SUBARU

SVX

1992

M MECHANISM AND FUNCTION

1. General

The Subaru 3300cc, 6-cylinders engine is made from aluminum alloy and is horizontally opposed. It is a 4-stroke cycle, water-cooled, DOHC 24-valve engine. The fuel system utilizes an MPFI (multiple fuel injection) design.

A summary of the major construction and function features is given below.

- The cylinder head is a center-plug type that utilizes pentroof combustion chambers. The four valve design is provided with two intake valves and two exhaust valves per cylinder. The intake and exhaust ports are arranged in a cross-flow design.
- The exhaust camshafts on the left and right banks are driven by a single timing belt, and a gear on the exhaust side camshaft engages with a gear on the intake side camshaft to drive it.
- A single timing belt drives two camshafts on the left and right banks and the water pump on the right bank. Belt tension is automatically adjusted to eliminate maintenance.
- The crankshaft is supported by seven bearings to provide high rigidity and strength.
- The cylinder block is made from aluminum diecast which is integrated with cast-iron cylinder liners.

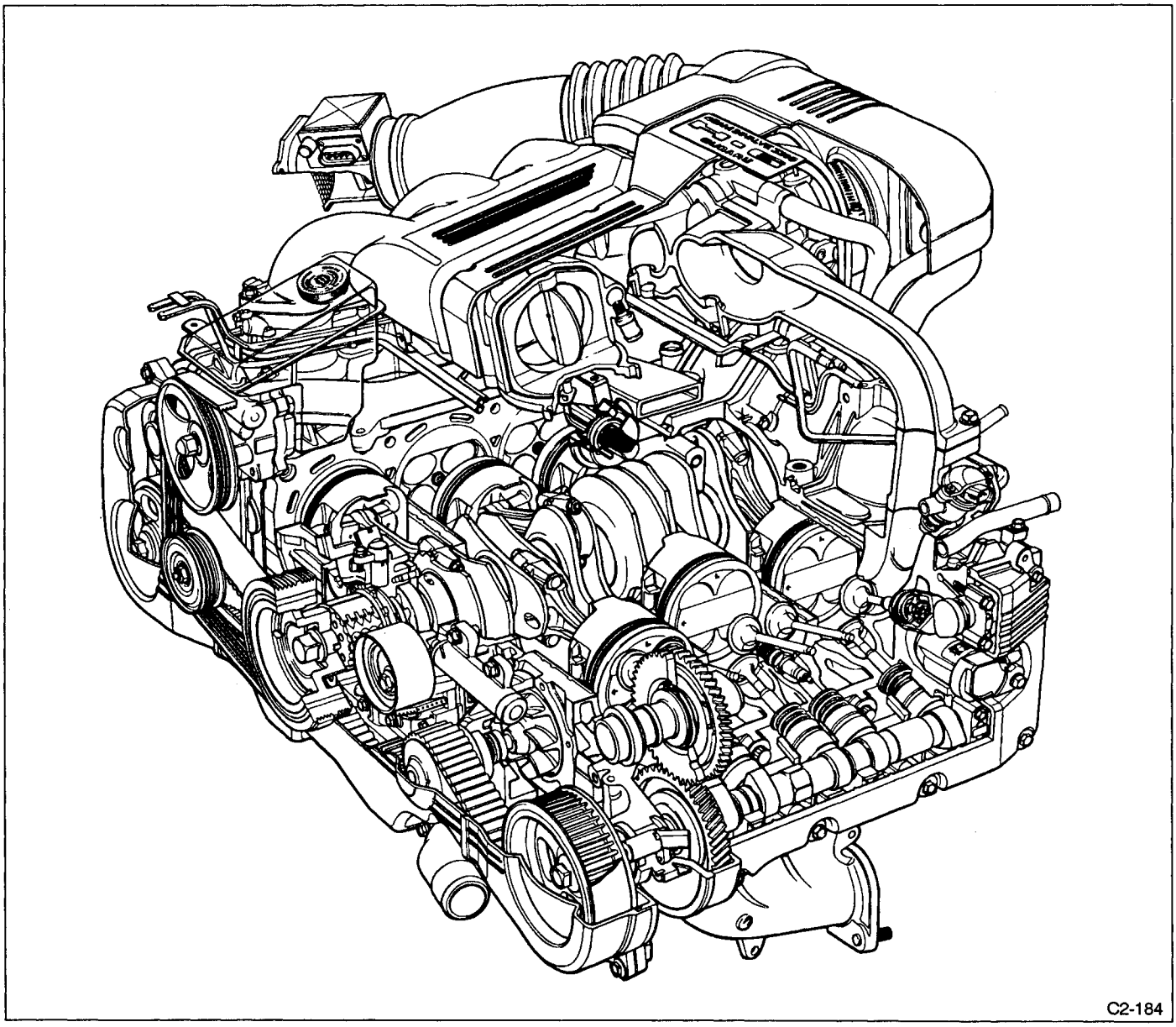


Fig. 1

2. Timing Belt

A single timing belt drives two exhaust camshafts (one in the left bank and one in the right bank). The back of the belt also drives the water pump.
The timing belt teeth have a specially designed round profile to provide quiet operation. The timing belt is composed of a strong and inflexible core wire, a wear-resistant canvas and heat-resistant rubber material.
A hydraulic belt-tension adjuster constantly maintains specified belt tension to properly drive the camshafts, as well as to provide a "maintenance-free" advantage.

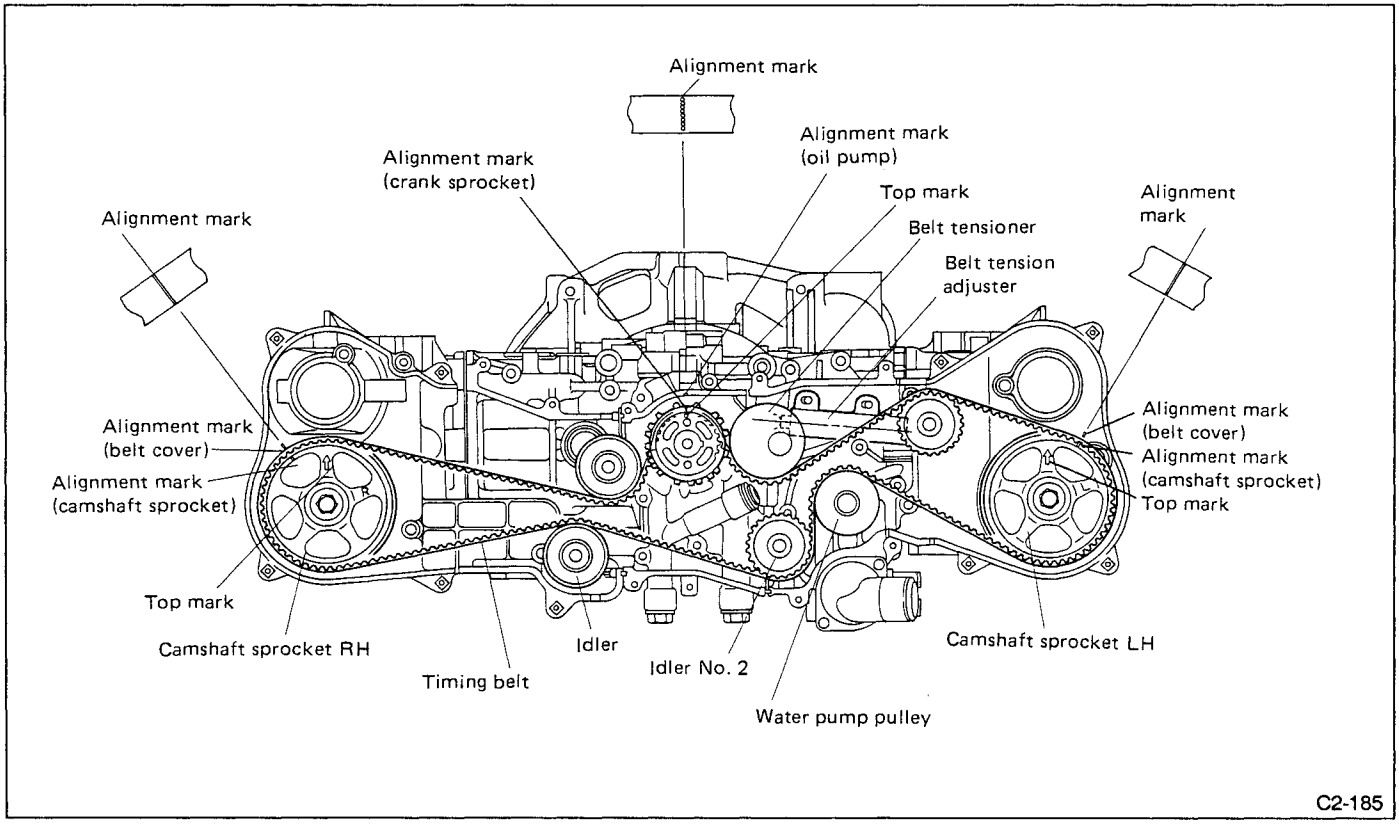


Fig. 2

3. Belt Tension Adjuster

The belt tension adjuster provides a constant value of tension for the timing belt. Proper belt tension is maintained using a rod to push the tension pulley. The location of the tensioner pulley shaft center is offset in relation to the center of the pulley's outside diameter. The tensioner adjuster rod provides a rotary movement for the tensioner pulley by both tension of the spring housed in the adjuster.

(1) Action when the belt is loose

When the belt is loose, the force between the arm and rod is unbalanced so that the rod is pushed out to the left by the force of the main spring. Then, the oil pressure in the reservoir compressed by the pressure of the main spring is increased more than in the oil pressure chamber, and the oil in the reservoir pushes past the check ball to flow into the oil pressure chamber. In this way the rod is pushed to the left until the force between the arm and rod is balanced. Since the thrust F works to the arm, the pulley is rotated counterclockwise, giving tension PB to the belt.

(2) Action for balancing the belt tension

When tension PB is given to the belt and the belt tension reaches the normal level, the belt generates the reaction TB, which works as the reaction P at the pressure cone apex of the rod. Since the reaction force pushes the rod to the right, the check ball in the oil pressure chamber is closed. When the rod is pushed to the left by the oil inflow, the balance between the rod and arm is maintained to stop the arm, and the belt tension is maintained at the fixed level.

(3) Action when the belt is too tight

When the timing belt reaction force increases to such an extent that the belt will be too tight, the arm force P is larger than the rod thrust F. Consequently, the oil in the oil pressure chamber passes through the clearance between the adjuster body and rod and is returned to the reservoir in small amounts. This oil return is stopped when the rod thrust F and arm force P are balanced to maintain tension at the fixed level.

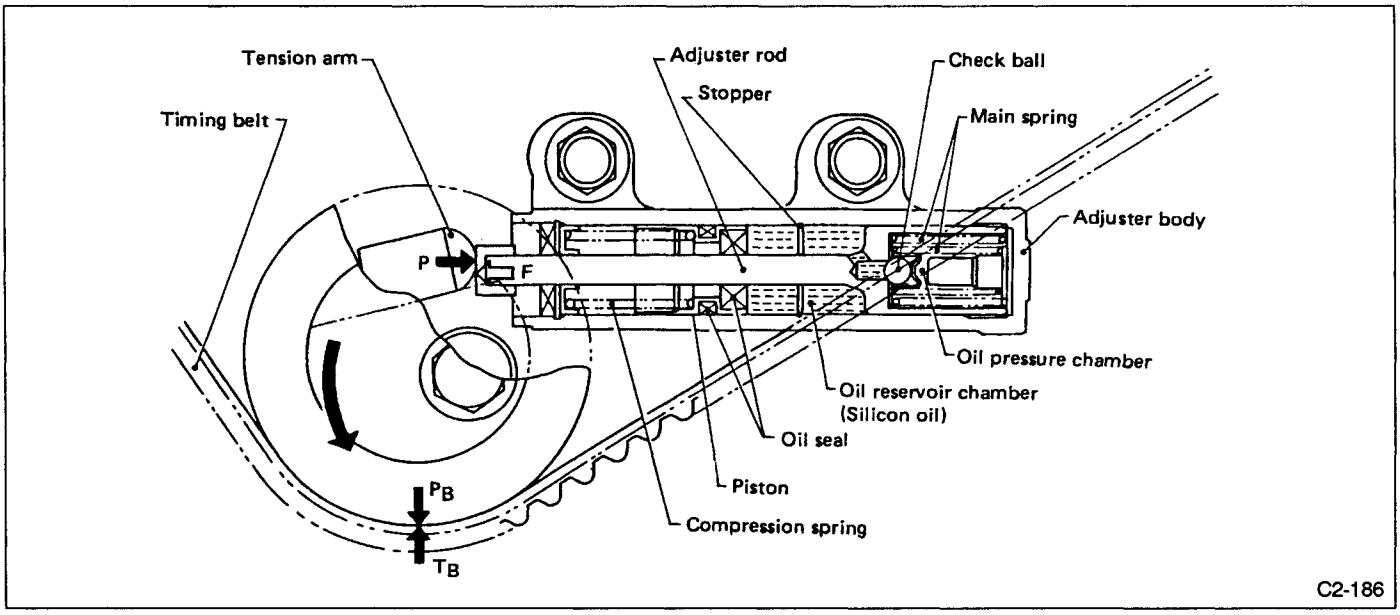


Fig. 3

4. Belt Cover

The belt cover is made of synthetic resin molding which is lightweight and heat resistant. It has a totally enclosed design that utilizes rubber packing at the mating surface of the cylinder block. This eliminates the chance of dust and water from entering the interior.
A floating design is utilized by placing rubber mounting between the cylinder block and belt cover to prevent the transmission of noise and vibration.
The front belt cover has a graduated line for ignition-timing confirmation.

5. Camshaft

The DOHC engine uses four camshafts in all; intake and exhaust camshafts on the RH bank and intake and exhaust camshafts on the LH bank.
Each camshaft has a gear which allows the exhaust camshaft to drive the intake camshaft. The intake camshaft also has a sub gear for eliminating gear backlash, thereby reducing gear noise.
The cam nose part is finished with "chill" treatment to increase wear resistance and anti-scuffing properties.
Each camshaft is supported by four journals with three camshaft caps and a front camshaft cap. Each camshaft flange is supported by a groove provided in the cylinder head to receive thrust force.

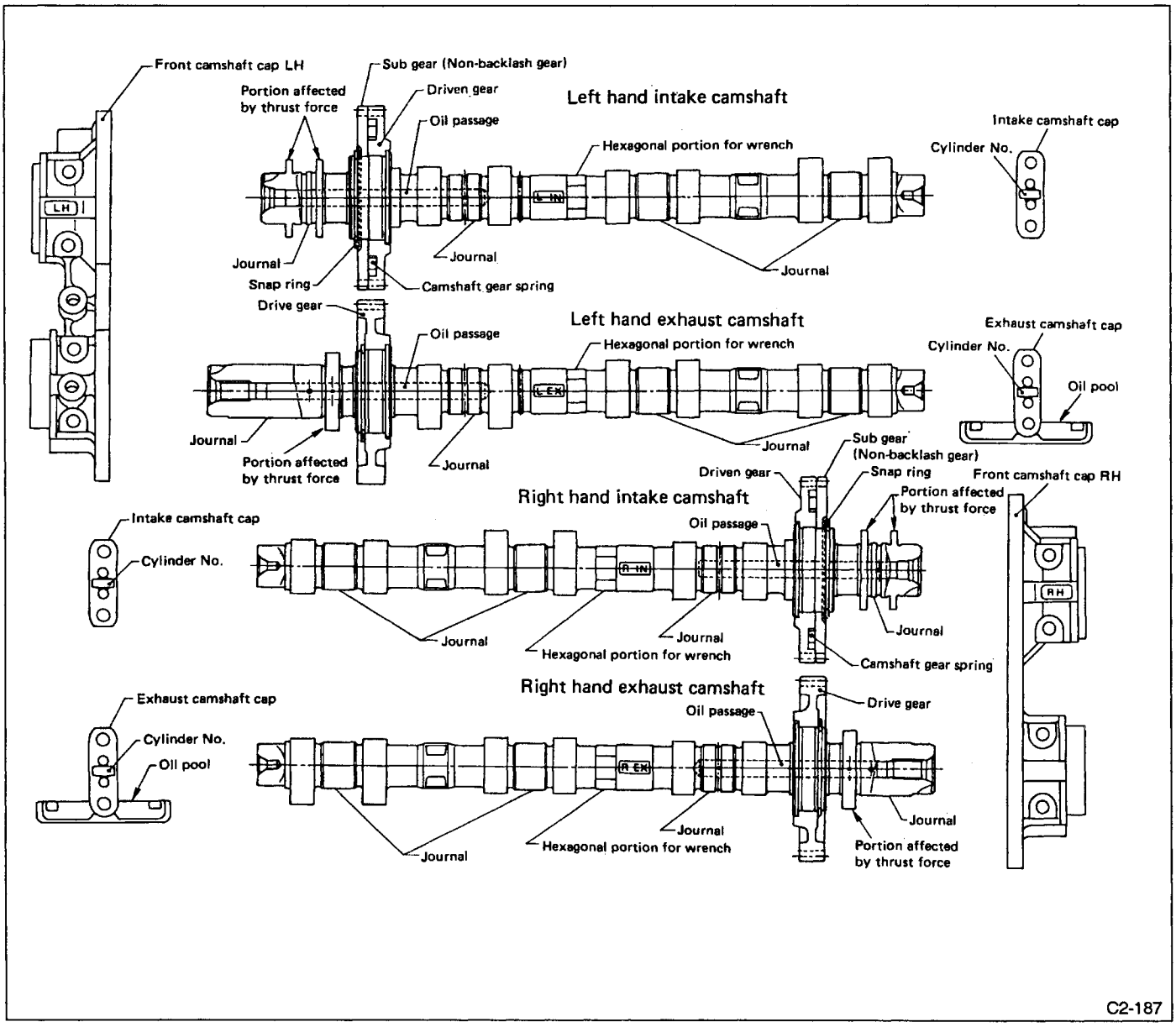


Fig. 4

6. Hydraulic Lash Adjuster

The hydraulic lash adjuster is located between the camshaft and valve stem. The top surface of the hydraulic lash adjuster is always in contact with the cam face. The cam directly pushes the lash adjuster to open or close the valve.

The engine oil flows through the cylinder head and goes into the lash adjuster so as to always maintain zero valve clearance.

1) Action when the valve starts to lift

When the cam begins to push the lash adjuster, the bucket and plunger are pushed down. At the same time, the body is pushed up by the reaction from the valve stem. This causes the high pressure chamber to compress, increasing the oil pressure in the high pressure chamber.

2) Action while the valve is lifted

As long as the cam is pushed by the lash adjuster, the oil pressure in the high pressure chamber is held high. The oil in the high pressure chamber leaks through a very small clearance between the plunger and body. Since the high pressure chamber is compressed in a very short time, almost no change occurs in the oil quantity inside the high pressure chamber. Accordingly, the bucket, plunger and adjuster body work as an integral unit to push down the valve stem to open the valve. The passage for supplying oil from the cylinder head to the lash adjuster is closed during this period, and no oil flows into the lash adjuster.

3) Action when the valve stops lifting

When the cam completes its lash adjuster pressing stroke, the passage for supplying oil from the cylinder head to the lash adjuster opens, allowing oil to flow from the cylinder head into reservoir II of the lash adjuster. Since the pressure in the high pressure chamber is lower than the pressure in reservoir II,the check ball is pushed down by the oil pressure in reservoir II. Accordingly, oil flows into the pressure chamber until the oil pressure becomes equal between the high pressure chamber and reservoir II. Under the action of this oil pressure, the body is pressed against the valve stem and the bucket against the camshaft.

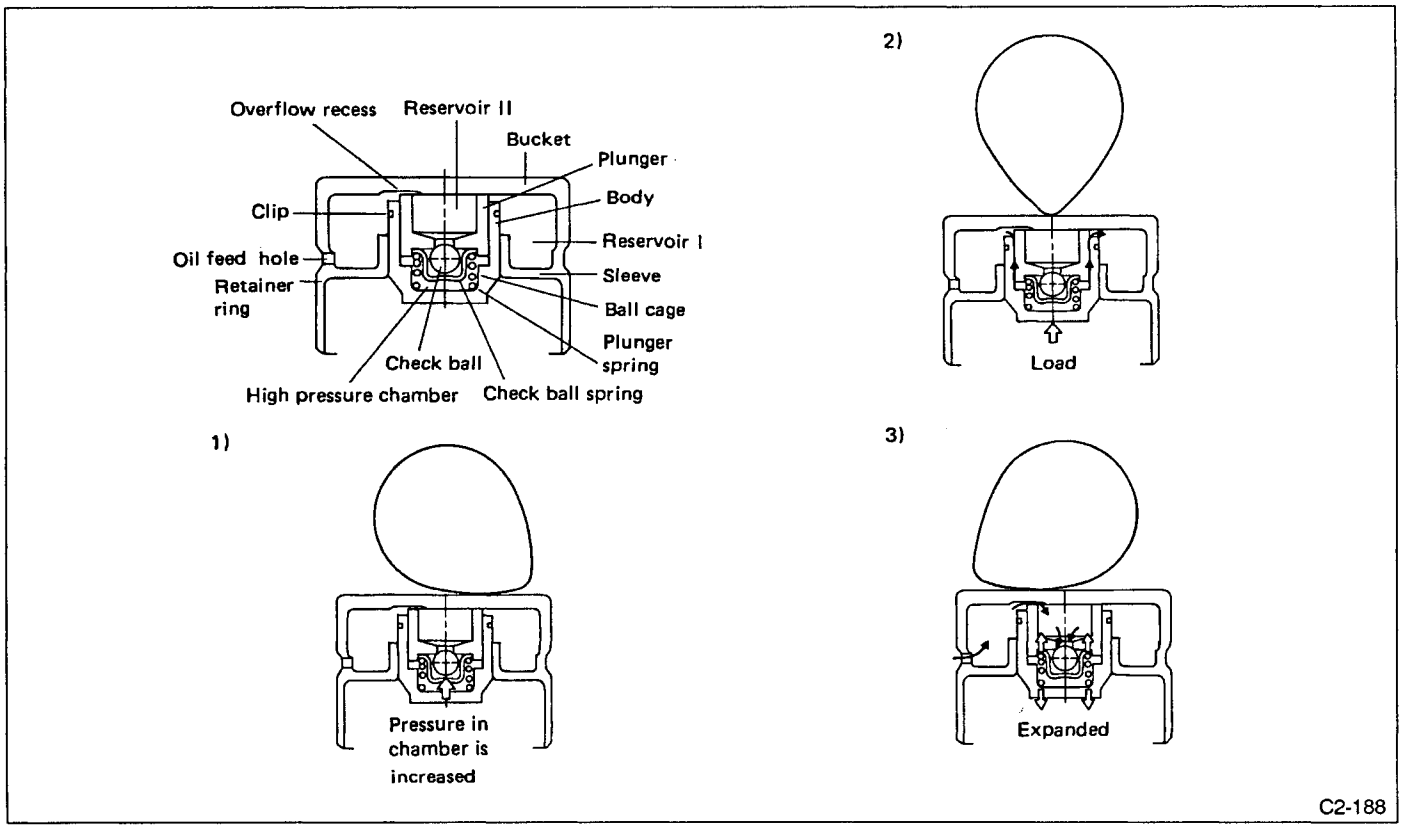


Fig. 5

7. Cylinder Head

Combustion chambers in the cylinder head are compact, center plug, pentroof types which feature a wide "squish" area for increased combustion efficiency.
Four valves (two intake and two exhaust), which are arranged in a cross-flow design, are used per cylinder.
The cylinder head gasket is made from carbon material (not asbestos). Its core is metal provided with metal hooks to increase resistance to both heat and wear.
The inner side of grommets used in the cylinder bore are reinforced with wire to withstand both high combustion pressure and temperature.

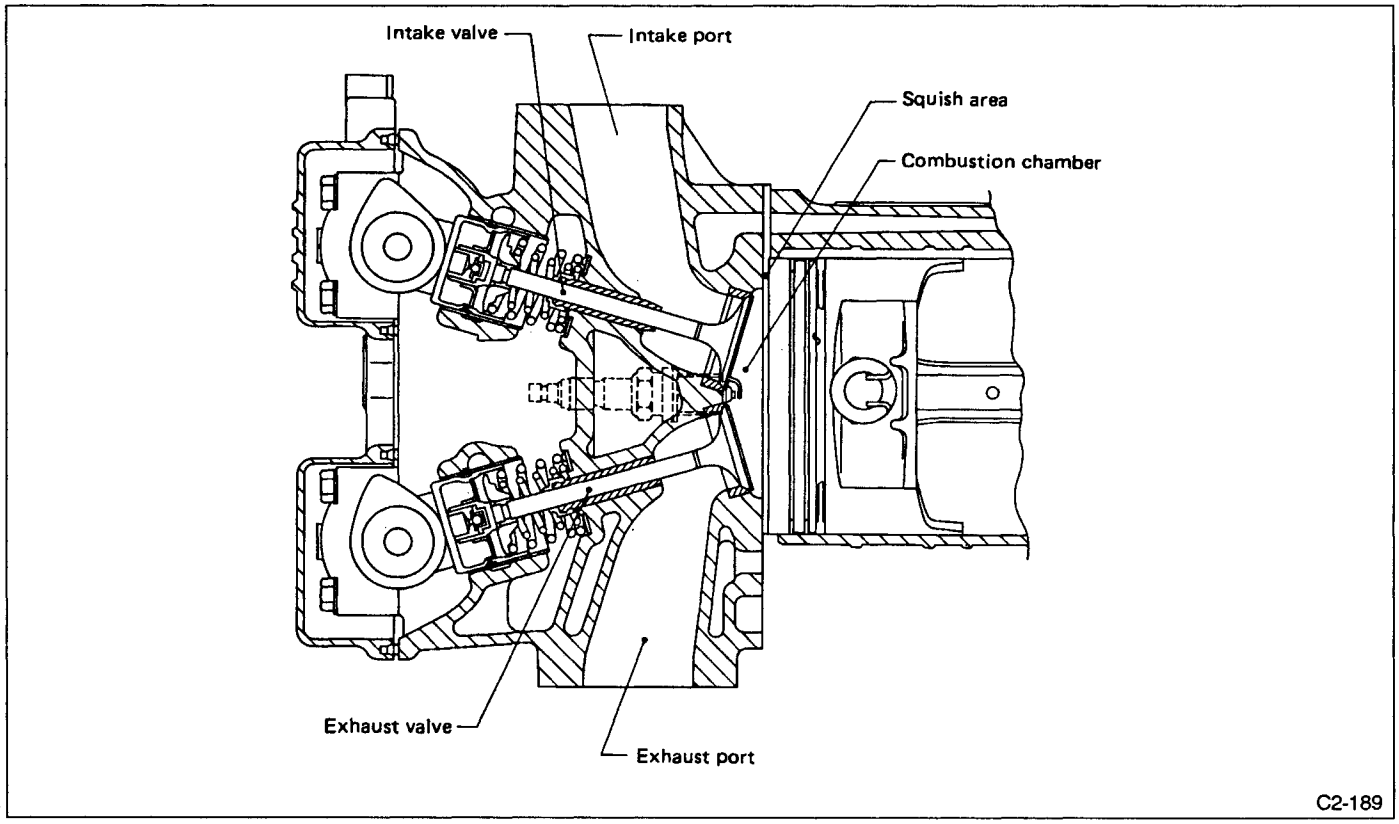


Fig. 6

8. Cylinder Block

The cylinder block is made from aluminum diecast. The cylinder perimeter has an open-deck design which is lightweight, highly rigid and has superb cooling efficiency.
The cylinder liners are made from cast iron and are dry types which are totally cast with aluminum cylinder block. Seven main journal block designs are employed to increase stiffness and quiet operation. The oil pump is located in the front center of the cylinder block and the water pump is located at the front of the left-cylinder bank. At the rear of the right-cylinder block is a separator which eliminates oil mist contained in the blow-by gas.

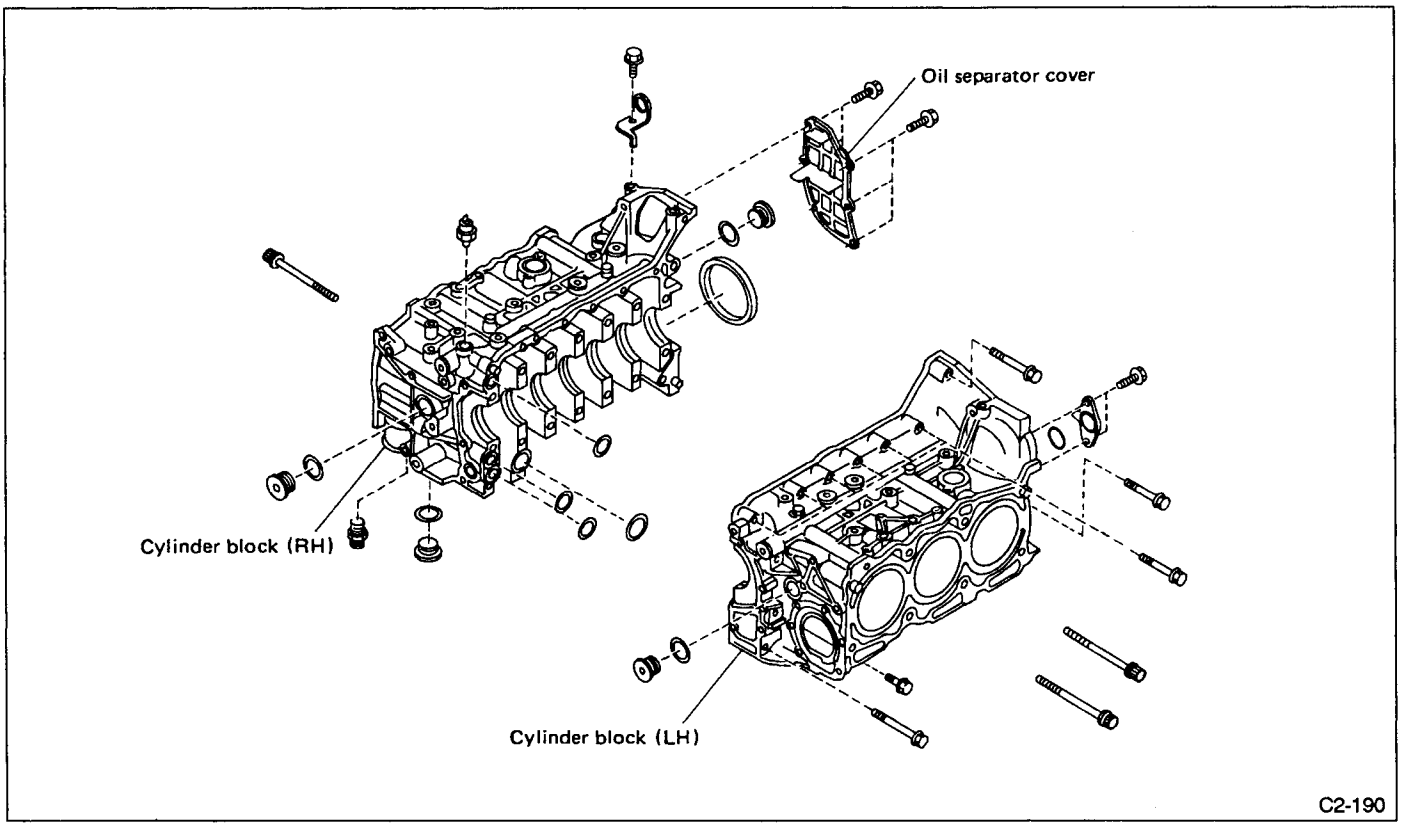


Fig. 7

9. Crankshaft

The crankshaft is supported by seven bearings to provide high rigidity and strength. The corners of the crankshaft journals and webs, as well as the crank pins and webs, are finished with fillet-roll work to increase strength. The seven crankshaft bearings are made from aluminum alloy and the No. 5 bearing is provided with a flanged metal to receive thrust force.

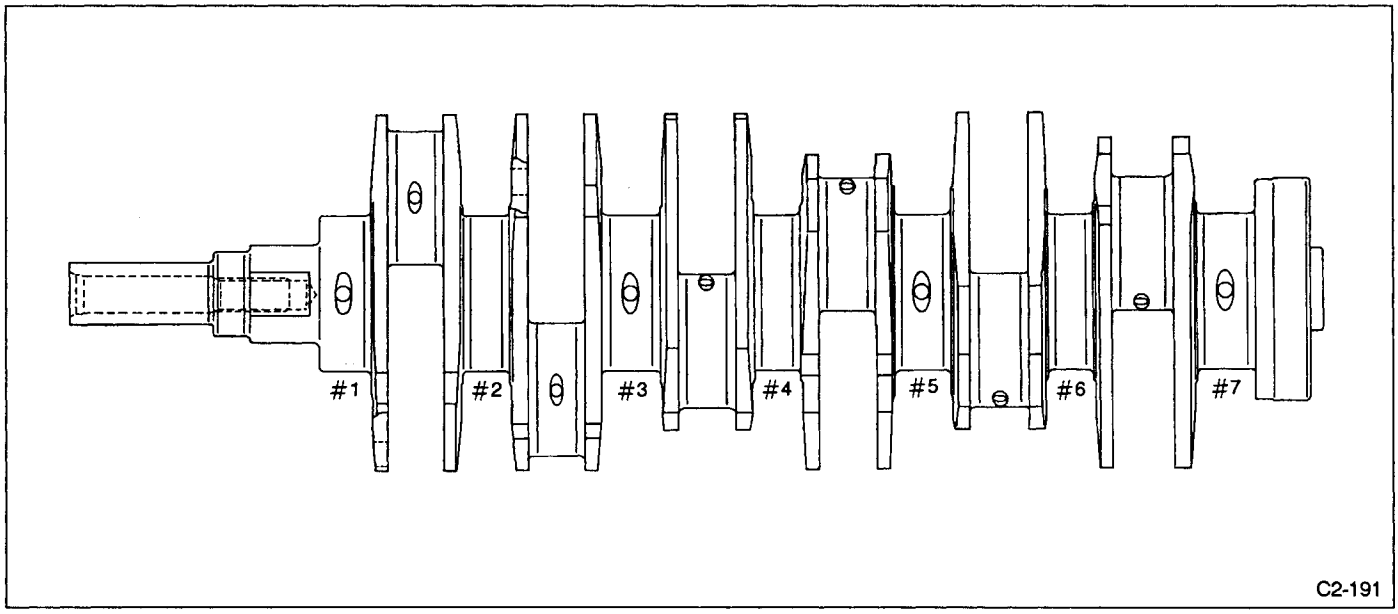


Fig. 8

10. Piston

The piston skirt has a "slipper" design to reduce weight and sliding. The oil control ring groove utilizes a slit design.

The piston pin is located in an offset position. The Nos. 1, 3 and 5 pistons are offset in the lower direction while the Nos. 2, 4 and 6 pistons are offset in the upper direction.

The piston head is recessed for both the intake and exhaust valves. It also has symbols used to identify the location and the direction of installation.

Three piston rings are used for each piston-two compression rings and one oil ring. The top piston ring has an inner-bevel design and the second piston ring has an interrupt design to reduce oil consumption.

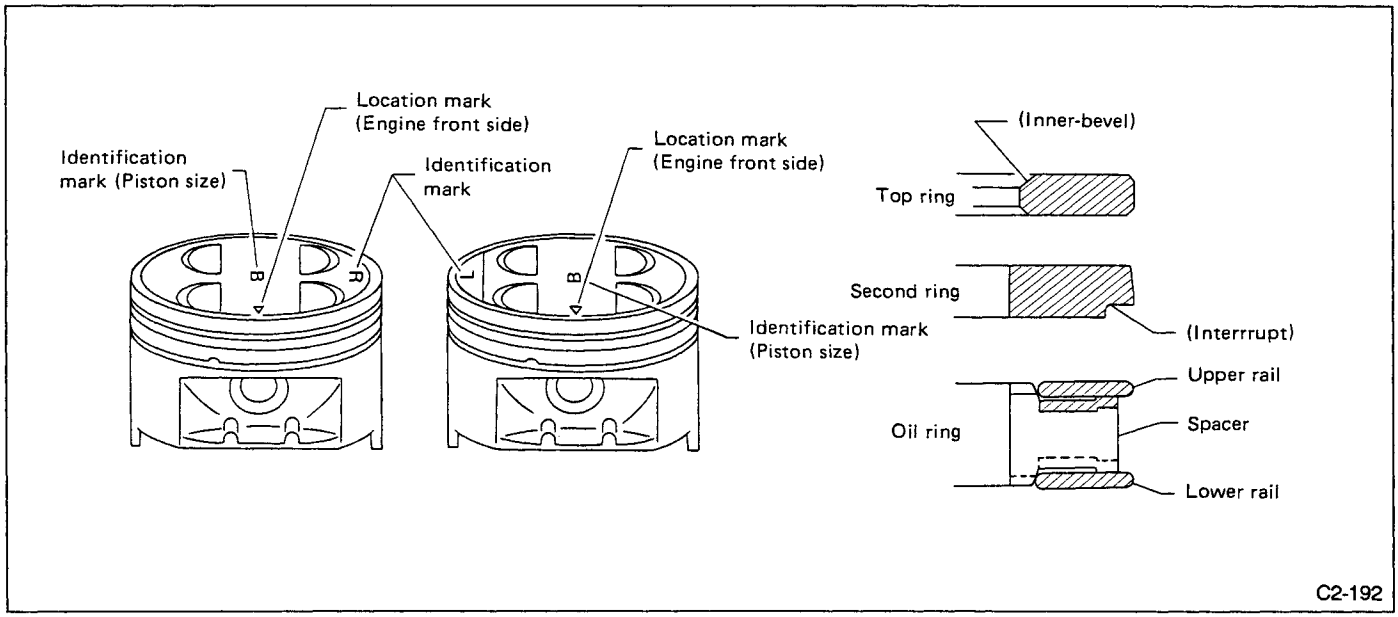


Fig. 9

S SPECIFICATIONS AND SERVICE DATA

A: SPECIFICATIONS

ENGINE	Type		Horizontally opposed, liquid cooled, 6-cylinder, 4-stroke gasoline engine
	Valve arrangement		Belt driven, double over-head camshaft, 4-valve/cylinder
	Bore x Stroke	mm (in)	96.9 x 75 (3.815 x 2.95)
	Piston displacement	cm^3 (cu in)	3,318 (202.46)
	Compression ratio		10.0
	Compression pressure (at 200 - 300 rpm)	kPa (kg/cm^2, psi)	1,177 - 1,422 (12 - 14.5, 171 - 206)
	Number of piston rings		Pressure ring: 2, Oil ring: 1
	Intake valve timing	Opening	4° BTDC
		Closing	52° ABDC
	Exhaust valve timing	Opening	55° BBDC
		Closing	9° ATDC
	Idling speed [At N or D position]	rpm	610± 100 (No load)
	Firing order		1 → 6 → 3 → 2 → 5 → 4
	Ignition timing	BTDC/rpm	20± 8°/610

B: SERVICE DATA

Unit: mm (in)

Belt tension adjuster	Adjuster rod protrusion			15.4 - 16.4 (0.606 - 0.646)
Belt tensioner	Spacer O.D.			16 (0.63)
	Tensioner bush I.D.			16.16 (0.6362)
	Clearance between spacer and bush		STD	0.117 - 0.180 (0.0046 - 0.0071)
			Limit	0.230 (0.0091)
	Side clearance of spacer		STD	0.37 - 0.54 (0.0146 - 0.0213)
			Limit	0.8 (0.031)
Camshaft	Bend limit			0.02 (0.0008)
	Cam lobe height	Intake	STD	39.05 - 39.15 (1.5374 - 1.5413)
			Limit	38.90 (1.5315)
		Exhaust	STD	39.85 - 39.95 (1.5689 - 1.5728)
			Limit	39.70 (1.5630)
	Camshaft journal OD	#1		31.946 - 31.963 (1.2577 - 1.2584)
		#2, #3, #4		27.946 - 27.963 (1.1002 - 1.1009)
	Thrust clearance	Intake	STD	0.03 - 0.09 (0.0012 - 0.0035)
			Limit	0.13 (0.0051)
		Exhaust	STD	0.02 - 0.08 (0.0008 - 0.0031)
			Limit	0.12 (0.0047)
	Oil clearance		STD	0.037 - 0.072 (0.0015 - 0.0028)
			Limit	0.10 (0.0039)
Camshaft gear	Backlash		STD	0.029 - 0.175 (0.0011 - 0.0069)
			Limit	0.30 (0.0118)
	Free distance between camshaft spring ends			24.88 - 28.88 (0.9795 - 1.1370)
Cylinder head	Surface warping limit			0.05 (0.0020)
	Surface grinding limit			0.30 (0.0118)
	Standard height			127.5 (5.020)
Valve seat	Refacing angle			90°
	Contacting width	Intake	STD	1.0 (0.039)
			Limit	1.7 (0.067)
		Exhaust	STD	1.5 (0.059)
			Limit	2.2 (0.087)
Valve guide	Inner diameter			6.000 - 6.012 (0.2362 - 0.2367)
	Height above head			8.5 (0.335)
Valve	Head edge thickness	Intake	STD	0.8 (0.031)
			Limit	0.6 (0.024)
		Exhaust	STD	1.0 (0.039)
			Limit	0.8 (0.031)
	Stem diameter	Intake		5.955 - 5.970 (0.2344 - 0.2350)
		Exhaust		5.945 - 5.960 (0.2341 - 0.2346)

STD: Standard ID: Inner diameter OD: Outer diameter

Unit: mm (in)

Valve	Stem oil clearance	Intake	STD	0.030 - 0.057 (0.0012 - 0.0022)
			Limit	0.10 (0.0039)
		Exhaust	STD	0.040 - 0.067 (0.0016 - 0.0026)
			Limit	0.10 - (0.0039)
	Overall length	Intake		90.00 (3.5433)
		Exhaust		90.85 (3.5768)
Valve spring	Free length	Outer spring		36.4 (1.433)
		Inner spring		34.9 (1.374)
	Squareness	Outer spring		2.5°, 1.6 (0.063)
		Inner spring		2.5°, 1.5 (0.059)
	Tension/spring height	Outer spring		124.5 - 142.2 N (12.7 - 14.5 kg, 28.0 - 32.0 lb)/29 (1.14) 308.9 - 356.0 N (31.5 - 36.3 kg, 69.5 - 80.0 lb)/21.1 (0.831)
		Inner spring		58.8 - 66.7 N (6 - 6.8 kg, 13.2 - 15.0lb)/27.5 (1.083) 147.1 - 168.7 N (15 - 17.2 kg, 33.1 - 37.9 lb)/19.6 (0.772)
Hydraulic lash adjuster	Outer diameter			32.965 - 32.975 (1.2978 - 1.2982)
	Bush I.D.			33.009 - 33.031 (1.2996 - 1.3004)
	Oil clearance		STD	0.028 - 0.078 (0.0011 - 0.0031)
			Limit	0.110 (0.0043)
Cylinder block	Surface warpage limit (mating with cylinder head)			0.05 (0.0020)
	Surface grinding limit			0.4 (0.016)
	Cylinder bore	STD	A	96.905 - 96.915 (3.8151 - 3.8155)
			B	96.895 - 96.905 (3.8148 - 3.8151)
			C	96.885 - 96.895 (3.8144 - 3.8148)
	Taper		STD	0.015 (0.0006)
			Limit	0.050 (0.0020)
	Outer-of-roundness		STD	0.010 (0.0004)
			Limit	0.050 (0.0020)
	Piston clearance		STD	0.010 - 0.030 (0.0004 - 0.0012)
			Limit	0.060 (0.0024)
	Enlarging (boring) limit			0.5 (0.020)
Piston	Outer diameter	STD	A	96.885 - 96.895 (3.8144 - 3.8148)
			B	96.875 - 96.885 (3.8140 - 3.8144)
			C	96.865 - 96.875 (3.8136 - 3.8140)
		0.25 mm (0.0098 in) OS		97.125 - 97.135 (3.8238 - 3.8242)
		0.50 mm (0.0197 in) OS		97.375 - 97.385 (3.8337 - 3.8340)

STD: Standard ID: Inner diameter OS: Over size

Unit: mm (in)

Piston pin	Standard clearance between piston pin and hole in piston			0.004 - 0.008 (0.0002 - 0.0003)
	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 - 0.30 (0.0079 - 0.0118)
			Limit	0.5 (0.020)
		Second ring	LTD	0.37 - 0.52 (0.0146 - 0.0205)
			Limit	1.0 (0.039)
		Oil ring	STD	0.20 - 0.60 (0.0079 - 0.0236)
			limit	1.5 (0.059)
	Clearance between piston ring and piston ring groove	Top ring	STD	0.04 - 0.09 (0.0016 - 0.0035)
			Limit	0.15 (0.0059)
		Second ring	STD	0.03 - 0.07 (0.0012 - 0.0028)
			Limit	0.15 (0.0059)
Connecting rod	Bend twist per 100 mm (3.94 in) length		Limit	0.10 (0.0039)
	Side clearance		STD	0.070 - 0.330 (0.0028 - 0.0130)
			Limit	0.4 (0.016)
Connecting rod bearing	Oil clearance		STD	0.020 - 0.046 (0.0008 - 0.0018)
			Limit	0.05 (0.0020)
	Thickness at center portion	STD		1.486 - 1.498 (0.0585 - 0.0590)
		0.03 mm (0.0012 in) U.S.		1.496 - 1.509 (0.0589 - 0.0594)
		0.05 mm (0.0020 in) U.S.		1.506 - 1.519 (0.0593 - 0.0598)
		0.25 mm (0.0098 in) U.S.		1.606 - 1.619 (0.0632 - 0.0637)
Connecting rod bushing	Clearance between piston pin and bushing		STD	0 - 0.018 (0 - 0.0007)
			Limit	0.030 (0.0012)
Crankshaft	Bend limit			0.035 (0.0014)
	Crank pin and crank journal	Out of roundness		0.03 (0.0012) or less
		Taper limit		0.07 (0.0028)
		Grinding limit		0.25 (0.0098)
	Crankpin outer diameter		STD	51.984 - 52.000 (2.0466 - 2.0472)
			0.03 mm (0.0012 in) U.S.	51.954 - 51.970 (2.0454 - 2.0461)
			0.05 mm (0.0020 in) U.S.	51.934 - 51.950 (2.0446 - 2.0453)
			0.25 mm (0.0098 in) U.S.	51.734 - 51.750 (2.0368 - 2.0374)
	Crank journal outer diameter		STD	59.992 - 60.008 (2.3619 - 2.3625)
			0.03 mm (0.0012 in) U.S.	60.022 - 60.038 (2.3631 - 2.3637)
			0.05 mm (0.0020 in) U.S.	60.042 - 60.058 (2.3639 - 2.3645)
			0.25 mm (0.0098 in) U.S.	60.242 - 60.258 (2.3717 - 2.3724)

STD: Standard U.S.: Undersize

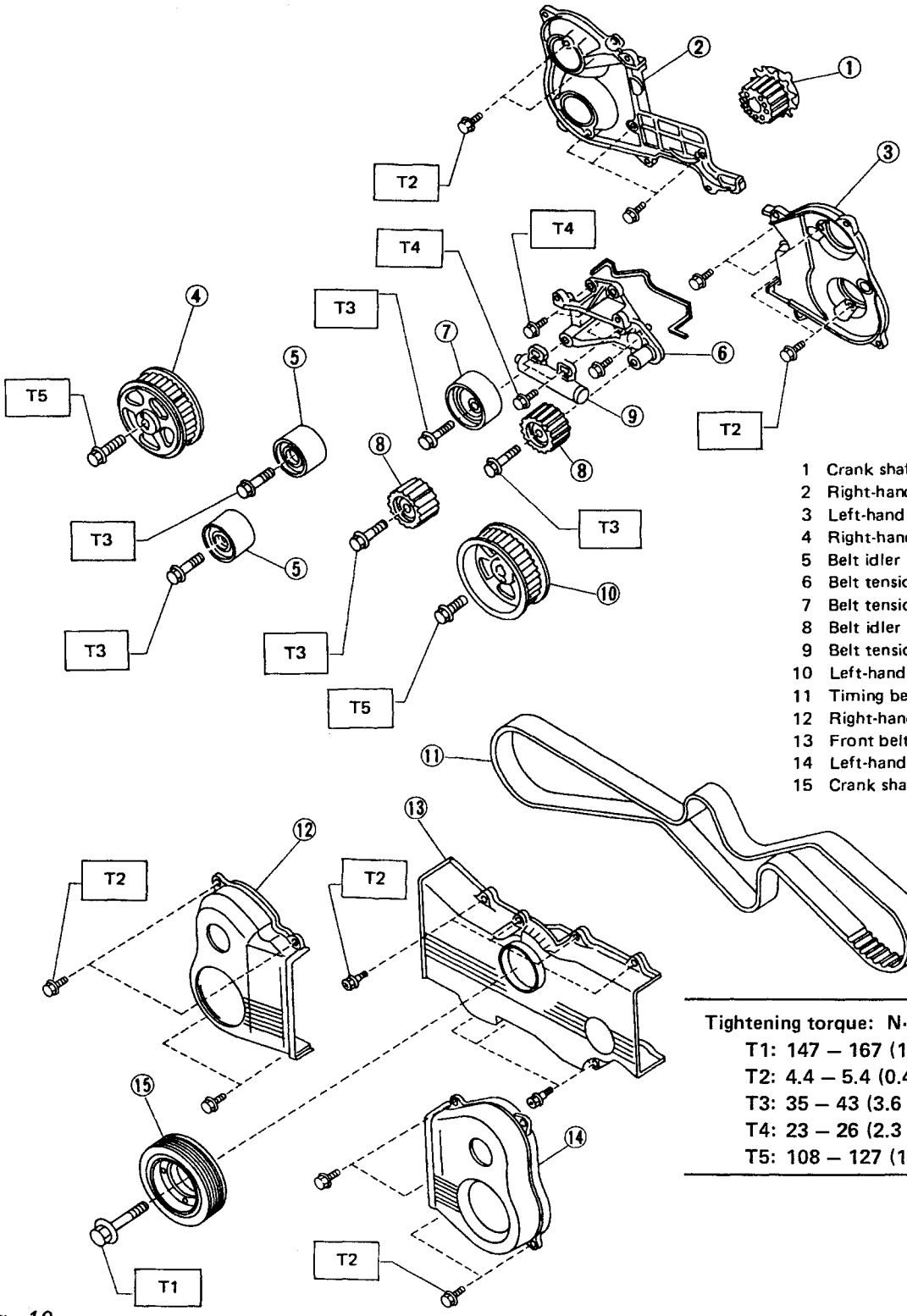
Unit: mm (in)

Crankshaft	Thrust clearance		STD	0.030 - 0.115 (0.0012 - 0.0045)
			Limit	0.25 (0.0098)
	Oil clearance	STD	#1, #3, #7	0.005 - 0.035 (0.0002 - 0.0014)
			#2, #4, #6	0.013 - 0.038 (0.0005 - 0.0015)
			#5	0.013 - 0.034 (0.0005 - 0.0013)
		Limit	#1, #2, #6, #7	0.045 (0.0018)
			#3, #4, #5	0.040 (0.0016)
Crankshaft bearing	Crankshaft bearing thickness	#1, #3, #7	STD	1.998 - 2.011 (0.0787 - 0.0792)
			0.03 mm (0.0012 in) U.S.	2.017 - 2.020 (0.0794 - 0.0795)
			0.05 mm (0.0020 in) U.S.	2.027 - 2.030 (0.0798 - 0.0799)
			0.25 mm (0.0098 in) U.S.	2.127 - 2.130 (0.0837 - 0.0839)
		#2, #4, #6	STD	2.000 - 2.013 (0.0787 - 0.0793)
			0.03 mm (0.0012 in) U.S.	2.019 - 2.022 (0.0795 - 0.0796)
			0.05 mm (0.0020 in) U.S.	2.029 - 2.032 (0.0799 - 0.0800)
			0.25 mm (0.0098 in) U.S.	2.129 - 2.132 (0.0838 - 0.0839)
		#5	STD	2.000 - 2.013 (0.0787 - 0.0793)
			0.03 mm (0.0012 in) U.S.	2.019 - 2.022 (0.0795 - 0.0796)
			0.05 mm (0.0020 in) U.S.	2.029 - 2.032 (0.0799 - 0.0800)
			0.25 mm (0.0098 in) U.S.	2.129 - 2.132 (0.0838 - 0.0839)

STD: Standard U.S.: Under size

C COMPONENT PARTS

1. Timing Belt



1 Crank shaft sprocket
2 Right-hand belt cover No. 2
3 Left-hand belt cover No. 2
4 Right-hand camshaft sprocket
5 Belt idler
6 Belt tensioner bracket
7 Belt tensioner
8 Belt idler No. 2
9 Belt tension adjuster
10 Left-hand camshaft sprocket
11 Timing belt
12 Right-hand belt cover
13 Front belt cover
14 Left-hand belt cover
15 Crank shaft pulley

Tightening torque: N·m (kg-m, ft-lb)
T1: 147 – 167 (15 – 17, 108 – 123)
T2: 4.4 – 5.4 (0.45 – 0.55, 3.3 – 4.0)
T3: 35 – 43 (3.6 – 4.4, 26 – 32)
T4: 23 – 26 (2.3 – 2.7, 17 – 20)
T5: 108 – 127 (11 – 13, 80 – 94)

C2-193

Fig. 10

2. Cylinder Head and Camshaft

Tightening torque: N.m (kg-m, ft-lb)
T1: Refer to [W4E1].
T2: 9.1 – 10.5 (0.93 – 1.07, 6.7 – 7.7)
T3: 4.4 – 5.4 (0.45 – 0.55, 3.3 – 4.0)

1 Cylinder head cover (RH)
2 Cylinder head cover gasket (RH)
3 Intake camshaft cap
4 Exhaust camshaft cap
5 Front camshaft cap (RH)
6 Intake camshaft (RH)
7 Camshaft gear spring
8 Sub gear
9 Wave washer
10 Snap ring
11 Camshaft plug
12 Exhaust camshaft (RH)
13 Camshaft oil seal
14 Cylinder head bolt (short)
15 Cylinder head bolt (long)
16 Intake valve guide
17 Exhaust valve guide
18 Cylinder head (RH)
19 Cylinder head gasket (RH)
20 Cyolinder head gasket (LH)
21 Cylinder head (LH)
22 Intake camshaft (LH)
23 Exhaust camshaft (LH)
24 Intake camshaft cap
25 Exhaust camshaft cap
26 Front camshaft cap (LH)
27 Cylinder head cover gasket (LH)
28 Cylinder head cover

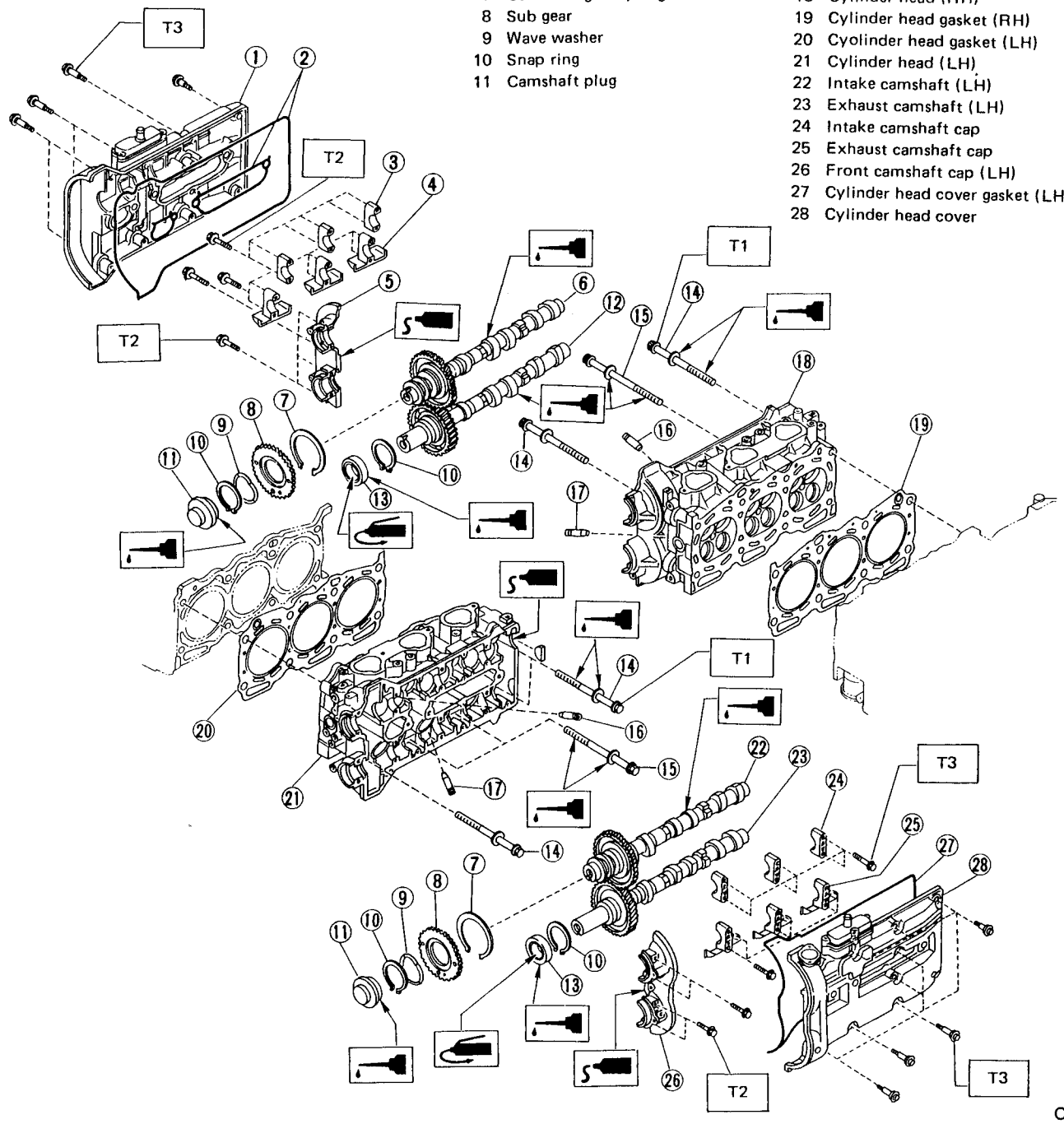
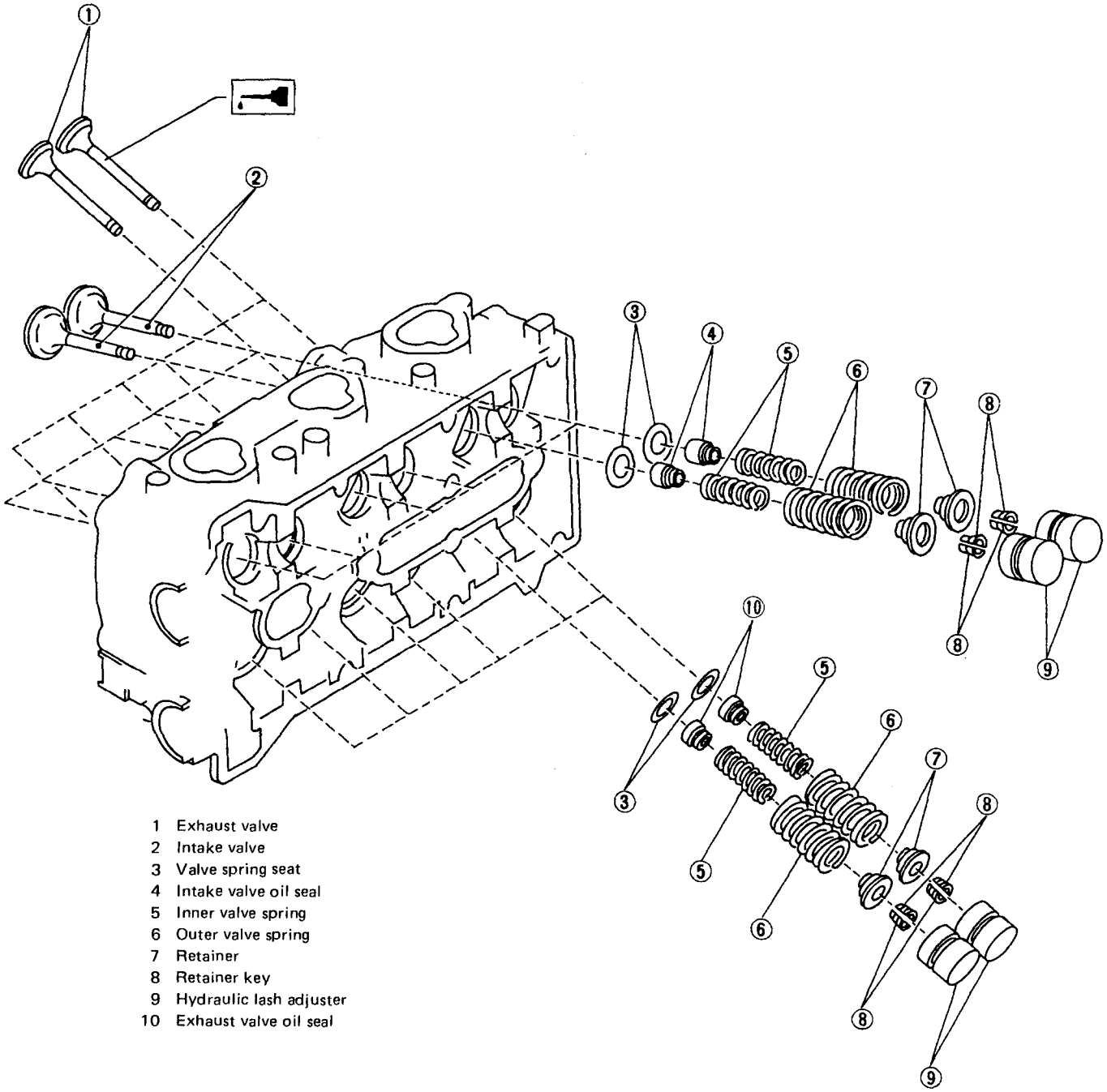


Fig. 11

3. Cylinder Head and Valve ASSY

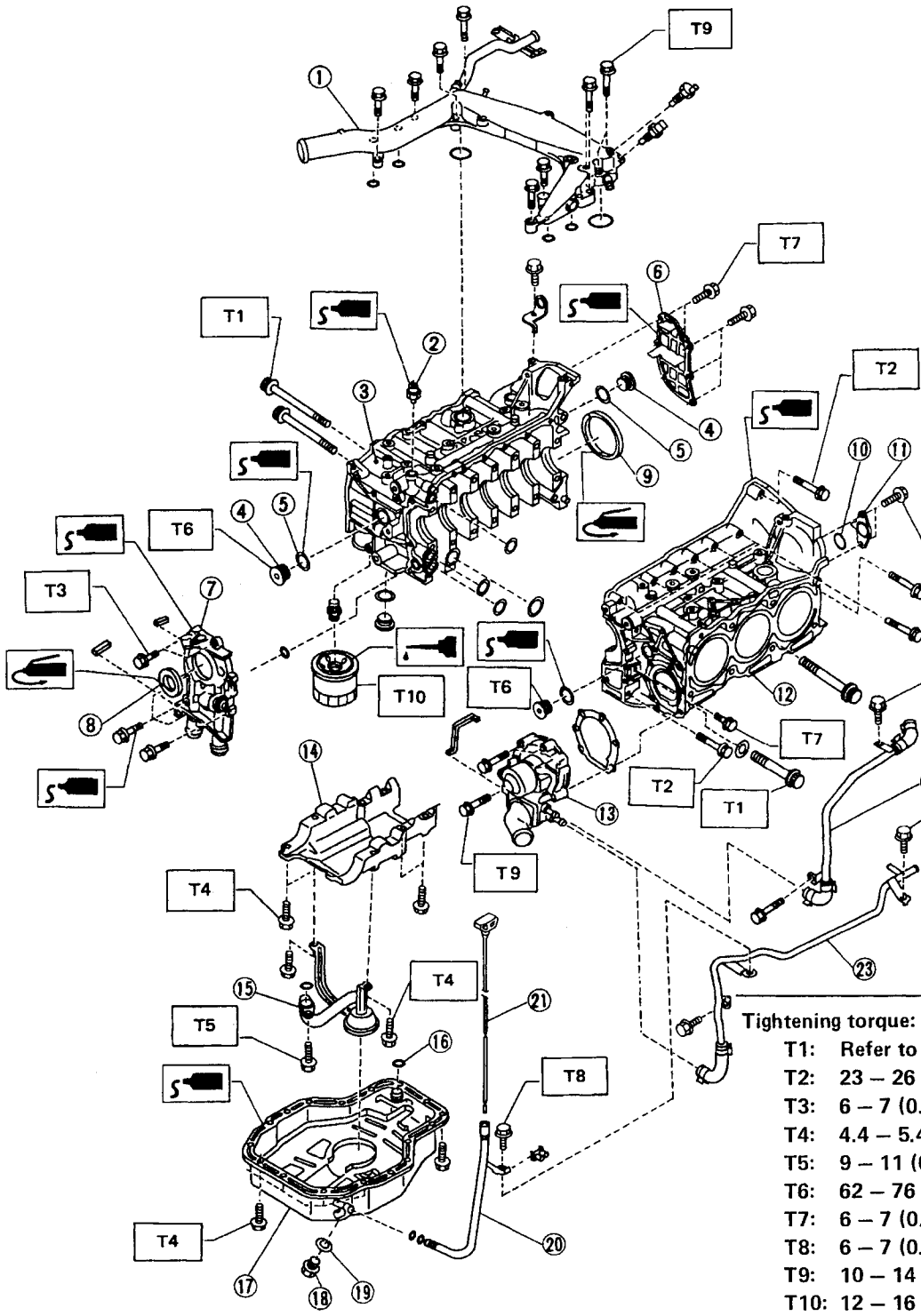


1 Exhaust valve
2 Intake valve
3 Valve spring seat
4 Intake valve oil seal
5 Inner valve spring
6 Outer valve spring
7 Retainer
8 Retainer key
9 Hydraulic lash adjuster
10 Exhaust valve oil seal

C2-195

Fig. 12

4. Cylinder Block



1 Water pipe
2 Oil pressure switch
3 Cylinder block (RH)
4 Service hole plug
5 Gasket
6 Oil separator cover
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 Buffle plate
15 Oil strainer
16 Gasket
17 Oil pan
18 Oil drain plug
19 Gasket
20 Oil level gauge guide
21 Oil level gauge
22 Water by-pass pipe
23 Heater pipe

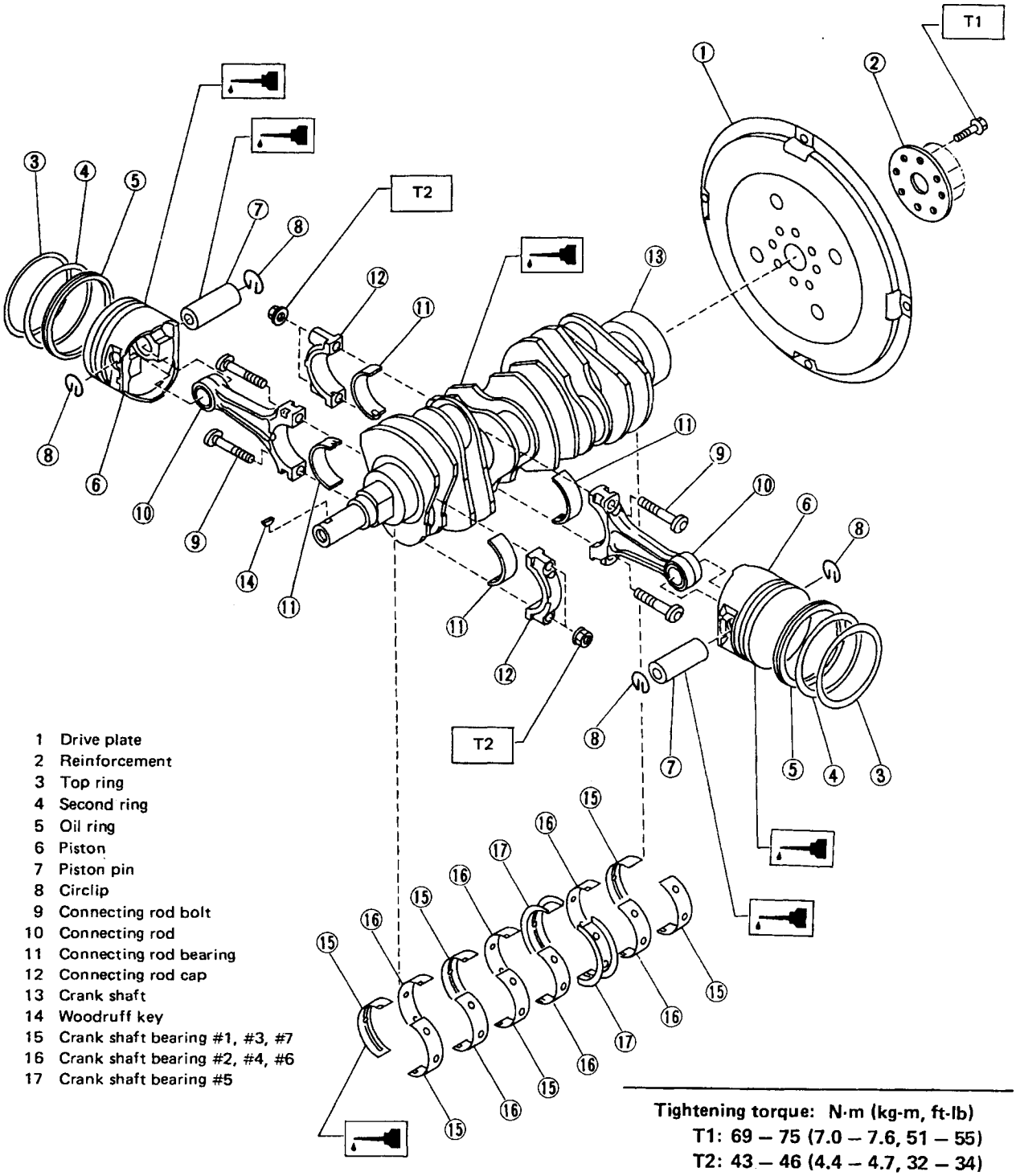
Tightening torque: N·m (kg-m, ft-lb)

T1:	Refer to [W502]
T2:	23 – 26 (2.3 – 2.7, 17 – 20)
T3:	6 – 7 (0.6 – 0.7, 4.3 – 5.1)
T4:	4.4 – 5.4 (0.45 – 0.55, 3.3 – 4.0)
T5:	9 – 11 (0.9 – 1.1, 6.5 – 8.0)
T6:	62 – 76 (6.3 – 7.7, 46 – 56)
T7:	6 – 7 (0.6 – 0.7, 4.3 – 5.1)
T8:	6 – 7 (0.6 – 0.7, 4.3 – 5.1)
T9:	10 – 14 (1.0 – 1.4, 7 – 10)
T10:	12 – 16 (1.2 – 1.6, 8.7 – 11.6)

C2-196

Fig. 13

5. Crankshaft and Piston



1 Drive plate
2 Reinforcement
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 Crank shaft
14 Woodruff key
15 Crank shaft bearing #1, #3, #7
16 Crank shaft bearing #2, #4, #6
17 Crank shaft bearing #5

Tightening torque: N·m (kg-m, ft-lb)
T1: 69 – 75 (7.0 – 7.6, 51 – 55)
T2: 43 – 46 (4.4 – 4.7, 32 – 34)

C2-197

Fig. 14

W SERVICE PROCEDURE

1. General Precautions

1) Before disassembling engine, install on ENGINE STAND .

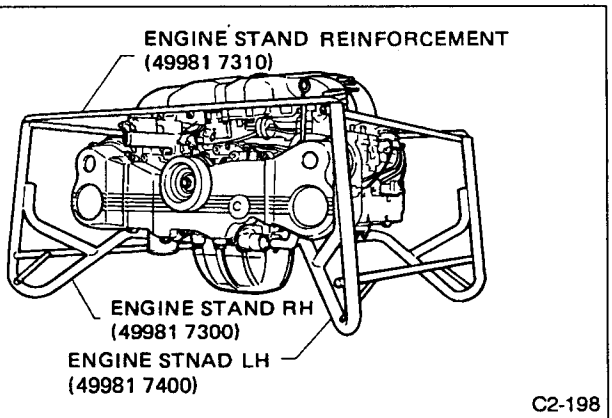


Fig. 15

2) Since the engine is very heavy, be sure to use more than four persons when lifting the engine.
Never hold ENGINE STAND REINFORCEMENT when lifting the engine.

3) All parts should be thoroughly cleaned, paying special attention to the engine oil passages, pistons and bearings.
4) Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.
5) Be careful not to let oil, grease or coolant contact the timing belt.
6) All removed parts, if to be reused, should be reinstalled in the original positions and directions.
7) Gaskets and lock washers must be replaced with new ones. Liquid gasket should be used where specified to prevent leakage.
8) Bolts, nuts and washers should be replaced with new ones as required.
9) Even if necessary inspections have been made in advance, proceed with assembly work while making rechecks.

2. Timing Belt

A: REMOVAL

1. RELATED PARTS

1) Remove V-belts.
〈Refer to 1-5 Drive Belts [01B1].〉
2) Remove power steering pump.
3) Remove alternator and V-belt cover bracket.

2. CRANKSHAFT PULLEY AND BELT COVER

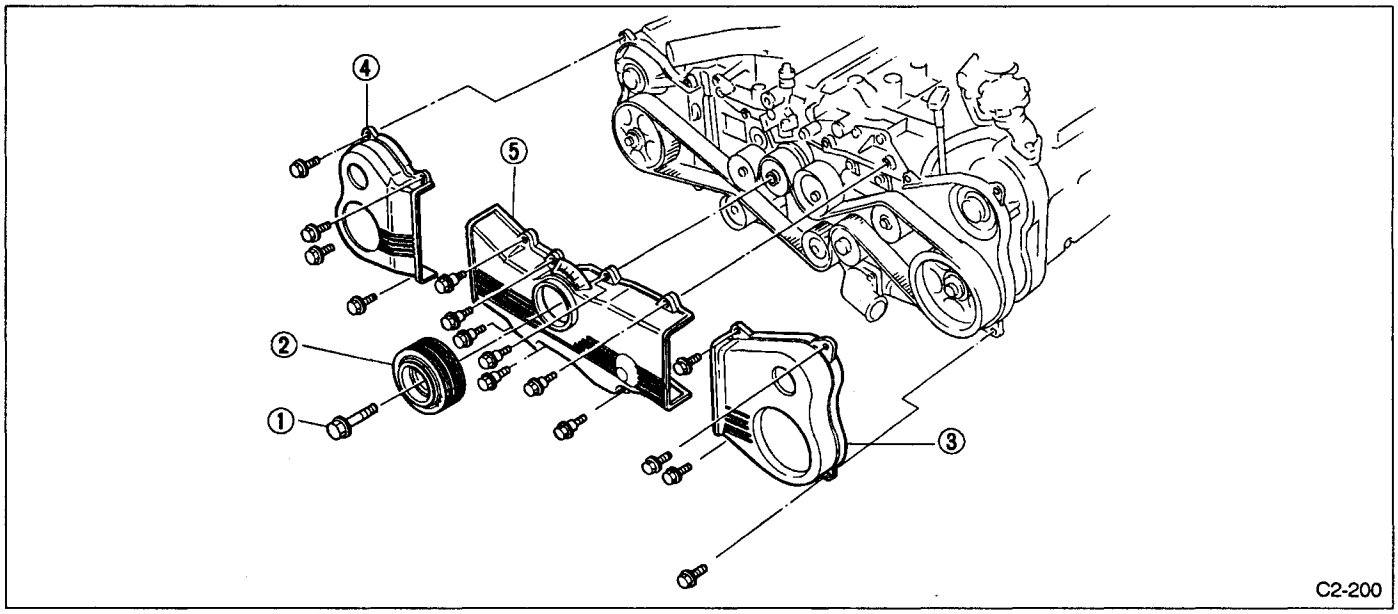


Fig. 16

1) Remove pulley bolt. To lock crankshaft, use Special Tool.

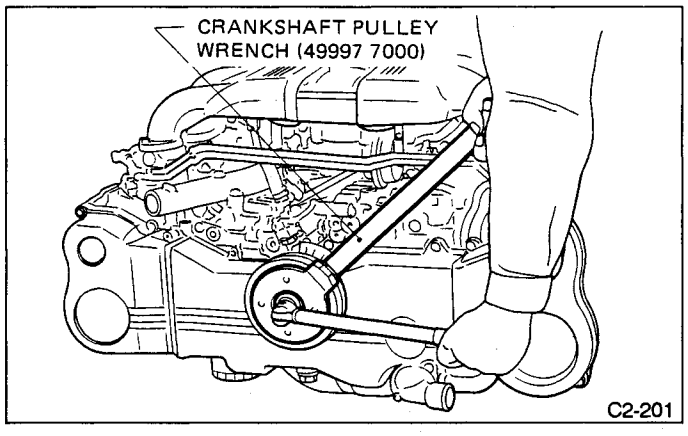


Fig. 17

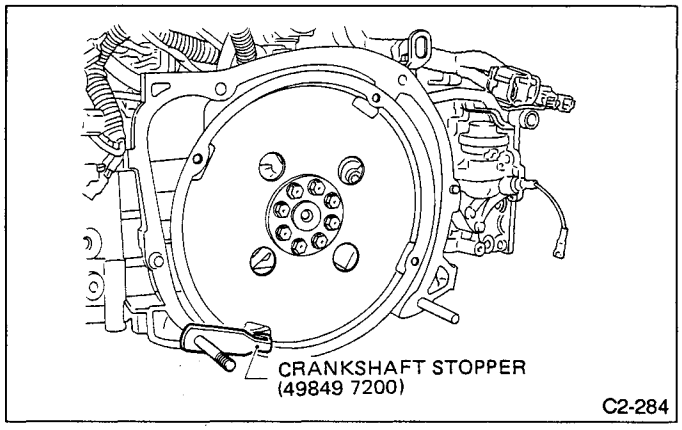


Fig. 18

4) Remove power steering pump bracket.
5) Remove A/C belt tensioner bracket.
6) Remove A/C compressor.
7) Remove A/C compressor bracket.

2) Remove crankshaft pulley.
3) Remove left-hand belt cover.
4) Remove right-hand belt cover.
5) Remove front belt cover.

3. TIMING BELT

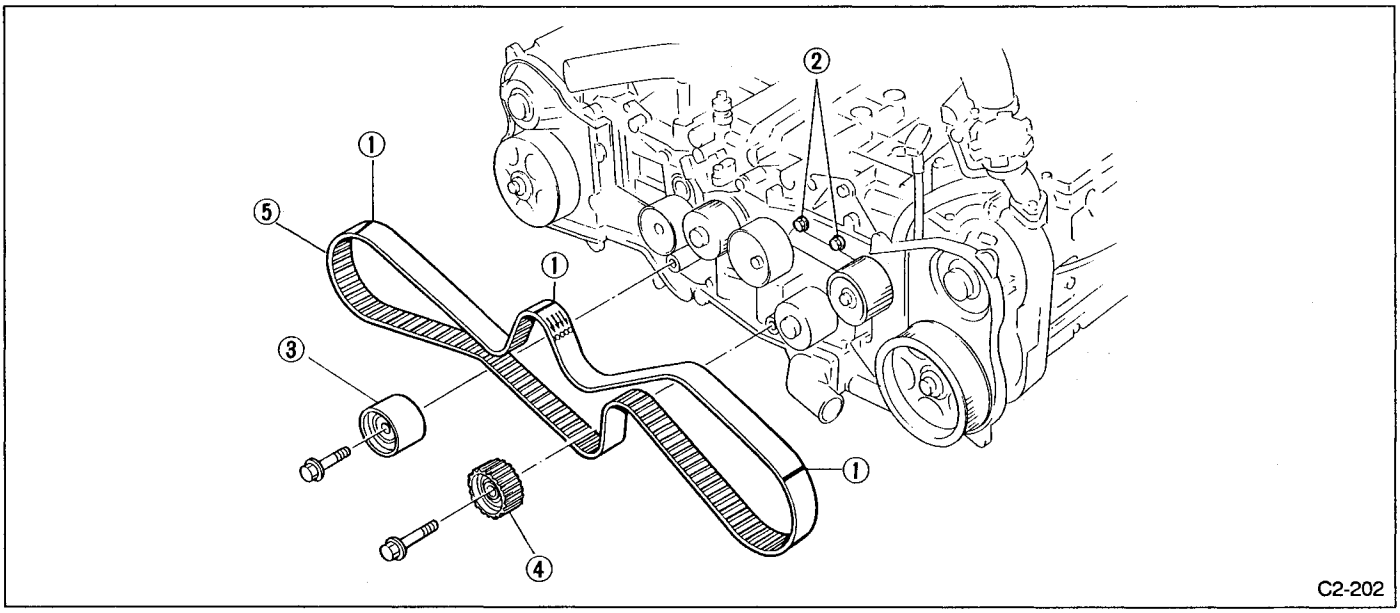


Fig. 19

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, and align alignment marks on crankshaft sprocket, and left and right camshaft sprockets with marks of belt cover and cylinder block.

Special tool: CRANKSHAFT SOCKET (499987500)

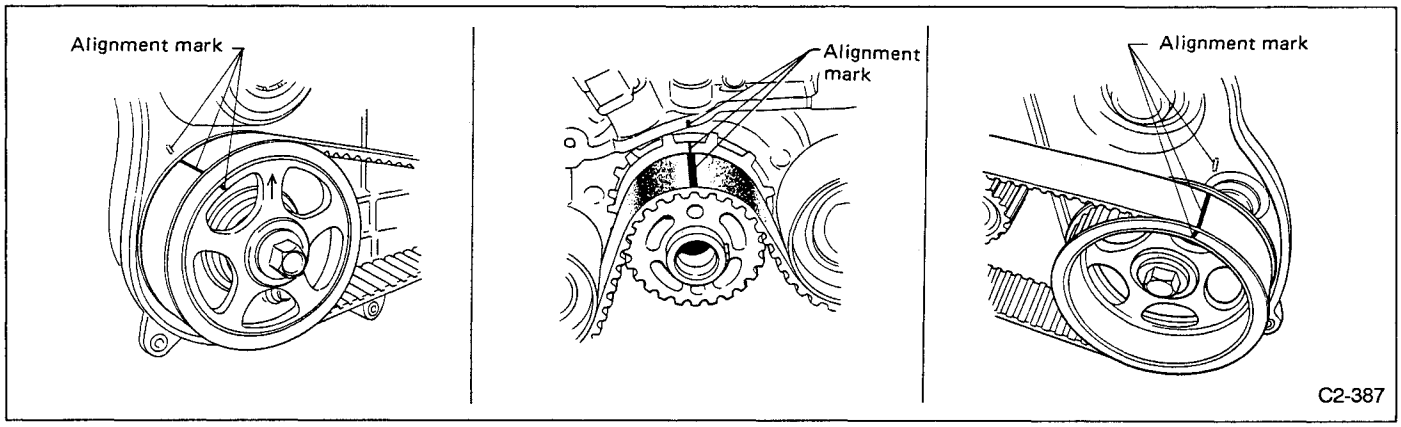


Fig. 20

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

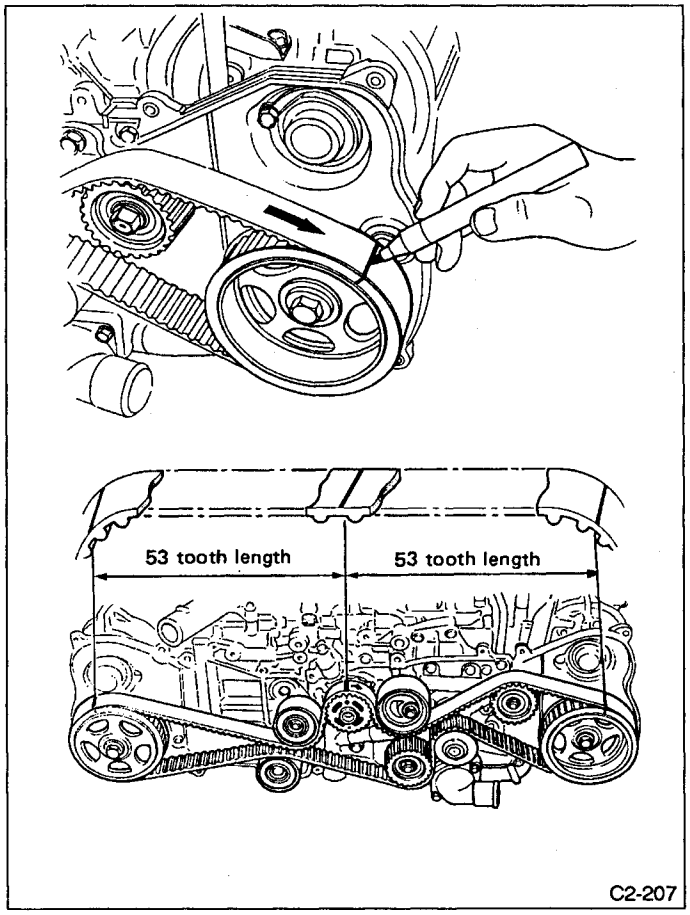


Fig. 21

2) Loosen tensioner adjuster mounting bolts.
3) Remove belt idler.
4) Remove belt idler No. 2
5) Remove timing belt.

4. BELT TENSIONER AND IDLER

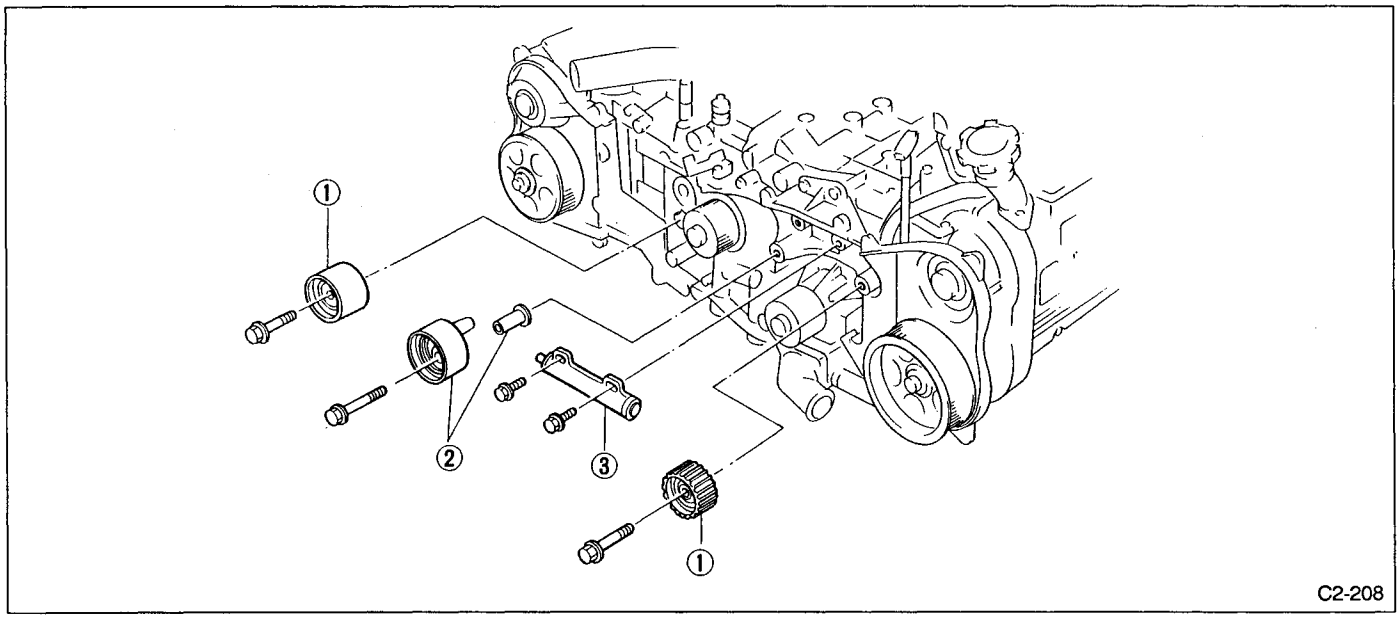


Fig. 22

1) Remove belt idlers.
2) Remove belt tensioner and spacer.

3) Remove belt tension adjuster.

5. SPROCKET

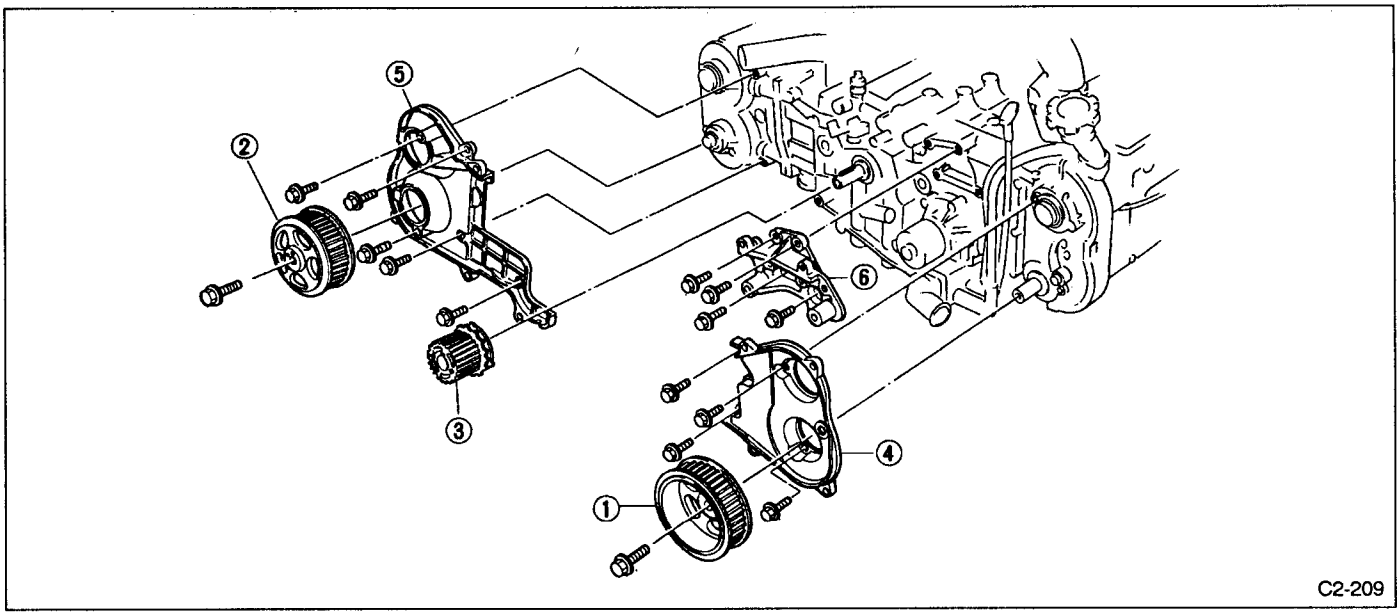


Fig. 23

1) Remove left-hand camshaft sprocket.

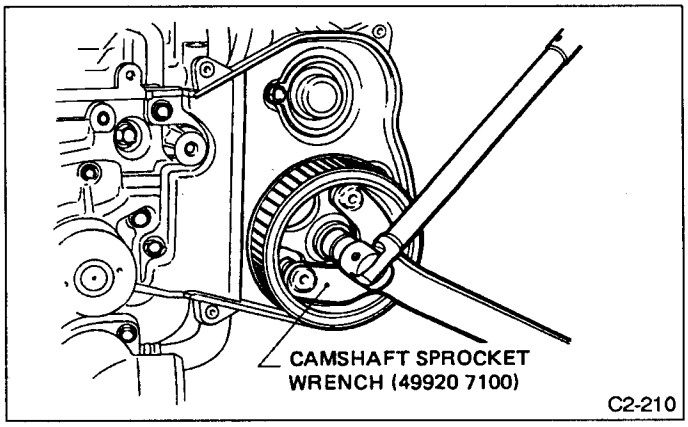


Fig. 24

2) Remove right-hand camshaft sprocket. To lock camshaft, use CAMSHAFT SPROCKET WRENCH.
3) Remove crankshaft sprocket.

If unable to remove crankshaft sprocket, tap two holes in crankshaft sprocket, and remove using PULLER and BOLT.
But this PULLER has no holes to fit crank shaft sprocket holes.
Therefore drill two holes in PULLER to fit crankshaft sprocket holes to following dimensions:

Hole center — to — hole center (Pitch):
41 mm (1.61 in)
Hole diameter:
10 mm (0.39 in)

Recommended tap :
Thread diameter 8mm (0.31 in)
Thread pitch 1.25 mm (0.0492 in)

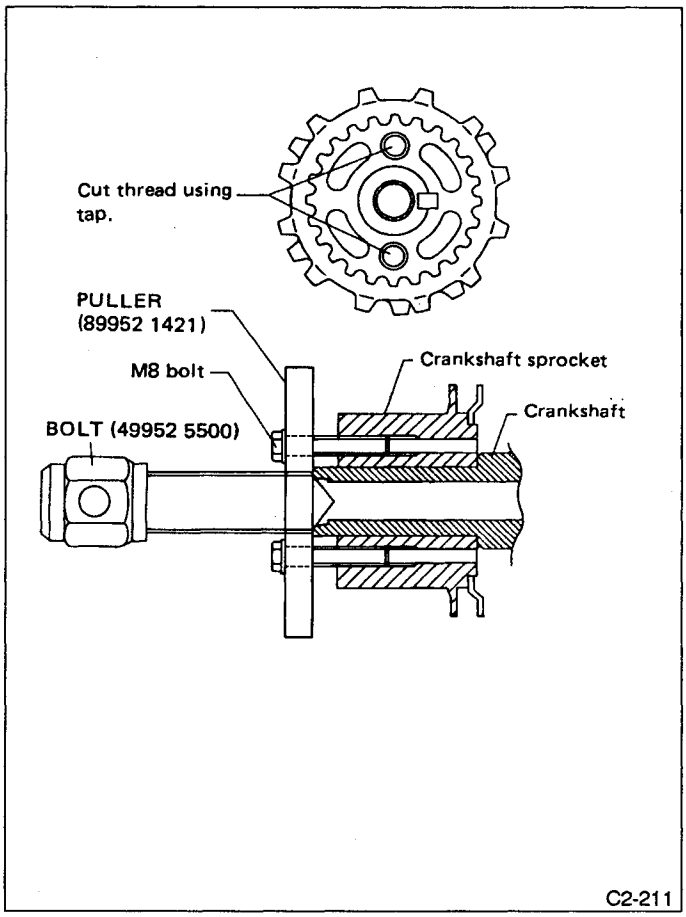


Fig. 25

4) Remove left-hand belt cover No. 2.
5) Remove right-hand belt cover No. 2.
6) Remove tensioner bracket.

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.

a. Be careful not to let oil, grease or coolant contact the belt. Remove quickly and thoroughly if this happens.

b. Do not bend the belt sharply. [The bending radius must be greater than 60 mm (2.36 in).]

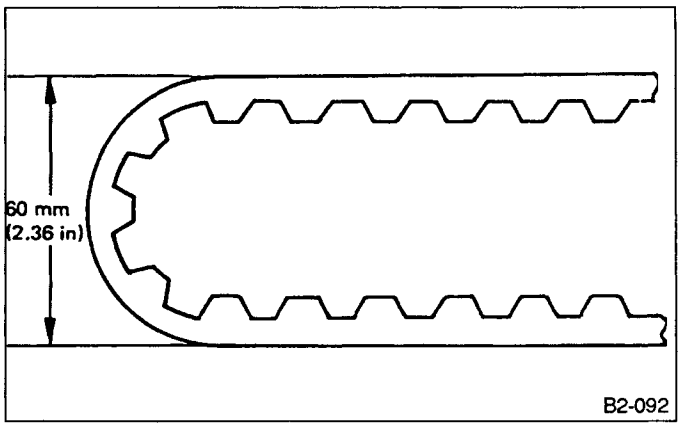


Fig. 26

2. BELT TENSION ADJUSTER

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

Slight traces of oil at rod' 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.

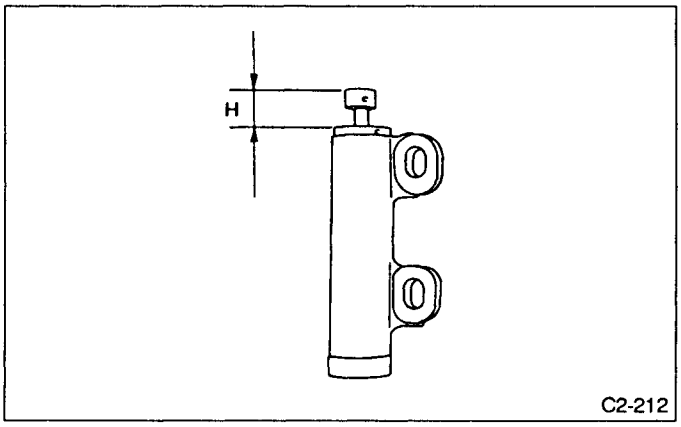


Fig. 27

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

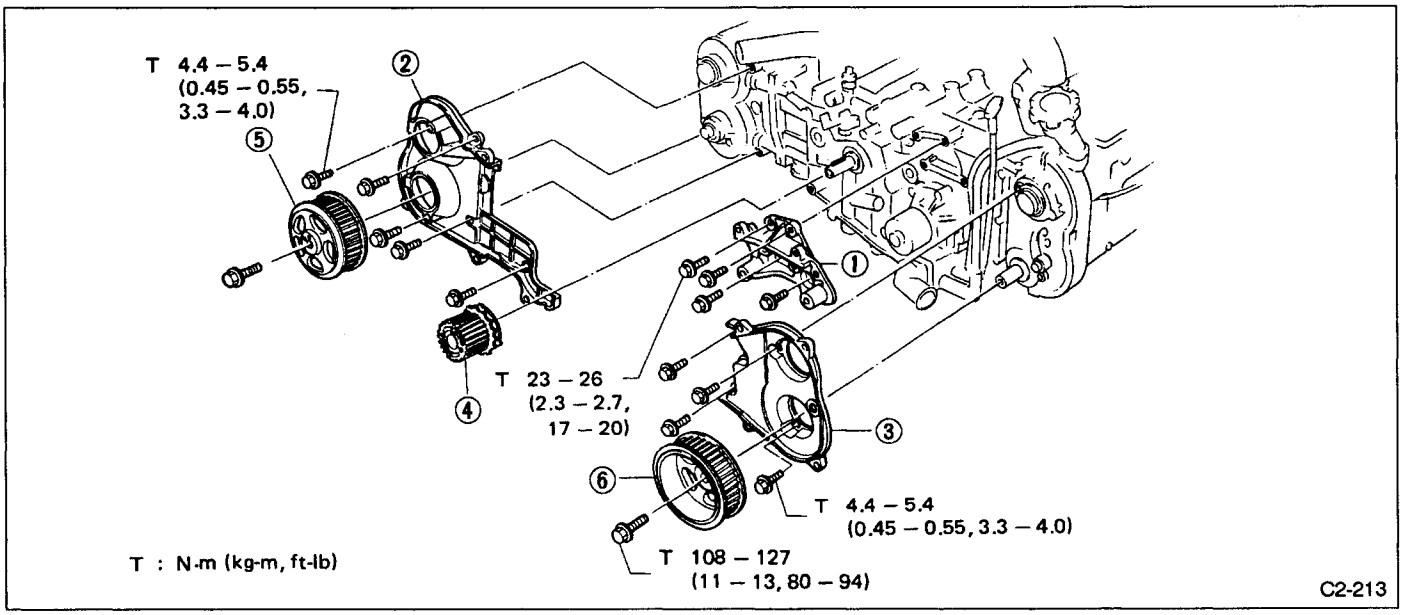


Fig. 28

1) Install tensioner bracket.
2) Install right-hand belt cover No. 2.
3) Install left-hand belt cover No. 2.
4) Install crankshaft sprocket.
5) Install right-hand camshaft sprocket.

To lock camshaft, use CAMSHAFT SPROCKET WRENCH.

6) Install left-hand camshaft sprocket.

Do not confuse left- and right-hand camshaft sprockets during installation. The left-hand camshaft sprocket is identified by a projection used to monitor cam-angle sensor.

2. BELT TENSIONER AND IDLER

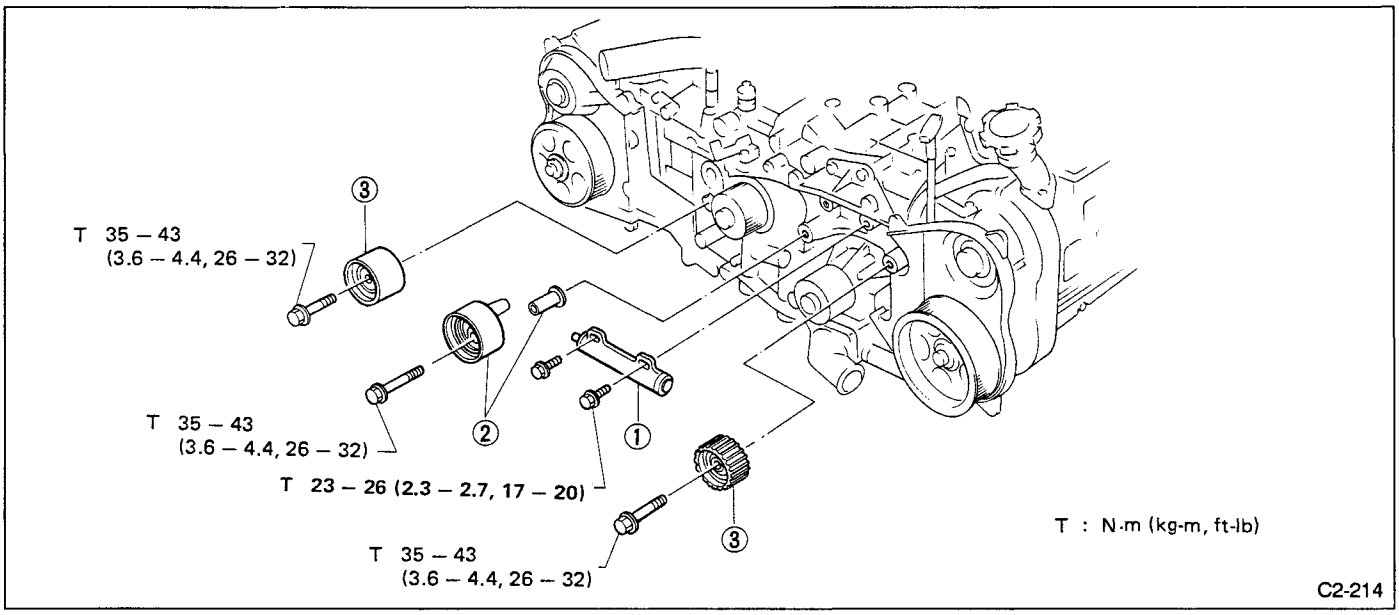


Fig. 29

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

a. Do not allow press pressure to exceed 9,807 N (1,000 kg, 2,205 lb).

b. Do not release press pressure until stopper pin is completely inserted.

c. Push tension adjuster rod vertically.

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

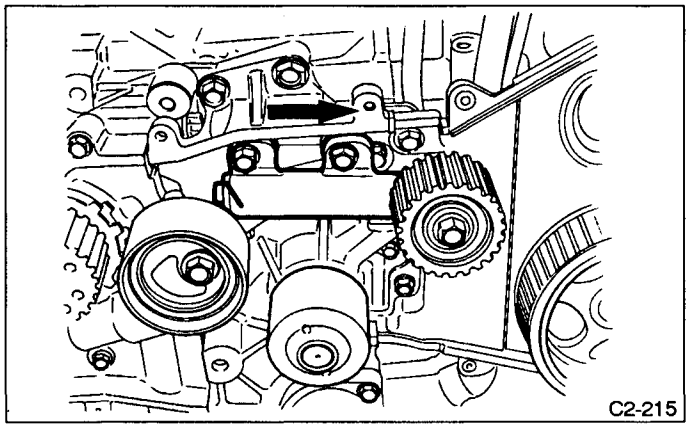


Fig. 30

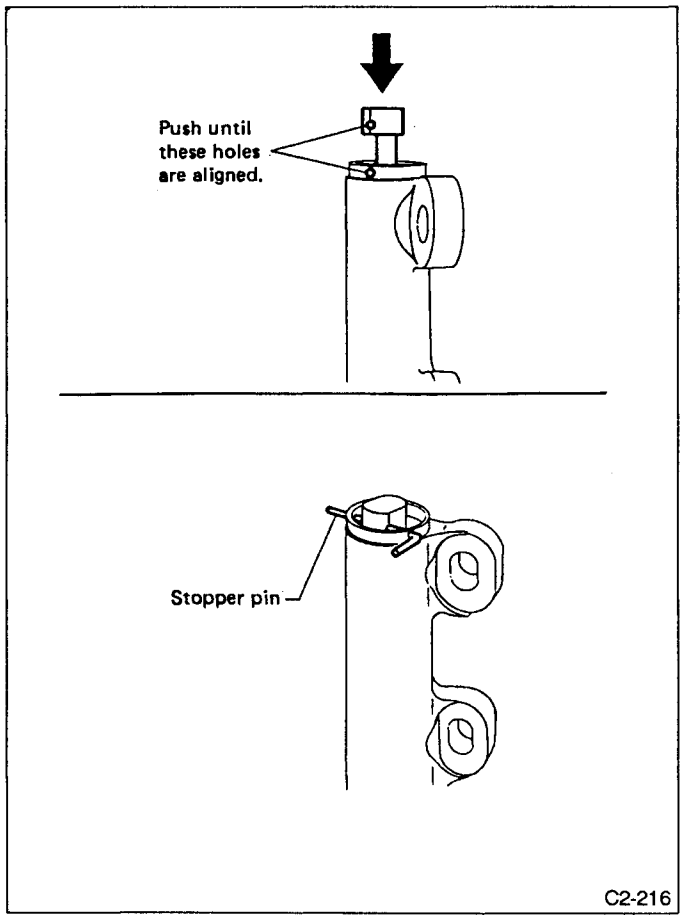


Fig. 31

2) Install belt tensioner.
3) Install belt idlers.

3. TIMING BELT

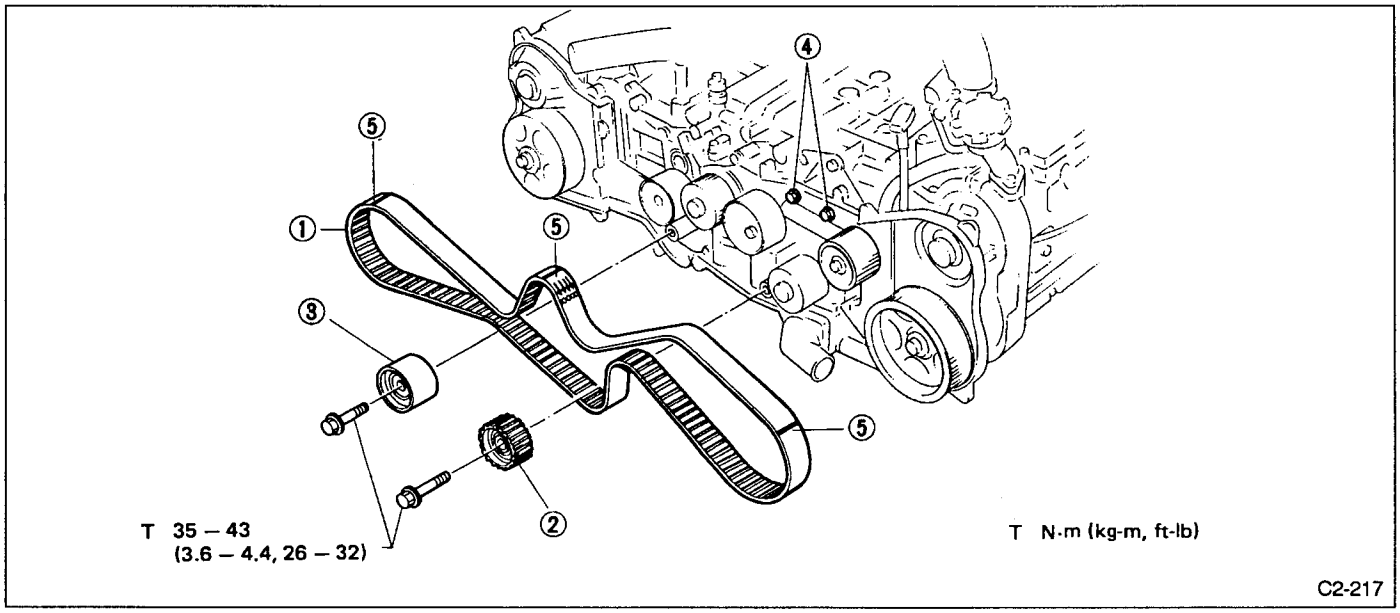


Fig. 32

1) Installation of timing belt
   (1) Using SPROCKET WRENCH, turn sprockets and align their alignment marks with marks of belt covers and oil pump.

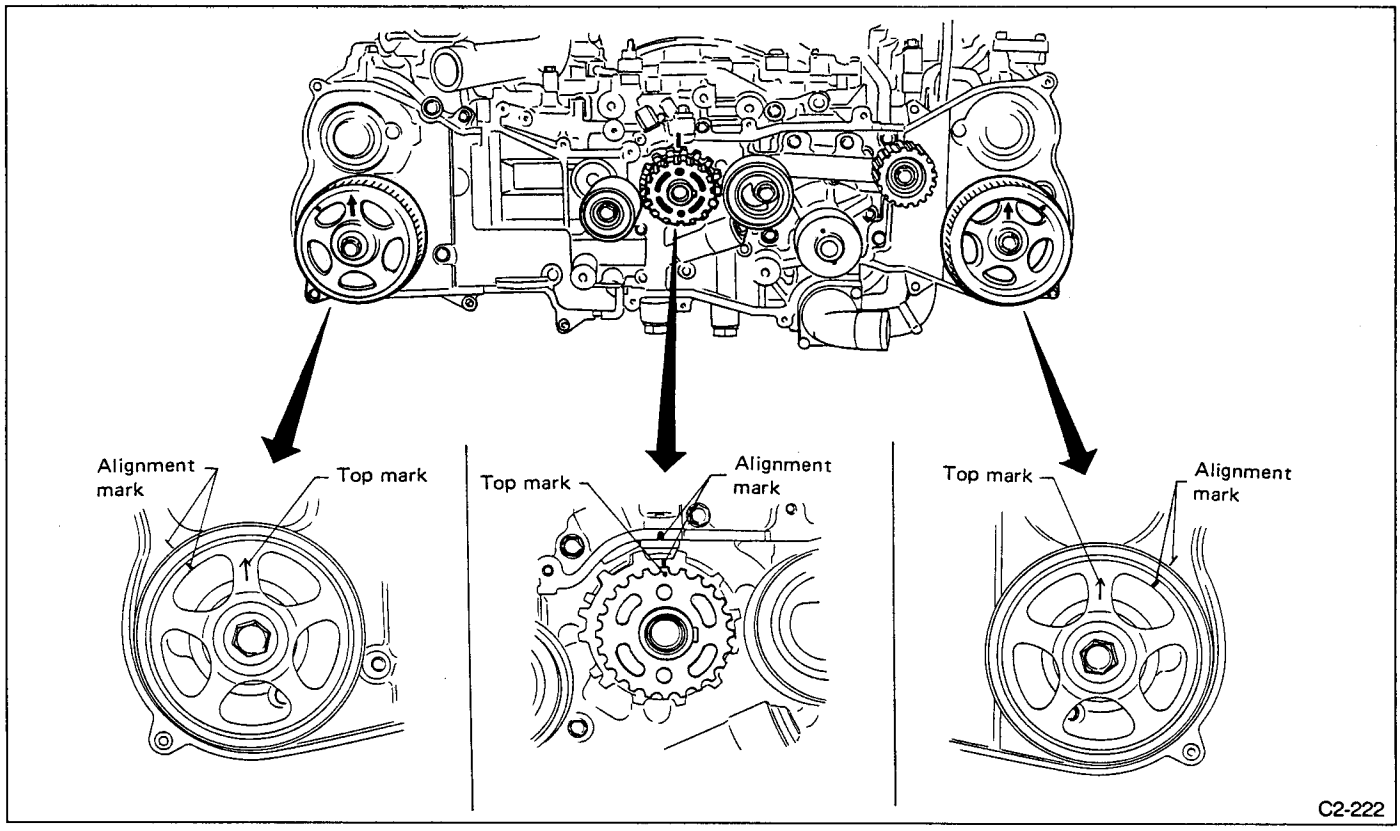


Fig. 33

(2) While aligning alignment mark on timing belt with marks on sprockets, position timing belt properly.

Ensure belts rotating direction is correct.

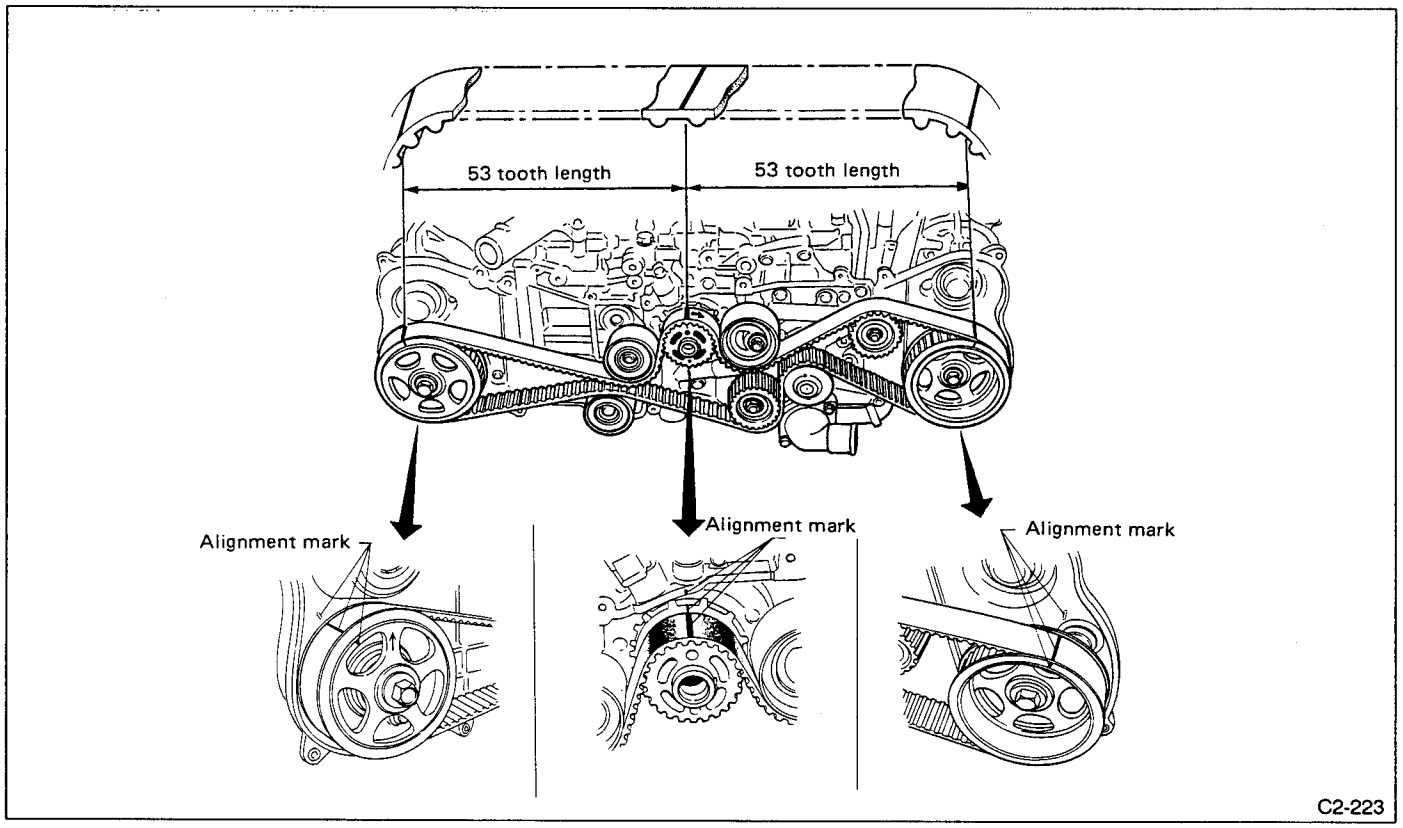


Fig. 34

2) Install belt idler No. 2.
3) Install belt idler.
4) Loosen tension adjuster attaching bolts and move adjuster all the way to the left. Tighten the bolts.

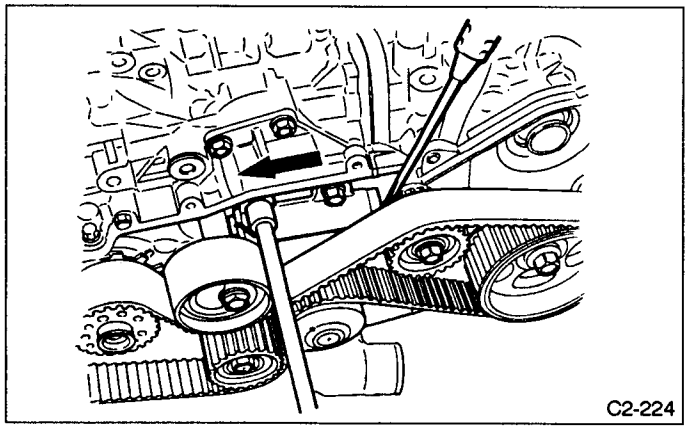


Fig. 35

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

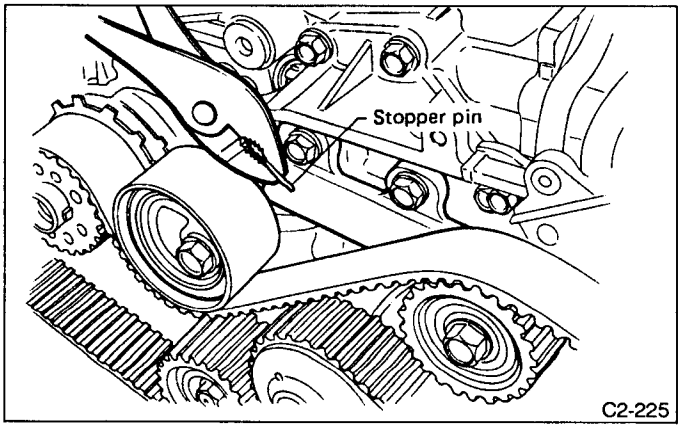


Fig. 36

4. CRANKSHAFT PULLEY AND BELT COVER

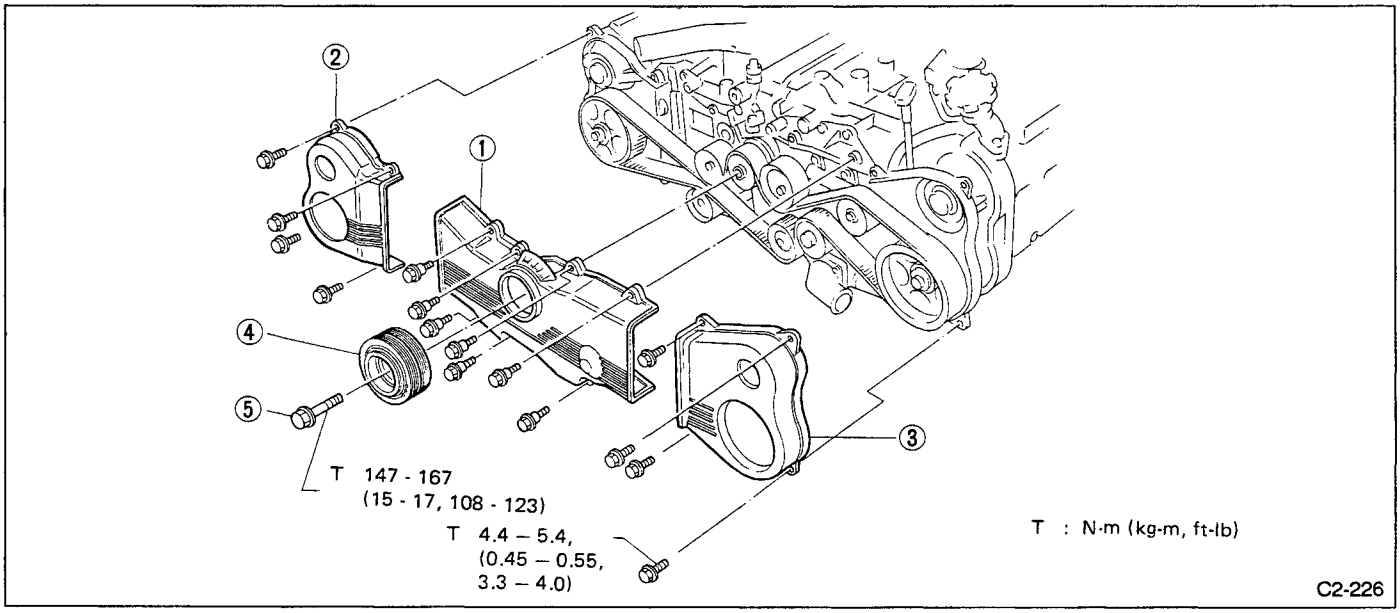


Fig. 37

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. To lock crankshaft, use CRANKSHAFT PULLEY WRENCH.

5. RELATED PARTS

1) Install A/C compressor bracket.
2) Install A/C compressor.
3) Install A/C belt tensioner bracket.
4) Install power steering pump bracket.
5) Install alternator and V-belt cover bracket.
6) Install power steering pump.
7) Install V-belts.

⟨Refer to 1-5 Drive Belts [01B1].⟩

3. Camshaft

A: REMOVAL

1. RELATED PARTS

1) Remove timing belt, camshaft sprockets and related parts
〈Refer to Timing Belt [W2A0].〉
2) Disconnect cam angle sensor connector.
3) Disconnect ignition coil connectors.

2. CAMSHAFTS LH

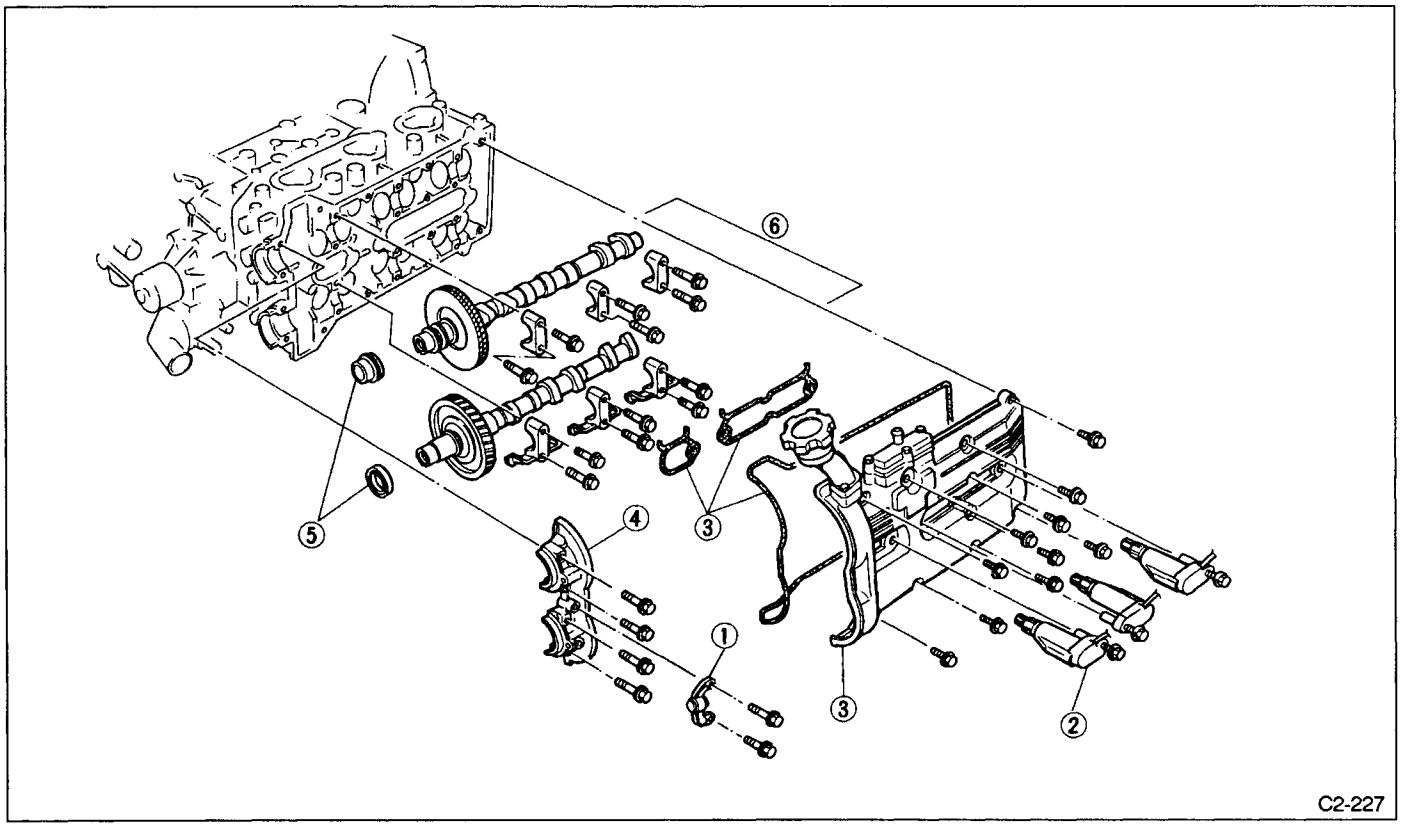


Fig. 38

1) Remove cam angle sensor with bracket.
2) Remove ignition coils.
Fully loosen ignition coil mounting bolts, and pull the bolt head using pliers.
Be careful not to pull any harness by mistake.
3) Disconnect blow-by hose and remove cylinder head cover and gasket.
4) Remove front camshaft cap.
5) Remove camshaft oil seal and plug.
6) Removal of intake and exhaust camshafts.
Since the camshaft thrust clearance is small, the camshaft must be removed by holding it parallel to the cylinder head. If the camshaft is not parallel to the cylinder head, the cylinder head thrust bearing portion may be damaged by the camshaft. To avoid this, proceed as follows:

(1) Rotate the intake camshaft (upper) and exhaust camshaft (lower) so that the notch at the front end of each camshaft faces directly downward, by applying a wrench to the hexagonal portion of the camshafts.

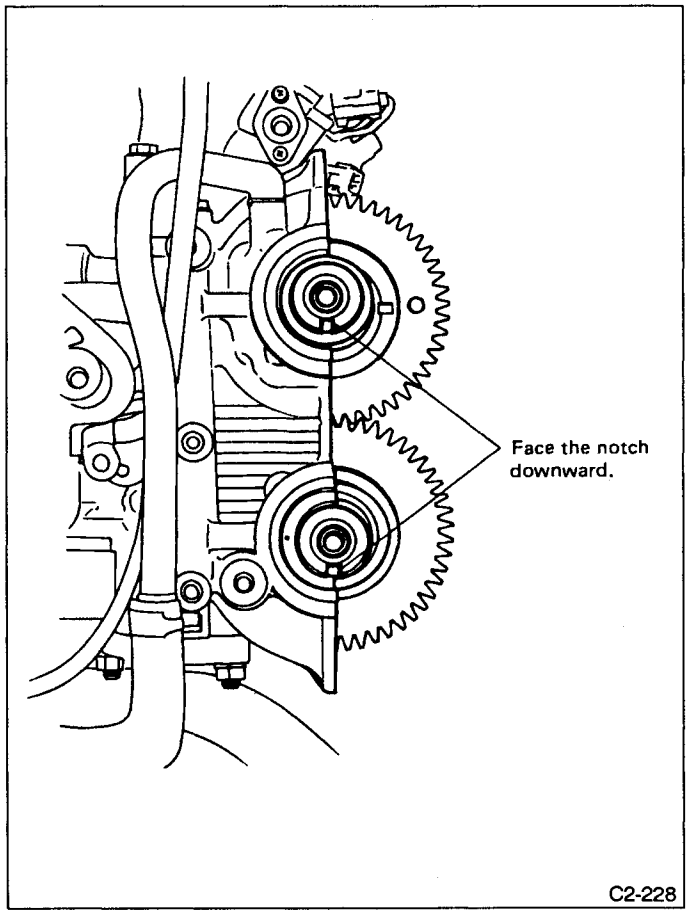


Fig. 39

(2) See the rear side of the camshaft gears, and make sure that the match marks of the intake camshaft gear (driven gear) and exhaust camshaft gear (drive gear) are aligned.

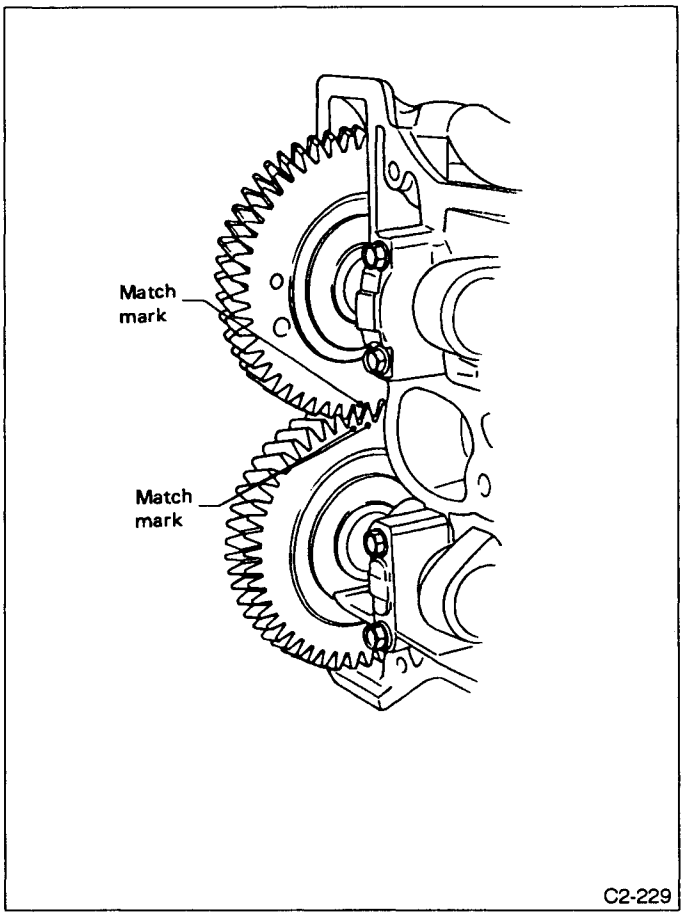


Fig. 40

(3) Install a service bolt to the sub-gear mounting bolt hole of the intake camshaft gear to secure the sub-gear and driven gear.

Recommended service bolt:
Thread diameter
6 mm (0.24 in)
Thread pitch
1.0 mm (0.039 in)
Bolt length
16 — 20 mm (0.63 — 0.79 in)

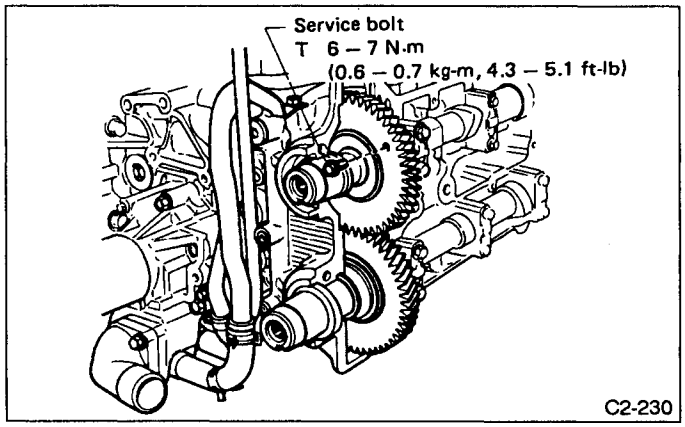


Fig. 41

When removing camshafts, make certain that the torsional spring force of the sub-gear has been eliminated by the above operation.

(4) Loosen six bolts on three intake camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

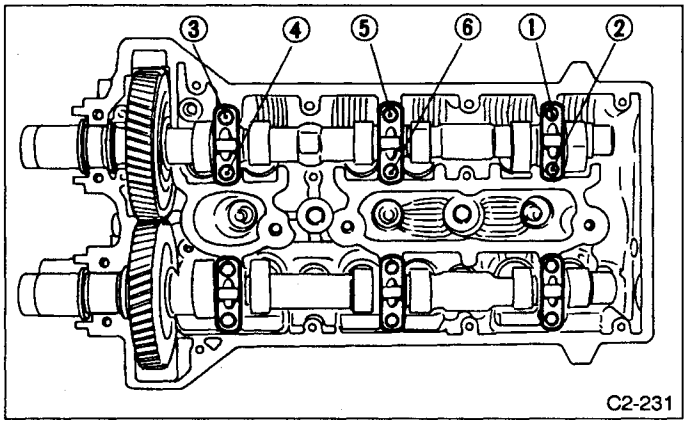


Fig. 42

Make sure that, as the bolts are loosened, the clearance between the camshaft journal and the cylinder head journal bearing increases evenly at three places. If not, tighten the bolts by reversing the illustrated numerical sequence, and then repeat step (4) above.

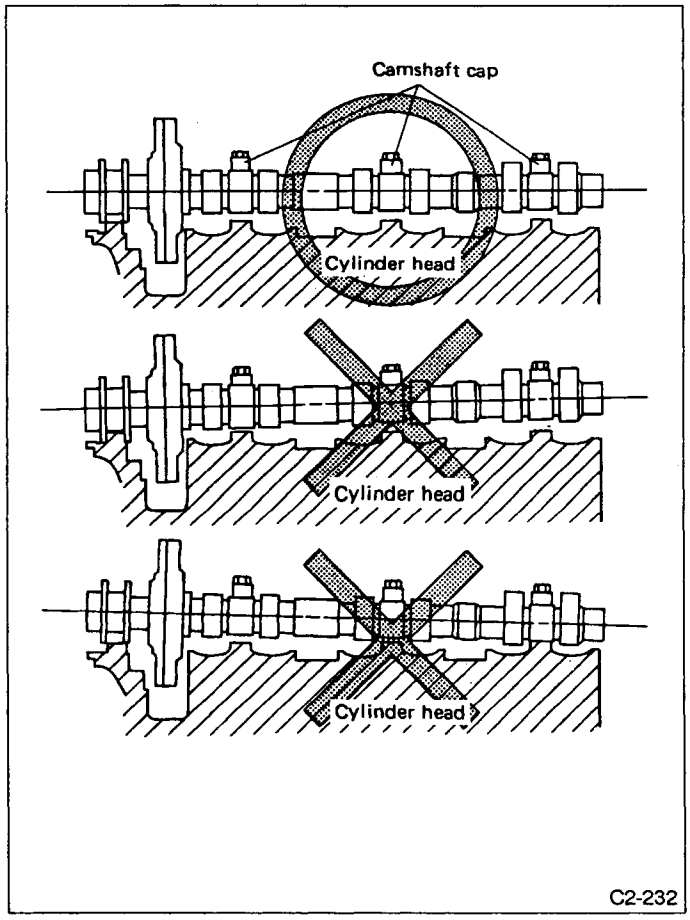


Fig. 43

(5) Remove the camshaft cap while holding the intake camshaft with one hand, and then remove the camshaft. If it is hard to remove the camshaft, rotate the exhaust camshaft clockwise.

Arrange the camshaft caps in correct order.

(6) Loosen six bolts of three exhaust camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

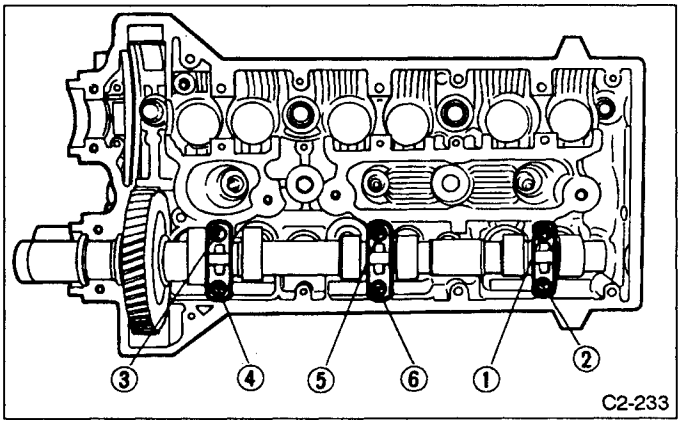


Fig. 44

Make sure that, as the bolts are loosened, the clearance between the camshaft journal and the cylinder head journal bearing increases evenly at three places. If not, tighten the bolts by reversing the illustrated numerical sequence, and then repeat step (6) above.

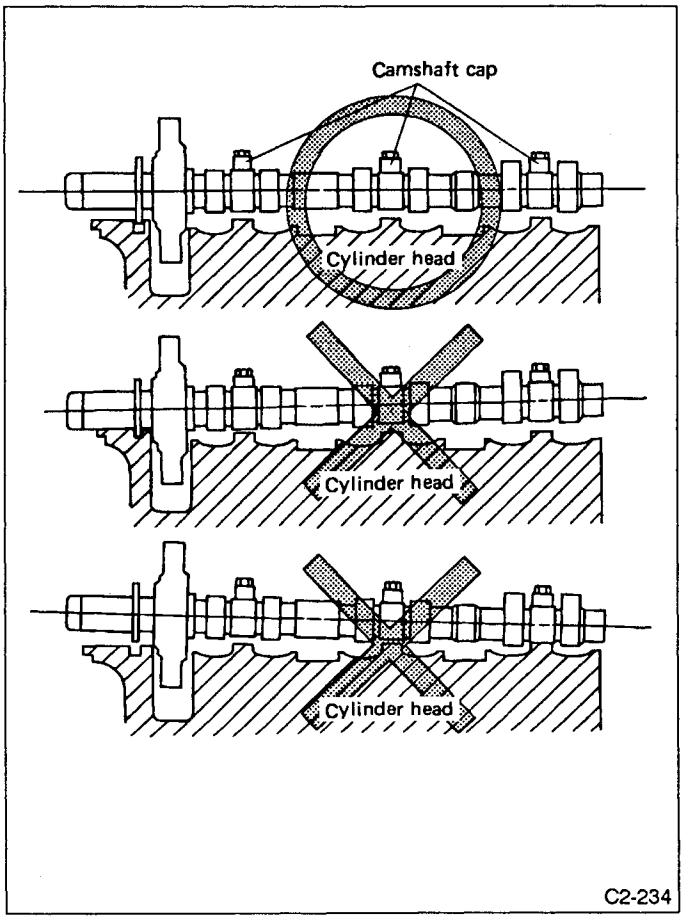


Fig. 45

(7) Remove the camshaft cap while holding the exhaust camshaft with one hand, and then remove the camshaft.

Arrange the camshaft caps in correct order.

7) Remove hydraulic lash adjusters.
Arrange the hydraulic lash adjusters in order so that they can be installed in their original positions.

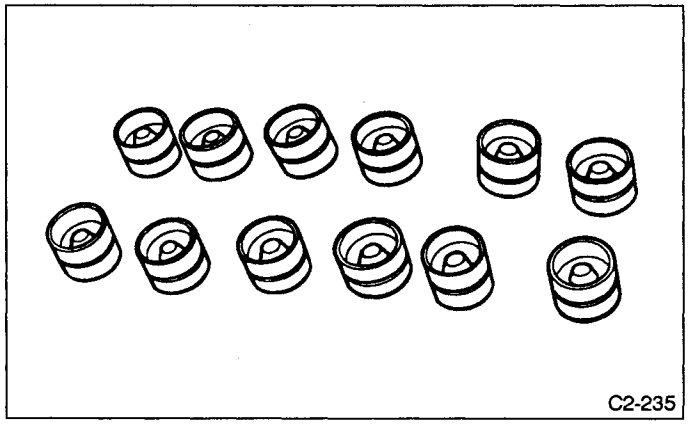


Fig. 46

3. CAMSHAFTS RH

Operation precautions are the same as those for the LH camshafts, except the method for aligning the camshaft gear match marks before removing camshafts.

1) Remove ignition coils.
2) Disconnect blow-by hose and remove cylinder head cover and gasket.
3) Remove front camshaft cover.
4) Remove camshaft oil seal and plug.
5) Removal of intake and exhaust camshafts
   (1) Rotate the intake camshaft (upper) and exhaust camshaft (lower) so that the notch at the front end of each camshaft faces directly upward.

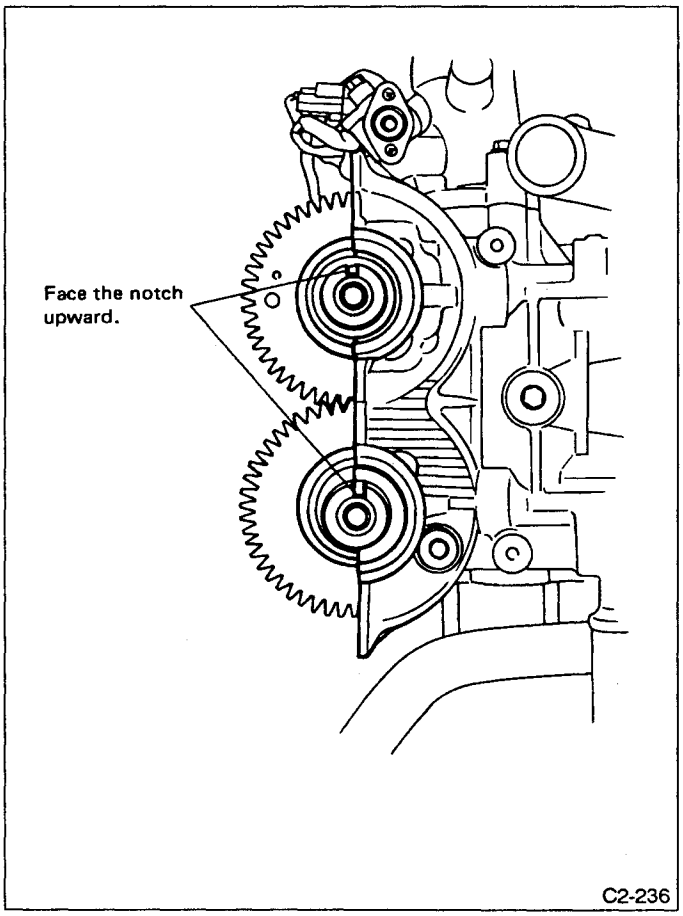


Fig. 47

(2) See the rear side of the camshaft gears, and make sure that the match marks of the intake camshaft gear (driven gear) and exhaust camshaft gear (drive gear) are aligned.

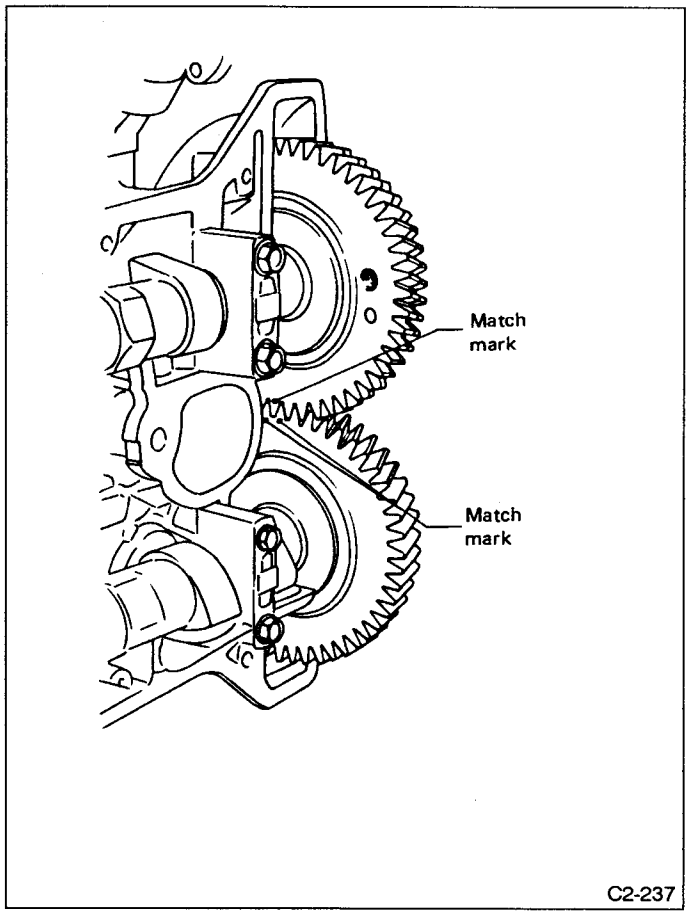


Fig. 48

(3) Install a service bolt to the sub-gear mounting bolt hole of the intake camshaft gear to secure the sub-gear and driven gear.

(4) Loosen six bolts on three intake camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

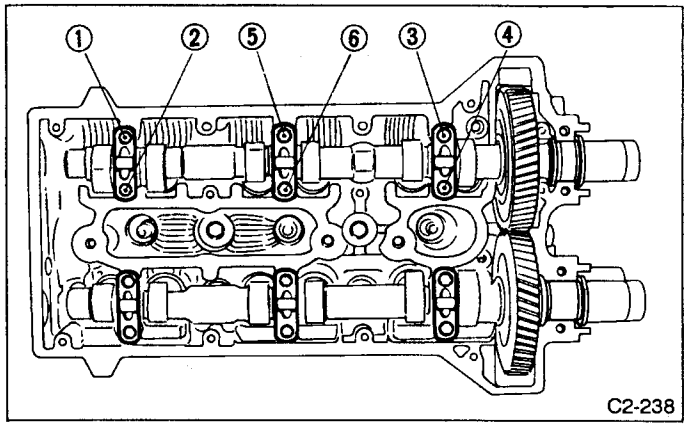


Fig. 49

Make sure that, as the bolts are loosened, the clearance between the camshaft journal and the cylinder head journal bearing increases evenly at three places. If not, tighten the bolts by reversing the illustrated numerical sequence, and then repeat step (4) above.

(5) Remove the camshaft cap while holding the intake camshaft with one hand, and then remove the camshaft. If it is hard to remove the camshaft, rotate the exhaust camshaft counterclockwise.

Arrange the camshaft caps in correct order.

(6) Loosen six bolts of three exhaust camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

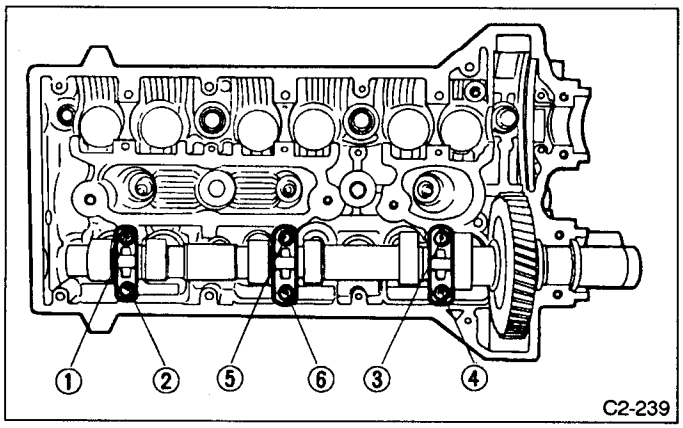


Fig. 50

Make sure that, as the bolts are loosened, the clearance between the camshaft journal and the cylinder head journal bearing increases evenly at three places. If not, tighten the bolts by reversing the illustrated numerical sequence, and then repeat step (6) above.

(7) Remove the camshaft cap while holding the exhaust camshaft with one hand, and then remove the camshaft.

Arrange the camshaft caps in correct order.

6) Remove hydraulic lash adjusters.

Arrange the hydraulic lash adjusters in order so that they can be installed in their original positions.

B: DISASSEMBLY

1. INTAKE CAMSHAFT

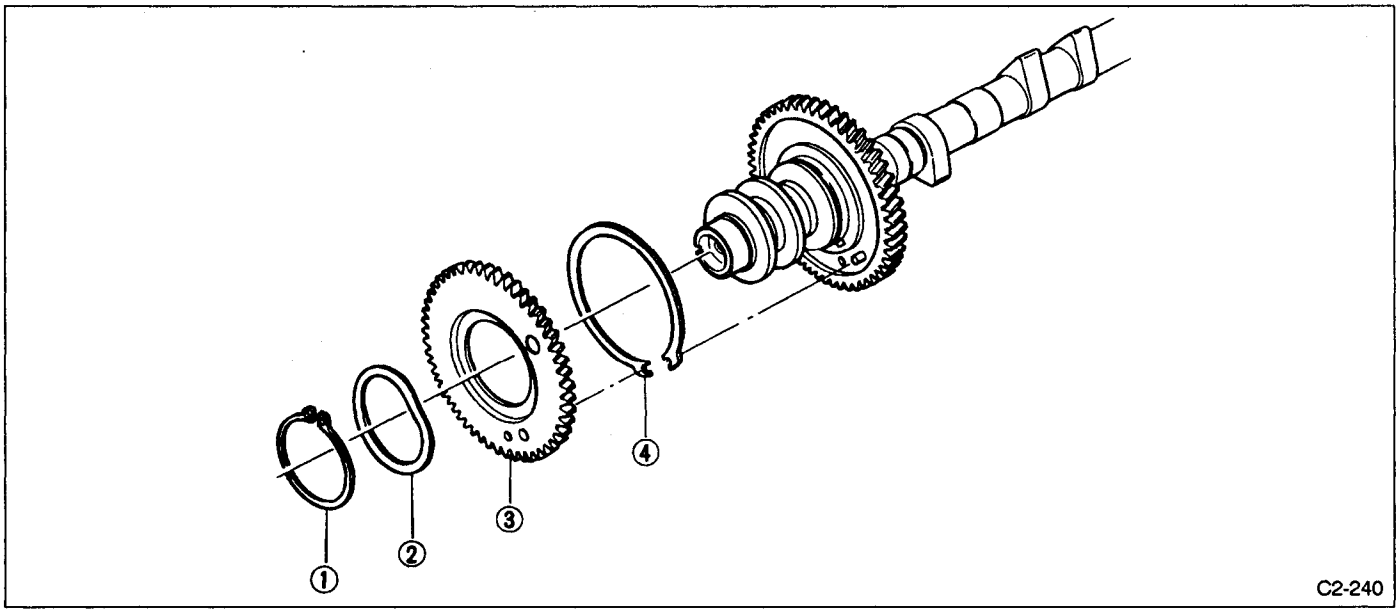


Fig. 51

1) Removal of snap ring

(1) Secure the shaft portion of the camshaft in a vice using a rag.

a. Never attempt to hold the cam lobe or journal in the vice.

b. Pay attention not to damage the cam lobe and journal.

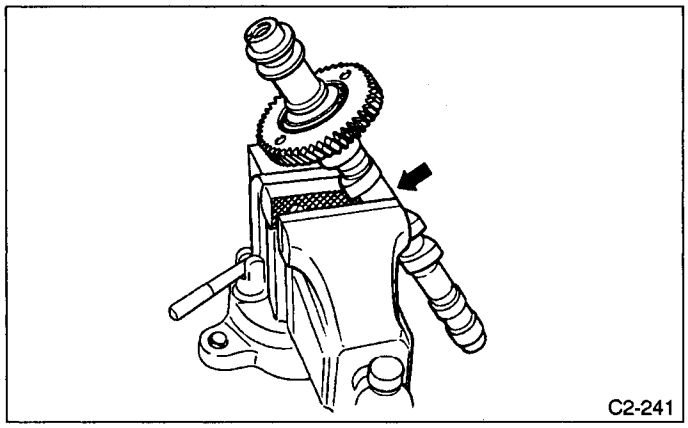


Fig. 52

(2) Turn the sub-gear clockwise using CAMSHAFT GEAR WRENCH, and remove service bolt.

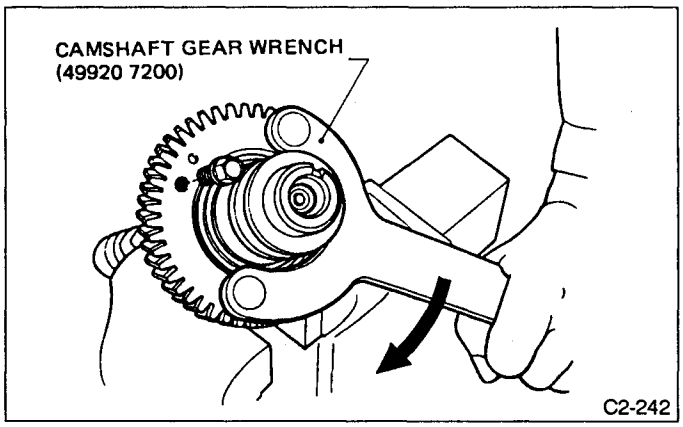


Fig. 53

(3) Remove snap ring using CAMSHAFT GEAR PLIERS.

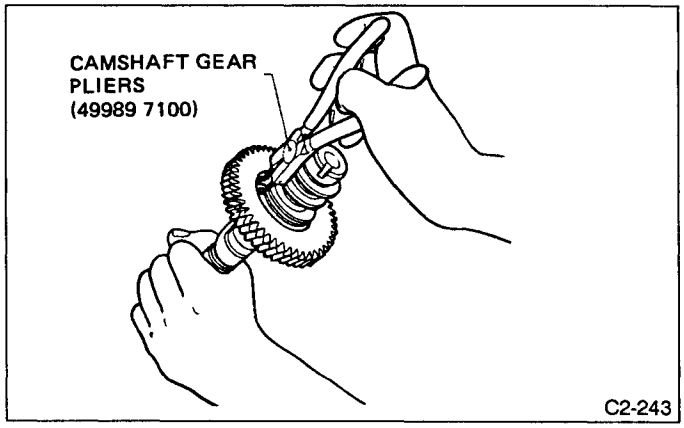


Fig. 54

2) Remove wave washer.
3) Remove camshaft sub-gear.
4) Remove camshaft gear spring.
Arrange the camshaft sub-gears and gear springs.

C: INSPECTION

1. CAMSHAFT

1) Visually check the camshafts for scratches flaking and wear.
2) Measurement of the camshaft bend.
(1) Place the camshaft on V-blocks at the No. 2 and No.4 journal.
(2) Measure the camshaft runout at the No.3 journal.

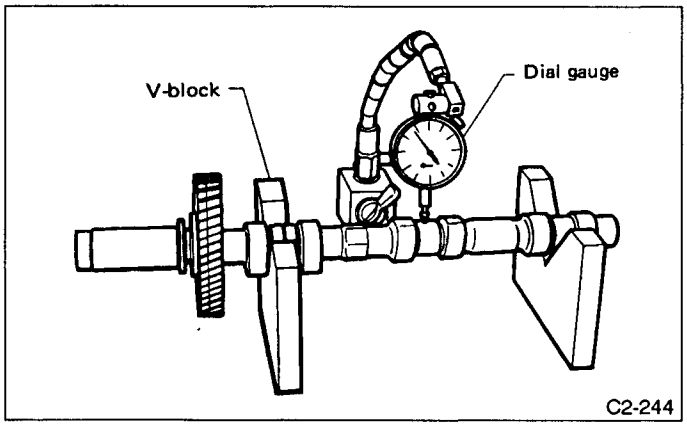


Fig. 55

Limit:
0.02 mm (0.0008 in)

(3) If it exceeds the limit, replace camshaft.
3) Measure outside diameter of the camshaft journal. If the journal diameter is not as specified, check the oil clearance.

Camshaft journal outer diameter		
	#1	#2, #3, #4
Standard	31.943 — 31.963 mm (1.2576 — 1.2584 in)	27.946 — 27.963 mm (1.1002 — 1.1009 in)

4) Measure the cam height H.
If it exceeds the limit, replace camshaft.

Standard cam height H:
Intake: 39.05 — 39.15 mm (1.5374 — 1.5413 in)
Wear limit
38.90 mm (1.5315 in)
Exhaust: 39.85 — 39.95 mm (1.5689 — 1.5728 in)
Wear limit
39.70 mm (1.5630 in)

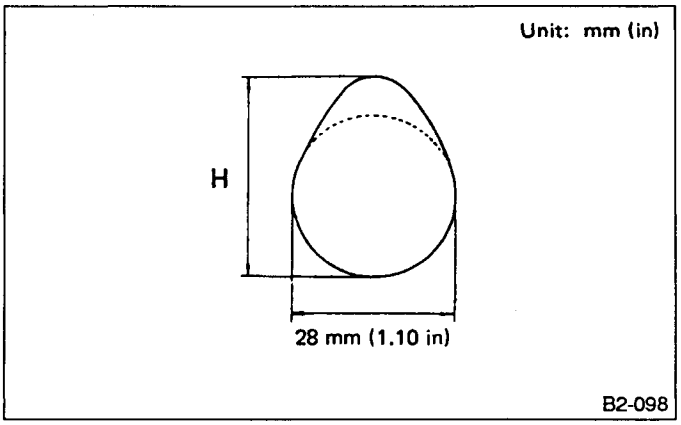


Fig. 56

5) Visually check the camshaft caps for scratches, flaking and wear.
If the camshaft caps are damaged, replace the camshaft caps and cylinder head as a set.
6) Measurement of the thrust clearance of camshaft
Measure the clearance of each camshaft.
(1) Install camshaft without installing valve lash adjusters.
〈Refer to [W3E1].〉
Be sure to install the camshaft at the specified position.
(2) Measure the thrust clearance of the camshaft.

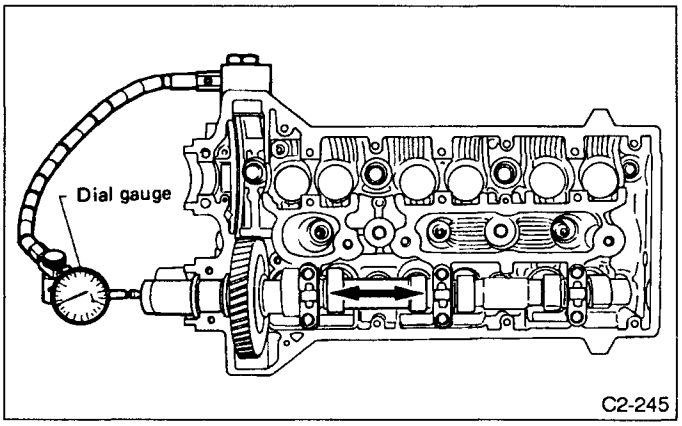


Fig. 57

Standard camshaft thrust clearance:
Intake:0.03 — 0.09 mm (0.0012 — 0.0035 in)
Wear limit
0.13 mm (0.0051 in)
Exhaust:0.02 — 0.08 mm (0.0008 — 0.0031 in)
Wear limit
0.12 mm (0.0047 in)

(3) If the thrust clearance exceeds the limit, replace the camshaft caps and cylinder head as a set. If necessary, replace the camshaft.

7) 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 lash adjuster.)
(3) Place plastigauge across each of the camshaft journals.
(4) Install the bearing caps.
⟨Refer to [W3E1].⟩
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)

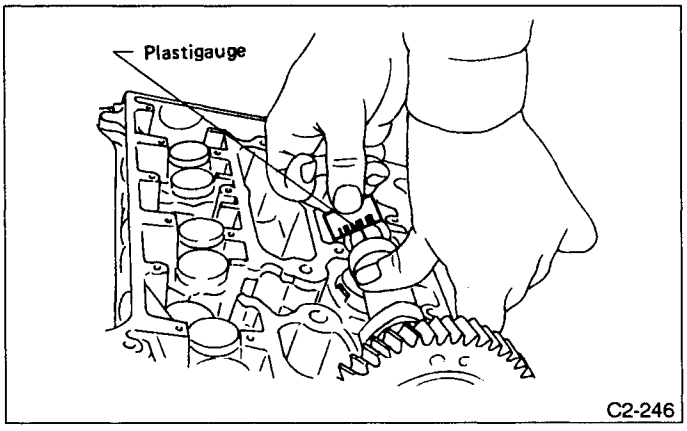


Fig. 58

(7) Completely remove the plastigauge.

2. CAMSHAFT GEAR

1) Inspection of camshaft gear backlash.
(1) Install the intake and exhaust camshafts without installing hydraulic lash adjusters.
⟨Refer to [W3E1].⟩
Do not install the intake camshaft sub-gear.
(2) Measure the backlash using dial gauge. If the backlash exceeds the limit, replace the intake and exhaust camshafts as a set.

Standard camshaft gear backlash:
0.029 — 0.175 mm (0.0011 — 0.0069 in)
Limit:
0.30 mm (0.0118 in)

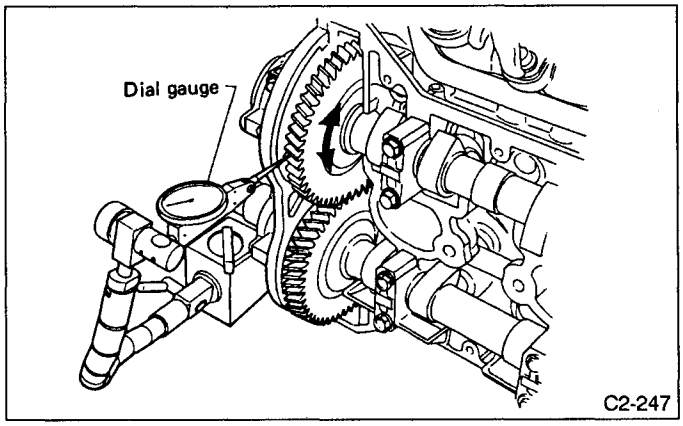


Fig. 59

2) Measure the free distance between the camshaft gear spring ends.
If the free distance is not as specified, replace the gear spring.

Free distance:
24.88 — 28.88 mm (0.9795 — 1.1370 in)

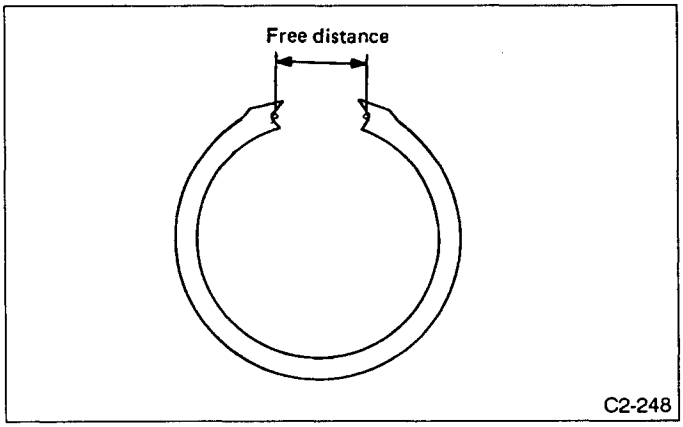


Fig. 60

D: ASSEMBLY

1. INTAKE CAMSHAFTS

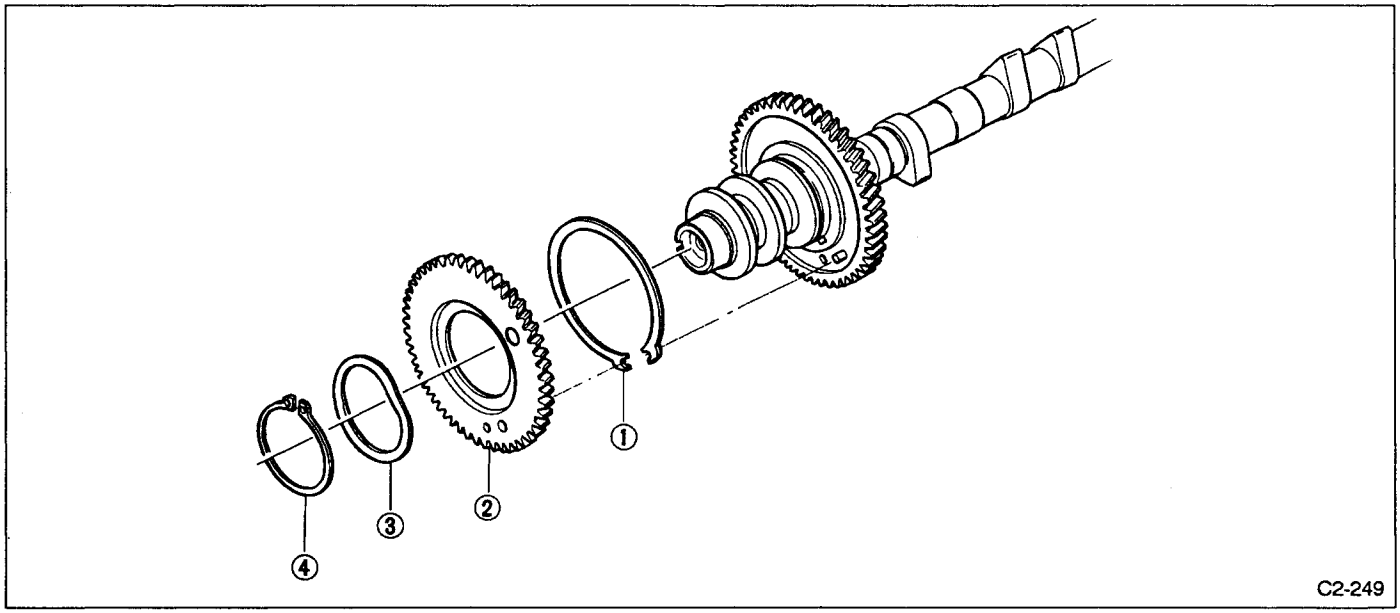


Fig. 61

1) Install camshaft gear spring.
2) Install camshaft sub-gear.
3) Install wave washer.
4) Install snap ring using CAMSHAFT GEAR PLIERS.

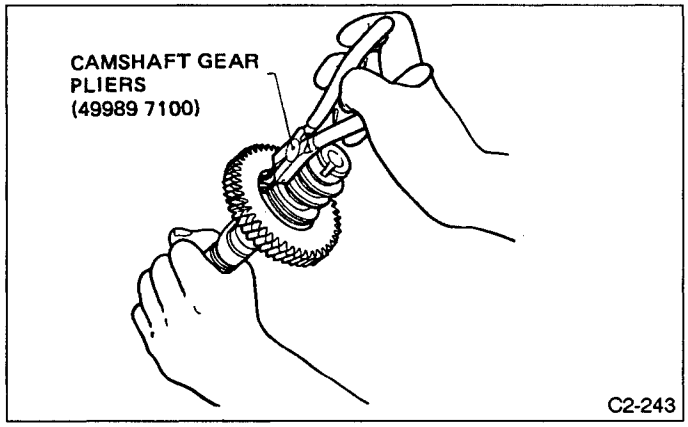


Fig. 62

5) Installation of service bolt
   (1) Secure the shaft portion of the camshaft in a vice using a rag.

a. Never attempt to hold the cam lobe or journal in the vice.

b. Pay attention not to damage the cam lobe and journal.

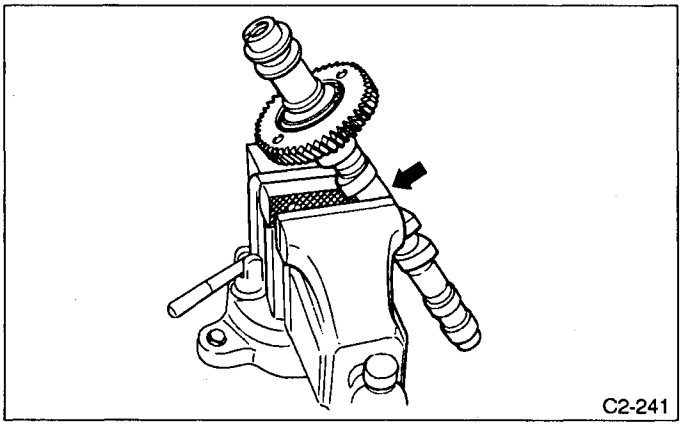


Fig. 63

(2) Turn the sub-gear clockwise and align the holes of the camshaft driven gear and sub-gear using CAMSHAFT GEAR WRENCH, and install service bolt.

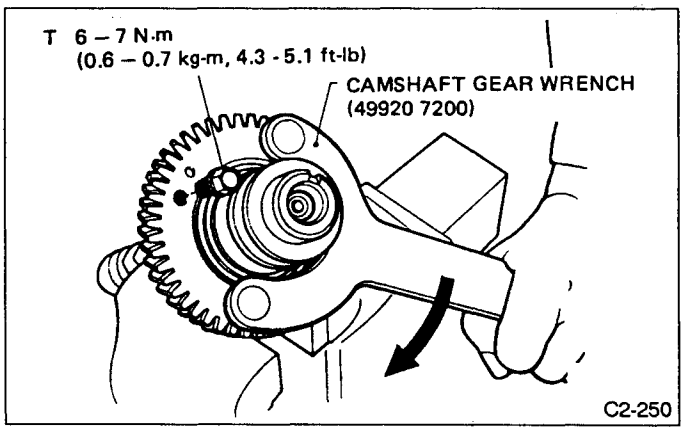


Fig. 64

E: INSTALLATION

1. CAMSHAFTS LH

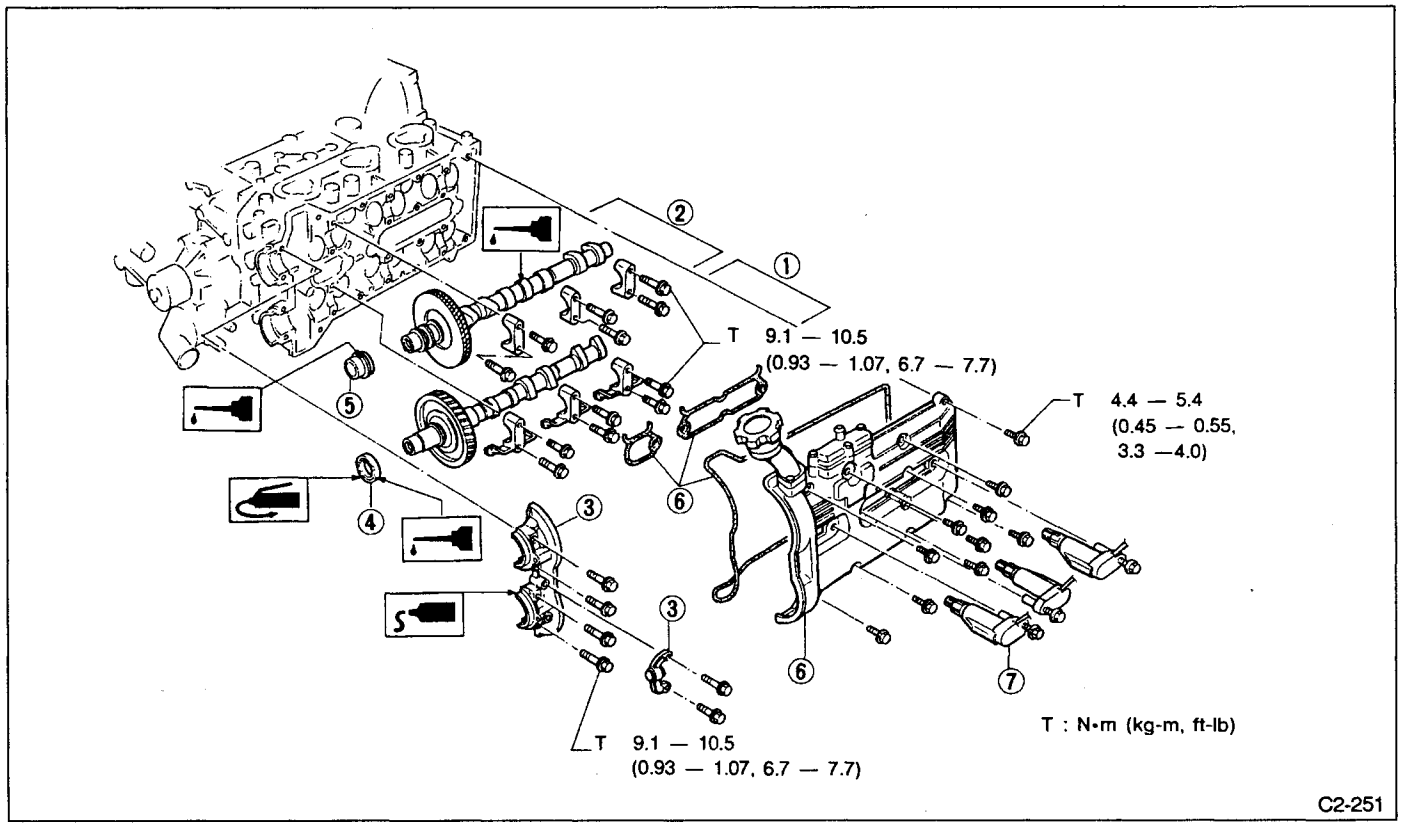


Fig. 65

Since the camshaft thrust clearance is small, the camshaft must be installed by holding it parallel to the cylinder head. If the camshaft is not parallel to the cylinder head, the cylinder head thrust bearing portion may be damaged by the camshaft. To avoid this, proceed as follows:

1) Installation of exhaust camshaft
   (1) Apply a coat of engine oil to the hydraulic lash adjuster surface and insert hydraulic lash adjusters.
   (2) Apply a coat of engine oil to the camshaft journals.
   (3) Set the exhaust camshaft on the cylinder head with the front end notch of the camshaft facing directly downward. Then attach three camshaft caps to the correct positions, and fully hand-tighten the cap bolts.

Hold the camshaft with one hand so that it will not drop while tightening the camshaft caps.

   (4) Tighten six bolts on three exhaust camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

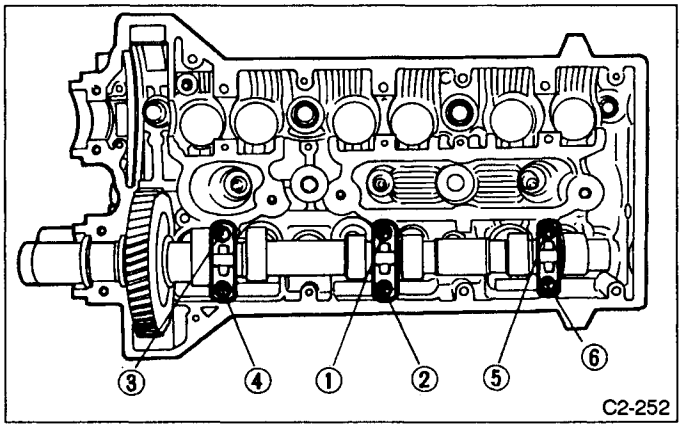


Fig. 66

Make sure that, as the bolts are tightened, the clearance between the camshaft journal and the cylinder head journal bearing decreases evenly at three places. If not, loosen the bolts by reversing the illustrated numerical sequence, and then repeat step (4) above.

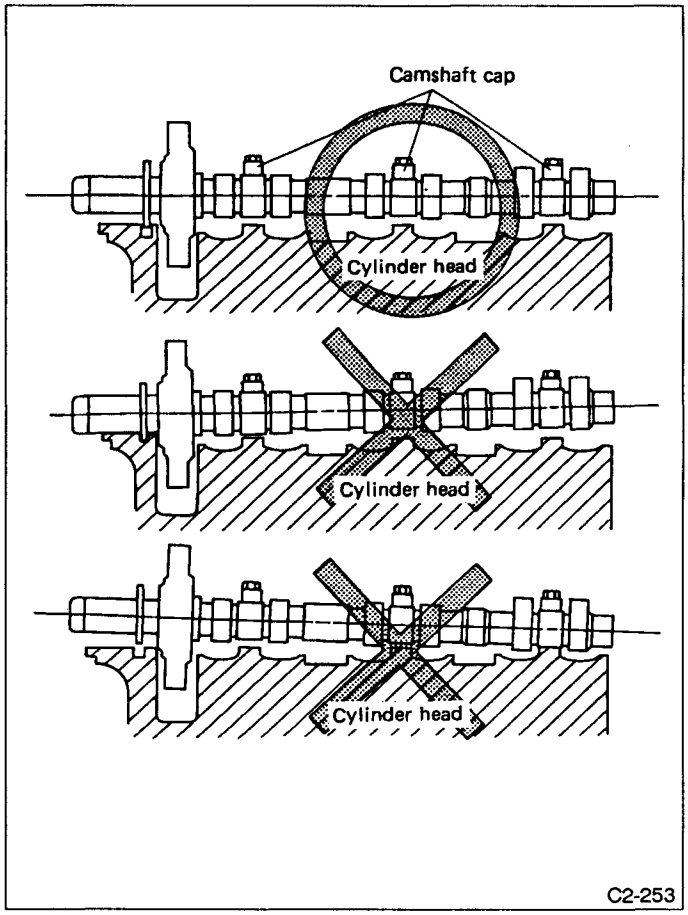


Fig. 67

(5) Tighten each bolt to the specified torque in the sequence explained in step (4).

2) Installation of intake camshaft

Each intake and exhaust camshaft gear has match marks at two places. Accordingly, if the match marks are incorrectly aligned, the cam timing will be misaligned by 180° between the intake side and exhaust side. To avoid this, be sure to use the following method when assembling the camshafts.

(1) Apply a coat of engine oil to the hydraulic lash adjuster surface and insert hydraulic lash adjusters.

(2) Apply a coat of engine oil to the camshaft journals.

(3) Align the intake camshaft match mark with the match mark of the exhaust camshaft which is already installed. In this case, make sure that the notch on the front end of the intake camshaft and that of the exhaust camshaft are facing the same direction (facing downward). After that, install the three camshaft caps at the specified positions, and fully hand-tighten the bolts.

Be sure to hold the camshaft with one hand so that it will not drop while installing the camshaft caps.

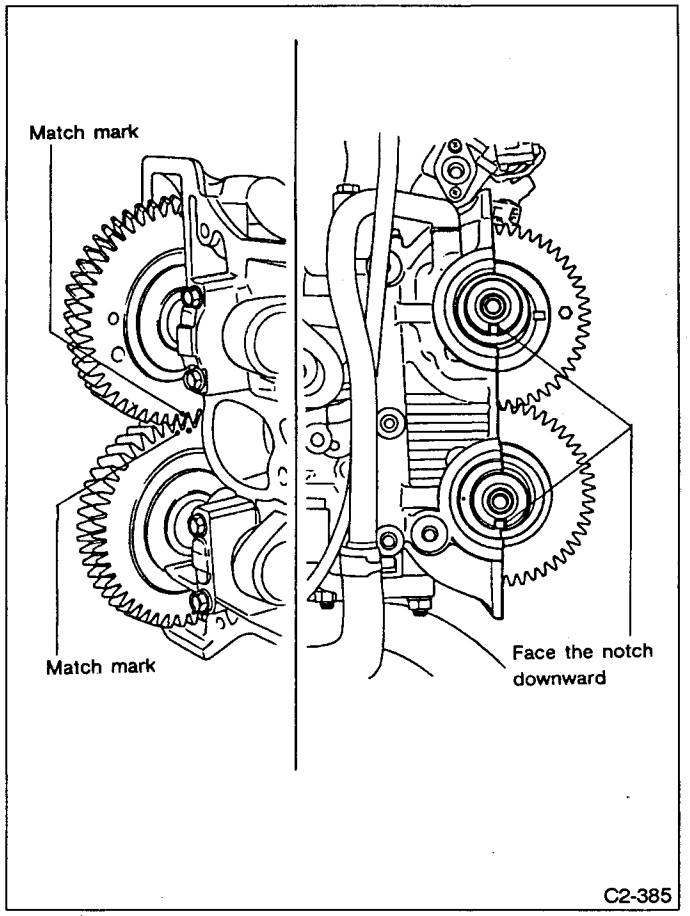


Fig. 68

(4) See the rear side of the camshaft gears, and make sure that the match marks of the camshaft gears are aligned. If not, re- assemble the camshaft using procedure (3) again.

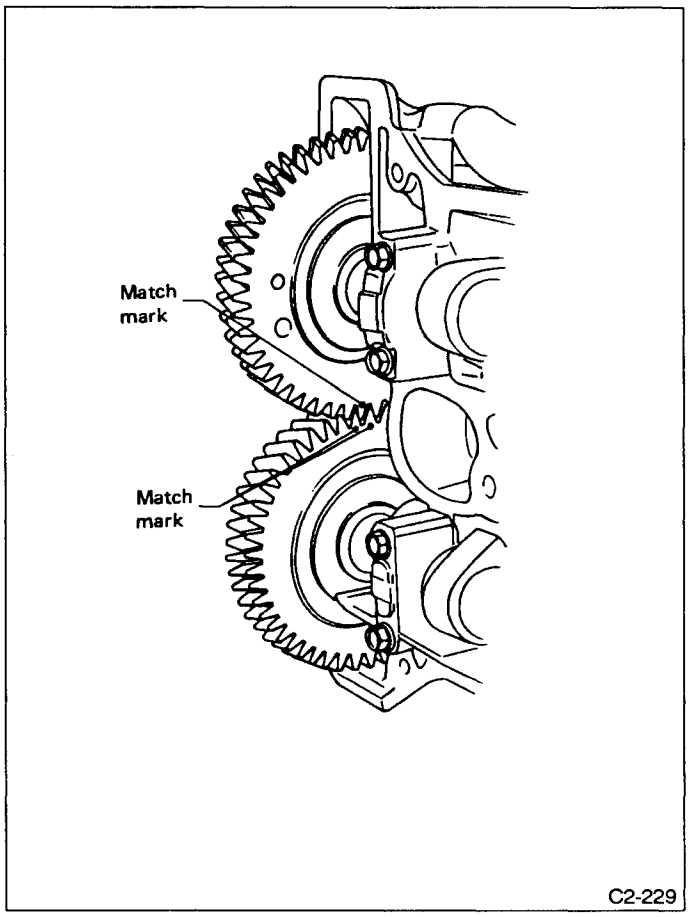


Fig. 69

(5) Tighten six bolts of three intake camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

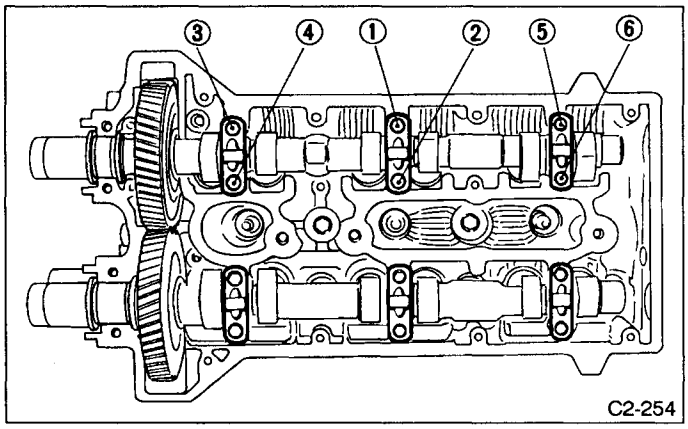


Fig. 70

Make sure that, as the bolts are tightened, the clearance between the camshaft journal and the cylinder head journal decreases evenly at three places. If not, loosen the bolts by reversing the illustrated numerical sequence, and then repeat step (5) above.

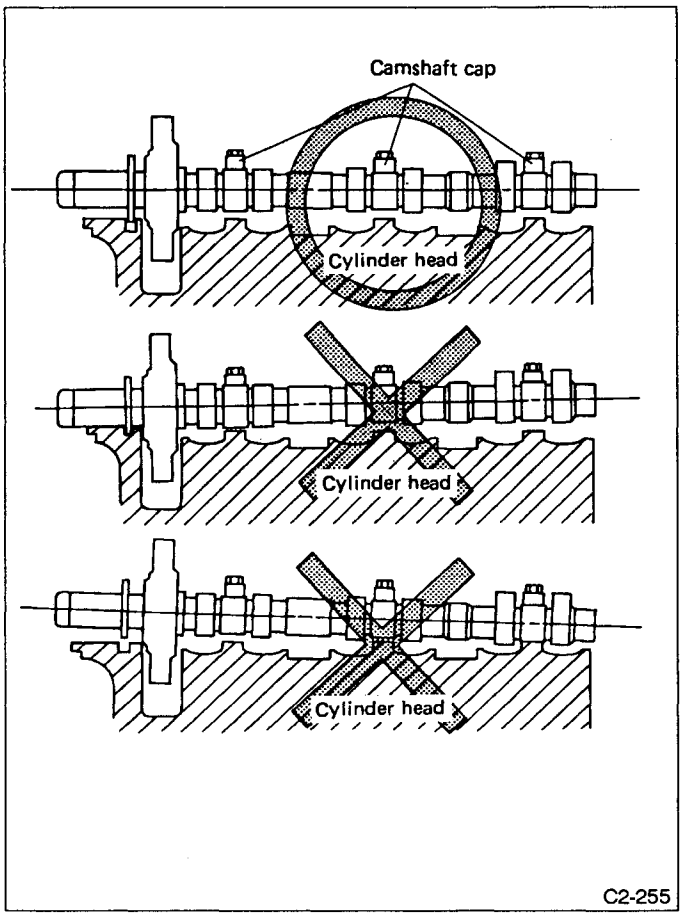


Fig. 71

(6) Tighten each bolts to the specified torque in the sequence explained in step (5).

(7) Remove the sub-gear securing service bolt from the intake camshaft gear.

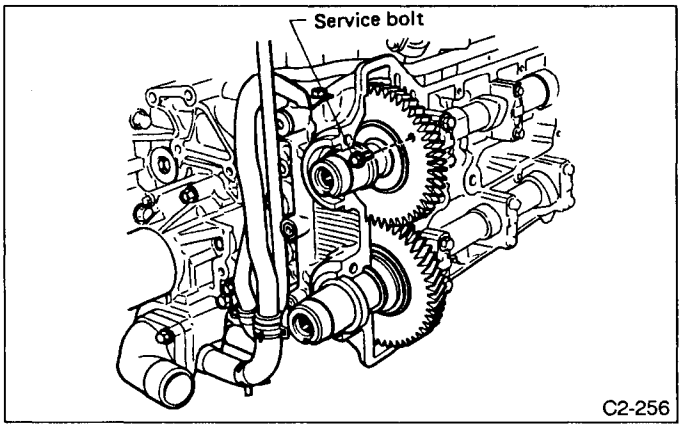


Fig. 72

3) Installation of front camshaft cap

(1) Apply fluid packing for mating surface of front camshaft cover.

Use only enough fluid packing to avoid its entrance into the camshaft oil hole.

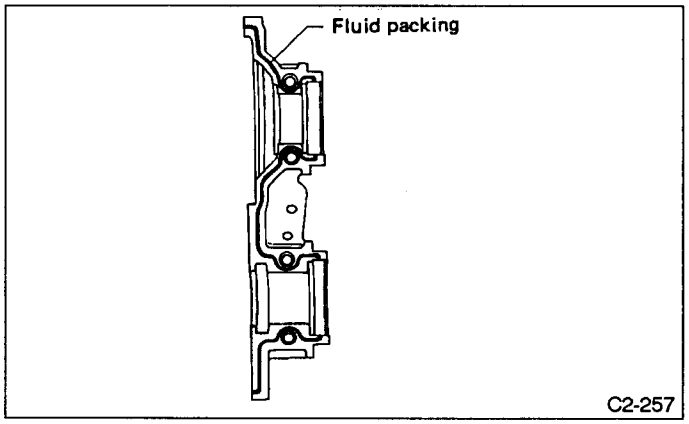


Fig. 73

(2) Install front camshaft cover.

4) Apply a coat of grease to oil seal lips and install oil seal.

Use a new oil seal.

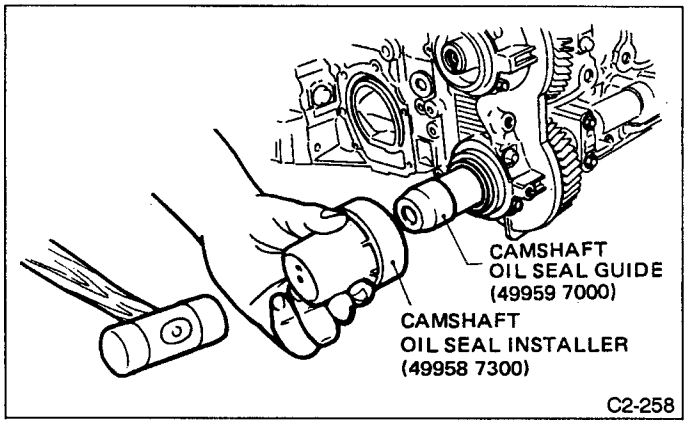


Fig. 74

5) Install camshaft plug.

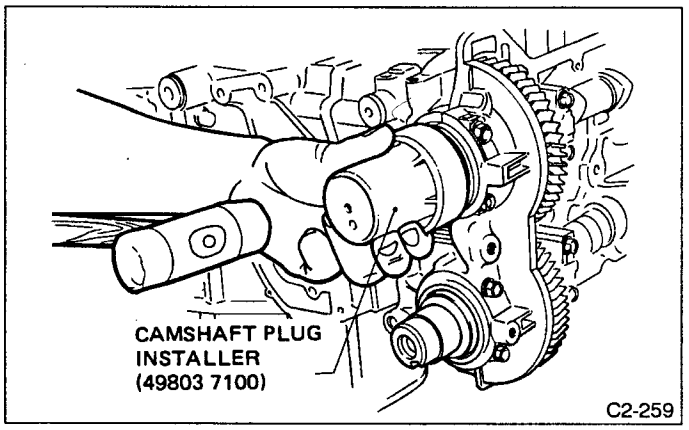


Fig. 75

6) Installation of cylinder head cover

(1) Completely remove excess fluid packing from location Ⓐ in the figure.

(2) Apply soapy water over Ⓐ and Ⓑ shown in the figure.

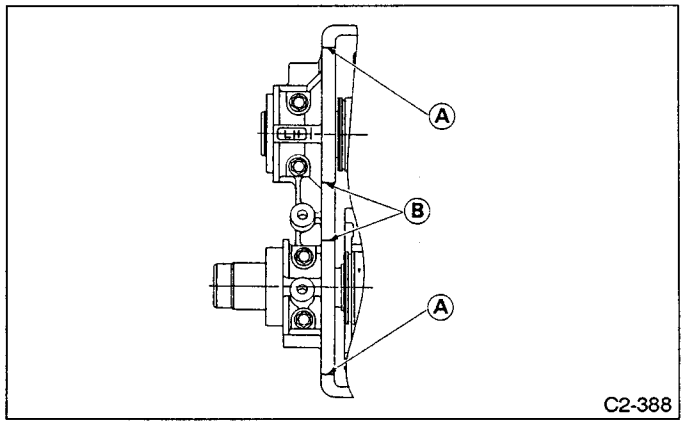


Fig. 76

(3) Install cylinder head cover and gasket.

(4) Connect blow-by hose.

7) Install ignition coils.

8) Install cam angle sensor.

2. CAMSHAFT RH

Operation precautions are the same as those for the LH camshafts, except the method of aligning the camshaft gear match marks.

1) Installation of exhaust camshaft

(1) Apply a coat of engine oil to the hydraulic lash adjuster surface and insert hydraulic lash adjusters.

(2) Apply a coat of engine oil to the camshaft journals.

(3) Set the exhaust camshaft on the cylinder head with the front end notch of the camshaft facing directly downward. Then attach three camshaft caps to the correct positions, and fully hand- tighten the cap bolts.

Hold the camshaft with one hand so that it will not drop while tightening the camshaft caps.

(4) Tighten six bolts on three exhaust camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

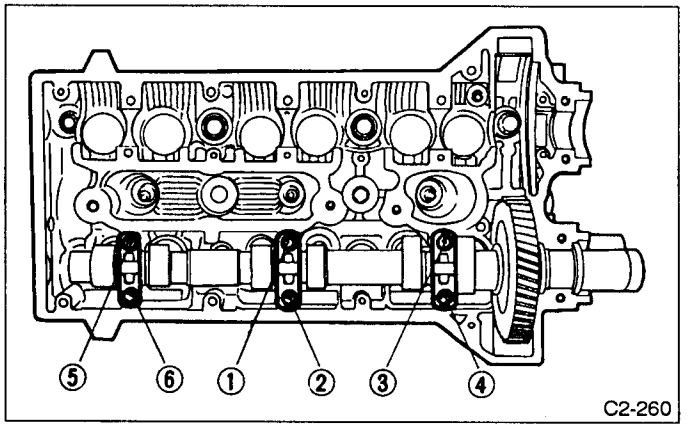


Fig. 77

Make sure that, as the bolts are tightened, the clearance between the camshaft journal and the cylinder head journal decreases evenly at three places. If not, loosen the bolts by reversing the illustrated numerical sequence, and then repeat step (4) above.

(5) Tighten each bolt to the specified torque in the sequence explained in step (4).

2) Installation of intake camshaft

Each intake and exhaust camshaft gear has match marks at two places. Accordingly, if the match marks are incorrectly aligned, the cam timing will be misaligned by 180° between the inside and exhaust side. To avoid this, be sure to use the following method when assembling the camshafts.

(1) Apply a coat of engine oil to the hydraulic lash adjuster surface and insert hydraulic lash adjusters.

(2) Apply a coat of engine oil to the camshaft journals.

(3) Align the intake camshaft match mark with the match mark of the exhaust camshaft which is already installed. In this case, make sure that the notch on the front end of the intake camshaft and that of the exhaust camshaft are facing the same direction (facing upward). After that, install the three camshaft caps at the specified positions, and fully hand-tighten the bolts.

Be sure to hold the camshaft with one hand so that it will not drop while installing the camshaft caps.

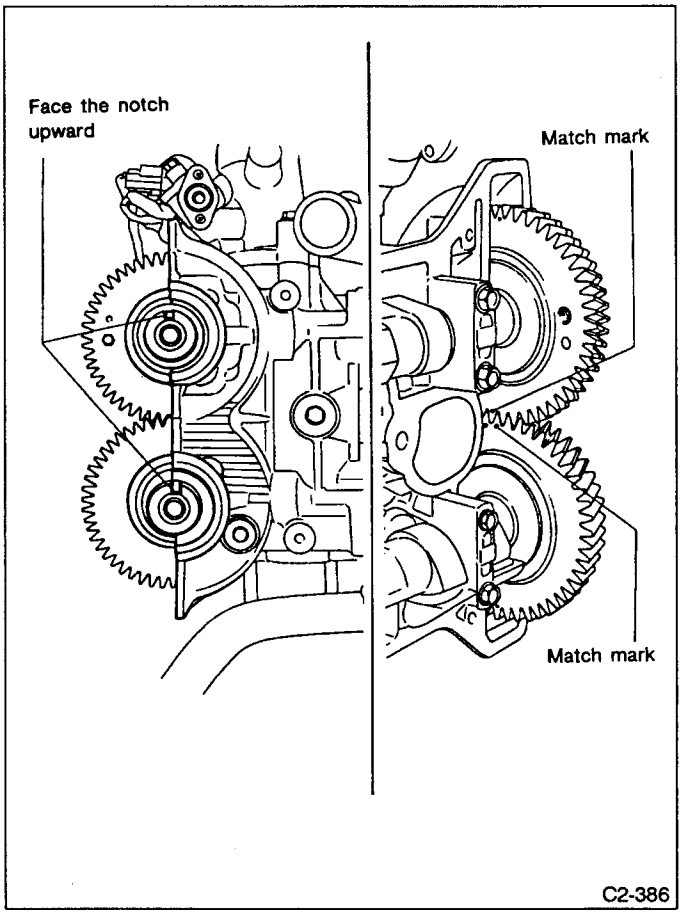


Fig. 78

(4) See the rear side of the camshaft gears, and make sure that the match marks of the camshaft gears are aligned. If not, re-assemble the camshaft using procedure (3) again.

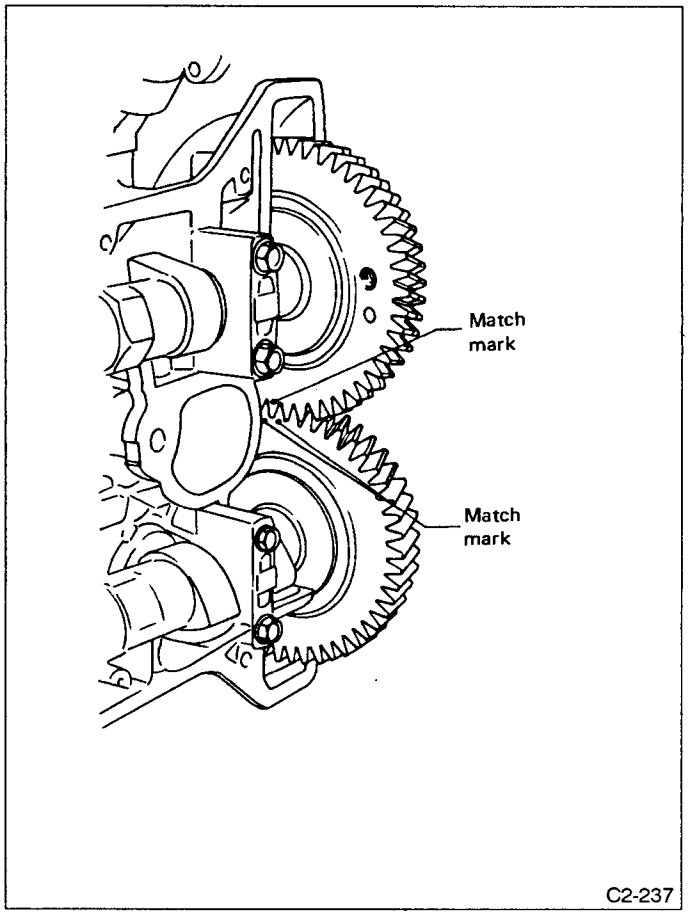


Fig. 79

(5) Tighten six bolts of three intake camshaft caps equally, a little at a time, in the numerical sequence as illustrated.

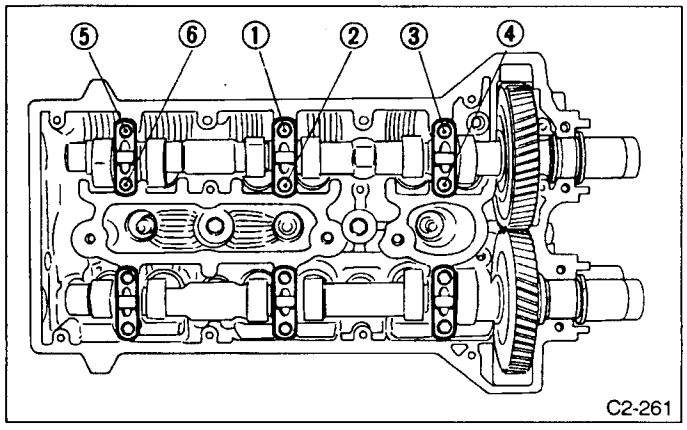


Fig. 80

Make sure that, as the bolts are tightened, the clearance between the camshaft journal and the cylinder head journal bearing decreases evenly at three places. If not, loosen the bolts by reversing the illustrated numerical sequence, and then repeat step (5) above.

(6) Tighten each bolt to the specified torque in the sequence explained in step (5).

(7) Remove the sub-gear securing service bolt from the intake camshaft gear.

3) Installation of front camshaft cap

(1) Apply fluid packing for mating surface of front camshaft cap.

Use only enough fluid packing to avoid its entrance into the camshaft oil hole.

(2) Install front camshaft cover.

4) Apply a coat of grease to oil seal lips and install oil seal.

Use a new oil seal.

5) Install camshaft plug.

6) Installation of cylinder head cover

(1) Completely remove excess fluid packing from location Ⓐ in the figure.

(2) apply soapy water over Ⓐ shown in the figure.

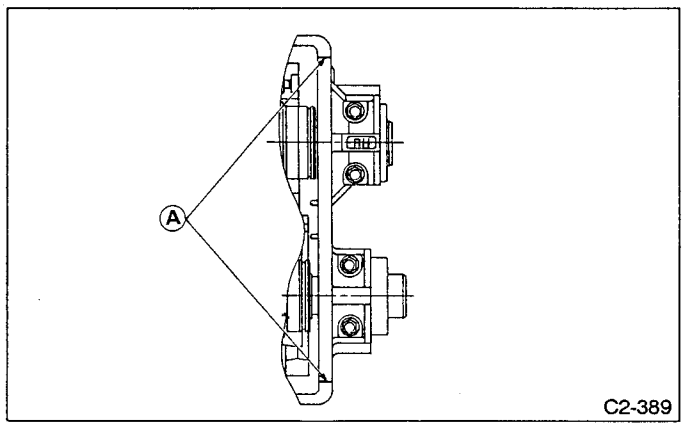


Fig. 81

(3) Install cylinder head cover and gasket.

(4) Connect blow-by hose.

7) Install ignition coils.

3. RELATED PARTS

1) Connect ignition coil connectors.

2) Connect cam angle sensor connector.

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

⟨Refer to Timing Belt [W2C0].⟩

4. Cylinder Head

A: REMOVAL

1. INTAKE MANIFOLD

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

⟨Refer to 2 Timing Belt [W2A0].⟩

2) Remove EGR valve, EGR pipe and BPT.

3) Disconnect auxiliary air control valve connector.

4) Disconnect blow-by hoses.

5) Disconnect auxiliary air control valve hose.

6) Disconnect PCV hose from connector PCV.

7) Disconnect two water hoses from throttle body.

8) Remove collector and intake manifold ASSY and gaskets.

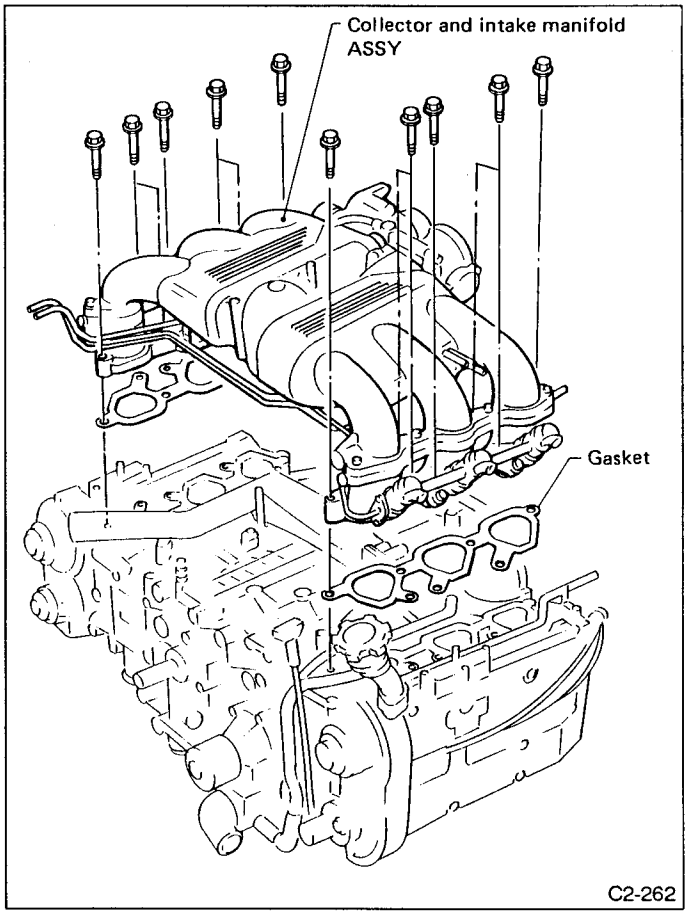


Fig. 82

9) Remove exhaust manifold and gasket.
10) Remove cylinder head covers, camshafts and related parts.
⟨Refer to 3 Camshafts [W3A0].⟩

2. CYLINDER HEAD

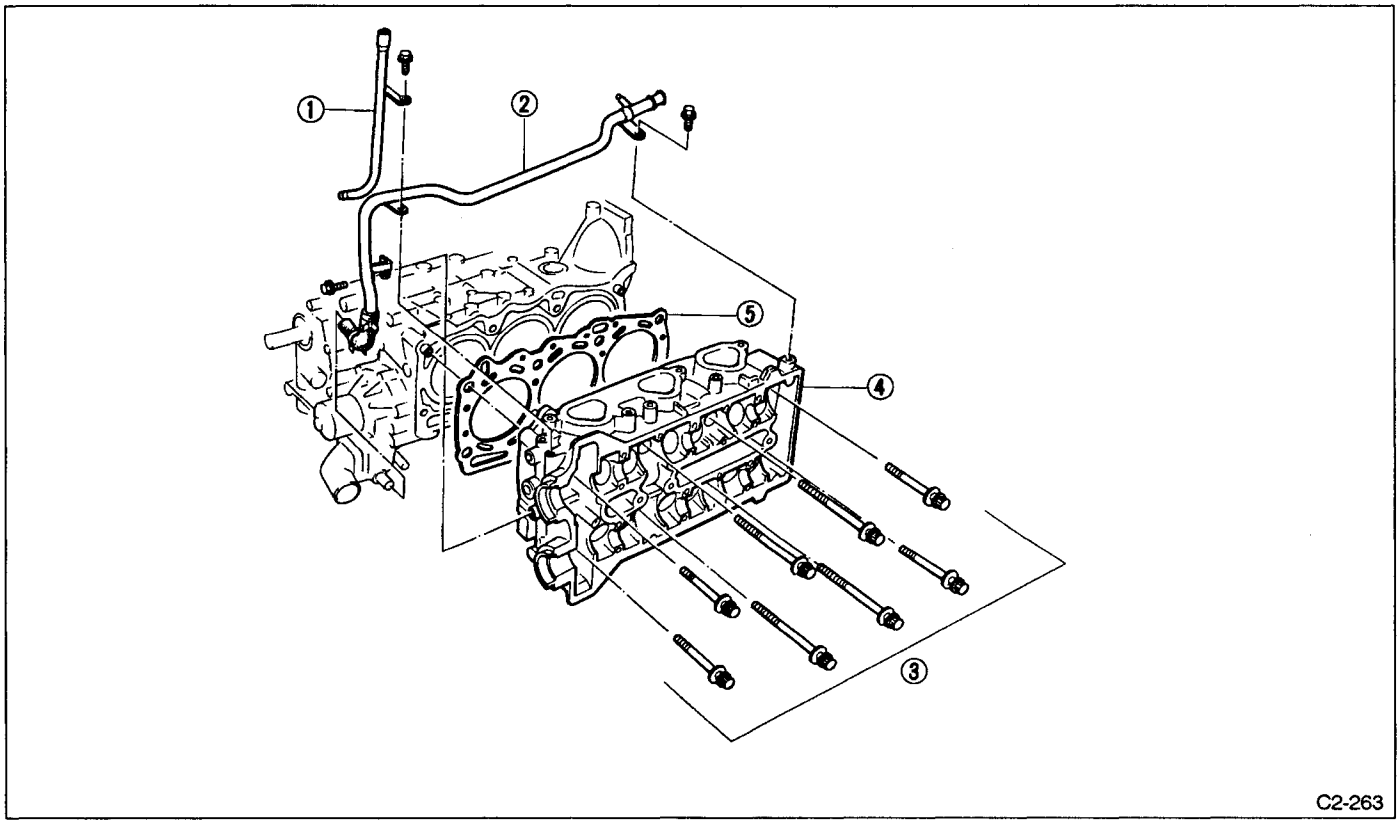


Fig. 83

1) Remove oil level gauge guide.
2) Remove heater pipe.
3) Remove cylinder head bolts in numerical sequence shown in Figure.
Leave bolts ⑤ or ⑧ engaged by three or four threads to prevent cylinder head from falling.

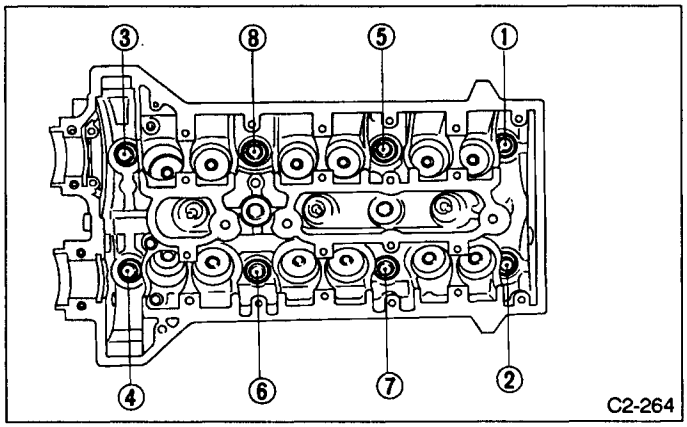


Fig. 84

4) While tapping cylinder head with a plastic hammer, separate it from cylinder block. Remove bolts ⑤ or ⑧ to remove cylinder head.
5) Remove cylinder head gasket.
6) Similarly, remove right-hand cylinder head.

B: DISASSEMBLY

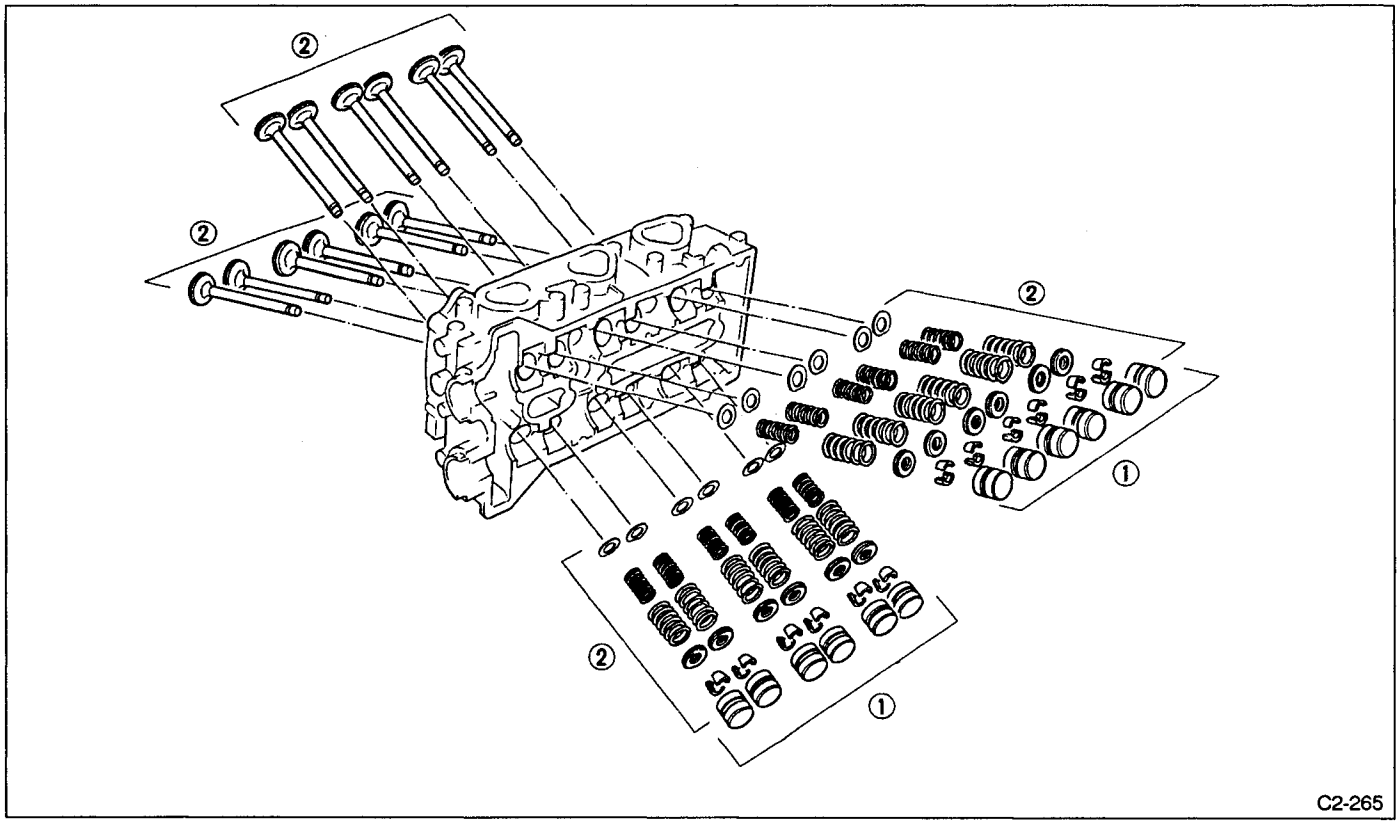


Fig. 85

1) Remove hydraulic lash adjusters.
Arrange the hydraulic lash adjusters in order so that they can be installed in their original positions.

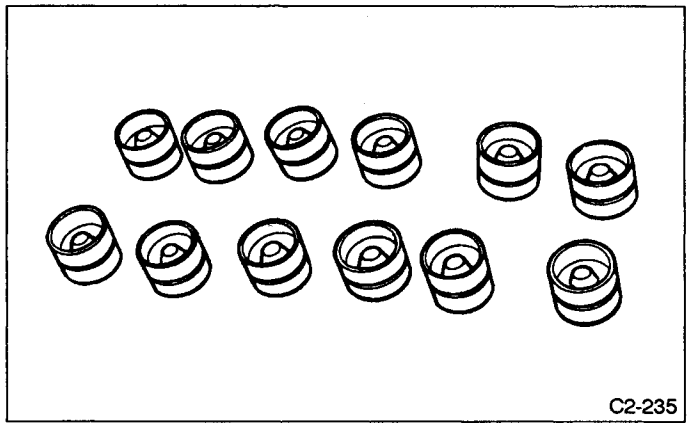


Fig. 86

2) Compress the valve spring and remove the valve spring retainer key. Remove each valve and valve spring.

a. Mark each valve to prevent confusion.
b. Use extreme care not to damage the lips of the intake valve oil seals and exhaust valve oil seals.

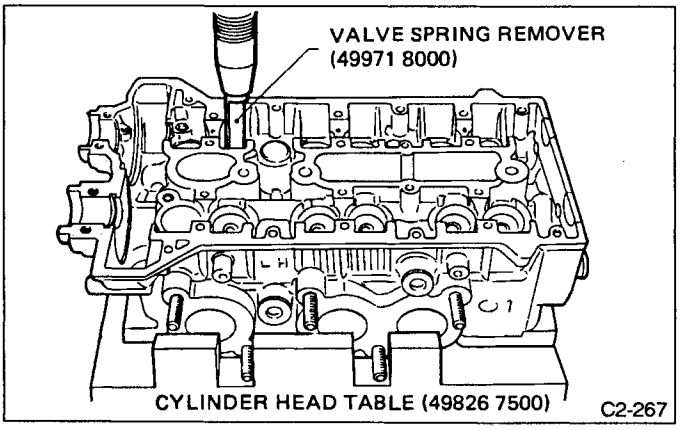


Fig. 87

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:
0.30 mm (0.0118 in)
Standard height of cylinder head:
127.5 mm (5.020 in)

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

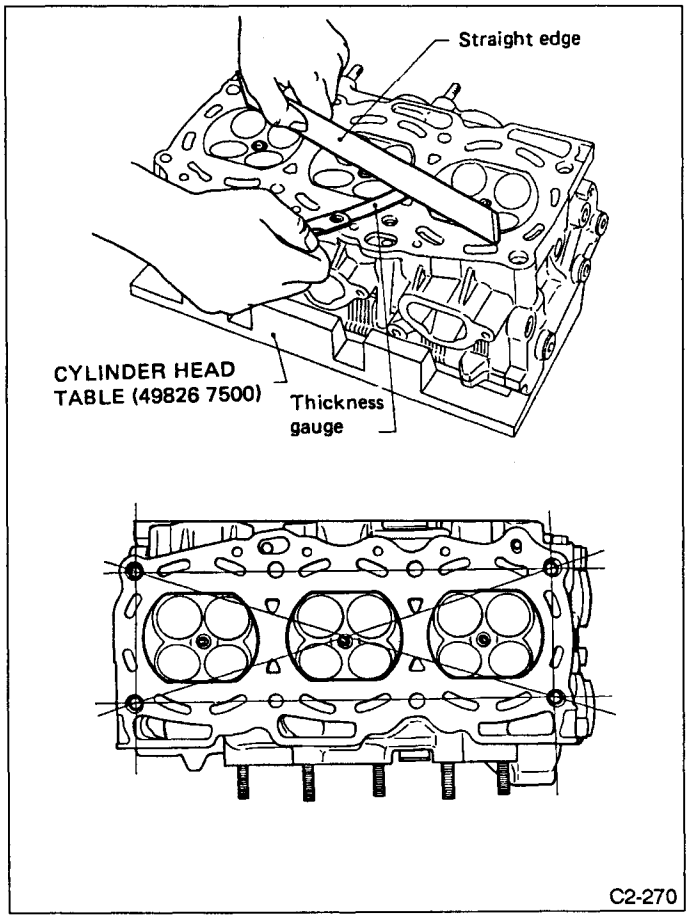


Fig. 88

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.

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)

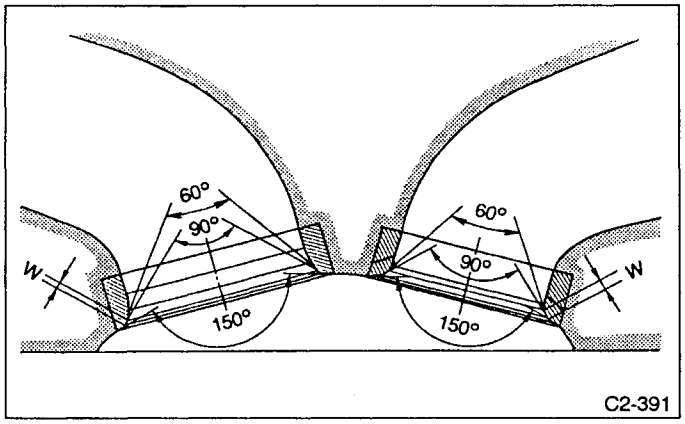


Fig. 89

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
0.030 — 0.057 mm (0.0012 — 0.0022 in)
Exhaust
0.040 — 0.067 mm (0.0016 — 0.0026 in)
Limit
0.10 mm (0.0039 in)
Valve guide inner diameters:
6.000 — 6.012 mm (0.2362 — 0.2367 in)
Valve stem outer diameter:
Intake
5.955 — 5.970 mm (0.2344 — 0.2350 in)
Exhaust
5.945 — 5.960 mm (0.2341 — 0.2346 in)

2) If the clearance between valve guide and stem exceeds the specification, replace guide as follows:
(1) Place cylinder head on CYLINDER HEAD TABLE with the combustion chamber upward so that valve guides enter the holes in CYLINDER HEAD TABLE.

(2) Insert VALVE GUIDE REMOVER into valve guide and press it down to remove valve guide.

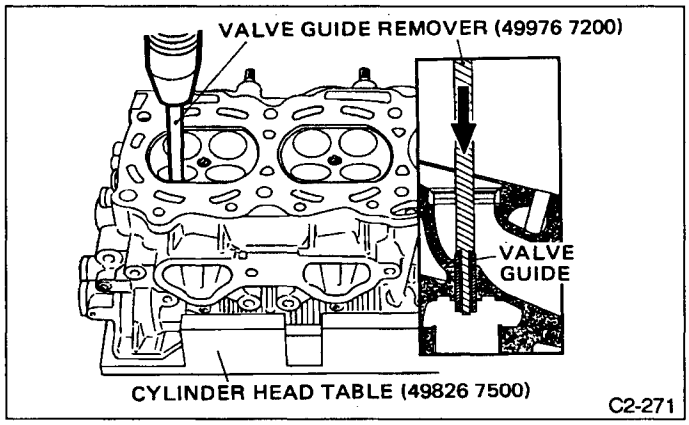


Fig. 90

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

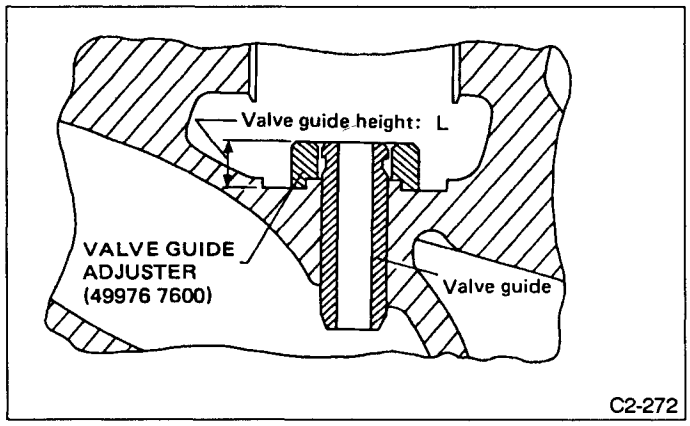


Fig. 91

(4) Before installing a new valve guide, be certain that the valve guide bore in the cylinder head is not scratched, pitted or damaged.

(5) Coat a new valve guide with oil and insert it into the bore. Place the VALVE GUIDE REMOVER into the valve guide, and press the guide into the cylinder head until the upper end of the guide is flush with the upper edge of the VALVE GUIDE ADJUSTER.

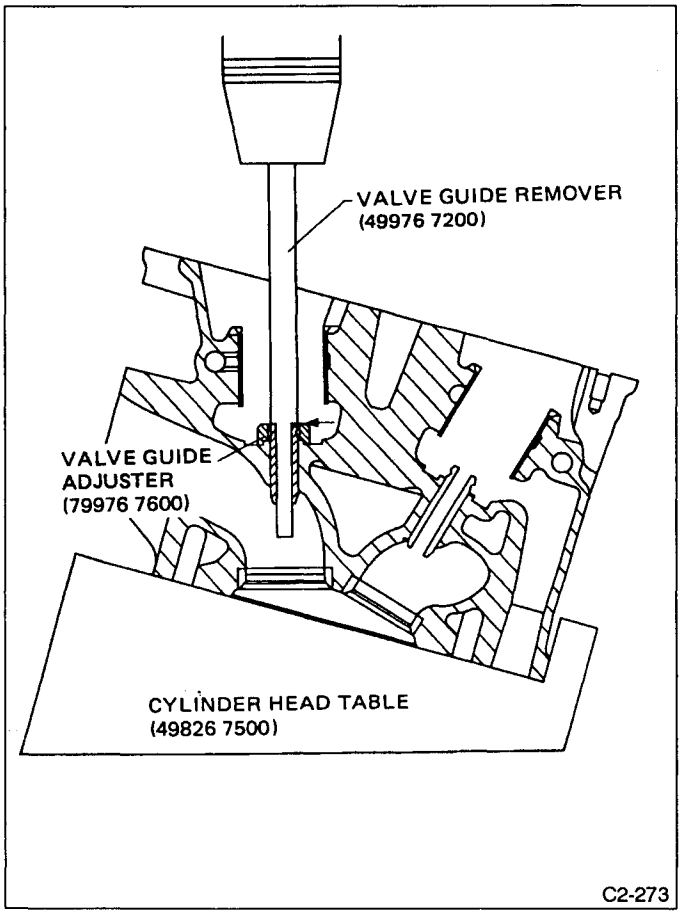


Fig. 92

(6) Check the valve guide height.

Valve guide height: L
8.5 mm (0.335 in)

(7) Ream the inside of the valve guide using VALVE GUIDE REAMER (499767400). Apply engine oil to the reamer, insert it into the guide and with light downward pressure, rotate the reamer clockwise. Continue rotating until the reamer is completely through the guide. Remove the reamer by rotating clockwise, while pulling upward. After reaming, clean the guide with engine oil to remove chips.

If the reamer is glazing the inside of the guide, sharpen or replace the reamer.

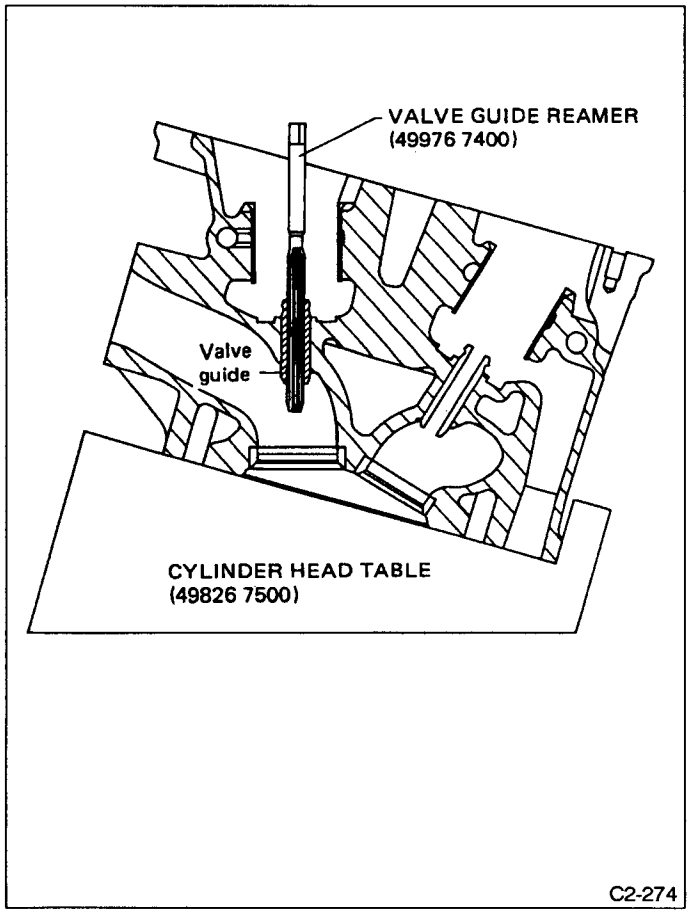


Fig. 93

(8) Coat the face of the valve with talcum powder, and lightly rotate the valve against the seat to inspect for proper valve seating.

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**
    - **0.8 mm (0.031 in)**
  - **Limit**
    - **0.6 mm (0.024 in)**
- **Exhaust**
  - **Standard**
    - **1.0 mm (0.039 in)**
  - **Limit**
    - **0.8 mm (0.031 in)**
- **Valve overall length:**
  - **Intake 90.00 mm (3.5433 in)**
  - **Exhaust 90.85 mm (3.5768 in)**

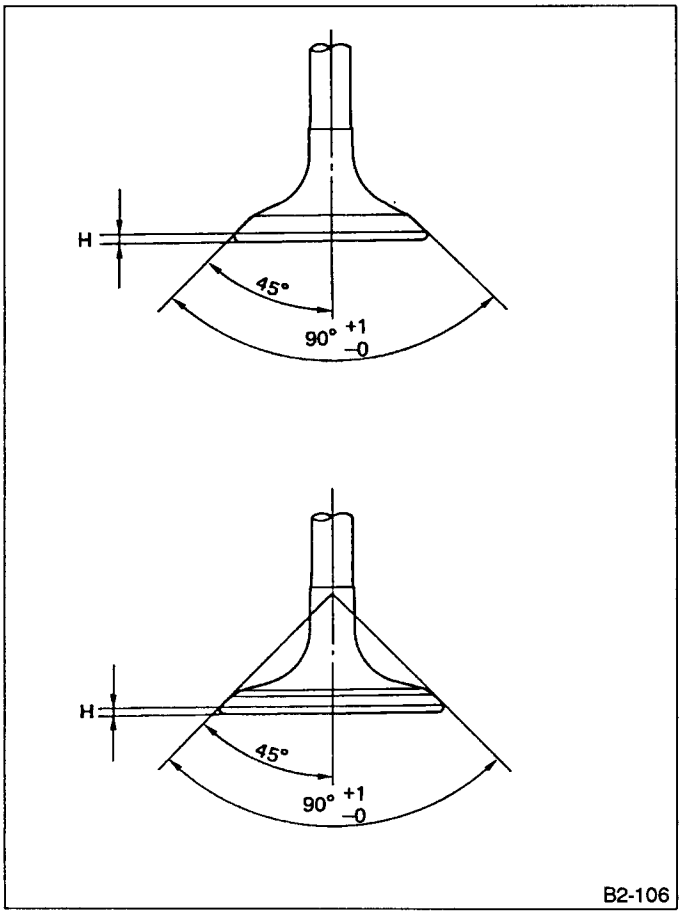


Fig. 94

2) Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. Also refer to Cylinder Head 4) at this time. 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.

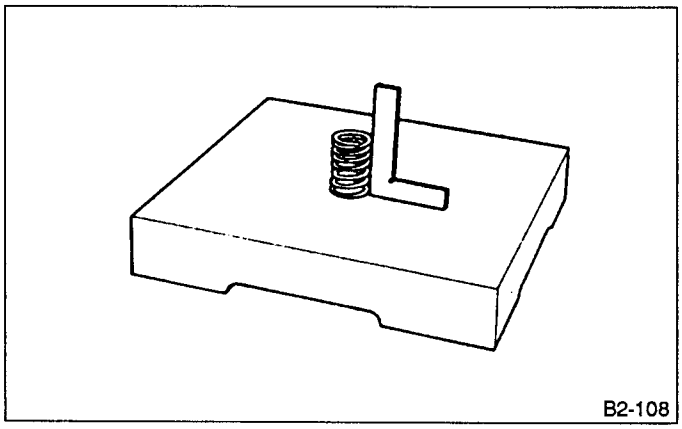


Fig. 95

	Outer spring	Inner spring
Free length	36.4 mm (1.433 in)	34.9 mm (1.374 in)
Tension/ spring height	124.5 — 142.2 N (12.7 — 14.5 kg, 28.0 — 32.0 lb)/29 mm (1.14 in)	58.8 — 66.7 N (6 — 6.8 kg, 13.2 — 15.6Normal Control lb)/ 27.5 mm (1.083 in)
	308.9 — 356.0 N (31.5 — 36.3 kg, 69.5 — 80.0 lb)/ 21.1 mm (0.831 in)	147.1 — 168.7 N (15 — 17.2 kg, 33.1 — 37.9 lb)/ 19.6 mm (0.772 in)
Squareness	2.5°, 1.6 mm (0.063 in)	2.5°, 1.5 mm (0.059 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.

Press in oil seal to the specified dimension indicated in the figure, using OIL SEAL INSTALLER.

a. Apply engine oil to oil seal before force-fitting.

b. Be sure to press by hand, never hammer on the special tool.

c. 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 [white]
Exhaust [white]

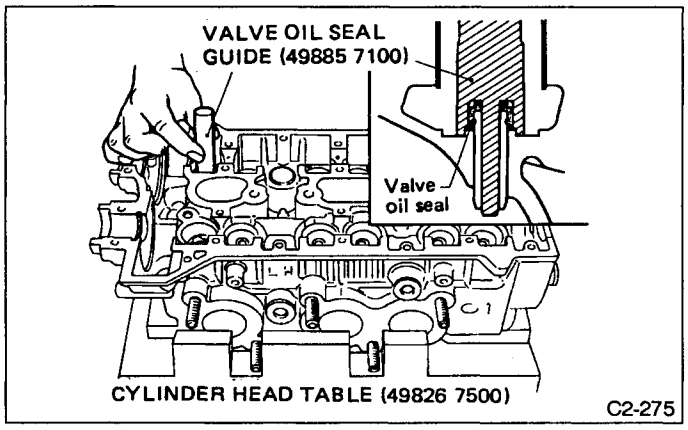


Fig. 96

7. HYDRAULIC LASH ADJUSTER

1) Visually, check the contact and sliding surface for wear or scratches.

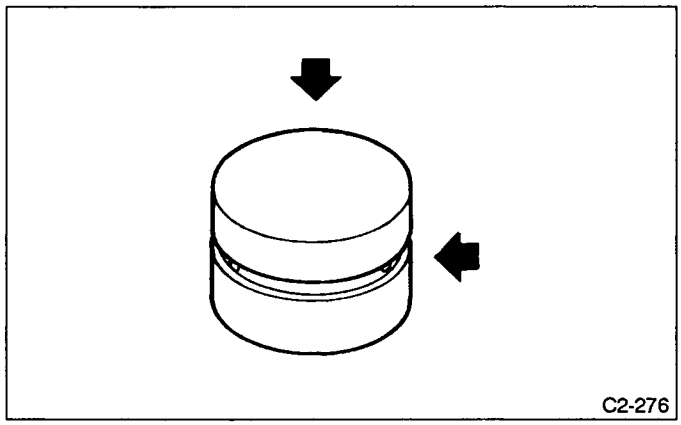


Fig. 97

2) Measure the hydraulic lash adjuster diameter.

Diameter D:
32.965 — 32.975 mm (1.2978 — 1.2982 in)

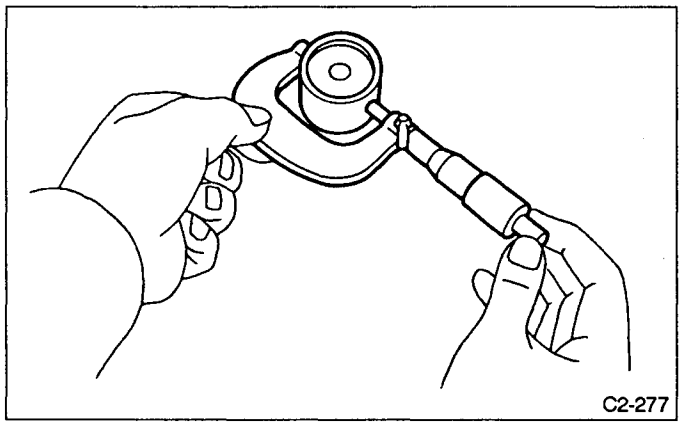


Fig. 98

3) Measure the hydraulic lash adjuster bush inner diameter.

Inner diameter:
33.009 — 33.031 mm (1.2996 — 1.3004 in)

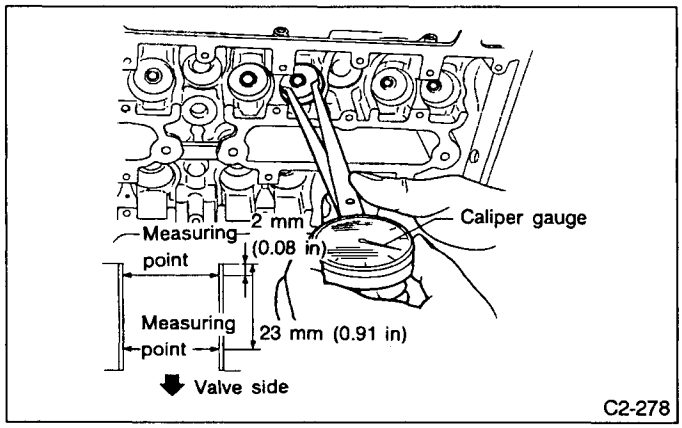


Fig. 99

4) Subtract the hydraulic lash adjuster diameter from the hydraulic lash adjuster bush inner diameter measurement. The oil clearance can be calculated. If the oil clearance exceeds the limit, replace cylinder head.

Standard oil clearance:
0.028 — 0.078 mm (0.0011 — 0.0031 in)
Limit:
0.110 mm (0.0043 in)

D: ASSEMBLY

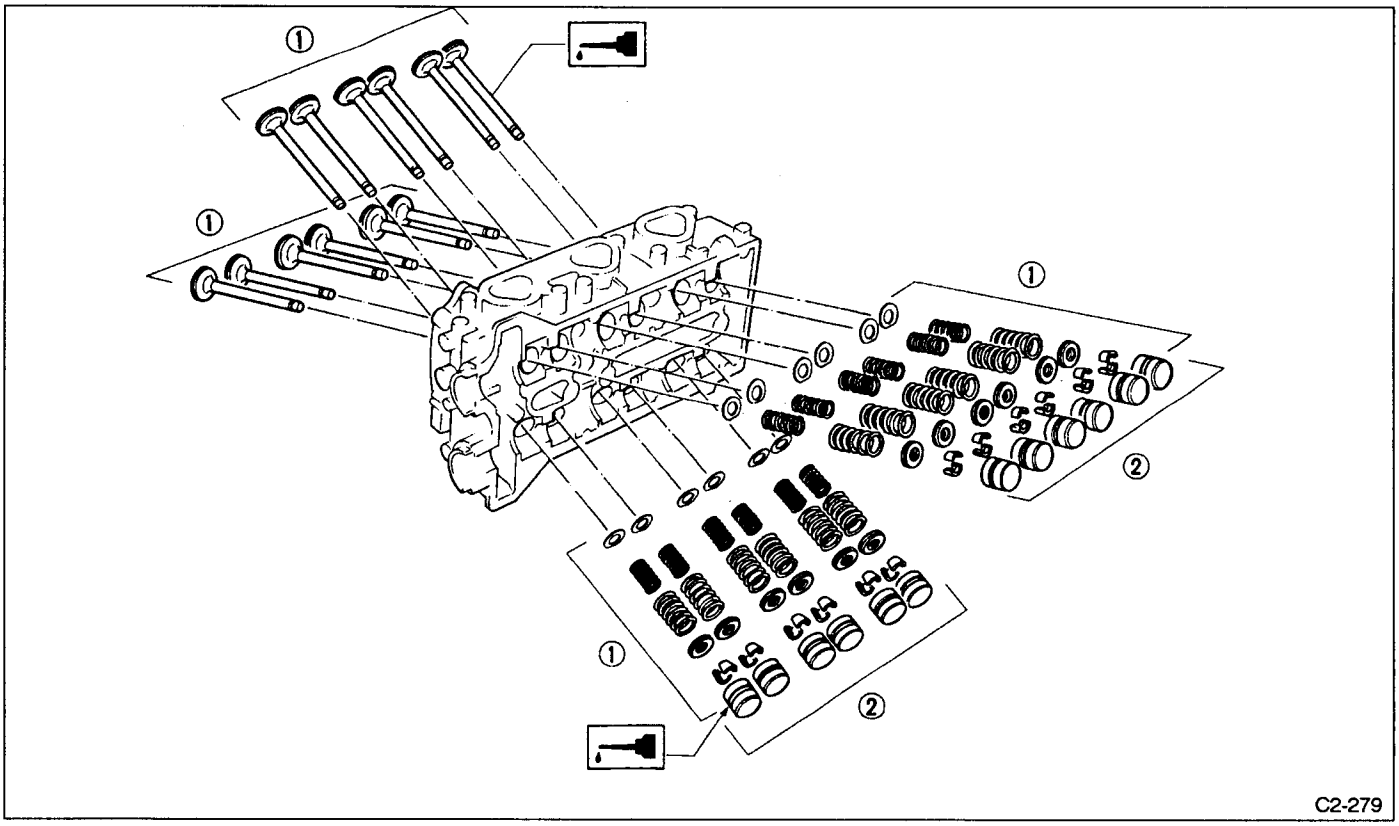


Fig. 100

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

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

(2) Install valve spring and retainer.

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

(3) Compress valve spring and fit valve spring retainer key.

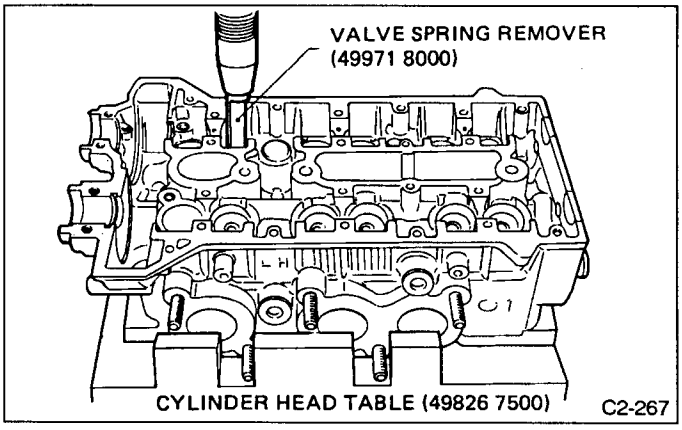


Fig. 101

(4) After installing tap valve spring retainers, lightly with wooden hammer for better seating.

2) Apply a coat of engine oil to hydraulic lash adjuster sliding surface and insert hydraulic lash adjusters.

E: INSTALLATION

1. CYLINDER HEAD

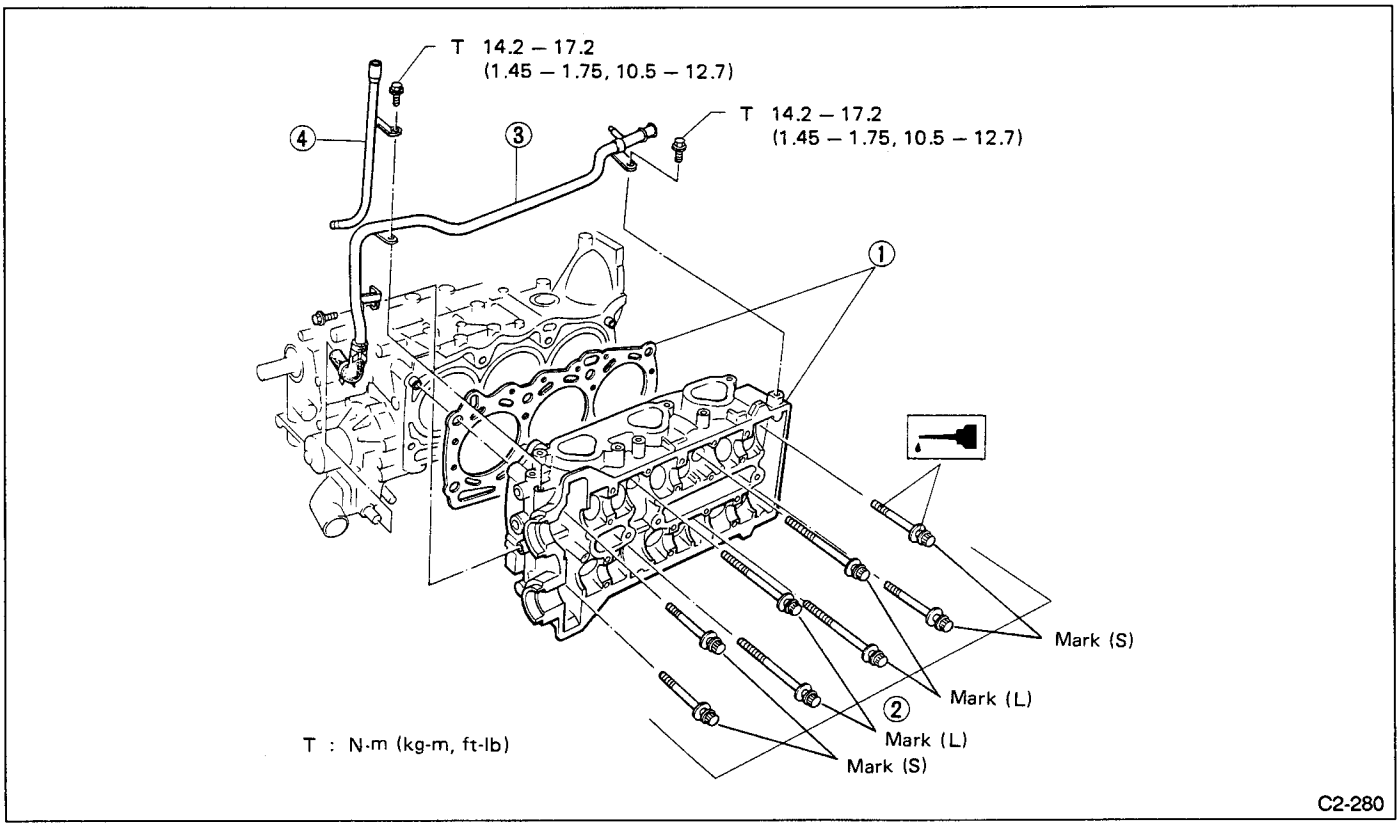


Fig. 102

1) Install cylinder head and gaskets on cylinder block.
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 the numerical order shown in Figure.
   (3) Tighten all bolts to 69 N•m (7.0 kg-m, 51 ft-lb) in the numerical order shown in Figure.
   (4) Back off all bolts by 180°.
   (5) Further back off all bolts by 180°.
   (6) Tighten all bolts to 27 N•m (2.8 kg-m, 20 ft-lb), in the numerical order shown in Figure.
   (7) Re-tighten bolts ①, ②, ③ and ④ by 80° - 90° in the numerical order shown in Figure.
Do not tighten bolts more than 90°.
   (8) Re-tighten bolts ⑤, ⑥, ⑦ and ⑧ to 44 N•m (4.5 kg-m, 33 ft-lb) in the numerical order shown in Figure.
   (9) Further tighten all bolts by 80° - 90° in the numerical order shown in Figure.
Ensure that the total "re-tightening angle" (Steps (7) and (9) above) does not exceed 180°.

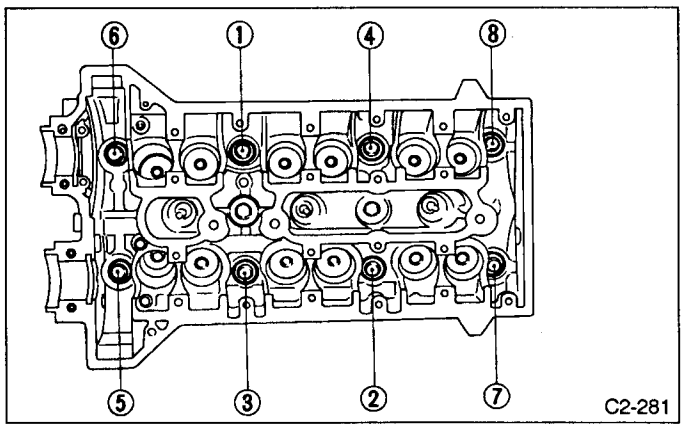


Fig. 103

3) Install heater pipe.
4) Install oil level gauge.

2. INTAKE MANIFOLD

Use dry compressed air to remove foreign particles before installing sensors.

1) Install camshafts, cylinder head covers and related parts.
⟨Refer to 3 Camshafts [W3E0].⟩
2) Install exhaust manifold and gasket.
3) Install collector and intake manifold ASSY and gaskets.

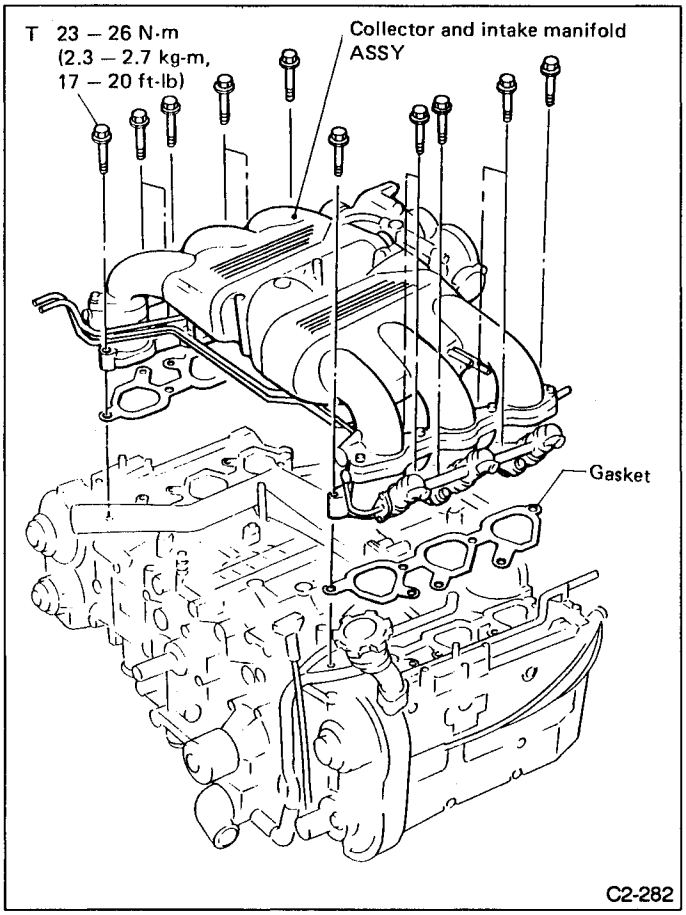


Fig. 104

4) Connect two water hoses to thotttle body.
5) Connect PCV hose to connector PCV.
6) Connect auxiliary air control valve hose.
7) Connect blow-by hoses.
8) Connect auxiliary air control valve connector.
9) Install EGR valve, EGR pipe and BPT.
10) Install camshaft sprockets, timing belt and related parts.
⟨Refer to 2 Timing belt [W2C0].⟩

5. Cylinder Block

A: REMOVAL

1. RELATED PARTS

1) Remove timing belt, camshaft sprockets and related parts.
(Refer to 2 Timing belt [W2A0].)
2) Remove cylinder head covers and camshafts and related parts.
(Refer to 3 Camshafts [W3A0].)
3) Remove intake manifold, cylinder head and related parts.
(Refer to 4 Cylinder head [W4A0].)
4) Remove crank angle sensor and knock sensors.

2. OIL PUMP AND WATER PUMP

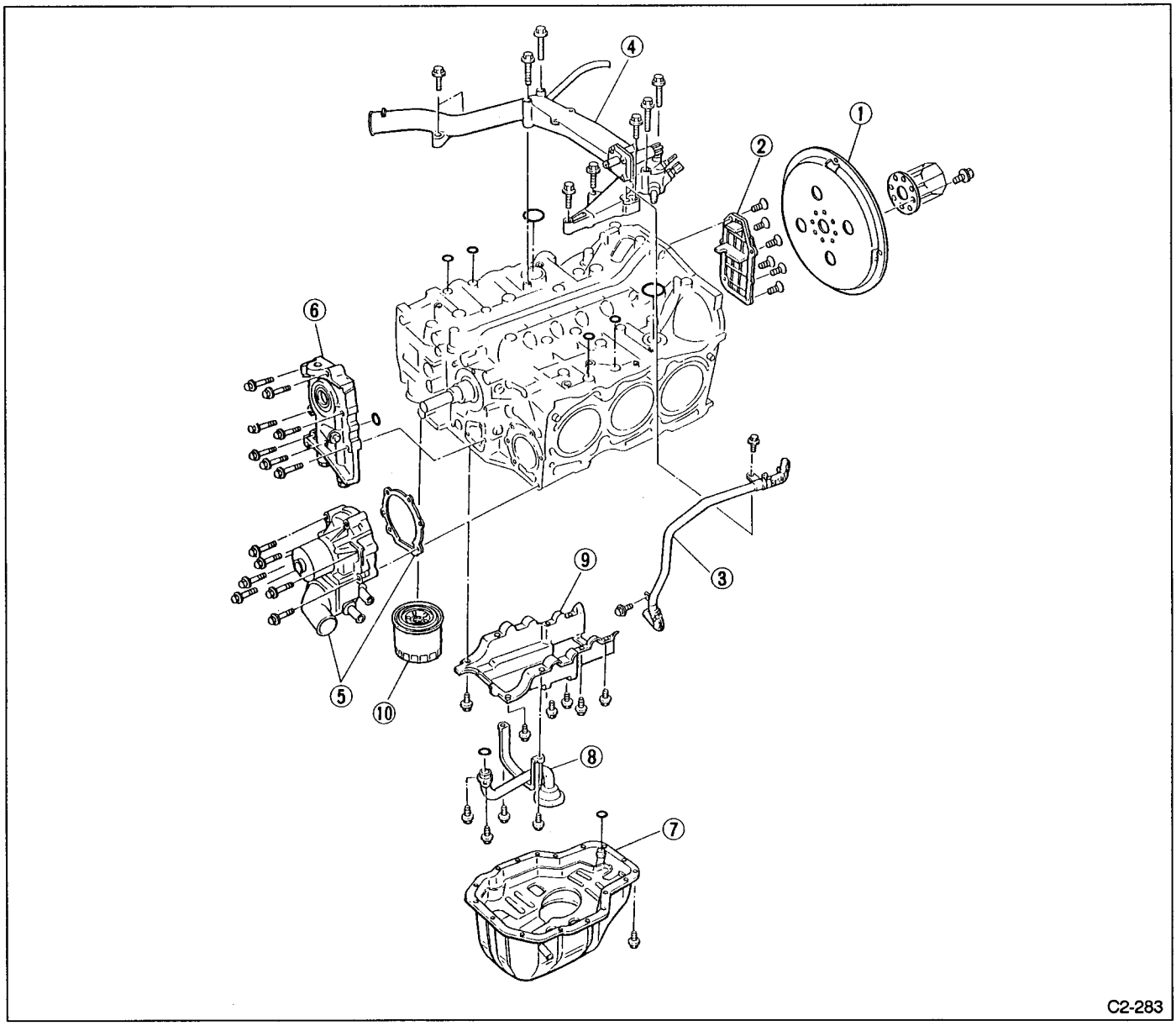


Fig. 105

1) Remove drive plate.
To lock crankshaft, use CRANKSHAFT STOPPER.

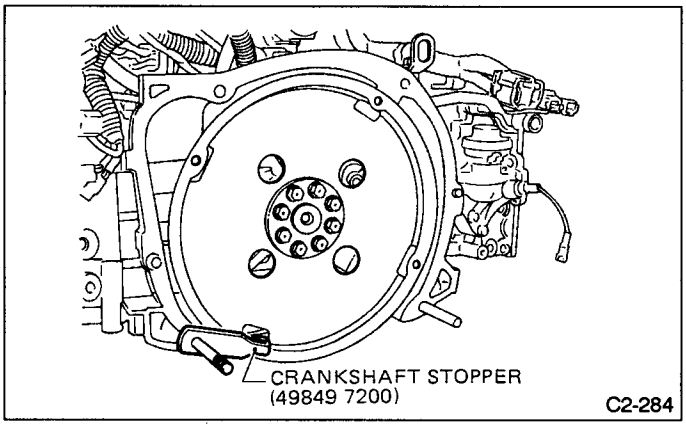


Fig. 106

2) Remove oil separator cover.
3) Remove water by-pass pipe.
4) Remove water pipe.
5) Remove water pump and gasket.
6) Remove oil pump from cylinder block. Use a standard screwdriver as shown in Figure when removing oil pump.
Be careful not to scratch the matching surface of cylinder block and oil pump.

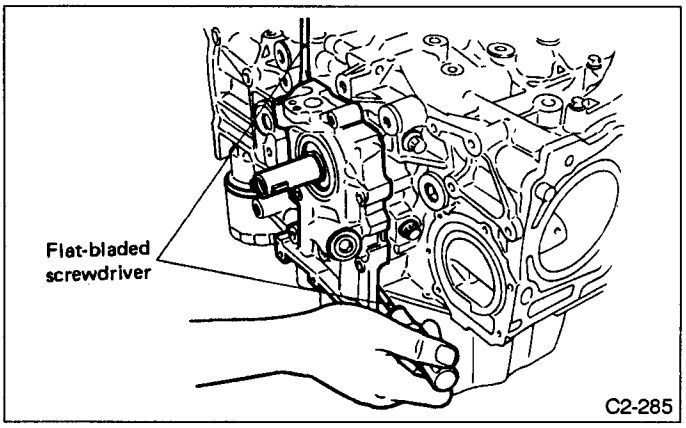


Fig. 107

7) Removal of oil pan.
(1) Turn cylinder block with #2, #4 and #6 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.
Do not use a screwdriver or similar tool in place of oil-pan cutter blade.

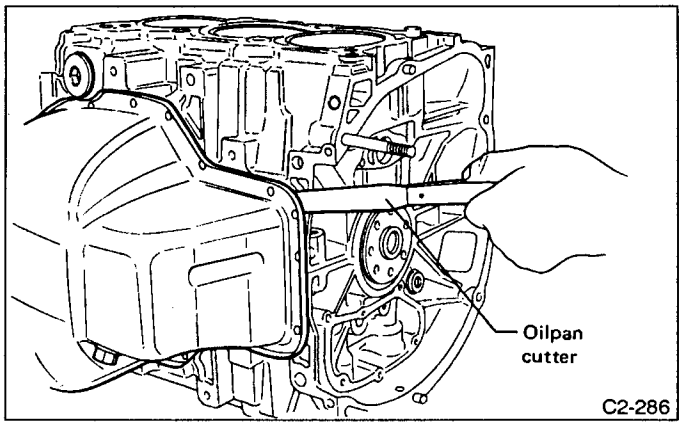


Fig. 108

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

B: DISASSEMBLY

1. PISTON PIN AND CYLINDER BLOCK CONNECTING BOLT

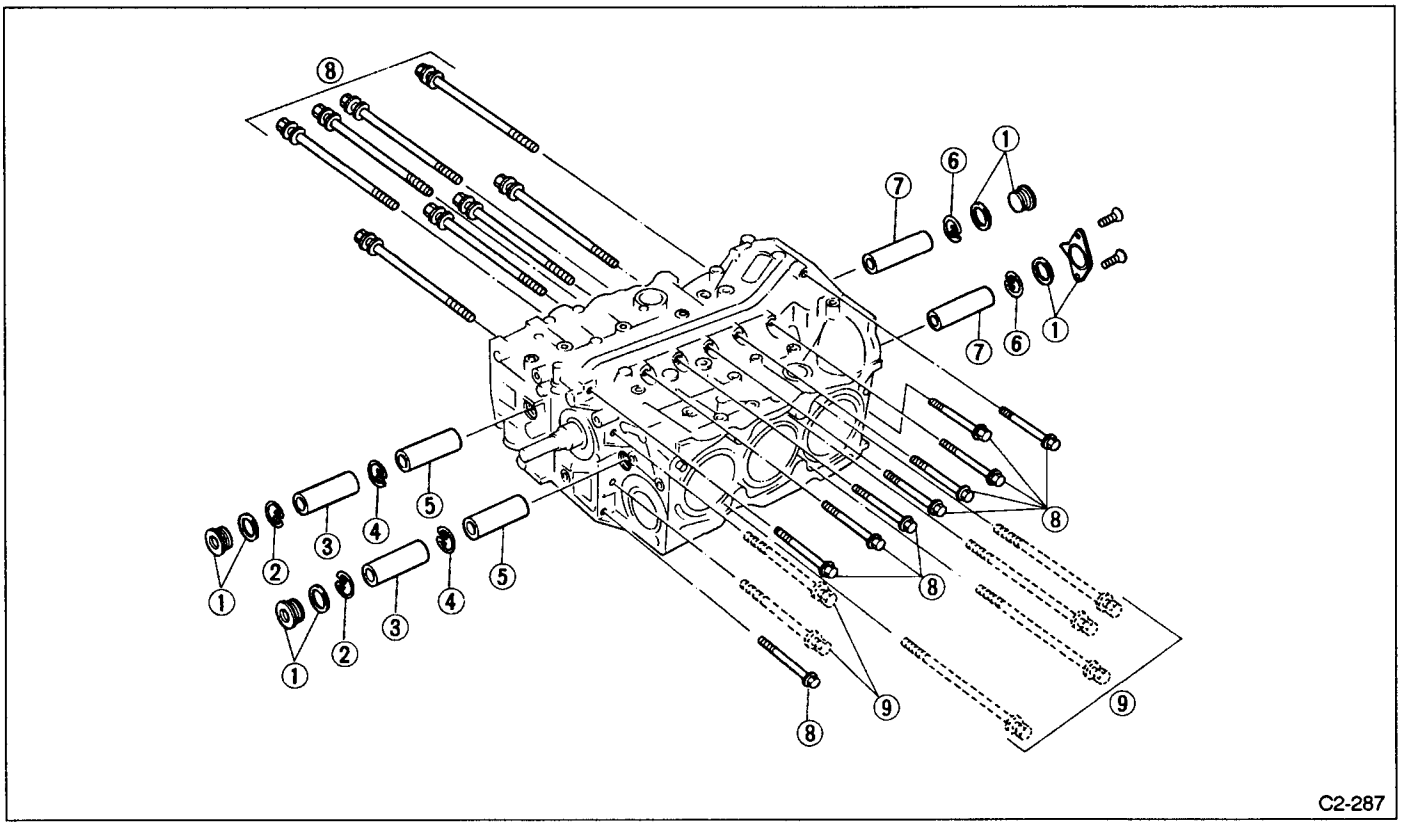


Fig. 109

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

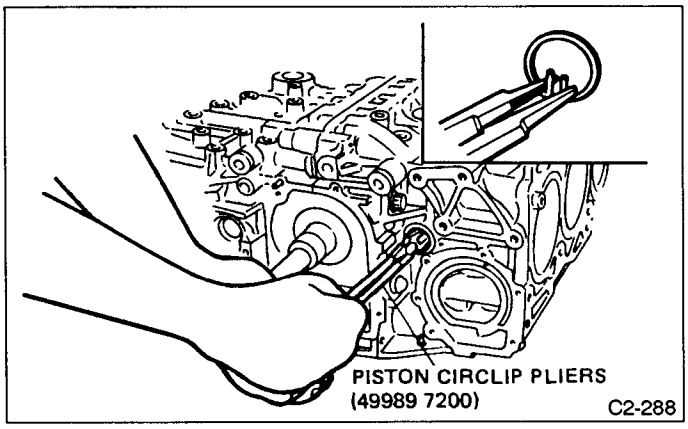


Fig. 110

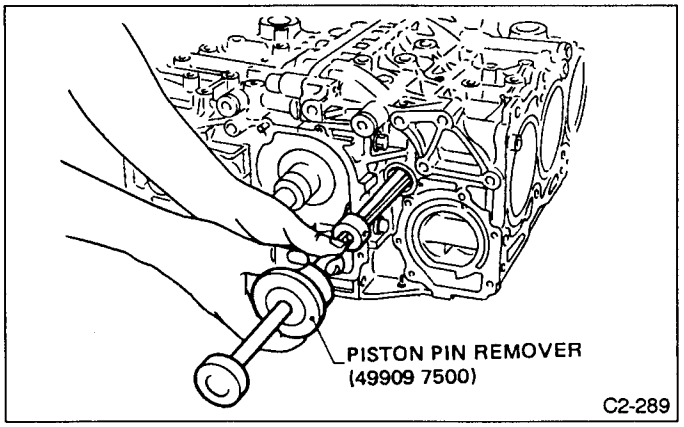


Fig. 111

3) Draw out piston pin from #1 and #2 pistons.
Be careful not to confuse original combination of piston, piston pin and cylinder.

4) Rotate crankshaft to bring #3 and #4 piston to BDC position, then remove piston circlip through service hole of #1 and #2 cylinders with PISTON CIRCLIP PLIERS.

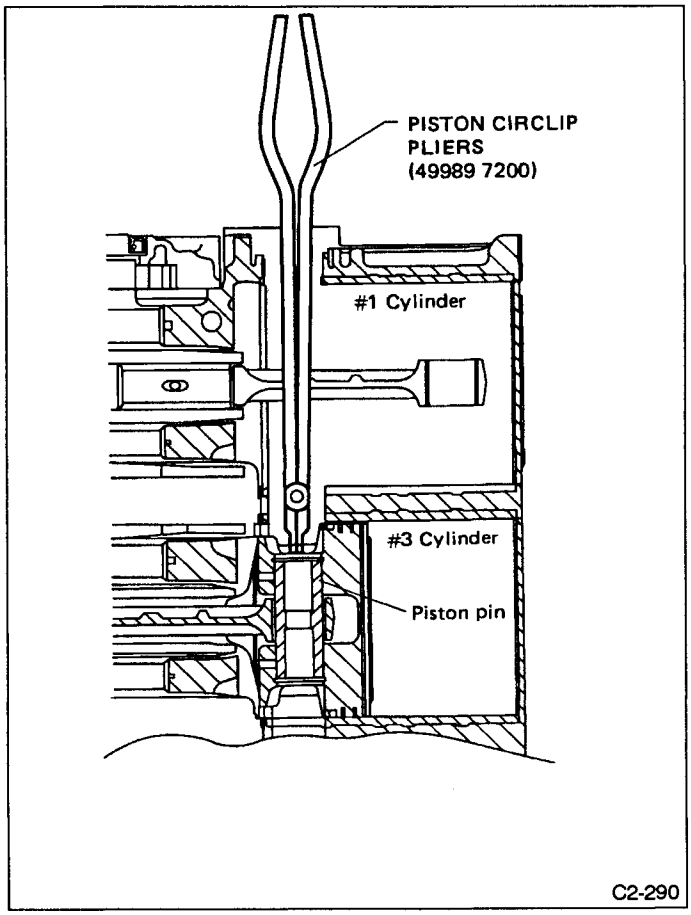


Fig. 112

5) Draw out piston pin from #3 and #4 pistons through service hole of #1 and #2 cylinders.

6) Rotate crankshaft to bring #5 and #6 pistons BDC position, then remove piston circlip through service hole of #5 and #6 cylinders.

7) Draw out piston pin from #5 and #6 pistons.

8) Remove bolts which connect cylinder block on the side of #1, #3 and #5 cylinders.

9) Back off bolts which connect cylinder block on the side of #2, #4 and #6 cylinders two or three turns.

2. CYLINDER BLOCK

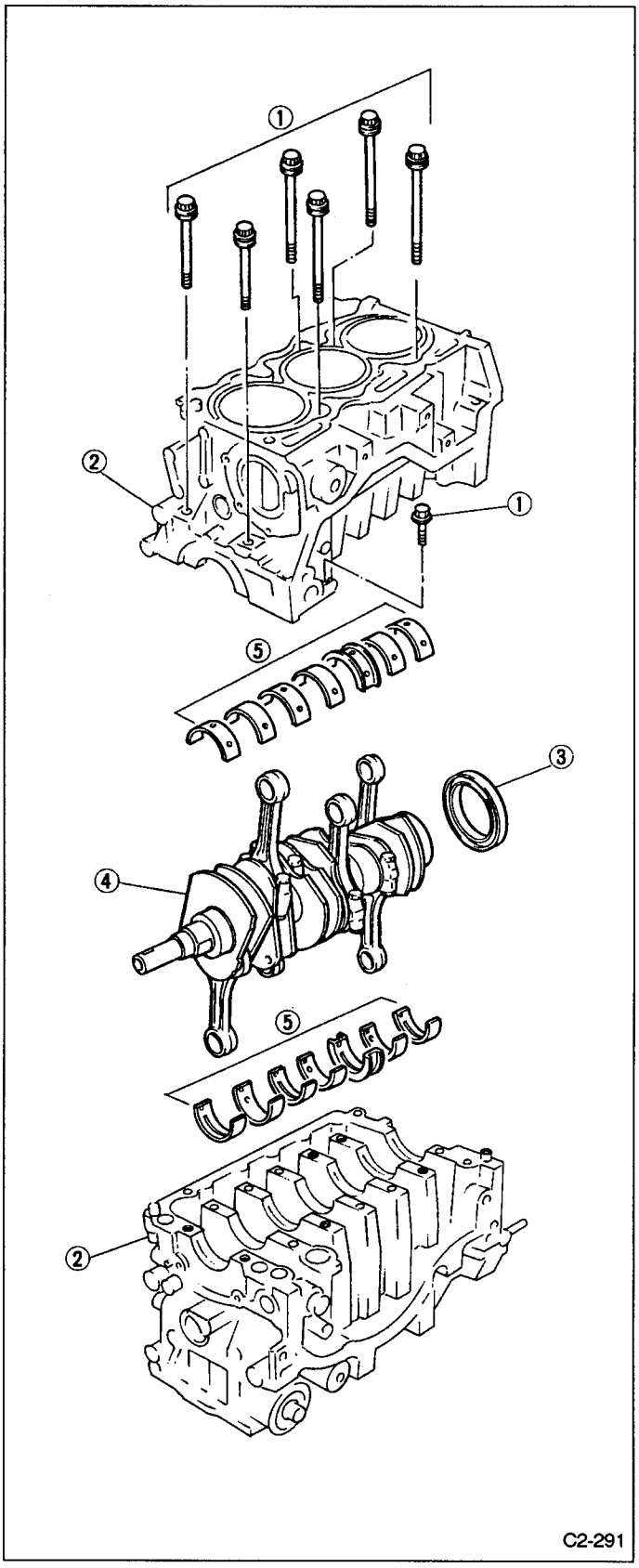


Fig. 113

1) Set up cylinder block so that #2, #4 and #6 cylinders are on the upper side, then remove cylinder block connecting bolts.
Be sure to remove small connecting bolt in the crankcase.

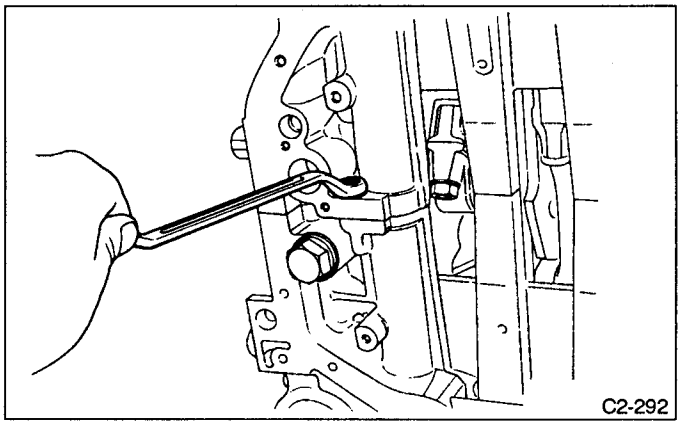


Fig. 114

2) Separate left-hand and right-hand cylinder blocks.
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 by hand.
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.
Do not confuse combination of piston and cylinder.

3. CRANKSHAFT AND PISTON

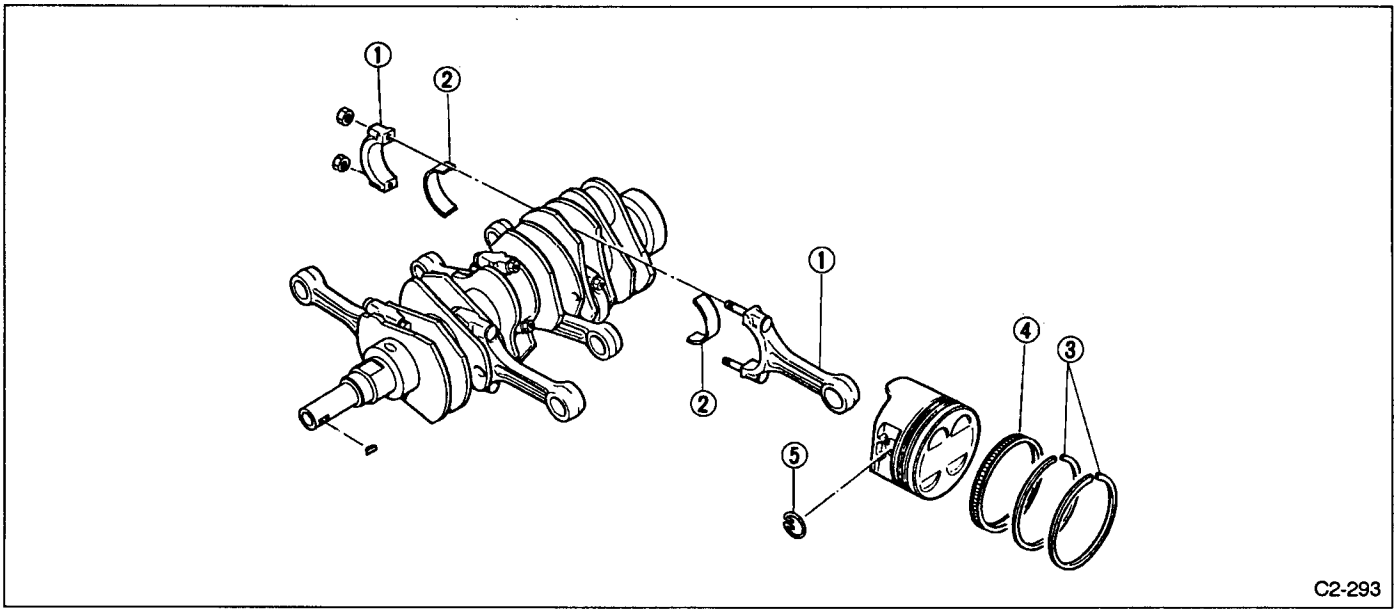


Fig. 115

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

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

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

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 the 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:
0.4 mm (0.016 in)

2. CYLINDER AND PISTON

1) The cylinder bore size is stamped on the cylinder block's front upper surface.
   (1) Standard sized pistons are classified into three grades, "A", "B" and "C". These grades should be used as a guideline in selecting a standard piston.
   (2) When piston is to be replaced due to general or cylinder wear, determine a suitable sized piston by measuring the piston clearance.

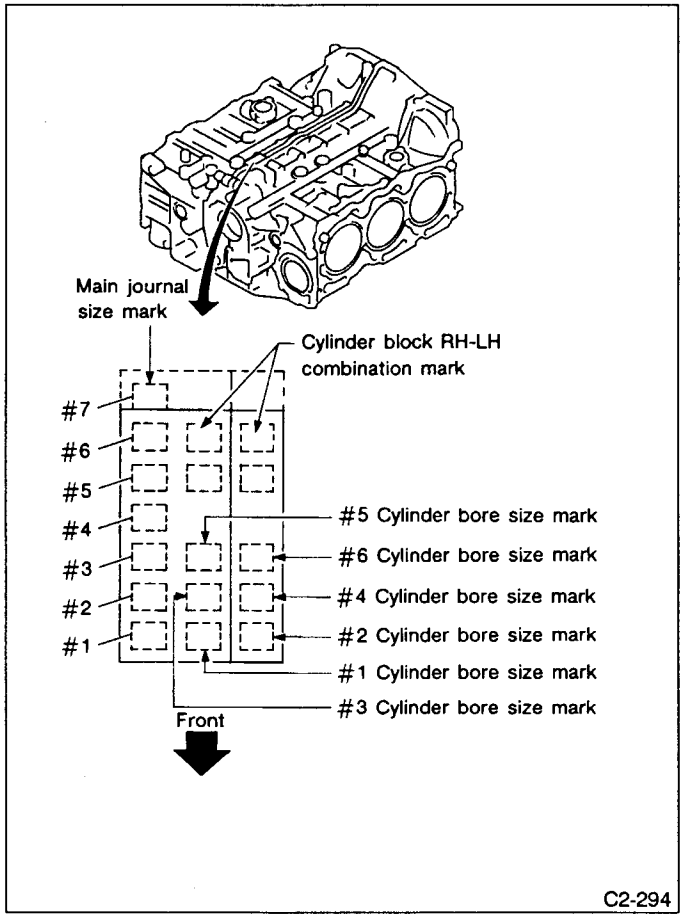


Fig. 116

(3) Proper combination of pistons and cylinders

Cylinder		Piston		Piston clearance 20°C (68° F)
Bore size symbol	Cylinder bore dia.	Piston grade symbol	Standard piston dia.	
A	96.905 — 96.915 mm (3.8151 — 3.8155 in)	A	96.885 — 96.895 mm (3.8144 — 3.8148 in)	0.01 — 0.03 mm (0.0004 — 0.0012 in)
B	96.895 —96.905 mm (3.8148 — 3.8151 in)	B	96.875 — 96.885 mm (3.8140 — 3.8144 in)	
C	96.885 — 96.895 mm (3.8144 — 3.8148 in)	C	96.865 — 96.875 mm (3.8136 — 3.8140 in)	

2) 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.
Measurement should be performed at a temperature 20°C (69°F).

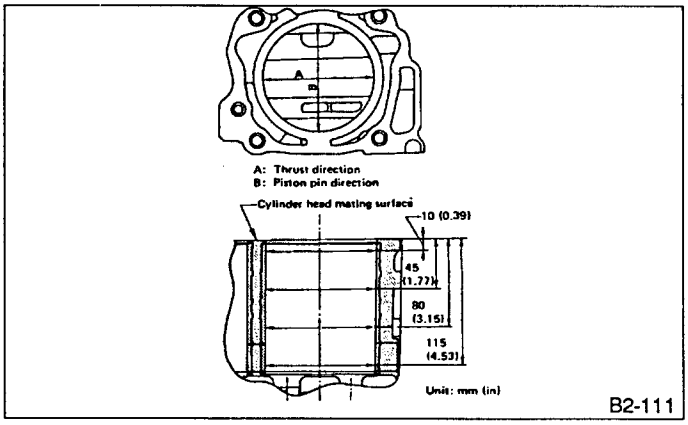


Fig. 117

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)
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)
Standard diameter:
A 96.905 — 96.915 mm (3.8151 — 3.8155 in)
B 96.895 — 96.905 mm (3.8148 — 3.8151 in)
C 96.885 — 96.895 mm (3.8144 — 3.8148 in)

3) 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.
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) Get six of the oversize pistons and measure the outer diameter of each piston at the height shown in the figure. (Thrust direction)
Measurement should be performed at a temperature of 20°C (68°F).

Piston outer diameter:
Standard
A 96.885 — 96.895 mm (3.8144 — 3.8148 in)
B 96.875 — 96.885 mm (3.8140 — 3.8144 in)
C 96.865 — 96.875 mm (3.8136 — 3.8140 in)
0.25 mm (0.0098 in) oversize
97.125 — 97.135 mm (3.8238 — 3.8242 in)
0.50 mm (0.0197 in) oversize
97.375 — 97.385 mm (3.8337 — 3.8340 in)

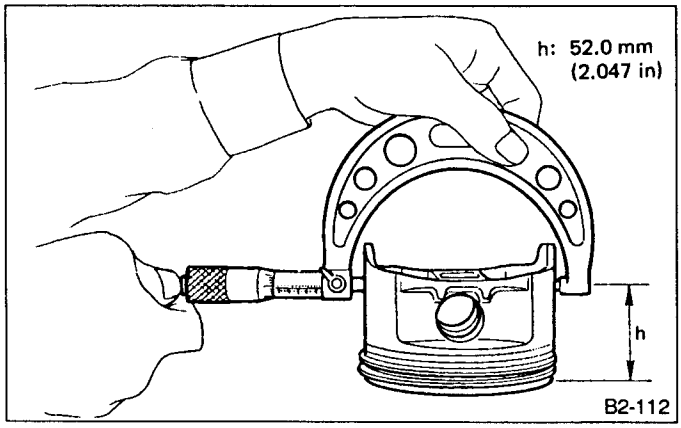


Fig. 118

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

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):
0.3 mm (0.012 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 CYLINDER AND PISTON. 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:
0.004 — 0.008 mm (0.0002 — 0.0003 in)
Standard clearance between piston pin and hole in connecting rod:
0 — 0.018 mm (0 — 0.0007 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.
"R" is marked on the end of the top and second rings. When installing the rings to the piston, face this mark upward.

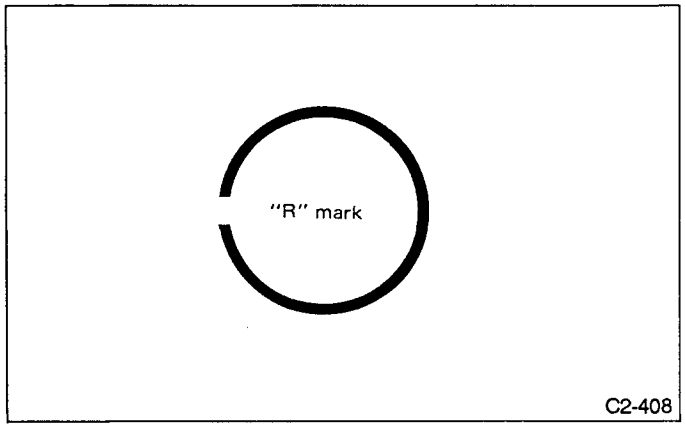


Fig. 119

The oil ring is a combined ring consisting of two rails and a spacer in between. When installing, be careful not to make misassembly.

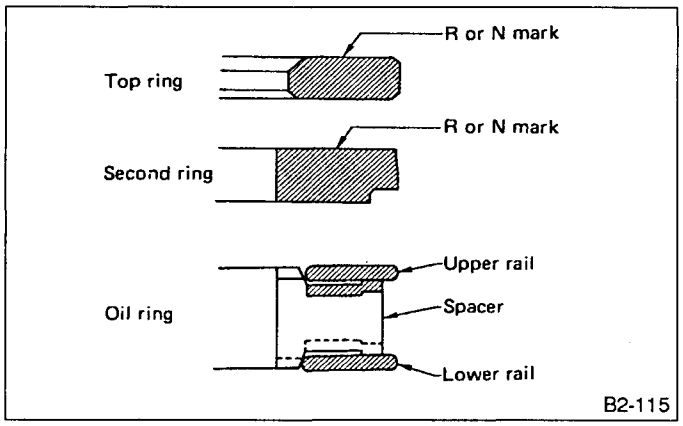


Fig. 120

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

Unit: mm (in)

		Standard	Limit
Piston ring gap	Top ring	0.20 — 0.30 (0.0079 — 0.0118)	0.5 (0.020)
	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)

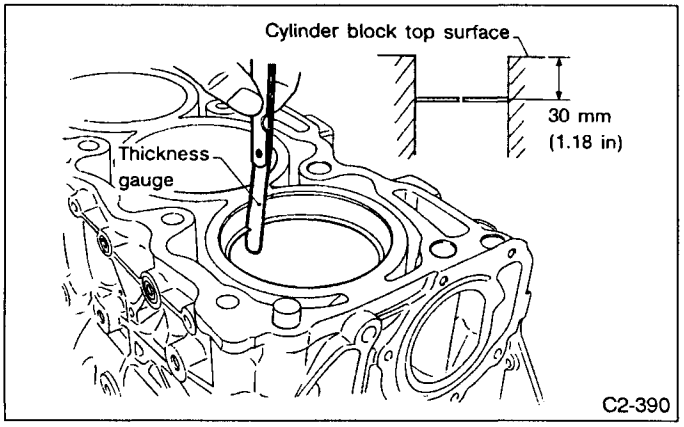


Fig. 121

3) Measure the clearance between piston ring and piston ring groove with a thickness gauge.
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 — 0.09 (0.0016 — 0.0035)	0.15 (0.0059)
	Second ring	0.03 — 0.07 (0.0012 — 0.0028)	0.15 (0.0059)

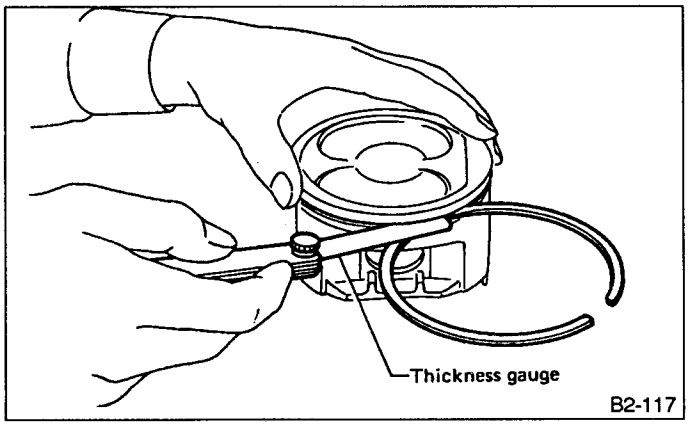


Fig. 122

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)

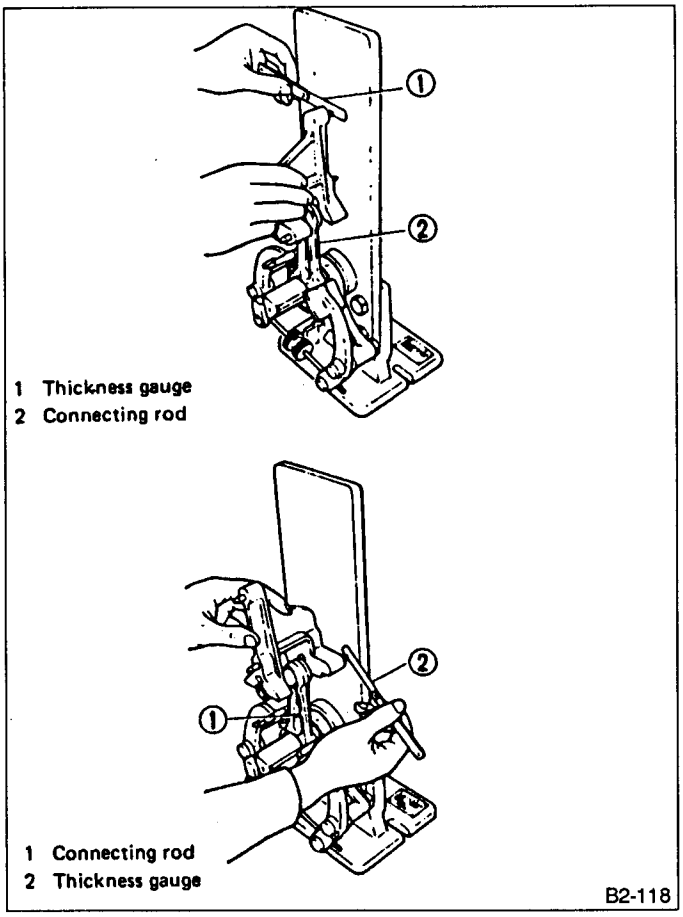


Fig. 123

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)

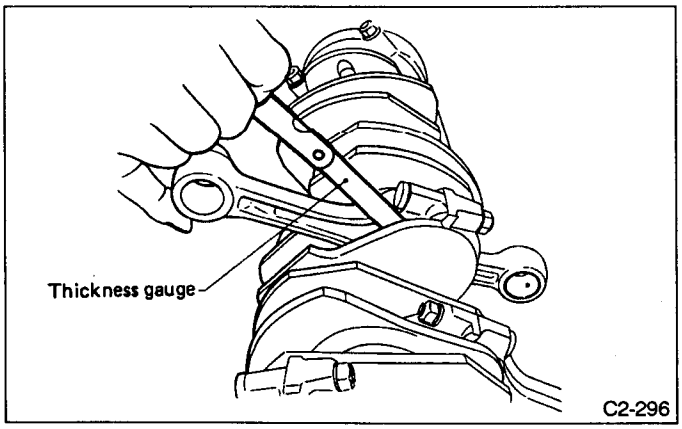


Fig. 124

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, necessary. (See the table below.)

Connecting rod oil clearance:
Standard
0.020 — 0.046 mm (0.0008 — 0.0018 in)
Limit
0.05 mm (0.0020 in)

Unit: mm (in)

Bearing	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.486 — 1.498 (0.0585 — 0.0590)	51.984 — 52.000 (2.0466 — 2.0472)
0.03 undersize	1.520 — 1.524 (0.0598 — 0.0600)	51.954 — 51.970 (2.0454 — 2.0461)
0.05 undersize	1.540 — 1.544 (0.0606 — 0.0608)	51.934 — 51.950 (2.0446 — 2.0453)
0.25 Undersize	1.740 — 1.744 (0.0685 — 0.0687)	51.734 — 51.750 (2.0368 — 2.0374)

6) Inspect the bushing at connecting rod small end for wear or damage.
Also measure the piston pin clearance at the connecting rod small end.
If not within specifications, replace connecting rod and connecting rod cap as a set.

Clearance between piston pin and bushing:
Standard
0 — 0.018 mm (0 — 0.0007 in)
Limit
0.030 mm (0.0012 in)

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.
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)

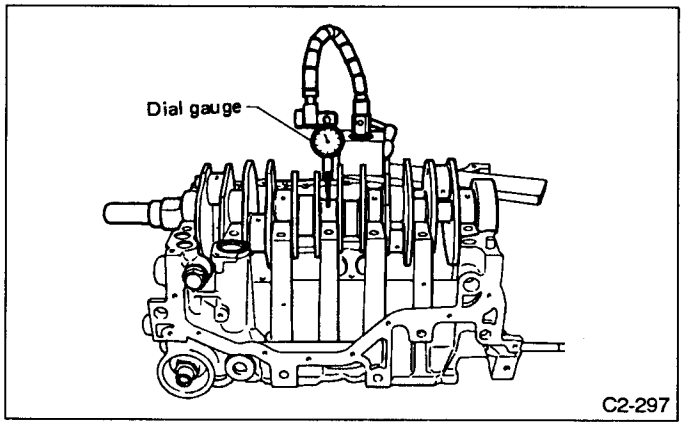


Fig. 125

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

Crankpin 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, #3, #7	#2, #4, #6	#5	
Standard	Journal O.D.	59.992 — 60.008 (2.3619 — 2.3625)	←	←	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.	59.962 — 59.978 (2.3607 — 2.3613)	←	←	51.954 — 51.970 (2.0454 — 2.0461)
	Bearing size (Thickness at center)	2.017 — 2.020 (0.0794 — 0.0795)	2.019 — 2.022 (0.0795 — 0.0796)	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)	←	←	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.	59.742 — 59.758 (2.3520 — 2.3527)	←	←	51.734 — 51.750 (2.0368 — 2.0374)
	Bearing size (Thickness at center)	2.127 — 2.130 (0.0837 — 0.0839)	2.129 — 2.132 (0.0838m — 0.0839)	2.129 — 2.132 (0.0838 — 0.0839)	1.620 — 1.623 (0.0638 — 0.0639)

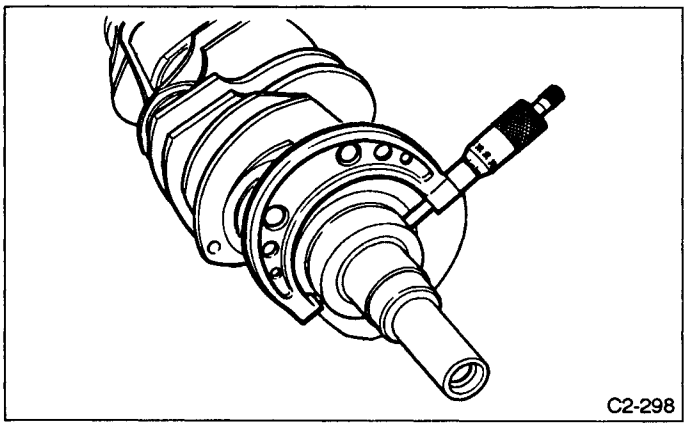


Fig. 126

4) Measure the thrust clearance of crankshaft at #5 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)

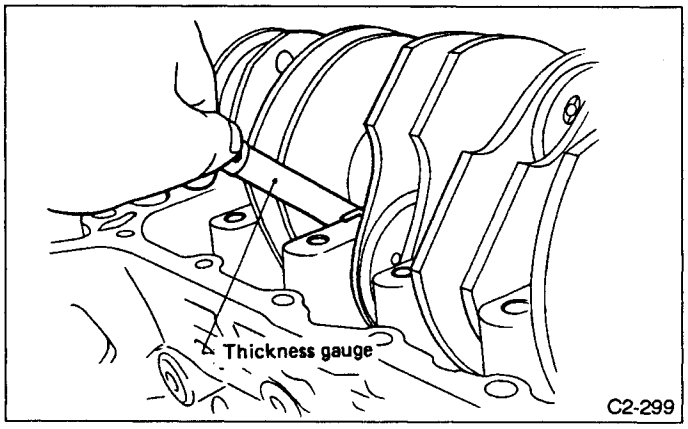


Fig. 127

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, #3, #7	0.005 — 0.035 (0.0002 — 0.0014)
	#2, #4, #6	0.013 — 0.038 (0.0005 — 0.0015)
	#5	0.013 — 0.034 (0.0005 — 0.0013)
Limit	#1, #2, #6, #7	0.045 (0.0018)
	#3, #4, #5	0.040 (0.0016)

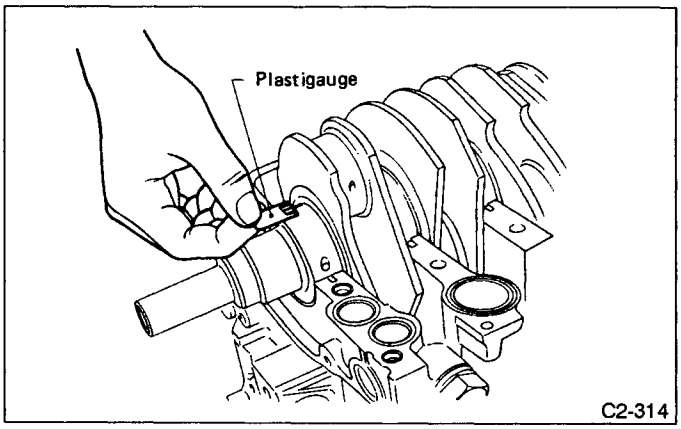


Fig. 128

D: ASSEMBLY

1. CRANKSHAFT AND PISTON

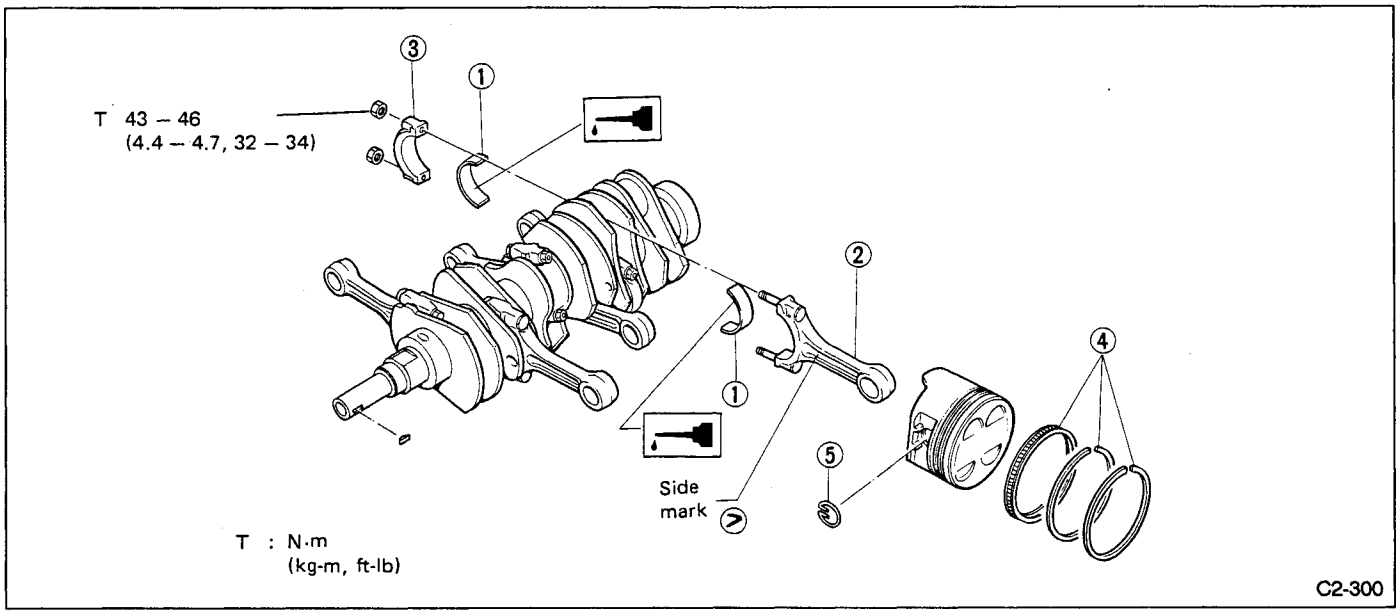


Fig. 129

1) Install connecting rod bearings on connecting rods and connecting rod caps.
2) Install connecting rod on crankshaft.
a. Apply oil to the surfaces of the connecting rod bearings.
b. 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.
a. Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching number.
b. 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.

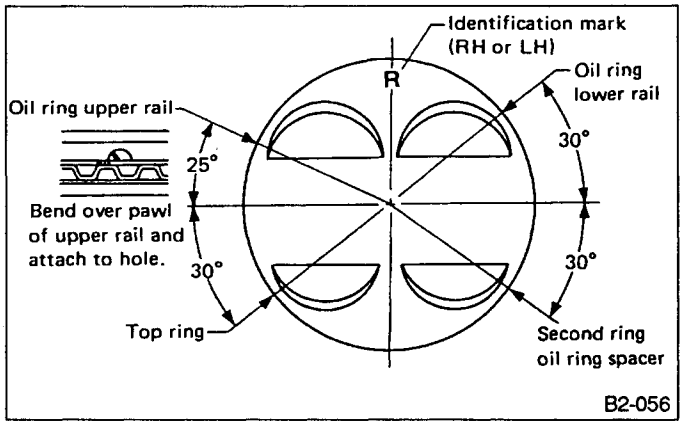


Fig. 130

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

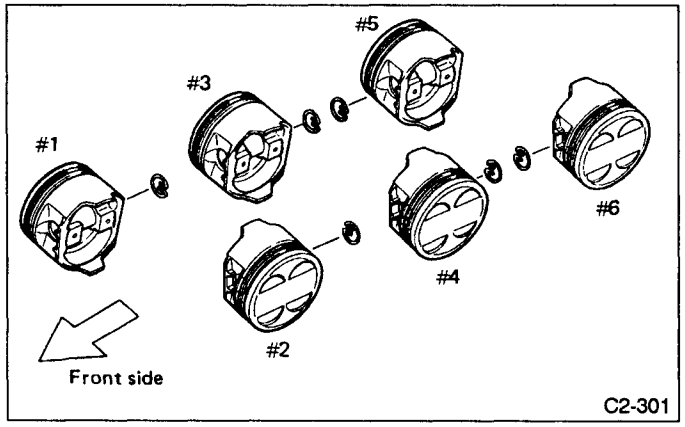


Fig. 131

2. CYLINDER BLOCK

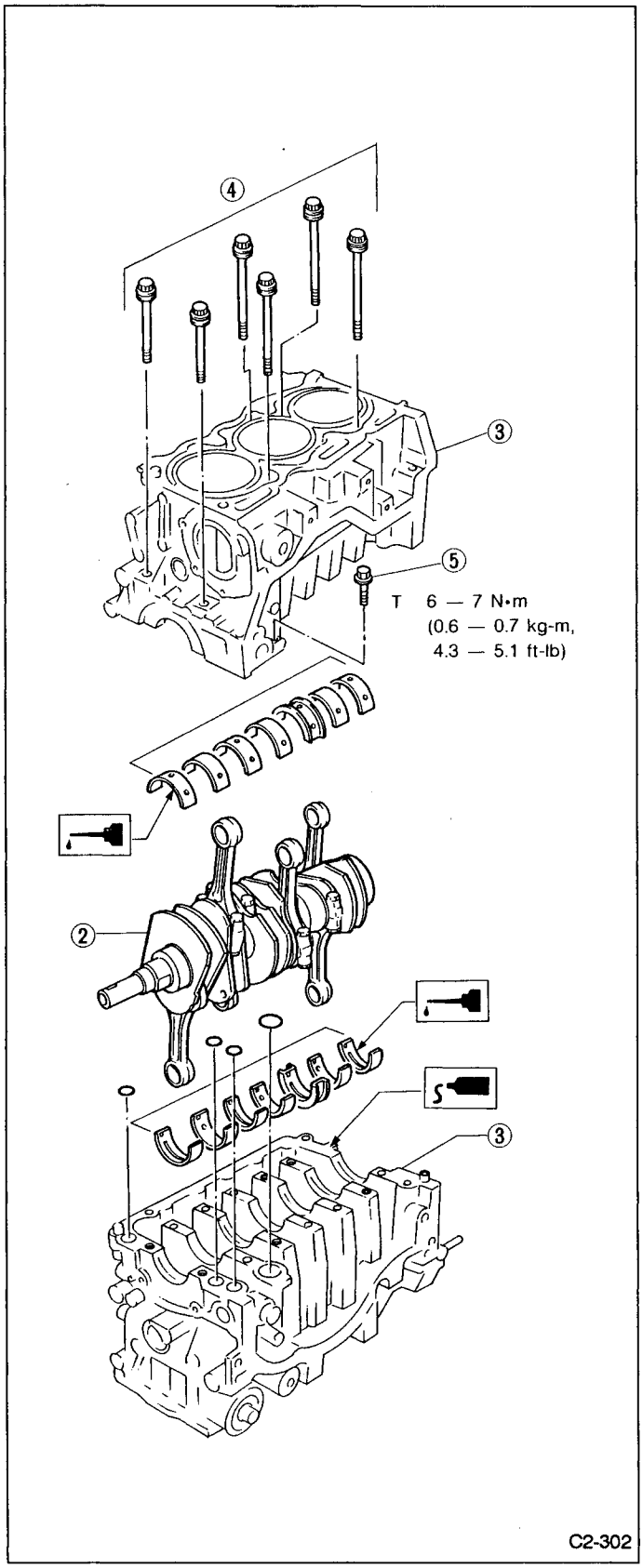


Fig. 132

1) Install ENGINE STAND to cylinder block, then install crankshaft bearings.
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 #1, #3 & #5 cylinder block.
3) Apply fluid packing to the mating surface of #1, #3 & #5 cylinder block, and put O-rings on the grooves of #1, #3 & #5 cylinder block, and then position #2, #4 & #6 cylinder block on it.

Fluid packing:
Three-bond 1215B or equivalent

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

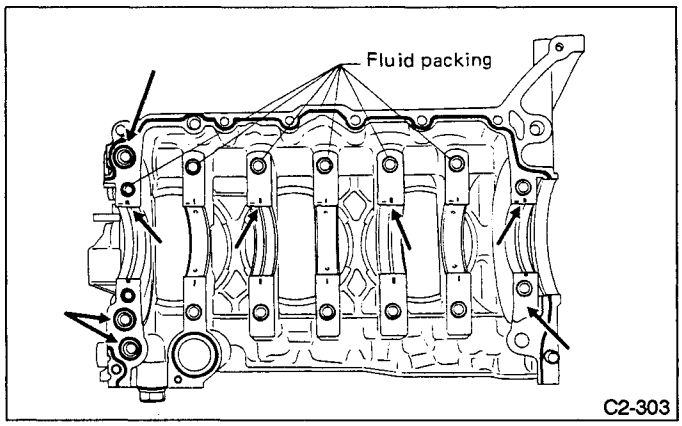


Fig. 133

4) Tighten #2, #4 & #6 cylinder block side connecting bolts to 15 N•m (1.5 kg-m, 11 ft-lb) in the numerical sequence shown in figure..

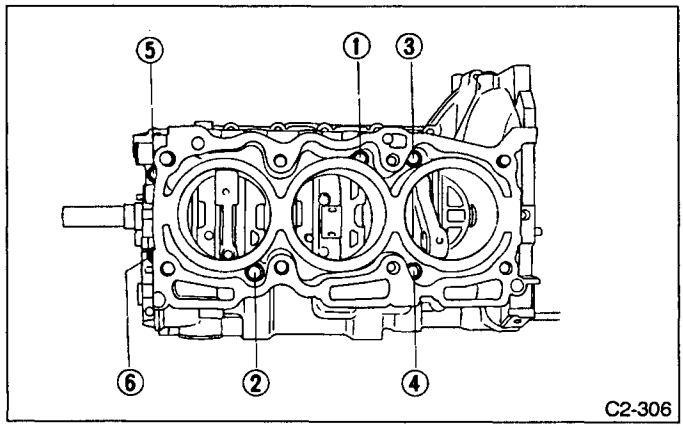


Fig. 134

5) Tighten small bolt in the crank case.

3. CYLINDER BLOCK CONNECTING BOLT

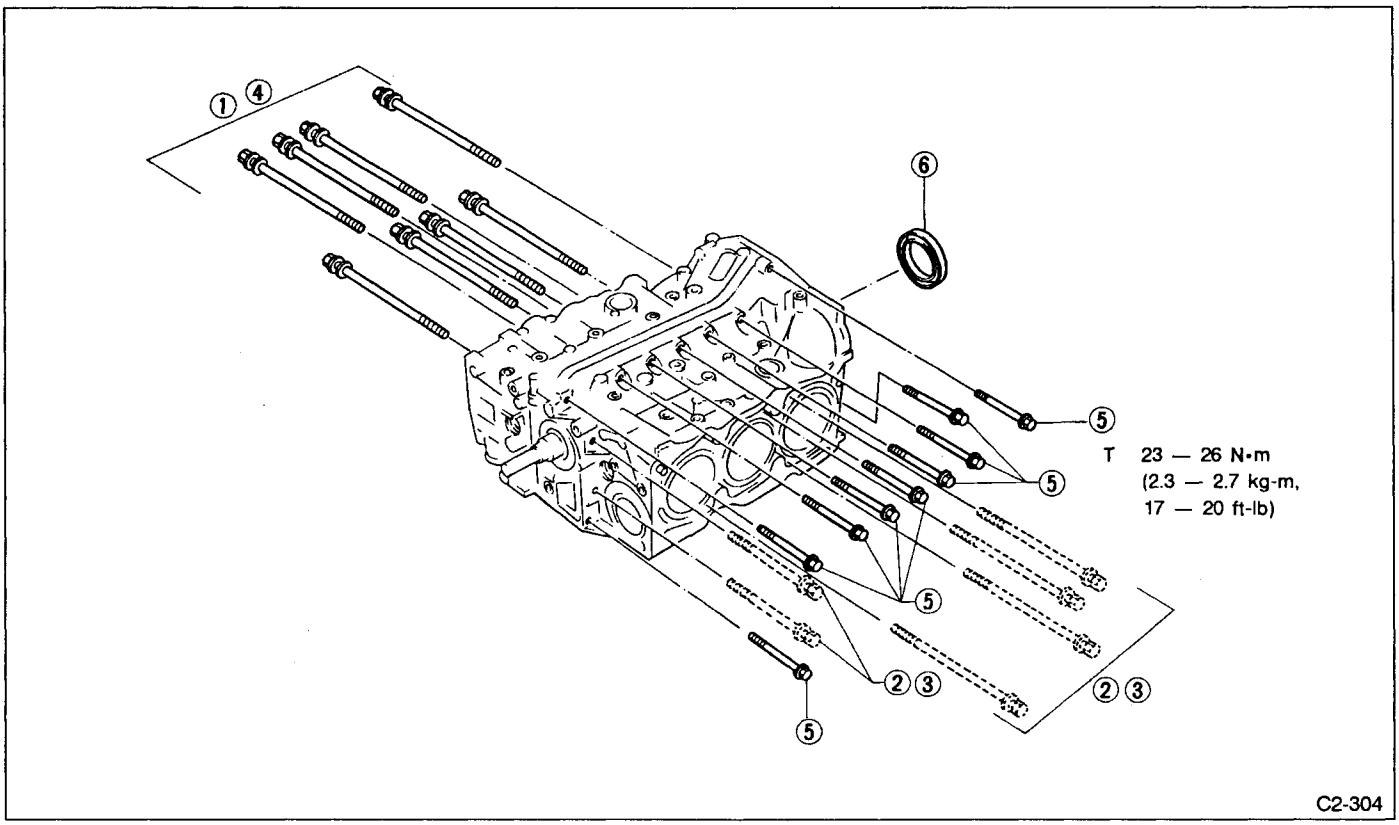


Fig. 135

1) Turn cylinder block so that it is horizontal.
Tighten cylinder block connecting bolts to 15 N•m (1.5 kg-m, 11 ft-lb) on the #1, #3 and #5 cylinder block side in the numerical sequence shown in Figure.

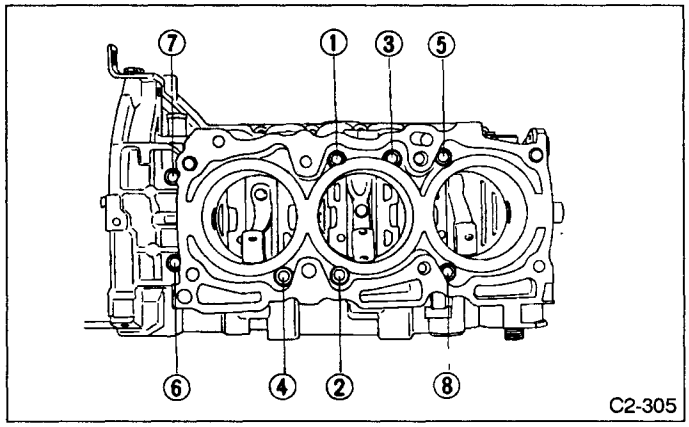


Fig. 136

2) To confirm tightening torque on the #2, #4 and #6 cylinder block side connecting bolts re-tighten connecting bolts to 15 N•m (1.5 kg-m, 11 ft-lb), in the numerical sequence shown in figure.

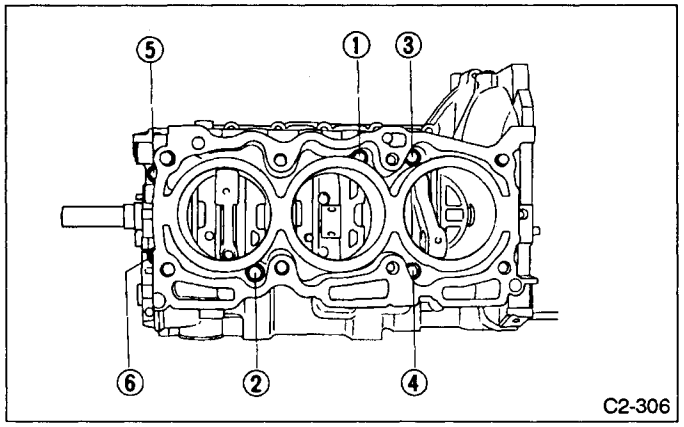


Fig. 137

3) Re-tighten connecting bolts by 90° — 110° on the #2, #4 and #6 cylinder block side in the numerical sequence shown in figure.

4) Re-tighten connecting bolts by 90° — 110° on the #1, #3 and #5 cylinder block side in the numerical sequence shown in figure.
5) Tighten other cylinder block connecting bolts to specified torque.
6) Install rear oil seal.

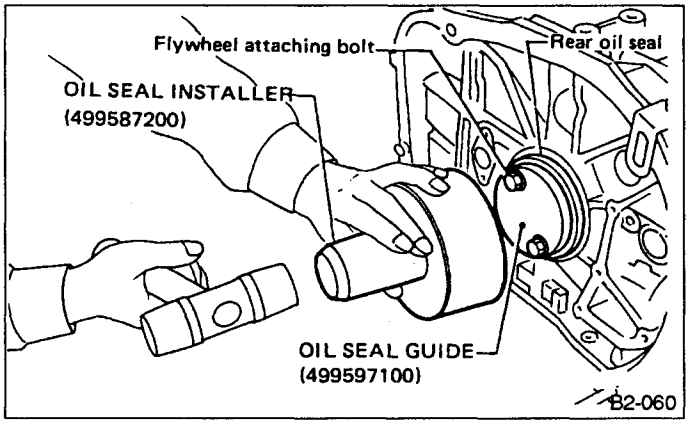


Fig. 138

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

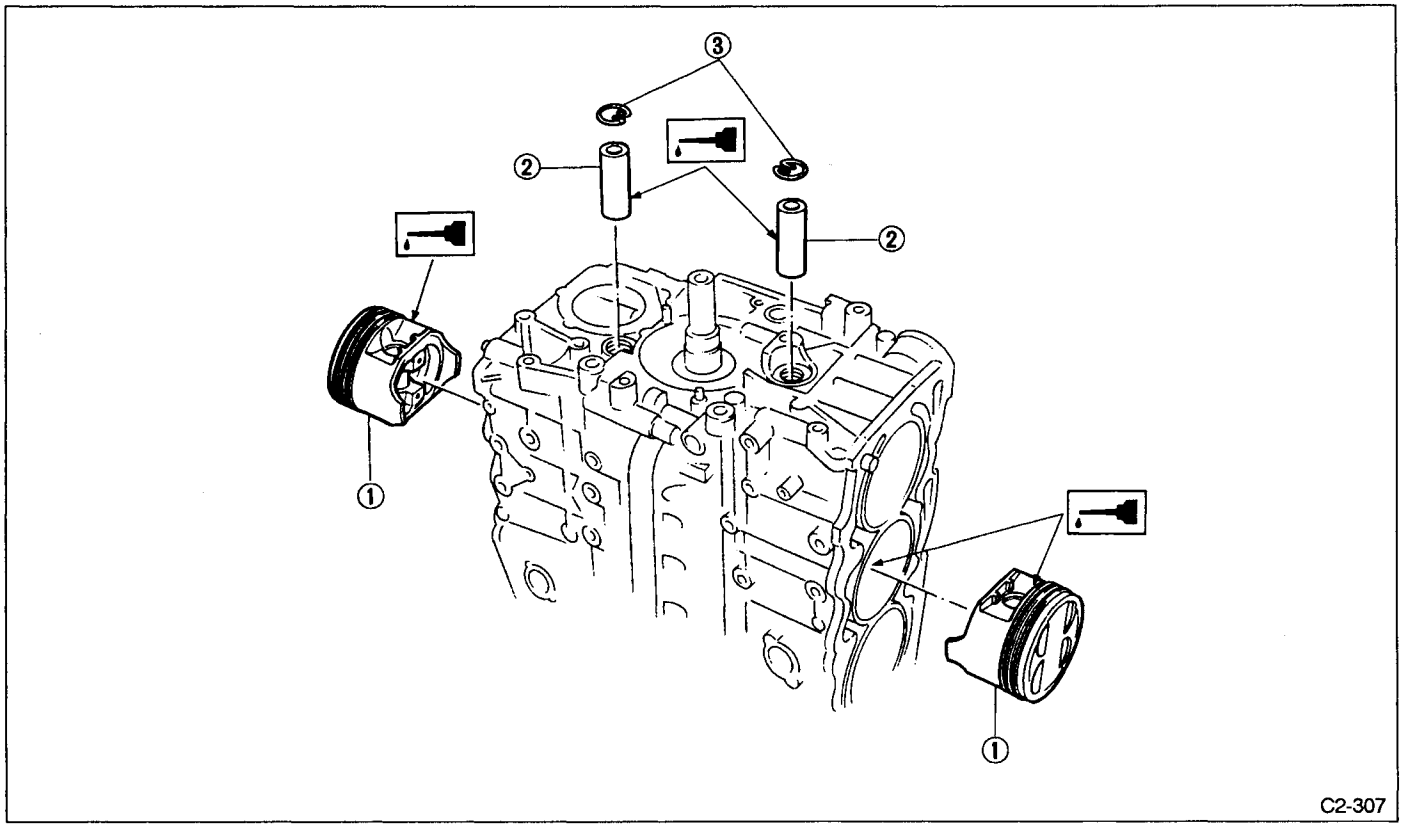


Fig. 139

1) Installing piston.
(1) Turn cylinder block so that #1 and #2 cylinders face upward.
(2) Turn crankshaft so that #3 and #4 connecting rods are set at bottom dead center.
(3) Apply a coat of engine oil to pistons and cylinders and insert #3 and #4 pistons in their cylinders.

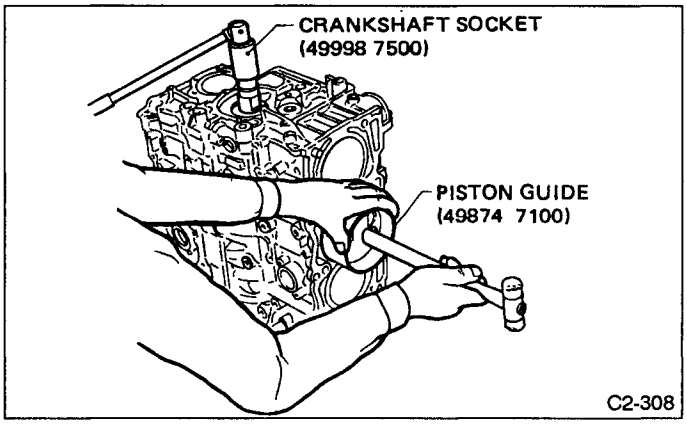


Fig. 140

2) Installing piston pin.
(1) Insert the PISTON PIN GUIDE into service hole to align piston pin hole with connecting rod small end.
Apply a coat of engine oil to PISTON PIN GUIDE before insertion.

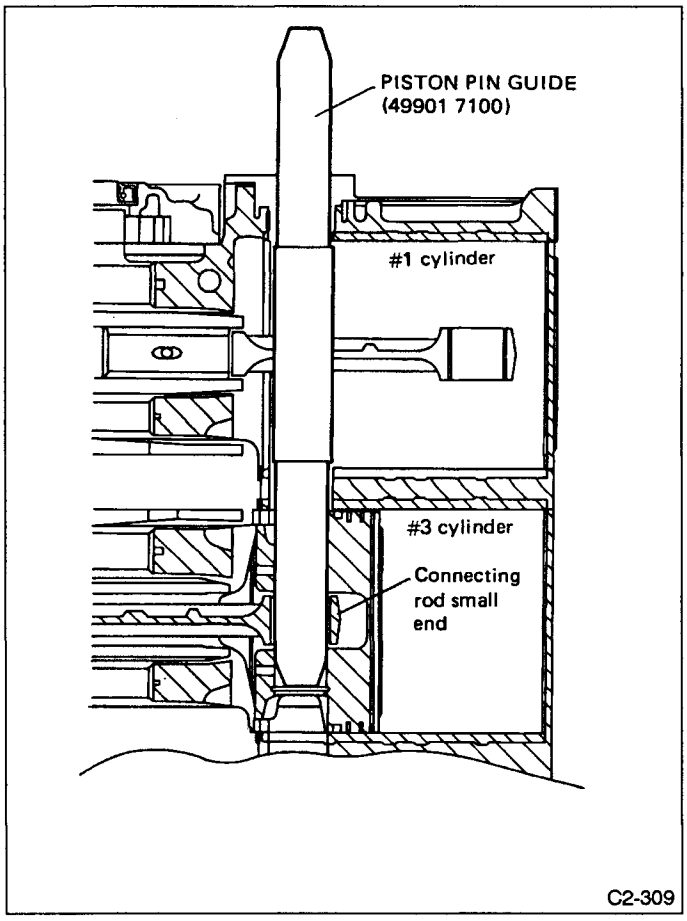


Fig. 141

(2) Apply a coat of engine oil to piston pin and insert piston pin into piston and connecting rod through service hole.
(3) Install new circlip with PISTON CIRCLIP PLIERS.

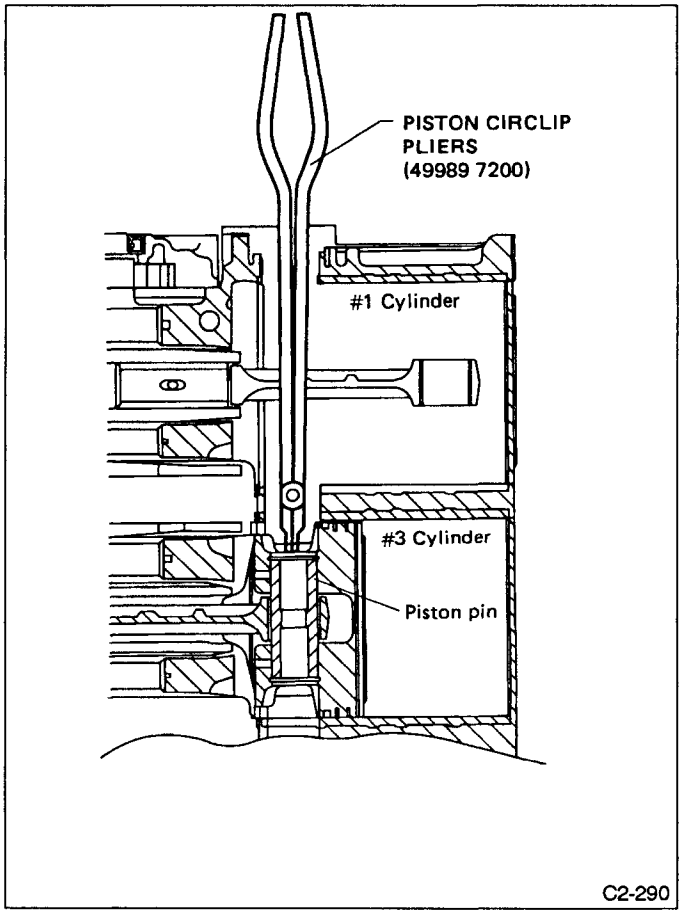


Fig. 142

5. PISTON AND PISTON PIN (#1 and #2)

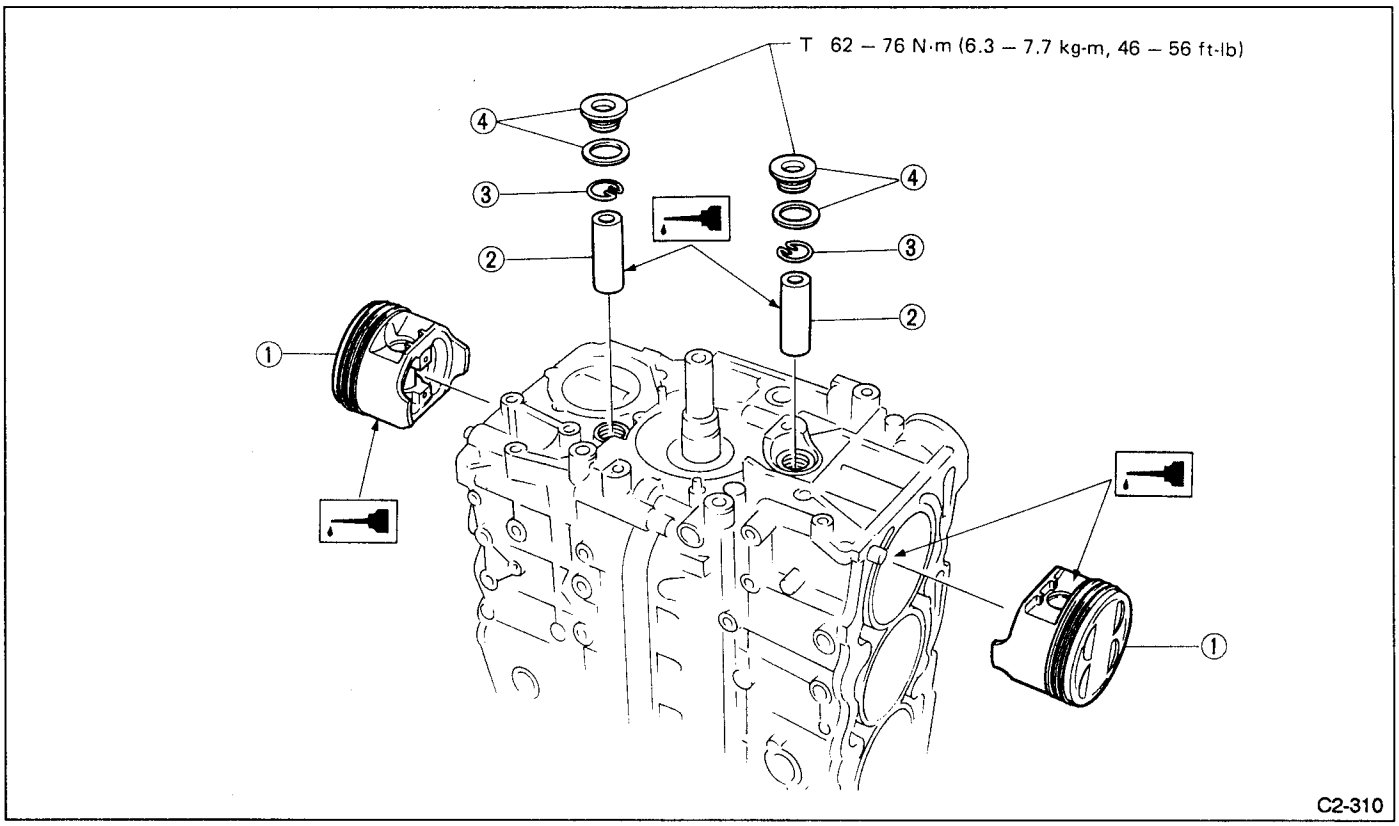


Fig. 143

1) Installing piston
   (1) Turn cylinder block so that #1 and #2 cylinders face upward.
   (2) Turn crankshaft so that #1 and #2 connecting rods are set at bottom dead center.
   (3) Apply a coat of engine oil to pistons and cylinders and insert pistons in their cylinders.
2) Installing piston pin
   (1) Insert the PISTON PIN GUIDE into service hole to align piston pin hole with connecting rod small end.

Apply a coat of engine oil to PISTON PIN GUIDE before insertion.

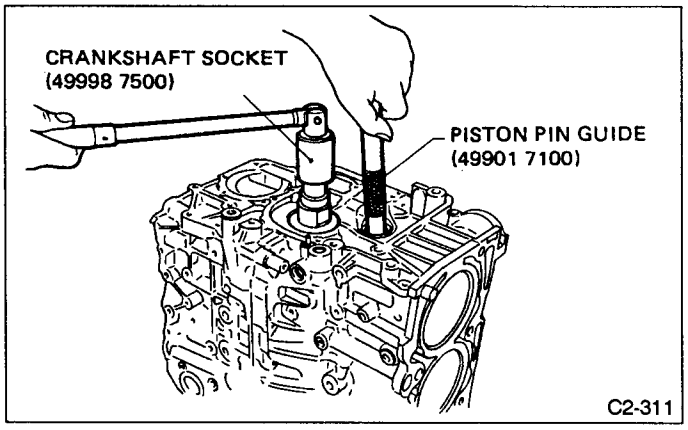


Fig. 144

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

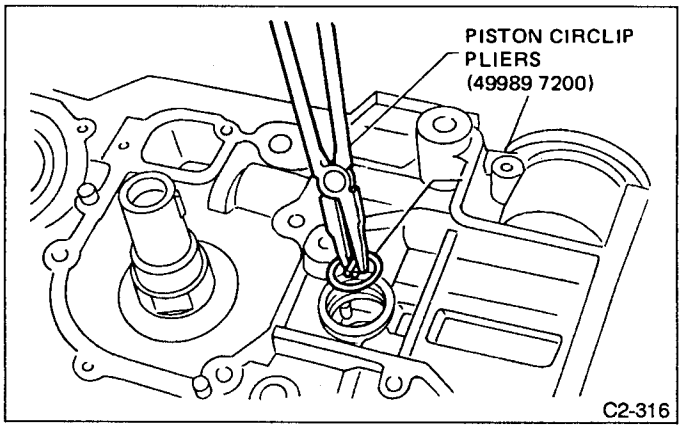


Fig. 145

   (4) Install service hole plug and gasket.

Use a new gasket.

6. PISTON AND PISTON PIN (#5 and #6)

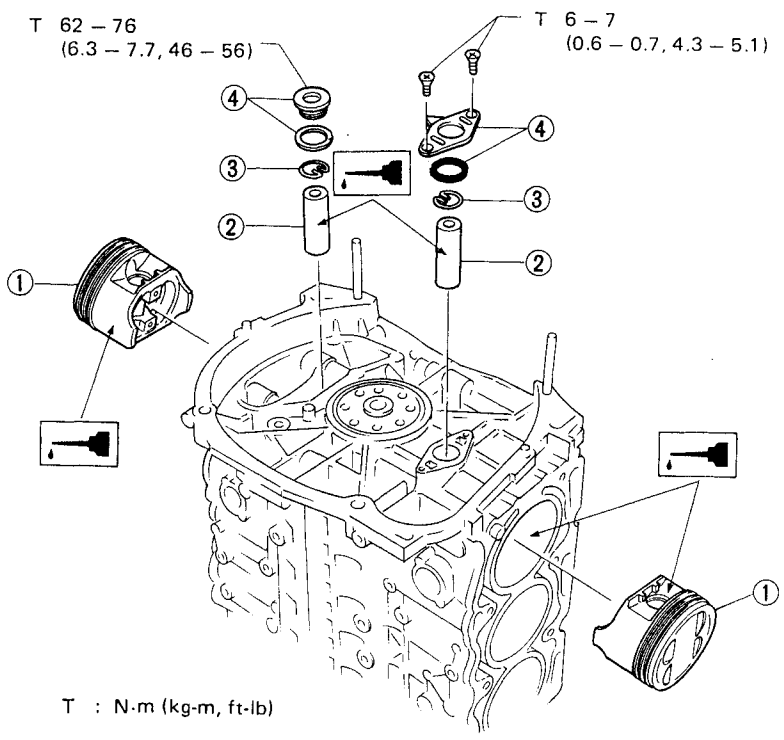


Fig. 146

Turn cylinder block so that #5 and #6 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

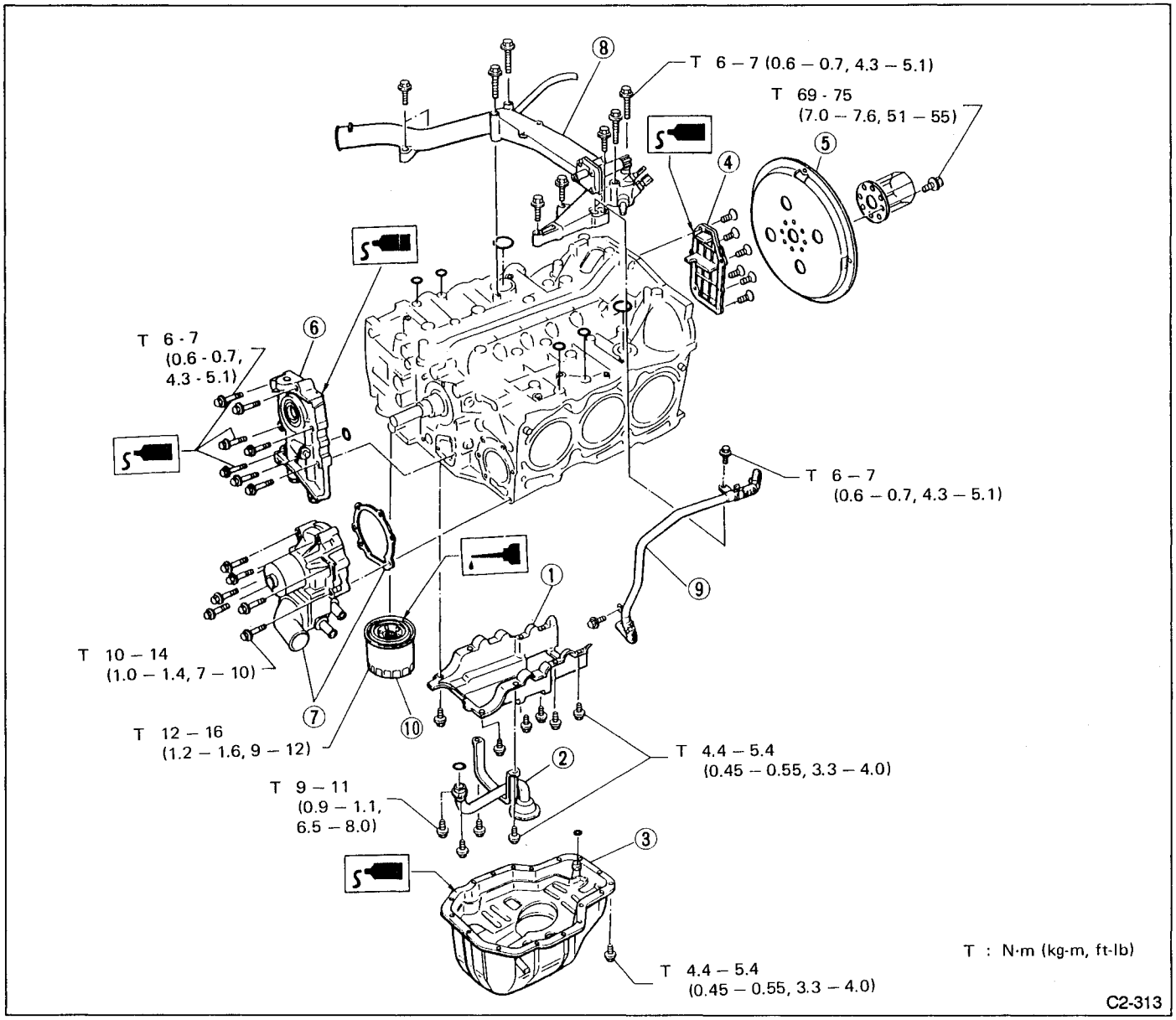


Fig. 147

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

Fluid packing:
Three-bond 1207F or equivalent

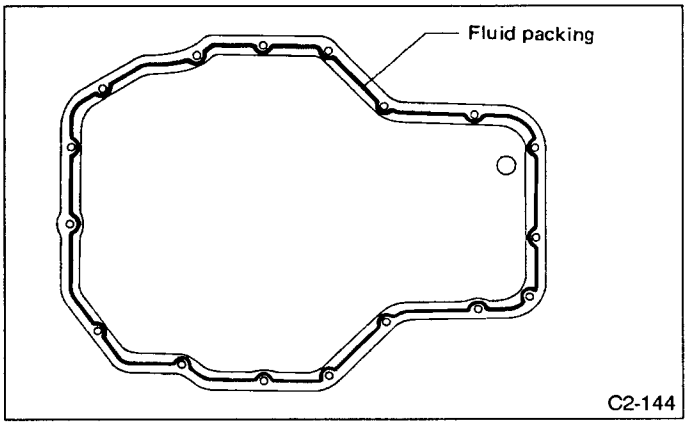


Fig. 148

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

Fluid packing:
Three-bond 1215B or equivalent

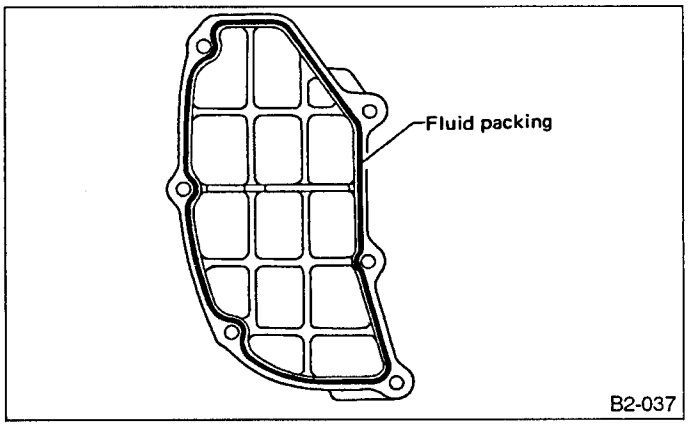


Fig. 149

5) Install drive plate.
6) Installation of oil pump.
(1) Discard front oil seal after removal. Replace with a new one.

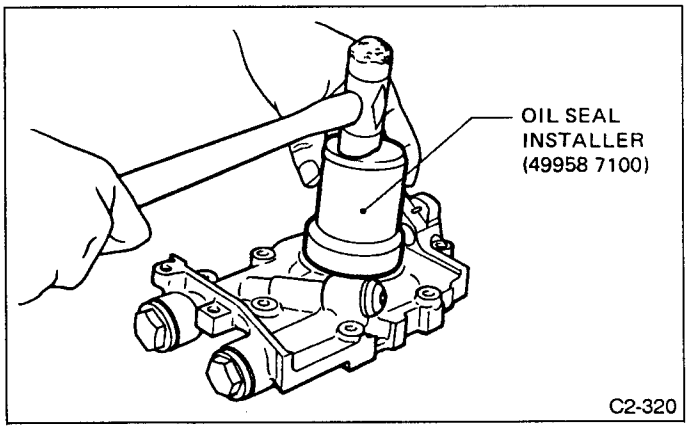


Fig. 150

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

Fluid packing:
Three-bond 1215B or equivalent

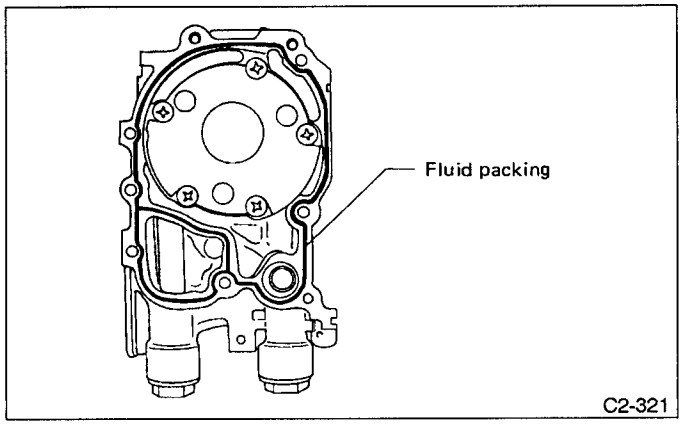


Fig. 151

(3) Install oil pump on cylinder block. Be careful not to damage oil seal during installation.
〈Refer to 2-4 ENGINE LUBRICATION SYSTEM [W1E0].〉
a. Do not forget to install O-ring and seal when installing oil pump.
b. Align flat surface of oil pump's inner rotor with crankshaft before installation.
7) Install water pump and gasket.
After tightening all bolts to the specified torque, tighten all bolts to specified torque again.
〈Refer to 2-5 ENGINE COOLING SYSTEM [W2C0].〉
Be sure to use a new gasket.
8) Install water pipe.
9) Install water by-pass pipe.
10) Install oil filter with OIL FILTER WRENCH.

2. RELATED PARTS

1) Install cylinder head and intake manifold.
〈Refer to Cylinder Head [W4A0].〉
2) Install camshaft and related parts.
〈Refer to Camshaft [W3A0].〉
3) Install camshaft sprocket, timing belt and related parts.
〈Refer to Timing Belt [W2A0].〉

T TROUBLESHOOTING

1. Engine Trouble in General

Symbols shown in the chart refer to the possibility of reason for the trouble in order ("Very often" to "Rarely")
⊙— Very often
○— Sometimes
△— Rarely

No.	TROUBLE	
1	Engine will not start.	Starter does not turn.
2		Initial combustion does not occur.
3		Initial combustion occurs.
4		Engine stalls after initial combustion.
5	Rough idle and engine stall.	
6	Low output, hesitation and poor acceleration.	
7	Surging.	
8	Engine does not return to idle.	
9	Dieseling (Run-on).	
10	After burning in exhaust system.	
11	Knocking.	
12	Excessive engine oil consumption.	
13	Excessive fuel consumption.	

TROUBLE No.													POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10	11	12	13	
													STARTER
○													• Defective battery-to-starter harness.
△													• Defective starter switch.
△													• Defective inhibitor switch.
○	△												• Defective starter.
													BATTERY
⊙													• Poor terminal connection.
⊙													• Run-down battery.
○													• Defective charging system.
	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙		⊙	MPFI SYSTEM (See Chap. 2-7.)
													IGNITION SYSTEM
	○	○	○	⊙	⊙	⊙	⊙	⊙	⊙	⊙		⊙	• Incorrect ignition timing.
	○	⊙		○	○	○			△			△	• Disconnection of ignition coil connector.
	○			△	○	○							• Defective ignition coil.
	○			△	△	△							• Defective cord or wiring.
		○		○	○	○			⊙				• Defective spark plug.
	○	○	○	⊙	○	⊙	△		○	○			• Incorrect cam timing.
1	2	3	4	5	6	7	8	9	10	11	12	13	

TROUBLE No.													POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10	11	12	13	
													INTAKE SYSTEM
		○	○	⊙	○	○	⊙	○	○			⊙	• Improper idle adjustment.
			○	⊙	⊙	⊙			△	⊙			• Loosened or cracked intake boot.
			○	⊙	⊙	⊙			△	⊙			• Loosened or cracked intake duct.
			△	⊙	⊙	⊙			△	⊙	⊙		• Loosened or cracked blow-by hose.
			△	⊙	○	⊙	⊙		○	⊙			• Loosened or cracked vacuum hose.
			△	○	○	○				⊙			• Defective air cleaner gasket.
		○	○	○	○	○				⊙			• Defective intake manifold gasket.
		○	○	○	○	○				⊙			• Defective throttle body gasket.
				△	○	○			○	○	○		• Defective PCV valve.
				○	○	○			△	○	△		• Loosened oil filler cap.
			△	△	⊙	○				○		⊙	• Dirty air cleaner element.
													FUEL LINE
	⊙	△		△	○	○							• Defective fuel pump.
		△	△	△	○	○							• Clogged fuel line.
	○	○	○	○	△	△							• Lack of or insufficient fuel.
													BELT
	○	○	○										• Defective.
	○	○	○	△	○	○			○	○		○	• Defective timing.
													FRICTION
△													• Seizure of crankshaft and connecting-rod bearing.
△													• Seized camshaft.
△													• Seized or stuck piston and cylinder.
													COMPRESSION
	△	△	△	○	○	○			○	△		○	• Worn or broken lash adjuster.
	△	△	△	○	○	△			△			△	• Loosened spark plugs or defective gasket.
	△	△	△	○	○	△			△			△	• Loosened cylinder head nuts or defective gasket.
	△	△	△	○	○	△			○			○	• Improper valve seating.
	△	△	△	△	△	△			△		⊙	△	• Defective valve stem.
	○	○	○	○	○	△			△			△	• Worn or broken valve spring.
	△	△	△	○	△	△			△		⊙	○	• Worn or stuck piston rings, cylinder and piston.
	○	○	○	⊙	⊙	⊙			⊙	○		○	• Incorrect valve timing.
	○	○	○	○	○	○							• Improper engine oil (low viscosity).
1	2	3	4	5	6	7	8	9	10	11	12	13	

TROUBLE No.													POSSIBLE CAUSE
1	2	3	4	5	6	7	8	9	10	11	12	13	
													LUBRICATION SYSTEM
				○	○				△			△	• Incorrect oil pressure.
											○		• Loosened oil pump attaching bolts and defective gasket.
											○		• Defective oil filter seal.
											○		• Defective crankshaft oil seal.
				△							○		• Defective rocker cover gasket.
											○		• Loosened oil drain plug or defective gasket.
											○		• Loosened oil pan fitting bolts or defective oil pan.
													COOLING SYSTEM
				△	△	○		○		⊙			• Overheating.
					△				△			△	• Over cooling.
													OTHERS
				⊙	⊙	△			△				• Malfunction of Evaporative Emission Control System. (See Chap. 2-1.)
				○			⊙						• Stuck or damaged throttle valve.
				△			○	○				○	• Accelerator cable out of adjustment.
1	2	3	4	5	6	7	8	9	10	11	12	13	

2. Engine Noise

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 drive it at approximately 3,000 rpm for twenty minutes. If noise still exists, conduct troubleshooting procedures in accordance with the following table.

Type of sound	Condition	Possible cause
Regular clicking sound.	Sound increases as engine speed increases.	Valve mechanism is defective • Broken and worn lash adjuster. • Worn camshaft. • Broken valve spring. • Worn lash adjuster guide.
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 spark plug in noisy cylinder is shortened out.	• 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 spark plug in noisy cylinder is shortened out.	• 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 spark plug is shortened out in turn.	• Unusually worn valve lifter. • Worn cam gear. • Worn camshaft journal bore in crankcase.
Squeaky sound.	—	• Insufficient alternator lubrication.
Rubbing sound.	—	• Defective alternator brush and rotor contact.

Type of sound	Condition	Possible cause
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 water 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.