

M9961-03E070

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# **YANMAR**

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**SERVICE MANUAL**

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**FUEL INJECTION EQUIPMENT**

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**MODEL YPD-MP2/YPD-MP4 SERIES**

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**YANMAR CO.,LTD.**

## **Introduction**

This document describes the features, disassembly, reassembly and adjustment procedure of the fuel injection unit (Model YPD-MP2,MP4) for Yanmar Diesel Engine Model TNV.

Fuel injection unit is an essential mechanism of diesel engines, and thus, has to be designed to allow fine adjustment to the engine load.

Therefore, the components of the fuel injection pumps are required to be given high-precision. To meet this requirement, we process and assemble them very accurately.

Accordingly, when performing disassembly and adjustment works in the market, keep the workbenches and their environment clean to surely prevent dirt and dust from attaching to the components of the unit, and take special care that the components are not rusted.

Please note that the specifications of the components are revised to improve the quality of the product, and thus, the details of the changed specifications will be notified through the correction table every time the change occurs.

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# 1. For Safe Servicing

- Most accidents are caused by negligence of basic safety rules and precautions. For accident prevention, it is important to avoid such causes before development to accidents.

Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures.

Attempting at a repair or maintenance job without sufficient knowledge may cause an unexpected accident.

- It is impossible to cover every possible danger in repair or maintenance in the manual. Sufficient consideration for safety is required in addition to the matters marked CAUTION. Especially for safety precautions in a repair or maintenance job not described in this manual, receive instructions from a knowledgeable leader.

## 1.1. Warning Symbols

- Safety marks used in this manual and their meanings are as follows:



**DANGER**

**DANGER** indicates an imminently hazardous situation, which if not avoided, WILL result in death or serious injury.



**WARNING**

**WARNING** indicates a potentially hazardous situation, which if not avoided, COULD result in death or serious injury.



**CAUTION**

**CAUTION** indicates a potentially hazardous situation, which if not avoided, may result in minor or moderate injury.

- Any matter marked **[NOTICE]** in this manual is especially important in servicing. If not observed, the product performance and quality may not be guaranteed.

## 1.2. Safety Precautions



- Place allowing sufficient ventilation  
Jobs such as engine running part welding and polishing the paint with sandpaper should be done in a well-ventilated place.  
Failure to Observe  
Very dangerous for human body due to the possibility of inhaling poisonous gas or dust.



- Sufficient wide and flat place  
The floor space of the service shop for inspection and maintenance should be sufficiently wide and flat without any holes.  
Failure to observe  
An accident such as a violent fall may be caused.



- Clean, orderly arranged place  
No dust, mud, Oil or parts should be left on the floor surface.  
Failure to Observe  
An unexpected accident may be caused.



- Bright, safety illuminated place  
The working place should be illuminated sufficiently and safety. For a job in a dark place where it is difficult to see, use a portable safety lamp. The bulb should be covered with a wire cage for protection.  
Failure to observe  
The bulb may be broken accidentally causing ignition of leaking oil.



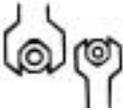
- Place equipped with a fire extinguisher  
Keep a first aid kit and fire extinguisher close at hand in preparation for fire emergencies

**CAUTION**



- Wears for safe operation  
Wear a helmet, working clothes, safety shoes and other safety protectors suited to the job. It is especially important to wear well-fitting work clothes.  
Failure to observe  
A serious accident such as trapping by a machine may occur.

**WARNING**



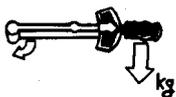
- Use of appropriate tools  
Use tools appropriate for the jobs to be done. Use a correctly sized tool for loosening or tightening a machine part.  
Failure to observe  
A serious injury or engine damage may occur.

**CAUTION**



- Always use genuine parts  
Jobs such as engine running part welding and polishing the paint with sandpaper should be done in a well-ventilated place.  
Failure to Observe  
Shortening of MP pump unit life or an unexpected accident may arise.

**WARNING**



- Always tighten to the specified torque if designated in the manual.  
Failure to Observe  
Loosening or falling may cause parts damage or injury.

**CAUTION**

Observe the following instructions with regard to waste disposal.

Negligence of each instruction will cause environmental pollution.

- Waste fluids such as engine oil and cooling water shall be discharged into a container without spillage onto the ground
- Do not let waste fluids be discharged into the sewerage, a river or the sea.
- Harmful wastes such as oil, fuel, solvents, filter elements and battery shall be treated according to the respective laws and regulations. Ask a qualified collecting company for example.

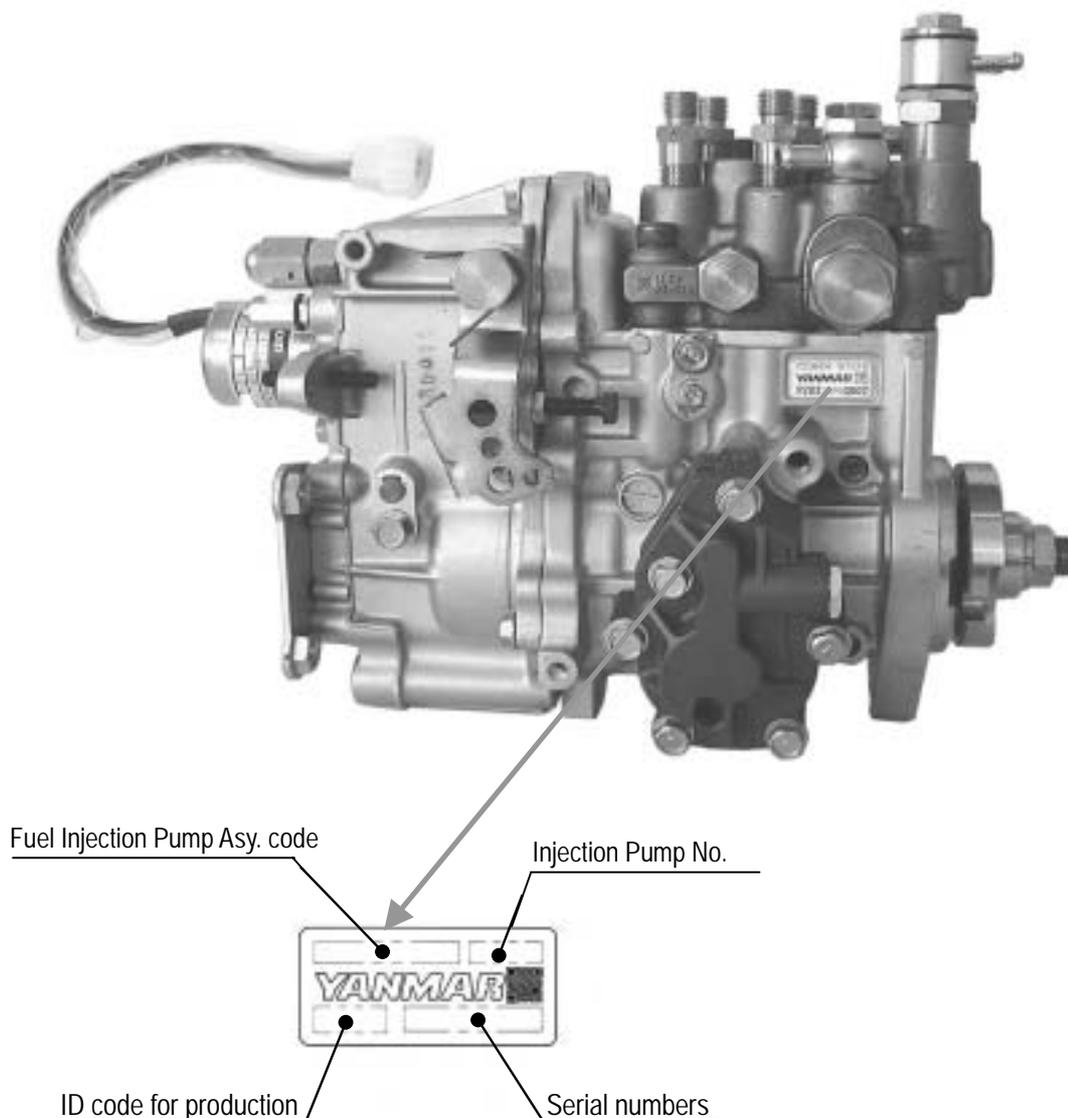
## 2. General information

### 2.1. Outline of MP pump

MP pump is a fuel injection pump that has been newly developed to be installed on Yanmar direct injection system diesel engines for the purpose of complying with the regulation for the exhaust gas emission that are becoming tighter in the future.

The fuel injection pump is a fuel distribution type pump that supplies fuel to each cylinder of the engine through a distribution shaft by using a single plunger unlike conventional rail system or distribution system pumps.

- Pump name plate



## 2.2. Specifications

Model	YPD-3MP2	YPD-4MP2	YPD-4MP4
Applicable Engine	3TNV82A /84(T)/88	4TNV84(T) /88	4TNV94 /98(T)/106(T)
Plunger Diameter (mm)	9mm		10mm
Max. Cam Lift (mm)	8.1mm		10mm
Governor-System	Mechanical All Speed Governor		
Fuel Injection Timing Control System	Built-in Hydraulic Control Timer		
Fuel feed pump	Forced Lubrication System With Trochoid Pump		
Lubrication system	Engine System Oil		
Dry Weight (kg)	8.4	8.6	11.5

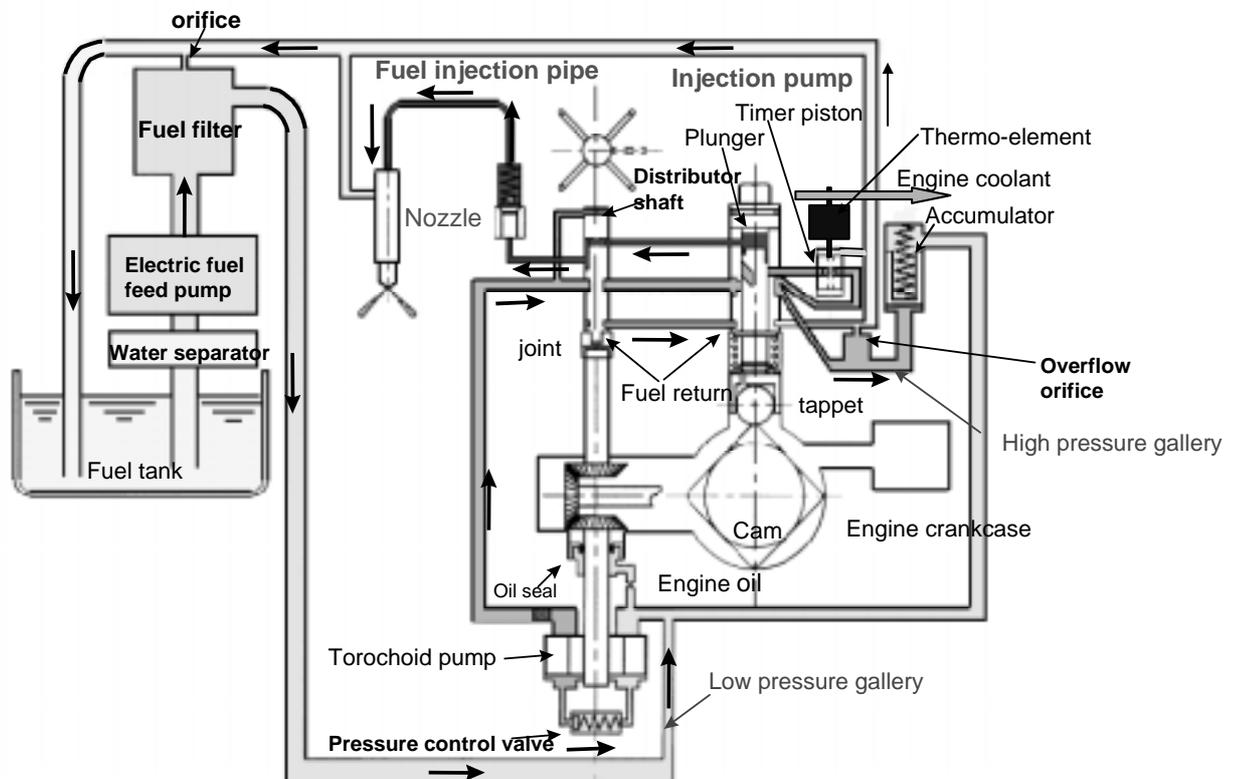
## 2.3. Outline of fuel injection pump

Yanmar distribution type fuel injection pump YPD-MP consists of a hydraulic head that is equipped with a single plunger, a single distribution shaft, and delivery valves for each individual cylinders, a pump housing that includes camshafts, and a governor, all of which are integrated into the main unit of the pump.

For the feed of the fuel, the plunger moves up / down and the distribution shaft rotates with the revolution of the camshaft to distribute the fuel among the cylinders individually.

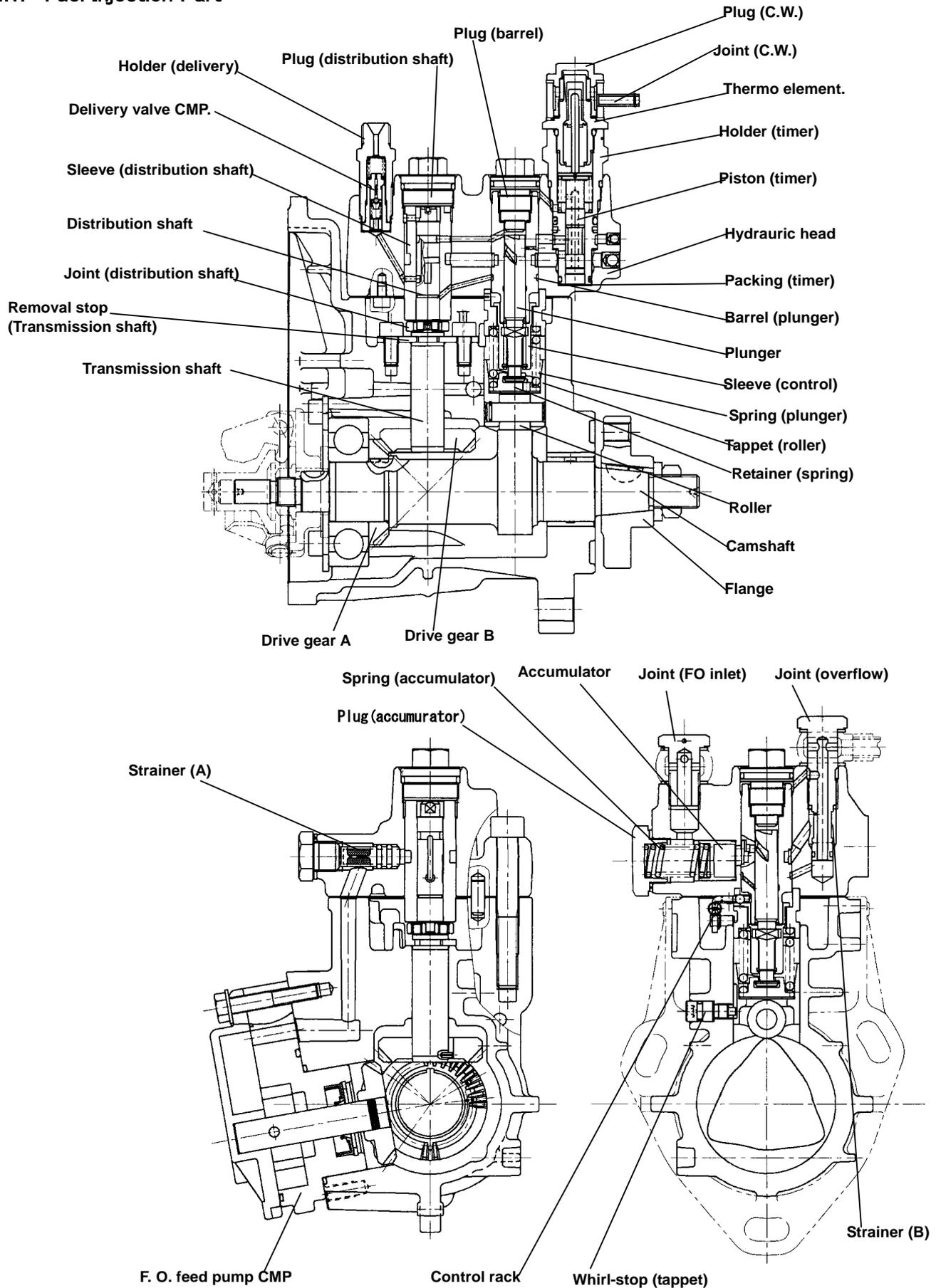
Specifically, one revolution of camshaft completes three cycles (for three cylinder engine) of a process, including switching over to the high pressure flow path to each cylinder with the distribution shaft, opening delivery valve, high pressure pipe, fuel injection valve, and engine cylinders in this order. This process is repeated by the revolution of the camshaft.

### < The Flow of the Fuel >



## 2.4. Construction of MP-Pump

### 2.4.1. Fuel Injection Part



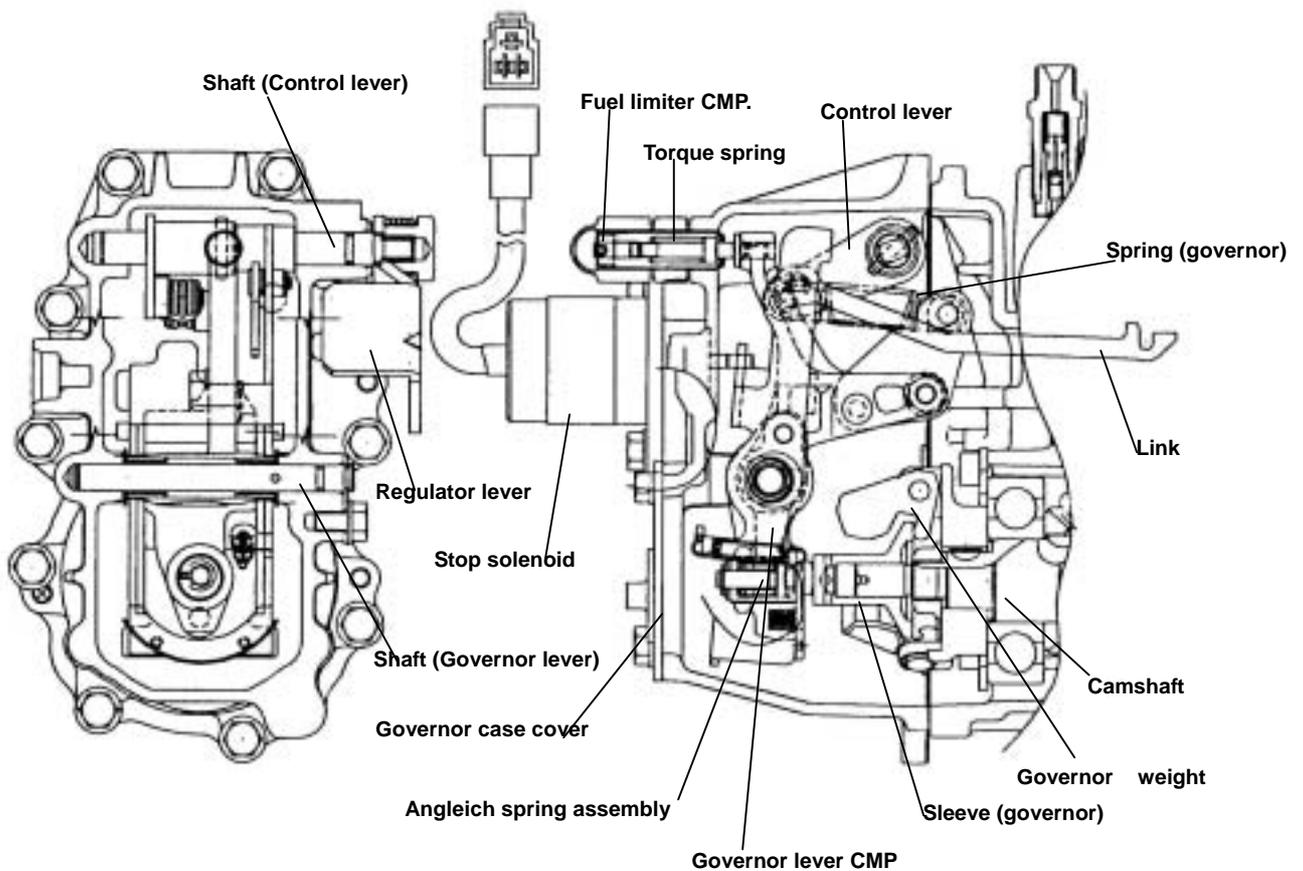
## 2.4.2. Governor Part

### 2.4.2.1. Construction of Governor

Usage condition of diesel engines are extremely varied, with a wide range of loads and speeds. The governor plays an important role in the operation of the engine by quickly adjusting the position of the control rack to control the amount of fuel injected, according to changes of engine speed.

It also automatically controls the engine to prevent engine speed from exceeding the maximum, and keeps the engine from stopping.

- Mechanical governor



The governor weight mounted on the end of the fuel injection pump cam shaft rotates around the governor support pin, driven by the cam shaft, and is forced outwards by the centrifugal force acting on the weight.

The thrust force acting on the cam shaft due to this centrifugal force acts on the lower part of the tension lever through the sleeve. A starting excess fuel spring is mounted on the bottom of the tension lever.

One end of the governor spring is hooked to the right upper end of the tension lever, and the other end to the spring lever of the control lever shaft.

As the spring lever and control lever are mounted on the same shaft, when the control lever is turned towards full, the governor spring is pulled and the load gradually increases.

Since the tension lever can move freely around the governor shaft on the player bearing, as speed increases and the shifter is pushed to the left, the tension lever rotates clockwise, and when speed decreases, the tension lever rotates counterclockwise.

The governor lever rotates smoothly on the second shaft installed on the tension lever. The bottom part of this lever is in contact with the sleeve through the shifter, which is in contact with the bottom of the tension lever through the excess fuel spring. It therefore moves with the tension lever according to increases/decreases in engine speed.

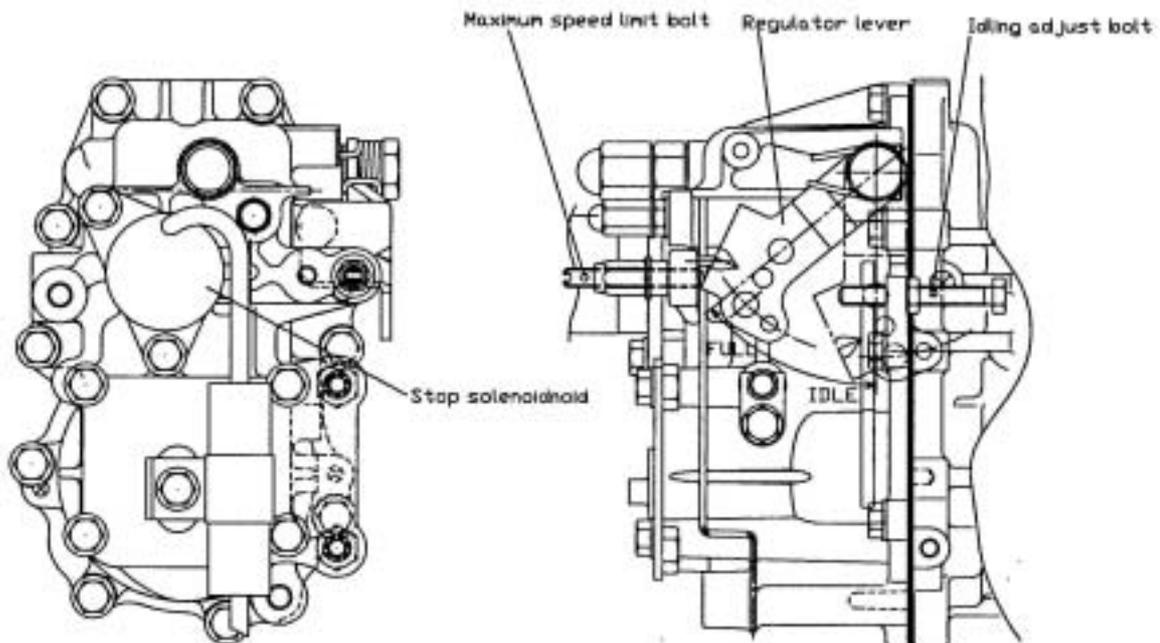
The top of the governor lever is connected to the fuel pump control rack through the governor link. The movement of the lever controls the volume of fuel injected by the pump. When speed increases the lever rotates clockwise to cause the control rack to reduce fuel and when speed decreases the lever rotates counterclockwise to cause the control rack to increase fuel, thus engine speed is controlled.

The top of the tension lever comes in contact with the stopper built into the top of the governor case to limit the maximum fuel injection volume.

#### (1) Shape of control and stop levers

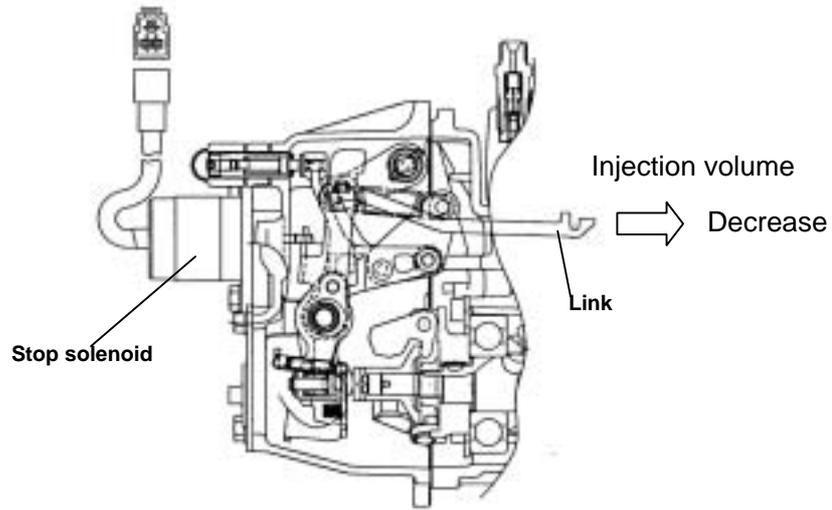
The control and stop levers that operate the governor have different shapes depending on engine design and method of attachment, as seen in the pictures below.

The motion of the control lever is regulated by the maximum speed adjustment bolt and the idling adjustment bolt. This maintains the necessary engine speed.



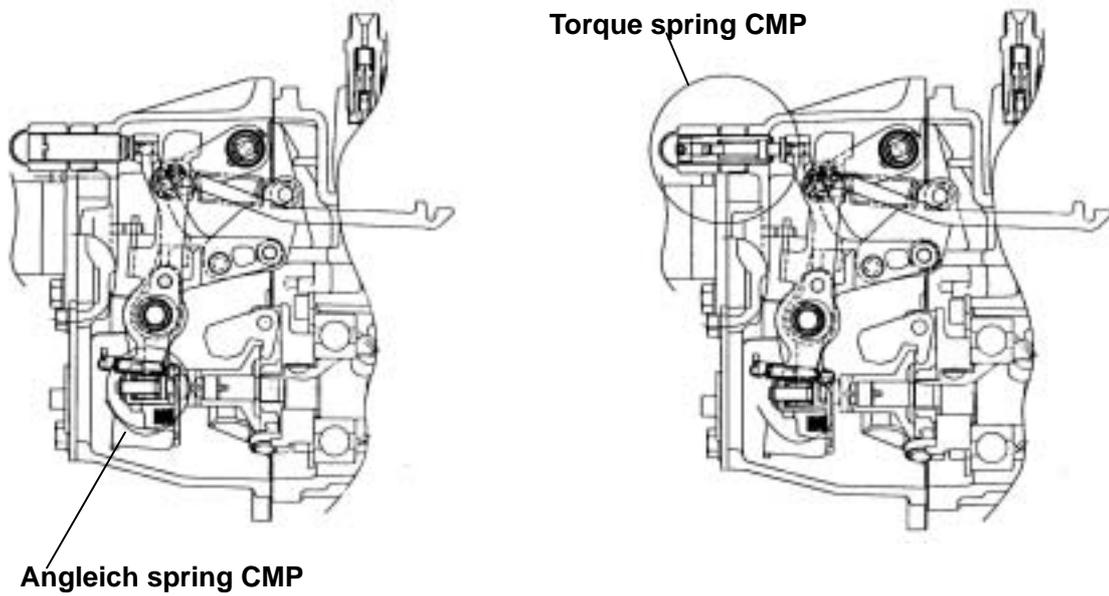
(2) Engine stop device

The magnetic solenoid is equipped to stop the engine.



(3) Torque rise equipment

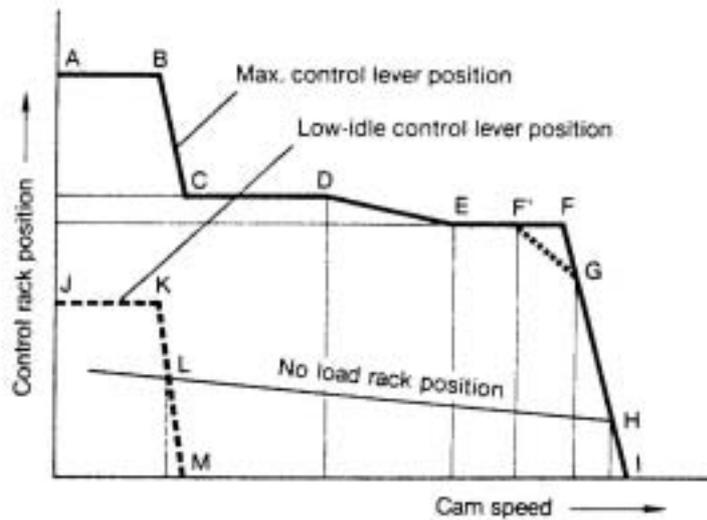
As mentioned before, this governor has a structure that allows you to equip it with an angleich and/or torque spring as torque rise equipment. In this way the requirements for different engines can full filled.



### 2.4.2.2. Function of Governor

#### (1) Function of governor

Following is a representation of the movement characteristics of the control rack at respective speeds, when the speed rise from 0, with the governor control lever at the maximum speed position:



A-B : Fuel volume condition during starting. Volume is controlled by excess fuel spring.

B-C : The rack moves towards decrease after engine starts and speed increase as the load of the excess fuel spring is overcome by the centrifugal force of the governor weight.

C-D : High torque at low speed is developed by increasing fuel injection volume equivalent to the angleich stroke.

D-E : Condition when the thrust force exceeds that of the angleich spring force on the bottom of the tension lever and it gradually pushes the rack to decrease fuel when engine speed increases.

E-F : Condition when both right and left ends of the shifter come in contact with the sleeve and the bottom of the tension lever, and the control rack is kept at the normal position by the stopper. (max. injection volume position on models not equipped with an angleich spring)

F : Point when governor starts to take effect.

This is the rated output of the engine.

F' : Point when governor start to take effect on models with torque spring.

G : Continuous rating point (usually 85—90% injection volume of F point).

H : No load max. speed

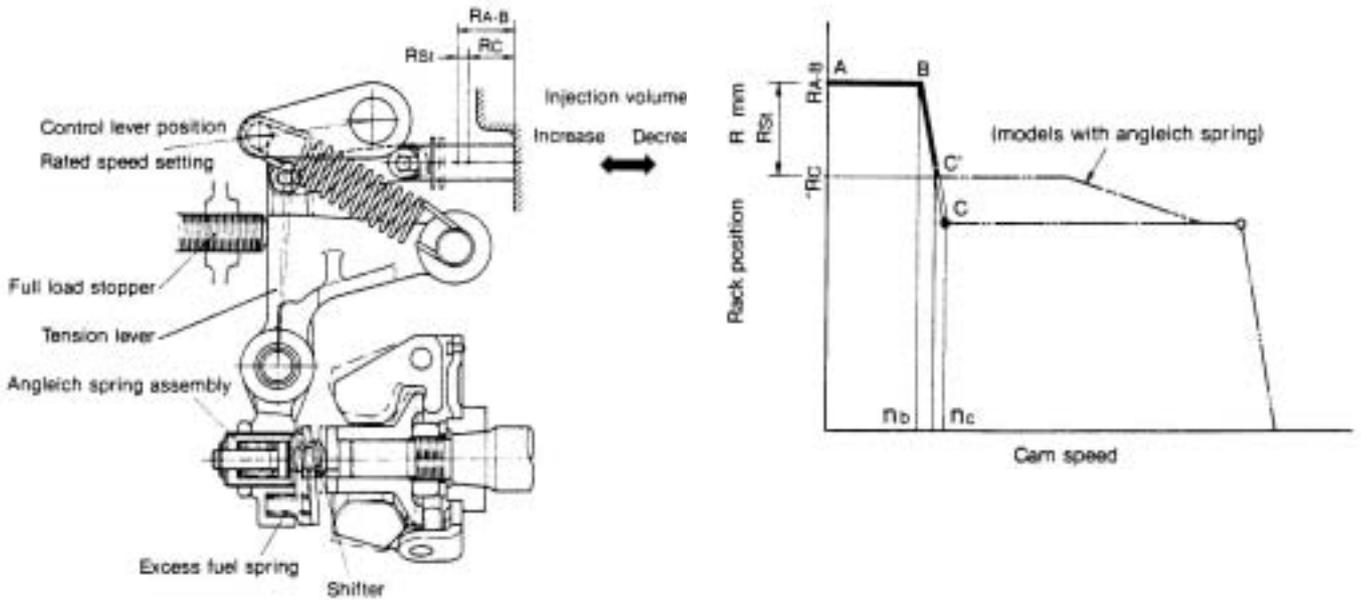
L : Low-idle position

(2) Starting control

Moving the control lever to the max. speed position pulls the governor spring, and moves the tension lever until it comes in contact with the control stopper.

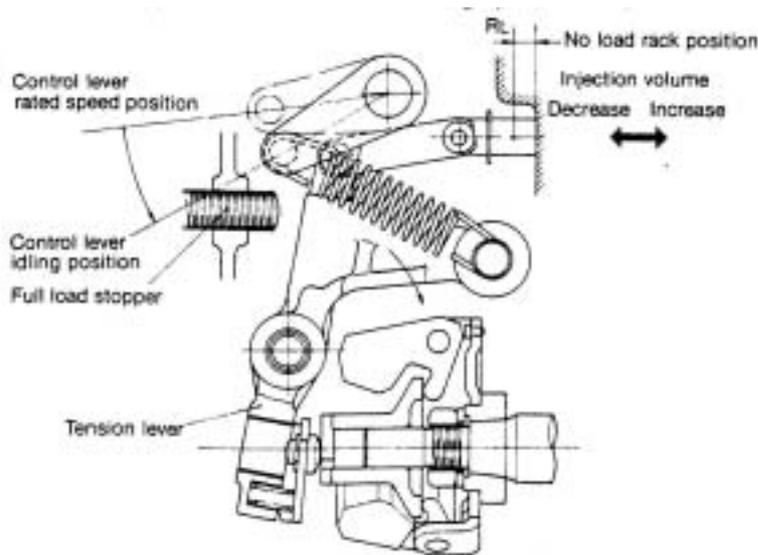
When this is done, the excess fuel spring provided in between the tension lever and governor lever holds the control rack at the maximum starting injection volume position RA-B.

After the engine is started, the excess fuel spring is compressed when the centrifugal force of the governor weight overcomes the set of the excess fuel spring as speed exceeds Nb, speed goes from B to C' (on models with angleich spring) or B to C (on models without angleich spring). The rack reaches the position of Rc where the governor lever and tension lever are interlocked.



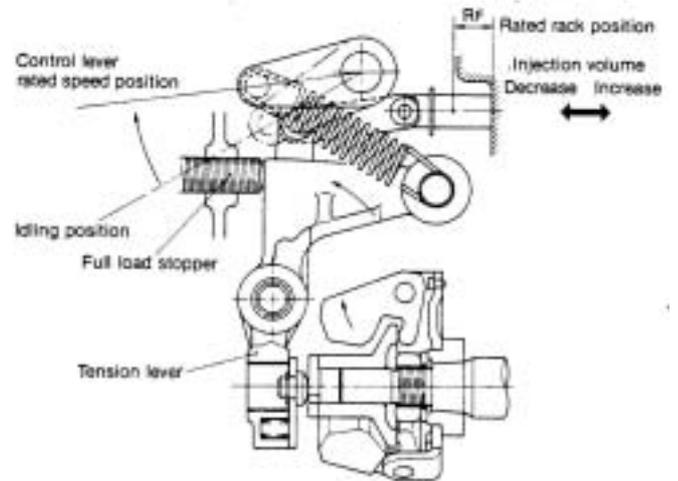
(3) Idling

When the control lever is returned to the idling position after the engine is started. the governor spring tension decreases and the tension lever descends clockwise, and the governor weight load keeps the governor spring and the excess fuel spring load in equilibrium to maintain idling speed at (RL).



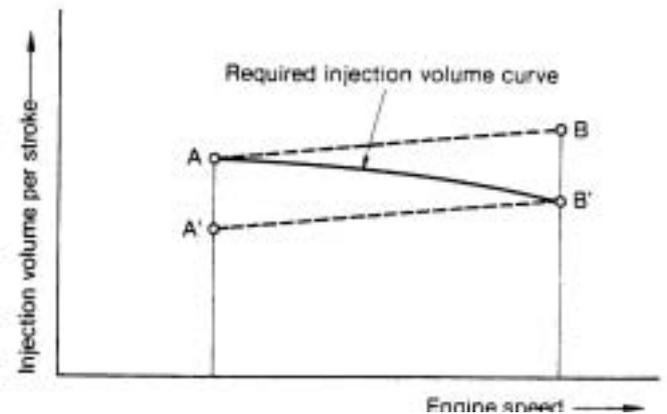
(4) Max speed

The angle of the control lever is set at determined engine speed. The governor keeps engine speed constant by adjusting speed when load changes. For example, if the operator moves the control lever with the link from the idling position to max. Output, governor spring tension increases, the tension lever is pulled until it comes in contact with the full load stopper, the movement of the governor lever is transmitted to the control rack via the link, maintaining the full load rack position, and engine speed increase until the governor weight thrust load and governor spring tension come into equilibrium at full load max. Speed.



(5) Necessity and function of angleich

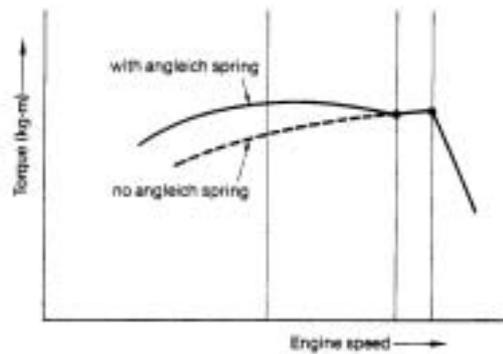
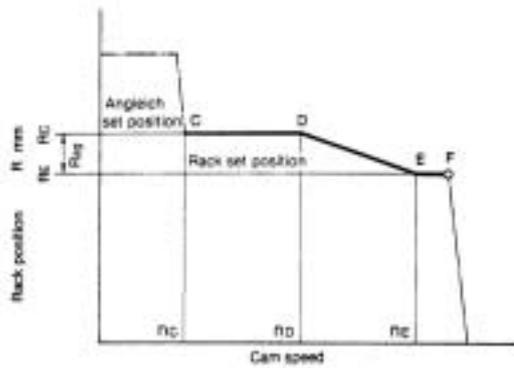
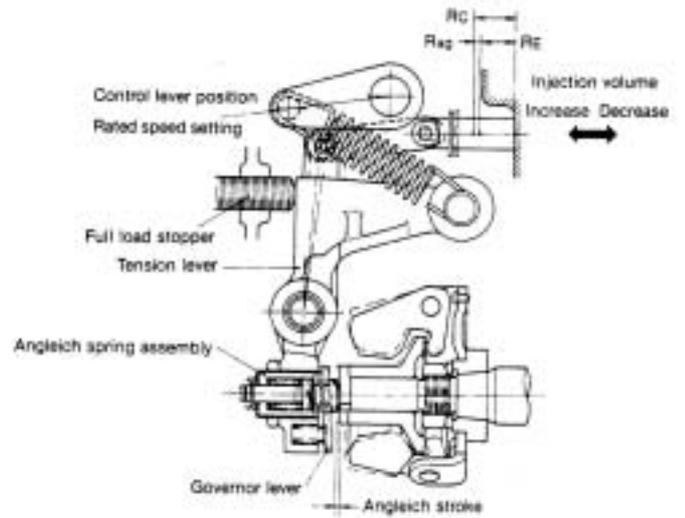
The governor must satisfy the required injection curves represented in the diagram below in order to obtain sufficient output at low speed, and not emit black smoke at high speed. the angleich spring was devised to provide for maximum torque at low speed by setting injection volume at point A, and shifting injection volume to point B' at high engine speed.



The angleich spring is mounted to the part of the tension lever (however some engine are not equipped with an angleich spring depending on usage and speed range utilized).

When engine speed is low, the governor weight cannot compress the angleich spring as the angleich spring load is larger than the governor weight, thrust load, and the control rack is held at a position ( $R_c$ ) to increase injection volume.

Furthermore, as engine speed rise, the angleich spring is gradually compressed as governor weight thrust load increases and exceeds angleich load, before high speed control is effected. When the governor lever and the bottom of the tension lever come into contact (end of angleich stroke), injection volume is reduced by that amount, and the rack reaches the rated position ( $R_e$ ).



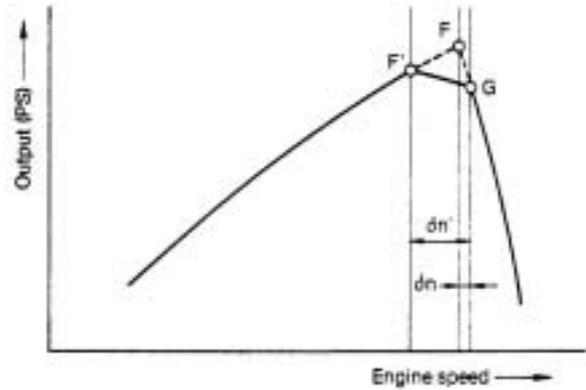
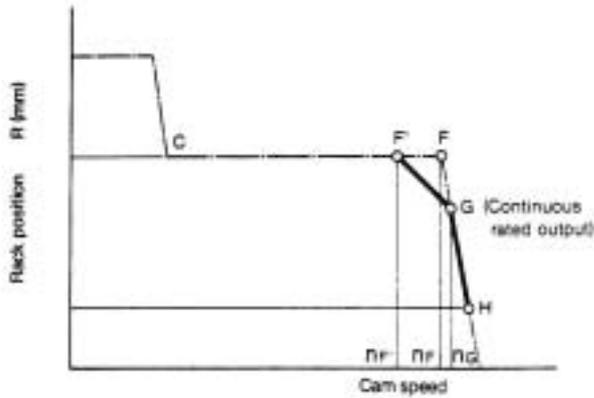
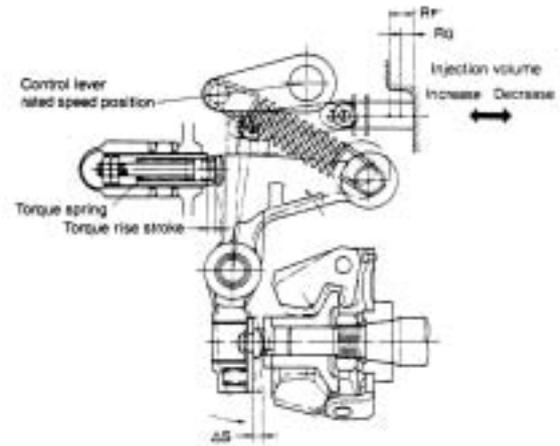
(6) Necessity of torque spring and function

Engines used in construction machinery are subjected to sudden loads which cause a decrease in speed and sometimes results in stopping of the engine. A torque spring is provided to move the control rack towards injection volume increase when engine speed decrease, to increase torque to withstand overloads, and in turn prevent the engine from stopping.

The governor control lever is fixed at point G in the diagram below, the continuous rated output position.

At this time, when engine is loaded, the tension lever encompasses the torque spring, the control rack comes away from full load stopper, and fluctuates between G and H according to engine load.

When the load on the engine exceeds the continuous rated output, speed decrease, governor spring tension exceeds the governor weight thrust load and overcomes the torque spring set load. The tension lever then gradually causes the control rack to move towards injection volume increase via the governor lever and link, and the torque rise stroke ends when the control rack reaches F'.

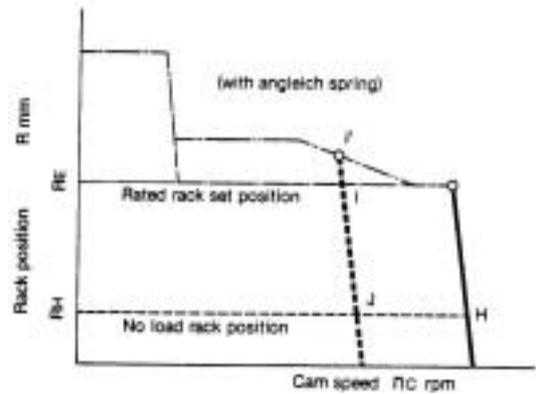
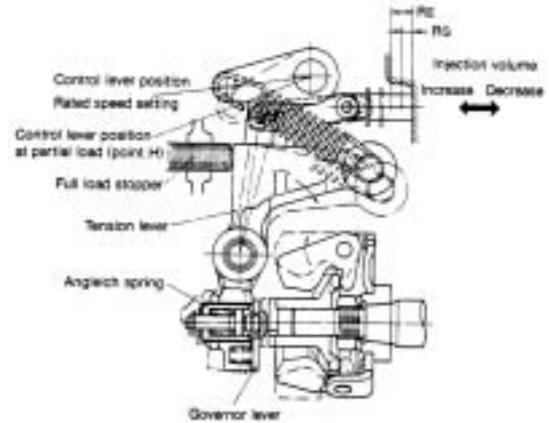


The torque spring thus provides for increasing of injection volume when speed decrease, to increase engine torque and in turn prevent engine stopping due to sudden increases in load, and also provide for strong engine output characteristics.

(7) No load max. speed

When the load decreases from full load max. speed and engine speed further increase, the increased thrust load of the governor weight acting on the governor spring through the tension lever exceeds the set load of the spring, the tension lever and governor lever descend clockwise, the control rack is pushed to the no load injection volume position (RH), and the engine is operated at no load max. Speed.

When the engine is being used at partial load, the governor spring functions in the same way at a lower speed (i, i'-j) as for full load max. Speed, as the governor spring set load is smaller.



(8) Stopping engine

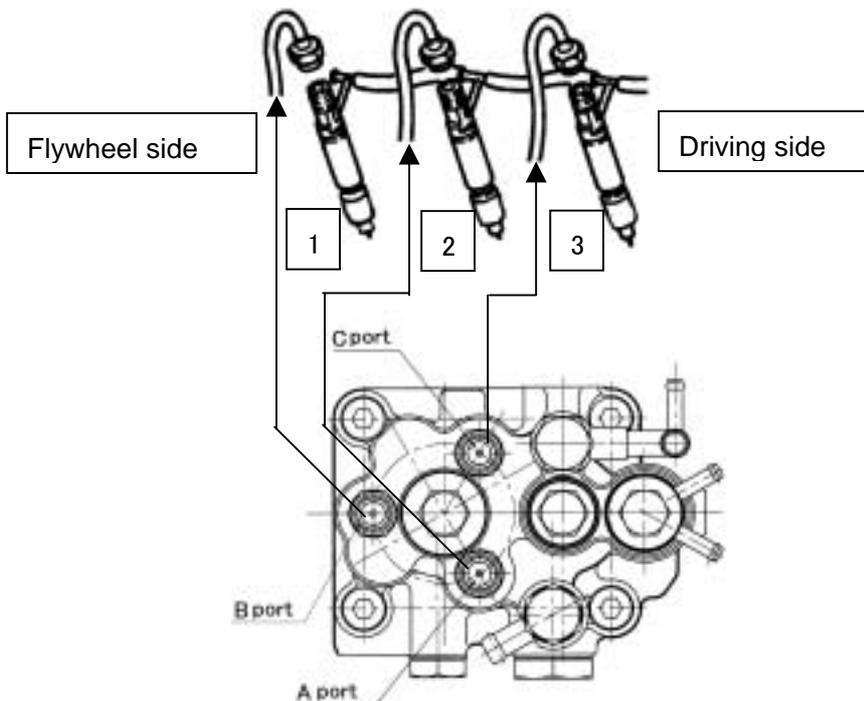
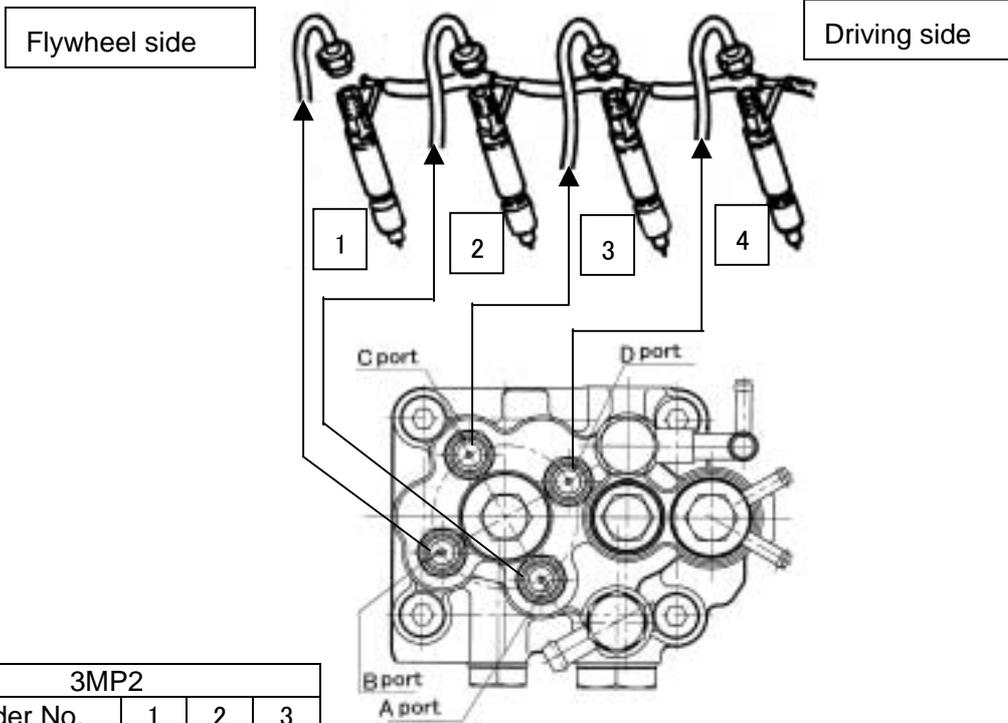
The engine stops when you turn the governor control lever all the way towards stop.

On engine equipped with a stop device, the engine can be stopped by moving the control rack to the stop position, regardless of the control lever position.

### 2.4.3. Delivery Part

#### Delivery Ports and Cylinder Number

4MP2, 4MP4				
Cylinder No.	1	2	3	4
Port No.	B	A	C	D
Injection Order	2	1	3	4



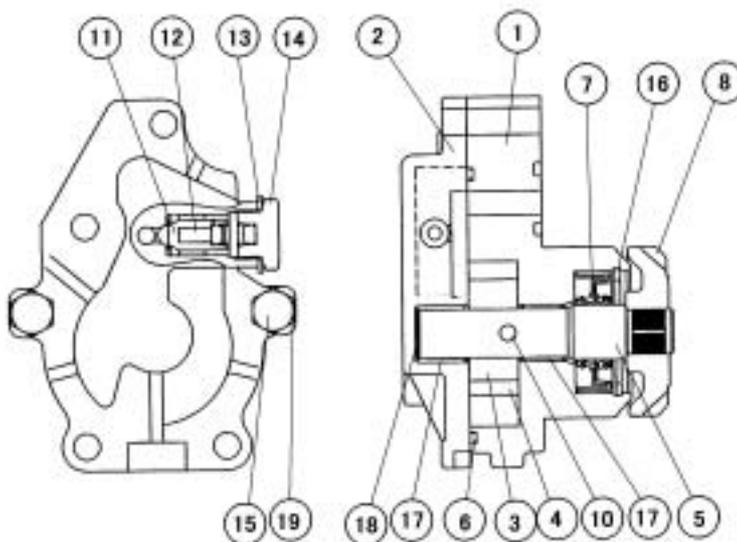
## 2.5. Function of Component

### 2.5.1. F.O. Feed Pump

The FO feed pump feeds fuel oil from the fuel tank to the fuel injection pump via the water separator and fuel filter. The trochoid FO feed pump, installed on the fuel injection pump side, is driven by the fuel camshaft via the bevel gear. This feed pump can feed high pressure fuel oil into the FO injection pump, but while the fuel oil inside the piping is empty due to shortage of gases, etc., the pump's self-feeding performance is low. Accordingly, the manual priming pump with FO filter or solenoid pre-feed pump is used together. The feed pump failure causes the delivery pressure and volume to drop. This, in turn, shortens the service life of the fuel injection pump and causes the pump to become faulty. Replace the feed pump assembly after 10,000 hours' use as a standard.



FO feed pump



- ① Pump case
- ② Pump cover
- ③ Inner rotor
- ④ Outer rotor
- ⑤ Shaft
- ⑥ Molded ring
- ⑦ Oil seal
- ⑧ Bevel gear
  
- ⑩ Drive pin
- ⑪ Relief valve
- ⑫ Spring
- ⑬ Seal washer
- ⑭ Relief plug
- ⑮ Bolt
- ⑯ C-ring
- ⑰ Bush
- ⑱ Thrust washer
- ⑲ Washer

### 2.5.1.1. Specifications of F.O. Feed Pump

	YPD-MP2	YPD-MP4
Suction Head (kPa)	-10	
Std. Delivery Pressure (MPa)	0.4-0.5	0.6-0.7
Std. Delivery Volume (cm <sup>3</sup> /min)	500	600

Pressure & delivery volume figures at conditions below:

Conditions:

Outlet orifice dia. :  $\phi$  0.7mm  
F.O. grade : ISO 8217  
Revolutions : 1000min<sup>-1</sup>  
F.O. temp. : 40 degC (104 degF)

### 2.5.1.2. Inspection of F.O. Feed Pump

- (1) Check for the abnormal flaws and chipping on the bevel gear face. If found to be abnormal, replace the whole feed pump assembly.
- (2) Check for the abnormal flaws or wear on the face contacting with the pump case, pump cover, inner rotor and outer rotor. If wear exceeds 0.1mm, replace the whole feed pump assembly.
- (3) Check for the abnormal wear of the shaft and oil seal moving area. If wear exceeds 0.05mm in depth, replace the whole feed pump assembly.
- (4) When no abnormality was found, just replace the molded ring and seal washer and re-assemble.
- (5) After install the fuel injection pump, operate the fuel injection pump to check that no oil leaks from each part.

## 2.6. Timer Mechanism

When the engine is used in a wide range from low to high speeds, it is necessary to change the fuel injection timing according to the engine speeds for always keeping the optimum firing timing. It is also necessary to optimize the injection timing for reducing noise and exhaust gas emissions.

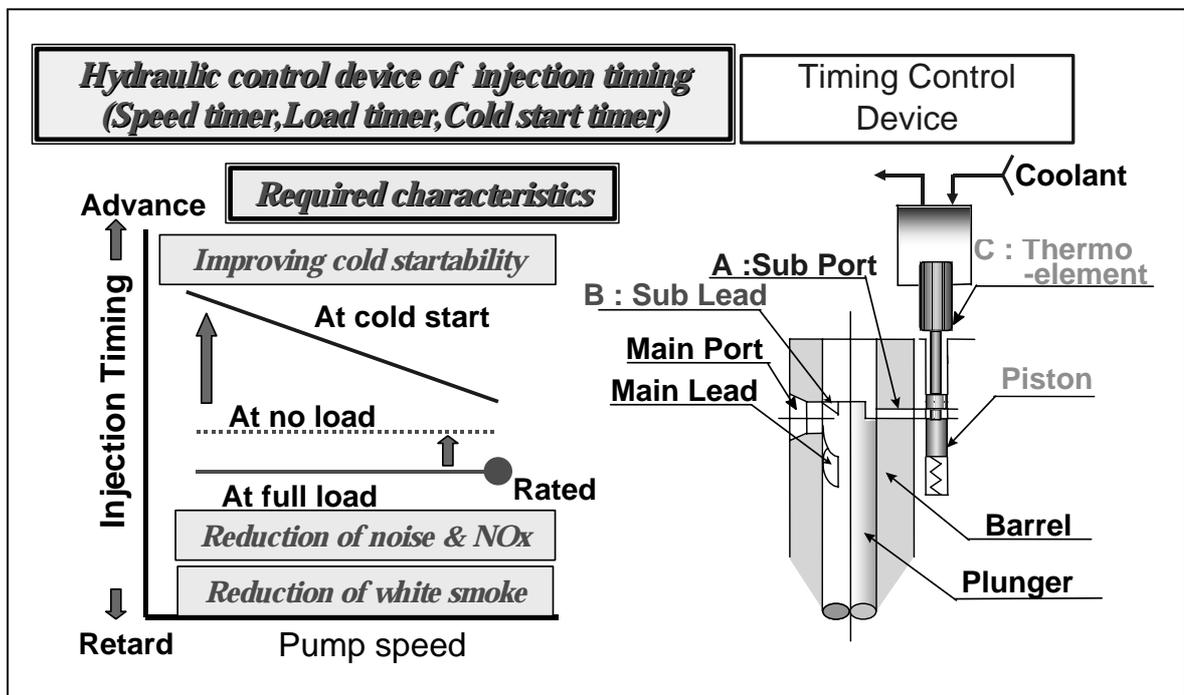
This pump has the timer mechanism for revolutions, load and cold starting.

### 2.6.1. Structure and Functions

The engine speed timer is the mechanical timer which uses the oil leakage from the small diameter sub spill port installed slightly upper side of the main spill port of the jerk pump. When the engine speed is high, pressure rises before oil leaks from the small diameter port and injection is started. But when the engine speed is low, pressure does not rise until the port blocked by the plunger and the injection start is delays. Usually, the lower the engine speed, further the injection timing advances. But this engine speed timer prevents the injection timing from advancing during the low engine speed ranges and thus the noise and Nox. emissions can be controlled.

The fewer the injection amount, the earlier the load timer causes the main port to close by the plunger's upper lead for advancing the injection timing. This feature is instrumental in preventing misfire or emission of bluish white smoke during low load operation.

The cold start timer causes the sub port to be blocked only under cold temperatures for accelerating injection timing and facilitating in cold starting. The timer houses the thermo element and cooling water circulates around the temperature sensing section. The thermo-element senses the coolant temperature for adjusting the control piston. The sub-port is blocked when the temperature is lower than the set temperature and the pressure is raised earlier than in the normal temperature for advancing the injection timing. When the temperature exceeds the set temperature, the sub-port is opened and the regular injection characteristics are recovered.



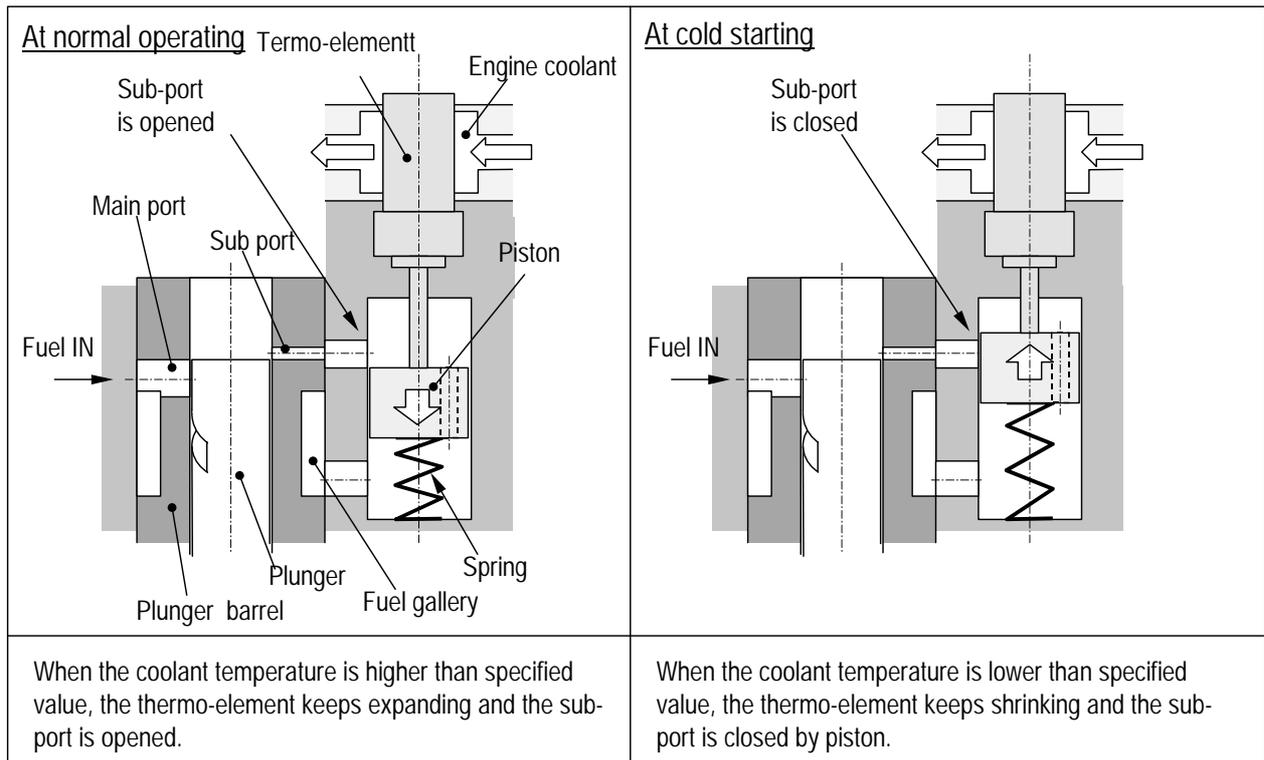
## 2.7. C.S.D.(Cold Start Device)

### 2.7.1. Cold Starting Advancer

#### Purpose

In order to facilitate easy engine starting under cold temperatures, the advancer senses the cooling water temperature for advancing the fuel injection timing.

#### 2.7.1.1. Structure & Function

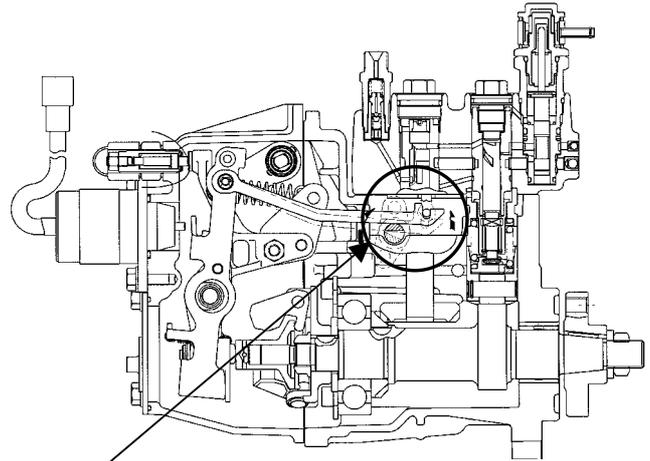


# 3. Disassembly ,Reassembly and Inspection

## 3.1. Disassembly

Disassembled parts must be put aside in order.  
Wash them before reassembly.

### 3.1.1. Separating the pump body from the governor body



Rotating the link lifter will move the inside link upward/downward, so the control rack may be engaged/disengaged.



Install the pump body to the disassembly table.



Remove the bolt fixing the pump and governor bodies.



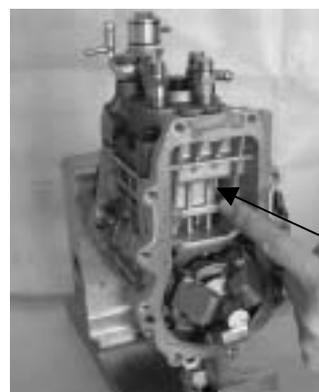
Remove the link lifter fix bolt.



Separate the governor from the pump body.



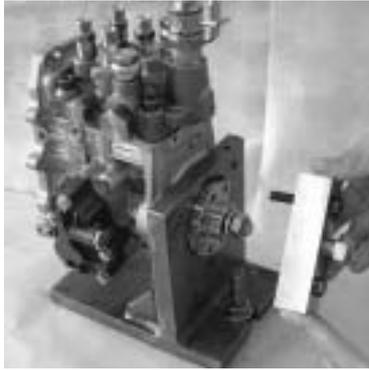
Turn the link lifter plate counterclockwise.



Link insertion window

The pump body separated from the governor body

### 3.1.2. Separating the governor weight CMP



Providing whirl-stop to the camshaft



Example of whirl-stop



Remove the nut, (governor support).

### 3.1.3. Disassembling the hydraulic head

Disassembling the hydraulic head



Remove the joint, (FO inlet pipe).

### Disassembling the delivery valve



Remove the holder, (delivery).



Remove the delivery valve and gasket.



Delivery valve parts disassembled. (Take care not to mix these with other parts on reassembly. Reassemble these to the original port as a set.)



Remove the delivery valve and gasket.  
Remove gasket



Remove the distribution shaft.

Removed parts must be stored in the cleaning oil sump.



Remove the holder and gasket, (timer)



Remove the plug and gasket, (barrel).



Remove the plug, (accumulator).

Make sure that the seal washer remains on the plug.



Remove the plug, (C.W.) and the joint, (C.W.)



Parts disassembled.



Remove the thermo element.

### 3.1.4. Separating hydraulic head CMP



Remove the hydraulic head CMP fixing bolt.



Remove the hydraulic head CMP.

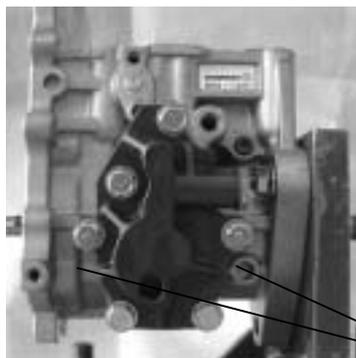


Remove the packing.

### 3.1.5. Separating the cam shaft



Remove the joint, (distribution shaft).



Remove the feed pump.

Do not loosen two bolts (A)



O-ring

Make sure that two O-rings are free from damages.



Remove the removal stop, (transmission shaft) fastening bolt.





Remove the whirl-stop, (tappet).



Take out the tappet.



Tappet disassembled and FIC adjust shim.



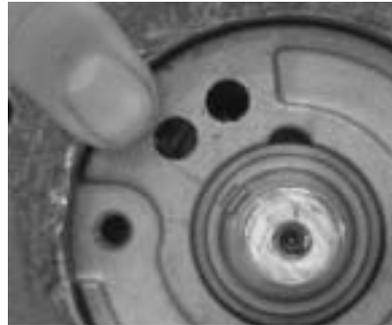
Remove the retainer, (bearing) fastening bolt.



Remove the retainer, (bearing).



Lift the transmission shaft slightly by your hand.



Align the camshaft's key groove with the embossed mark on the body.



Lift the transmission shaft a little and pull out the camshaft.



Camshaft extracted



Remove the transmission shaft CMP.



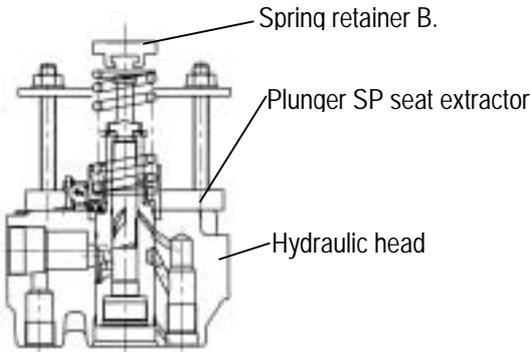
Remove the transmission shaft CMP.

### 3.1.6. Disassembling the hydraulic head CMP



Compress the plunger spring and remove the spring retainer, (B).

While compressing the plunger spring using special service tool, remove spring retainer B.



Remove the rack return spring.



Remove the rack guide fastening bolt.



Remove the spring retainer.



Remove the control sleeve.



Remove the plunger.



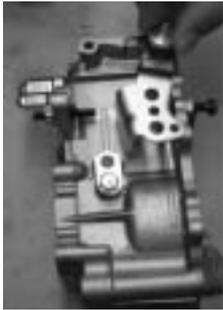
Cleaning oil sump



Cleaning oil sump

Parts removed from hydraulic head CMP  
Disassembled parts must be separately stored in the cleaning oil sump.

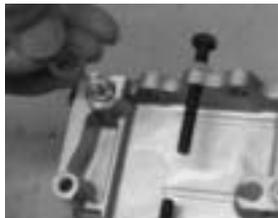
### 3.2. Disassembling the Governor



Remove the lock nut, (Control lever).



Remove the regulator lever.



Remove the shim.



Remove the removal stop. (governor lever shaft) fixing bolt.



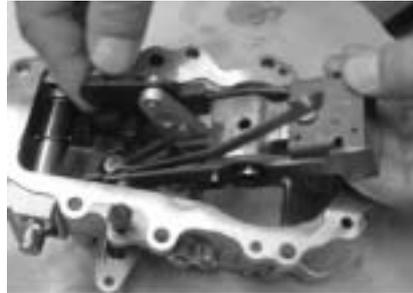
Remove the removal stop, (governor lever shaft).



Pull out the governor lever shaft.



Removed governor lever shaft



Take out the governor lever CMP.



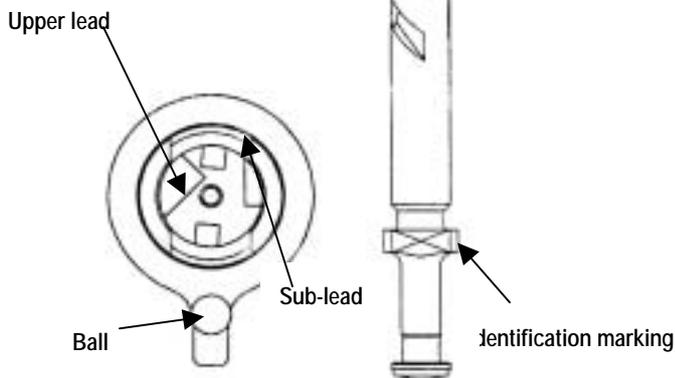
Remove the spring.

## 3.3. Reassembly

### 3.3.1. Re-assembling the hydraulic head



Install the plunger.



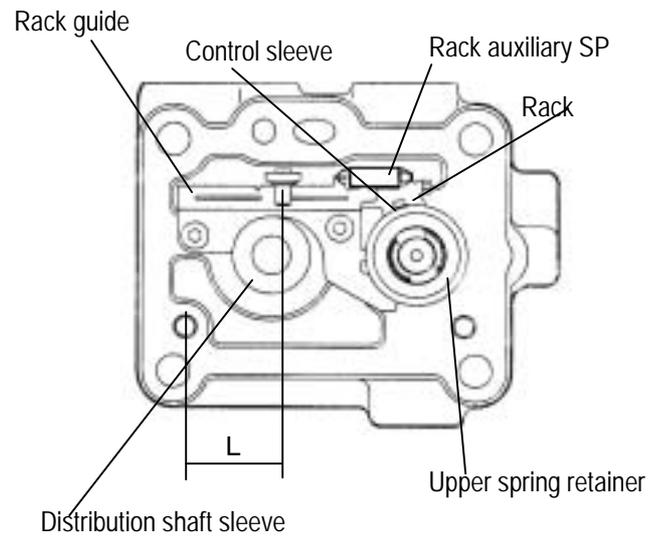
- Note that the positional relationship of the upper lead and sub-lead of the plunger and the ball of the control sleeve is as shown below. (Plunger identification marking (such as "W4") and the ball of the control sleeve are oriented in the same direction.)
- Be careful that the plunger is NOT inserted upside down.



Install the control sleeve and spring retainer.



Install the rack guide.



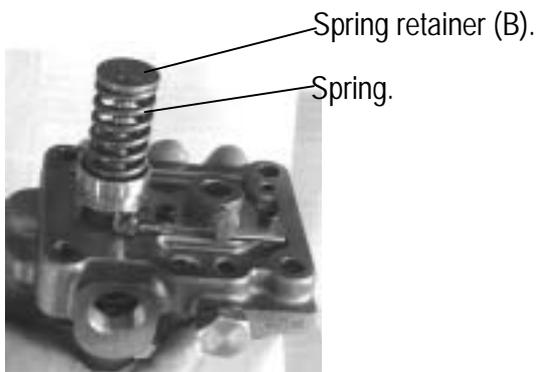
Attaching rack and rack guide

- When installing rack guide, push it against the distribution shaft sleeve and upper spring retainer so that the rack is in parallel with the direction of camshaft. ( $T = 3$  to  $4 \text{ N}\cdot\text{m}$ )
- Movable range of rack is to be equal to or larger than  $\pm 7 \text{ mm}$ .
- Fix the rack at the position of  $L = 25$ , and measure the effective stroke and sub-step (overflow stroke) to check that they are within the standards (Refer to attached drawing 1.)
- The rack must not separate from the ball of the control sleeve within the movable range.
- Fix the plunger with a jig and measure the total backlash. (To be equal to or less than  $0.2 \text{ mm}$ )
- The load of rack auxiliary SP must be able to return the rack from the maximum decreased position to the maximum increased position).



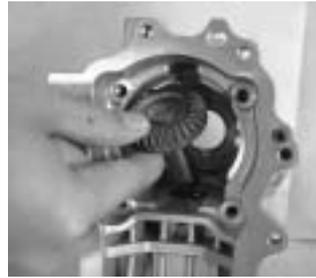
Install the rack guide fastening bolt.

Tightening Torque : 3.9-4.9 N-m

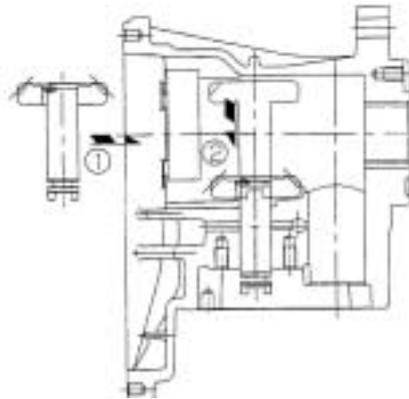


Install the plunger spring and spring retainer (B).

### 3.3.2. Re-assembling Cam Shaft



Install the transmission shaft CMP.

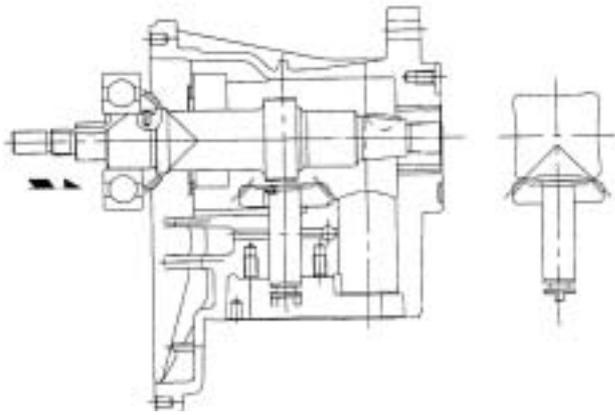


Attaching transmission shaft CMP

- Apply molybdenum disulfide to the shaft section.
- Check that the transmission shaft rotates



Install the camshaft.



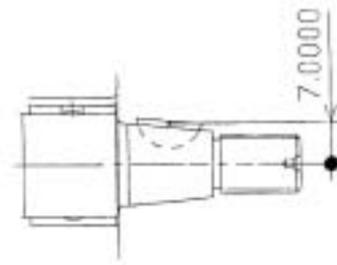
Install the camshaft.

#### Attaching camshaft

- Apply molybdenum disulfide to the bushing or the bearing.
- Insert the camshaft into the pump body with transmission shaft CMP at the lowered position (gear B touching the pump body).
- Be careful that the cam and gear B do not interfere with each other.
- (Especially for 4 cylinder engine, note that the phase in which the cam passes is limited.)
- The shaft can be inserted with the key of the driving side press-fitted to the camshaft.

Be careful not to damage the camshaft bushing.

Tightening Torque : 8-10 N-m

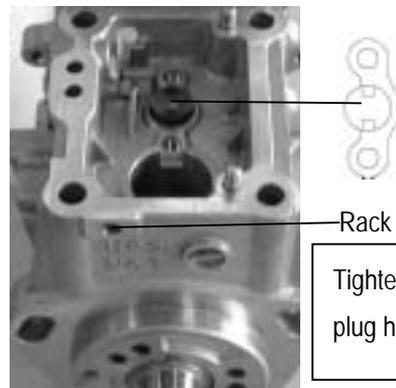


#### Checking backlash

- Rotate camshaft to check that transmission shaft rotates smoothly.
- Fix transmission shaft from upper surface of the housing, and turn the camshaft to check the backlash.

Backlash must be in the range from 0.2 to 1.5 degree.

Note: When measuring at the position of camshaft driving side key (at the center of the key as shown below), the displacement must be in the range from 0.03 to 0.25.

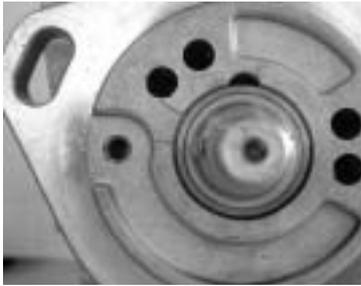


Rack plug

Tighten the rack plug. (If rack plug has been removed.)

Tightening Torque : 79-84 N-m

Position the transmission shoe of the transmission shaft CMP as shown in the illustration.



Position the camshaft key groove as shown in the illustration.

**Engagement of gears**

- With the phase of camshaft and collar of transmission shaft set in the direction as shown below, engage gears A and B with each other. (Check that the match mark of gear B and the mark of gear A shown below are aligned with each other by looking through the feed pump installation hole.)
- When inserting the stopper pin, do not raise the transmission shaft excessively, or the gears will be disengaged. (Check the engagement again after inserting the stopper pin.)
- The positions of the collars of transmission shaft are not limited only if either one is at the top or bottom as shown

Transmission shaft angle		
Camshaft angle (as viewed from drive side)		
	4 Cyl	3 Cyl
	MP2	
	MP4	

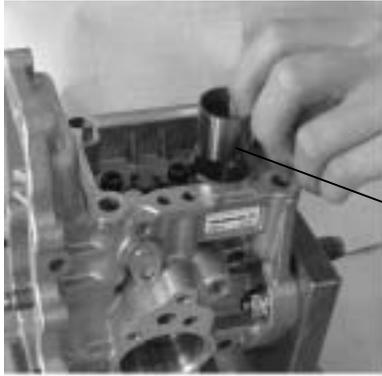


Install the removal stop, (transmission shaft).



Fasten the removal stop, (transmission shaft).

Tightening Torque : 8-10 N-m



Whirl-stop groove

Install the tappet.

Direct the tappet's whirl-stop groove as shown in the illustration.

**Assembling tappets**

- Insert tappet into the pump body with the slit directed toward the lock side, and attach the tappet lock. (T = 4 to 5 N·m)
- Turn the camshaft to check that the tappet moves up and down smoothly.

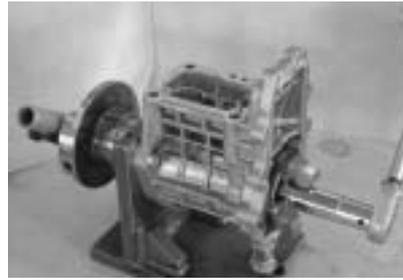


Install the whirl-stop, (tappet).

Tighten the tappet, while moving it upward and downward.



Install the governor weight CMP and nut, (governor support).

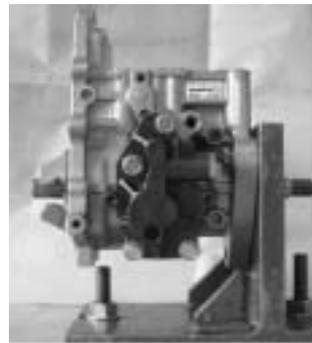


Fasten the nut, (governor support), (and provide the whirl-stop to the cam shaft.)

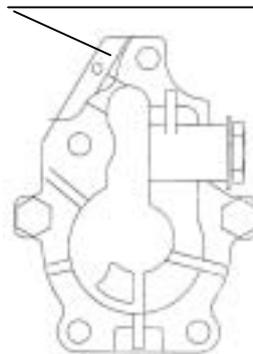
Tightening Torque : 79 - 84 N·m



Install the feed pump.



Identification hole (  $\phi$  3, depth 2 mm)



**Identification of feed pump**

Spec.	$\phi$ 3 identification hole
General purpose	Not provided
TK	Provided

Note that the identification hole can be seen only when looking from obliquely above because it is located on the pump case side.

### 3.3.3. Install the hydraulic head CMP.



Install the hydraulic head CMP.

Insert the two positioning pins. Be sure not to confuse packing front with rear surface. (Align them with holes on the body.)



Install the joint, (transmission shaft).

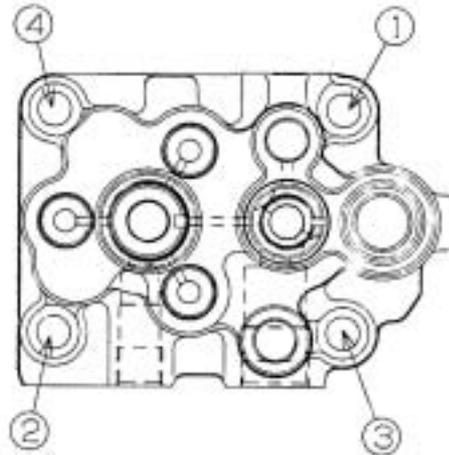


Assemble the FIC adjust shim inside the tappet.



Install the hydraulic head CMP.

While hand pressing the hydraulic head, temporarily tighten the tightening bolts. Then, tighten them with specified torque.



Installing H head

- Assemble shims with an appropriate thickness that corresponds to the measurement of the bottom clearance (refer to attached drawing 3).
- Temporarily tighten the hexagon socket head bolts evenly in the order as shown below until the surfaces of H head and pump body contact with each other, and subsequently tighten to the specified torque in the same order.
- After assembling H head, check the top clearance again.
- After assembling H head, push the rack from governor side to check that the rack is returned with the force of rack auxiliary SP.
- When reassembling H head, be sure to replace the head packing with new one.



Install the hydraulic head CMP fastening bolt.

**Important**

Tightening Torque : 18-22 N-m

Tighten the bolts in diagonal order, while checking the torque with torque meter.



Measure the plunger top position.

Bottle clearance adjustment should refer to Page 59.

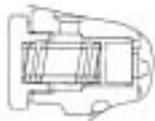
### 3.3.4. Assembling the Hydraulic Head



Install the accumulator.

#### Attaching accumulator

- Be sure to install the piston in the correct direction.
- Make sure that the piston can slide smoothly.



Install the spring, (accumulator).



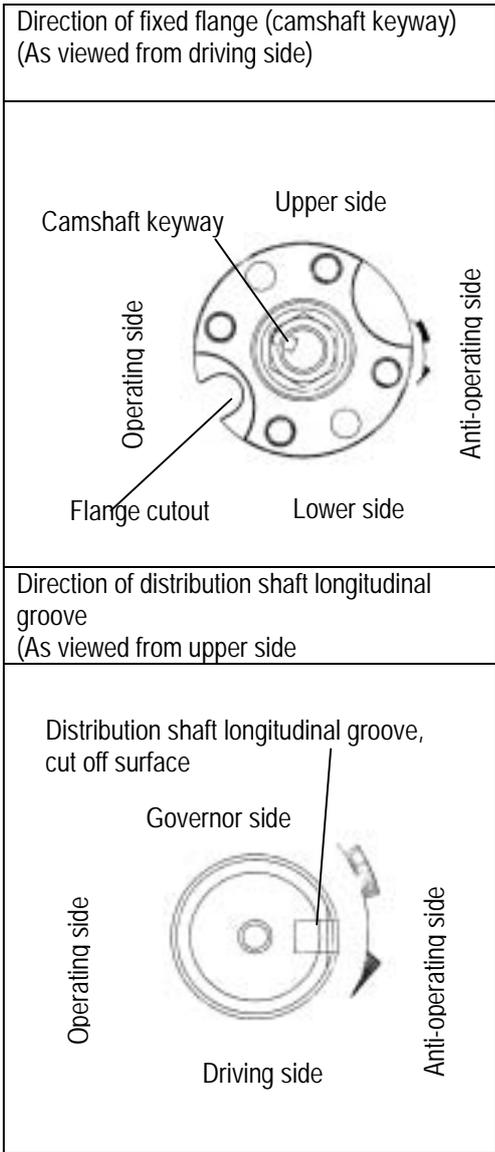
Install the plug with new seal washer, (accumulator).



Install the distribution shaft.

Inserting distribution shaft

- Insert distribution shaft so that the directional relationship between the shaft and camshaft is as shown below (Do not assemble upside down).
- Use the following drawing simply as a reference because the component can be inserted in either of two orientations.
- Insert the component securely into the distribution shaft joint until it is sunk below the end surface of the distribution shaft sleeve.





Install the plug, (distribution shaft).



Fasten the plug, (distribution shaft).

Tightening Torque : 10-15 N-m



Install the plug with new copper packing, (barrel).



Fasten the plug, (barrel).

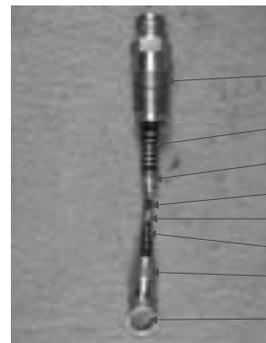
Tightening Torque : 30-35 N-m



Install the new packing, (delivery valve seat).



Install the delivery valve CMP.



- Holder (delivery)
- Spring (delivery)
- Valve (delivery)
- Returnvalve (φ 2)
- Spring seat (return valve)
- Returnspring
- Seat (delivery)
- Packing (delivery)



Install the spring, (delivery).



Install the holder, (delivery).

Tightening Torque : 40-45 N-m



Install the new packing, (timer).



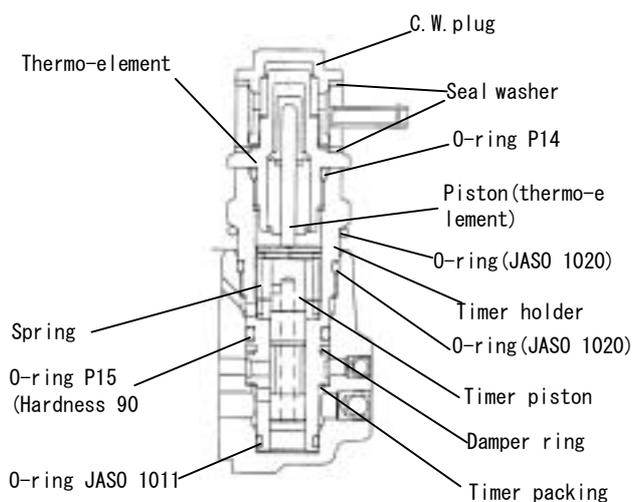
Fasten the holder, (timer).



Install the holder with new O-ring, (timer).



Install the thermo-element with new O-ring.

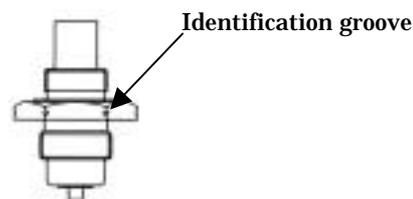


\* JASO : Japanese Automobile Standard

- Do not forget to assemble the timer packing, (at holder bottom).
- Do not forget to assemble the damper ring.
- Take care not to use O-rings with inappropriate sizes.

Check that the timer piston moves smoothly in the timer holder hole (clearance: 4-8 micron m).

- Before installing the thermo-element, press down the piston with the timer holder being installed to the head, ( $T=40-45N.m$ ), and check that the piston returns up through the spring load.
- The standard thermo-element release temperature shall be 5-8 degC (41-46.4 degF). (Thermo-element released at 15-18 degC (59-64.4 degF) is available as option. Take care not to mistake the specifications: see diagram below.)



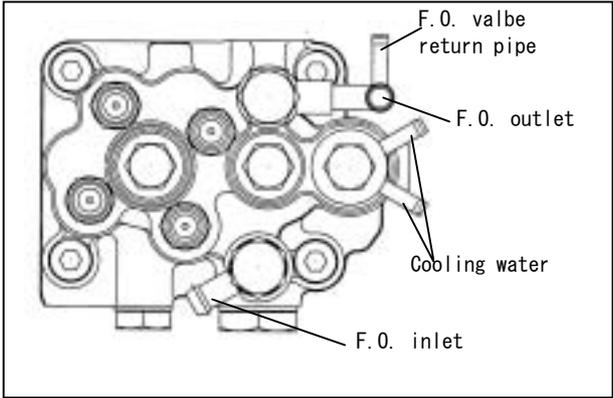
Thermo-element for 15~18 degC

- Do not pull out the piston housed in the thermo-element manually. If it is extracted manually, discard it since the re-use of the piston is no longer possible.
- Do not tighten the thermo-element with excessive tightening torque, ( $T=30-35N.m$ ).
- Do not tighten the cooling water plug with excessive tightening torque, ( $T=22-25N.m$ ).
- Take care not to catch impurities in the seal washer.



Fasten the thermo-element.

Tightening Torque : 30-35 N-m

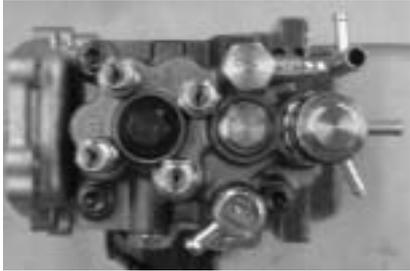


Install the joint, (C.W), and he plug, (C.W.)

Assemble the seal washers, taking care not the washer stride over steps. (One seal washer is required for respective upper and lower portions.)



Install the joint, (FO inlet).



Installation position of Joints

Direction of pipe depends on respective specifications.

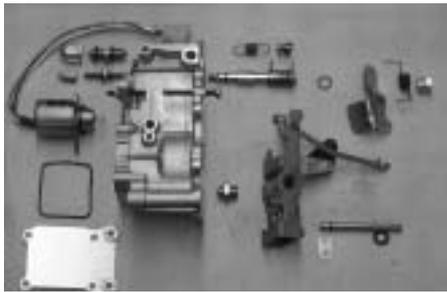


Fasten the plug, (C.W.)



Install the joint, (overflow) and the joint, (overflow).

### 3.4. Re-assembling the Governor



Governor Body Parts



Governor Lever CMP End Float Adjust Shim



Pierce the governor lever CMP and shim through the governor lever shaft and assemble.

Measure the side clearance of the tension lever with thickness gauge.  
Standard: 0.3 to 0.6 mm (adjusting with shim)



Fit the governor lever shaft with the removal stop, (governor lever shaft) and fasten the removal stop bolt.



Install the shim to the shaft, (control lever).



Install the regulator lever.



Pierce the spring, (control lever) through the lock nut, (control lever) and fasten it to the thread of the shaft, (control lever).



Fasten the nut, (control lever).

Tightening Torque : 19.6-24.5 N·m

Measure the side clearance with thickness gauge.  
Standard: 0.3 to 0.6 mm (adjusting with shim)

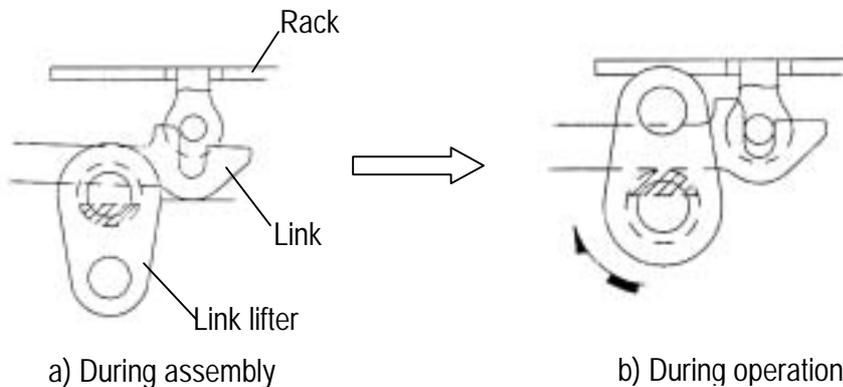
### 3.5. Combining Governor and Pump Bodies



Turn the link lifter plate counterclockwise, and install the governor body to the pump bodies

Install the new packing.

Do not confuse front with rear surface. Assemble it, while aligning bolt holes with those on the body.



#### Attaching governor CMP

- Be careful not to bend or damage the governor case packing (GRC). (It is not reusable. If it sticks to the packing surface, remove it without giving damage to the surface of the packing.)
- Direct the link lifter as shown in Fig. a) shown below, where the semicircular section is positioned at the lower side, and bring governor CMP to the pump body until the link comes into contact with the rack.  
At this time, be careful that the link does not hit the pump body. (If the link hit the pump body severely, check that the link is not bent or deformed.)
- Direct the link lifter as shown in Fig. b) shown below, where the semicircular section is positioned at the upper side, and engage the rack and the link with each other.  
At this time, if it is difficult to engage the rack and the link with each other, assemble them while pushing the governor lever to the decreasing side (when mechanical governor is used).
- After putting the link lifter in the state shown in Fig. b), pull the governor CMP a little to check that the link and rack are engaged with each other. (Be sure not to pull governor CMP excessively).  
(If the barrel plug is not installed yet, the following method can be used to check the **plunger rotation**.  
Mechanical governor: Push the governor lever to the decreasing side through the solenoid attaching hole.  
New ECO governor: Push the rack to the increasing side through the rack inspection port.)
- Be sure to tighten the link lifter securing bolt. (T = 8 to 10 N · m)



Insert the governor link into the link hole of the pump body.



Fit the link lifter to the installation hole and fasten the bolt.



Pull the governor assembly slightly to check that the link is engaging securely.

Combine Governor and Pump Bodies



Install the new U-ring to the stop solenoid and assemble them to the governor case.

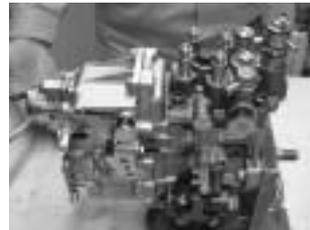
Tightening Torque : 7.8-9.8 N-m



Install a new packing, (governor case cover) to the case.



Install the governor case cover to the case.



This completes reassembly of the pump.

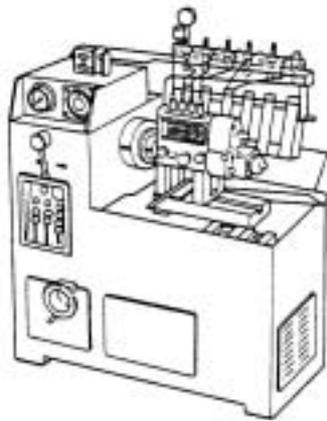
## 4. Adjustment of Fuel Injection Pump and Governor

Adjust the fuel injection pump after you have completed reassembly. The pump itself must be readjusted with a special pump tester when you have replaced major parts such as the plunger assembly, roller guide assembly, fuel camshaft, etc. Procure a pump tester like the one illustrated below.

### 4.1. Preparations

Prepare for adjustment of the fuel injection pump as follows:

- (1) Adjusting nozzle assembly and inspection of injection starting pressure.



Mpa (kgf/cm<sup>2</sup>)

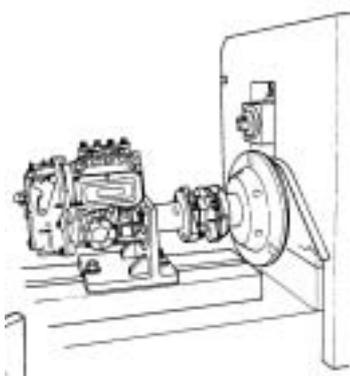
Adjusting nozzle type	YDN-12SD12
Injection starting pressure	16.2 – 17.2(165 – 175)

- (2) Adjusting injection pipe.

mm

Inner dia./outer dia. × length	Φ 2.0/Φ 6.0 × 600
Minimum bending radius	25

- (3) Mount the fuel injection pump on the pump tester platform.



- (4) Remove the plug in the oil fill hole on the top of the governor case, and fill the pump with about 200cc of pump oil or engine oil.



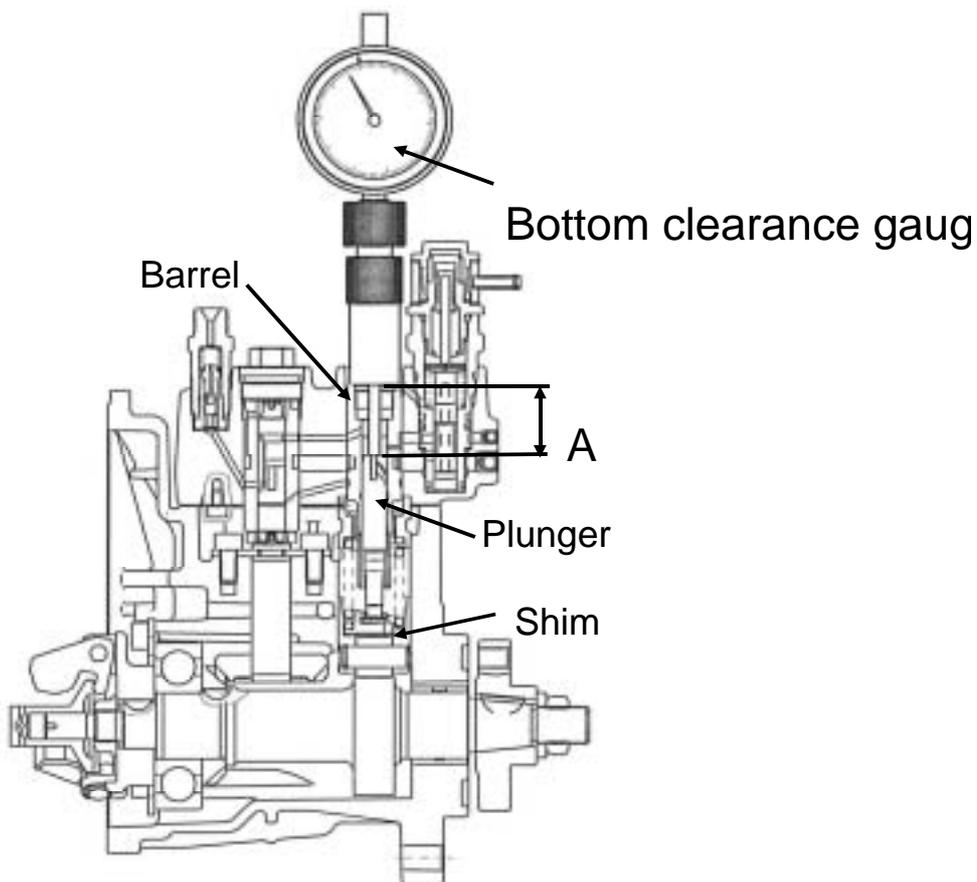
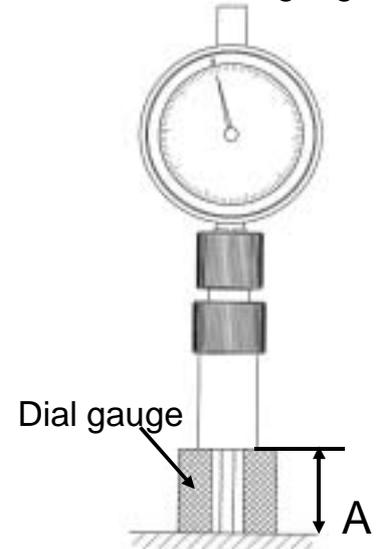
- (5) Complete fuel oil piping and operate the pump tester to purge the line of air.
- (6) Set the pressure of oil fed from pump tester to injection pump at  $19.6-29.4\text{kPa}(0.2-0.3\text{kgf/cm}^2)$  ,temp. at  $40\pm 2\text{ degC}(104\pm 3.6\text{ degF})$



## 4.2. Bottom clearance adjustment(Fuel Injection Timing)

1. The Fuel Injection Timing of MP-pump is made by means of adjusting the bottom clearance of the Cam ie. adjustment of the Pre-stroke of the plunger , as follows.
2. The adjustment of the clearance shall be made at cam-top position in order to get the reliable and easier method. Therefore herein after we will mention that "The adjustment of the bottoms clearance (of the Cam)".
3. First of all , put the JIG of the bottom clearance measurement on the standard gauge(W/A"- measurement). Then set the O-point of the dial gauge.
4. Next adjust the clearance by shims into the standard after measuring the bottom clearance A\* with JIG (Dial gauge)(Refer to the attached sheet)\*Measurement between upper surface of the Barrel and upper surface of the plunger at Cam bottom position

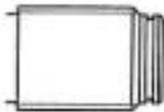
Bottom clearance gauge



**4.2.1. The bottom clearance adjusting value and the Cam classification**

Cam shaft				Plunger bottom Clearance (dimension: A) (mm)	Standard shim thickness (mm)
	Cam speed	3 cylinder	4 cylinder		
<b>MP2</b>	1.1 m/s	158552-51020	158553-51020	25.5±0.05	1.3
	1.3 m/s	158552-51030	158553-51030	25.9±0.05	0.9
	1.7 m/s	158552-51040	158553-51040	26.3±0.05	0.8
<b>MP4</b>	1.8 m/s	—————	123907-51040	25.55±0.05	1.05
	2.1 m/s		129906-51040		
	2.3m/s		129907-51040		

Shape of cam shaft end

	Cam Speed	
	MP2	MP4
	1.1m/s	2.3m/s
	1.3m/s	2.1m/s
	1.7m/s	1.8m/s

## 4.3. Adjustment of Governor

### 4.3.1. Adjustment of No Load Max. Engine Speed



Set the engine speed at the no load max. speed. Pull the regulator lever and adjust the max. speed limit bolt to obtain the specified injection amount. Fasten the nut after completing the adjustment.

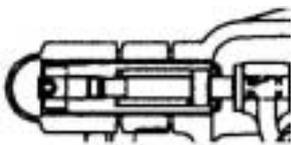
### 4.3.2. Adjustment of Fuel Limit Bolt



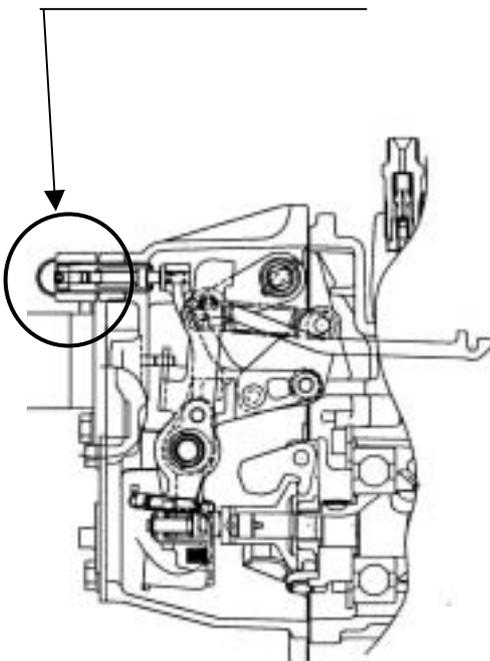
- ① The MP2 pump has the lift adjustment FO limiter as a standard equipment. Screw in the lift adjustment screw fully, then return the screw by 0.5 turns and fasten the screw with the lock nut. (In the specifications where no torque control spring is used, keep the lift adjustment screw completely free.)
- ② Set the pump speed at the rated speed and move the regulator lever until it contacts the maximum speed limit bolt.
- ③ Check that the amount being injected exceeds the rated injection amount, screw in the fuel limit bolt and adjust the injection amount.

### 4.3.3. Adjustment of Torque-Rise Point

The Torque-Rise adjustment comprises the FO limiter (torque spring) and the torque control spring.



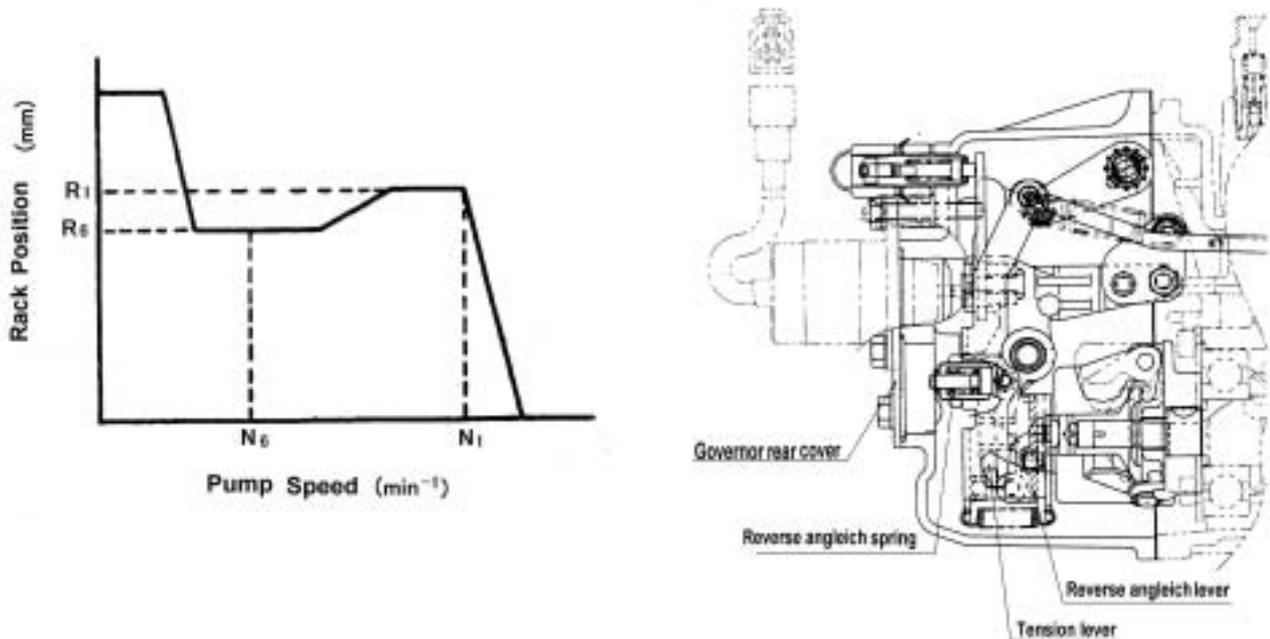
Adjustable lift torque spring



- ① Set the pump speed at the Torque-Rise speed and leave the regulator lever at the position in 2 above.
- ② When both of the FO limiter and torque control spring are used:
  - Screw in the torque control assembly, adjust to obtain the specified injection amount and fasten the lock nut.
- ③ Specifications of Only the FO Limiter
  - Screw in lift limit bolt of the FO limiter, adjust to obtain the specified injection amount and fasten the lock nut.

### 4.3.4. Adjustment of Reverse Angleich

In the case of the governor with reverse angleich mechanism, use the reverse angleich spring in the assembled state.



#### Adjustment of Reverse Angleich

Make adjustment of reverse angleich after completing the following processes:

- Adjustment of fuel volume limiter bolt
- Adjustment of no-load max, and min. revolutions limiter bolt

- ① Shift the control lever to the full load position, and maintain the fuel injection pump revolution to the specified reverse angleich control revolution number ( $N_6$ ).
- ② In this condition, remove the governor rear cover, and screw the reverse angleich assembly into the threaded portion of the tension lever until it hits the reverse angleich lever. If screwing it in additionally, the reverse angleich lever will shift in the direction of fuel reduction. Screw and set it to the position of the specified injection quantity ( $R_6$ ).
- ③ Tighten the lock nut with specified tightening torque, and attach the governor rear cover.

N-m (kgf-m)

Lock Nut Tightening Torque	24.5-29.4(2.5-3.0)
----------------------------	--------------------

- ④ Again, increase the revolution of the fuel injection pump to the rated revolution speed ( $N_1$ ), check that the control rack will change the position of the reverse angleich stroke smoothly, and confirm that the rack position ( $R_1$ ) and injection volume are within the specified limits.

#### 4.3.5. Adjustment of Starting Injection Amount



- ① Set the engine speed at the starting injection amount adjust speed and leave the regulator lever at the position in 2 above.
- ② Screw in the starting injection amount adjust bolt and adjust it to obtain the specified injection amount.
- ③ Set the pump speed at  $50 \text{ min}^{-1}$  and check that the amount exceeding the specifications is being injected.

#### 4.3.6. Checking the Injection Stop

Leave the regulator lever at the position as before.

- ① Checking the Injection Stop: Set the pump speed at the speed  $50 \text{ min}^{-1}$  higher than the no load max. speed, and check that the injection amount reduces to zero.
- ② Checking the Stopping: Set the pump speed at the rated speed, turn off the stop solenoid and check that the injection amount reduces to zero.

## 5. Fuel injection Nozzle

When fuel oil pumped by the fuel injection pump reaches the injection nozzle, it pushes up the nozzle valve (held down by spring), and is injected into the combustion chamber at high pressure.

The fuel is atomized by the nozzle to mix uniformly with the air in the combustion chamber. How well the fuel is mixed with high temperature air directly affects combustion efficiency, engine performance and fuel economy.

Accordingly, the fuel injection nozzles must be kept in top condition to maintain performance and operating efficiency.

### 5.1. Functioning of fuel injection nozzle

Fuel from the fuel injection pump passes through the oil port in the nozzle holder and enters the nozzle body reservoir. When oil reaches the specified pressure, it pushes up the nozzle valve (held by the nozzle spring), and is injected through the small hole on the tip of the nozzle body.

The nozzle valve is automatically pushed down by the nozzle spring and closed after fuel is injected.

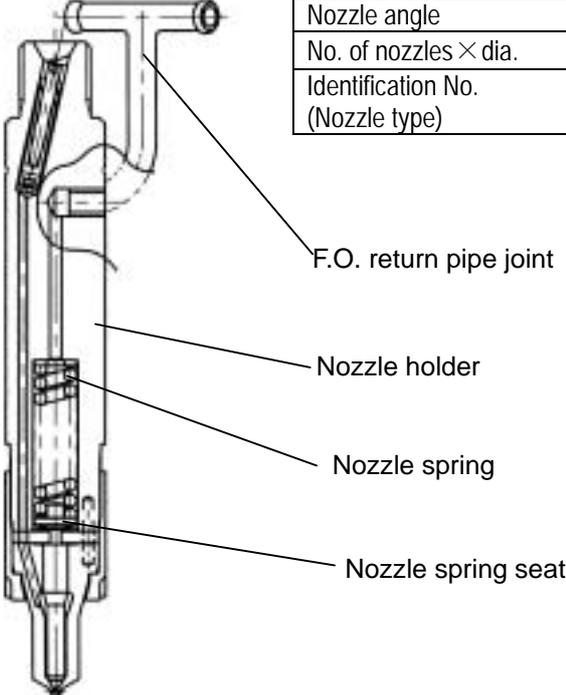
Oil that leaks from between the nozzle valve and nozzle body goes from the hole on top of the nozzle spring through the oil leakage fitting and back into the fuel tank.

Adjustment of injection starting pressure is effected with the adjusting shims.

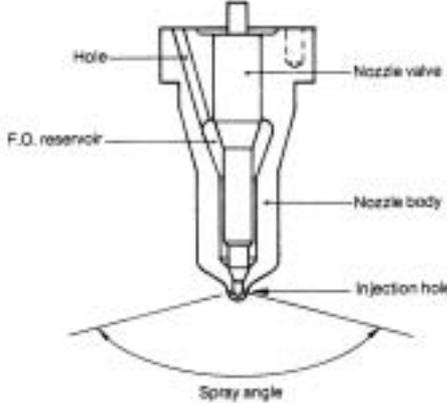
### 5.2. Type/construction of fuel injection nozzle

There are two types of fuel injection nozzles. Direct injection engines are equipped with the hole type, and indirect injection engines with the pintle type.

The YPD-MP fuel injection pump is designed for use with both direct and indirect injection engines. The hole type/pintle type of fuel injection nozzle are used according to the engine type.

Hole type fuel injection nozzle	Nozzle opening pressure	MPa (kgf/cm <sup>2</sup> )	21.6	+1.0 0	(220)	(+10) (0)
	Nozzle angle	deg.	162		159	
	No. of nozzles × dia.	mm	5 × 0.16		5 × 0.17	
	Identification No. (Nozzle type)	—	162P165VAE1		159P175VAD1	
						

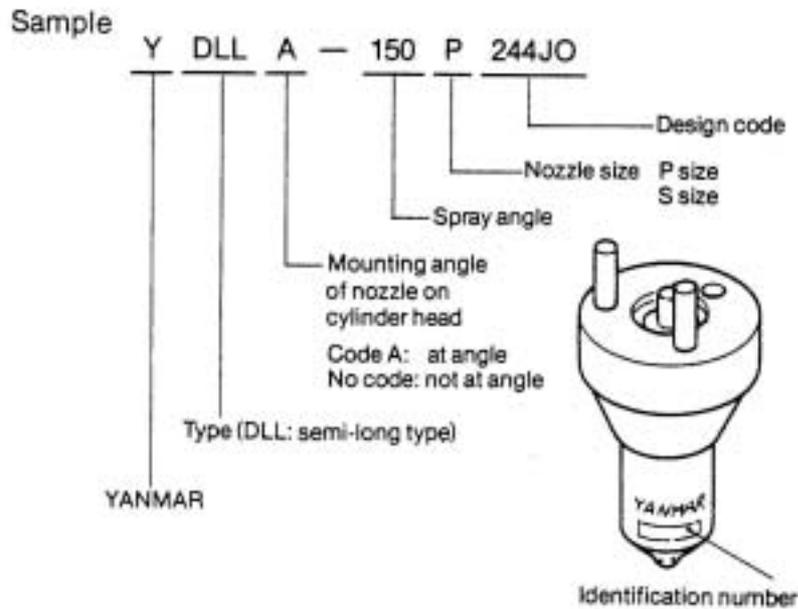
  

## Nozzle body identification number

The type of nozzle can be determined from the number inscribed on the outside of the nozzle body.

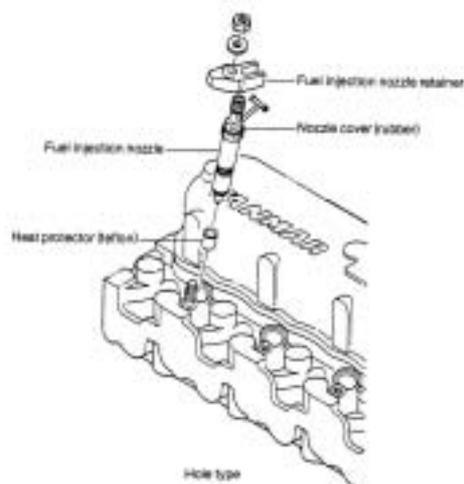
### 1) Hole type fuel injection nozzles



## 5.3. Fuel injection nozzle disassembly

Note:

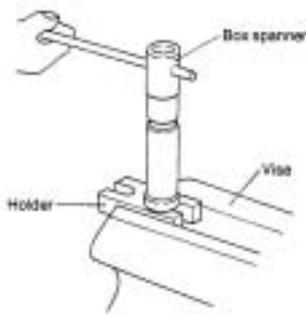
1. Disassemble fuel injection nozzle in a clean area as for fuel injection pump.
  2. When disassembling more than one fuel injection nozzle, keep the parts for each injection nozzle separate for each cylinder (i.e. the nozzle for cylinder 1 must be remounted in cylinder 1).
- (1) When removing the injection nozzle from the cylinder head, remove the high pressure fuel pipe, fuel leakage pipe, etc., the injection nozzle retainer nut, and then the fuel injection nozzle.



(2) Put the nozzle in a vise

NOTE: Use the special nozzle holder for the hole type injection nozzle so that the high pressure mounting threads are not damaged.

- (3) Remove the nozzle nut



NOTE: Use a special box spanner for the hole type (the thickness of the two nozzle nuts is 15mm(0.5906in.)).

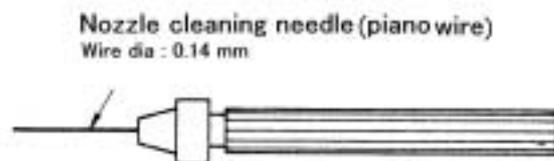
- (4) Remove the inner parts

NOTE: Be careful not to loosen the spring seat, adjusting shims or other small parts.

## 5.4. Fuel injection nozzle inspection

### 5.4.1. Washing

- (1) Make sure to use new diesel oil to wash the fuel injection nozzle parts.
- (2) Wash the nozzle in clean diesel oil with the nozzle cleaning kit.



- (3) Clean off the carbon on the outside of the nozzle body with a brass brush.
- (4) Clean the nozzle seat with cleaning spray.
- (5) Clean off the carbon on the tip of nozzle with a piece of wood.

### 5.4.2. Nozzle inspection

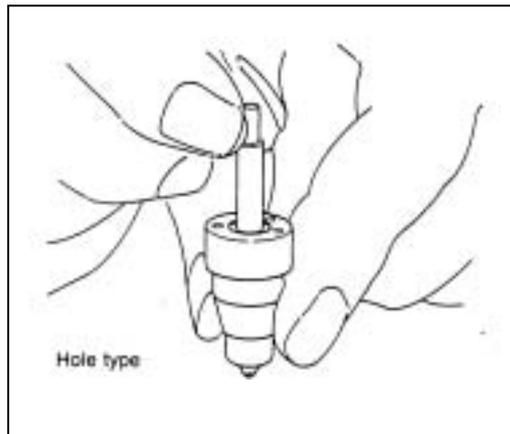
(1) Inspect for scratches/wear

Inspect oil seals for abnormal scratches or wear and replace nozzle if the nozzle sliding surface or seat are scratched or abnormally worn.

(2) Check nozzle sliding

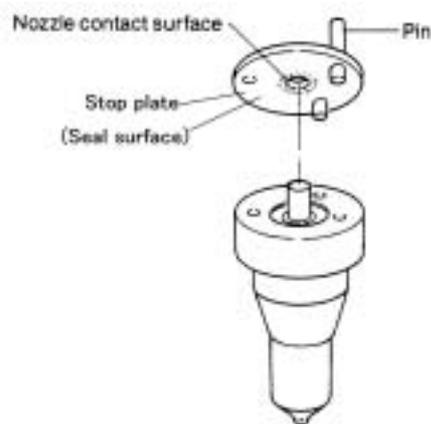
Wash the nozzle and nozzle body in clean diesel oil, and make sure that when the nozzle is pulled out about half way from the body, it slides down by itself when released.

Rotate the nozzle a little ; replace nozzle/nozzle body as a set if there are some places where it does not slide smoothly.



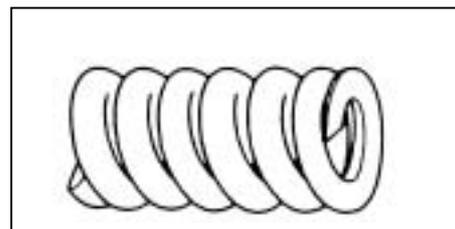
(3) Inspecting stop plate (inter-piece)

Check for scratches/wear in seals on both ends, check for abnormal wear on the surface where it comes in contact with the nozzle ; replace if stop plate is excessively worn.



(4) Inspecting nozzle spring

Replace the nozzle spring if it is extremely bent, or surface is scratched or rusted.



(5) Nozzle holder

Check oil seal surface for scratches/wear ; replace if wear is excessive.

## 5.5. Fuel injection nozzle reassembly

The fuel injection nozzle is reassembled in the opposite order to disassembly.

- (1) Insert the adjusting shims, nozzle spring and nozzle spring seat in the nozzle holder, mount the stop plate with the pin and insert the nozzle body/nozzle set and tighten the nut.
- (2) Use the special holder when tightening the nut for the hole type nozzle as in disassembly.

Nozzle nut tightening torque

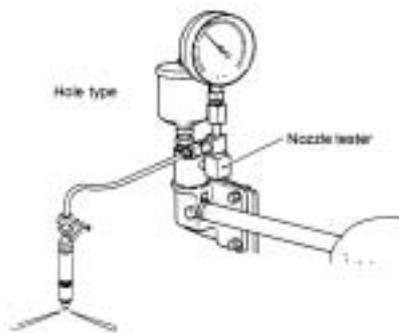
	N-m(kgf-m)
Hole type nozzle	39 – 44 ( 4 – 5 )

## 5.6. Adjusting fuel injection nozzle

### 5.6.1. Adjusting opening pressure

Mount the fuel injection nozzle on the nozzle tester and use the handle to measure injection starting pressure. If it is not at specified pressure, use the adjusting shims to increase/decrease pressure (both hole and pintle types).

Adjusting by 0.1 mm results in a change in the injection starting pressure of about 2 Mpa ( 20 kgf / cm<sup>2</sup> )



Injection starting pressure

	MPa(kgf/cm <sup>2</sup> )
Injection starting pressure	19.6 - 20.6 ( 200 – 210 )
	21.6 – 22.6 ( 220 – 230 )

Remark ) Injection starting pressure changes on engine specifications.

## 5.6.2. Injection test

After adjusting the nozzle to the specified starting pressure, check the fuel spray condition and seat oil tightness.

### (1) Check seat oil tightness

After two or three injections, gradually increase the pressure up to 1.96MPa (20kg/cm<sup>2</sup>) before reading the starting pressure maintain the pressure for 5seconds, and make sure that no oil is dripping from the tip of the nozzle.

Test the injection with a nozzle tester ; retighten and test again if there is excessive oil leakage from the overflow coupling.

Replace the nozzle as set if oil leakage is still excessive.

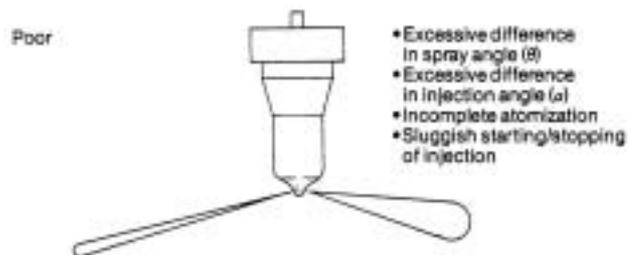
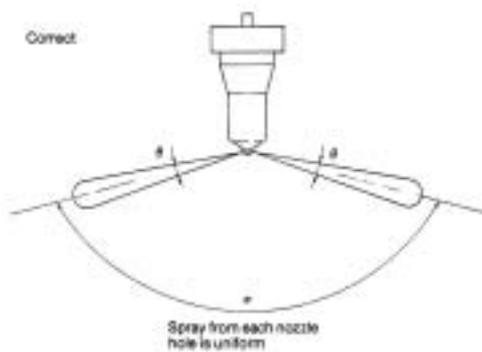
### (2) injection spray condition

Operate the nozzle tester lever once to twice a second and check for abnormal injection.

### 5.6.2.1. Hole type nozzles

Replace hole type nozzles that do not satisfy the following conditions :

- Proper spray angle ( $\theta$ )
- Correct injection angle ( $\alpha$ )
- Complete atomization of fuel
- Prompt starting /stopping of injection



## 6. Troubleshooting

### 6.1. Troubleshooting of fuel injection pump

Complete repair means not only replacing defective parts, but finding and eliminating the cause of the trouble as well. The cause of the trouble may not necessarily be in the pump itself, but may be in the engine or the fuel system. If the pump is removed prematurely, the true cause of the trouble may never be known. Before removing the pump from the engine, at least go through the basic check points given here.

#### Basic checkpoints

- Check for breaks or oil leaks throughout the fuel system, from the fuel tank to the nozzle.
- Check the injection timings for all cylinders. Are they correctly adjusted? Are they too fast or too slow?
- Check the nozzle spray.
- Check the fuel delivery. Is it in good condition? Loosen the fuel pipe connection at the injection pump inlet and test operate the fuel feed pump.

### 6.2. Major faults and troubleshooting

Fault		Cause	Remedy
1. Engine won't start.	Fuel not delivered to injection pump.	(1) No fuel in the fuel tank.	Resupply
		(2) Fuel tank cock is closed.	Open
		(3) Fuel pipe system is clogged.	Clean
		(4) Fuel filter element is clogged.	Disassemble and clean, or replace element
		(5) Air is sucked into the fuel due to defective connections in the piping from the fuel tank to the fuel pump.	Repair
		(6) Fuel feed pump is damaged.	Replace
		(7) Fuel freeze.	Replace with a fuel for cold weather.
	Fuel delivered to injection pump.	(1) Defective connection of control lever and accel. rod of injection pump.	Repair or adjust
		(2) Plunger is worn out or stuck.	Repair or replace
		(3) Delivery valve is stuck.	Repair or replace
		(4) Control rack doesn't move.	Repair or replace
		(5) Injection pump coupling is damaged, or the key is broken.	Replace
		(6) Air sucking.	Bleed air.
		(7) Plunger/Distribution shaft is seized.	Replace pump.
	(8) Tappet is seized.	Replace pump.	
	(9) Stop solenoid is damaged.	Replace	
	(10) Cold start device is damaged.	Replace	
	(11) Low cranking speed.	Replace battery.	
	(12) Governor is damaged.	Replace	
	(13) Barrel crack	Replace pump.	
	(14) Transmission shaft is seized. Gear slip.	Replace	

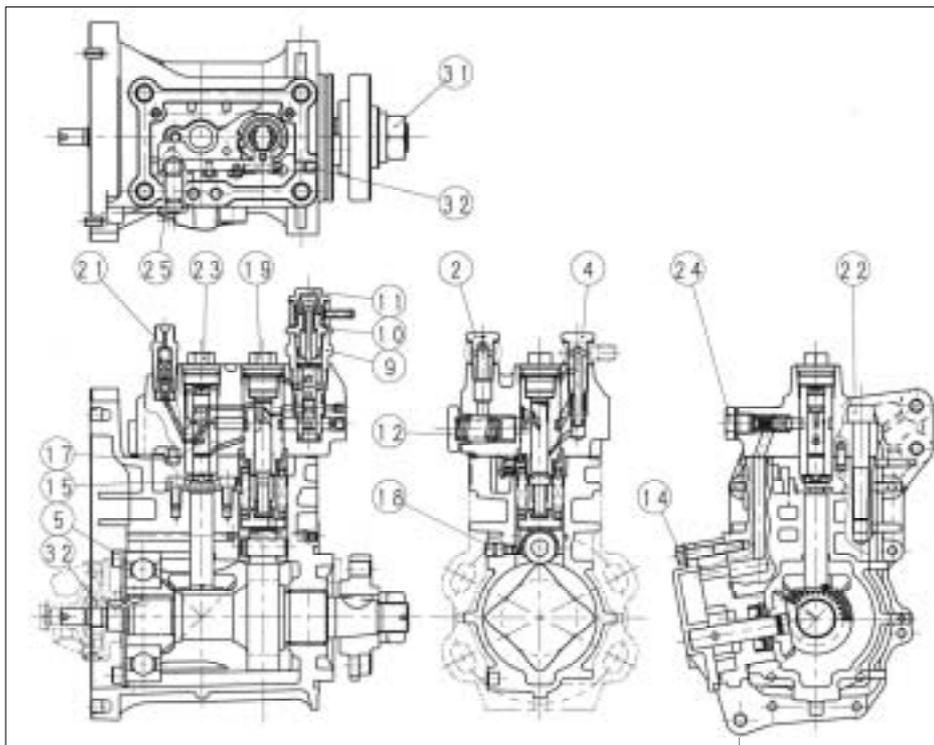
	Nozzle doesn't work.	(1) Nozzle valve doesn't open or close normally.	Repair or replace
		(2) Nozzle seat is defective.	Repair or replace
		(3) Case nut is loose.	Inspect and tighten
		(4) Injection nozzle starting pressure is too low.	Adjust
		(5) Nozzle spring is broken.	Replace
		(6) Fuel oil filter is clogged.	Repair or replace
		(7) Excessive oil leaks from the nozzle sliding area.	Replace the nozzle assembly
		(8) Deformation due to excessive tightening of nozzle retaining bolt.	Replace or adjust.
		(9) Strainer is clogged.	Replace or clean
	Injection timing is defective.	(1) Injection timing is retarded due to failure of the coupling.	Adjust
		(2) Camshaft is excessively worn.	Replace camshaft
		(3) Roller tappet incorrectly adjusted or excessively worn.	Adjust or replace
		(4) Plunger is excessively worn.	Replace plunger assembly
		(5) Bad installation of injection pump.	Adjust.
(6) Air sucking.		Bleed air.	
(7) Delivery valve is defective.		Replace.	
2. Engine starts, but immediately stops.	(1) Fuel pipe is clogged.	Clean	
	(2) Fuel filter is clogged.	Disassemble and clean, or replace the element.	
	(3) Improper air-tightness of the fuel pipe connection, or pipe is broken and air is being sucked in.	Replace packing; repair pipe	
	(4) Insufficient fuel delivery from the feed pump.	Repair or replace.	
	(5) Trochoid pump is defective.	Replace.	
	(6) Air sucking.	Bleed air or hose check.	
	(7) Electromagnetic feed pump is clogged.	Replace.	
	(8) Out of fuel.	Fill the fuel.	
	(9) Stop solenoid is defective.	Replace.	
	(10) Accumulator is abnormal.	Replace.	
3. Engine's output is insufficient.	Defective injection timing, and other failures.	(1) Knocking sounds caused by improper (too fast) injection timing.	Inspect and adjust
		(2) Engine overheats or emits large amount of smoke due to improper (too slow) injection timing.	Inspect and adjust
		(3) Insufficient fuel delivery from feed pump.	Repair or replace
		(4) Trochoid pump is defective.	Replace.
		(5) Type of fuel is incorrect.	Check and refill proper fuel.
		(6) Fuel temperature is high.	Cool.
	Nozzle movements is defective	(1) Case nut loose.	Inspect and retighten
		(2) Defective injection nozzle performance.	Repair or replace nozzle
		(3) Nozzle spring is broken.	Replace
		(4) Excessive oil leaks from nozzle.	Replace nozzle assembly
	Injection pump is defective.	(1) Max. delivery limit bolt is screwed in too far.	Adjust
		(2) Plunger is worn.	Replace
		(3) Injection amount is not uniform.	Adjust
		(4) Injection timings are not even.	Adjust
		(5) The 1st and 2nd levers of the governor and the control rack of the injection pump are improperly lined up.	Repair
		(6) Delivery holderr is loose	Inspect and retighten
		(7) Delivery packing is defective.	Replace packing
		(8) Delivery valve seat is defective.	Repair or replace
		(9) Delivery spring is broken.	Replace
		(10) Carbon deposit is adhered.	Clean
		(11) Spray pattern is abnormal.	Replace
		(12) Nozzle crack.	Replace
		(13) Plunger barrel crack.	Replace fuel injection pump.

4. Idling is rough.	(1) Movement of central rack is defective.	—————	
	1) Stiff plunger movement or sticking.	Repair or replace	
	2) Rack and pinion fitting is defective.	Repair	
	3) Movement of governor is improper.	Repair	
	4) Delivery holder is too tight.	Inspect and adjust	
	(2) Uneven injection volume.	Adjust	
	(3) Injection timing adjustment failure.	Adjust	
	(4) Plunger is worn and fuel injection adjustment is difficult.	Replace	
	(5) Governor spring is too weak.	Replace	
	(6) Feed pump can't feed oil at low speeds.	Repair or replace	
	(7) Fuel supply is insufficient at low speeds due to clogging of fuel filter.	Disassemble and clean, or replace element	
	(8) Weight abnormality.	Replace	
	(9) Shifter is worn.	Replace governor.	
(10) Air sucking.	Check piping.		
(11) Torochid pump is defective.	Replace		
(12) Governor is worn.	Replace or adjust.		
5. Engine runs at high speeds, but cuts out at low Speeds.	(1) The wire or rod of the accel is caught.	Inspect and repair	
	(2) Control rack is caught and can't be moved.	Inspect and repair	
	(3) Low idling stopper bolt is abnormal.	Replace or adjust.	
6. Engine doesn't reach max, rpm.	(1) Governor spring is broken or excessively worn.	Replace	
	(2) Injection performance of nozzle is poor.	Repair or replace	
	(3) Trochiod pump is defective.	Replace	
	(4) Accumulator is abnormal.	Replace	
	(5) Filter and pipe are clogged.	Check piping.	
	(6) Governor is abnormal.	Replace	
7. Loud knocking.	(1) Injection timing is too fast or too slow.	Adjust	
	(2) Injection from nozzle is improper fuel drips after each infection.	Adjust	
	(3) Injection nozzle starting pressure is too high.	Adjust	
	(4) Uneven injection.	Adjust	
	(5) Engine overheats, or insufficient compression.	Repair	
8.Engine exhausts too much smoke.	When exhaust smoke is black:	(1) Injection timing is too fast.	Adjust
		(2) Air volume intake is insufficient.	Inspect and repair
		(3) The amount of injection is uneven.	Adjust
		(4) Injection from nozzle is improper.	Repair or replace
	When exhaust smoke is white:	(1) Injection timing is too slow.	Adjust
		(2) Water is mixed in fuel.	Inspect fuel system, and clean
		(3) Shortage of lube oil m the engine.	Repair
		(4) Engine is over-cooled.	Inspect

# 7. Tightening torques for main bolts and nuts

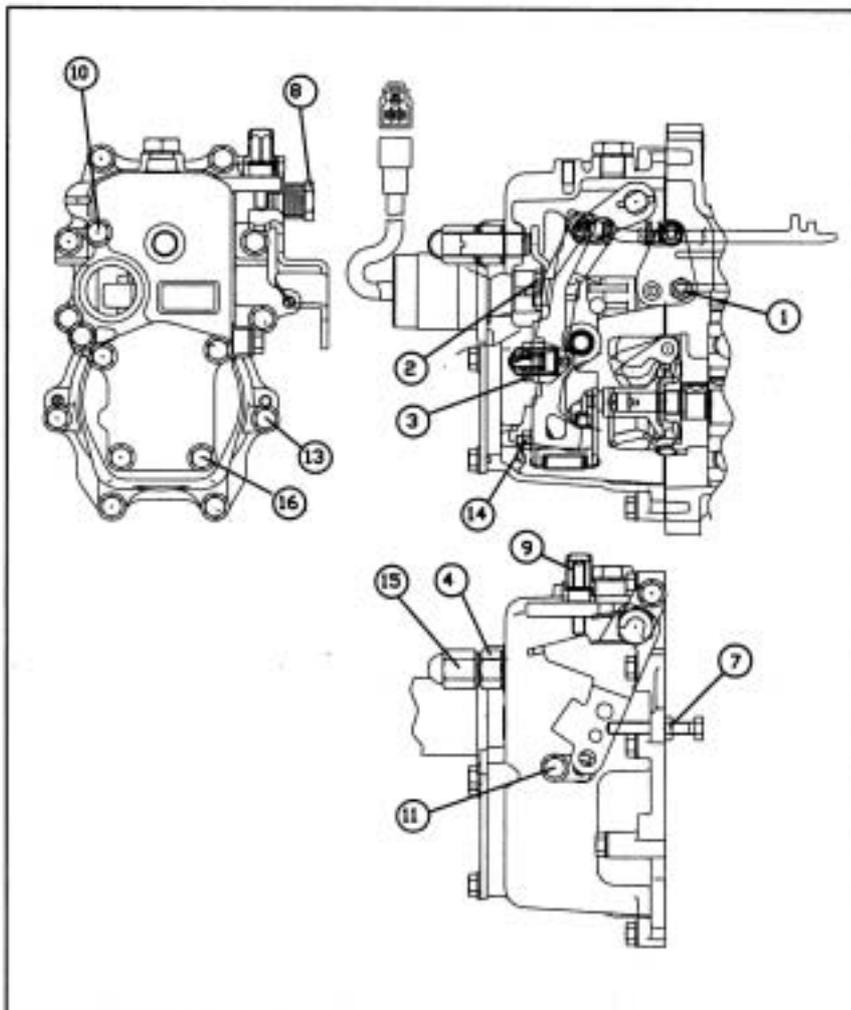
## 7.1. Pump part

No.	Name of parts	Tightening torque ( N-m )		No.	Name of parts	Tightening torque ( N-m )	
		MP4	MP2			MP4	MP2
2	Pipe joint bolt, fuel inlet	25 - 29		18	Tappet guide	4 - 5	
		M12×1.25				M6×1 (hexagon socket head)	
4	Overflow joint, fuel outlet	25 - 29		19	Plug, barrel	50 - 55	30 - 35
		M12×1.25				M18×1	M14×1
5	Bearing retaining screw	8 - 10		21	Delivery holder	40 - 45	
		M6×1 (hexagon socket head)				M14×1.25	
9	Timer holder	40 - 45		22	Head bolt	28 - 32	18 - 22
		M22×1				M10×1.5 (hexagon socket head)	M8×1.25 (hexagon socket head)
10	Thermo element	30 - 35		23	Plug, distribution shaft	15 - 20	
		M16×1				M22×1	
11	Plug, cooling water	22 - 25		24	plug, strainer	25 - 29	
		M14×1				M12×1.25	
12	Accumulator	50 - 55		25	Bolt, rink lifter	8 - 10	
		M20×1				M6×1	
14	Bolt, trochoid pump	8 - 10		31	Nut, FIC fixing flange	113 - 123	78 - 88
		M6×1				M18×1.5	M14×1.5
15	Bolt, driving shaft	8 - 10		32	End nut	79 - 84	
		M6×1 (hexagon socket head)				M12×1.25	
17	Retaining screw, rack guide	3 - 4		33	plug, rack	4 - 5	
		M4×0.7 (hexagon socket head)				M6×1	

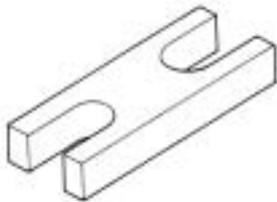
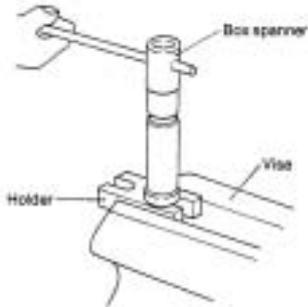
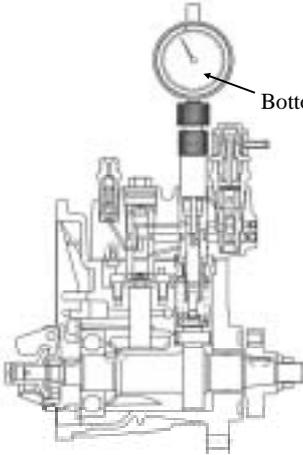


## 7.2. Mechanical governor part

No.	Name of parts	Tightening torque ( N-m )		No.	Name of parts	Tightening torque ( N-m )	
		MP4	MP2			MP4	MP2
1	Fixing bolt, tension lever hook	6 - 8 M6×1		10	Bolt, solenoid	8 - 10 M6×1	
2	Fixing bolt, patch	5 - 7 M5×0.8	—	11	Bolt, governor lever shaft	8 - 10 M6×1	
3	Angleich complete	25 - 29 M14×1		13	Bolt, governor assy	8 - 10 M6×1	
4	Nut, fuel limiter	19.6 - 21.6 M12×1.25		14	Starting fuel limiter	6 - 8 M5×0.8	8 - 10 M6×1
7	Setting bolt, min. idling speed	8 - 10 M6×1		15	Cap nut	20 - 22 M12×1.25	
8	Nut, speed lever	19.6 - 21.6 M8×1.25		16	Bolt, back cover	8 - 10 M6×1	
9	Setting nut, max. idling speed	8 - 10 M6×1					



## 8. Tools

Name of tool	Shape and size	application
Nozzle plate 158090-51700		
Bottom clearance gauge  158090-51800 : MP2 158090-51810 : MP4		
Plunger SP seat extractor  158090-51900	