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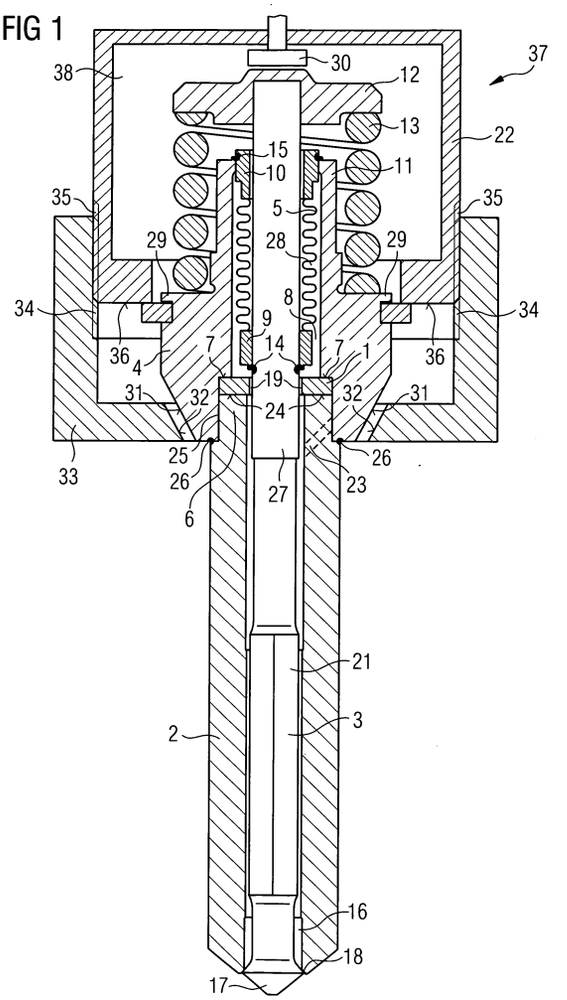
(54) Nozzle for a fuel injector

(57) The invention describes a nozzle (2) for a fuel injector (37) that comprises a simple damping element (1) for protecting a sealing connection between the needle (3) and the nozzle (2) from high pressure waves. The damping element (1) has the shape of a ring plate (1) that is positioned above an upper surface of the nozzle (2). The ring plate (1) is held against the upper surface of the nozzle (2) by a holding member (4). The holding member (4) has basically the shape of a sleeve and is used with a bellow (5) for tightly sealing off an actor chamber (38) from fuel.

FIG 1



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Description

[0001] The present invention relates to a nozzle for a fuel injector.

[0002] In the non-disclosed patent application W002/36959A2 a nozzle for a fuel injector is described that comprises a needle which is movably arranged within the nozzle. At the lower end, the needle comprises a closing member with a seat face. The seat face is opposed to a second seat face of the nozzle. Depending on the position of the needle the first and second seat faces close or open an injection opening that is connected to a fuel chamber. The fuel chamber is arranged between the needle and the nozzle. The fuel chamber is connected to a high pressure fuel line. At an upper side, the nozzle comprises a sleeve that is arranged within an opening of the nozzle. The needle is guided through the sleeve into an injector housing in an upward direction. In the injector housing a second sleeve is provided that is tightly connected with the housing at a lower end. A bellow is arranged between the second sleeve and the needle whereby the bellow is tightly connected with the needle at a lower end and with the second sleeve at an upper end. A lower part of the injector is tightly sealed off against an upper part of the injector. In the lower part of the injector fuel is inserted that is prevented from flowing to the upper part in which the actuator, particularly a piezoelectric actuator, is arranged. The actuator has to be protected against the fuel which might damage the actuator.

[0003] The first sleeve has the task of damping high pressure waves that are generated in the fuel chamber by starting and stopping the injection. The high pressure waves might damage the bellow that tightly seals the lower part of the injector from the upper part.

[0004] The object of the present invention is to provide a nozzle with a simple and inexpensive damping element. The object is attained by means of a nozzle according to claim 1. Further advantageous embodiments of the invention are disclosed in the dependent claims.

[0005] The nozzle for the fuel injector according to an exemplary embodiment of the present invention is believed to have an advantage over the related prior art since the nozzle comprises a simple damping element in the shape of a ring plate. The ring plate is held by a holding member and a clearance is provided between an inner face of the ring plate and the needle between 10 to 120 μm.

[0006] Using a simple ring plate as a damping element reduces the production costs of the nozzle. Furthermore, the ring plate is easier to incorporate into the nozzle in comparison to the sleeve that is known from the prior art. Furthermore, the ring plate is not used for guiding the needle. Therefore the ring plate does not have to be placed into a precise position to the needle. Therefore the nozzle and the ring plate can be produced independently. As a result, it is not necessary to adjust the shape of the nozzle and the shape of the ring plate to each other.

[0007] In a preferred embodiment of the invention the ring plate is arranged on an upper end surface of the nozzle. The upper end surface is directed towards the housing and the ring plate is pressed against the upper end surface by a holding element. This arrangement of the ring plate is advantageous for mounting the ring plate.

[0008] In a further advantageous embodiment of the invention the ring plate is held by a holding element that basically has the shape of a sleeve that is tightly connected with the bellow at its upper end and tightly connected with the nozzle at its lower end. Therefore the sleeve is used with a first function for holding the ring plate at the upper end surface of the nozzle and with a second function for tightly sealing off the nozzle from an upper part of the injector. Using the sleeve for this two functions saves a separate member for holding the ring plate at the upper end surface of the nozzle.

[0009] In a further preferred embodiment of the invention the sleeve comprises at an outer face a holding face that is used for pressing the nozzle against the injector housing with a nut. Therefore, a separate element for providing a holding face for fixing the nozzle with the housing of the injector is made expedient.

[0010] An advantageous connection between the sleeve and the nozzle is attained by providing a ring nut at the upper end of the nozzle that is stuck into the sleeve. The sleeve comprises a first cylindrical part that surrounds the ring nut. The first cylindrical part merges with a second cylindrical part by means of a step face. The second cylindrical part has a smaller diameter than the first part. The step face is adjacent to an upper plane of the ring plate and presses the ring plate with a lower face to the upper end surface of the nozzle. The described shape of the nozzle and of the sleeve has the advantage that the sleeve can easily be fixed tightly to the nozzle pressing the ring plate against the upper end face of the nozzle.

Brief description of the drawings

[0011]

Fig. 1 shows a cross-sectional view of a nozzle of a fuel injector in an exemplary embodiment of the present invention.

Fig. 2 shows the damping element and the needle in more detail.

Description of an exemplary embodiment of the present invention

[0012] Fig. 1 shows a sectional view of a fuel injector 37. The fuel injector 37 comprises a housing 22 in which an actuator 30, especially a piezoelectric actuator, is arranged. The actuator can be used for directly or indirect-

ly actuating a needle 3 that is arranged within a nozzle 2. If the actuator 30 does not directly act upon the needle, a pressure chamber can be used for actuating the needle. In this case the actuator controls a pressure valve that determines the pressure of the pressure chamber. The pressure chamber may be limited by a movable piston that is actuating the needle 3.

[0013] Fig. 1 shows an outwardly opening nozzle 2. However, the invention is not limited to an outwardly opening nozzle 2 and could also be implemented with an inwardly opening nozzle.

[0014] The needle 3 comprises at a lower end a valve head 17 which is directed towards a valve seat 18 of the nozzle 2. In a closed position the valve head 17 rests on the valve seat 18 with a sealing face and closes a fuel chamber 16. The fuel chamber 16 is arranged between the needle 3 and the nozzle 2. The fuel chamber 16 is connected to a fuel line 23 that delivers fuel with high pressure.

[0015] The needle 3 comprises in a middle part a guiding section 21 that is used to precisely guide the needle 3 in the nozzle 2. For a precise guiding, a small clearance is arranged between an outer face of the needle 3 and an inner face of the nozzle 2. The needle 3 extends in a housing 22 of the fuel injector.

[0016] The nozzle 2 has the shape of a sleeve with an upper end face 24 that is directed towards the housing 22. The upper end face 24 has the shape of a plane ring face. Furthermore the nozzle 2 comprises at an outer, upper end face a ring nut 25 showing a smaller diameter than a lower part of the nozzle 2.

[0017] On the upper end face 24 a damping member in the shape of a ring plate 1 is arranged. The ring plate 1 comprises a center hole that has a greater diameter than the diameter of the needle 3. The needle 3 extends through the ring plate 1 from the nozzle 2 into the housing 22. Between the needle 3 and the ring plate 1, a clearance is provided that is within a range of values from 10 μm to 120 μm.

[0018] At the upper end face 24, the ring plate 1 is held by a holding element 4 which basically shows the shape of a sleeve. With a first part, the holding element 4 encloses the ring nut 25. Advantageously, the holding element 4 is connected by a welding line 26 at a lower end face of the first part. The first part comprises a cylindrical first opening 6 with a first diameter. The first cylindrical opening 6 merges with a second cylindrical opening 8 with a smaller diameter via a stop shoulder 7. The stop shoulder 7 has the shape of a ring face that is perpendicularly arranged to a longitudinal axis of the holding element 4. The longitudinal axis of the holding element is arranged in parallel to the longitudinal axis of the needle 3. The stop shoulder 7 is arranged in parallel to the upper surface 24. Between the stop shoulder 7 and the upper end face 24 the ring plate 1 is arranged.

[0019] The diameter of the second opening 8 of the holding element 4 is smaller than the outer diameter of the ring plate 1. Furthermore the diameter of the first opening 6 of the holding element 4 is greater than the outer diameter of the ring plate 1.

[0020] The second opening 8 is guided up to an end section at which the holding element 4 is tightly connected to a second ring 10. The second ring 10 is tightly connected to a bellow 5 through which the needle 3 extends into an actor chamber of the housing 22. A lower end of the bellow 5 is tightly connected over a first ring 9 with the needle 3. The first ring 9 is arranged above the ring plate 1. For tightly connecting the first ring 9 with the needle 3, a first welding 14 is used.

[0021] For tightly connecting the second ring 10 a second welding 15 is used. The first and the second welding 14, 15 show a shape of a ring.

[0022] Between the bellow 5 and the holding element 4 a second chamber 28 is arranged. The second chamber 28 is hydraulically connected via a clearance 19 which is arranged between the ring plate 1 and the needle 3 to the fuel chamber 16. The fuel chamber 16 is connected with the fuel line 23.

[0023] In a closed position of the needle 3, high pressures act within the fuel chamber 16. In this situation, high pressures also act within the second chamber 28. If the needle 3 is moved to an open position, the valve head 17 is moved from the valve seat 18, thus opening the fuel chamber 16. This causes a fast and large decrease in pressure within the fuel chamber 16. If the needle 3 is moved to the closing position, the pressure in the fuel chamber quickly increases to a high value. These changes in pressure are not directly guided to the second chamber 28 because of the ring plate 1. The dimensions of the clearance 19 between the ring plate 1 and the needle 3 are such that pressure changes in the first chamber 16 are guided to the second chamber 28 with a time delay. Furthermore the time gradient of the pressure change is reduced. This causes smaller pressure waves in the second chamber 28. Small pressure waves have the advantage that the bellow 5 and the tight connections between the bellow 5 and the holding element 4 or the needle 3 are protected against high pressure changes. As a result, the connections seal off the second chamber 28 against an actor chamber 38 that is arranged within the housing 22 of the fuel injector 37 for a longer time.

[0024] At an upper side, the holding member 4 comprises a ring face 29 that is arranged perpendicularly to the longitudinal axis of the needle 3 and bordering the actor chamber 38. The upper end of the needle 3 is connected with a plate 12 whereby the end of the needle 3 is arranged within a center of the plate 12. Between the plate 12 and the ring face 29, a biased pressure spring 13 is arranged. The pressure spring 13 prestresses the valve head 17 of the needle 3 against the valve seat 18 of the nozzle 2. For pushing the needle 3 in an open position, the actuator 30 has to push down the plate 12.

[0025] In a preferred embodiment of the invention, the holding element 4 comprises a slanting holding face 31 that is directed to a corresponding slanting second hold-

ing face 32 of a nut 33. The holding face 31 is arranged on the outside of the first part of the holding element 4. The nut 33 comprises a screw thread 34. The screw thread 34 is connected with a second screw thread 35 that is arranged on the outside of the housing 22. The nozzle 2 is fixed to the housing 22 by screwing the nut 33 in the direction of the housing 22. The screwing of the nut 33 pushes the holding element 4 to a stop face 36 of the housing 22.

[0026] Fig. 2 shows in detail the clearance 19 between the ring plate 1 and the needle 3. The center hole of the ring plate 1 has the shape of a circle. In the region of the ring plate 1, the cross section of the needle 3 also shows the shape of a circle.

Claims

1. Nozzle (2) for an injector (37) that can be fixed to a housing (22) of the injector (37), comprising a needle (3) that is movably arranged within the nozzle (2), whereby a bellow (5) is provided as a sealing element in order to separate a fuel region (16, 28) from an actor chamber (38),
whereby a first end ring of the bellow (5) is tightly connected with an element (4) that is part of the nozzle (2) or at least tightly connected with the nozzle (2),
whereby a damping element (1) is provided,
whereby the needle (3) extends through the damping element (1) ,
whereby the damping element (1) divides the fuel region into a fuel chamber (16) and a second chamber (28),
whereby the second chamber (28) is limited by the bellow (5), whereby the fuel chamber is limited by the nozzle (2) and the needle (3),
characterized in
that a ring plate (1) is arranged as a damping element,
that the ring plate is held by a holding member (4).

2. Nozzle according to claim 1, **characterized in that** a clearance (19) between the needle and the ring plate has a value in the range of 10 to 120 μm.

3. Nozzle according to claim 1 or 2, **characterized in that** the element (4) is a sleeve,
that a lower part of the sleeve is tightly connected to an upper end of the nozzle (2),
that the needle (3) is partly arranged within the sleeve, that the second end of the bellow (5) is tightly connected to an upper end of the sleeve.

4. Nozzle according to any of the claims 1 to 3, **characterized in that** the ring plate (1) is arranged on an upper end face of the nozzle (2),
that the upper end face (24) is directed towards the housing (22),
that the ring plate (1) is held against the upper end face (24) by the element (4).

5. Nozzle according to claim 3, **characterized in that** the sleeve comprises a holding face (31) on the outside that is used for pressing the nozzle (2) against the injector housing (22) by means of a holding face (32) of a nut (33).

6. Nozzle according to any of the claims 2 to 5, **characterized in that** the nozzle (2) comprises a ring nut (25) on the outside of an upper end,
that the sleeve (4) surrounds the ring nut (25) with a first cylindrical part,
that the sleeve (4) is fixed to the nozzle (2),
that the first cylindrical part merges by a step face (7) into a second cylindrical part,
that the second part has a smaller diameter than the first part,
that the step face (7) is adjacent to the ring plate (1) and holds the ring plate (1) at the upper end face (24).

FIG 1

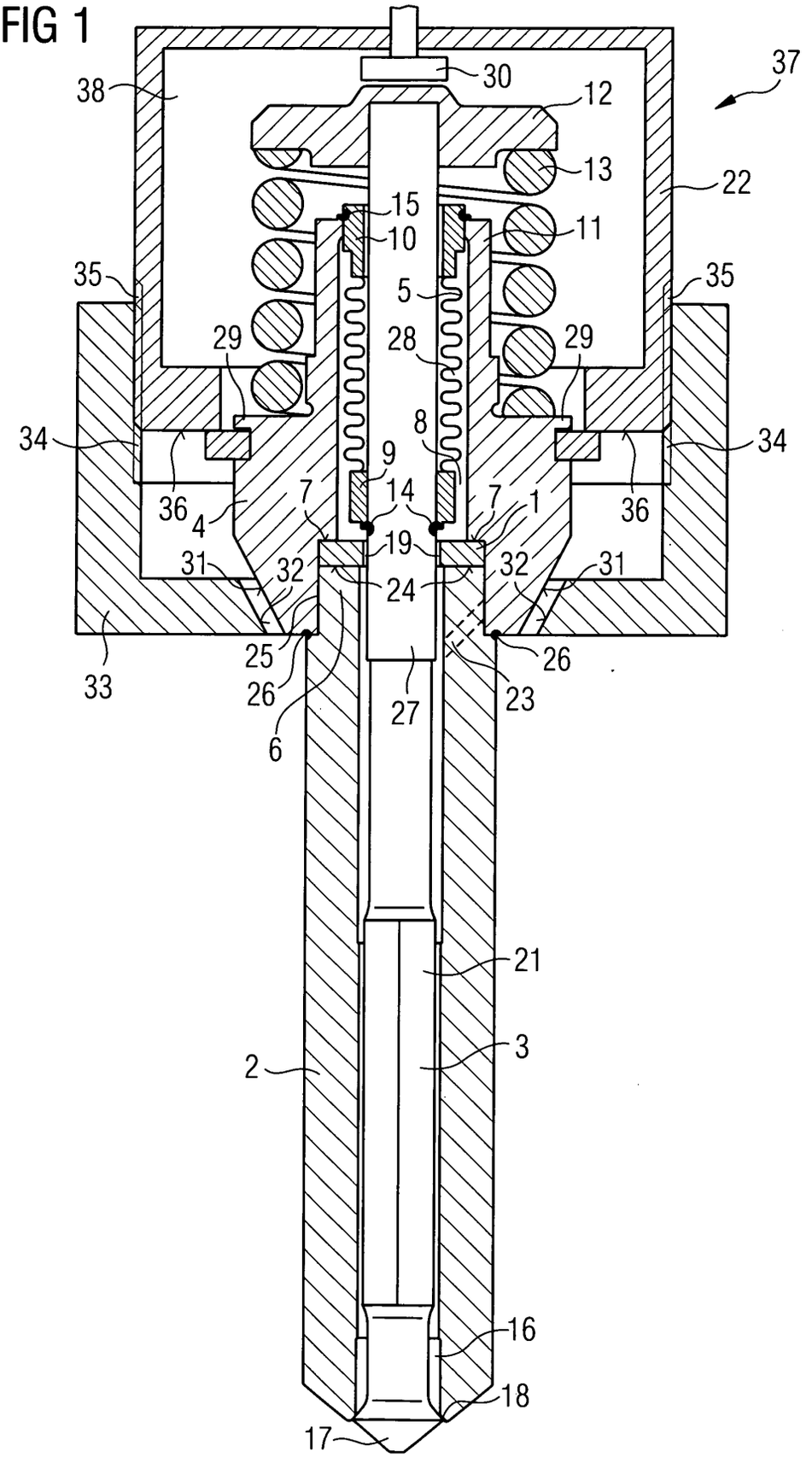
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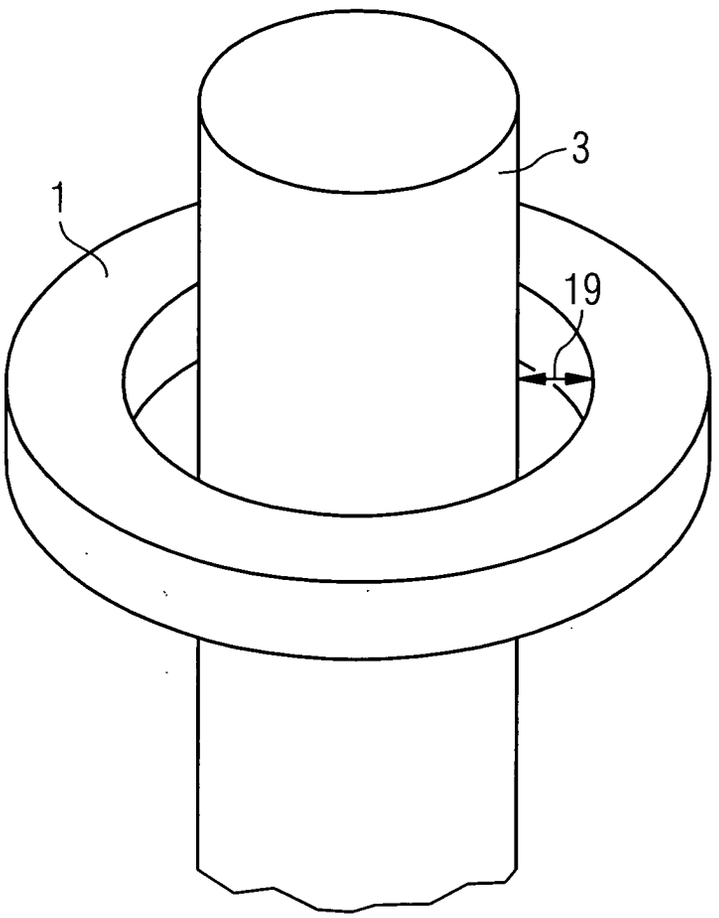
FIG 2



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EUROPEAN SEARCH REPORT

Application Number
EP 02 02 3553

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 March 2003	Morales, M

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