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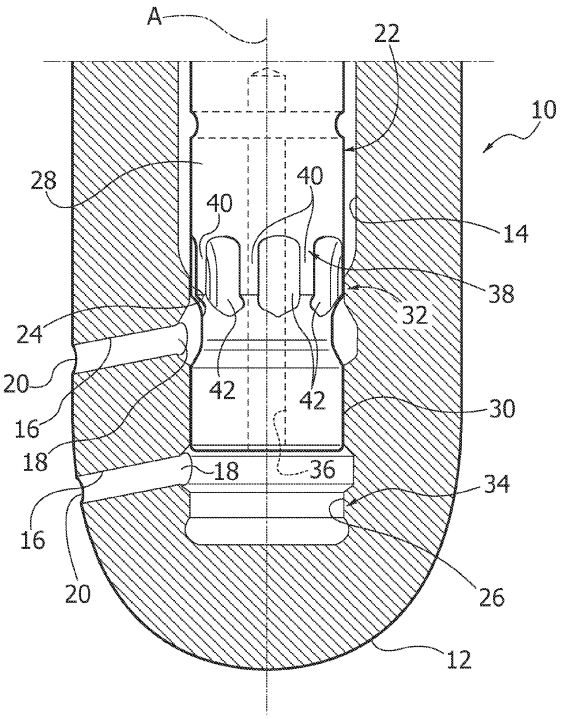
(54) A fuel injector for internal combustion engines

(57) A fuel injector for internal combustion engines, comprising:
- an atomizer (10) having a longitudinal bore (14) and a plurality of nozzle bores (16) having inlet openings (18) facing into said longitudinal bore (14), said inlet openings (18) being divided into an upper group and a lower group, spaced apart from each other in a longitudinal direction (A), and
- a cut-off element (22) extending into said longitudinal bore (14) of the atomizer (10), the cut-off element (22) being movable in said longitudinal direction (A) between an open and a closed position,
wherein the longitudinal bore (14) and the cut-off element (22) have respective upper and lower sealing portions (24, 28, 26, 30) cooperating with each other in said closed position of the cut-off element (22) to define an upper and a lower cut-off section (32, 34) which extend, respectively, above the upper group of inlet openings (18) and below the lower group of inlet openings (18).

FIG. 1



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Description

Background of the invention

[0001] The present invention relates to a fuel injector for internal combustion engines. The invention relates in particular to a fuel injector for large two-stroke internal combustion engines, such as diesel engines for naval propulsion.

[0002] More specifically, the present invention relates to a fuel injector according to the preamble of claim 1, comprising an atomizer fixed at a lower end of a valve guide and provided with a plurality of nozzle bores, a spindle having a valve portion cooperating with a valve seat of the valve guide, and a cut-off element extending into a longitudinal bore of the atomizer to reduce the volume in fluid connection with the nozzle bores when the spindle is in a closed position.

Background of the invention

[0003] EP-A-052937 discloses a fuel injector comprising an axially displaceable spindle having a valve portion which cooperates with a corresponding valve seat of the valve guide and a cut-off element extending below the valve portion of the valve spindle into a central bore of the atomizer. The outer wall of the cut-off element is effective to open and close inlet openings of the nozzle bores.

[0004] In the solution disclosed in EP-A-052937 the nozzle bores are arranged in a single row, i.e. the inlet openings of the nozzle bores are all placed at approximately the same distance from the lower end of the atomizer. A problem of this solution is that the total number of nozzle bores arranged within a maximum angle cannot be increased without compromising the strength of the side wall of the atomizer.

[0005] W02008/071187 discloses a fuel injector according to the preamble of claim 1, wherein the inlet openings of the nozzle bores of the atomizer are arranged in a first row and in a second row axially spaced apart and separated from each other by a cylindrical sealing portion. A cut-off element extending into a longitudinal bore of the atomizer has a first cylindrical section arranged to open and close the lower row of inlet openings and a second cylindrical section cooperating with a secondary valve seat for closing off the upper row of inlet openings when the valve spindle is closed.

[0006] When the valve spindle is open, the lower row of inlet openings is supplied by fuel flowing through a central duct of the cut-off element and the upper row of inlet openings is supplied by fuel flowing in an annular passage defined between the inner wall of the atomizer bore and the outer surface of the cut-off element.

[0007] A problem of the solution disclosed in W02008/071187 is that in the open position of spindle the cut-off element is not completely guided. Thus, during the closing phase of the spindle, when the cut-off element is moving downwards, there is the possibility that an edge of the cut-off element hits against the atomiser wall. This is caused by the fluid dynamic forces which act on the cut-off element at the height of the injection holes. These forces push the cut-off element towards the injection holes and can even bend the cut-off element.

Summary of the invention

[0008] The object of the present invention is to provide improved injector designs which overcome the problems caused by the fluid dynamic forces which act on the cut-off element.

[0009] In accordance with the present invention, this object is achieved by fuel injectors having the features defined in claim 1.

Brief description of the drawings

[0010] Further characteristics and advantages of the present invention will become clear in the course of the detailed description which follows, given purely by way of non-limiting example, with reference to the annexed drawings, wherein:

- figure 1 is a partial axial cross-section of an atomizer according to a first embodiment of the present invention,
- figures 2 is a partial cross-section of a second embodiment, and
- figure 3 and 4 are partial cross-sections of a third embodiment, respectively in an open and in a closed position.

Description of the preferred embodiments

[0011] Referring to figure 1, the reference number 10 indicates the lower portion of an atomizer for a fuel injector for diesel engines.

[0012] In the following description and in the claims the terms "upper", "lower", "top", "bottom" and the like refer to the normal position of use of the injector. It is however envisaged that the injector 10 could be mounted in a more or less inclined position with respect to a vertical axis.

[0013] The atomizer 10 consists of a cylindrical body of corrosion-resistant material with a closed rounded bottom end 12.

[0014] The atomizer 10 has a longitudinal bore 14 closed at its bottom end and having a longitudinal axis A. A plurality of nozzle bores 16 is formed in the lateral wall of the atomizer 10. The nozzle bores 16 have respective inner openings 18 facing into the longitudinal bore 14 and outlet openings 20 open on the outer surface of the atomizer. The inlet openings 18 of the nozzle bores 16 are divided into an upper group and a lower group, spaced apart from each other in the longitudinal direction A.

[0015] The injector includes a spindle (not visible in figure 1) having a cut-off element 22 which extends into the longitudinal bore 14 of the atomizer 10.

[0016] The cut-off element 22 is movable in the longitudinal direction A with respect to the longitudinal bore 14 between an open and a closed position.

[0017] The longitudinal bore 14 has an upper an a lower cylindrical sealing portion 24, 26. The upper sealing portion 24 is above the upper group of inner openings 18 and the lower sealing portion 26 is below the lower group of inner openings 18.

[0018] The cut-off element 22 has a cylindrical upper sealing portion 28 and a cylindrical lower sealing portion 30. In the closed position the upper and lower sealing portions 28, 30 of the cut-off element 22 are in sealing contact respectively with the upper and lower sealing portions 24, 26 of the longitudinal bore 14 and define an upper cut-off section 32 and a lower cut-off section 34.

[0019] In the open position shown in figure 1 the upper and lower sealing portions 28, 30 of the cut-off element 22 are axially offset with respect to the upper and lower sealing portions 24, 26 of the longitudinal bore 14. In this position the upper and lower cut-off sections 32, 34 are open. The lower sealing portion 30 of the cut-off element 22 is positioned between the upper and lower groups of inner openings 18.

[0020] The cut-off element has a central duct 36 which in the closed position of the cut-off element 22 is in flow connection with the longitudinal bore 14 both above the upper cut-off section 32 and below the lower cut-off section 34.

[0021] The cut-off element 22 is provided with a supplementary guiding section 38 extending below the upper sealing portion 28 of the cut-off element 22. The supplementary guiding section 38 is in guiding contact with the upper sealing portion 24 of the longitudinal bore 14.

[0022] The supplementary guiding section 38 includes a plurality of guiding ribs 40 spaced apart from each other in a circumferential direction and having outer cylindrical surfaces in sliding contact with the upper sealing portion 24. Channels 42 are formed between adjacent guiding ribs 40. The channels 42 allow passage of a flow of fuel through the upper cut-off section 32 in the open position of the cut-off element 22.

[0023] In the open position of the cut-off element, fuel under pressure is admitted in the annular channel defined between the inner surface of the longitudinal bore 14 and the outer surface of the cut-off element 22. A first fuel flow passes through the channels 42 and reaches the upper group of inner openings 18. A second fuel flow passes into the axial duct 36 of the cut-off element 14 and reaches the lower group of inner openings 18. In the open position the guiding ribs 40 are in contact with the upper sealing portion 24 of the atomiser 10. The guiding ribs 40 eliminate the risk of impact between the cut-off element and the inner wall of the atomizer due to fluid dynamic forces acting on the cut-off element 22. The clearance between the cut off element 22 and longitudinal bore 14 can be kept at a minimum thus reducing the leakage of fuel.

[0024] Figure 2 shows an alternative embodiment wherein the lower sealing portion 30 of the cut-off element 22 extends below the lower group of inner openings both in the closed and in the open position of the cut-off element 22.

[0025] In the open position shown in figure 2 the whole fuel flow runs downwards through the upper sealing section 32 towards the upper and lower groups of inner openings 18. All the injection holes 16 are supplied by the fuel which flows outside the cut-off element 22. In this way the fluid pressure drop is limited because no big flow restrictions or change in flow directions are necessary.

[0026] In order to avoid disturbing the fuel flow which supply the injection holes, the cut off element is guided on the lower sealing portion 30, below the lower group of inner openings 18.

[0027] In the embodiment of figure 2 manufacturing of the cut-off element 22 is simplified because drilling of relatively big holes on the cut off element 22 is avoided and only small holes might be required just to balance pressures on the end face of the cut-off element. No holes bigger than 35% of the diameter of the cut-off element 22 are formed. In this way the cut-off element 22 is subjected to much smaller stresses than in prior art designs thus increasing the reliability of the component. This design also provides a very high sac volume reduction.

[0028] Figures 3 and 4 show a further solution for closing the injection holes with nearly zero sac volume and without any radial forces caused by the fluid flow dynamic, which can lead to friction between the nozzle wall and valve body.

[0029] The cut-off element is designed as a pipe and a spherical element 44, such as a ball, is positioned on the bottom end of the longitudinal bore 14. In the closed position the bottom end of the cut-off element 22 abuts on the spherical element 44 and closes the main flow on the sealing surface of the spherical element 44.

[0030] In order to cut also the leakage into the cylinder through the gap between the longitudinal bore 14 and the cut-off element 22 an elastic disc 46 is provided at the upper end of the longitudinal bore 14. A spindle 48 is provided with a conical sealing portion 50 above the cut-off element 22. The sealing area between the conical sealing portion 50 and the disc 46 is closed at the same time as the bottom end of the cut-off element 22 contacts the spherical element 44.

[0031] Although not shown in the figures, the embodiments of figures 2,3 and 4 may have the same guiding portion 38 as disclosed with reference to figure 1.

Claims

1. A fuel injector for internal combustion engines, comprising:

- an atomizer (10) having a longitudinal bore (14) and a plurality of nozzle bores (16) having inlet openings (18) facing into said longitudinal bore (14), said inlet openings (18) being divided into an upper group and a lower group, spaced apart from each other in a longitudinal direction (A), and
- a cut-off element (22) extending into said longitudinal bore (14) of the atomizer (10), the cut-off element (22) being movable in said longitudinal direction (A) with respect to the longitudinal bore (14) between an open and a closed position,

the longitudinal bore (14) and the cut-off element (22) having respective upper and lower sealing portions (24, 28, 26, 30) cooperating with each other in said closed position of the cut-off element (22) to define an upper and a lower cut-off section (32, 34) which extend, respectively, above the upper group of inlet openings (18) and below the lower group of inlet openings (18),
characterized in that the cut-off element (22) is provided with a supplementary guiding section (38) which is in guiding contact with the upper sealing portion (24) of the longitudinal bore (14) and allows passage of a fuel flow therethrough in the open position of the cut-off element (22).

2. A fuel injector according to claim 1, **characterized in that** the supplementary guiding section (38) includes a plurality of guiding ribs (40) having cylindrical outer surfaces in sliding contact with said cylindrical upper sealing portion (24) of the longitudinal bore (14) in said open position of the cut-off element (22).

3. A fuel injector according to claim 2, **characterized in that** said guiding ribs (40) are circumferentially spaced apart from each other by channels (42) for the passage of said fuel flow.

4. A fuel injector according to claim 1, **characterised in that** the lower sealing portion (30) of the cut-off element (22) in said open position of the cut-off element (22) extends between the upper and the lower group of inner openings (18).

5. A fuel injector according to claim 1, **characterised in that** the lower sealing portion (30) of the cut-off element (22) in said open position of the cut-off element (22) extends below the lower group of inner openings (18) .

6. A fuel injector according to claim 1, **characterized in that** the cut-off element (22) has a bottom end which in said closed position abuts in sealing contact against a spherical element (44).

7. A fuel injector according to claim 6, **characterized in that** a deformable disc (46) is provided at an upper end of the longitudinal bore (14) and a conical sealing portion (50) is provided at an upper end of the cut-off element (22), said conical sealing portion (50) abutting against said deformable disc (46) in the closed position of the cut-off element (22).

FIG. 1

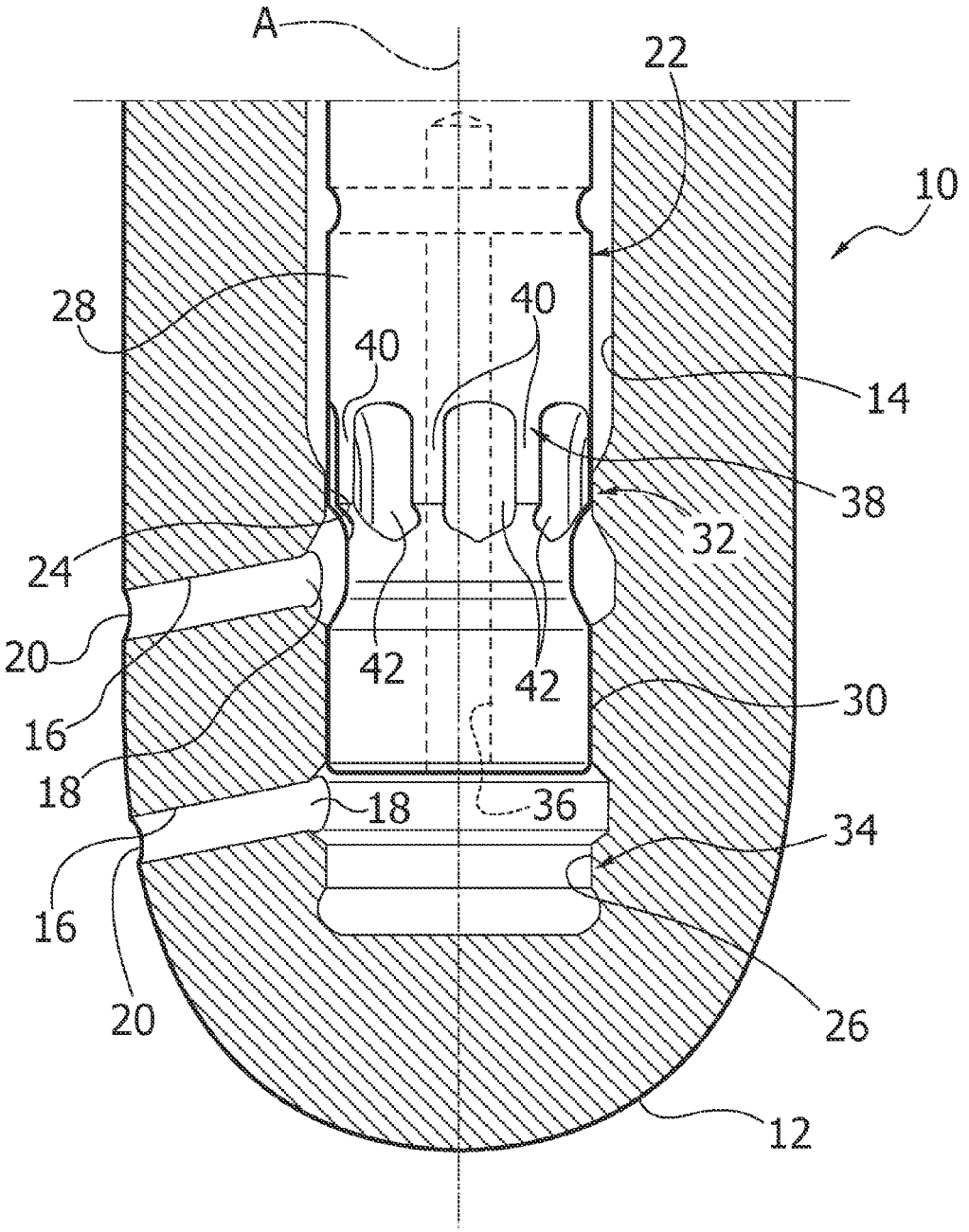


FIG. 2

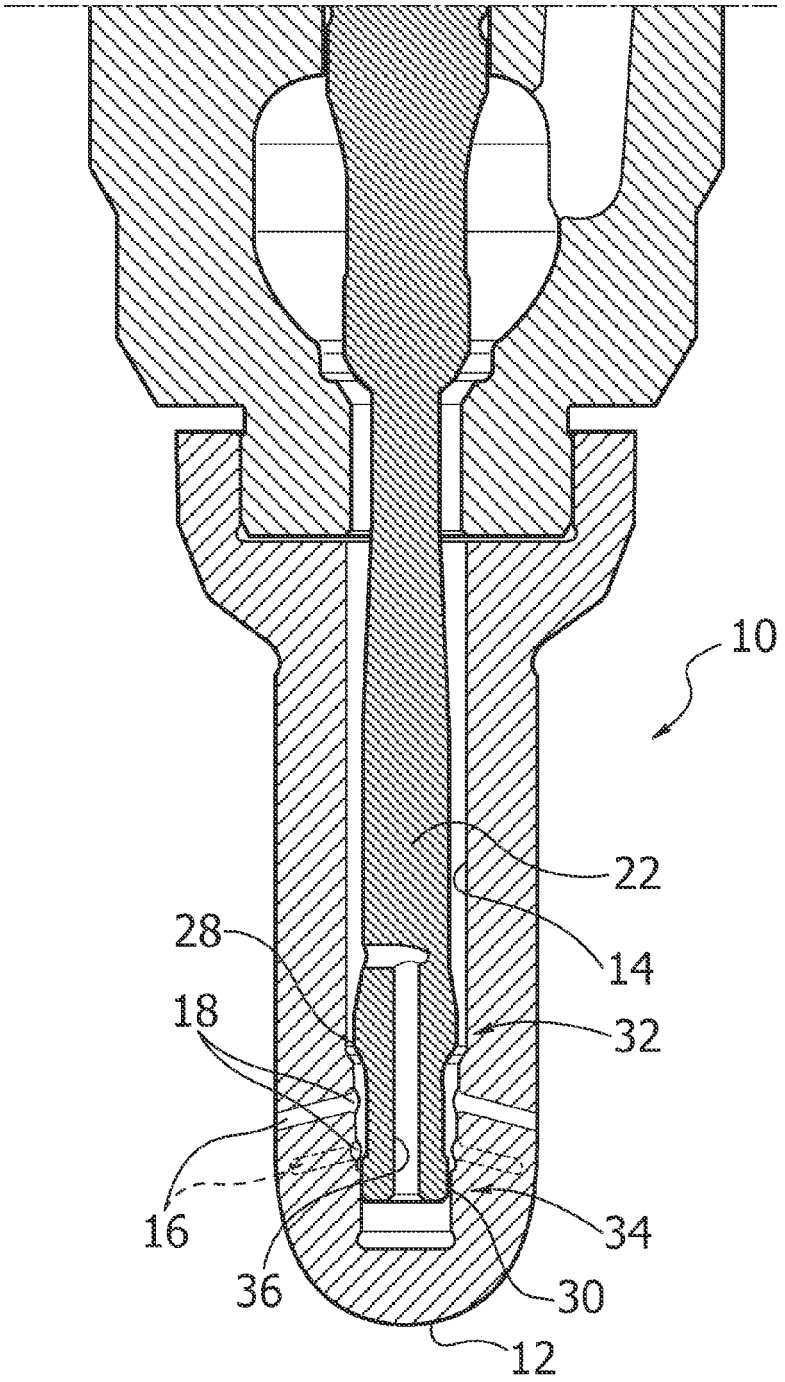


FIG. 3

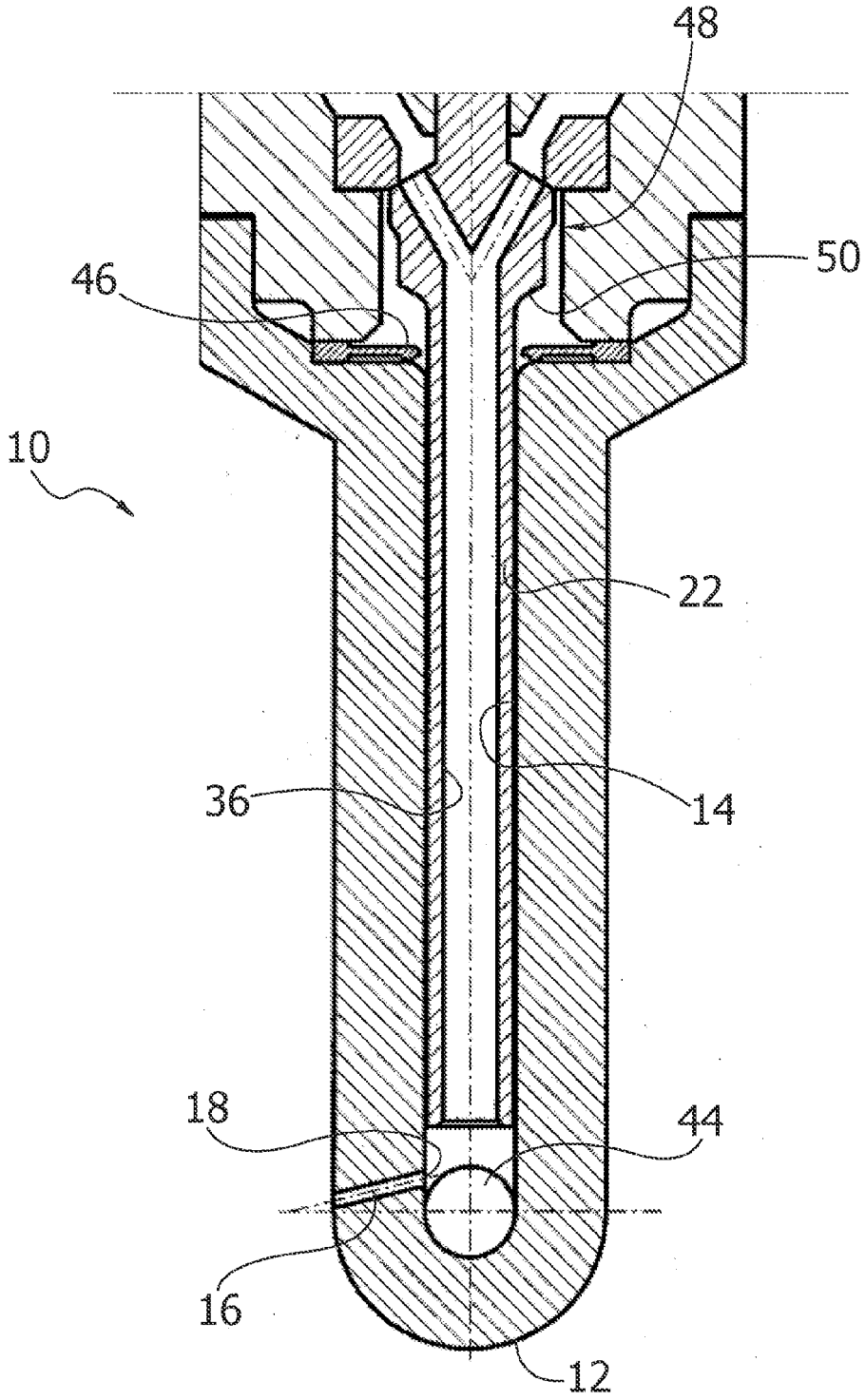
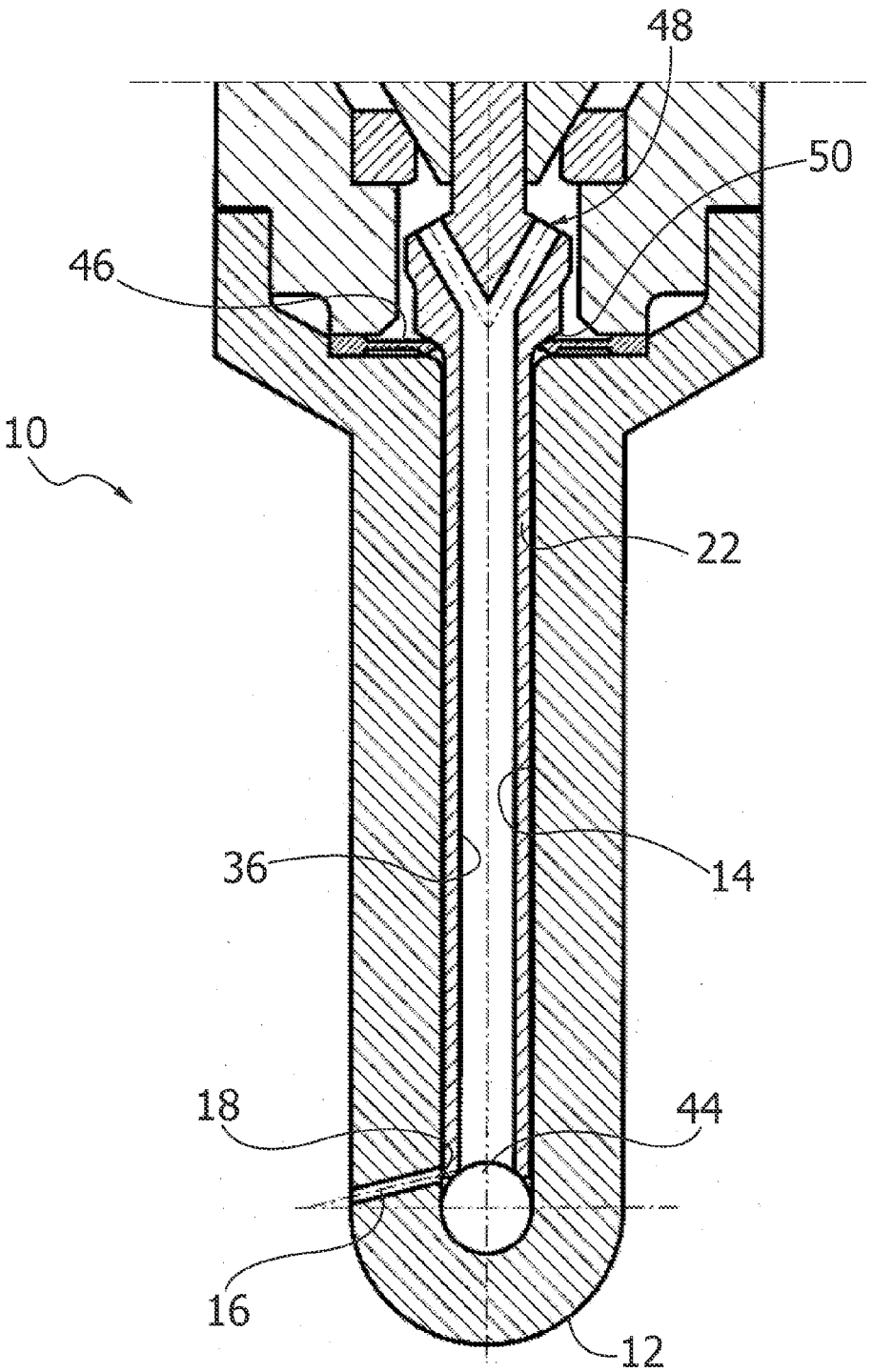


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 10 16 8684

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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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
Munich	28 October 2010	Landriscina, V

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3

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 16 8684

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28-10-2010

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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