



## Contents

<b>Chapter 1</b>	<b>Technical Parameters and Maintenance Preparation Data of Engine .....</b>	<b>2</b>
Section 1	Technical Parameters of Engine .....	3
Section 2	Maintenance Preparation .....	5
Section 3	General Maintenance Parameters .....	8
Section 4	Engine Maintenance .....	14
<b>Chapter 2</b>	<b>Engine Structure .....</b>	<b>16</b>
Section 1	Cylinder block, cylinder head and crank connecting rod mechanism .....	17
Section 2	Valve actuating mechanism .....	24
Section 3	Lubrication System .....	29
Section 4	Cooling System.....	33
Section 5	Intake and Exhaust Systems .....	35
Section 6	Fuel System .....	38
Section 7	Ignition System.....	40
Section 8	Other sensors and other actuating mechanism.....	42
<b>Chapter 3</b>	<b>Engine Adjustment and Maintenance.....</b>	<b>44</b>
Section 1	Engine Adjustment .....	45
Section 2	Engine Maintenance When Engine is Installed on the Vehicle.....	49
Section 3	Engine Adjustment and Maintenance .....	62



# Chapter 1

## Technical Parameters and Maintenance

### Preparation Data of Engine

Section 1 Technical Parameters of Engine .....	3
Section 2 Maintenance Preparation .....	5
Section 3 General Maintenance Parameters .....	8
Section 4 Engine Maintenance .....	14



## Section 1 Technical Parameters of Engine

Engine model: CA4GA5

Displacement: 1.497 L

Bore × stroke: 73×89.4 mm

Compression ratio: 10.2: 1,

Rated power/rotating speed: 75kW/6000r/min

Maximum net torque/rotating speed: 135N.m/4400r/min

Fuel specification: octane number above 93#, unleaded gasoline or 93# ethanol gasoline and above.

Engine dimension (L\*W\*H): 421\*554\*637 (mm)

Note: The length refers to the distance from rear end of cylinder block to front end of crank pulley;

The width refers to the distance from the outermost end of left side to that of right side when the engine is in upright state.

The height refers to the distance from the highest point to the lowest point of the engine when the engine is in upright state.

Net weight of engine (cooling compressor, power steering pump and combination bracket are excluded): 104Kg

Valve timing

Intake valve opening: 38 °before TDC~12 °after TDC.

Intake valve closing: 22 ~72 °after BDC.

Exhaust valve opening: 48.5 °before BDC.

Exhaust valve closing: 5.5 °after TDC

Lubrication system volume

Total volume of lubrication system: 4.0L.

High level oil volume of engine oil pan: 3.5L.

Low level oil volume of engine oil pan: 2.5L

Cooling system:

Use the coolant containing water (at 20°C, PH is 6.5-8.5) and ethylene glycol. Pure water is not allowed.

Coolant volume percentage

Ethylene glycol content	Corresponding water content	Protection temperature
Min. 35%	65%	-20°C
40%	60%	-24°C
Max. 45%	55%	-31°C

The maximum allowed temperature of engine coolant: 110°C.

Coolant alarm temperature: 115°C.



Temperature regulation range of thermosistor:

Opening temperature:  $(82 \pm 2)^\circ\text{C}$ ; full-open temperature:  $95^\circ\text{C}$ .

Maximum lift of the thermosistor:  $\geq 8\text{mm}$ .

Alternator:

Generator type: integrated alternator.

Voltage (V):  $13.5 \pm 0.1$ .

Output current (refer to the table):

Generator output current

Output current (A)		Engine speed (r/min)
Cold state	Hot state	
$\geq 35$	24~27	1800
$\geq 45$	31~34	2000
$\geq 77$	$\geq 65$	6000

Engine speed: 1000~18000(r/min).

Operating temperature of the generator:  $-40^\circ\text{C} \sim 105^\circ\text{C}$ .

Generator weight: 4.1kg.

Note:

Cold state: the state when the generator starts to work.

Hot state: the state after the generator works for 30 minutes.

Multi-wedge belt (belt pulley slot type): 6PK

Starter

Electromagnetic operation forced engagement.

Rated voltage: 12V;

Nominal power: 1.1kW ( $20^\circ\text{C}$ ).

Operating temperature of the starter:  $-40^\circ\text{C} \sim 120^\circ\text{C}$ .

Emission control standard: National III and IV



## Section 2 Maintenance Preparation

### 1. Maintenance Notes (refer to CA4GA1 Engine Maintenance Manual)

### 2. Maintenance preparation notes

(1) Mechanical part of the engine

#### ① Special maintenance tools

No.	Description	Location
1	Special fixture for installing and removing piston pin	Main body
		Spring
		“C” bushing
		“M” guide rod
		“N” guide rod
2	Piston tool	Piston
3	Adjustment tool for spark plug	Spark plug clearance

#### ② Recommended tools

No.	Description	Location
1	Disassembling tool for valve guide pipe	Valve guide pipe
2	Disassembling tool for valve stem oil seal	Valve stem oil seal
3	Press-mounting tool for valve lock clamp	Valve lock clamp
4	Attachment	
5	Cylinder head bolt wrench joint	Cylinder head bolt
6	Disassembling fixture for crank pulley	Fixing tool for crankshaft and flywheel
		Disassembling bar for crank pulley
7	Special fixture for piston pin	Main body
		Spring
		“C” bushing
		“M” guide rod
		“N” guide rod
8	Disassembling tool for rear oil seal of crankshaft	Rear oil seal of crankshaft
9	Disassembling tool for front oil seal of crankshaft	Front oil seal of crankshaft
10	Disassembling tool for engine oil filter	Engine oil filter
11	Valve clearance adjustment tool kits	Valve tappet pressure clamp
		Feeler gauge
12	Fixing fixture for crank pulley	Crank pulley
13	Hose plug	All hoses
14	Fuel pressure gauge	Fuel pressure
15	Disassembling tool for water pump	Disassembling tool for water pump bearing
		Disassembling tool for water pump seals
		Disassembling tool for water pump rotor
		Receiving tool for water pump bearing
		Water pump bearing base plate
16	Engine overhaul bracket	Engine
17	Engine overhaul connection bracket	Engine
18	Flywheel locking tool	Flywheel
19	Disassembling fixture for cylinder head	Cylinder head



20	Engine slings	Engine
21	Piston tool	Piston
22	Sealant gun	All kinds of sealant
23	Disassembling tool for clutch housing and pressure plate	Clutch housing and pressure plate
24	Stainless steel wire wiper	Remove sealant and carbon deposit etc.
25	Scraper knife	
26	Disassembling tool for engine oil pan	Engine oil, rear oil seal seat assembly etc.
27	Screwdriver (flat head screwdriver, Phillips screwdriver)	
28	spark plug wrench	Spark plug
29	Radiator cover tester	Radiator cover
30	Measuring tool for cylinder bore	Cylinder bore
31	Chamfering reamer for cylinder hole	Cylinder hole
32	All kinds of casing heads	Bolt and nut

## ③ Equipments

No.	Description
1	Straightening tool for connecting rod
2	Expanding tool for piston ring
3	Compressing tool for piston ring

## ④ Special sealant

No.	Location	Sealant type	Remark
1	Stud – install engine front support bracket	TB1322	Apply the sealant on the end connecting with cylinder head
2	Cylinder block sand outlet hole bowl-type plug	TB1386D	Apply the sealant on the edge of the plug
3	Cylinder block main oil channel bowl-type plug	TB1386D	Apply the sealant on the edge of the plug
4	Hexagon head tapered screw plug-at drainage hole of cylinder block	TB1110B	Apply the sealant on plug screw thread
5	Cylinder head sand outlet hole bowl-type plug	TB1386D	Apply the sealant on the edge of the plug
6	Rear oil seal seat assembly for crankshaft	TB1280E	Apply the sealant on rear oil seal seat surface of crankshaft
7	Stud - intake manifold	TB1322	Apply the sealant on the end connecting with cylinder head
8	Stud – exhaust manifold	TB1322	Apply the sealant on the end connecting with cylinder head
9	Engine oil pan assembly	TB1280E	Apply the sealant on the bottom of cylinder block, applied diameter is determined by testing
10	Joint surface of engine oil dipstick pipe and cylinder block location hole	TB1280E	Apply the sealant on the head of engine oil gauge pipe
11	Joint – engine oil filter	TB1110B	Apply the sealant on the end connecting engine oil filter
12	Stud - install idler assembly	TB1322	Apply the sealant on the end connecting with cylinder head
13	Chain chamber cover assembly	TB1280E	Apply the sealant on chain chamber cover surface
14	Engine water inlet pipe seat assembly	TB1280E	Apply the sealant on engine water inlet pipe seat surface
15	Engine water outlet pipe	TB1280E	Apply the sealant on engine outlet pipe surface
16	Stud- install engine water inlet pipe seat	TB1110B	Apply the sealant on threads



	assembly		
17	Coolant temperature sensor assembly	TB1110B	Apply the sealant on threads
18	Engine oil pressure alarm assembly	TB1110B	Apply the sealant on threads
19	Relief valve assembly	TB1110B	Apply the sealant on threads
20	Stud- chain tensioner assembly	TB1322	Apply the sealant on threads
21	Chain lubrication nozzle	TB1110B	Apply the sealant on threads
22	Cylinder gasket assembly	TB1280E	Apply the sealant on cylinder block front end top surface edge
23	Drain plug assembly	TB1280E	Apply the sealant on drain plug assembly thread.

- (Note) 1. Sealant manufacturer recommends using products Three Bond Chemical Industry Co., Ltd.  
 2. When applying sealant on the threads, do not apply it on the first two threads.  
 3. When applying sealant on sealed oil channel and water channel, do not squeeze sealants into water channel or oil channel to prevent them from being blocked.

⑤ Comparison of CA4GA5 and CA4GA1 Engine Changing Parts

No.	Part description	Changing point	Remark
1	Cylinder block	1. Height increase	
2	Crankshaft	1. Crank arm lengthened 2. Connecting rod shaft diameter enlarged	Crankshaft diameter unchanged
3	Piston	Top pit enlarged	
4	Connecting rod	Big end hole enlarged	
5	Upper bearing shell for connecting rod	Connecting rod shaft diameter enlarged	
6	Lower bearing shell for connecting rod	Connecting rod shaft diameter enlarged	
7	Cylinder head assembly	1. Intake valve seat 2. Exhaust valve seat 3. Lift changing	
8	Spark plug	Heat value changing	Model and clearance changing
9	Intake valve	Dimension enlarged	
10	Exhaust valve	Dimension enlarged	
11	Intake camshaft assembly	Lift changing	
12	Exhaust camshaft assembly	Lift changing	
13	Chain guide rail assembly	Length changing	Engine block heightened
14	Chain tension arm assembly	Length changing	Engine block heightened
15	Timing chain	Number of teeth increasing	Engine block heightened
16	Chain tooth cover assembly	Enlarging	Engine block heightened
17	Engine oil dipstick assembly	Lengthening	Engine block heightened
18	Engine oil dipstick pipe assembly	Lengthening	Engine block heightened
19	Intake manifold assembly	Change to central updraught type	
20	Hexagon flange nut		Install intake manifold
21	Intake manifold bracket	Lengthening	Engine block heightened
22	Exhaust manifold assembly	Appearance changing	
23	Canister solenoid valve exhaust pipe	Lengthening	Position change
24	Electronic throttle valve water inlet/outlet pipe	Lengthening	Position change

(2) Electronic control fuel injection

Refer to *CA4GA1 Engine Maintenance Manual (electronic control)*



## Section 3 General Maintenance Parameters

### 1. Mechanical Part

#### (1) Maintenance Data

Cylinder head	Joint surface deformation		
	Cylinder block side	Specified value	0.05
		Allowed limit	0.10
	Maximum repairing and fitting quantity		0.16
	Intake/exhaust manifold side	Specified value	0.08
		Allowed limit	0.16
	Valve seat opening label and width	Intake side	1.3±0.2
		Exhaust side	1.25±0.2
		Valve seat opening contact angle	45°±30'
	Allowed lower limit of valve seat opening	Intake side	0.49
		Exhaust side	0.46
	1 <sup>st</sup> camshaft bearing support		φ32(+0.055, +0.030)
		Intake	φ26(+0.021,0)
		Exhaust	φ23(+0.021,0)
2 <sup>nd</sup> ~5 <sup>th</sup> camshaft bearing support hole standard value			
Fuel spray nozzle hole diameter	Standard	φ12	
	Limit	φ12.5	
1st camshaft bearing cover	Intake side	Locating slot width	3(+0.05,0)
	Exhaust side	Bearing cap width	21(+0.05,0)
Valve guide pipe	Valve guide pipe diameter		
	Intake valve		φ5(+0.022,+0.010)
	Exhaust valve		φ5(+0.022,+0.010)
	Protruding height of valve guide pipe		15.1±0.2
Valve	Conical surface angle		45°30'
	Valve stem outer diameter		
	Intake valve	Specified value	φ5(-0.010,-0.028)
		Limit	φ4.962
	Exhaust valve	Specified value	φ5(-0.020,-0.038)



	Valve clearance	Limit	φ4.952
	Standard	Intake	0.02~0.05
		Exhaust	0.03~0.06
	Limit	Intake	0.07
		Exhaust	0.09
	Edge thickness		
	Standard	Intake	1.40
		Exhaust	1.45
	Limit	Intake	0.9
		Exhaust	0.9
Intake camshaft	Shaft diameter standard value	1 <sup>st</sup> camshaft diameter	φ32(0,-0.016)
		2 <sup>nd</sup> ~ 5 <sup>th</sup> camshaft diameter	φ23(-0.035,-0.051)
	Cam height	Standard value	41.2
		Limit value	40.95
	1 <sup>st</sup> shaft diameter oil clearance	Standard value	0.03~0.071
		Limit value	0.10
	5 <sup>th</sup> shaft diameter oil clearance	Standard value	0.035~0.072
		Limit value	0.11
	Radial runout	Standard value	0.03
		Limit value	0.04
Exhaust camshaft	Shaft diameter standard value	1 <sup>st</sup> camshaft diameter	φ26(-0.035,-0.051)
		2 <sup>nd</sup> ~ 5 <sup>th</sup> camshaft diameter	φ23(-0.035,-0.051)
	Cam height	Standard value	41.1
		Limit value	40.04
	Shaft diameter oil clearance	Standard value	0.035~0.072
		Limit value	0.11
	Radial runout	Standard value	0.03
		Limit value	0.04
Cylinder block	Top surface deformed	Standard value	0.05
		Maximum value	0.10
	Cylinder bore diameter (standard)	Grade A	φ73~φ73.01
		Grade B	φ73.01~φ73.02
		Grade C	φ73.02~φ73.03



		Wear limit	0.08	
		Enlarging 0.25mm type	$\phi 73.25 \sim \phi 73.28$	
		Enlarging 0.50mm type	$\phi 73.50 \sim \phi 73.53$	
	Engine oil pump hole diameter	Standard	$\phi 55.1(+0.06, +0.03)$	
		Limit	$\phi 55.3$	
Piston	Piston diameter	Standard	Grade A $\phi 72.97 \sim \phi 72.98$	
			Grade B $\phi 72.98 \sim \phi 72.99$	
			Grade C $\phi 72.99 \sim \phi 73.00$	
	Piston oil clearance	Wear limit		
		Enlarging 0.25mm type		$\phi 73.25$
		Enlarging 0.50mm type		$\phi 73.50$
		Standard value		0.02~0.04
	Limit value		0.06	
Piston top pit diameter			$\phi 60.4$	
Piston ring	Piston ring thickness	1 <sup>st</sup> compression ring	Less than 1.2	
		2 <sup>nd</sup> compression ring	Less than 1.2	
		Oil ring	Less than 2.0	
	Piston ring opening clearance (Standard)	1 <sup>st</sup> compression ring	0.20~0.30	
		2 <sup>nd</sup> compression ring	0.40~0.55	
		Oil ring	0.20~0.70	
	Limit value	1 <sup>st</sup> compression ring	0.5	
		2 <sup>nd</sup> compression ring	0.7	
		Oil ring	1.0	
	Piston ring groove clearance(Standard)	1 <sup>st</sup> compression ring	0.04~0.09	
		2 <sup>nd</sup> compression ring	0.02~0.06	
Limit value				
	1 <sup>st</sup> compression ring	0.13		
	2 <sup>nd</sup> compression ring	0.08		
Piston pin	Piston pin Clearance between outer ring and piston	Standard	$\phi 18(+0.034, +0.028)$	
		Limit	0.016	
	Interference fit with connecting rod		0.017~0.034	
Connecting rod	Bent and deformed	Limit	0.03	



	Bent and deformed	Limit	0.03
	Connecting rod big end clearance	Standard	0.017~0.029
		Limit	0.046
	Connecting rod axial clearance	Standard	0.20~0.40
		Limit	0.50
Crankshaft	Main shaft diameter	Standard	$\phi 46(0,-0.018)$
		Enlarging 0.25mm type	$\phi 45.75 \sim \phi 45.57$
		Enlarging 0.50mm type	$\phi 45.5 \sim \phi 45.32$
	Main shaft diameter clearance	Standard	0.025~0.043
		Limit	0.068
	Connecting rod shaft diameter clearance	Standard	0.017~0.035
		Limit	0.052
	Crank pin diameter	Standard	$\phi 44(0,-0.018)$
		Enlarging 0.25mm type	$\phi 39.75 \sim \phi 39.57$
		Enlarging 0.50mm type	$\phi 39.50 \sim \phi 39.32$
Intake manifold	Seal groove depth		$4 \pm 0.1\text{mm}$
	Seal ring protruding height	Standard	$2 \pm 0.1\text{mm}$
		Limit	1.8mm
Exhaust manifold	Flange deformation	Standard	0.25
		Limit	0.40
Valve clearance	Cold state	intake valve	$0.2 \pm 0.03\text{mm}$
		Exhaust valve	$0.3 \pm 0.03\text{mm}$
Timing chain	Flexibility limit		4mm [with 127N applied]
Chain chamber cover	OCV Control valve hole diameter	Standard	$\phi 18(+0.018,0)$
		Limit	$\phi 18.045$
	Joint surface deformation	Standard	0.10
		Limit	0.25
Upper and lower connecting rod bearing shell	Shell width		$14.5(0,-0.2)$
	Free opening width		$47(+1.5,+0.5)$
	Central thickness		$1.5(+0.009,-0.003)$



(Note) Unit: mm

## (2) Tightening torque specifications

No.	Name	Qty.	Spec.	Tightening torque (N.m)	Remark
1	Bolt and nut for engine front support	2+2	M10	50±10	
2	Cylinder head bolt	10	M9×1.25	34±3+120°	Dipping oil
3	Cylinder head cover bolt	11+2	M6	11±2	
4	Connecting rod bolt	8	M8X1	22±2.5+90°	Dipping oil
5	Main bearing bolt	10	M10×1.25	60±5	Dipping oil
6	Flywheel bolt	6	M10×1.25	78±5	
7	Crankshaft belt pulley bolt	1	M14×1.5	200±10	
8	Rear oil seal seat assembly	4	M6	8±2	
9	Camshaft bearing cover	20	M6	12.5±2	
10	Stud for connecting intake and exhaust manifold and cylinder head	5+5	M8	6±1.2	
11	Nut for tightening intake manifold	5	M8	19±4	
12	Nut for tightening exhaust manifold	5	M8	23±5	
13	Bolt and nut for engine oil pan	14+2	M6	8±2	
14	Drain plug assembly	1	M16×1.5	30±5	
15	Engine oil pump assembly	3	M6	9±1.8	
16	Relief valve assembly	1	M22×1.5	40±5	
17	Engine oil filter joint	1	M20×1.5	44±9	
18	Idler assembly	1	M10	44±9	
19	VCT controller assembly	1	M10	47±7	
20	OCV control valve assembly	1	M6	8±2	
21	OCV control valve filter bolt	1	M14×1.5	24.5±5	
22	Exhaust camshaft sprocket wheel	3	M6	8±1.6	
23	Chain tensioning arm bolt	1	M10	19±3.8	
24	Chain guide rail assembly	2	M6	8±2	
25	Bolt and nut for chain tensioner assembly	1+1	M6	9±1.8	



26	Mounting bracket for chain	2	M6	8±2	
27	Chain chamber cover assembly	10	M6	12±2.4	
28	Water inlet pipe seat	3	M8	22±4	
29	Water outlet pipe	2	M8	22±4	
30	Water pump assembly	5	M6	9±1.8	
31	Coolant temperature sensor assembly	1	M12×1.5	20±2	
32	Intake temperature pressure sensor assembly	2	M6	5±1	
33	Camshaft position sensor assembly	1	M6	7±1	
34	Knock sensor assembly	1	M8	20±5	
35	Front/rear oxygen sensor assembly	1, each	M18×1.5	45±5	
36	Electronic throttle valve body assembly	4	M6	10±2	
37	Bar type ignition coil assembly	4	M6	8±2	
38	Spark plug assembly	4	M14×1.25	18±3.5	
39	Engine pressure alarm switch assembly	1	NPT 1/8	15±5	

## 2. Cooling system maintenance data

Water pump	Type Lift Flow	Centrifugal ≥147KPa ≥135L/min
Cooling fan	Type Rotating type	Inhaling type Rotate right
Thermosistor	the temperature °C, when the valve is opened the temperature °C, when the valve is fully opened Valve lift mm	80±2 95 ≥8

## 3. Lubricating oil maintenance data (refer to CA4GA1 Engine Maintenance Manual)

## 4. Ignition system maintenance data

Spark plug	Model Electrode gap	XU22EPR-U 0.8—0.9
------------	------------------------	----------------------

5. For fuel system maintenance data, please refer to CA4GA1 Engine Maintenance Manual (Electronic Control)

6. For electronic system maintenance data, please refer to CA4GA1 Engine Maintenance Manual (Electronic Control)



## Section 4 Engine Maintenance

### 1. Engine running-in

#### Notes

(1) CA4GA5 engine is an engine with high compression ratio. The gasoline used shall be above RON93#. Gasoline below this grade is not allowed.

(2) Check if the engine oil pressure is correct. Under normal circumstances, when power switch (key) is turned to “ON”, low pressure indicator lamp (red) of the engine oil pressure is light with the function of engine oil pressure sensor. It means no pressure is in the lubrication system. Turn the switch to “Start”, and the engine starts and runs idly. Now, low pressure indicator lamp of engine oil pressure goes out automatically. It means engine oil pressure in the lubrication system is normal. Now the engine can be used.

Note: the engine can be used only after confirming engine oil pressure is normal. Otherwise, the engine will have a serious fault and lead to economic loss.

(3) Check the coolant. First open the filler cap on the top of water tank. After filling the coolant, tighten the filler cap. Then observe the liquid storage tank. When the engine is in cold state, the coolant level shall be close to “FULL” scale of liquid storage tank, and now the cooling system is in normal and the engine can be used. If coolant level is too low and below “LOW” scale, first open liquid storage tank cover and then fill coolant with specified model and concentration to “FULL”.

After filling the coolant, tighten the liquid storage tank fixedly. Align the anti-rotating claw and tighten it. Do not operate the engine without enough coolant. Check the coolant level of liquid storage tank once every two weeks to keep the level at “FULL” all the time.

(4) Check the water temperature. When the engine water temperature is higher than or close to danger area of water temperature gauge, the vehicle shall be stopped to check. After troubleshooting, the engine can go on running. Otherwise, cylinder head will be deformed to damage the engine. At the time of normal driving, water temperature gauge pointer shall be in the middle or deflect to the right a little. The temperature does not exceed 100°C.

(5) When a new engine is running at high speed with high load, it is not allowed to stop the engine suddenly. The engine shall run at low speed for 3~5 minutes and then stop. In this way, it is helpful to reduce engine faults and prolong service life.

(6) When the engine is installed on a mini vehicle or minicar for running-in, it is better to drive on a cement or asphalt road and avoid driving on muddy or sandy road.

(7) For a vehicle with this engine, the highest speed in the running-in period shall be less than 80Km/h.

(8) During 1/2 mileage in running-in period, the load shall not exceed 50% of the maximum load. It shall not exceed 75% of the maximum load during the latter half of mileage.

(9) Other requirements of the engine in running-in period shall strictly observe running-in specifications of the vehicle.

### 2. Engine Maintenance

(1) It is necessary to check the engine lubricating oil. If the lubricating oil consumption is abnormal, it is necessary to check the engine in details to find out (all kinds of) oil seal leakage, piston ring fault or piston fault.

(2) Cooling system of the engine is closed. When stopping in hot state, do not open water tank cover. Otherwise, the liquid sprayed in high pressure will cause personal hurt.

(3) Make maintenance and achieve it according to engine notes on both sides of the door.



(4) During the course of driving, check if all kinds of instruments in instrument panel and fault indicator are normal. If any of them is abnormal, it is necessary to stop and check. After troubleshooting, restart the engine.

(5) It is necessary to check all pipes of the engine frequently to keep connection normal and reliable. Otherwise, the engine will work abnormally.

(6) Pay special attention to engine oil alarm lamp. If the lamp is light, it means the engine oil pressure is too low. The vehicle shall be stopped immediately to check lubrication system. After troubleshooting, restart it.

(7) Replace engine oil once every 5,000km.

Clean the air filter once every 5,000km when driving on an asphalt road, clean it every 2,500km when driving on an earth road and replace it every 15,000km.

Check electronic throttle valve assembly once every 10,000km.

Clean gasoline tank every 20,000km.

After various bolts are tightened according to specified torque, the vehicle can start driving.

(8) Replace engine oil filter assembly every 2,000Km initially, then replace it every 8,000Km. Apply engine oil on seal ring every time.

(9) If you find the engine dynamic property and economical efficiency reduce greatly; you shall check the engine and not allow the engine to run with a fault.



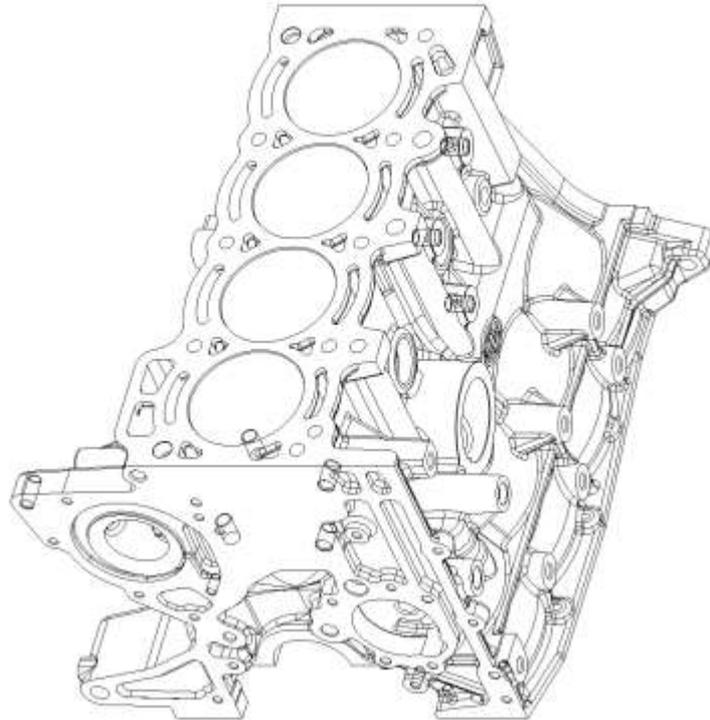
## Chapter 2 Engine Structure

Section 1 Cylinder block, cylinder head and crank connecting rod mechanism .....	17
Section 2 Valve actuating mechanism .....	24
Section 3 Lubrication System .....	29
Section 4 Cooling System .....	33
Section 5 Intake and Exhaust Systems .....	35
Section 6 Fuel System .....	38
Section 7 Ignition System .....	40
Section 8 Other sensors and other actuating mechanisms .....	42

## Section 1 Cylinder block, cylinder head and crank connecting rod mechanism

### Cylinder block

The cylinder block has four cylinders, five main bearing supporting crankshaft main journals, equal cylinder center distance and gantry structure. Cylinder block and crankcase are integrated. Material is alloy cast iron. The weight is less than 28.7kg. The wall thickness is 3.5mm and the maximum wall thickness shall be not more than 4.5mm.



Cylinder block

Water jackets are provided on both sides of each cylinder to ensure a good cooling result. Water jacket thickness on both side walls is 4mm. Water jacket height is 110mm, which is a little higher than the stroke.

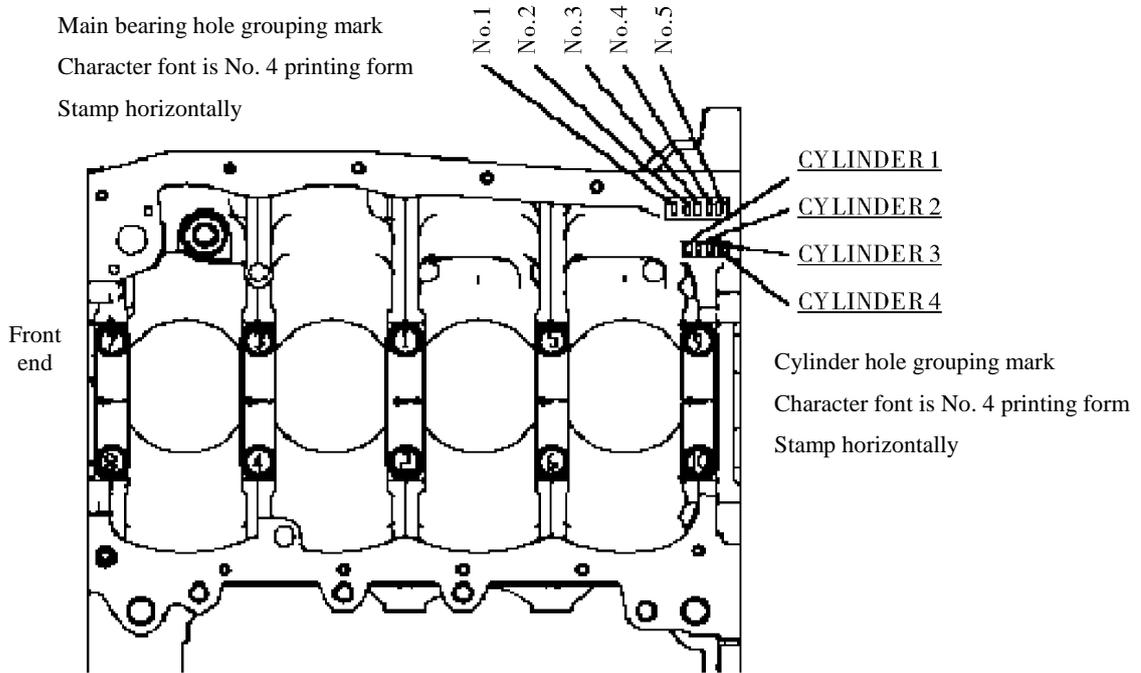
Main bearing cap material is iron-based powder metallurgy, which is integrated with main bearing seat of engine block. They are fully-support type structure, with reliable rigidity and strength. There is a forward arrow and number on main bearing cap. When assembling, the number shall be checked and followed.

In order to reduce the noise and vibration, reinforced rib is provided on side wall and around main bearing to form a rigid structure.

There are grouping numbers of cylinder hole, and grouping numbers of main bearing hole and main bearing shell on the bottom of engine block.

#### Cylinder block dimensions

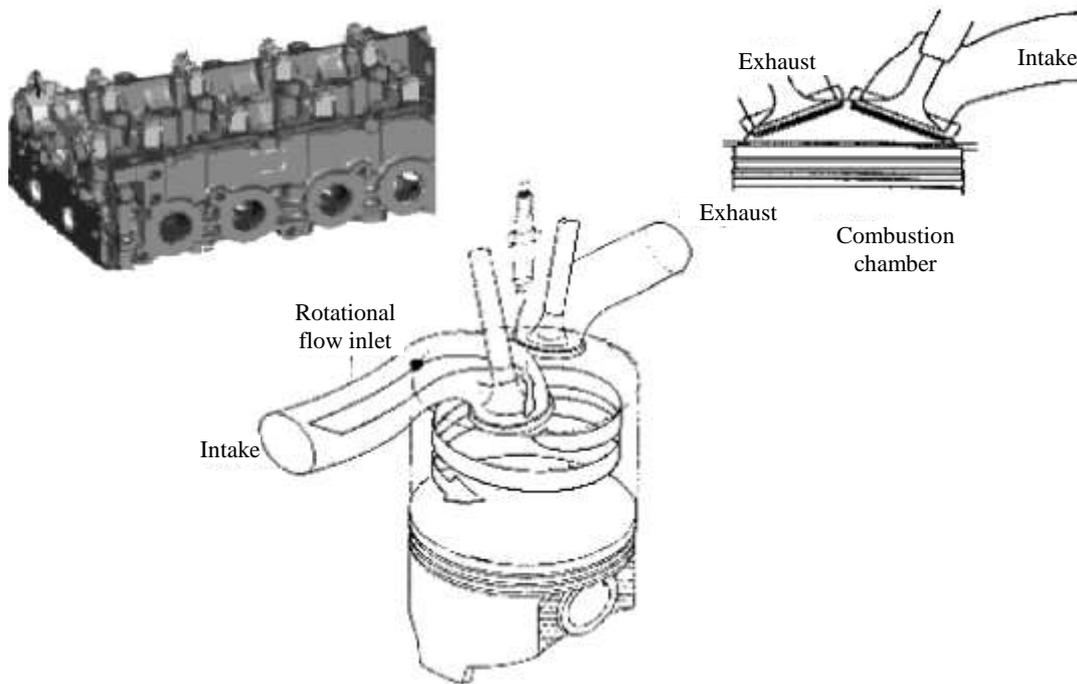
Total height ×full length ×total width	(mm)	270.2×355.5×326.5
Cylinder bore	(mm)	73
Cylinder center distance	(mm)	80
Main bearing hole diameter	(mm)	φ50



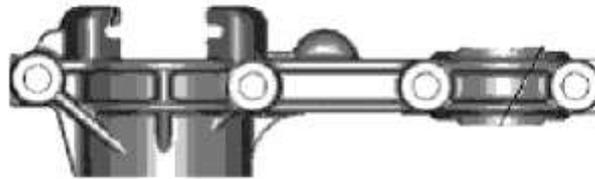
### Cylinder head and combustion chamber

The cylinder head adopts aluminum alloy casting, double top-mounted camshaft structure and is provided with water jacket to cool cylinder head. Combustion chamber is like a roof ridge and spark plug is installed at the center of combustion chamber to keep flame spread uniform.

The valve seat opening is a little declined type The intake valve seat opening inclination is  $14^{\circ}30'$  and exhaust valve seat opening inclination is  $15^{\circ}12'$ . The cylinder head is pressed into valve seat opening. There are two lines of camshaft bearing supports on the cylinder head. The first camshaft bearing support is combined. The cylinder head height is enlarged and rigidity is increased. Combined camshaft bearing support is provided with lubricating oil slot. The cylinder head bolt head seat is position in deep place. Fuel injector is installed on the cylinder head.



Cylinder head and combustion chamber

1<sup>st</sup> camshaft bearing support

In order to increase combustion efficiency, air inlet adopts spiral-flow type to rotate gases in combustion chamber so as to increase the charging efficiency. The cylinder head is provided with longitudinal water channel.

### **Piston, piston rod and piston ring**

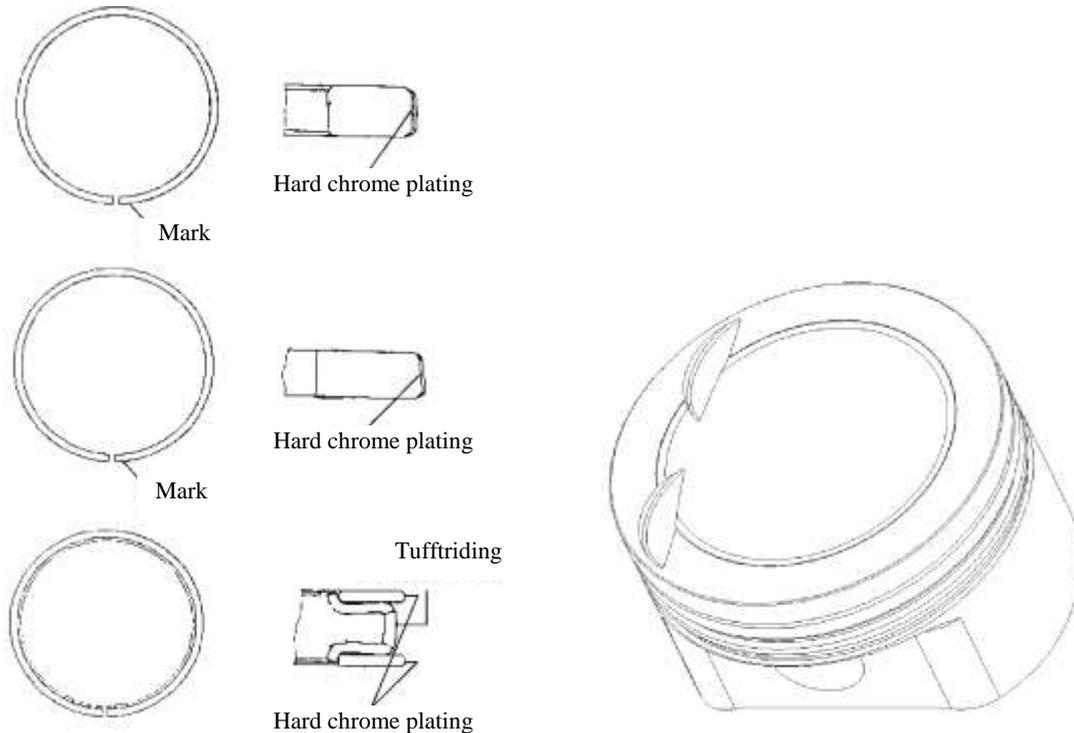
Piston is made of aluminum casting alloy. There is a  $\phi 60.4$  pit on the top (Note: piston top pit diameter of 1.3L engine is different from that of 1.5L engine) to enlarge combustion volume. There are two pits on the air intake side on the top of the piston to prevent it from colliding with intake valve. Piston is of three-ring short skirt type. Graphite coating is printed on the surface of piston. The first ring groove and some ring edges (including piston top) is oxidized to ensure safety and durability, resist heat load and mechanical load, and reduce the weight at the same time. Piston and cylinder block shall be matched to ensure fit clearance. The weight difference among four pistons of the same engine shall not be more than 6g. There is a forward mark (arrow) and piston outer diameter grouping number (A, B, C) printed on the top of the piston. Piston pin hole grouping adopts red and yellow. Piston skirt barrel line adopts hyperbolic cosine function. Barrel skirt and cylinder wall formed bidirectional wedge oil film make the skirt have higher bearing capacity and good lubrication. In addition, inclination in piston motion can avoid load on closed angle to reduce impact of the piston on cylinder wall.

In order to endure surface hardness of piston pin, inner and outer surfaces of the piston pin are carburized. Piston pin diameter adopts red and yellow marks on piston pin end face.

In order to reduce mechanical loss, 1<sup>st</sup> and 2<sup>nd</sup> piston rings shall be thin rings. Oil ring adopts two side rings and one grommet.

1<sup>st</sup> piston ring is barrel surface ring. The surface that contacts the cylinder is plated with hard chromium coat to reduce surface wear. 2<sup>nd</sup> piston ring is taper-face ring, which is treated by phosphorization. The surface of scraper blade in combination oil ring, which contacts the cylinder, is plated with hard chromium. Other surfaces are treated by phosphorization. Grommets go through tufftriding.

When installing piston ring, the surface with a mark shall be upward. Opening for each ring shall be separated by 120°.



Piston and piston ring

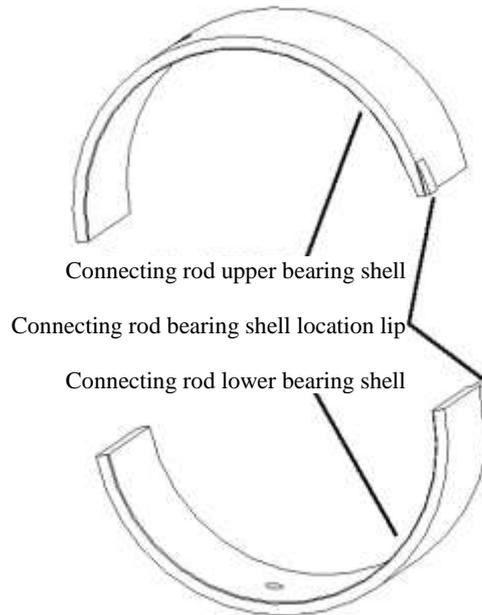
**Connecting rod and connecting rod bearing shell**

Connecting rod is forged by chrome steel, with high rigidity. When assembling connecting rod cap, forward marks shall be on the same side. When installing it on the engine, this surface shall face engine front. The weight difference among four connecting rods of four cylinders in the same group shall be no more than 3g. Connecting rod big end grouping marks (1 and 2) have two groups, which are printed on connecting rod body side. Connecting rod quality grouping mark (A, B, C, D, E) have five groups, which are printed on connecting rod cover.



Connecting rod

Connecting rod bearing shell includes upper half and lower half. Upper half is installed on connecting rod body and lower half on connecting rod cap. Connecting rod bearing shell (upper and lower half) is divided into four groups within specified thickness tolerance. The bearing shell is colored on both ends. Connecting rod bearing positioning lip is on the side. When assembling, in order to ensure fit clearance, select and assemble according to grouping dimension of related parts.



Connecting rod bearing shell

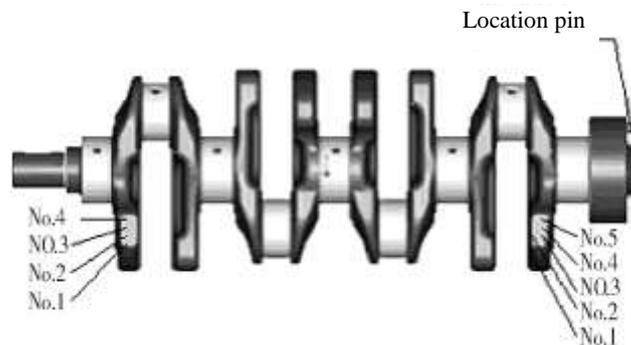
### Crankshaft and bearing shell

Crankshaft is made of nodular cast iron, which consists of five main journals, eight pieces of balance weights, crank throw included angle 180°, with symmetrical plane. It has dynamic balance itself. But it bears inner bending moment to make crankshaft reach inner balance. Two groups of different balance weights are prepared.

The third main journal bears axial thrust. Two thrust shims made of mock silver are installed on both sides of cylinder block supporting the third main journal.

Balance weight removes all inherent vibration of the engine.

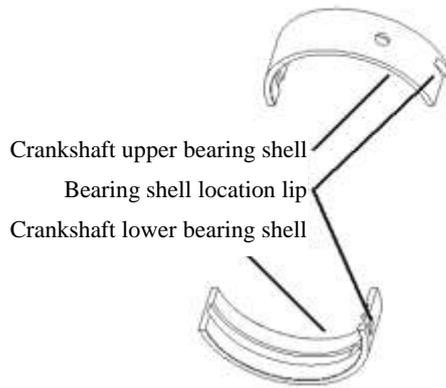
Connecting rod journal grouping code is stamped on the side of front balance weight. Main bearing journal grouping code is stamped on the side of rear balance weight.



Main bearing journal and connecting rod journal of crankshaft adopt rolling fillet to increase fatigue strength.

Main bearing journal diameter of crankshaft mm	46
Connecting rod journal diameter of crankshaft mm	44

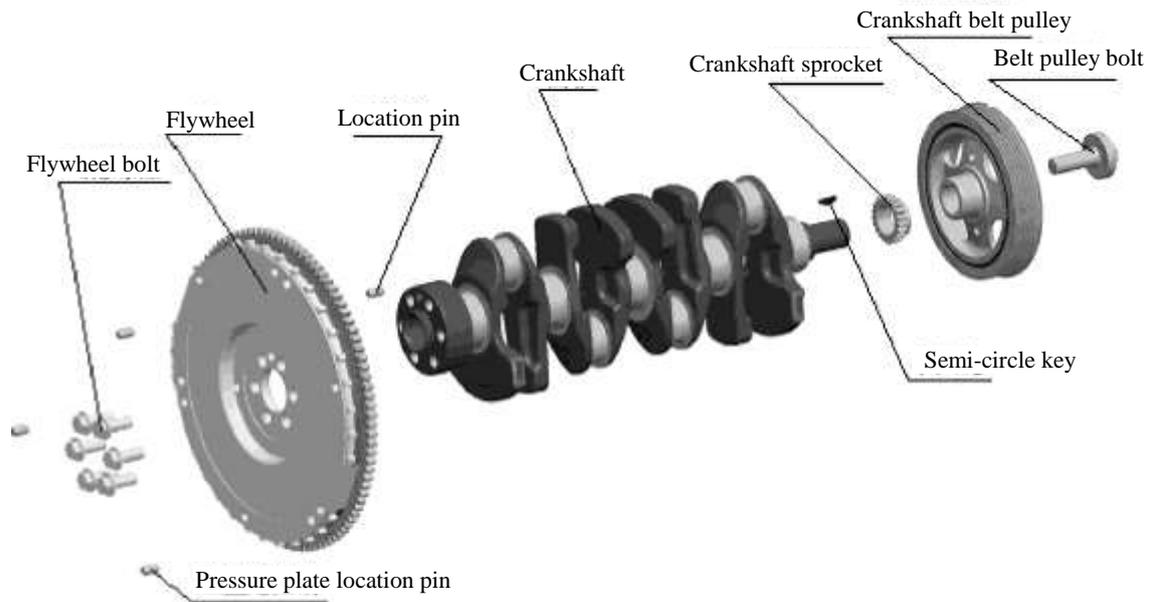
1<sup>st</sup> ~5<sup>th</sup> main bearing shells of crankshaft adopt the same aluminum-tin alloy bearing shell. Upper bearing shell is provided with one oil groove and oil hole. Positioning lip for bearing shell is on the side.



Crankshaft bearing shell

### Flywheel

Crankshaft front end is provided with timing sprocket and crank shaft belt pulley. They are used to drive camshaft, water pump and generator, respectively.



The flywheel with ring gear is installed on rear end of crankshaft by 6 bolts. The flywheel body has signal teeth used to output the engine speed signal. The specifications as follows:

Outer diameter mm	242
Mass kg	6.45
Gear ring tooth number	103
Gear ring modulus	2.54

Pressure plate surface diameter mm	205
Rotating speed signal tooth number	30 teeth
Dynamic unbalance less than	25gcm

**Crank pulley**

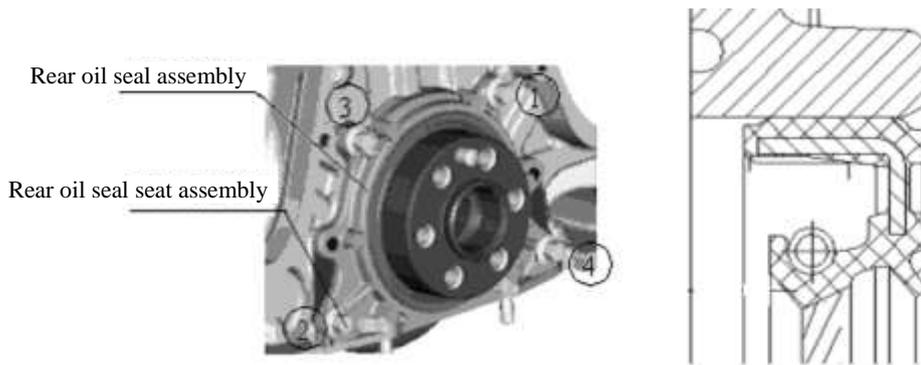
In order to reduce torsional vibration, the engine adopts spoke type V-belt crank pulley with shock absorber to reduce radiation noise on front end of the engine so as to reduce noise of complete machine and reduce weight.

Crank pulley specifications

Crank pulley outer diameter (mm)	144
V-belt groove angle	40°
V-belt groove number	6
Dynamic unbalance is less than	5gcm

**Crankshaft oil seal**

Front and rear oil seals of crankshaft are T structure with spiral line (spiral groove) in order to prevent oil leakage. T oil seal applies spiral groove oil pump. When crankshaft is running, oil is forced to return to the engine. T oil seal has obvious sealing characteristics.



Rear seal oil of crankshaft



Front seal oil of crankshaft

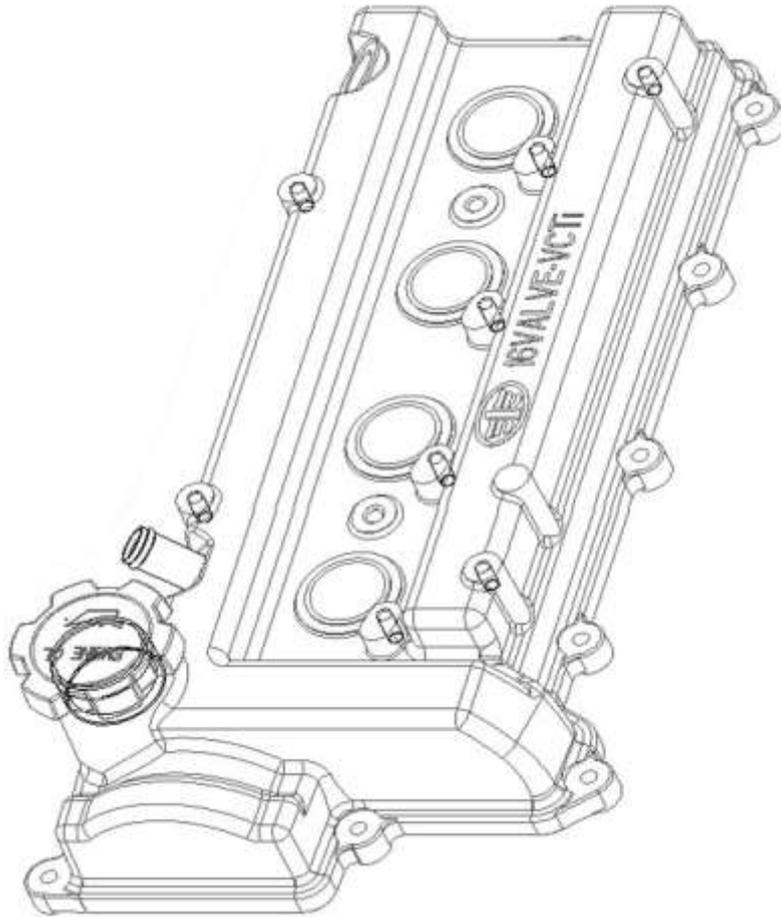
Oil seal specification



Item	Inner diameter	Outer diameter	Thickness
Front oil seal (mm)	φ33.8	φ49	6
Rear oil seal (mm)	φ72.1	φ89	8.5

### Cylinder head cover assembly

Cylinder head cover assembly is cast by aluminum alloy, with many arc surfaces. A ventilation baffle is used to separate the engine oil in blow-by gas and then oil flows into intake pipe through crankshaft case vent valve assembly for combustion.



Cylinder head cover assembly

## Section 2 Valve actuating mechanism

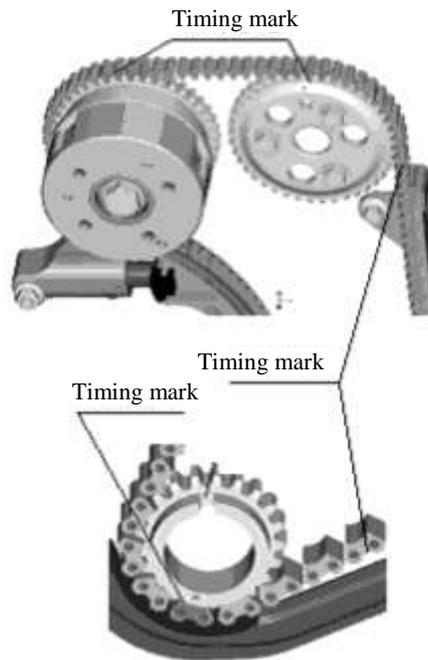
Valve actuating mechanism of CA4GA5 engine adopts double top-mounted camshafts with intake VCT controller assembly driven by timing chain drive belt. The camshaft is fastened on the upper part of cylinder head, which is supported by five bearing supports to drive two intake valves and two exhaust valves. This is a typical direct drive of valve. It has high rigidity and good follow-up characteristics within the whole working range. Similarly in-line intake and exhaust valves can get an almost smooth torque characteristic curve and increase passing capacity of air flow to ensure thorough intake and exhaust.

### Timing chain assembly and sprocket

**Timing chain**

Pitch circumference length mm	Pitch mm	Pieces	Width mm
1054	6.35	166	11.5

For this engine, timing chain drives exhaust camshaft to ensure stable running and low noise. When timing chain is bent, it will reduce strength greatly. Therefore, timing sprocket shall not be bent. Do not make water or other chemical liquids contact timing chain during the course of using. These contaminants will corrode chain link pieces. Timing chain has two groups and one yellow link piece which is timing mark.



Timing chain

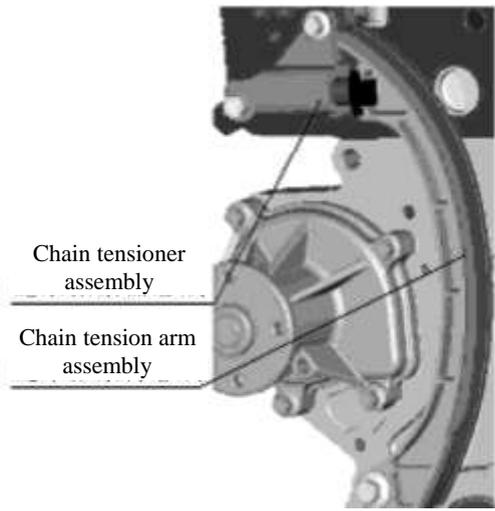
**Sprocket**

There are four sprockets. The first is exhaust camshaft sprocket installed on exhaust camshaft; the second is crankshaft sprocket installed on crankshaft; the third is a sprocket installed on engine oil pump; the fourth is a sprocket installed on VCT controller assembly. Each sprocket has engagement mark (except the sprocket on engine oil pump). When assembling, it shall align with the mark on the chain.

	Exhaust camshaft sprocket	Crankshaft sprocket	Engine oil pump sprocket	VCT controller assembly sprocket
Number of teeth	42	21	25	42
Outer diameter	83	40.5	48.6	83

**Chain tensioner assembly and chain tension arm assembly**

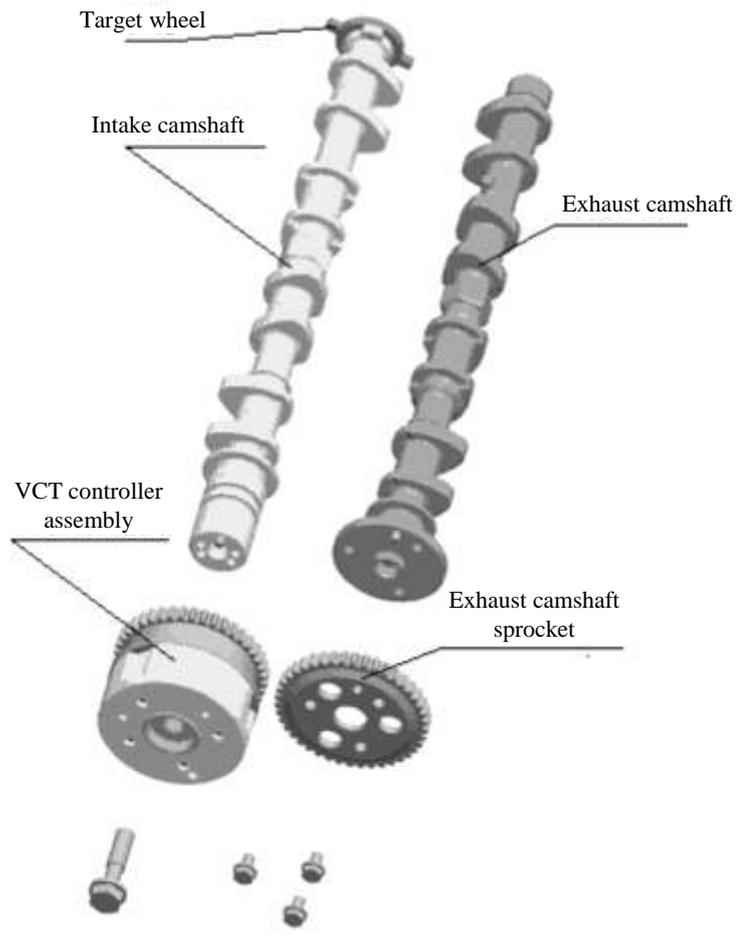
Open the chain tensioner spring to eject tensioning ball of chain tensioner to provide appropriate tension for chain tensioner assembly so as to ensure reliable drive and prolong service life of timing chain. Parts for tensioner are free of maintenance.



Chain tensioner assembly and chain tension arm assembly

**Camshaft**

Intake and exhaust camshaft are made of cold shock alloy cast iron. Cam included angle is 90°. Exhaust camshaft assembly drives intake camshaft assembly. The first journal of intake camshaft assembly has phase advance and delayed oil line.



Intake and exhaust camshaft assembly



## Camshaft specifications

Item	1 <sup>st</sup> journal dimension (mm)	Other journal dimension (mm)	Tip height (mm)
Exhaust camshaft	26(-0.035~-0.051)	23(-0.035~-0.051)	41.1
Intake camshaft	32(0,-0.016)	23(-0.035~-0.051)	41.2

3. Intake camshaft assembly is driven by exhaust camshaft assembly, that is, exhaust camshaft sprocket drives VCT controller and sprocket on the intake camshaft sprocket assembly. VCT controller and intake camshaft sprocket assembly are fixed on intake camshaft assembly.

4. Intake valve, exhaust valve and valve spring

	Full length mm	Valve head diameter mm	Valve stem diameter mm
Intake valve	88.1	27.5	5.0
Exhaust valve	88.65	23	5.0

Intake valve and exhaust valve are made of chrome-silicon steel. Head diameter is designed to be larger so as to increase intake and exhaust efficiency. Valve spring is made of chrome-silicon steel. At high speed, it has high follow-up performance and natural frequency.

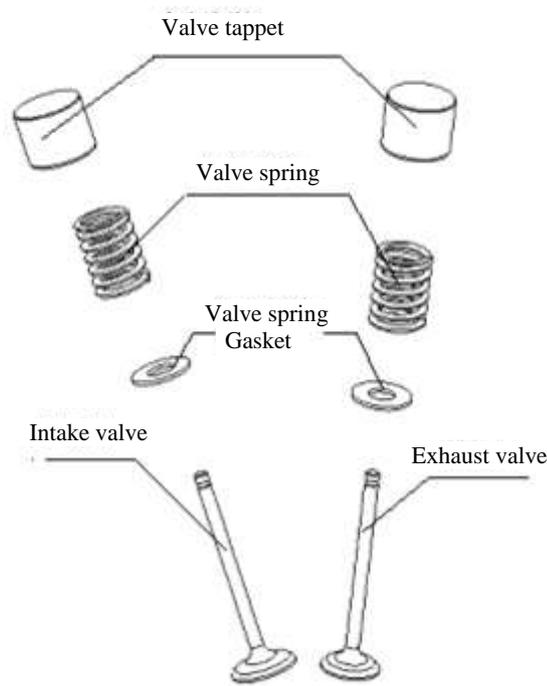
## Free state specifications of valve spring

Free length mm	Mean diameter of spring mm	Steel wire diameter mm	Total number of turns	Effective number of turns
45.2	16.6	3.2	9	7

## Assembled state of valve spring

Length mm	Load N
37	160±8
29.5	399±20

Spring rigidity: 31.9N/mm

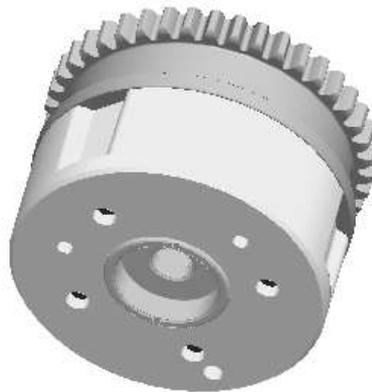


#### 4. Valve tappet

Valve tappet is cylindrical to ensure uniform force when the valve moves, and has high follow-up performance. Tappet surface is carbonitriding. After carbonitriding, actual thickness of tappet is stamped on the inner top. In order to keep valve clearance within specified range, select integrated tappet with corresponding thickness according to actual measuring result when installing the engine.

#### 5. VCT controller and intake camshaft sprocket assembly

VCT controller and intake camshaft sprocket assembly control cam peach-shaped phase position of intake camshaft assembly by using engine oil pressure difference, and change intake camshaft intake angle with engine working conditions changing so as to save fuel.



VCT controller assembly





Rotor engine oil pump assembly is installed on the cylinder block, driven by crankshaft sprocket through timing chain. Outer and inner rotors of engine oil pump are installed on cylinder block. The relief valve is installed on cylinder block oil line. When engine oil pump reaches the oil supply pressure, the relief valve will work and drain oil. Drained lubrication oil returns to the engine oil pump. The engine oil pump is provided with drive sprocket used to drive engine oil pump.



Engine oil pump assembly

Engine oil pump assembly specifications

Type	Cycloid curve
Output flow (L/min)	> 4.5 (Output pressure 150KPa, engine oil pump speed 588r/min)
	> 14 (Output pressure 400KPa, engine oil pump speed 1680r/min)
	> 41 (Output pressure 450KPa, engine oil pump speed 5040r/min)

Relief valve is an integral structure. Spring is compressed in plunger and housing.

Free state specifications of relief valve spring

Free length mm	Mean diameter of spring mm	Steel wire diameter mm	Total number of turns	Effective number of turns
43.6	9.8	1.4	12	10

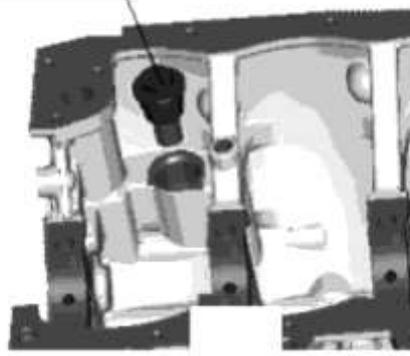
Assembled state of relief valve spring

Length mm	Load N
30.9	50.85
24.6	76.2

Spring rigidity: 4N/mm



Relief valve assembly

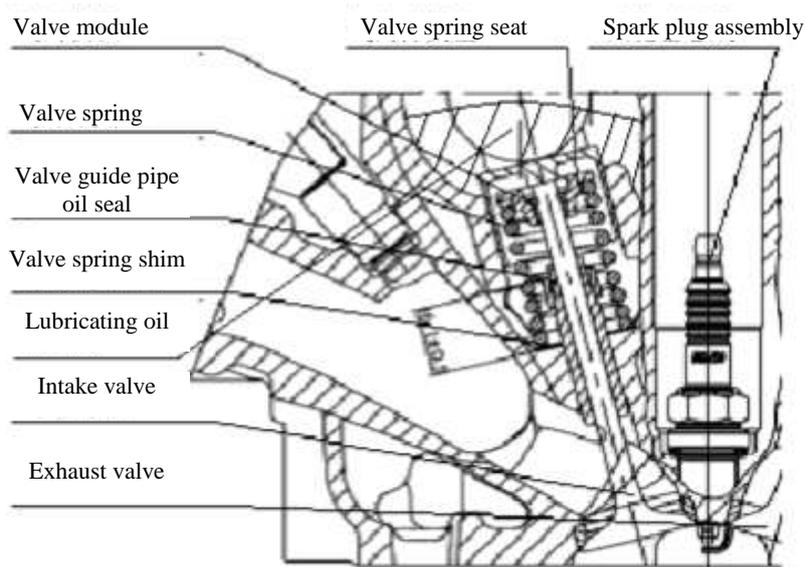


Engine oil pump sprocket tooth number

Tooth number of engine oil pump sprocket	Outer diameter of engine oil pump sprocket (mm)
25	48.6

**Lubrication for Valve Actuating Mechanism**

Lubricating oil required for valve actuating mechanism goes through camshaft bearing support to submerge tappet and valve components in lubricating oil to ensure sufficient lubrication and heat dissipation.



Valve actuating mechanism lubrication

**Engine oil filter**

Engine oil filter has an element. There is a relief valve in closed structure. When inlet/outlet pressure difference reaches the specified value, bypass valve is opened. At 2 MPa, engine oil filter shall not leak and be damaged within 2 minutes.

Engine oil filter

Filtering area	860 cm <sup>2</sup>
Opening pressure of bypass-valve	0.1 ±0.02MPa(1.0 ±0.2 kgf/cm <sup>2</sup> )



For a new vehicle, replace engine oil filter every 2,000km, then replace engine oil filter every 5,000km.

### Engine oil pan

It is used for storing lubricating oil, which is made of steel sheet. Oil baffle is welded in the middle. In order to prevent lubricating oil leakage, apply sealant on joint surface between engine oil pan and engine block. Oil drain plug assembly is a device with a magnetic core, which can absorb scrap metal. Oil drain plug assembly is installed on the lowest end of engine oil pan.

#### Engine oil capacity

Engine oil capacity (L)	Maximum capacity of oil pan (L)	Minimum capacity of oil pan (L)
4.0	3.5	2.5

### Lubrication System Maintenance

According to lubricating oil API (American Petroleum Institute) classification

Gasoline engine SC, SD, DE, SF, SJ, SL etc.

Recommended lubricating oil viscosity SL

Recommended lubricating oil brand SL 5W/30 or 10w/30

Based on the area in which the customer is located, select lubricating oil with appropriate viscosity. It is important to obtain good performance in the driving state. Especially in cold area, in order to start the engine easily, viscosity of lubricating oil is more important because lubricating oil directly affects start speed.

When it is necessary to fill or replace the lubricating oil for the engine, select lubricating oil with appropriate viscosity according to the local climate. When the engine runs continuously at a high speed, SL 5W/30 or 10w/30 lubricating oil shall be used.

#### Replacement period of engine lubricating oil

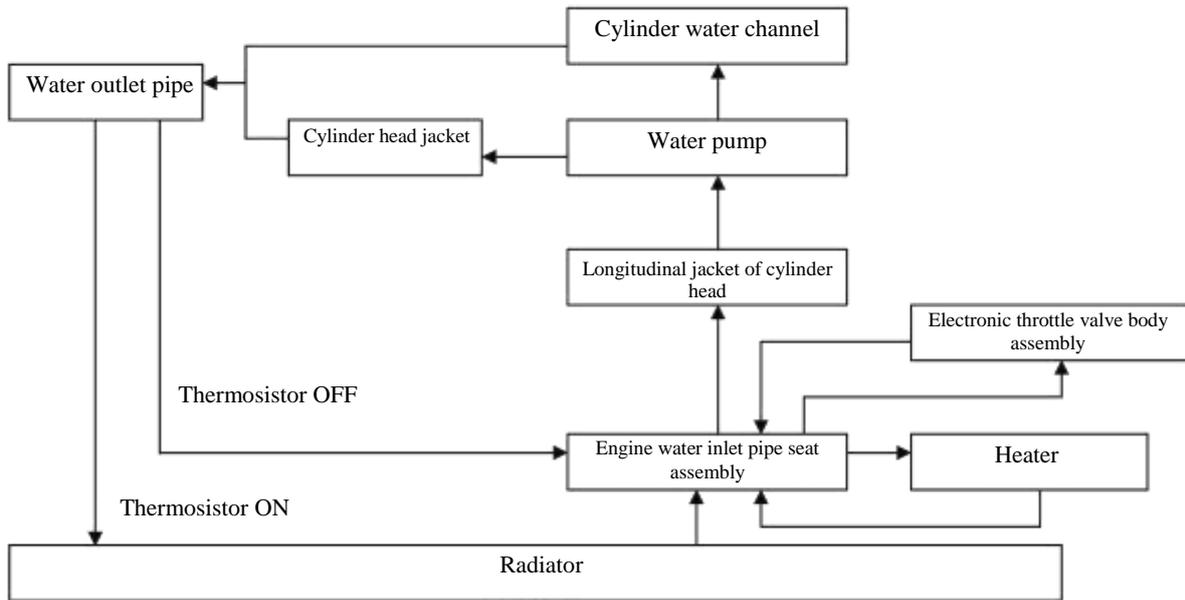
Item	API classification	Replacement period
Gasoline engine lubricating oil	above SL	Every 5,000km or half a year

Note: whichever mileage and date reach the limit, it will prevail.

At the time of maintenance, check engine lubricating oil and engine oil filter are invalid.

## Section 4 Cooling System

Engine cooling system is enclosing forced water cooling circulation system, including various water jackets and water pipes for water pump, thermostator assembly, water temperature sensor, cylinder block, cylinder head and electronic throttle valve body.



Cooling system block diagram

### Water pump assembly

Water pump assembly is centrifugal, installed on the front end of engine block. Pump body is made of aluminum alloy, which can reduce the weight. The water pump impeller is made of metal, with the impeller diameter 59mm.

Testing water pressure is 0.138 MPa, time is 1 min and leakage is less than 3ml/min.

Flow rate characteristics water pump assembly

Rotating speed \ Item	Temp. °C	Lift kPa	Flow rate l/min
7200r/min	80±2	≥147	135

### Thermosistor assembly

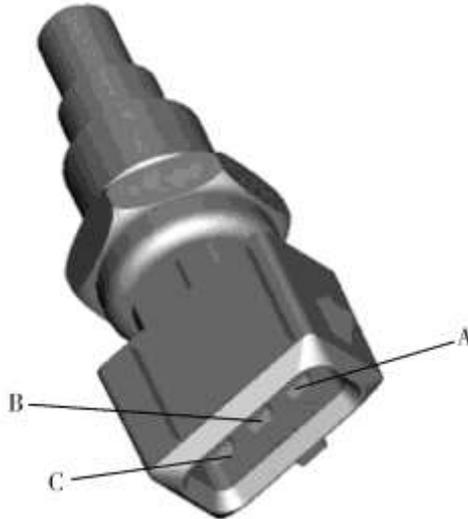
This engine adopts wax-type thermostator assembly and is provided with one anti-push rod and baffle. Opening thermometer scale is on the edge of thermostator assembly. This thermostator assembly is not affected by internal pressure in cooling channel. When the temperature reaches above 80°C, the wax will expand to open the valve and coolant will go into internal cooling system of the engine. When the temperature is lower than 80°C, the valve is closed and only keeps internal cycle of the engine.

Initial-open temperature for thermostator assembly valve °C	80±2
Full-open temperature for thermostator assembly valve °C	95
Full lift of the valve mm	≥8



**Coolant temperature sensor**

The engine adopts thermistor coolant temperature sensor with negative temperature coefficient, which is installed on water inlet pipe seat on the rear end of cylinder head. Coolant temperature sensor transfers induction signal to control computer so as to control oil injection and ignition of the engine optimally. At the same time, it displays cooling temperature and controls electric fan running.



Coolant temperature

Performance parameters between A and C pins:

Temperature range (°C)	Resistance (KΩ)
-20±0.1	13.71~16.49
25±0.1	1.825~2.155
80±0.1	0.303~0.326
110±0.1	0.1383~0.1451

Resistance between B terminal pin and sensor ground:

Temperature range (°C)	Resistance (Ω)	Combined with standard resistance (°C)
55	220.5(+48.6,-38.7)	±5
60	181.8(+38.7,-27.7)	±5
112	33.8(+5.1,-4.07)	±5
117	29.8(+4,-3)	±5



## Section 5 Intake and Exhaust Systems

Fresh air absorbed from air filter goes through the intake hose and flows into electronic throttle body assembly, then flows into the intake manifold and cylinder head air channel. Gases generated in combustion chamber are discharged through exhaust manifold.

### 1. Intake system

#### Electronic throttle body assembly

Electronic throttle body assembly consists of throttle valve body, position sensor and drive motor. Electronic throttle body assembly is installed on air inlet of intake manifold by four long bolts. Drive motor on electronic throttle body assembly controls throttle valve openness automatically. { Refer to CA4GA1 *Engine Maintenance Manual (Electronic Control)* in details }



Electronic throttle body assembly

Basic parameters of electronic throttle body assembly

Throttle body	Hole diameter (mm)	$\phi 45$
	Inlet diameter $\times$ length (mm)	$\phi 55 \times 25$
	Shut height	$6^\circ$
	Working angle (Max)	$99^\circ$
Drive motor	Shaft locking current (A)	$9.4 \pm 3.2 (25^\circ\text{C}, 12\text{V})$
Position sensor	Output voltage when valve is fully closed (V)	$0.6 \pm 0.1$
Intake valve angle	90% response (full closed $\rightarrow$ full open)(ms)	150
	90% response (full closed $\rightarrow$ full open)(ms)	120

#### Intake manifold assembly

Intake manifold assembly is made of engineering plastic. Intake manifold assembly adopts updraught-type structure. Manifold assembly joint surface and electronic throttle valve body joint surface form  $68^\circ$  angle. Intake manifold assembly is provided with electronic throttle body assembly and intake temperature/pressure sensor. Air goes into intake manifold balance box through electronic throttle valve body throat. In the balance box, intake fluctuation is eliminated. Stable and uniform air goes into air channels of four cylinders and combustion chamber. There are two joint pipes on balance box, which are connected to canister control valve and brake booster pump, respectively. Seal ring of air inlet is made of silicon rubber, with red color.



## Performance parameter of intake manifold assembly

Intake manifold assembly burst pressure (MPa)	$\geq 0.5$
Intake manifold assembly leakage rate (mL)	$\leq 70$
Intake manifold assembly withdrawal force (KN)	$\geq 2$

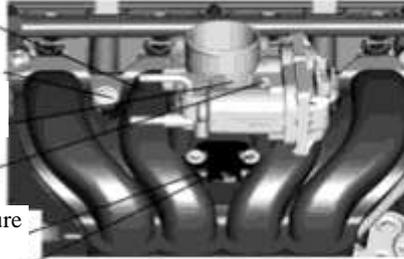
Intake manifold assembly

Electronic throttle valve  
body assembly

Combination bolt

Intake pressure/temperature  
sensor

Hexagon head flange bolt



Intake manifold assembly and electronic throttle body assembly

**Intake temperature/pressure sensor assembly**

Intake temperature/pressure sensor assembly can detect absolute pressure and air temperature of the engine intake manifold at the same time. Intake temperature/pressure sensor assembly is main component of air quality in the engine control system.

## Performance parameters of intake temperature/pressure sensor assembly

Intake temperature/pressure sensor assembly	Power supply voltage (V)	$5 \pm 0.25$		
	Operating temperature ( $^{\circ}\text{C}$ )	$-30 \sim +120$		
Pressure sensor	Operating pressure (KPa)	$13.3 \sim 120$		
	Accuracy ( $25^{\circ}\text{C}$ )(KPa)	$\pm 1.06$		
Temperature sensor	Temperature characteristics (K $\Omega$ )		Resistance	Testing current
		$-20^{\circ}\text{C}$	16.2	-
		$20^{\circ}\text{C}$	$2.45 \pm 0.24$	Max100uA
		$80^{\circ}\text{C}$	$0.322 \pm 0.032$	Max1000uA

**2. Exhaust system****(1) Exhaust manifold assembly**

Exhaust manifold assembly is made of chrome steel pipe to reduce exhaust resistance. Exhaust manifold assembly is provided with two oxygen sensors to detect oxygen content in exhaust gases and transfer signals to ECU. Then ECU controls fuel capacity and controls air-fuel ratio within in target range.



Exhaust manifold sub-assembly

**(2) Front/rear oxygen sensor assembly**

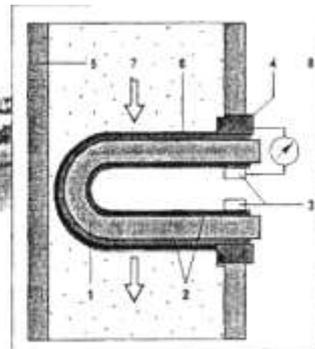
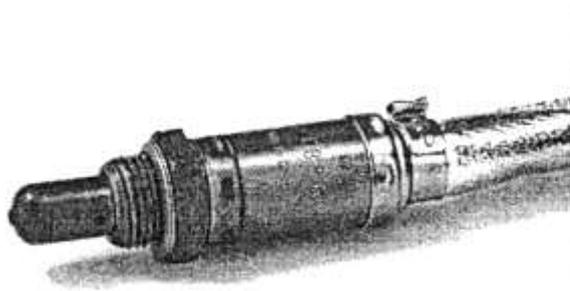
Front/rear oxygen sensor assembly is used to detect oxygen content in exhaust gases from the engine to determine actual air-fuel ratio of real-time fuel supply in the engine. Front/rear oxygen sensor assembly is of heating type. Front/rear oxygen sensor assembly cannot be exchanged (their length is different).

Performance parameters of front oxygen sensor assembly

Item	Performance parameters
Operating temperature (°C)	-30~900
Working temperature (°C)	300~900
Maximum temperature change (°C/s)	-50~+75
Insulation resistance (MΩ)	1
Heating resistance (Ω)	5.6
Total length	321.5

Performance parameters of rear oxygen sensor assembly

Item	Performance parameters
Operating temperature (°C)	-30~900
Working temperature (°C)	300~900
Maximum temperature change (°C/s)	-50~+75
Insulation resistance (MΩ)	1
Heating resistance (Ω)	13.0
Total length	371.5



- 1. Zirconium dioxide porcelain coating
- 2. Electrode
- 3. Contact
- 4. Housing contact
- 5. Exhaust pipe
- 6. Multi-hole ceramic protection layer
- 7. Exhaust
- 8. Air

Front/rear oxygen sensor assembly

**(3) Three-way catalytic converter**

Three-way catalytic converter is connected on the rear end of exhaust manifold, which uses three-way catalyst in the converter to change harmful gases in engine emission to harmless gases. It is forbidden to use leaded gasoline, which prevent the catalyst from being invalid due to “lead poisoning”. Mesh density of converter core is  $620 \times 10^3/m^2$ , capacity is 1.083L, and section area is  $333.1cm^2$ .

## Section 6 Fuel System

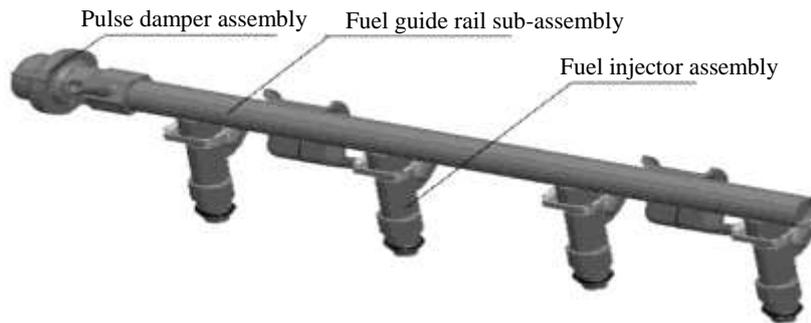
Fuel system adopts EFI (electronic fuel injection) system, including the power-driven fuel pump, gasoline filter and fuel inlet hose, fuel guide rail assembly and fuel injector.

### Gasoline filter

For details, please refer to *CA4GA1 Engine Maintenance Manual (Electronic Control)*.

### Fuel guide rail assembly

Fuel guide rail assembly consists of fuel guide rail sub-assembly, ripple damper assembly and four fuel injector assemblies. Fuel guide rail assembly is fastened on cylinder head by two hexagon head flange bolts. Fuel injector is inserted into fuel injector mouth on cylinder head to keep a certain pressure to inject fuel to each injector hole. Fuel injector is an important actuator of EFI system, which injects fuel accurately according to ECU fuel injection signal.



Fuel guide rail assembly

#### 1. Fuel guide rail sub-assembly

Fuel guide rail sub-assembly adopts no fuel return pipe made of stainless steel. Main components include fuel conveying pipe of fuel spray nozzle, pipe joint and mounting support of fuel spray nozzle.

Performance parameters of fuel guide rail sub-assembly

Operating temperature (°C)	-30~120
Burst pressure (PSI/min)	300
Leakage rate (ml/min)	2.5
Cleanness (mg)	2.0

#### 2. Ripple damper assembly

Ripple damper assembly absorbs pulse energy of fuel in fuel guide rail sub-assembly to ensure constant pressure of fuel in fuel guide rail sub-assembly. Ripple damper assembly is non-detachable. When installing, the applied force is less than 20KN to avoid threads from being deformed and damaged.

#### 3. Fuel injector assembly

Fuel injector assembly is an electromagnet control component, consisting of electromagnetic coil, valve needle and housing, with light weight and high fuel tightness. Fuel injector assembly injects fuel within specified time according to ECU command to provide fuel to the engine and atomize fuel. Fuel injector assembly is provided with two O seal rings.



Suggestion: (1) Use special washing analyzer to clean fuel injector per 20000KM.

(2) Fuel injector shall be tested in a specified maintenance company. It is forbidden to test without permission to avoid it from being damaged.

Note: For all parts of electronic control fuel system in details, please refer to CA4GA1 *Engine Maintenance Manual* (electronic control).



Fuel injector assembly

Main technical parameters of fuel injector assembly

Working temperature (°C)	-30~130
Working voltage (V)	14
Fuel pressure (KPa)	250~350
Coil resistance(Ω)	12±0.5 (at 20°C)
Ejection angle	20°



## Section 7 Ignition System

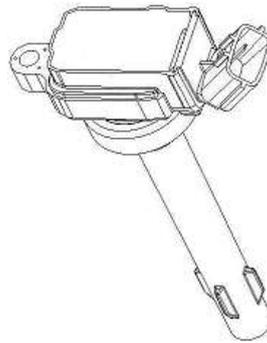
Ignition system mainly consists of engine control unit assembly, bar type ignition coil assembly and spark plug assembly.

### Bar type ignition coil assembly

Bar type ignition coil assembly changes input low-voltage power to high voltage power through primary and secondary coils. It ignites gas mixture through spark plug. Because they are integrated, high voltage line is not required. Ignition fault and electromagnetic interference are reduced. For details, please refer to *CA4GA1 Engine Maintenance Manual* (electronic control).

Main technical parameters of bar type ignition coil assembly

Rated voltage (V)	12
Power supply voltage (V)	5~6
Working temperature (°C)	Coil: -30~130 Igniter: -40~120



Bar type ignition coil assembly

### (2) Spark plug assembly

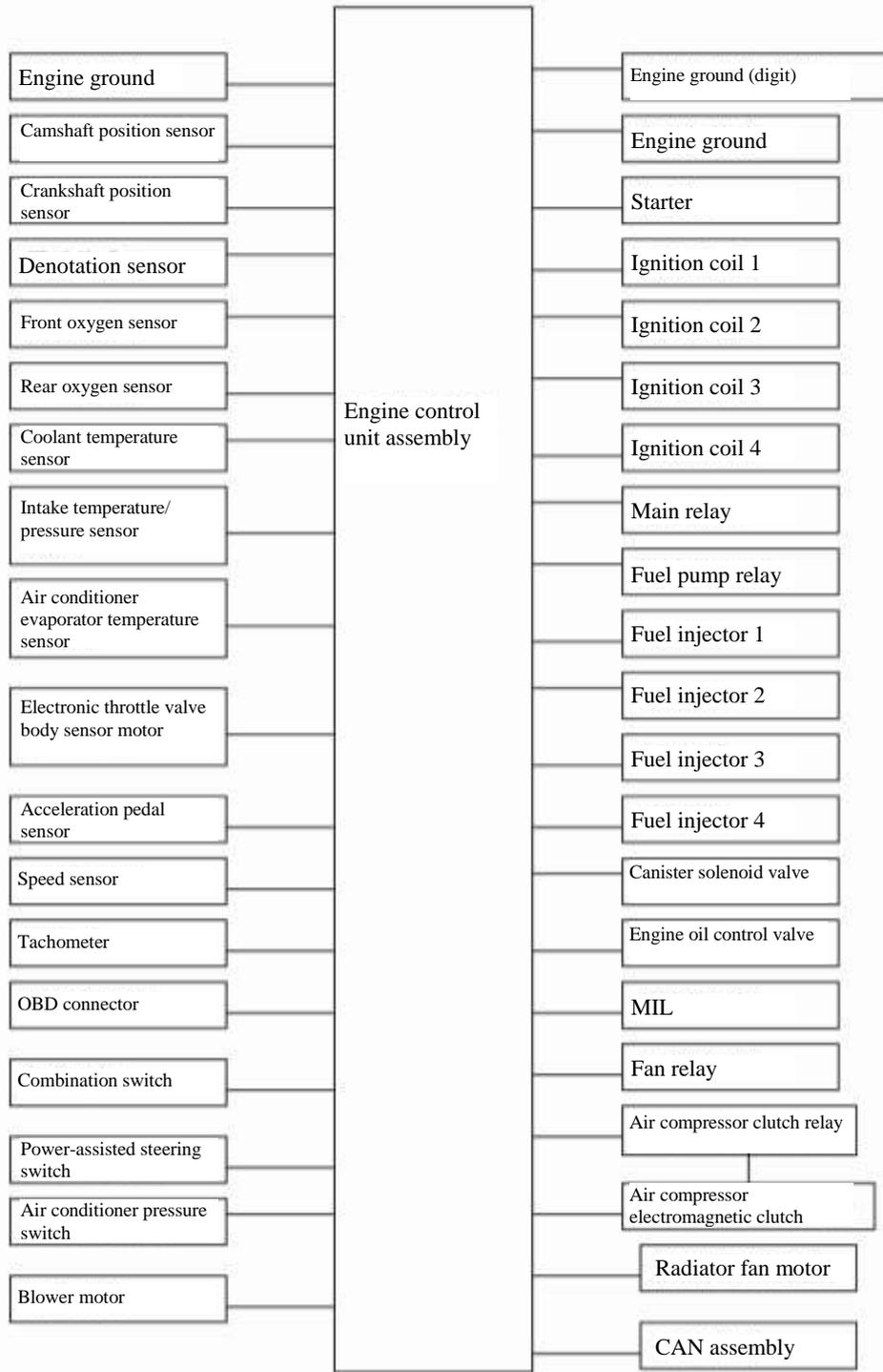
Use high voltage generated by bar type ignition coil assembly to produce spark and light mixing gases in the cylinder. Use XU22EPR-U spark plug. Spark plug clearance is 0.8—0.9mm. When removing and installing, tighten it according to specified torque.

Technical parameters of spark plug assembly

Full length (mm)	75.2±1
Thread diameter (mm)	M12
Clearance (mm)	0.8-0.9

### (3) Engine control unit assembly

Engine control unit assembly is used to monitor and control engine normal running continuously. Engine control unit assembly calculates required air-fuel ratio and ignition advance angle according to input test data of each sensor. Engine control unit assembly controls fuel injection quantity, fuel injection timing, ignition coil input closed angle, engine ignition advance angle, electronic throttle valve opening angle, combustion and emission of the complete vehicle, cooling fan and air conditioner system in the vehicle in all working conditions directly. Engine control unit assembly is provided with OBD system. For details, please refer to *CA4GA1 Engine Maintenance Manual* (electronic control).



Functional block diagram for engine control unit assembly



## Section 8 Other sensors and other actuating mechanism

### (1) Crank shaft position sensor assembly

Crank shaft position sensor assembly is an electromagnetic actuator, which generates voltage through magnetic line of force sent by signal wheel cutting sensor to determine crankshaft position. Crank shaft position sensor assembly outputs frequency signals.



Camshaft position sensor assembly

Item	performance parameters	Test conditions
Operating temperature (°C)	-30~135	
Air gap (mm)	2.5±0.5	
Resistance (V)	1100±150	20°C
Insulation resistance(Ω)	MIN10MΩ	DC 500V ohmmeter between terminal and other conductive parts.

### (2) Camshaft position sensor assembly

Camshaft position sensor assembly is an electromagnetic actuator, which generates voltage through magnetic line of force sent by signal wheel cutting sensor to determine camshaft position. Camshaft position sensor assembly outputs frequency signals.

Item	Performance parameters	Test conditions
Working temperature (°C)	-30~135	
Air gap (mm)	0.8±0.35	
Resistance (V)	2150±300	20°C
Insulation resistance (V)	MIN10MΩ	DC 500V ohmmeter between terminal and other conductive parts.



Camshaft position sensor assembly

**(3) Knock sensor assembly**

Knock sensor assembly is an off-resonance piezocrystal vibrating sensor, which is installed on the side of engine cylinder block to test vibration during the course of running the engine. It is compact, light, and easy to be assembled.

Technical parameters of Knock sensor assembly

Item	Test conditions	
	Initial stage	After durability
Operating temperature (°C)	15~35	
Output voltage(mV)	26±8	14.4~40.8
DC resistance $R_0(K\Omega)$	200±40%	200±40%
Insulation resistance $R_{\infty}(M\Omega)$	Min 2	Min 1



Knock sensor assembly

**(4) Canister solenoid valve assembly**

Canister solenoid valve assembly is an electromagnetic component of control canister.

Technical parameters of canister solenoid valve assembly

Rated voltage, working voltage range	12V, 10~16V
Working temperature (°C)	-40~+120
Maximum reset voltage (-60KPa,120°C)	0.7V(min)
Coil resistance (20°C)	24.5±1.5Ω
Insulation resistance(Ω)(DC 500V ohmmeter)	Min10MΩ
Valve seal leakage (-60KPa,20°C)	70cm <sup>3</sup> /minMAX
Body leakage (-60KPa,20°C)	1cm <sup>3</sup> /minMAX



Canister solenoid valve assembly



## Chapter 3 Engine Adjustment and Maintenance

Section 1 Engine Adjustment .....	45
Section 2 Engine Maintenance When Engine is Installed on the Vehicle .....	49
Section 3 Engine Adjustment and Maintenance .....	62



## Section 1 Engine Adjustment

### 1. Connection method and operating instructions of instruments

#### 1) Engine analyzer

Engine analyzers shall be connected according to related requirements of engine diagnosis in *CA4GA1 Engine Maintenance Manual (Electronic Control)*.

2) Read engine state parameters, such as engine speed, water temperature and ignition angle.

3) When the engine is running, it is not allowed to disconnect the battery electrode contact (if you ignore this, abnormal pulse signal will be input into the transistor, even transistors and other electrical instruments are damaged).

4) When washing, do not make any electrical component contact water or steam.

5) Before using exhaust emission tester, it is necessary to calibrate it accurately. The following operations shall be done at the same time:

- (1) Preheating;
- (2) Zero adjustment;
- (3) Range adjustment.

### 2. Check engine oil level

After preheating the engine for several minutes, stop it and then take out engine oil dipstick to check oil level.

Oil level shall be between the highest limit and the lowest limit. It is closer to the highest level.

Engine oil capacity

Highest	3.5L
Lowest	2.5L

**(Note) When engine oil is lower than the specified limit, fill specified engine oil to the highest level (when engine oil level is lower than specified limit, please check if any leakage occurs).**

### 3. Check cooling water level

(1) Check water level of the storage tank to make sure cooling water level is between the highest limit and the lowest limit.

(2) When water level of the storage tank is lower than specified limit, fill water to the highest level.

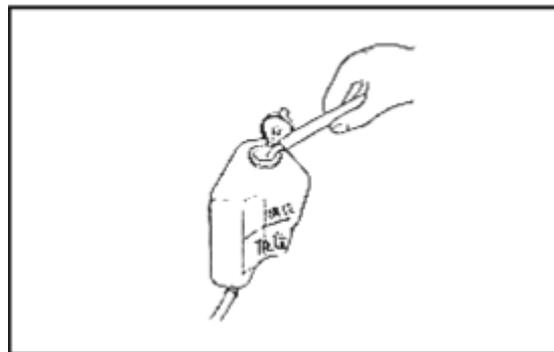
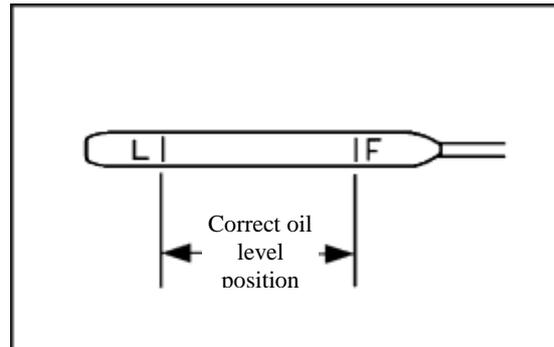
(3) If cooling water level is lower than the lowest level, it is necessary to open radiator cover to check cooling water level of the radiator.

(4) If cooling water level is always lower than specified level, it is necessary to check if radiator cover leaks with radiator cover detector.

[Note] ① When the engine is running or the coolant is not cool, it is forbidden to open radiator cover.

② Cooling water capacity in the engine: 1.76L

③ Coolant contains water and ethylene glycol.



**Table of comparisons for coolant percentage**

Ethylene glycol content	Water content	Protection temperature
Minimum 35%	65%	-20°C
40%	60%	-24°C
Maximum 45%	55%	-31°C

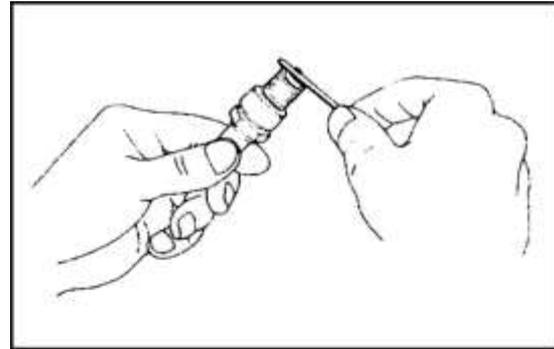
**4. Check air filter element**

(1) Check if filter element is blocked, dirty or damaged.

(Note) Replace filter element if necessary.

(2) Clean filter element with compressed air.

Blow filter element from inside or top side with compressed air. It is forbidden to use improper method to clean filter element, such as knocking on it, blowing it with strong air flow.

**5. Check spark plug**

(1) Check if spark plug is damaged or broken.

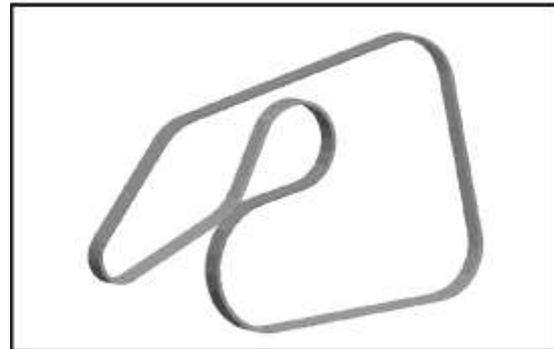
(Note) Replace spark plug if necessary

(2) Clean spark plug.

(3) Check and adjust spark plug clearance.

Specified value of spark plug clearance

Manufacturer	Denso, Japan
Model	XU22EPR-U
Clearance	0.8—0.9

**6. Check V belt**

(1) Check if V belt is damaged, cracked or worn.

(Note) Replace V belt if necessary.

(2) Tension the belt and rotate crankshaft by more than 2 turns.

Specified value of belt tensioning is (650±50) N.

**7. Check valve clearance**

Stop running the engine: make cooling water temperature reach ambient temperature. Check and adjust valve clearance.

Specified value of valve clearance (cold state):

Intake valve clearance is  $0.2 \pm 0.03$ mm,

Exhaust valve clearance is  $0.3 \pm 0.03$ mm.

**(Note) When the piston of 1<sup>st</sup> cylinder is at TDC of compression stroke or intake/exhaust stroke, check and adjust valve clearance. Refer to the following table and adjust corresponding valve clearance according to 1<sup>st</sup> cylinder piston position.**

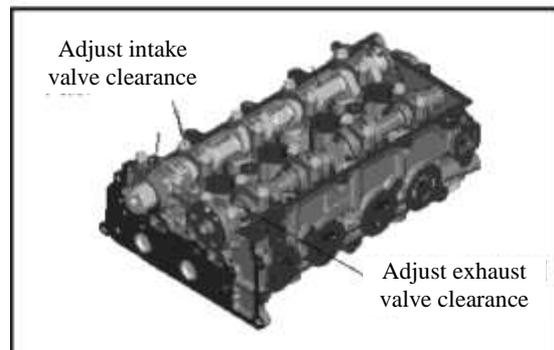


Table of Comparisons for Adjustment

Crankshaft rotation angle cylinder		1	2	3	4
When compression stroke of 1 <sup>st</sup> cylinder piston is at TDC.	Intake	√	×	√	√
	Exhaust	√	×	√	√
When compression stroke of 3 <sup>rd</sup> cylinder piston is at TDC.	Intake	×	√	×	×
	Exhaust	×	√	×	×



× means unadjustable, √ means adjustable

## 8. Check compression pressure

When the engine runs at 230 r/min above: the pressure is not less than 1350kPa (13.5kgf/cm<sup>2</sup>), pressure difference of each cylinder is less than 100Kpa (1.05kgf/cm<sup>2</sup>)

(Note) When checking, remove all spark plugs and keep throttle valve at full-open position.

Compression pressure shall be measured in a short time. Measuring time for each cylinder shall be the same.

If the pressure cannot reach specified value, it is necessary to check if the clearance between cylinder and piston conforms to the specification. In addition, check if piston ring is worn excessively.

9. Check fuel injector, working pressure of fuel and relay: refer to CA4GA1 *Engine Maintenance Manual* (electronic control).

10. Check working pressure of fuel: refer to CA4GA1 *Engine Maintenance Manual* (electronic control).

11. Check relay: refer to CA4GA1 *Engine Maintenance Manual* (electronic control).

## 12. Check idle speed emission

(1)1. Check and adjust preheated engine and test device initially →2. Install test device →3. Check idle speed →4. Check idle speed emission

(2) Notes

Before checking idle speed or during the course of checking, please observe the following notes.

- ① Preheat the engine thoroughly.
- ② When fan motor is still running, it is not allowed to check idle speed.
- ③ When checking idle speed, it is not allowed to use additional load, such as headlamps, rear defroster, etc.
- ④ Air filter shall be installed.
- ⑤ Electronic throttle valve, ECU and wire harness shall be in good state.
- ⑥ Intake system shall not leak.
- ⑦ Exhaust system shall not leak.
- ⑧ For electronic control adjustment, refer to 4GA1 *Engine Maintenance Manual* (electronic control).

(3) Check and adjust idle speed emission initially

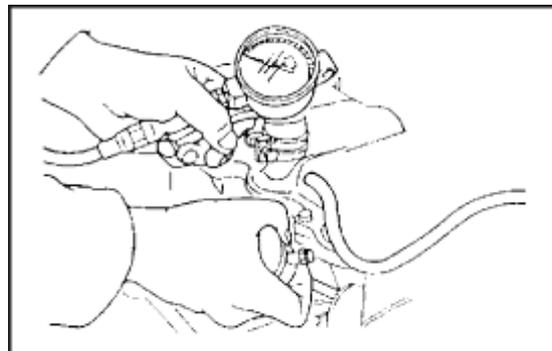
① Preheat the engine until cooling water temperature reaches 80~90°C. (When the fan stops running, it means the temperature reaches this value. When fan motor is running, do not adjust idle speed.)

② Preheat the emission analyzer.

③ Check if electronic throttle body surface is damaged and if bypass pipe water temperature is normal.

(4) Install the engine speed tester on the engine. For details, please refer to 4GA1 *Engine Maintenance Manual* (electronic control).

(5) Check idle speed of the engine and measure carbon monoxide and hydrocarbon concentration. (After contacting





agent).

At  $700 \pm 50$ rpm, carbon monoxide and hydrocarbon concentration:  $CO < 0.5$ ;  $HC < 100$ PPM. Engine oil pressure shall not be less than 0.9bar.

Note: for details, please refer to *4GA1 Engine Maintenance Manual* (electronic control).

### **13. Check high idle speed emission**

Check high idle speed of the engine and measure carbon monoxide and hydrocarbon concentration. (After contacting agent).

At  $2000 \pm 50$ rpm, carbon monoxide and hydrocarbon concentration:  $CO < 0.3$ ;  $HC < 100$ PPM.

Note: 1. For check method of high idle speed, refer to (1), (2) and (3) in Item 12 Idle speed emission.

2. For electronic control in details, please refer to *4GA1 Engine Maintenance Manual (Electronic Control)*.



## Section 2 Engine Maintenance When Engine is Installed on the Vehicle

### 2—1 Operating Instructions of Maintenance

1) This section describes procedures for removing and installing parts only when the engine is installed on the vehicle.

Note: It is difficult to remove and install the engine under the complete vehicle. It is easy to damage parts or cause personal hurt. It is not suggested to remove and install the engine under the complete vehicle.

2) Operate timing chain, intake/exhaust camshaft, VCT controller assembly, crankshaft front oil seal, chain chamber cover assembly and cylinder head gasket. Before operation, 1<sup>st</sup> cylinder piston shall be at TDC of compression stroke.

**(Note) TDC of compression stroke is confirmed by observing timing marks of VCT controller assembly and exhaust camshaft gear after removing cylinder head cover assembly.**

### 2—2 Timing chain and water pump

Removal

- 1) Drain engine coolant.
- 2) Remove connection between front engine support and the frame.

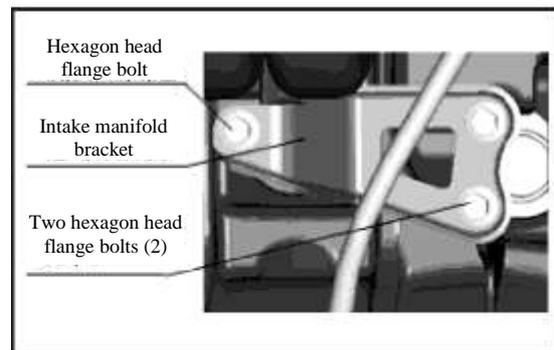
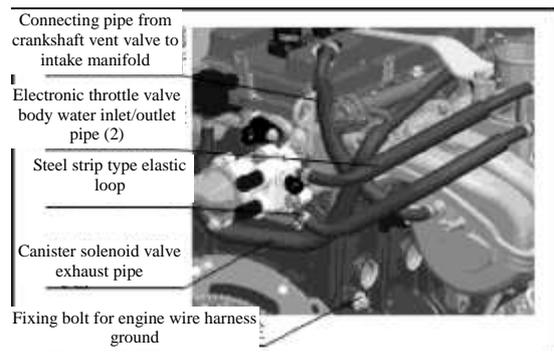
Before removing connection between front engine support and the frame, use a jack to support oil pan.

(Note) ① Be careful! Do not deform oil pan. Otherwise, it will block the engine oil line.

② Be careful! Do not damage oil drain plug.

3) Disconnect the connection of each wire harness plug between the engine and actuator/sensor.

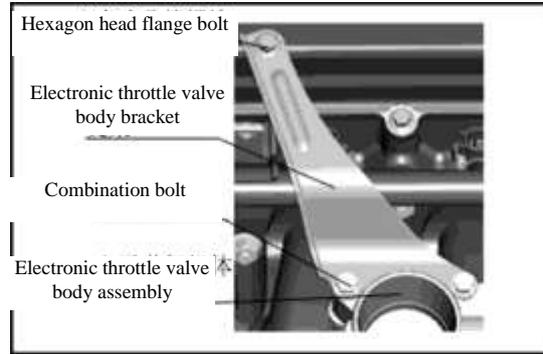
**4) Remove intake manifold and canister solenoid valve outlet pipe, disconnect connecting pipe from crankcase vent valve to intake manifold and fixing bolt of engine wire harness ground.**



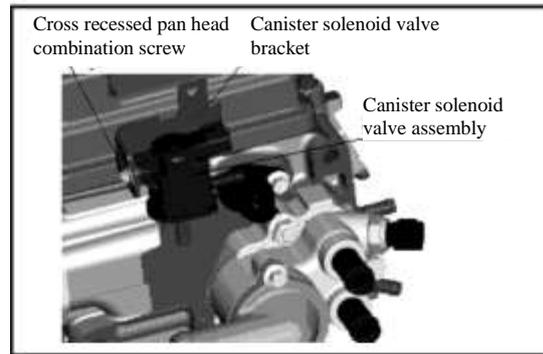
**5) Loosen combination bolt of intake manifold bracket.**



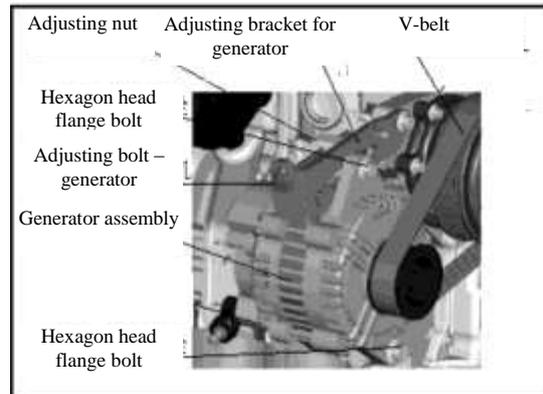
**6) Remove electronic throttle body bracket**



**7) Remove canister solenoid valve bracket and canister solenoid valve.**

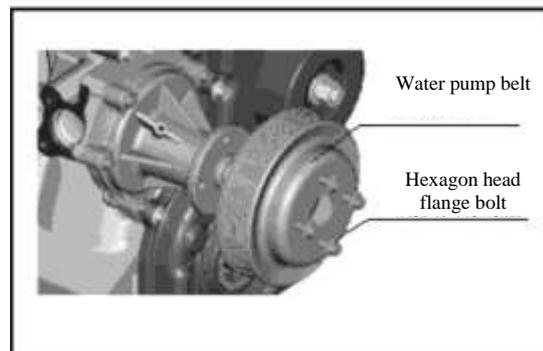


**8) Loosen adjusting bolt, adjusting nut and hexagon head flange bolt for generator assembly.**



**9) Remove V-belt.**

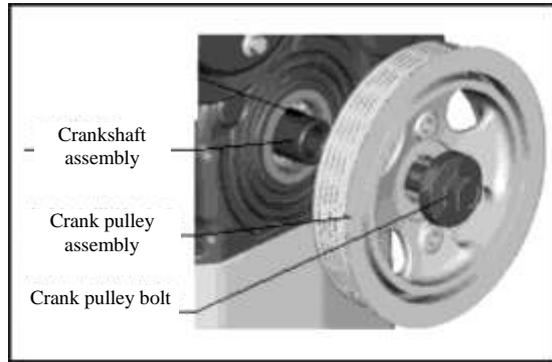
**10) Remove water pump belt pulley. Loosen water pump belt pulley hexagon head flange bolt.**



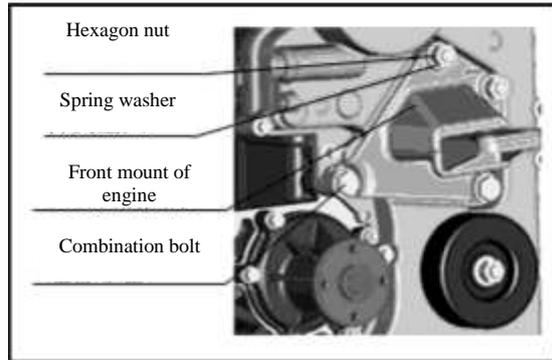


11) Remove crank pulley.

Before loosening crank pulley bolt, use a screwdriver to lock crank pulley in order to prevent the crankshaft from rotating.



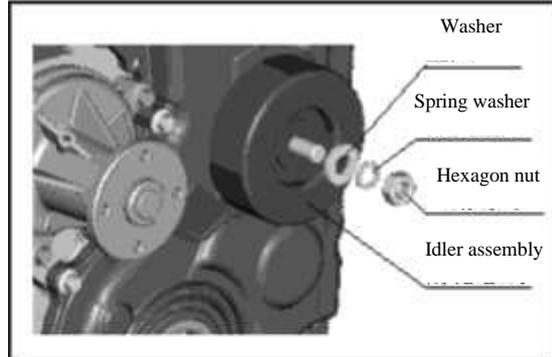
2) Remove front engine support.



13) Remove idler assembly.

Idler assembly is installed on the stud of cylinder block front end. Loosen hexagon nut and take down hexagon nut, spring washer and washer. Then take down idler assembly.

**Note: keep all removed parts in a safe place to avoid them from being lost.**



14) Remove bar type ignition coil assembly

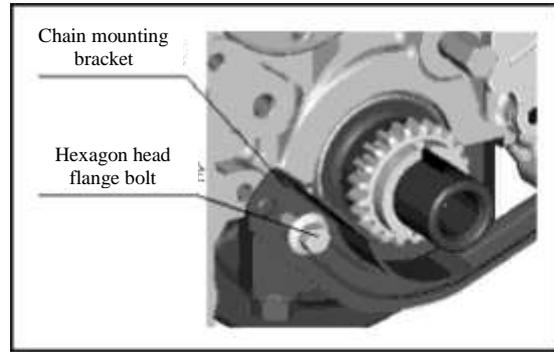
Loosen hexagon head flange bolt and remove bar type ignition coil assembly.

Note: when removing bar type ignition coil assembly, it is not allowed to use a screwdriver to pry bar type ignition coil assembly to avoid bar type ignition coil assembly insulation sheath from being damaged.



15) Remove cylinder head cover assembly and engine oil filler cap.

16) Remove chain chamber cover assembly

**17) Remove chain mounting bracket****18) Remove tensioner assembly.**

(Note) 1. Before removing the tensioner, keep timing marks on exhaust camshaft sprocket and VCT controller assembly sprocket upwards. Now key slot on crankshaft sprocket shall be upwards. 1<sup>st</sup> cylinder piston is at TDC of compression stroke.

2. Before removing the tensioner, fasten tensioner top pillar with snap spring on the tensioner to avoid top pillar from ejecting, which may cause personal hurt.

**19) Remove timing chain.**

(Note) ① When removing timing chain, do not use any screwdriver.

② Do not bend timing chain sharply. Otherwise, it will damage timing chain pin shaft and leaf.

③ Do not get timing chain wet. Otherwise, it will shorten service life of timing chain.

20) Take out crankshaft key on small head of crankshaft and then remove crankshaft sprocket.

**21) Remove water pump assembly.**

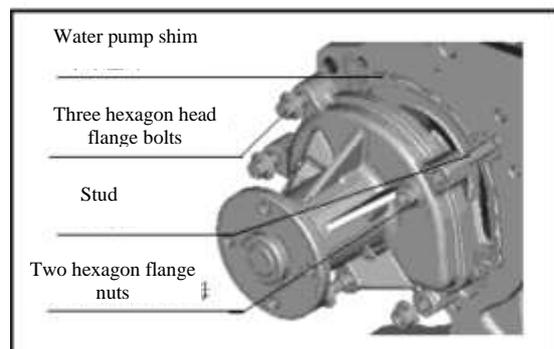
Install

**1) Install water pump assembly.**

Install water pump body and water pump shim on corresponding position of cylinder block front end with hexagon head flange bolts (3 pieces) and hexagon flange nuts (2 pieces). Tightening torque is  $9 \pm 1.8 \text{N.m}$ .

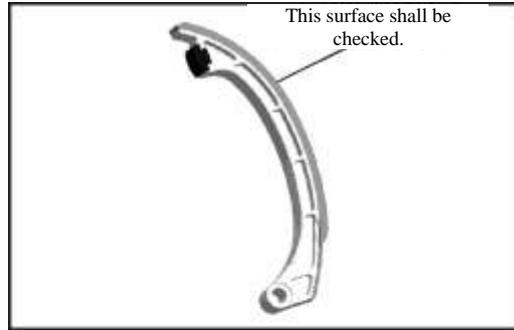
(Note) 1. Elasticity and state of water pump shim shall be checked to determine if it is necessary to replace with new water pump shims.

**2. After tightening bolts and nuts, pump pulley of water pump assembly shall be rotated flexibly.**



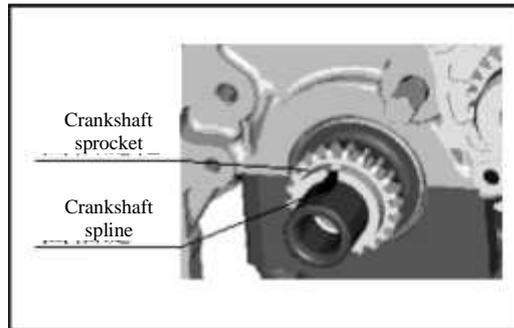


2) Check tension arm surface wear condition of chain tension arm assembly. If deep scratch, groove or burr occurs on tension arm surface, replace chain tension arm assembly. Chain tension arm assembly is installed on cylinder block and cylinder head front end surface. Chain tension arm bolts shall not be tightened.



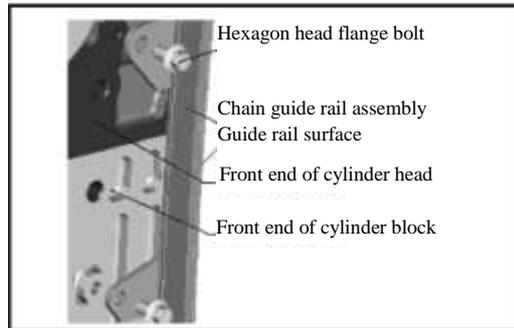
3) Install the crankshaft sprocket.

Keep the crankshaft sprocket key slot outwards and install it on front end of crankshaft. Sprocket key slot and crankshaft key slot coincide. Install crankshaft key into the key slot by hand. Do not use other tools.



4) Install the chain guide rail assembly

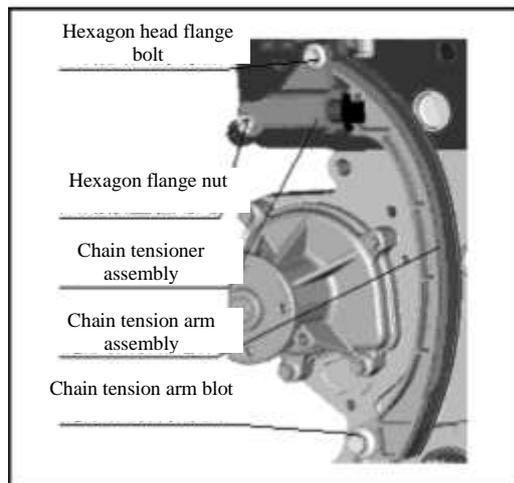
Chain guide rail assembly is installed on cylinder block and cylinder head front end surface. If deep scratch, groove or burr occurs on chain guide rail surface, replace chain guide rail assembly. Tightening torque of hexagon head flange bolt is  $8 \pm 2 \text{N.m}$ .



5) Install the chain tension arm and tensioner assembly

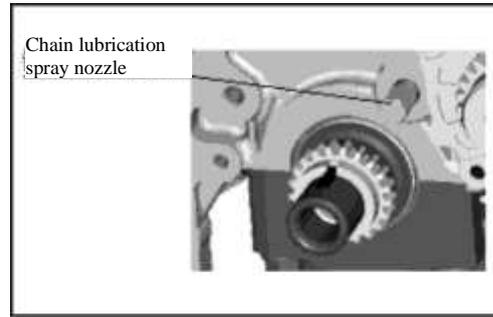
(1) Chain tension arm assembly is installed on cylinder block and cylinder head front end surface. Do not tighten bolts temporarily.

**(2) Install chain tensioner assembly, bolts and nuts. Tightening torque is  $9 \pm 1.8 \text{Nm}$**



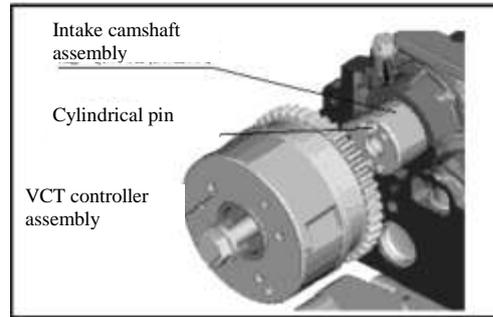


6) Apply anaerobic sealant on chain lubrication nozzle thread and install it on cylinder block front end surface, tighten it and keep injection hole downwards.

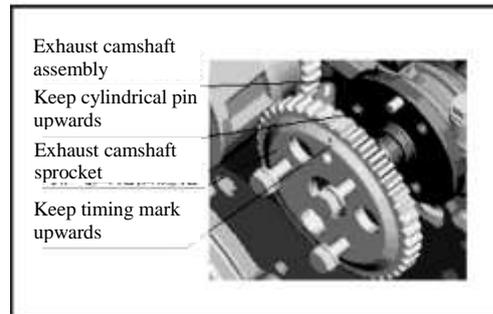


7) Install timing chain.

Rotate intake camshaft to make round pin upwards to keep timing mark of chain gear on VCT controller assembly upwards. So intake camshaft is at TDC of compression stroke.



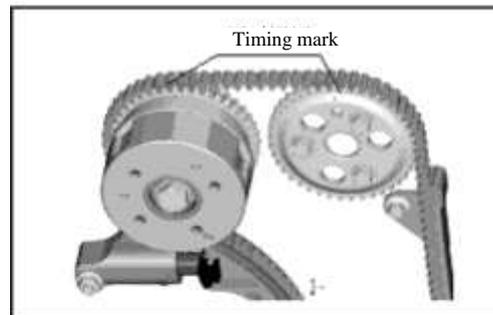
(2) Rotate exhaust camshaft to make round pin upwards to keep timing mark of chain gear on exhaust camshaft sprocket upwards. So exhaust camshaft is at TDC of compression stroke.



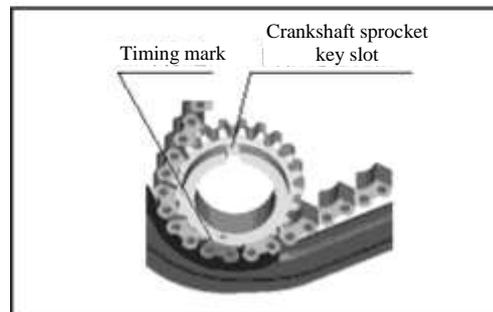
(3) Install timing chain

Check timing chain.

Check if each leaf of timing chain is worn, broken and warped. Check tooth number between timing chain yellow marks. There are 5 leaves (10 teeth) between two groups of double yellow leaves. There are 39 leaves (78 teeth) between single yellow leaves and double yellow leaves.



**② When installing timing chain, align timing marks as shown in the Fig.**



(4) Tension timing chain



Hold snap spring on chain tensioner by hand to make tensioning plunger pop out so as to tension timing chain.

Note: ① Before holding snap spring on chain tensioner, please check if marks on timing chain coincide with timing marks of each sprocket.

② Please check if the plunger extension is 9-12mm. Do not tighten bolts with shims excessively.

(5) Rotate crankshaft by two turns in normal direction, check timing marks of VCT controller assembly sprocket and exhaust camshaft sprocket are upwards and crankshaft sprocket key slot is upwards.

(Note) ① When installing timing chain, it is not allowed to use any screwdriver to pry or twist timing chain to avoid timing chain leaves from being damaged.

② Do not bend timing chain sharply. Otherwise, it will damage timing chain pin shaft and leaf.

③ Do not make timing chain contact water or sealant. Otherwise, it will shorten service life of timing chain.

④ When installing timing chain and rotating the engine, it is necessary to apply the force on crankshaft.

⑤ If using an old timing chain, check timing chain pin shaft and leaf carefully when installing so as to avoid timing chain from being broken.

⑥ Operating requirements of timing chain: check or replace timing chain within 50,000km.

8) Tighten chain tension arm assembly bolt. Tightening torque of bolts is  $19 \pm 3.8 \text{N.m}$ .

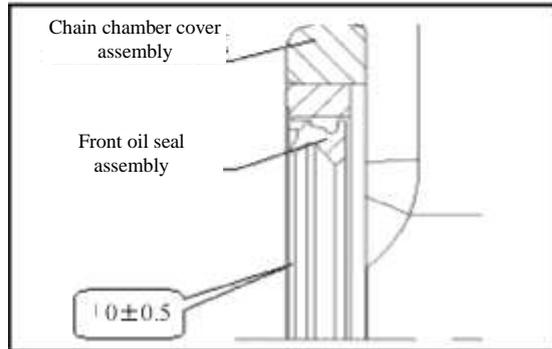
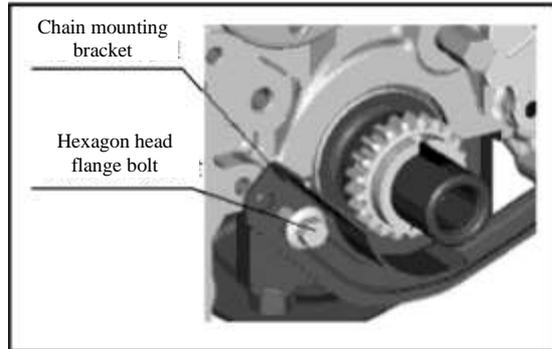
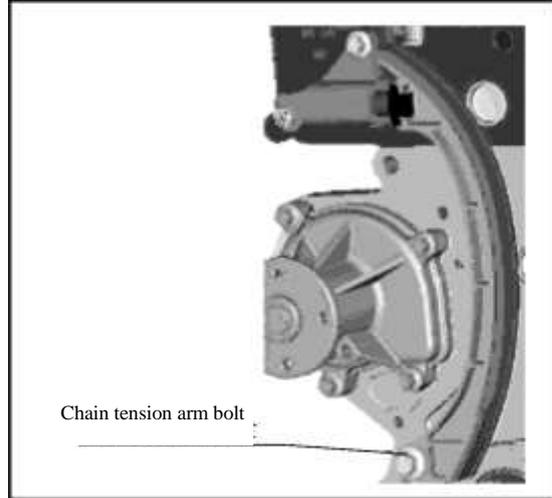
9) Install chain mounting bracket.

Chain mounting bracket is fastened on cylinder block front end surface by hexagon head flange bolt. Tightening torque of bolts is  $8 \pm 2 \text{N.m}$ .

10) Install chain chamber cover assembly

(1) Install front oil seal assembly

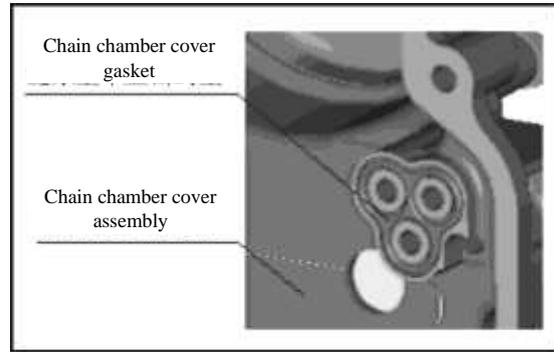
When using new front oil seal assembly, press it into chain chamber cover hole with a special tool. The depth from cylinder block contact surface:  $0 \pm 0.5 \text{mm}$ .





(2) Install gasket

Apply some lubricating oil on chain chamber cover gasket and press it into the groove of OCV control valve to which chain chamber cover and cylinder head correspond. Be careful to avoid falling off.

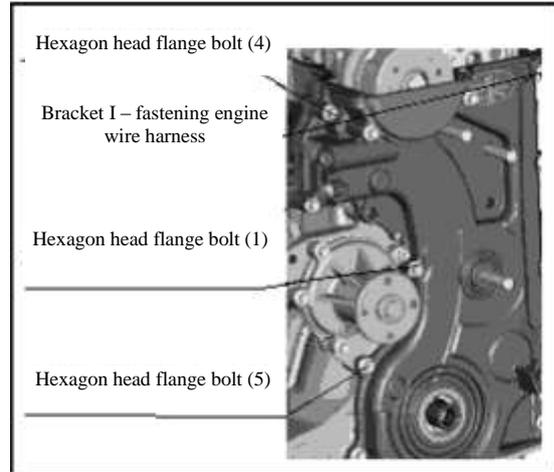


(3) Install the chain chamber cover assembly

① Apply anaerobic sealant on joint part between chain chamber cover and cylinder block uniformly, align it with location pin hole on front end of cylinder head and press it into the hole. It is allowed to use a wood or rubber hammer to knock it slightly.

Note: After applying glue, assemble it within 3 minutes; tighten it within 15 minutes,.

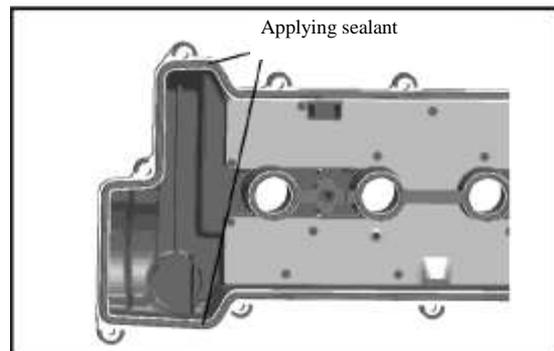
② Use hexagon head flange bolt (10 bolts) to fasten. The tightening torque is  $12 \pm 2.4 \text{ N.m}$ . Engine wire harness bracket I and the cover share one bolt.



11) Install the cylinder head cover assembly.

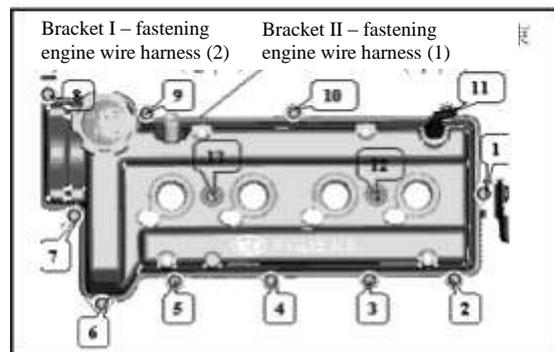
Put cylinder head cover gasket into gasket slot on cylinder head. Apply glue on the joints between corresponding cylinder head and timing chain cover.

Note: After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.



(2) Tighten each bolt and hexagon head flange bolt

- ① At ⑥ and ⑦ as shown in the Fig, use M6×20.
- ② At ⑫ and ⑬ positions as shown in the Fig., use M6 stud and M6 hexagon flange nut.
- ③ At other positions, use M6×25 bolt. Tightening torque is 9-13(target value 11) N.m.
- ④ Canister solenoid valve bracket and cylinder head cover share M6 × 25 bolts at ① position as shown in the Fig.
- ⑤ Engine wire bracket II and cylinder head cover share M6×25 bolts at ⑧ position as shown in the following Fig.
- ⑥ Engine wire harness bracket I and cylinder head cover share M6×20 bolt at ⑦ position as shown in the following Fig.





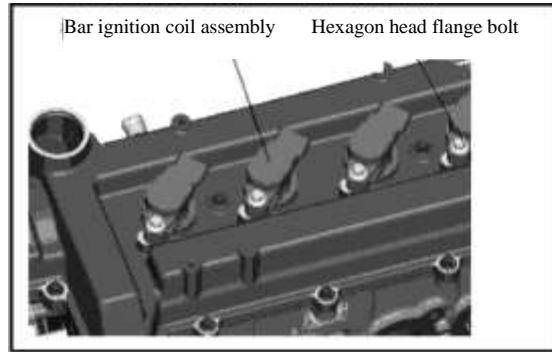
(3) Install engine oil filler cap on cylinder head cover by rotating.

12) Install bar type ignition coil assembly.

Insert bar type ignition coil assembly into cylinder head cover assembly spark plug until it reaches the bottom.

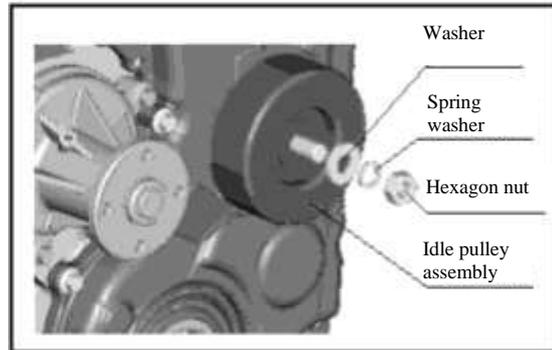
Tighten hexagon head flange bolt. Tightening torque of bolt is  $8 \pm 2 \text{N.m}$ .

Note: When installing bar type ignition coil assembly, it is allowed to use a rubber hammer to knock on bar type ignition coil assembly surface slightly.



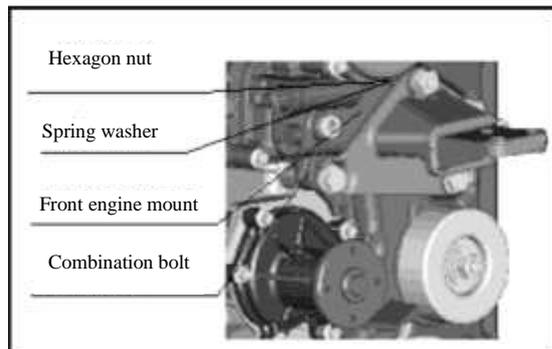
13) Install idler assembly.

Install idler assembly on the stud of cylinder block front end and tighten it with a nut. Tightening torque of the nut is  $44 \pm 9 \text{N.m}$ .



14) Install the front engine support.

Install front engine support on front end of timing chain cover. Tighten it with two combination bolts and two hexagon nuts. Tightening torque of bolts is  $51 \pm 10 \text{N.m}$ .

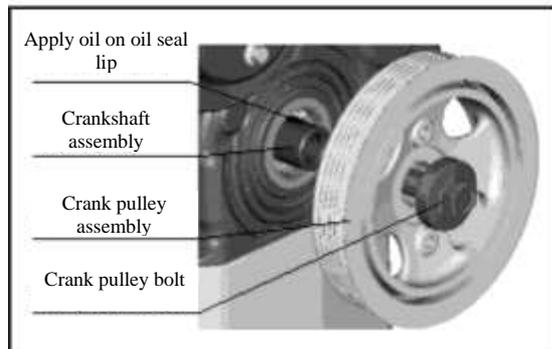


15) Install connecting bolt between front engine support and the frame.

16) Install crank pulley and shock absorber assembly

(1) Apply some lubricating grease on front oil seal assembly lip of timing chain cover;

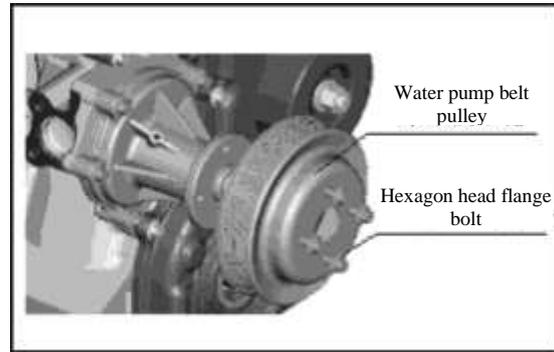
(2) Insert aligning key of crank pulley and shock absorber assembly into crankshaft front end and insert the journal into front oil seal assembly of timing chain cover. Tightening torque is  $200 \pm 10 \text{N.m}$ .





17) Install water pump belt pulley

Tightening torque of bolt:  $11.5 \pm 2.5 \text{ N.m}$

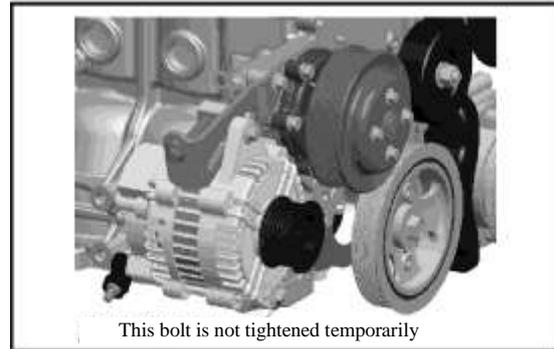


18) Install generator assembly and V-belt

Install generator assembly: it is installed on front end of cylinder block and adjusting bracket of the generator through bolts and nuts. Bolts are not tightened temporarily.

(2) Install V-belt. Install V-belt as shown in the Fig. Adjust adjusting bolt on the generator bracket to tension the belt and rotate crankshaft by more than two turns. Specified value of belt tensioning is  $(650 \pm 50) \text{ N}$ . Measuring position is at the arrow as shown in the Fig.

Tighten hexagon head flange bolt with tightening torque  $23 \pm 4 \text{ N m}$ , tighten hexagon head bolt with tightening torque  $50 \pm 10 \text{ N m}$ .



19) Install canister solenoid valve bracket and canister solenoid valve

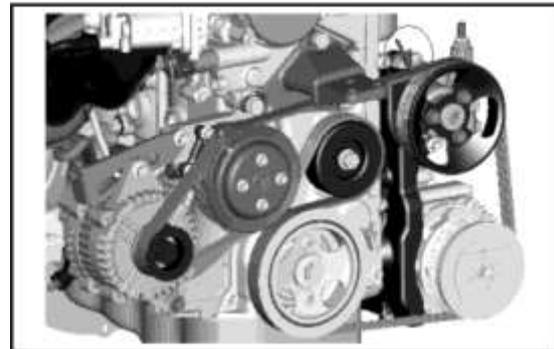
20) Install intake manifold and canister solenoid valve exhaust pipe; install connecting pipe from crankcase vent valve to intake manifold and fixing bolt of engine wire harness ground.

21) Install electronic throttle body bracket

22) Install each wire harness plug, actuator and sensor of the engine.

23) Install engine support and frame, and connect them. Tighten bolts and move out the jack under oil pan.

22) Fill cooling water.





2-3 intake/exhaust camshafts

Remove

After removing timing chain according to “Remove timing chain and water pump” section, remove camshaft.

- 2) Remove air filter assembly.
- 3) Remove intake manifold balance box bracket and wire harness.
- 4) Remove VCT controller assembly.

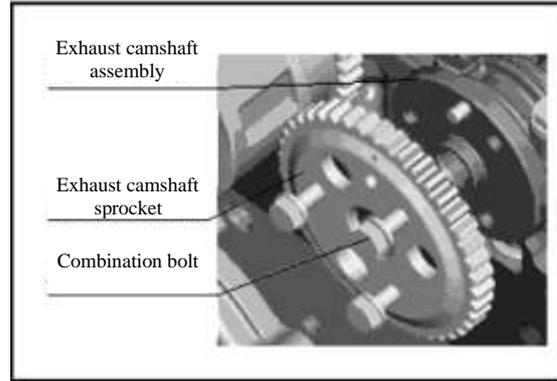
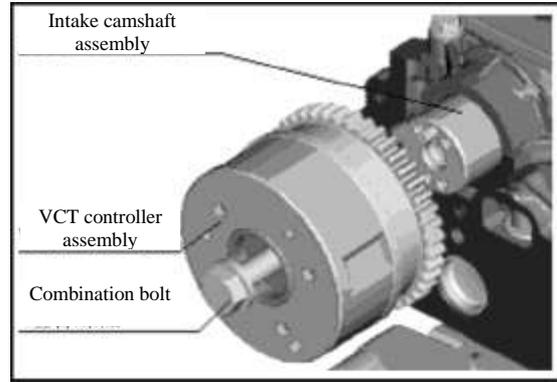
Loosen combination bolt. Remove VCT controller assembly.

(Note) 1. When removing VCT controller assembly, use open spanner to hold intake camshaft S24 hexagon to prevent intake camshaft from rotating.

2. Remove VCT controller assembly and then put it into a special container. Do not contaminate oil hole and damage gear.

5) Remove exhaust camshaft sprocket

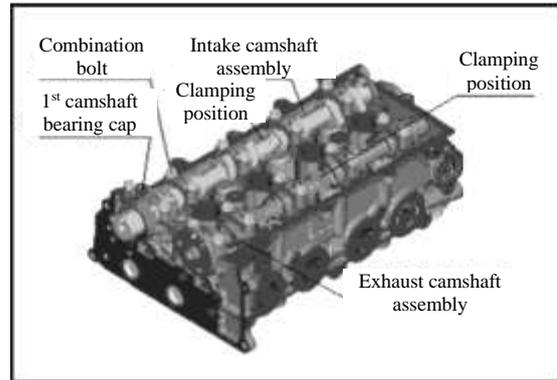
Use an open spanner to hold exhaust camshaft S24 hexagon to avoid exhaust camshaft from rotating. Loosen exhaust camshaft sprocket combination bolt.



6) Loosen 1<sup>st</sup> ~ 5<sup>th</sup> cam bearing cover bolts of intake/exhaust camshaft (20 bolts).

Note: 1. 1<sup>st</sup> cam bearing cap of camshaft is combination bearing cap of intake/exhaust camshaft.

- 2. After removing 1<sup>st</sup> ~ 5<sup>th</sup> cam bearing covers of camshaft, clean them to remove sealant.
- 3. After removing, put 1<sup>st</sup> ~ 5<sup>th</sup> cam bearing covers of camshaft into a special container. Do not lose location pin bush.





7) Remove intake/exhaust camshafts.

(Note) when taking down intake/exhaust camshafts, do not try to use a tool or other tools to pry or remove them forcedly to avoid damaging camshafts.

**Install**

1) Install camshaft according to reverse order of removing procedures.

2) For adjusting valve clearance, refer to 3.5 cylinder head installation 7)

3) After adjusting valve clearance, install intake/exhaust camshafts

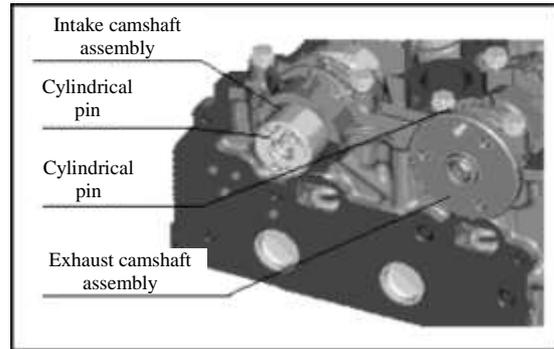
(1) When the piston of 1<sup>st</sup> cylinder is at TDC of compression stroke, rotate crankshaft by 90° along rotary direction of the engine (crankshaft angle).

(2) Pour several drops of lubricating oil on cylinder head camshaft seat hole and valve tappet top surface

(3) Keep cylindrical pins of intake/exhaust camshafts upwards, put them into exhaust camshaft

(4) Fasten cam bearing cap with combination bolt. Tightening torque of bolt is 12.5±2N·m.

Note: Recheck the clearance between the valve and tappet.



2-4 Cylinder head liner

**Removal**

1) After removing intake/exhaust camshafts according to “Remove intake/exhaust camshafts” section, remove cylinder head gasket.

2) Drain engine oil.

3) Disconnect exhaust front pipe.

4) Remove each hose.

5) Remove cylinder head bolt and washer.

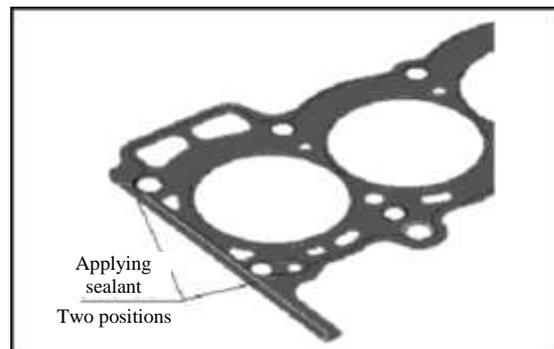
6) Remove cylinder head assembly.

7) Remove cylinder head gasket.

**Install**

1) Install cylinder head gasket.

Two positions of cylinder head gasket coated with glue: apply glue on the joint between cylinder block front end top surface and cylinder head gasket front end bottom/timing chain cover.

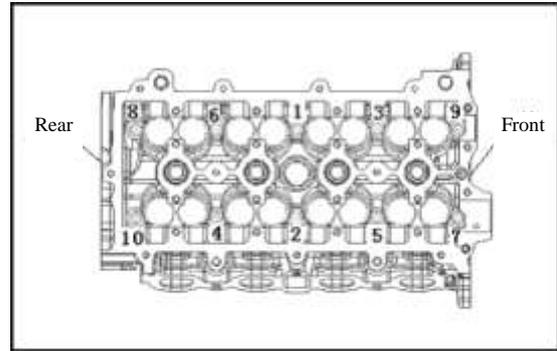




Align two pin holes of cylinder head gasket with locating ring on cylinder block and place it on cylinder block top surface.

(Note) Check cylinder head gasket thickness and if there is any defect. If necessary, replace with a new gasket.

Installation compression thickness of cylinder head gasket is more than 0.3mm.

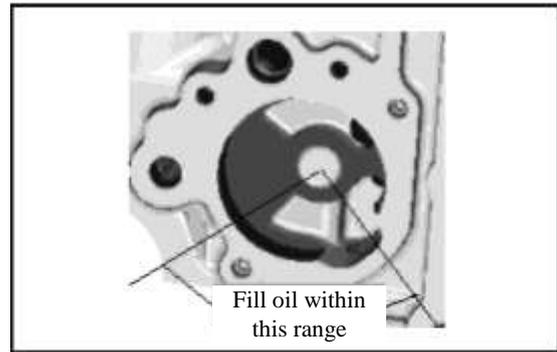


2) Install cylinder head assembly

① Clean cylinder head bottom and front end, align locating pin hole with locating ring on cylinder block and place it on cylinder head gasket carefully.

② Cylinder head bolt thread is applied by lubricating oil and then inserted into cylinder head bolt hole.

Tightening torque:  $34 \pm 2$ N.m, then rotate by  $120^\circ$ .



2-5 Remove and install engine oil pump

After removing timing chain and water according to "Remove Timing Chain and Water Pump" section, remove engine oil pump.

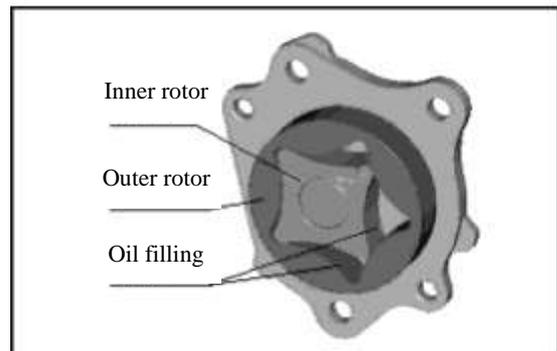
Remove engine oil pump

Loosen hexagon head flange bolt and remove engine oil pump. Check wear conditions of inner and outer rotors of engine oil pump.

Install engine oil pump

Fill lubricating oil into the clearance between inner and outer rotors of engine oil pump.

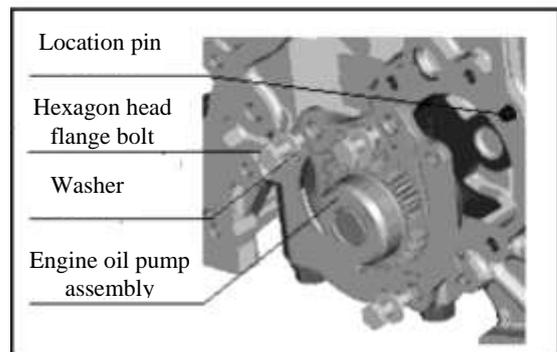
Fill lubricating oil from lower side of rotor mounting hole on cylinder block.



③ The mark on outer rotor faces to the outside of cylinder block.

④ Locate the bolt and washer with locating pin, and tighten them on front end of cylinder block. Tightening torque is  $9 \pm 1.8$ N.m.

(Note) Rotate engine oil pump sprocket by at least one turn to lubricate the rotor completely and run flexibly.





## Section 3 Engine Adjustment and Maintenance

### 3.1 Fuel guide rail assembly and fuel injector

#### Removal

1) Remove each plug for engine wire harness and fuel injector, and then remove wire harness.

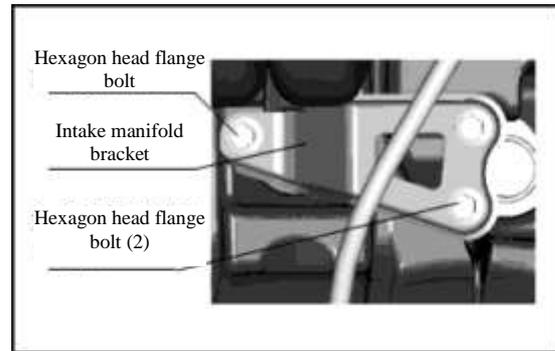
(Note) 1. Keep removed engine wire harness in good state, do not bend wire harness.

2. Do not damage each plug of engine wire harness.

2) Remove intake pipe bracket connected with intake manifold assembly.

(Note) Before removing intake pipe bracket, first remove hexagon head flange bolt connected with intake pipe bracket.

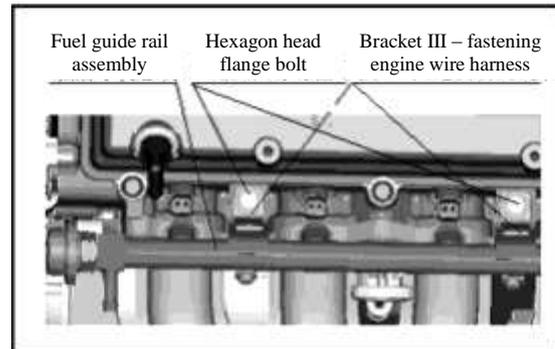
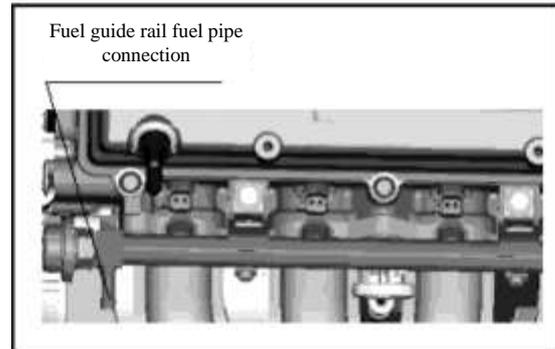
3) Remove fuel pipe.



4) Remove two hexagon head flange bolts tightening fuel guide rail assembly (with fuel injector), remove fuel guide rail assembly and engine wire harness bracket (2 brackets).

(Note) ① If it is difficult to remove it, please use a soft stick to pry fuel guide rail assembly uniformly. Do not pry it forcedly to avoid damaging fuel guide rail assembly.

② Do not use a wooden stick to pry fuel guide rail assembly directly to avoid damaging fuel guide rail and fuel nozzle.

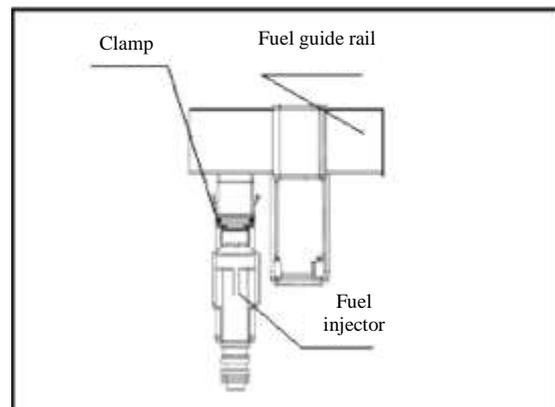


5) Remove fuel injector clamp and then fuel injector.

Remove fuel injector clamp by hand, hold fuel guide rail, rotate fuel injector and pull it up at the same time in order to remove fuel injector.

(Note) After removing fuel injector and fuel guide rail, put them in a clean and smooth place to avoid contaminating and knocking.

**Note:** Ripple damper assembly is assembled together with fuel guide rail. Do not detach them at will. If it is necessary to detach them, please observe the following operations.





1. Use a special clamp to fasten guide rail assembly. Use a special tool to remove ripple damper assembly. Do not apply axial force on fuel guide rail assembly. Otherwise, fuel guide rail will deform.

2. Remove fuel guide rail assembly of ripple damper assembly to check if there is any leakage.

**Check**

1) Check fuel injector

- ① Fuel injector surface is not damaged.
- ② Fuel hole is not blocked by any dirt.
- ③ Use an ohm gauge to measure fuel injector joint terminal resistance (refer to CA4GA1 Engine Maintenance Manual (electronic control))

2) Check the fuel guide rail assembly (including ripple damper assembly)

- ① Fuel guide rail surface has no crack, scratch, groove and corrosion.
- ② Ripple damper assembly surface has no crack, scratch, groove and corrosion. Thread surface is not deformed and damaged.
- ③ Two brackets for fuel guide rail assembly are in the same plane.
- ④ Measure fuel guide rail assembly pressure (including ripple damper assembly).

No leakage occurs at 490KPa

⑤ Measure cylinder head assembly fuel injector hole dimension: less than 13.2mm.

3) Check if each plug for engine wire harness body and fuel injector is damaged and broken.

4) For measuring fuel injector hole on cylinder head, refer to Cylinder Head section.

**Install**

1) Install ripple damper assembly onto fuel guide rail

Assembly ripple damper assembly and fuel guide rail according to the following operations.

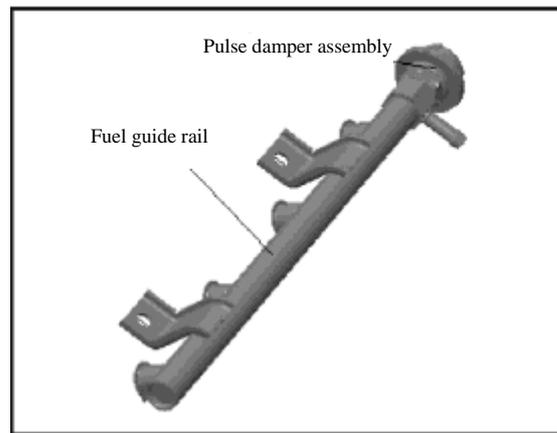
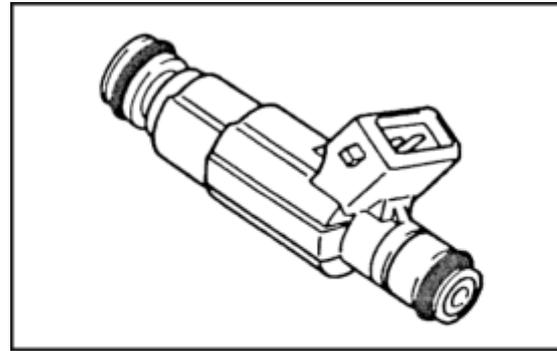
1. Use a special clamp to fasten guide rail assembly. Use a special tool to install ripple damper assembly. Do not apply axial force on fuel guide rail assembly. Otherwise, fuel guide rail will deform.

2. Install fuel guide rail assembly of ripple damper assembly. Leakage rate shall be measured.

Test with 100% dry air. Leakage rate shall not exceed 2.5ml/min.

3. Tightening torque of ripple damper assembly is 30±6Nm.

2) Install fuel injector on fuel guide rail assembly.



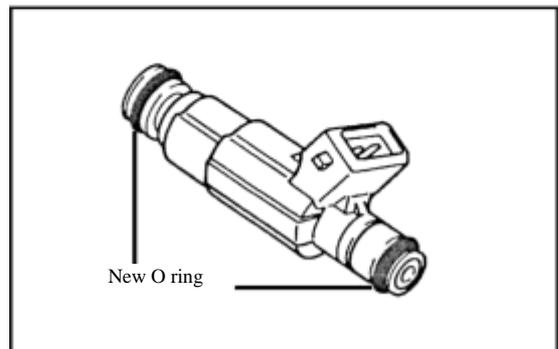
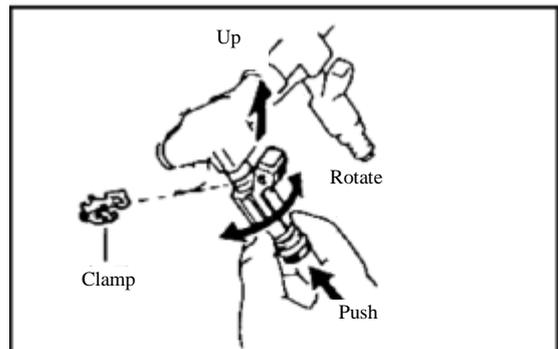
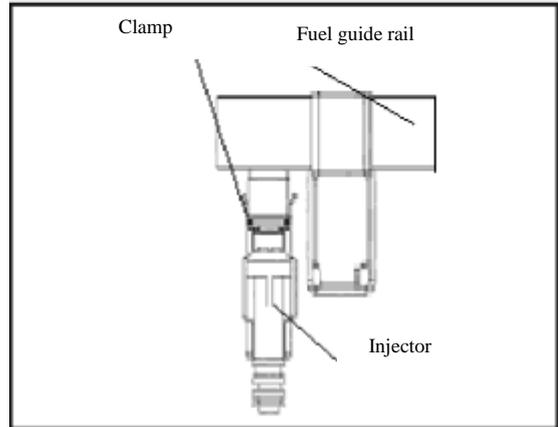
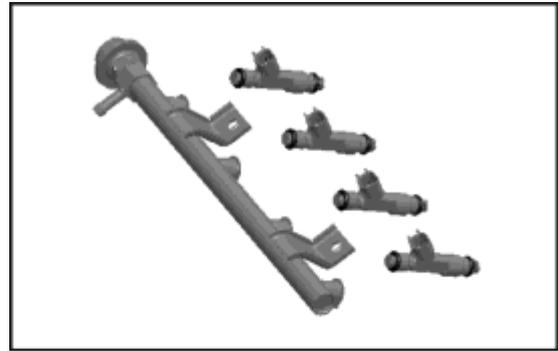


Apply a thin layer of engine lubricating oil on the new O ring.

Replace with two new O rings for fuel injector and place them into O ring slots of fuel injector.

Rotate fuel injector left and right and insert it into fuel guide rail at the same time. Keep fuel injector wire harness joint upwards.

Hold fuel injector with a clamp.





**Note:** 1. Put assembled fuel guide rail and fuel injector assembly in a clean place. Do not scratch and contaminate fuel injector.

2. Rotate fuel injector by hand, without stagnation.

3) Install fuel guide rail assembly

① Put fuel injector and fuel guide rail assembly into fuel injector hole of cylinder head.

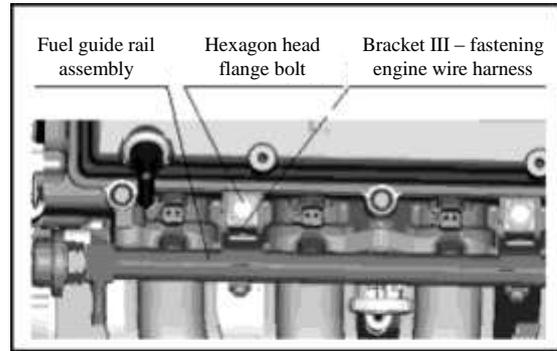
**Note:** Rotate fuel injector slightly. Do not insert it forcedly to avoid damaging fuel injector O ring.

② After inserting fuel injector, put fuel guide rail assembly on cylinder head, tighten fuel guide rail assembly and engine wire harness bracket with two hexagon head flange bolts.

Tightening torque:  $23 \pm 5$ N.m

**Note:** If it is not in the right position, it is allowed to use a soft stick to knock fuel guide rail assembly slightly.

4) Install each plug for engine wire harness and fuel injector, and install wire harness in right position.

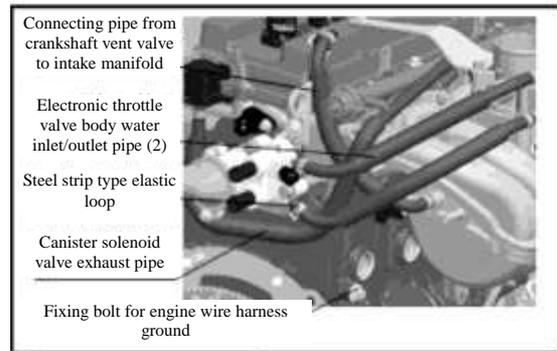
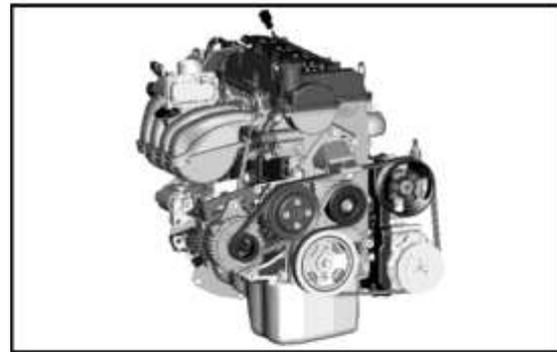


### 3.2 Intake system

#### Removal

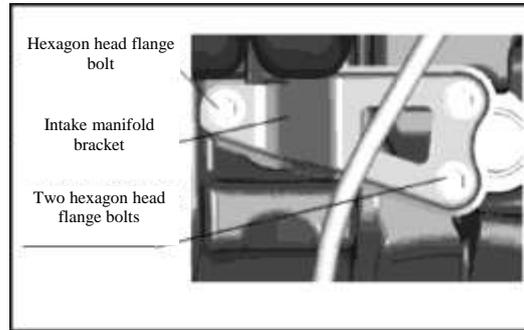
1) Remove air filter intake pipe and each connecting pipe of cylinder head cover.

2) Disconnect intake manifold and canister solenoid valve outlet pipe, disconnect connecting pipe from crankcase vent valve to intake manifold and fixing bolt of engine wire harness ground.



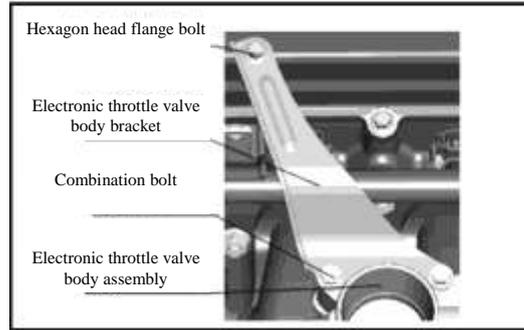


3) Loosen combination bolt of intake manifold bracket



Before removing intake manifold bracket, first remove hexagon head flange bolt connected with intake manifold to avoid damaging plastic intake manifold.

4) Remove electronic throttle body bracket

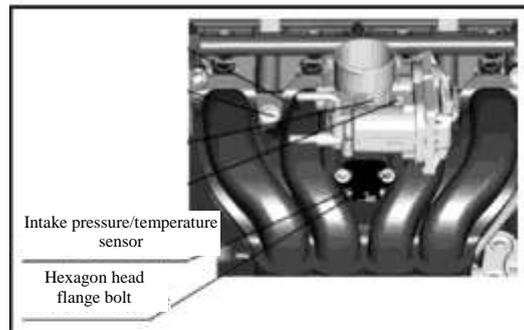


(Note) Do not damage throttle valve body, especially, do not make terminals contact grease or water.

5) Remove intake manifold assembly and seal ring.

Loosen hexagon head flange bolt of intake manifold assembly and remove intake manifold assembly. Be careful! Do not damage intake manifold assembly.

6) Remove intake pressure/temperature sensor.



**Check**

1) Check intake pressure sensor.

- ① The surface is not damaged.
- ② All pins are in good state and intake holes are not blocked.
- ③ Shake intake pressure sensor by hand slightly. No abnormal noise occurs.



2) Check intake manifold assembly

① Check if contact surface between intake manifold assembly and cylinder head/electronic throttle valve body is deformed.

Measure deformation on the diagonal line. If deformation exceeds the allowable limit, it is not allowed to trim it by means of grinding. Only other methods can be used except grinding.

Allowable limit: 0.50mm

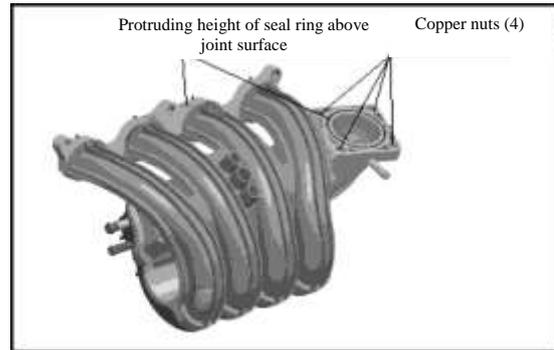
② Check air inlet seal washer and throttle valve body seal ring.

Air inlet seal washer and throttle valve body seal ring is made of silicon rubber. The color is red. When checking, no obvious scratch, breakage and burr are allowed. Otherwise, replace with new seal rings.

③ Check air inlet seal groove depth. No breakage and unedged phenomenon occur. Otherwise, replace intake manifold assembly.

Specified groove depth:  $4 \pm 0.1$ mm

④ Air inlet seal washer and throttle valve body seal ring are  $2 \pm 0.1$ mm above joint surface. The minimum shall not be less than 1.8mm.



④ Check pullout force of copper nut: M8: more than 2.7KN.

M6: more than 2.0KN.

⑤ Check if there is foreign object on inner and outer surfaces of intake manifold. If they are dirty, clean them with detergent.

⑥ Check leakage rate of intake manifold

At 0.11Mpa, hold the pressure for 8 seconds. Leakage rate:  $\leq 70$ mL

3) Check there is foreign matter on inner and outer surfaces of electronic throttle valve body. If necessary, please clean them with detergent.

Note: 1. The plug for electronic throttle body assembly is not corrosive and damaged. Connectors are fastened.

2. Place electronic throttle body assembly in a clean place. Do not damage and contaminate electronic throttle body assembly.





For check method, refer to CA4GA1 *Engine Maintenance Manual* (electronic control)

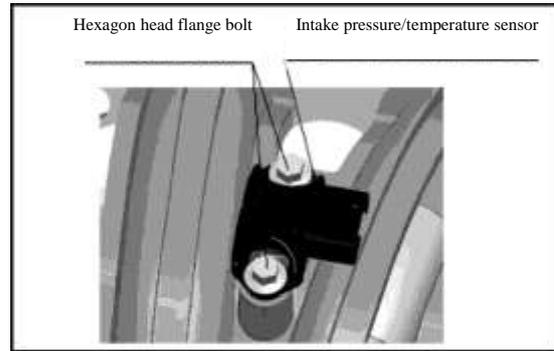
Install

1) Install air inlet seal washer and throttle valve body seal ring of intake manifold.

Install air inlet seal washer and throttle valve body seal ring into corresponding groove of intake manifold. It is allowed to apply a thin layer of lubricating oil on seal ring projection.

2) Install intake temperature/pressure sensor.

Intake temperature/pressure sensor is installed on intake manifold. Tightening torque of hexagon head flange bolt is 5-7 (target value 6) Nm.



3) Install intake manifold assembly.

① Clean air intake side surface of cylinder head

② Apply anti-loose glue on threads on the one end of stud and screw it in air intake side bolt hole of cylinder head. Tightening torque is  $6 \pm 2$  N.m.

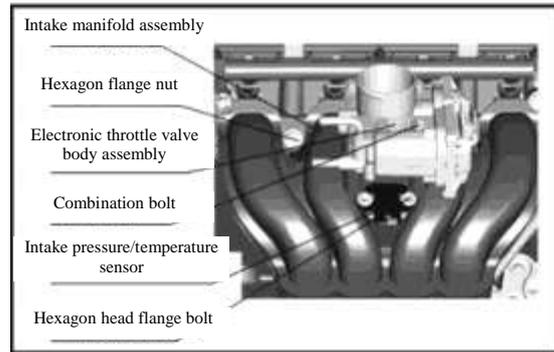
③ Put intake manifold assembly on the stud, and tighten it with nuts. Tightening sequence is from the middle and then left and right sides in turn. Tightening torque is  $19 \pm 4$  N.m

4) Install electronic throttle body assembly

Use four combination bolts to tighten electronic throttle body assembly. Tightening torque:  $10 \pm 0.2$  Nm.

5) Install intake manifold bracket

Install electronic throttle body bracket as shown in the Fig., tighten combination bolt (CQ1460650) and hexagon head flange bolt (Q18406 12) for electronic throttle valve. Tightening torque is  $9 \pm 2$  N.m.



6) Install vacuum boosting intake hose and canister solenoid valve hose.

7) Install air filter intake connection pipe and cylinder head cover connection pipe.

3.3 Exhaust manifold

Remove

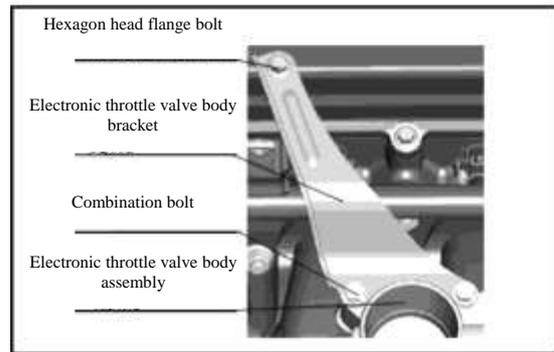
1) Remove upper and lower heat shields of exhaust manifold.

Disconnect connectors between front oxygen sensor and rear oxygen sensor/wire harness.

Loosen four M6 hexagon head flange bolts for upper heat shield of exhaust manifold.

Loosen four M6 hexagon head flange bolts for lower heat shield of exhaust manifold.

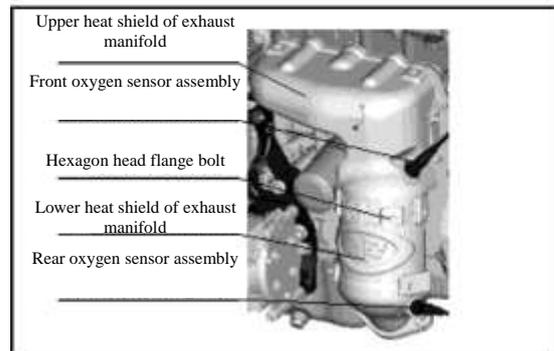
Remove upper and lower heat shields of exhaust manifold.



2) Remove front and rear oxygen sensors

Note: ① Do not use a tool to pry or knock oxygen sensor.

② Keep them proper to avoid them from contacting oil and water, which may be damaged.

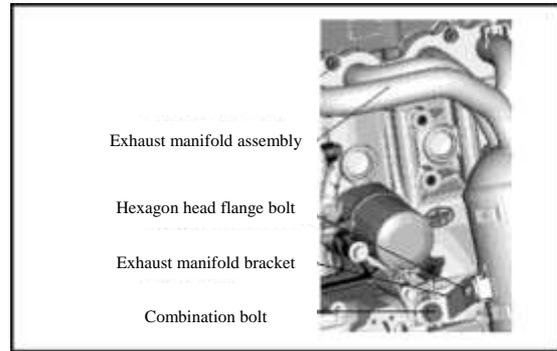




3) Remove exhaust manifold bracket

Loosen one M8 hexagon head flange bolt, and then loosen one M10 combination bolt. Remove exhaust manifold bracket.

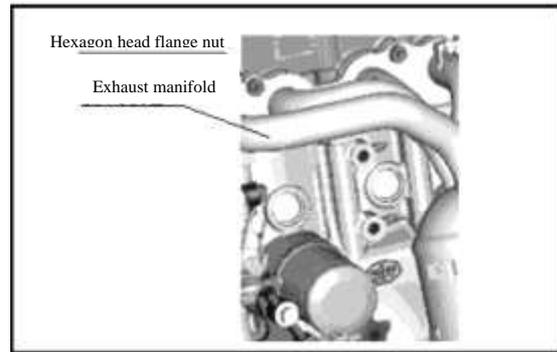
Note: First remove M8 hexagon head flange bolt.



4) Remove exhaust manifold

Loosen five M8 hexagon flange nuts and remove exhaust manifold.

Note: Do not place exhaust manifold at will to avoid impacting and damaging contact agent.

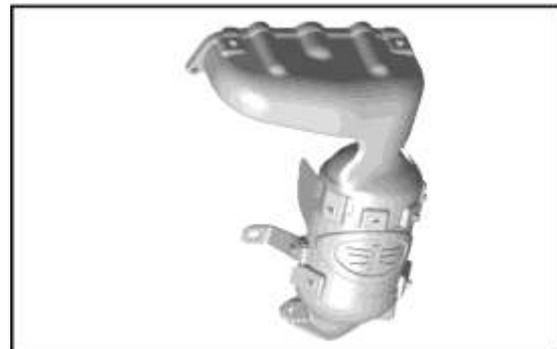


Check

1) Check exhaust manifold

Check if exhaust manifold flange is deformed. Allowable limit: 0.15mm

If the deformation exceeds allowable limit, repair it by means of grinding. But grinding amount shall not be greater than 0.25mm





2) Check if exhaust manifold catalyst is broken or cracked. If catalyst is damaged, replace the whole exhaust manifold.

3) Check exhaust manifold cushion assembly

① Check base material thickness of exhaust manifold cushion assembly: 0.6mm.

② Check protruding height of seal ring on both sides of exhaust manifold cushion assembly: less than 0.25mm.

③ Five connecting screws of exhaust manifold cushion assembly shall be in good state.

Install

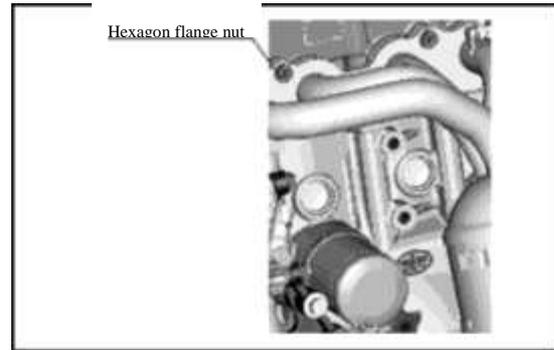
1) Install exhaust manifold subassembly

(1) Install exhaust manifold liner.

(2) Install exhaust manifold subassembly.

Tightening torque of hexagon flange nut is  $23 \pm 5$ N.m.

(Note) Tightening sequence is from the middle and then left and right sides in turn.



2) Install front and rear oxygen sensors

① Screw oxygen sensor into exhaust manifold hole by hand

Note: front and rear oxygen sensors are not the same. Front oxygen sensor is short and rear oxygen sensor is long.

② Tighten oxygen sensor

Tightening torque:  $45 \pm 5$ N.m.

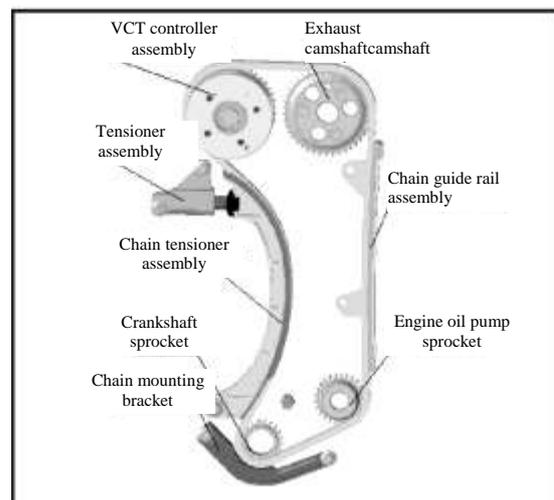
③ Connect oxygen sensor plug to wire harness and clamp it.

3) Install upper and lower thermal shields of exhaust manifold.

Tighten eight hexagon head flange bolts. Tightening torque of bolt is  $8 \pm 2$ N.m.

### 3.4 V-belt and timing chain

Timing chain composition





Remove

1) Remove V-belt

Loosen hexagon head flange bolt, but do not make it too loose.

Loosen adjusting bolt of the generator.

Remove V-belt.

Note: before removing, mark the running direction of V belt on the back of V belt with chalk (an arrow).



2) Remove water pump belt pulley.

Remove crank pulley

(1) When loosening crank pulley bolt, use a special maintenance tool to prevent the flywheel from rotating.

(2) Because tightening torque of crank pulley bolt is large, extended torque wrench can be used.

4) Remove engine front mounting bracket.

Loosen hexagon nut and combination bolt. Do not lose spring washer.

5) Remove idler assembly.

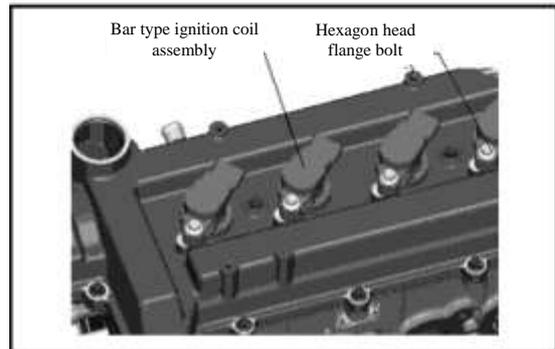
Remove hexagon nut. Do not lose washer and spring washer.

6) Remove engine oil filler cap assembly

7) Remove bar type ignition coil assembly

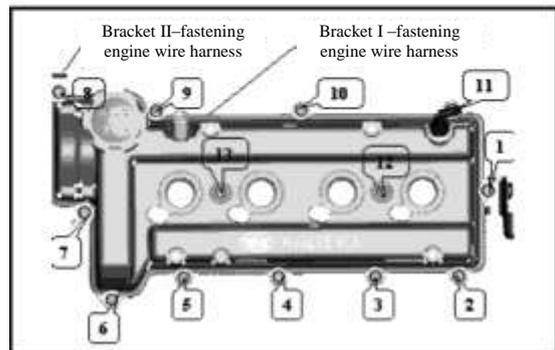
Loosen four hexagon head flange bolts and then take out bar type ignition coil assembly.

Note: When taking out bar type ignition coil assembly, if it is not easy to take out bar type ignition coil assembly, it is not allowed to use a screwdriver to pry bar type ignition coil assembly. Otherwise, bar type ignition coil assembly will be damaged.



8) Remove cylinder head cover assembly

Loosen hexagon head flange nut at (12) and (13) positions and bolts at (6) and (7) positions, and loosen bolts at other positions. Remove cylinder head cover assembly. (Note) put canister solenoid valve bracket (No. 1 position), engine wire harness bracket II (No. 8 position), engine wire harness bracket I (No. 7 position) and cylinder head cover gasket in a special container.





9) Remove chain chamber cover assembly

Note: Joint part between chain chamber cover and cylinder block is coated with anaerobic sealant. It is allowed to use a screwdriver or rubber hammer to knock it slightly when removing.

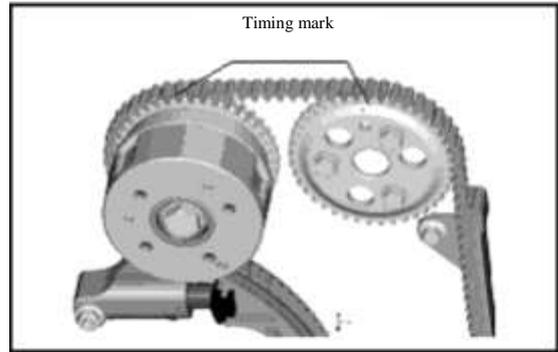


10) Remove chain mounting bracket.

11) Remove chain tensioner assembly.

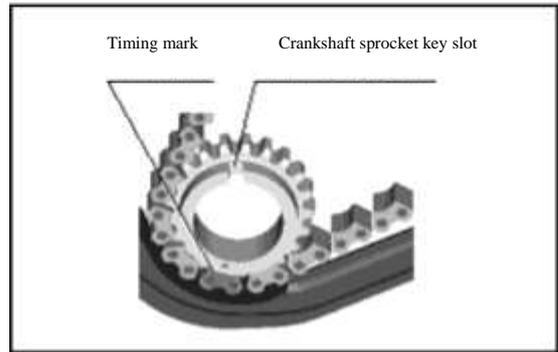
Keep timing marks on VCT controller assembly and exhaust camshaft sprocket upwards.

Note: now, timing mark of timing chain may not coincide with timing marks of VCT controller assembly and exhaust camshaft sprocket.



Keep crank shaft timing sprocket key slot upwards.

Note: now, timing mark of timing chain may not coincide with timing mark of crank shaft timing sprocket.



③ Loosen hexagon head flange bolt and hexagon flange nuts. Hold snap spring on chain tensioner by hand and fasten tensioner plunger and then remove chain tensioner assembly.

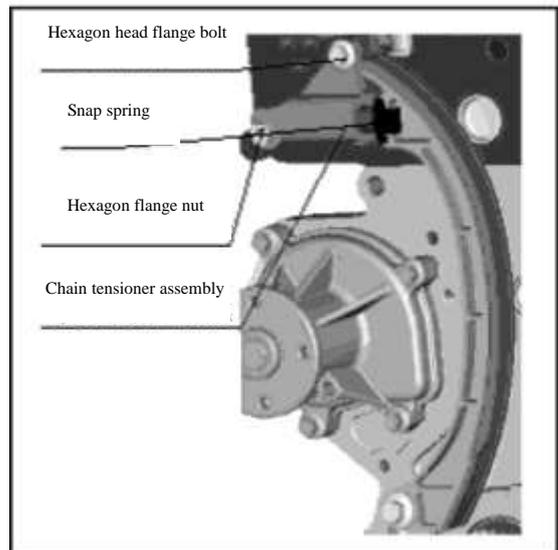
[Note] ① After removing chain tensioner, do not rotate crankshaft and camshaft. Otherwise, the piston and valve will collide, which damages these parts.

② After removing chain tensioner, do not loosen snap spring on the tension to avoid personal hurt.

12) Remove timing chain

[Note] ① When removing timing chain, do not bend chain sharply in small radius.

② When removing timing chain, do not use any screwdriver to pry or twist timing chain to avoid timing chain leaves from being damaged.

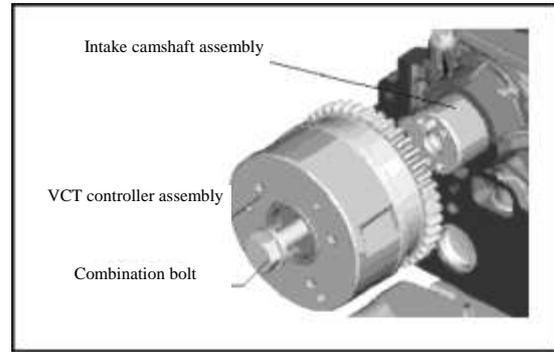




13) Remove exhaust camshaft sprocket

14) Remove VCT controller assembly

Note: Use S24 open spanner to hold intake camshaft hexagon to avoid intake camshaft from rotating.



15) Remove chain guide rail assembly and chain tension arm assembly.

16) Remove OCV control valve assembly

Check

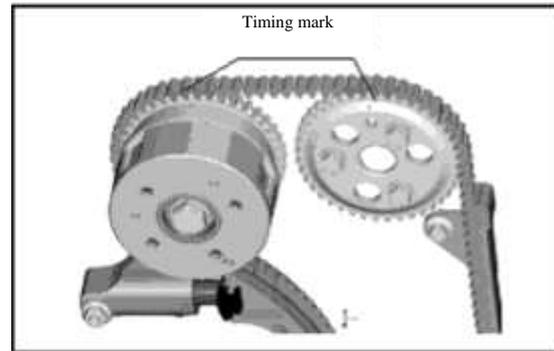
1) Check timing chain.

Check each part of the chain. If the following damage occurs, replace the chain.

- ① Chain leaf warped or deformed.
- ② Chain pin shaft bent or cracked.
- ③ Chain if leaf in the same line deformed or worn.

Note: In the following cases, even if no external damage occurs, it is also necessary to replace timing chain.

- ① Because water pump leaks, timing chain contacts water continuously.
- ② Because a lot of engine oil is on the chain, chain leaves are sticky.
- ③ Because camshaft is stuck, the chain may bear applied force excessively.



2) Check chain tensioner assembly

Lubricating oil hole of chain tensioner assembly is smooth, without oil dirt.

② Chain tensioner assembly tension is good and snap ring is not damaged.





3) Check chain guide rail assembly

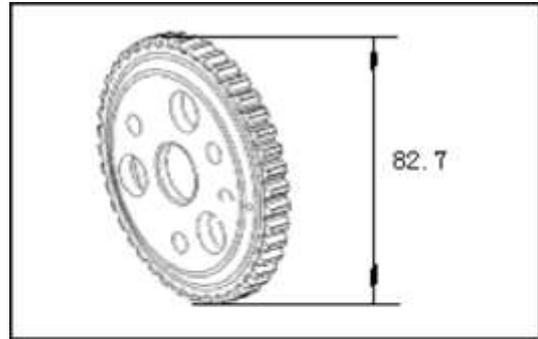
If deep scratch, groove and overlap occur on chain guide rail surface, replace chain guide rail assembly.

4) Check chain tension arm assembly

If deep scratch, groove and overlap occur on tension arm, replace chain tension arm assembly.

5) Check exhaust camshaft sprocket

Exhaust camshaft sprocket wear limit: 82.7mm.



6) Check VCT controller assembly sprocket

VCT controller assembly sprocket wear limit: 82.7mm.

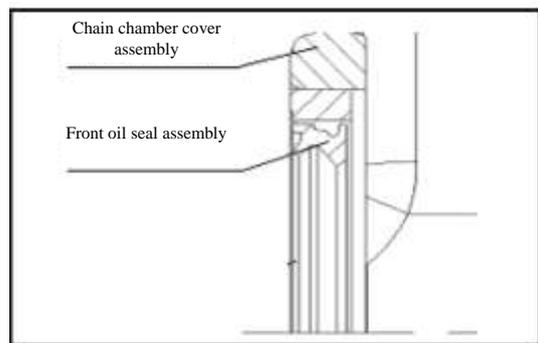


7) Check chain gear cover assembly

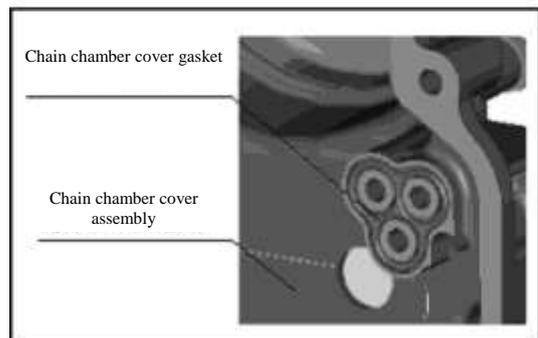
Check front oil seal assembly

Check front oil seal assembly lip. If any gap, wrinkle or crack occurs, replace front oil seal assembly.

Check front oil seal assembly spring. If breakage, extension and skipping occur, replace front oil seal assembly.



Replace it with new chain gear cover gasket



③ Check each seal surface of chain gear cover assembly is in

good state and has no crack, sand hole and warping. Otherwise, replace chain gear cover assembly.

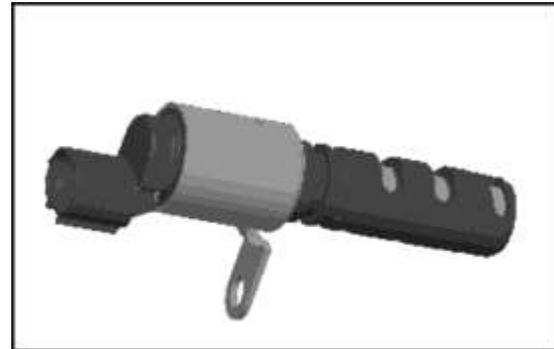
8) For checking V-belt, refer to 3.1.

9) Check OCV control valve assembly

Minimum valve diameter of OCV control valve assembly shall be larger than  $\phi 17.7\text{mm}$ . If the measured value is less than the minimum valve diameter, replace OCV control valve assembly.

② Check oil inlet duct hole, oil drainage duct hole, phase advance oil duct hole and phase delay oil duct hole of OCV control valve assembly. If scale formation occurs, replace OCV control valve assembly.

Note: For OCV control valve assembly in details, please refer to CA4GA1 *Engine Maintenance Manual* (electronic control).



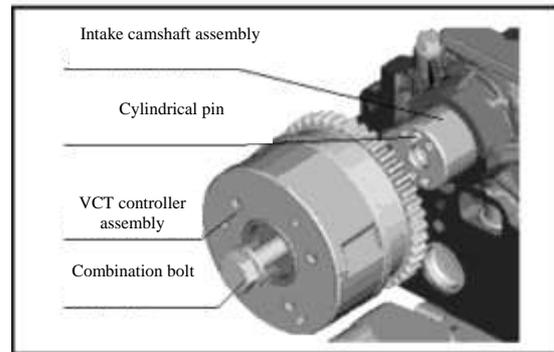
### Install

1) Install VCT controller assembly

Fasten intake camshaft with a special tool, pour several drops of lubricating oil on the front end journal of intake camshaft, align pin hole of VCT controller assembly with cylindrical pin on camshaft.

After inserting, twist the sprocket slightly to check if location pin is inserted into location hole.

Tighten VCT controller assembly on camshaft with combination bolt. Tightening torque is:  $47 \pm 7\text{N}$ .

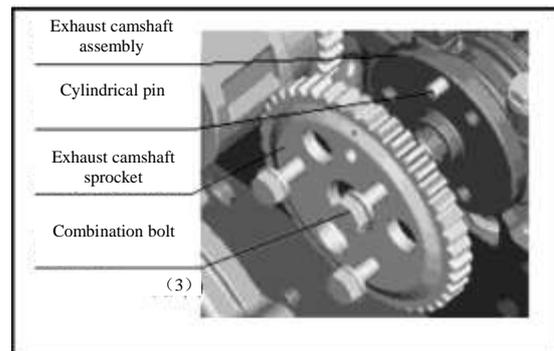


2) Install exhaust camshaft sprocket

① Use a special tool to fasten exhaust camshaft, align pin hole on exhaust camshaft sprocket with the pin on camshaft and place it on exhaust camshaft.

Note: After inserting, twist the sprocket slightly to check if location pin is inserted into location hole.

Tighten the sprocket on camshaft with combination bolt. Tightening torque is  $8 \pm 1.6\text{N.m}$ .



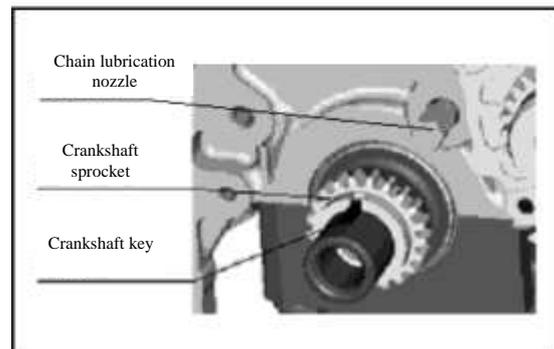
3) Install crankshaft sprocket

① Use a special tool to fasten crankshaft, keep crankshaft sprocket slot side outwards and make sprocket key slot and crankshaft key slot coincide.

② Install crankshaft key

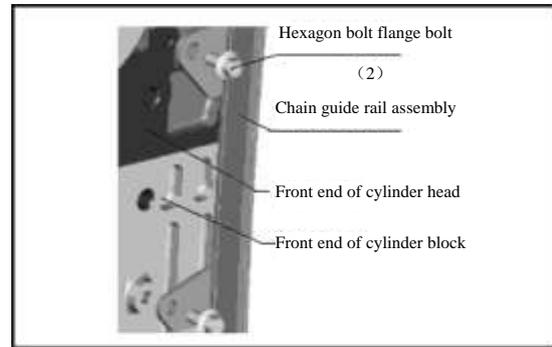
4) Install chain lubrication nozzle

Apply anaerobic sealant on threads of chain lubrication nozzle and install it on cylinder block front end, tighten it and keep injecting hole downwards.



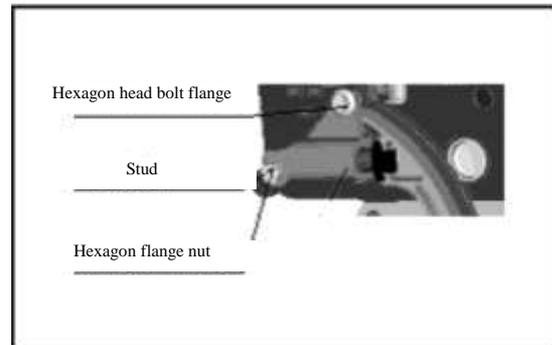
**5) Install chain guide rail assembly**

Install chain guide rail assembly on cylinder block and cylinder head front end. Tightening torque of bolts is  $8 \pm 2 \text{N.m}$ .


**6) Install tensioner assembly**

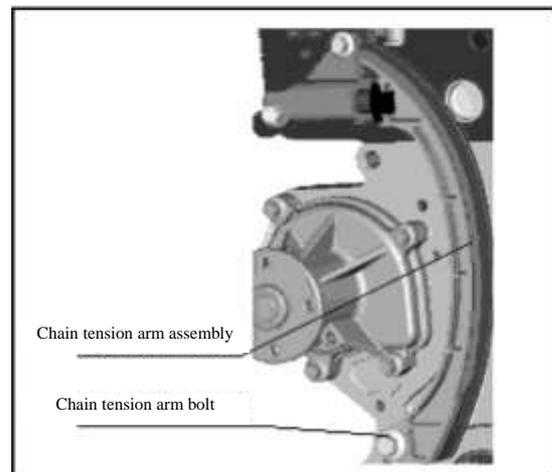
Stud is installed on cylinder head front end.

Tightening torque for installing chain tensioner assembly, stud and nut is  $9 \pm 1.8 \text{Nm}$


**7) Install chain tension arm**

Chain tension arm assembly is installed on cylinder block and cylinder head block front end. Tightening torque of chain tension arm bolt is  $19 \pm 3.8 \text{N.m}$ .

Note: after tightening chain tension arm bolt, chain tension arm shall move flexibly.

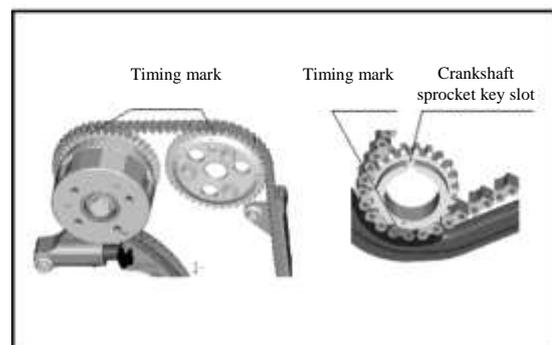

**8) Install timing chain**

Keep timing marks of VCT controller assembly sprocket and exhaust camshaft sprocket upwards, rotate crankshaft to make crankshaft sprocket key slot upwards.

Install timing chain and align timing mark (yellow leaf) with timing mark on the sprocket.

Note: If there is no timing mark on replaced timing chain, make timing mark according to the following requirements.

There are 14 teeth between timing mark of VCT controller assembly sprocket and timing mark of exhaust camshaft sprocket, 78 teeth between timing mark of VCT controller assembly sprocket and timing mark of crankshaft sprocket, and 78 teeth between timing mark of exhaust camshaft sprocket and timing mark of crankshaft sprocket.





③ When installing timing chain, do not twist the chain too much to avoid damaging timing chain.

9) Tighten tensioner assembly

Hold snap spring on chain tensioner by hand to make tensioner plunger pop out to tension timing chain.

Rotate crankshaft by two turns in normal direction (clockwise) to check if each sprocket position returns to installation position.

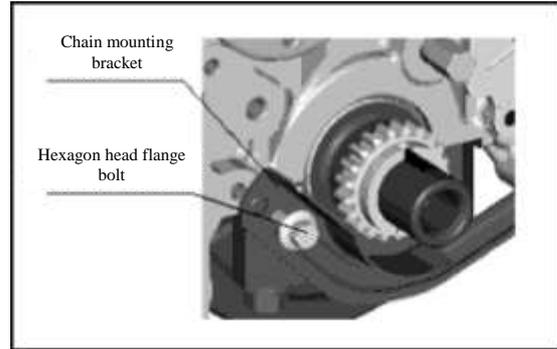
Note: ① Before holding snap spring on chain tensioner, please check if marks on timing chain coincide with timing marks of each sprocket.

② Please check if the plunger extension is 9-12mm.

③ When rotating crankshaft, do not exert force on timing chain.

10) Install chain mounting bracket

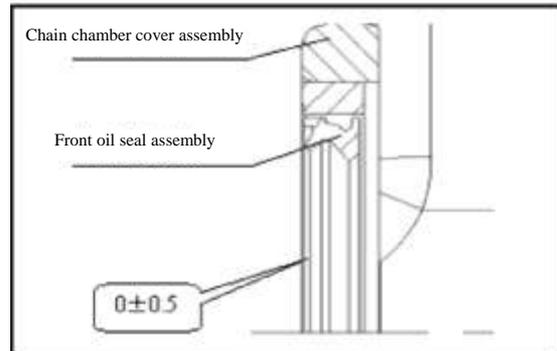
Fasten chain mounting bracket on cylinder block front end with hexagon head flange bolt. Tightening torque of the bolt is  $8 \pm 2N.m$ .



11) Install chain chamber cover assembly

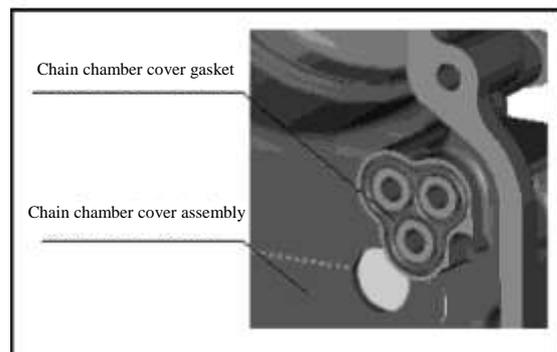
① Install front oil seal assembly

Clean front oil seal assembly, and press it into chain chamber cover hole with a special tool. The depth from cylinder block joint surface:  $0 \pm 0.5mm$ .



② Install gasket

Apply some lubricating oil on chain chamber cover gasket and press it into the groove of OCV control valve to which chain chamber cover and cylinder head correspond. Be careful to avoid falling off.





③ Install chain chamber cover assembly

(1) Apply anti-loose glue on threads on one end of two studs and screw in front end of cylinder head.

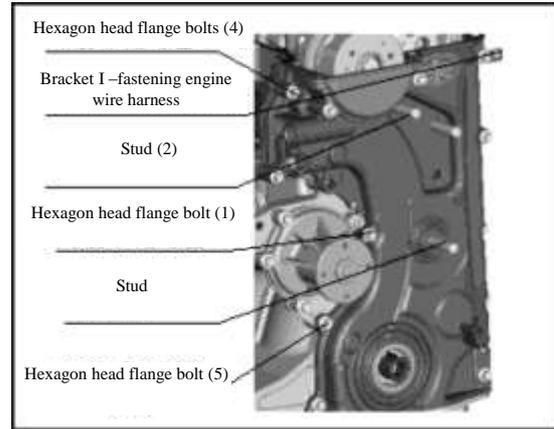
(2) Apply anaerobic sealant on joint between chain chamber cover and cylinder block uniformly, align it with location pin hole on front end of cylinder head and press it into the hole. It is allowed to use a wood or rubber hammer to knock it slightly.

Note: After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.

(3) Fasten it with hexagon head flange bolt. Tightening torque is  $12 \pm 2.4 \text{N.m}$ . Engine wire harness bracket I and cover share one bolt.

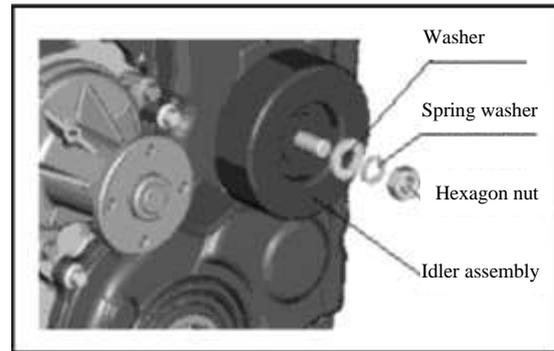
(4) Apply anti-loose glue on threads on one end of one stud and screw in front end of cylinder head.

Apply anti-loose glue on threads on one end of two studs and screw in front end of cylinder head.



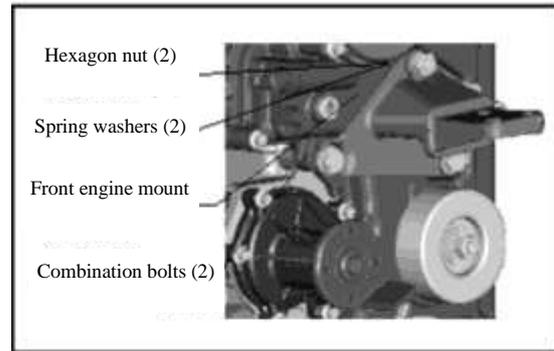
12) Install idler assembly

Install idler assembly on cylinder block front end and tighten it with studs. Tightening torque of the nut is  $44 \pm 9 \text{N.m}$ .



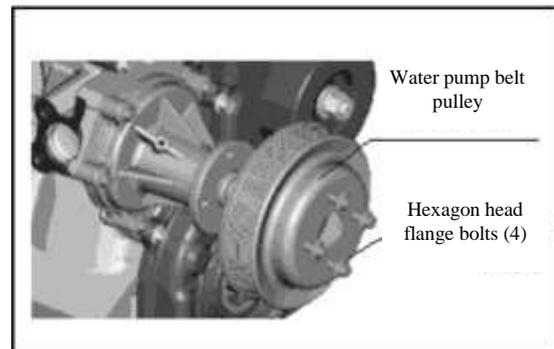
13) Install front engine support

Install it on front end of timing chain cover. Tightening torque of bolt is  $51 \pm 10 \text{N.m}$ .



14) Install water pump belt pulley

Tightening torque of bolt:  $11.5 \pm 2.5 \text{N.m}$





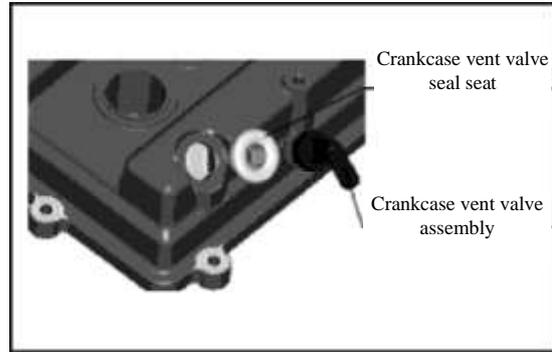
15) Install cylinder head cover assembly

① Install crankcase vent valve seal adapter

Apply some lubricating oil on crankcase vent valve seal adapter surface and press it into corresponding hole on the cover.

② Install crankcase vent valve assembly

Apply some lubricating oil on crankcase vent valve assembly surface, insert it into seal adapter of crankcase vent valve.



③ Install cylinder head cover assembly and wire harness

(1) Put cylinder head cover gasket into gasket slot on cylinder head. Apply glue on the joints (2 positions) between corresponding cylinder head and timing chain cover.

Note: After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.

(2) At ⑥ and ⑦ positions, use M6×20 bolts.

(3) At ⑫ and ⑬ positions, use M6×55 studs and M6 hexagon head flange nut.

(4) At other positions, use M6×25 bolts, tightening torque is 9-13 (target value 11) N.m.

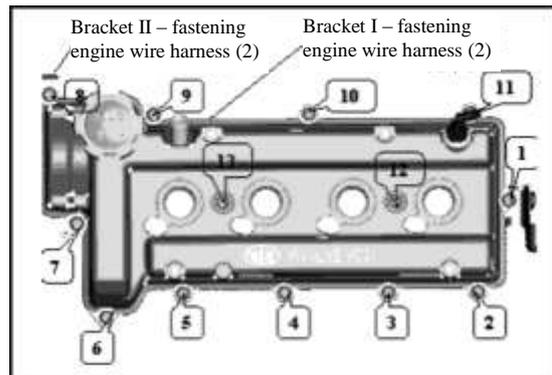
(5) Canister solenoid valve bracket and cylinder head cover share M6×25 bolt at ① position as shown in the following Fig.

(6) Engine wire bracket II and cylinder head cover share M6×25 bolt at ⑧ position as shown in the following Fig.

(7) Engine wire harness bracket I and cylinder head cover share M6×20 bolt at ⑦ position as shown in the following Fig.

Note: M6 hexagon head flange nuts at ⑫ and ⑬ positions fall into spark plug hole easily. When installing, pay attention to it. If they fall into spark plug hole, take them out with a magnetic bar.

④ Install engine oil filler cap on cylinder head cover by rotating.



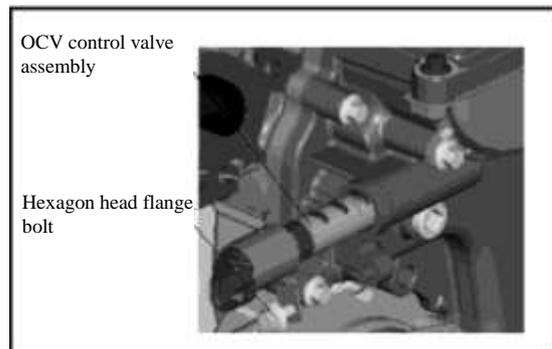
16) When installing bar type ignition coil assembly, refer to "Ignition System"

17) Install OCV control valve assembly

Install OCV control valve assembly in corresponding hole of chain chamber cover. Tightening torque of bolt is 8±2N m.

18) Install engine oil filler cap assembly

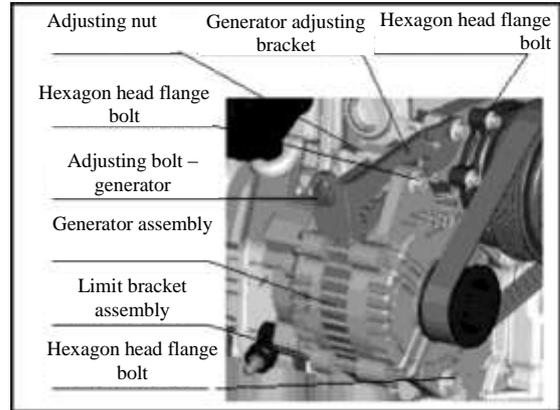
After applying lubricating oil on rubber washer of engine oil filler cap, install it on cylinder head cover assembly by rotating.



19) Install generator assembly

Adjusting bracket of the generator is fastened on cylinder block. Tightening torque of bolt is  $24 \pm 5 \text{N.m}$ . Note: make sure lifting lug of the generator can slide along adjusting bracket slot of the generator.

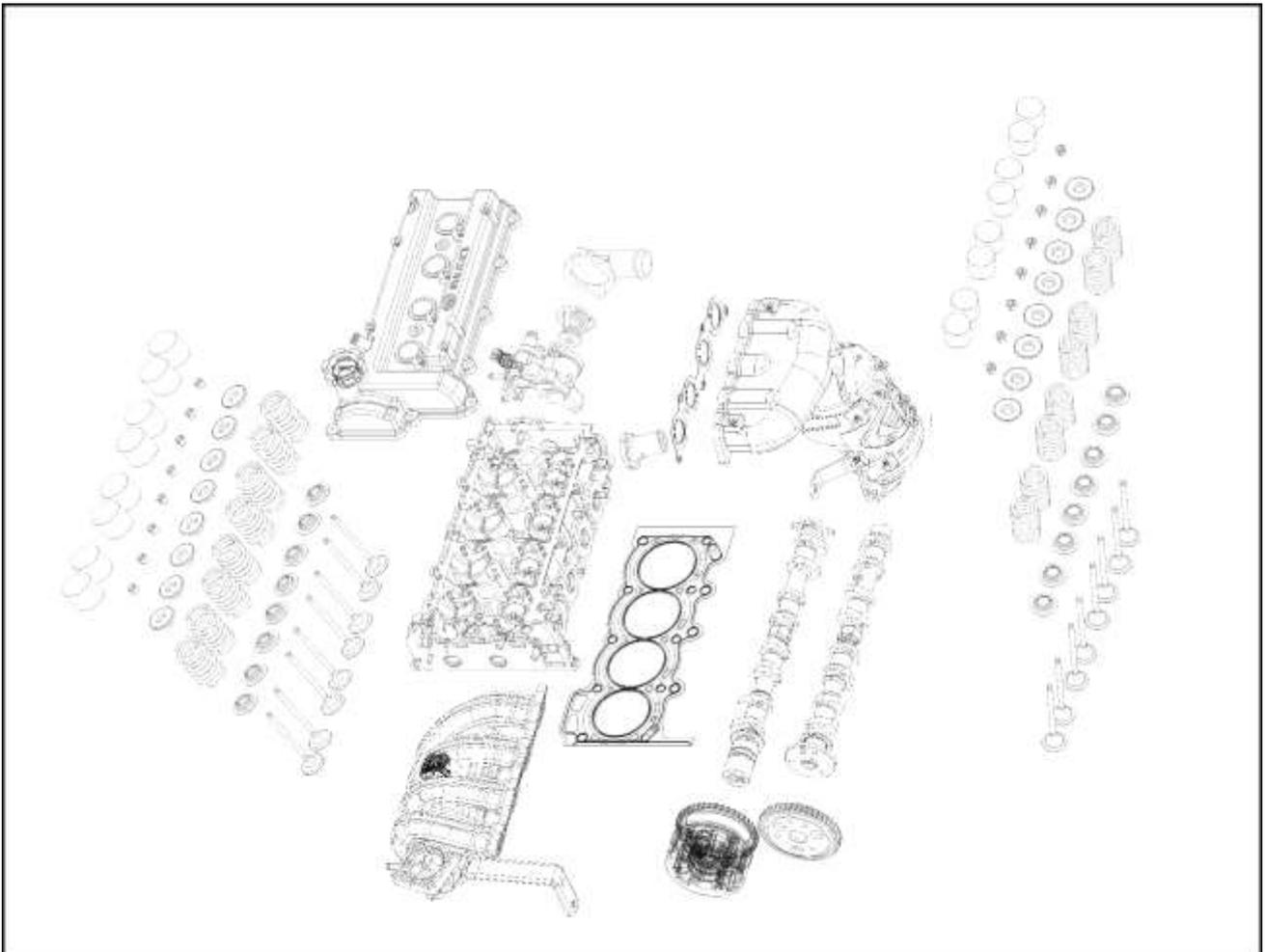
Install generator assembly: install it on cylinder block front end and adjusting bracket of the generator through hexagon head flange bolt and adjusting nut. Do not tighten the bolt temporarily.



20) When installing V belt, refer to corresponding section in “Cylinder Block”

3.5 Cylinder Head

Cylinder head composition





Remove

Remove bar type ignition coil assembly.

Remove spark plug.

Remove cylinder head cover assembly, liner and wire harness bracket I and II.

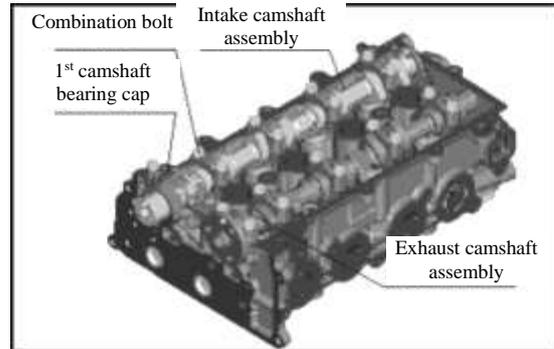
Remove canister solenoid valve bracket and canister solenoid valve.

Remove camshaft position sensor.

Remove 1<sup>st</sup> ~ 5<sup>th</sup> camshaft bearing caps. Loosen 20 bolts twice or three times uniformly and then remove them.

Loosening method as follows: 1. Loosen 1<sup>st</sup> camshaft bearing cap bolt. First loosen 2 bolts inside and then loosen other two bolts, remove 1st camshaft bearing cap.

2. Loosen other camshaft bearing caps. Loosening sequence of camshaft bearing cap is from outside to inside alternatively.



Note: 1. Do not lose location pin bush on camshaft bearing cap.

2. When removing camshaft bearing cap, do not knock or pry with a hard object. Otherwise, it may damage camshaft bearing cap.

3. After removing camshaft bearing cap, put it into the container in order.

7) Remove intake/exhaust camshaft

(1). Use S24 open spanner to hold exhaust or intake camshaft hexagon, rotate camshaft to keep camshaft peach away from tappet surface.

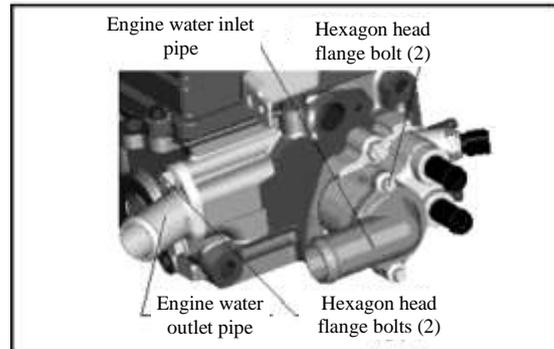
(2) Shake camshaft by hand to remove it.

(Note) 1. If camshaft can not be lifted straight, it is necessary to tighten 3<sup>rd</sup> camshaft bearing cap bolt again. Shake camshaft by hand to loosen it. Loosen 3<sup>rd</sup> camshaft bearing cap bolt again and remove camshaft.

2. Do not use a tool or other objects to pry camshaft or take it down forcedly. Otherwise, it may be broken.

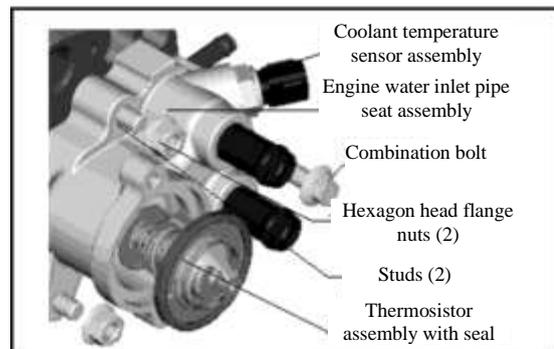
8) Remove valve tappet.

9) Loosen water inlet and outlet pipes.



10) Loosen water inlet seat, thermistor and coolant temperature sensor.

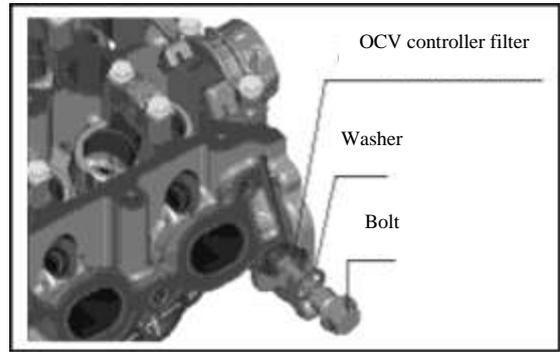
Use an open spanner to remove coolant temperature sensor. Do not use any impact tool.





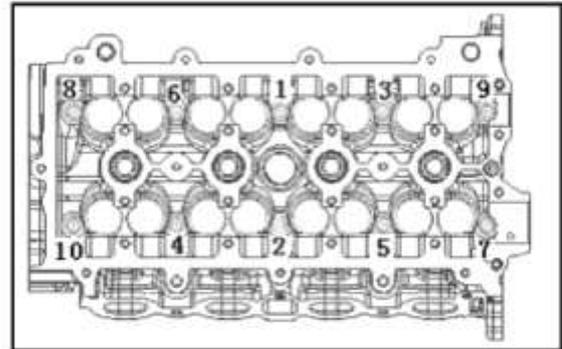
11) Remove OCV control valve filter

Loosen the bolt, take out the washer and OCV control valve filter. Please put OCV control valve filter into a special container to avoid damaging.



12) Loosen cylinder head bolt

According to the sequence (⑩→①) as shown in the Fig., loosen cylinder head bolt twice or three times gradually.

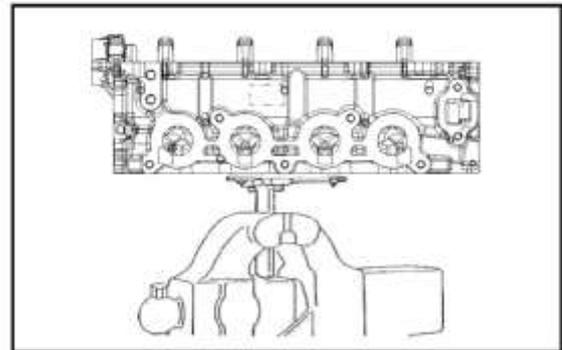


(2) Take out cylinder head bolt and washer with a magnetic bar.

13) Remove cylinder head assembly

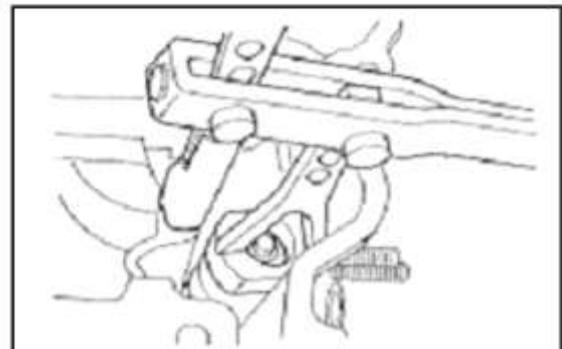
Remove cylinder head. Fasten the cylinder on a special maintenance tool and fix the special tool on the vise reliably.

(Note) Be careful! Do not scratch joint surface between cylinder head and the liner.



14) Remove valve lock.

Press valve spring with a special tool. Remove valve lock.



Note: for the parts removed according to 15~18, put them in group according to valve or cylinder to know installation position in advance.

15) Remove valve spring seat.

16) Remove valve spring.

17) Remove valve.

18) Remove valve stem pipe oil seal.

19) Remove valve spring washer.

Note: Clean removed parts with detergent and dry them with compressed air. Do not use any cloth or similar objects to clean parts.

20) Remove cylinder head from a special maintenance tool.

Check

Check cylinder head

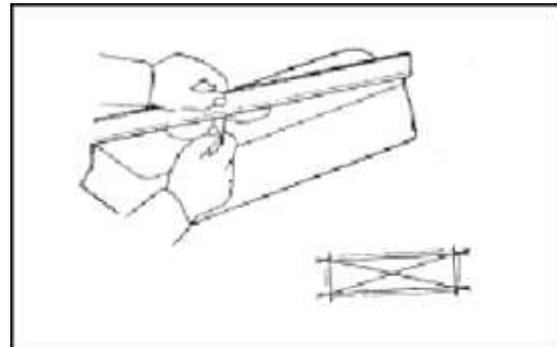
(1) Check if cylinder head is cracked, damaged and deformed. If it is cracked or damaged, replace cylinder head if necessary.

Check if cylinder head is deformed on three surfaces.

1. Deformation of joint surface between cylinder head and cylinder head gasket assembly.

Maximum limit: 0.05mm.

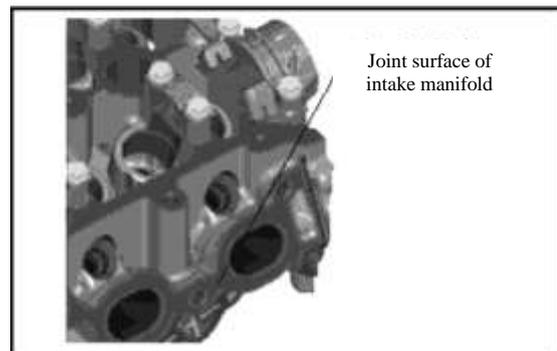
If joint surface deformation exceeds the maximum limit, it is necessary to repair the surface. But the height shall not be less than 112.9 mm.



2. Deformation for intake manifold joint surface

Maximum limit: 0.08mm.

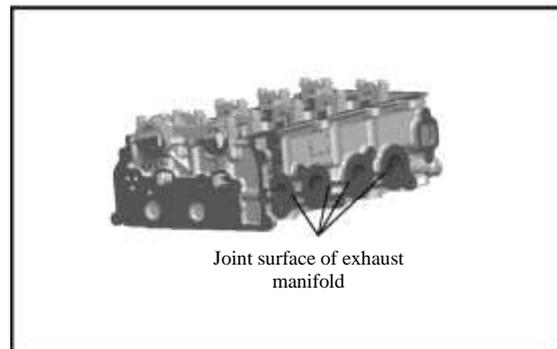
Included angle between intake manifold joint surface and the bottom is 68°.



3. Deformation of exhaust manifold joint surface

Maximum limit: 0.08mm.

If deformation of exhaust manifold joint surface exceeds the maximum limit, repair it. The distance from location pin hole on the bottom shall be not less than 124.8mm.

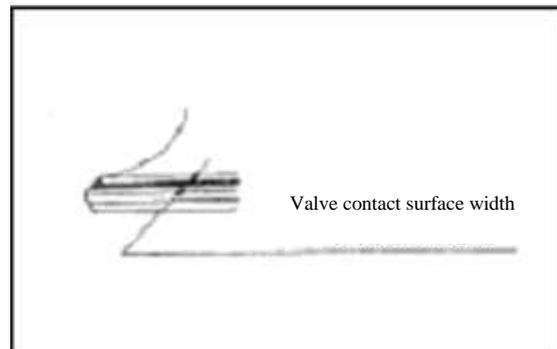


(2) Check valve seat.

Apply one thin layer of red lead oil on valve seat.

Let the valve fall onto the valve seat twice or three times by dead weight, take out the valve, and measure valve seat contact surface width. Specified value of contact width: 1.1~1.3 mm.

Note: If contact surface between valve and valve seat does not conform to specifications or contact surface is broken, or rough, repair cylinder head. If necessary, replace cylinder head.



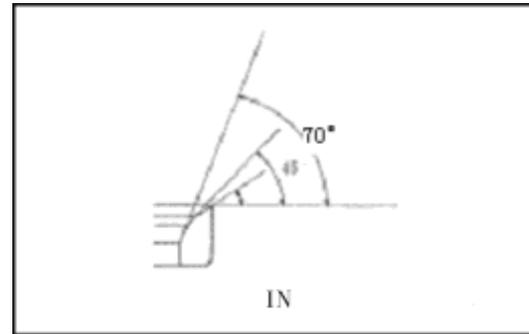


1. Repair valve seat surface again. Use a valve seat reamer to repair valve seat.

Note: If valve guide pipe is worn, first replace and then repair valve seat.

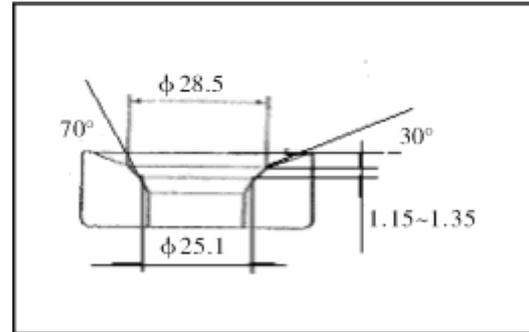
Repairing steps for intake valve seat:

Repair rough contact surface of valve seat with 45° reamer.

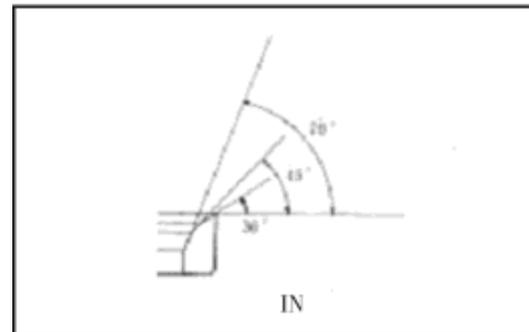


Repair valve seat with 30° reamer to change perimeter of the seat repaired with 45° reamer to φ26.9 mm (as shown in the Fig.).

Repair valve seat with 70° reamer to change perimeter of the seat repaired with 45° reamer to φ25.1 mm (as shown in the Fig.).

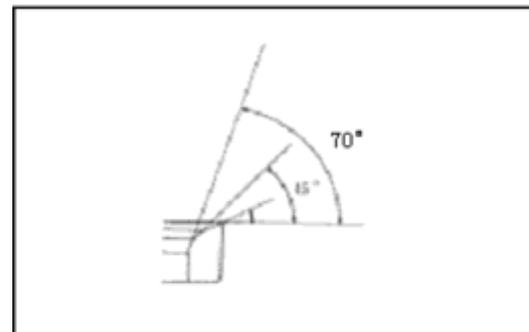


Use 45° reamer to remove the burr generated during the course of repairing by 30° reamer



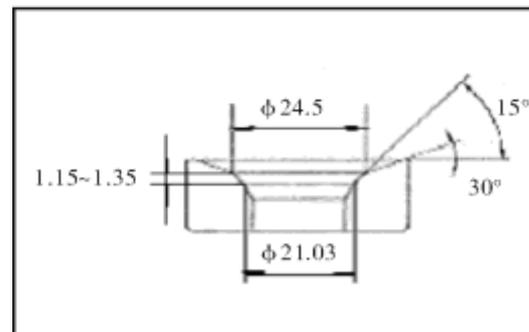
Repairing steps for exhaust valve seat:

Repair rough contact surface of valve seat with 45° reamer.



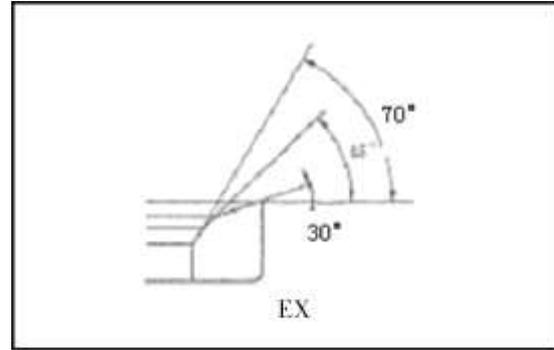
Repair valve seat with 30° reamer to change perimeter of the seat repaired with 45° reamer to φ22.8 mm (as shown in the Fig.).

Repair valve seat with 70° reamer to change perimeter of the seat repaired with 45° reamer to φ21.03mm (as shown in the Fig.).





Use 45° reamer to remove the burr generated during the course of repairing by 30° and 70° reamers



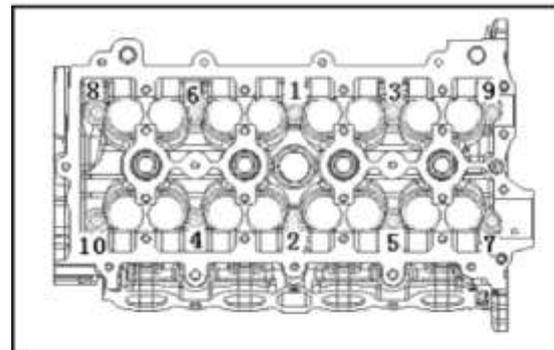
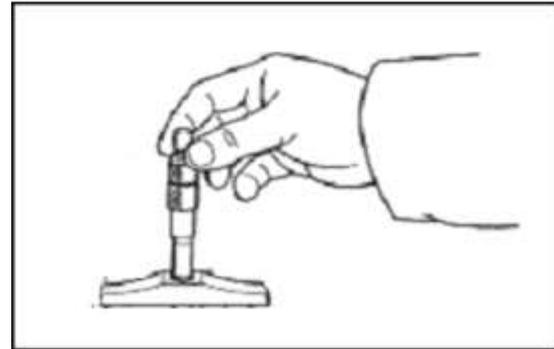
2. Check valve sinkage.

After repairing valve seat, place a new valve. Measure the distance between joint surface of cylinder block and cylinder head (contact surface of cylinder head gasket) and the highest of valve. Make sure the distance shall not exceed the following limit value.

Maximum limit value: Intake valve: 2.855 mm

Exhaust valve: 3.01 mm

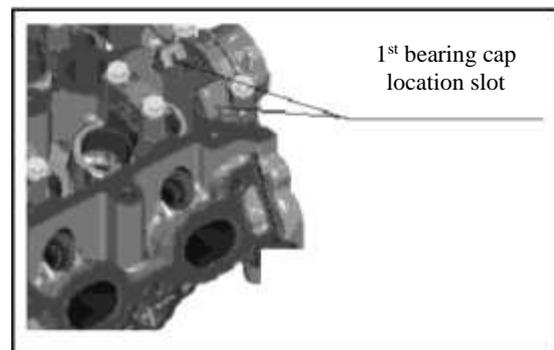
Note: if sinkage exceeds the maximum limit, replace cylinder head.



Check camshaft bearing cap.

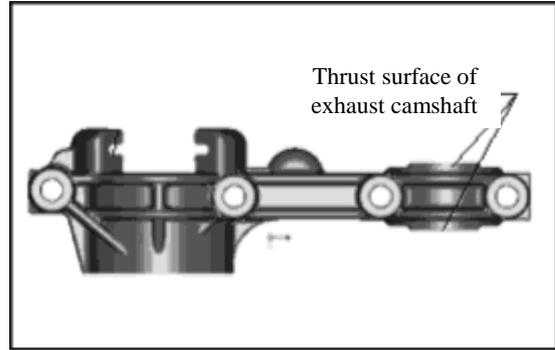
1. Check if camshaft bearing cap and camshaft bearing support are peeling off or burnt. If they are damaged, replace the complete set of camshaft bearing cap and cylinder head.

2. Check location slot width for 1<sup>st</sup> bearing cap intake camshaft side: 3~3.05mm. If it cannot meet the requirement, replace the complete set of cylinder head assembly.





3. Check thrust surface width of 1<sup>st</sup> bearing cap exhaust camshaft side: 21~21.05mm. If it cannot meet the requirement, replace the complete set of cylinder head assembly.



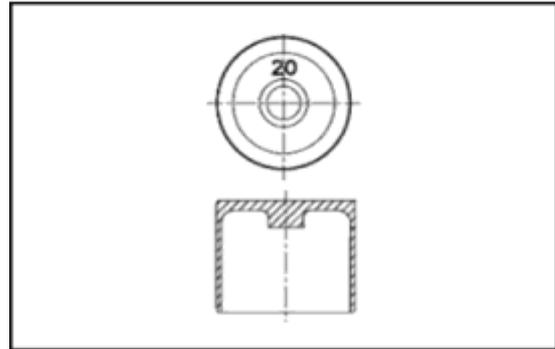
Check valve tappet.

1. Check if there is any slide mark on the top of valve tappet. If there is deep slide mark or sintering, replace the valve tappet.

2. Check if there is any slide mark on cylindrical surface of valve tappet. If there is deep slide mark or sintering, replace the valve tappet.

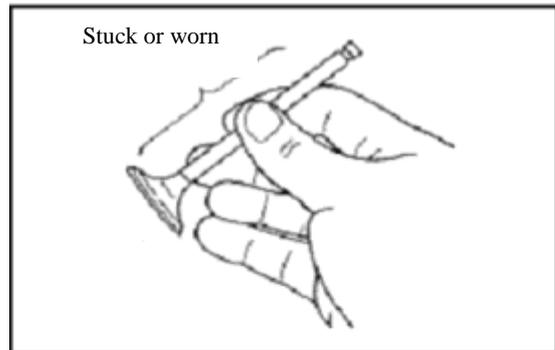
3. Check if valve tappet thickness is within 5.20~5.80mm. Otherwise, replace valve tappet.

Note: Make a mark on checked valve tappet and place them in a good order.



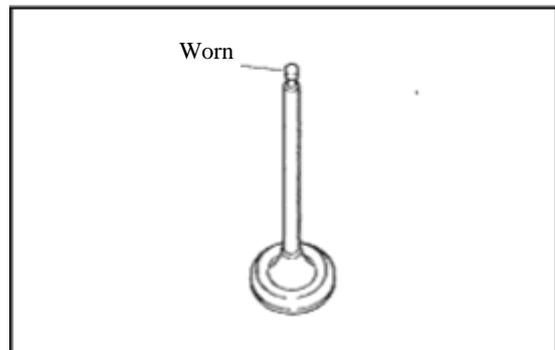
Check valve.

Check valve stem. Check if valve stem is stuck or damaged. If valve stem is damaged, replace the valve and valve guide pipe together.



Check valve stem tail.

Check if valve stem tail is worn abnormally.



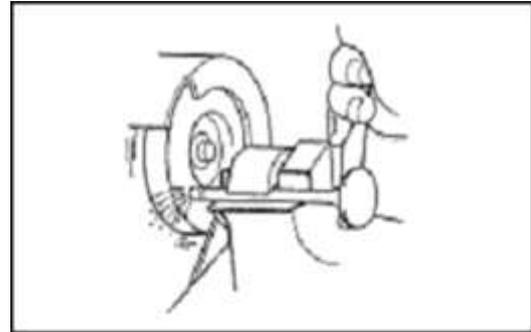


If valve stem tail is worn abnormally, repair the tail with valve grinder.

Ensure minimum valve of the whole length of valve:

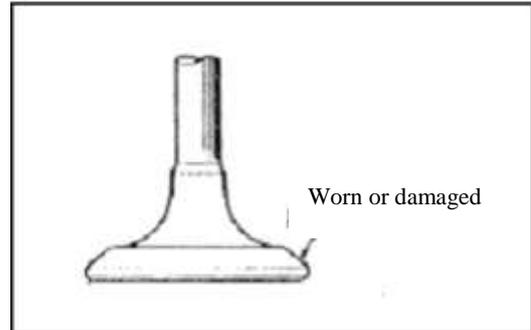
Intake valve: 87.9mm

Exhaust valve: 88.40mm



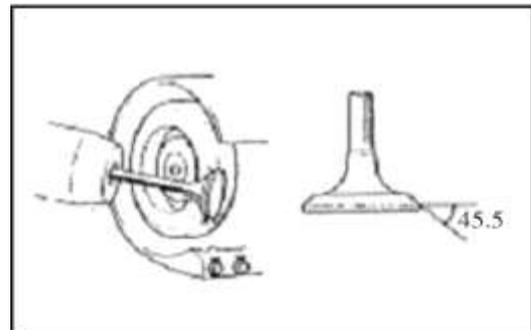
Check valve head.

① Check roughness and wear conditions on contact surface between the valve and valve seat. Remove carbon deposit on the head.



If contact surface between the valve and valve seat is damaged, grind contact surface with a valve grinder.

Conical angle of the valve: 45.5°



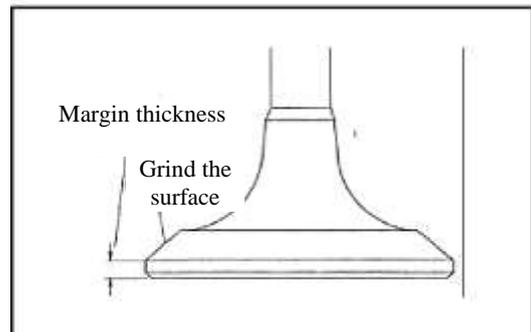
After grinding the valve head, measure margin thickness of the valve head.

The minimum limit value

Intake valve	0.9mm
Exhaust valve	0.9 mm

(Note) If margin thickness of the valve head is less than limit value, replace it with a new valve.

When replacing with a new valve, it is necessary to check oil clearance between the valve stem and valve guide pipe.



Check clearance between valve stem and valve guide pipe.

Measure the clearance.

Measure oil clearance between valve guide pipe and valve stem.

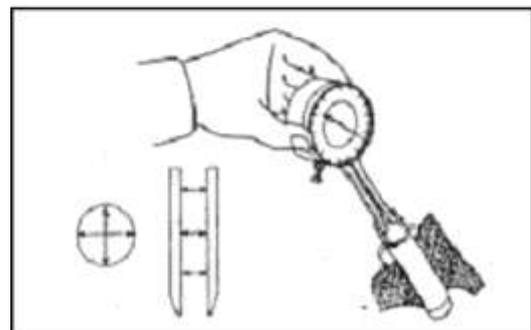
Oil clearance = inner diameter of valve guide pipe - outer diameter of valve stem

Specified value: Intake valve: 0.050—0.020 mm

Exhaust valve: 0.060—0.030 mm

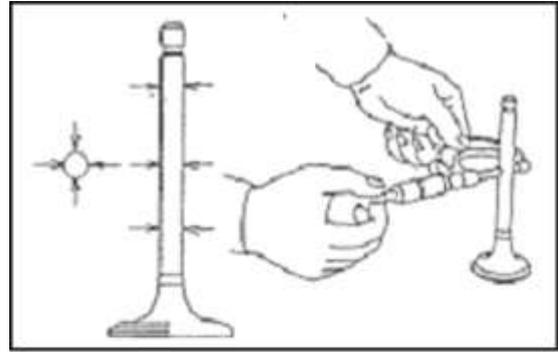
Note: If the measured clearance exceeds specified value, replace valve guide pipe and the valve together

① Measure inner diameter of valve guide pipe. Measure it at six positions.





Measure outer diameter of valve stem. Measure it at six positions.

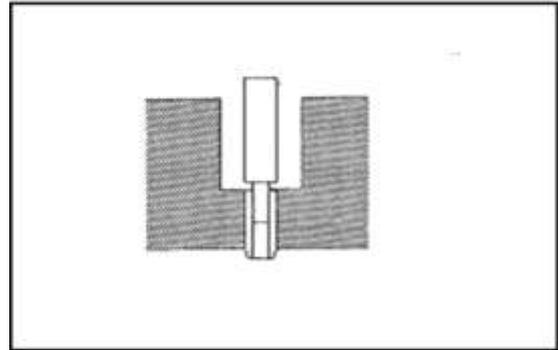


(2) Replace valve guide pipe.

(Note) When replacing valve guide pipe, the valve shall be replaced together.

Exhaust valve side

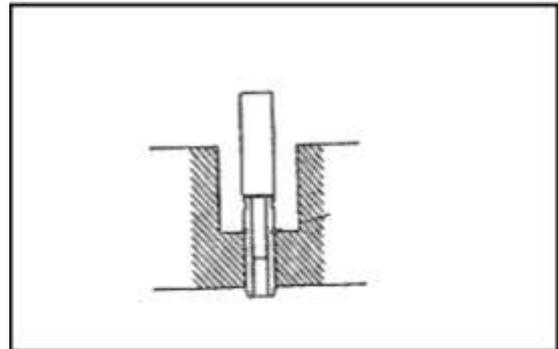
Use a special tool to eject valve guide pipe out towards combustion chamber.



Use a special tool to press new valve guide pipe into it.

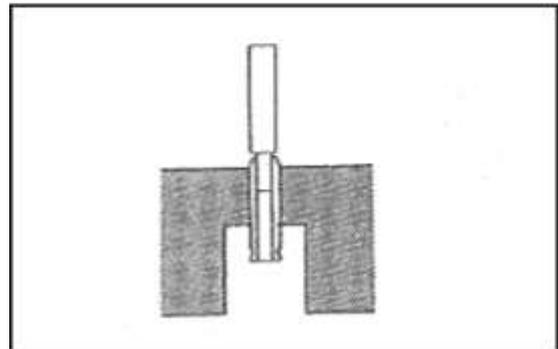
Protruding height of valve guide pipe:  $15.1 \pm 0.2\text{mm}$

Note: After pressing valve guide pipe, use an adjustable reamer to get rid of burr. Now, specified clearance between valve guide pipe and valve stem shall be ensured.



Intake valve side

Use a special tool to eject valve guide pipe out from combustion chamber side.

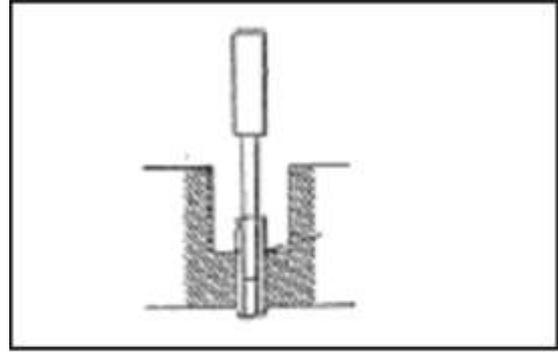




Use a special tool to press new valve guide pipe into it.

Protruding height of valve guide pipe:  $15.1 \pm 0.2\text{mm}$

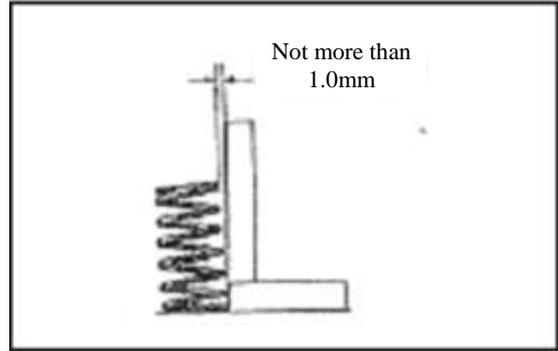
Note: After pressing valve guide pipe, use an adjustable reamer to get rid of burr. Now, specified clearance between valve guide pipe and valve stem shall be ensured.



Check valve spring.

Check perpendicularity of valve spring with an angle square.

Maximum limit: 1.0 mm



Use a spring tester to measure free length of the spring, and measure the pressure when the spring is compressed to specified installation length.

The minimum free length: 44.2 mm

Spring pressure: minimum limit/installation length: 160N/37mm

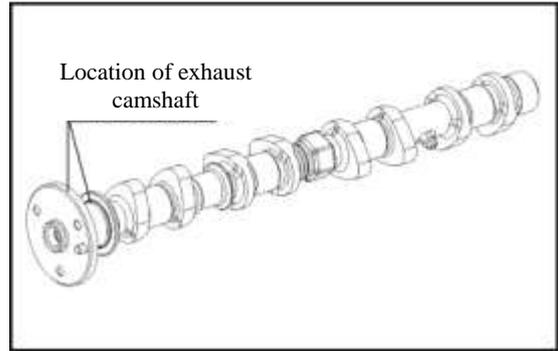
Check camshaft.

(1) Check exhaust camshaft

1. Check axial location clearance of exhaust camshaft

Check if exhaust camshaft is cracked and worn abnormally. In addition, check location dimension of exhaust camshaft.

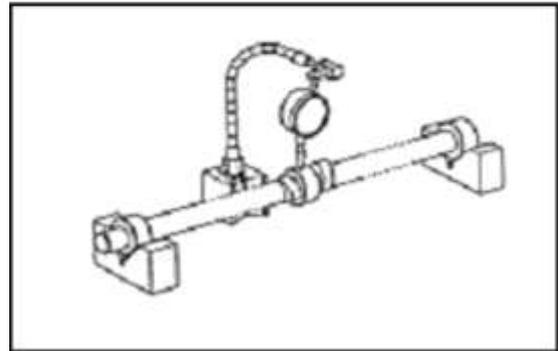
Location dimension of exhaust camshaft: 21.1~21.2mm.



2. Check radial runout of camshaft.

Use V block to support both ends of camshaft. Place dial gauge on the center of middle journal of camshaft, rotate camshaft by one turn to ensure camshaft does not move axially. When camshaft rotates, take down reading on dial gauge and calculate the maximum radial runout, i.e. the difference between the maximum and minimum readings.

Maximum radial runout: 0.03 mm



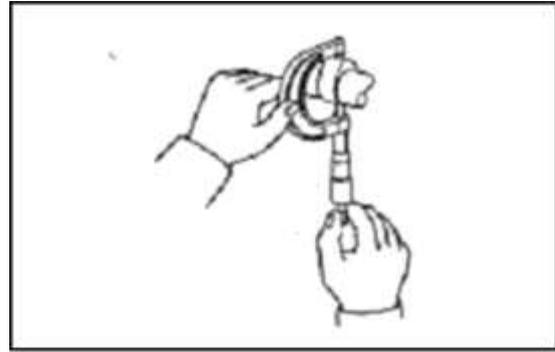


3. Check protruding height of cam.

Minimum limit: 40.92mm (intake camshaft)

40.04mm (exhaust camshaft)

If the height measured is less than the minimum limit value, replace the camshaft.



4. Check the clearance between exhaust camshaft journal and cylinder head bearing hole.

① Measure outer diameter of camshaft journal.

② Measure inner diameter of five camshaft bearing seat holes on cylinder head. Measure each hole in two directions which are perpendicular to each other.

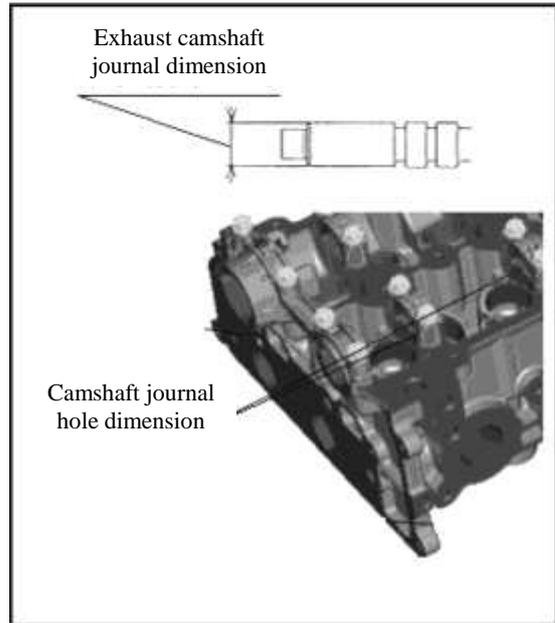
Clearance

1 <sup>st</sup> camshaft bearing clearance	0.035~0.072 mm
2 <sup>nd</sup> ~5 <sup>th</sup> camshaft bearing clearance	0.035~0.072 mm

If the clearance exceeds specified value, it is necessary to replace parts to make the clearance conform to specified value. Refer to the following specified dimension of camshaft journal and camshaft hole on cylinder head.

Specified dimension

	1 <sup>st</sup> journal	2 <sup>nd</sup> ~ 5 <sup>th</sup> journal
Outer diameter of camshaft journal mm	25.965~25.949	22.965~22.949
Inner diameter of camshaft hole on cylinder head mm	26.000~26.021	23.000~23.021

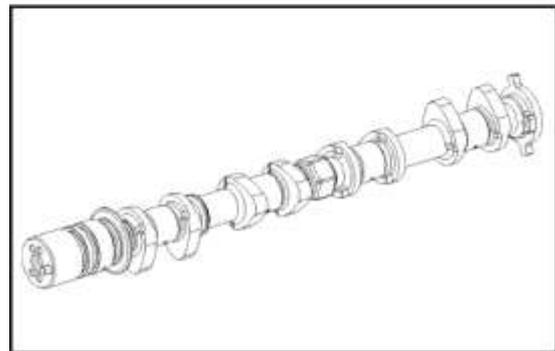


(2) Check intake camshaft

Check if intake camshaft is cracked and worn abnormally, and if oil hole is blocked. If yes, replace intake camshaft.

Check axial dimension of intake camshaft front end phase advance and delay oil hole.

Axial dimension of phase advance oil line	21.4~21.6
Axial dimension of phase delay oil line	29.9~30.1

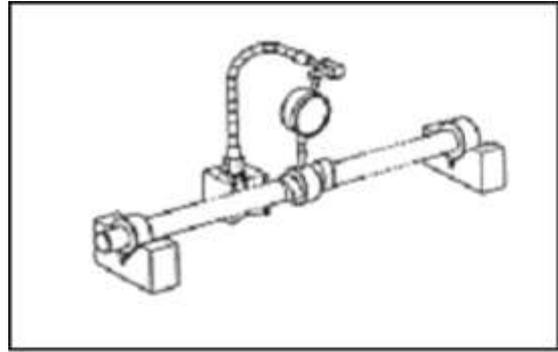




3. Check radial runout of camshaft.

Use V block to support both ends of camshaft. Place dial gauge on the center of middle journal of camshaft, rotate camshaft by one turn to ensure camshaft does not move axially. When camshaft rotates, take down reading on dial gauge and calculate the maximum radial runout, i.e. the difference between the maximum reading and the minimum reading.

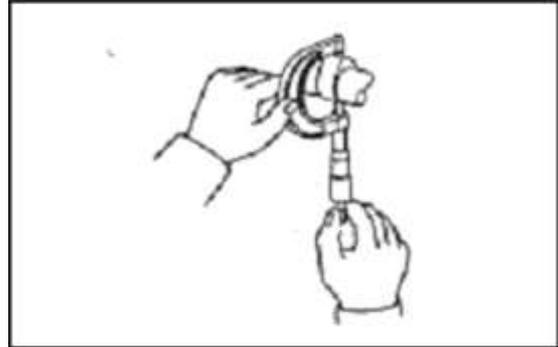
Maximum radial runout: 0.03mm



3. Check protruding height of cam.

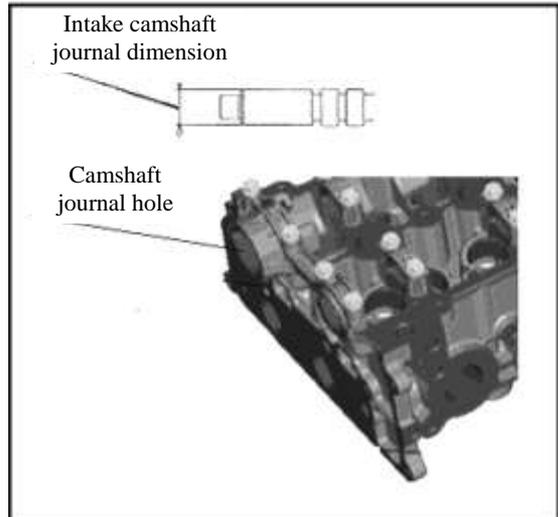
Minimum limit: 39.45mm

If the height measured is less than the minimum limit value, replace the camshaft.



4. Check the clearance between camshaft journal and cylinder head bearing hole.

- ① Measure outer diameter of camshaft journal.
- ② Measure inner diameter of five camshaft bearing seat holes on cylinder head. Measure each hole at two directions which are perpendicular to each other.



Clearance

1 <sup>st</sup> camshaft bearing clearance	0.030~0.071mm
2 <sup>nd</sup> ~5 <sup>th</sup> camshaft bearing clearance	0.035~0.072 mm



If the clearance exceeds specified value, it is necessary to replace parts to make the clearance conform to specified value. Refer to the following specified dimension of camshaft journal and camshaft hole on cylinder head.

Specified dimension

	1 <sup>st</sup> journal	2 <sup>nd</sup> ~ 5 <sup>th</sup> journal
Outer diameter of camshaft journal mm	32.984~32.000	22.965~22.949
Inner diameter of camshaft hole on cylinder head mm	32.030~32.055	23.000~23.021

Grind the valve manually.

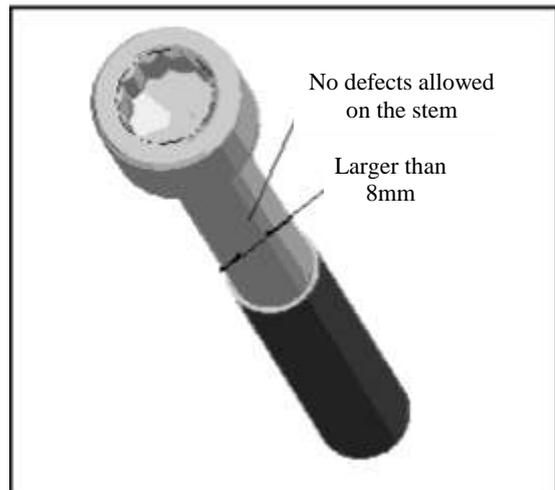
After checking all, grind the valve manually before assembling.

Apply a thin layer of abrasive material on the valve and valve seat and grind them with abrasive tool of the valve.

After grinding, clean the valve and cylinder head with detergent, and then dry them with compressed air.



9) Check cylinder head bolt



(1)Check if cylinder head bolt and screw surface is cracked, corrugated and spotted. Otherwise, replace them.



(2)Cylinder head bolt and screw shall not be larger than 87mm. otherwise, replace them.

(3) Cylinder head bolt and screw diameter. Standard diameter: 8.1mm

Minimum diameter: 8.0mm

If the diameter is less the minimum value, replace the bolt.

10) For checking coolant temperature sensor, camshaft position sensor, refer to CA4GA1 Engine Maintenance Manual (electronic control)

11) Check cylinder head cover

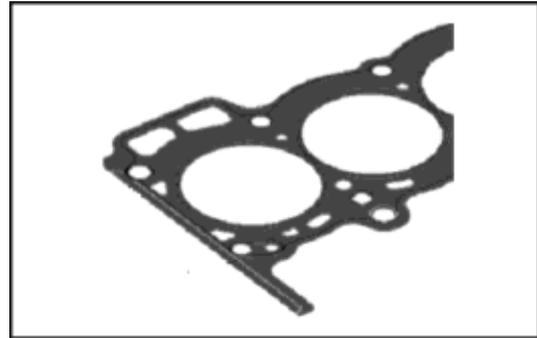
Check cylinder head cover surface. If it is damaged, replace the complete set.

12) Check OCV control valve filter

OCV control valve filter shall not be damaged and have no engine oil deposit. Otherwise, replace it.

13) Check cylinder head gasket assembly

Measure compression thickness of cylinder head gasket assembly. It is 0.4mm and the minimum thickness is 0.37mm. If the thickness is less than the minimum thickness, replace cylinder head gasket assembly.

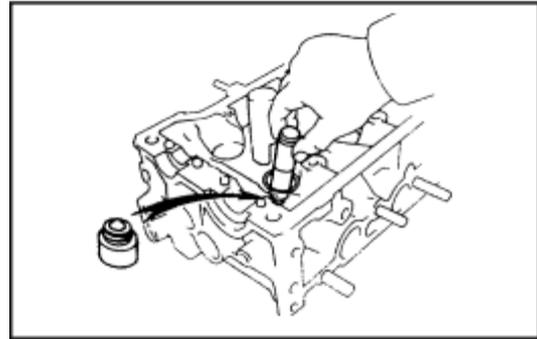


14) For checking spark plug assembly, refer to Ignition System Installation

Place cylinder head on a special maintenance tool.

1) Install valve spring seat.

Install valve guide pipe oil seal assembly. Apply engine oil on new valve guide pipe oil seal assembly, and then use a special maintenance tool to insert it into valve guide pipe.



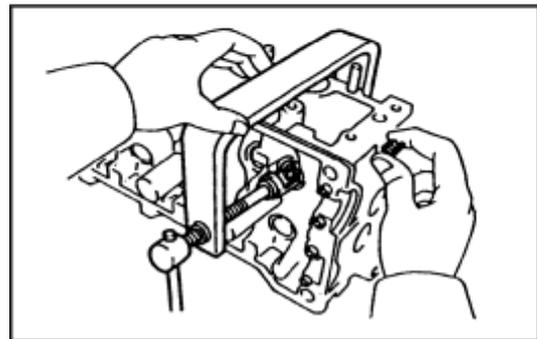
Note: do not press new valve guide pipe oil seal assembly too tightly to avoid damaging rubber sheets on inner wall of new valve guide pipe oil seal assembly.

Install intake/exhaust valve.

After applying clean lubricating oil on small head of valve stem intake/exhaust valve, insert it into corresponding valve guide pipe from combustion chamber. Be careful! Do not damage valve stem oil seal.

Note: after inserting the valve, do not pull it out. If it is necessary to pull the valve out, check if new valve stem oil seal assembly is damaged.

Install valve spring.





- 5) Install valve spring seat.
- 6) Install valve lock. Use the following special maintenance tool to install valve lock.

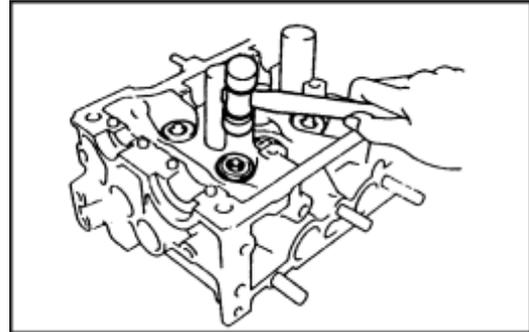
After installing valve lock, use a plastic hammer to knock valve spring seat slightly. In this way, valve lock can be installed reliably.

Note: When checking valve lock, make sure valve spring seat and valve lock will not jump out.

- 7) Install valve tappet and adjust valve clearance.
  - (1) Install checked tappet on cylinder head.
  - (Note) 1. After installing, rotate the tappet flexibly by hand.
  - 2. Take out the tappet by magnetic bar or by hand easily.

Grouped table of valve tappet

Mark	Thickness t						
20	5.20	36	5.36	52	5.52	68	5.68
22	5.22	38	5.38	54	5.54	70	5.70
24	5.24	40	5.40	56	5.56	72	5.72
26	5.26	42	5.42	58	5.58	74	5.74
28	5.28	44	5.44	60	5.60	76	5.76
30	5.30	46	5.46	62	5.62	78	5.78
32	5.32	48	5.48	64	5.64	80	5.80
34	5.34	50	5.50	66	5.66		



(Note) 1. Stamp mark figure on the inner top surface of valve tappet.

2. According to the data in grouped table of valve tappet, select or replace the tappet.

- (2) Adjust intake side valve clearance.
  - 1. Clean intake camshaft assembly, apply some lubricating oil on the journal, and place it in camshaft hole on cylinder head slightly.
  - 2. Install 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> camshaft bearing cap machined with cylinder head camshaft bearing hole on cylinder head bearing support.
  - 3. Apply new engine oil on bolt head and tighten with 8 combination bolts, tightening torque is 12.5±2N m. Tightening sequence is from inside to outside in turn.



4. Rotate camshaft hexagon with S24 open spanner, check the clearance between tappet top and cam clearance with a feeler, remove camshaft and replace the tappet according to recorded data to ensure valve clearance.

Intake valve clearance is  $0.2 \pm 0.03$ mm.

5. Loosen 8 combination bolts according to reverse sequence of tightening, and then remove 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> camshaft bearing cap.

(3) Adjust exhaust side valve clearance.

1. Clean exhaust camshaft assembly, apply some lubricating oil on the journal, and place it in camshaft hole on cylinder head slightly.

2. Install 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> cam bearing cap machined with cylinder head cam bearing hole on cylinder head bearing support.

3. Apply new engine oil on bolt head and tighten with 8 combination bolts. Tightening torque is  $12.5 \pm 2$ N·m. Tightening sequence is from inside to outside in turn.

4. Rotate camshaft hexagon with S24 open spanner, check the clearance between tappet top and cam clearance with a feeler, remove camshaft and replace the tappet according to recorded data to ensure valve clearance.

Exhaust valve clearance is  $0.3 \pm 0.03$ mm.

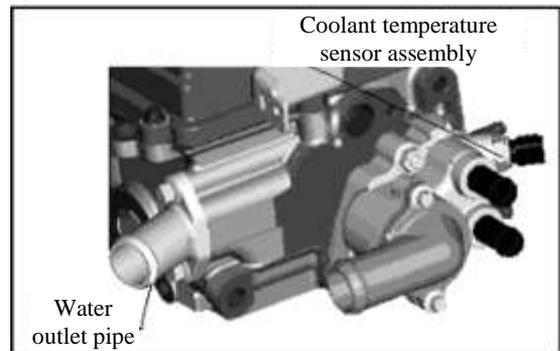
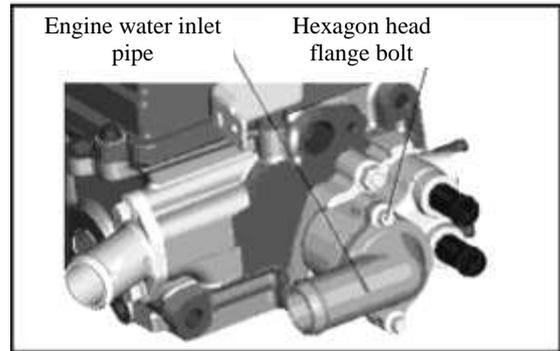
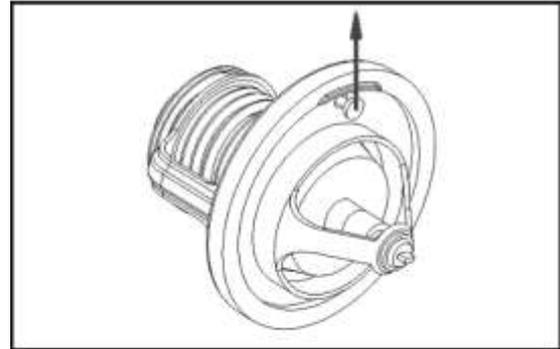
5. Loosen 8 combination bolts according to reverse sequence of tightening, and then remove 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> camshaft bearing cap.

8) Install engine water inlet pipe seat assembly

Clean joint surface of engine water inlet pipe seat assembly and then apply glue on it; apply sealant on bolt threads and then fasten it on rear end of cylinder head. Tightening torque of bolts is  $22 \pm 4$ N·m.

9) Install thermosistor assembly and engine water inlet pipe

(1)Put thermosistor assembly with seal ring into water inlet pipe seat assembly and keep rocking valve upwards.





(2) Apply joint surface of engine water inlet pipe, use hexagon head flange bolt to fasten it on the engine water inlet pipe seat assembly. Tightening torque of bolt is  $8 \pm 2 \text{N.m}$ .

10) Install coolant temperature sensor and water outlet pipe

(1) Install coolant temperature sensor assembly

Apply sealant on threads of coolant temperature sensor assembly and install it on engine water inlet pipe seat assembly. Tightening torque is  $20 \pm 4 \text{N.m}$ .

(2) Install engine water outlet pipe

Tightening torque of bolt: M6.  $9 \pm 2 \text{N.m}$ .



11) Install cylinder head assembly.

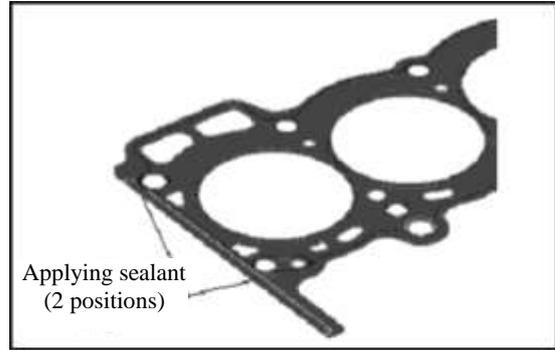
(1) Remove cylinder head from a special tool.

(2) Install cylinder head gasket assembly

① Do not apply lubricating oil on seal surface of cylinder head gasket.

② Two positions of cylinder head gasket coated with glue: apply glue on the joint between cylinder block front end top surface and cylinder head gasket front end bottom/timing chain cover.

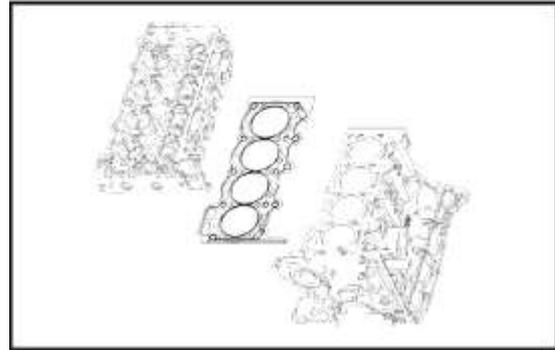
③ Align two pin holes of cylinder head gasket with locating ring on cylinder block and place it on cylinder block top surface.



(3) Check if there is oil or water in mounting hole of cylinder head bolt. Blow them off with compressed air.

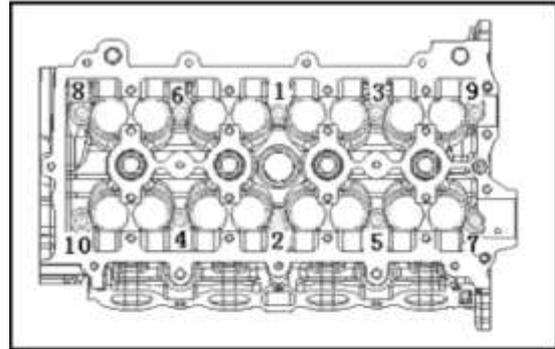
12) Tighten cylinder head bolt.

(1) Use a special tool to put cylinder head bolt washer into cylinder head bolt hole.



(2) Apply engine oil on threads and bolt head bottom of cylinder head bolt, and then put it into cylinder head bolt hole.

(3) According to the sequence as shown in the Fig., tighten 10 cylinder head bolts twice.



Tightening torque:  $34 \pm 2 \text{ N.m}$ , rotate it by  $120^\circ$ . Final tightening torque shall not be less than  $65 \text{ Nm}$ . Tightening sequence is as shown in the Fig.

(Note) 1. If final tightening force exceeds this range, the bolt shall be replaced.

2. After replacing the bolt, if final tightening torque is still lower than  $65 \text{ Nm}$ , increase rotation angle appropriately to make the torque greater than  $65 \text{ Nm}$ .

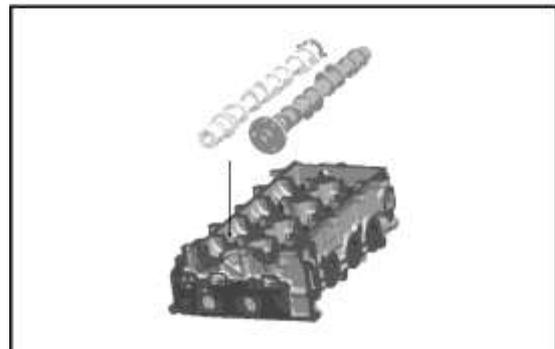
3. Cylinder head bolt is reused: three times at most.

11) Install intake/exhaust camshaft.

(1) Install exhaust camshaft.

1. Apply engine oil on tappet and camshaft bearing seat of cylinder head (especially on 1<sup>st</sup> camshaft bearing seat of cylinder head).

2. Place exhaust camshaft on cylinder head, keep cylindrical pin of exhaust camshaft upwards and place it into exhaust camshaft.

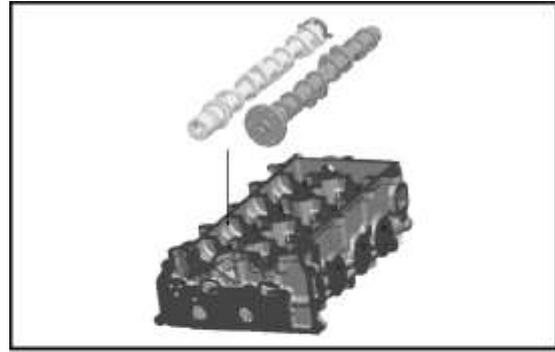




Note: Because thrust clearance of camshaft is too small, camshaft shall be installed horizontally. If camshaft cannot be kept level, cylinder head will bear thrust force of the shaft, which may deform or crack camshaft, even break it off.

Install intake camshaft.

1. Install intake camshaft position sensor target disk and press it to the bottom.
2. Apply engine oil on tappet and camshaft bearing seat of cylinder head (especially on 1<sup>st</sup> camshaft bearing seat of cylinder head).
3. Keep cylindrical pin of intake camshaft upwards and place intake camshaft on cylinder head.

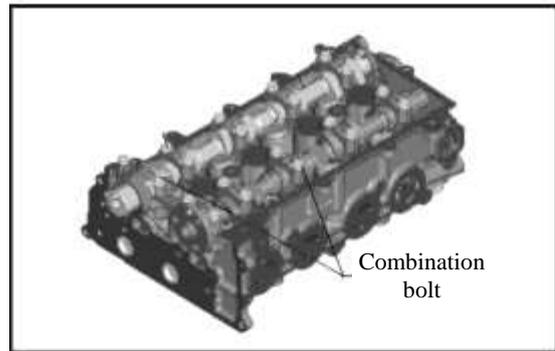


Note: Because thrust clearance of camshaft is too small, camshaft shall be installed horizontally. If camshaft cannot be kept level, cylinder head will bear thrust force of the shaft, which may deform or crack camshaft, even break it off.

12) Tighten camshaft bearing cap.

- 1) After camshaft is placed, clean 2<sup>nd</sup> ~ 5<sup>th</sup> intake/exhaust camshaft bearing caps, install them on cylinder head and apply engine oil under bolt head. Tighten the bolt twice.

Tightening torque:  $12.5 \pm 2$  N.m.



- 2) Install 1<sup>st</sup> camshaft bearing cap and apply engine oil under bolt head. Tighten the bolt twice uniformly.

Tightening torque:  $12.5 \pm 2$  N.m.

Note: Tightening sequence of camshaft bearing cap is from inside to outside alternatively.

13) Install camshaft position sensor and canister solenoid valve.

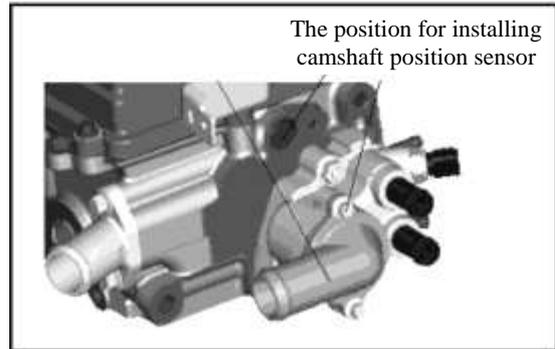
(1) Install camshaft position sensor

- ① Apply clean engine oil on O seal ring of camshaft position sensor. Tighten with hexagon flange bolt.

Tightening torque: 6-8N.m

- ② Check axial clearance between camshaft position sensor and camshaft signal target wheel with a special feeler.

Axial clearance:  $0.8 \pm 0.35$  mm

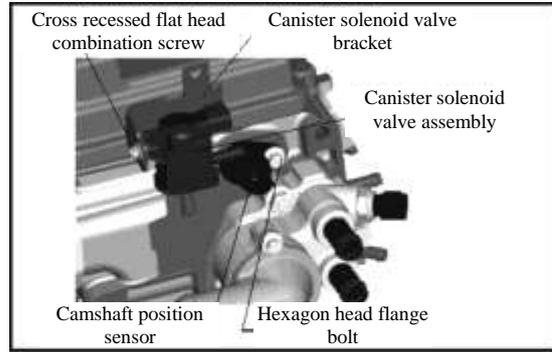




(2) Install canister solenoid valve

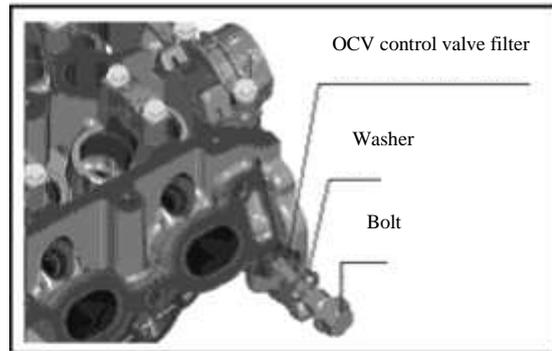
Canister solenoid valve and engine wire harness bracket IV are fastened by the same cross recessed flat head combination screw.

Tightening torque is  $6 \pm 2$  N.m.



14) Install OCV control valve filter.

Insert OCV control valve filter into the hole on the side of cylinder head intake. Install bolt and washer into corresponding screw hole. Tightening torque is  $24.5 \pm 5$  N.m.

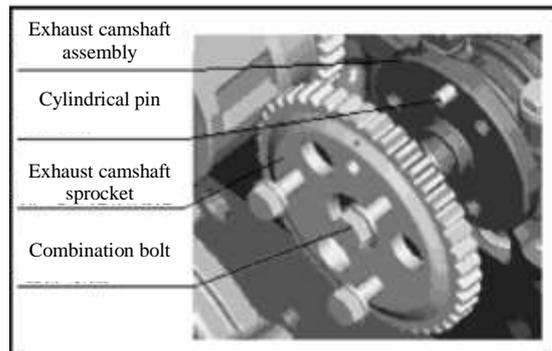


15) Install exhaust camshaft sprocket.

Use S24 open spanner to fasten exhaust camshaft hexagon, align pin hole on exhaust camshaft sprocket with cylindrical pin on camshaft, and place it on exhaust camshaft.

Note: After inserting, twist the sprocket slightly to check if location pin is inserted into location hole.

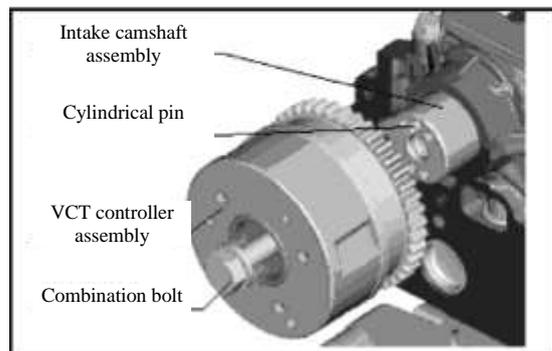
Fasten the sprocket on camshaft by combination bolt. Tightening torque is  $8 \pm 1.6$  N.m.



16) Install VCT controller assembly.

Use S24 open spanner to fasten intake camshaft, pour a few drops of lubricating oil on the front end journal of intake camshaft and align pin hole on VCT controller assembly with cylindrical pin on camshaft. After inserting, twist the sprocket slightly to check if locating pin is inserted in locating hole.

Tighten VCT controller assembly on camshaft with combination bolts. Tightening torque:  $47 \pm 7$  N.m.





17) Install chain chamber cover assembly

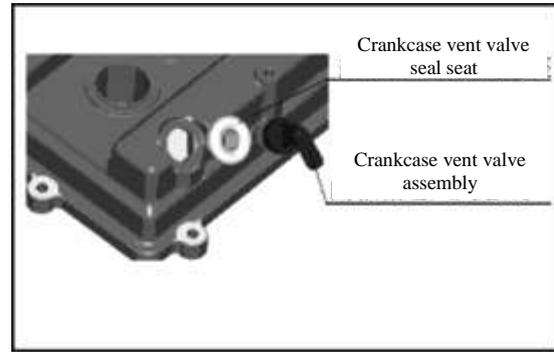
18) Install cylinder head cover assembly.

(1) Install crankcase vent valve seal adapter.

Apply some lubricating oil on crankcase vent valve seal adapter and then press it into corresponding hole on the cover.

(2) Install crankcase vent valve assembly.

Apply some lubricating oil on crankcase vent valve assembly surface, insert it into seal adapter of crankcase vent valve and then install cylinder head cover, gasket and wire clip bracket.

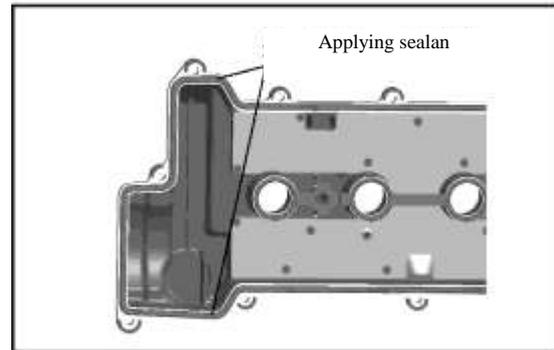


(3) Install cylinder head cover assembly, engine oil filler cap and wire harness bracket.

Put cylinder head cover gasket into gasket slot on cylinder head. Apply glue on the joints (2 positions) between corresponding cylinder head and timing chain cover.

Note: ① After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.

② At (12) and (13) positions, M6 hexagon flange nut is easy to fall into spark plug hole. Be careful.



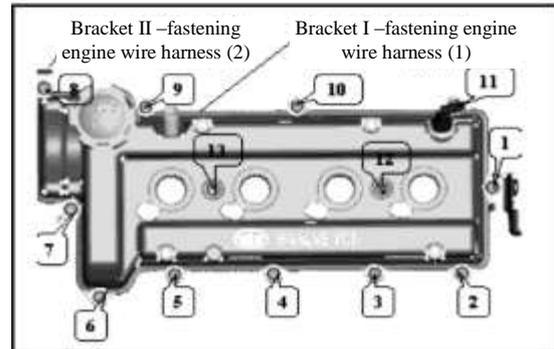
② Install canister solenoid valve bracket onto cylinder head cover (① as shown in the Fig.). Bolt: M6×25

③ Install the engine wire harness bracket II onto cylinder head cover (⑧ as shown in the Fig.) bolt: M6×25

④ Install the engine harness bracket I onto cylinder head cover (⑦ as shown in the Fig.). Bolt: M6×20

⑤ At ⑥ and ⑦ positions as shown in the Fig, use M6×20. At (12) and (13) positions as shown in the Fig., use M6 stud and M6 hexagon flange nut. At other positions, use bolt M6×25.

Tightening torque: 9-13 (target value 11) N.m.





19) Install engine oil filler cap.

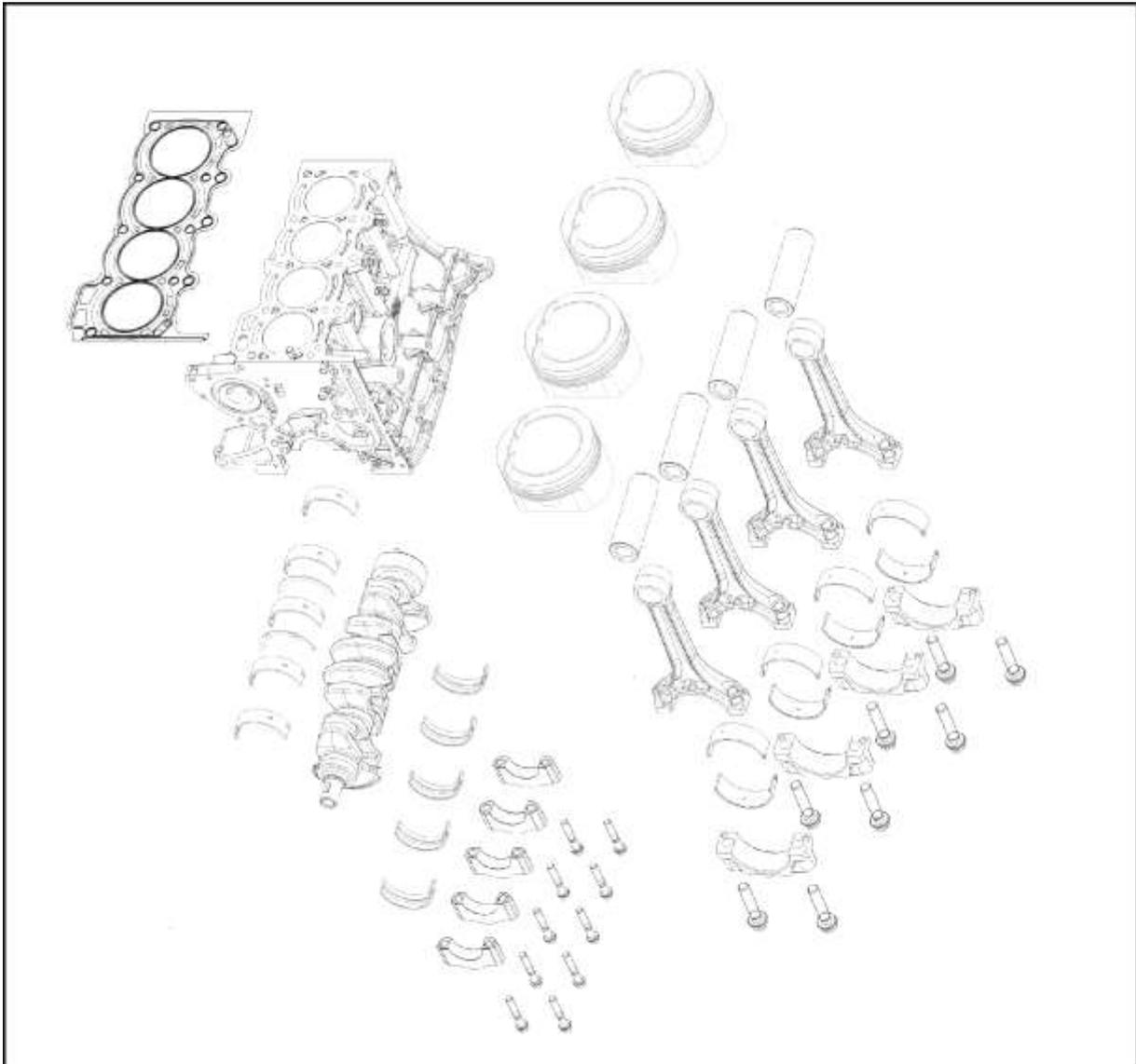
After applying lubricating oil on rubber seal ring of engine oil filler cap, install engine oil filler cap on cylinder head cover by rotating.

20) For installing spark plug assembly, refer to related section of ignition system.

21) For installing bar type ignition coil assembly, refer to related section of ignition system.

### 3.6 Cylinder block

#### Cylinder block composition





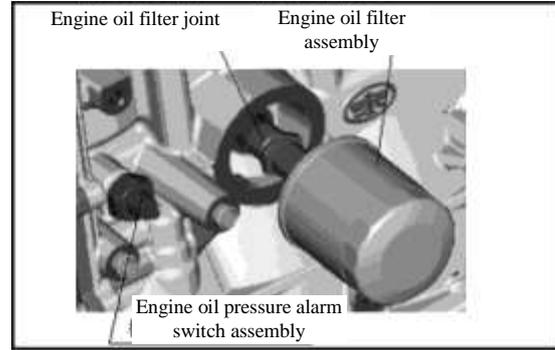
Remove

- 1) Remove generator assembly
- 2) Remove engine oil filter assembly
- 3) Remove engine oil filter joint

Note: Do not remove engine oil filter joint except that engine oil filter joint is damaged, If it is necessary to remove the joint, do not damage cylinder block (engine oil filter joint threads are coated with thread fastening glue).

- 4) Remove engine oil pressure alarm assembly

When removing engine oil pressure alarm assembly, do not use any impact torque wrench to avoid damage.

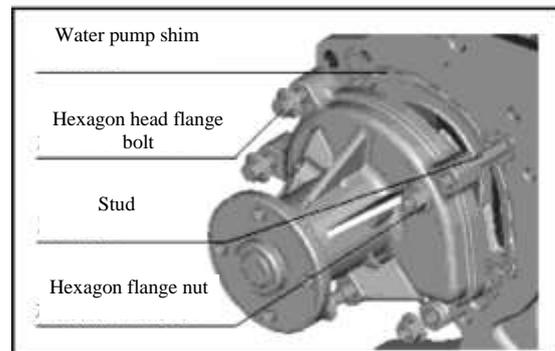


Remove knock sensor assembly

When removing knock sensor assembly, do not use any impact torque wrench to avoid damage.

- 6) Remove engine oil dipstick pipe assembly
- 7) Remove idler assembly
- 8) Remove cool air compressor assembly
- 9) Remove cool air compressor and power steering pump combination bracket
- 10) Remove water pump assembly

Loosen hexagon head flange bolt (3 pieces) and hexagon flange nuts (2 pieces) to take down water pump body and water pump shims.



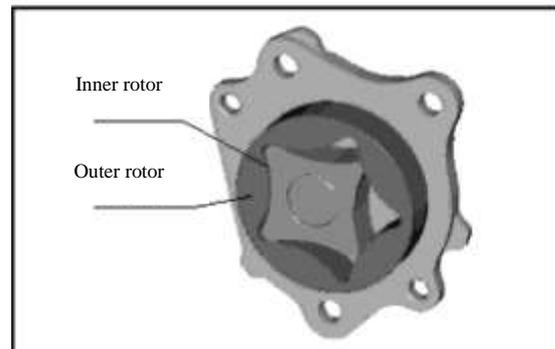
- 11) Remove chain mounting bracket
- 12) Remove crankshaft sprocket

After fastening crankshaft, take out crankshaft key with a screwdriver and then take out crankshaft sprocket.

- 13) Remove chain lubrication nozzle
- 14) Remove engine oil pump assembly

Loosen hexagon head flange bolt, remove hexagon head flange bolt and washer. Remove engine oil pump assembly.

Note: After removing engine oil pump assembly, put outer rotor and inner rotors together to avoid them from being lost.





15) Remove clutch cover assembly and clutch driven plate assembly

Insert removing tool for clutch housing and pressure plate into the spline of clutch driven plate assembly, loosen clutch cover assembly and six M8 joint bolts of the flywheel, and remove clutch cover assembly and clutch driven plate assembly.

Note: After removing clutch cover assembly and clutch driven plate assembly, put them into a special container. Do not impact or knock against clutch cover assembly and clutch driven plate assembly. Otherwise, dynamic balance of clutch cover assembly will be damaged.

16) Remove flywheel gear ring assembly

(1)Loosen the bolt of flywheel gear ring assembly twice or three times uniformly and then remove the bolt.

(2)Remove flywheel gear ring assembly.

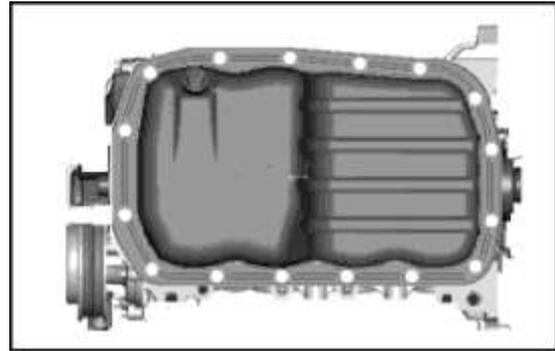
Note: Flywheel gear ring assembly is heavy. Be careful during the course of operation.

17) Remove engine oil assembly

Use a special tool to loosen engine oil pan bolt and nut, use a screwdriver and removing tool of engine oil pan to tilt engine oil pan, and then remove engine oil pan assembly.

Note: ① During the course of tilting engine oil pan, do not exert too much force to avoid engine oil pan from being deformed.

②After removing engine oil pan with removing tool of engine oil pan, remove the sealant.



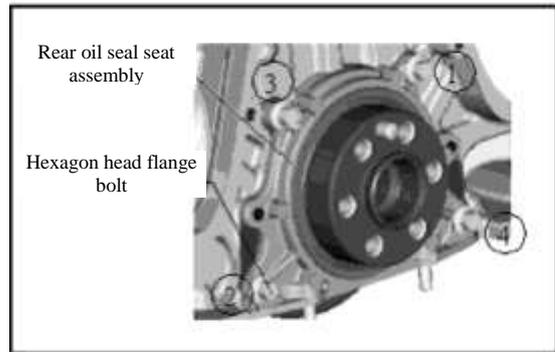
18) Remove clutch baffle

19) Remove rear oil seal seat assembly

Use a special tool to loosen rear oil seal seat assembly bolt, use a screwdriver and removing tool of engine oil pan to tilt rear oil seal seat assembly and then remove rear oil seal seat assembly.

Note: ①When tilting rear oil seal seat assembly, do not apply too much force to avoid oil seal of rear oil seal seat assembly from being damaged.

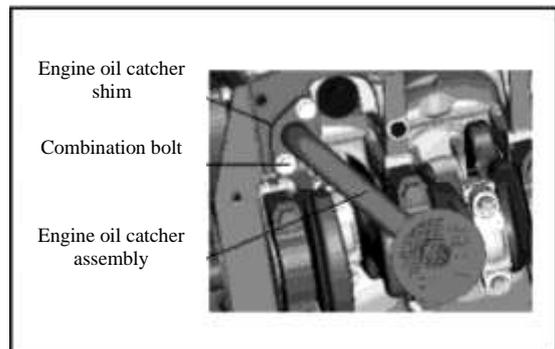
②After removing rear oil seal seat assembly, remove all sealant.



20) Remove engine oil collector assembly and shim

Loosen combination bolts (2 pieces) and remove engine oil collector assembly and shim.

Note: combination bolt threads are coated with anti-loose glue. After removing, clean anti-loose glue with a special tool.





21) Loosen connecting rod bolt and remove connecting rod cap

(1) Rotate crank shaft until connecting rod cap moves to the side of engine oil pan.

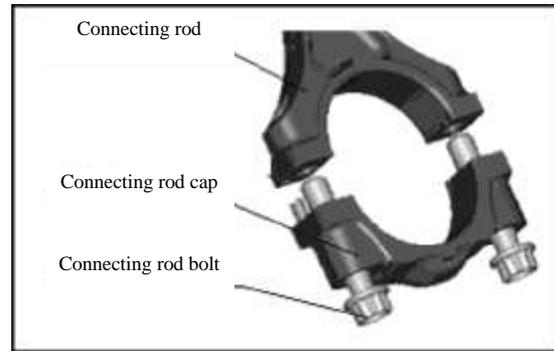
(2) Loosen connecting rod bolt twice or three times uniformly and remove connecting rod nut.

Note: ① Put removed connecting rod cap into a special container in turn to know installation position in advance.

② Do not damage threads of connecting rod bolt.

③ Do not touch bearing shell surface.

④ Be careful. Do not let connecting rod bolt damage crankshaft.



22) Remove main bearing cap

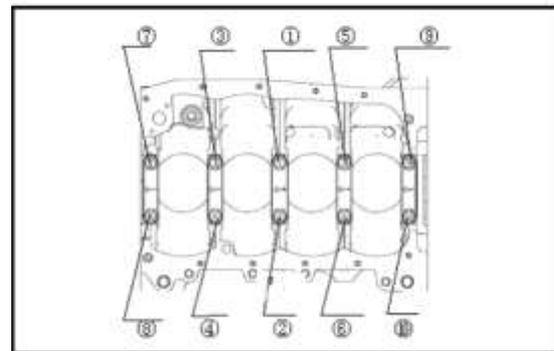
Loosen main bearing bolts as shown in the Fig and then remove main bearing cap.

Note:

① After removing main bearing bolt, put it together with corresponding main bearing cap to avoid messing.

② During the course of removing, it is allowed to use a stick or copper hammer to strike main bearing cap slightly to separate it from main bearing support.

③ After taking down crankshaft assembly, place it into a special container to avoid scratching or knocking.



23) Remove crankshaft assembly

Note: When removing crankshaft, lift it up horizontally to avoid damaging crankshaft journal. In addition, cylinder block shall not prevent crankshaft from being taken out.

(1) Remove thrust shim

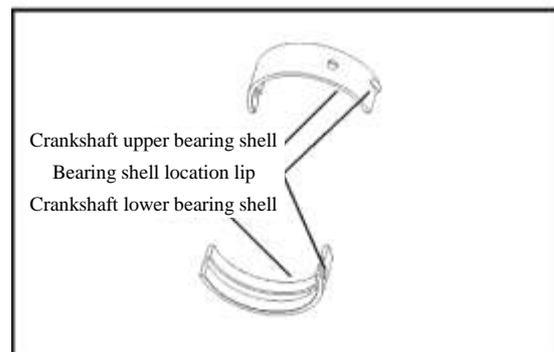
Thrust shim is provided on both sides of 3<sup>rd</sup> main journal.

(2) Remove upper/lower main bearing shells

Removing method for upper/lower main bearing shells as follows: push and press bearing shell on the side without orientation rabbet with your finger to tilt the other end so as to take down bearing shell. When removing, your hands shall not touch working surface and back face of bearing shell.

Note: ① Put removed bearing shells in turn to know installation position in advance.

② Clean removed parts with detergent and then dry it with compressed air. But this method is not applicable to rubber parts.





24) Remove piston connecting rod assembly

(1) If any bulge is formed on the top of cylinder block due to carbon deposition, eliminate it with cylinder opening reamer or similar tool.

(2) Pull out piston connecting rod assembly on one side of cylinder head.

(3) After removing put it into a special container.

Note: During the course of removing piston connecting rod assembly, do not scratch cylinder wall, crankshaft journal and piston connecting rod assembly.



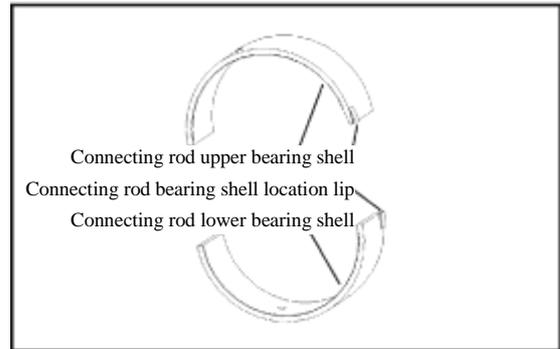
25) Remove connecting rod upper/lower bearing shells

After removing, put them in a special container, do not mess them up.

Removing method for connecting rod upper/lower bearing shells: push and press bearing shell on the side without orientation rabbet with your finger to tilt the other end so as to take down bearing shell. When removing, do not touch working surface and back face of bearing shell by hand.

Note: ① Put removed bearing shells in turn to know installation position in advance.

② Clean removed parts with detergent and then dry it with compressed air. But this method is not applicable to rubber parts.



26) Remove piston ring

(1) Remove upper compression ring, middle compression ring and combination oil ring assembly of the piston. During the course of removing, use piston expander or similar tool to remove upper compression ring and middle compression ring. Do not scratch upper compression ring and middle compression ring. After removing, put them in a special container in order to know installation position in advance.

Note: When expanding piston ring, do not exceed the required range.

(2) Remove combination oil ring assembly.

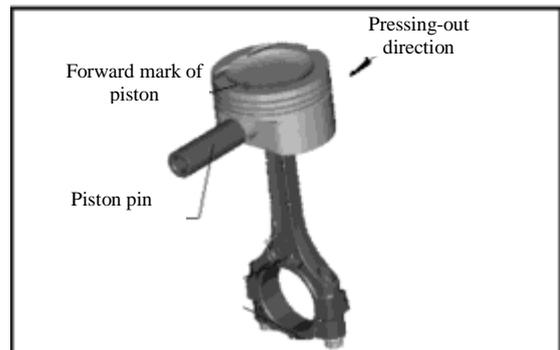
Remove combination oil ring assembly by hand and then place removed combination oil ring assembly in a special container in order to know installation position in advance.

Note: When expanding combination oil ring assembly, do not exceed the required range.

27) Remove piston rod

(1) Keep piston top forwards and mark downwards, and apply some lubricating oil, use a special tool to eject piston rod out of piston pin hole.

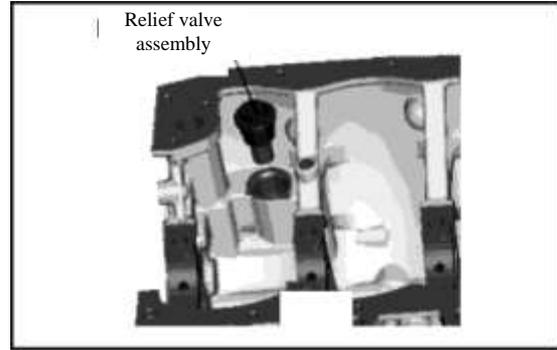
(2) Put removed piston pin in a special container in order to know installation position in advance.





28) Remove relief valve assembly

Note: There is sealant applied on threads of relief valve assembly. Remove the sealant after removing relief valve assembly.



29) Remove hexagon head tapered plug

Note: Because threads of hexagon head tapered plug are coated with anaerobic sealant, it is necessary to remove anaerobic sealant after removing hexagon head tapered plug.

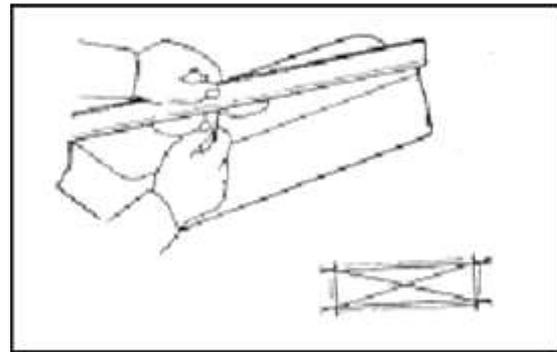
30) Take down cylinder block from special maintenance tool.

Check

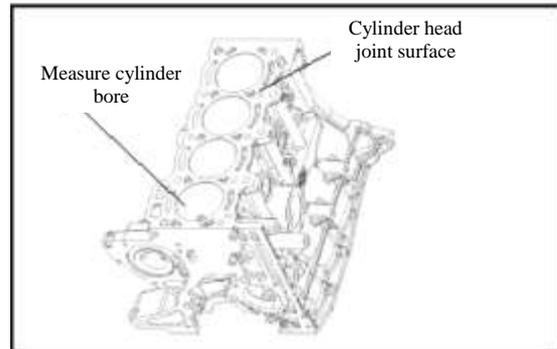
1) Check cylinder block

- (1) Check if cylinder block is damaged or cracked.
- (2) Check if joint surface between cylinder block and cylinder head gasket is deformed.

Note: Measure it in six directions. Maximum deforming limit: 0.1mm



If surface deformation exceeds the maximum deformation limit, you have to repair the surface. But grinding limit shall not be greater than 0.3mm. In addition, make sure the distance between cylinder head gasket joint surface and engine oil installation surface shall not be less than 222mm.





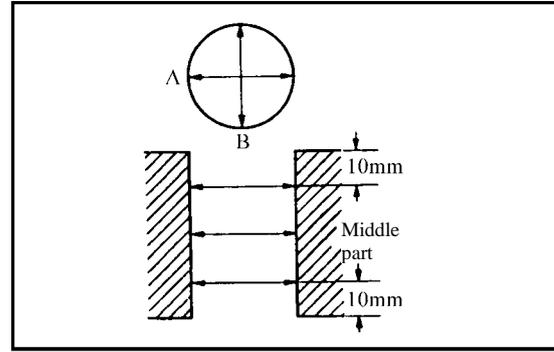
(3) Measure cylinder bore

Measure cylinder bore of each cylinder. Measure it in six directions.

Note: after checking or repairing the cylinder, put the special measuring tool for cylinder bore into the cylinder until the distance from cylinder block top installation surface is above 40mm, and then measure cylinder bore of each cylinder.

The difference between the maximum cylinder bore and the minimum cylinder bore shall be not more than 0.1mm.

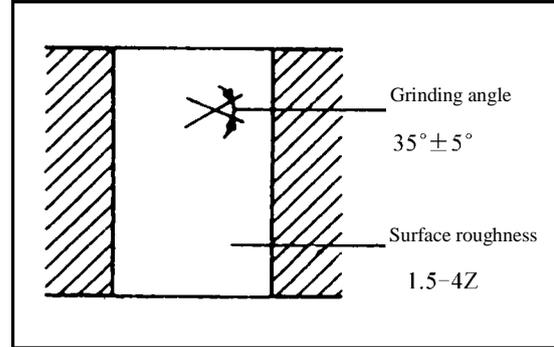
Note: record measured results.



If the difference between the maximum and minimum exceeds specified value (0.1mm), the cylinder shall be bored and ground.

Specified value of cylinder bore after grinding

When using standard piston	$\phi 73.00 \sim \phi 73.03$
When using the piston enlarged by 0.25mm	$\phi 73.25 \sim \phi 73.28$
When using the piston enlarged by 0.50mm	$\phi 73.50 \sim \phi 73.53$



After washing and checking cylinder block, calculate the clearance between cylinder and piston. When calculating, the minimum of measured diameter for the cylinder and the maximum of measured diameter of the piston will be used.

The clearance between cylinder and piston: 0.02~0.04mm

Note: if calculated clearance exceeds specified value, the cylinder shall be bored and ground. Please refer to ②. But, if the piston installed is enlarged one and the clearance between cylinder and piston exceeds specified value, replace cylinder block and piston.

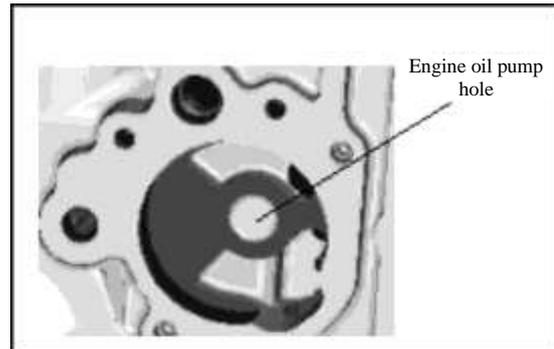
Cylinder block knock sensor surface is flat, not damaged or dirty, and threads are in good conditions.

(4) Measure engine oil pump hole

Measure engine oil hole diameter:  $\phi 55.1 (+0.06, +0.03)$

Engine oil hole diameter limit:  $\phi 55.3\text{mm}$

If the diameter exceeds specified value, replace with a new cylinder block.



(5) Check if there is any sealant in each hole (including bolt hole) of cylinder block. If there is sealant, eliminate it.

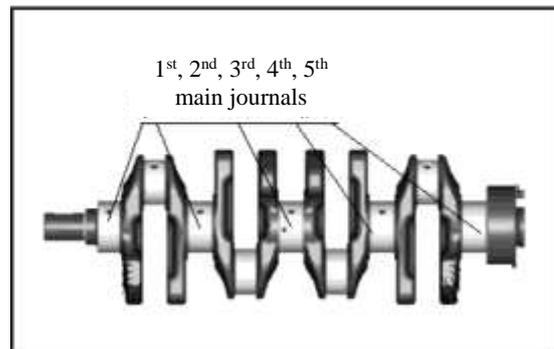
2) Check crankshaft

(1) Check radial runout of main journal for crankshaft

Rotate crankshaft on special clamp by hand and measure runout of each main journal for crankshaft.

Maximum radial runout limit: 0.06mm

Note: Be careful. Do not scratch crankshaft journal.



**(2) Check crankshaft wear**

Check if main journal of crankshaft and connecting rod journal are scratched and worn.

**(3) Check main journal and connecting rod journal**

Measure outer diameter at four points of each main journal and connecting rod journal respectively.

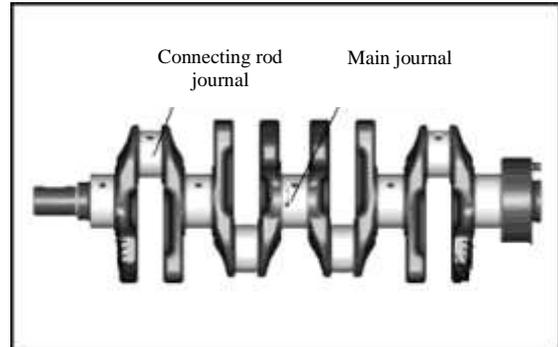
② According to each measured result of main journal and connecting rod journal, calculate the difference between maximum value and minimum value.

Out-of-roundness and taper limit: 0.01mm

Note: ① Measurement shall be carried out on the whole surface of each journal. Oil hole on the journal shall be avoided.

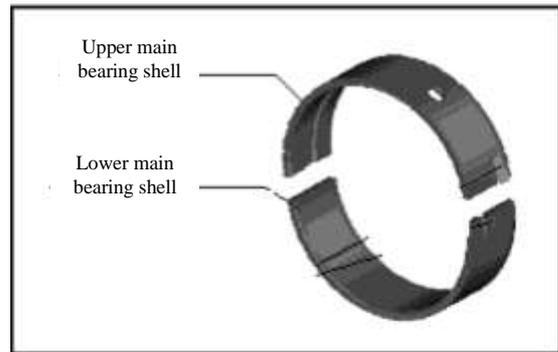
② Record measured result.

③ Be careful! Do not scratch crankshaft.


**(4) Check main journal clearance of crankshaft**

Install main bearing shell on main bearing and main bearing shell cover of cylinder block. During the course of checking, do not touch working surface and back face of main bearing shell, and installation surface of main bearing and main bearing shell cover of cylinder block.

Note: When operating, do not make upper main bearing shell and lower main bearing shell upside down. Upper main bearing shell (on cylinder block)..... is provided with oil groove and oil hole. Lower main bearing shell (on bearing cap)..... is not provided with oil groove and oil hole.



Install crankshaft onto cylinder block.

Note: ① Be careful! Do not scratch crankshaft and main bearing shell.

② Do not apply lubricating oil on crankshaft and main bearing shell.



Install plastic clearance gauge.

Install main bearing cap. Tighten it twice according to specified torque  $60 \pm 5 \text{N.m}$ . Tightening torque is as shown in the Fig.

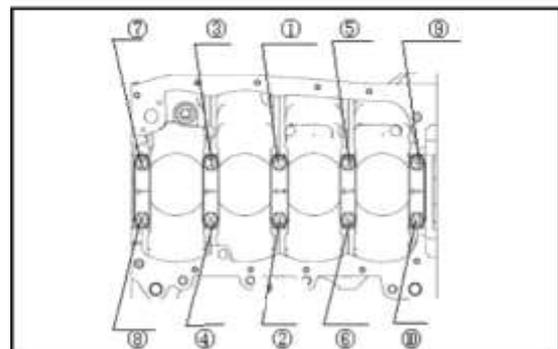
Note: Do not rotate crankshaft by hand after tightening.

Remove main bearing cap, read the clearance value. Main journal clearance: 0.025-0.043mm.

If the clearance exceeds specified value, grind or replace crankshaft according to main journal dimension in the following table.

Note: when grinding main journal, make finish machining on each main journal to keep fillet radius R1.3mm.

Main bearing shell dimension	Main journal diameter
Standard dimension	$\phi 46(0, -0.018)$
Minification dimension 0.25mm	$\phi 45.75 \sim \phi 45.57$
Minification dimension 0.50mm	$\phi 45.50 \sim \phi 45.32$

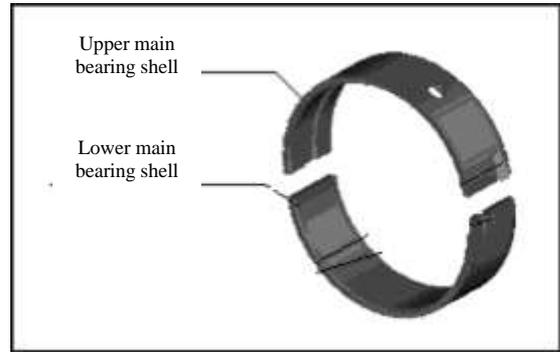




(5) Check axial clearance of crankshaft

① Install main bearing shell on main bearing and main bearing shell cover of cylinder block. During the course of checking, do not touch working surface and back face of main bearing shell, and installation surface of main bearing and main bearing shell cover of cylinder block.

Note: When operating, do not make upper main bearing shell and lower main bearing shell upside down. Upper main bearing shell (on cylinder block)..... is provided with oil groove and oil hole. Lower main bearing shell (on bearing cap)..... is not provided with oil groove and oil hole.

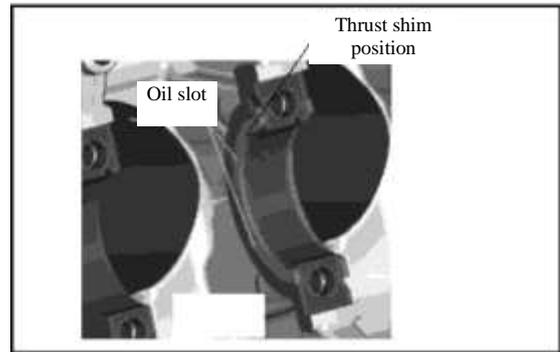


② Place crankshaft on cylinder block

Note: Be careful! Do not scratch crankshaft and main bearing shell.

③ Push two crankshaft thrust shims into two sides of 3<sup>rd</sup> main bearing support and keep oil groove outwards, i.e., oil groove is on the side of crankshaft.

Note: do not apply lubricating oil on crankshaft thrust shim.



④ Install main bearing cap, tighten it twice according to specified torque 60±5N.m.

⑤ Pry crankshaft balance block with a flat screwdriver to make crankshaft run out forwards, measure axial clearance of crankshaft with a dial gauge

Axial clearance: 0.04~0.20mm.

Note: record measured result.

⑥ If axial clearance exceeds specified value, you will determine which kind of thrust shim will be used or replace thrust shim according to the following calculation.

Measured axial clearance: A

The sum of crankshaft thrust shim thickness on the left and right: B

Specified axial clearance: C

Required crankshaft thrust shim thickness:  $D = \{ (A+B) - C \} \div 2$

Based on calculated result of D value, select appropriate crankshaft thrust shim from the data in the following table.

Crankshaft thrust shim size	Crankshaft thrust shim thickness (mm)	Remark
Standard size	2.15~2.18	When the maximum of $D \leq 2.18$
Enlarged size 0.125	2.275~2.305	When the maximum of $D > 2.18$
Enlarged size 0.250	2.40~2.43	When the maximum of $D > 2.305$

For example: measured axial clearance: A=0.53mm

The sum of left and right crankshaft thrust shim thickness: B=4.2mm



Specified axial clearance:  $C=0.04\sim 0.20\text{mm}$

Crankshaft thrust shim thickness required:  $D=?$

$$D = \{(A+B) - C\} \div 2$$

$= \{(0.53+4.2) - 0.04\sim 0.20\} \div 2 = 2.275\sim 2.345\text{mm}$ . In this case, use crankshaft thrust shim enlarged by 0.125mm. But, if the minimum of D value exceeds 2.43 mm, it is necessary to replace crankshaft and crankshaft thrust shim together.

### 3) Check piston and piston ring

#### (1) Wash piston

Use a scraper knife to remove carbon deposit.

Use a broken piston ring or other removing tool for ring groove to remove carbon deposit in piston ring groove.

Clean the piston with soft brush and detergent. Be careful! Do not scratch the piston surface.

Check if the piston is cracked, damaged or stuck.

(2) Measure upper compression ring, lower compression ring and combination oil ring with a thickness gauge.

Standard thickness of upper compression ring: 1.2mm

Standard thickness of middle compression ring: 1.2mm

Standard thickness of combination oil ring: 2.0mm

#### (3) Check piston ring groove backlash.

Measure lateral clearance of piston ring groove on the whole perimeter of each ring groove with plug gauge or thickness gauge. The maximum value measured is lateral clearance of piston ring groove.

Upper compression ring backlash: standard 0.04~0.09mm

Limit value 0.13mm

Middle compression ring backlash: standard 0.02~0.06mm

Limit value 0.08mm

If measured lateral clearance exceeds specified value, measure piston ring thickness with micrometer. According to the following standard piston ring thickness, replace piston ring or piston or both of them.



(4) Check if combination oil ring assembly is damaged.

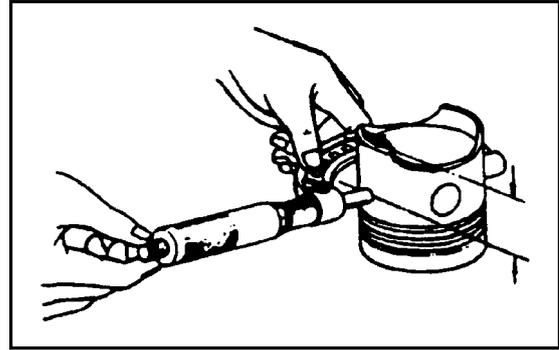
Note: for one cylinder, if any of upper compression rings, middle compression ring and combination oil ring assembly are defective, replace piston ring as a whole group.

(5) Measure outer diameter of the piston

Measure outer diameter of the piston at a distance from the lowest end of the piston

Measuring position for outer diameter of piston pin: 8mm away from lower end

Note: record measuring result. (When calculating the clearance between cylinder and piston, this measured result is required data.)

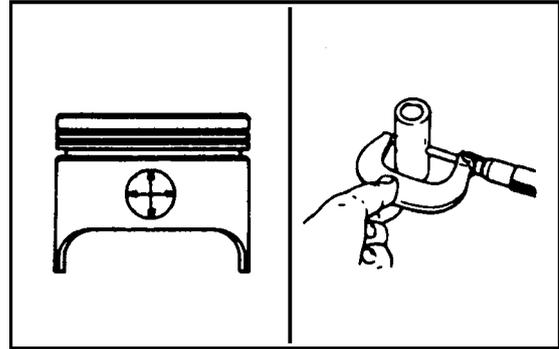


(6) Check piston pin clearance.

- ① Measure inner diameter of piston pin hole.
- ② Measure outer diameter of piston pin.
- ③ Calculate the clearance between piston pin hole and piston pin.

Allowable limit:

Note: If the clearance exceeds specified value, replace piston and piston rod in group.



(7) Measure opening clearance of piston ring

After checking or repairing the cylinder, place piston ring into the cylinder until it is above 40mm from top installation surface of cylinder block. Measure piston ring opening clearance with a plug gauge.

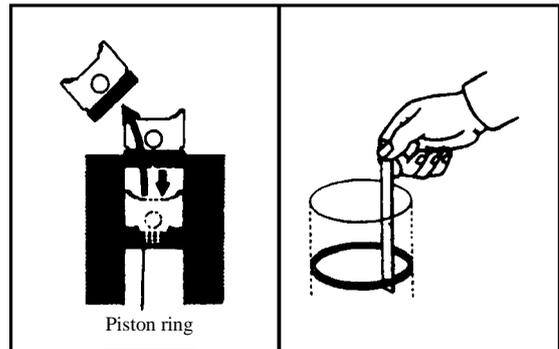
Lateral clearance between upper compression ring and ring groove: 0.04~0.09mm.

Lateral clearance between middle compression ring and ring groove: 0.02~0.06mm.

Backlash between oil ring and ring groove: 0.03~0.11mm.

Note: ① Before placing, apply lubricating oil on outside of piston ring.

② If opening clearance exceeds specified limit, replace piston ring in group.

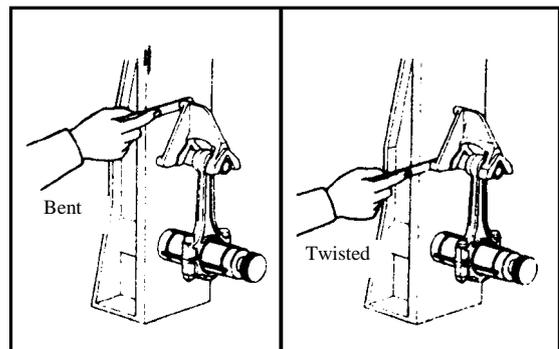


Check connecting rod

- (1) Check if connecting rod is damaged or cracked.
- (2) Check if connecting rod is bent and twisted.

Maximum bending limit: 0.03mm

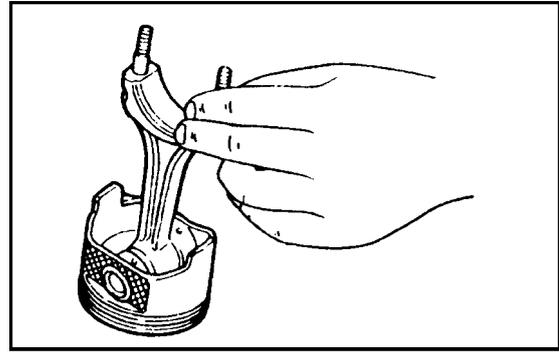
Maximum torsion limit: 0.03mm





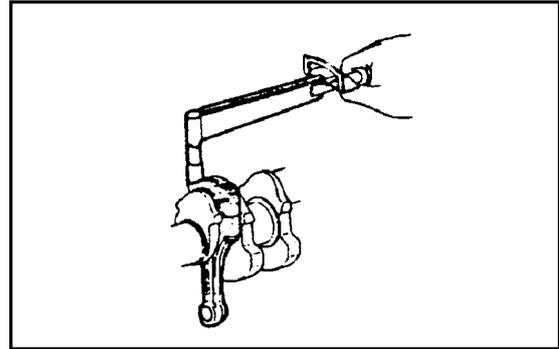
(3) Measure the clearance of big head hole of connecting rod.

① Install upper and lower shells of connecting rod on connecting rod body and connecting rod cap.



② Install plastic clearance gauge on crankshaft connecting rod journal. After installing connecting rod bearing cap, tighten connecting rod cap according to specified torque.

Tightening torque:  $22 \pm 2.5$ N.m, then rotate by  $90^\circ \pm 10^\circ$

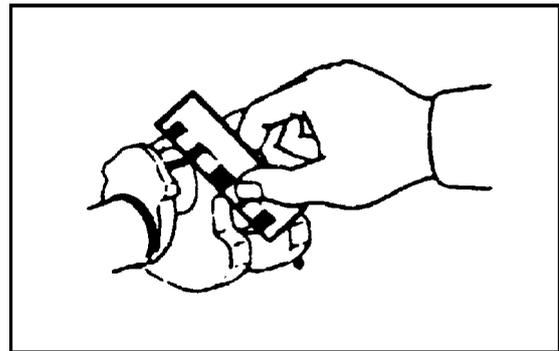


③ Remove connecting rod cap and measure the clearance.

Clearance between connecting rod bearing shell and crankshaft connecting rod journal: 0.017~0.035mm. If the clearance exceeds specified value, grind or replace the crankshaft according to the following table of crankshaft connecting rod journal dimension.

Connecting rod bearing shell dimension	Crankshaft connecting rod journal dimension
Standard dimension	$\phi 44.000 \sim \phi 43.982$
Minification size 0.25	$\phi 43.750 \sim \phi 43.732$
Minification size 0.50	$\phi 43.500 \sim \phi 43.482$

Note: when grinding crankshaft connecting rod journal, make finish machining for each crankshaft connecting rod journal to keep fillet angle radius R1.3mm.



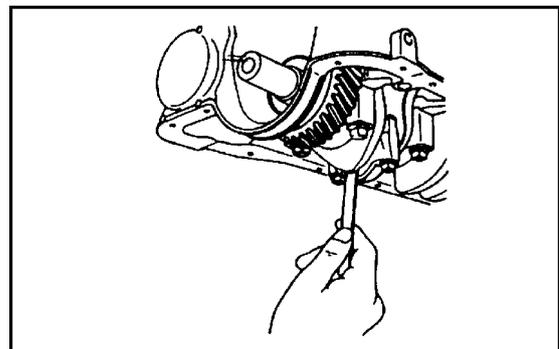
(4) Check axial clearance of connecting rod.

① Measure axial clearance between connecting rod and crankshaft with thickness gauge.

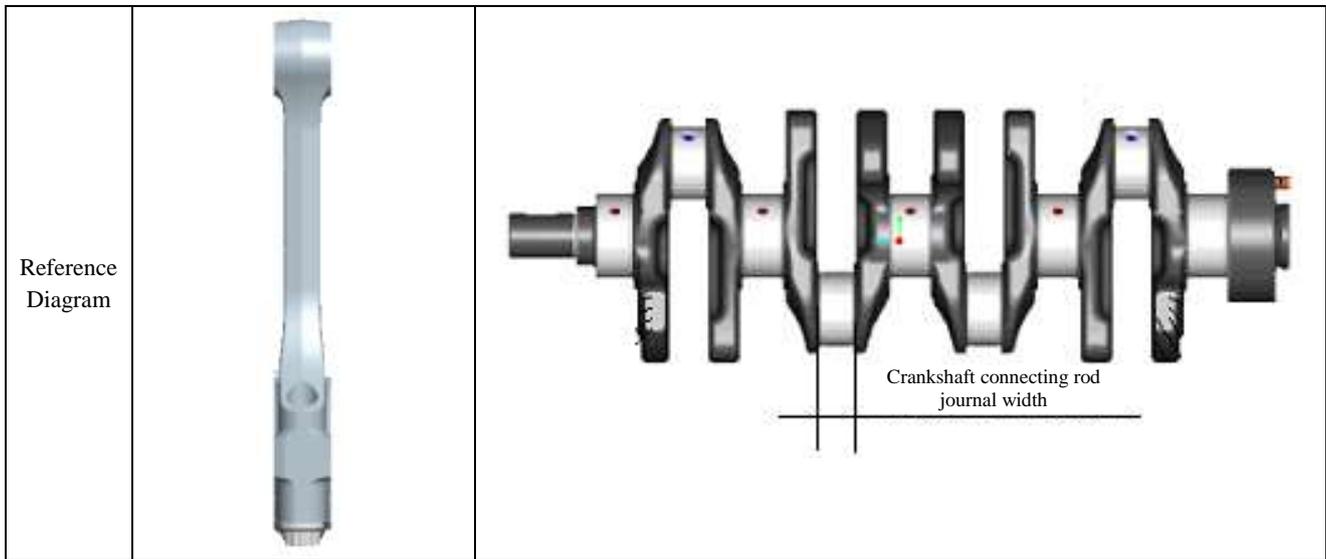
Axial clearance: 0.20~0.47mm

Note: when measuring axial clearance, push connecting rod down to any side of crankshaft along the shaft and then measure the clearance on the other side with thickness gauge.

② If the clearance exceeds specified value, replace connecting rod or crankshaft or both of them according to axial width of big head of connecting rod and axial width of connecting rod journal.

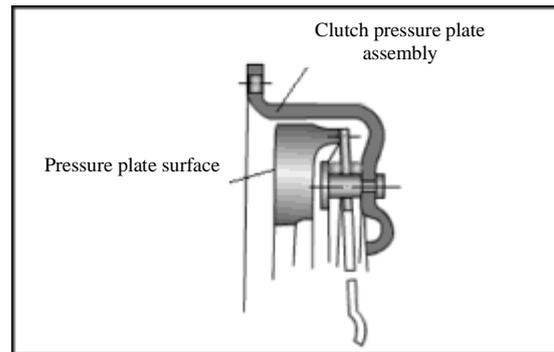


	Axial width of big head of connecting rod	Axial width of crankshaft connecting rod journal
	18.80~18.73mm	19.00~19.13mm



5) Check clutch cover assembly

- (1) Check if pressure plate surface of clutch cover assembly is worn and scratched. Wear limit is less than 0.3mm.
- (2) Check runout of clutch cover assembly diaphragm spring center within  $\phi 70$ . Runout limit is less than 0.7mm.

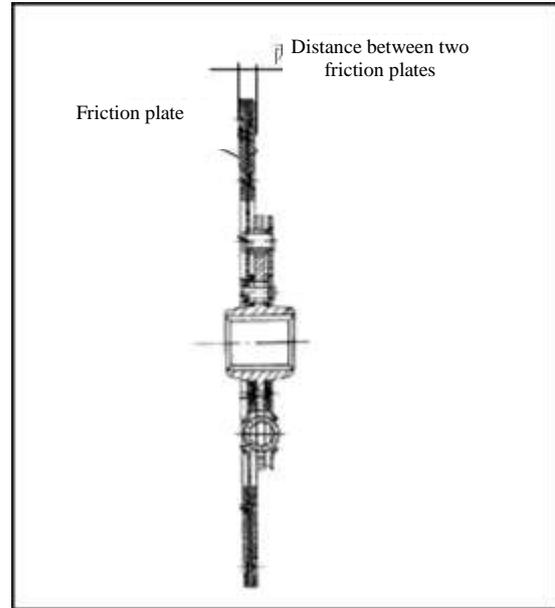




6) Check clutch driven plate assembly

(1) Check average thickness of two friction surfaces for clutch driven plate assembly is 8.0~8.4mm. Average limit thickness of two friction surfaces is 7.8mm.

(2) Friction plate of clutch driven plate assembly shall not be broken, greasy and dirty.



7) Check flywheel gear ring assembly

(1) Confirm contact surface between gear ring of flywheel gear ring assembly and clutch plate is not worn and damaged.

(2) Check radial runout of flywheel gear ring assembly

Tighten flywheel bolt according to specified torque.

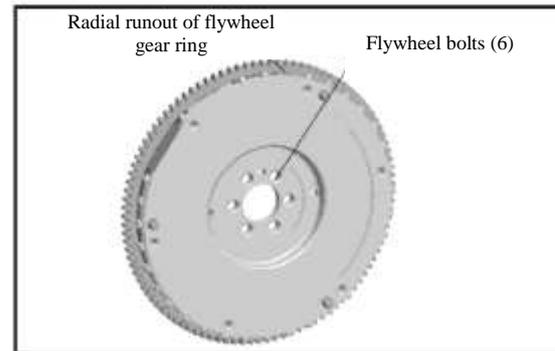
Tightening torque is 73.3~82.7N.m

Note: Before checking, tighten main bearing shell cover of crankshaft to specified torque.

Measure radial runout of flywheel gear ring assembly with dial gauge

Radial runout limit of flywheel gear ring assembly: 0.12mm

Note: if measured radial runout exceeds the limit, it is necessary to replace flywheel gear ring assembly.



8) For checking relief valve assembly, refer to “Lubrication System”

9) Check other parts

(1) Check if other parts are damaged or cracked. If necessary, replace them.

(2) For checking engine oil pump assembly, refer to “Lubrication System”

(3) For checking water pump assembly, refer to “cooling system”.

Install

(Notes)

(1) Clean all parts thoroughly.

(2) Before assembling, apply lubricating oil on all moving parts and rotating parts.

(3) Replace defective gasket to remove all sealant.

(4) If necessary, apply sealant to prevent water leakage and oil leakage.

(5) Use appropriate bolt, nut and shim. Tighten bolt and nut according to specified torque. Do not tighten stud on aluminum alloy parts too tightly.



(6) If making marks when removing, reinstall them according to the marks. Confirm the piston and other parts are installed properly to make them conform to specified clearance.

Install cylinder block on the engine overhaul bracket and tighten it with bolts to ensure safety.

2) Install cylinder block location pin

(1) Press two location rings of cylinder head into two holes on the top of cylinder block, with extension length 5.5~6mm

(2) Press two location pins of clutch housing into two holes on the rear end of cylinder block, with extension length 12~12.5mm

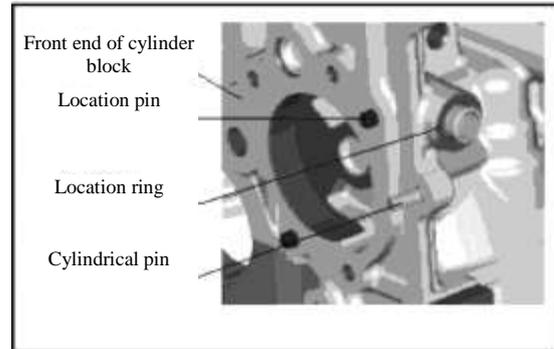
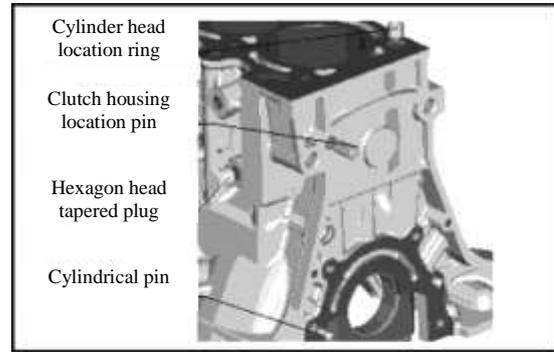
(3) Press two cylindrical pins into two holes of rear oil seal installation surface on the rear end of cylinder block, with extension length 6~6.5mm

(4) Before assembling, apply anaerobic sealant uniformly on threads of hexagon head tapered plug

(5) Press two location pins of engine oil pump into two holes on front end, with extension length 4~4.2mm.

(6) Press two cylindrical pins into two holes on front end of cylinder block, with extension length 6~6.5mm

(7) Press two location rings of combination bracket into two holes on exhaust side, with extension length 5~5.5mm



3) For installing relief valve assembly, refer to “Lubrication System”

4) Install crankshaft assembly

(1) Install crankshaft location pin

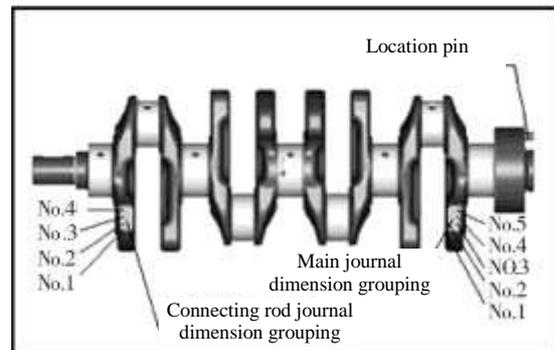
Install location pins on flywheel flange surface on the rear end of crankshaft with a special tool, with extension length of location pin 6~7mm

Note: ① Grouping mark of main journal is stamped on 8<sup>th</sup> crank arm.

② Grouping mark of connecting rod journal is stamped on 1<sup>st</sup> crank arm.

③ Main journal diameters have three groups. See the following table for grouping dimension of main journal diameters.

④ Connecting rod journal diameters have three groups. See the following table for grouping dimension of connecting rod journal diameters.





Main journal diameter grouping

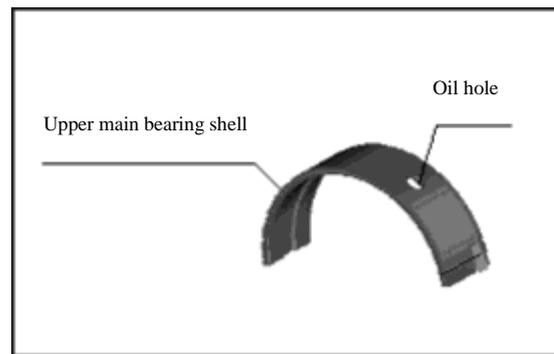
Symbol	$\theta 46^{0-0.018}$ Actual dimension
3	>-0.006~0
2	>-0.012~-0.006
1	>-0.018~-0.012

Connecting rod journal diameter grouping

Symbol	$\theta 46^{0-0.018}$ Actual dimension
3.	>-0.006~0
2	>-0.012~-0.006
1	>-0.018~-0.012

(2) Select main bearing shell wall thickness

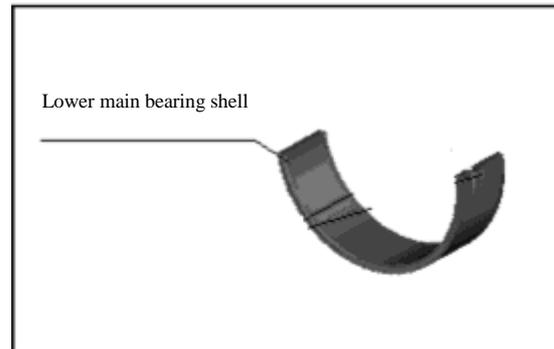
Main bearing shell wall thickness grouping mark is on the back. Upper main bearing shell is provided with oil hole, but lower main bearing shell is not provided with oil hole.



Note: see the table for main bearing shell wall thickness

Main bearing shell wall thickness grouping

Grouping code	color mark	grouping dimension
5	Cyan	2 $\begin{matrix} +0.012 \\ +0.009 \end{matrix}$
4	Black	2 $\begin{matrix} +0.009 \\ +0.008 \end{matrix}$
3	Dark brown	2 $\begin{matrix} +0.008 \\ +0.002 \end{matrix}$
2	Green	2 $\begin{matrix} +0.002 \\ +0 \end{matrix}$
1	Yellow	2 $\begin{matrix} 0 \\ -0.003 \end{matrix}$



(3) Select main bearing shell

Select appropriate main bearing shell according to main bearing hole grouping code and crankshaft main journal grouping code of cylinder block.

Select bearing shell code=7-(hole code + bearing code)

See the following table for assembling relationship among main bearing support, journal and main bearing shell



Support whole grouping	1		2		3	
	$\phi 50 +0.043$ $+0.037$		$\phi 50 +0.037$ $+0.031$		$\phi 50 +0.031$ $+0.025$	
Bearing shell grouping						
Main bearing grouping						
1	Clearance 0.025 0.043	Bearing shell code 05	Clearance 0.025 0.043	Bearing shell code 04	Clearance 0.025 0.043	Bearing shell code 03
$\phi 46 +0.012$ $+0.018$						
2	Clearance 0.025 0.043	Bearing shell code 04	Clearance 0.025 0.043	Bearing shell code 03	Clearance 0.025 0.043	Bearing shell code 02
$\phi 46 -0.006$ $+0.012$						
3	Clearance 0.025 0.043	Bearing shell code 03	Clearance 0.025 0.043	Bearing shell code 02	Clearance 0.025 0.043	Bearing shell code 01
$\phi 46 -0$ $+0.006$						

#### (4) Install main bearing shell

Keep cylinder block bottom upwards, clean main bearing support surface with silk cloth, apply lubricating oil on five upper main bearing shells of corresponding crankshaft journal and support hole group, and then place them on main bearing supports, put location lip on the back of the shell in corresponding slot and make bearing shell back lean against main bearing support surface. Apply lubricating oil on working surface of each upper main bearing shell.

Install lower main bearing shell on main bearing shell cover, put location lip of bearing shell into corresponding slot and make bearing shell back lean against main bearing support surface. Apply lubricating oil on working surface of each lower main bearing shell.

Note: ① Oil or other foreign matters are forbidden between bearing shell back and main bearing support surface. Oil hole on the shell and oil hole on the support face shall be interlinked.

② After bearing shell location lip is pressed into location slot of main bearing support, it will not become loose.

③ When installing, do not touch working surface and back face of main bearing shell, and installation surface of cylinder block bearing shell.

④ Wipe off lubricating oil on the back of each main bearing shell.

#### (5) Install crankshaft

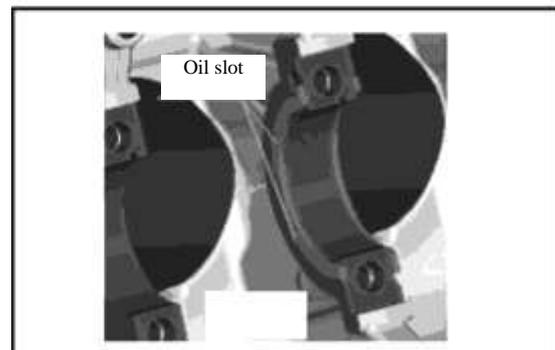
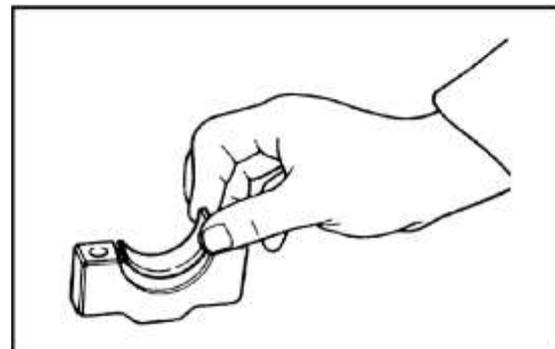
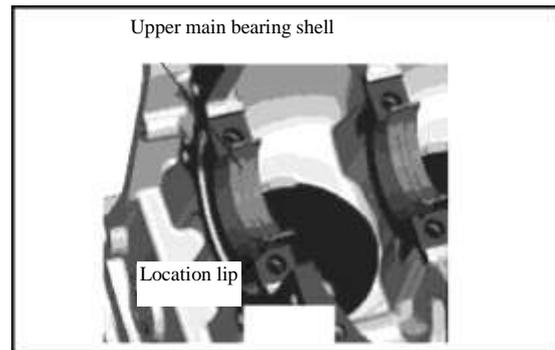
① Before installing crankshaft assembly, clean lubricating oil duct hole. No foreign matters are allowed on each journal.

② Apply 3~5 drops of lubricating oil on inner surface of assembled upper main bearing shell. Lift cleaned crankshaft assembly, place main journal on main bearing support slightly and rotate it by two turns.

#### ③ Install thrust shim

Push two thrust shims into both sides of 3<sup>rd</sup> main bearing support, keep oil groove outwards, i.e., oil groove is on the side of crankshaft.

Note: pushing position is on the upper side of 3<sup>rd</sup> main journal of crankshaft.





④ Install main bearing cap

Apply lubricating oil on lower main bearing shells of five main bearing shell covers of corresponding crankshaft journal and support hole group and then place them on main bearing cap support. Put location lip on the back of the shell in corresponding slot and make bearing shell back lean against main bearing support surface. Make five main bearing cap points to front end face direction of cylinder block according to the arrow and then install them in main bearing support from front end of cylinder block according to the sequence. Use wooden stick or copper bar to knock main bearing support slightly in order to make them lean against main bearing support reliably. Tighten main bearing bolts twice.

Initial tightening torque:  $20 \pm 5 \text{Nm}$ .

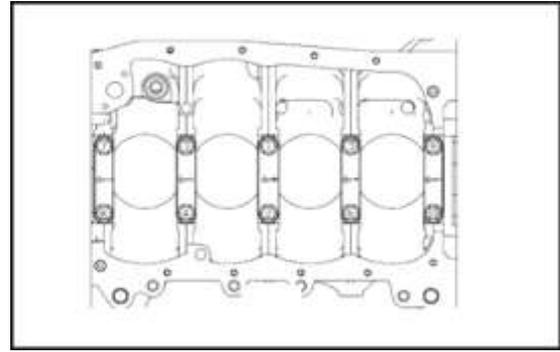
Final tightening torque:  $60 \pm 5 \text{N.m}$ , tightening sequence is as shown in the Fig.

Note: ① when installing main bearing shell cover, do not scratch each journal of crankshaft.

② After tightening main bearing cap initially, crankshaft can be rotated flexibly. In addition, after it is tightened further every time, it can be rotated flexibly.

⑤ Use magnetometer bracket to attach cylinder block and measure axial clearance of crankshaft with a dial gauge

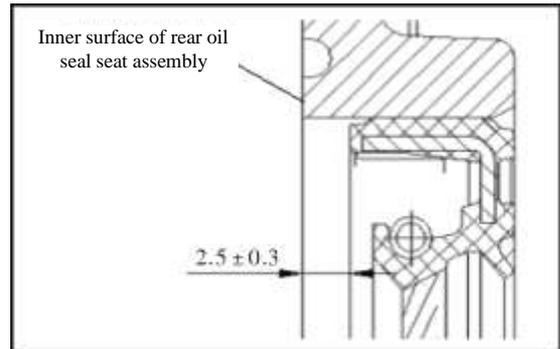
Axial clearance:  $0.04 \sim 0.2 \text{mm}$



5) Install rear oil seal seat assembly

(1) Clean rear oil seal seat assembly and press rear oil seal into rear oil seal seat hole with a special tool.

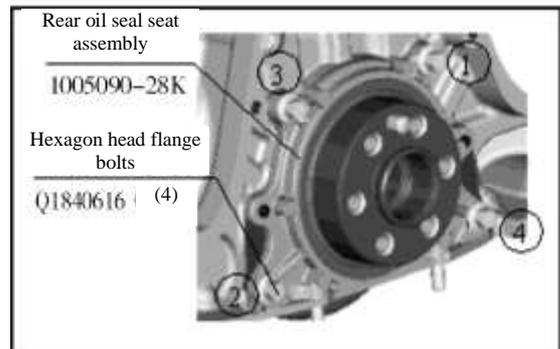
Press-in depth is away from joint surface of rear seal seat:  $2.5 \pm 0.3 \text{mm}$ , i.e., oil seal shall not go beyond rear end face of oil seal seat.



(2) Apply appropriate lubrication oil on the lip and then clean joint surface of rear oil seal seat and apply sealant uniformly.

Note: ① Check rear seal lip surface and confirm there is no paint, dirt and scratches.

② After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.

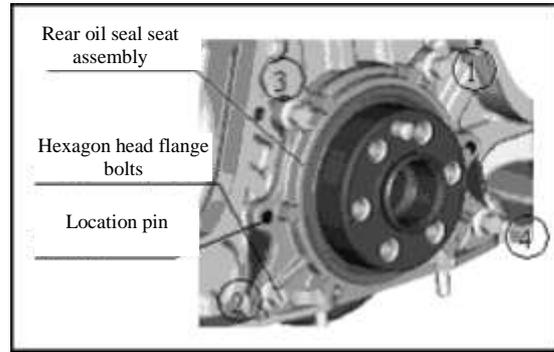




(3) Align location pin hole on oil seal seat with location pin on cylinder block, and knock external surface of oil seal seat slightly by hand or rubber hammer to make rear flange journal of crankshaft insert into oil seal lip and make oil seal seat lean against rear end face of cylinder block. Tighten hexagon head flange bolt according to the sequence as shown in the Fig..

Tightening torque of bolt is  $8 \pm 2N \cdot m$

Note: when installing rear oil seal seat assembly, do not damage oil seal surface.



6) Install connecting rod, piston and connecting rod bearing shell

(1) Select outer diameter grouping of piston pin

Group outer diameter of piston pin, and mark red and yellow colors on end face of piston pin.

Piston pin outer diameter grouping

Mark	Piston pin	$\phi 18$	$\begin{matrix} +0.034 \\ +0.028 \end{matrix}$
Red			$+0.028 \sim +0.031$
yellow			$>+0.031 \sim +0.034$

(2) Select piston pin hole and skirt grouping

Piston pin hole has two groups, with red and yellow marks on piston pin seat.

Piston skirt has three groups, with A, B and C marks on piston top.

Piston pin outer diameter grouping

Mark	Piston pin hole	$\begin{matrix} +0.042 \\ +0.039 \end{matrix}$
Red		$>+0.036 \sim +0.039$
Yellow		$>+0.039 \sim +0.042$

Piston skirt grouping

Grouping No.	Piston skirt diameter	$\phi 73$	$\begin{matrix} 0 \\ -0.03 \end{matrix}$
A			$>-0.03 \sim -0.02$
B			$>-0.02 \sim -0.01$
C			$>-0.01 \sim 0$

(3) Install piston rod with a special tool for installing and removing piston rod.

① Insert spring into main body of special fixture for installing and removing piston rod.

Insert long bar into main body.

Install the block on main body, with the notch upwards.

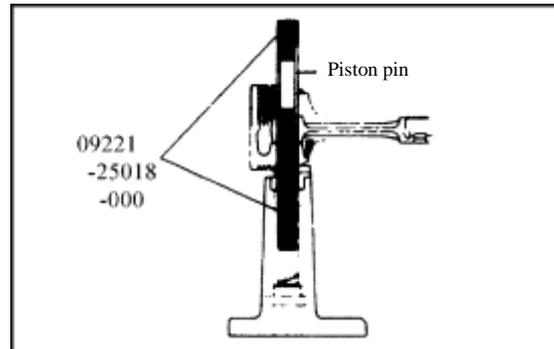
Install the piston on main body and align it with the notch on the block.

Note: inject lubricating oil into piston pin hole.

② Insert piston pin into piston pin hole.

Note: apply lubricating oil on piston pin.

Align small head hole of connecting rod with piston pin hole.





Note: Keep front mark of the piston and front mark of connecting rod in the same direction.

③ Insert small bar into middle hole of piston pin and keep it flat. Press piston pin into piston pin hole and small head hole of connecting rod by a special tool.

Press-in load of piston pin: 100N.m

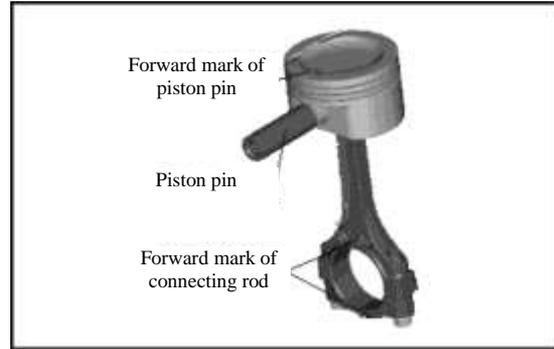
Press-in depth: when connecting rod end is close to inner flange of the piston, the distance between piston and piston pin is  $0 \pm 0.5\text{mm}$ .

Note: ① Put forward mark on the top of piston and forward mark on connecting rod on the same side, select piston pin with the same color as piston pin seat and then press it in.

② Clean all parts and apply appropriate lubricating oil on them.

③ Select the piston with  $\phi 60.4\text{mm}$  pit on the top. Do not mix it up with the piston on 1.3L engine.

④ If no appropriate piston can be used during the course of maintenance, piston for 1.3L engine can be used in a short term, but it shall not be used for a long time because it will damage the engine seriously.

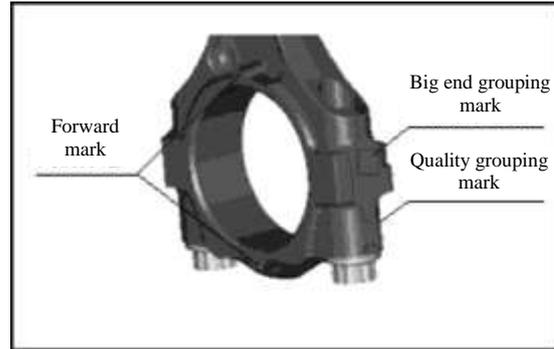


(4) Select connecting rod assembly grouping

For stamping positions of forward marks, big head grouping marks and quality grouping marks, see the Fig.

Connecting rod assembly has five groups, with A, B, C, D and E marks on big end.

Big end hole diameter of connecting rod has two groups, with marks 1 and 2 on big end.



Connecting rod quality grouping

symbol	Quality grouping
A	$\geq 383.5 - 386.5\text{g}$
B	$> 386.5 - 389.5\text{g}$
C	$> 389.5 - 392.5\text{g}$
D	$> 395.5 - 395.5\text{g}$
E	$> 395.5 - 398.5\text{g}$

Big end hole of connecting rod grouping

Grouping No.	$\phi 47$	Actual size
2	$\geq +0.017$	$+0.023$
1	$> +0.023$	$+0.029$

(5) Select connecting rod bearing shell

Select piston connecting rod assembly and connecting rod bearing shell according to upper connecting rod grouping mark of crankshaft and assembling table above.

Note: Connecting rod upper and lower bearing shells have four groups according to the thickness. The color is black, dark brown, green and yellow on bearing shell back.



Grouping according to thickness of connecting rod bearing shell

Grouping No.	color mark.	Grouping size
4	Black	1.5 <sup>+0.003</sup> / <sub>-0.003</sub>
3	Dark brown	1.5 <sup>+0.005</sup> / <sub>-0.003</sub>
2	Green	1.5 <sup>+0.003</sup> / <sub>+0</sub>
1	Yellow	1.5 <sup>0</sup> / <sub>-0.003</sub>

(6) Assembling relations of support hole, shaft hole, connecting rod journal

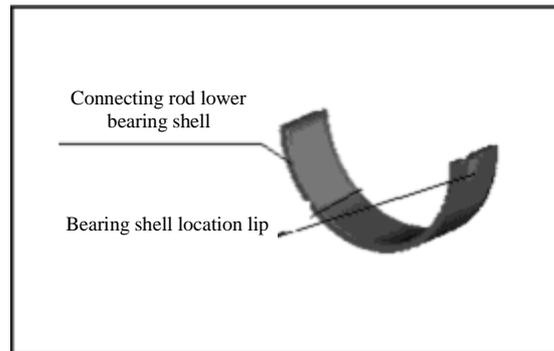
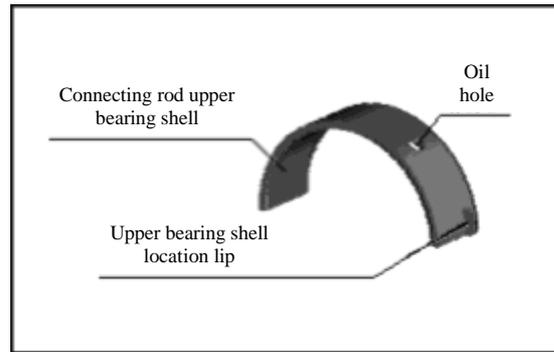
According to crankshaft connecting rod journal grouping code and connecting rod big end diameter grouping code, select appropriate connecting rod bearing shell.

Bearing shell code = 6 - (hole code + bearing code)

Table of assembling relation of support hole, bearing shell, connecting rod journal

support hole grouping bearing shell grouping main shaft split shaft	1		2	
	$\phi 43^{+0.029}$ / <sub>+0.023</sub>		$\phi 43^{+0.023}$ / <sub>+0.017</sub>	
1	Clearance	Bearing shell code	clearance	Bearing shell code
$\phi 40^{-0.012}$ / <sub>+0.018</sub>	0.017 0.035	04	0.017 0.035	03
2	Clearance	Bearing shell code	clearance	Bearing shell code
$\phi 40^{-0.006}$ / <sub>+0.012</sub>	0.017 0.035	03	0.017 0.035	02
3	Clearance	Bearing shell code	clearance	Bearing shell code
$\phi 40^{-0}$ / <sub>+0.006</sub>	0.017 0.035	02	0.017 0.035	01

Bearing shell = 6 - (Hole code + Bearing code)



(7) Install connecting rod upper/lower bearing shells

Install connecting rod upper bearing shell into connecting rod bearing shell seat hole, make location lip in corresponding slot of bearing shell seat and make shell back lean against connecting rod big end hole seat surface reliably.

Install connecting rod lower bearing shell into connecting rod bearing shell seat hole, make location lip in corresponding slot of bearing shell seat and make shell back lean against connecting rod big end hole seat surface reliably.

Note: ① Connecting rod upper bearing shell is provided with oil hole, but connecting rod lower bearing shell is not provided with oil hole.

② Oil or other foreign matters are forbidden between bearing shell back and connecting rod bearing support surface. Oil hole on the shell and oil hole on the support face shall be interlinked.

③ After bearing shell location lip is pressed into location slot of connecting rod bearing support, it will not become loose.

④ When installing, do not touch working surface and back face of connecting rod bearing shell, and installation surface of connecting rod bearing shell.

⑤ Wipe off lubricating oil on the back of each connecting rod bearing shell.



## 7) Install piston ring

(1) Clean piston ring groove. No foreign matters are allowed in ring groove.

(2) First place combination oil ring assembly into oil ring groove; then install middle compression ring and upper compression ring by hand or a special tool.

Note: ① Keep the surface with upward mark of piston ring upwards.

② Be careful! Avoid piston ring opening end from scratching piston surface.

(3) After piston ring is installed in ring groove, it can rotate flexibly.

## 8) Install piston connecting rod assembly

(1) Rotate crankshaft to make 1<sup>st</sup> and 4<sup>th</sup> connecting rod journals at TDC.

(2) Apply appropriate lubricating oil on inner surface of bearing shell; apply appropriate lubricating oil on the perimeter within 10mm beginning from the top in the cylinder barrel.

(3) As shown in the Fig., stagger piston ring opening positions. For each ring opening position, see the following Fig.,

(4) Forward mark of piston connecting rod group points to the front of the engine. Push connecting rod assembly into the cylinder with a special tool. When connecting rod bearing shell leans against connecting rod journal reliably, install connecting rod big end cap of connecting rod lower bearing shell (apply appropriate lubricating oil on inner surface) into connecting rod.

Note: Forward mark on connecting rod cap and the mark on connecting rod body shall be on the same side.

(5) Apply some lubricating oil on threads of connecting rod bolts.

(6) Tighten connecting rod bolt

Tightening torque:  $22 \pm 2.5 \text{ N.m}$ , and then twist to plastic area:  $90^\circ \pm 10^\circ$

(7) Rotate crankshaft to make 2<sup>nd</sup> and 3<sup>rd</sup> connecting rod journal at TDC, repeat the above steps to install another two piston connecting rod assemblies.

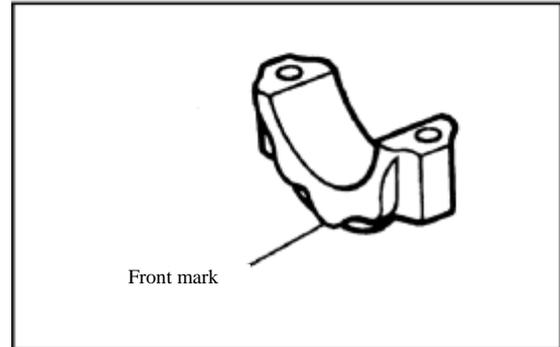
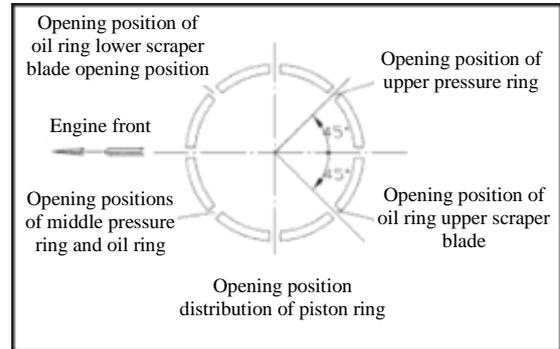
(8) Rotating torque of crankshaft shall be less than 5~15N.m.

Note: ① One engine shall use connecting rods with the same quality grouping marks.

② During the course of removing and installing connecting rod assembly, do not damage threads of connecting rod bolts.

③ During the course of installing connecting rod assembly, align location pin of connecting rod cap with location pin hole of connecting rod body and then knock it into installation position slightly.

9) For installing engine oil catcher assembly, refer to "Lubrication System"





10) Install engine oil pan assembly

(1) Clean engine oil pan assembly.

(2) Apply  $\Phi 3$ mm sealant on cylinder block bottom, timing chain cover bottom, rear oil seal seat bottom and thread hole periphery (as shown in the Fig.), place engine oil pan and tighten it with nuts and bolts. Tightening torque is  $8 \pm 2$ N.m.

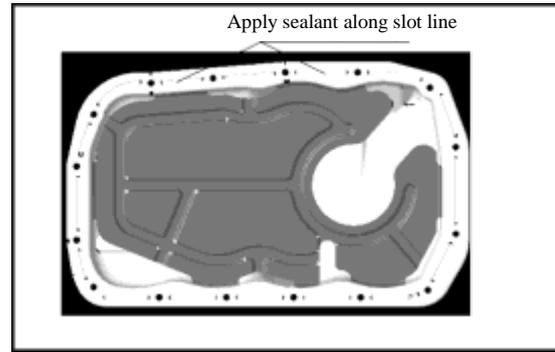
Tightening sequence: first tighten 2 nuts on front end, and then begin from the middle to tighten 14 bolts on left and right sides in turn.

Note: After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.

(3) Install oil drain plug assembly

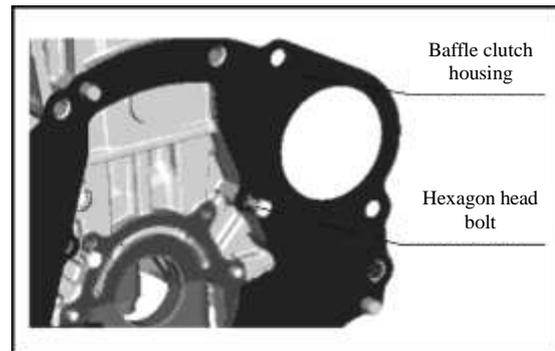
Tightening torque is  $30 \pm 5$ N.m.

Note: apply sealant on threads of oil drain plug assembly.



11) Install clutch housing baffle

Clutch housing baffle is smooth and not warping. Tightening torque of hexagon head bolt is  $5 \sim 10$ N.m.



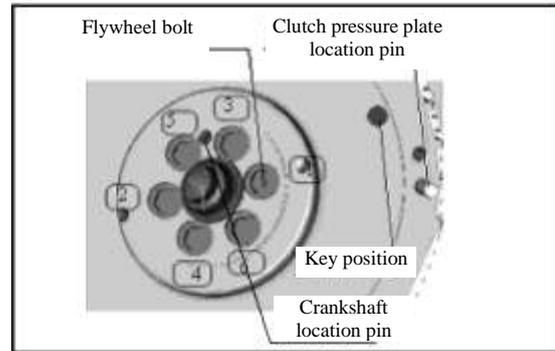
12) Install flywheel gear ring assembly

(1) Press three location pins of clutch pressure plate into flywheel location pin hole with a special tool, with extension length  $7 \sim 8$ mm.

(2) Fasten crankshaft with a special tool to prevent the flywheel from rotating. Align location pin hole on flywheel gear ring assembly with location pin on rear end of crankshaft, place it on rear end counter lock of crankshaft and tighten it with flywheel bolts. Tightening sequence is as shown in the Fig.

Tightening torque is  $73.3 \sim 82.7$ N.m

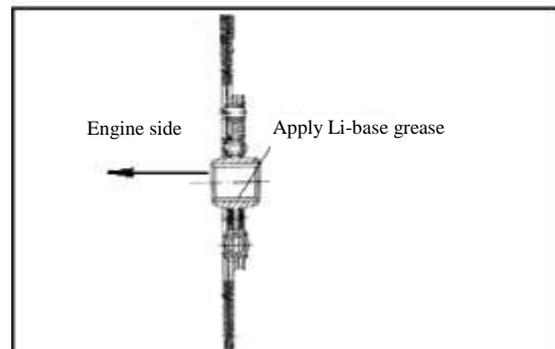
Note: Red mark on the flywheel is the key position of the flywheel. Do not install a flywheel without a red mark.



13) Install clutch driven plate assembly and clutch cover assembly

(1) Insert a tool for removing and installing clutch housing and pressure plate into rear end hole of crankshaft. Apply Li-base grease on the spline of clutch driven plate assembly, and then install clutch driven plate assembly as shown in the Fig.

Note: when installing, do not apply Li-base grease or water on friction plate of clutch driven plate assembly.





Clutch driven plate assembly

(2) Install clutch cover assembly on the flywheel. Tighten fixing bolts of clutch cover assembly and flywheel diagonally three times. Tightening torque:  $19.1 \pm 1.2 \text{ Nm}$ .

Note: Red mark on the flywheel is the key position of the flywheel. When installing clutch cover assembly, stagger key position of clutch cover assembly and key position of flywheel.

14) For installing engine oil pump assembly, refer to "Lubrication System"

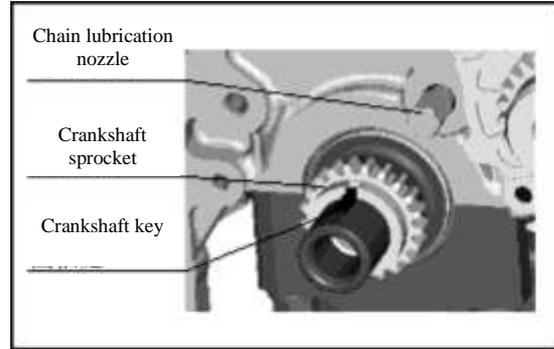
15) Install crankshaft sprocket

Fasten crankshaft with a special tool, keep crankshaft sprocket key slot outwards to make sprocket key slot and crankshaft key slot coincide.

16) Install chain lubrication nozzle

Apply anaerobic sealant on threads of chain lubrication nozzle and install it on cylinder block front end. Tighten it and keep injecting hole downwards to make injected lubricating oil flow to timing chain directly.

Note: apply anaerobic sealant on threads of chain lubrication nozzle. Do not block oil hole.



17) For installing timing chain, refer to "V-belt and timing chain"

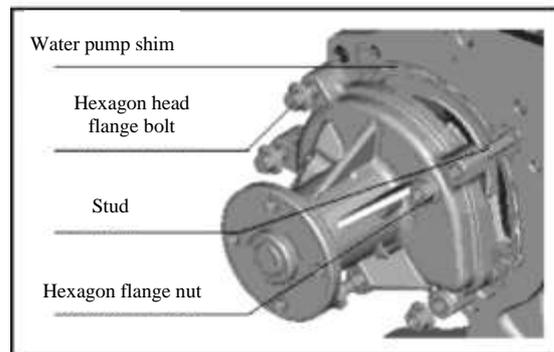
18) For installing chain mounting bracket, refer to "V-belt and Timing Chain"

19) Install water pump assembly

(1) First apply sealant on two studs and screw them in corresponding position of cylinder block front end.

(2) Install water pump body and water pump shim on corresponding positions of cylinder block front end with three hexagon head flange bolts and two hexagon flange nuts. Tightening torque is  $9 \pm 1.8 \text{ N.m}$ .

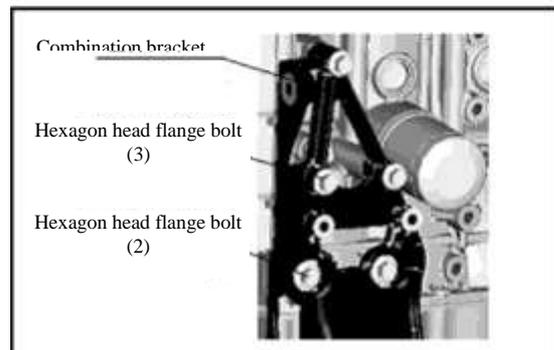
Note: water pump shim shall have good elasticity. Otherwise, replace it with new water pump shim.



20) Install idler assembly and cooling air compressor assembly combination bracket

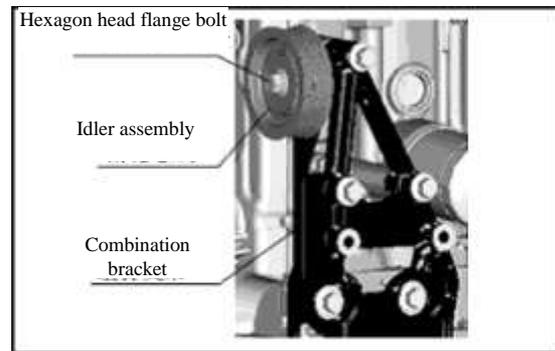
Install idler assembly and cooling air compressor assembly combination bracket on cylinder block and tighten them with hexagon head flange bolts.

Tightening torque is  $50 \pm 10 \text{ N.m}$ .



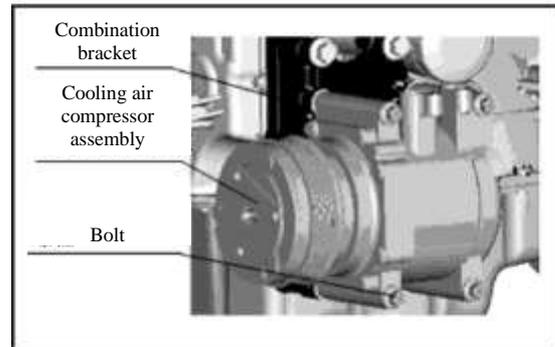
## 21) Install idler assembly

Tightening torque of the bolt is  $44 \pm 9 \text{ N} \cdot \text{m}$



## 22) Install cooling air compressor assembly

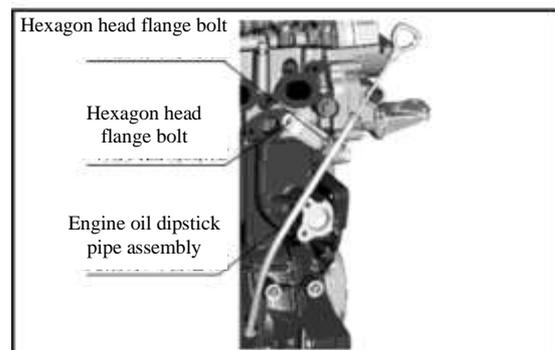
Fasten cooling air compressor assembly on combination bracket with bolts. Tightening torque of bolts (four bolts) is  $24 \pm 5 \text{ N} \cdot \text{m}$ .



## 23) Install engine oil dipstick pipe assembly

(1) Apply sealant on one end of engine oil dipstick pipe assembly, and insert it into engine oil dipstick pipe hole on cylinder block. Use hexagon head flange bolt to fasten it on air intake side of cylinder head. Tightening torque is  $22 \pm 4 \text{ N} \cdot \text{m}$ .

(2) Insert engine oil dipstick assembly into engine oil dipstick pipe.



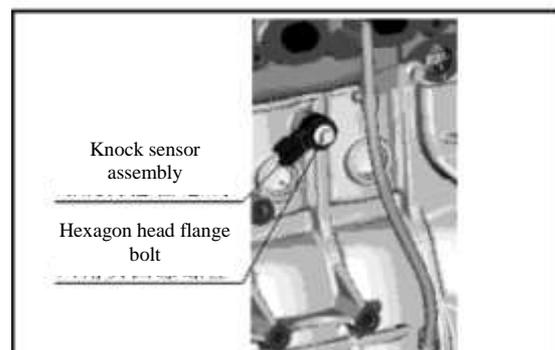
## 24) Install knock sensor assembly

Fasten knock sensor assembly on air intake side with hexagon head flange bolt, with a horizontal included angle of  $45^\circ$ .

Tightening torque is  $20 \pm 5 \text{ N} \cdot \text{m}$ .

Note: ① There is no damage on the surface of knock sensor assembly and joint surface is smooth.

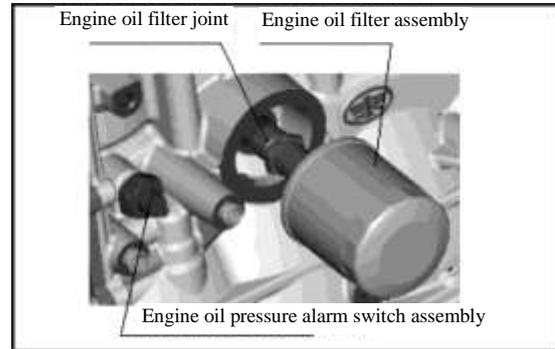
② Do not use an impact torque wrench to tighten knock sensor assembly.



**25) Install engine oil pressure alarm switch assembly**

Apply sealant on 2<sup>nd</sup> and 3<sup>rd</sup> threads on engine oil pressure alarm switch assembly (avoid sealant from being squeezed into main oil channel) and then screw it into bypass hole of main oil channel, tighten it with a special tool. Tightening torque is  $15 \pm 5 \text{N.m}$ .

Note: Do not use an impact torque wrench to tighten engine oil pressure alarm switch assembly.


**26) Install engine oil filter joint and engine oil filter assembly**

(1) Clean engine oil filter joint, apply sealant on end threads and screw it into cylinder block until it contacts cylinder block surface. Tighten it with a special tool. Tightening torque is  $34-54 \text{N.m}$ .

(2) Apply lubricating oil on seal ring of engine oil filter assembly; screw engine oil filter into engine oil filter joint with a special torque wrench until seal ring contacts seal surface of cylinder block. Then rotate by  $3/4$  turns.

27) For installing generator assembly, refer to “V-belt and Timing Chain”

**28) Install V-belt**

Install V-belt as shown in the Fig., and adjust adjusting bolts on generator bracket to tension the belt.

Rotate crankshaft by more than 2 turns. Specified value of belt tension is  $(650 \pm 50) \text{N}$ . Measuring position is the arrow position as shown in the Fig..

Tighten hexagon head flange bolt on adjusting nut. Tightening torque is  $23 \pm 4 \text{N.m}$ . Tighten hexagon head flange bolt for limit bracket assembly. Tightening torque is  $50 \pm 10 \text{N.m}$ .

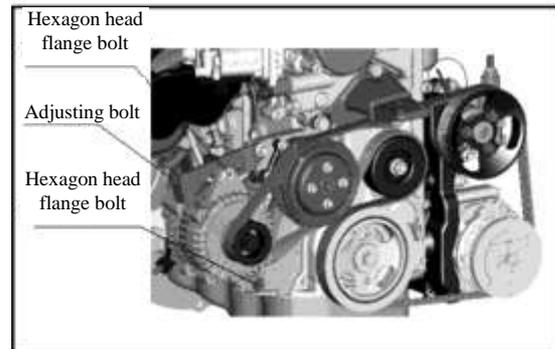
Note: ① If original V-belt is reused, V-belt rotation direction shall be the same as the arrow direction on V-belt back.

② Do not bend V-belt sharply by small radius to avoid breaking off core wire.

③ Do not make V-belt contact engine oil, grease or water.

④ When installing V-belt, do not try to pry it with a screwdriver or similar tool.

⑤ It is suggested to check or replace V-belt at 20,000km and it is necessary to replace at 50,000km.





### 3.7 Ignition System

Ignition system includes: bar type ignition coil assembly and spark plug

#### Remove

1) For removing bar type ignition coil assembly, refer to “Timing Chain and Water Pump”

2) Remove park plug

Use a special tool to remove spark plug. Be careful when taking out spark plug to avoid damaging.

#### Check

1) Check spark plug

(1) Check if spark plug assembly body is peeling off and damaged.

(2) Check if spark plug assembly electrodes, threads and body have carbon deposit and are damaged. If yes, please clean them with special detergent.

(3) Check spark plug clearance

Bend outer electrode carefully to obtain correct spark plug clearance. Adjust spark plug clearance to 0.8~0.9mm.



For checking bar type ignition coil assembly, please refer to CA4GA1 *Engine Maintenance Manual* (electronic control).

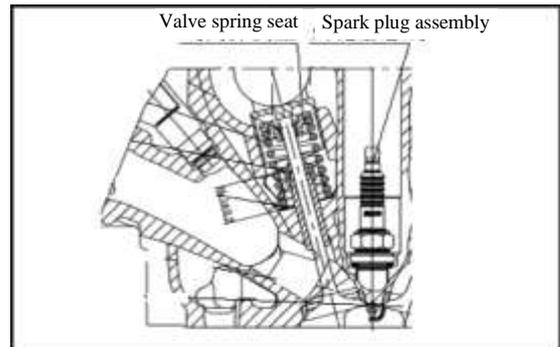
#### Install

1) Install spark plug assembly.

Install four spark plug assemblies into corresponding bolt hole of cylinder head with a special tool.

Tightening torque:  $18 \pm 3.5N$

Note: place spark plug into cylinder head spark plug hole slightly with a special tool. Do not let spark plug in spark plug guide pipe hole fall down freely. Otherwise, it will be damaged.

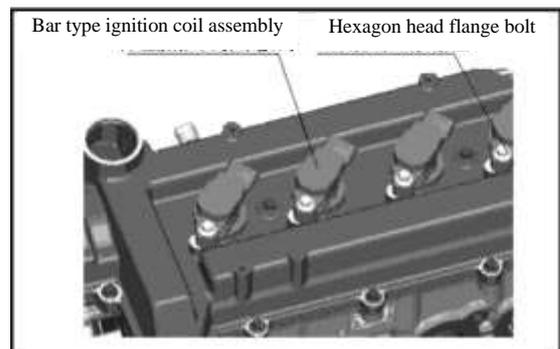


2) Install bar type ignition coil assembly

(1) Insert bar type ignition coil into cylinder head spark plug hole until it reaches the bottom.

(2) Tighten it by hexagon head flange bolt. Tightening torque:  $8 \pm 2N.m$

Note: Press (rubber hammer can be used) bar type ignition coil assembly slightly by hand to make bar type ignition coil assembly and spark plug contact closely, with click sound.





### 3.8 Lubrication system

Note: After installing engine oil pump assembly, rotate it for check to determine leak tightness of engine oil pump assembly. Therefore, be careful during the course of checking engine oil pump assembly. Make sure each clearance is within normal range.

#### Check

#### Check engine oil pump assembly

##### (1) Check the appearance of engine oil pump assembly

Engine oil pump assembly sprocket, inner and outer rotors and housing shall not be deformed, cracked and warped. Otherwise, replace them.

##### (2) Clearance of outer rotor top end for engine oil pump

Check the clearance between outer rotor top end and cylinder block front end with a feeler gauge: 0.7~0.8mm. Limit clearance: 1.3mm.

##### (3) Backlash of inner rotor

Measure backlash of inner rotor with a feeler: 0.05~0.10mm. Clearance limit: 0.18mm.

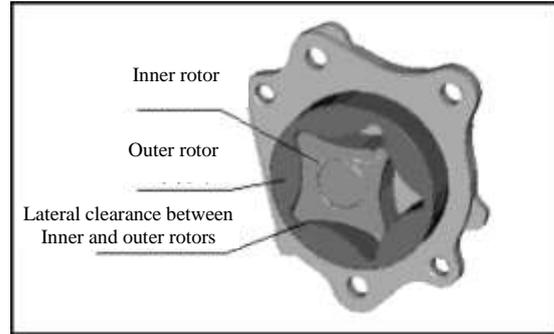
##### (4) Clearance between driven rotor and cylinder block

Check the clearance between driven rotor and cylinder block: 0.19~0.27mm. Clearance limit: 0.4mm.

#### Check relief valve assembly

Press relief valve plunger by hand to determine the plunger can be compressed.

Check relief valve assembly length: 36mm.



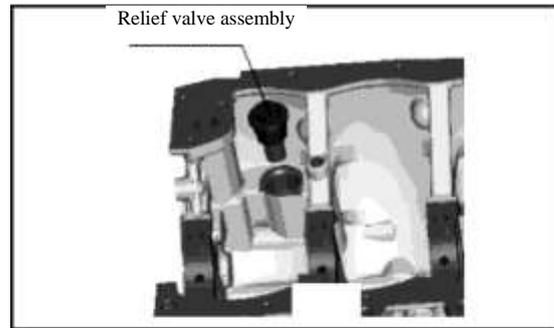
#### Install

##### 1) Install relief valve assembly

Apply sealant on threads of relief valve and screw it into thread hole of cylinder block.

Note: No foreign matters are allowed in mounting hole.

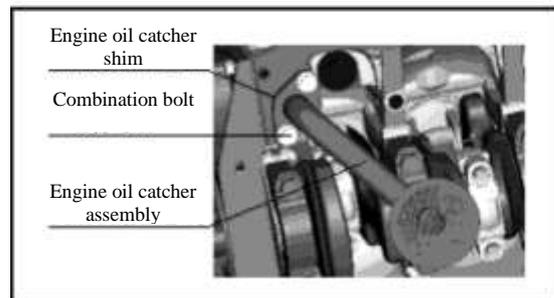
Tightening torque: 40±5N.m



##### 2) Install engine oil catcher assembly

Place new engine oil catcher shim on the flange surface of engine oil catcher assembly. Tighten combination bolt.

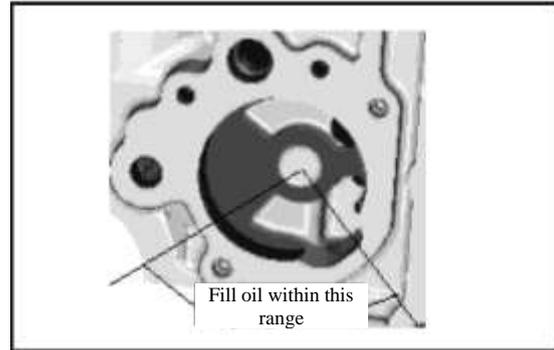
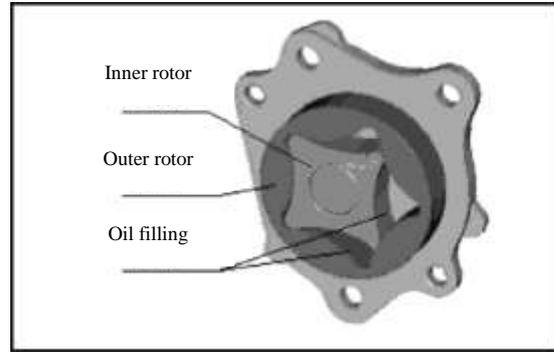
Tightening torque of bolt: 6~11N.m.





3) Install engine oil pump assembly

- (1) Fill lubricating oil into the clearance between inner and outer rotors of engine oil pump.
- (2) Fill lubricating oil into lower side of rotor mounting hole on cylinder block.



- (3) Keep outer rotor mark face to outside of cylinder block and install outer rotor into rotor mounting hole of cylinder block.
- (4) Fasten it on cylinder block front end with bolts and washers. Tightening torque is  $9 \pm 1.8 \text{ N} \cdot \text{m}$ .

Note: ① Rotate engine oil pump sprocket by at least one turn in order to lubricate the rotor completely.

- ② Engine oil pump sprocket shall be rotated flexibly.

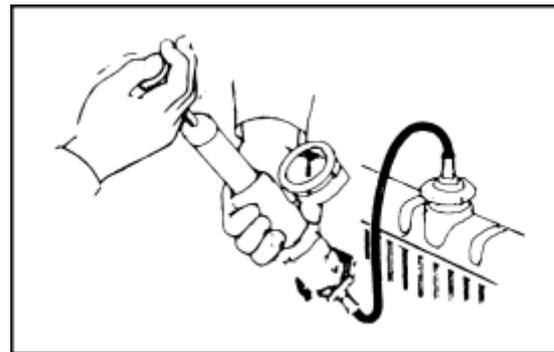
3.9 Cooling system

Radiator

Check cooling system on the vehicle according to the following step, tighten loose bolt or replace defective parts.

- (1) Remove radiator cover and fill cooling water into cooling system. Install radiator covers tester.
- (2) Apply 117.6KPa (1.2kgf/cm<sup>2</sup>) pressure on cooling system with radiator cover tester. Check the following items.
  - ① Radiator leakage.
  - ② Water pump leakage.
  - ③ Leakage at hose joint.
  - ④ Excessive expansion of hose.

Note: When installing or removing radiator cover tester and during the course of testing, do not deform water filling port of radiator cover.

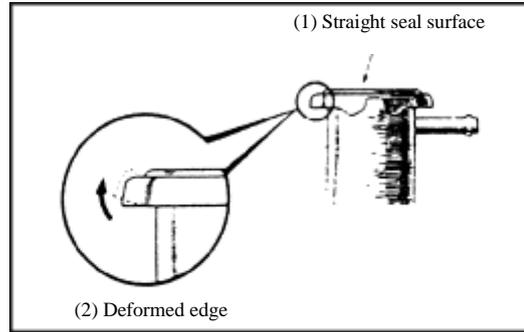




(3) Check water filling port of radiator

- ① Deformation or sinkage of seal surface
- ② Deformation of edge

Note: If water filling port is deformed, radiator cover cannot be tight, which will reduce cooling water.



Radiator cover

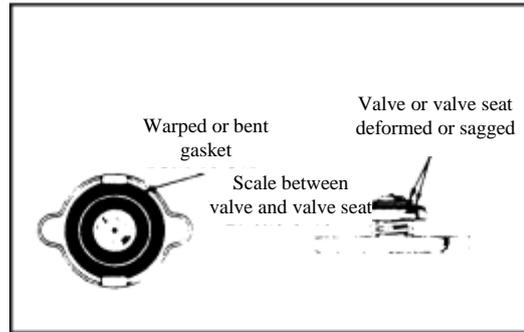
Check

(1) Check the following parts and replace defective parts.

- ① Bent or deformed gasket
- ② Deformed or sunk valve and valve seat.

Scale deposit between valve and valve seat.

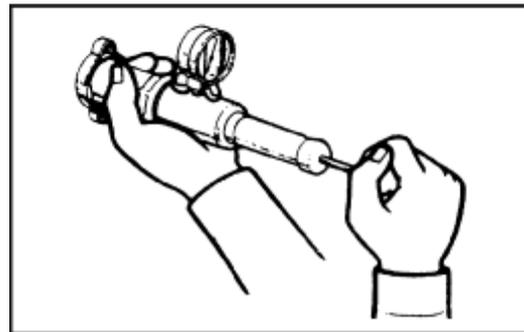
Note: Scale deposit between valve and valve seat shall be removed.



(2) Check seal pressure and vacuum safety valve.

Opening pressure limit value of seal safety valve: 58.8KPa (0.6kgf/cm<sup>2</sup>).

Opening pressure standard value of seal safety valve: 73.5~102.9KPa (0.75~1.05kgf/cm<sup>2</sup>).



Thermosistor assembly

Check

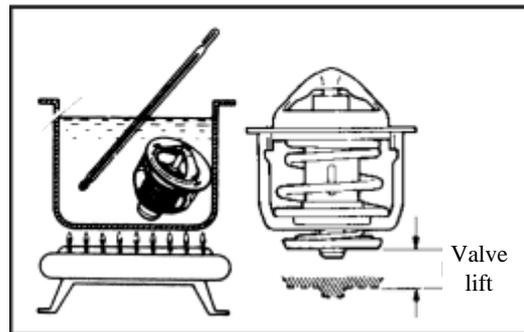
(1) Immerse thermosistor assembly, heat water gradually and check opening temperature of the valve.

(2) If the valve cannot be opened or closed tightly at normal temperature, replace thermosistor assembly.

Initial opening temperature of thermosistor assembly valve: 80±2°C

Full-open temperature of thermosistor assembly valve: 95°C

Full lift of the valve (mm): ≥8





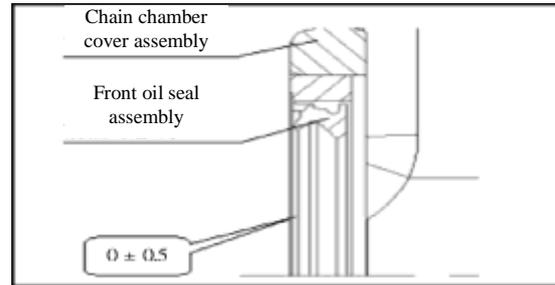
## Attachment 1: Install chain chamber cover assembly

### (1) Install front oil seal assembly

① Use new front oil seal assembly and press it into chain chamber cover hole with a special tool. Press-in depth is away from joint surface of cylinder block:  $0 \pm 0.5$ mm.

Note: ① After installing new front oil seal assembly, use your fingertip to dip lubricating oil to apply it on the lip of new front oil seal assembly. Do not apply lubricating oil on the outside.

② If using front oil seal assembly of original one, please check if front oil seal assembly lip and skeleton rubber is damaged or cracked. If it is defective, replace new front oil seal assembly.



### (2) Install gasket

Apply some lubricating oil on chain chamber cover gasket and press it into the groove of OCV control valve to which chain chamber cover and cylinder head correspond. Be careful to avoid falling off.

Note: Before installing gasket, it is necessary to check if seal surface is cracked, damaged and wrinkled. If any defect is found, please replace with new gasket. (Suggestion: it is better to use new gaskets.)

### (3) Install chain chamber cover assembly

① Use special detergent (recommended Three Bond Super Detergent TB6602T or Kesaixin Efficient Detergent 1755EF) or cleaning tape (clean white cloth) to clean chain chamber cover assembly joint surface and make sure joint surface is clean.

② Spray special detergent on joint surface of engine block, cylinder head and chain chamber cover assembly (recommended Three Bond Super Detergent TB6602T). Keep it static for several minutes and remove fallen glue seam and other foreign matters on the surface with soft brush.

Note: only soft copper brush can be used, because nylon soft brush will not clean completely. In addition, hard brush will damage joint surface.

③ After cleaning, spray detergent (recommended Three Bond Super Detergent TB6602T) on pure cotton knitted fabric to clean joint surface until there are no oil stains and dirt.

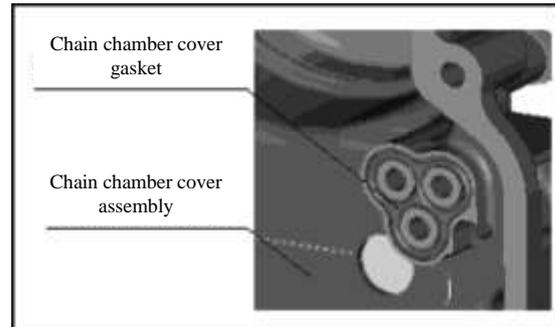
④ Apply anaerobic sealant on cylinder block joint surface of chain chamber cover and surfaces of four bolt holes. Apply the sealant uniformly as far as possible; do not apply it too widely to avoid sealant from falling into crankcase after installation.

⑤ Apply sealant on the joint between engine block and cylinder head separately.

⑥ Align it with location pin hole of cylinder block front end and push it into the hole slightly. A wooden hammer or rubber hammer can be used to knock it into the hole.

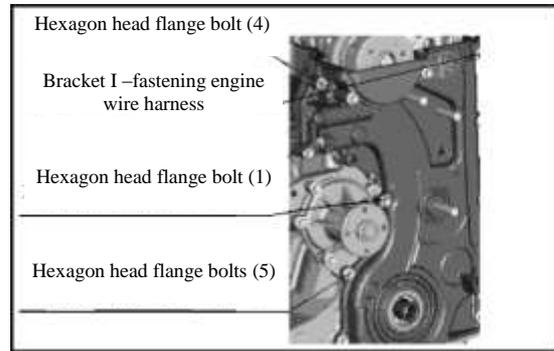
Note: After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.

Note: when installing chain chamber cover assembly, do not make the gasket fall off.





⑦ Use hexagon head flange bolt (10 bolts) to fasten it. Tightening torque is  $12 \pm 2.4 \text{N.m}$ . Engine wire harness bracket I and cover share one bolt.



⑧ Use scraper blade to remove squeezed sealant and use cleaning tape to clean residual sealant on joint surface.

Note: The cloth cannot remove residual sealant completely. It will affect seal quality of joint surface after curing.



(4)Note: after installing the engine, keep it at  $15^{\circ}\text{C} \sim 25^{\circ}\text{C}$  for at least 6 hours, and then start it.



## Attachment 2: Install cylinder head cover assembly

### (1) Install cylinder head cover assembly

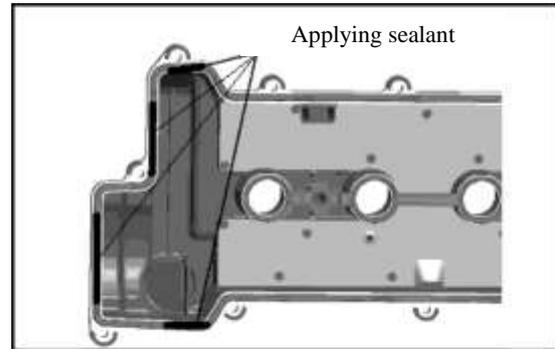
- ① Check if there is residual sealant on cylinder head top and chain chamber cover assembly top.

Note: If there is residual sealant, please remove it with scraper blade and spray high-efficient detergent on joint surface and then clean joint surface top with cleaning tape.

- ② Put cylinder head cover gasket into gasket slot on cylinder head.

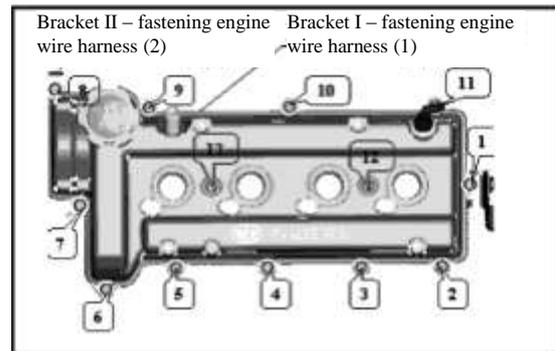
- ③ Apply glue on the joint and turning (4 positions) between cylinder head and timing chain cover.

Note: After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.



### (2) Install cylinder head cover assembly on cylinder head. Tighten each bolt and hexagon head flange bolt.

- ① Use M6×20 bolts at ⑥ and ⑦ positions as shown in the Fig..
- ② Use M6×55 studs and M6 hexagon head flange nuts at ⑫ and ⑬ positions as shown in the Fig..
- ③ At other positions, use M6×25 bolts, tightening torque is 9-13 (target value 11) N.m.
- ④ Canister solenoid valve bracket and cylinder head cover share M6 × 25 bolts at ① position as shown in the Fig.
- ⑤ Engine wire bracket II and cylinder head cover share M6×25 bolt at ⑧ position as shown in the Fig.
- ⑥ Engine wire harness bracket I and cylinder head cover share M6 × 20 bolts at ⑦ position as shown in the Fig.



### (3) Install engine oil filler cap on cylinder head cover by rotating.

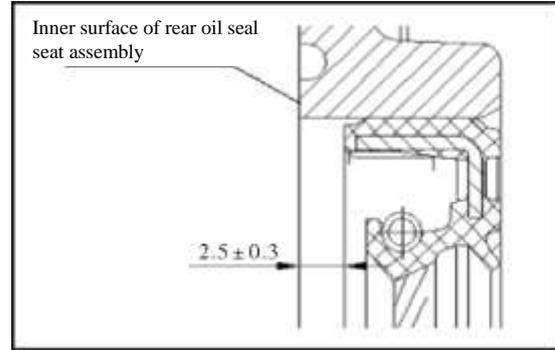
- (4) Note: after installing the engine, keep it at 15°C~25°C for at least 6 hours, and then start it.



### Attachment 3: Install Rear Oil Seal Seat Assembly

(1) Clean rear oil seal seat assembly and press rear oil seal into rear oil seal seat hole with a special tool.

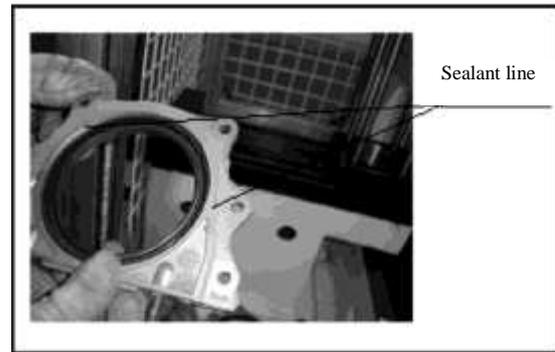
Press-in depth is away from joint surface of rear oil seal seat:  $2.5 \pm 0.3$ mm, i.e., oil seal shall not exceed rear end of oil seal seat.



(2) Clean rear oil seal joint surface and apply sealant uniformly.

Note: ① Do not leave any residual sealant and oil dirt on joint surface. If there is residual sealant, please remove it with scraper blade and spray high-efficient detergent on joint surface and then clean joint surface top with cleaning tape.

② After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.



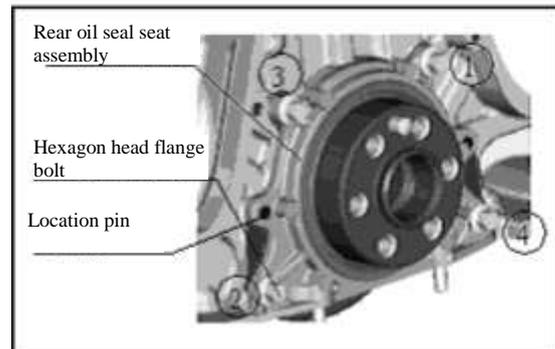
(3) Apply appropriate lubricating oil on the lip.

Note: It can be used only after checking no paint, dirt and scratch is on rear oil seal lip seat.

(4) Align location pin hole on oil seal seat with location pin on cylinder block. It is allowed to knock outer surface of oil seal seat slightly by hand or rubber hammer to make rear flange journal of crankshaft insert into oil seal lip and make oil seal seat lean against rear end of cylinder block reliably. Tighten hexagon head flange bolt according to the sequence as shown in the Fig.

Tightening torque of bolt is  $8 \pm 2$ N·m

Note: When installing rear oil seal seat assembly, do not damage oil seal surface.



(4) Note: after installing the engine, keep it at  $15^{\circ}\text{C} \sim 25^{\circ}\text{C}$  for at least 6 hours, and then start it.

## Attachment 4: Install Engine Oil Pan Assembly

(1) Clean engine oil pan assembly.

Note: Do not leave any residual sealant and oil dirt on the top of engine oil pan assembly. If there is residual sealant or oil dirt, please remove it with scraper knife or blade and spray high-efficient detergent on joint surface and then clean joint surface with cleaning tape.

(2) Clean cylinder block bottom, timing chain cover bottom, rear oil seal seat bottom and joint.

Remove residual sealant and oil dirt on the bottom of each part, and dirt on each joint with scraper knife or blade. Spray high-efficient detergent on joint surface and clean each bottom and joint with cleaning tape.

Note: the cloth cannot remove residual sealant completely. It will affect seal quality of joint surface after curing. (3) Apply sealant on the joint surface of cylinder block and chain chamber cover assembly and rear oil seal seat assembly (four positions).

Note: do not apply too much sealant.

(4) Apply  $\phi 5\text{mm}$  sealant along slot line track of joint surface between engine oil pan assembly and cylinder block (as shown in the Fig.).

(5) Place engine oil pan on the bottom of cylinder block, tighten it with nuts and bolts. Tightening torque is  $8\pm 2\text{N}\cdot\text{m}$ .

Tightening sequence: first tighten 2 nuts on front end, and then begin from the middle to tighten 14 bolts on left and right sides in turn.

Note: After applying glue, within 3 minutes, assemble it; within 15 minutes, tighten it.

(6) Install oil drain plug assembly

Tightening torque is  $30\pm 5\text{N}\cdot\text{m}$ .

Note: apply sealant on threads of oil drain plug assembly.

(7) Note: after installing the engine, keep it at  $15^{\circ}\text{C}\sim 25^{\circ}\text{C}$  for at least 6 hours, and then start it.

