Table of Contents

1. Maintenance

1.1 Diagnosis and troubleshooting

1.1.1 Start problems

1. The starter motor fails to work.		
Check	**Causes**	**Remedies**
Battery	The battery terminal post is loose. There is bad connection caused by oxidation or corrosion.	Clean and/or tighten the loose terminal post(s)
	The battery is uncharged or in shortage of charge.	Charge the battery or replace the old battery with a new one
	The belt of fan is loose or broken.	Adjust the belt of fan, or replace it
Fuse	The fuse is short circuited.	Replace the fuse with a new one
Starter switch	The starter switch or relay has failed.	Replace the starter switch or relay
Starter motor	The solenoid switch has failed.	Repair or replace the solenoid switch
	The starter motor has failed.	Repair or replace the starter motor
2. The starter motor works well, but the engine fails to run.		
Battery	The battery terminal post is loose. There is bad connection caused by oxidation or corrosion.	Clean and/or tighten the loose battery terminal post(s)
	The battery is uncharged or in shortage of charge.	Charge the battery or replace the old battery with a new one
	The belt of fan is loose or broken.	Adjust the belt of fan, or replace it
Starter motor	The pinion is broken.	Replace the broken pinion
	The solenoid switch has failed.	Repair or replace the solenoid switch
	The brush is worn or the brush spring is too soft.	Replace the brush and/or the brush spring
Engine	The piston or crankshaft bearing is jammed or damaged.	Repair or replace the damaged part(s)

3. The engine rotates but it cannot be ignited to start.		
Check	**Causes**	**Remedies**
Brake mechanism of engine	The fuel cut-off solenoid valve is broken.	Replace the fuel cut-off solenoid
The fuel fails to flow into the injection pump.		
Fuel	The fuel tank is empty.	Fill in the fuel tank
Fuel pipe system	The fuel pipe is clogged or broken. The fuel tube joint is loose.	Repair or replace the fuel pipe Retighten the fuel tube joint
Fuel filter	The fuel filter overflow valve cannot be closed.	Repair or replace the fuel filter overflow valve

1.2 Data and specifications

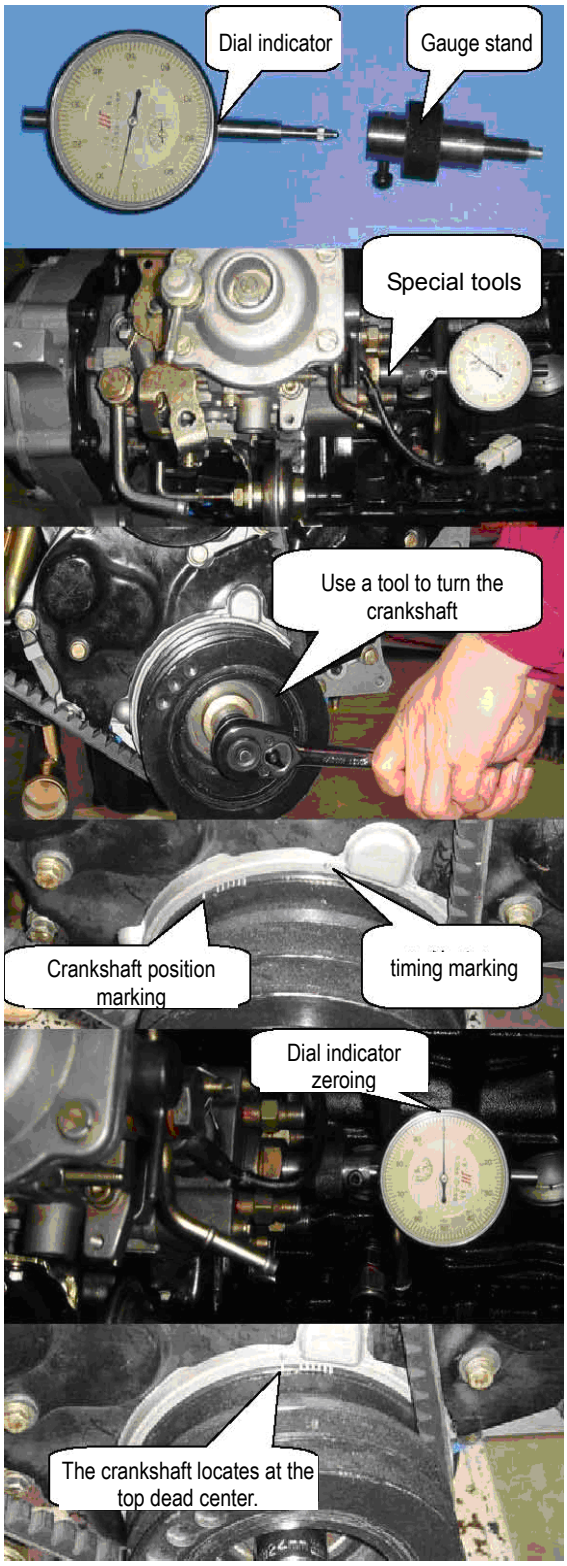
1.2.1 Data and specifications

Item \ Engine model			4DA1		4DA1-1	
Engine type			Natural admission (NA)		Turbocharged Inter-cooling (TCI)	
			Four strokes, high mounted valve, water cooling			
Combustion chamber type			ω type direct injection			
Cylinder liner type			Dry type, thin-wall chrome-plated steel cylinder liner			
Cylinder number - cylinder bore × stroke		mm	4—93×102			
Number of piston ring			2 gas rings, 1 oil ring			
Total piston displacement		L	2.771			
Compression ratio			18.2		17.5	
Design compression pressure		kPa	3040			
Engine weight (net)		kg	230		240	
Fuel injection sequence			1—3—4—2			
Fuel injection timing		°	16° to the top dead center (before)		12° to the top dead center (before)	
Required fuel type	Ambient temperature		Above 4 ℃	Above -5 ℃	Above -14 ℃	Above -29 ℃
	Light diesel fuel type		0 #	-10 #	-20 #	-35 #
Idle speed		r/min	750±50			
Valve clearance (cold)	Intake valve	mm	0.30～0.40			
	Exhaust valve	mm	0.30～0.40			
Valve clearance (hot)	Intake valve	mm	0.30			
	Exhaust valve	mm	0.30			
Intake valve	Open (before top dead center) °		24.5			
	Close (after bottom top dead center) °		55.5			
Exhaust valve	Open (before bottom top dead center) °		54			
	Close (after top dead center) °		26			
Lubricant system						
Lubrication method			Pressure feed lubrication and spray lubrication			
Required oil (class AP1)			CF-4 15W-40			
Oil pump type			External gearing			
Oil filter type			Full-flow type, paper element, replaceable			
Oil volume (including oil filter)		L	6			
Oil cooler type			Water cooling			

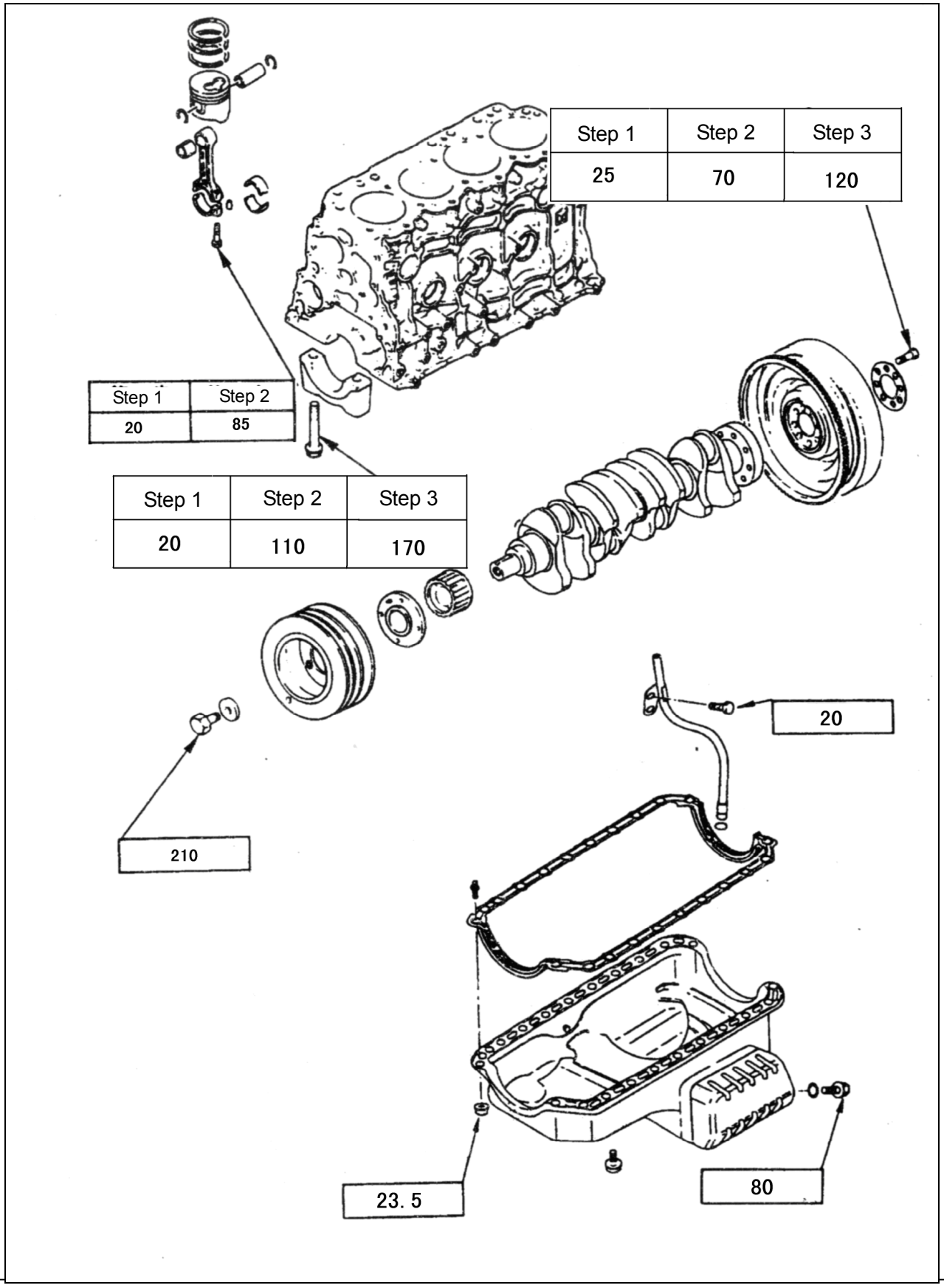
Adjust injection timing

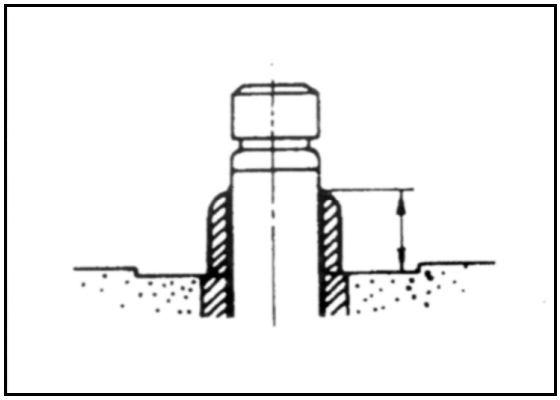
Step 1 Remove the front screw (at the rear end of injection pump) on the injection pump distribution plunger.
Step 2 Mount special tools for injection advance angle adjustment: dial indicator and gauge stand.
Step 3 Turn the engine crankshaft clockwise to a position with approximate 45° to the top dead center of the first cylinder.
Step 4 Turn the engine crankshaft about 8° to left or right, the pointer of dial indicator shall stand still.
Step 5 Turn the dial indicator to zero the pointer. The position of dial indicator shall not be changed after zero adjustment.
Step 6 Turn the crankshaft clockwise to the top dead center. For assembly, to determine the top dead center, use a lever indicator to measure the height difference between top surface of piston in the first cylinder and upper surface of body. For commissioning and inspection, alignment timing marking (position marking of crankshaft pulley top dead center and timing marking on the gear case) is allowed to use.
Step 7 Unscrew two tight nuts to the injection pump flange and the connecting bolt to the injection pump support.
Step 8 Pull the injection pump inward or outward to make the reading of dial indicator show **X** mm.
Step 9 Screw down two tight nuts to the fuel pump flange and the connecting bolt to the injection pump support. Fuel pump running shall be avoided in screwing.
Step 10 Repeat Step 3 to verify zero adjustment.If the zero adjustment is not proper, return to Step 5.
Step 11 Repeat Step 6 to verify the reading of dial indicator. If the reading is not correct, return to Step 7.
Step 12 Remove the special tools: dial indicator and gauge stand.
Step 13 Mount the front screw on the injection pump distribution plunger. Injection advance angle adjustment is over.

Type	X Value（mm）
HFC4DA1	1.60
HFC4DA1-1	1.50



1.5.2 Torque for crankshaft, bearing cap, connecting rod bearing cap, crankshaft damper pulley, flywheel and oil pan (N·m)





Note

Never apply excess compressive force on the valve seat when you use a table press. Otherwise, the valve seat may be damaged.

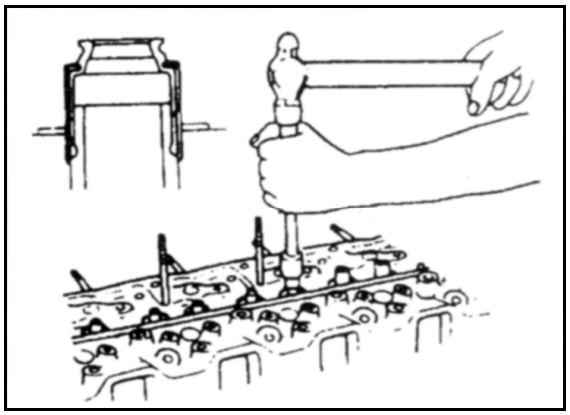
Measure upper height of valve guide from the upper surface of cylinder head.

Upper height of valve guide (H) (reference value)

13 mm

Note

If a valve guide has been disassembled, you should replace the valve and valve guide in pairs.



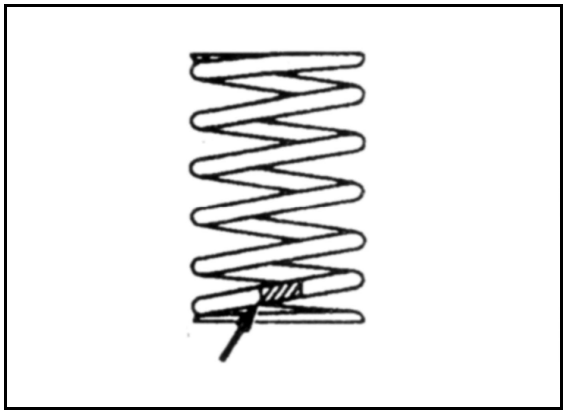
2) Lower spring seat

3) Valve stem oil seal

- Mount a new oil seal to the valve.
- Use a special tool to guide.
  Oil seal erector: 1003016FA-9101

4) Valve

- Apply oil to the part above the borehole diameter of valve stem before you install a valve.



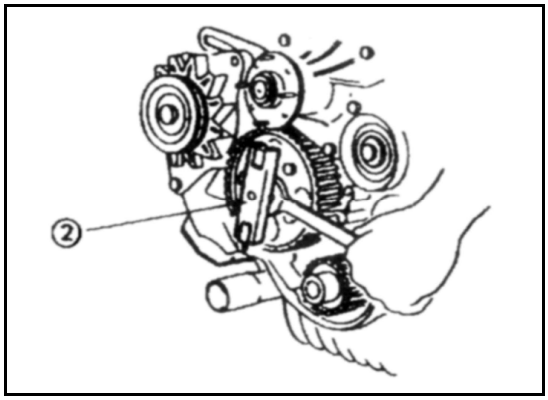
5) Valve spring

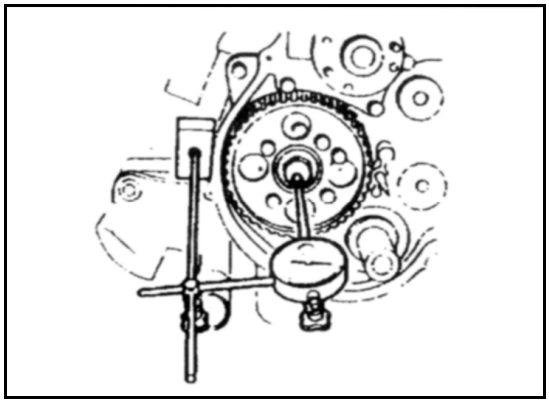
- Mount the valve spring on the upper spring seat.

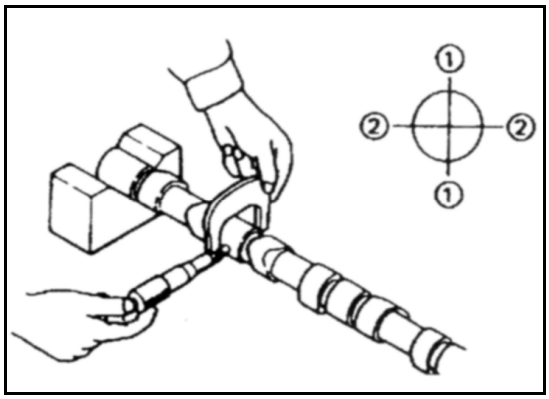
Caution

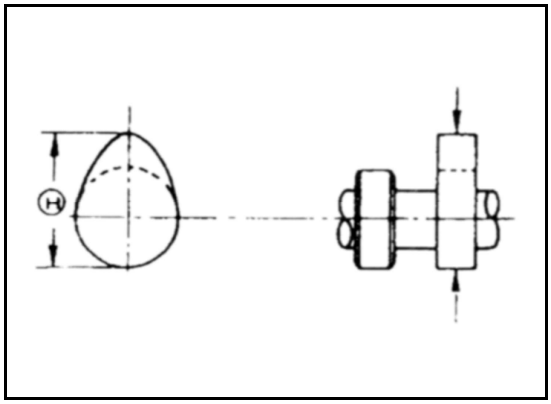
- **The section with painting on the valve spring shall be placed downwards.**
- **Supply compressed air from glow plug hole to cylinder until the valve seats in place.**
- **Install the valve cotter with special tools.**

Valve spring compressor: 1003015FA-9101









7. Camshaft thrust washer
8. Camshaft
9. Tappet

Inspection and repair

If excessive abrasion and damage is found during checking, adjust, repair and replace parts in time.

1. Measure the camshaft thrust clearance

- Measure the camshaft axial clearance with a dial gauge.

This shall be done before disassembling the camshaft gear.

If the camshaft axial clearance exceeds prescribed limit, the thrust washer shall be replaced.

Camshaft axial clearance mm

Nominal	Limit
0.005-0.114	0.2

2. Camshaft journal outer diameter

- Use a micrometer to measure the outer diameter of each camshaft journal in direction ① and ②. If the measurement value exceeds prescribed limit, the camshaft shall be replaced.

Journal outer diameter mm

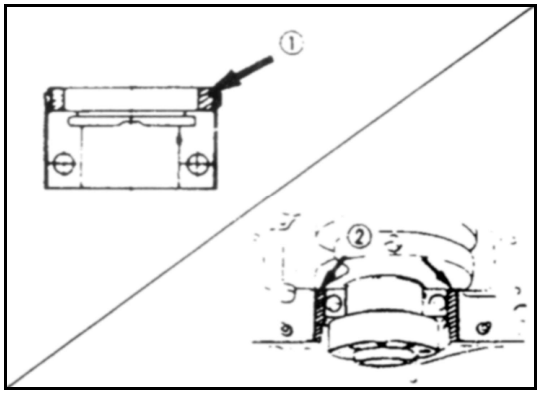
Nominal	Limit
49.945—49.975	49.60

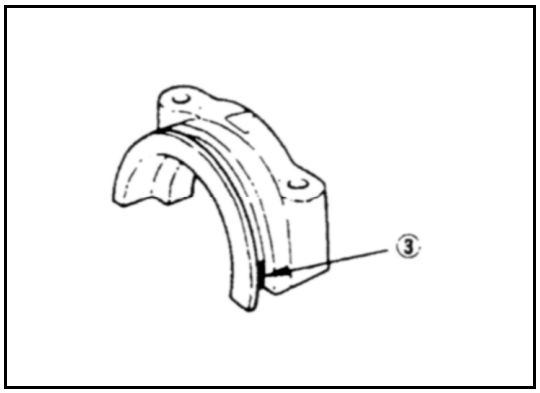
3. Cam height

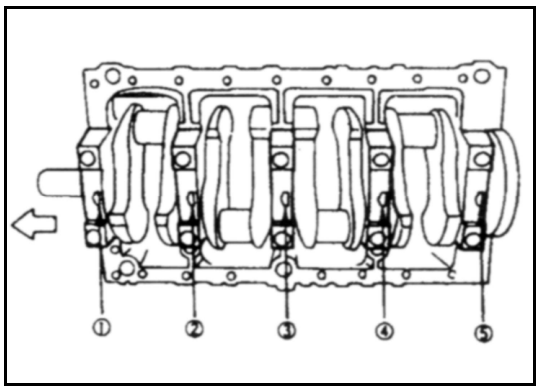
- Use a micrometer to measure the cam height a. If the measurement value is lower than the prescribed value, the cam shall be replaced.

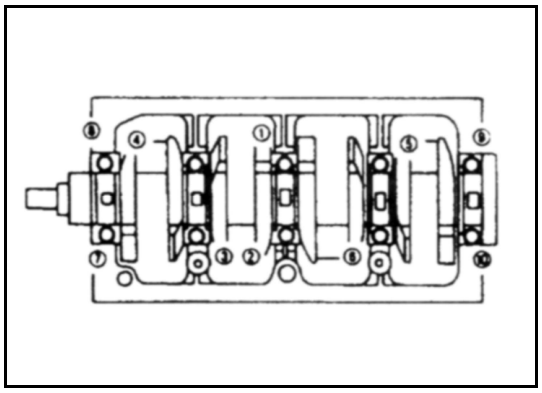
Cam height mm

Nominal	Limit
42.02±0.05	41.65









12. Main bearing cap

- Apply recommended liquid sealant or other equivalents to the fifth crankshaft bearing cap ① as shown in the drawing.
- Install arc gasket ② on the fifth bearing cap. Put the arc gasket into the bearing cap groove with fingers.

- Apply recommended liquid sealant or other equivalents to the fifth crankshaft bearing cap ③ as shown in the drawing.

- Apply recommended liquid sealant or other equivalents to points ③ and ④ of the fifth crankshaft bearing cap cylinder block mating surface as shown in the drawing.

Note:

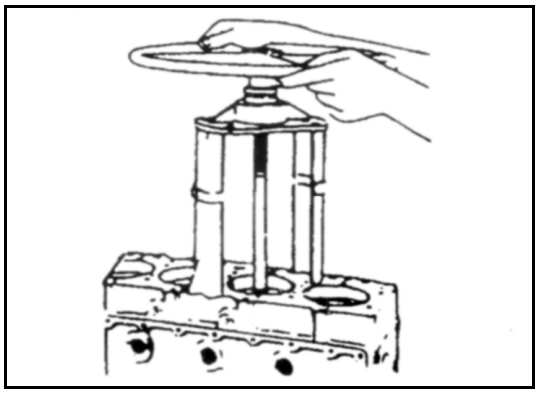
Ensure that there in no oil stain on the mating surface of bearing cap before coating liquid sealant.

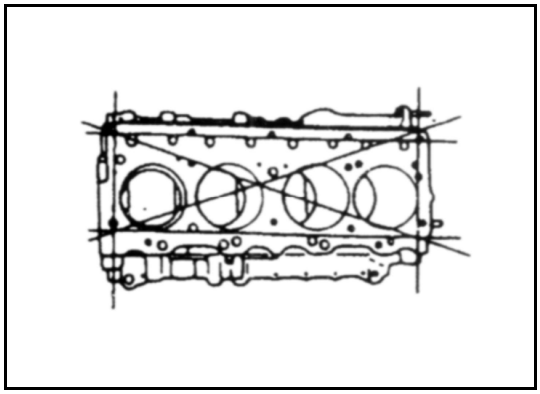
Make sure the liquid sealant do not block cylinder thread hole and bearing.

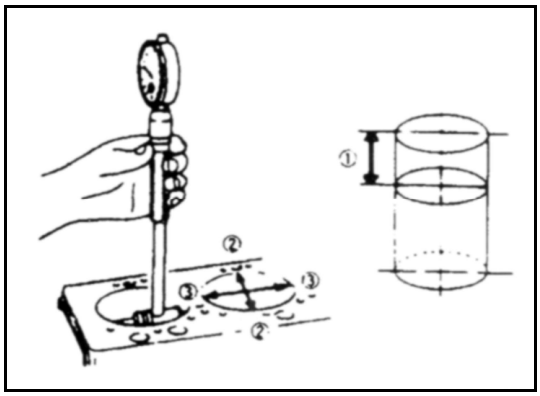
- Install the bearing cap, and make sure the arrow mark on its top points at engine forepart.
- Apply oil to crankshaft bearing cap bolts.
- Tighten the crankshaft bearing cap bolts step by step in several times according to the sequence shown in the drawing until specified torque is reached.

Nm

Step Ⅰ (sealing torque)	Step Ⅱ (sealing torque)	Step Ⅲ (final torque)
20	110	170







Flatness

1. Remove the dowel from cylinder block.
2. Install cylinder liner detacher on the cylinder liner.
3. Check the base on the detacher shaft covers the bottom edge of cylinder liner firmly.
4. Slowly rotate the detacher shaft hand wheel anticlockwise to pull out the cylinder liner.

Detacher base of cylinder liner:
1002106FA-9102 (4DA1 Series)

Note: be careful not to damage the upper surface of cylinder during disassembling the cylinder liner.

5. Measure four edges and two diagonals of cylinder block upper surface with ruler ①and clearance gauge ②.

If measurement value exceeds the limit, the cylinder block has to be replaced.

Measurement of cylinder liner bore diameter

Measure the bore diameter of cylinder liner along thrust direction ②-② and the axial direction ③ of crankshaft with inside dial indicator in the depth of 20mm,90mm,160mm, and take the average value of 6 sizes as group size.

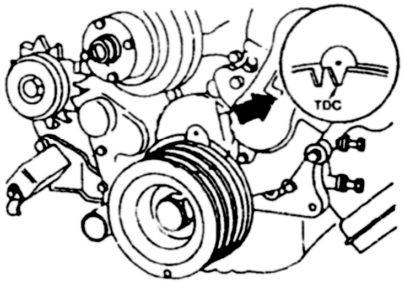
If measurement value exceeds prescribed limit, the cylinder liner has to be replaced.

Notes:

The inner surface of dry cylinder liner is chromalized, so it is not allowed to reface or perform honing.

If there are nicks or burns with the inner surface of cylinder liner, the cylinder liner has to be replaced.

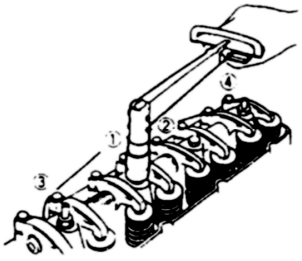
Valve clearance adjustment



① Rotate the crankshaft until TDC line of the crankshaft damper pulley is aligned with timing pointer, and either the first cylinder piston or the fourth cylinder piston is at the top dead center (TDC) of compression stroke.

② Check the nuts of rocker shaft support are loose.

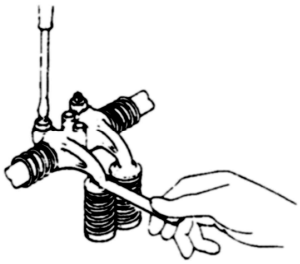
Tighten all the loose nuts of the rocker shaft support before adjusting valve clearance.



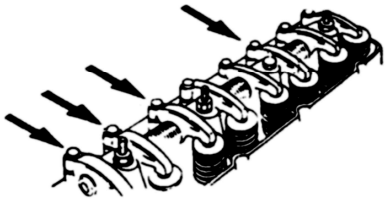
Rocker shaft support nut torque	N.m
55	

③ Check the clearance between intake valve and exhaust valve push rod for the first cylinder.If there is clearance between intake valve and exhaust valve push rod for the first cylinder, the first cylinder piston locates at the top dead center of compression stroke.

If there is no clearance between intake valve and exhaust valve push rod for the first cylinder, the fourth cylinder piston locates at the top dead center of compression stroke.



Top dead center of the first cylinder compression stroke

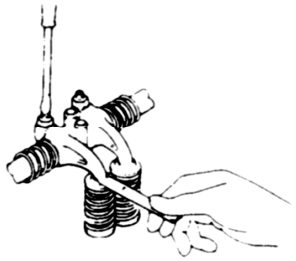


The piston of cylinder must locate at the top dead center of compression stroke when the valve clearance of the first cylinder or fourth cylinder is adjusted.

Valve clearance (cold state)	mm
0.3-0.4	

④ Loosen the adjustment screw(s) for each valve clearance shown in the drawing.

⑤ Insert a clearance gauge with proper thickness between the rocker arm and valve stem end.

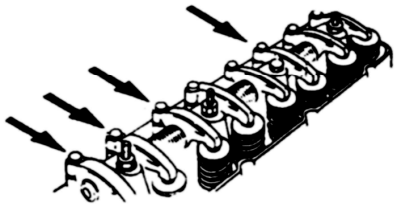


③ Check the clearance between intake valve and exhaust valve push rod for the first cylinder.If there is clearance between intake valve and exhaust valve push rod for the first cylinder, the first cylinder piston locates at the top dead center of compression stroke.If there is no clearance between intake valve and exhaust valve push rod for the first cylinder, the fourth cylinder piston locates at the top dead center of compression stroke.

The piston of cylinder must locate at the top dead center of compression stroke when the valve clearance of the first cylinder or fourth cylinder is adjusted.

Valve clearance (cold state) mm
0.3-0.4

Top dead center of the first cylinder compression stroke



④ Loosen the adjustment screw(s) for each valve clearance shown in the drawing.

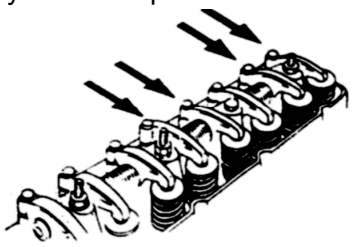
⑤ Insert a clearance gauge with proper thickness between the rocker arm and valve stem end.

⑥ Rotate the adjustment screw(s) for valve clearance until a touch of resistance is felt on the clearance gauge.

⑦ Tighten the locking nut(s) firmly.

⑧ Rotate the crankshaft for 360°.

Top dead center of the fourth cylinder compression stroke

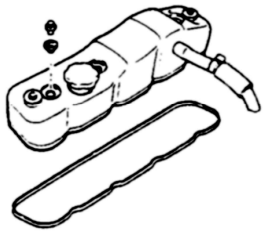


⑨ Then align zero scale line of crankshaft damper pulley with timing pointer.

⑩ Adjust the clearance of other valves shown in the drawing.

15. Cylinder head cover

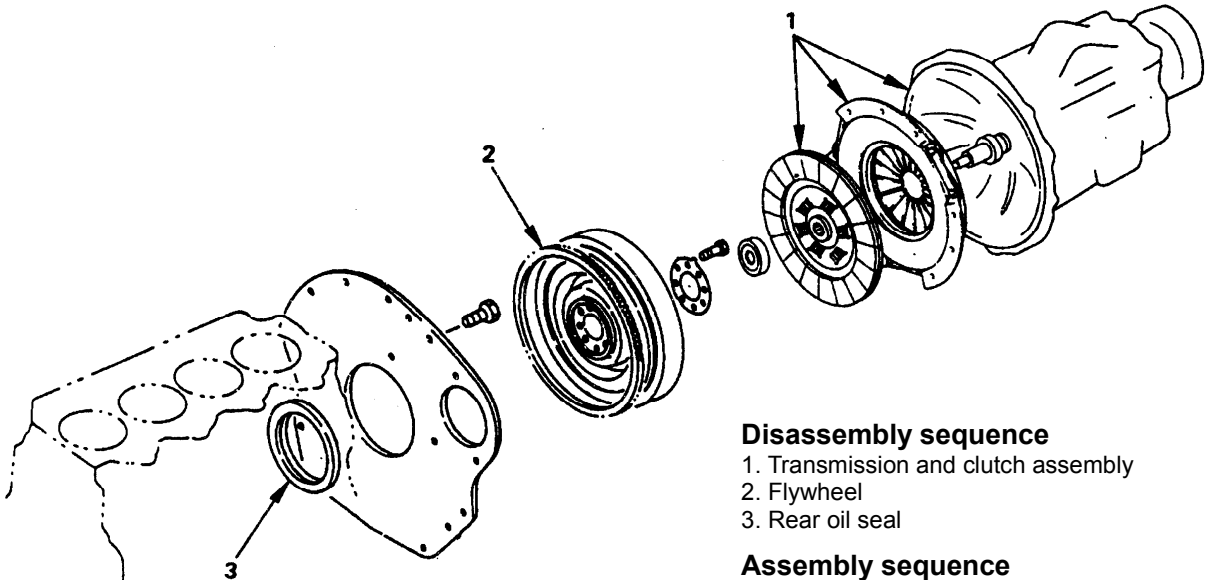
- Apply oil to the rocker arm and valve spring.
- Install cylinder head cover gasket(s) of on the cylinder head cover.
- The gasket(s) must be flat and without damage.
- Tighten cylinder head cover nut(s) to the specified torque.



Cylinder head cover torque	N.m
13	

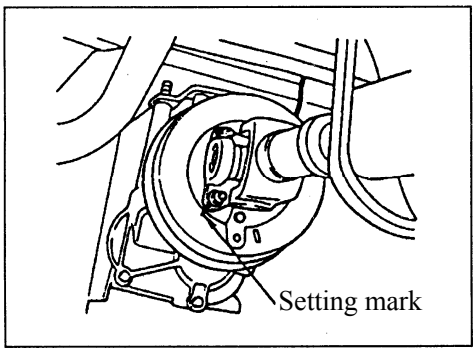
14. Bypass hose

3.18 Crankshaft rear oil seal



Disassembly sequence
1. Transmission and clutch assembly
2. Flywheel
3. Rear oil seal

Assembly sequence
As assembling, go on according to the reverse sequence of disassembly.



Disassembly

Preparation:

- Remove the battery ground cable.

1. Transmission and clutch assemblies

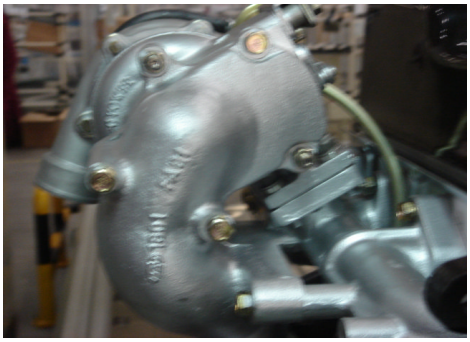
Hoist the car and support it with a suitable and safe bench.

1) Transmission

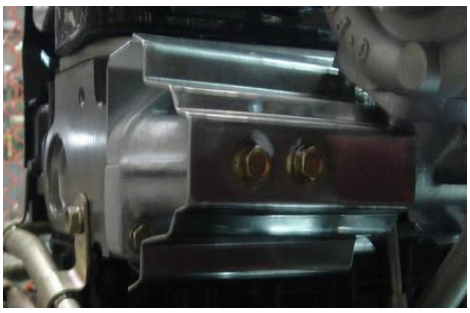
① Transmission

Mark the parking brake drum and flange yoke beforehand.

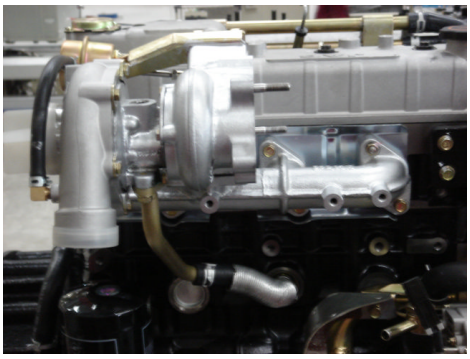
- Remove the flange yoke drive shaft.
- Put the bundled up drum and flange yoke aside so as to facilitate maintenance work.



2. Unscrew the charger exhaust pipe bolt with a wrench and remove the charger exhaust pipe.



3. Remove the exhaust pipe heat insulator.



4. Remove the charger and exhaust manifold subassembly

5. Disassemble the charger assembly

Inspection

(1) Check the airtightness and tightening of the connecting pipes between the air filter and charger and between the charger and engine intake/exhaust pipes.

(2) Check if the fuel inlet/return hoses of the turbocharger are damaged or blocked and if the connecting bolt on the connector is tight.

(3) Check of the oil quality and clean or replace the oil.

(4) Check the air filter and clean or replace the element periodically.

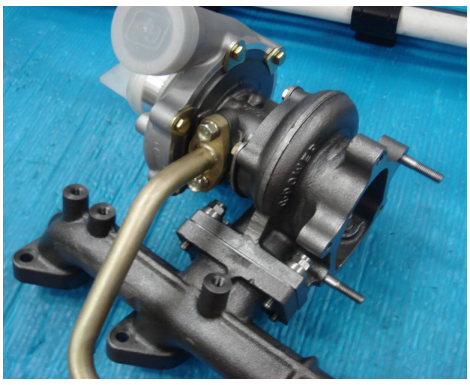
Notes

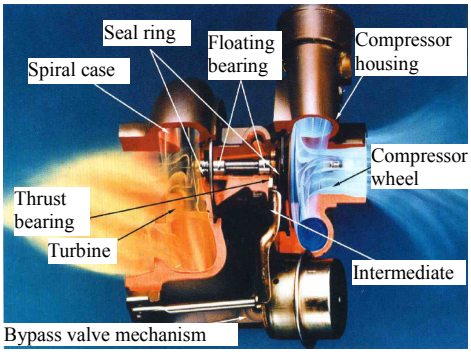
(1) Protect the charger return pipe from being bended or damaged.

(2) Make sure the fuel inlet/return hoses of the charger are unblocked.

(3) Always check the airtightness of the connecting pipes between the charger and engine.

(4) The duration of idle state shouldn't be too +long





Bypass valve mechanism