

# **YANMAR**

# **SERVICE MANUAL**

***DIESEL ENGINE***

**(FUEL OIL INJECTION DEVICE)**

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**MODEL 2TR/2T/3T SERIES**

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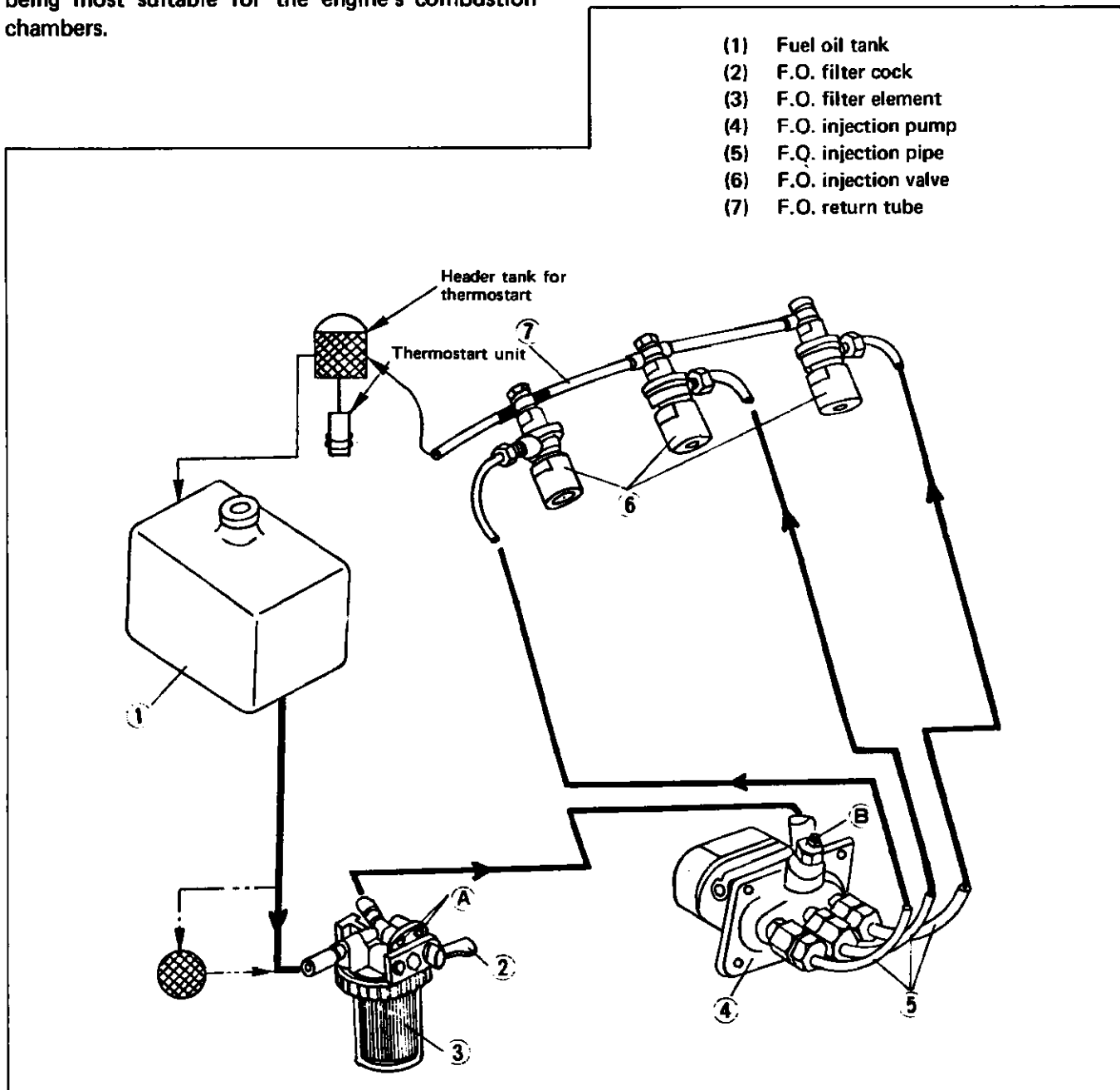
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## Fuel injection system

In a diesel engine the fuel injection system takes the place of the carburetor for the so-called gasoline engine and ignition system. It draws fuel from the supply tank, forces it through filters, places it under high pressure, which is required for mechanical atomization, accurately measures it, and distributes it in proper sequence to the various cylinders. Individual cylinder injection is done with precision timing and with a uniform spray (atomization) pattern selected by the engine builder as being most suitable for the engine's combustion chambers.

The diesel engine fuel injection system is made up of an injection pump complete with fuel feed pump and speed control governor, a fuel filter or filters, a nozzle and nozzle holder for each cylinder, and high pressure steel lines to connect the injection pump discharge outlets with the nozzles.



# SPECIFICATIONS FOR FUEL INJECTION EQUIPMENT PERFORMANCE

Model		2T73A	2TR13A	2TR20A-X 2T75LE 2T80LE	2T90LE	3T80J 3T84A 3T90J	3T80LE 3T84LE	3T90LE
No. of cylinders		2				3		
Fuel injection pump	Type	PFR-2K				PFR-3K		
	Plunger diameter (mm $\phi$ )	6	7 with up- per lead	7	7.5	8	7.5	
	Plunger lift (mm)	7						
	Delivery valve suction volume	36 mm <sup>3</sup> /stroke						
	Injection pressure (kg/cm <sup>2</sup> )	0.5						
Injection valve	Type	YDN-OSYD1						
	Injection pressure (kg/cm <sup>2</sup> )	160						
	Injection pipe	Outer diam. 6mm $\phi$ ; Inner diam. 2mm $\phi$ ; Length 900 mm						

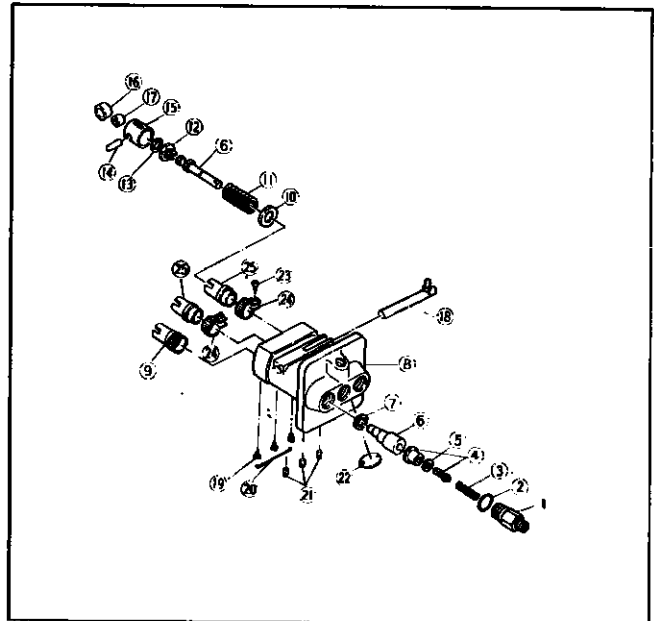
## 1. Fuel injection pump

The fuel injection pump is the heart of the fuel injection system. It is a highly precise, mechanized device that places fuel under high pressure, meters it accurately, delivers it in proper sequence to the injection nozzles, and injects it into the cylinders in the form of a very fine spray with precise timing.

In order to meet engine builders' reliability and performance specifications, the fuel injection pump is subjected to stringent quality inspections and tests, and precise settings and adjustments. It is quite possible to adjust the latter in order to obtain increased power. However, it should be clearly understood that such tampering is done at the owner's risk, and often with disastrous consequences to his equipment.

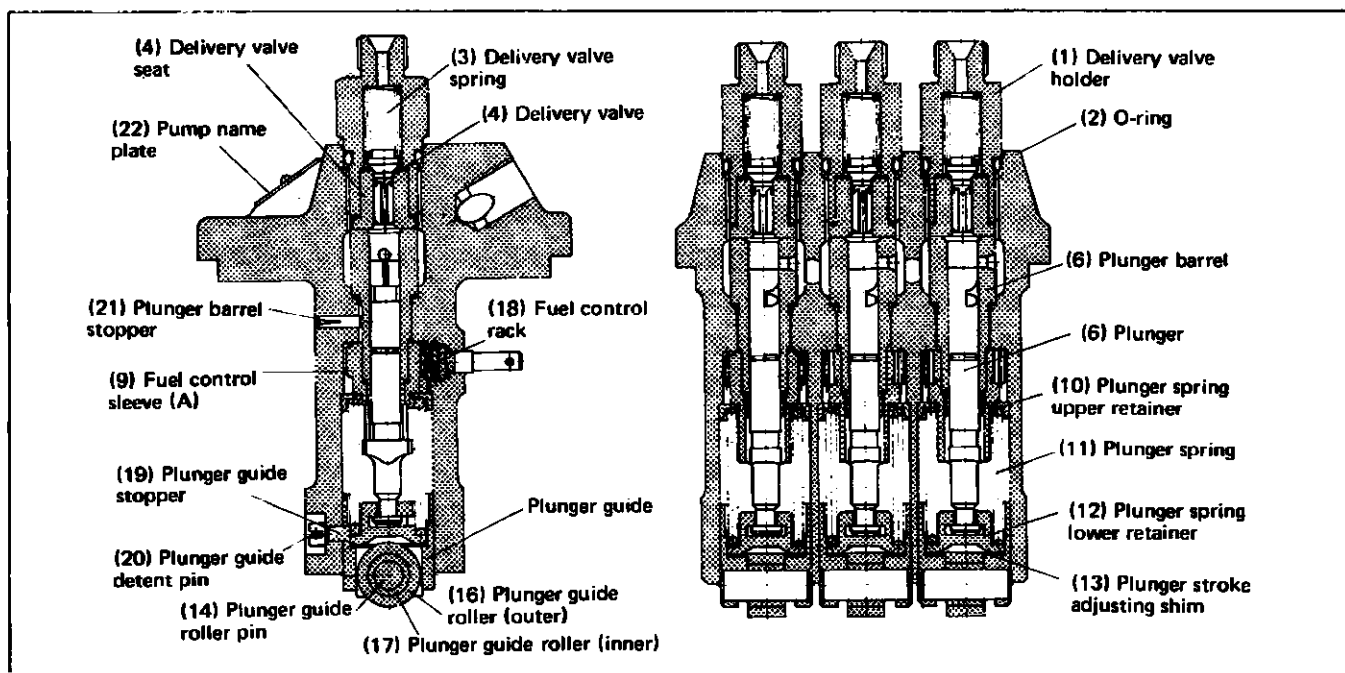
The T-LE engines are equipped with a two or three-cylinder PFR2K or PFR3K type, fuel injection pump. This is one of Yanmar's own products, and is best suited for Yanmar diesel engines. The fuel injection pump and injection nozzles are pre-

cision component parts machined to the close accuracy of 1/1000mm. They form the heart of the diesel engine. Users are requested to handle them carefully.



### [Nomenclature of Component Parts]

No.	Part name	No.	Part name
1	Delivery valve holder	14	Plunger guide roller pin
2	O-ring for delivery valve holder	15	Plunger guide
3	Delivery valve spring	16	Plunger guide roller (outer)
4	Delivery valve and delivery valve seat	17	Plunger guide roller (inner)
5	Delivery valve gasket	18	Fuel control rack
6	Plunger and plunger barrel	19	Plunger guide stopper
7	Packing for plunger barrel	20	Plunger guide detent pin
8	Fuel pump body	21	Plunger barrel stopper
9	Fuel control sleeve (A)	22	Pump name plate
10	Plunger spring upper retainer	23	Set-screw for fuel control pinion
11	Plunger spring	24	Fuel control pinion
12	Plunger spring lower retainer	25	Fuel control sleeve (B)
13	Plunger stroke adjusting shim		

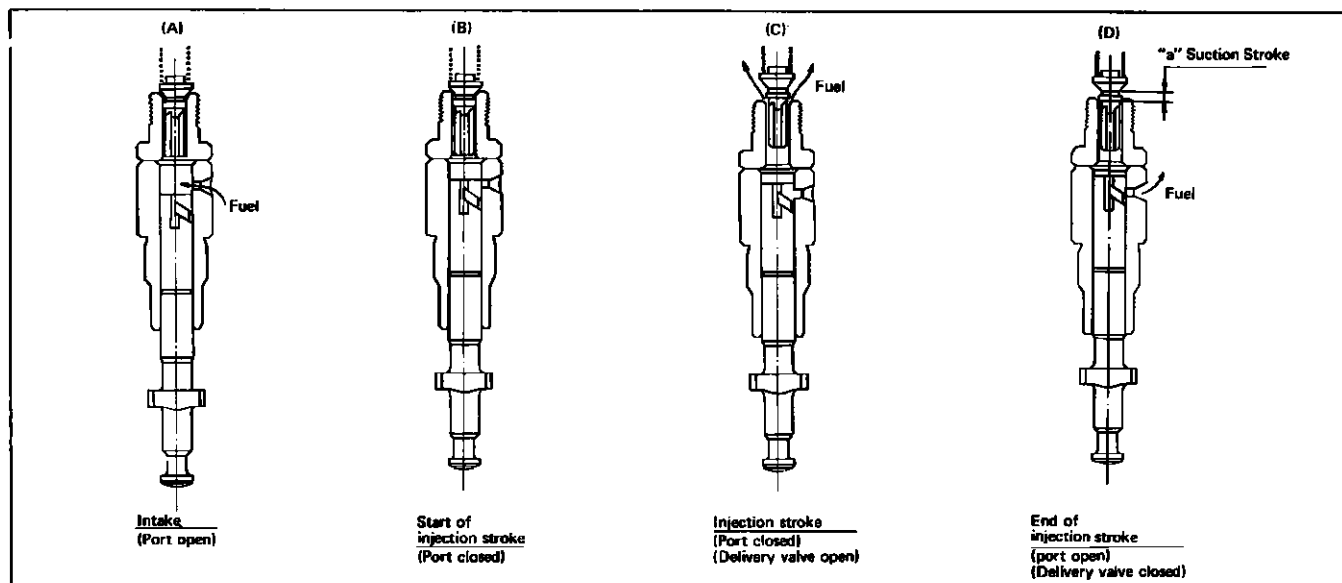


## THE PLUNGER ACTION

When the plunger is at the bottom of its stroke (cam at base circle) as illustrated in "A", fuel from the pump sump flows through the barrel ports and fills the space above the plunger. The sump fuel initially fills the vertical slots and connecting cut-away areas of the plunger.

The upward movement of the plunger seals off the

barrel ports thus trapping fuel as illustrated in "B". Further upward movement of the plunger, as illustrated in "C", forces fuel through the delivery valve, high pressure tubing, nozzle and finally to the combustion chamber. Fuel delivery ceases when the plunger helix uncovers the barrel port as illustrated in "D". This releases the trapped fuel through the annulus in the plunger and out the barrel ports.



The fuel pressure increases, after the plunger seals off the barrel port, to the preset pressure and forces the delivery valve to open as in "C". And through the delivery valve equipped to the fuel pump, fuel is forced to the fuel injection valve.

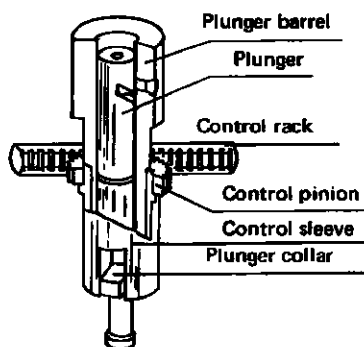
The fuel pressure reduces after the effective stroke of the plunger is completed by the opening of the barrel port. At the same time, the delivery valve is closed by the force of the delivery valve spring.

The suction collar equipped on the delivery valve draws the fuel volume "a" illustrated in "D".

The suction collar makes "sharp" fuel injections and prevents after-drip from the fuel injection valve.

The principle and construction of the plunger is shown below. The winged portion, located on the lower side of the plunger, is assembled with the control sleeve.

Only the control pinion and sleeve for the No. 1 cylinder come as a unit since the fuel injection volume standard is based on the No. 1 cylinder.



**Fuel Injection Volume Control  
Mechanism (No. 2 & No. 3 Cylinders)**

## FUEL INJECTION PUMP DISASSEMBLY

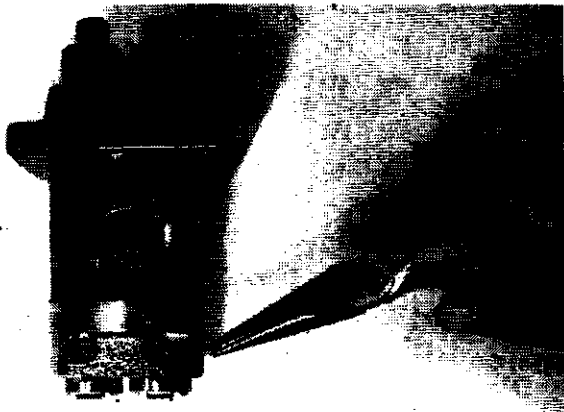
In the event that complete disassembly of the fuel pump is necessary, refer to the following instructions.

Prepare containers to keep the various parts of each cylinder in order to insure correct reassembly. Do not mix the various parts for one cylinder with other cylinder's.

### 1.1 2T SERIES PUMP

#### (1) DISASSEMBLY

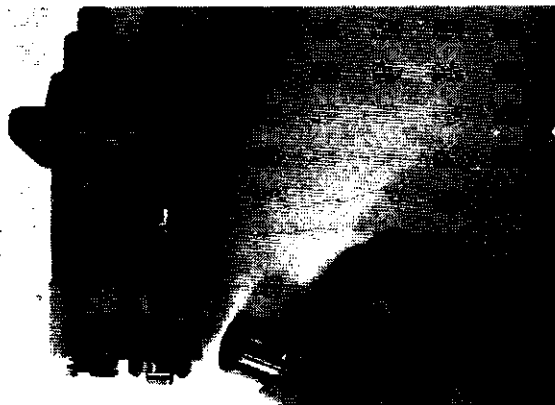
1. Remove the plunger guide stopper pin.



2. Remove the left plunger guide stopper.



3. Remove the left plunger guide.



4. Remove the left plunger, plunger spring lower seat, plunger spring and plunger prestroke adjusting shim.



5. Remove the left plunger spring upper step seat and fuel control sleeve.





6. Remove the left delivery valve holder and spring.

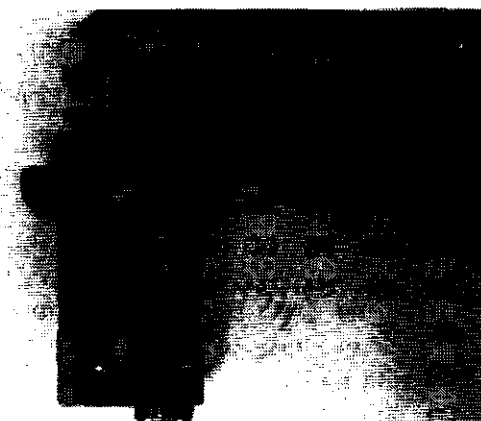


7. Remove the left delivery valve, delivery valve seat and gasket together.

Visually check for damage and wear on the delivery valve and delivery valve seat.



8. Remove the left plunger barrel.



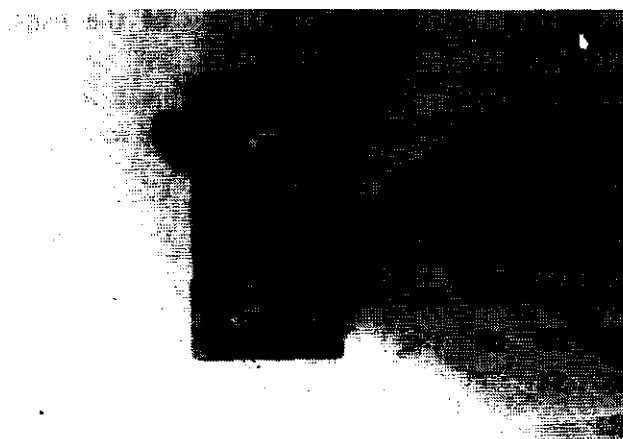
9. Since the right fuel control pinion is separated into the control sleeve and the control pinion, the mated part of the two must be marked.

10. Loosen the right fuel control pinion set screw.

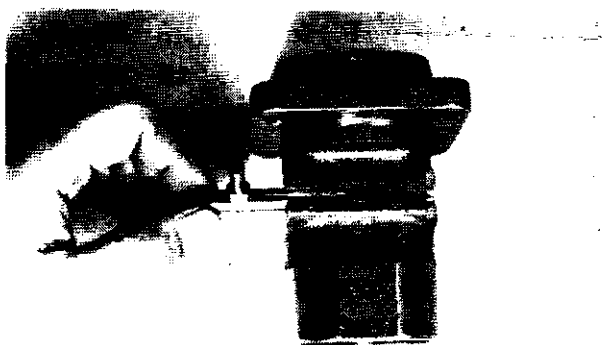


11. Apply the procedures given in (2)–(8) above to the right unit.

12. Remove the right fuel control sleeve.



13. Remove fuel control rack.



14. Remove the left/right plunger barrel gaskets.

## (2) INSPECTION OF MAJOR COMPONENTS

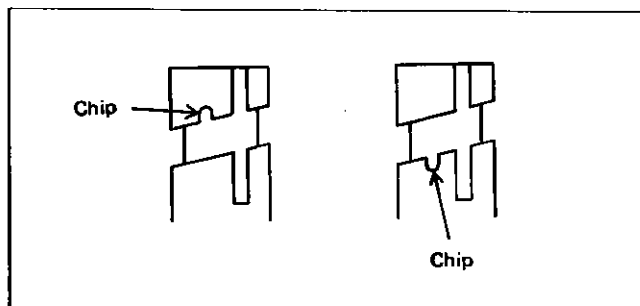
### a) Inspection of the Plunger and Barrel

The plunger and barrel assembly is one of the most important and precisely built parts of the fuel system. Due to the close tolerance (0.001 mm), make sure it is free from excessive scratches, wear, chips and foreign material. Also the free fall of the plunger should be smooth.

The plunger should be checked visually, under a magnifying glass, for excessive wear or possible chips on the helix.

If there is any chipped area on the lead helix, it will not be indicated in any of the tests.

i) Inspect the plunger. If the plunger is chipped, replace the plunger and barrel assembly.



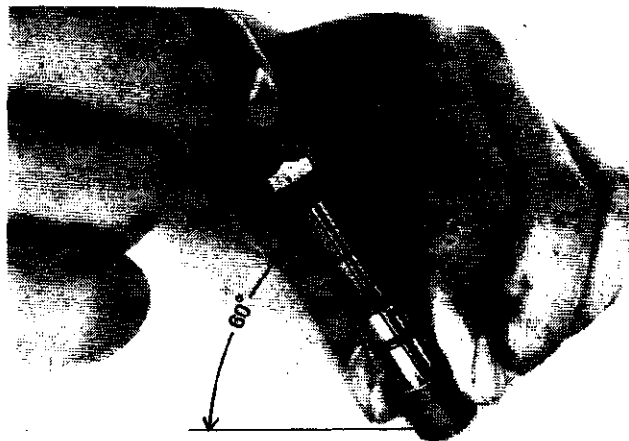
ii) Inspect the outside diameter of the plunger. Examine the surface with a magnifying glass; even the slightest imperfection will prevent the plunger from operating properly. Check for burrs, nicks, erosion, cracks, chipping and excessive wear.

If necessary, replace the plunger and barrel assembly.

### b) Free Fall of the Plunger and Barrel

After thoroughly cleaning the plunger and the barrel, tilt them about 60°, as shown in the figure. Plunger should slide down slowly.

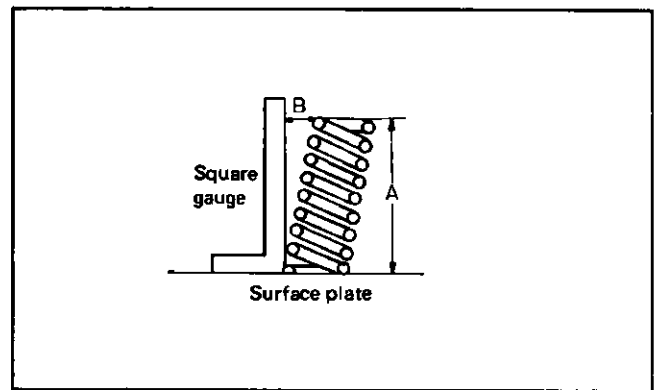
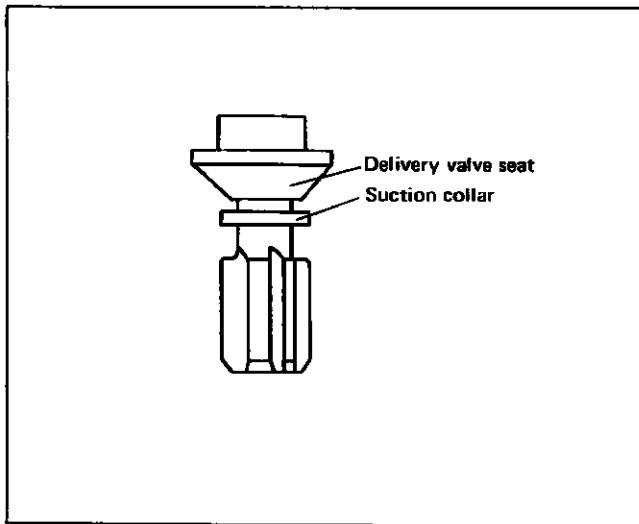
Repeat this test several times while rotating the plunger. If it slides down too fast, or if it sticks halfway, correct (lap or clean) or replact it.



### c) Delivery Valve Inspection

i) Inspect the delivery valve, and replace it if the suction collar or seat is scratched, dented, or shows signs of wear.

ii) Thoroughly clean the delivery valve. After cleaning, press the lower end down with your finger to close it. Remove your finger, and it should spring back. If it does not spring back, it should be replaced because the suction collar section is probably badly worn.



Unit: mm (in.)

Name of spring	B
Delivery spring	0.55 (0.021)
Plunger spring	0.7 (0.027)



#### d) Inspection of the Control Sleeve and Control Rack

Check that the control sleeve and control rack do not have any abnormal gear contact, scratches, or foreign matter on them. Any abnormal gear engagement will increase the friction resistance of the control rack and may cause engine trouble.

#### e) Inspection of the Delivery Spring and Plunger Spring

Check for any abnormal contact/damage on the springs, and deformation of the springs.

#### f) Plunger Guide Inspection

There should not be any "play" between the pin and the inside/outside roller pin. Also be sure there is no "pitching" on the surface of the outside wheel of the roller.

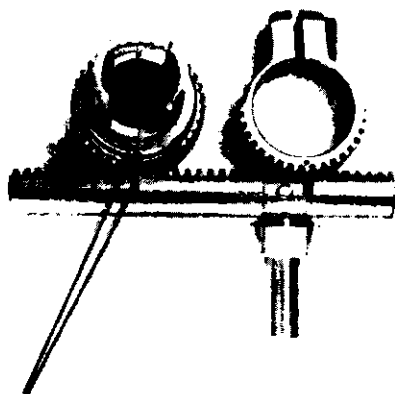
### (3) ASSEMBLY

Do not mix the various parts of each valve. If one valve part is defective, replace all the valves. During assembly, keep the parts in clean fuel oil and match the "matching marks."

1. Place the left plunger barrel gasket in position.
2. Install the left plunger barrel.
3. Install the left delivery valve assembly and gasket together.
4. Install the left delivery valve spring.

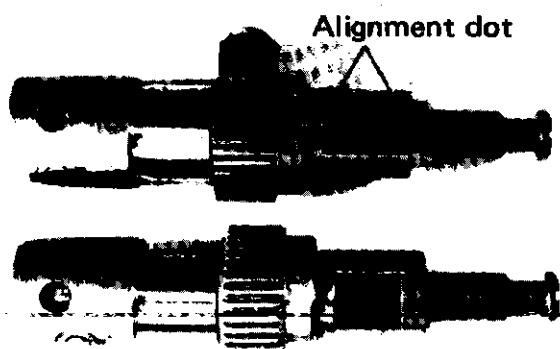
Tighten the left delivery valve holder with a torque wrench. Torque should be  $4^{+0.5}_0$  kg/m (29–32.6 ft-lb).

5. Install the fuel control rack.
6. Install the left fuel control sleeve (A).



Alignment mark

7. Install the upper seat of the left plunger spring.
8. Install the left plunger spring.
9. Install the left plunger.



10. Install the lower seat of the left plunger spring.
11. Install the plunger location adjusting shim.
12. Install the left plunger guide.
13. Install the left plunger guide stop.  
Set the stop by pressing the plunger by hand.  
(Press the plunger guide by moving the rack so that the plunger collar can be fixed into the groove of the regulating gear tooth.)

14. Place only the right fuel control gear tooth in the pump body.
15. Apply the procedures given in (1)–(4) to the right unit.
16. Insert the right fuel control sleeve in the pump body.  
Check that the “matching lines” of both the regulating ring and regulating gear tooth match.
17. Apply the procedures given in (7)–(13) to the right unit.
18. Set the plunger guide checking pin.

#### (4) FUEL INJECTION PUMP TEST

If inspection does not reveal any external damage, then a series of tests should be made to determine if the injector is acceptable for use in the engine. All tests must be performed using fuel pump test oil SAE-No. 1D or its equivalent.

#### FUEL CONTROL RACK FREE MOVEMENT AND PLUNGER MOVEMENT TEST

After the reassembly of the fuel injection pump is completed, rinse it in clean fuel oil and move the control rack. Check the control rack for free movement by performing the following procedures:

##### a) Testing Method: Free Movement of the Fuel Control Rack

Lay the fuel injection pump on its side and stand the fuel control rack upright. If the rack smoothly moves down by its own weight along the full length of the pump side, its free movement is good. Turn it upside-down to test its downward movement.

##### b) When the control rack has high sliding resistance, possible main causes are:

- i) The rotary sliding section of the plunger assembly offers high resistance.
- ii) The delivery valve holder has been excessively tightened (as a result the plunger barrel is distorted).

iii) The fuel control rack, the gear segment of the fuel control bush, or the outside of the fuel control rack has been scratched or dirt has stuck to these parts. As a result, the fuel control rack cannot move smoothly.

iv) The fuel control rack hole of the fuel injection pump body has been scratched.

v) The plunger barrel packing is improperly fitted and as a result the plunger barrel is distorted. (The fuel oil will leak into the crankcase and dilute the lubricating oil.)

Disassemble the fuel injection pump and rinse or recondition it.

## ADJUSTING THE FUEL INJECTION PUMP

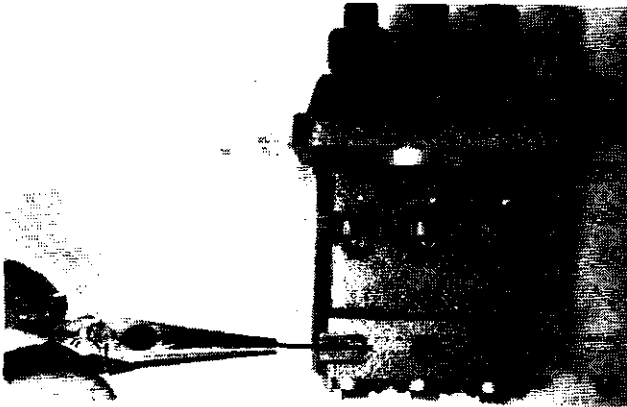
The fuel injection volume of each cylinder should be adjusted equally based on the following table.

Model	Camshaft speed (rpm)	Measurement strokes	Injection volume (c.c.)	
			Standard volume	Permissible balance on each cylinder
2T73A	1250	1000	22.0	±0.5
2TR13A	1350	1000	23.6	±0.5
2TR20A-X	1200	500	18.6	±0.25
2T75LE	1500	1000	23.0	±0.5
2T90LE	1500	1000	39.0	±0.5

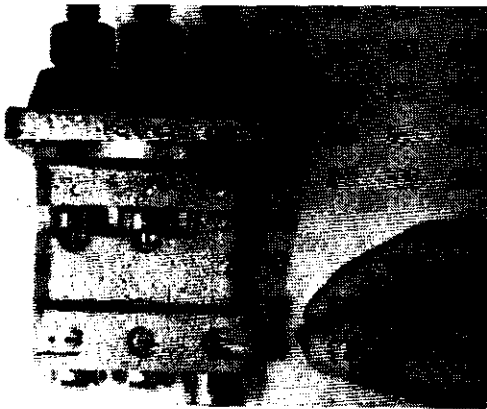
## 1.2 3T SERIES PUMP

### (1) DISASSEMBLY

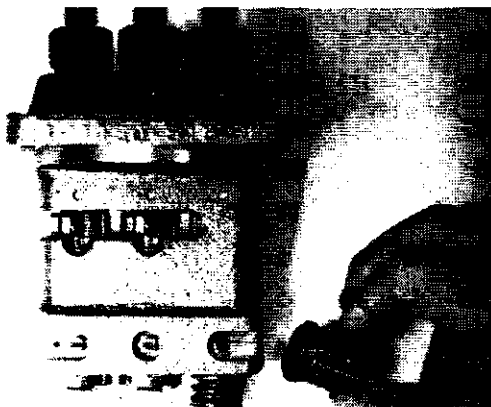
1. Remove the plunger guide stopper pin.



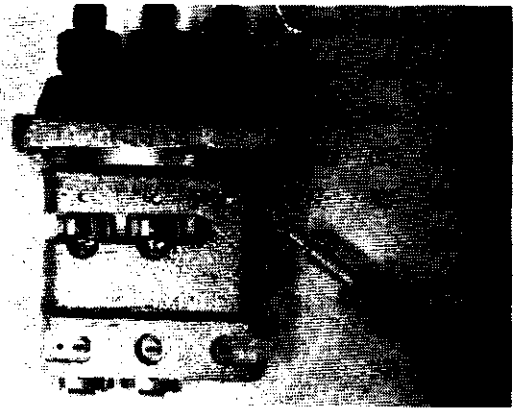
2. Remove the right plunger guide stopper.



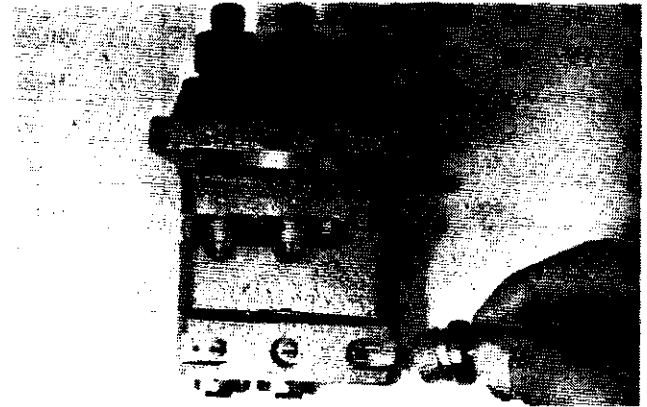
3. Remove the right plunger guide.



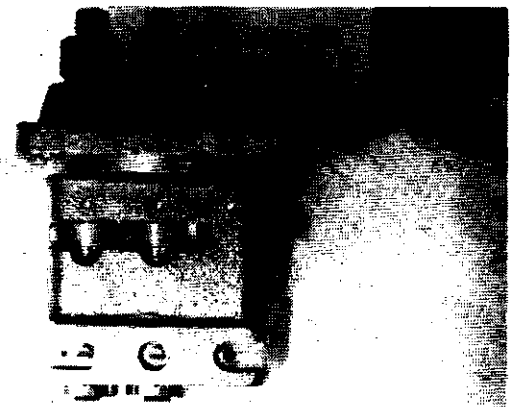
4. Remove the right plunger, plunger spring lower seat, plunger spring and plunger prestroke adjusting shim.



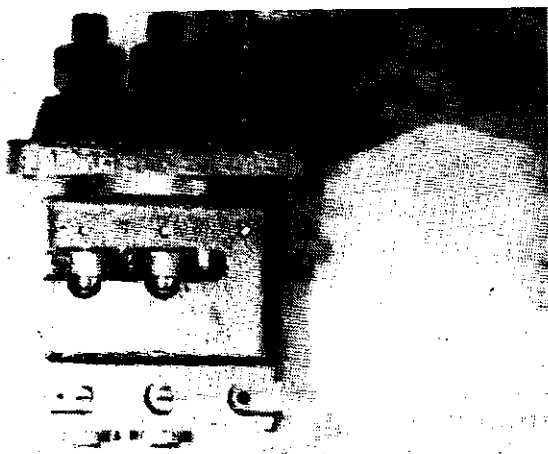
5. Remove the right plunger spring upper step seat and fuel control sleeve.



6. Remove the right delivery valve holder and spring.

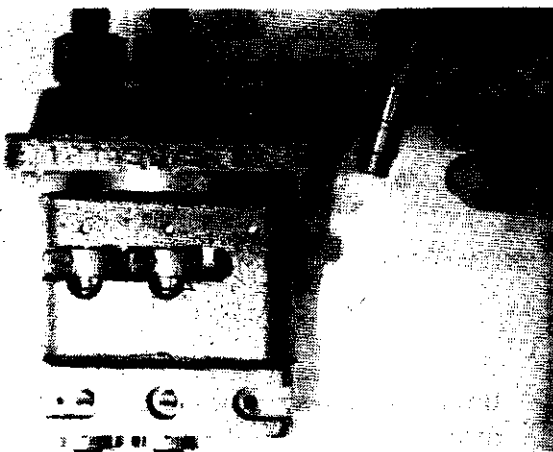


7. Remove the right delivery valve, delivery valve seat and gasket together.



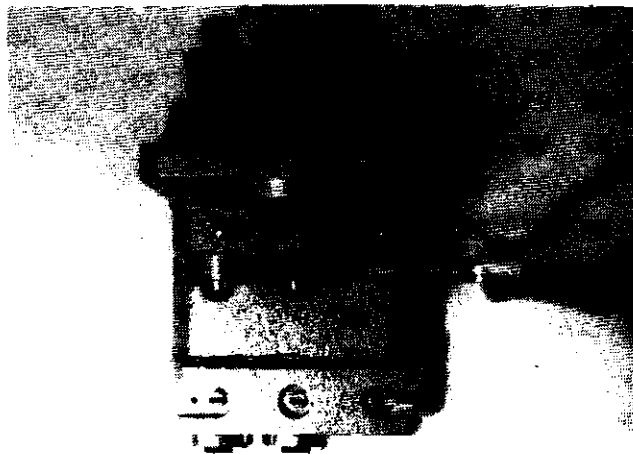
Visually check for damage and wear on the delivery valve and delivery valve seat.

8. Remove the right plunger barrel.



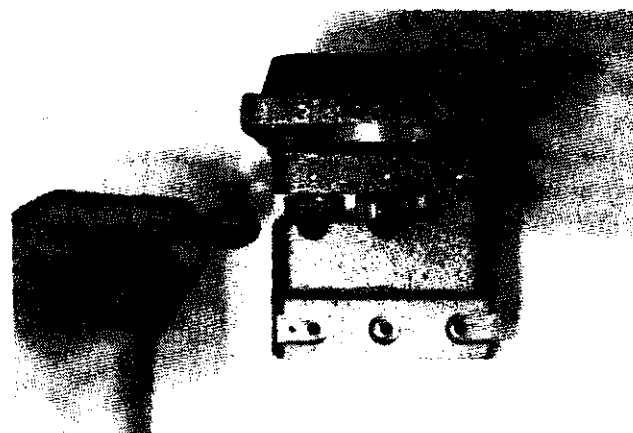
9. Since the center and left fuel control pinion is separated into the control sleeve and the control pinion, the mated part of the two must be marked.

10. Loosen the center fuel control pinion set screw.

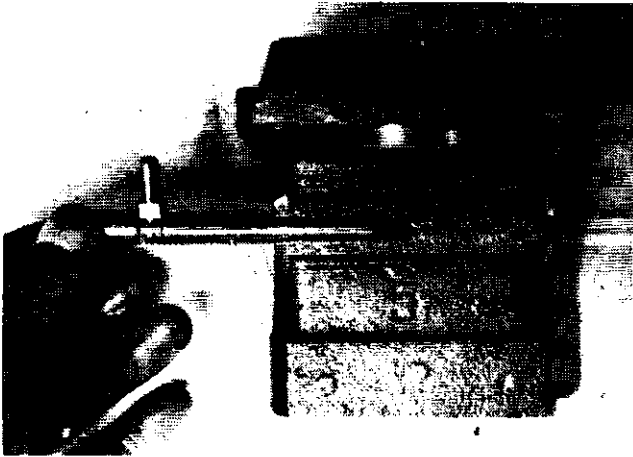


11. Apply the procedures given (2)–(8) to the center unit.

12. Remove the center fuel control sleeve.



13. Apply (10) to the left unit.
14. Apply (2) - (8) to the left unit.
15. Apply (12) to the left.
16. Remove the fuel control rack.



17. Remove the plunger barrel gaskets.

## (2) INSPECTION OF MAJOR COMPONENTS

The 3T-fuel injection pump is basically the same as the 2T-pump.

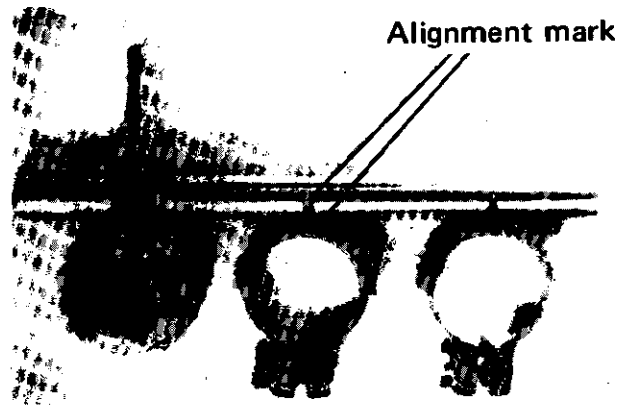
## (3) ASSEMBLY

### Fuel Injection Pump Assembly

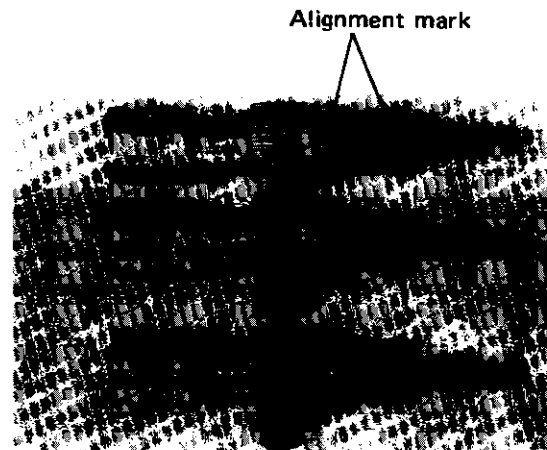
Be sure to observe the following "precautions" when assembling the fuel injection pump.

Do not mix the various parts of each valve. If one valve part is defective, replace all the valves. During assembly, clean the parts in clean fuel oil and match the "matching marks."

1. Install the right plunger barrel gaskets.
2. Install the right plunger barrel.
3. Install the right delivery valve, delivery valve seat and gaskets together.
4. Install the right delivery valve spring.  
Tighten the right delivery valve holder. Tightening torque  $4^{+0.5}_0$  kg-m (29–32.6 ft-lb).
5. Install the fuel control rack.
6. Install the right fuel control sleeve (A).



7. Install the copper seat of the right plunger spring.
8. Install the right plunger spring.
9. Install the right plunger.



10. Install the lower seat of the right plunger spring.
11. Install the plunger pre-stroke adjusting shim.
12. Install the right plunger guide.
13. Install the right plunger guide stop.

Set the stop by pressing the plunger by hand.  
(Press the plunger guide by moving the rack



so that the plunger can be fixed into the groove of the fuel control sleeve tooth.)

14. Place only the center fuel control pinion in the pump body.
15. Apply the same procedures (1) – (4) to the center unit.
16. Install the center fuel control sleeve in the pump body.  
  
Confirm that the corresponding scribal lines of both the control sleeve and pinion "match".
17. Apply the same procedure (17) – (13) to the center unit.
18. Apply (14) to the left unit.
19. Apply (1) – (4) to the left unit.
20. Apply (16) to the left unit.
21. Apply (7) – (13) to the left.
22. Insert the plunger guide stop with pliers.

#### **(4) FUEL INJECTION PUMP TEST**

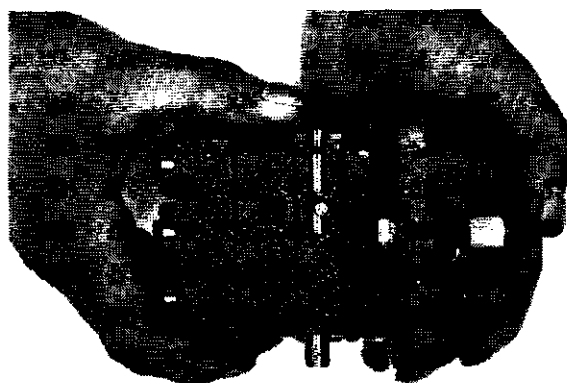
Basically the same as the 2T-pump except the fuel output will be different.

#### **CONTROL RACK FREE MOVEMENT AND PLUNGER MOVEMENT TEST**

Any pump that passes all of the tests outlined below may be considered to be satisfactory for service. However, any pump that fails to pass one

or more of the tests is unsatisfactory and the faults must be corrected. After the reassembly of the fuel injection pump, rinse it in clean fuel oil and move the control rack. Check the control rack for free movement by performing the following procedures.

a) This test is conducted to check the sliding resistance of the fuel control rack. If the sliding resistance should be excessive, it will give rise to various undesirable engine conditions, such as irregular running or bursts of engine speed, etc.



#### **b) Testing Method for Free Movement of Fuel Control Rack**

Lay the fuel injection pump on its side and stand the fuel control rack upright. If the rack smoothly moves down by its own weight along the full length of the pump side, its free movement is good. Turn it upside-down to test its downward movement.

c) When the control rack has high sliding resistance, possible main causes are:

- i) The rotary sliding section of the plunger assembly offers high resistance.
- ii) The delivery valve holder has excessively been tightened (as a result the plunger barrel is distorted).
- iii) The fuel control rack, the gear segment of the fuel control bush, or the outside of the fuel control rack has been scratched; or dirt has stuck to these parts. As a result the fuel control rack cannot move smoothly.

iv) The fuel control rack hole of the fuel injection pump body has been scratched.

v) The plunger barrel packing is improperly fitted and as a result the plunger barrel is distorted. (In this case the fuel oil will leak into the crank case and dilute the lubricating oil. This demands careful attention.)

In the above case disassemble the fuel injection pump and rinse or recondition it.

## ADJUSTING THE FUEL INJECTION PUMP

Be sure to adjust the fuel injection pump after it is reassembled by using an injection pump tester and its attachments.



### Pump Tester

#### • Yanmar Tester Type I

*\* When using a non-Yanmar tester, the following cambox is necessary.*

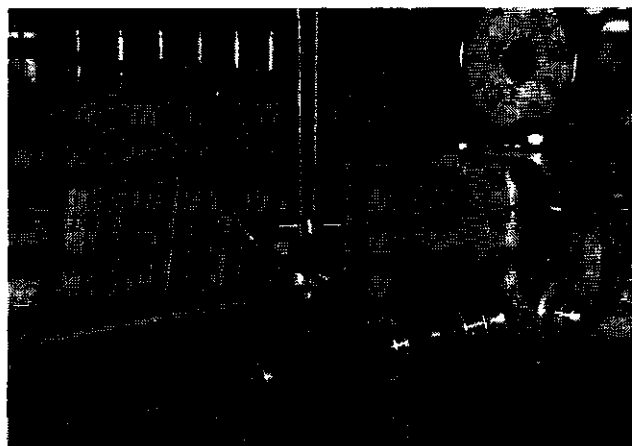
Pump type	Cam box part No.	Applicable pump tester
2 cyl.	D24761-51300	Bosch 385
3 cyl.	D21120-51300	Bosch 385
2 cyl.		Bacharach specialist 10 U7500A
3 cyl.		Bacharach specialist 10 U7500A
4 cyl.		

## (A) Preparation for Adjustment

a) Place the reassembled pump on the pump tester.

### b) Check the Control Rack Stroke

Operate the control lever and make sure that the total stroke of the control rack is about 18 mm (0.7 in.) and that the rack moves smoothly. If the rack does not move smoothly, recheck the pump and recondition the rack.



### c) Bleeding Air Out of the Fuel System

Run the pump tester at a low speed and loosen the air bleeder screw of the pump to bleed air out.



## (B) Adjusting Injection Timing

### a) Adjusting Space above the Plunger Top

Remove the delivery valve holder and the de-

livery valve. By rotating the camshaft, set the plunger at top dead center [7 mm (0.276 in.) lift time]. With a dial gauge measure the clearance in the level between the tops of the plunger barrel and the plunger (space above the top).

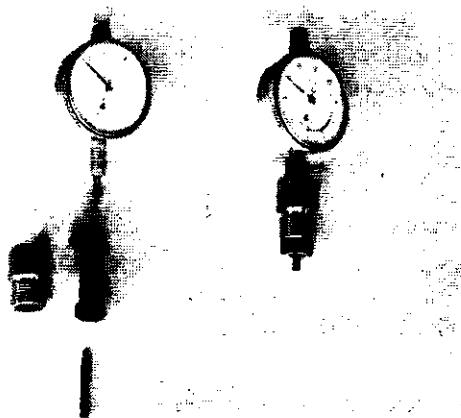


Vertical Dimension of Space above Plunger Top
$0.5^{+0.05}_{-0.05}$ mm $(0.0197^{+0.00197}_{-0.00197}$ in.)

**b) How to Use a Measuring Jig for Top Clearance of the Plunger**

i) Attach the dial gauge to the measuring jig.

ii) Stand the jig on a surface plate and adjust the dial gauge reading to zero.

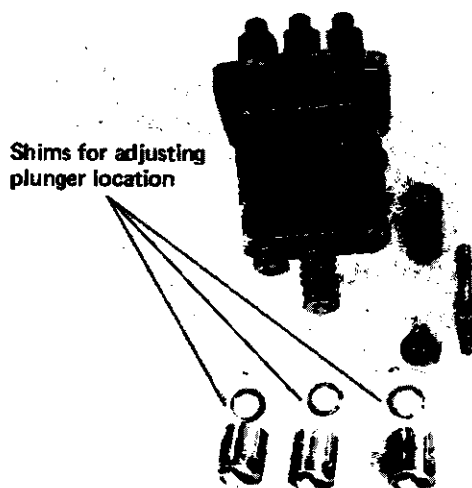


iii) Remove the delivery valve of the pump and instead mount the measuring jig.

iv) Rotate the camshaft to bring the plunger to top dead center. The indication of the dial gauge at this time is the vertical dimension of the space above the plunger top.

- If the top clearance of the plunger is greater than the specified value, remove the plunger guide and insert a plunger position adjusting shim between the lower plunger seat and the plunger guide. Adjust each cylinder in a similar manner.

If a measuring jig is not available, insert a shim with the same thickness as the one removed. Measure the injection timing of all cylinders, and make the space above the plunger top of each cylinder uniform.



Unit: mm (in.)

Plunger prestroke adjusting shim		
Thickness	0.1 (0.004)	0.2 (0.008)
Code No.	174307-51710	174307-51720

- After checking the adjusting shim install the delivery valve.

Delivery valve holder tightening torque
$4^{+0.5}_{-0}$ kg-m ( $28.9^{+3.6}_{-0}$ ft-lb)

**c) The Injection Intervals of Each Cylinder**

i) Align the punched mark on the control rack with the reference level of the pump.

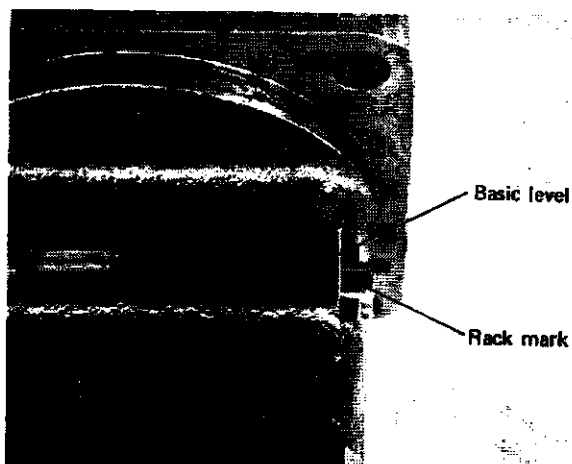
ii) Manually rotate the pump to check the injection timing of the No. 1 cylinder.

iii) Rotate the pump clockwise, as seen from the driver's side, and measure the injection timing of the No. 3 (No. 2) cylinder. Adjust the injection timing intervals by using the plunger position adjusting shim so that they are spaced  $120^\circ$  ( $180^\circ$ ) apart.

iv) Make the following injection intervals uniform in a similar manner:

1~3~2~1: should be spaced  $120^\circ$  apart.

1~2~1: should be spaced  $180^\circ$  apart.



**(C) Testing the Oil Tightness of the Delivery Valve**

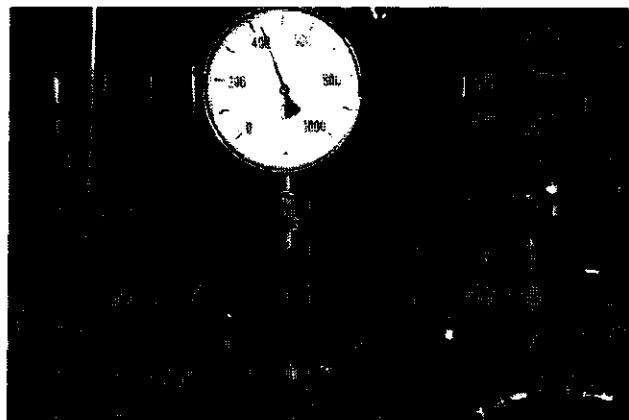
a) Attach a  $1,000 \text{ kg/cm}^2$  (about 14,200 psi) pressure gauge to the delivery valve holder.

b) Operate the pump and apply a pressure of about  $120 \text{ kg/cm}^2$  (1,700 psi) to the delivery valve. Measure the time required for the pressure to drop from  $100 \text{ kg/cm}^2$  (1,420 psi) to  $10 \text{ kg/cm}^2$  (142 psi).

Pump speed	200rpm
Time limit for the pressure drop test	Maximum 5 sec.

**(D) Testing Plunger Pressure**

a) Attach a  $1,000 \text{ kg/cm}^2$  (about 14,200 psi) pressure gauge to the delivery valve holder.



b) Raise the pressure above  $500 \text{ kg/cm}^2$  (7,100 psi) and check for fuel oil leaks from the delivery valve holding screw and the high-pressure pipe mounting section; also make sure that no sudden pressure drop takes place.

**(E) FUEL OUTPUT TEST**

a) Set the revolution speed of the pump camshaft at 1,500 rpm.

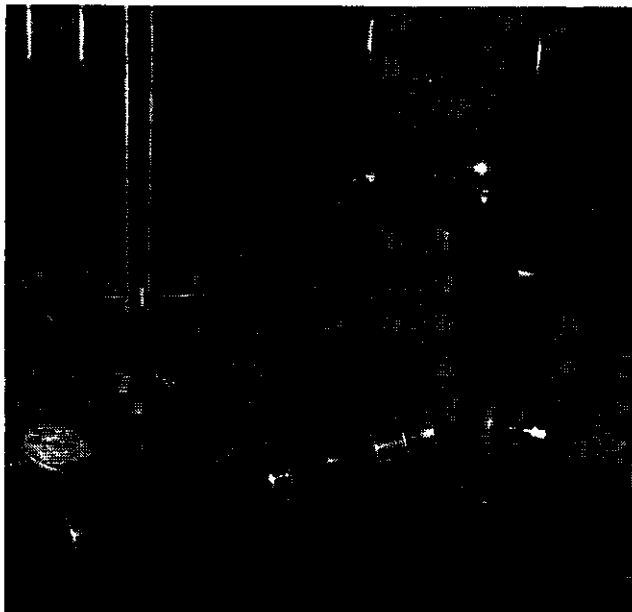
b) Check the fuel injection valve.

Type	YDN-OSDYD1
Injection pressure	160kg/cm <sup>2</sup>

Fuel Injection Line: Outside dia.  $\phi 6.0$  x Inside dia.  $\phi 2.0$  x 900 (mm) Code No. 1211-20 - 51960

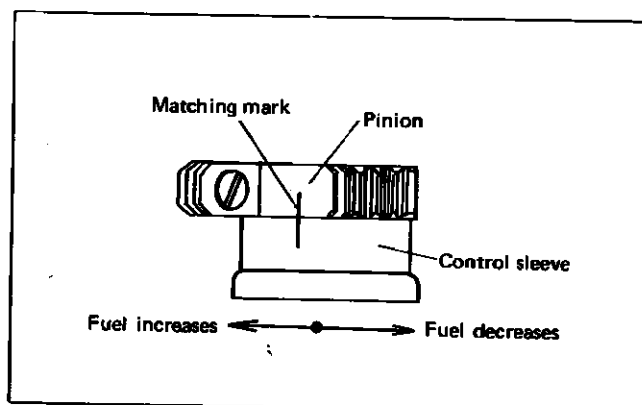
c) Inspection oil . . . . . JIS No. 2 Diesel Oil (SUS34~36 2.38-2.99CS @100F)

d) Oil delivery pressure . . . . .0.5 kg/cm<sup>2</sup>



## (F) Adjusting the Fuel Injection Delivery

Use the No. 1 cylinder as the standard and adjust the discharge of the No. 2 and 3 cylinders by shifting the control sleeve.



*[To increase the fuel injection volume, turn the control sleeve clockwise from the matching marks (righthand lead)]*

To have the fuel injection within the specified allowance:

First, adjust the fuel injection volume of the No. 1 cylinder. Then adjust the fuel injection volume of the No. 2 and No. 3 cylinder.

Model	Camshaft speed (rpm)	Measurement strokes	Injection volume (c.c.)	
			Standard volume	Permissible balance on each cylinder
3T84A	1300	1000	17.0	±0.25
3T80J	1300	1000	30.5	±0.5
3T90J	1200	1000	38.0	±0.5
3T80LE				
3T84LE				
3T90LE	1500	1000	39.0	±0.5

## 2. Fuel injection nozzle

In a diesel engine, a nozzle and nozzle holder for each cylinder are positioned in the cylinder head like spark plugs are positioned in a gasoline combustion engine. Fuel is supplied in a specified quantity from the fuel injection pump to each assembly. And it is the function of the fuel injection nozzle to mechanically atomize the fuel and spray it in a definite pattern into the combustion chambers to produce the most efficient engine performance.

### (1) FUEL INJECTION NOZZLE

The fuel injection nozzle receives fuel oil from the fuel injection pump, and in a finely atomized pattern, sprays it into the combustion chamber. The spray pattern and the amount of fuel are automatically adjusted to create the proper air-fuel mixture in the chambers, thereby producing ignition and optimum combustion.

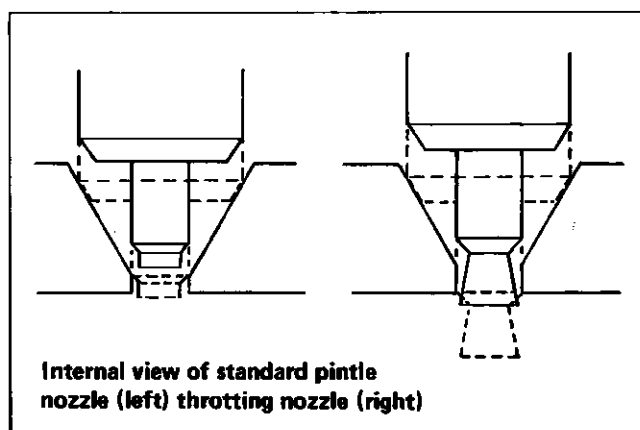
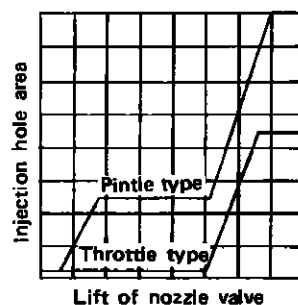
Injection nozzles are designed and manufactured to exact specifications to assure long term operation with maximum efficiency and a minimum of preventive maintenance.

Most Yanmar spray nozzles, which consist of a body and a valve, are made of heat treated alloy steel to minimize wear and improve durability. Some modern diesel engines operate at such high temperatures that they require nozzles made of specially processed, heat treated, stainless steel. These nozzles are also resistant to corrosive fuels. The body and valve of both types of spray nozzles are lapped to form such an extremely close fit that the "matched" assembly, i.e. the two parts, are not interchangeable but must be replaced as "one set."

### (2) YANMAR THROTTLE NOZZLE

The throttle nozzle is similar to the standard pintle type except that the pintle and the hole in the bottom of the nozzle body are longer. This design produces a "throttling" or delaying action by permitting only a small amount of fuel into the combustion chamber at the beginning of injection. However, as the valve continues to lift, the rate of fuel is progressively increased. Yanmar throttling

nozzles are used to obtain maximum performance from small bore, high speed engines.



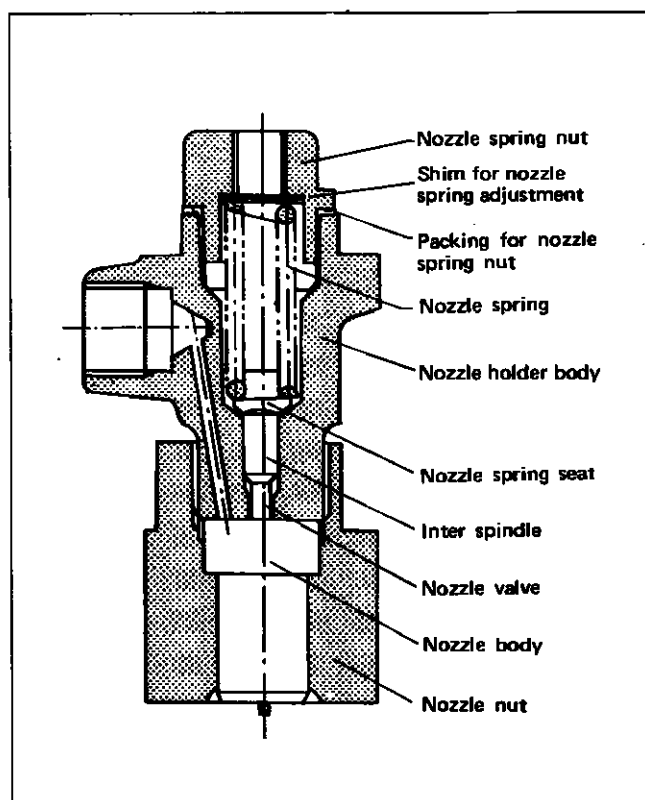
Pressure is exerted on the valve stem by a pressure adjusting spring to hold the valve in a tightly closed position on the valve seat.

Fuel, under high pressure from the injection pump, enters the annular groove in the top of the nozzle body, flows through the fuel ducts into the pressure chamber above the valve seat and acts on the differential area of the nozzle valve. When the hydraulic pressure exceeds the force exerted by the pressure adjusting spring, the valve is lifted off its seat and fuel is injected through the spray holes (or the orifice of pintle and throttling nozzles) into the spray hole chamber and into the combustion chamber.

The valve returns to its "normally closed" position on the valve seat when the hydraulic pressure in the pressure chamber drops below the force exerted on the valve by the pressure adjusting spring. This cycle occurs with each opening and closing of the delivery valve in the fuel injection pump.

### (3) NOZZLE HOLDER

AKB, AKC, AKF, and AKL nozzle holders consist of a steel body, spindle, pressure adjusting spring, pressure adjusting screw or shims, nozzle retaining nut (cap nut), fuel inlet, fuel leakoff, and protection cap. (Refer to below). Machined into the holder body are ducts for conducting the fuel from the inlet connection to the nozzle. These ducts also carry the normal fuel leakage past the spindle and through the leak-off connection. The lapped surface of the nozzle holder is assembled on top of the lapped top of the nozzle body to provide a pressure-tight, leak-proof connection when the nozzle body is secured to the holder with the cap nut.



### (4) NOZZLE AND NOZZLE HOLDER DIS-ASSEMBLY

When disassembling and assembling the fuel injection valve to replace the nozzle, follow the following instructions:

a) Completely clean each part after disassembly. Be sure to clean the threads of the nozzle body, which fits into the nozzle attaching nut, since carbon is likely to be deposited. Failure to clean the carbon deposits will prevent even tightening of the nozzle and cause improper injection.

b) A brand new nozzle is coated with rust-preventive oil and wrapped in a plastic sealing to completely protect it from air. Before using the nozzle, remove the plastic sealing and rinse the inside and outside in clean diesel to thoroughly remove the rust preventive oil.

c) Loosen the nozzle spring retainer and assemble the nozzle to the nozzle holder body. If the nozzle spring retainer is not loosened, the end face of the nozzle body will not properly screw into and fit the nozzle holder body. And will result in oil leakage from the threads and/or improper injection.

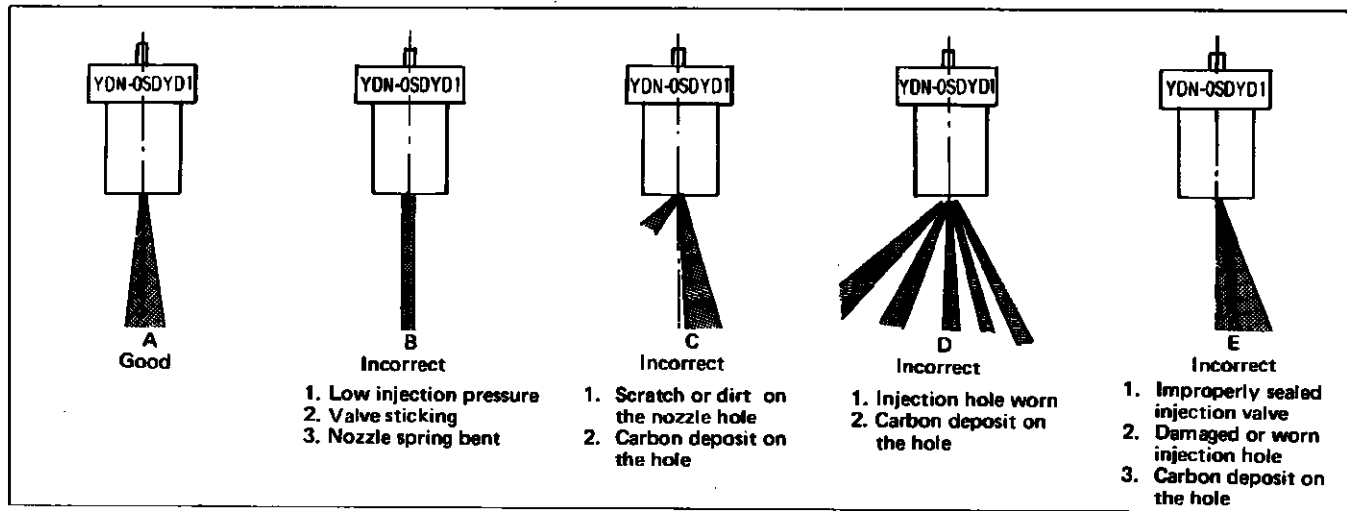
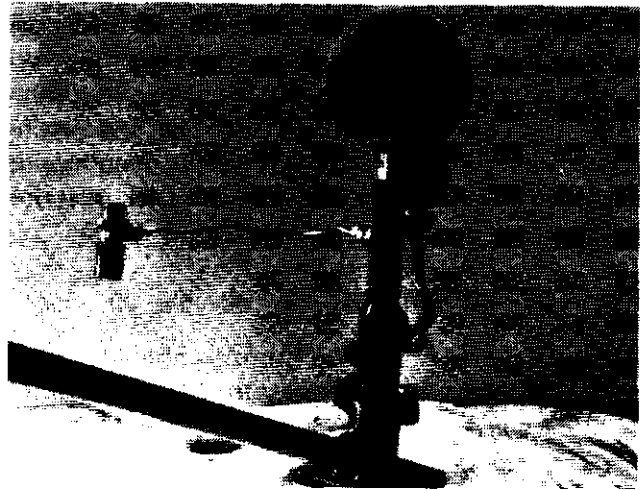
### (5) INSPECTION AND ADJUSTMENT OF NOZZLE

#### a) Nozzle Opening Pressure

Connect the injection valve to the high-pressure tube of a nozzle tester. Slowly operate the nozzle tester lever and take the pressure reading when fuel is injected from the nozzle. If the injection pressure is lower than  $160 \pm 5 \text{ kg/cm}^2$ , remove the nozzle spring retainer and adjust it by adding a nozzle spring adjusting shim. An adjusting shim of 0.1 mm increases injection pressure by approximately  $10 \text{ kg/cm}^2$ .

#### b) Spray Pattern

After the injection pressure has been adjusted to the proper specification, check the spray pattern by operating the nozzle tester lever 4 to 6 times per second.





## (6) NOZZLE VALVE FREE FALL TEST

Thoroughly clean the nozzle in fuel oil and hold the nozzle valve upright. Lift the nozzle by one hand to a height corresponding to about one-third of its length and let go of it. It is good if it falls smoothly by itself.



## (7) CHECKING THE OIL TIGHTNESS OF THE NOZZLE VALVE SEAT

Inject fuel oil from the nozzle several times by operating the nozzle tester lever, then wipe off the fuel oil around the spray tip. Raise the injection pres-

sure of the nozzle to 140 kg/cm<sup>2</sup> (1.990 psi), which is 20 kg/cm<sup>2</sup> (284 psi) lower than the specified opening pressure. If the oil drips from the spray hole, the nozzle valve seat is defective. Replace or recondition the nozzle valve seat.

Item \ Model		2T75LE	2T80LE	2T90LE	3T80LE	3T90LE	4T90LE
Fuel pump type		Y-PFR2K			Y-PFR3K		
Condition	Nozzle valve type	YDN-OSDYD1					
	Injection pressure	160kg/cm <sup>2</sup>					
	Oil feeding pressure	0.5kg/cm <sup>2</sup>					
	Fuel injection pump (d/DxL)	φ1.5/φ6x620	φ2/φ6x785	φ2/φ6x800	φ2/φ6x900	φ2/φ6x1000	
Plunger		φ7(with upper lead)	φ1				φ7.5
Delivery valve suction volume		24.5mm <sup>3</sup> /stroke		36mm <sup>3</sup> /stroke			

### 3. Fuel filter

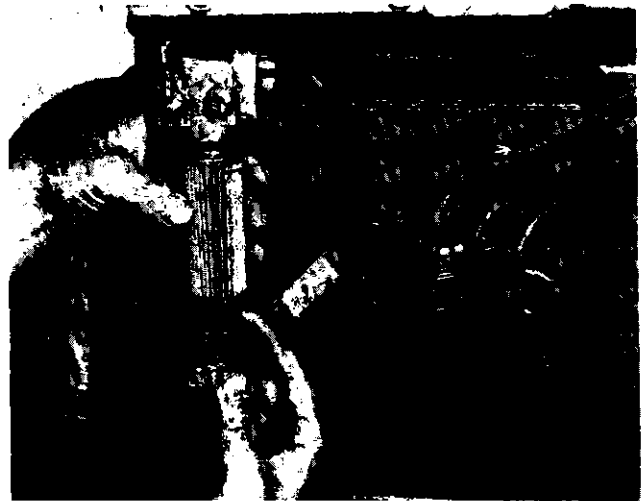
The fuel filter, which is located between the fuel tank and the fuel injection pump, removes any impurities from the fuel. It has a replaceable paper type element to ensure consistent fuel filtration.

The sucking action of the fuel injection pump draws fuel from the fuel tank and into the filter element to remove dirt particles. Clean fuel flows to the interior of the filter element, up through the central passage, into the outlet passage, and to the fuel injection pump.

Check and completely clean the fuel filter with clean fuel oil if it is contaminated with deposits, water, etc. The filter element should be replaced every 300 service hours, or sooner if it is stained or broken.

If the fuel appears to be contaminated, check the filter carefully and replace it even if the maximum number of service hours has not been reached.

Cleaning the inside filter	Every 50 service hours
Replacing of filter element	Every 300 hours
Part code No. of element	124550-55700



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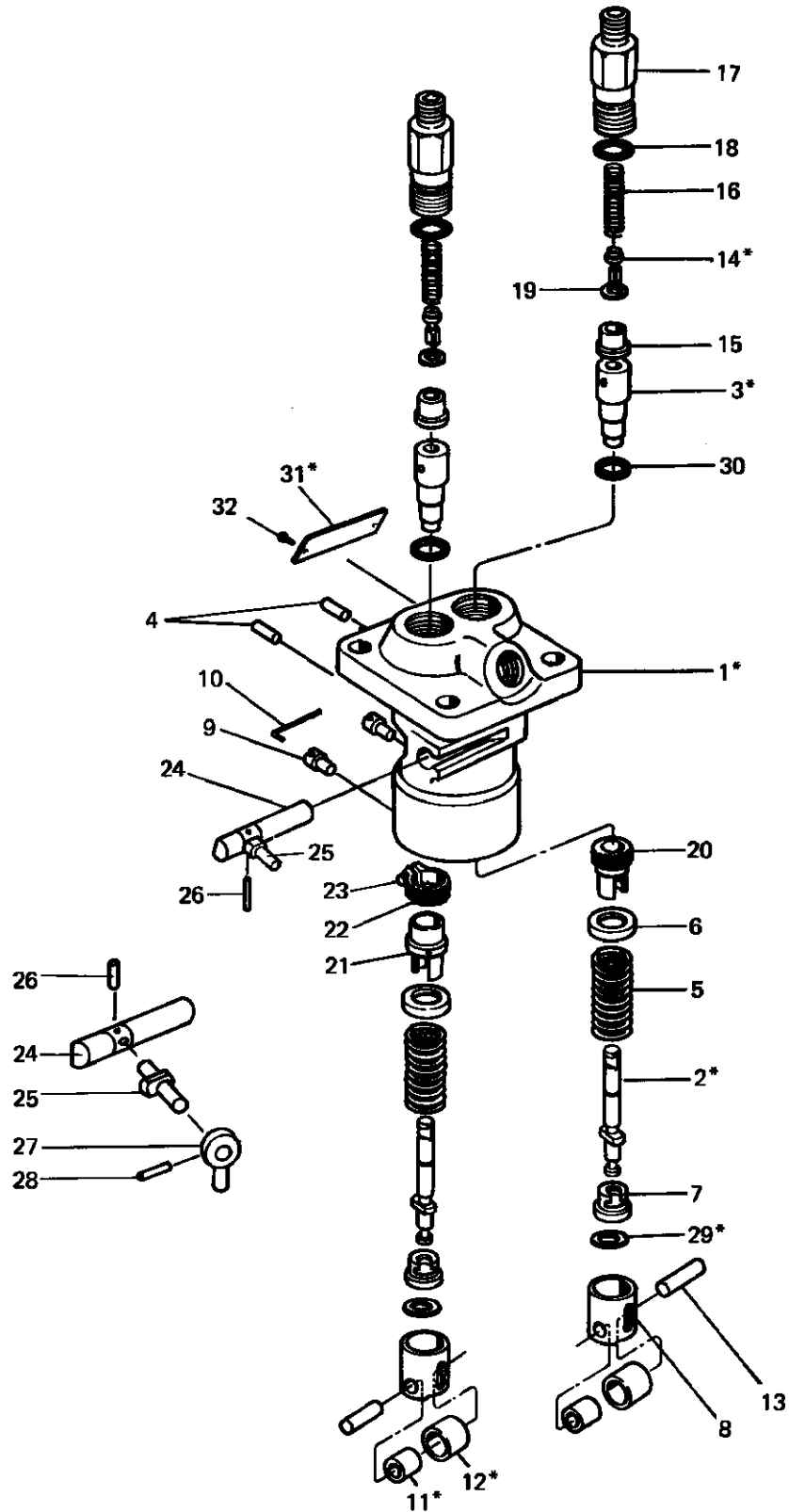
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# **PARTS LIST**

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# FUEL INJECTION PUMP (2 Cylinder)

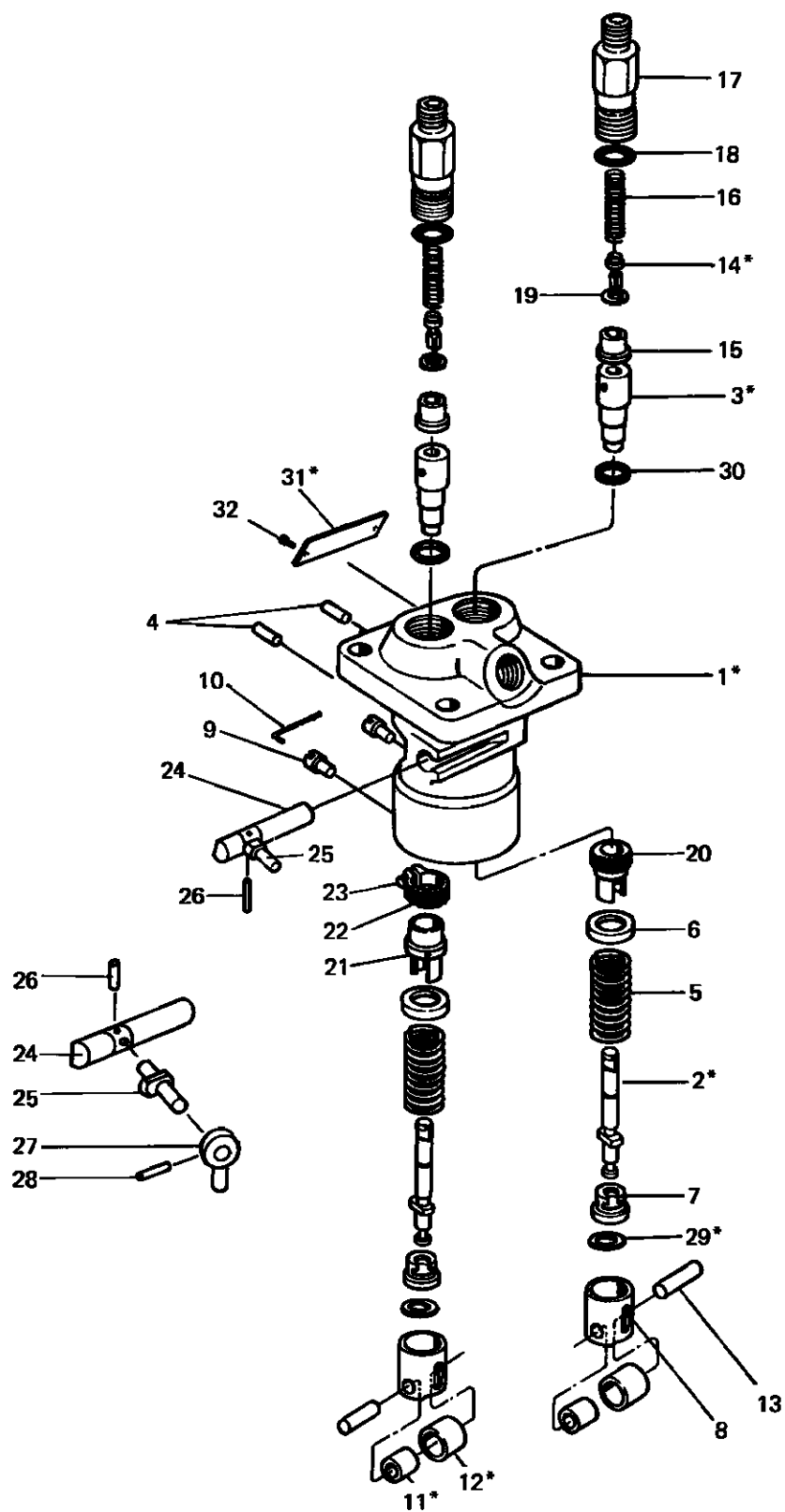


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# FUEL INJECTION PUMP (2 Cylinder)

Refer No.	Description	Part No.	Q'ty/Unit						Inter-change-ability	Sales Unit	Remarks
			2T 73 A	2TR 13 A	2TR 20 A-X	2T 75 LE	2T 80 LE	2T 90 LE			
	PUMP ASS'Y, fuel injection	D24660-51101	1								
		D24060-51101		1							
		D24761-51101			1						
		D24701-51100						1			Assembly *
1	BODY, fuel injection pump	124550-51011	1	1	1			1			*
	PLUNGER & BARREL ASS'Y	124230-51100	2								
2	PLUNGER	124230-51130	(2)								Assembly *
3	PLUNGER & BARREL	124230-51120	(2)								*
	PLUNGER & BARREL ASS'Y	124060-51100		2							
2	PLUNGER	124060-51130		(2)							Assembly *
3	PLUNGER & BARREL	124060-51120		(2)							*
	PLUNGER & BARREL ASS'Y	124240-51100			2						
2	PLUNGER	124240-51130			(2)						Assembly *
3	PLUNGER & BARREL	124240-51120			(2)						*
	PLUNGER & BARREL ASS'Y	124560-51100						2			
2	PLUNGER	124560-51130						(2)			Assembly *
3	PLUNGER & BARREL	124560-51120						(2)			*
4	PIN, plunger barrel stopping	103854-51251	2	2	2			2			
5	SPRING, plunger	174307-51190	2	2	2			2			
6	RETAINER, plunger spring	174307-51170	2	2	2			2			
7	RETAINER, plunger spring lower	174307-51180	2	2	2			2			
8	GUIDE, plunger	124550-51200	2	2	2			2			
9	STOPPER, plunger guide	174307-51450	2	2	2			2			
10	PIN, plunger guide stopping	174307-51460	1	1	1			1			
	ROLLER ASS'Y	711100-51540	2	2	2			2			
11	ROLLER, plunger guide inner	111100-51210	(2)	(2)	(2)			(2)			Assembly *
12	ROLLER, plunger guide outer	111100-51220	(2)	(2)	(2)			(2)			*
13	PIN, plunger guide roller	174100-54120	2	2	2			2			
	VALVE ASS'Y, delivery	124060-51300	2	2							
14	VALVE, delivery	111100-51891	(2)	(2)							Assembly *
15	SEAT, delivery valve	124550-51310	(2)	(2)							*

# FUEL INJECTION PUMP (2 Cylinder)

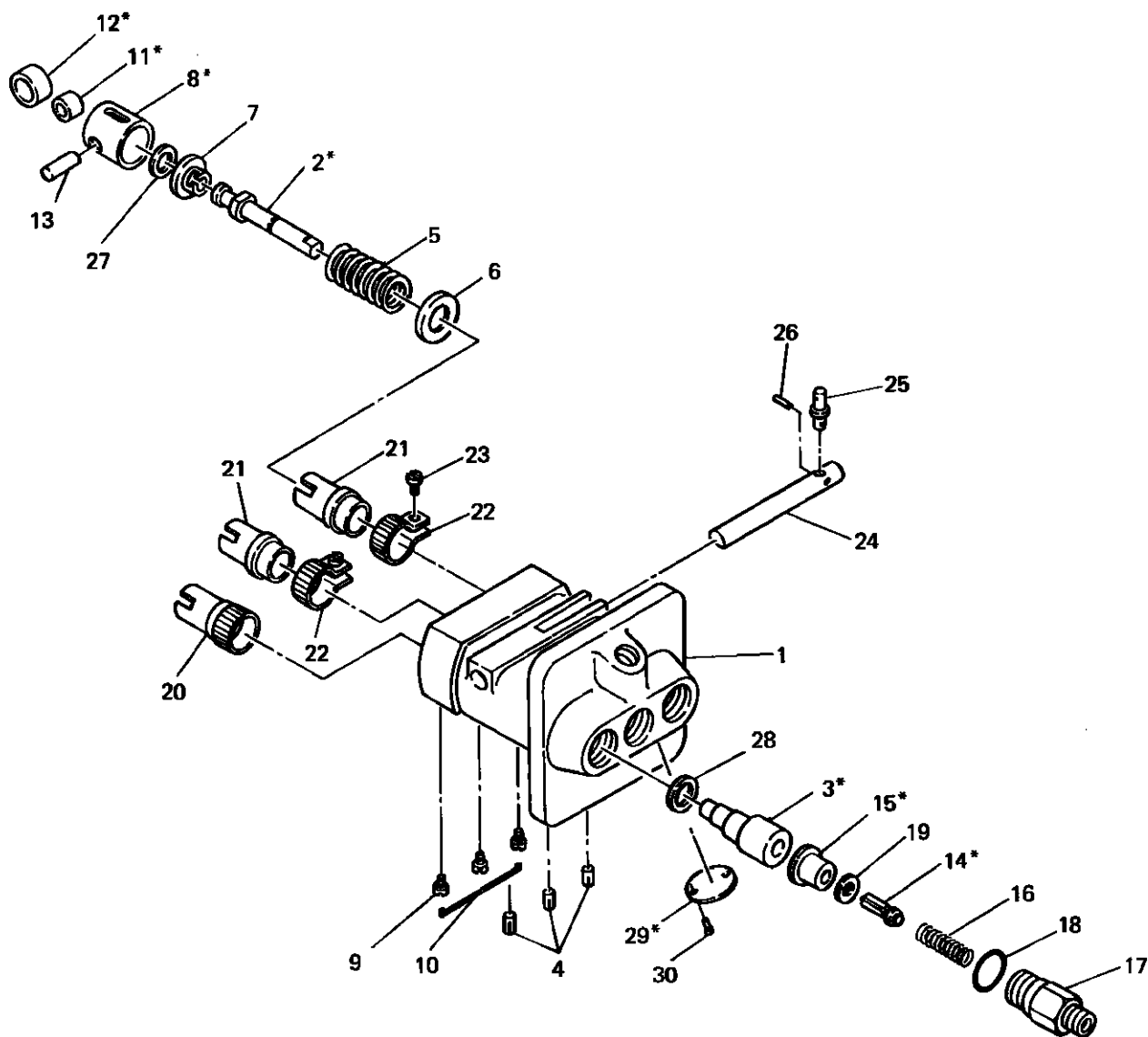


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### FUEL INJECTION PUMP (2 Cylinder)

Refer No.	Description	Part No.	Q'ty/Unit						Inter-change-ability	Sales Unit	Remarks
			2T 73 A	2TR 13 A	2TR 20 A-X	2T 75 LE	2T 80 LE	2T 90 LE			
	VALVE ASS'Y, delivery	124550-51301			2			2			
14	VALVE, delivery	124240-51300			(2)			(2)			Assembly *
15	SEAT, delivery valve	124550-51310			(2)			(2)			*
16	SPRING, delivery valve	124550-51320	2	2	2			2			
17	HOLDER, delivery valve	124550-51341	2	2	2			2			
18	O-RING, for delivery valve (P15, 2 types)	124550-51370	2	2	2			2			
19	PACKING, delivery valve seat	124550-51350	2	2	2			2			
20	PINION (A), fuel control toothed	174307-51510	1	1	1			1			
21	PINION (B), fuel control toothed	174307-51550	1	1	1			1			
22	SLEEVE, fuel control	174307-51560	1	1	1			1			
23	LOCK SCREW, fuel control toothed clamp	122117-51560	1	1	1			1			
24	RACK, fuel control	124240-51500	1	1	1			1			
25	PIN, fuel control rack	124240-51550			1			1			
26	STUD, fuel control rack	124550-51590	1	1	1			1			
25	PIN, fuel control rack	124060-51550	1	1							
27	FITTINGS, governor No. 2 lever coupling	124060-51560	1	1							
28	STUD, governor No. 2. lever coupling	124060-51570	1	1							
29	SHIM, plunger position adjusting	174307-51700	2	2	2			2			
	(t = 0.1)	174307-51710	(2)	(2)	(2)			(2)			Assembly *
	(t = 0.2)	174307-51720	(2)	(2)	(2)			(2)			*
30	PACKING, plunger barrel	174307-51270	2	2	2			2			
31	NAME PLATE, fuel pump	124660-51920	1								*
		124060-51920		1							*
		124761-51920			1						*
		124701-51920						1			*
32	RIVET, small round 2.3 x 3	22624-230030	2	2	2			2			

# FUEL INJECTION PUMP (3 Cylinder)



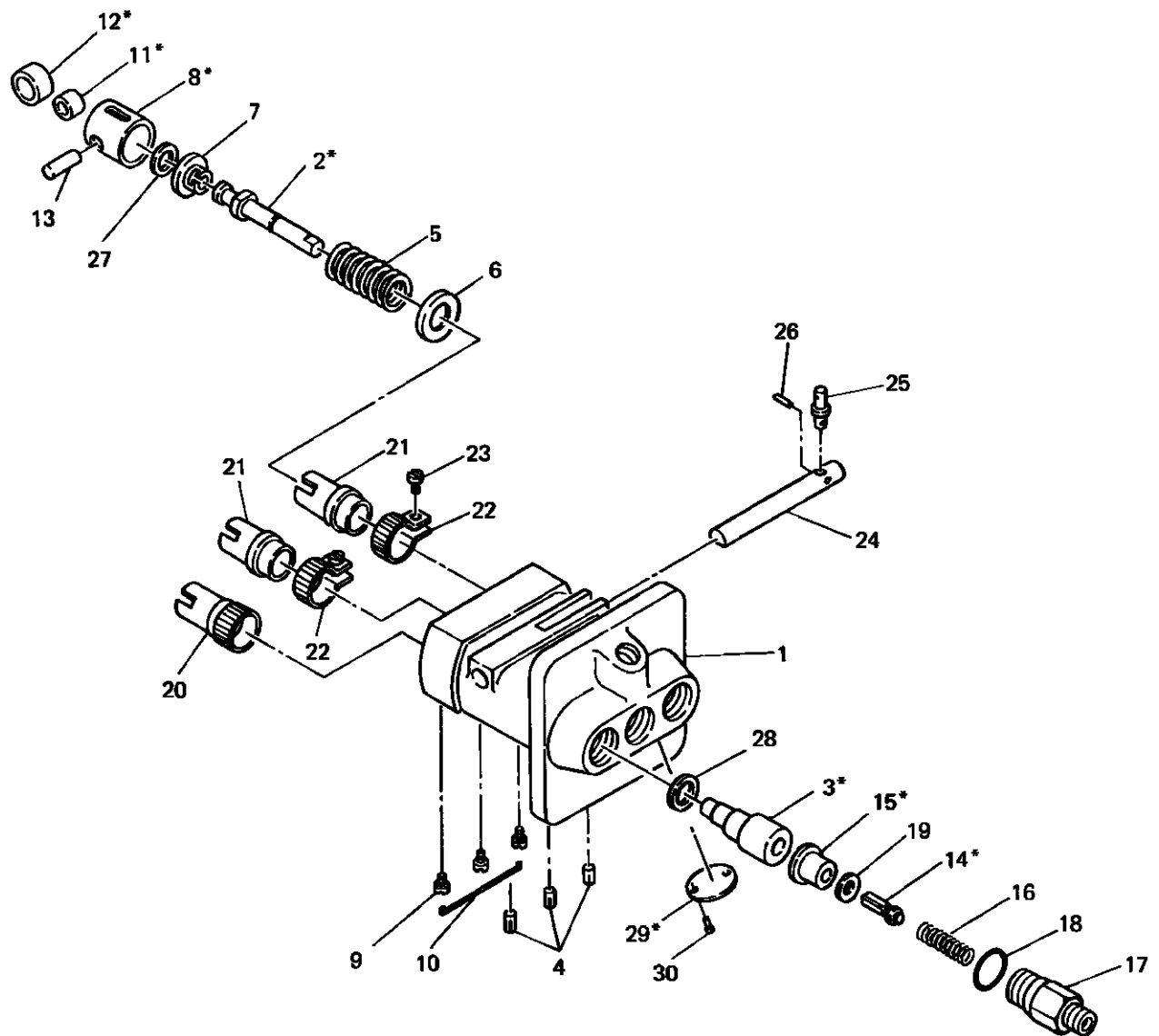
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# FUEL INJECTION PUMP (3 Cylinder)

Refer No.	Description	Part No.	Q'ty/Unit						Inter-change-ability	Sales Unit	Remarks
			3T 84 A	3T 80 J	3T 90 J	3T 80 LE	3T 84 LE	3T 90 LE			
	PUMP ASS'Y, fuel injection	D21250-51100	1								
		D21120-51100		1							
		D21400-51100			1						
		D21400-51100						1			
1	PUMP ASS'Y, fuel injection	121150-51010	1	1	1			1			Assembly *
	PLUNGER & BARREL ASS'Y	124240-51100	3	3	3			3			
2	PLUNGER	124240-51130	(3)	(3)	(3)			(3)			Assembly *
3	PLUNGER & BARREL	124240-51120	(3)	(3)	(3)			(3)			*
4	PIN, plunger barrel stopping	103854-51251	3	3	3			3			
5	SPRING, plunger	174307-51190	3	3	3			3			
6	RETAINER, plunger	174307-51170	3	3	3			3			
7	LOWER RETAINER, plunger spring	174307-51180	3	3	3			3			
8	GUIDE, plunger	124550-51200	3	3	3			3			
9	STOPPER, plunger guide	174307-51450	3	3	3			3			
10	PIN, plunger guide stopping	121150-51460	1	1	1			1			
	ROLLER ASS'Y	711100-51540	3	3	3			3			
11	ROLLER, plunger guide inner	111100-51210	(3)	(3)	(3)			(3)			Assembly *
12	ROLLER, plunger guide outer	111100-51220	(3)	(3)	(3)			(3)			*
13	PIN, plunger guider roller	174100-54120	3	3	3			3			
	DELIVERY VALVE ASS'Y	124550-51301	3	3	3			3			
14	VALVE, delivery	124240-51300	(3)	(3)	(3)			(3)			Assembly *
15	SEAT, delivery valve	124550-51310	(3)	(3)	(3)			(3)			
16	SPRING, delivery valve	124550-51320	3	3	3			3			
17	HOLDER, delivery valve	124550-51341	3	3	3			3			
18	O-RING, for delivery valve (D15, 2 types)	124550-51370	3	3	3			3			
19	PACKING, delivery valve seat	124550-51350	3	3	3			3			
20	PINION (A), fuel control toothed	174307-51510	1	1	1			1			
21	PINION (B), fuel control toothed	174307-51550	2	2	2			2			
22	SLEEVE, fuel control pinion	174307-51560	2	2	2			2			
23	LOCK SCREW, fuel control toothed clamp	122117-51560	2	2	2			2			
24	RACK, fuel control	121150-51500	1	1	1			1			

# FUEL INJECTION PUMP (3 Cylinder)

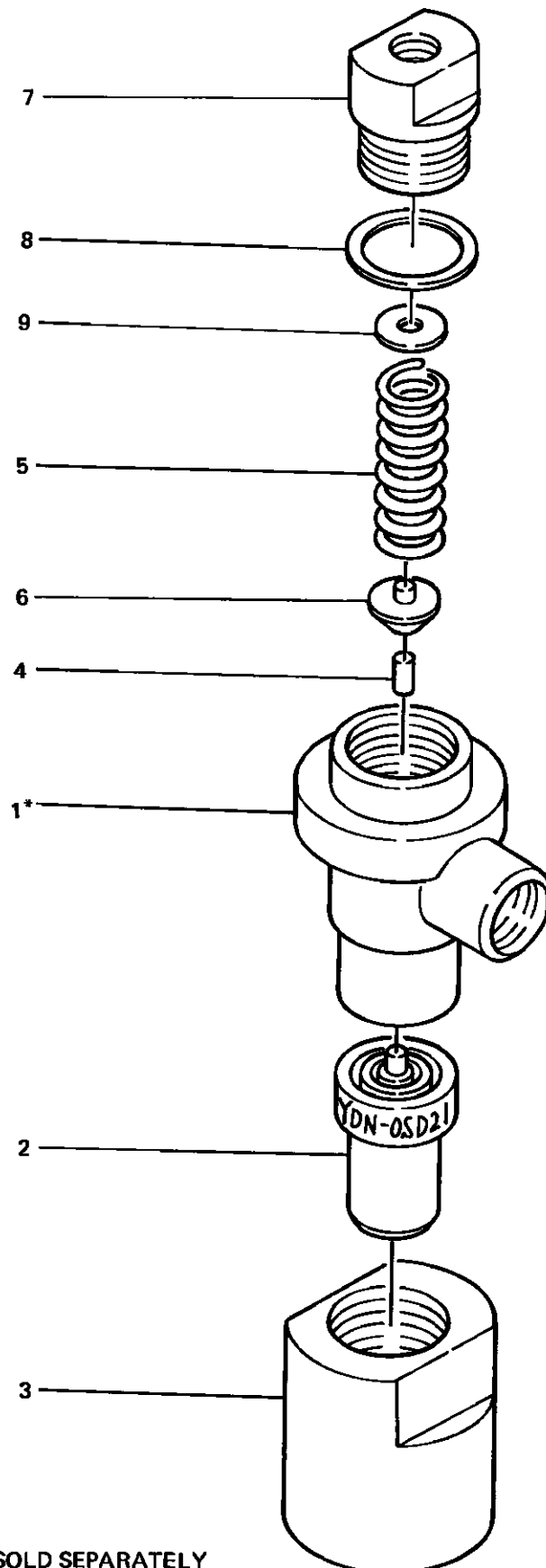


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### FUEL INJECTION PUMP (3 Cylinder)

Refer No.	Description	Part No.	Q'ty/Unit						Inter-change-ability	Sales Unit	Remarks
			3T 84 A	3T 80 J	3T 90 J	3T 80 LE	3T 84 LE	3T 90 LE			
25	PIN, fuel control rack	124240-51550	1	1	1			1			
26	RETAINER, fuel control rack	124550-51590	1	1	1			1			
27	SHIM, plunger position adjusting	174307-51700	3	3	3			3			
	(t = 0.1)	174307-51710	(3)	(3)	(3)			(3)			Assembly *
	(t = 0.2)	174307-51720	(3)	(3)	(3)			(3)			Assembly *
28	PACKING, plunger barrel	174307-51270	3	3	3			3			
29	NAMEPLATE, fuel plate	121250-51920	1								Assembly *
		121120-51920		1							Assembly *
		121400-51920			1						Assembly *
		121400-51100						1			Assembly *
30	RIVET, small round 2.3 x 3	22624-230030	2	2	2			2			

# FUEL INJECTION VALVE (2 Cylinder)

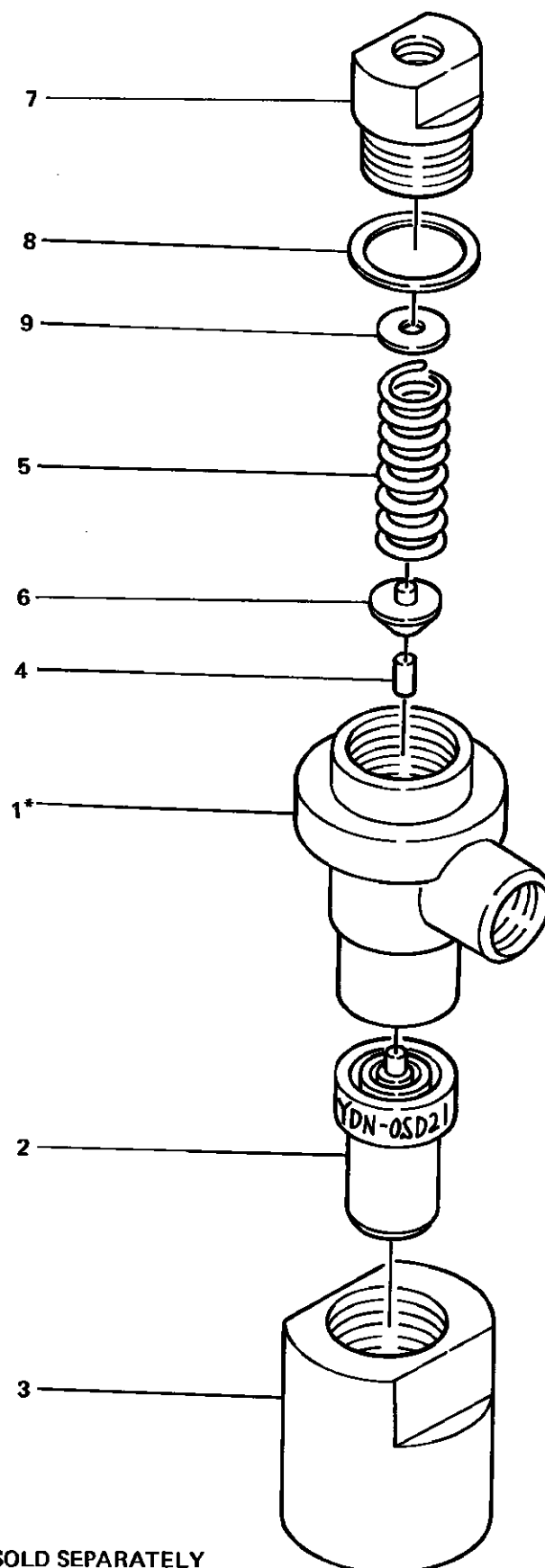


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# FUEL INJECTION VALVE (2 Cylinder)

Refer No.	Description	Part No.	Q'ty/Unit						Inter-changeability	Sales Unit	Remarks
			2T 73 A	2TR 13 A	2TR 20 A-X	2T 75 LE	2T 80 LE	2T 90 LE			
	VALVE ASS'Y, fuel injection	D24060-53101	2	2							
		D24770-53100						2			
1	BODY, fuel valve	103854-53100	2	2	2			2			
2	NOZZLE ASS'Y	124770-53000	2	2	2			2			
	VALVE, nozzle	124770-53010	(2)	(2)	(2)			(2)			Assembly *
	BODY, nozzle	124770-53040	(2)	(2)	(2)			(2)			*
3	NUT, fuel valve tightening	104200-53080	2	2							
		104900-53080			2			2			
4	SPINDLE, inter	113200-53110	2	2	2			2			
5	SPRING, nozzle	103854-53120	2	2	2			2			
6	RETAINER, fuel valve	113200-53120	2	2	2			2			
7	RETAINER, fuel valve spring	103854-53180	2	2	2			2			
8	PACKING, spring retainer	172100-53200	2	2	2			2			
9	SHIM, nozzle valve spring adjusting	110250-53150	2	2	2			2			
	(t = 0.1)	110250-53400	(2)	(2)	(2)			(2)			Assembly *
	(t = 0.2)	110250-53410	(2)	(2)	(2)			(2)			*
	(t = 0.3)	110250-53420	(2)	(2)	(2)			(2)			*
	(t = 0.5)	110250-53430	(2)	(2)	(2)			(2)			*

# FUEL INJECTION VALVE (3 Cylinder)



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# FUEL INJECTION VALVE (3 Cylinder)

Refer No.	Description	Part No.	Q'ty/Unit						Inter-change-ability	Sales Unit	Remarks
			3T 84 A	3T 80 J	3T 90 J	3T 80 LE	3T 84 LE	3T 90 LE			
	VALVE ASS'Y, fuel injection	D24160-53101		3							
		D24770-53100	3		3			3			
1	BODY, fuel valve	103854-53100	3	3	3			3			
2	NOZZLE ASS'Y	124770-53000	3	3	3			3			
	VALVE, nozzle	124770-53010	(3)	(3)	(3)			(3)			Assembly *
	BODY, nozzle	124770-53040	(3)	(3)	(3)			(3)			*
3	NUT, fuel valve tightening	104300-53080		3							
		104900-53080	3		3			3			
4	SPINDLE, inter	113200-53110	3	3	3			3			
5	SPRING, nozzle	103854-53120	3	3	3			3			
6	RETAINER, fuel valve spring	113200-53120	3	3	3			3			
7	RETAINER, fuel valve spring	103854-53180	3	3	3			3			
8	PACKING, spring retainer	172100-53200	3	3	3			3			
9	SHIM, nozzle spring adjusting	110250-53150	3	3	3			3			
	(t = 0.1)	110250-53400	(3)	(3)	(3)			(3)			*
	(t = 0.2)	110250-53410	(3)	(3)	(3)			(3)			Assembly *
	(t = 0.3)	110250-53420	(3)	(3)	(3)			(3)			*
	(t = 0.5)	110250-53430	(3)	(3)	(3)			(3)			*



**YANMAR DIESEL ENGINE CO.,LTD.**

1-11-1, Marunouchi, Chiyoda-ku, Tokyo, Japan Cable: YANMAR TOKYO Telex: 0222-2310, 0222-4733

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