

**Action code: Immediately****Fuel Injection Valve Test**February 2010
SL10-525/JXN**Concerns**Owners and Operators of MAN
Four-stroke Diesel Engines Type
Propulsion and GenSet L27/38.

Dear Sirs

MAN Diesel would like to emphasize the importance of correct testing of fuel valves. This is a key factor for good performance of our engines. Experience with these new instructions has shown that the information will be of help during overhauls and adjustment.

We kindly ask you to insert the enclosed information in your instruction book.

In case you should have any questions to this Service Letter, please feel free to contact us at our common e-mail address as stated below:

GenSet engines: PrimeServ-hol@mandiesel.com
Propulsion engines: PrimeServ-frh@mandiesel.com

Yours faithfully

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L27/38

<p>Safety precautions</p> <ul style="list-style-type: none"> <input type="checkbox"/> Stopped engine <input type="checkbox"/> Shut-off starting air <input type="checkbox"/> Shut-off cooling water <input type="checkbox"/> Shut-off fuel oil <input type="checkbox"/> Stopped lub. oil circul. <p>Description</p> <p>Execute work on time according to the maintenance schedule, enable/support economic operation, prevent operating problems damages. Fuel injection valves affect the loading of the injection system and the operating values of the engine. They are to be checked if there are deviations in the operating values, to be overhauled if necessary or changed.</p> <p>Starting position</p> <p>Operating media systems closed/depressurised. Engine shut down.</p> <p>Related procedure</p> <p>Man power</p> <p>Working time : 1 hours Capacity : 1 man</p> <p>Data</p> <p>Data for pressure and tolerance (Page 500.35) Data for torque moment (Page 500.40) Declaration of weight (Page 500.45)</p>	<p>Special tools</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Plate No</th> <th style="text-align: left;">Item No</th> <th style="text-align: left;">Note</th> </tr> </thead> <tbody> <tr> <td>52000</td> <td>013</td> <td></td> </tr> <tr> <td>52000</td> <td>050</td> <td></td> </tr> <tr> <td>52000</td> <td>074</td> <td></td> </tr> <tr> <td>52000</td> <td>407</td> <td></td> </tr> </tbody> </table> <p>Hand tools</p> <p>Ring- and open end spanner, 12 mm Ring- and open end spanner, 24 mm Socket spanner, 24 mm</p> <p>Replacement and wearing parts</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Plate No</th> <th style="text-align: left;">Item No</th> <th style="text-align: left;">Qty /</th> </tr> </thead> <tbody> </tbody> </table>	Plate No	Item No	Note	52000	013		52000	050		52000	074		52000	407		Plate No	Item No	Qty /
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Dismantling of a fuel injection valve

Notice: An engine that runs usually on heavy oil, should be operated for a short while on Diesel oil before disassembling the fuel injection valves.

Initial state: Stop valves on fuel pipes closed. Oil pump (Reserve) shut off, Cylinder head cover removed, indicator valve opened.

Caution: Injection valve should be disassembled only with opened indicator valve.

- 1) Remove the side cover over the fuel pump and the top cover over the rocker arms for the cylinder head.
- 2) Dismantle the delivery pipe between the fuel pump and the lance (5) fig 1
- 3) Remove the nuts (1) and the thrust piece (2)
- 4) Unscrew the screw (3) and remove the locking device (4)
- 5) Unscrew the lance (5) and remove it from the cylinder head.
- 6) Install the extractor tool, see fig. 2 and pull out the fuel valve.
- 7) Extract injector valve by turning the spindle nut until it is loose.

Notice: Injection valve may be dismantled only with disassembly and assembly fixture.

- 8) Thread off spindle nut and remove the extractor tool.
- 9) Cover opening in the cylinder head.
- 10) Place injection valve on workbench.
- 11) Clean complete injection valve outside with fuel, remove adhering with wire brush. Scratch injection nozzle only with wooden spatulas, in order not to damage nozzle bore. Clean cylindrical set of nozzle bodies.

Caution: Cleaning should be done on the side away of the workbench.

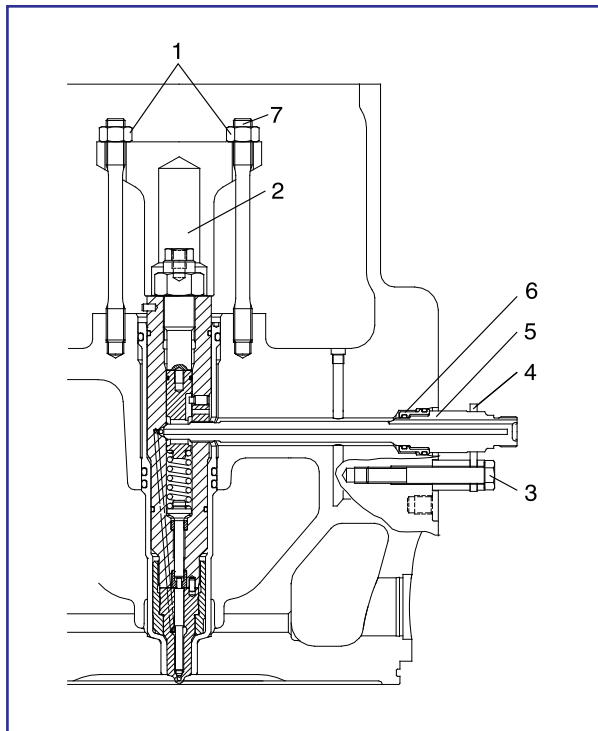


Fig 1 Fuel injection valve assembly.

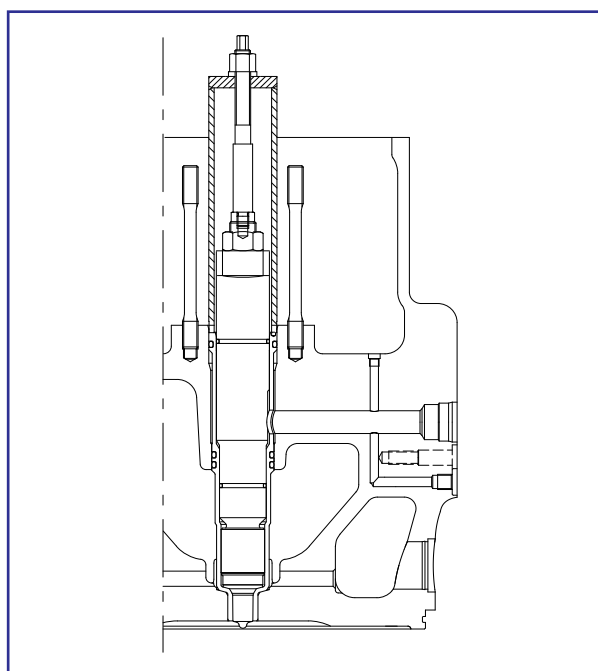


Fig 2 Extractor tool mounted on fuel injection valve

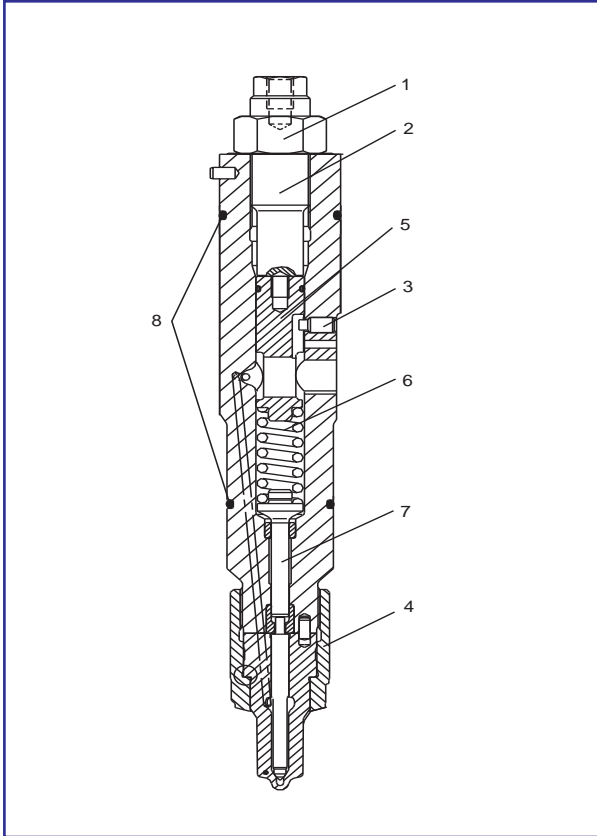


Fig 3 Fuel injection valve complete

Assembling of fuel injection valve

Initial state: Injection valve, especially cylindrical seat of nozzle bodies cleaned carefully. Opening pressure, tightness and nozzle bores checked.

Notice: Injection valve from reserve stock or spares delivery cleaned and check from outside.

Working steps

- 1) Fit new round ring seals (8), lubricated with clean lubricating oil, in the ring groove, ensuring that this is tensioned equally on the entire periphery and not twisted.
- 2) Fill the inside space (spring room) of the injection valve through leakage fuel draining hole, with clean fuel.
- 3) Remove cover for bore in the cylinder head and clean the bore and seat face in the cylinder head carefully.

Caution: When cleaning, see that no external objects fall into the combustion chamber!

4) Assemble injection valve in bore, taking care of correct positioning of the bore for threaded piece. Fit new round ring seals (8), lubricated with clean lubricating oil, in the ring groove, ensuring that this is tensioned equally on the entire periphery and not twisted.

5) Ad lubricant pasta to the thread of the lance (5) and screw it into the fuel valve.

6) Place the thrust collar (item 2 figure 1) on the fuel injection valve and apply lubricant type GN or similar on screw thread, contact surface and hexagon nuts (1). Then tighten with hand and after installation of the lance (5) the hexagon nuts (1) can be tightened to the specified torque of 115 Nm. Prior to the tightening It might be necessary to turn the fuel valve a little to make the thread catch. Tightening torque for the lance is 75 Nm.

Notice: If the injection valve is installed in an operating hot cylinder head, tighten the hexagonal nuts (7) only after temperature equalisation, with specified torque.

7) Place the locking device on the hexagon of the lance and secure it with the screw (4) lubricated with oil. Tightening torque 115 Nm.

8) Ad lubricant type GN or similar to the lance (5) and the fuel pump top and install the high pressure pipe. Tightening torque: 50 Nm.

9) Close indicator valve.

10) Open stop valves on fuel pipes.

11) Attach cylinder head cover.

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Working Card Page 1 (4)	Fuel Injection Valve to be Checked	514-01.02 Edition 01H
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<p>Safety precautions</p> <ul style="list-style-type: none"> <input type="checkbox"/> Stopped engine <input type="checkbox"/> Shut-off starting air <input type="checkbox"/> Shut-off cooling water <input type="checkbox"/> Shut-off fuel oil <input type="checkbox"/> Stopped lub. oil circul. <p>Description</p> <p>Check components for quality/wear condition ensure/ restore operating reliability. Fuel injection valve affect the loading of the fuel injection system and the operating values of the engine. They are to be checked if there are deviations in the operating values, to be overhauled if necessary or changed.</p> <p>The work extends: Checking of parts / components.</p> <p>Starting position</p> <p>Related procedure</p> <p>Assembly of the fuel injection valve 514-01.04</p> <p>Man power</p> <p>Working time : 2 hours Capacity : 1 man</p> <p>Data</p> <p>Data for pressure and tolerance (Page 500.35) Data for torque moment (Page 500.40) Declaration of weight (Page 500.45)</p>	<p>Special tools</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Plate No</th> <th style="text-align: left;">Item No</th> <th style="text-align: left;">Note</th> </tr> </thead> <tbody> <tr> <td>52000</td> <td>013</td> <td></td> </tr> <tr> <td>52000</td> <td>050</td> <td></td> </tr> </tbody> </table> <p>Hand tools</p> <p>Replacement and wearing parts</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Plate No</th> <th style="text-align: left;">Item No</th> <th style="text-align: left;">Qty /</th> </tr> </thead> <tbody> <tr> <td>51701</td> <td>015</td> <td>1/V</td> </tr> <tr> <td>51702</td> <td>010</td> <td>1/V</td> </tr> </tbody> </table>	Plate No	Item No	Note	52000	013		52000	050		Plate No	Item No	Qty /	51701	015	1/V	51702	010	1/V
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Preliminary observations

Functioning capability and setting of the injection valve affect the combustion course, the operating values and the loading of the injection system. If the operating values are changed (ignition pressure, exhaust temperature) the opening pressure and tightness of the concerned valves should be checked. The nozzle test stand allows to pressure-test and adjust the injection valve, using a hydraulic hand pump. The fixture ensure comfortable working under reproducible conditions.

In the testing of injection valves of modern 4-stroke engines the atomisation is no longer a test criterion, because the behaviour of the injection nozzle in engine operation cannot be verified.

An inferior spray pattern does not say anything about the functioning of the injection nozzles in the engine. It is fully functional if the criteria for opening pressure, tightness and free nozzle bores are fulfilled.

Structure and pattern of the nozzle test stand

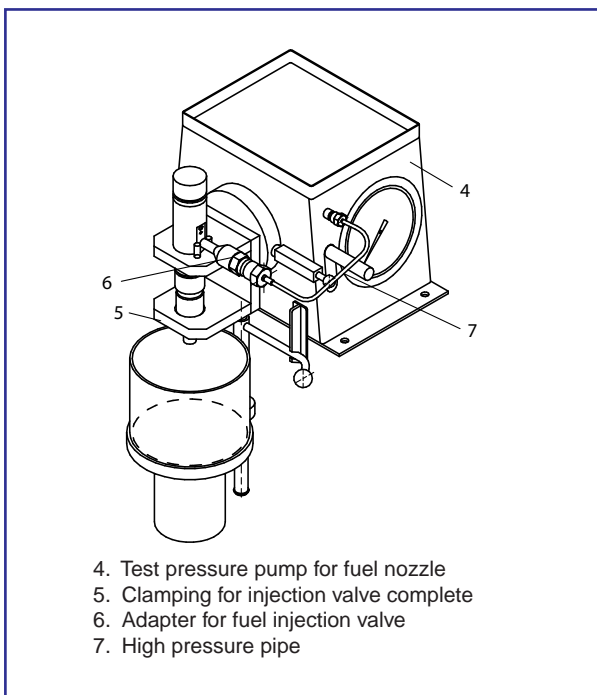


Fig 1 Nozzle test stand

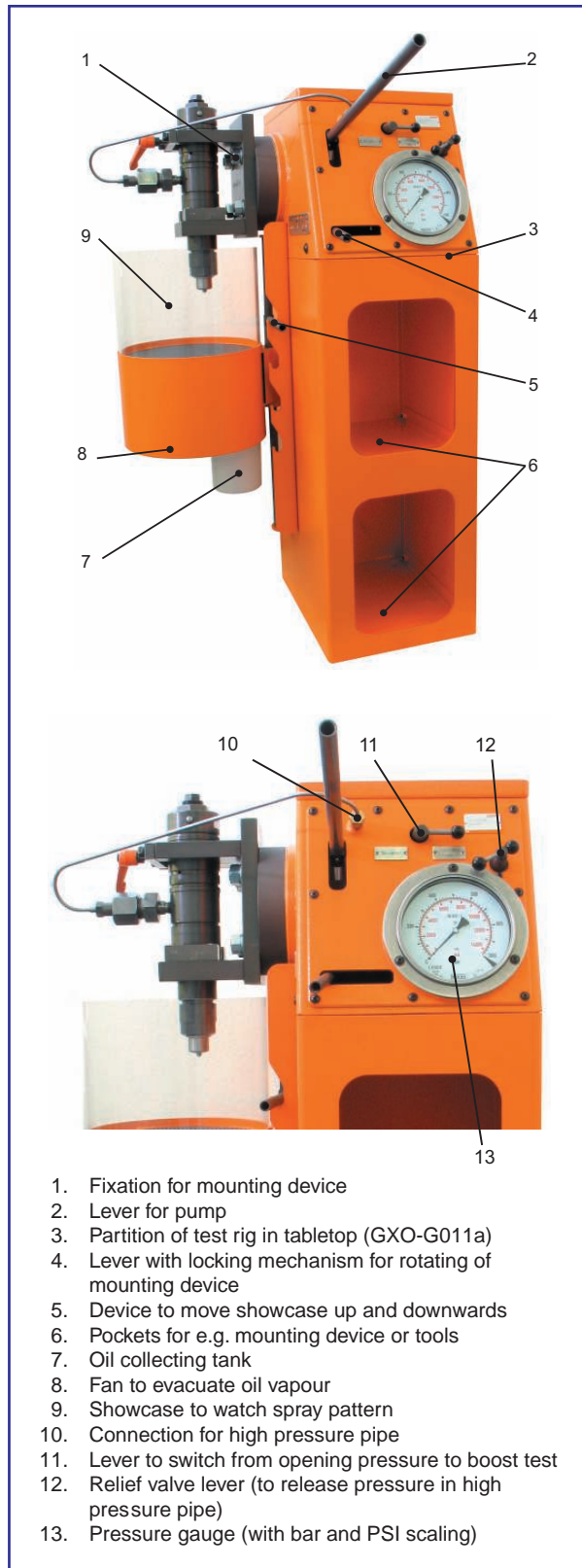


Fig 2 Nozzle test stand

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Preparation for inspection

Notice: Heavy oil residues in the injection valves can adversely affect test result and make cleaning more difficult. It is therefore recommended that the engine run on Diesel oil for about 1 hour before disassembling the injection valves.

If that is not possible then it is important to carry out the described test at once after injection valves are removed from engine. Otherwise the injection valve has to be separated and cleaned before testing.

Initial state: Injection valve is dismantled and cleaned on the outside.

Notice: Use anti-corrosion oil for checking the injection valves, so that they also given the conservation treatment. Only absolutely clean anti-corrosion oil should be filled in the nozzle test stand otherwise there could be malfunctioning in the pump or in the injection valve to be tested. The fill level of the oil container (12) should be checked.

- 1) Insert injection valve in the adapter head and tighten uniformly with holder.
- 2) Thread in connection piece on pressure hose connection of the injection valve and screw in high pressure hose on connecting piece.
- 3) Set nozzle jet collector vessel under the injection nozzle and push it up until the expected jets meet on the outer walls of the nozzle jets collector vessel.

Caution: Never allow injection nozzle to spray into open air but only in the collector! Do not touch fuel jets, as they penetrate the skin structure and cause painful inflammation! Do not use any open flames at workplace! Smoking is absolutely prohibited! Use suction on oil mist wherever possible!

The checking and setting of the injection valves extends to the following steps:

- Check opening pressure,
- Check nozzle bores,
- Set target pressure,
- Check tightness.

Check opening pressure

- 1) Close pressure relief valve (12) if it exist on the test equipment used.
- 2) Actuate hand pump (26) uniformly and raise pressure until the injection nozzle opens. Note opening pressure and compare with reference value 420 bar. Actuate hand pump for min. 20 strokes and rinse injection valve.

Notice: Opening pressure

The hydraulic pressure must be taken slowly past the opening pressure, as otherwise there are errors while reading off the opening pressure. The test pressure must not exceed 430 bar! In case of new nozzles elements, the nozzle needle can be stuck at the first spray test and must be released by strong rinsing. In case of already run-in nozzles, collect the anti corrosion oil contaminated with fuel and do not fill it again in the pressing device. In case of new nozzles, there can be a drop in the opening pressure up to 90 bar after a few operating hours.

This pressure drop does not mean any functional deficiency and is characteristic of all fuel injection nozzles.

It cannot be expected that the nozzle will spray or make a sound, only opening pressure can be checked.

Decision: Opening pressure drop less /greater than 90 bar.

Opening press. drop less than 90 bar:

- Continue with the next step.

Opening press. drop greater than 90 bar:

- Separate injection valve as mentioned in workcard 514-01.03.
- Carry out visual inspection (spring breakage)
- If component is in order, continue with the next step

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Check nozzle bores

1) Loosen the hexagonal nut (1) and turn back adjusting screw (2) until compression spring (6) is released.

2) Close pressure relief valve (if it exist or retighten the high pressure pipe). Actuate hand pump uniformly and adjust opening pressure with adjusting screw (2) to 30 bar.

Decision: All nozzle holes open? Please refer to figure 3.

Yes, continue with the next step
No, Separate the injection valve as mentioned in work card 514-01.03.

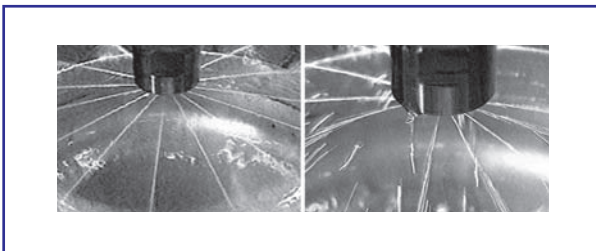


Fig 3 Assessment of the nozzle holes. Left – open, right – partly clogged

Adjust opening pressure to reference value

1) Actuate hand pump uniformly and thus raise the hydraulic pressure, at the same time tension the compression spring (6) a little by using adjusting screw (2). Repeat the process until the reference value of 420 bar is reached.

Notice: Compression spring

Do not set a higher pressure than indicated, otherwise the compression spring will be deformed. Adjust to the indicated higher spray pressure value only after assembling a new compression spring to compensate for the initial setting of the compression springs.

2) If the reference value is set reproducibly, lock the adjusting screw (2) with the hexagonal nut (1) and check the opening pressure again.

Check leak proofing

1) Stop the pumping of the tester and open the pressure relief valve (12) if it exist on the test equipment reducing the pressure to 0 bar. Or release pressure by loosening high pressure pipe until pressure has dropped to 0 bar. This ensures, that the nozzle is closed completely.

2) Close pressure relief valve and pressurize pipe again.

3) To check the leak proofing, actuate hand pump evenly until 250 bar are reached on the pressure gauge (13). The injection valve is considered tight if no drops fall within 5 seconds.

Notice: Make sure, that no oil drop off from the nozzle leakage bore (9) (Fig. 5 working cards 514-01.03). This may causes a misinterpretation of the tight nozzle. Avoid this by wrapping a cleaning rag around the injection nozzle.

Decision: Tightness OK? Please refer to figure 4.

Yes, The injection valve can be made available for use!
No, The injection valve should be replaced with new unit.

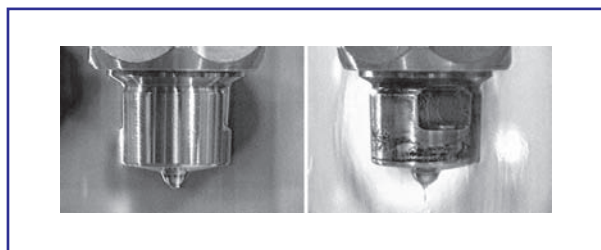


Fig 4 Judgement on the tightness. Left – tight, right - drops

Working Card Page 1 (3)	Fuel Injection Valve to be Separated	514-01.03 Edition 01H
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Preliminary observation

Notice: Separate injection valve if, during the test according to work card 514-01.02, errors are detected and if the nozzle element should be changed due to the operation time. The separation is done by placing the valve in a vice with soft jaws.

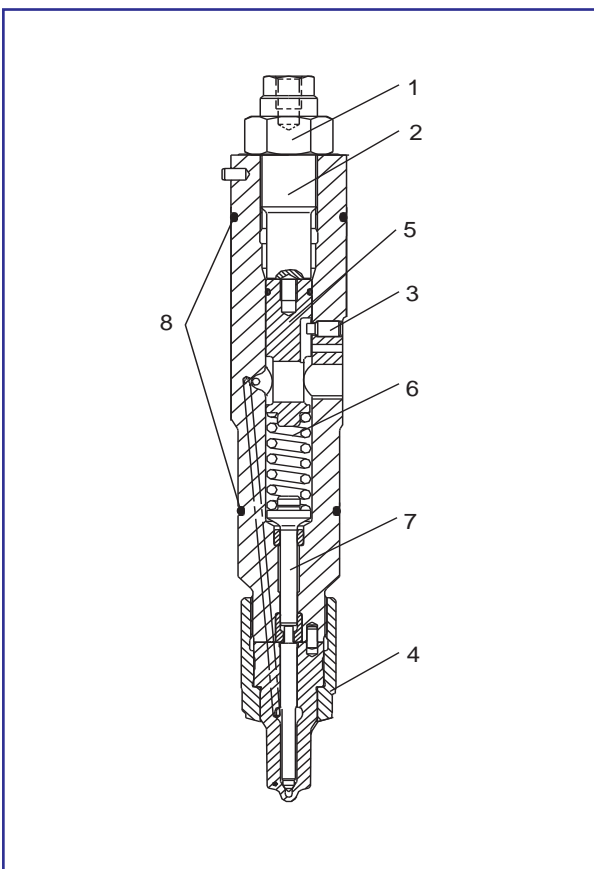


Fig 1 Fuel injection valve

Separating of a fuel injection valve

- 1) Wash injection valve in fuel and remove adhering coke with a wire brush.
- 2) Place the fuel valve in a vice with soft jaws.
- 3) Loosen hexagonal nut (1) and turn back adjusting screw (2) until compression spring (6) is released.
- 4) Turn the fuel valve 180° so the hexagon nut (1) is turned down.

- 5) Loosen nozzle tensing nut (4) carefully.

Releasing the nozzle tensing nut

Notice: If there is heavy resistance when releasing, try to make the threads free again by softening them in fuel and turning to and fro. Do not release nozzle tensing nut with force, as otherwise threads can wear out and parts can become useless.

- 6) When threading out the nozzle tensing nut (4) use the following method: Unscrew released nozzle tensing nuts and at the same time prevent them from lifting axially from holder by continuously lightly hitting with rubber hammer on nozzle bodies.

Notice: This method should prevent shaving or scratching of the parallel pin of the sealing face between nozzle body and holder during the threading off of the nozzle tensing nut.

- 7) Thread off nozzle tensing nut and remove nozzle body. See that nozzle needle does not fall out.

- 8) Extract nozzle needle from nozzle body and place it in fuel for cleaning.

Nozzle needle

Notice: Never interchange nozzle needles from nozzle body to nozzle body. They are manufactured in pairs.

- 9) Remove the injection valve from the vice with soft jaws and place it on the workbench.
- 10) Thread off adjusting screw (2).
- 11) Disassemble threaded pin (3) if existing.
- 12) If all internal parts are not loose, screw in suitable eye bolt in thrust piece (5) and extract thrust piece. Then disassemble compression spring (6) and thrust piece (7).
- 13) Place all parts for cleaning in Diesel oil and wash them off. Then blow with compressed air.

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Check components

The inspection of the components extends to:

- the nozzle holes
- the quality of fitting faces
- the mobility of the needle
- Traces of corrosion on the nozzle tensing nut and the nozzle body
- The nozzle specifications

1) Clamp a suitable cleaning wire, please see plate 52000, item No 013 for cleaning the nozzles holes.

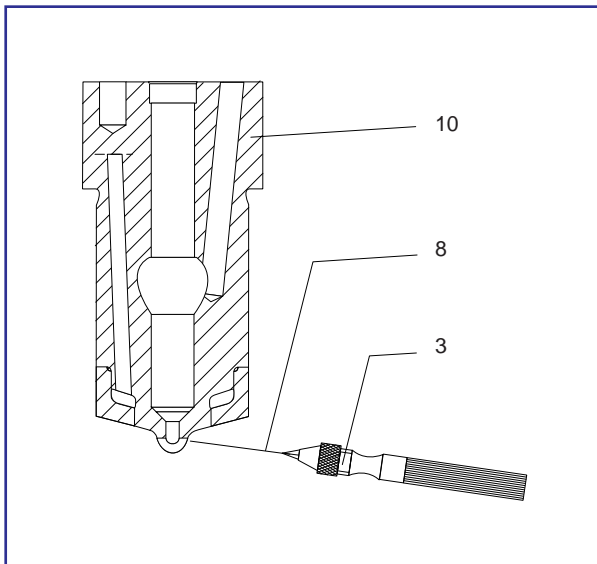


Fig 2 Cleaning the nozzle holes

2) Examine all components and especially sealing faces for damage / traces of wear.

No rework on the seat and fitting faces

Notice: Seat and fitting faces should not be machined manually nor mechanically, as the requisite accuracies cannot be achieved.

3) Check if nozzle needle can be moved in the nozzle body easily and without perceivable resistance, see Fig. 3.

4) Examine nozzle bodies for traces of corrosion.

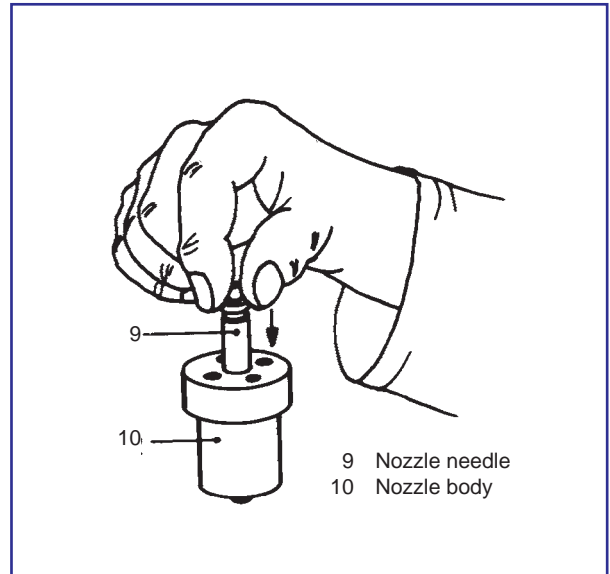


Fig 3 Checking the mobility of the nozzle needle

5) Read off nozzle specifications on the collar of the nozzle body

Original specification - see acceptance record of the motor.



Fig 4 Nozzle element with specification and IMO number

6) Change damaged parts. Replace nozzle needle and nozzle body together.

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Working Card Page 1 (2)	<h2 style="margin: 0;">Assembly of the Fuel Injection Valve</h2>	514-01.04 Edition 01H
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Specification of the injection nozzle

Notice: Check before the assembly whether specification of the injection nozzle matches with the reference specification. The original specification can be referred from the acceptance record (number, number of nozzle bores, bore diameter, spraying angle).

Initial situation: Injection valve separated, all individual parts carefully cleaned, damaged parts changed.

1) Clean threaded pin (3) and bore carefully as given in Loctite-specifications.

2) Hold holder body at an angle (with sealing face facing up) and guide in thrust piece (5) including compression spring (6) and spring plate (7). Pay attention to the position of the groove for the threaded pin (3) (see fig.1).

3) Paint screw thread of the threaded pin (3) with securing compound Loctite 243 on a length of 5mm and thread in into holder until threaded pin no longer projects. **Check that the thrust piece can still move in axial direction.**

4) Screw in adjusting screw (2), do not yet tighten compression spring.

5) Insert holder complete fuel valve in the nozzle tester such that the sealing surface for nozzle body (10) faces up and tighten evenly. Rotate take-up head by 180° and fix it.

6) Dip nozzle needle (10) in clean fuel and guide into the nozzle body, check easy movement.

7) Check nozzle needle stroke between top edge of nozzle body and offset on nozzle needle. For reference value see section "technical data" in instruction book.

8) Rub sealing face dry with sealing paper towel. Insert nozzle body with nozzle needle on holder, paying attention to the position of pins.

9) Paint pressure shoulder (11) on nozzle body (10) with lubricant "Optimol Paste White T". Please see Fig. 1.

10) Paint screw threads of holder and nozzle tensioning nut (4) as well as pressure shoulder (4) on nozzle tensioning nut with lubricant "Optimol Paste White T". Please see Fig. 1.

11) Screw on by hand nozzle tensioning nut on holder and in the second step tighten with specified torque (see work card). Rotate take-up head by 180° and fix it.

12) Screw on hexagonal nut (1) loosely on adjusting screw and tighten only after adjusting the opening pressure, please see description 500.35.

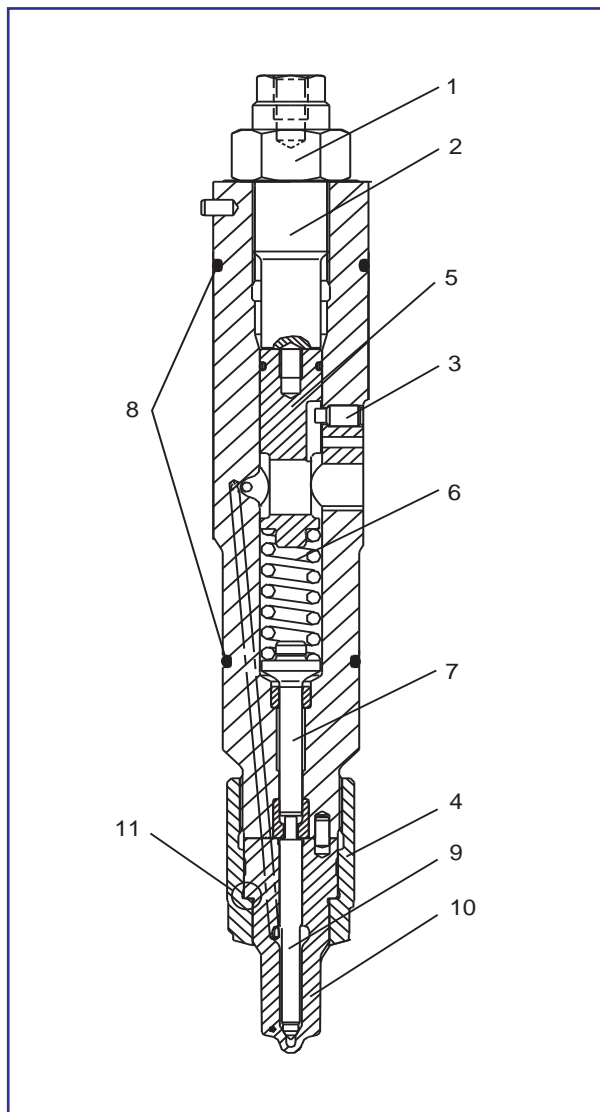


Fig 1. Assembly of the nozzle

L27/38**Safety precautions**

- Stopped engine
- Shut-off starting air
- Shut-off cooling water
- Shut-off fuel oil
- Stopped lub. oil circul.

Description

Ensure correct execution of work, assess contact pattern/wear status, restore contact pattern again.

The injection valve seat face in the cylinder head should be checked on every disassembly of the fuel injection valve by means of touching up sampling and reworked if necessary.

Starting position**Related procedure**

Creating of correct contact pattern.

Man power

Working time : 0.5 hours
Capacity : 1 man

Data

Data for pressure and tolerance (Page 500.35)
Data for torque moment (Page 500.40)
Declaration of weight (Page 500.45)

Special tools

Plate No	Item No	Note
52000	050	

Hand tools**Replacement and wearing parts**

Plate No	Item No	Qty /
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Grinding the seat area

Initial state: Fuel injection valve dismantled.

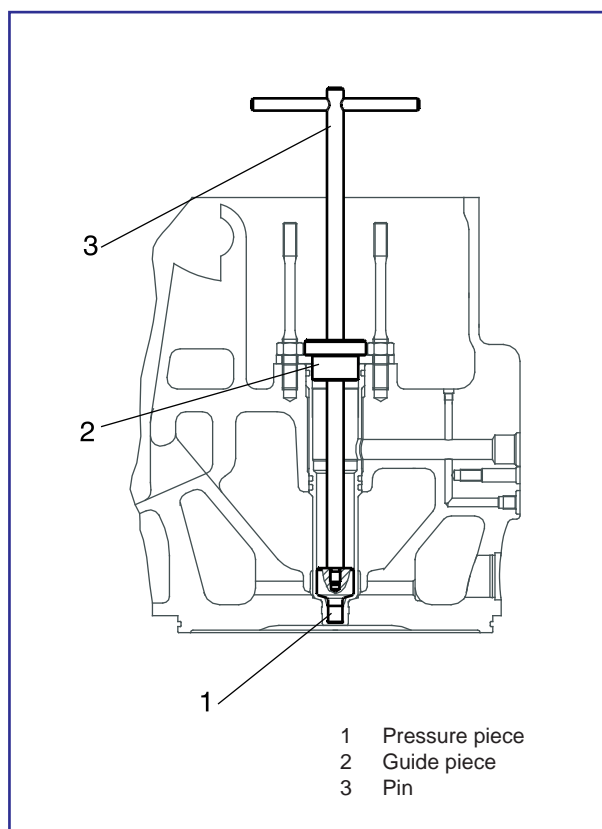


Fig 1 Grinding tools complete

1) Before mounting the fuel valve, clean and inspect the valve sleeve in the cylinder head.

2) If necessary, grind the seating face with the grinding tool see Fig. 1.

3) Place grinding tool in cylinder head, paying attention to guide piece (2) is in correct position inside cylinder head.

4) Rotate grinding tool to and fro, raise in-between and blow off grinding dust with compressed air.

5) Remove grinding tool see Fig. 1 after the grinding process is complete and clean valve seat carefully.