ISUZU

Bellett

# FUEL SYSTEM (DIESEL ENGINE)

## ENGINE SERIES

## PART 9

# INTRODUCTION

**ISUZU MOTORS LIMITED**

TOKYO, JAPAN

# PART 9 FUEL SYSTEM (DIESEL ENGINE)

CONTENTS

# PART 9 FUEL SYSTEM (DIESEL ENGINE)

## 9-1 INTRODUCTION

The fuel system of the Bellett diesel engine has the mechanical construction substantially same to that mounted on the Bellett diesel engine and comprises light weight and compactly built component parts carefully designed to give the maximum of operating efficiency at high-speed engine performance.

Fuel system of the Bellett diesel engine

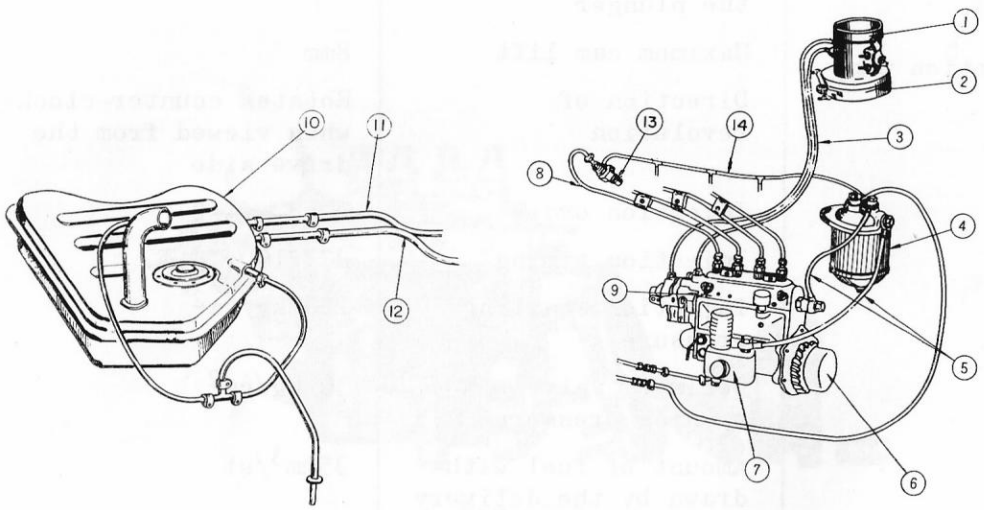



Fig. 9-1

(1) - Throttle valve
(2) - Intake shutter
(3) - Vacuum pipe
(4) - Fuel filter
(5) - Fuel pipe
(6) - Automatic injection timing control
(7) - Feed pump
(8) - Injection pipe
(9) - Injection pump
(10) - Fuel tank
(11) - Fuel return pipe
(12) - Fuel delivery pipe
(13) - Nozzle
(14) - Nozzle leak-off pipe

## 9-2 SPECIFICATIONS OF THE FUEL SYSTEM

| | | |
|---|---|---|
| Injection pump | Parts number | 8120—0256 |
| | Model of the injection pump body | NP—PES4A55B312LS75NP86 |
| | Model of the feed pump | NP—FP/KS22AC6NP6 |
| | Model of the governor | NP—EP/MZ60A47P23d |
| | Model of the automatic injection timing control | NP—EP/SCD500 1250A5LN10 |
| | Outside diameter of the plunger | 5.5ø |
| | Maximum cam lift | 8mm |
| | Direction of revolution | Rotates counter-clockwise when viewed from the drive side |
| | Injection order | 1—3—4—2 |
| | Injection timing | 27°/100r.p.m. |
| | Injection starting pressure | 120 kg/cm$^2$ |
| | Delivery valve opening pressure | 30 kg/cm$^2$ |
| | Amount of fuel withdrawn by the delivery valve | 35mm$^3$/st |
| Nozzle | Parts number | 15311—185 |
| | Model | N—DNOSD2NP5 (Throttle type) |
| | Parts number of the nozzle holder | 15330—018 |
| | Model of the nozzle holder | NP—KCA30SD212 |
| | Angle of fuel injection | 0° |
| | Inside diameter and number of nozzle hole | 1ø x 1 |
| Injection pipe | Inside and outside diameter | 1.6ø x 6ø |
| Fuel tank | Capacity | 40 ℓ |





## 9-3 CONSTRUCTION AND FUNCTION OF THE INJECTION PUMP

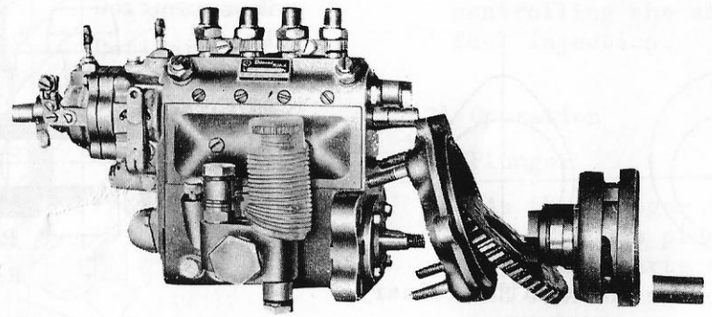


Fig. 9-2

### 9-3-1 Construction and function of the injection pump unit

The fuel injection pump comprises major component parts which may be regarded as "heart" of the diesel engine and serves to optimumly control the amount of pressurized fuel and timing at which the fuel is delivered to the injection nozzle, and furthermore the pump is designed to regulate sensitively the amount of fuel

supply in response to the varying engine load. The model C180 diesel engine is equipped with Bosch A type high-performance injection pump utilizing a flange-mounting method.

(1) Model PE injection pump comprises the camshaft in the pump housing, the cam which actuate the tappet for operating the plunger and another cam to operate the fuel feed pump in the pump body. These parts are arranged to drive the feed pump for feeding the fuel as far as to the fuel injection pump from the fuel tank.

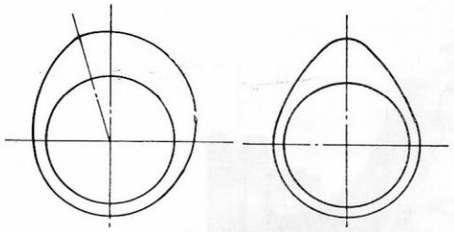



Fig. 9-3

(2) On the camshaft, there is arranged a tappet which serves to convert the eccentrical motion of the cam into reciprocal movement and transmit this motion to the plunger thereby pressurizing the fuel before it is delivered to the injection pump.

(3) The pump housing is provided with the fuel reservoir for holding the fuel transmitted through the feed pump. The fuel in the reservoir is sucked into the plunger through the suction hole in the plunger barrel with the descending stroke of the plunger.

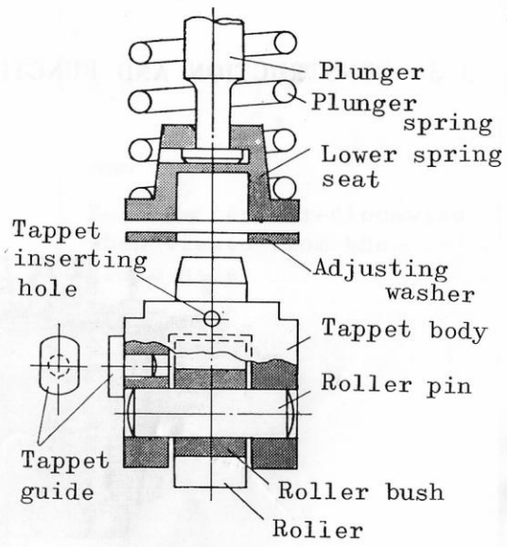



Fig. 9-4

(4) The fuel is pressurized as the plunger started ascending with rotation of the cam.

(5) As the pressure of the fuel overcomes the tensile force of the spring acting on the delivery valve, the valve is caused to open thereby permitting the fuel to flow into the injection nozzle through the injection pipe.

(6) The component parts such as tappet, plunger and delivery valve are journaled in the pump housing in the number of set equal to the number of cylinders of the engine.

Operating of the plunger actuated by the control rack




Fig. 9-5

(7) The controlling of the amount of fuel injection is carried out successfully by the control rack arranged in the following manner as illustrated in Fig. 9-5.

The pinion on the upper portion of the control sleeve fitted into the T-shaped flange provided on the lower part of the plunger is held in engagement with the control rack mounted on the pump housing. The control rack is directly linked with the governor which serves to operate the control rack in response to varying engine load and speeds in order to rotate the plunger thereby controlling the amount of fuel injection.

(2) Operation

Plunger

1) As the plunger is associated with the plunger barrel, these parts should be held from being interchanged with those from other unit.

2) As previously mentioned, the plunger is so arranged that it controls the amount of fuel injection when turned as necessary whilst reciprocally operated within the rated stroke with the cam and tappet.

3) As illustrated in Fig. 9-6, the plunger has a hole on its tip end drilled through the axial direc-

tion whilst its circumference is provided with the spiral groove (lead) communicating with the above mentioned hole.

4) The plunger barrel is provided with a fuel intake hole.

5) When the plunger travels upward and its tip end comes in contact with the upper wall of the plunger barrel thereby plugging the fuel intake hole thereof, the fuel is compressed and allowed to flow out through the hole in the plunger. (This is regarded as "start of static fuel injection").

6) As the plunger travels further upward and comes to a point where the spiral groove on the plunger meets the fuel intake hole in the plunger barrel, the pressurized fuel counter-flows into the fuel reservoir in pump housing through the said hole in the plunger barrel and thus fuel feeding cycle is completed. (This is regarded as "Completion of static fuel injection").

7) Thus, the fuel is allowed to flow into the injection pump through the hole in the plunger only after the fuel intake hole in the plunger barrel is held closed in contact with the tip end of the plunger until the very moment when the plunger comes up to a point at which the spiral groove thereof meet the fuel intake hole in the plunger barrel thereby releasing the pressure acting upon the fuel. (This may be regarded as "period of static fuel injection" or "effective stroke".)

8) The "effective stroke" can be controlled by turning the plunger thereby adjusting the position of the spiral groove on the plunger relative to the fuel intake hole in the plunger barrel.

9) As the plunger is further turned and the "effective stroke" becomes shorter and the spiral groove on the plunger no longer meets the fuel intake hole in the plunger barrel, the fuel is held from being transmitted to the injection nozzle. (This is regarded a "non-feeding stroke".)





Function of the plunger

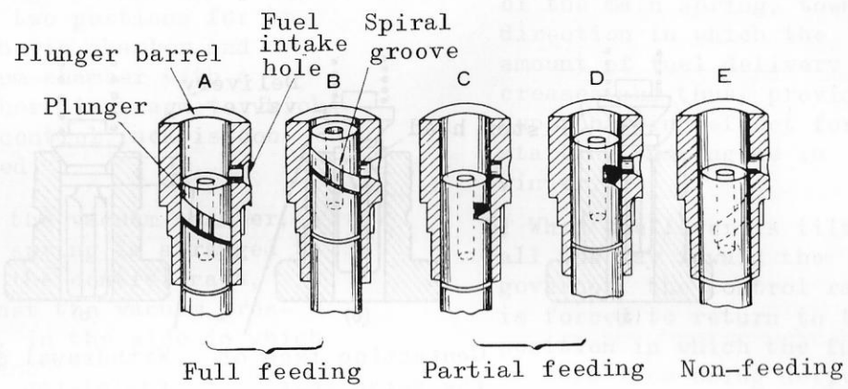



Fig. 9-6

(3) Delivery valve

1) The delivery valve is secured to the upper end of the plunger with the delivery valve holder.

2) The delivery valve is normally held in good contact with the valve seat with the delivery valve spring but when the pressure in the fuel increases with the elevation of the plunger and overcomes the tensile force of the valve spring, it causes the valve to open as illustrated in Fig. 9-7 (a) allowing the fuel to flow into the injection pipe. The delivery valve opening pressure is set to 30 $kg/cm^2$.

3) Upon completion of ascending stroke of the plunger the pressure acting upon the fuel in the plunger side suddenly decreases allowing the valve to settle back in the valve seat with the aid of the valve spring as illustrated in Fig. 9-7 (b).

4) The piston arranged in the delivery valve serves to withdraw the residual oil pressure in the fuel injection pipe. This is for cutting the fuel supply clear off the injection nozzle thereby preventing the fuel dripping from the injection nozzle.

5) As the delivery valve rests properly on the valve seat as illustrated in Fig. 9-7 (c), the fuel is held from counter-flowing into the plunger side.

Function of the delivery valve

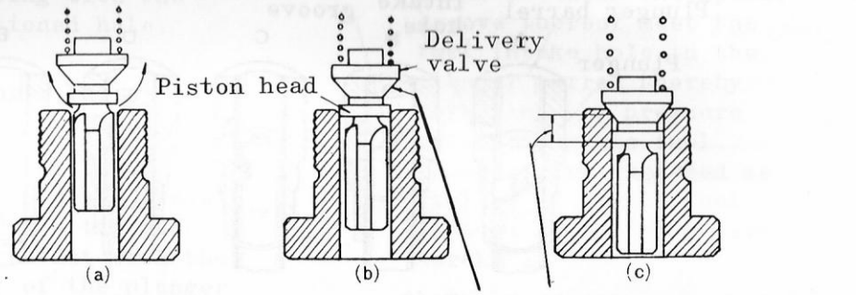



Fig. 9-7

Sectional view of the governor

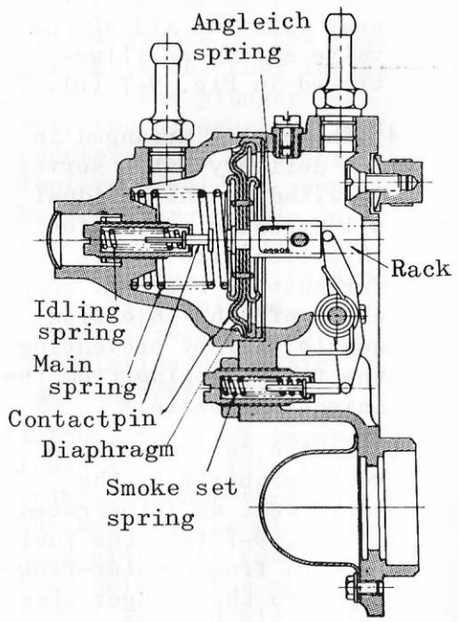



Fig. 9-8

### 9-3-2 Construction and function of the governor

The fuel injection pump of the Isuzu Bellett engine is equipped with the pneumatic governor.

The atmospheric pressure and the negative pressure generated in the venturi are led to the governor respectively through the pipes connected to the pair of pressure take out units provided at the portion where the butterfly valve is installed. The governor acts sensitively upon the pressure differential transmitted from the venturi and lead the control rack into operation.

(1) Construction

The construction of the governor is illustrated in Fig. 9-8.

1) The governor is divided into two portions for atmospheric chamber and vacuum chamber with a leather diaphragm to which the control rack is connected.

2) In the vacuum chamber, a main spring is arranged to hold the control rack, against the vacuum pressure, in the side in which the amount of fuel increases.

3) The governor is provided with a double-arm stopple lever an arm of which serves to hole the control rack from being depressed further through the Angleich spring thereby controlling the maximum amount of fuel injection while the other arm is held in contact with a stopper bolt mounted on the smoke set screw.

4) Thus, the position of the control rack in which the maximum amount of fuel injection is regulated can be varied by controlling the smoke set screw. After the smoke set screw is properly adjusted, it should not be moved unless readjustment is absolutely necessary.

5) The smoke set screw is equipped with a spring and when the lever is tilted toward the injection pump, this spring is depressed and causes the control rack to move, with the aid of the main spring, toward direction in which the amount of fuel delivery increases and thus, provide supercharging effect for starting the engine in winter.

6) When the lever is tilted all the way toward the governor, the control rack is forced to return to the position in which the fuel is held from being delivered to injection pump and causes the engine to stop running.

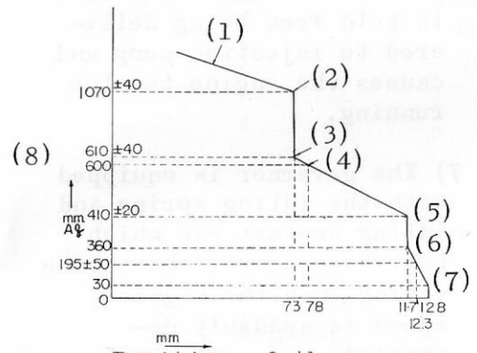
7) The governor is equipped with the idling spring and idling contact pin which serve to control the engine idling when the engine speed is suddenly decreased.

(2) Function of the governor

1) The vinyl tubes extended from the vacuum side and atmospheric pressure side of the throttle valve should be connected to vacuum side and atmospheric pressure side of the governor chamber respectively. If the vinyl tube is connected in a wrong manner joining the wrong side of the governor chamber to wrong side of the throttle valve, the governor is held from being operated and the amount of fuel injection consequently increases to

a maximum causing the engine to operate at undue speed. To abviate such troubles, the vinyl tube connections should be carefully checked to make sure that they are properly connected before operating the engine.

Relations between the vacuum pressure in the governor and position of the control rack




Position of the control rack.

Fig. 9-9

(Spot-translation)

(1) - Control rack position in which the fuel is not delivered.
(2) - The point at which the idling spring is forced to start contracting.
(3) - The point at which the control rack comes in contact with the idling spring.
(4) - Position of the control rack when the engine is held idling.
(5) - The point at which the main spring is forced to start contracting.
(6) - The point at which the Angleich spring is elongated to a maximum.
(7) - The point at which the Angleich spring is forced to elongate.
(8) - Negative pressure in the governor (Difference of pressure between the atmospheric pressure side and vacuum side).

2) Function of the governor when the engine is operated with full load

When the engine speed is increased by opening the throttle valve, the governor is operated as illustrated in Fig. 9-9. As the negative pressure in the governor increases and overcomes the tensile force of the main spring, the diaphragm depresses the main spring and moves the control rack toward the direction in which the amount of fuel delivery decreases. As the tensile force of the Angleich spring is acting upon the control rack, the control rack tends to move slightly toward the direction in which the amount of fuel





delivery decreases but settles in a point (11.7mm aparted from the "0" point) until the main spring begins to contract.

During this operation, the amount of fuel delivered with a single stroke of the plunger is held constant and the maximum power (50PS/4,000r.p.m.) is developed when the main spring begins to contract.

Angleich spring serves to prevent the reduction of fuel supply when the injection pump is operated at low speed thereby compensating for undue variation in the engine speed. The Angleich spring also serves to equalize the amount of fuel delivered with a single stroke of the injection pump when the engine is operated with full load.

As the engine speeds further increases through the point in which the maximum power is developed, the negative pressure in the vacuum chamber of the governor also increases and moves the control rack toward the direction in which the amount of fuel delivery decreases resulting in a sudden reduction of engine power. If the engine load is released (If the engine is operated with throttle fully opened while the clutch is held disengaged), the governor may be held in position at which the maximum engine speed is attained without load permitting no further increase in engine speed.

3) Function of the governor when the engine is operated with partial load

When the engine is operated with the throttle valve partially opened, the negative pressure in the governor suddenly increases in response to the increasing engine speeds thereby retracting the control rack toward the direction in which the amount of fuel delivery decreases. Thus, the governor serves to control the amount of fuel injection and ensures the maximum torque at any speed of engine operation in response to the throttle valve opening.

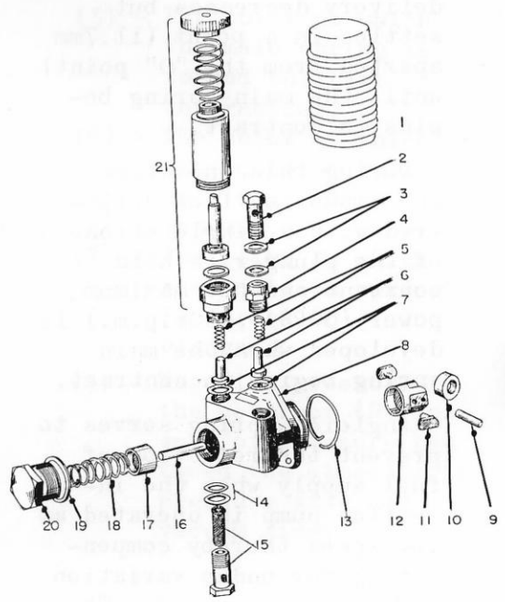
4) Function of the governor when the engine is operated without load

The engine idling speed is normally set to 600 r.p.m. by adjusting the throttle valve opening. The negative pressure in the governor retains as high as about 600 mm-Aq and the control rack positioned at 7.8mm apart from "0" point, whilst the engine is held running at idling speed. However, when the throttle valve is suddenly closed

with a foot off the accelerator pedal, the negative pressure in the governor temporarily increases to retract the control rack toward the direction in which the amount of fuel delivery decreases but the control rack is so arranged that the engine is held running at idling speed as the contact pin on the idling spring comes in contact with the tip end of the control rack and ensures a minimum of fuel supply required for engine idling.

5) When the engine braking effect is utilized

When the rolling power of the rear wheels is countertransmitted to the engine when the throttle valve is fully closed, the negative pressure in the governor maximumly increases thereby depressing the idling spring and causes the control rack to return to its non-injecting position.




(1) - Dust cover
(2) - Joint bolt
(3) - Packing
(4) - Nipple
(5) - Check valve spring
(6) - Check valve
(7) - Washer
(8) - Feed pump housing
(9) - Pin
(10) - Roller
(11) - Tappet guide
(12) - Tappet
(13) - Snap ring
(14) - Washer
(15) - Pipe joint assembly
(16) - Push rod
(17) - Piston
(18) - Spring
(19) - Washer
(20) - Plug screw
(21) - Hand priming pump assembly

第 9—10 図





9-3-3 Construction and function of the feed pump

(1) Construction

1) The feed pump is so designed to pick up fuel in the fuel tank and transmit it to the pump housing on application of pressure through the fuel piping in which there may be provided friction resistance generated by the flowing fuel.

2) As illustrated in Fig. 9-11, the feed pump comprises the major component parts linked with the camshaft of the pump and mechanically operated with the engine and the manually operated pump which may be used for bleeding the air from the fuel system as necessary.

Diagram illustrating the construction of the feed pump

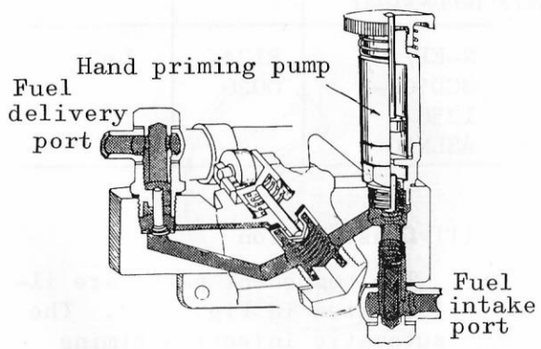



Fig. 9-11

(2) Function

1) The feed pump relies upon the reciprocative motion of the piston for feeding the fuel into the pump housing and is operated with the camshaft of the fuel injection pump.

2) Fig. 9-12(b) illustrates the feed pump with the piston elevated with the cam (1) and the check valve (3) is held closed. Through the check valve (9) and the fuel passage (6) the fuel flows into the reservoir (5) permitting the excessive fuel to flow into the injection pump through the fuel delivery port (7).

3) As the cam further rotates and brings the pertinent parts into positions as illustrated in Fig. 9-12(a), the fuel in the reservoir (5) is fed into the injection pump through the passage (6) and fuel delivery port (7) as the piston (1) is urged to travel downward by the piston spring (2) and causes the check valve (9) to close and another check valve (3) to open thereby allowing the fuel to flow into the internal reservoir (4).

4) As the pressure of the fuel delivery increases, the piston is forced to travel upwards against the tensile force of the piston spring (2) as illustrated in

Operation of the feed pump

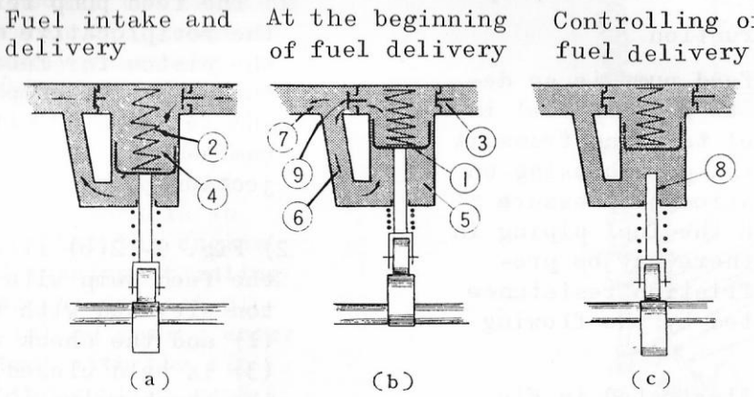



Fig. 9-12

Fig. 9-12(c) and thus, the piston (1) is released from the push rod (8) and gives no fuel delivery in the next stroke of the cam thereby preventing undue increase in the pressure of duel delivery.

### 9-3-4 Construction and function of the automatic injection timing control

As the diesel engine with a small cylinder capacity is normally subjected to operation at wide ranges of speed, optimumly advanced in response to increasing engine speeds in order to ensure maximum operating efficiency of the engine at any speed of revolution. For all practical purposes, the Bellett engine is provided with a compactly built automatic injection timing control at the front part of the fuel injection pump.

| Type of the automatic injection timing control | Parts number | Direction of revolution |
|---|---|---|
| N-EP/ SCD500-1250 ASLN10 | 8134-0020 | Left |

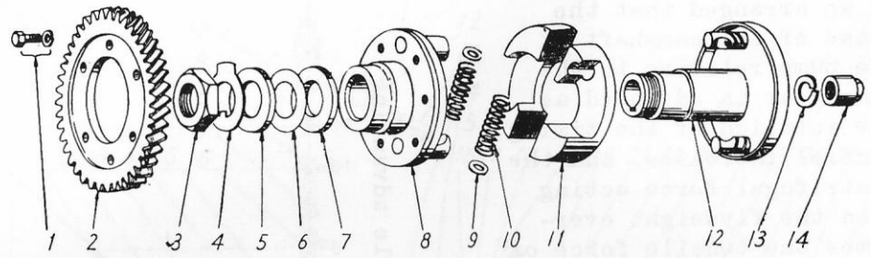
(1) Construction

The component parts are illustrated in Fig. 9-13. The automatic injection timing control comprises a flyweight holder, a pair of flyweights, a spring and a flange.





Exploded view of the automatic injection timing control

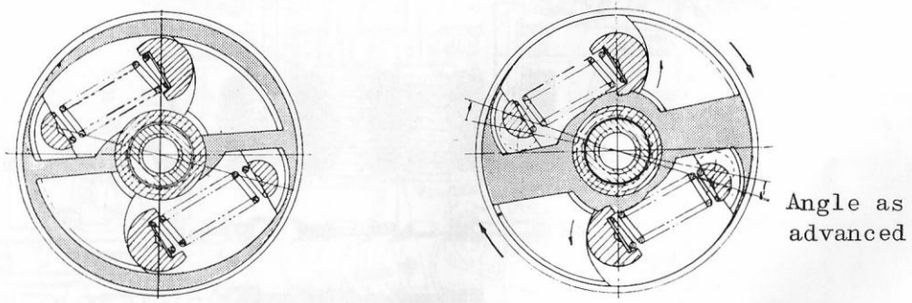



(1) - Bolt and spring washer
(2) - Injection pump drive gear
(3) - Nut
(4) - Lock washer
(5) - Plain washer
(6) - Adjusting washer
(7) - Thrust bearing
(8) - Flange assembly
(9) - Adjusting washer
(10) - Spring
(11) - Flyweight
(12) - Flyweight holder
(13) - Spring washer
(14) - Round nut

Fig. 9-13

(2) Function

Function of the automatic injection timing control




The component parts held in their respective stationary positions

Fig. 9-14

1) The automatic injection timing control relies upon the centrifugal force and is so arranged that the phase of the camshaft of the pump relative to the pump gear is advanced as the rotation of the timing control increases, and the centrifugal force acting upon the flyweight overcomes the tensile force of the spring.

2) The angle advancing characteristic of the automatic injection timing control is illustrated in Fig. 9-15.

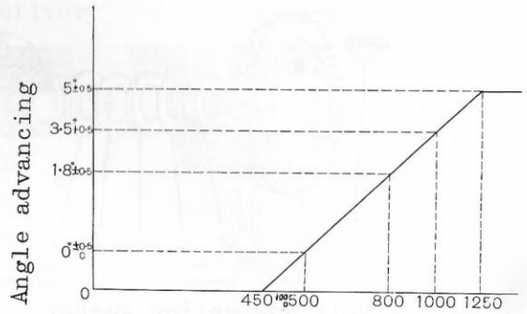



Fig. 9-15

## 9-4 DISMANTLING, INSPECTING AND ADJUSTING THE INJECTION PUMP BODY

Diagram illustrating the construction of the injection pump

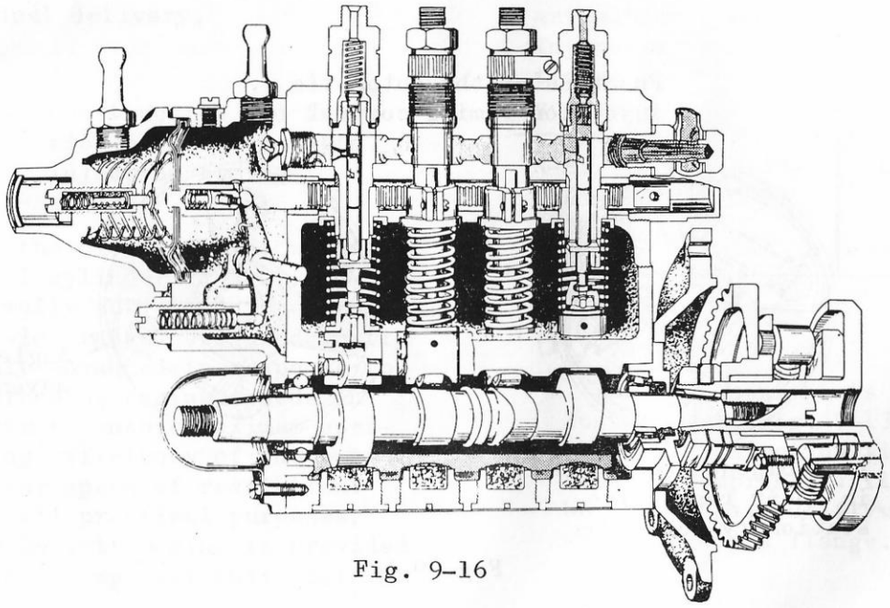


Fig. 9-16





Exploded view of the injection pump (1)

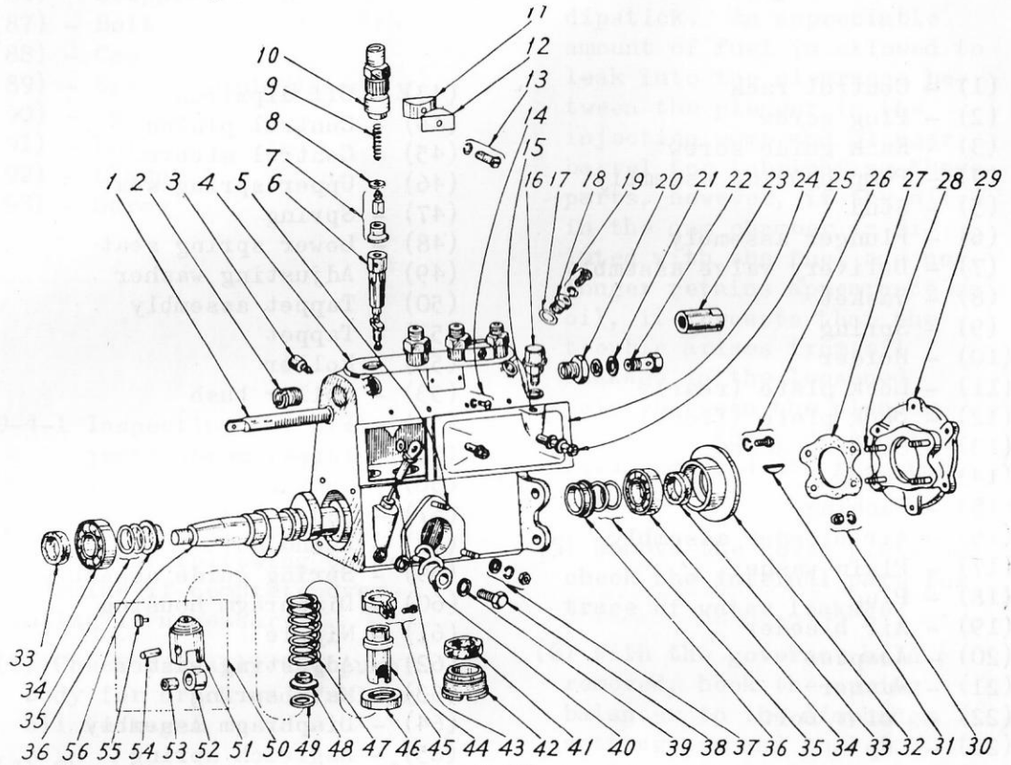



Fig. 9-17

Exploded view of the injection pump (2)

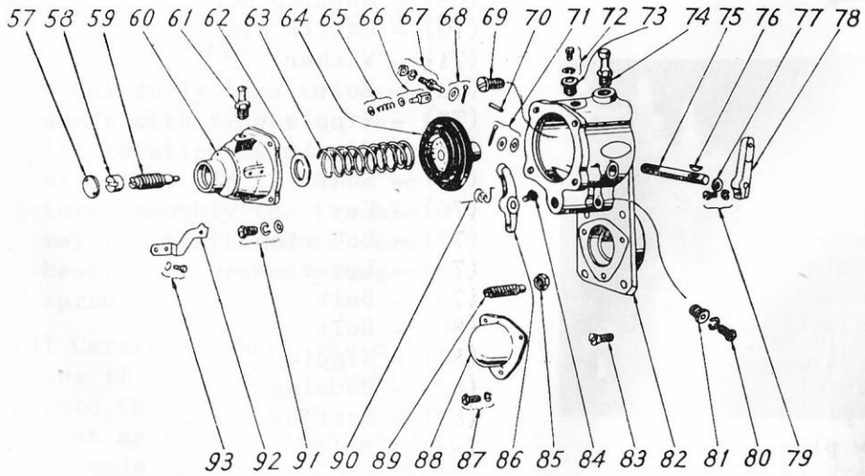



Fig. 9-18

Fig. 9-17-18 Parts name of the injection pump

(1) - Control rack
(2) - Plug screw
(3) - Rack guide screw
(4) - Pump housing assembly
(5) - Stud
(6) - Plunger assembly
(7) - Delivery valve assembly
(8) - Gasket
(9) - Spring
(10) - Holder
(11) - Lock plate (rear)
(12) - Lock plate (front)
(13) - Setting screw
(14) - Screw
(15) - Packing
(16) - Air bleeder assembly
(17) - Plain washer
(18) - Plug
(19) - Air bleeder
(20) - Adapter
(21) - Washer
(22) - Joint bolt
(23) - Cap
(24) - Cover
(25) - Setting screw
(26) - Setting screw
(27) - Packing
(28) - Stud
(29) - Bracket
(30) - Nut
(31) - Key
(32) - Bearing cover
(33) - Oil seal
(34) - Bearing
(35) - Shim
(36) - Distance ring
(37) - Nut
(38) - Joint bolt
(39) - Packing
(40) - Eye joint
(41) - Felt plate
(42) - Screw plug
(43) - Oil dipstick
(44) - Control pinion
(45) - Control sleeve
(46) - Upper spring seat
(47) - Spring
(48) - Lower spring seat
(49) - Adjusting washer
(50) - Tappet assembly
(51) - Tappet
(52) - Roller
(53) - Roller bush
(54) - Pin
(55) - Tappet guide
(56) - Camshaft
(57) - End plate
(58) - Round nut
(59) - Spring guide assembly
(60) - Diaphragm housing
(61) - Nipple
(62) - Adjusting washer
(63) - Main spring
(64) - Diaphragm Assembly
(65) - Angleich spring
(66) - Push rod
(67) - Connecting bolt
(68) - Washer
(69) - Setting screw
(70) - Castle pin
(71) - Washer
(72) - Bolt
(73) - Nipple
(74) - Nipple
(75) - Shaft
(76) - Key
(77) - "o" ring
(78) - Lever
(79) - Bolt
(80) - Bolt
(81) - Nipple
(82) - Housing
(83) - Setting screw
(84) - Bolt





(85) - Adjusting nut
(86) - Stopple lever
(87) - Bolt
(88) - Cap
(89) - Spring guide assembly
(90) - Spring
(91) - Bolt
(92) - Clamp
(93) - Screw

### 9-4-1 Inspecting the fuel injection pump before it is dismantled

Check the injection pump against the following to predetermine if complete overhauling is necessary.

(1) Check visually the pump body for crack and fuel or oil leakage.

(2) Check the upper part of the pump body for any trace of oil leakage from the delivery valve holder. The leakage often attributed to falty packing.

(3) Carefully turn the camshaft with finger to see if its rotation is not restricted. If it fails to turn smoothly the trouble may be attributed to worn bearing or broken plunger spring.

(4) Carefully check the oil to see if the fuel is leaking into the cam chamber. Judgement as to fuel leakage may be made by checking the viscosity, color and smell of the oil as sampled with the dipstick. An appreciable amount of fuel is allowed to leak into the clearance between the plunger in the injection pump and plunger barrel for lubricating these parts, however, if the oil in the cam chamber is diluted with the fuel and no longer retains appearance as oil, it forcasts that the trouble arises from oil leakage in the loosened joint between the plunger barrel to the body and the feed pump body to the push rod.

(5) Remove the cover plate and check the internal part for trace of water leakage.

(6) With the governor held removed, hook the spring balancer to the diaphragm setting pin and pull it horizontally. If the torque required to move the control rack is about 150 grm, the

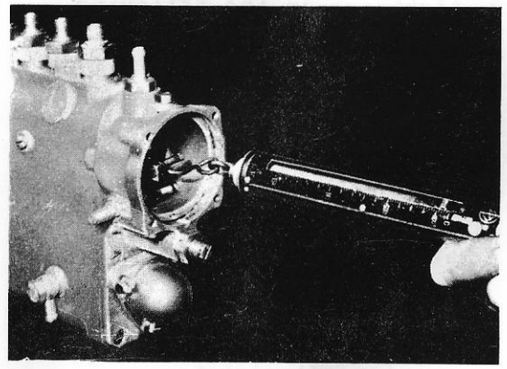


Fig. 9-19

control rack and its associated parts may be regarded as normal. (See Fig. 9-19)

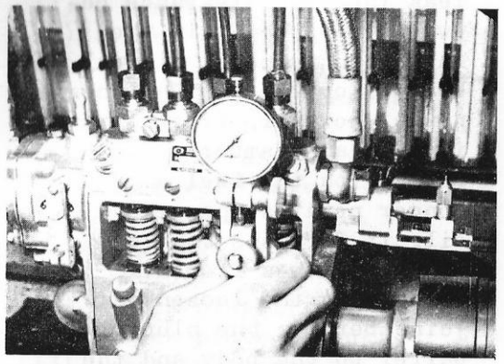


Fig. 9-20

(7) Check the injection timing in the following manner: Mount the plunger lift measuring gage on the lst barrel and check to see if the fuel delivery is held to a stop when the tappet is brought into a position about 1.75 ± 0.05mm lifted from its B.D.C. (See Fig. 9-20)

(8) Test the plunger for oil-tightness in the following manner with the aid of a pump tester.

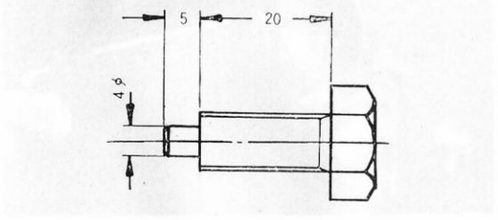



Fig. 9-21

1) Mount the injection pump on the pump tester.

2) Fix the control rack in position with the fixing bolt: Remove the control sleeve and fix the control rack in position after it is slid 9mm from "0" point in direction in which the amount of fuel delivery increases. The control rack may be fixed in position by removing the control rack screw in the reverse side of the pump body and inserting the fixing bolt (See Fig. 9-21) into place.

3) Mount the pressure gage on the delivery valve holder on the lst barrel in the following manner:

Mount the pressure gage with 100mm in diameter having divisions of up to 350 kg/cm$^2$ to the delivery valve holder through the high pressure pipe with 2mm in diameter and 100mm in length. If the pressure gage is not provided with the air bleeder screw, the extension pipe should be temporarily fastened to the delivery valve.

4) With the pump operated at 200 r.p.m. adjust the pressure indicated by the pressure gage to 100 kg/cm$^2$. The pressure may be adjusted by loosening or tightening the air bleeder screw or the connection of the injection pipe.





5) When the pressure is adjusted to specified value, quickly tighten the injection pipe connection or air bleeder screw. Then, operate the plunger 5 strokes to see if the pressure indicated by the pressure gage increases as high as to 125 kg/cm$^2$.

6) The same procedure as introduced in the above paragraph may be applied to each barrel for testing the oil-tightness.

(9) Test the delivery valve for oil-tightness in the following manner.

1) Properly secure the pressure gage and injection pipe which have been utilized for testing the plunger for oil-tightness to the delivery valve.

2) Increase the pressure as high as to 150 kg/cm$^2$ by operating the pump or by manually reciprocating the plunger.

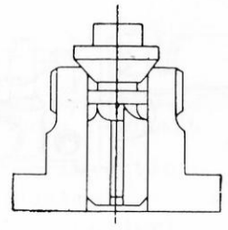


Fig. 9-22

3) Carefully stop the operation of the pump so as to bring the testing plunger into B.D.C. and then measure the reduction in the pressure with the gage.

4) Judgement may be made as to the oil-tightness of the delivery valve by checking the reduction in the pressure with the aid of the pressure gage. For this purpose, the time taken for the pressure to drop from 100 kg/cm$^2$ to 95 kg /cm$^2$ should be measured. This is standard at 10 sec. but if the time measured indicate 5 sec. or below, the delivery valve and its pertinent parts should be regarded as due for replacement.

(10) Inspect the piston of the delivery valve. Excessively worn piston is often detrimental to proper injection nozzle performance.

1) Dismantle the delivery valve and wash the valve body and the valve in clean detergent oil.

2) Plug the hole in the oil soaked valve body by holding finger right against the valve seat and then insert the oil wet valve into the valve body.

3) If the air bubbles arises from around the valve seat and the valve is not provided with strong repulsive action as the valve is pressed into the valve

body, the trouble may be attributed to the worn parts and hence, the delivery valve assembly should be replaced.

(11) Inspecting the diaphragm in the pneumatic governor. If the diaphragm is damaged, it no longer serves to control the engine operation. The air leakage attributed to faulty diaphragm may be detected in the following manner.

1) Tilt the stop lever all the way rearward and then, plug the nipple on the vacuum chamber with finger and release the lever.

2) After 5 seconds, quickly release the finger from the nipple. If the diaphragm inflates with a pop, it may be regarded as normal. (See Fig. 9-24)

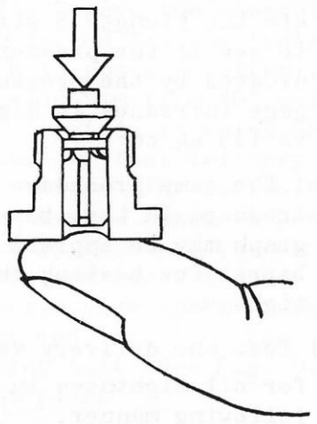


Fig. 9-23

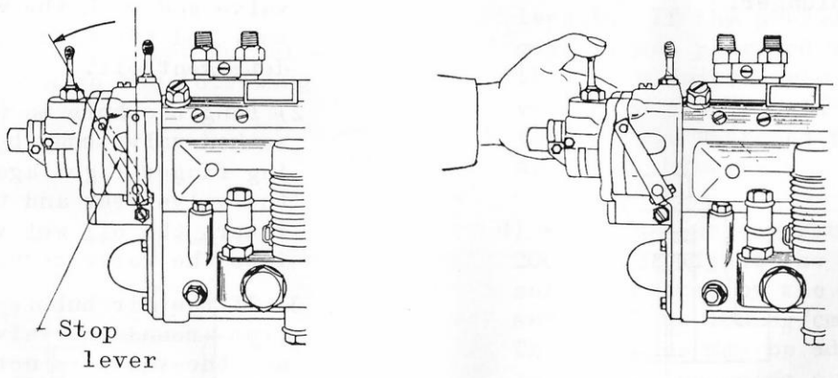



Fig. 9-24





(12) Testing the pump for fuel leakage

With 2.5 kg/cm$^2$ of compressed air supplied to the pump through the fuel intake port in the front part of the pump, immerse the pump body in clean detergent oil to see if air bubbles arises.

Parts with leak should be carefully repaired.

9-4-2 Dismantling the injection pump

The external part of the pump should be carefully cleaned before it is dismantled. The injection pump should be carefully handled to prevent contaminated oil from coming into the delivery valve and other internal parts.

(1) Dismantling the automatic injection timing control

1) Remove the round nuts on the autcmatic injection timing control.

With the camshaft firmly held from turning by inserting a jig (retainer 5811-1930) into the hole in the flyweight holder, loosen the round nuts with the aid of jig (injection pump camshaft wrench - 8511-1343). Reverse this procedure for reassembling the parts. (Fig. 9-25)

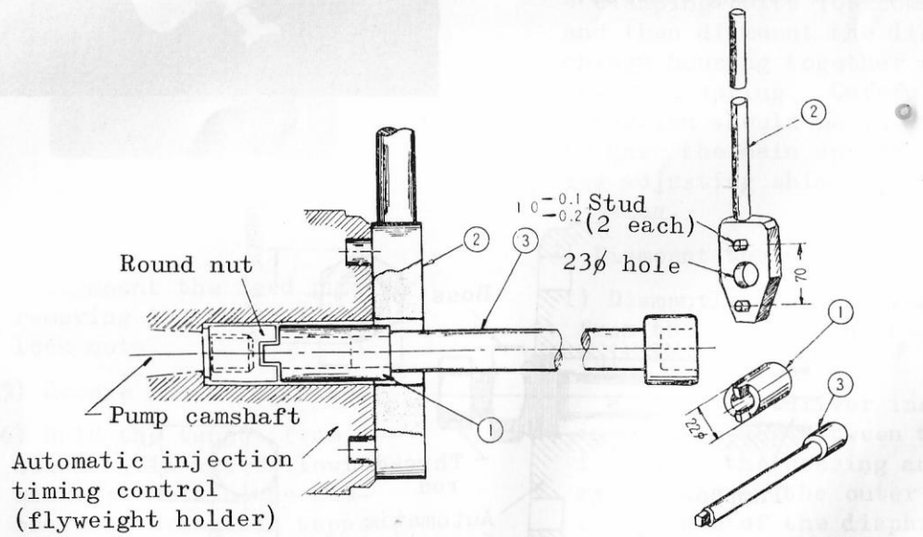



Fig. 9-25

| | Parts No. | Parts name |
|---|---|---|
| 1 | 8511-1343 | Wrench |
| 2 | 8511-1930 | Retainer |
| 3 | 8511-4201 | Extension bar |

2) Dismounting the automatic injection timing control

The automatic injection timing control may be removed in the following manner with the aid of puller assembly (8521-0069). Screw in the boss into threaded hole in the flyweight holder and fit the threaded rod over the boss. Then, screw in the threaded rod so as to depress the outer edge of the camshaft for removing the automatic injection timing control.

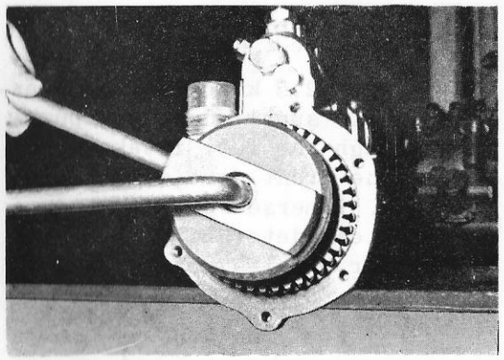


Fig. 9-26

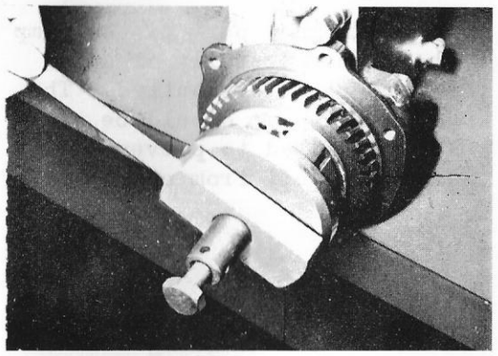


Fig. 9-27

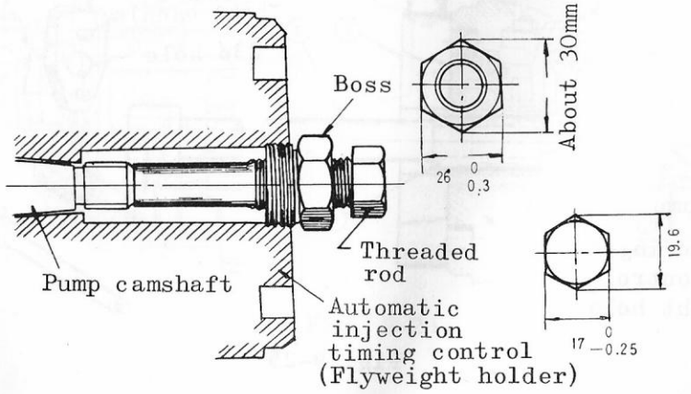



Fig. 9-28





3) Remove the key from the pump camshaft.

(2) Remove the injection pump bracket.

Turn loose the four (4) lock nuts and remove the bracket carefully so as to prevent the packing from being damaged.

(3) Firmly hold the pump in vice in the following manner.

Fasten the pump to the mounting plate (EF 9558) by clamping the two (2) opposed setting bolts and hold the mount plate securely in vice. (See Fig. 9-29)

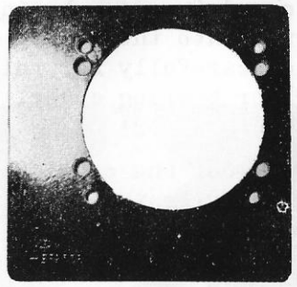


Fig. 9-29

(4) Dismount the feed pump by removing the three (3) 6ø lock nuts.

(5) Remove the cover plate.

(6) Hold the tappet from descending in the following manner: Rotate the camshaft to bring the tappets into their T.D.C. and then put the tappet insert (EF 9094) through the holes on the tappet body. (See Fig. 9-30)

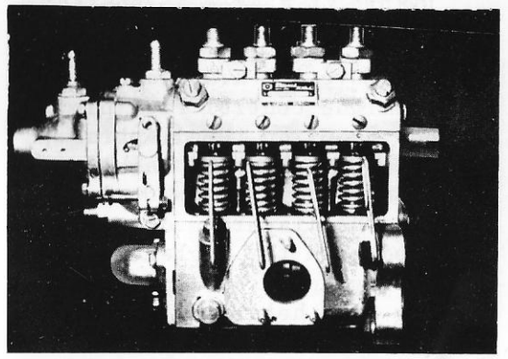


Fig. 9-30

(7) Remove the diaphragm housing in the pneumatic governor. First remove the 4 clamping bolts (6øx20mm) and then dismount the diaphragm housing together with the main spring. Careful attention should be invited to keep the main spring and its adjusting shim from missing.

(8) Dismount the diaphragm.

1) Dismantle the diaphragm from the housing in the following manner.

With a screwdriver inserted into the space between the flange of the housing and metal ring on the outer circumference of the diaphragm, pry the screwdriver carefully to release the grip of the parts. Don't rocalize

the prying force to a spot but spread the force evenly over the entire space.

Carry out the work carefully as the diaphragm is liable to damage in contact with the screwdriver's edge.

2) Remove the diaphragm from the control rack pin: For removing the diaphragm, the split pin and washer should be first removed and the diaphragm dismantled with the Angleich spring, pushrod and adjusting shim held with finger as illustrated in photograph 9-31 to keep them from missing. (See Fig. 9-31)

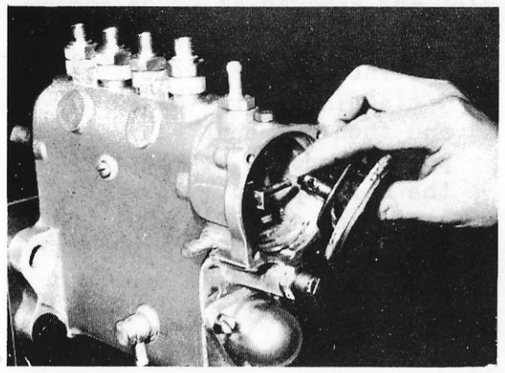


Fig. 9-31

(9) Pull out the camshaft in the following manner.

1) Dismount the bearing cover by removing the four (4) clamping bolts (6ø x 13mm). If the bolts are stuck in position, they may be loosened by holding a screwdriver in the groove of the bolt and hit it lightly with a hammer. As the bearing cover is provided with grooves in the right and lefthand side, a screwdriver may be inserted into the groove and pried carefully for releasing for bearing cover. (See Fig. 9-32)

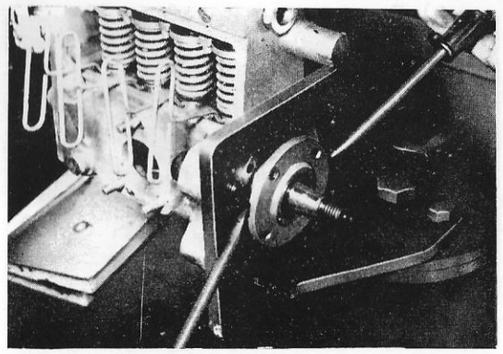


Fig. 9-32

2) Pull out the camshaft carefully lest it should contact with adjacent parts. (Fig. 9-33)

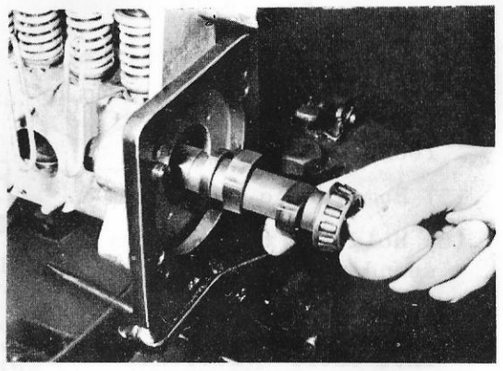


Fig. 9-33





(10) Remove the main housing in the following manner.

1) Dismount the rear cap from the camshaft by removing the three (3) clamping bolts (6øx13mm).

2) Dismount the main housing in the following manner. The main housing is fastened with one (1) clamping bolt (8øx13mm) and four (4) clamping bolts (6øx13mm).

As the main housing is provided with a groove on the right and left-hand sides, insert a screwdriver into the groove and pry it carefully whilst lightly hitting the main housing with a hide mallet. (See Fig. 9-34)

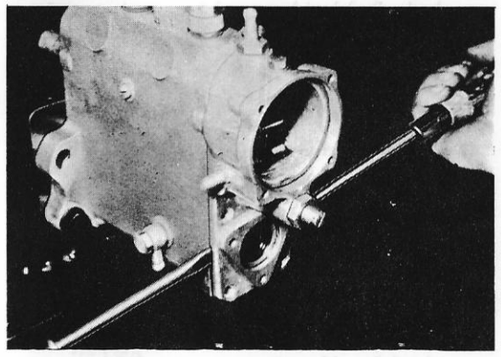


Fig. 9-34

(11) Dismantle the tappet and plunger. All the components and parts that have been disassembled subsequent to this stage of maintenance work should be carefully handled so as not to damage them or not to cause confusion in the order of putting them back in each associated cylinder.

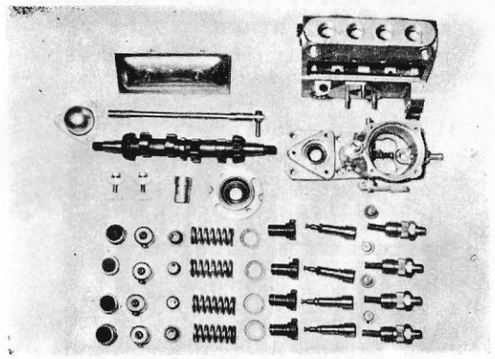


Fig. 9-35

1) Hold the pump base in vice and fix the pump thereon with the pump flipped on its side.

2) Remove the screw plug from the pump by slacking it with special wrench (EF9663) and L-shape handle. (See Fig. 9-36)

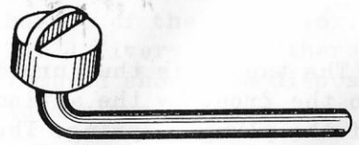


Fig. 9-36

The screw plug is threaded clockwise, hence may be removed by turning it counter clockwise.

3) Remove the tappet. This may be done more easily by beginning with the 4th cylinder and back to the 1st cylinder.

With the roller clamp (EF 9563) inserted in place from the bottom of the pump and the roller pinched, pry the lever handle of the roller clamp upwardly so that the tappet insert is released and the roller clamp handle is put back in position. (See Fig. 9-37)

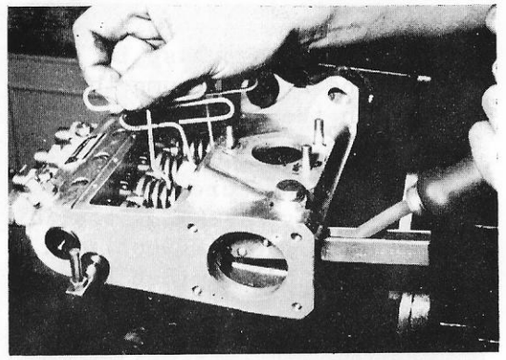


Fig. 9-37

The tappet is thus urged to the front by the action of the plunger spring. Then, the tappet clamp (EF9564) is inserted through the hole in the bearing cover and held from its side, and should then be quietly pulled out after the roller clamp is removed. (See Fig. 9-38)

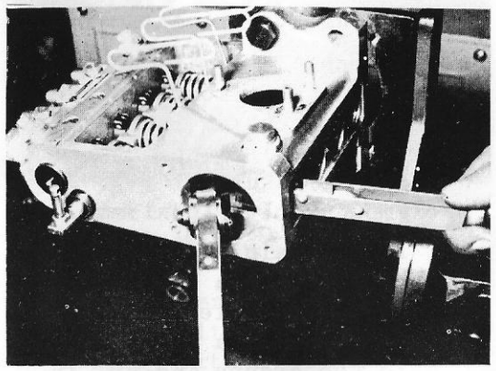


Fig. 9-38

In this operation, care must be exercised not to let fall the roller pin and the injection timing adjusting washer.

(12) Remove the plunger and plunger spring.

1) Insert the plunger clamp (EF9095) through the bottom of the pump into the hole of the lower spring seat. Grip the clamp so that its tip end opens apart and holds the lower spring seat. (See Fig. 9-39)

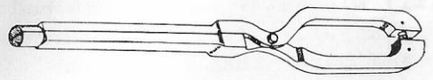


Fig. 9-39





2) Pulling out the plunger clamp permits removal of the lower spring seat together with the plunger. Place the plunger in clean kerosene to keep its number legible. (See Fig. 9-40)

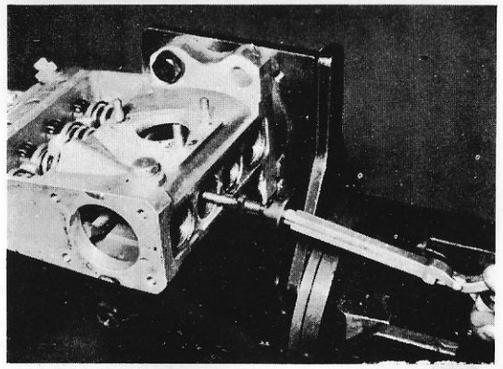


Fig. 9-40

3) Dismount the plunger spring from the bottom hole of the pump.

4) Dismount the lower spring seat from the cover plate.

(13) Dismount the control sleeve with its pinion from the cover plate.

(14) Remove the delivery valve.

1) Mount the pump back in place and adjust its position so that the cover plate comes around to the front.

2) Dismount the lock plate of the delivery valve.

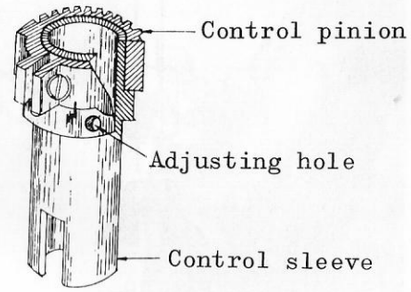



Fig. 9-41

3) Remove the delivery valve by slowly releasing it with socket wrench (EF9059) and ratchet handle. (See Fig. 9-43)

4) Remove the delivery valve spring and place it in the light oil in which the plunger has previously been placed. Keep all the removed parts in a neat manner so as to avoid erroneous cylinder assembling.

5) Draw out the delivery valve.

Screw the valve extractor (EF8117) into the threaded top portion of the delivery valve body and turn the nut clockwise while holding the handle of the extractor. The delivery valve thereby removed should be disposed in a clean kerosene.

Keep all the dismounted parts in a neat arrangement to assure correct reassembling of their associated cylinders. (See Fig. 9-42)

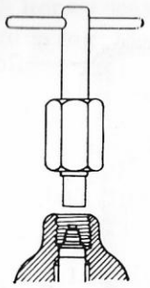


Fig. 9-42

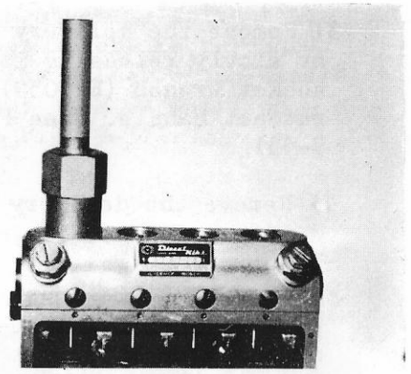


Fig. 9-43

(15) Remove the plunger barrel.

Raise the plunger barrel with finger tip from the cover plate and remove it from where the delivery valve has been removed. The plunger barrel thus removed should be kept in a set with the previously removed plunger and disposed identifiably in a kerosene. This plunger barrel to plunger combination should be carefully selected.

(16) Dismount the control rack.

The control rack may be removed by drawing it toward the governor after first removing the rack guide screw located at the back of the pump body. (See Fig. 9-44)

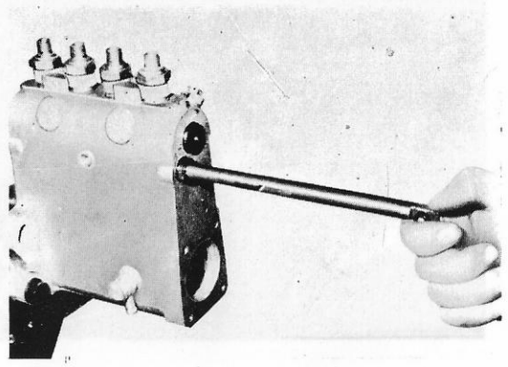


Fig. 9-44

(17) Draw the bearing out of its camshaft.

This should be done only when replacement is due for the camshaft or bearing.

1) Secure the camshaft in a vice. In this instance, a copper or zinc washer should preferably be used to avoid the possible damage to the cam.

2) The bearing may be easily removed by screwing the bolt into the center hole of the camshaft with the flat portion of the receptacle for the bearing puller (EF9088) engaged with the distance ring and with





the puller thus abutting on the receptacle. (See Fig. 9-45)

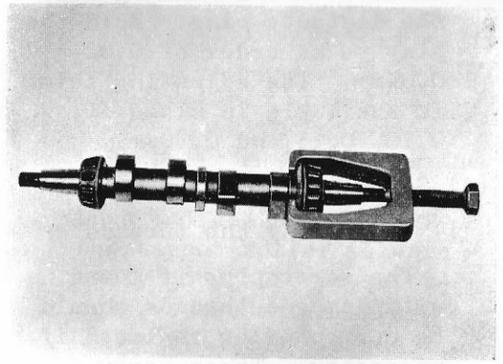


Fig. 9-45

(18) The outer lace of the bearing should be dismounted with use of the special tool (EF9087). With the tapered portion of the tool inserted in between the cover and the outer lace and with its nut fully tightened, the outer lace may be removed from the roulette side of the bolt by forcing it out with a press or hitting it out with a hammer. (See Fig. 9-45)

9-4-3 Inspecting the dismounted parts

(1) Pneumatic governor diaphragm

Check the diaphragm and see if its skin is damaged or hardened.

This checkup may be done

Fig. 9-46

by dismounting the Angleich spring, its pushrod and adjusting shim and thereafter stretching the diaphragm skin with finger tip after removing the grease therefrom. The diaphragm should be inspected at both sides, and if its skin fails to elongate as desired, the diaphragm should be immersed in a suitable diaphragm oil (or less viscous engine oil) thereby rendering it soft.

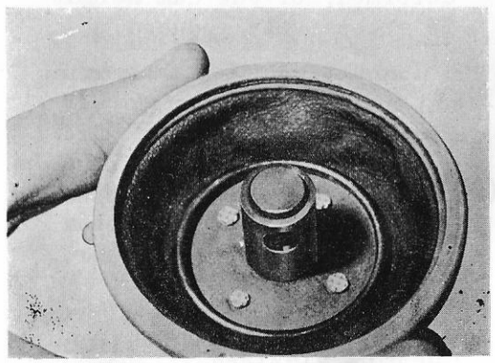


Fig. 9-47

If the skin is rather satisfactory, it will suffice just to apply a diaphragm oil thereto. (See Fig. 9-47)

(2) Camshaft

1) Inspecting the key groove

Any camshaft that has excessive play between the key and its groove must be replaced either with a new key or camshaft, whichever is deemed required.

2) Inspecting the taper

If the tapered portion of the camshaft is found roughened, the roughened surface should be flattened out by an oil stone.

3) Inspecting the threaded parts

All threads that are found defective must be corrected.

4) Inspecting the cam face

The camshaft should be regarded as due for replacement if the cam face is scored or scratched, the cam profile is deformed, or the cam height is excessively reduced.

5) Inspecting the cam bearing

Replace those cam bearings which are scored or worn.

(3) Axial play of the camshaft

1) Measuring the play

Mount the camshaft in the body and clamp the front cover and the main housing then, check the cam shaft for its axial play using a dial gage.

2) Adjusting the play

This adjustment may be done with the shim inserted in between the bearing and the distance ring. Hold the play to an order of 0.02-0.04mm. The adjusting shim is available in sizes of 0.10, 0.15 and 0.30mm.

(4) Screw plug

1) Inspecting the threads

The screw plug if found with damaged threads should be corrected or replaced if necessary. Those screw plugs which have excessively deformed grooves should be properly corrected or replaced if necessary.

2) Replacing the felt plate

The screw plug felt plate should always be replaced with a new one at the time of dismounting. The felt plate should be assembled with the screw plug before

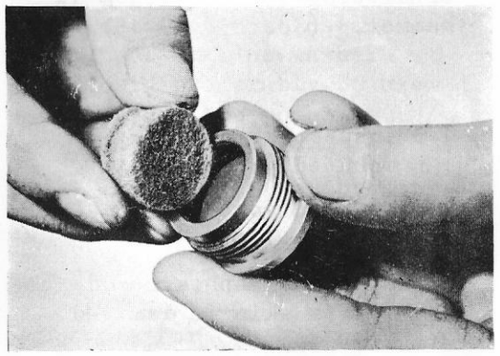


Fig. 9-48





it is immersed in engine oil.

(5) Tappet

1) Inspecting the tappet roller

The tappet roller if badly worn or damaged must be always replaced with a new one. Check the clearance each between the roller and the bush and between the bush and the pin, and if the tappet roller is worn badly enough to cause excessive mechanical play, it should be replaced.

2) Inspecting the clearance between the pump body and the tappet body

This clearance is normal at 0.02-0.07mm. If it exceeds 0.17mm, it is necessary to replace the pertinent parts.

(6) Plunger spring

1) Inspecting the spring for damage

Check the spring for damage rips or deflected worn and replace it if so found defective.

2) Checking the spring tension

This may be conveniently done with a spring tester. The spring may be considered satisfactory if it retains a tension of 13.5 kg when compressed to 44mm. Replacement should be made if the spring action is below 13.3 kg.

3) Checking the spring for free length

The free length of the spring is normal at 51.5mm. The spring with its free length less than 49.5mm must be replaced.

4) Checking the spring for rectangularity

Hold the spring upright with a right-angle rule on a surface plate, and see if it is straight with its upper end spaced not more than 1mm apart from the corresponding end of the rule. The spring with this displacement above 1.5mm (that is, 3mm per 100mm) must be removed.

(7) Inspecting the plunger collar

Check the clearance between the plunger collar and the control sleeve groove. This clearance is normally held in the range of 0.02-0.08mm. If it exceeds 0.12mm, then the control sleeve should be replaced.

(8) Checking the contact between the plunger barrel and the pump body. The two abutting surfaces, if deformed, scored or projecting, should be corrected by means of the reamer (EF8488).

(9) Control pinion

1) Inspecting the gear

Any excessively worn or deformed pinion gear should be replaced.

2) Inspecting the clamp screw

If the clamp screw is stiff, it should be either replaced or corrected by straightening out the threads.

(10) Control rack

Check the control rack teeth for proper alignment. The teeth may be checked for warp by rolling the rack on a surface plate and should be replaced if so found defective.

(11) Air bleeder screw

Both air bleeder screws should be replaced for their packings. (See Fig. 9-49)

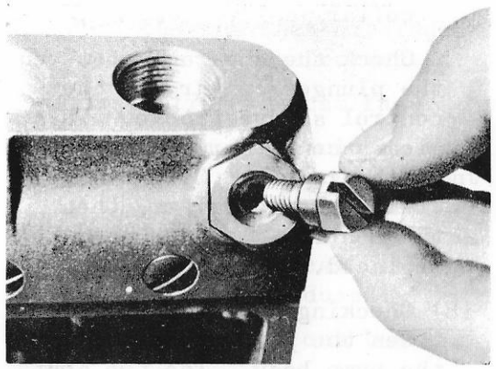


Fig. 9-49

(12) Delivery valve gasket

When the delivery valve is removed, it is necessary always to replace its gasket.

(13) Pneumatic governor main spring

1) Checking the spring for damage

Make visual inspection of the spring for score, rupture or deflected wear and replace it if found defective.

2) Inspecting the tension of the spring

With use of a spring tester, apply 720 gr of load to the spring and check to make sure that it retains 35mm of length and then, increase the load from 750 gr to 1450 gr and check also to make sure that the variation in the length of the spring is about 5mm at a maximum.

(14) Oil seal

Dismantling of the injection pump should always be followed by the replacement of the oil seals attached to the bearing covers on the both sides of the pump body.

(15) Cleaning the parts

The fuel port on the body and all other parts associated with the fuel pump should be washed in clean kerosene with the aid of compressed air.

(16) Threaded portion of the parts

Check all the threaded portions of the parts and rectify as necessary.





9-4-4 Reassembling the injection pump

Secure the pump body to the pump mount plate and hold this in a vice.

(1) Reassembling the plunger barrels

Insert the barrel into the pump body with the knock in the body properly aligned with the groove in the barrel and then, insert fingers into the body through the opening at the cover plate situated in the front side of the body and check to see if the barrel is properly settled in position. If the barrel is allowed to turn, fitting of the knock to its groove should be rectified to hold the barrel securely in position. (See Fig. 9-50)

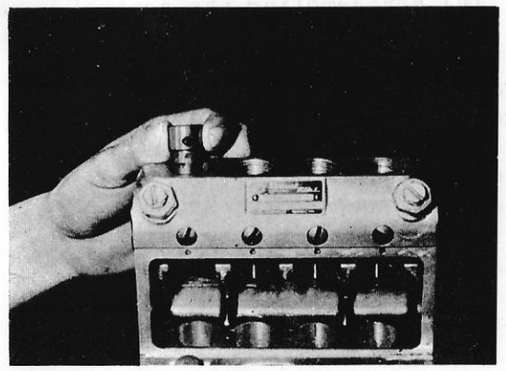


Fig. 9-50



(2) Mounting the delivery valve in position

1) Refit the delivery valve to the upper end of the plunger barrel. Both the upper part of the plunger barrel and the lower part of the delivery valve should be clean and free from any foreign particles.

2) Refit the delivery valve gasket into position in the following manner. With the plain side of the limit sleeve extractor (EF9554) held right against the gasket, hit this lightly with a hide mallet to fit the gasket into position. Make sure that the gasket is refitted into position with the right side up.

Also make sure to refit the delivery valve gasket (nylon ring) into position with its changerred side faced upward. (See Figs. 51 and 52)

3) Mount the delivery valve spring on the delivery valve head.

4) Clamp the delivery valve holder to the plunger barrel by applying specified torque.

The delivery valve holder should be carefully tightened to safeguard the gasket from being damaged. The clamping torque is standard at 4.5-5.5 m-kg. (See Fig. 9-53)

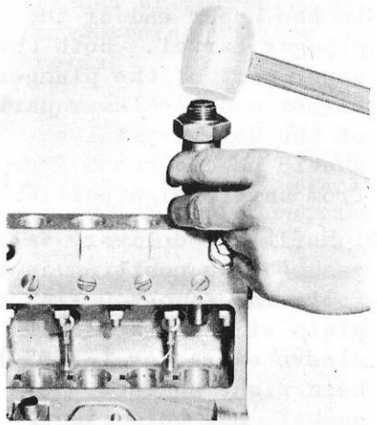


Fig. 9-51

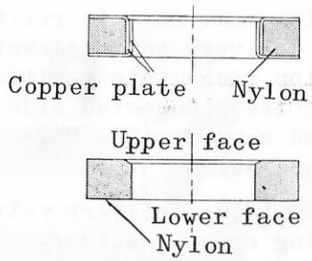



Fig. 9-52

5) Clamp the lock plate tightly so as to prevent the parts from turning loose.

(3) Mounting the main housing on the body

Apply liquid packing to the mounting face of the main housing and fasten this to

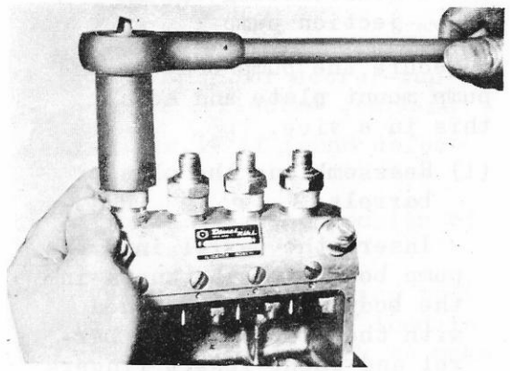


Fig. 9-53

the pump body with a flat head screw 8ø x 15mm and four (4) flat head screws 6ø x 13mm.

Locally available "Packleace B" manufactured by DIESEL KIKI Co., Ltd. is recommended for use as liquid packing.

(4) Reassembling the control rack

1) Smear the control rack with engine oil and insert this into the pump body through the governor side with its end provided with a stamping "Stop" turned toward the governor side and another end with gear teeth faced toward the cover plate.

2) Tighten the control rack guide screw on the reverse side of the pump body. (See Fig. 9-54)

Release the pump body from the vice and again





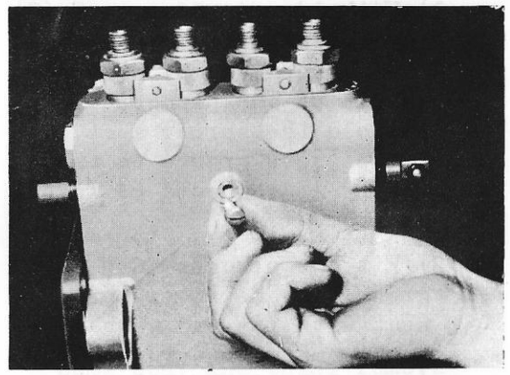


Fig. 9-54

hold it in vice with the cover plate faced upward.

(5) Refit the control pinion and sleeve into their respective positions

Refit these parts into positions in the following manner commencing with the 1st barrel.

1) Align the control rack to the body with the equal travel distance provided at right and left hand side of the control rack. Refer the notched marking on the outer circumference of the control rack for aligning the control rack with equal distances apart from each side of the body. The control rack may be properly aligned by setting it to position 17.5mm apart from the level of the injection timing control on the body. (See Figs. 9-55 and 56)

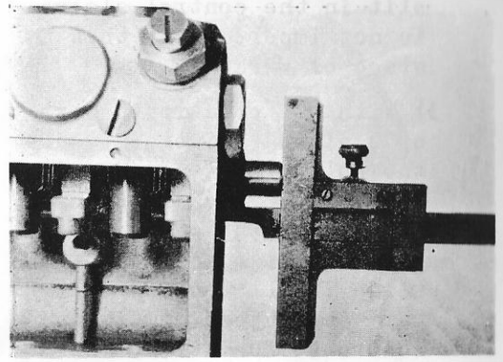


Fig. 9-55

2) With control rack held in position as aligned in the preceding paragraph, bring the control pinion into engagement with the control rack in the right angle thereto with the split end of the control pinion opposed to the control rack (180°). Alignment of the

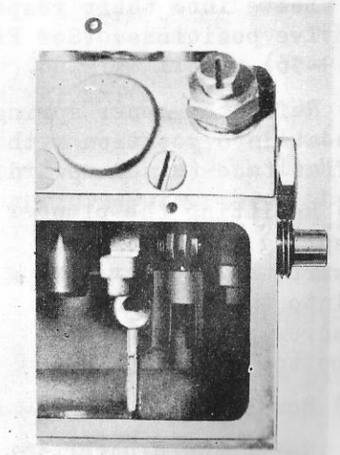


Fig. 9-56

slit in the control sleeve is not important at this stage of work.

3) With use of a depth gage or a slide caliper, measure the full travel stroke of the control rack by bringing it all the way to the governor side and again slide it all the way toward the injection timing control. The stroke is standard at 21mm. The measurement may be taken while the stop lever is held tilted all the way to the right and if the stroke thus obtained does not meet the specified value, recheck the alignment of the control rack and again mesh the pinion with the control rack.

4) Apply the same procedure to the 2nd, 3rd and 4th barrel for refitting the control rack and control sleeve into their respective positions. (See Fig. 9-56)

(6) Refit the upper spring seat into position with its flat face turned upward.

(7) Refitting the plunger spring into position. Insert the plunger spring into the body through the screw plug hole on the bottom of the pump body.

(8) Reassembling the plunger

Refit the plunger into the pump body after it is fastened with the lower spring seat.

1) With lower spring seat mounted on the tip end of the plunger clamp, grab the handle of the plunger clamp to hold the spring seat. The plunger groove on the spring seat should be faced upward.

2) Fit the plunger into the groove in the lower spring seat with its end with parts number marking turned up. (A symbol of the DIESEL KIKI is brought into the reverse side of the plunger)

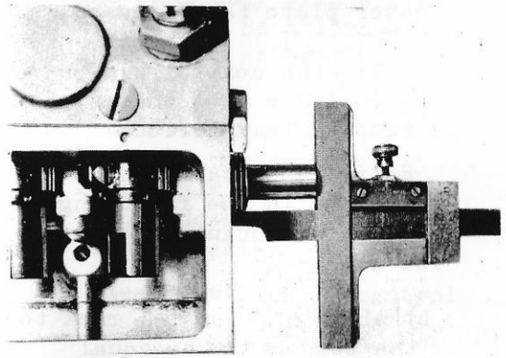


Fig. 9-57

3) With the plunger and its pertinent parts held by the plunger clamp, insert these parts into the pump body through the screw plug hole in the bottom of the pump and fit them carefully into the plunger barrel.

4) When the lower spring seat comes in contact with the plunger spring, remove the plunger clamp.





(9) Reassemble the tappet assembly in the following manner.

1) Hold the lower part of the tappet body with the tappet clamp and insert this into the pump body through the camshaft hole.

2) Fit the tappet and the tappet guide into position in proper alignment with the pump body and then, remove the tappet clamp. (The work may be carried out easily when commenced with the 4th barrel)

3) Insert the roller clamp into the pump body through the screw plug hole in the bottom of the body and hold the tappet roller.

4) Fit the flange of the plunger into the slit in the control sleeve properly and set up the lever handle on the roller clamp so as to bring the tappet body inserting hole into alignment with opening on the cover plate of the pump body.

5) Put the tappet insert through the tappet insert hole on the tappet body to hold the tappet from descending and pull out the roller clamp.

(10) Refitting the camshaft into position

1) Insert the camshaft into the pump body with the end provided with a setting mark (notched line) turned

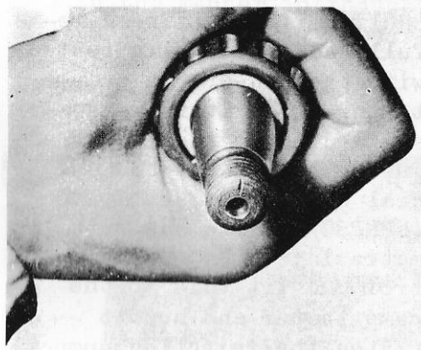


Fig. 9-58

toward the governor through the side in which the injection timing control is located. Check to make sure that the feed pump mounting hole is properly aligned with the feed pump drive cam on the camshaft. (See Fig. 9-58)

2) Apply jointing compound to the mounting face of the bearing cover and fasten this to the pump body with the four (4) fixing screw (6ϕ x 13mm)

3) If the camshaft fails to rotate smoothly with light finger pressure, check the bearing for wear or damage.

(11) Clamping the screw plug

Connect L-shaped auxiliary handle to the special wrench, clamp the screw plug tightly.

(12) Refitting the automatic injection timing control

If the injection pump has

been dismantled for overhauling if should be carefully adjusted while tested with the aid of the pump tester after it is reassembled. For the future adjustment, connect the special coupling assembly (EFEP5C/51C) to the automatic injection timing control and fit this to the pump tester and not to fasten the injection pump gear to the automatic injection timing control. (See Fig. 9-75)

1) Fit the key to the camshaft.

2) Align the key groove on the automatic injection timing control with the key on the camshaft and then, fit the injection timing control to the camshaft.

3) Put the spring washer through the camshaft and clamp the round nut over the washer.

The round nut should be tightly clamped with the aid of a wrench while the flyweight holder is firmly held with the retainer. The clamping torque is standard at 7.5-8 m-kg

(13) Pull out the tappet insert

The tappet insert may be pulled out easily while the plungers are held at their T.D.C.

(14) Check the operation of the control rack

In order to check the sliding operation of the control rack, measure the torque required to move the control rack with use of a spring balance. Take the measurement while the plungers are held at their T.D.C. and the operation of the control rack may be regarded as normal if the measured value all indicate less than 150 gr.

(15) Fitting the diaphragm into position

Check the operation of the control rack to make sure that it is held in trouble-free condition. Then, fit the diaphragm into position in the following manner.

1) Bring the diaphragm assembly (with angleich spring and push rod) into proper alignment with the groove in the main housing with the projection on the outer circumference faced downward. (See Fig. 9-59)

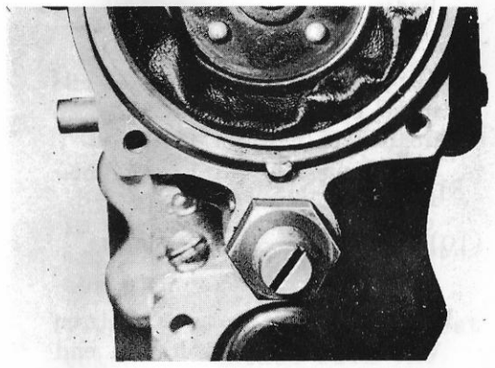


Fig. 9-59





2) Fit the push rod of the angleich spring into the pin on the control rack and then, put a plain washer and split pin through the pin on the control rack and split the tip ends of the pin apart to prevent it from coming out.

3) Fasten the main spring and diaphragm housing to the main housing with four (4) screws (5ø x 20mm) and four (4) spring washers.

(16) Fasten the camshaft rear cap to the body with three fixing screws (6ø x 10mm) using a screwdriver or a wrench.

(17) Mount the pump to the pump tester and readjust as necessary. (Refer the subparagraph 9-4-5)

(18) Reassembling the pump after readjustment

1) Remove the automatic injection timing control from the pump together with the coupling assembly.

2) Mount the pump bracket on the pump body flange. (See Fig. 9-60)

3) Remove the coupling assembly from the automatic injection timing control and mount the injection pump gear in place.

4) Mount the automatic injection timing control (with injection pump gear) on the pump camshaft. This work should be carried out in the manner introduced in the foregoing subparagraph 9-4-2-(1).

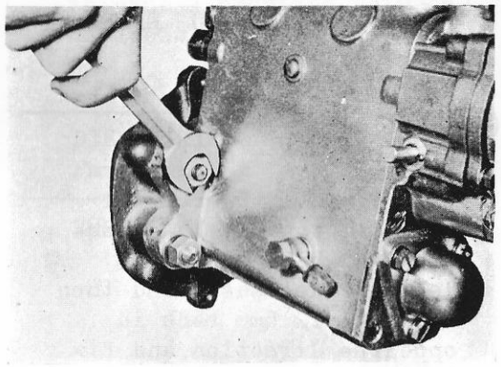


Fig. 9-60

9-4-5 Readjusting the injection pump

The injection pump should be readjusted while it is mounted on the pump tester but the injection pump for the model C180 engine does not fit the pump tester and hence, it should be mounted on the tester through the special pump mount plate. (See Fig. 9-61)

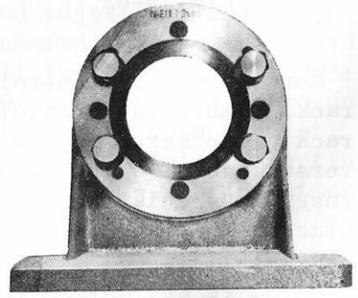


Fig. 9-61

Parts number of the pump mount plate;

Pump tester { For EFEP5C / For EFEP5NI } EFEP29N
Pump tester { For EF8345D } EFEP29NI

(1) Readjusting the fuel injection timing

1) First move the control rack all the way in direction in which the fuel delivery decreases and then slide it 12.6mm back in opposite direction and fix it in that position. (See Fig. 9-62)

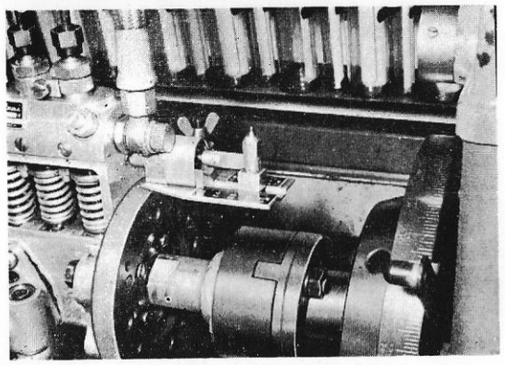


Fig. 9-62

For fixing the control rack, remove the control rack guide screw in the reverse side of the pump and insert a special bolt in place. (Refer subparagraph 9-4-4-(4))

2) Carefully turn the camshaft so as to bring the tappet in the 1st barrel into its B.D.C. (See Fig. 9-63)

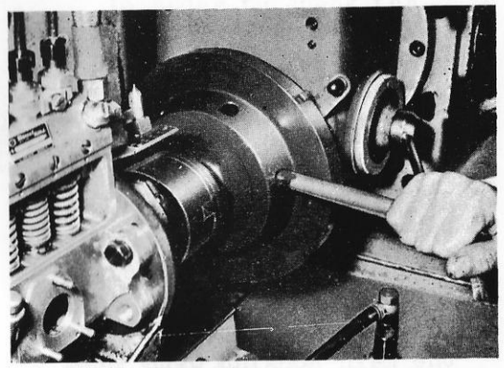


Fig. 9-63

3) Remove the delivery valve holder from the 1st barrel and taken out the delivery valve spring. Refit the delivery valve holder into position and supply fuel at 40-50 kg/cm$^2$ of pressure. If the pump tester used for this test is equipped with high pressure generating device, this operation may be omitted.

4) Mount a dial gage on the special measuring tool (NP-EPEP51Cb) and hold the test piece against the upper portion of the tappet. Hold the measuring tool so as to bring the clearance between the tool and side plate opening aside. (See Fig. 9-20)

5) Calibrate the dial gage pointer to "0" and turn the camshaft slightly to both ways to make sure that the gage pointer is held still. The tappet should be checked to see if it is held in its B.D.C.

6) Carefully turn the camshaft counter-clockwise when viewed from the drive side and adjust the tappet by inserting adjusting washer into the clearance between the tappet and lower spring seat so as to make the tappet to cut-off the fuel supply when the gage pointer comes within 1.75±0.05mm.

The tappet may be adjusted in the following manner:

Hold the cam in position holding the respective tappet in the T.D.C. and then insert a plunger spring insert (EF9093) into the groove on the tappet body and turn the cam and hold it in B.D.C. Then, push up the lower spring seat and add or remove the adjusting washer to or from the tappet. (Fig. 9-64)

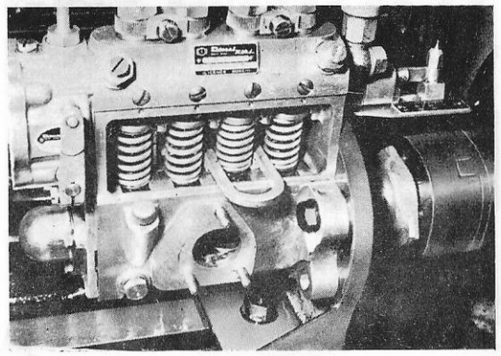


Fig. 9-64

7) The adjusting washers are available in the following 9 different kinds from 0.6mm in thickness up to 1.4mm with every 0.1mm of adjusting thickness provided between adjacent washers.

| DIESEL KIKI Parts number | Thickness mm |
|---|---|
| WMS25P41X | 0.6 |
| " 42X | 0.7 |
| " 43X | 0.8 |
| " 44X | 0.9 |
| " 45X | 1.0 |
| " 46X | 1.1 |
| " 47X | 1.2 |
| " 48X | 1.3 |
| " 49X | 1.4 |

8) Refit the delivery valve spring into position and clamp the valve holder by applying the specified torque.

9) Carefully turn the camshaft counter-clockwise and adjust the injection intervals so as to provide all the barrels with 90°± 30' of intervals based on the period when the 1st barrel completed injecting operation. The adjustment should be carried out in the sequence of 1-3-4-2.

(2) Adjusting the amount of fuel injection

The adjustment should be performed with use of a pump tester in the following manner:

The injection nozzle which is used for this test should be the parts specified as genuine parts for the model C180. Mount the nozzle on the nozzle holder (NP-KCA30 SD2NP5) and adjust the nozzle injection pressure to 120 kg/cm$^2$.

Use the injection pipe with 1.6ϕ in inside diameter, 6.0ϕ in outside diameter and 600mm in length for testing the injection nozzle performance.

1) Set the control rack in position as specified in the "fuel injection standard table" in the sequence of adjustment with use of control rack fixing bolt. (See Fig. 9-21)

* Sequence of adjustment: position of the control rack are 12.8mm, 11.7mm, 10.0mm and 7.8mm, respectively.

2) Operate the pump with the speed as specified and adjust the amount of the injection conforming to the standard. The amount of fuel injection should be adjusted by slackening the clamp screw on the control pinion and then turn the control sleeve either way as necessary.

The amount of fuel injection increases when the control sleeve turned to the right and decreases with the control sleeve turned to the left.

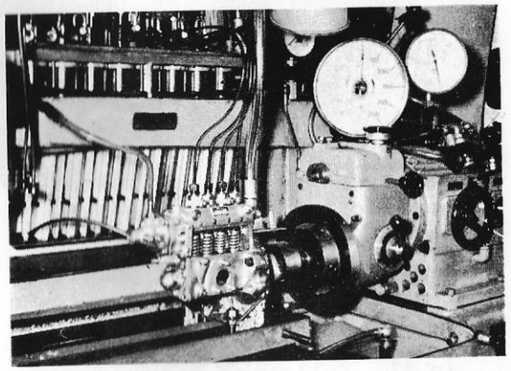


Fig. 9-65

3) Adjust the spring guide assembly which serves to hold the maximum fuel injection delivered by the control rack so as to bring the control rack into the position of 12.8mm and then secure the control rack with the lock nut.

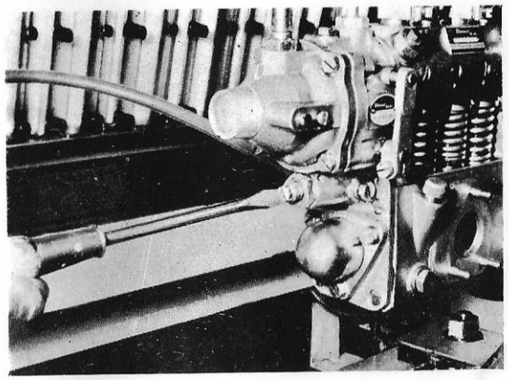


Fig. 9-66





(3) Fuel injection standard table

Standard table for fuel injection pump 8120-0256 for model C180

| Control rack position mm | Pump speed r.p.m. | mm$^3$/st | Disproportion % | Remarks |
|---|---|---|---|---|
| 12.8 | 1,500 | 33.4±1.3 | ± 4 | Nozzle in use NP—DNOSD212 |
| 11.7 | 750 | 30.4±0.7 | ± 2.5 | |
| 10.0 | 1,800 | 22.6±1.0 | ± 4.5 | |
| About 7.8 | 300 | 8.0±11 | ±11 | |

Note: The term disproportion represents:

(+) Disproportion % = $\frac{\text{Maximum - average}}{\text{Average}}$ x 100

(-) Disproportion % = $\frac{\text{Average - Minimum}}{\text{Average}}$ x 100

(4) Testing the pneumatic governor

Before performing the test, mount the measuring scale on the governor and operate the pump at 500 r.p.m. for measuring the position of the control rack by setting the position of the control rack slid all the way in direction in which the fuel delivery decreases as "0" point.

1) Conduct the air-tightness test on the governor chamber

Apply 500 mmAq (36.7 mmHg) of negative pressure to the governor chamber (side in which the nipple is identified with orange color) and measure the time taken for the pressure to drop to 480 mmAq (35.0 mmHg). If the time thus measured is above 10 second the governor chamber may be regarded as normal. If the test result is unsatisfactory, rectify the leakage in the diaphragm housing as necessary.

2) Test the operation of the governor in the following manner.

a. Test the function of the angleich spring. Check to see if the control rack starts moving toward the direction in which the fuel delivery decreases when 30 mmAq of negative pressure is applied and also check

to make sure that negative pressure should be held within 360 mmAq when the control rack is forced to move to the position of 11.7mm through the angleich stroke of 1.1mm.

b. Test the function of the main spring in the following manner:

If the control rack tends to move toward the direction in which the fuel delivery decreases from the position of 11.7mm when the negative pressure is further increased as high as to 390-430 mmAq the main spring may be regarded as functioning normally.

The starting period of the main spring may be adjusted with use of main spring adjusting washers.

The adjusting washer for the main spring is available in the following 4 different thickness:

| Description | Thickness (mm) |
|---|---|
| 8131-5120 (NP-WMS5010/1X) | 0.5 |
| 8131-5121 ( " /2X) | 1.0 |
| 8131-5122 (NP-WMS100N1X) | 0.2 |
| 8131-5123 ( " 2X) | 0.3 |

Increase the negative check to make sure that the negative pressure is held as high as to 570-650 mmAq when the control rack is positioned at 7.3mm from "0" point.

(5) Adjusting the position of idling

Loosen the rock nut for the idling spring assembly (sub-spring assembly) using a wrench (EF9092) and adjust the idling spring assembly with the aid of a screw driver so as to make the rock position come to 7.5mm while the load pressure is between 570-650 mmAq. After this procedure, secure the idling spring assembly with a round nut.

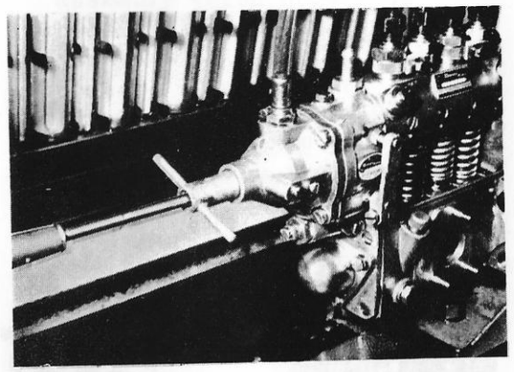


Fig. 9-67

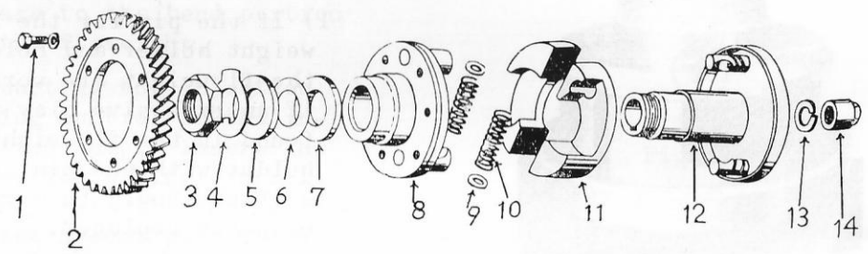
Lastly, cover the rear of the diaphragm with a plate plug.





## 9-5 DISMANTLING, INSPECTING AND ADJUSTING THE AUTOMATIC INJECTION TIMING CONTROL

### 9-5-1 Dismantling the automatic injection timing control




(1) - Bolt
(2) - Gear
(3) - Nut
(4) - Rock washer
(5) - Washer
(6) - Adjusting washer
(7) - Bearing
(8) - Flange assembly
(9) - Adjusting washer
(10) - Spring
(11) - Flyweight
(12) - Holder
(13) - Spring washer
(14) - Round nut

Fig. 9-68

(1) Dismount the automatic injection timing control from the injection pump. For a proper dismounting of the injection timing control, refer to Section ( ) "Disassembly of Injection Pump".

(2) Hold the injection timing control

Hold a special mount plate (EFEP131C) (Fig. 9-70) in a vise, set the hole of the flyweight holder of the injection timing control to the boss of the mount plate.

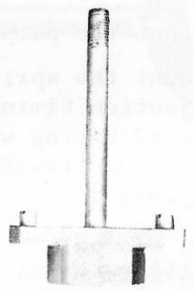


Fig. 9-69

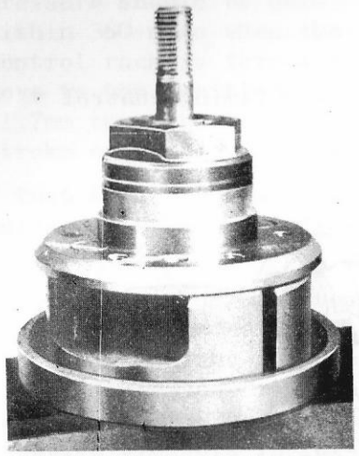


Fig. 9-70

(3) Carry out the disassembling work in the following sequence

1) Stretch the rock washer and remove the nut, using a 38mm wrench.

2) Dismount the rock washer, the washer, the adjusting washer, and the needle roller bearing.

3) Dismount the pump gear.

4) Dismount the spring of the injection timing control, and its adjusting washer, and also the flyweight from the flyweight holder. (Fig. 9-70)

(4) Inspecting the dismounted parts

Use the injection pump tester and the strobo unit to accurately inspect the characteristic of the injection timing control. But, if any of the dismounted parts is found defective, it forecasts that the timing control has been function inaccurately. So, any of those parts should be replaced as necessary.

1) If the pin for the flyweight holder and holes of the flyweight are worn, or if an excessive play is found in the flyweight holder with the pin, such setback should be corrected or parts replaced.

2) If the flyweight stopper is found loose due to wear or deformation, correct or replace it.

3) Should the spring of the injection timing control be weakened, or damaged, or otherwise broken, replace the both springs. The tension of these spring constitutes a complete set with the adjusting washer. The adjusting washer should therefore be replaced when the springs are replaced.

4) Check and see if all pertinent parts are properly located in position, and correct as necessary.

9-5-2 Reassembling the automatic injection timing control

(1) Hold the flyweight holder

Install the flyweight holder on the table (EFEP 131C/1) held in a vise. In this operation, set the holes of the flyweight holder to the boss of the mount plate.





(2) Mounting the flyweight on the flyweight holder. Apply grease to the bend portion of the flyweight.

(3) Mounting the injection timing control on the injection pump. Insert the injection timing control spring into the spring seat of the holder pin, and also insert the spring supporter (EFEP131C/6) (Fig. 9-71) under the spring so that the inserted spring may not roll or become flat.

The adjusting washer which comes in a set with the timing control spring should be inserted in the bottom of the seat for the holder pin.

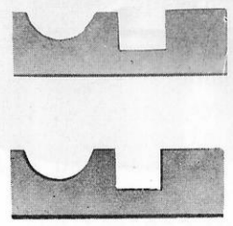


Fig. 9-71

(4) Refitting the flange assembly.

Reassemble the driving flange with the flange assembly in such a manner that the stamped line indicating the key groove on the driving flange comes in contact with the key groove of the flange assembly. Then, tighten the thrust bearing and the guide bushing (EFEP131C/1) (Fig. 9-72)

Fig. 9-72

(5) Position the injection timing control spring in place. In this operation, use a special wrench (EFEP 119C) (Fig. 9-73) and screw two bosses into the 6.2mm dia. holes of the driving flange, using this special wrench (Fig. 9-73). Then refit the washer and the nut, remove the spring supporter using the special wrench, and tighten the nut securely, following which procedure, the timing control spring should be placed in position by holding the flange. Fix the timing control spring into

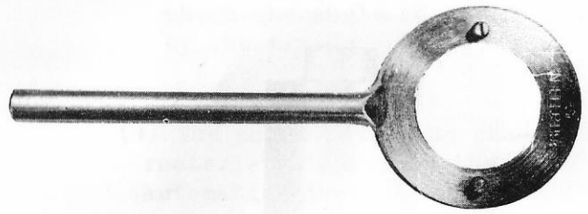


Fig. 9-73

Fig. 9-74

the clearance between the flange face and the spring seat of the holder pin.

(6) Tighten the nut

Dismantling the nut, washer, guide bushing. Tighten the nut on the adjusting washer, washer, rock washer in that order. Place the rock washer and bend its edge against the bolt to hold if from turning loose. Further the thrust bearing must be fitted to let the needle roller come in contact with the face of the flange.

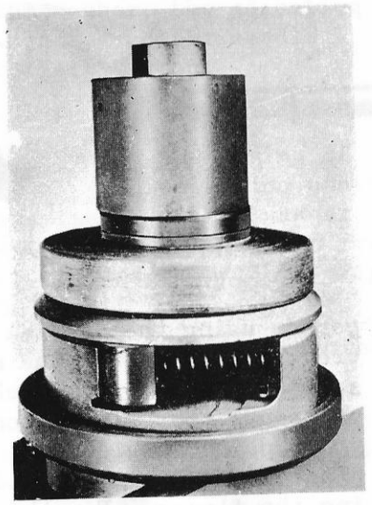


Fig. 9-75

(7) Mount the pump gear.

9-5-3 Testing the characteristic of automatic injection timing control

For a proper execution of this test, the pump tester and the stroboscope (timing lamp) must be used.

Mount the automatic injection timing control on the injection pump which in turn is installed on the pump test. For further details refer to "Founting the automatic injection timing control" on Section ( ) "Assembly of injection pump".

(1) Install the dial and the indicator

Fig. 9-76

The dial (EFEP103/291) should be affixed to the coupling assembly (SFEP 5C/51C) (Fig. 9-76) using an adhesive tape. The indicator (EFEP103/20a) should be attached to the





injection timing control by unscrewing the nut. (Fig. 9-77)

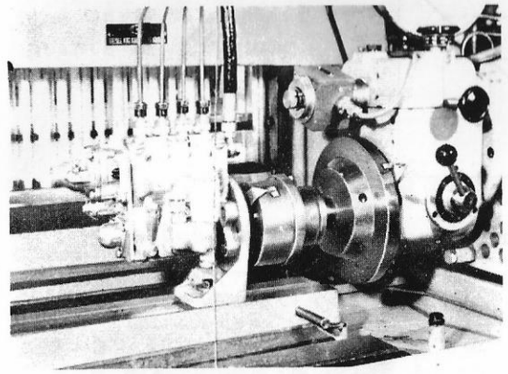


Fig. 9-77

(2) Hold the stroboscope

1) Take off the blind lid from the one side of timing control where the bosses are located. Install the advance angle adjusting synchronizer (EFEP103N2) provided with the stroboscope in the pump.

Dismount the mounting sleeve from the synchronizer, attach this sleeve to the pump tester, and set the synchronizer pin with the tester pin.

2) Connect the strobo light (timing lamp) and the synchronizer with the stroboscope using attached cords.

(3) Inspecting the angle advancing characteristic

1) Switch on the strobo-

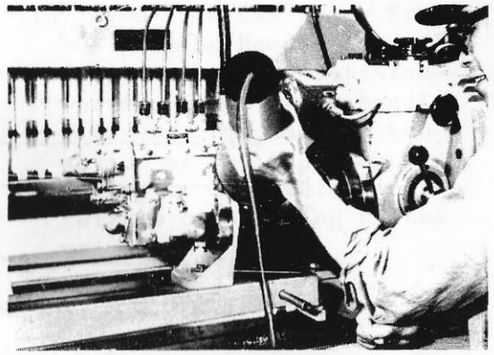


Fig. 9-78

scope after rotating the pump, increase the pump speed to 500 r.p.m.

2) With the strobo light held against the coupling assembly, calibrate the pointer to register with the "0" marking.

3) Increase the speed of the pump rotation gradually from 500 r.p.m. and check the angle advanced by the timing control.

(4) The angle advancing characteristic curve of the automatic timer.

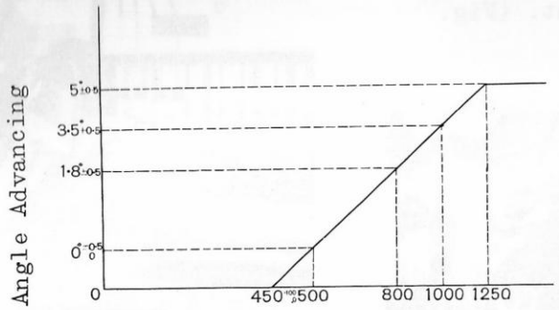



Fig. 9-79

## 9-6 DISASSEMBLY, INSPECTION, AND ADJUSTMENT OF FEED PUMP

(1) - Diecasting
(2) - Joint bolt
(3) - Packing
(4) - Nipple
(5) - Check valve spring
(6) - Check valve
(7) - Washer
(8) - Feed pump housing
(9) - Pin
(10) - Roller
(11) - Tappet guide
(12) - Tappet
(13) - Snap ring
(14) - Washer
(15) - Pipe joing assembly
(16) - Push rod
(17) - Piston
(18) - Spring
(19) - Washer
(20) - Plug screw
(21) - Priming pump assembly

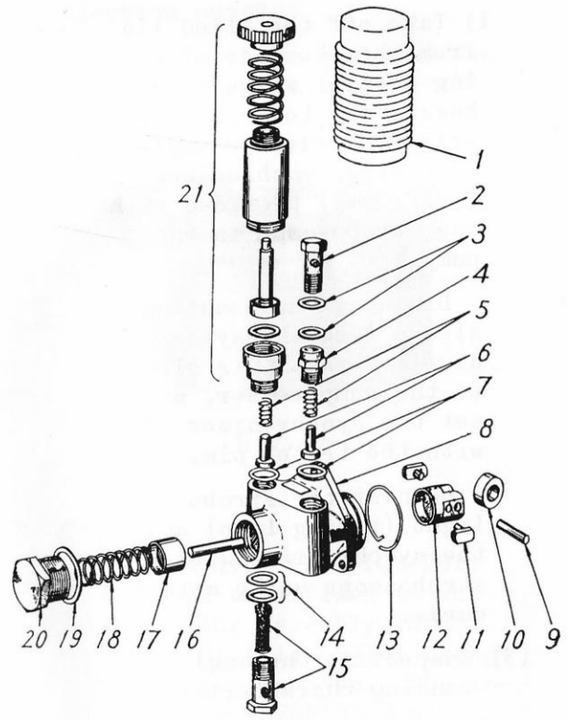



Fig. 9-80





### 9-6-1 Inspecting the feed pump

Check the feed pump dismantled from the injection pump in the following manner and correct all defective points of the pump.

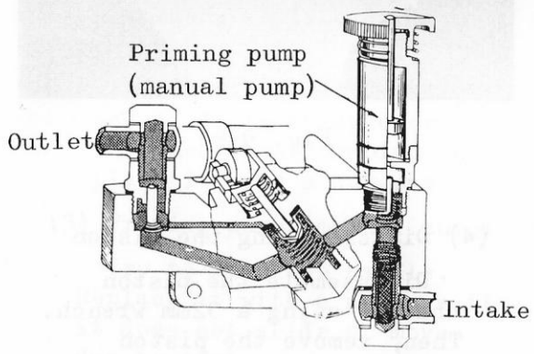



Fig. 9-81

(1) Inspecting the piston

Depress the tappet with your thumb. If the tappet cannot satisfactorily be depressed, it may be attributed to seized or stuck push rods.

Even with the tappet satisfactorily depressed, if the tappet fails to bounce back to its original position, the piston may be seized or stuck in its innermost position. The same applies where the piston crown is raptured.

(2) Inspecting the tappet

If the tappet does not return to its original position, the tappet spring is probably broken.

(3) Even with the screw for the priming handle (manual pump) moved back satisfactorily, if the pump handle fails to come back by the action of the tappet spring, it may be attributed to the seizure or sticking of the priming pump.

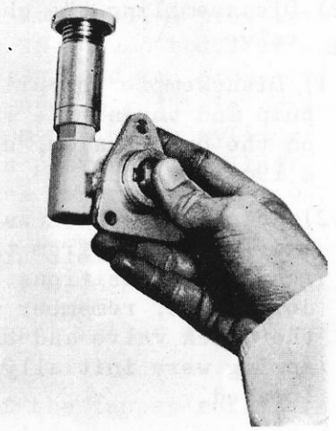


Fig. 9-82

(4) Inspecting the feed pump

Inspection of the feed pump should be performed in accordance with the instructions given in section 9-6-5 "Feed pump test".

### 9-6-2 Disassembling the feed pump

(1) Dismount the nipple joint bolt

Dismount the nipple joint bolt, nipple and joint bolt, and also disassemble the gauze filter (a filter net) from inside the joint bolt on the intake side of the feed pump. As the gauze filter is inserted into the joint bolt, the filter can be taken out simply by turning the joint bolt counterslockwise using a screw driver.

(2) Disassembling the check valve

1) Disassemble the priming pump and the nipple located on the outlet side, using a 19mm wrench.

2) Remove the check valve and its spring from their respective positions. When doint this, remember where the check valve and the spring were initially located.

(3) Disassembling the tappet

1) Remove the snap ring with a scriber or the like. After one side of the snap ring is inserted into the hole of the feed pump body, remove the snap ring by slightly raising the other end of this snap ring.

2) Remove the tappet first. If the tappet is not taken out easily, use a narrow stick, in which case, exercise caution not to let the guide fall off.

3) Remove the tappet spring.

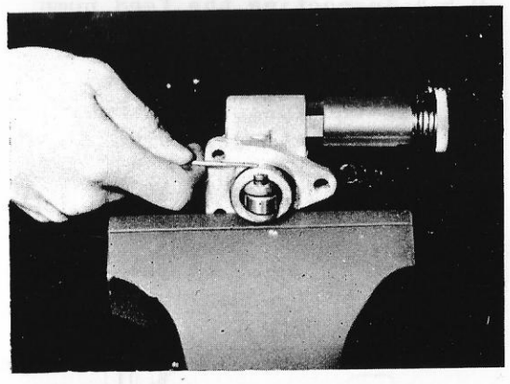


Fig. 9-83

(4) Disassembling the piston

Disassemble the piston chamber using a 32mm wrench. Then, remove the piston spring and the piston push rod in the order mentioned.

(5) Disassembling the tappet assembly

Remove the tappet guide and also the roller.

9-6-3 Repairing or replacing the disassembled parts

(1) Gauze filter (filter net)

If the gauze filter is meshed with wires, it should be washed and cleaned. And if the net is broken, replace it with a new one.

(2) Check valve

1) Check and see if the contact surface of the check valve is worn or cracked. If it is badly worn or cracked, the check valve





should be replaced. In case the wear is very slight, rub a fine abrasive compound on a glass plate and apply it to the worn area of the valve.

2) Check the valve seat of the feed pump body, and should it be damaged or deformed, replace it.

3) Make a visual check-up of the check valve spring, and if it is damaged or deformed considerably, replace it with a new one.

(3) Priming pump (manual pump)

Try to move the handle. Replace it with a new one if it does not slide or move due to rust.

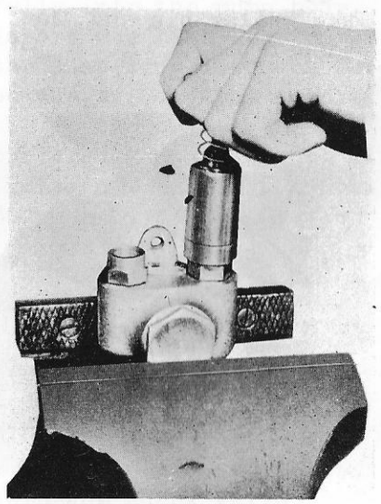


Fig. 9-84

(4) Piston spring

If the piston spring is found damaged or deformed, replace it.

(5) Piston

1) Check and see if the piston surface is scored or deformed.

2) Insert the piston into the feed pump body and see if there is proper clearance therebetween. If the piston has too great a play with the feed pump body, it must be replaced and properly aligned to maintain optimum movement in the cylinder. This piston is available in sizes ranging from 21.987mm (Standard size) up to 21.977 mm in diameter with every other 0.002mmø difference.

(6) Tappet roller and roller pin

1) If the tappet roller is found worn, cracked or otherwise damaged, replace all of its pertinent parts.

2) Set the roller with the pin and see if they are properly fit together.

These with excessive play should always be repaired or replaced.

(7) Tappet spring

Check the tappet spring for crack, damage or deformation, and replace it if found defective.

(8) Feed pump body

Wash the feed pump body,

particularly the oil holes linking the fuel intake opening with the push rod, using a sprayer.

(9) Screws

Check the screws on all pertinent component parts, and correct or replace them if deemed necessary.

9-6-4 Assembling the feed pump

Assembly of the feed pump should be carried out in the manner described below.

(1) Fitting the piston

1) Apply engine oil to the push rod, and then insert the piston with its larger end into the feed pump body.

2) Insert the piston into the feed pump body. When doint this, care should be taken to put the concave side of the piston into the push rod. (See Fig. 9-85)

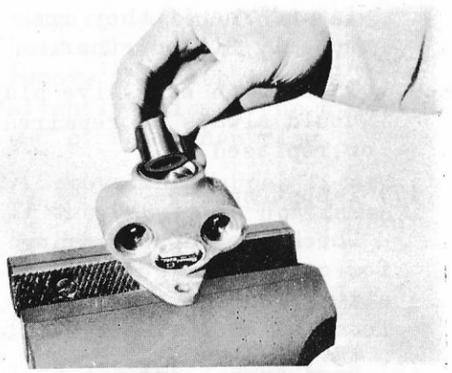


Fig. 9-85

3) Insert the piston spring into the feed pump body.

4) Insert the piston chamber plug in the feed pump body. In this case, apply liquid packing to its threaded portion of the plug and the pump face in contact with the plug, and tightly clamp the piston chamber plug in place.

(2) Assembling the tappet assembly

1) Insert the tappet roller into the interior of the tappet body and put the roller pins into their corresponding pin holes.

2) Position the roller pin with its tip end facing the tappet and fix the tappet guide in between the roller pin and the tappet body.

Fig. 9-86

(3) Mounting the tappet assembly





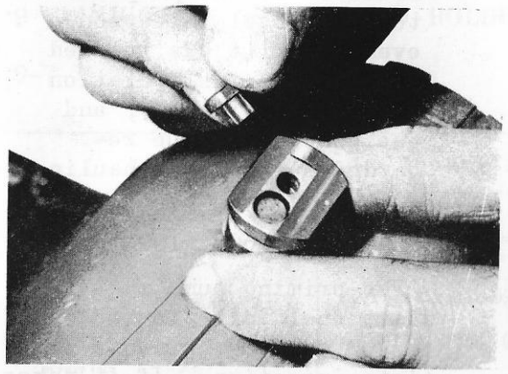


Fig. 9-87

1) Insert the tappet spring into the pump body.

2) Press the tappet assembly guide into the groove of the feed pump body.

3) After inserting the tappet fully into the pump body, insert the bent section of the snap ring into the feed pump body, and the insert the snap ring into the outer groove around the circumference of the feed pump body.

(4) Mounting the check valve

1) Insert the check valve into the pump body. Mount the check valves on the priming pump and the delivery nipple simultaneously.

2) Fit the check valve spring into the check valve.

3) Secure the priming pump and the delivery nipple on the feed pump body. When doing so, apply a liquid packing to the threaded portion of the feed pump body, but do not locate the priming pump and the delivery nipple in wrong positions.

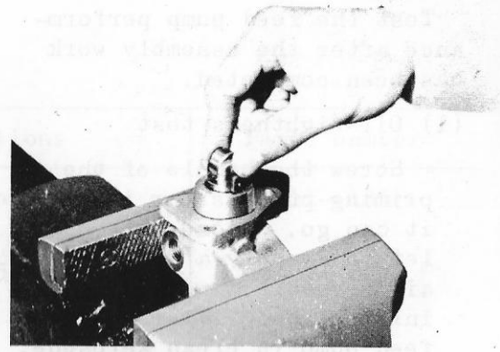


Fig. 9-88

(5) Fitting the nipple

Fit the nipple using a joint bolt. Make sure that the joint bolt with a gauze filter is mounted on the intake side.

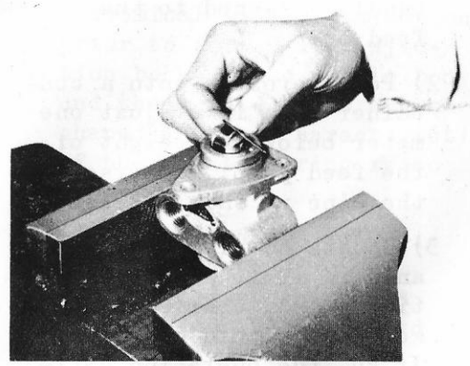


Fig. 9-89

9-6-5 Feed pump test

Test the feed pump performance after the assembly work has been completed.

(1) Oil-tightness test

Screw the handle of the priming pump as far in as it can go. Close the outlet, and apply a 2.5 kg/cm$^2$ air pressure through the inlet. Then, immerse the feed pump in clean kerosene. And, if bubbles develop from the nipple, the piston chamber plug, the clearance between the tappet and the feed pump body, the fixed end of the priming pump, or other associated parts of the feed pump, this leakage must be carefully eliminated.

(2) Pumping efficiency test

1) Mount the feed pump on the injection pump and connect the intake nipple with the nipple 8mm in diameter and 2 meters in length. In this case, keep the priming pump handle attached to the feed pump.

2) Pour kerosene into a container to a level just one meter below the height of the feed pump. Immerse the pipe in this kerosene.

3) Rotate the injection pump and see if it starts suction and discharge of the kerosene within 60 r.p.m. If so, the operating efficiency of this injection pump may be regarded as normal. If the pump fails to start fuel injection, even after it has reached 120 r.p.m., its operation is not satisfactory, and the pump should be regarded due for overhauling.

(3) Rotate the priming pump handle at 60 - 100 r.p.m.

The priming pump must start fuel injection during its 60 to 100 r.p.m. to initiate injection. If it takes more than 120 r.p.m., the priming pump should be regarded due for overhauling.

1) Follow the same procedure described in Section (2).

"Pumping efficiency test". Then, raise the pipe on the discharge side by 0.3m and bring it over to the cylinder having a capacity of about 500cc. Operate the injection pump at 1,000 r.p.m., regulate the oil feeding pressure to 1.6 kg/cm$^2$, and check the volume of the kerosene discharged for 15 seconds. If this test shows the amount of oil discharged exceeds 300cc, its pumping efficiency is satisfactory and if it is less than 200cc, thorough overhaul is required.





## 9-7 INJECTION NOZZLE AND HOLDER

9-7-1 Specifications

| | Specifications | Parts number |
|---|---|---|
| Nozzle type | N-DNOSD212 (Throttle type) | 15311—185 |
| Nozzle holder type | NP-KCA3OSD2NP5 | 15330—018 |
| Nozzle injection angle | 0° | |
| Nozzle injection diameter x number | 1ø x 1 | |
| Injection pressure | 120kg/cm$^2$ | |
| Nozzle holder tightening torque | 10~12 m-kg | |
| Nozzle spring constant | 35 kg/mm | 15343—009 |

9-7-2 Construction and function of nozzle

(1) Construction

The nozzle comprises a nozzle body and a needle valve. The nozzle is fabricated with a special material and is precision-machined to meet any severe temperature and pressure conditions. For this reason, the nozzle and the needle valve cannot be replaced separately.

(2) Function of nozzle

1) The nozzle is required to properly inject a high pressure fuel into the fuel chamber from the injection pump.

2) This is a throttle type of nozzle which gives an economical rate of injection prior to full-scale injection because the nozzle body and the needle valve are so shaped and the characteristic of the nozzle spring is so determined.

3) When the needle valve is lifted slightly in the early stage of injection the fuel will be injected in a foggy form. (See "Throttle Process" (b) shown in Fig. 9-91)

4) As the needle valve in lifted, the injection gap increases to a point where the full-scale injection begins.

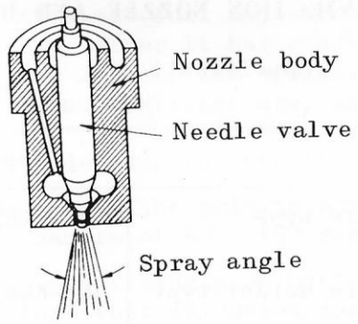



Fig. 9-90

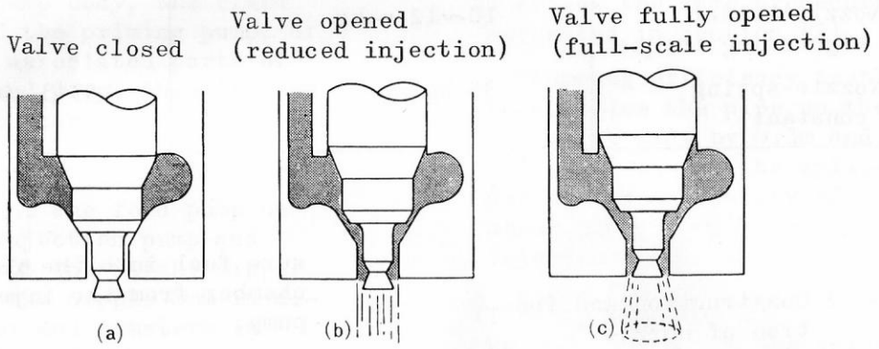



Fig. 9-91

9-7-3 Construction and function of nozzle holder

(1) The nozzle holder is adapted to support the nozzle on the engine, and at the same time induce the fuel into the nozzle. It also regulates the pressure for opening the valve.

(2) The nozzle spring is located on the upper section of the nozzle holder, and the needle valve is pressed against the seat of the nozzle body by the action of the push rod.

(3) Load on the nozzle spring, namely, the pressure required for opening the valve may be adjusted by the adjusting washer.





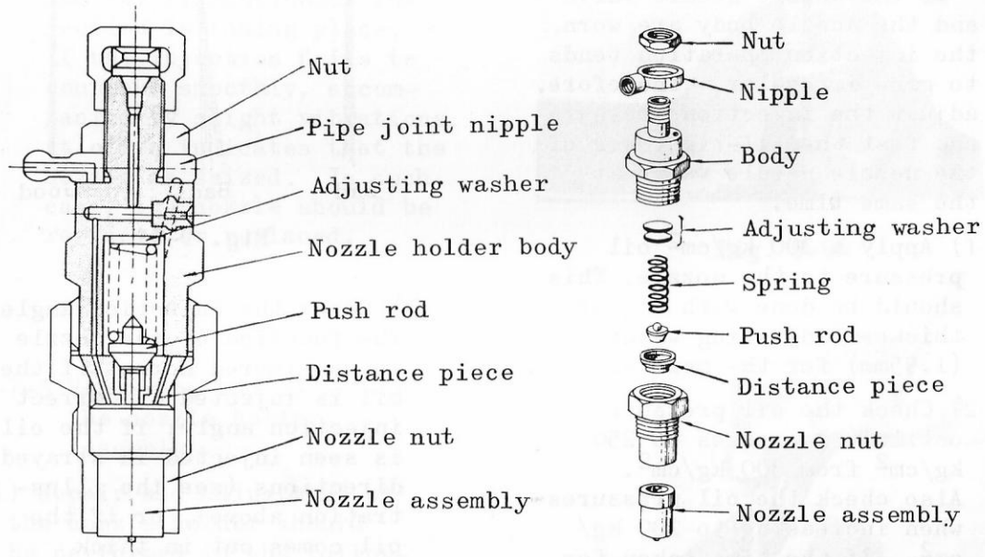



Fig. 9-92

9-7-4 How to determine the need for disassembling the nozzle holder assembly

(1) Testing the nozzle valve seat for oil proofness. Keep the oil pressure at 100 kg/cm$^2$, and check the tip end of the needle valve, the nozzle nut, the nozzle, and the threaded portion of the nozzle nut. If there is any oil leakage, correct the needle valve seat and the head of the nozzle (where the holder comes in contact) by grinding them against each

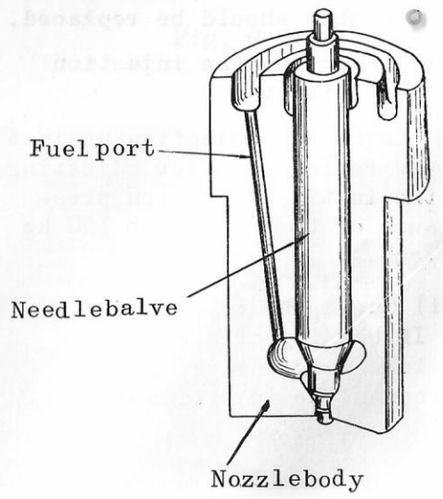



Fig. 9-93

other. Or replace them with new ones.

(2) Testing the oil-tightness of the nozzle needle valve

If the nozzle needle valve and the nozzle body are worn, the injection operation tends to grow irregular. Therefore, adjust the injection pressure and test the oil-tightness of the nozzle needle valve at the same time.

1) Apply a 300 kg/cm$^2$ oil pressure to the nozzle. This should be done with one of thickest adjusting washer (1.95mm) for the nozzle.

2) Check the oil pressure until it decreases to 250 kg/cm$^2$ from 300 kg/cm$^2$. Also check the oil pressures when increasing to 200 kg/cm$^2$. If the time taken for this is within 6 seconds the nozzle may be considered normal; if it exceeds 6 seconds, the nozzle assembly should be replaced.

(3) Inspecting the injection efficiency

Check the injection against the following after adjusting the initial injection pressure of the nozzle to 120 kg /cm$^2$.

1) Check the injections. If the injected oil looks like large drips, it indicates the injection is not normal.

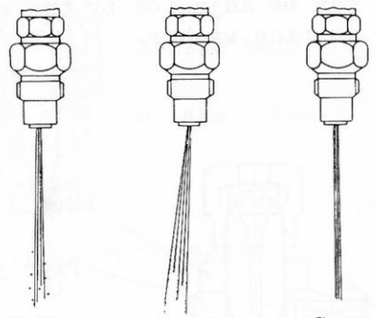



Fig. 9-94

2) Check the injection angle. The function of the nozzle is considered normal if the oil is injected at correct injection angle; if the oil is seen injected in strayed directions (see the illustration above), or if the oil comes out in thick drips (see the illustration above), this points to its malfunctioning.

3) Check and see if the oil is still dripping from the nozzle even after the injection is completed. If this is the case, the nozzle is not properly functioning.

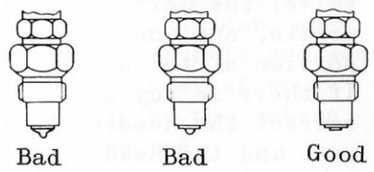



Fig. 9-95





4) Check the injecting condition at the outset. Operate the nozzle tester handle at 10 r.p.m. at the beginning of the injection and see if continuous injection is taking place. If the injection fails to continue smoothly, accompanied by slight vibrations, it often indicates that the nozzle is seized. In such case, the nozzle should be re-faced or replaced.

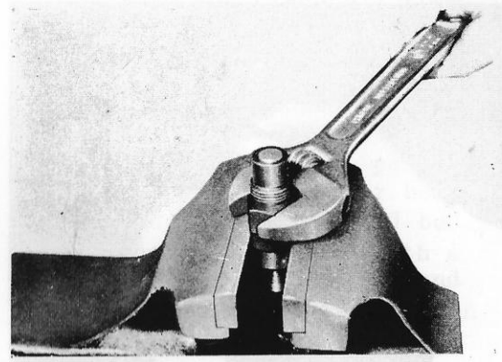


Fig. 9-96

9-7-5 Repairing and adjusting the nozzle holder assembly

(1) Repair and adjustment of the nozzle holder should be performed in the following manner.

1) Hold the nozzle body in the vise with the nozzle face up.

2) Loosen the nozzle nut with a wrench (27mm), and remove it by raising the nozzle nut slightly, so as not to let the nozzle nut fall. Care should be taken not to let drop the needle valve for the nozzle.

3) Dismount the distance piece.

4) Release the nozzle holder from the vise and then remove the push rod the nozzle spring, and the adjusting washer.

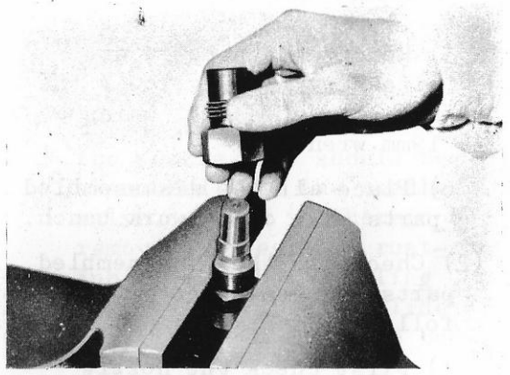


Fig. 9-97

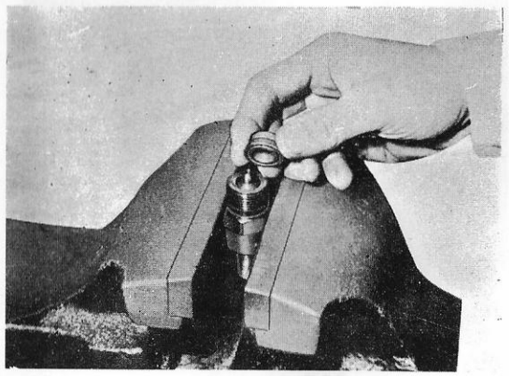


Fig. 9-98

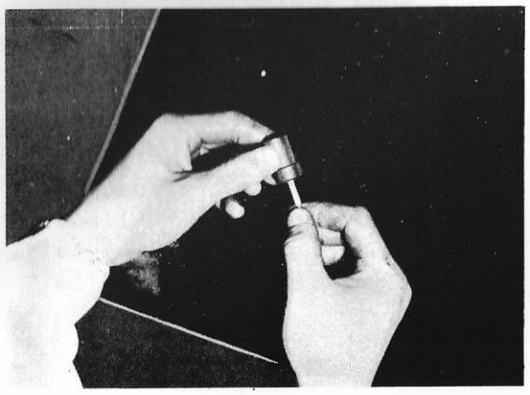


Fig. 9-99

5) Remove the pipe joint nipple by turning loose the nut, if necessary, using a 19mm wrench.

6) Place all the disassembled parts on a clean work bench.

(2) Check all the disassembled parts in accordance with the following instructions.

1) First check the nozzle for seizure or sticking.

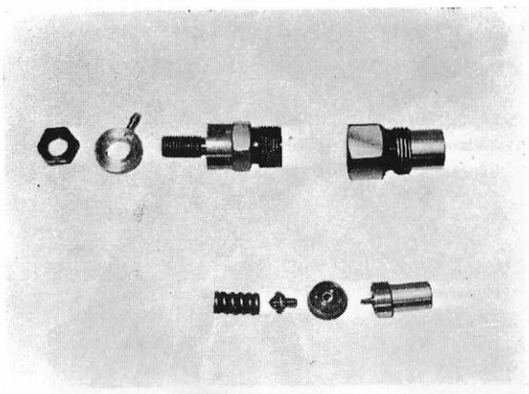


Fig. 9-100

Place the nozzle in a clean kerosene, separate the needle valve from the nozzle body, and wash them, so as to let the needle valve move lightly inside the nozzle body.

Furthermore, should the oil be leaking from the nozzle seat, correct the seat by re-facing and let it slide lightly.

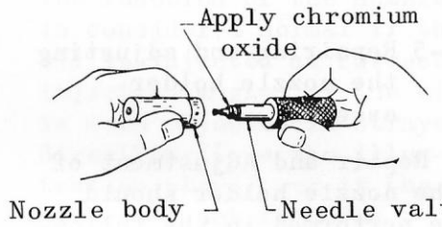



Fig. 9-101

Knead chromium oxide with vegetable oil and apply a small amount of this compound to the tip end of the needle valve. If a large amount of this compound is applied to the needle valve, any excess is allowed to go in between the needle valve port and the nozzle body, which would result in mechanical wear.

A similar problem will arise if the compound is not washed away completely from the parts it has been applied to. Therefore, do this washing carefully.





2) Inspect the tip end of the nozzle body and replace the nozzle assembly if it is seized or damaged.

3) Inspect the tip end of the needle valve and replace it if the square section of the nozzle assembly (see Fig. 9-102) is badly deformed or damaged.

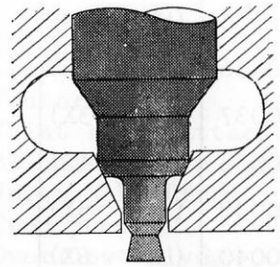


Fig. 9-102

4) Inspect the contact surfaces of the upper and lower portions of the nozzle holder distance piece and see if they come in close contact with each other.

5) Inspect the push rod.

Check and see if the portion touching the nozzle needle valve of the push rod is worn. Also, check the spring seat for any crack.

6) Inspect the screws on all pertinent component part and correct or replace them if found defective.

7) Wash and clean all component parts.

Do not forget to clean all the oil holes of the nozzle as well. Clean carefully the fuel passage of the nozzle holder body. The nozzle nut should be washed and cleaned with a stick covered with a sand paper to get rid of carbon deposit in the inner wall of the nut.

(3) Installing the new nozzle.

When replacing defective nozzle, the following should carefully be observed.

First, warm the kerosene to 50° to 60°C, in which the nozzle body should be assembled with the needle valve. Slide it therein to remove the residual rust-inhibitor, thus enabling the needle valve to slide freely with the nozzle body.

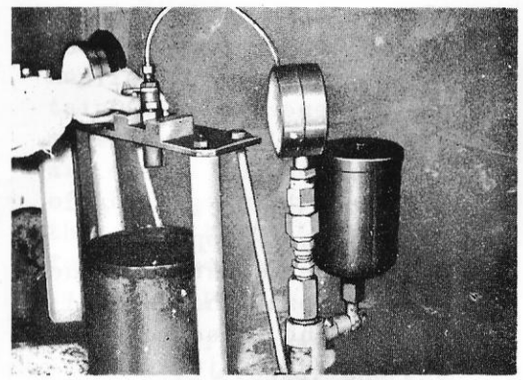


Fig. 9-103

(4) Reassembling and adjusting the nozzle holder assembly.

This should be done with the following in mind. The previously described disassembling procedure should be followed in an inverse order. In the course of this reassembling all the pertinent parts should be kept clean.

Do not let the needle valve drop on the floor.

(5) Adjusting the feed pump after assembly.

1) When the nozzle holder assembly has been assembled, mount this nozzle holder assembly on the nozzle tester.

2) Check the initial injection pressure of the nozzle. Move the tester handle rather quickly and increase the injection pressure as much as to 100 kg/cm$^2$. Then, operate the handle about at 10 r.p.m. and check the initial injection pressure. In the case of C180 type diesel engine, the injection pressure of the injection nozzle is 120 kg/cm$^2$.

3) If the injection pressure is not proper, replace the adjusting washer in the nozzle holder and adjust the injection pressure. This adjusting washer comes in sizes ranging from 1.0mm to 1.95mm at every other 0.05mm difference. If thickness of the washer is increased by 0.05mm, the injection pressure will accordingly increase by 5-7 kg/cm$^2$.

| Parts number | | Thickness mm |
|---|---|---|
| 8997-0035 | (WMS1G1X) | 1.0 |
| 8997-0036 | ( " 2X) | 1.05 |
| 8997-0037 | ( " 3X) | 1.10 |
| 8997-0038 | ( " 4X) | 1.15 |
| 8997-0039 | ( " 5X) | 1.20 |
| 8997-0040 | ( " 6X) | 1.25 |
| 8997-0041 | ( " 7X) | 1.30 |
| 8997-0042 | ( " 8X) | 1.35 |
| 8997-0043 | ( " 9X) | 1.40 |
| 8998-0044 | ( " 10X) | 1.45 |
| 8997-0045 | ( " 11X) | 1.50 |
| 8997-0046 | ( " 12X) | 1.55 |
| 8997-0047 | ( " 13X) | 1.60 |
| 8997-0048 | ( " 14X) | 1.65 |
| 8997-0049 | ( " 15X) | 1.70 |
| 8997-0050 | ( " 16X) | 1.75 |
| 8997-0051 | ( " 17X) | 1.80 |
| 8997-0052 | ( " 18X) | 1.85 |
| 8997-0053 | ( " 19X) | 1.90 |
| 8997-0054 | ( " 20X) | 1.95 |





## 9-8 FUEL FILTER

9-8-1 Function fuel filter

(1) - Element
(2) - Upper cover
(3) - Body
(4) - Lower cover
(5) - Center pipe
(6) - Joint bolt (attached to injection pump)
(7) - Joint bolt (from feed pump)
(8) - Overflow valve
(9) - Drain plug
(10) - Plug
(11) - Strainer
(12) - Coil spring

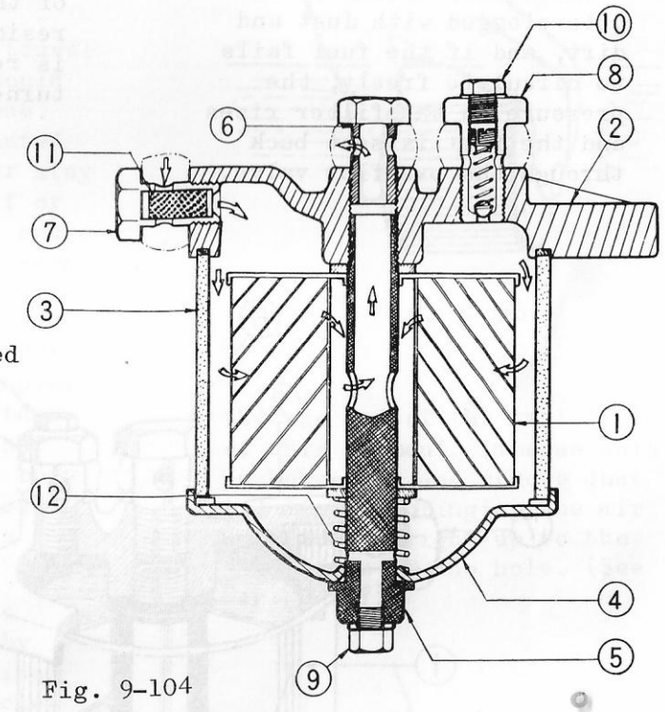



Fig. 9-104

(1) The fuel filter is mounted on the upper right hand corner of the engine, and serves to filtrate the fuel supplied to the injection pump from the feed pump. Fig. 9-104 illustrates a cut-away view of the fuel filter. The fuel fed from the feed pump is removed of course dust, dirt, and other foreign particles by passing through a strainer (11) housed in the joint bolt (7), and then goes into the interior of the body (3) Any fine dust and dirt contained in this fuel is removed by the element (1) and are sent from the inner hole of the center pipe (5) to the joint bolt (6), thus feeding the fuel into the injection pump.

The overflow valve is normally held closed, but when the oil feeding pressure of the feed pump rises to an

alarming extent, the ball on the overflow valve is forced to open, thereby permitting the fuel to flow back directly into the fuel tank.

Therefore, if the element gets clogged with dust and dirt, and if the fuel fails to circulate freely, the pressure in the filter rises and the fuel is sent back through the overflow valve.

As a result, the fuel supplied to the injection pump run extremely low.

A plug (10) for air bleeding is located on the head of the overlow valve, and residual air in the filter is released when the plug is turned loose.

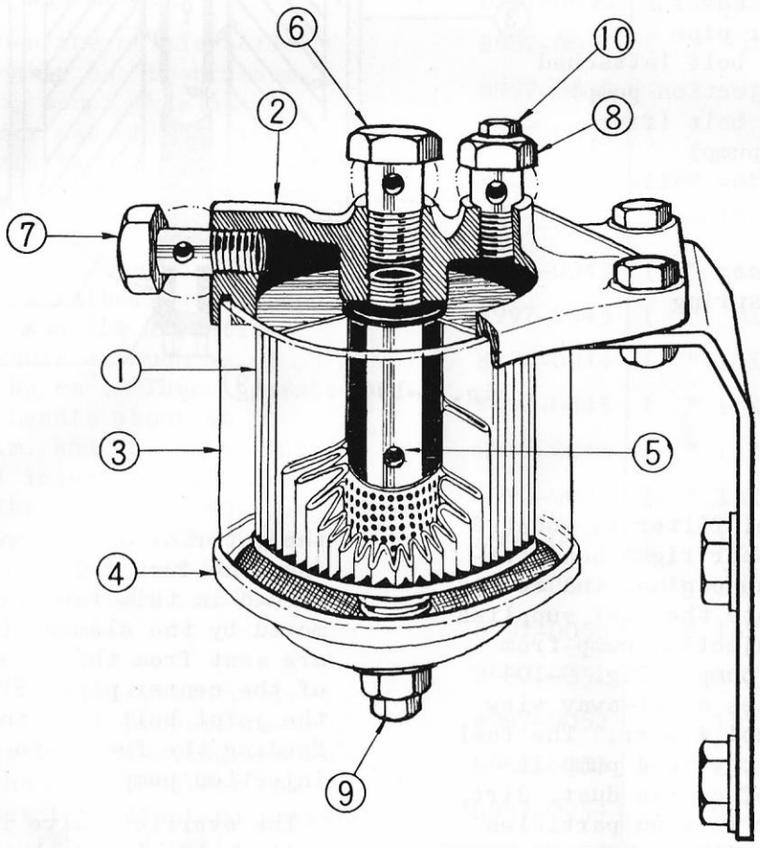



Fig. 9-105





9-8-2 Handling the fuel filter

At every 3,000 km of travel intervals this fuel filter drains the fuel, remove dust and dirt, and clean the fuel filter element.

At every 18,000 km of travel intervals this filter should be replaced with a new one. The dust and dirt eliminated by the element may either stay put on the element itself or accumulates on the inner section of the lower cover. When the drain plug is removed, the dust and dirt can be removed together with the fuel from filter. In replacing or cleaning the element, detach the center pipe (5) so that the lower cover (4), the body (3) and the element (1) can be removed together. (See Fig. 9-104)

Water is a taboo to the diesel engine. Should, by accident, water be contained in kerosene, the filter element, which sucks this contaminated oil, may expand or be deformed.

Should this so happen, it is imperative that the element be replaced regardless of any small mileage a car covered. And should the fuel contain water, replace this fuel. To clean the element, hold the holes on the both ends with your fingers so as not to let the kerosene go in directly, and rinse the the element in kerosene. (See Fig. 9-106) Then hold

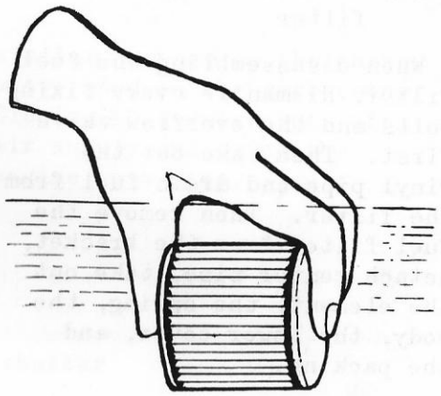


Fig. 9-106

the one end of the small hole of this element, immerse this in kerosene, and remove dust and dirt by bringing the air hose nozzle right up to the inner face of the hole. (See Fig. 9-107)

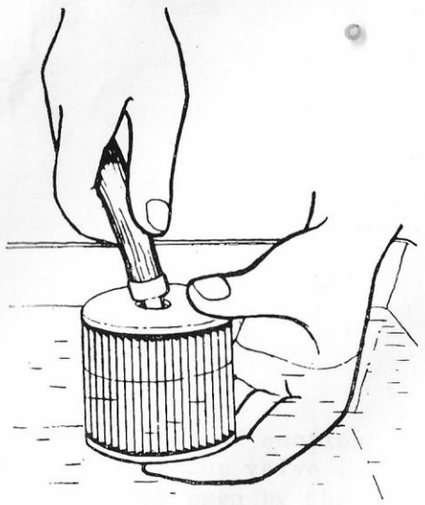


Fig. 9-107

9-8-3 Disassembling the fuel filter

When disassembling the fuel filter, dismantle every fixing bolts and the overflow valve first. Then take out the vinyl pipe and drain fuel from the filter. Then remove the fuel filter from the bracket, detach center pipe, take out the element, the spring, the body, the lower cover, and the packing.

Check carefully the overflow valve for wear of its ball or ball sheet, and also for its weakened spring. If any of these are found defective, replace them with a complete set of overflow valve assembly. As the strainer is housed in the joint bolt to receive fuel from the feed pump, wash and clean carefully the joint bolt in a bucket filled with kerosene, and remove all dust and dirt deposits. Also wash the body and the covers. Reassembly of the filter should be carried out in the reverse order of disassembling.

In this operation, care should be exercised not to let the packing, and the like slip out of position.





## 9-9 INTAKE SHUTTER

"Isuzu's" every small diesel engine is equipped with the intake shutter. The intake shutter has on the lower portion of the throttle valve a special valve that serves the similar purpose as the choke valve used in the carburetor. Closing this valve cuts off air supply and bring the engine to a stop.

Exploded view of intake shutter

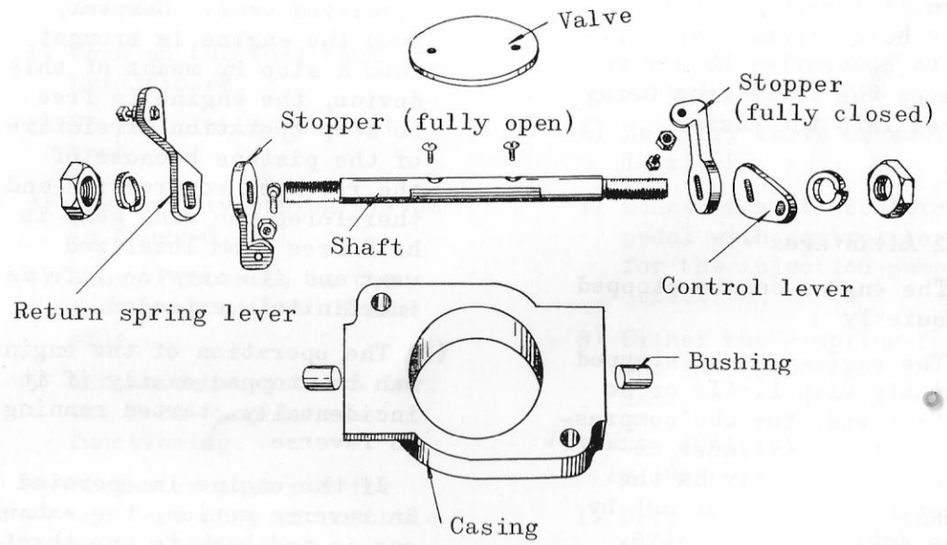



Fig. 9-108

9-9-1 Construction

As shown in Fig. 9-108, a brass valve is encased in a aluminum casing, the holes of which are large enough to avoid increase of suction resistance. The valve is usually kept open by the action of the return spring attached to the return spring

lever located on the left side of the intake shutter.

The control lever situated on the left side of the casing can be closed by operating the lever.

All the stoppers on the outer portion of the casing fuctions independently and control the "opening" and "closing" operation of the valves. When the valve is held open, the valve stays vertically so that air can be taken in freely; with the valve held closed, the valve can be controlled by screws to keep the valve from being forced into the casing.

9-9-2 Advantages

(1) The engine can be stopped quietly

The engine can be stopped quietly with little or no vibrations, for the compression in the cylinder decreases gradually as the suction air is shut out by the action of the valve.

This arrangement prolongs the service lives of the exhaust system as well as the engine support (the mounting rubber and the stabilizer).

(2) Wear of the flywheel ring gear is held to a minimum.

When the engine is brought into a stop in an ordinary manner by cutting of the fuel supply, the engine is normally held to a stop with one of the pistons brought into a position close to B.T.D.C. or A.T.D.C. in the compression stroke because of the resistance provided by the compression in the cylinder, and hence, the portion of the flywheel ring gear which comes into contact with the starter pinion for each engine starting is held unchanged thereby subjecting the ring gear to localized wear. However, when the engine is brought into a stop by means of this device, the engine is free to stop operation irrelative of the pistons because of the released compression and therefore, the ring gear is held free from localized wear and its service life is indefinitely extended.

(3) The operation of the engine can be stopped easily if it incidentally started running in reverse.

If the engine is operated in reverse motion, the exhaust gas is fed back to the throttle valve side. The exhaust gas is held from flowing into the throttle valve by shutting out the transfer port by means of the shutter valve. As the shutter valve is pivoted in the mid center of the valve, the strength of the exhaust gas is off-setted by the moment acting on the shutter valve shaft thereby permitting the shutter valve to close with considerably small force when the strength of the exhaust gas overcomes the tension of the return spring. As the intake shutter is arranged in the portion lower than the level of the throttle valve, the air cleaner element and the diaphragm of the fuel injection pump are held intact of the hazard of the exhaust gas.





## 9-10 FAILURE AND CAUSES OF FUEL SYSTEM

9-10-1 Engine does not start

(1) Fuel pump is not feeding the fuel

1) Cock on the fuel tank is held closed.

2) No fuel is in the fuel tank.

3) Fuel supply piping system is clogged.

4) Gause filter is in the feed pump on the intake side.

5) Intake exhaust valve for the feed pump is not functioning.

6) Piston or push rod for the feed pump is unstable while functioning.

(2) Feed pump is feeding the fuel but the injection pump is not injecting its fuel

1) Filter element for the filter is clogged.

2) Over-flow valve for the filter is held open.

3) Air is present in the filter or the injection filter.

4) Plunger for the injection pump is stuck.

5) Delivery valve assembly is out of position.

6) Delivery valve assembly is stuck.

7) Connection of accelerator pedal with control lever for the injection pump is defective.

8) Either the coupling for the injection pump is damaged, or key is broken.

(3) When fuel injection timing is inaccurate

1) Defective coupling connection.

2) Position of timer lever is out of position.

3) Connection of the injection pump and the engine is defective.

4) Tappet for the injection pump is not properly adjusted.

5) Tappet roller is overly worn.

6) Cam of the camshaft is excessively worn.

7) Plunger is worn badly

(4) When the nozzle does not function.

1) Nozzle needle valve is tightly clamped or constricted.

2) Nozzle valve is out of position.

3) Injection pressure is too low.

4) Edge filter for the nozzle holder is clogged.

5) Air is present in the injection pipe.

6) Excessive oil is leading from a clearance between the nozzle and needle valve.

7) Nozzle and nozzle holder are not properly clamped.

9-10-2 Engine starts but stops soon

(1) Either the pipe through to the injection pump is clogged or filter too dirty.

(2) Air is present in the injection pump.

(3) Air or water is in the fuel.

(4) Pipe linking the fuel tank with the feed pump is damaged, or the joint portion is sucking much air.

(5) Amount of oil in the feed pump is insufficient.

(6) Ventilation device for the fuel tank is clogged.

9-10-3 Engine output is inadequate

(1) Injection volume is extremely small

1) Stopper screw of the limit sleeve for the injection pump is screwed in too tightly.

2) Plunger is worn.

3) Injected amount of the injection pump is not normal.

4) Oil is leaking from the delivery valve as it is not tightly fixed.

5) Delivery valve is out of position.

6) Delivery valve spring is broken.

7) Excessive oil is leading from the nozzle.

(2) Nozzle spring for the nozzle holder is broken.

(3) Engine causes knocking due to excessive injection of the fuel.

(4) Engine overheating due to slow fuel injection or smoke rising from the exhaust.

(5) Defective injection bility of the nozzle.





(6) Injection holes of the nozzle is clogged.

9-10-4 Engine causes knocking

(1) Premature oil injection.

(2) Injection pressure of nozzle is too high.

(3) Injection of nozzle is bad.

9-10-5 Smoke developing from the exhaust for the engine and engine causes knocking

(1) Untimely fuel injection.

(2) Injection pressure of nozzle is too low.

(3) Nozzle spring broken.

(4) Poor injecting operation of nozzle.

(5) Plunger is worn.

(6) Displaced islivery valve.

(7) Untimely injection due to excessive fuel supply.

9-10-6 Unstabilized engine output

(1) Filter is broken and fuel supply is too little.

(2) Feeding oil of feed pump is too little.

(3) Air is present in injection pump.

(4) Water contained in fuel.

(5) Occasional failure of plunger function as plunger is tightly clamped.

(6) Plunger spring is broken.

(5) Occasional failure of plunger function as plunger is tightly clamped.

(6) Plunger spring is broken.

(7) Unsmooth control rack function.

(8) Defective tappet function or abnormal wear thereof.

(9) Broken delivery valve spring.

(10) Defective delivery valve assembly.

(11) Defective injecting function of nozzle.

(12) Unsmooth action of nozzle needle valve.

(13) Injection pressure of nozzle varies from pipe to pipe.

(14) Broken nozzle spring.

(15) Initial injection pressure varies from pipe to pipe.

(16) Excessive clearance between parts in timer.

(17) Excessive clearance between every connecting portions of operating rod for timer's adjusting lever.

(18) Mulaligned injection timing.

9-10-7 Maximum engine speed is not available

(1) Pneumatic governor main spring is too weak

(2) Defective nozzle function

9-10-8 Maximum engine speed is excessively high

(1) The control rack fails to return to position in which the amount of fuel delivery decreases.

(2) Too strong pneumatic governor main spring

9-10-9 Unstabilized engine idling

(1) Unsmooth function of injection pump control rack

1) Constricted or restricted movement of the plunger.

2) Improperly engaged rack and pinion

(2) Constricted governor ring

(3) Excessive play in the governor.