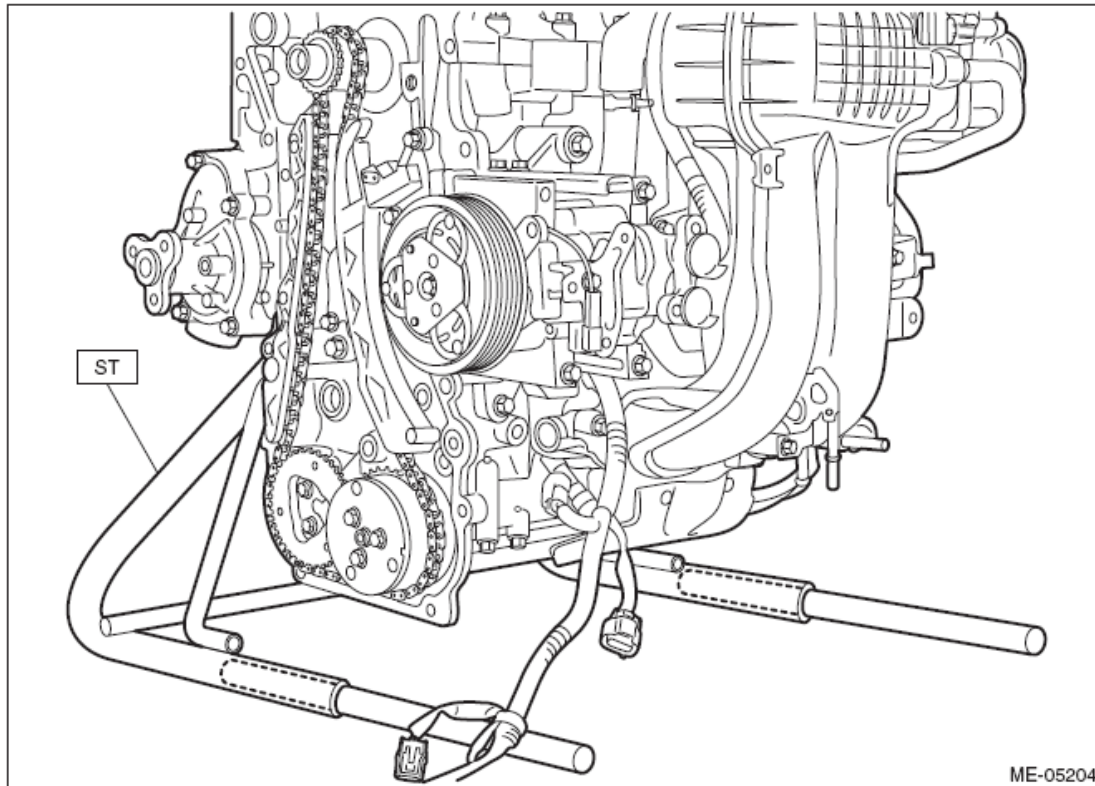


Fig. 238: Supporting Engine Using Engine Stand
Courtesy of SUBARU OF AMERICA, INC.

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.

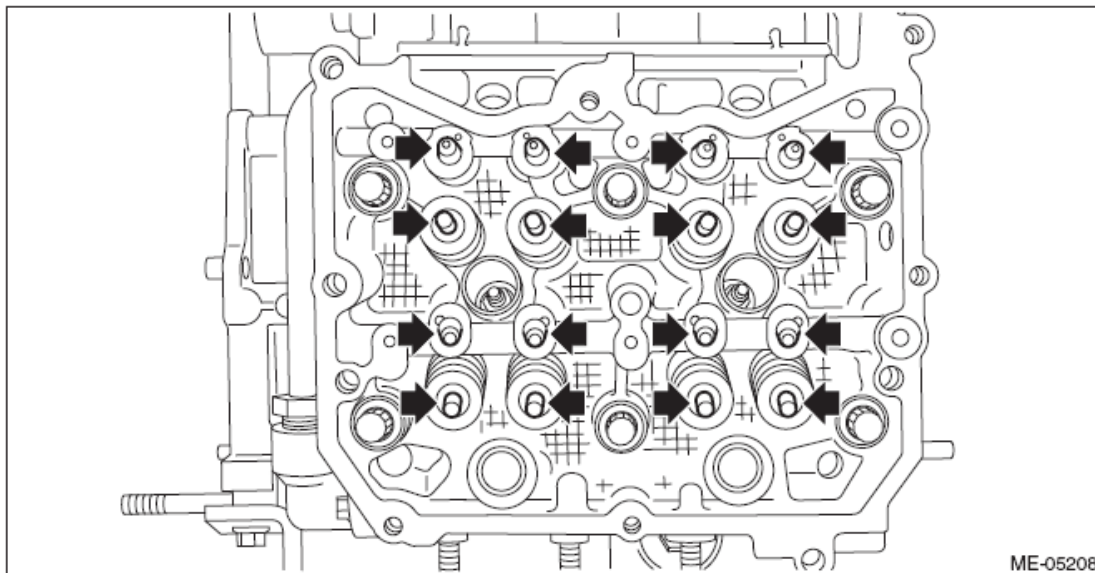


Fig. 239: Locating Cylinder Head RH Valve Shims And Roller Arm Pivots
Courtesy of SUBARU OF AMERICA, INC.

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.

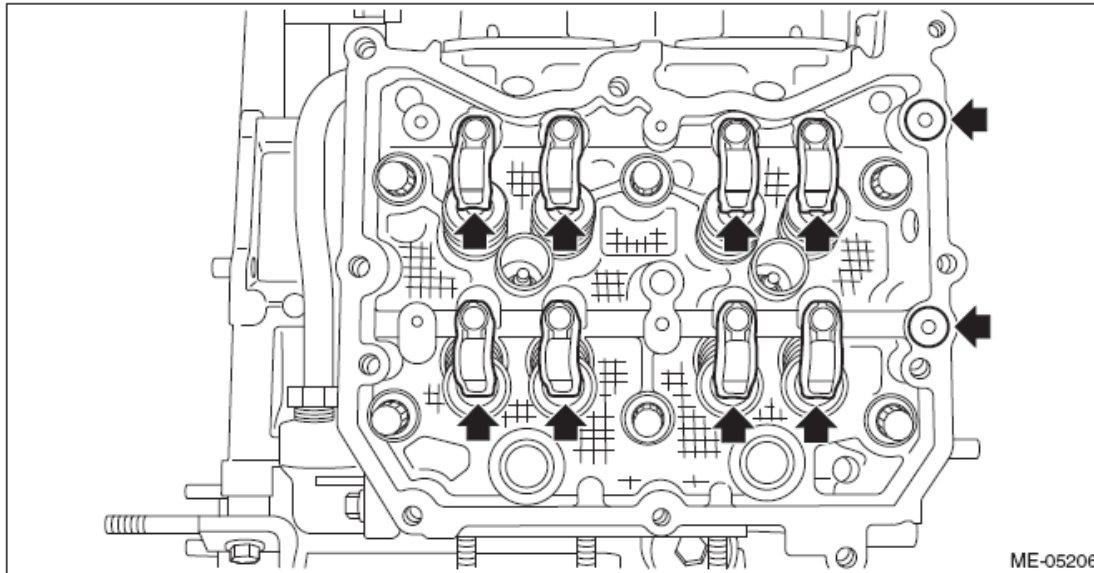


Fig. 240: Locating Cylinder Head RH O-Ring And Roller Rocker Arms
Courtesy of SUBARU OF AMERICA, INC.

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

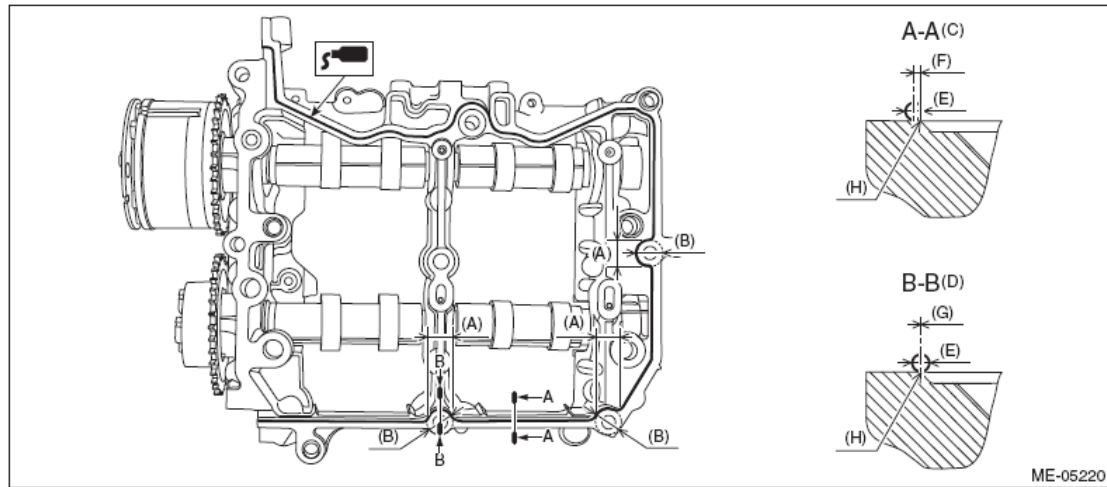
- NOTE:**
- Before applying liquid gasket, degrease the old liquid gasket seal surface of the cylinder head RH and cam carrier RH.
 - Install within 5 min. after applying liquid gasket.

Liquid gasket:

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

Liquid gasket applying diameter:

3.0±0.5 mm (0.1181±0.0197 in)



- | | | |
|---|--|--|
| (A) Range A | (D) Liquid gasket applying position of mating surfaces of range A | (G) $0 \pm 0.5 \text{ mm}$ ($0 \pm 0.0197 \text{ in}$) |
| (B) $\phi 18 \text{ mm}$ (0.7087 in) | (E) $\phi 3.0 \pm 0.5 \text{ mm}$ ($0.1181 \pm 0.0197 \text{ in}$) | (H) Chamfer edge |
| (C) Liquid gasket applying position of mating surfaces other than range A | (F) 1 mm (0.0394 in) or less | |

Fig. 241: 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.

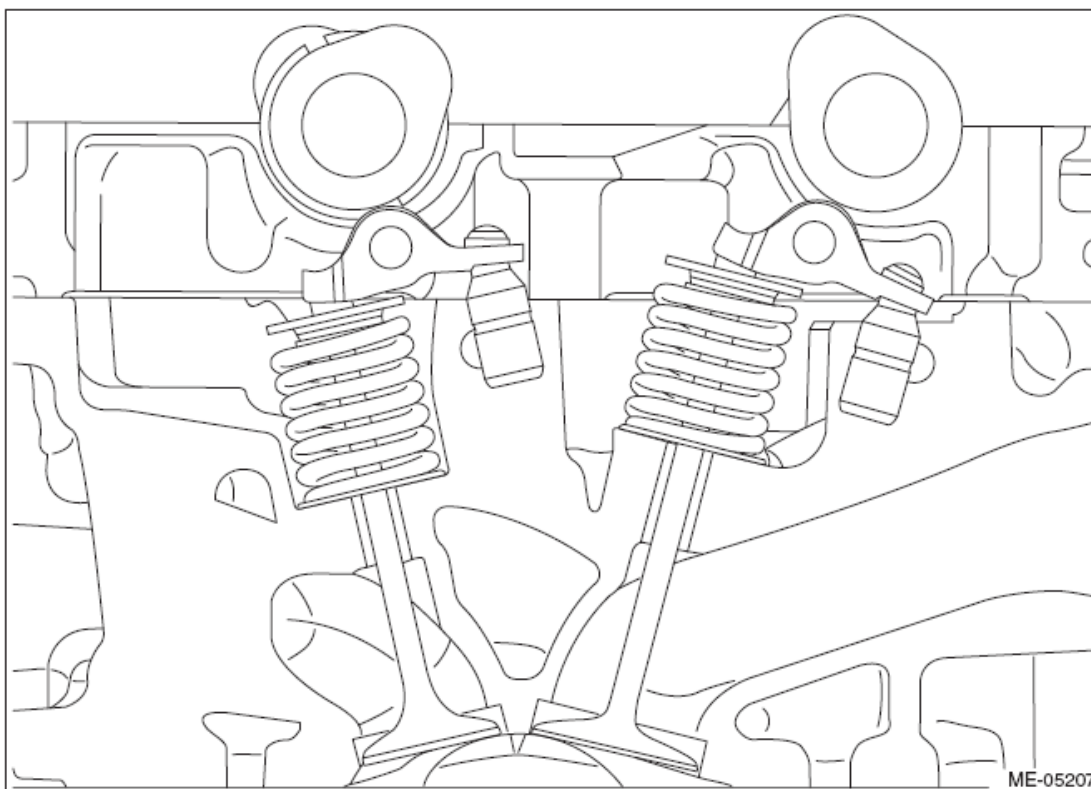


Fig. 242: Identifying Intake And Exhaust Camshaft RH At Zero-Lift Position
 Courtesy of SUBARU OF AMERICA, INC.

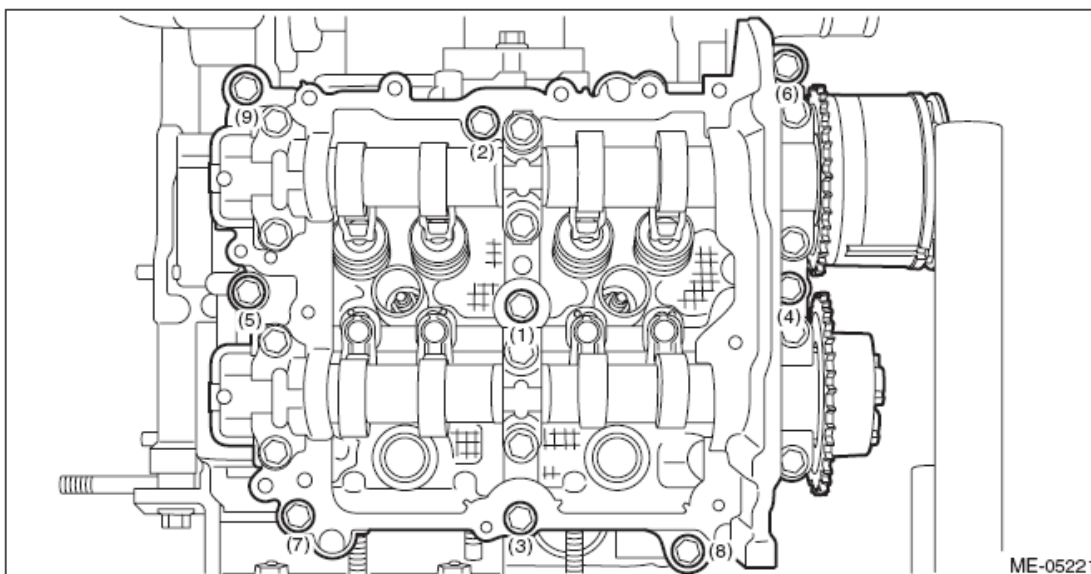


Fig. 243: Identifying Tightening Sequence Of Cam Carrier RH To Cylinder Head RH Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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

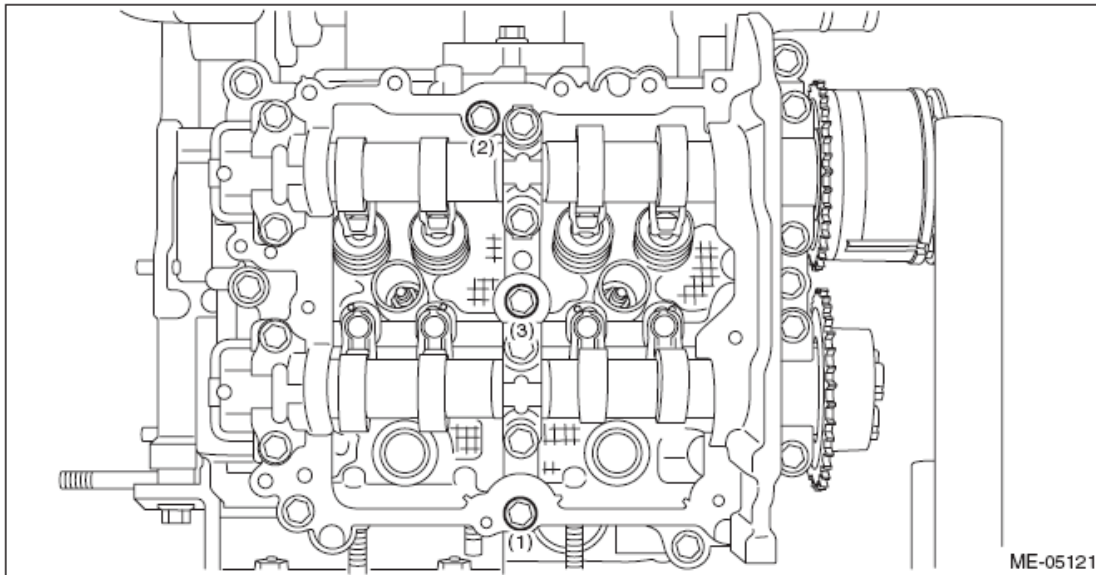


Fig. 244: Identifying Loosening Sequence Of Cam Carrier RH To Cylinder Head RH Mounting Bolts

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.

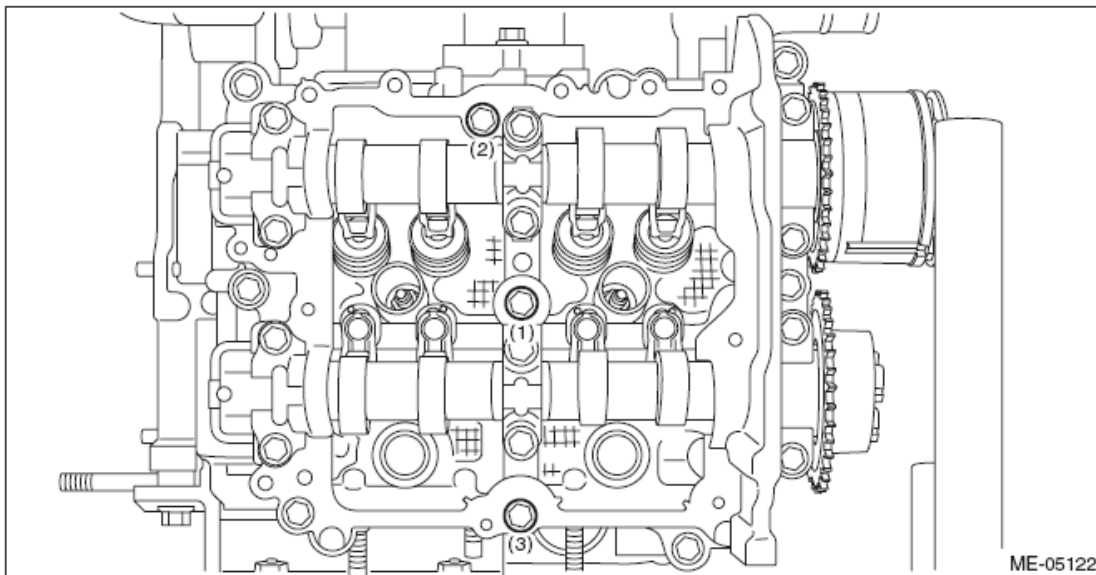


Fig. 245: Identifying Tightening Sequence Of Cam Carrier RH To Cylinder Head RH Mounting Bolts

Courtesy of SUBARU OF AMERICA, INC.

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

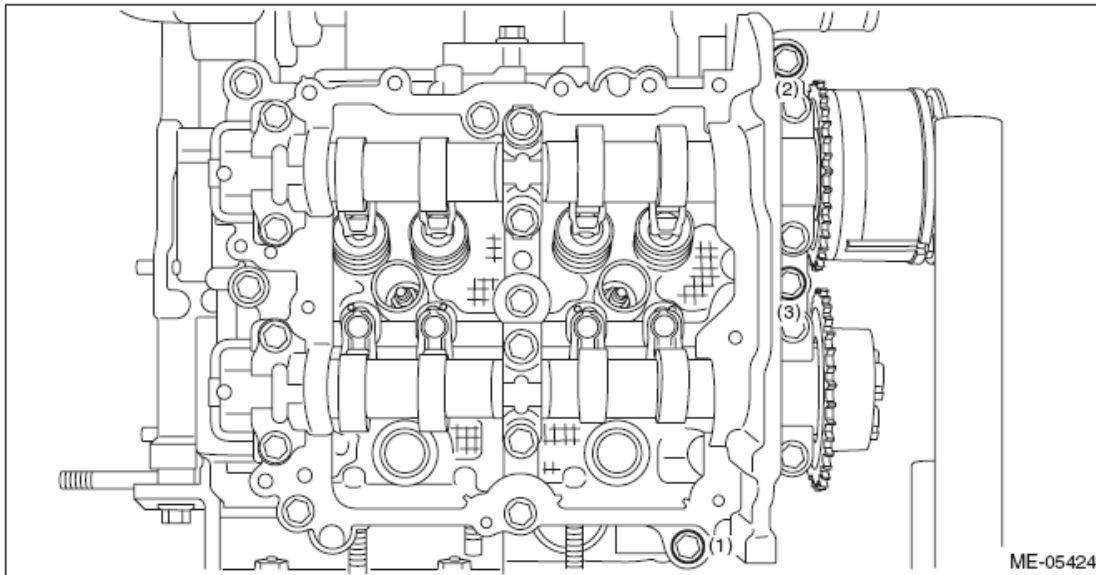


Fig. 246: Identifying Loosening Sequence Of Cam Carrier RH To Cylinder Head RH Mounting Bolts

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.

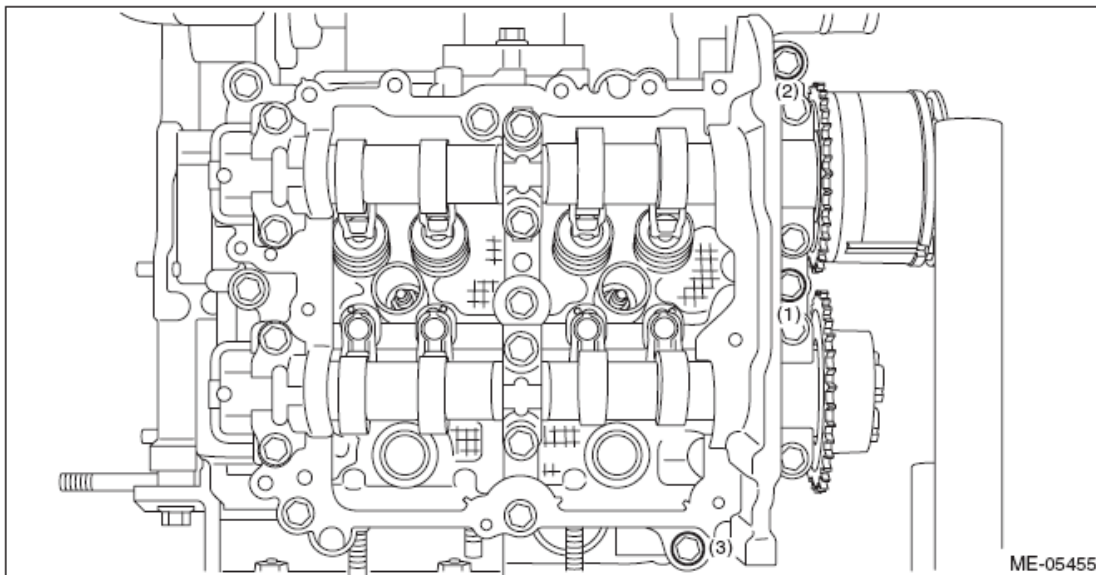


Fig. 247: Identifying Tightening Sequence Of Cam Carrier RH To Cylinder Head RH Mounting Bolts

Courtesy of SUBARU OF AMERICA, INC.

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

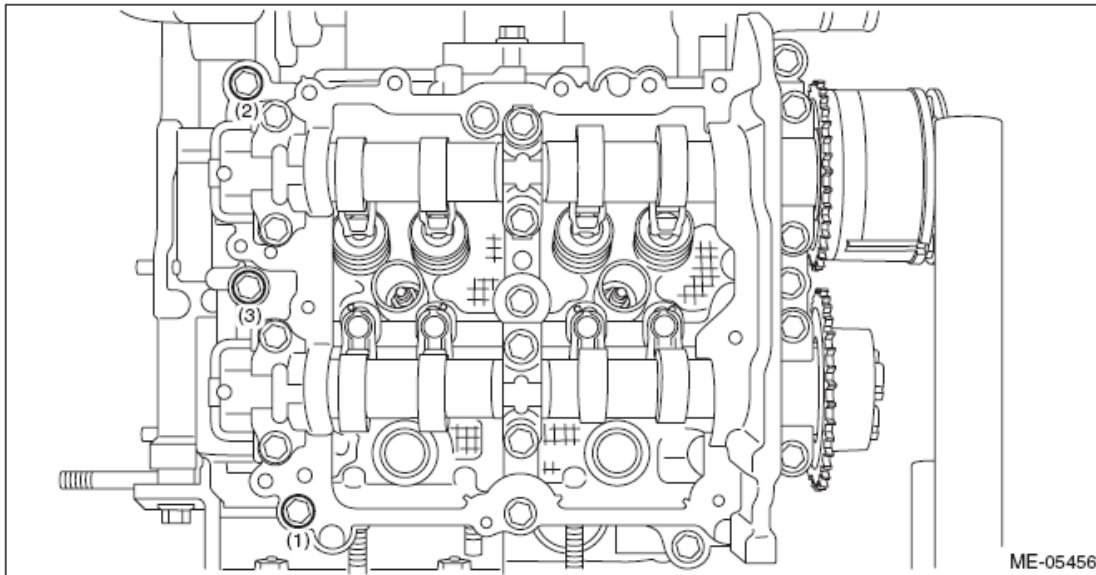


Fig. 248: Identifying Loosening Sequence Of Cam Carrier RH To Cylinder Head RH Mounting Bolts

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.

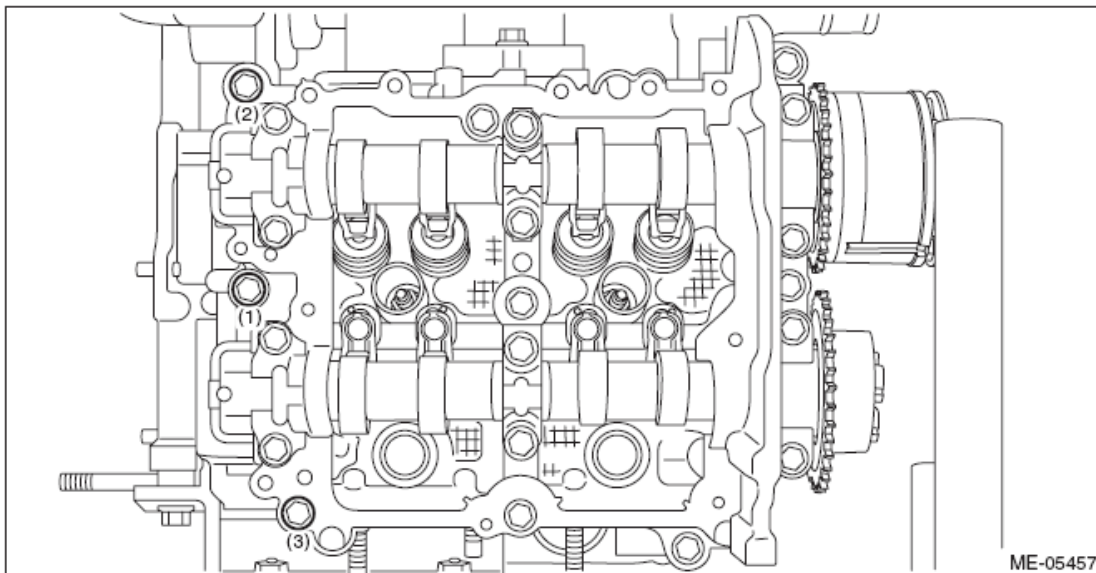


Fig. 249: Identifying Tightening Sequence Of Cam Carrier RH To Cylinder Head RH Mounting Bolts

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.**

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.**
9. Install the timing chain RH. Refer to **TIMING CHAIN RH.**
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)

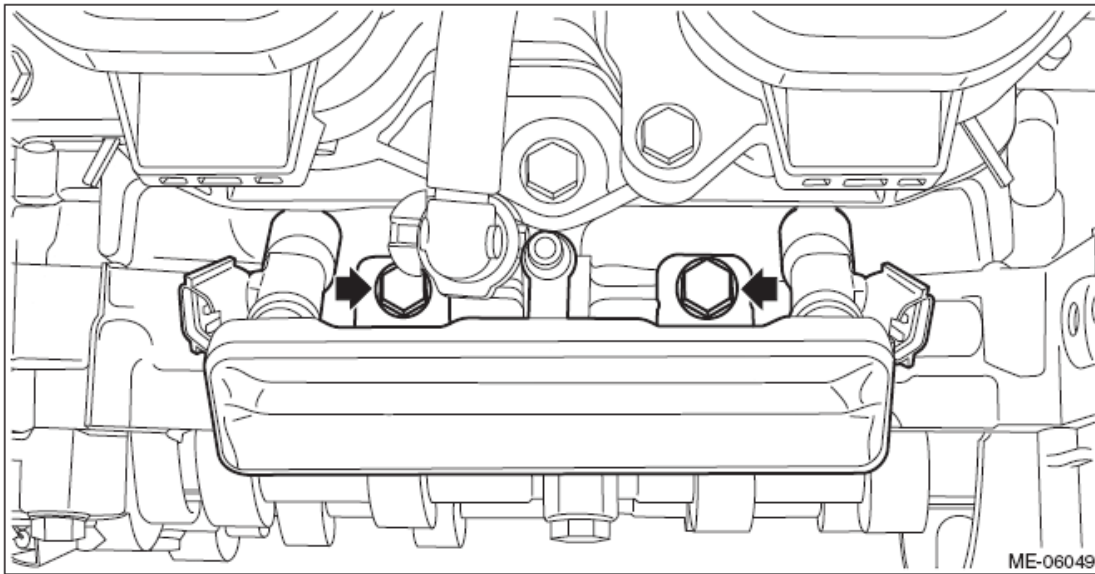


Fig. 250: Locating Fuel Pipe RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

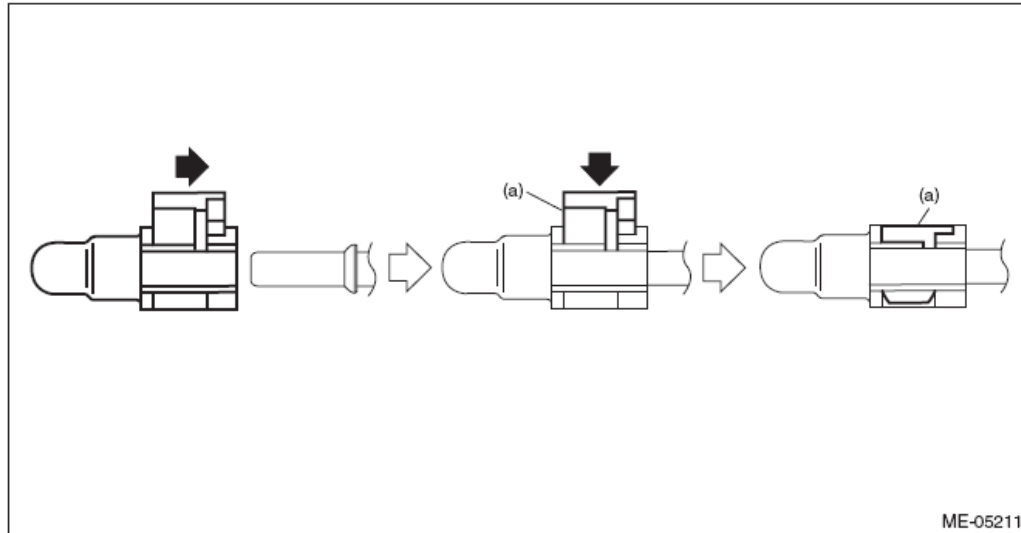
CAUTION:

- 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.

- When it is difficult to lock the slider, check that the pipe is fully inserted.
- Make sure that the quick connector is securely connected.

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



(a) Slider

Fig. 251: Connecting Fuel Pipe RH Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

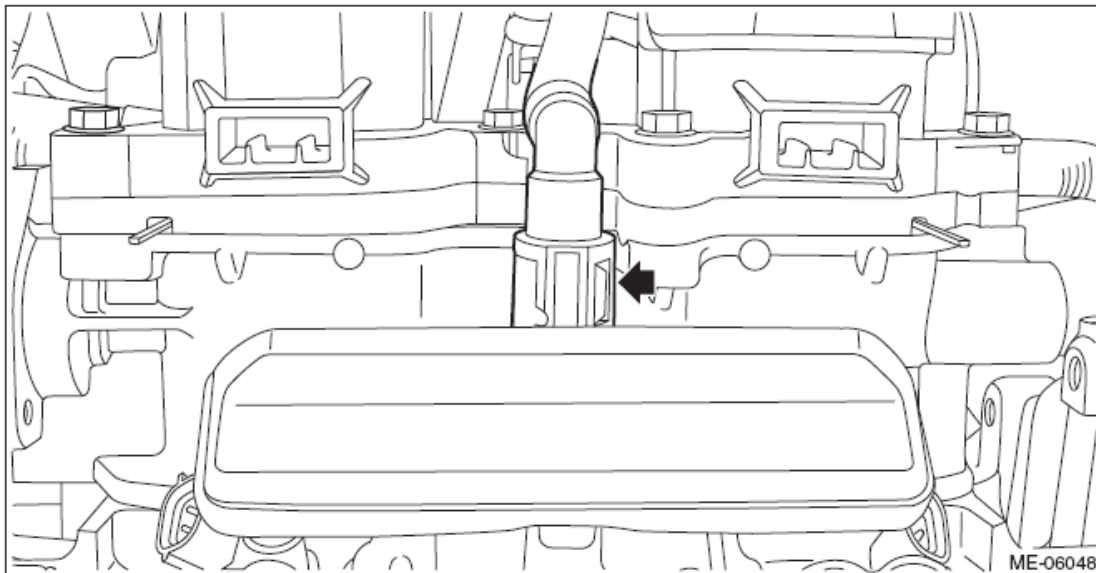


Fig. 252: Locating Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the connectors to the fuel injector RH.

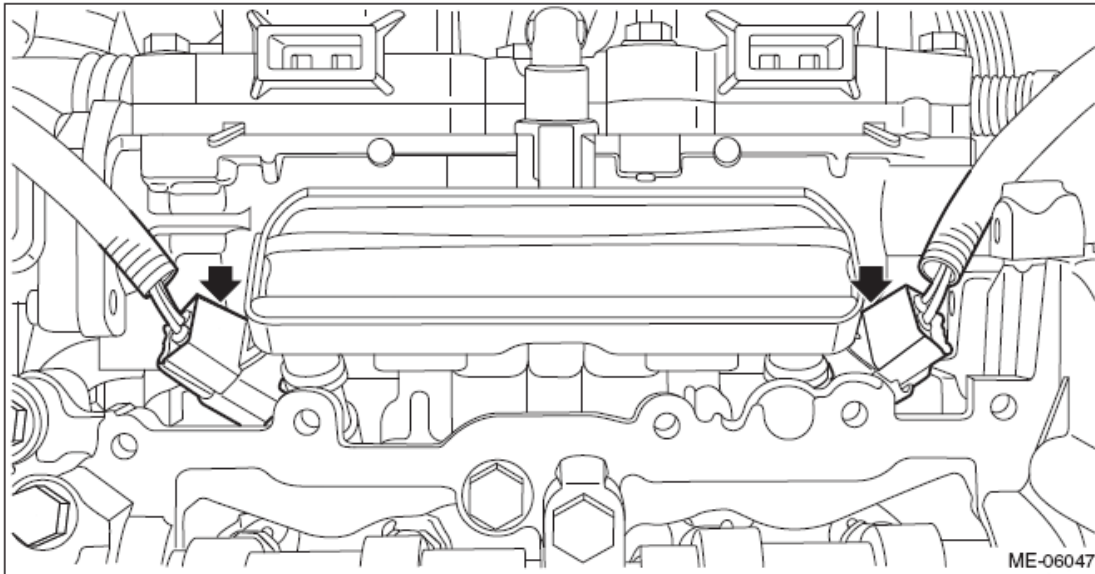


Fig. 253: Locating Fuel Injector RH Connectors
Courtesy of SUBARU OF AMERICA, INC.

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

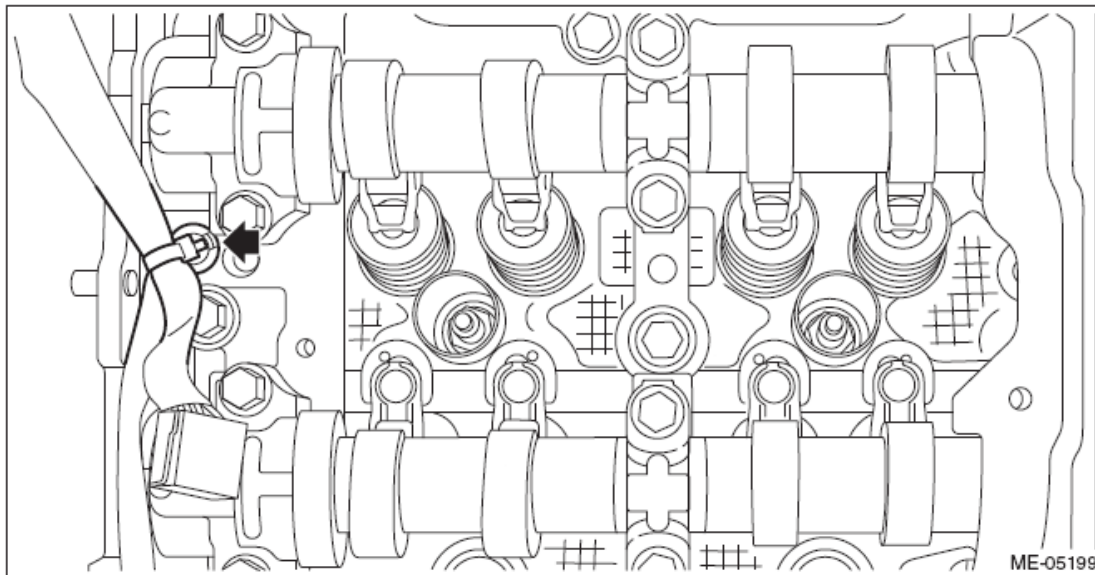


Fig. 254: Locating Engine Harness Holding Clip
Courtesy of SUBARU OF AMERICA, INC.

12. Install the rocker cover RH. Refer to **ROCKER COVER RH**.
13. Install the chain cover. Refer to **INSTALLATION**.
14. Install the engine to the vehicle. Refer to **INSTALLATION**.

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.

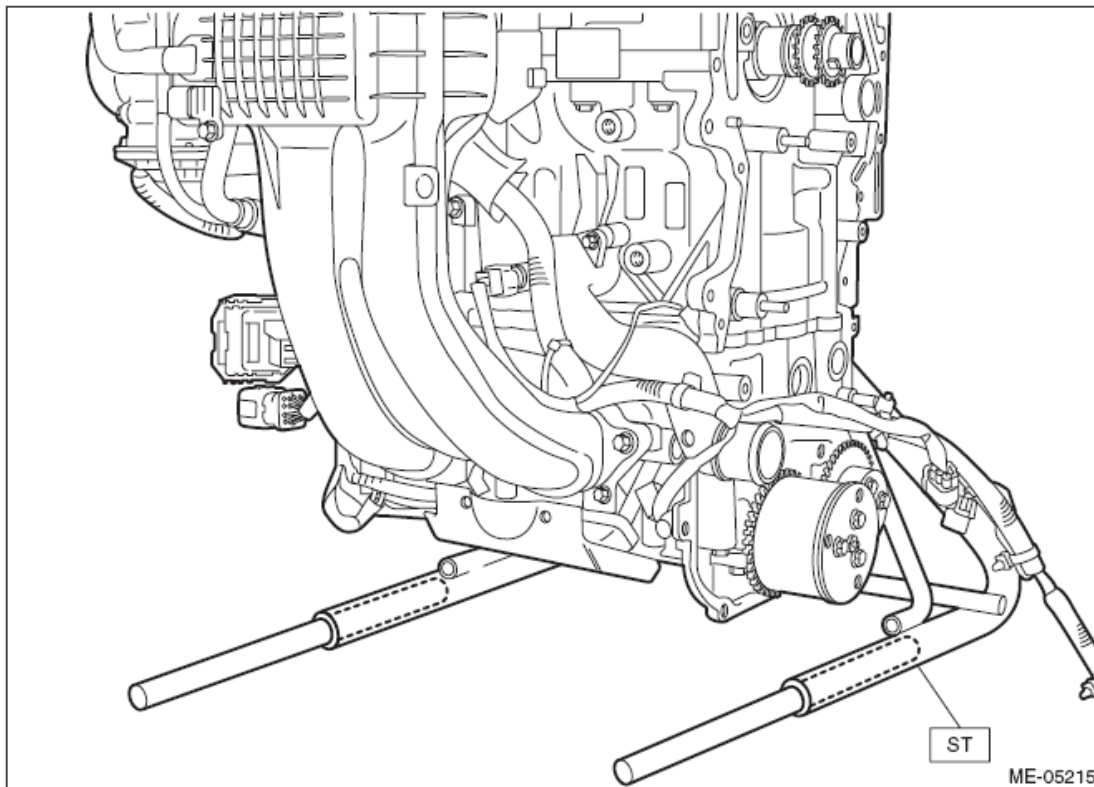
ST 499817100 ENGINE STAND

Fig. 255: Inserting Steel Rods Into Engine Stand
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.

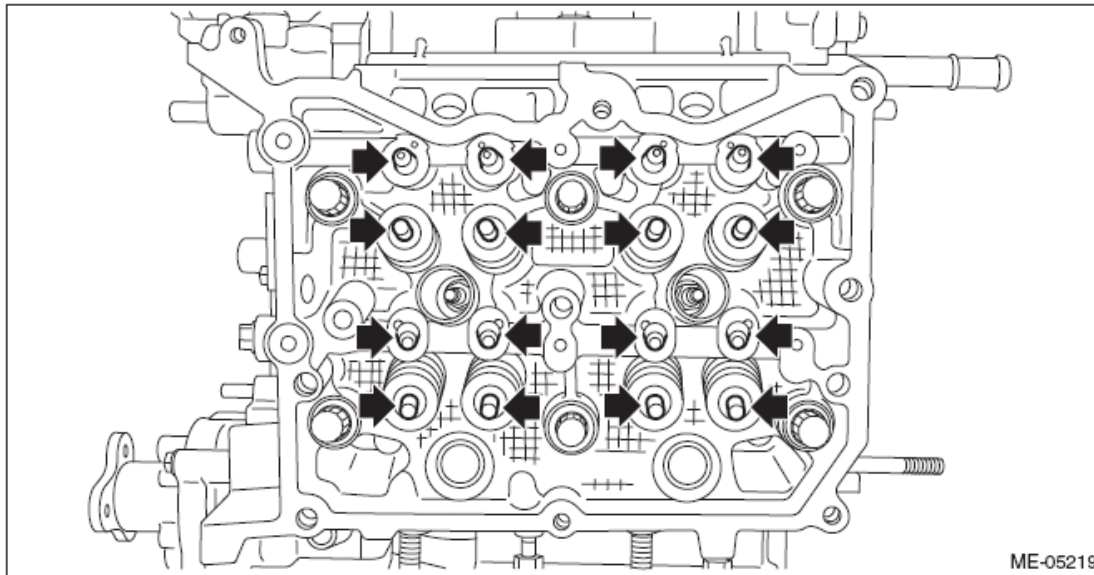


Fig. 256: Locating Cylinder Head LH Valve Shims And Roller Rocker Arm Pivots
Courtesy of SUBARU OF AMERICA, INC.

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.

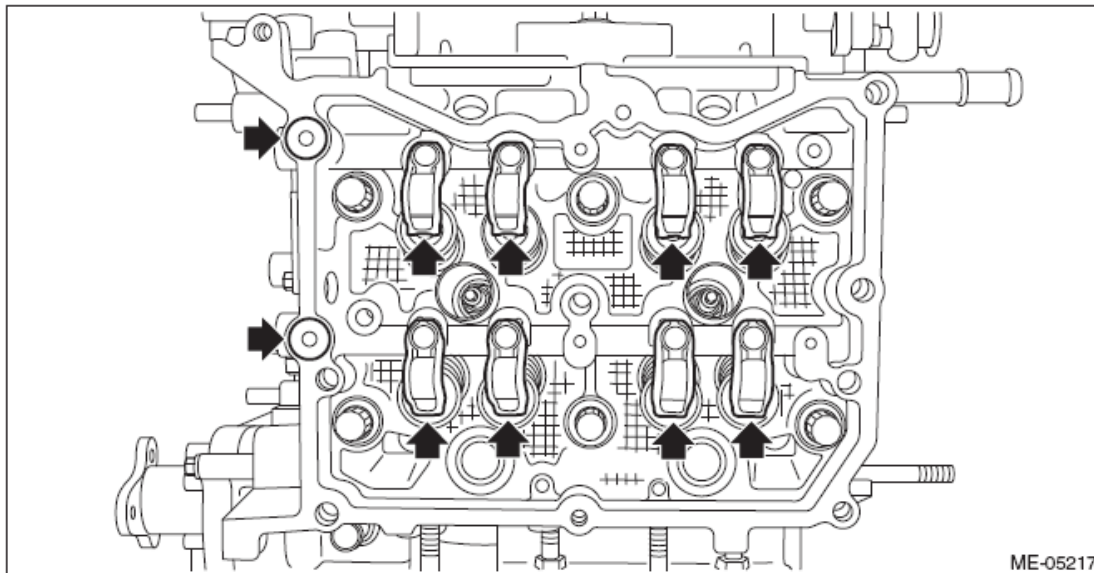


Fig. 257: Locating Cylinder Head LH O-Ring And Roller Rocker Arms
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE:

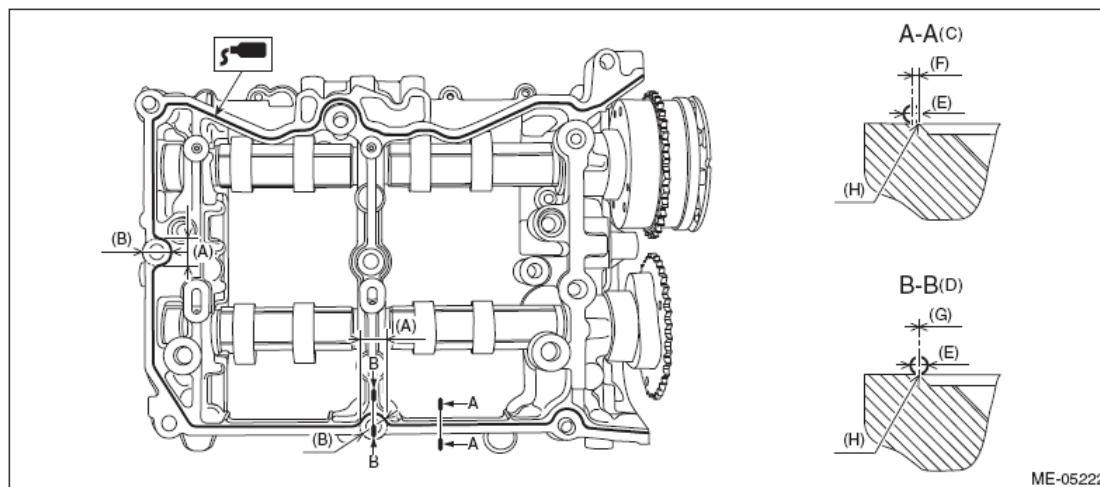
- Before applying liquid gasket, degrease the old liquid gasket seal surface of the cylinder head LH and cam carrier LH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket:

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

Liquid gasket applying diameter:

3.0±0.5 mm (0.1181±0.0197 in)



- | | | |
|---|---|----------------------------|
| (A) Range A | (D) Liquid gasket applying position of mating surfaces of range A | (G) 0±0.5 mm (0±0.0197 in) |
| (B) $\phi 18$ mm (0.7087 in) | (E) $\phi 3.0 \pm 0.5$ mm (0.1181±0.0197 in) | (H) Chamfer edge |
| (C) Liquid gasket applying position of mating surfaces other than range A | (F) 1 mm (0.0394 in) or less | |

Fig. 258: 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.

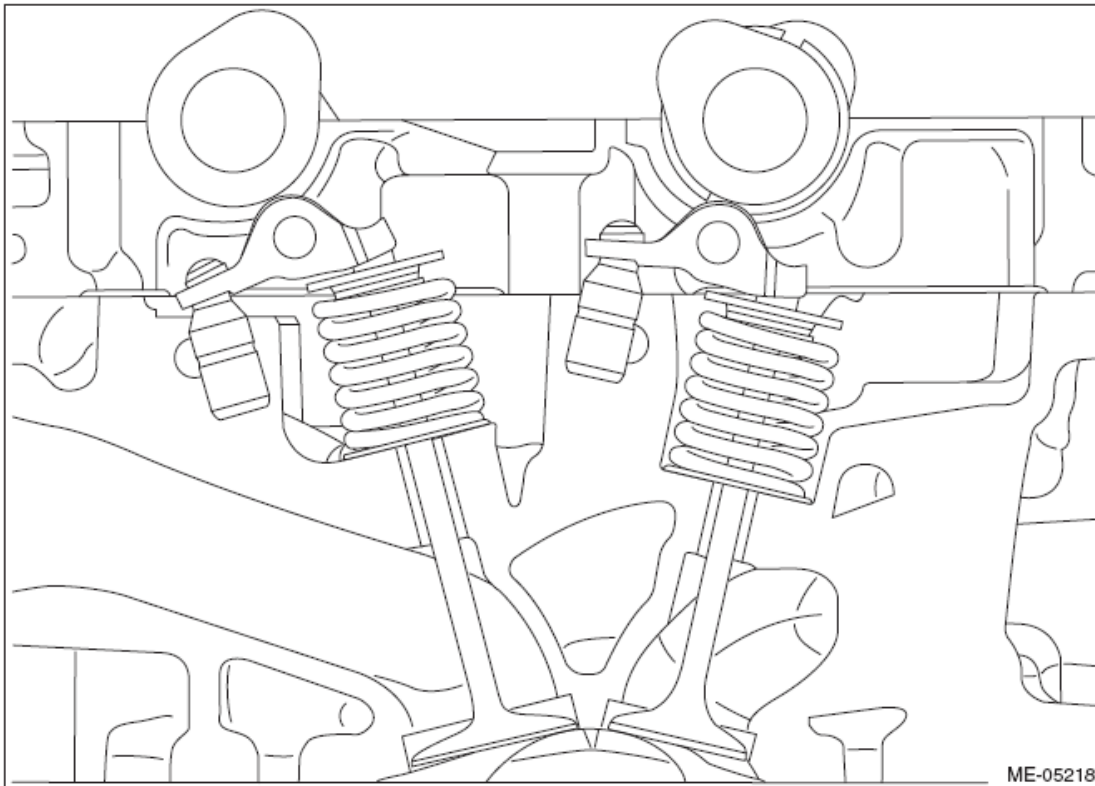


Fig. 259: Identifying Intake And Exhaust Camshaft LH At Zero-Lift Position
Courtesy of SUBARU OF AMERICA, INC.

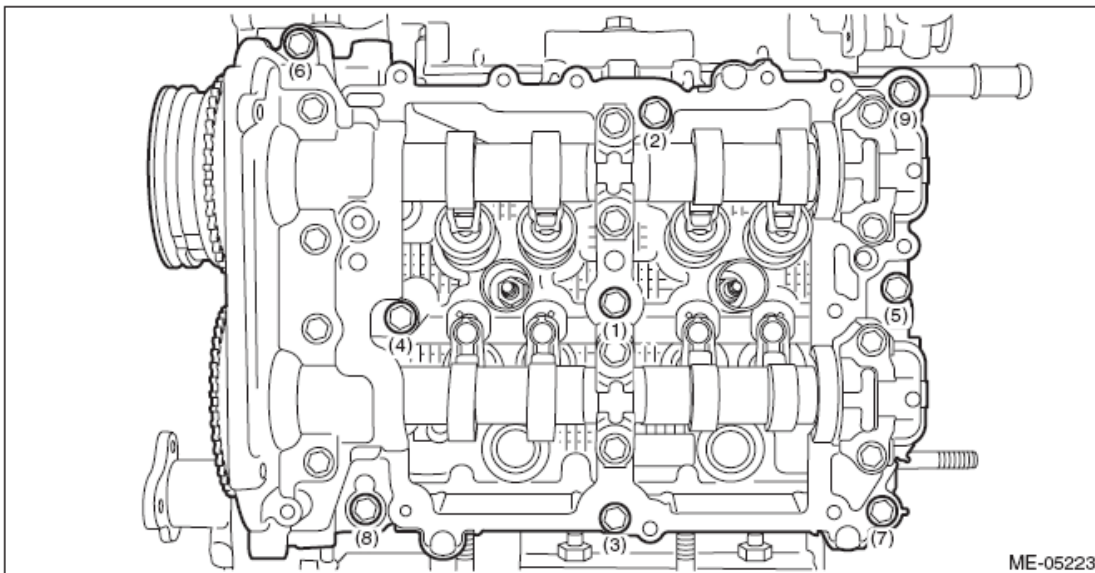


Fig. 260: Identifying Tightening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

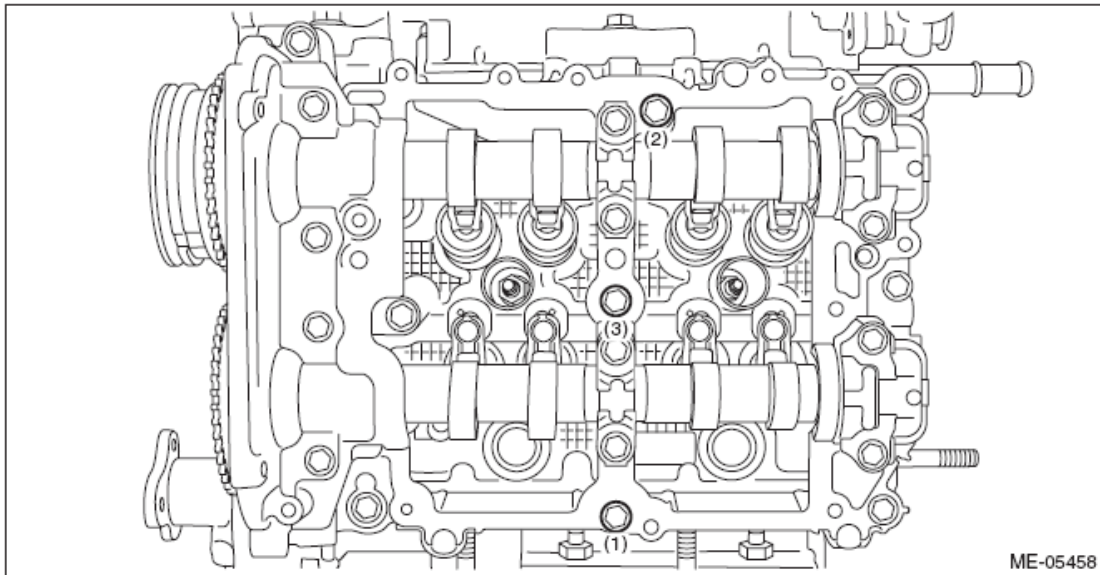


Fig. 261: Identifying Loosening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

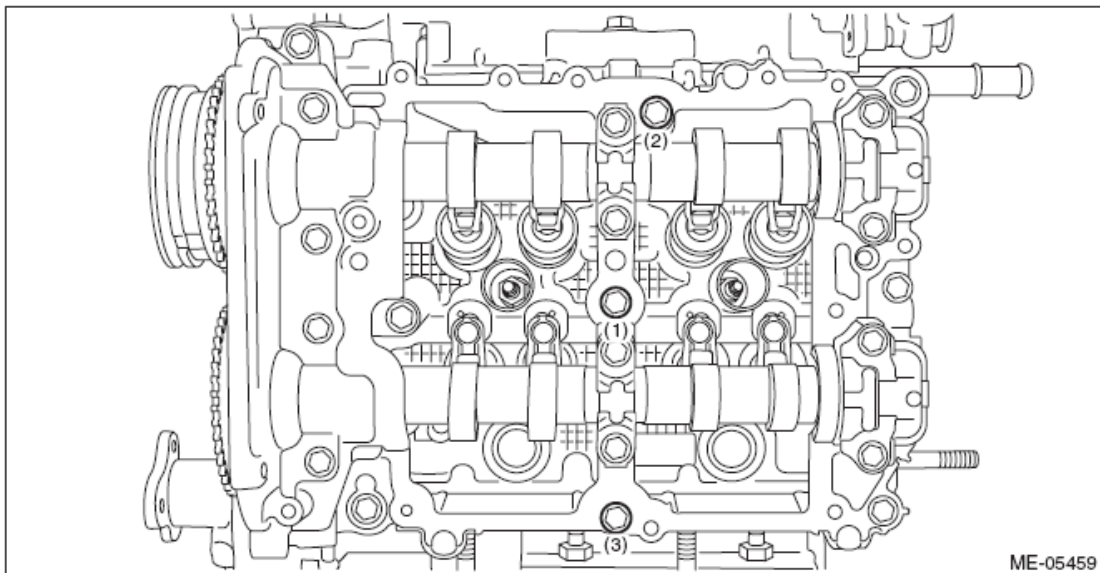


Fig. 262: Identifying Tightening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

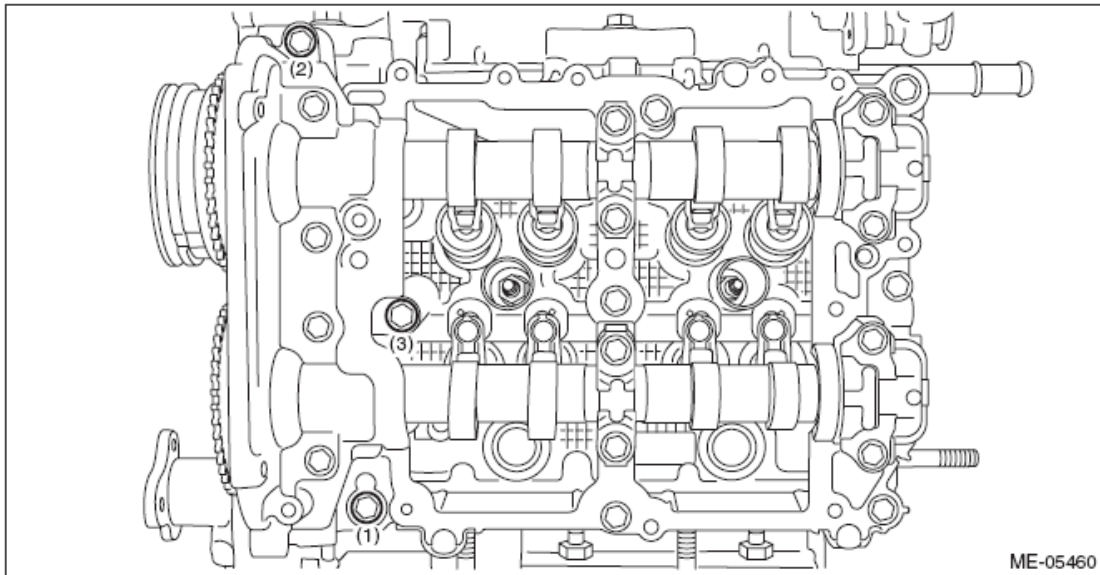


Fig. 263: Identifying Loosening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

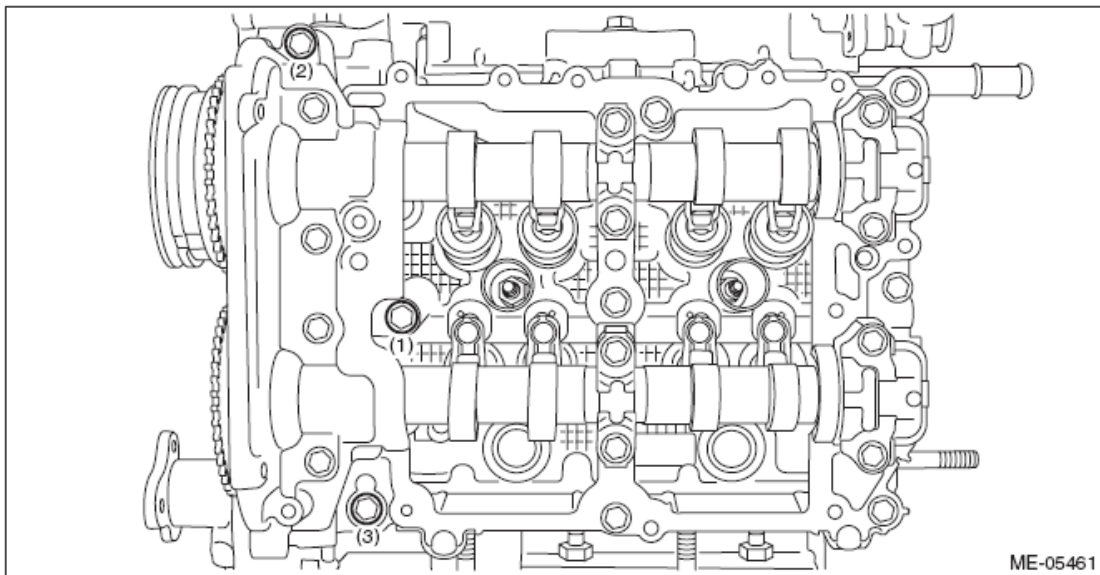


Fig. 264: Identifying Tightening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

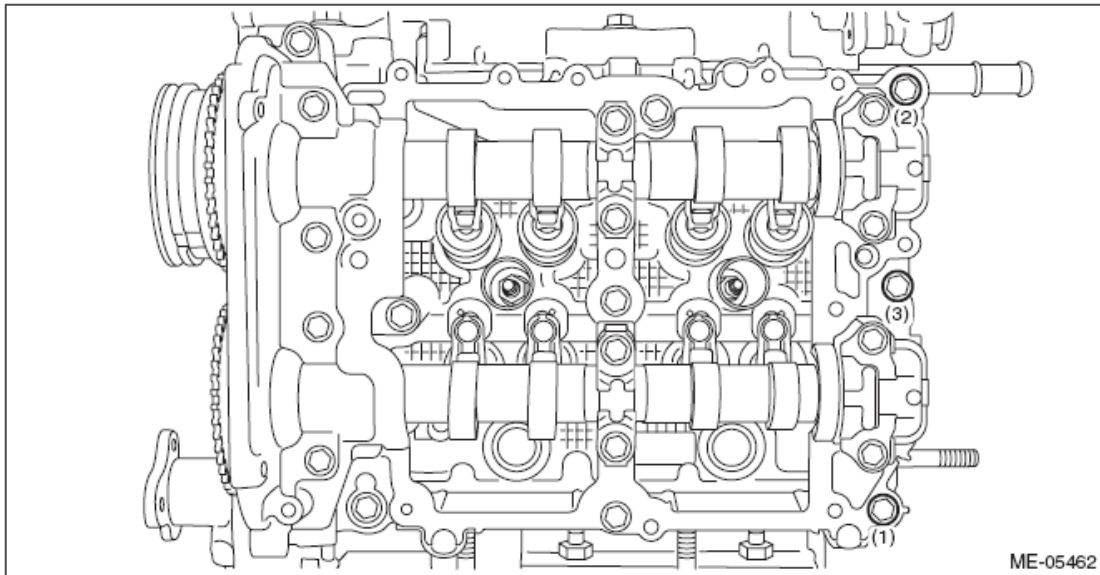


Fig. 265: Identifying Loosening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

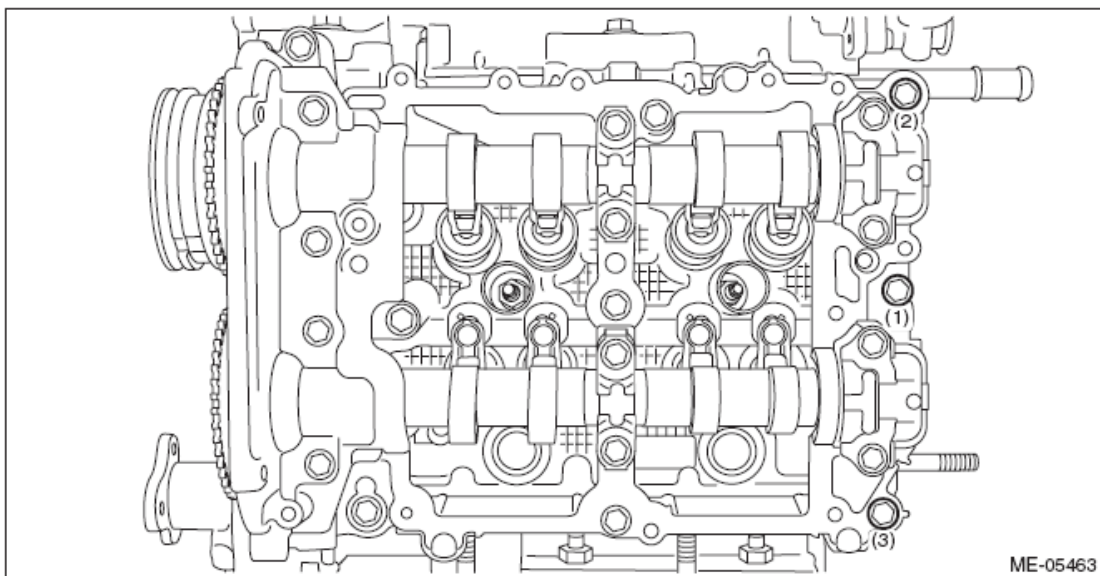


Fig. 266: Identifying Tightening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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**.

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**.
9. Install timing chain LH. Refer to **TIMING CHAIN LH**.
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)

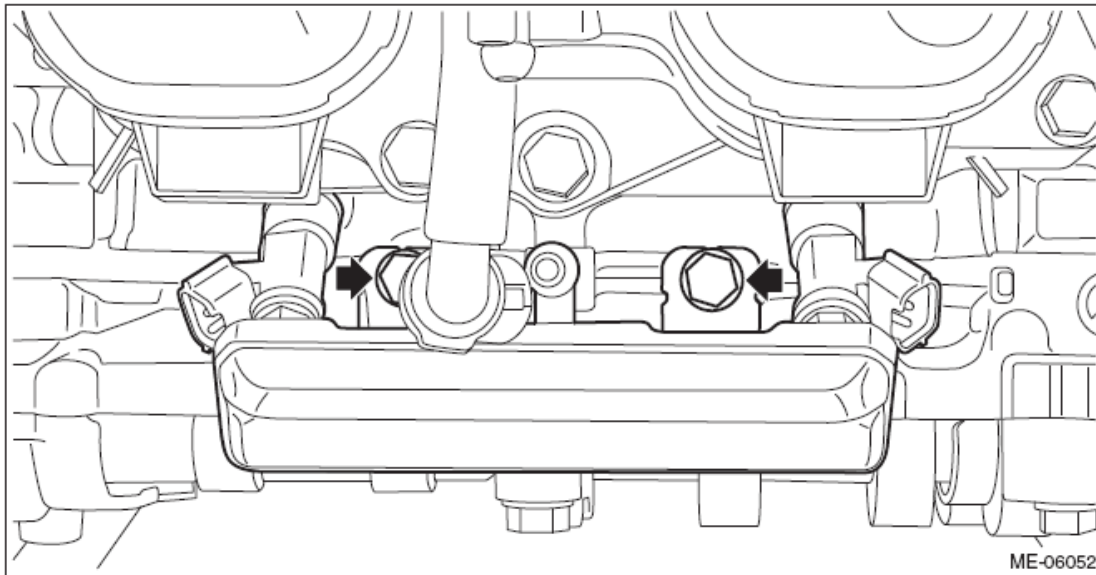


Fig. 267: Locating Fuel Pipe LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

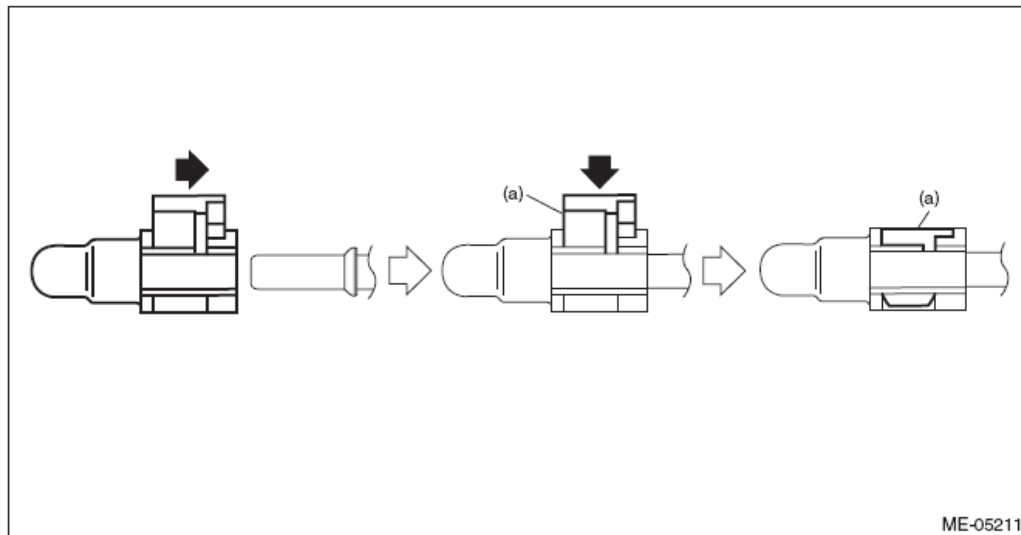
2. Connect the quick connector to the fuel pipe LH.

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.

- When it is difficult to lock the slider, check that the pipe is fully inserted.
- Make sure that the quick connector is securely connected.

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



(a) Slider

Fig. 268: Connecting Quick Connector To Fuel Pipe LH
Courtesy of SUBARU OF AMERICA, INC.

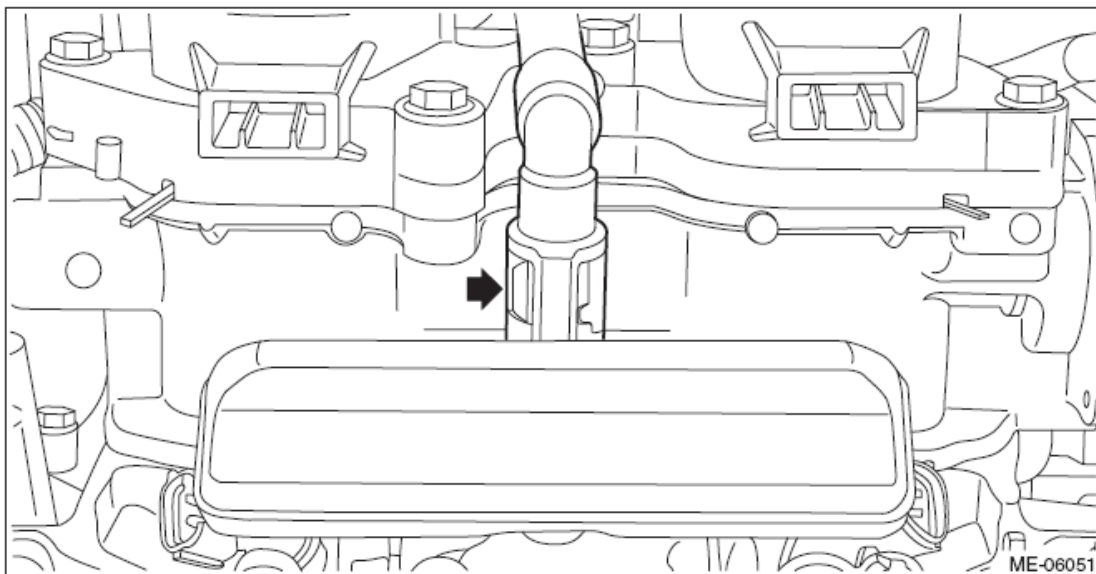


Fig. 269: Locating Quick Connector
Courtesy of SUBARU OF AMERICA, INC.

3. Connect the connectors to the fuel injector LH.

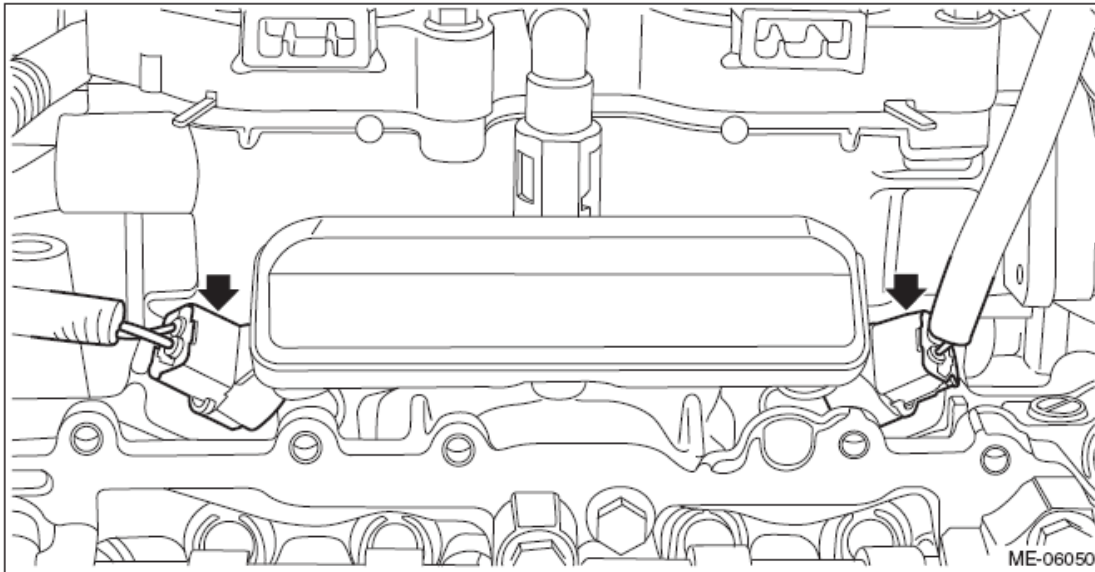


Fig. 270: Locating Fuel Injector LH Connectors
Courtesy of SUBARU OF AMERICA, INC.

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)

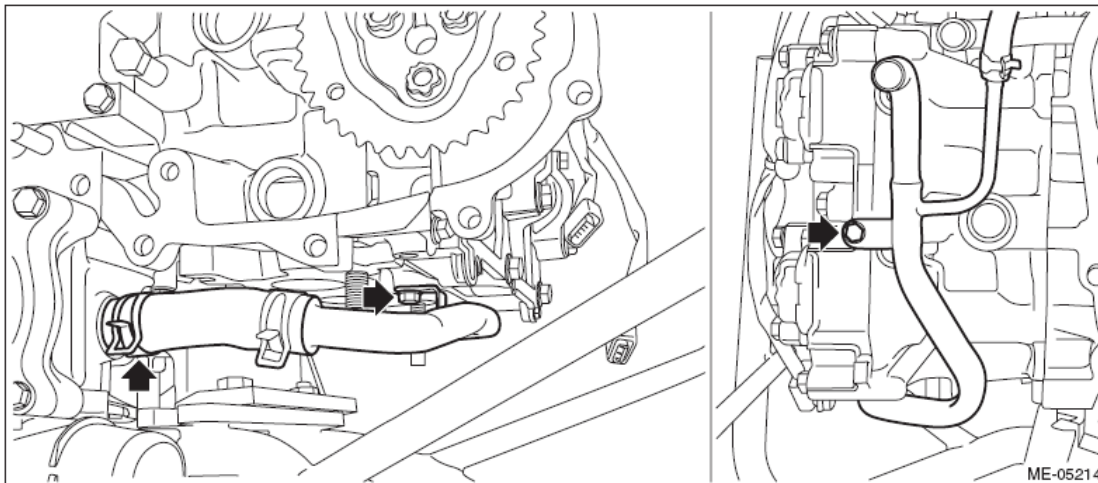


Fig. 271: Locating Water Pipe Hose To Oil Pan Upper Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

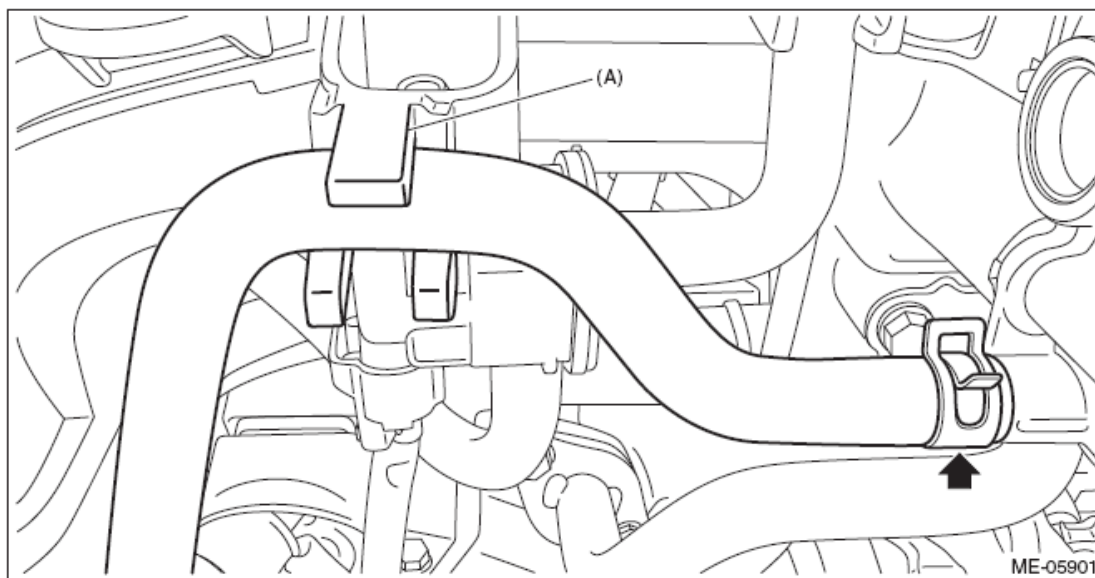


Fig. 272: Locating Preheater Hose Mounting Clip
Courtesy of SUBARU OF AMERICA, INC.

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

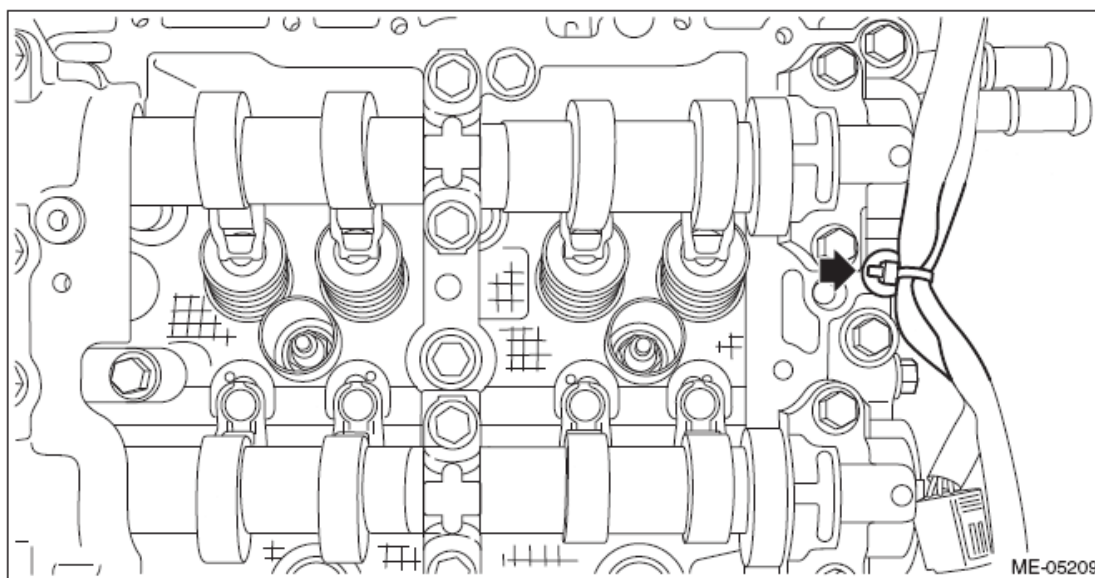


Fig. 273: Locating Cam Carrier LH Engine Harness Mounting Clip
Courtesy of SUBARU OF AMERICA, INC.

14. Install the rocker cover LH. Refer to **ROCKER COVER LH**.
15. Install the chain cover. Refer to **INSTALLATION**.
16. Install the engine to the vehicle. Refer to **INSTALLATION**.

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 each camshaft cap.

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

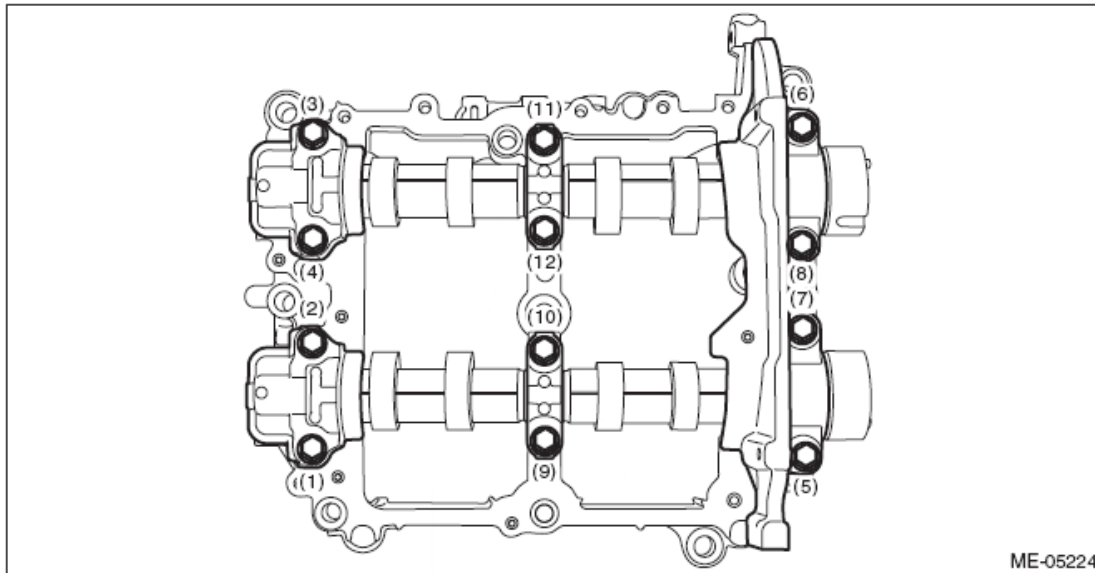


Fig. 274: Identifying Loosening Sequence Of Cam Carrier RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

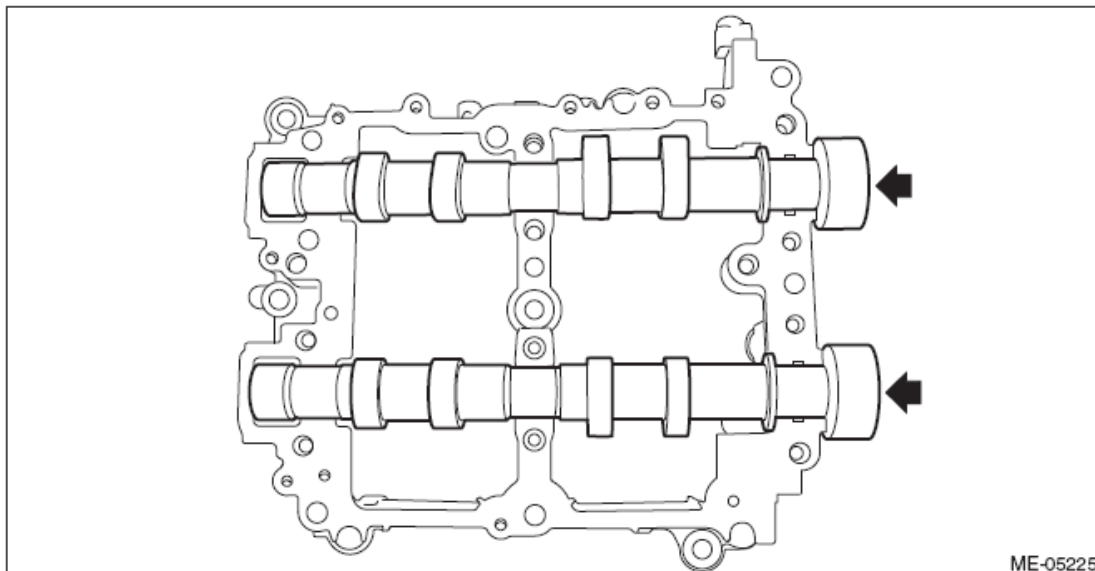


Fig. 275: Locating Intake And Exhaust Camshaft RH
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the filter from cam carrier RH.

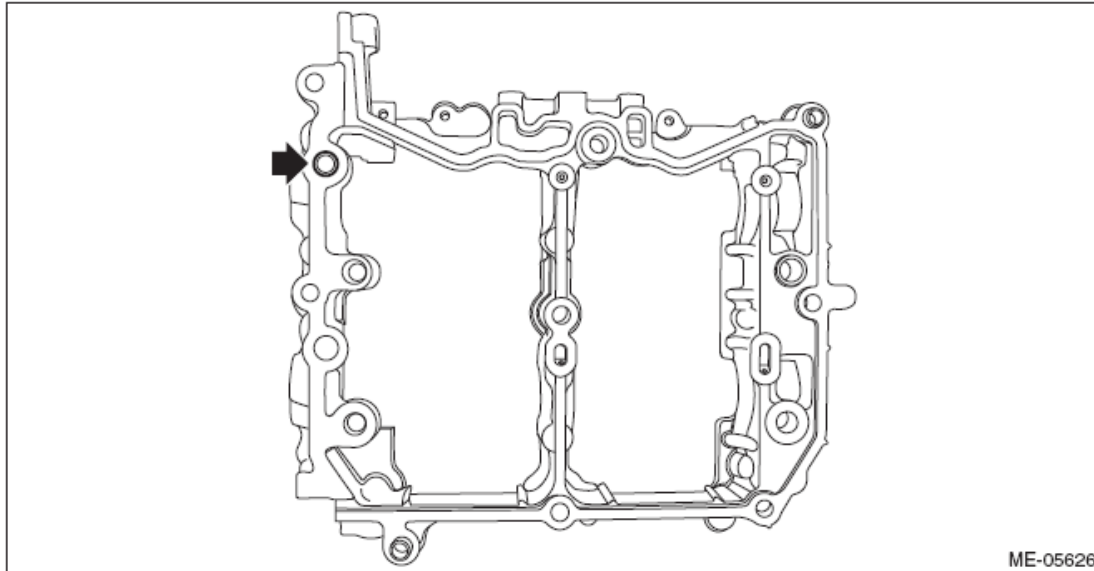


Fig. 276: Locating Cam Carrier RH Filter
Courtesy of SUBARU OF AMERICA, INC.

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 each camshaft cap.

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

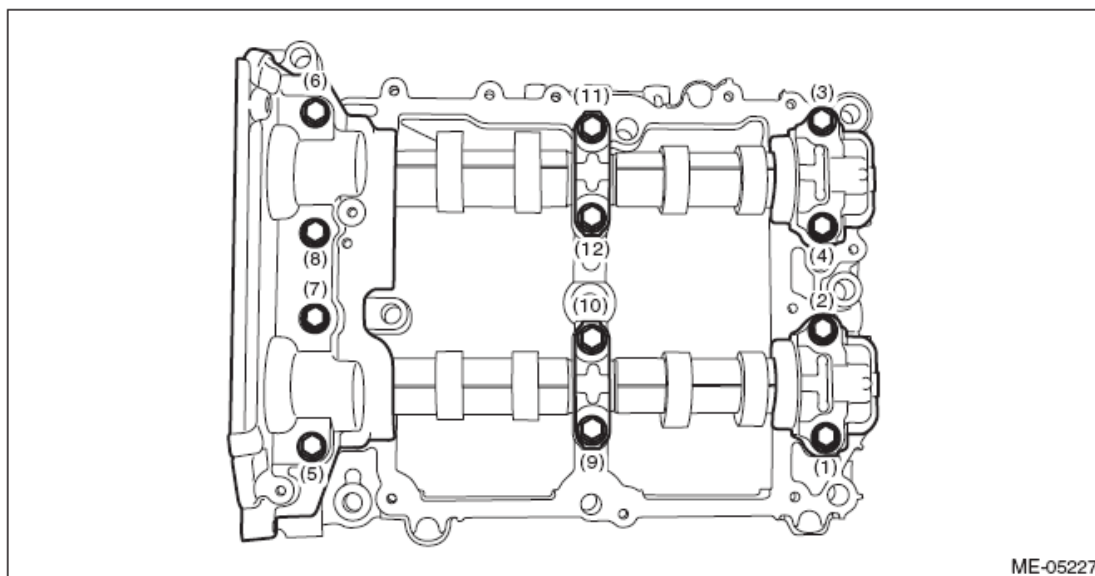


Fig. 277: Identifying Loosening Sequence Of Cam Carrier LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

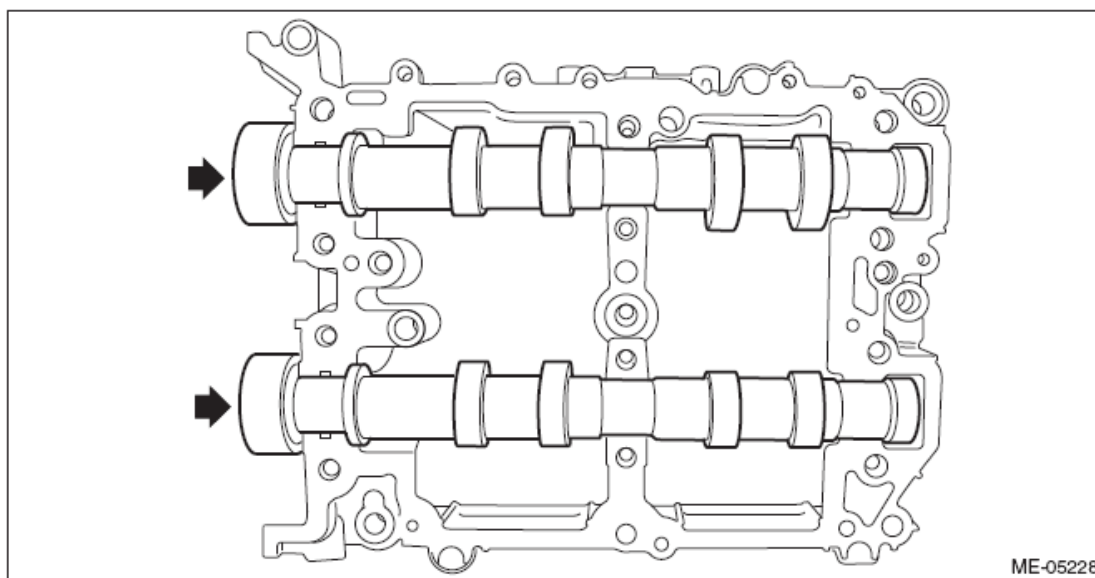


Fig. 278: Locating Intake And Exhaust Camshaft LH
Courtesy of SUBARU OF AMERICA, INC.

3. Remove the filter from cam carrier LH.

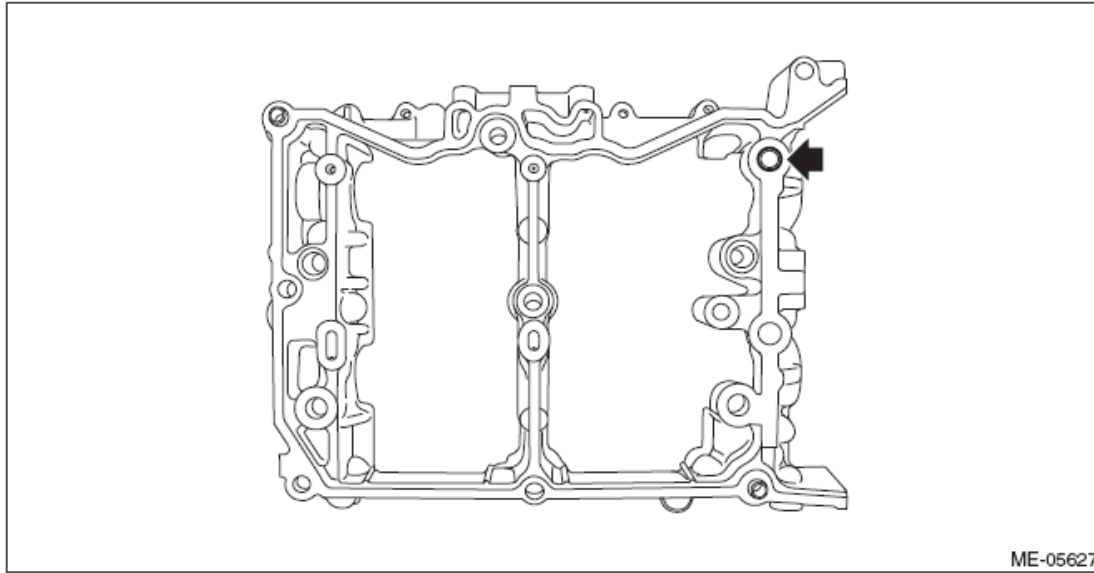


Fig. 279: Locating Cam Carrier LH Filter
Courtesy of SUBARU OF AMERICA, INC.

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 $0^{+0}_{-0.5}$ mm ($^{+0}_{-0.0197}$ in) position

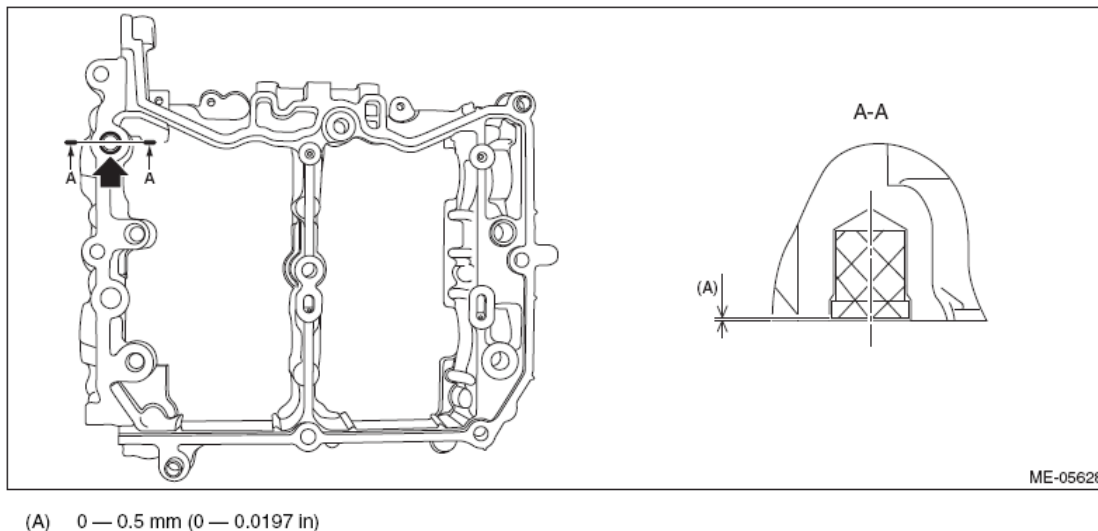


Fig. 280: Locating Cam Carrier RH Filter Insertion Position
Courtesy of SUBARU OF AMERICA, INC.

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 camshaft 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, degrease the old 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

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

Mating surfaces of range A

$3.5 \pm 0.5 \text{ mm}$ ($0.1378 \pm 0.0197 \text{ in}$)

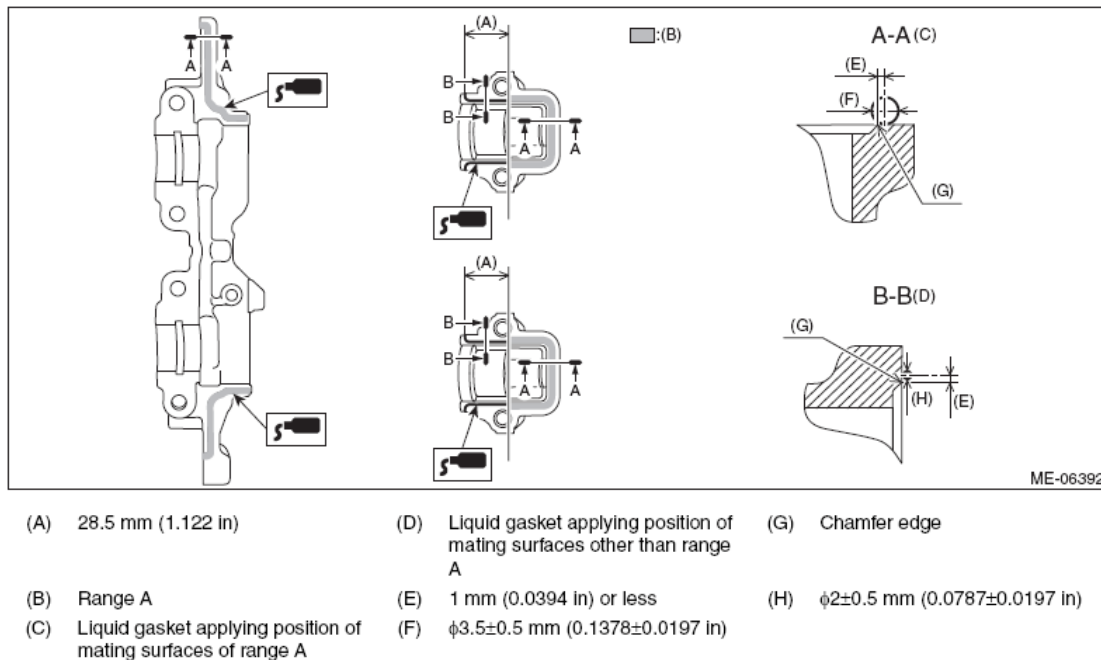


Fig. 281: Identifying Liquid Gasket Applying Area On Mating Surface Of Front Camshaft Cap RH, Intake And Exhaust Rear Camshaft Cap RH
Courtesy of SUBARU OF AMERICA, INC.

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)

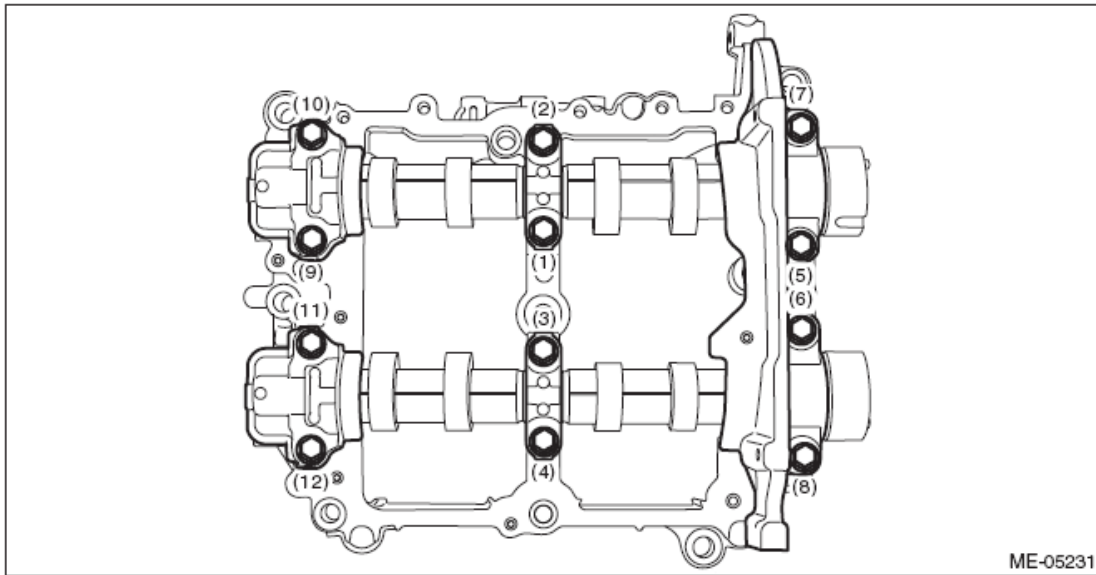


Fig. 282: Identifying Tightening Sequence Of Camshaft Cap RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

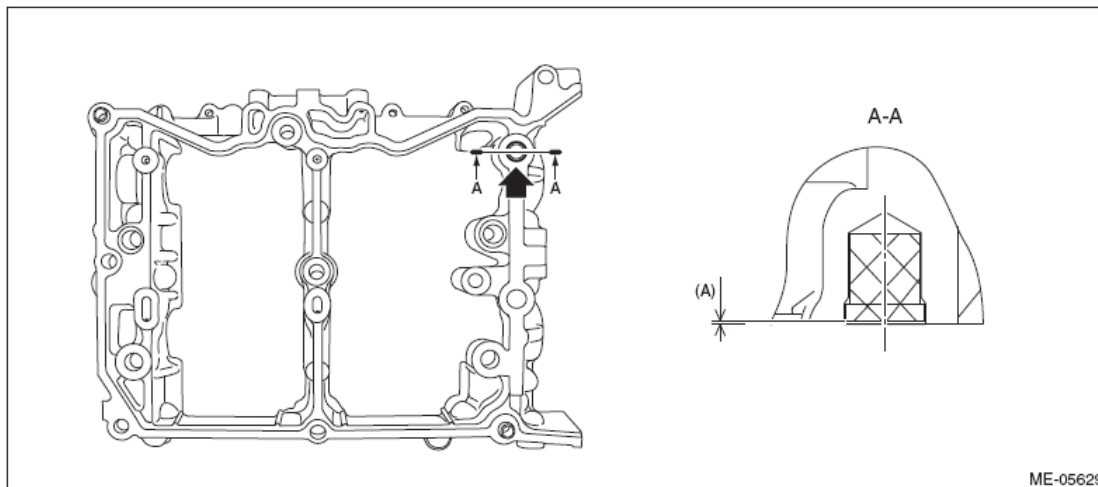
CAM CARRIER LH

1. Install the filter to the cam carrier LH.

NOTE: Use a new filter.

Filter insert position:

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



(A) 0 — 0.5 mm (0 — 0.0197 in)

Fig. 283: Locating Cam Carrier LH Filter Insertion 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 camshaft 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, degrease the old 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 ranges A, B and C

2±0.5 mm (0.0787±0.0197 in)

Mating surfaces of ranges A and C

3.5±0.5 mm (0.1378±0.0197 in)

Mating surfaces of range B

3^{+0.5}₋₀ mm (0.1181^{+0.0197}₀ in)

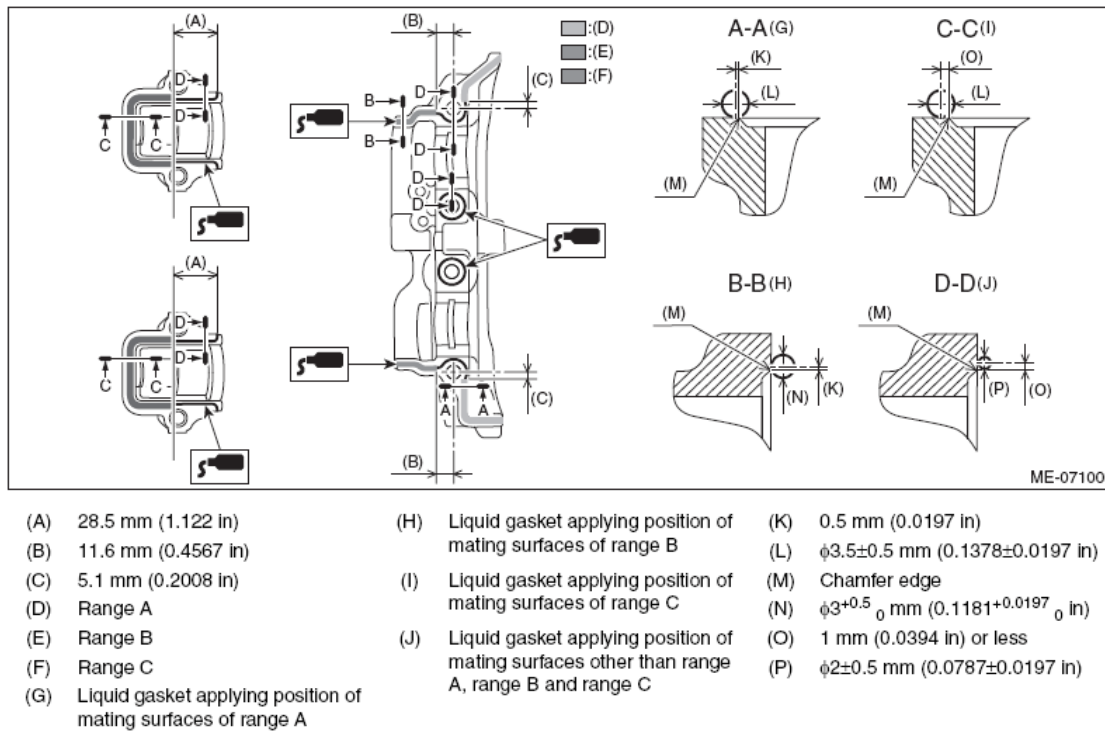


Fig. 284: Identifying Liquid Gasket Applying Area On Mating Surface Of Front Camshaft Cap LH, Intake And Exhaust Rear Camshaft Cap LH
 Courtesy of SUBARU OF AMERICA, INC.

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)

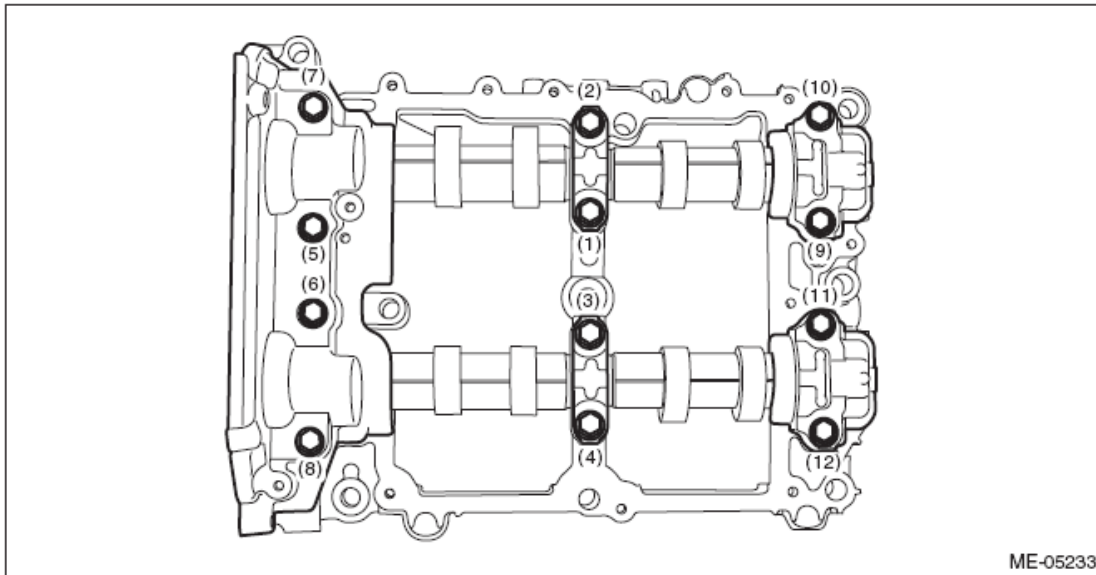


Fig. 285: Identifying Tightening Sequence Of Camshaft Cap LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

INSPECTION

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

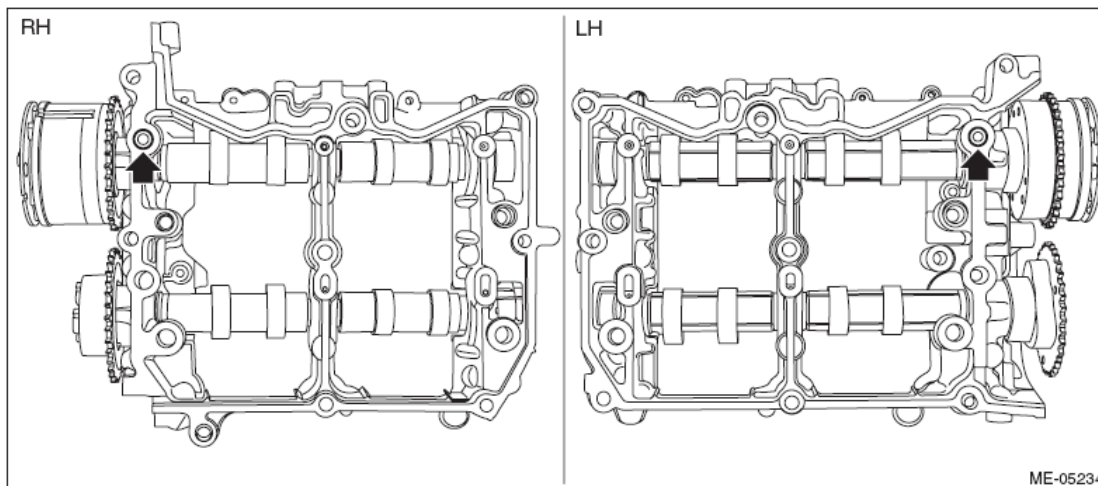


Fig. 286: Locating Cam Carrier Filter
Courtesy of SUBARU OF AMERICA, INC.

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)

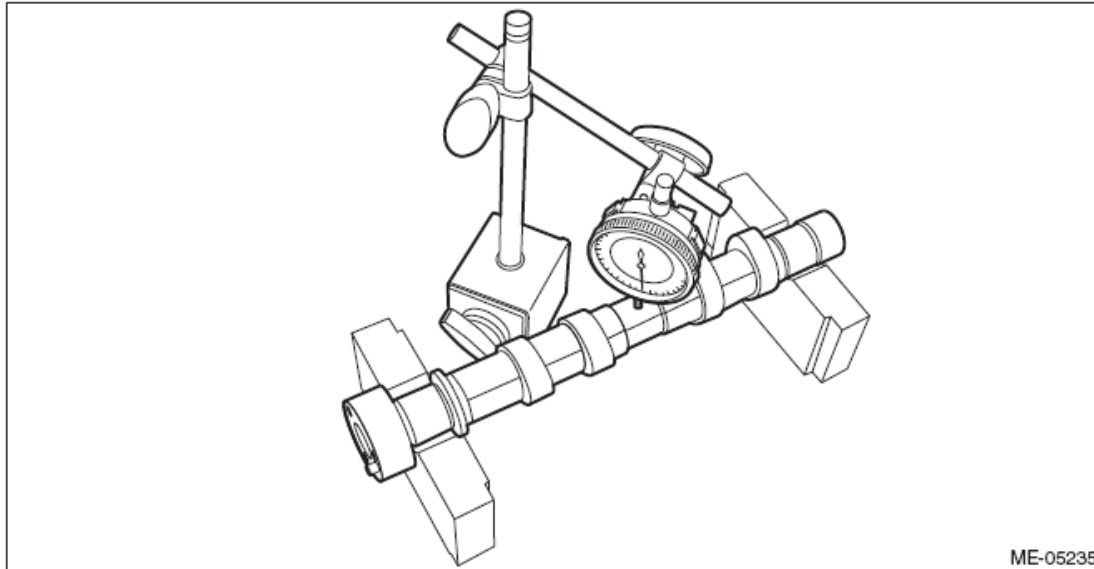


Fig. 287: Measuring Camshaft Bending Using Dial Gauge

Courtesy of SUBARU OF AMERICA, INC.

5. Check the cam lobe height "H" and cam base circle diameter "A" of camshaft as shown in the figure, 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).

Camshaft cam lobe overall height H:

Intake

Standard

40.77 - 40.87 mm (1.605 - 1.609 in)

Exhaust

Standard

40.15 - 40.25 mm (1.581 - 1.585 in)

Camshaft cam base circle diameter A:

Standard

34.0 mm (1.339 in)

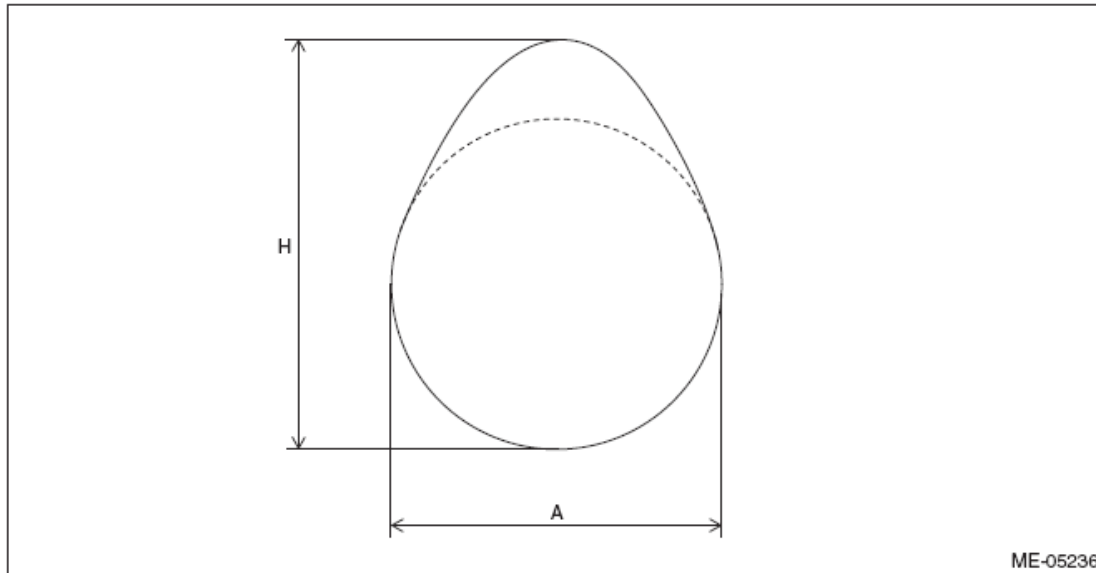


Fig. 288: Identifying Camshaft Cam Lobe Overall Height And Base Circle Diameter
 Courtesy of SUBARU OF AMERICA, INC.

6. Check the camshaft journal outer diameter 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).
- Measure outer diameter of each journal at several points, and read the value of most worn location.

Camshaft journal outer diameter:

Standard

25.946 - 25.963 mm (1.0215 - 1.0222 in)

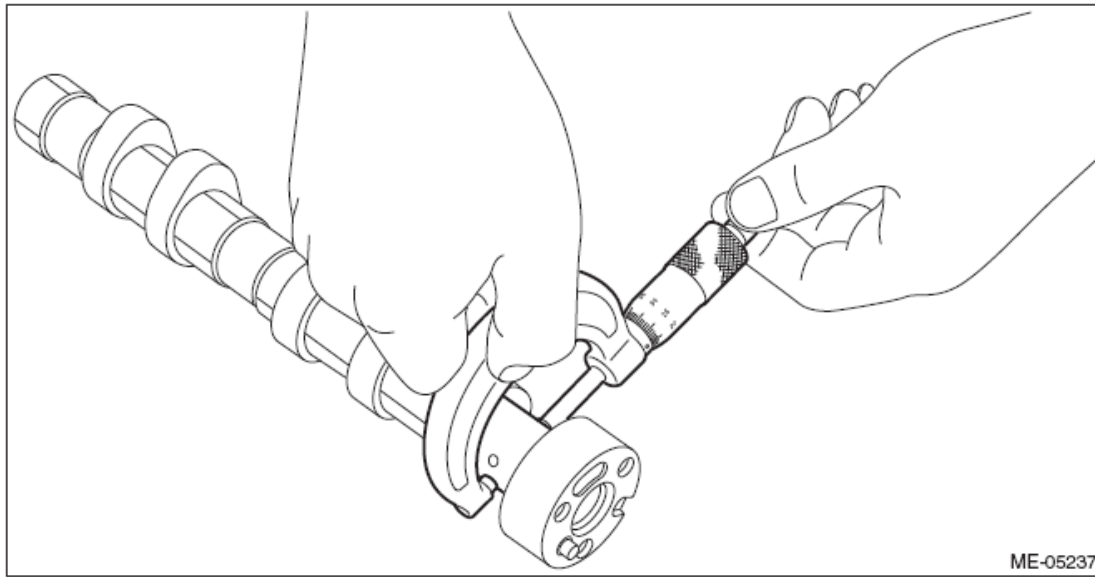


Fig. 289: Measuring Camshaft Journal Outer Diameter Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

7. Using a dial gauge, check the thrust clearance of the camshaft. 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)

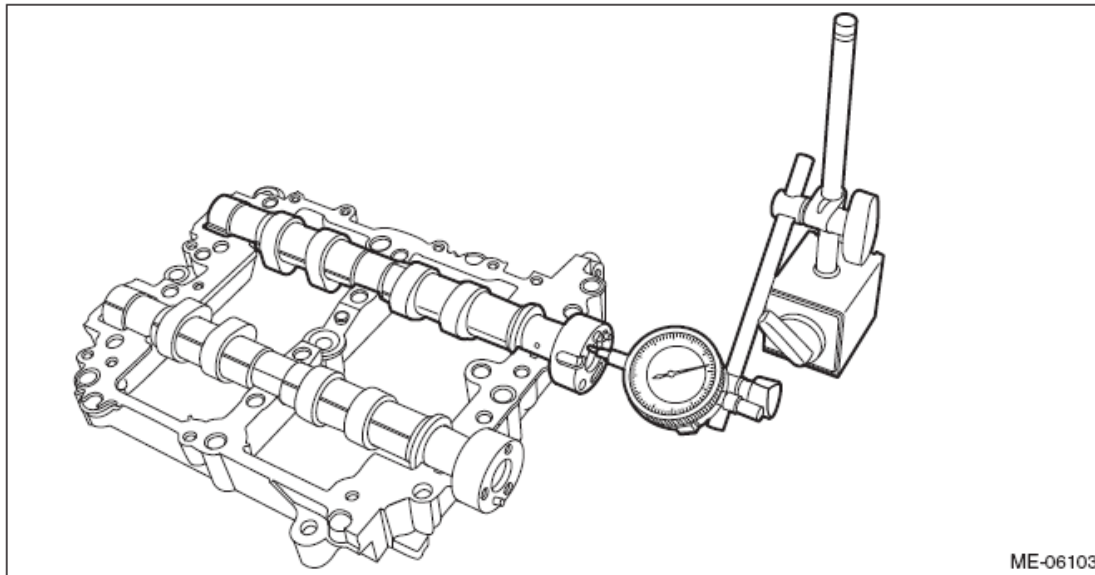


Fig. 290: Measuring Camshaft Thrust Clearance Using Dial Gauge
 Courtesy of SUBARU OF AMERICA, INC.

8. Check the oil clearance on the camshaft using a plastigauge.

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 plastigauge 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)

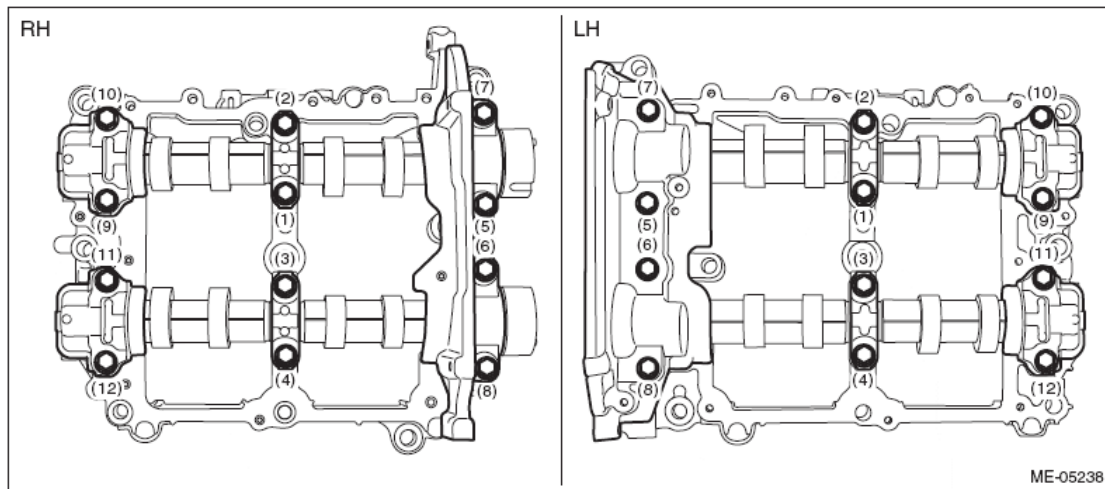


Fig. 291: Identifying Tightening Sequence Of Camshaft Cap Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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 each camshaft cap.

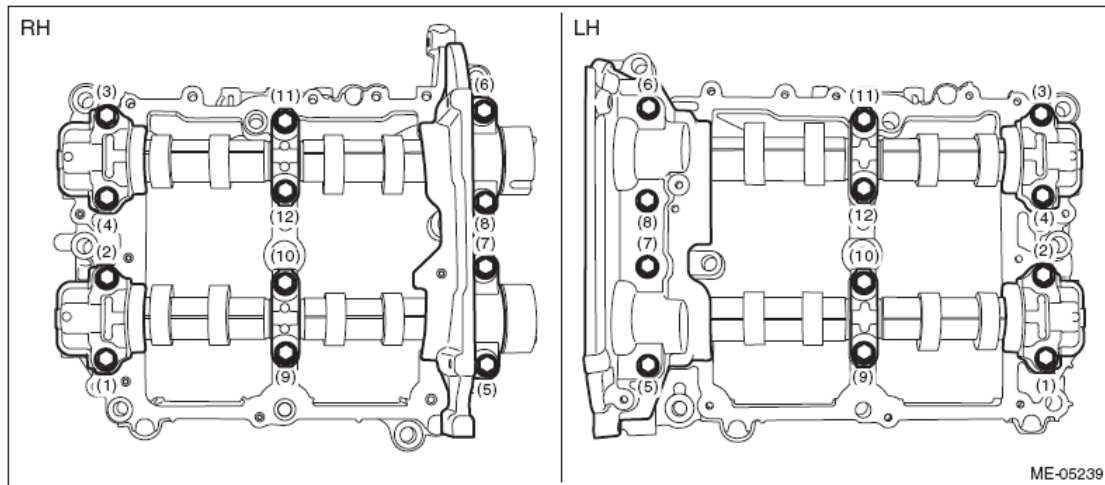


Fig. 292: Identifying Loosening Sequence Of Camshaft Cap Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

7. Determine camshaft oil clearance by matching the widest point of plastigauge on each journal against scale printed on a package of plastigauge. If it is not within the standard, replace each camshaft cap and cam carrier as a set. If necessary replace the camshaft.

Camshaft oil clearance:

Standard

0.037 - 0.072 mm (0.0015 - 0.0028 in)

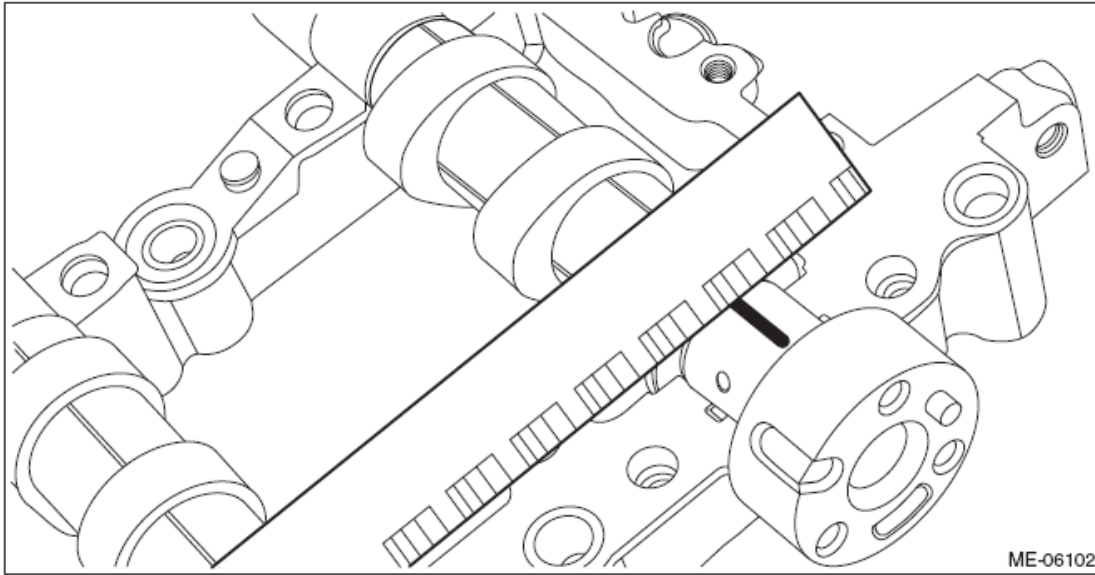


Fig. 293: Measuring Camshaft Oil Clearance Using Plastigauge
Courtesy of SUBARU OF AMERICA, INC.

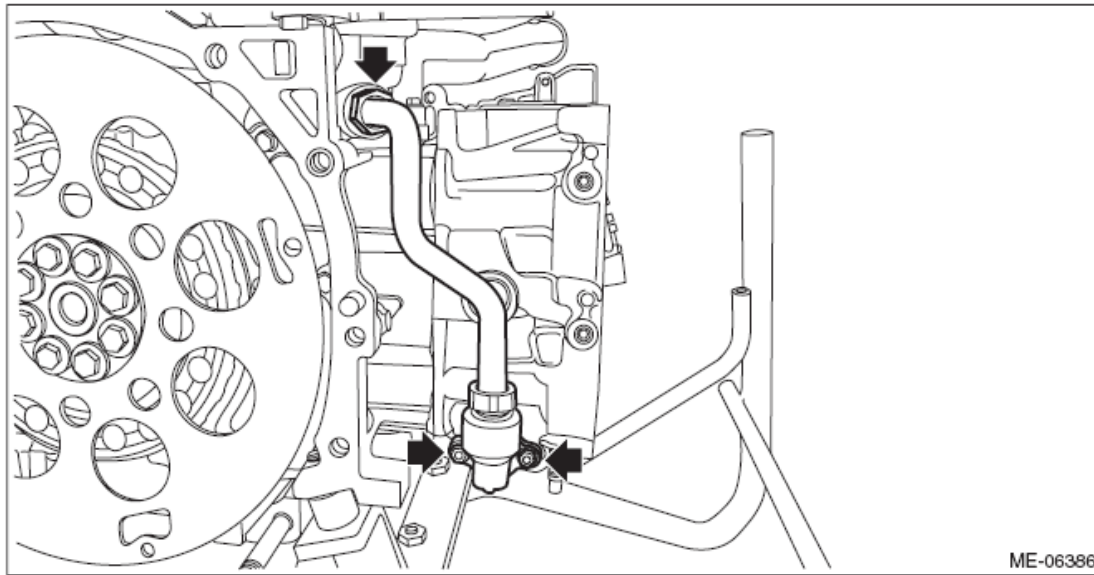
8. Completely remove the plastigauge.

CYLINDER HEAD

REMOVAL

CYLINDER HEAD RH

1. Remove the engine from the vehicle. Refer to **REMOVAL**.
2. Remove the intake manifold. Refer to **REMOVAL**.
3. Remove the tumble generator valve assembly RH. Refer to **REMOVAL**.
4. Remove the chain cover. Refer to **REMOVAL**.
5. Remove the rocker cover RH. Refer to **ROCKER COVER RH**.
6. Remove the cam carrier RH. Refer to **CAM CARRIER RH**.
7. Remove the EGR pipe assembly from the water pipe assembly and the cylinder block RH.

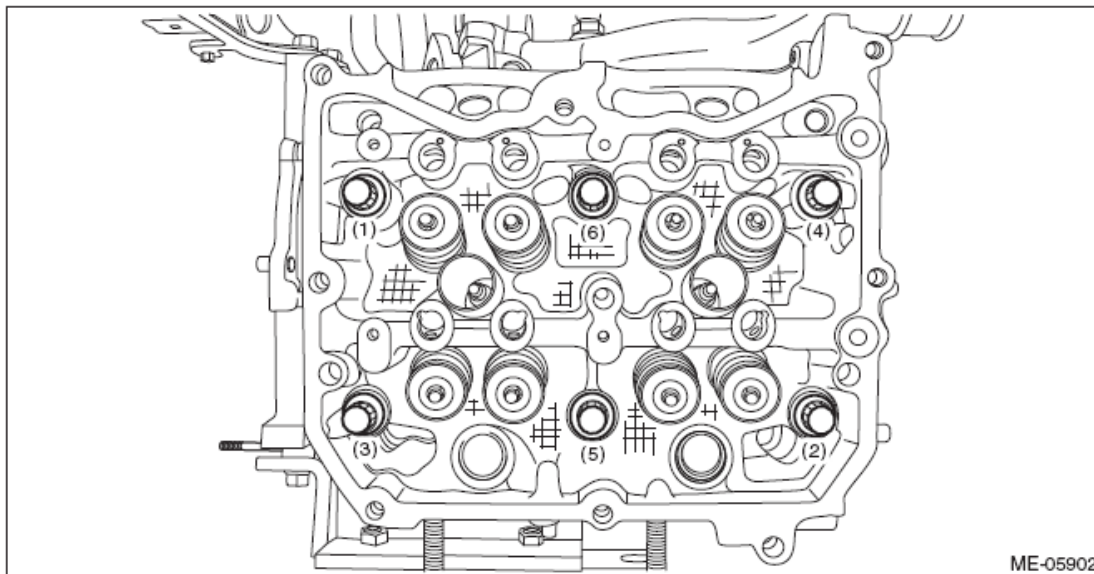


ME-06386

Fig. 294: Locating EGR Pipe Assembly Mounting 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 as shown in the figure, and while leaving the cylinder head bolts (1) and (4) engaged by three or four threads, remove the other cylinder head bolts.

NOTE: Leaving the cylinder head bolts (1) and (4) engaged by three or four threads prevents the cylinder head RH from falling.



ME-05902

Fig. 295: Identifying Loosening Sequence Of Cylinder Head RH Mounting 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**.
2. Remove the intake manifold. Refer to **REMOVAL**.
3. Remove the tumble generator valve assembly LH. Refer to **REMOVAL**.
4. Remove the chain cover. Refer to **REMOVAL**.
5. Remove the rocker cover LH. Refer to **ROCKER COVER LH**.
6. Remove the cam carrier LH. Refer to **CAM CARRIER LH**.
7. Remove the A/C compressor. Refer to **REMOVAL**.
8. Loosen the bolts holding the cylinder head LH equally, a little at a time in numerical sequence as shown in the figure, and while leaving the cylinder head bolts (1) and (4) engaged by three or four threads, remove the other cylinder head bolts.

NOTE: Leaving the cylinder head bolts (1) and (4) engaged by three or four threads prevents the cylinder head LH from falling.

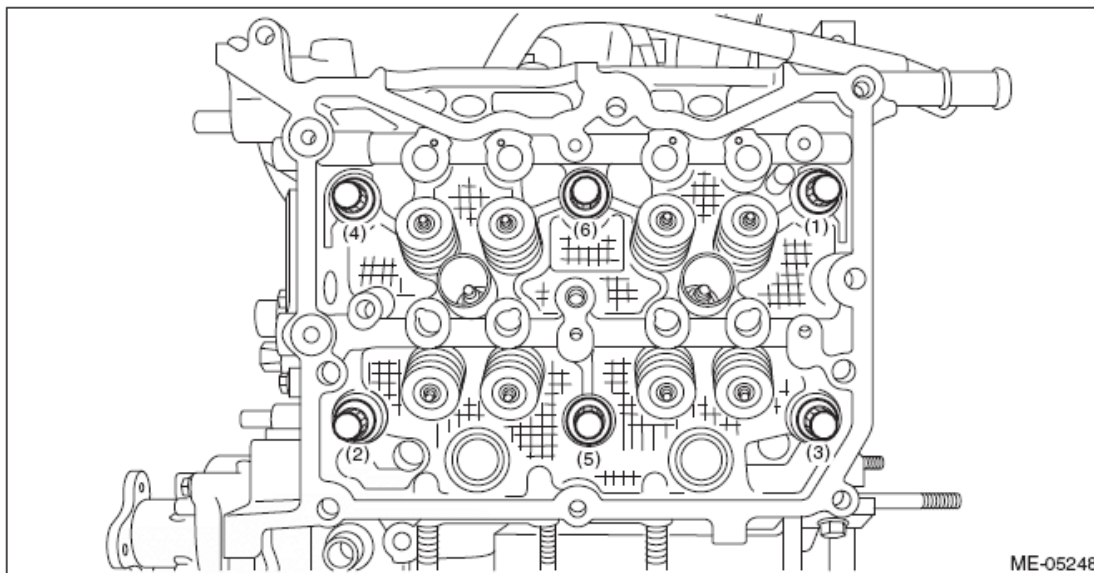


Fig. 296: Identifying Loosening Sequence Of Cylinder Head LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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:

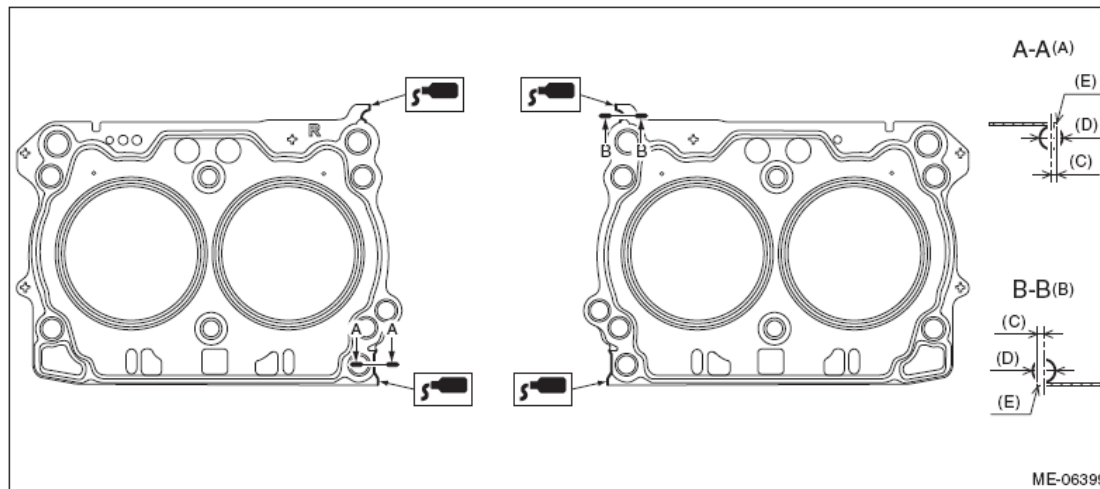
- Use a new cylinder head gasket RH.
- Before applying liquid gasket, degrease the mating surface of cylinder blocks RH and cylinder head RH.
- Install within 5 min. after applying liquid gasket.

Liquid gasket:

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

Liquid gasket applying diameter:

3±1 mm (0.1181±0.0394 in)



- | | | |
|--|---|-------------------------------|
| (A) Liquid gasket applying position to the cylinder head side | (C) 1 mm (0.0394 in) or less | (E) Cylinder head gasket edge |
| (B) Liquid gasket applying position to the cylinder block side | (D) $\phi 3\pm 1$ mm (0.1181 $\pm$ 0.0394 in) | |

Fig. 297: Identifying Liquid Gasket Applying Area On 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, and 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.

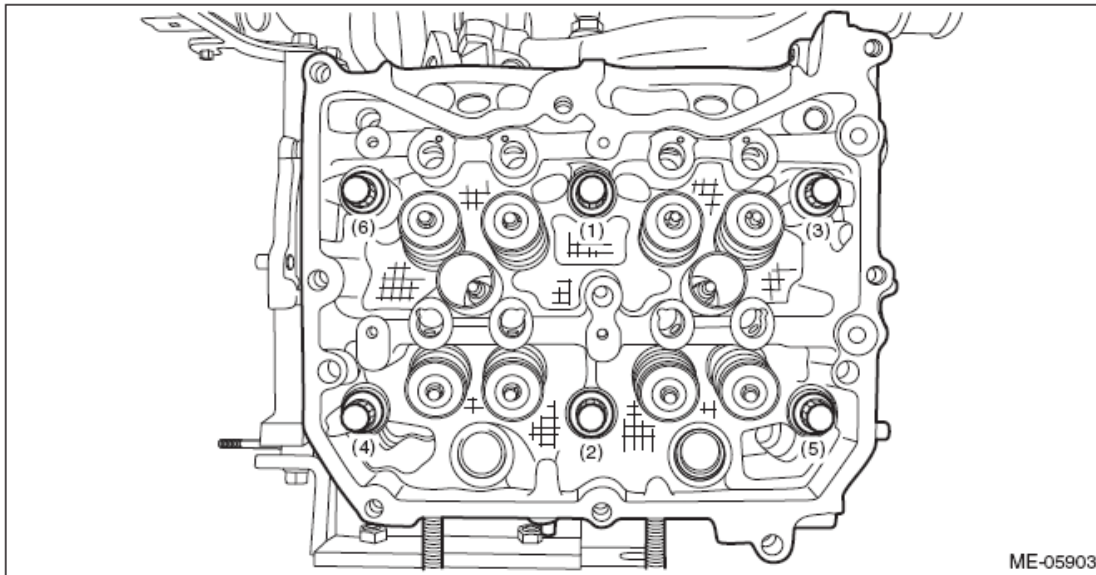


Fig. 298: Identifying Tightening Sequence Of Cylinder Head RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

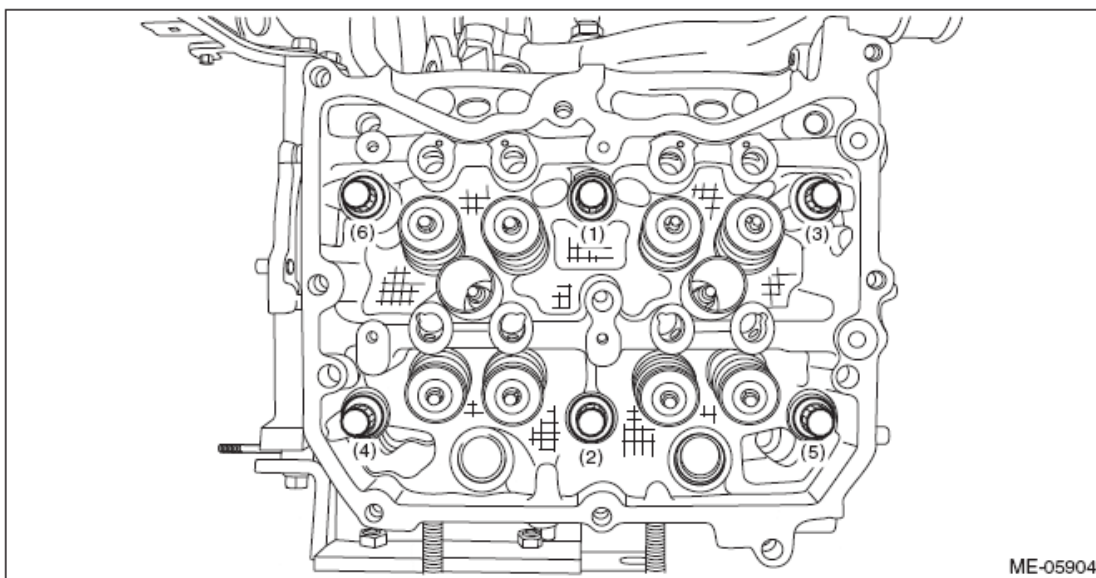


Fig. 299: Identifying Tightening Sequence Of Cylinder Head Mounting Bolts

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.

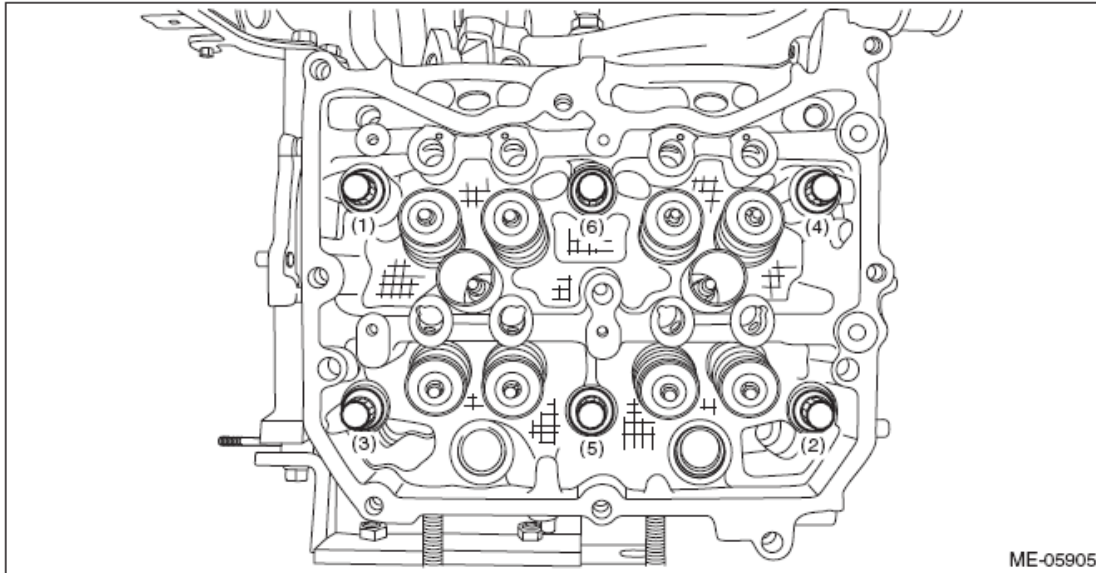


Fig. 300: Identifying Loosening Sequence Of Cylinder Head Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

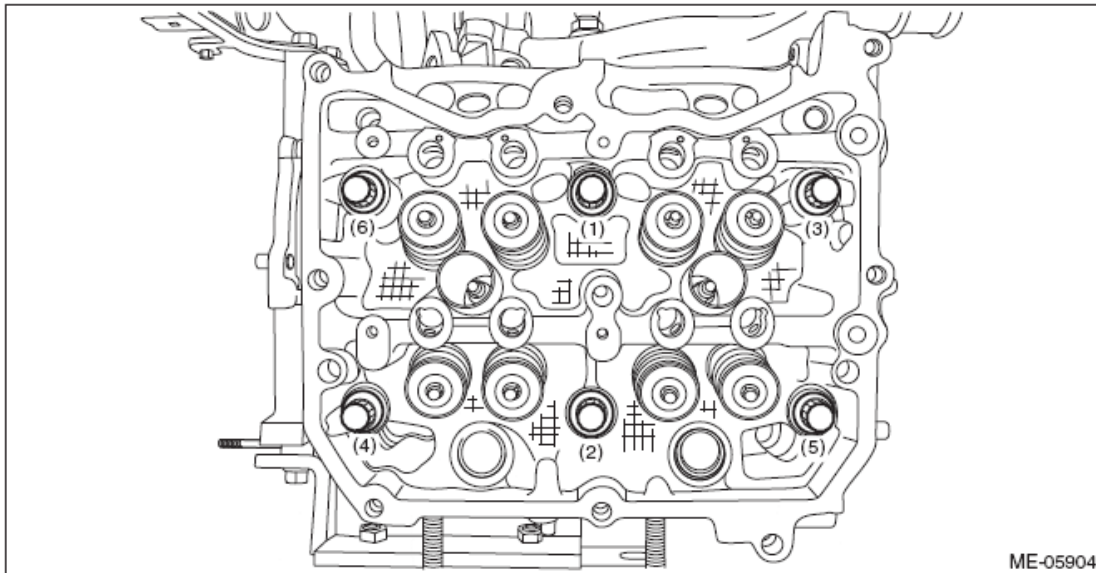


Fig. 301: Identifying Tightening Sequence Of Cylinder Head Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Using ST2, tighten all cylinder head bolts with specified angle in numerical order as shown in the figure.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle:

$80^{\circ} \pm 2^{\circ}$

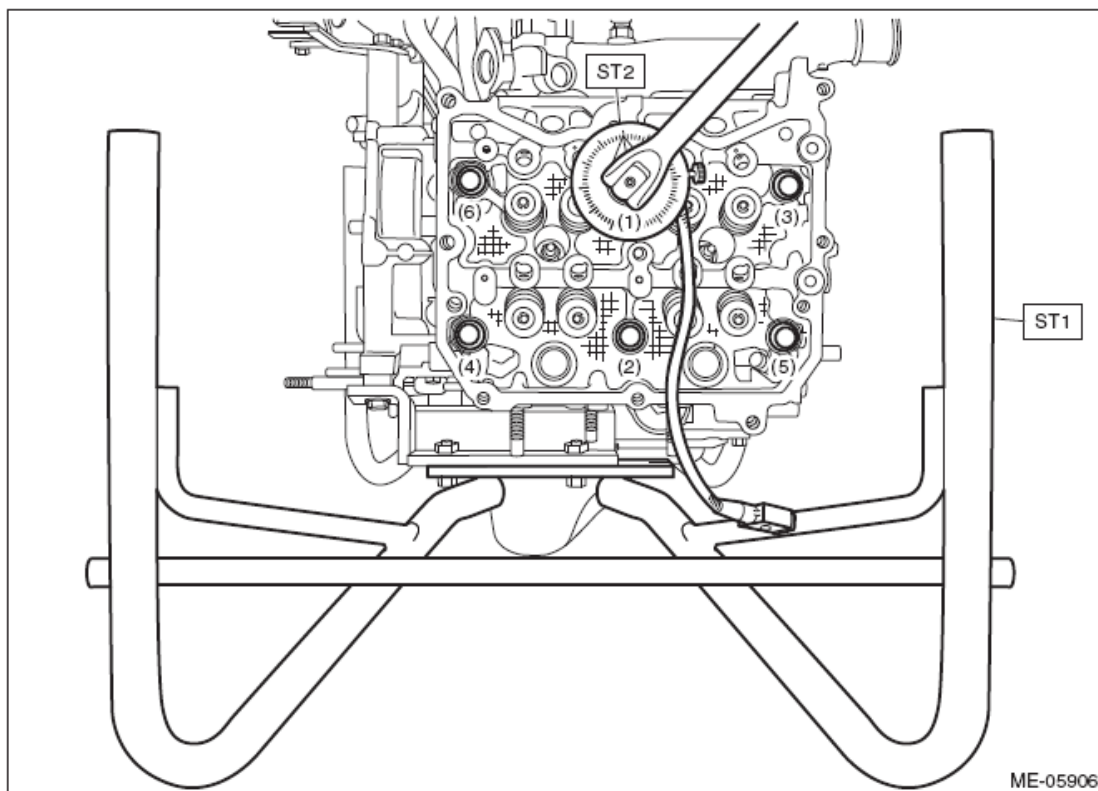


Fig. 302: Tightening Cylinder Head Bolts Using Angle Gauge
Courtesy of SUBARU OF AMERICA, INC.

7. Using ST2, tighten the cylinder head bolts (2 places) with specified angle in numerical order as shown in the figure.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle:

$75^{\circ} \pm 2^{\circ}$

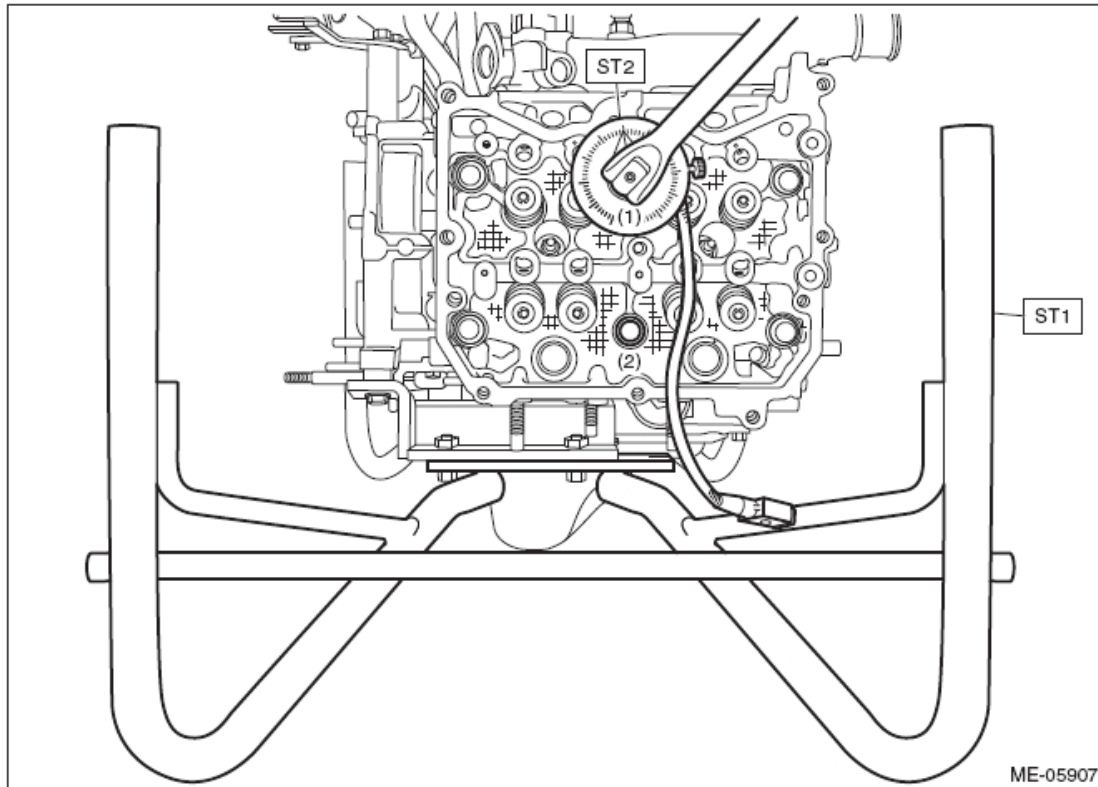


Fig. 303: Tightening Cylinder Head Bolts Using Angle Gauge (2 Places)
 Courtesy of SUBARU OF AMERICA, INC.

8. Using ST2, tighten the cylinder head bolts (4 places) with specified angle 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.
- Attach the magnet used for securing the ST2 (ANGLE GAUGE) to ST1.

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle:

$30^{\circ} \pm 2^{\circ}$

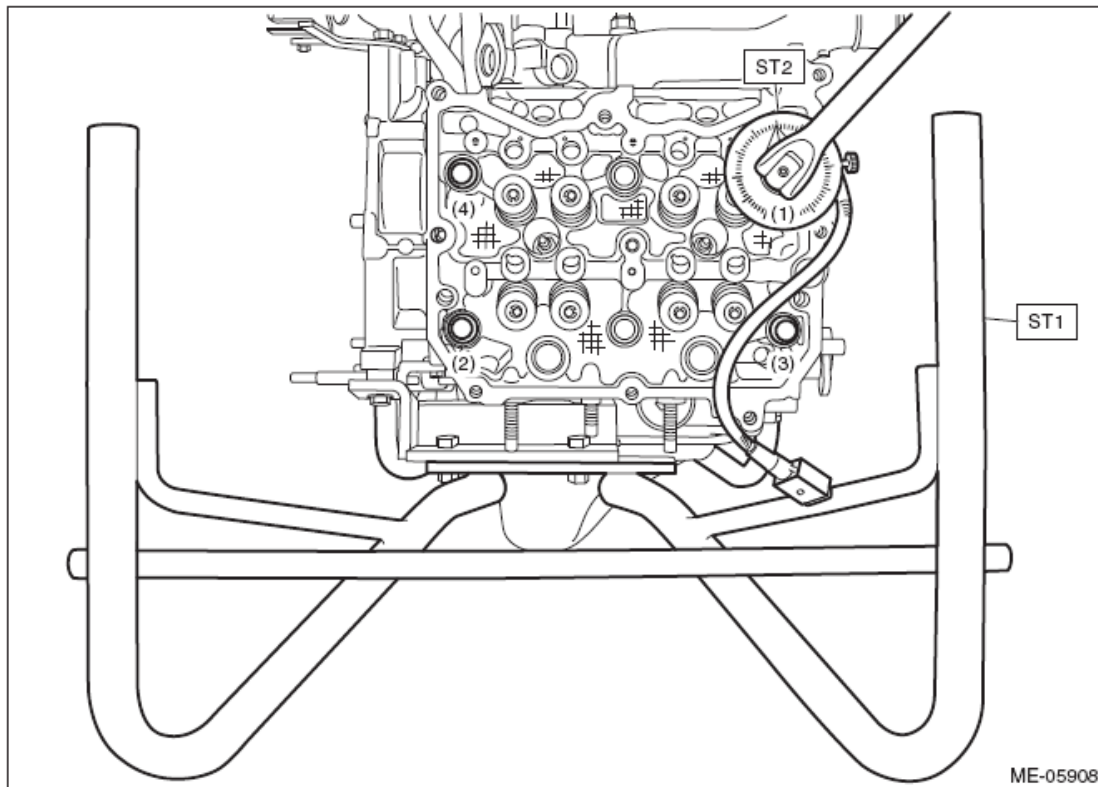


Fig. 304: Tightening Cylinder Head Bolts Using Angle Gauge (4 Places)
 Courtesy of SUBARU OF AMERICA, INC.

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)

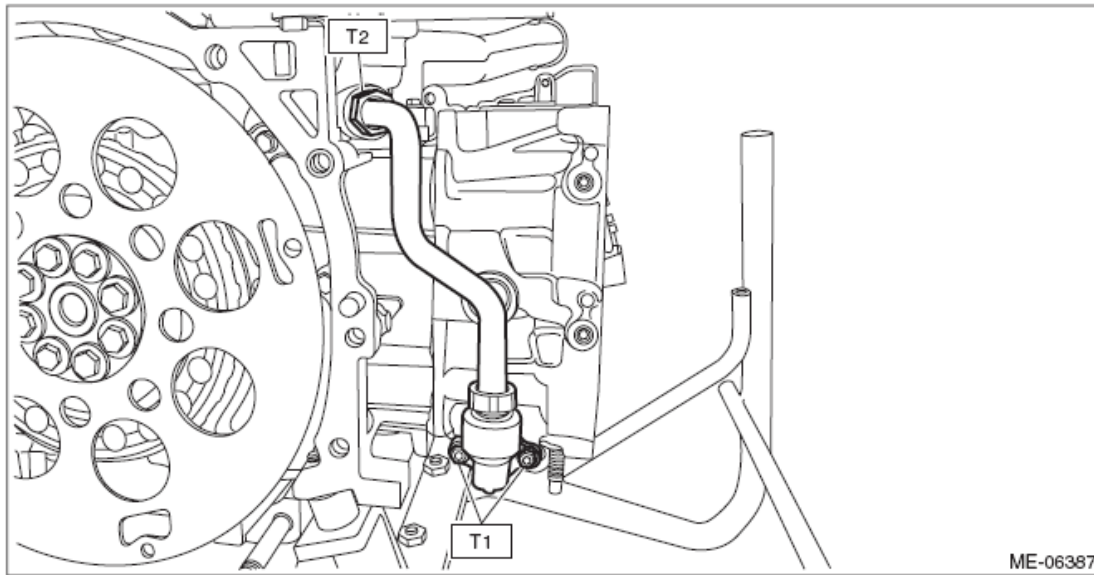


Fig. 305: Identifying EGR Pipe Assembly Mounting Bolts With Torque Specifications
 Courtesy of SUBARU OF AMERICA, INC.

6. Install the cam carrier RH. Refer to **CAM CARRIER RH.**
7. Install the rocker cover RH. Refer to **ROCKER COVER RH.**
8. Install the chain cover. Refer to **INSTALLATION.**
9. Install the tumble generator valve assembly RH. Refer to **INSTALLATION.**
10. Install the intake manifold. Refer to **INSTALLATION.**
11. Install the engine to the vehicle. Refer to **INSTALLATION.**

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, degrease the mating surface of cylinder blocks LH and 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)

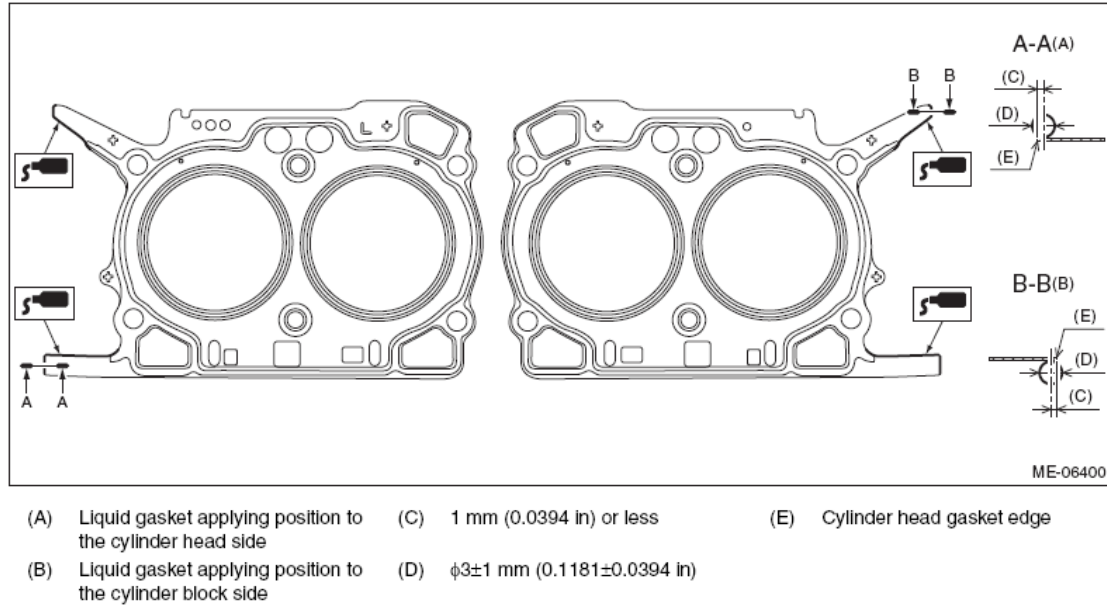


Fig. 306: Identifying Liquid Gasket Applying Area On Cylinder Head Gasket LH
 Courtesy of SUBARU OF AMERICA, INC.

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.

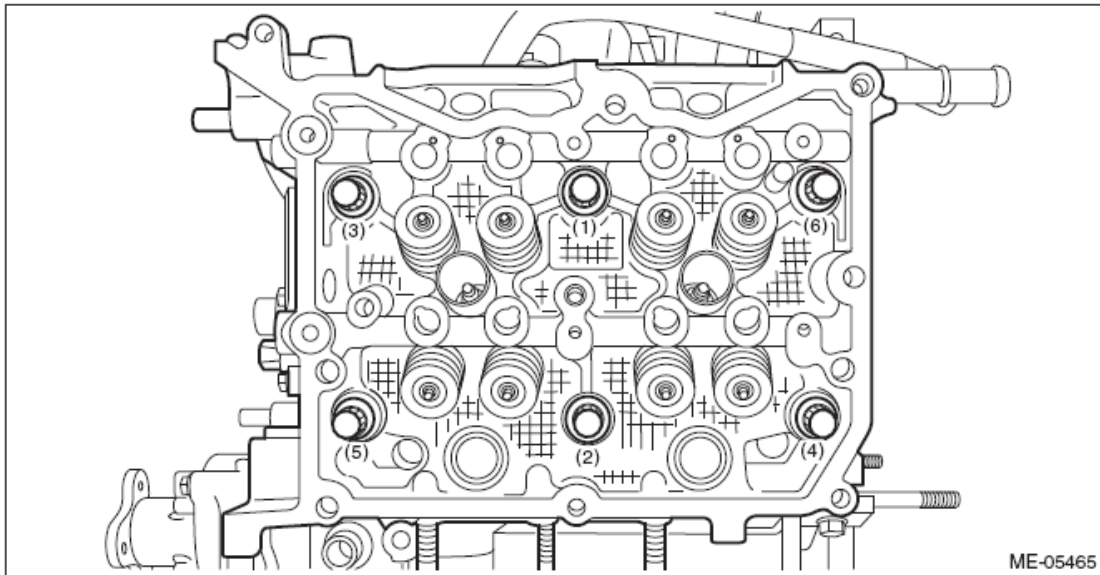


Fig. 307: Identifying Tightening Sequence Of Cylinder Head LH Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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.

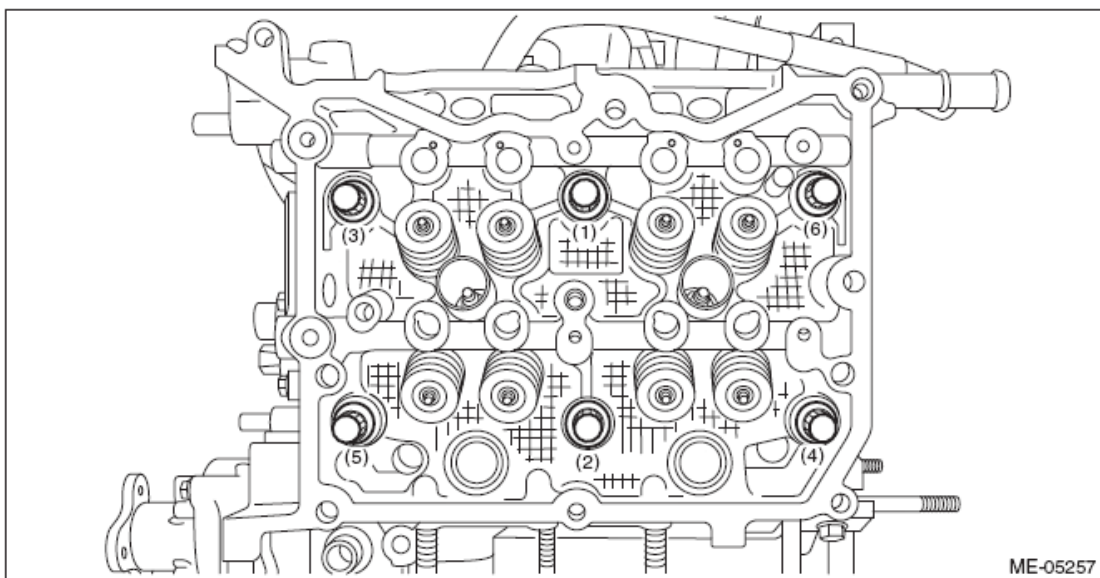


Fig. 308: Identifying Tightening Sequence Of Cylinder Head Mounting Bolts

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.

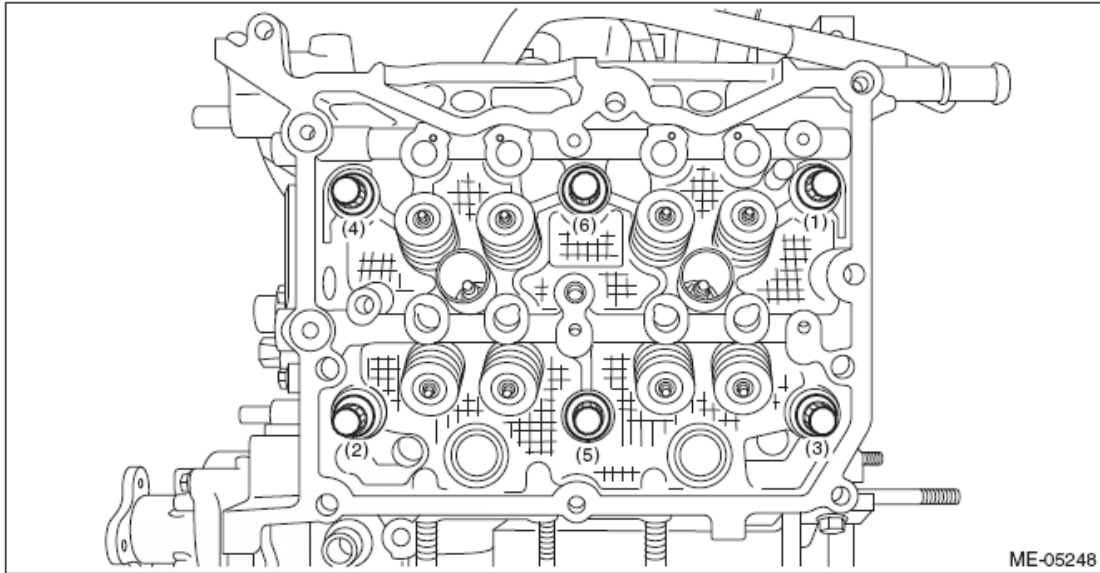


Fig. 309: Identifying Loosening Sequence Of Cylinder Head Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

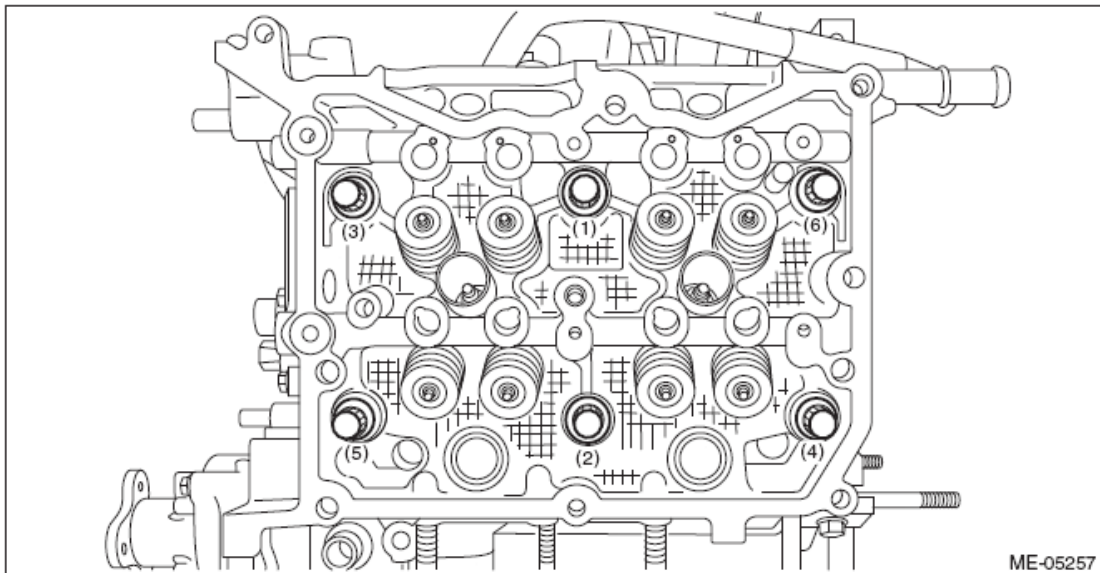


Fig. 310: Identifying Tightening Sequence Of Cylinder Head Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

6. Using ST2, tighten all cylinder head bolts with specified angle in numerical order as shown in the figure.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle:

$80^{\circ} \pm 2^{\circ}$

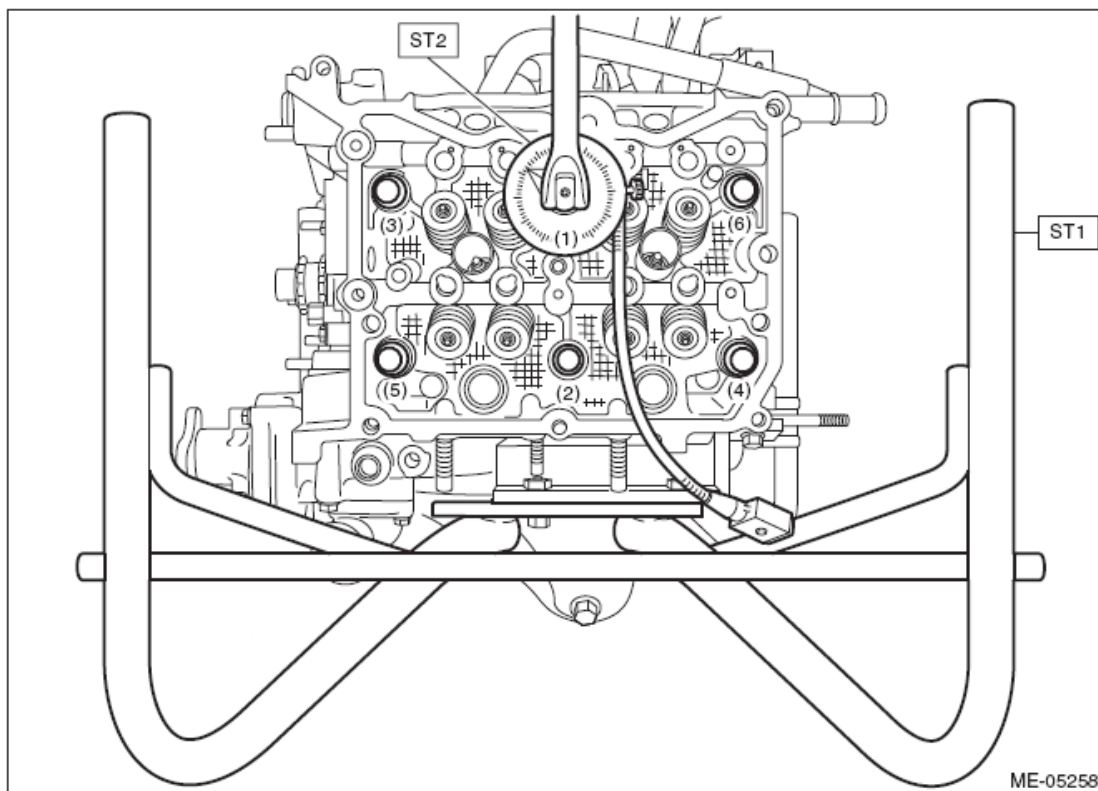


Fig. 311: Tightening Cylinder Head Bolts Using Angle Gauge
Courtesy of SUBARU OF AMERICA, INC.

7. Using ST2, tighten the cylinder head bolts (2 places) with specified angle in numerical order as shown in the figure.

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

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle:

$75^{\circ} \pm 2^{\circ}$

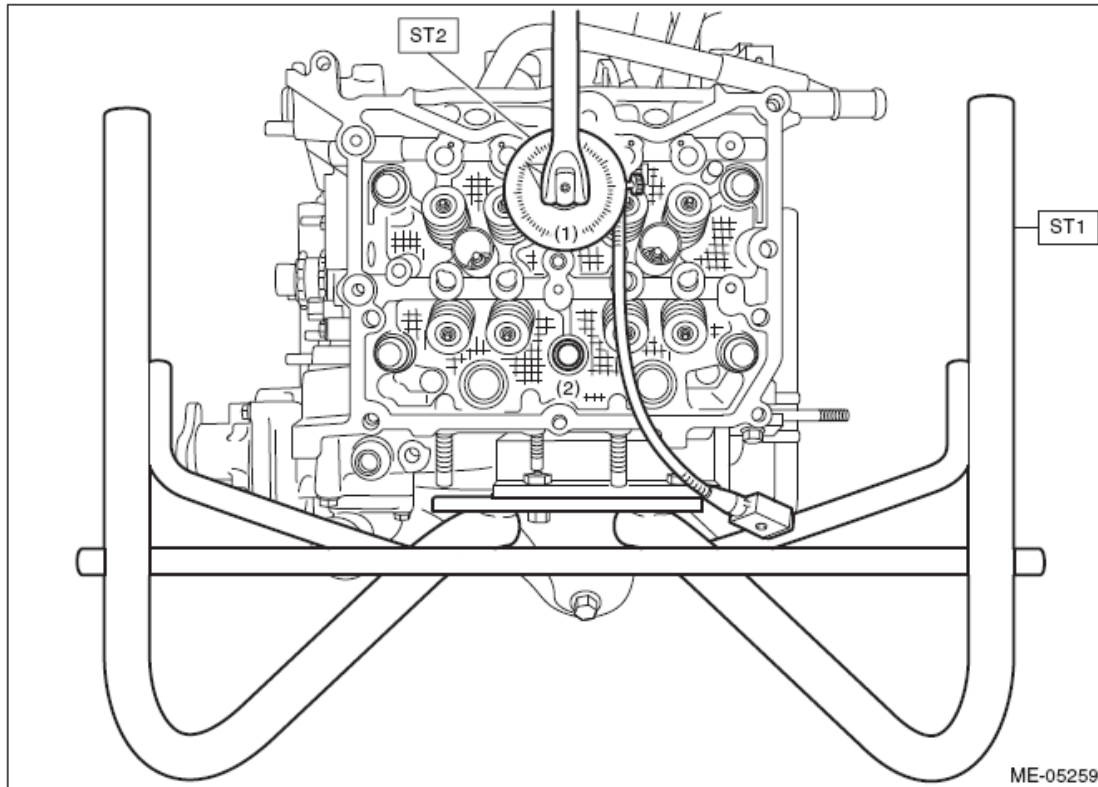


Fig. 312: Tightening Cylinder Head Bolts Using Angle Gauge (2 Places)
 Courtesy of SUBARU OF AMERICA, INC.

8. Using ST2, tighten the cylinder head bolts (4 places) with specified angle 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.
- Attach the magnet used for securing the ST2 (ANGLE GAUGE) to ST1.

ST1 499817100 ENGINE STAND

ST2 18854AA000 ANGLE GAUGE

Tightening angle:

$30^{\circ} \pm 2^{\circ}$

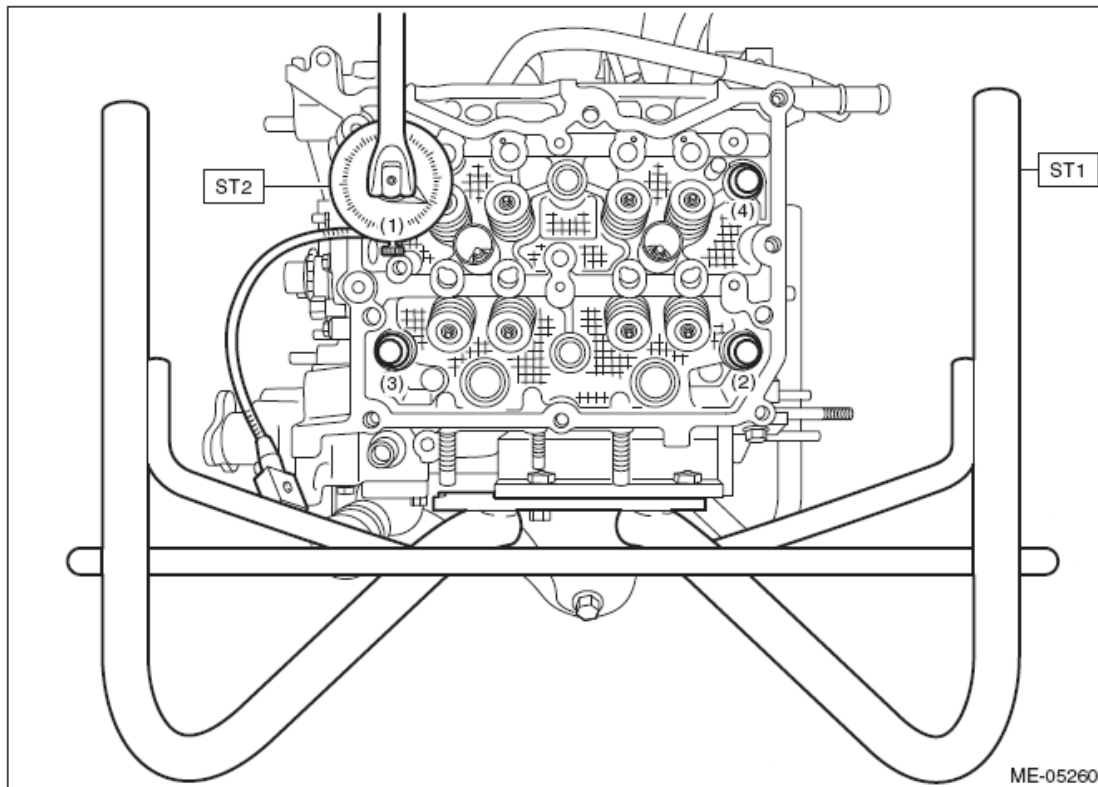


Fig. 313: Tightening Cylinder Head Bolts Using Angle Gauge (4 Places)
 Courtesy of SUBARU OF AMERICA, INC.

5. Install the A/C compressor. Refer to INSTALLATION .
6. Install the cam carrier LH. Refer to CAM CARRIER LH.
7. Install the rocker cover LH. Refer to ROCKER COVER LH.
8. Install the chain cover. Refer to INSTALLATION.
9. Install the tumble generator valve assembly LH. Refer to INSTALLATION .
10. Install the intake manifold. Refer to INSTALLATION .
11. Install the engine to the vehicle. Refer to INSTALLATION.

DISASSEMBLY

1. Remove the chain cover securing bolt from the cylinder head LH.

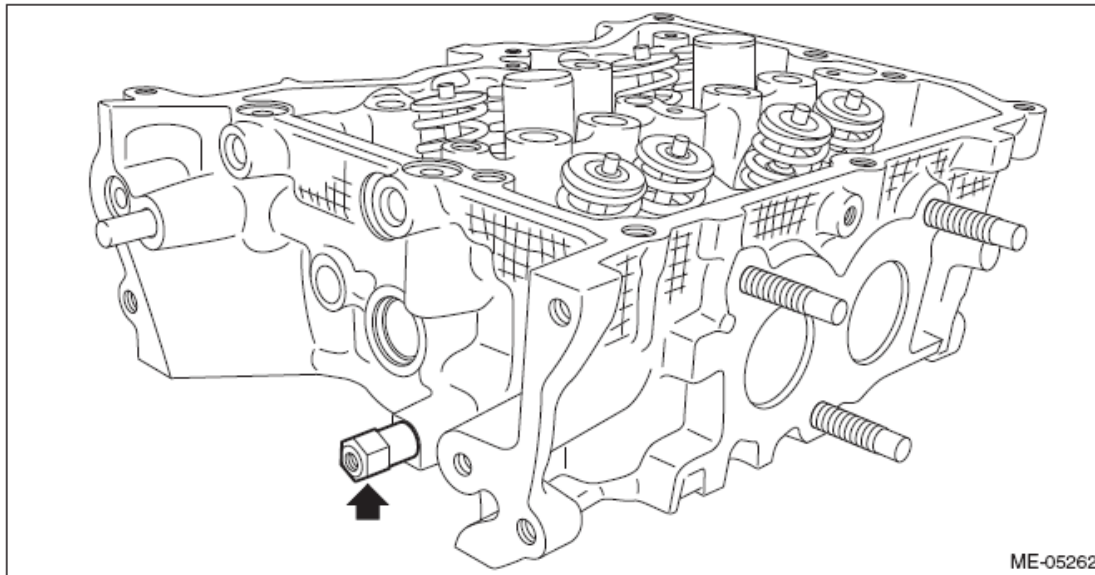


Fig. 314: Locating Cylinder Head LH Chain Cover Securing Bolt
 Courtesy of SUBARU OF AMERICA, INC.

2. Remove the stud bolts from the cylinder head.

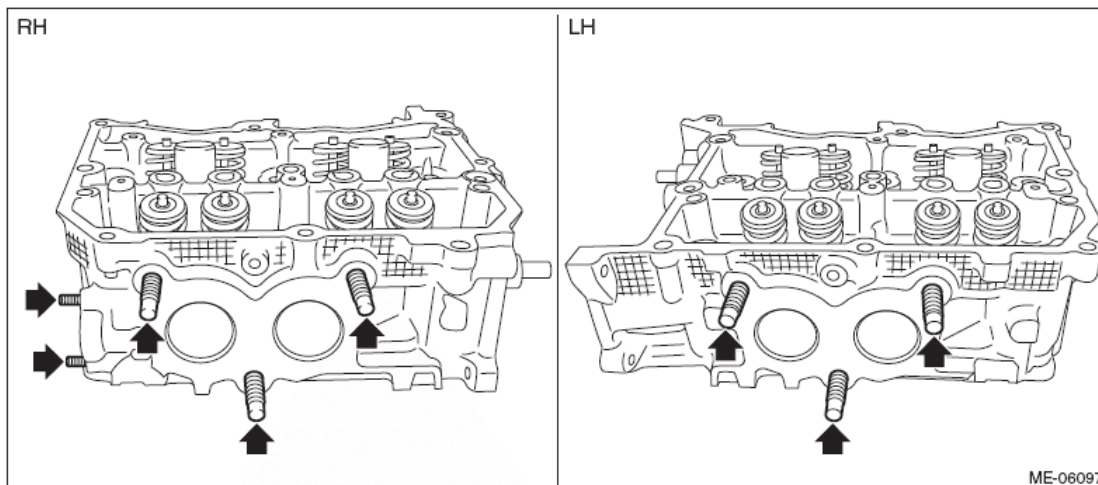


Fig. 315: Locating Cylinder Head Stud Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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 RH.

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.

ST 0920287002000 REMOVER AND REPLACER

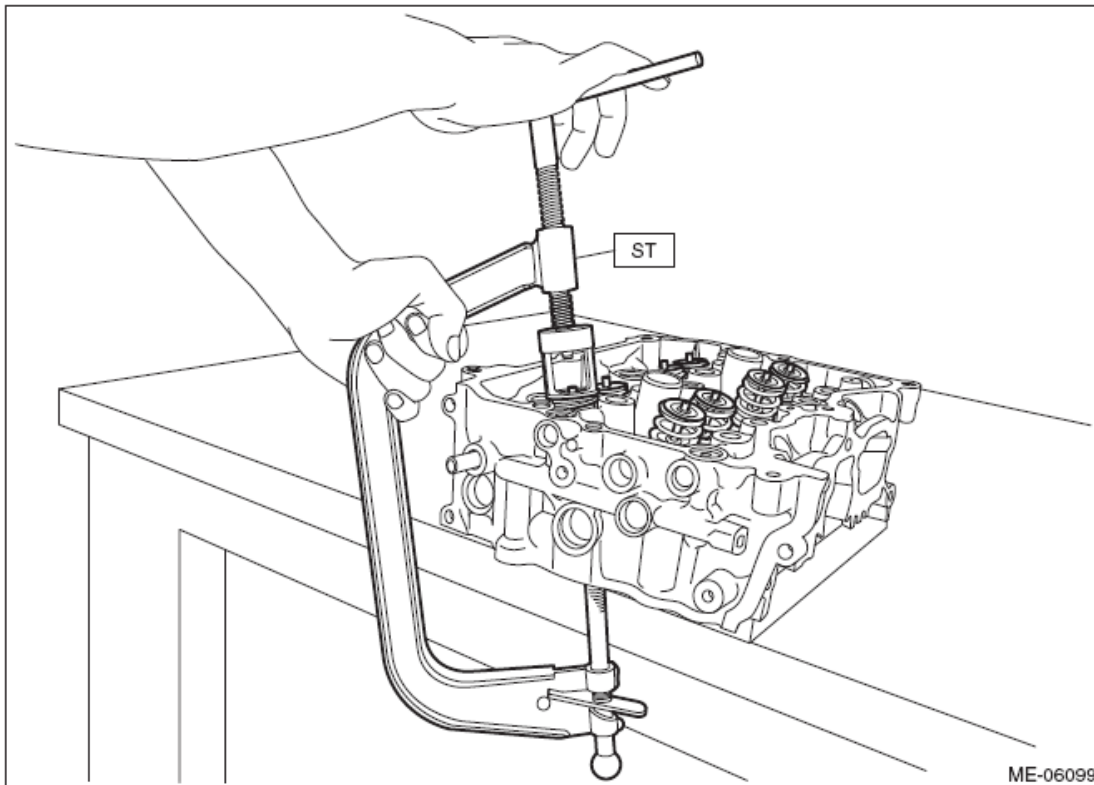


Fig. 316: Compressing Valve Spring Using Remover And Replacer
Courtesy of SUBARU OF AMERICA, INC.

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 seals from valve guides of cylinder head RH.

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 & VALVE GUIDE**.

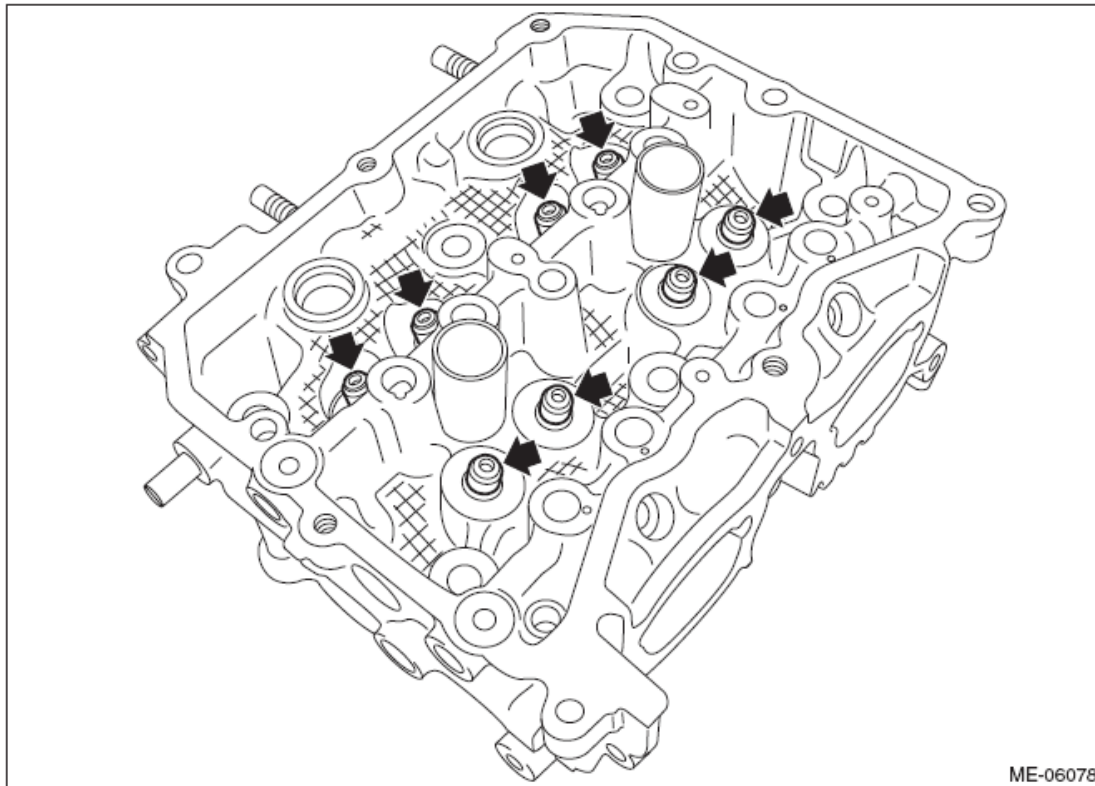
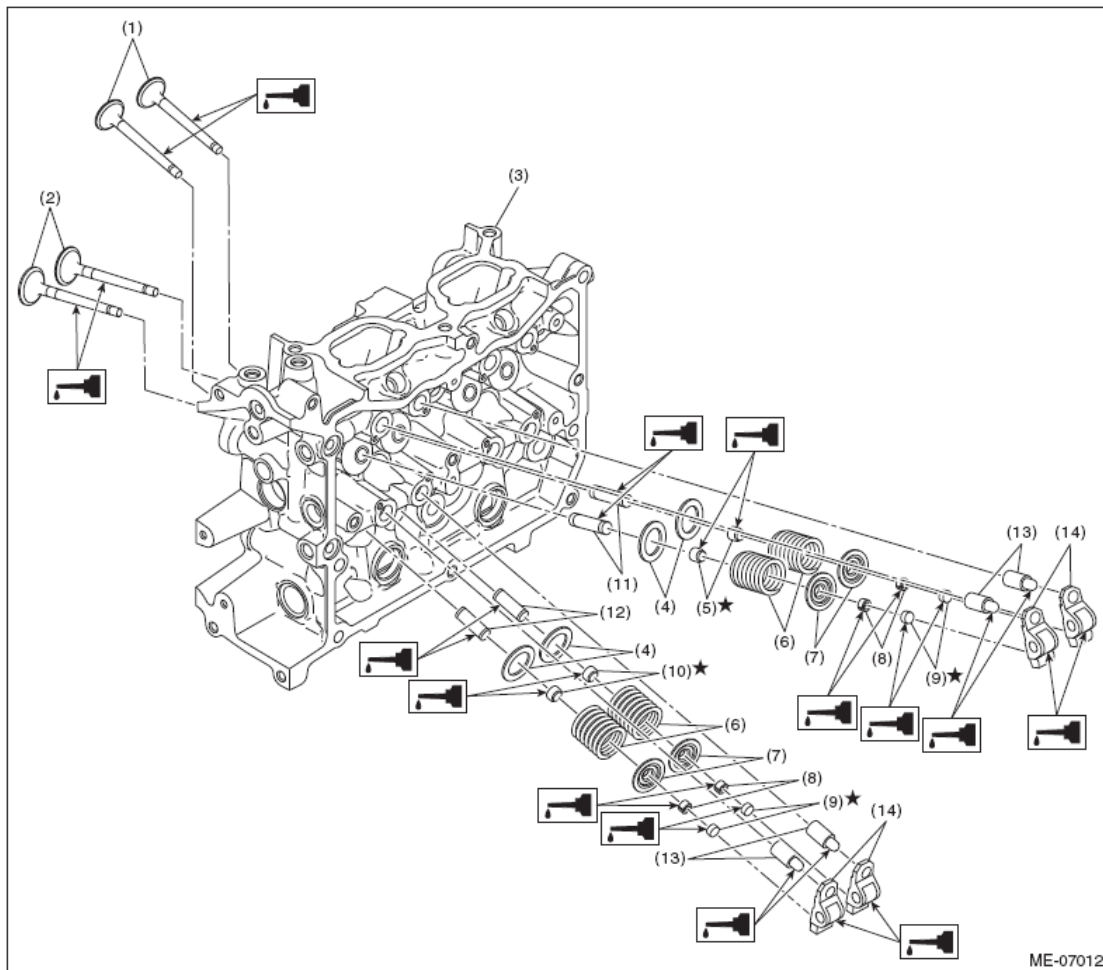


Fig. 317: Locating Valve Guide Oil Seals
Courtesy of SUBARU OF AMERICA, INC.

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

1. Using the ST, install the valve oil seals to valve guides of cylinder head RH.

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.
- When installing the valve oil seal, press the ST with hands to install it and never drive the ST with a plastic hammer, otherwise the valve oil seal can be damaged.

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 distinguished by their colors.

Identification colors:

Intake [Gray]

Exhaust [Green]

- For installation of valve guide, refer to INSPECTION. Refer to **VALVE & VALVE GUIDE**.

ST 18261AA010 VALVE OIL SEAL GUIDE

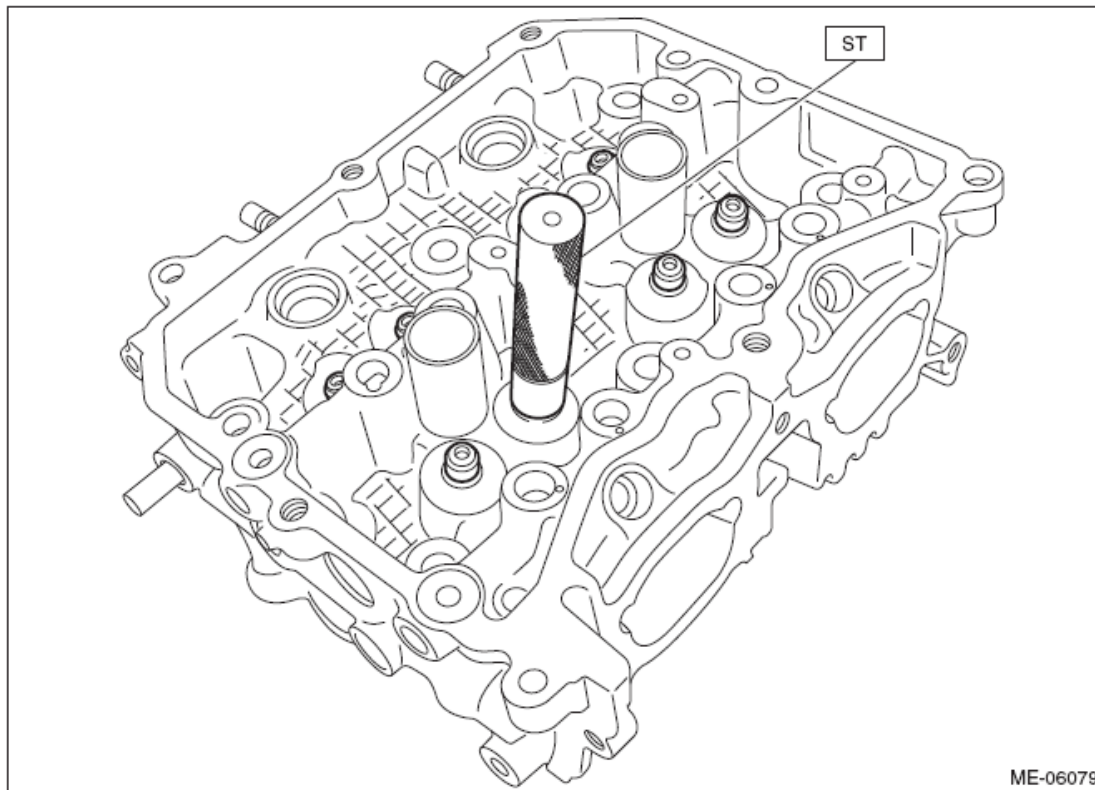


Fig. 319: Installing Valve Guide Using Valve Oil Seal Guide
Courtesy of SUBARU OF AMERICA, INC.

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 RH.

1. Set the valve spring seat, valve spring and valve spring retainer onto the cylinder head RH.

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

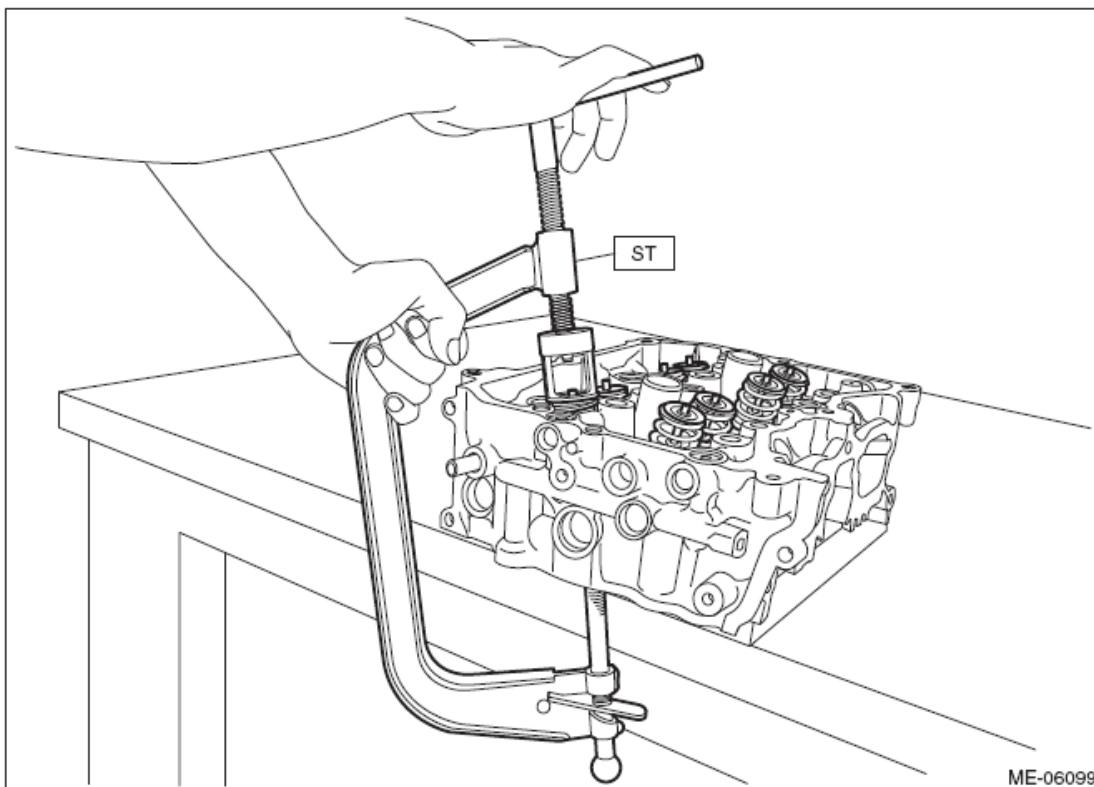


Fig. 320: Compressing Valve Spring Using Remover And Replacer
Courtesy of SUBARU OF AMERICA, INC.

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)

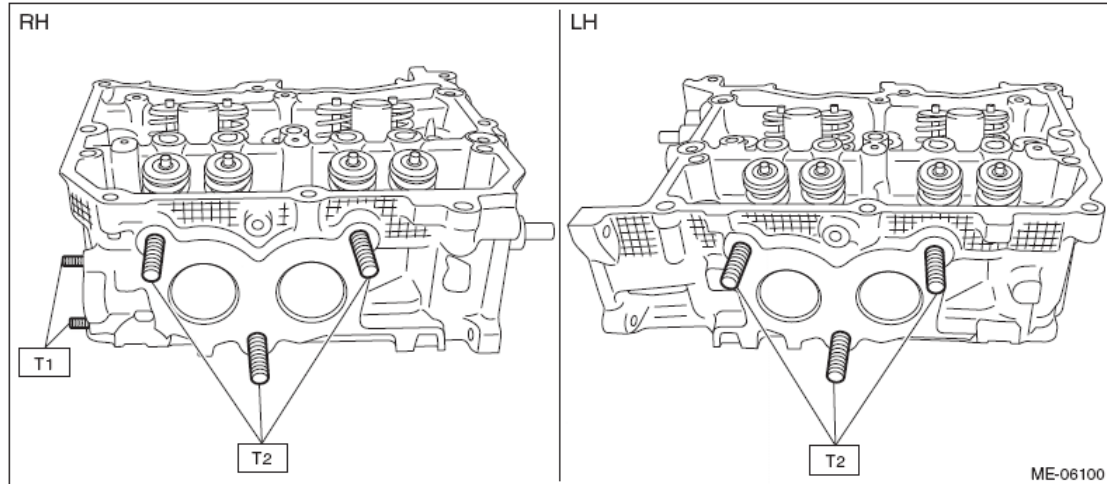


Fig. 321: Identifying Cylinder Head Stud Bolts With Torque Specifications
Courtesy of SUBARU OF AMERICA, INC.

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)

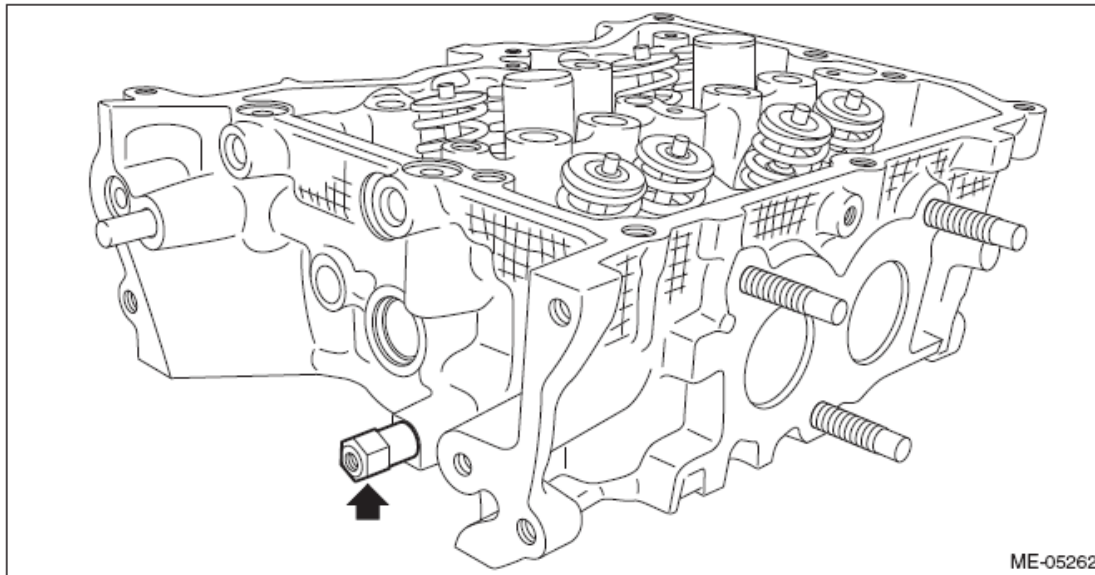


Fig. 322: Locating Cylinder Head LH Chain Cover Securing Bolt
Courtesy of SUBARU OF AMERICA, INC.

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 at the locations shown in the figure using a straight edge (A) and thickness gauge (B). 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).
- If there is warpage on the cylinder head mating surface, the cylinder head bolt tightening torque and angle tightening may be improper. When installing the cylinder head, make sure that tightening torque and angle tightening work is performed precisely according to the operation procedures.
- When the cylinder head is replaced, lap each valve. Refer to "VALVE SEAT" for lapping. Refer to VALVE SEAT.

Cylinder head warpage:

Limit

0.035 mm (0.0014 in)

Cylinder head grinding limit:

To 98.4 mm (3.874 in)

Cylinder head height:

Standard

98.5 mm (3.878 in)

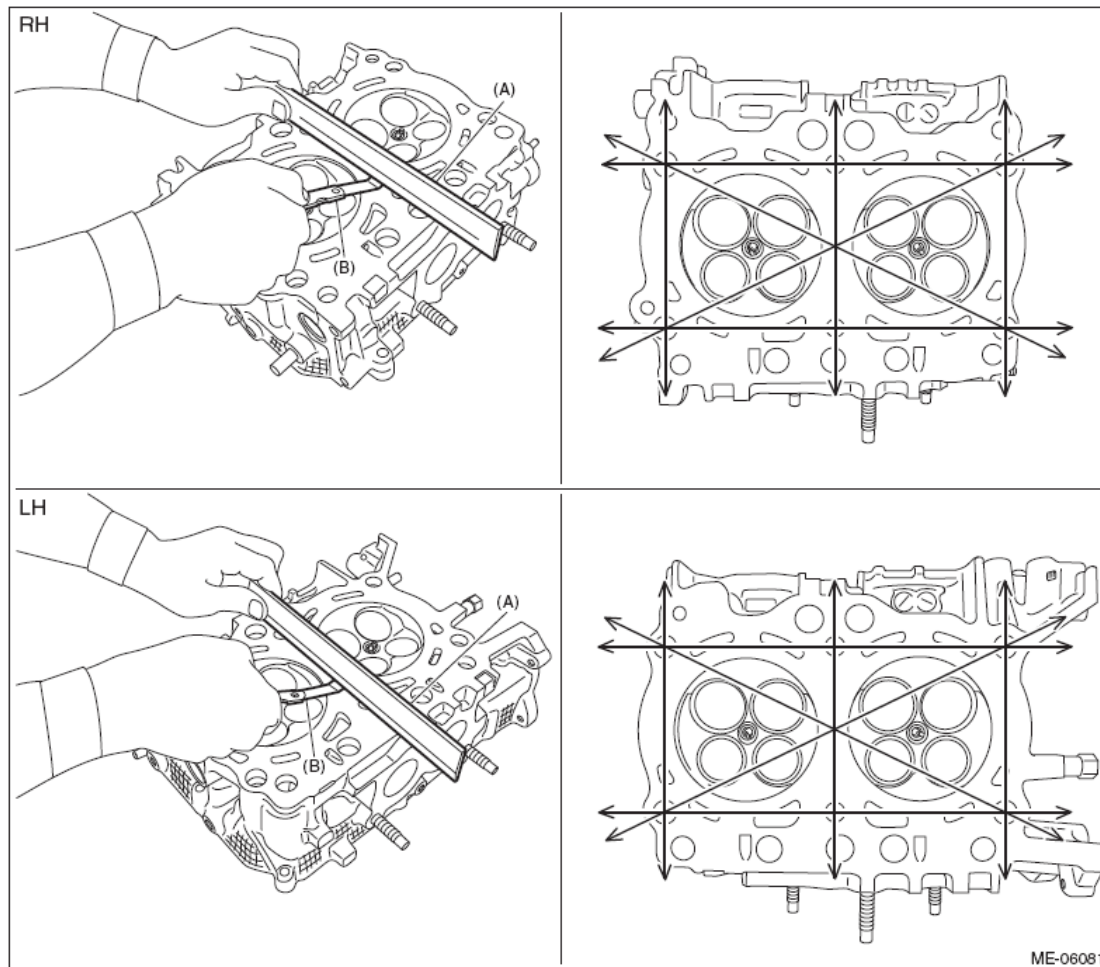


Fig. 323: Measuring Cylinder Head Warpage And Height Using Straight Edge And Thickness Gauge

Courtesy of SUBARU OF AMERICA, INC.

VALVE & VALVE GUIDE

1. Check the valve flange and stem for damage, wear or deformation.
2. Measure the thickness "H" of valve head edge as shown 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

103.3 mm (4.067 in)

Exhaust

94.1 mm (3.705 in)

- When the valve is replaced, lap the valve. Refer to "VALVE SEAT" for lapping. Refer to VALVE SEAT.

Valve head edge thickness H:

Intake (A)

Standard

0.8 - 1.2 mm (0.031 - 0.047 in)

Exhaust (B)

Standard

1.0 - 1.4 mm (0.039 - 0.055 in)

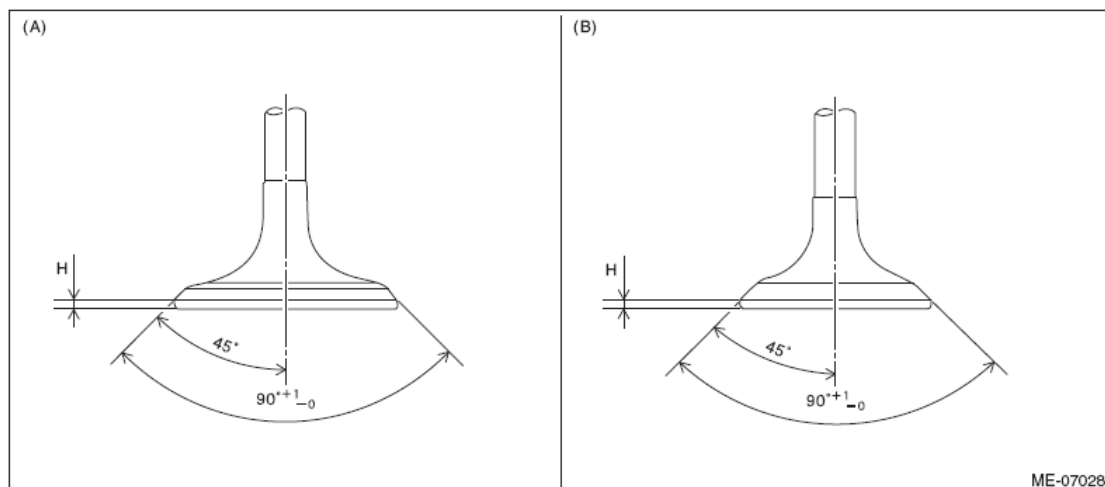


Fig. 324: Identifying Intake And Exhaust Valve Head Edge Thickness
 Courtesy of SUBARU OF AMERICA, INC.

3. Check the clearance between valve and valve guide. Check the clearance between valve and valve guide by measuring the outer diameter of valve stem and the inner diameter of valve guide respectively.
 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 six locations as shown in the figure, and read the value of most worn location.
- When the valve is replaced, lap the valve. Refer to "VALVE SEAT" for lapping. Refer to VALVE SEAT.

Valve stem outer diameter:

Intake

Standard

5.455 - 5.470 mm (0.2148 - 0.2154 in)

Exhaust

Standard

5.445 - 5.460 mm (0.2144 - 0.2150 in)

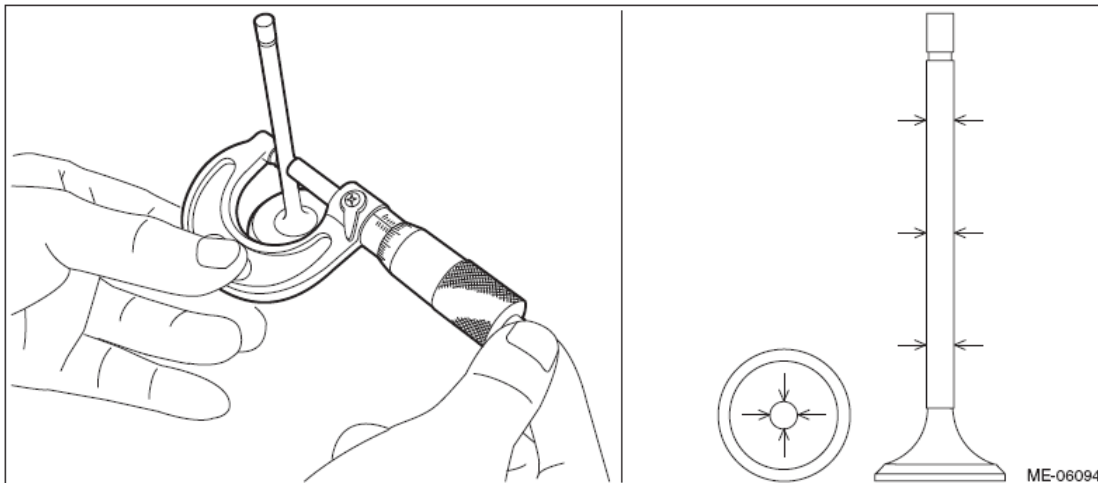


Fig. 325: Measuring Valve Stem Outer Diameter Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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 4).

NOTE:

- **Measurement should be performed at a temperature of 20°C (68° F).**
- **Measure the inner diameter of the valve guide at the six locations as shown in the figure, and read the value of most worn location.**

Valve guide inner diameter:

Standard

5.500 - 5.512 mm (0.2165 - 0.2170 in)

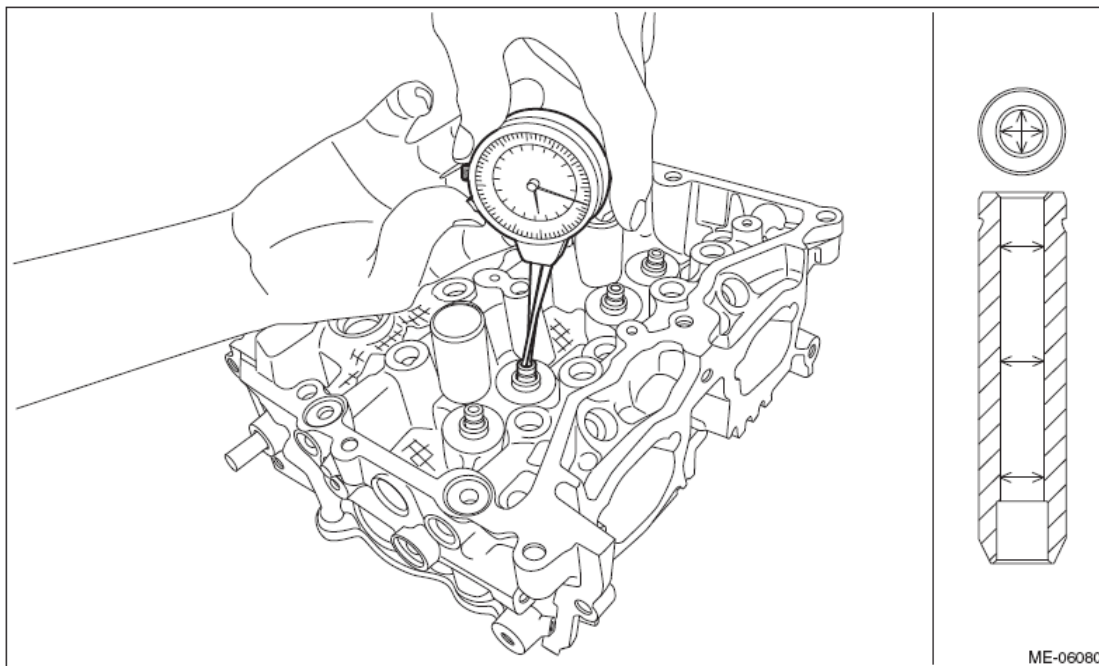


Fig. 326: Measuring Valve Guide Inner Diameter Using Caliper Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Calculate the clearance between valve and valve guide.

Clearance between valve and valve guide:

Intake

Standard

0.030 - 0.057 mm (0.0012 - 0.0022 in)

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

4. If the clearance between valve and valve guide exceeds the standard, replace the valve or valve guide, whichever shows the greater amount of wear or damage. For replacement procedure of valve guide, refer to the following.

NOTE: When the valve is replaced, lap the valve. Refer to VALVE SEAT for lapping.

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

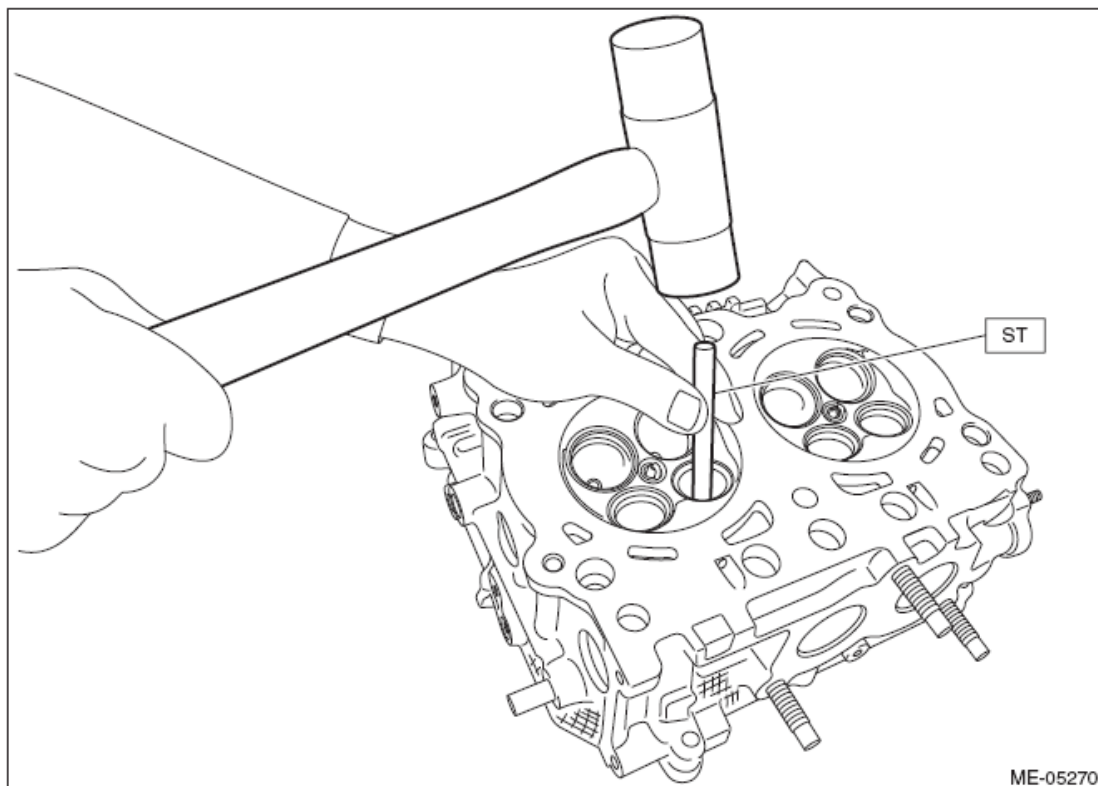


Fig. 327: Removing Valve Guide Using Plastic Hammer
Courtesy of SUBARU OF AMERICA, INC.

2. Before installing the valve guide, make sure that neither scratches nor damages exist on the inner surface of valve guide installation holes of 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)

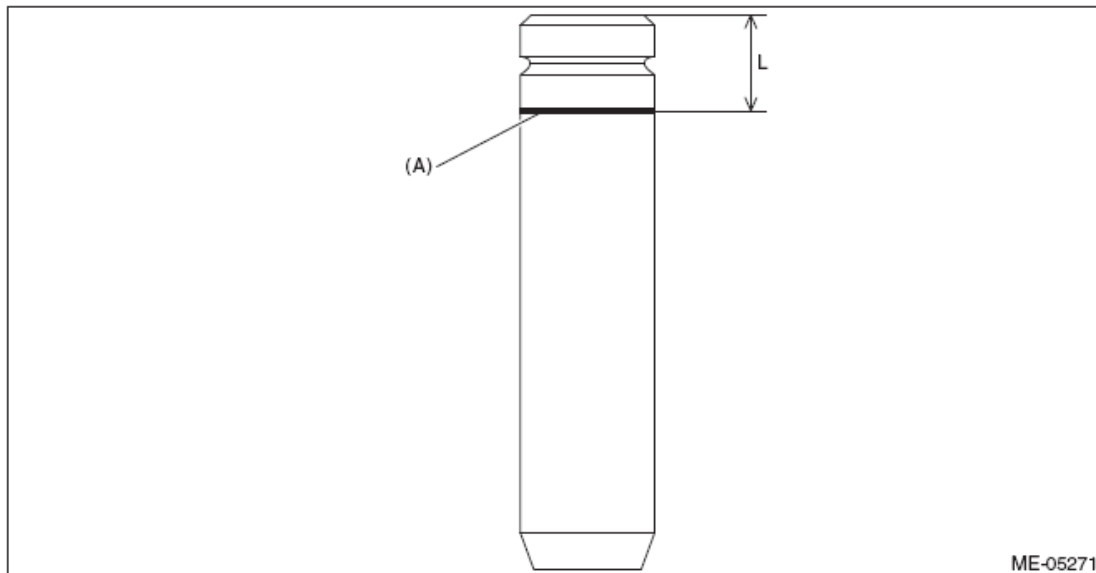


Fig. 328: Identifying Length Of Valve Guide From Reference Line
Courtesy of SUBARU OF AMERICA, INC.

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

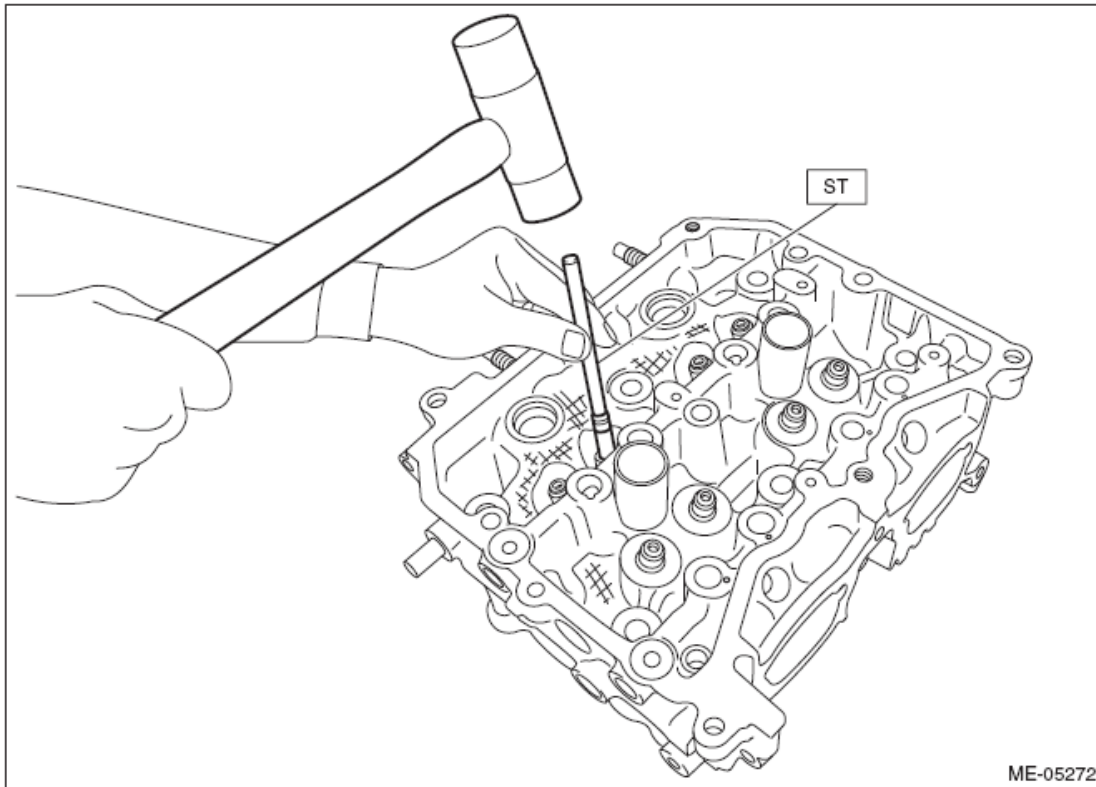


Fig. 329: Tapping Valve Guide To Reference Line Using Plastic Hammer
Courtesy of SUBARU OF AMERICA, INC.

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)

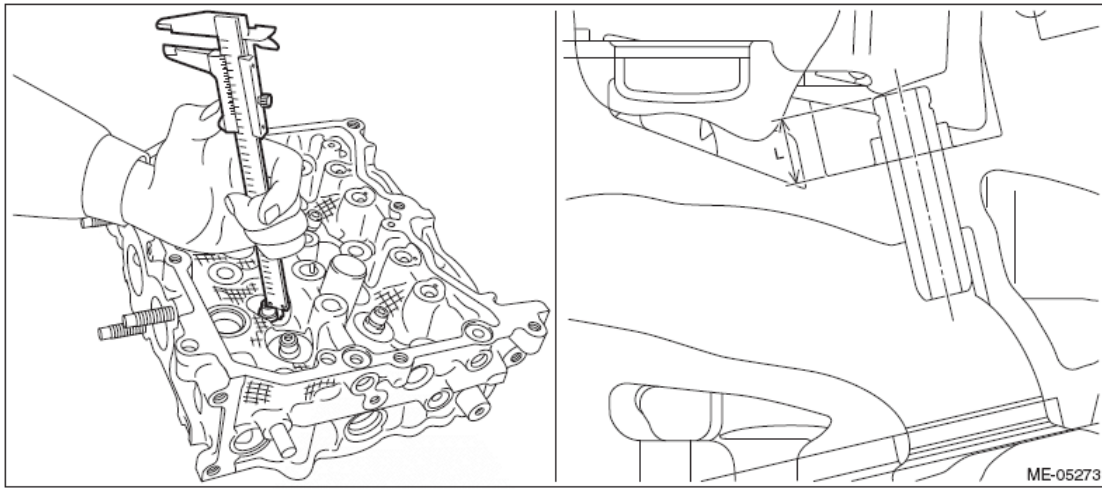


Fig. 330: Measuring Valve Guide Protrusion Length
Courtesy of SUBARU OF AMERICA, INC.

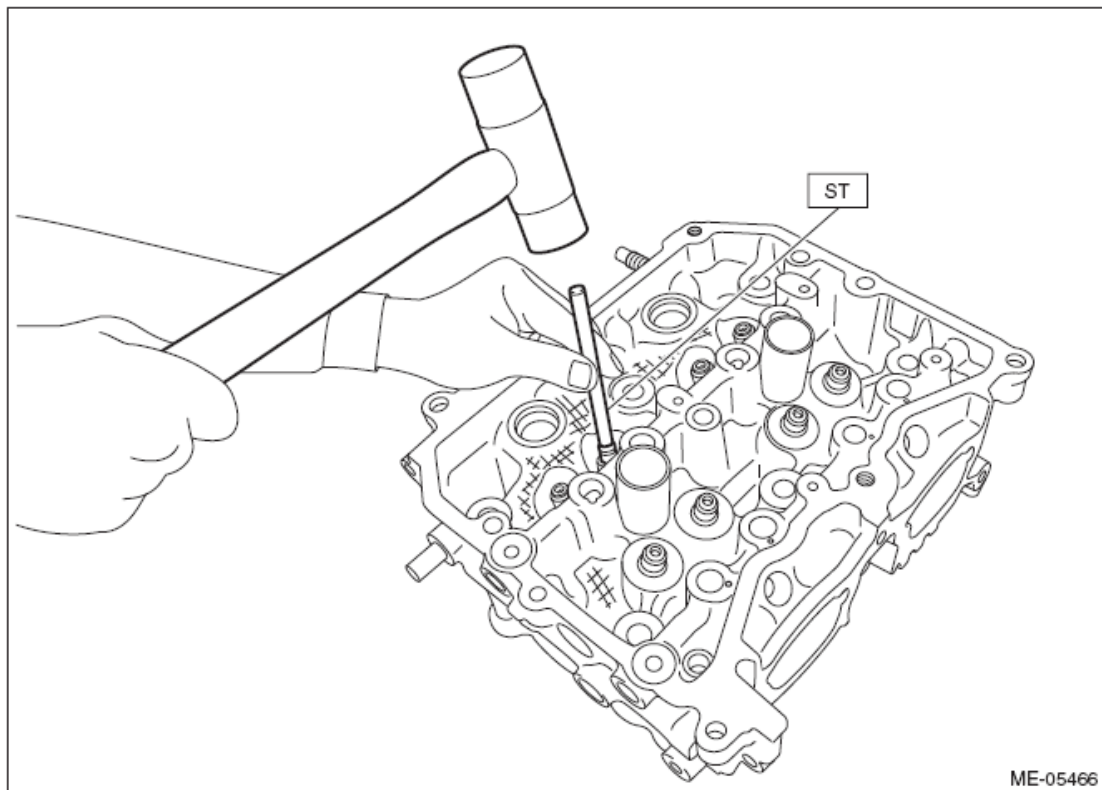


Fig. 331: Pressing To Fit Valve Guide To Position
Courtesy of SUBARU OF AMERICA, INC.

7. Ream the inside of valve guide with the combustion chamber upward using the 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.
- 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

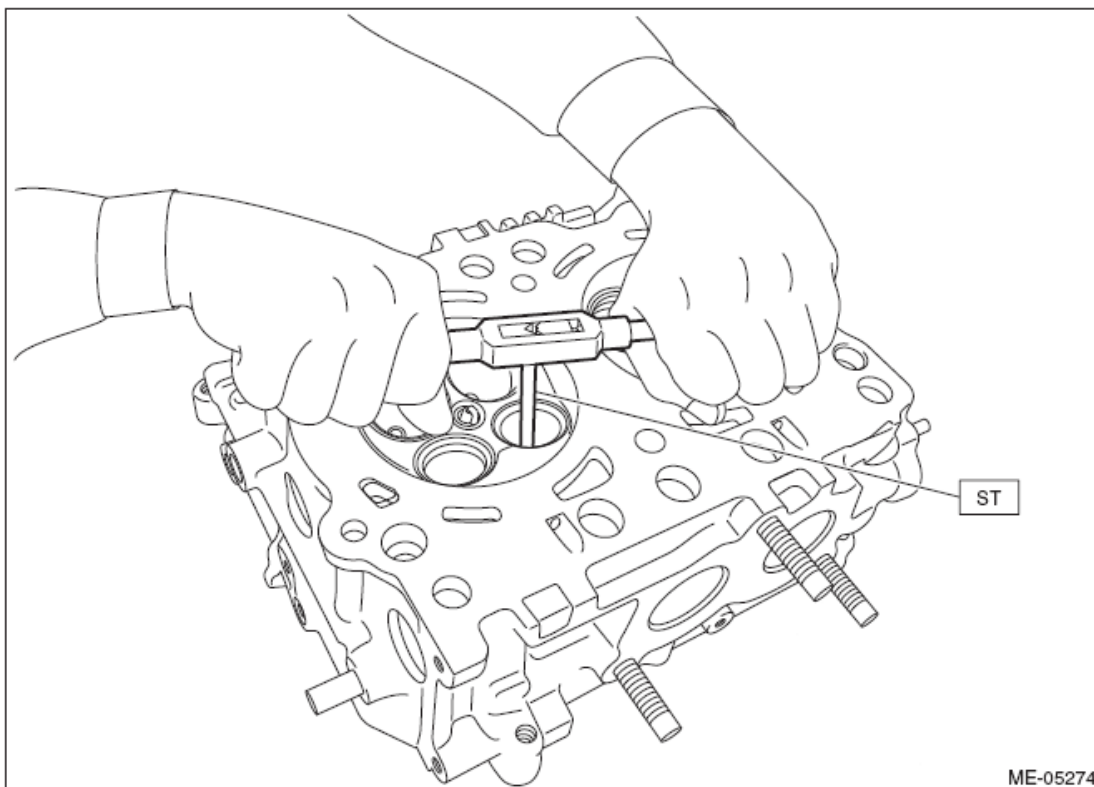


Fig. 332: Reaming Inside Of Valve Guide And Combustion Chamber Using Valve Guide Reamer

Courtesy of SUBARU OF AMERICA, INC.

8. After reaming, clean the valve guide to remove chips.
9. Check the seating width between valve and valve seat. Refer to **VALVE SEAT**.

VALVE & VALVE SHIM

1. Visually check the valve shim for damage.
2. Check the clearance between valve and valve shim. Check the clearance between valve and valve shim by measuring the outer diameter of valve stem end and the inner diameter of valve shim respectively.
 1. 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).
- Measure the outer diameter of the valve stem end at the two locations as shown in the figure, and read the value of most worn location.
- When the valve is replaced, lap the valve. Refer to VALVE SEAT for lapping.

Valve stem end outer diameter:

Intake

Standard

5.455 - 5.470 mm (0.2148 - 0.2154 in)

Exhaust

Standard

5.445 - 5.460 mm (0.2144 - 0.2150 in)

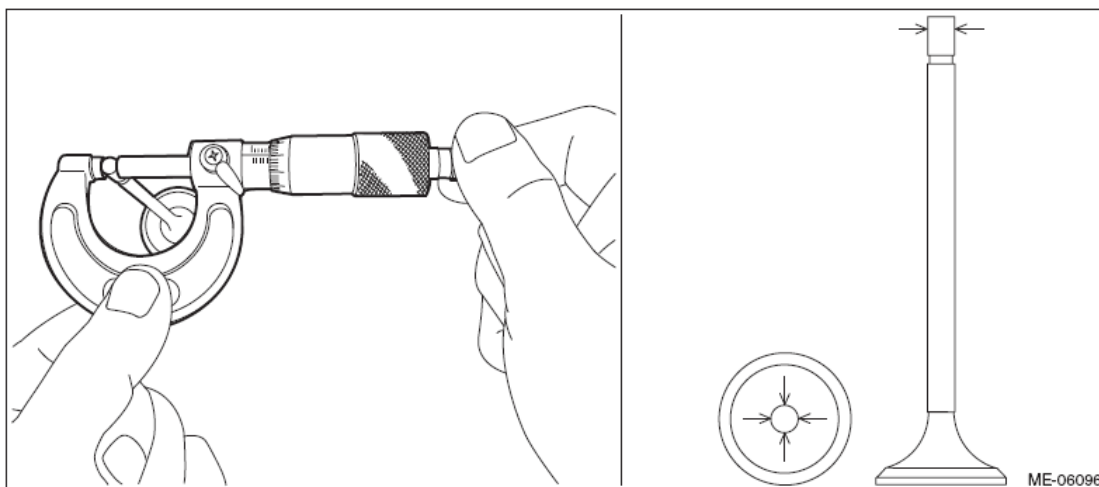


Fig. 333: Measuring Valve Stem End Outer Diameter
 Courtesy of SUBARU OF AMERICA, INC.

- 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).
- Measure the inner diameter of the valve shim at the two locations as shown in the figure, and read the value of most worn location.
- 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.

Valve shim inner diameter:

Standard

5.500 - 5.560 mm (0.2165 - 0.2189 in)

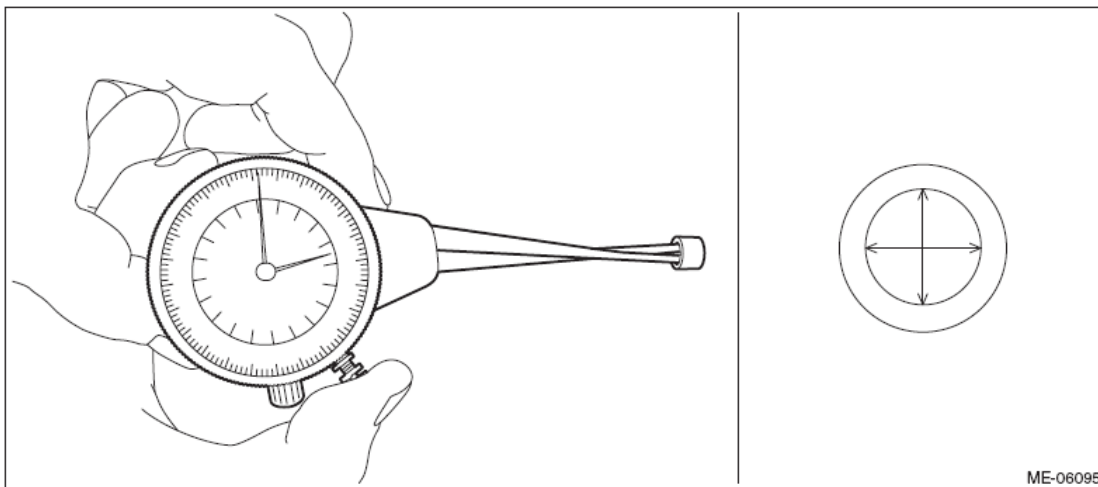


Fig. 334: Measuring Valve Shim Inner Diameter
Courtesy of SUBARU OF AMERICA, INC.

- Calculate the clearance between valve and valve shim. If the clearance exceeds the standard, replace the valve or valve shim, whichever shows the greater amount of wear or damage.

NOTE:

- When the valve is replaced, lap the valve. Refer to VALVE SEAT for lapping.
- 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.

Clearance between valve and valve shim:

Intake***Standard******0.030 - 0.105 mm (0.0012 - 0.0041 in)******Exhaust******Standard******0.040 - 0.115 mm (0.0016 - 0.0045 in)*****VALVE SEAT**

1. Check the valve seat for damage and deformation.
2. Check the seating width and seating position between valve and valve seat for the intake valve seat and exhaust valve seat.
 1. Clean the valve and valve seat.
 2. Coat the stem (A) of the valve lightly with engine oil and apply red dye evenly on the valve face (B).

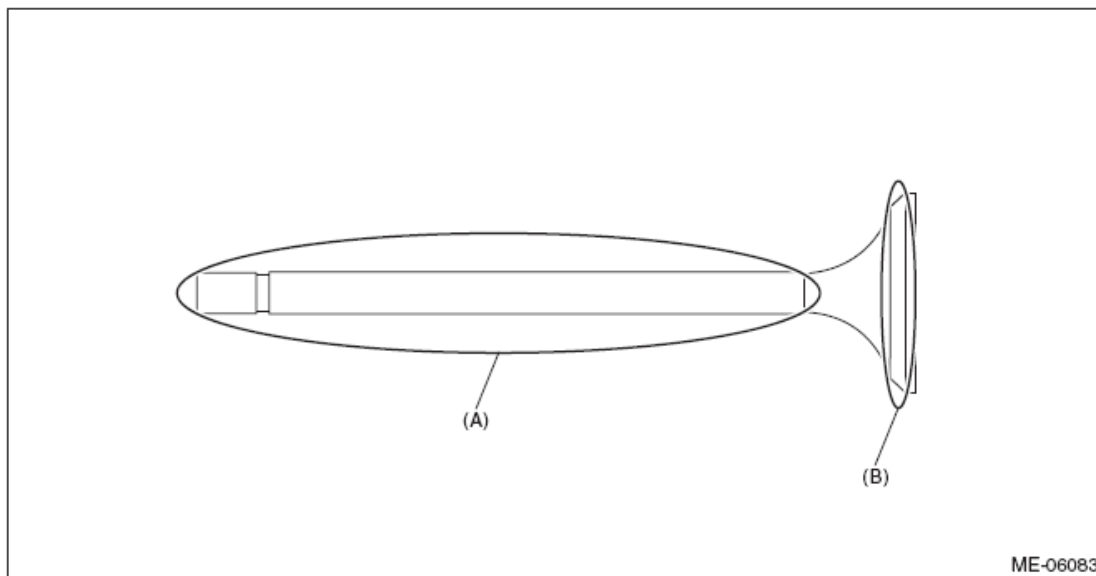


Fig. 335: Identifying Valve Stem And Valve Face
Courtesy of SUBARU OF AMERICA, INC.

3. Using the valve lapper, slowly insert the valve with red dye applied into the valve guide. Lightly press the valve against the valve seat without turning the valve, and then slowly pull out the valve.
4. Check the seating width "W" of valve seat as shown in the figure, using a caliper gauge. Check the seating width "W" between valve and valve seat by measuring the width of red dye on the seating surface of valve seat. If the seating width "W" between valve and valve seat is out of the standard, correct the seating surface of valve seat using the valve seat cutter. For correcting procedures of the

valve seat seating surface, refer to step 3).

NOTE:

- When the red dye does not appear seamlessly on the valve seat seating surface, lap the valve. For lapping procedure, refer to step 4).
- When the red dye does not appear seamlessly on the valve seat seating surface even after lapping the valve, correct the valve seat seating surface using the valve seat cutter. For correcting procedures of the valve seat seating surface, refer to step 3).

Seating width W between valve and valve seat:

Intake

Standard

0.8 - 1.6 mm (0.031 - 0.063 in)

Exhaust

Standard

1.1 - 1.7 mm (0.043 - 0.067 in)

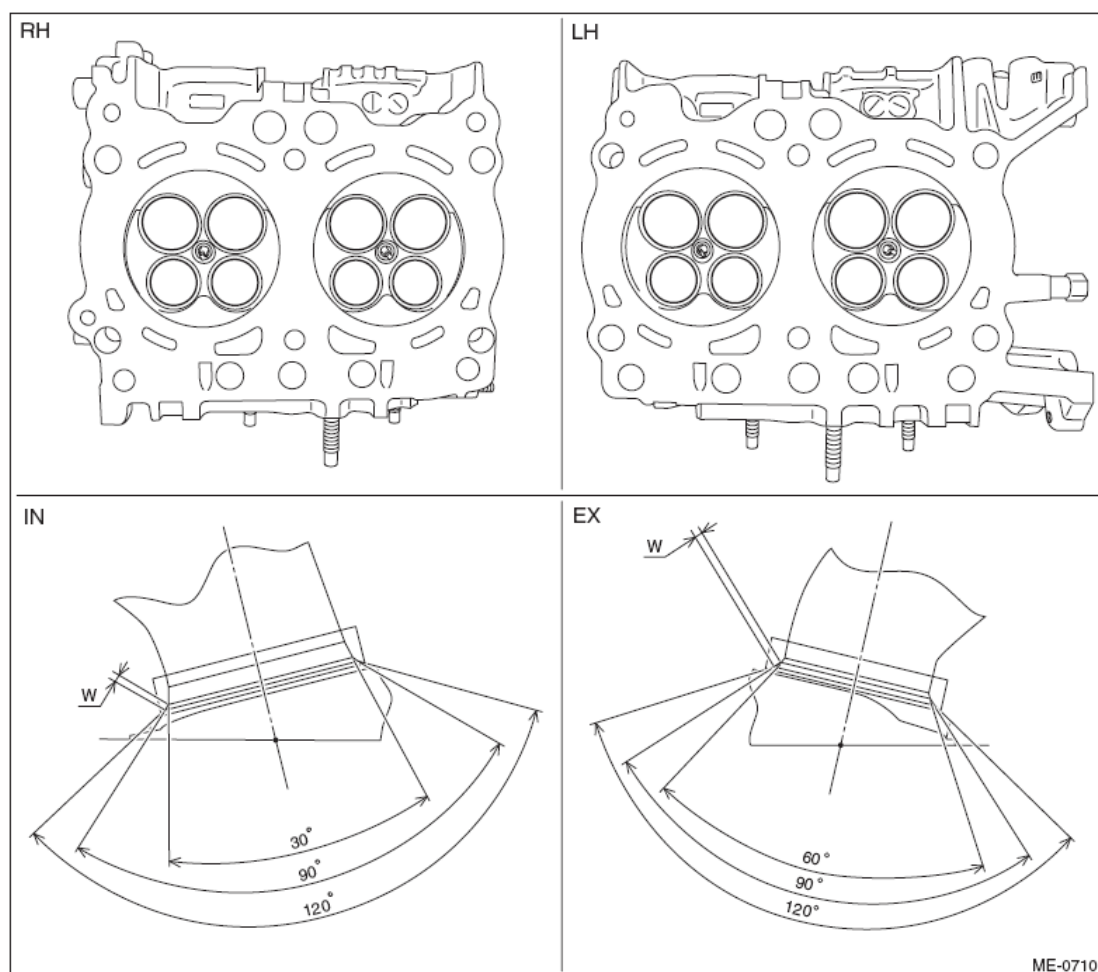


Fig. 336: Identifying Seating Width Between Valve And Valve Seat
Courtesy of SUBARU OF AMERICA, INC.

5. Wipe off the red dye on the valve and valve seat completely.
6. Coat the stem (A) of the valve lightly with engine oil and apply red dye evenly on the seating surface (B) between valve and valve seat.

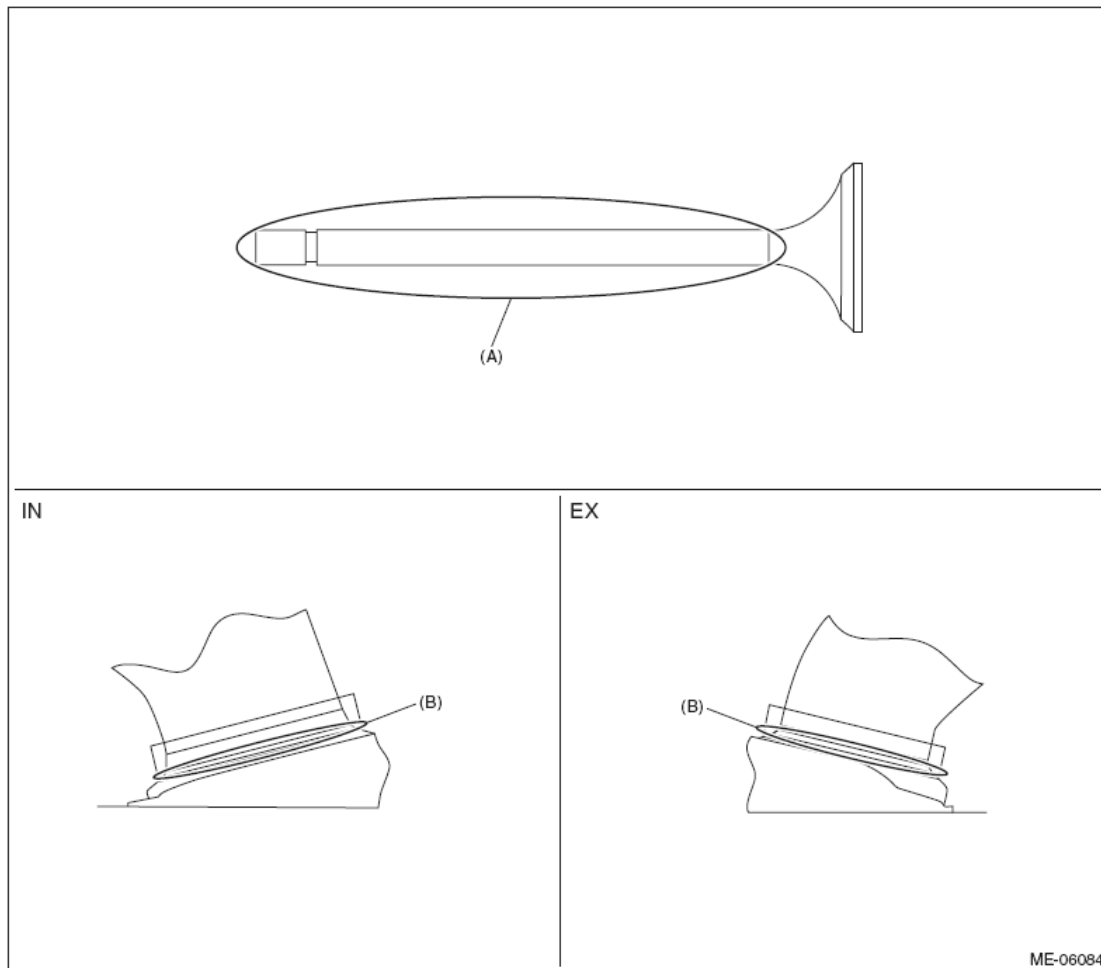


Fig. 337: Identifying Valve Stem And Valve Seat
Courtesy of SUBARU OF AMERICA, INC.

7. Using the valve lapper, slowly insert the valve into the valve guide. Lightly press the valve against the valve seat without turning the valve, and then slowly pull out the valve.
8. Check the seating position between valve and valve seat. Check the seating position between valve and valve seat by checking the position of red dye on the valve face. If the seating position between valve and valve seat is not at the center of valve face, correct the seating surface of valve seat using the valve seat cutter. For correcting procedures of the valve seat seating surface, refer to step 3).

Seating position between valve and valve seat:

Valve face center

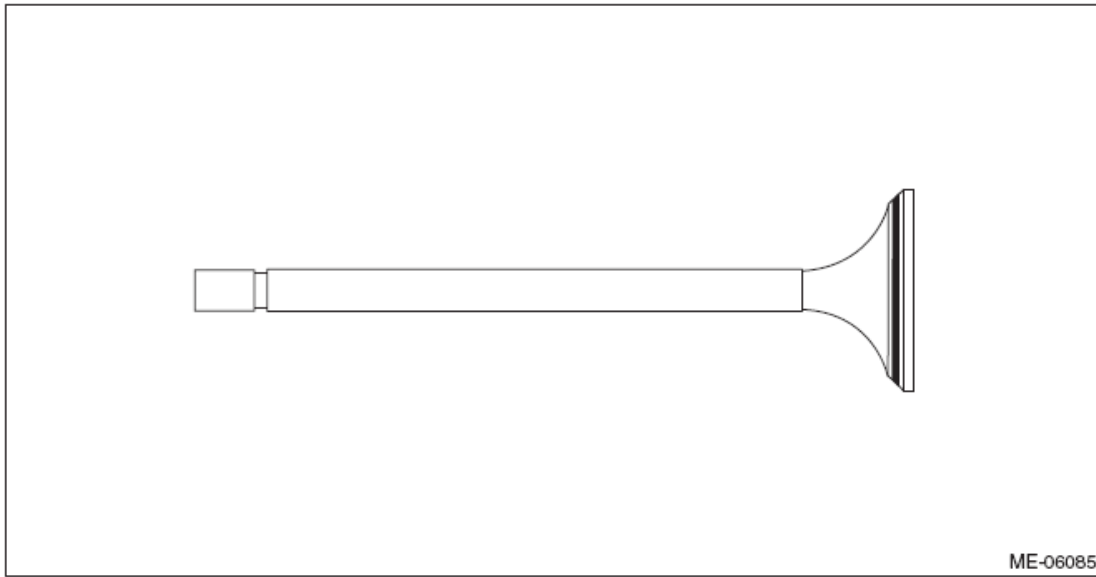


Fig. 338: Identifying Seating Position Between Valve And Valve Seat
Courtesy of SUBARU OF AMERICA, INC.

9. After inspection, wipe off the red dye completely.
3. When correcting the seating surfaces of valve seat
 1. Correct the seating angle between valve and valve seat using the 45° valve seat cutter.

NOTE:

- **Select the size of the valve seat cutter by referring to the outer diameters of the intake valve and exhaust valve.**

Valve outer diameter:

Intake

Standard

33.9 - 34.1 mm (1.335 - 1.343 in)

Exhaust

Standard

27.9 - 28.1 mm (1.098 - 1.106 in)

- Grind the seating surface so that the seating width between valve and valve seat becomes slightly larger than the standard value.
- Gradually reduce pressure at the end of grinding process in order to avoid creating a gap on the valve seat correcting surface.

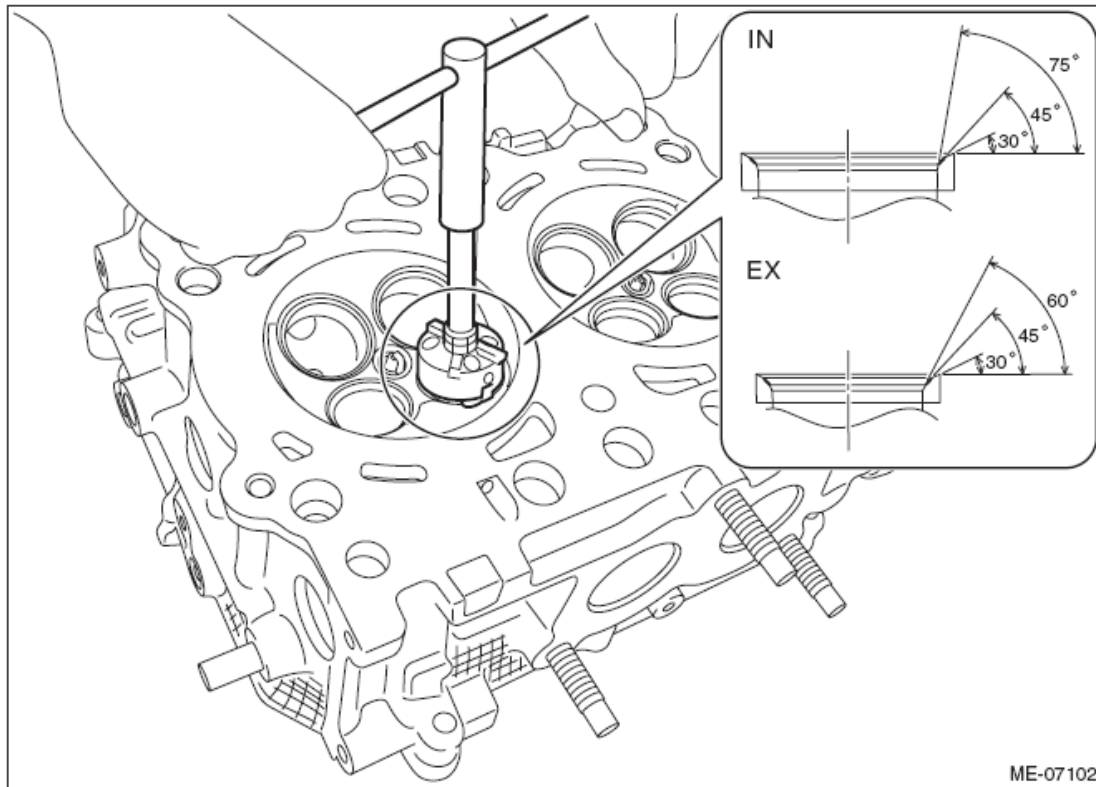
Seating angle between valve and valve seat:**45°**

Fig. 339: Grinding Seating Surface Width Between Valve And Valve Seat
 Courtesy of SUBARU OF AMERICA, INC.

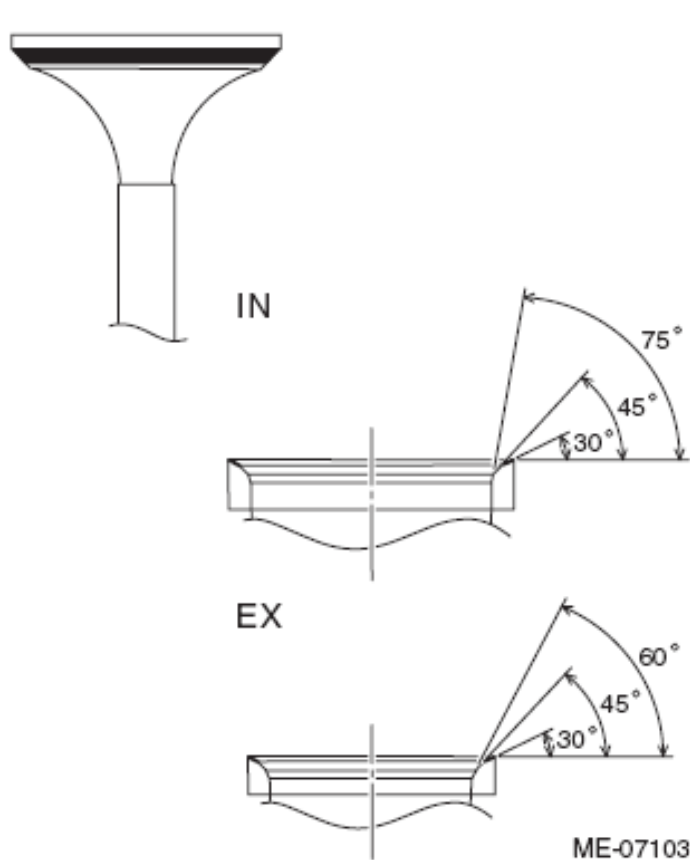
2. Lap the valve. For lapping procedure of the valve, refer to step 4).
3. Check the seating position between valve and valve seat. For inspection of the seating position between valve and valve seat, refer to step 2).

NOTE: This procedure is necessary to select a seat cutter to be used in step (4).

4. Using the 30°, 75° (IN) or 60° (EX) seat cutter, correct the valve seat so that the seating width between valve and valve seat becomes the standard value.

NOTE: • Select a proper valve seat cutter according to the following table.

Seating position between valve and valve seat	Seat cutter selection

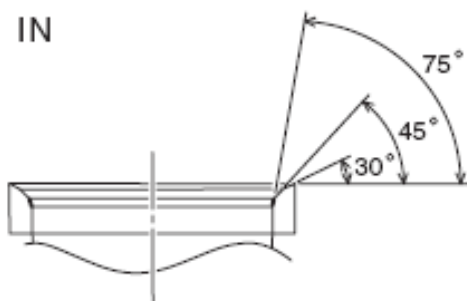


When the seating position of valve face is high, grind the surface using the 30° seat cutter until seating width between valve and valve seat becomes the standard value.

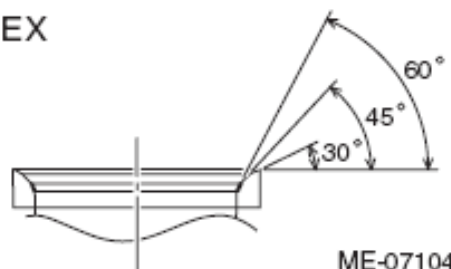
When the seating position of valve face is low, grind the surface using the 75° (IN) or 60° (EX) seat cutter until seating width between valve and valve seat becomes the standard value.



IN



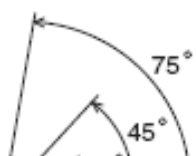
EX



ME-07104



IN



When the seating position of valve face is at center, grind the surface evenly using the 30°, 75° (IN) or 60° (EX) seat cutters until seating width between valve and valve seat becomes the standard value.

- Gradually reduce pressure at the end of grinding process in order to avoid creating a gap on the valve seat correcting surface.

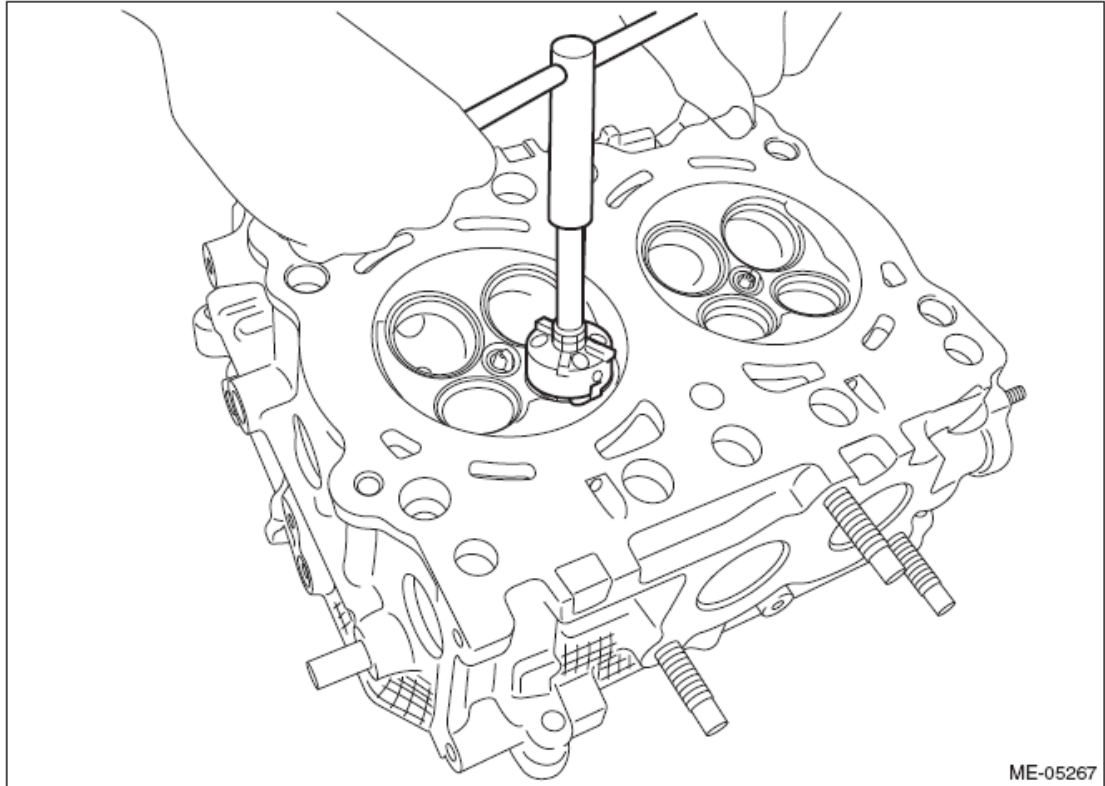


Fig. 340: Creating Gap On Valve Seat Correcting Surface
Courtesy of SUBARU OF AMERICA, INC.

5. Lap the valve. For lapping procedure of the valve, refer to step 4).
4. When lapping the valve
 1. Coat the stem (A) of the valve lightly with engine oil and put a small amount of valve compound evenly on the valve face (B).

NOTE:

- Be careful not to put the valve compound more than necessary.
- To avoid damaging the valve guide and valve stem, be careful not to let the valve compound contact the valve stem.

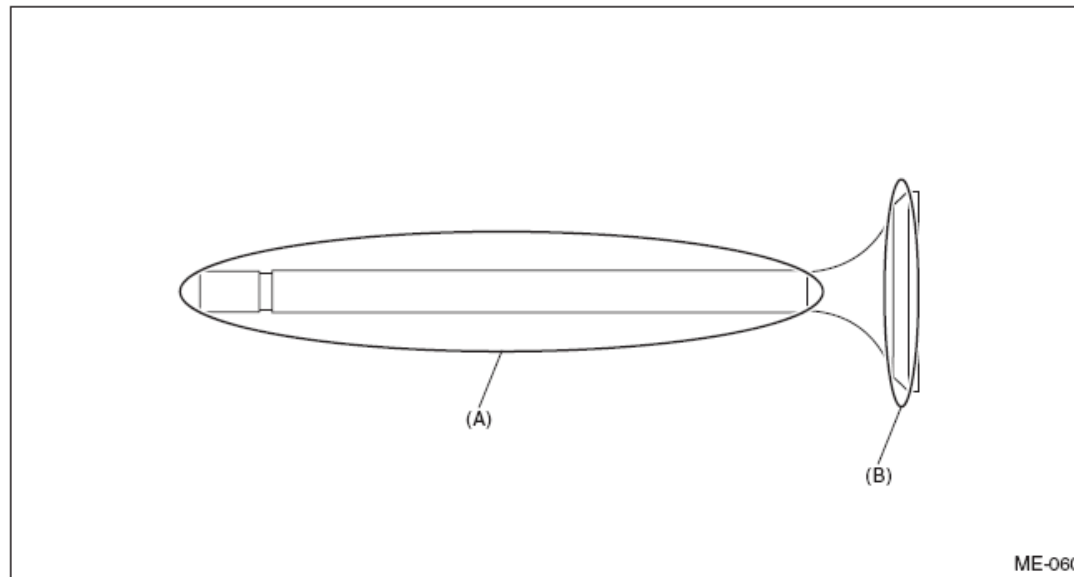


Fig. 341: Identifying Valve Stem And Valve Face
Courtesy of SUBARU OF AMERICA, INC.

2. Using the valve lapper, slowly insert the valve with the valve compound applied into the valve guide, and lap the seating surface between valve and valve seat. First, lift the valve and strike it against the valve seat twice, and then slightly turn the valve once. Repeat these steps as one set.

NOTE:

- To prevent the seating width between valve and valve seat from exceeding the standard value, be careful not to keep turning the valve while pressing it against the valve seat during lapping.
- Be careful not to lift the valve too far during lapping in order to prevent the valve from coming off the valve guide.

3. Wipe off the valve compound on the valve and valve seat completely after lapping.

NOTE:

Be careful not to leave any valve compound in order to avoid malfunction.

4. Check the seating width and seating position between valve and valve seat.

VALVE SPRING

1. Check the valve spring for damage and deformation.
2. Using a caliper gauge, valve spring tester, surface plate and try square, check the valve spring free length, tension/spring height and squareness. If it is not within the standard, replace the valve spring.

NOTE:

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

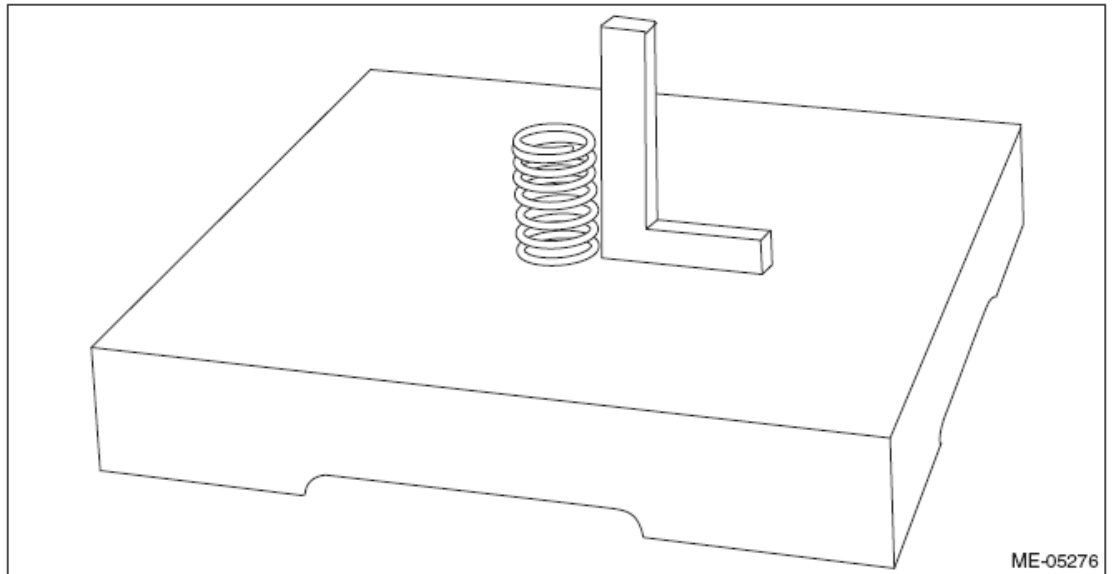


Fig. 342: Checking Squareness Of Valve Spring
Courtesy of SUBARU OF AMERICA, INC.

Valve spring free length:

Standard

41.06 mm (1.617 in)

Valve spring tension/spring height:

Set

Standard

182 - 210 N (18.56 - 21.41 kgf, 40.92 - 47.22 lbf)/33.0 mm (1.299 in)

Lift

Standard

552 - 610 N (56.29 - 62.20 kgf, 124.11 - 137.15 lbf)/22.0 mm (0.866 in)

Valve spring squareness:

Standard

2.5°, 1.8 mm (0.071 in) or less

CYLINDER BLOCK

REMOVAL

1. Remove the engine from the vehicle. Refer to **REMOVAL**.
2. Remove the intake manifold. Refer to **REMOVAL**.
3. Remove the tumble generator valve assembly. Refer to **REMOVAL**.
4. Remove the chain cover. Refer to **REMOVAL**.
5. Remove the rocker cover. Refer to **REMOVAL**.
6. Remove the cam carrier. Refer to **REMOVAL**.
7. Remove the cylinder head. Refer to **REMOVAL**.
8. Remove the crank sprocket. Refer to **REMOVAL**.
9. Remove the engine rear hanger from cylinder block RH.

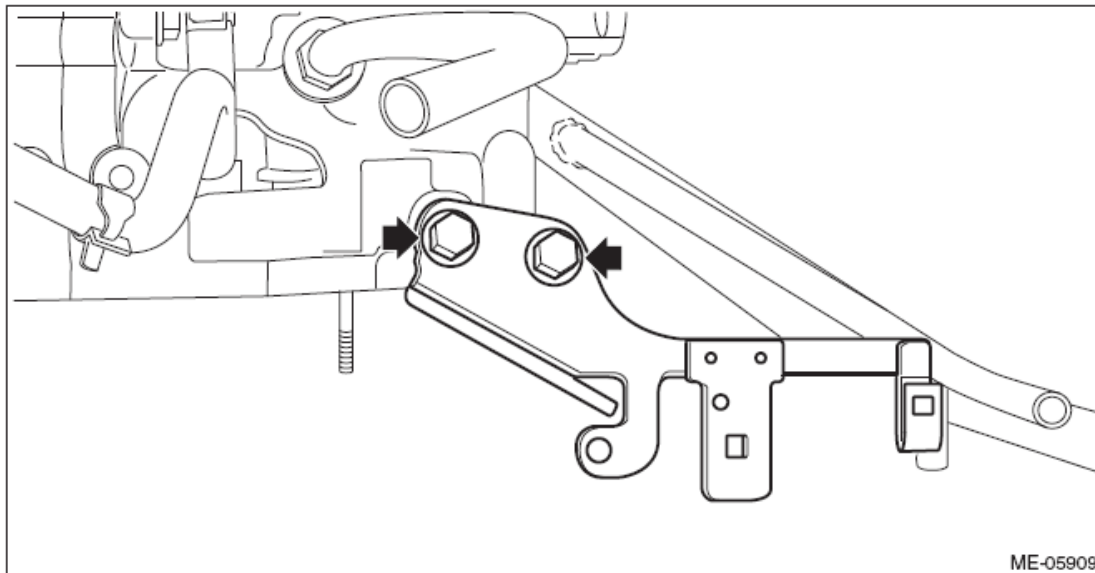


Fig. 343: Locating Engine Rear Hanger Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

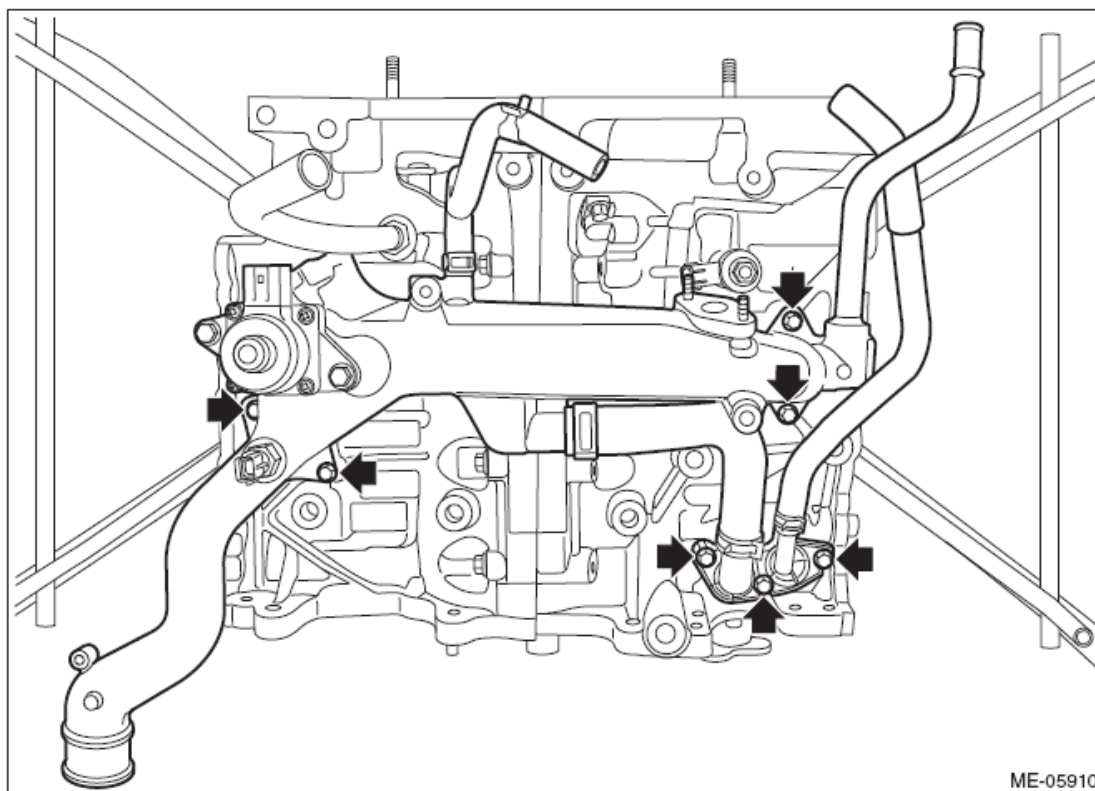


Fig. 344: Locating Water Pipe Assembly And PCV Connector Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

11. Remove the O-ring from the cylinder block and PCV connector.

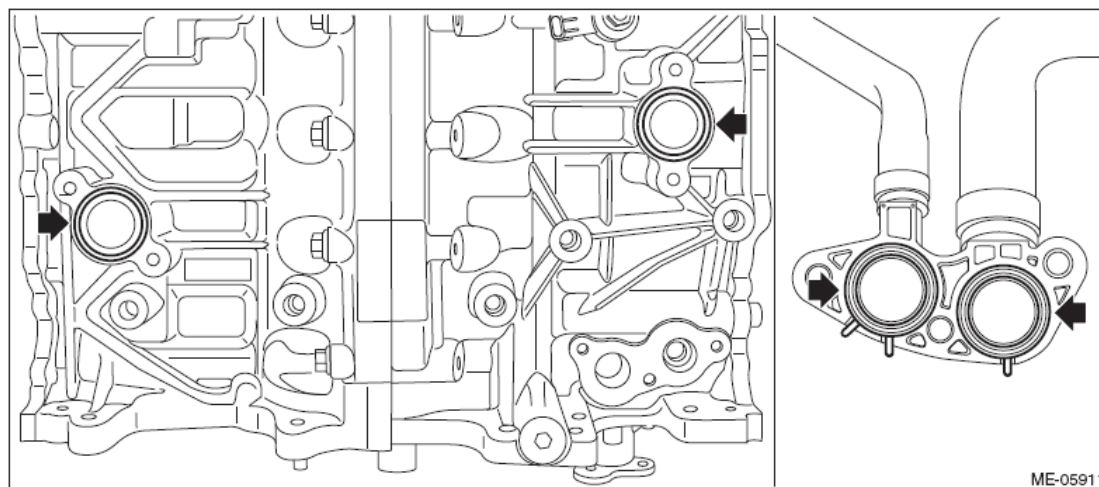


Fig. 345: Locating Cylinder Block And PCV Connector O-Rings
 Courtesy of SUBARU OF AMERICA, INC.

12. Remove the knock sensor from cylinder block LH.

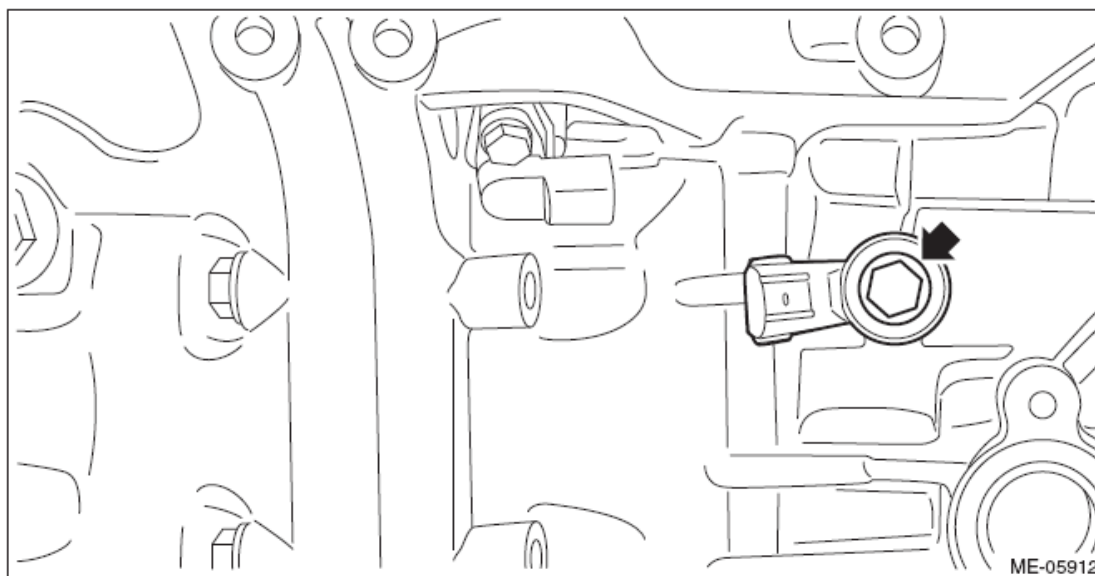


Fig. 346: Locating Cylinder Block LH Knock Sensor
Courtesy of SUBARU OF AMERICA, INC.

13. Remove the vacuum hose from the PCV valve.

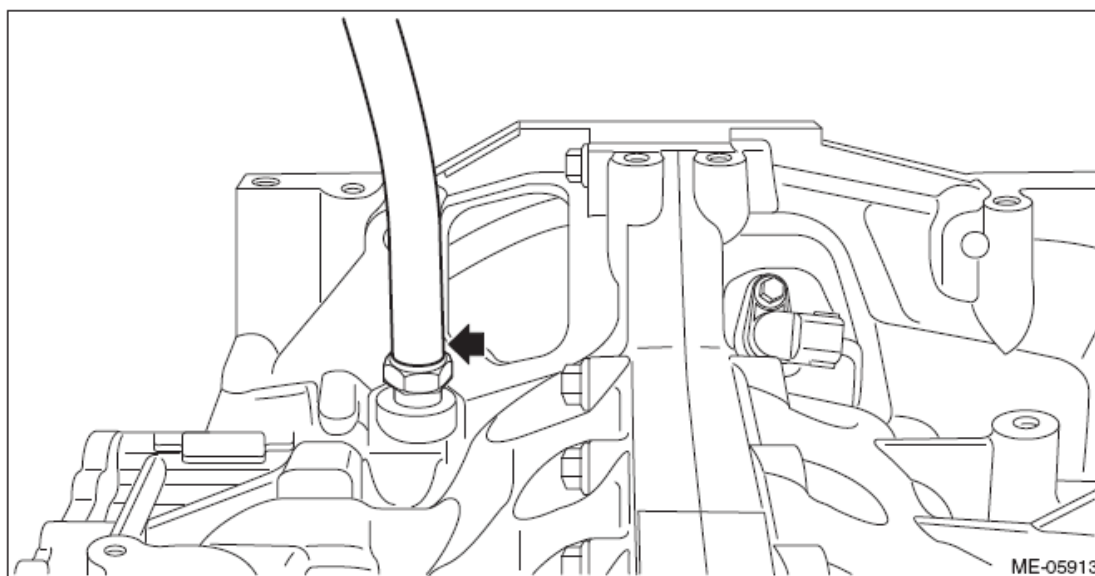


Fig. 347: Locating PCV Valve Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

14. Remove the PCV valve from the cylinder block RH.

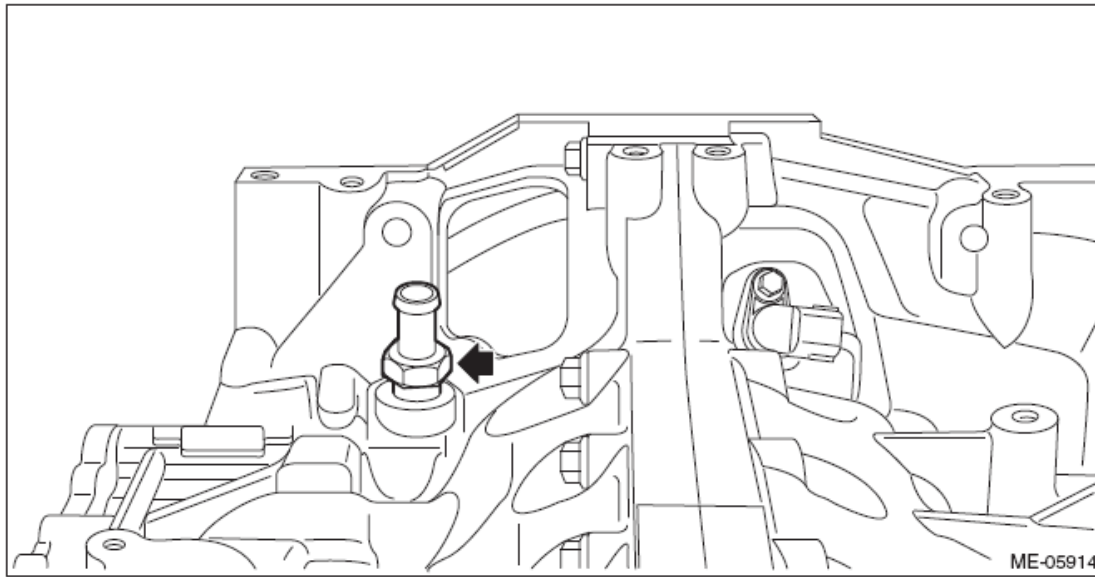


Fig. 348: Locating Cylinder Block RH PCV Valve
Courtesy of SUBARU OF AMERICA, INC.

15. Remove the crankshaft position sensor plate with drive plate. (CVT model) Refer to **REMOVAL** .
16. Remove the clutch disc and cover. (MT model) Refer to **REMOVAL** .
17. Remove the crankshaft position sensor plate with flywheel. (MT model) Refer to **REMOVAL** .
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.

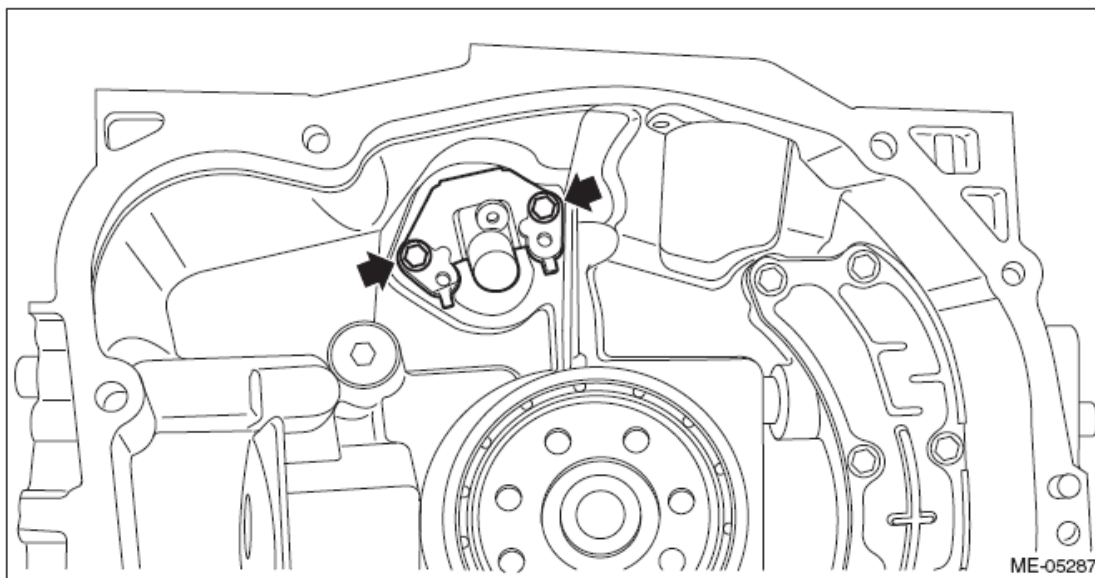


Fig. 349: Locating Crankshaft Position Sensor Holder Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

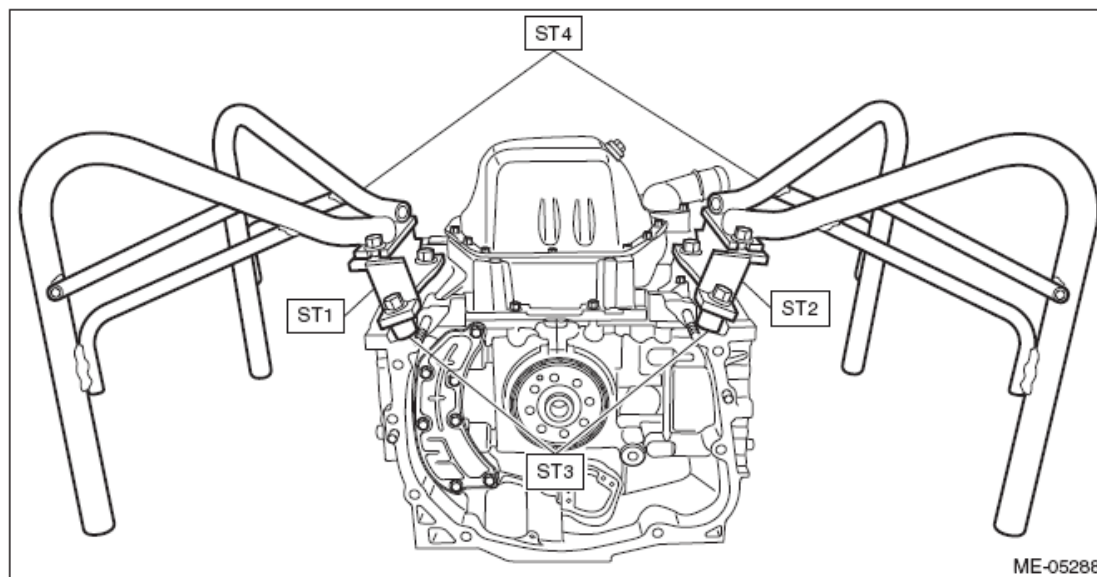


Fig. 350: Supporting Cylinder Block Using Special Tools
Courtesy of SUBARU OF AMERICA, INC.

20. Remove the thermostat cover from oil pan upper, and then remove the thermostat.

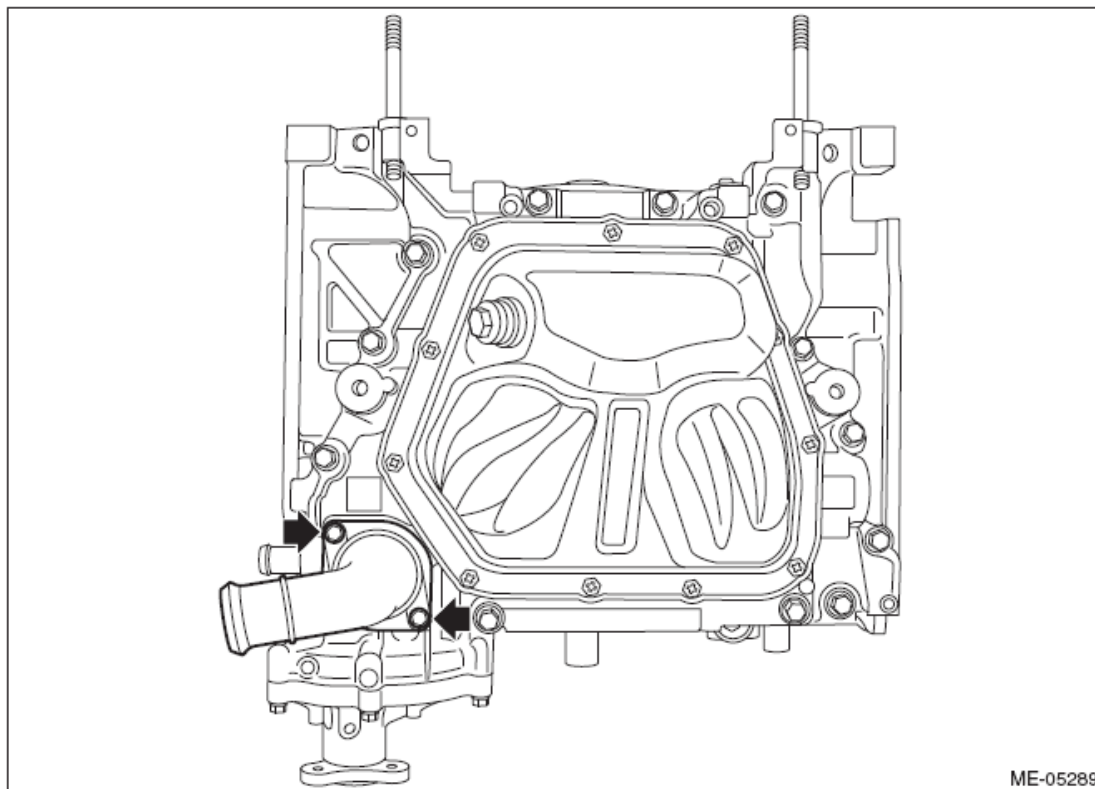


Fig. 351: Locating Thermostat Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

21. Remove the oil pan upper with oil pan from cylinder block.

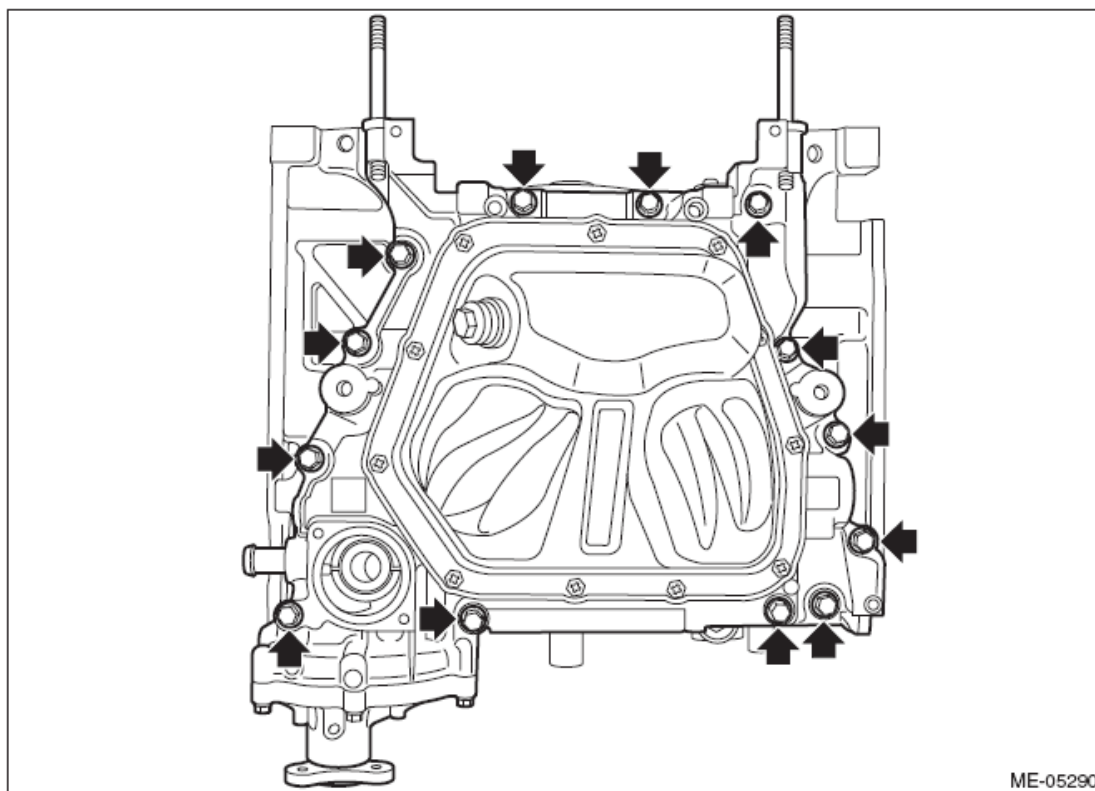


Fig. 352: Locating Cylinder Block Oil Pan Upper Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

22. Remove the O-ring from the cylinder block.

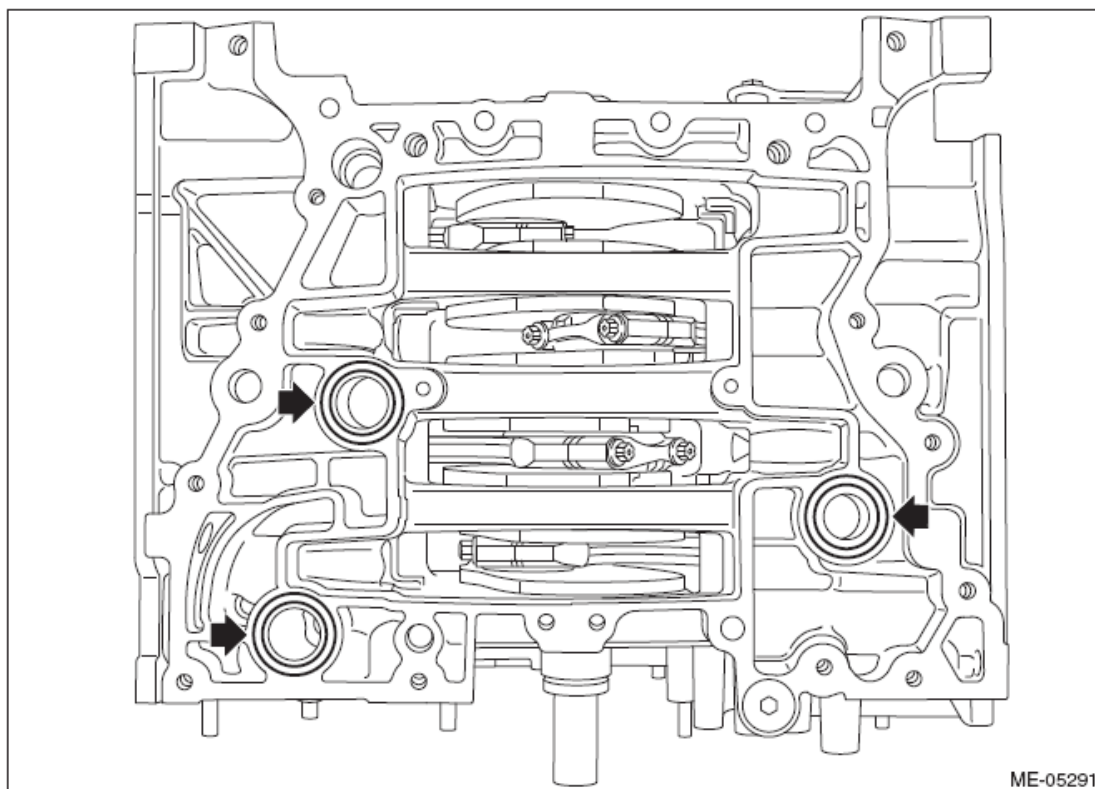


Fig. 353: Locating Cylinder Block O-Rings
Courtesy of SUBARU OF AMERICA, INC.

23. Install the mounting bolts for the A/C compressor and the generator bracket 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.

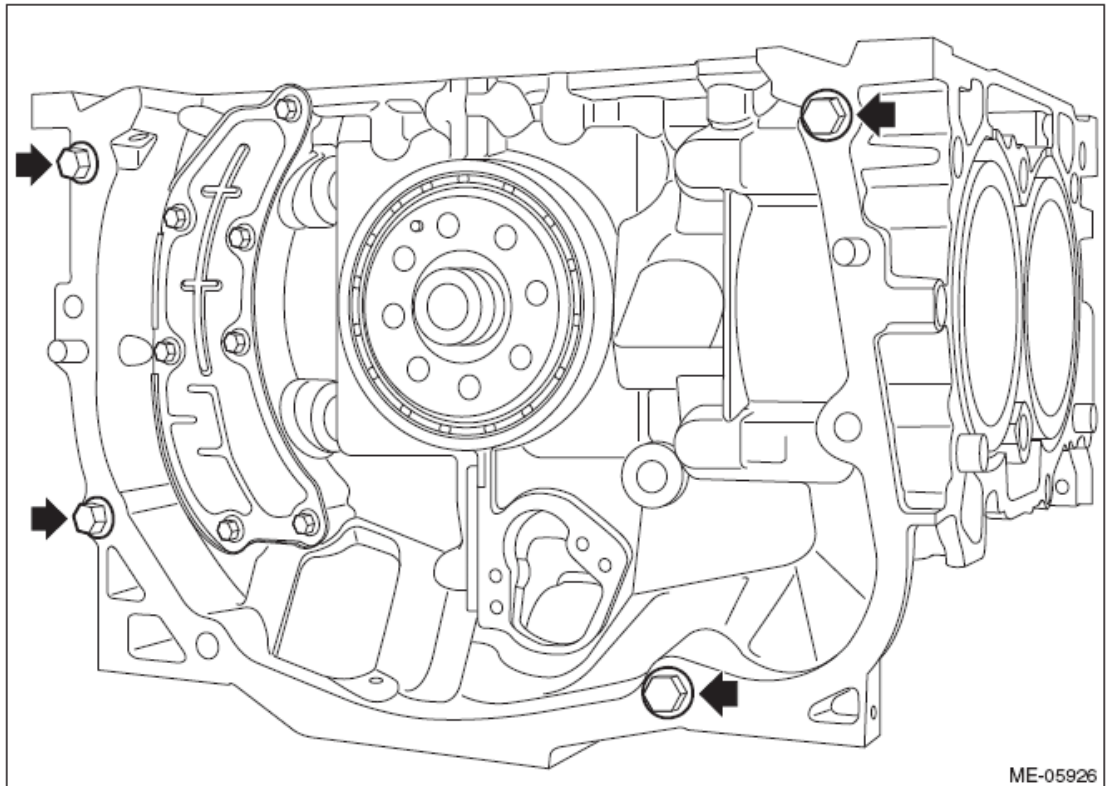


Fig. 354: Locating A/C Compressor And Generator Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

24. Raise the cylinder block so that the rear oil seal is on the lower side.
25. 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

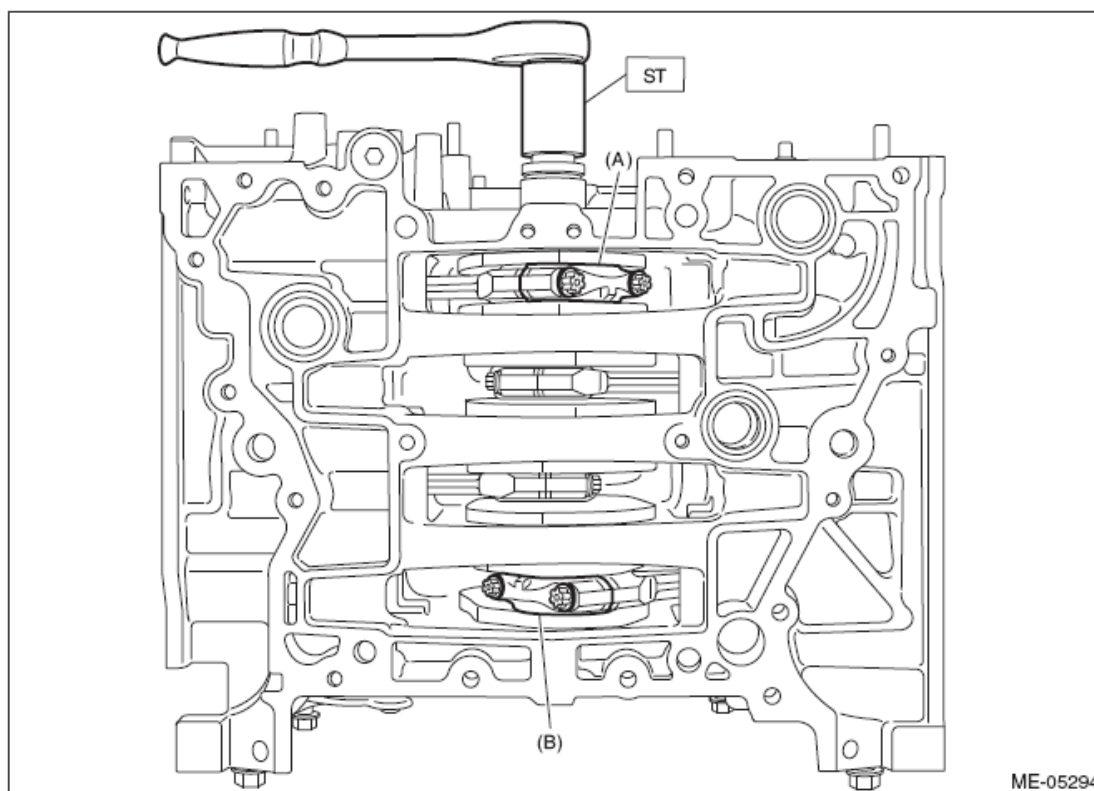


Fig. 355: Aligning No. 1 And No. 4 Connecting Rod Cap
Courtesy of SUBARU OF AMERICA, INC.

2. Using ST, loosen the #1 connecting rod cap bolt, and remove the #1 connecting rod cap bolt and #1 connecting rod cap.

ST 18270AA020 SOCKET

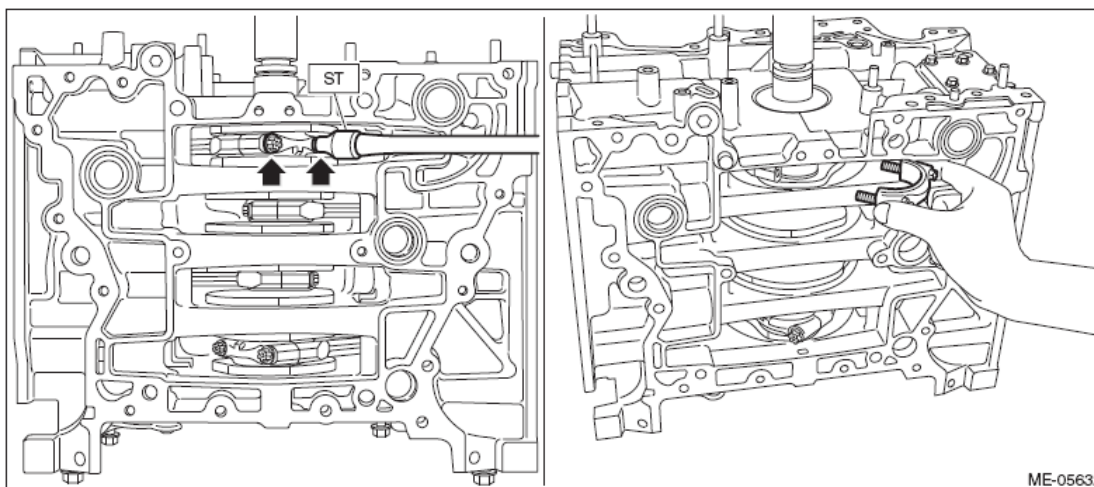


Fig. 356: Removing No. 1 Connecting Rod Cap
Courtesy of SUBARU OF AMERICA, INC.

3. Using ST, loosen the #4 connecting rod cap bolt, and remove the #4 connecting rod cap bolt and #4 connecting rod cap.

ST 18270AA020 SOCKET

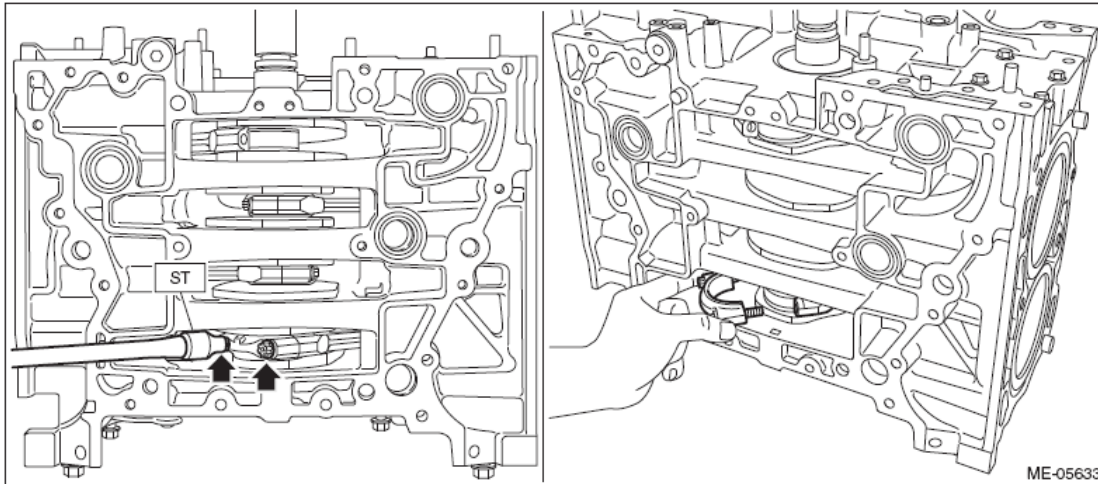


Fig. 357: Removing No. 4 Connecting Rod Cap
Courtesy of SUBARU OF AMERICA, INC.

4. Using the ST, turn the crankshaft clockwise and separate the positions of the #1 pin (A) of crankshaft and the large end (B) of #1 connecting rod.

ST 18252AA000 CRANKSHAFT SOCKET

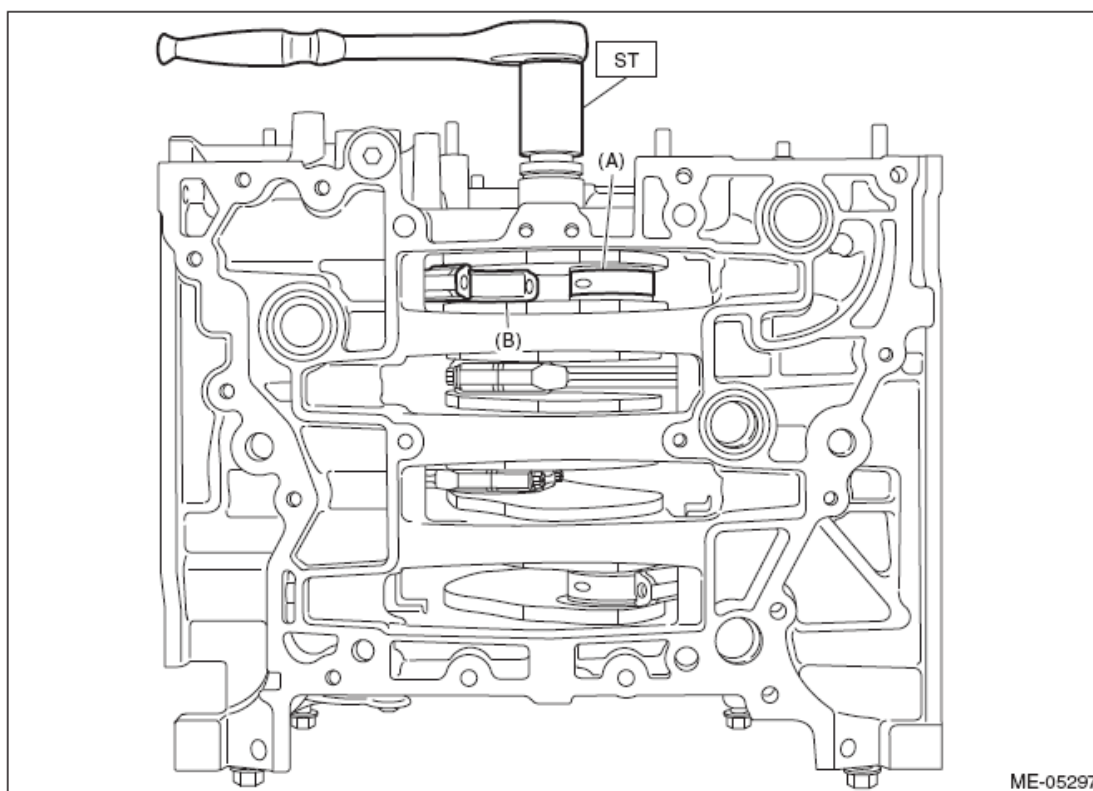


Fig. 358: Aligning No. 1 Crank Pin And Large End Of No. 1 Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

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.

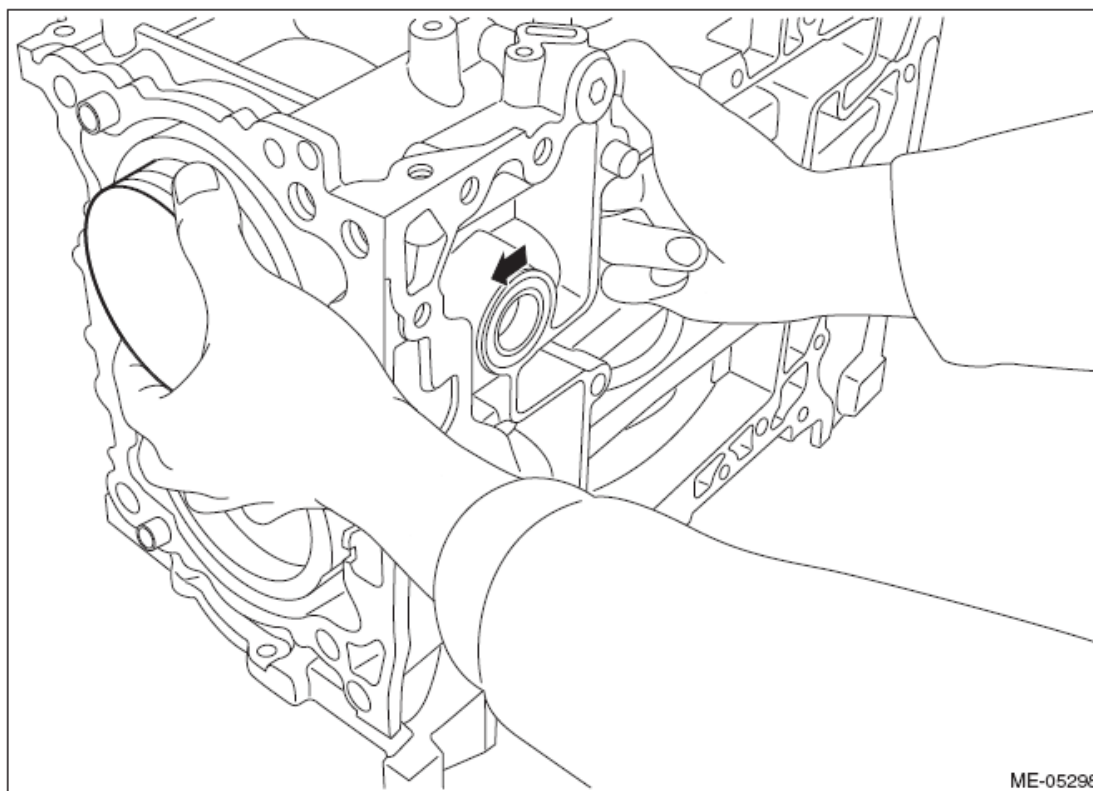


Fig. 359: Removing No. 1 Piston And No. 1 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

6. Using the ST, turn the crankshaft counterclockwise and separate the positions of the #4 pin (A) of crankshaft and the large end (B) of #4 connecting rod.

ST 18252AA000 CRANKSHAFT SOCKET

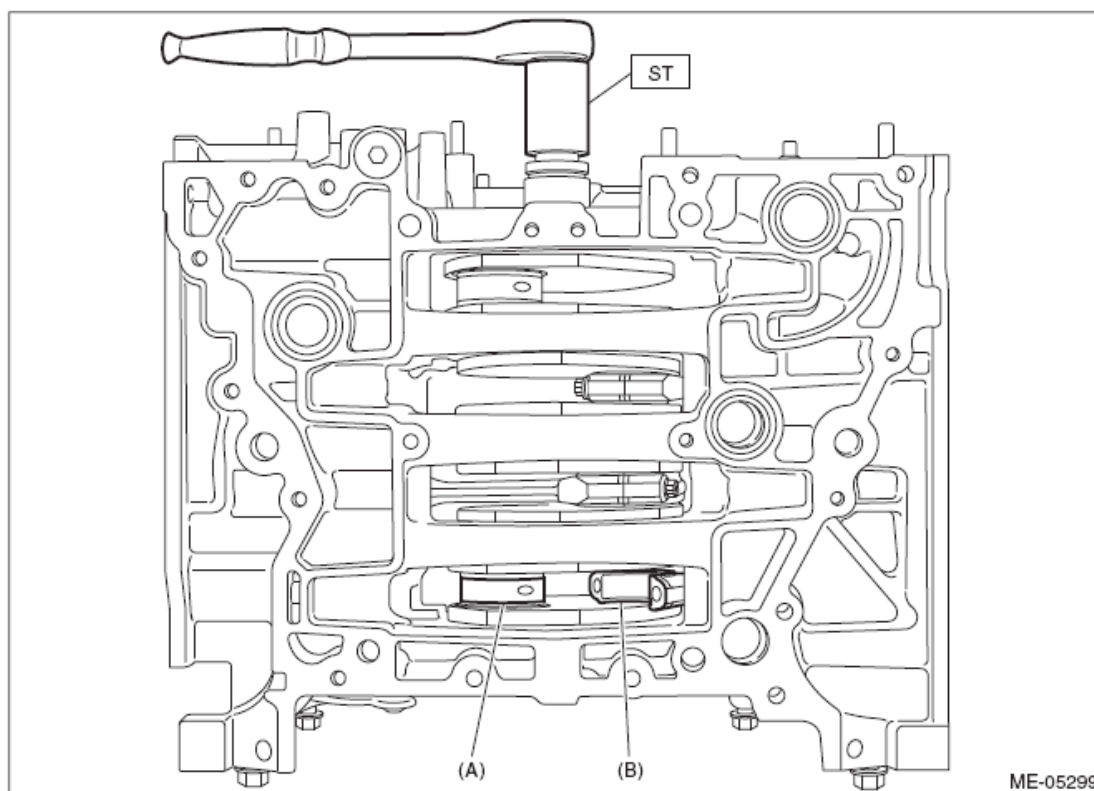


Fig. 360: Aligning No. 4 Crank Pin And Large End Of No. 4 Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

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.

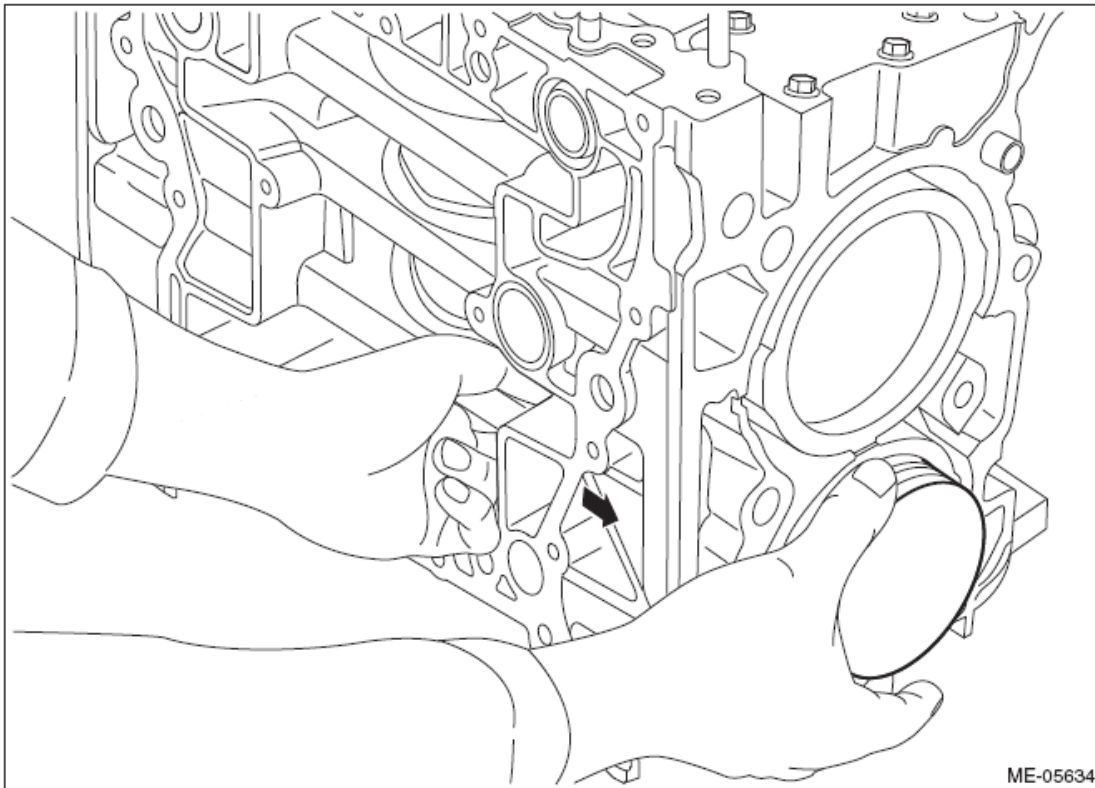


Fig. 361: Removing No. 4 Piston And No. 4 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

26. 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

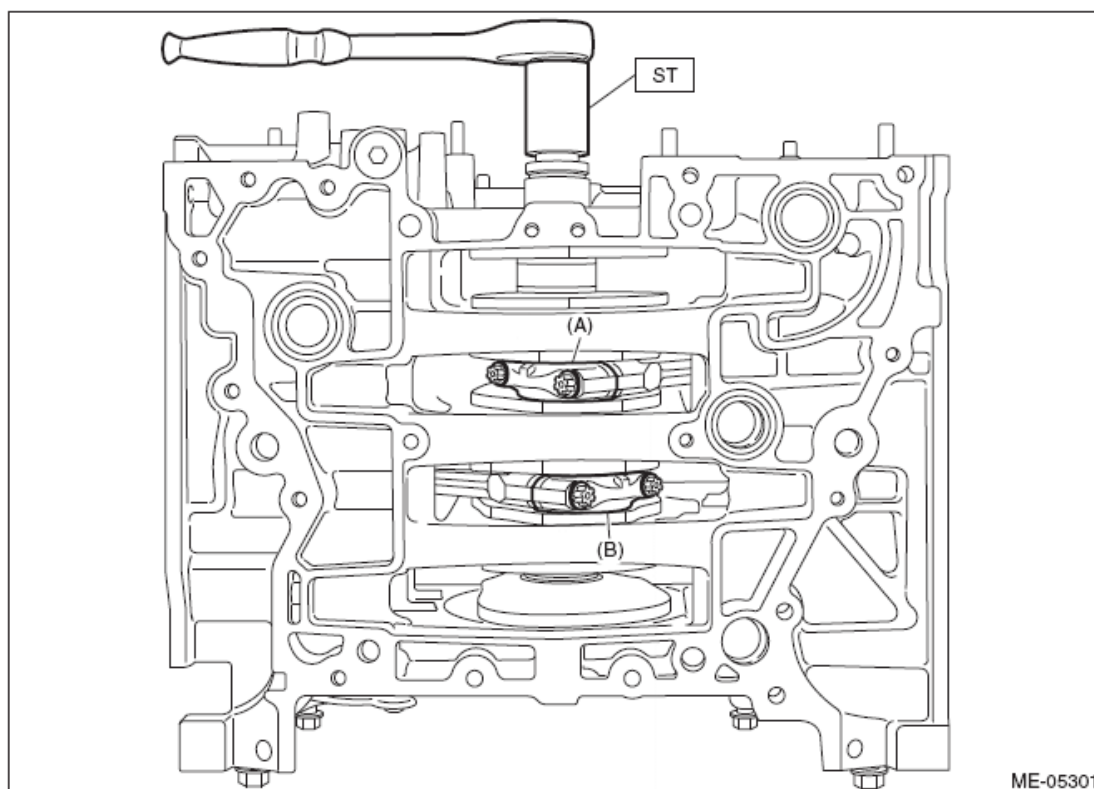


Fig. 362: Aligning No. 2 And No. 3 Connecting Rod Cap
Courtesy of SUBARU OF AMERICA, INC.

2. Using ST, loosen the #2 connecting rod cap bolt, and remove the #2 connecting rod cap bolt and #2 connecting rod cap.

ST 18270AA020 SOCKET

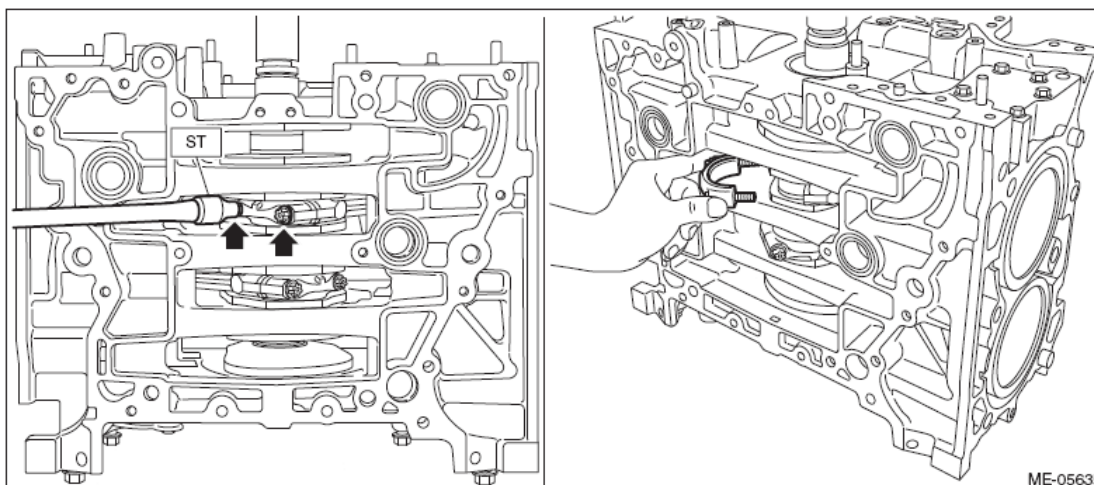


Fig. 363: Removing No. 2 Connecting Rod Cap
Courtesy of SUBARU OF AMERICA, INC.

3. Using ST, loosen the #3 connecting rod cap bolt, and remove the #3 connecting rod cap bolt and #3 connecting rod cap.

ST 18270AA020 SOCKET

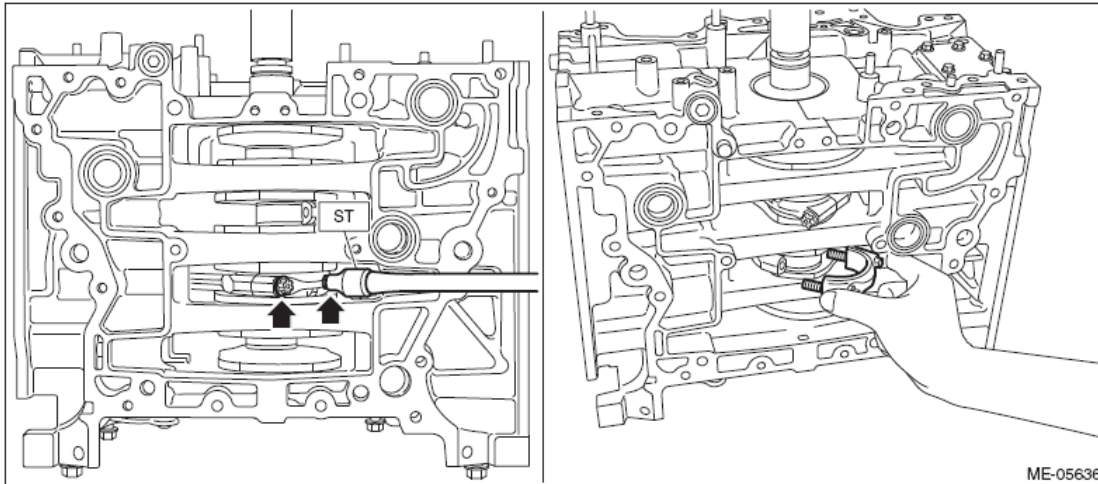


Fig. 364: Removing No. 3 Connecting Rod Cap
Courtesy of SUBARU OF AMERICA, INC.

4. Using the ST, turn the crankshaft counterclockwise and separate the positions of the #2 pin (A) of crankshaft and the large end (B) of #2 connecting rod.

ST 18252AA000 CRANKSHAFT SOCKET

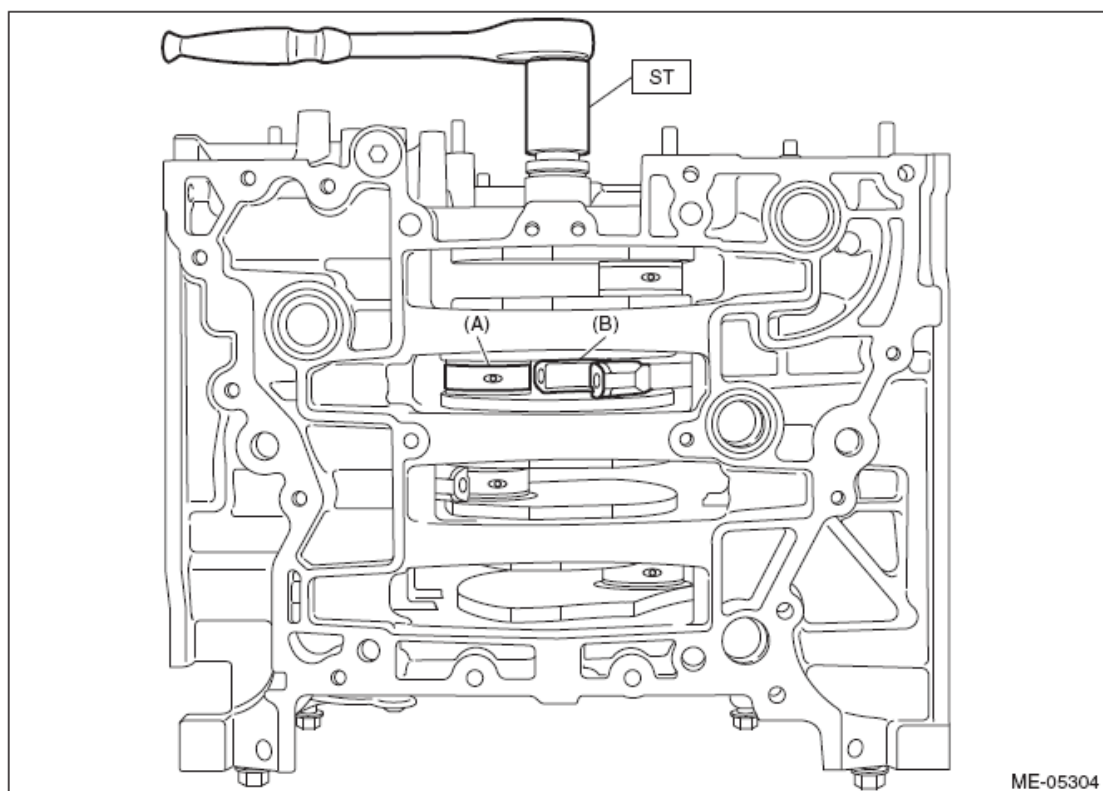


Fig. 365: Aligning No. 2 Crank Pin And Large End Of No. 2 Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

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.

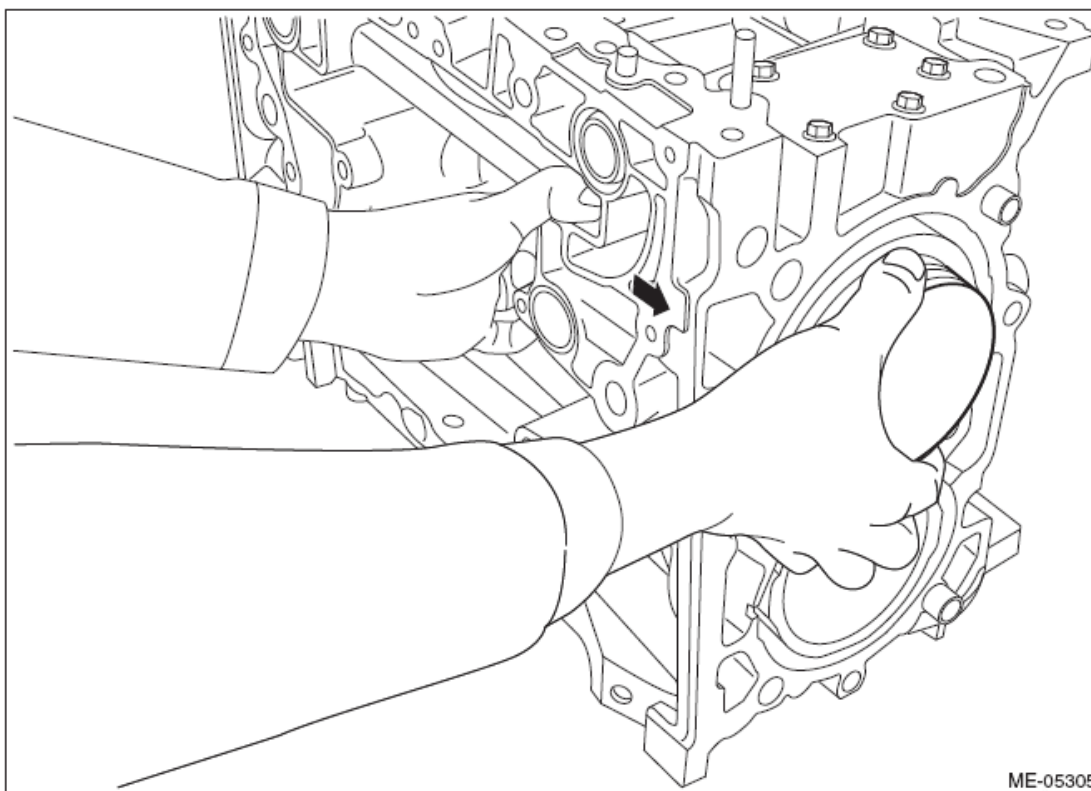


Fig. 366: Removing No. 2 Piston And No. 2 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

6. Using the ST, turn the crankshaft clockwise and separate the positions of the #3 pin (A) of crankshaft and the large end (B) of #3 connecting rod.

ST 18252AA000 CRANKSHAFT SOCKET

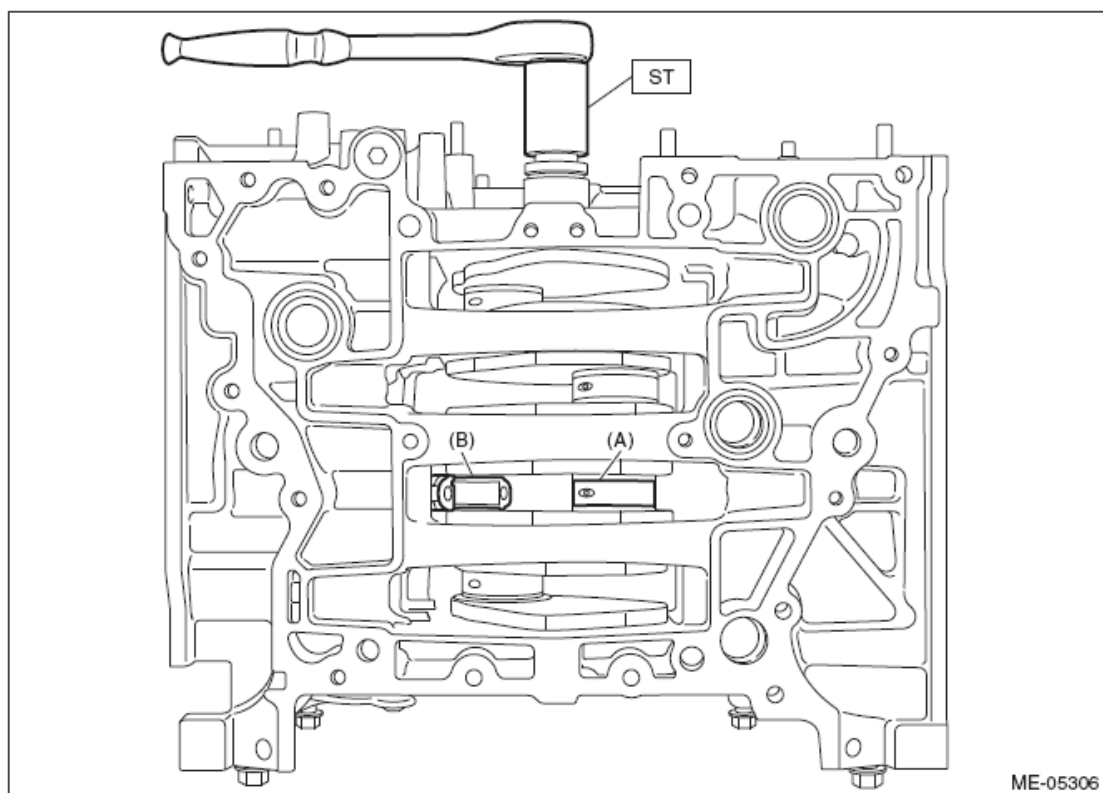


Fig. 367: Aligning No. 3 Crank Pin And Large End Of No. 3 Connecting Rod
Courtesy of SUBARU OF AMERICA, INC.

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.

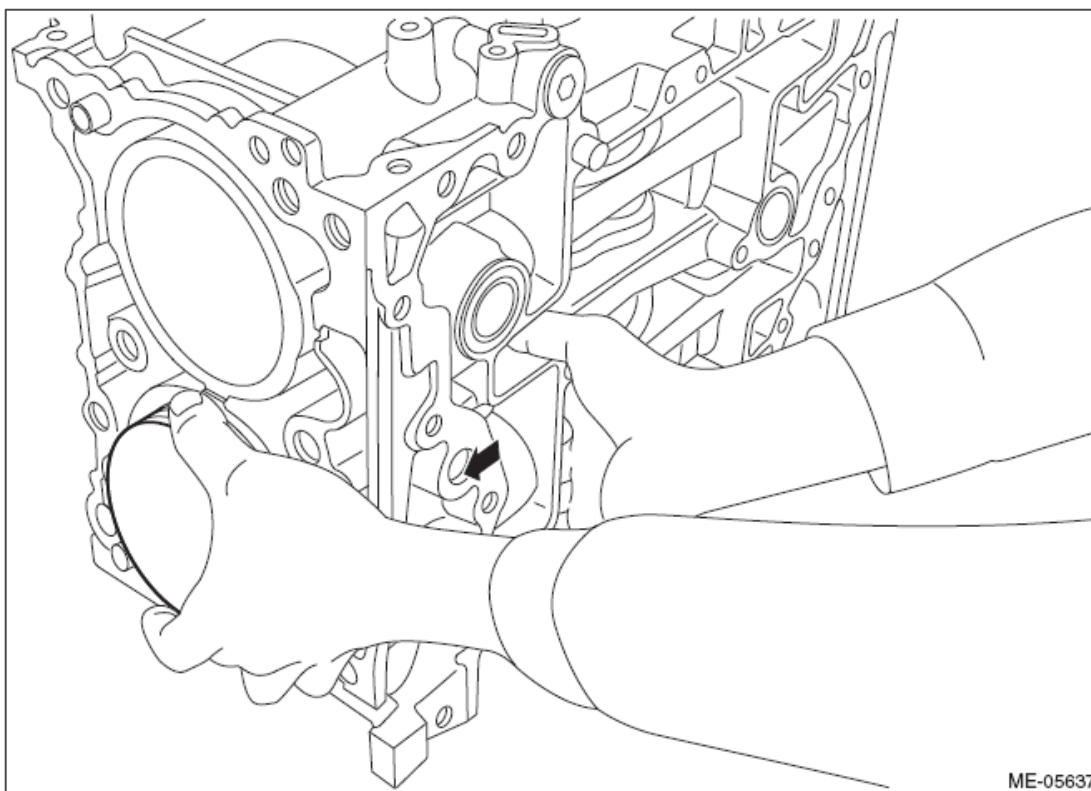


Fig. 368: Removing No. 3 Piston And No. 3 Connecting Rod From Cylinder Block
Courtesy of SUBARU OF AMERICA, INC.

27. Set the cylinder block so that the oil pan side faces upward, and remove the mounting bolts for A/C compressor and the generator bracket attached to the locations shown in the figure.

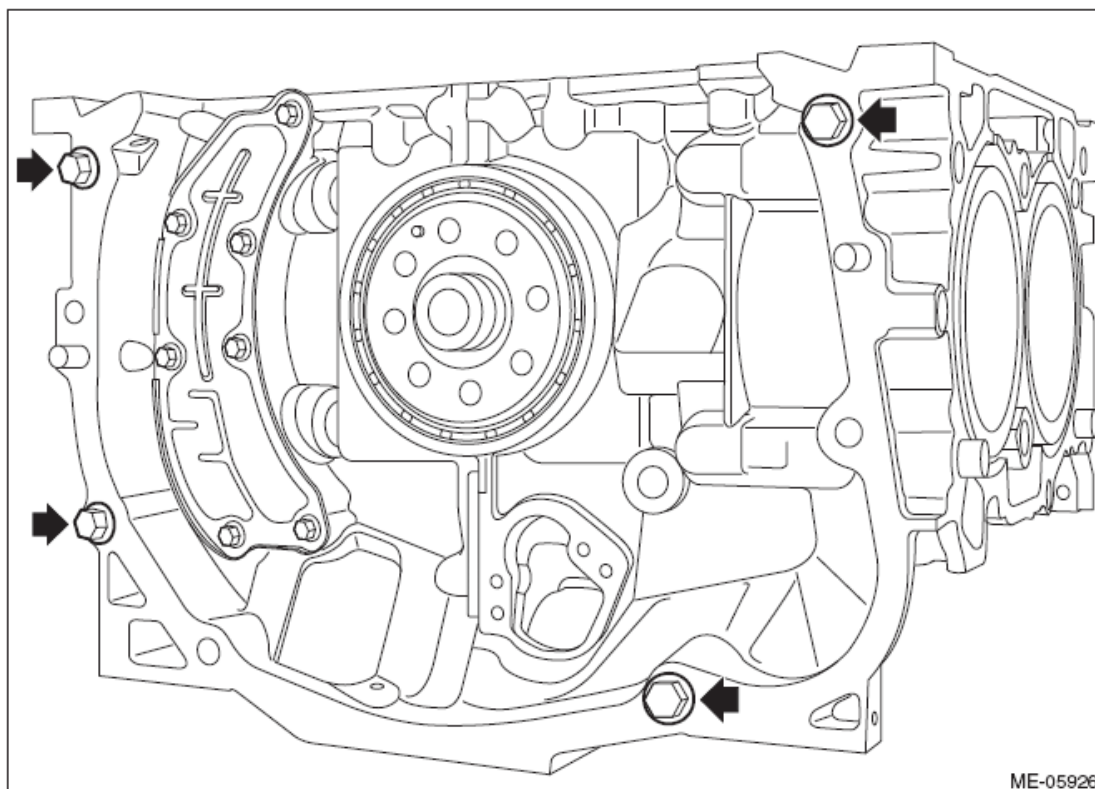


Fig. 369: Locating A/C Compressor And Generator Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

28. 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.

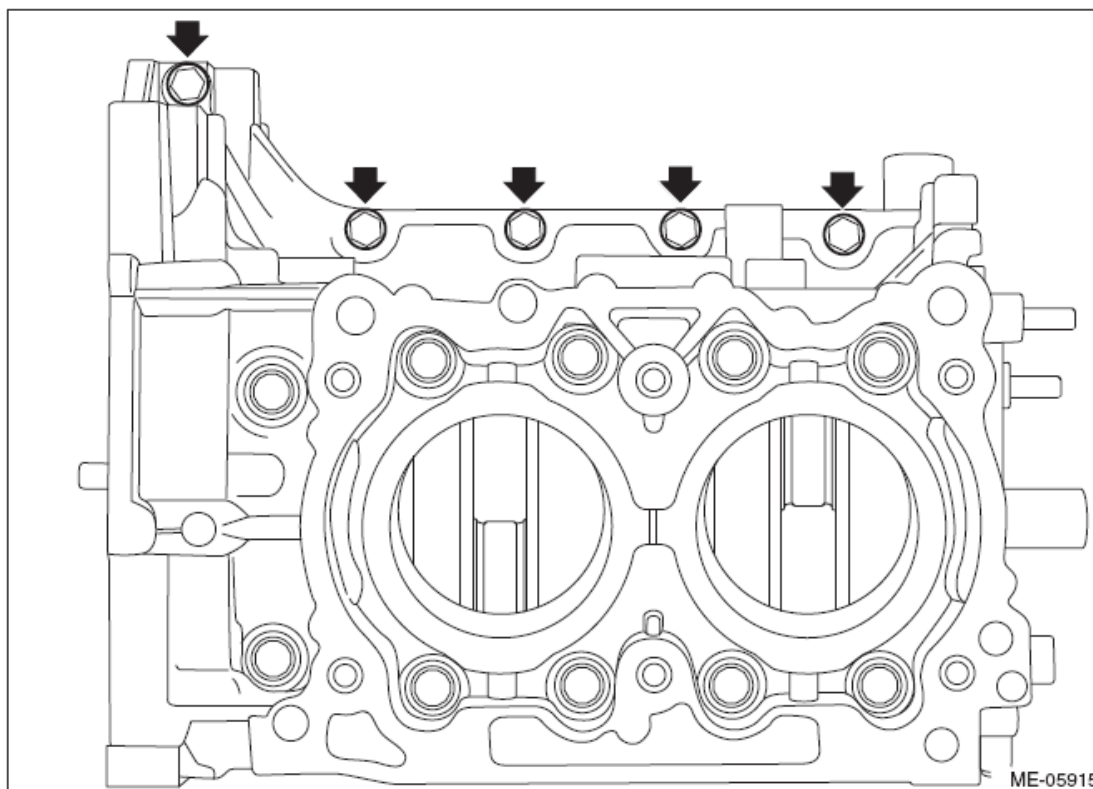


Fig. 370: Locating Cylinder Block RH Upper Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

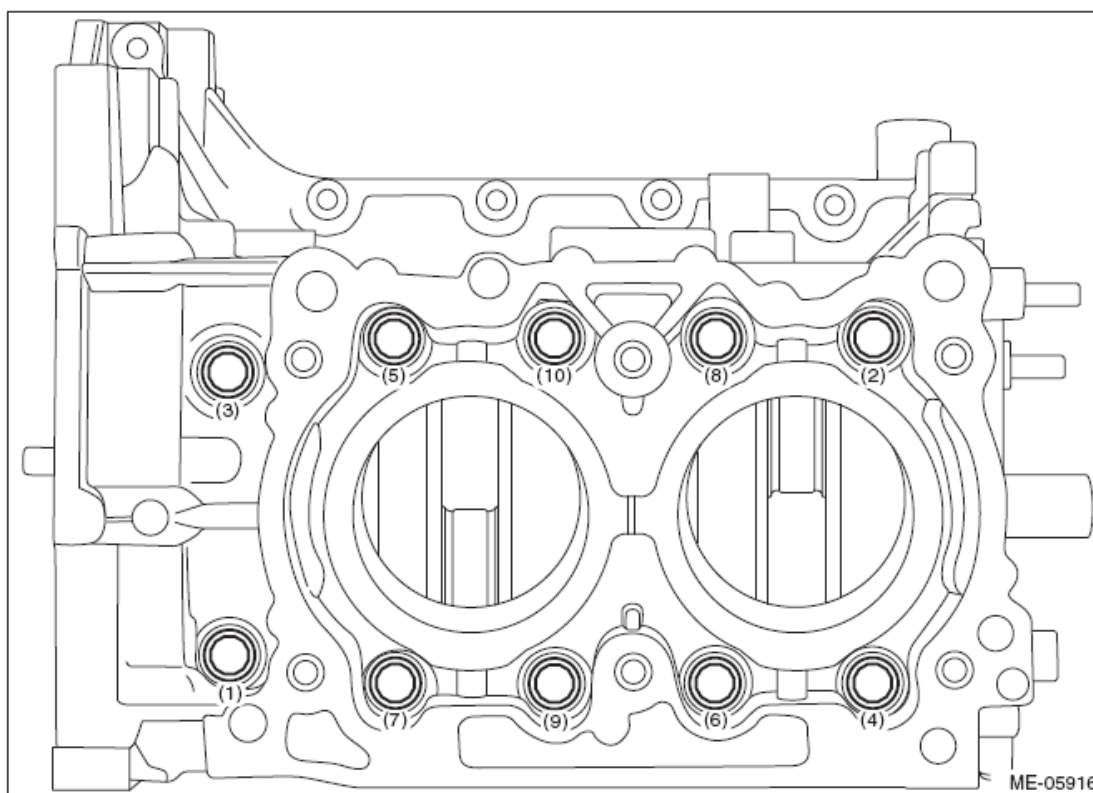


Fig. 371: Identifying Loosening Sequence Of Cylinder Block Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

29. Remove the crankshaft from cylinder block LH, and remove the rear oil seal.
30. Remove the O-ring from the cylinder block LH.

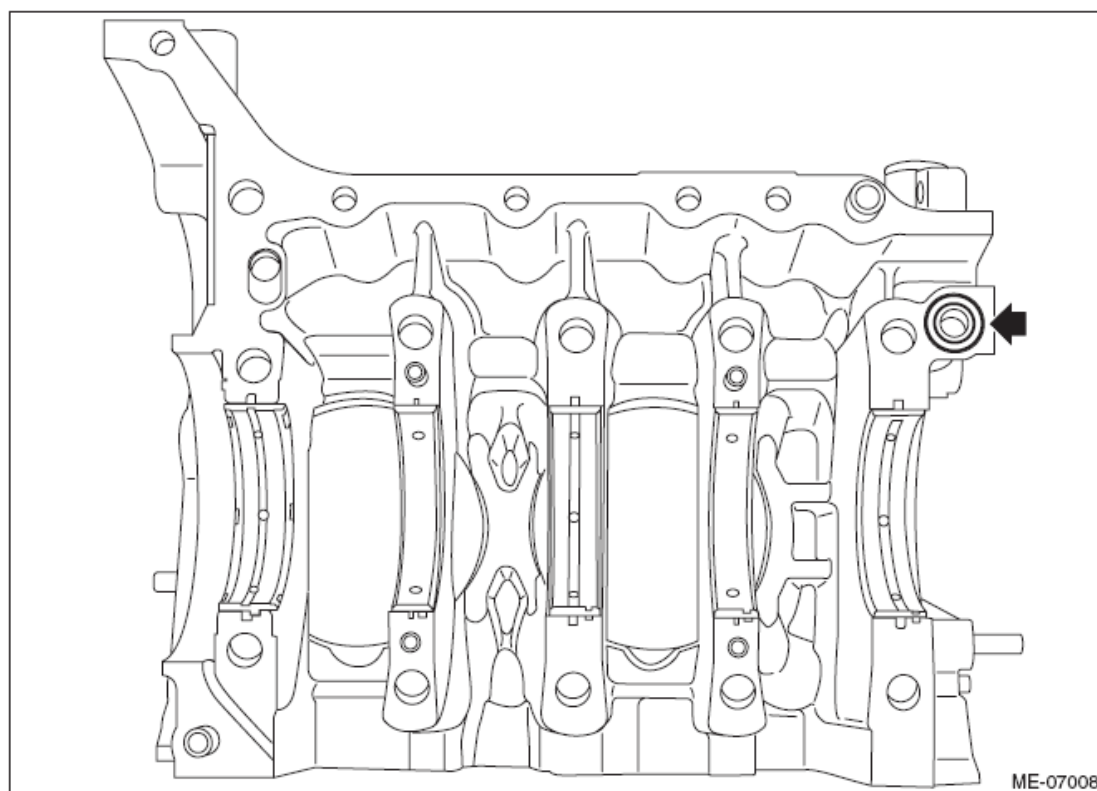


Fig. 372: Locating Cylinder Block LH O-Ring
 Courtesy of SUBARU OF AMERICA, INC.

31. 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).

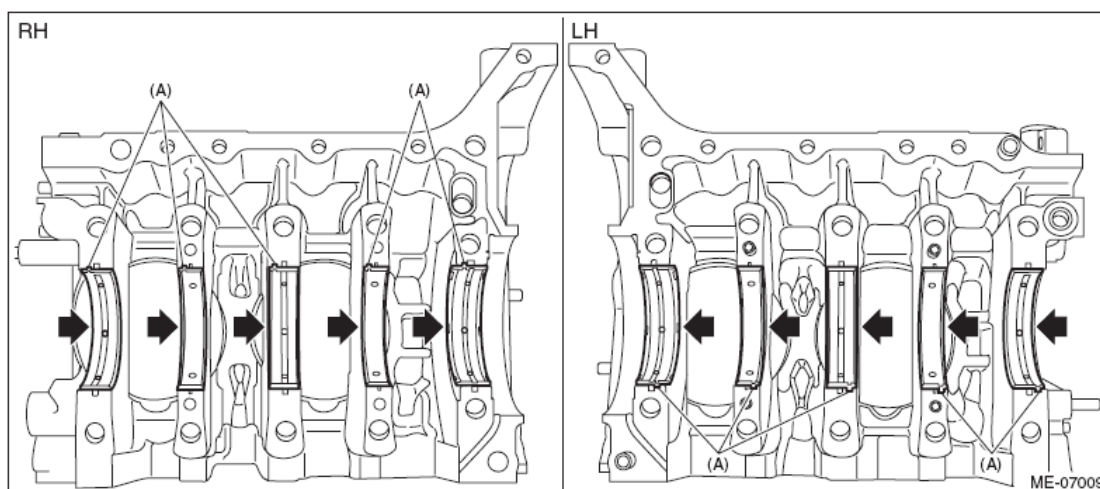


Fig. 373: Locating Crankshaft Bearings

Courtesy of SUBARU OF AMERICA, INC.

32. 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.

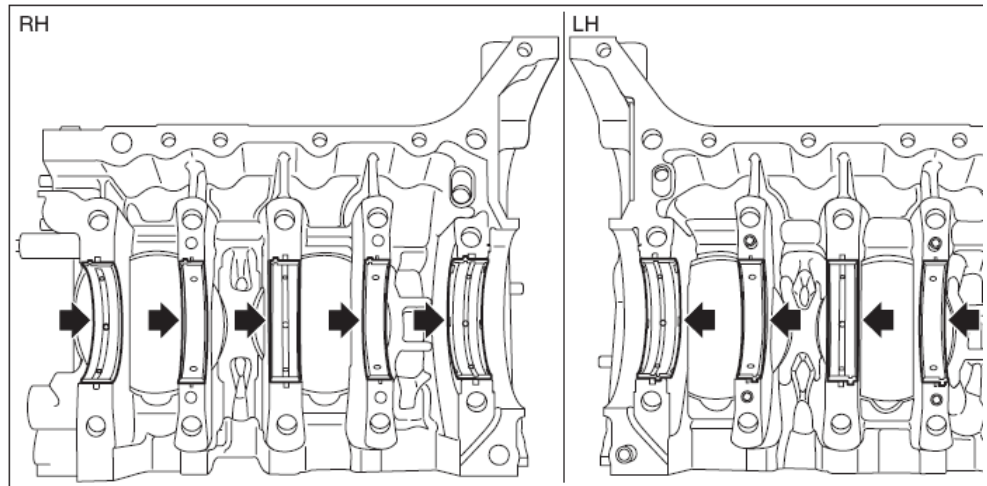


Fig. 374: Locating Liquid Gasket Applying Area On Crankshaft Bearing
Courtesy of SUBARU OF AMERICA, INC.

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

NOTE: Use new O-rings.

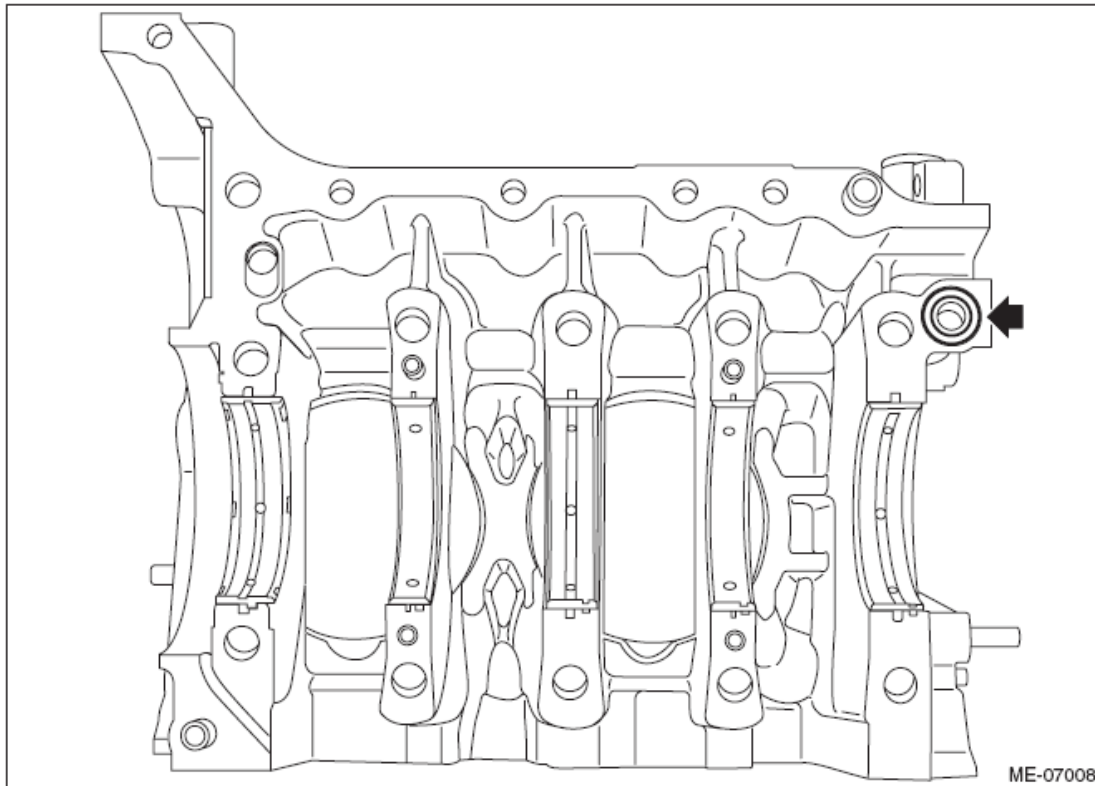


Fig. 375: Locating Cylinder Block LH O-Ring
Courtesy of SUBARU OF AMERICA, INC.

3. Apply engine oil to the crankshaft journal, and set the crankshaft to cylinder block LH.

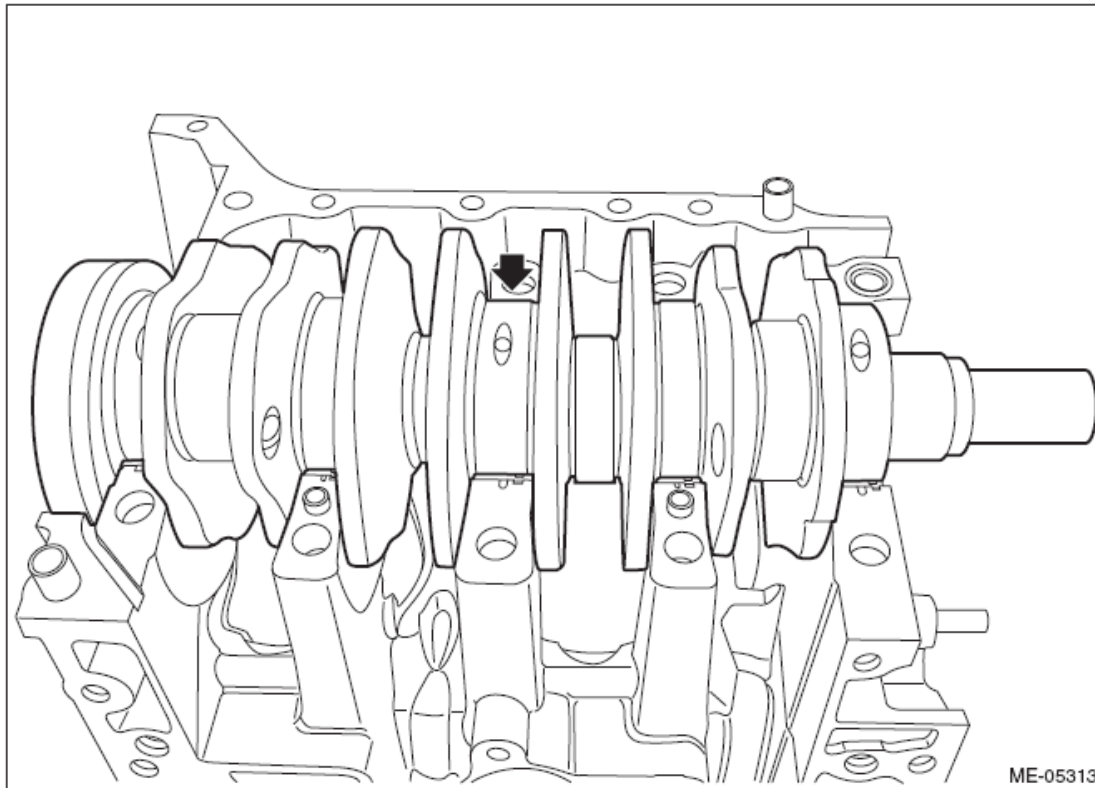


Fig. 376: Locating Engine Oil Applying Area On Crankshaft Journal
Courtesy of SUBARU OF AMERICA, INC.

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 and crankshaft bearing portions, because the engine seizure may result.

NOTE:

- Before applying liquid gasket, degrease the old liquid gasket seal surface of the cylinder block RH and 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, B and C

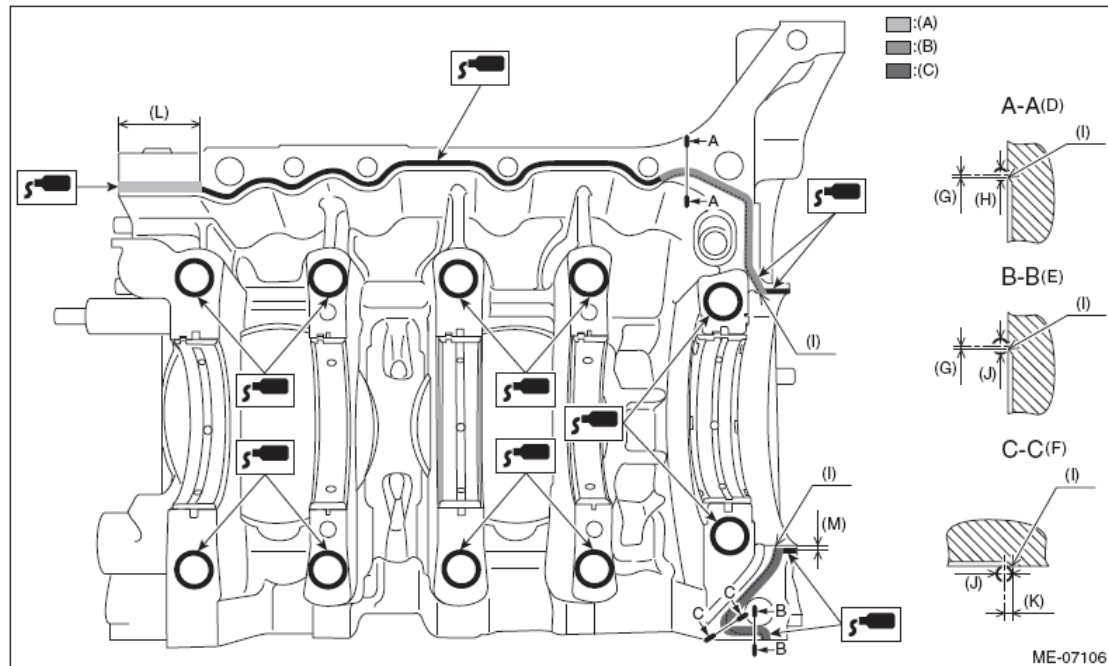
$1 \pm 0.5 \text{ mm}$ ($0.0394 \pm 0.0197 \text{ in}$)

Mating surfaces of ranges A and C

$4\pm0.5 \text{ mm}$ ($0.1575\pm0.0197 \text{ in}$)

Mating surfaces of range B

$3.2\pm0.5 \text{ mm}$ ($0.1260\pm0.0197 \text{ in}$)



- | | | |
|---|--|------------------------|
| (A) Range A | (F) Liquid gasket applying position of mating surfaces (the edge) of range C | (K) 2 mm (0.0787 in) |
| (B) Range B | (G) 1 mm (0.0394 in) or less | (L) 36 mm (1.4173 in) |
| (C) Range C | (H) $\phi 3.2\pm0.5 \text{ mm}$ ($0.1260\pm0.0197 \text{ in}$) | (M) 2.5 mm (0.0984 in) |
| (D) Liquid gasket applying position of mating surfaces of range B | (I) Chamfer edge | |
| (E) Liquid gasket applying position of mating surfaces (other than the edge) of range C | (J) $\phi 4\pm0.5 \text{ mm}$ ($0.1575\pm0.0197 \text{ in}$) | |

Fig. 377: Identifying Liquid Gasket Applying Area On 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.

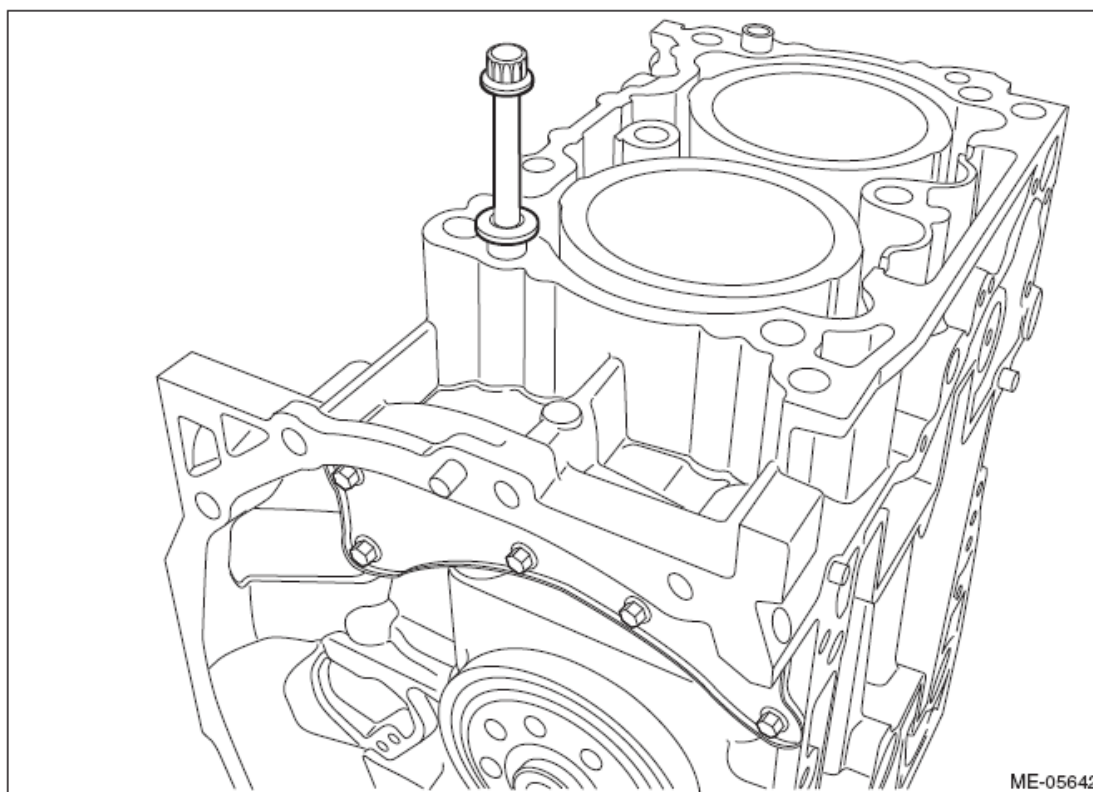


Fig. 378: Identifying Cylinder Head Bolt Position
Courtesy of SUBARU OF AMERICA, INC.

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.

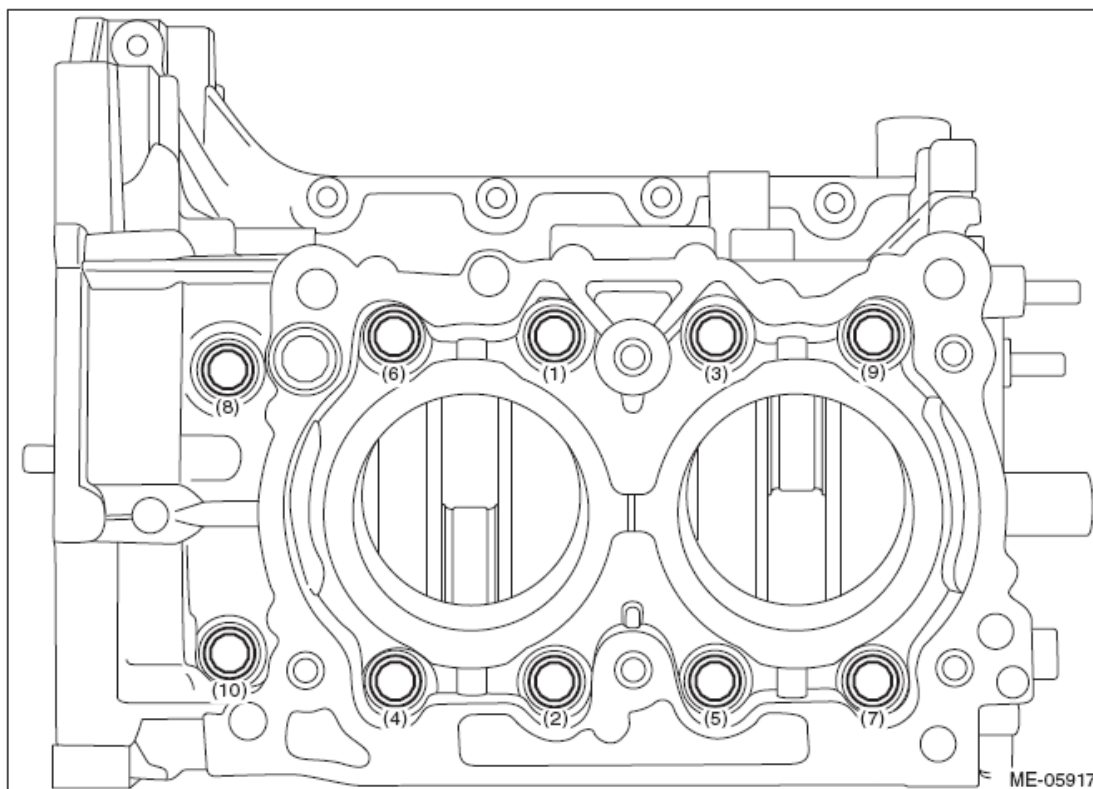


Fig. 379: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

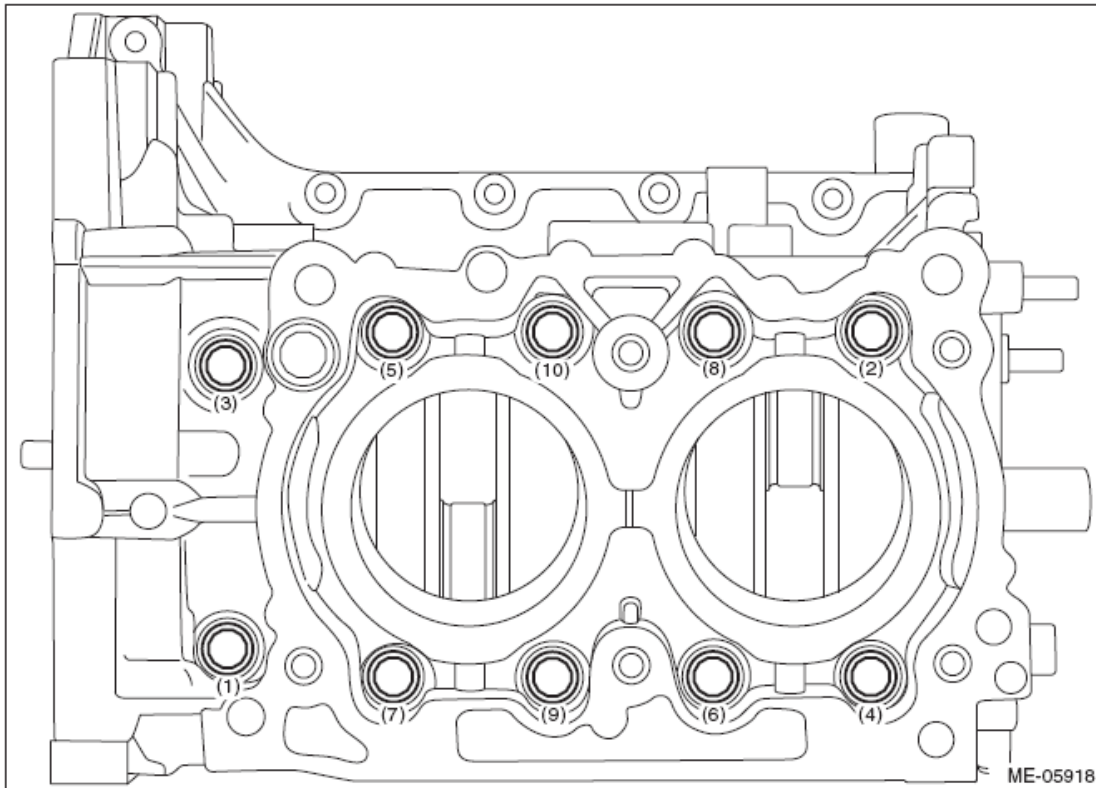


Fig. 380: Identifying Loosening Sequence Of Cylinder Block LH Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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.

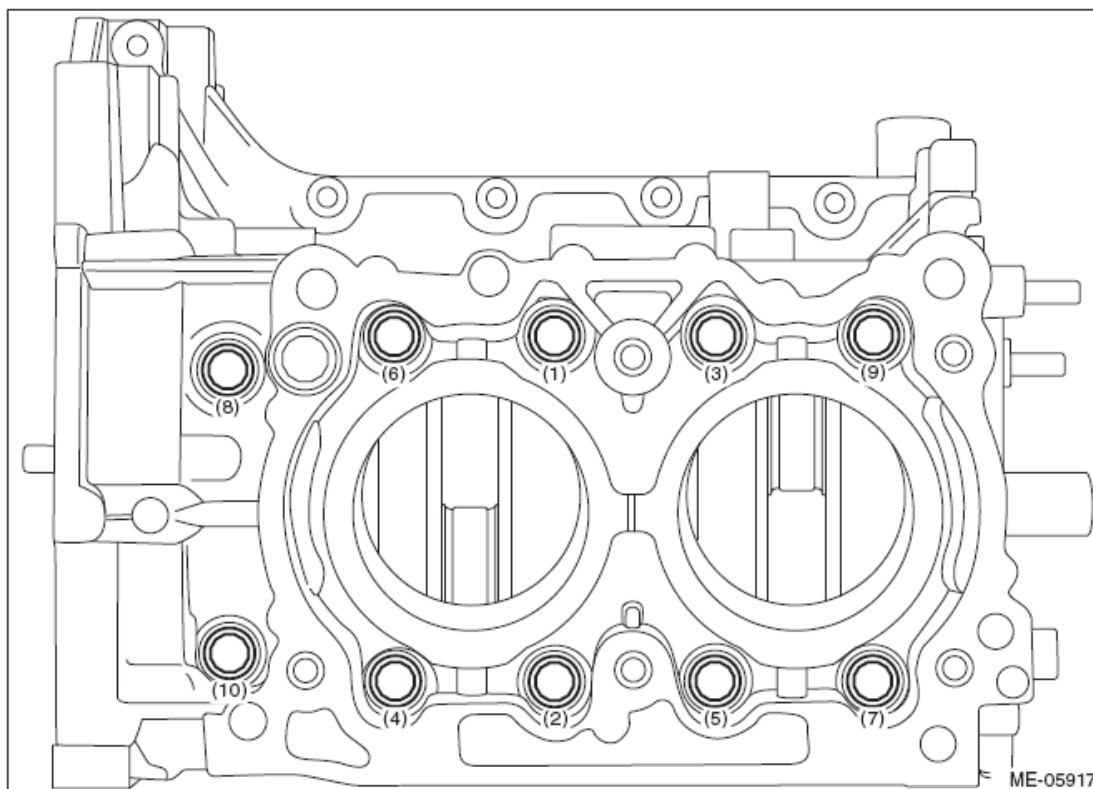


Fig. 381: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

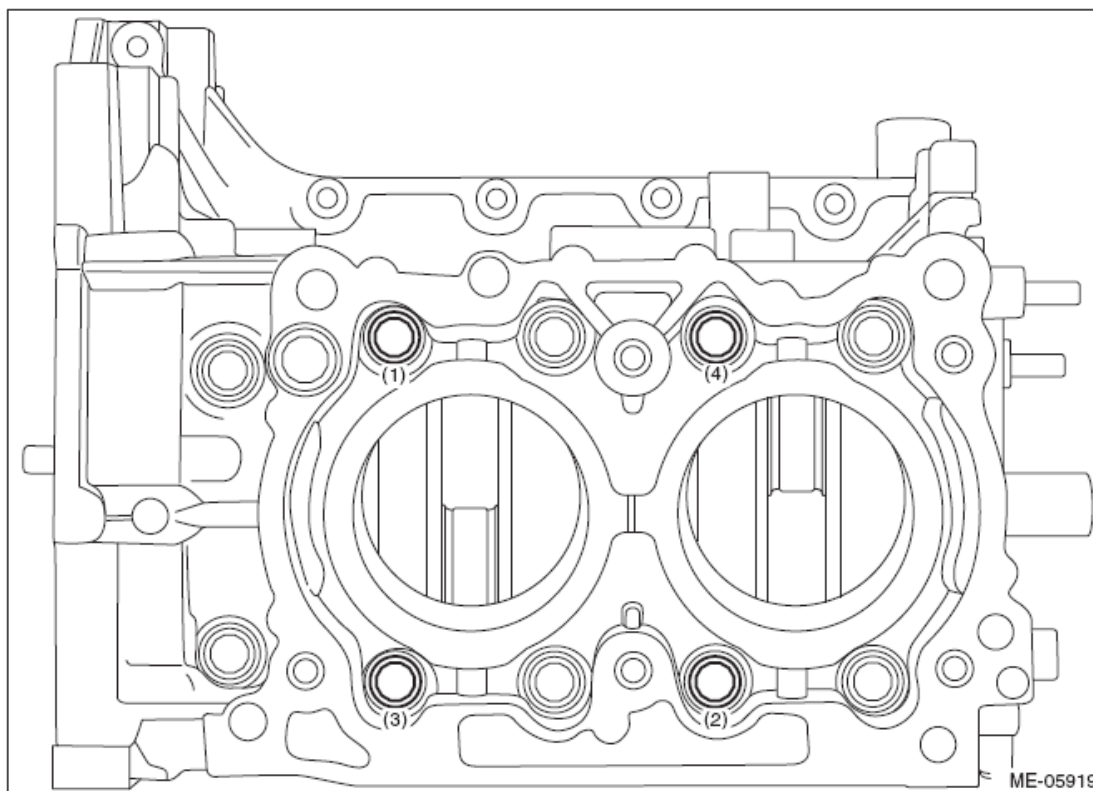


Fig. 382: Identifying Loosening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

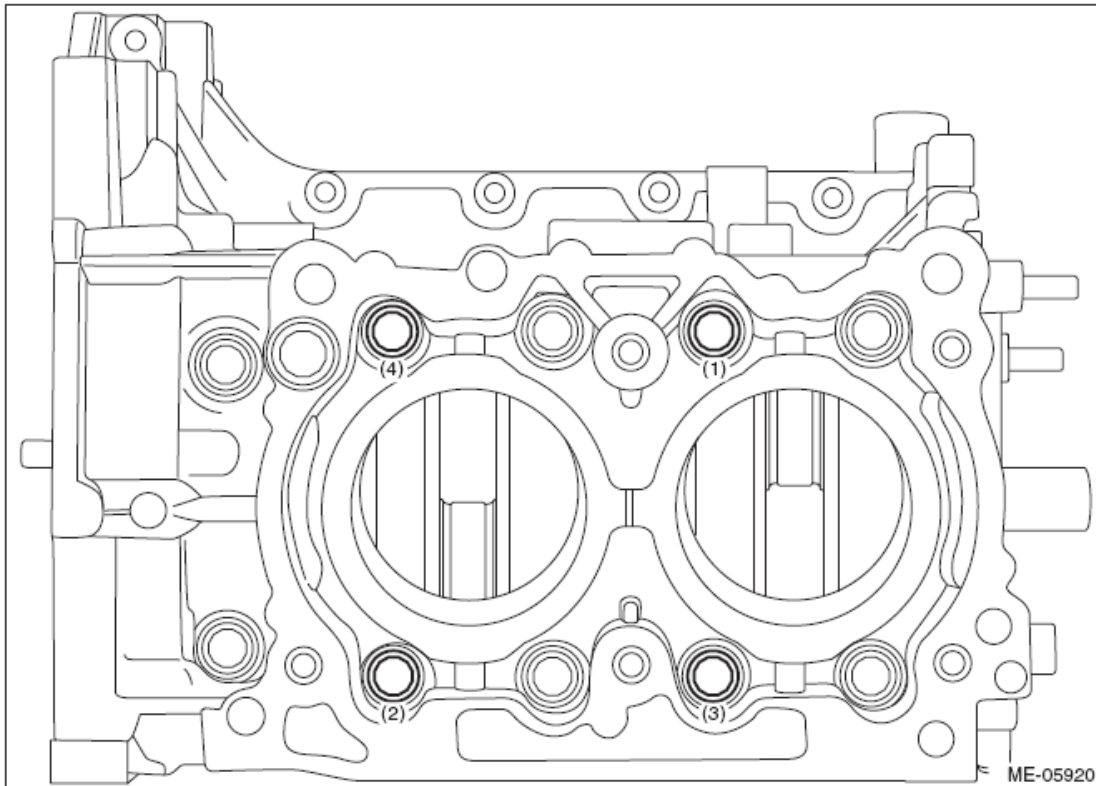


Fig. 383: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

8. Using ST, tighten the mounting bolts (4 places) with specified angle in numerical order as shown in the figure.

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:

$60^{\circ} \pm 2^{\circ}$

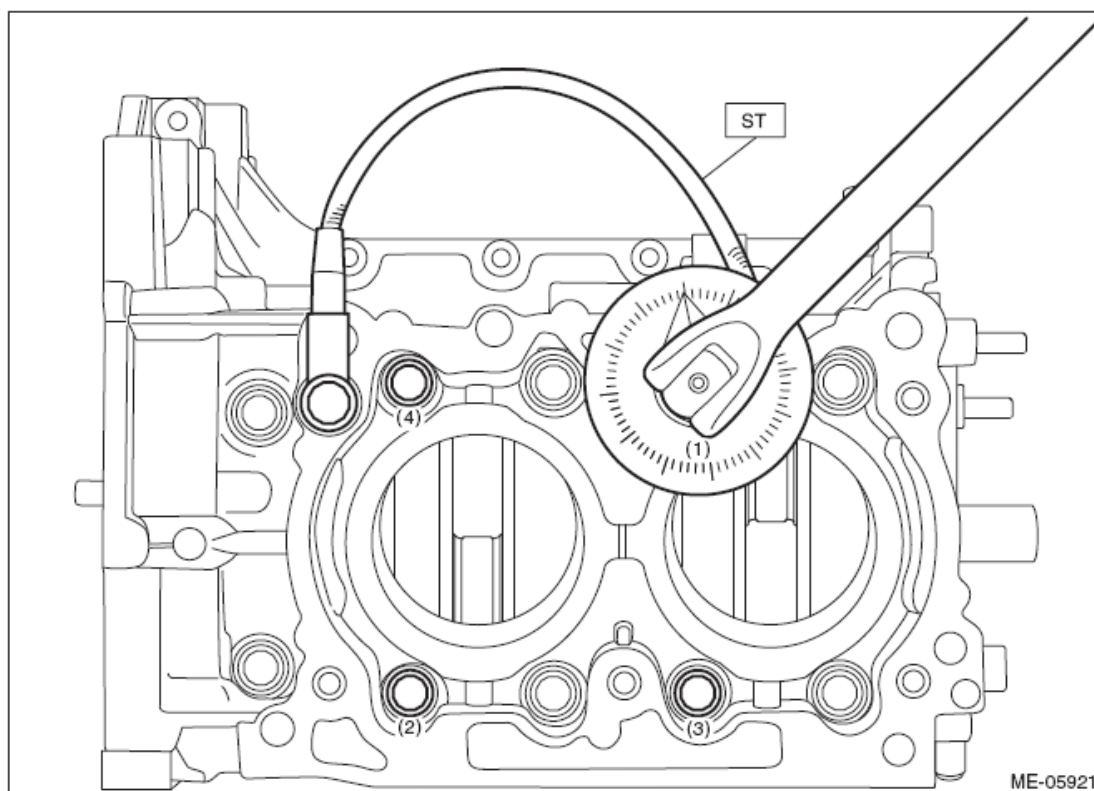


Fig. 384: Tightening Cylinder Head Bolt Using Angle Gauge
Courtesy of SUBARU OF AMERICA, INC.

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.

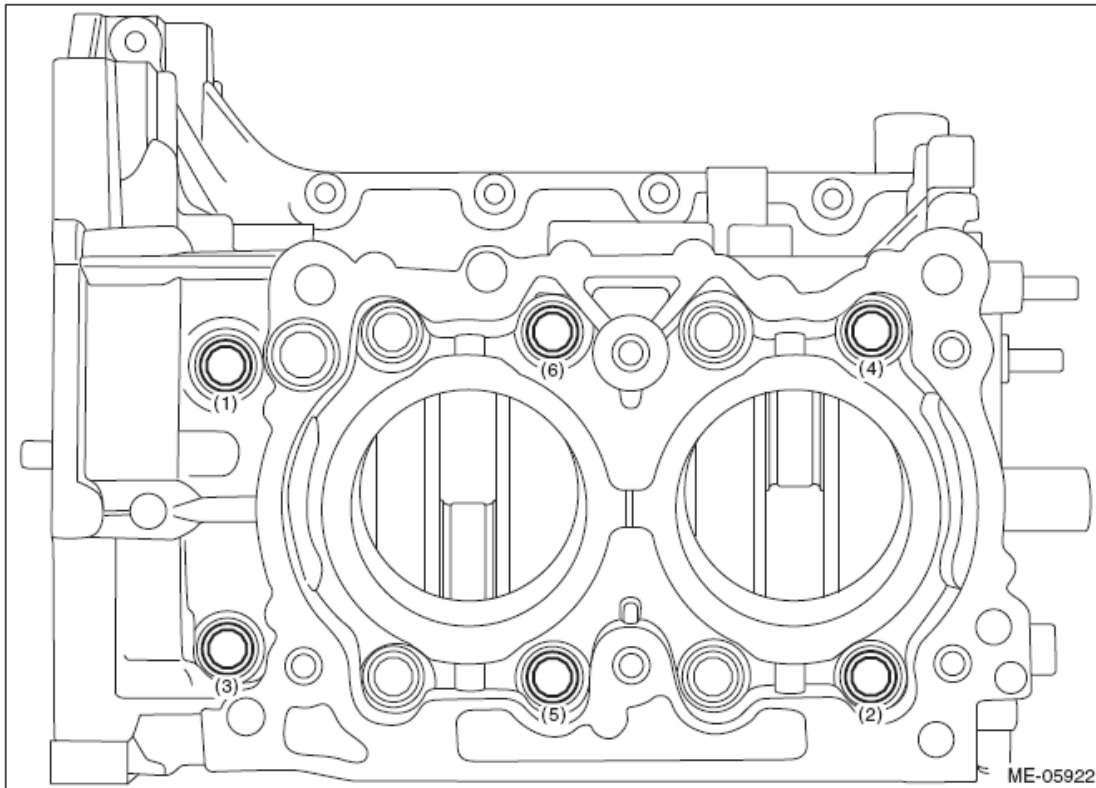


Fig. 385: Identifying Loosening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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.

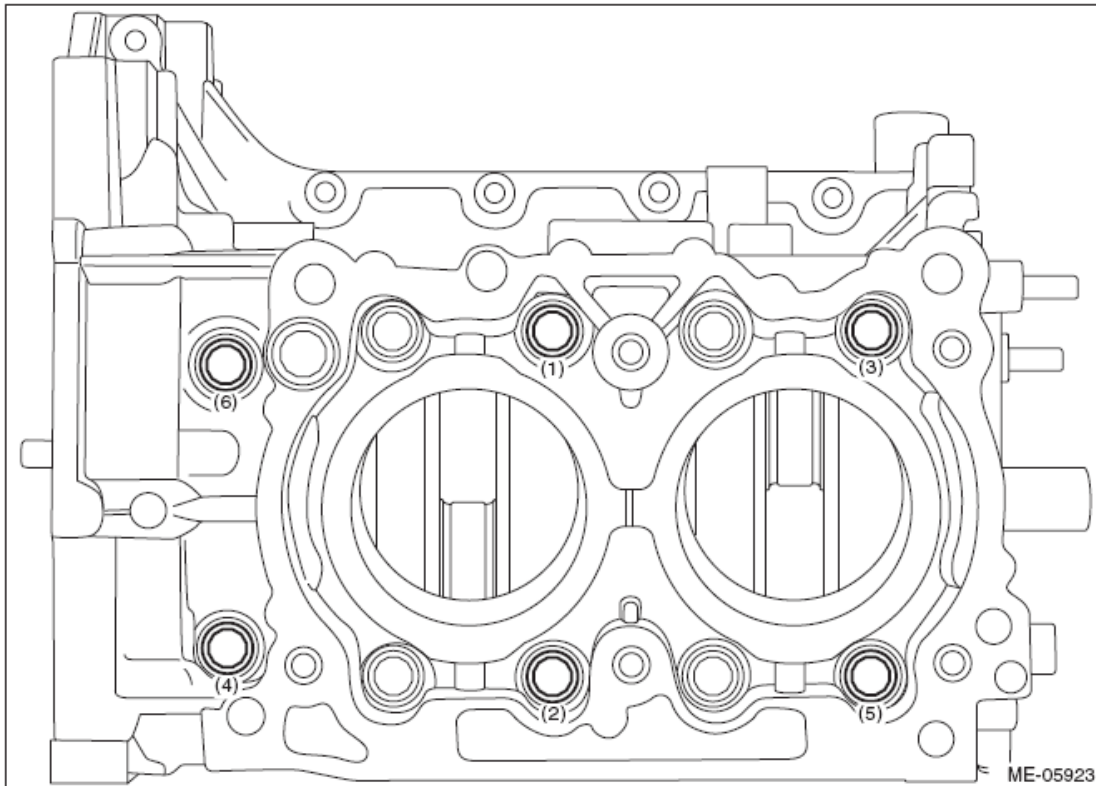


Fig. 386: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

11. Using ST, tighten the mounting bolts (6 places) with specified angle in numerical order as shown in the figure.

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:

$60^{\circ} \pm 2^{\circ}$

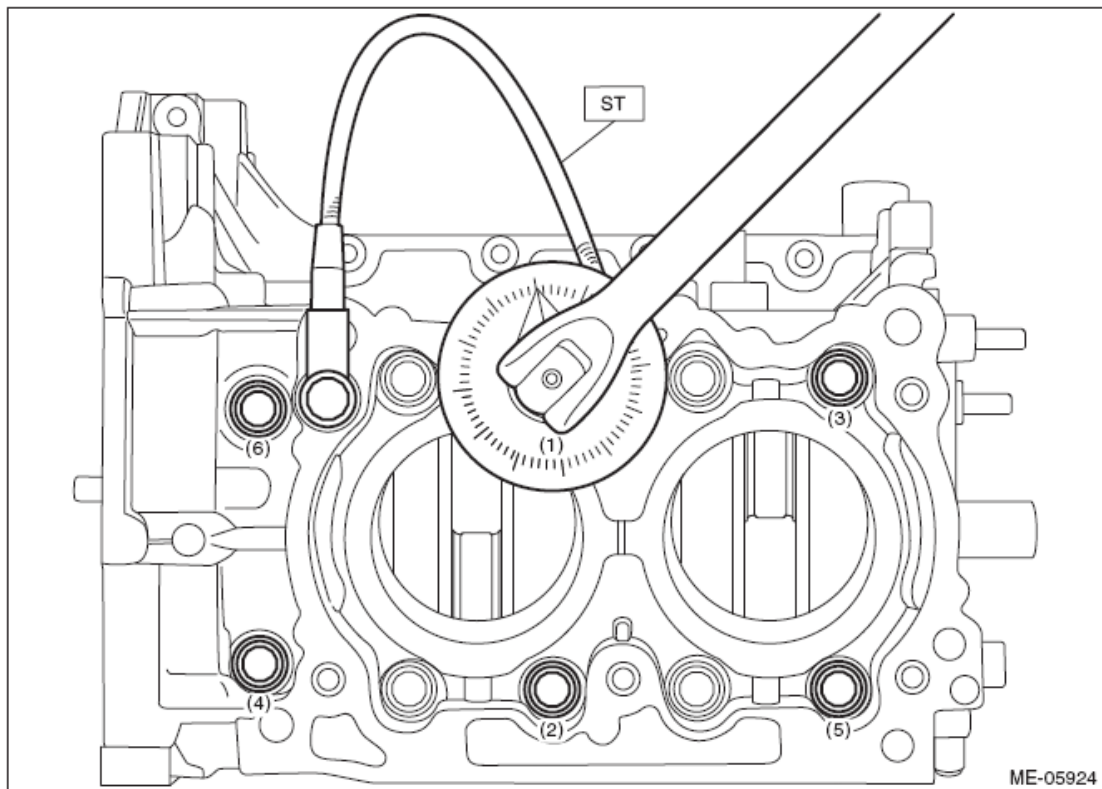


Fig. 387: Tightening Cylinder Head Bolt Using Angle Gauge
Courtesy of SUBARU OF AMERICA, INC.

12. Remove the cylinder head bolt attached at the locations shown in the figure.

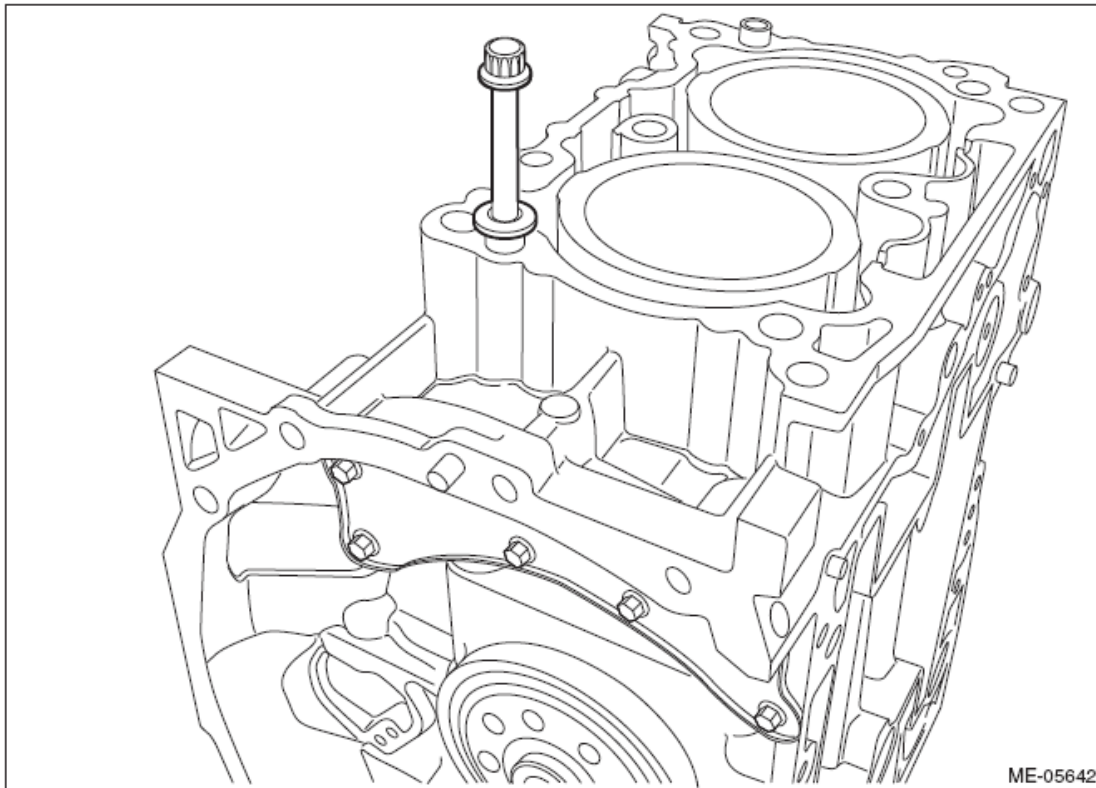


Fig. 388: Identifying Cylinder Head Bolt Position
Courtesy of SUBARU OF AMERICA, INC.

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. Any liquid gasket on the chamfer area, however, should not be removed.

Tightening torque:

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

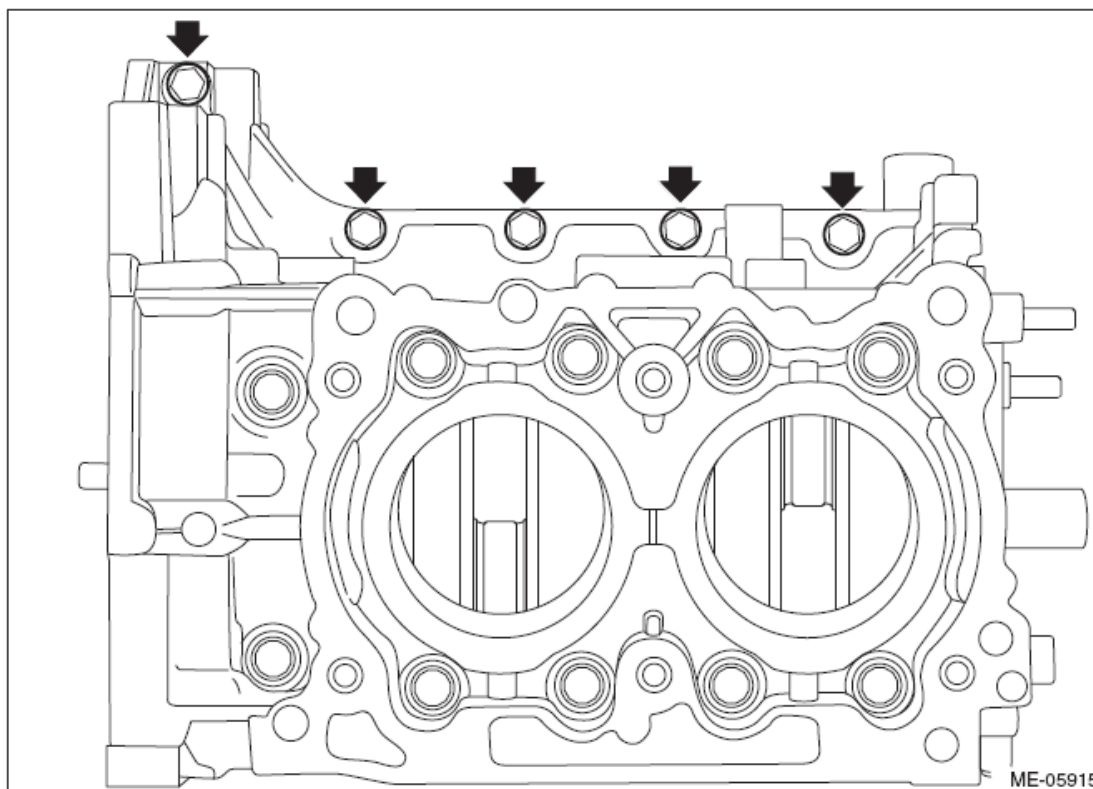


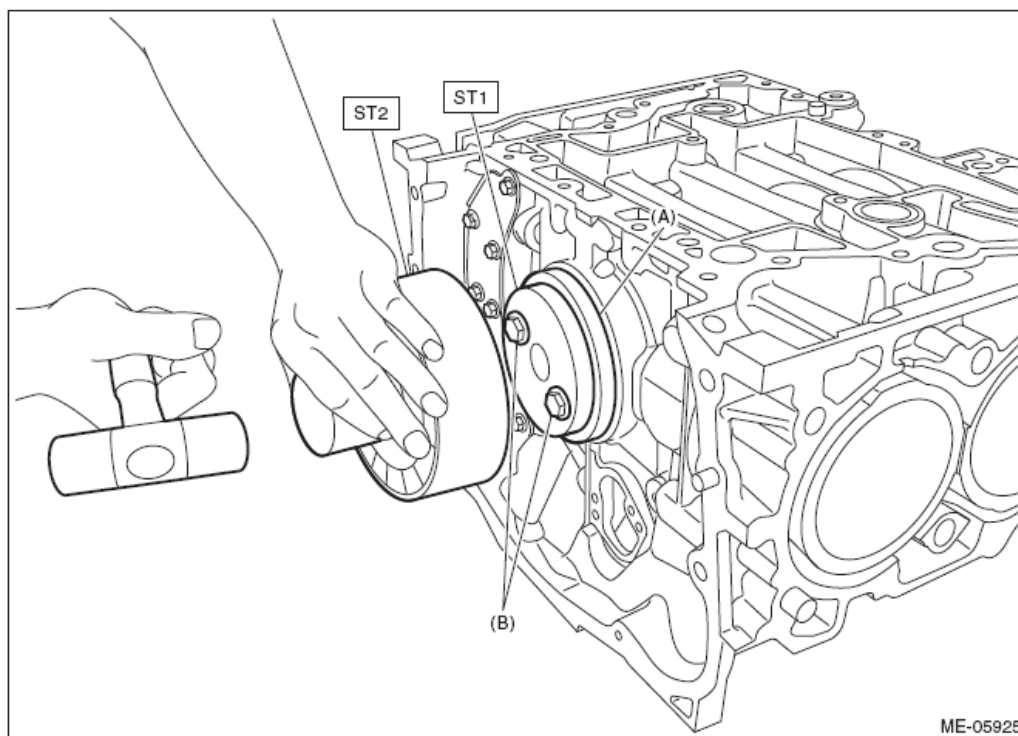
Fig. 389: Locating Cylinder Block RH Upper Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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. 390: Installing Rear Oil Seal Using ST1 And ST2
Courtesy of SUBARU OF AMERICA, INC.

9. Install the mounting bolts for the A/C compressor and the generator bracket 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.

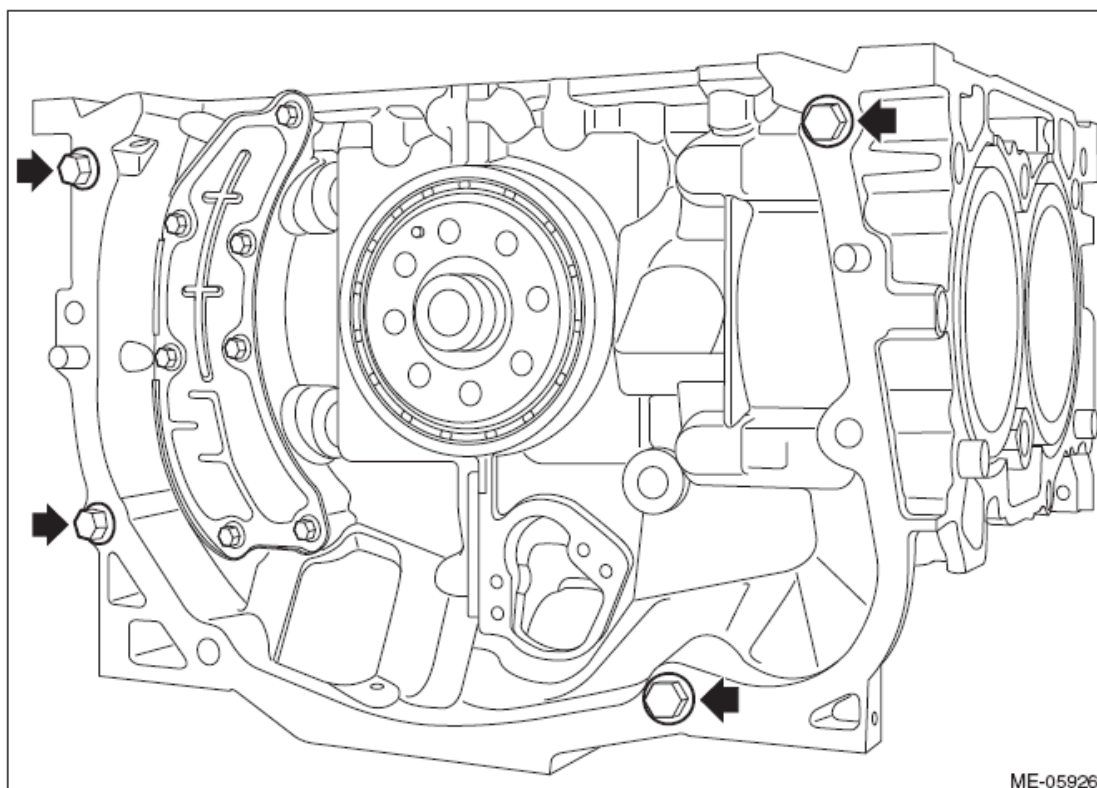


Fig. 391: Locating A/C Compressor And Generator Bracket Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

10. Raise the cylinder block so that the rear oil seal is on the lower side.
11. Adjust the positions of piston ring gap for each piston.

NOTE: Check that the piston ring mark of compression ring faces the top side of the piston.

1. Set the ring gap of the top ring to the position (A) in the figure.

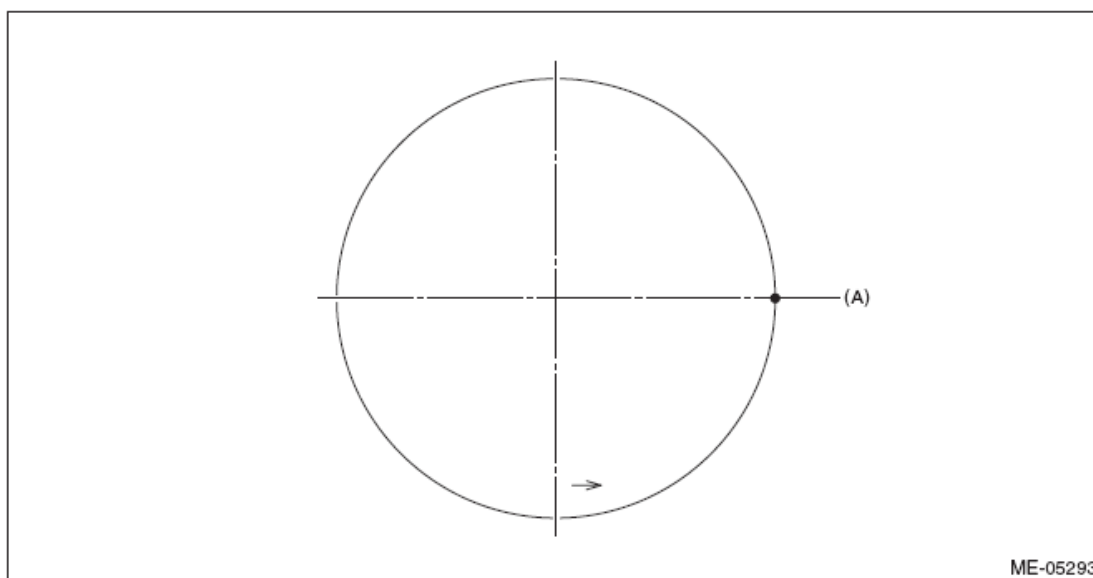


Fig. 392: Setting Ring Gap Of Top Ring To Position
Courtesy of SUBARU OF AMERICA, INC.

2. Position the ring gap of second ring at (B) in the figure on the 180° opposite direction of (A).

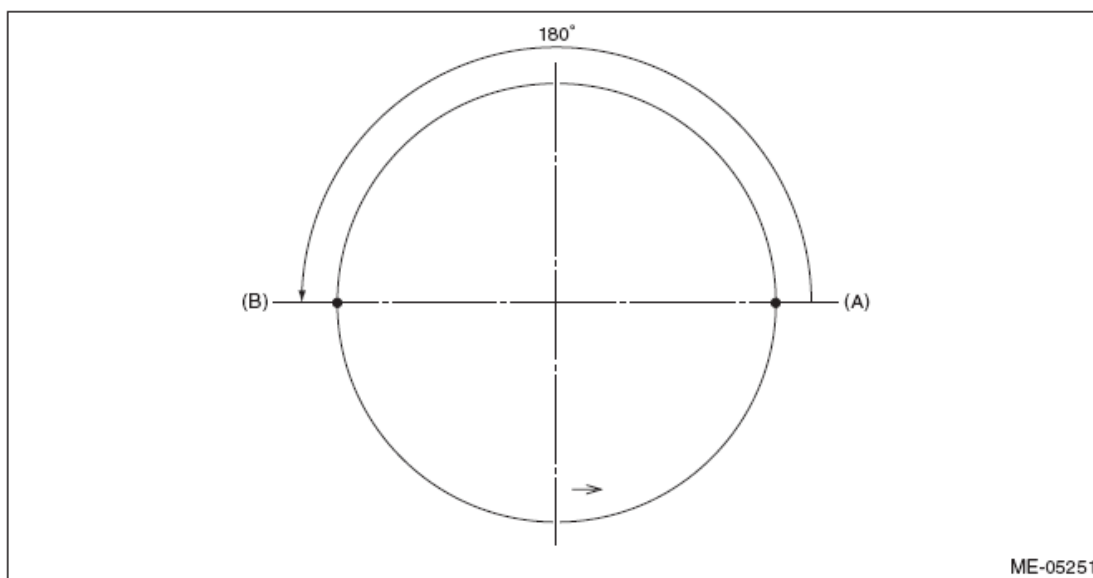


Fig. 393: Identifying Second Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

3. Set the ring gap of the upper rail to the position (C) in the figure.

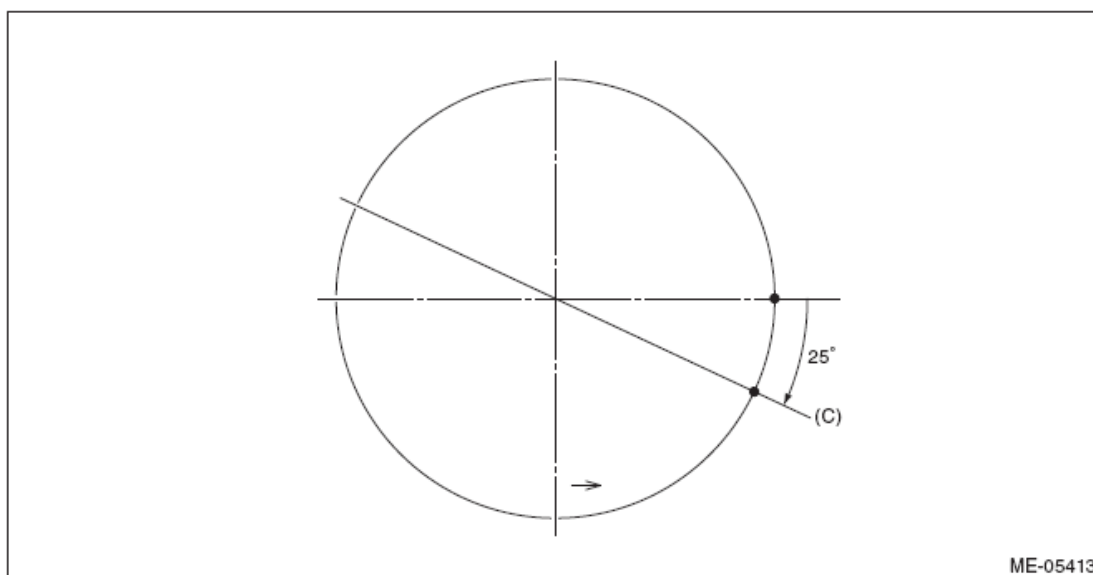


Fig. 394: Identifying Upper Rail Ring Gap Position
 Courtesy of SUBARU OF AMERICA, INC.

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

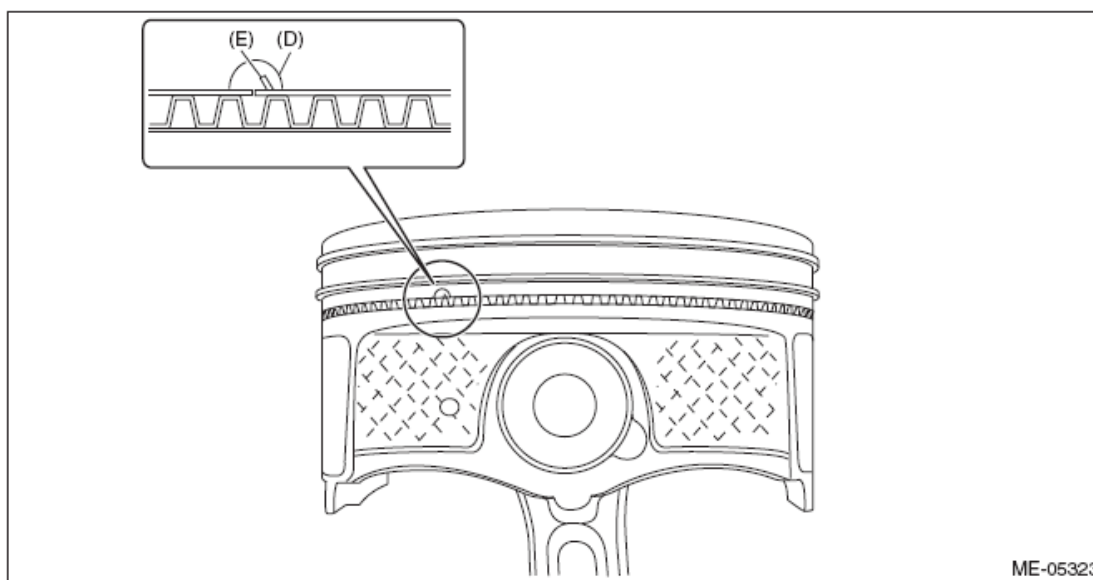


Fig. 395: Identifying Piston Upper Rail Spin Stopper And Side Hole
 Courtesy of SUBARU OF AMERICA, INC.

5. Position the ring gap of expander at (F) in the figure on the 180° opposite direction of (C).

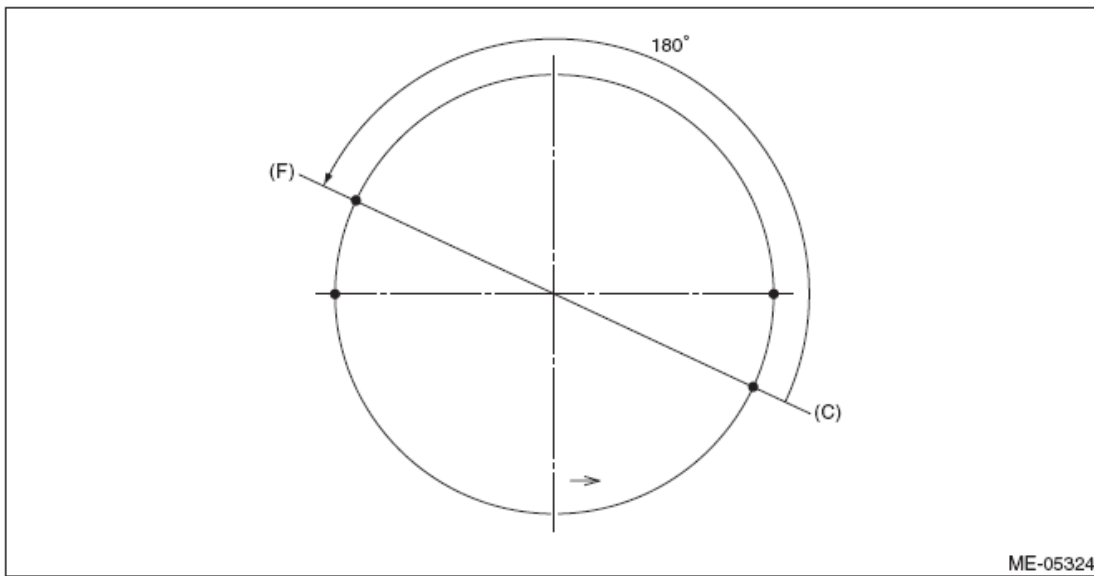


Fig. 396: Identifying Expander Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

6. Set the ring gap of lower rail at position (G), located 120° clockwise from (C) in the figure.

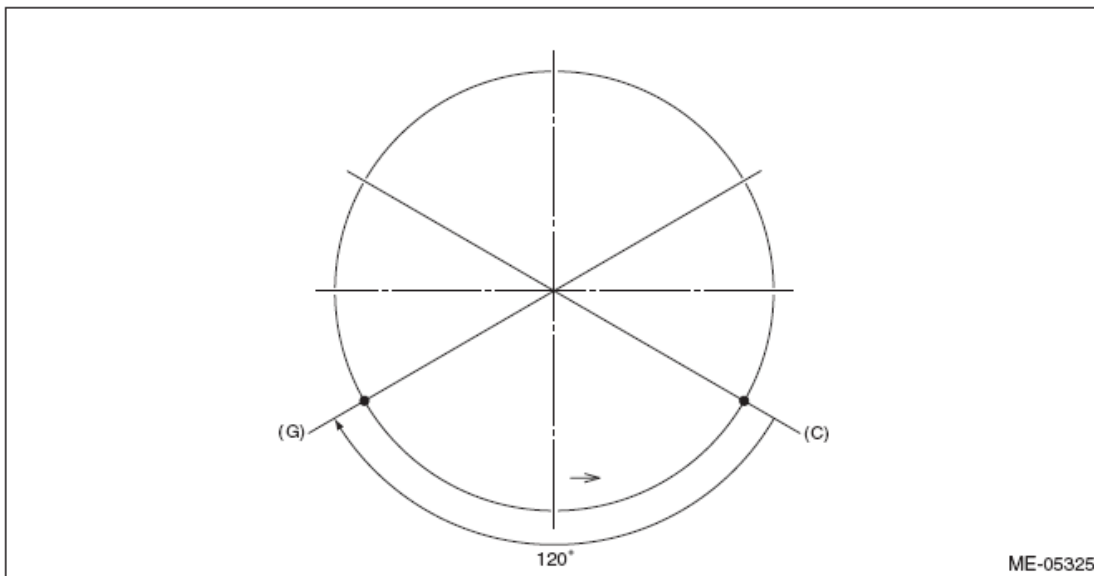


Fig. 397: Identifying Position Of Lower Rail Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

7. Check that the positions of piston ring gap are properly adjusted.

NOTE: When checking the positions of piston ring gap, also check that the piston ring gaps are not positioned within the range of piston skirt extended line.

12. Install the piston and connecting rod to the cylinder block.
 1. Apply engine oil to the outer circumference of each piston, crankshaft pin, and in the cylinder block.
 2. Turn the crankshaft so that the #1 pin (A) of crankshaft is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

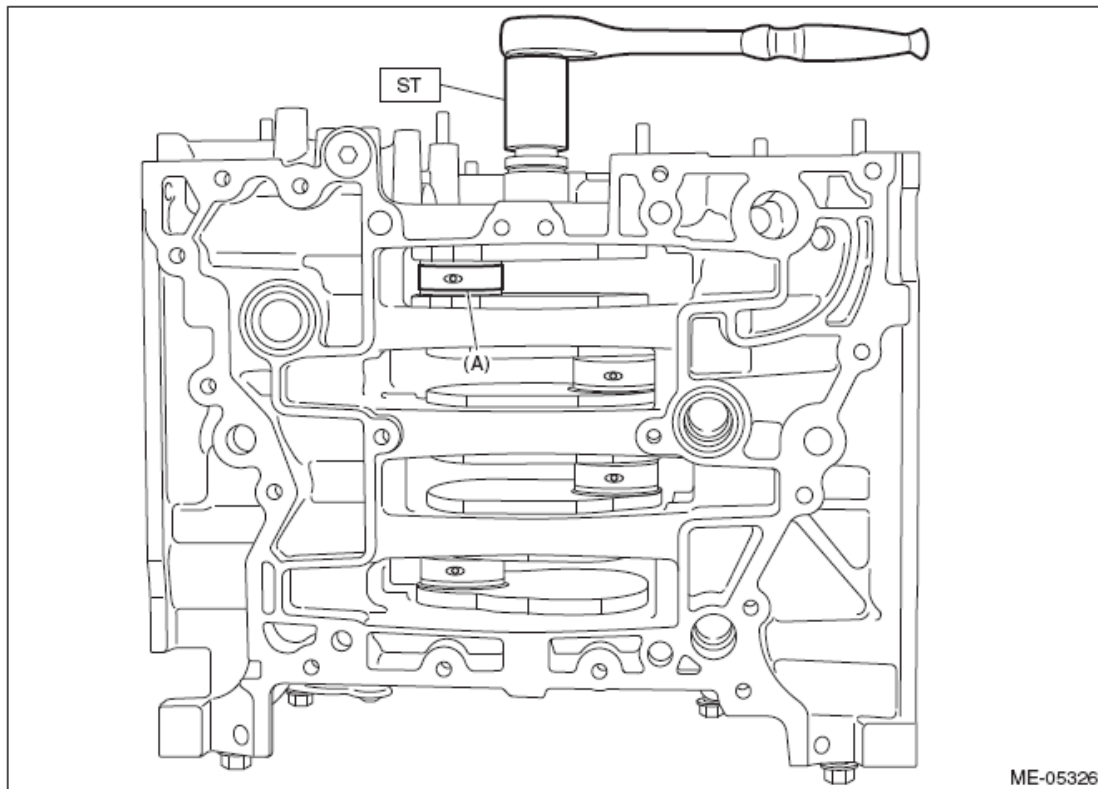


Fig. 398: Positioning Of Crankshaft No. 1 Pin At TDC
Courtesy of SUBARU OF AMERICA, INC.

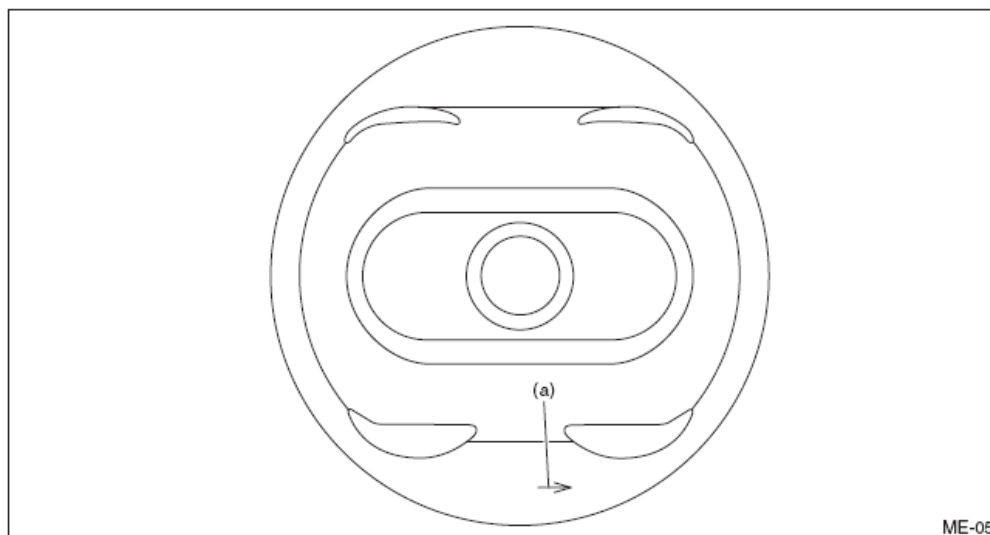
3. Compress the piston ring using piston ring compressor, and insert the #1 connecting rod with #1 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #1 pin of crankshaft 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.

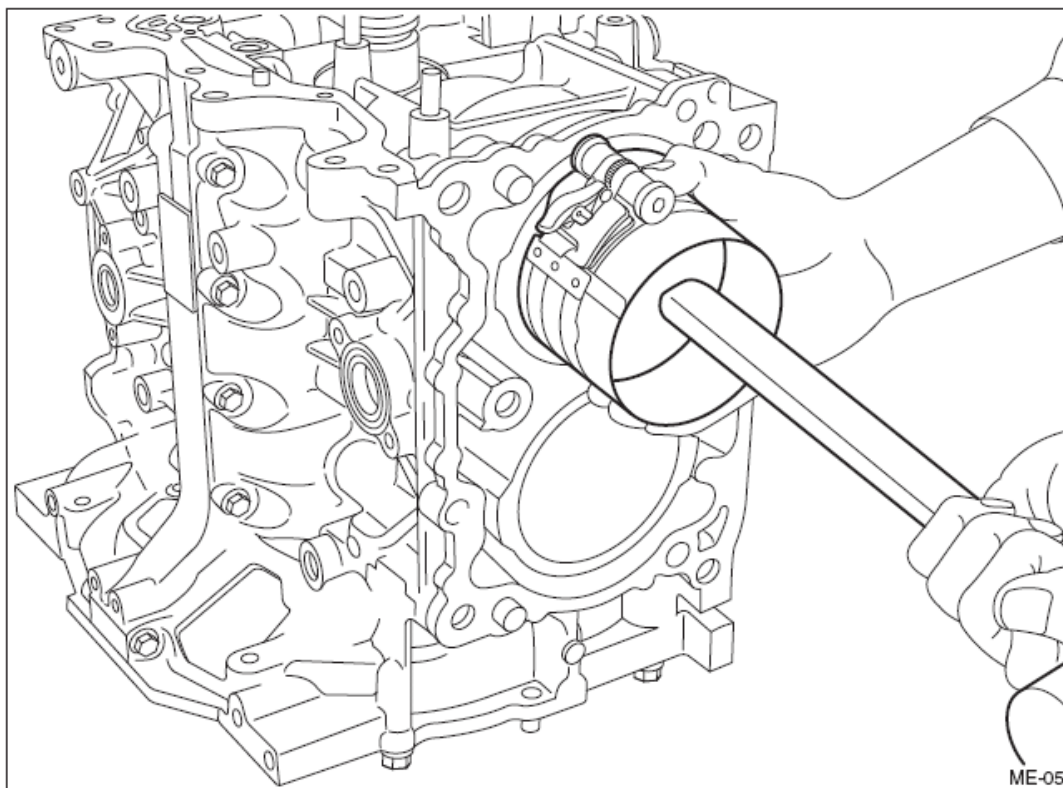


ME-05

(a) Front mark

Fig. 399: 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-05

Fig. 400: Tapping Crown Of Piston Using Handle Of Plastic Hammer

Courtesy of SUBARU OF AMERICA, INC.

4. Turn the crankshaft counterclockwise so that the #1 pin of crankshaft and the large end (A) of #1 connecting rod 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

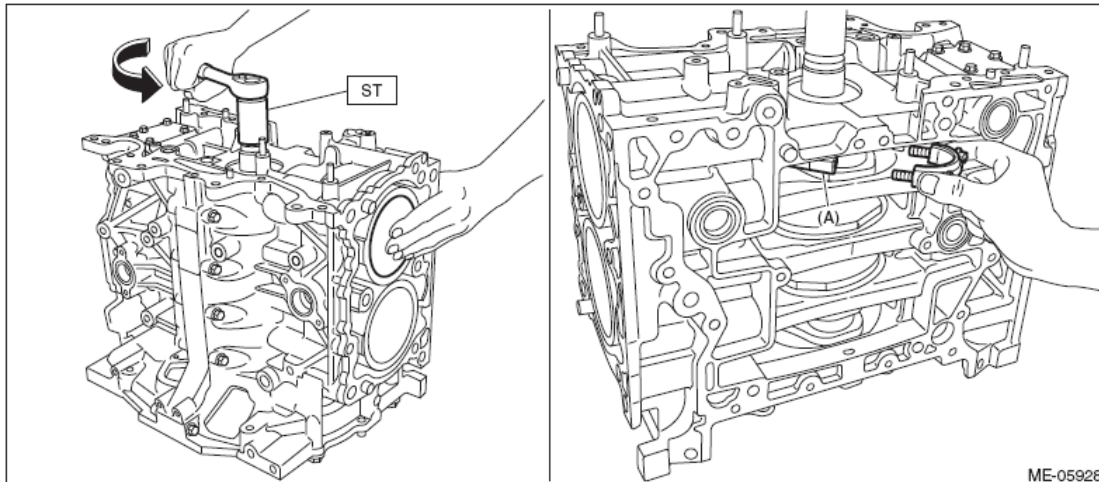


Fig. 401: Aligning No. 1 Connecting Rod Cap Seat And Connecting Rod Cap Bolt Threads
Courtesy of SUBARU OF AMERICA, INC.

5. Using ST, 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.

ST 18270AA020 SOCKET

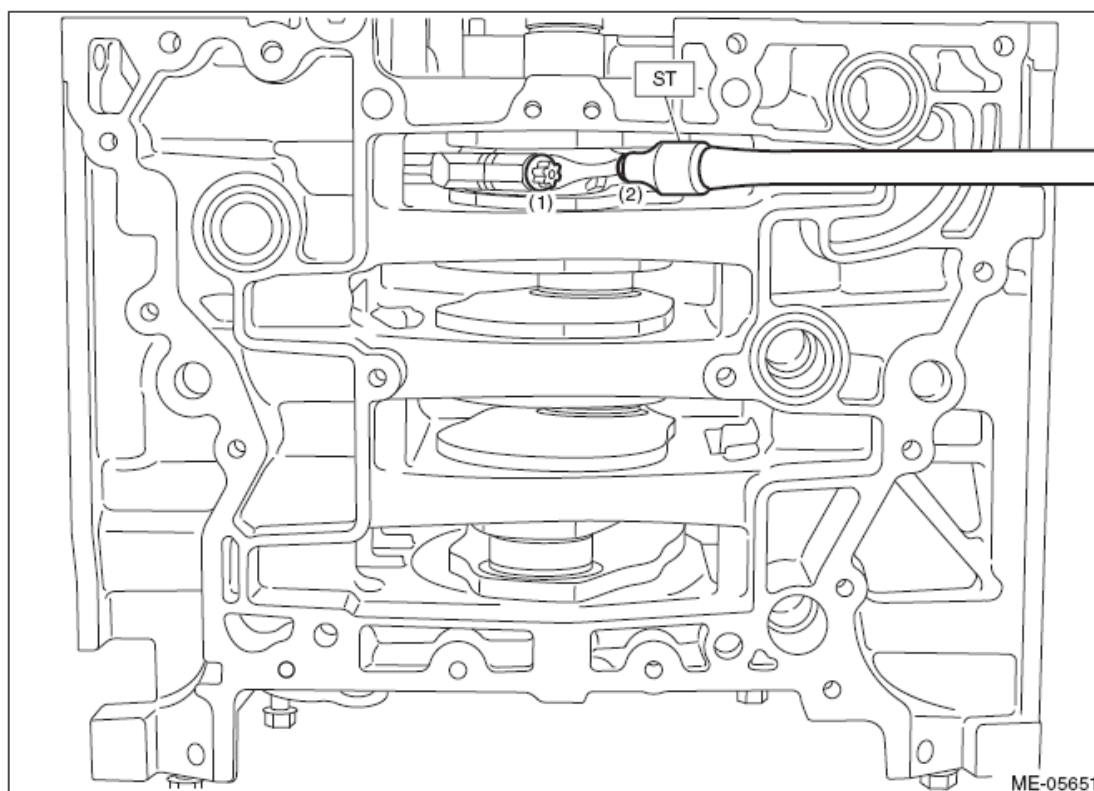


Fig. 402: Tightening No. 1 Connecting Rod Cap Bolts Using Tool
Courtesy of SUBARU OF AMERICA, INC.

6. Turn the crankshaft clockwise so that the #2 pin (A) of crankshaft is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

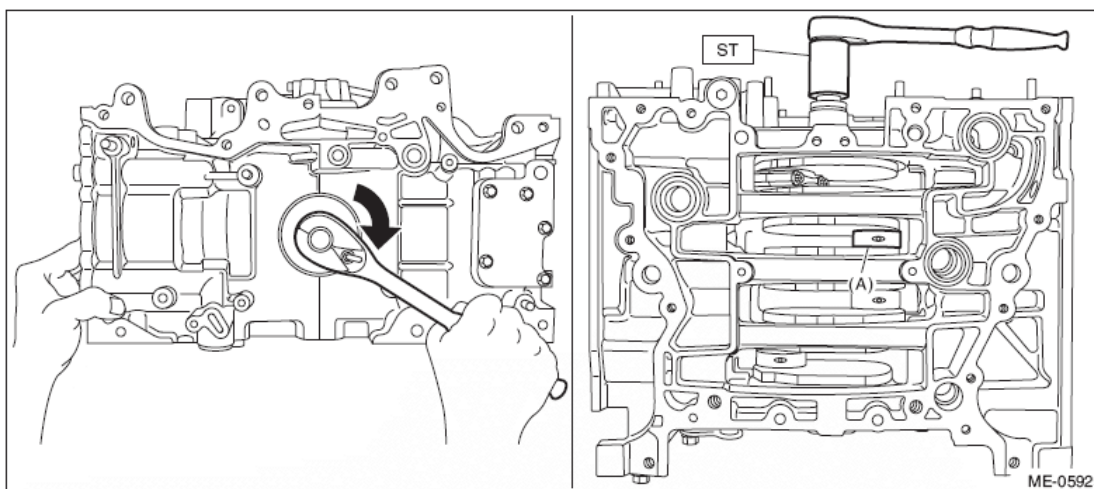


Fig. 403: Positioning Of Crankshaft No. 2 Pin At TDC
Courtesy of SUBARU OF AMERICA, INC.

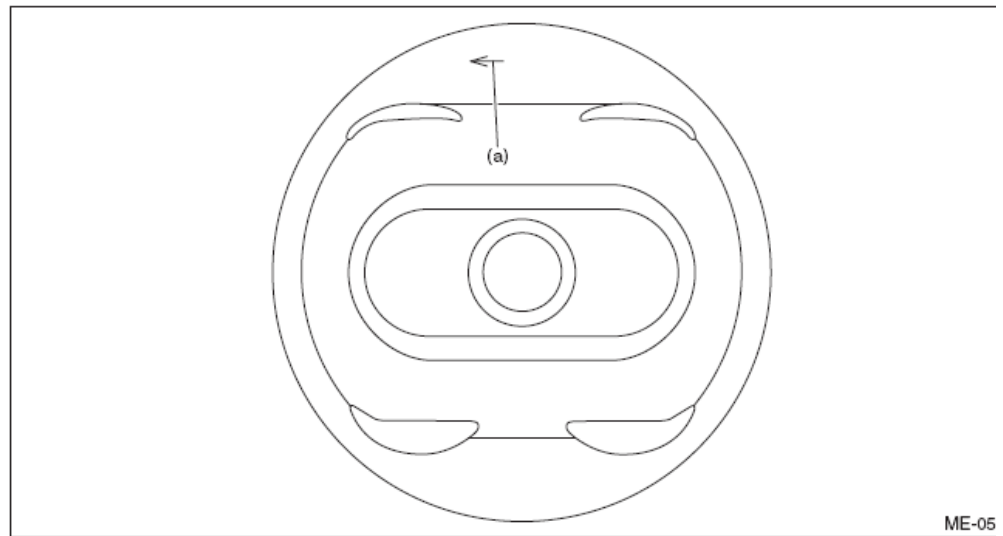
7. Compress the piston ring using piston ring compressor, and insert the #2 connecting rod with #2 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #2 pin of crankshaft 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. 404: 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.

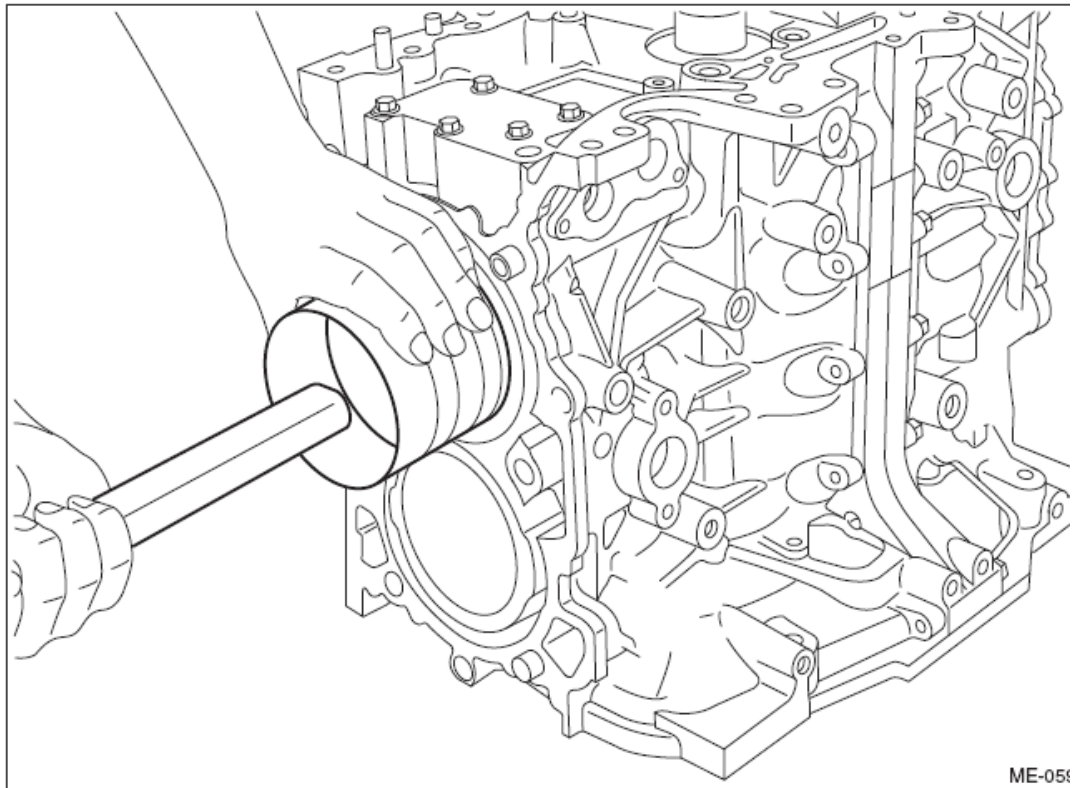


Fig. 405: Tapping Crown Of Piston Using Handle Of Plastic Hammer
Courtesy of SUBARU OF AMERICA, INC.

8. Turn the crankshaft clockwise so that the #2 pin of crankshaft and the large end (A) of #2 connecting rod 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

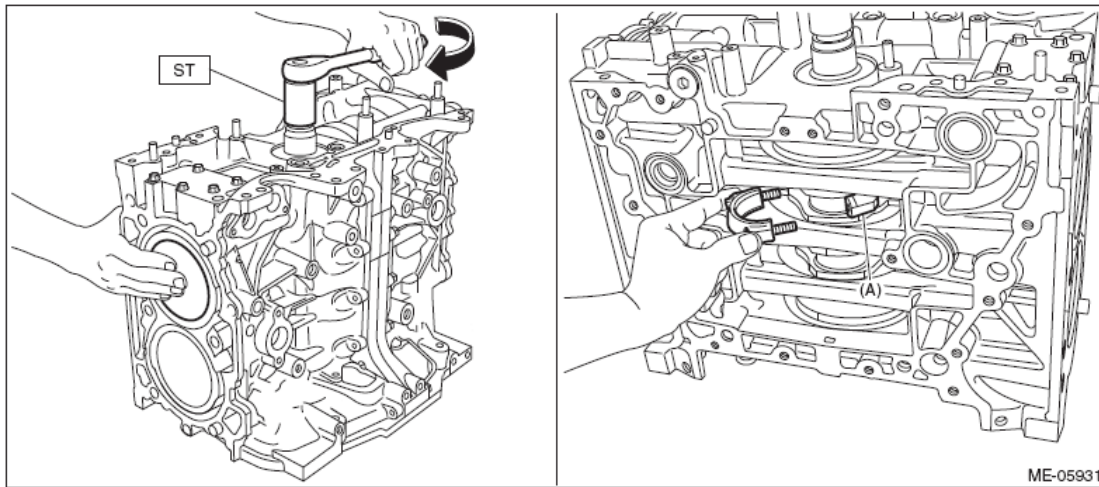


Fig. 406: Setting No. 2 Connecting Rod Cap And Bolt
Courtesy of SUBARU OF AMERICA, INC.

9. Using ST, 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.

ST 18270AA020 SOCKET

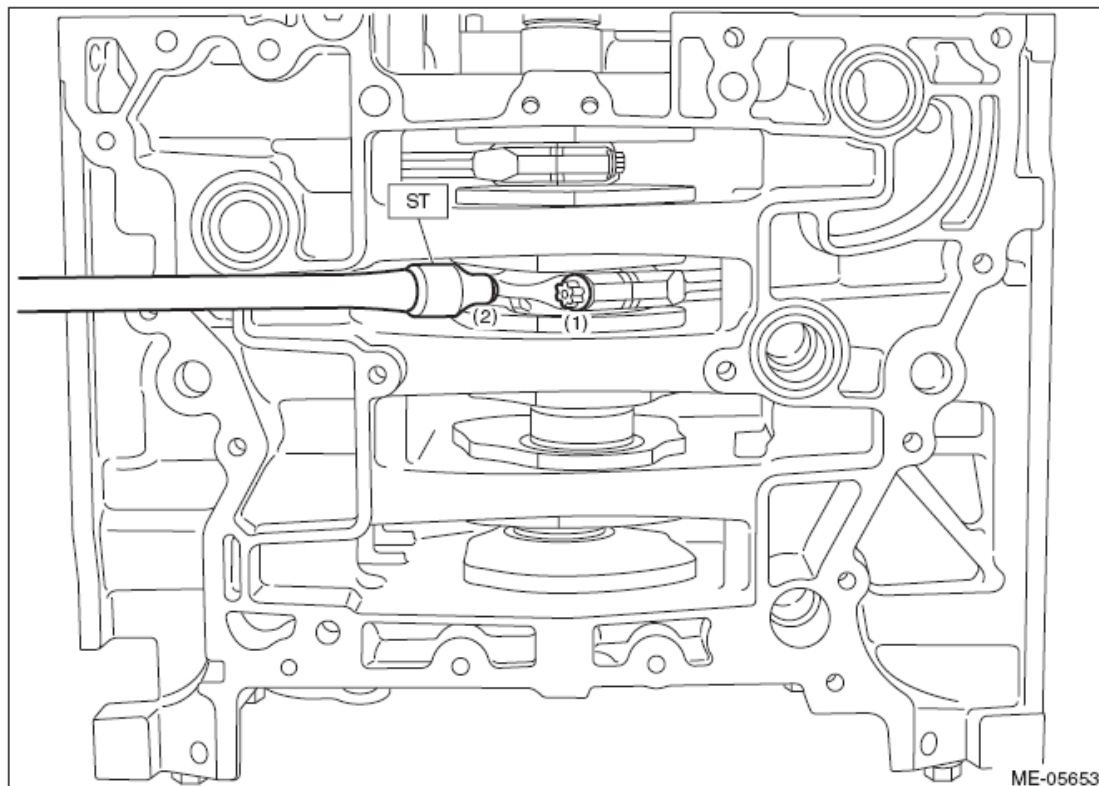


Fig. 407: Tightening No. 2 Connecting Rod Cap Bolts Using ST

Courtesy of SUBARU OF AMERICA, INC.

10. Turn the crankshaft clockwise so that the #3 pin (A) of crankshaft is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

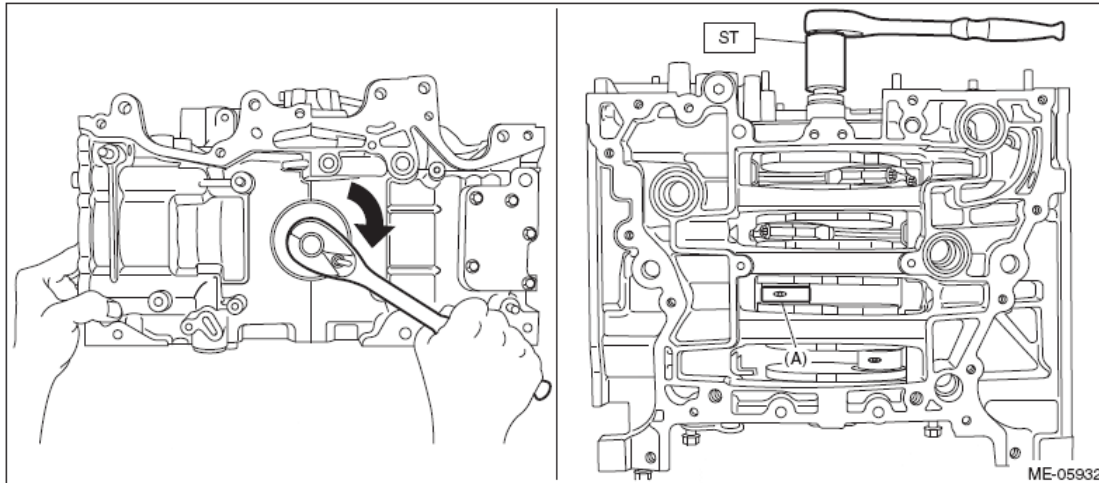


Fig. 408: Positioning Of Crankshaft No. 3 Pin At TDC

Courtesy of SUBARU OF AMERICA, INC.

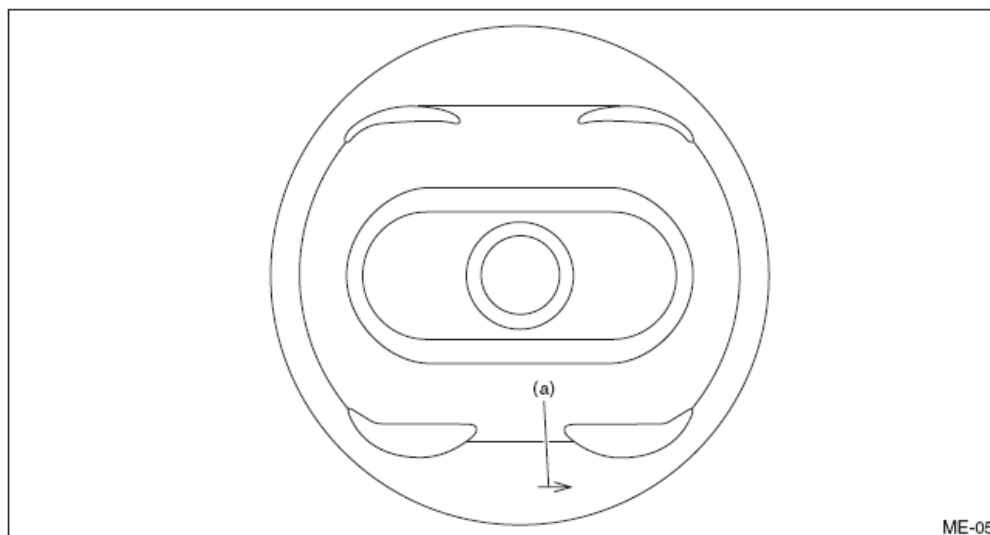
11. Compress the piston ring using piston ring compressor, and insert the #3 connecting rod with #3 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #3 pin of crankshaft 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.

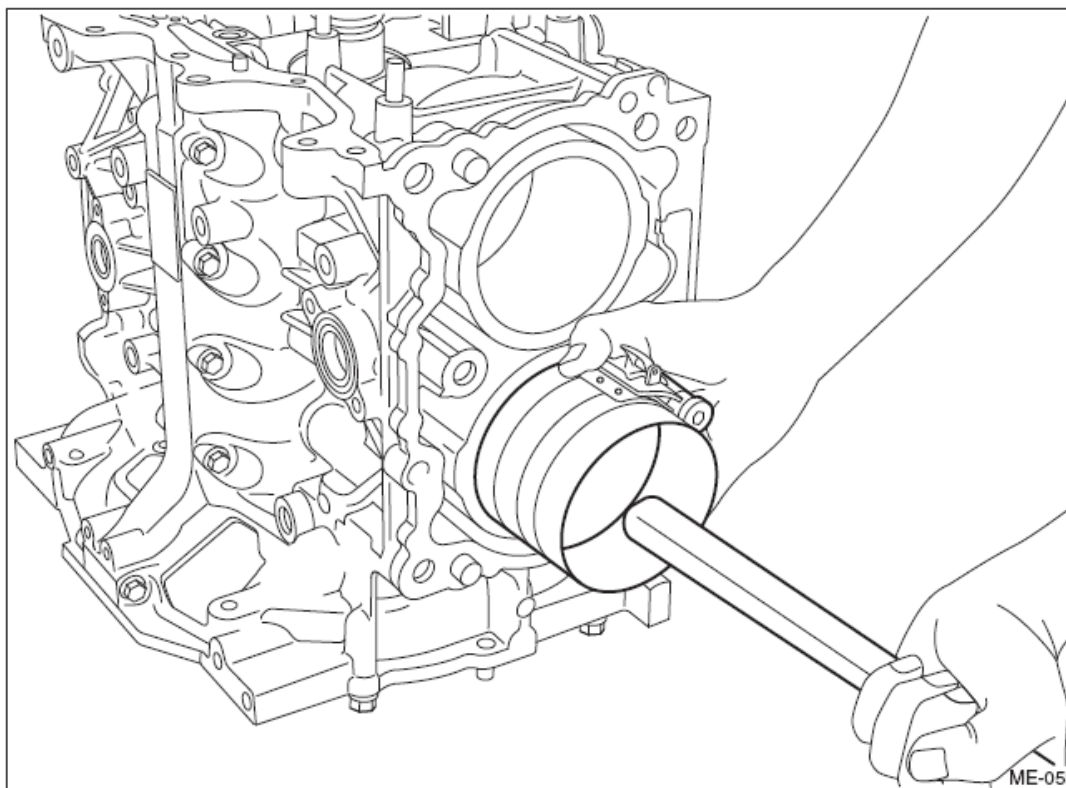


ME-05

(a) Front mark

Fig. 409: 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-05

Fig. 410: Tapping Crown Of Piston Using Handle Of Plastic Hammer

Courtesy of SUBARU OF AMERICA, INC.

12. Turn the crankshaft counterclockwise so that the #3 pin of crankshaft and the large end (A) 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

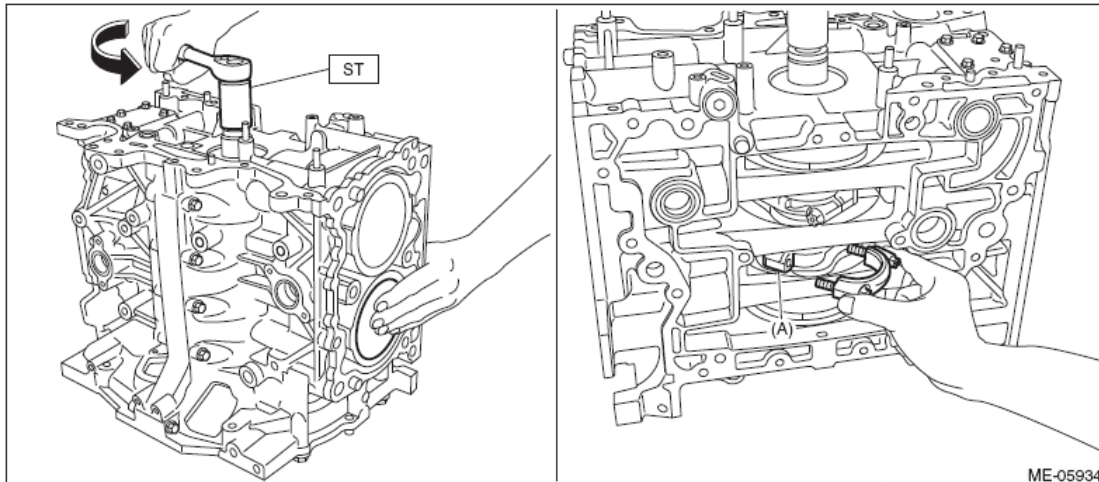


Fig. 411: Setting No. 3 Connecting Rod Cap And Bolt
Courtesy of SUBARU OF AMERICA, INC.

13. Using ST, 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.

ST 18270AA020 SOCKET

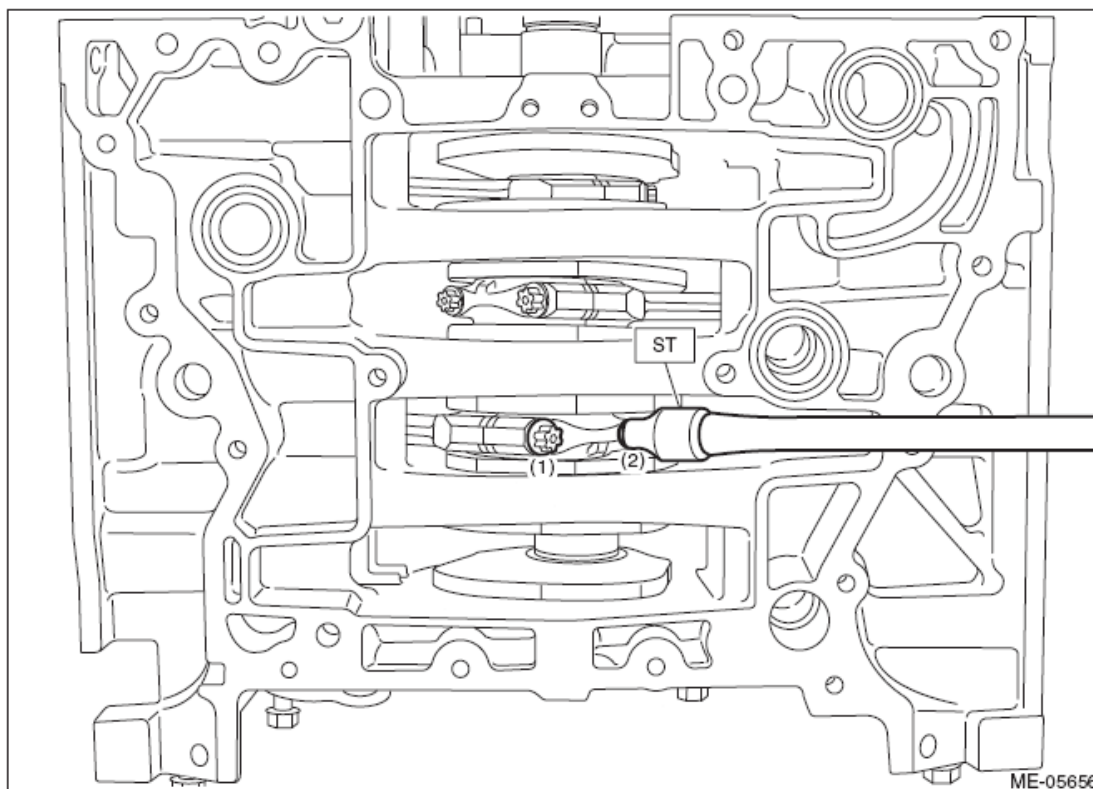


Fig. 412: Tightening No. 3 Connecting Rod Cap Bolts Using Tool
Courtesy of SUBARU OF AMERICA, INC.

14. Turn the crankshaft clockwise so that the #4 pin (A) of crankshaft is positioned at TDC using ST.

ST 18252AA000 CRANKSHAFT SOCKET

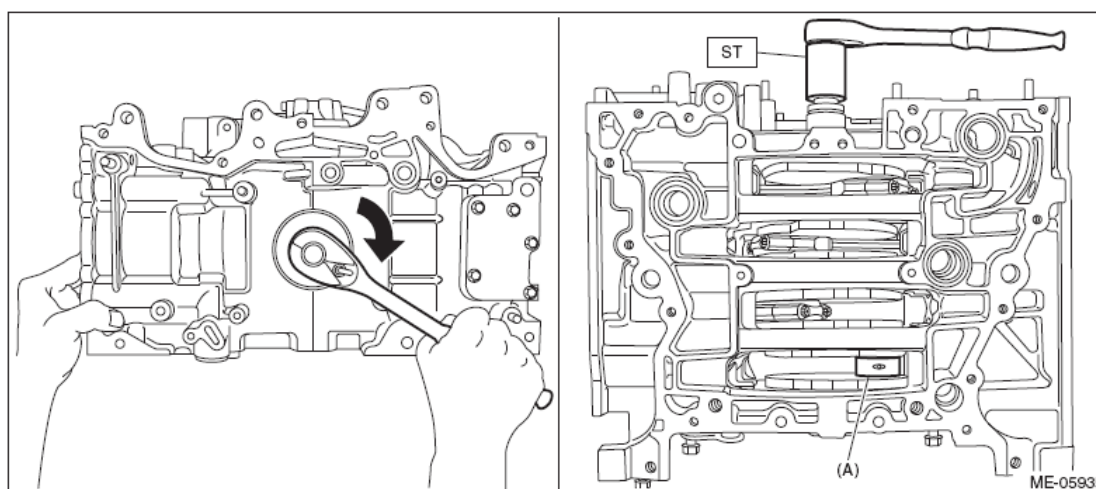


Fig. 413: Positioning Of Crankshaft No. 4 Pin At TDC
Courtesy of SUBARU OF AMERICA, INC.

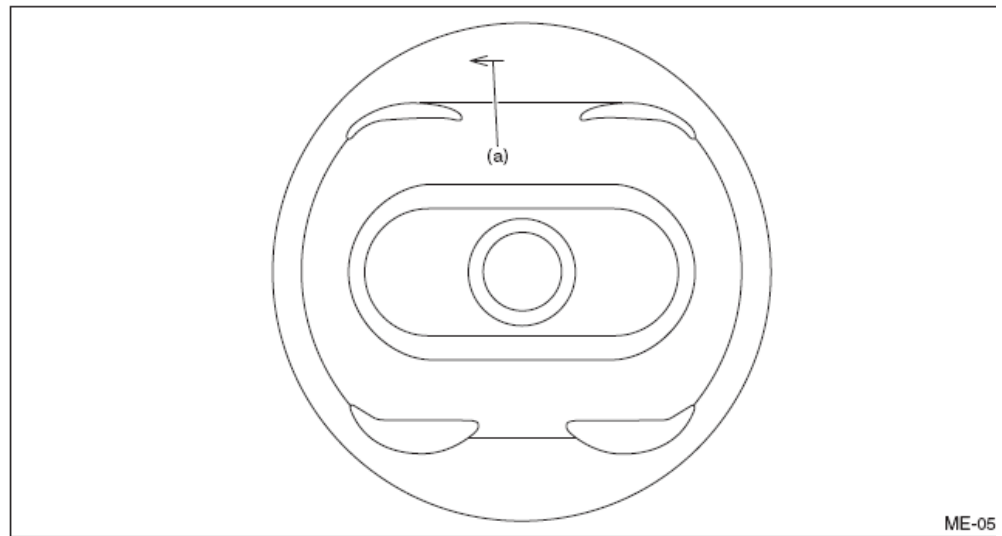
15. Compress the piston ring using piston ring compressor, and insert the #4 connecting rod with #4 piston into cylinder block.

CAUTION:

- Be careful not to damage the cylinder liner and #4 pin of crankshaft 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.

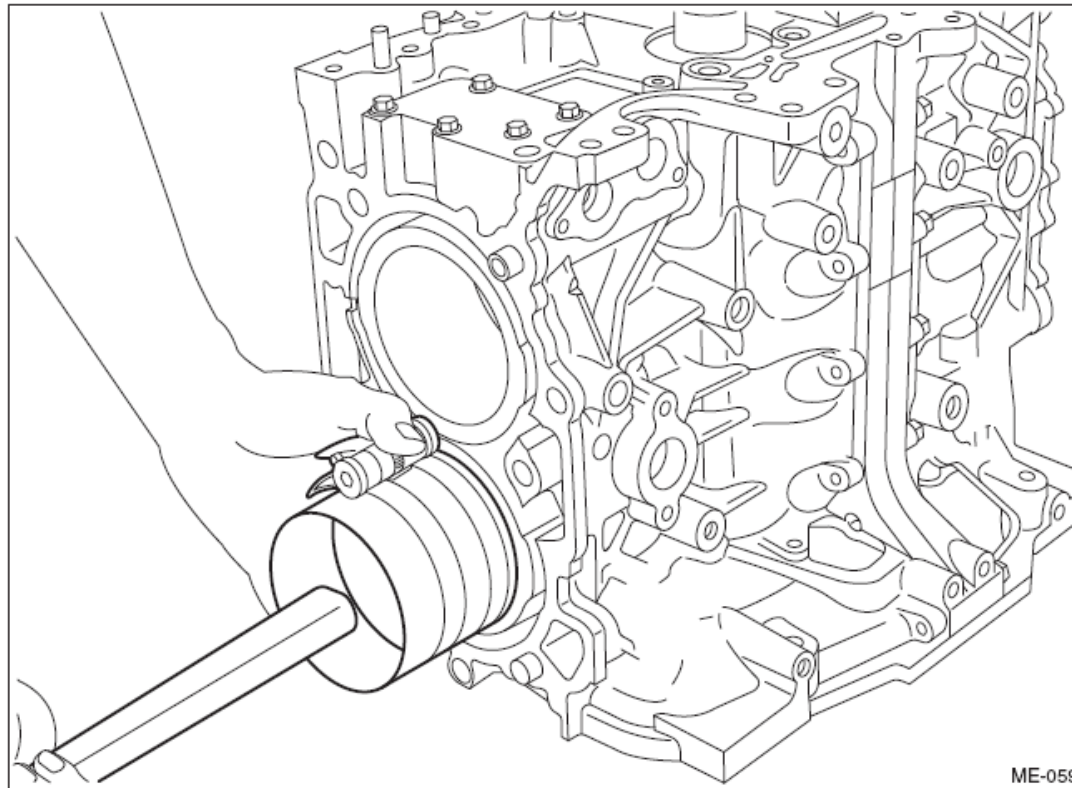


ME-05

(a) Front mark

Fig. 414: 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-055

Fig. 415: Tapping Crown Of Piston Using Handle Of Plastic Hammer
Courtesy of SUBARU OF AMERICA, INC.

16. Turn the crankshaft clockwise so that the #4 pin of crankshaft and the large end (A) of #4 connecting rod 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

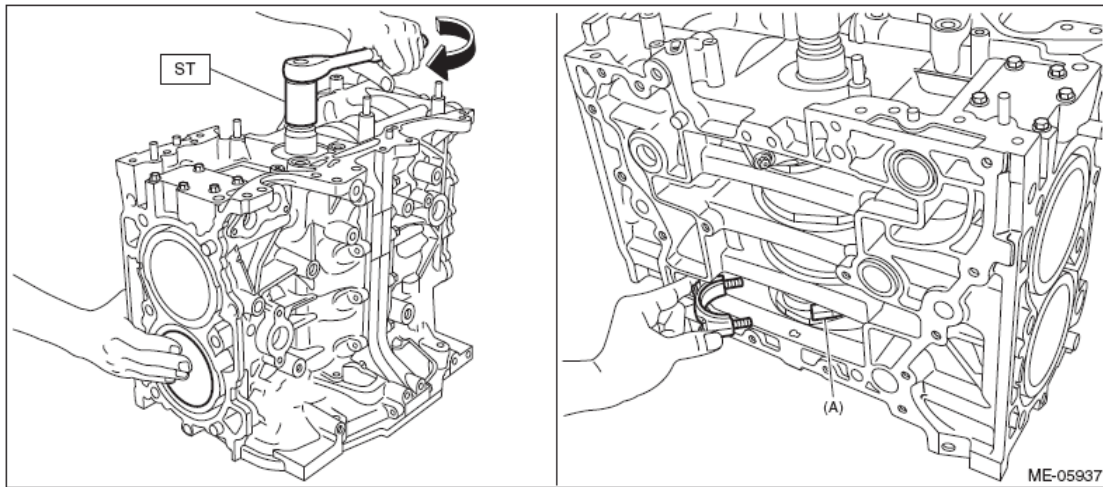


Fig. 416: Setting No. 4 Connecting Rod Cap And Bolt
Courtesy of SUBARU OF AMERICA, INC.

17. Using ST, 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.

ST 18270AA020 SOCKET

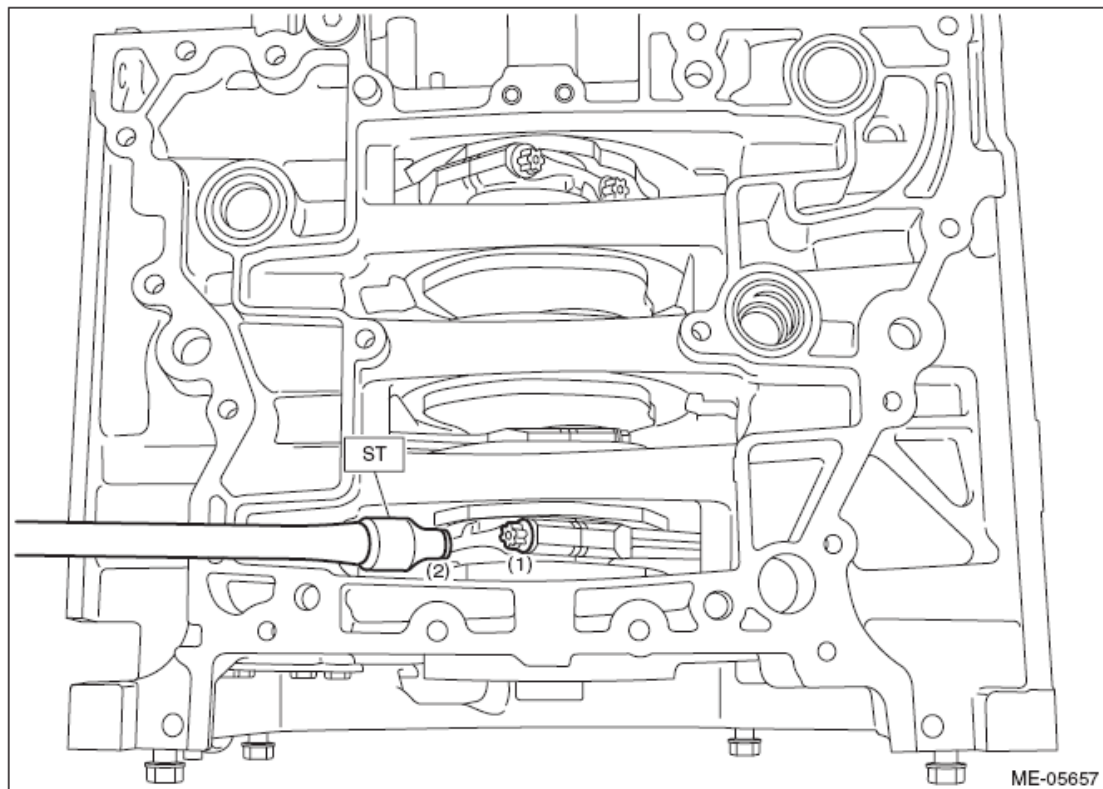


Fig. 417: Tightening No. 4 Connecting Rod Cap Bolts Using Tool

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.

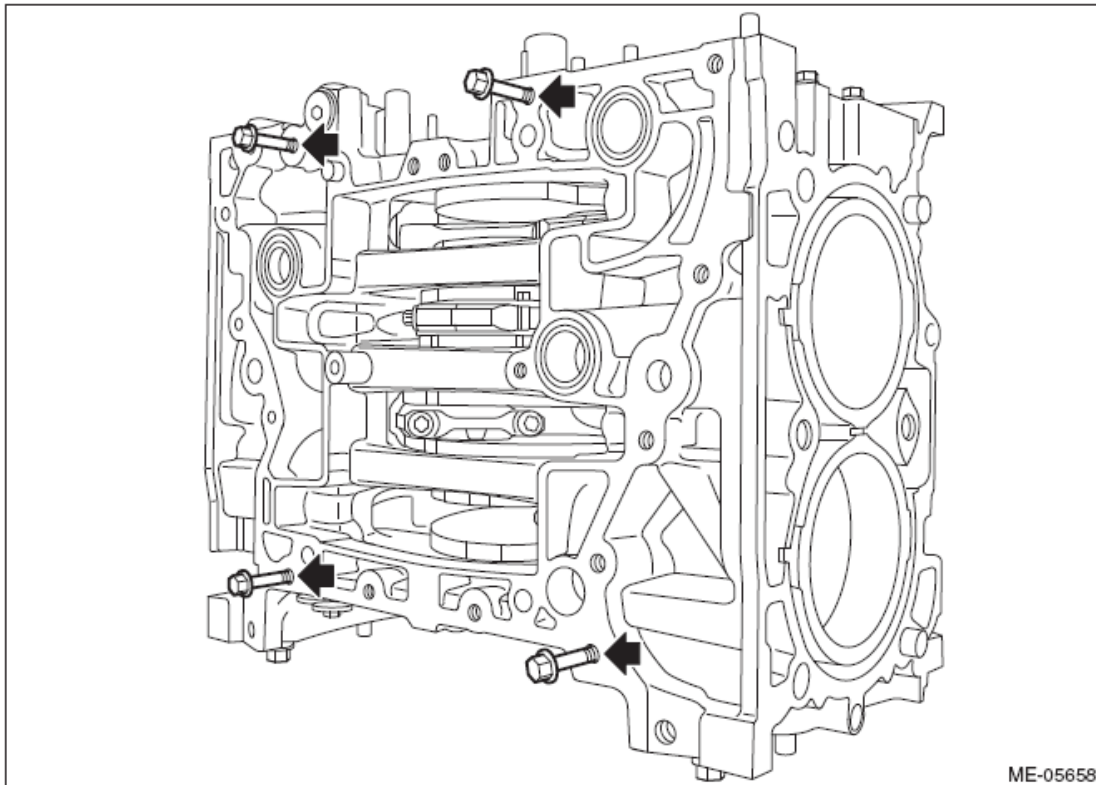


Fig. 418: Locating Cam Carrier Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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

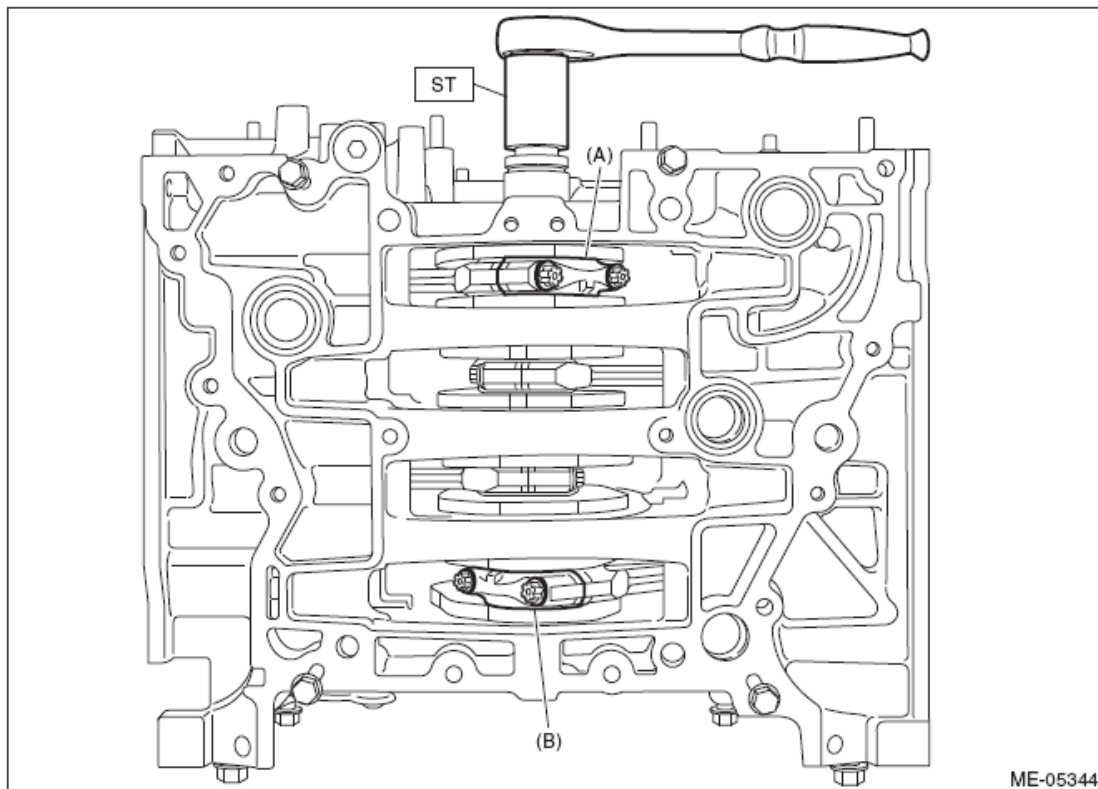


Fig. 419: Aligning No. 1 Connecting Rod Cap And No. 4 Connecting Rod Cap Using Crankshaft Socket
 Courtesy of SUBARU OF AMERICA, INC.

20. Using ST1 and ST2, tighten the #1 connecting rod cap bolt and #4 connecting rod cap bolt with specified angle in numerical order as shown in the figure.

NOTE: **Attach the magnet used for securing the ST1 (ANGLE GAUGE) to the cam carrier mounting bolt attached in step (18).**

ST1 18854AA000 ANGLE GAUGE

ST2 18270AA020 SOCKET

Tightening angle:

137°±2°

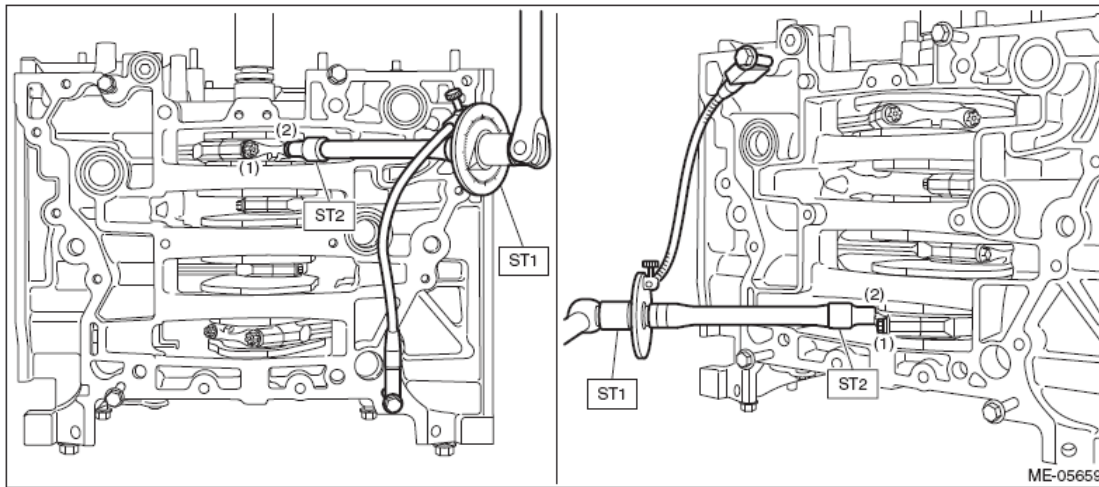


Fig. 420: Tightening No. 1 And No. 4 Connecting Rod Cap Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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

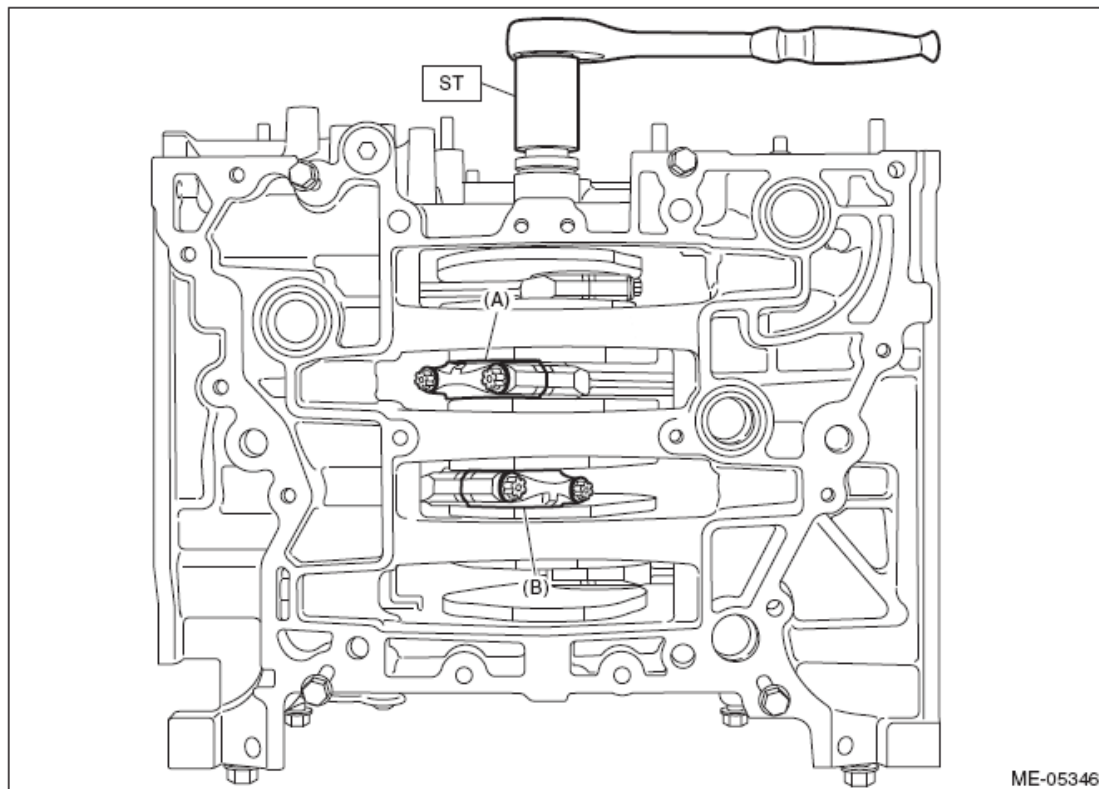


Fig. 421: Aligning No. 2 And No. 3 Connecting Rod Cap
 Courtesy of SUBARU OF AMERICA, INC.

22. Using ST1 and ST2, 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 ST1 (ANGLE GAUGE) to the cam carrier mounting bolt attached in step (18).

ST1 18854AA000 ANGLE GAUGE

ST2 18270AA020 SOCKET

Tightening angle:

137°±2°

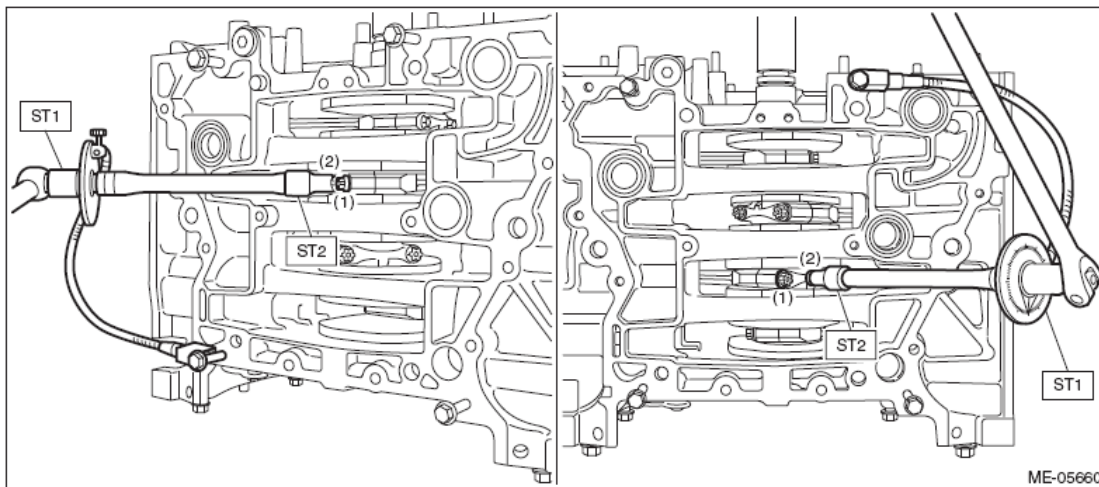


Fig. 422: Aligning No. 2 And No. 3 Connecting Rod Cap Bolts
Courtesy of SUBARU OF AMERICA, INC.

23. Remove the cam carrier mounting bolts attached at the locations shown in the figure.

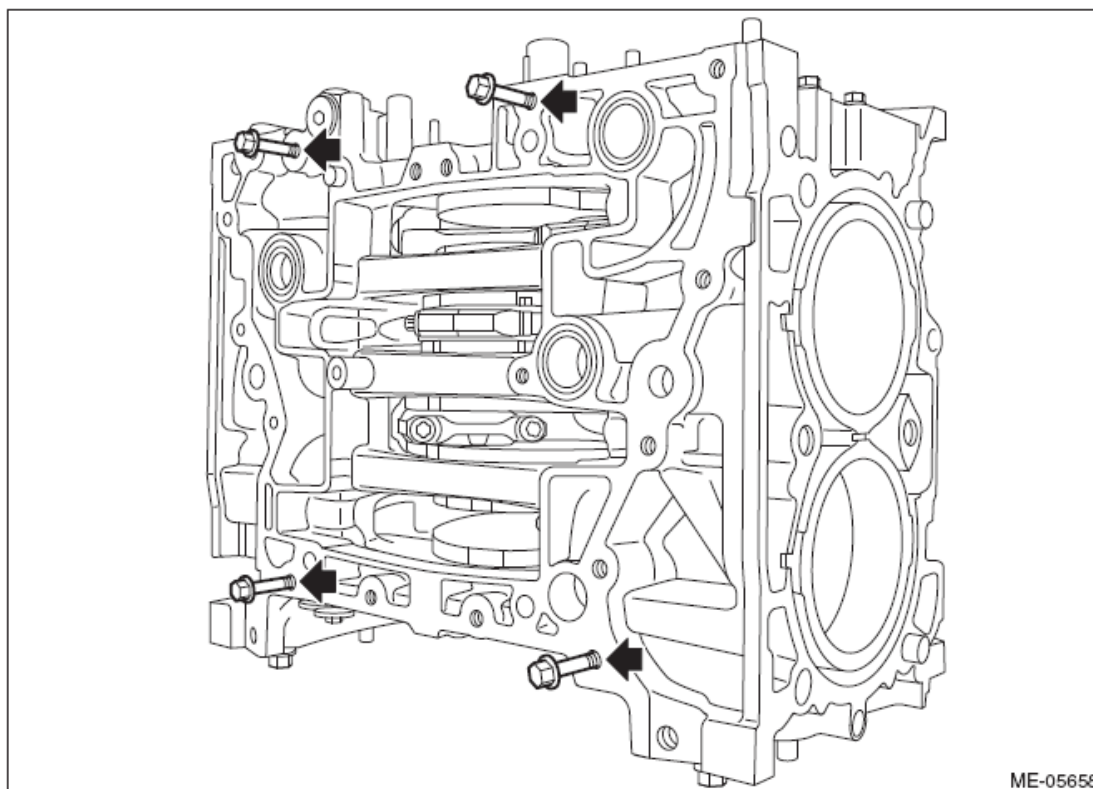


Fig. 423: Locating Cam Carrier Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

13. Set the cylinder block so that the oil pan side faces upward, and remove the mounting bolts for A/C compressor and the generator bracket attached to the locations shown in the figure.

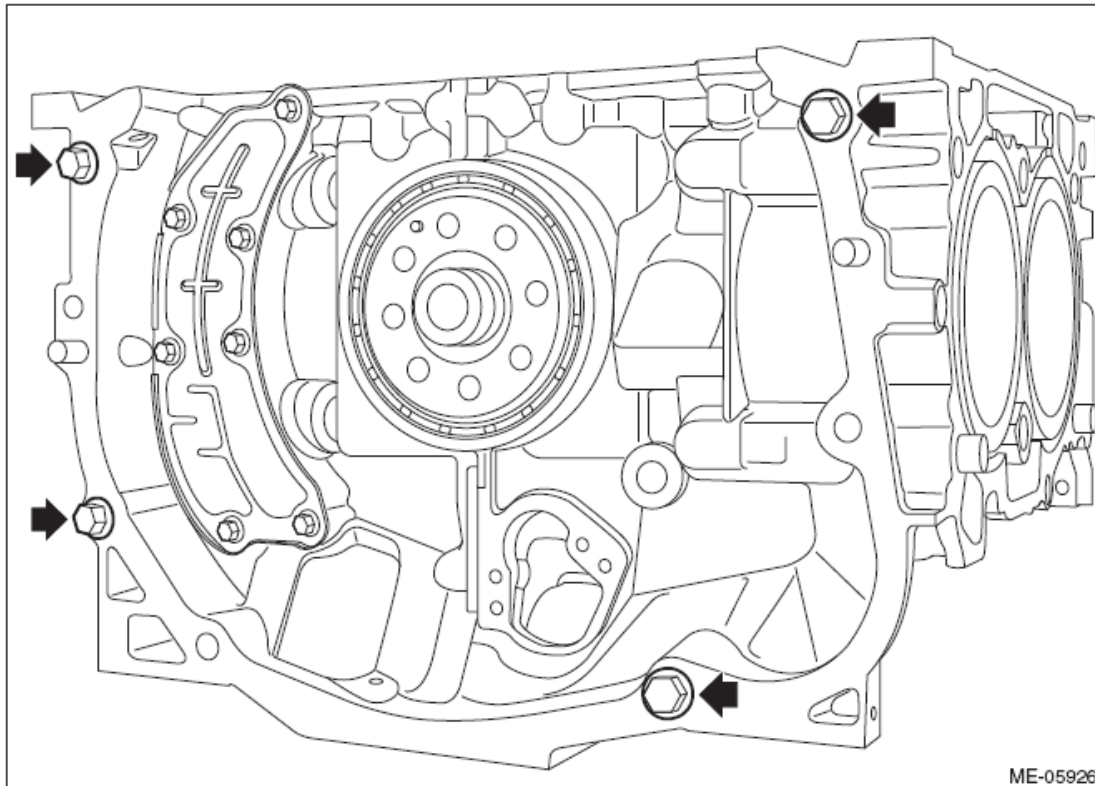


Fig. 424: Locating A/C Compressor And Generator Bracket Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

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:

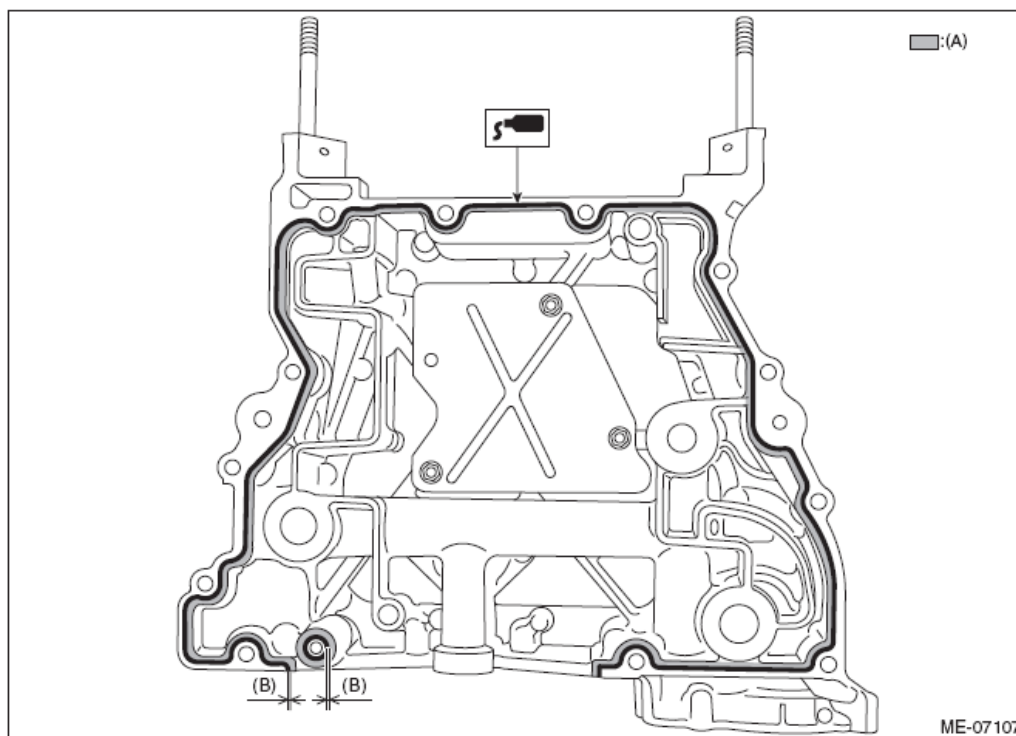
- Before applying liquid gasket, degrease the old liquid gasket seal surface of the cylinder block and the oil pan upper.
- Install within 5 min. after applying liquid gasket.
- Apply liquid gasket 1.5 mm (0.0591 in) outside from the chamfer surface. However, application of liquid gasket on the chamfer 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±0.0394 in)



(A) Chamfer surface

(B) 1.5 mm (0.0591 in)

Fig. 425: Identifying Liquid Gasket Applying Area On Oil Pan Upper Mating Surface
Courtesy of SUBARU OF AMERICA, INC.

2. Install the O-ring to the cylinder block.

NOTE: Use new O-rings.

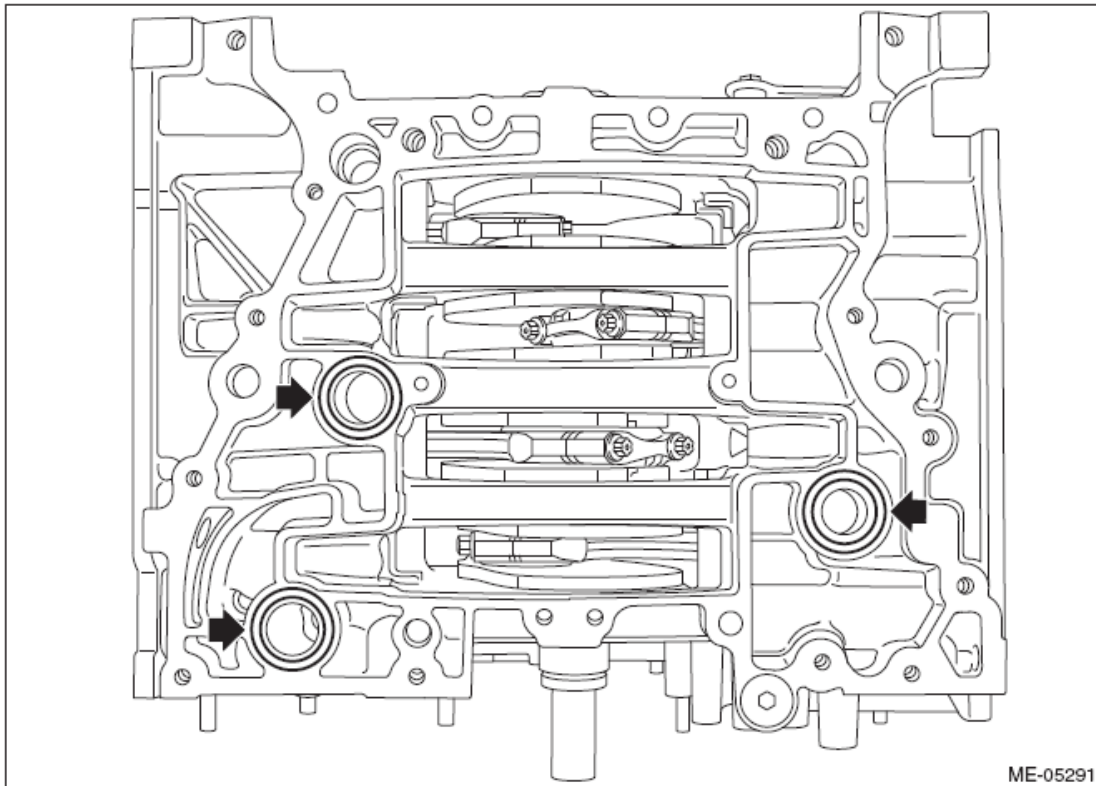


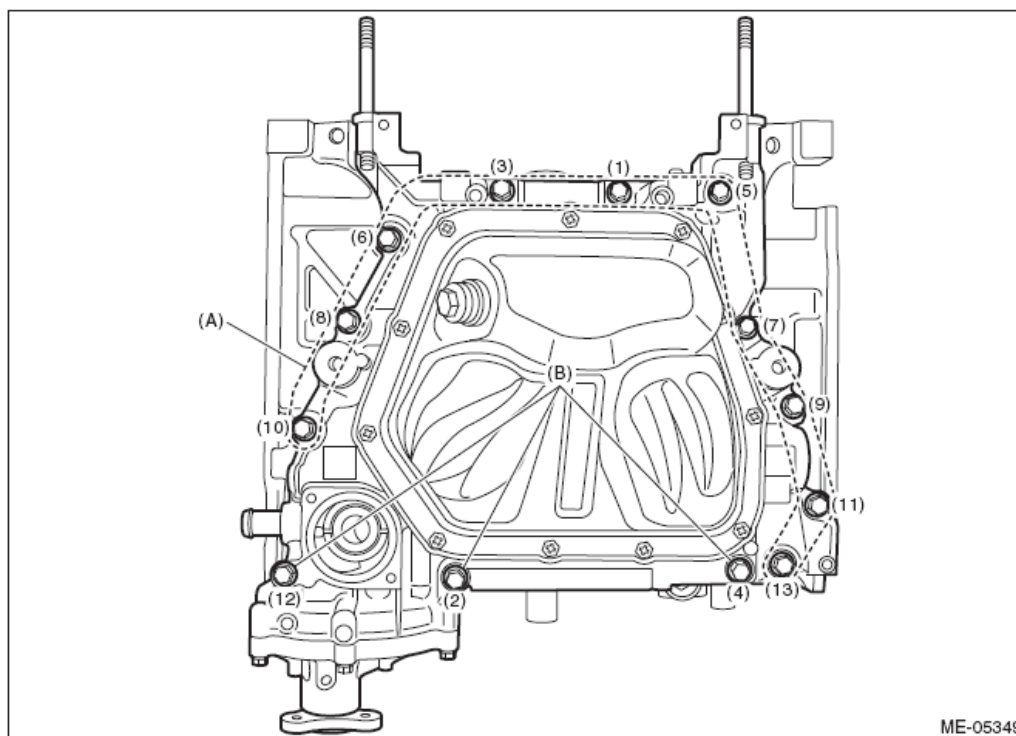
Fig. 426: Locating Cylinder Block O-Rings
Courtesy of SUBARU OF AMERICA, INC.

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. 427: Identifying Tightening Sequence Of Oil Pan Upper Mounting Bolts
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)

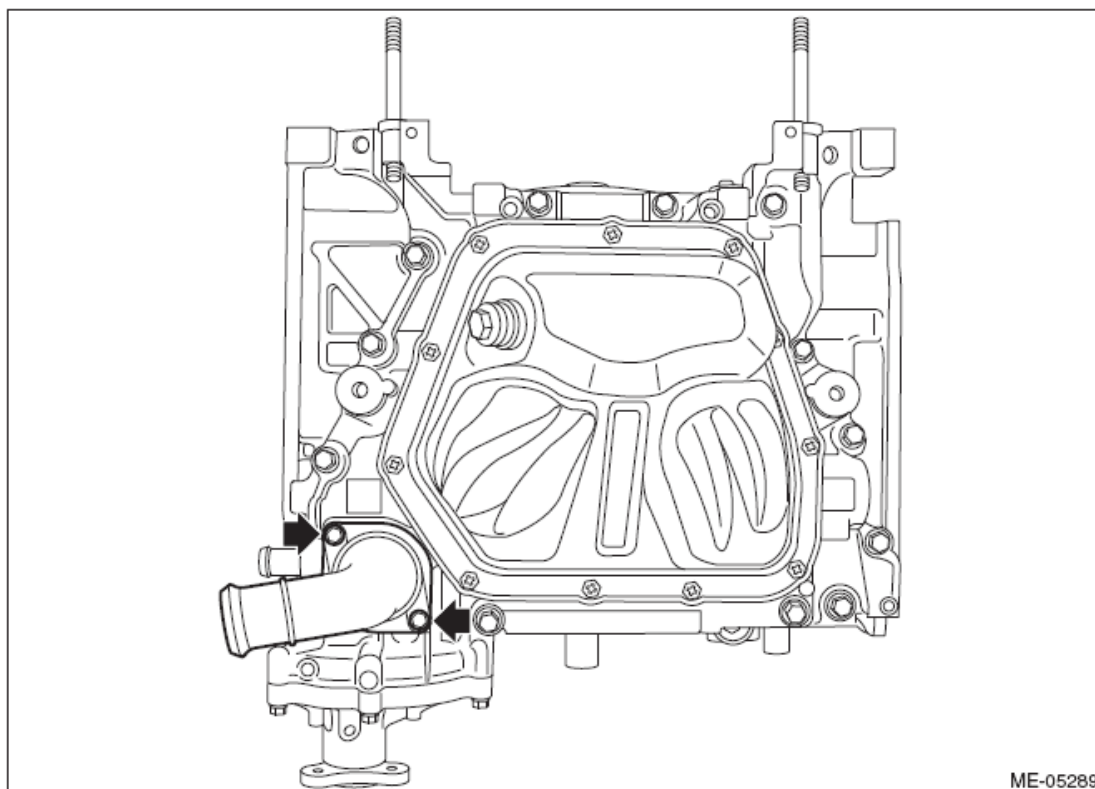


Fig. 428: Locating Thermostat Cover Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

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)

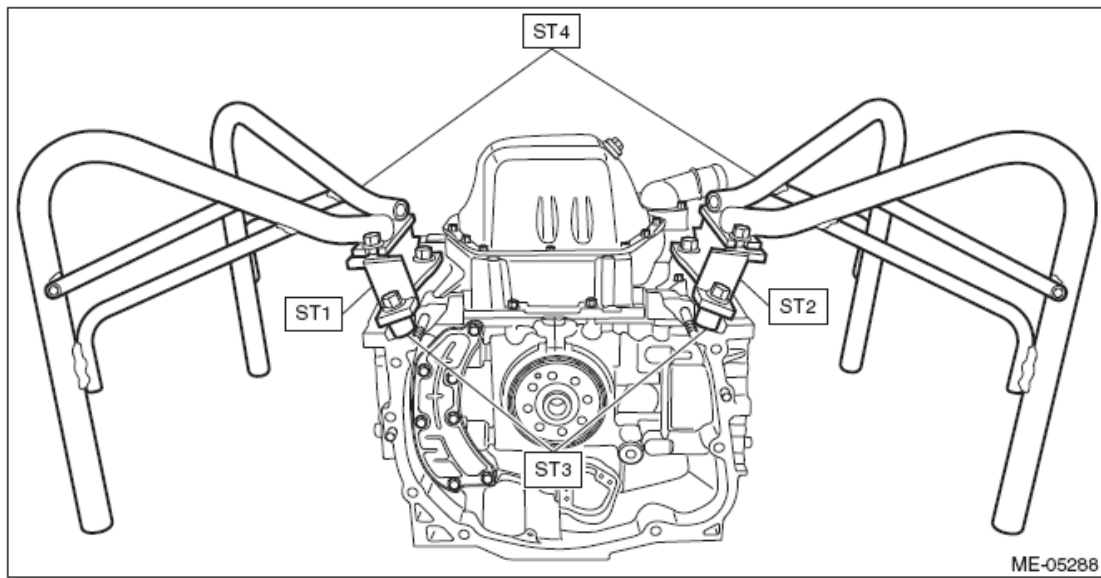


Fig. 429: Supporting Cylinder Block Using Special Tools
Courtesy of SUBARU OF AMERICA, INC.

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)

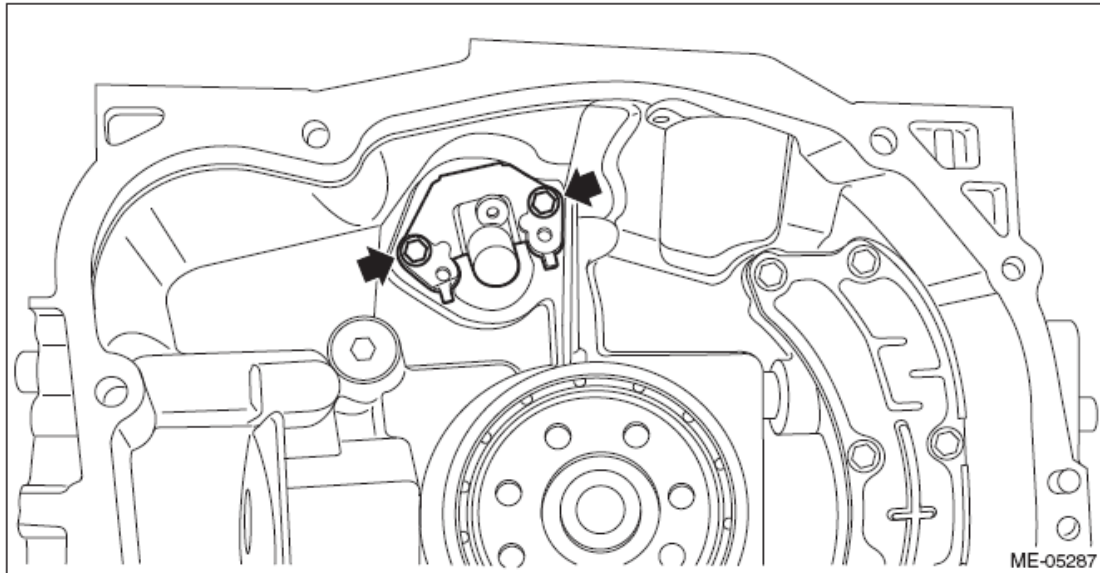


Fig. 430: Locating Crankshaft Position Sensor Holder Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

18. Install the crankshaft position sensor plate with drive plate. (CVT model) Refer to **INSTALLATION** .

19. Install the crankshaft position sensor plate with flywheel. (MT model) Refer to **INSTALLATION** .
20. Install the clutch disc and cover. (MT model) Refer to **INSTALLATION** .
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)

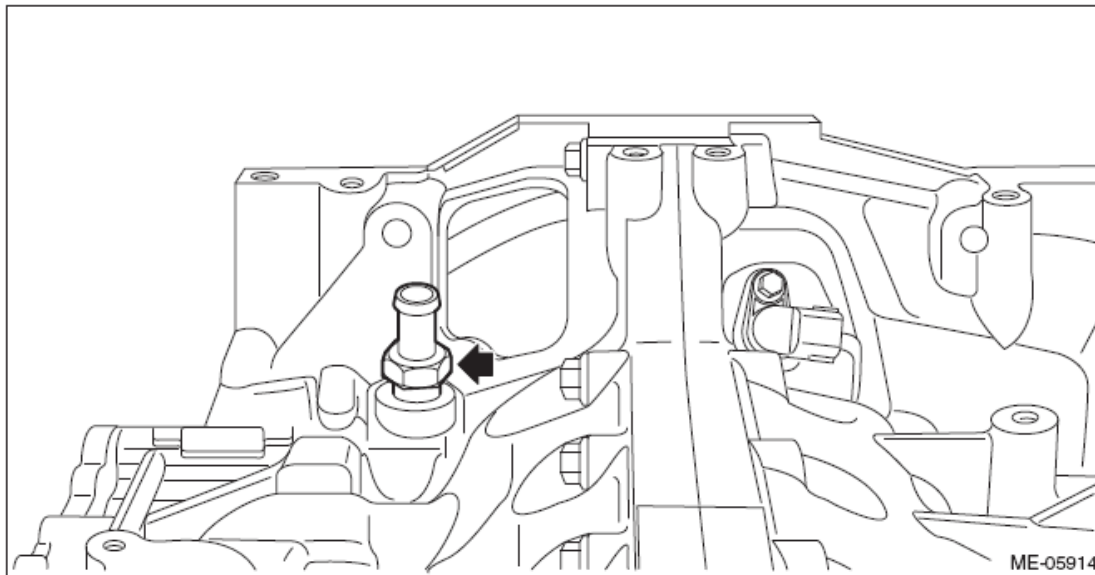


Fig. 431: Locating Cylinder Block RH PCV Valve
Courtesy of SUBARU OF AMERICA, INC.

22. Install the vacuum hose to the PCV valve.

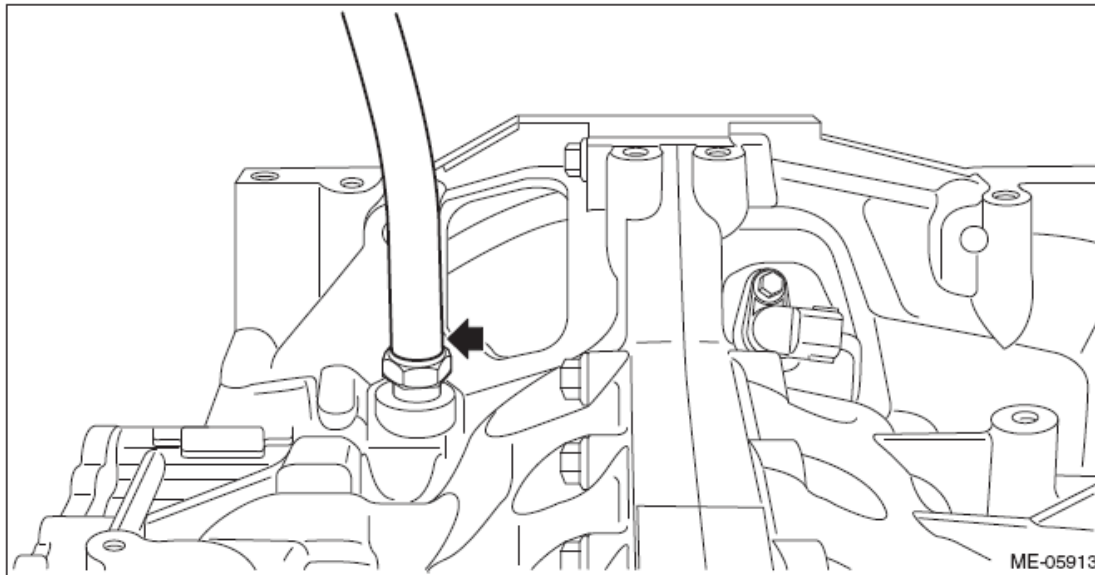


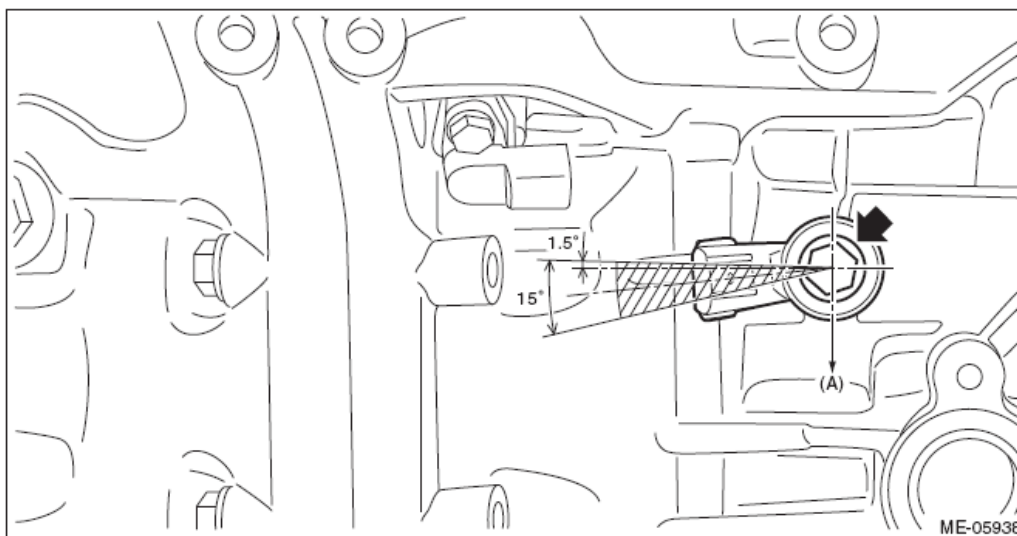
Fig. 432: Locating PCV Valve Vacuum Hose
Courtesy of SUBARU OF AMERICA, INC.

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. 433: Identifying Knock Sensor Connector Installation Angle

Courtesy of SUBARU OF AMERICA, INC.

24. Install the O-ring to the cylinder block and PCV connector.

NOTE: Use new O-rings.

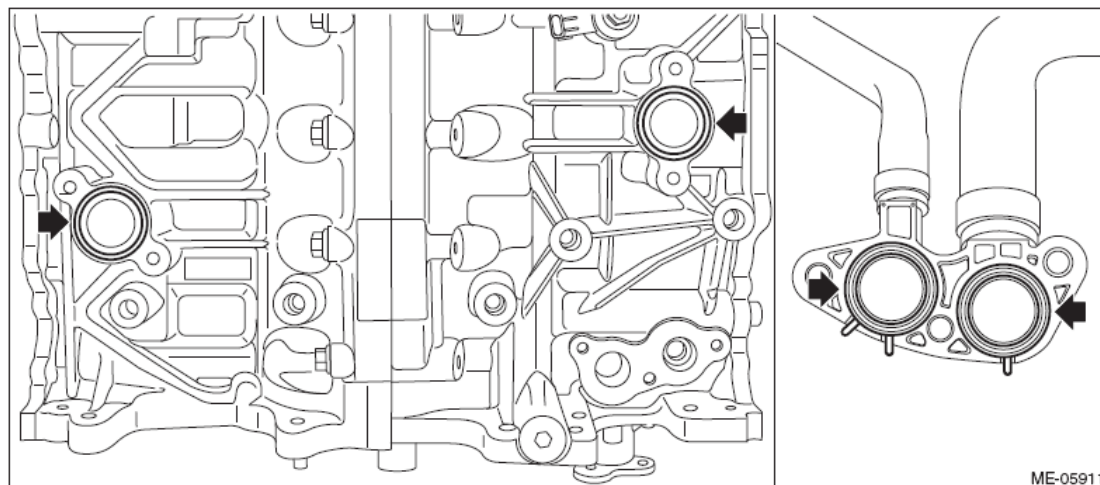


Fig. 434: Locating Cylinder Block And PCV Connector O-Rings
Courtesy of SUBARU OF AMERICA, INC.

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)

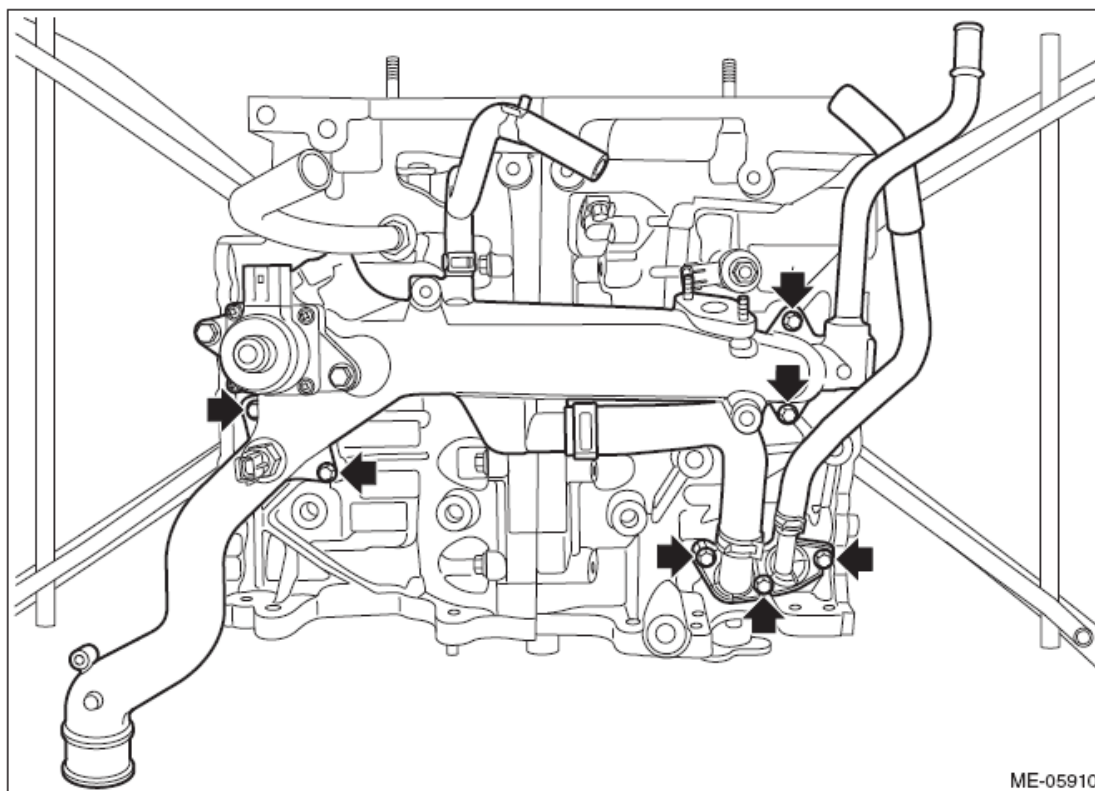


Fig. 435: Locating Water Pipe Assembly And PCV Connector Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

26. Install the engine rear hanger to the cylinder block RH.

Tightening torque:

21 N.m (2.1 kgf-m, 15.5 ft-lb)

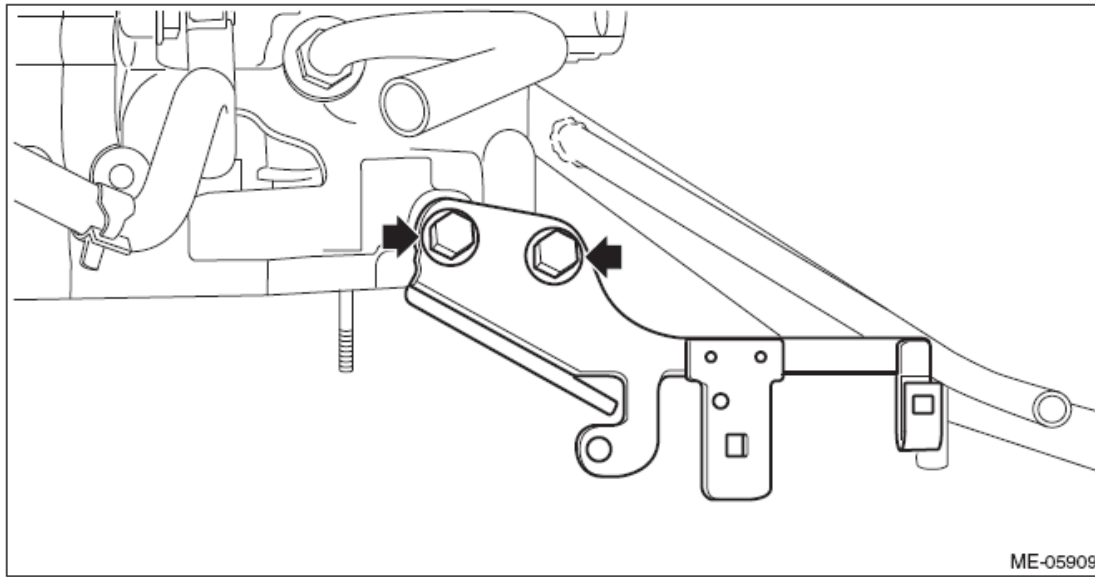


Fig. 436: Locating Engine Rear Hanger Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

27. Install the crank sprocket. Refer to **INSTALLATION**.
28. Install the cylinder head. Refer to **INSTALLATION**.
29. Install the cam carrier. Refer to **INSTALLATION**.
30. Install the rocker cover. Refer to **INSTALLATION**.
31. Install the chain cover. Refer to **INSTALLATION**.
32. Install the tumble generator valve assembly. Refer to **INSTALLATION**.
33. Install the intake manifold. Refer to **INSTALLATION**.
34. Install the engine to the vehicle. Refer to **INSTALLATION**.

DISASSEMBLY

CYLINDER BLOCK

1. Remove the water jacket spacer from the cylinder block RH and cylinder block LH.

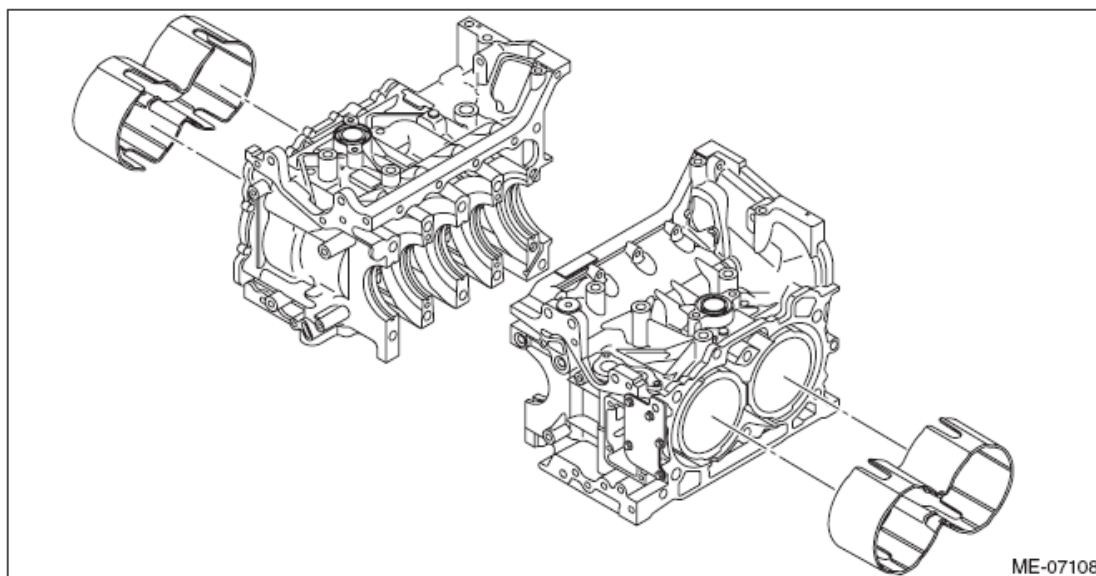


Fig. 437: Identifying Cylinder Block And Related Components
 Courtesy of SUBARU OF AMERICA, INC.

2. Remove the oil separator cover from cylinder block RH.

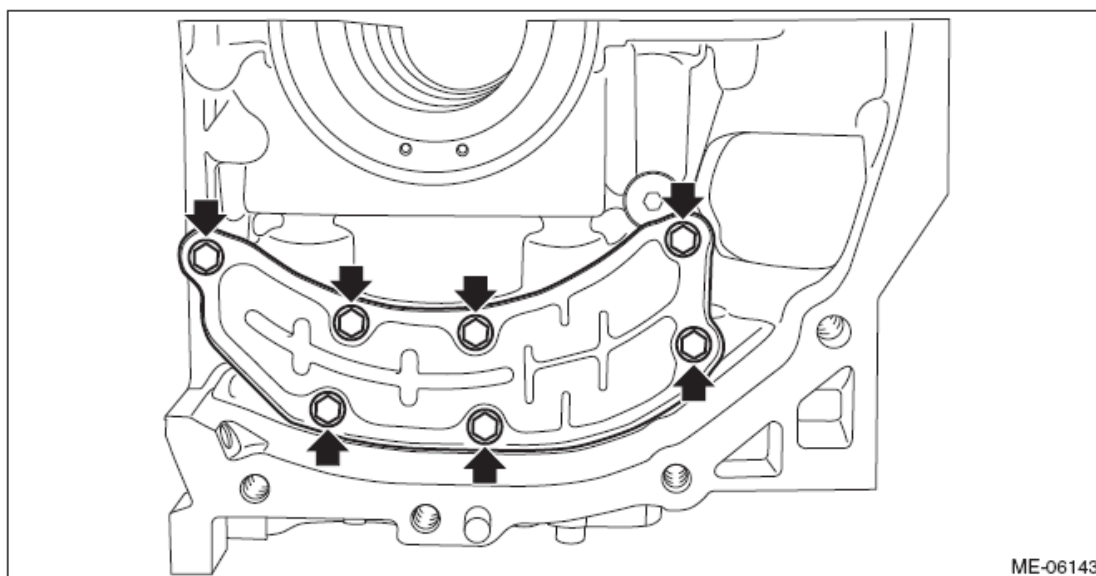


Fig. 438: Locating Cylinder Block RH Oil Separator Cover Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

3. Remove the liquid gasket from cylinder block RH.
4. Remove the cylinder block plug (A) and the main gallery plug (B) from cylinder block RH.

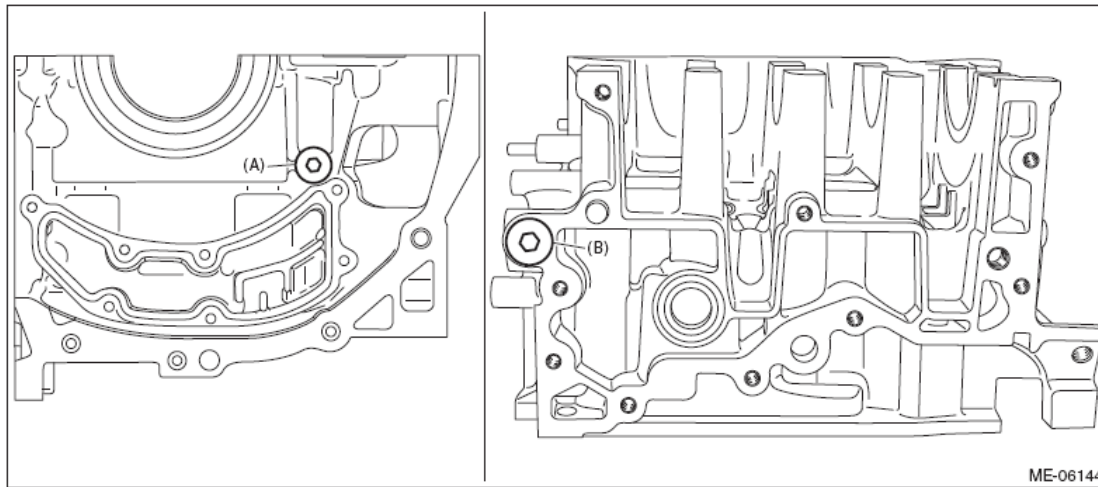


Fig. 439: Identifying Cylinder Block RH Cylinder Block Plug And Main Gallery Plug
Courtesy of SUBARU OF AMERICA, INC.

5. Remove the liquid gasket from the thread holes of the cylinder block RH, and from the threaded portions of cylinder block plug and main gallery plug.
6. Remove the cylinder block plate from cylinder block LH.

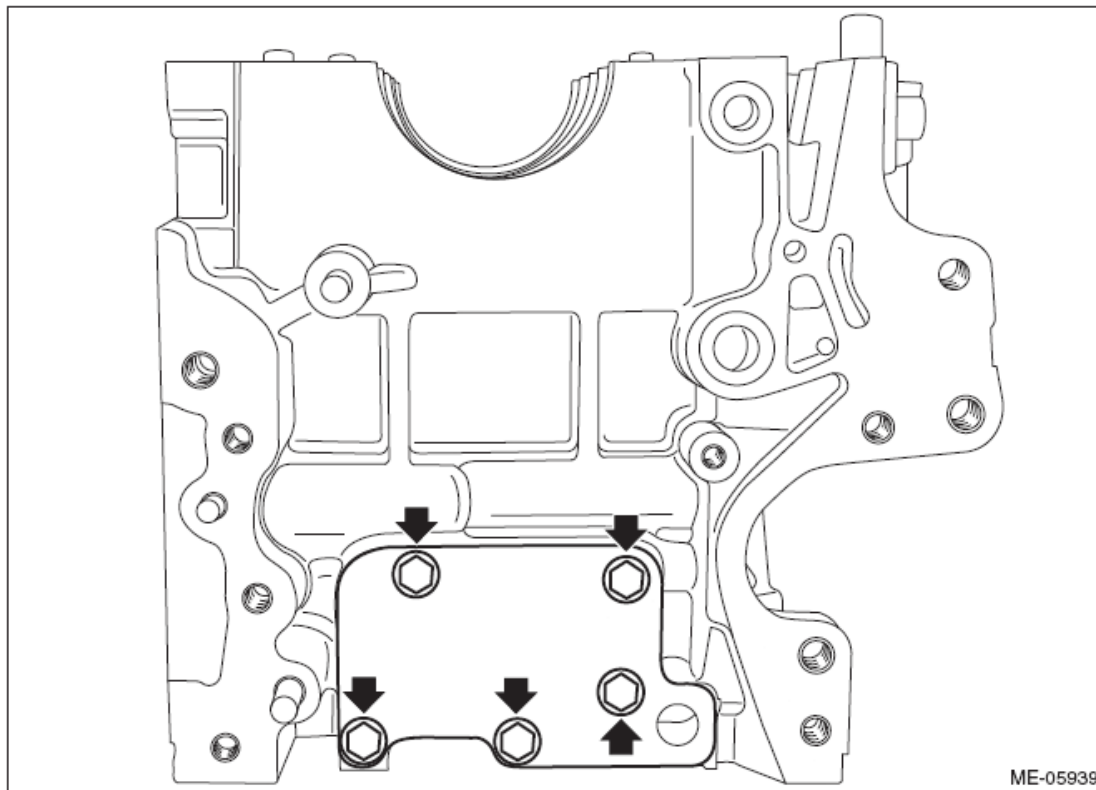


Fig. 440: Locating Cylinder Block Plate Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

7. Remove the main gallery plug from cylinder block LH.

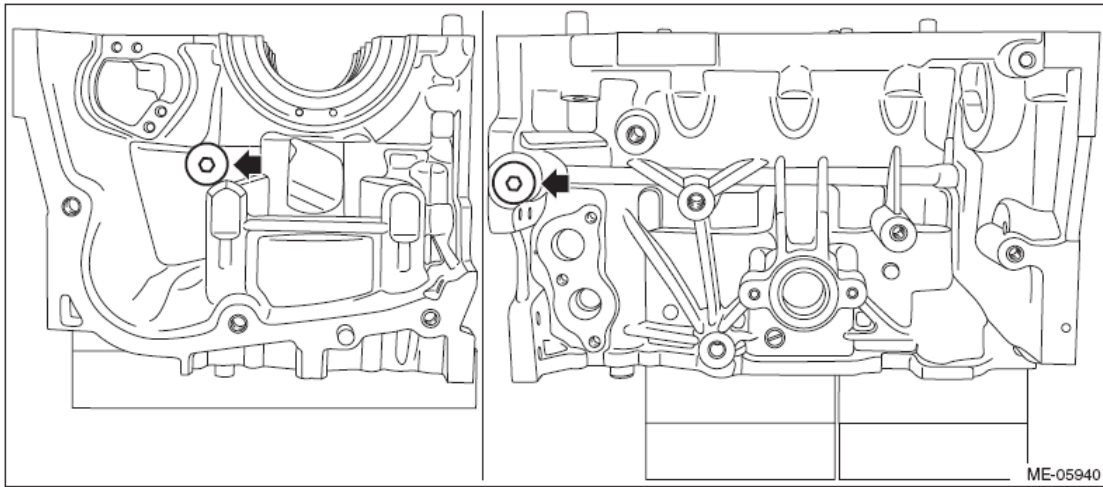
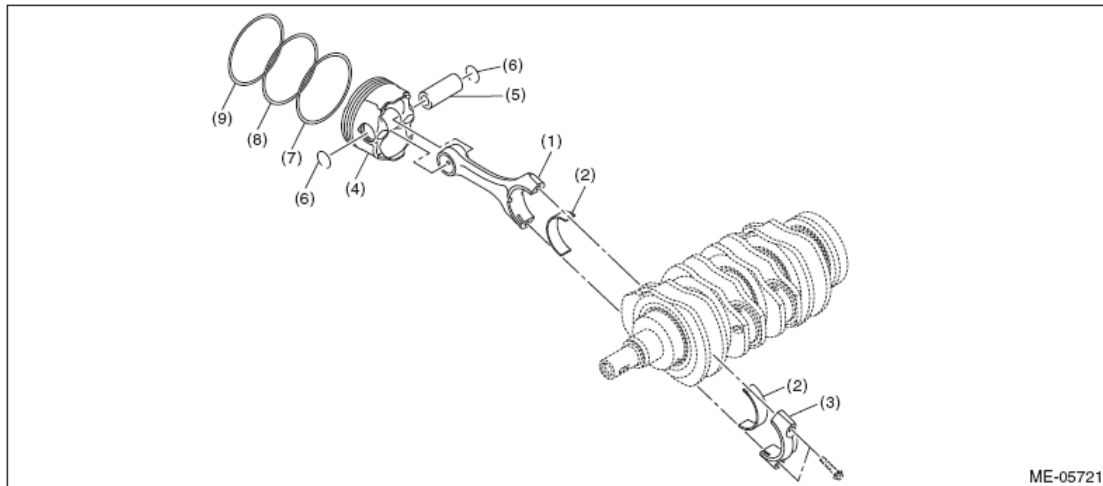


Fig. 441: Locating Cylinder Block LH Main Gallery Plug
Courtesy of SUBARU OF AMERICA, INC.

8. Remove the liquid gasket from the thread holes of the cylinder block LH and 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. 442: 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 from the piston.

NOTE: **Arrange the piston rings in order so that they can be installed in their original positions without confusion.**

1. Remove the compression rings in the order of top ring and second ring, using piston ring expander.
2. Remove the oil rings in the order of upper rail, lower rail and expander by hand.

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. 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, degrease the thread holes of the cylinder block LH and 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)

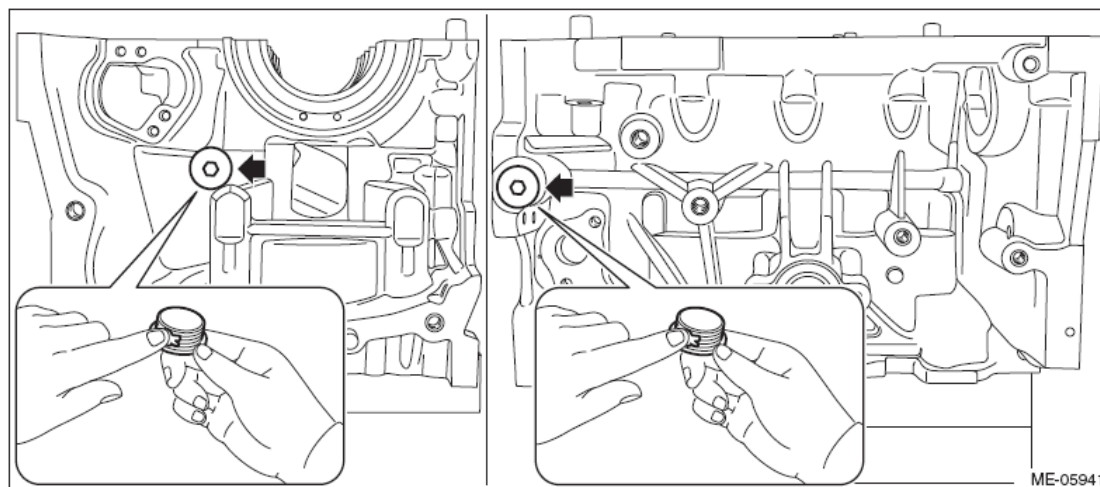


Fig. 443: Applying Liquid Gasket To Threaded Portion Of Main Gallery Plug
Courtesy of SUBARU OF AMERICA, INC.

2. Install the cylinder block plate onto cylinder block LH.

Tightening torque:

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

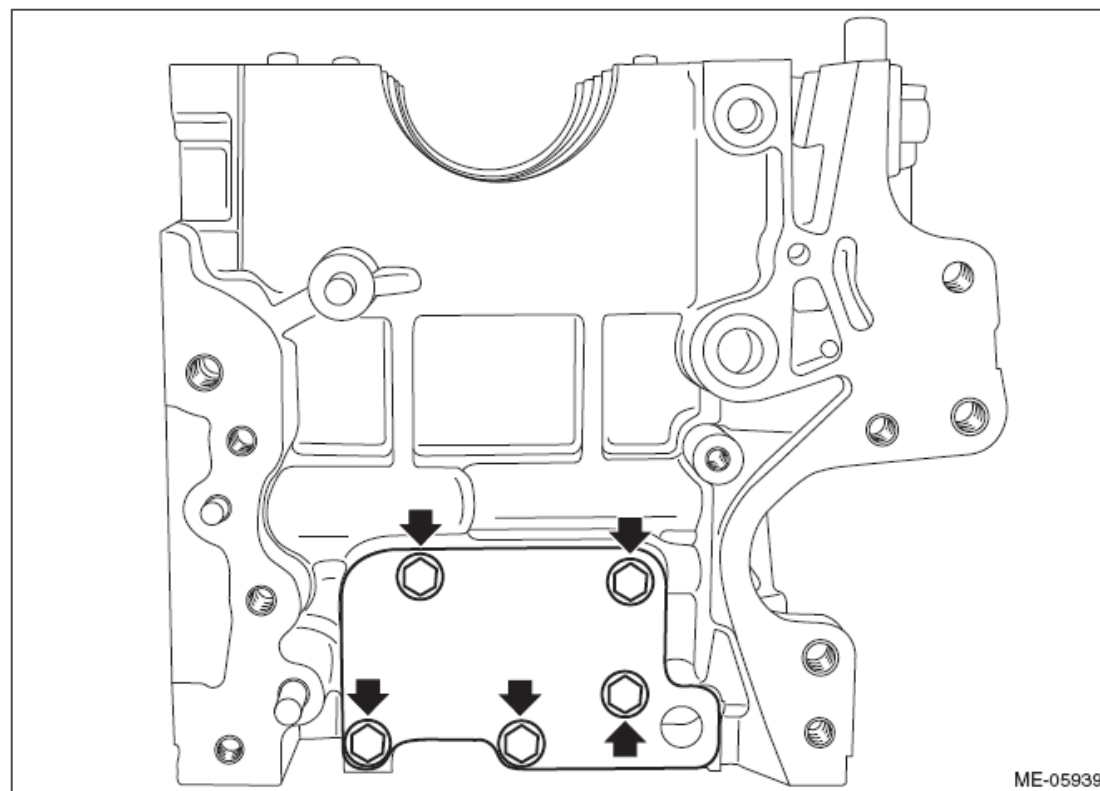


Fig. 444: Locating Cylinder Block Plate Mounting Bolts

Courtesy of SUBARU OF AMERICA, INC.

3. Apply liquid gasket to the threaded portions of cylinder block plug and main gallery plug, and install the cylinder block plug (A) and main gallery plug (B) to cylinder block RH.

NOTE: Before applying liquid gasket, degrease the thread holes of the cylinder block RH, and the threaded portions of cylinder block plug and main gallery plug.

Liquid gasket:

THREE BOND 1105 (Part No. 004403010) or equivalent

Tightening torque:

T1: 16 N.m (1.6 kgf-m, 11.8 ft-lb)

T2: 37 N.m (3.8 kgf-m, 27.3 ft-lb)

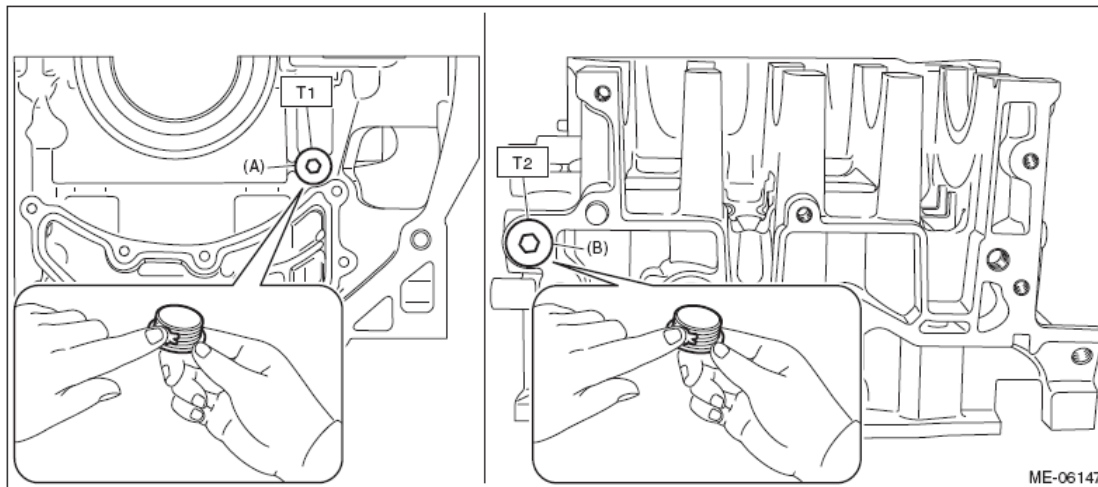


Fig. 445: Applying Liquid Gasket To Threaded Portions Of Cylinder Block Plug And Main Gallery Plug

Courtesy of SUBARU OF AMERICA, INC.

4. 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, degrease the old liquid gasket seal surface of 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)

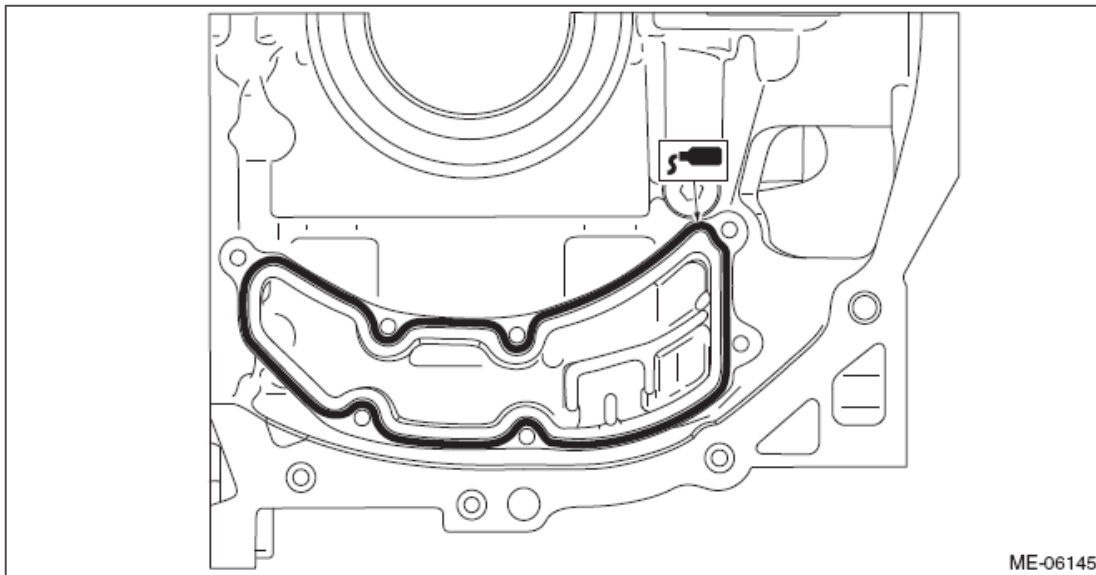


Fig. 446: Identifying Liquid Gasket Applying Area On Mating Surfaces Of Oil Separator Cover

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)

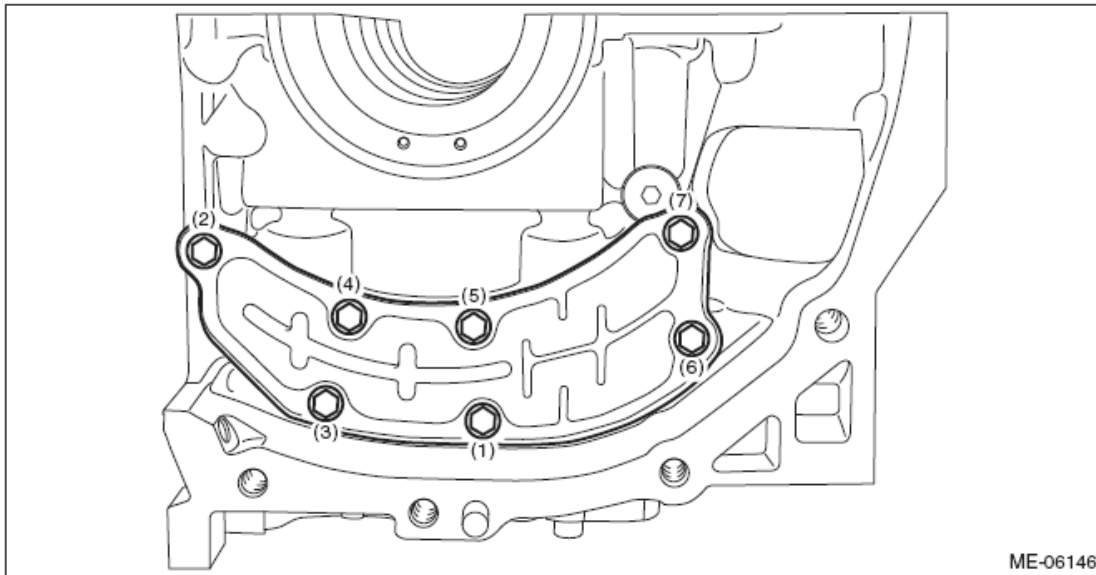


Fig. 447: Locating Oil Separator Cover To Cylinder Block RH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

5. Install the water jacket spacer to the cylinder block RH and cylinder block LH.

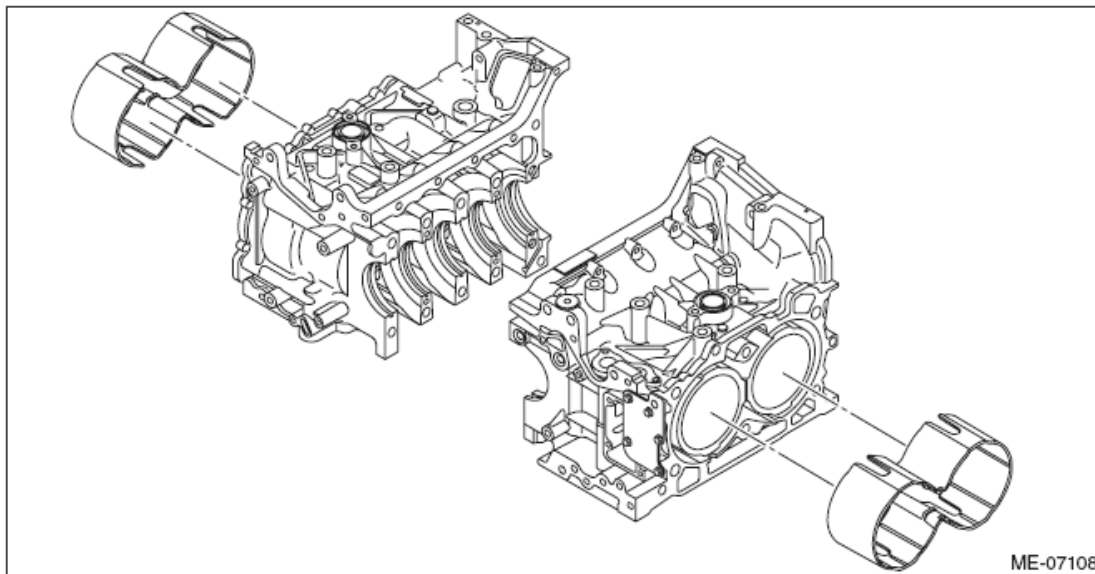
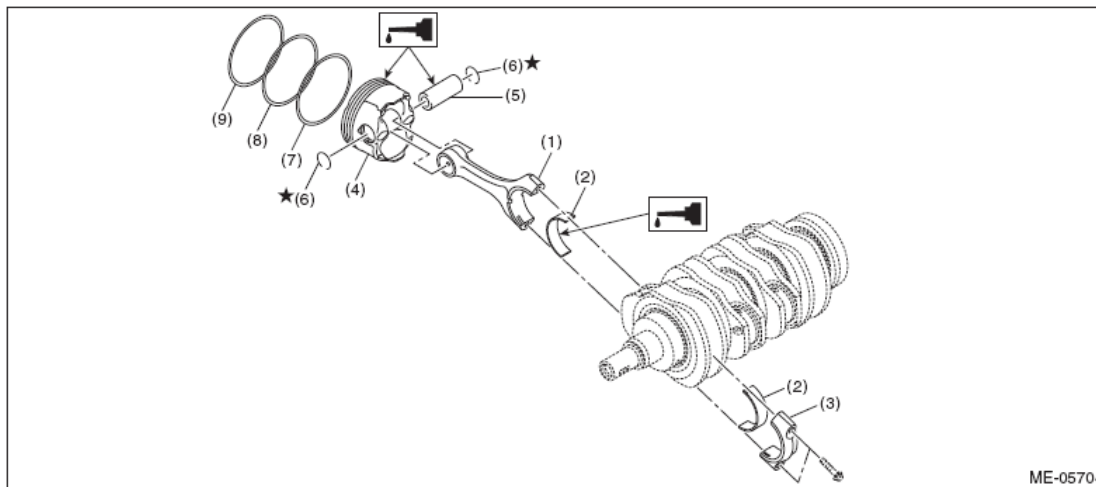


Fig. 448: Identifying Cylinder Block And Related Components
Courtesy of SUBARU OF AMERICA, INC.

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. 449: 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 installing the circlip, rotate the circlip so that its end part (a) and the cutout portion of circlip groove (b) do not match.

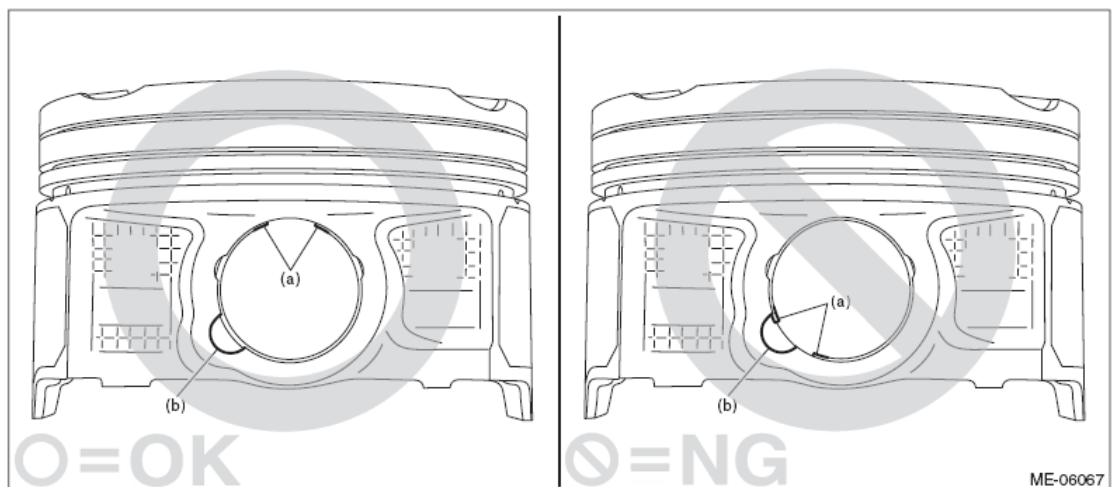
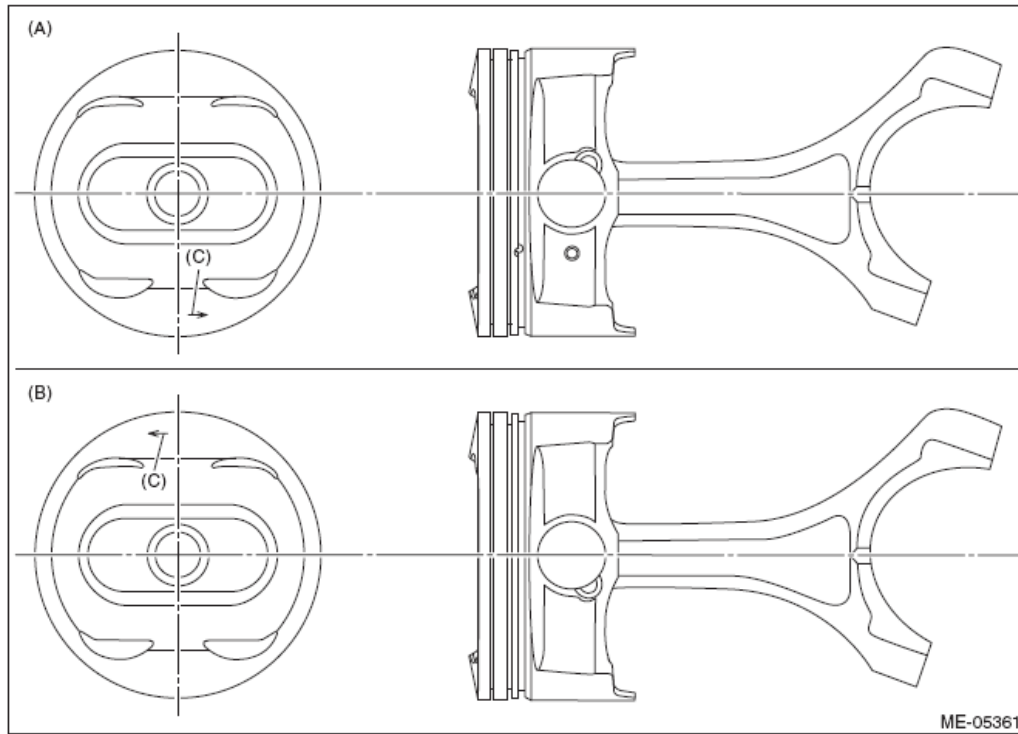


Fig. 450: Caution For Installing Piston End Circlip
Courtesy of SUBARU OF AMERICA, INC.

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. 451: Identifying Piston Front Mark
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 installing the circlip, rotate the circlip so that its end part (a) and the cutout portion of circlip groove (b) do not match.

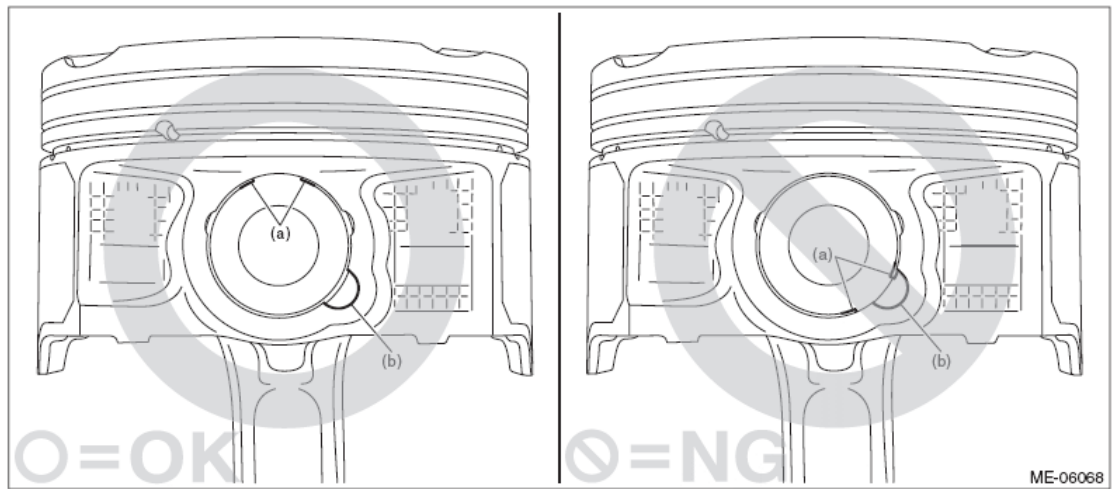
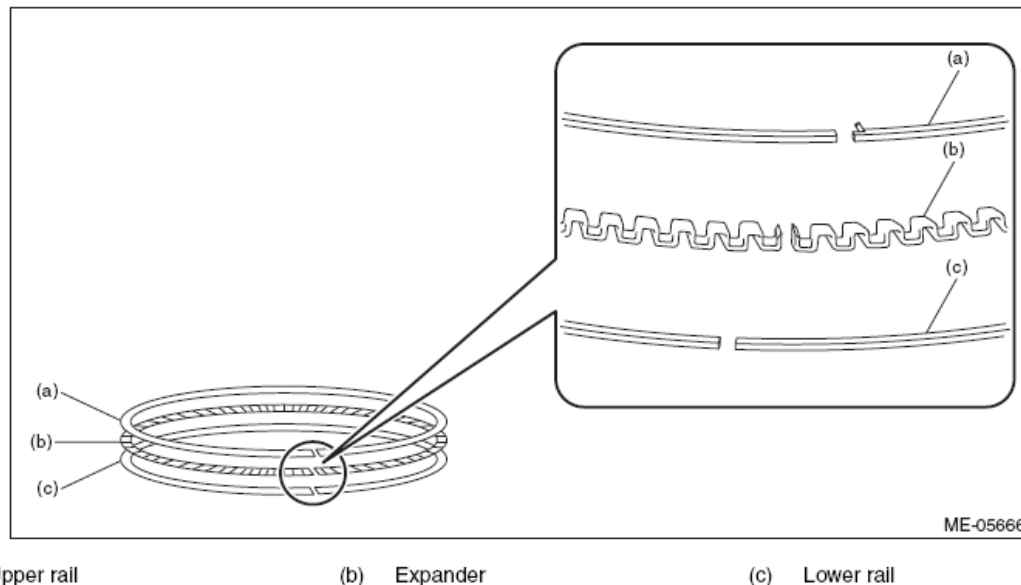


Fig. 452: Caution For Installing Piston End Circlip
Courtesy of SUBARU OF AMERICA, INC.

6. Install the piston rings onto the piston.
 1. Install the oil rings in the order of expander, lower rail and upper rail by hand.

NOTE: Oil ring consists of the upper rail, expander and lower rail.



(a) Upper rail

(b) Expander

(c) Lower rail

Fig. 453: Identifying Expander, Upper And Lower Rails
Courtesy of SUBARU OF AMERICA, INC.

2. Install the compression rings in the order of second ring and top ring, using piston ring expander.

NOTE: Install so that the compression ring mark faces the top side of the piston.

INSPECTION**CYLINDER BLOCK & PISTON**

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.

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

Cylinder block warpage:

Limit

0.025 mm (0.00098 in)

Grinding limit of cylinder block :

To 204.9 mm (8.067 in)

Height of cylinder block:

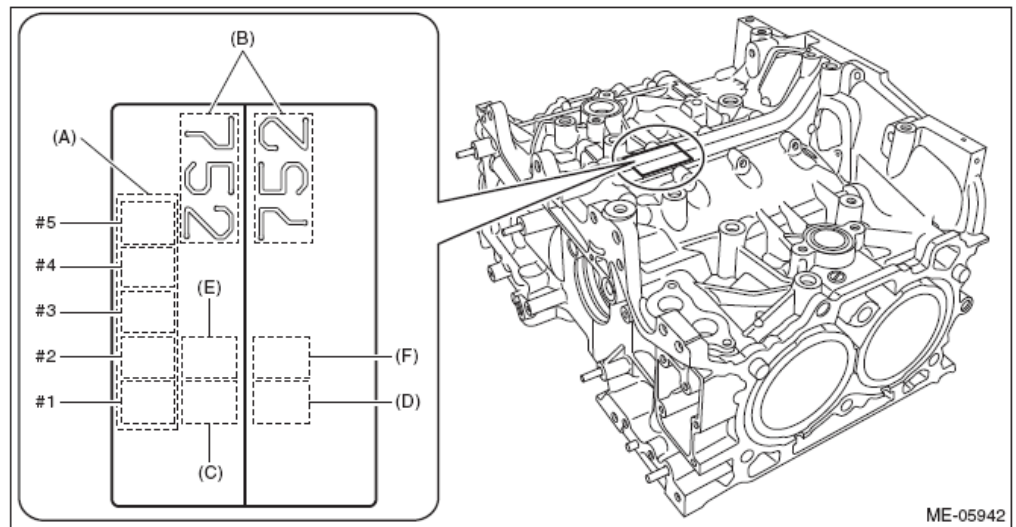
Standard

205.0 mm (8.071 in)

6. Using a cylinder bore gauge, check the inner diameter of cylinder liner, cylindricity, 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 8).

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 mark is stamped on the upper face of the cylinder block.**



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

Fig. 454: Identifying Main Journal Size Marks, Cylinder Bore Size Marks And Cylinder Block Combination Marks
Courtesy of SUBARU OF AMERICA, INC.

Inner diameter of cylinder liner:

Cylinder bore size mark A

Standard

94.005 - 94.015 mm (3.7010 - 3.7014 in)

Cylinder bore size mark B

Standard

93.995 - 94.005 mm (3.7006 - 3.7010 in)

Cylindricity of cylinder liner:

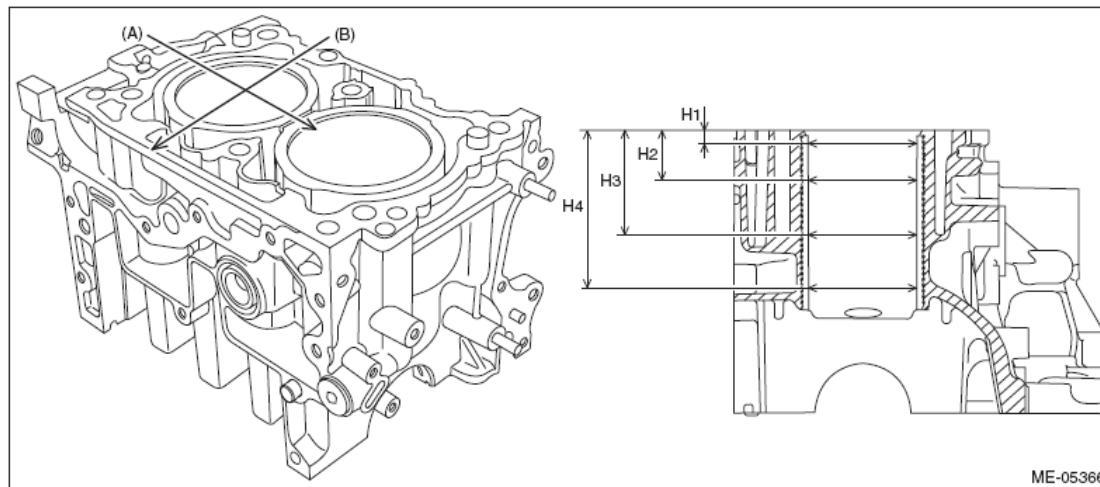
Limit

0.015 mm (0.0006 in)

Out-of-roundness of cylinder liner:

Limit

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. 455: Identifying Roundness Of Cylinder Liner
Courtesy of SUBARU OF AMERICA, INC.

7. Check the clearance between cylinder liner and piston. Check the clearance between cylinder liner and piston by measuring the inner diameter of cylinder liner and the outer diameter of piston respectively.

NOTE: For the measurement of the inner diameter of cylinder liner, refer to step 6).

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:

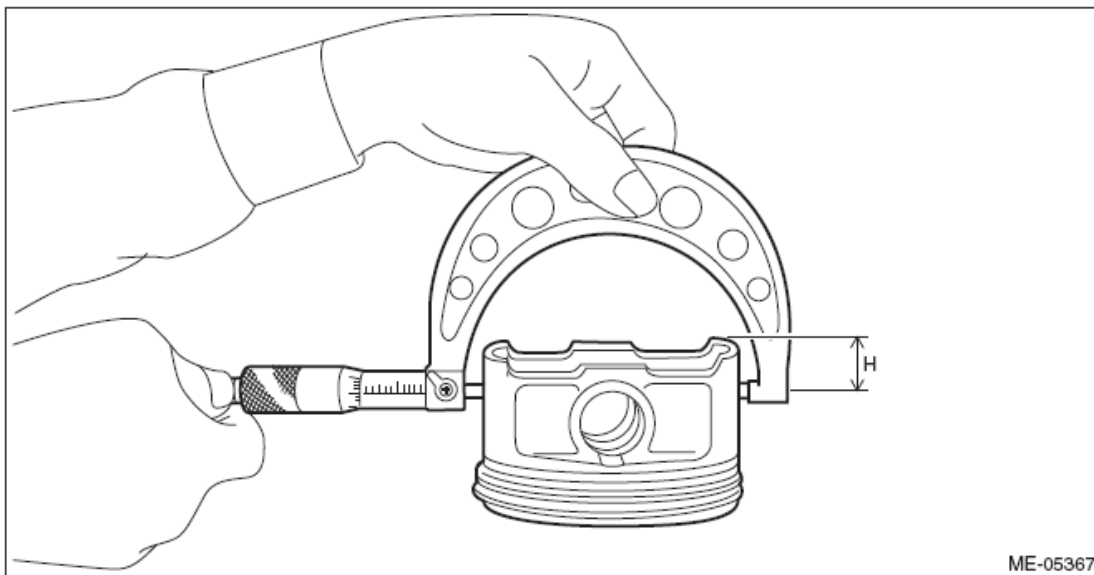
Standard size (grade A)***Standard******93.980 - 93.990 mm (3.7000 - 3.7004 in)******Standard size (grade B)******Standard******93.970 - 93.980 mm (3.6996 - 3.7000 in)******0.25 mm (0.0098 in) oversize******Standard******94.220 - 94.240 mm (3.7094 - 3.7102 in)******0.50 mm (0.0197 in) oversize******Standard******94.470 - 94.490 mm (3.7193 - 3.7201 in)***

Fig. 456: Measuring Piston Outer Diameter
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 8).

Clearance between cylinder liner and piston:***Standard******0.015 - 0.035 mm (0.00059 - 0.00138 in)*****8. Boring and honing**

1. If any of the inner diameter, cylindricity, out-of-roundness or clearance between cylinder liner and piston 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 the temperature has cooled to 20°C (68°F).
- For the measurement of the inner diameter of cylinder liner, refer to step 6).

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.

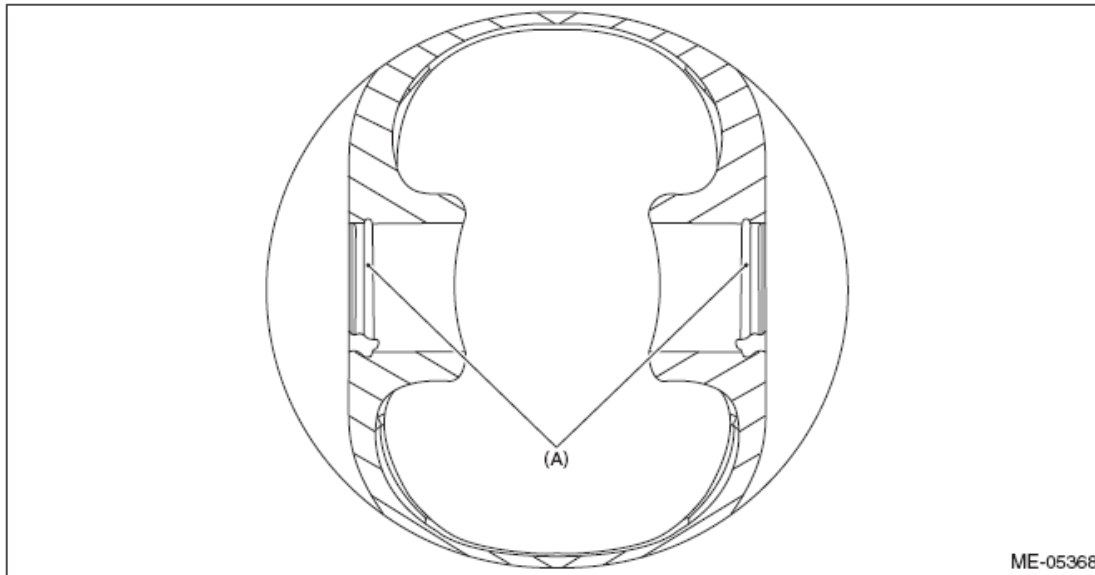


Fig. 457: Identifying Burr Circlip Groove
Courtesy of SUBARU OF AMERICA, INC.

5. Check that the piston pin can be inserted into the piston with a thumb at 20°C (68°F).
6. Check the clearance between piston and piston pin. Check the clearance between piston and piston pin by measuring the inner diameter of piston pin hole and the outer diameter of piston pin respectively.
 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).
- Measure the inner diameter of the piston pin hole at the four locations : shown in the figure, and read the value of most worn location.
- Record the measured value.

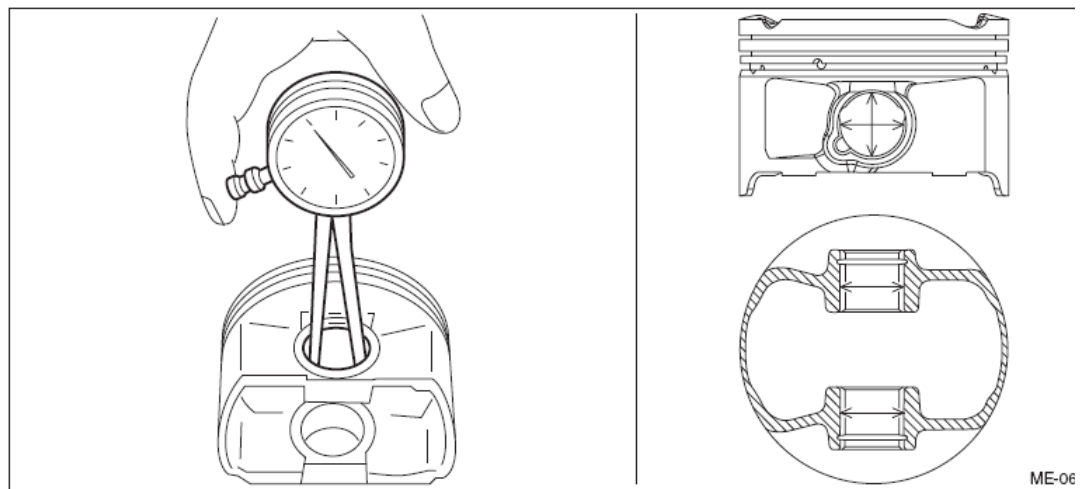


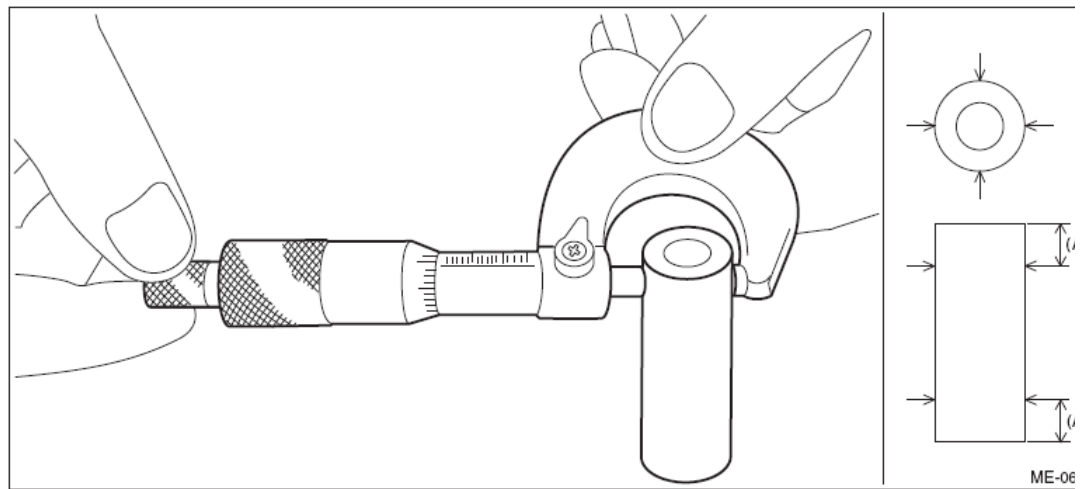
Fig. 458: Measuring Inner Diameter Of Piston Pin Hole Using Caliper Gauge

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).
- Measure the outer diameter of the piston pin at the four locations as shown in the figure, and read the value of most worn location.
- Record the measured value.



(A) 10 mm (0.394 in)

Fig. 459: Measuring Outer Diameter Of Piston Pin Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

3. Calculate the clearance between piston and piston pin. If it is not within the standard, replace the piston and piston pin as a set.

Clearance between piston 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 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.

NOTE:

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

- Use piston ring with same size as piston when replacing piston ring.

Piston ring gap:

Compression ring (top ring)

Standard

0.20 - 0.30 mm (0.0079 - 0.0118 in)

Compression ring (second ring)

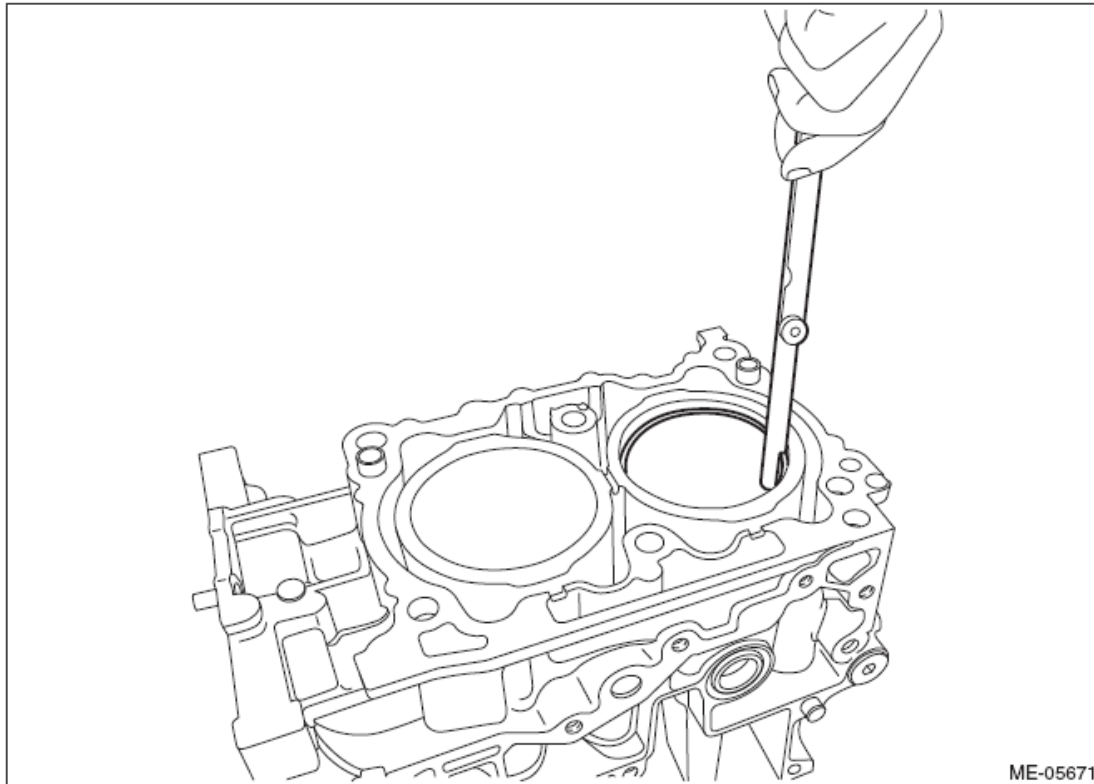
Standard

0.30 - 0.45 mm (0.0118 - 0.0177 in)

Oil ring (upper rail and lower rail)

Standard

0.20 - 0.50 mm (0.0079 - 0.0197 in)



ME-05671

Fig. 460: Measuring Piston Ring Gap
Courtesy of SUBARU OF AMERICA, INC.

3. Fit the compression ring straight into the piston ring groove, then check the clearance between compression ring and piston with a thickness gauge. If it is not within the standard, replace the compression ring.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Before inspecting the clearance, clean the piston ring groove and compression ring.
- Use compression ring with same size as piston when replacing compression ring.

Clearance between compression ring and piston:

Top ring

Standard

0.040 - 0.080 mm (0.0016 - 0.0031 in)

Second ring

Standard

0.030 - 0.070 mm (0.0012 - 0.0028 in)

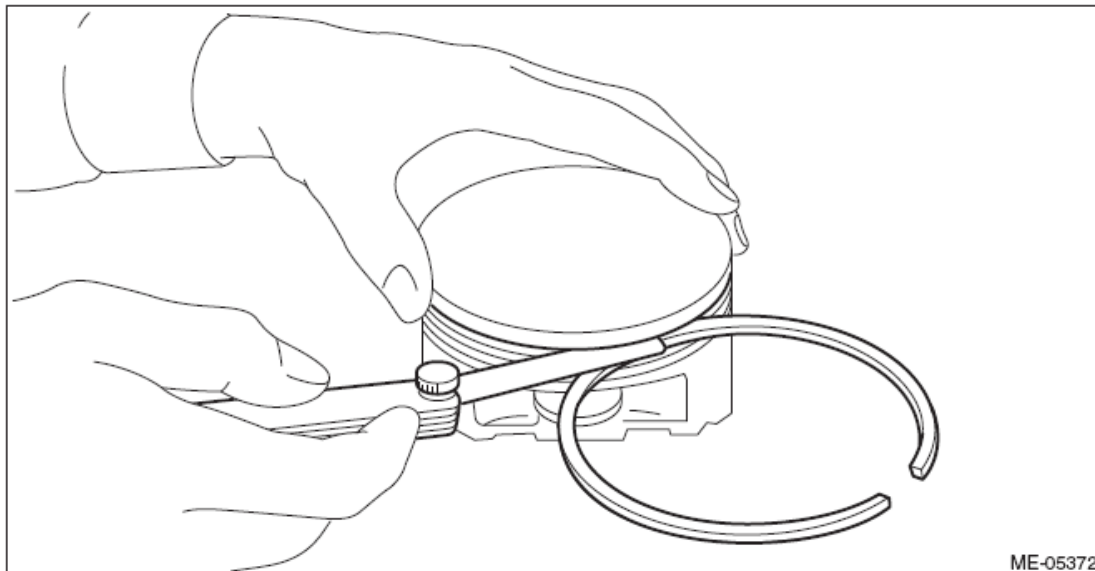


Fig. 461: Measuring Clearance Between Compression Ring And Piston Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

CONNECTING ROD AND CONNECTING ROD BEARING

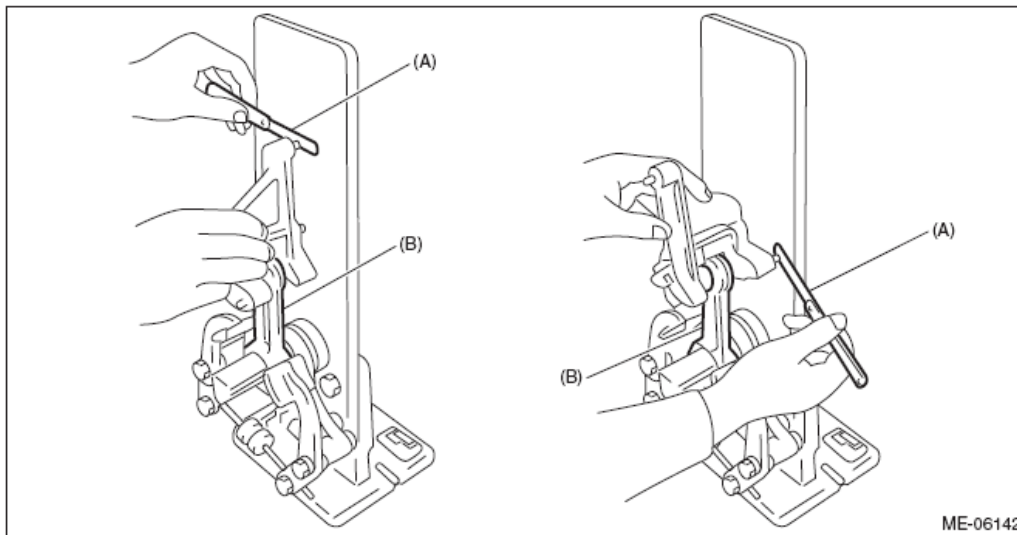
1. Check for bend or twist using a connecting rod aligner. If it exceeds the limit, replace the connecting rod.

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

Bend or twist per 100 mm (3.94 in) in length:

Limit

0.10 mm (0.0039 in)



(A) Thickness gauge

(B) Connecting rod

Fig. 462: Checking Bend Or Twist Using Connecting Rod Aligner
Courtesy of SUBARU OF AMERICA, INC.

2. Check that the large or small end thrust surface of each connecting rod is not damaged.
3. Check each connecting rod bearing for scar, peeling, seizure, melting or wear, etc.
4. Check the thrust clearance of each connecting rod using a thickness gauge.

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

1. Clean the #1 connecting rod bearing and the #1 pin of crankshaft, and apply engine oil to the #1 pin of crankshaft.
2. Set the #1 connecting rod bearing to the #1 connecting rod and #1 connecting rod cap.
3. Set the #1 connecting rod, #1 connecting rod cap and #1 connecting rod cap bolt to the #1 pin of crankshaft.

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 bolt thread.**
4. Using ST, 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.

CAUTION:

- **Make sure to hold the crankshaft securely during work.**
- **When holding the crankshaft, be careful not to damage the crankshaft.**

ST 18270AA020 SOCKET

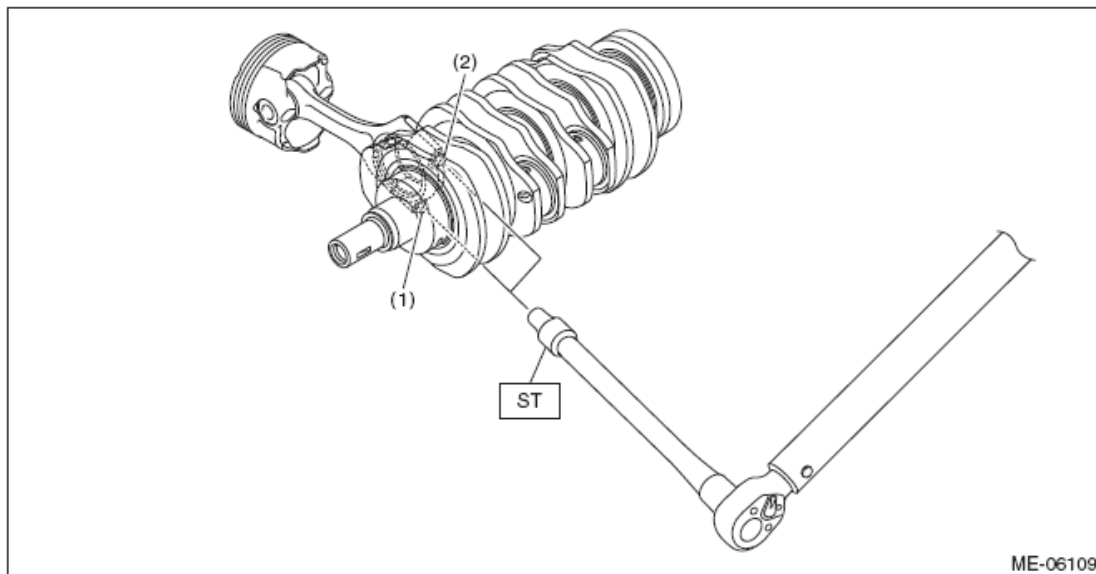


Fig. 463: Tightening No. 1 Connecting Rod Cap Bolt
Courtesy of SUBARU OF AMERICA, INC.

5. Using ST1 and ST2, tighten the #1 connecting rod cap bolts with specified angle in numerical order as shown in the figure.

CAUTION:

- **Make sure to hold the crankshaft securely during work.**
- **When holding the crankshaft, be careful not to damage the crankshaft.**

NOTE: **Attach the magnet used for securing the ST1 to V-block.**

ST1 18854AA000 ANGLE GAUGE

ST2 18270AA020 SOCKET

Tightening angle:

137°±2°

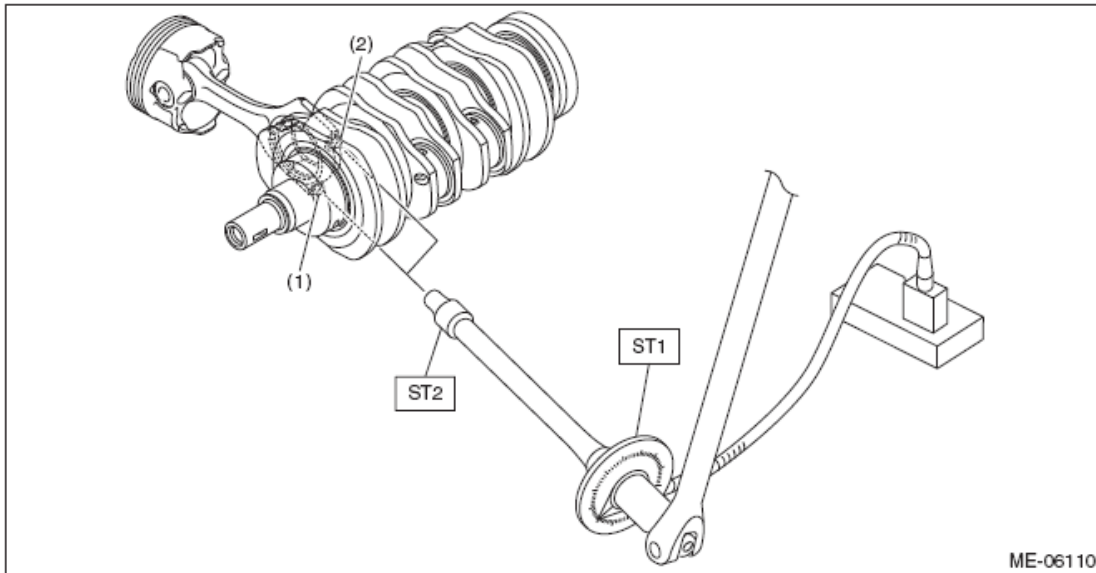


Fig. 464: Tightening No. 1 Connecting Rod Cap Bolt
 Courtesy of SUBARU OF AMERICA, INC.

6. In the same manner, install the #2, #3 and #4 connecting rods.
7. Check the thrust clearance of each connecting rod using a thickness gauge. If it is not within the standard, replace the connecting rod.

NOTE: **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)

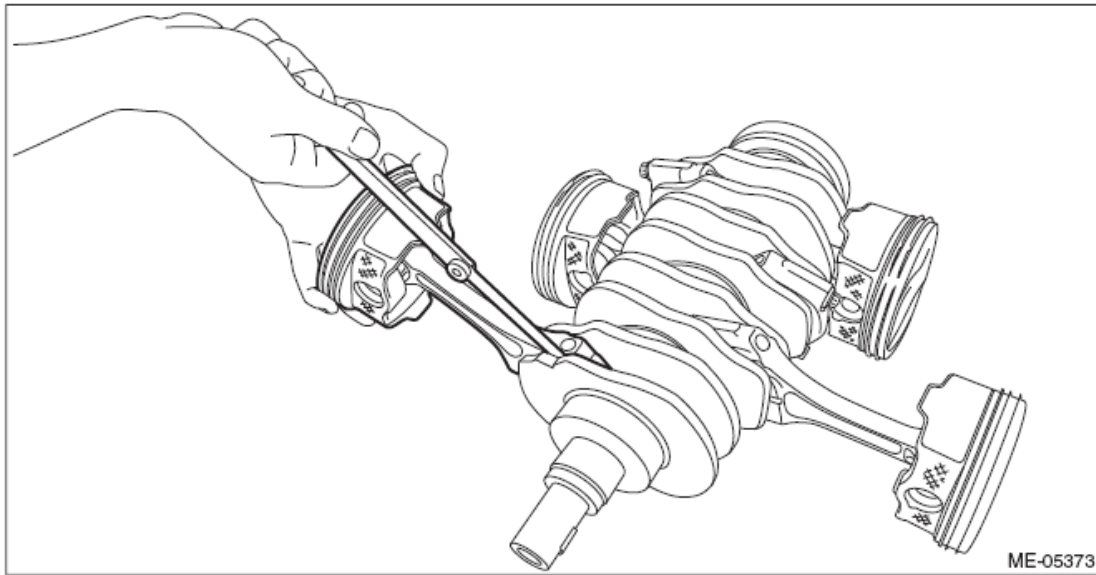


Fig. 465: Measuring Connecting Rod Thrust Clearance Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

5. Check the oil clearance on each connecting rod bearing using plastigauge.

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

1. Clean the #1 connecting rod bearing and the #1 pin of crankshaft.
2. Set the #1 connecting rod bearing to the #1 connecting rod and #1 connecting rod cap.
3. Place a plastigauge across the #1 pin of crankshaft, and set the #1 connecting rod, #1 connecting rod cap and #1 connecting rod cap bolt to the #1 pin of crankshaft.

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 bolt thread.
4. Using ST, 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.

CAUTION:

- Make sure to hold the crankshaft securely during work.
- When holding the crankshaft, be careful not to damage the crankshaft.
- During tightening, be careful not to move the #1

connecting rod and the #1 connecting rod cap.

ST 18270AA020 SOCKET

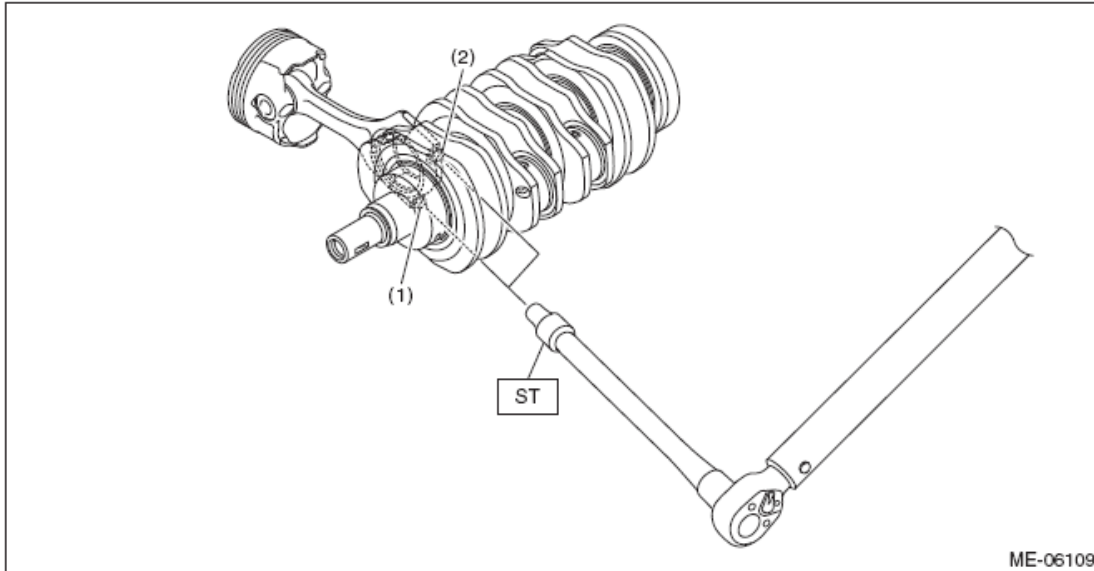


Fig. 466: Tightening No. 1 Connecting Rod Cap Bolt
 Courtesy of SUBARU OF AMERICA, INC.

5. Using ST1 and ST2, tighten the #1 connecting rod cap bolts with specified angle in numerical order as shown in the figure.

CAUTION:

- Make sure to hold the crankshaft securely during work.
- When holding the crankshaft, be careful not to damage the crankshaft.
- During tightening, be careful not to move the #1 connecting rod and the #1 connecting rod cap.

NOTE: Attach the magnet used for securing the ST1 to V-block.

ST1 18854AA000 ANGLE GAUGE

ST2 18270AA020 SOCKET

Tightening angle:

137°±2°

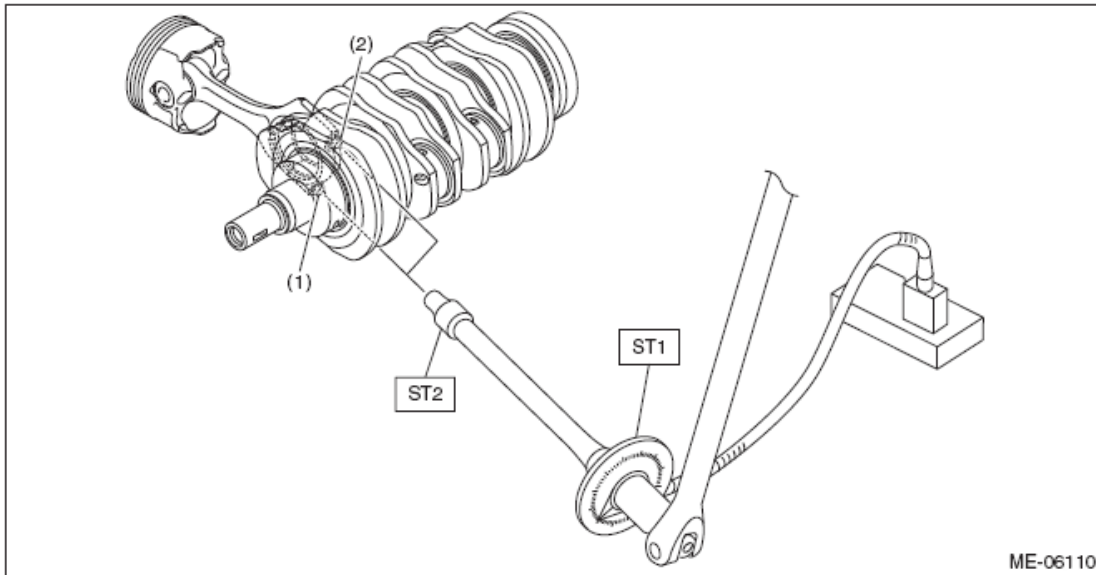


Fig. 467: Tightening No. 1 Connecting Rod Cap Bolt
Courtesy of SUBARU OF AMERICA, INC.

6. Using ST, loosen the #1 connecting rod cap bolt, and remove the #1 connecting rod cap bolt and #1 connecting rod cap.

CAUTION:

- Make sure to hold the crankshaft securely during work.
- When holding the crankshaft, be careful not to damage the crankshaft.
- During removal, be careful not to move the #1 connecting rod and the #1 connecting rod cap.

ST 18270AA020 SOCKET

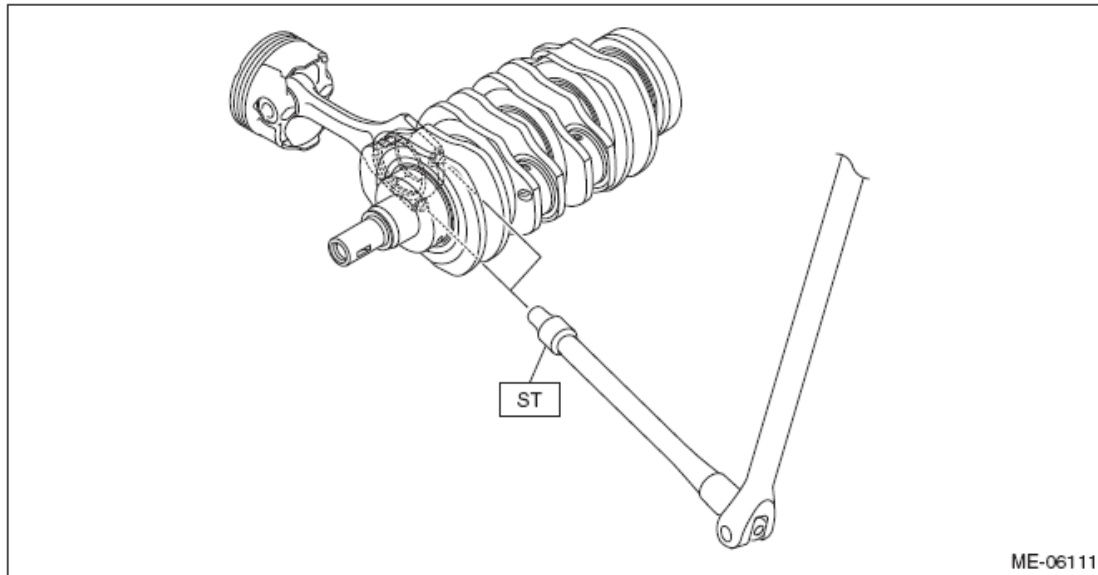


Fig. 468: Tightening No. 1 Connecting Rod Cap Bolt
 Courtesy of SUBARU OF AMERICA, INC.

7. Determine oil clearance of the #1 connecting rod bearing by matching the widest point of the plastigauge on #1 pin of crankshaft against scale printed on a package of the plastigauge. If it is not within the standard, replace the #1 connecting rod bearing.

NOTE: Measure the outer diameter of crankshaft pin using micrometer, and select the suitable size connecting rod bearing when replacing the connecting rod bearing.

Unit: mm (in)		
Bearing	Connecting rod bearing thickness (at center)	Crankshaft pin outer diameter
	Standard	Standard
Standard size	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 bearing oil clearance:

Standard

0.017 - 0.047 mm (0.0007 - 0.0019 in)

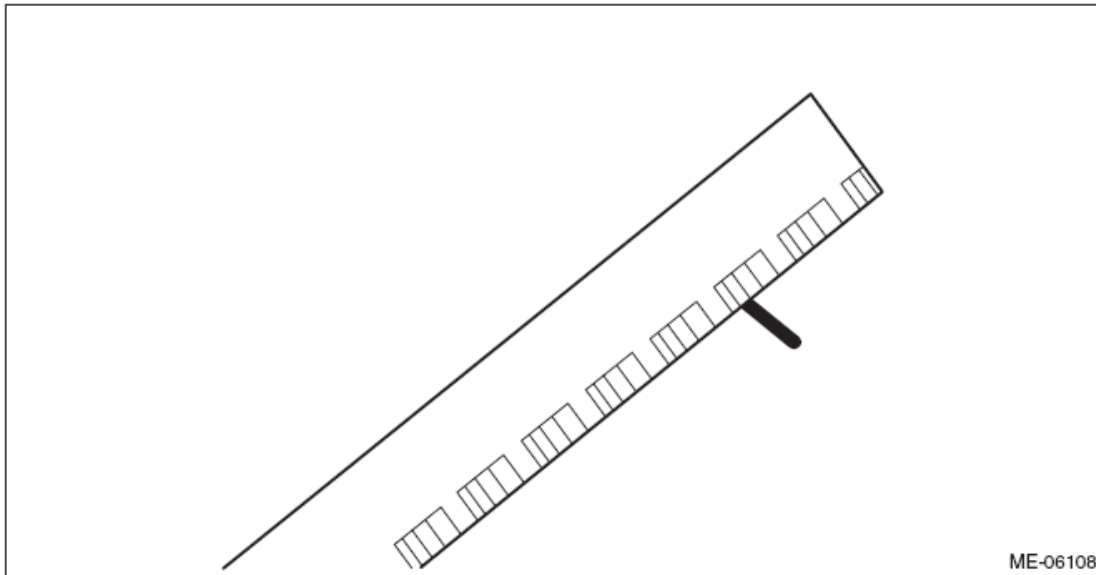


Fig. 469: Checking Connecting Rod Bearing Oil Clearance
Courtesy of SUBARU OF AMERICA, INC.

8. Completely remove the plastigauge.
9. In the same manner, check oil clearance of the #2, #3 and #4 connecting rod bearings.

PISTON PIN & CONNECTING ROD BUSHING

1. Check the connecting rod bushing for damage.
2. Check the clearance between piston pin and connecting rod bushing. Check the clearance between piston pin and connecting rod bushing by measuring the outer diameter of piston pin and the inner diameter of connecting rod bushing respectively.
 1. Measure the outer diameter of piston pin with a micrometer.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Measure the outer diameter of the piston pin at the two locations as shown in the figure, and read the value of most worn location.
- Record the measured value.

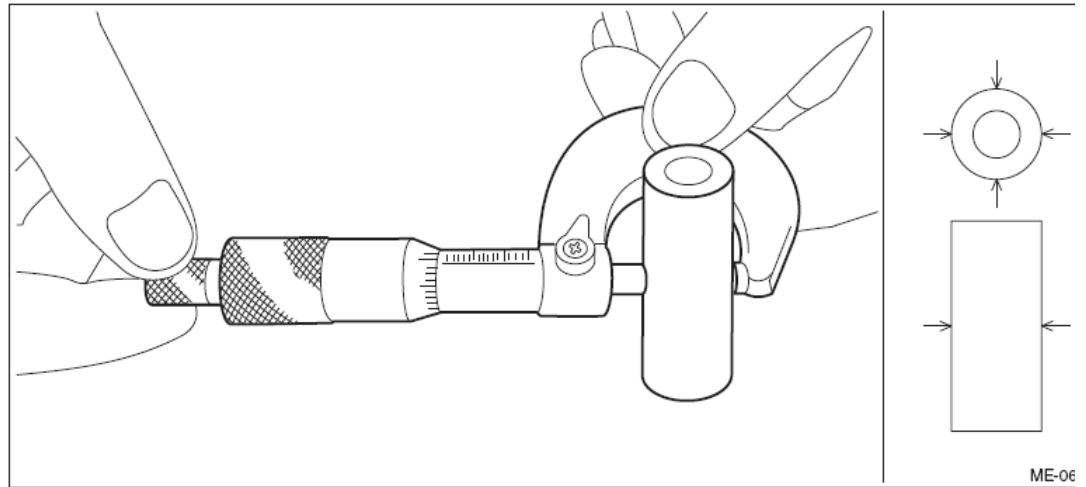


Fig. 470: Measuring Outer Diameter Of Piston Pin
Courtesy of SUBARU OF AMERICA, INC.

2. Using a caliper gauge, measure the inner diameter of connecting rod bushing.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Measure the inner diameter of the connecting rod bushing at the two locations as shown in the figure, and read the value of most worn location.
- Record the measured value.

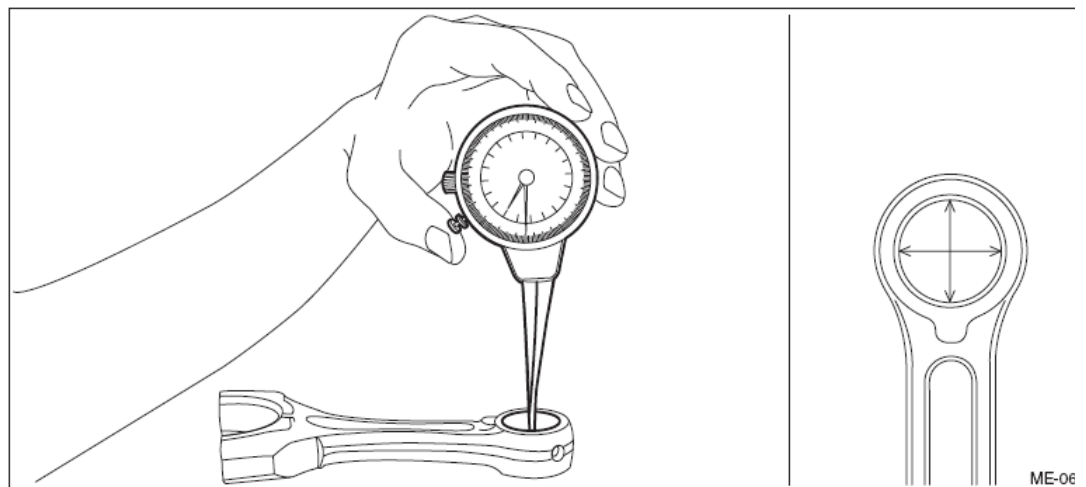


Fig. 471: Measuring Inner Diameter Of Connecting Rod Bushing Using Caliper Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Calculate the clearance between piston pin and connecting rod bushing.

Clearance between piston pin and connecting rod bushing:***Standard******0.004 - 0.026 mm (0.0002 - 0.0010 in)***

3. If the clearance between piston pin and connecting rod bushing is not within the standard, replace the connecting rod bushing and piston pin as a set. For replacement procedure of connecting rod bushing, refer to the following.
 1. Remove the connecting rod bushing from connecting rod small end with ST and press.

NOTE: **Be careful not to confuse the direction of the ST, because it is used in opposite directions for extraction and press-fit.**

ST 18350AA000 CONNECTING ROD BUSHING REMOVER AND INSTALLER

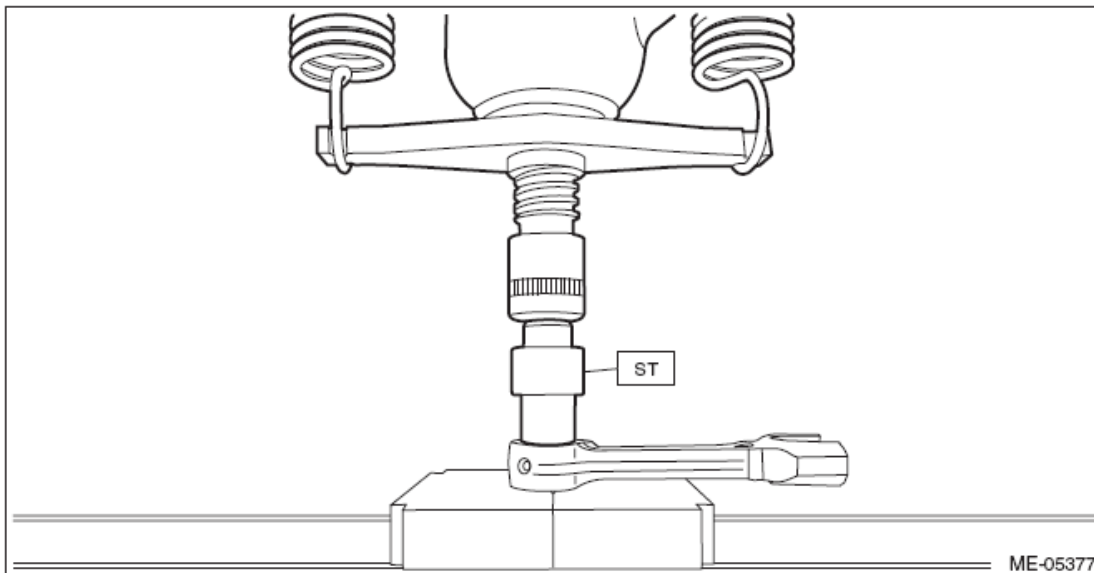
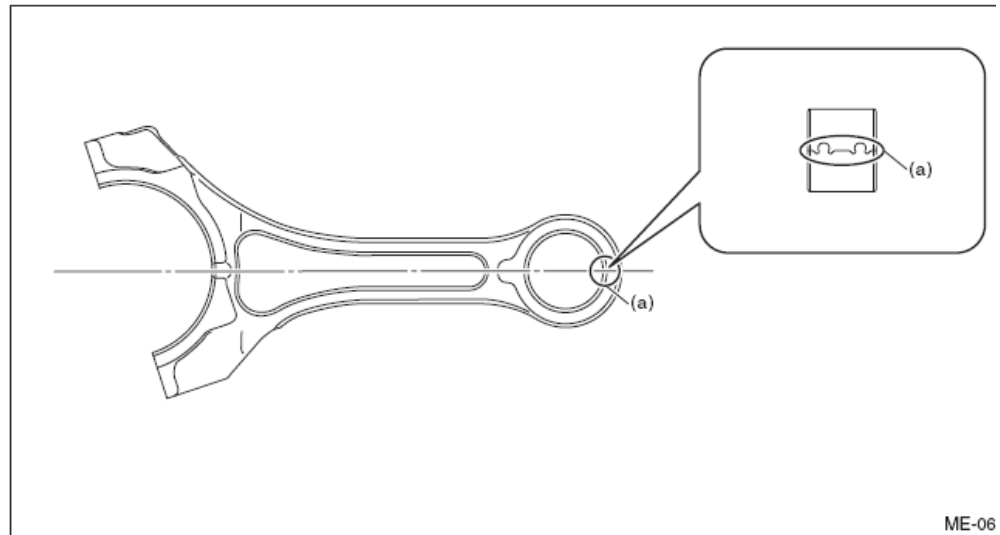


Fig. 472: Removing Connecting Rod Bushing From Connecting Rod Small End
Courtesy of SUBARU OF AMERICA, INC.

2. Press the connecting rod bushing with ST and the press, after applying engine oil on the periphery of connecting rod bushing.

NOTE: • **Position the clinch portion of connecting rod bushing as shown in the figure.**



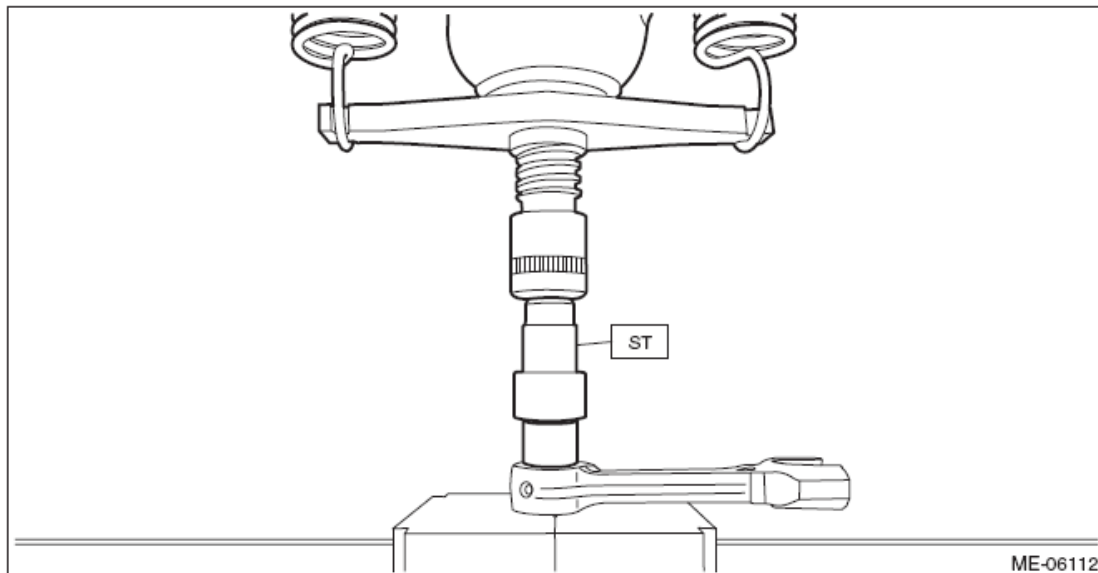
ME-06

(a) Clinch portion of connecting rod bushing

Fig. 473: Identifying Connecting Rod Bushing Clinch Portion
Courtesy of SUBARU OF AMERICA, INC.

- Be careful not to confuse the direction of the ST, because it is used in opposite directions for extraction and press-fit.

ST 18350AA000 CONNECTING ROD BUSHING REMOVER AND INSTALLER



ME-06112

Fig. 474: Removing Connecting Rod Bushing From Connecting Rod Small End Using Tool
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 on the connecting rod small end.

4. Ream the inside of connecting rod bushing using the reamer. 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 $\varnothing 22$ reamer.
- 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 the crankshaft journal or replace the crankshaft.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- 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.
- When grinding to correct the crankshaft journal, refer to step 3).

Crankshaft bend:

Limit

0.035 mm (0.0014 in)

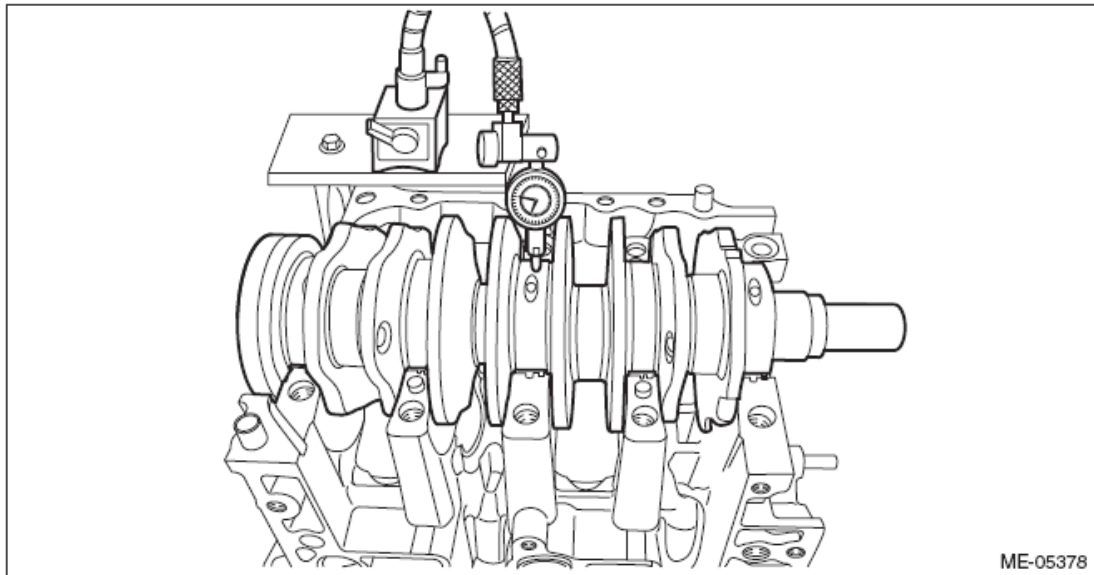


Fig. 475: Checking Crankshaft Bending Using Dial Gauge
Courtesy of SUBARU OF AMERICA, INC.

3. Using a micrometer, check the outer diameter of crankshaft pin, outer diameter of journal, cylindricity, and out-of-roundness. If it is not within the standard, replace the connecting rod bearing or crankshaft bearing, and grind to correct the crankshaft pin or journal or replace the crankshaft as required.

NOTE:

- 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 crankshaft pin or journal, finish them to the suitable outer diameter as shown in the table below according to the undersize bearing to be used.

Unit: mm (in)						
Bearing	Connecting rod bearing thickness (at center)	Crankshaft pin outer diameter	Crankshaft bearing thickness (at center)		Crankshaft journal outer diameter	
			#1, #2, #3, #4	#5	#1, #2, #3, #4	#5
	Standard	Standard	Standard	Standard	Standard	Standard
Standard size	1.492 - 1.508 (0.0587 - 0.0594)	47.976 - 48.000 (1.8888 - 1.8898)	2.495 - 2.513 (0.0982 - 0.0989)	2.493 - 2.511 (0.0981 - 0.0989)	67.985 - 68.009 (2.6766 - 2.6775)	67.985 - 68.009 (2.6766 - 2.6775)
0.03 (0.0012) Undersize	1.511 - 1.515 (0.0595 - 0.0596)	47.946 - 47.970 (1.8876 - 1.8886)	2.519 - 2.522 (0.0992 - 0.0993)	2.517 - 2.520 (0.0991 - 0.0992)	67.955 - 67.979 (2.6754 - 2.6763)	67.955 - 67.979 (2.6754 - 2.6763)

2013 Subaru Legacy

2013 ENGINE Engine Mechanical (H4DO) - Legacy/Outback

0.05 (0.0020) Undersize	1.521 - 1.525 (0.0599 - 0.0600)	47.926 - 47.950 (1.8868 - 1.8878)	2.529 - 2.532 (0.0996 - 0.0997)	2.527 - 2.530 (0.0995 - 0.0996)	67.935 - 67.959 (2.6746 - 2.6755)	67.935 - 67.959 (2.6746 - 2.6755)
0.25 (0.0098) Undersize	1.621 - 1.625 (0.0638 - 0.0640)	47.726 - 47.750 (1.8790 - 1.8799)	2.629 - 2.632 (0.1035 - 0.1036)	2.627 - 2.630 (0.1034 - 0.1035)	67.735 - 67.759 (2.6667 - 2.6677)	67.735 - 67.759 (2.6667 - 2.6677)

Crankshaft pin:***Cylindricity******Limit******0.006 mm (0.0002 in)******Out-of-roundness******Limit******0.005 mm (0.0002 in)******Grinding limit (dia.)******To 47.726 mm (1.8790 in)******Crankshaft journal:******Cylindricity******Limit******0.006 mm (0.0002 in)******Out-of-roundness******Limit******0.005 mm (0.0002 in)******Grinding limit (dia.)******To 67.735 mm (2.6667 in)***

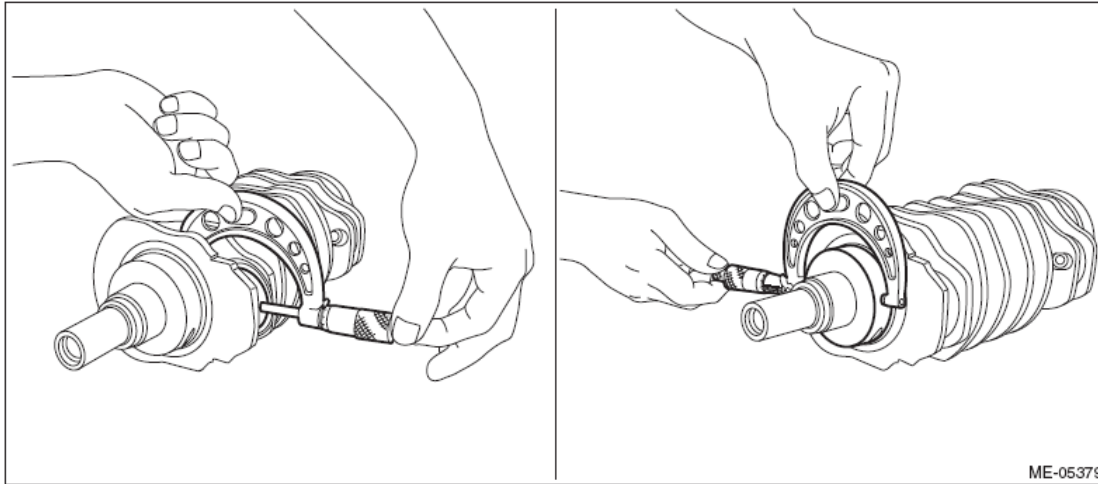


Fig. 476: Measuring Crankshaft Pin And Crankshaft Journal Using Micrometer
Courtesy of SUBARU OF AMERICA, INC.

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 thrust of #5 crankshaft bearing. If it is not within the standard, replace the #5 crankshaft bearing.

NOTE:

- Measurement should be performed at a temperature of 20°C (68°F).
- Set all the crankshaft bearings onto the cylinder block, then mount the crankshaft on the cylinder block, and use a thickness gauge to measure the thrust clearance of crankshaft.
- Select the #5 crankshaft bearing of 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)

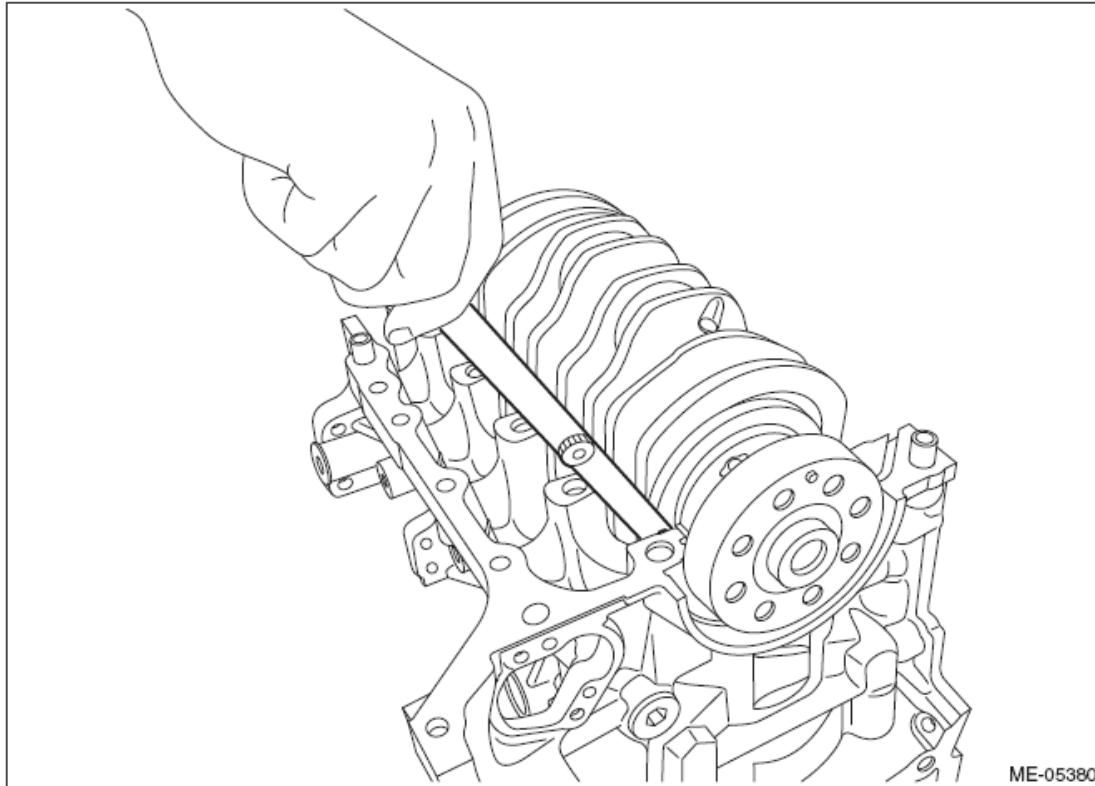


Fig. 477: Measuring Crankshaft Thrust Clearance Using Thickness Gauge
Courtesy of SUBARU OF AMERICA, INC.

6. Check the oil clearance on each crankshaft bearing using plastigauge.

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

1. Remove the liquid gasket from cylinder block.
2. Clean each crankshaft bearing and crankshaft journal.
3. Set each crankshaft bearing to the cylinder block.

CAUTION:

- **Place a wood board wrapped with a waste cloth to prevent damage and to stabilize the cylinder block before work.**
- **Be careful not to scratch the mating surface of cylinder block work.**

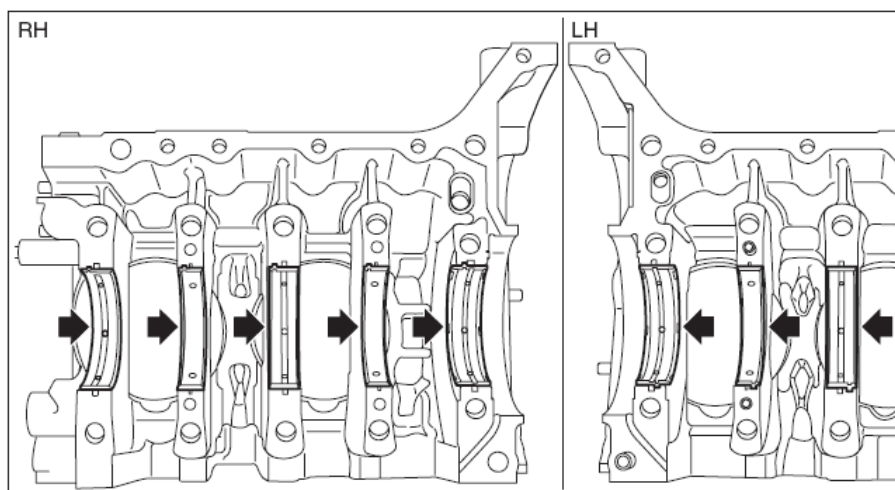


Fig. 478: Locating Liquid Gasket Applying Area On Cranksh
Courtesy of SUBARU OF AMERICA, INC.

4. Set the crankshaft to the cylinder block LH.

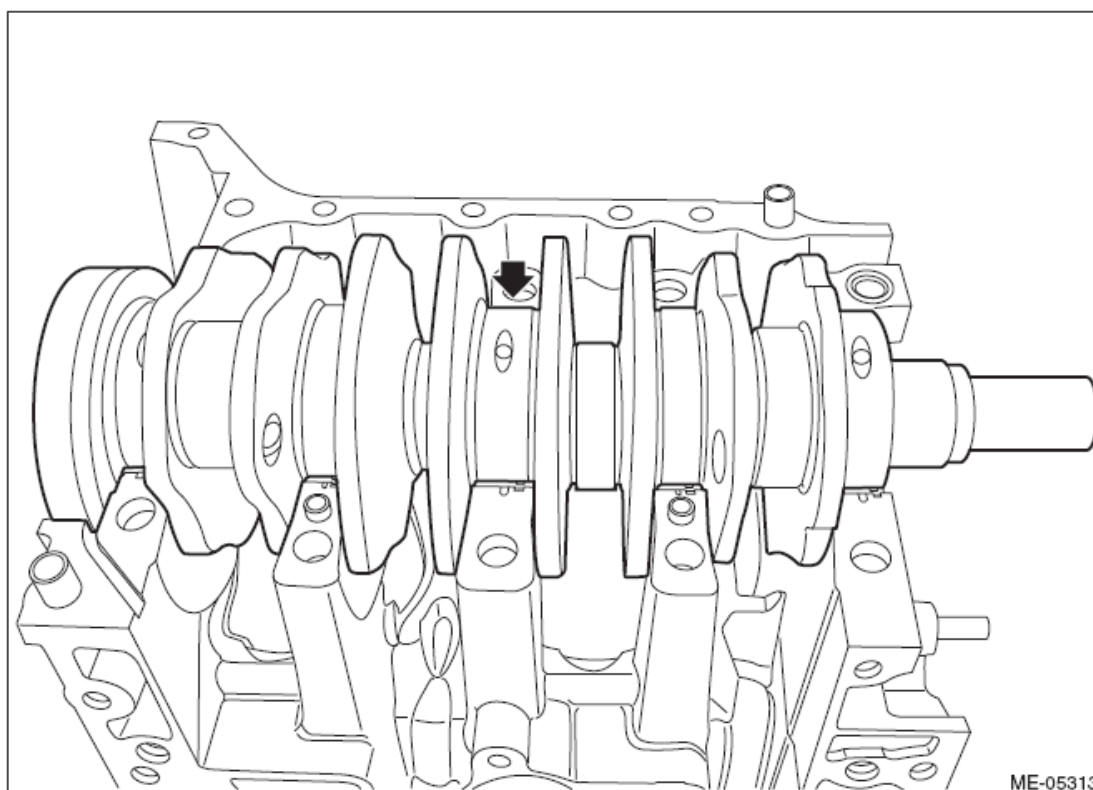


Fig. 479: Locating Engine Oil Applying Area On Crankshaft Journal
Courtesy of SUBARU OF AMERICA, INC.

5. Place a plastigauge across the crankshaft journals and set the cylinder block RH to the cylinder block LH.

6. 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.

7. 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.

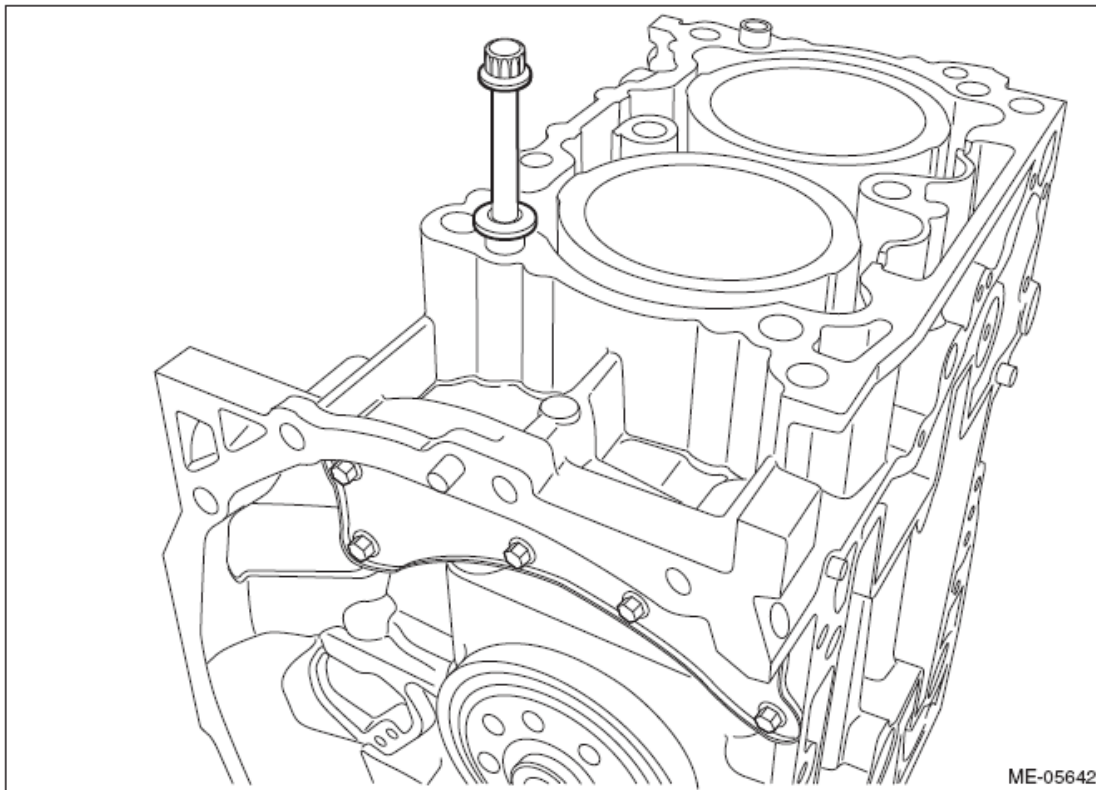


Fig. 480: Identifying Cylinder Head Bolt Position
Courtesy of SUBARU OF AMERICA, INC.

8. 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.

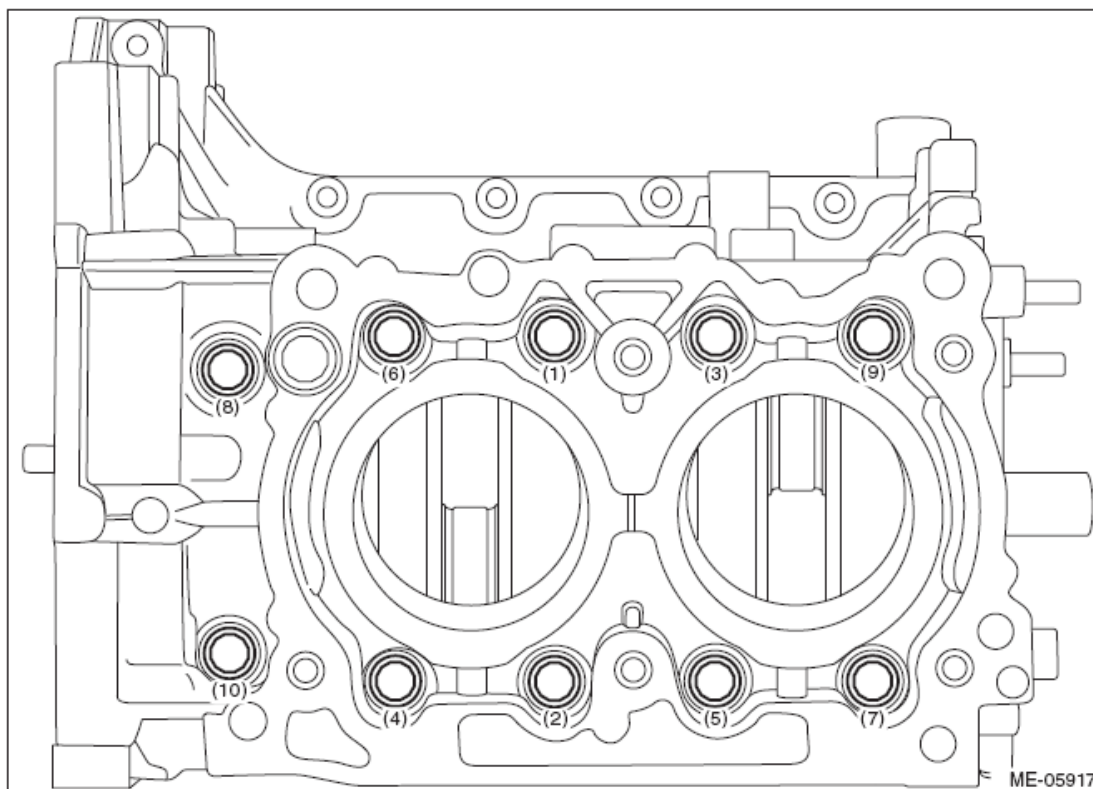


Fig. 481: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

9. 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.

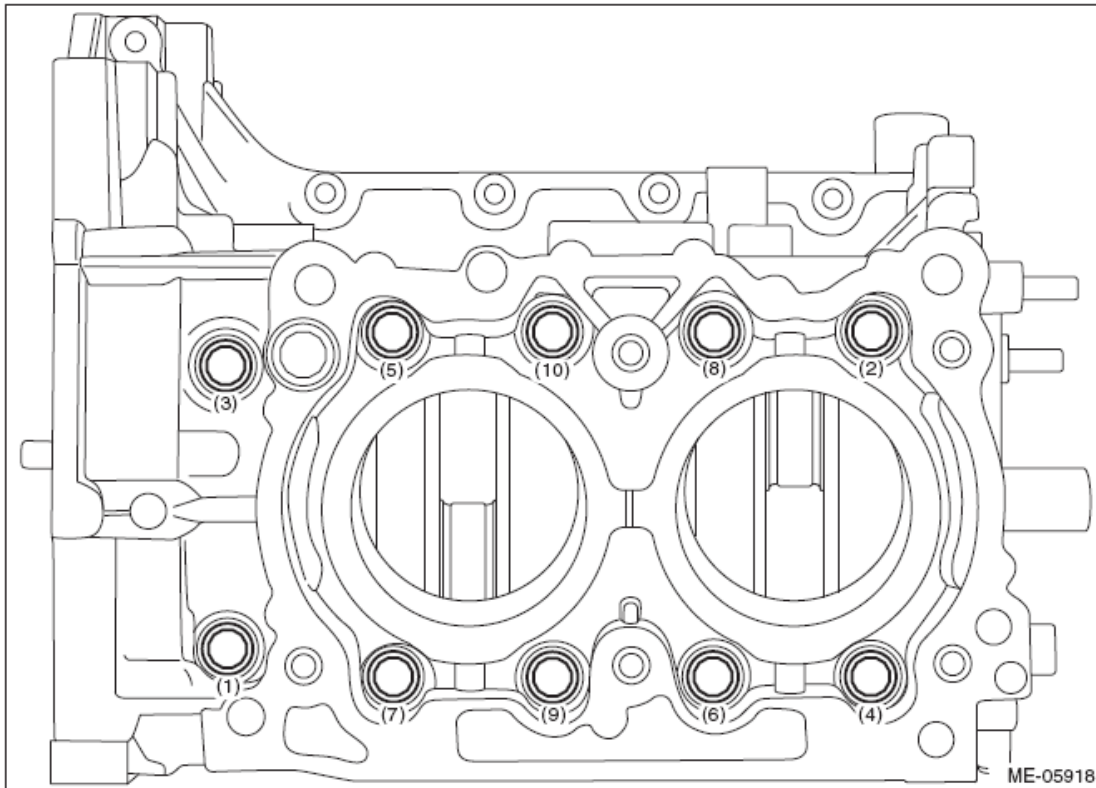


Fig. 482: Identifying Loosening Sequence Of Cylinder Block LH Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

10. 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.

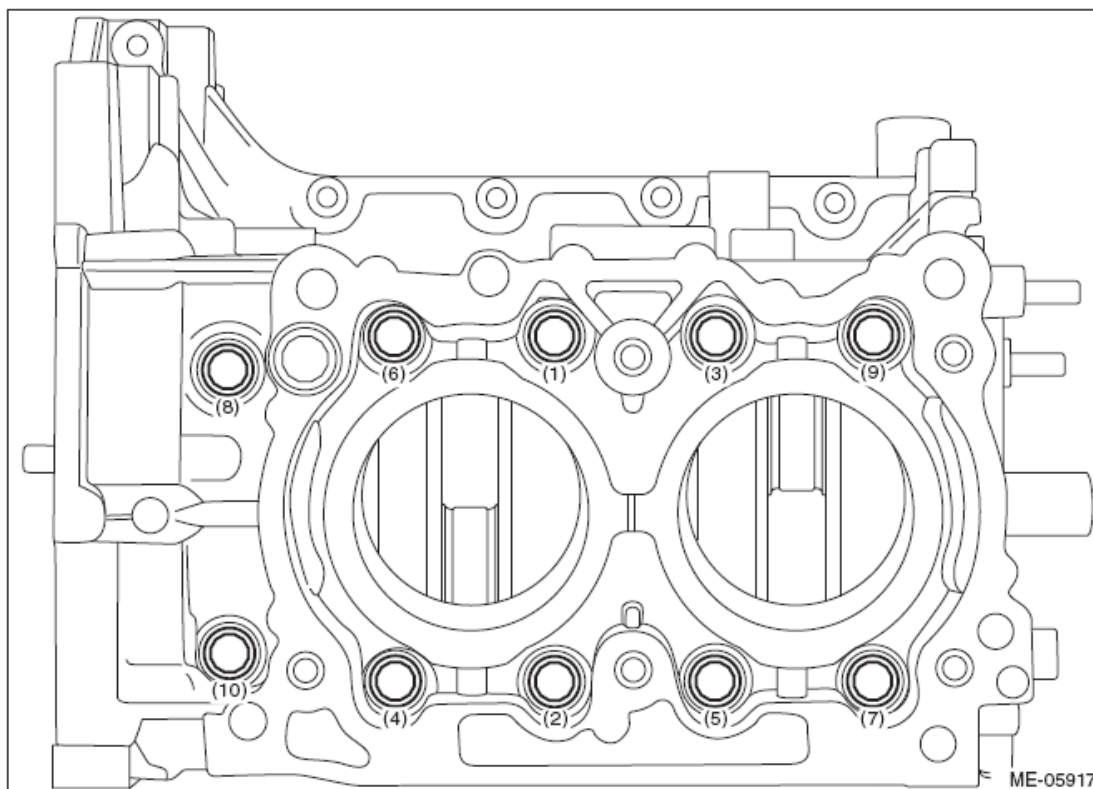


Fig. 483: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

11. 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.

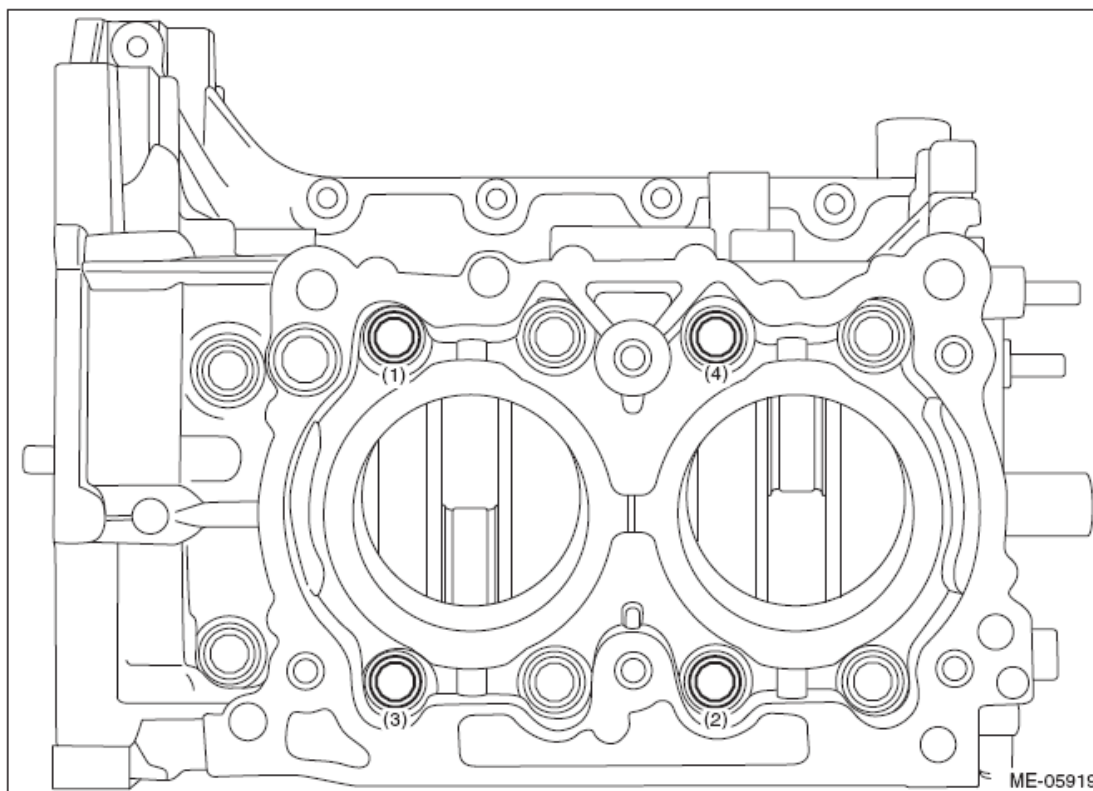


Fig. 484: Identifying Loosening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

12. 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.

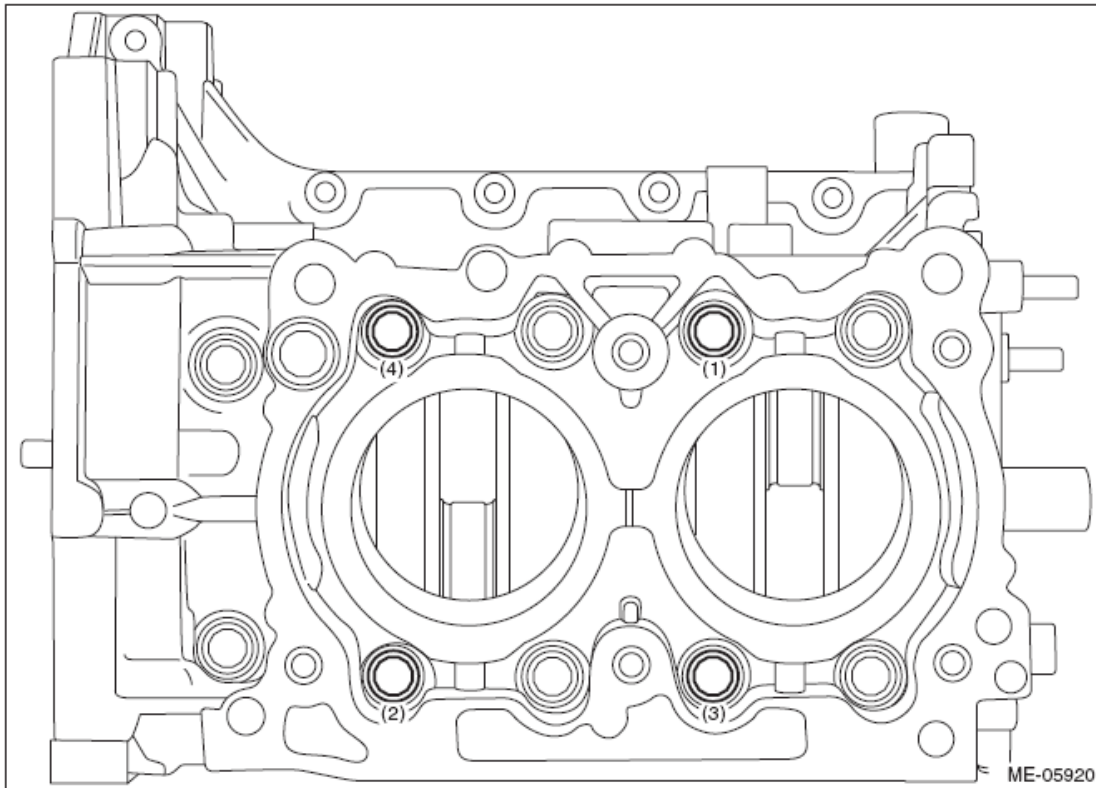


Fig. 485: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
 Courtesy of SUBARU OF AMERICA, INC.

13. Using ST, tighten the mounting bolts (4 places) with specified angle in numerical order as shown in the figure.

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:

$60^{\circ} \pm 2^{\circ}$

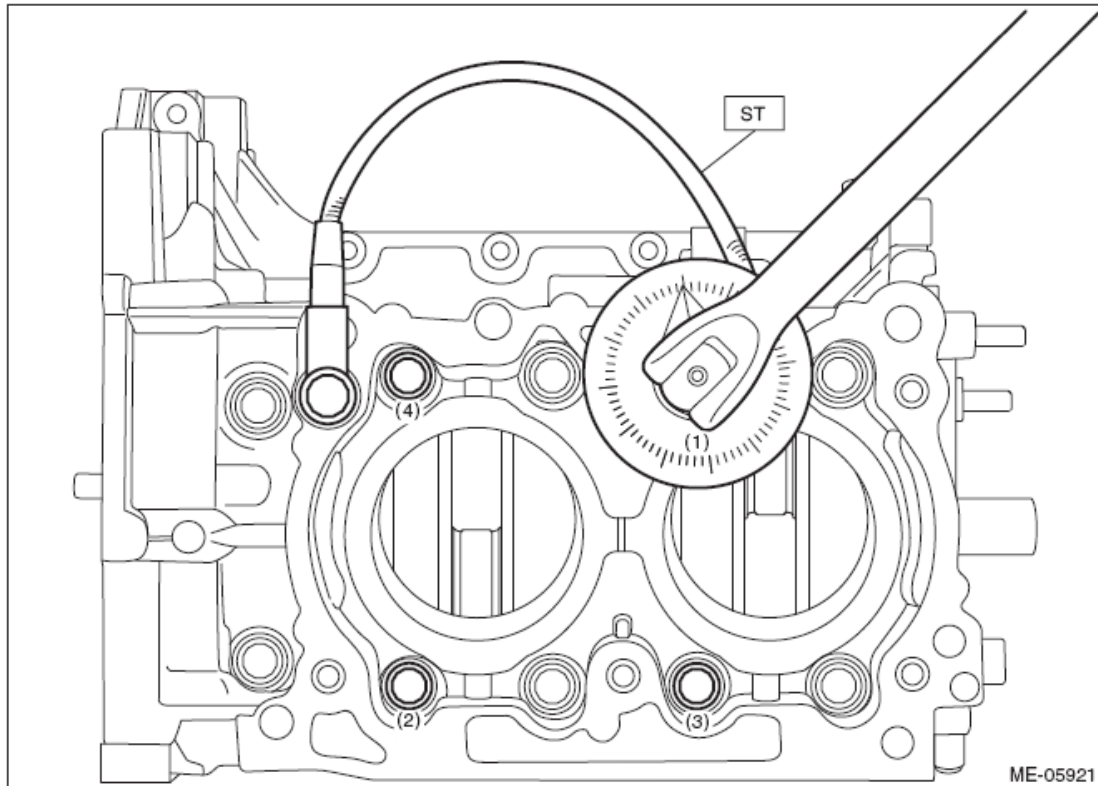


Fig. 486: Tightening Cylinder Head Bolt Using Angle Gauge
 Courtesy of SUBARU OF AMERICA, INC.

14. 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.

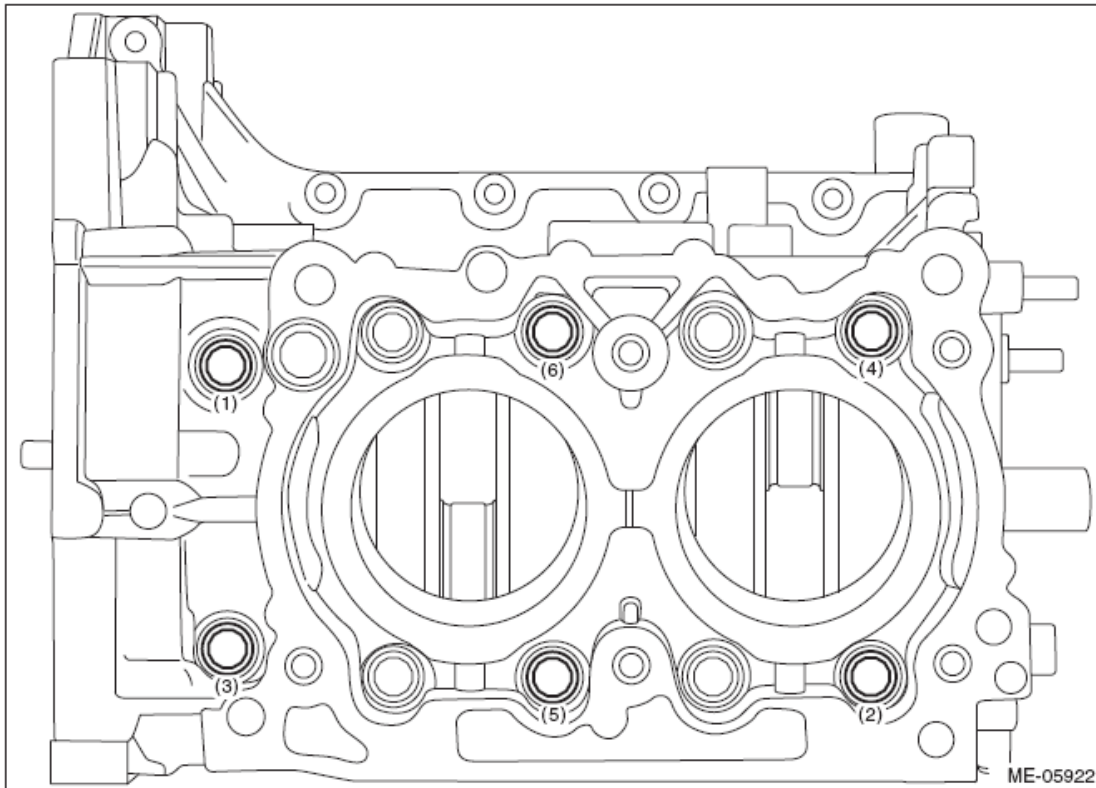


Fig. 487: Identifying Loosening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

15. 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.

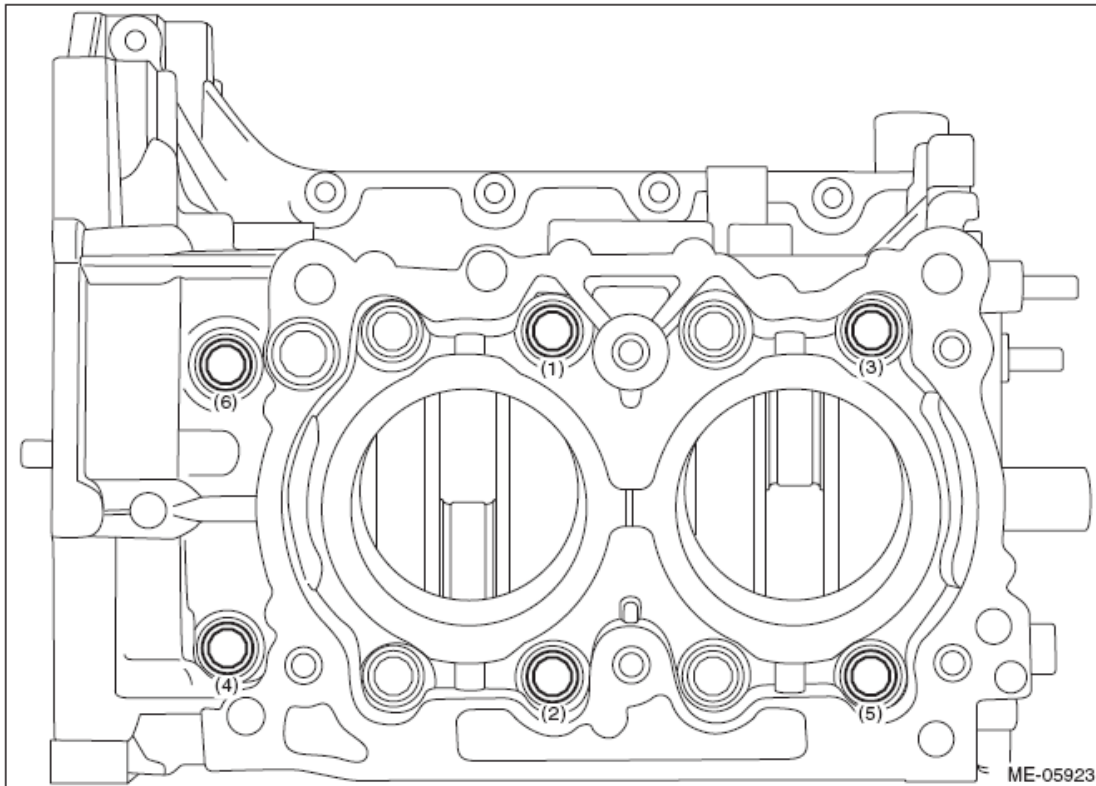


Fig. 488: Identifying Tightening Sequence Of Cylinder Block LH Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

16. Using ST, tighten the mounting bolts (6 places) with specified angle in numerical order as shown in the figure.

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:

$60^{\circ} \pm 2^{\circ}$

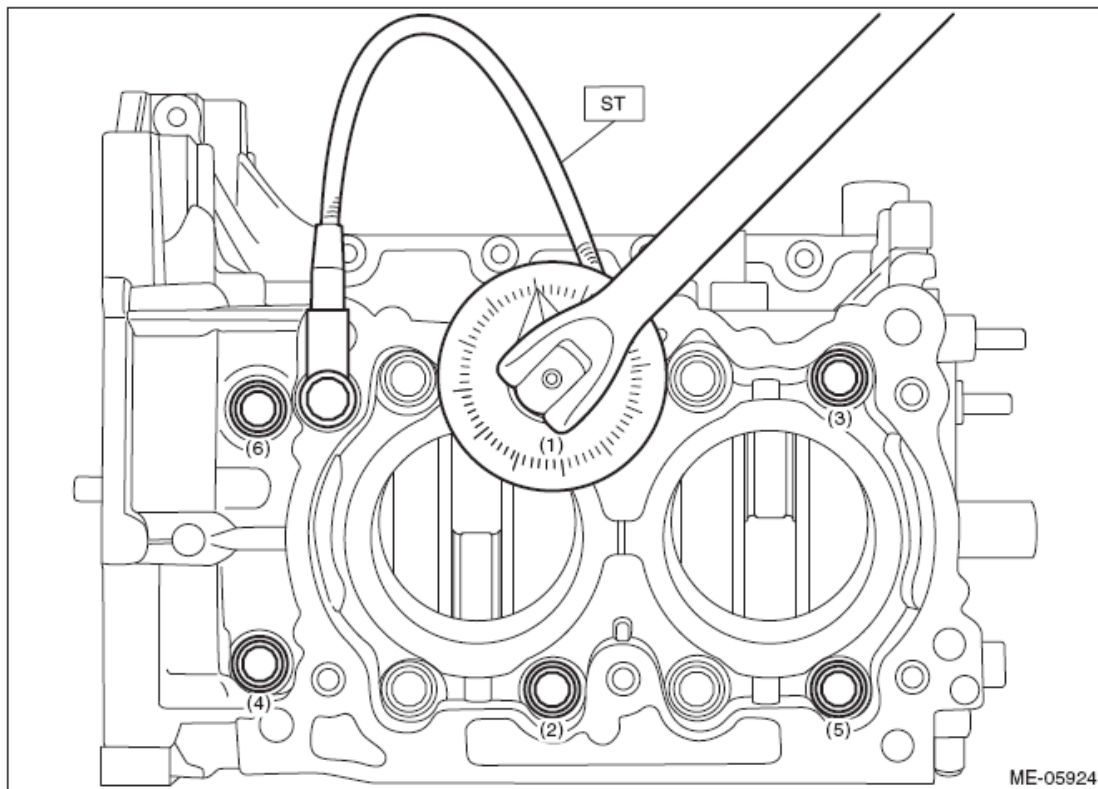


Fig. 489: Tightening Cylinder Head Bolt Using Angle Gauge
Courtesy of SUBARU OF AMERICA, INC.

17. Remove the cylinder head bolt attached at the locations shown in the figure.

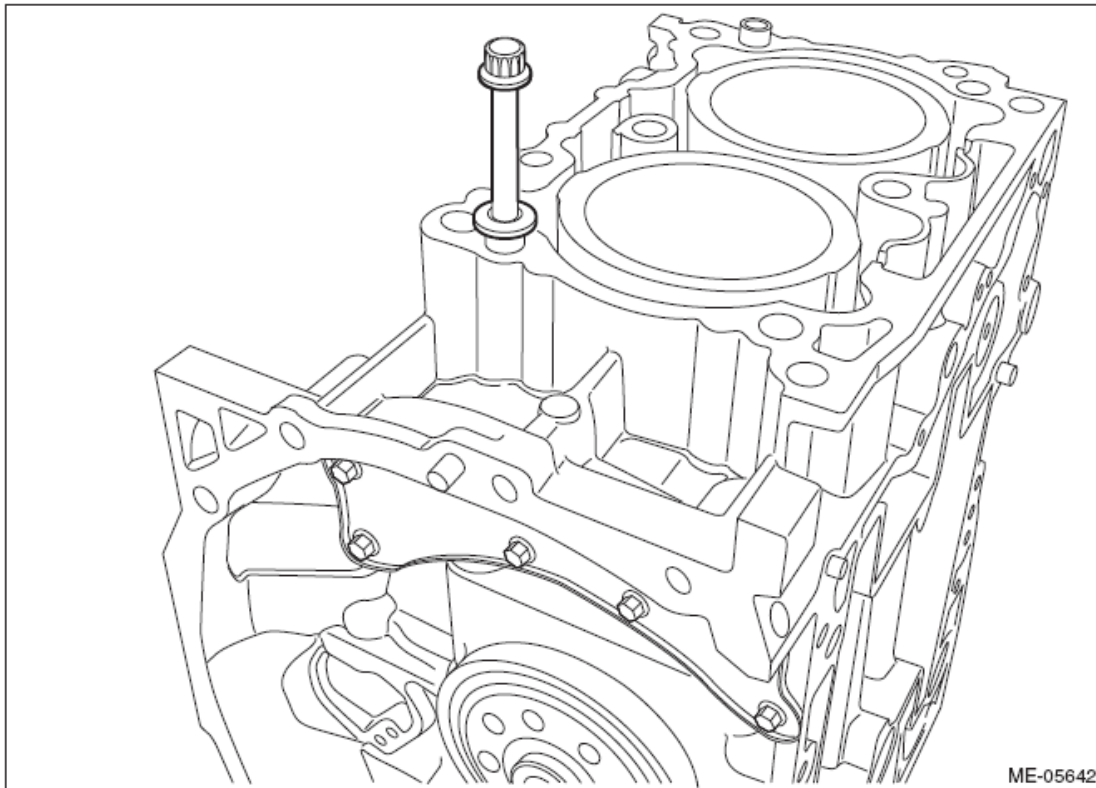


Fig. 490: Identifying Cylinder Head Bolt Position

Courtesy of SUBARU OF AMERICA, INC.

18. 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.

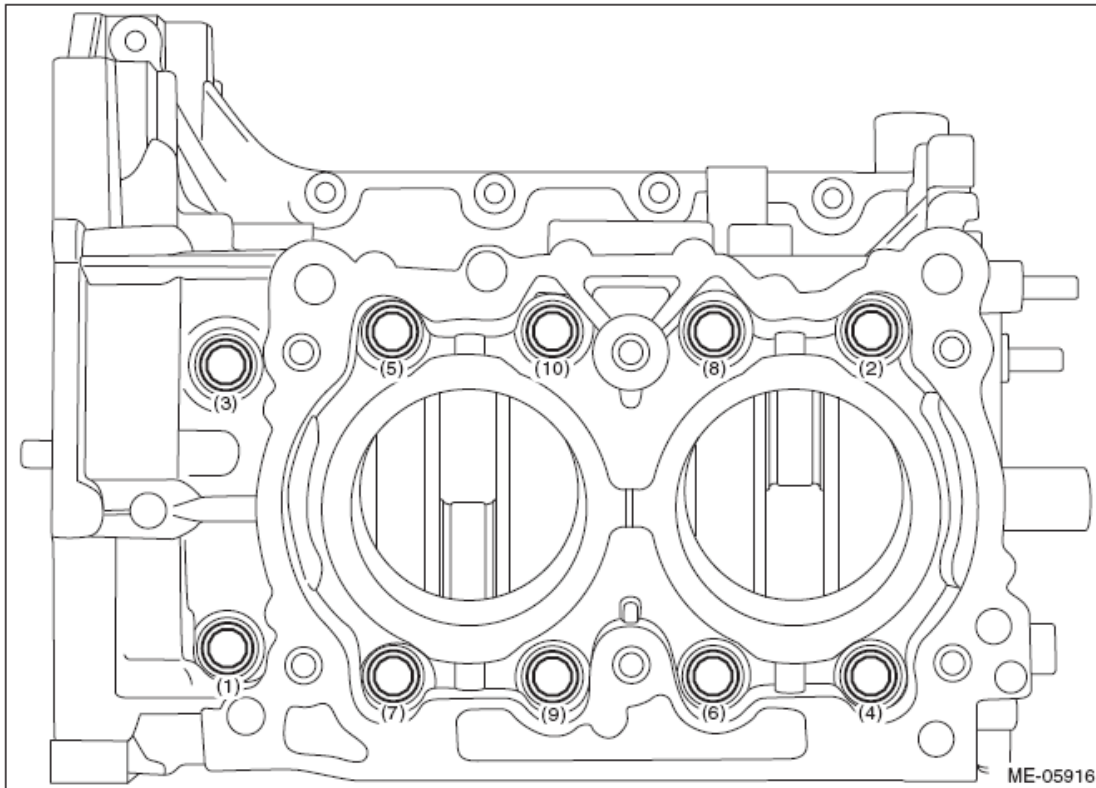


Fig. 491: Identifying Loosening Sequence Of Cylinder Block Mounting Bolts
Courtesy of SUBARU OF AMERICA, INC.

19. Determine the crankshaft oil clearance by matching the widest point of the plastigauge on each journal against scale printed on a package of the plastigauge. If it is not within the standard, replace the crankshaft bearing, and grind to correct the crankshaft journal or replace the crankshaft as required.

NOTE:

- Select the crankshaft bearing of suitable size by referring to step 3) when replacing crankshaft bearing.
- When grinding to correct the crankshaft journal, finish it to the suitable outer diameter 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)

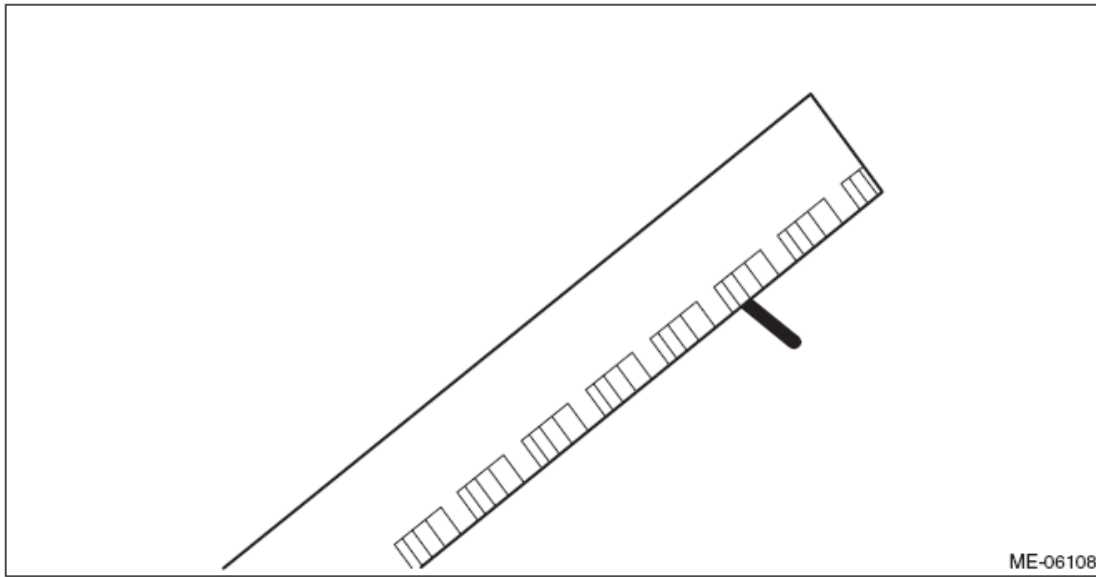


Fig. 492: Checking Connecting Rod Bearing Oil Clearance
Courtesy of SUBARU OF AMERICA, INC.

20. Completely remove the plastigauge.

INTAKE AND EXHAUST VALVE

SPECIFICATION

Refer to **REMOVAL** and **INSTALLATION** for removal and installation procedures of the intake and exhaust valves.

PISTON

SPECIFICATION

Refer to **REMOVAL** and **INSTALLATION** for removal and installation procedures of pistons.

CONNECTING ROD

SPECIFICATION

Refer to **REMOVAL** and **INSTALLATION** for removal and installation procedures of connecting rod.

CRANKSHAFT

SPECIFICATION

Refer to **REMOVAL** and **INSTALLATION** for removal and installation procedures of the crankshaft.

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

Symptoms	Problem parts etc.	Possible cause	RANK
1. Engine does not start.			
1) Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective inhibitor switch	C
		Defective starter	B
	Battery	Improper connection of terminal	A
		Run-down battery	A
		Defective charging system	B
	Friction	Seizure of crankshaft and connecting rod bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
	Immobilizer system Refer to BASIC DIAGNOSTIC PROCEDURE .		A
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system Refer to BASIC DIAGNOSTIC PROCEDURE .		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

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		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
3) 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
		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
4) Engine stalls after initial combustion.	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
	Fuel line	Clogged fuel line	C
		Lack of fuel or insufficient fuel	B
	Timing chain	Trouble	B
		Defective timing	B
		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

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	Compression	Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
2. Rough idle and engine stall	Engine control system 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	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
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Over-heating	C
	Other	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B
	Engine control system Refer to <u>BASIC DIAGNOSTIC PROCEDURE</u> .		A
		Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	B

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3. Low output, hesitation and poor acceleration	Intake system	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
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
	Cooling system	Over-heating	C
		Over-cooling	C
	Other	Evaporative emission control system malfunction	A
4. Surging	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	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
		Incorrect cam clearance	B
		Loosened spark plug or defective gasket	C

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	Compression	Loosened cylinder head bolt or defective cylinder head gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Cooling system	Over-heating	B
	Other	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
	Other	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
	Other	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
		Evaporative emission control system	

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	Other	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 chain cover 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

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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
	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
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
	Sound is not reduced if each fuel injector connector is disconnected in turn. ⁽¹⁾	• Unusually worn valve rocker • Unusually worn valve shim • Worn cam sprocket • Worn 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
		• Defective automatic belt

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Sound like polishing glass with a dry cloth	-	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 **OPERATION** and **PROCEDURE** after connecting the fuel injector connector.