

# SERVICE MANUAL

## 2-Spring Nozzle & Nozzle Holder

**REPAIR**

November,2003

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## 1. 2-Spring Nozzle & Nozzle Holder Service Manual

### 1-1. Outline

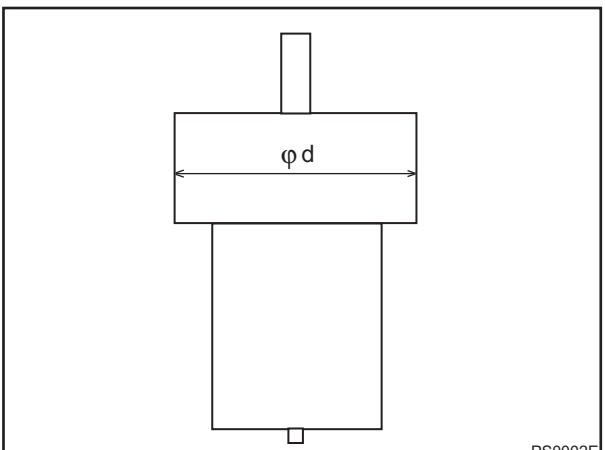
- This manual describes the 2-spring nozzles and nozzle holders and explains their repair and adjustment methods by citing their representative models as examples. While the nozzles that are currently used can be broadly divided into two types, there are four types of adjustment methods. Thus, for an effective operation, refer to this manual before performing a repair.

### 1-2. Models and Types of 2-spring Nozzles and Nozzle Holders

Nozzle holder model	Nozzle model	Construction	Type
KBL, KBAL	DLL-P	Capsule type (conventional type)	1
		Shim adjustment (reinforced type)	2
	DLL-S	Shim adjustment (conventional type)	3
		Shim adjustment (reinforced type)	4

#### A. Differences in nozzle models

Nozzles come in size P, R, S, T, U, V, or W, which designates the outer diameter dimension of the collar portion of the nozzle body. For most automotive applications, nozzles sized P or S are used.

Size symbol	$\phi$ d (mm)	
P	14.3	
R	16	
S	17	
T	22	
U	30	
V	42	
W	50	

#### < NOTE >

- To adjust the pre-lift, the conventional type uses a pre-lift adjustment shim and the reinforced type uses a pre-lift adjustment spring seat.

### 1-3. Adjustment Method and Applicable Engine Model by Construction Type

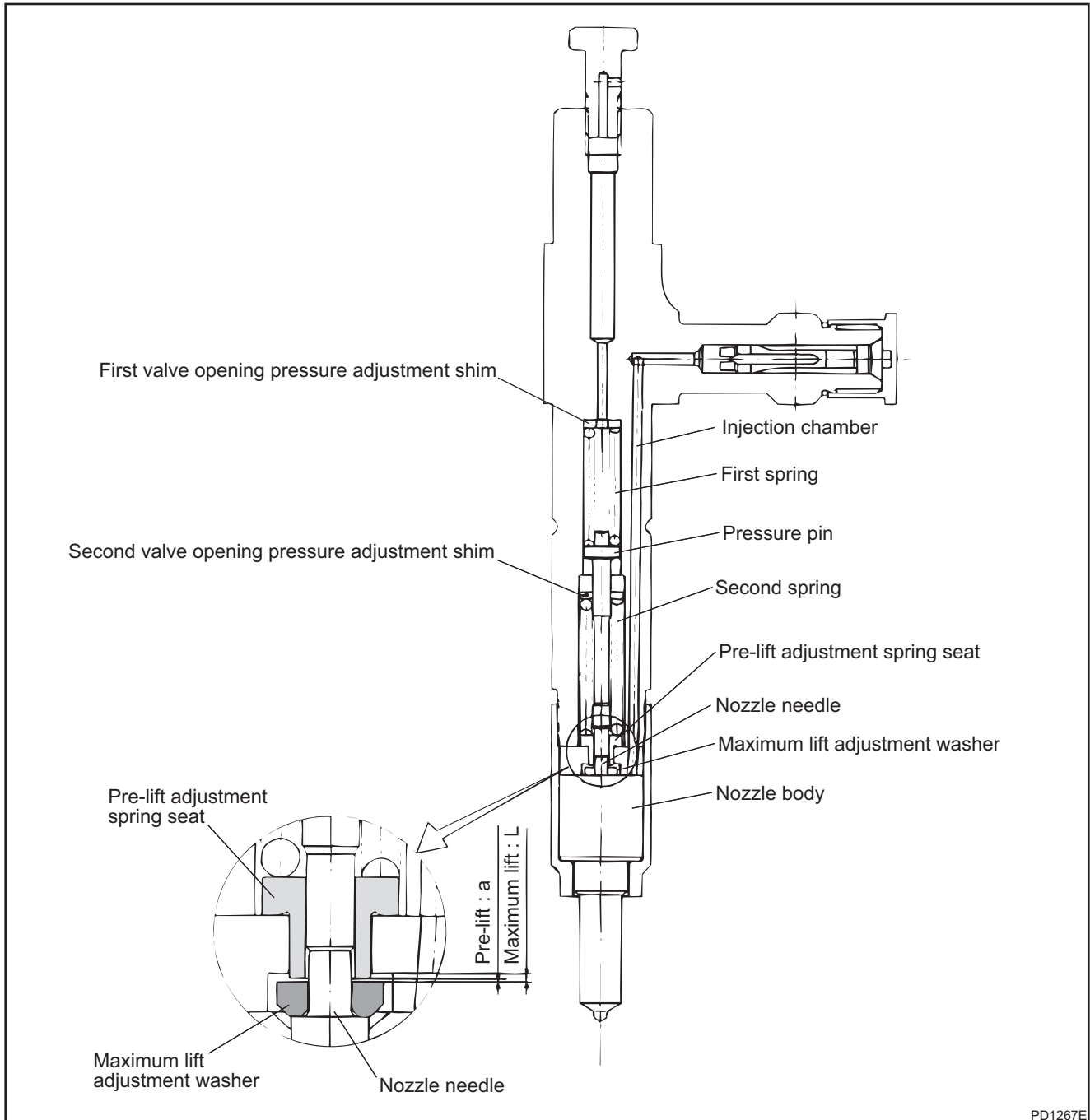
Type	Construction	Representative engine model	Manufacturer
1	Capsule type (conventional type)	1Z, 1HD-T	TOYOTA
		4D32, 4D33, 4D33-2, 4D35	MITSUBISHI
2	Shim adjustment (reinforced type)	1HD-FT, 15B-F, 15B-FT	TOYOTA
		4D33-4, 4D34T4, 4D35, 4M5# series	MITSUBISHI
3	Shim adjustment (conventional type)	EF500, EK100, EM100, M10U, H07C, H06C-TE	HINO
		8DC, 8DC10, 8DC11	MITSUBISHI
4	Shim adjustment (reinforced type)	F17D, F17D-T, F17E, EM100, M10C, H07C-T, J-1, JT-1, JT-2, FT-1	HINO
		6D16T6	MITSUBISHI
		H07B-T	YAMAHA

#### 1-4. STT Application

No.	Part Name	DENSO P/N	Type 1	Type 2	Type 3	Type 4
1	2-spring nozzle adjustment tool	95091-10770			O	
2	2-spring tool set	95093-00040	O			
2-1	2-spring base	95093-10230	O	O		O
2-2	2-spring box	95093-10250	O			
2-3	Measure attachment	95093-10300	O	O		
2-4	Straight pin	95904-10070	O			
2-5	Dial gauge	95800-10050	O	O	O	O
3	Master spring seat	95093-10330		O		
4	Base	95093-20180				O
5	Dial gauge holder unit	95800-20010				O
6	Probe joint	95800-20020				O
7	Probe	95800-20030				O
8	Socket wrench	95991-10150				O
2-spring tool set is composed of 2-1, 2-2, 2-3, 2-4 and 2-5.						

### 1-5. Construction

- A 2-spring nozzle holder contains two springs to enable the nozzle needle to be lifted in two stages in accordance with the pressure in the injection pipe. To show its construction, an example of a nozzle and nozzle holder (type II, reinforced) used on the 1HD-FT engine is given below. Although there are some differences in construction and operation by type, they are all identical in principle.

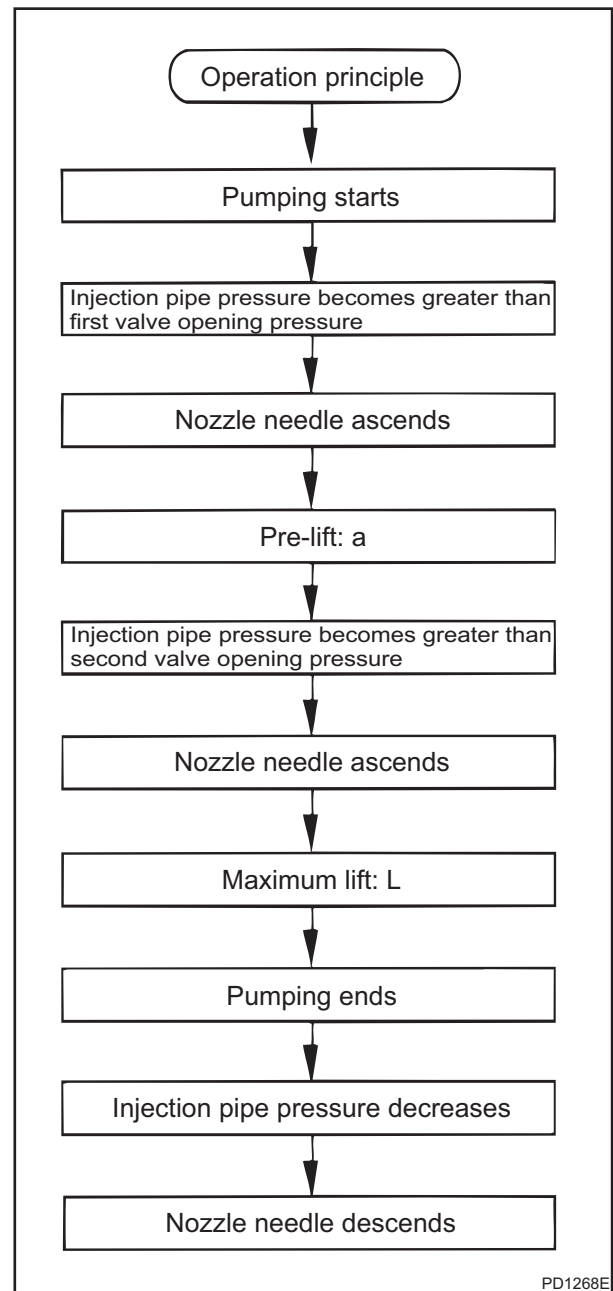


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## 1-6. Operation

### A. Operation Principle

- a. The sequence of operations from the time the fuel is pumped until the injection is completed is indicated below:
- The high-pressure fuel that has been pumped by the injection pump travels via the injection pipe and enters the nozzle body.
  - The injection pipe pressure rises, becomes greater than the first valve opening pressure (the force of the first spring), and lifts the nozzle needle.
  - Pushed by the nozzle needle, the maximum lift adjustment washer rises only for the amount of "pre-lift: a", and upon coming in contact with the pre-lift adjustment spring seat, the nozzle needle stops momentarily.
  - The injection pipe pressure rises further, becomes greater than the second valve opening pressure (the resultant force of the first and second springs), and lifts the nozzle needle further.
  - Pushed by the nozzle needle, the maximum lift adjustment washer and the pressure pin ascend only for the amount of "maximum lift: L", and the nozzle needle comes to a stop.
  - The pumping of fuel ends and the injection pipe pressure becomes lower than the second opening valve pressure (the resultant force of the first and second springs).
  - Pushed by the second spring, the pre-lift adjustment spring seat, the maximum lift adjustment washer, and the nozzle needle are pushed further by the first spring. As a result, the pressure pin and the nozzle needle descend, thus completing the injection.

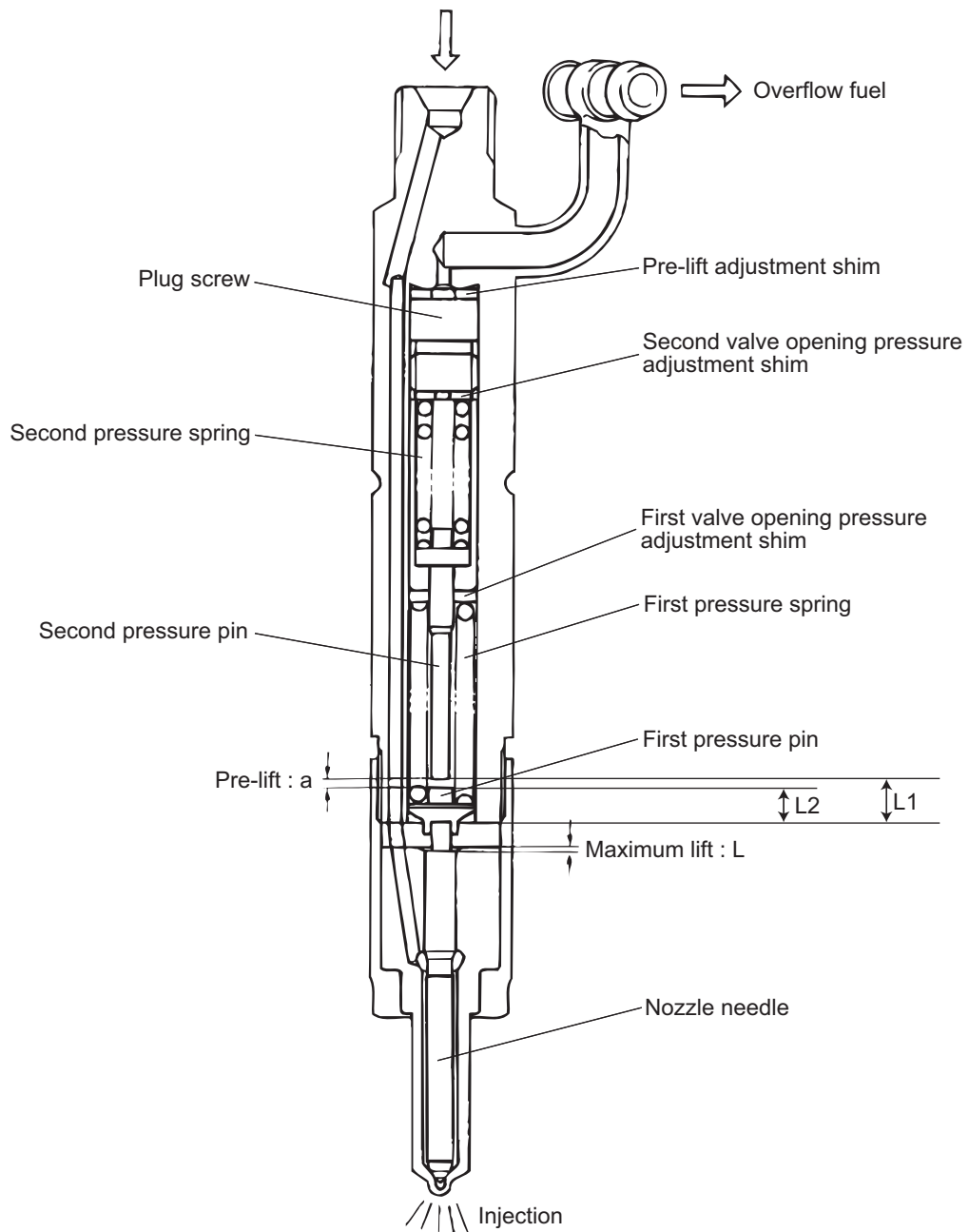


- b. The sequence of operations described above can be explained more simply as follows:
- It is the first spring that determines the first valve opening pressure. To adjust this pressure, the first valve opening pressure adjustment shim is used to change the set load of the first spring.
  - To adjust the amount of pre-lift, the pre-lift adjustment spring seat is used.
  - It is the resultant force of the first and second springs that determines the second valve opening pressure. To adjust this pressure, the second valve opening pressure adjustment shim is used to change the set load of the second spring.
  - The amount of maximum lift is adjusted by using the maximum lift adjustment washer.

## 1-7. Adjustment Procedure by Type

### A. Type 1 (Capsule Type)

#### a. Construction Diagram



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b. Constituent Parts and Names

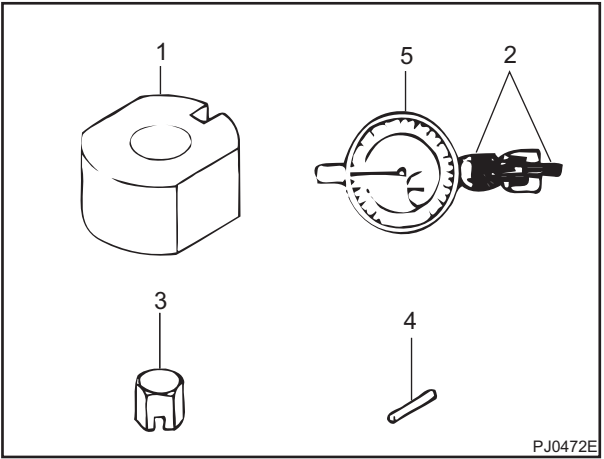
No.	Name	
1	Nozzle holder body	
2	Pre-lift adjustment shim	
3	Plug screw	
4	Second valve opening pressure adjustment shim	
5	Second pressure spring	
6	Second pressure pin	
7	Capsule screw	
8	Capsule sub-assembly	
9	First valve opening pressure adjustment shim	
10	First pressure spring	
11	First pressure pin	
12	Tip packing	
13	Straight pin	
14	Nozzle	
15	Retaining nut	
		PJ0471E

c. Adjustment Procedure (Summary)

Adjustment Sequence	1. Pre-lift	2. Second Valve Opening Pressure	3. First Valve Opening Pressure
Measure-ment Method	Measure "L1 - L2", the difference between the holder dimension L1 and the nozzle dimension L2.	Pull out the first pressure spring and the first valve opening pressure adjustment shim, loosen the plug screw one to two turns, and measure the valve opening pressure.	Assemble parts other than the hollow screw and measure the valve opening pressure.
Adjustment Method	Select a pre-lift adjustment shim (the thicker the shim, the smaller the pre-lift will be).	Select a second valve opening pressure adjustment shim (the thicker the shim, the higher the valve opening pressure will be).	Select a first valve opening pressure adjustment shim (the thicker the shim, the higher the valve opening pressure will be).
Tools	2-spring tool set (STT: 95093-00040) Dial gauge	Nozzle hand tester	Nozzle hand tester



d. STT

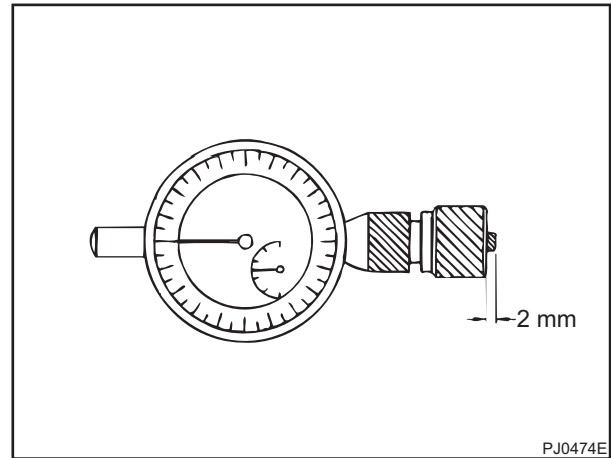
No.	Part Name	DENSO P/N	
0	2-spring tool set	95093-00040	
1	2-spring base	95093-10230	
2	Measure attachment	95093-10300	
3	2-spring box	95093-10250	
4	Straight pin	95904-10070	
5	Dial gauge	95800-10050	

e. Detailed Adjustment Procedure (For 093500-4491 as an example)

(1) Pre-lift adjustment

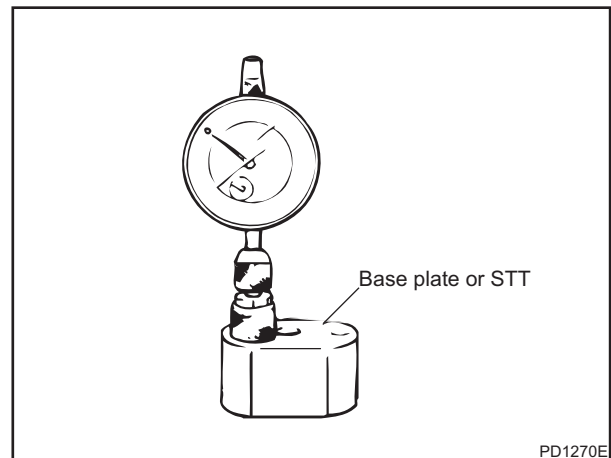
A) Adjustment 1

Assemble the STT on the dial gauge so that the distance between the probe and the end of the STT is 2mm or less.



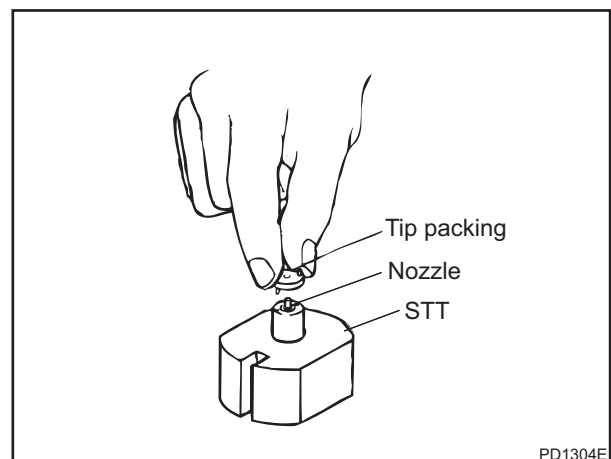
B) Adjustment 2

On a base plate or STT, set the dial gauge graduation to zero.



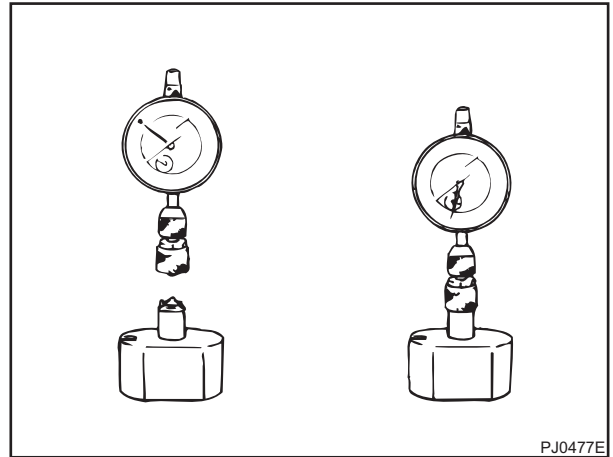
C) Adjustment 3

Assemble the nozzle, tip packing, and straight pin on the STT, and install the first pressure pin.



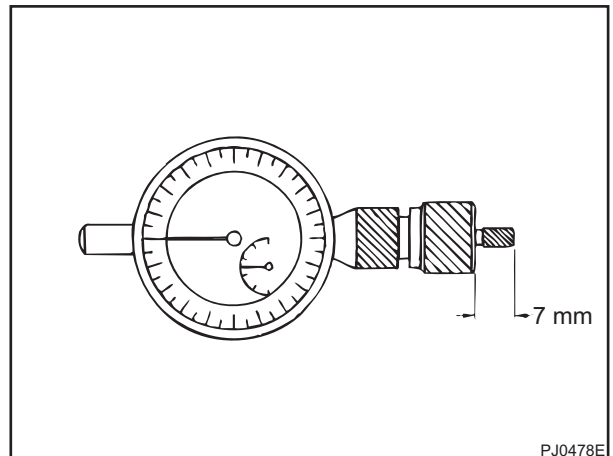
D) Adjustment 4

Align the hole of the STT with the straight pin and measure the dimension L2.



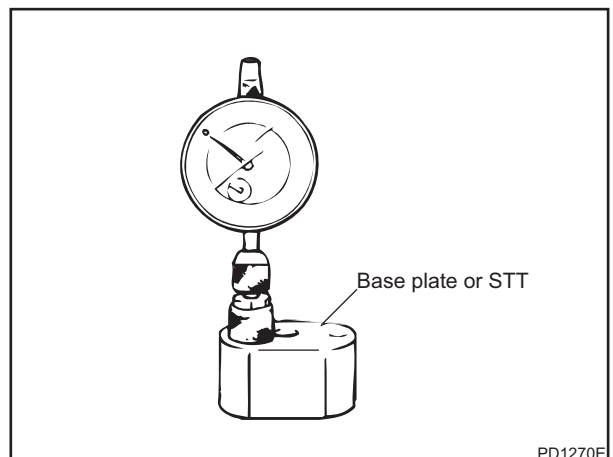
E) Adjustment 5

Assemble the STT on the dial gauge so that the distance between the probe and the end of the STT is 7mm or more.



F) Adjustment 6

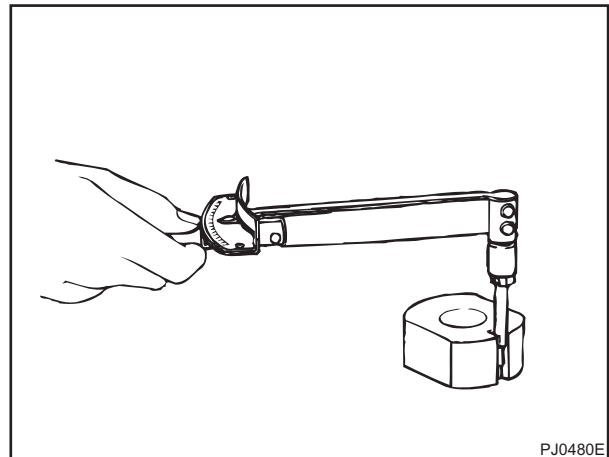
On a base plate or STT, set the dial gauge graduation to zero.



#### G) Adjustment 7

Assemble the capsule sub-assembly. Assemble the second pressure pin, the second pressure spring, and the second valve opening pressure adjustment shim on the capsule screw, and use the STT to tighten the plug screw.

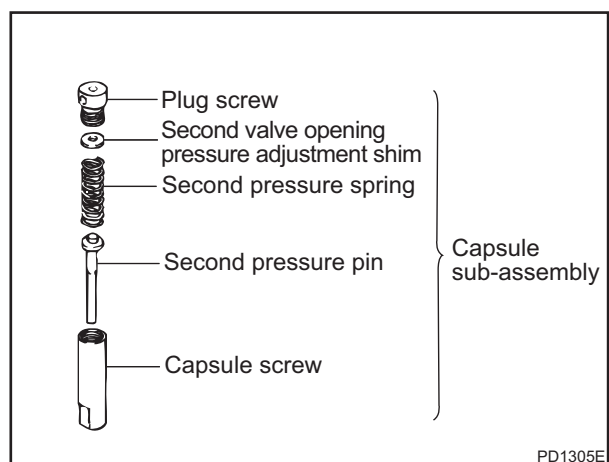
- Tightening torque: 2.0 - 2.9N·m (0.2 - 0.3kgf·m)



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#### < NOTE >

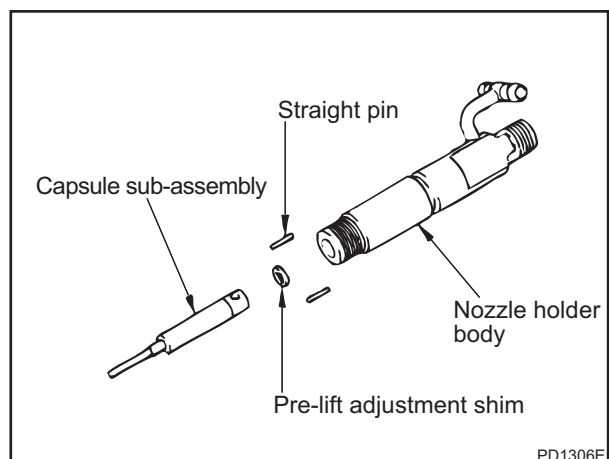
- If the thickness of the second valve opening pressure adjustment shim is unknown, use 1.5mm as a nominal value.



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#### H) Adjustment 8

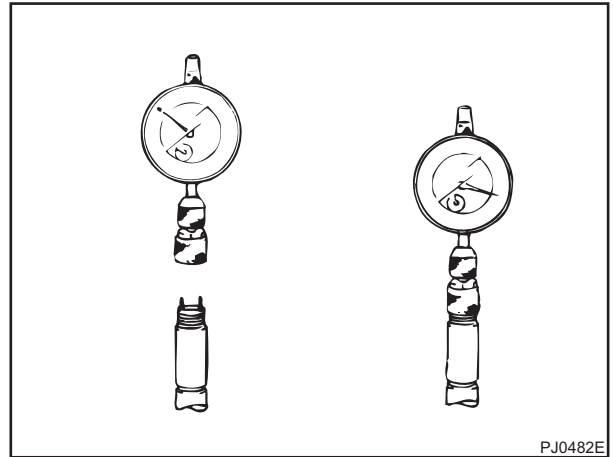
Assemble the pre-lift adjustment shim, the capsule sub-assembly, and the straight pin in the nozzle holder body.



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I) Adjustment 9

Align the straight pin with the hole of the STT and measure the dimension L1.



J) Adjustment 10

Using dimensions L1 and L2 obtained in steps "Adjustment 4" and "Adjustment 9", calculate the amount of pre-lift a.

- Pre-lift a = L1 - L2
- Pre-lift a (specified value) =  $0.08 \pm 0.02\text{mm}$

K) Adjustment 11

If the amount of pre-lift deviates from the specified value, adjust it by changing the pre-lift adjustment shim to one with a different thickness.

< NOTE >

- The thicker the pre-lift adjustment shim, the smaller the pre-lift will be.

< CAUTION >

- Because adjusting the pre-lift requires high precision, thoroughly clean the parts and make sure that they are free of foreign objects before performing the operation.

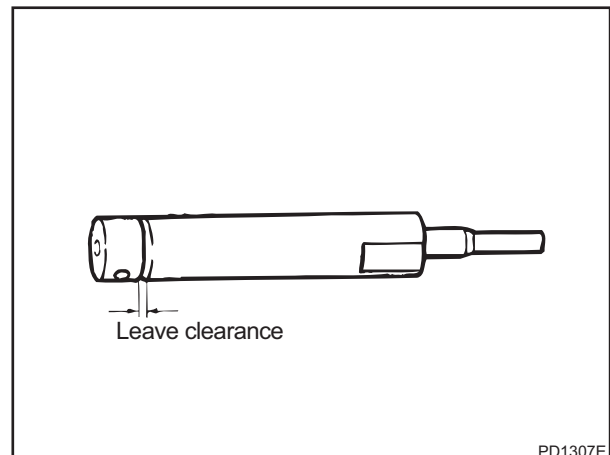
(2) Second valve opening pressure adjustment

A) Adjustment 1

Loosen the plug screw of the capsule sub-assembly one to two turns.

< NOTE >

- After the plug screw has been loosened one to two turns, the amount of pre-lift will be 0mm when it is installed in the nozzle holder.

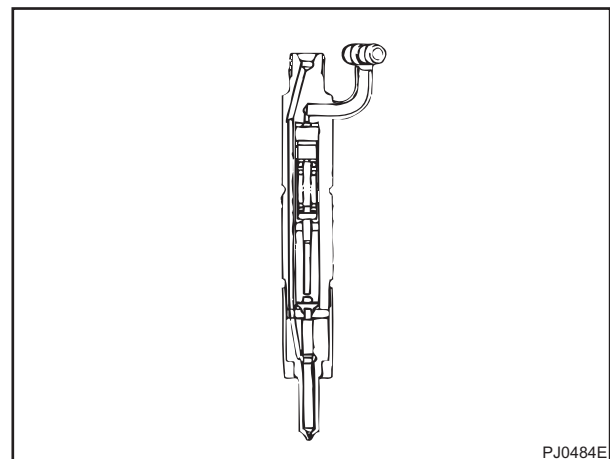


B) Adjustment 2

In the nozzle holder body, install the pre-lift adjustment shim that was selected in section "(1)", the capsule sub-assembly in the state described in "Adjustment 1", the first pressure pin, tip packing, straight pin, and the nozzle. Then, tighten the retaining nut.

< NOTE >

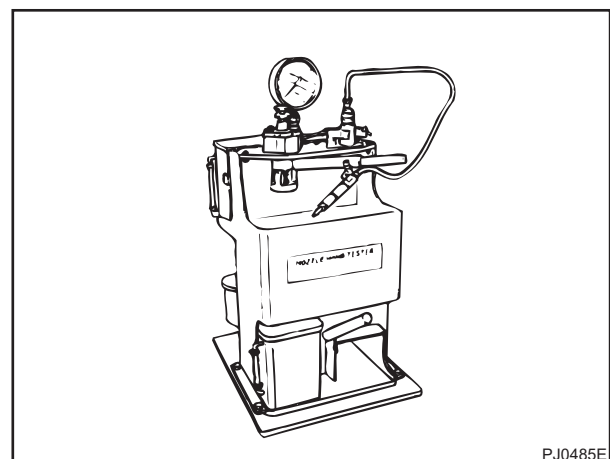
- At this time, do not install the first pressure spring and the first valve opening pressure adjustment shim.
- Tightening torque: 24.5 - 34.3N·m (2.5 - 3.5kgf·m)



C) Adjustment 3

On the nozzle hand tester, install the nozzle and the nozzle holder that were installed in "Adjustment 2", and measure the valve opening pressure.

- Second valve opening pressure (specified value):  
13.5 - 14.5MPa (138 - 148kgf/cm<sup>2</sup>)



D) Adjustment 4

If the pressure deviates from the specified value, adjust it by changing the second valve opening pressure adjustment shim to one with a different thickness.

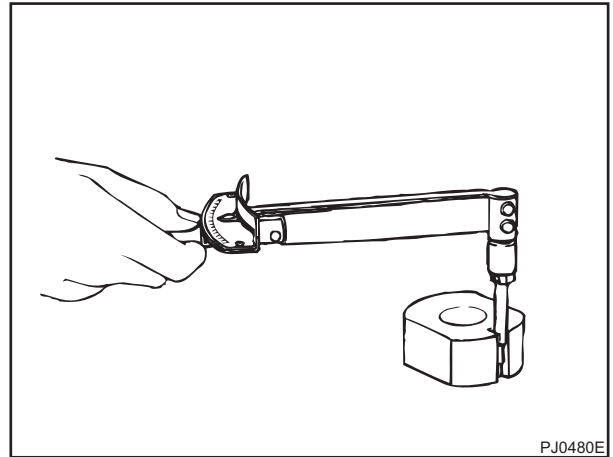
< CAUTION >

- Make sure to loosen the plug screw one to two turns before assembling the capsule sub-assembly by changing the second valve opening pressure adjustment shim.

E) Adjustment 5

After completing the second valve opening pressure adjustment, remove the capsule sub-assembly from the nozzle and nozzle holder. Then, use the STT to tighten the plug screw.

- Tightening torque: 2.0 - 2.9N·m (0.2 - 0.3kgf·m)



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(3) First valve opening pressure adjustment

A) Adjustment 1

In the nozzle holder body, install the pre-lift adjustment shim that was selected in section "(1)", the capsule sub-assembly that was adjusted in section "(2)", the first valve opening pressure adjustment shim, the first pressure spring, the first pressure pin, the tip packing, the straight pin, and the nozzle. Then, tighten the retaining nut.

- Tightening torque: 24.5 - 34.3 N·m (2.5 - 3.5 kgf·m)

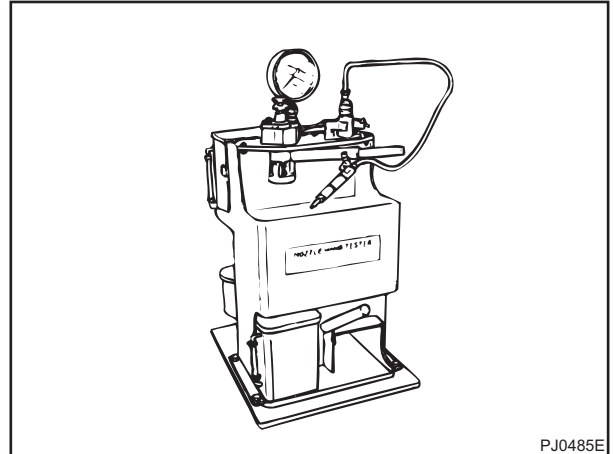
< NOTE >

- If the thickness of the first valve opening pressure adjustment shim is unknown, use 1.5mm as a nominal value.

B) Adjustment 2

On the nozzle hand tester, attach the nozzle and the nozzle holder that were installed in "Adjustment 1", and adjust the valve opening pressure.

- First valve opening pressure:  
16.2 - 17.2 MPa (165 - 175 kgf/cm<sup>2</sup>)



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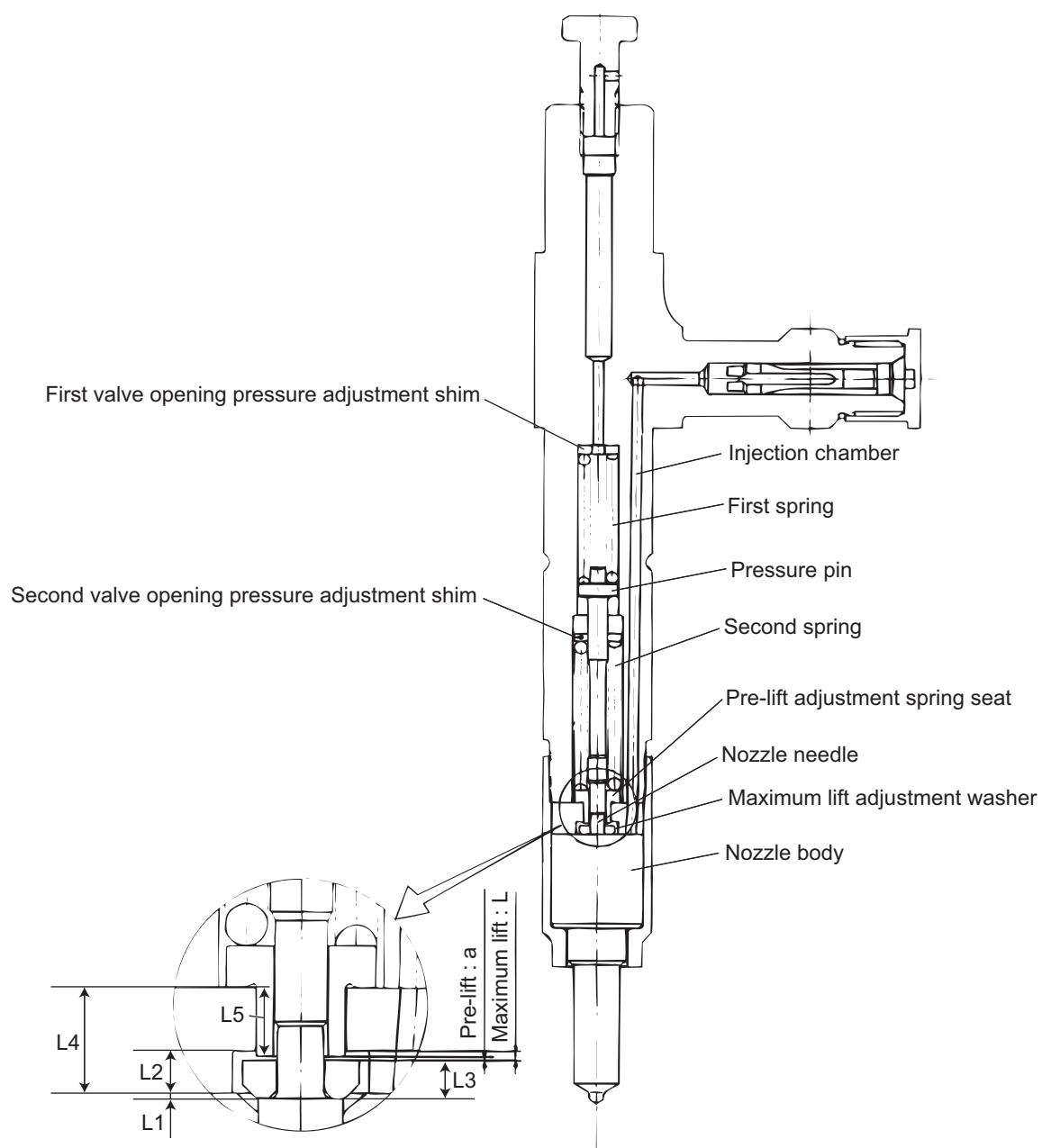
C) Adjustment 3

If the pressure deviates from the specified value, adjust it by changing the first valve opening pressure adjustment shim to one with a different thickness.



## B. Type 2 (Reinforced Type)

### a. Construction Diagram



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b. Constituent Parts and Names

No.	Name	
1	Hollow screw	
2	Washer	
3	Nozzle holder body	
4	First valve opening pressure adjustment shim	
5	First spring	
6	Pressure pin	
7	Spring seat	
8	Second valve opening pressure adjustment shim	
9	Second spring	
10	Pre-lift adjustment spring seat	
11	Tip packing	
12	Maximum lift adjustment washer	
13	Straight pin	
14	Nozzle needle	
15	Nozzle	
16	Retaining nut	
		PQ0064E

< NOTE >

- There are two types of nozzle needles as follows.

[Nozzle needle with protrusion]



[Nozzle needle without protrusion]



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< CAUTION >

- A measurement of the dimension L1 of the nozzle needle without a protrusion will give a negative value. Therefore, make sure that you measure it correctly.

< NOTE >

- The method for calculating the amount of pre-lift of the type of nozzle needle without a protrusion is described below. For dimensions L1 to L5, refer to the construction diagram.

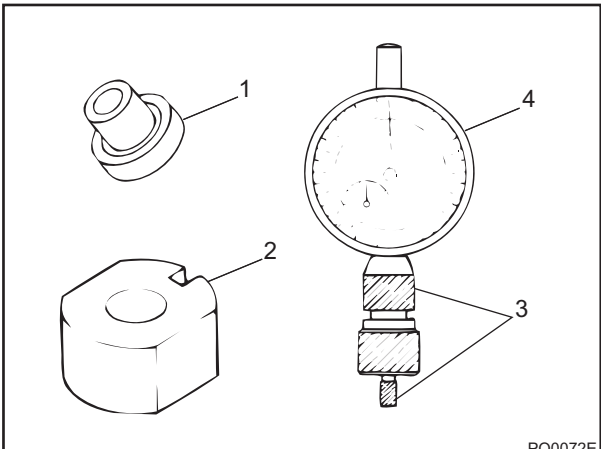
$\begin{pmatrix} L1 = -0.1 \text{ mm} \\ L3 = 2.1 \text{ mm} \\ L4 = 5.0 \text{ mm} \\ L5 = 2.9 \text{ mm} \end{pmatrix}$	<p>Hence, the pre-lift amount will be:</p> $L4 - L5 - (L3 - L1) = 5.0 - 2.9 - (2.1 - (-0.1))$ $= 5.0 - 2.9 - (2.1 + 0.1)$ $= -0.1 = -0.1 \text{ mm}$
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c. Adjustment Procedure (Summary)

Adjustment Sequence	1. Maximum Lift	2. Pre-lift	3. Second Valve Opening Pressure	4. First Valve Opening Pressure
Measurement Method	Measure the needle recession dimension L1, the tip packing groove depth L2, and the maximum lift adjustment washer thickness L3, in order to calculate the maximum lift (L1 + L2) - L3. * Dimension L1 may be a negative value.	Measure the tip packing thickness L4 and the spring seat leg length L5 in order to calculate the pre-lift: L4 - L5 - (L3-L1). * Dimension L1 may be a negative value.	Pull out the first valve opening pressure adjustment shim, the first spring, and the pressure pin. Replace the pre-lift adjustment spring seat with the master spring seat (STT) and measure the valve opening pressure.	Assemble all parts and measure the valve opening pressure.
Adjustment Method	Select a maximum lift adjustment washer.	Select a pre-lift adjustment spring seat.	Select a second valve opening pressure adjustment shim.	Select a first valve opening pressure adjustment shim.
Tools	2-spring base (STT: 95093-10230) Measure attachment (STT: 95093-10300) Dial gauge, Micrometer	Micrometer	Master spring seat (STT: 95093-10330) Nozzle hand tester	Nozzle hand tester

d. STT

No.	Name	DENSO P/N	
1	Master spring seat	95093-10330	
2	2-spring base	95093-10230	
3	Measure attachment	95093-10300	
4	Dial gauge	95800-10050	

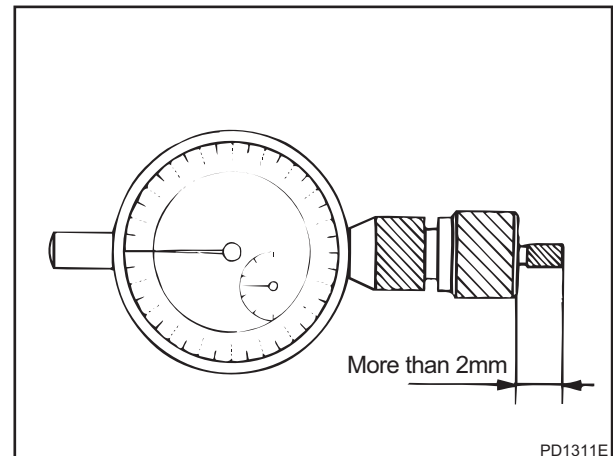
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e. Detailed Adjustment Procedure

(1) Maximum lift adjustment

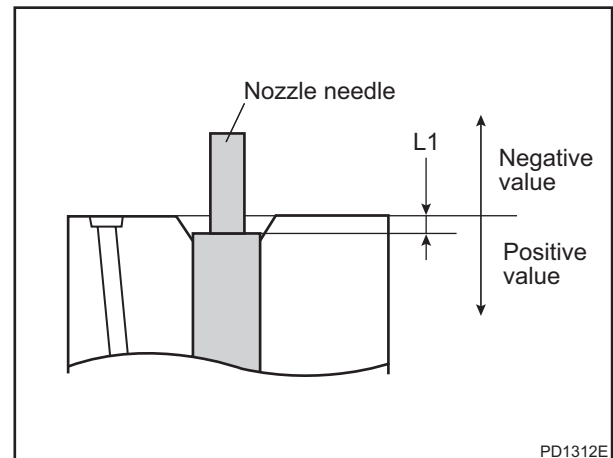
A) Adjustment 1

Attach the measure attachment (STT) to the dial gauge.



B) Adjustment 2 (nozzle needle with protrusion)

Measure dimension L1.



a) Measurement 1

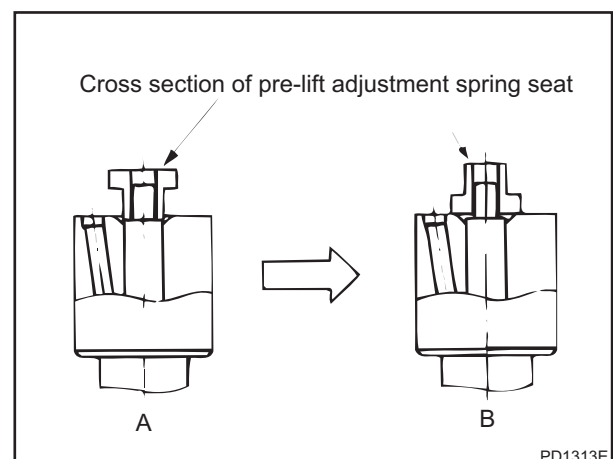
Place the nozzle on the 2-spring base (STT), and place the pre-lift adjustment spring seat as indicated by "A" in the diagram on the right.

b) Measurement 2

Align the hole of the measure attachment (STT) with the pre-lift adjustment spring seat and set the graduation on the dial gauge to zero.

c) Measurement 3

Place the pre-lift adjustment spring seat by facing it in the opposite direction ("B" in the diagram on the right). Align the hole of the measure attachment (STT) with the pre-lift adjustment spring seat and measure L1.



C) Adjustment 2' (nozzle needle without protrusion)

Measure dimension L1.

a) Measurement 1

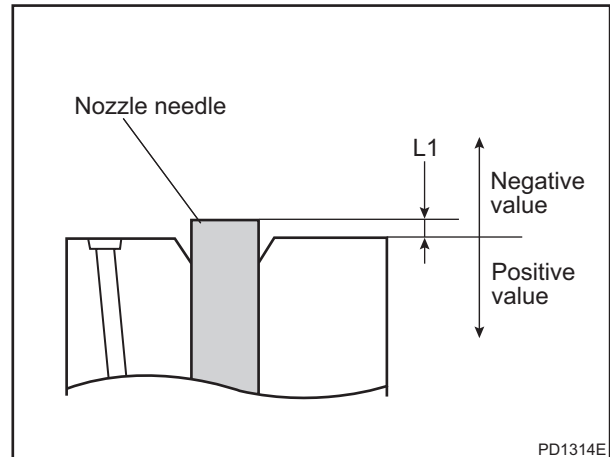
Place the dial gauge on the flat surface of the 2-spring base. Then, set the dial gauge graduation to zero.

b) Measurement 2

Place the dial gauge on the nozzle needle to measure dimension L1.

< NOTE >

- At this time, dimension L1 will result in a negative value.



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D) Adjustment 3

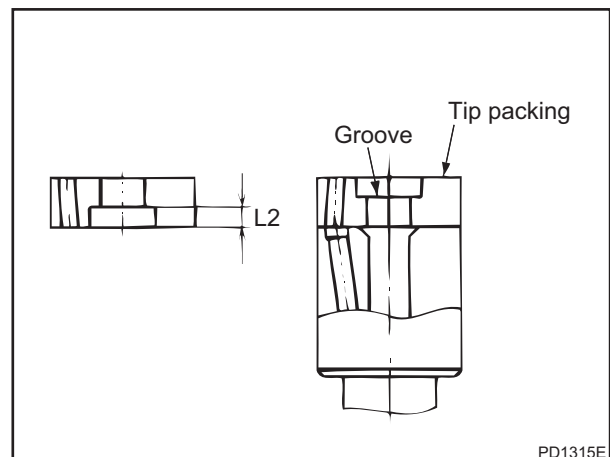
Place the nozzle body (nozzle needle removed) on the 2-spring base (STT) and place the tip packing (groove facing up) as shown in the diagram on the right.

E) Adjustment 4

On the 2-spring base (STT), set the graduation of the dial gauge to zero.

F) Adjustment 5

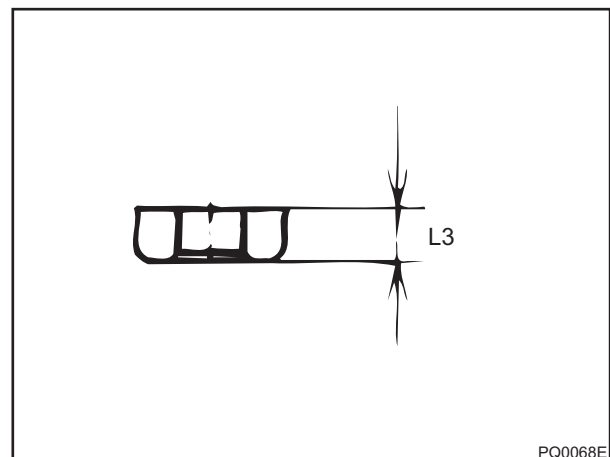
Place the needle of the dial gauge so that it comes in contact with the groove of the tip packing and measure L2.



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G) Adjustment 6

Using a micrometer, measure the thickness L3 of the maximum lift adjustment washer.



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H) Adjustment 7

Calculate the maximum lift according to the measured L1, L2, and L3.

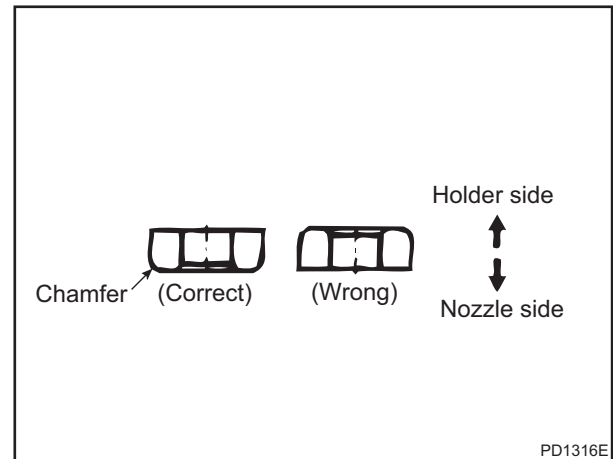
- Specified value:  $(L1 + L2) - L3$

I) Adjustment 8

If the amount of maximum lift deviates from the specified value, adjust it by changing the maximum lift adjustment washer to one with a different thickness.

< CAUTION >

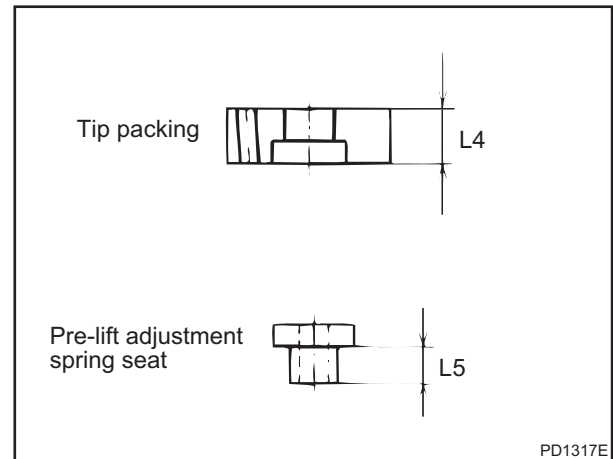
- Make sure to install the maximum lift adjustment washer correctly (chamfer facing the nozzle), as it could lead to damage or other problems if it is installed upside down.



(2) Pre-lift adjustment

A) Adjustment 1

Using a micrometer, measure the thickness L4 of the tip packing.



B) Adjustment 2

Using a micrometer, measure the length L5 of the leg of the pre-lift adjustment spring seat.

C) Adjustment 3

Calculate the amount of pre-lift according to the measured L1, L3, L4, and L5.

- Specified value:  $L4 - L5 - (L3 - L1)$

D) Adjustment 4

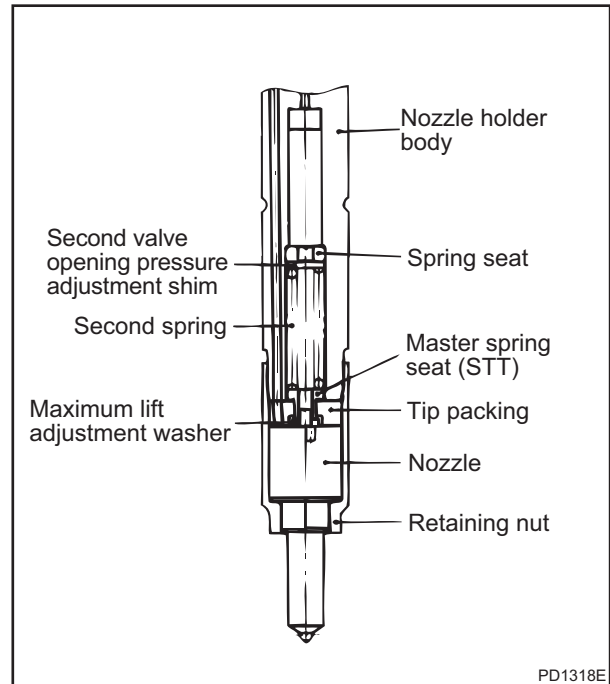
If the amount of pre-lift deviates from the specified value, adjust it by changing the pre-lift adjustment spring seat to one with a different thickness.

(3) Second valve opening pressure adjustment

A) Adjustment 1

In the nozzle holder body, install the spring seat, the second valve opening pressure adjustment shim, the second spring, master spring seat (STT), the straight pin, the tip packing, the maximum lift adjustment washer, and the nozzle. Then, tighten the retaining nut.

- Tightening torque: 24.5 - 34.3N·m (2.5 - 3.5kgf·m)



B) Adjustment 2

On the nozzle hand tester, install the nozzle and nozzle holder that were assembled in step "Adjustment 1", and measure the second valve opening pressure.

- Second valve opening pressure: 23.1 - 24.0MPa (235 - 245kgf/cm<sup>2</sup>)

< NOTE >

- For production number '97/9 and thereafter, the second valve opening pressure has been changed in accordance with the change in the shape of the part. Therefore, refer to "1-8. Reference Material" at the end of the manual for the specified value.

C) Adjustment 3

If the pressure deviates from the specified value, adjust it by changing the second valve opening pressure adjustment shim to one with a different thickness.

< NOTE >

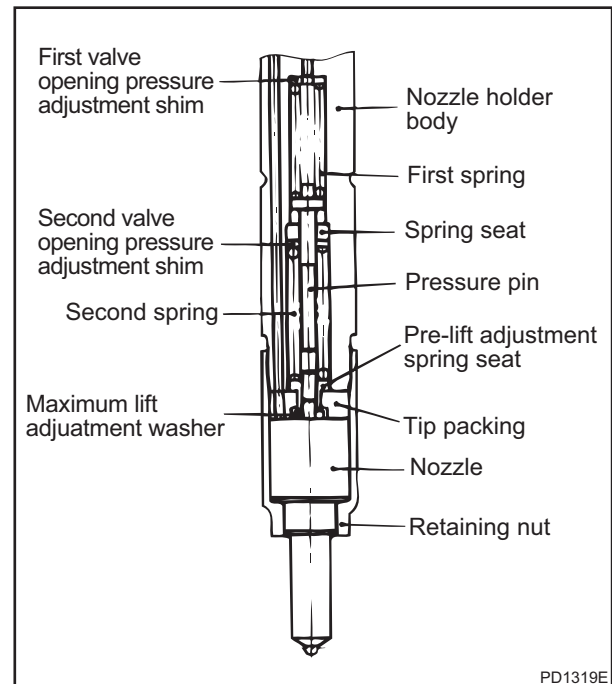
- Using a shim that is thicker by 0.05mm increases the valve opening pressure by approximately 0.7MPa (7.6kgf/cm<sup>2</sup>).

(4) First valve opening pressure adjustment

A) Adjustment 1

In the nozzle holder body, install the first valve opening pressure adjustment shim, first spring, pressure pin, spring seat, second valve opening pressure adjustment shim, second spring, pre-lift adjustment spring seat, straight pin, tip packing, nozzle maximum lift adjustment washer, and the nozzle. Then, tighten the retaining nut.

- Tightening torque: 24.5 - 34.3N·m (2.5 - 3.5kgf·m)



B) Adjustment 2

Attach onto the nozzle hand tester the nozzle and the nozzle holder that were installed in step "Adjustment 1", and measure the first valve opening pressure.

- First valve opening pressure: 17.7 - 18.6MPa (180 - 190kgf/cm<sup>2</sup>)

C) Adjustment 3

If the pressure deviates from the specified value, adjust it by changing the first valve opening pressure adjustment shim to one with a different thickness.

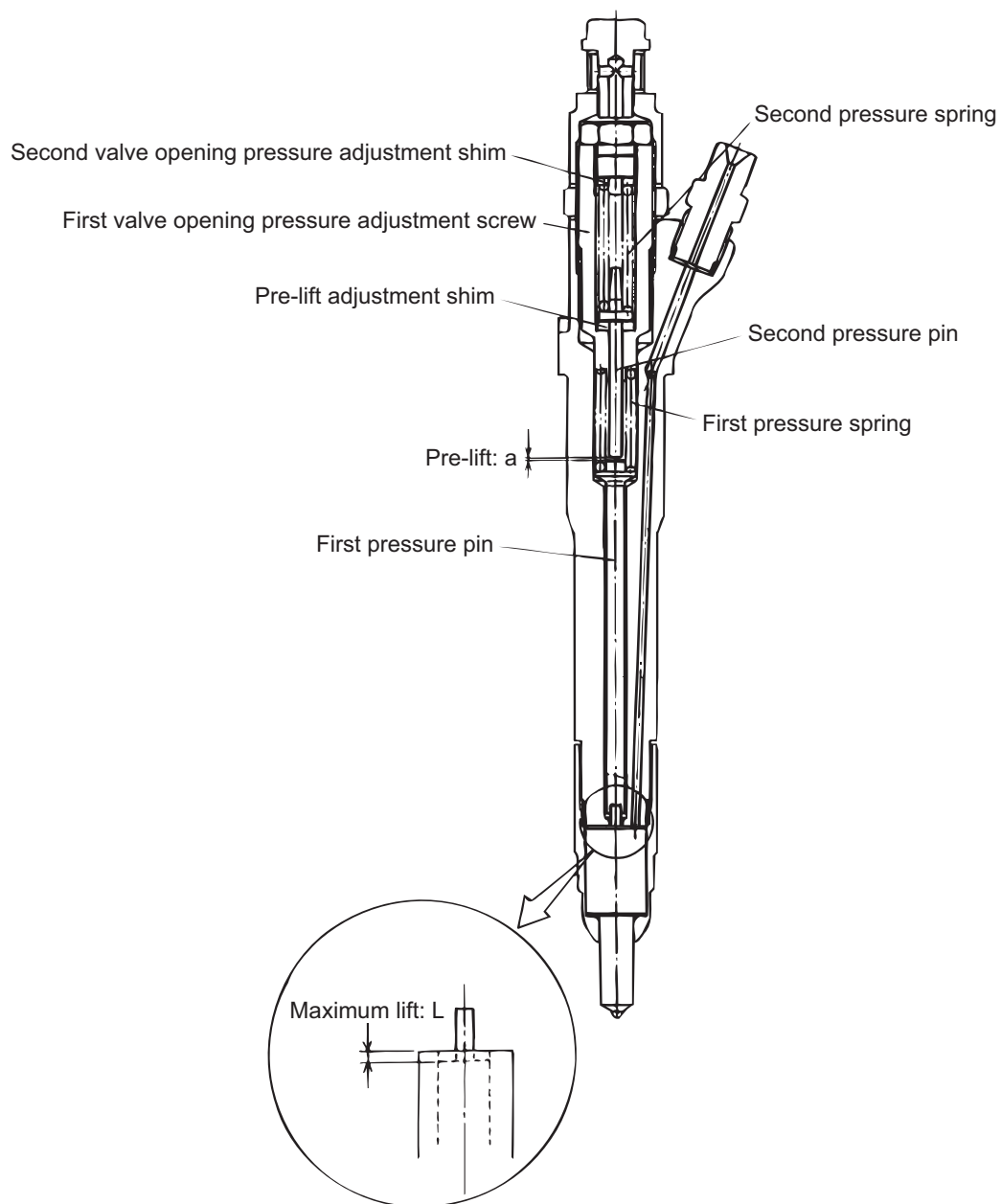
< NOTE >

- Using a shim that is thicker by 0.05mm increases the valve opening pressure by approximately 0.7MPa (7.6kgf/cm<sup>2</sup>).



### C. Type 3 (Conventional Type)

#### a. Construction Diagram



PD1320E

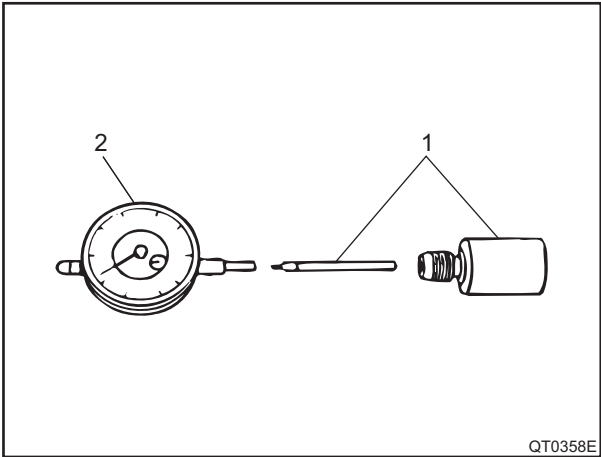
b. Constituent Parts and Names

No.	Name	
1	Hollow screw	
2	Washer	
3	Cap nut	
4	Washer	
5	Locknut	
6	Washer	
7	Plug screw	
8	Second valve opening pressure adjustment shim	
9	Second pressure spring	
10	Second pressure pin	
11	Pre-lift adjustment shim	
12	Capsule screw	
13	First pressure spring	
14	First pressure pin	
15	Inlet connector	
16	Washer	
17	Nozzle holder body	
18	Nozzle assembly	
19	Retaining nut	

c. Adjustment Procedure (Summary)

Adjustment Sequence	1. First Valve Opening Pressure	2. Second Valve Opening Pressure	3. Pre-lift	4. First Valve Opening Pressure
Measure-ment Method	Pull out the plug screw, the second valve opening pressure adjustment shim, the second pressure spring, the second pressure pin, and the pre-lift adjustment shim; then, measure the valve opening pressure.	Set the pre-lift to zero by pulling out the pre-lift adjustment shim; then, measure the valve opening pressure.	Measure the amount of deflection of the dial gauge with the pre-lift adjustment shim removed and installed.	Assemble all parts and measure (verify) the valve opening pressure.
Adjustment Method	Adjust with the capsule screw (tightening the screw increases the valve opening pressure).	Select a second valve opening pressure adjustment shim (the thicker the shim the higher the valve opening pressure will be).	Select a pre-lift adjustment shim (the thicker the shim the greater the pre-lift will be).	—
Tools	Nozzle hand tester	Nozzle hand tester	2-spring nozzle adjustment tool (STT: 95091-10770) Dial gauge	Nozzle hand tester

d. STT

No.	Part Name	DENSO P/N	
1	2-spring nozzle adjustment tool	95091-10770	
2	Dial gauge	95800-10050	

e. Detailed Adjustment Procedure (For 093500-3090 as an example)

(1) First valve opening pressure adjustment

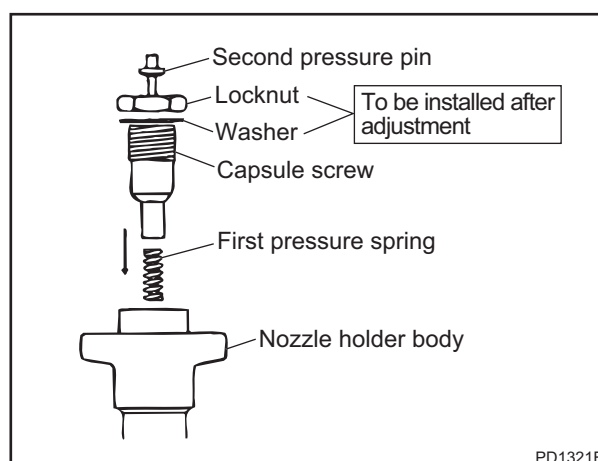
A) Adjustment 1

Assemble the nozzle and the first pressure pin on the nozzle holder and tighten them with the retaining nut.

- Tightening torque: 58.8 - 78.5N·m (6.0 - 8.0kgf·m)

B) Adjustment 2

Insert the first pressure spring and install the capsule screw.



C) Adjustment 3

Place it on the nozzle hand tester, and regulate the amount in which to screw in the capsule screw in order to adjust the first valve opening pressure.

- First valve opening pressure:  
17.7 - 18.6MPa (180 - 190kgf/cm<sup>2</sup>)

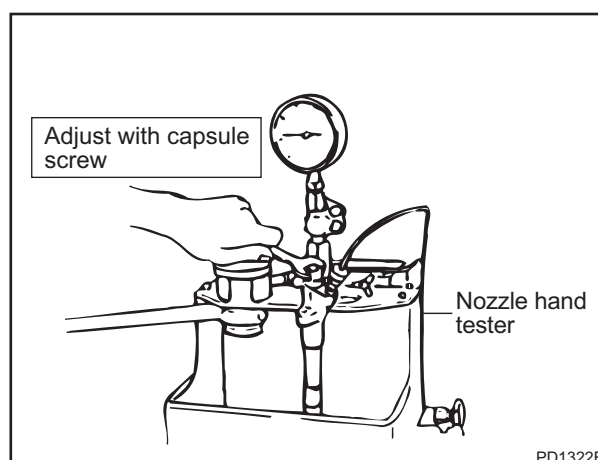
< NOTE >

- Screwing in the capsule screw increases the first valve opening pressure.

D) Adjustment 4

Tighten the locknut to secure the capsule screw in place.

- Tightening torque: 58.8 - 68.6N·m (6.0 - 7.0kgf·m)



(2) Second valve opening pressure adjustment

A) Adjustment 1

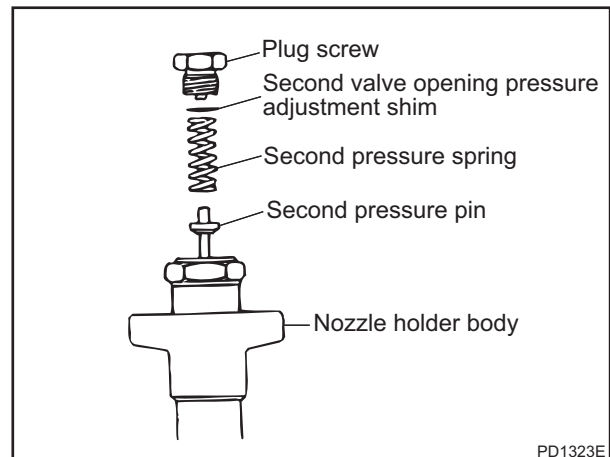
Assemble the second pressure pin, second pressure spring, and the second valve opening pressure adjustment shim. Then, tighten the plug screw until it comes in contact with the capsule screw.

< CAUTION >

- At this time, do not install the pre-lift adjustment shim.

< NOTE >

- At this time, a set load is applied to the second pressure spring, which pushes the second pressure pin downward. Because no pre-lift adjustment shim is installed, the amount of pre-lift is zero.



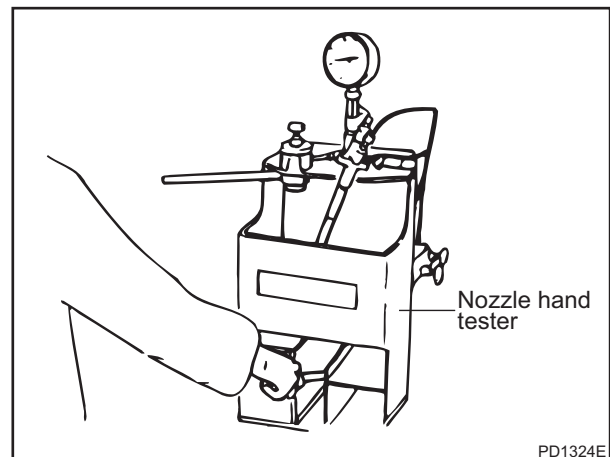
< NOTE >

- If the thickness of the second valve opening pressure adjustment shim that was installed is unknown, use 1.9mm as a nominal value.

B) Adjustment 2

Place it on the nozzle hand tester and measure the second valve opening pressure.

- Second valve opening pressure:  
24.9 - 25.7MPa (254 - 262kgf/cm<sup>2</sup>)



C) Adjustment 3

If the pressure deviates from the specified value, adjust it by changing the second valve opening pressure adjustment shim to one with a different thickness.

< NOTE >

- Although the relationship between shim thickness and valve opening pressure differs from product to product, the pressure changes approximately 0.1MPa (1.1 kgf/cm<sup>2</sup>) for every 0.01mm of shim thickness.

(3) Pre-lift adjustment

A) Adjustment 1

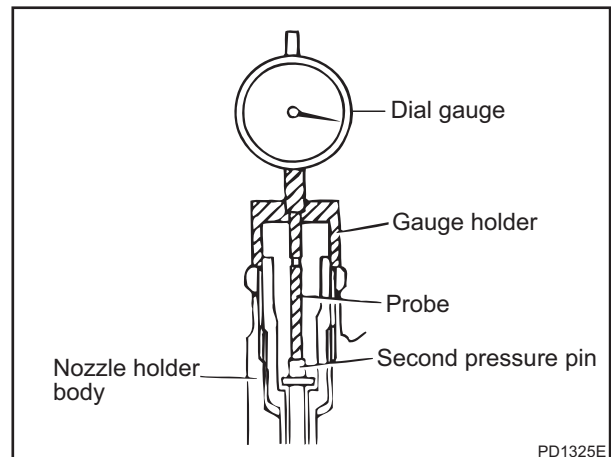
Remove the plug screw, second valve opening pressure adjustment shim, and the second pressure spring.

B) Adjustment 2

Place the dial gauge, probe, and the gauge holder on the nozzle holder.

C) Adjustment 3

Set the dial gauge graduation to zero (repeat this process two or three times).



D) Adjustment 4

Remove the second pressure pin and install the pre-lift adjustment shim.

E) Adjustment 5

Re-install the second pressure pin.

F) Adjustment 6

Similar to step "Adjustment 3", place the dial gauge and measure the amount of pre-lift.

- Pre-lift: 0.08 - 0.12mm

< NOTE >

- Because the pressure pins are in contact at this time, the second pressure pin will be slightly lifted. When a pre-lift adjustment shim is inserted in this state, the second pressure pin will move upward only in the amount of the pre-lift.

< NOTE >

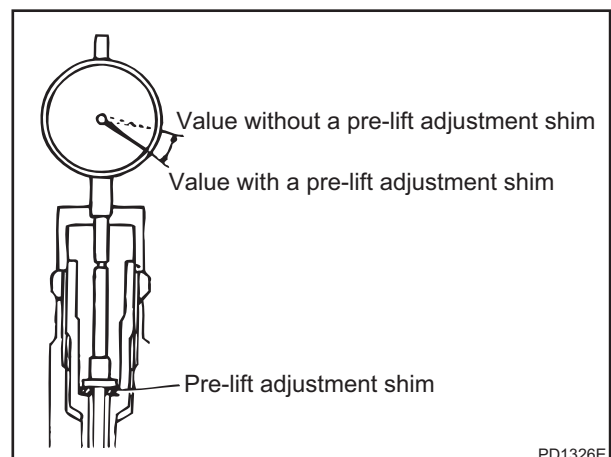
- If the thickness of the pre-lift adjustment shim that was installed is unknown, use 1.1mm as a nominal value.

G) Adjustment 7

If the amount of pre-lift deviates from the specified value, adjust it by changing the pre-lift adjustment shim to one with a different thickness.

< NOTE >

- If the amount of pre-lift is greater than the specified value, use a thinner shim. If it is smaller than the specified value, use a thicker shim.



(4) First valve opening pressure verification

A) Verification 1

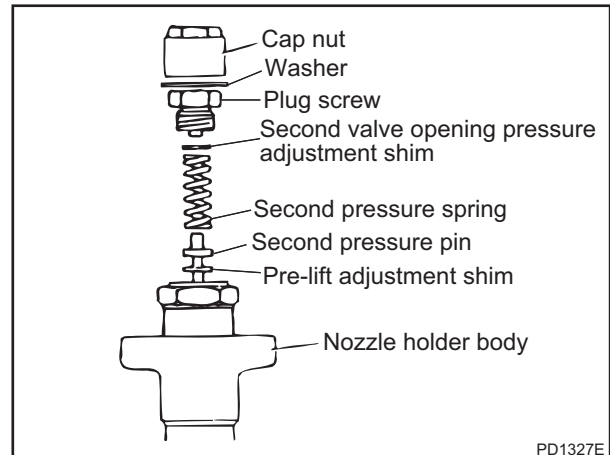
Install the pre-lift adjustment shim, the second pressure pin, the second pressure spring, and the second valve opening pressure adjustment shim; then, tighten the plug screw.

- Tightening torque: 29.4 - 39.2N·m (3.0 - 4.0kgf·m)

B) Verification 2

Using a washer in between, install the cap nut.

- Tightening torque: 39.2 - 49.0N·m (4.0 - 5.0kgf·m)



< CAUTION >

- Make sure to use a pre-lift adjustment shim and a second valve opening pressure adjustment shim as determined in the previously mentioned adjustment process.

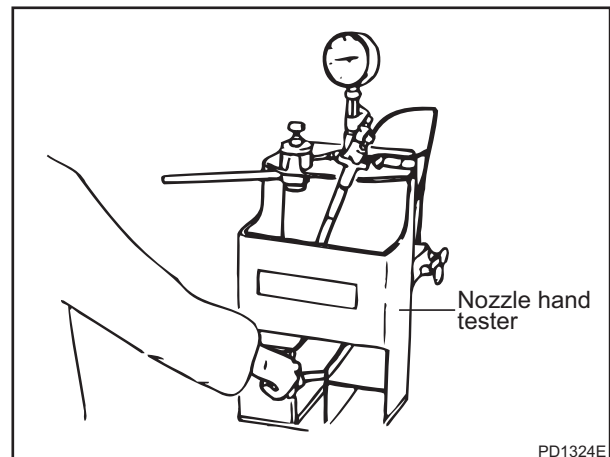
< CAUTION >

- Be careful in distinguishing a pre-lift adjustment shim and a second valve opening pressure adjustment shim, as both have the same size and shape.

C) Verification 3

Place the nozzle on the nozzle hand tester and verify that the first valve opening pressure has the following value:

- First valve opening pressure:  
17.7 - 18.4MPa (180 - 188kgf/cm<sup>2</sup>)

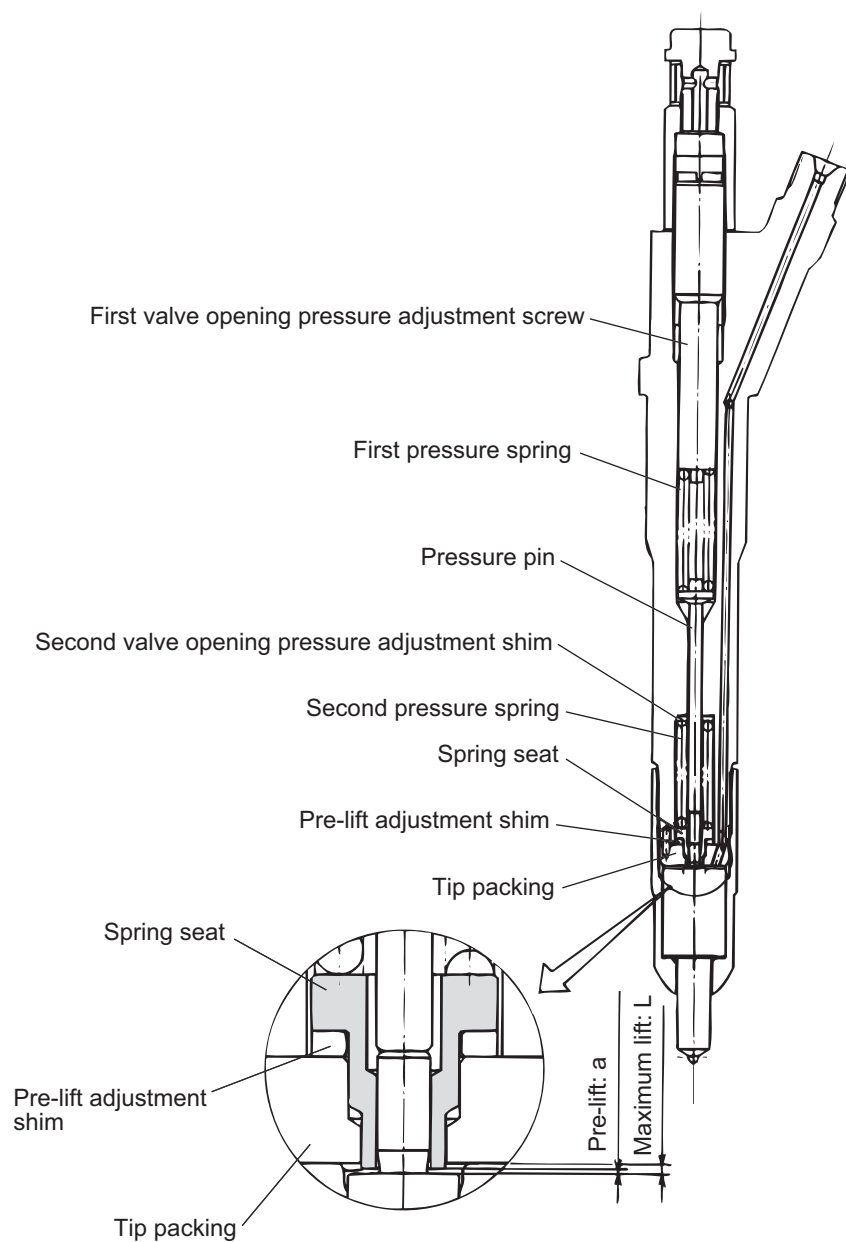


< CAUTION >

- If the pressure deviates from the specified value, repeat the adjustment process from the beginning.

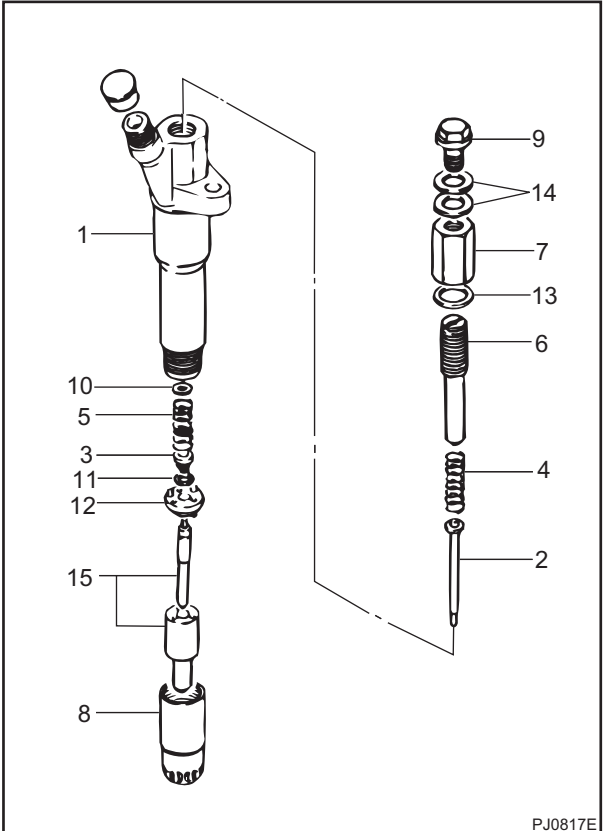
#### D. Type 4 (Reinforced Type)

##### a. Construction Diagram



PD1328E

b. Constituent Parts and Names

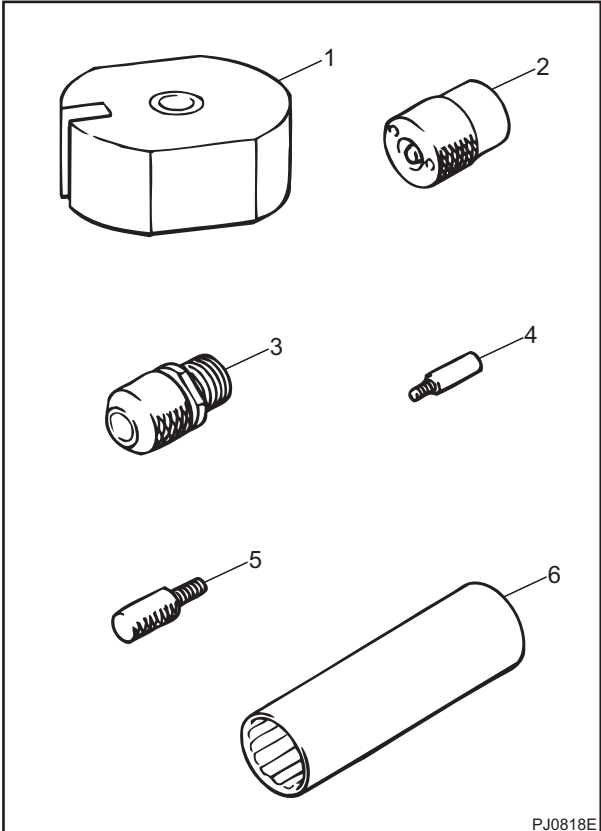
No.	Name	
1	Nozzle holder body	
2	Pressure pin	
3	Spring seat	
4	First pressure spring	
5	Second pressure spring	
6	First valve opening pressure adjustment screw	
7	Cap nut	
8	Retaining nut	
9	Hollow screw	
10	Second valve opening pressure adjustment shim	
11	Pre-lift adjustment shim	
12	Tip packing	
13	Copper plate washer	
14	Washer	
15	Nozzle assembly	
		PJ0817E



c. Adjustment Procedure (Summary)

Adjustment Sequence	1. Pre-lift	2. First Valve Opening Pressure	3. Second Valve Opening Pressure	4. First Valve Opening Pressure
Measure-ment Method	Measure the amount of deflection of the dial gauge with the pre-lift adjustment shim removed and installed.	Pull out the pre-lift adjustment shim, the second valve opening pressure adjustment shim, the spring seat, and the second pressure spring; then, measure the valve opening pressure.	Pull out the pre-lift adjustment shim and measure the valve opening pressure.	Install all parts and measure (verify) the valve opening pressure.
Adjustment Method	Select a pre-lift adjustment shim.	Adjust with the first valve opening pressure adjustment screw.	Select a second valve opening pressure adjustment shim.	—
Tools	2-spring base (STT: 95093-10230) Base (STT: 95093-20180) Dial gauge holder unit (STT: 95800-20010) Probe joint (STT: 95800-20020) Probe (STT: 95800-20030) Socket wrench (STT: 95991-10150) Dial gauge	Nozzle hand tester	Nozzle hand tester	Nozzle hand tester

d. STT

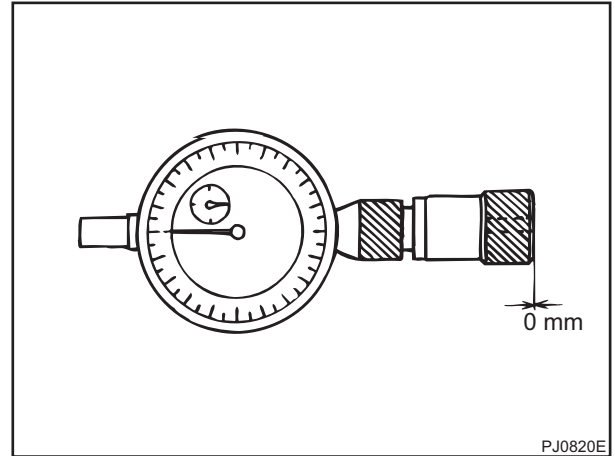
No.	Part Name	DENSO P/N	
1	2-spring base	95093-10230	
2	Base	95093-20180	
3	Dial gauge holder unit	95800-20010	
4	Probe joint	95800-20020	
5	Probe	95800-20030	
6	Socket wrench	95991-10150	
			PJ0818E

e. Detailed Adjustment Procedure (For 093500-4880 as an example)

(1) Pre-lift adjustment

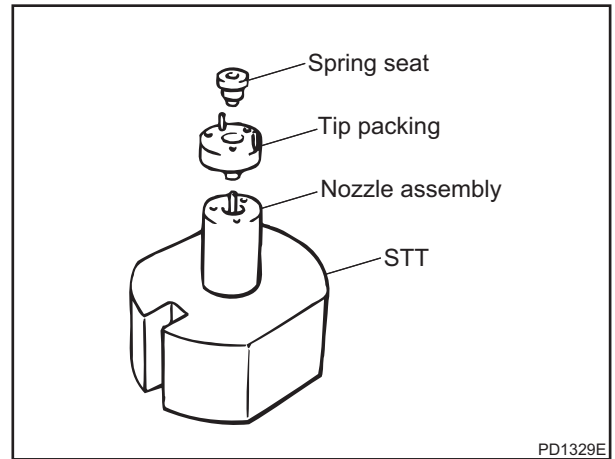
A) Adjustment 1

Render the distance between the probe and the end of the STT to be approximately 0mm; then install the STT on the dial gauge.



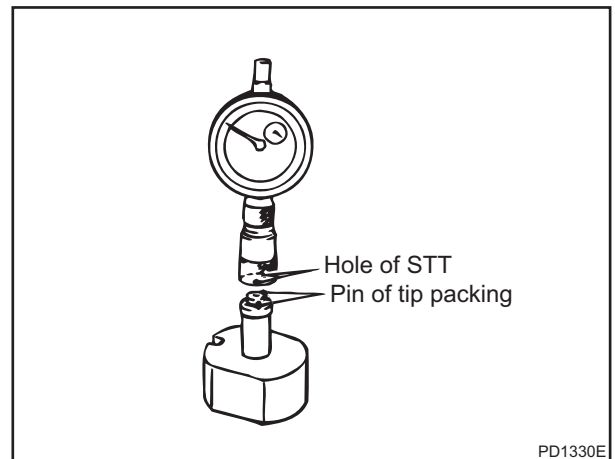
B) Adjustment 2

Install the nozzle assembly, the tip packing, and the spring seat on the STT.



C) Adjustment 3

Align the hole of the STT with the pin of the tip packing and set the dial gauge graduation to zero.

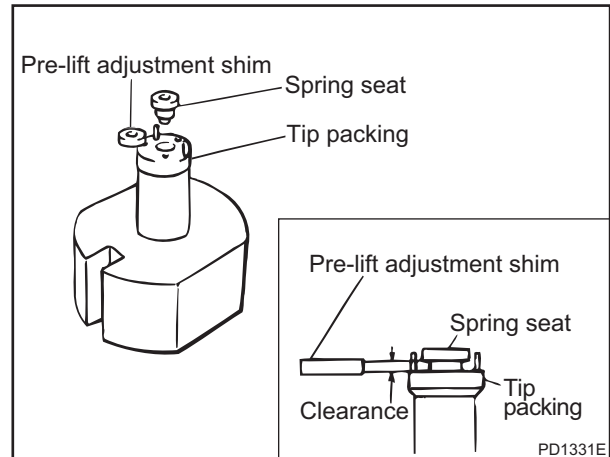


D) Adjustment 4

Select a pre-lift adjustment shim that is thicker than the clearance between the tip packing and the spring seat. Then install the shim between the tip packing and the spring seat.

< NOTE >

- Select and install a pre-lift adjustment shim with a nominal value of 1.5mm.



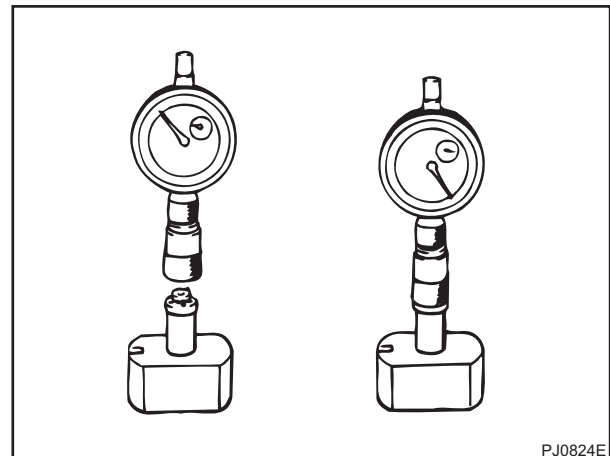
E) Adjustment 5

Using a dial gauge, measure the amount of pre-lift. Then, replace the pre-lift adjustment shim with one of a different thickness in order to attain the specified value indicated below.

- Specified value:  $0.095 \pm 0.015\text{mm}$

< NOTE >

- Using a thicker pre-lift adjustment shim increases the amount of pre-lift.



< CAUTION >

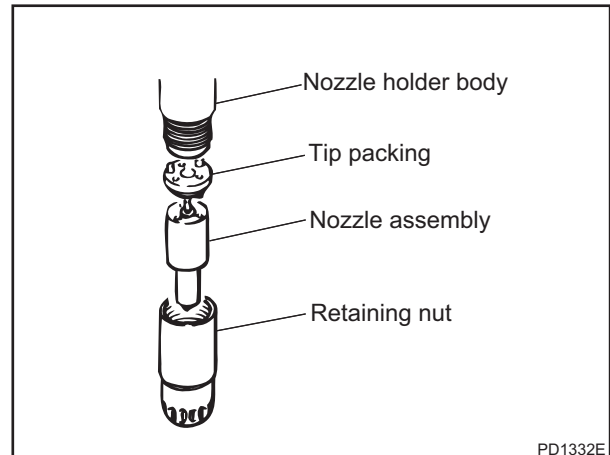
- Because adjusting the pre-lift requires high precision, thoroughly clean the parts and make sure that they are free of foreign objects before performing the operation.

(2) First valve opening pressure adjustment

A) Adjustment 1

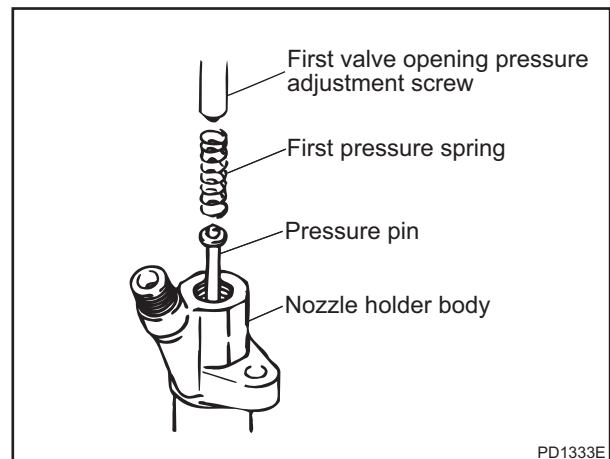
Install the nozzle assembly and the tip packing in the nozzle holder body. Using the STT, tighten the retaining nut.

- Tightening torque: 58.8 - 78.5N.m (6.0 - 8.0kgf.m)



B) Adjustment 2

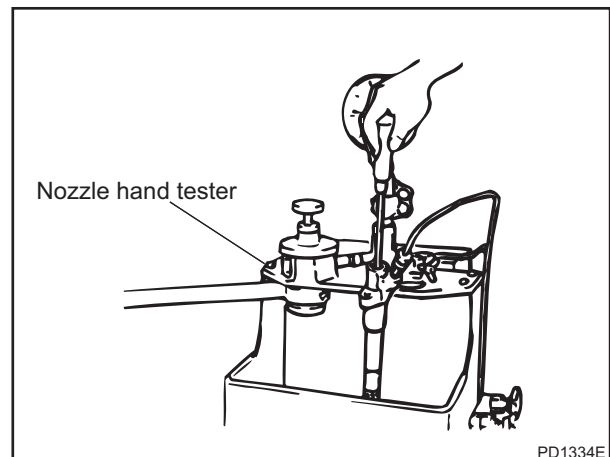
Insert the pressure pin into the nozzle holder body. Then, insert the first pressure spring, install the first valve opening pressure adjustment screw, and tighten it until it comes in contact with the first pressure spring.



C) Adjustment 3

Place it on the nozzle hand tester, and regulate the amount in which to screw in the first valve opening pressure adjustment screw in order to adjust the first valve opening pressure.

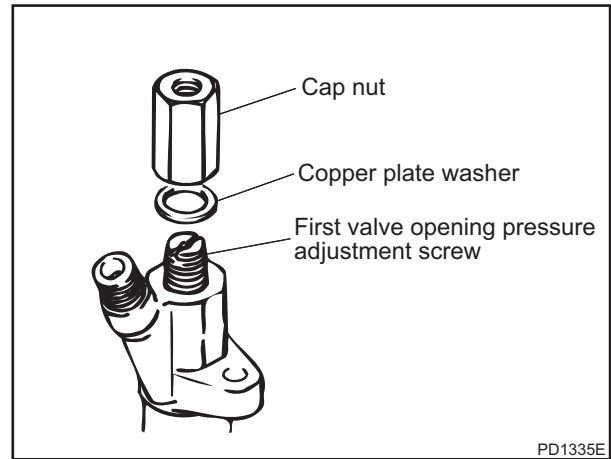
- First valve opening pressure:  
14.7 - 15.5MPa (150 - 158kgf/cm<sup>2</sup>)



D) Adjustment 4

Using the copper plate washer and the cap nut, secure the first valve opening pressure adjustment screw in place.

- Tightening torque: 39.2 - 49.0N·m (4.0 - 5.0kgf·m)



(3) Second valve opening pressure adjustment

A) Adjustment 1

In the nozzle holder body, install the second valve opening pressure adjustment shim, the second pressure spring, the spring seat, the tip packing, and the nozzle assembly.

Then, use the STT to tighten the retaining nut.

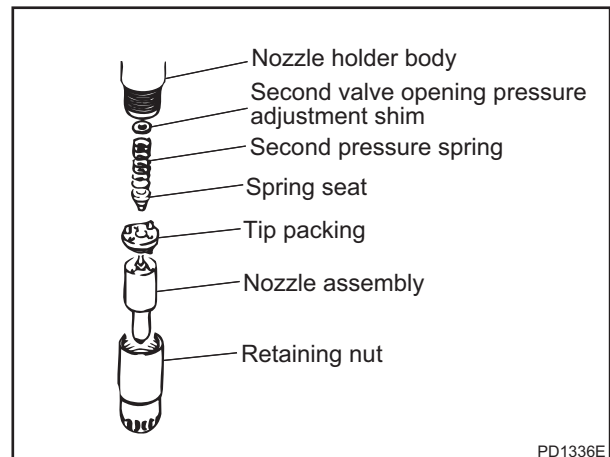
- Tightening torque: 58.8 - 78.5N.m (6.0 - 8.0kgf.m)

< CAUTION >

- Do not install the pre-lift adjustment shim.

< NOTE >

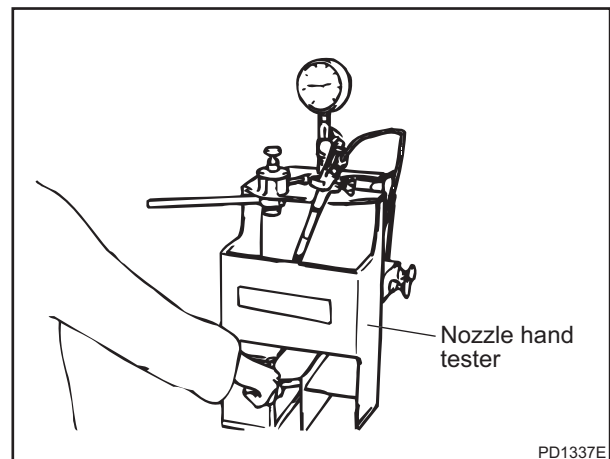
- If the thickness of the second valve opening pressure adjustment shim that was installed is unknown, use 1.4mm as a nominal value.



B) Adjustment 2

Place it on the nozzle hand tester and measure the second valve opening pressure.

- Second valve opening pressure:  
27.6 - 28.3MPa (281 - 289kgf/cm<sup>2</sup>)



C) Adjustment 3

If the pressure deviates from the specified value, adjust it by changing the second valve opening pressure adjustment shim to one with a different thickness.

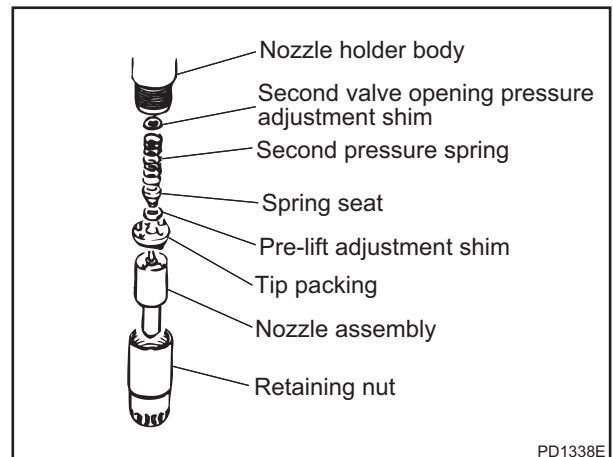
< NOTE >

- Although the relationship between shim thickness and valve opening pressure differs from product to product, the pressure changes approximately 0.1MPa (0.9 kgf/cm<sup>2</sup>) for every 0.01mm of shim thickness.

(4) First valve opening pressure verification

A) Verification 1

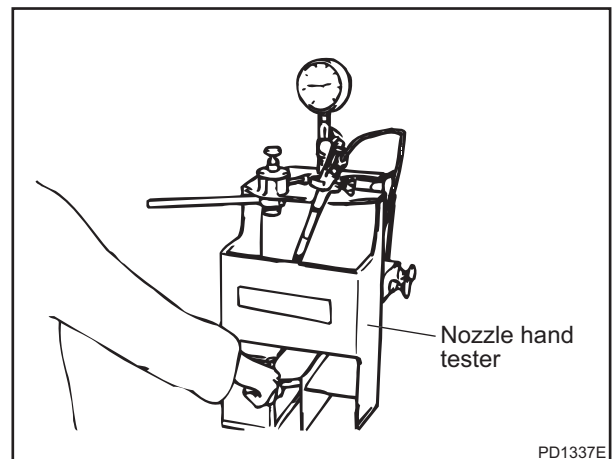
Install the pre-lift adjustment shim that was used in the adjustment in section (1).



B) Verification 2

Place it on the nozzle hand tester and verify that the first valve opening pressure has the value indicated below.

- First valve opening pressure:  
14.7 - 15.5MPa (150 - 158kgf/cm<sup>2</sup>)





1-8. Reference Material (Reference only. The latest data is updated on ETSI.)

A. List of Adjustment Values

Nozzle & Nozzle Holder P/N	Nozzle Holder Type	Nozzle P/N	First Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Second Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Pre-lift (mm)	Maximum Lift (mm)	Type
093500-2680	KBL	093400-1540	15.2 - 16.0 [155 - 163]	26.3 - 27.1 [268 - 276]	0.140 ± 0.02	0.4 ± 0.02	3
093500-2690	KBL	093400-1550	15.2 - 16.0 [155 - 163]	26.3 - 27.1 [268 - 276]	0.140 ± 0.02	0.4 ± 0.02	3
093500-2730	KBL	093400-1170	15.2 - 15.7 [155 - 160]	26.9 - 27.7 [274 - 282]	0.11 ± 0.02	0.34 ± 0.02	3
093500-3090	KBL	093400-1810	17.7 - 18.4 [180 - 188]	24.9 - 25.7 [254 - 262]	0.1 ± 0.02	0.305 ± 0.025	3
093500-3210	KBL	093400-1900	15.2 - 15.7 [155 - 160]	26.9 - 27.7 [274 - 282]	0.11 ± 0.02	0.34 ± 0.02	3
093500-3443	KBL	093400-2270	15.2 - 15.7 [155 - 160]	22.7 - 23.4 [231 - 239]	0.08 ± 0.02	0.245 ± 0.015	3
093500-3452	KBL	093400-2002	15.7 - 16.2 [160 - 165]	22.7 - 23.4 [231 - 239]	0.08 ± 0.02	0.245 ± 0.015	3
093500-3980	KBL	093400-2210	17.7 - 18.4 [180 - 188]	24.9 - 25.7 [254 - 262]	0.1 ± 0.02	0.305 ± 0.025	3
093500-3991	KBAL	093400-6020	17.2 - 18.1 [175 - 185]	8.9 - 9.9 [91 - 101]	0.09 ± 0.02	0.205 ± 0.025	1
093500-4170	KBL	093400-2260	17.7 - 18.4 [180 - 188]	24.9 - 25.7 [254 - 262]	0.1 ± 0.02	0.355 ± 0.025	3
093500-4350	KBAL	093400-5770	17.7 - 18.6 [180 - 190]	12.8 - 13.7 [130 - 140]	0.09 ± 0.01	0.305 ± 0.025	1
093500-4481	KBAL	093400-5500	16.2 - 17.2 [165 - 175]	13.7 - 14.7 [140 - 150]	0.08 ± 0.02	0.275 ± 0.025	1
093500-4491	KBAL	093400-5790	16.2 - 17.2 [165 - 175]	13.8 - 14.8 [141 - 151]	0.08 ± 0.02	0.275 ± 0.025	1
093500-4530	KBL	093400-2380	15.2 - 16.0 [155 - 163]	27.0 - 27.8 [275 - 283]	0.125 ± 0.018	0.39 ± 0.02	4
093500-4590	KBL	093400-2400	15.2 - 16.0 [155 - 163]	27.0 - 27.8 [275 - 283]	0.125 ± 0.16	0.4 ± 0.02	4
093500-4610	KBL	093400-2410	15.2 - 16.0 [155 - 163]	27.0 - 27.8 [275 - 283]	0.125 ± 0.16	0.4 ± 0.02	4
093500-4620	KBL	093400-2420	16.2 - 17.0 [165 - 173]	25.0 - 25.8 [255 - 263]	0.08 ± 0.02	0.305 ± 0.025	3
093500-4631	KBL	093400-2431	16.2 - 17.0 [165 - 173]	25.0 - 25.8 [255 - 263]	0.08 ± 0.02	0.305 ± 0.025	3
093500-4640	KBL	093400-2440	16.2 - 17.0 [165 - 173]	13.0 - 13.8 [133 - 141]	0.125 ± 0.018	0.39 ± 0.02	4

Nozzle & Nozzle Holder P/N	Nozzle Holder Type	Nozzle P/N	First Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Second Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Pre-lift (mm)	Maximum Lift (mm)	Type
093500-4730	KBL	093400-2480	15.2 - 15.7 [155 - 160]	26.9 - 27.7 [274 - 282]	0.11 ± 0.02	0.34 ± 0.02	3
093500-4820	KBL	093400-2510	18.1 - 18.9 [185 - 193]	29.2 - 30.0 [298 - 306]	0.1 ± 0.02	0.345 ± 0.015	3
093500-4860	KBL	093400-2530	18.1 - 18.9 [185 - 193]	29.2 - 30.0 [298 - 306]	0.1 ± 0.02	0.345 ± 0.015	3
093500-4890	KBL	093400-2410	15.2 - 16.0 [155 - 163]	27.6 - 28.3 [281 - 289]	0.095 ± 0.15	0.4 ± 0.02	4
093500-5140	KBL	093400-2650	15.2 - 16.0 [155 - 163]	14.3 - 15.1 [146 - 154]	0.095 ± 0.018	0.39 ± 0.02	4
093500-5200	KBL	093400-2670	15.2 - 16.0 [155 - 163]	27.6 - 28.3 [281 - 289]	0.095 ± 0.18	0.4 ± 0.02	4
093500-5270	KBAL	093400-6100	16.2 - 17.2 [165 - 175]	13.8 - 14.8 [141 - 151]	0.08 ± 0.02	0.225 ± 0.025	1
093500-5282	KBL	093400-2710	15.2 - 15.7 [155 - 160]	14.6 - 15.1 [148.5 - 153.5]	0.125 ± 0.018	0.34 ± 0.02	4
093500-5490	KBAL	093400-6180	22.6 - 23.5 [230 - 240]	15.0 - 16.0 [153 - 163]	0.09 ± 0.01	0.355 ± 0.025	1
093500-5520	KBAL	093400-2750	17.2 - 18.0 [175 - 183]	15.0 - 15.8 [153 - 161]	0.095 ± 0.018	0.39 ± 0.02	4
093500-5540	KBAL	093400-2760	17.2 - 18.0 [175 - 183]	13.3 - 14.1 [136 - 144]	0.115 ± 0.018	0.245 ± 0.015	4
093500-5570	KBAL	093400-2790	18.1 - 19.0 [185 - 193]	11.8 - 12.6 [120 - 128]	0.115 ± 0.018	0.31 ± 0.02	4
093500-5610	KBAL	093400-5770	17.7 - 18.6 [180 - 190]	13.5 - 14.5 [138 - 148]	0.06 ± 0.01	0.255 ± 0.025	1
093500-5730	KBAL	093400-6240	16.2 - 17.2 [165 - 175]	13.8 - 14.8 [141 - 151]	0.08 ± 0.02	0.255 ± 0.025	1
093500-5780	KBAL	093400-5770	17.7 - 18.6 [180 - 190]	13.2 - 14.2 [135 - 145]	0.07 ± 0.1	0.255 ± 0.025	2
093500-5800	KBAL	093400-5770	18.0 - 18.2 [184 - 186]	13.6 - 13.8 [139 - 141]	0.07 ± 0.005	0.255 ± 0.025	1
093500-5830	KBAL	093400-6290	22.6 - 23.5 [230 - 240]	15.0 - 16.0 [153 - 163]	0.09 ± 0.01	0.355 ± 0.025	1
093500-6000	KBAL	093400-2990	16.2 - 17.0 [165 - 173]	12.3 - 13.0 [125 - 133]	0.085 ± 0.018	0.255 ± 0.025	4
093500-6010	KBAL	093400-6390	17.7 - 18.6 [180 - 190]	23.1 - 24.0 [235 - 245] (- 97/8)	0.095 ± 0.01	0.255 ± 0.025	2

Nozzle & Nozzle Holder P/N	Nozzle Holder Type	Nozzle P/N	First Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Second Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Pre-lift (mm)	Maximum Lift (mm)	Type
093500-6010	KBAL	093400-6390	17.7 - 18.6 [180 - 190]	30.5 - 31.5 [311 - 321] (97/9 -)	0.095 ± 0.01	0.255 ± 0.025	2
093500-6030	KBAL	093400-6410	16.2 - 17.2 [165 - 175]	19.6 - 20.6 [200 - 210] (- 97/8)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6030	KBAL	093400-6410	16.2 - 17.2 [165 - 175]	27.1 - 28.1 [276 - 286] (97/9 -)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6040	KBAL	093400-6420	16.2 - 17.2 [165 - 175]	19.6 - 20.6 [200 - 210] (- 97/8)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6040	KBAL	093400-6420	16.2 - 17.2 [165 - 175]	27.1 - 28.1 [276 - 286] (97/9 -)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6051	KBAL	093400-6490	17.7 - 18.6 [180 - 190]	18.1 - 19.1 [185 - 195] (- 97/8)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6051	KBAL	093400-6490	17.7 - 18.6 [180 - 190]	25.6 - 26.6 [261 - 271] (97/9 -)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6110	KBAL	093400-6440	16.7 - 17.7 [170 - 180]	19.5 - 20.5 [199 - 209] (- 97/8)	0.11 ± 0.01	0.255 ± 0.025	2
093500-6110	KBAL	093400-6440	16.7 - 17.7 [170 - 180]	27.0 - 28.0 [275 - 285] (97/9 -)	0.11 ± 0.01	0.255 ± 0.025	2
093500-6120	KBAL	093400-6450	17.7 - 18.6 [180 - 190]	18.5 - 19.5 [189 - 199] (- 97/8)	0.11 ± 0.01	0.255 ± 0.025	2
093500-6120	KBAL	093400-6450	17.7 - 18.6 [180 - 190]	25.9 - 26.9 [264 - 274] (97/9 -)	0.11 ± 0.01	0.255 ± 0.025	2
093500-6130	KBAL	093400-6460	23.5 - 24.5 [240 - 250]	21.7 - 22.7 [221 - 231] (- 97/8)	0.118 ± 0.01	0.325 ± 0.025	2
093500-6130	KBAL	093400-6460	23.5 - 24.5 [240 - 250]	29.1 - 30.1 [297 - 307] (97/9 -)	0.118 ± 0.01	0.325 ± 0.025	2

Nozzle & Nozzle Holder P/N	Nozzle Holder Type	Nozzle P/N	First Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Second Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Pre-lift (mm)	Maximum Lift (mm)	Type
093500-6140	KBAL	093400-6470	23.5 - 24.5 [240 - 250]	21.7 - 22.7 [221 - 231] (- 97/8)	0.118 ± 0.01	0.325 ± 0.025	2
093500-6140	KBAL	093400-6470	23.5 - 24.5 [240 - 250]	29.1 - 30.1 [297 - 307] (97/9 -)	0.118 ± 0.01	0.325 ± 0.025	2
093500-6150	KBAL	093400-6480	23.5 - 24.5 [240 - 250]	21.7 - 22.7 [221 - 231] (- 97/8)	0.118 ± 0.01	0.325 ± 0.025	2
093500-6150	KBAL	093400-6480	23.5 - 24.5 [240 - 250]	29.1 - 30.1 [297 - 307] (97/9 -)	0.118 ± 0.01	0.325 ± 0.025	2
093500-6160	KBL	093400-2710	15.2 - 15.7 [155 - 160]	14.6 - 15.1 [148.5 - 153.5]	0.125 ± 0.018	0.34 ± 0.02	2
093500-6170	KBAL	093400-6390	17.7 - 18.6 [180 - 190]	23.1 - 24.0 [235 - 245]	0.085 ± 0.105	0.255 ± 0.025	2
093500-6230	KBAL	093400-6440	16.7 - 17.7 [170 - 180]	19.5 - 20.5 [199 - 209]	0.11 ± 0.1	0.255 ± 0.025	2
093500-6240	KBAL	093400-6450	17.7 - 18.6 [180 - 190]	18.5 - 19.5 [189 - 199]	0.11 ± 0.1	0.255 ± 0.025	2
093500-6260	KBAL	093400-3050	17.2 - 18.0 [175 - 183]	12.9 - 13.7 [132 - 140]	0.115 ± 0.018	0.295 ± 0.015	4
093500-6400	KBAL	093400-6410	16.2 - 17.2 [165 - 175]	19.6 - 20.6 [200 - 210] (- 97/8)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6400	KBAL	093400-6410	16.2 - 17.2 [165 - 175]	27.1 - 28.1 [276 - 286] (97/9 -)	0.08 ± 0.01	0.255 ± 0.025	2
093500-6420	KBAL	093400-6660	17.7 - 18.6 [180 - 190]	18.8 - 19.8 [192 - 202] (- 97/8)	0.09 ± 0.01	0.255 ± 0.025	2
093500-6420	KBAL	093400-6660	17.7 - 18.6 [180 - 190]	26.3 - 27.3 [268 - 278] (97/9 -)	0.09 ± 0.01	0.255 ± 0.025	2
093500-6440	KBAL	093400-6670	17.7 - 18.6 [180 - 190]	22.5 - 23.4 [229 - 239] (- 97/8)	0.075 ± 0.01	0.255 ± 0.025	2
093500-6440	KBAL	093400-6670	17.7 - 18.6 [180 - 190]	29.9 - 30.9 [305 - 315] (97/9 -)	0.075 ± 0.01	0.255 ± 0.025	2

Nozzle & Nozzle Holder P/N	Nozzle Holder Type	Nozzle P/N	First Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Second Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Pre-lift (mm)	Maximum Lift (mm)	Type
093500-6510	KBAL	093400-6660	17.7 - 18.6 [180 - 190]	18.8 - 19.8 [192 - 202]	0.09 ± 0.01	0.255 ± 0.025	2
093500-6600	KBAL	093400-6770	24.5 - 25.5 [250 - 260]	16.1 - 17.1 [164 - 174]	0.09 ± 0.01	0.255 ± 0.025	1
093500-6610	KBAL	093400-6780	24.5 - 25.5 [250 - 260]	21.6 - 22.6 [220 - 230] (- 97/8)	0.09 ± 0.01	0.285 ± 0.025	2
093500-6610	KBAL	093400-6780	24.5 - 25.5 [250 - 260]	29.0 - 30.0 [296 - 306] (97/9 -)	0.09 ± 0.01	0.285 ± 0.025	2
093500-6640	KBAL	093400-2970	17.2 - 18.0 [175 - 183]	31.3 - 32.3 [319 - 329]	0.115 ± 0.018	0.3 ± 0.02	4
093500-6650	KBAL	093400-2960	18.1 - 18.9 [185 - 193]	16.2 - 17.0 [165 - 173]	0.095 ± 0.018	0.3 ± 0.02	4
093500-6740	KBAL	093400-7180	17.7 - 18.6 [180 - 190]	27.2 - 28.2 [277 - 287] (- 97/8)	0.043 ± 0.008	0.255 ± 0.025	2
093500-6740	KBAL	093400-7180	17.7 - 18.6 [180 - 190]	34.0 - 35.0 [347 - 357] (97/9 -)	0.043 ± 0.008	0.255 ± 0.025	2
093500-6810	KBAL	093400-6880	17.7 - 18.6 [180 - 190]	18.1 - 19.1 [185 - 195]	0.08 ± 0.01	0.255 ± 0.025	2
093500-6820	KBAL	093400-6890	16.2 - 17.2 [165 - 175]	19.6 - 20.6 [200 - 210]	0.08 ± 0.01	0.255 ± 0.025	2
093500-6830	KBAL	093400-6910	17.7 - 18.6 [180 - 190]	18.1 - 19.1 [185 - 195]	0.08 ± 0.01	0.255 ± 0.025	2
093500-6840	KBAL	093400-6920	17.7 - 18.6 [180 - 190]	22.5 - 23.4 [229 - 239]	0.075 ± 0.01	0.255 ± 0.025	2
093500-6880	KBAL	093400-3140	17.2 - 18.0 [175 - 183]	13.0 - 13.8 [133 - 141]	0.115 ± 0.018	0.3 ± 0.02	4
093500-6950	KBAL	093400-3180	17.2 - 18.0 [175 - 183]	21.6 [220]	0.115 ± 0.018	0.295 ± 0.015	4
093500-6960	KBAL	093400-6970	17.2 - 18.1 [175 - 185]	35.5 [362]	0.055 ± 0.01	0.255 ± 0.025	2
093500-7001	KBAL	093400-7000	17.2 - 18.1 [175 - 185]	8.9 - 9.9 [91 - 101]	0.09 ± 0.02	0.205 ± 0.025	1
093500-7030	KBAL	093400-7050	17.6 - 18.6 [180 - 190]	18.1 - 19.1 [185 - 195]	0.08 ± 0.01	0.255 ± 0.025	2
093500-7060	KBAL	093400-6420	16.2 - 17.2 [165 - 175]	19.6 - 20.6 [200 - 210]	0.08 ± 0.01	0.255 ± 0.025	2

Nozzle & Nozzle Holder P/N	Nozzle Holder Type	Nozzle P/N	First Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Second Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Pre-lift (mm)	Maximum Lift (mm)	Type
093500-7070	KBAL	093400-6840	17.7 - 18.6 [180 - 190]	34.0 - 35.0 [347 - 357]	0.0425 ± 0.075	0.255 ± 0.025	2
093500-7110	KBAL	093400-7130	17.7 - 18.6 [180 - 190]	29.5 - 30.5 [301 - 311]	0.047 ± 0.005	0.355 ± 0.025	2
093500-7140	KBAL	093400-7150	16.2 - 17.2 [165 - 175]	26.3 - 27.3 [268 - 278]	0.08 ± 0.01	0.305 ± 0.025	2
093500-7150	KBAL	093400-7160	17.7 - 18.6 [180 - 190]	24.8 - 25.8 [253 - 263]	0.08 ± 0.01	0.305 ± 0.025	2
093500-7160	KBAL	093400-3220	17.2 - 18.0 [175 - 183]	19.9 - 20.7 [203 - 211]	0.085 ± 0.01	0.3 ± 0.02	4
093500-7180	KBAL	093400-7210	17.7 - 18.6 [180 - 190]	18.1 - 19.1 [185 - 195]	0.08 ± 0.01	0.255 ± 0.025	2
093500-7210	KBAL	093400-3140	16.7 - 17.5 [170 - 178]	13.6 - 14.4 [139 - 147]	0.105 ± 0.01	0.3 ± 0.02	4
093500-7270	KBAL	093400-6840	17.7 - 18.6 [180 - 190]	34.0 - 35.0 [347 - 357]	0.0425 ± 0.075	0.25 ± 0.02	2
093500-7310	KBAL	093400-7380	18.1 - 19.1 [185 - 195]	32.6 - 32.5 [332 - 342]	0.06 ± 0.01	0.255 ± 0.025	2
093500-7350	KBAL	093400-6840	17.7 - 18.6 [180 - 190]	34.0 - 35.0 [347 - 357]	0.0425 ± 0.075	0.25 ± 0.02	2
093500-7390	KBAL	093400-7440	20.6 - 21.6 [210 - 220]	35.3 - 36.3 [360 - 370]	0.0425 ± 0.075	0.255 ± 0.025	2
093500-7410	KBAL	093400-7370	17.7 - 18.6 [180 - 190]	29.9 - 30.9 [305 - 315]	0.07 ± 0.05	0.255 ± 0.025	2
093500-7430	KBL	093400-3300	20.1 - 20.9 [205V213]	29.6 - 30.6 [302 - 312]	0.09 ± 0.02	0.30 ± 0.02	4
093500-7440	KBAL	093400-7510	24.5 [250]	28.0 - 28.9 [285 - 295]	0.08 ± 0.01	0.355 ± 0.025	2
093500-7450	KBAL	093400-7550	15.7 - 16.7 [160 - 170]	26.5 - 27.5 [270 - 280]	0.08 ± 0.01	0.275 ± 0.025	2
093500-7460	KBAL	093400-7560	15.7 - 16.7 [160 - 170]	26.5 - 27.5 [270 - 280]	0.08 ± 0.01	0.275 ± 0.025	2
093500-7470	KBAL	093400-7570	17.7 - 18.6 [180 - 190]	25.6 - 26.6 [261 - 271]	0.08 ± 0.01	0.255 ± 0.025	2
093500-7480	KBAL	093400-7580	17.7 - 18.6 [180 - 190]	25.6 - 26.6 [261 - 271]	0.08 ± 0.01	0.255 ± 0.025	2
093500-7500	KBAL	093400-7680	17.7 - 18.6 [180 - 190]	25.6 - 26.6 [261 - 271]	0.08 ± 0.01	0.255 ± 0.025	2
093500-7510	KBAL	093400-7680	17.7 - 18.6 [180 - 190]	25.6 - 26.6 [261 - 271]	0.08 ± 0.01	0.255 ± 0.025	2

Nozzle & Nozzle Holder P/N	Nozzle Holder Type	Nozzle P/N	First Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Second Valve Opening Pressure MPa [kgf/cm <sup>2</sup> ]	Pre-lift (mm)	Maximum Lift (mm)	Type
093500-7530	KBAL	093400-7870	17.7 - 18.6 [180 - 190]	29.5 - 30.5 [301 - 311]	0.04MIN.	0.355 ± 0.025	2
093500-7550	KBAL	093400-7910	17.7 - 18.6 [180 - 190]	34.0 - 35.0 [347 - 357]	0.0425 ± 0.075	0.255 ± 0.025	2
093500-7570	KBAL	093400-7870	17.7 - 18.6 [180 - 190]	29.5 - 30.5 [301 - 311]	0.04MIN.	0.355 ± 0.025	2
093500-7590	KBAL	093400-7910	17.7 - 18.6 [180 - 190]	34.0 - 35.0 [347 - 357]	0.0425 ± 0.075	0.255 ± 0.025	2U
093500-7650	KBAL	093400-8090	17.7 - 18.6 [180 - 190]	34.5 [352.04]	0.0445 ± 0.05	0.255 ± 0.025	2
093500-7680	KBAL	093400-8230	17.7 - 18.8 [180.1 - 192.1]	25.3 [257.9]	0.095 ± 0.01	0.355 ± 0.025	2
093500-7690	KBAL	0934008300	17.7 - 18.8 [180.1 - 192.1]	26.5 [270.61]	0.08 ± 0.01	0.255 ± 0.025	2

B. List of Adjustment Shims (First Valve Opening Pressure/ Second Valve Opening Pressure/ Pre-lift)

DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)	DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)
093175-2180	7.35	3	1	093175-2600	7.35	3	0.9
093175-2190	7.35	3	1.05	093175-2610	7.35	3	0.975
093175-2200	7.35	3	1.1	093175-2620	7.35	3	1.025
093175-2210	7.35	3	1.15	093175-2630	7.35	3	1.075
093175-2220	7.35	3	1.2	093175-2640	7.35	3	1.125
093175-2230	7.35	3	1.25	093175-2650	7.35	3	1.175
093175-2240	7.35	3	1.3	093175-2660	7.35	3	1.225
093175-2250	7.35	3	1.35	093175-2670	10.2	3.8	1
093175-2260	7.35	3	1.4	093175-2690	10.2	3.8	1.02
093175-2270	7.35	3	1.45	093175-2710	10.2	3.8	1.04
093175-2280	7.35	3	1.5	093175-2730	10.2	3.8	1.06
093175-2290	7.35	3	1.55	093175-2750	10.2	3.8	1.08
093175-2300	7.35	3	1.6	093175-2770	10.2	3.8	1.1
093175-2310	7.35	3	1.65	093175-2790	10.2	3.8	1.12
093175-2320	7.35	3	1.7	093175-2810	10.2	3.8	1.14
093175-2330	7.35	3	1.75	093175-2830	10.2	3.8	1.16
093175-2340	7.35	3	1.8	093175-2850	10.2	3.8	1.18
093175-2350	7.35	3	1.85	093175-2870	10.2	3.8	1.2
093175-2360	7.35	3	1.9	093175-2890	10.2	3.8	1.22
093175-2370	7.35	3	1.95	093175-2910	10.2	3.8	1.24
093175-2380	7.35	3	2	093175-2930	10.2	3.8	1.26
093175-2390	7.35	3	2.05	093175-2950	10.2	3.8	1.28
093175-2400	7.35	3	2.1	093175-2970	10.2	3.8	1.3
093175-2410	7.35	3	2.15	093175-2990	10.2	3.8	1.32
093175-2420	7.35	3	1.275	093175-3010	10.2	3.8	1.34
093175-2430	7.35	3	1.325	093175-3030	10.2	3.8	1.36
093175-2440	7.35	3	1.375	093175-3050	10.2	3.8	1.38
093175-2450	7.35	3	1.425	093175-3070	10.2	3.8	1.4
093175-2460	7.35	3	1.475	093175-3090	10.2	3.8	1.42
093175-2470	7.35	3	1.525	093175-3110	10.2	3.8	1.44
093175-2480	7.35	3	1.575	093175-3130	10.2	3.8	1.46
093175-2490	7.35	3	1.625	093175-3150	10.2	3.8	1.48
093175-2500	7.35	3	1.675	093175-3170	10.2	3.8	1.5
093175-2510	7.35	3	1.725	093175-3190	10.2	3.8	1.52
093175-2520	7.35	3	1.775	093175-3210	10.2	3.8	1.54
093175-2530	7.35	3	0.95	093175-3230	10.2	3.8	1.56
093175-2560	7.35	3	0.7	093175-3250	10.2	3.8	1.58
093175-2570	7.35	3	0.75	093175-3270	10.2	3.8	1.6
093175-2580	7.35	3	0.8	093175-3290	10.2	3.8	1.62
093175-2590	7.35	3	0.85	093175-3310	10.2	3.8	1.64



DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)	DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)
093175-3330	10.2	3.8	1.66	093175-4100	6.2	2	0.875
093175-3350	10.2	3.8	1.68	093175-4110	6.2	2	0.9
093175-3370	10.2	3.8	1.7	093175-4120	6.2	2	0.925
093175-3390	10.2	3.8	1.72	093175-4130	6.2	2	0.95
093175-3410	10.2	3.8	1.74	093175-4140	6.2	2	0.975
093175-3430	10.2	3.8	1.76	093175-4150	6.2	2	1
093175-3450	10.2	3.8	1.78	093175-4160	6.2	2	1.025
093175-3470	10.2	3.8	1.8	093175-4170	6.2	2	1.05
093175-3490	10.2	3.8	1.82	093175-4180	6.2	2	1.075
093175-3510	10.2	3.8	1.84	093175-4190	6.2	2	1.1
093175-3530	10.2	3.8	1.86	093175-4200	6.2	2	1.125
093175-3550	10.2	3.8	1.88	093175-4210	6.2	2	1.15
093175-3570	10.2	3.8	1.9	093175-4220	6.2	2	1.175
093175-3590	10.2	3.8	1.92	093175-4230	6.2	2	1.2
093175-3610	10.2	3.8	1.94	093175-4240	6.2	2	1.225
093175-3630	10.2	3.8	1.96	093175-4250	6.2	2	1.25
093175-3650	10.2	3.8	1.98	093175-4260	6.2	2	1.275
093175-3670	10.2	3.8	2	093175-4270	6.2	2	1.3
093175-3680	10.2	3.8	2.05	093175-4280	6.2	2	1.325
093175-3690	10.2	3.8	2.1	093175-4290	6.2	2	1.35
093175-3700	10.2	3.8	2.15	093175-4300	6.2	2	1.375
093175-3710	10.2	3.8	2.2	093175-4310	6.2	2	1.4
093175-3720	10.2	3.8	2.25	093175-4320	6.2	2	1.425
093175-3730	10.2	3.8	2.3	093175-4330	6.2	2	1.45
093175-3740	10.2	3.8	2.35	093175-4340	6.2	2	1.475
093175-3750	10.2	3.8	2.4	093175-4350	6.2	2	1.5
093175-3760	10.2	3.8	2.45	093175-4360	6.2	2	1.525
093175-3770	10.2	3.8	2.5	093175-4370	6.2	2	1.55
093175-3780	10.2	3.8	0.5	093175-4380	6.2	2	1.575
093175-3790	10.2	3.8	0.55	093175-4390	6.2	2	1.6
093175-3800	10.2	3.8	0.6	093175-4400	6.2	2	1.625
093175-3810	10.2	3.8	0.65	093175-4410	6.2	2	1.65
093175-3820	10.2	3.8	0.7	093175-4420	6.2	2	1.675
093175-3830	10.2	3.8	0.75	093175-4430	6.2	2	1.7
093175-3840	10.2	3.8	0.8	093175-4440	6.2	2	1.725
093175-3850	10.2	3.8	0.85	093175-4450	6.2	2	1.75
093175-3860	10.2	3.8	0.9	093175-4460	6.2	2	1.775
093175-3870	10.2	3.8	0.95	093175-4470	6.2	2	1.8
093175-4070	6.2	2	0.8	093175-4480	6.2	2	1.825
093175-4080	6.2	2	0.825	093175-4490	6.2	2	1.85
093175-4090	6.2	2	0.85	093175-4500	6.2	2	1.875

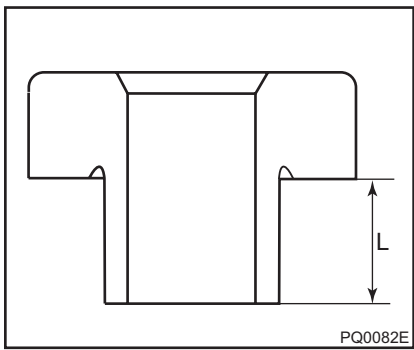
DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)	DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)
093175-4510	6.2	2	1.9	093175-5000	10	6.3	1.1
093175-4520	6.2	2	1.925	093175-5010	10	6.3	1.125
093175-4530	6.2	2	1.95	093175-5020	10	6.3	1.15
093175-4540	6.2	2	1.975	093175-5030	10	6.3	1.175
093175-4550	6.2	2	2	093175-5040	10	6.3	1.2
093175-4560	6.2	2	2.025	093175-5050	10	6.3	1.225
093175-4570	6.2	2	2.05	093175-5060	10	6.3	1.25
093175-4580	6.2	2	2.075	093175-5070	10	6.3	1.275
093175-4590	6.2	2	2.1	093175-5080	10	6.3	1.3
093175-4600	6.2	2	2.125	093175-5090	10	6.3	1.325
093175-4610	6.2	2	2.15	093175-5100	10	6.3	1.35
093175-4620	6.2	2	2.175	093175-5110	10	6.3	1.375
093175-4630	6.2	2	2.2	093175-5120	10	6.3	1.4
093175-4640	7.35	3	1.28	093175-5130	10	6.3	1.425
093175-4650	7.35	3	1.29	093175-5140	10	6.3	1.45
093175-4660	7.35	3	1.31	093175-5150	10	6.3	1.475
093175-4670	7.35	3	1.32	093175-5160	10	6.3	1.5
093175-4680	7.35	3	1.33	093175-5170	10	6.3	1.525
093175-4690	7.35	3	1.34	093175-5180	10	6.3	1.55
093175-4700	7.35	3	1.36	093175-5190	10	6.3	1.575
093175-4710	7.35	3	1.37	093175-5200	10	6.3	1.6
093175-4720	7.35	3	1.38	093175-5210	10	6.3	1.625
093175-4730	7.35	3	1.39	093175-5220	10	6.3	1.65
093175-4740	7.35	3	1.41	093175-5230	10	6.3	1.675
093175-4750	7.35	3	1.42	093175-5240	10	6.3	1.7
093175-4760	7.35	3	1.43	093175-5250	10	6.3	1.75
093175-4770	7.35	3	1.44	093175-5260	10	6.3	1.8
093175-4780	7.35	3	1.46	093175-5270	9.5	6.3	1.3
093175-4790	7.35	3	1.47	093175-5280	9.5	6.3	1.32
093175-4800	7.35	3	1.48	093175-5290	9.5	6.3	1.34
093175-4810	7.35	3	1.49	093175-5300	9.5	6.3	1.36
093175-4820	7.35	3	1.51	093175-5310	9.5	6.3	1.38
093175-4830	7.35	3	1.52	093175-5320	9.5	6.3	1.4
093175-4840	7.35	3	1.53	093175-5330	9.5	6.3	1.42
093175-4850	7.35	3	1.54	093175-5340	9.5	6.3	1.44
093175-4860	7.35	3	1.56	093175-5350	9.5	6.3	1.46
093175-4870	7.35	3	1.57	093175-5360	9.5	6.3	1.48
093175-4960	7.35	3	1.68	093175-5370	9.5	6.3	1.5
093175-4970	7.35	3	1.69	093175-5380	9.5	6.3	1.52
093175-4980	10	6.3	1	093175-5390	9.5	6.3	1.54
093175-4990	10	6.3	1.05	093175-5400	9.5	6.3	1.56

DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)	DENSO P/N	Outer Diameter (mm)	Inner Diameter (mm)	Plate Thickness (mm)
093175-5410	9.5	6.3	1.58	093175-5930	9.4	3.8	1.05
093175-5420	9.5	6.3	1.6	093175-5940	9.4	3.8	1.075
093175-5430	9.5	6.3	1.62	093175-5950	9.4	3.8	1.1
093175-5440	9.5	6.3	1.64	093175-5960	9.4	3.8	1.125
093175-5450	9.5	6.3	1.66	093175-5970	9.4	3.8	1.15
093175-5460	9.5	6.3	1.68	093175-5980	9.4	3.8	1.175
093175-5470	9.5	6.3	1.7	093175-5990	9.4	3.8	1.2
093175-5480	9.4	3.8	1.4	093175-6000	9.4	3.8	1.225
093175-5490	9.4	3.8	1.425	093175-6010	9.4	3.8	1.25
093175-5500	9.4	3.8	1.45	093175-6020	9.4	3.8	1.275
093175-5510	9.4	3.8	1.475	093175-6030	9.4	3.8	1.3
093175-5520	9.4	3.8	1.5	093175-6040	9.4	3.8	1.325
093175-5530	9.4	3.8	1.525	093175-6050	9.4	3.8	1.35
093175-5540	9.4	3.8	1.55	093175-6060	9.4	3.8	1.375
093175-5550	9.4	3.8	1.575	093175-6120	7.35	3	1.825
093175-5560	9.4	3.8	1.6	093175-6130	7.35	3	1.875
093175-5570	9.4	3.8	1.625	093175-6140	7.35	3	1.925
093175-5580	9.4	3.8	1.65	093175-6150	7.35	3	1.975
093175-5590	9.4	3.8	1.675	093175-6160	7.35	3	2.025
093175-5600	9.4	3.8	1.7	093175-6170	7.35	3	2.075
093175-5610	9.4	3.8	1.725	093175-6180	7.35	3	2.125
093175-5620	9.4	3.8	1.75	093175-6190	7.35	3	2.175
093175-5630	9.4	3.8	1.775	093175-6200	7.35	3	2.2
093175-5640	9.4	3.8	1.8	093175-6210	7.35	3	2.225
093175-5650	9.4	3.8	1.825	093175-6220	7.35	3	2.25
093175-5660	9.4	3.8	1.85	093175-6630	9.5	6.3	1.43
093175-5670	9.4	3.8	1.875	093175-6640	9.5	6.3	1.45
093175-5680	9.4	3.8	1.9	093175-6650	9.5	6.3	1.47
093175-5690	9.4	3.8	1.925	093175-6660	9.5	6.3	1.49
093175-5700	9.4	3.8	1.95	093175-6670	9.5	6.3	1.51
093175-5710	9.4	3.8	1.975	093175-6680	9.5	6.3	1.53
093175-5720	9.4	3.8	2	093175-6690	9.5	6.3	1.55
093175-5730	9.4	3.8	2.025	093175-6700	9.5	6.3	1.57
093175-5740	9.4	3.8	2.05	093175-6710	9.5	6.3	1.59
093175-5750	9.4	3.8	2.075	093175-6720	9.5	6.3	1.61
093175-5760	9.4	3.8	2.1	093175-6730	9.5	6.3	1.63
093175-5910	9.4	3.8	1	093175-6740	9.5	6.3	1.65
093175-5920	9.4	3.8	1.025	093175-6750	9.5	6.3	1.67

### C. List of Maximum Lift Adjustment Washers

DENSO P/N	T (mm)		DENSO P/N	T (mm)	
093175-6070	1.9		093175-6350	2.4	
093175-6080	1.925		093175-6360	2.425	
093175-6090	1.95		093175-6370	2.45	
093175-6100	1.975		093175-6380	2.475	
093175-6110	2		093175-6390	2.5	

### D. List of Pre-lift Adjustment Spring Seats

DENSO P/N	L (mm)		DENSO P/N	L (mm)	
093128-0120	3.07		093128-0430	2.61	
093128-0130	3.08		093128-0440	2.615	
093128-0140	3.09		093128-0450	2.62	
093128-0150	3.1		093128-0460	2.625	
093128-0160	3.11		093128-0470	2.63	
093128-0170	3.12		093128-0480	2.635	
093128-0180	3.13		093128-0490	2.64	
093128-0190	3.14		093128-0500	2.645	
093128-0200	3.15		093128-0510	2.65	
093128-0210	3.16		093128-0520	2.655	
093128-0220	3.17		093128-0530	2.66	
093128-0230	3.18		093128-0540	2.665	
093128-0240	3.19		093128-0550	2.67	
093128-0250	3.2		093128-0560	2.675	
093128-0260	3.21		093128-0570	2.68	
093128-0270	3.22		093128-0580	2.685	
093128-0280	3.23		093128-0590	2.69	
093128-0290	3.24		093128-0600	2.695	
093128-0300	3.25		093128-0610	2.7	
093128-0310	3.26		093128-0620	2.705	
093128-0320	3.27		093128-0630	2.71	
093128-0330	3.28		093128-0640	2.715	
093128-0390	2.59		093128-0650	2.72	
093128-0400	2.595		093128-0660	2.725	
093128-0410	2.6		093128-0670	2.73	
093128-0420	2.605		093128-0680	2.735	

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