

ENGINE (DOHC) *2-3b*

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1. Engine

A: SPECIFICATIONS

Engine	Type		Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve arrangement		Belt driven, double overhead camshaft, 4-valve/cylinder
	Bore x Stroke	mm (in)	92 x 75 (3.62 x 2.95)
	Piston displacement	cm ³ (cu in)	1,994 (121.67)
	Compression ratio		8.0
	Compression pressure (at 200 — 300 rpm)	kPa (kg/cm ² , psi)	981 — 1,177 (10 — 12, 142 — 171)
	Number of piston rings		Pressure ring: 2, Oil ring: 1
	Intake valve timing	Opening	6° BTDC
		Closing	56° ABDC
	Exhaust valve timing	Opening	55° BBDC
		Closing	11° ATDC
	Idling speed [At neutral or position]	rpm	900 ± 100 (No load)
	Firing order		1 → 3 → 2 → 4
	Ignition timing	BTDC/rpm	18° ± 10°/900

B: SERVICE DATA

Belt tension adjuster	Protrusion of adjuster rod			15.4 — 16.4 mm	(0.606 — 0.646 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			0.20 mm	(0.0079 in)	
	Thrust clearance	STD	0.015 — 0.070 mm	(0.0006 — 0.0028 in)		
		Limit	0.10 mm	(0.0039 in)		
	Cam lobe height	Intake	STD	41.78 — 41.88 mm	(1.6449 — 1.6488 in)	
			Limit	41.62 mm	(1.6386 in)	
		Exhaust	STD	41.78 — 41.88 mm	(1.6449 — 1.6488 in)	
			Limit	41.62 mm	(1.6386 in)	
	Journal O.D.	STD	Front	31.946 — 31.963 mm	(1.2577 — 1.2584 in)	
			Center rear	27.946 — 27.963 mm	(1.1002 — 1.1009 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	93.3 mm	(3.673 in)		
Exhaust		93.6 mm	(3.685 in)			

STD: Standard I.D.: Inner diameter O.D.: Outer diameter

Valve spring	Free length			39.8 mm (1.567 in)		
	Squareness			2.5°, 1.7 mm (0.067 in)		
	Tension/spring height		Set	228.5 — 261.8 N (23.3 — 26.7 kg, 51.4 — 58.9 lb)/31 mm (1.22 in)		
			Lift	462.9 — 531.5 N (47.2 — 54.2 kg, 104.1 — 119.5 lb)/23.2 mm (0.913 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		A	92.005 — 92.015 mm (3.6222 — 3.6226 in)		
			B	91.995 — 92.005 mm (3.6218 — 3.6222 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	0.010 — 0.030 mm (0.0004 — 0.0012 in)		
			Limit	0.060 mm (0.0024 in)		
Enlarging (boring) limit			0.5 mm (0.020 in)			
Piston	Outer diameter		STD	A	91.985 — 91.995 mm (3.6214 — 3.6218 in)	
				B	91.975 — 91.985 mm (3.6211 — 3.6214 in)	
			0.25 mm (0.0098 in) OS		92.225 — 92.235 mm (3.6309 — 3.6313 in)	
			0.50 mm (0.0197 in) OS		92.475 — 92.485 mm (3.6407 — 3.6411 in)	
	Standard inner diameter of piston pin hole			23.000 — 23.006 mm (0.9055 — 0.9057 in)		
Piston pin	Outer diameter			22.994 — 23.000 mm (0.9053 — 0.9055 in)		
	Standard clearance between piston pin and hole in piston			0.001 — 0.013 mm (0.00004 — 0.00051 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 — 0.26 mm (0.0079 — 0.0102 in)	
				Limit	0.5 mm (0.020 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 — 0.70 mm (0.0079 — 0.0276 in)		
			Limit	1.5 mm (0.059 in)		
	Clearance between piston ring and piston ring groove		Top ring	STD	0.040 — 0.080mm (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)		

STD: Standard OS: Oversize

SPECIFICATIONS AND SERVICE DATA

[S1B0] 2-3b

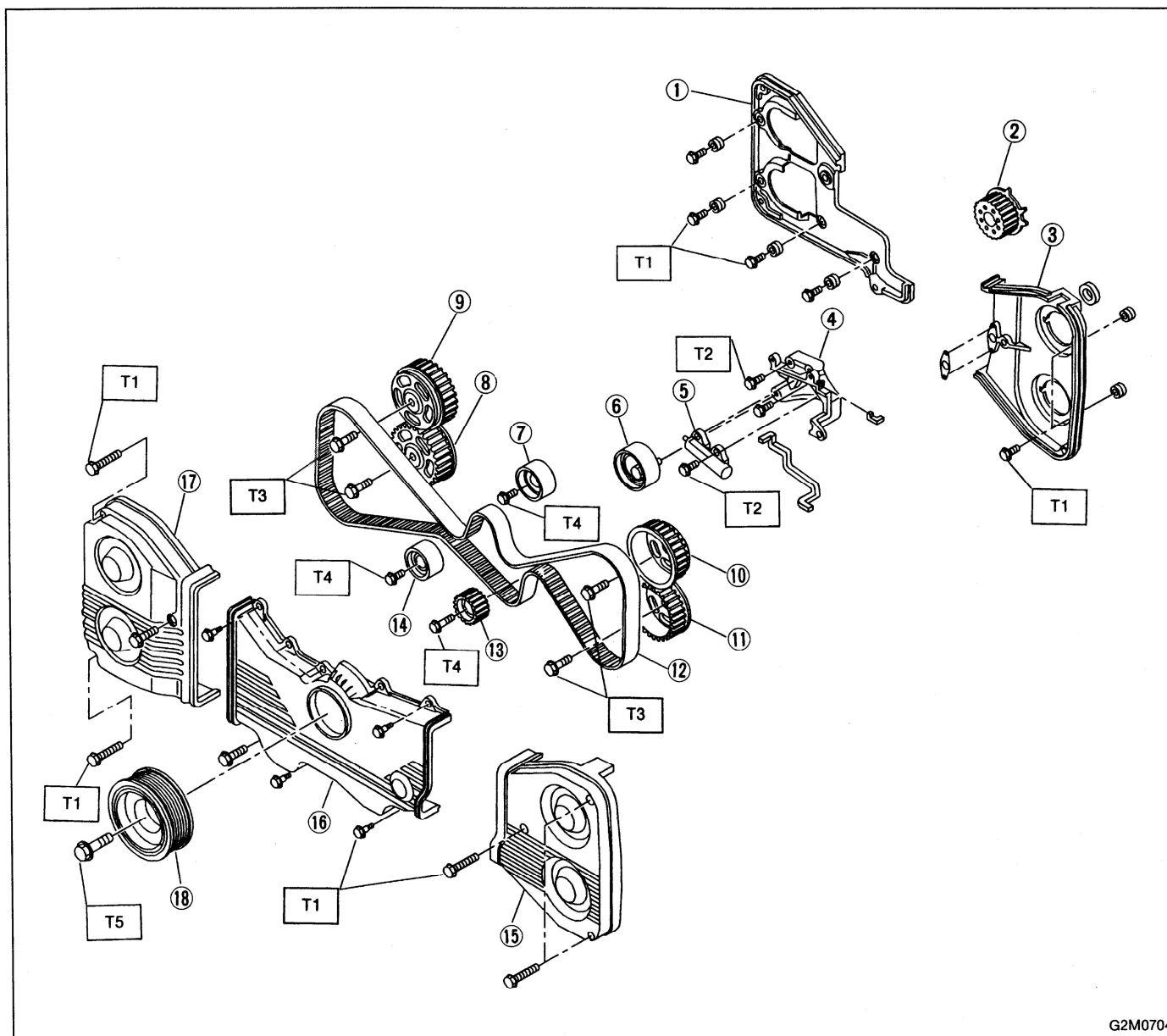
1. Engine

Connecting rod bearing	Oil clearance		STD	0.025 — 0.055 mm	(0.0010 — 0.0022 in)
			Limit	0.06 mm	(0.0024 in)
	Thickness at center portion	STD		1.487 — 1.496 mm	(0.0585 — 0.0589 in)
		0.03 mm (0.0012 in) US		1.505 — 1.508 mm	(0.0593 — 0.0594 in)
		0.05 mm (0.0020 in) US		1.515 — 1.518 mm	(0.0596 — 0.0598 in)
		0.25 mm (0.0098 in) US		1.615 — 1.618 mm	(0.0636 — 0.0637 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)
	Crankpin and crank journal	Out-of roundness		0.030 mm (0.0012 in) or less	
		Grinding limit		0.250 mm	(0.0098 in)
	Crankpin outer diameter	STD		51.984 — 52.000 mm	(2.0466 — 2.0472 in)
		0.03 mm (0.0012 in) US		51.954 — 51.970 mm	(2.0454 — 2.0461 in)
		0.05 mm (0.0020 in) US		51.934 — 51.950 mm	(2.0446 — 2.0453 in)
		0.25 mm (0.0098 in) US		51.734 — 51.750 mm	(2.0368 — 2.0374 in)
	Crank journal outer diameter	STD		59.984 — 60.000 mm	(2.3616 — 2.3622 in)
		0.03 mm (0.0012 in) US		59.954 — 59.970 mm	(2.3604 — 2.3610 in)
		0.05 mm (0.0020 in) US		59.934 — 59.950 mm	(2.3596 — 2.3602 in)
		0.25 mm (0.0098 in) US		59.734 — 59.750 mm	(2.3517 — 2.3524 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	0.010 — 0.030 mm	(0.0004 — 0.0012 in)
			Limit	0.040 mm	(0.0016 in)
		#2, #3, #4	STD	0.010 — 0.030 mm	(0.0004 — 0.0012 in)
			Limit	0.035 mm	(0.0014 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)

STD: Standard US: Under size

COMPONENT PARTS

1. Timing Belt



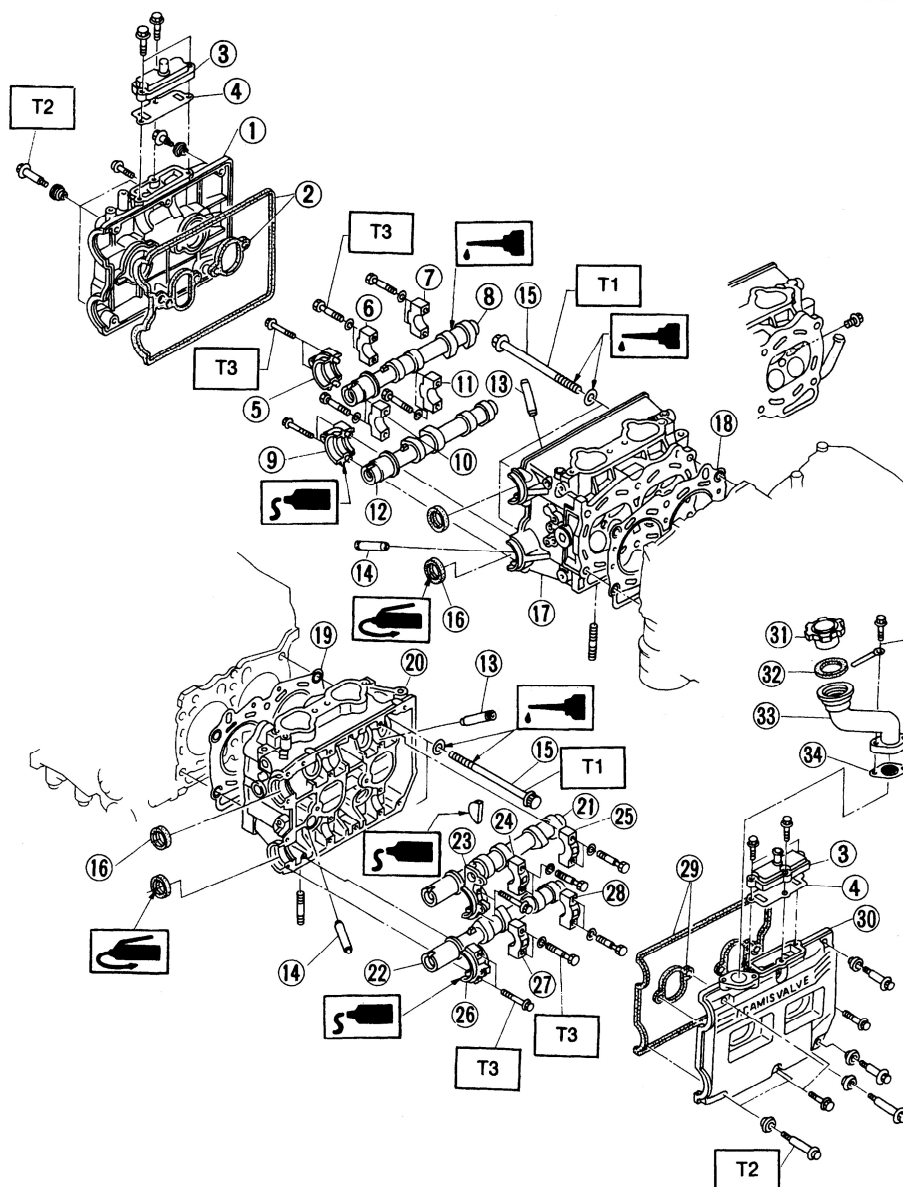
G2M0704

- ① Right-hand belt cover No. 2
- ② Crankshaft sprocket
- ③ Left-hand belt cover No. 2
- ④ Tensioner bracket
- ⑤ Tensioner adjuster
- ⑥ Belt tensioner
- 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: 25 ± 2 (2.5 ± 0.2 , 18.1 ± 1.4)****T3: 39 ± 4 (4.0 ± 0.4 , 28.9 ± 2.9)****T4: 78 ± 5 (8.0 ± 0.5 , 57.9 ± 3.6)****T5: 98 ± 5 (10.0 ± 0.5 , 72.3 ± 3.6)**

2. Cylinder Head and Camshaft



G2M0705

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

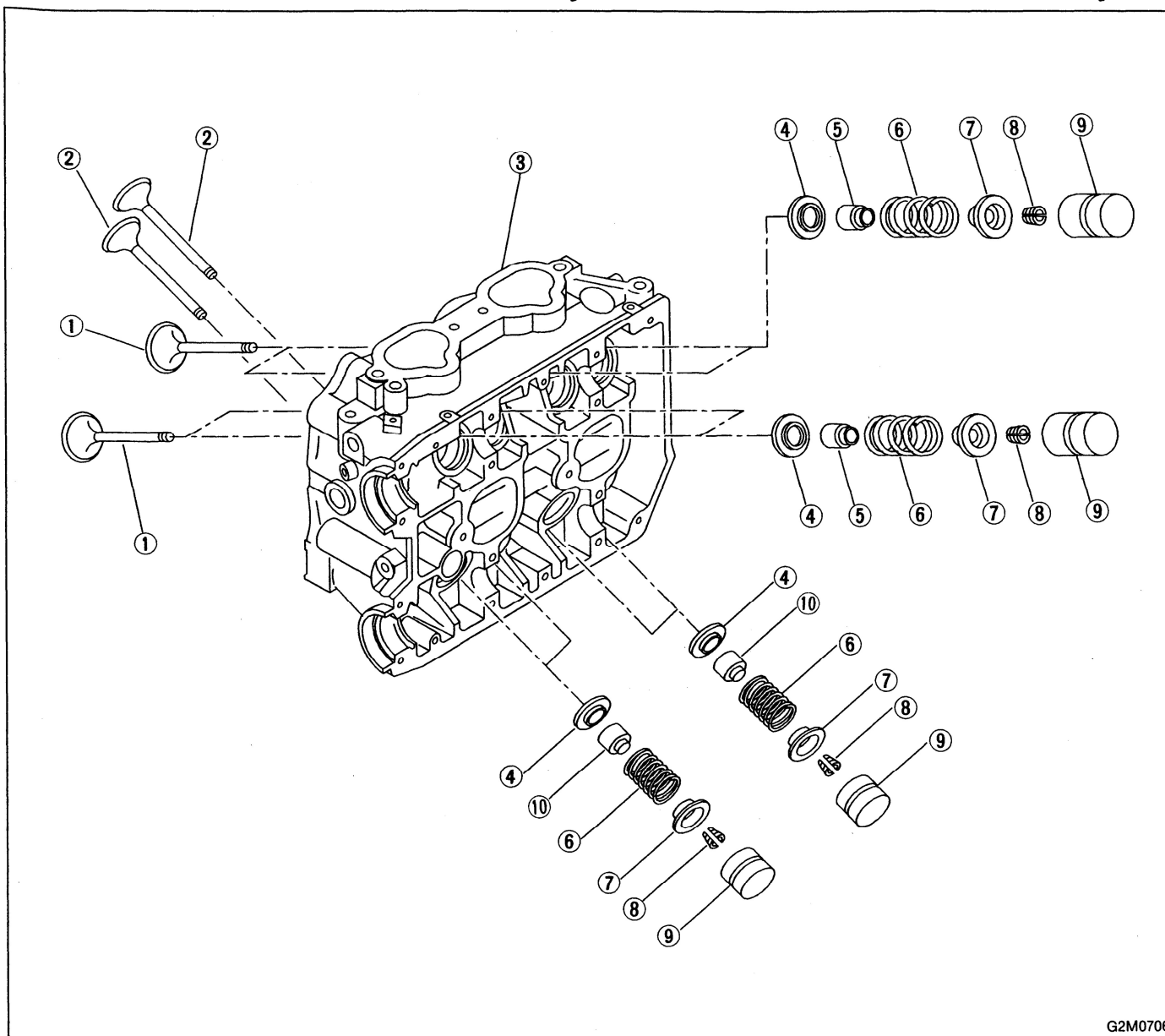
Tightening torque: N·m (kg-m, ft-lb)

T1: Refer to [W5E1].

T2: 5 (0.5, 3.6)

T3: 10 (1.0, 7)

3. Cylinder Head and Valve Assembly



G2M0706

- 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

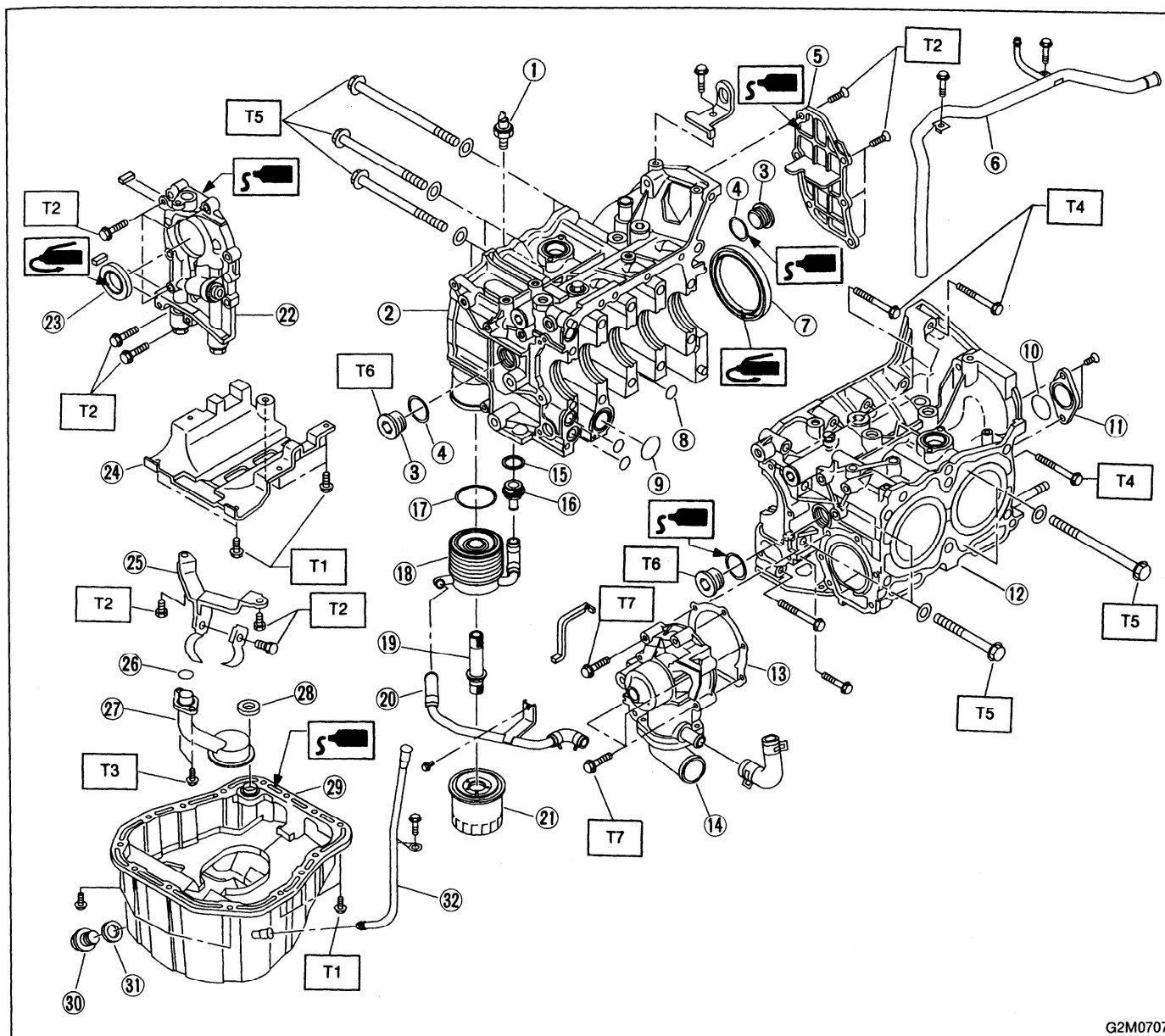
- ⑨ Hydraulic lash adjuster
- ⑩ Exhaust valve oil seal

Tightening torque: N·m (kg-m, ft-lb)

T1: 5 (0.5, 3.6)

T2: 12 (1.2, 9)

4. Cylinder Block



- ① Oil pressure switch
- ② Right-hand cylinder block
- ③ Service hole plug
- ④ Metal gasket
- ⑤ Oil separator cover
- ⑥ Engine coolant pipe A
- ⑦ Rear oil seal
- ⑧ O-ring
- ⑨ O-ring
- ⑩ O-ring
- ⑪ Service hole cover
- ⑫ Left-hand cylinder block
- ⑬ Gasket
- ⑭ Engine coolant pump
- ⑮ Metal gasket

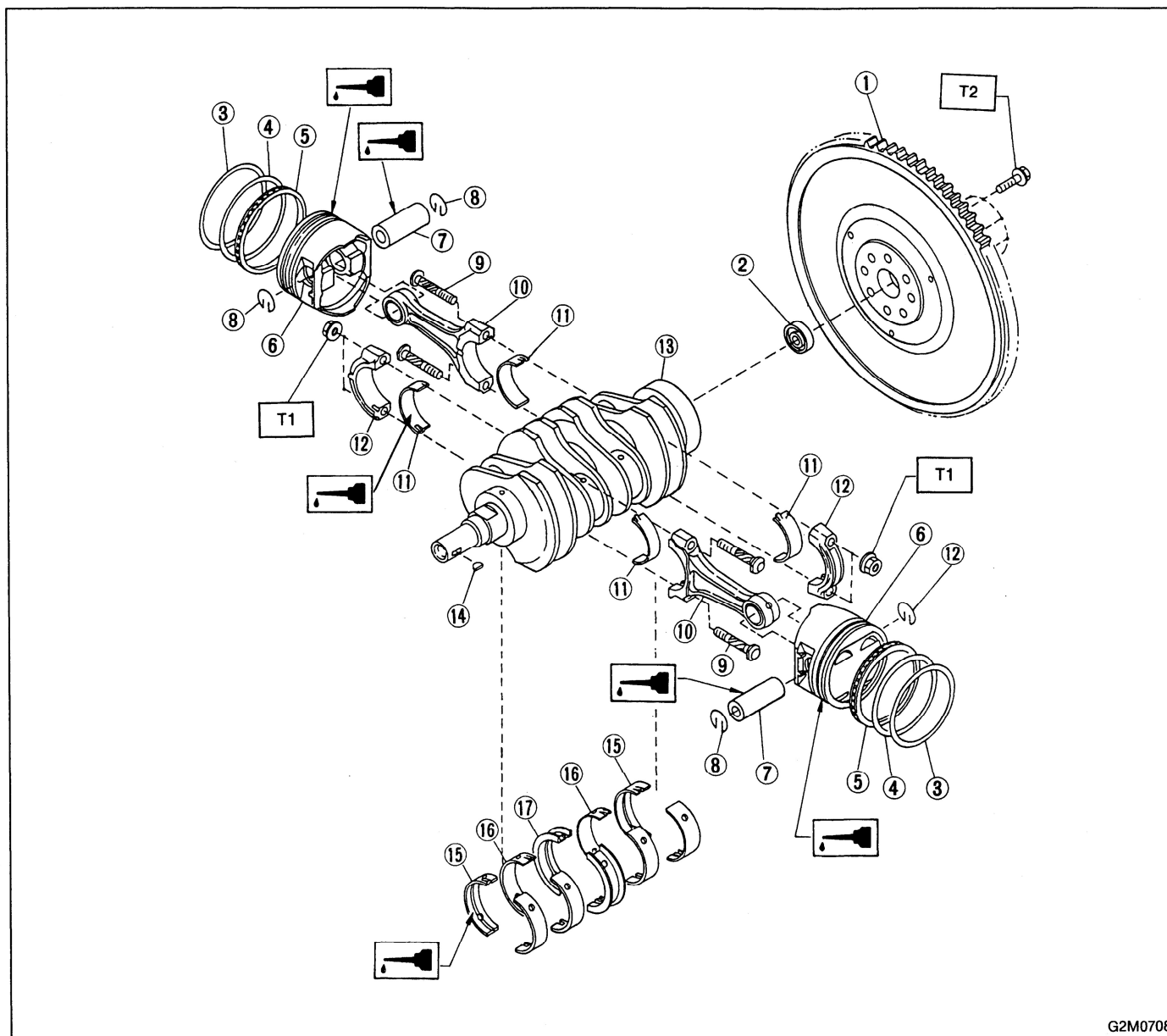
- ⑯ Joint plug
- ⑰ O-ring
- ⑱ Oil cooler
- ⑲ Connector
- ⑳ Engine coolant pipe B
- ㉑ Oil cleaner
- ㉒ Oil pump
- ㉓ Front oil seal
- ㉔ Baffle plate
- ㉕ Oil strainer stay
- ㉖ O-ring
- ㉗ Oil strainer
- ㉘ Gasket
- ㉙ Oil pan
- ㉚ Oil drain plug

- ㉛ Metal gasket
- ㉜ 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



G2M0708

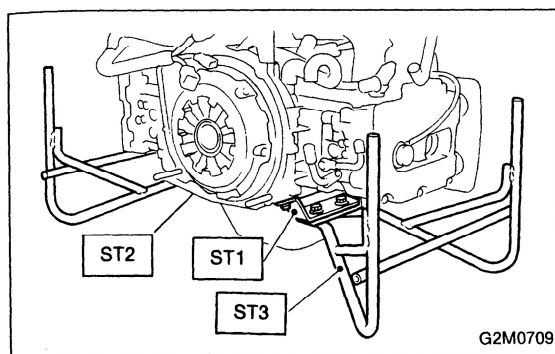
- ① Flywheel
- ② Bell bearing
- ③ Top ring
- ④ Second ring
- ⑤ Oil ring
- ⑥ Piston
- ⑦ Piston pin
- ⑧ Circlip
- ⑨ Connecting rod bolt
- ⑩ Connecting rod
- ⑪ Connecting rod bearing

- ⑫ Connecting rod cap
- ⑬ Crankshaft
- ⑭ Woodruff key
- ⑮ Crankshaft bearing #1, #5
- ⑯ Crankshaft bearing #2, #4
- ⑰ Crankshaft bearing #3

Tightening torque: N·m (kg-m, ft-lb)

T1: 43 — 46 (4.4 — 4.7, 32 — 34)

T2: 69 — 75 (7.0 — 7.6, 51 — 55)



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

On turbocharged engine, remove exhaust manifolds, turbo joint pipe and turbocharger before placing it on ST3.

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.

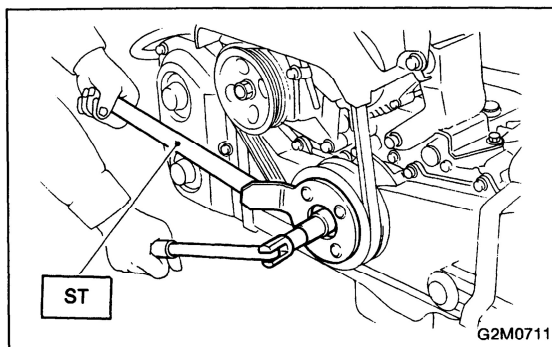
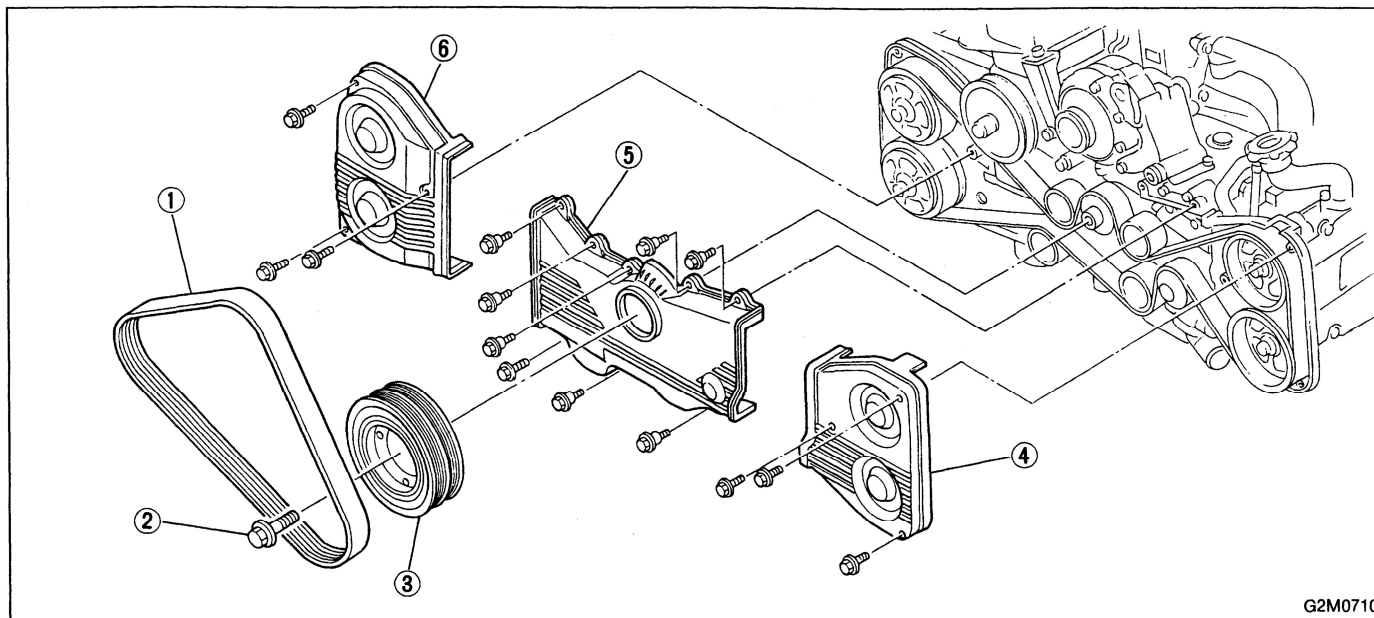
7) Bolts, nuts and washers should be replaced with new ones as required.

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

2. Timing Belt

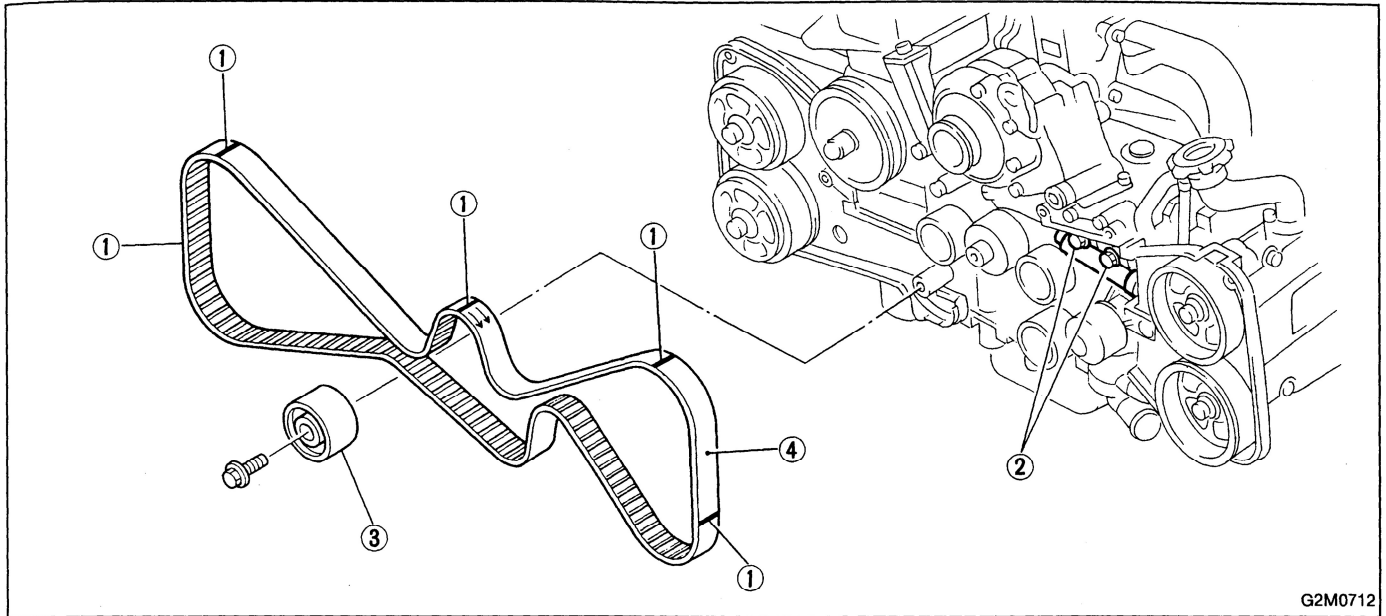
A: REMOVAL

1. CRANKSHAFT PULLEY AND BELT COVER

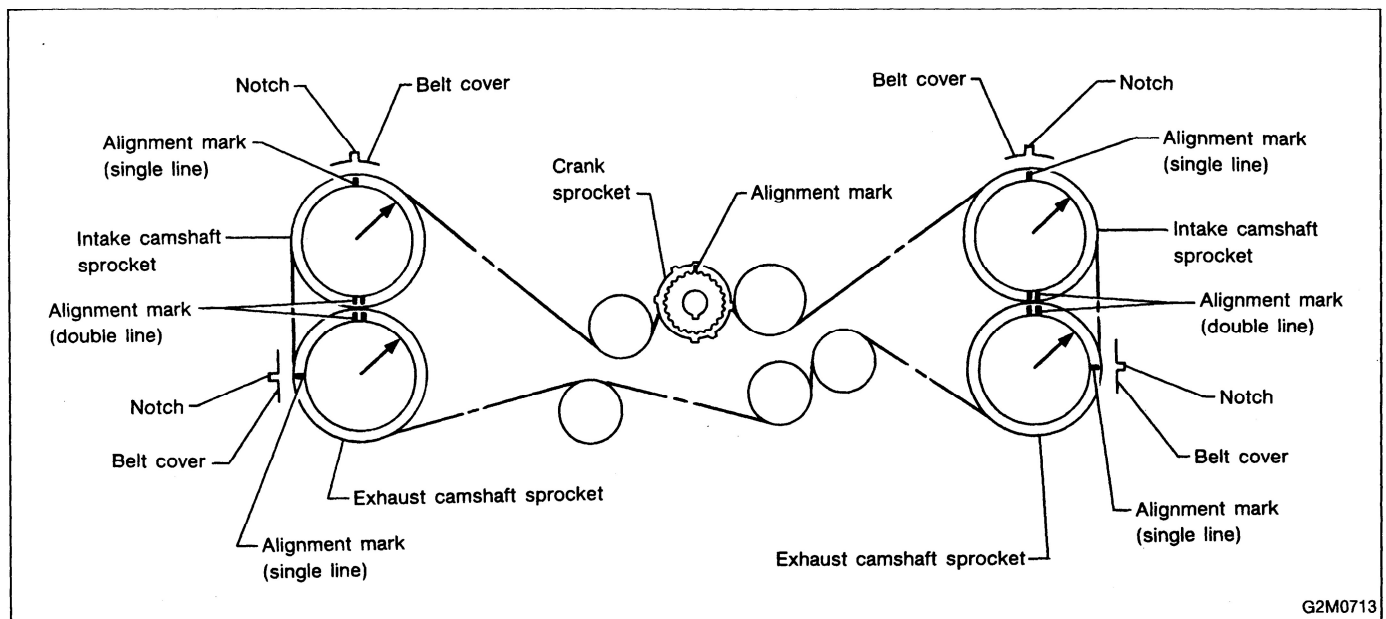


- 1) Remove V-belt.
- 2) Remove pulley bolt. To lock crankshaft, use ST.
ST 499977000 CRANKSHAFT PULLEY WRENCH
- 3) Remove crankshaft pulley.
- 4) Remove left-hand belt cover.
- 5) Remove right-hand belt cover.
- 6) Remove front belt cover.

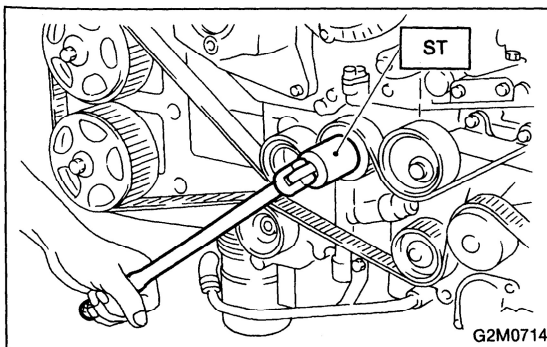
2. TIMING BELT



G2M0712



G2M0713



1) 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:

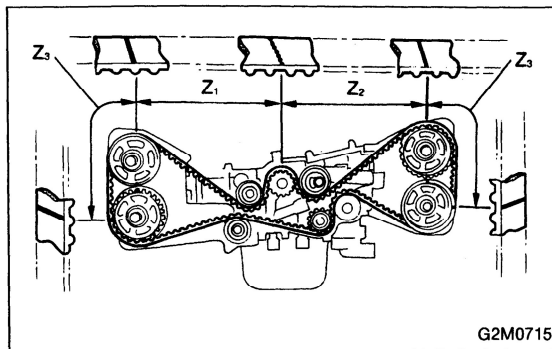
(1) Turn crankshaft using ST, and align alignment marks on crankshaft sprocket, left-hand intake camshaft sprocket, left-hand exhaust camshaft sprocket, right-hand intake camshaft sprocket and right hand exhaust camshaft sprocket with notches of belt cover and cylinder block.

ST 499987500 CRANKSHAFT SOCKET

2-3b [W2A2]

2. Timing Belt

SERVICE PROCEDURE

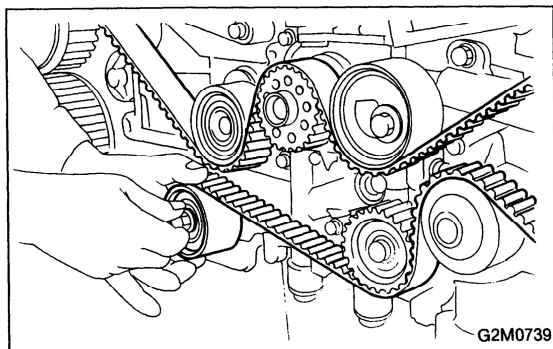
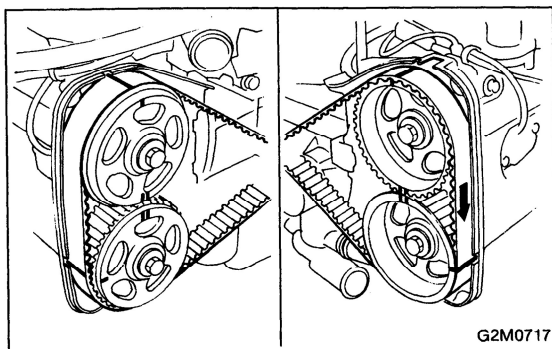
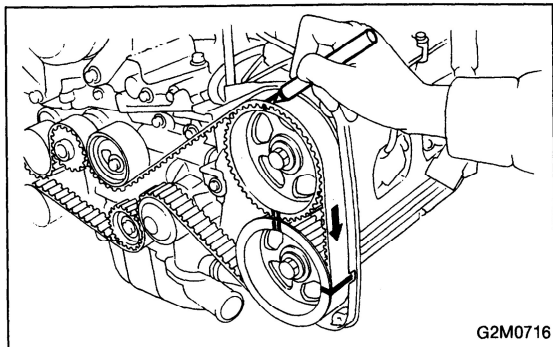


(2) Using white paint, put alignment and/or arrow marks on timing belts in relation to the sprockets.

Z_1 : 54.5 tooth length

Z_2 : 51 tooth length

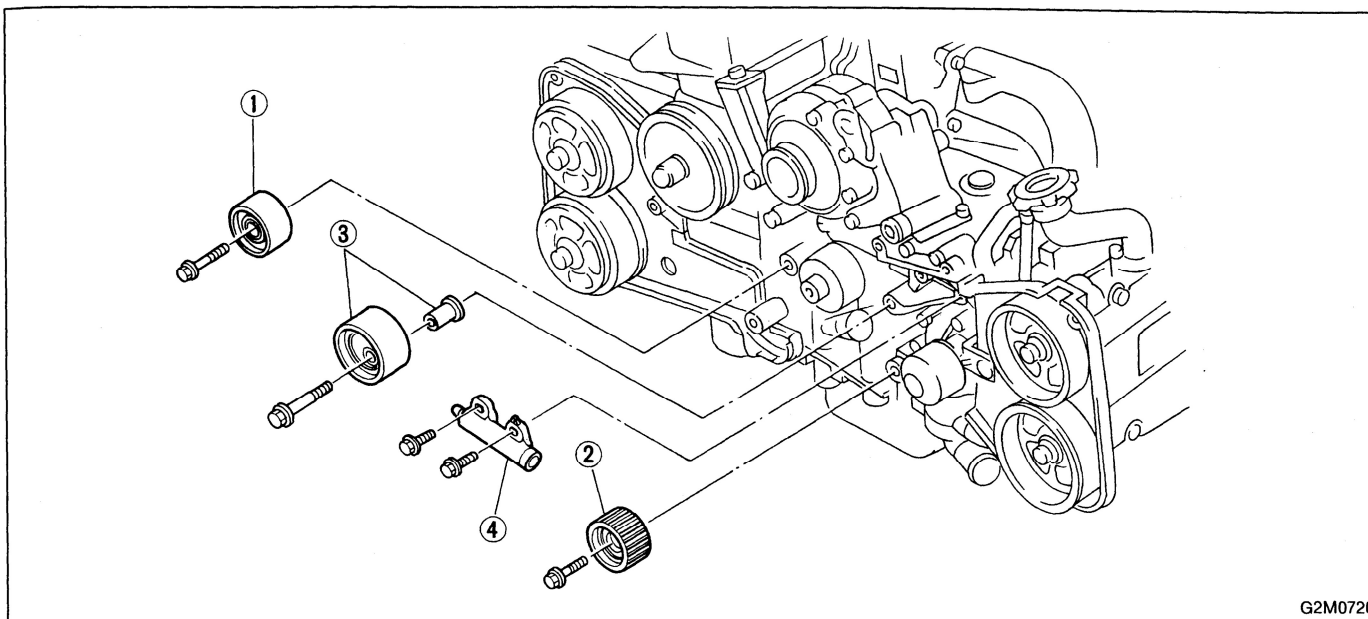
Z_3 : 28 tooth length



- 2) Loosen tensioner adjuster mounting bolts.
- 3) Remove belt idler.

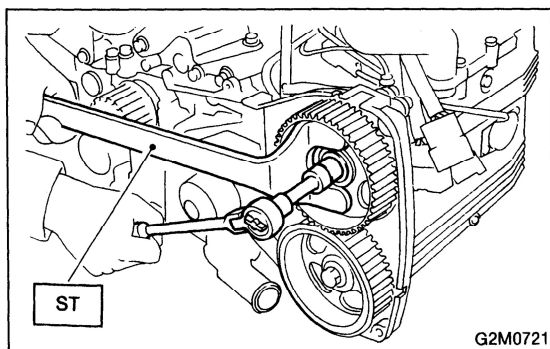
- 4) Remove timing belt.

3. BELT TENSIONER AND IDLER



G2M0720

- 1) Remove belt idler.
- 2) Remove belt idler No. 2.
- 3) Remove belt tensioner and spacer.
- 4) Remove belt tension adjuster.



G2M0721

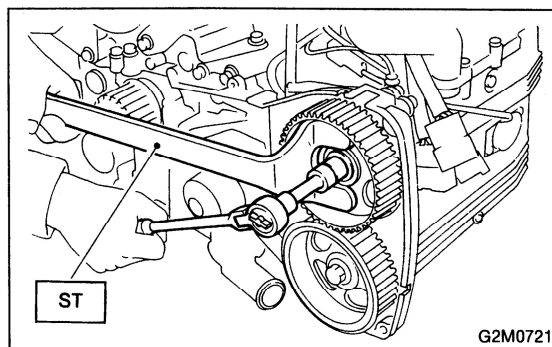
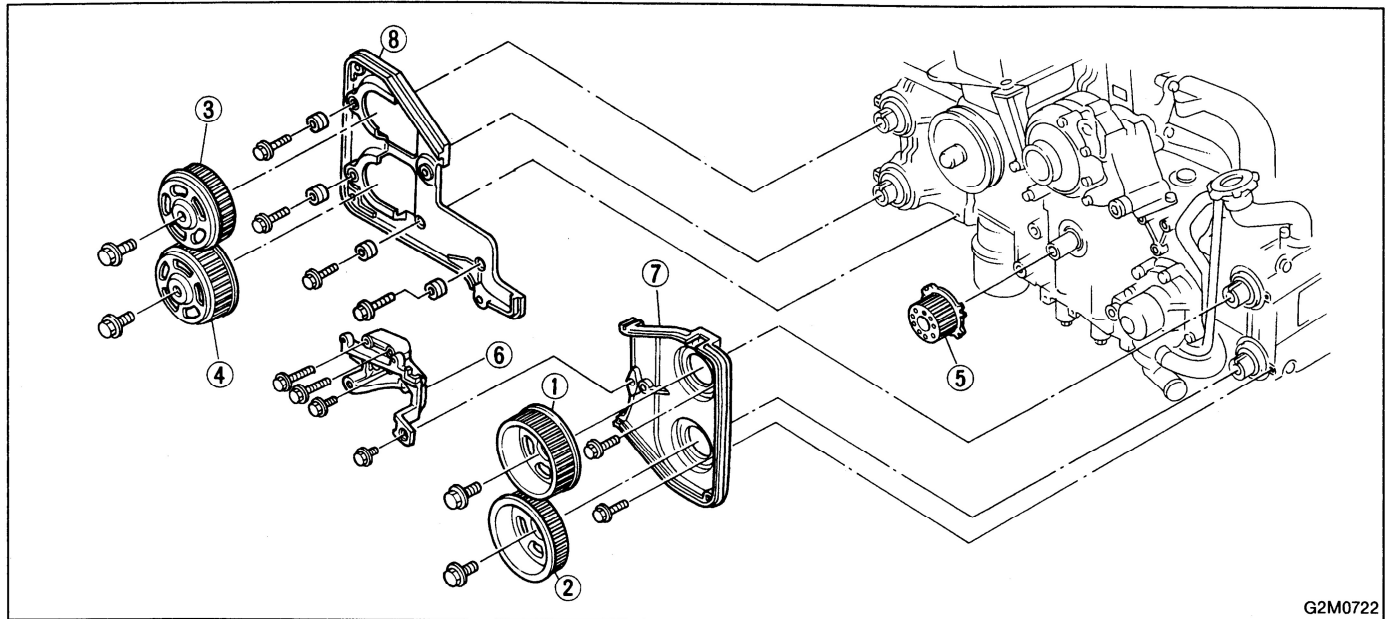
CAUTION:

After timing belt has been removed, never rotate intake and exhaust, camshaft sprocket.

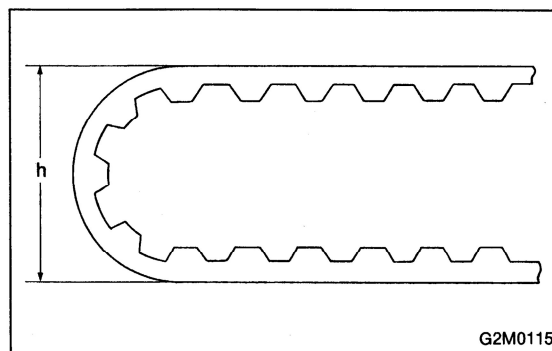
If camshaft sprocket is rotated, the intake and exhaust valve heads strike together and valve stems are bent. For this reason, when removing camshaft sprocket, lock the camshaft sprocket using ST so as to avoid turning camshaft.

ST 499207100 CAMSHAFT SPROCKET WRENCH

4. SPROCKET



- 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 499207100 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

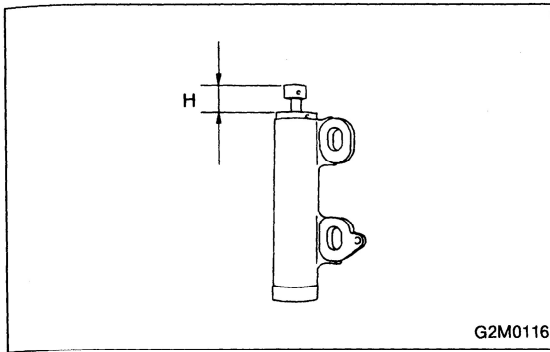
- 1) Check timing belt teeth for breaks, cracks, and wear. If any fault is found, replace belt.
- 2) Check the condition of back side of belt; if any crack is found, replace belt.

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. BELT TENSION ADJUSTER

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

CAUTION:

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

2) While holding tensioner with both hands, push the rod section against floor or wall with a force of 147 to 490 N (15 to 50 kg, 33 to 110 lb) to ensure that the rod section does not move. If it moves, replace tension adjuster with a new one.

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

Rod extension: H

15.4 — 16.4 mm (0.606 — 0.646 in)

3. BELT TENSIONER

1) Check mating surfaces of timing belt and contact point of tension adjuster rod for abnormal wear or scratches. Replace belt tensioner if faulty.

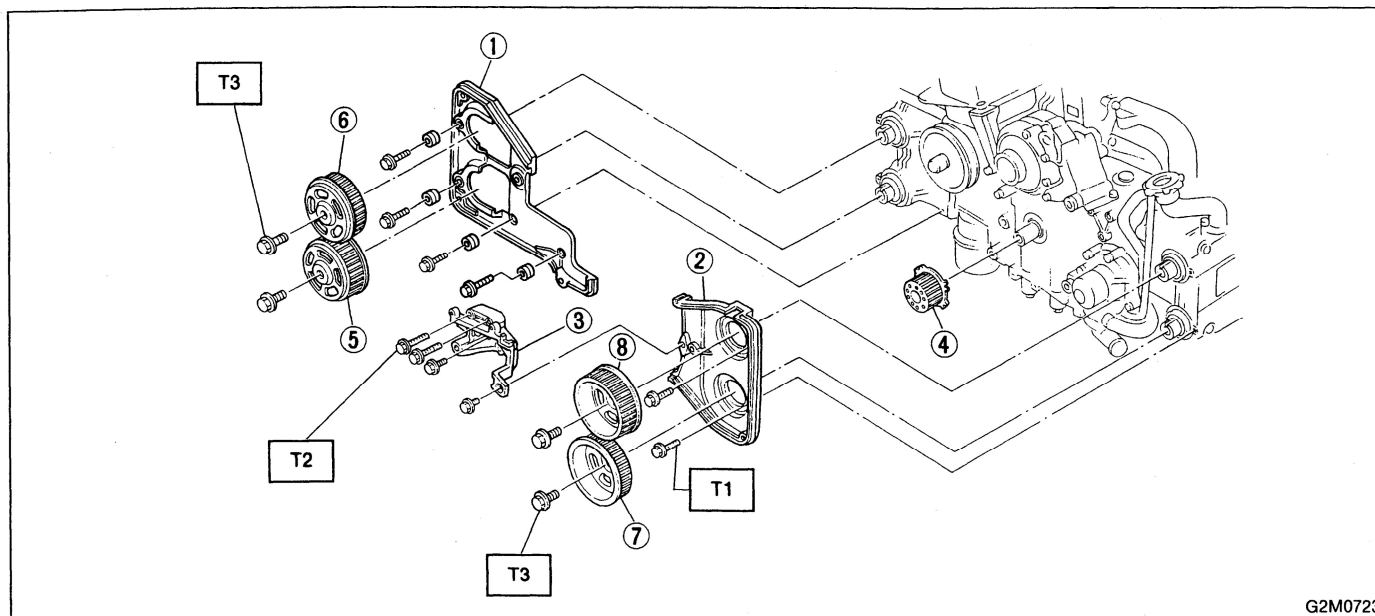
2) Check spacer and tensioner bushing for wear.

4. BELT IDLER

Check idler for smooth rotation. Replace if noise or excessive play is noted.

C: INSTALLATION

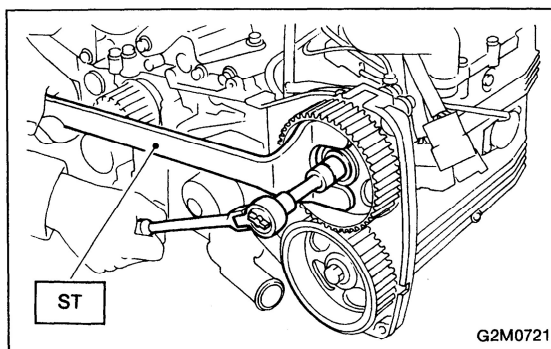
1. SPROCKET



G2M0723

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.

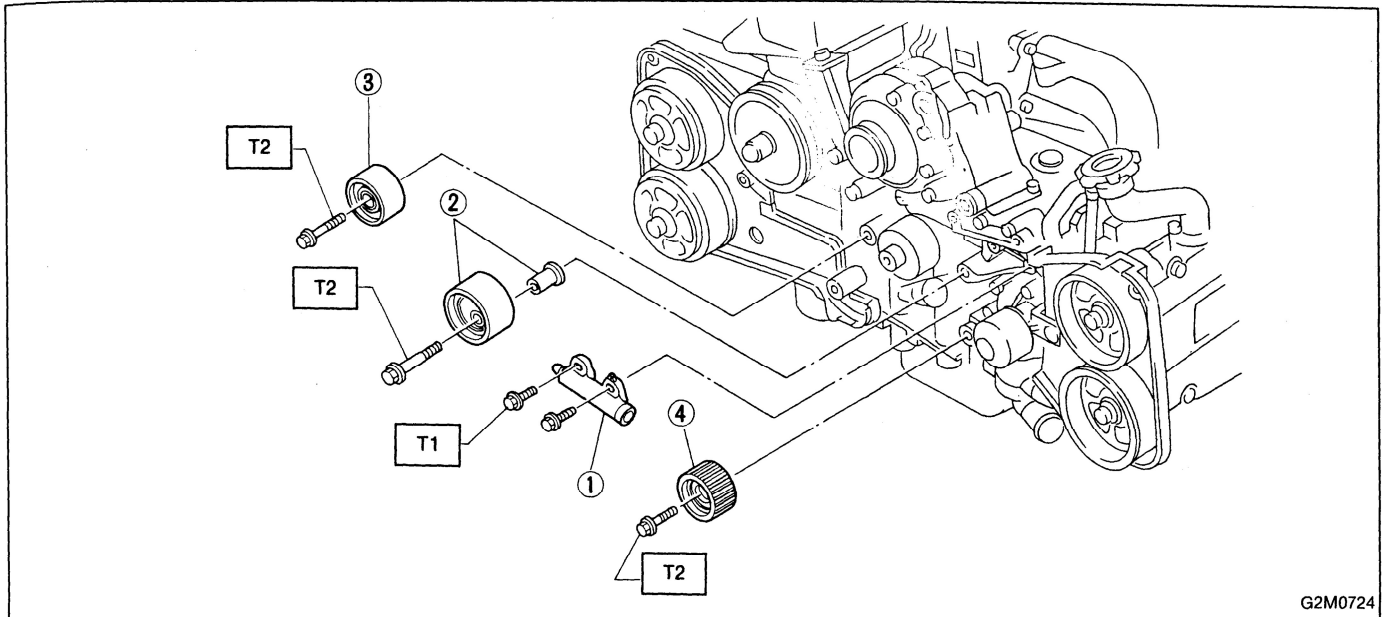


G2M0721

- 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 499207100 CAMSHAFT SPROCKET WRENCH

2. BELT TENSIONER AND IDLER

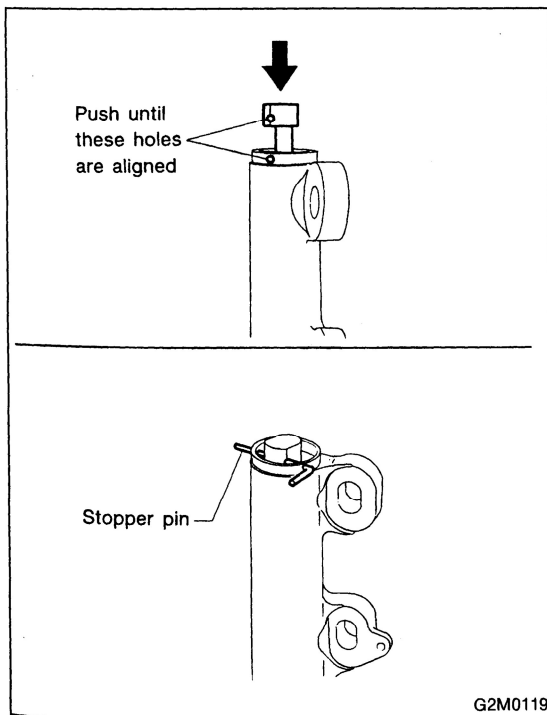


G2M0724

Tightening torque: N·m (kg·m, ft·lb)

T1: 25 ± 2 (2.5 ± 0.2 , 18 ± 1.4)

T2: 39 ± 4 (4.0 ± 0.4 , 29 ± 2.9)



G2M0119

1) Installation of belt tensioner adjuster

(1) Insert stopper pin 1.5 mm (0.059 in) dia. into place while pushing tension adjuster rod into body using a press.

CAUTION:

- Do not allow press pressure to exceed 9,807 N (1,000 kg, 2,205 lb).
- Do not release press pressure until stopper pin is completely inserted.
- Push tension adjuster rod vertically.

2. Timing Belt

SERVICE PROCEDURE



(2) Temporarily tighten bolts while tension adjuster is pushed all the way to the right.

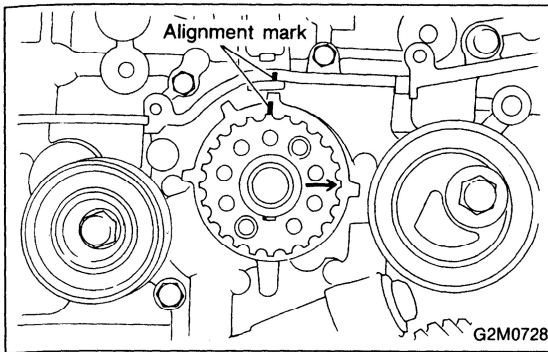


- 2) Install belt tensioner.
- 3) Install belt idler.
- 4) Install belt idler No. 2.

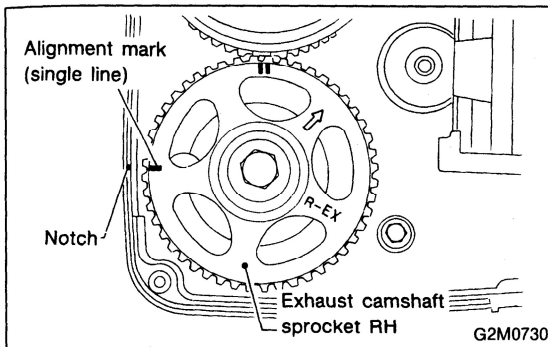
3. TIMING BELT



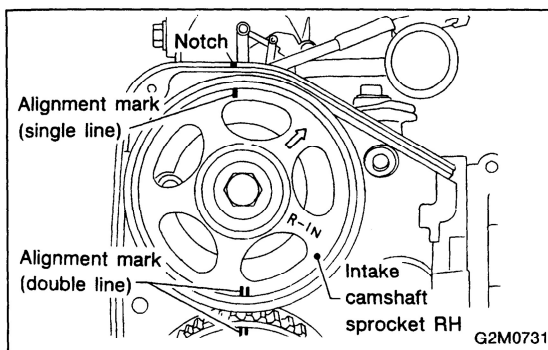
Tightening torque: N·m (kg·m, ft·lb)
T: 39 ± 4 (4.0 ± 0.4, 29 ± 2.9)



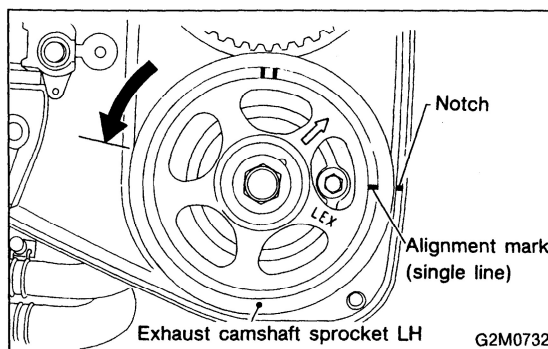
- 1) Crankshaft and camshaft sprocket alignment
 - (1) Align mark on crankshaft sprocket with mark on the oil pump cover at cylinder block.



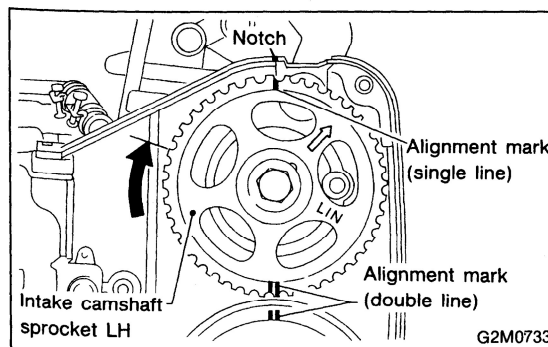
- (2) Align single line mark on right-hand exhaust camshaft sprocket with notch on belt cover.



- (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.)

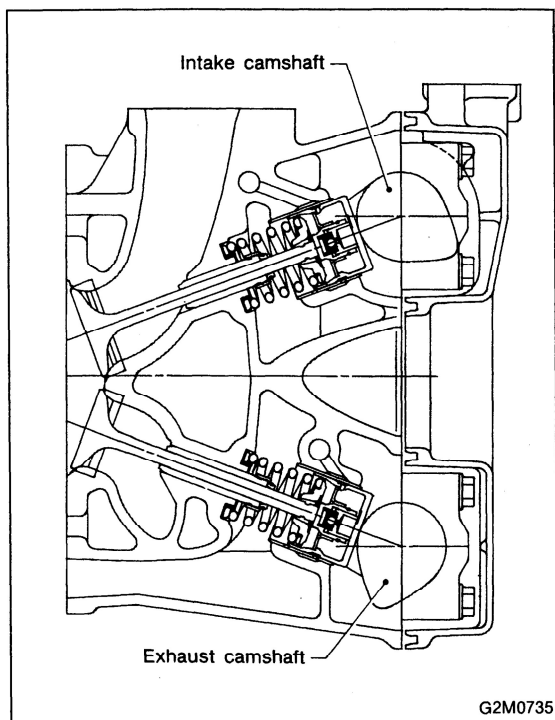
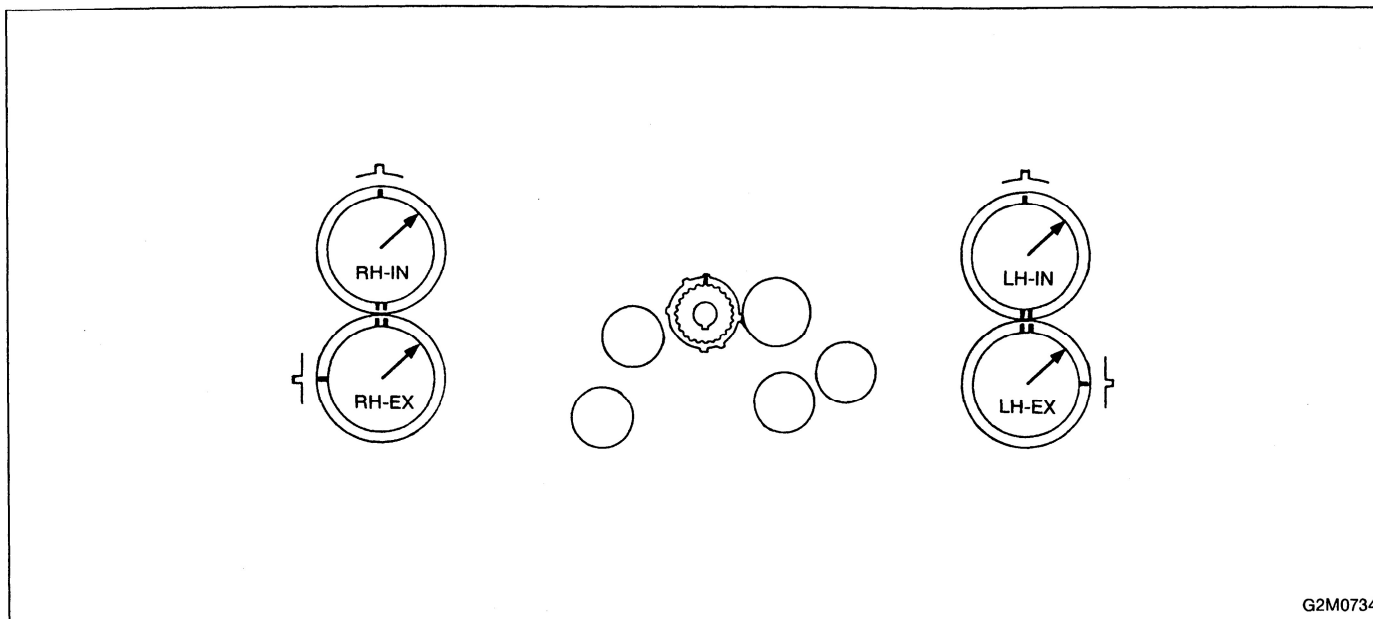


- (4) Align single line mark on left-hand exhaust camshaft sprocket with notch on belt cover by turning sprocket counter-clockwise (as viewed from front of engine).



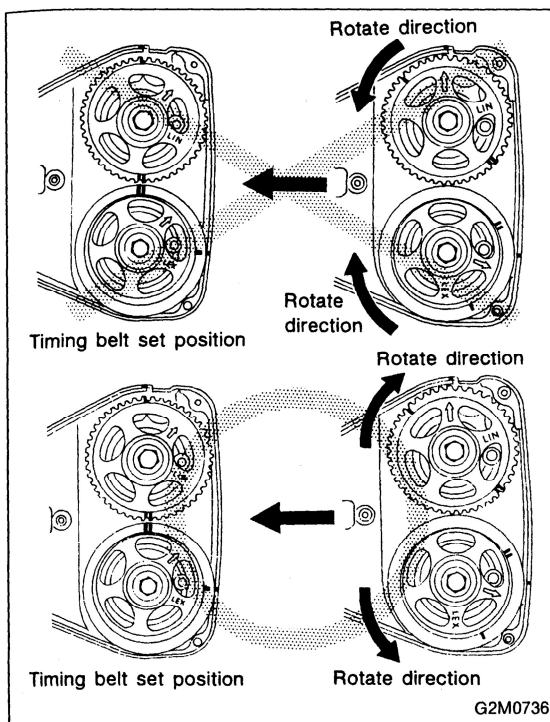
- (5) Align single line mark on left-hand intake camshaft sprocket with notch on belt cover by turning sprocket clockwise (as viewed from front of engine). Ensure double lines on intake and exhaust camshaft sprockets are aligned.

(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.

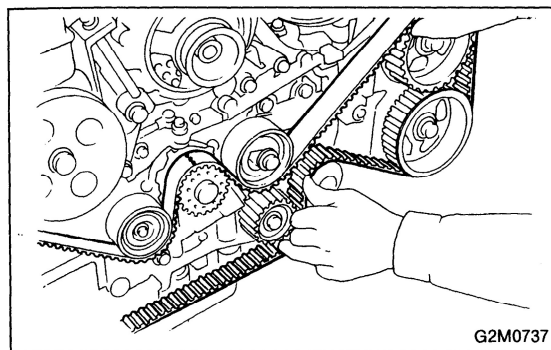


● When timing belts are not installed, four camshafts are held at the “zero-lift” position, where all cams on camshafts do not push intake and exhaust valves down. (Under this condition, all valves remain unlifted.)

● 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 upper of figure as this causes both intake and exhaust valves to lift simultaneously, resulting in interference with their heads.

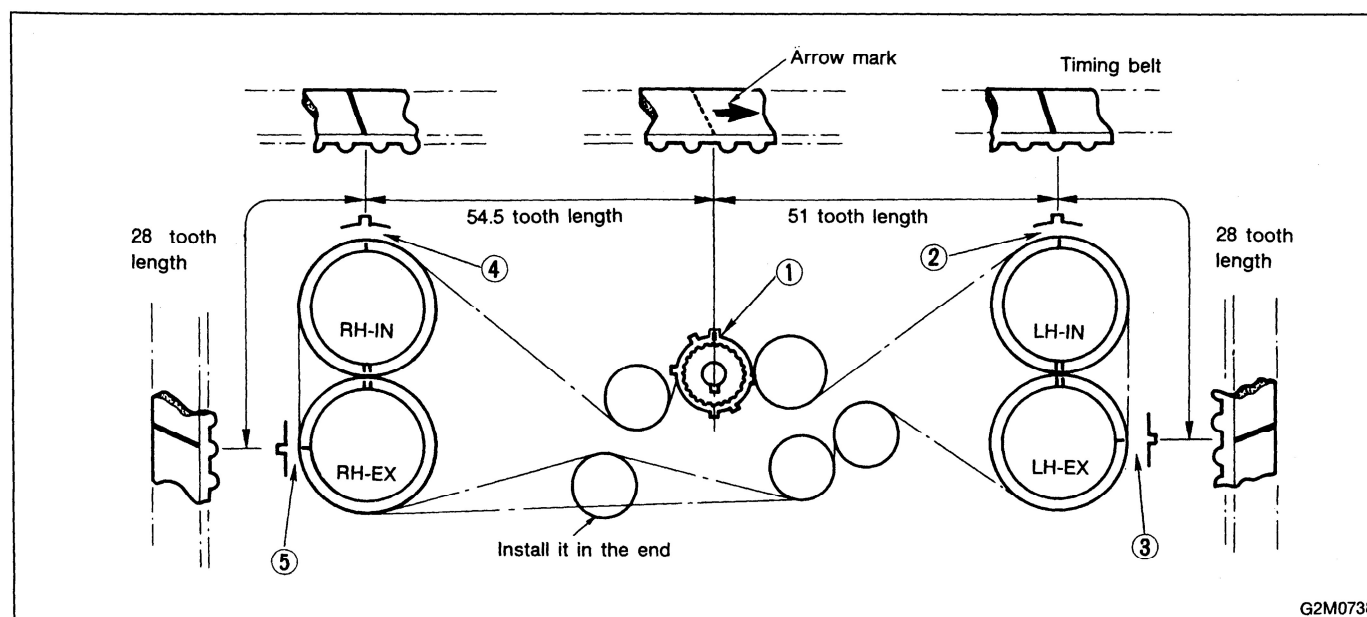


2) Installation of timing belt

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

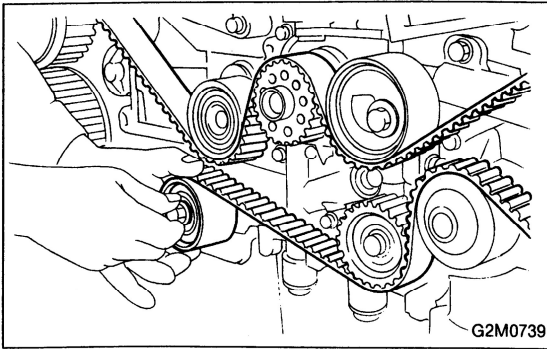
CAUTION:

Ensure belt's rotating direction is correct.



2-3b [W2C3]
2. Timing Belt

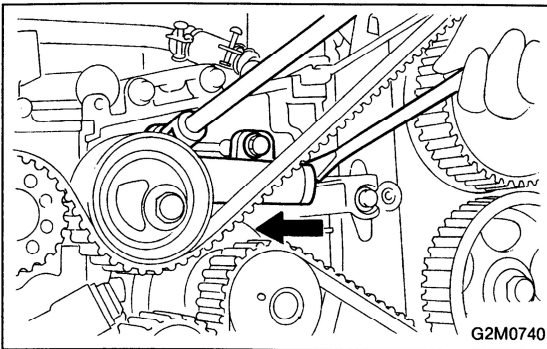
SERVICE PROCEDURE



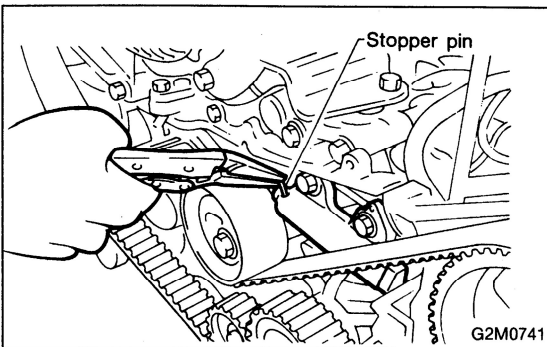
3) Install belt idler.

CAUTION:

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

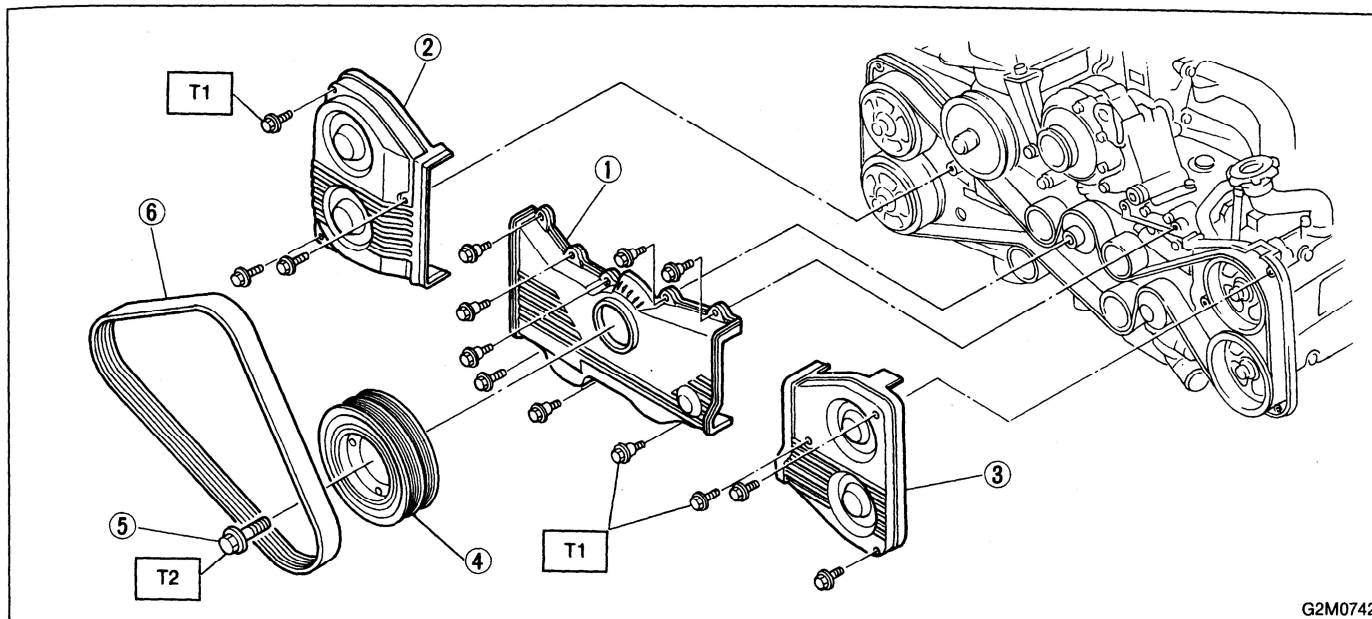


4) Loosen tension adjuster attaching bolts and move adjuster all the way to the left. Tighten the bolts.



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

4. CRANKSHAFT PULLEY AND BELT COVER



G2M0742

Tightening torque: N·m (kg·m, ft·lb)

T1: 5 ± 0.5 (0.5 ± 0.05 , 3.6 ± 0.4)

T2: 110.3 ± 7.4 (11.25 ± 0.75 , 81.4 ± 5.4)

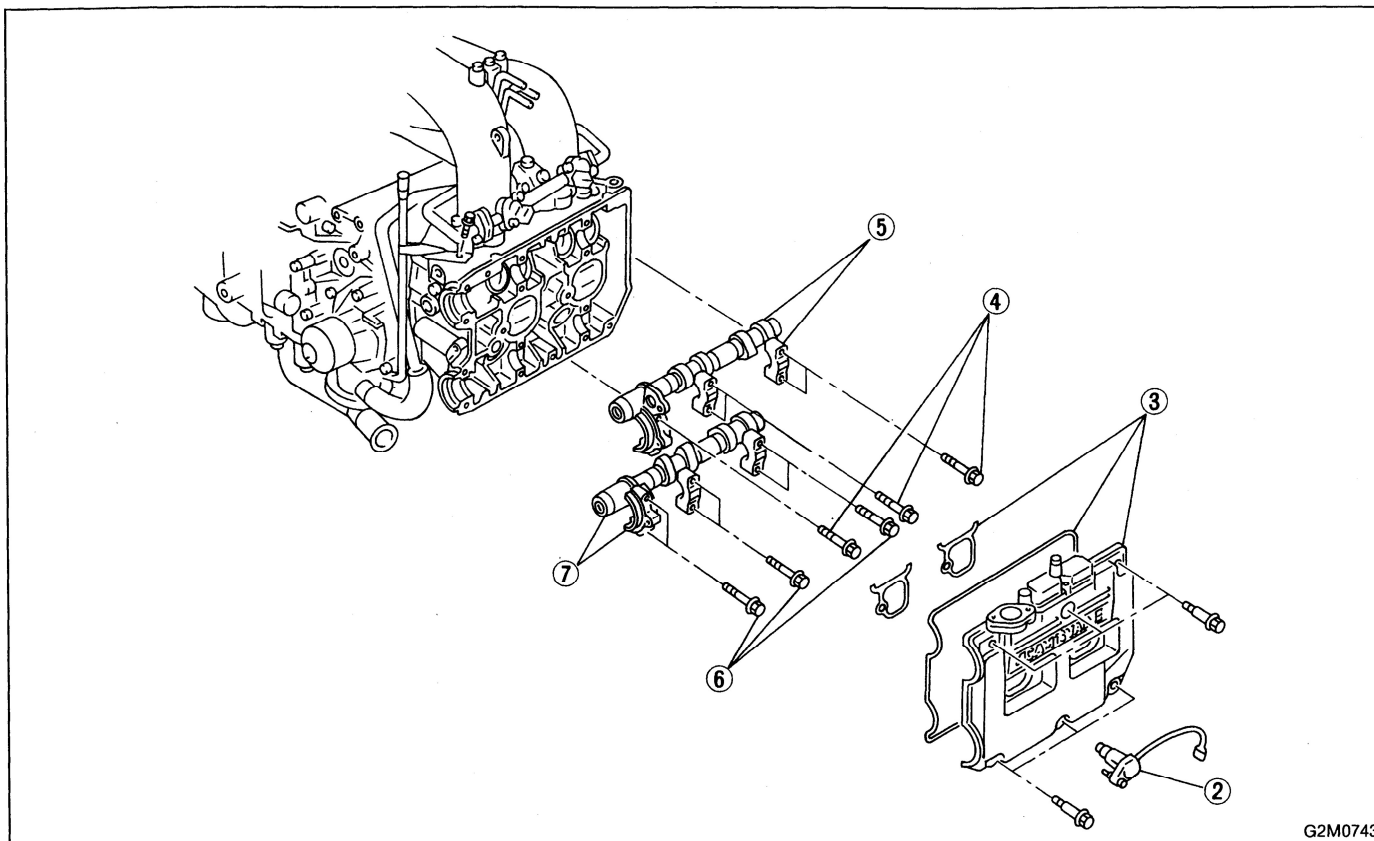
- 1) Install front belt cover.
- 2) Install right-hand belt cover.
- 3) Install left-hand belt cover.
- 4) Install crankshaft pulley.
- 5) Install pulley bolt by using ST.
ST 499977000 CRANKSHAFT PULLEY WRENCH
- 6) Install V-belt.

CAUTION:

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

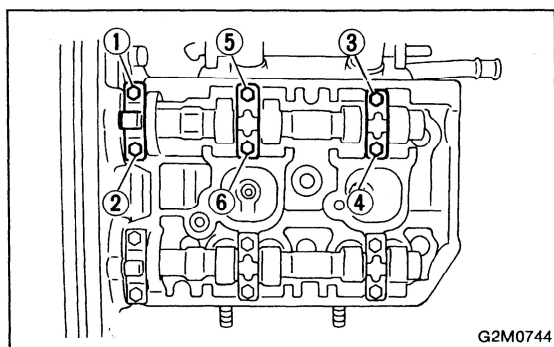
3. Camshaft**A: REMOVAL****1. RELATED PARTS**

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

2. CAMSHAFT LH

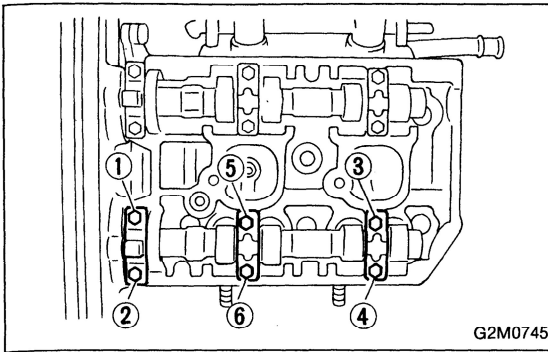
G2M0743

- 1) Remove camshaft position sensor.
- 2) Remove ignition coils.
- 3) Remove cylinder head cover and gasket.



G2M0744

- 4) Loosen intake camshaft cap bolts equally, a little at a time in the numerical sequence shown in figure.
- 5) Remove camshaft caps and intake camshaft.



G2M0745

- 6) Loosen exhaust camshaft cap bolts equally, a little at a time in the numerical 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.

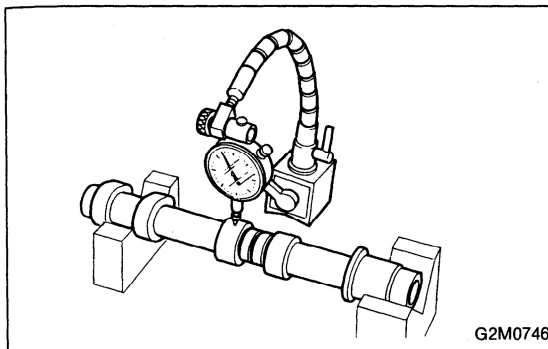
B: INSPECTION

1. CAMSHAFT

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

Limit:

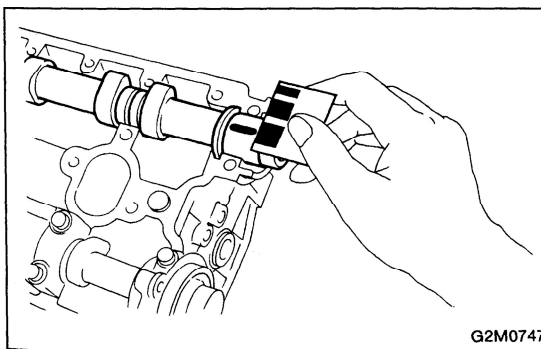
0.020 mm (0.0008 in)



G2M0746

- 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)



G2M0747

- 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:

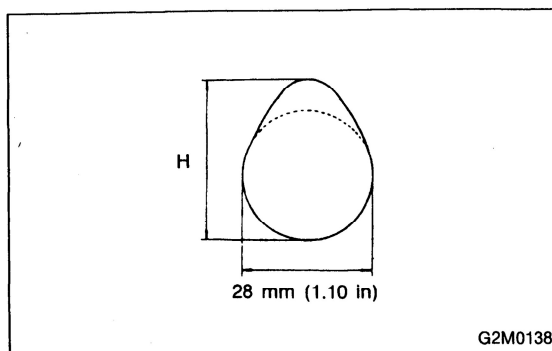
0.10 mm (0.0039 in)

- (7) Completely remove the plastigauge.

2-3b [W3C-1]

3. Camshaft

SERVICE PROCEDURE



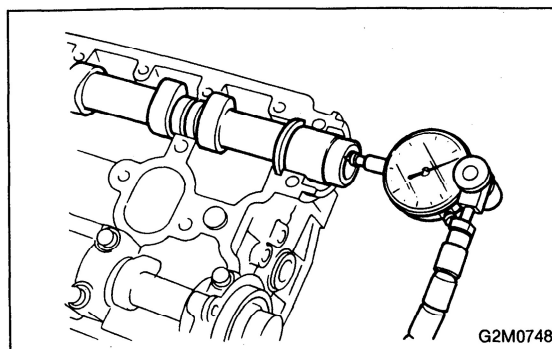
5) Check cam face condition; remove minor faults by grinding with oil stone. Measure the cam height H; replace if the limit has been exceeded.

Standard:

41.78 — 41.88 mm (1.6449 — 1.6488 in)

Limit:

41.62 mm (1.6386 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:

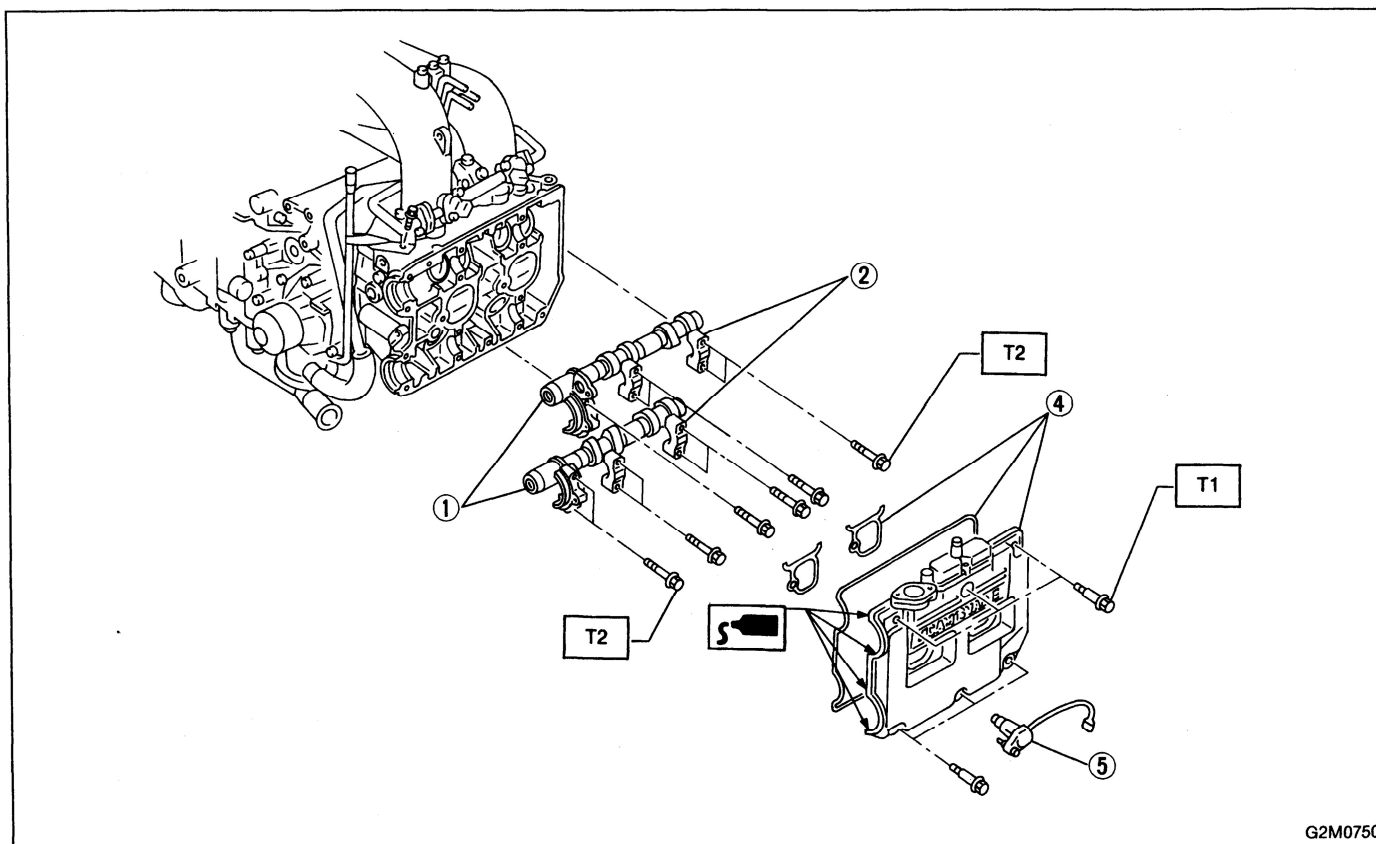
0.015 — 0.070 mm (0.0006 — 0.0028 in)

Limit:

0.1 mm (0.004 in)

C: INSTALLATION

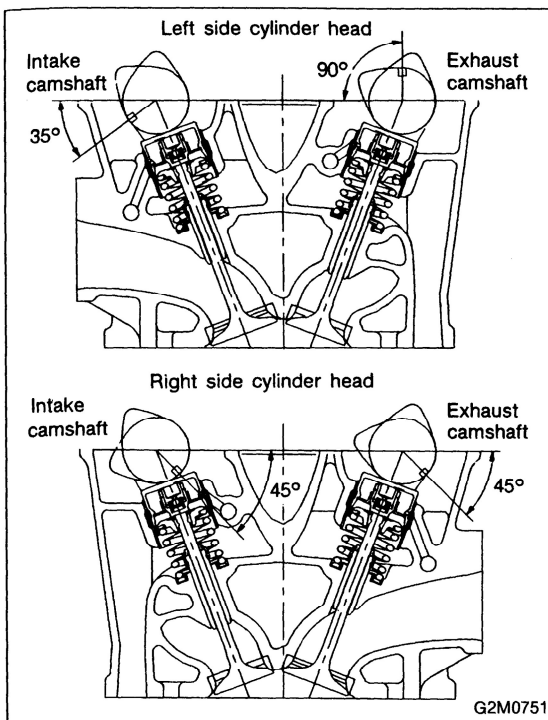
1. CAMSHAFT



Tightening torque: N·m (kg·m, ft·lb)

T1: 10 ± 0.7 (1.0 ± 0.07, 7.2 ± 0.5)

T2: 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.

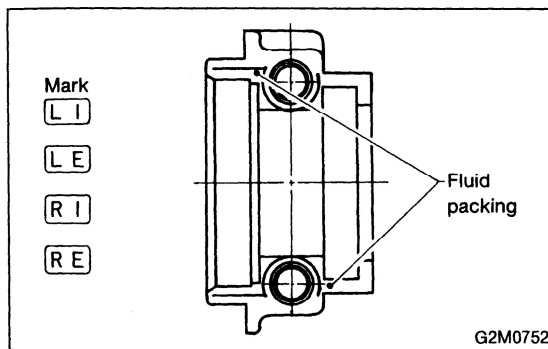
CAUTION:

- 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

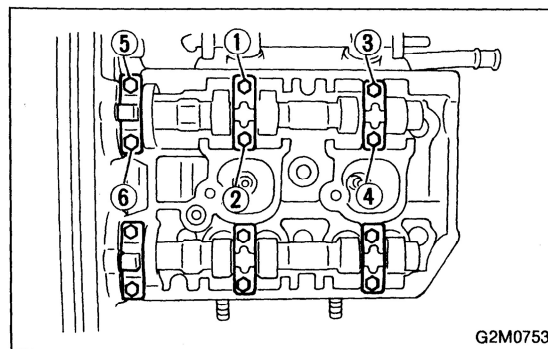
(1) Apply fluid packing sparingly to cap mating surface.

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

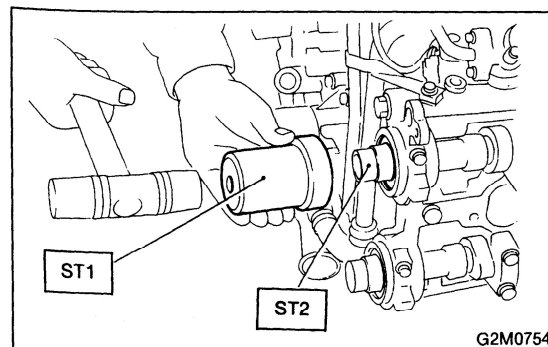


(2) Apply engine oil to cap bearing surface and install cap on camshaft as shown by identification mark.

(3) Gradually tighten cap in at least two stages in the numerical order 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

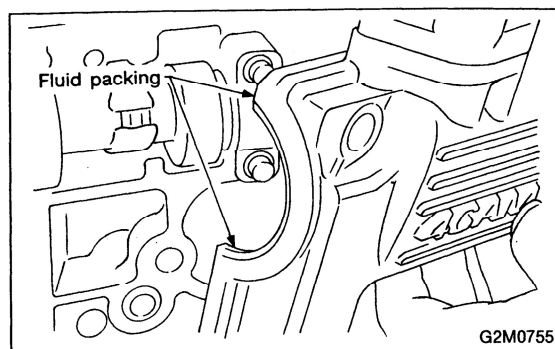
Apply grease to new oil seal lips and press onto front end of camshaft by using ST1 and ST2.

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].>

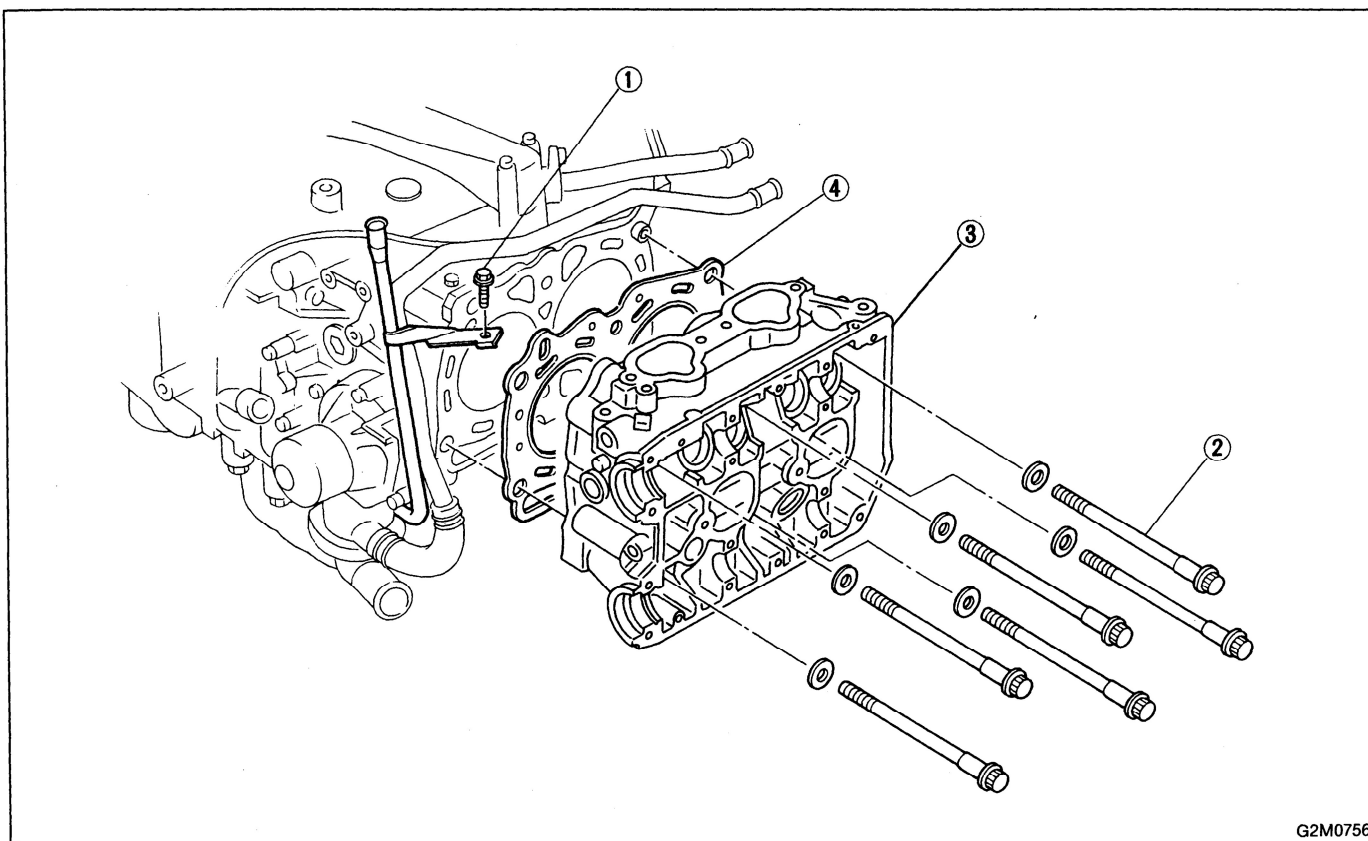
4. Cylinder Head

A: REMOVAL

1. INTAKE MANIFOLD

- 1) Remove V-belt.
- 2) Remove alternator, air conditioner compressor and brackets.
- 3) Remove hoses and tubes from cylinder block.
- 4) Disconnect each connector and/or remove connector bracket.
- 5) Remove coolant filler tank.
- 6) Remove intake manifold assembly and gasket.
- 7) Remove water pipe.
- 8) Remove crank angle sensor, cam angle sensor and knock sensor.
- 9) Remove timing belt, camshaft sprockets and related parts.
<Ref. to 2-3b [W2A0].>
- 10) Remove rocker cover, camshafts and related parts.
<Ref. to 2-3b [W3A0].>

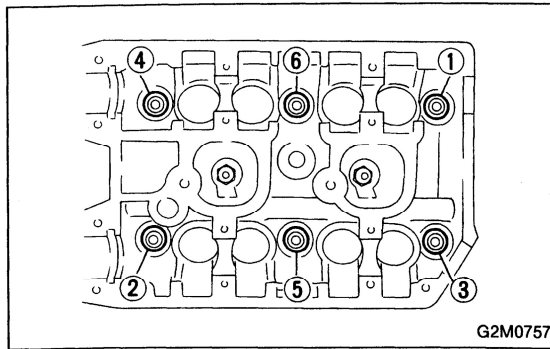
2. CYLINDER HEAD



G2M0756

2-3b [W4B0]
4. Cylinder Head

SERVICE PROCEDURE



1) Remove oil level gauge guide attaching bolt (left-hand only).

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

CAUTION:

Leave bolts ① and ④ engaged by three or four threads to prevent cylinder head from falling.

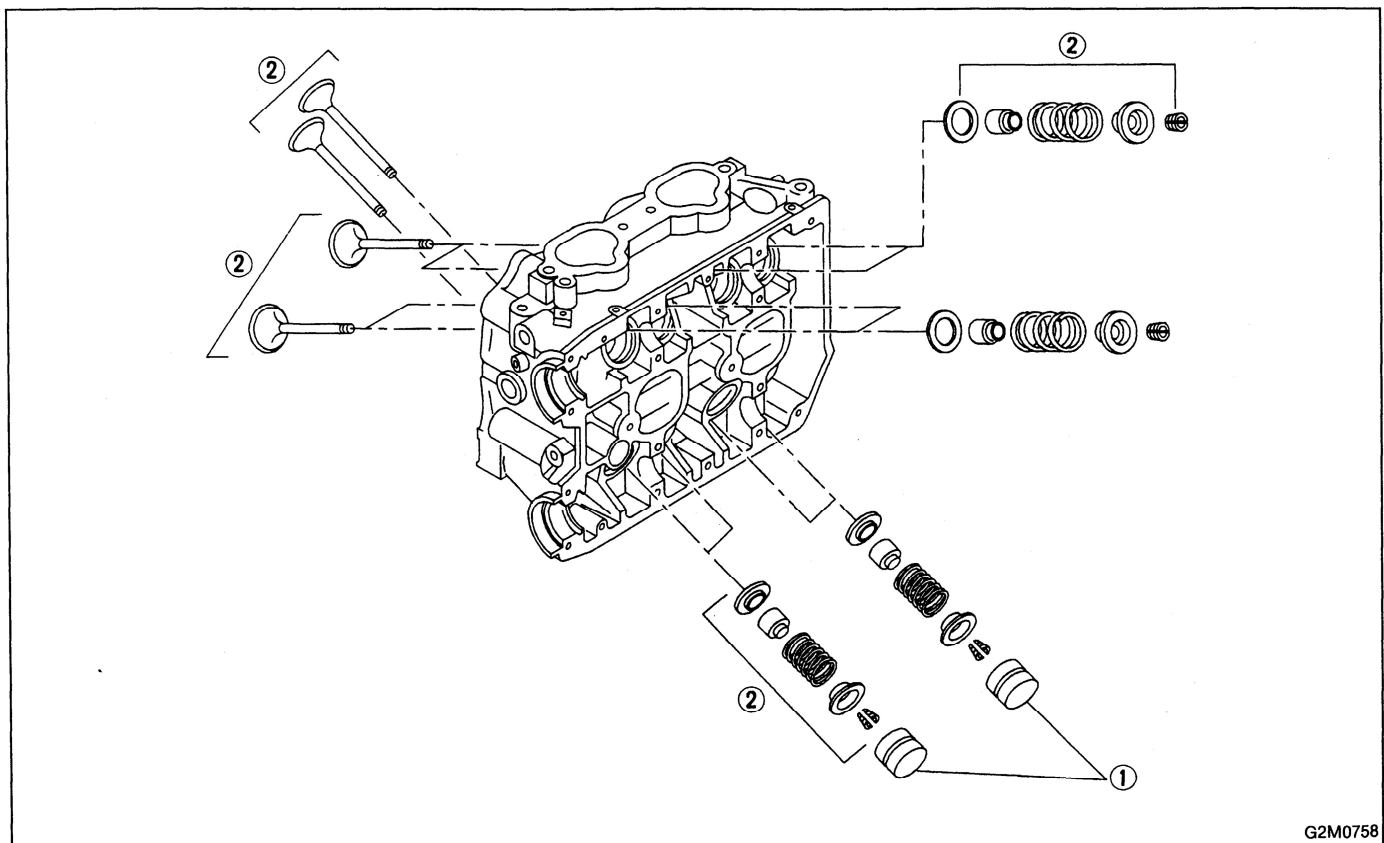
3) While tapping cylinder head with a plastic hammer, separate it from cylinder block.

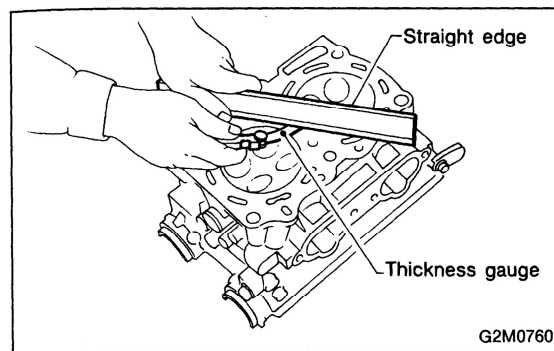
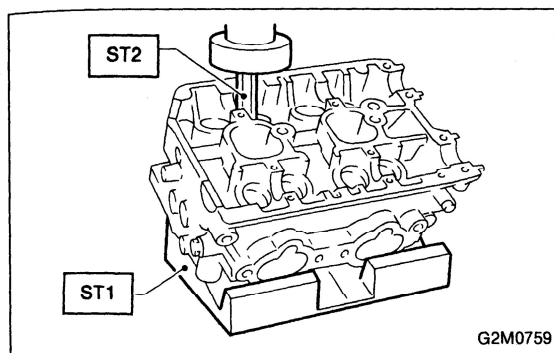
Remove bolts ① and ④ to remove cylinder head.

4) Remove cylinder head gasket.

5) Similarly, remove right-hand cylinder head.

B: DISASSEMBLY





- 1) Remove hydraulic lash adjusters.
- 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:

- 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:

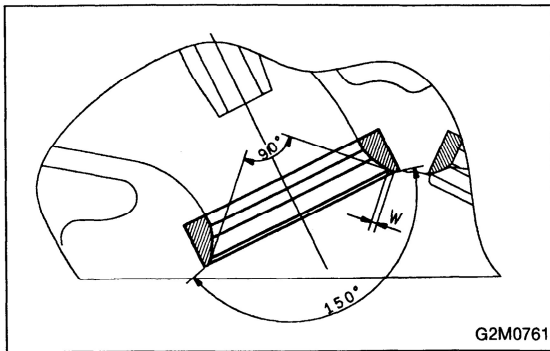
0.3 mm (0.012 in)

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

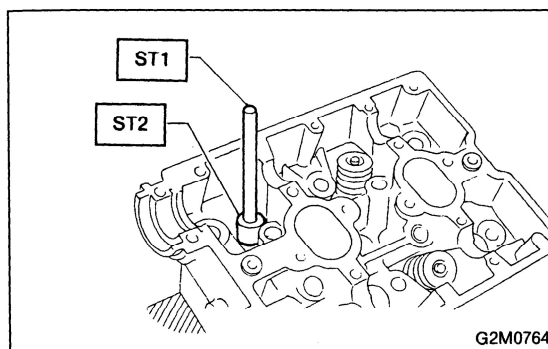
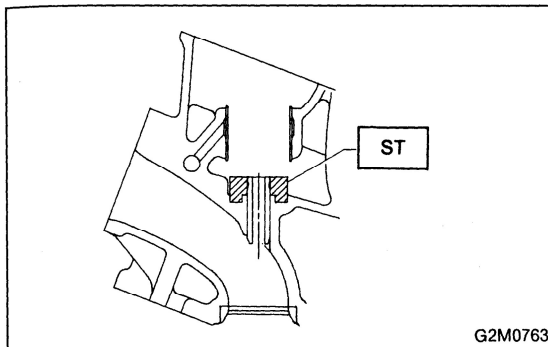
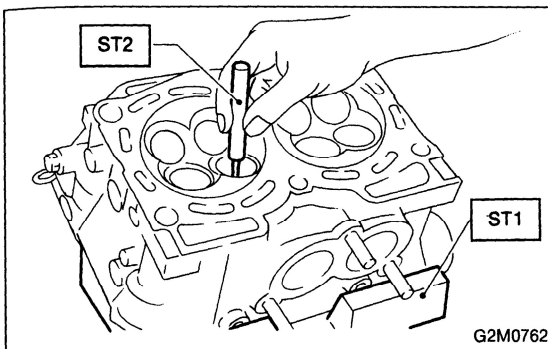
5.950 — 5.965 mm (0.2343 — 0.2348 in)

Exhaust

5.950 — 5.965 mm (0.2343 — 0.2348 in)

SERVICE PROCEDURE

[W4C3] 2-3b
4. Cylinder Head



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 498267300 CYLINDER HEAD TABLE

ST2 499767300 VALVE GUIDE REMOVER

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

ST 499767100 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 499767000 VALVE GUIDE ADJUSTER

(6) Check the valve guide protrusion.

Valve guide protrusion: L

13.3 — 13.7 mm (0.524 — 0.539 in)

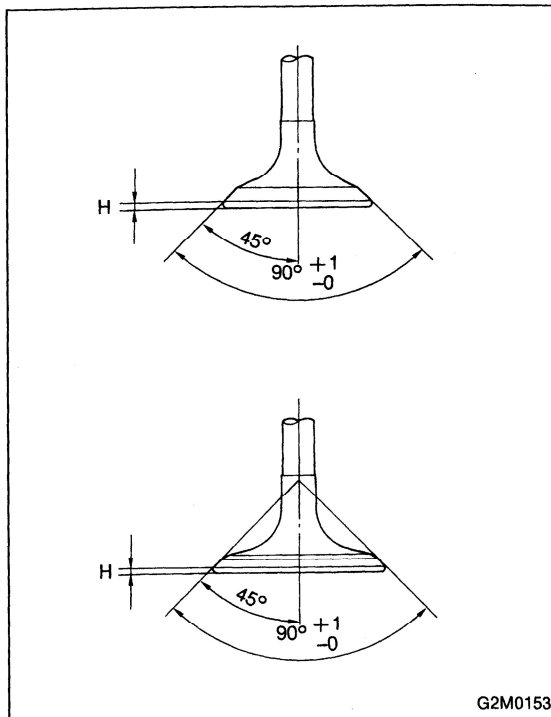
(7) Ream the inside of valve guide with ST. Gently rotate the reamer clockwise while pressing it lightly into valve guide, and return it also rotating clockwise. After reaming, clean valve guide to remove chips.

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 chip, 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

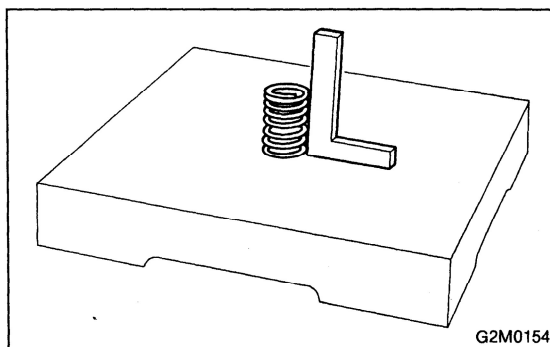
0.8 mm (0.031 in)

Valve overall length:

Intake 93.3 mm (3.673 in)

Exhaust 93.6 mm (3.685 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.

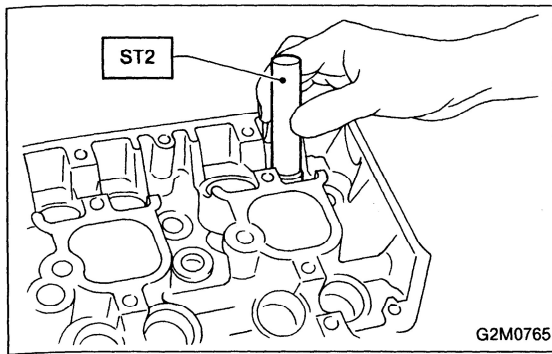


5. VALVE SPRINGS

1) Check valve springs for damage, free length, and tension. Replace valve spring if it is not to the specifications presented below.

2) To measure the squareness of the valve spring, stand the spring on a surface plate and measure its deflection at the top using a try square.

	Valve spring
Free length	39.8 mm (1.567 in)
Tension/spring height	228.5 — 261.8 N (23.3 — 26.7 kg, 51.4 — 58.9 lb)/31.0 mm (1.220 in)
	462.9 — 531.5 N (47.2 — 54.2 kg, 104.1 — 119.5 lb)/23.2 mm (0.913 in)
Squareness	2.5°, 1.7 mm (0.067 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 498267200 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:

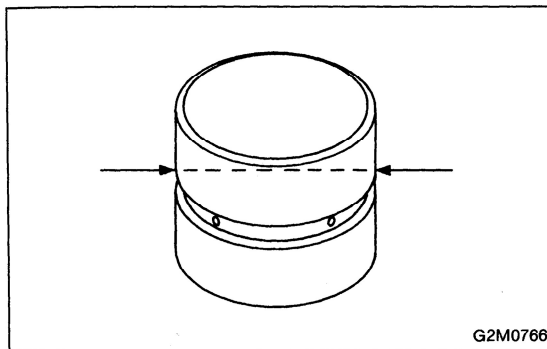
Intake [Black]

Exhaust [Brown]

Color of spring part:

Intake [Black]

Exhaust [Black]

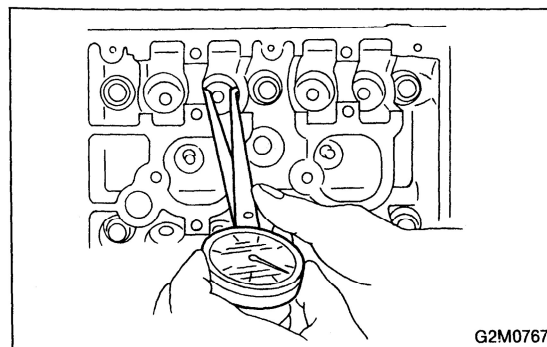


7. VALVE LASH ADJUSTER

- 1) Check valve lash adjuster visually.
- 2) Measure outer diameter of valve lash adjuster.

Outer diameter:

29.959 — 29.975 mm (1.1795 — 1.1801 in)



- 3) Measure inner diameter of bush on cylinder head.

Inner diameter:

29.994 — 30.016 mm (1.1809 — 1.1817 in)

CAUTION:

If difference between outer diameter of valve lash adjuster and inner diameter of bush is over the limit, replace cylinder head.

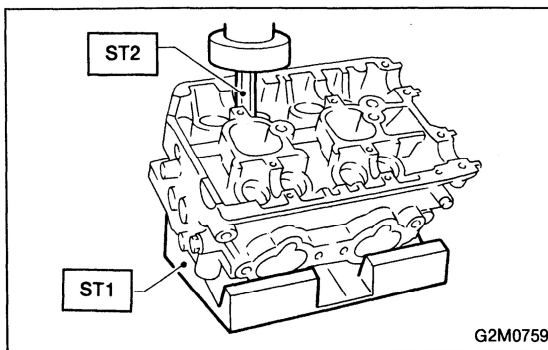
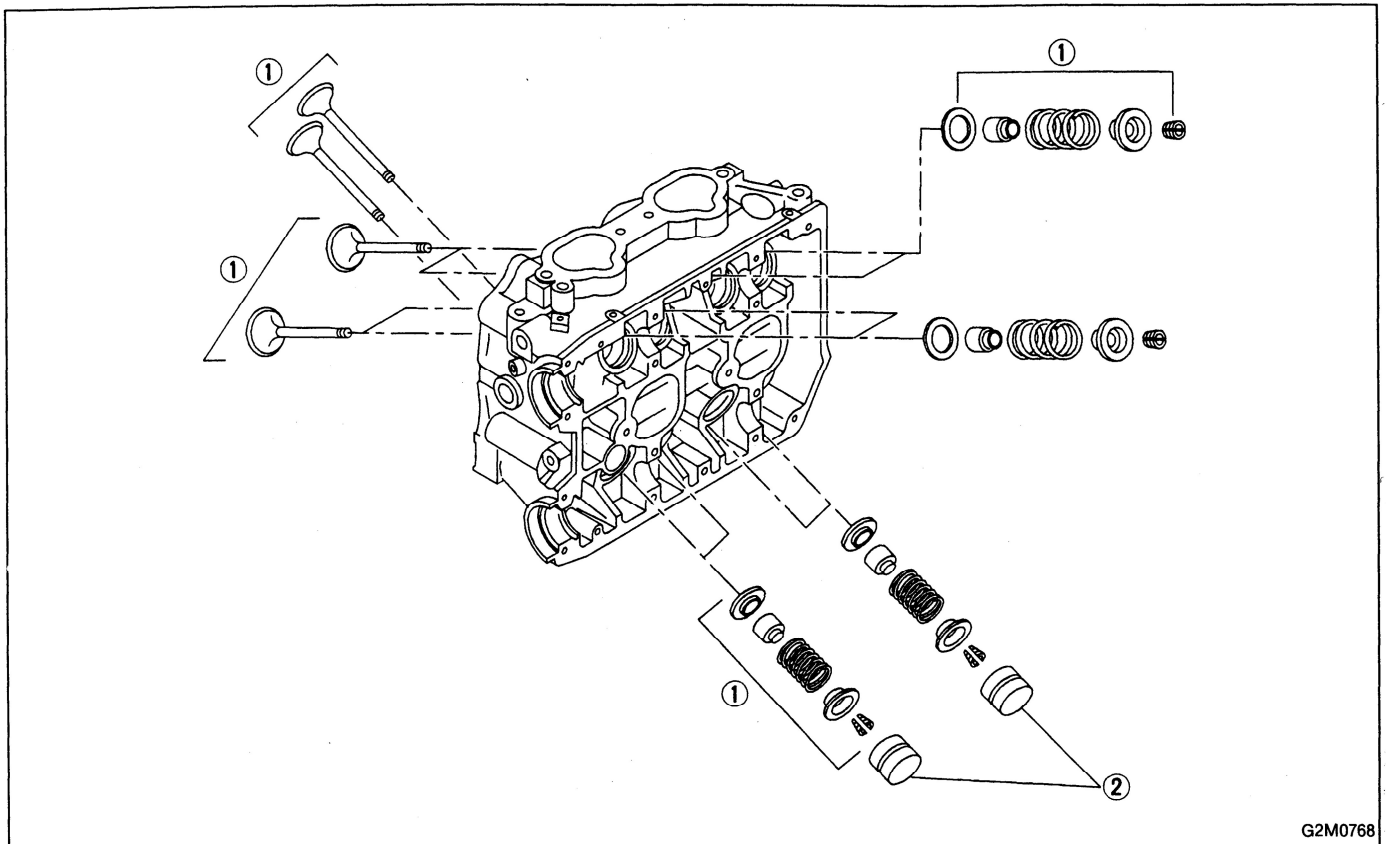
Standard:

0.019 — 0.057 mm (0.0007 — 0.0022 in)

Limit:

0.100 mm (0.0039 in)

D: ASSEMBLY



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

CAUTION:

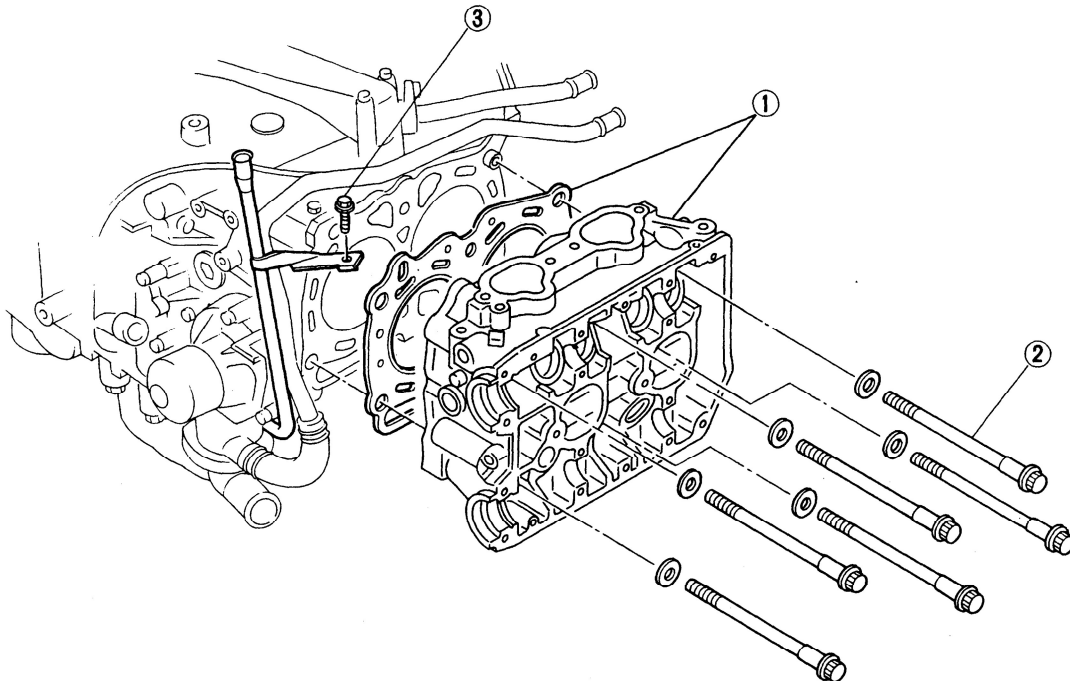
When inserting valve into valve guide, use special care not to damage the oil seal lip.

- (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.

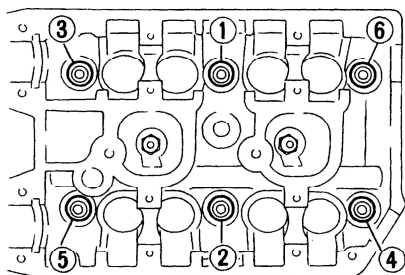
- (4) Compress valve spring and fit valve spring retainer key.
 - (5) After installing, tap valve spring retainers lightly with wooden hammer for better seating.
- 2) Install hydraulic lash adjuster.

E: INSTALLATION**1. CYLINDER HEAD**

- 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) First tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb) in the order shown in the figure. After this, tighten them further to 69 N·m (7.0 kg-m, 51 ft-lb) in the same order.

(3) Back off all bolts by 180°. After this, back them off another 180°.

(4) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb) in the order shown in the figure.

(5) Tighten all bolts by 80° to 90° in numerical sequence.

CAUTION:

Do not tighten bolts more than 90°.

(6) Further tighten all bolts by 40° to 45° in numerical sequence.

(7) Further tighten bolts ① and ② by 40° to 45°.

CAUTION:

● Ensure that "tightening angle" [steps (6) and (7)] do not exceed 45°.

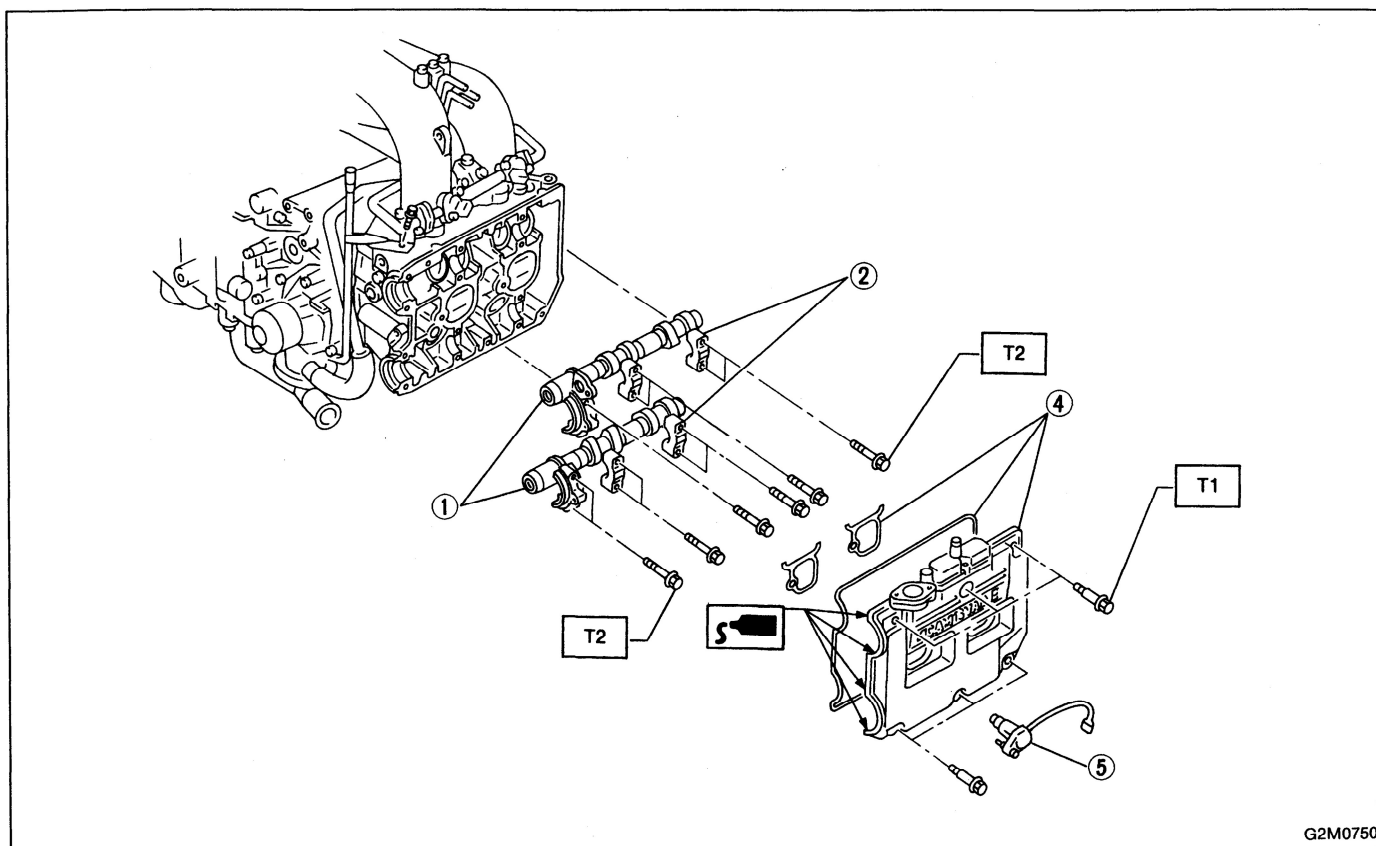
- Ensure that the total "re-tightening angle" [steps (6) and (7)] do not exceed 90°.

3) Install oil level gauge guide attaching bolt (left-hand only).

2. INTAKE MANIFOLD

1) Install camshafts, cylinder head cover and related parts.

<Ref. to 2-3b [W3C0].>



Tightening torque: N·m (kg·m, ft·lb)

T1: 10 ± 0.7 (1.0 ± 0.07 , 7.2 ± 0.5)

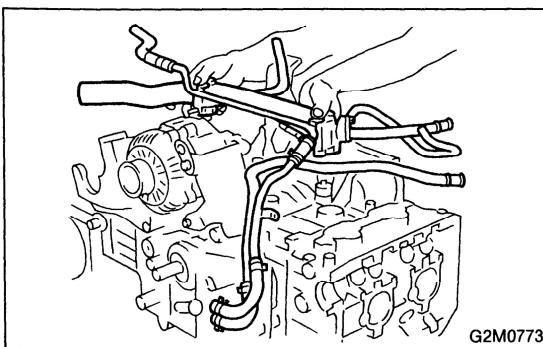
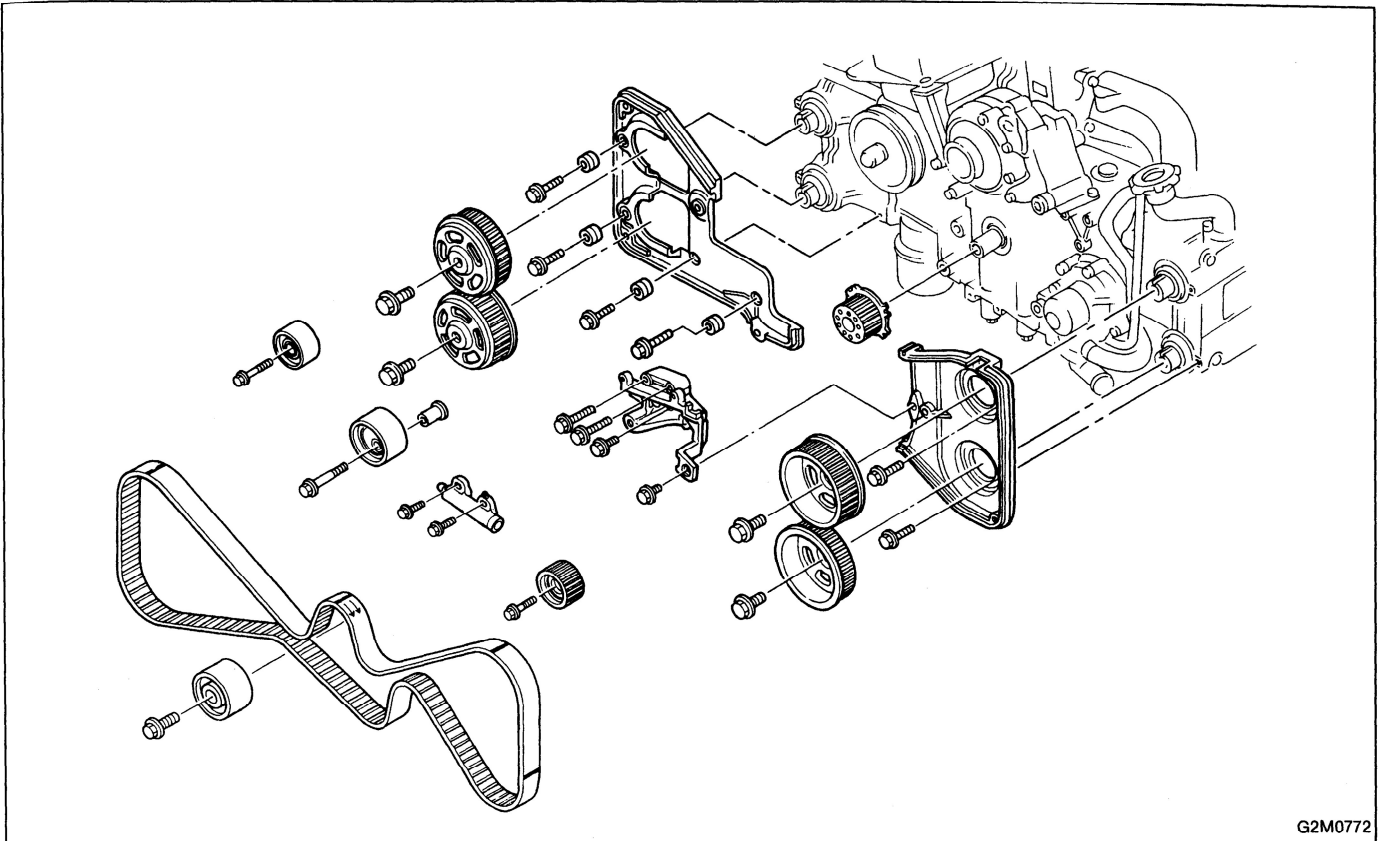
T2: 20 ± 2 (2.0 ± 0.2 , 14.5 ± 1.4)

SERVICE PROCEDURE

[W4E2] 2-3b
4. Cylinder Head

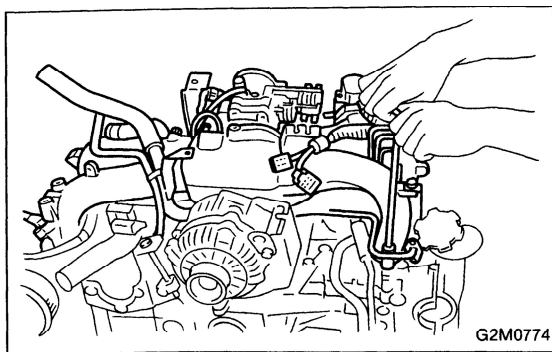
2) Install camshaft sprockets, timing belt and related parts.

<Ref. to 2-3b [W2C0].>



3) Install water pipe.

CAUTION:
Use new gaskets.



4) Install intake manifold.

CAUTION:

Use new gaskets.

5) Install coolant filler tank.

6) Install crankshaft position sensor, camshaft position sensor and knock sensor. Use dry compressed air to remove foreign particles before installing sensors.

7) Connect each connector and/or install connector bracket.

8) Connect hoses and tubes to cylinder block.

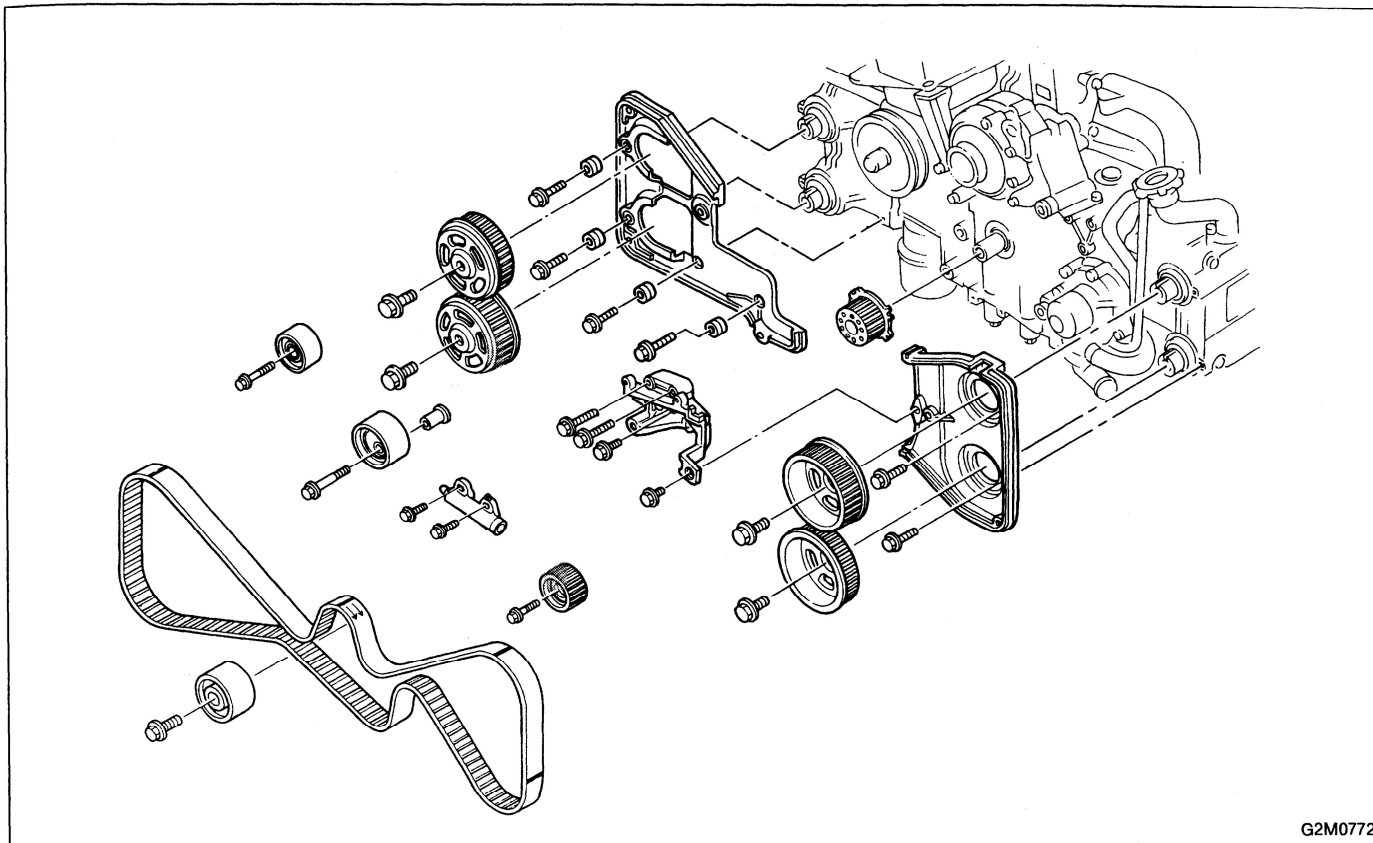
9) Install brackets, alternator and air conditioner compressor.

10) Install V-belt.

5. Cylinder Block**A: REMOVAL****1. RELATED PARTS**

1) Remove timing belt, camshaft sprockets and related parts.

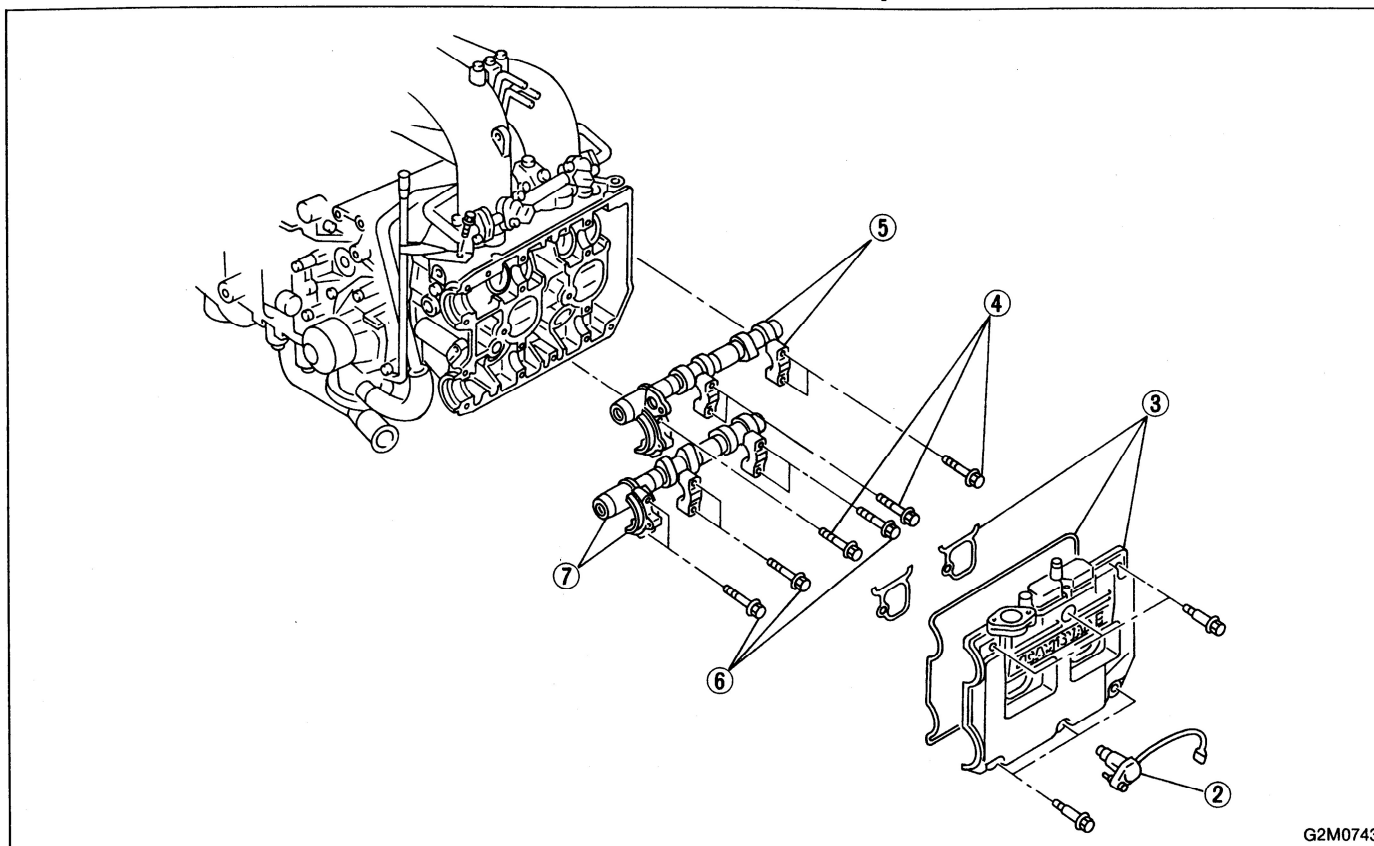
< Ref. to 2-3b [W2A0]. >



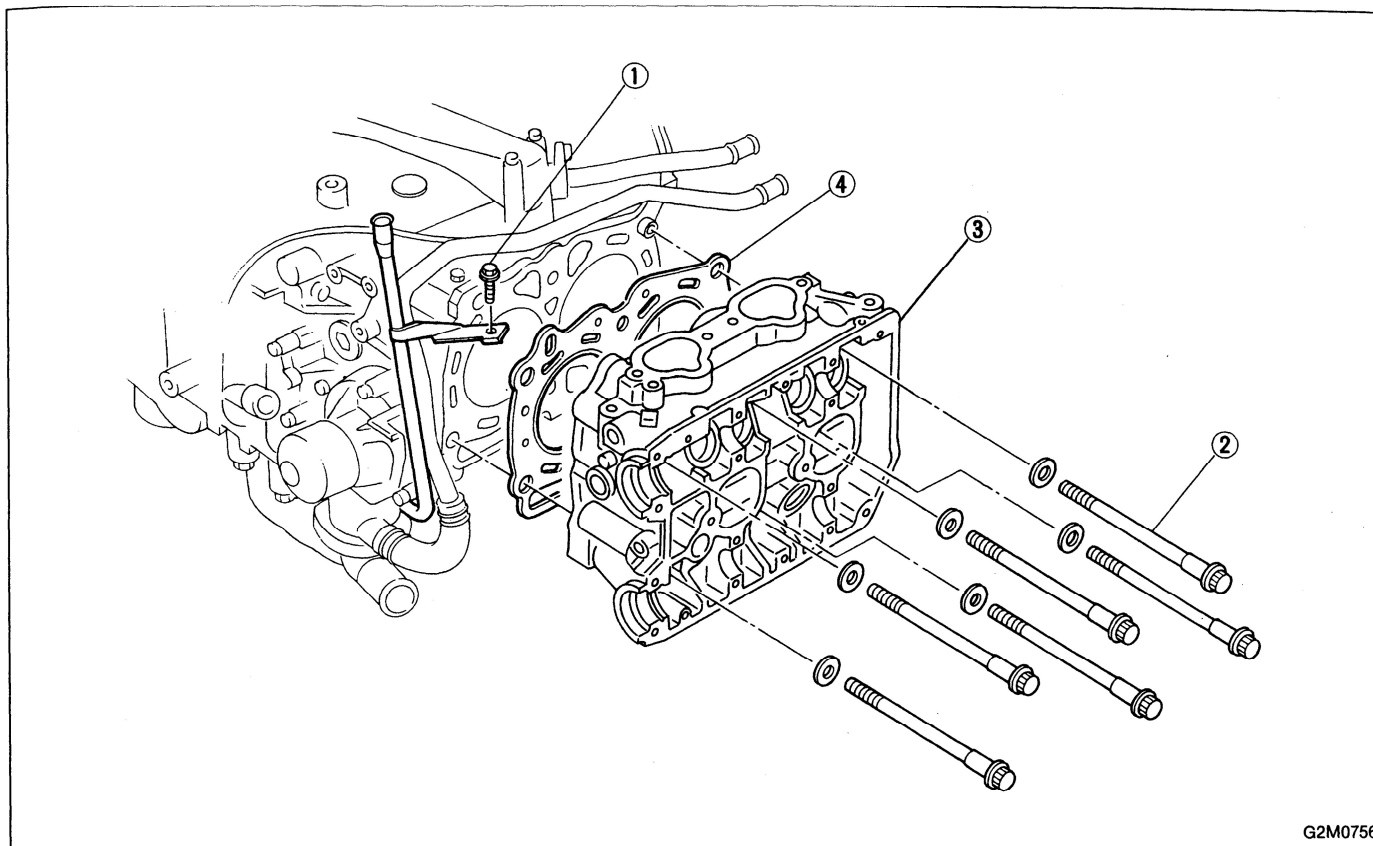
G2M0772

2) Remove cylinder head covers, camshafts and related parts.

< Ref. to 2-3b [W3A0]. >

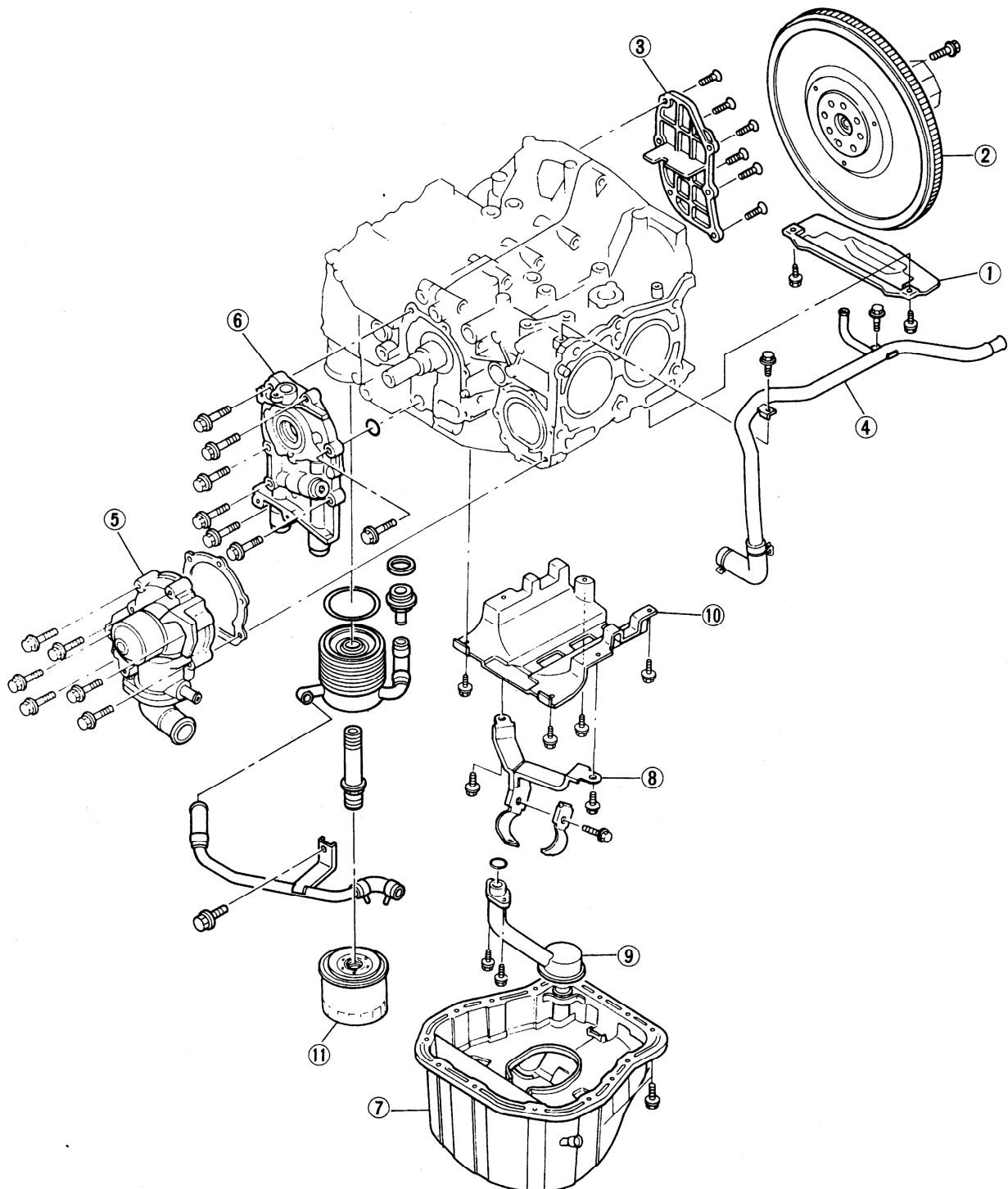


- 3) Remove cylinder heads.
< Ref. to 2-3b [W4A0]. >

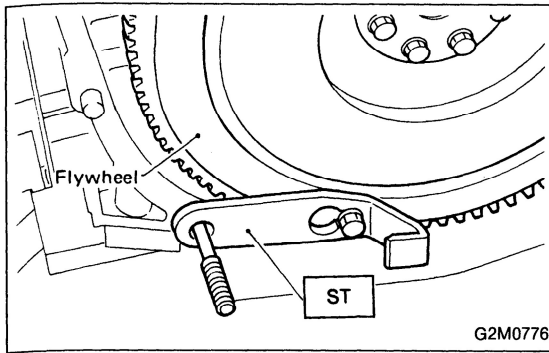


G2M0756

2. OIL PUMP AND ENGINE COOLANT PUMP

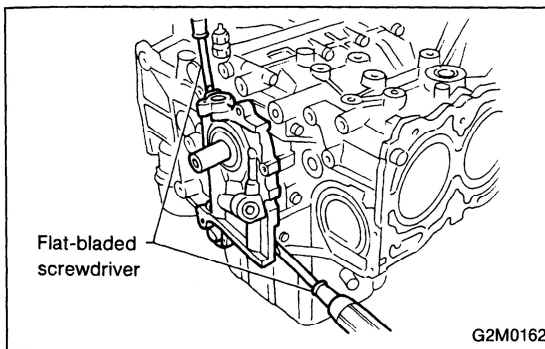


G2M0775



- 1) Remove housing cover.
 - 2) Remove flywheel.
- Using ST, lock crankshaft.
ST 498497100 CRANKSHAFT STOPPER

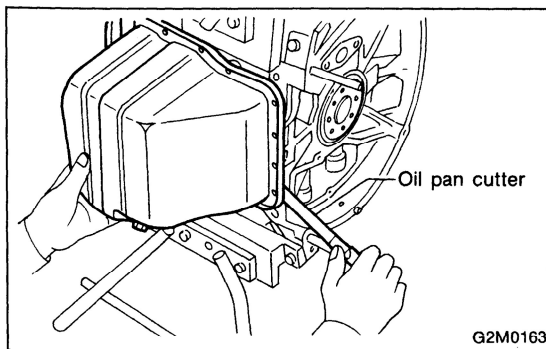
- 3) Remove oil separator cover.
- 4) Remove engine coolant pipe.
- 5) Remove engine coolant pump.



- 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 blade.

- 8) Remove oil strainer stay.
- 9) Remove oil strainer.

SERVICE PROCEDURE

10) Remove baffle plate.

11) Remove oil filter.

12) Disconnect U-shaped hose from cylinder block.

13) Remove bolt which secure engine coolant pipe to cylinder block.

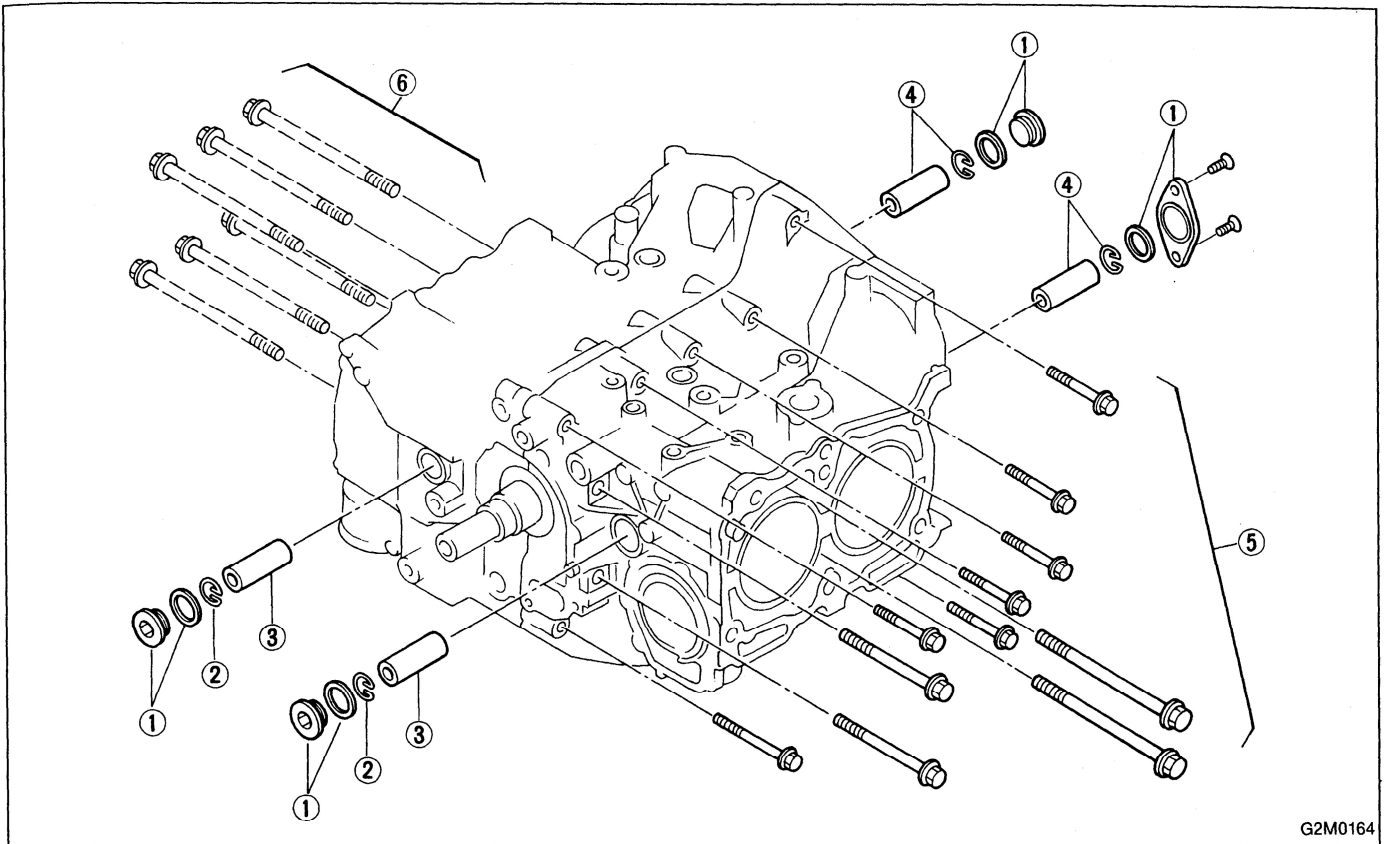
14) Remove connector pipe.

15) Remove oil cooler.

16) Remove engine coolant pipe from oil cooler.

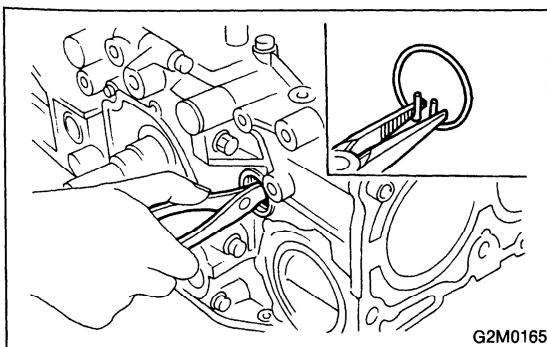
B: DISASSEMBLY

1. PISTON PIN AND CYLINDER BLOCK CONNECTING BOLT



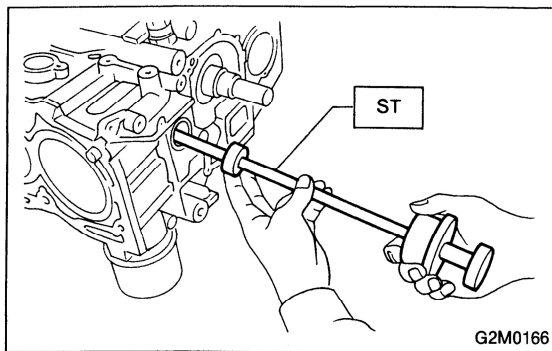
G2M0164

1) Remove service hole cover and service hole plugs using hexagon wrench (14 mm).



G2M0165

2) Rotate crankshaft to bring #1 and #2 pistons to BDC 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 499097500 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 by using ST.

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) 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.

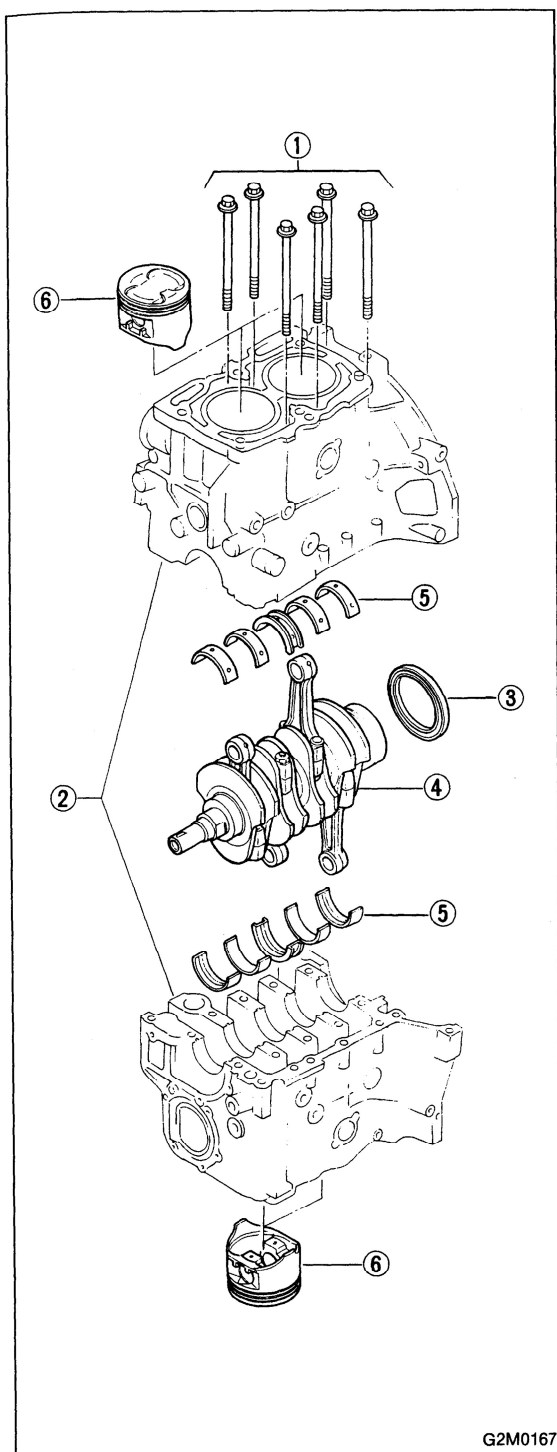
CAUTION:

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.

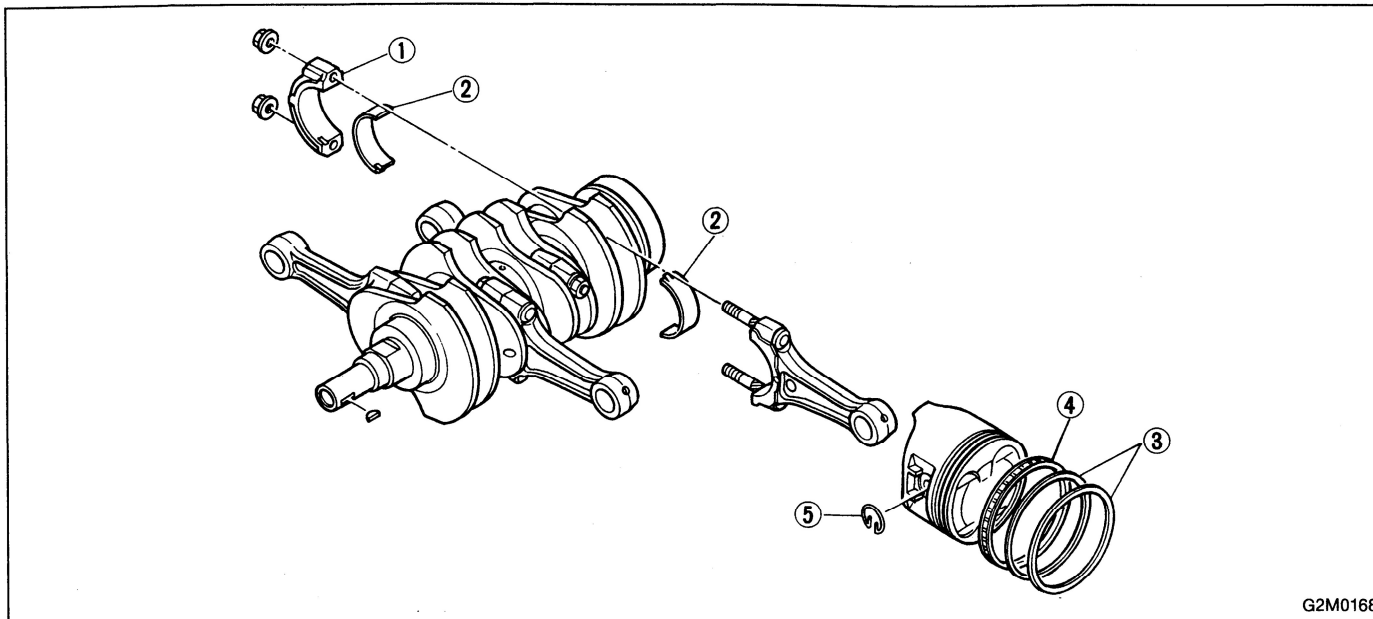
CAUTION:

Do not confuse combination of piston and cylinder.



G2M0167

3. CRANKSHAFT AND PISTON



- 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**

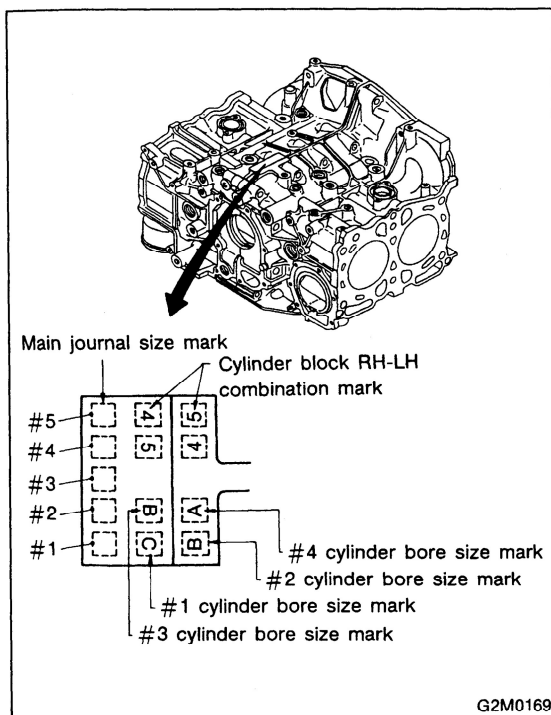
- 1) Check for cracks and damage visually. Especially, inspect important parts by means of red check.
- 2) Check the oil passages for clogging.
- 3) Inspect crankcase surface that mates with cylinder head for warping by using a straight edge, and correct by grinding if necessary.

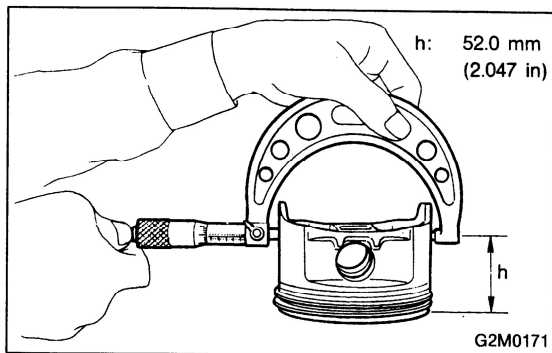
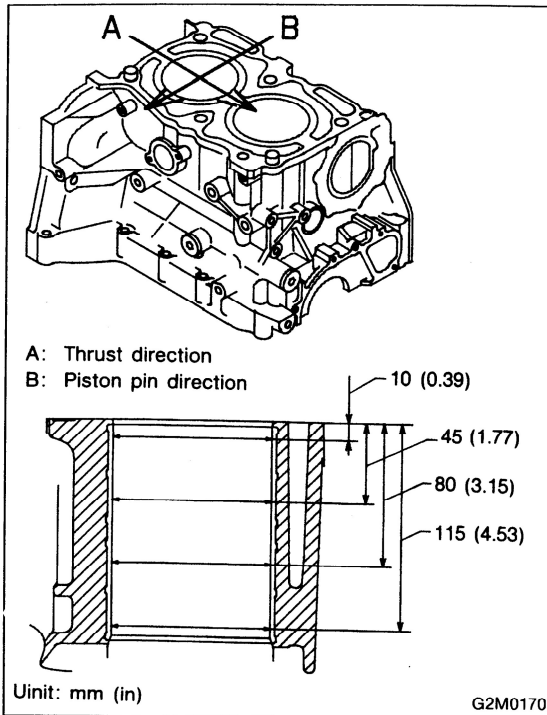
Warping limit:**0.05 mm (0.0020 in)****Grinding limit:****0.1 mm (0.004 in)****2. CYLINDER AND PISTON**

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

NOTE:

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

Standard diameter:**A: 92.005 — 92.015 mm (3.6222 — 3.6226 in)****B: 91.995 — 92.005 mm (3.6218 — 3.6222 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 the figure, using a cylinder bore gauge.

CAUTION:

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

Taper:

Standard

0.015 mm (0.0006 in)

Limit

0.050 mm (0.0020 in)

Out-of-roundness:

Standard

0.010 mm (0.0004 in)

Limit

0.050 mm (0.0020 in)

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

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

CAUTION:

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

Piston outer diameter:

Standard

A: 91.985 — 91.995 mm (3.6214 — 3.6218 in)

B: 91.975 — 91.985 mm (3.6211 — 3.6214 in)

0.25 mm (0.0098 in) oversize

92.225 — 92.235 mm (3.6309 — 3.6313 in)

0.50 mm (0.0197 in) oversize

92.475 — 92.485 mm (3.6407 — 3.6411 in)

5) How to measure the clearance between cylinder and piston

CAUTION:

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

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

Standard

0.010 — 0.030 mm (0.0004 — 0.0012 in)

Limit

0.060 mm (0.0024 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 as instructed in 2. CYLINDER AND PISTON [W5C2]. If any of the clearances is not to specification, replace the piston or bore the cylinder to use an oversize piston.

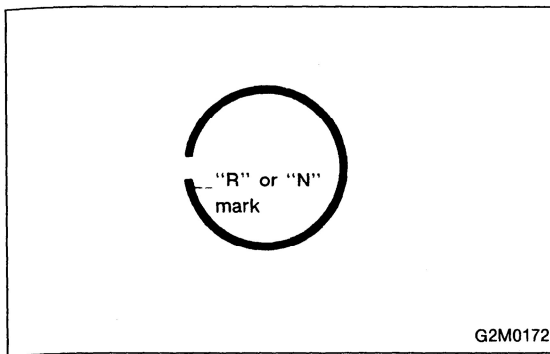
3) Make sure that piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F). Replace if defective.

Standard clearance between piston pin and hole in piston:

0.001 — 0.013 mm (0.00004 — 0.00051 in)

Standard clearance between piston pin and hole in connecting rod:

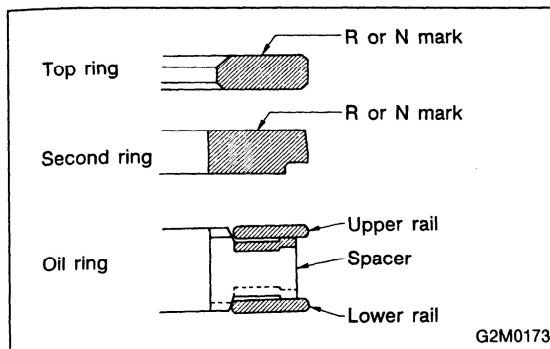
0 — 0.022 mm (0 — 0.0009 in)

**4. PISTON RING**

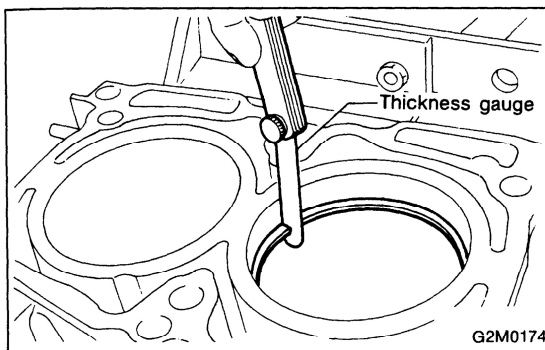
1) If piston ring is broken, damaged, or worn, or if its tension is insufficient, or when the piston is replaced, replace piston ring with a new one of the same size as the piston.

CAUTION:

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



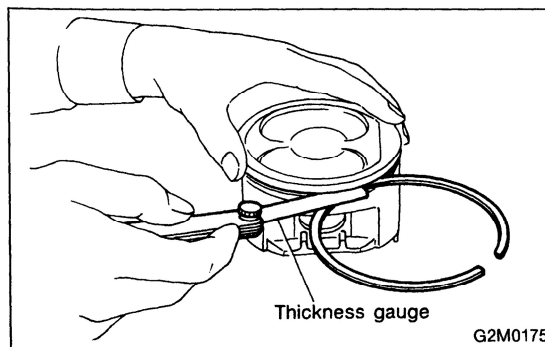
● The oil ring is a combined ring consisting of two rails and a spacer in between. When installing, be careful to assemble correctly.



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 — 0.26 (0.0079 — 0.0102)	0.5 (0.020)
	Second ring	0.37 — 0.52 (0.0146 — 0.0205)	1.0 (0.039)
	Oil ring rail	0.20 — 0.70 (0.0079 — 0.0276)	1.5 (0.059)



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

CAUTION:

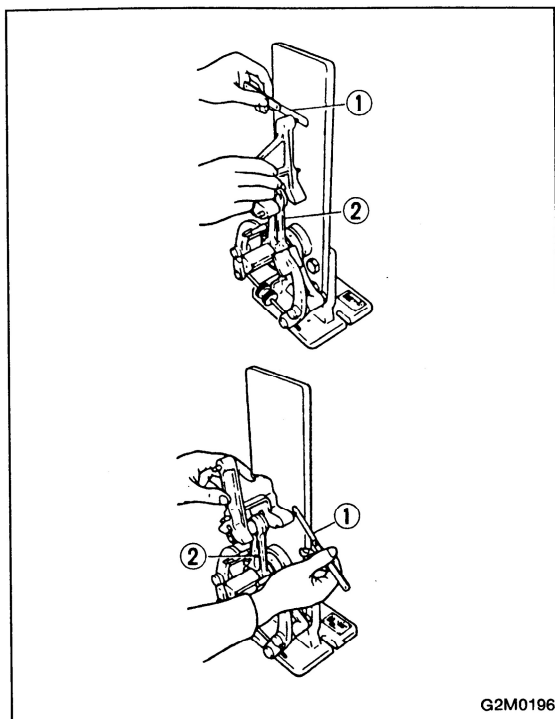
Before measuring the clearance, clean the piston ring groove and piston ring.

Unit: mm (in)

		Standard	Limit
Clearance between piston ring and piston ring groove	Top ring	0.04 — 0.08 (0.0016 — 0.0031)	0.15 (0.0059)
	Second ring	0.03 — 0.07 (0.0012 — 0.0028)	0.15 (0.0059)

5. CONNECTING ROD

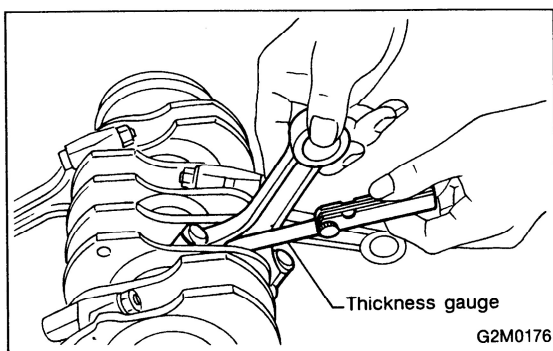
1) Replace connecting rod, if the large or small end thrust surface is damaged.



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)

- ① Thickness gauge
- ② Connecting rod



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 below.)

Connecting rod oil clearance:

Standard

0.0158 — 0.0438 mm (0.0006 — 0.0017 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)	51.984 — 52.000 (2.0466 — 2.0472)
0.03 (0.0012) undersize	1.510 — 1.513 (0.0594 — 0.0596)	51.954 — 51.970 (2.0454 — 2.0461)
0.05 (0.0020) undersize	1.520 — 1.523 (0.0598 — 0.0600)	51.934 — 51.950 (2.0446 — 2.0453)
0.25 (0.0098) undersize	1.620 — 1.623 (0.0638 — 0.0639)	51.734 — 51.750 (2.0368 — 2.0374)

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

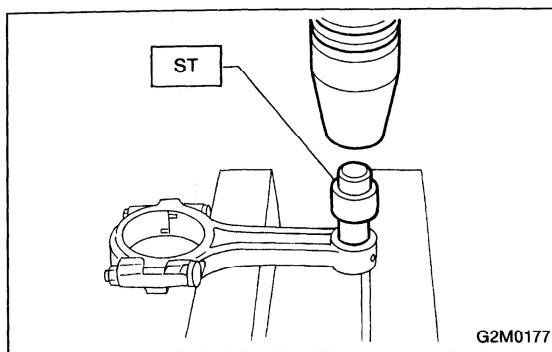
Clearance between piston pin and bushing:

Standard

0 — 0.022 mm (0 — 0.0009 in)

Limit

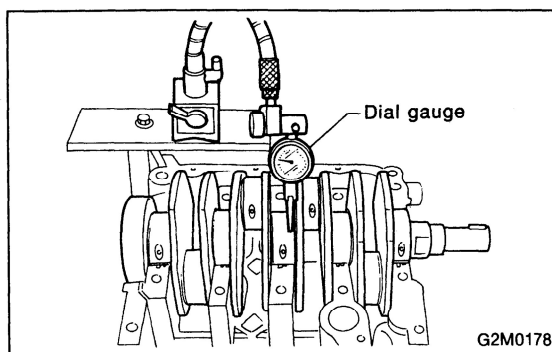
0.030 mm (0.0012 in)



- 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
- (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 check etc., and replace if defective.



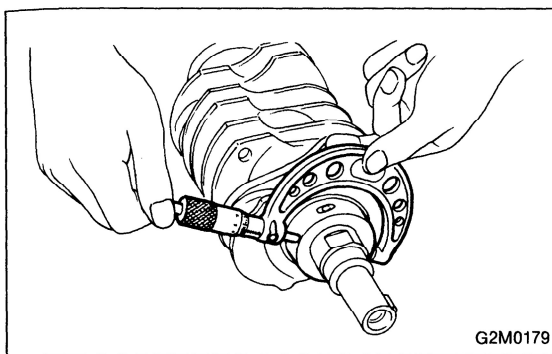
- 2) Measure the crankshaft bend, and correct or replace if it exceeds the limit.

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)



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

0.03 mm (0.0012 in) or less

Taper limit

0.07 mm (0.0028 in)

Grinding limit

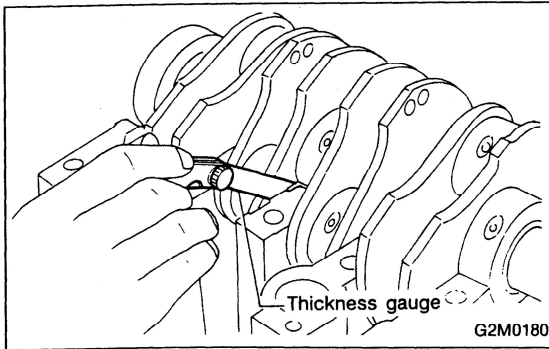
0.25 mm (0.0098 in)

Unit: mm (in)

		Crank journal			Crank pin O.D.
		#1, #5	#2, #4	#3	
Standard	Journal O.D.	59.984 — 60.000 (2.3616 — 2.3622)	59.984 — 60.000 (2.3616 — 2.3622)	59.984 — 60.000 (2.3616 — 2.3622)	51.984 — 52.000 (2.0466 — 2.0472)
	Bearing size (Thickness at center)	1.998 — 2.011 (0.0787 — 0.0792)	2.000 — 2.013 (0.0787 — 0.0793)	2.000 — 2.013 (0.0787 — 0.0793)	1.492 — 1.510 (0.0587 — 0.0594)
0.03 (0.0012) undersize	Journal O.D.	59.954 — 59.970 (2.3604 — 2.3610)	←	←	51.954 — 51.970 (2.0454 — 2.0461)
	Bearing size (Thickness at center)	2.017 — 2.020 (0.0794 — 0.0795)	2.019 — 2.022 (0.0795 — 0.0796)	2.019 — 2.022 (0.0795 — 0.0796)	1.510 — 1.513 (0.0594 — 0.0596)
0.05 (0.0020) undersize	Journal O.D.	59.934 — 59.950 (2.3596 — 2.3602)	←	←	51.934 — 51.950 (2.0446 — 2.0453)
	Bearing size (Thickness at center)	2.027 — 2.030 (0.0798 — 0.0799)	2.029 — 2.032 (0.0799 — 0.0800)	2.029 — 2.032 (0.0799 — 0.0800)	1.520 — 1.523 (0.0598 — 0.0600)
0.25 (0.0098) undersize	Journal O.D.	59.734 — 59.750 (2.3517 — 2.3524)	←	←	51.734 — 51.750 (2.0368 — 2.0374)
	Bearing size (Thickness at center)	2.127 — 2.130 (0.0837 — 0.0839)	2.129 — 2.132 (0.0838 — 0.0839)	2.129 — 2.132 (0.0838 — 0.0839)	1.620 — 1.623 (0.0638 — 0.0639)

O.D. ... Outer diameter

SERVICE PROCEDURE



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

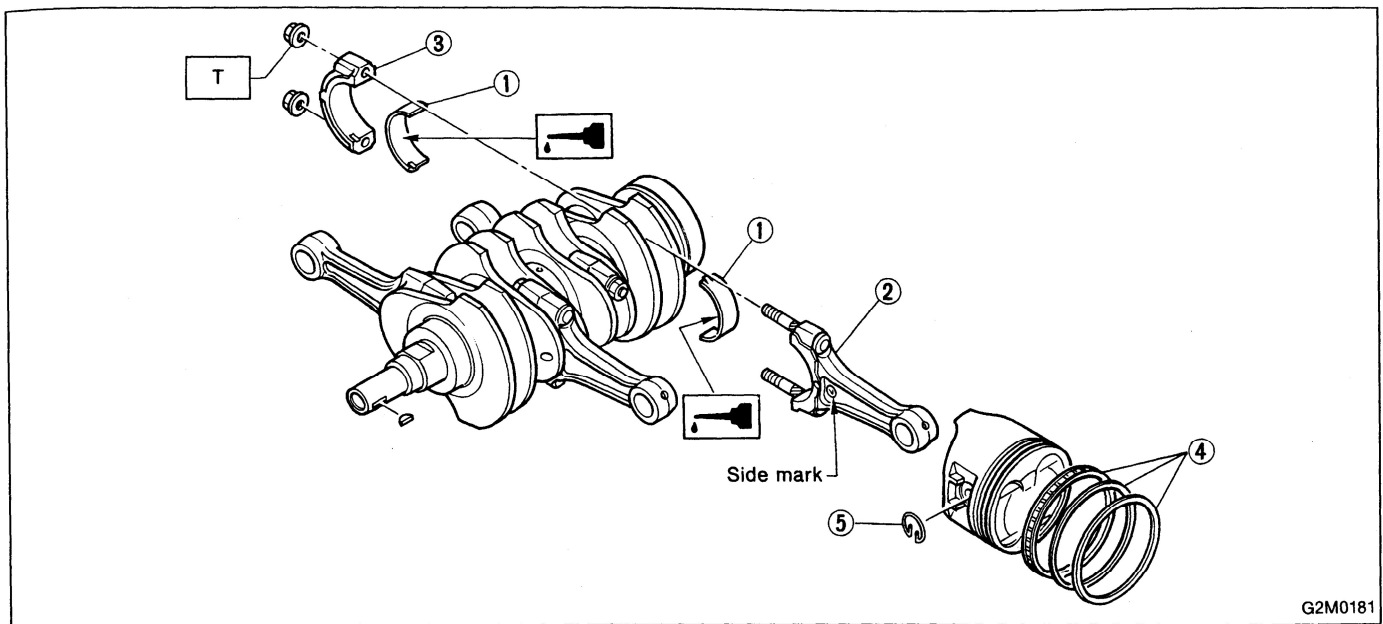
0.25 mm (0.0098 in)

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 under-size one, and replace or recondition crankshaft as necessary.

Unit: mm (in)

Crankshaft oil clearance		
Standard	#1, #5	0.010 — 0.030 (0.0004 — 0.0012)
	#2, #3, #4	0.010 — 0.030 (0.0004 — 0.0012)
Limit	#1, #5	0.040 (0.0016)
	#2, #3, #4	0.035 (0.0014)

D: ASSEMBLY**1. CRANKSHAFT AND PISTON**

Tightening torque: N·m (kg-m, ft-lb)
T: 44.6 ± 1.5 (4.55 ± 0.15, 32.9 ± 1.1)

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:

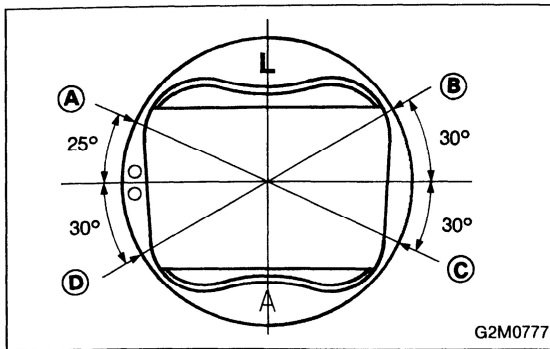
Position each connecting rod with the side marked facing forward.

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

CAUTION:

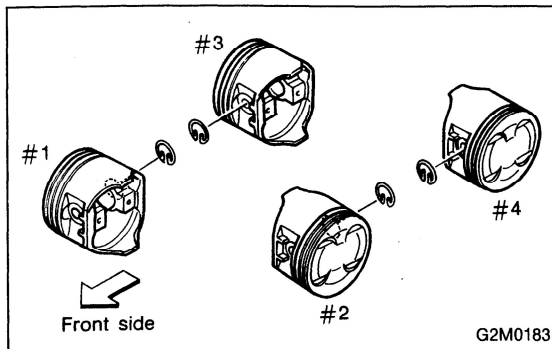
● Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching number.

● 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 gaps of the piston rings and oil ring as shown in the figure.

- (A) : Oil ring lower rail
(B) : Oil ring upper rail
(C) : Top ring
(D) : Second ring



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

2. CYLINDER BLOCK

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

ST 499817000 ENGINE STAND

CAUTION:

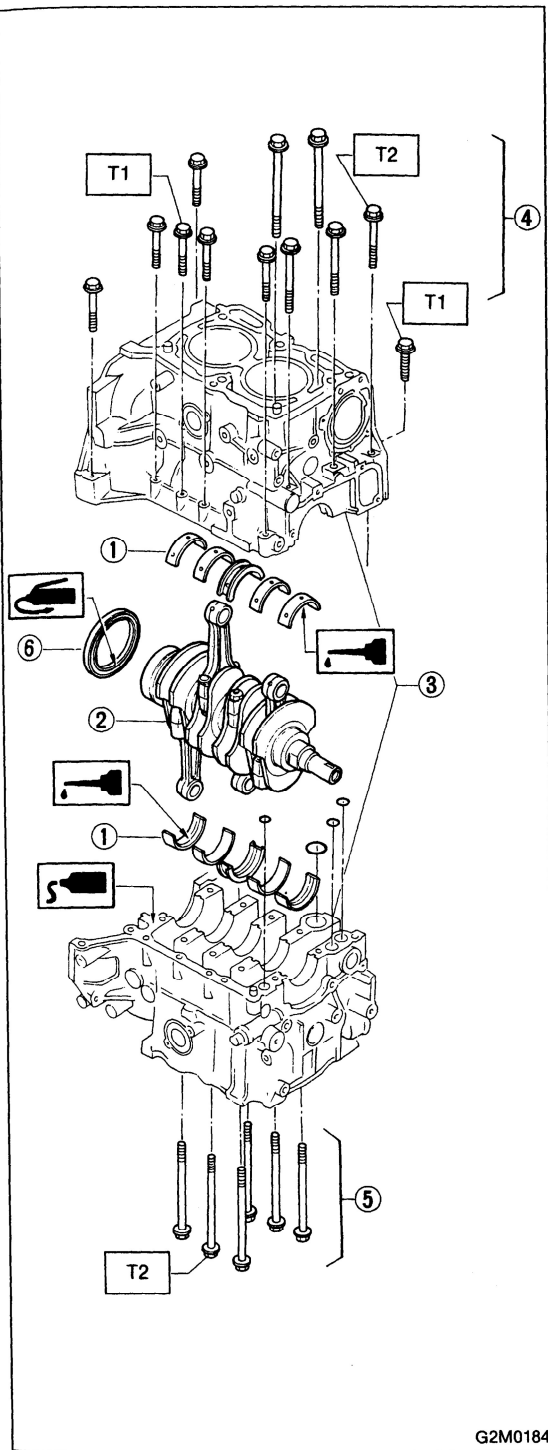
Remove oil the mating surface of bearing and cylinder block before installation. Also apply a coat of engine oil to crankshaft pins.

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

Tightening torque:

T1: 25 ± 5 N·m (2.5 ± 0.5 kg·m, 18.1 ± 3.6 ft·lb)

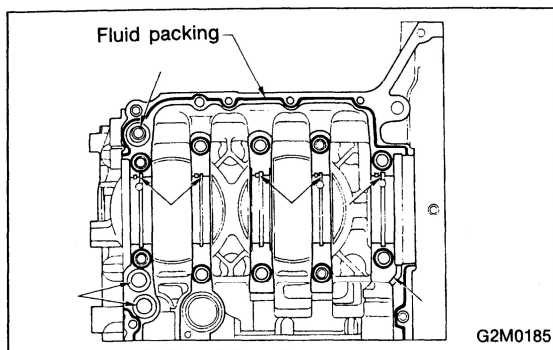
T2: 47 ± 3 N·m (4.8 ± 0.3 kg·m, 34.7 ± 2.2 ft·lb)



2-3b [W5D2]

5. Cylinder Block

SERVICE PROCEDURE



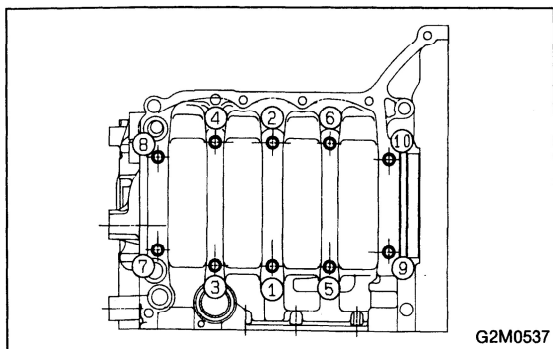
3) Apply fluid packing to the mating surface of #1 and #3 cylinder block, and position it on #2 and #4 cylinder block.

Fluid packing:

THREE BOND 1215 or equivalent

CAUTION:

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

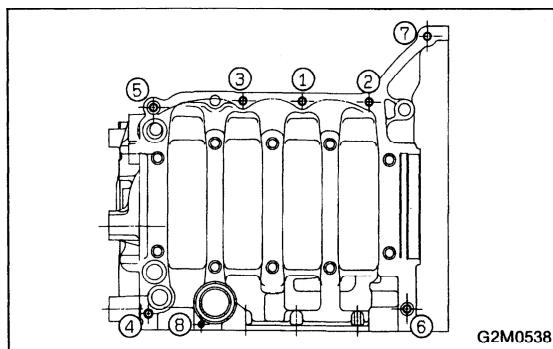


4) Temporarily tighten 10 mm cylinder block connecting bolts in numerical order shown in figure.

5) Tighten 10 mm cylinder block connecting bolts in numerical order.

Tightening torque:

$47 \pm 3 \text{ N}\cdot\text{m}$ ($4.8 \pm 0.3 \text{ kg}\cdot\text{m}$, $34.7 \pm 2.2 \text{ ft}\cdot\text{lb}$)

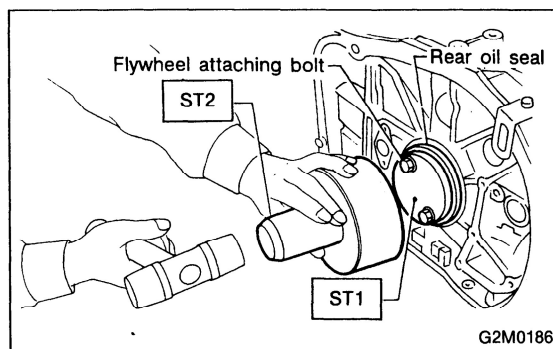


6) Tighten 8 mm and 6 mm cylinder block connecting bolts in numerical order shown in figure.

Tightening torque:

① — ⑦ : $25 \pm 2 \text{ N}\cdot\text{m}$ ($2.5 \pm 0.2 \text{ kg}\cdot\text{m}$, $18.1 \pm 1.4 \text{ ft}\cdot\text{lb}$)

⑧ : $6.4 \text{ N}\cdot\text{m}$ ($0.65 \text{ kg}\cdot\text{m}$, $4.7 \text{ ft}\cdot\text{lb}$)

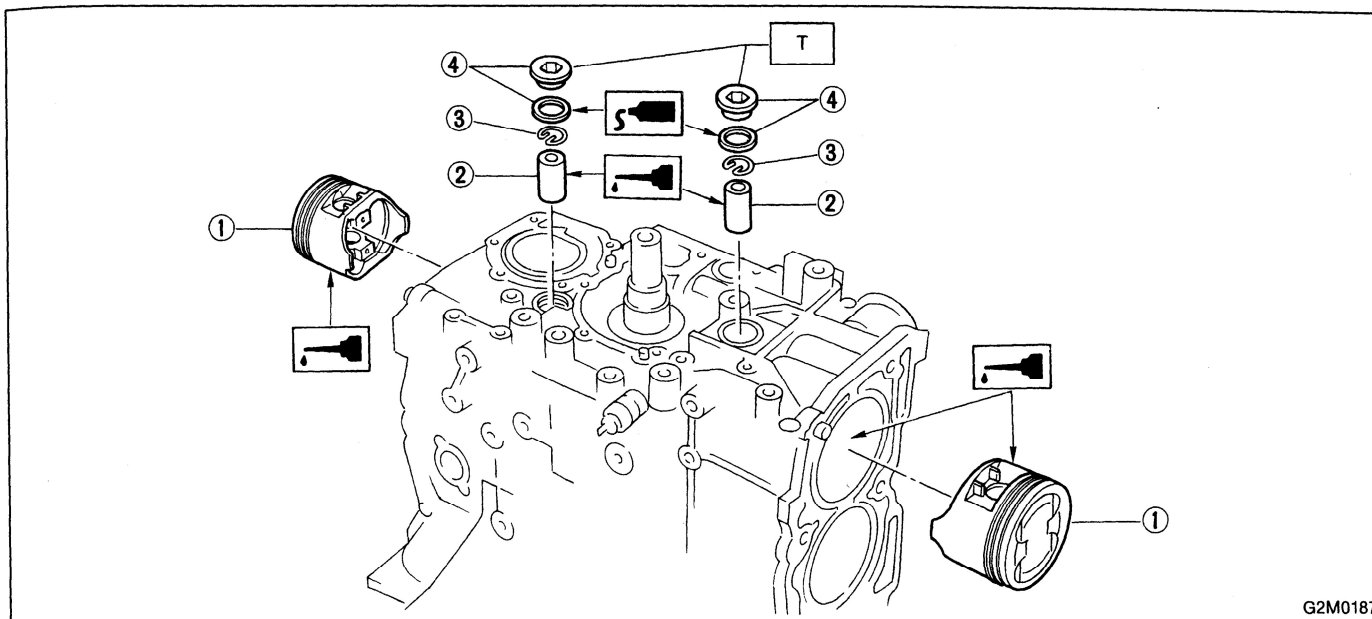


7) Install rear oil seal by using ST1 and ST2.

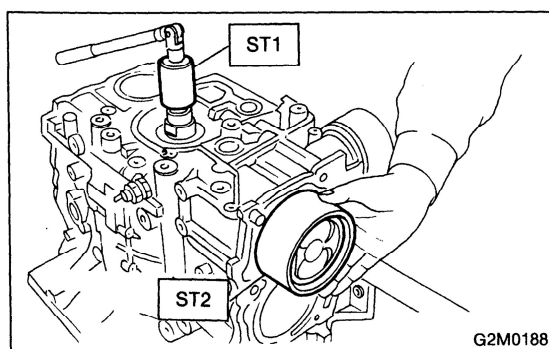
ST1 499597100 OIL SEAL GUIDE

ST2 499587200 OIL SEAL INSTALLER

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



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

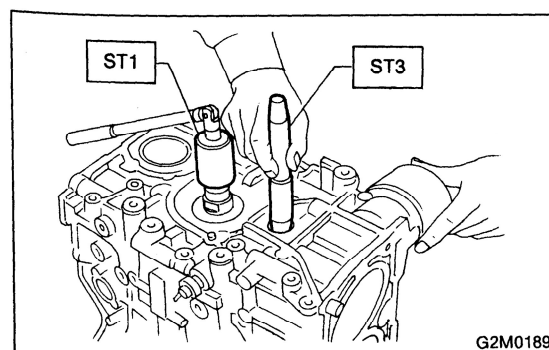


- 1) Installing piston
 - (1) Turn cylinder block so that #1 and #2 cylinders face upward.
 - (2) Using ST1, turn crankshaft so that #1 and #2 connecting rods are set at bottom dead center.

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



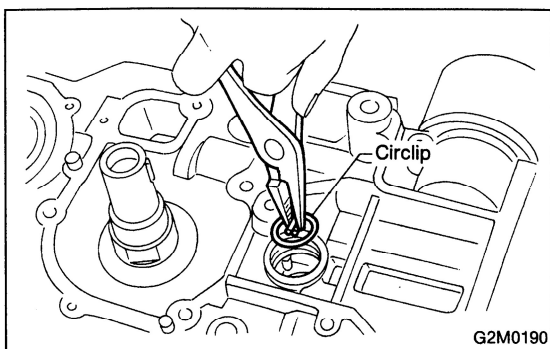
- 2) Installing piston pin
 - (1) Insert ST3 into service hole to align piston pin hole with connecting rod small end.

CAUTION:

Apply a coat of engine oil to ST3 before insertion.

ST3 499017100 PISTON PIN GUIDE

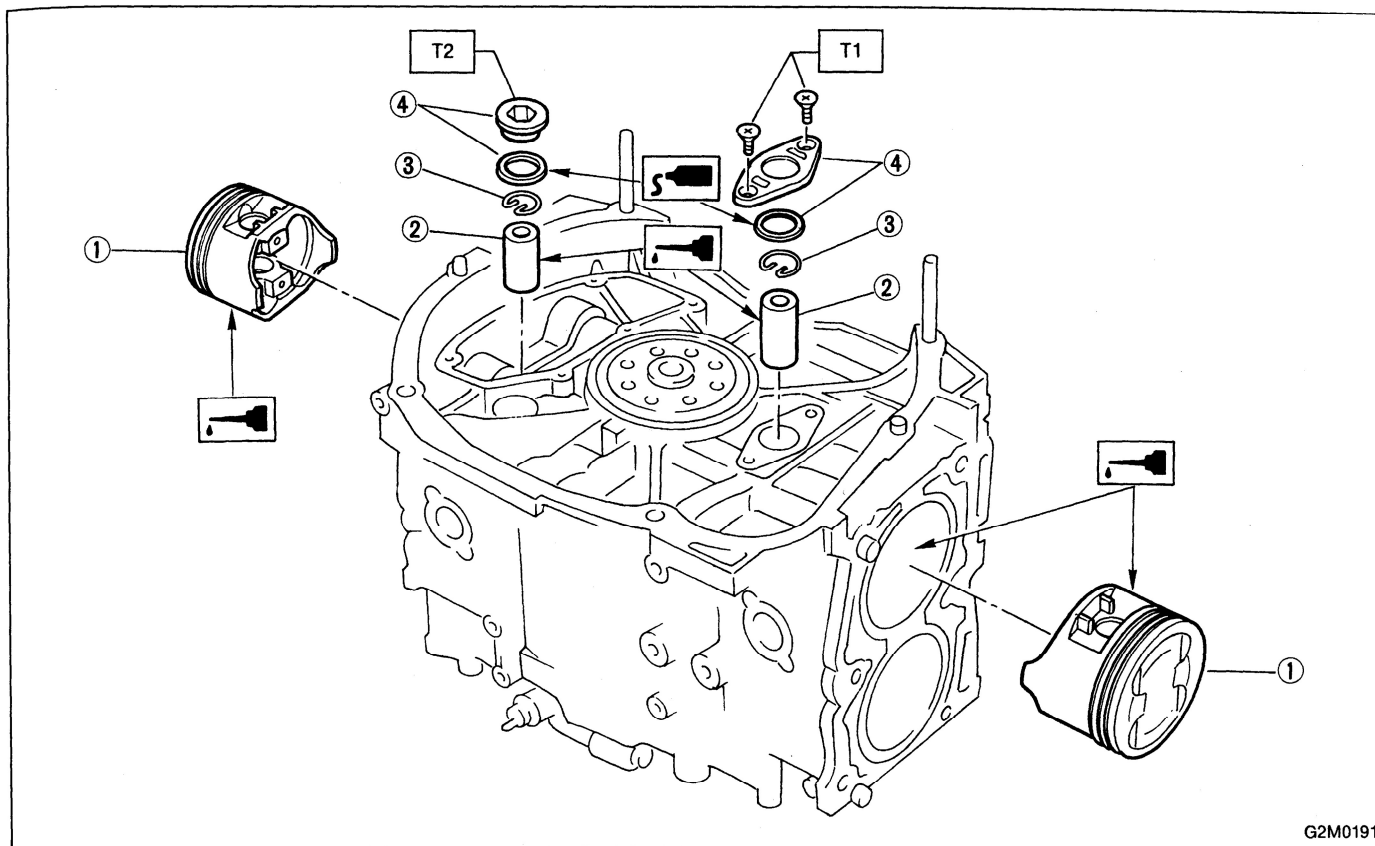
- (2) Apply a coat of engine oil to piston pin and insert piston pin into piston and connecting rod through service hole.



- 3) Install circlip.
CAUTION:
Use a new circlip.

- 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

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



Tightening torque: N·m (kg-m, ft-lb)

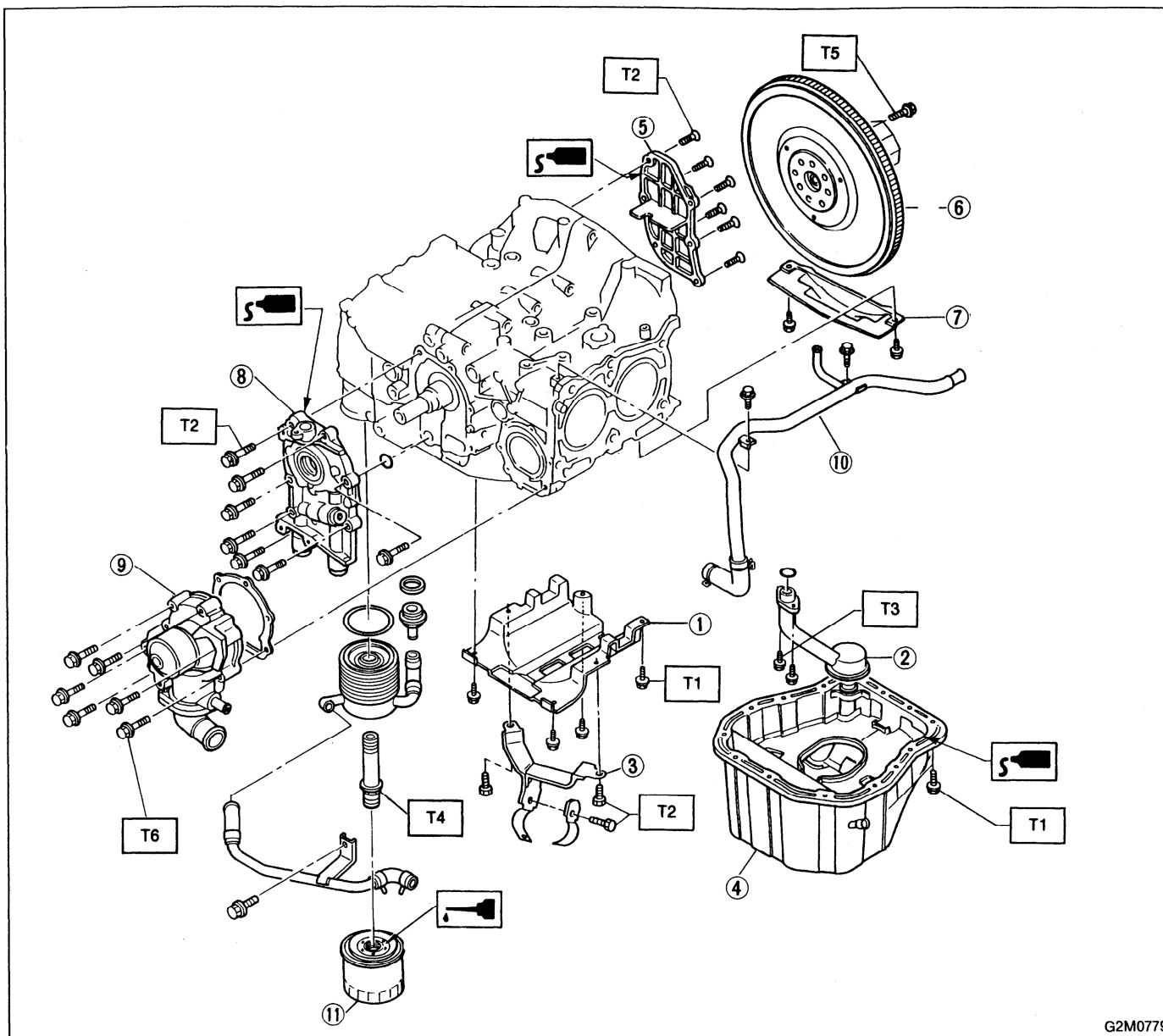
T1: 6.4 (0.65, 4.7)

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

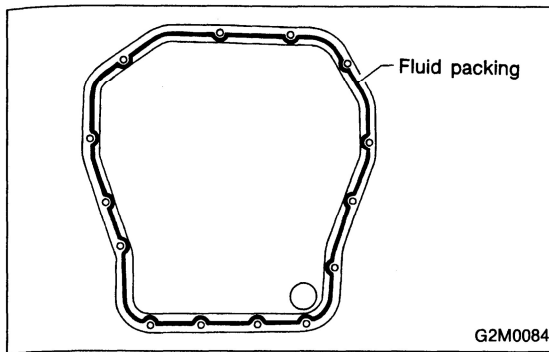
1. OIL PUMP AND ENGINE COOLANT PUMP



G2M0779

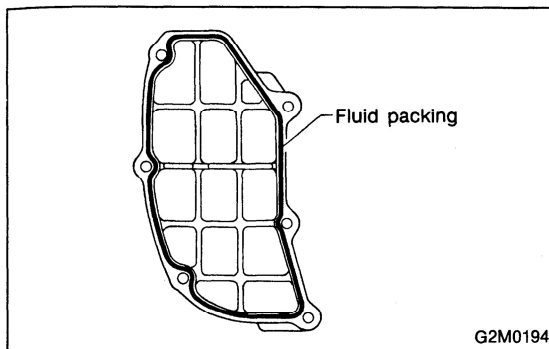
Tightening torque: N·m (kg-m, ft-lb)

- T1: 5 (0.5, 3.6)**
- T2: 6.4 (0.65, 4.7)**
- T3: 10 (1.0, 7)**
- T4: 54 ± 5 (5.5 ± 0.5, 39.8 ± 3.6)**
- T5: 72 ± 3 (7.3 ± 0.3, 52.8 ± 2.2)**
- T6: First 12 ± 2 (1.2 ± 0.2, 8.7 ± 1.4)**
Second 12 ± 2 (1.2 ± 0.2, 8.7 ± 1.4)



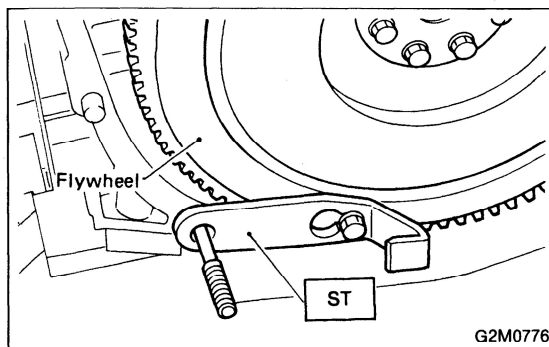
- 1) Install baffle plate.
- 2) Install oil strainer and O-ring
- 3) Install oil strainer stay.
- 4) Apply fluid packing to matching surfaces and install oil pan.

Fluid packing:
THREE BOND 1215 or equivalent

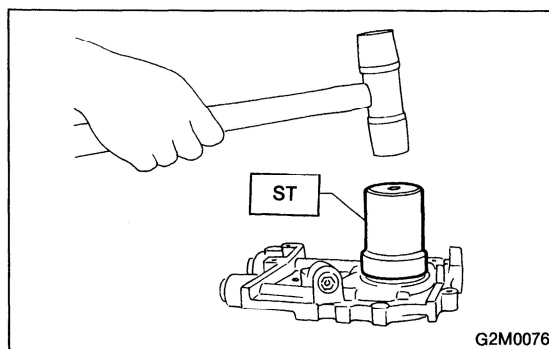


- 5) Apply fluid packing to matching surfaces and install oil separator cover.

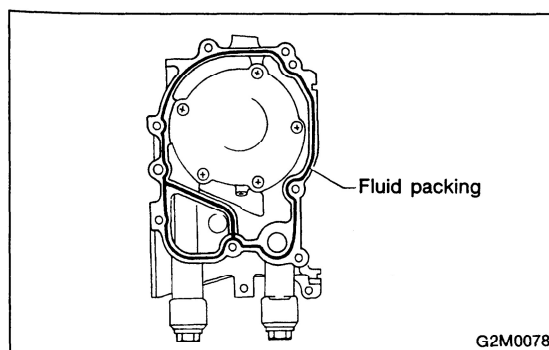
Fluid packing:
THREE BOND 1215 or equivalent



- 6) Install flywheel. Set ST, and tighten retaining bolts.
ST 498497100 CRANKSHAFT STOPPER
- 7) Install housing cover.



- 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

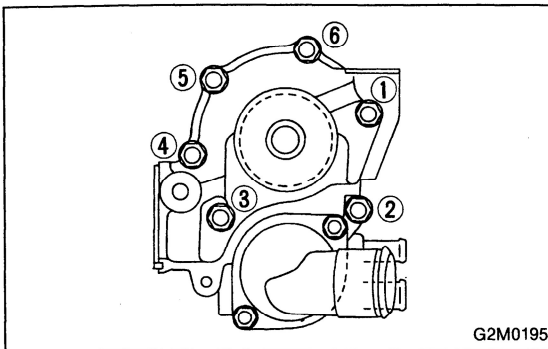
- (3) Install oil pump on cylinder block. Be careful not to damage oil seal during installation.

CAUTION:

- Do not forget to install O-ring and seal when installing oil pump.

SERVICE PROCEDURE

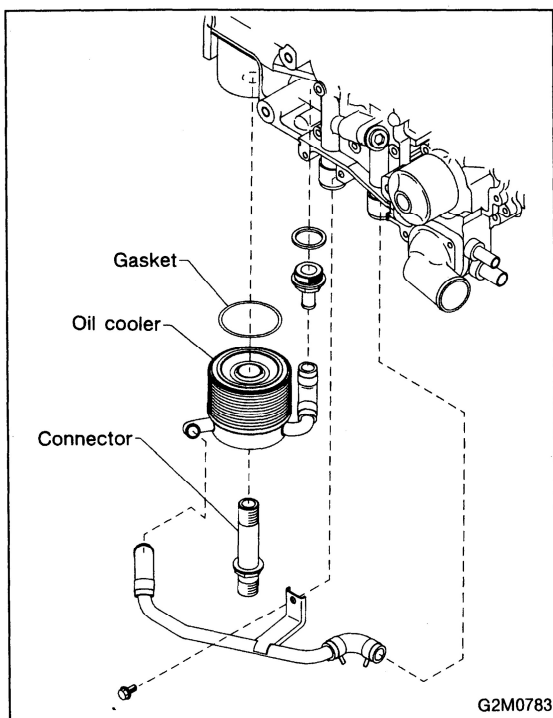
- Align flat surface of oil pump's inner rotor with crankshaft before installation.



9) Install engine coolant pump and gasket.

CAUTION:

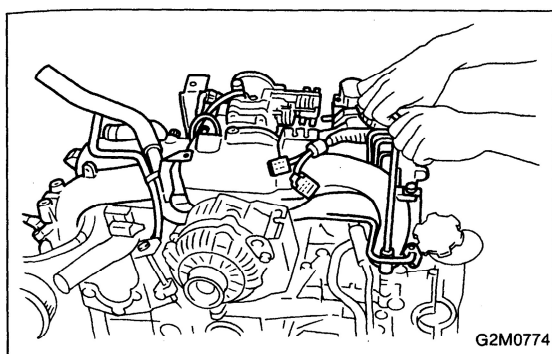
- Be sure to use a new gasket.
 - When installing engine coolant pump, tighten bolts in two stages in numerical sequence as shown in figure.
- 10) Install engine coolant pipes to engine coolant pump.



11) Install oil cooler.

12) Install engine coolant pipe to oil cooler.

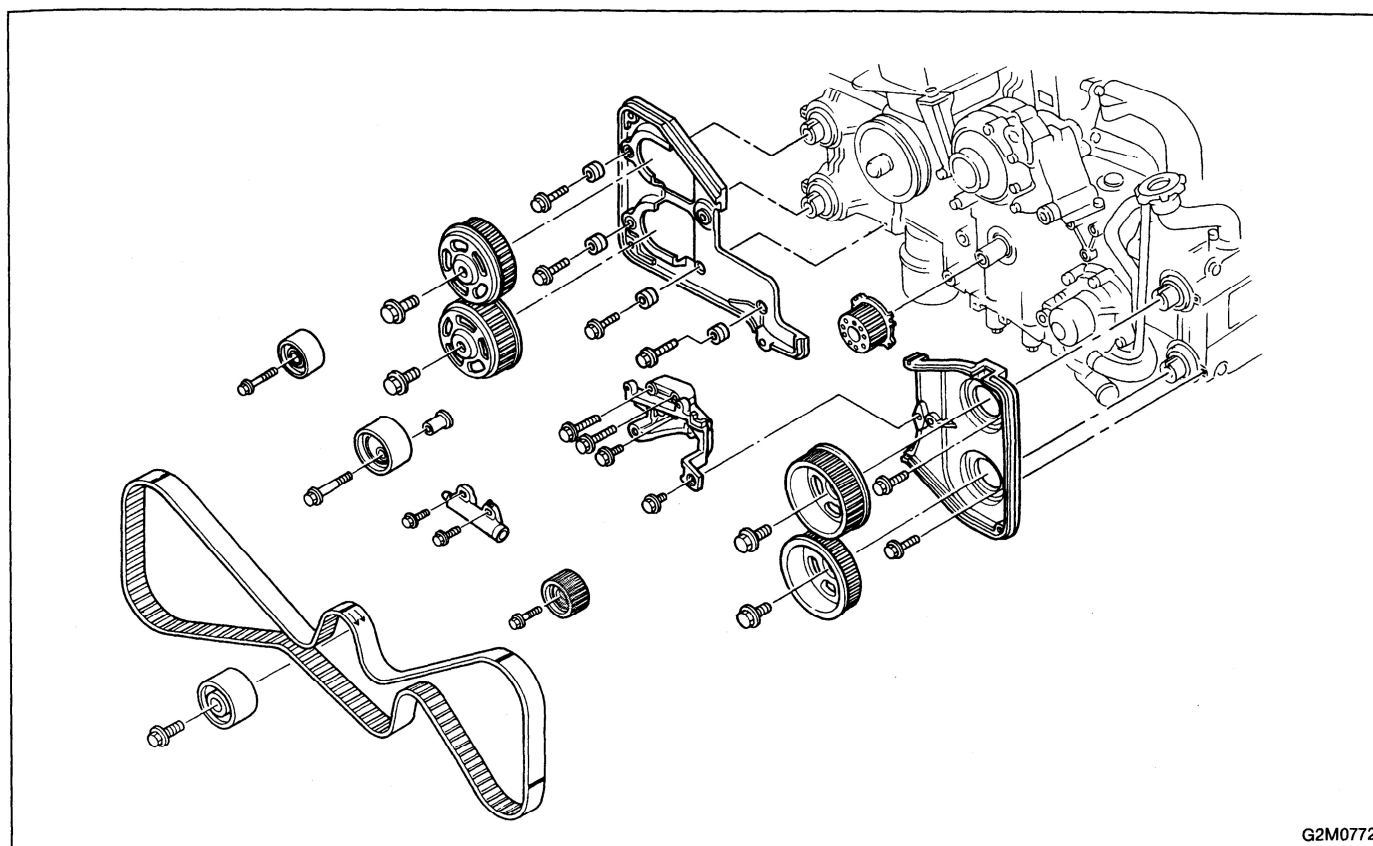
13) Install oil filter.



2. RELATED PARTS

- 1) Install cylinder head and intake manifold.
<Ref. to 2-3b [W6E0].>

- 2) Install timing belt, camshaft sprocket and related parts.
<Ref. to 2-3b [W3C0].>



1. Engine Trouble in General

Numbers shown in the chart refer to the possibility of reason for the trouble in order. ("Very often" to "Rarely")

1 — Very often

2 — Sometimes

3 — Rarely

TROUBLE														
Engine will not start.														
Starter does not turn.	Initial combustion does not occur.	Initial combustion occurs.	Engine stalls after initial combustion.											
													POSSIBLE CAUSE	
2														STARTER
3														● Defective battery-to-starter harness.
3														● Defective starter switch.
2	3													● Defective inhibitor switch.
														● Defective starter.
														BATTERY
1														● Poor terminal connection.
1														● Run-down battery.
2														● Defective charging system.
	1	1	1	1	1	1	1	1	1	1		1		MFI SYSTEM <Ref. to 2-7b.>
														IGNITION SYSTEM
	2	2	2	1	1	1	1	1	1	1		1		● Incorrect ignition timing.
	2	1		2	2	2			3			3		● Disconnection of ignition coil.
	2			3	1	2	2		1	2				● Defective ignitor.
	2			3	2	2								● Defective ignition coil.
	2			3	3	3								● Defective cord or wiring.
		2		2	2	2			1					● Defective spark plug.
	2	2	2	1	2	1	3		2	2				● Incorrect cam timing.

DIAGNOSTICS

[T100] 2-3b

1. Engine Trouble in General

TROUBLE													
Engine will not start.				Rough idle and engine stall.	Low output, hesitation and poor acceleration.	Surging.	Engine does not return to idle.	Dieseling (Run-on).	After burning in exhaust system.	Knocking.	Excessive engine oil consumption.	Excessive fuel consumption.	
Starter does not turn.	Initial combustion does not occur.	Initial combustion occurs.	Engine stalls after initial combustion.										
													INTAKE SYSTEM
		2	2	1	2	2	1	2	2			1	● Improper idle adjustment.
			2	1	1	1			3	1			● Loosened or cracked intake duct.
			3	1	1	1			3	1	1		● Loosened or cracked blow-by hose.
			3	1	2	1	1		2	1			● Loosened or cracked vacuum hose.
			3	2	2	2				1			● Defective air cleaner gasket.
		2	2	2	2	2				1			● Defective intake manifold gasket.
		2	2	2	2	2				1			● Defective throttle body gasket.
				3	2	2			2	2	2		● Defective PCV valve.
				2	2	2			3	2	3		● Loosened oil filler cap.
			3	3	1	2				2		1	● Dirty air cleaner element.
													FUEL LINE
	1	3		3	2	2							● Defective fuel pump.
		3	3	3	2	2							● Clogged fuel line.
	2	2	2	2	3	3							● Lack of or insufficient fuel.
													BELT
	2	2	2										● Defective.
	2	2	2	3	2	2			2	2		2	● Defective timing.
													FRICTION
3													● Seizure of crankshaft and connecting rod bearing.
3													● Seized camshaft.
3													● Seized or stuck piston and cylinder.
													COMPRESSION
	3	3	3	2	2	2			2	3		2	● Defective hydraulic lash adjuster.
	3	3	3	2	2	3			3			3	● Loosened spark plugs or defective gasket.
	3	3	3	2	2	3			3			3	● Loosened cylinder head nuts or defective gasket.
	3	3	3	2	2	3			2			2	● Improper valve seating.
	3	3	3	3	3	3			3		1	3	● Defective valve stem.
	2	2	2	2	2	3			3			3	● Worn or broken valve spring.
	3	3	3	2	3	3			3		1	2	● Worn or stuck piston rings, cylinder and piston.
	2	2	2	1	1	1			1	2		2	● Incorrect valve timing.
	2	2	2	2	2	2							● Improper engine oil (low viscosity).

1. Engine Trouble in General

1. Engine Trouble in General

1. Engine Trouble in General

2. Engine Noise

Hydraulic valve lash adjusters may make clicking noise once engine starts. It is normal if clicking noise ceases after a few minutes.

If clicking noise continues after a few minutes, check engine oil level and add oil if necessary. Warm-up engine for five minutes, then operate it at approximately 3,000 rpm for twenty minutes. If noise still exists, conduct diagnostics procedures in accordance with the following table.

CAUTION:

Do not disconnect ignition coil from spark plug while engine is running.

Type of sound	Condition	Possible cause
Regular clicking sound.	Sound increases as engine speed increases.	Valve mechanism is defective ● Broken lash adjuster. ● Worn valve rocker. ● Worn camshaft. ● Broken valve spring. ● Worn valve lifter hole.
Heavy and dull metallic knock.	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 metallic knock. (Engine knocking)	Sound is noticeable when accelerating with an overload.	● Ignition timing advanced. ● Accumulation of carbon inside combustion chamber. ● Wrong spark plug. ● Improper gasoline.
Metallic knock when engine speed is medium (1,000 to 2,000 rpm).	Sound is reduced when fuel injector connector of noisy cylinder is disconnected.	● 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.	● 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.	● Unusually worn valve lifter. ● Worn cam sprocket gear. ● Worn camshaft journal bore in crankcase.
Squeaky sound.	—	● Insufficient alternator lubrication.
Rubbing sound.	—	● Defective alternator 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 timing 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.