ENGINE (DOHC) 2-3b

1. Engine

A: SPECIFICATIONS

Engine	Type			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve arrangement			Belt driven, double over-head camshaft, 4-valve/ cylinder
	Bore × Stroke		mm (in)	99.5 × 79.0 (3.917 × 3.110)
	Displacement		cm^3 (cu in)	2,457 (149.93)
	Compression ratio			9.7
	Compression pressure (at 200 — 300 rpm)	Standard	kPa (kg/cm^2, psi) − rpm	1,245 (12.7, 181) − 350
		Limit	kPa (kg/cm^2, psi) − rpm	991 (10.1, 144) − 350
	Number of piston rings			Pressure ring: 2, Oil ring: 1
	Intake valve timing	Opening		6° BTDC
		Closing		50° ABDC
	Exhaust valve timing	Opening		Front: 54° BBDC, Rear: 30° BBDC (Position in degrees)
		Closing		Front: 10° ATDC, Rear: 10° ATDC (Position in degrees)
	Valve clearance	Intake	mm (in)	0.20±0.02 (0.0079±0.0008)
		Exhaust	mm (in)	0.25±0.02 (0.0098±0.0008)
	Idling speed [At neutral position on MT, or “P” or “N” position on AT]		rpm	700±100 (No load) 850±50 (A/C switch ON)
	Firing order			1 → 3 → 2 → 4
Ignition timing			BTDC/rpm	15°±8°/700 rpm

B: SERVICE DATA

NOTE:
STD: Standard, I.D.: Inner Diameter, O.D.: Outer Diameter, OS: Oversize, US: Undersize

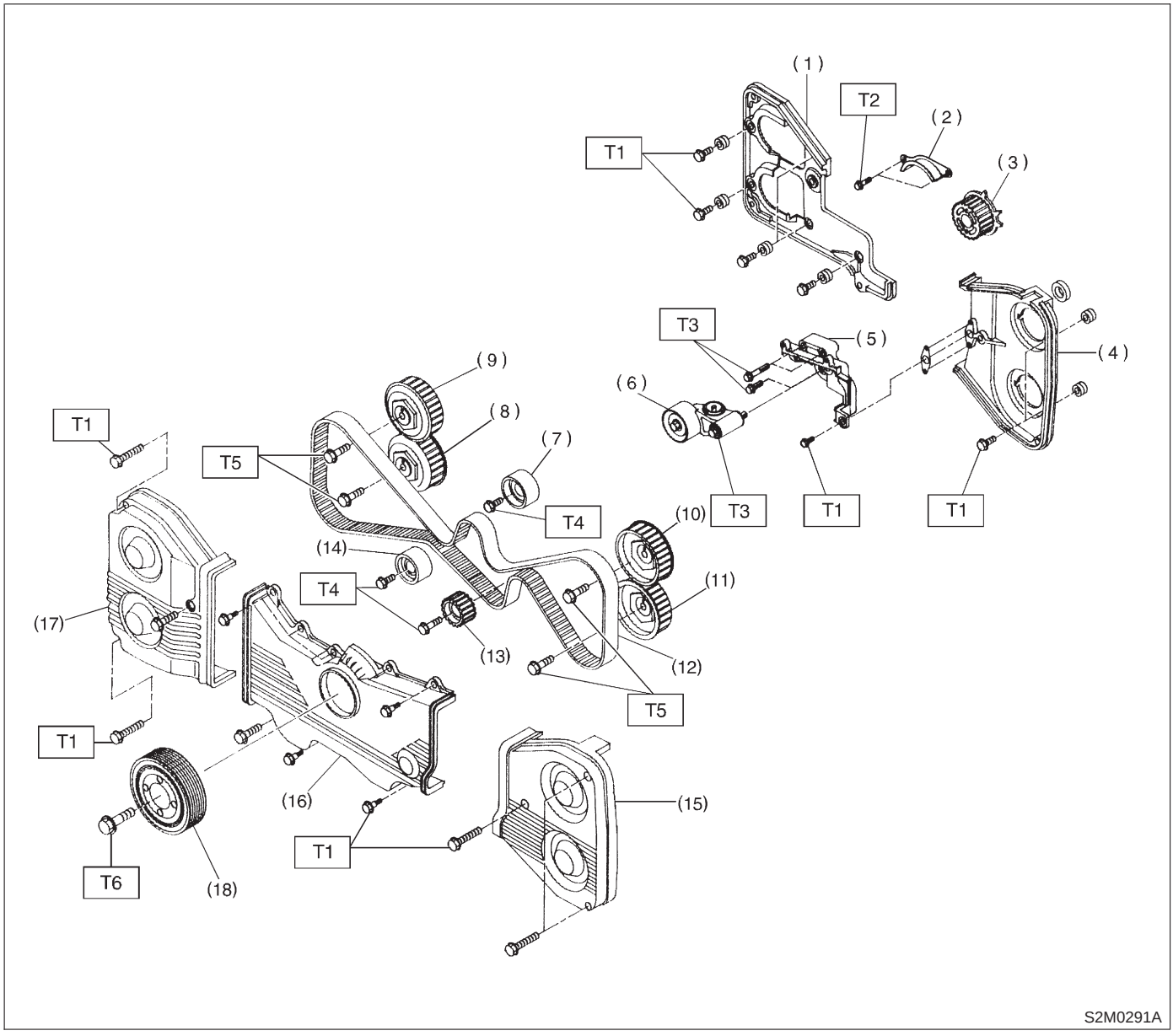
Belt tension adjuster	Protrusion of adjuster rod			0 — 5.7 mm	(0 — 0.224 in)
Belt tensioner	Spacer O.D.			16 mm	(0.63 in)
	Tensioner bush I.D.			16.16 mm	(0.6362 in)
	Clearance between spacer and bush		STD	0.117 — 0.180 mm	(0.0046 — 0.0071 in)
			Limit	0.230 mm	(0.0091 in)
	Side clearance of spacer		STD	0.37 — 0.54 mm	(0.0146 — 0.0213 in)
			Limit	0.8 mm	(0.031 in)
Camshaft	Bend limit			0.020 mm	(0.0008 in)
	Thrust clearance		STD	0.040 — 0.065 mm	(0.0016 — 0.0026 in)
			Limit	0.10 mm	(0.0039 in)
	Cam lobe height	Intake	STD	42.20 — 42.30 mm	(1.6614 — 1.6654 in)
			Limit	42.05 mm	(1.6555 in)
		Exhaust	STD	Front: 42.50 — 42.60 mm Rear: 41.40 — 41.50 mm	(1.6732 — 1.6772 in) (1.6299 — 1.6339 in)
			Limit	Front: 42.35 mm Rear: 41.25 mm	(1.6673 in) (1.6240 in)
	Camshaft journal O.D.		Front	31.946 — 31.963 mm	(1.2577 — 1.2584 in)
			Center	27.946 — 27.963 mm	(1.1002 — 1.1009 in)
			Rear	27.946 — 27.963 mm	(1.1002 — 1.1009 in)
	Camshaft journal hole I.D.		Front	32.000 — 32.018 mm	(1.2598 — 1.2605 in)
			Center	28.000 — 28.018 mm	(1.1024 — 1.1031 in)
			Rear	28.000 — 28.018 mm	(1.1024 — 1.1031 in)
	Oil clearance		STD	0.037 — 0.072 mm	(0.0015 — 0.0028 in)
			Limit	0.10 mm	(0.0039 in)
Cylinder head	Surface warpage limit			0.05 mm	(0.0020 in)
	Surface grinding limit			0.3 mm	(0.012 in)
	Standard height			127.5 mm	(5.02 in)
Valve seat	Refacing angle			90°	
	Contacting width	Intake	STD	1.0 mm	(0.039 in)
			Limit	1.7 mm	(0.067 in)
		Exhaust	STD	1.5 mm	(0.059 in)
			Limit	2.2 mm	(0.087 in)
Valve guide	Inner diameter			6.000 — 6.015 mm	(0.2362 — 0.2368 in)
	Protrusion above head			12.0 — 12.4 mm	(0.472 — 0.488 in)
Valve	Head edge thickness	Intake	STD	1.2 mm	(0.047 in)
			Limit	0.8 mm	(0.031 in)
		Exhaust	STD	1.5 mm	(0.059 in)
			Limit	0.8 mm	(0.031 in)
	Stem diameter		Intake	5.950 — 5.965 mm	(0.2343 — 0.2348 in)
			Exhaust	5.950 — 5.965 mm	(0.2343 — 0.2348 in)
	Stem oil clearance	STD	Intake	0.035 — 0.062 mm	(0.0014 — 0.0024 in)
			Exhaust	0.040 — 0.067 mm	(0.0016 — 0.0026 in)
		Limit	—	0.15 mm	(0.0059 in)
	Overall length		Intake	105.9 mm	(4.169 in)
			Exhaust	106.2 mm	(4.181 in)

Valve spring	Free length			48.04 mm	(1.8913 in)
	Squareness			2.5°, 2.1 mm	(0.083 in)
	Tension/spring height			146.1 — 167.7 N (14.9 — 17.1 kg, 32.9 — 37.7 lb)/42.0 mm (1.654 in) 455.0 — 523.7 N (46.4 — 53.4 kg, 102.3 — 117.7 lb)/33.4 mm (1.315 in)	
Cylinder block	Surface warpage limit (mating with cylinder head)			0.05 mm	(0.0020 in)
	Surface grinding limit			0.1 mm	(0.004 in)
	Cylinder bore	STD	A	99.505 — 99.515 mm	(3.9175 — 3.9179 in)
			B	99.495 — 99.505 mm	(3.9171 — 3.9175 in)
	Taper		STD	0.015 mm	(0.0006 in)
			Limit	0.050 mm	(0.0020 in)
	Out-of-roundness		STD	0.010 mm	(0.0004 in)
			Limit	0.050 mm	(0.0020 in)
	Piston clearance		STD	0.004 — 0.010 mm	(0.0002 — 0.0004 in)
			Limit	0.020 mm	(0.0008 in)
	Enlarging (boring) limit			0.5 mm	(0.020 in)
Piston	Outer diameter	STD	A	99.485 — 99.495 mm	(3.9167 — 3.9171 in)
			B	99.475 — 99.485 mm	(3.9163 — 3.9167 in)
		0.25 mm (0.0098 in) OS		99.725 — 99.735 mm	(3.9262 — 3.9266 in)
		0.50 mm (0.0197 in) OS		99.975 — 99.985 mm	(3.9360 — 3.9364 in)
Piston pin	Standard clearance between piston pin and hole in piston		STD	0.004 — 0.010 mm	(0.0002 — 0.0004 in)
			Limit	0.020 mm	(0.0008 in)
	Degree of fit			Piston pin must be fitted into position with thumb at 20°C (68°F).	
Piston ring	Piston ring gap	Top ring	STD	0.20 — 0.35 mm	(0.0079 — 0.0138 in)
			Limit	1.0 mm	(0.039 in)
		Second ring	STD	0.37 — 0.52 mm	(0.0146 — 0.0205 in)
			Limit	1.0 mm	(0.039 in)
		Oil ring	STD	0.20 — 0.60 mm	(0.0079 — 0.0236 in)
			Limit	1.5 mm	(0.059 in)
	Clearance between piston ring and piston ring groove	Top ring	STD	0.040 — 0.080 mm	(0.0016 — 0.0031 in)
			Limit	0.15 mm	(0.0059 in)
		Second ring	STD	0.030 — 0.070 mm	(0.0012 — 0.0028 in)
			Limit	0.15 mm	(0.0059 in)
Connecting rod	Bend twist per 100 mm (3.94 in) in length		Limit	0.10 mm	(0.0039 in)
	Side clearance		STD	0.070 — 0.330 mm	(0.0028 — 0.0130 in)
			Limit	0.4 mm	(0.016 in)
Connecting rod bearing	Oil clearance		STD	0.010 — 0.038 mm	(0.0004 — 0.0015 in)
			Limit	0.05 mm	(0.0020 in)
	Thickness at center portion		STD	1.492 — 1.501 mm	(0.0587 — 0.0591 in)
			0.03 mm (0.0012 in) US	1.510 — 1.513 mm	(0.0594 — 0.0596 in)
			0.05 mm (0.0020 in) US	1.520 — 1.523 mm	(0.0598 — 0.0600 in)
			0.25 mm (0.0098 in) US	1.620 — 1.623 mm	(0.0638 — 0.0639 in)
Connecting rod bushing	Clearance between piston pin and bushing		STD	0 — 0.022 mm	(0 — 0.0009 in)
			Limit	0.030 mm	(0.0012 in)

Crankshaft	Bend limit			0.035 mm	(0.0014 in)
	Crank pin and crank journal	Out-of-roundness		0.020 mm (0.0008 in) or less	
		Grinding limit		0.25 mm	(0.0098 in)
	Crank pin outer diameter		STD	47.984 — 48.000 mm	(1.8891 — 1.8898 in)
			0.03 mm (0.0012 in) US	47.954 — 47.970 mm	(1.8879 — 1.8886 in)
			0.05 mm (0.0020 in) US	47.934 — 47.950 mm	(1.8872 — 1.8878 in)
			0.25 mm (0.0098 in) US	47.734 — 47.750 mm	(1.8793 — 1.8799 in)
	Crank journal outer diameter	#1, #5	STD	59.992 — 60.008 mm	(2.3619 — 2.3625 in)
			0.03 mm (0.0012 in) US	59.962 — 59.978 mm	(2.3607 — 2.3613 in)
			0.05 mm (0.0020 in) US	59.942 — 59.958 mm	(2.3599 — 2.3605 in)
			0.25 mm (0.0098 in) US	59.742 — 59.758 mm	(2.3520 — 2.3527 in)
		#2, #3, #4	STD	59.992 — 60.008 mm	(2.3619 — 2.3625 in)
			0.03 mm (0.0012 in) US	59.962 — 59.978 mm	(2.3607 — 2.3613 in)
			0.05 mm (0.0020 in) US	59.942 — 59.958 mm	(2.3599 — 2.3605 in)
			0.25 mm (0.0098 in) US	59.742 — 59.758 mm	(2.3520 — 2.3527 in)
	Thrust clearance		STD	0.030 — 0.115 mm	(0.0012 — 0.0045 in)
			Limit	0.25 mm	(0.0098 in)
	Oil clearance	#1, #5	STD	0.003 — 0.030 mm	(0.0001 — 0.0012 in)
		#2, #3, #4	STD	0.010 — 0.033 mm	(0.0004 — 0.0013 in)
		#1, #3, #5	Limit	0.040 mm	(0.0016 in)
		#2, #4	Limit	0.045 mm	(0.0018 in)

Crankshaft bearing	Crankshaft bearing thickness	#1, #5	STD	1.998 — 2.011 mm	(0.0787 — 0.0792 in)
			0.03 mm (0.0012 in) US	2.017 — 2.020 mm	(0.0794 — 0.0795 in)
			0.05 mm (0.0020 in) US	2.027 — 2.030 mm	(0.0798 — 0.0799 in)
			0.25 mm (0.0098 in) US	2.127 — 2.130 mm	(0.0837 — 0.0839 in)
		#2, #3, #4	STD	2.000 — 2.013 mm	(0.0787 — 0.0793 in)
			0.03 mm (0.0012 in) US	2.019 — 2.022 mm	(0.0795 — 0.0796 in)
			0.05 mm (0.0020 in) US	2.029 — 2.032 mm	(0.0799 — 0.0800 in)
			0.25 mm (0.0098 in) US	2.129 — 2.132 mm	(0.0838 — 0.0839 in)

1. Timing Belt

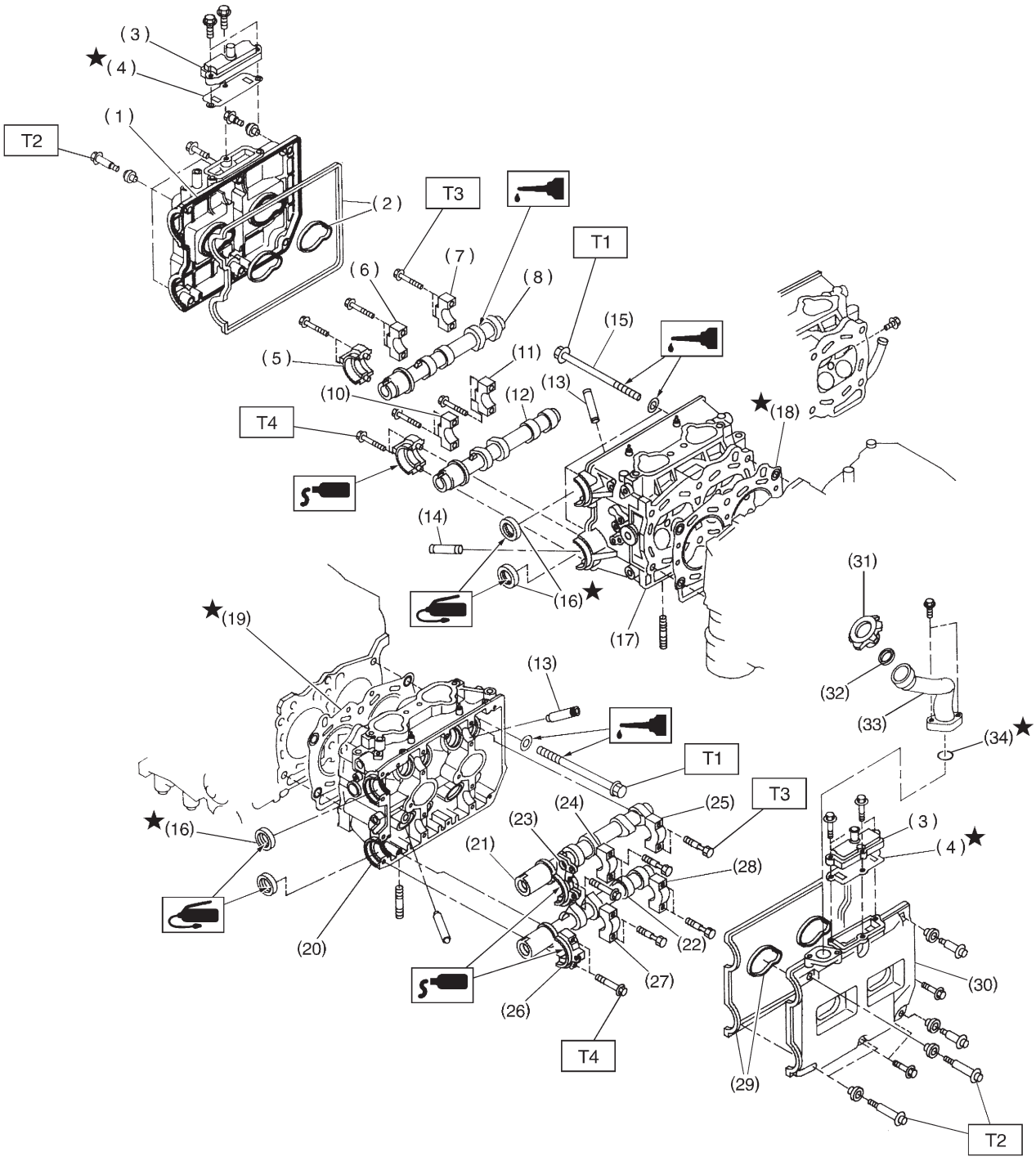


S2M0291A

(1) Right-hand belt cover No. 2
(2) Timing belt guide (MT vehicles only)
(3) Crankshaft sprocket
(4) Left-hand belt cover No. 2
(5) Tensioner bracket
(6) Automatic belt tension adjuster ASSY
(7) Belt idler
(8) Right-hand exhaust camshaft sprocket
(9) Right-hand intake camshaft sprocket
(10) Left-hand intake camshaft sprocket
(11) Left-hand exhaust camshaft sprocket
(12) Timing belt
(13) Belt idler No. 2
(14) Belt idler
(15) Left-hand belt cover
(16) Front belt cover
(17) Right-hand belt cover
(18) Crankshaft pulley

Tightening torque: N·m (kg-m, ft-lb)
T1: 4.9±0.5 (0.5±0.05, 3.6±0.4)
T2: 9.8±1.0 (1.0±0.1, 7.2±0.7)
T3: 25±3 (2.5±0.3, 18.1±2.2)
T4: 39±4 (4.0±0.4, 28.9±2.9)
T5: 78±5 (8.0±0.5, 57.9±3.6)
T6: 177±10 (18.0±1.0, 130±7)

2. Cylinder Head and Camshaft

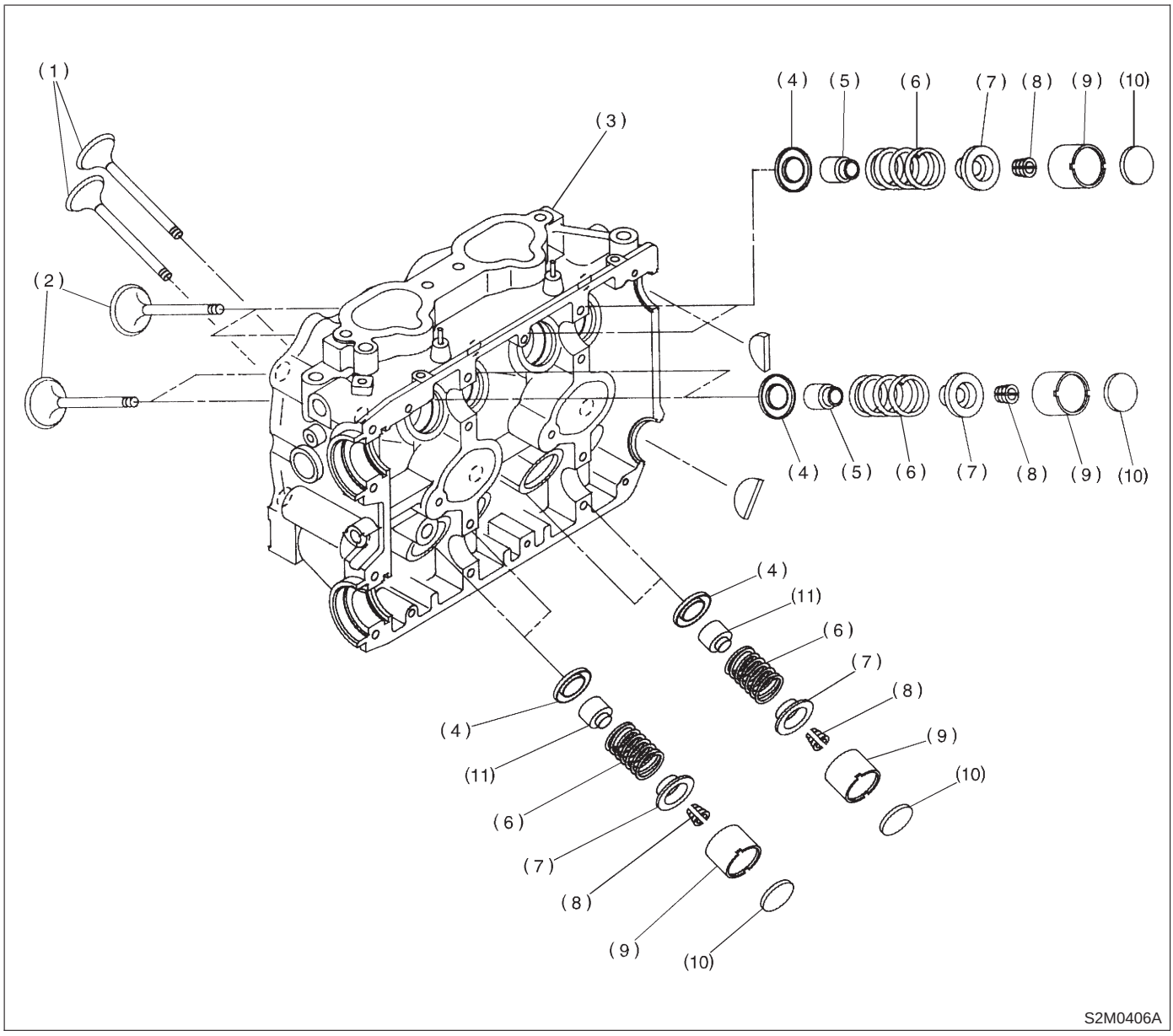


S2M0292D

(1) Rocker cover (RH)
(2) Rocker cover gasket (RH)
(3) Oil separator cover
(4) Gasket
(5) Intake camshaft cap (Front RH)
(6) Intake camshaft cap (Center RH)
(7) Intake camshaft cap (Rear RH)
(8) Intake camshaft (RH)
(9) Exhaust camshaft cap (Front RH)
(10) Exhaust camshaft cap (Center RH)
(11) Exhaust camshaft cap (Rear RH)
(12) Exhaust camshaft (RH)
(13) Intake valve guide
(14) Exhaust valve guide
(15) Cylinder head bolt
(16) Oil seal
(17) Cylinder head (RH)
(18) Cylinder head gasket (RH)
(19) Cylinder head gasket (LH)
(20) Cylinder head (LH)
(21) Intake camshaft (LH)
(22) Exhaust camshaft (LH)
(23) Intake camshaft cap (Front LH)
(24) Intake camshaft cap (Center LH)
(25) Intake camshaft cap (Rear LH)
(26) Exhaust camshaft (Front LH)
(27) Exhaust camshaft cap (Center LH)
(28) Exhaust camshaft cap (Rear LH)
(29) Rocker cover gasket (LH)
(30) Rocker cover (LH)
(31) Oil filler cap
(32) Gasket
(33) Oil filler duct
(34) O-ring

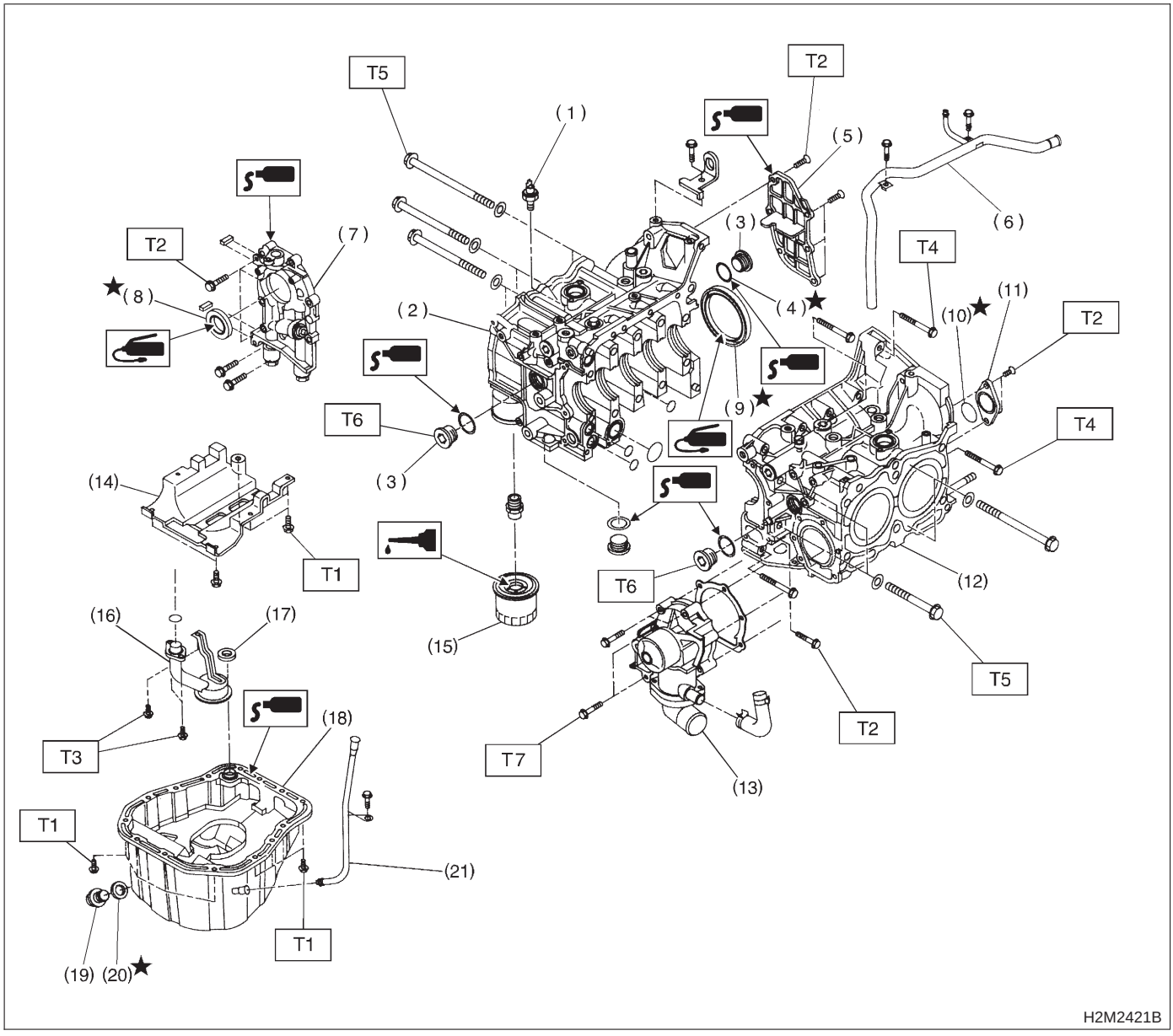
Tightening torque: N·m (kg-m, ft-lb)
T1: <Ref. to 2-3b [W4E1].>
T2: 5±0.5 (0.5±0.05, 3.6±0.4)
T3: 9.8±0.7 (1.0±0.07, 7.2±0.5)
T4: 20±2 (2.0±0.2, 14.5±1.4)

3. Cylinder Head and Valve Assembly



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

4. Cylinder Block

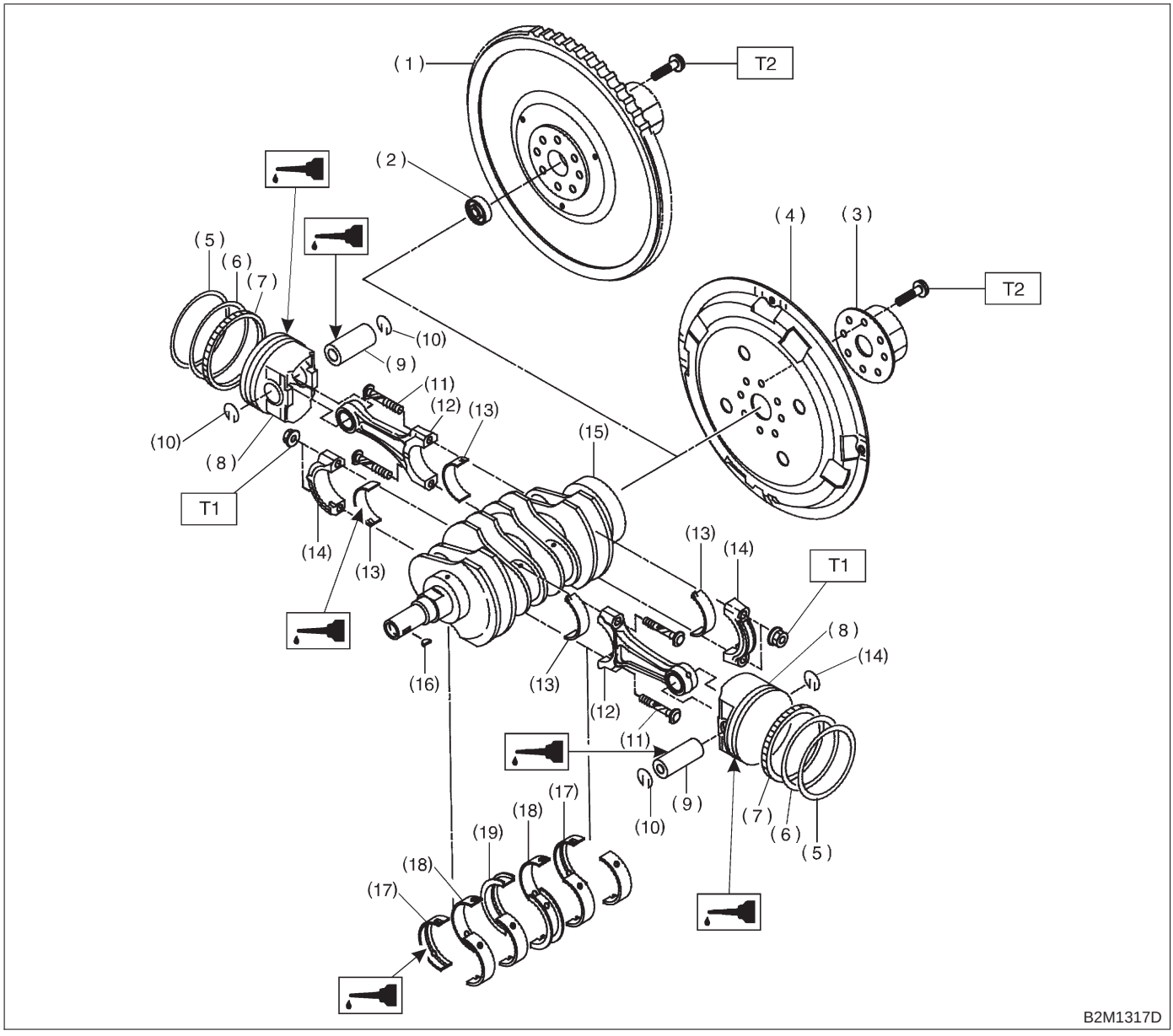


H2M2421B

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

Tightening torque: N·m (kg-m, ft-lb)
T1: 5 (0.5, 3.6)
T2: 6.4 (0.65, 4.7)
T3: 10 (1.0, 7)
T4: 25±2 (2.5±0.2, 18.1±1.4)
T5: 47±3 (4.8±0.3, 34.7±2.2)
T6: 69±7 (7.0±0.7, 50.6±5.1)
T7: First 12±2 (1.2±0.2, 8.7±1.4)
Second 12±2 (1.2±0.2, 8.7±1.4)

5. Crankshaft and Piston



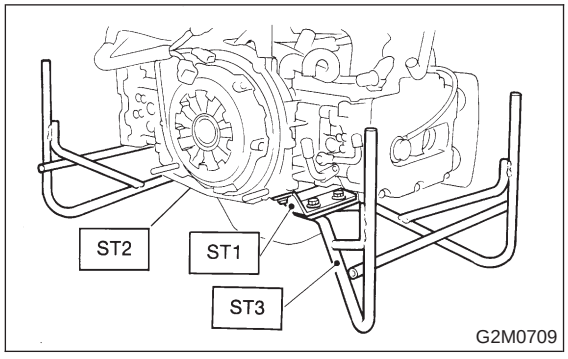
(1) Flywheel (MT vehicles only)
(2) Bell bearing (MT vehicles only)
(3) Reinforcement (AT vehicles only)
(4) Drive plate (AT vehicles only)
(5) Top ring
(6) Second ring
(7) Oil ring
(8) Piston
(9) Piston pin
(10) Circlip
(11) Connecting rod bolt
(12) Connecting rod
(13) Connecting rod bearing
(14) Connecting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

Tightening torque: N·m (kg-m, ft-lb)
T1: 44±2 (4.5±0.2, 32.5±1.4)
T2: 72±3 (7.3±0.3, 52.8±2.2)

1. General Precautions

(1) Before disassembling engine, place it on ST3.

ST1	498457000	ENGINE STAND ADAPTER RH
ST2	498457100	ENGINE STAND ADAPTER LH
ST3	499817000	ENGINE STAND



(2) All parts should be thoroughly cleaned, paying special attention to the engine oil passages, pistons and bearings.

(3) Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.

(4) Be careful not to let oil, grease or coolant contact the timing belt, clutch disc and flywheel.

(5) All removed parts, if to be reused, should be reinstalled in the original positions and directions.

(6) Gaskets and lock washers must be replaced with new ones. Liquid gasket should be used where specified to prevent leakage.

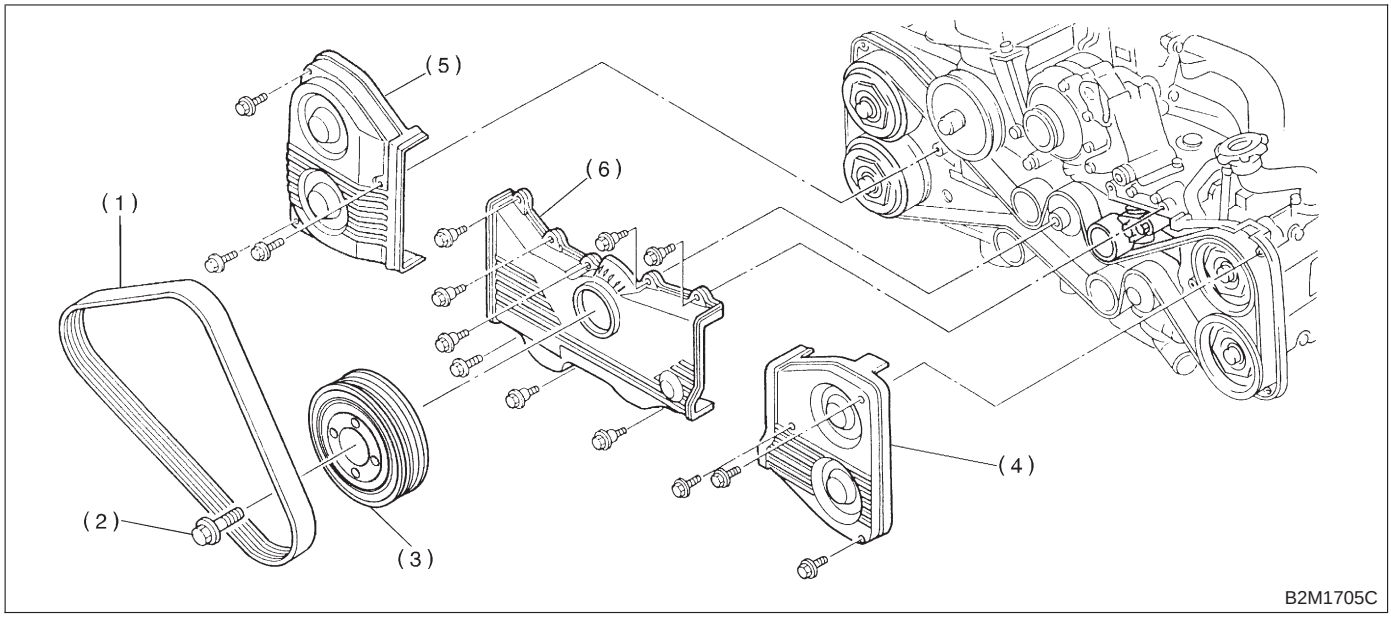
(7) Bolts, nuts and washers should be replaced with new ones as required.

(8) Even if necessary inspections have been made in advance, proceed with assembly work while making rechecks.

2. Timing Belt

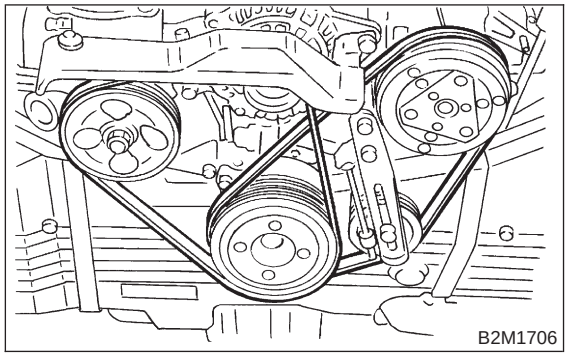
A: REMOVAL

1. CRANKSHAFT PULLEY AND BELT COVER

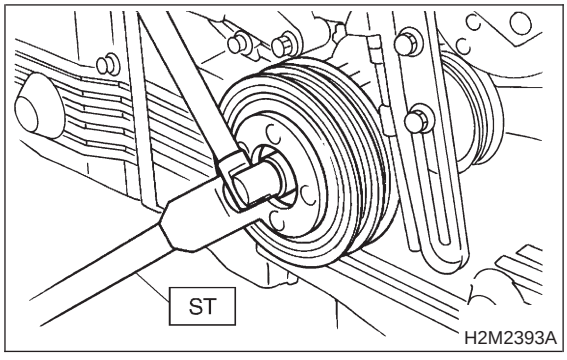


(1) V-belt
(2) Crankshaft pulley bolt
(3) Crankshaft pulley
(4) Left-hand belt cover No. 1
(5) Right-hand belt cover No. 1
(6) Front belt cover

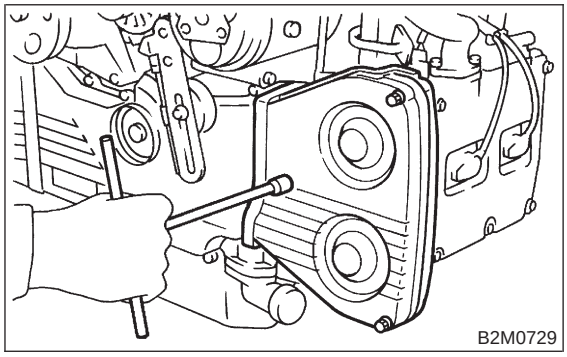
1) Remove V-belt cover, V-belt and air conditioning compressor drive belt tensioner. <Ref. to 1-5 [G200].>



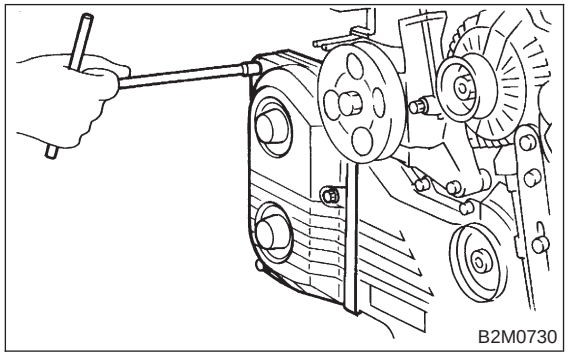
2) Remove pulley bolt. To lock crankshaft, use ST.
ST 499977100 CRANKSHAFT PULLEY WRENCH



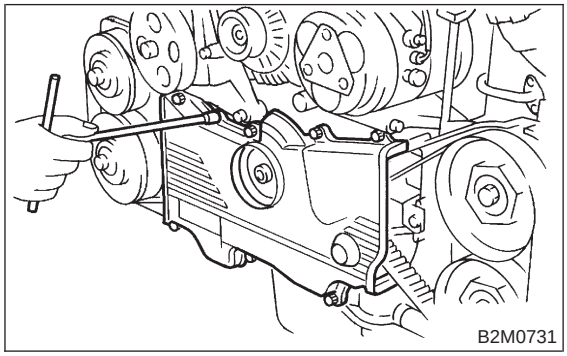
3) Remove crankshaft pulley.
4) Remove left-hand belt cover.



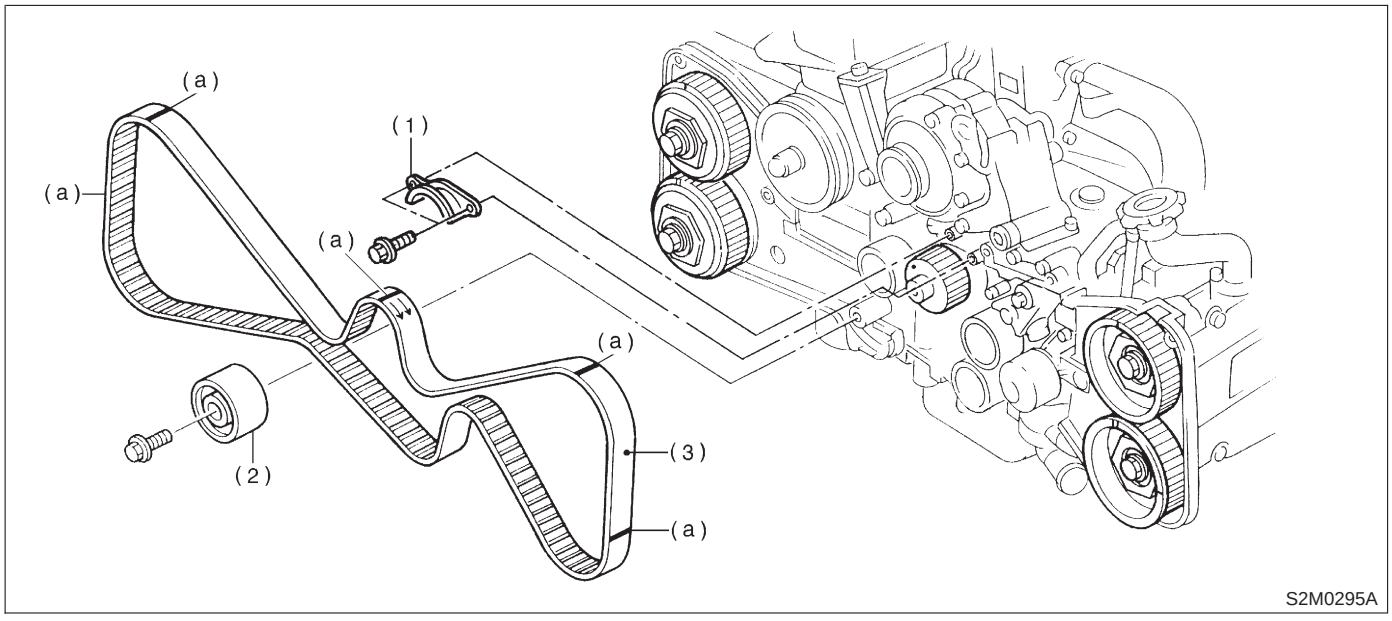
5) Remove right-hand belt cover.



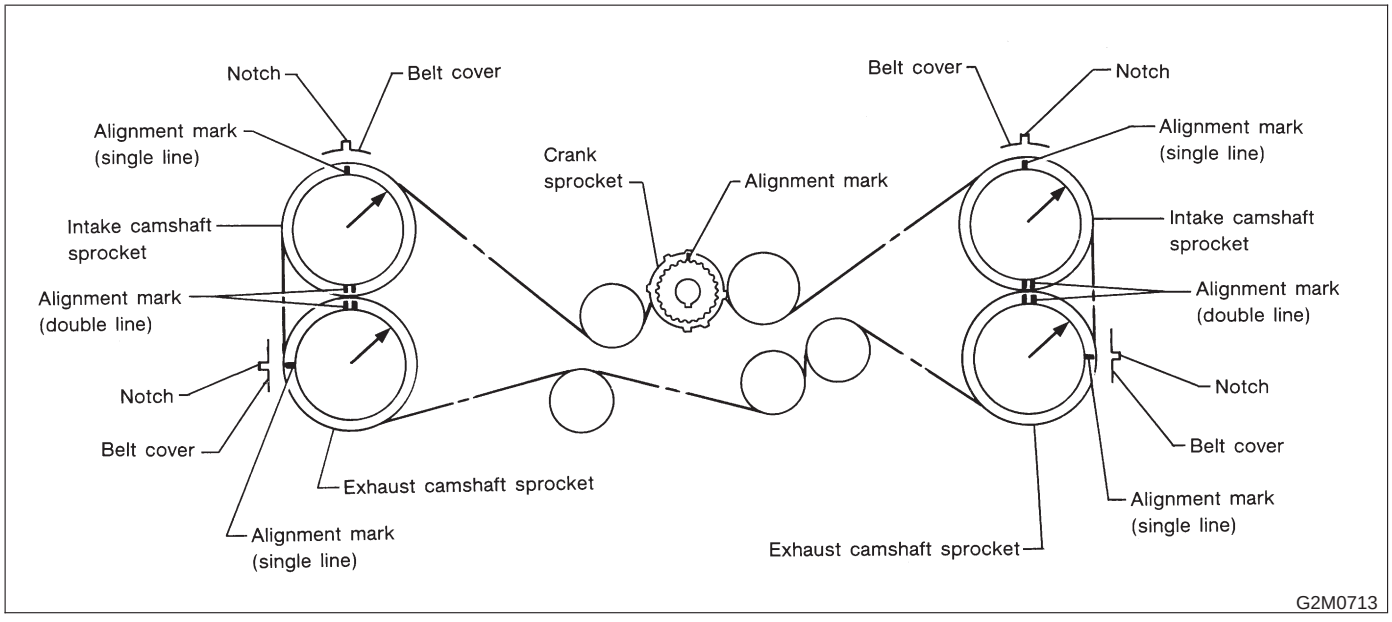
6) Remove front belt cover.



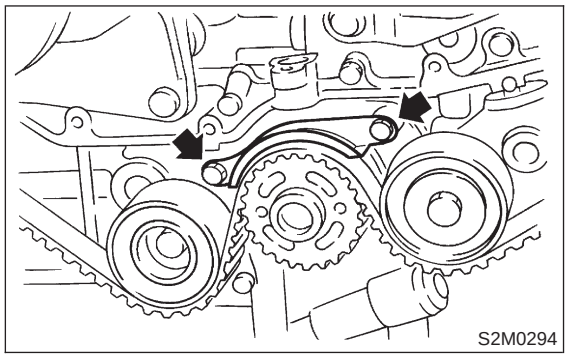
2. TIMING BELT



(1) Timing belt guide (MT vehicles only)
(2) Belt idler
(3) Timing belt
(a) Alignment marks



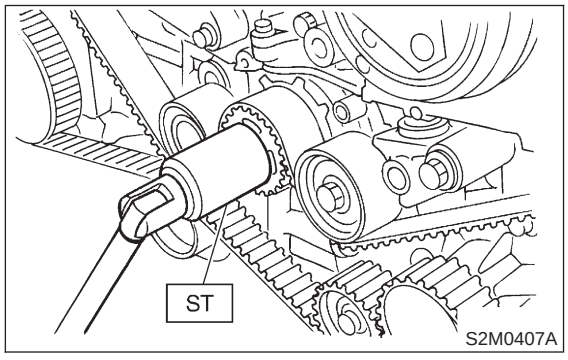
1) Remove timing belt guide. (MT vehicles only)


S2M0294

2) If alignment mark and/or arrow mark (which indicates rotation direction) on timing belt fade away, put new marks before removing timing belt as follows:

(1) Turn crankshaft using ST, and align alignment marks on crankshaft sprocket, left-hand intake camshaft sprocket, left-hand exhaust camshaft sprocket, right-hand intake camshaft sprocket and right hand exhaust camshaft sprocket with notches of belt cover and cylinder block.

ST 499987500 CRANKSHAFT SOCKET



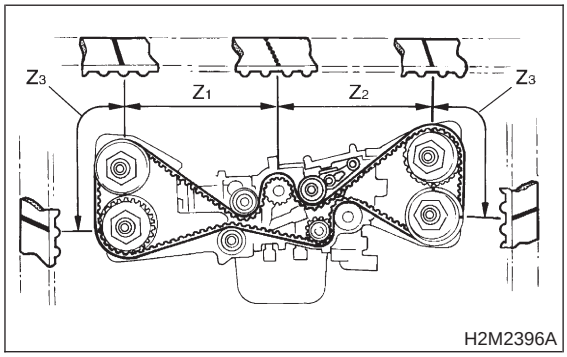
S2M0407A

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

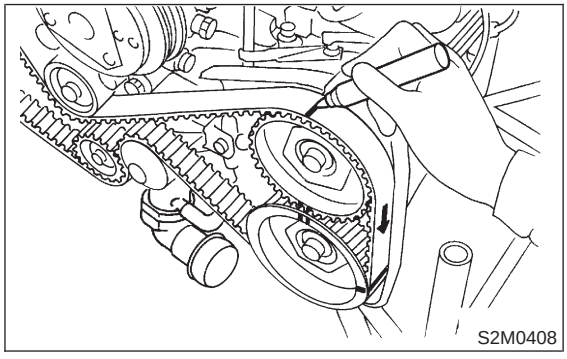
Z_1: 54.5 tooth length

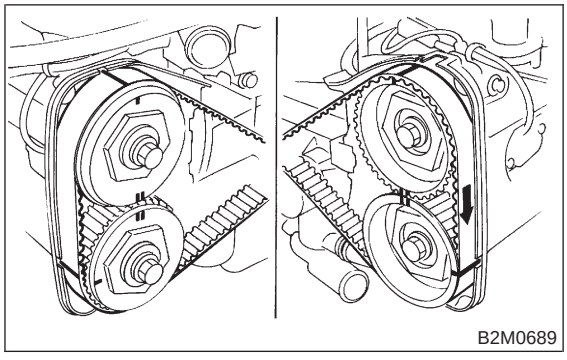
Z_2: 51 tooth length

Z_3: 28 tooth length

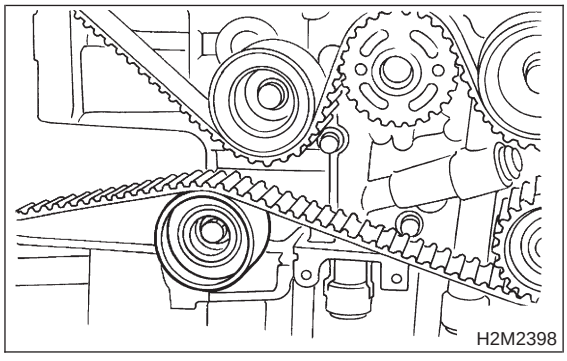


H2M2396A


S2M0408

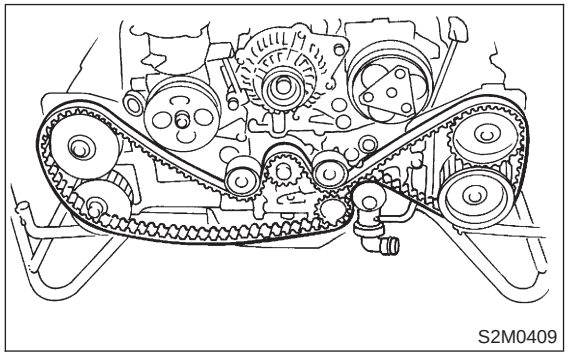

B2M0689

3) Remove belt idler.

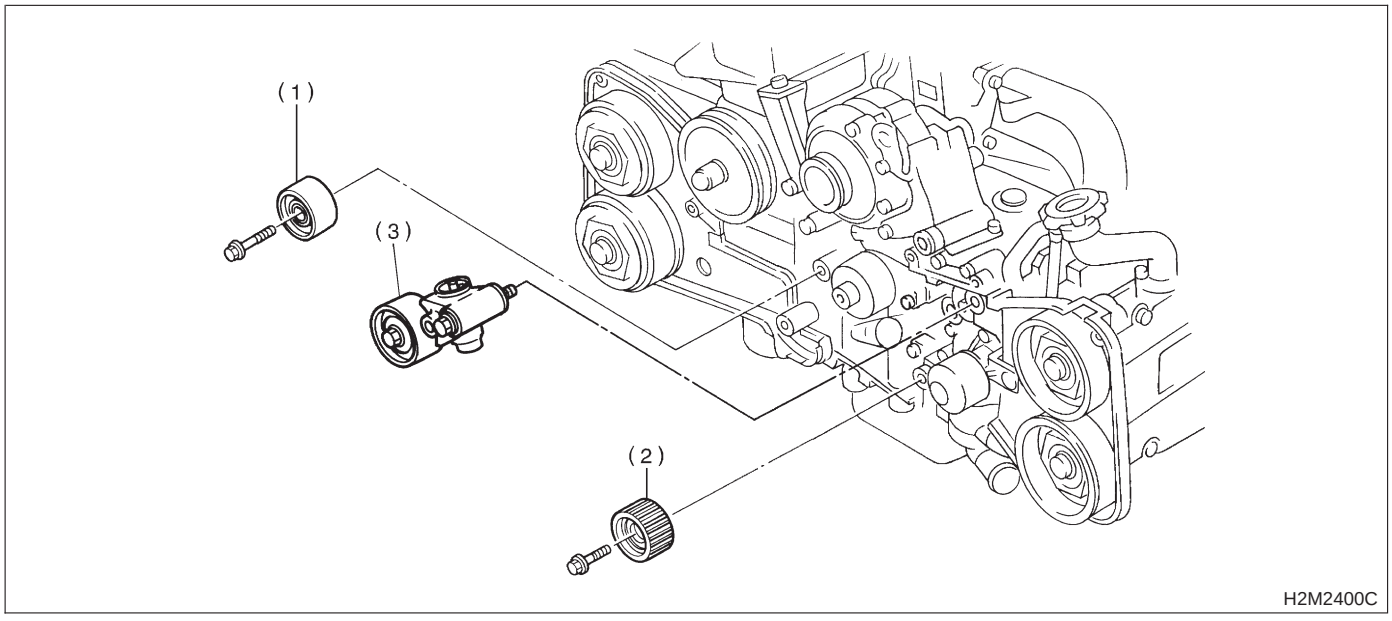

H2M2398

4) Remove timing belt.

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


S2M0409

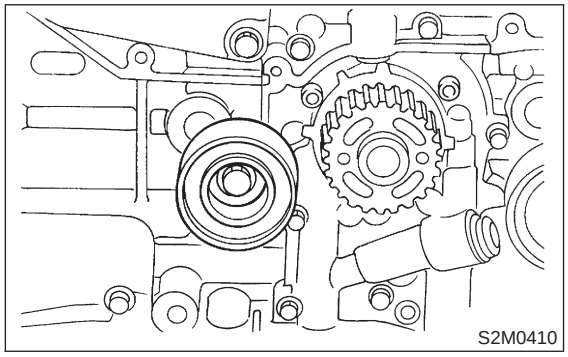
3. BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY



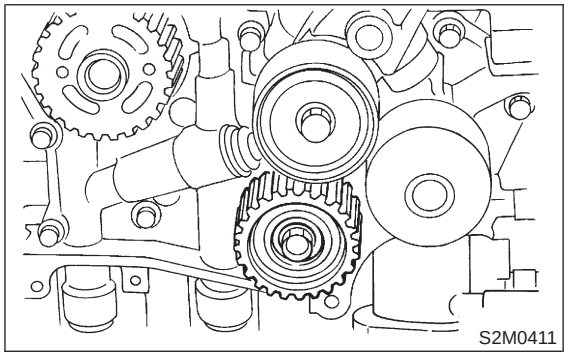
H2M2400C

(1) Belt idler
(2) Belt idler No. 2
(3) Automatic belt tension adjuster ASSY

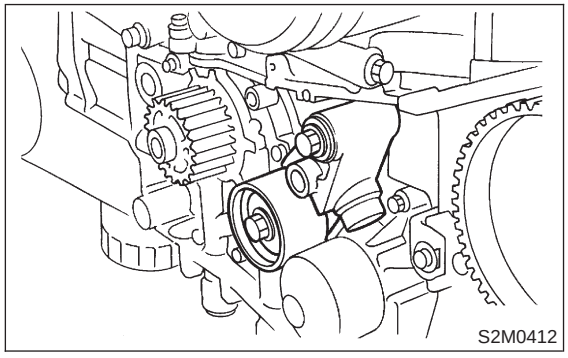
1) Remove belt idler.


S2M0410

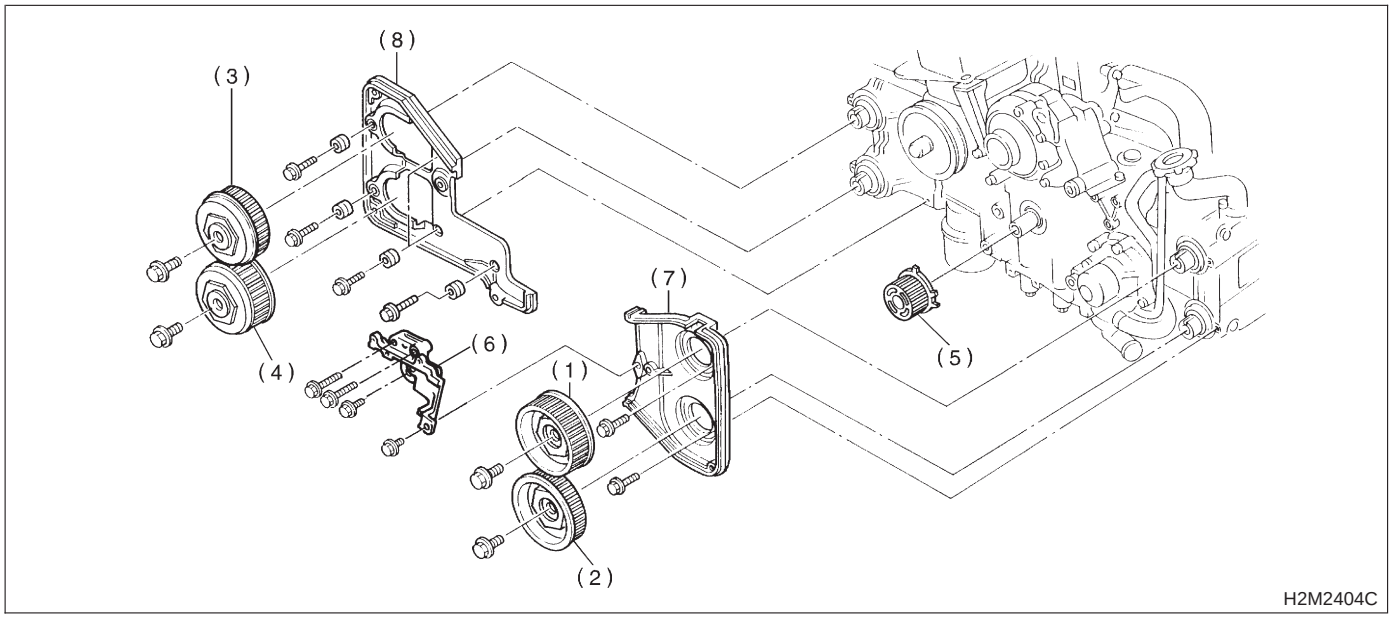
2) Remove belt idler No. 2.


S2M0411

3) Remove automatic belt tension adjuster assembly.



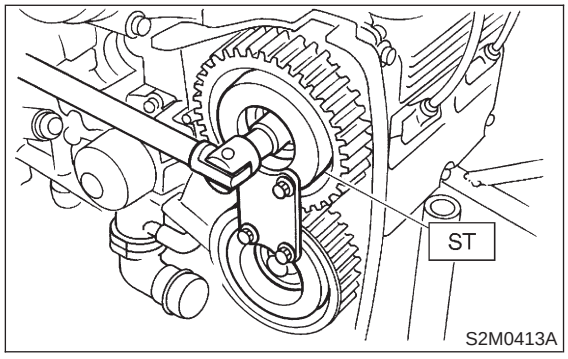
4. SPROCKET



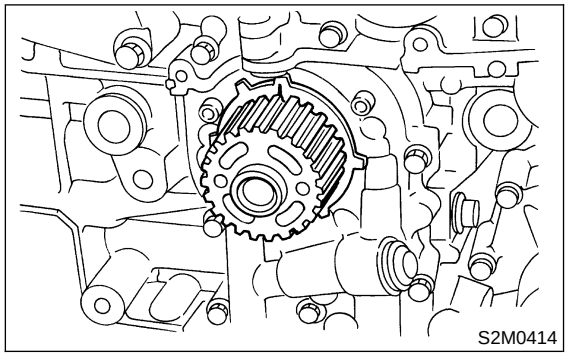
(1) Left-hand intake camshaft sprocket
(2) Left-hand exhaust camshaft sprocket
(3) Right-hand intake camshaft sprocket
(4) Right-hand exhaust camshaft sprocket
(5) Crankshaft sprocket
(6) Tensioner bracket
(7) Left-hand belt cover No. 2
(8) Right-hand belt cover No. 2

1) Remove left-hand intake camshaft sprocket.
2) Remove left-hand exhaust camshaft sprocket.
3) Remove right-hand intake camshaft sprocket.
4) Remove right-hand exhaust camshaft sprocket.

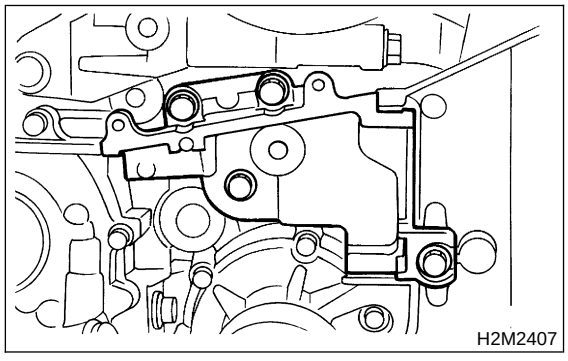
ST 499207300 CAMSHAFT SPROCKET WRENCH



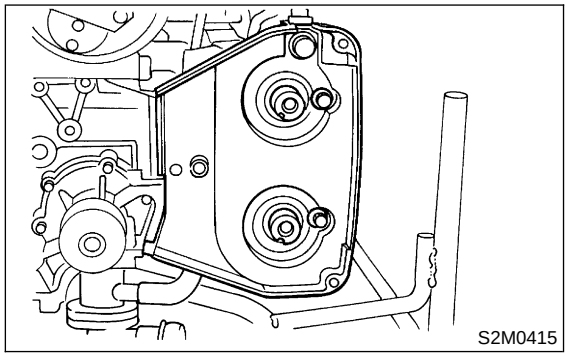
5) Remove crankshaft sprocket.



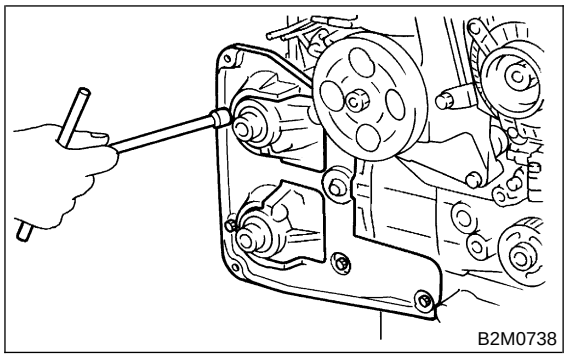
6) Remove tensioner bracket.



7) Remove left-hand belt cover No. 2.



8) Remove right-hand belt cover No. 2.



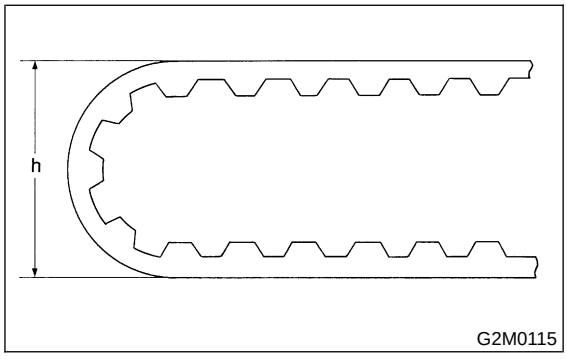
B: INSPECTION

1. TIMING BELT

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

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

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



2. AUTOMATIC BELT TENSION ADJUSTER

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

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

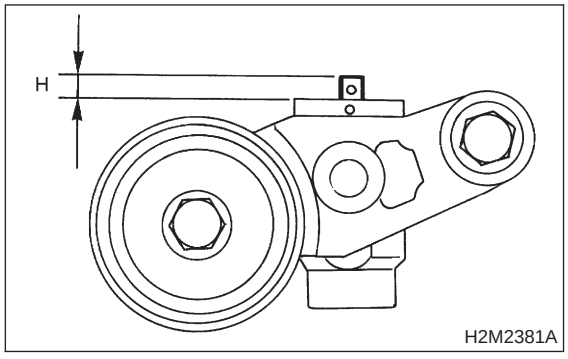
2) Check that the adjuster rod does not move when a pressure of 294 N (30 kg, 66 lb) is applied to it. This is to check adjuster rod stiffness.
3) If the adjuster rod is not stiff and moves freely when applying 294 N (30 kg, 66 lb), check it using the following procedures:

(1) Slowly press the adjuster rod down to the end surface of the cylinder. Repeat this motion 2 or 3 times.
(2) With the adjuster rod moved all the way up, apply a pressure of 294 N (30 kg, 66 lb) to it. Check adjuster rod stiffness.
(3) If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new one.

CAUTION:
● Always use a vertical type pressing tool to move the adjuster rod down.
● Do not use a lateral type vise.
● Push adjuster rod vertically.
● Press-in the push adjuster rod gradually taking more than three minutes.
● Do not allow press pressure to exceed 9,807 N (1,000 kg, 2,205 lb).
● Press the adjuster rod as far as the end surface of the cylinder. Do not press the adjuster rod into the cylinder. Doing so may damage the cylinder.

4) Measure the extension of rod beyond the body. If it is not within specifications, replace with a new one.

Rod extension: H
5.7±0.5 mm (0.224±0.020 in)



3. BELT TENSION PULLEY

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

4. BELT IDLER

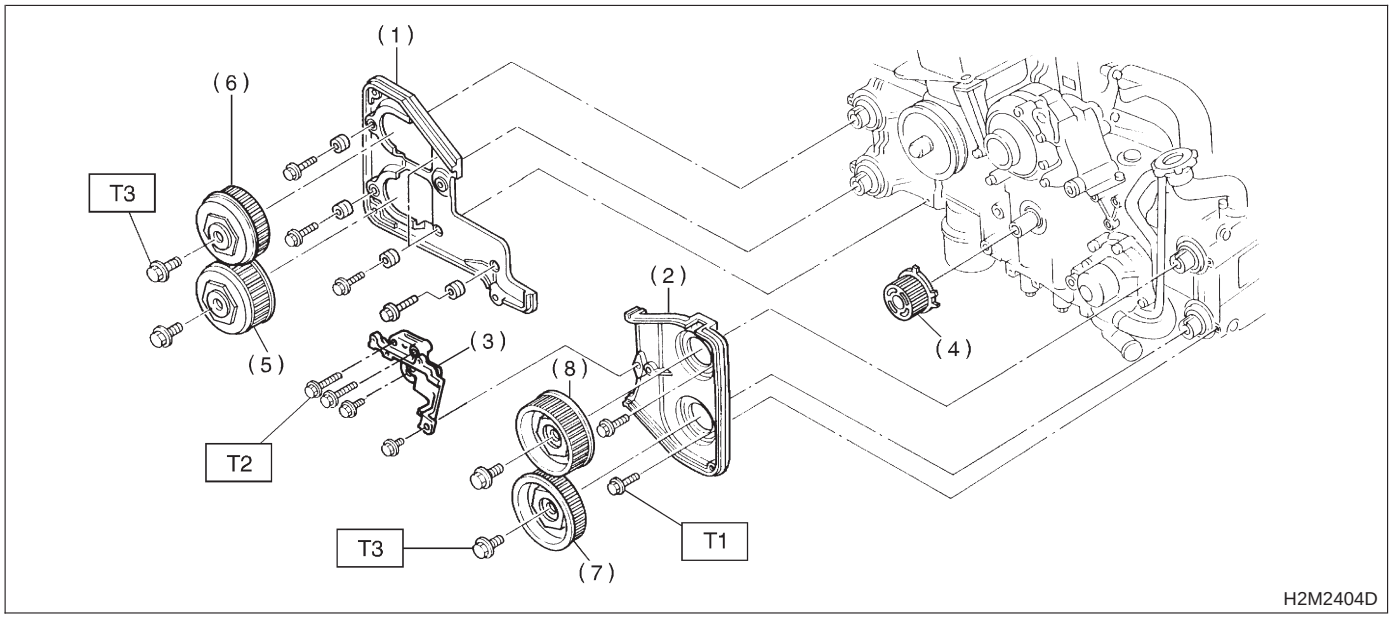
1) Check idler for smooth rotation. Replace if noise or excessive play is noted.
2) Check outer contacting surfaces of idler pulley for abnormal wear and scratches.
3) Check idler for grease leakage.

5. SPROCKET

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

C: INSTALLATION

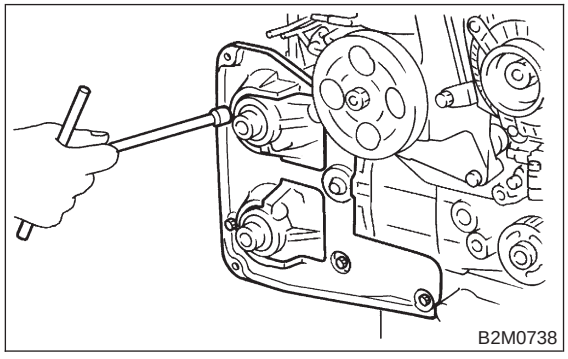
1. SPROCKET



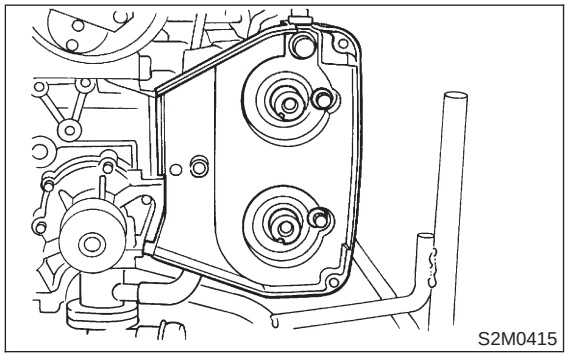
(1) Right-hand belt cover No. 2
(2) Left-hand belt cover No. 2
(3) Tensioner bracket
(4) Crankshaft sprocket
(5) Right-hand exhaust camshaft sprocket
(6) Right-hand intake camshaft sprocket
(7) Left-hand exhaust camshaft sprocket
(8) Left-hand intake camshaft sprocket

Tightening torque: N·m (kg-m, ft-lb)
T1: 4.9±0.5 (0.5±0.05, 3.6±0.4)
T2: 25±2 (2.5±0.2, 18±1.4)
T3: 78±5 (8.0±0.5, 58±3.6)

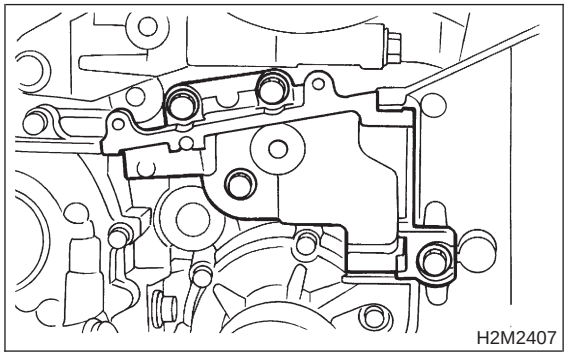
1) Install right-hand belt cover No. 2.



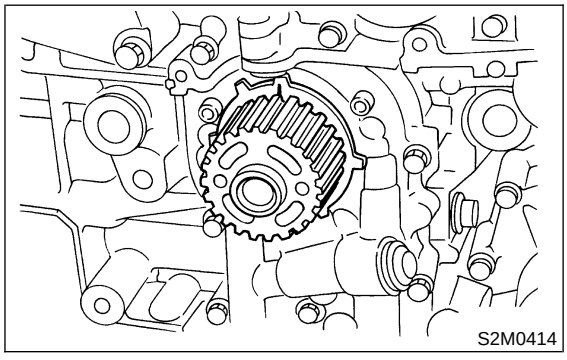
2) Install left-hand belt cover No. 2.



3) Install tensioner bracket.

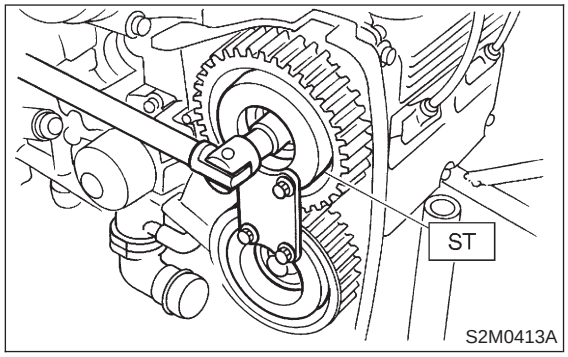


4) Install crankshaft sprocket.

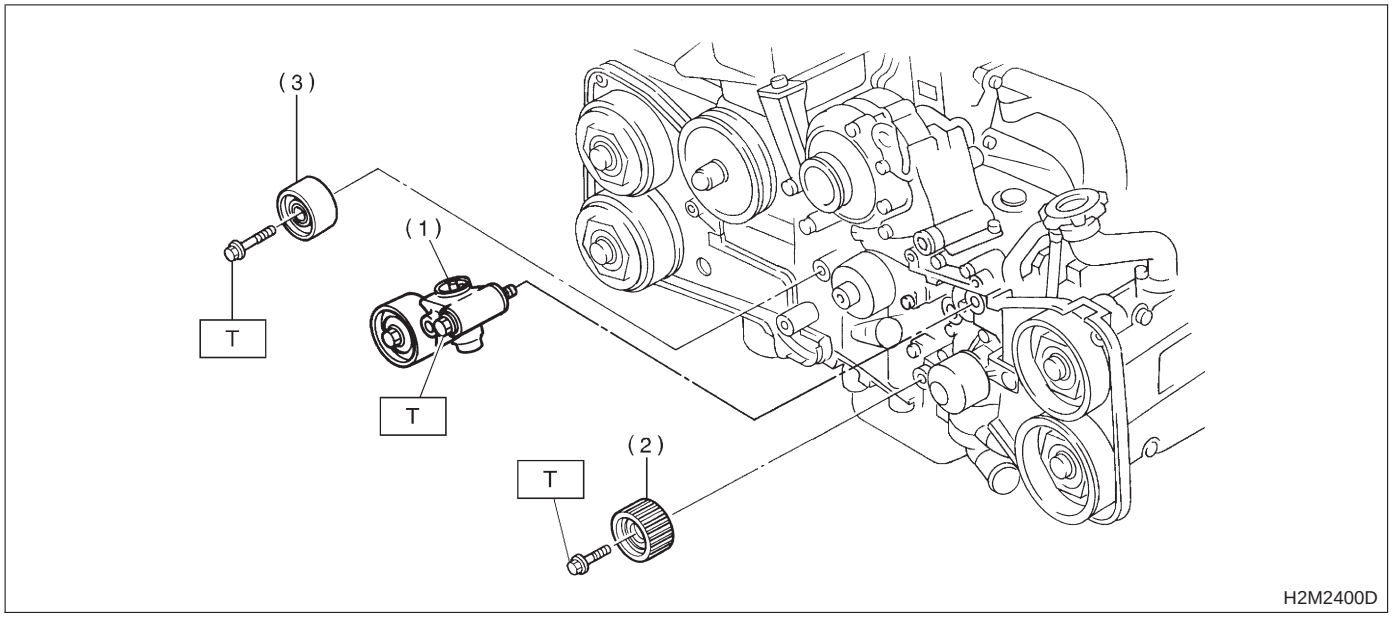


5) Install right-hand exhaust camshaft sprocket. To lock camshaft, use ST.
6) Install right-hand intake camshaft sprocket using ST.
7) Install left-hand exhaust camshaft sprocket using ST.
8) Install left-hand intake camshaft sprocket using ST.

ST 499207300 CAMSHAFT SPROCKET WRENCH



2. AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER



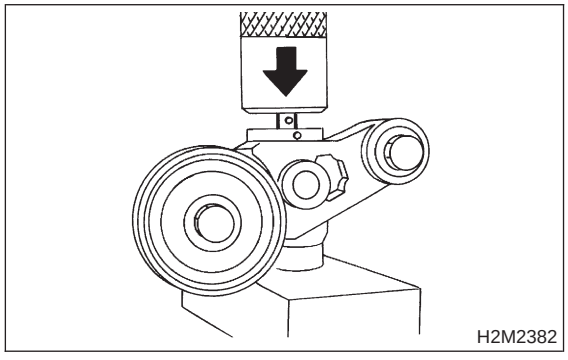
(1) Automatic belt tension adjuster ASSY
(2) Belt idler No. 2
(3) Belt idler

Tightening torque: N·m (kg-m, ft-lb)
T: 39±4 (4.0±0.4, 29±2.9)

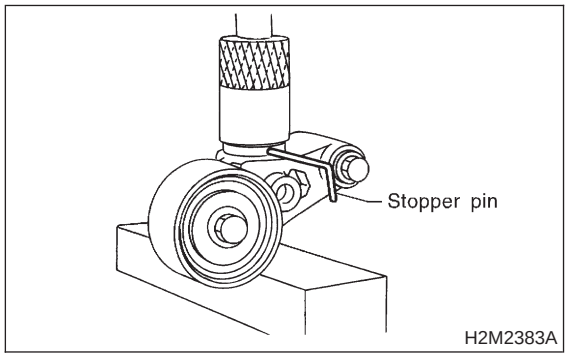
1) Preparation for installation of automatic belt tension adjuster assembly:

CAUTION:
- **Always use a vertical type pressing tool to move the adjuster rod down.**
- **Do not use a lateral type vise.**
- **Push adjuster rod vertically.**
- **Be sure to slowly move the adjuster rod down applying a pressure of 294 N (30 kg, 66 lb).**
- **Press-in the push adjuster rod gradually taking more than three minutes.**
- **Do not allow press pressure to exceed 9,807 N (1,000 kg, 2,205 lb).**
- **Press the adjuster rod as far as the end surface of the cylinder. Do not press the adjuster rod into the cylinder. Doing so may damage the cylinder.**
- **Do not release press pressure until stopper pin is completely inserted.**

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

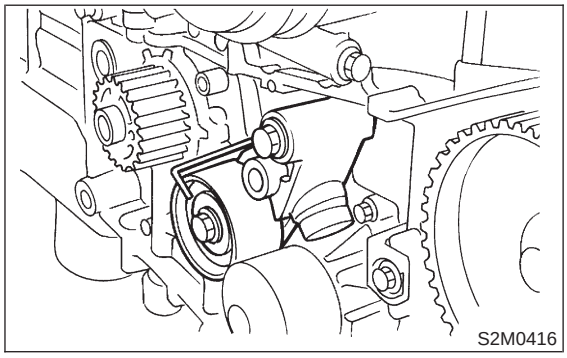

H2M2382

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

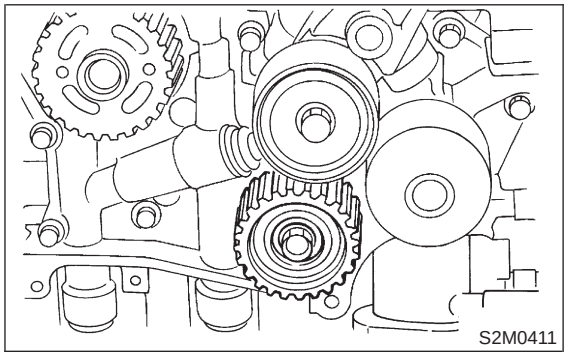


H2M2383A

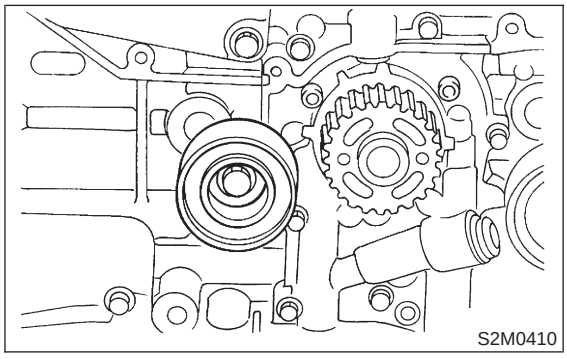
2) Install Automatic belt tension adjuster assembly.


S2M0416

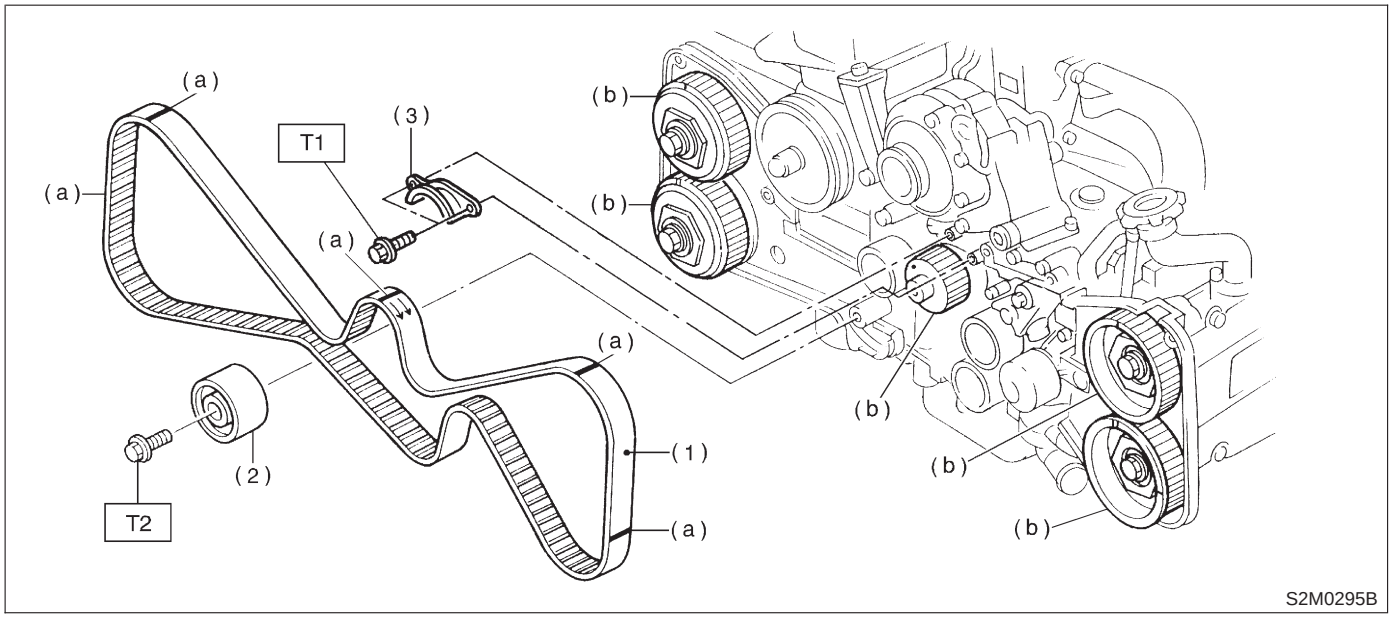
3) Install belt idler No. 2.


S2M0411

4) Install belt idler.


S2M0410

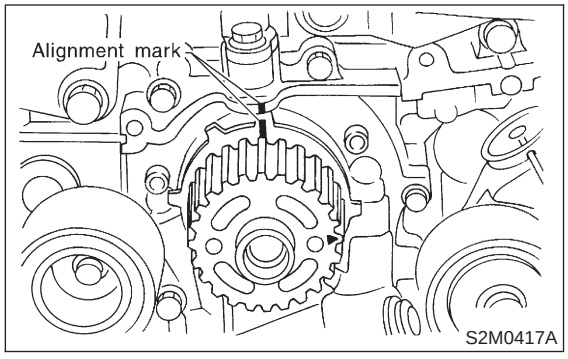
3. TIMING BELT



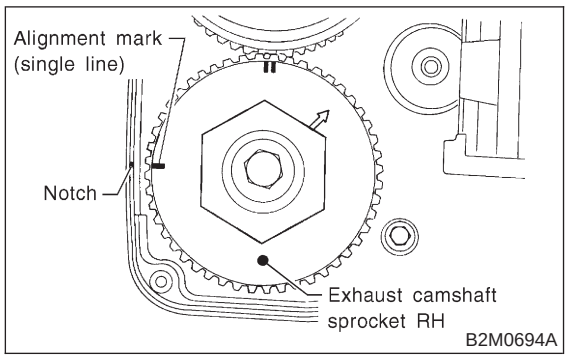
(1) Timing belt
(2) Belt idler
(3) Timing belt guide (MT vehicles only)
(a) Alignment mark (Timing belt side)
(b) Alignment mark (Sprocket side)

Tightening torque: N·m (kg-m, ft-lb)
T1: 9.8±1.0 (1.0±0.1, 7.2±0.7)
T2: 39±4 (4.0±0.4, 29±2.9)

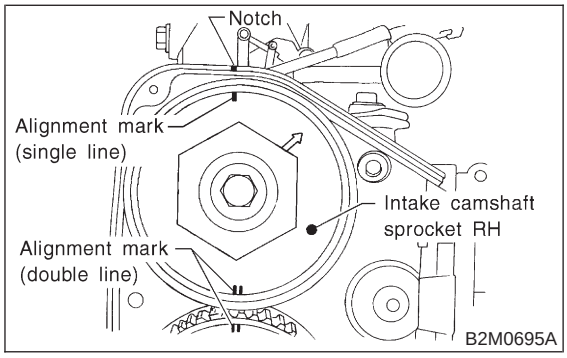
1) Crankshaft and camshaft sprocket alignment.
(1) Align mark on crankshaft sprocket with mark on the oil pump cover at cylinder block.



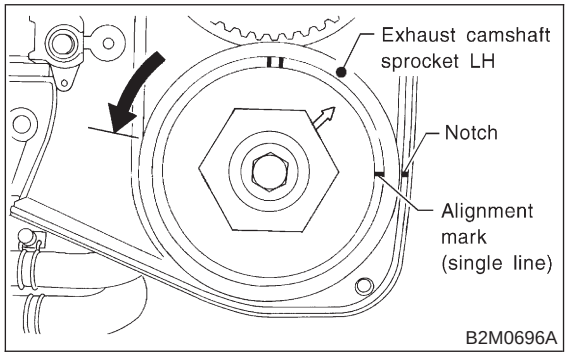
(2) Align single line mark on right-hand exhaust camshaft sprocket with notch on belt cover.



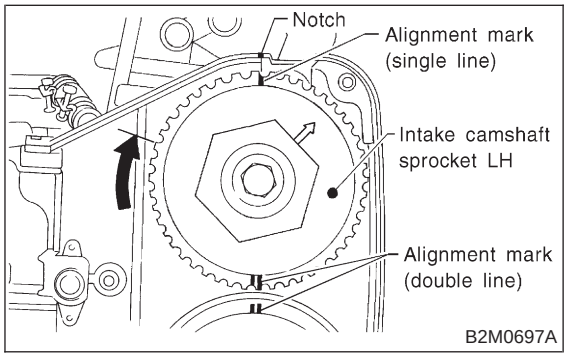
(3) Align single line mark on right-hand exhaust camshaft sprocket with notch on belt cover. (Make sure double lines on intake camshaft and exhaust camshaft sprockets are aligned.)



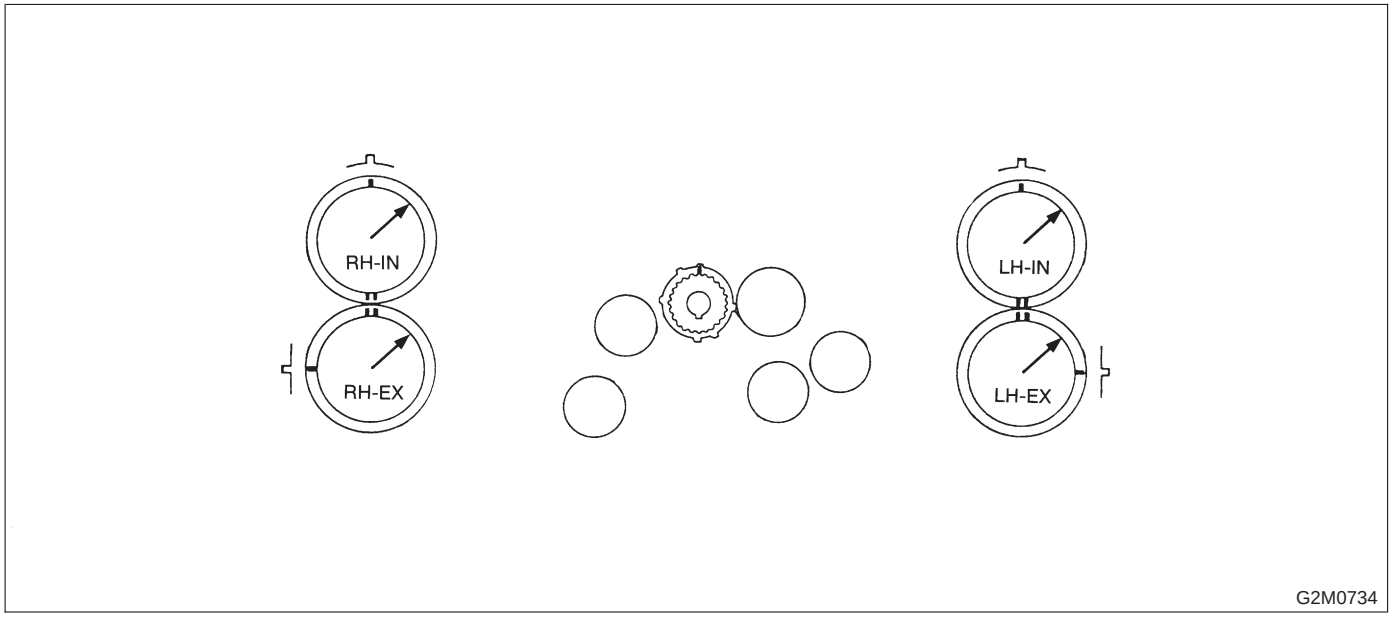
(4) Align single line mark on left-hand exhaust camshaft sprocket with notch on belt cover by turning sprocket counter-clockwise (as viewed from front of engine).



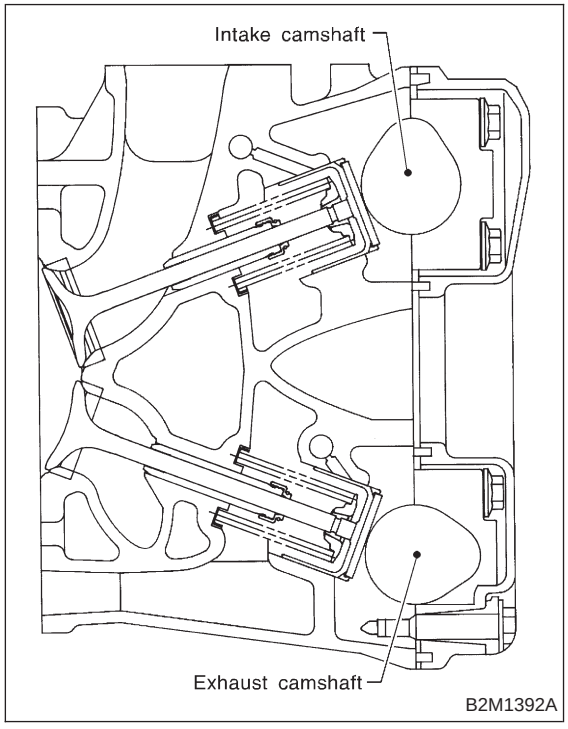
(5) Align single line mark on left-hand intake camshaft sprocket with notch on belt cover by turning sprocket clockwise (as viewed from front of engine).
Ensure double lines on intake and exhaust camshaft sprockets are aligned.



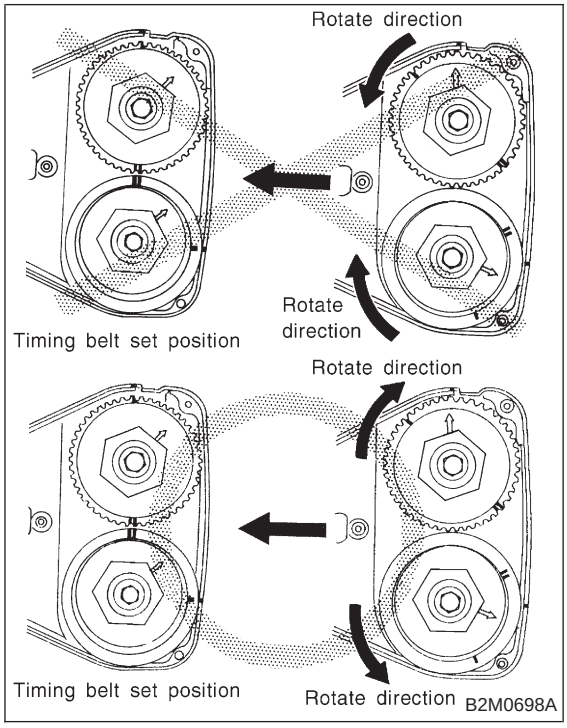
(6) Ensure camshaft and crankshaft sprockets are positioned as shown.



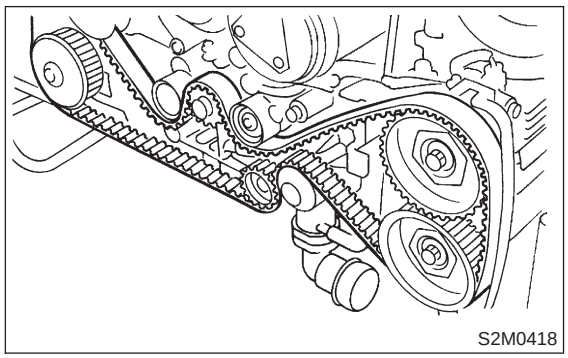
CAUTION:
● Intake and exhaust camshafts for this DOHC engine can be independently rotated with timing belts removed. As can be seen from the figure, if intake and exhaust valves are lifted simultaneously, their heads will interfere with each other, resulting in bent valves.



● When timing belts are not installed, four camshafts are held at the "zero-lift" position, where all cams on camshafts do not push intake and exhaust valves down. (Under this condition, all valves remain unlifted.)
● When camshafts are rotated to install timing belts, #2 intake and #4 exhaust cam of left-hand camshafts are held to push their corresponding valves down. (Under this condition, these valves are held lifted.) Right-side camshafts are held so that their cams do not push valves down.
● Left-hand camshafts must be rotated from the "zero-lift" position to the position where timing belt is to be installed at as small an angle as possible, in order to prevent mutual interference of intake and exhaust valve heads.
● Do not allow camshafts to rotate in the direction shown in the figure as this causes both intake and exhaust valves to lift simultaneously, resulting in interference with their heads.

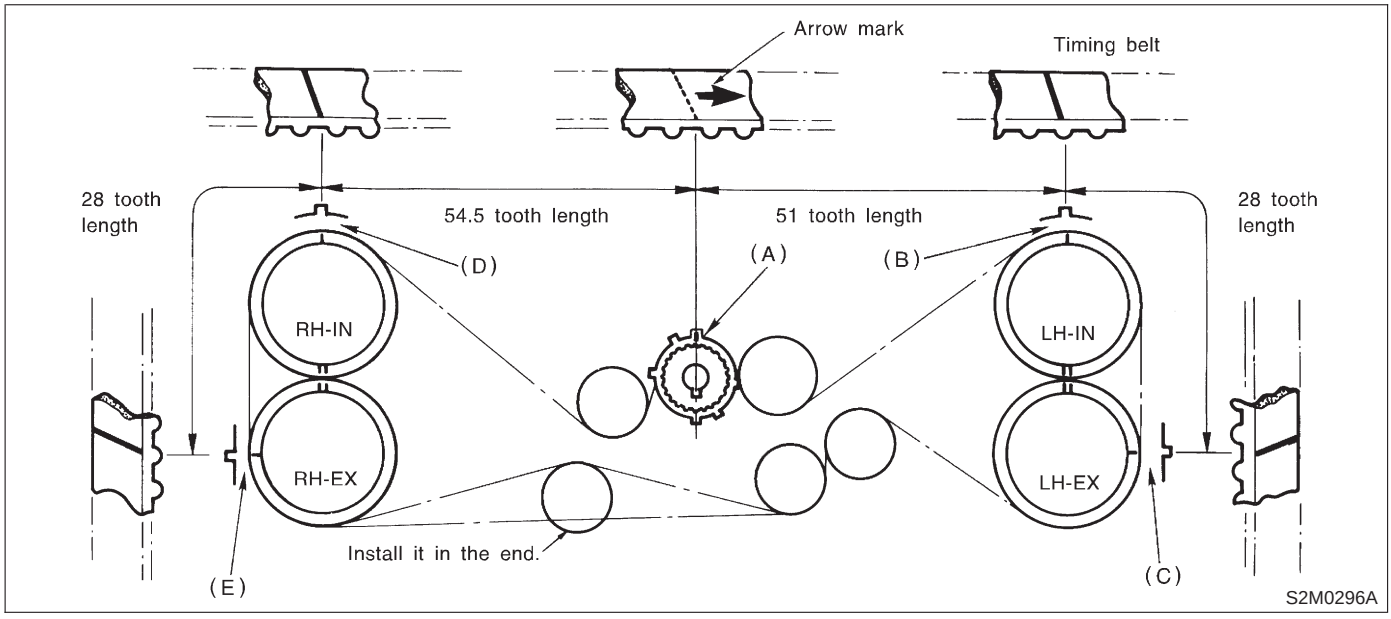


2) Installation of timing belt



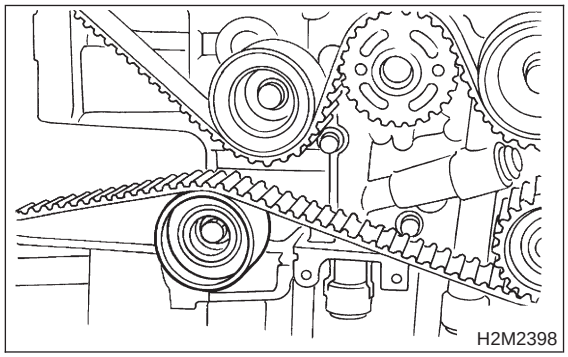
Align alignment mark on timing belt with marks on sprockets in the numerical order shown in figure. While aligning marks, position timing belt properly.

CAUTION:
- **Disengagement of more than three timing belt teeth may result in interference between the valve and piston.**
- **Ensure belt's rotating direction is correct.**

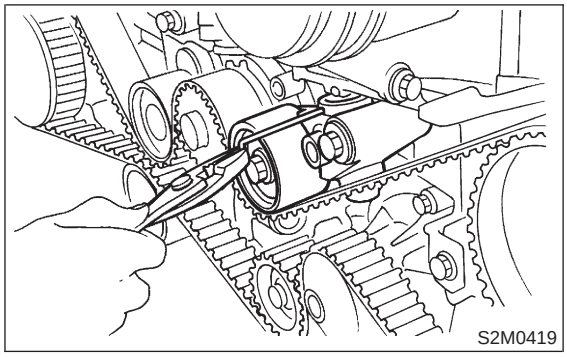


3) Install belt idler.

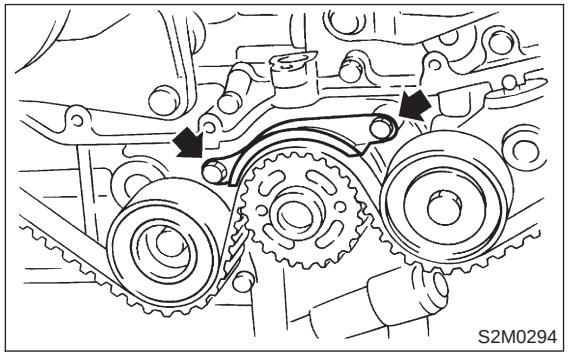
CAUTION:
Make sure that the marks on timing belt and sprockets are aligned.



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

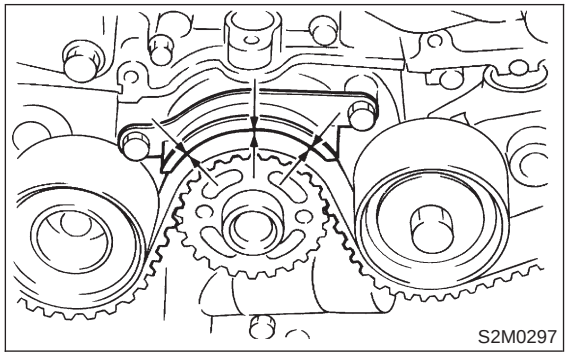


5) Install timing belt guide. (MT vehicles only)
(1) Temporarily tighten remaining bolts.

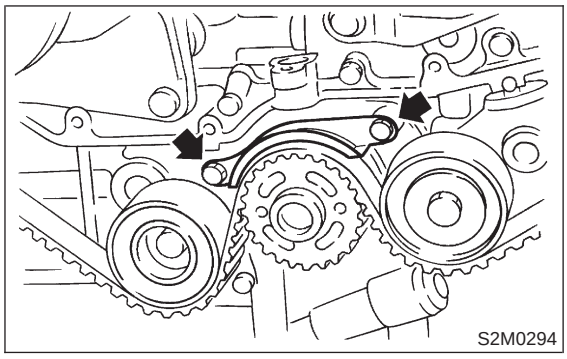


(2) Check and adjust clearance between timing belt and timing belt guide.

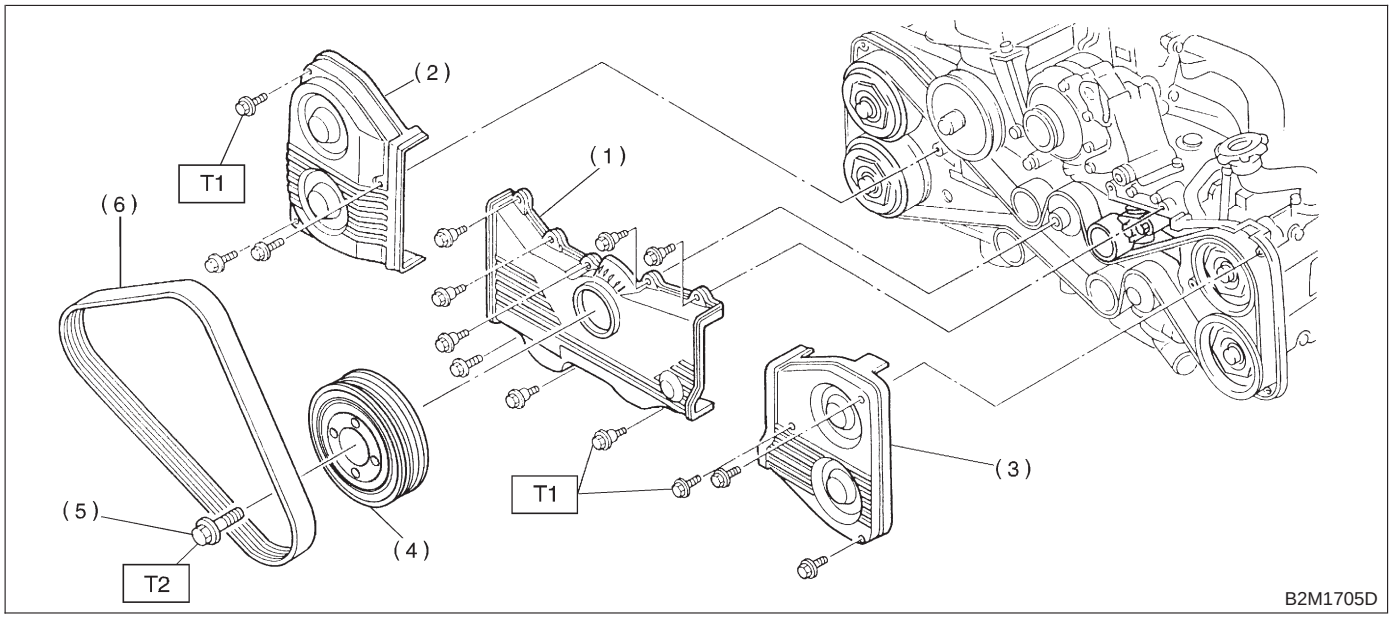
Clearance:
1.0±0.5 mm (0.039±0.020 in)



(3) Tighten remaining bolts.



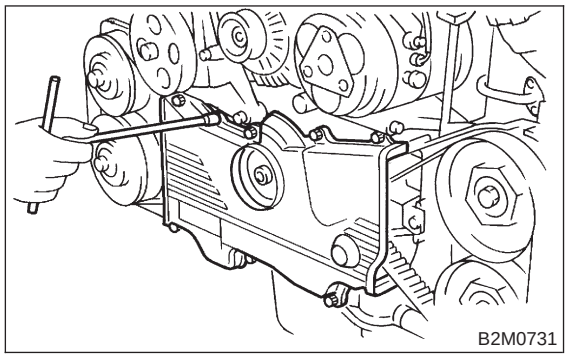
4. CRANKSHAFT PULLEY AND BELT COVER



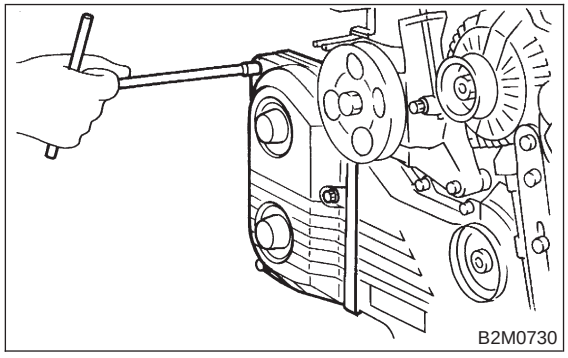
(1) Front belt cover
(2) Right-hand belt cover No. 1
(3) Left-hand belt cover No. 1
(4) Crankshft pulley
(5) Crankshaft pulley bolt
(6) V-velt

Tightening torque: N·m (kg-m, ft-lb)
T1: 5±0.5 (0.5±0.05, 3.6±0.4)
T2: 177±10 (18.0±1.0, 130±7)

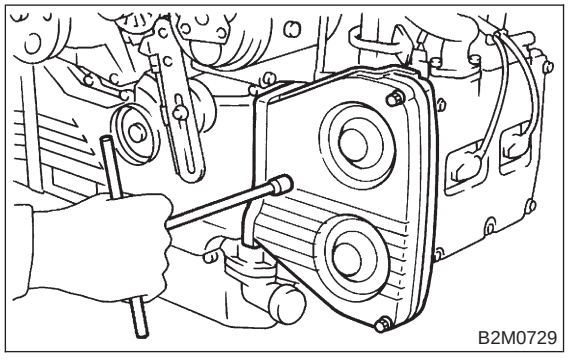
1) Install front belt cover.



2) Install right-hand belt cover.

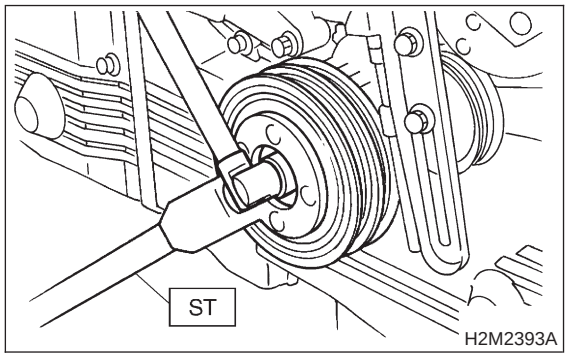


3) Install left-hand belt cover.



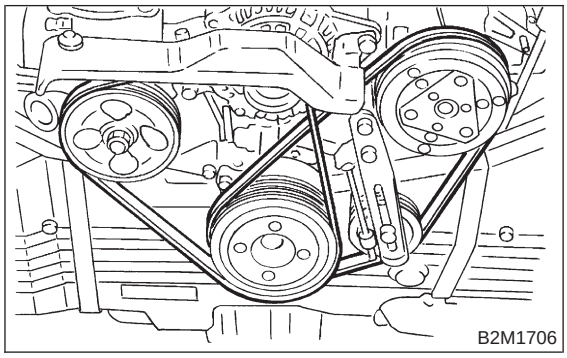
4) Install crankshaft pulley.
5) Tighten pulley bolt by using ST.

ST 499977100 CRANKSHAFT PULLEY WRENCH



6) Install V-belt, air conditioning compressor drive belt tensioner and V-belt cover. <Ref. to 1-5 [G200].>

CAUTION:
After installing V-belt, check and adjust V-belt tension.



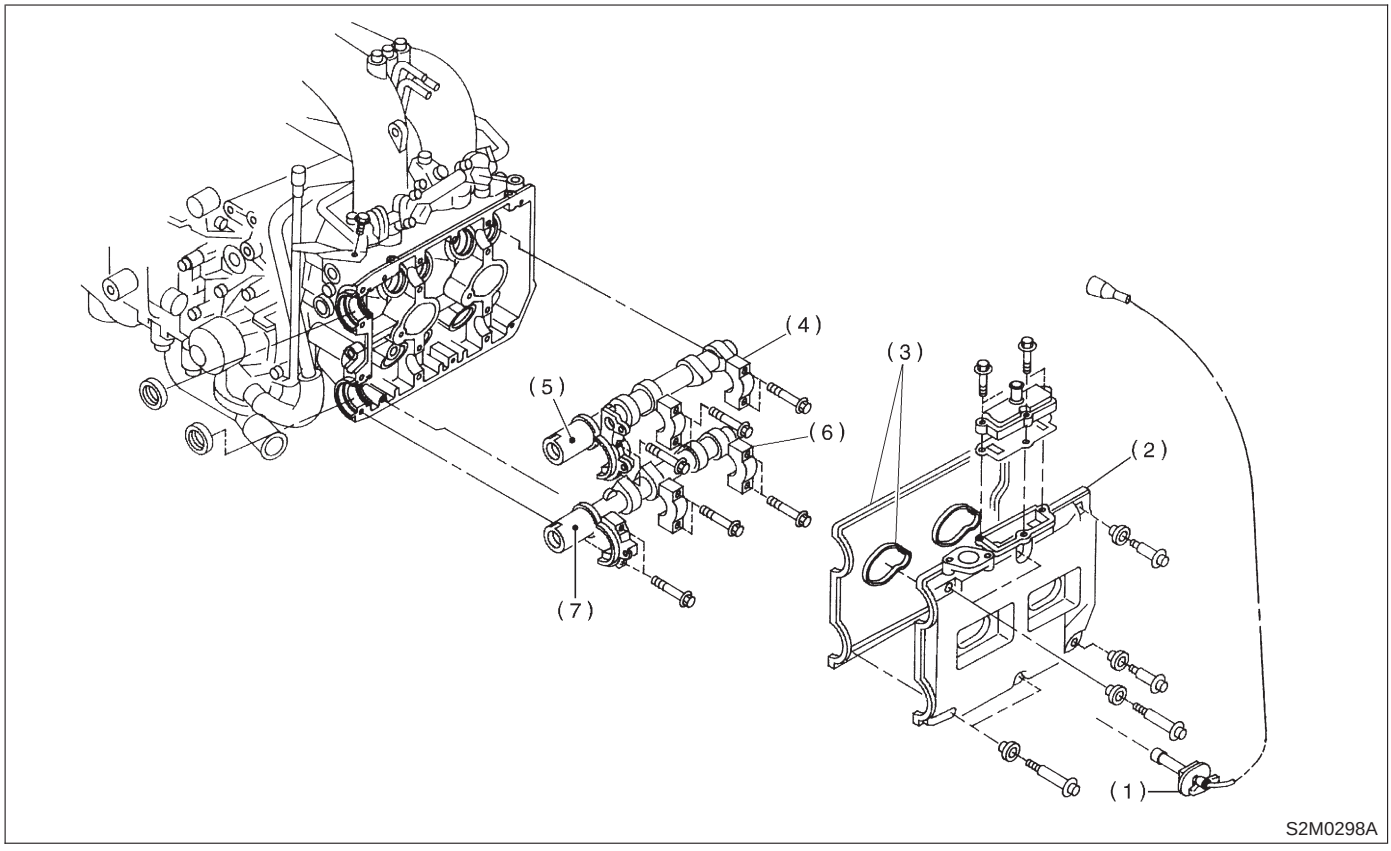
3. Camshaft

A: REMOVAL

1. RELATED PARTS

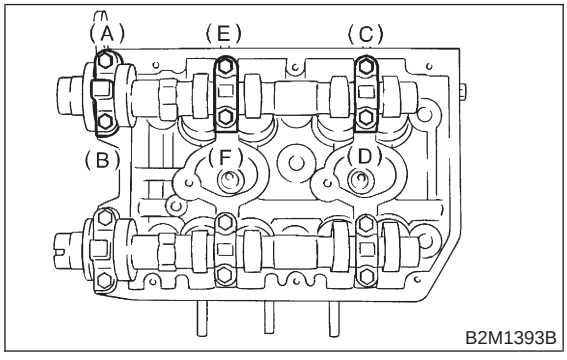
Remove timing belt, camshaft sprockets and related parts.
<Ref. to 2-3b [W2A0].>

2. CAMSHAFT



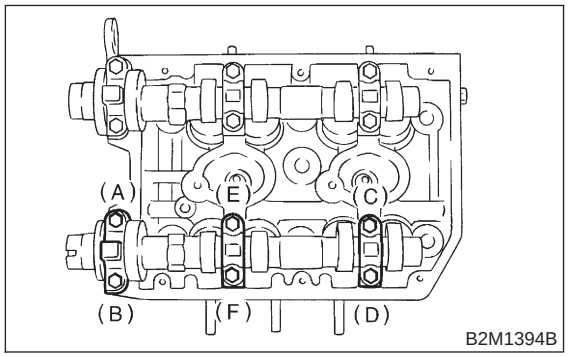
(1) Spark plug cord
(2) Rocker cover (LH)
(3) Rocker cover gasket (LH)
(4) Intake camshaft cap (LH)
(5) Intake camshaft (LH)
(6) Exhaust camshaft cap (LH)
(7) Exhaust camshaft (LH)

1) Remove camshaft position sensor (LH side only).
2) Remove spark plug cord.
3) Remove rocker cover and gasket.
4) Loosen intake camshaft cap bolts equally, a little at a time in alphabetical sequence shown in figure.



5) Remove camshaft caps and intake camshaft.

6) Loosen exhaust camshaft cap bolts equally, a little at a time in alphabetical sequence shown in figure.



7) Remove camshaft caps and exhaust camshaft.

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

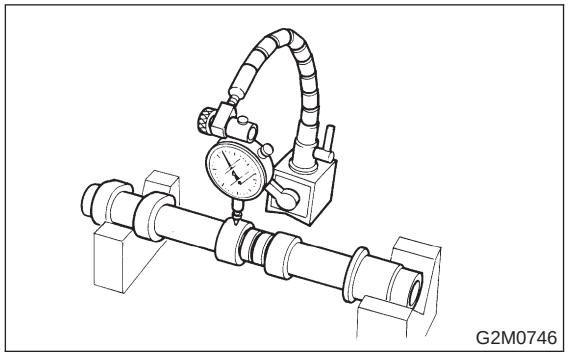
8) Similarly, remove right-hand camshafts and related parts.

B: INSPECTION

1. CAMSHAFT

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

Limit:
0.020 mm (0.0008 in)



2) Check journal for damage and wear. Replace if faulty.
3) Measure outside diameter of camshaft journal. If the journal diameter is not as specified, check the oil clearance.

	Camshaft journal	
	Front	Center, rear
Standard	31.946 — 31.963 mm (1.2577 — 1.2584 in)	27.946 — 27.963 mm (1.1002 — 1.1009 in)

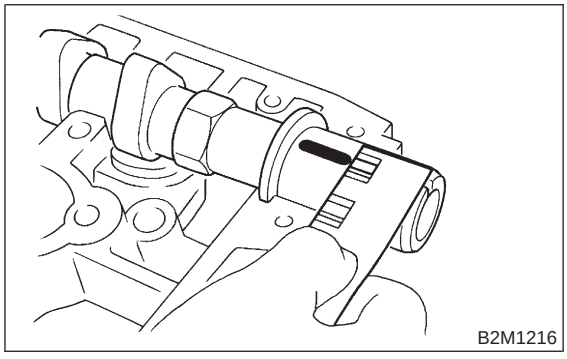
4) Measurement of the camshaft journal oil clearance
(1) Clean the bearing caps and camshaft journals.
(2) Place the camshafts on the cylinder head. (Without installing valve rocker.)
(3) Place plastigauge across each of the camshaft journals.
(4) Install the bearing caps.
<Ref. to 2-3b [W3C1].>

CAUTION:
Do not turn the camshaft.

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

Standard oil clearance:
0.037 — 0.072 mm (0.0015 — 0.0028 in)

Limit:
0.10 mm (0.0039 in)



(7) Completely remove the plastigauge.

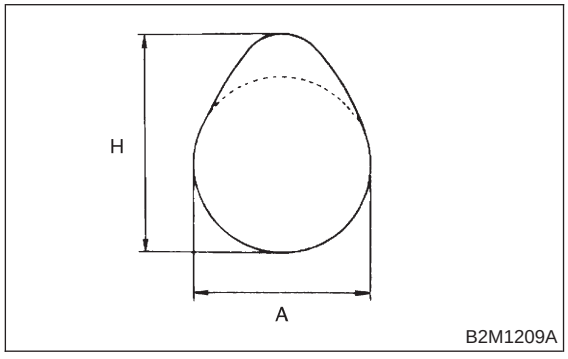
5) Check cam face condition; remove minor faults by grinding with oil stone. Measure the cam height H; replace if the limit has been exceeded.

Cam height: H

Standard:
Intake:
42.20 — 42.30 mm (1.6614 — 1.6654 in)
Exhaust:
Front: 42.50 — 42.60 mm (1.6732 — 1.6772 in)
Rear: 41.40 — 41.50 mm (1.6299 — 1.6339 in)

Limit:
Intake:
42.05 mm (1.6555 in)
Exhaust:
Front: 42.35 mm (1.6673 in)
Rear: 41.25 mm (1.6240 in)

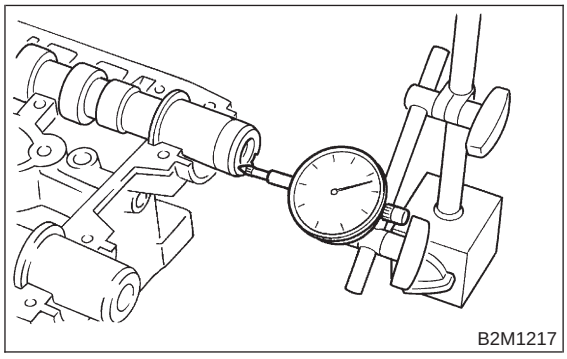
Cam base circle diameter A:
28.0 mm (1.102 in)



6) Measure the thrust clearance of camshaft with dial gauge. If the clearance exceeds the limit, replace caps and cylinder head as a set. If necessary replace camshaft.

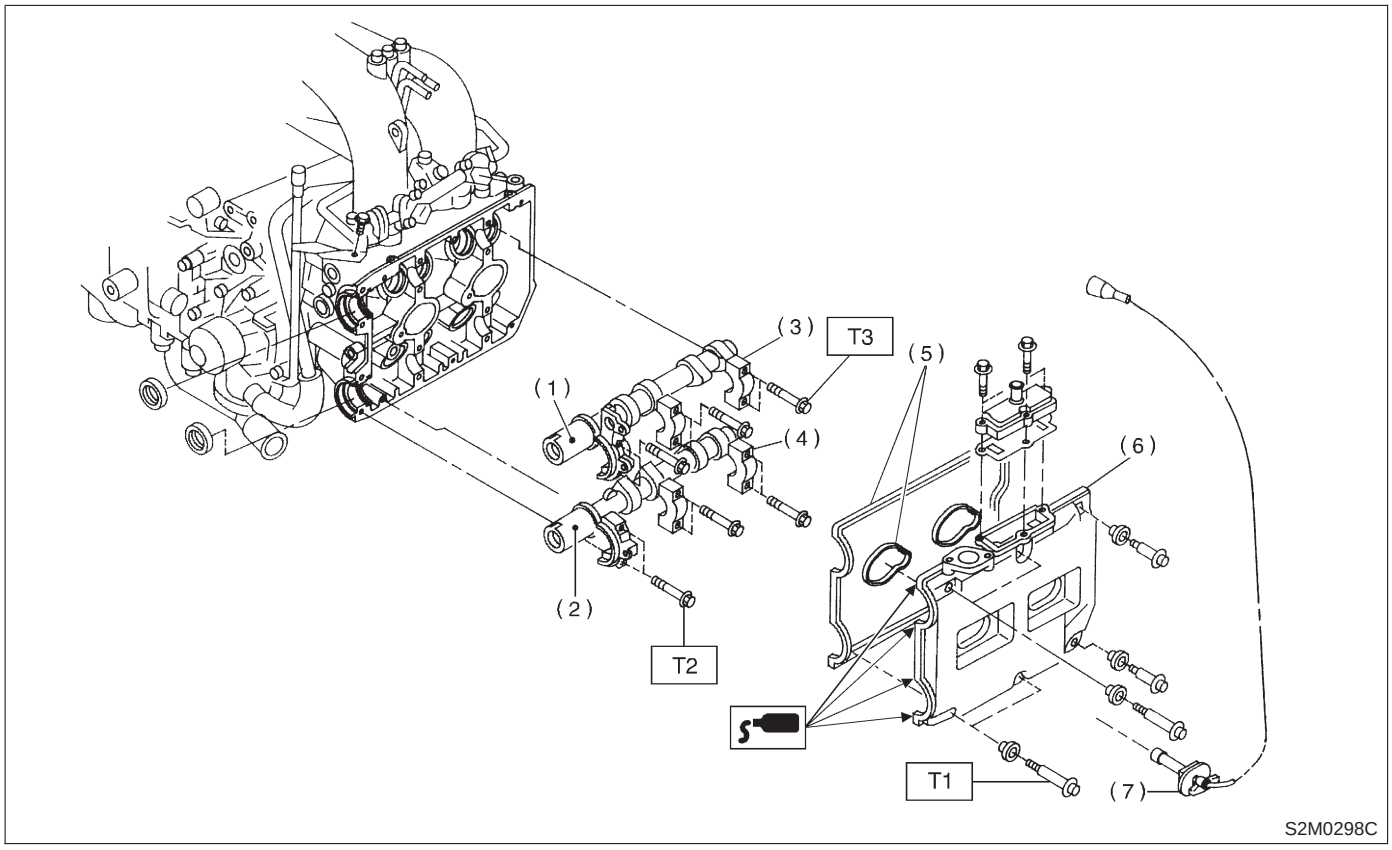
Standard:
0.040 — 0.080 mm (0.0016 — 0.0031 in)

Limit:
0.1 mm (0.004 in)



C: INSTALLATION

1. CAMSHAFT

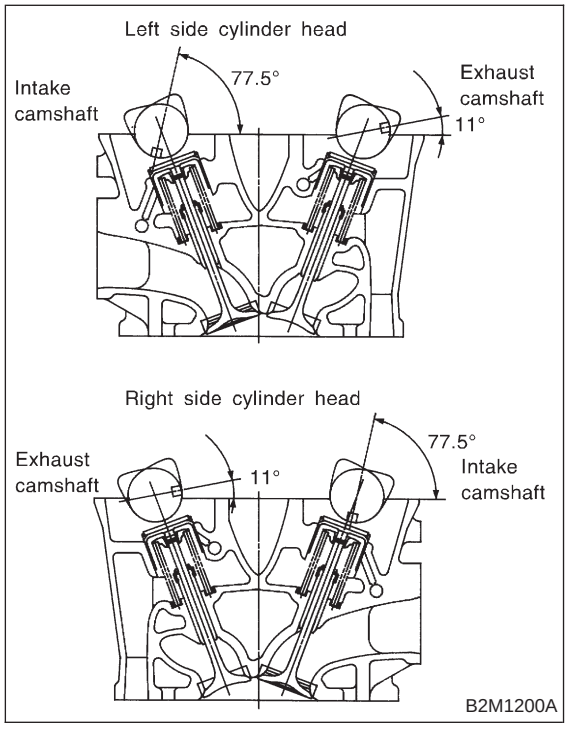


(1) Intake camshaft (LH)
(2) Exhaust camshaft (LH)
(3) Intake camshaft cap (LH)
(4) Exhaust camshaft cap (LH)
(5) Rocker cover gasket (LH)
(6) Rocker cover (LH)
(7) Spark plug cord

Tightening torque: N·m (kg-m, ft-lb)
T1: 5±0.5 (0.5±0.05, 3.6±0.4)
T2: 9.8±0.7 (1.0±0.07, 7.2±0.5)
T3: 20±2 (2.0±0.2, 14.5±1.4)

1) Camshaft installation
Apply engine oil to cylinder head at camshaft bearing location before installing camshaft. Install camshaft so that rocker arm is close to or in contact with “base circle” of cam lobe.

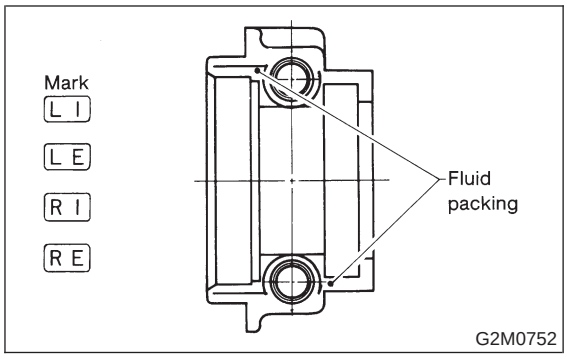
CAUTION:
● When camshafts are positioned as shown in figure, camshafts need to be rotated at a minimum to align with timing belt during installation.
● Right-hand camshaft need not be rotated when set at position shown in figure.
Left-hand intake camshaft: Rotate 80° clockwise.
Left-hand exhaust camshaft: Rotate 45° counter-clockwise.



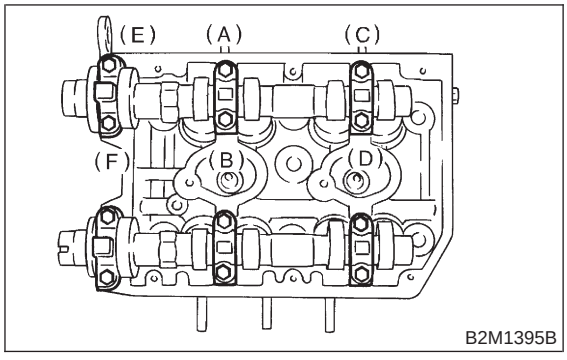
2) Camshaft cap installation
(1) Apply fluid packing sparingly to cap mating surface.

CAUTION:
Do not apply fluid packing excessively. Failure to do so may cause excess packing to come out and flow toward oil seal, resulting in oil leaks.

Fluid packing:
THREE BOND 1215 or equivalent



(2) Apply engine oil to cap bearing surface and install cap on camshaft as shown by identification mark.
(3) Gradually tighten cap in at least two stages in alphabetical sequence shown in figure, and then tighten to specified torque.

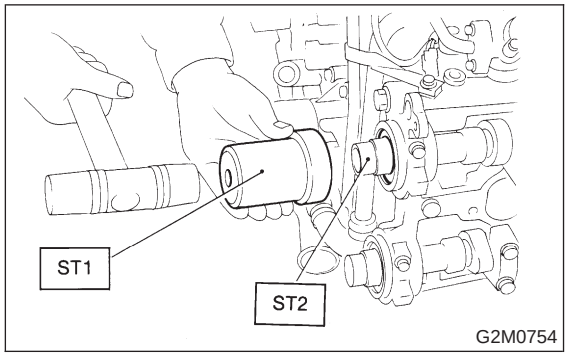


(4) Similarly, tighten cap on exhaust side.
After tightening cap, ensure camshaft rotates only slightly while holding it at “base” circle.

3) Camshaft oil seal installation
Apply grease to new oil seal lips and press onto front end of camshaft by using ST1 and ST2.

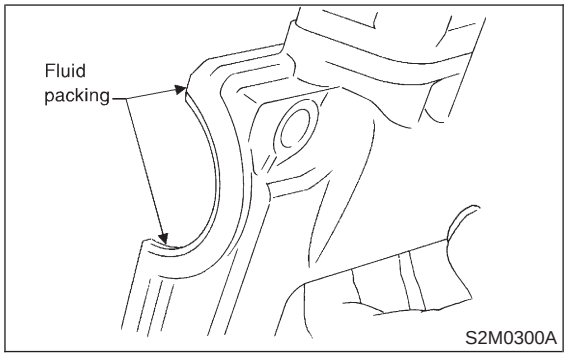
CAUTION:
Use a new oil seal.

ST1 499587100 OIL SEAL INSTALLER
ST2 499597000 OIL SEAL GUIDE



4) Rocker cover installation
(1) Install gasket on rocker cover.
Install peripheral gasket and ignition coil gasket.
(2) Apply fluid packing to four front open edges of peripheral gasket.

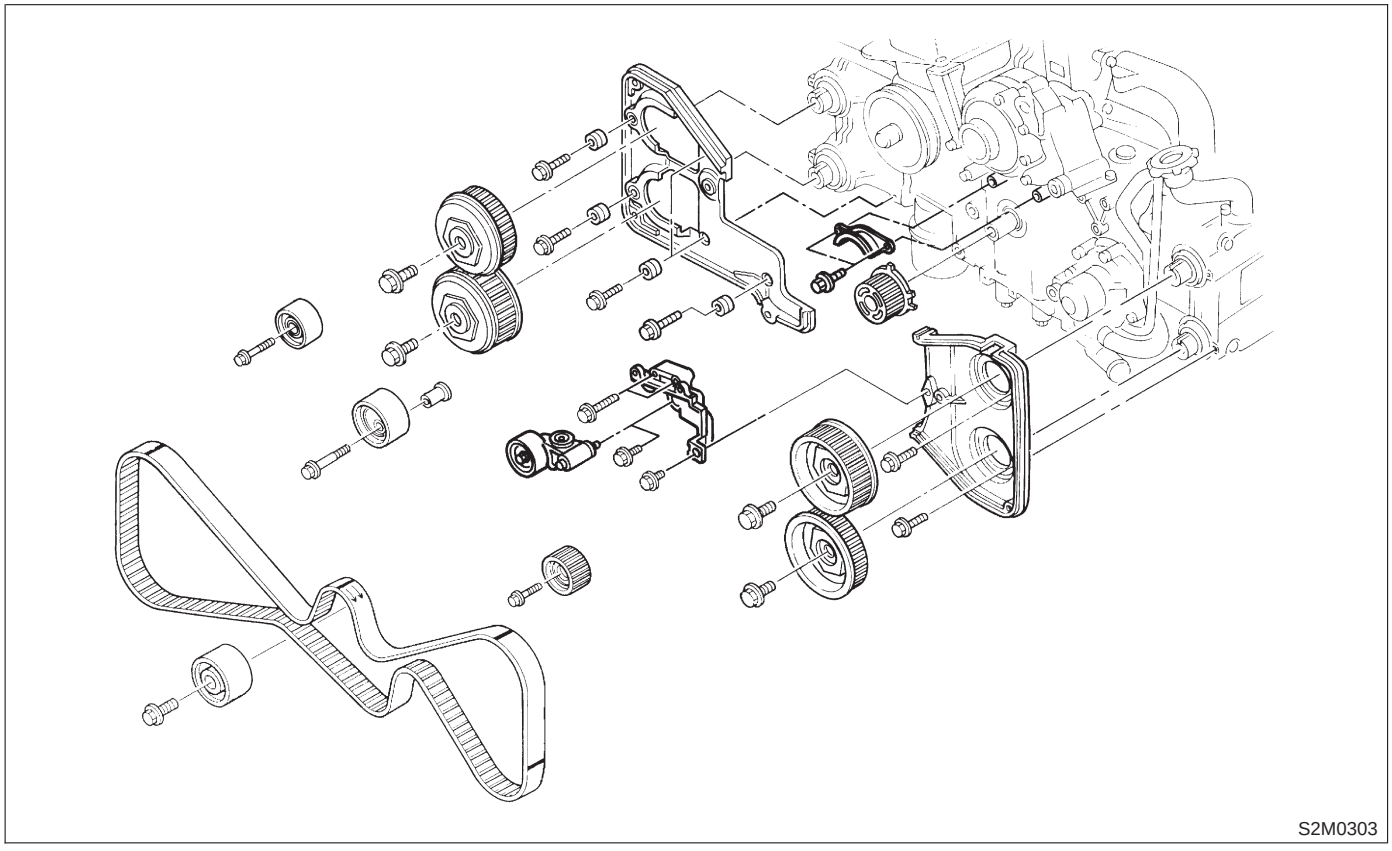
Fluid packing:
THREE BOND 1215 or equivalent



(3) Install rocker cover on cylinder head. Ensure gasket is properly positioned during installation.
5) Install ignition coil.
6) Install cam angle sensor.
7) Similarly, install parts on right-hand side.

2. RELATED PARTS

Install timing belt, camshaft sprockets and related parts.
<Ref. to 2-3b [W2C0].>



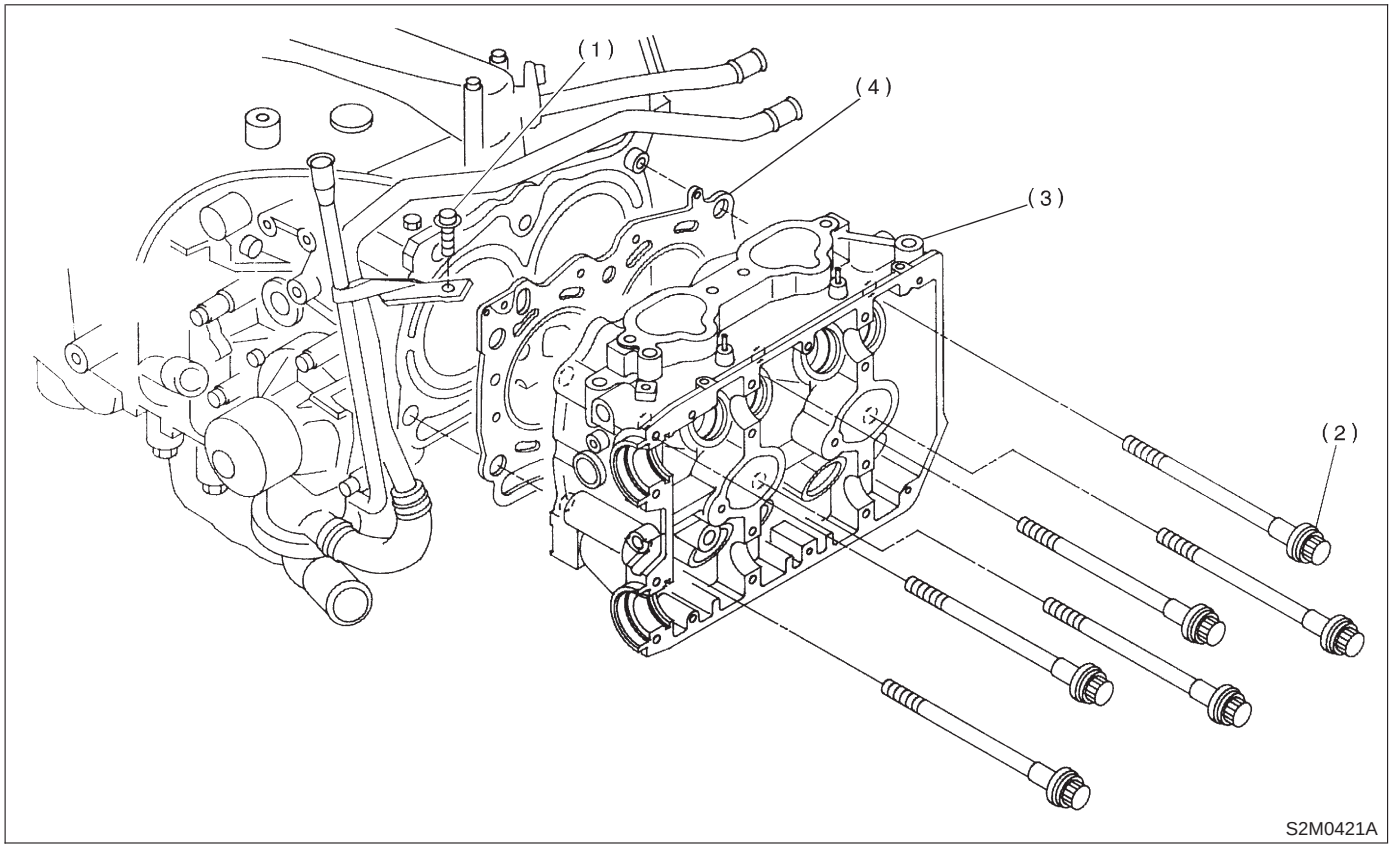
4. Cylinder Head

A: REMOVAL

1. RELATED PARTS

1) Remove V-belt.
2) Remove generator, air conditioner compressor and brackets.
3) Remove hoses and tubes from cylinder block.
4) Disconnect each connector and/or remove connector bracket.
5) Remove intake manifold assembly and gasket.
6) Remove camshaft position sensor.
7) Remove timing belt, camshaft sprockets and related parts.
<Ref. to 2-3b [W2A0].>
8) Remove rocker cover, camshafts and related parts.
<Ref. to 2-3b [W3A0].>

2. CYLINDER HEAD

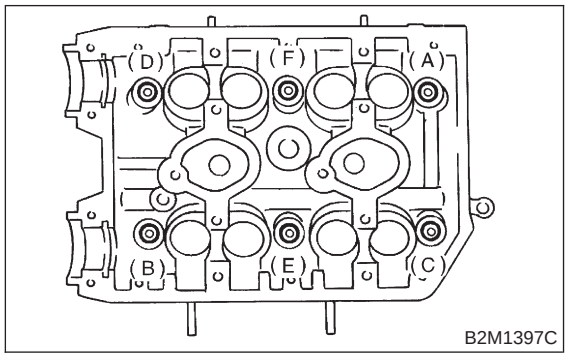


(1) Bolt
(2) Cylinder head bolt
(3) Cylinder head
(4) Cylinder head gasket

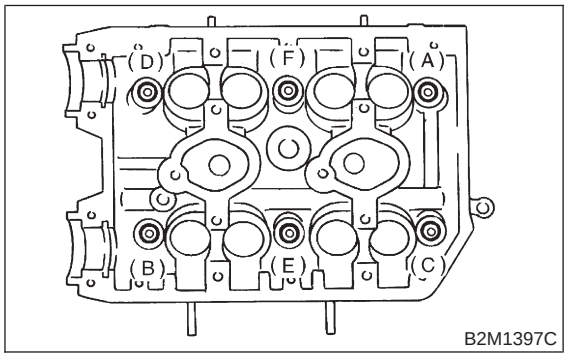
1) Remove oil level gauge guide attaching bolt (LH side only).

2) Remove cylinder head bolts in alphabetical sequence shown in figure.

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

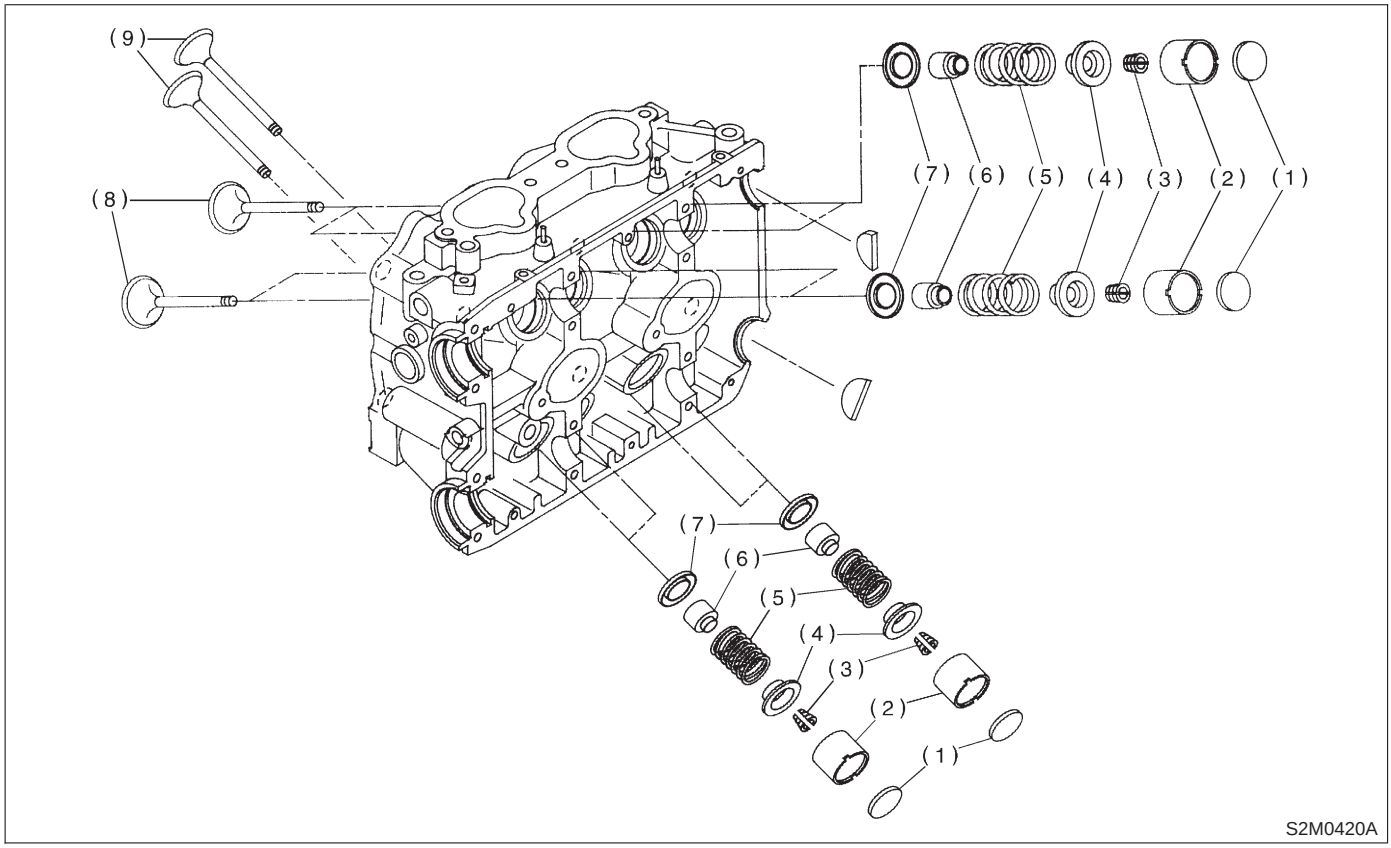


3) While tapping cylinder head with a plastic hammer, separate it from cylinder block.
Remove bolts (A) and (D) to remove cylinder head.



4) Remove cylinder head gasket.
5) Similarly, remove right-hand cylinder head.

B: DISASSEMBLY

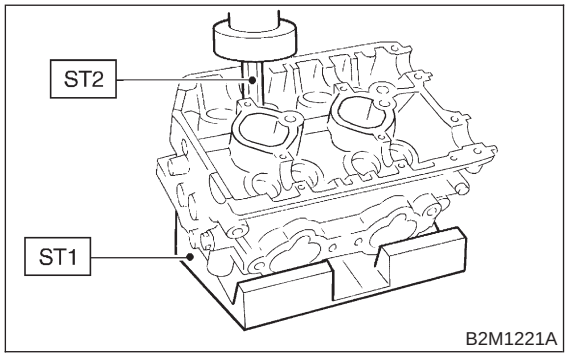


(1) Valve shim
(2) Valve lifter
(3) Valve retainer key
(4) Valve retainer
(5) Valve spring
(6) Valve oil seal
(7) Valve spring seat
(8) Intake valve
(9) Exhaust valve

1) Remove valve shims and valve lifters.

2) Compress the valve spring and remove the valve spring retainer key. Remove each valve and valve spring.
ST1 498267600 CYLINDER HEAD TABLE
ST2 499718000 VALVE SPRING REMOVER

CAUTION:
● Keep removed parts in order for re-installing in their original positions.
● Mark each valve to prevent confusion.
● Use extreme care not to damage the lips of the intake valve oil seals and exhaust valve oil seals.



C: INSPECTION

1. CYLINDER HEAD

1) Make sure that no crack or other damage exists. In addition to visual inspection, inspect important areas by means of red check.

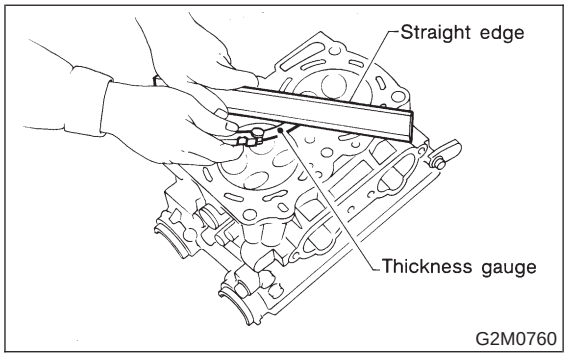
2) Measure the warping of the cylinder head surface that mates with crankcase by using a straight edge and thickness gauge.
If the warping exceeds 0.05 mm (0.0020 in), regrind the surface with a surface grinder.

Warping limit:
0.05 mm (0.0020 in)

Grinding limit:
0.3 mm (0.012 in)

Standard height of cylinder head:
127.5 mm (5.02 in)

CAUTION:
Uneven torque for the cylinder head nuts can cause warping. When reassembling, pay special attention to the torque so as to tighten evenly.



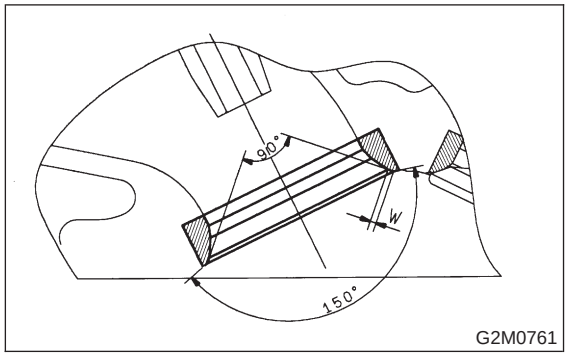
2. VALVE SEAT

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

Valve seat width: W

Intake
Standard
1.0 mm (0.039 in)
Limit
1.7 mm (0.067 in)

Exhaust
Standard
1.5 mm (0.059 in)
Limit
2.2 mm (0.087 in)



3. VALVE GUIDE

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

Clearance between the valve guide and valve stem:

Standard
Intake
0.035 — 0.062 mm (0.0014 — 0.0024 in)
Exhaust
0.040 — 0.067 mm (0.0016 — 0.0026 in)

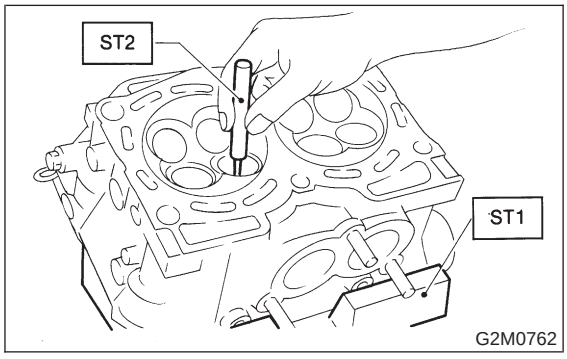
Limit
0.15 mm (0.0059 in)

Valve guide inner diameter:
6.000 — 6.015 mm (0.2362 — 0.2368 in)

Valve stem outer diameter:
Intake
5.950 — 5.965 mm (0.2343 — 0.2348 in)
Exhaust
5.950 — 5.965 mm (0.2343 — 0.2348 in)

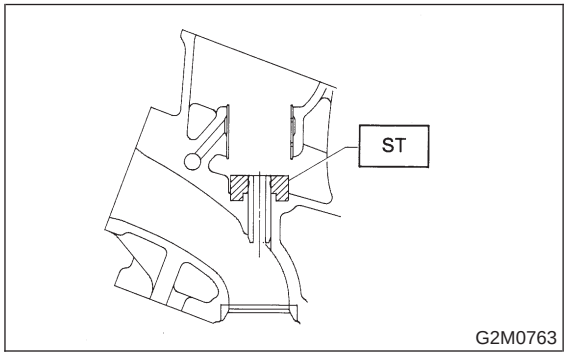
2) If the clearance between valve guide and stem exceeds the specification, replace guide as follows:
(1) Place cylinder head on ST1 with the combustion chamber upward so that valve guides enter the holes in ST1.
(2) Insert ST2 into valve guide and press it down to remove valve guide.

ST1 498267600 CYLINDER HEAD TABLE
ST2 499767200 VALVE GUIDE REMOVER



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

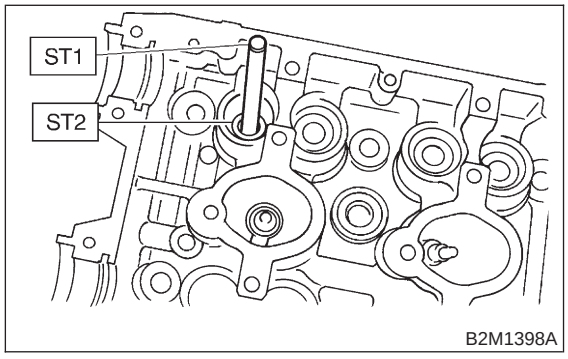
ST 498267700 VALVE GUIDE ADJUSTER



(4) Before installing new valve guide, make sure that neither scratches nor damages exist on the inside surface of the valve guide holes in cylinder head.

(5) Put new valve guide, coated with sufficient oil, in cylinder, and insert ST1 into valve guide. Press in until the valve guide upper end is flush with the upper surface of ST2.

ST1 499767200 VALVE GUIDE REMOVER
ST2 498267700 VALVE GUIDE ADJUSTER



(6) Check the valve guide protrusion.

Valve guide protrusion: L
12.0 — 12.4 mm (0.472 — 0.488 in)

(7) Ream the inside of valve guide with ST. Gently rotate the reamer clockwise while pressing it lightly into valve guide, and return it also rotating clockwise. After reaming, clean valve guide to remove chips.

ST 499767400 VALVE GUIDE REAMER

CAUTION:
● Apply engine oil to the reamer when reaming.
● If the inner surface of the valve guide is torn, the edge of the reamer should be slightly ground with an oil stone.
● If the inner surface of the valve guide becomes lustrous and the reamer does not chips, use a new reamer or remedy the reamer.

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

4. INTAKE AND EXHAUST VALVE

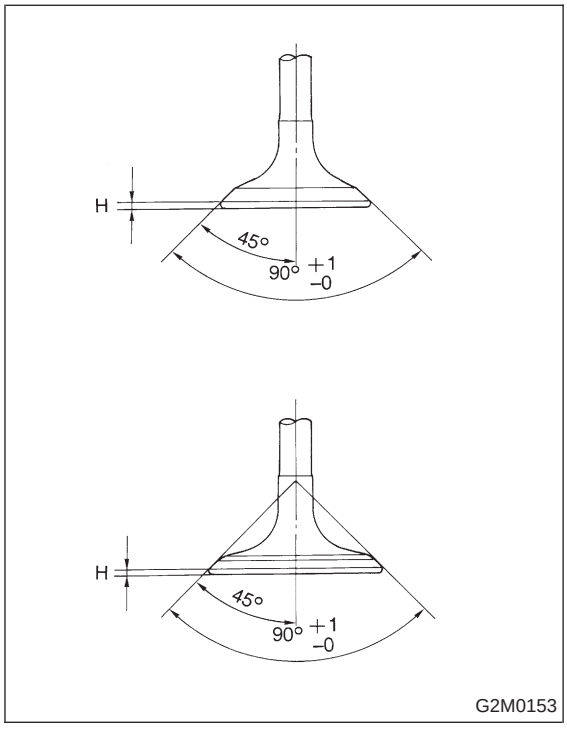
1) Inspect the flange and stem of valve, and replace if damaged, worn, or deformed, or if “H” is less than the specified limit.

H:

Intake
Standard
1.2 mm (0.047 in)
Limit
0.8 mm (0.031 in)

Exhaust
Standard
1.5 mm (0.059 in)
Limit
0.8 mm (0.031 in))

Valve overall length:
Intake
105.9 mm (4.169 in)
Exhaust
106.2 mm (4.181 in)

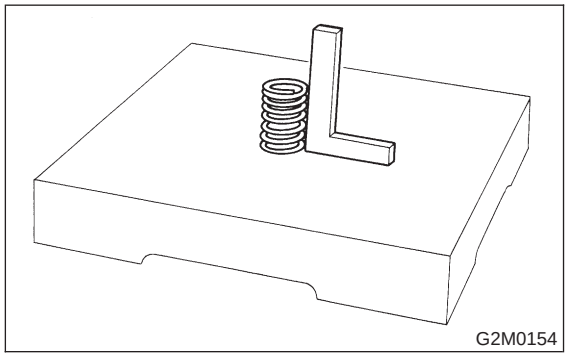


2) Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. Install a new intake valve oil seal after lapping.

5. VALVE SPRINGS

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

	Valve spring
Free length	48.04 mm (1.8913 in)
Tension/spring height	146.1 — 167.7 N (14.9 — 17.1 kg, 32.9 — 37.7 lb)/42.0 mm (1.654 in)
	455.0 — 523.7 N (46.4 — 53.4 kg, 102.3 — 117.7 lb)/33.4 mm (1.315 in)
Squareness	2.5°, 2.1 mm (0.083 in)



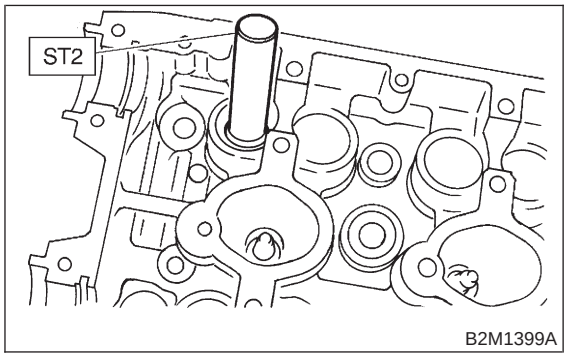
6. INTAKE AND EXHAUST VALVE OIL SEAL

Replace oil seal with new one, if lip is damaged or spring out of place, or when the surfaces of intake valve and valve seat are reconditioned or intake valve guide is replaced.
1) Place cylinder head on ST1.
2) Press in oil seal to the specified dimension indicated in the figure by using ST2.
ST1 498267600 CYLINDER HEAD TABLE
ST2 498857100 VALVE OIL SEAL GUIDE

CAUTION:
● Apply engine oil to oil seal before force-fitting.
● Differentiate between intake valve oil seal and exhaust valve oil seal by noting their difference in color.

Color of rubber part:
Intake [Black]
Exhaust [Brown]

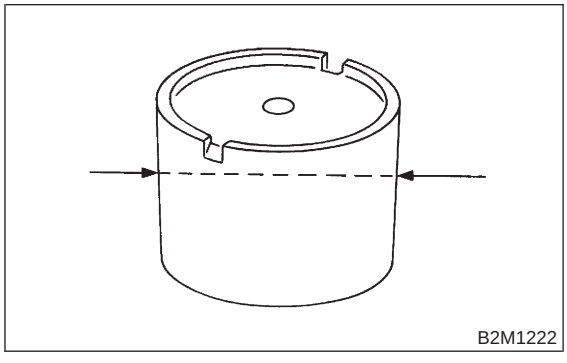
Color of spring part:
Intake [Silver]
Exhaust [Silver]



7. VALVE LIFTER

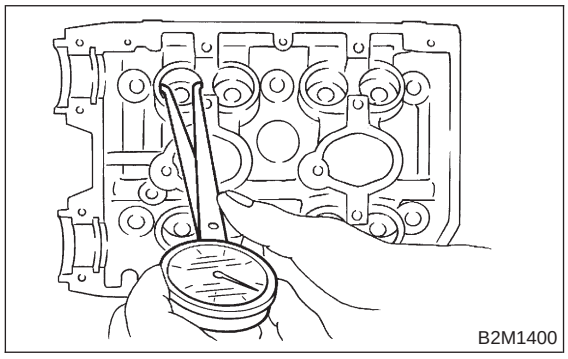
1) Check valve lifter visually.
2) Measure outer diameter of valve lifter.

Outer diameter:
32.959 — 32.975 mm (1.2976 — 1.2982 in)



3) Measure inner diameter of valve lifter mating part on cylinder head.

Inner diameter:
32.994 — 33.016 mm (1.2990 — 1.2998 in)

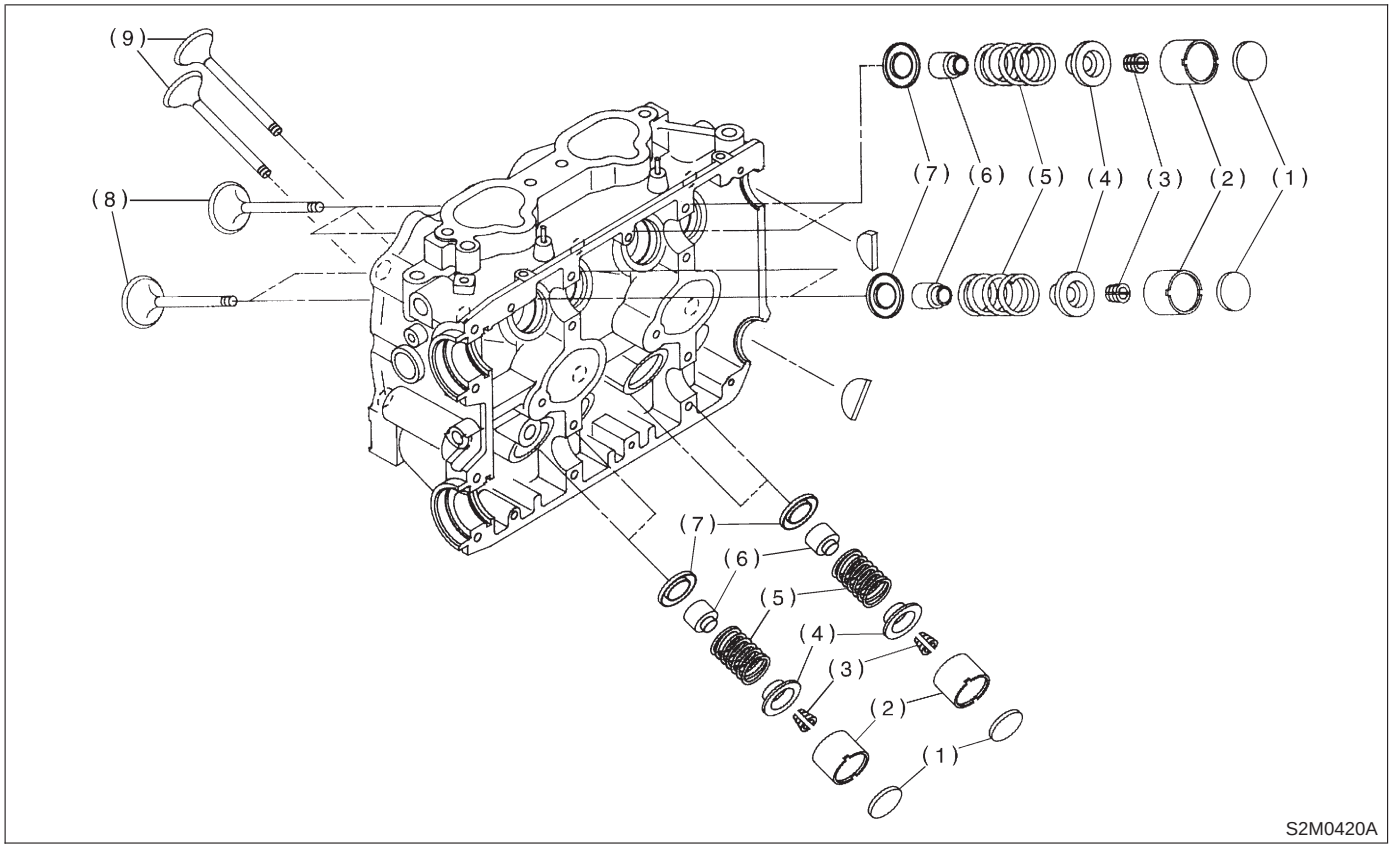


CAUTION:
If difference between outer diameter of valve lifter and inner diameter of valve lifter mating part is over the limit, replace cylinder head.

Standard:
0.019 — 0.057 mm (0.0007 — 0.0022 in)

Limit:
0.100 mm (0.0039 in)

D: ASSEMBLY



(1) Valve shim
(2) Valve lifter
(3) Valve retainer key
(4) Valve retainer
(5) Valve spring
(6) Valve oil seal
(7) Valve spring seat
(8) Intake valve
(9) Exhaust valve

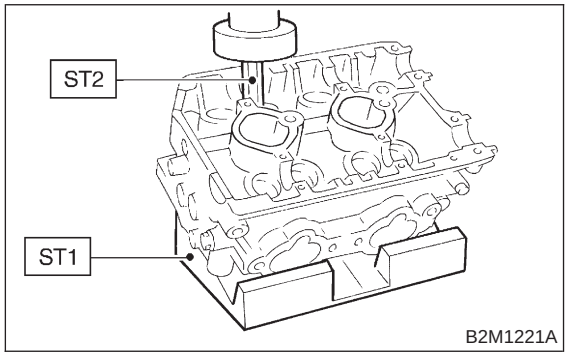
1) Installation of valve spring and valve
   (1) Coat stem of each valve with engine oil and insert valve into valve guide.

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

   (2) Set cylinder head on ST1.
   (3) Install valve spring and retainer using ST2.

ST1 498267600 CYLINDER HEAD TABLE
ST2 499718000 VALVE SPRING REMOVER

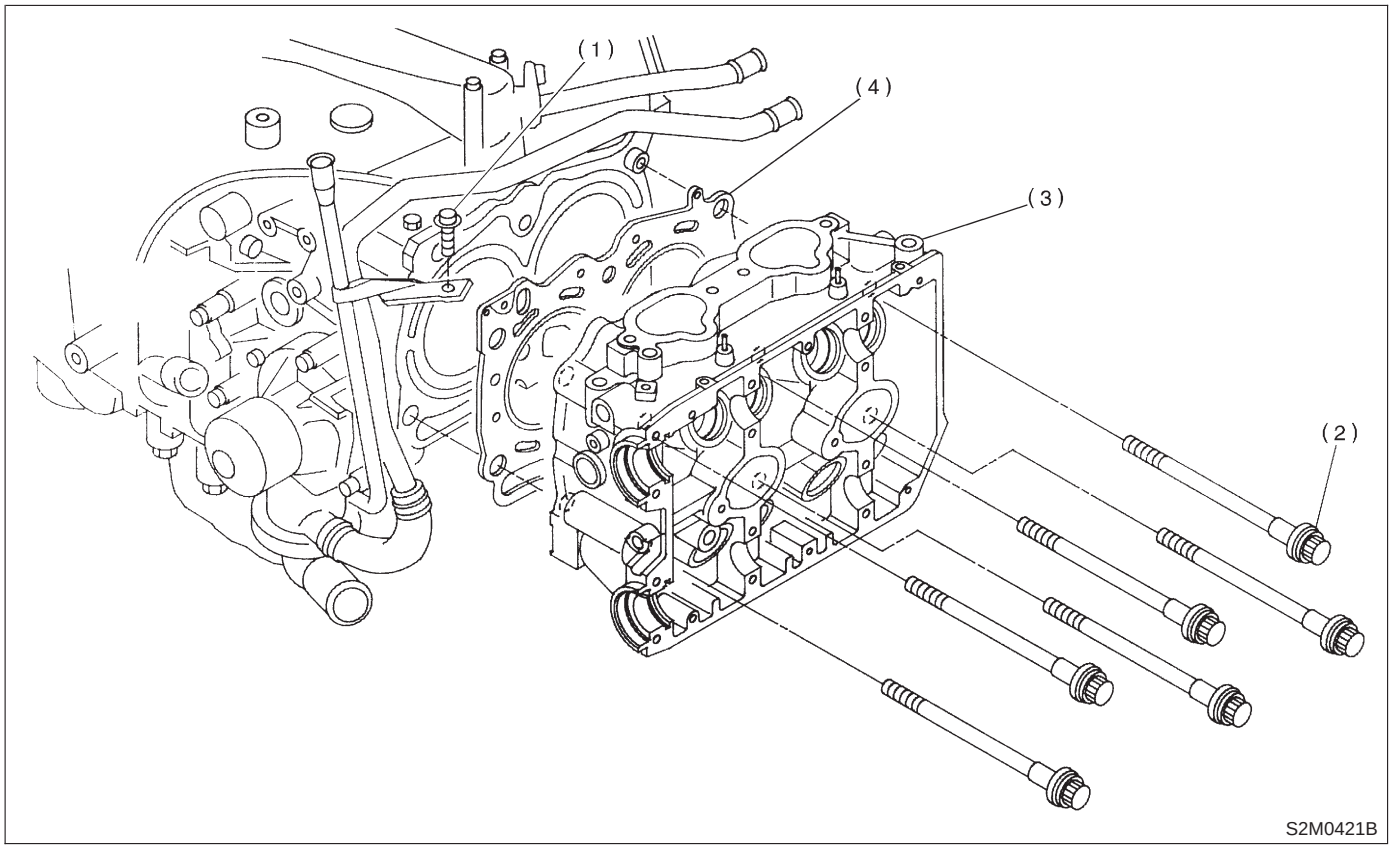
CAUTION:
Be sure to install the valve springs with their close-coiled end facing the seat on the cylinder head.



   (4) Compress valve spring and fit valve spring retainer key.
   (5) After installing, tap valve spring retainers lightly with wooden hammer for better seating.
2) Install valve lifter and valve shim.

E: INSTALLATION

1. CYLINDER HEAD



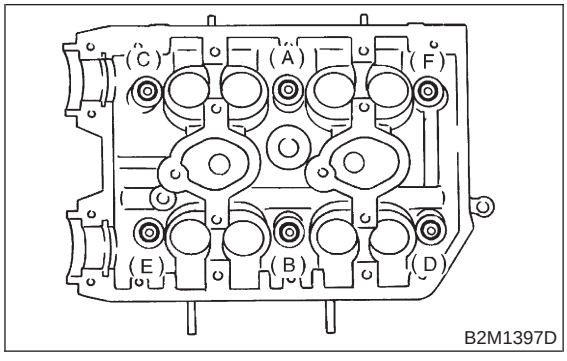
(1) Bolt
(2) Cylinder head bolt
(3) Cylinder head
(4) Cylinder head gasket

1) Install cylinder head and gaskets on cylinder block.

CAUTION:
Use new cylinder head gaskets.

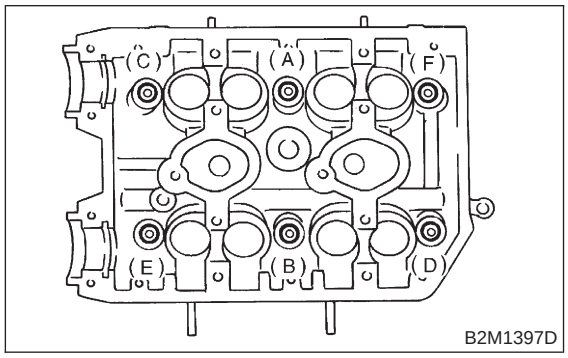
2) Tighten cylinder head bolts.
(1) Apply a coat of engine oil to washers and bolt threads.
(2) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb) in alphabetical sequence.
Then tighten all bolts to 69 N·m (7.0 kg-m, 51 ft-lb) in alphabetical sequence.
(3) Back off all bolts by 180° first; back them off by 180° again.
(4) Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb) in alphabetical sequence.
(5) Tighten all bolts by 80 to 90° in alphabetical sequence.
(6) Tighten all bolts by 40 to 45° in alphabetical sequence.

CAUTION:
Do not tighten bolts more than 45°.



(7) Further tighten bolts (A) and (B) by 40 to 45°.

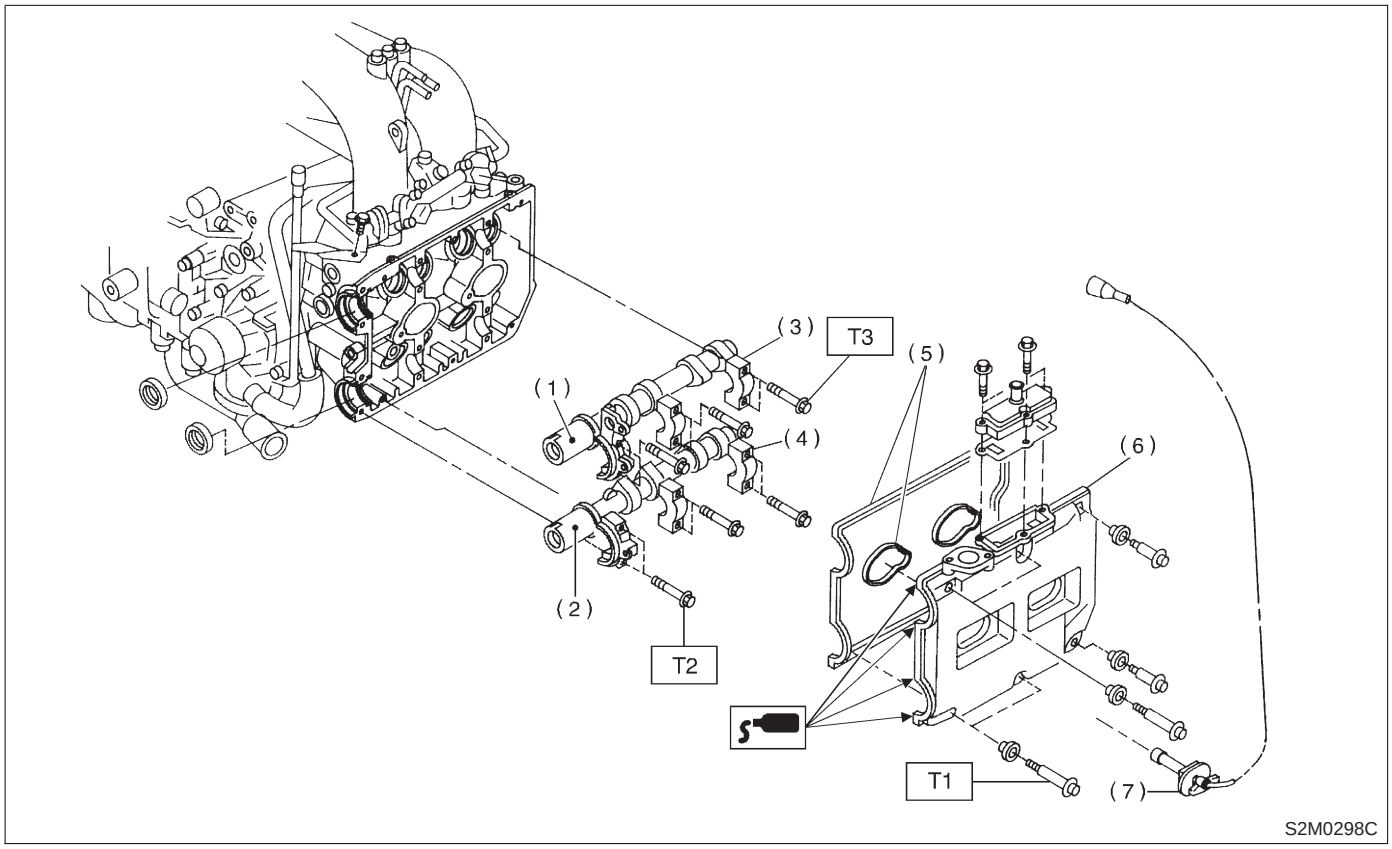
CAUTION:
Ensure that the total "re-tightening angle" [in the two previous steps] do not exceed 90°.



3) Install oil level gauge guide attaching bolt (LH side only).

2. RELATED PARTS

1) Install camshafts, rocker cover and related parts.
<Ref. to 2-3b [W3C0].>

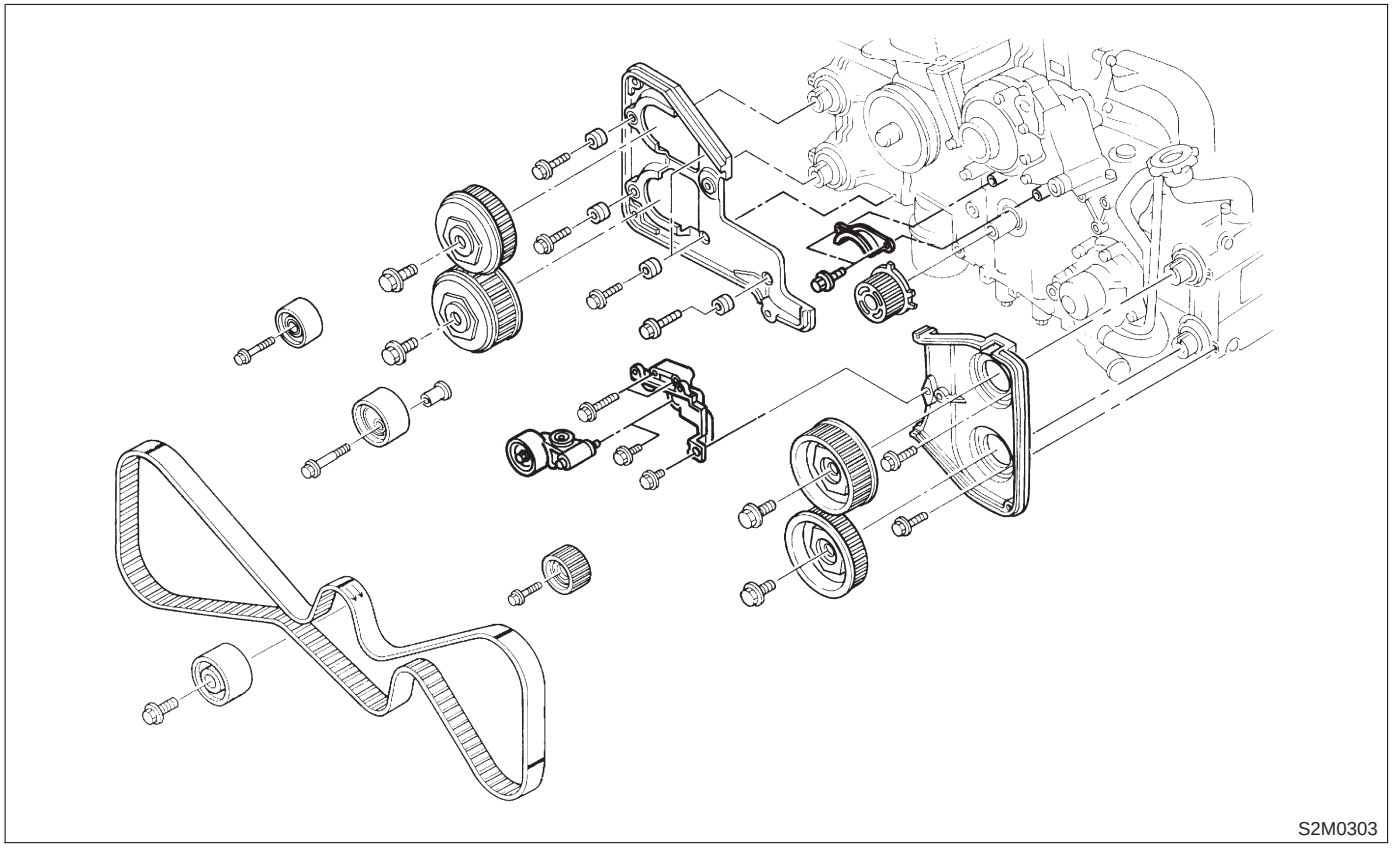


(1) Intake camshaft (LH)
(2) Exhaust camshaft (LH)
(3) Intake camshaft cap (LH)
(4) Exhasut camshaft cap (LH)
(5) Rocker cover gasket (LH)
(6) Rocker cover (LH)
(7) Spark plug cord

Tightening torque: N·m (kg-m, ft-lb)
T1: 5±0.5 (0.5±0.05, 3.6±0.4)
T2: 9.8±0.7 (1.0±0.07, 7.2±0.5)
T3: 20±2 (2.0±0.2, 14.5±1.4)

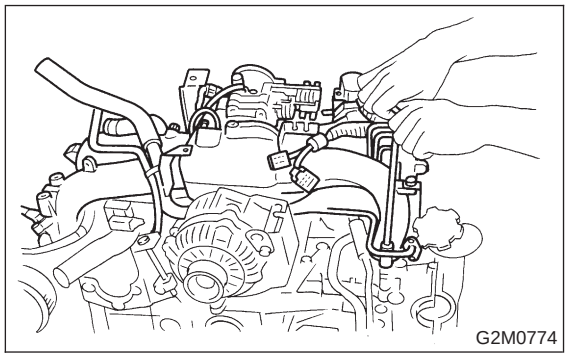
2) Similarly, install parts on right-hand side.

3) Install camshaft sprockets, timing belt and related parts.
<Ref. to 2-3b [W2C0].>


S2M0303

4) Install intake manifold.

CAUTION:
Use new gaskets.


G2M0774

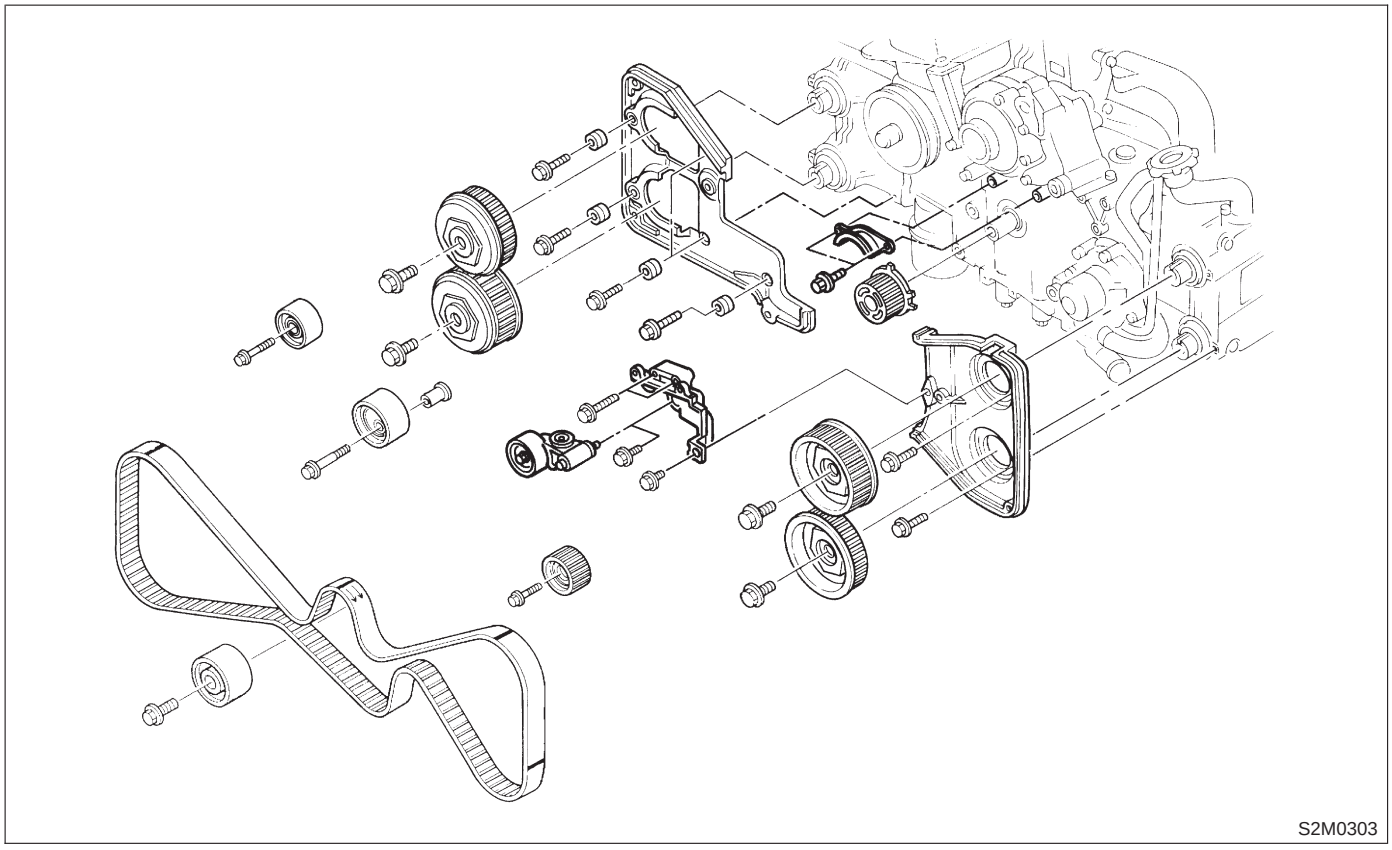
5) Install camshaft position sensor. Use dry compressed air to remove foreign particles before installing sensor.
6) Connect each connector and/or install connector bracket.
7) Connect hoses and tubes to cylinder block.
8) Install brackets, generator and air conditioner compressor.
9) Install V-belt.

5. Cylinder Block

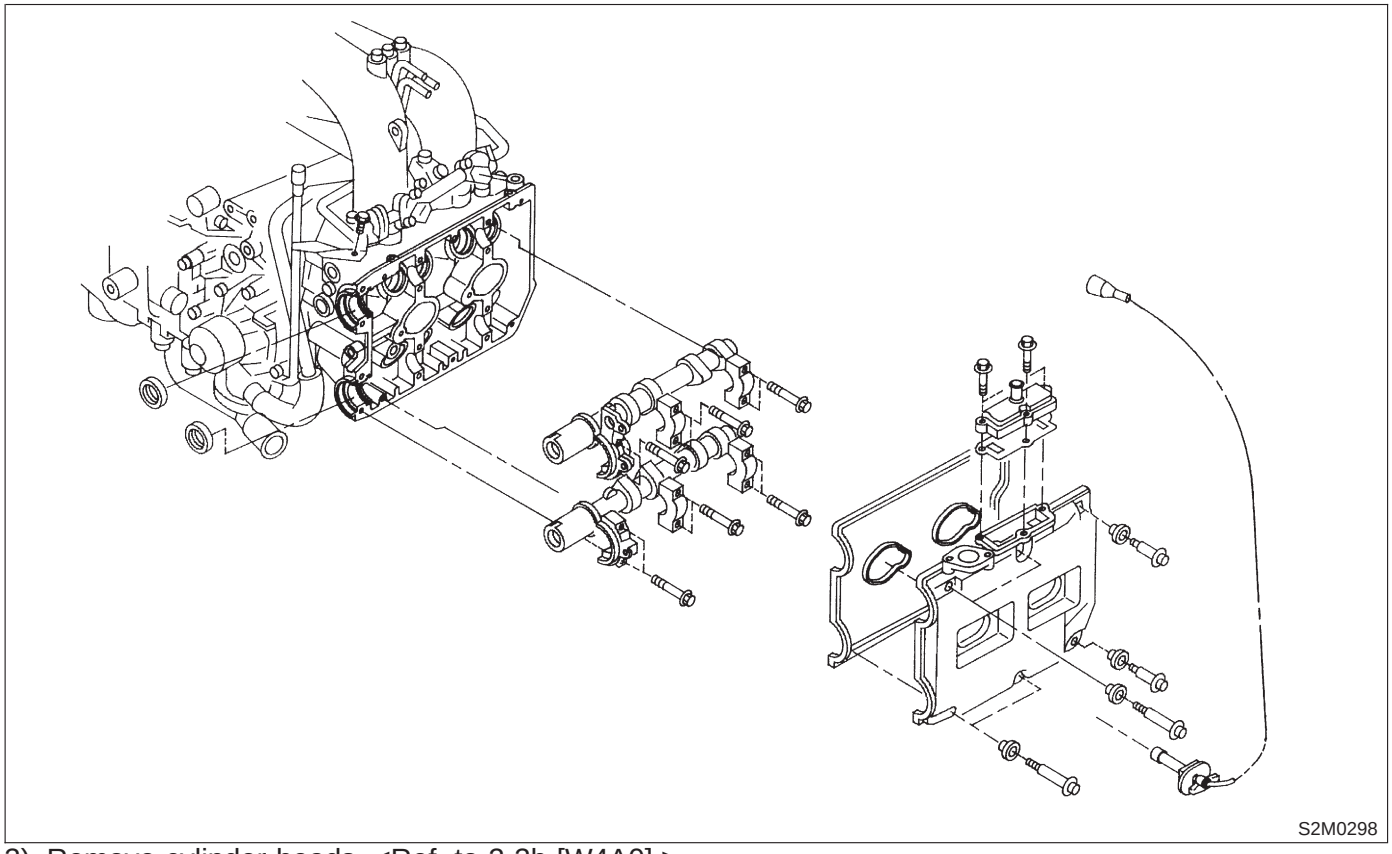
A: REMOVAL

1. RELATED PARTS

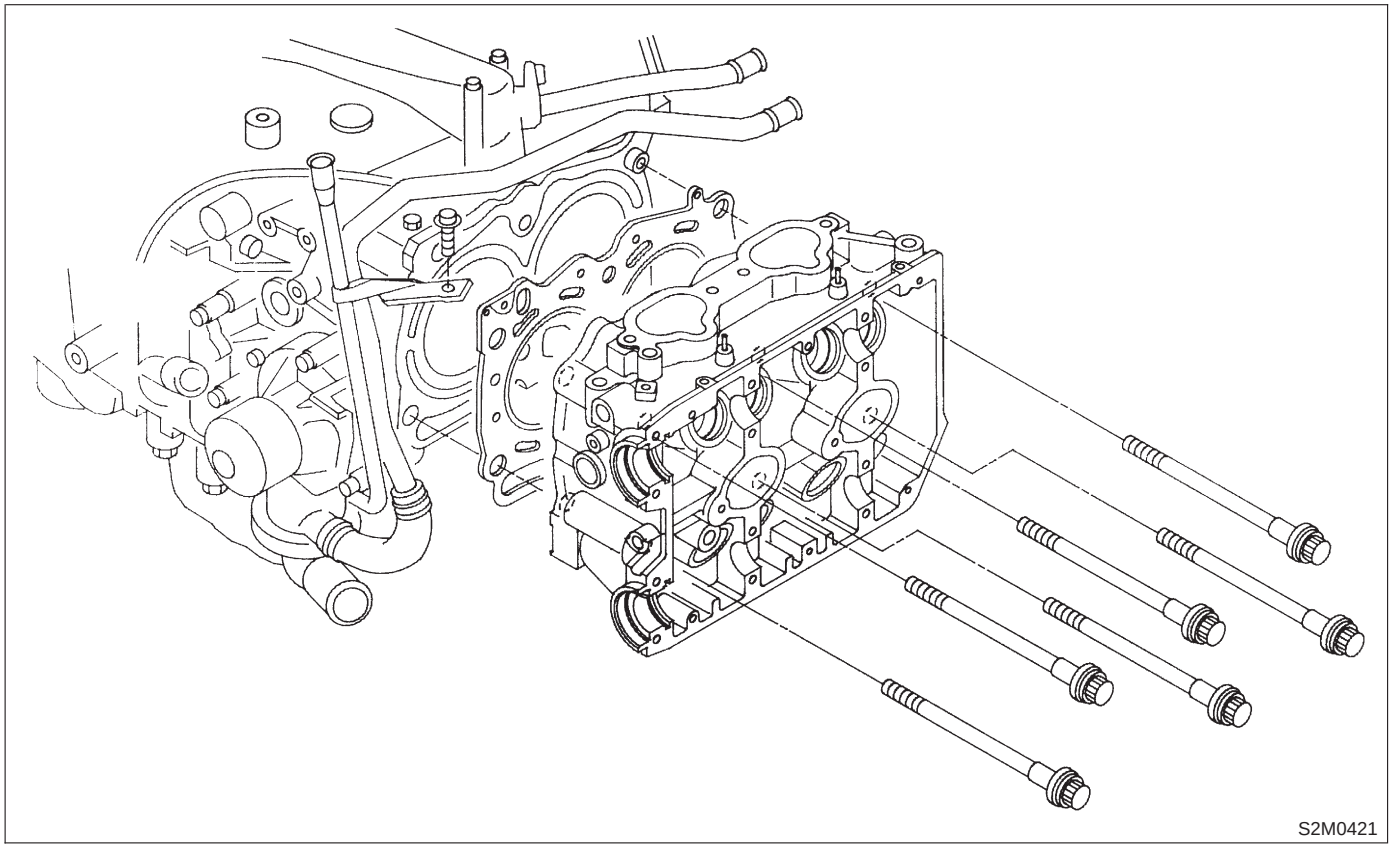
1) Remove timing belt, camshaft sprockets and related parts.
<Ref. to 2-3b [W2A0].>



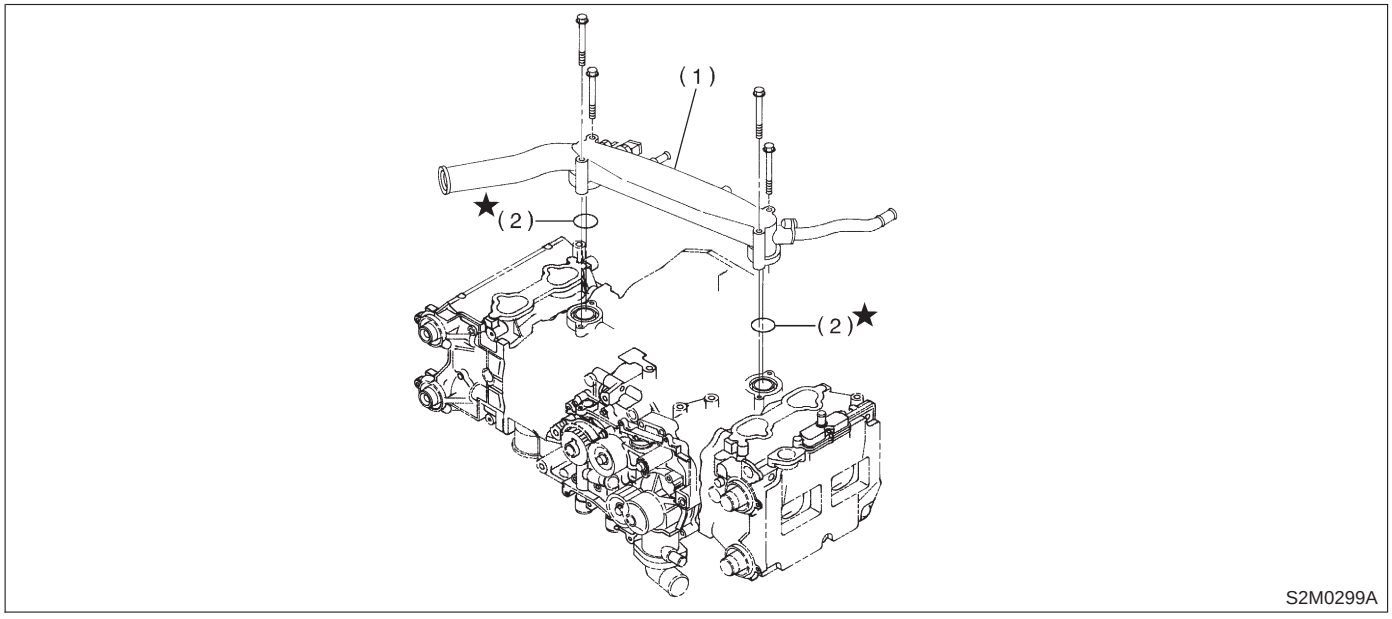
2) Remove rocker cover, camshafts and related parts. <Ref. to 2-3b [W3A0].>



3) Remove cylinder heads. <Ref. to 2-3b [W4A0].>

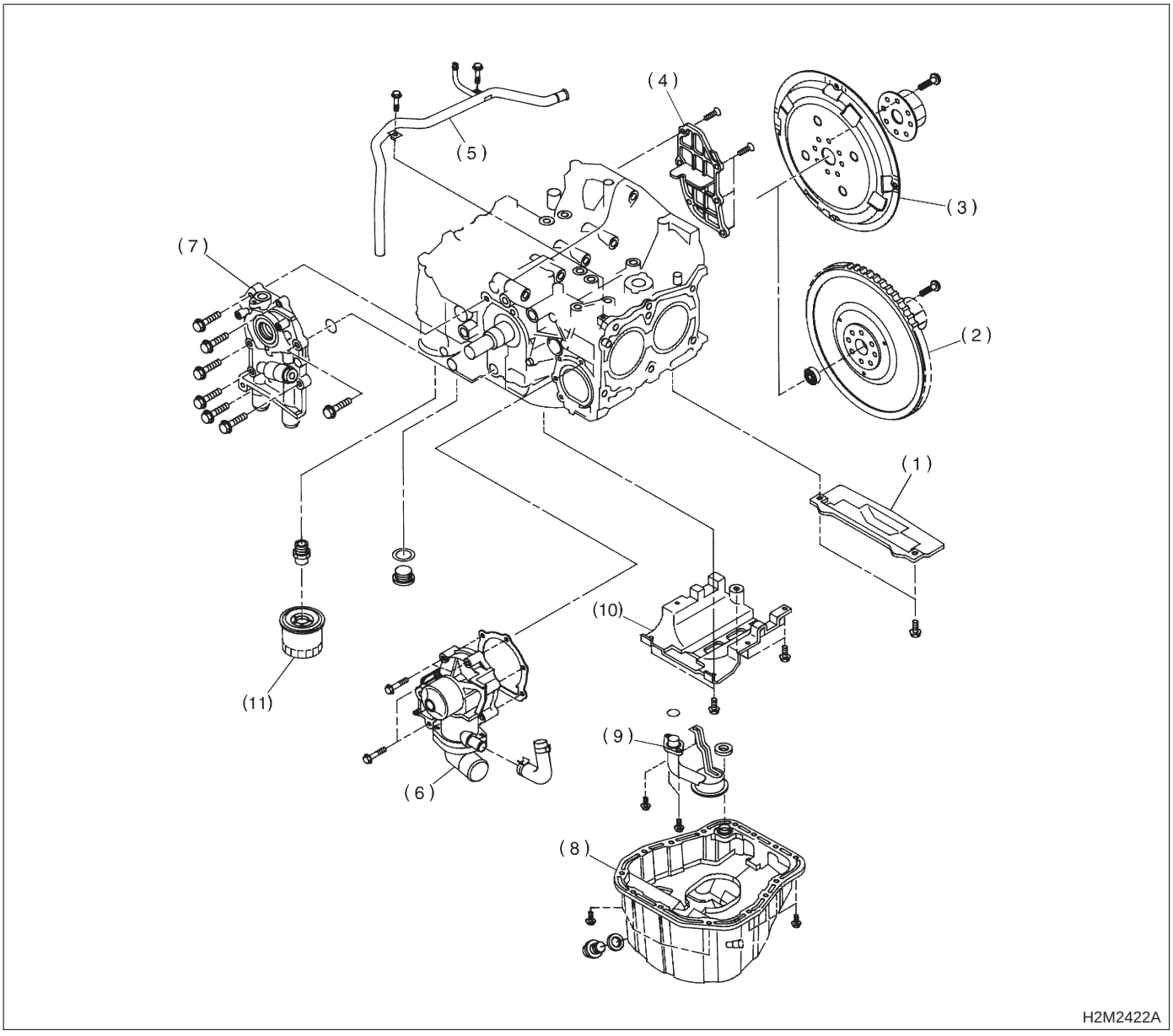


4) Remove water pipe. <Ref. to 2-5 [W8A0].>



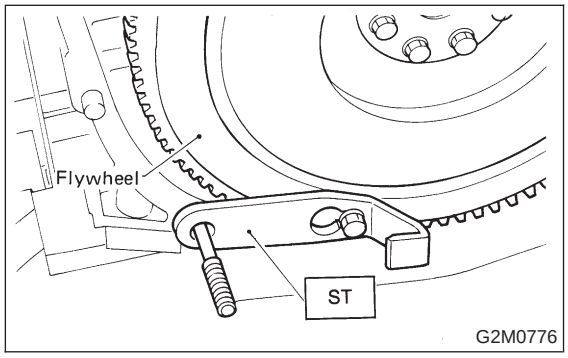
(1) Water pipe
(2) O-ring

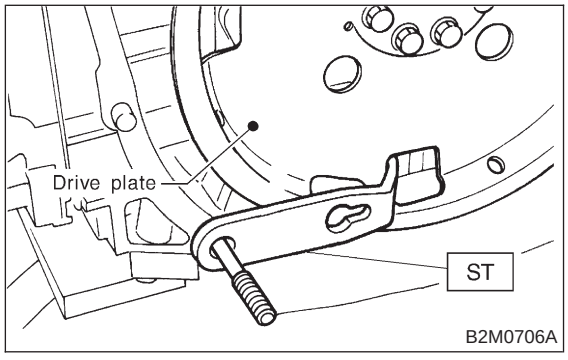
2. OIL PUMP AND WATER PUMP



(1) Clutch housing cover (MT vehicles only)
(2) Flywheel (MT vehicles only)
(3) Drive plate (AT vehicles only)
(4) Oil separator cover
(5) Water by-pass pipe
(6) Water pump
(7) Oil pump
(8) Oil pan
(9) Oil strainer
(10) Baffle plate
(11) Oil filter

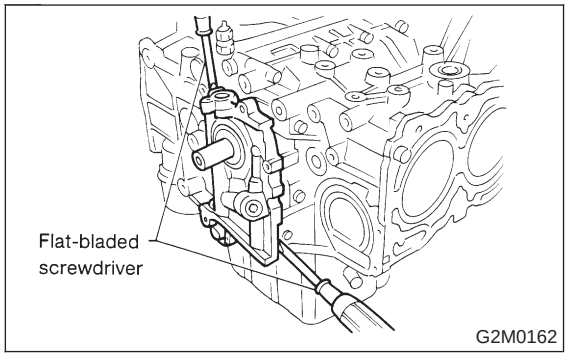
1) Remove clutch housing cover (MT vehicles only).
2) Remove flywheel (MT vehicles only) or drive plate (AT vehicles only).
Using ST, lock crankshaft.
ST 498497100 CRANKSHAFT STOPPER





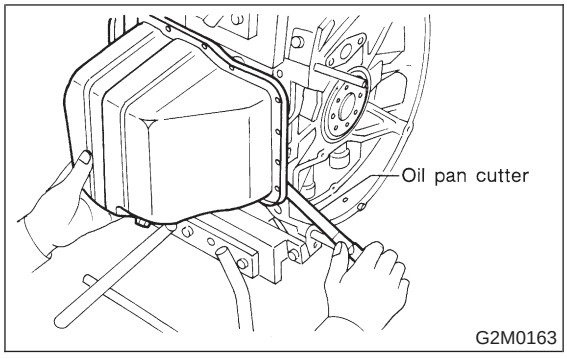
3) Remove oil separator cover.
4) Remove water by-pass pipe for heater.
5) Remove water pump.
6) Remove oil pump from cylinder block.
Use a flat-bladed screwdriver as shown in figure when removing oil pump.

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



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

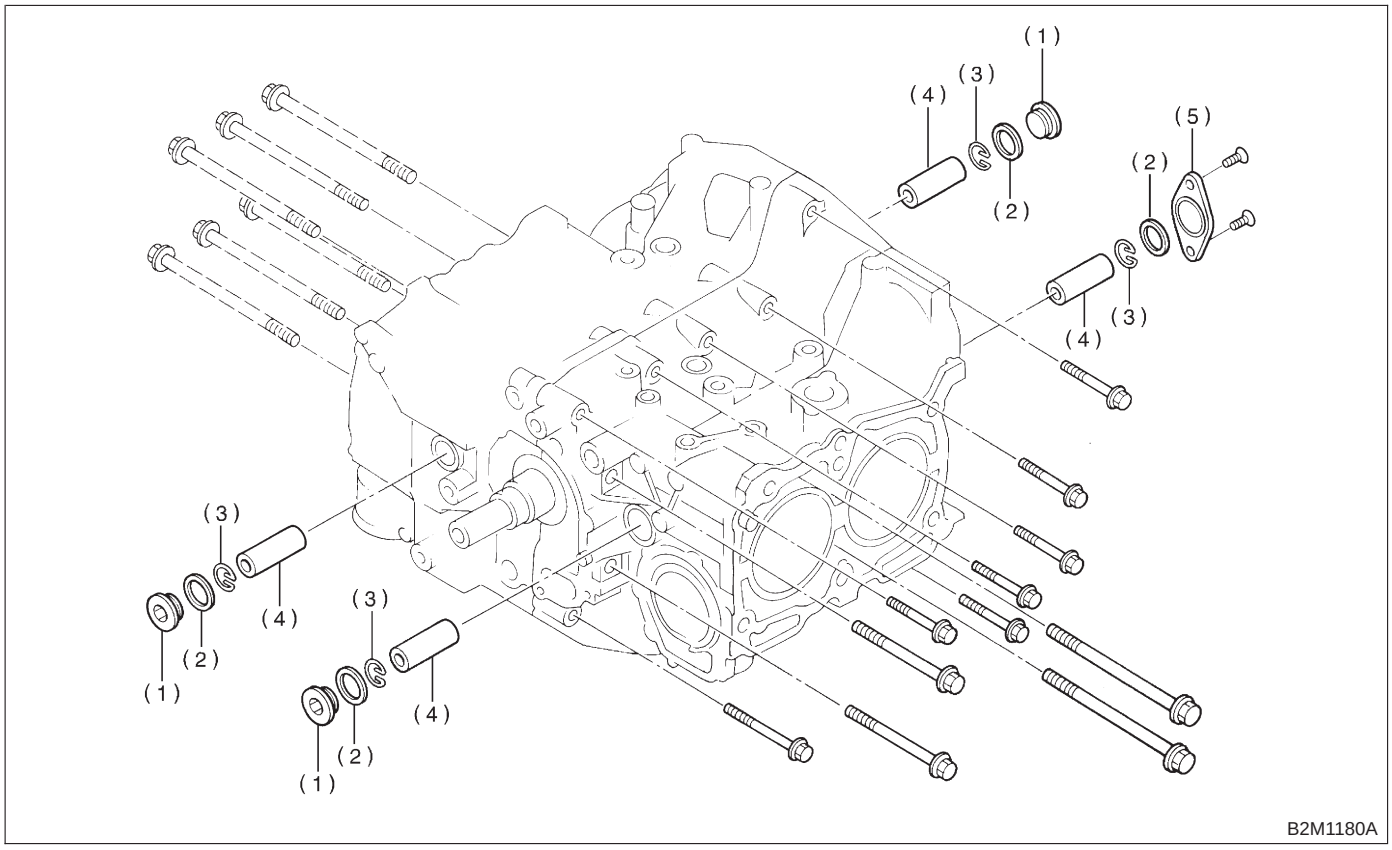
CAUTION:
Do not use a screwdriver or similar tool in place of oil pan cutter.



8) Remove oil strainer stay.
9) Remove oil strainer.
10) Remove baffle plate.
11) Remove oil filter.

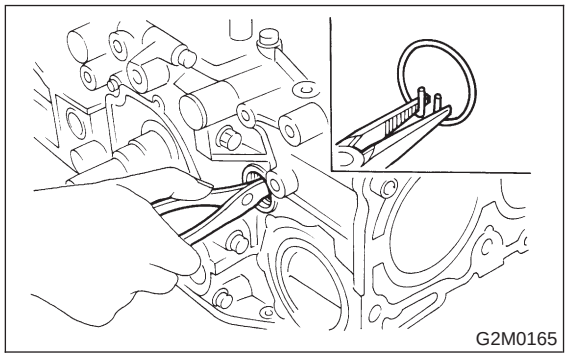
B: DISASSEMBLY

1. PISTON PIN AND CYLINDER BLOCK CONNECTING BOLT



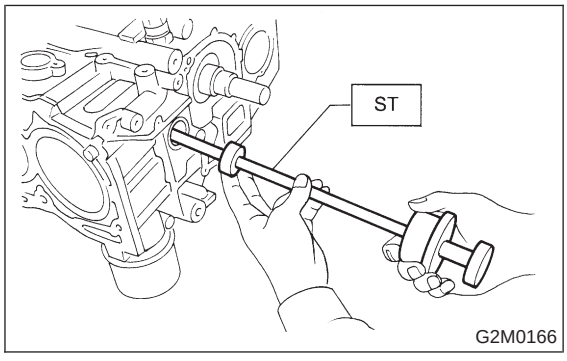
(1) Service hole plug
(2) Gasket
(3) Circlip
(4) Piston pin
(5) Service hole cover

1) Remove service hole cover and service hole plugs using hexagon wrench (14 mm).
2) Rotate crankshaft to bring #1 and #2 pistons to bottom dead center position, then remove piston circlip through service hole of #1 and #2 cylinders.



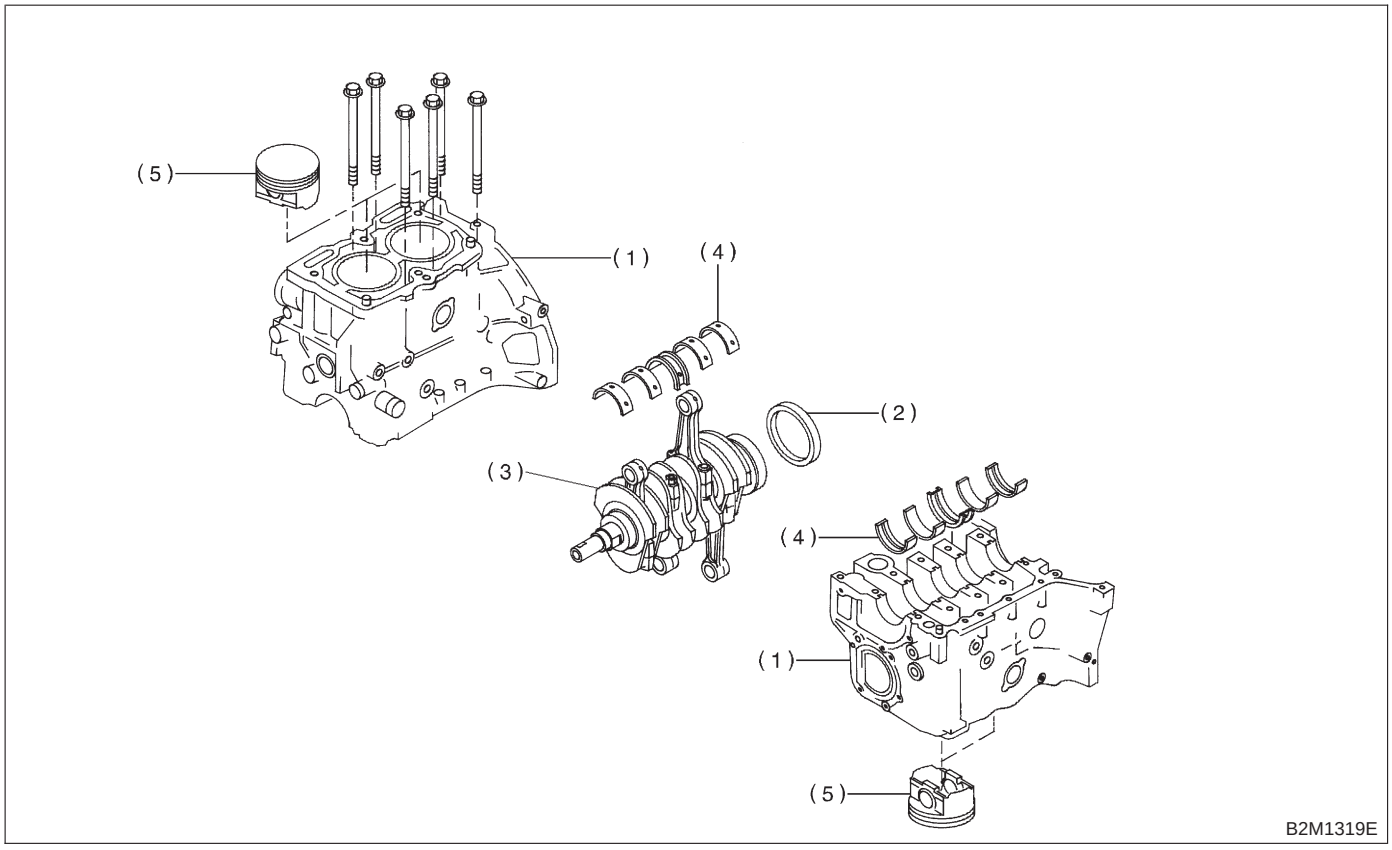
3) Draw out piston pin from #1 and #2 pistons by using ST.
ST 499097700 PISTON PIN REMOVER

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



4) Similarly remove piston pins from #3 and #4 pistons.
5) Remove bolts which connect cylinder block on the side of #2 and #4 cylinders.
6) Back off bolts which connect cylinder block on the side of #1 and #3 cylinders two or three turns.

2. CYLINDER BLOCK



(1) Cylinder block
(2) Rear oil seal
(3) Crankshaft
(4) Crankshaft bearing
(5) Piston

1) Set up cylinder block so that #1 and #3 cylinders are on the upper side, then remove cylinder block connecting bolts.
2) Separate left-hand and right-hand cylinder blocks.

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

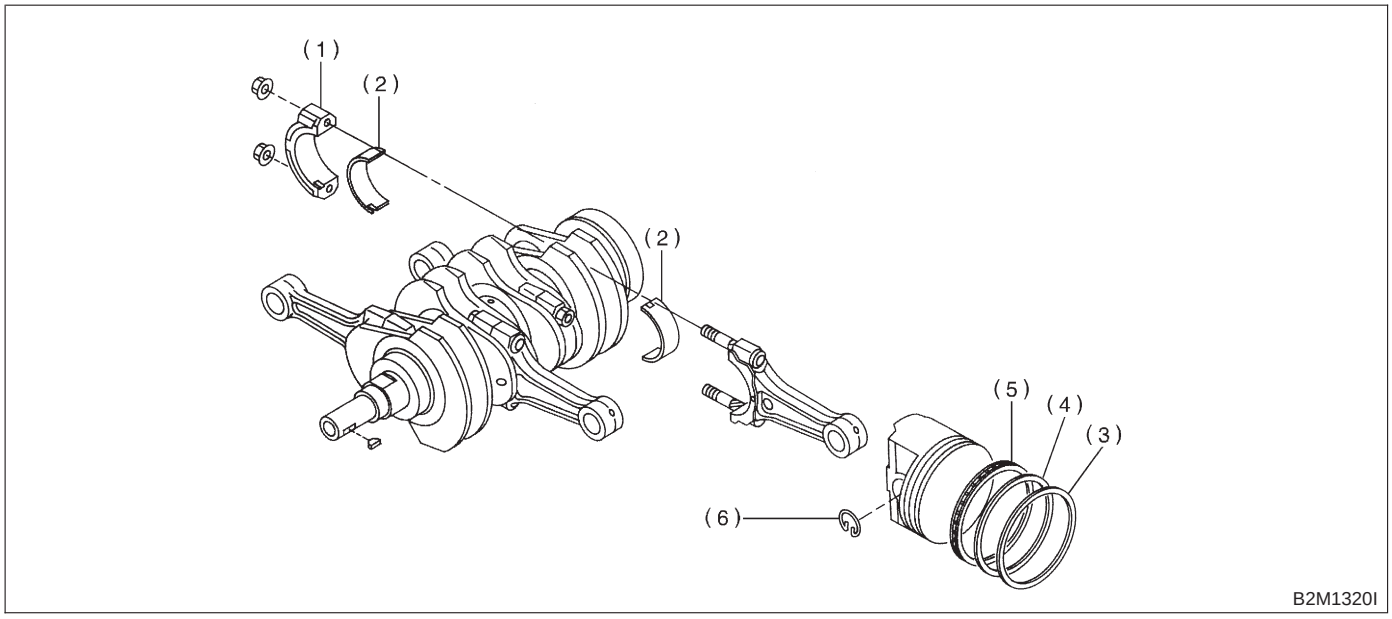
3) Remove rear oil seal.
4) Remove crankshaft together with connecting rod.
5) Remove crankshaft bearings from cylinder block using hammer handle.

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

6) Draw out each piston from cylinder block using wooden bar or hammer handle.

CAUTION:
Do not confuse combination of piston and cylinder.

3. CRANKSHAFT AND PISTON



(1) Connecting rod cap
(2) Connecting rod bearing
(3) Top ring
(4) Second ring
(5) Oil ring
(6) Circlip

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

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

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

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

5) Remove circlip.

C: INSPECTION

1. CYLINDER BLOCK

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

Warping limit:
0.05 mm (0.0020 in)

Grinding limit:
0.1 mm (0.004 in)

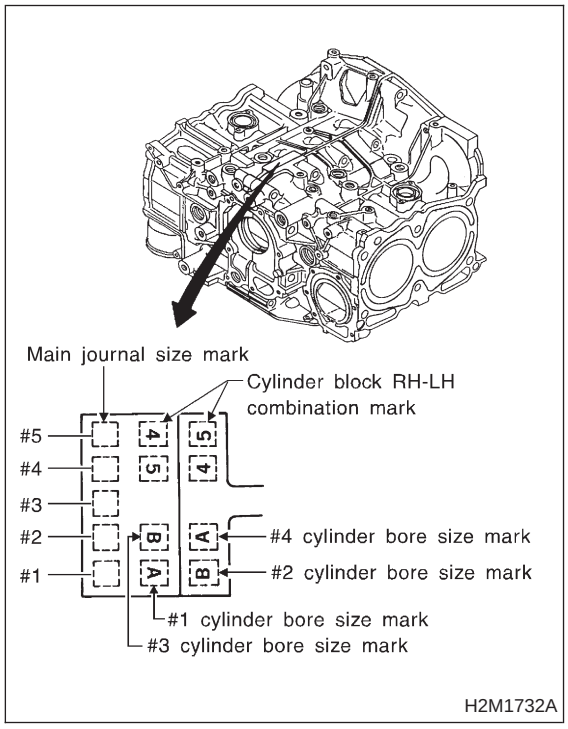
Standard height of cylinder block:
201.0 mm (7.91 in)

2. CYLINDER AND PISTON

1) The cylinder bore size is stamped on the cylinder block's front upper surface.

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

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

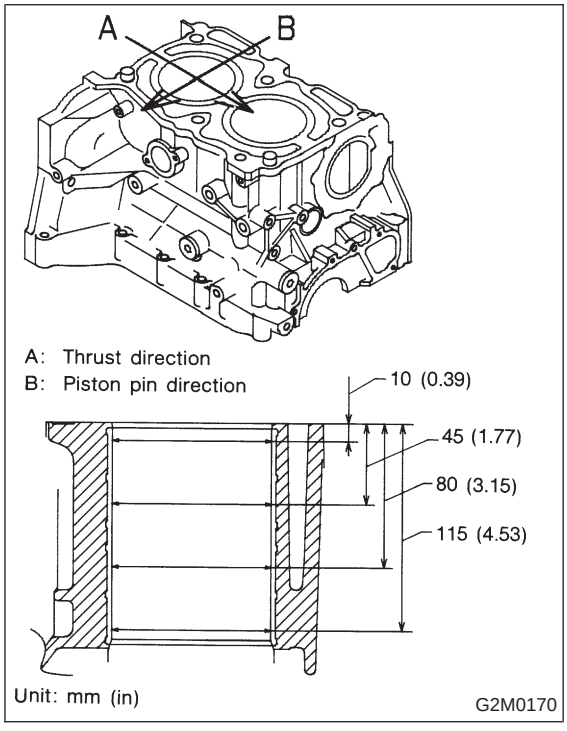


2) How to measure the inner diameter of each cylinder
Measure the inner diameter of each cylinder in both the thrust and piston pin directions at the heights shown in figure, using a cylinder bore gauge.

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

Taper:
Standard
0.015 mm (0.0006 in)
Limit
0.050 mm (0.0020 in)

Out-of-roundness:
Standard
0.010 mm (0.0004 in)
Limit
0.050 mm (0.0020 in)



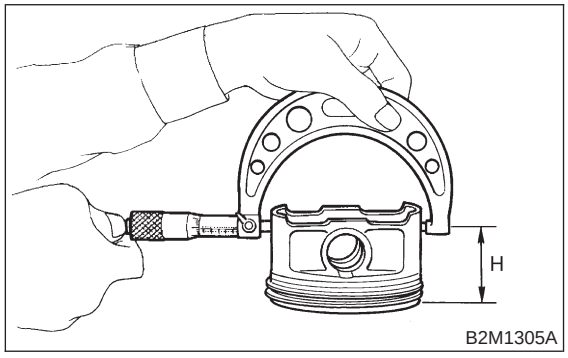
3) When piston is to be replaced due to general or cylinder wear, determine a suitable sized piston by measuring the piston clearance.

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

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

Piston grade point H:
37.0 mm (1.457 in)

Piston outer diameter:
Standard
A: 99.485 — 99.495 mm (3.9167 — 3.9171 in)
B: 99.475 — 99.485 mm (3.9163 — 3.9167 in)
0.25 mm (0.0098 in) oversize
99.725 — 99.735 mm (3.9262 — 3.9266 in)
0.50 mm (0.0197 in) oversize
99.975 — 99.985 mm (3.9360 — 3.9364 in)



5) Calculate the clearance between cylinder and piston.

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

Cylinder to piston clearance at 20°C (68°F):
Standard
0.004 — 0.010 mm (0.0002 — 0.0004 in)
Limit
0.020 mm (0.0008 in)

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

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

(2) If the cylinder inner diameter exceeds the limit after boring and honing, replace the crankcase.

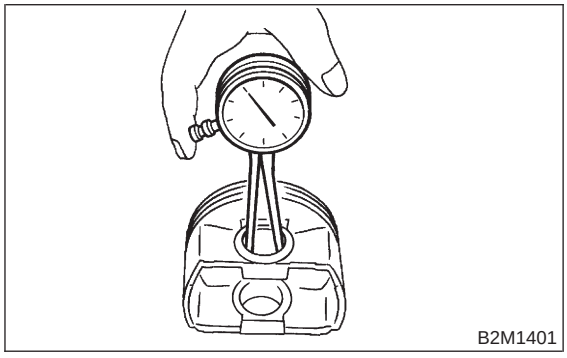
CAUTION:
Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, pay attention to this when measuring the cylinder diameter.

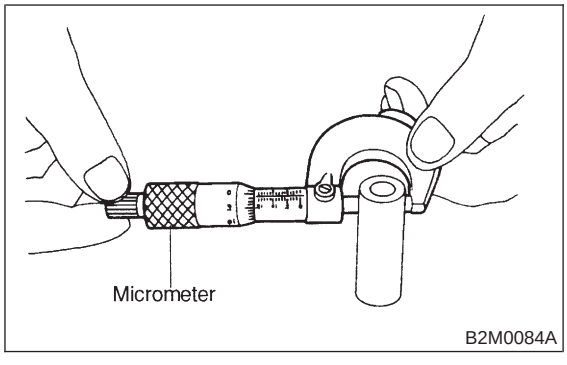
Limit of cylinder enlarging (boring):
0.5 mm (0.020 in)

3. PISTON AND PISTON PIN

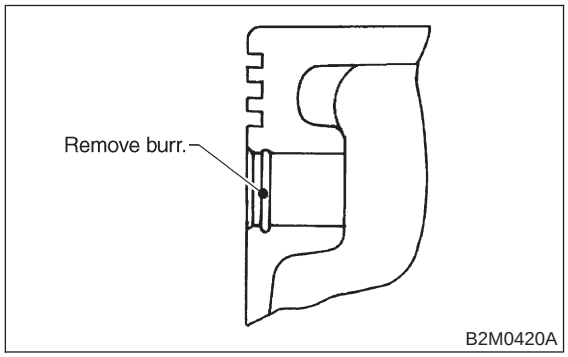
1) Check pistons and piston pins for damage, cracks, and wear and the piston ring grooves for wear and damage. Replace if defective.
2) Measure the piston-to-cylinder clearance at each cylinder.
<Ref. to 2-3b [W5C2].>
If any of the clearances is not to specification, replace the piston or bore the cylinder to use an oversize piston.
3) Make sure that piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F). Replace if defective.

Standard clearance between piston pin and hole in piston:
Standard
0.004 — 0.010 mm (0.0002 — 0.0004 in)
Limit
0.020 mm (0.0008 in)





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

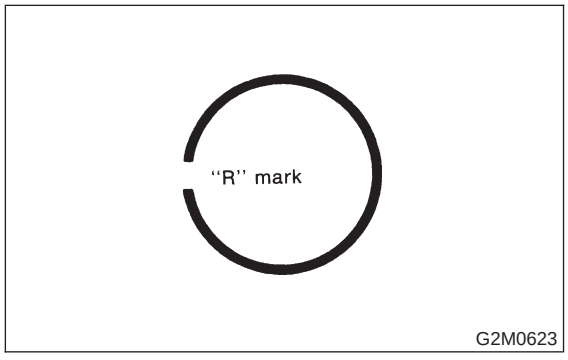


5) Check piston pin circlip for distortion, cracks and wear.

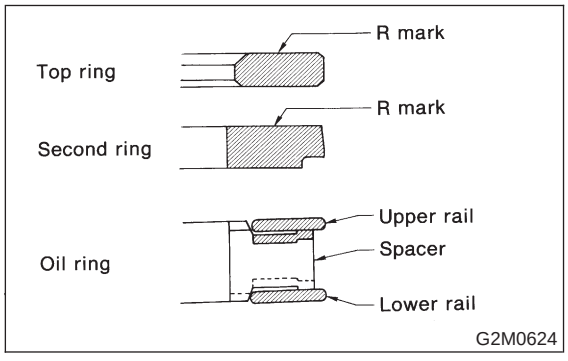
4. PISTON RING

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

CAUTION:
● "R" is marked on the end of the top and second rings. When installing the rings to the piston, face this mark upward.

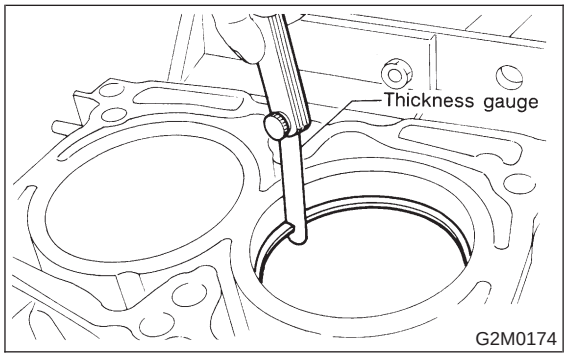


● The oil ring is a combined ring consisting of two rails and a spacer in between. When installing, be careful to assemble correctly.



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

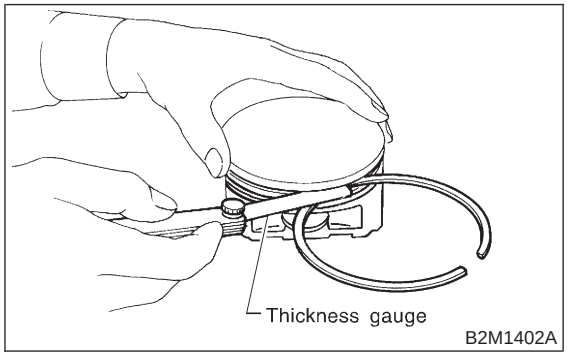
		Unit: mm (in)	
		Standard	Limit
Piston ring gap	Top ring	0.20 — 0.35 (0.0079 — 0.0138)	1.0 (0.039)
	Second ring	0.37 — 0.52 (0.0146 — 0.0205)	1.0 (0.039)
	Oil ring rail	0.20 — 0.60 (0.0079 — 0.0236)	1.5 (0.059)



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

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

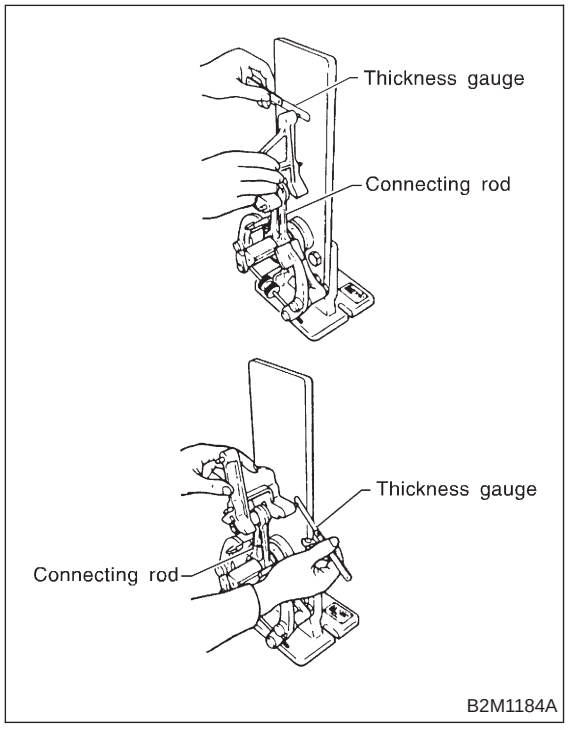
		Unit: mm (in)	
		Standard	Limit
Clearance between piston ring and piston ring groove	Top ring	0.040 — 0.080 (0.0016 —0.0031)	0.15 (0.0059)
	Second ring	0.030 — 0.070 (0.0012 —0.0028)	0.15 (0.0059)



5. CONNECTING ROD

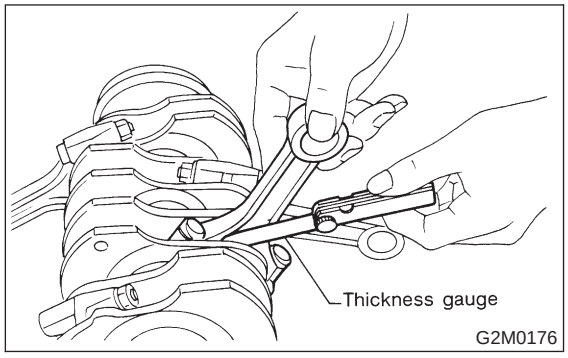
1) Replace connecting rod, if the large or small end thrust surface is damaged.
2) Check for bend or twist using a connecting rod aligner. Replace connecting rod if the bend or twist exceeds the limit.

Limit of bend or twist per 100 mm (3.94 in) in length:
0.10 mm (0.0039 in)



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

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



4) Inspect connecting rod bearing for scar, peeling, seizure, melting, wear, etc.

5) Measure the oil clearance on individual connecting rod bearings by means of plastigauge. If any oil clearance is not within specification, replace the defective bearing with a new one of standard size or undersize as necessary. (See the table.)

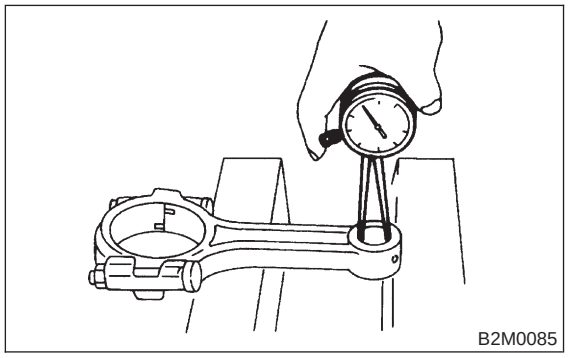
Connecting rod oil clearance:
Standard
0.010 — 0.038 mm (0.0004 — 0.0015 in)
Limit
0.05 mm (0.0020 in)

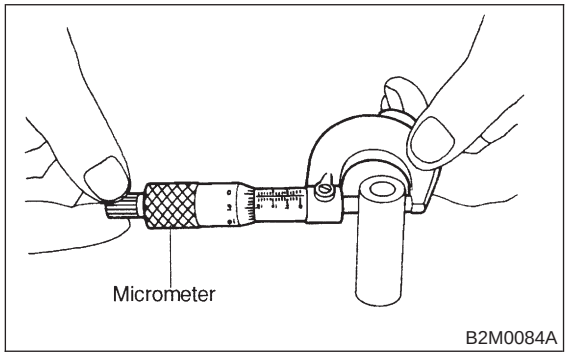
Unit: mm (in)

Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.492 — 1.501 (0.0587 — 0.0591)	47.984 — 48.000 (1.8891 — 1.8898)
0.03 (0.0012) undersize	1.510 — 1.513 (0.0594 — 0.0596)	47.954 — 47.970 (1.8879 — 1.8886)
0.05 (0.0020) undersize	1.520 — 1.523 (0.0598 — 0.0600)	47.934 — 47.950 (1.8872 — 1.8878)
0.25 (0.0098) undersize	1.620 — 1.623 (0.0638 — 0.0639)	47.734 — 47.750 (1.8793 — 1.8799)

6) Inspect bushing at connecting rod small end, and replace if worn or damaged. Also measure the piston pin clearance at the connecting rod small end.

Clearance between piston pin and bushing:
Standard
0 — 0.022 mm (0 — 0.0009 in)
Limit
0.030 mm (0.0012 in)

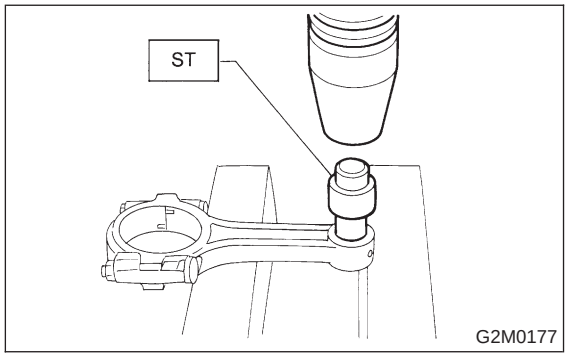

B2M0085



B2M0084A

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

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER



G2M0177

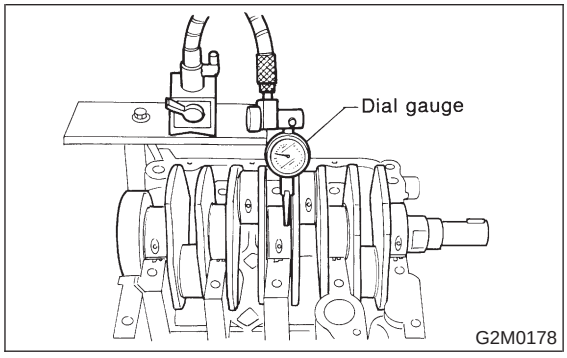
(3) Make two 3 mm (0.12 in) holes in bushing. Ream the inside of bushing.
(4) After completion of reaming, clean bushing to remove chips.

6. CRANKSHAFT AND CRANKSHAFT BEARING

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

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

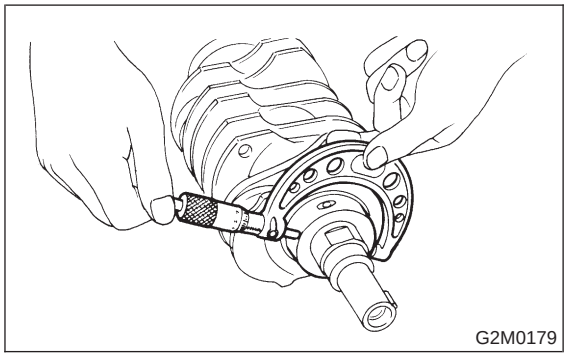
Crankshaft bend limit:
0.035 mm (0.0014 in)



G2M0178

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

Crank pin and crank journal:
Out-of-roundness
0.020 mm (0.0008 in) or less
Taper limit
0.07 mm (0.0028 in)
Grinding limit
0.25 mm (0.0098 in)


G2M0179

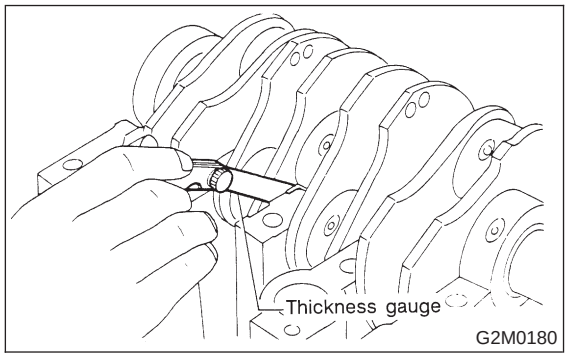
Unit: mm (in)

		Crank journal diameter		Crank pin diameter
		#1, #5	#2, #3, #4	
Standard	Journal O.D.	59.992 — 60.008 (2.3619 — 2.3625)	59.992 — 60.008 (2.3619 — 2.3625)	47.984 — 48.000 (1.8891 — 1.8898)
	Bearing size (Thickness at center)	1.998 — 2.011 (0.0787 — 0.0792)	2.000 — 2.013 (0.0787 — 0.0793)	1.492 — 1.501 (0.0587 — 0.0591)
0.03 (0.0012) undersize	Journal O.D.	59.962 — 59.978 (2.3607 — 2.3613)	59.962 — 59.978 (2.3607 — 2.3613)	47.954 — 47.970 (1.8879 — 1.8886)
	Bearing size (Thickness at center)	2.017 — 2.020 (0.0794 — 0.0795)	2.019 — 2.022 (0.0795 — 0.0796)	1.510 — 1.513 (0.0594 — 0.0596)
0.05 (0.0020) undersize	Journal O.D.	59.942— 59.958 (2.3599 — 2.3605)	59.942 — 59.958 (2.3599 — 2.3605)	47.934 — 47.950 (1.8872 — 1.8878)
	Bearing size (Thickness at center)	2.027 — 2.030 (0.0798 — 0.0799)	2.029 — 2.032 (0.0799 — 0.0800)	1.520 — 1.523 (0.0598 — 0.0600)
0.25 (0.0098) undersize	Journal O.D.	59.742 — 59.758 (2.3520 — 2.3527)	59.742 — 59.758 (2.3520 — 2.3527)	47.734 — 47.750 (1.8793 — 1.8799)
	Bearing size (Thickness at center)	2.127 — 2.130 (0.0837 — 0.0839)	2.129 — 2.132 (0.0838 — 0.0839)	1.620 — 1.623 (0.0638 — 0.0639)

O.D. ... Outer Diameter

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

Crankshaft thrust clearance:
Standard
0.030 — 0.115 mm (0.0012 — 0.0045 in)
Limit
0.25 mm (0.0098 in)



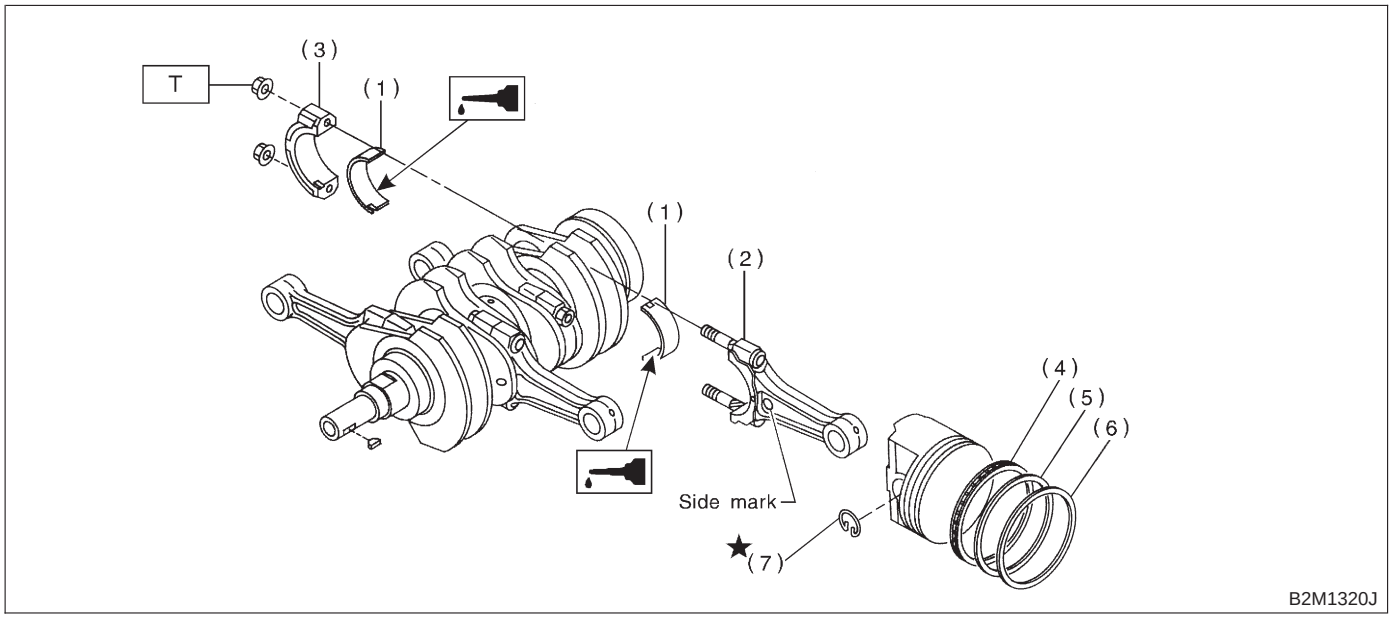
5) Inspect individual crankshaft bearings for signs of flaking, seizure, melting, and wear.
6) Measure the oil clearance on each crankshaft bearing by means of plastigauge. If the measurement is not within the specification, replace defective bearing with an undersize one, and replace or recondition crankshaft as necessary.

Unit: mm (in)

Crankshaft oil clearance		
Standard	#1, #5	0.003 — 0.030 (0.0001 — 0.0012)
	#2, #3, #4	0.010 — 0.033 (0.0004 — 0.0013)
Limit	#1, #3, #5	0.040 (0.0016)
	#2, #4	0.045 (0.0018)

D: ASSEMBLY

1. CRANKSHAFT AND PISTON



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

Tightening torque: N·m (kg-m, ft-lb)
T: 44±2 (4.5±0.2, 32.5±1.4)

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

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

2) Install connecting rod on crankshaft.

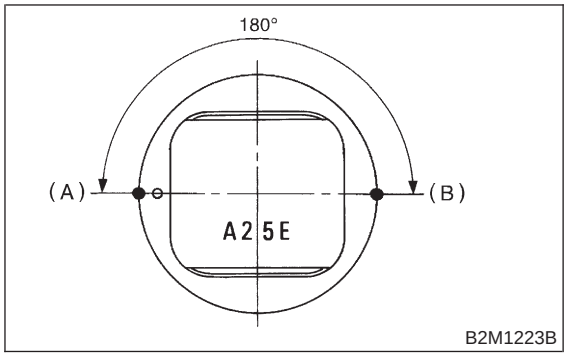
CAUTION:
Position each connecting rod with the side marked facing forward.

3) Install connecting rod cap with connecting rod nut.
Ensure the arrow on connecting rod cap faces the front during installation.

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

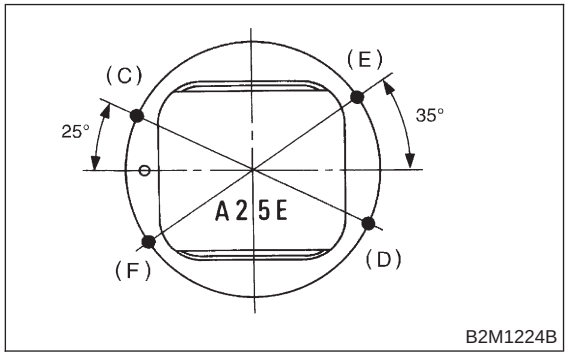
4) Installation of piston rings and oil ring
(1) Install oil ring spacer, upper rail and lower rail in this order by hand. Then install second ring and top ring with a piston ring expander.

(2) Position the top ring gap at (A) or (B) in the figure.



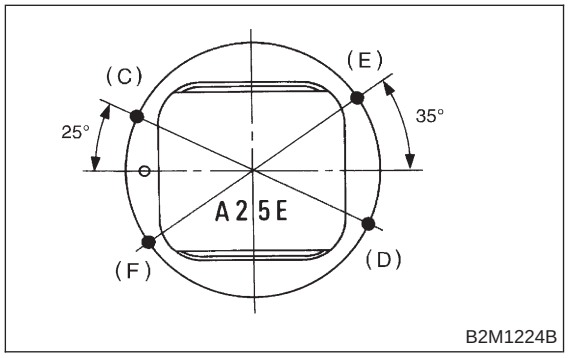
(3) Position the second ring gap at 180° on the reverse side for the top ring gap.

(4) Position the upper rail gap at (C) or (D) in the figure.



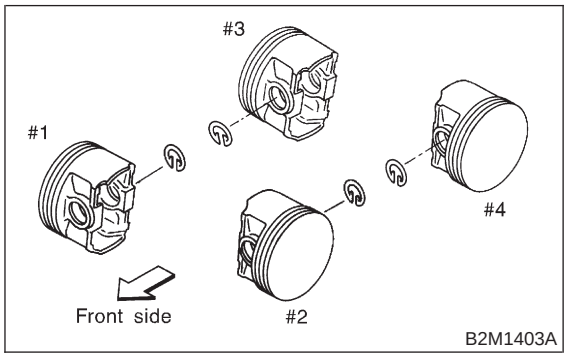
(5) Position the expander gap at 180° of the reverse side for the upper rail gap.
(6) Position the lower rail gap at (E) or (F) in the figure.

CAUTION:
● Ensure ring gaps do not face the same direction.
● Ensure ring gaps are not within the piston skirt area.

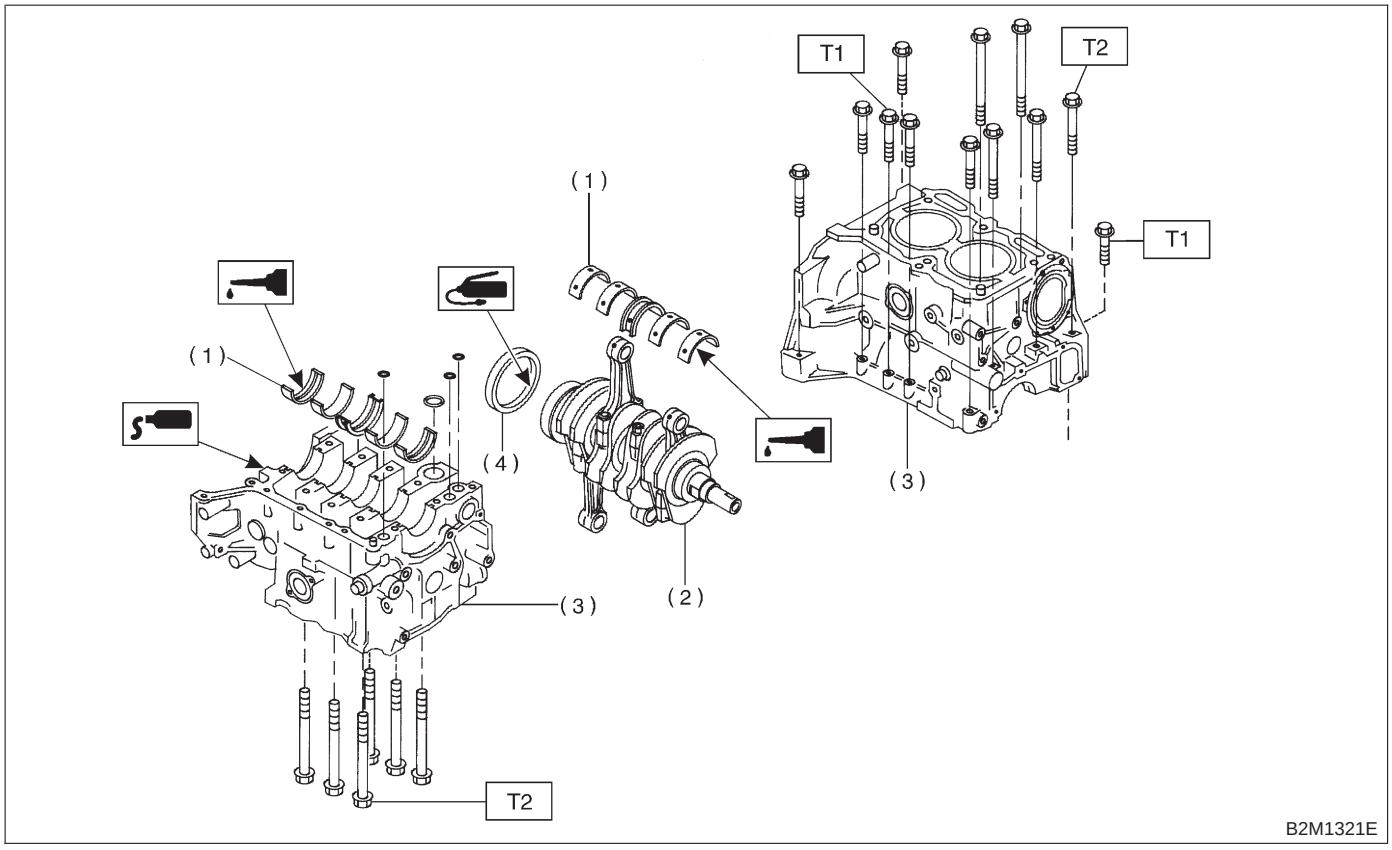


5) Install circlip.
Install circlips in piston holes located opposite service holes in cylinder block, when positioning all pistons in the corresponding cylinders.

CAUTION:
Use new circlips.



2. CYLINDER BLOCK



(1) Crankshaft bearing
(2) Crankshaft
(3) Cylinder block
(4) Rear oil seal

Tightening torque: N·m (kg-m, ft-lb)
T1: 25±2 (2.5±0.2, 18.1±1.4)
T2: 47±3 (4.8±0.3, 34.7±2.2)

1) Install ST to cylinder block, then install crankshaft bearings.
ST 499817000 ENGINE STAND

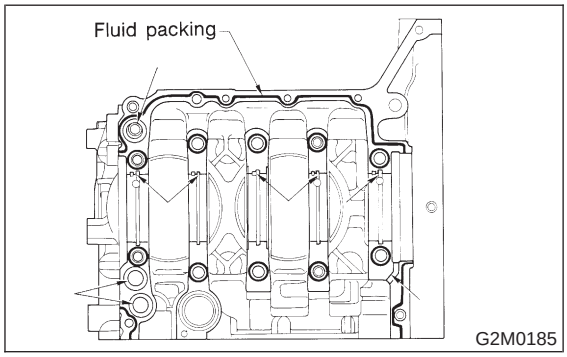
CAUTION:
Remove oil the mating surface of bearing and cylinder block before installation. Also apply a coat of engine oil to crankshaft pins.

2) Position crankshaft on the #2 and #4 cylinder block.

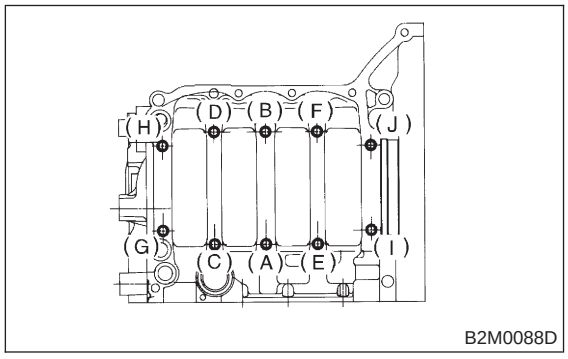
3) Apply fluid packing to the mating surface of #1 and #3 cylinder block, and position it on #2 and #4 cylinder block.

Fluid packing:
THREE BOND 1215 or equivalent

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

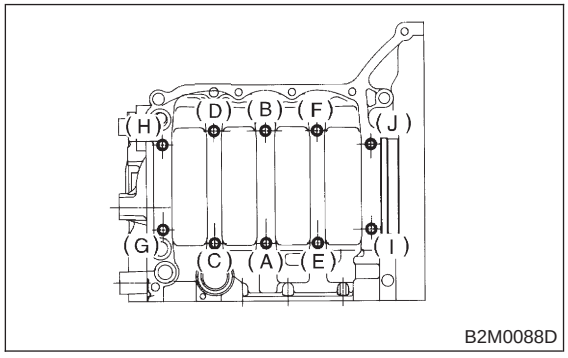


4) Temporarily tighten 10 mm cylinder block connecting bolts in alphabetical sequence shown in figure.



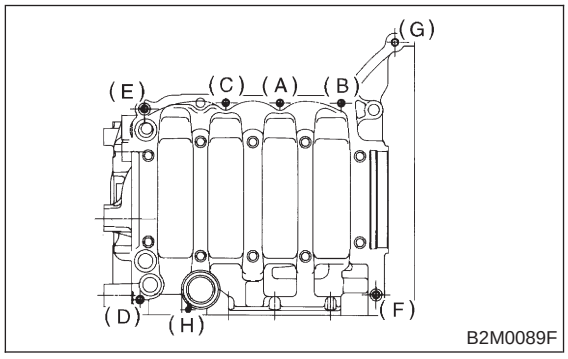
5) Tighten 10 mm cylinder block connecting bolts in alphabetical sequence.

Tightening torque:
47±3 N·m (4.8±0.3 kg-m, 34.7±2.2 ft-lb)

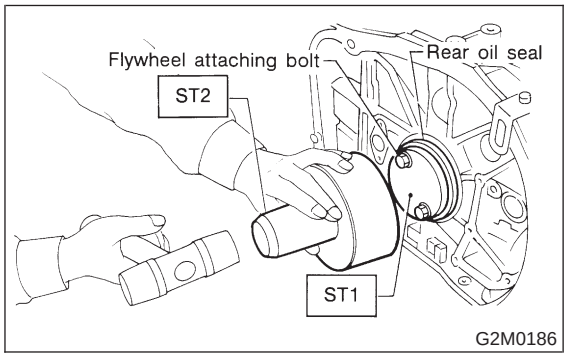


6) Tighten 8 mm and 6 mm cylinder block connecting bolts in alphabetical sequence shown in figure.

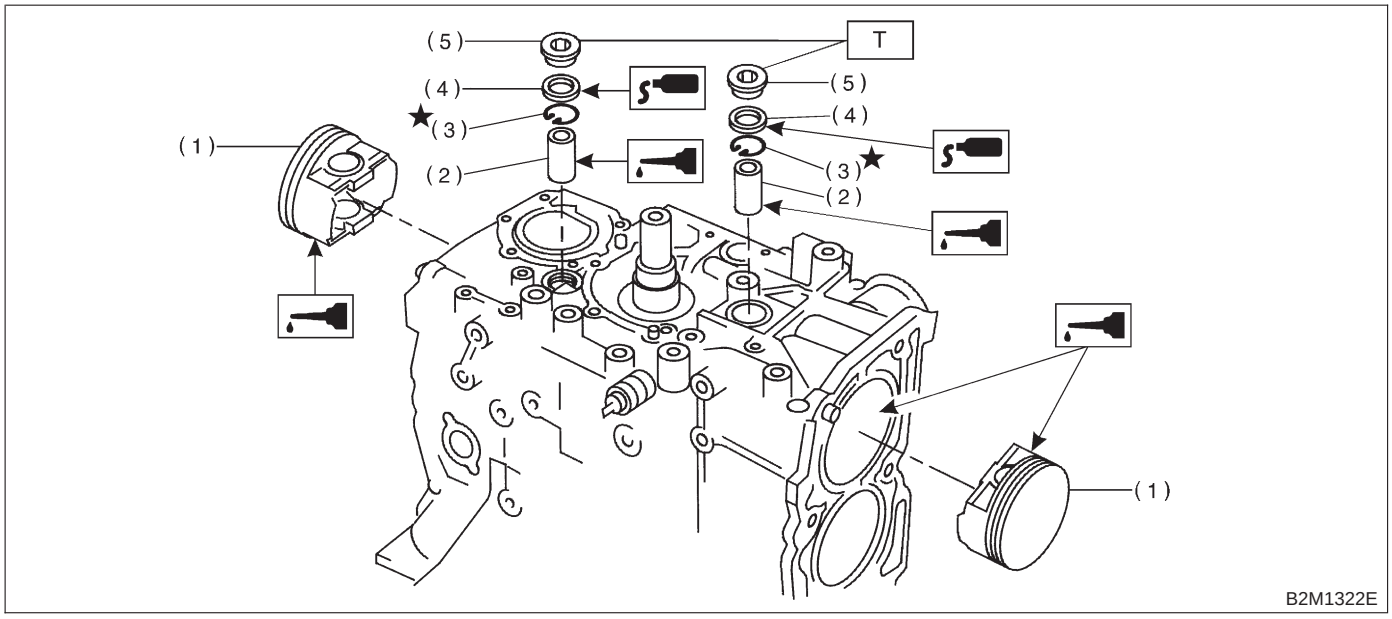
Tightening torque:
(A) — (G): 25±2 N·m (2.5±0.2 kg-m, 18.1±1.4 ft-lb)
(H): 6.4 N·m (0.65 kg-m, 4.7 ft-lb)



7) Install rear oil seal by using ST1 and ST2.
ST1 499597100 OIL SEAL GUIDE
ST2 499587200 OIL SEAL INSTALLER



3. PISTON AND PISTON PIN (#1 AND #2)



(1) Piston
(2) Piston pin
(3) Circlip
(4) Gasket
(5) Service hole plug

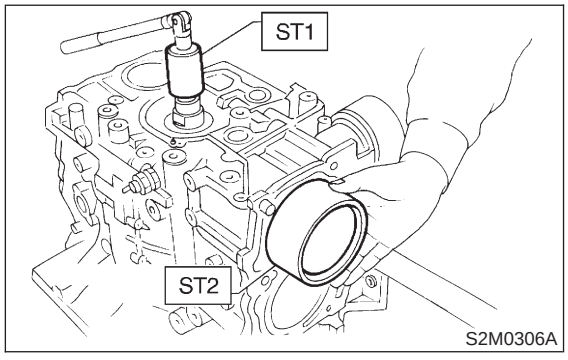
Tightening torque: N·m (kg-m, ft-lb)
T: 69±7 (7.0±0.7, 50.6±5.1)

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

ST1 499987500 CRANKSHAFT SOCKET

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

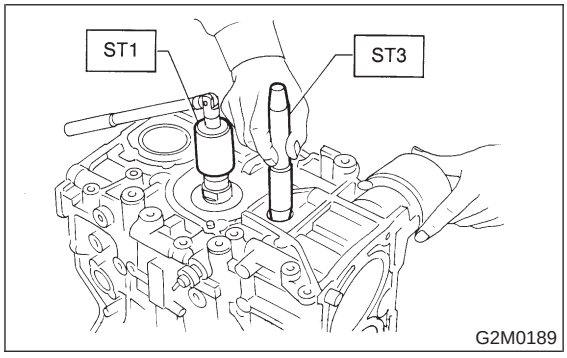
ST2 498747300 PISTON GUIDE



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

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

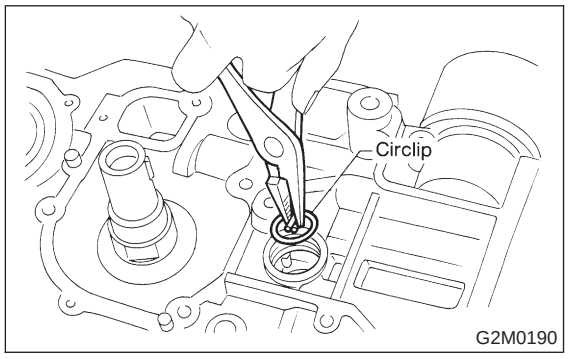
ST3 499017100 PISTON PIN GUIDE



(2) Apply a coat of engine oil to piston pin and insert piston pin into piston and connecting rod through service hole.

(3) Install circlip.

CAUTION:
Use new circlips.

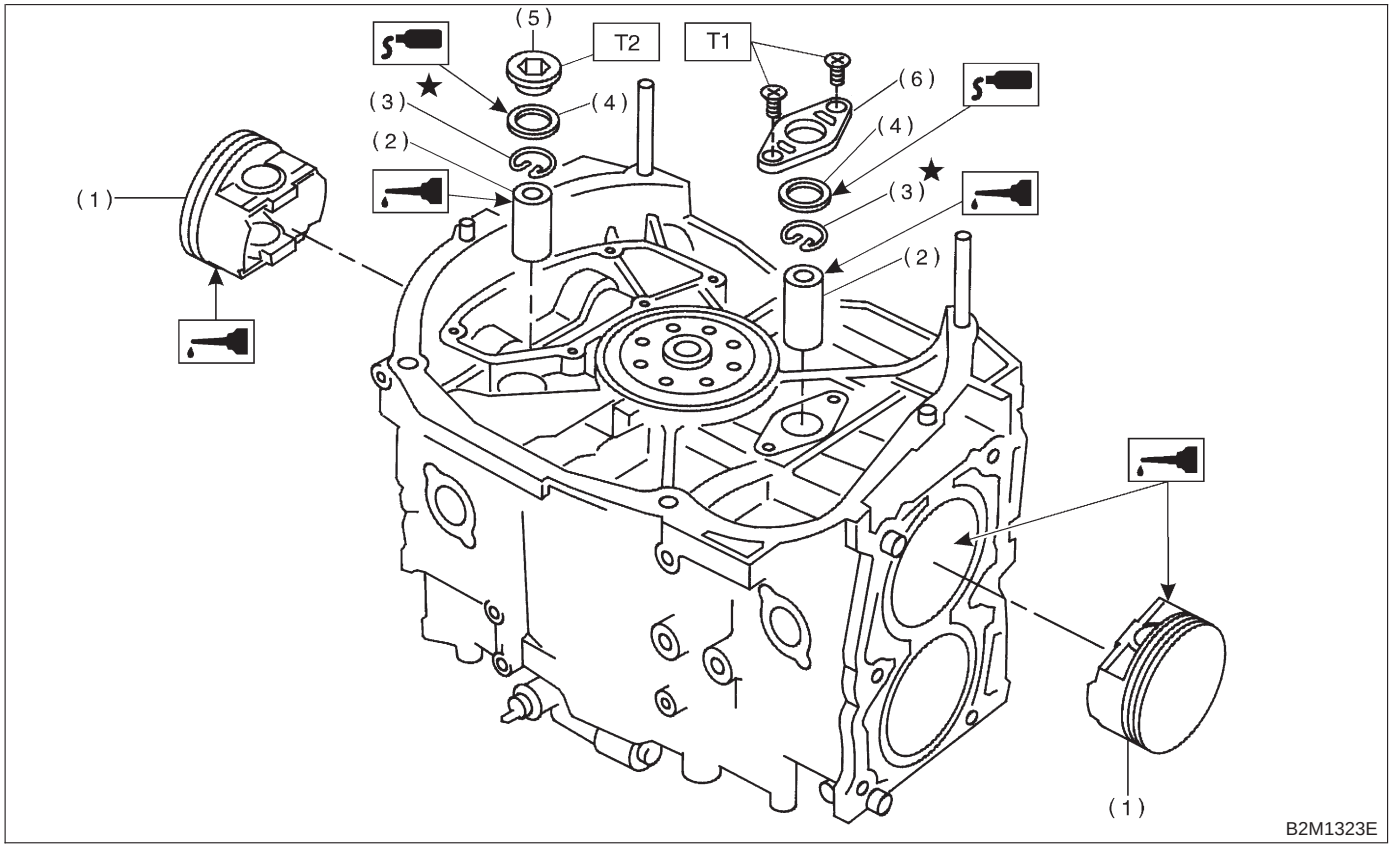


(4) Install service hole plug and gasket.

CAUTION:
Use a new gasket and apply a coat of fluid packing to it before installation.

Fluid packing:
THREE BOND 1215 or equivalent

4. PISTON AND PISTON PIN (#3 AND #4)



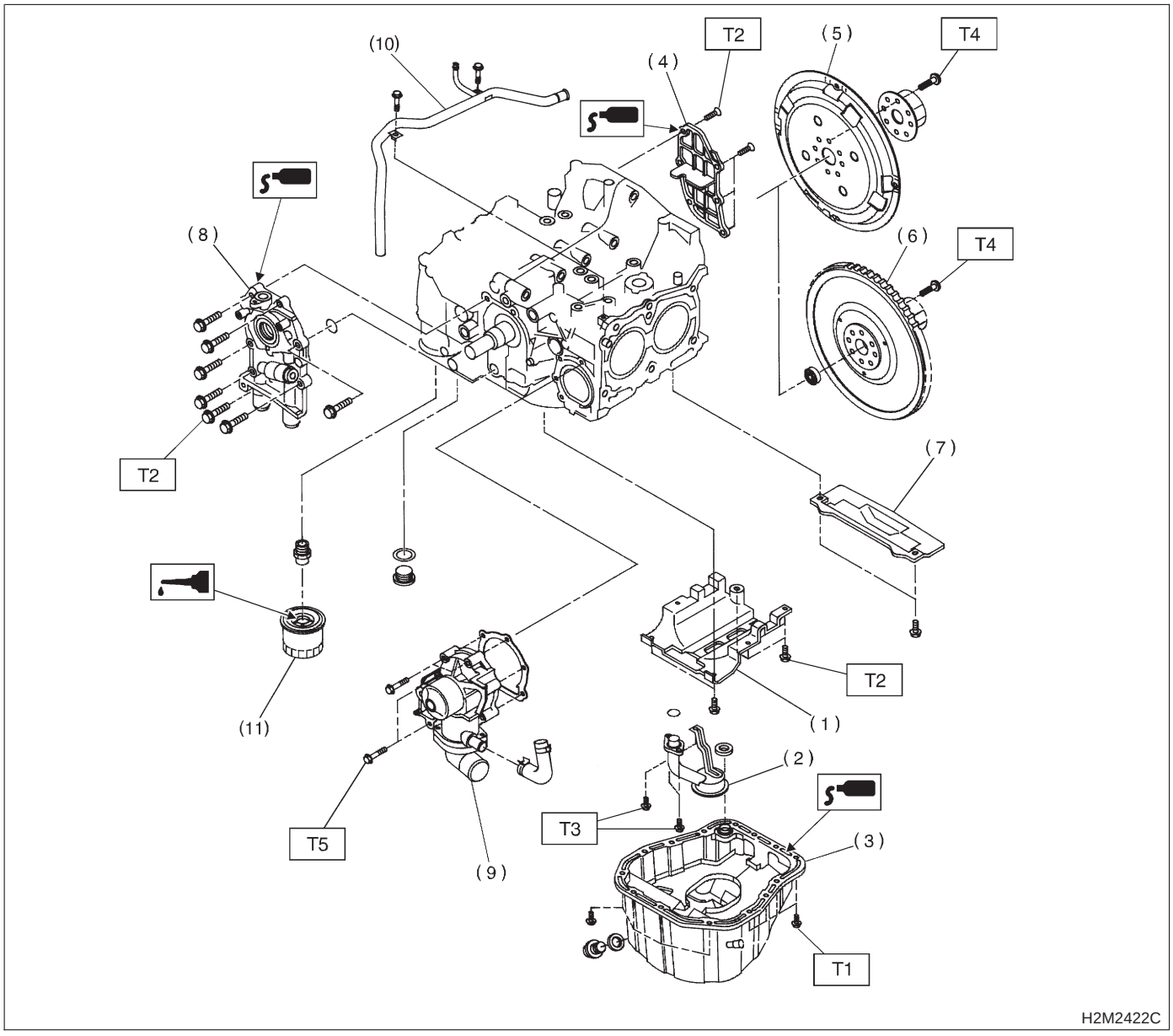
(1) Piston
(2) Piston pin
(3) Circlip
(4) Gasket
(5) Service hole plug
(6) Service hole cover

Tightening torque: N·m (kg-m, ft-lb)
T1: 6.4 (0.65, 4.7)
T2: 69±7 (7.0±0.7, 50.6±5.1)

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

E: INSTALLATION

1. OIL PUMP AND WATER PUMP

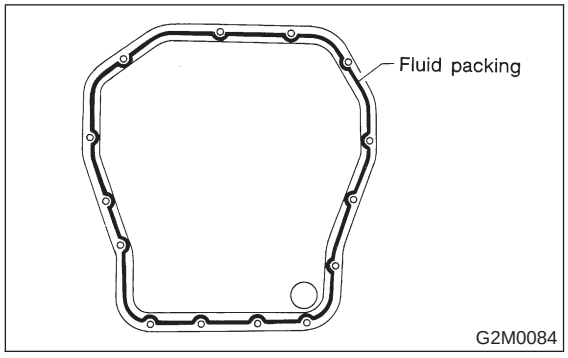


(1) Baffle plate
(2) Oil strainer
(3) Oil pan
(4) Oil separator cover
(5) Drive plate (AT vehicles only)
(6) Flywheel (MT vehicles only)
(7) Clutch housing cover (MT vehicles only)
(8) Oil pump
(9) Water pump
(10) Water by-pass pipe
(11) Oil filter

Tightening torque: N·m (kg-m, ft-lb)
T1: 5 (0.5, 3.6)
T2: 6.4 (0.65, 4.7)
T3: 10 (1.0, 7)
T4: 72±3 (7.3±0.3, 52.8±2.2)
T5: First 12±2 (1.2±0.2, 8.7±1.4)
Second 12±2 (1.2±0.2, 8.7±1.4)

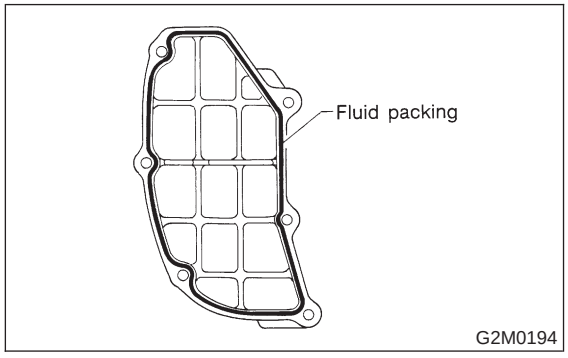
1) Install baffle plate.
2) Install oil strainer and O-ring.
3) Install oil strainer stay.
4) Apply fluid packing to matching surfaces and install oil pan.

Fluid packing:
THREE BOND 1215 or equivalent

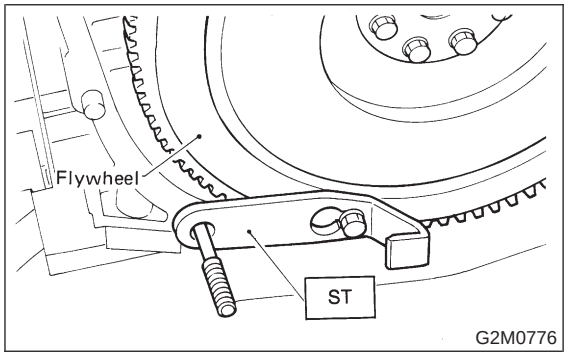


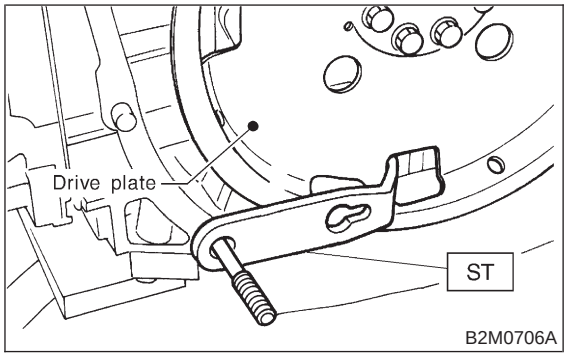
5) Apply fluid packing to matching surfaces and install oil separator cover.

Fluid packing:
THREE BOND 1215 or equivalent

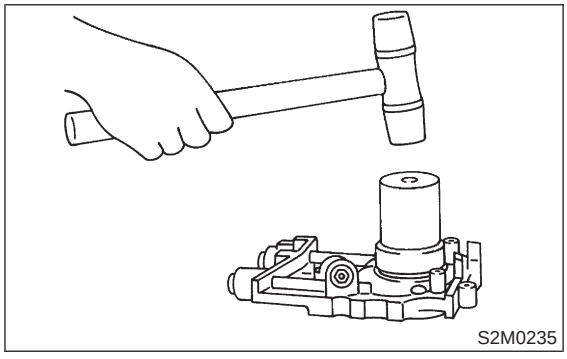


6) Install flywheel (MT vehicles only) or drive plate (AT vehicles only).
To lock crankshaft, use ST.
ST 498497100 CRANKSHAFT STOPPER



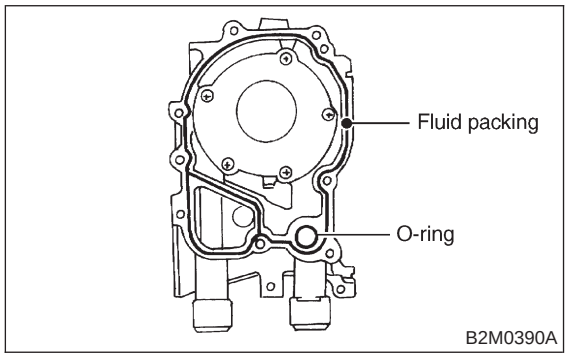


7) Install clutch housing cover. (MT vehicles only)
8) Installation of oil pump
(1) Discard front oil seal after removal. Replace with a new one by using ST.
ST 499587100 OIL SEAL INSTALLER



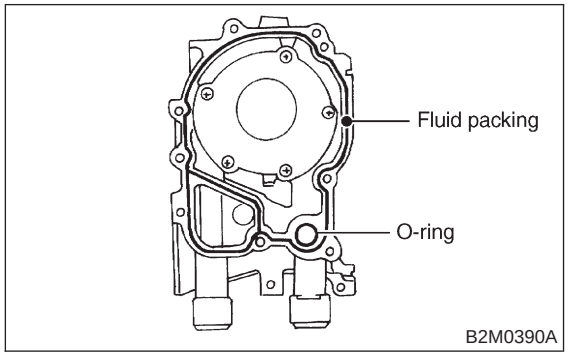
(2) Apply fluid packing to matching surface of oil pump.

Fluid packing:
THREE BOND 1215 or equivalent



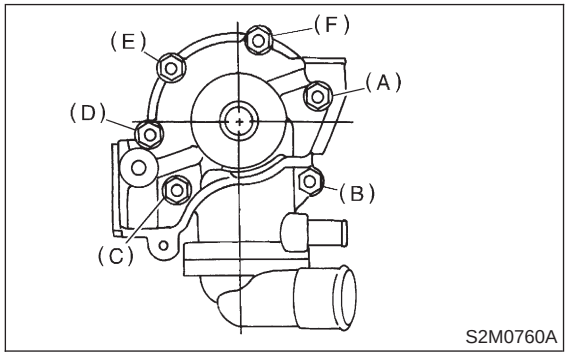
(3) Install oil pump on cylinder block. Be careful not to damage oil seal during installation.

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



9) Install water pump and gasket.

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

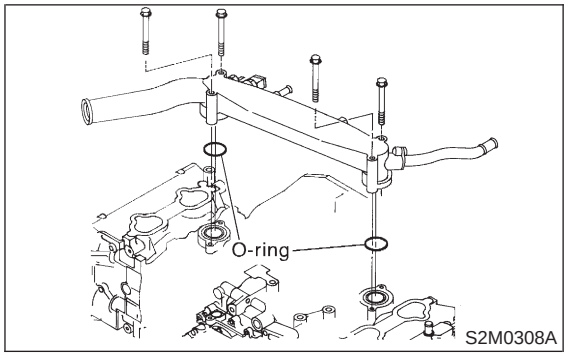


10) Install water by-pass pipe for heater.
11) Install oil filter.

2. RELATED PARTS

1) Install water pipe. <Ref. to 2-5 [W8B0].>

CAUTION:
Always use a new O-ring.



2) Install cylinder heads.
<Ref. to 2-3b [W4E0].>
3) Install camshafts, rocker cover and related parts.
<Ref. to 2-3b [W3C0].>
4) Install camshaft sprockets, timing belt and related parts.
<Ref. to 2-3b [W2C0].>

1. Engine Trouble in General

NOTE:
A, B and C shown in the RANK of table refer to the possibility of reason for the trouble in order (“Very often” to “Rarely”).

A : Very often
B : Sometimes
C : Rarely

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
1. Engine will not start.			
1) Starter does not turn.	● Starter	● Defective battery-to-starter harness	B
		● Defective starter switch	C
		● Defective inhibitor switch or neutral switch	C
		● Defective starter	B
	● Battery	● Poor terminal connection	A
		● Run-down battery	A
		● Defective charging system	B
	● Friction	● Seizure of crankshaft and connecting rod bearing	C
		● Seized camshaft	C
		● Seized or stuck piston and cylinder	C
2) Initial combustion does not occur.	● Starter	● Defective starter	C
	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Fuel line	● Defective fuel pump and relay	A
		● Lack of or insufficient fuel	B
	● Belt	● Defective	B
		● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	B
		● Improper engine oil (low viscosity)	B
3) Initial combustion occurs.	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
	● Fuel line	● Defective fuel pump and relay	C
		● Clogged fuel line	C
		● Lack of/or insufficient fuel	B
	● Belt	● Defective	B
		● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	B
		● Improper engine oil (low viscosity)	B

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
4) Engine stalls after initial combustion.	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Loosened or cracked intake duct	B
		● Loosened or cracked PCV hose	C
		● Loosened or cracked vacuum hose	C
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Dirty air cleaner element	C
	● Fuel line	● Clogged fuel line	C
		● Lack of or insufficient fuel	B
	● Belt	● Defective	B
		● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	B
		● Improper engine oil (low viscosity)	B
2. Rough idle and engine stall	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Loosened or cracked intake duct	A
		● Loosened or cracked PCV hose	A
		● Loosened or cracked vacuum hose	A
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Defective PCV valve	C
		● Loosened oil filler cap	B
		● Dirty air cleaner element	C
	● Fuel line	● Defective fuel pump and relay	C
		● Clogged fuel line	C
		● Lack of/or insufficient fuel	B
	● Belt	● Defective timing	C
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	B
		● Loosened cylinder head bolts or defective gasket	B
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	B
		● Incorrect valve timing	A
		● Improper engine oil (low viscosity)	B
	● Lubrication system	● Incorrect oil pressure	B
		● Defective rocker cover gasket	C
	● Cooling system	● Overheating	C
	● Others	● Malfunction of evaporative emission control system	A
		● Stuck or damaged throttle valve	B
		● Accelerator cable out of adjustment	C

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
3. Low output, hesitation and poor acceleration	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Loosened or cracked intake duct	A
		● Loosened or cracked PCV hose	A
		● Loosened or cracked vacuum hose	B
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Defective PCV valve	B
		● Loosened oil filler cap	B
		● Dirty air cleaner element	A
	● Fuel line	● Defective fuel pump and relay	B
		● Clogged fuel line	B
		● Lack of/or insufficient fuel	C
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	B
		● Loosened cylinder head bolts or defective gasket	B
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken valve spring	B
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	A
		● Improper engine oil (low viscosity)	B
	● Lubrication system	● Incorrect oil pressure	B
	● Cooling system	● Overheating	C
		● Over cooling	C
	● Others	● Malfunction of evaporative emission control system	A
4. Surging	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Loosened or cracked intake duct	A
		● Loosened or cracked PCV hose	A
		● Loosened or cracked vacuum hose	A
		● Defective intake manifold gasket	B
		● Defective throttle body gasket	B
		● Defective PCV valve	B
		● Loosened oil filler cap	B
		● Dirty air cleaner element	B
	● Fuel line	● Defective fuel pump and relay	B
		● Clogged fuel line	B
		● Lack of/or insufficient fuel	C
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	C
		● Defective valve stem	C
		● Worn or broken valve spring	C
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	A
		● Improper engine oil (low viscosity)	B
	● Cooling system	● Overheating	B
	● Others	● Malfunction of evaporative emission control system	C

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
5. Engine does not return to idle.	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Loosened or cracked vacuum hose	A
	● Others	● Stuck or damaged throttle valve	A
		● Accelerator cable out of adjustment	B
6. Dieseling (Run-on)	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Cooling system	● Overheating	B
	● Others	● Accelerator cable out of adjustment	B
7. After burning in exhaust system	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Loosened or cracked intake duct	C
		● Loosened or cracked PCV hose	C
		● Loosened or cracked vacuum hose	B
		● Defective PCV valve	B
		● Loosened oil filler cap	C
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken valve spring	C
		● Worn or stuck piston rings, cylinder and piston	C
		● Incorrect valve timing	A
	● Lubrication system	● Incorrect oil pressure	C
	● Cooling system	● Over cooling	C
	● Others	● Malfunction of evaporative emission control system	C
8. Knocking	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Loosened oil filler cap	B
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	C
		● Incorrect valve timing	B
	● Cooling system	● Overheating	A
9. Excessive engine oil consumption	● Intake system	● Loosened or cracked PCV hose	A
		● Defective PCV valve	B
		● Loosened oil filler cap	C
	● Compression	● Defective valve stem	A
		● Worn or stuck piston rings, cylinder and piston	A
	● Lubrication system	● Loosened oil pump attaching bolts and defective gasket	B
		● Defective oil filter seal	B
		● Defective crankshaft oil seal	B
		● Defective rocker cover gasket	B
		● Loosened oil drain plug or defective gasket	B
		● Loosened oil pan fitting bolts or defective oil pan	B

TROUBLE	PROBLEM PARTS, ETC.	POSSIBLE CAUSE	RANK
10. Excessive fuel consumption	● Fuel injection system <Ref. to 2-7 On-Board Diagnostics II System.>		A
	● Intake system	● Dirty air cleaner element	A
	● Belt	● Defective timing	B
	● Compression	● Incorrect valve clearance	B
		● Loosened spark plugs or defective gasket	C
		● Loosened cylinder head bolts or defective gasket	C
		● Improper valve seating	B
		● Defective valve stem	C
		● Worn or broken spring	C
		● Worn or stuck piston rings, cylinder and piston	B
		● Incorrect valve timing	B
	● Lubrication system	● Incorrect oil pressure	C
	● Cooling system	● Over cooling	C
	● Others	● Accelerator cable out of adjustment	B

2. Engine Noise

If noise still exists, conduct diagnostics procedures in accordance with the following table.

CAUTION:
Do not disconnect spark plug cord while engine is running.

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	Valve mechanism is defective. ● Incorrect valve clearance ● Worn camshaft ● Broken valve spring
Heavy and dull clank	Oil pressure is low.	● Worn crankshaft main bearing ● Worn connecting rod bearing (big end)
	Oil pressure is normal.	● Loose flywheel mounting bolts ● Damaged engine mounting
High-pitched clank (Spark knock)	Sound is noticeable when accelerating with an overload.	● Ignition timing advanced ● Accumulation of carbon inside combustion chamber ● Wrong spark plug ● Improper gasoline
Clank when engine speed is medium (1,000 to 2,000 rpm).	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. (NOTE*)	● Worn crankshaft main bearing ● Worn bearing at crankshaft end of connecting rod
Knocking sound when engine is operating under idling speed and engine is warm.	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. (NOTE*)	● Worn cylinder liner and piston ring ● Broken or stuck piston ring ● Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. (NOTE*)	● Unusually worn valve lifter ● Worn camshaft journal bore in crankcase
Squeaky sound	—	● Insufficient generator lubrication
Rubbing sound	—	● Defective generator brush and rotor contact
Gear scream when starting engine	—	● Defective ignition starter switch ● Worn gear and starter pinion
Sound like polishing glass with a dry cloth	—	● Loose drive belt ● Defective engine coolant pump shaft
Hissing sound	—	● Loss of compression ● Air leakage in air intake system, hoses, connections or manifolds
Timing belt noise	—	● Loose timing belt ● Belt contacting case/adjacent part
Valve tappet noise	—	● Incorrect valve clearance

NOTE*:
When disconnecting fuel injector connector, Malfunction Indicator Lamp (CHECK ENGINE lamp) illuminates and trouble code is stored in ECM memory.
Therefore, carry out the CLEAR MEMORY MODE and INSPECTION MODE after connecting fuel injector connector. (Ref. to 2-7 On-Board Diagnostics II System.)