

15. ADJUSTMENT

Once the pump has been properly assembled, the pump will need to be installed on a test stand, for the purpose of adjusting to the specified values. The engine's operation and performance can be directly related to adjustment of the fuel injection pump.

General Adjustment steps:

- (1) Preparation and prechecks
- (2) Warm-up
- (3) Full load fuel preadjustment
- (4) Pump internal pressure
- (5) Checking overflow quantity
- (6) Timer
- (7) Adjustment of fuel delivery
- (8) Load sensing timer
- (9) Setting of adjusting lever at low speed
- (10) Adjustment of boost compensator
- (11) Throttle position sensor
(Rotary position sensor)
- (12) A.C.S.D.
- (13) D.A.C.
- (14) Final checks

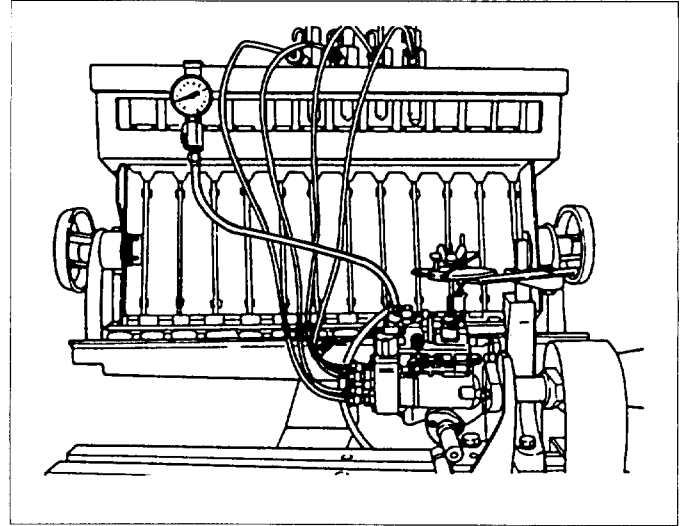


Fig.15-1 Mounting the pump the test stand

15-1. PREPARATION AND PRECHECKS

- (1) Test nozzles must be the correct type, set the specific opening pressure.

NOTE:

1. Check and set opening pressure every 20 hours of use.
2. Test nozzles must be flow matched on a regular basis. (Every 20 hours of use.)
- (2) Install the pump on the proper pump mounting bracket for the test stand. (See Fig.15-2)
- (3) Position the adjusting lever protractor mounting stand. (See Fig.15-2)
- (4) Mount the drive coupling, with woodruff key, washer, and round nut, to the pump and connect to the test stand drive. (See Fig.15-2)

NOTE:

Rotate the pump by hand to ensure smooth rotational operation.

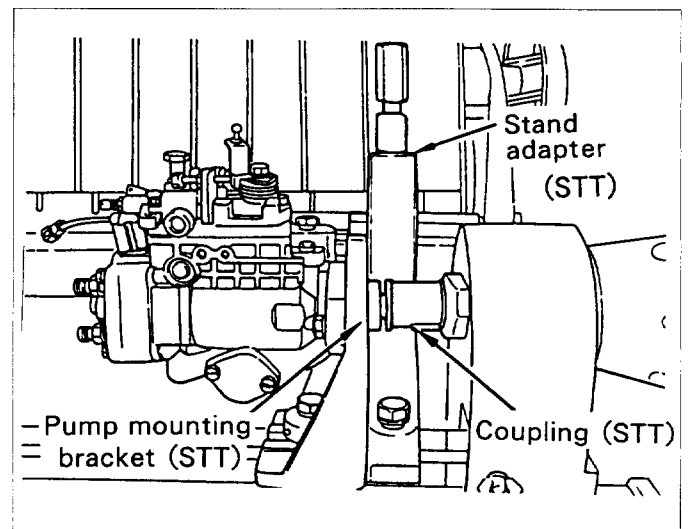


Fig.15-2 Mounting the pump on the test stand

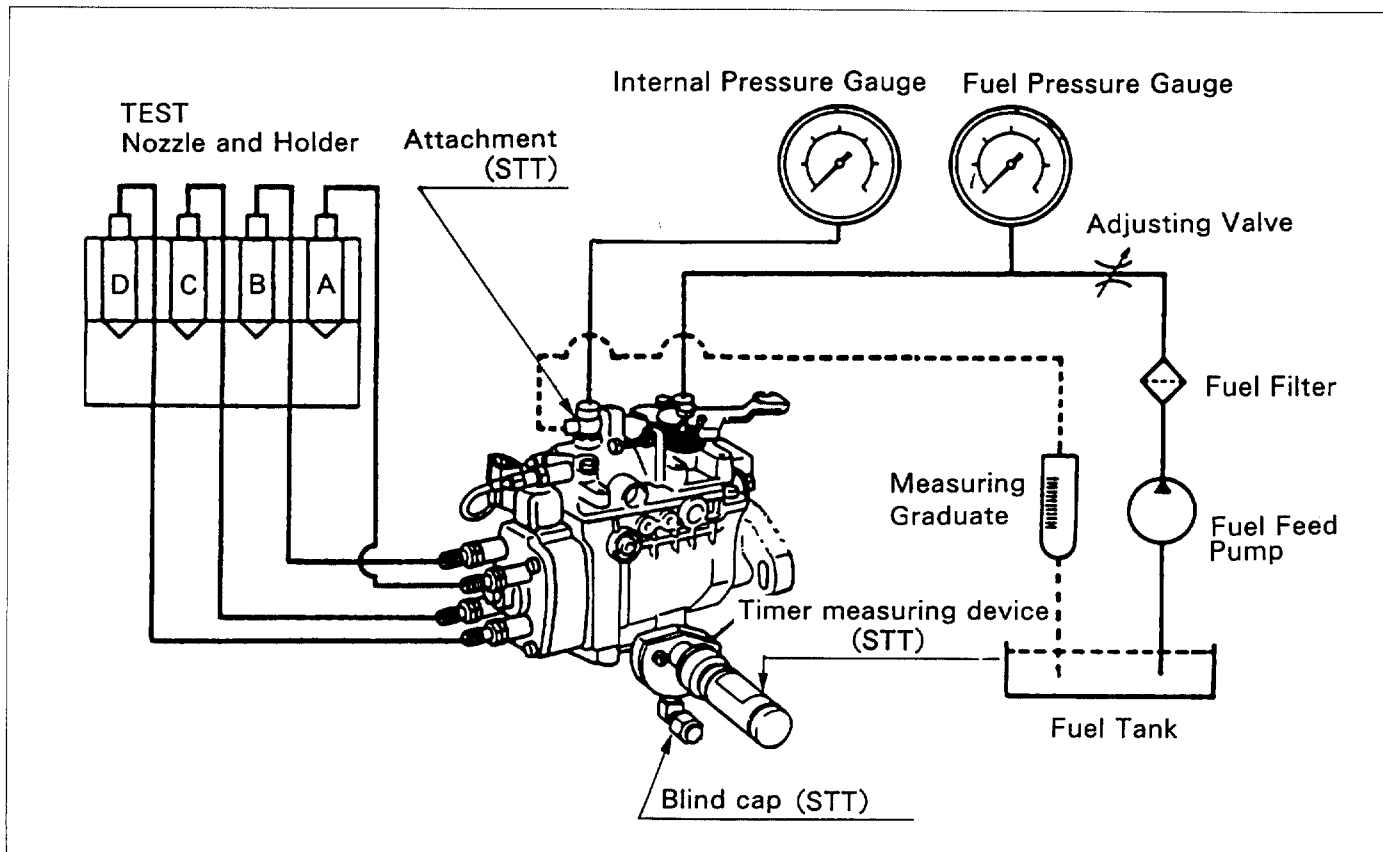


Fig.15-3 VE pump test hook-up

(5) Connect the fuel supply line to the fuel inlet of the pump. (See Fig.15-4)

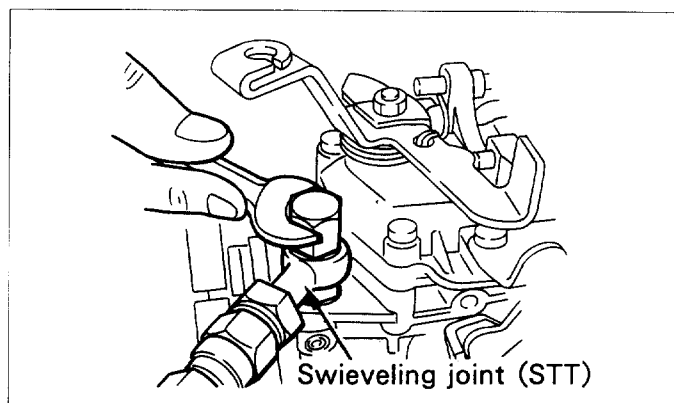


Fig.15-4 Connecting the fuel inlet hose

(6) Connect the internal pressure measurement attachment to the pump fuel return outlet, and then connect the overflow line of the test stand.

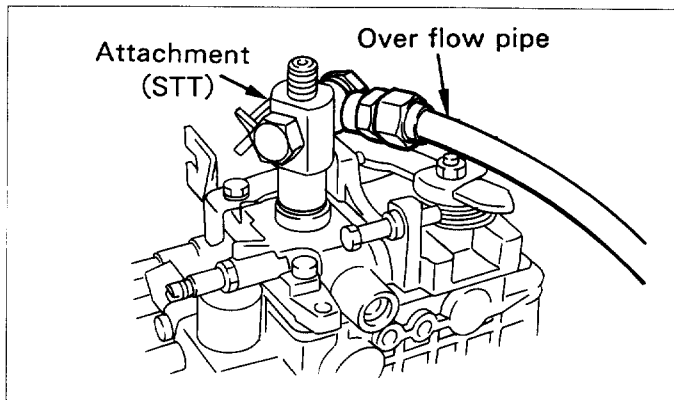


Fig.15-5 Installing the overflow line

NOTE:

1. The banjo bolt marked "OUT" is to be used for the overflow during adjusting and must stay with the pump after adjustment is complete. (See Fig.15-6)
2. The fuel inlet banjo bolt will be hollow with appropriate size openings to allow fuel to enter the pump. (See Fig.15-6)
3. If the attachment is used, be sure to attach the blind cap to the timer measuring device.

(7) Connect the high pressure test lines. (See Fig.15-7)

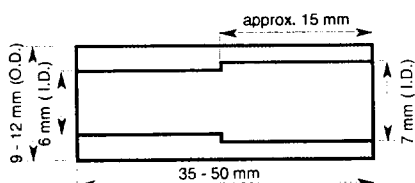
NOTE:

The proper test line dimension is $\phi 2.0 \times \phi 6.0 \times 840\text{mm}$. (Inner dia. \times outer dia. \times length)

(8) Connect the adjusting lever protractor. (See Fig.15-8)

NOTE:

The pipe shown in Fig.15-8 is required for connection of the adjusting lever. Prepare the pipe illustrated below.



(9) Connect the proper voltage to the shut-off solenoid (See Fig.15-9) and energize.

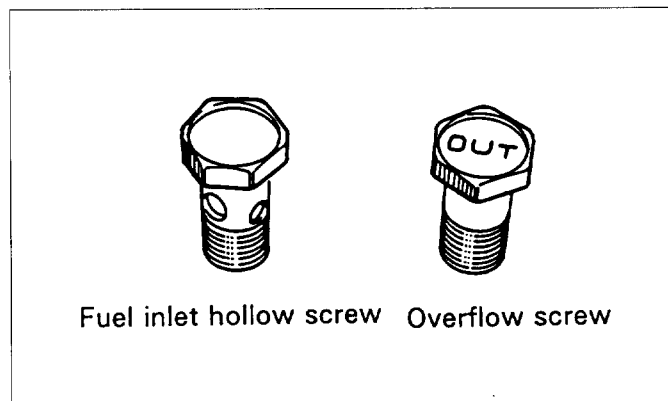


Fig.15-6 Screws

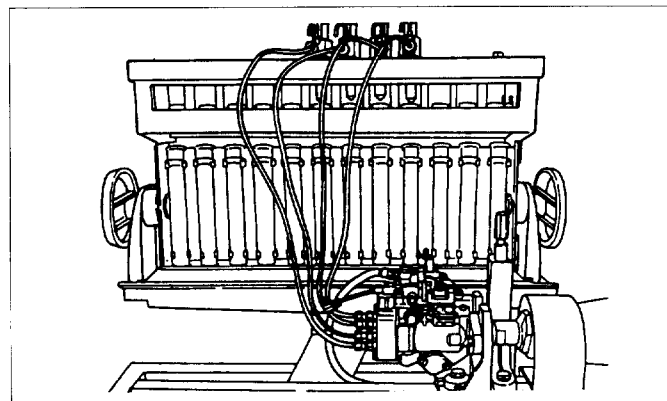


Fig.15-7 Connecting the high pressure line

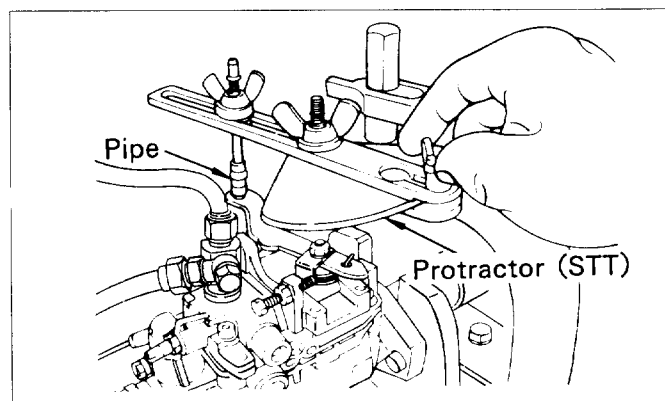


Fig.15-8 Installing the protractor

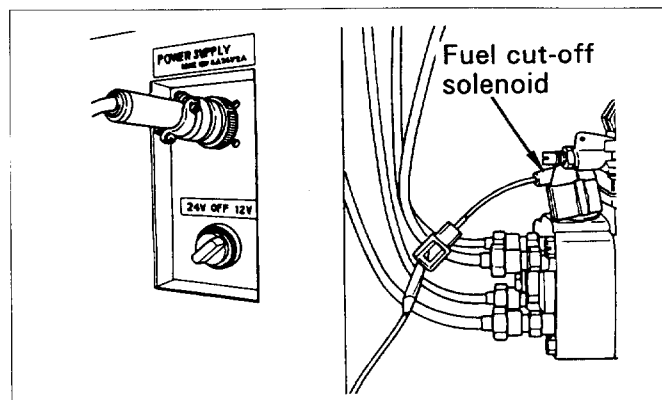


Fig.15-9 Applying prescribed voltage to the fuel-cut solenoid

15-2. WARM-UP

- (1) Set the test oil temperature to 40—45°C.
- (2) Set the test stand fuel feed pressure to 0.2kg/cm².
- (3) Turn the pump at approximately 300rpm, test stand speed, until all air has been expelled through the overflow line.
- (4) Set the adjusting lever to full load position and lock in place with the protractor. Slowly increase the test stand speed to 2000rpm and ensure injection is taking place.
- (5) Continue to run to five minutes at 2000rpm and check for leaks.

NOTE:

1. If leaks, no injection, or abnormal noise are present, stop the test stand immediately and correct the problem.
2. To check for correct camplate position, remove the delivery valve from outlet "C", with feed pressure on, and the driveshaft rotated to a position where the keyway aligns with the mounting flange slot on the left side (viewed from the drive end) fuel will flow from the outlet. No fuel flow from outlet "C" means the camplate is installed 180 degrees out of time. (See Fig.15-10)

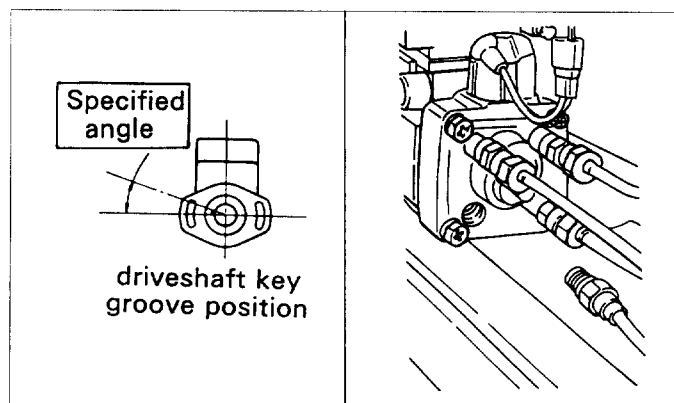


Fig.15-10 Confirming the correct camplate installation

15-3. FULL LOAD FUEL PREADJUSTMENT

Example of the test specification

	Pump Speed (rpm)	Fuel Delivery (cc/200st, 1cyl)	Remarks
Full Load	1200	12.20-13.00	By full load setting screw
High Speed	2250	4.30-6.70	By max. speed setting screw

Load Sensing Timer: Adjust the governor shaft so that the dimension "L" between the housing flange and the end of the governor shaft is about 2.5mm.

- (1) Pre-adjustment for fuel delivery quantity at full load

Adjust the full load adjusting screw to obtain the specified fuel delivery at the specified pump speed. (See Fig. 15-11)

NOTE:

One half turn is equal to approximately 2.4cc /200 strokes per cycle.

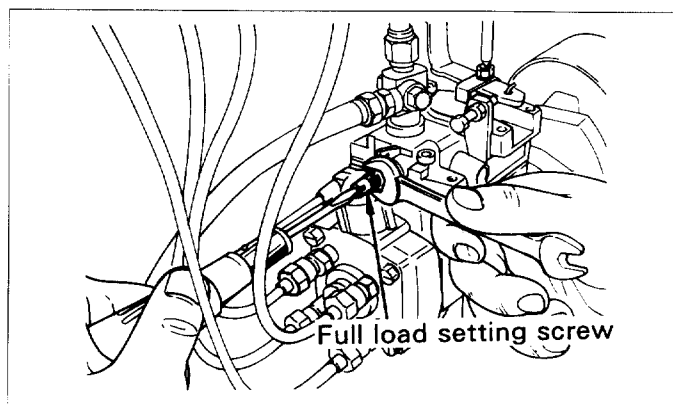


Fig.15-11 Fixing the adjusting lever at full load position

(2) Lever pre-setting of high speed range
Adjust the maximum speed lever position to obtain the specified fuel delivery at the specified pump speed. (See Fig.15-12)

NOTE:

Backing the screw out increases the amount of fuel at a given pump speed. Turning the screw in reduces the amount of fuel at a given pump speed.

(3) Initial setting of the load sensing timer
Check whether dimension "L" (distance from the governor shaft's end to the pump housing's end) matches the one given in the test specifications.

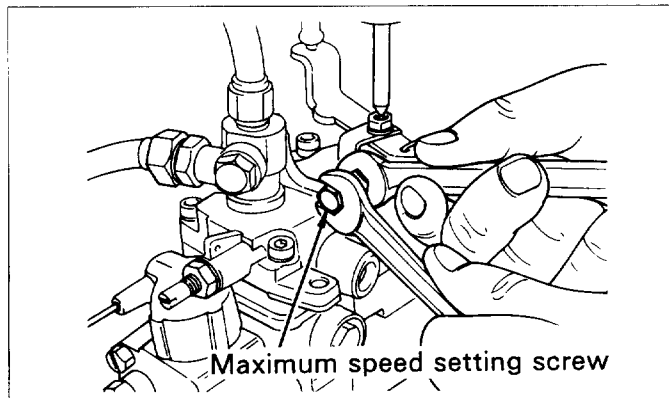


Fig.15-12 High-speed lever setting

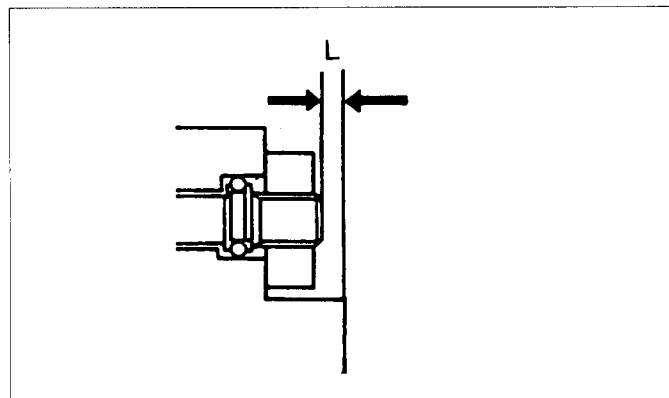


Fig.15-13 Initial setting of load sensing timer

15-4. PUMP INTERNAL PRESSURE

Example of the test specification

Pump Speed (rpm)	Internal Pressure (kgf/cm ²)	Remarks
500	2.5-3.1	By the regulating valve
1800	6.6-7.2	

(1) Set the pump speed according to the test specifications, and then measure pump's internal pressure. During measurement, make sure that the adjusting lever is positioned to the FULL side.

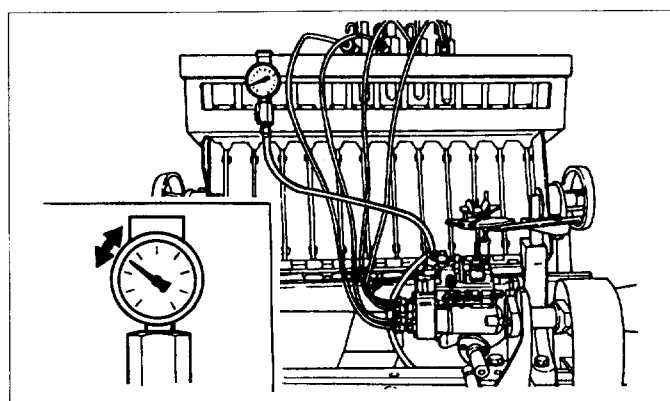


Fig.15-14 Measurement of pump internal pressure

(2) If the internal pressure is below the specified level, attach the adjust regulating valve (STT) to the regulating valve, turn the bolt to push in the regulating valve so that the internal pressure is set to the specified level. (See Fig.15-15)

NOTE:

Do not tighten the bolt of regulating valve adjust's body.

(3) If the internal pressure is beyond the specified level, replace the regulating valve.

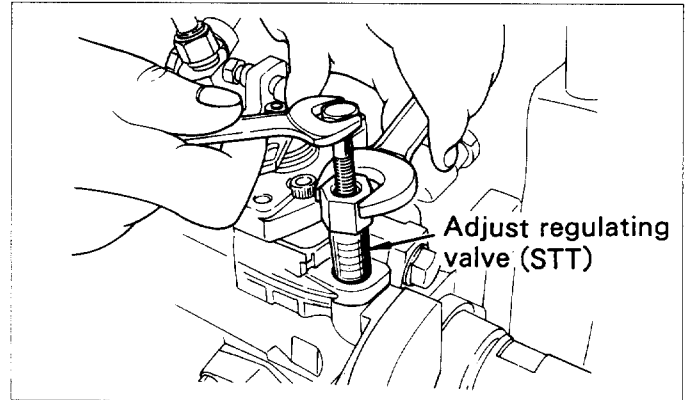


Fig.15-15 Adjustment of regulating valve

15-5. CHECKING OVERFLOW QUANTITY

Example on the test specification

Run the pump at the specified speed and measure the quantity of overflow fuel coming out of the return

Pump Speed (rpm)	Overflow Quantity (cc/1000st)	Remarks
2000	183.0-400.0	The overflow valve belonging to the pump should be used for checking.

(use a graduate of at least a 500cc capacity). The overflow should be measured for the duration of time specified on the test specification. Adjusting lever should be at full position.

NOTE:

Use the overflow fitting (return banjo marked "OUT") provided with the pump. When the pump has been checked and adjusted with a overflow screw, that screw should remain with the pump. (See Fig.15-16)

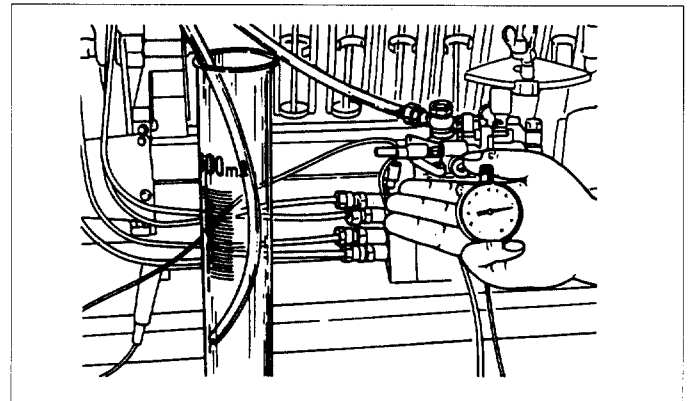


Fig.15-16 Overflow quantity check

15-6. TIMER

Example of the test specification

(1) With the timer stroke gauge mounted, set the

Pump Speed (rpm)	800	1200	1440	1800
Piston Travel (mm)	0.52-1.52	1.95-2.95	2.78-3.78	4.13-5.13

gauge to "zero". (See Fig.15-17)

(2) Run the pump at the specified speeds on the test specifications. Check the piston travel at each speed, and compare it to the test data.

(3) Adjusting lever should be full position.

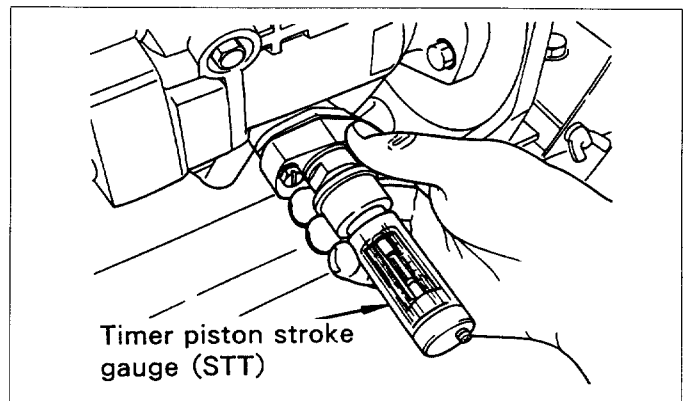


Fig.15-17 Piston travel measurement

(4) The timer piston ④① moves against the timer piston spring ④②, as the internal pressure increases as the pump speed increases. Spring tension is regulated by adjusting washers ④③ placed on both sides of the spring. Reducing the thickness of the washers will permit the piston travel to take place at a lower internal pressure, and thereby a lower pump speed. Increasing the adjusting washer ④③ thickness will have the opposite effect on the piston travel. (See Fig.15-18)

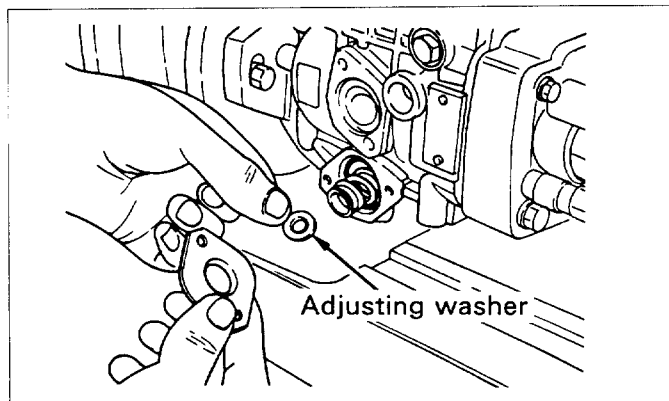


Fig.15-18 Adjustment of timer

(5) Externally adjustable timers

Use one adjusting washer as a spring seat, between the timer piston ④①.

NOTE:

When checking timer piston travel, make note of the hysteresis (bouncing or oscillating), it should be less than 0.3mm. A value greater than 0.3mm would indicate wear between the timer piston ④① and the pump housing ①.

CAUTION: Make sure that an anti-wear washer is installed at both ends of the timer spring.

15-7. ADJUSTMENT OF FUEL DELIVERY

Example of the test specification

Lever Position	Pump speed(rpm)	Fuel Delivery (cc/2000st,1cyl)	Max. Spread In Delivery (cc)	Boost Pressure (mmHg)	Remarks
FULL	1200	12.40-12.80	0.5	—	By full load setting screw
	2250	4.50-6.50	—	—	By max. speed setting screw
	1950	11.50-13.90	—	—	Check
	2500	Less than 2.00	—	—	Check
	100	10.00-14.00	1.2	—	By governor sleeve plug
	500	10.45-11.55	0.6	—	Check
	1800	12.00-13.60	0.6	—	Check

(1) Full load fuel is adjusted by turning the full load setting screw in, to increase the full load quantity, and out, to reduce the full load fuel quantity. (See Fig.15-19)

(2) If the variation of fuel delivery between cylinders (spread) is greater than the value shown on the test specification, the fault will be in the delivery valve ②②, the delivery valve spring ②③, delivery valve spring shim ②⑤, delivery valve gasket ②④, or possibly the delivery valve holder or snubber valve.

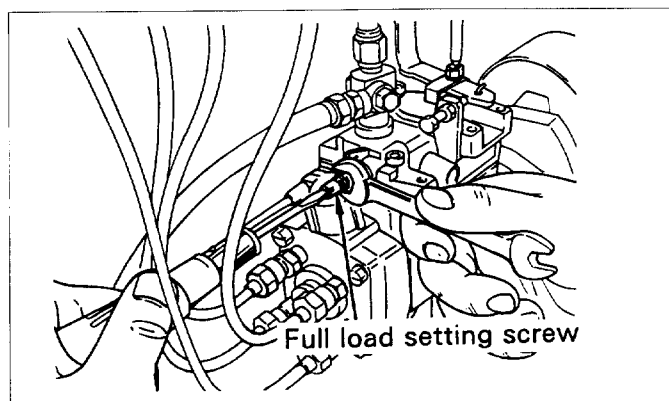


Fig.15-19 Fixing the adjusting lever at full load position

NOTE:

Be sure fuel variation is not caused by test lines or test nozzles before making any change in pump parts.

(3) High speed fuel quantities are set by making the appropriate adjustment of the high speed adjustment screw. Turning the screw in will reduce the fuel quantity, while backing out the adjusting screw will increase the high speed fuel delivery. (See Fig.15-20 and example below)

(4) Run the pump at the various speeds, as listed on the test specifications, and check the fuel delivery of the pump, as compared to the test specification.

(5) If start fuel quantity is out of the specified limit, it can be adjusted, to achieve the specific value, by changing the governor sleeve plug ⑨. An increase in the length of the plug by 0.2mm will reduce the start quantity by approximately 1.6cc/200st. Plug length (See Fig.15-21) are available in eight different lengths as following table.

L (mm)	L (mm)
4.3	5.1
4.5	5.3
4.7	5.5
4.9	5.7

NOTE:

If the maximum spread is outside the specified limit, replace the delivery valve and the delivery valve spring. Furthermore, if the check portion of fuel delivery (500rpm or 1800rpm in this example) is outside the specified limit, replace the governor lever.

15-8. LOAD SENSING TIMER

Example of the test specification

	Pump Speed (rpm)	Fuel Delivery (cc/200st, 1cyl)	Remarks
Start of Load Sensing	1440	Full-load delivery -(1.0-1.8)	By governor shaft
End of Pressure Drop	1440	More than 9.6	Check

Check Points 1. Piston Travel at End of Pressure Drop: 1.76–2.76mm (pump speed 1440rpm)
Dimension of Governor Shaft: L=0.30–2.00mm

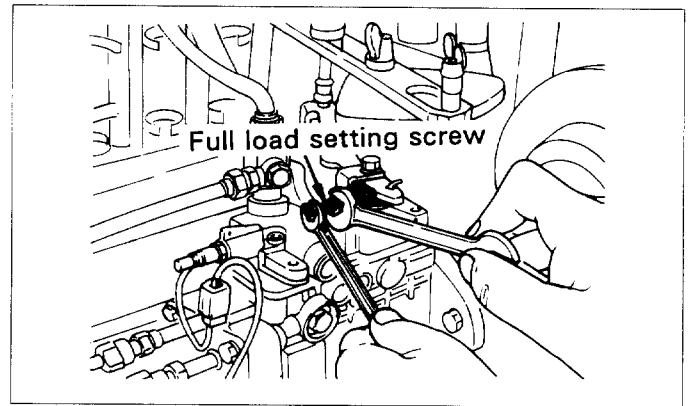


Fig.15-20 Adjustment of maximum speed setting screw

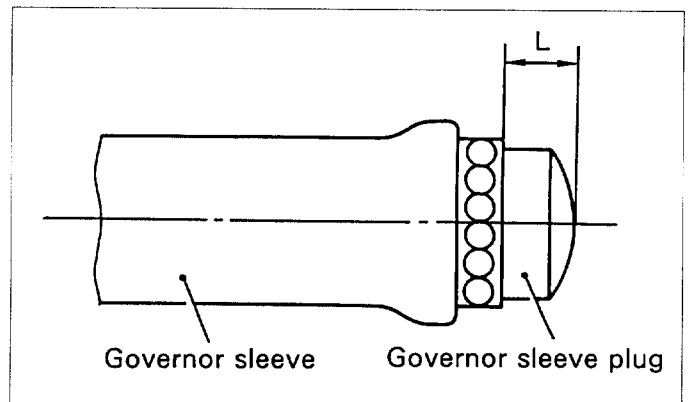


Fig.15-21 Governor sleeve plug

(1) Adjusting Start of Load Sensing

With the pump running at the specified speed, slowly move the adjusting lever from the full load position toward the idle position. Lock the adjusting lever at the position where the internal pressure starts to decrease. Adjust the governor shaft to obtain the amount of fuel delivery specified. Recheck full load fuel and start of load sensing.

NOTE:

The angle of rotational adjustment of the governor shaft is in proportion to a change of injection quantity. (See Fig.15-24)

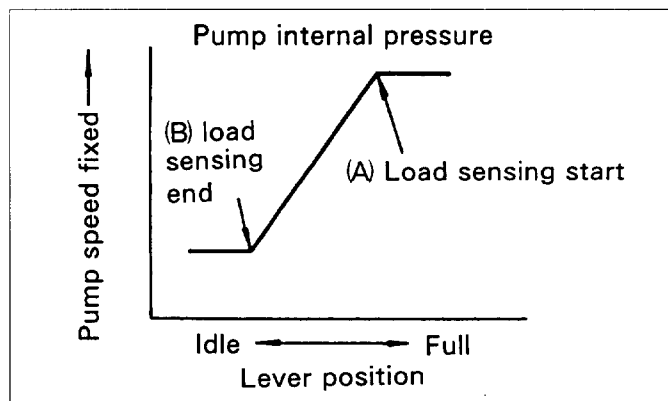


Fig.15-22 Lever position and pump internal pressure (Under constant pump revolution)

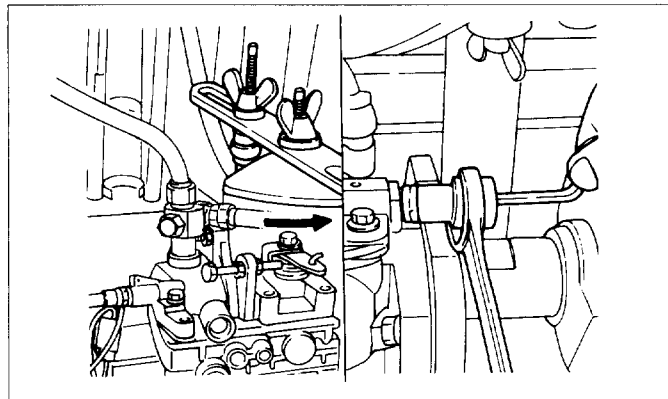


Fig.15-23 Setting load sensing start

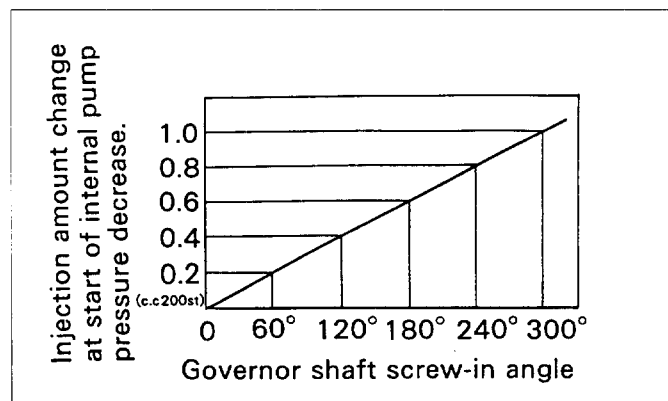


Fig.15-24 Example of governor shaft adjustment angle and fuel delivery change

(2) Adjusting The End of Pressure Drop

With the pump running at the specified speed, slowly move the adjusting lever from the idle position toward the full load position. Lock the adjusting lever at the position where the internal pressure starts to increase. (See Fig.15-25) If the adjustment is made it will be necessary to repeat (1) of 15-8.

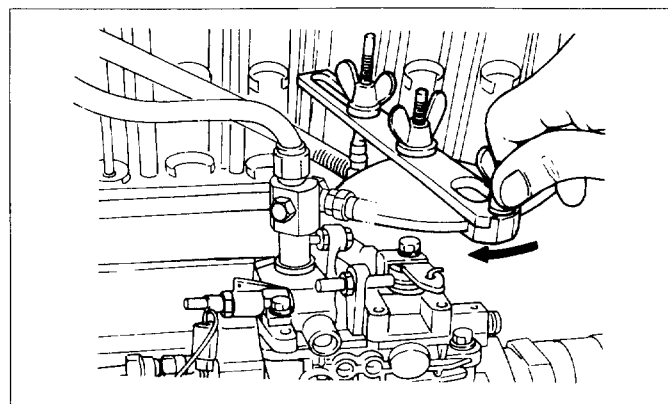


Fig.15-25 Setting load sensing end

(3) Check Timer Piston Stroke Change

Run the pump at the specified speed. Move the adjusting lever from full fuel position toward the idle position. Check the amount of change in the timer piston stroke (travel to be $1.0 \pm 0.2\text{mm}$).

(4) Governor Shaft Position Check

After completing the governor shaft adjustment, check the "L" dimension to ensure that it is within its specific value. (See Fig.15-26)

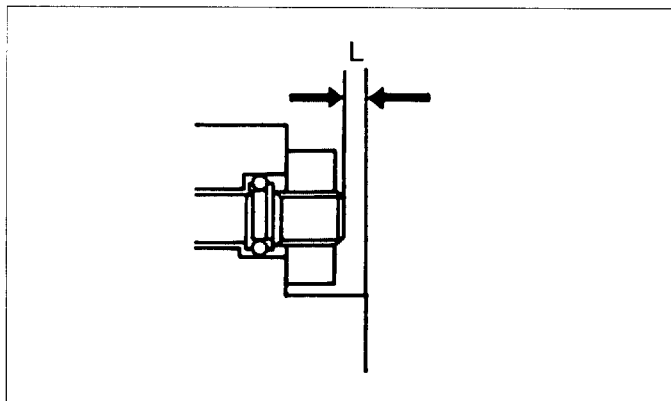


Fig.15-26 Check governor shaft position

15-9. SETTING OF ADJUSTING LEVER AT LOW SPEED

Example of the test specification

Lever Position	Pump Speed (rpm)	Fuel Delivery (cc/500st, 1cyl)	Max. Spread in Delivery (cc)	Remarks
IDLE	350 850	Q=4.13-6.38 Less than 0.50	0.85 —	By idle setting screw

15-9-1. SETTING OF ADJUSTING LEVER AT LOW SPEED

(1) With the adjusting lever free to be held against the idle adjustment screw, by the adjusting lever return spring, adjust the idle fuel delivery to the specified value by the idle adjustment screw. (See Fig.15-27)

(2) Check the angle of the adjusting lever to ensure that it is within the specified value on the test specification.

NOTE:

If specified fuel deliveries can be achieved, but adjusting lever angles can not be set, within the specified values on the test specifications, it will be necessary to replace the adjusting lever with the alternate lever.

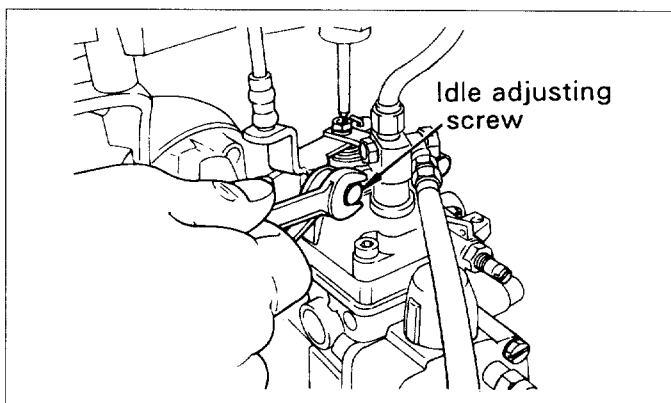


Fig.15-27 Setting idle adjusting screw

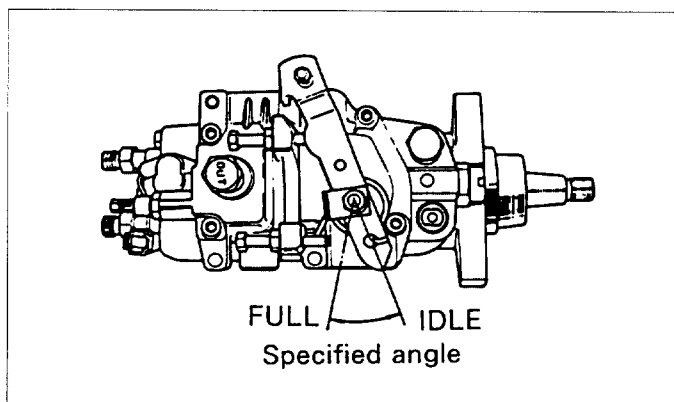


Fig.15-28

15-9-2. WITH DASH POT

Example of the test specification

Lever position	Pump Speed (rpm)	Fuel Delivery (cc/500st, 1cyl)	Max. Spread in Delivery (cc)	Remarks
IDLE	600	$q = 1.8 - 2.3$	—	Presetting
	600	$q + (0.3 - 0.8)$	—	Dash pot adjustment
	400	7.8-8.3	0.9	—
	Lever setting	1300	Less than 0.5	—

(1) Presetting

Loosen the dash pot lock nut and loosen the screw from the dash pot. During this operation, make sure that dash pot characteristic is not present. Then, adjust the lever's angle so that the fuel delivery is inside the limit given in the test specification. (See Fig.15-29)

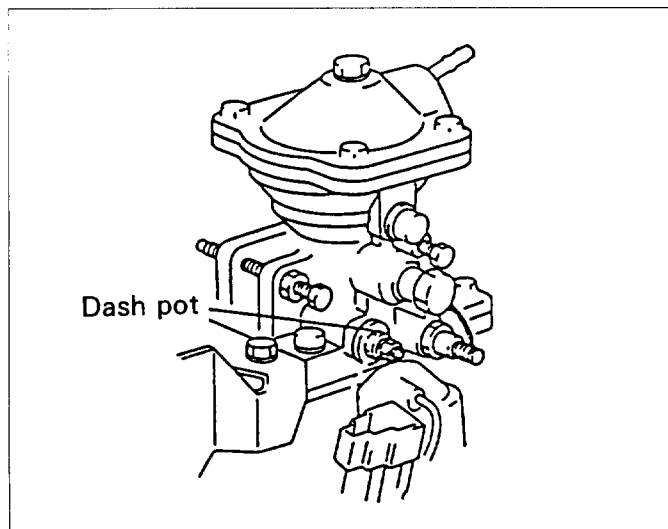


Fig.15-29

(2) Dash pot adjustment

After the lever's angle has been adjusted, tighten the screw so that the fuel delivery is inside the limit given in the test specification.

(3) Lever setting

Adjust the lever's angle again. Make sure that the fuel delivery is inside the limit given in the test specification.

(This step is necessary to ascertain idle characteristic including dash pot characteristic.)

15-10. ADJUSTMENT OF BOOST COMPENSATOR

Example of the test specification

Pump Speed (rpm)	Boost Pressure (mmHg)	Fuel Delivery (cc/1000st, 1cyl)	Remarks
1100	0	39.2-46.2	
	1100	200	
	43.6-49.6	1100	
	280	50.6-56.6	
	1100	600	

The boost compensator normally has the characteristics shown in Fig.15-30.

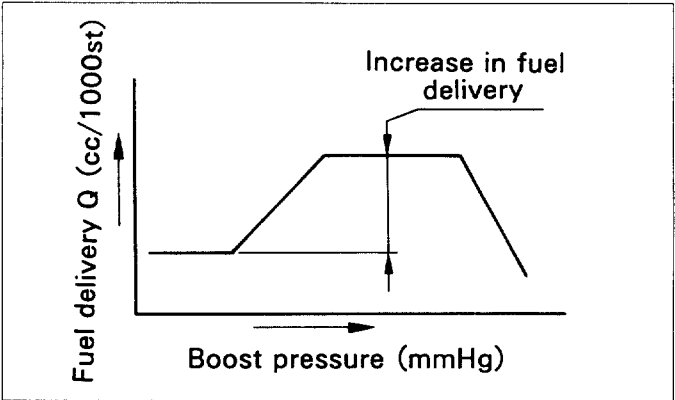


Fig.15-30 Boost compensator characteristics

(1) Adjustment using the stop screw
Tightening the stop screw changes the fuel delivery as shown by the dotted line, and loosening it changes the fuel delivery as shown by the broken line. (See Fig.15-31)

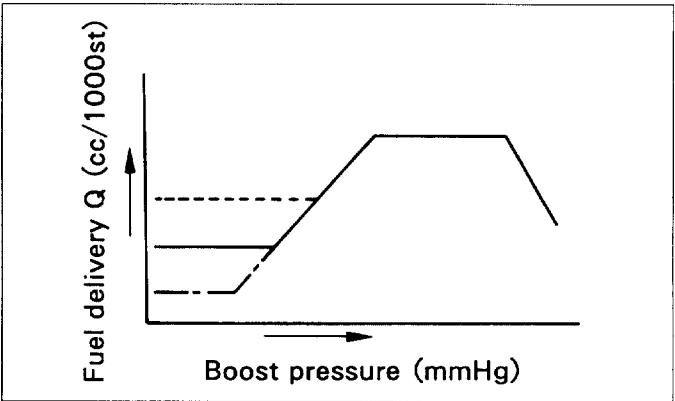


Fig.15-31 Adjustment using stop screw

(2) Carry out adjustment of the stop screw as shown in Fig.15-32.

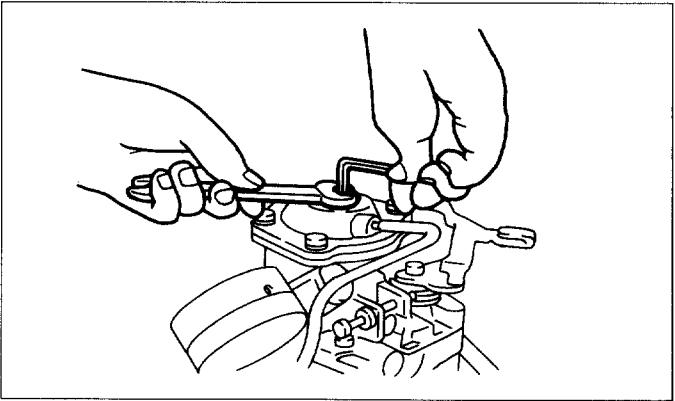


Fig.15-32 Adjusting the stop screw

(3) Adjustment using shim (located on the top of the guide bushing)

Using a thicker shim changes the fuel delivery as shown by the dotted line, and using a thinner shim changes the fuel delivery as shown by the broken line. (See Fig.15-33)

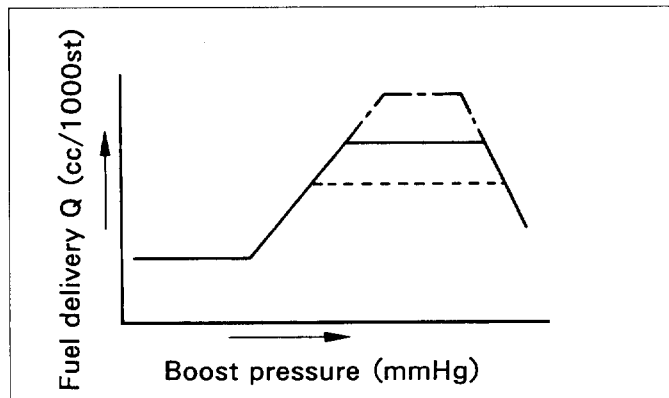


Fig.15-33 Adjustment using shim

(4) Disassemble the boost compensator cover, diaphragm and spring, and then replace the shim located on the top of the bushing as illustrated in Fig.15-34.

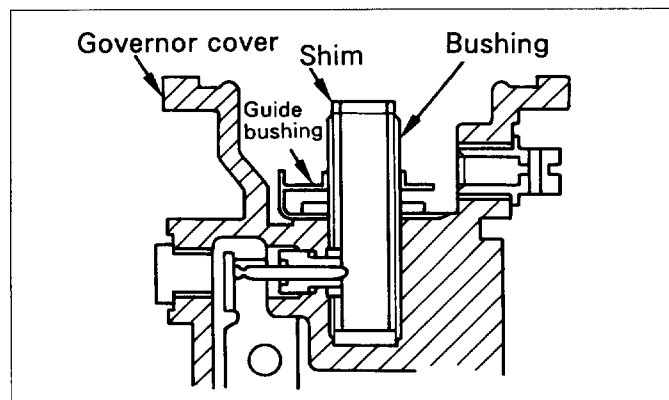


Fig.15-34 Replacing the shim

(5) Adjustment using guide bushing

Turning the guide bushing counter-clockwise (when viewed from the top) changes the fuel delivery as shown by the dotted line, and turning it clockwise changes the fuel delivery as shown by the broken line. (See Fig.15-35)

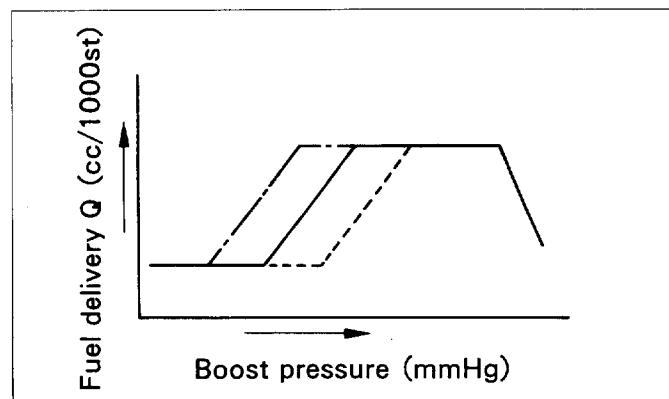


Fig.15-35 Adjustment using guide bushing

(6) Insert a screwdriver through the overflow screw fixing hole, and then turn the guide bushing. (See Fig.15-36)

If the fuel delivery is still outside the specified limit, check the guide bushing for its direction or replace the spring.

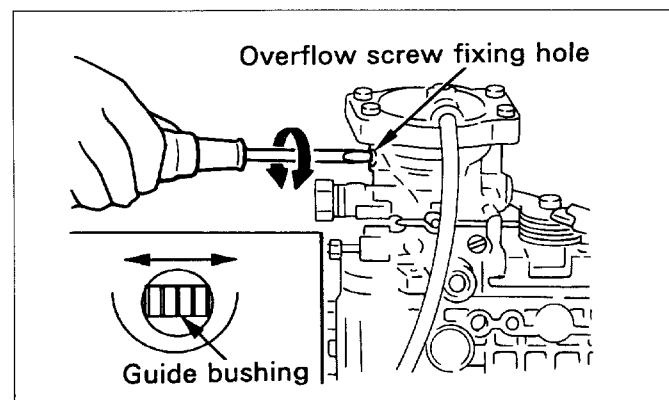


Fig.15-36 Adjusting the guide bushing

15 - 11. ADJUSTMENT OF ROTARY POSITION SENSOR (Throttle Position Sensor)

Example of the test spec.

Adjustment of Throttle Position Sensor. (Applying 5.0 \pm 0.005 V sensor.)

Condition	Pump Speed: 0rpm Fuel Delivery Quantity:—
Sensor Output Voltage	0.35-0.40

(1) Remove the RPS, and fix the angle index plate by setting the center of the angle index plate of the adjusting lever protractor. (See Fig.15-37)

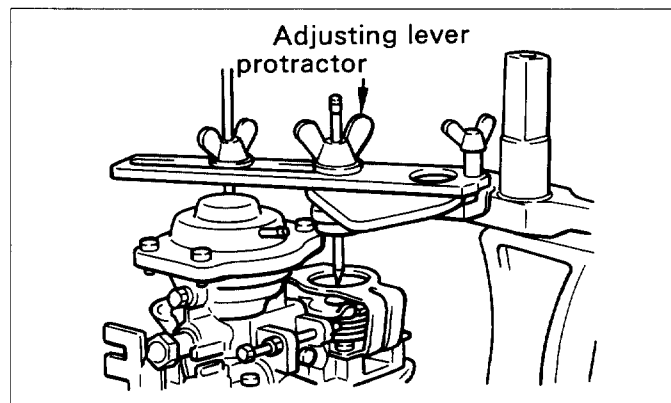


Fig.15-37

(2) Install the RPS and fix the adjusting lever while adjusting the pump speed and the injection quantity by shifting the adjusting lever from the FULL position to the IDLE position as indicated in the test specifications. (See Fig.15-38)

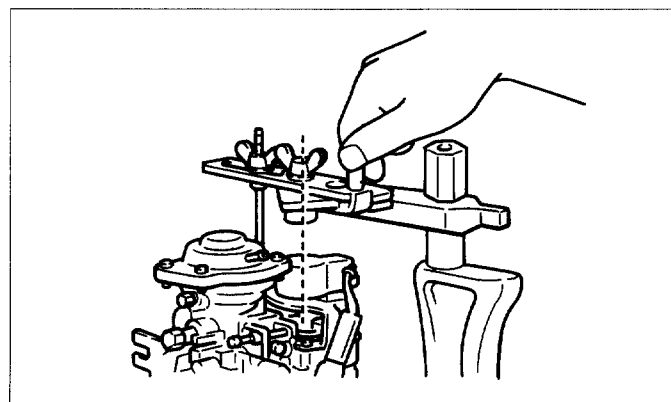


Fig.15-38

(3) Connect the check harness to the connector of the RPS.

If it is not possible, use the sub-harness to connect to the RPS. (See Fig.15-39)

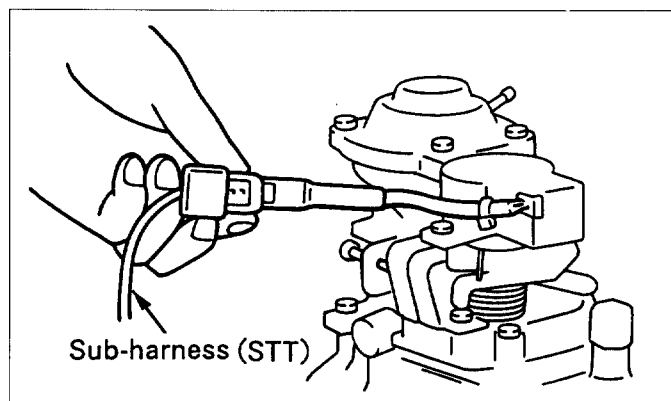
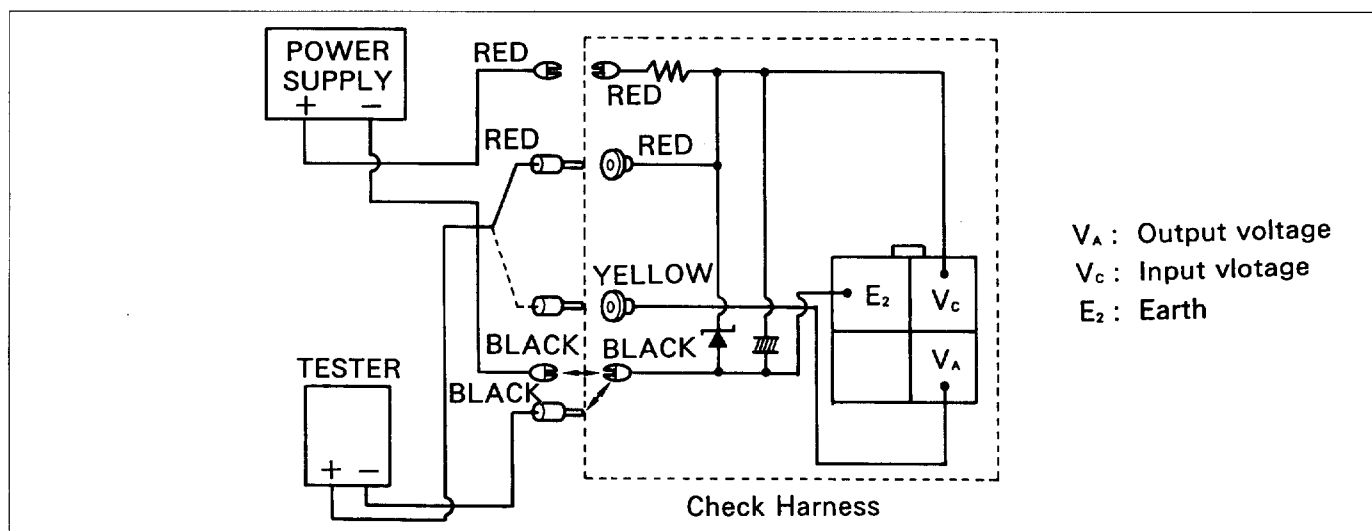


Fig.15-39

(4) Connect the power supply, the tester and the check harness (with a sub-harness) as shown below:



(5) Turn on the power and apply 5V or 12V.
Wait for a few minutes for the voltage to stabilize.
(6) Make sure that the input voltage V_c is stable by connecting the \oplus of the tester to the yellow jack of the check harness.

(7) Connect the \oplus of the tester to the yellow jack of the check harness, and while measuring the output voltage, rotate the RPS so that the V_A will become the "sensor output voltage" as specified in the test specifications. When the output voltage has reached the specified value, fix the RPS by tightening the screws. (See Fig.15-41)

For a value for the V_A , use the formula shown below.

(Example)

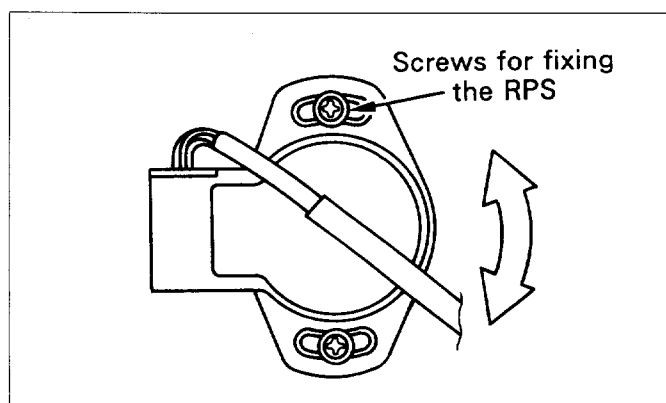
Power supply voltage (V)	Output voltage V_A
5	$V_A = \text{Measurement}$
12	$V_A = V_c (\text{Measurement Value}) \times 5/12$

Adjustment of Throttle Position Sensor. (Applying $5.0 \pm 0.005V$ to sensor.)
(Rotary Position Sensor)

NOTE:Following is an example of specified value.

Condition	Pump Speed: 750rpm, Fuel Delivery Quantity: 9.8-10.2 (cc/500st)
Sensor Output Voltage	3.339-3.387V

Rotate the sensor so that V_A , which is calculated with the formula shown above, will become the output voltage specified in the test specification.



15-12. ADJUSTMENT OF ACSD

Example of the test specification

Lever Position	Pump Speed (rpm)	Fuel Temperature (°C)	Measuring Value	Remarks
IDLE	325	24-26	Piston Travel (mm): 0.6-0.8	
	325	24-26	Idle-up Quantity (cc/1000st): 1.7-2.7	

(1) Using a screwdriver, turn the levers counter-clockwise and put a metal plate of approx. 10mm in thickness between the lever A and thermo wax piston. (See Fig.15-42)

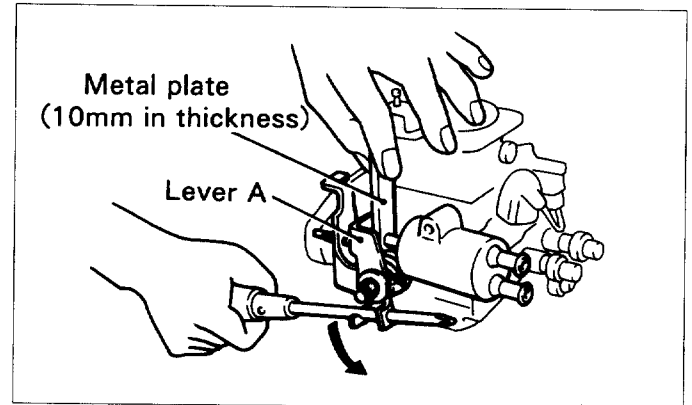


Fig.15-42

(2) Timer stroke adjustment

- Remove the overflow screw and check the fuel temperature in the pump.
Fuel temperature: 24 °C-26 °C (75 °F-84 °F)
- Set the scale of the timer measuring to zero.
- Remove the metal plate between the lever A and thermo wax.
- In order to standardize testing methods, apply torque clockwise (0.5kgm) to lever A for 10 seconds, then release torque. (See Fig.15-43)

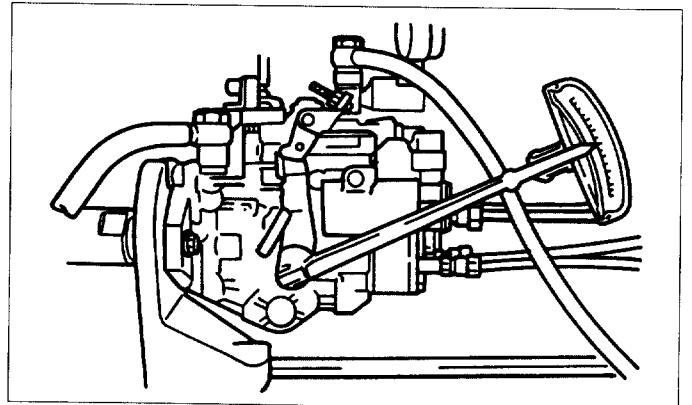


Fig.15-43

e) Measure the timer piston stroke.

If not within specifications, adjust with the timer stroke adjust screw. (See Fig.15-44)

Note: Screw in - The stroke decreases

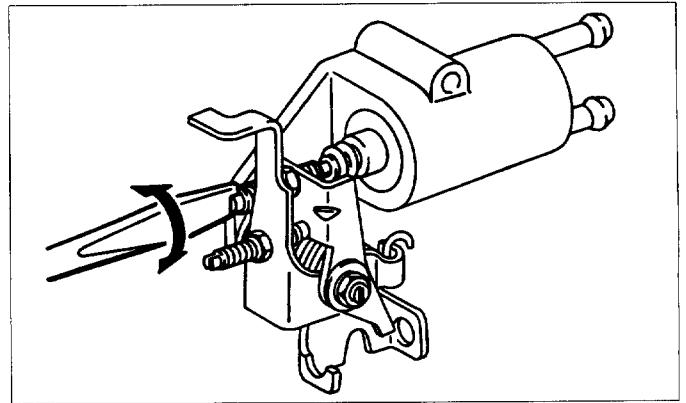


Fig.15-44

(3) Adjustment of Idle-up Quantity

Adjust the pump speed and diesel fuel temperature as specified in the test specifications, and then measure the fuel delivery. If they are outside the specified limit, adjust the idle-up adjusting screw. (See Fig.15-45)

NOTE:

Screw in - Fuel injection quantity increases

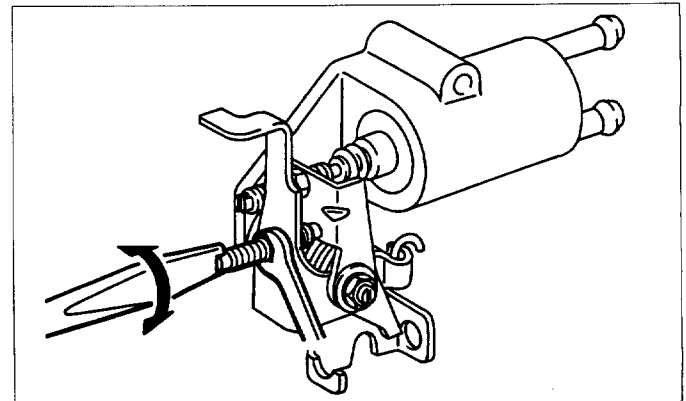


Fig.15-45

15-13. ADJUSTMENT OF DAC

Example of the test specification

Lever Piston	Pump speed (rpm)	Fuel Delivery (cc/200st, 1cyl)	Max. Spread In Delivery (cc)	Absolute Pressure (mmHg)	Remarks
FULL	1200	9.04-9.64	—	530	Check DAC
	1200	9.99-10.59	—	630	Check DAC
	1200	More than 11.06	—	730	Check DAC

(1) Setting

Attach the hose, digital air pressure meter and vacuum hose as illustrated in Fig.15-46.

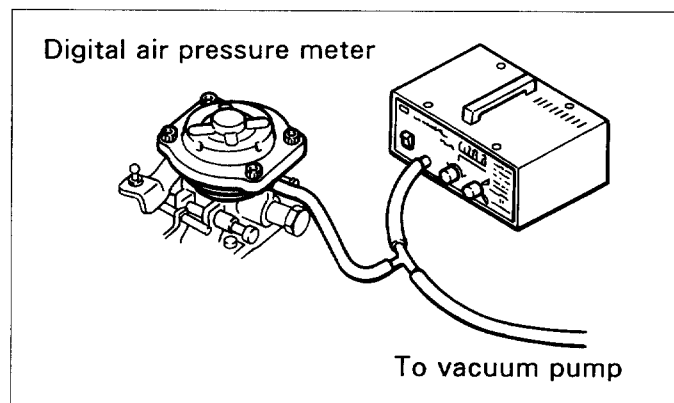


Fig.15-46

(2) Adjustment of fuel delivery

Adjust the lever position, pump speed and negative pressure as specified in the test specifications, and then measure the fuel delivery.

NOTE: Before adjustment, perform 5 cycles of "full - idle". (See Fig.15-47)

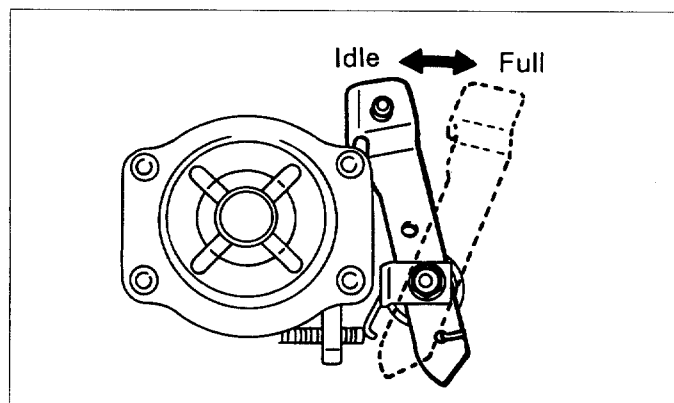


Fig.15-47

If the measured fuel delivery is outside the specified limit, adjust by replacing the shim with an appropriate one. (See Fig.15-48)

NOTE: Using a thinner shim will increase fuel delivery.

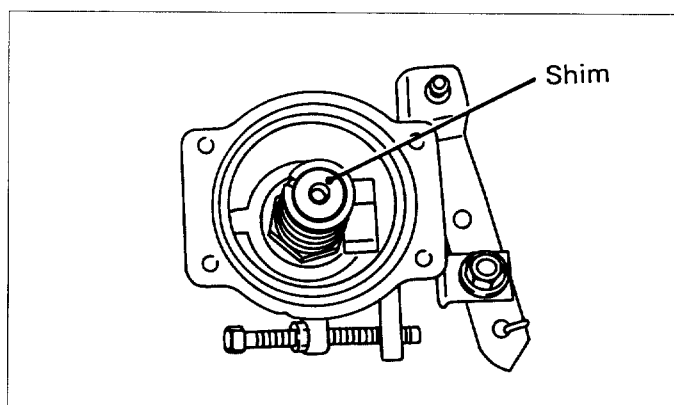


Fig.15-48

15-14. FINAL CHECKS

- (1) Check for no fuel delivery with the power off to the solenoid.
- (2) Seal the maximum-minimum setting screw and full load setting screw.

The following two methods can be used to seal the full load setting screw. (If you choose the calking method, use STT.)

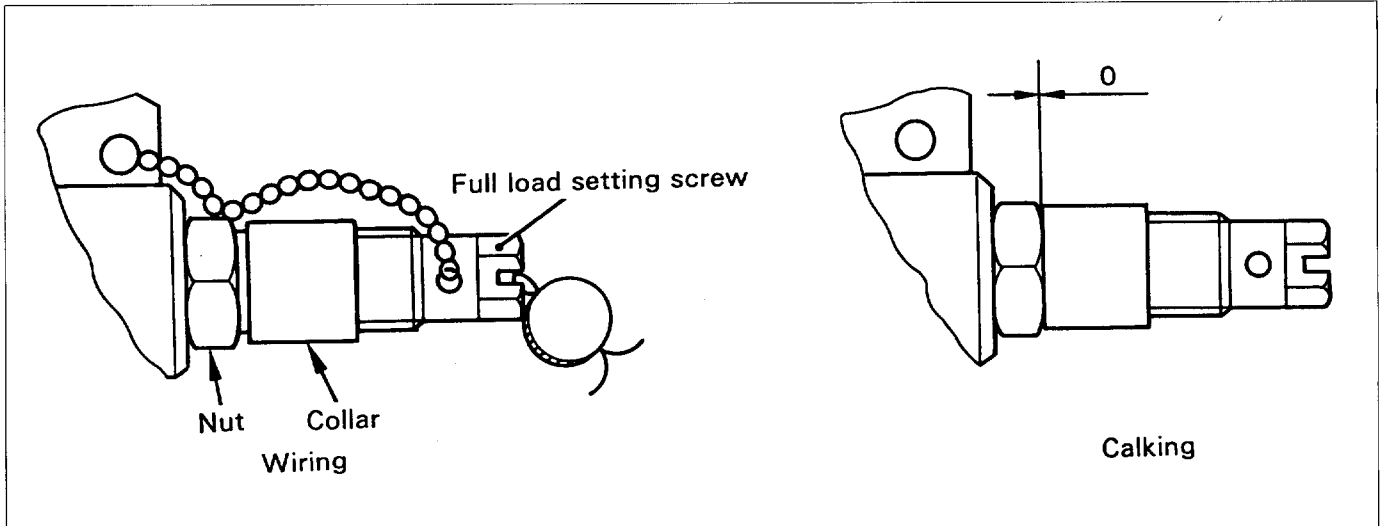


Fig.15-49

Eliminate the gap between the collar and the full load set screw's lock nut as illustrated in Fig.15-50, push the calking tool (STT) against the screw, and then close the calking tool's lever to seal the screw.

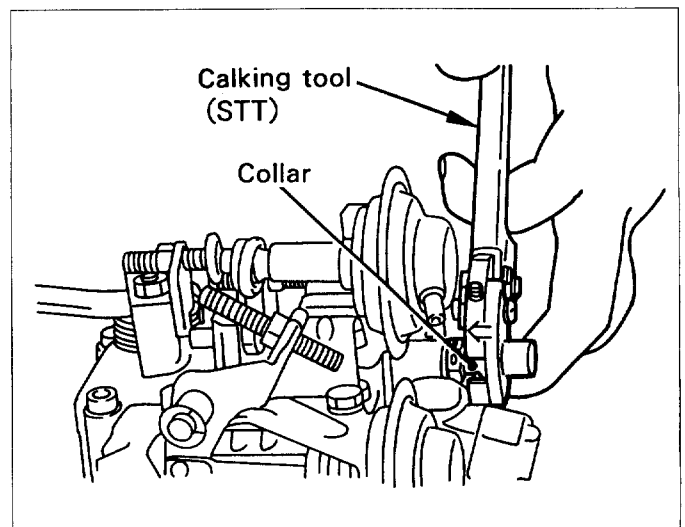


Fig.15-50 Sealing by calking tool