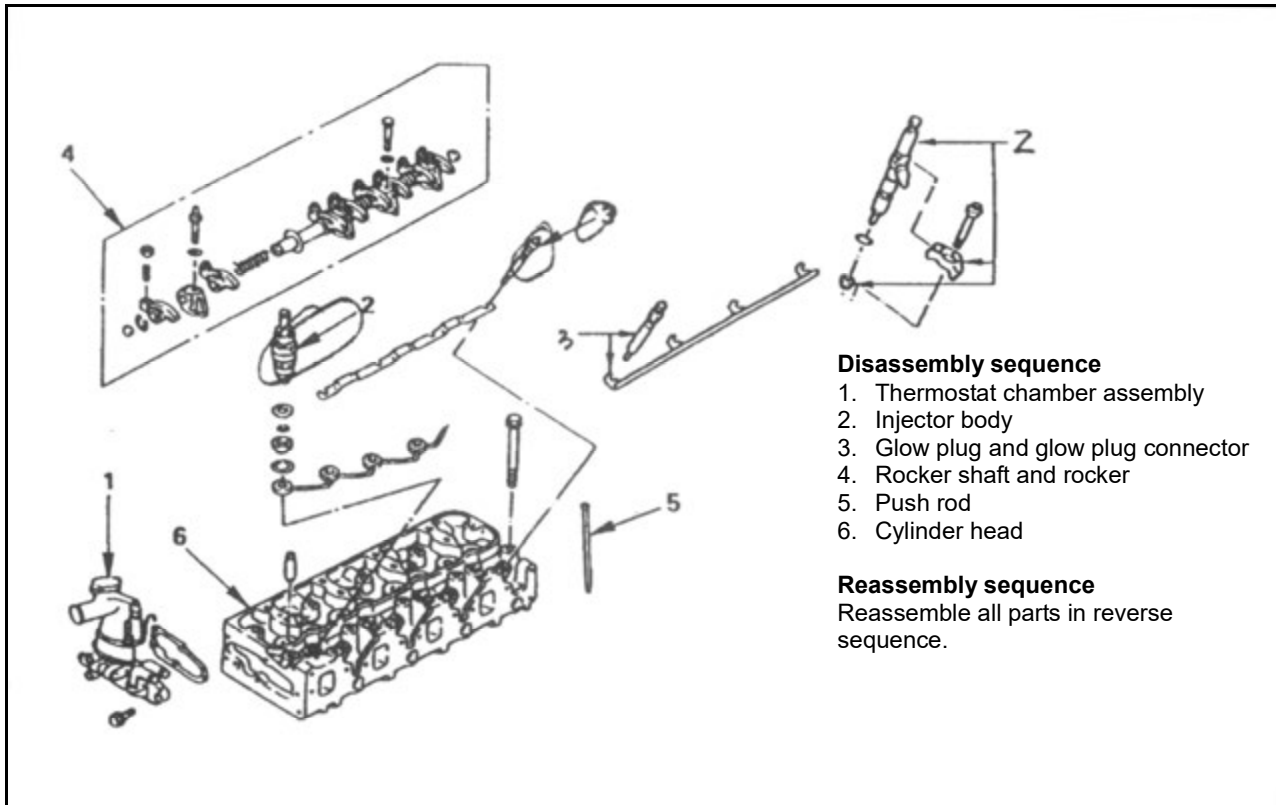


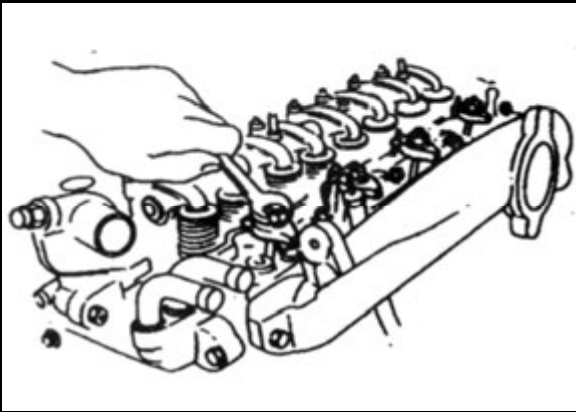
## 2. Engine mechanical system

### 2.1 Cylinder head



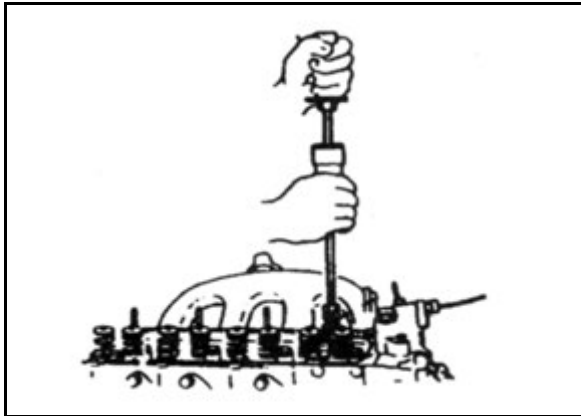
**Note:**

- In disassembly, you should collect all parts of valve set and identify each part so that they will return to their original positions by assembling.
- Before you remove the cylinder head from the engine and disassemble the valve mechanism, you should carry out a compression test and record the test result.

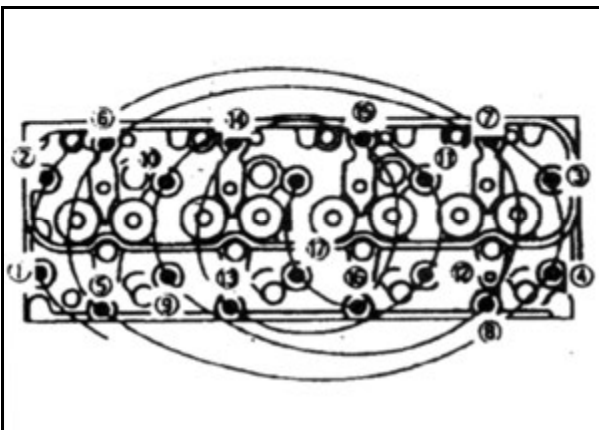


### Disassembly

1. Thermostat casing and water outlet assembly
2. Injector body
  - 1) Unscrew the injector body support nut.



- 2) Use an injector remover and a sliding hammer to disassemble the injector and its support together.



3. Glow plug and glow plug connection board
4. Rocker shaft and rocker
5. Push rod
6. Cylinder head
  - Unscrew the cylinder head bolts in several times according to the sequence number given in the figure. Unscrew a bolt in at least two times.

**Note:**

If you don't unscrew the cylinder head bolts in several times according to the sequence number, bad effect like warping may incur on the undersurface of cylinder head.



## Cleaning

- Cylinder head bolt
- Cylinder head

Carefully clean up any oil sludge, smoke and carbon deposit until the natural color of metal is exposed. Never use an electrical wire brush on any gasket or sealing surface.

## Inspection and repair

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

- Check whether there is leakage, corrosion or blow-by gas of cylinder head gasket and contact surface. If a gasket fails, investigate the causes:
    - Improper assembling
    - Loose or warping cylinder head
    - Insufficient tightening torque for the cylinder head bolt
    - Warping cylinder block surface
1. Check whether the cylinder head bolt thread is damaged or drawn out. Also, check whether the cylinder head is damaged caused by improper tool usage.

### Caution

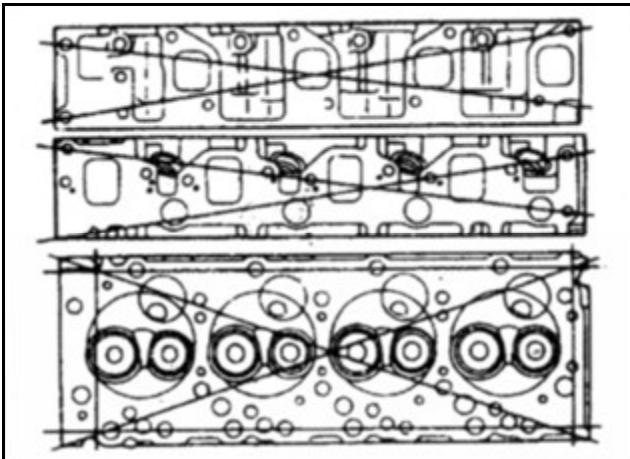
**Any questionable bolt must be replaced by a new one.**

2. Check whether there is any crack on the cylinder head, particularly the valve edge and exhaust port.
3. Check whether there is any corrosion at the cylinder head cover plate, any sand or loose hole inside the cylinder head.

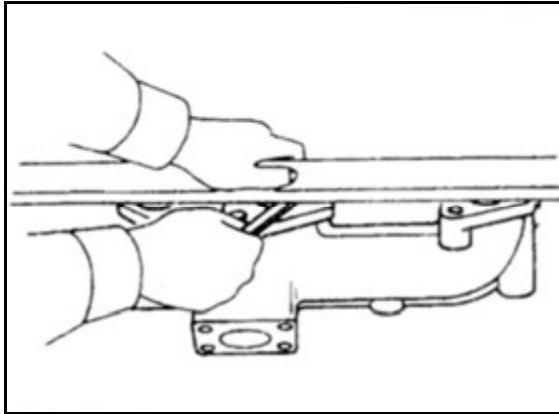
### Caution

**Never repair the key surface of cylinder head. If it is broken, replace it with a new one.**

4. There are strict requirements for flatness of cylinder head undersurface and contact surface of intake and exhaust manifolds. Use grinding process to repair these surfaces. If the surface "flatness" exceeds the specified value, you should grind the surface until the flatness meets the requirement. If the flatness exceeds the specified value too much, the part shall be replaced by a new one.



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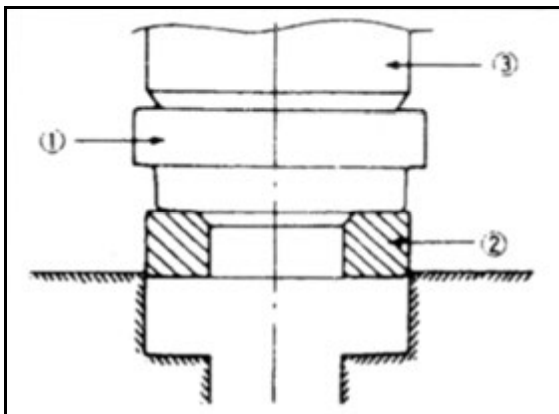


	mm	
	Nominal	Limit
Warpage of cylinder head undersurface	0.05 or less	0.20
Height of cylinder head	92	91.55

5. Check the contact surface of water jacket bowel-like plug.
6. Use a ruler or clearance gauge to measure the warpage of contact surface between the exhaust manifold and cylinder head.  
If the measurement value is greater than the nominal value but less than then limit value, you should regrinding the contact surface between the exhaust manifold and cylinder head.  
If the measurement value exceeds the specified limit, the manifold has to be replaced.

Warpage of exhaust manifold mm

Nominal	Limit
0.05 or less	0.20



## Reassembly

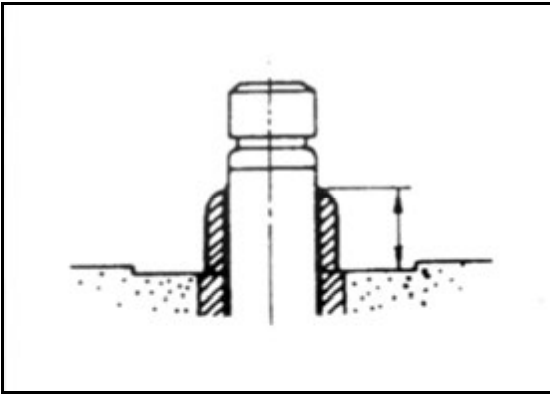
### 6. Cylinder head

- 1) Mount the valve seat
  1. Carefully place the attachment ① (its outer diameter is slightly less than that of valve seat) on the valve seat ②.

#### Note

**Make sure that the surface contacting with the valve seat is the smooth side of attachment.**

2. Use a table press ③ to gradually press the attachment until the valve seat seats in place.



**Note**

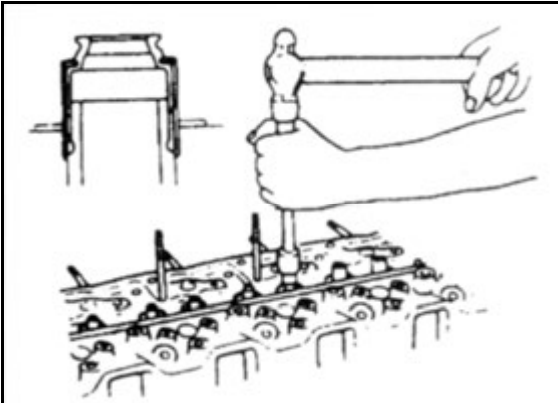
**Never apply excess compressive force on the valve seat when you use a table press. Otherwise, the valve seat may be damaged.**

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.

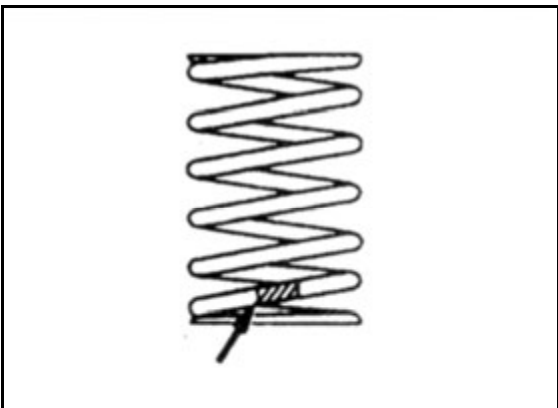
5) **Valve spring**

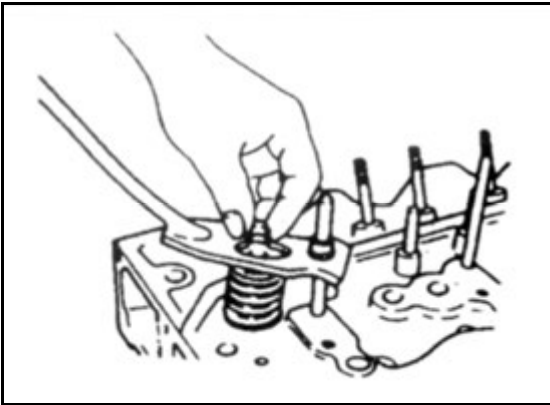
- Mount the valve spring on the upper spring seat.

**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





**6) Valve cotter**

- Use a spring compressor to press the valve spring to the proper position.
- Mount the spring seat and valve cotter.
- Use a soft-faced hammer to tap the cotter head until it seats in place.

Valve spring compressor: 1003015FA-9101

**5. Push rod**

**4. Rocker shaft and rocker**

- Tighten the rocker shaft fixing bolt.

55±5 N • m

**3. Glow plug and glow plug connection board**

- Tighten the glow plug.

25±5 N • m

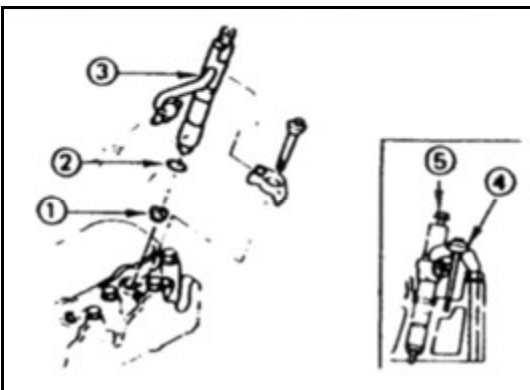
**2. Injector body**

- 1) Install the injector copper gasket ① and O-ring ② onto the injector body ③. Make sure tight contact between the O-ring and injector groove.
- 2) Apply oil in the cylinder head hole where the injector body seats.
- 3) Mount the injector body and injector pressure plate together to the cylinder head.

40±5 N • m

- 4) Tighten the injector body nut and gasket ⑤ to the specified torque.

40±5 N • m



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**2. Fuel injector**

- Use a wrench or a special tool to tighten the nut (s) on the fuel injector to the specified torque as shown in the figure.

**Caution**

- **When you mount the return pipe, injector and injection pipe, use air to blow off dust.**

Injector tightening torque                      34±5N · m

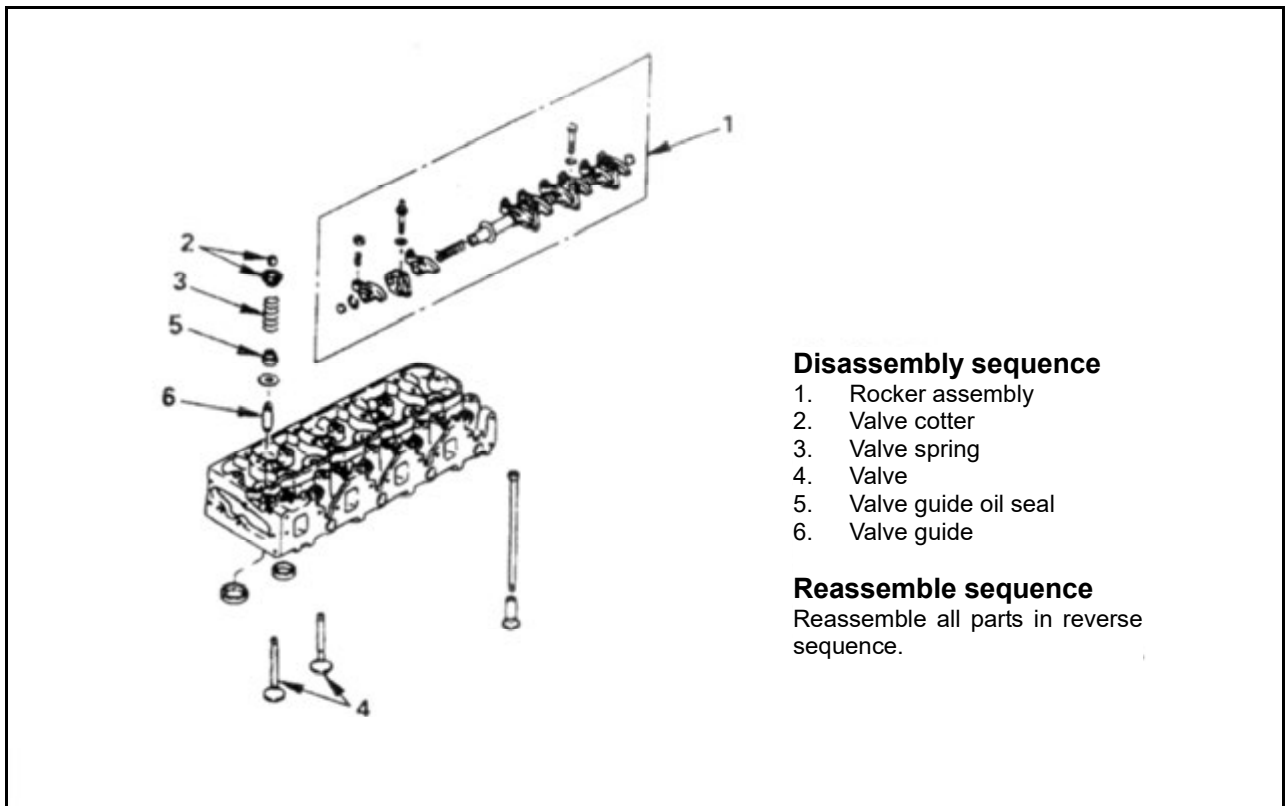
**1. Thermostat casing assembly**

- Tighten the thermostat casing assembly fixing bolt.

25 ±5 N · m



## 2.2 Valve spring, valve guide oil seal, valve guide and push rod



### Disassembly sequence

1. Rocker assembly
2. Valve cotter
3. Valve spring
4. Valve
5. Valve guide oil seal
6. Valve guide

### Reassemble sequence

Reassemble all parts in reverse sequence.

## Disassembly

### 1. Rocker assembly

### 2. Valve cotter

Use a special tool to compress the valve spring.

Valve spring compressor: 1003015FA-9101

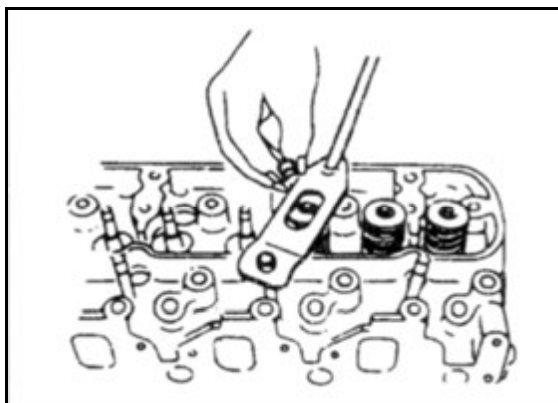
### 3. Valve spring

### 4. Valve

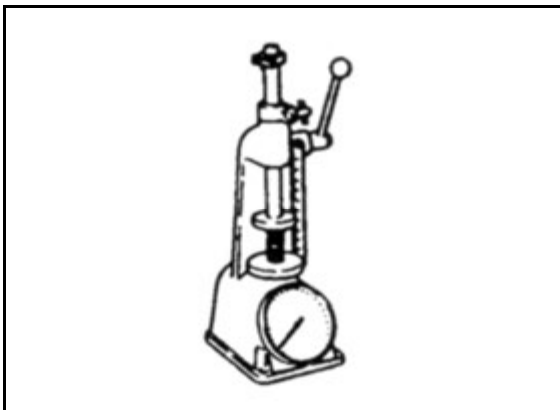
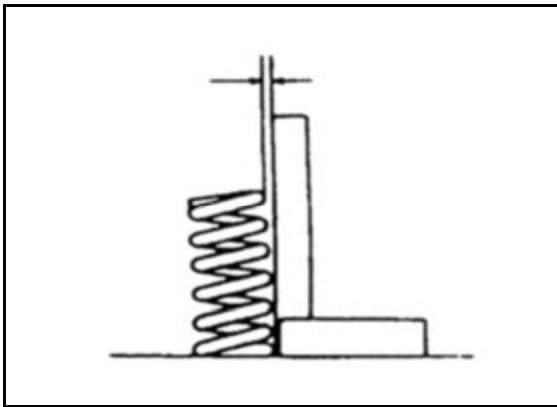
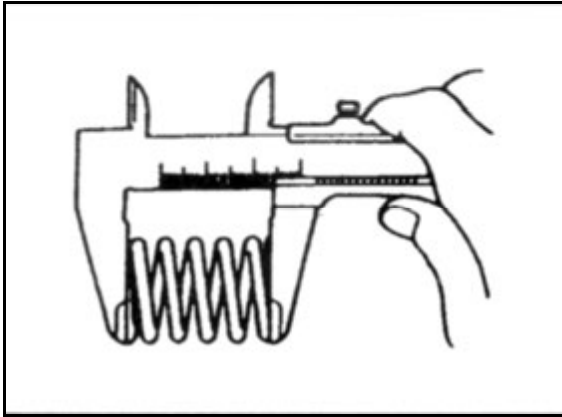
### 5. Valve guide oil seal

### 6. Valve guide

Valve guide replacer: 1003102FA-9101







**Inspection and repair**

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

Valve spring

**Caution**

**Visually check the valve spring. If there is damage or obvious abnormal abrasion, you should replace it with a new one.**

**1. Free height**

- Measure the free height of valve spring. If the height is less than the specified limit value, the spring shall be replaced.

Free height mm

Nominal	Limit
48.0	47.10

**2. Squareness**

- Use a steel square to measure the squareness of valve spring. The measurement value shall be less than 1.2 mm.
- If measurement value exceeds prescribed limit, the valve spring shall be replaced.

Limit 1.5 mm

**3. Spring tension**

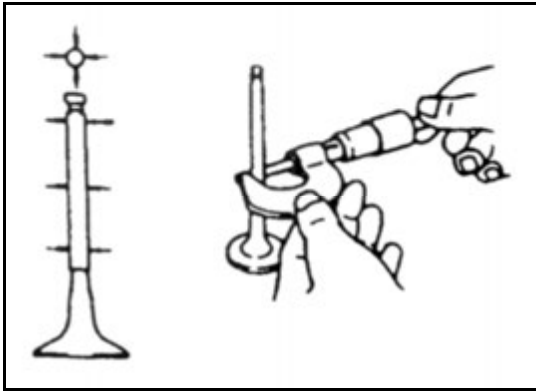
- Use a spring tester to compress the spring to the installation height. Measure the compression spring tension.

If the measured tension is lower than the prescribed limit, the spring shall be replaced.

Tension N

Installation height	Nominal	Limit
38.9mm	296	268

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**Valve guide**

**Caution**

Carefully clean up the carbon deposit at the valve head to protect the valve seat contact surface from damaging.

Carefully check whether there is any damage or abnormal abrasion on the valve stem.

If so, replace the valve and valve guide in pairs.

**1. Valve guide clearance**

- Use a micrometer to measure the outer diameter of valve stem.

If the out diameter of valve stem is lower than the specified limit, replace the valve and valve guide in pairs.

Mm

		Nominal	Limit
Valve stem diameter	Intake valve	7.946-7.961	7.880
	Exhaust valve	7.921-7.936	7.850

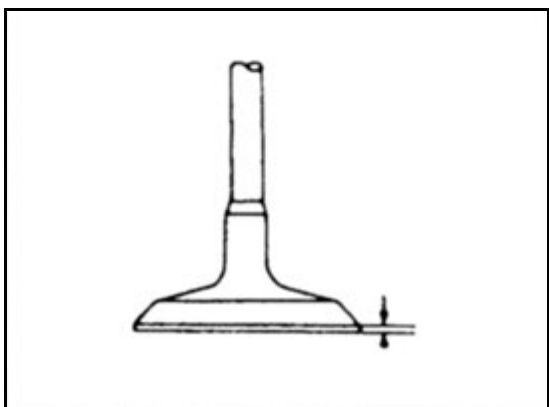
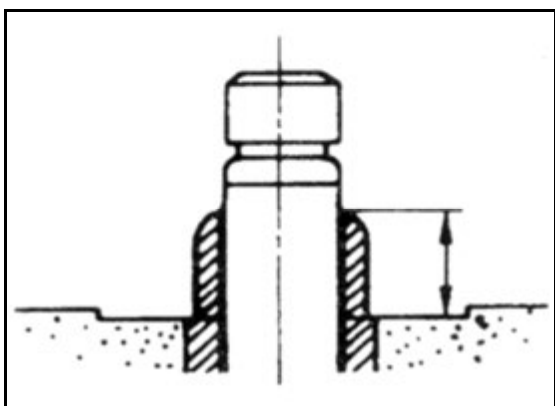
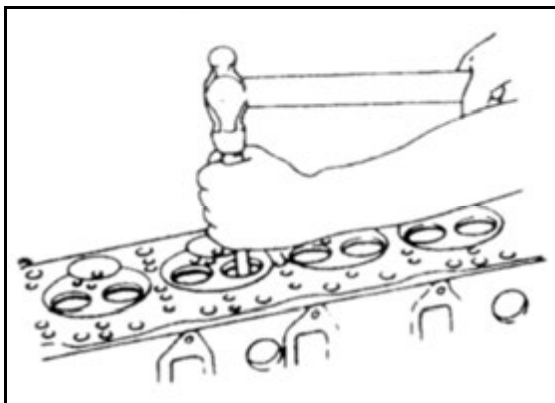
- Use a micrometer to measure the inner diameter of valve guide.
- Make a subtraction between the valve guide inner diameter and the valve stem outer diameter.

If the subtraction value is lower than the specified limit, replace the valve and valve guide in pairs.

Valve guide clearance mm

	Nominal	Limit
Inlet clearance	0.200	7.880
Exhaust clearance	0.250	7.850

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**Valve guide replacement**

1. Use a special tool to knock the valve guide out from one side of combustion chamber.  
Valve guide replacer: 1003102FA-9101

2. Apply oil to the outer surface of valve guide.  
Use a special tool to mount a new valve guide from one side of cylinder head upper surface and check the valve guide height.  
Valve guide replacer: 1003102FA-9101  
Height 13 mm

**Note**

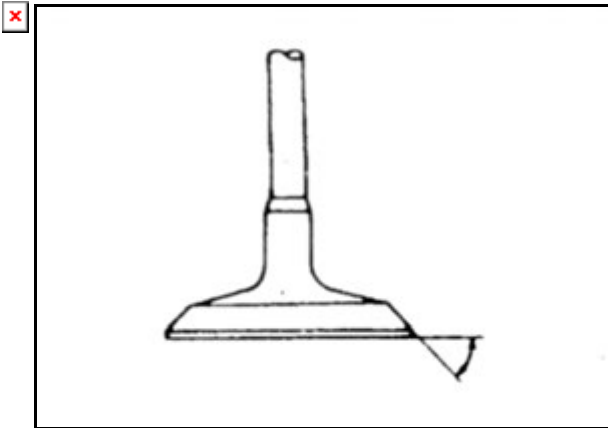
If a valve guide has been disassembled, you should replace the valve and valve guide in pairs.

**Valve thickness**

1. Measure the valve thickness.
2. If the measured value is lower than the specified limit, replace the valve and valve guide in pairs.

Valve thickness mm

	Nominal	Limit
Intake valve	1.76	1.25
Exhaust valve	1.5	



**Valve seat conical surface angle on the valve**

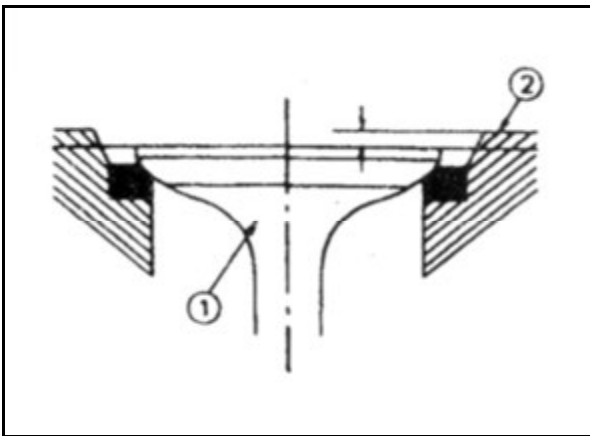
1. Measure the valve seat conical surface angle.
2. If the measurement value exceeds the limit, you should replace the valve, valve guide and valve seat together.

Nominal: 45°

**Valve sinkage**

1. Mount the valve (1) to the cylinder head (2).
2. Use a depth gauge or a ruler and steel square to measure the valve sinkage from the bottom surface of cylinder head.

If the measurement value exceeds prescribed limit, the valve seat shall be replaced.



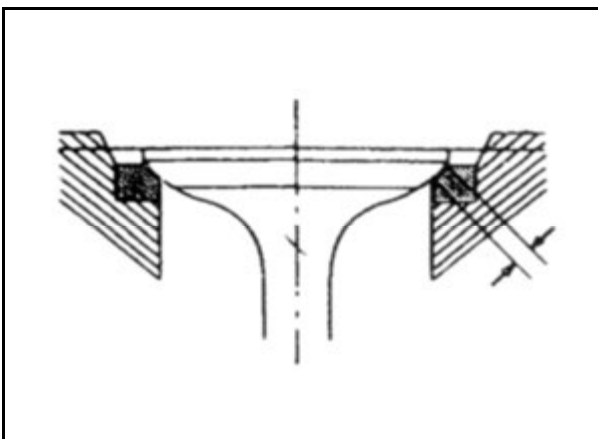
Valve sinkage mm

		Nominal		Limit
4DA1 Series	Intake valve	0.65	1.28	
	Exhaust valve	0.65	1.20	

**Valve contact width**

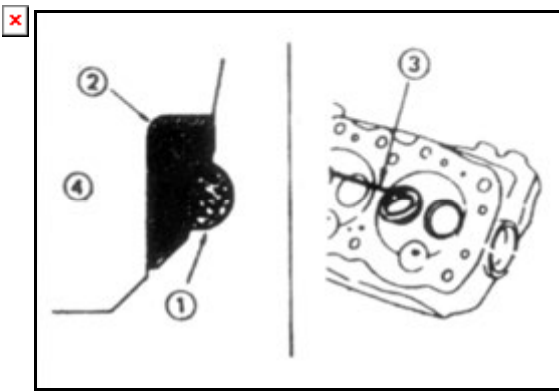
1. Check the roughness and flatness of valve contact surface. Make sure that the contact surface is smooth.
2. Measure the valve contact width.

If the measurement value exceeds prescribed limit, the valve seat shall be replaced.



Contact width mm

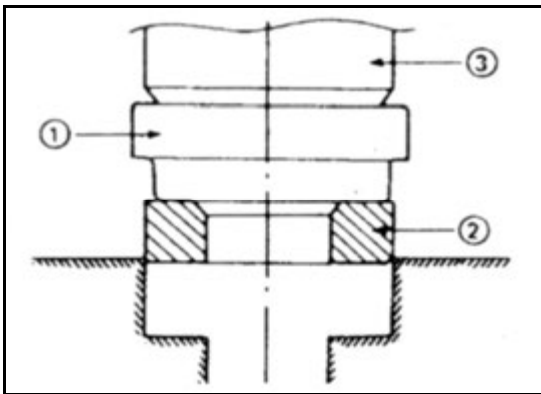
		Nominal		Limit
Intake valve	1.7	2.2		
Exhaust value	2	2.5		



## Valve seat replacement

### Disassemble valve seat

1. Perform arc welding at the inside periphery ① of valve seat ②.
2. Cool down the valve seat for several minutes.  
The contraction will facilitate the disassembly of valve seat.
3. Use a screwdriver ③ to pry off the valve seat.  
Carefully pry off it. Otherwise, the cylinder head ④ may be damaged.
4. Carefully clean up carbon deposits and other foreign matters on the valve seat installation hole of cylinder head.



### Assemble valve seat

1. Carefully place the attachment ① (its borehole diameter is slightly less than that of valve seat) on the valve seat ②.

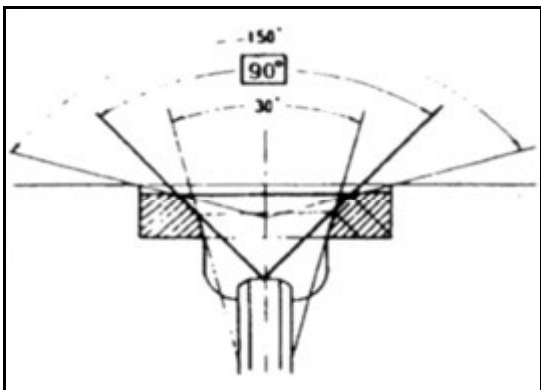
### Note

**Make the smooth side of attachment contact with the valve seat.**

2. Use a table press ③ to gradually press the attachment until the valve seat seats in place.

### Note

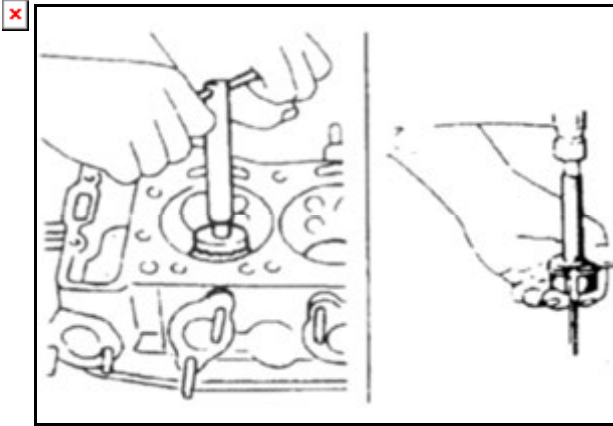
**Never apply excess compressive force on the valve seat when you use a table press. Otherwise, the valve seat may be damaged.**



### Valve seat correction

1. Clean up the carbon deposit on valve seat surface.
2. Use a milling cutter (blade angle of 15° , 45° and 75° ) to minimize abrasion and rough areas of valve seat so that the contact width reaches the nominal value.

You should only eliminate abrasion and rough areas. Don't cut off too much. Carefully avoid cutting off good areas on valve seat surface.

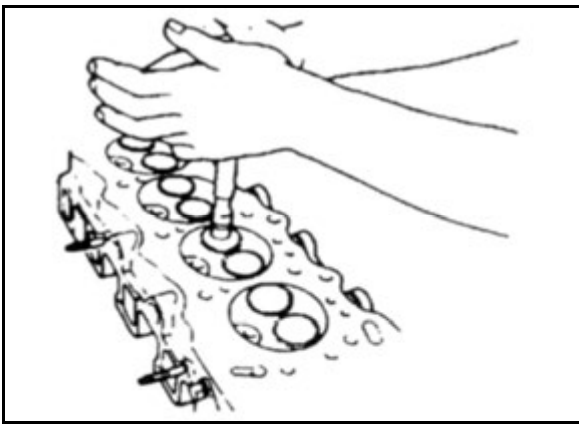


Valve seat angle: 45°

**Note**

**You may use an adjustable milling cutter guide lever. It is not allowed to stir the milling cutter guide lever in the valve guide hole.**

3. Apply grinding paste on valve seat surface.
4. Insert the valve into the valve guide.
5. Turn the valve for perfect fitting with the valve seat while tapping it from top or bottom.
6. Check the valve contact width is proper.
7. Check whether the valve seat surface has completely contacted with the whole valve periphery.



**Bending of push rod**

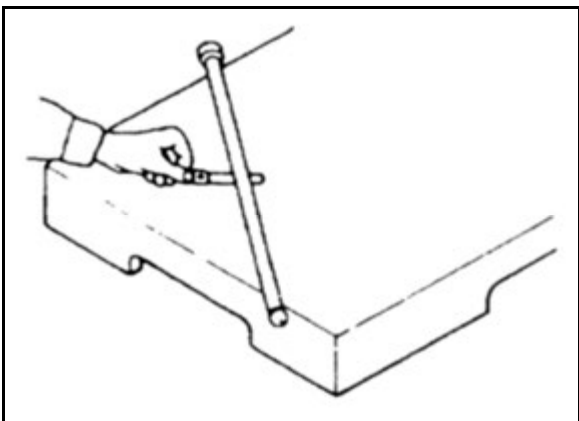
1. Put the push rod on a platform.
2. Roll the push rod along the platform and use a feeler gauge to measure bending of push rod. If the measurement value exceeds prescribed limit, the push rod shall be replaced.

Push rod bending limit:

0.4 mm or less

3. Visually check whether there is any excess abrasion or damage at both ends of push rod.

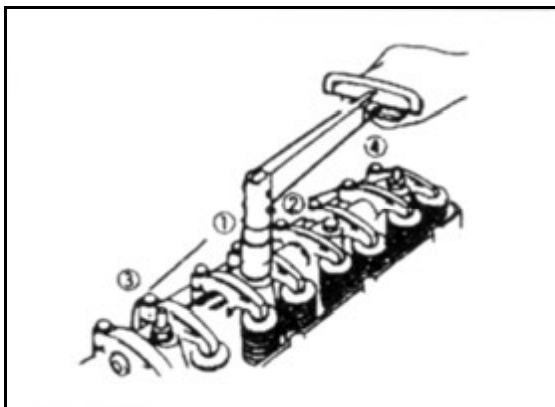
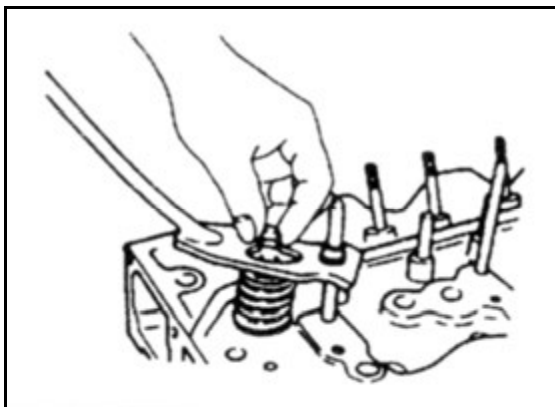
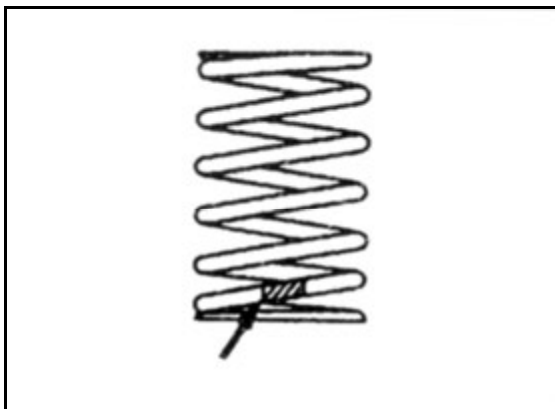
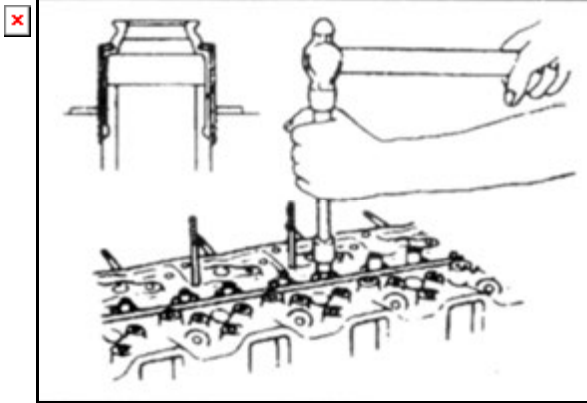
If so, replace the push rod.



**Reassembly**

**6. Valve guide**

- Apply oil to the outer surface of valve guide. Use a special tool to mount a new valve guide from one side of camshaft.



Valve guide replacer: 1003102FA-9101

**5. Valve guide oil seal**

- Press in a new oil seal with a special tool.  
Oil seal erector: 1003016FA-9101

**4. Valve**

- Apply oil to the outer surface of valve stem.

**3. Valve spring**

- Mount the valve spring on the upper spring seat. The section with painting on the valve spring shall be placed downwards (i.e. the spring with less pitch placed downwards).

**2. Valve cotter**

- Use a spring compressor to press the valve spring to a proper position.
- Mount the spring seat and valve cotter.
- Use a soft-faced hammer to slightly tap the cotter head until it seats in place.

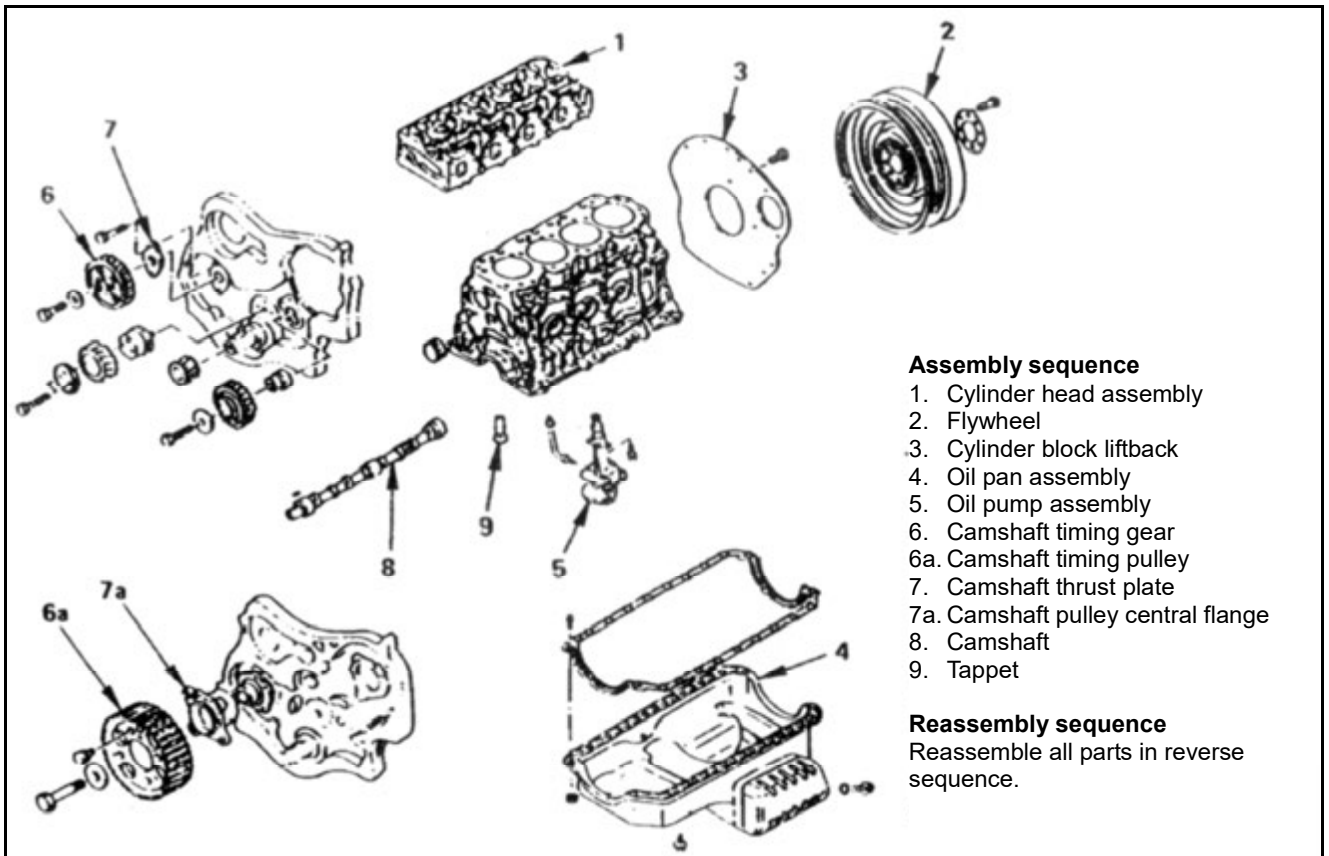
Valve spring compressor: 1003015FA-9101

**1. Rocker assembly**

Installation torque:  $55 \pm 5 \text{ N} \cdot \text{m}$



## 2.3 Camshaft and tappet



### Assembly sequence

1. Cylinder head assembly
2. Flywheel
3. Cylinder block liftback
4. Oil pan assembly
5. Oil pump assembly
6. Camshaft timing gear
- 6a. Camshaft timing pulley
7. Camshaft thrust plate
- 7a. Camshaft pulley central flange
8. Camshaft
9. Tappet

### Reassembly sequence

Reassemble all parts in reverse sequence.

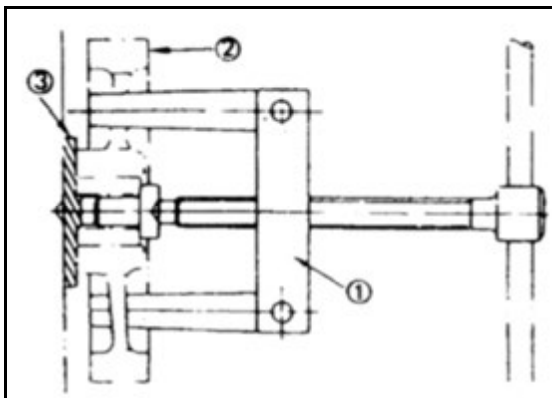
## Disassembly

1. Cylinder head assembly
2. Flywheel
3. Flywheel baffle
4. Oil pan assembly
5. Oil pump assembly
6. Camshaft timing gear
  - Remove camshaft timing gear bolt(s) from the camshaft.

### Note

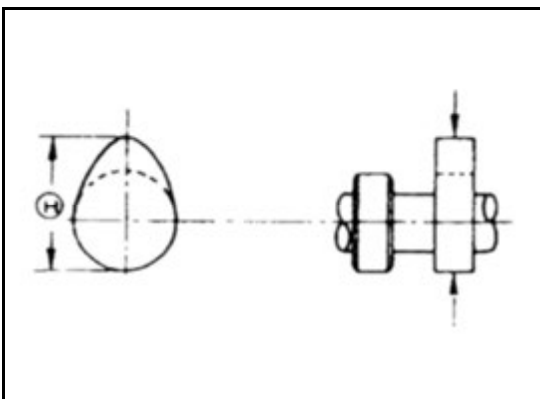
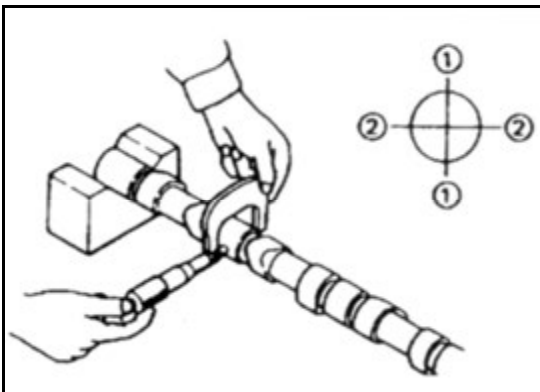
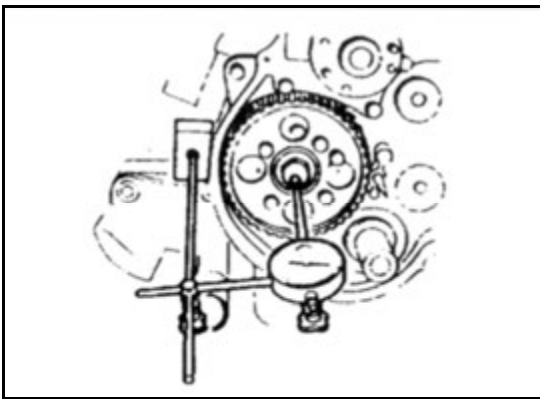
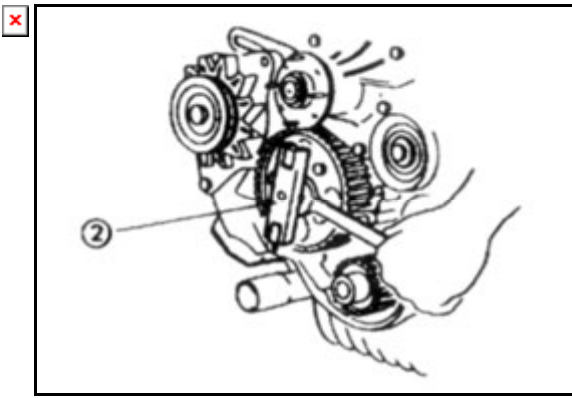
#### Fasten the camshaft to avoid turning.

- Pull out camshaft timing gear ② with a universal puller ①. Universal puller: 1007017FA-9101
- Remove the thrust washer ③.



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- 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

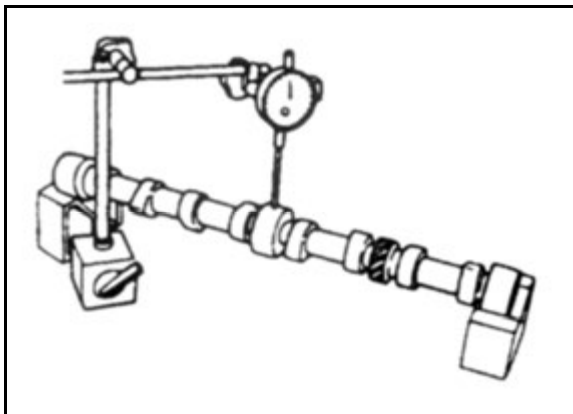
Nominal	Limit
49.945—49.975	49.60

#### 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

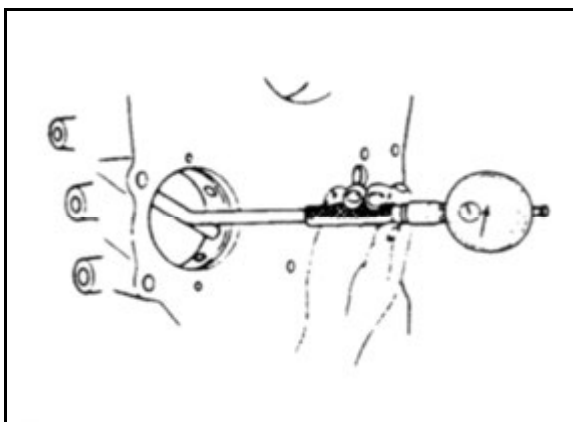


#### 4. Camshaft radial runout

- Put the camshaft on a V block.
  - Measure the radial runout with a dial gauge.
- If the measurement value exceeds prescribed limit, the camshaft shall be replaced.

Radial runout mm

Nominal	Limit
0.04 or less	0.10



#### 5. Camshaft and camshaft bearing clearance

- Measure the camshaft bearing inner diameter with a dial gauge.

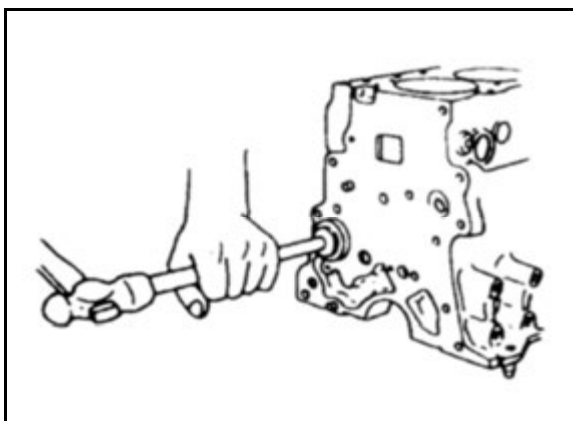
Camshaft bearing inner diameter mm

Nominal	Limit
50.00—50.03	50.08

Camshaft bearing clearance mm

Nominal	Limit
0.025—0.080	0.12

If the camshaft bearing inner diameter or the journal clearance exceeds the prescribed values, the camshaft bearing shall be replaced.



#### Camshaft bearing replacement



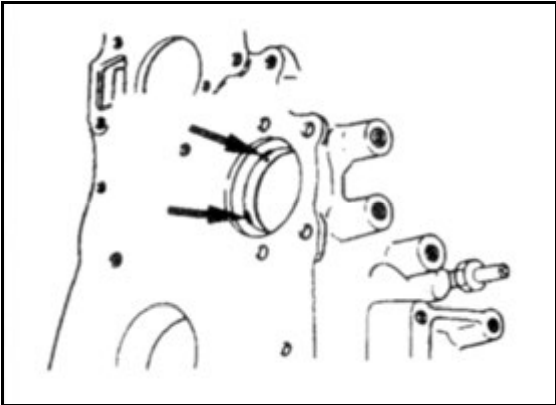
##### Camshaft bearing disassembly



1. Remove cylinder block stopper.
2. Disassemble the camshaft bearing with a camshaft bearing replacer.

Camshaft bearing replacer:

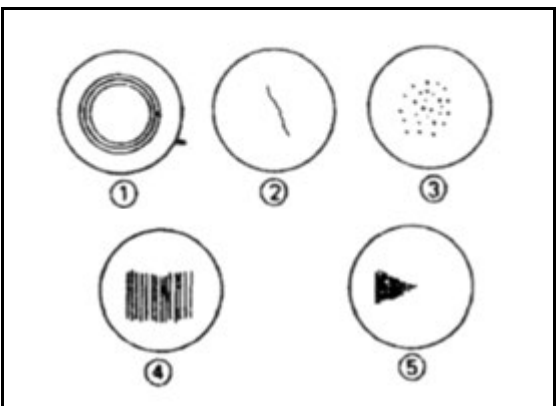
1002107FA-9101



**Camshaft bearing assembly**

1. Align the oil hole on the bearing to the oil hole on the cylinder block.
2. Mount the camshaft bearing with a camshaft bearing replacer.

Camshaft bearing replacer: 1002107FA-9101



**Tappet**

Visually check whether there is any point corrosion, crack and other abnormalities on contact surface between the camshaft and tappet. If so, replace the tappet.

See left figure.

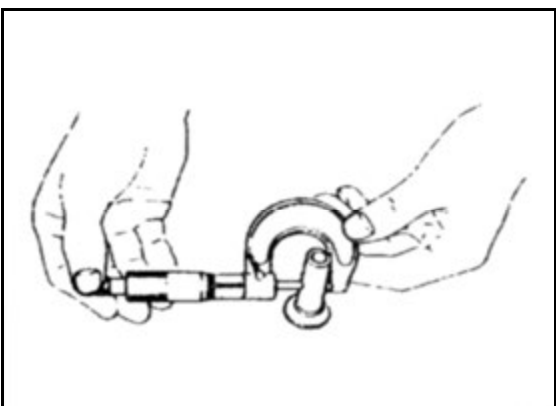
- ① Normal contact
- ② Crack
- ③ point corrosion
- ④ Abnormal contact
- ⑤ Abnormal contact

**Note**

**The tappet has spherical surface. Never use an oilstone or similar tools to grind the spherical surface when you repair the tappet. If the tappet is damaged, you must replace it with a new one.**

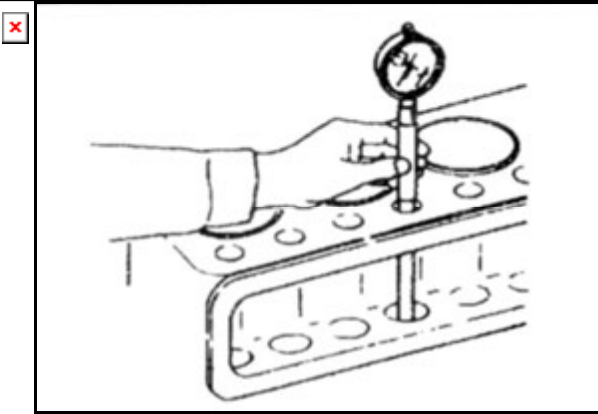
**Tappet outer diameter**

1. Measure the tappet outer diameter with a dial gauge. If the measurement value exceeds prescribed limit, the tappet shall be replaced.



Tappet outer diameter mm

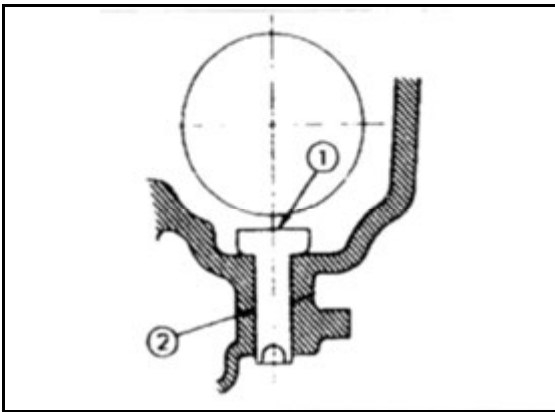
Nominal	Limit
12.72—12.90	12.70



2. Measure the upper tappet installation hole inner diameter on the cylinder block and calculate the clearance.  
If the clearance exceeds the limit value, replace the tappet and/or cylinder block.

Clearance between the tappet and tappet hole  
mm

Nominal	Limit
0.010-0.046	0.10



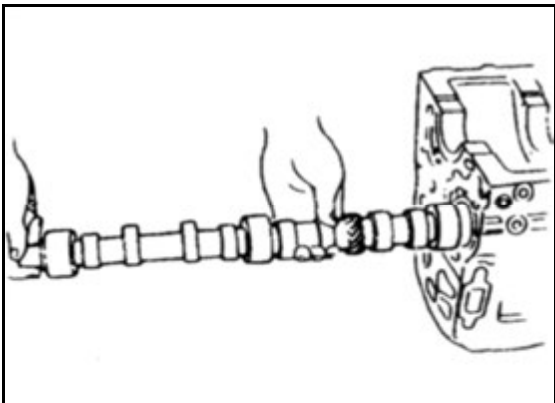
## Reassembly

### 9. Tappet

- 1) Apply oil to the tappet ① and in the upper tappet installation hole on the cylinder block.
- 2) Determine the tappet position according to the identification made in disassembling (if the tappet is newly used).

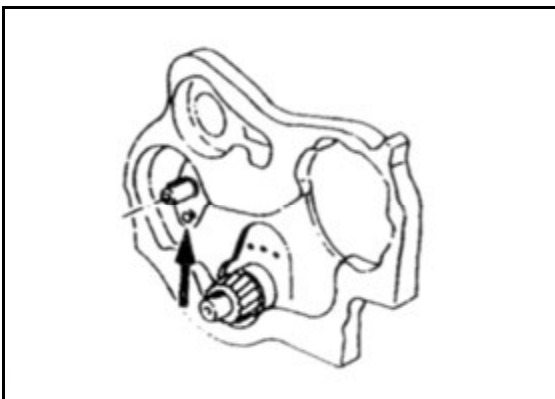
#### Note

**The tappet shall be installed before assembling the camshaft.**



### 8. Camshaft

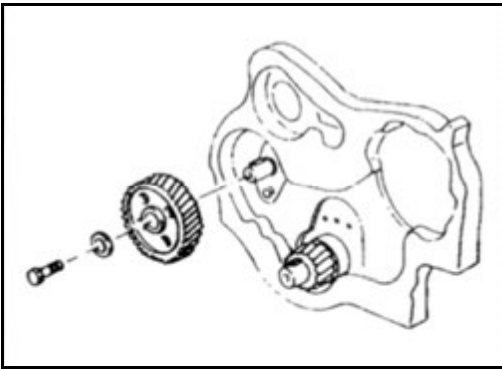
- 1) Apply oil to the camshaft and camshaft bearing.
- 2) Install the camshaft to the cylinder block.  
Be careful not to damage the camshaft bearing.



### 7. Camshaft thrust washer

Mount the thrust washer to the cylinder block and tighten the thrust washer bolt (s) to specified torque.

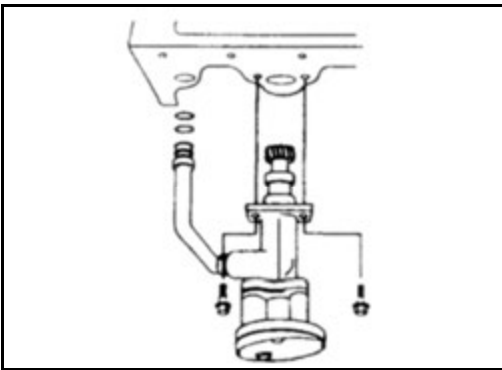
Thrust washer bolt torque :  $25 \pm 5 \text{ N} \cdot \text{m}$



### 6. Camshaft timing gear

- 1) Install camshaft timing gear to the camshaft. The timing gear mark ("Y-Y") shall face outwards.
- 2) Tighten the timing gear bolt to the specified torque.

Timing gear bolt torque  $110 \pm 10 \text{ N} \cdot \text{m}$

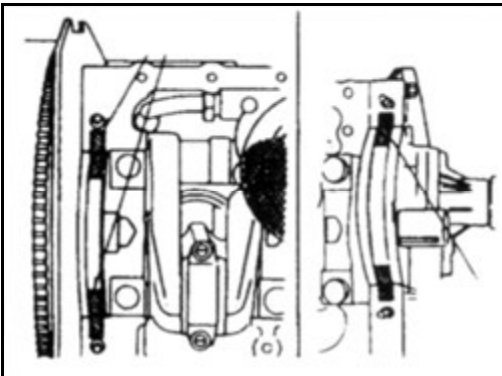


### 5. Oil pump assembly

- Apply some oil on the oil pipe O-ring and mount it to the cylinder block O-ring groove.
- Install the oil pump assembly and oil outlet pump to the cylinder block. Tighten the fixing bolt(s) to specified torque.
- Tighten sleeve nut(s) to the following specified torque:

$25 \pm 5 \text{ N} \cdot \text{m}$

$30 \pm 5 \text{ N} \cdot \text{m}$

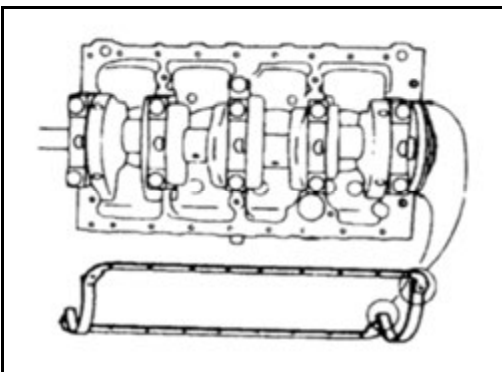


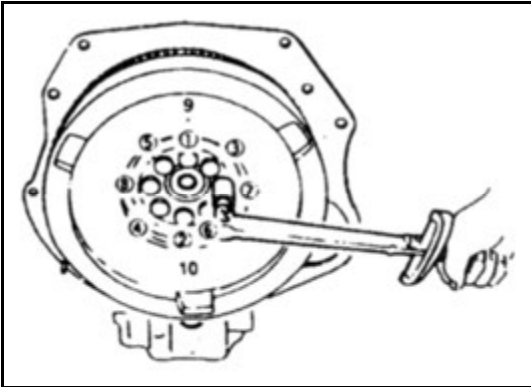
### 4. Oil pan assembly

As shown in the figure, apply recommended silica gel (Loctite 598) or equivalent in alignment on the arc area of the fifth bearing cap, groove, the arc area of timing gear casing and oil pan gasket.

- Mount the rear lip of seal washer into the groove of the fifth bearing cap.
- Make sure the lip perfectly contacts with the groove.
- Install the oil pan to the cylinder block.
- Tighten oil pan bolt(s) to the specified torque.

Oil pan bolt torque  $23.5 \pm 3.5 \text{ N} \cdot \text{m}$





### 3. Flywheel baffle

- Tighten the flywheel baffle fixing bolts to the specified torque.

Flywheel baffle bolt torque  $85 \pm 10 \text{ N} \cdot \text{m}$

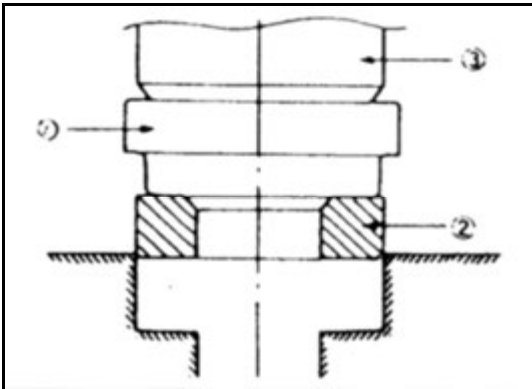
### 2. Flywheel

- Apply some oil to fixing bolts.
- Screw down the flywheel bolts to the specified torque in two steps by torque tightening method.

Tighten them as the sequence number shown in the figure.

Flywheel bolt torque  $\text{N} \cdot \text{m}$

Step 1	Step 2	Step 3
25	70	$120 \pm 10$



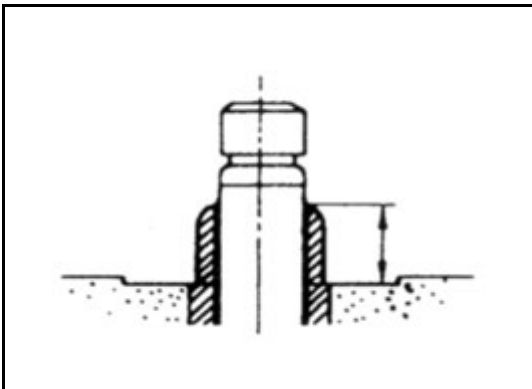
### 1. Cylinder head assembly

- 1) Assemble the valve seat
  1. Carefully place the attachment ① (its outer diameter is less than that of valve seat) on the valve seat ②.

**Note**

Make the smooth side of attachment contact with the valve seat.

2. Use a table press ③ to gradually press the attachment until the valve seat seats in place.

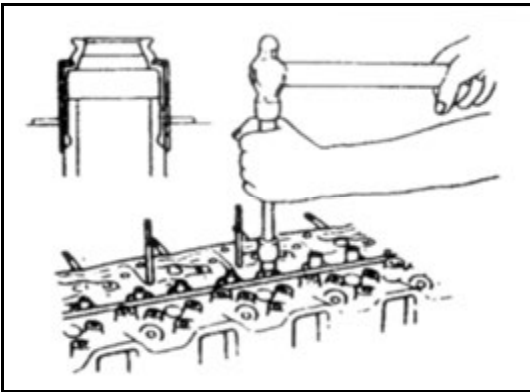


**Note**

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

Measure the 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**

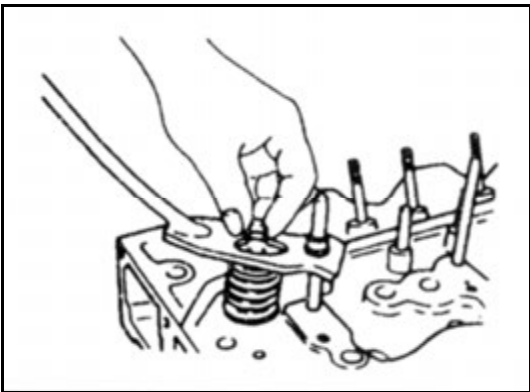
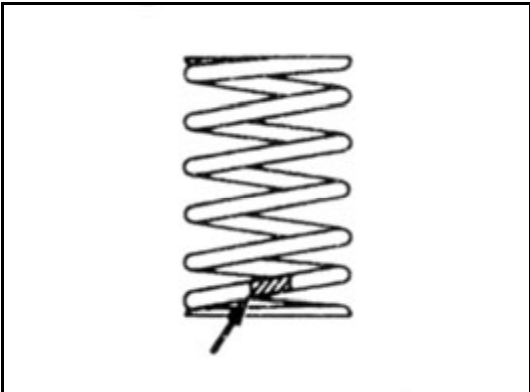
**5) Valve spring**

- 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 a special tool.

Valve spring compressor: 1003015FA-9101



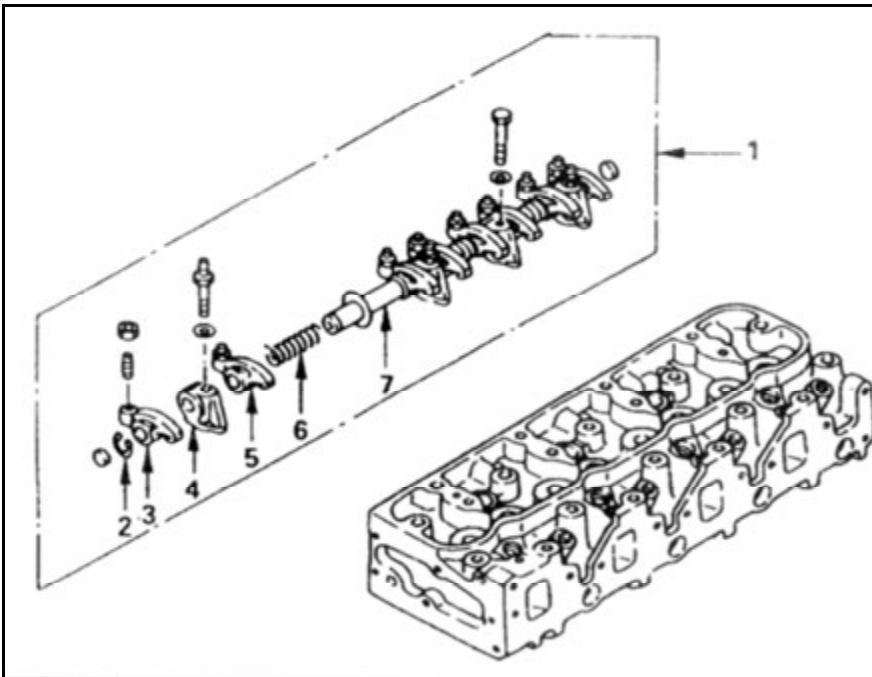
**6) Valve cotter**

- Use a spring compressor to press the spring in place.
- Mount the spring seat and valve cotter.
- Use a soft-faced hammer to tap the cotter head until it seats in place.

Valve spring compressor: 1003015FA-9101



## 2.4. Rocker arm assembly



**Disassembling sequence:**

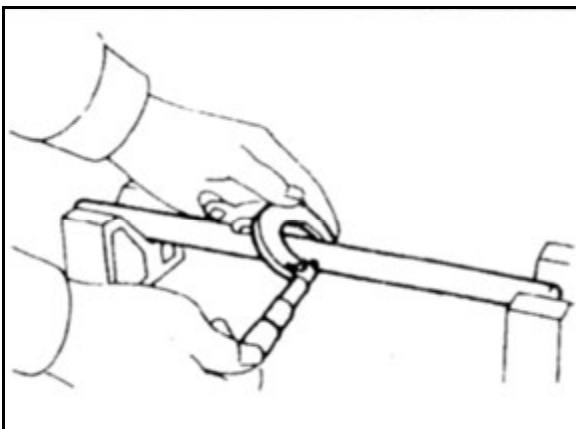
1. Rocker shaft assembly
2. Rocker shaft elastic retainer
3. Rocker arm
4. Rocker shaft support
5. Rocker arm
6. Rocker shaft spring
7. Rocker shaft

**Reassembling sequence:**

Reassemble all parts in reverse sequence.

### Disassembly

1. Rocker shaft assembly
2. Elastic retainer of rocker shaft
3. Rocker arm
4. Rocker shaft retainer
5. Rocker arm
6. Rocker shaft spring
7. Rocker shaft



### Inspection and repair

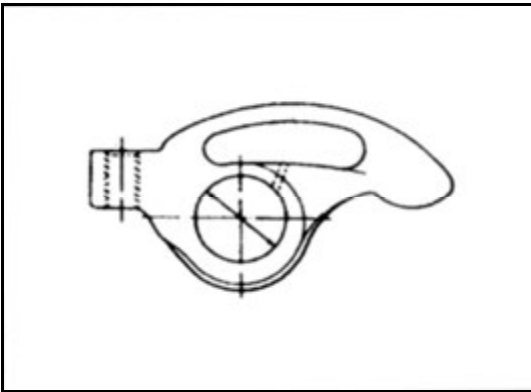
If excessive abrasion and damage is found during checking, adjust, repair and replace parts in time.

Measure the outer diameter of rocker shaft at its swinging position with a dial gauge.

Replace the rocker shaft if the diameter exceeds prescribed limit.

mm.	
Nominal	Limit
18.98—19.00	18.9





**Oil film clearance**

1. Measure the inner diameter of rocker shaft hole with a vernier caliper or dial gauge.

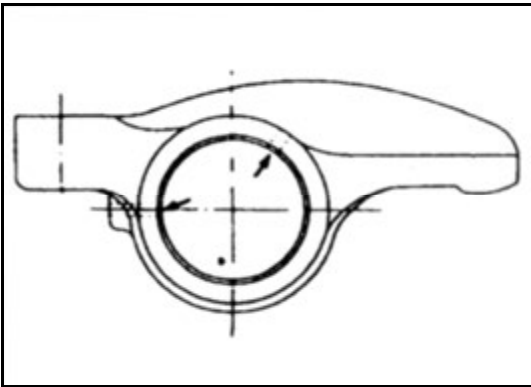
Inner diameter of rocker shaft hole mm

Nominal	Limit
19.010—19.030	19.100

2. Measure the outer diameter of rocker shaft. If the measured value exceeds prescribed limit, replace rocker arm or rocker shaft.

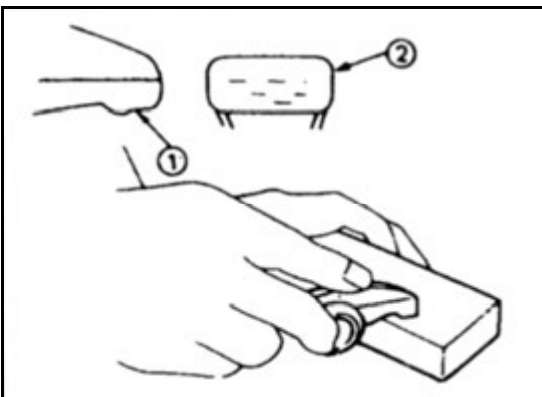
Clearance between rocker arm and rocker shaft mm

Nominal	Limit
0.01—0.05	0.10



3. Check the upper oil hole of rocker arm is blocked.

Blow clean the oil hole of rocker shaft with compressed air if necessary.

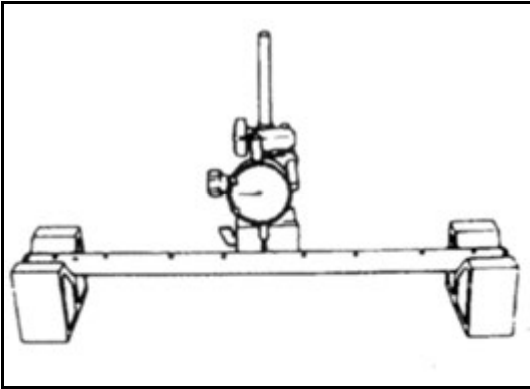


**Rocker arm correction**

Check there is abrasion or scratch with the upper valve stem contact surface.

If there is slight abrasion or scratch of step shape with the contact surface, polish it with oil.

The rocker arm has to be replaced if this abrasion or scratch is serious.



### Radial runout of rocker shaft

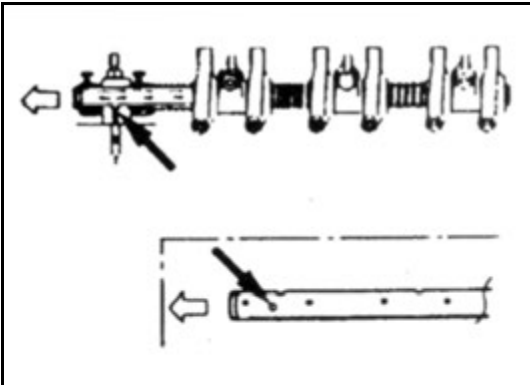
1. Put the rocker shaft on a V block.
2. Measure the radial runout at middle part of rocker shaft with a dial gauge.

If the radial runout is slight, correct this runout with a table press.

If the radial runout of rocker shaft exceeds prescribed limit, the rocker shaft has to be replaced.

Radial runout of rocker shaft mm

Limit
0.2



### Reassembly

#### 7. Rocker shaft

- Apply a thin layer of oil to the rocker shaft.
- The rocker shaft should be placed in such a way that the bigger hole ( $\varnothing 4$ ) faces the engine forepart.
- Install the rocker shaft, rocker shaft retainer and spring together.

#### 6. Rocker shaft spring

#### 5. Rocker arm

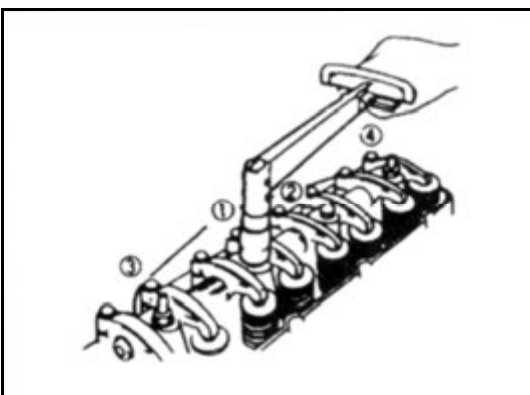
#### 4. Rocker shaft retainer

#### 3. Rocker arm

#### 2. Elastic retainer of rocker shaft

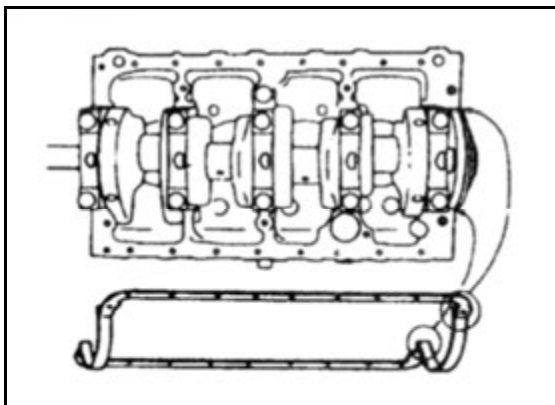
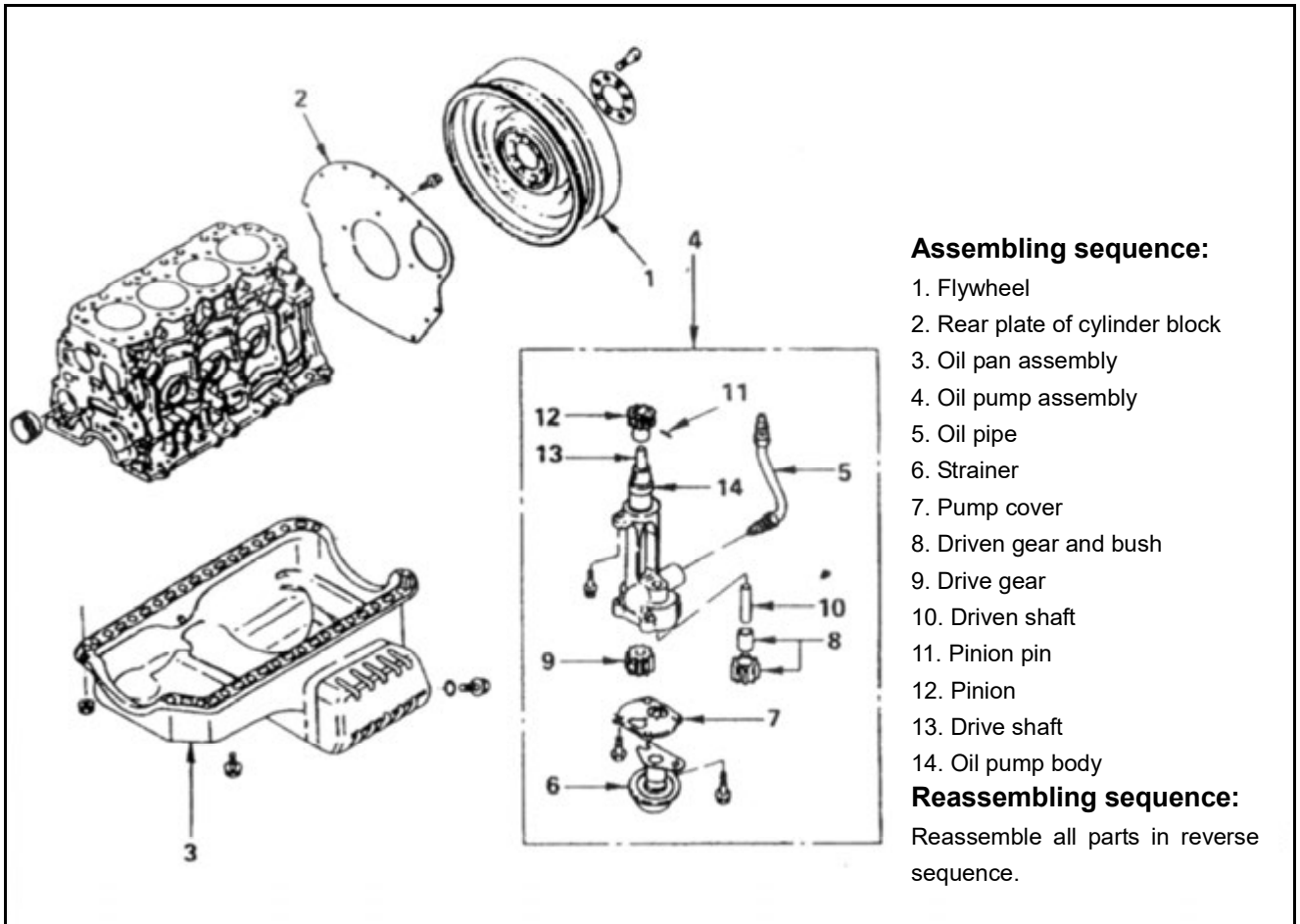
#### 1. Rocker shaft assembly

- Install the rocker shaft assembly on the cylinder head.
- Tighten the flywheel baffle fixing bolts to the specified torque.



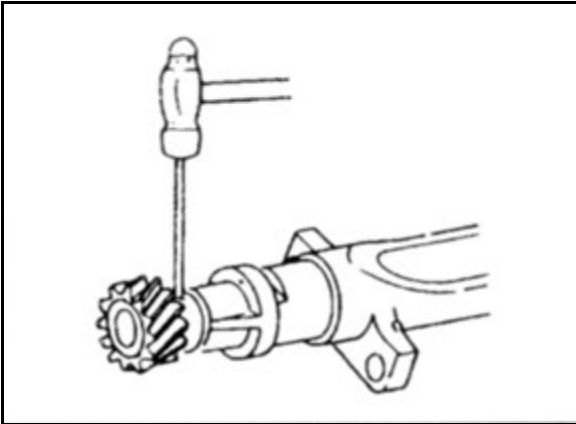


## 2.5 Oil pump

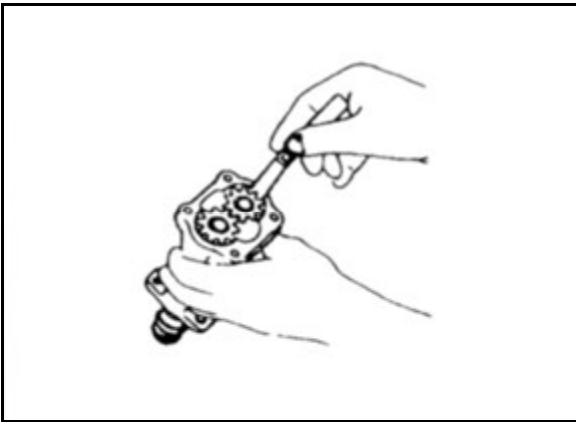


### Disassembly

1. Flywheel
2. Flywheel baffle
3. Oil pan assembly



4. Oil pump assembly
5. Oil pipe
6. Strainer
7. Pump cover
8. Driven gear and bush
9. Drive gear
10. Driven shaft
11. Pinion pin
  - File flat the tip of pinion stop pin.
  - Knock out the pinion pin with a hammer and bar.
  - Remove the pinion.
12. Pinion
13. Drive shaft
14. Oil pump body



**Inspection and repair**

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

Housing and gear

The oil pump assembly must be replaced if one of the following conditions is found:

- The driven gear sleeve is worn or damaged seriously.
- The upper gear teeth is worn or damaged seriously.

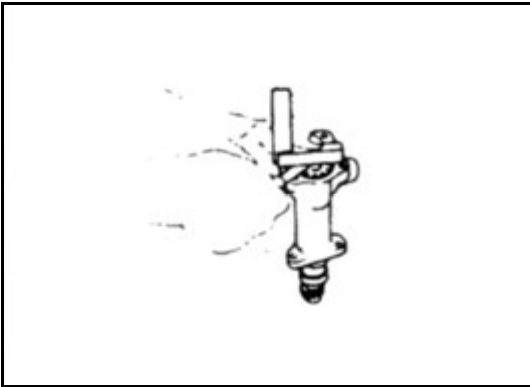
**Clearance between upper gear teeth and inner housing wall**

- Measure the clearance between upper gear teeth and inner housing wall with a clearance gauge.
- If the clearance between upper gear teeth and inner housing wall exceeds prescribed limit, either the gear or housing has to be replaced.

Clearance between upper gear teeth and inner housing wall

mm

Nominal	Limit
0.14	0.20

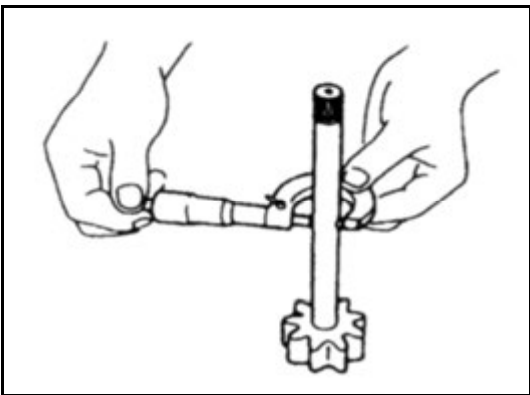


**Clearance between gear and cover**

- Measure the clearance between gear and cover with a clearance gauge.
- If the clearance between gear and cover exceeds prescribed limit, the housing must be replaced.

Clearance between gear and cover mm

Nominal	Limit
0.06	0.15

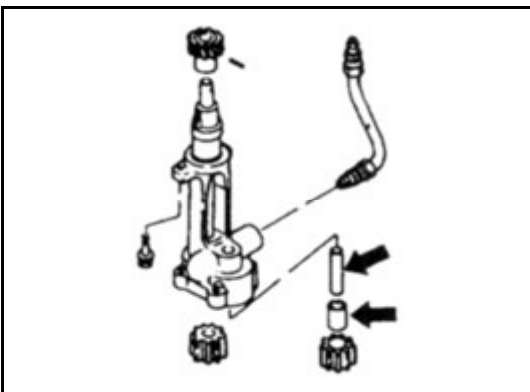


**Clearance between drive shaft and oil pump body**

- Use a micrometer to measure the borehole diameter of drive shaft.
- Measure the inner diameter of pump body with a dial gauge.
- If the Clearance between drive shaft and oil pump body exceeds prescribed limit, the oil pump assembly has to be replaced.

Clearance between drive shaft and oil pump body mm

Nominal	Limit
0. 04	0. 20



**Clearance between driven shaft and bush**

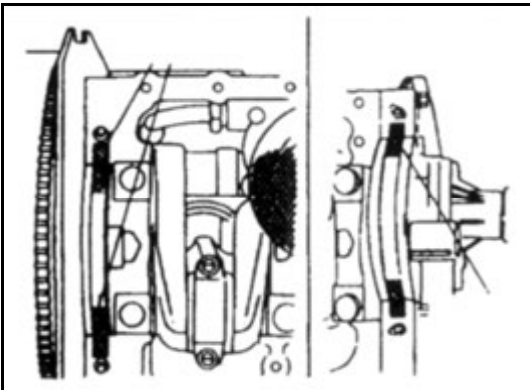
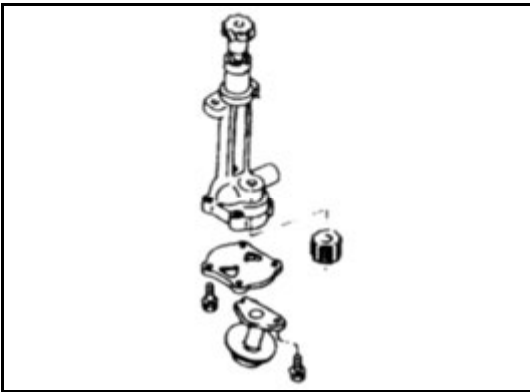
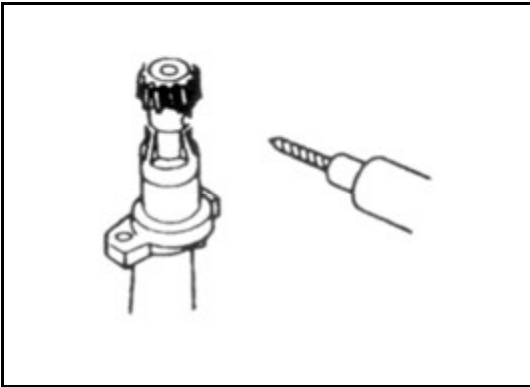
- Use a micrometer to measure the outer diameter of driven shaft.
- Measure the inner diameter of bush with a dial gauge.
- If the clearance between driven shaft and bush exceeds prescribed limit, the bush must be replaced.

Clearance between driven shaft and bush mm

Nominal	Limit
0.05	0.15

**Reassembly**

14. Oil pump body
13. Drive shaft
12. Pinion



**11. Pinion pin**

- Install new drive shaft on the pump body.
- Install the pinion on the drive shaft.
- Drill a hole with  $\phi 5\text{mm}$  (0.20in) bore bit for the pinion and drive shaft to pass through.
- Insert the pinion pin into the hole.  
Rivet the pin.

**10. Driven shaft**

**9. Drive gear**

**8. Driven gear and bush**

**7. Pump cover**

**6. Strainer assembly**

- Mount the strainer assembly and screw down its fixing bolts.

20±5 N·m

**5. Oil pipe**

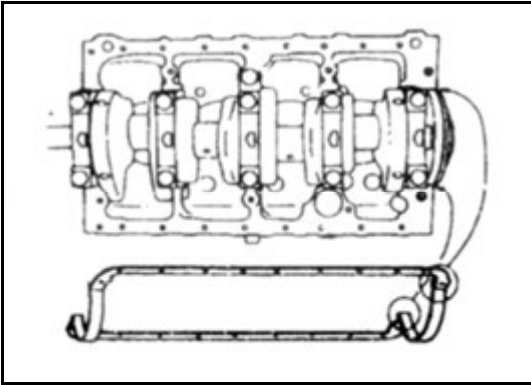
**4. Oil pump assembly**

- Apply oil containing molybdenum to the oil pump driven gear and camshaft drive gear.
- Tighten the oil pump fixing bolts to the specified torque.

20±5 N·m

**3. Oil pan assembly**

- Apply recommended liquid sealant or equivalents to the fifth bearing cap arch section, groove and timing gear chamber arch section shown in the diagram.

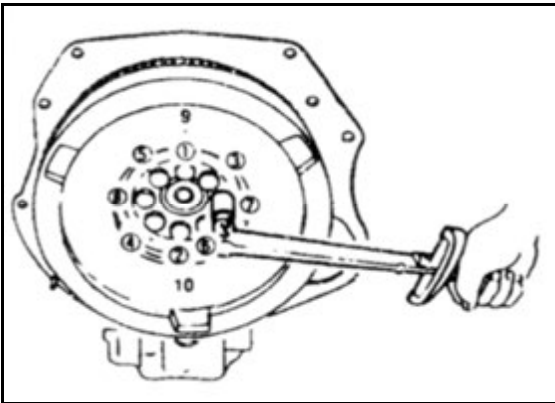


- Mount the rear lip of seal washer into the groove of the fifth bearing cap.
- Make sure that the lip is perfectly in contact with the groove.
- Install the oil pan on the cylinder block.
- Tighten oil pan bolt(s) to the specified torque.

Oil pan bolt torque:  $23.5 \pm 3.5 \text{ N}\cdot\text{m}$

**2. Flywheel baffle**

- Align the flywheel baffle with the anchor pin of cylinder block, and tighten flywheel baffle bolt(s) to the specified torque:  $85 \pm 10 \text{ N}\cdot\text{m}$



**1. Flywheel**

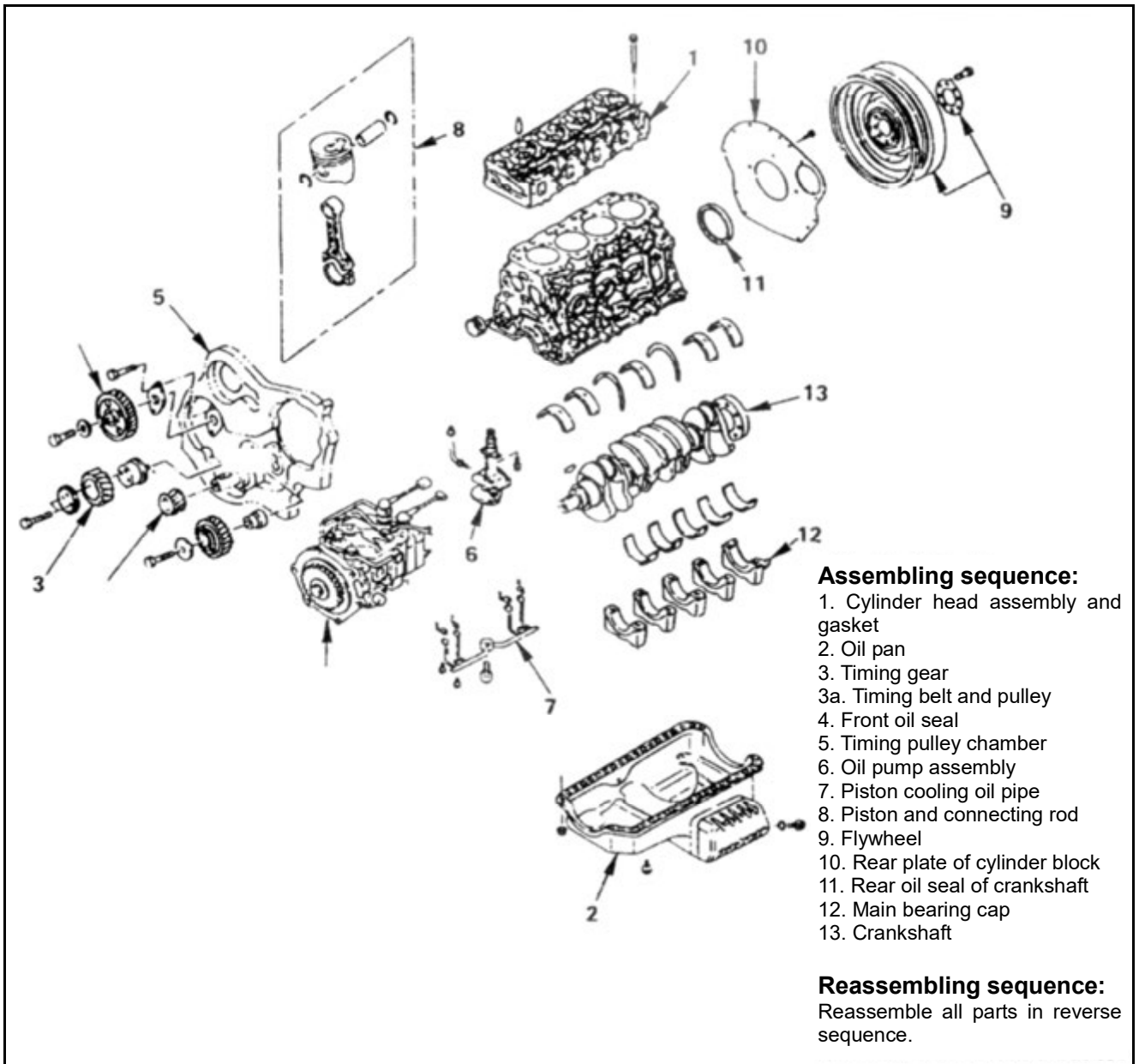
- Apply some oil to fixing bolt.
- Screw down the flywheel bolts to the specified torque in two steps by torque tightening method.

Flywheel bolt torque N·m

Step I	Step II	Step III
25	70	$120 \pm 10$



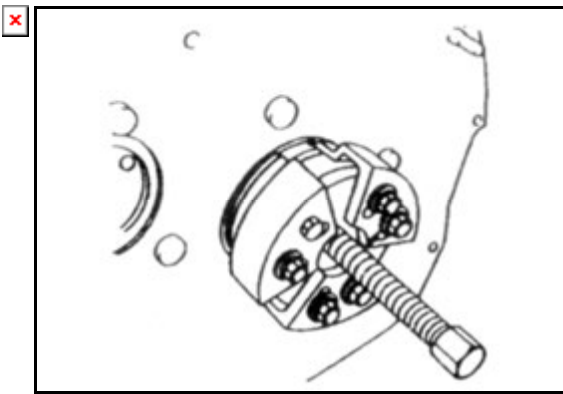
## 2.6. Crankshaft



### Disassembly

1. Cylinder head assembly and gasket
2. Oil pan assembly
3. Timing gear
4. Timing gear chamber
5. Oil pump assembly
6. Piston cooling oil pipe





7. Piston and connecting rod
8. Flywheel
9. Flywheel baffle
10. Rear oil seal
  - Push in the oil seal, install the special tools according to the sequence shown in the diagram to facilitate removing the oil seal.

Rear oil seal remover: 1002430FA-9102

**Note: Take care not to damage the flywheel baffle and crankshaft sealing surface during oil seal removal.**

11. Main bearing cap
12. Crankshaft

### Inspection and repair

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

#### 1. Crankshaft

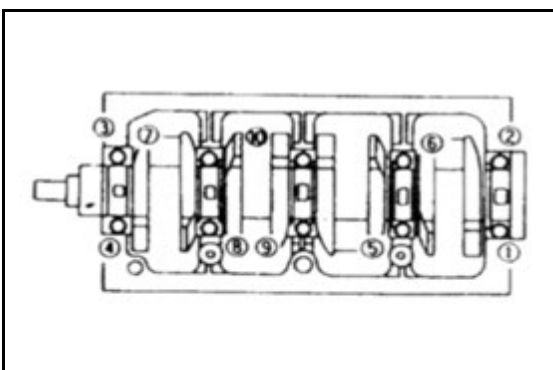
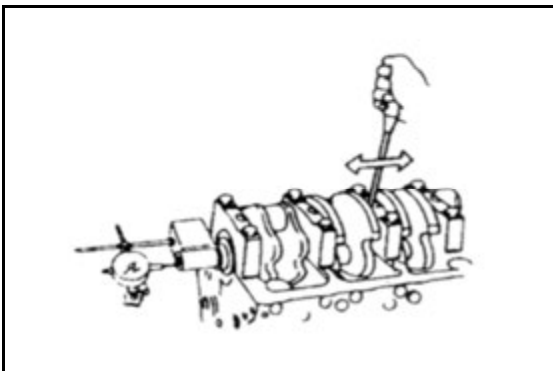
Thrust clearance

Install dial gauge according to the sequence shown in the diagram and measure the thrust clearance of crankshaft.

If the thrust clearance exceeds prescribed limit, the thrust bearing shall be replaced in pair.

Thrust clearance mm

Nominal	Limit
0.040-0.201	0.30



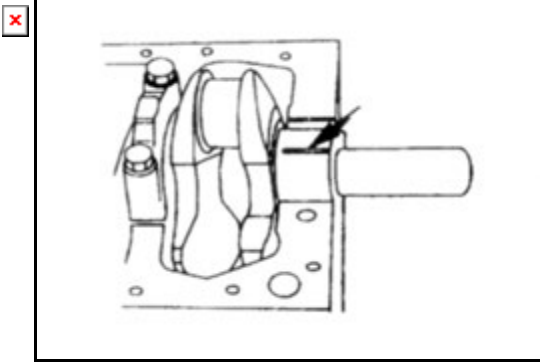
#### 2. Main bearing clearance

- 1) Remove the main bearing cap according to the sequence shown in the diagram.

Place the removed main bearing cap according to the sequence number of cylinder.

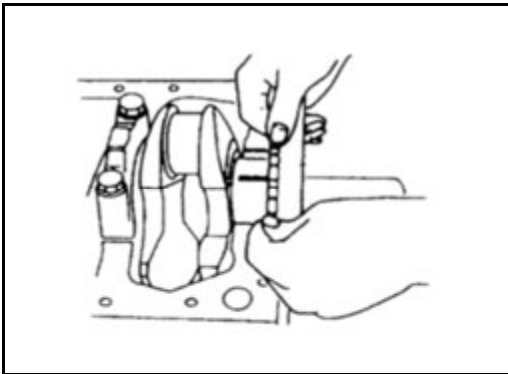
- 2) Remove crankshaft. Dismantle main bearing.
- 3) Clean the upper and lower bearings and main journal of crankshaft.
- 4) Check the bearing is damaged or excessively worn.

If excessive abrasion or damage is found during checking, the bearing has to be replaced in pair.



- 5) Install the upper bearing and thrust washer on their original positions. Carefully install the crankshaft.
- 6) Mount the lower bearing to the bearing cap in its original position.
- 7) Install plastic cord clearance gauge on the main journal of crankshaft.
- 8) Install main bearing cap. Apply oil to the threads and mating surfaces of bolts. Tighten the bolt to the specified torque.

170±10 N·m



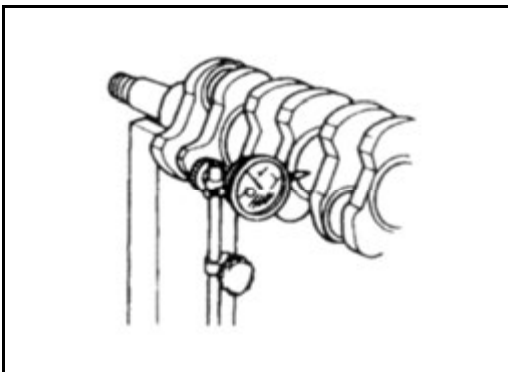
**Note:**

**The crankshaft is not allowed to rotate.**

- 9) Remove main bearing cap.
- 10) Measure the width of plastic cord clearance gauge and determine the oil film clearance. If the oil film clearance exceeds prescribed limit, the main bearing and (or) crankshaft has to be replaced in pair.
- 11) Remove the plastic cord clearance gauge off bearing and crankshaft.  
Dismantle crankshaft and bearing.

Oil film clearance mm(in)

Nominal	Limit
0.031—0.066	0.11

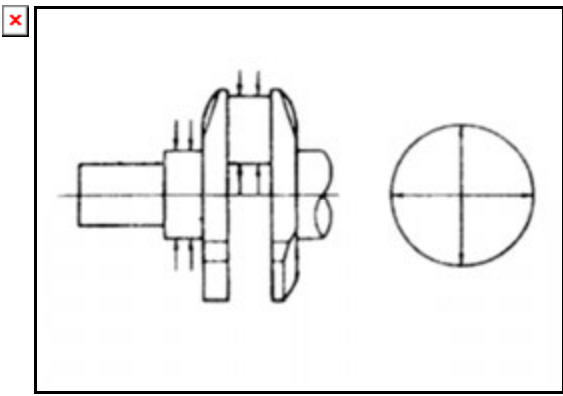


**3. Radial runout**

- 1) Carefully put the crankshaft on a V block. Slowly rotate the crankshaft and measure the radial runout. If the radial runout of crankshaft exceeds prescribed limit, the crankshaft has to be replaced.

Radial runout mm

Nominal	Limit
0.05 or less	0.08



Measure the diameter of main journal and crankpin and the uneven abrasion.



If the abrasion of crankshaft exceeds prescribed limit, the crankshaft has to be replaced.

mm

	Nominal	Limit
Main journal diameter	69.91—69.932	69.910
Crankpin diameter	52.91—52.930	52.900
Uneven abrasion limit	0.05 or less	0.08

**Crankshaft inspection**

Check the main journal of crankshaft and crankpin surface are damaged or excessively worn.

Check there is excessive abrasion or damage on the mating surface of oil seal.

Check the oil hole is blocked.

**Inspection on soft nitrogen treatment of crankshaft**

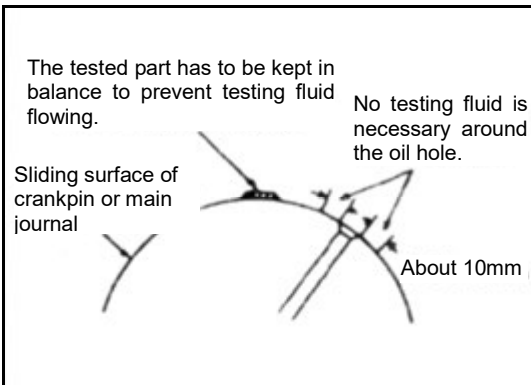
1. Thoroughly clean the crankshaft with a kind of organics. There must be no oil stains on the tested surface.
2. Prepare some solution containing 5%—10% ammonium cupric chloride (dissolved in distilled water).
3. Apply the solution on the tested surface with an injector.  
Keep the tested surface in full level state to prevent solution flowing.

**Note:**

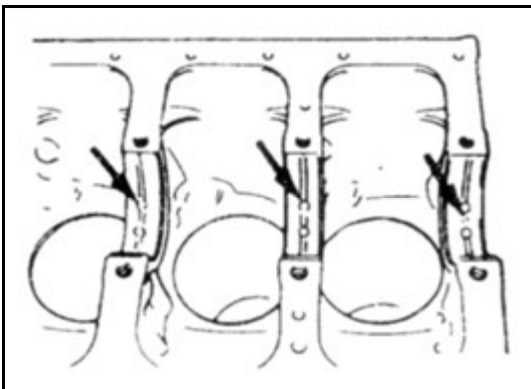
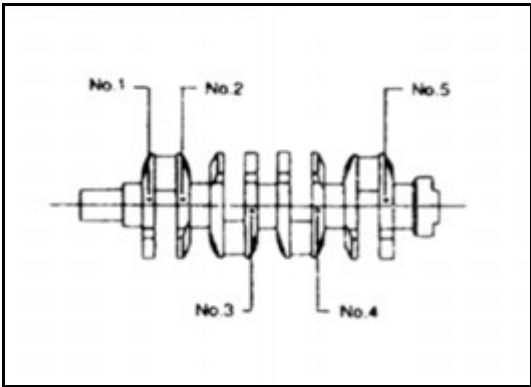
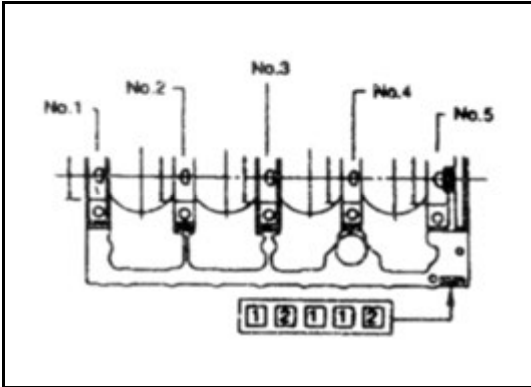
**The solution is not allowed to wash the oil hole and area around.**

**Test**

1. Wait for 30—40 seconds.  
If the color does not change after 30—40 seconds, the crankshaft can be used.  
If the color changes (the tested surface becomes copper color), the crankshaft has to be replaced.



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2. Clean the crankshaft surface with steam immediately after test is completed.

**Note:**

There is high corrosiveness with ammonium cupric chloride solution. Therefore, it is absolutely necessary to clean the crankshaft surface immediately after test is completed.

**Crankshaft bearing selection**

When assembling new crankshaft bearing or replacing old bearing, see the selection table below.

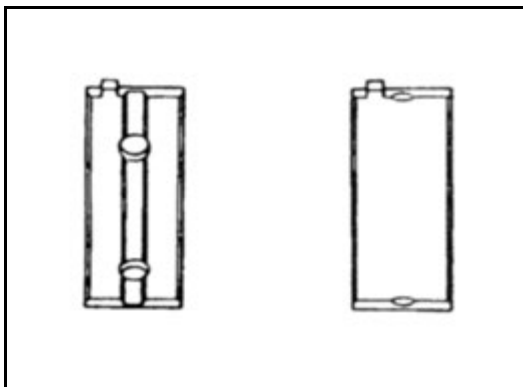
When selecting and installing new crankshaft bearing, pay attention to the diameter size mark of the upper journal hole and crankshaft main journal 2.

**Note:**

Although there are oil grooves and holes (cylinder block side) with all the upper bearings of main journal and there are not oil grooves and holes (bearing cap side) with all the lower bearings, still pay attention to identify them during assembly.



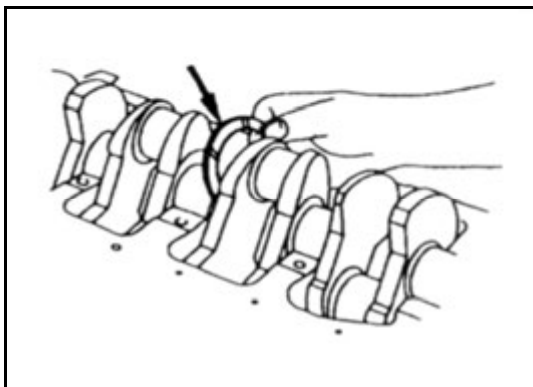
Main bearing hole diameter (mm)		Crankshaft main journal diameter (mm)		Main bearing size mark	Oil film clearance
Size mark	Bore diameter	Size mark	Outer diameter		
1	73.988-74.000	1	>69.926-69.932	Black ( $\Phi 2^{+0.010}_{+0.006}$ )	0.036-0.062
		2	>69.920-69.926	Blue ( $\Phi 2^{+0.014}_{+0.010}$ )	0.034-0.060
		3	69.914-69.920		0.040-0.066
2	73.975-73.987	1	>69.926-69.932	Green ( $\Phi 2^{+0.006}_{+0.002}$ )	0.031-0.057
		2	>69.920-69.926		0.037-0.063
		3	69.914-69.920	Black ( $\Phi 2^{+0.010}_{+0.006}$ )	0.035-0.061

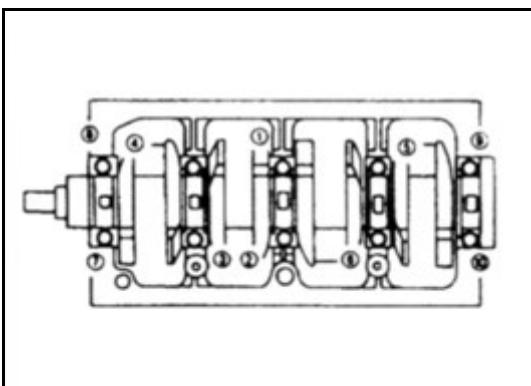
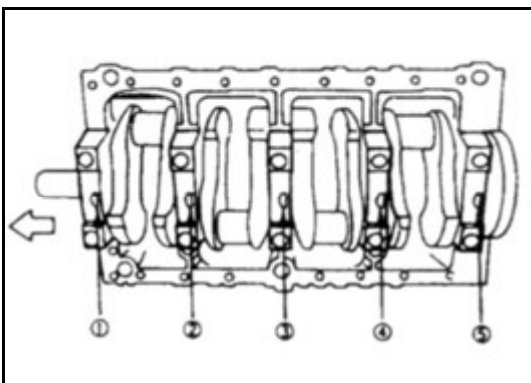
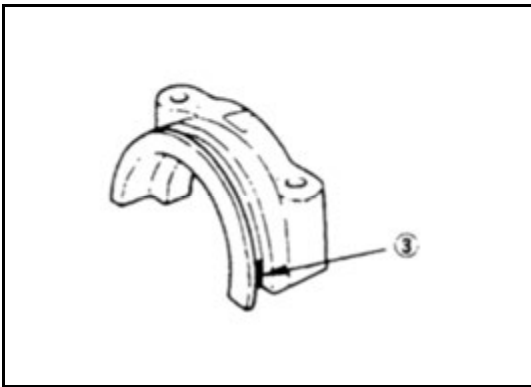
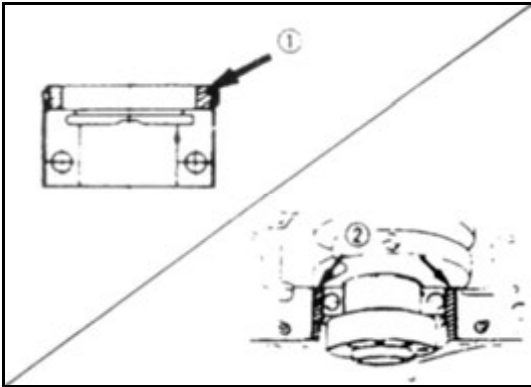


## Reassembly

### 13. Crankshaft

- Install the main bearing on the cylinder block and main bearing cap.
- Make sure that their positions are correct.
- Apply fresh oil to the upper and lower main bearing surfaces.
- Carefully install the crankshaft.
- Apply oil to the thrust washer.
- Install the thrust washer on the third main journal. Its oil groove must face the crankshaft.





## 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.

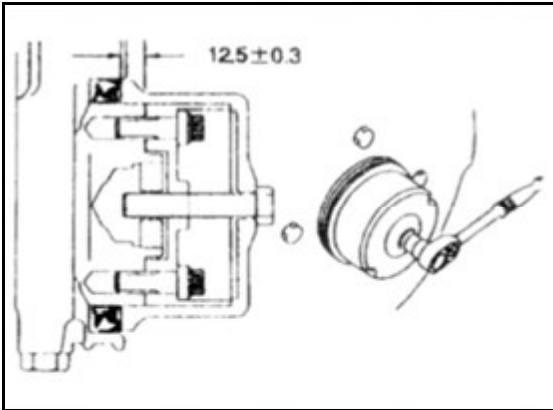
### Note:

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

**Make sure the liquid sealant does 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	



**Note:**

**Manually rotate the crankshaft to check whether it is flexible.**

**11. Rear oil seal of crankshaft**

Install the oil seal on the cylinder block with an oil seal erector.

Rear oil seal erector: 1002430FA-9101

**Notes:**

**Clean the rust and chips off the press-in portion of the oil seal.**

**Pay attention to the press-in direction of the oil seal.**

- 1) Connect the adaptors of special tools to the rear end of the crankshaft with two bolts.
- 2) Install the oil seal to the periphery of the adaptors.
- 3) Insert the socket into the adaptor and screw down the bolt (M12XL75L=70) until the adaptor tip is in contact with the socket.
- 4) Remove the adaptor and socket.
- 5) Check the oil seal installation depth and flatness after it is installed.

Depth standard: 12.5±0.3mm



**10. Flywheel baffle**

Align the baffle with the upper anchor pin of cylinder block.

Tighten the flywheel baffle bolts to the specified torque: 85±10N·m

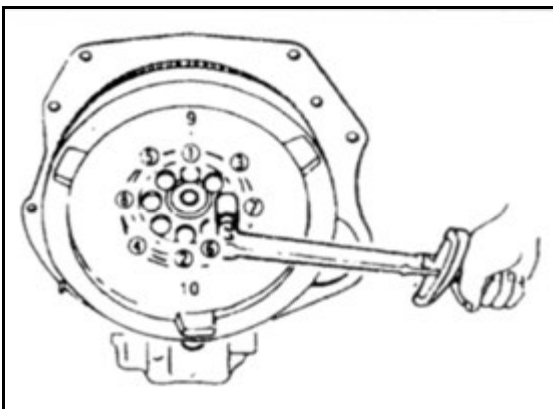
**9. Flywheel**

- 1) Thoroughly clean out the oil stains on the crankshaft thread(s).
- 2) Install the flywheel on the crankshaft, and then mount the washer(s).
- 3) Apply oil to flywheel bolt thread(s).
- 4) Align the flywheel with the anchor pin of crankshaft.
- 5) Screw down the flywheel bolts to the specified torque in two steps by torque tightening method. Tightening sequence is shown in the diagram.

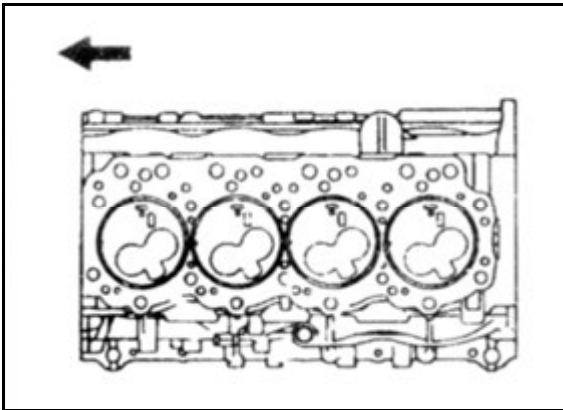
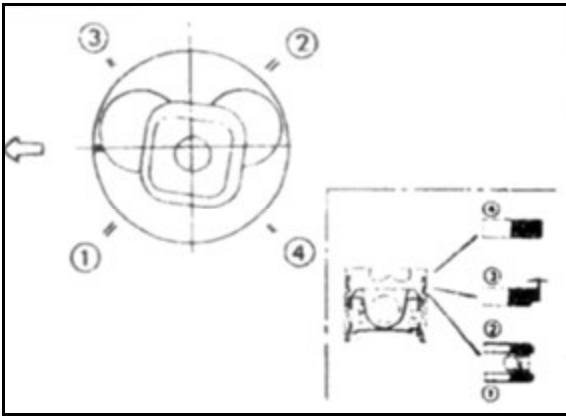


Flywheel bolt torque N·m

Step I (sealing torque)	Step II (sealing torque)	Step III (final torque)
25	70	120±10



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**8. Piston and connecting rod assembly**

- Apply oil to cylinder hole, connecting rod bearing, crankpin, piston ring and piston. Check the position of piston ring opening is correct.

- Encase piston/connecting rod assembly into each cylinder with a piston ring compressor. The front mark must face the engine forepart.
- The number on cap should be in pair with the one on connecting rod. Align the printing mark on connecting rod with the one on cap.
- Apply oil to the threads and mating surfaces of nuts.
- Screw down the connecting rod cap nuts in two steps by torque tightening method according to the following descriptions.

N·m	
First step (pretightening)	Second step (tightening)
20	85±5

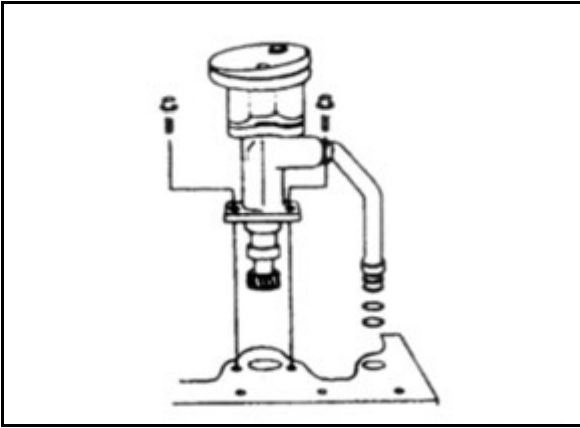
Check the crankshaft rotates freely after the connecting rod nuts are tightened.

**7. Piston cooling oil pipe**

- Tighten bolt(s) and injection nozzle plug (pressure limiting valve) to the specified torque.

Bolt:	20±5 N·m
Injection nozzle plug (pressure limiting valve):	30±5 N·m





**6. Oil pump assembly**

- 1) Prepare some solution containing 80% oil and 20% supramoly.
- 2) Apply a thin layer of the above solution to the teeth of oil pump pinion.
- 3) Install the oil pump and tighten bolt(s) to the specified torque.

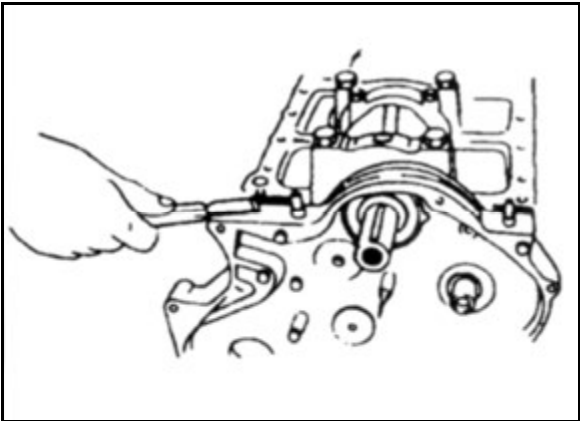
25±5 N·m

**Note:**

**Take care not to damage O-ring when screwing down oil pipe bolt(s).**

- 4) Tighten sleeve nut(s) to the specified torque:

30±5 N·m



**5. Timing pulley chamber**

- 1) Install timing pulley chamber on the cylinder block.
- 2) Use bolt(s) to tighten both timing pulley chamber and timing pulley chamber gasket(s) to the specified torque.

25±5 N·m

- 3) Cut off the gasket tip on the mating surface (as shown in the diagram).

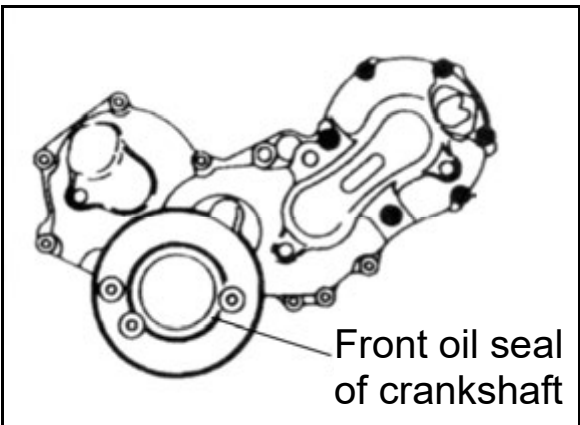
**4. Front oil seal of crankshaft**

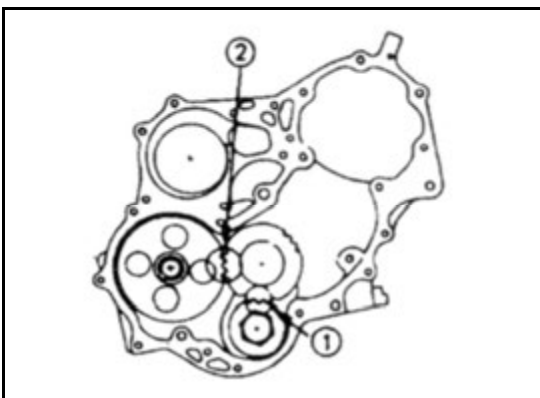
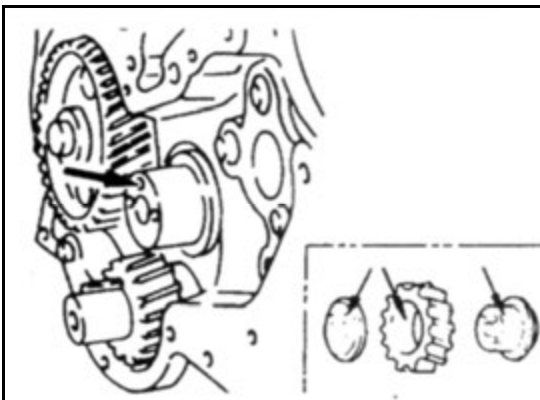
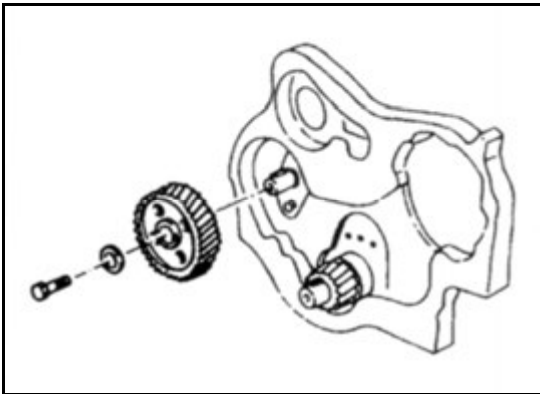
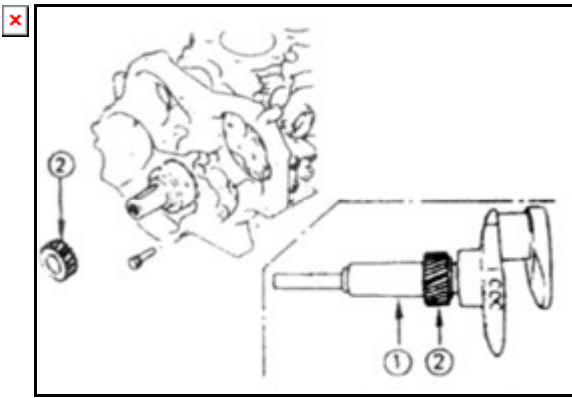
Install the front oil seal of crankshaft on the gear chamber cover assembly with a front oil seal erector as shown in the diagram.

Front oil seal erector: 1002420FA-9101

**Note:**

Take care not the twist the front oil seal.





### 3. Timing gear

#### 11) Crankshaft gear

- ① Install crankshaft gear
- ② Install crankshaft gear ② with crankshaft gear erector ①. Crankshaft gear timing mark ("K-X") must face the outside.

#### 10) Camshaft timing gear

- ① Install camshaft timing gear to the camshaft with timing gear mark ("Y-Y") toward outside.
- ② Tighten camshaft timing gear bolt(s) to the specified torque:

110±10 N·m

#### 9) Idler gear

- ① Apply some oil to the idler gear and its shaft.  
The oil hole in idler gear shaft must face upward.
- ② Idler gear setting marks "X" and "Y" should face the engine forepart during assembly.

- ③ Align idler gear setting mark "X" with setting mark "X-X" of crankshaft timing gear ①.

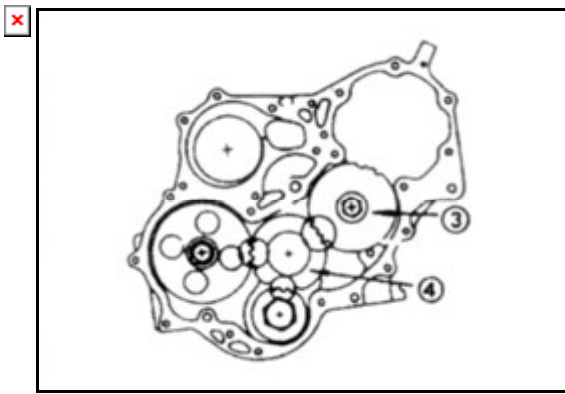
- ④ Align idler gear setting mark "Y" with setting mark "Y-Y" of camshaft timing gear ②.

- ⑤ Install thrust ring and bolt(s) on the cylinder block.

Thrust ring oil hole must be toward upward, while its chamfer shall face the outside.

- ⑥ Tighten idler gear bolt(s) to the specified torque.

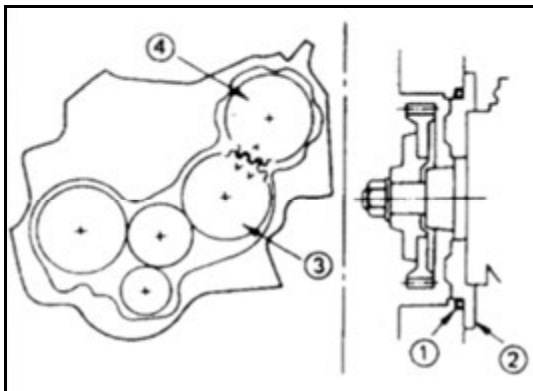
25±5 N·m



**8) Idler gear “B” and its shaft**

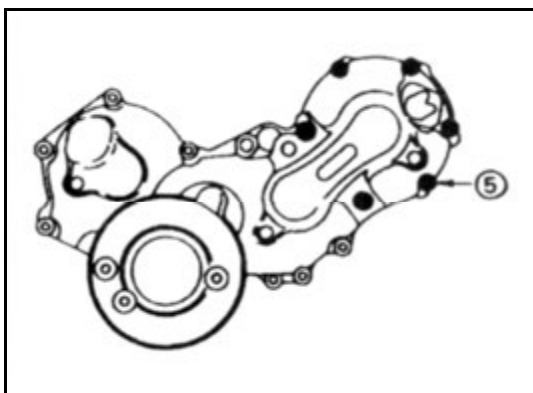
- ① Apply some oil to the idler gear and its shaft.
- ② Align idler gear setting marks “B” ③ “Z” with “A” ④ “Z-Z”.
- ③ Tighten idler gear bolt(s) to the specified torque.

110±10 N·m



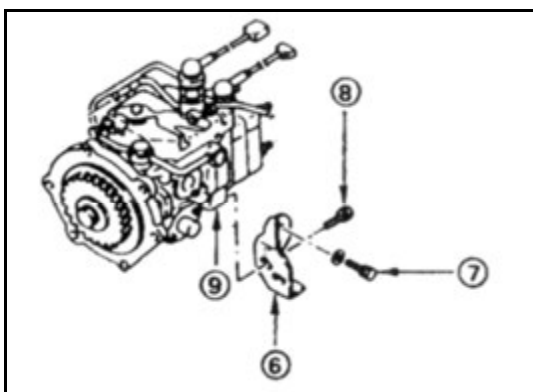
**7) Injection pump**

- ① Install O-ring ① on injection pump flange ②.
- ② Install the injection pump to the timing gear chamber. Align idler marks “B” ③ “V-V”.



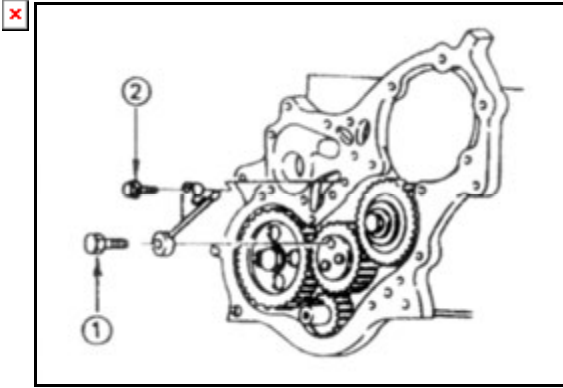
- ③ Temporarily tighten six injection pump nuts ⑤.

The final screwing down of injection pump nuts is conducted after the rear support bolt(s) of injection pump is tightened.



- ④ Install rear support ⑥ and rear support bolt ⑦ of injection pump on the cylinder block.
- ⑤ Mount rear support bolt ⑧ to the injection pump support ⑨. Finally tighten rear support bolts ⑦ and ⑧ to the specified torque.

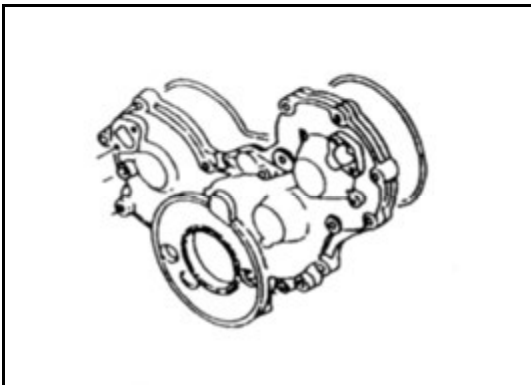
25±5 N·m



**6) Timing gear injection pipe**

- ① Install the oil pipe to the timing gear chamber and idler gear "A".
- ② Tighten oil pipe punching bolt ① and bolt ② to the specified torque.

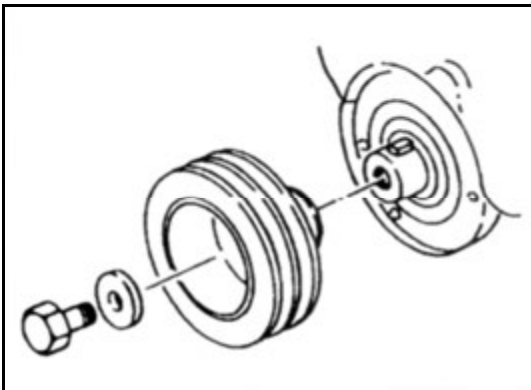
20±5 N·m



**5) Timing gear chamber cover**

- ① Align the timing gear chamber with timing gear chamber anchor pin, then install timing gear chamber cover.
- ⑥ Tighten gear chamber cover bolt to the specified torque.

25±5 N·m



**4) Crankshaft damper pulley**

Screw down the crankshaft damper pulley bolt(s) to the specified torque.

**Note:**

**While screwing down the damper pulley bolt(s), fix the flywheel gear to prevent crankshaft rotating.**

210±15 N·m

**3) Cooling fan assembly**

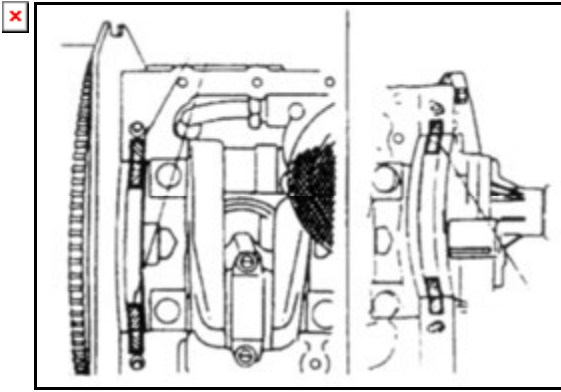
- Install the fan pulley and cooling fan assembly to the water pump in turn and tighten the bolt to the specified torque.

12.5±2.5N·m

**2) Drive belts of the alternator and power steering pump**

- Mount drive belts of the alternator and power steering pump and adjust the belt tension.
- Press the belt center with 100N force.

Drive belt deflection 8~10 mm

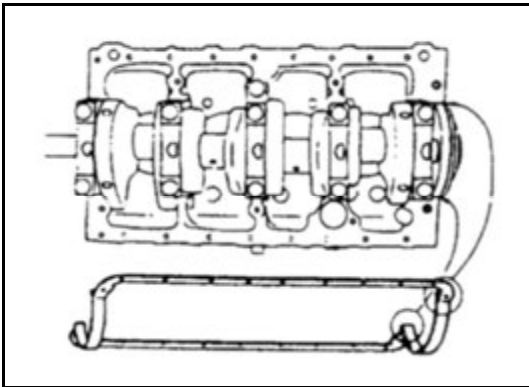


**1) Fan guard**

- Install the fan guard and coolant storage tank hose.
- Fill in coolant.

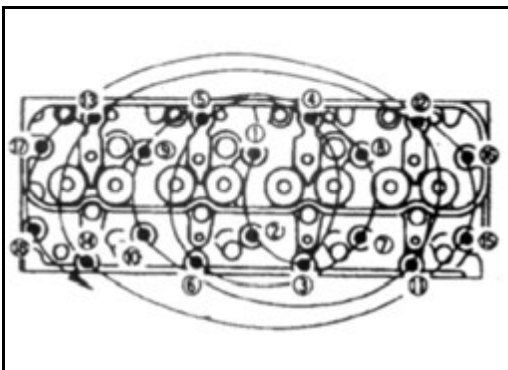
**2. Oil pan assembly**

- Apply recommended liquid sealant or equivalents to the fifth bearing cap arch section, groove and timing gear chamber arch section shown in the diagram.



- Mount the rear lip of seal washer into the groove of the fifth bearing cap.
- Make sure the lip perfectly contacts with the groove.
- Install the oil pan to the cylinder block.
- Tighten oil pan bolt(s) to the specified torque.

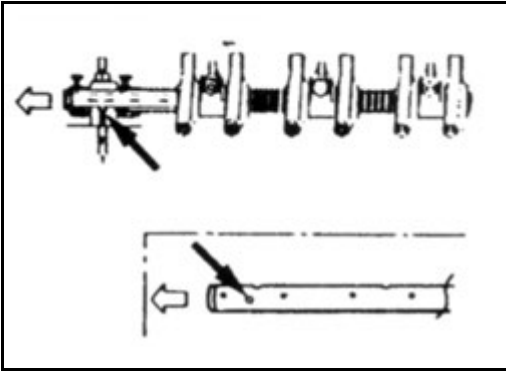
Oil pan bolt torque:  $23.5 \pm 3.5 \text{ N}\cdot\text{m}$



**1. Cylinder head**

**Cylinder head assembly**

- ① Mount the anchor pin to the cylinder block.
- ② Install cylinder head gasket with top mark toward upside.
- ③ Clean the lower cylinder head surface and upper cylinder block surface.
- ④ Mount the cylinder head carefully.
- ⑤ Apply oil to the threads and mating surfaces of cylinder head bolts.
- ⑥ Tighten the cylinder head bolts to the specified torque in three steps according to the sequence shown in the diagram.



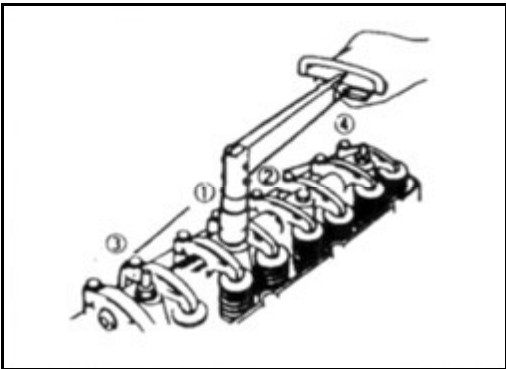
Cylinder head bolt torque		N·m
Step I	Step II	Step III
65	85	105±5

**Push rod**

- Apply oil to the push rod and insert it into the cylinder head.

**Rocker shaft assembly**

- ① Loosen all adjusting screws.
- ② Install the rocker shaft so that the bigger oil hole ( $\Phi 4$ ) faces engine forepart.



- ③ Tighten the rocker shaft support bolt(s) to the specified torque according to the sequence shown in the diagram.

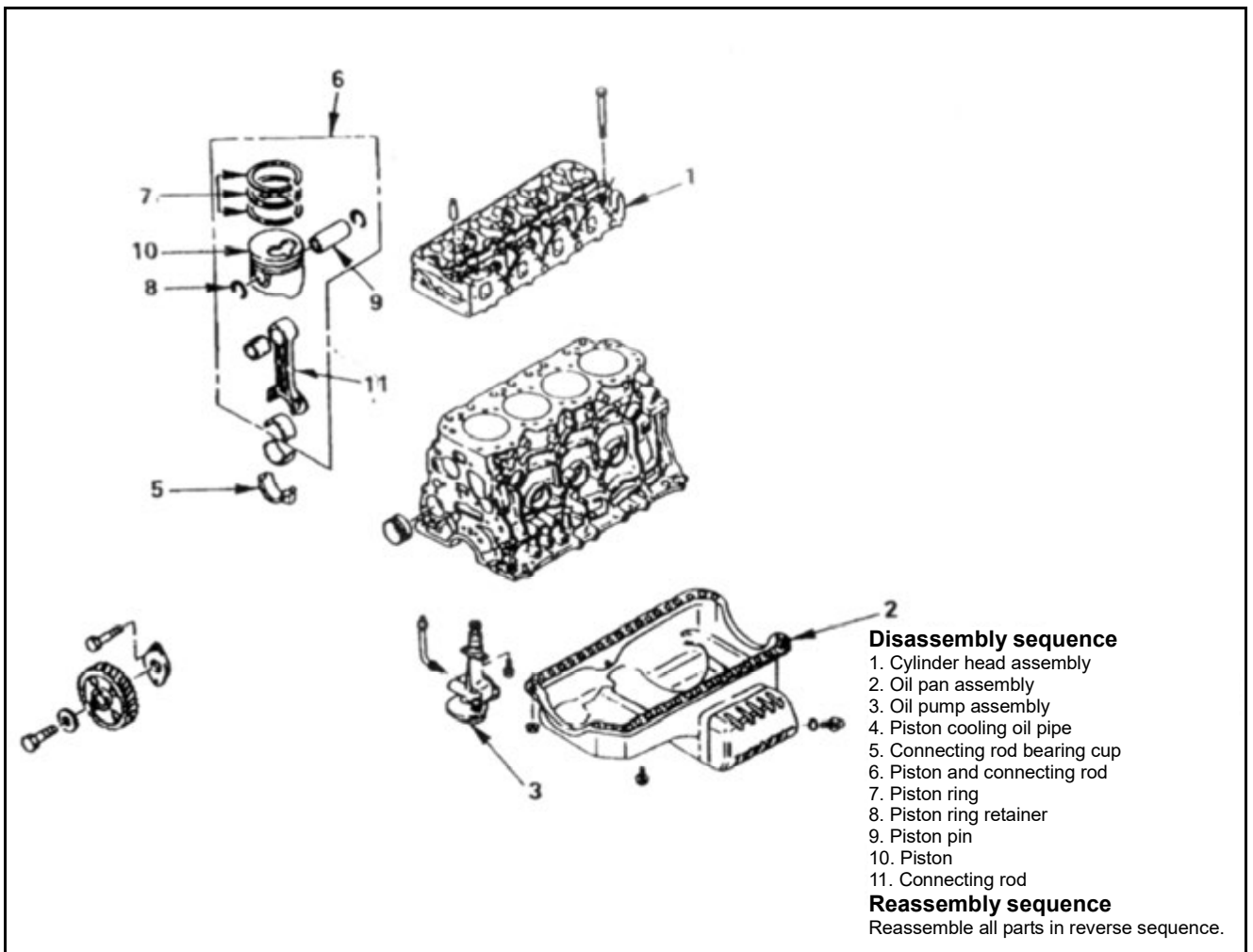
Rocker shaft support bolt torque  
55±5 N·m

- Adjust the valve clearance.

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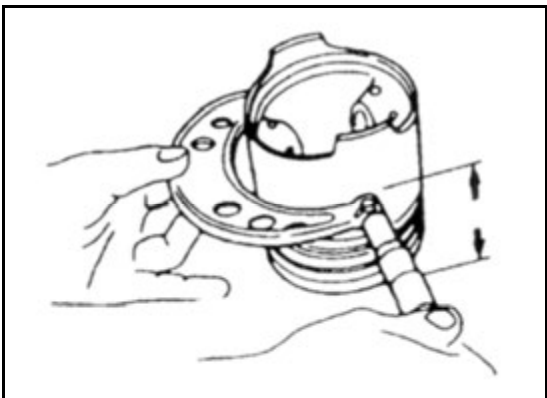
## 2.7. Piston and connecting rod



### Disassembly

1. **Cylinder head assembly**
2. **Oil pan assembly**
3. **Oil pump assembly**
4. **Piston cooling oil pipe**
5. **Connecting rod cap**
6. **Piston and connecting rod**

- Scrape carbon deposits on upper cylinder wall with a scraper before disassembling the piston and connecting rod.



**7. Piston ring**

- Remove the piston ring with a piston ring expander.
- Place the removed piston ring as the sequence number in the drawing.

**8. Piston ring retainer**

- Dismantle piston pin retainer with pliers.

**9. Piston pin**

**Note:**

**Place parts removed from each cylinder. All the parts have to be reassembled to the original positions.**

**10. Piston**

**11. Connecting rod**

**Inspection and repair**

Piston and piston ring

**Piston**

Carefully clean up carbon deposits on the piston top and piston ring groove.

**Notes:**

**Never use metal brush for cleaning the piston. Otherwise it will damage the piston. Visually inspect if there are any cracks, scratches or other signs of excessive abrasion on each piston.**

**If so, replace the piston.**

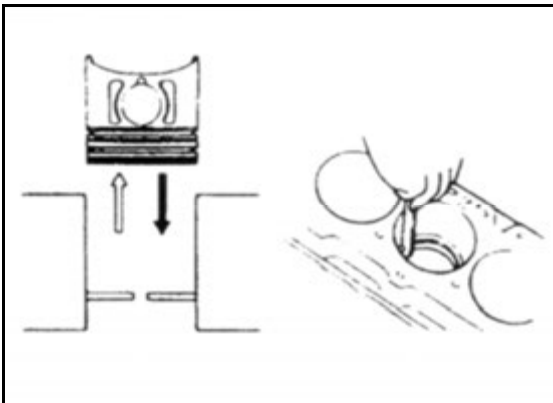
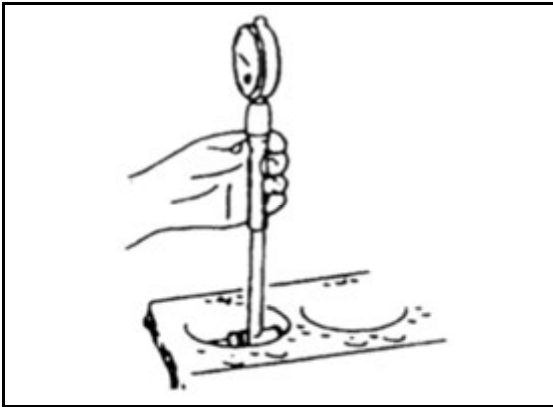
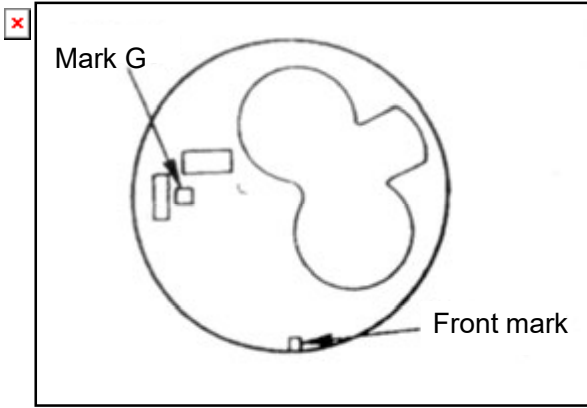
**Piston outer diameter**

1. Measure the outer diameter of the piston at the position of each piston group.

Position of each piston group:

Distance to the piston top is 73.9 mm





Outer diameter groups of 4DA1 series pistons

Diameter mark	Outer diameter
A	92.957~92.970
B	92.970~92.983
C	92.983~92.996

4 DA1 series cylinder liner bore diameters

Diameter mark	Outer diameter
A	93.021~93.034
B	93.034~93.047
C	93.047~93.060

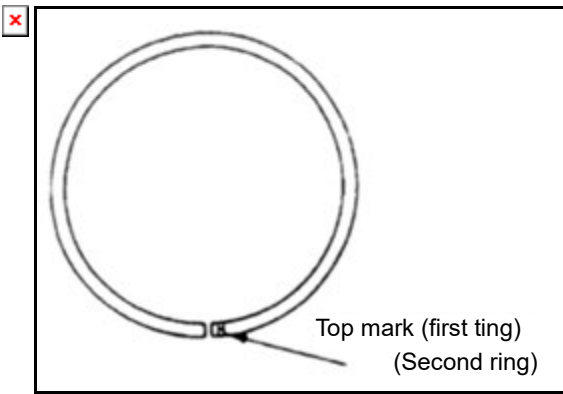
Measure the cylinder bore diameter (refer to "Inspection of the cylinder block" in this section). If the piston clearance does not comply with the specified values, replace the piston and/or cylinder liner.

Piston clearance	mm
4DA1 Series	0.051~0.077

**Piston ring**

If during engine overhaul it is found that any part is worn-out or damaged, you should replace it.

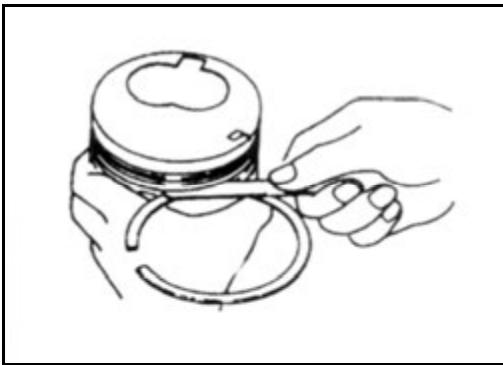
1. Piston ring opening measurement
  - Install the piston ring into the cylinder liner.



- Push the piston ring with the piston into the most narrow part of the cylinder liner bore in such a way that it is vertical to the cylinder wall.

4DA1 series piston ring opening gap mm

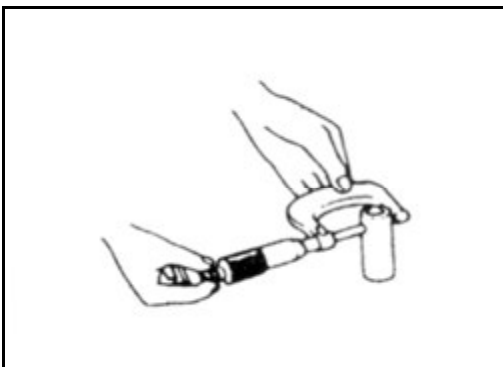
Piston ring	4DA1	4DA1-1	Limits
First gas ring	0.2~0.4	0.2~0.4	1.5
Second gas ring	0.2~0.4	0.6~0.85	1.5
Oil ring	0.1~0.3	0.35~0.65	1.5



2. Measure the clearance between the piston ring groove and piston ring with a clearance gauge. If the clearance exceeds the specified limits, you should replace the piston

4DA1 series piston ring end gap mm

Piston ring	4DA1	4DA1-1	Limits
First gas ring	0.09~0.125	0.078~0.139	0.15
Second gas ring	0.05~0.075	0.045~0.09	0.15
Oil ring	0.03~0.07	0.03~0.07	0.15



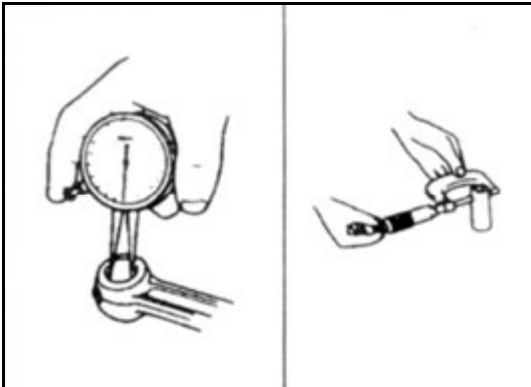
**Piston pin**

Visually inspect if there are any cracks, scratches or other signs of abrasion on the piston pin and replace the piston pin if necessary.

1. Measure the piston pin outer diameter with a micrometer at three positions in two directions. If the measurement values exceed the specified limits, the piston pin has to be replaced.

Piston pin outer diameter mm

	Nominal	Limits
4DA1	30.994~31.000	30.970
4DA1-1	33.994~34.000	33.970



2. Measure the inner diameter of the connecting rod small end. If the clearance between the connecting rod small end and pin does not comply with the specified values, you have to change the connecting rod or bushing and pin.

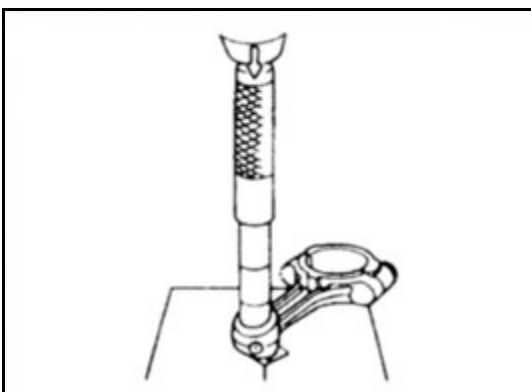
mm

Nominal	Limits
0.008~0.026	0.05

3. Insert the piston pin into the piston and rotate it. If the pin rotates freely and is compact with the piston, it means the clearance is permissible. If there is any clearance or the surface between them is rough, measure the clearance. If the clearance exceeds the specified values, you have to replace the piston and piston pin.

mm

	Nominal	Limits
4DA1 系列	0.002~0.016	0.04



**Replacing the bushing**

Disassembly: use suitable compression bar and table press or hammer.

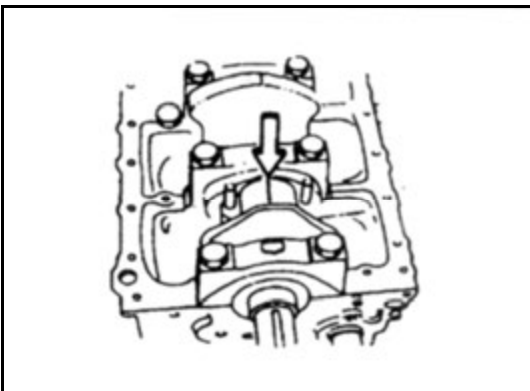
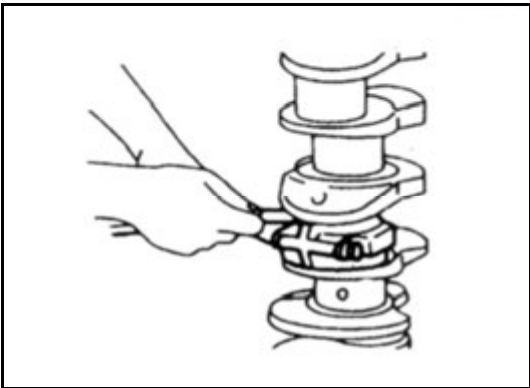
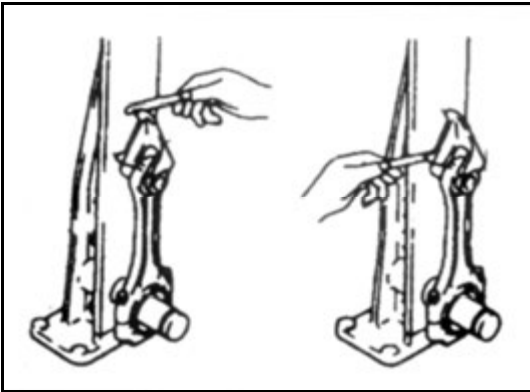
Assembly: use suitable compression bar and table press

**Notes:**

**The bushing should be aligned with the oil hole on the connecting rod.**

**Grind the bushing bore with a pin hole grinder before mounting new bushing.**

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**Connecting rod**

1. Check the centerline deviations of two connecting rod holes with a connecting rod aligner.  
If the amount of inclination or twist exceeds the specified limits, you have to replace the connecting rod.

	mm	
	Nominal	Limits
Amount of inclination (Per 100m)	0.08 or less	0.20
Twist (Per 100m)	0.05 or less	0.15

2. Measure the axial clearance of the connecting rod  
Measure the connecting rod thrust clearance at its big end with a clearance gauge.  
If the clearance exceeds the specified limits, you have to replace the connecting rod.

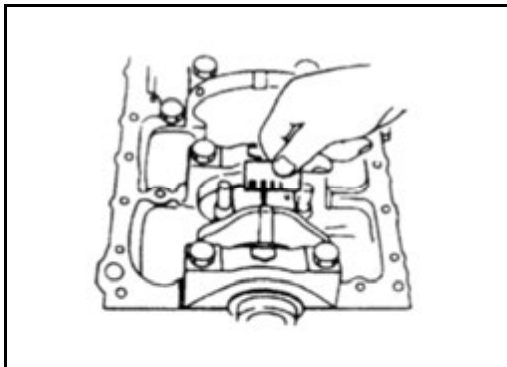
Axial clearance		mm
Nominal	Limit	
0.175~0.290	0.350	

3. Measure the oil film clearance between the connecting rod and crankshaft:
  - 1) Remove the connecting rod cap nut and the cap.  
Place the removed connecting rod according to the cylinder sequence number
  - 2) Clean the connecting rod bearings and crankpin.
  - 3) Inspect the connecting rod bearings carefully.  
Even if there is only one damaged or severely worn-out bearing, all the bearings have to be replaced. Reassemble the bearings to their original positions. Place a plastigage on the crankpin.
  - 4) Reinstall the connecting rod cap to its original position.
  - 5) Screw down the connecting rod cap nut to the specified torque in two steps via torque tightening method according to the following instructions.

	N·m	
	First step (pretightening)	Second step (tightening)
4DA1 Series	20	85

**Note:**  
**Never rotate the crankshaft.**

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- 6) Remove the connecting rod cap
- 7) Measure the plastigage width and determine the oil film clearance. If the oil film clearance exceeds the prescribed limit, the connecting rod bearings shall be replaced in pair.
- 8) Remove the plastigage from the bearings and crankpin.

Clearance between the crankshaft main journal and bearing mm

	Nominal	Limit
4DA1 Series	0.029—0.066	0.100

### Reassembly

#### 11. Connecting rod

#### 10. Piston

#### 9. Piston pin

Apply oil to the piston pin and piston pin hole.

#### 8. Piston ring retainer

Apply a thin layer of oil to the piston pin. Manually press the piston pin into piston pin hole.

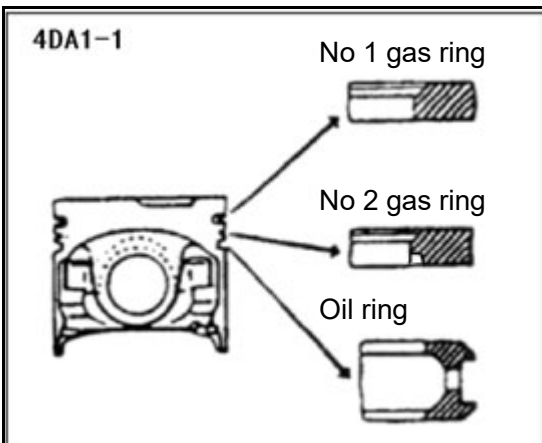
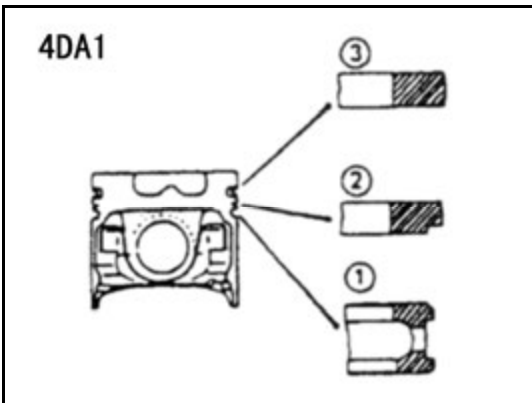
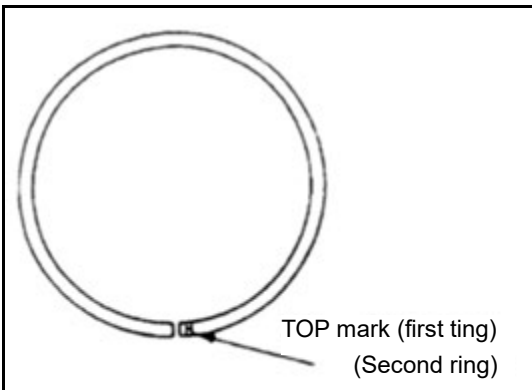
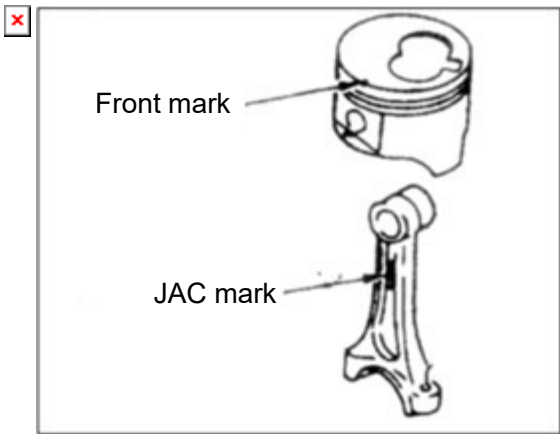
Weigh each piston and connecting rod assembly.

Select the piston and connecting rod assembly in such a way that the assembly weight difference varies within the specified limits.

Weight variation after combined as an assembly	4DA1	Less than 10g
	4DA1-1	Less than 8g

**Note:**

**When replacing the piston/connecting rod assembly, do not change the piston/piston pin assembly.**



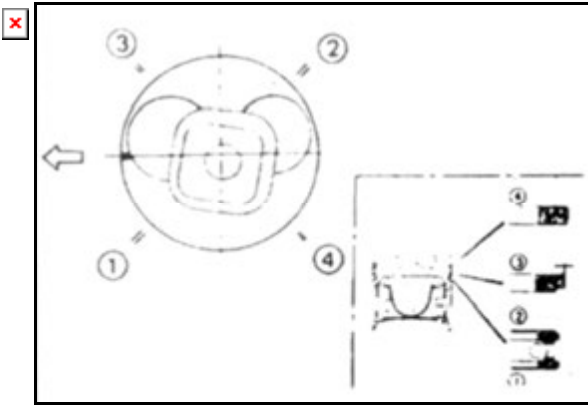
- Mount the piston onto the connecting rod in such a way that the piston front mark and connecting rod mark should face the same direction.

### 7. Piston ring

- Install the piston ring with a piston ring expander.  
The TOP mark should face upward during gas ring erection.
- The position of the identification sign is shown in the drawing.

- Mount the piston ring in following sequence.
  - ① Oil ring
  - Oil ring with a spiral cup ring
  - ② Second gas ring
  - ③ First gas ring
- The TOP mark should face upward during gas ring erection.

- First gas ring: TOP.
- Second gas ring: TOP.
- Apply some oil to all piston rings after installing the rings.  
Check whether all piston rings can rotates freely.
- Install the bearings onto the connecting rod and its cap.  
Apply fresh oil to the bearing surfaces.



**6. Piston and connecting rod**

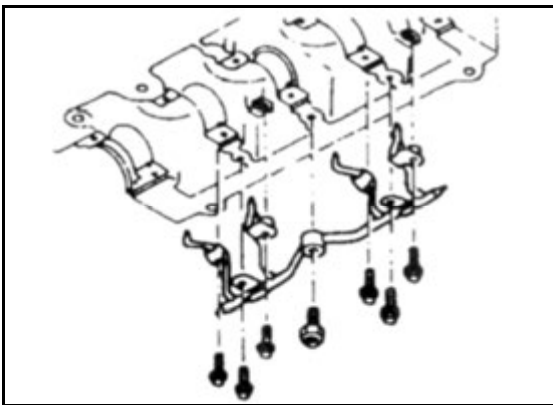
- Apply oil to the cylinder hole, connecting rod bearings and crankpin.
- Check whether the piston ring opening position is correct.
- Install the piston/connecting rod assembly into each cylinder with a piston ring compressor.
- The front mark must be towards the engine forepart.

**5. Connecting rod bearing cap**

- Screw down the connecting rod cap nut in two steps via torque tightening method according to the following instructions.

	N·m	
	First step (pretightening)	Second step (tightening)
4DA1 Series	20	85

Check if the crankshaft rotates freely after tightening the cap nut.



**4. Piston cooling oil pipe**

- Mount the piston cooling oil pipe to the cylinder block.
- Screw down the oil pipe bolt and relief valve to the specified torque.

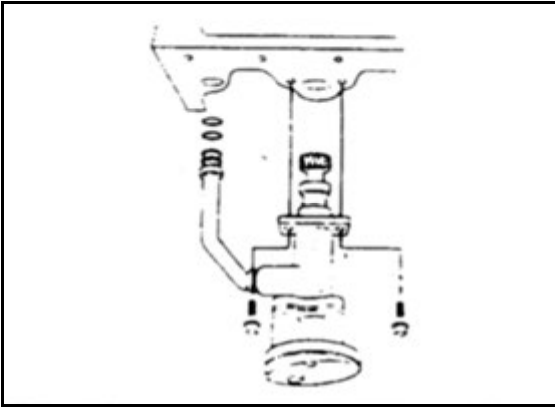
Oil pipe bolt torque		N·m
(1)M8×1.25	25	

N·m	
(2)M6×1.00	7.5

Oil-pressure adjusting valve torque		N·m
(3)M16×1.5	30	

**Note:**

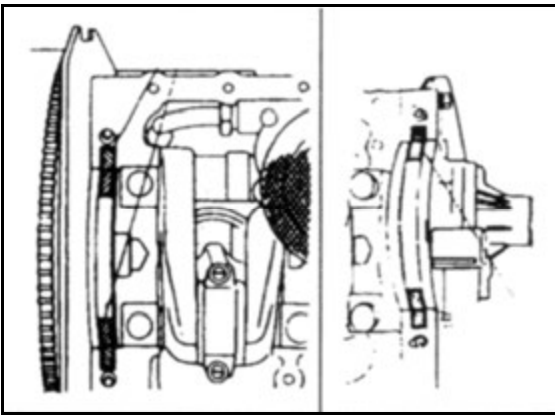
Turn the crankshaft slowly; make sure the piston and the oil injection pipe don't interfere with each other.



### 3. Oil pump assembly

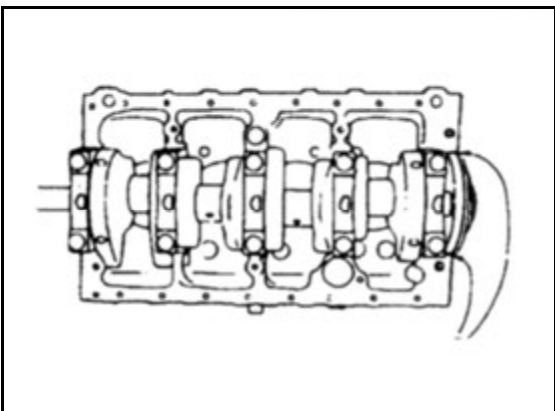
- Apply some oil on the oil pipe O-ring and mount it to the cylinder block O-ring groove.
- Install the oil pump assembly and oil pump to the cylinder block and tighten the fixing bolt(s) to the specified torque:  $25 \pm 5$  N·m

Tighten sleeve nut(s) to the following specified torque:  $30 \pm 5$  N·m



### 2. Oil pan assembly

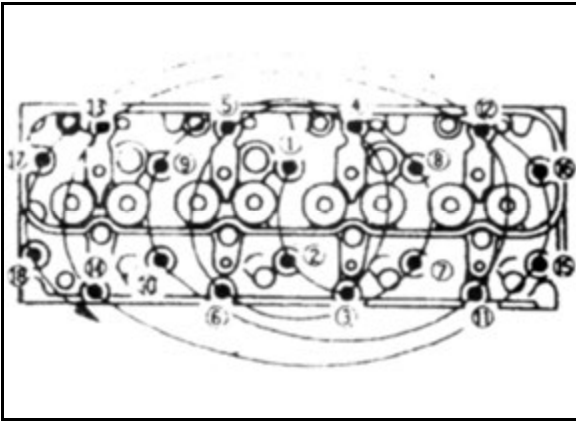
- Apply recommended liquid sealant or equivalents to the fifth bearing cap arch section, groove and timing gear chamber arch section shown in the diagram.
- Mount the rear lip of seal washer into the groove of the fifth bearing cap.



- Make sure that the lip is perfectly in contact with the groove.
- Install the oil pan to the cylinder block.
- Tighten oil pan bolt(s) to the specified torque

Oil pan bolt torque:  $23.5 \pm 3.5$  N·m



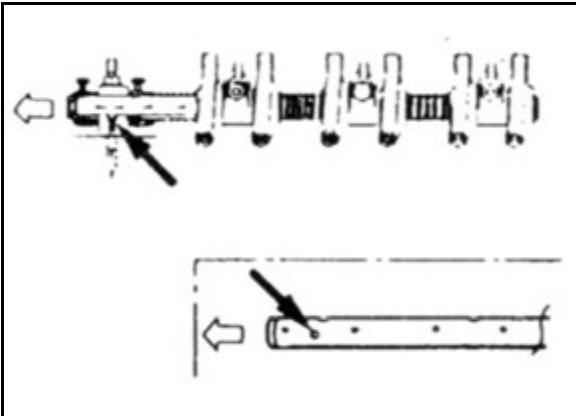


**1. Cylinder head assembly**

- ① Mount the anchor pin to the cylinder block.
- ② Install cylinder head gasket with its top mark toward upside.
- ③ Clean the lower cylinder head surface and upper cylinder block surface.
- ④ Mount the cylinder head carefully.
- ⑤ Apply oil to the threads and mating surfaces of cylinder head bolts.
- ⑥ Tighten the cylinder head bolts to the specified torque in three steps according to the sequence shown in the diagram.

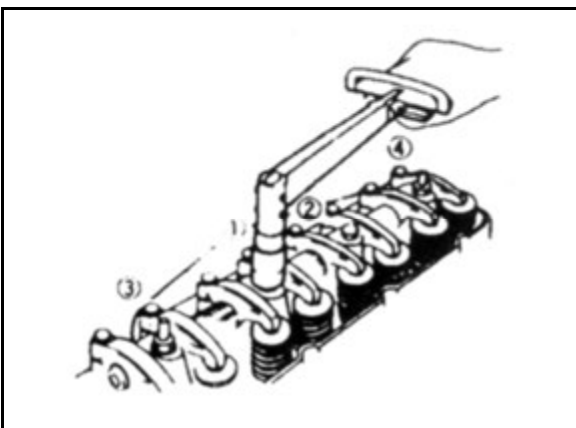
Cylinder head bolt torque N·m

Step I	Step II	Step III
65	85	105±5



**Push rod**

- Apply oil to the push rod and insert it into the cylinder head.



**Rocker shaft assembly**

- ① Loosen all adjusting screws.
- ② Install the rocker shaft so that the bigger oil hole (Φ4) faces engine forepart.
- ③ Tighten the rocker shaft support bolt(s) to the specified torque according to the sequence shown in the diagram.

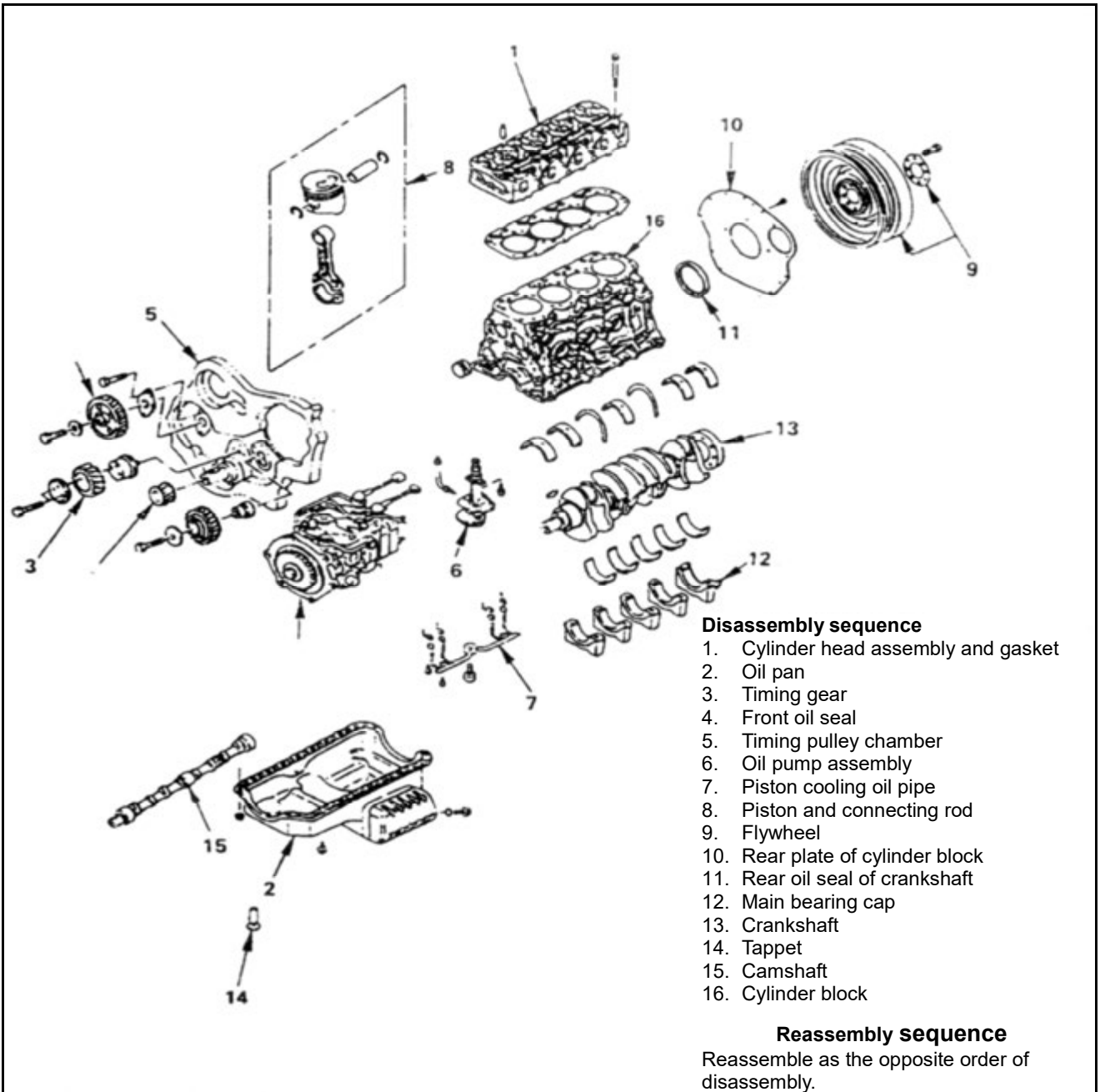
Rocker shaft support bolt torque 55±5 N·m

- Adjust the valve clearance

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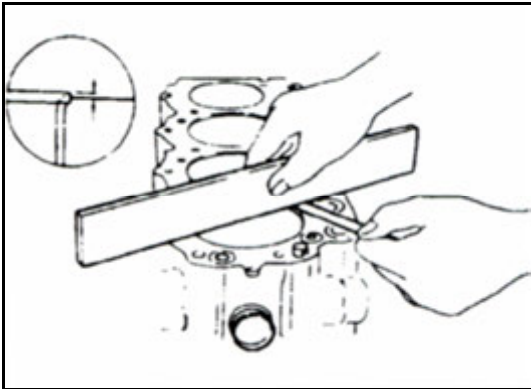
## 2.8 Cylinder block



### Disassembly

#### 1. Cylinder head assembly and gasket

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2. Oil pan assembly
3. Timing gear
4. Front oil seal
5. Timing pulley chamber
6. Oil pump assembly
7. Piston cooling oil pipe
8. Piston and connecting rod
9. Flywheel
10. Flywheel baffle
11. Rear oil seal of crankshaft
12. Main bearing cap
13. Crankshaft
14. Tappet
15. Camshaft
16. Cylinder block

### Inspection and repair

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

1. Remove the gasket(s) and any other attached matters on the surface of cylinder block.

Be careful to prevent matters falling into the cylinder block by accident.

Take care not to scratch the cylinder block.

2. Carefully remove the oil pump, rear oil seal retainer and the seal on the oil pan assembly surface.

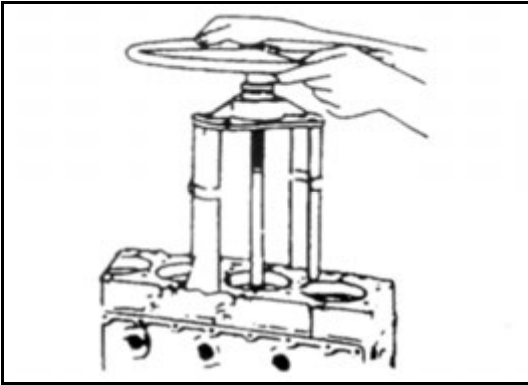
3. Wipe the cylinder block clean.

Inspection of cylinder liner protrusion size

1. Put ruler ① at the top edge of cylinder liner to be measured.
2. Measure the protrusion size of each cylinder liner with clearance gauge ②.

The difference between any two adjacent cylinders in cylinder liner protrusion height shall not exceed 0.05mm.

Standard value	mm
0~0.08	

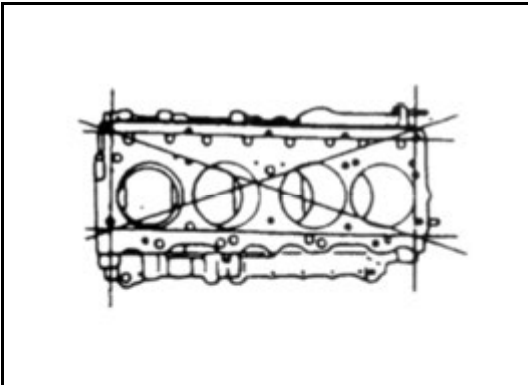


**Flatness**

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 ① and clearance gauge ②.

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

**Measurement of cylinder liner bore diameter**

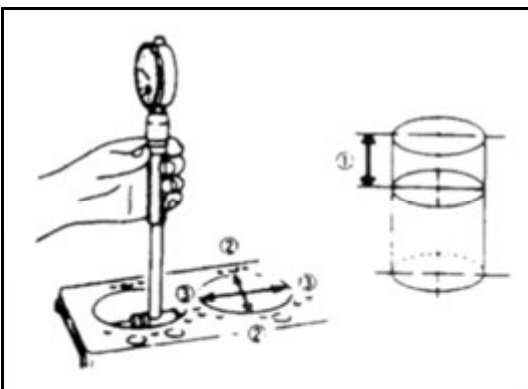
Measure the bore diameter of cylinder liner along thrust direction ②-② and the axial direction ③ of crankshaft with inside dial indicator in the depth of 20mm,90mm,160mm, and take the average value of 6 sizes as group size.

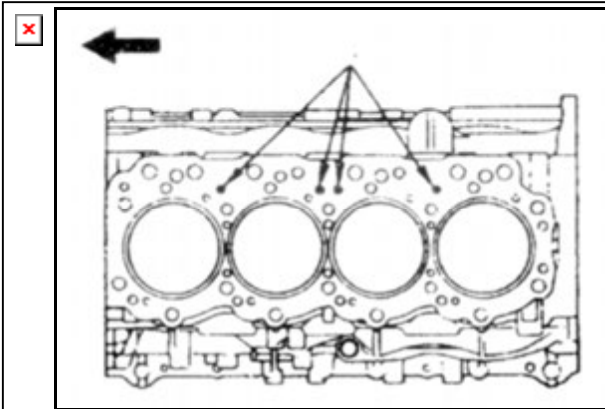
If measurement value exceeds prescribed limit, the cylinder liner has to be replaced.

**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.





**Group selection of cylinder liner**

Measure the inner diameter of cylinder block and choose appropriate cylinder liner group.

Standard over-fitting	mm
0.001~0.019	

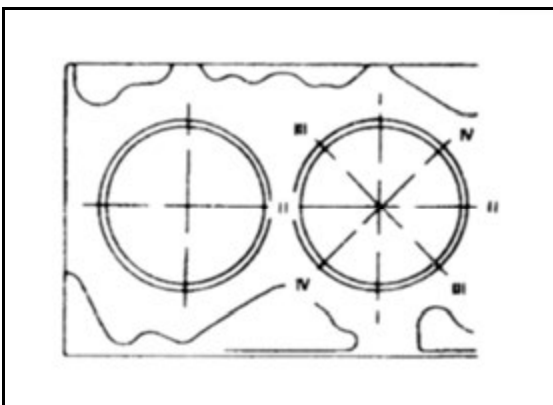
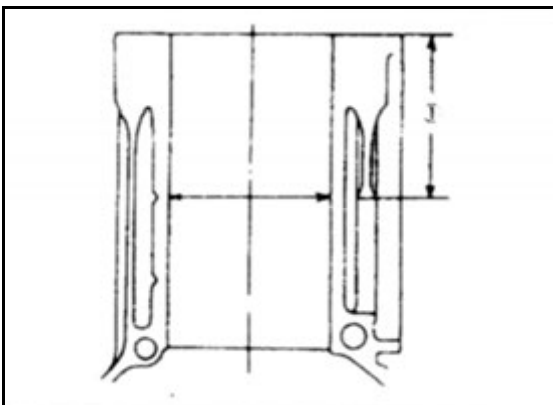
Too little over-fitting of cylinder liner will have adverse effect on cooling efficiency of engine. If the over-fitting of cylinder liner is too large, it will be difficult for the cylinder liner to encase gas.

**Note:**

**There are two ways to select cylinder liner.**

**Method I**

The surface of the cylinder block has been marked during manufacturing to indicate the correct size of cylinder liner. Cylinder liner groups (1, 2, 3, 4, etc.) are written with permanent ink. When there is doubt with cylinder liner marks, select the cylinder liner properly with the method below.

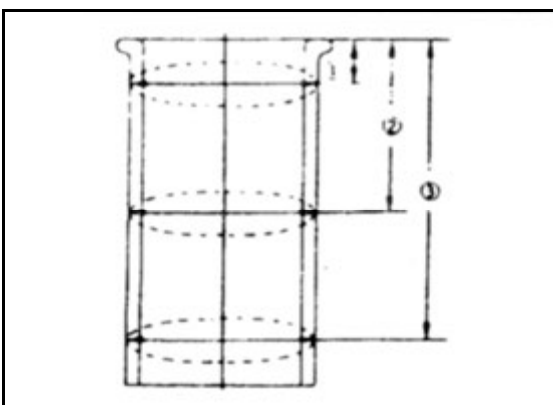


**Method II**

**Measurement of cylinder block bore diameter**

- 1) Measure the diameter at measuring point (A) ①-①、②-②、③-③。

The measuring point is the position 20mm, 90mm, 160mm away from the cylinder block surface.

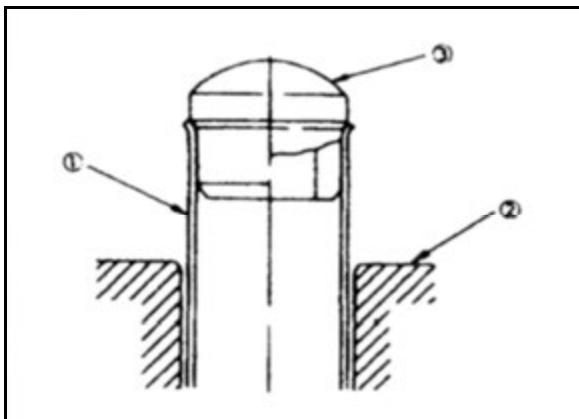




- 2) Calculate the average value of 6 measured sizes to determine appropriate cylinder liner group.
- 3) Refer to the table below according to the average value, and apply proper cylinder liner.

4DA1 Series mm

Cylinder liner groups	Average value of cylinder bore diameter	Outer diameter of cylinder liner
0	94.991~95.000	95.001~95.010
1	95.001~95.010	95.011~95.020
2	95.011~95.020	95.021~95.030
3	95.021~95.030	95.031~95.040
4	95.031~95.040	95.041~95.050

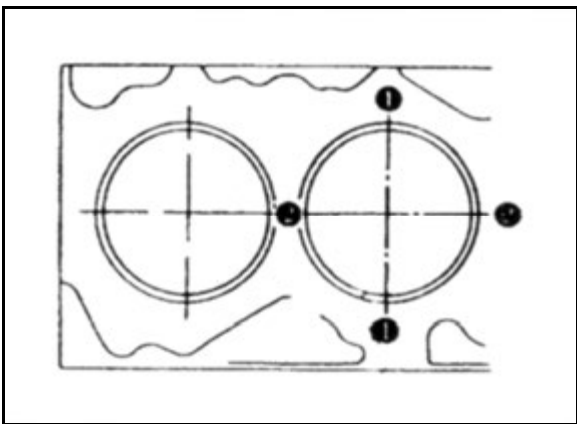
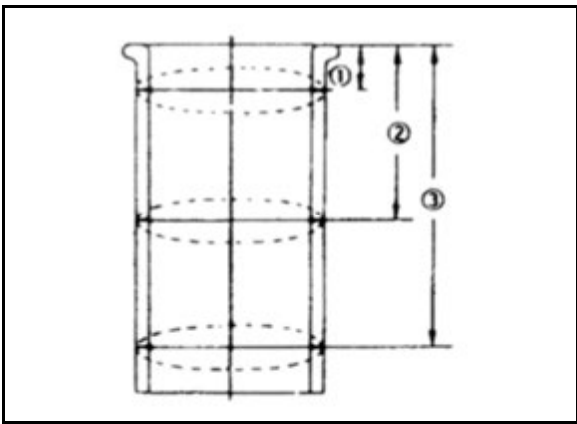
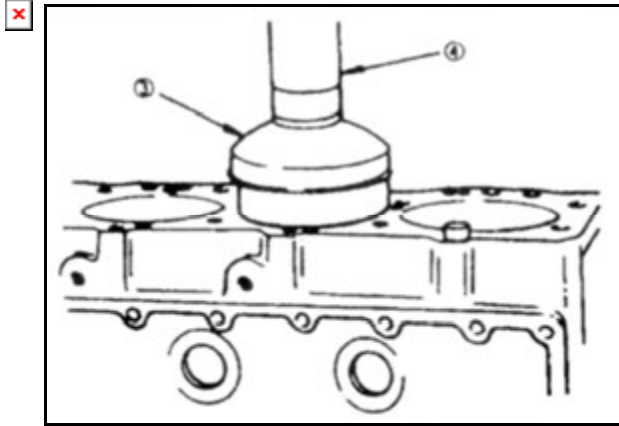


### Cylinder liner installation

1. Install the cylinder liner with special tools.
  - 1) Thoroughly clean the cylinder liner and hole surface with new kerosene or diesel oil.
  - 2) Dry the surface of cylinder liner hole with compressed air. Cylinder liner erector 1002106FA-9101

**Note:**

**Be sure to carefully remove all the foreign matters from the cylinder liner and cylinder hole before installation.**



3) Insert cylinder liner ① into cylinder block ② from the top of cylinder block.

4) Install cylinder liner erector ③ at the top of cylinder liner.

The position of cylinder block shall ensure that the erector center is directly under desk-top pressing machine shaft ④.

Erector 1002106FA-9101

**Note:**

Check the cylinder liner is in vertical with desk-top pressing machine and without swinging.

5) Apply detent force 500kg (4900N) to the cylinder liner with desk-top pressing machine.

6) Apply 2500ka (1102.5lb/24500N) force to put the cylinder liner in place completely.

7) After the cylinder liner is installed, measure the protrusion size.

See “Inspection of cylinder liner protrusion size” in this chapter.

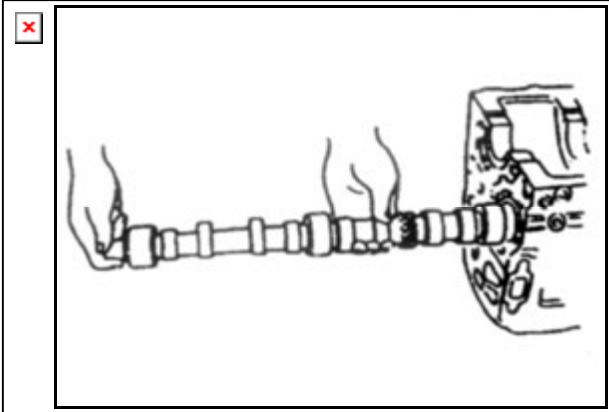
Measure the inner diameter of cylinder liner hole and choose appropriate piston group.

**Reassembly**

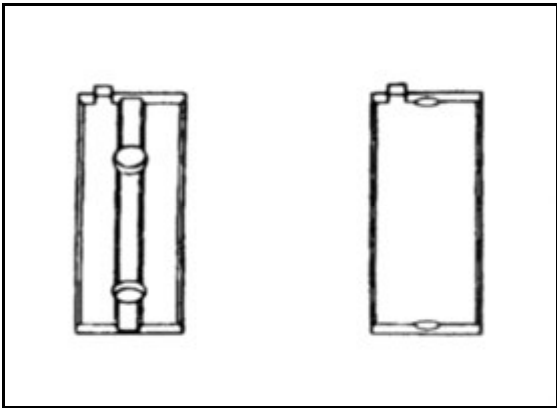
**16. Cylinder block**

**15. Camshaft**

- Coat oil on tappet and in the installation hole of upper cylinder block tappet.
- Fix position according to the position mark made during removal (if the tappet is reused).

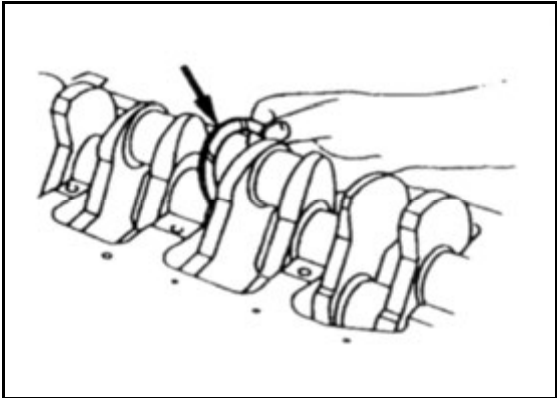


- Coat oil on the camshaft and camshaft bearing.
- Install the camshaft on the cylinder block. Be careful not to damage the camshaft bearing.

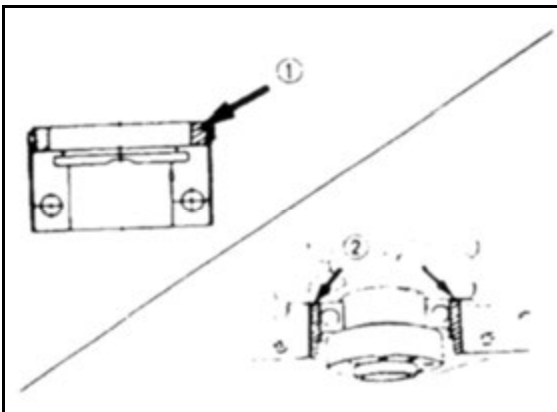


**14. Tappet**  
**13. Crankshaft**

- Install the main bearing on the cylinder block and main bearing cap.
- Ensure that their position is correct.
- Apply fresh oil to the upper and lower main bearing surfaces.
- Carefully install the crankshaft.



- Apply oil to the thrust plate.
- Install the thrust plate at the third main journal bearing. Its oil groove must face the crankshaft.

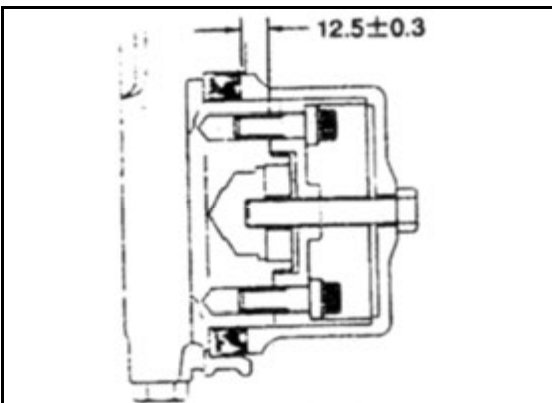
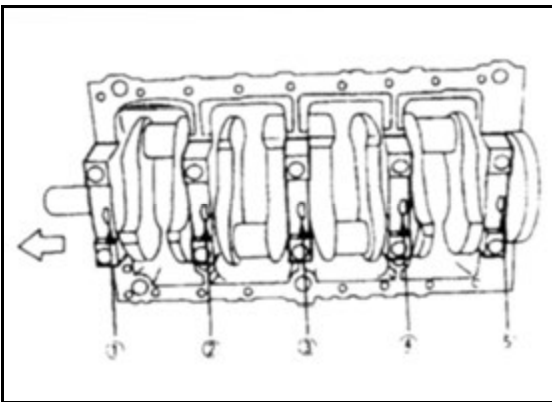
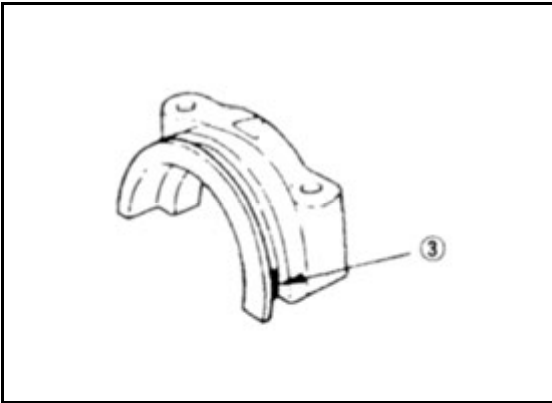


**12. Main bearing cap**

- 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.

**Note:**  
**Ensure that there is no oil stain on the mating surface of bearing cap before coating liquid sealant. Make sure the liquid sealant does not block cylinder thread hole and bearing.**





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

- 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 as the sequence shown in the drawing until specified torque is reached:

170 ± 10 Nm

**Note:**

**Manually rotate the crankshaft to check it is flexible.**

**11. Rear oil seal of crankshaft**

- Install the oil seal on the cylinder block with an oil seal erector.

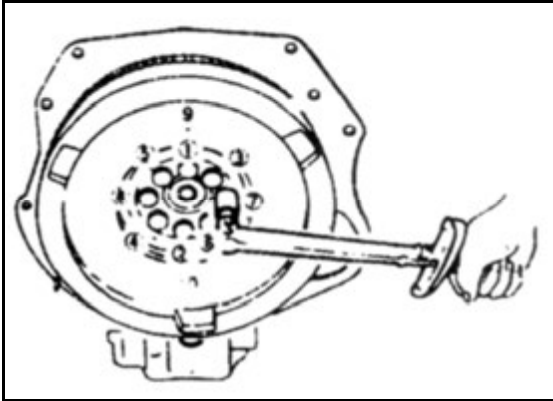
Rear oil seal erector: 1002430FA-9101

Notes:

Clean the rust and chips off the press-in portion of the oil seal.

Pay attention to the press-in direction of the oil seal.

- 1) Use two bolts to connect the adaptors of special tools to the rear end of the crankshaft.
- 2) Install the oil seal to the periphery of the adaptors.



- 3) Insert the socket into the adaptor and screw down the bolt until the adaptor tip is in contact with the socket.
- 4) Remove the adaptor and socket.
- 5) Check the oil seal size after it is installed.

Standard value	mm
$12.5 \pm 0.3$	

**10. Flywheel baffle**

- Tighten the flywheel baffle fixing the bolt(s) to the specified torque:

$85 \pm 10N \cdot m$

**9. Flywheel**

- Apply oil to the fixing bolts.
- Screw down the flywheel bolts to the specified torque in two steps via torque tightening method.  
Tighten them as the sequence number shown in the drawing.

**8. Piston and connecting rod**

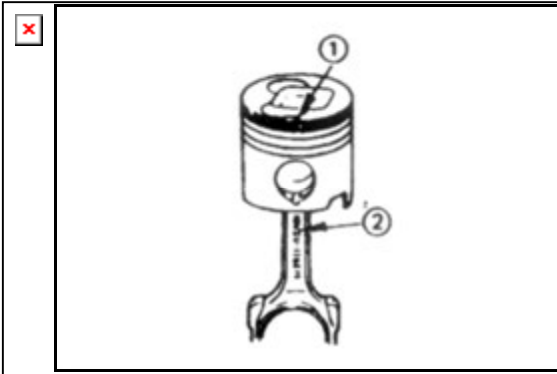
- 1) Press the piston pin into piston pin hole with fingers.  
Weigh each piston and connecting rod assembly. Select the piston and connecting rod assembly in such a way that the assembly weight difference varies within the specified limits.

Weight variation after combined as an assembly	4DA1	4DA1-1
	Less than 10g	Less than 8g

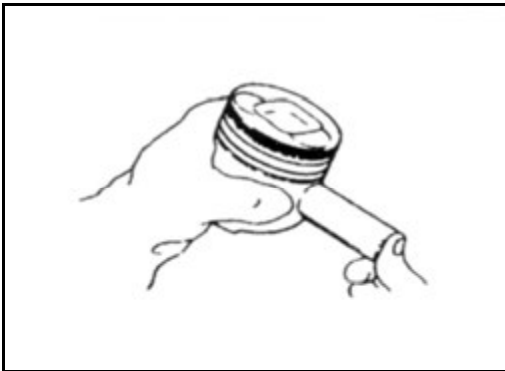
- 2) Clamp the connecting rod by a vice. Be careful not to damage the connecting rod.
- 3) Encase the piston pin retainer into piston with pliers.

**Note:**

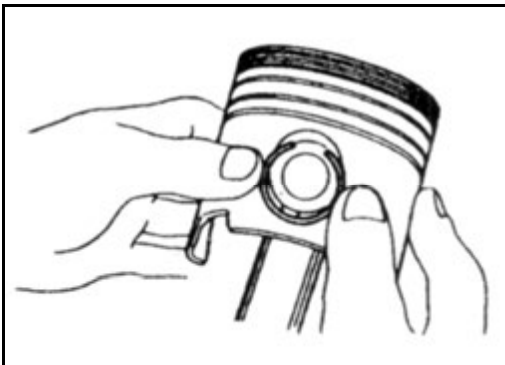
**When changing the piston/connecting rod assembly, do not change the piston/piston pin assembly.**



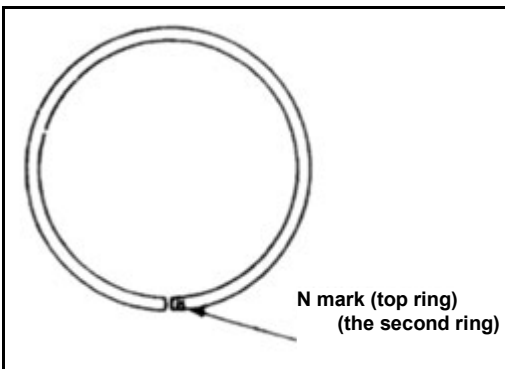
4) Install the piston onto the connecting rod. Mark ① on the piston head and casting symbol “F908” ② on the connecting rod should be toward the same direction.



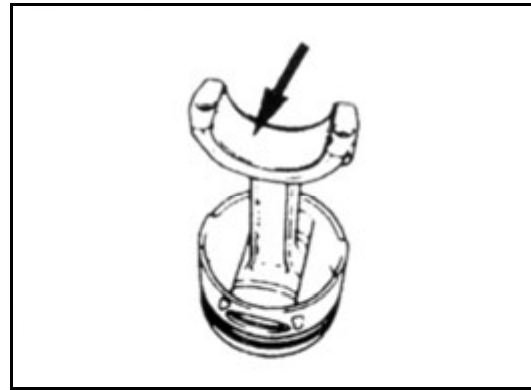
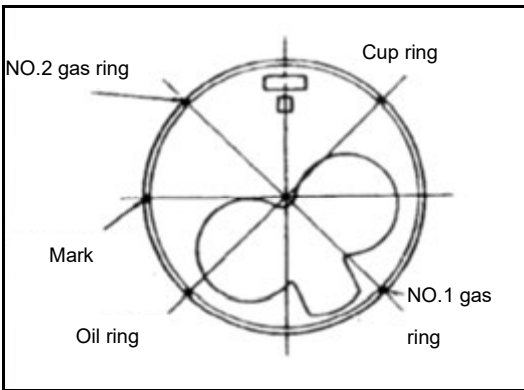
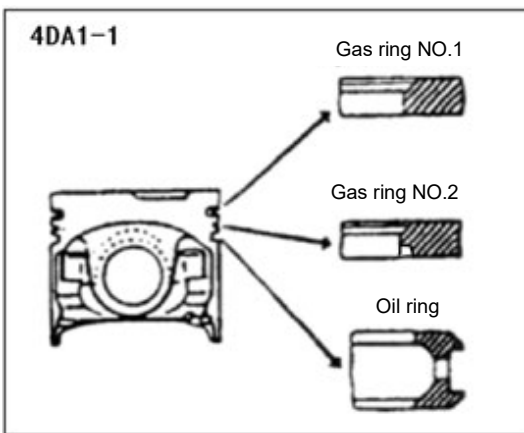
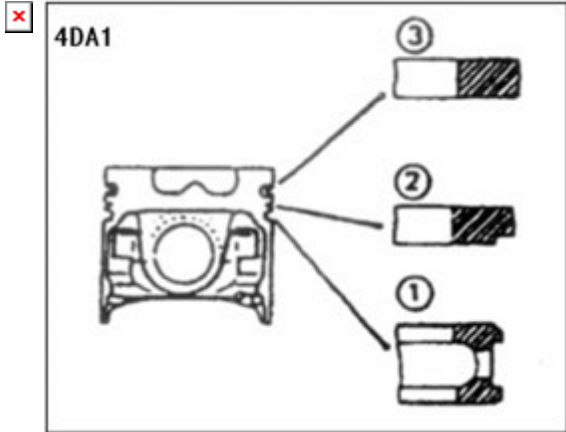
5) Apply oil to the piston pin and piston pin hole. Forcibly push the piston pin into piston with fingers until it is in contact with piston pin retainer.



6) Forcibly press the piston pin retainer into piston retainer groove with fingers. Check whether the connecting rod swings freely on the piston pin.



7) Install the piston ring with piston ring expansion lip. The TOP mark on gas ring should be toward upwards. Identification sign is shown in the drawing.



8) Mount three piston rings with a piston ring replacer.

Piston ring replacer:

Install the piston ring as the sequence number shown in the drawing.

- ① Oil ring
- ② The second gas ring
- ③ The first gas ring

**Notes:**

**Make sure that the surface with marks is toward the upward when gas ring is installed.**

Encase the spiral cup ring into the oil ring, and make sure that there is no clearance at any side of the spiral cup ring before the oil ring is installed.

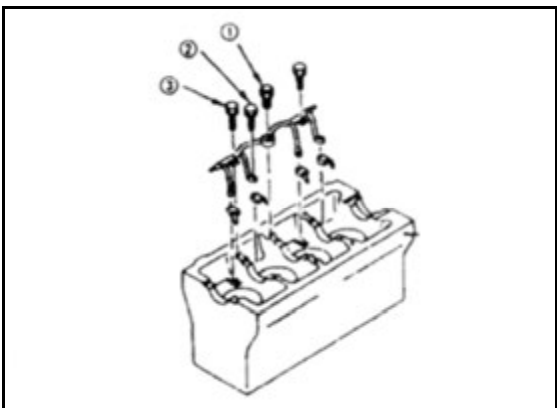
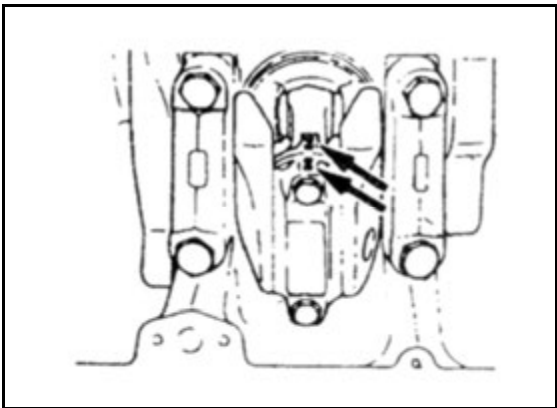
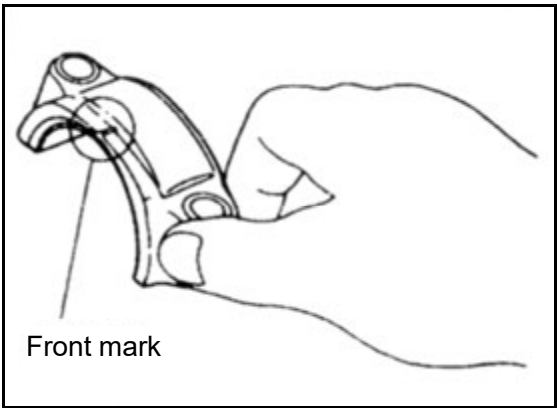
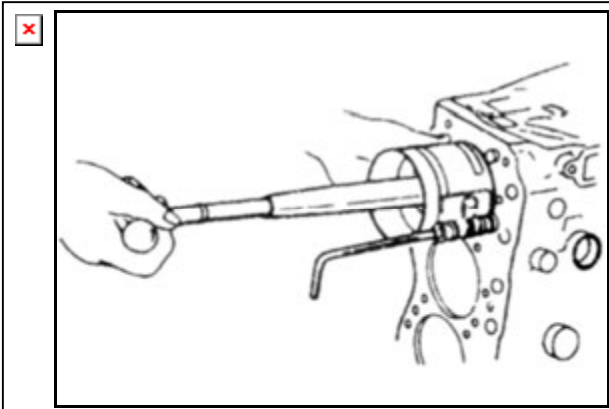
9) Apply some oil to the piston ring surface.

10) Check whether the piston ring turns freely in the piston ring groove.

11) Place the piston ring opening as shown in the drawing.

12) Carefully remove the oil stains or other foreign matters from the back of connecting rod bearing or the installation surface of connecting rod bearing.

13) Apply some oil to the upper bearing surface. Apply some oil to the cylinder wall.



14) Place the piston in such a way that the front mark on the bearing cap must be toward the engine forepart.

Encase the piston into engine block with piston installation taper sleeve.

Piston installation taper sleeve:

1004001FA-9102

15) Push in the piston with a hammer handle until the connecting rod touches the crankpin. In addition, rotate the crankshaft until the crankpin is at bottom dead center.

16) Place the bearing cap in such a way that its front mark is toward the engine forepart.

17) Install connecting rod bearing cap. Align the cylinder sequence mark on connecting rod bearing cap with the one on connecting rod.

18) Apply oil to the thread and mating surface of each connecting rod bearing cap bolt.

19) Screw down the connecting rod bearing cap bolt to the specified torque in two steps via torque tightening method.

Torque of connecting rod bearing cap bolt N • m

	First step (pre-tightening)	Second step (tightening)
4DA1 Series	20	85

**Note:**

**Manually rotate the crankshaft to check whether it is flexible.**

**7. Piston cooling oil pipe**

**6. Oil pump assembly**

**5. Timing pulley chamber**

**4. Front oil seal**

**3. Timing gear**

**2. Oil pan assembly**

**1. Cylinder head assembly and gasket**

See “Crankshaft” in 2.6 for the reassembly of “7 - 1”.