'96 Pub.No.EE17E-11040

ZEXEL

SERVICE MANUAL

CONSTRUCTION & OPERATION
REPAIR & MAINTENANCE

TWO-SPRING NOZZLE HOLDER

ZEXEL

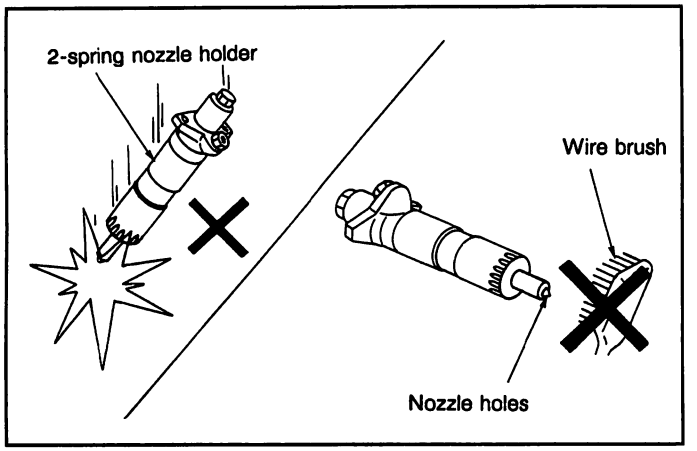
FOREWORD

This service manual describes the construction and operation, disassembly and reassembly, and adjustment of the two-spring nozzle holder.
The contents of this manual, including illustrations, drawings and specifications were the latest available at the time of printing.
The right is reserved to make changes in specifications and procedures at any time without notice.
Refer to the separate service manual listed below to facilitate two-spring nozzle holder maintenance.

ZEXEL CORPORATION

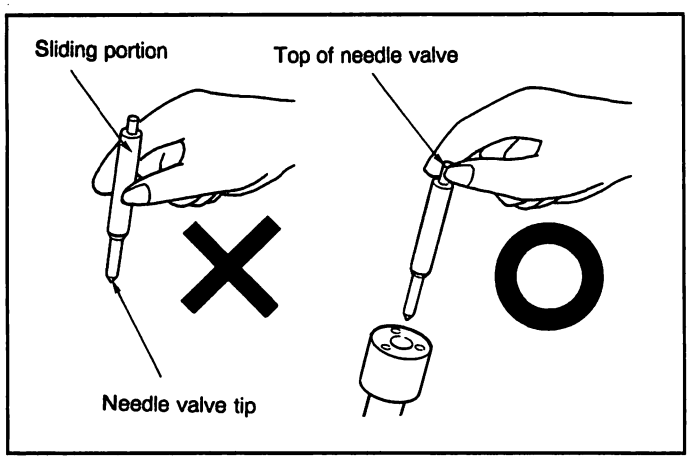
Service manual		Publication number
NOZZLE AND NOZZLE HOLDER	Repair & maintenance Examples of Damage	EE17E-11011

CONTENTS



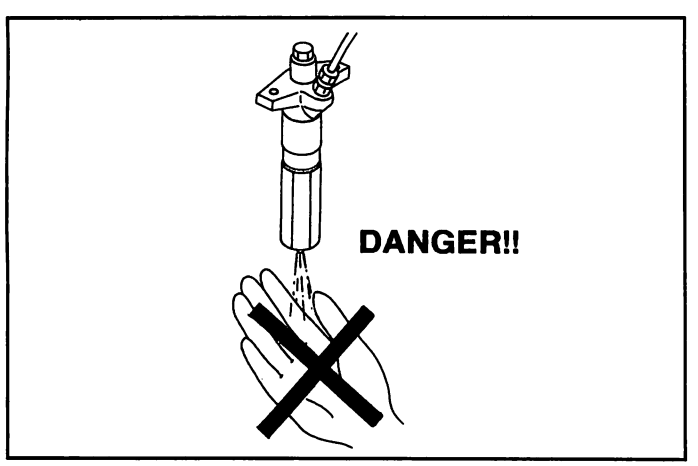
HANDLING

- Do not knock or drop the two-spring nozzle holder. In particular, do not damage the injection holes at the tip of the nozzle.
- When cleaning the nozzle holder, do not touch the nozzle holes with the wire brush. Use only nozzle cleaning tools when cleaning the nozzle.



DISASSEMBLY, REASSEMBLY AND ADJUSTMENT

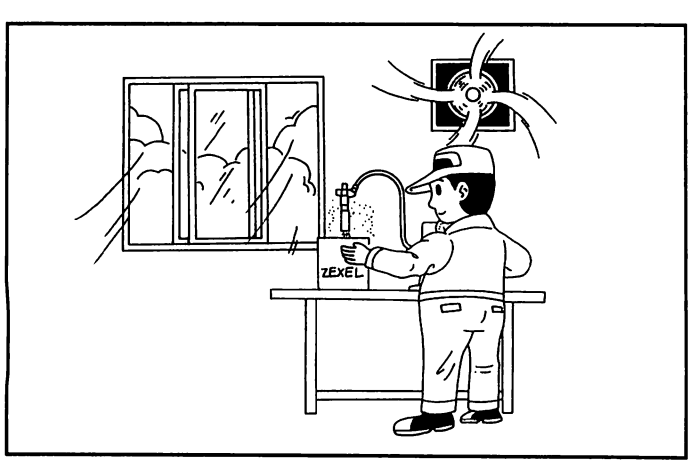
- When handling the nozzle needle valve at disassembly and reassembly, hold the top of the needle valve. Do not touch the sliding portion or the tip of the needle valve. Do not knock the needle valve against metal or hard objects.
- As the nozzle is a precision part, do not change the needle valve - nozzle pair.



- Observe the following warning when adjusting the nozzle on the nozzle tester.

DANGER !!

The fuel injected from the nozzle is under extremely high pressure and can pierce the skin. This is extremely dangerous.
Do not allow fuel injected from the nozzle to contact any part of the body.



- Adjust the nozzle in a well ventilated area.

WARNING!!

Do not inhale oil or spray injected from the nozzle.

2 COMPONENT OUTLINE

OUTLINE

Vehicle exhaust and noise regulations are becoming increasingly strict, particularly in regard to the reduction of NOx (nitrogen oxides) and particulates.

The two-spring nozzle holder has been developed to reduce NOx (nitrogen oxides) and particulates from direct injection diesel engine exhaust.

FEATURES

The two-spring nozzle holder limits needle valve lift at initial valve opening to throttle the injection quantity. Main injection occurs when the in-line pressure has increased sufficiently to move the needle valve through its full lift.

This gives the following features.

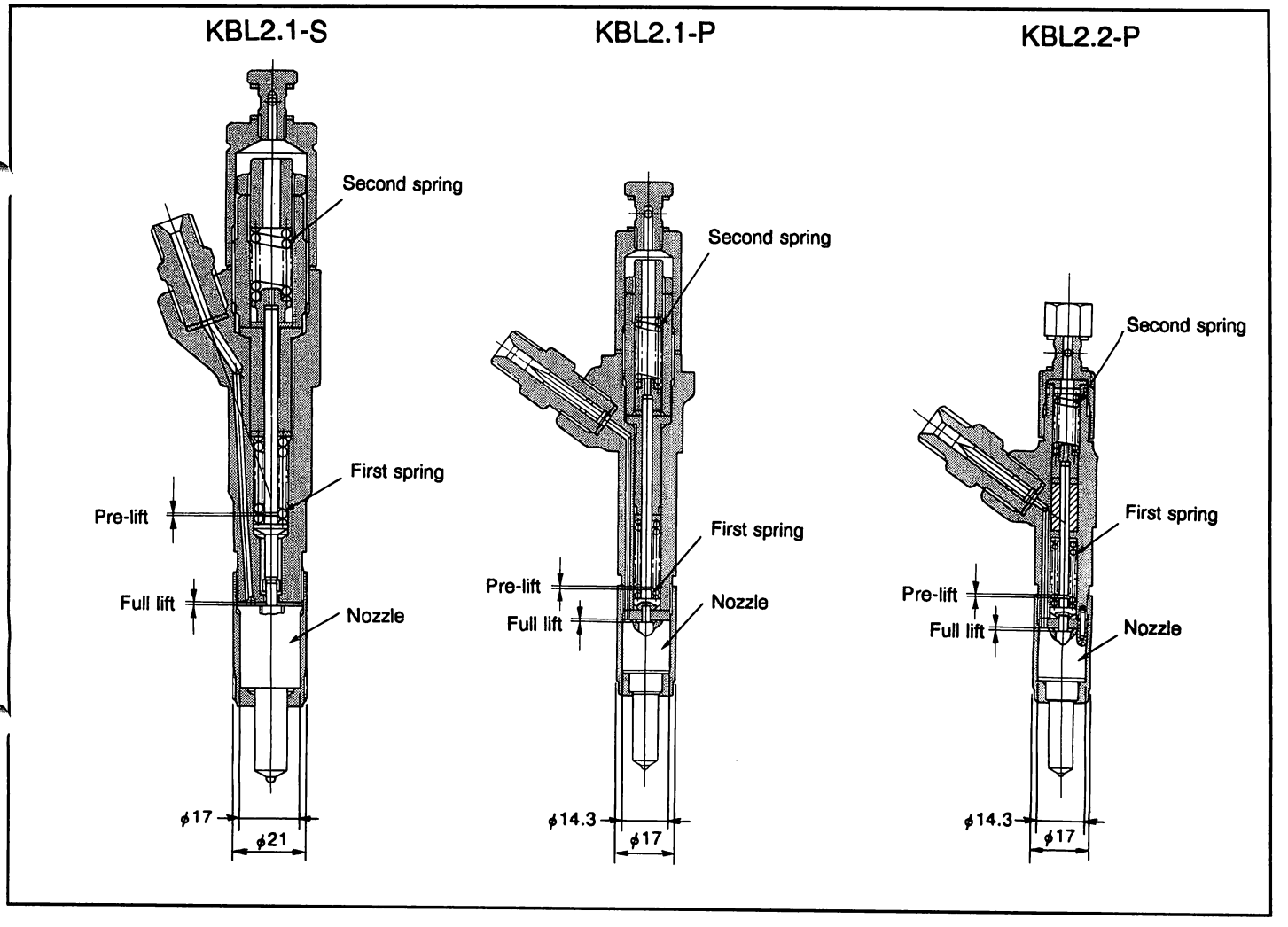
- Improved engine stability at low and intermediate speeds.
- Decreased engine hunting and surge.
- Decreased noise at idling.
- Decreased idling speed because of improved engine stability.
- Stabilized fuel injection characteristics from the injection pump and nozzle system, and easier matching of governor characteristics to engine demand.

TYPES

The two-spring nozzle holder is generally classified into two types in accordance with the pre-lift adjusting method. These two types are the shim adjustment type and the lift piece adjustment type.
Shim adjustment types are the KBL2.1 type and the KBL2.2 type.

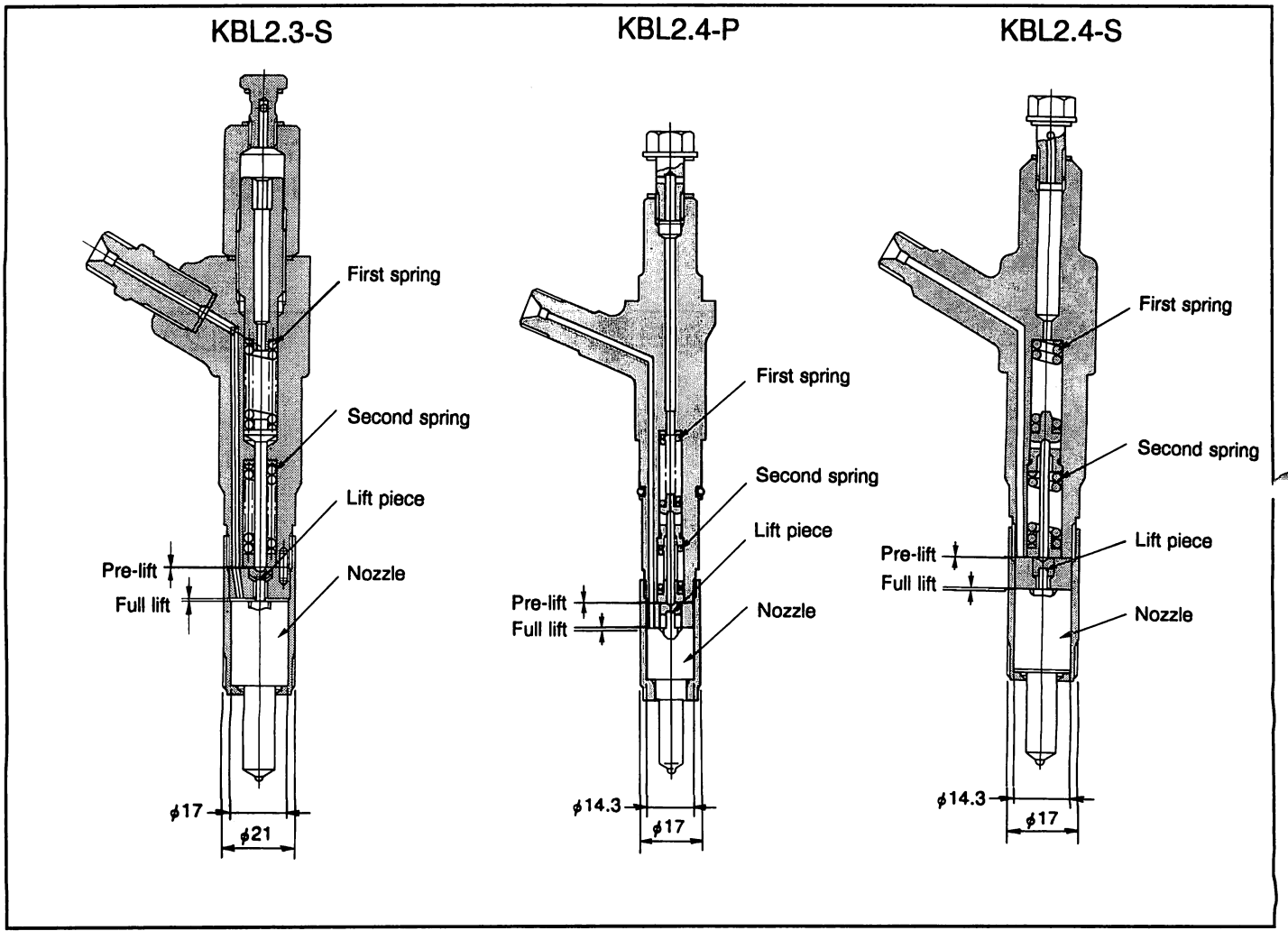
Lift piece adjustment types are the KBL2.3 type and the KBL2.4 type.
Two-spring nozzle holders are further classified in accordance with the nozzle body diameter (ie, the diameter of the nozzle body's thickest part). These are the S type (ϕ17 mm), and the P type (ϕ14.3 mm).

Shim adjustment type



2 COMPONENT OUTLINE

Lift piece adjustment type

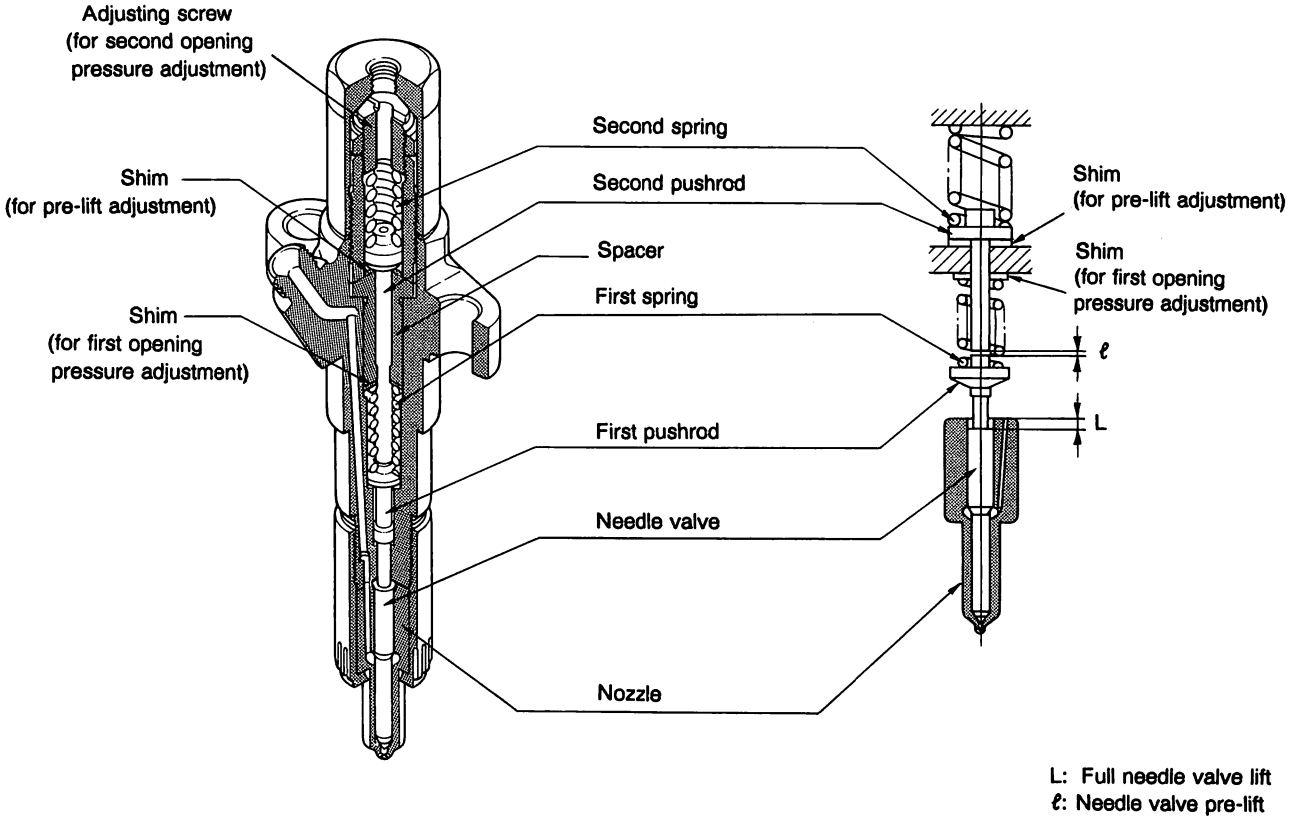


ADJUSTMENT OUTLINE

Unit: mm

Type \ Adjustment	First opening pressure	Second opening pressure	Pre-lift	Remarks
KBL2.1-S	Shim D = φ11.5 d = φ4.5	Screw	Shim D = φ11.5 d = φ4.5	Open method
KBL2.1-P	Shim D = φ7.2 d = φ3.6	Screw	Shim D = φ7.2 d = φ3.6	Open method
KBL2.2-P	Shim D = φ7.2 d = φ3.6	Shim D = φ7.2 d = φ3.6	Shim D = φ7.2 d = φ3.6	Open method
KBL2.3-S	Screw	Shim D = φ9.5 d = φ4.5	Lift piece	Closed method
KBL2.4-P	Shim D = φ6.2 d = φ2.6	Shim D = φ7.2 d = φ3.6	Lift piece	Closed method
KBL2.4-S	Shim D = φ8.9 d = φ3.8	Shim D = φ9.9 d = φ4.8	Lift piece	Closed method

KBL2.1 AND 2.2 TYPES

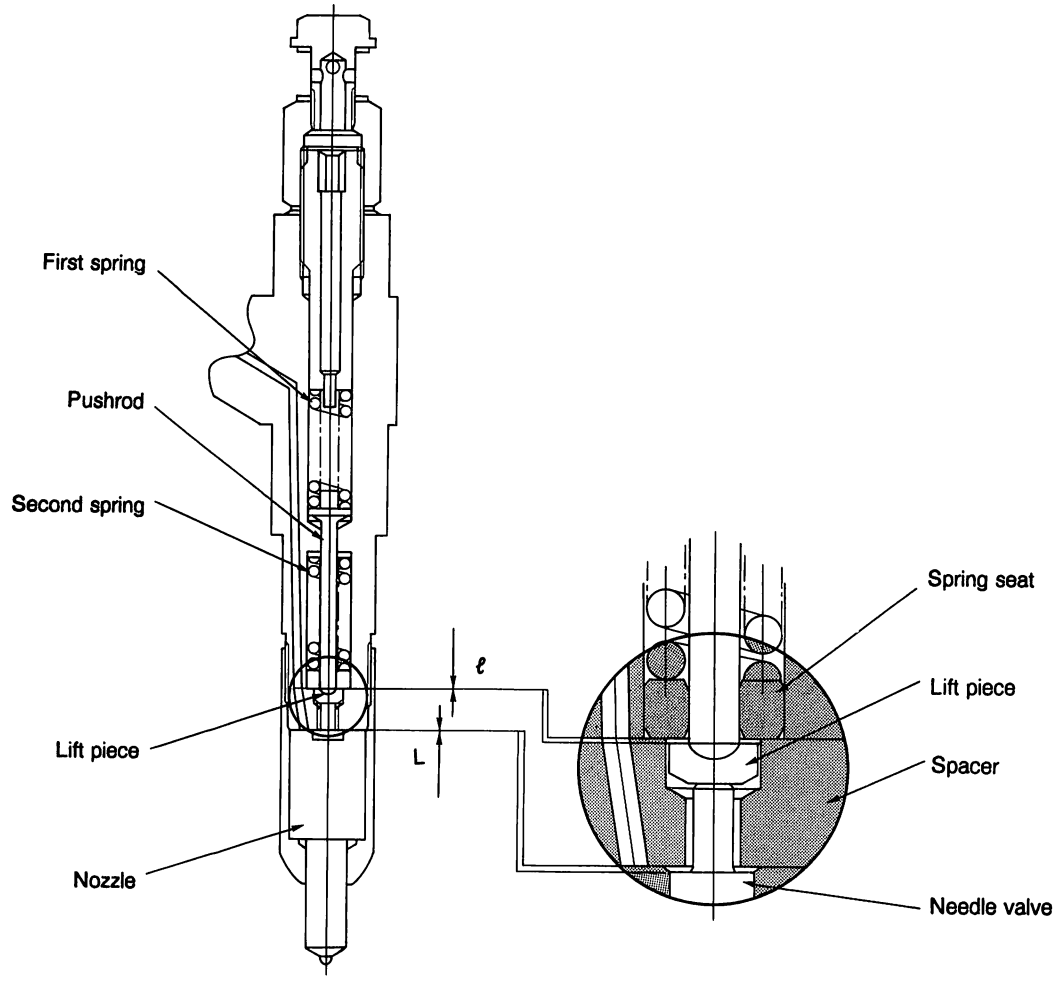


The figure shows the KBL2.1-S type.

The construction of the KBL2.1 and KBL2.2 type two-spring nozzle holders is basically the same.
The nozzle holder has two springs and two pushrods. A clearance (pre-lift) is provided between the two pushrods. (With the KBL2.2 type, pre-lift is provided between one pushrod and a spring seat.)
The nozzle opening pressure is determined by the first spring. After the nozzle has been opened by the increase in in-line pressure, the needle valve is lifted through the previously determined lift, and the first pushrod contacts the second pushrod.
In-line pressure increases until it exceeds the combined forces of the two springs, when it this time fully lifts the needle valve.
The first spring (for nozzle opening pressure) is adjusted using a shim.
With the KBL2.1 type, the second spring is adjusted using an adjusting screw. With the KBL2.2 type, the second spring is adjusted using an adjusting shim.

3 CONSTRUCTION

KBL2.3 TYPE

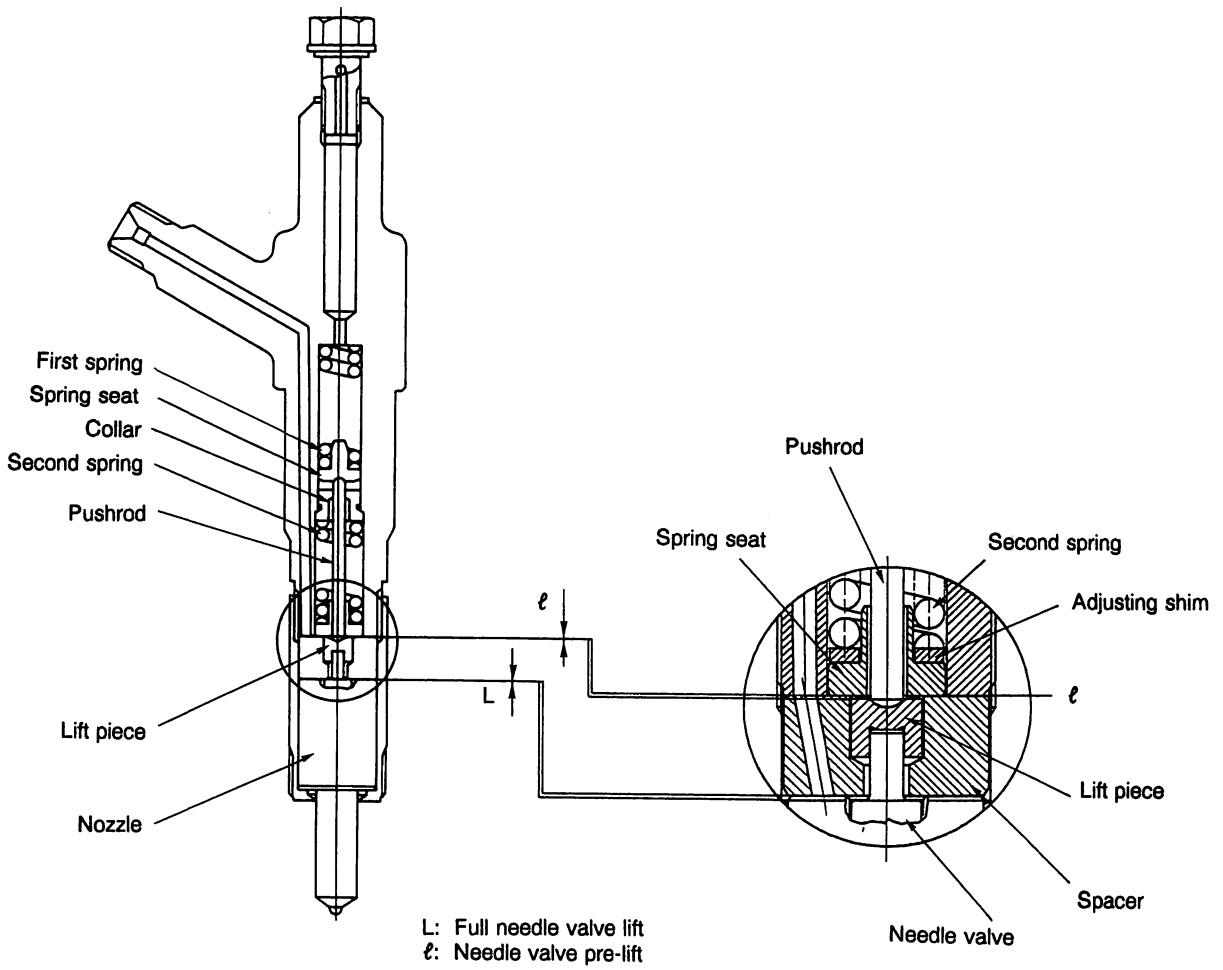


L: Full needle valve lift
ℓ: Needle valve pre-lift

The KBL2.3 type two-spring nozzle holder differs from the KBL2.1 and 2.2 types as follows.

- The positions of the first and second springs are reversed, with the first spring located at the top. (With the KBL2.1 and 2.2 types, the first spring is located at the bottom.)
- Pre-lift is provided between the lift piece and the spring seat. (With the KBL2.1 type, pre-lift is provided between the first and second pushrods; with the KBL2.2 type, pre-lift is provided between the pushrod and a spring seat.)
- Pre-lift is adjusted at the factory. (Pre-lift is ensured through the assembly of the nozzle, spacer and lift piece.)
- Full needle valve lift, second opening pressure and pre-lift can be measured simultaneously.

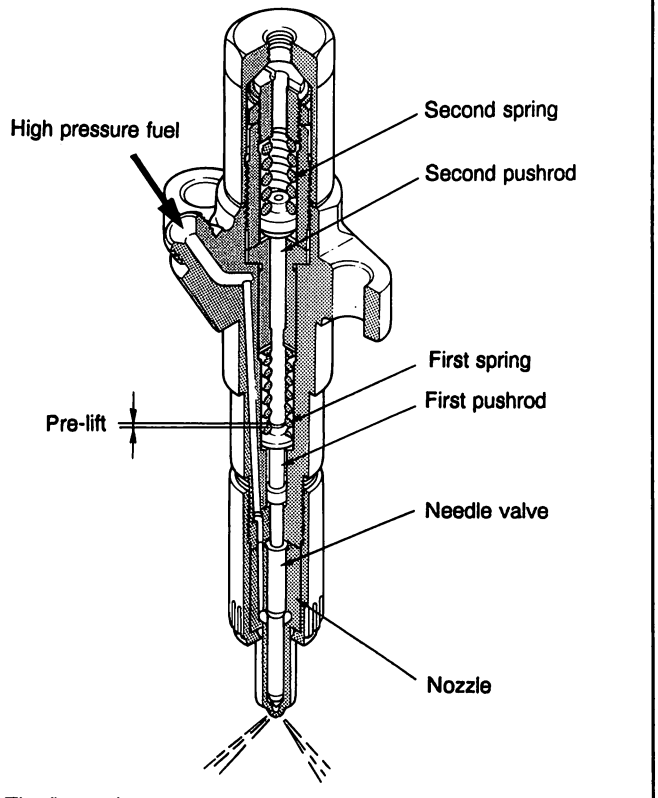
KBL2.4 TYPE



The figure shows the KBL2.4-S type.

The KBL2.4 type two-spring nozzle holder differs from the KBL2.1 and 2.2 types as follows.

- The positions of the first and second springs are reversed, with the first spring located at the top. (With the KBL2.1 and 2.2 types, the first spring is located at the bottom.)
- The nozzle holder body is a unified construction, decreasing the number of component parts.
- Pre-lift is provided between the lift piece and the spring seat. (With the KBL2.1 type, pre-lift is provided between the first and second pushrods; with the KBL2.2 type, pre-lift is provided between the pushrod and a spring seat.)
- Pre-lift is adjusted at the factory. (Pre-lift is ensured through the assembly of the nozzle, spacer and lift piece.)
- Full needle valve lift, second opening pressure and pre-lift can be measured simultaneously.



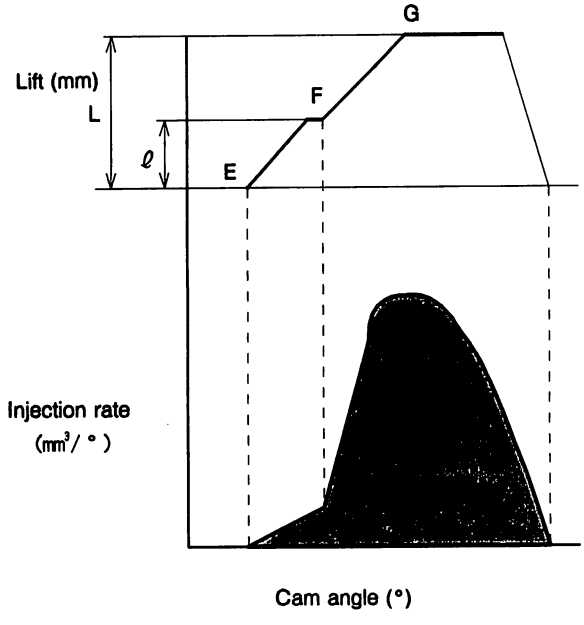
The figure shows the KBL2.1-S type.

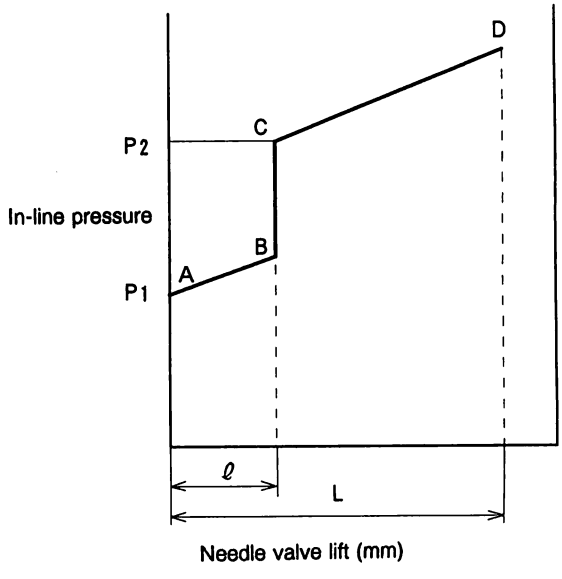
FIRST OPENING PRESSURE

(Opening pressures are described only for the KBL2.1 nozzle holder.)
The force of the high pressure fuel delivered by the injection pump acts to push the needle valve up. When this force exceeds the set force of the first spring, the nozzle's needle valve pushes the first pushrod up and the valve opens. (First opening pressure is represented by point E in the bottom left hand figure, and point A in the bottom right hand figure.)

SECOND OPENING PRESSURE

When the first pushrod has been lifted through the pre-lift, it contacts the second pushrod. As the set force of the second spring is acting on the second pushrod, the combined forces of both the first spring and the second spring then act on the needle valve, which will not lift unless these forces are overcome.
When the high pressure fuel (ie, in-line pressure) overcomes the combined forces of the first and second springs, the needle valve is again lifted and main injection can begin. (Second opening pressure is represented by point F in the bottom left hand figure and B ~ C in the bottom right hand figure.)





L : Full needle valve lift
ℓ : Needle valve pre-lift

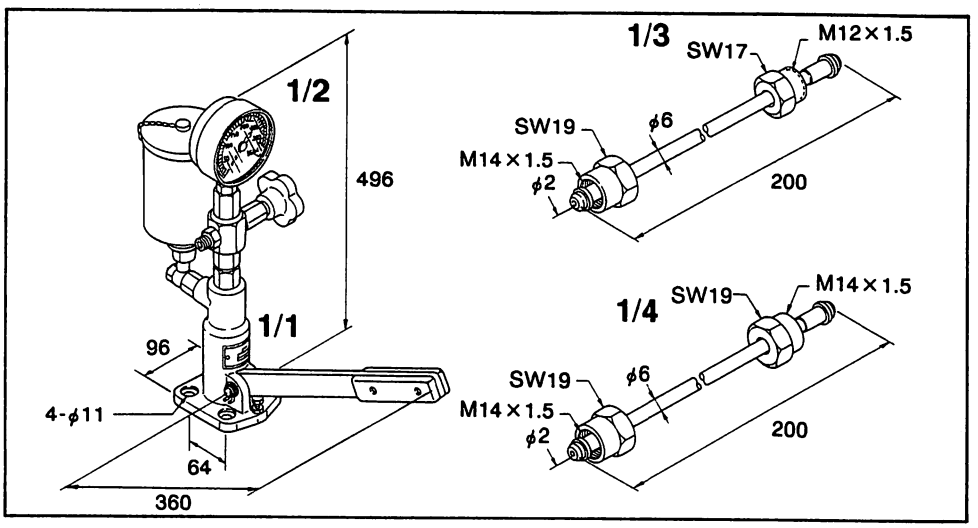
A ~ B : First spring's set force
B ~ C ~ D : Combined forces of first and second springs
P1 : First opening pressure
P2 : Second opening pressure

The following special tools (in addition to general tools) are required for disassembly, reassembly and adjustment of the two-spring nozzle holder.

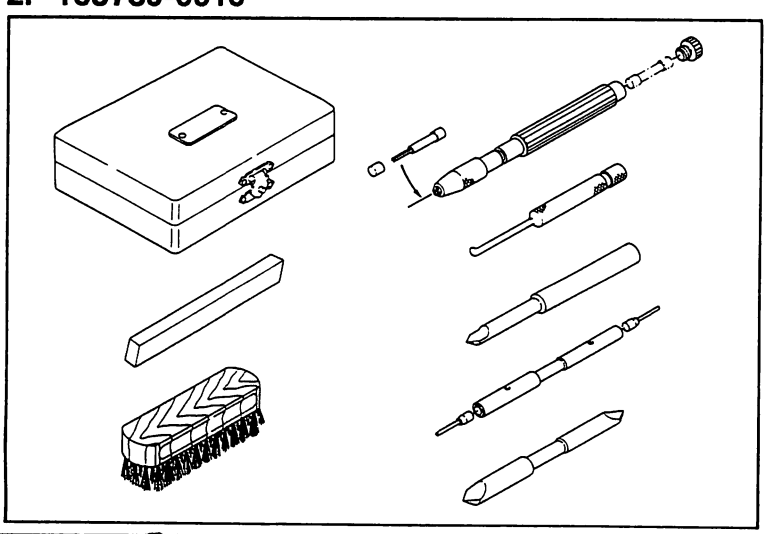
COMMON TOOLS

Key no	Part name	Part no	Q'ty	Application
1	Nozzle tester	105785-1010	1	For adjusting two-spring nozzle holder
1/1	Nozzle tester	105785-0030	1	
1/2	Pressure gauge	157955-2000	1	Maximum scale: 50 MPa {500 kgf/cm^2}
1/3	Injection pipe	157856-0520	1	M14×1.5; M12×1.5
1/4	Injection pipe	157856-6320	1	M14×1.5; M14×1.5
2	Nozzle cleaning kit	105789-0010	1	For cleaning nozzle
3	Torque wrench	Commercially available	1	
4	Micrometer	Commercially available	1	For measuring adjusting shim thickness

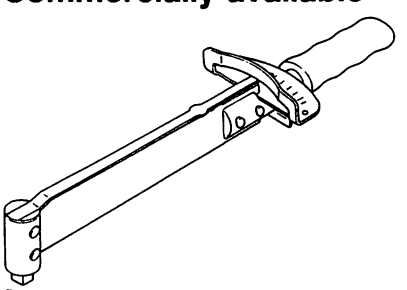
1. 105785-1010



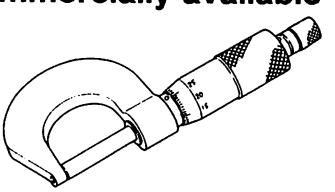
2. 105789-0010



3. Commercially available



4. Commercially available



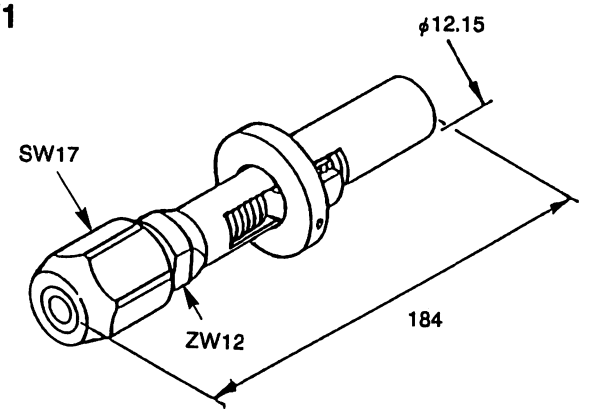
5 SPECIAL TOOLS

KBL2.1-S TYPE SPECIAL TOOLS

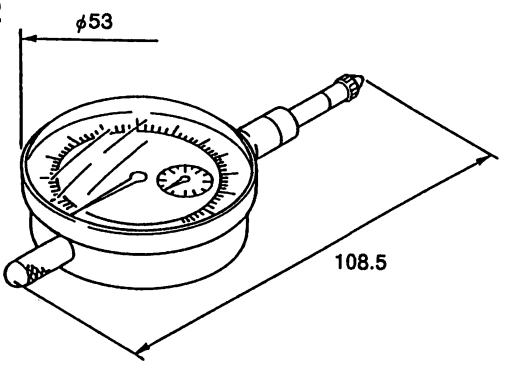
Key no	Part name	Part no	Q'ty	Application
1	Adjusting device assembly	105789-0540	1	For adjusting needle valve pre-lift
1/1	Adjusting device	157892-0220	1	Part of Key No 1
1/2	Dial gauge	157954-3800	1	Measuring range: 0~10mm (×0.01mm)
1/3	Base	157892-1800	1	For adjusting zero point
1/4	Pin	157892-1100	1	Length: 60.5 mm
2	Torque spanner	Commercially available	1	SW17 mm
3	Socket wrench	157914-2800	1	For removing/installing nozzle retaining nut; SW19 mm
4	Plate	157944-9520	1	For supporting nozzle holder

1. 105789-0540

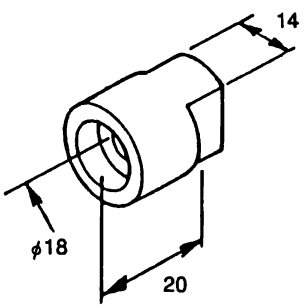
1/1



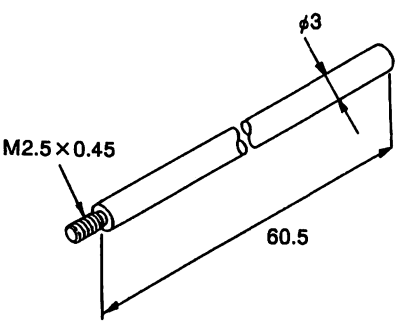
1/2



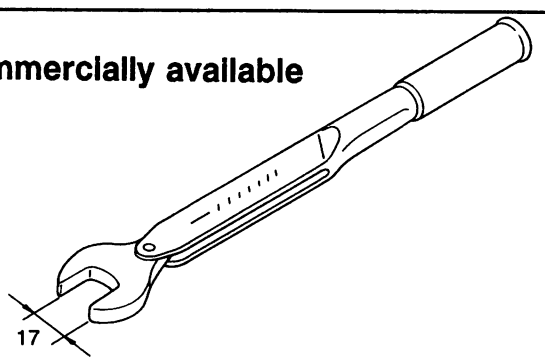
1/3



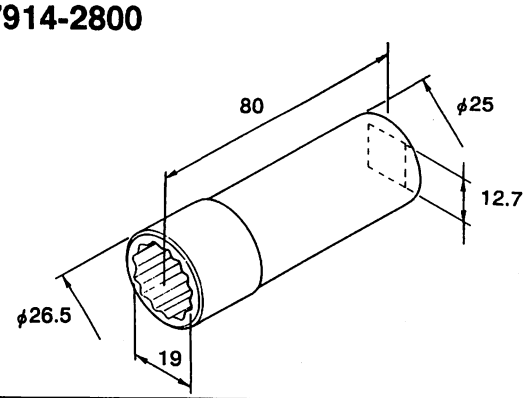
1/4



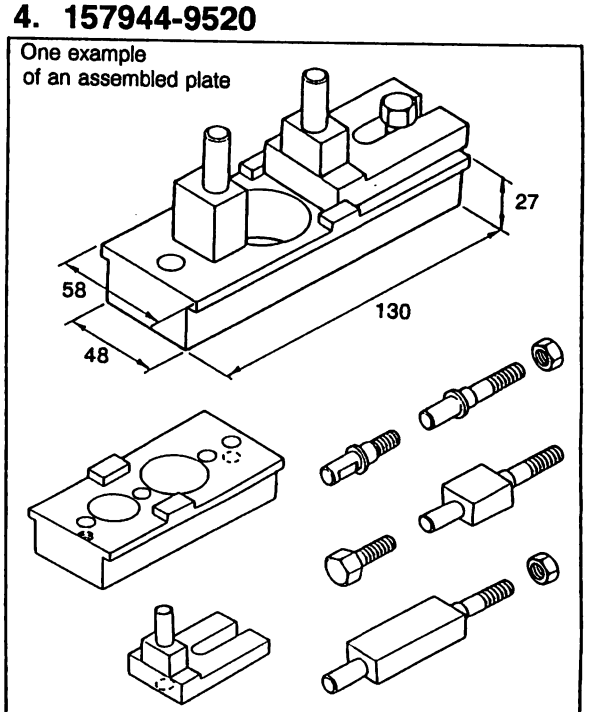
2. Commercially available



3. 157914-2800



4. 157944-9520

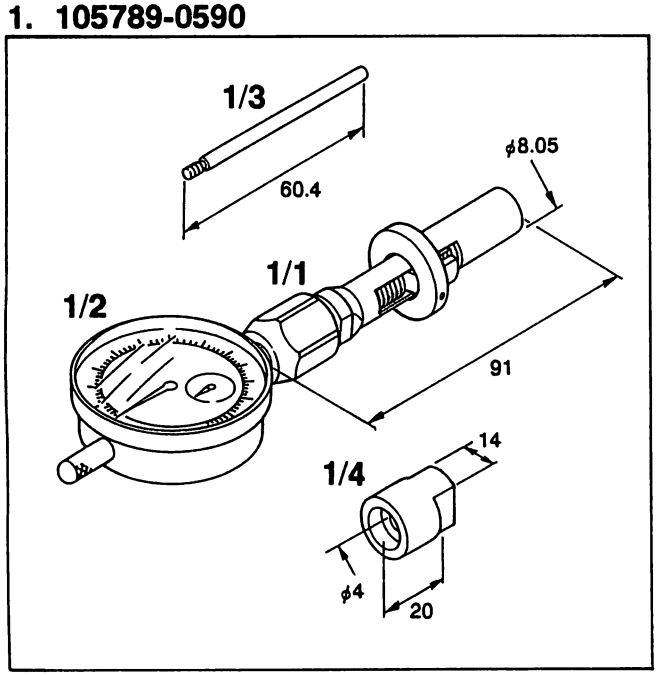


KBL2.1-P TYPE SPECIAL TOOLS

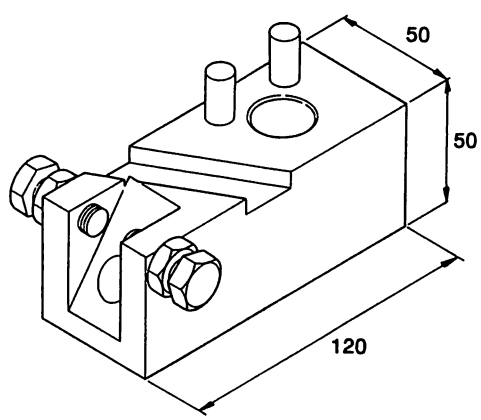
Key no	Part name	Part no	Q'ty	Application
1	Adjusting device	105789-0590	1	
1/1	Adjusting device	157892-2220	1	
1/2	Dial gauge	157954-3800	1	Measuring range: 0~5 mm (×0.01 mm)
1/3	Pin	157892-3000	1	Length 60.4 mm
1/4	Base	157892-3300	1	For setting zero point
2	Plate	157992-2521	1	For supporting nozzle holder
3	Scraper	157890-6200	1	For cleaning nozzle seat
4	Scraper	157890-6300	1	For cleaning nozzle fuel oil chamber

The adjusting device is available without the dial gauge (157954-3800). The part number is 105789-0600.

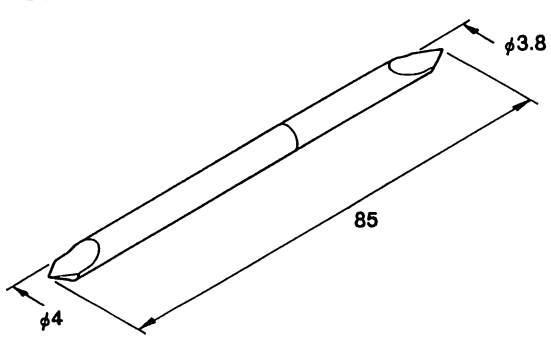
1. 105789-0590



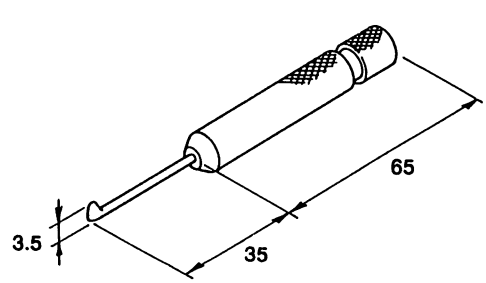
2. 157992-2521



3. 157890-6200



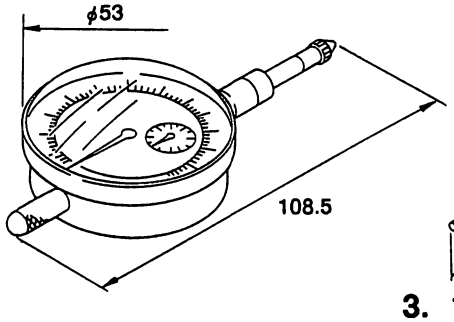
4. 157890-6300



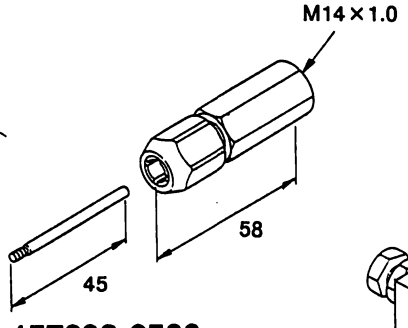
KBL2.2-P TYPE SPECIAL TOOLS

Key no	Part name	Part no	Q'ty	Application
1	Dial gauge	157954-3800	1	Measuring range: 0~5 mm (×0.01 mm)
2	Connector assembly	157892-3620	1	
3	Pin	157892-3500	1	Length: 45 mm
4	Plate	157992-2820	1	For supporting nozzle holder
5	Torque spanner	Commercially available	1	For tightening connector assembly (SW17 mm); Tightening torque: 20~25 N·m {2.0~2.5 kgf·m}
6	Scraper	157890-6200	1	For cleaning nozzle seat
7	Scraper	157890-6300	1	For cleaning nozzle fuel oil chamber

1. 157954-3800

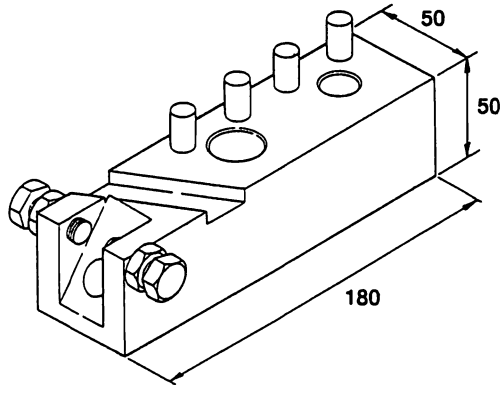


2. 157892-3620

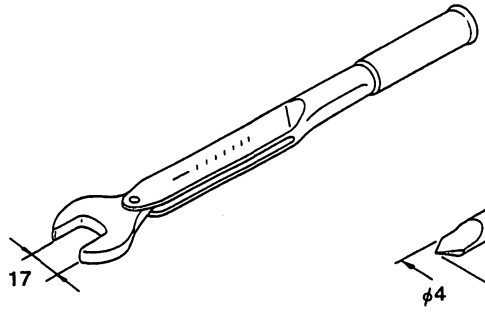


3. 157892-3500

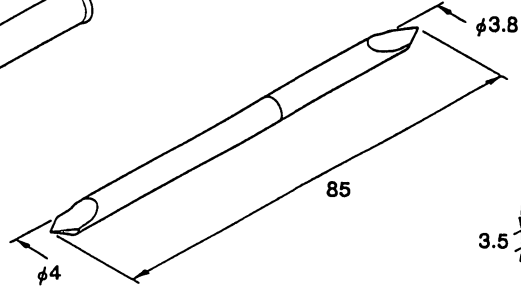
4. 157992-2820



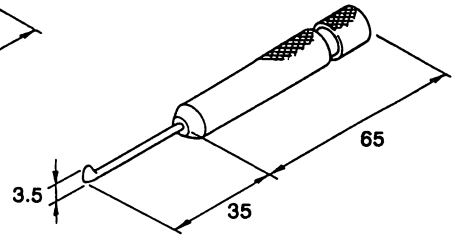
5. Commercially available



6. 157890-6200



7. 157890-6300



KBL2.3-S TYPE SPECIAL TOOLS

1. FOR LARGE HINO TRUCKS

Key no	Part name	Part no	Q'ty	Application
1	Adjusting device	105789-0680	1	
1/1	Adjusting device	157892-4120	1	Part of key no 1
1/1/1	Holder	157892-4100	1	For installing cap nut; M10×1.0
1/1/2	Holder	157892-5400	1	For installing cap nut; M10×1.25
1/1/3	Nut	157892-1000	1	For securing dial gauge
1/2	Dial gauge	157954-3800	1	Measuring range: 0~5 mm (×0.01)
1/3	Pin	157892-4200	1	L = 160 mm (excluding length of thread)
1/4	Pin	157892-4300	1	L = 110 mm (excluding length of thread)
1/6	Retaining nut	157892-4020	1	
1/6/1	Retaining nut	157892-4000	1	M19×0.75; SW22 mm, L = 84 mm
1/6/2	Gasket	026508-1140	1	For plug; D = ϕ11.4, d = ϕ8.2, t = 1.0 mm
1/6/3	Plug	157892-1600	1	M8×1.0, SW12 mm
1/7	Gasket	157892-1500	1	D = ϕ15.9, d = ϕ12.2, t = 1.0 mm
2	Plate	157944-9520	1	For supporting nozzle holder
3	Wrench	157911-8100	1	For adjusting first opening pressure; SW5 mm
4	Wrench	157914-2800	1	For removing/installing retaining nut; SW19 mm
5	Wrench	157914-0500	1	For removing/installing adjustment retaining nut; SW22 mm

The adjusting device is available without the dial gauge (157954-3800). The part number is 105789-0690.

2. FOR MEDIUM-SIZED HINO TRUCKS

Key no	Part name	Part no	Q'ty	Application
1	Adjusting device	105789-0700	1	
1/1	Adjusting device	157892-4420	1	Part of key no 1
1/1/1	Holder	157892-4400	1	For installing cap nut; M8×1.0
1/1/3	Nut	157892-1000	1	For securing dial gauge
1/2	Dial gauge	157954-3800	1	Measuring range: 0~5 mm (×0.01)
1/5	Pin	157892-4700	1	L = 85 mm (excluding length of thread)
1/6	Retaining nut	157892-4020	1	
1/6/1	Retaining nut	157892-4000	1	M19×0.75; SW22 mm, L = 84 mm
1/6/2	Gasket	026508-1140	1	For plug; D = ϕ11.4, d = ϕ8.2, t = 1.0 mm

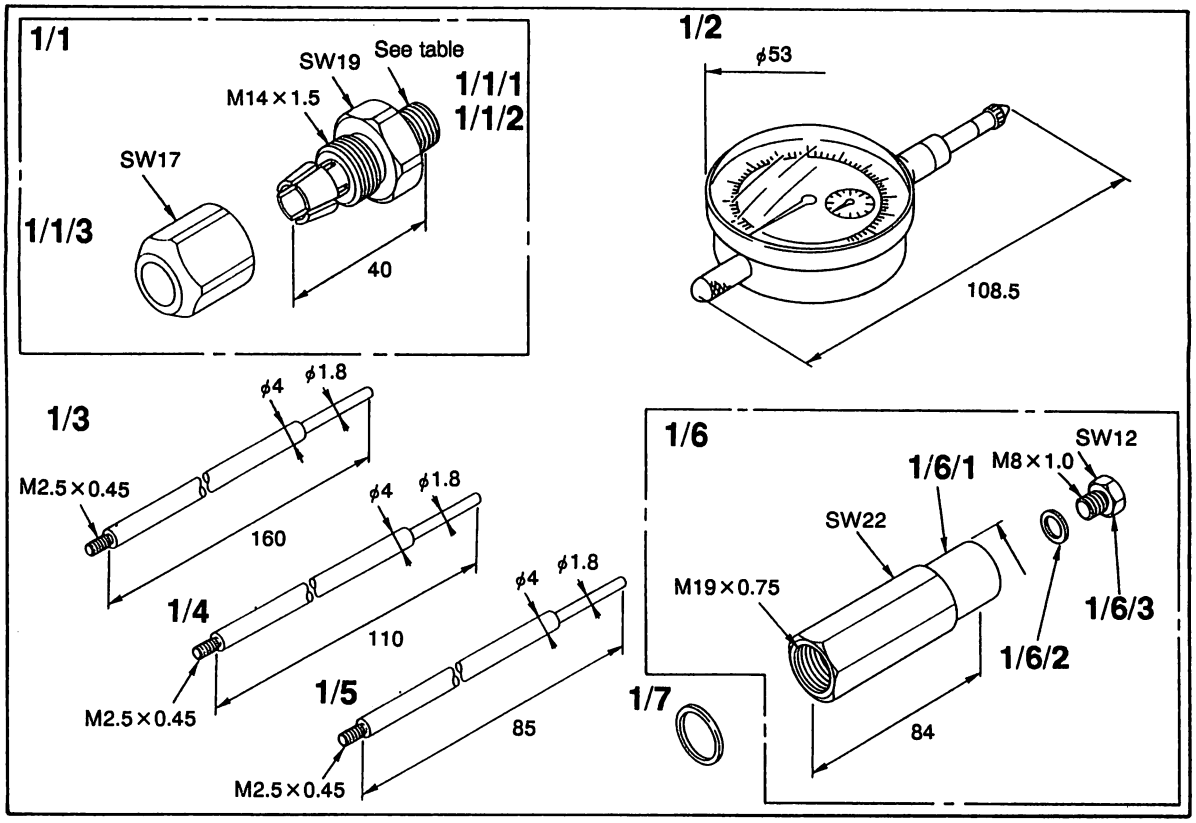
Continued on next page

2. FOR MEDIUM-SIZED HINO TRUCKS (continued)

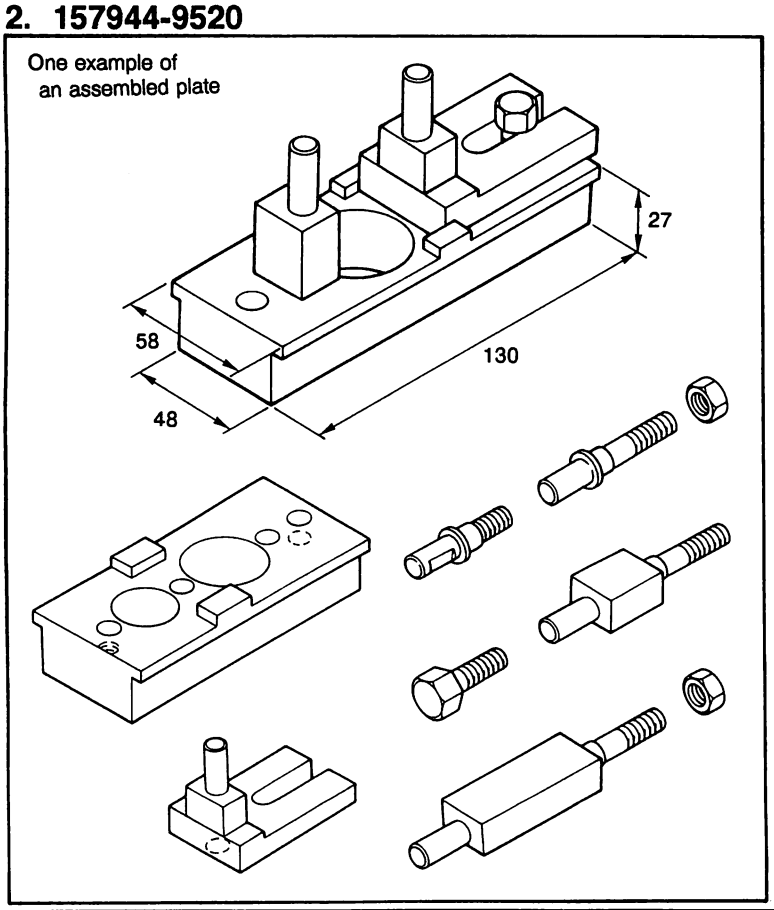
Key no	Part name	Part no	Q'ty	Application
1/6/3	Plug	157892-1600	1	M8 × 1.0, SW12 mm
1/7	Gasket	157892-1500	1	D = ϕ15.9, d = ϕ12.2, t = 1.0 mm
2	Plate	157944-9520	1	For supporting nozzle holder
3	Wrench	157911-8100	1	For adjusting first opening pressure; SW5 mm
4	Wrench	157914-2800	1	For removing/installing retaining nut; SW19 mm
5	Wrench	157914-0500	1	For removing/installing adjustment retaining nut; SW22 mm

The adjusting device is available without the dial gauge (157954-3800). The part number is 105789-0710.

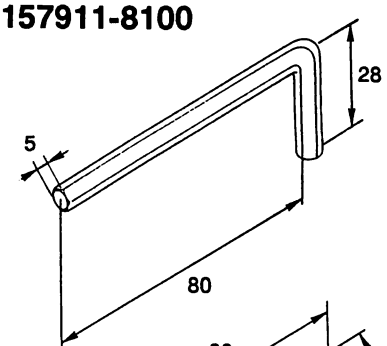
1. 105789-0680, -0700



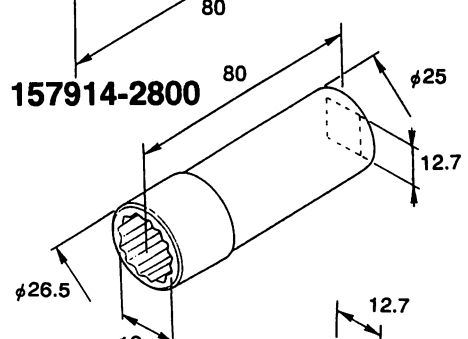
2. 157944-9520



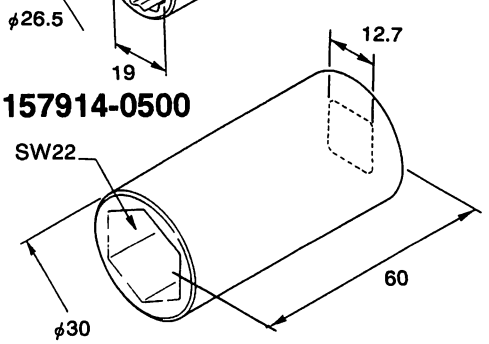
3. 157911-8100



4. 157914-2800



5. 157914-0500



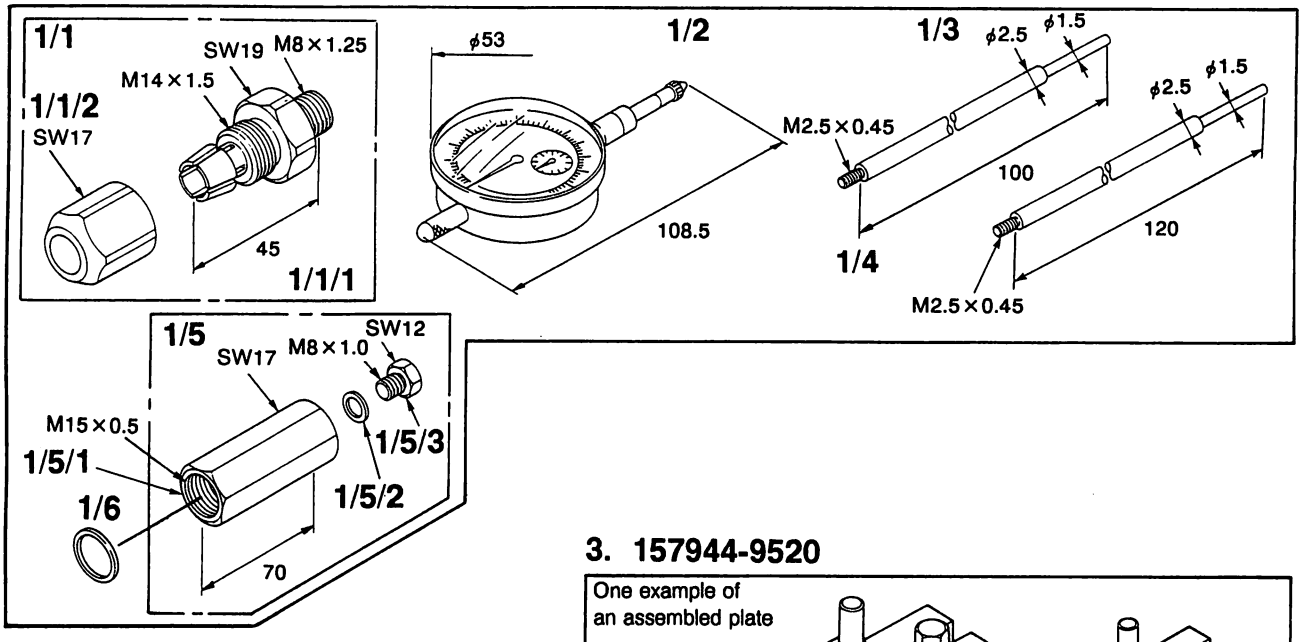
KBL2.4-P TYPE SPECIAL TOOLS

Key no	Part name	Part no	Q'ty	Application
1	Adjusting device	105789-0720	1	
1/1	Adjusting device	157892-5020	1	Part of key no 1
1/1/1	Holder	157892-5000	1	M8×1.25
1/1/2	Nut	157892-1000	1	For fixing dial gauge
1/2	Dial gauge	157954-3800	1	Measuring range: 0~5 mm (×0.01)
1/3	Pin	157892-5200	1	L = 100 mm (excluding length of thread)
1/4	Pin	157892-5700	1	L = 120 mm (excluding length of thread)
1/5	Retaining nut	157892-5120	1	
1/5/1	Retaining nut	157892-5100	1	M15×0.5; SW17, L = 70 mm
1/5/2	Gasket	026508-1140	1	For plug; D = ϕ11.4, d = ϕ8.2, t = 1.0mm
1/5/3	Plug	157892-1600	1	M8×1.0; SW12 mm
1/6	Gasket	157892-3200	1	For retaining nut; D = ϕ13.2, d = ϕ10.2, t = 1.0 mm
2	Plate	157992-2820	1	For supporting nozzle holder
3	Plate	157944-9520	1	For supporting flange type nozzle holder

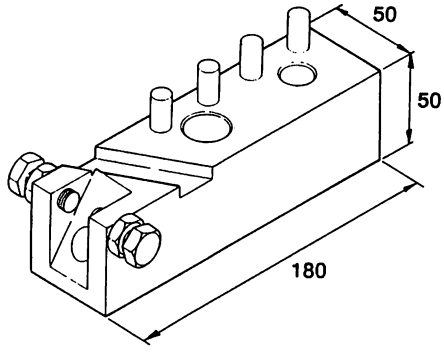
The adjusting device is available without the dial gauge (157954-3800). The part number is 105789-0730.

5 SPECIAL TOOLS

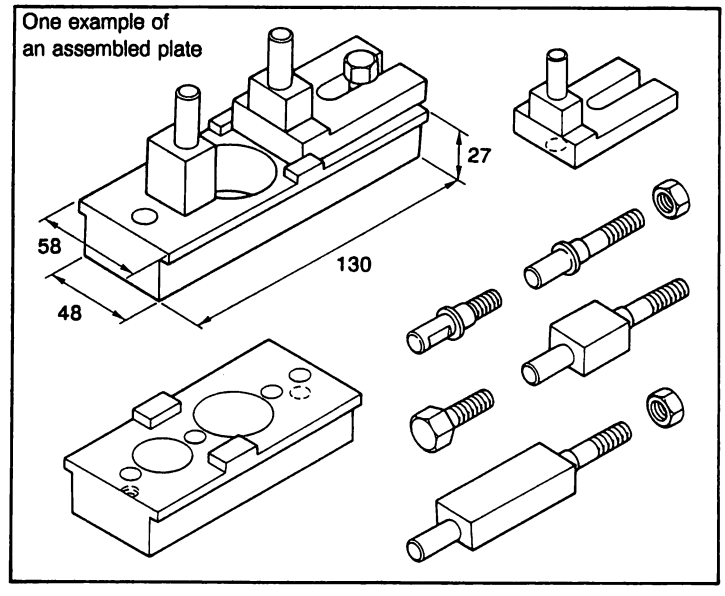
1. 105789-0720



2. 157992-2820



3. 157944-9520



KBL2.4-S TYPE SPECIAL TOOLS

1. FOR MITSUBISHI VEHICLES

Key no	Part name	Part no	Q'ty	Application
1	Adjusting device	105789-0640	1	
1/1	Adjusting device	157892-4420	1	Part of key no 1
1/1/1	Holder	157892-4400	1	M8×1.0
1/1/3	Nut	157892-1000	1	For securing dial gauge
1/2	Dial gauge	157954-3800	1	Measuring range: 0~5 mm (×0.01)
1/3	Pin	157892-4700	1	L=85 mm (excluding length of thread)
1/4	Pin	157892-5200	1	L=100 mm (excluding length of thread)
1/6	Pin	157892-5500	1	L=55 mm (excluding length of thread)
1/7	Pin	157892-5700	1	L=120 mm (excluding length of thread)
1/8	Retaining nut	157892-4020	1	
1/8/1	Retaining nut	157892-4000	1	M19×0.75; SW22 mm, L=84 mm
1/8/2	Gasket	026508-1140	1	For plug; D=ϕ11.4, d=ϕ8.2, t=1.0 mm
1/8/3	Plug	157892-1600	1	M8×1.0; SW12 mm
1/9	Gasket	157892-1500	1	For retaining nut; D=ϕ15.9, d=ϕ12.2, t=1.0 mm
2	Plate	157944-9520	1	For supporting nozzle holder
3	Wrench	157914-2800	1	For removing/installing retaining nut, SW19 mm
4	Wrench	157914-0500	1	For removing/installing adjustment retaining nut, SW22 mm

The adjusting device is available without the dial gauge (157954-3800). The part number is 105789-0650

2. FOR NISSAN DIESEL VEHICLES

Key no	Part name	Part no	Q'ty	Application
1	Adjusting device	105789-0660	1	
1/1	Adjusting device	157892-4120	1	Part of key no 1
1/1/1	Holder	157892-4100	1	M10×1.0
1/1/2	Holder	157892-5400	1	M10×1.25
1/1/3	Nut	157892-1000	1	For securing dial gauge
1/2	Dial gauge	157954-3800	1	Measuring range: 0~5 mm (×0.01)
1/3	Pin	157892-4700	1	L=85 mm (excluding length of thread)

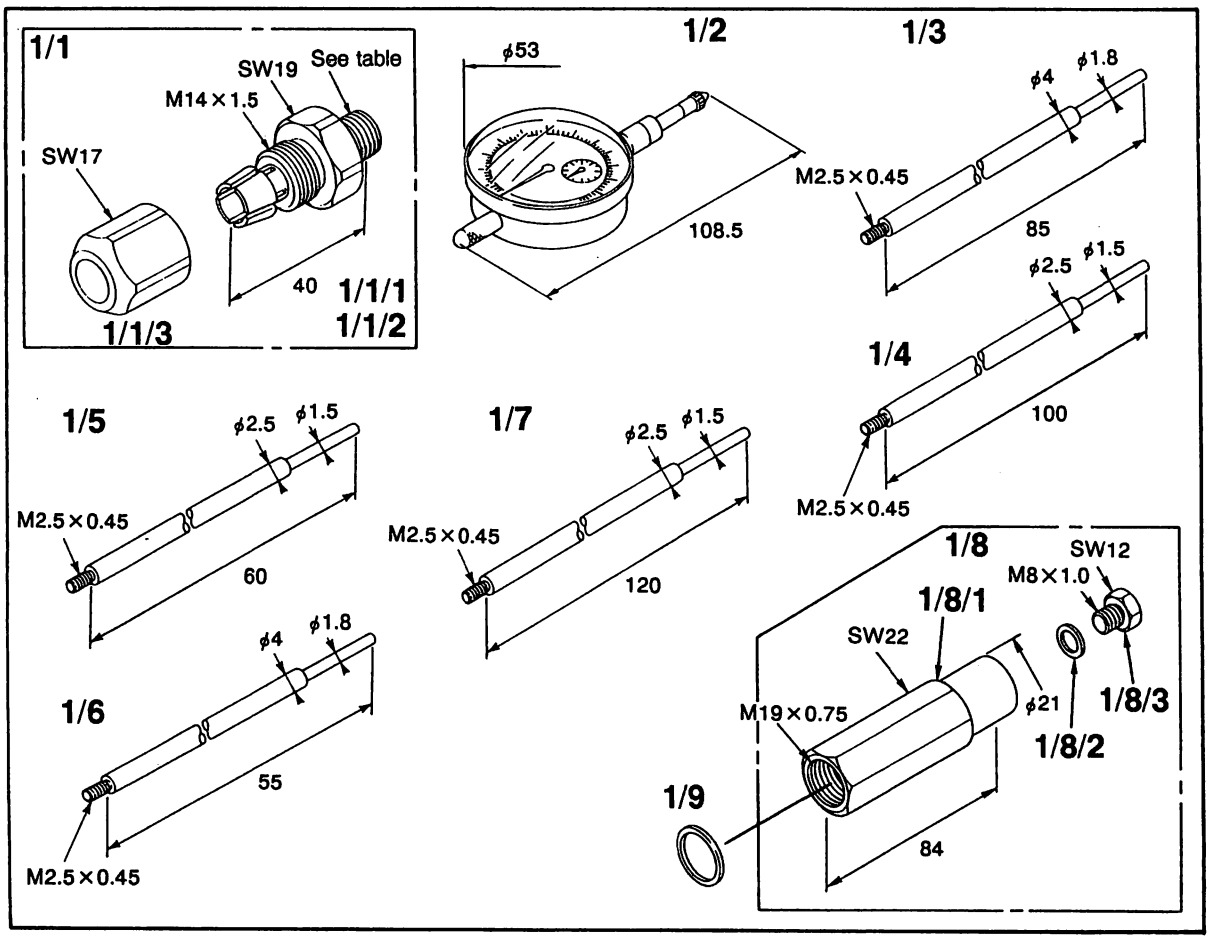
Continued on next page

2. FOR NISSAN DIESEL VEHICLES (continued)

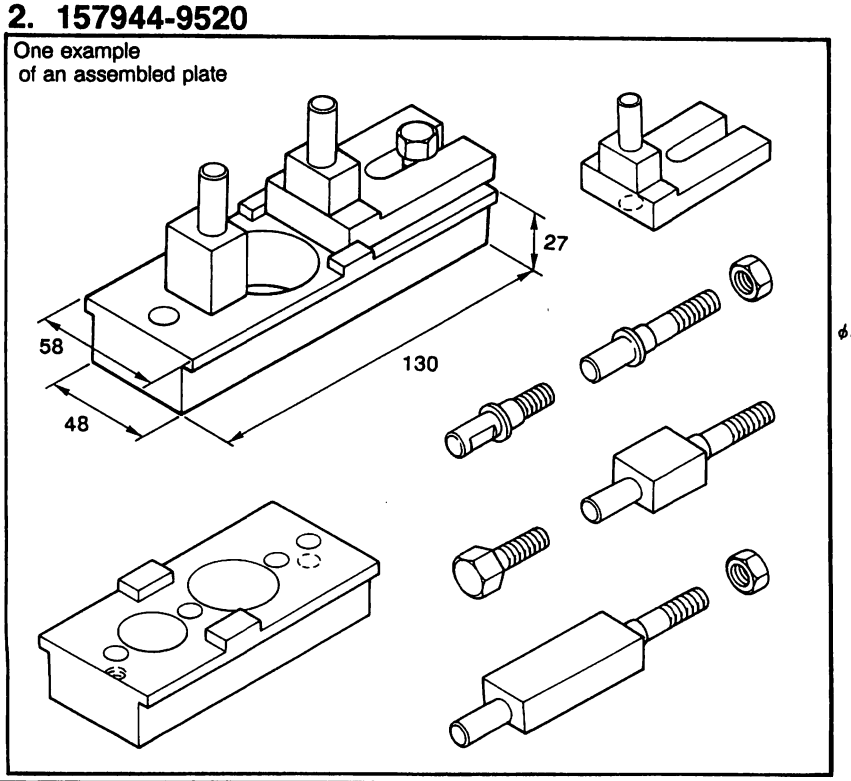
Key no	Part name	Part no	Q'ty	Application
1/5	Pin	157892-5300	1	L = 60 mm (excluding length of thread)
1/6	Pin	157892-5500	1	L = 55 mm (excluding length of thread)
1/8	Retaining nut	157892-4020	1	
1/8/1	Retaining nut	157892-4000	1	M19 × 0.75; SW22 mm, L = 84 mm
1/8/2	Gasket	026508-1140	1	For plug; D=ϕ11.4, d = ϕ8.2, t = 1.0 mm
1/8/3	Plug	157892-1600	1	M8 × 1.0; SW12 mm
1/9	Gasket	157892-1500	1	For retaining nut; D = ϕ15.9, d = ϕ12.2, t = 1.0 mm
2	Plate	157944-9520	1	For supporting nozzle holder
3	Wrench	157914-2800	1	For removing/installing retaining nut, SW19 mm
4	Wrench	157914-0500	1	For removing/installing adjustment retaining nut, SW22 mm

The adjusting device is available without the dial gauge (157954-3800). The part number is 105789-0670

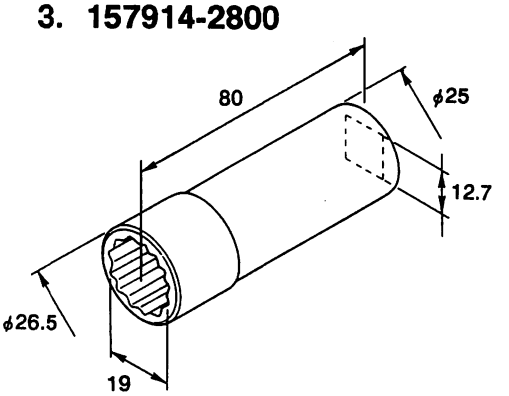
1. 105789-0640, -0660



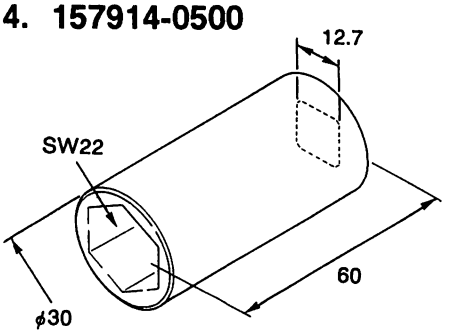
2. 157944-9520



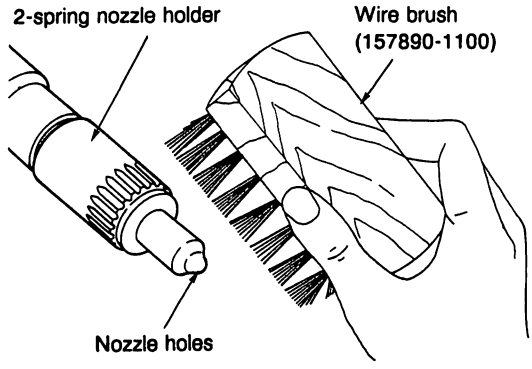
3. 157914-2800



4. 157914-0500



6 KBL2.1-S TYPE



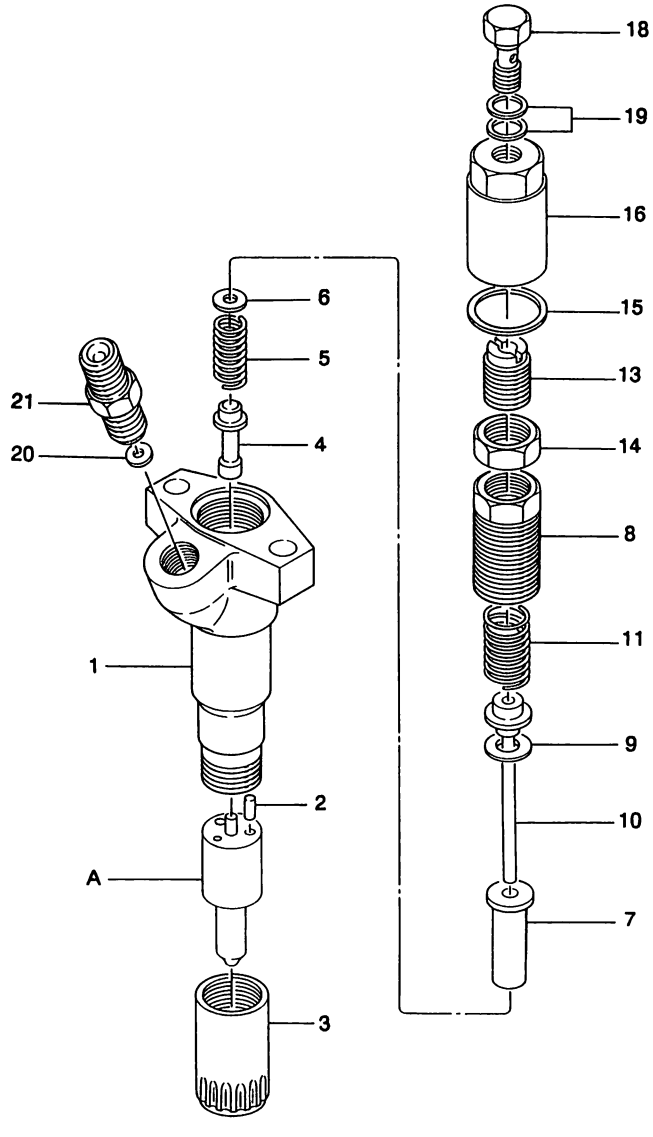
KBL2.1-S TYPE DISASSEMBLY

Before disassembly, remove any carbon from the nozzle holder using a wire brush and wash the outside.

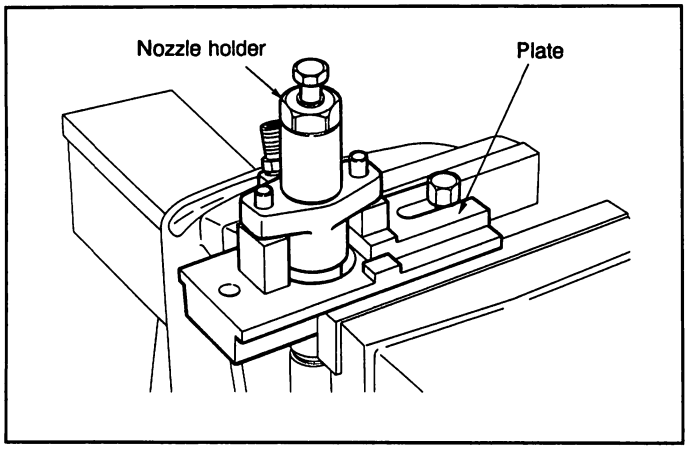
CAUTION

- **Do not touch the nozzle holes with the wire brush.**
- **Place all disassembled parts in order of disassembly on the bench.**

KBL2.1-S TYPE NOZZLE HOLDER: EXPLODED VIEW

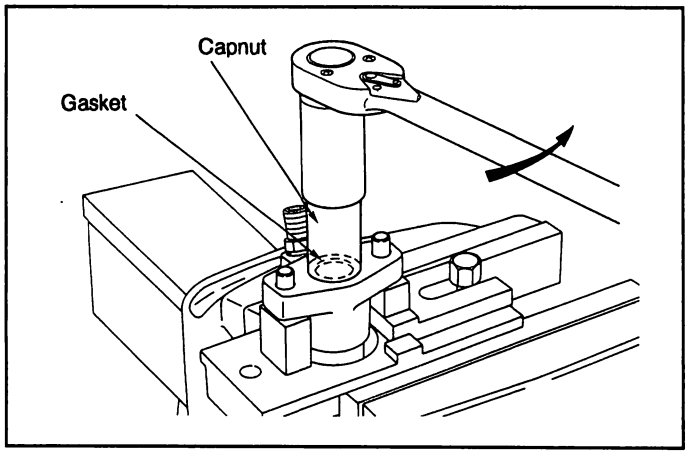


Key no	Part name
1	Nozzle holder body
2	Pins
3	Retaining nut
4	First pushrod
5	First spring
6	Shim (for first opening pressure adjustment)
7	Spacer
8	Set screw
9	Shim (for pre-lift adjustment)
10	Second pushrod
11	Second spring
13	Adjusting screw
14	Locknut
15	Gasket
16	Capnut
18	Eye bolt
19	Gasket
20	Gasket
21	Inlet connector
A	Nozzle

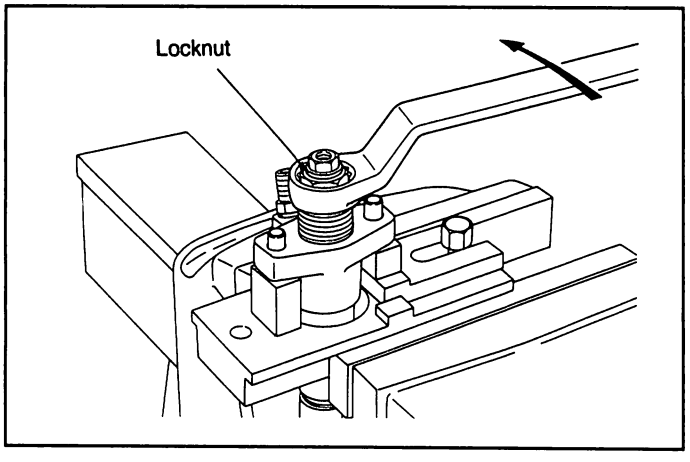


1. Position the nozzle holder on the plate (157944-9520).

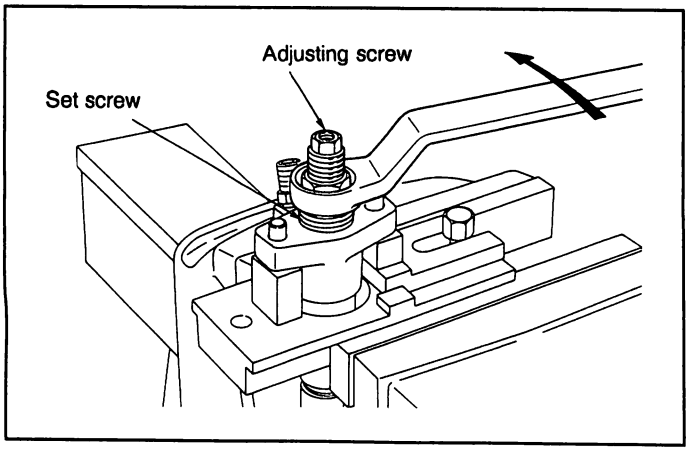
Note:
Assemble the plate as shown at left.



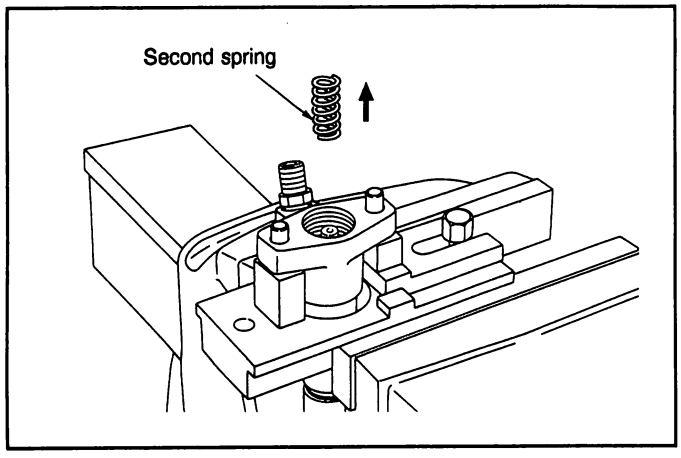
2. Remove the capnut and gasket.



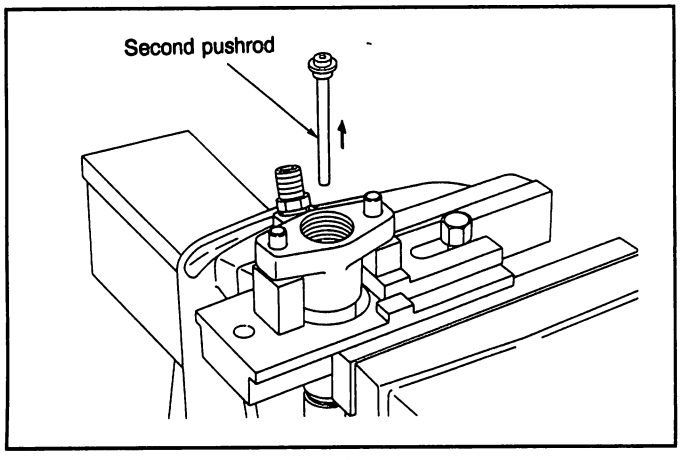
3. Remove the locknut.



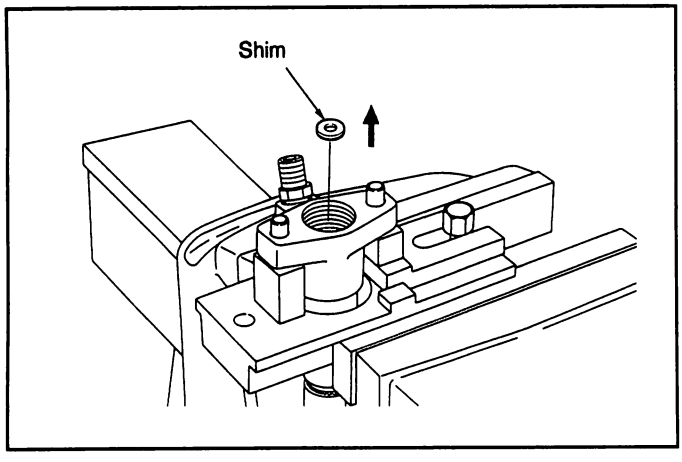
4. Remove the set screw and adjusting screw.



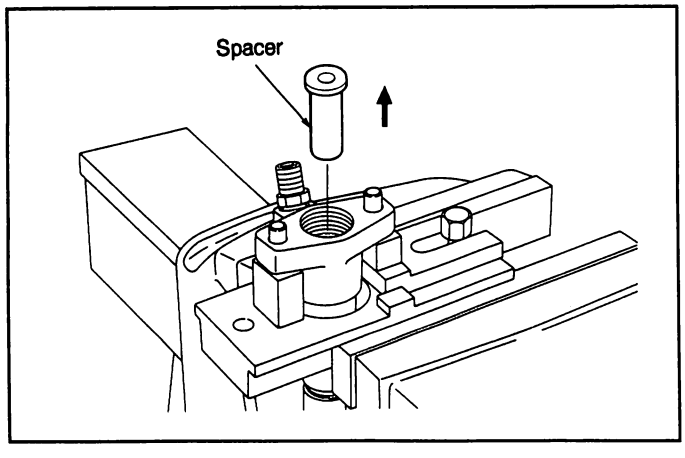
5. Remove the second spring.



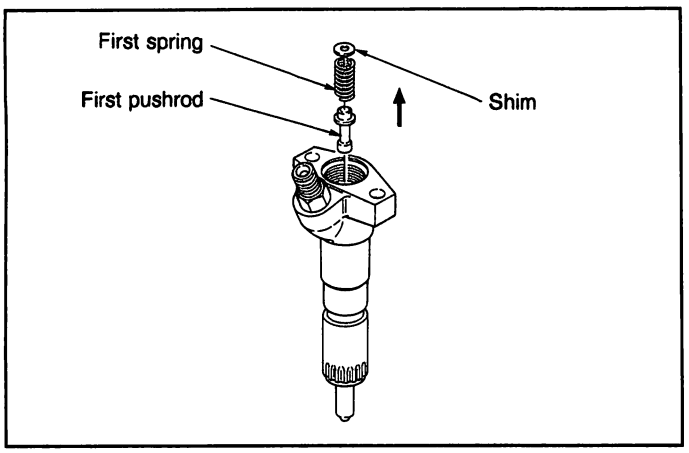
6. Remove the second pushrod.



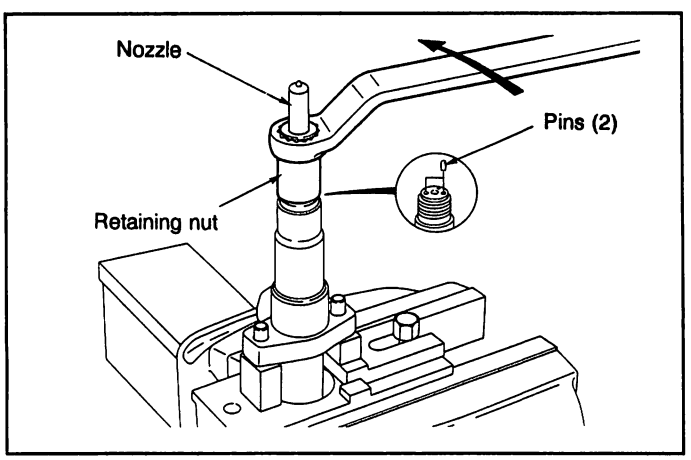
7. Remove the pre-lift adjusting shim.



8. Remove the spacer.



9. Remove the first opening pressure adjusting shim, first spring and first pushrod.



10. Position the nozzle holder with the nozzle facing up, then remove the retaining nut, nozzle and pins.
11. Soak the disassembled parts in clean solvent and remove any carbon using the cleaning kit (105789-0010).
12. Visually inspect the cleaned parts for wear, rust, erosion, etc.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for cleaning kit use and inspection standards.

KBL2.1-S TYPE
REASSEMBLY AND ADJUSTMENT

The nozzle holder is adjusted as the components are reassembled in the sequence below.

As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

REASSEMBLY AND ADJUSTMENT PROCEDURE

1 First nozzle opening pressure adjustment
Page 27

Adjust the first nozzle opening pressure using the shim.

CAUTION

Do not install the pre-lift adjusting shim during procedures 1 to 3.

2 Pre-lift adjusting shim selection
Page 29

Select the pre-lift adjusting shim.

3 Second nozzle opening pressure adjustment
Page 32

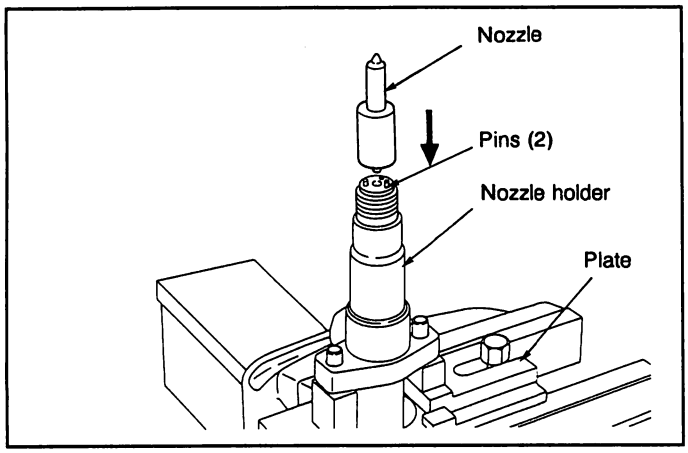
Adjust the second nozzle opening pressure using the adjusting screw.

4 Pre-lift shim assembly
Page 33

Install the pre-lift adjusting shim selected in procedure 2.

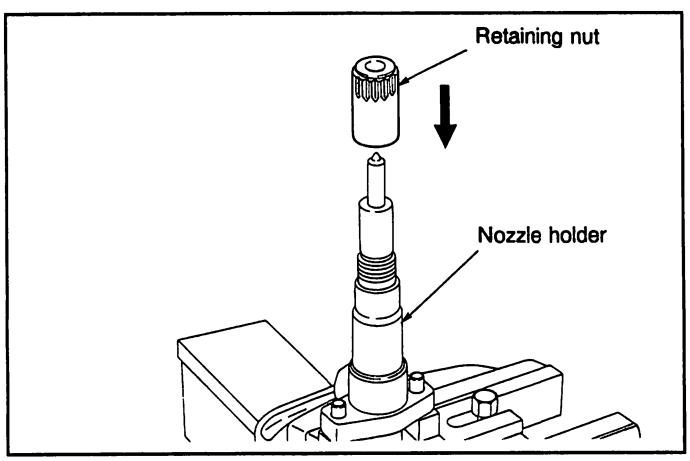
5 Final inspection
Page 34

Confirm the condition of the fuel spray with the nozzle and nozzle holder assembled.

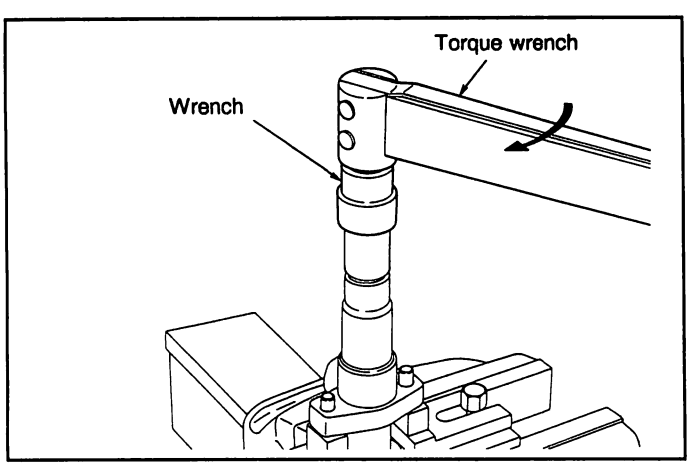


First nozzle opening pressure adjustment

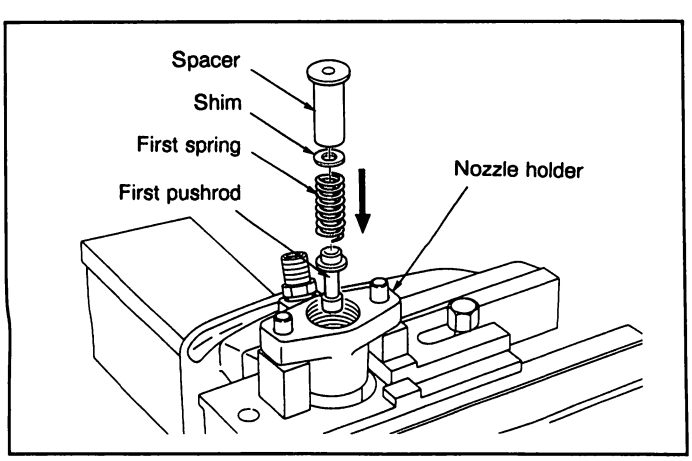
1. Position the nozzle holder on the plate with the capnut facing down.
2. Assemble the pins in the nozzle holder.
3. Assemble the nozzle on the pins.



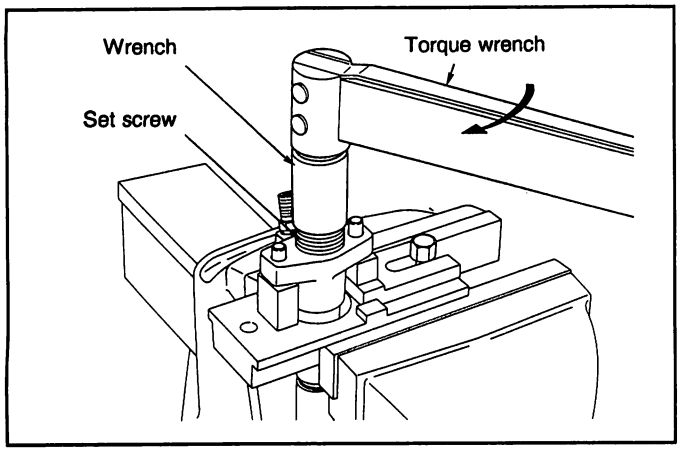
4. Hand-tighten the retaining nut to the nozzle holder.



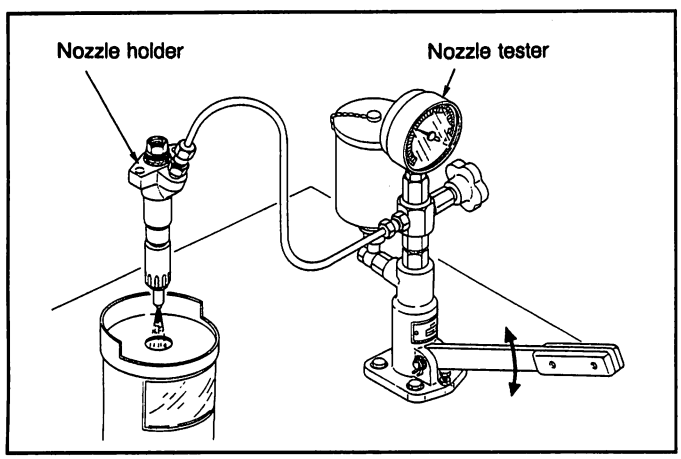
5. Tighten the retaining nut to the specified torque using the wrench (157914-2800).
   Specified torque: 59~78 N · m {6.0~8.0 kgf · m}



6. Position the nozzle holder on the plate with the capnut facing up.
7. Install the first pushrod, first spring, shim and spacer in the nozzle holder.



8. Install the set screw on the nozzle holder and tighten to the specified torque.
Specified torque: 49~59 N · m {5.0~6.0 kgf · m}



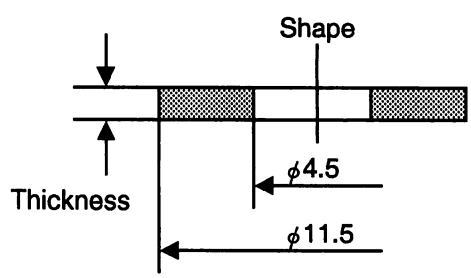
9. Attach the nozzle holder to the nozzle tester and confirm the first nozzle opening pressure.
If the first nozzle opening pressure is not as specified, vary the thickness of the shim until it is as specified. Adjusting shims are listed below.

CAUTION

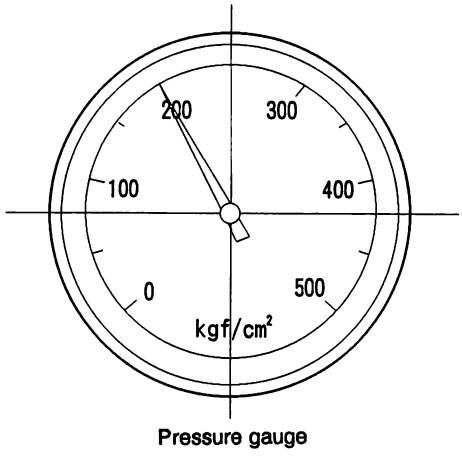
- **Two shims may be necessary.**
- **Use a micrometer to measure shim thickness.**
- **Opening pressure adjusting shims and pre-lift adjusting shims are identical.**

- **First nozzle opening pressure and pre-lift adjusting shims**

Part No.	Thickness (mm)
150523-5000	0.50
150523-5100	0.52
150523-5200	0.54
150523-5300	0.56
150523-5400	0.58
150523-5500	0.60
150523-6000	0.70
150523-6500	0.80
150523-7000	0.90
150523-7500	1.00
150532-6700	0.10
150532-6800	0.20
150532-6900	0.30
150532-7000	0.40

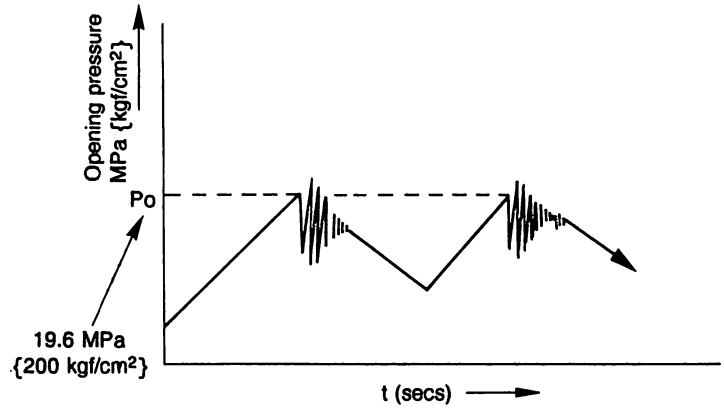


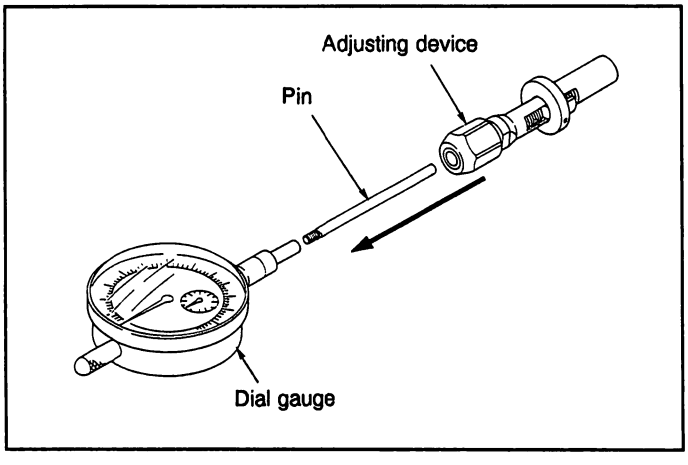
- **Reading the beginning-of-injection pressure**
  When the nozzle tester handle is operated, the nozzle tester's pressure gauge needle moves as shown below. The point P_0 shown below is the beginning-of-injection pressure. Measure this value.



Pressure gauge

When the nozzle tester is operated, the nozzle opens and, simultaneously, the gauge needle suddenly begins to deflect. The beginning of this deflection is the beginning-of-injection pressure. For example, at P_0 = 19.6 MPa {200 kgf/cm²}, the needle's maximum deflection differs from the beginning-of-injection pressure.



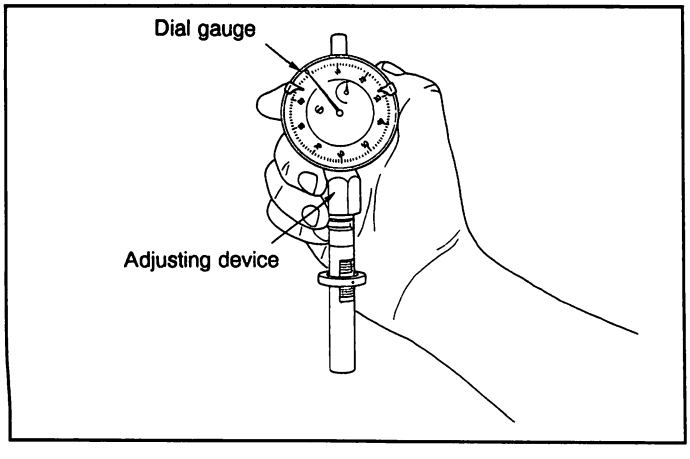


Pre-lift adjusting shim selection

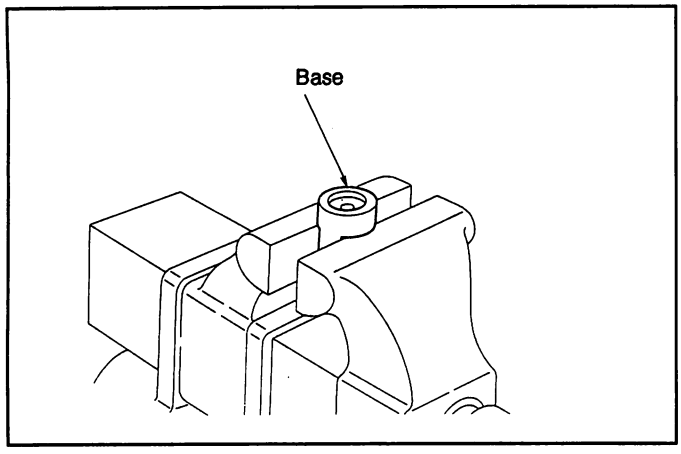
1. Attach the pin to the dial gauge.

Tool Name	Part No.	Remarks
Pin	157892-1100	L = 60.5 mm
Dial gauge	157954-3800	

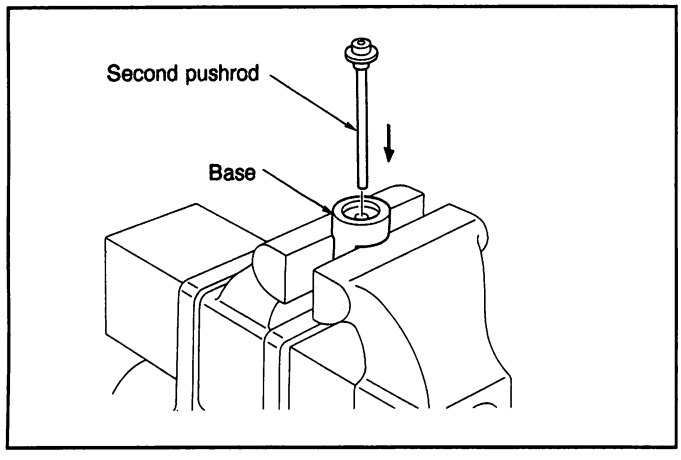
2. Insert the dial gauge into the adjusting device (157892-0220).



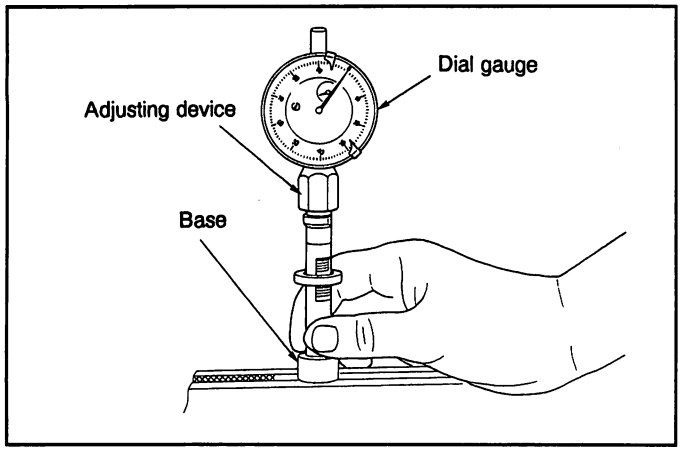
3. Attach the dial gauge to the adjusting device.



4. Secure the base (157892-1800) in the vise.



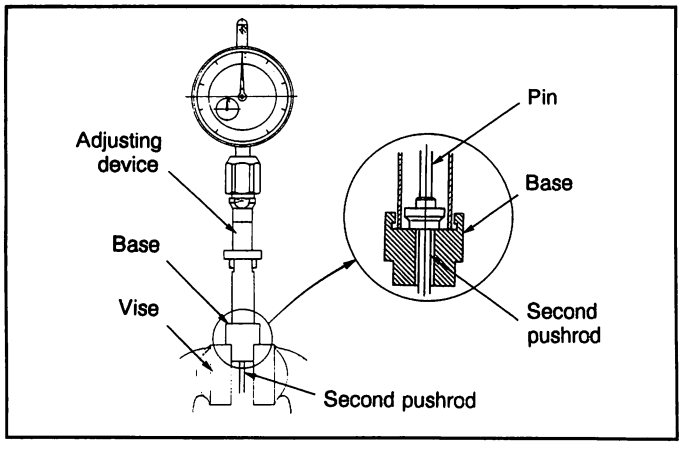
5. Assemble the second pushrod in the base.

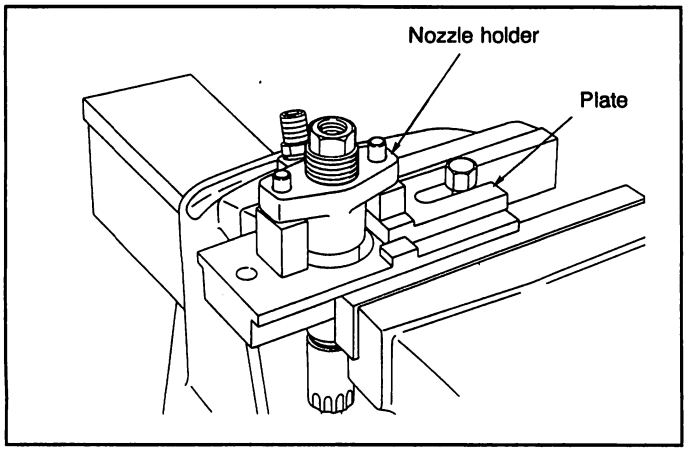


6. Assemble the adjusting device in the base.
7. Push the adjusting device down and zero the dial gauge.

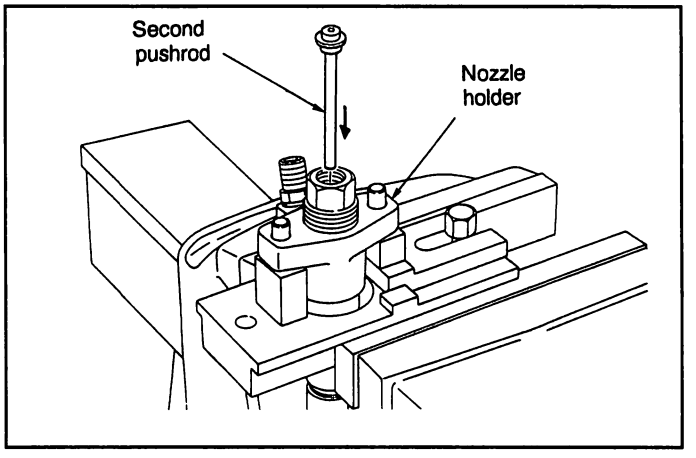
CAUTION

- **Confirm the zero position several times.**
- **Handle the adjusting device carefully after setting the zero position so that the zero position is maintained.**





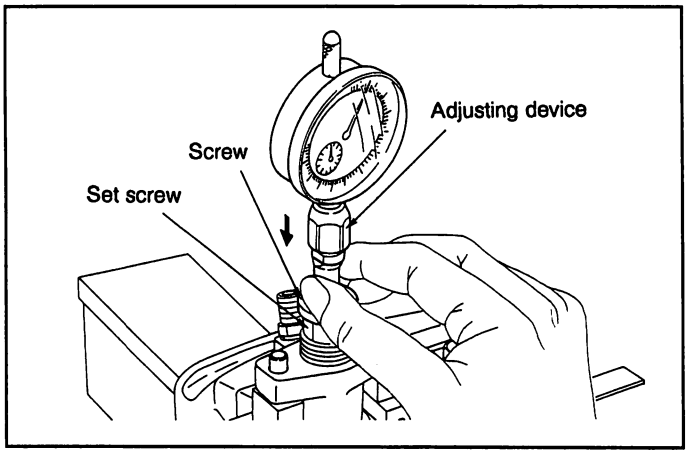
8. Position the nozzle holder on the plate.



9. Assemble the second pushrod in the nozzle holder.

CAUTION

Do not assemble the second spring or the pre-lift adjusting shim at this time.



10. Attach the adjusting device to the nozzle holder set screw and tighten the middle adjusting device screw.

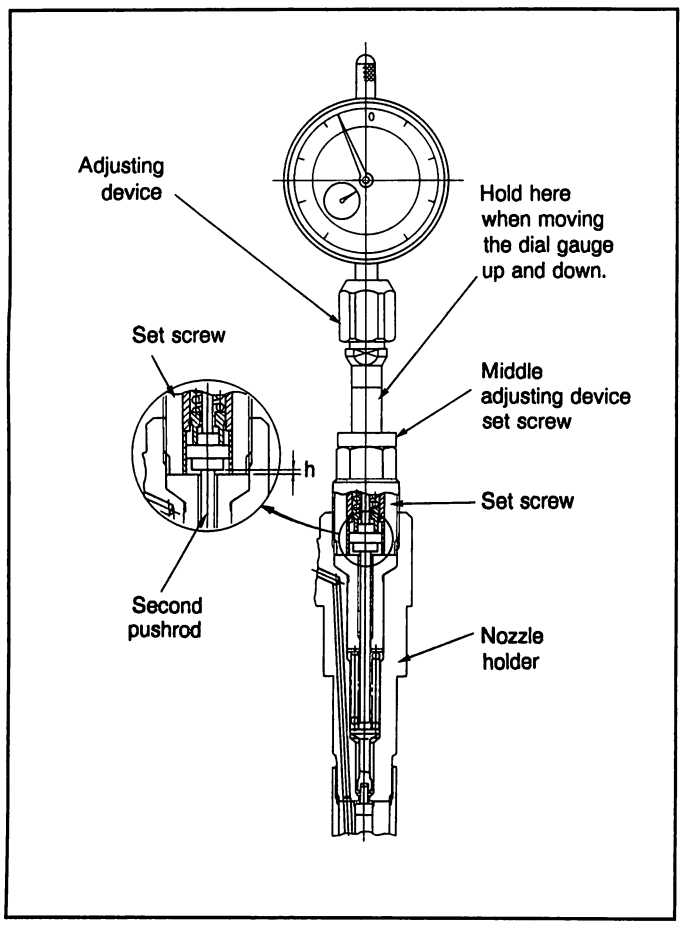
CAUTION

Hold the dial gauge holder, move the dial gauge up and down, and confirm that the dial gauge needle moves smoothly.

11. Push the adjusting device down (in the direction of the arrow) and measure the dial gauge lift 'h.'

CAUTION

Measure the lift to within 0.01mm.



12. Select the pre-lift adjusting shim.

$t = \ell + h$
t: shim thickness (measured value)
ℓ: pre-lift (specified value)
h: value measured in 11 above
T: thickness of actual selected shim
$T = t \pm 0.015$ mm

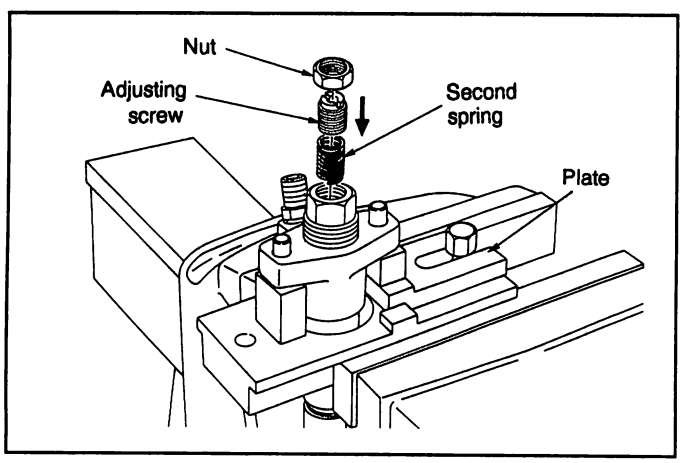
Note:
Refer to the first nozzle opening pressure and pre-lift adjusting shims on page 28.

Example:
$h = 0.98$ mm, $\ell = 0.1$ mm
$t = 0.1 + 0.98 = 1.08$
$T = 1.08 \pm 0.015 = 1.065 \sim 1.095$
That is, the selected shims (2) are part numbers 150523-5000 and 150523-5400, which give a total shim thickness of 1.08.

CAUTION

- **Two shims may be necessary.**
- **Use a micrometer to measure shim thickness.**
- **Do not assemble the selected shim(s) at this time.**

13. Remove the adjusting device.



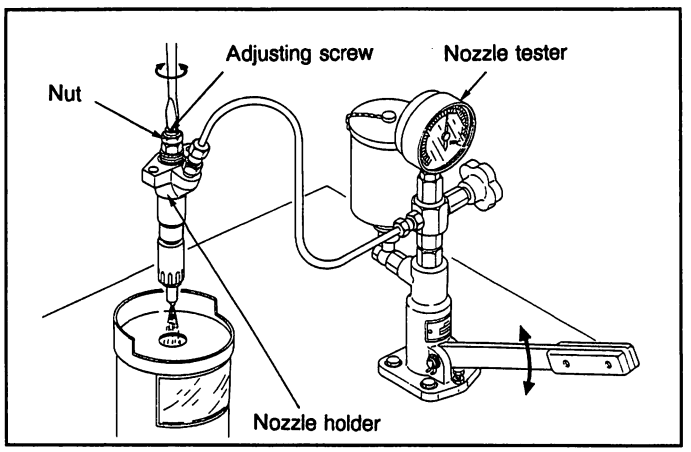
Second nozzle opening pressure adjustment

1. Assemble the second spring, adjusting screw and nut in the nozzle holder.

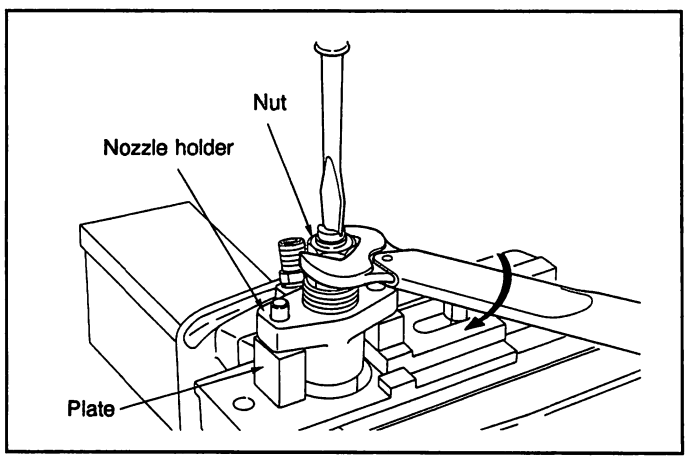
Note:
In this condition the first and second pushrods contact.

CAUTION

Do not assemble the pre-lift adjusting shim(s) at this time.



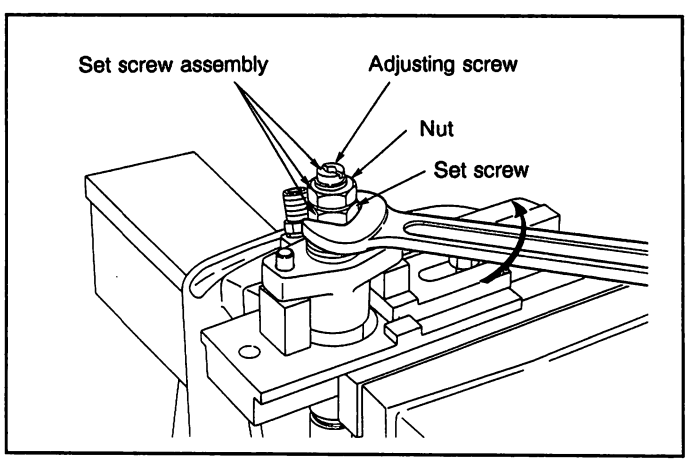
2. Attach the nozzle holder to the nozzle tester and adjust the second nozzle opening pressure using the adjusting screw.
   Then, secure the adjusting screw using the nut.
3. Remove the nozzle holder from the nozzle tester.



4. Position the nozzle holder on the plate and tighten the nut.
   Specified torque: 20~25 N·m {2.0~2.5 kgf·m}
5. Confirm the second nozzle opening pressure. If not as specified, readjust the opening pressure.

CAUTION

Reconfirmation is necessary as the second nozzle opening pressure may change when the nut is tightened.

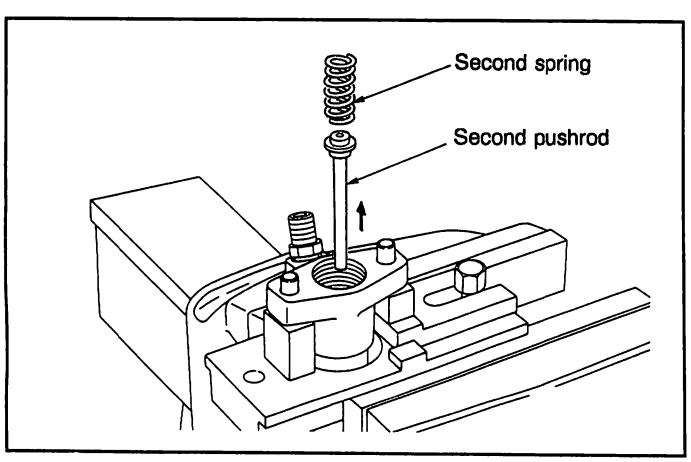


Pre-lift shim assembly

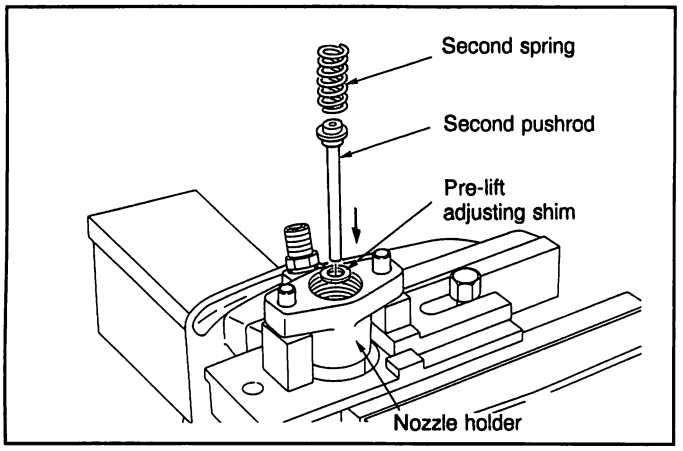
1. Remove the set screw assembly (ie, the set screw, adjusting screw and nut as an assembly).

CAUTION

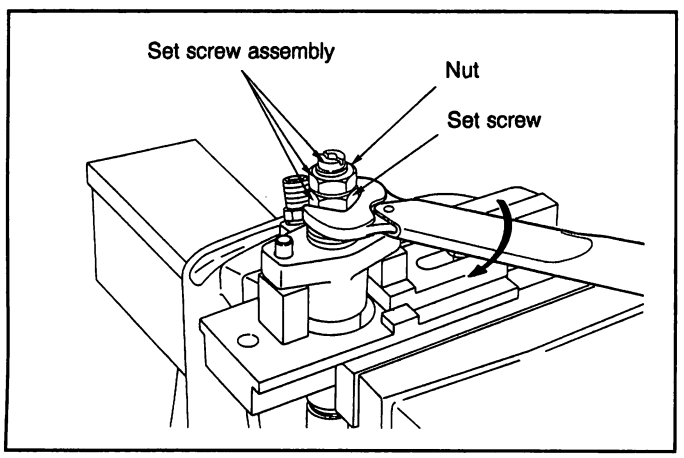
Do not loosen the nut at this time.



2. Remove the second spring and second pushrod.



3. Assemble the pre-lift adjusting shim (selected in 12 on page 32) on the second pushrod, and then assemble the second spring and second pushrod in the nozzle holder.

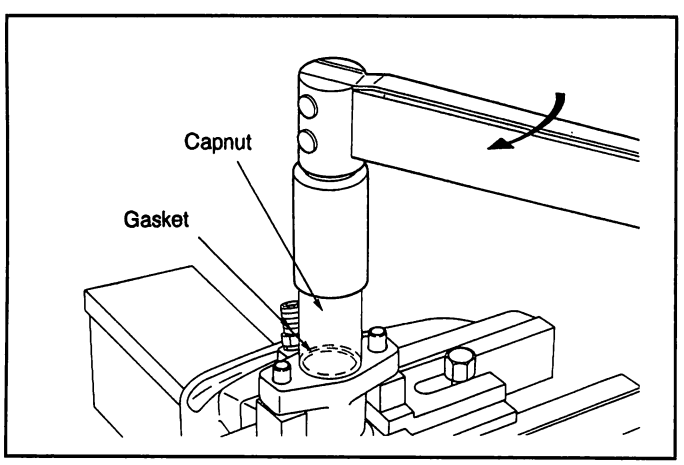


4. Install the set screw assembly and tighten the set screw to the specified torque.
   Specified torque: 49~59 N·m {5.0~6.0 kgf·m}

Note:
In this condition, pre-lift clearance can be maintained between the first pushrod and the second pushrod.

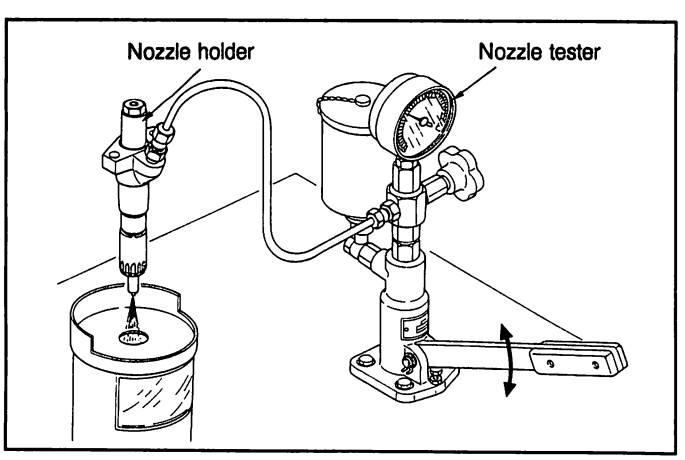
CAUTION

Do not tighten the nut at this time.



Final Inspection

1. Install the gasket and capnut.
2. Tighten the capnut to the specified torque.
   Specified torque: 39~49 N·m {4.0~5.0 kgf·m}

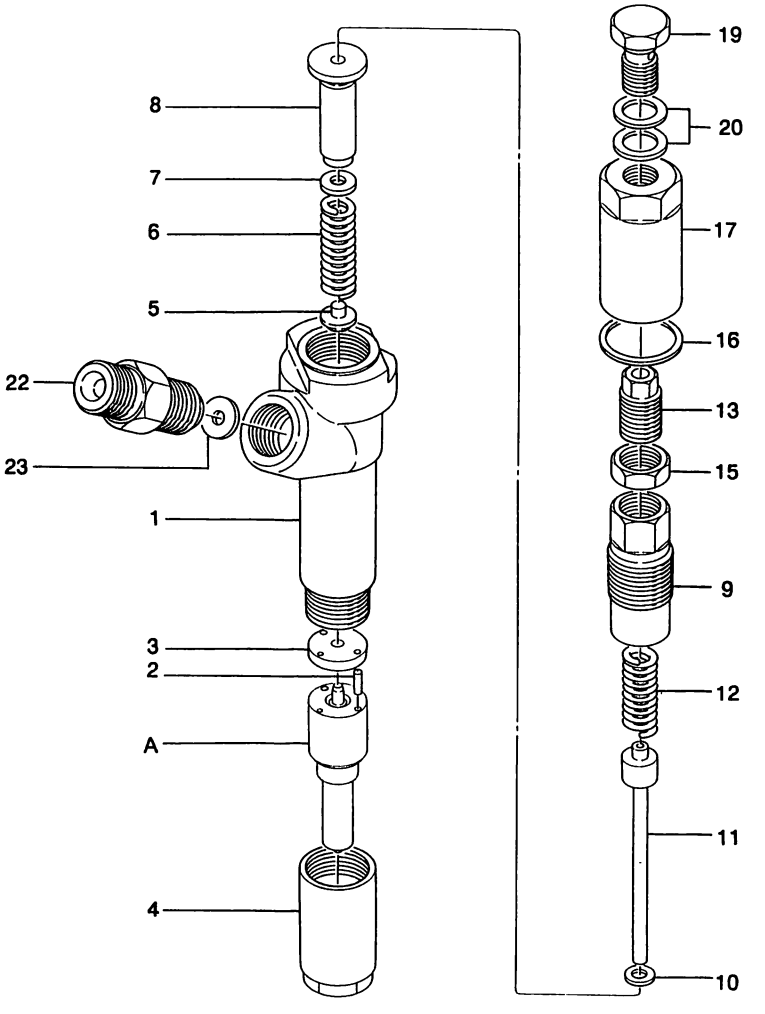


3. Attach the nozzle holder to the nozzle tester and check first nozzle opening pressure, spray pattern, seat oil-tightness and each part for oil leaks.

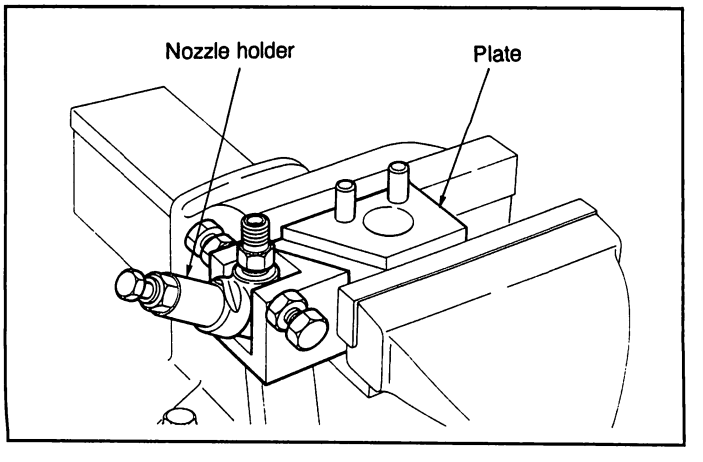
Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for spray patterns and inspection standards.

Disassembly, reassembly and adjustment procedures are identical to those for the KBL2.1-S type two spring nozzle holder. Refer to pages 22~34.

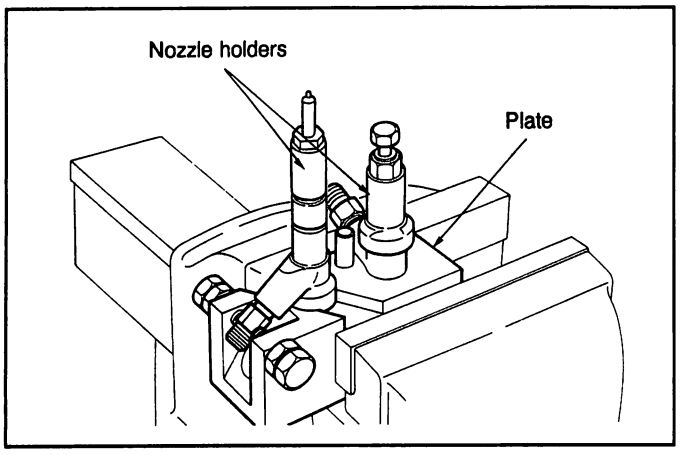
KBL2.1-P TYPE NOZZLE HOLDER: EXPLODED VIEW



Key no	Part name
1	Nozzle holder body
2	Pins
3	Spacer
4	Retaining nut
5	First pushrod
6	First spring
7	Shim (for first opening pressure adjustment)
8	Spacer
9	Set screw
10	Shim (for pre-lift adjustment)
11	Second pushrod
12	Second spring
13	Adjusting screw
15	Nut
16	Gasket
17	Capnut
19	Eye bolt
20	Gasket
22	Inlet connector
23	Gasket
A	Nozzle



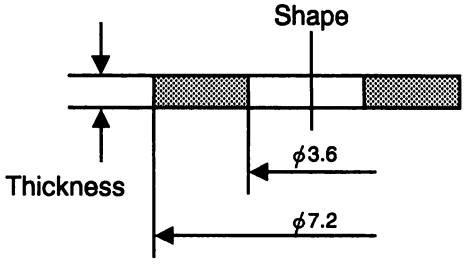
- The plate (157992-2521) is necessary for the disassembly, reassembly and adjustment of the KBL2.1-P type two-spring nozzle holder.
  Examples of its use are shown at left and on the following page.



- Plate use

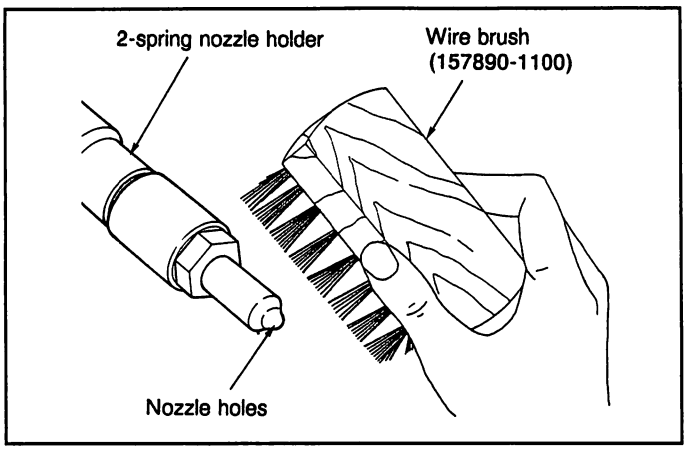
Part No.	Thickness (mm)
150591-1000	0.10
150591-2000	0.20
150591-3000	0.30
150591-4000	0.40
150591-5000	0.50
150591-5100	0.51
150591-5200	0.52
150591-5300	0.53
150591-5400	0.54
150591-5500	0.55
150591-5600	0.56
150591-5700	0.57
150591-5800	0.58
150591-5900	0.59

- First nozzle opening pressure and pre-lift adjusting shim



CAUTION

- **Two shims may be necessary.**
- **Use a micrometer to measure shim thickness.**
- **Opening pressure adjusting shims and pre-lift adjusting shims are identical.**



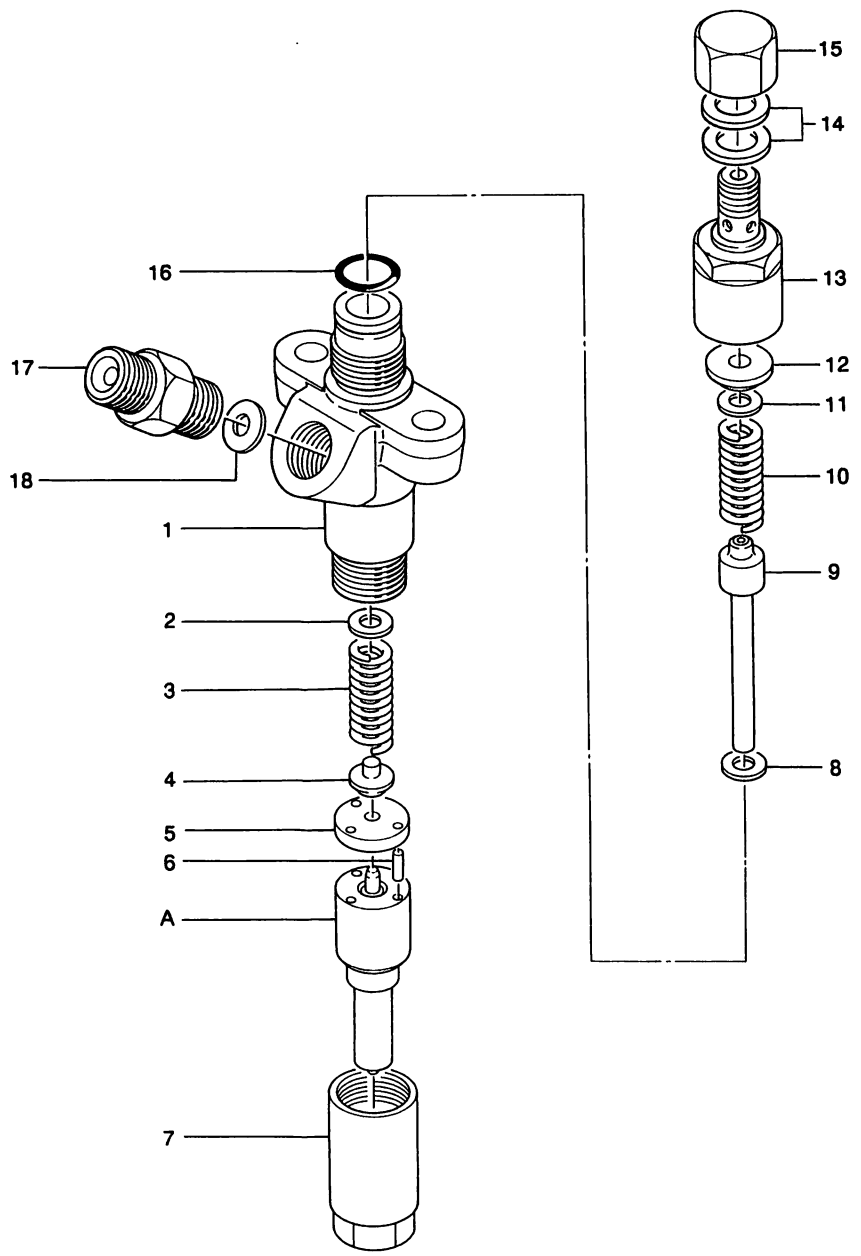
KBL2.2-P TYPE DISASSEMBLY

Before disassembly, remove any carbon from the nozzle holder using a wire brush and wash the outside.

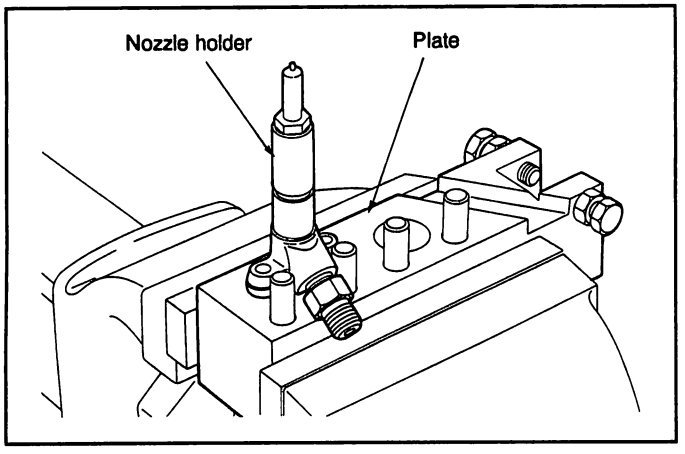
CAUTION

- **Do not touch the nozzle holes with the wire brush.**
- **Place all disassembled parts in order of disassembly on the bench.**

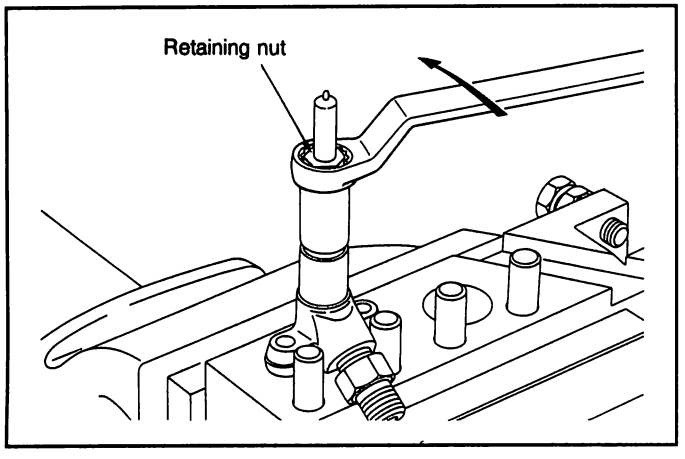
KBL2.2-P TYPE NOZZLE HOLDER: EXPLODED VIEW



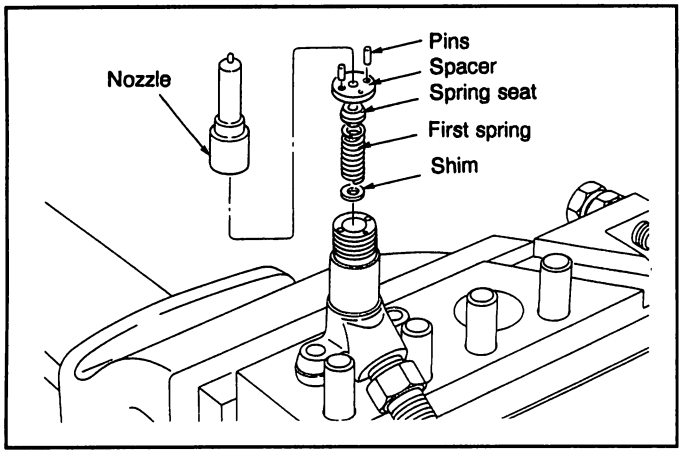
Key no	Part name
1	Nozzle holder body
2	Shim (for first opening pressure adjustment)
3	First spring
4	Spring seat
5	Spacer
6	Pins
7	Retaining nut
8	Shim (for pre-lift adjustment)
9	Pushrod
10	Second spring
11	Shim (for second opening pressure adjustment)
12	Spring seat
13	Capnut
14	Gasket
15	Nut
16	O-ring
17	Inlet connector
18	Gasket
A	Nozzle



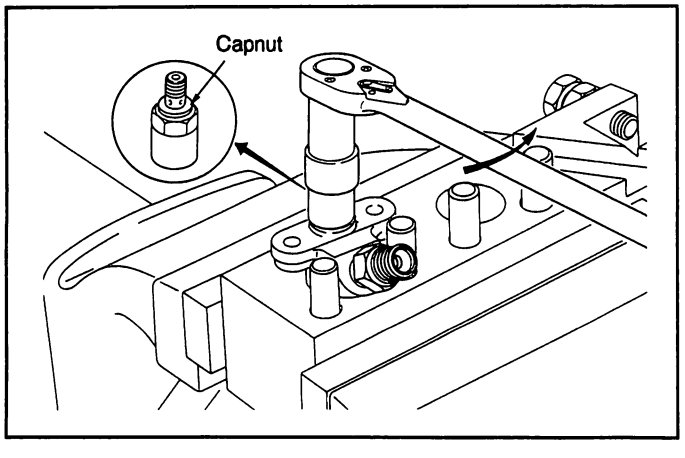
1. Position the nozzle holder on the plate (157992-2820).



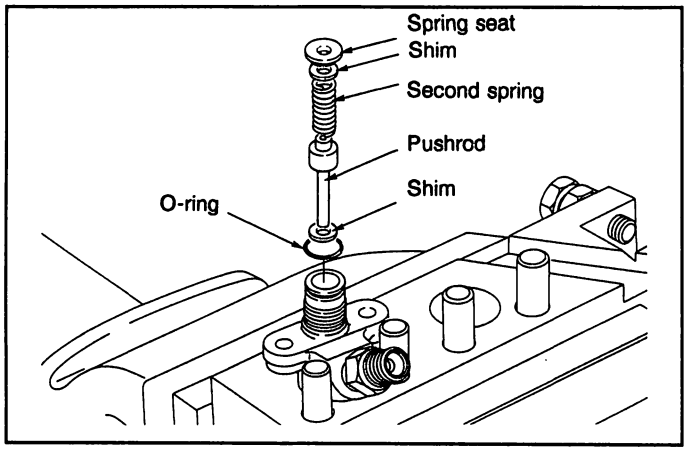
2. Remove the retaining nut.



3. Remove the nozzle, pins, spacer, spring seat, first spring and shim.



4. Position the nozzle holder with the nozzle facing down and remove the capnut.



5. Remove the spring seat, shim, second spring, pushrod, shim and O-ring.
6. Soak the disassembled parts in clean solvent and remove any carbon using the cleaning kit (105789-0010).
7. Visually inspect the cleaned parts for wear, rust, erosion, etc.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for cleaning kit use and inspection standards.

KBL2.2-P TYPE REASSEMBLY AND ADJUSTMENT

The nozzle holder is adjusted as the components are reassembled in the sequence below.
As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

REASSEMBLY AND ADJUSTMENT PROCEDURE

1 Zeroing the dial gauge
Page 41

Zero the dial gauge in preparation for selecting the pre-lift adjusting shim.

CAUTION

Do not install the pre-lift adjusting shim during procedures 1~4.

2 First nozzle opening pressure adjustment
Page 42

Adjust the first nozzle opening pressure using the shim.

3 Second nozzle opening pressure adjustment
Page 43

Adjust the second nozzle opening pressure using the shim.

4 Pre-lift adjusting shim selection
Page 44

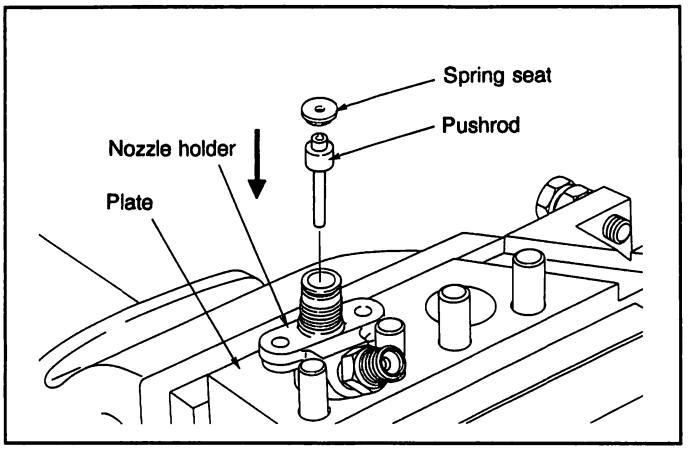
Select the pre-lift adjusting shim.

5 Pre-lift shim assembly
Page 45

Install the pre-lift adjusting shim selected in procedure 4.

6 Final inspection
Page 46

Confirm the condition of the fuel spray with the nozzle and nozzle holder assembled.

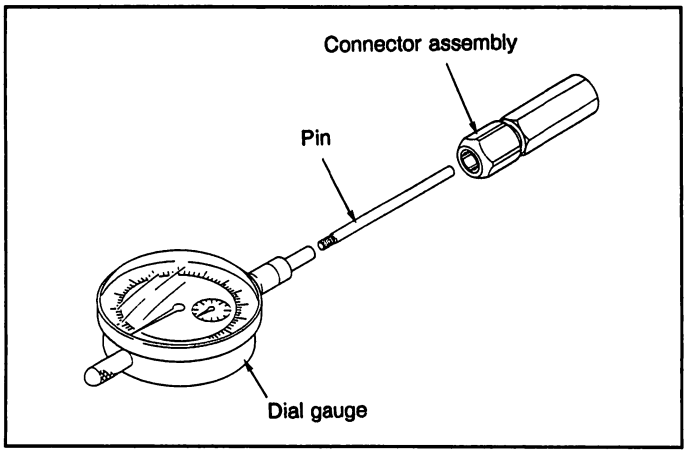


Zeroing the dial gauge

1. Position the nozzle holder on the plate.
2. Assemble the pushrod and spring seat in the nozzle holder.

CAUTION

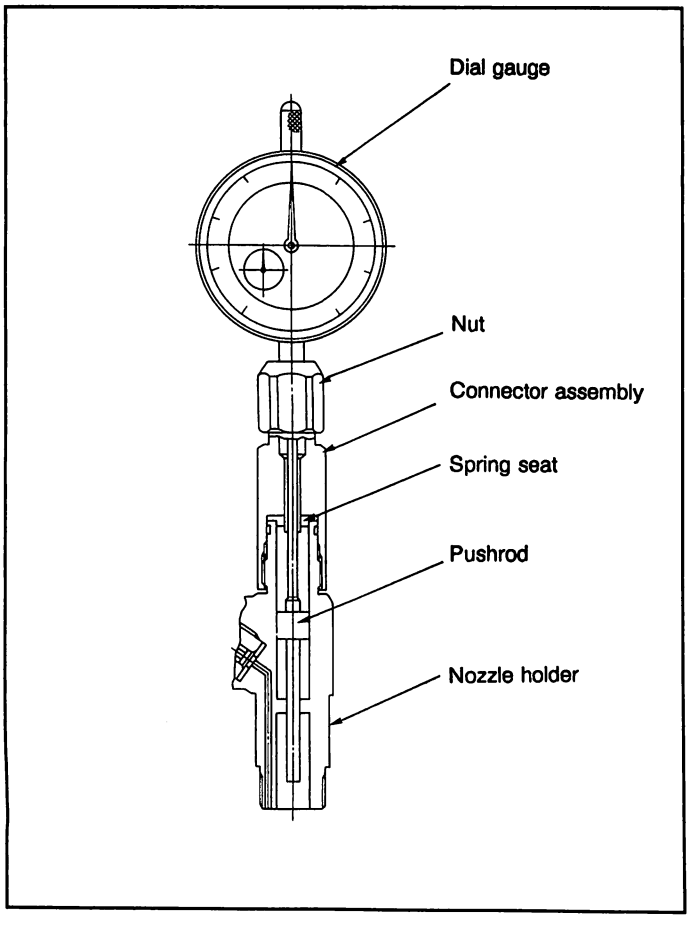
Do not assemble the pre-lift or second opening pressure adjusting shims.



3. Attach the pin to the dial gauge.

Tool Name	Part No.	Remarks
Pin	157892-3500	L = 45 mm
Dial gauge	157954-3800	

4. Insert the dial gauge into the connector assembly (157892-3620).



5. Attach the connector assembly to the nozzle holder and tighten it using a torque wrench.
   Specified torque: 20~25 N·m {2.0~2.5 kgf·m}
6. Zero the dial gauge and tighten the nut.

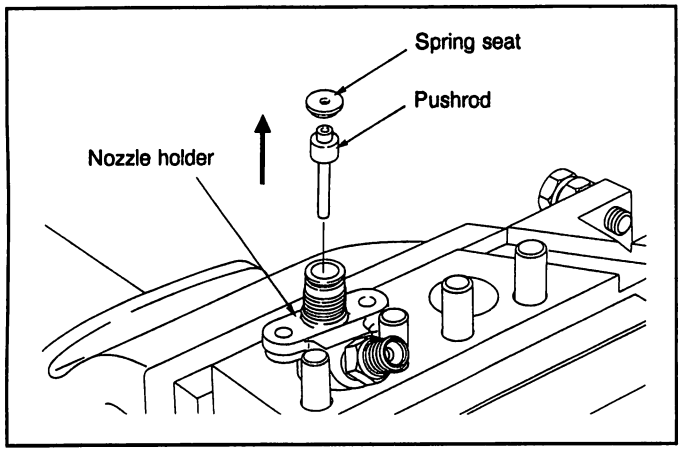
CAUTION

- **Secure the dial gauge so that a 2 mm stroke can be measured.**
- **Do not over tighten the nut as the dial gauge shaft may jam. (Confirm from the dial gauge that the shaft moves smoothly.)**

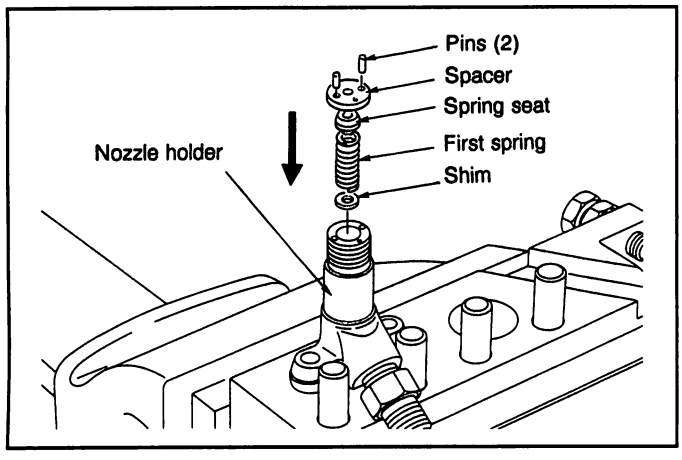
7. Loosen then remove the connector assembly (with the dial gauge).

CAUTION

Ensure the dial gauge reading remains at '0'.

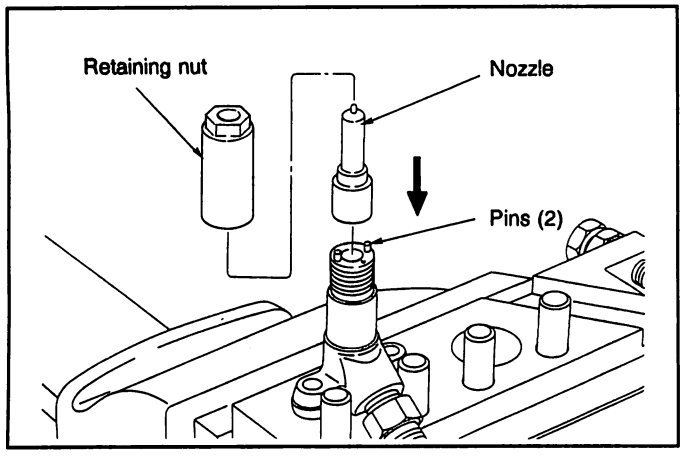


8. Remove the spring seat and pushrod.

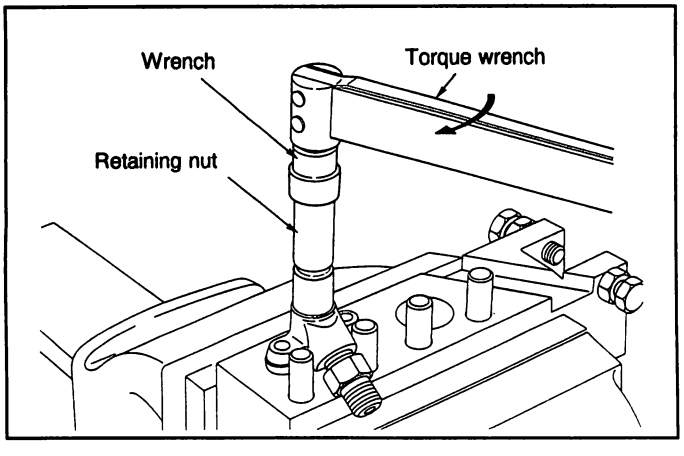


First nozzle opening pressure adjustment

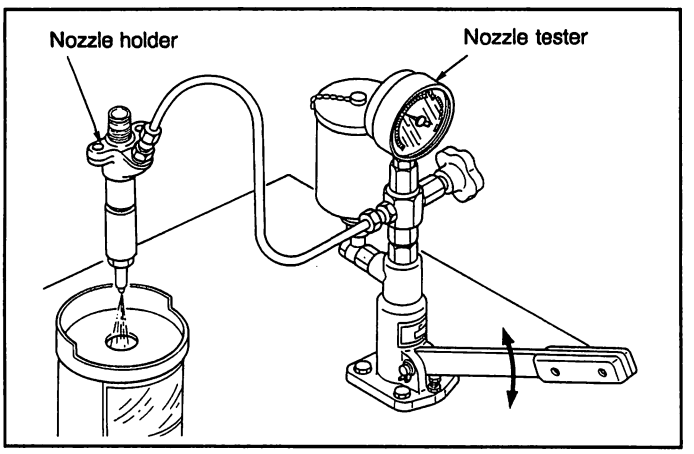
1. Position the nozzle holder on the plate with the nozzle facing up.
2. Assemble the first nozzle opening pressure adjusting shim, first spring, spring seat, spacer and pins in the nozzle holder.



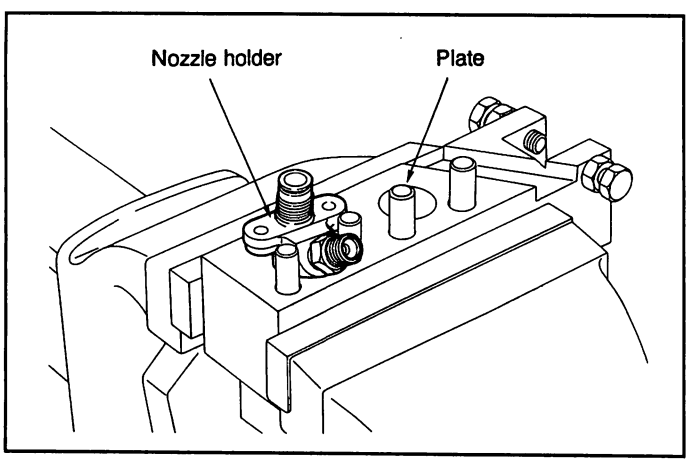
3. Assemble the nozzle on the pins and hand-tighten the retaining nut to the nozzle holder.



4. Tighten the retaining nut to the specified torque.
   Specified torque: 29~39 N·m {3.0~4.0 kgf·m}



Part No.	Thickness (mm)
150591-1000	0.10
150591-2000	0.20
150591-3000	0.30
150591-4000	0.40
150591-5000	0.50
150591-5100	0.51
150591-5200	0.52
150591-5300	0.53
150591-5400	0.54
150591-5500	0.55
150591-5600	0.56
150591-5700	0.57
150591-5800	0.58
150591-5900	0.59

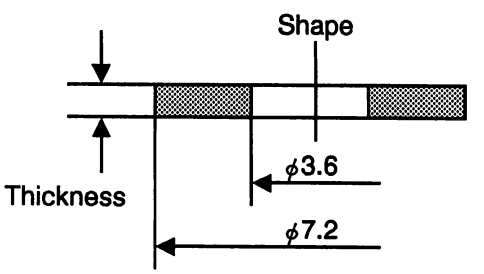


5. Attach the nozzle holder to the nozzle tester and adjust the first nozzle opening pressure.
   If the first nozzle opening pressure is not as specified, vary the thickness of the shim until it is as specified.

CAUTION

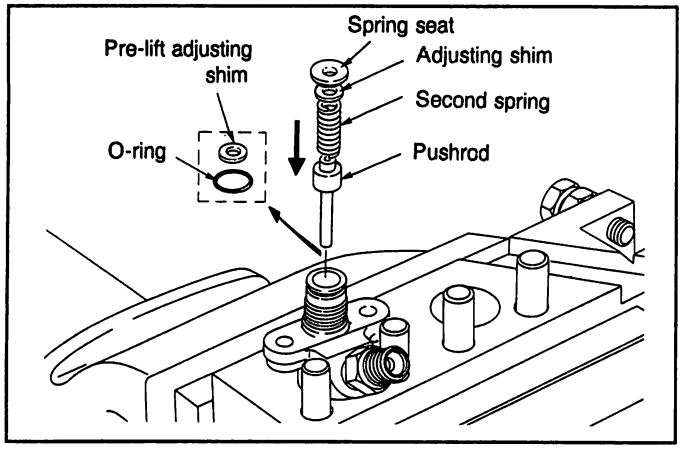
- **Two shims may be necessary.**
- **Use a micrometer to measure shim thickness.**
- **Opening pressure adjusting shims and pre-lift adjusting shims are identical.**

- First opening pressure and pre-lift adjusting shims



Second nozzle opening pressure adjustment

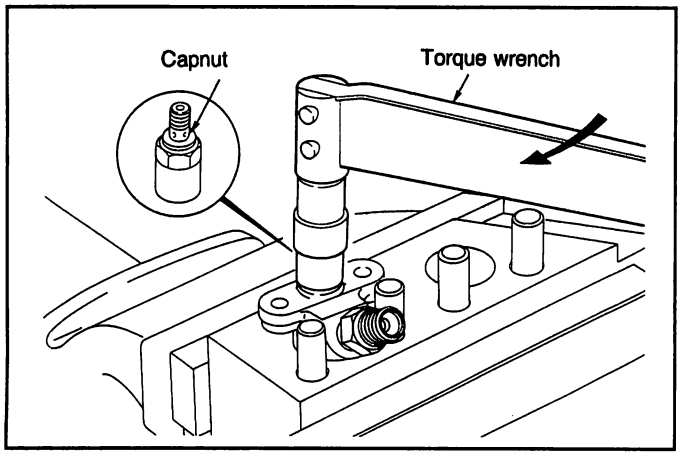
1. Position the nozzle holder on the plate.



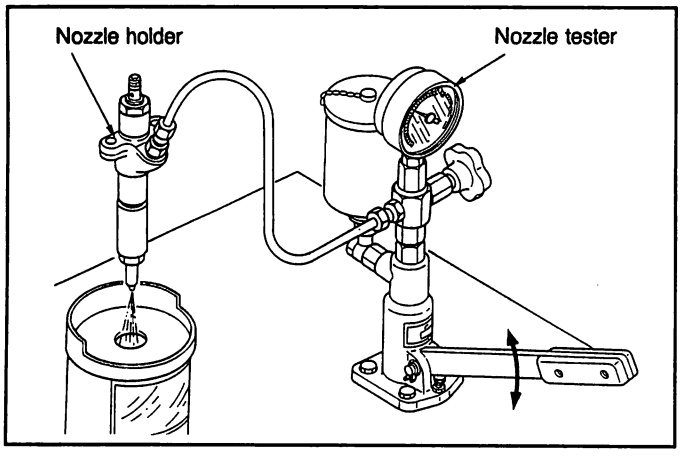
2. Assemble the pushrod, second spring, second nozzle opening pressure adjusting shim and spring seat on the nozzle holder.

CAUTION

Do not assemble the O-ring or pre-lift adjusting shim at this time.

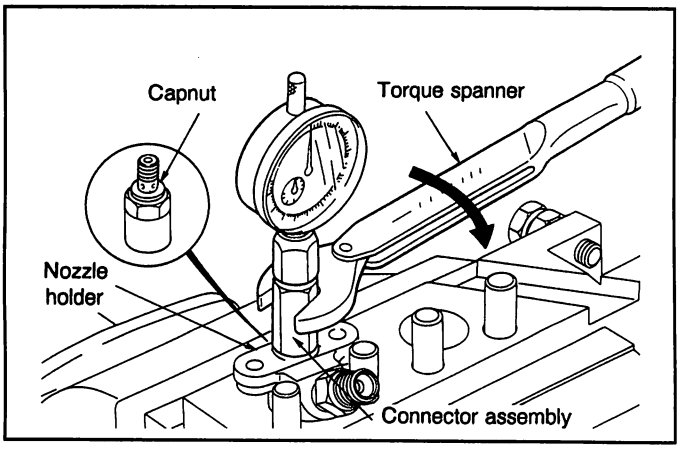


3. Install the capnut on the nozzle holder and tighten it to the specified torque.
Specified torque: 20~25 N·m {2.0~2.5 kgf·m}



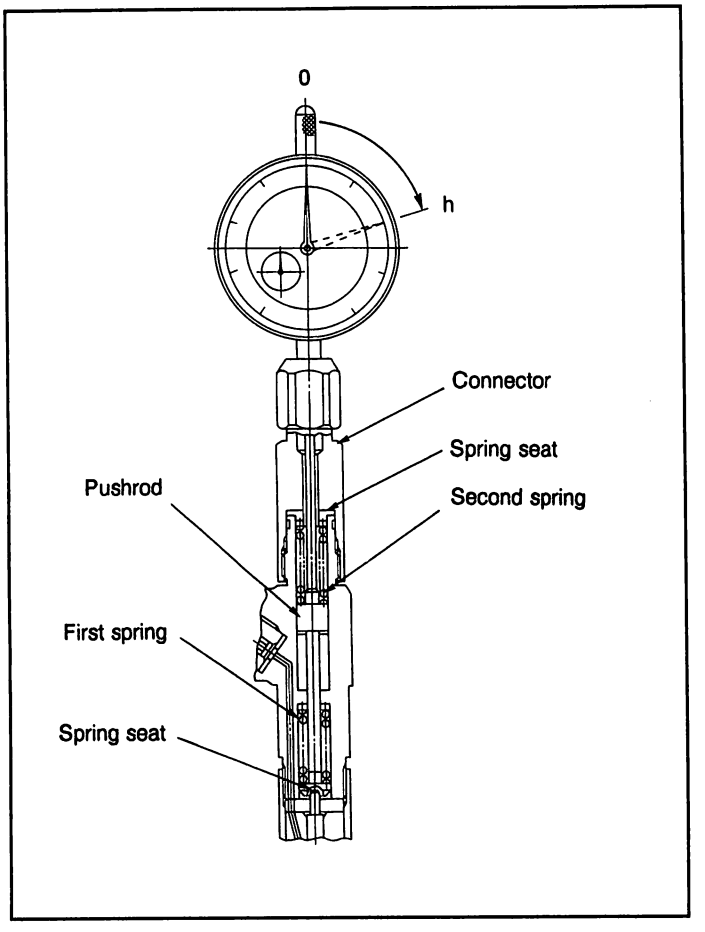
4. Attach the nozzle holder to the nozzle tester and adjust the second nozzle opening pressure.
5. If the second nozzle opening pressure is not as specified, vary the shim thickness until it is as specified.

Note:
Refer to the first and second opening pressure and pre-lift adjusting shims listed on the previous page.



Pre-lift adjusting shim selection

1. Position the nozzle holder with the nozzle facing down and then remove the capnut from the nozzle holder.
2. Attach the connector assembly (with dial gauge, set to '0') to the nozzle holder and tighten to the specified torque.
Specified torque: 20~25 N·m {2.0~2.5 kgf·m}

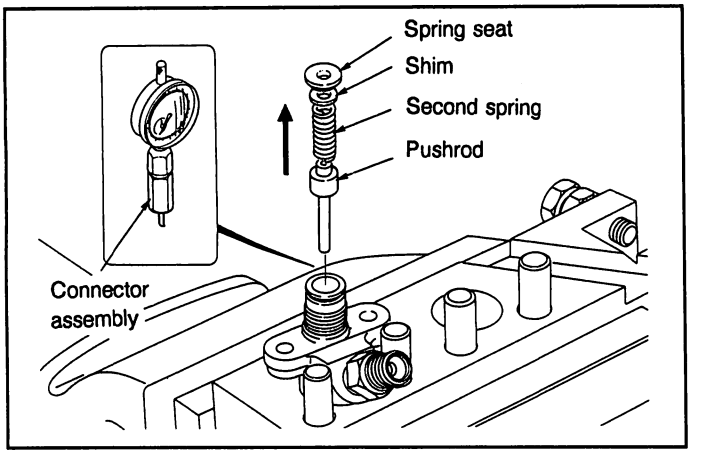


3. Measure and record the dial gauge indication 'h.'
4. Calculate the thickness (T) of the pre-lift adjusting shim using the formula:

   $T = (h + \ell) \pm 0.005$

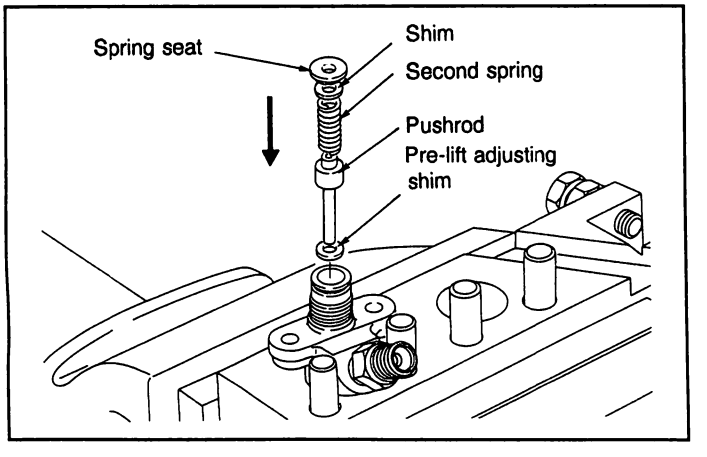
   T: thickness of assembled shim
   h: dial gauge indication from 3 above
   ℓ: pre-lift (as specified)

Note:
Refer to the first and second opening pressure and pre-lift adjusting shims listed on page 43.

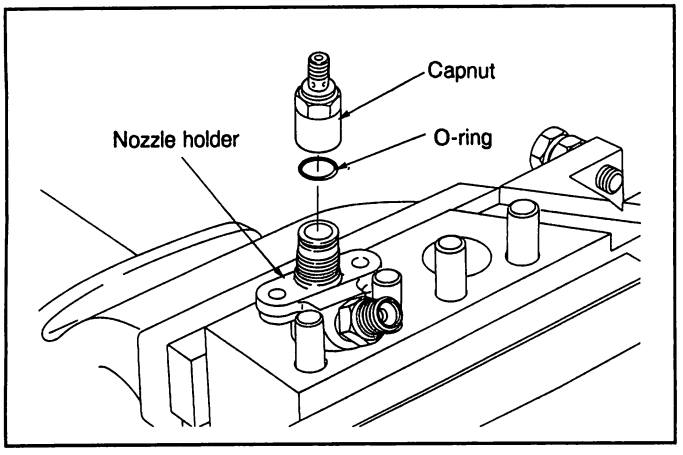


Pre-lift shim assembly

1. Remove the connector assembly (with the dial gauge).
2. Remove the spring seat, shim, second spring and pushrod.

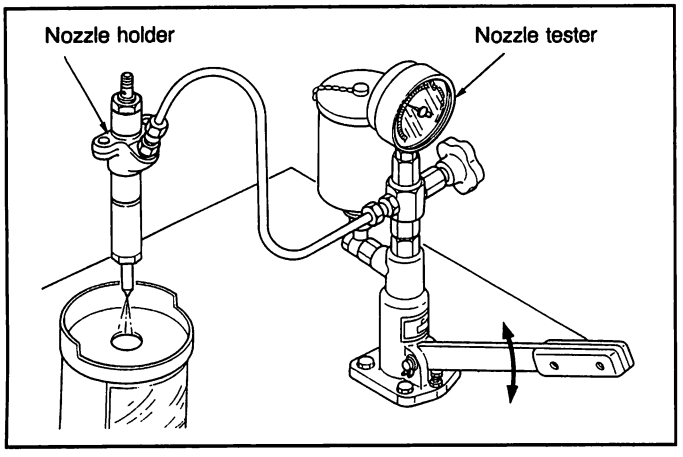


3. Assemble the pre-lift adjusting shim (selected above), pushrod, second spring, shim and spring seat.



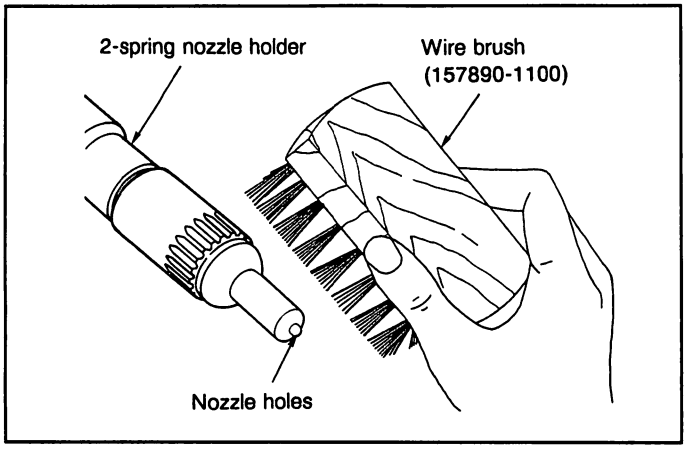
Final inspection

1. Install the O-ring on the nozzle holder and tighten the capnut to the specified torque.
   Specified torque: 20~25 N·m {2.0~2.5 kgf·m}



2. Attach the nozzle holder to the nozzle tester and check first nozzle opening pressure, spray pattern, seat oil-tightness and each part for oil leaks.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for spray patterns and inspection standards.



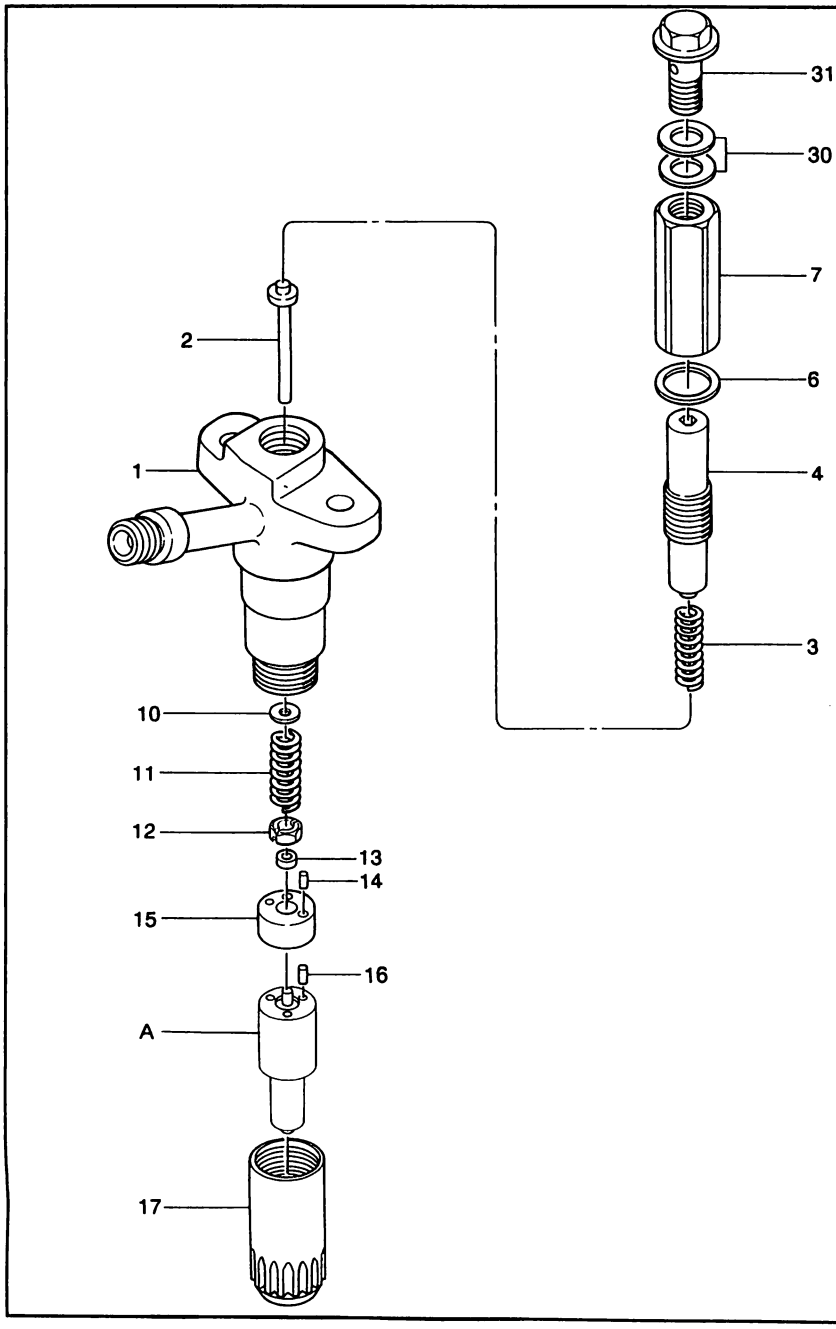
KBL2.3-S TYPE DISASSEMBLY

Before disassembly, remove any carbon from the nozzle holder using a wire brush and wash the outside.

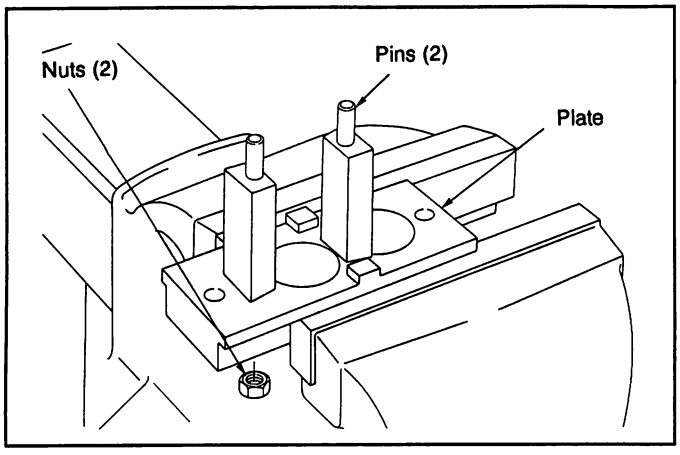
CAUTION

- **Do not clean the nozzle holes.**
- **Place all disassembled parts in order of disassembly on the bench.**

KBL2.3-S TYPE NOZZLE HOLDER: EXPLODED VIEW



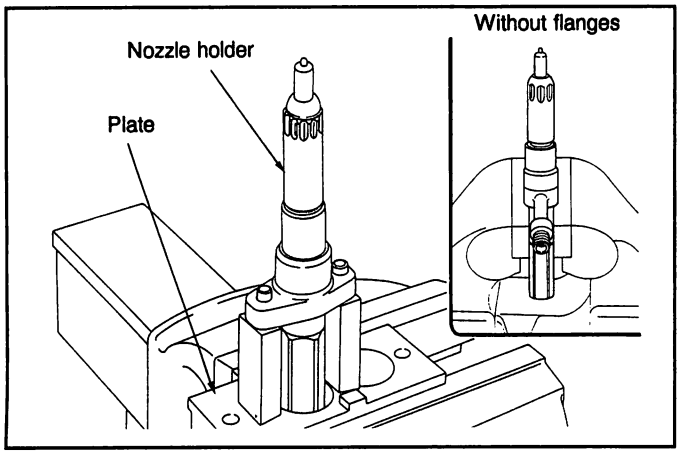
Key no	Part name
1	Nozzle holder body
2	Pushrod
3	First spring
4	Adjusting screw
6	Gasket
7	Capnut
10	Shim (for second opening pressure adjustment)
11	Second spring
12	Spring seat
13	Lift piece
14	Pins
15	Spacer
16	Pins
17	Retaining nut
30	Gasket
31	Eye bolt
A	Nozzle



1. Secure the pins to the plate using the nuts.

Tool Name	Part No.	Remarks
Pin	157944-1900	L = 115 mm
Plate	157944-9500	
Nut	013010-8020	M8 × 1.25

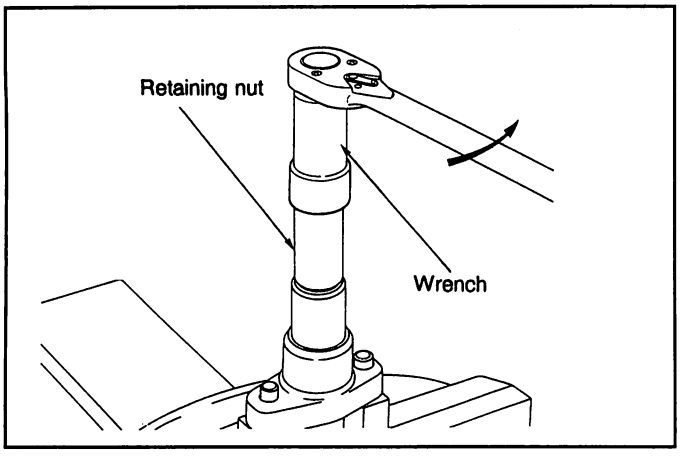
Note:
The above parts comprise the plate (157944-9520)



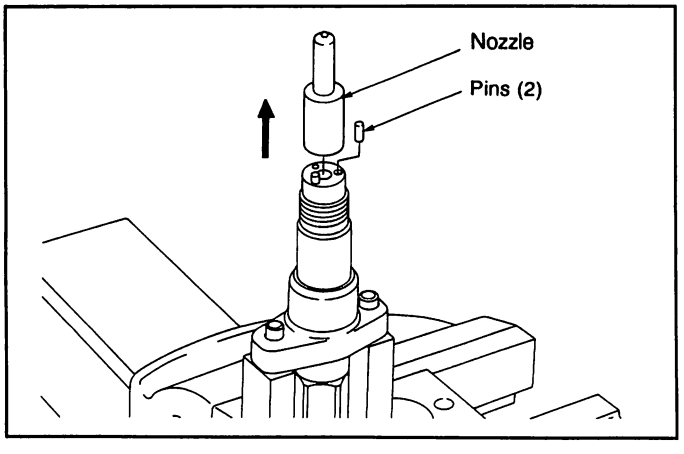
2. Position the nozzle holder on the plate.

CAUTION

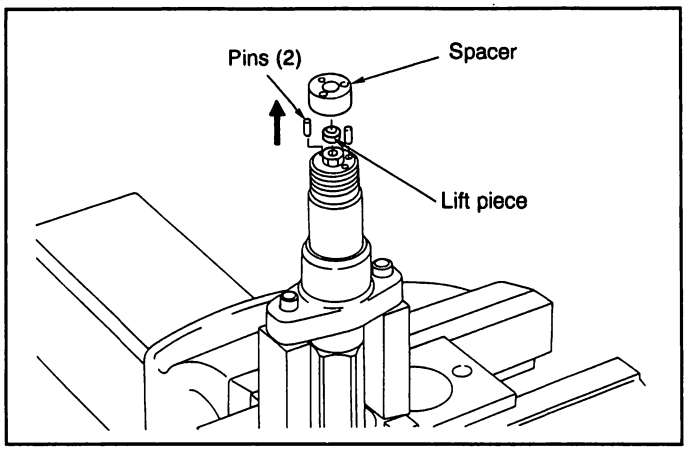
Secure nozzle holders without flanges directly in the vise between two metal plates.



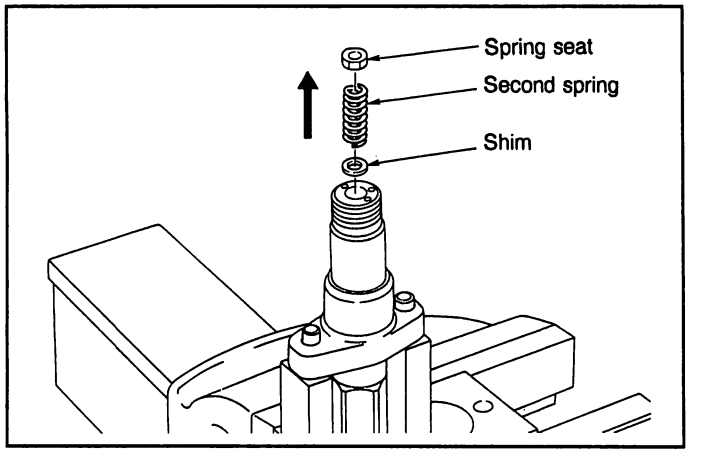
3. Remove the retaining nut using the wrench (157914-2800).



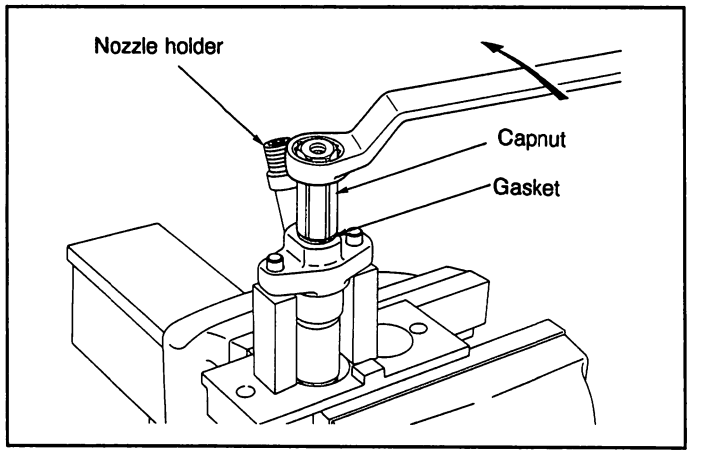
4. Remove the nozzle and pins.



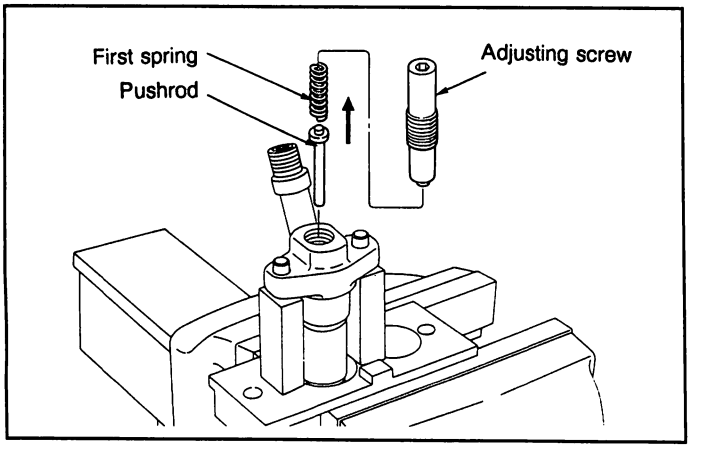
5. Remove the spacer, pins and lift piece.



6. Remove the spring seat, second spring and shim.



7. Position the nozzle holder with the nozzle facing down and remove the capnut and gasket.



8. Remove the adjusting screw, first spring and pushrod.
9. Soak the disassembled parts in clean solvent and remove any carbon using the cleaning kit (105789-0010).
10. Visually inspect the cleaned parts for wear, rust, erosion, etc.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for cleaning kit use and inspection standards.

KBL2.3-S TYPE REASSEMBLY AND ADJUSTMENT

The nozzle holder is adjusted as the components are reassembled in the sequence below.
As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

REASSEMBLY AND ADJUSTMENT PROCEDURE

1 **First nozzle opening pressure adjustment** Page 51

Adjust the first nozzle opening pressure using the adjusting screw.

2 **Full needle valve lift confirmation** Page 54

Confirm the full needle valve lift in accordance with the closed method.

3 **Pre-lift confirmation** Page 56

Confirm pre-lift in accordance with the closed method.

CAUTION

If not as specified, replace the nozzle assembly, lift piece, pins and spacer using the nozzle service kit.

4 **Second nozzle opening pressure confirmation** Page 57

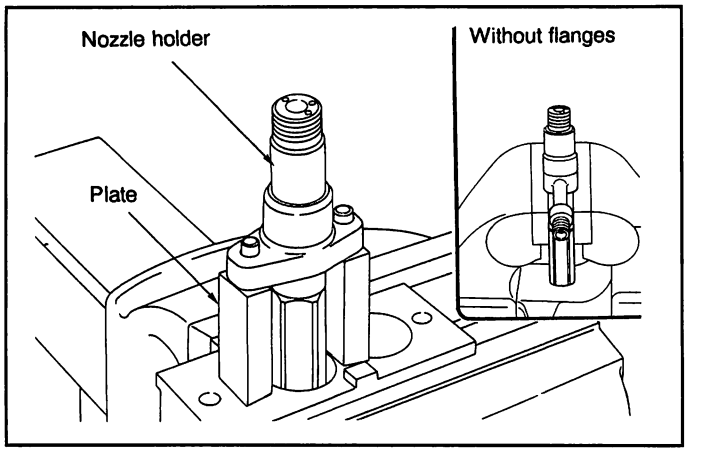
Confirm the second nozzle opening pressure in accordance with the closed method.

5 **Second nozzle opening pressure adjustment** Page 58

Adjust the second nozzle opening pressure using the shim.

6 **Final inspection** Page 59

Confirm the condition of the fuel spray with the nozzle and nozzle holder assembled.

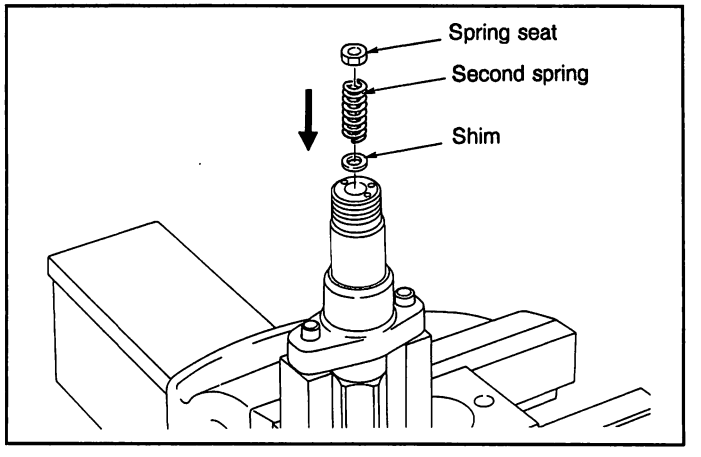


First nozzle opening pressure adjustment

1. Position the nozzle holder on the plate.

CAUTION

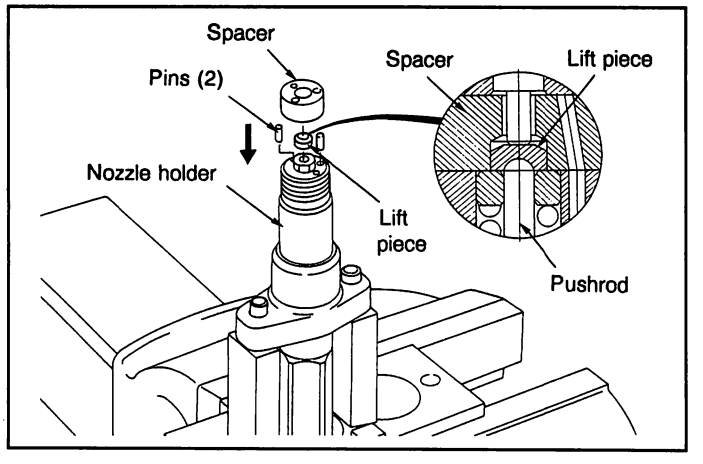
Secure nozzle holders without flanges directly in the vise between two metal plates.



2. Assemble the shim, second spring and spring seat in the nozzle holder.

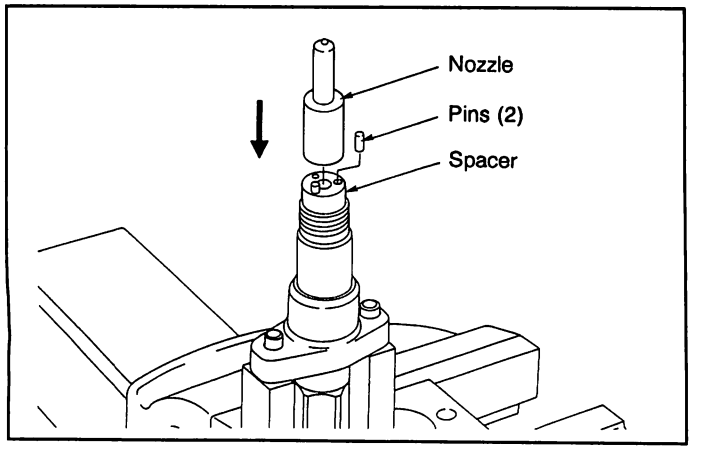
CAUTION

The second spring and first spring are identical.

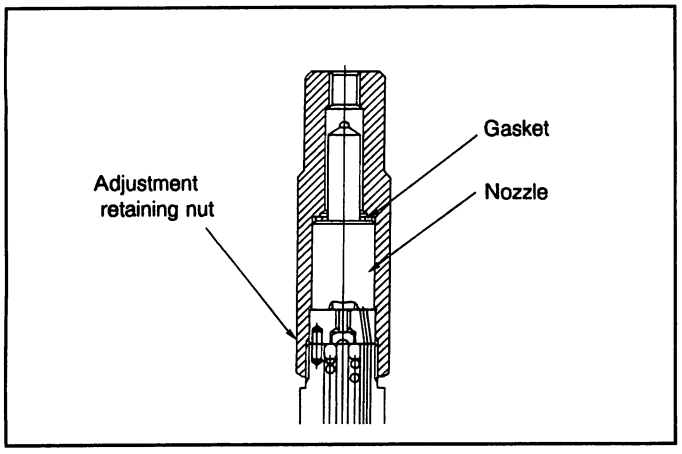


3. Assemble the pins, lift piece and spacer in the nozzle holder.

Note:
The indented face of the lift piece faces the pushrod.

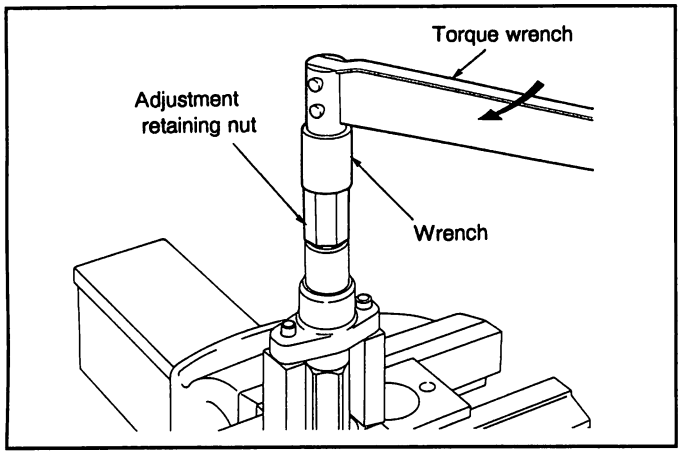


4. Assemble the pins in the spacer and then assemble the nozzle on the pins.

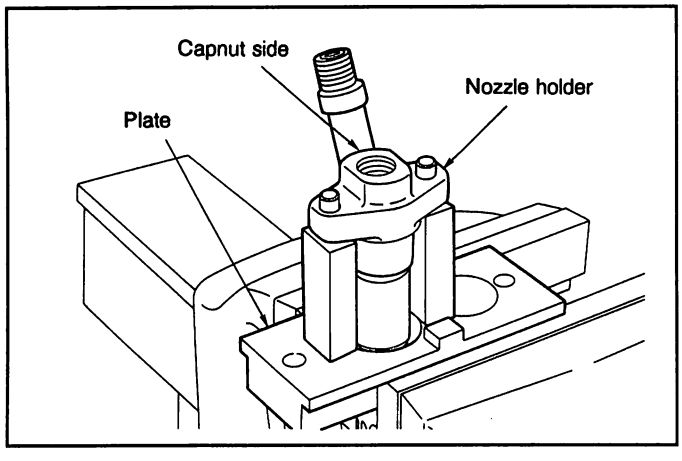


5. Hand-tighten the adjustment retaining nut together with the gasket to the nozzle holder.

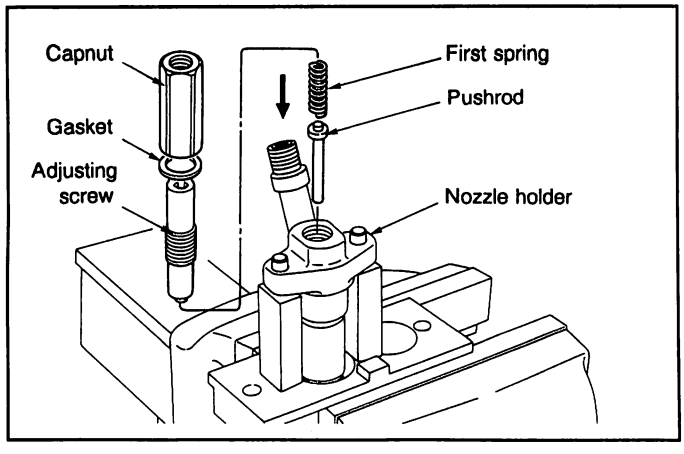
Tool Name	Part No.	Remarks
Gasket	157892-1500	
Retaining nut	157892-4000	



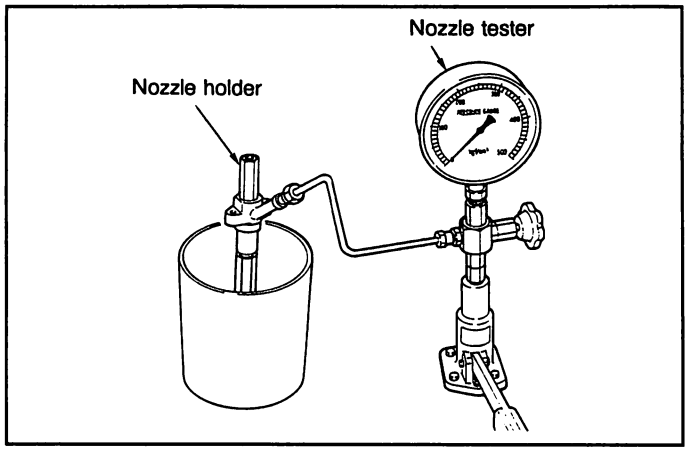
6. Tighten the adjustment retaining nut to the specified torque using the wrench (157914-0500).
Specified torque: 59~78 N·m {6.0~8.0 kgf·m}



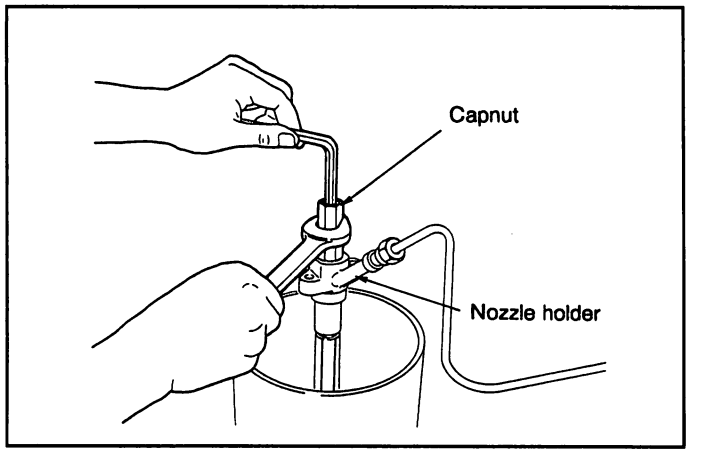
7. Position the nozzle holder on the plate with the nozzle holder capnut facing up.



8. Assemble the pushrod, first spring and adjusting screw in the nozzle holder.
9. Install the gasket and capnut on the adjusting screw.

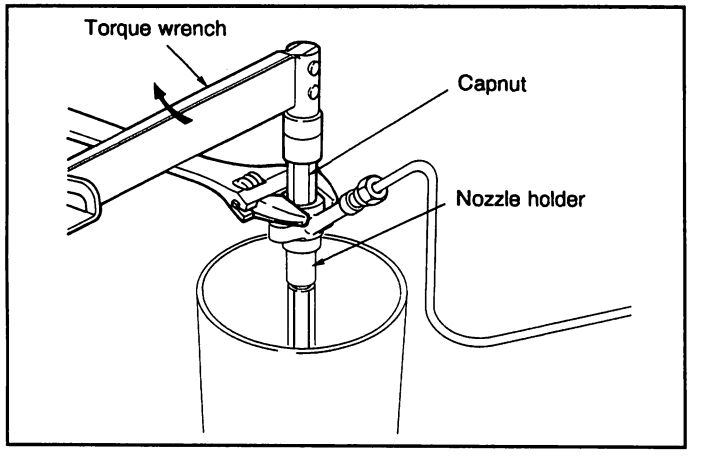


10. Attach the nozzle holder to the nozzle tester.

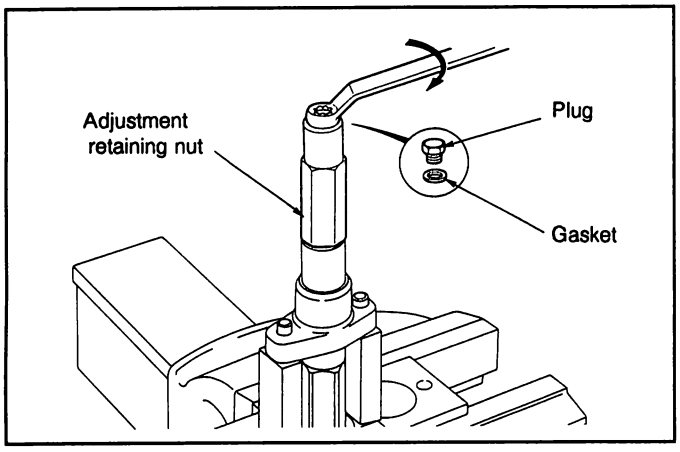


11. Operate the nozzle tester and adjust the adjusting screw until the first nozzle opening pressure is as specified.

Note:
Temporarily loosen the capnut and then adjust the adjusting screw.



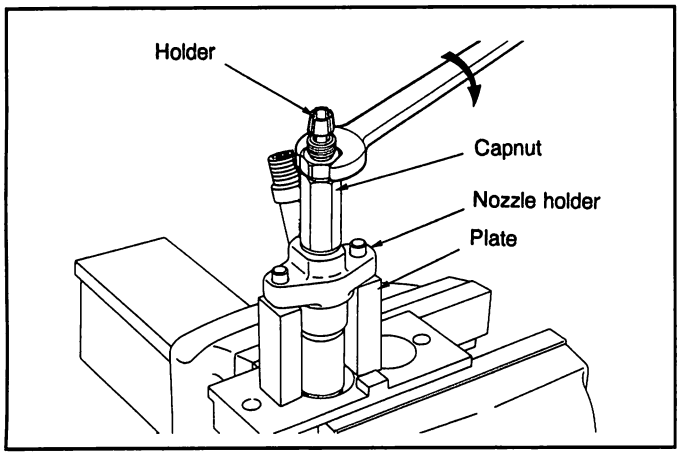
12. Secure the nozzle holder using a wrench and tighten the capnut to the specified torque.
Specified torque: 29~39 N·m {3.0~4.0 kgf·m}



Full needle valve lift confirmation

1. Install the gasket and plug on the adjustment retaining nut.

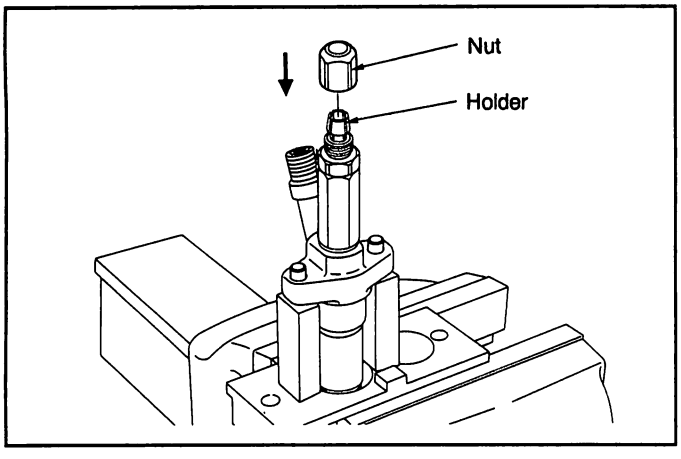
Tool Name	Part No.	Remarks
Gasket	026508-1140	
Plug	157892-1600	SW 12 mm



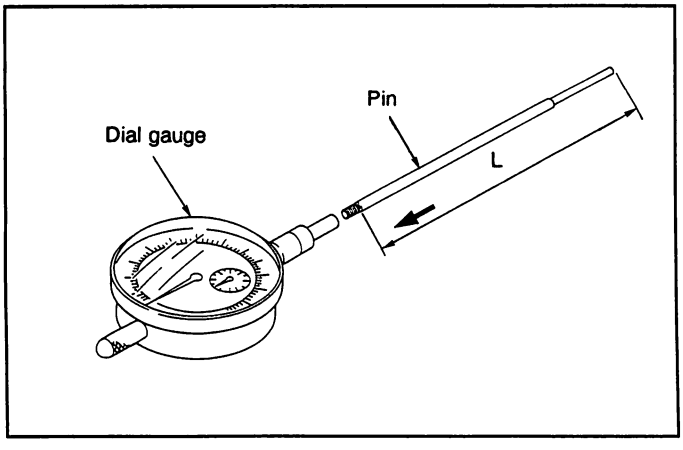
2. Position the nozzle holder on the plate with the nozzle holder capnut facing up.
3. Attach the holder to the capnut.

Note:
There are three types of holder. Choose the one that fits the capnut and thread.

Tool Name	Part No.	Remarks
Holder	157892-4100	M10×1.0
Holder	157892-5400	M10×1.25
Holder	157892-4400	M8×1.0



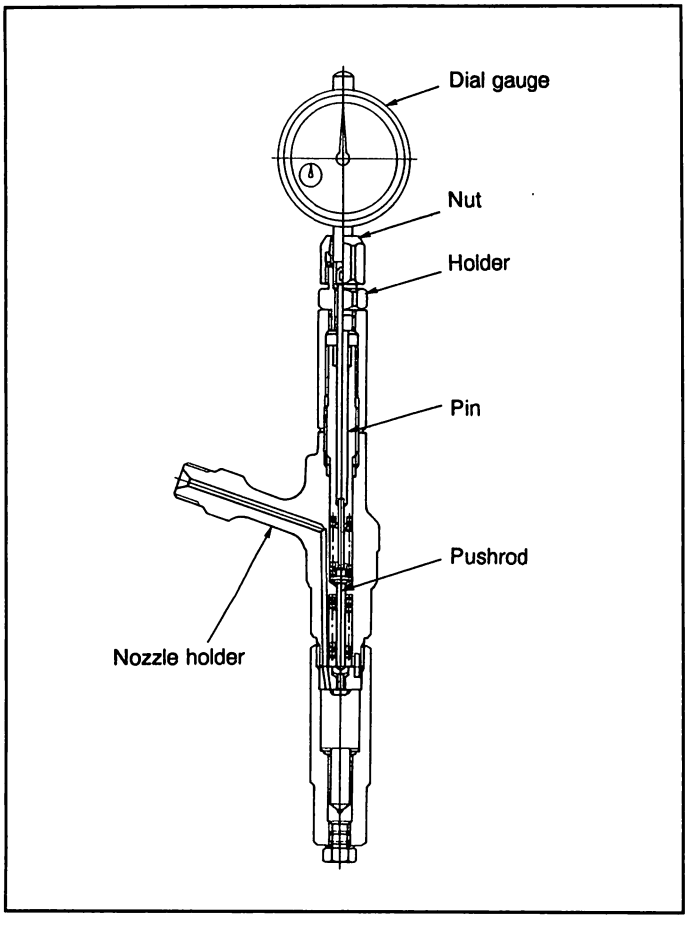
4. Attach the nut (157892-1000; SW17 mm) to the holder.



5. Attach the pin to the dial gauge.

Note:
There are three types of pin. Select a pin that contacts the tip of the nozzle holder pushrod in the following procedure.

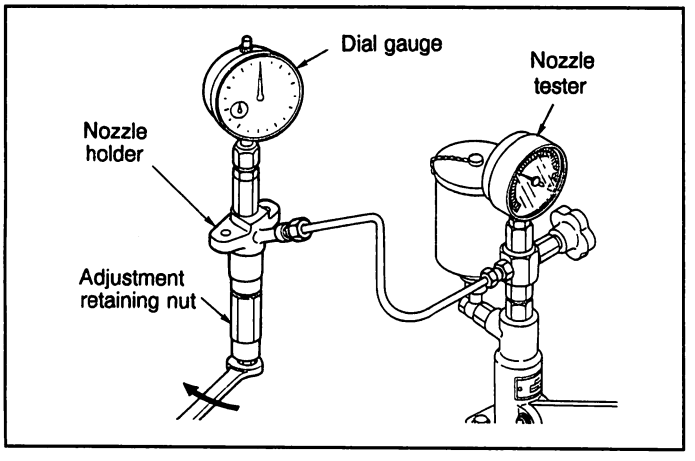
Tool Name	Part No.	Remarks
Dial gauge	157954-3800	
Pin	157892-4200	L = 160 mm
Pin	157892-4300	L = 110 mm
Pin	157892-4700	L = 85 mm



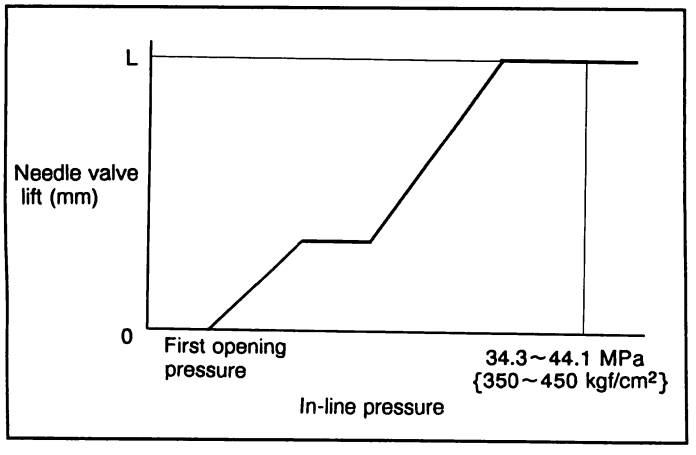
6. Secure the dial gauge to the nozzle holder using the nut so that the pin contacts the tip of the pushrod.

CAUTION

- **Secure the dial gauge so that a stroke of 2 mm can be measured.**
- **Do not over-tighten the nut as the dial gauge shaft may jam. (Confirm from the dial gauge that the shaft moves smoothly.)**

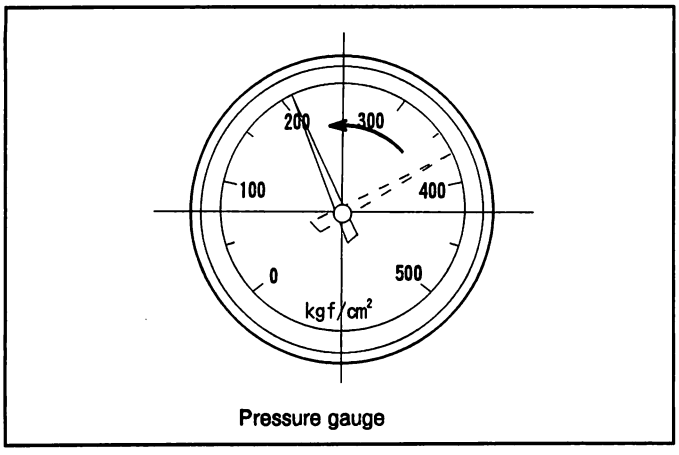


7. Attach the nozzle holder to the nozzle tester and zero the dial gauge.
8. Operate the nozzle tester to bleed any air from inside the adjustment retaining nut and to confirm that no fuel leaks.

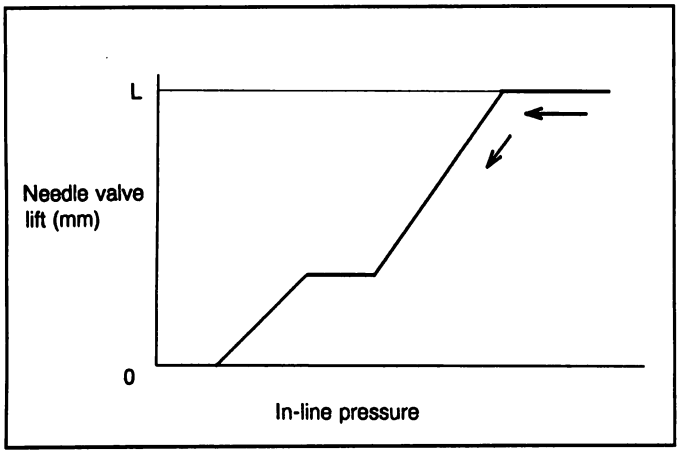


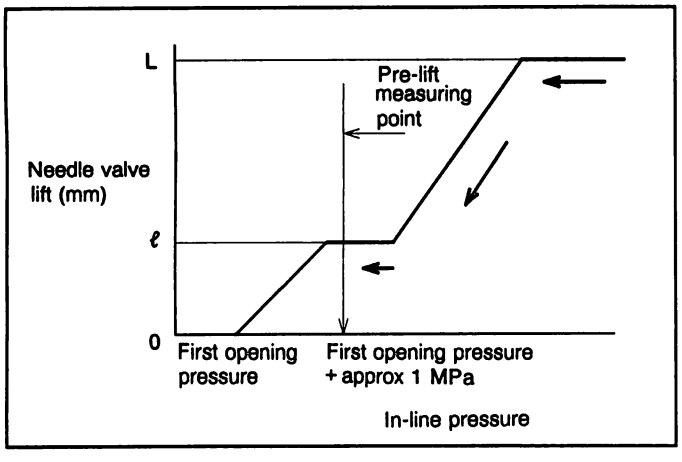
9. Operate the nozzle tester and increase the in-line pressure to 34.3~44.1 MPa {350~450 kgf/cm2} so that the nozzle's needle valve moves through its full lift. Record full lift 'L.'

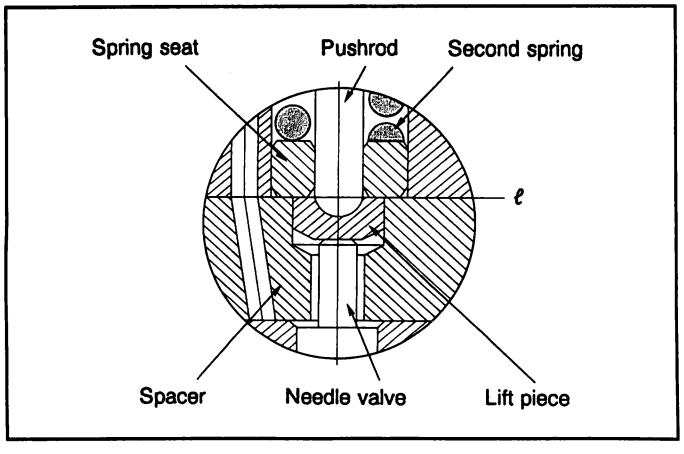
Note:
The above operation is used to determine whether the nozzle seat is worn and whether the nozzle assembly is in good condition.



Pressure gauge







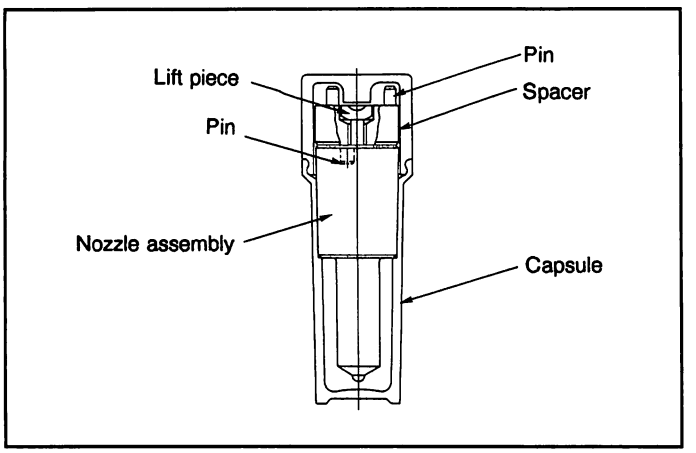
Pre-lift confirmation

1. With the needle valve in the full lift condition, release the nozzle tester handle.
   Note:
   The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

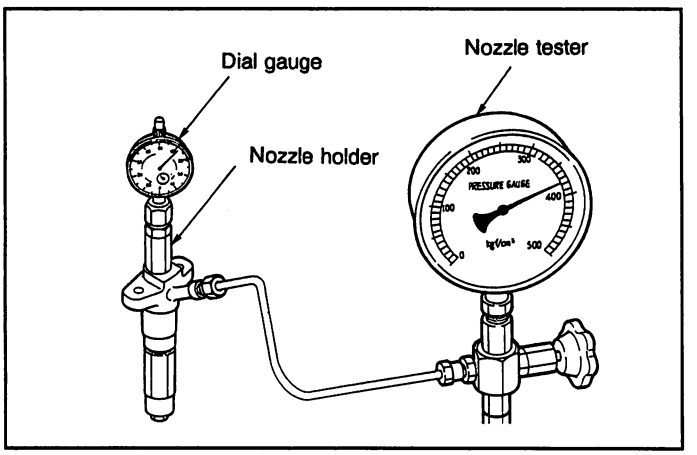
2. Read the needle valve lift 'ℓ' from the dial gauge indication (once the needle valve has descended when the second spring has stopped operating). Refer to the pre-lift measuring point for 'ℓ'.

Pre-lift measuring point
Read the dial gauge at first nozzle opening pressure + approx 1 MPa {10 kgf/cm^2}.
Note:
This point can be found when the pressure is decreasing.

3. Confirm that pre-lift 'ℓ' is as specified.

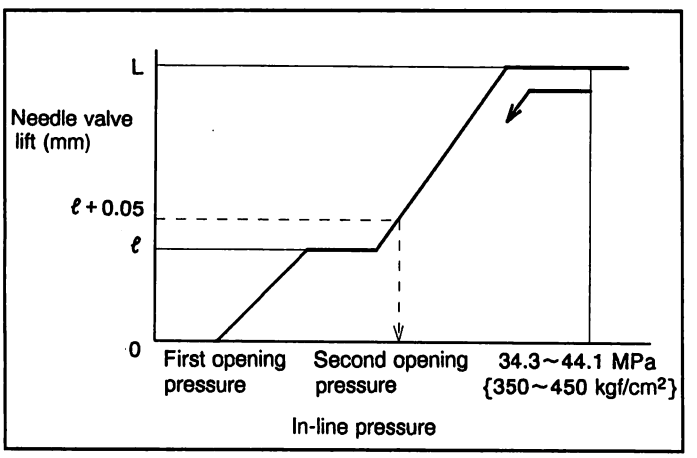


4. If pre-lift is not as specified, replace the pins, lift piece, spacer and nozzle assembly with the nozzle service kit.



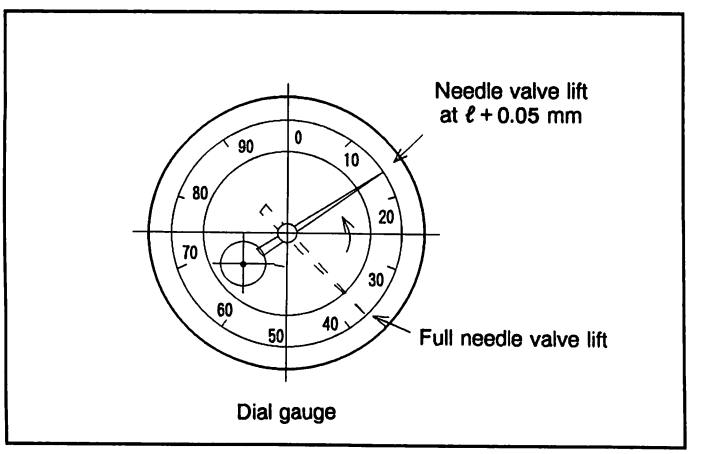
Second nozzle opening pressure confirmation

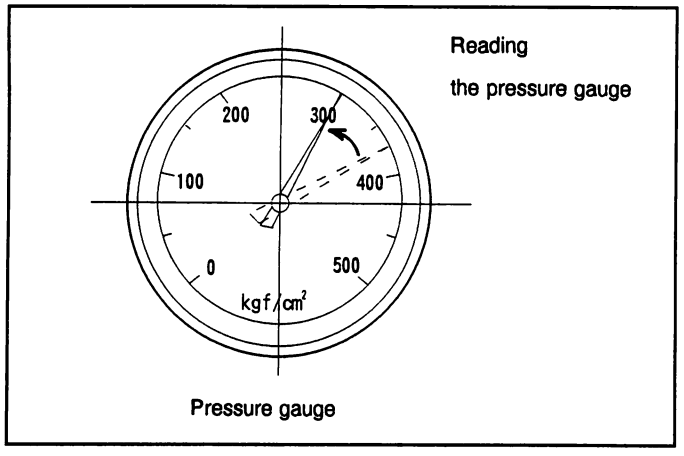
1. After pre-lift confirmation, operate the nozzle tester to increase in-line pressure to 34.3~44.1 MPa {350~450 kgf/cm²} so that the nozzle's needle valve moves through its full lift.

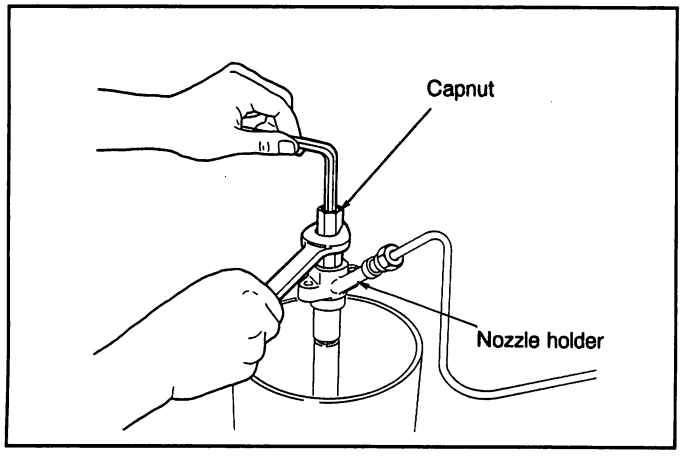


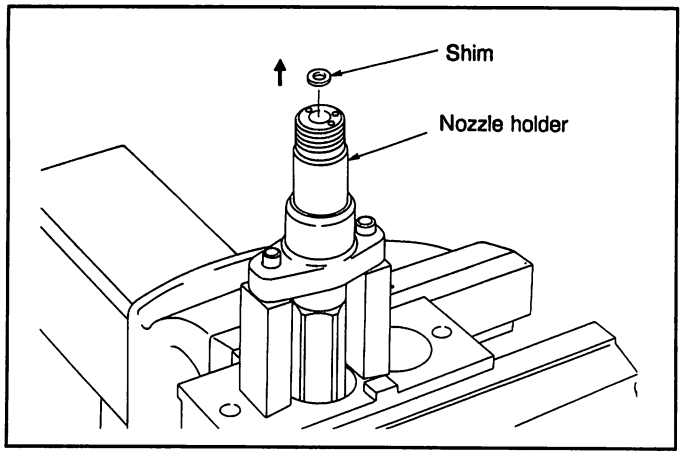
2. Release the nozzle tester handle so that in-line pressure decreases.
3. Read the pressure gauge indication the instant that the dial gauge indicates the specified needle valve lift (usually pre-lift ℓ + 0.05 mm; see top figure, next page).

Note:
The pressure gauge indicates second nozzle opening pressure.









Part No.	Thickness (mm)
150538-4900	0.40
150538-5000	0.50
150538-5100	0.52
150538-5200	0.54
150538-5300	0.56
150538-5400	0.58
150538-5500	0.60
150538-5600	0.70

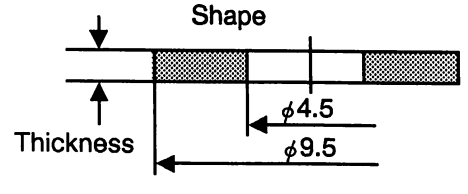
Second nozzle opening pressure adjustment

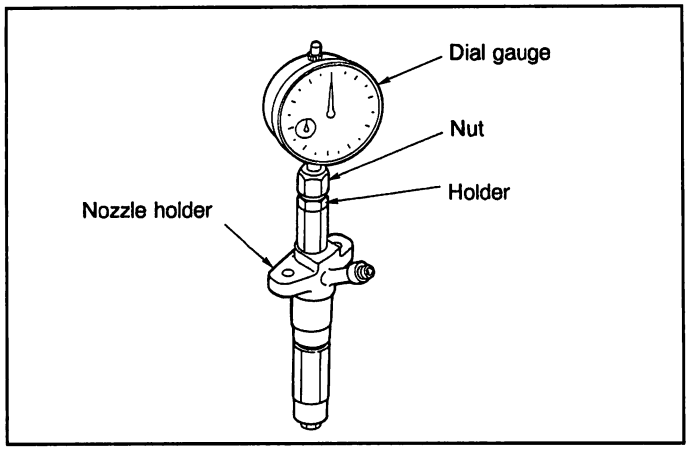
1. When the second nozzle opening pressure is a little outside the specified range, readjust the first nozzle opening pressure (within the first nozzle opening pressure's specified range).
   - When the second nozzle opening pressure is less than the specified value: Readjust the first nozzle opening pressure to the maximum specification and measure the second nozzle opening pressure.
   - When the second nozzle opening pressure is more than the specified value: Readjust the first nozzle opening pressure to the minimum specification and measure the second nozzle opening pressure.
2. If the second nozzle opening pressure is still not as specified, despite readjusting the first nozzle opening pressure, disassemble the nozzle and remove the adjusting shim.
3. When the second nozzle opening pressure exceeds the specified pressure, install a thinner adjusting shim. When less than specified, install a thicker shim.
4. After adjusting shim replacement, remeasure and adjust the second nozzle opening pressure until it is as specified.

CAUTION

Use a micrometer to measure shims.

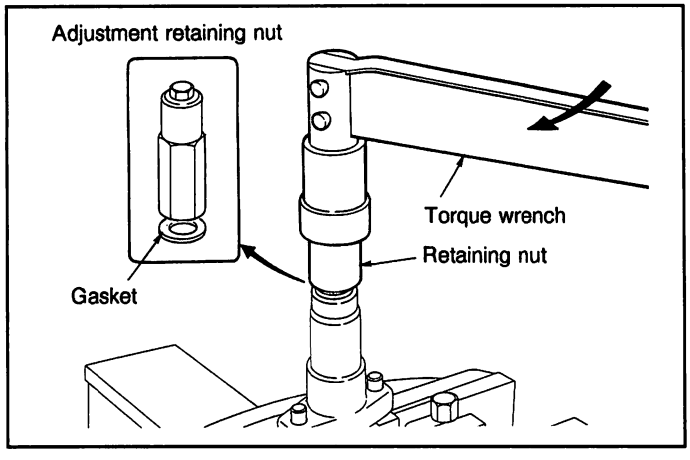
- Second opening pressure adjusting shims



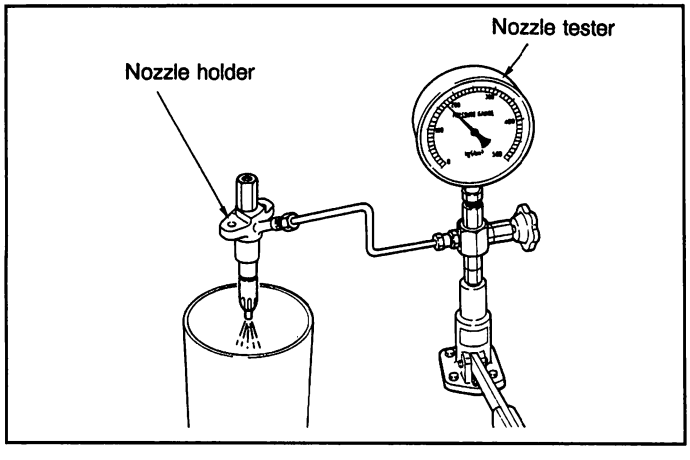


Final Inspection

1. Remove the dial gauge, nut and holder.

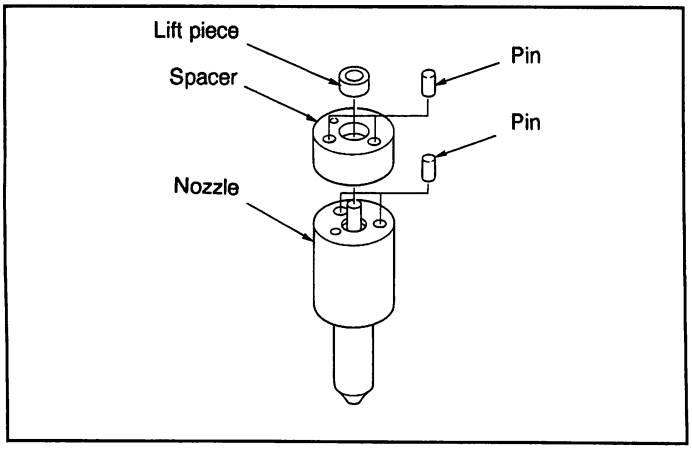


2. Remove the adjustment retaining nut and gasket.
3. Confirm that the pin is fully inserted into the nozzle and then install the specified retaining nut.
   First hand-tighten the nut, and then tighten it to the specified torque.
   Specified torque: 59~78 N·m {6.0~8.0 kgf·m}



4. Attach the nozzle holder to the nozzle tester and check first nozzle opening pressure, spray pattern, seat oil tightness and each part for oil leaks.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for spray patterns and inspection standards.

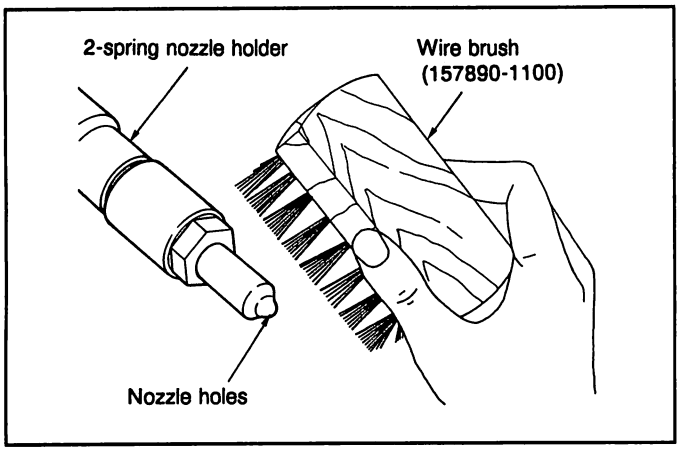


5. When replacing the nozzle, replace the nozzle, lift piece, pins and spacer as a set with the nozzle service kit.

CAUTION

Pre-lift will not be as specified if only the nozzle is replaced.

10 KBL2.4-P TYPE



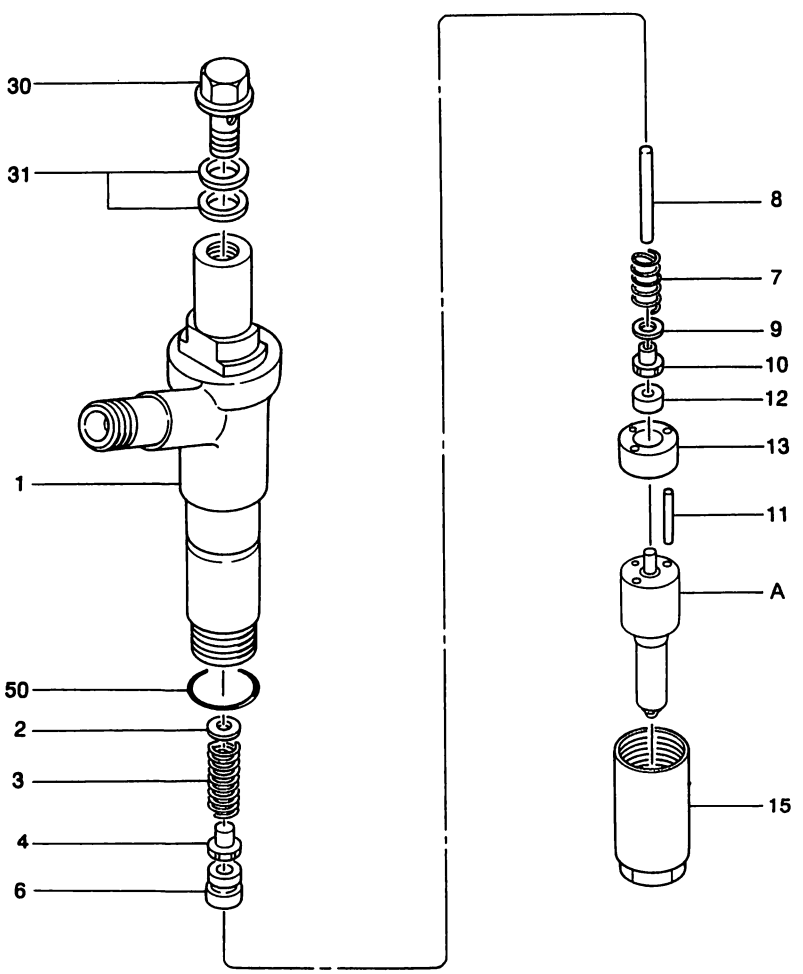
KBL2.4-P TYPE DISASSEMBLY

Before disassembly, remove any carbon from the nozzle holder using a wire brush and wash the outside.

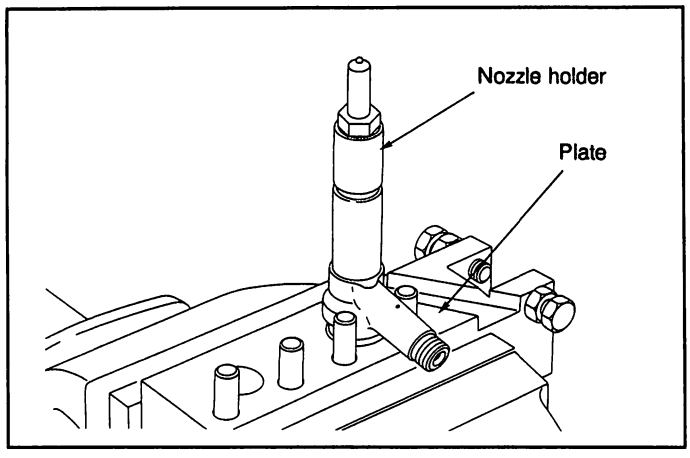
CAUTION

- **Do not touch the nozzle holes with the wire brush.**
- **Place all disassembled parts in order of disassembly on the bench.**

KBL2.4-P TYPE NOZZLE HOLDER: EXPLODED VIEW

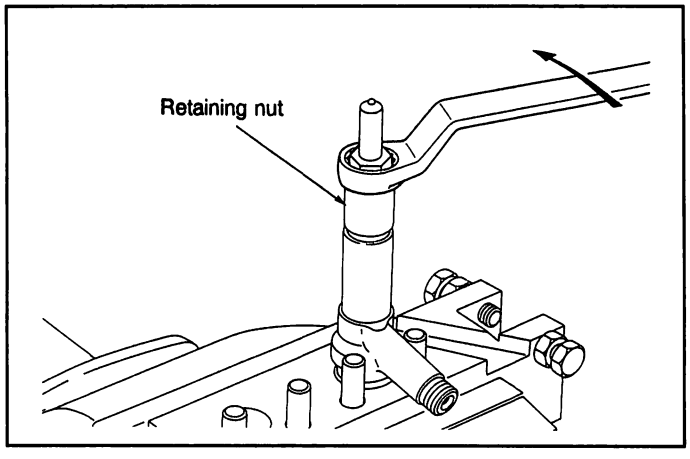


Key no	Part name
1	Nozzle holder body
2	Shim (for 1st opening pressure adjustment)
3	First spring
4	Spring seat
6	Collar
7	Second spring
8	Pushrod
9	Shim (for 2nd opening pressure adjustment)
10	Spring seat
11	Pins
12	Lift piece
13	Spacer
15	Retaining nut
30	Eye bolt
31	Gasket
50	O-ring
A	Nozzle

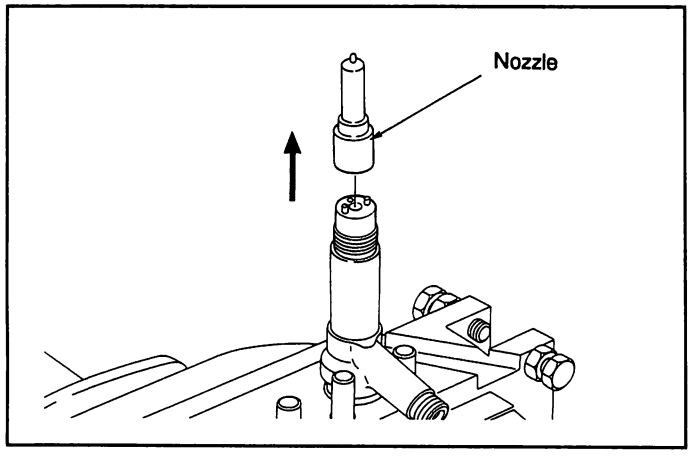


1. Position the nozzle holder on the plate (157992-2820).

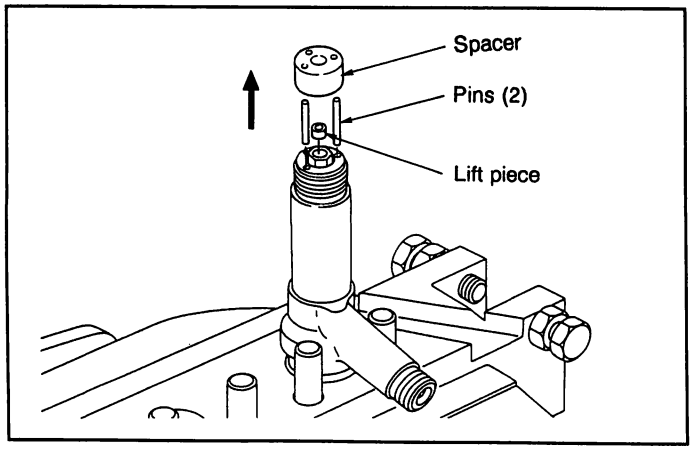
Note:
For nozzle holders with flanges, use a different plate (157944-9520).



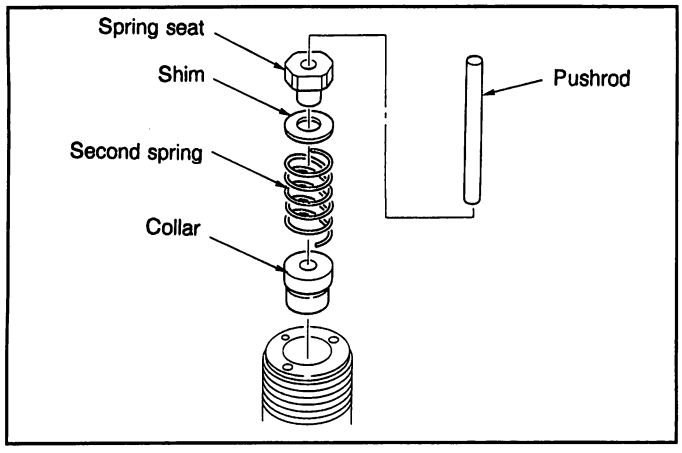
2. Remove the retaining nut.



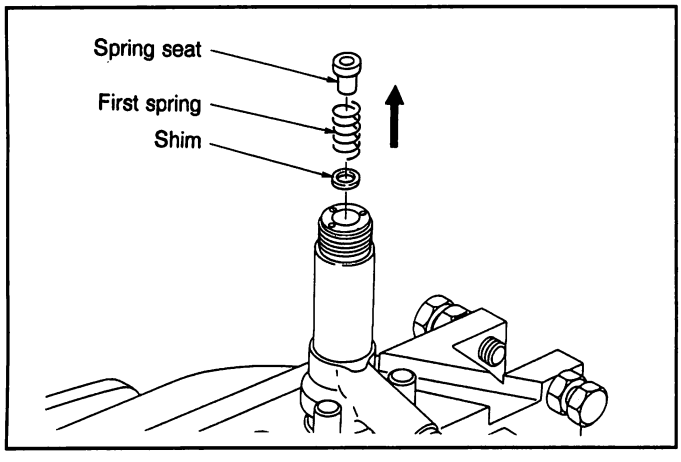
3. Remove the nozzle.



4. Remove the spacer, pins and lift piece.



5. Remove the spring seat, shim, second spring, pushrod and collar.



6. Remove the spring seat, first spring and shim.
7. Soak the disassembled parts in clean solvent and remove any carbon using the cleaning kit (105789-0010).
8. Visually inspect the cleaned parts for wear, rust, erosion, etc.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for cleaning kit use and inspection standards.

KBL2.4-P TYPE REASSEMBLY AND ADJUSTMENT

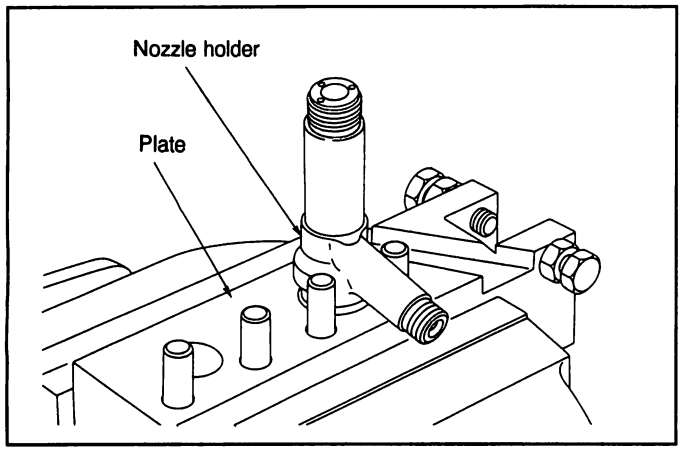
The nozzle holder is adjusted as the components are reassembled in the sequence below.
As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

REASSEMBLY AND ADJUSTMENT PROCEDURE

1. First nozzle opening pressure adjustment — Page 64
   Adjust the first nozzle opening pressure using the shim.
2. Full needle valve lift confirmation — Page 66
   Confirm the full needle valve lift in accordance with the closed method.
3. Pre-lift confirmation — Page 68
   Confirm pre-lift in accordance with the closed method.

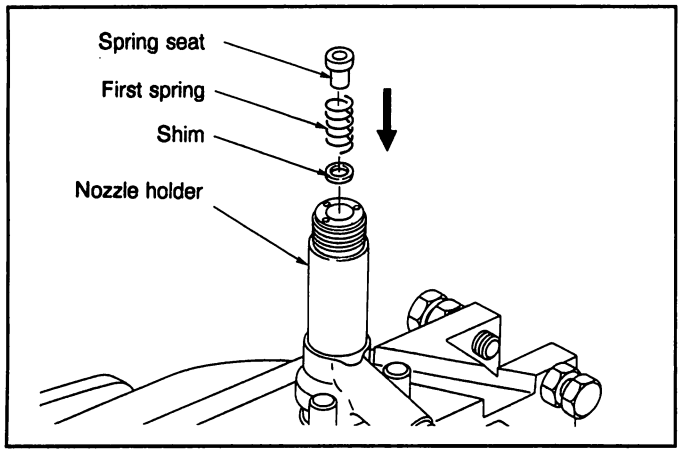
   CAUTION

   If not as specified, replace the nozzle assembly, lift piece, pins and spacer using the nozzle service kit.
4. Second nozzle opening pressure confirmation — Page 69
   Confirm the second nozzle opening pressure in accordance with the closed method.
5. Second nozzle opening pressure adjustment — Page 71
   Adjust the second nozzle opening pressure using the shim.
6. Final inspection — Page 71
   Confirm the condition of the fuel spray with the nozzle and nozzle holder assembled.

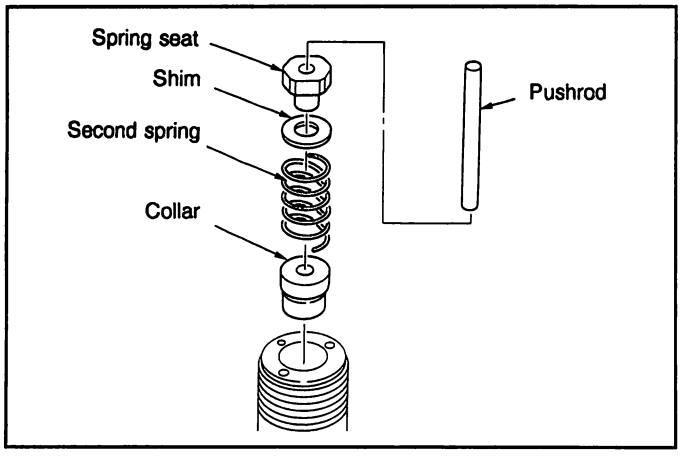


First nozzle opening pressure adjustment

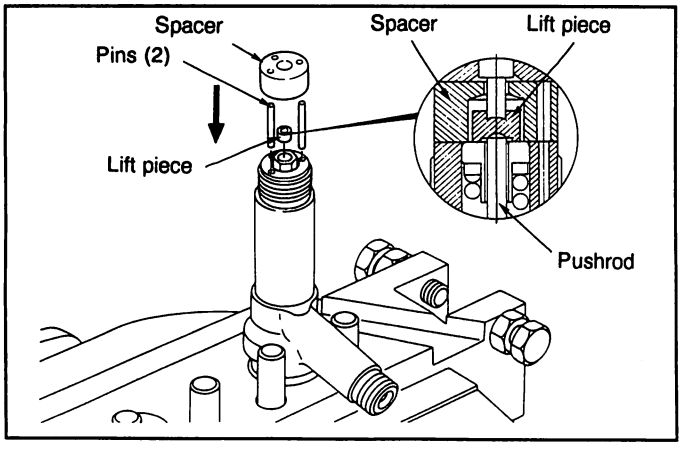
1. Position the nozzle holder on the plate.



2. Assemble the shim, first spring and spring seat in the nozzle holder.

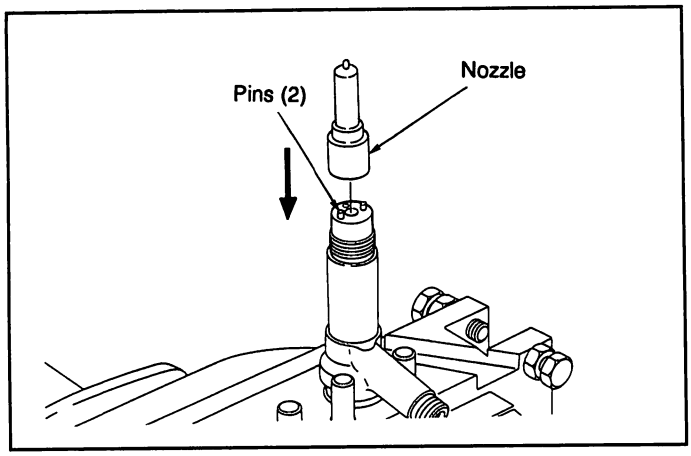


3. Assemble the collar, second spring, shim, spring seat and pushrod.

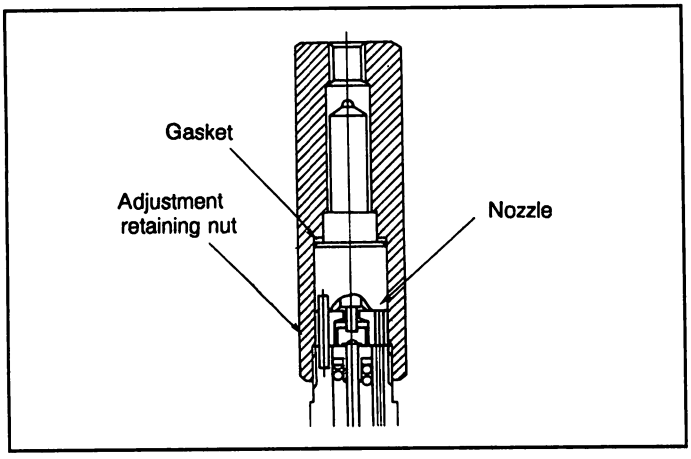


4. Assemble the pins, lift piece and spacer in the nozzle holder.

Note:
Position the lift piece with the rounded indentation facing the pushrod.

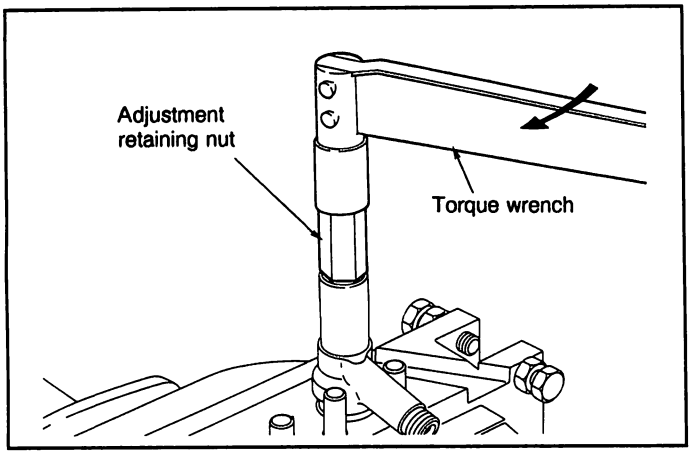


5. Assemble the nozzle on the pins.

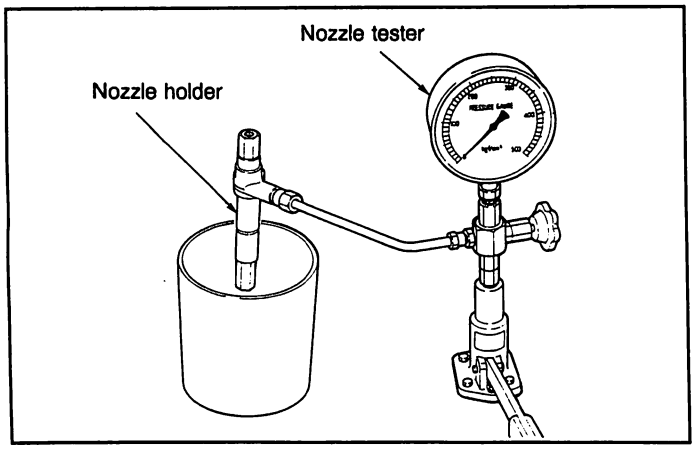


6. Hand-tighten the adjustment retaining nut on the nozzle holder together with the gasket.

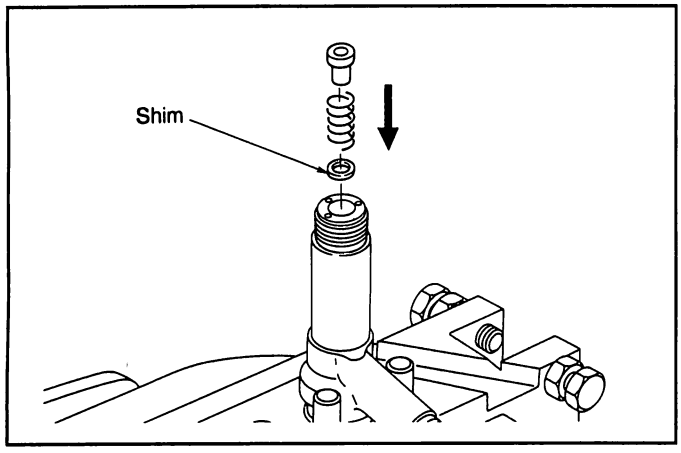
Tool Name	Part No.	Remarks
Gasket	157892-3200	
Retaining nut	157892-5100	



7. Tighten the adjustment retaining nut to the specified torque.
Specified torque: 29~39 N·m {3.0~4.0 kgf·m}



8. Attach the nozzle holder to the nozzle tester.
9. Operate the nozzle tester and measure the first nozzle opening pressure.



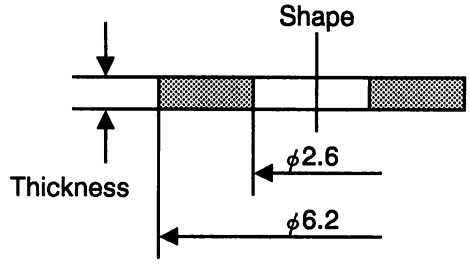
10. If the first nozzle opening pressure is not as specified, disassemble the nozzle holder and replace the shim until the pressure is as specified.
    Record opening pressures and adjusting shim thicknesses to facilitate adjustment.

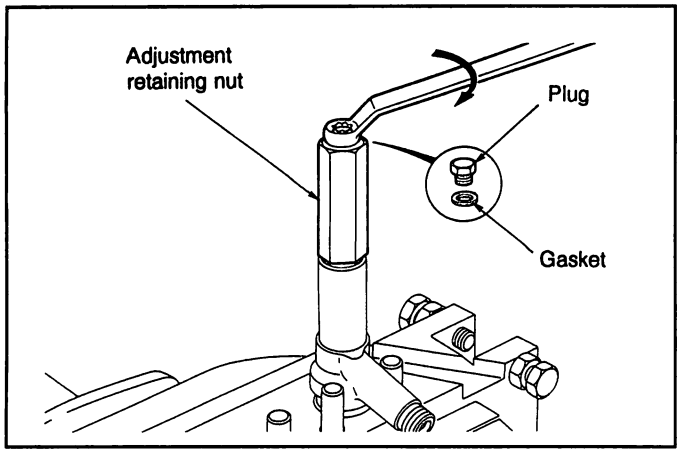
CAUTION

Use a micrometer to measure shim thickness.

Part No.	Thickness (mm)
150538-9800	0.40
150538-9900	0.50
150539-0000	0.52
150539-0100	0.54
150539-0200	0.56
150539-0300	0.58
150539-0400	0.60
150539-0500	0.70

- First opening pressure adjusting shims

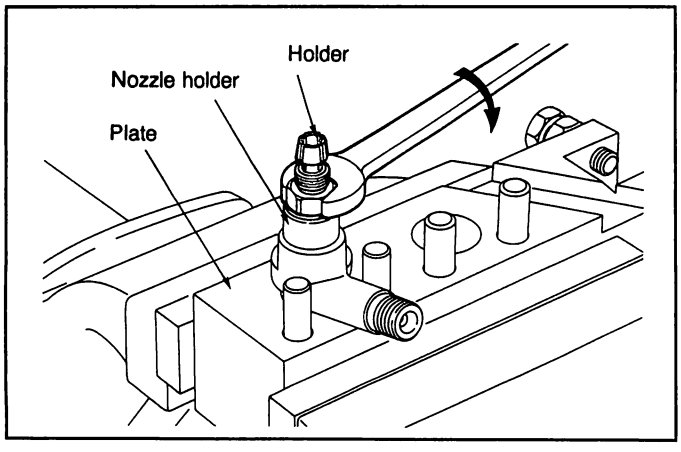




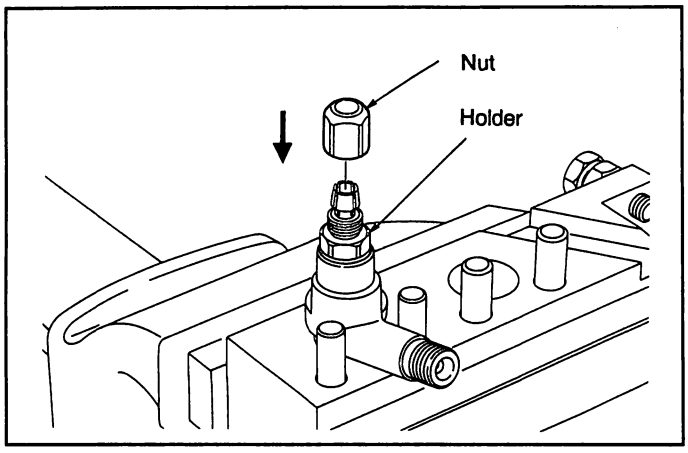
Full needle valve lift confirmation

1. Install the gasket and plug on the adjustment retaining nut.

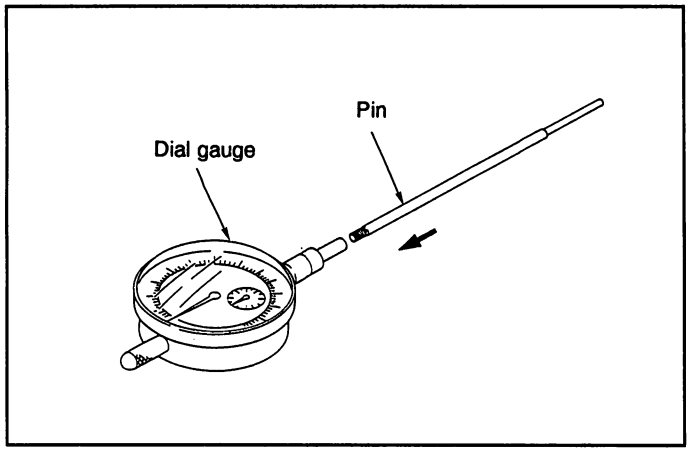
Tool Name	Part No.	Remarks
Gasket	026508-1140	
Plug	157892-1600	SW12



2. Position the nozzle holder on the plate with the nozzle facing down.
3. Install the holder (157892-5000) on the nozzle holder.

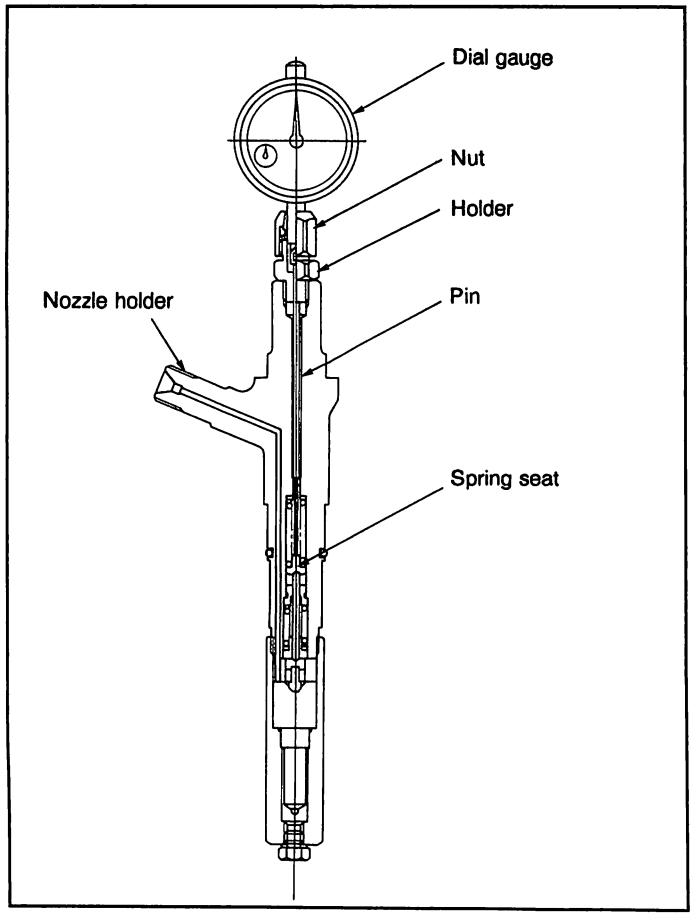


4. Install the nut (157892-1000) on the holder.



5. Attach the pin to the dial gauge.

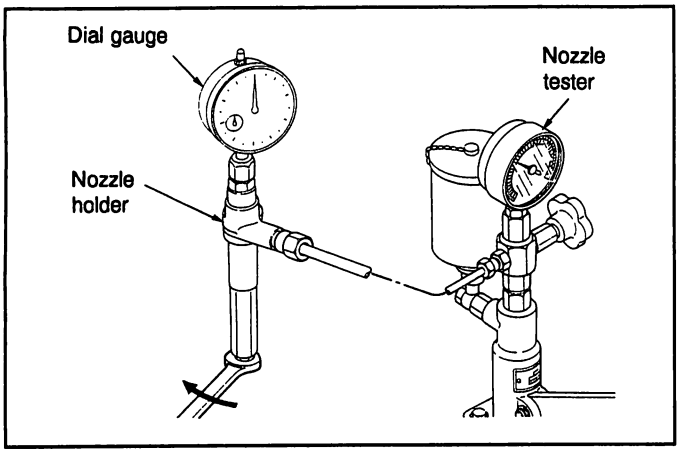
Tool Name	Part No.	Remarks
Pin	157892-5200	L = 100 mm (excluding thread)
Dial gauge	157954-3800	



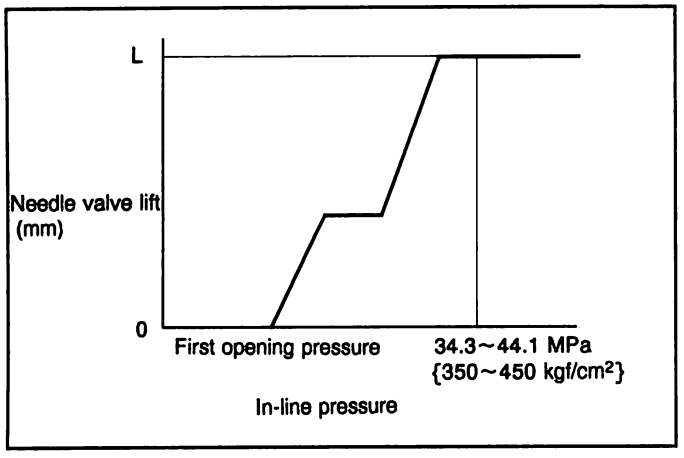
6. Install the dial gauge to the nozzle holder so that the pin contacts the top face of the spring seat and then tighten the nut.

CAUTION

- **Secure the dial gauge so that a stroke of 2 mm can be measured.**
- **Do not over-tighten the nut as the dial gauge shaft may jam. (Confirm from the dial gauge that the shaft moves smoothly.)**

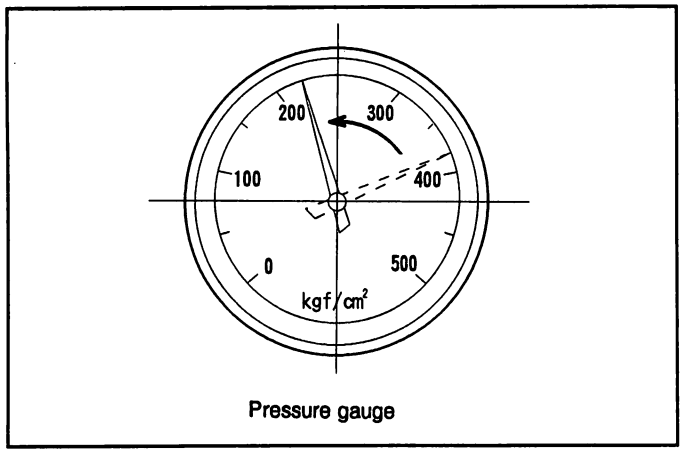


7. Attach the nozzle holder to the nozzle tester and zero the dial gauge.
8. Operate the nozzle tester to bleed any air from inside the adjustment retaining nut and to confirm that no fuel leaks.



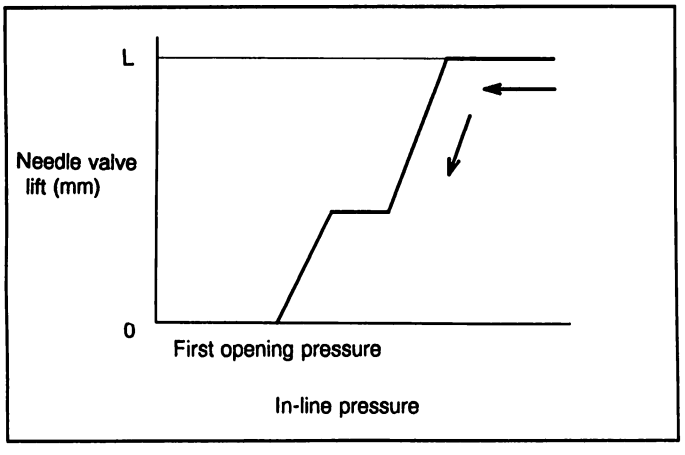
9. Operate the nozzle tester and increase the in-line pressure to 34.3~44.1 MPa {350~450 kgf/cm2} so that the nozzle's needle valve moves through its full lift. Record full lift 'L.'

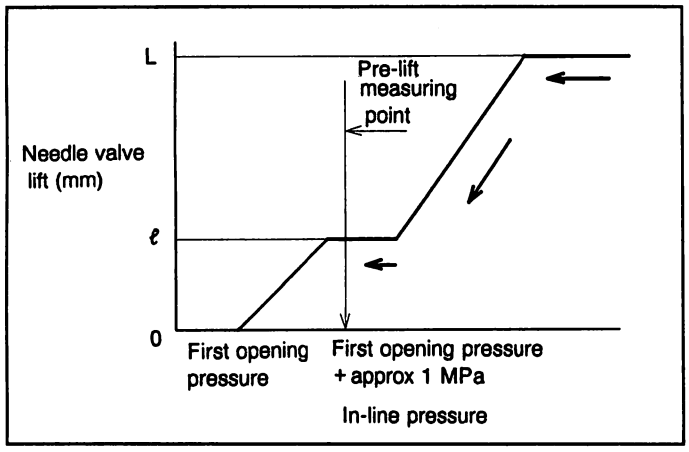
Note:
The above operation is used to determine whether the nozzle seat is worn and whether the nozzle assembly is in good condition.



Pre-lift confirmation

1. With the needle valve at full lift, release the nozzle tester handle.
   Note:
   The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.



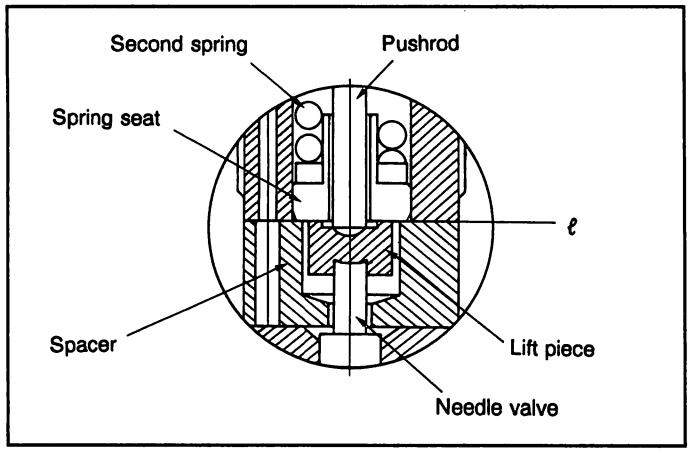


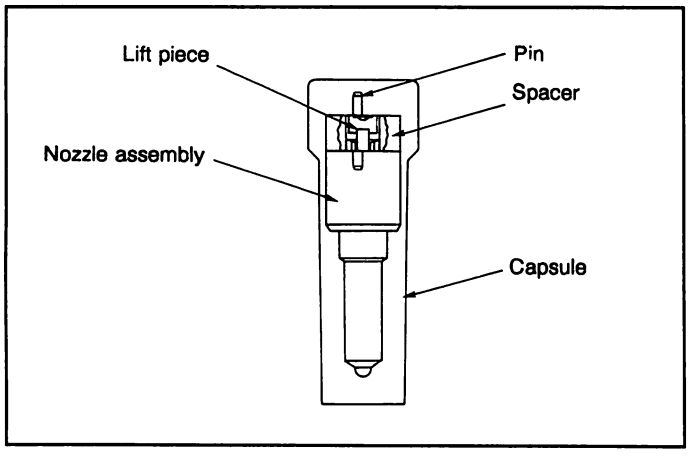
2. Read the needle valve lift 'ℓ' from the dial gauge indication (once the needle valve has descended when the second spring has stopped operating). Refer to the pre-lift measuring point for 'ℓ'.

Pre-lift measuring point
Read the dial gauge at first nozzle opening pressure + approx 1 MPa {10 kgf/cm^2}.

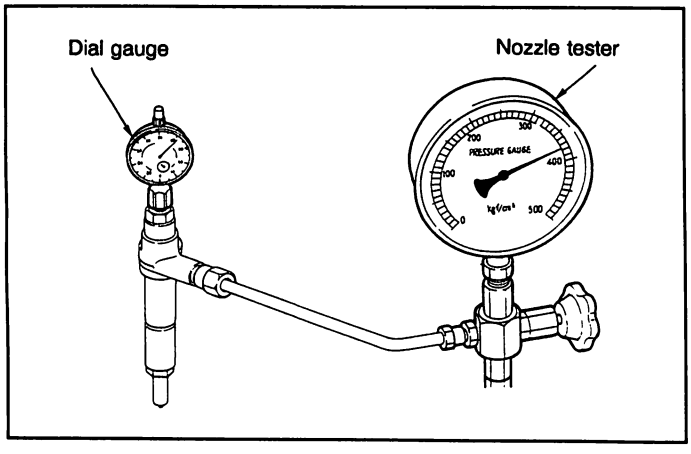
Note:
This point can be found when the pressure is decreasing.

3. Confirm that pre-lift 'ℓ' is as specified.



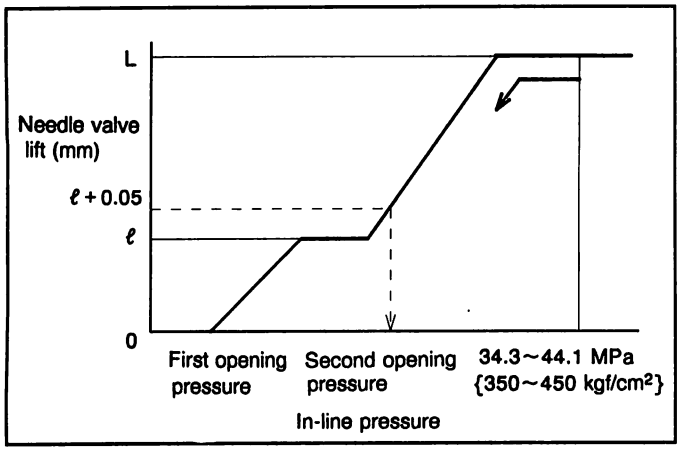


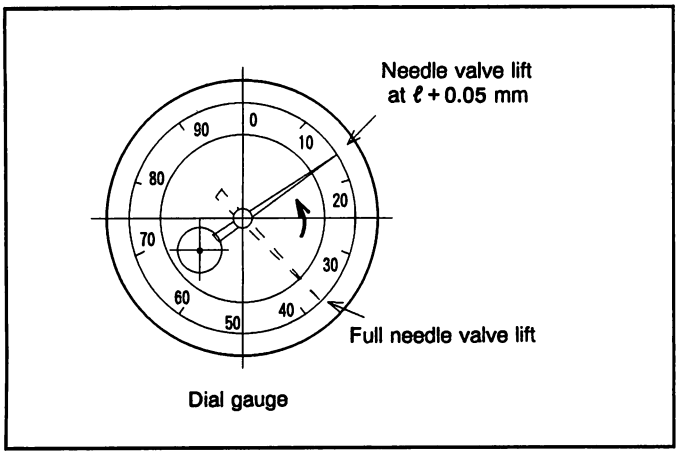
4. If pre-lift is not as specified, replace the pins, lift piece, spacer and nozzle assembly with the nozzle service kit.

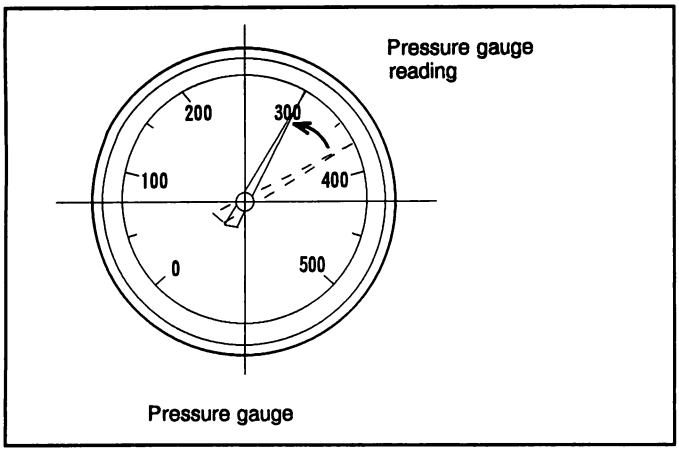


Second nozzle opening pressure confirmation.

1. After pre-lift confirmation, operate the nozzle tester to increase in-line pressure to 34.3~44.1 MPa {350~450 kgf/cm^2} so that the nozzle's needle valve moves through its full lift.



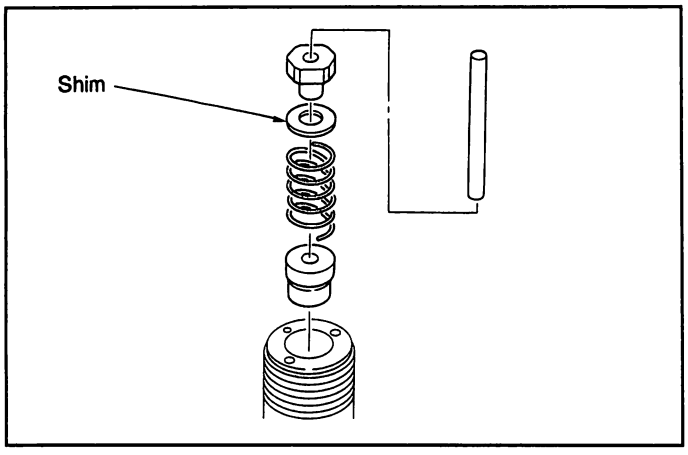




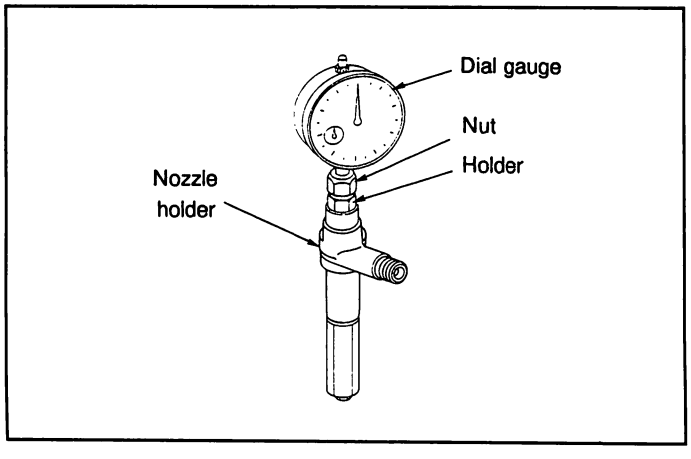
2. Release the nozzle tester handle.

Note:
The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

3. Then, read the pressure gauge indication the instant that the dial gauge indicates the specified needle valve lift (usually pre-lift ℓ + 0.05mm).



Part No.	Thickness (mm)
150591-1000	0.10
150591-2000	0.20
150591-3000	0.30
150591-4000	0.40
150591-5000	0.50
150591-5100	0.51
150591-5200	0.52
150591-5300	0.53
150591-5400	0.54
150591-5500	0.55
150591-5600	0.56
150591-5700	0.57
150591-5800	0.58
150591-5900	0.59



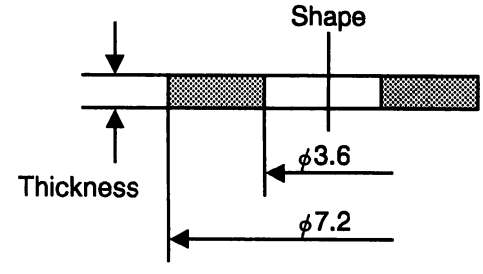
Second nozzle opening pressure adjustment

If the second nozzle opening pressure is not as specified, disassemble the nozzle from the nozzle holder and replace the shim until the pressure is as specified.
Adjusting shims are listed below.

CAUTION

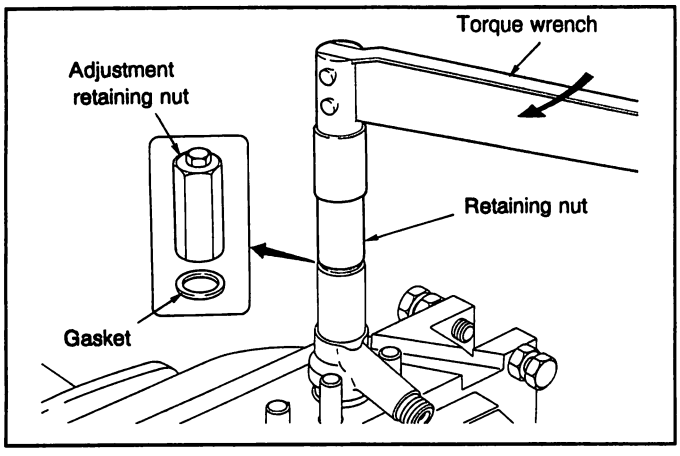
- **Because the second opening pressure changes when the first opening pressure changes, the second opening pressure must be adjusted when the first opening pressure changes.**
- **Use a micrometer to measure shim thickness.**

- Second nozzle opening pressure adjusting shims

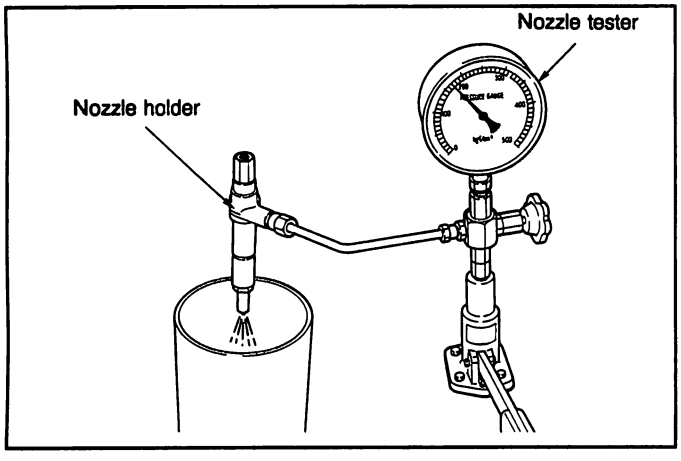


Final inspection

1. Remove the dial gauge, nut and holder.

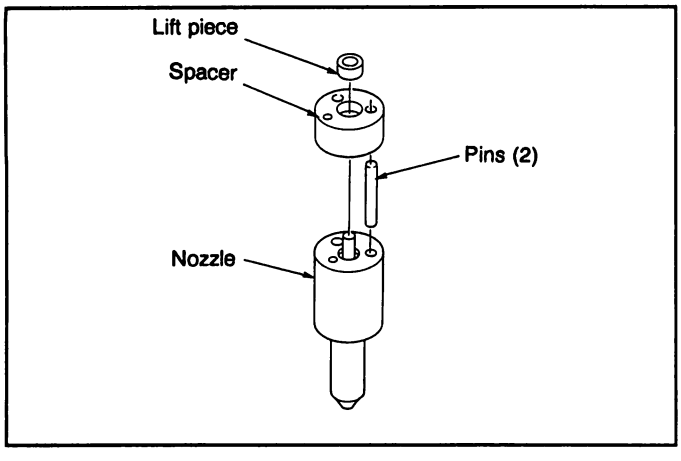


2. Remove the adjustment retaining nut and gasket.
3. Confirm that the pin is fully inserted into the nozzle and then install the specified retaining nut.
   First hand-tighten the nut and then tighten it to the specified torque.
   Specified torque: 29~39 N·m {3.0~4.0 kgf·m}



4. Attach the nozzle holder to the nozzle tester and check first nozzle opening pressure, spray pattern, seat oil tightness and each part for oil leaks.

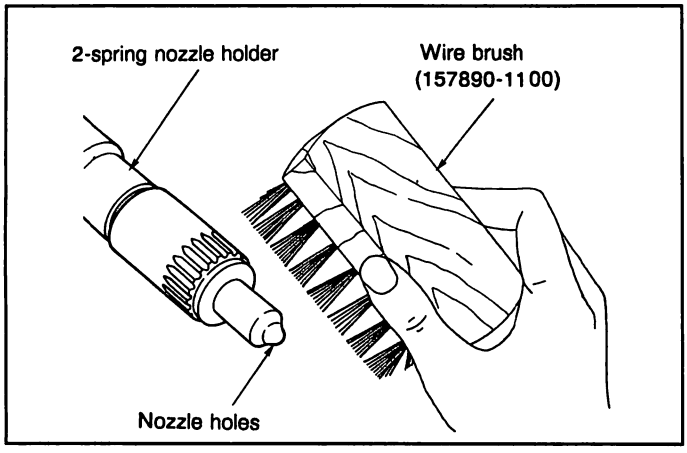
Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for spray patterns and inspection standards.



5. When replacing the nozzle, replace the nozzle, lift piece, pins and spacer as a set with the nozzle service kit.

CAUTION

Pre-lift will not be as specified if only the nozzle is replaced.



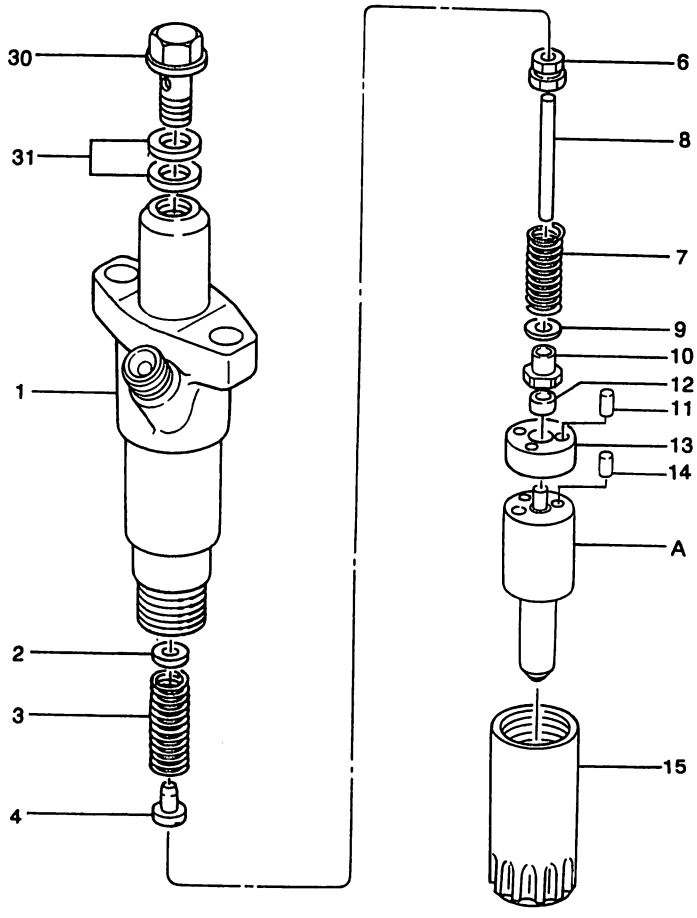
KBL2.4-S TYPE DISASSEMBLY

Before disassembly, remove any carbon from the nozzle holder using a wire brush and wash the outside.

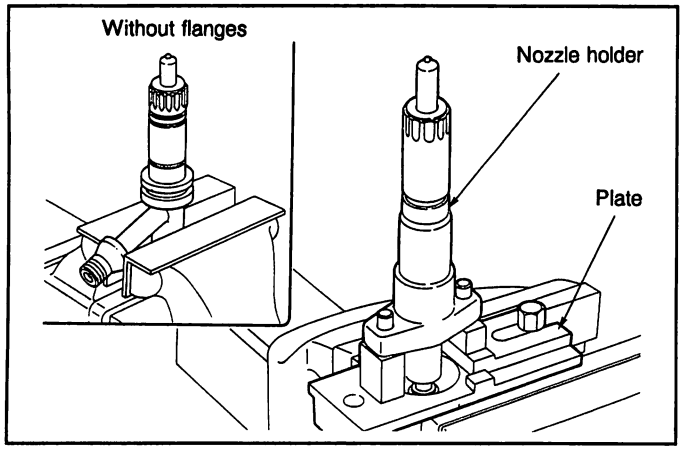
CAUTION

- **Do not touch the nozzle holes with the wire brush.**
- **Place all disassembled parts in order of disassembly on the bench.**

KBL2.4-S TYPE NOZZLE HOLDER: EXPLODED VIEW



Key no	Part name
1	Nozzle holder body
2	Shim (for 1st opening pressure adjustment)
3	First spring
4	Spring seat
6	Collar
7	Second spring
8	Pushrod
9	Shim (for 2nd opening pressure adjustment)
10	Spring seat
11	Pins
12	Lift piece
13	Spacer
14	Pins
15	Retaining nut
30	Eye bolt
31	Gasket
A	Nozzle

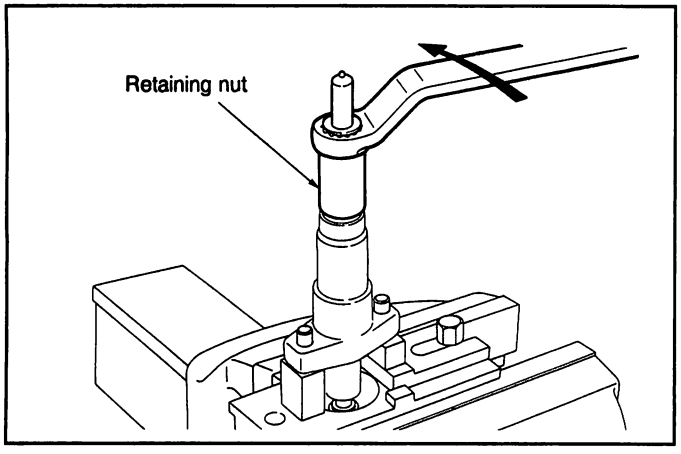


1. Position the nozzle holder on the plate (157944-9520).

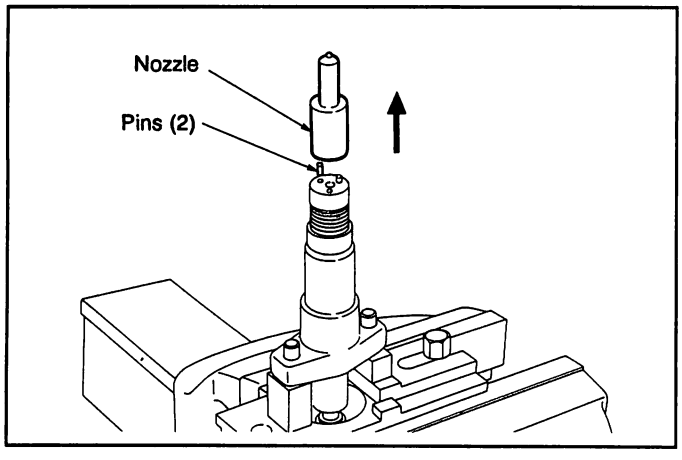
Note:
Assemble the plate as shown at left.

CAUTION

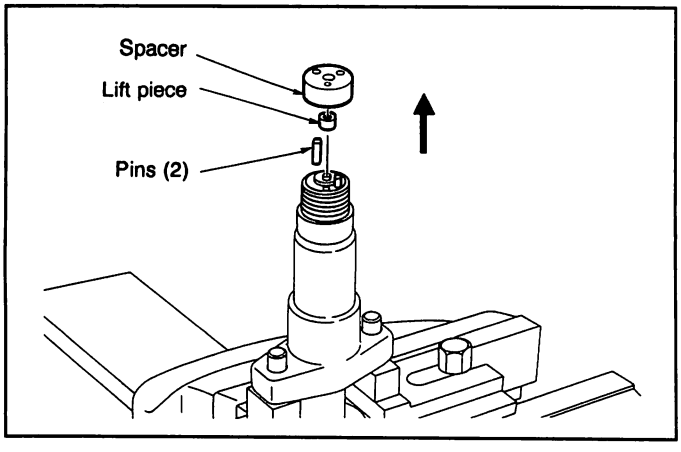
Secure nozzle holders without flanges directly in the vise between two metal plates.



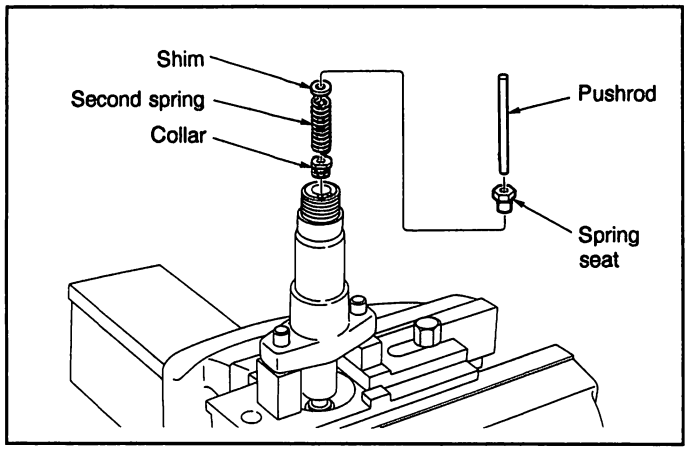
2. Remove the retaining nut.



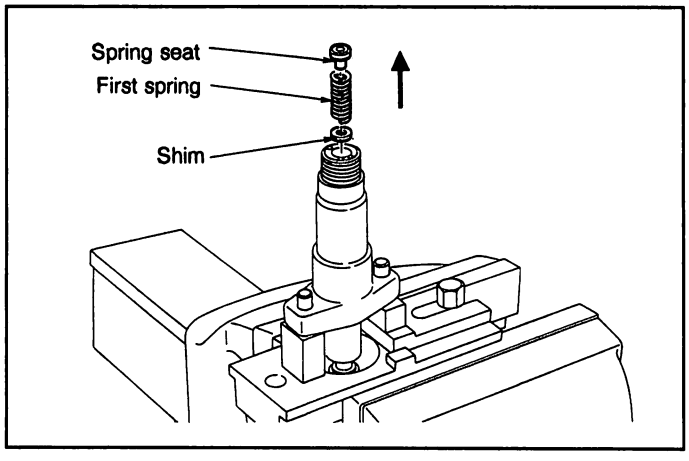
3. Remove the nozzle and pins.



4. Remove the spacer, lift piece and pins.



5. Remove the spring seat, shim, second spring, pushrod and collar.



6. Remove the spring seat, first spring and shim.
7. Soak the disassembled parts in clean solvent and remove any carbon using the cleaning kit (105789-0010).
8. Visually inspect the cleaned parts for wear, rust, erosion, etc.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for cleaning kit use and inspection standards.

KBL2.4-S TYPE REASSEMBLY AND ADJUSTMENT

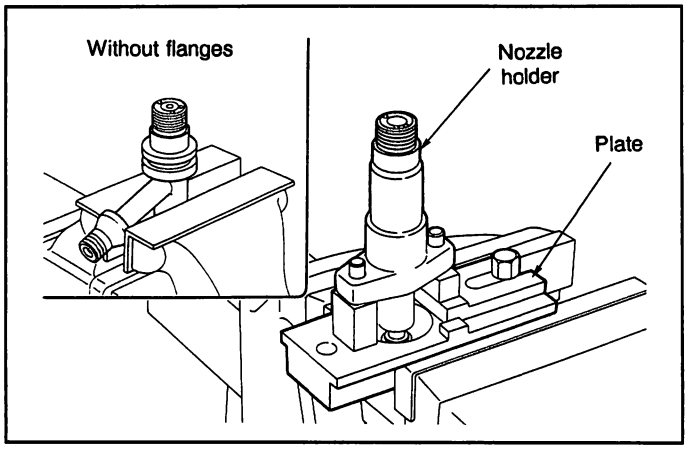
The nozzle holder is adjusted as the components are reassembled in the sequence below.
As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

REASSEMBLY AND ADJUSTMENT PROCEDURE

1. First nozzle opening pressure adjustment Page 77
   Adjust the first nozzle opening pressure using the shim.
2. Full needle valve lift confirmation Page 79
   Confirm the full needle valve lift in accordance with the closed method.
3. Pre-lift confirmation Page 81
   Confirm pre-lift in accordance with the closed method.

   CAUTION

   If not as specified, replace the nozzle assembly, lift piece, pins and spacer using the nozzle service kit.
4. Second nozzle opening pressure confirmation Page 82
   Confirm the second nozzle opening pressure in accordance with the closed method.
5. Second nozzle opening pressure adjustment Page 84
   Adjust the second nozzle opening pressure using the shim.
6. Final inspection Page 84
   Confirm the condition of the fuel spray with the nozzle and nozzle holder assembled.

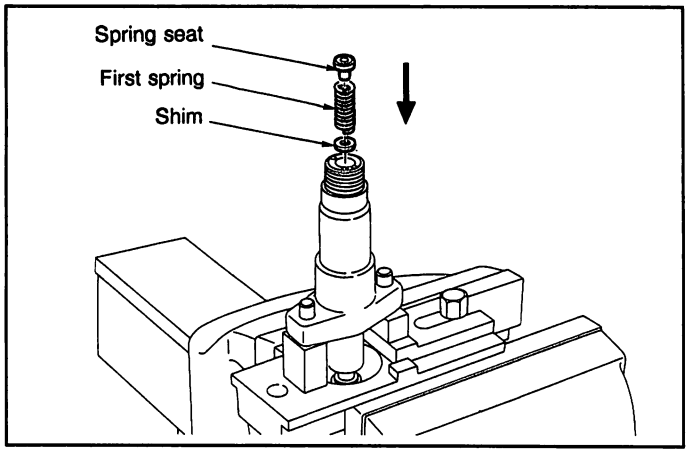


First nozzle opening pressure adjustment

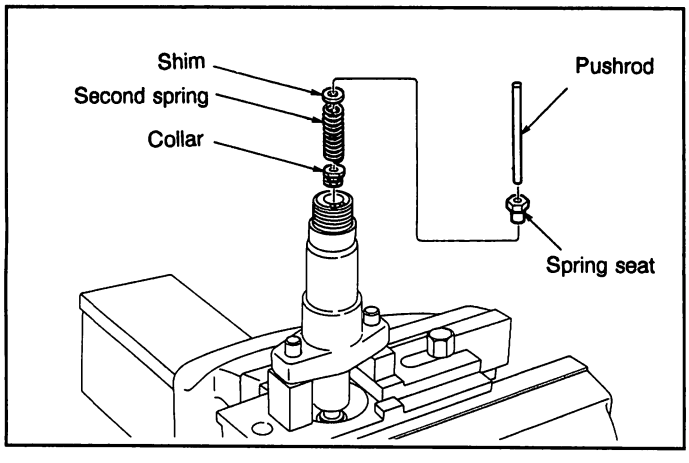
1. Position the nozzle holder on the plate.

CAUTION

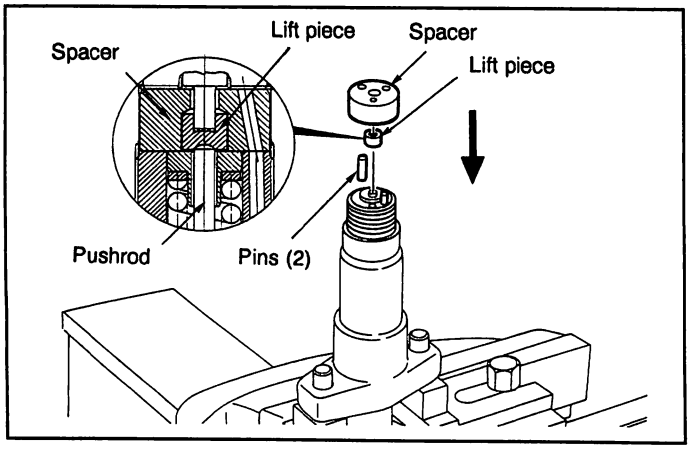
Secure nozzle holders without flanges directly in the vise between two metal plates.



2. Assemble the shim, first spring and spring seat in the nozzle holder.

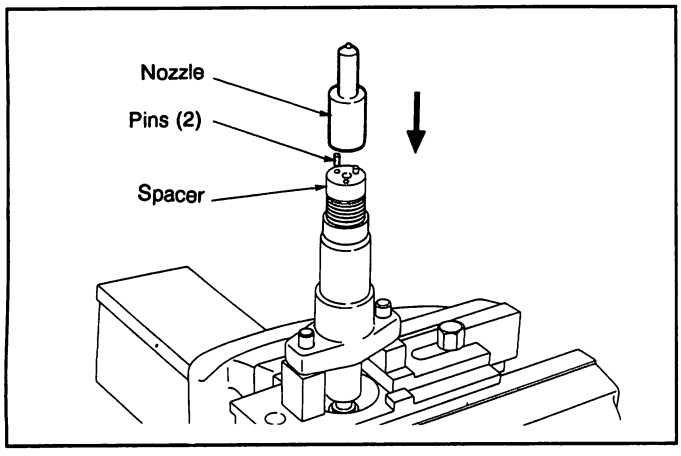


3. Assemble the collar, second spring, shim, spring seat and pushrod in the nozzle holder.

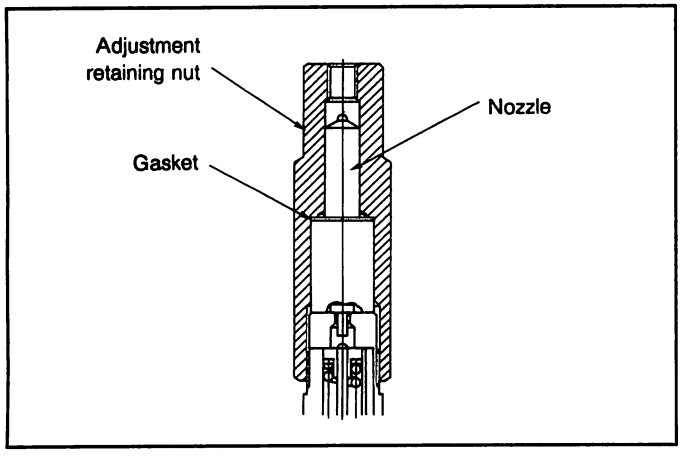


4. Assemble the pins, lift piece and spacer in the nozzle holder.

Note:
Assemble the lift piece with the rounded indentation facing the pushrod.

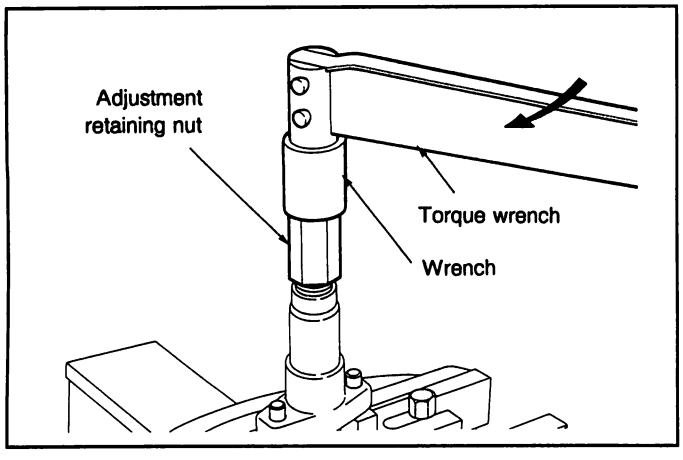


5. Assemble the pins in the spacer.
6. Assemble the nozzle on the pins.

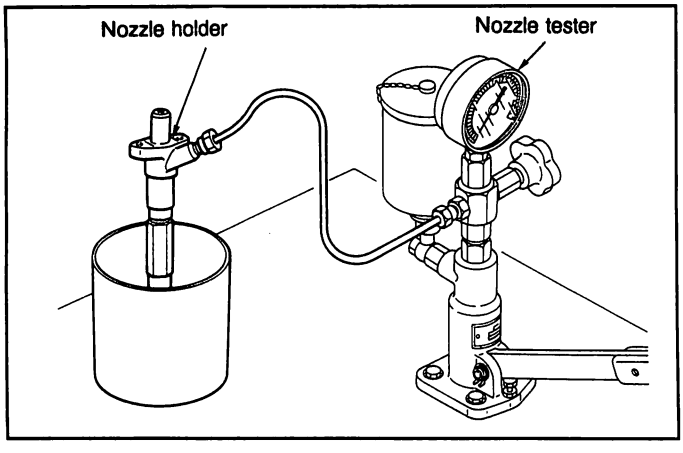


7. Hand-tighten the adjustment retaining nut together with the gasket to the nozzle holder.

Tool Name	Part No.	Remarks
Retaining nut	157892-4000	
Gasket	157892-1500	



8. Tighten the adjustment retaining nut to the specified torque using the torque wrench and wrench (157914-0500; SW22 mm).
   Specified torque: 29~39 N·m {3.0~4.0 kgf·m}



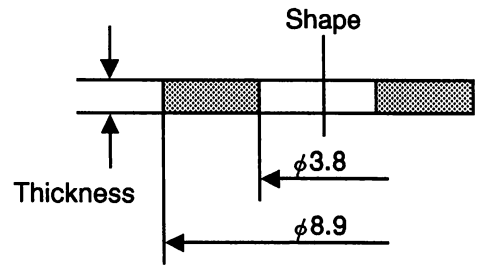
9. Attach the nozzle holder to the nozzle tester.
10. Operate the nozzle tester and measure the first nozzle opening pressure.
11. If the first nozzle opening pressure is not as specified, disassemble the nozzle holder and replace the shim until the pressure is as specified.

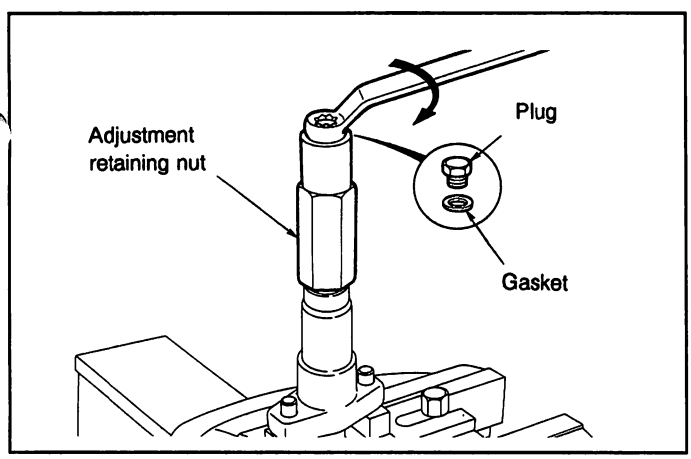
CAUTION

Use a micrometer to measure shim thickness.

Part No.	Thickness (mm)
150539-0700	0.40
150539-0800	0.50
150539-0900	0.52
150539-1000	0.54
150539-1100	0.56
150539-1200	0.58
150539-1300	0.60
150539-1400	0.70

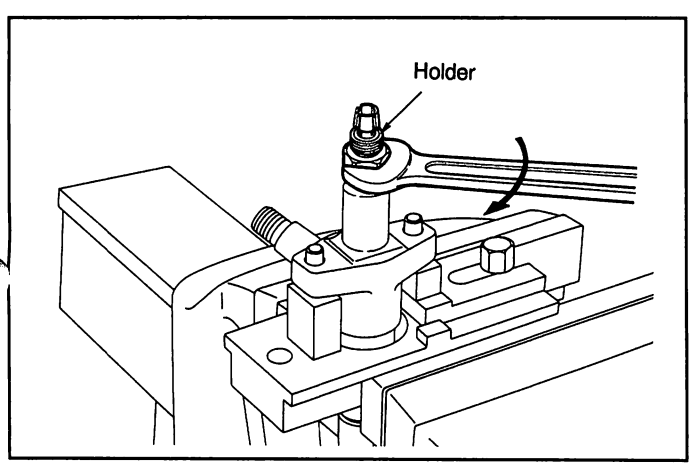
- First opening pressure adjusting shims





Full needle valve lift confirmation

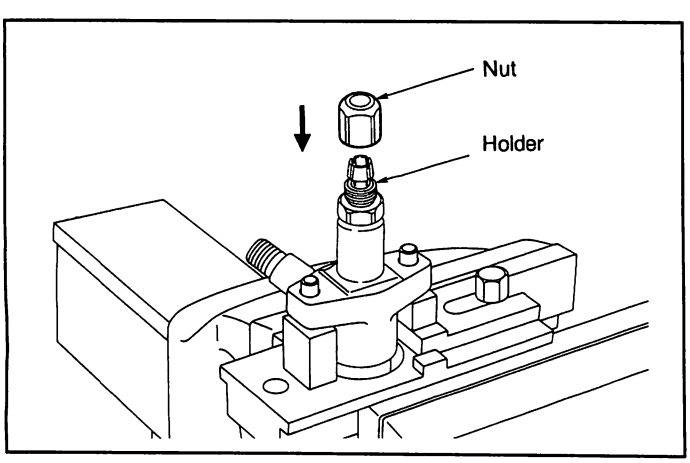
1. Install the gasket (026508-1140) and plug (157892-1600; SW12) on the adjustment retaining nut.



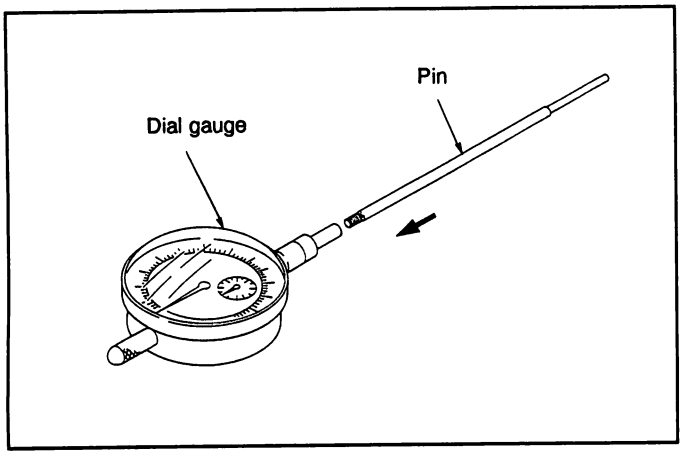
2. Position the nozzle holder with the nozzle facing down and install the holder on the nozzle holder.

Note:
There are three types of holder. Use a holder that fits the nozzle holder thread.

Tool Name	Part No.	Remarks
Holder	157892-4400	M8×1.0
Holder	157892-4100	M10×1.0
Holder	157892-5400	M10×1.25



3. Install the nut (157892-1000) on the holder.



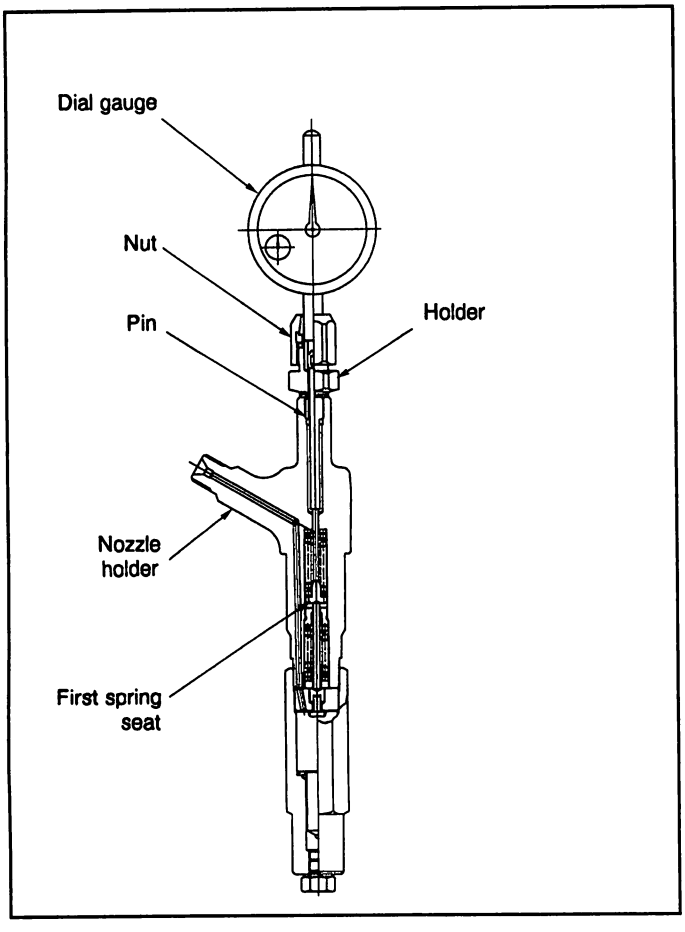
4. Attach the pin to the dial gauge.

Note:

-1. There are five types of pin. Select a pin that contacts the tip of the first spring seat. Refer to the figure below.

-2. The lengths of the pins do not include the threaded portions.

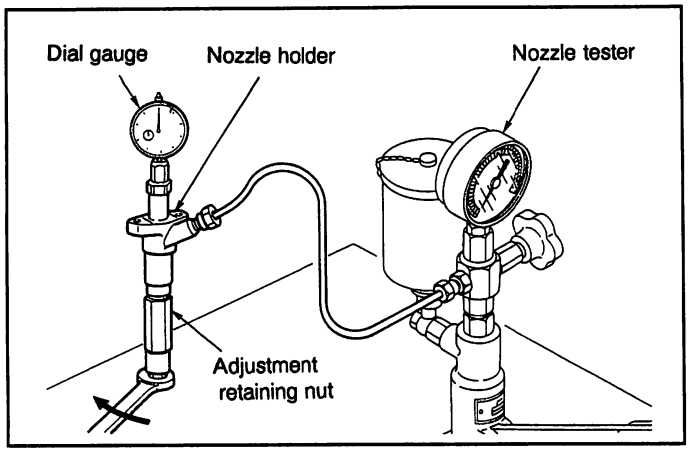
Tool Name	Part No.	Remarks
Pin	157892-4700	L = 85 mm
Pin	157892-5200	L = 100 mm
Pin	157892-5300	L = 60 mm
Pin	157892-5500	L = 55 mm
Pin	157892-5700	L = 120 mm
Dial gauge	157954-3800	



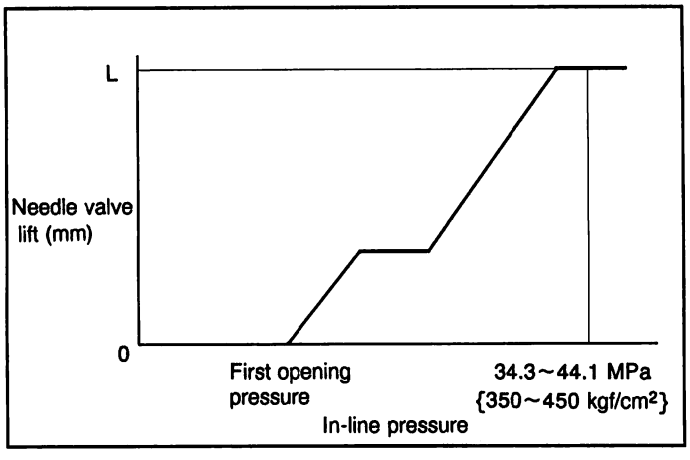
5. Secure the dial gauge to the nozzle holder using the nut so that the pin contacts the tip of the first spring seat.

CAUTION

- **Secure the dial gauge so that a stroke of 2 mm can be measured.**
- **Do not over-tighten the nut as the dial gauge shaft may jam. (Confirm from the dial gauge that the shaft moves smoothly.)**

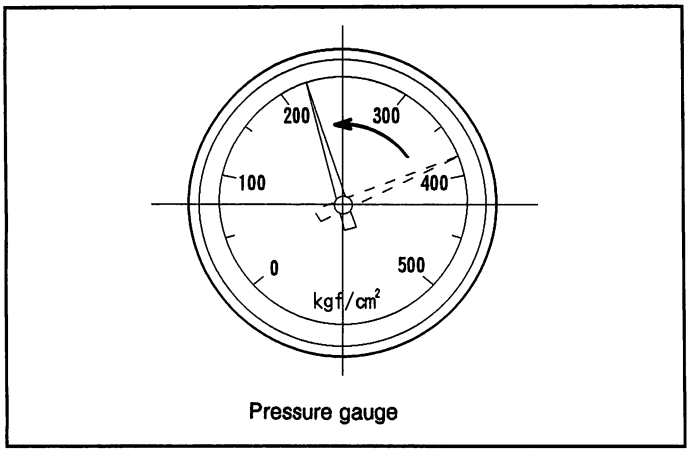


6. Attach the nozzle holder to the nozzle tester and zero the dial gauge.
7. Operate the nozzle tester to bleed any air from inside the retaining nut and to confirm that no fuel leaks.



8. Operate the nozzle tester and increase the in-line pressure to 34.3~44.1 MPa {350~450 kgf/cm2} so that the nozzle's needle valve moves through its full lift. Record full lift 'L.'

Note:
The above operation is used to determine whether the nozzle seat is worn and whether the nozzle assembly is in good condition.

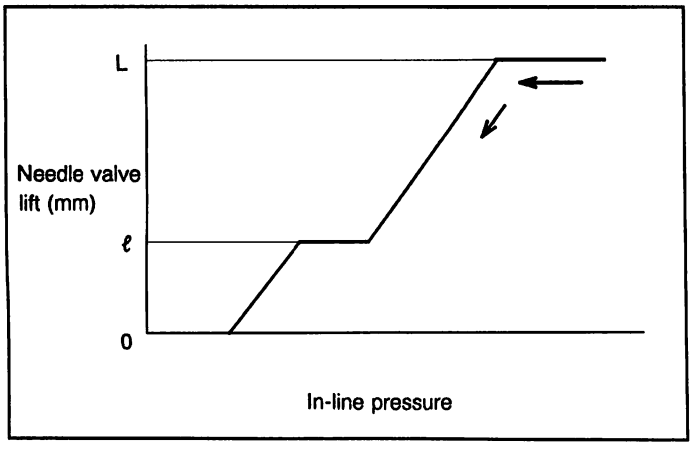


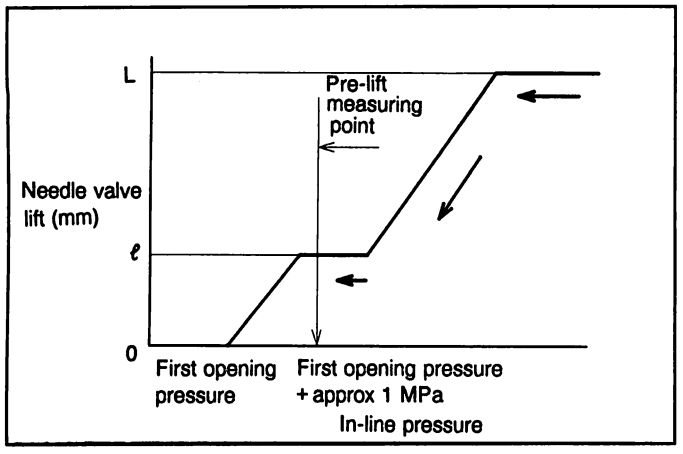
Pressure gauge

Pre-lift confirmation

1. With the needle valve at full lift, release the nozzle tester handle.

Note:
The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.



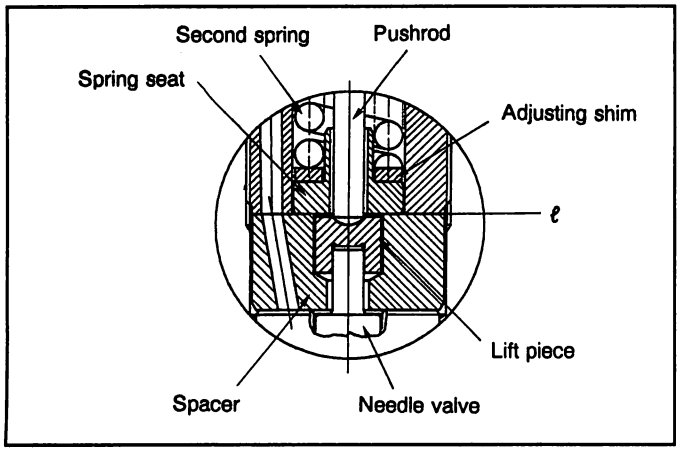


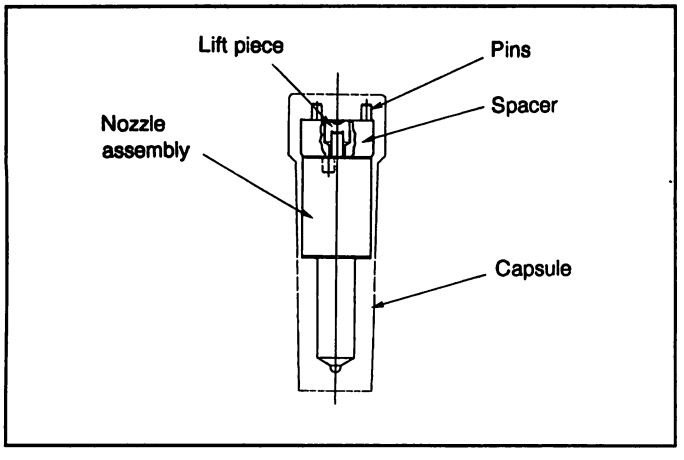
2. Read the needle valve lift 'ℓ' from the dial gauge indication (once the needle valve has descended when the second spring has stopped operating). Refer to the pre-lift measuring point for 'ℓ.'

Pre-lift measuring point:
Read the dial gauge at first nozzle opening pressure + approx 1 MPa {10 kgf/cm²}.

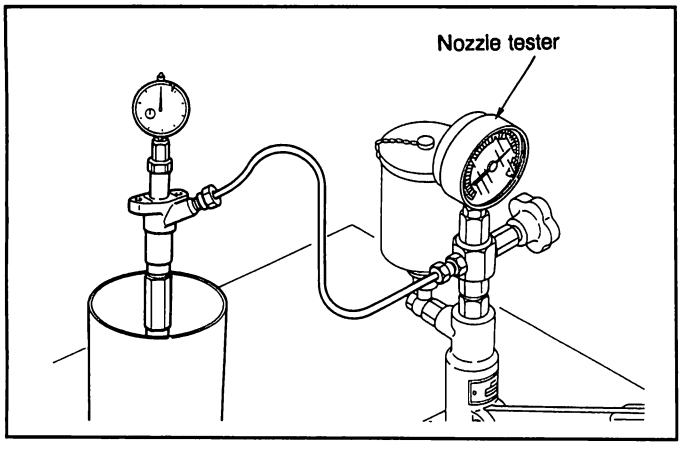
Note:
This point can be found while the pressure is decreasing.

3. Confirm that pre-lift 'ℓ' is as specified.



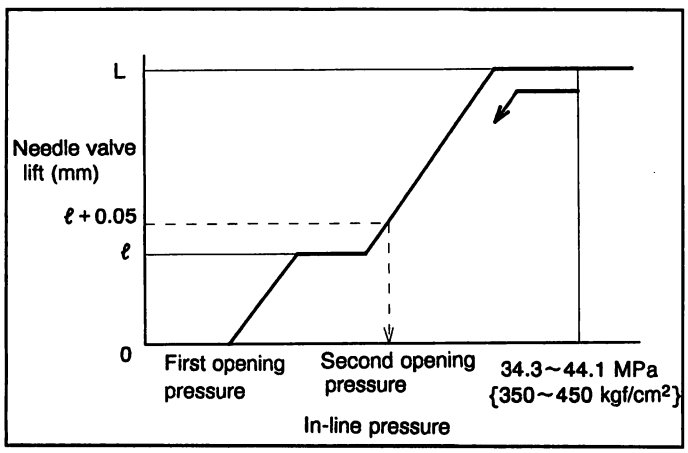


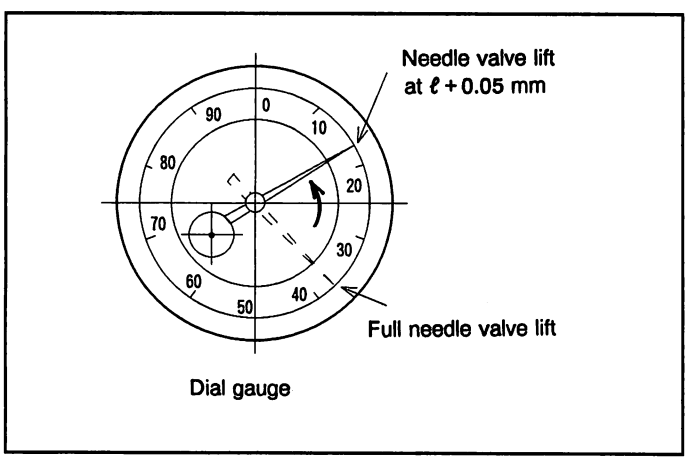
4. If pre-lift is not as specified, replace the pins, lift piece, spacer and nozzle assembly as a set with the service kit.

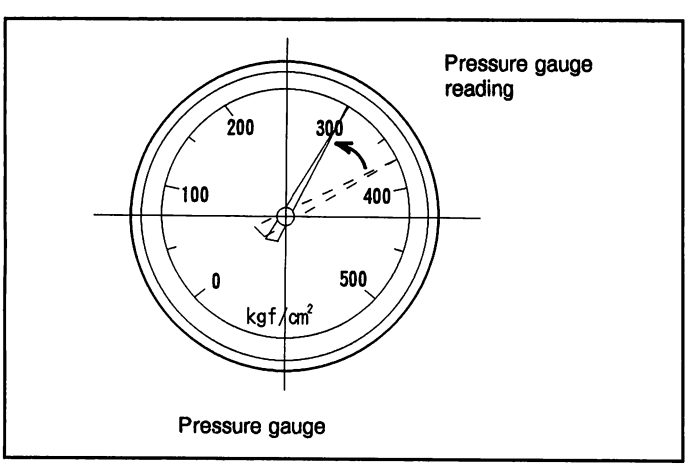


Second nozzle opening pressure confirmation

1. After pre-lift confirmation, operate the nozzle tester to increase in-line pressure to 34.3~44.1 MPa {350~450 kgf/cm²} so that the nozzle's needle valve moves through its full lift.



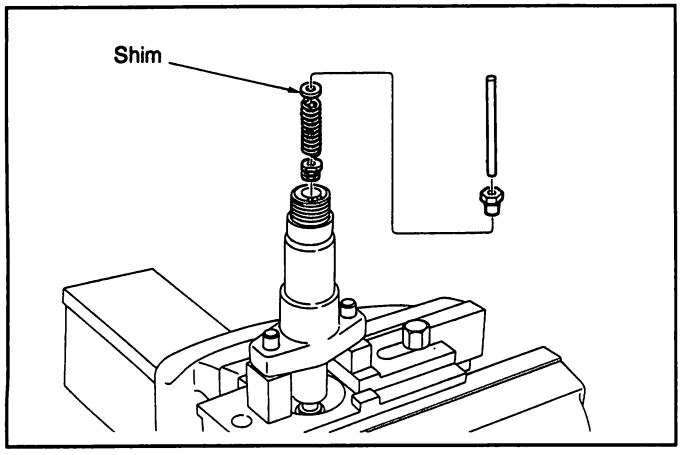




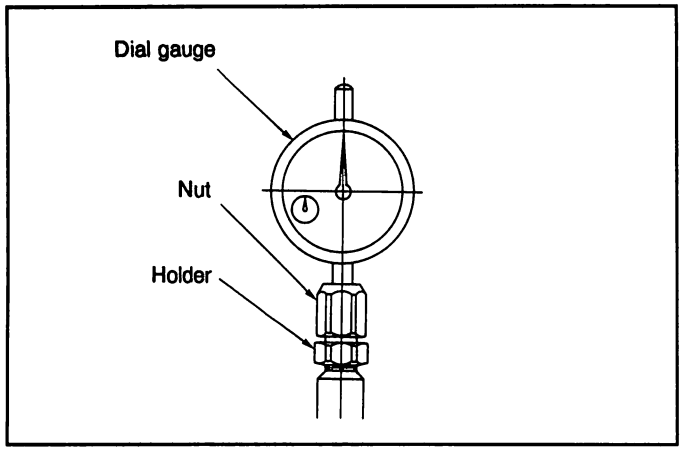
2. Release the nozzle tester handle so that in-line pressure decreases.

Note:
The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

3. Then, read the pressure gauge indication (second nozzle opening pressure) the instant that the dial gauge indicates the specified needle valve lift (usually pre-lift ℓ + 0.05mm).



Part No.	Thickness (mm)
150590-0600	0.40
150590-0700	0.50
150590-0800	0.52
150590-0900	0.54
150590-1000	0.56
150590-1100	0.58
150590-1200	0.60
150590-1300	0.70



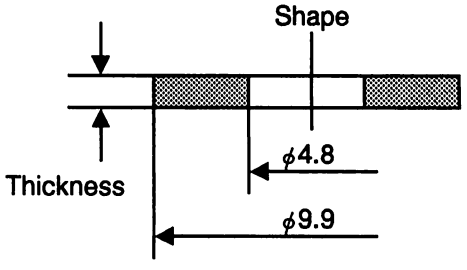
Second nozzle opening pressure adjustment

If the second nozzle opening pressure is not as specified, disassemble the nozzle from the nozzle holder and replace the shim until the pressure is as specified.

CAUTION

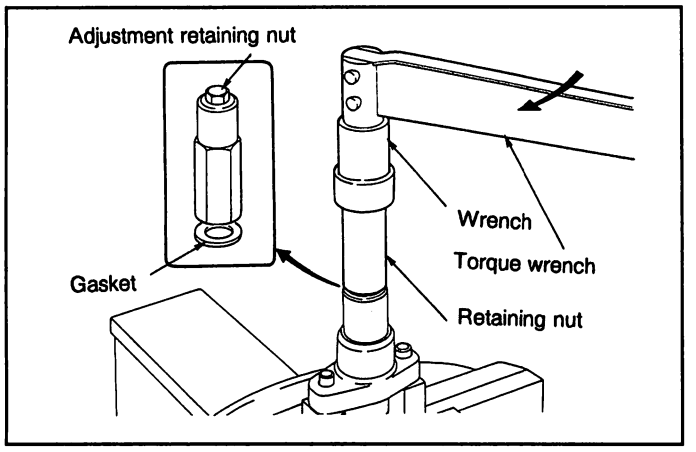
- **Because the second opening pressure changes when the first opening pressure changes, the second opening pressure must be adjusted when the first opening pressure changes.**
- **Use a micrometer to measure shim thickness.**

- Second nozzle opening pressure adjusting shims

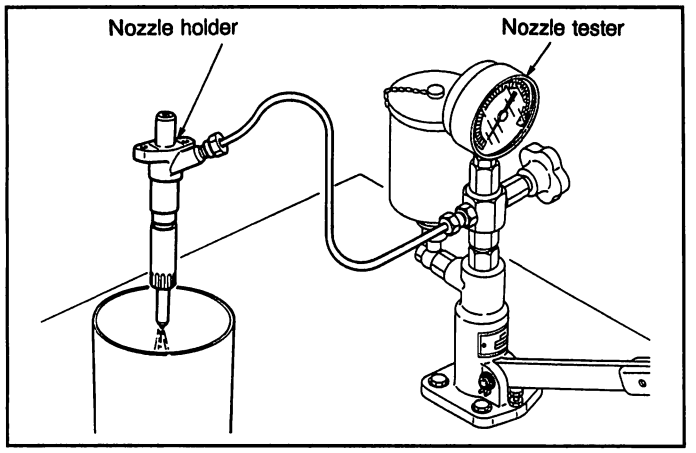


Final Inspection

1. Remove the dial gauge, nut and holder.

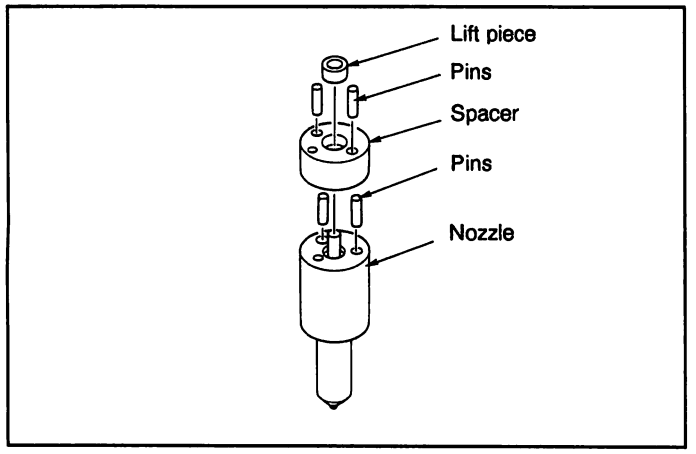


2. Remove the adjustment retaining nut and gasket.
3. Install the specified retaining nut, confirm that the pins are inserted fully into the nozzle, and then hand-tighten the retaining nut. Then, tighten the retaining nut to the specified torque using the torque wrench and wrench (157914-2800; SW19 mm).
   Specified torque: 59~79 N·m {6.0~8.0 kgf·m}



4. Attach the nozzle holder to the nozzle tester and check first nozzle opening pressure, spray pattern, seat oil tightness and each part for oil leaks.

Note:
Refer to the Nozzle and Nozzle Holder Service Manual (EE17E-11011) for spray patterns and inspection standards.



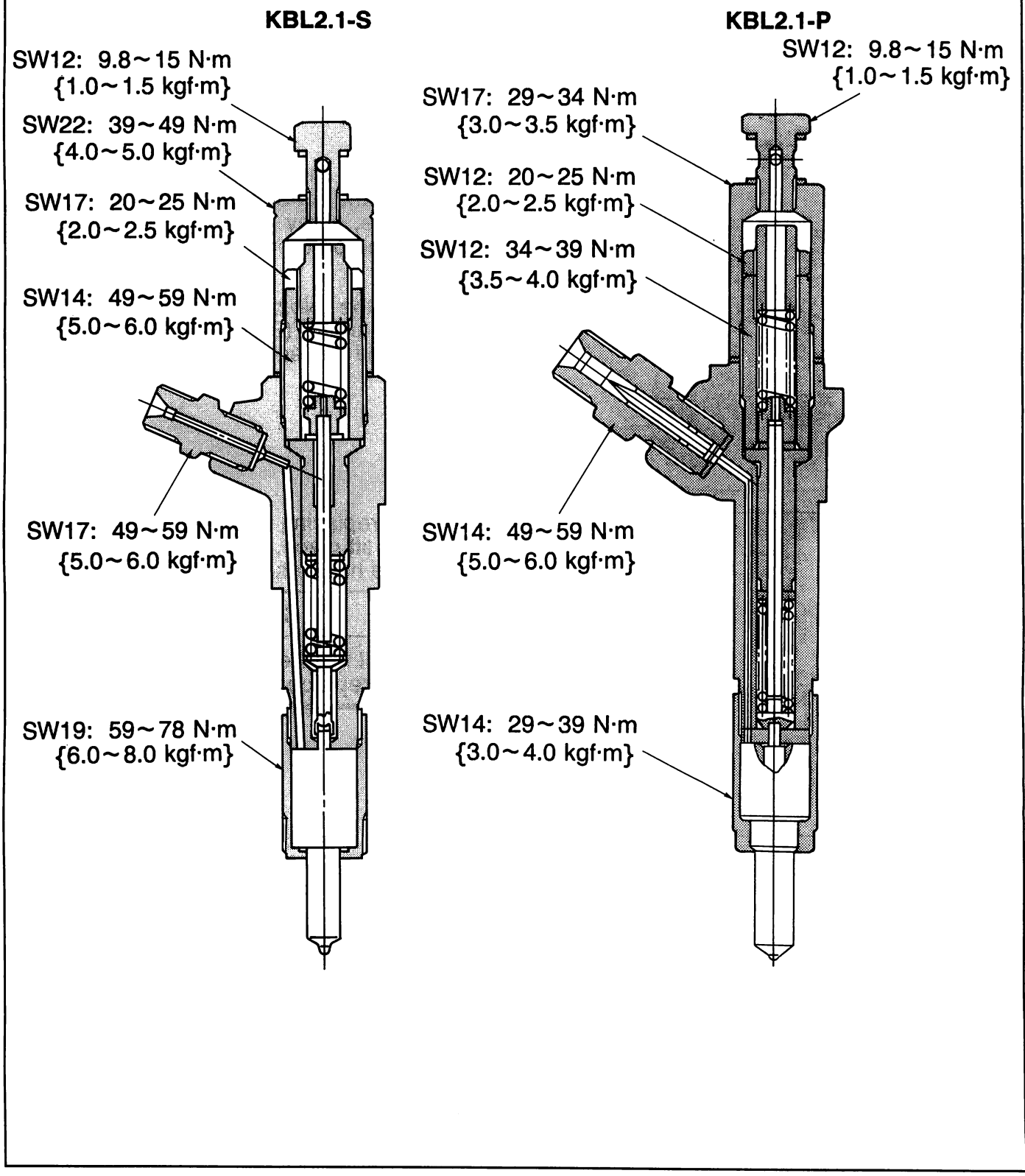
5. When replacing the nozzle, replace the nozzle, lift piece, pins and spacer as a set with the nozzle service kit.

CAUTION

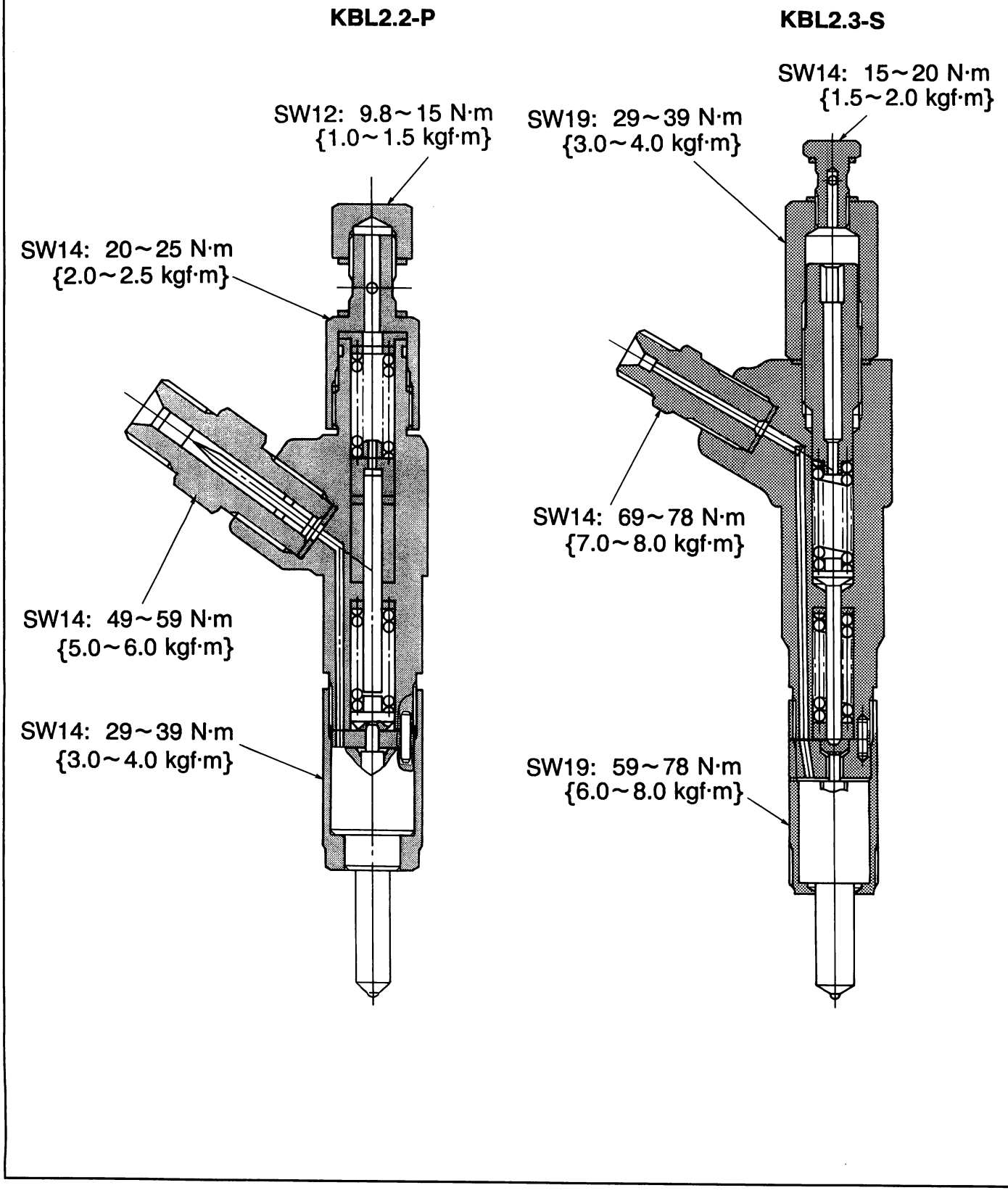
Pre-lift will not be as specified if only the nozzle is replaced.

12 TIGHTENING TORQUES

KBL2.1-S TYPE AND -P TYPE



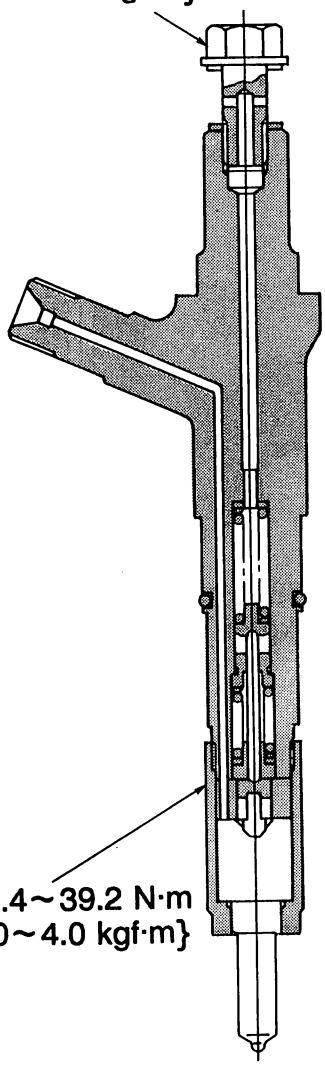
KBL2.2-P TYPE AND 2.3-S TYPE



KBL2.4-P TYPE AND -S TYPE

KBL2.4-P

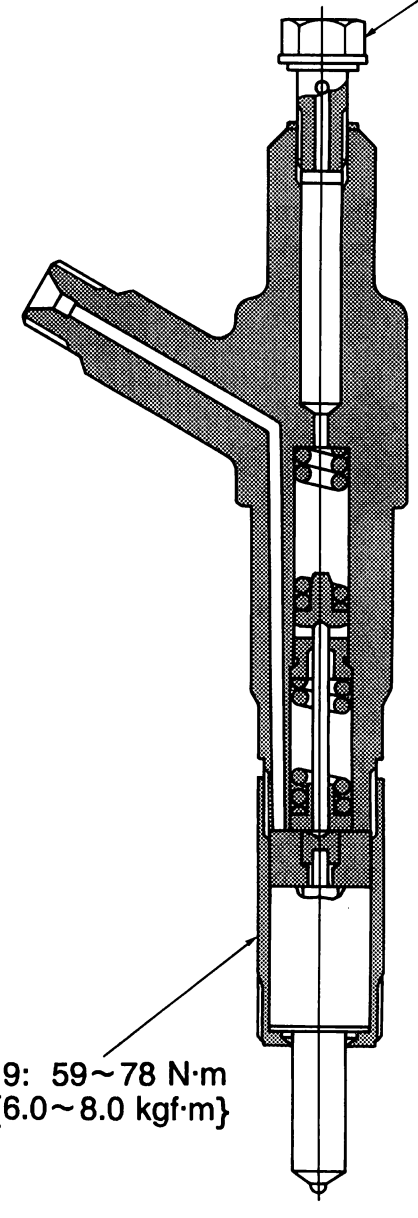
SW12: 9.8~14.7 N·m
{1.0~1.5 kgf·m}



SW14: 29.4~39.2 N·m
{3.0~4.0 kgf·m}

KBL2.4-S

SW12: 10~15 N·m
{1.0~1.5 kgf·m}



SW19: 59~78 N·m
{6.0~8.0 kgf·m}

Pub. No.: EE17E-11040

TWO-SPRING NOZZLE HOLDER
Service Manual
Construction & Operation
Repair & Maintenance
Printing: December, 1996
Published by: **ZEXEL** CORPORATION
Service Department
Printed in Japan

194-200-02 JPWS-02
Printed on recycled paper