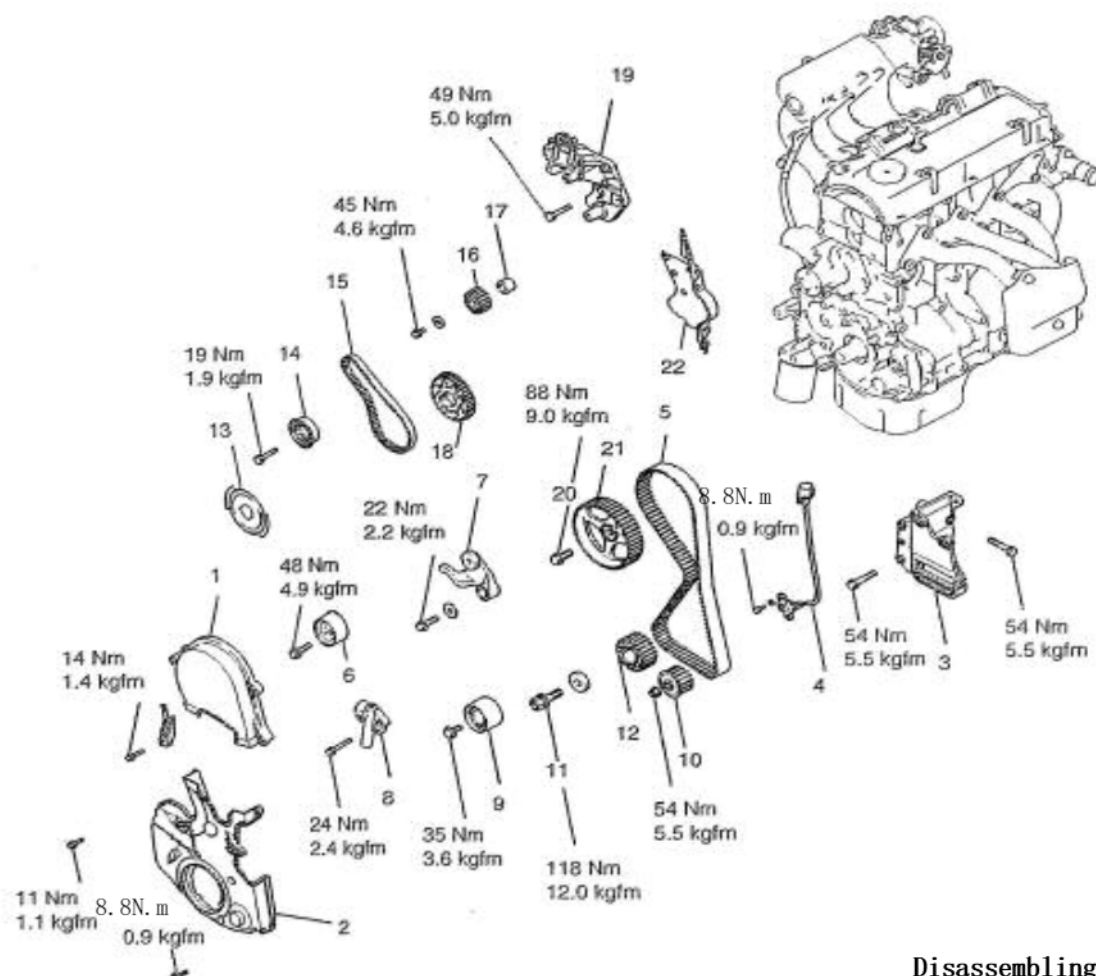


## Chapter 3 Valve gear

### I. Timing belt

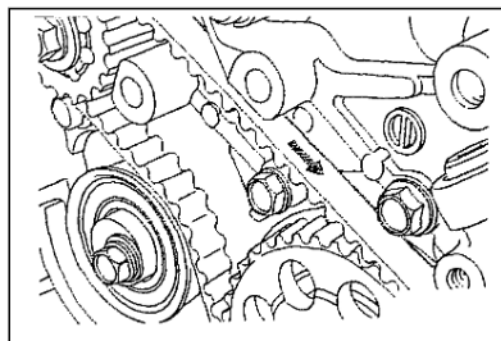
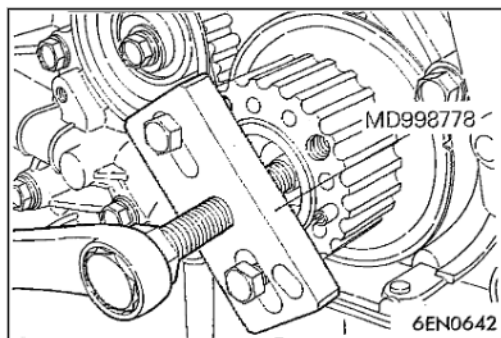
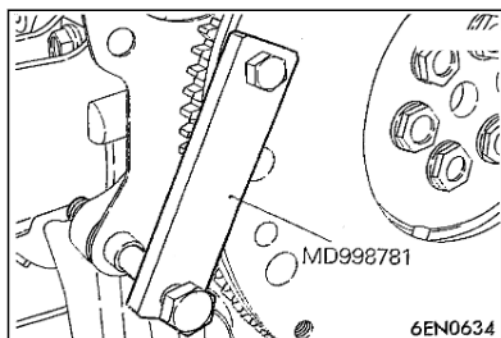
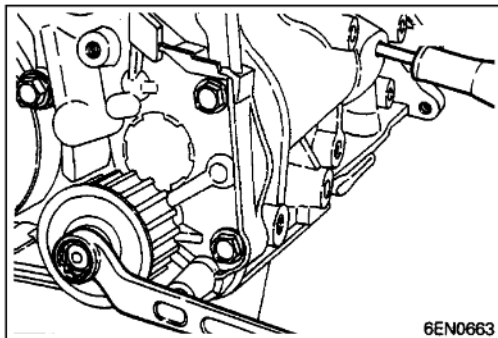
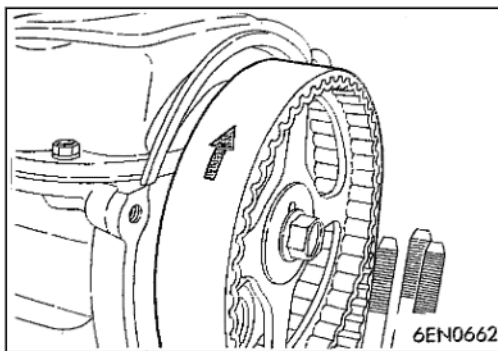


Disassembling  
illustration

#### Disassembling steps

1. front upper cap of timing belt
2. front lower cap of timing belt
3. power steering bracket
4. crankshaft position sensor
6. tensioning gear
7. tensioner arm
8. automatic tensioner
9. idler
10. oil pump pulley
11. crankshaft screw bolt

12. crankshaft timing pulley
13. flange
14. tensioner B
15. timing belt B
16. pulley of upper balance shaft
17. bushing
18. crankshaft timing pulley B
19. right bracket component of engine
20. screw bolt of camshaft pulley
21. camshaft timing pulley



## 1 Disassembling Notice

### ● Disassembling of timing belt

Remember the rotation direction of belt in order to avoid any error when reassembling.

#### Caution:

- 1) If there is water or grease on the belt, the lifecycle of belt will be decreased rapidly. So, after disassembling, take care not to have water or grease adhere to and pollute the belt, the pulley, and the tensioner. Do not clean these parts. When they are seriously polluted, please replace them with new ones.

2) If water or grease is found in these parts, please check whether there is any leakage in the oil seal of front cover, the oil seal of camshaft and water pump.

### ● Disassembling of oil pump pulley

- (1) Disassemble the plug cock on the cylinder side.
- (2) Insert an 8mm-diameter cross-ended screwdriver to fasten the left side balance shaft.
- (3) Disassemble the screw nut of oil pump pulley.
- (4) Disassemble the oil pump pulley.

### ● Disassembling of crankshaft screw bolt (Disassembling of flywheel)

- (1) Fix the driving board or flywheel with special tool.
- (2) Disassemble the crankshaft screw bolt. Support the driving board or flywheel with special tool.

### ● Disassembling of crankshaft pulley

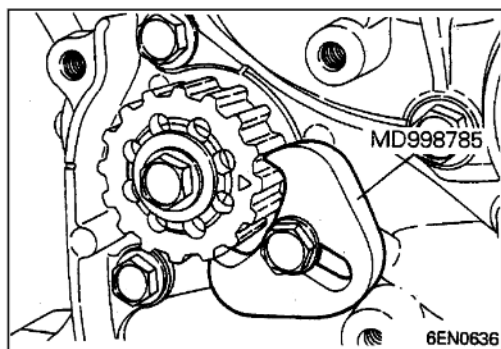
If it is difficult to disassemble due to the reason of adhering, please apply special tool.

### ● Disassembling of timing belt B

- (1) Remember the rotation direction of belt to avoid any error when reassembling.

#### Notice:

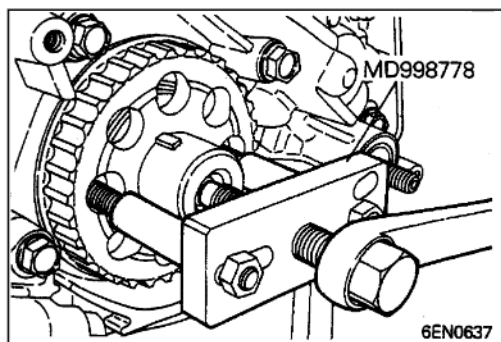
If there is water or grease on the belt, the lifecycle of belt will be decreased rapidly. So, after disassembling, take care not to have water or grease adhere to and pollute the belt, the pulley, and the tensioner. Do not clean these parts. When they are seriously polluted, please replace them with new ones.



(2) If water or grease is found in these parts, please check whether there is any leakage in the oil seal of front cover, the oil seal of camshaft and water pump.

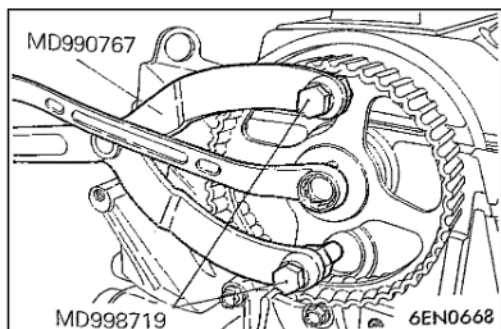
- **Disassembling of pulley of upper balance shaft**

- (1) Apply tool as shown in the illustration to fix the pulley of balance gear.
- (2) Disassemble the pulley of upper balance shaft.



- **Disassembling of crankshaft pulley B**

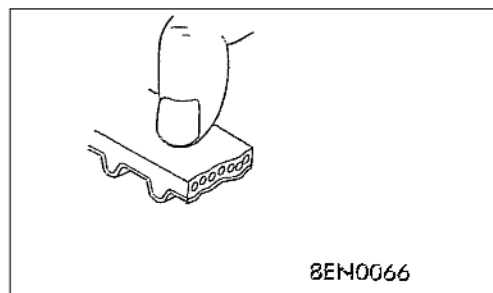
- (1) If it is difficult to disassemble due to the reason of adhering, please apply special tool.



- **Disassembling of camshaft pulley screw bolts**

- (1) Fix the camshaft timing pulley with special tool.

camshaft pulley.



## 2 Check

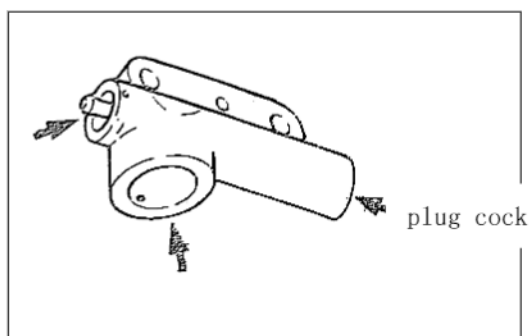
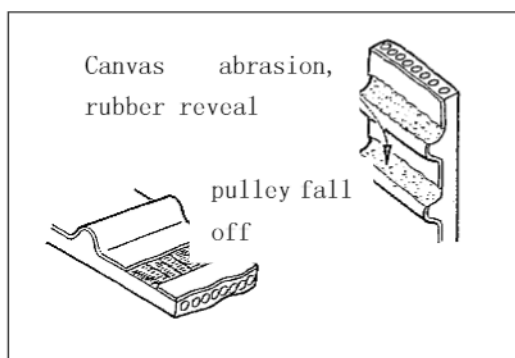
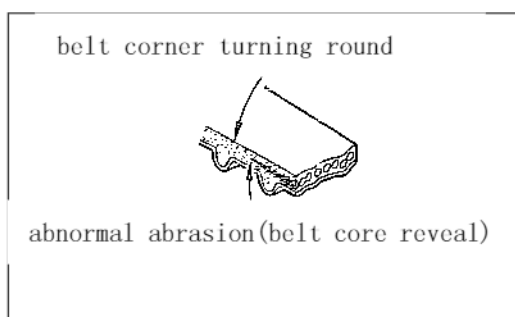
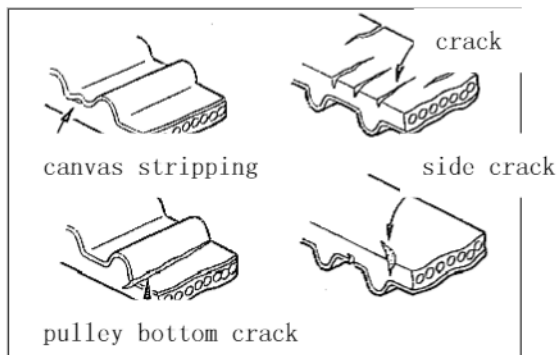
### ● Timing belt

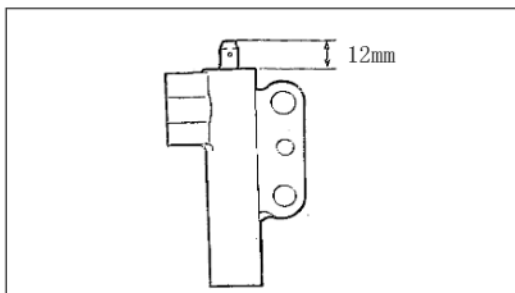
Check every part of the belt carefully, if there is any damage as the following, please replace with new one.

- (1) The back rubber is aging and glistening.  
There is no crack when fingernail scratches it and there is no flexibility.
- (2) There is crack in the back rubber.
- (3) There is crack and stripping in the canvas.
- (4) There is crack at the bottom of pulley.
- (5) There is crack in the side of pulley.
- (6) Abnormal abrasion in the side of pulley. When the side of belt is as smooth as surface of one cut by sharp knife, it is normal.
- (7) Abnormal abrasion in the part of pulley.
- (8) Teeth off.

### ● Automatic tensioner

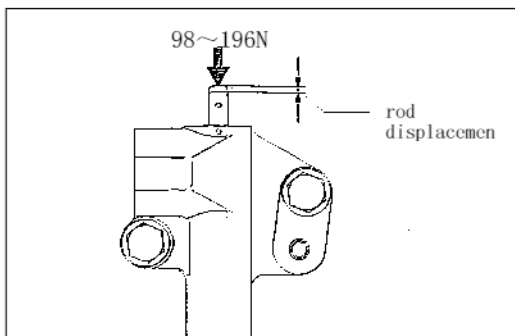
- (1) Check the leakage of automatic tensioner.  
Replace with a new one when necessary.
- (2) Check if there is any abrasion or damage at the end of the rod. Replace with a new one when necessary.





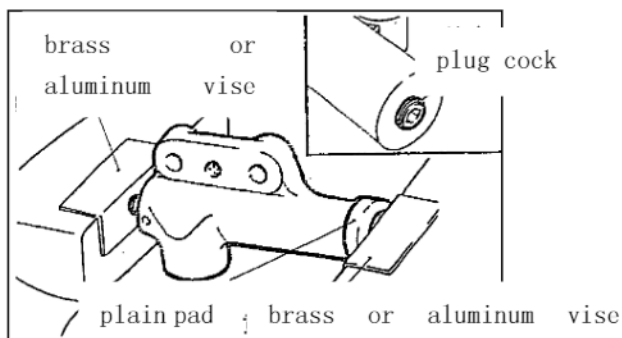
- (3) Measure the stretch of the rod. If it is not conformed to the standard, replace the automatic tensioner with a new one.

**Standard value: 12mm**



- (4) Press down the rod with a power of 98~196N and measure the rod displacement.  
(5) If the rod displacement is 1mm larger than the value measured in the (3) item, the automatic tensioner should be replaced.

**Standard value:  $\leq 1\text{mm}$**

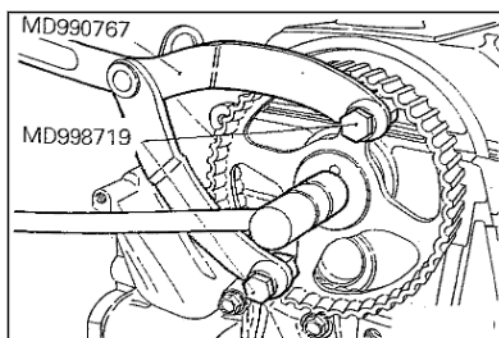


- (6) Fasten the automatic tensioner with vises which has soft opening.

**Caution:**

- As there is screw bolt stretching out at the bottom of automatic tensioner, a plain pad should be inserted between the vises and screw bolt to avoid their direct contact.

- (7) Rotate the handle of vises to push the rod of automatic tensioner in. If it is easy to push in, please replace the automatic tensioner with a new one. It should be felt as if there is some resistance when you push in the rod.



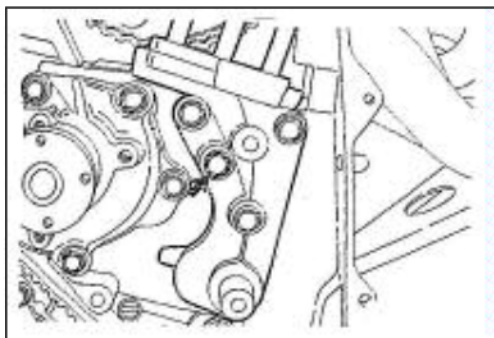
### 3 Installation Notice

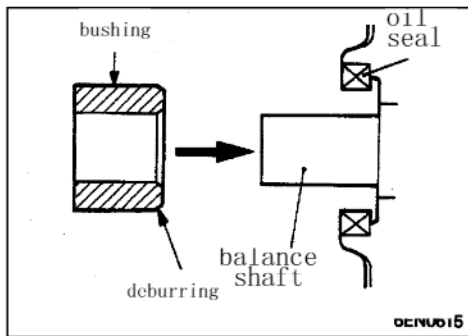
- **Fasten bolt of camshaft pulley**

- (1) Fix the camshaft pulley with special tool.
- (2) Fasten the bolt of camshaft pulley to the assigned torque.

- **Installation of engine bracket base**

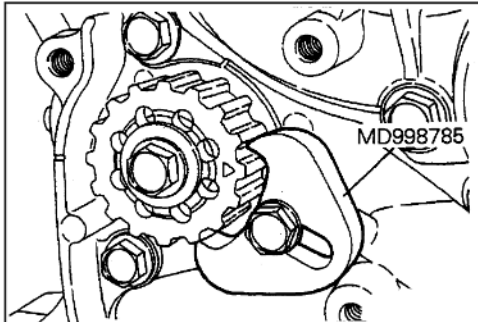
- (1) Before starting fastening, apply sealant to the bolt part as shown in the illustration.





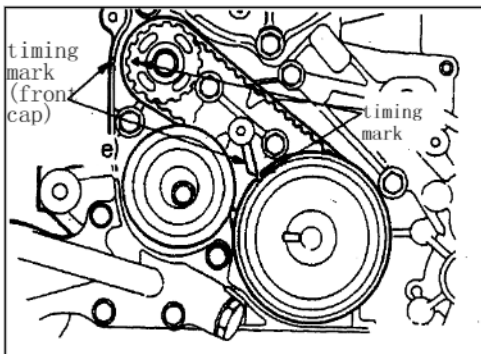
- **Installation of bushing in upper balance shaft**

(1) When installing the bushing, place the side with deburring to the direction of oil seal.



- **Installation of pulley in upper balance shaft**

- (1) Fix pulley in the balance shaft with a tool as shown in the illustration.
- (2) Fasten the bolt to assigned torque.

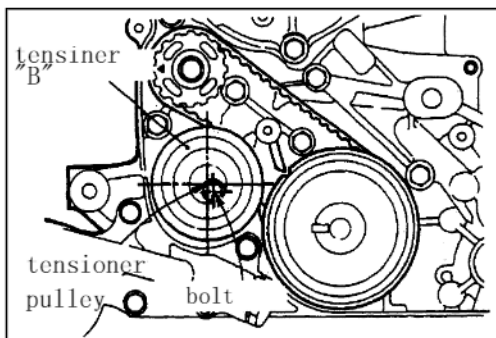


- **Installation of timing belt B**

- (1) Align the marks on the crankshaft pulley

the front cover respectively.

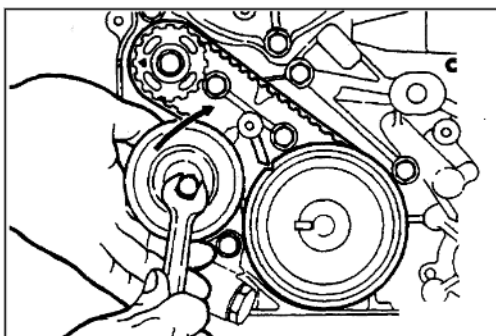
- (2) Install timing belt B in the crankshaft pulley and balance shaft pulley. There should not be loose in the tensioner side.

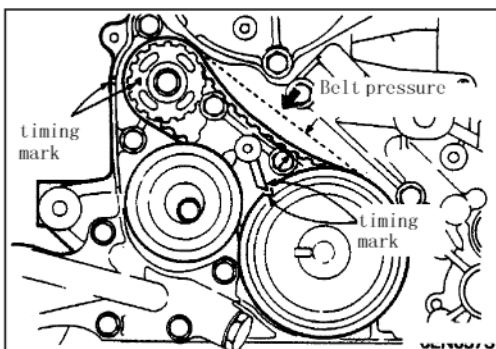


- (3) Make sure that the position of tensioner center and bolt center as shown in the illustration.

- (4) While putting power on the side of timing belt tensioner with finger, move tensioner B according to the arrow. Now fasten the screw bolt to fix tensioner B.

**Caution:** When fastening the bolt, do not keep the axle revolve with the pulley in case that the belt gets too tight.

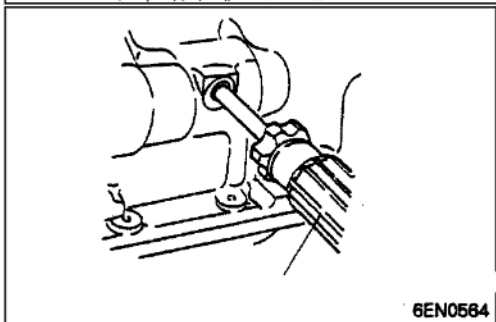
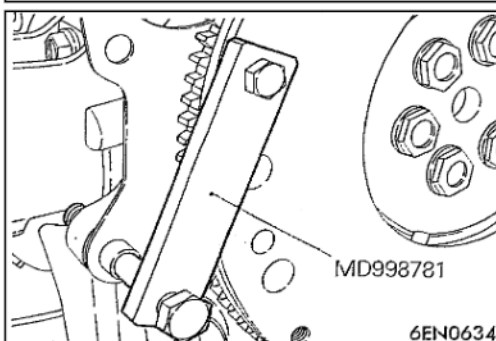




- (5) Ensure to keep the marks in the pulley and the front cover aligned.
- (6) Press the central part in the side of tensioner of the timing belt B with the index finger, with the pressure limit of 5~7mm.

#### ● Fasten the crankshaft bolt

- (1) Fix the flywheel with special tool.
- (2) Install crankshaft bolt.



#### ● Installation of pulley in oil pump

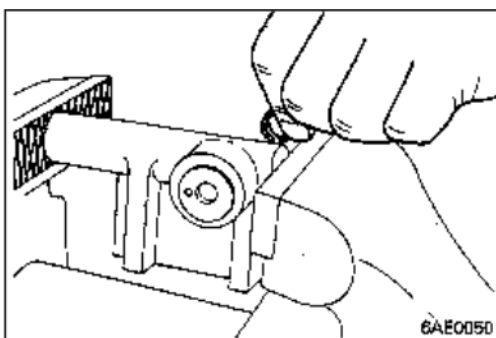
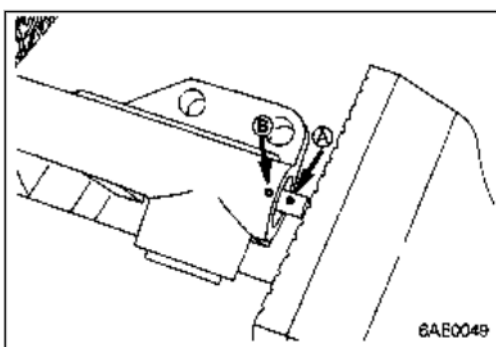
- (1) Insert cross-ended screwdriver to the left side of hole in the cylinder to prevent turning of balance shaft.
- (2) Install pulley of oil pump.
- (3) Apply oil to the combining side of screw nut and bearing.
- (4) Fasten the screw nut with a torque of 54Nm.

#### ● Installation of automatic tensioner

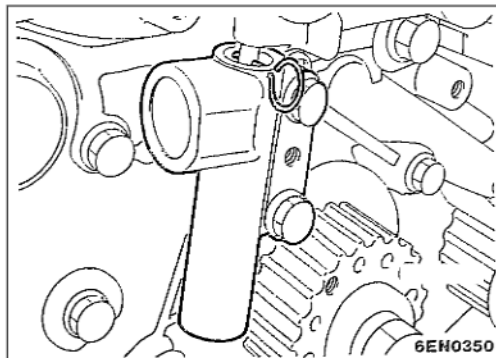
- (1) If the automatic tensioner is in the stretching position, it should be drawn back according to the following steps.
- (2) Fasten the automatic tensioner with vises that have soft opening.

#### Caution:

- As there is a stretching screw plug at the bottom of automatic tensioner, a plain pad should be inserted between the vises and the screw plug to prevent their direct contact.



- (3) Slowly push the vises in until the rod ① hole and oil tank ② gets aligned.
- (4) Insert the steel wire(diameter 1.4mm) to the aligned hole.
- (5) Disassemble the automatic tensioner from the vises.



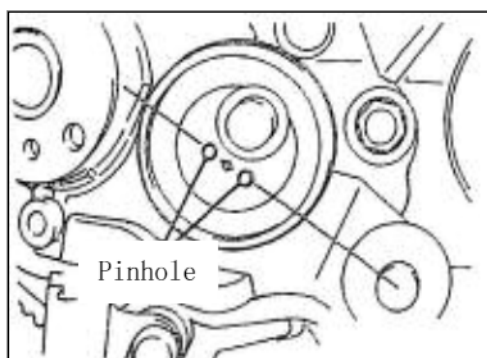
- (6) Install the automatic tensioner in the front cover, fastening the bolt with a torque of 24Nm.

**Caution:**

- Leave the steel wire in the automatic tensioner.

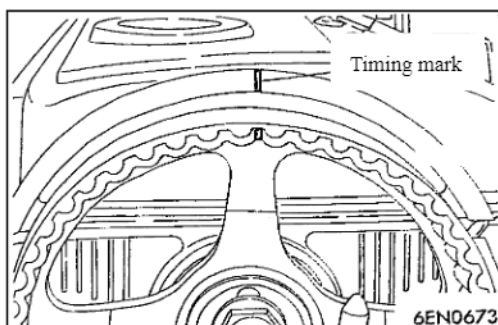
● **Installation of tensioning pulley**

- (1) Install the tensioning pulley and keep the two pin holes in a vertical line.

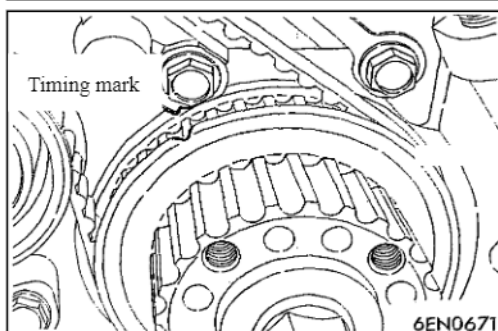


● **Installation of timing belt**

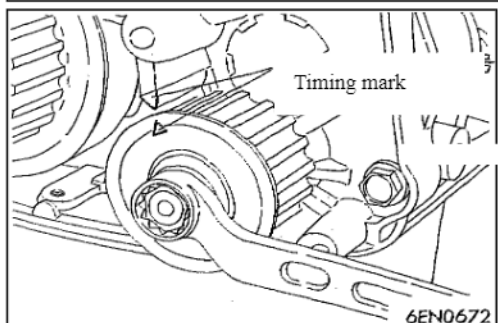
- (1) Make sure that the belt tensioner is installed properly.
- (2) Make the timing mark in the camshaft pulley and that in the cylinder cover aligned.

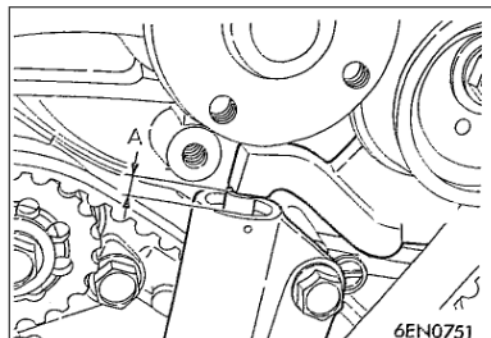
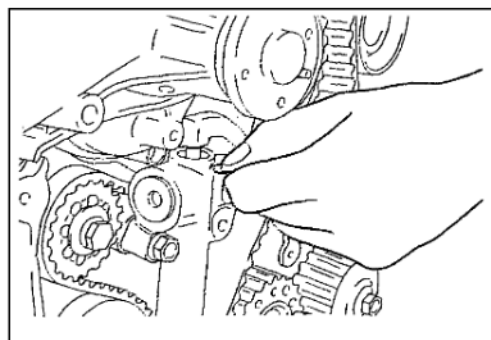
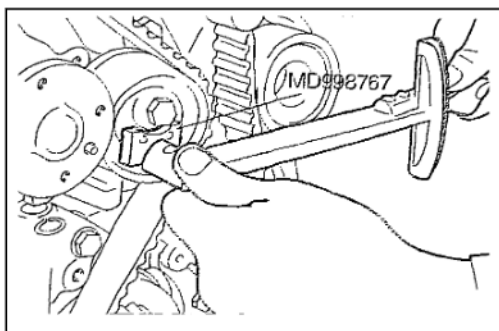
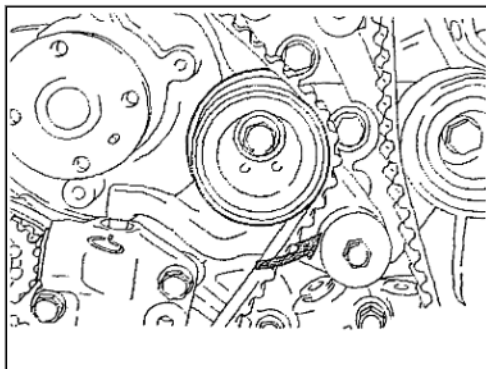
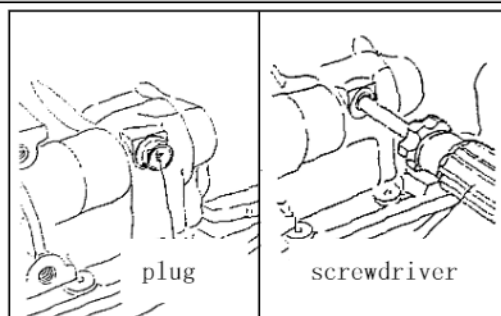


- (3) Make the timing mark in the crankshaft pulley and that in the



- (4) Keep the timing mark in the oil pump pulley and its conforming mark aligned.





(5) Disassemble the plug from the cylinder block and then insert the cross-ended screwdriver (diameter of 8mm) to the hole. If it could be inserted more than 60mm in, it means that the timing marks are aligned. If the range that could not be inserted above 20~25mm, the oil pump pulley should be turned for one revolution and the timing marks should be then aligned. Again check if the screwdriver could be inserted over 60mm. Keep the screwdriver in the inserting position until the installation of belt finishes.

(6) Connect the timing belt to the crankshaft pulley, middle pulley, camshaft pulley and tensioner pulley in turn.

(7) Raise the pulley of the tensioner to the direction of arrow and then fasten the central bolt.

(8) Make sure that all the timing marks are aligned.

(9) Disassemble the screwdriver inserted in step (5) and fix the plug.

(10) Rotate counterclockwise the crankshaft for a quarter of revolution until all the timing marks again get aligned.

(11) Install the special tools socket wrench and torque wrench to the tensioner pulley and then loosen the central bolt in the pulley of tensioner.

Remarks:

If special tools could not be applied, a general torque wrench that could measure a torque of 0 to 0.5 KgM may be used.

(12) Fasten to the torque of 3.5N.m (0.35 KgM) with a torque wrench.

(13) While keeping the tensioner pulley with special tool and torque, fasten the central bolt to

(14) Rotate clockwise the crankshaft two revolutions and lay it for about 15 minutes. Then check whether the fixing steel wire of automatic tensioner could slide freely.

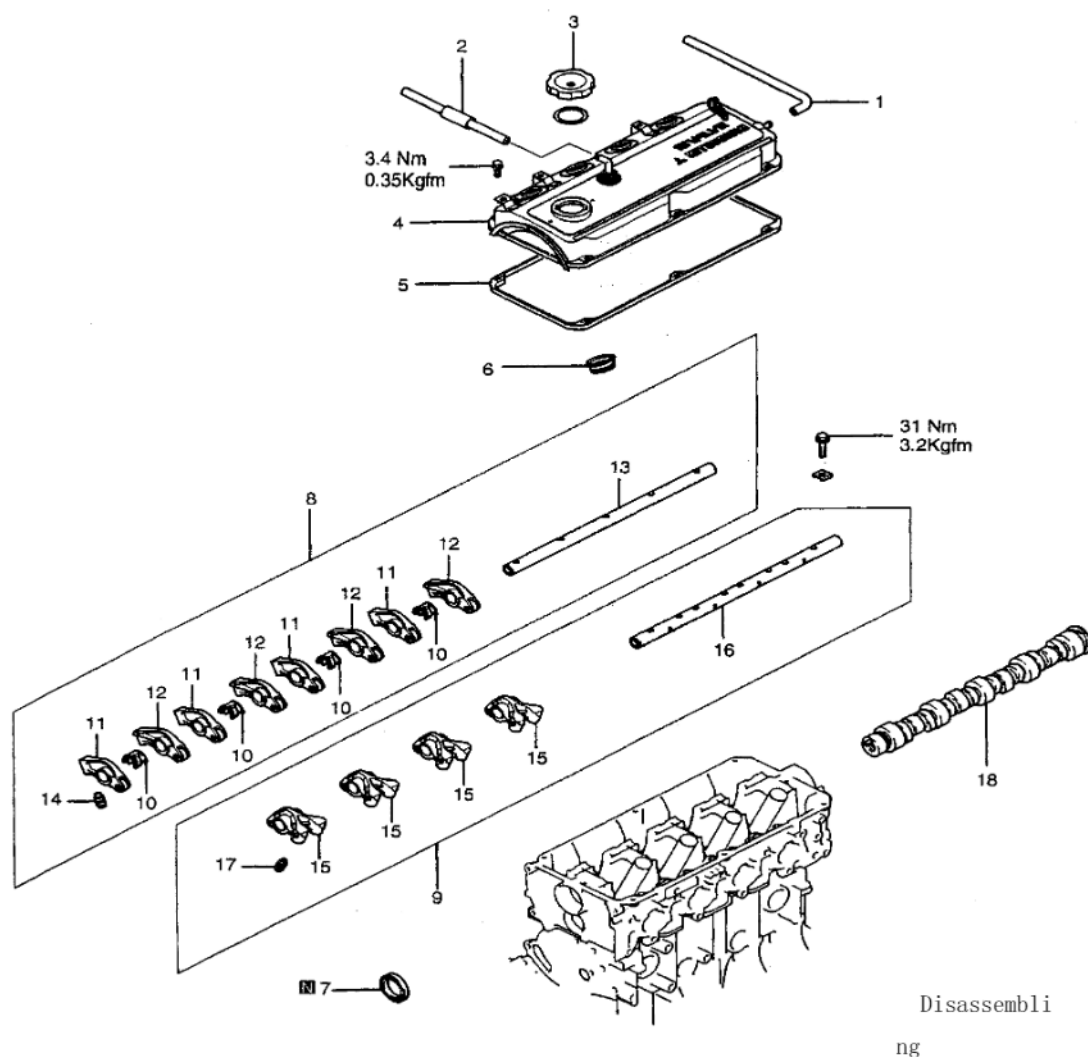
repeatedly do the steps after (10) until the steel wire slides.

(15) Take off the fixing steel wire of automatic tensioner.

(16) Measure the distance "A" (between the tensioner arm and the automatic tensioner itself).

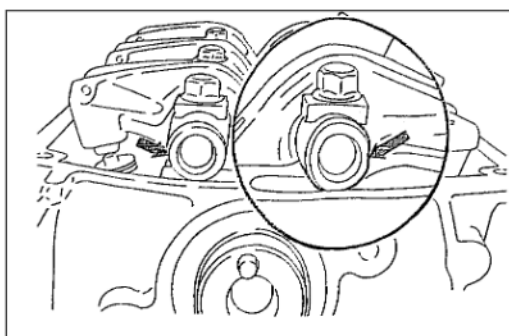
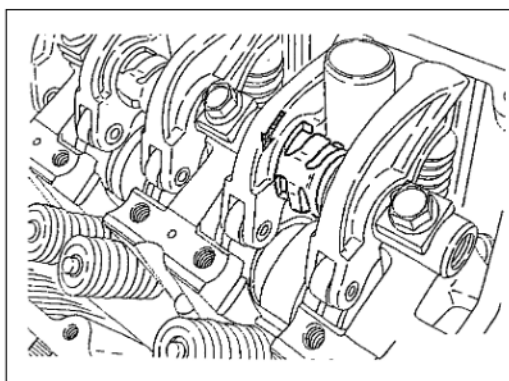
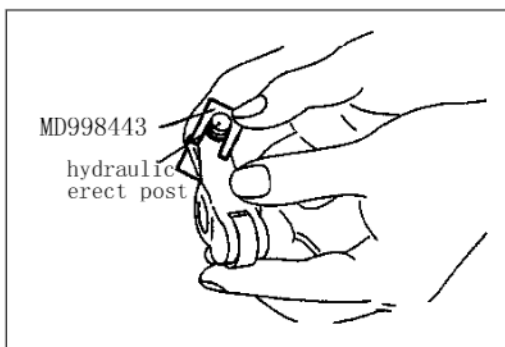
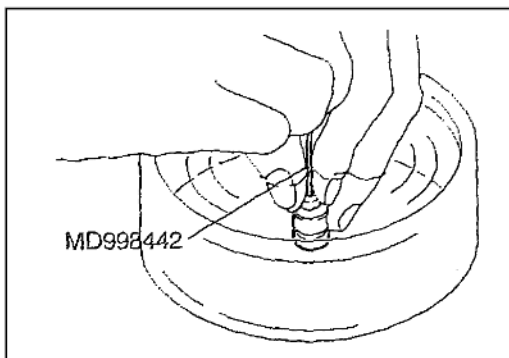
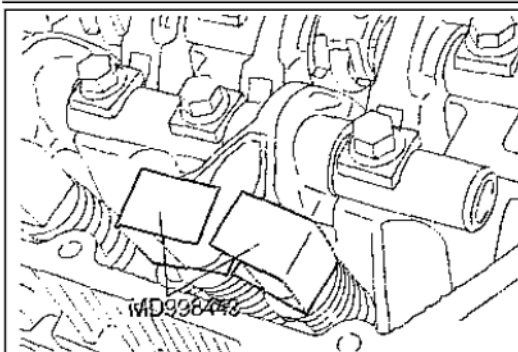
**Standard value: 3.8—4.5mm**

## II. Rocker arm and camshaft



### Disassembling steps

- |                                |                                 |
|--------------------------------|---------------------------------|
| 1. air flow tube               | 11. rocker arm A                |
| 2. P.C.V. tube                 | 12. rocker arm B                |
| 3. fuel filler cap             | 13. rocker shaft (intake side)  |
| 4. rocker arm cap              | 14. hydraulic erect post        |
| 5. pad of rocker arm cap       | 15. rocker arm C                |
| 6. oil seal                    | 16. rocker shaft (exhaust side) |
| 7. oil seal                    | 17. hydraulic erect post        |
| 8. rocker arm and rocker shaft | 18. camshaft                    |
| 9. rocker arm and rocker shaft |                                 |
| 10. rocker shaft spring        |                                 |



## 1. Disassembling Notice

### ● Disassembling of rocker arm and rocker shaft

- (1) Before disassembling the rocker arm and rocker arm shaft assembly, install the special tools as shown in the illustration to prevent dropping of hydraulic erect post.

## 2. Installation Notice

### ● installation of hydraulic erect post

- (1) Soak the hydraulic erect post in clean diesel oil.
- (2) With the special tool "exhaust steel wire", while slightly pressing the steel ball of check valve, move the plunger up and down for four to five times to exhaust the air.

**Caution:** As the rigid ball spring is especially soft, do not push the steel ball too violently with exhaust steel wire in case any damage to the hydraulic erect post.

It is easy to exhaust air from the hydraulic erect post installed by rocker arm with a **keeper** (special tool).

- (3) Insert the hydraulic erect post into the rocker arm, being careful to avoid diesel oil overflow. Then apply special tool to prevent the dropping of hydraulic erect post during the installation.

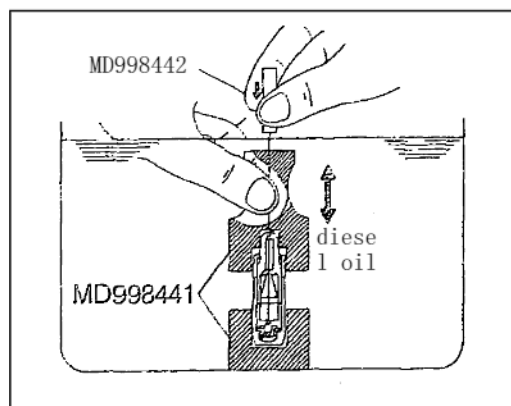
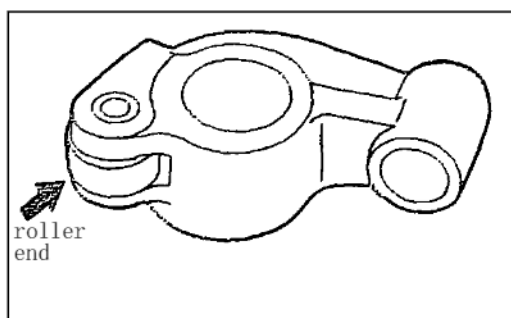
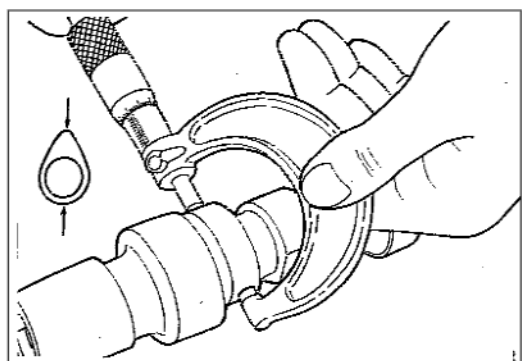
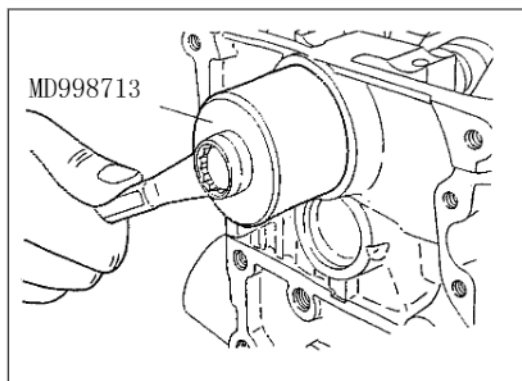
### ● Installation of rocker shaft spring, rocker arm and rocker shaft

- (1) Fasten the intake rocker shaft with a bolt temporarily until no rocker arm push and press the valve.
- (2) Assemble the rocker shaft spring from the upper until it is vertical with the duct of spark plug.

**Caution:** The rocker shaft spring should be installed first and then tighten the bolt of exhaust rocker arm.

- (3) Disassemble the special tool for keep the hydraulic erect post.
- (4) Make sure that the position of cutting opening in the rocker shaft is in that shown in the illustration.

**Caution:** The oil hole in the rocker shaft should be aligned with the cylinder block to ensure a correct installation position.



### ● Installation of camshaft oil seal

Install the oil seal of camshaft with special tool

## 3. Check

### ● camshaft

(1) Measure the height of cam

The standard value and usage limit value are as follows.

4G64:

|         | standard value | usage limit value |
|---------|----------------|-------------------|
| intake  | 37.39          | 36.89             |
| exhaust | 37.14          | 36.64             |

4G63:

|         | standard value | usage limit value |
|---------|----------------|-------------------|
| intake  | 37.50          | 37                |
| exhaust | 37.14          | 36.49             |

### ● Rocker arm

- (1) Check the surface of the roller. If there is any trace, there must be some damage or check and the rocker arm should be replaced.
- (2) Check whether the roller could revolve smoothly and evasively. If it could not revolve smoothly and evasively or is a bit loose, the rocker arm should be replaced.
- (3) Check the internal diameter. If there is some damage or lock is checked, the rocker arm should be replaced.

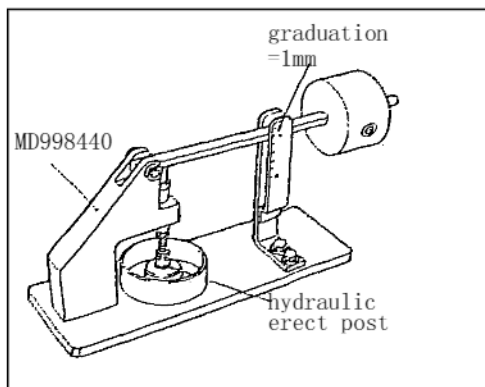
### ● Test on the return leakage of hydraulic erect post

Caution:

- The hydraulic erect post is a precision spare part. There should not be any dust or foreign matter on its surface
- It is not allowed to disassemble the hydraulic erect post.
- It is required to use clean diesel oil to clean the hydraulic erect post.

(1) Soak the hydraulic erect post in clean diesel oil.

With the special tool (MD998442), while pressing the steel ball in the inner side, exhaust the air by moving the plunger up and down for four to five times. It is easy to exhaust air from the hydraulic erect post installed by rocker arm.



- ( 3 ) Disassemble the special tool (MD998442) and check whether the plunger could be pressed. If it is not easy to press the plunger, the hydraulic erect post is normal. If it is easy to press the plunger to the end, the hydraulic erect post should be exhausted again and then be checked again. If the plunger is still loose, the hydraulic erect post should be replaced.

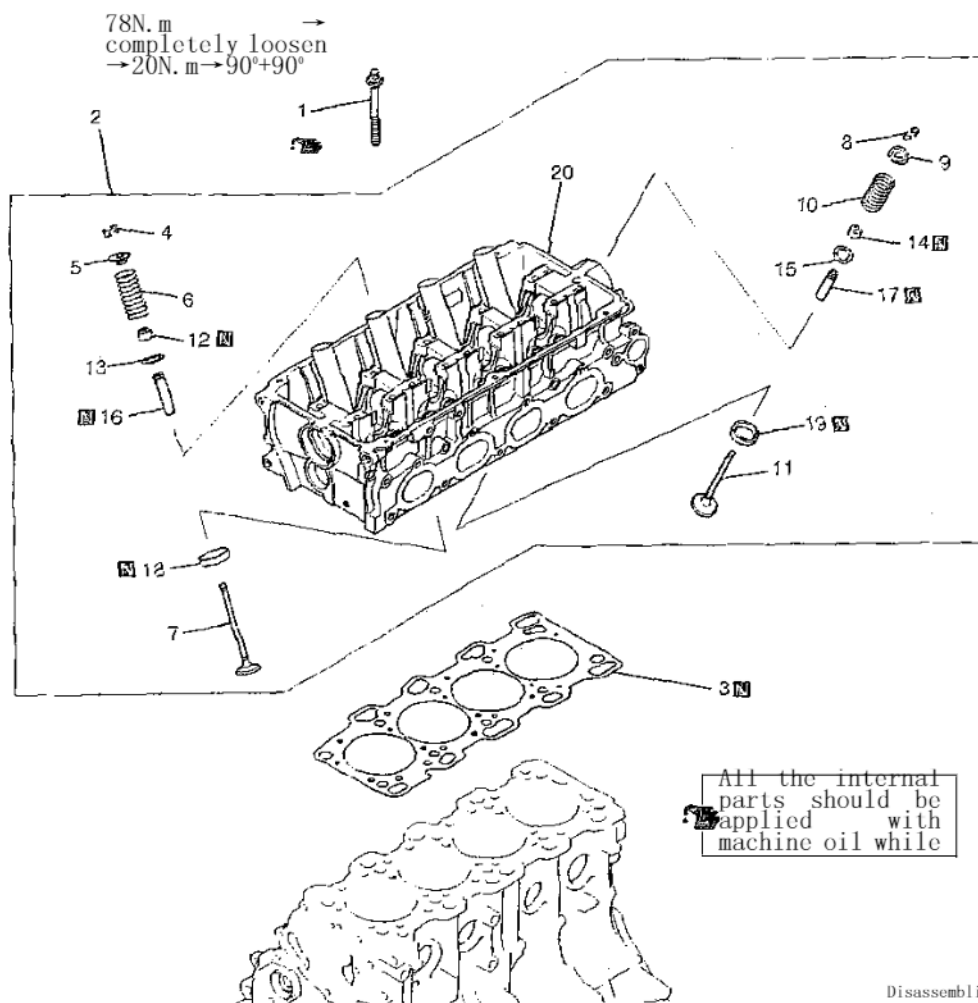
**Caution:**

- After the exhaust of air, the hydraulic erect post should be kept erect to avoid outflow of the internal diesel oil.

- (4) After the exhaust, the hydraulic erect post should be installed in special tool (return leakage tester).
- (5) When the plunger sinks a little (0.2~0.5mm), measure the time it needs to sink a second 1mm. If the measurement value is not conformed to the standard value, replace the hydraulic erect post.

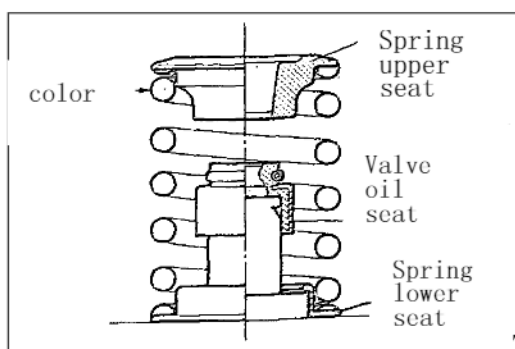
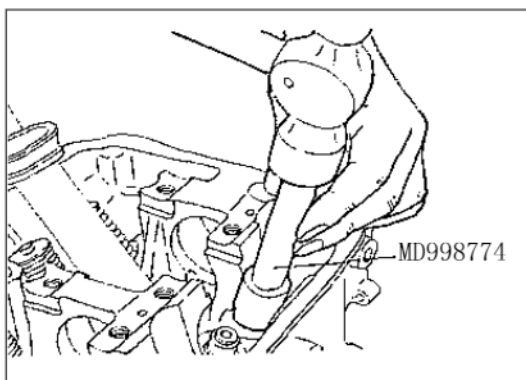
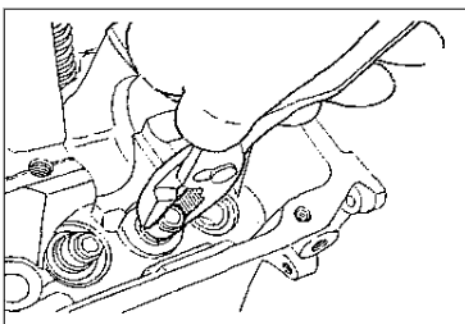
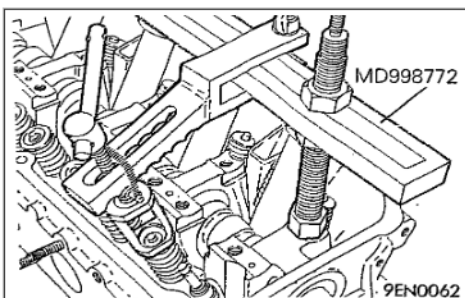
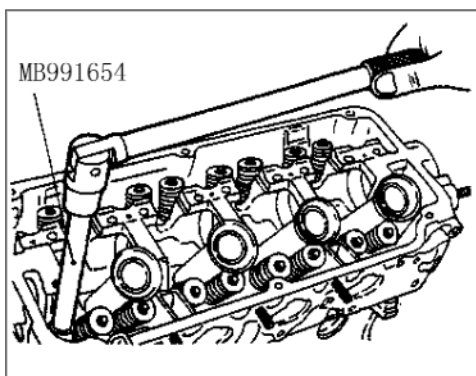
**Standard value: 4 ~ 20seconds/1mm  
(applying diesel oil of 15~20℃)**

### III. Disassembling and assembling of cylinder cover, valve



#### Disassembling steps

- |                                   |                            |
|-----------------------------------|----------------------------|
| 1. bolt for cylinder cover        | 11. exhaust valve          |
| 2. components for cylinder cover  | 12. valve oil seal         |
| 3. cylinder gasket                | 13. valve spring retainer  |
| 4. lock for valve spring retainer | 14. valve oil seal         |
| 5. upper valve spring retainer    | 15. valve spring retainer  |
| 6. compression spring for valve   | 16. duct for intake valve  |
| 7. intake valve                   | 17. duct for exhaust valve |
| 8. lock for valve spring retainer | 18. seat for intake valve  |
| 9. upper valve spring retainer    | 19. seat for exhaust valve |
| 10. compression spring for valve  | 20. cylinder cover         |



## Disassembling Notice

### 1. Cautions after disassembling

The parts disassembled must be placed according to the cylinder numbers and intake/exhaust area respectively.

- **Disassembling of the bolt of cylinder cover**

- (1) Loosen the bolts on every cylinder cover with special tool. It should be loosened evenly and gradually.

- **Disassembling of lock for valve spring retainer**

- (1) The disassembled parts such as valve and spring should be marked with cylinder No. and installation position, and should be kept well for use in the assembling.

- **Disassembling of valve oil seal**

- (1) Valve oil seal should not be used repeatedly.

## Installation Notice

- **Installation of valve oil seal**

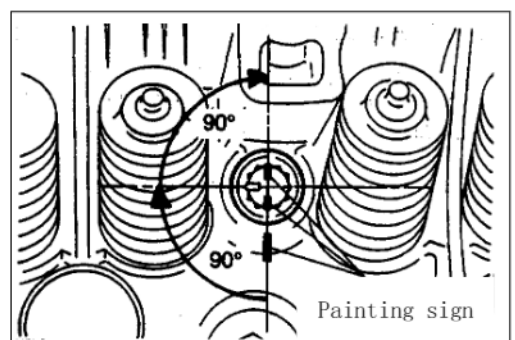
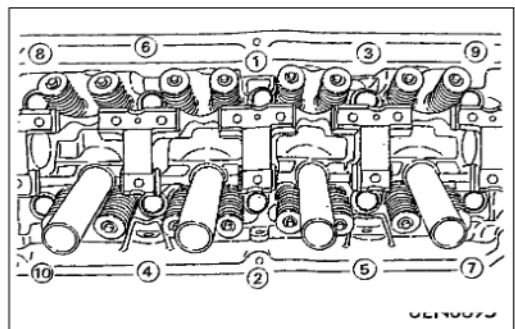
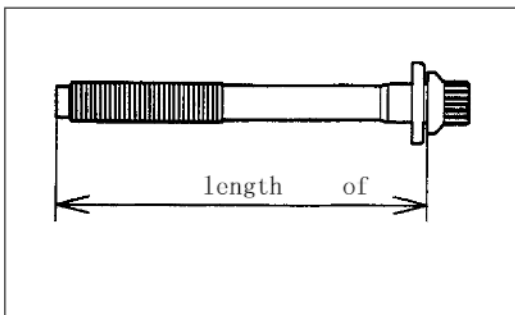
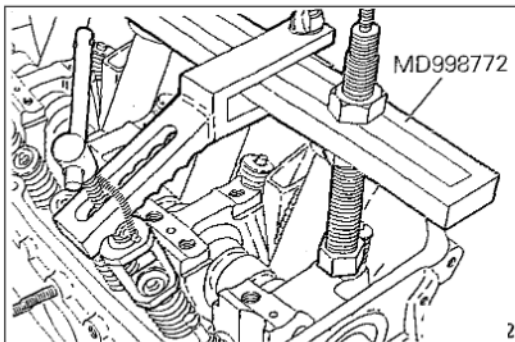
- (1) Install the lower retainer of valve spring.
- (2) Install the valve oil seal in the valve duct with special tool. Improper installation may cause leakage.

**Caution:**

- **Valve oil seal should not be used repeatedly.**

- **Installation of valve spring**

- (1) When installing the valve spring, the end with identifying color should be faced to the upper retainer for valve spring.



### ● Installation of lock for valve spring retainer

(1) If the valve spring is excessively compressed, the bottom of upper valve spring retainer will contact with it and will damage the valve oil seal.

(2) Install the spring lock with special tool.

### ● Installation of bolt for cylinder cover

(1) When assembling the bolt for the cylinder cover, make sure that the length of bolt is suitable to the limited value. If it is larger than the limited value, the bolt should be replaced.

**Limit value (A): maximum 99.4mm**

(2) Apply some machine oil to the rippling part of bolt and washer.

(3) According to the fastening sequence, tighten the bolts to the assigned torque with special tool (MB991654).

**Fasten torque: 78N.m**

(4) Completely loosen all the bolts.

(5) According to the fastening sequence again, tighten the bolt with a torque of 20N.m

(6) Make a lined painting mark in the bolt end of cylinder cover and the cylinder cover.

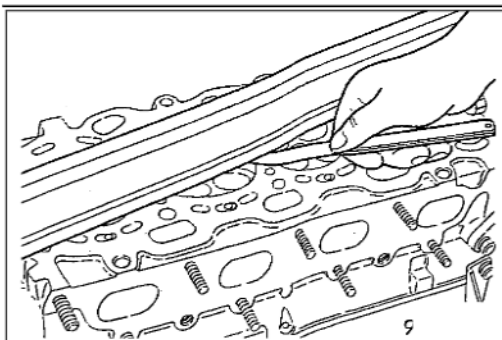
(7) Tighten the bolt of cylinder cover for 90° according to the fastening sequence.

(8) Further tighten the bolt for 90° and make sure that the painting mark in the bolt end of cylinder cover and that in the cylinder cover aligned.

### Caution:

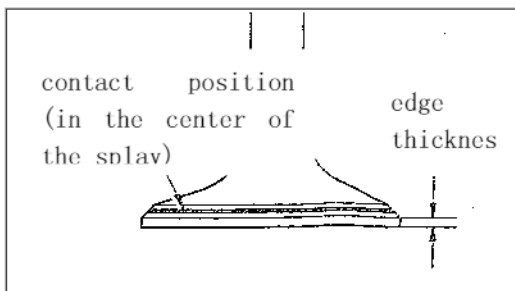
● If the tightening angle of bolt is smaller than 90°, the correct tightening torque is not expected. So while tightening, the correct tightening angle must be paid much attention to.

● When the bolt is excessively tightened, it should be fully loosened and then begin to be tightened again from step (1).



\*Together with the abrasion of cylinder block.

Height of cylinder cover (standard value of new part): 119.9~120.1mm



#### ● valve

- (1) Check whether the working surfaces of valve are contacted properly. If the contact is improper, abrade again with valve polishing machine. The contacting side of valve seat should be conformed to the center of valve working surface.
- (2) If the edge thickness exceeds the usage limit value, the valve should be replaced.

Edge thickness standard value:

intake.....1.0mm

exhaust.....1.2mm

Usage limit value: intake.....0.5mm

exhaust.....0.7mm

- (3) Measure the total height of valves. If it is smaller than the limit value, the valve should be replaced.

Standard value:

intake: .....112.30mm

exhaust.....114.11mm

Limit value: intake.....111.80mm

exhaust.....113.61mm

#### ● Valve spring

- (1) Check the free height of the valve spring. If it is smaller than the limit value, it should be replaced.

Standard value: 51.0mm

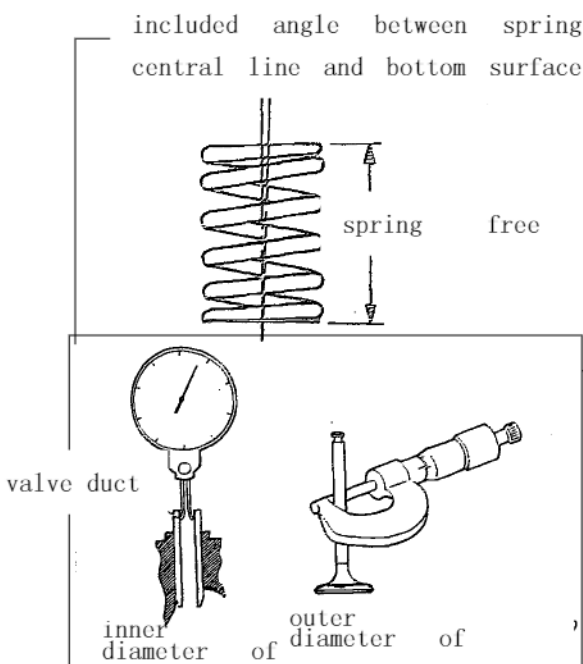
Limit value: 50.0mm

- (2) Check the verticality of spring central line and the bottom surface. If the gradient exceeds

Standard value:  $\leq 2^\circ$

Limit value:  $4^\circ$

#### ● Valve duct



Standard value: intake ..... 0.02 — 0.05mm

exhaust.....0.03—0.07mm

Limit value: intake.....0.10mm

exhaust.....0.15mm

### 3、Check

#### ● Cylinder cover

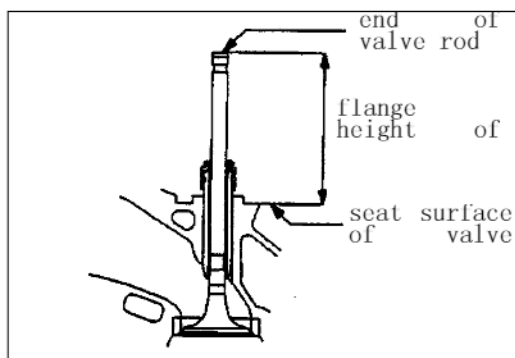
- (1) Check the flatness of the bottom of cylinder cover with straightedge and plug gauge.

Standard value: 0.03mm

Limit value: 0.2mm

- (2) When the distortion exceeds the limit value, modification by abrasion is needed.

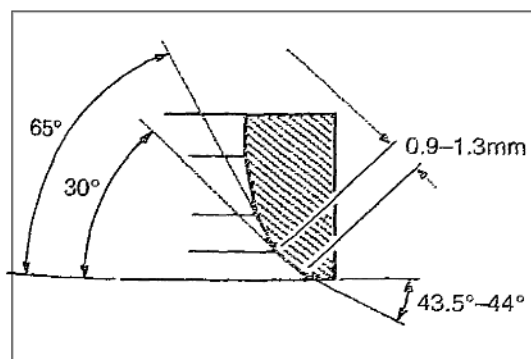
Abrasion limit value: \* 0.2mm



- (1) Assemble the valve and measure the flange height of valve rod between the end of valve rod and seat surface of valve spring. If the measurement value exceeds the assigned limit value, the valve seat should be replaced.

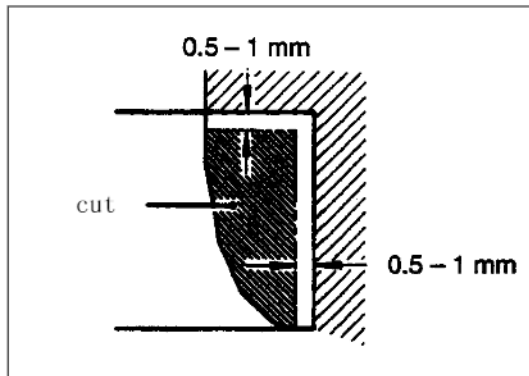
**Standard value:** intake.....49.30mm  
exhaust.....49.30mm

**Limit value:** intake.....49.80mm  
exhaust .....49.80mm



#### ● Points for maintaining the valve seat

- (1) Before maintaining the valve seat, check the clearance between the valve duct and the valve rod. Maintain after replacement of valve duct if necessary.
- (2) Repair the width and angle of the valve seat until their adjustment to the assigned value with abrasion machine.
- (3) After repairing the valve seat, rub the valve and the valve seat in pairs with rubbing cream. Then check the flange height of valve rod. (Refer to the checking item of **valve seat**).

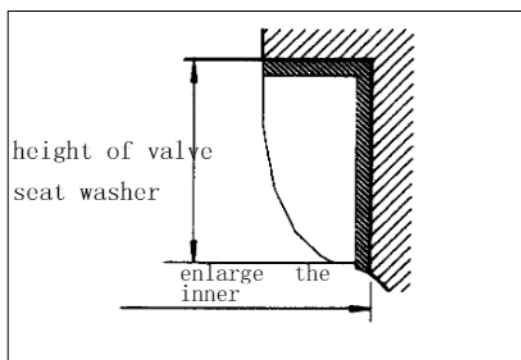


#### ● Points for changing valve seat

- (1) Cut a part of the to-be-replaced valve seat from the inner side to make it thinner and then remove it.
- (2) Repair and adjust the seat hole in cylinder cover according to the outer diameter of the enlarged valve seat.

#### Diameter of valve seat washer

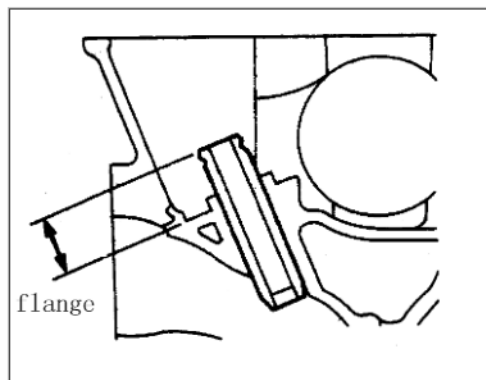
|            |                       |               |
|------------|-----------------------|---------------|
| intake     | enlargement size 0.30 | 34.435-34.455 |
| valve seat | enlargement size 0.60 | 34.735-34.755 |
| exhaust    | enlargement size 0.30 | 31.935-31.955 |
| valve seat | enlargement size 0.60 | 32.235-32.255 |



- (3) Before assemble the valve seat washer, heat the cylinder cover to the temperature of about 250°C, or cool the valve seat washer in the liquid nitrogen in order to engage inside the cylinder cover.

- (4) Repair and adjust the valve seat to the assigned width and angle with a valve seat milling cutter. (Refer to **Points for maintaining the valve seat**).

#### ● valve seat



#### Points for changing of valve duct

- (1) Press out the valve duct to the direction of cylinder with **press machine**.
- (2) Modify the valve duct hole of cylinder cover until the hole diameter gets to the size of enlarged valve duct to be installed.

#### • Caution:

**Do not use a new valve duct with the same size as the disassembled valve duct.**

**Duct hole diameter of valve in the cylinder cover.**

|                    |              |
|--------------------|--------------|
| enlarge size 0.05: | 11.05-11.068 |
| enlarge size 0.25: | 11.25-11.268 |
| enlarge size 0.50: | 11.50-11.518 |

- (3) As shown in the illustration, press the valve duct to the assigned flange value.

Standard value: 14mm

#### Caution:

- Press the valve duct from the top surface of cylinder head.
  - the length of intake valve duct and exhaust valve duct are different. (Intake valve: 45.5, exhaust valve: 50.5)
- (4) After installation of valve duct, insert the new valve and check if it could move smoothly.