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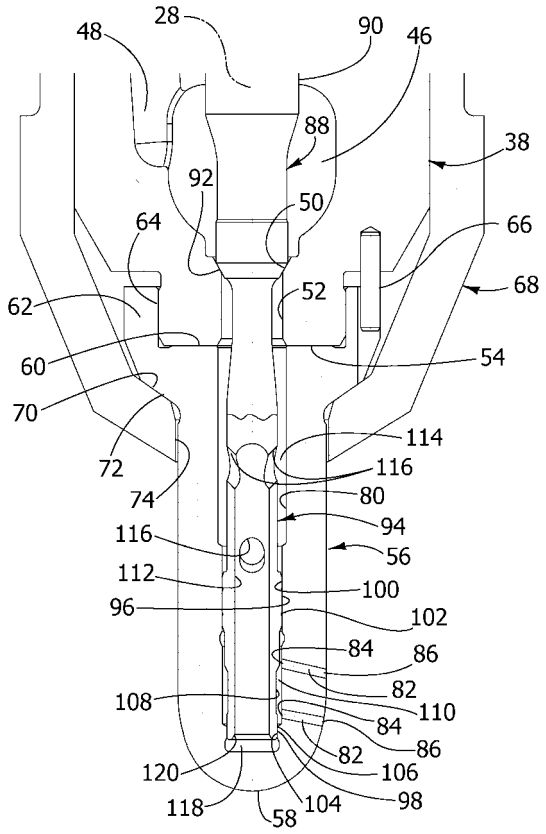
(54) A fuel injector for internal combustion engines

(57) A fuel injector for internal combustion engines, comprising:
- a housing (16),
- a valve guide (38) fixed at a lower end of said housing (16), the valve guide (38) having a longitudinal guide bore (44) and a chamber (46) provided with a valve seat (50), said chamber (46) being connected to a fuel supply duct (22,48);
- an atomizer (56) fixed at a lower end of said valve guide (38), the atomizer (56) having a longitudinal bore (80) in flow connection with said chamber (46), the atomizer having a plurality of nozzle bores (82) having inlet openings (84) facing into said longitudinal bore (80);
- a spindle (88) having a valve portion (92) cooperating with said valve seat (50), and a cut-off element (94) extending into said longitudinal bore (80) of the atomizer (56), wherein an upper cut-off section (102) and a lower cut-off section (106) axially spaced apart from each other are defined between the outer surface of the cut-off element (94) and the inner surface of the longitudinal bore (80), cut-off sections (102,106) being both closed in the closed position of the spindle (88), the cut-off element (94) having a central duct (112) in flow connection with the longitudinal bore (80) of the atomizer (56) both above the upper cut-off section (102) and below the lower cut-off section (106).

FIG. 2



EP 2 239 451 A1

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 a housing, a valve guide fixed at the lower end of the housing, an atomizer fixed at a lower end of the 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.

Summary of the invention

[0007] The object of the present invention is to provide an improved injector which gives greater freedom in the arrangement of the nozzle bores in the atomizer, which ensures that all the nozzle bores are supplied simultaneously and which requires a very short travel of the spindle even if the nozzle bores are arranged in an irregular pattern.

[0008] In accordance with the present invention, this object is achieved by a fuel injector having the features of claim 1.

[0009] In the solution according to the present invention, in the closed position of the spindle the inlet openings of the nozzle bores are all in flow connection with an injection chamber between upper and lower cut-off sections and in the open position of the spindle the upper cut-off section remains closed and the lower cut-off section is opened to establish a flow connection between a central duct of the cut-off element and the injection chamber.

[0010] In the solution according to the present invention all the nozzle bores are simultaneously supplied when the lower cut-off section is opened.

[0011] The arrangement according to the invention provides more freedom in the positioning of the nozzle bores, which can be located at any atomizer height and according to a pattern designed to optimize the spray quality. In accordance with the present invention, the nozzle bores should not necessarily be located in one or two single rows as in the prior art.

[0012] The atomizer of the present invention can be designed with a greater number of nozzle bores, thus improving the spray quality and the fuel combustion, without compromising the strength of the side wall of the atomizer.

[0013] The nozzle bores of the present invention can be axially spaced apart from each other with a relevant height difference even with a very short lift of the spindle. In particular, the lift of the spindle can be shorter than the axial distance between the nozzle bores.

Brief description of the drawings

[0014] 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 an axial cross-section of an injector according to the present invention,
- figures 2 and 3 are enlarged views of the part indicated by the arrow II in figure 1 respectively in a closed and open position,
- figure 4 is an enlarged perspective view of the part indicated by the arrow II in figure 1,
- figure 5 is a front view of the part indicated by the

arrow V in figure 4,

- figure 6 is a cross-section corresponding to figure 2 and showing a second embodiment of the present invention,
- figure 7 is a cross-section taken along line VII-VII of figure 6.

Description of the preferred embodiments

[0015] Referring to figure 1, the reference number 10 indicates a fuel injector for diesel engines according to the present invention. The injector 10 is intended to be mounted into an elongated cavity 12 formed in the head 14 of the engine. The injector 10 comprises an elongated housing 16 having at its top an enlarged head 18 protruding outside of the cavity 12 and fixed to the engine head 14 by screws 20 (only one of which is visible in figure 1).

[0016] 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 10. It is however envisaged that the injector 10 could be mounted in a more or less inclined position with respect to a vertical axis.

[0017] A fuel supply duct 22 is formed in the housing 16 and is connected at its upper end to an opening 24 connected to a fuel supply line (not shown). A thrust element 26 is axially movable along a longitudinal axis 28 inside a through cavity 30 formed in the housing 16. A compression spring 32 acts on a top head 34 of the thrust element 26. The upper end of the compression spring 32 acts against an adjustment member 36 screwed into an axial hole formed in the head 18 of the injector 10.

[0018] A valve guide 38 is fixed at a lower end of the housing 16. A tubular fixing member 40 engages a threaded portion 42 of the housing 16 to secure the valve guide 38 at the front bottom end of the housing 16. The guide valve 38 has a longitudinal guide bore 44. A chamber 46 is formed at the lower end of the guide bore 44. The chamber 46 is in flow connection with a fuel supply duct 48 the upper end of which is connected to the lower end of the fuel supply duct 22 of the housing 16.

[0019] With reference to figures 2 and 3, a conical valve seat 50 is provided at the bottom end of the chamber 46 of the valve guide 38. A short duct 52 extends downwardly of the valve seat 50 and opens on a front face 54 of the valve guide 38.

[0020] An atomizer 56 is fixed at a lower end of the valve guide 38. The atomizer 56 has a cylindrical body of corrosion-resistant material with a closed bottom end 58. As shown in figure 1, the lower end of the atomizer 56 extends in a combustion chamber C of the engine. An upper front face 60 of the atomizer 56 frontally abuts the front face 54 of the valve guide 38. A circular upper flange 62 of the atomizer 56 engages a bottom cylindrical surface 64 of the guide valve 38. A vertical pin 66 engages mutually facing openings of the valve guide 38 and of the atomizer 56 to set the atomizer 56 in a fixed angular position with respect to the valve guide 38.

[0021] The atomizer 56 is axially fixed to the valve guide 38 by means of a cup-shaped retaining element 68. The retaining element 68 and the atomizer 56 have mutually abutting conical surfaces 70 and 72. The cylindrical body of the atomizer 56 projects downwardly through a bottom opening 74 of the retaining element 68. As shown in figure 1, the retaining element 68 has an upper flange 76 which snap-engages an elastic ring 78 carried at the lower end of the tubular fixing member 40.

[0022] With reference to figures 2 and 3, the atomizer 56 has a longitudinal bore 80 closed at its bottom end. The upper end of the longitudinal bore 80 is in flow connection with the chamber 46 through the short duct 52 and the valve seat 50. A plurality of nozzle bores 82 is formed in the lateral wall of the atomizer 56. The nozzle bores 82 have respective inner openings 84 facing into the longitudinal bore 80 and outlet openings 86 open on the outer surface of the atomizer 56. The inlet openings 84 of at least some of the nozzle bores 82 are axially spaced from each other. In the example shown in figures 4 and 5, the nozzle bores 82 are positioned according to a substantially irregular pattern.

[0023] An important feature of the present invention is that the nozzle bores 82 can be arranged according to any desired pattern. The position of the nozzle bores 82 can be defined as desired by the designer in order to optimize the spray quality. In particular, the number of the nozzle bores 82, the axial position of the inlet and outlet openings 84, 86 and the inclination of the axes of the nozzle bores 82 with respect to the longitudinal axis 28 can be varied as desired for providing an optimal spraying pattern. The fact that the nozzle bores 82 can be placed at any desired axial position is particularly useful in that the total number of nozzle bores arranged within a maximum angle (of e.g. 120°) can be increased without compromising the strength of the side wall of the atomizer 56. The nozzle bores 82 are not necessarily located in parallel rows as in prior art solutions. For instance, as shown in figure 5, the outlet openings 86 of the nozzle bores 82 can be located at different atomizer heights H1, H2, H3, H4, H5.

[0024] With reference to figure 1, a spindle 88 is axially displaceable into the valve guide 38. The spindle 88 has a cylindrical portion 90 which slidably engages the longitudinal guide bore 44 of the valve guide 38. As best shown in figures 2 and 3, the spindle 88 has a conical valve portion 92 which cooperates with the conical valve seat 50 of the valve guide 38. The spindle 88 is axially movable between a closed position shown in figure 2 and an open position shown in figure 3. Referring to figure 1, the upper end of the spindle 88 abuts against the lower end of the thrust element 26. The compression spring 32, through the thrust element 26, biases the spindle 88 in its closed position wherein the valve portion 92 of the spindle 88 abuts against the valve seat 50 to shut-off the flow connection between the chamber 46 and the longitudinal bore 80 of the atomizer 56.

[0025] Referring to figures 2 and 3, the spindle 88 comprises a cut-off element 94 which extends coaxially below the valve portion 92 and into the longitudinal duct 80 of the atomizer 56. The cut-off element 94 is fixed to or integrally formed with the remaining part of the spindle 88. The outer surface of the cut-off element 94 has a first cylindrical sealing portion 96 and a second cylindrical sealing portion 98 axially spaced apart from each other. The first sealing portion 96 engages with tight fit a first cylindrical sealing surface 100 of the longitudinal bore 80 to define an upper cut-off section 102. The second sealing portion 98 engages with tight fit a second cylindrical sealing surface 104 of the longitudinal bore 80 to define a lower cut-off section 106. The first cylindrical sealing surface 100 has a diameter greater than that of the second cylindrical sealing surface 104.

[0026] In the closed position of the spindle 88 shown in figure 2 the upper cut-off section 102 and the lower cut-off section 106 are both closed. In the open position of the spindle 88 shown in figure 3 the upper cut-off section 102 remains closed and the lower cut-off section 106 is open. Preferably, the cut-off element 94 has a portion 108 with reduced diameter axially extending between the first sealing portion 96 and the second sealing portion 98.

[0027] In the closed position shown in figure 2 an annular injection chamber 110 is defined in a region of the longitudinal bore 80 comprised between the upper cut-off section 102 and the lower cut-off section 106. The inlet openings 84 of the nozzle bores 82 are all in flow connection with the injection chamber 110.

[0028] The cut-off element 94 has a central duct 112 which is in flow connection through transverse holes 116 with an upper region 114 of the longitudinal bore 80 located above the upper cut-off section 102. The central duct 112 is also in flow connection through a bottom opening 120 with a lower region 118 of the longitudinal bore 80 located below the lower cut-off off section 106.

[0029] When the spindle 88 is in the closed position shown in figure 2, the injection chamber 110 is sealed from the upper region 114 by the upper cut-off section 102 and is also sealed from the lower region 118 by the lower cut-off section 106. The upper region 114 is also sealed from the chamber 46 by the mutually abutting surfaces of the valve seat 50 and valve portion 92. When pressurised fuel is supplied to the chamber 46 through the supply ducts 22 and 48, an upwardly directed hydraulic force is generated on the spindle 88. When such force overcomes the force of the compression spring 32, the spindle 88 moves to the open position of figure 3. In this position, the upper region 114 of the longitudinal bore 80 is in flow connection with the chamber 46 through the open valve seat 50. The upward movement of the cut-off element 94 opens the lower cut-off section 106 and puts the injection chamber 110 in flow connection with the lower region 118. Pressurised fluid reaches the injection chamber 110 through the upper region 114, the transverse holes 116, the central duct 112 and the bottom opening 120. All the nozzle bores 82 are simultaneously supplied with pressurised fuel as soon as the lower cut-off section 106 is opened.

[0030] A second embodiment of the present invention is shown in figures 6 and 7. The elements corresponding to the ones previously disclosed are indicated by the same reference numbers. In this second embodiment of the present invention, the cut-off off element 94 has a constant or substantially constant outer diameter between the first sealing portion 96 and the second sealing portion 98. The longitudinal bore 80 of the atomizer 56 has an annular chamber 122 of increased diameter between the first sealing surface 100 and the second sealing surface 104. The chamber 122 can have any shape, not necessarily cylindrical. Preferably, in the annular chamber 122 there is formed a recess 124 in correspondence with the inlet openings 84 of the nozzle bores 82. The annular chamber 122 and the recess 124 form the injection chamber 110. The operation of this second embodiment is substantially identical to that of the embodiment previously described with reference to figures 2 and 3.

[0031] A remarkable advantage of the present invention is that a reduced axial travel of the spindle is sufficient for supplying simultaneously all the nozzle bores 82. The opening travel of the spindle 88 is independent of the position and dimensions of the nozzle bores 82. In addition, since the inlet openings 84 of all the nozzle bores 82 are all in flow communication with the same injection chamber 110, the nozzle bores 82 can be arranged according to any desired pattern, which can be chosen to optimize the spray quality. The number of the nozzle bores 82 can also be increased without compromising the strength of the wall of the atomizer.

Claims

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

   - a housing (16),
   - a valve guide (38) fixed at a lower end of said housing (16), the valve guide (38) having a longitudinal guide bore (44) and a chamber (46) provided with a valve seat (50), said chamber (46) being connected to a fuel supply duct (22, 48);
   - an atomizer (56) fixed at a lower end of said valve guide (38), the atomizer (56) having a longitudinal bore (80) in flow connection with said chamber (46), the atomizer having a plurality of nozzle bores (82) having inlet openings (84) facing into said longitudinal bore (80); and
   - a spindle (88) having a valve portion (92) cooperating with said valve seat (50) and a cut-off element (94) extending into said longitudinal bore (80) of the atomizer (56), wherein an upper cut-off section (102) and a lower cut-off section

(106) axially spaced apart from each other are defined between the outer surface of the cut-off element (94) and the inner surface of the longitudinal bore (80), cut-off sections (102, 106) being both closed in the closed position of the spindle (88), the cut-off element (94) having a central duct (112) in flow connection with the longitudinal bore (80) of the atomizer (56) both above the upper cut-off section (102) and below the lower cut-off section (106);
characterized in that in the closed position of the spindle (88) the inlet openings (84) of said nozzle bores (82) are all in flow connection with an injection chamber (110) between said upper and lower cut-off sections (102, 106), and that in the open position of the spindle (88) the upper cut-off section (102) remains closed and the lower cut-off section (106) is opened to establish a flow connection between the central duct (112) of the cut-off element (94) and said injection chamber (110).

2. A fuel injector according to claim 1, **characterized in that** the cut-off element (94) has a first and a second cylindrical sealing portion (96, 98) forming respectively with first and second cylindrical sealing surfaces (100, 104) of said longitudinal bore (80) said upper and lower cut-off sections (102, 106).

3. A fuel injector according to claim 1 or claim 2, **characterised in that** a lower region (118) of said longitudinal bore (80) below said lower cut-off section (106) is in flow connection with said central duct (112) of the cut-off element (94).

4. A fuel injector according to claim 2, **characterized in that** said first cylindrical sealing surface (100) has a diameter greater than that of said second cylindrical sealing surface (104).

5. A fuel injector according to claim 2, **characterized in that** the cut-off element (94) has a constant or substantially constant outer diameter between said first and second cylindrical sealing portions (96, 98) and that the longitudinal bore (80) of the atomizer (56) has a chamber (122) with increased diameter between said first and second cylindrical sealing surfaces (100, 104).

FIG. 1

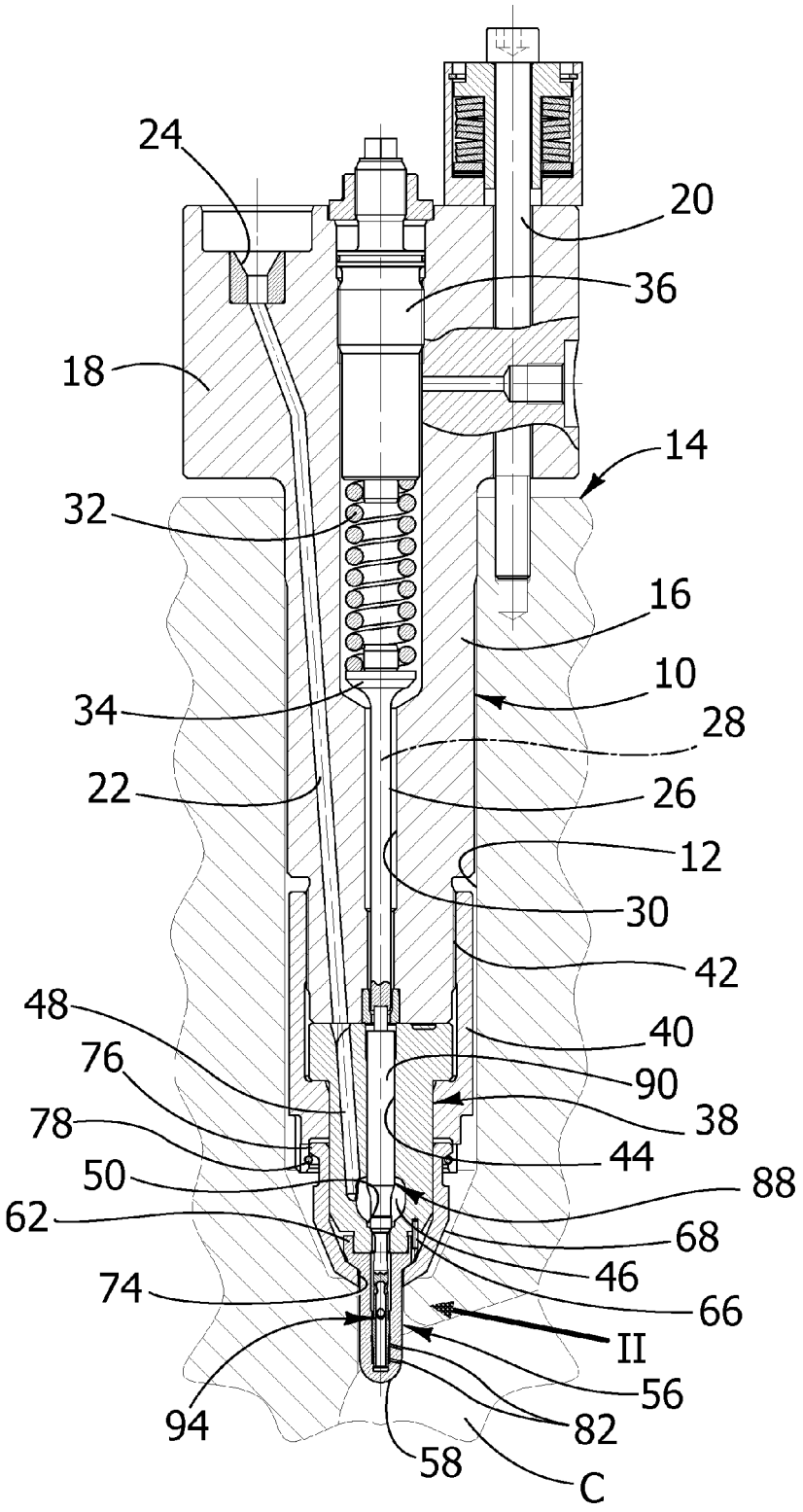

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FIG. 2

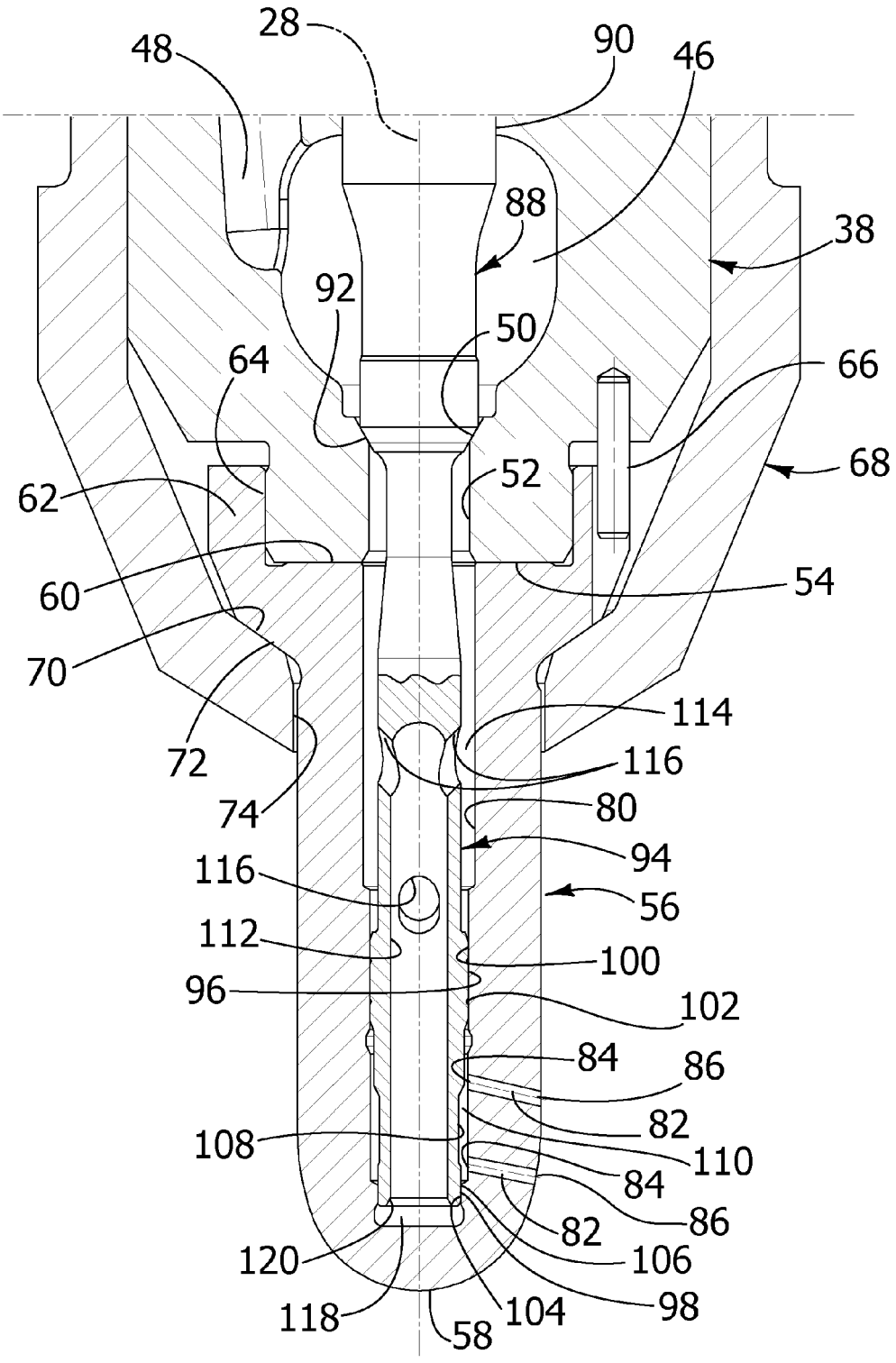
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FIG. 3

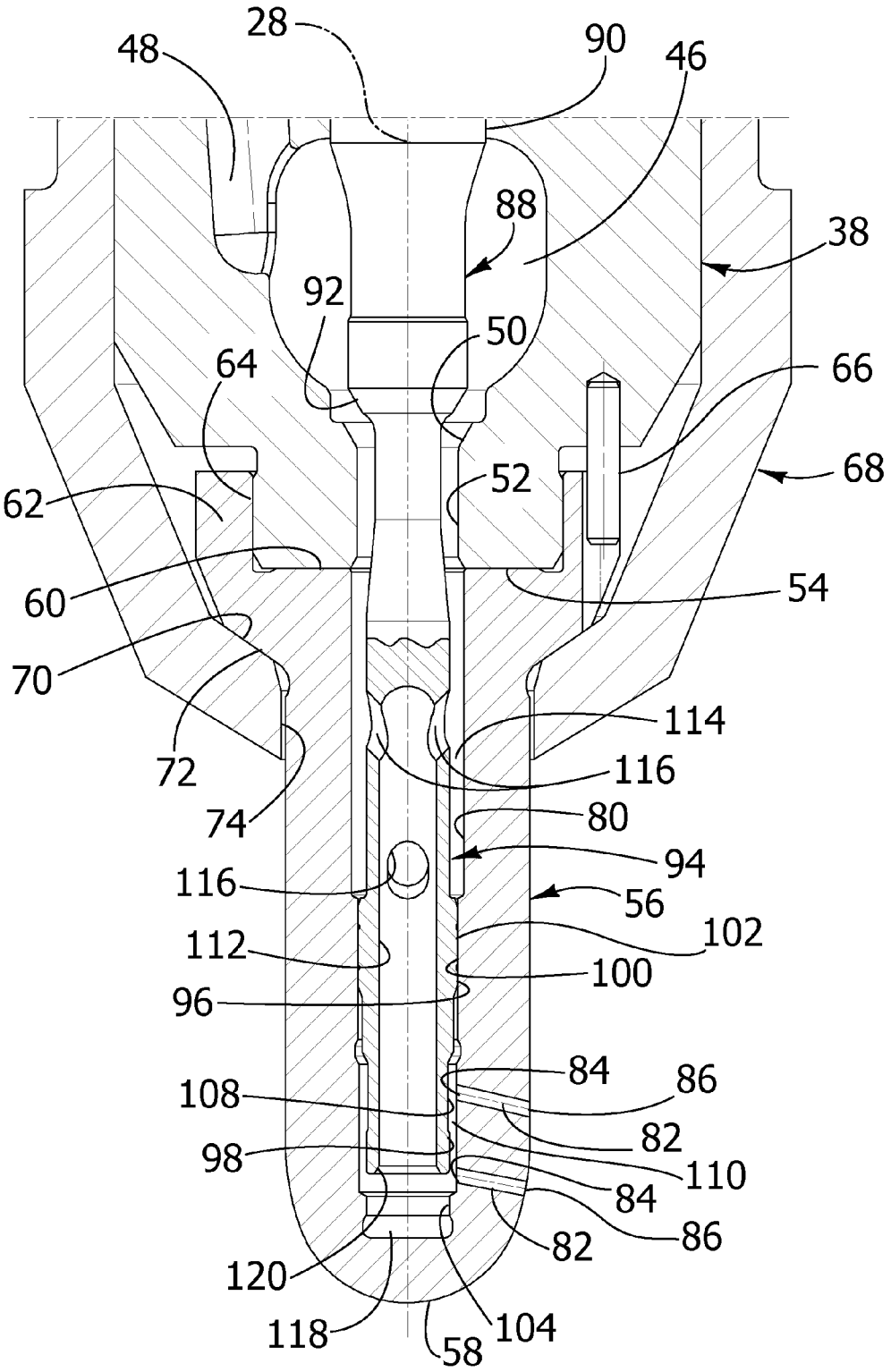
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FIG. 4

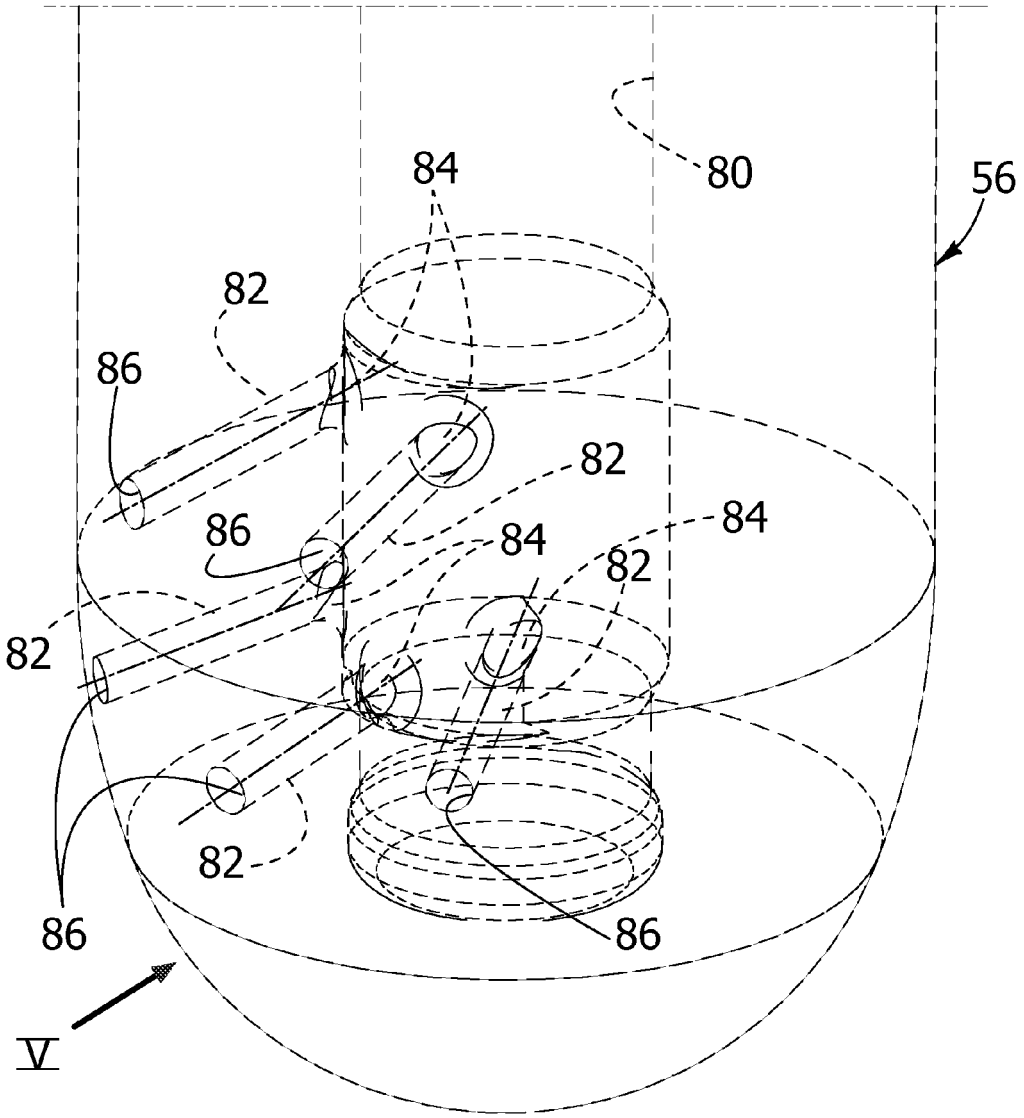

FIG. 5

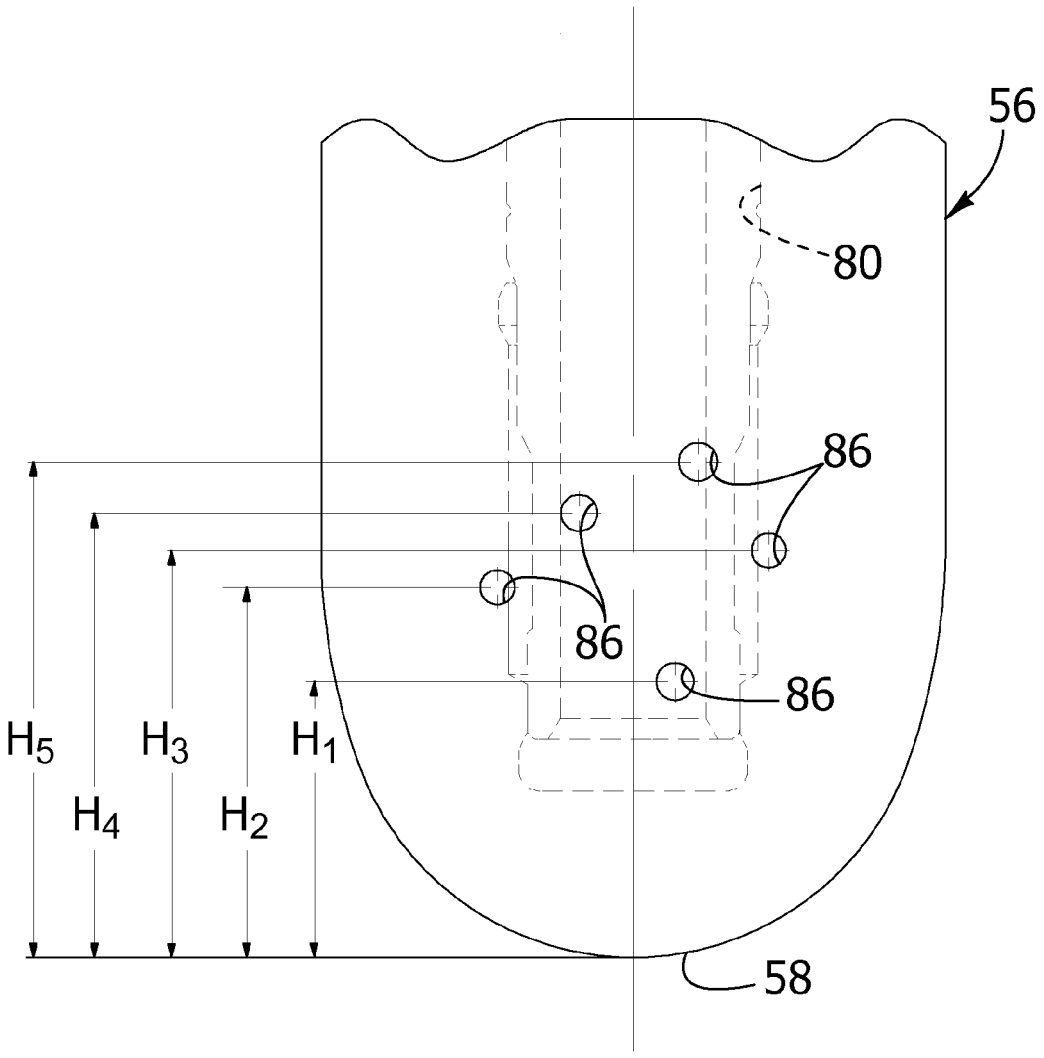

FIG. 6

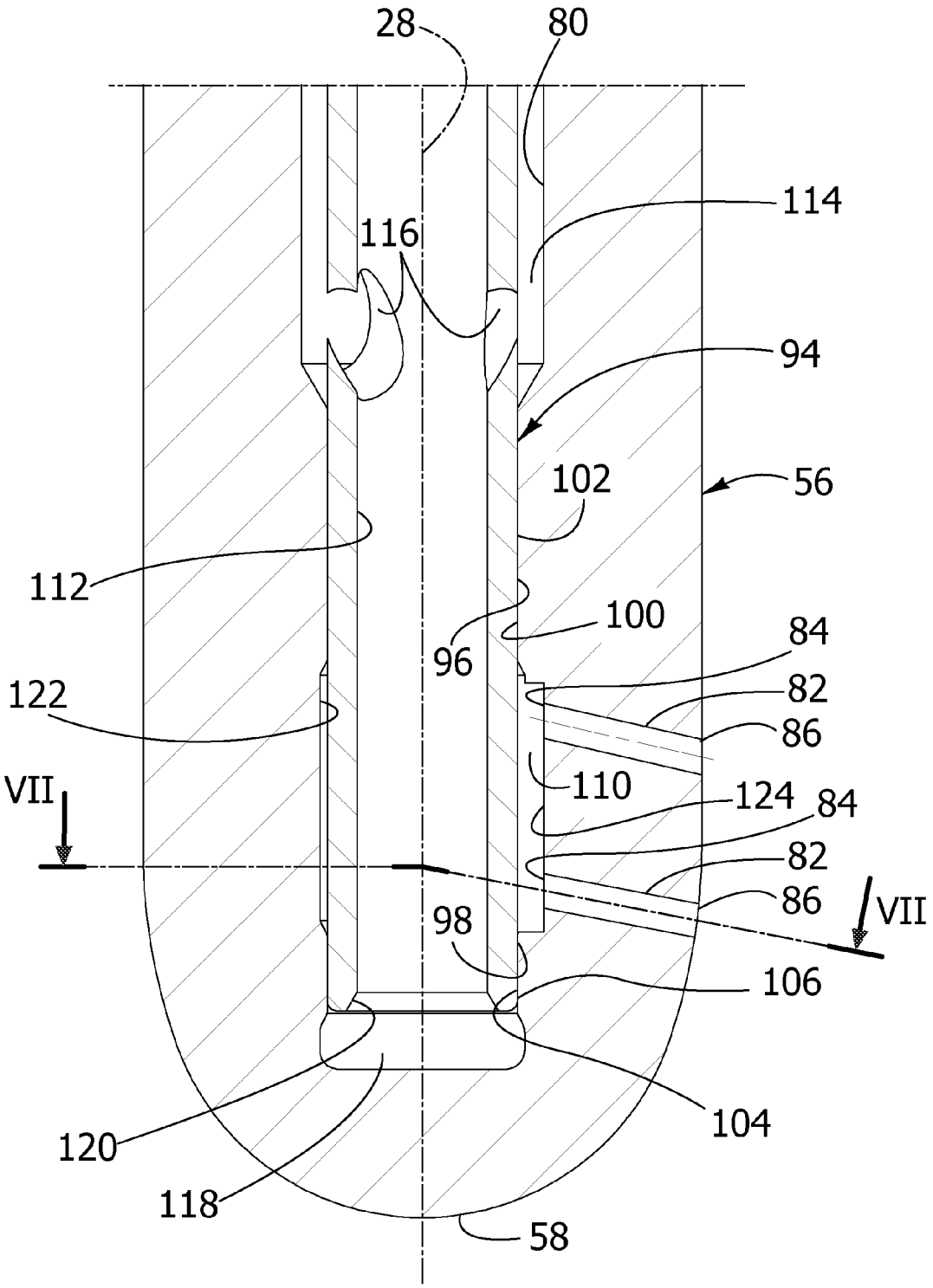
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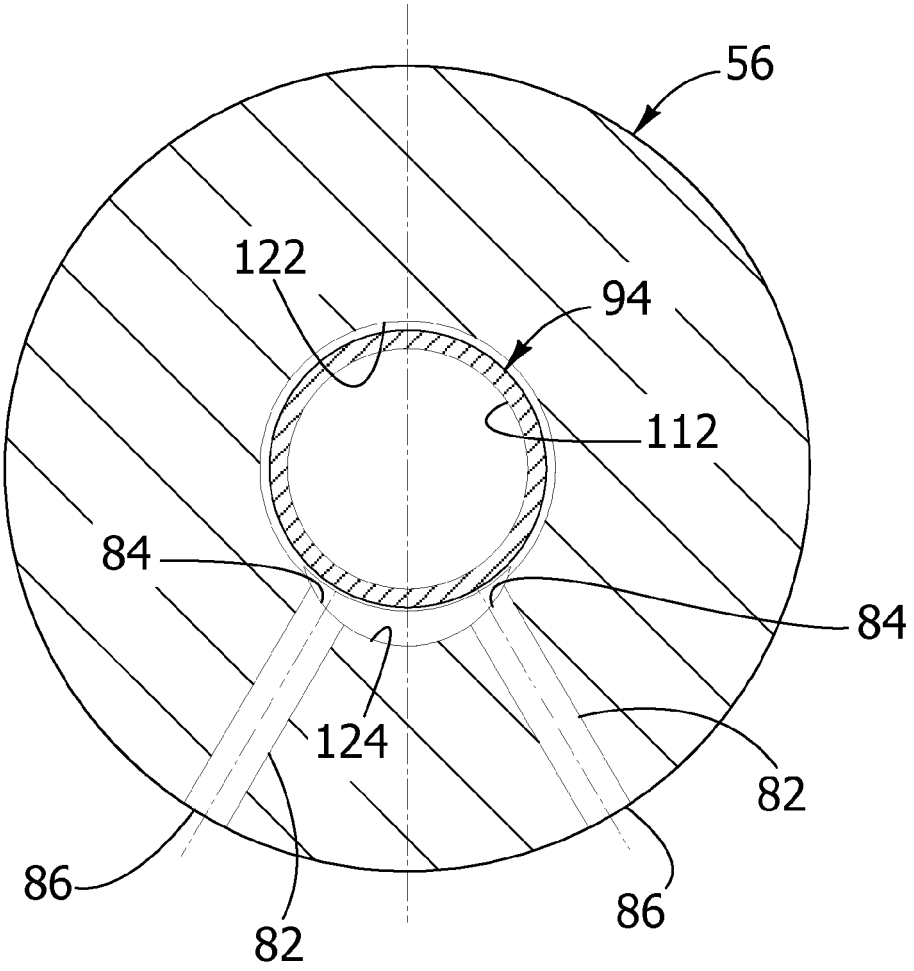
FIG. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 6590

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,A	WO 2008/071187 A (MAN DIESEL AS [DK]; FLARUP JOHANNES [DK]; STAEHR LARS ANTON [DK]) 19 June 2008 (2008-06-19) * page 5, line 14 - page 8, line 29 * * page 10, line 22 - page 11, line 3; figures 1-4,7 *	1-5	INV. F02M61/04 F02M61/06 F02M61/18
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D,A	EP 0 052 937 A (B & W DIESEL AS [DK]) 2 June 1982 (1982-06-02) * page 4, line 24 - page 8, line 30; figures 1-3 *	1-3	

TECHNICAL FIELDS SEARCHED (IPC)

F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18 August 2009	Jucker, Chava

CATEGORY OF CITED DOCUMENTS

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- WO 2008071187 A **[0005]**