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(71) Applicant: **Delphi International Operations Luxembourg S.à r.l.**
4940 Bascharage (LU)

(72) Inventor: **BICHON, Frédéric**
41000 Blois (FR)

(74) Representative: **Delphi France SAS**
Patent Department
22, avenue des Nations
CS 65059 Villepinte
95972 Roissy CDG Cedex (FR)

(54) INTERFACE ASSEMBLY FOR A FUEL INJECTOR

(57) The present disclosure relates to a back leak interface assembly (1) for connection to a back leak line of a fuel injector (2). The back leak interface assembly (1) includes a first interface member (7) having a first connector (8); and a second interface member (9) having a second connector (10). The back leak interface assembly (1) includes an intermediate member (11) that is a distinct component from at least one of the first or the second interface member. The intermediate member (11) defines a relative angle θ between said first and second interface members (7, 9), the relative angle θ being less than 180°. The present disclosure also relates to a fuel injector (2) in combination with a back leak interface assembly (1).

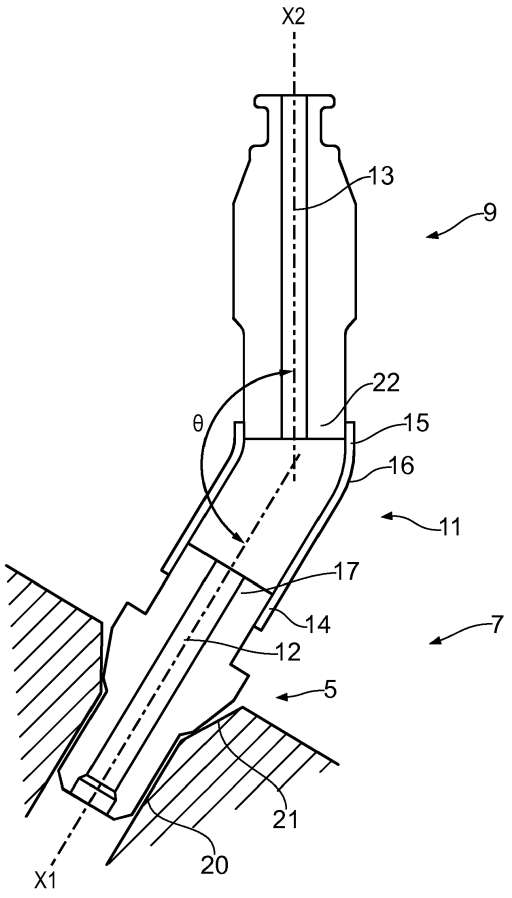

FIG. 4

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to an interface assembly. More particularly, but not exclusively, the present disclosure relates to a back leak interface assembly for a fuel injector. The back leak interface assembly may provide an interface between the fuel injector and a return line connector.

BACKGROUND

[0002] A fuel injection system for an internal combustion engine typically comprises a plurality of fuel injectors. The fuel injectors are configured to inject fuel into combustion chambers formed in a cylinder head. The fuel injectors each have a back leak line for returning fuel to a fuel reservoir, for example due to static or dynamic leakage. The back leak line of the fuel injector is connected to a return line to return the fuel to the fuel reservoir. The relative positioning and orientation of the back leak line and the return line may vary depending on the application. For example, the spatial positioning and/or the angular orientation of the fuel injectors relative to the return line may vary for different configurations of internal combustion engine. In certain cases, this may cause interference between the fuel injectors and the cylinder head.

[0003] A perspective view of a portion of an internal combustion engine 100 is shown in Figure 1. The internal combustion engine 100 comprises a cylinder head 101 and a plurality of fuel injectors 102 (only one of which is shown in Figure 1). The fuel injectors 102 each have a back leak line for returning fuel to a fuel reservoir. The back leak line is formed in a balcony 103 formed in the injector body. A back leak interface device 104 is mounted to the balcony 103. The back leak interface device 104 comprises a conduit having a linear longitudinal axis. First and second connectors (not visible in Figure 1) are formed integrally at each end of the conduit for connection to the balcony 103 and a return line connector 105 respectively. The return line connector 105 releasably connects the back leak interface device 104 to a return line 106 configured to return fuel to the fuel reservoir. A potential shortcoming of the illustrated arrangement is that the balcony 103 may interfere with the cylinder head 101. Interference between the balcony 103 and the cylinder head 101 may occur in a region R_{INT} highlighted in Figure 1.

[0004] One possible approach to overcoming the aforementioned problems would be to modify the back leak interface device 104 to incorporate a bend to enable the position and/or orientation of the outlet balcony 103 to be changed. The back leak interface device 104 could be machined to form the first and second connectors at each end and then bent to the desired shape. In order to accommodate forming the bend over a range of angles, for example up to 90°, it would be preferable to form the back leak interface device 104 from a ductile material. However, suitable materials are typically not readily machined and this may present problems in forming the first and second connectors to the required tolerances. If a material is selected which can be machined more readily, the range of angles through which the back leak interface device 104 may be bent is reduced. If the range of angles through which the angled connector can be formed is limited, or is fixed at a reference angle, it may be necessary to modify the position, shape and orientation of the back leak line. This may necessitate additional machining steps to form the back leak line which may prove difficult or may not be possible in certain scenarios.

[0005] It is against this backdrop that the present invention has been conceived. At least in certain embodiments, the present invention seeks to overcome or ameliorate at least some of the shortcomings associated with prior art devices.

SUMMARY OF THE INVENTION

[0006] Aspects of the present invention relate to a back leak interface assembly; and to a combination of a back leak interface assembly and a fuel injector.

[0007] According to a further aspect of the present invention there is provided a back leak interface assembly for connection to a back leak line of a fuel injector, the back leak interface assembly comprising:

a first interface member having a first connector;
a second interface member having a second connector; and
an intermediate member that is a distinct component from at least one of the first or the second interface member;
the intermediate member defining a relative angle θ between said first and second interface members, the relative angle θ being less than 180°.

[0008] The relative angle is defined to facilitate connection of the fuel injector to the return line. The back leak interface assembly may be modified for use with different internal combustion engines, for example to accommodate different spatial relationships between the fuel injector and the return line. By changing the configuration of the intermediate member, the back leak interface assembly may be configured to tailor the relative angle and/or relative spatial position for a given fuel injector geometry. Like first and second interface members can be used with different intermediate members to produce a range of variants of the back leak interface assembly. Alternatively, or in addition, the length of the first interface member and/or the second interface member may be adjusted. Alternatively, or in addition, the length of the intermediate member may be adjusted.

[0009] The first interface member may be configured to be connected to the fuel injector. In particular, the first

connector may be configured to be connected to a back leak line of the fuel injector. The first connector may, for example, be configured to be connected to a back leak port or outlet of said fuel injector. The second interface member may be configured to be connected to a return line. The second connector may be configured to be connected to a return line connector. The second connector may, for example, be releasably connected to a locking connector coupled to the return line.

[0010] The intermediate member may be a distinct component formed separately from both said first and second interface members, the first and second interface members both being coupled to said intermediate member. Alternatively, the intermediate member may be integral to either one of said first and second interface members, the other of said first and second interface members being coupled to said intermediate member.

[0011] The relative angle θ may be in a range from 90° to 150° inclusive.

[0012] The intermediate member may comprise a tubular member, the first and second interface members being disposed at respective first and second ends of the tubular member, said tubular member having a curved profile such that said first and second interface members are inclined at said relative angle θ relative to each other.

[0013] The intermediate member may comprise a body having first and second bores for assembling the first and second interface members.

[0014] According to a further aspect of the present invention there is provided a combination of a fuel injector and a back leak interface assembly (1) as described herein.

[0015] The first connector may have a first profile; and the second connector may have a second profile. The first and second profiles may be the same as each other, or may be different from each other.

[0016] The first interface member may have a first longitudinal axis and the second interface member may have a second longitudinal axis. The first interface member may have rotational symmetry about said first longitudinal axis; and/or the second interface member may have rotational symmetry about said second longitudinal axis. The relative angle θ may be defined between the first longitudinal axis and the second longitudinal axis.

[0017] The first interface member may comprise a first bore; and the second interface member may comprise a second bore. The first bore may have a first central axis extending along the first longitudinal axis; and the second bore may have a second central axis extending along the second longitudinal axis.

[0018] The intermediate member may be configured such that the relative angle is defined between said first and second longitudinal axes.

[0019] The first connector may comprise a first male connector or a first female connector. The second connector may comprise a second male connector or a second female connector.

[0020] The first interface member and/or the second interface member may be permanently assembled to the intermediate member. The first interface member and/or the second interface member may, for example, be welded or fastened to the intermediate member. Alternatively, the first interface member and/or the second interface member may be bonded to the intermediate member using an adhesive.

[0021] Alternatively, the first interface member and/or the second interface member may be releasably assembled to the intermediate member.

[0022] The intermediate member may comprise a tubular member. The first and second interface members may be disposed at respective first and second ends of the tubular member, said tubular member having a curved profile such that said first and second interface members are inclined at said relative angle θ relative to each other. The first interface member and/or the second interface member may be an interference fit in the respective first and second ends of the tubular member. Alternatively, the first end and/or the second end of the tubular member may be an interference fit in the respective first and second interface members. Alternatively, or in addition, the first and second interface members may be welded to the tubular member. Other means of fastening the first and second interface members to the tubular member are also contemplated. The term interference fit used herein may also be referred to as a press fit or a friction fit.

[0023] The tubular member may have a curved profile such that said first and second interface members are inclined at said relative angle relative to each other. The tubular member may comprise a bend or a curve.

[0024] The intermediate member may comprise a body having first and second bores for assembling the first and second interface members. The first and second bores may be inclined at an angle relative to each other in order to define the relative angle between the first and second interface members. The first and second interface members may be an interference fit in said first and second bores. Other means of fastening the first and second interface members to the body are also contemplated. Alternatively, or in addition, the first and second interface members may be welded to the body.

[0025] The first and second interface members are connected to the intermediate member to form sealed connections. The sealed connections may be formed by sealing means, for example comprising an O-ring.

[0026] According to a further aspect of the present invention there is provided a combination of a fuel injector and a back leak interface assembly as described herein.

[0027] Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combina-

tion, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] One or more embodiments of the present invention will now be described, by way of example only, with reference to the accompanying figures, in which:

Figure 1 shows a perspective view of a fuel injector outlet and a cylinder head;
Figure 2 shows a schematic representation of a fuel injector incorporating a back leak interface assembly in accordance with a first embodiment of the present invention;
Figure 3 shows a perspective view of the back leak interface assembly shown in Figure 2;
Figure 4 shows a cross-sectional view of the back leak interface assembly shown in Figure 3;
Figure 5 shows a perspective view of a body member of a back leak interface assembly in accordance with a second embodiment of the present invention;
Figure 6 shows a cross-sectional view of the back leak interface assembly shown in Figure 5;
Figure 7 shows a cross-sectional view of a third embodiment of the back leak interface assembly in accordance with the present invention; and
Figure 8 shows a cross-sectional view of a fourth embodiment of the back leak interface assembly in accordance with the present invention.

DETAILED DESCRIPTION

[0029] A back leak interface assembly 1 in accordance with an embodiment of the present invention will now be described with reference to Figures 2, 3 and 4. The back leak interface assembly 1 in the present embodiment is intended to be used in conjunction with a fuel injector 2 of an internal combustion engine 3. The internal combustion engine 3 in the present embodiment is a diesel engine. It will be appreciated, however, that the present invention is also applicable to a gasoline (petrol) engine.

[0030] With reference to Figure 2, the internal combustion engine 3 comprises a plurality of combustion chambers C formed in a cylinder head 4. The internal combustion engine 3 comprises a plurality of said fuel injectors 2 (only one of which is shown) for injecting fuel into the combustion chambers. The invention will be described with reference to one of said fuel injectors 2. In use, fuel leakage occurs within the fuel injector 2 due to static and/or dynamic leakage. The fuel injector 2 comprises an outlet 5 through which leaked fuel is returned to a fuel reservoir R, such as a fuel tank, via a (back leak) return line 6. The back leak interface assembly 1 establishes a fluid connection from the outlet 5 to the return line 6.

[0031] With reference to Figure 3, the back leak interface assembly 1 comprises a first interface member 7 having a first connector 8 for connection to the outlet 5; a second interface member 9 having a second connector 10 for connection to the return line 6; and a intermediate member 11 for connecting the first and second interface members 7, 9. The first interface member 7 has a first longitudinal axis X1; and the second interface member 9 has a second longitudinal axis X2. As shown in Figure 4, a continuous fluid pathway is formed through the back leak interface assembly 1 for transporting fuel from the outlet 5 to the return line 6. The first interface member 7 has a first bore 12; and the second interface member 9 has a second bore 13. In the present embodiment, the intermediate member 11 is a cylindrical tube having a substantially circular profile in transverse section. The intermediate member 11 has first and second ends 14, 15 for receiving the first and second interface members 7, 9 respectively. The intermediate member 11 is non-linear and comprises a bend 16 (or a curved profile) disposed between said first and second ends 14, 15. The bend 16 is formed to define a relative angle θ between the first and second longitudinal axis X1, X2 of the first and second interface members 7, 9. The intermediate member 11 is made of a material, such as stainless steel, which facilitates forming the bend 16 without compromising the integrity of the back leak interface assembly 1.

[0032] The first interface member 7 comprises a first coupling section 17 for mechanically cooperating with the first end 14 of the intermediate member 11 to fasten the first interface member 7 to the intermediate member 11. The first coupling section 17 comprises a cylindrical section which is a sliding fit in the first end 14 of the intermediate member 11. The intermediate member 11 is welded to the first interface member 7. In the present embodiment the first connector 8 is a male connector having a first profile (denoted generally by the reference P1) for engaging the outlet 5 to form a sealed connection. The first profile P1 comprises a cylindrical stem 18 and a first conical seal 19. The outlet 5 comprises an outlet bore 20 and a conical seat 21 for cooperating with the first connector 8 to form a sealed connection. When the back leak interface assembly 1 is connected to the outlet 5, the cylindrical stem 18 is disposed within the outlet bore 20 and the first conical seal 19 seats in the conical seat 21. The first interface member 7 in the present embodiment is formed from steel.

[0033] The second interface member 9 comprises a second coupling section 22 for mechanically cooperating with the second end 15 of the intermediate member 11 to fasten the second interface member 9 to the intermediate member 11. The second coupling section 22 comprises a cylindrical section which is a sliding fit in the second end 15 of the intermediate member 11. The intermediate member 11 is welded to the second interface member 9. In the present embodiment the second connector 10 is a male connector having a second profile

(denoted generally by the reference P2) for engaging a return line connector (not shown) disposed on the return line 6 to form a sealed connection. The second connector 10 may, for example, be configured to connect to a return line connector (not shown) disposed on said return line 6. The second profile P2 may be the same as the first profile P1, or may be different from the first profile P1. In the present embodiment, the second connector 10 comprises a flange 25 for locating an O-ring (not shown). When the back leak interface assembly 1 is connected to the return line connector, the O-ring forms a seal with the return line connector. The second interface member 9 in the present embodiment is formed from steel. The first and second interface members 7, 9 may be formed from the same material or a different material.

[0034] The fabrication and assembly of the back leak interface assembly 1 will now be described. The first and second interface members 7, 9 are machined to form the first and second profiles P1, P2 respectively. The first and second bores 12, 13 are formed in said first and second interface members 7, 9. The first and second bores 12, 13 extend along the first and second longitudinal axis X1, X2 of the first and second interface members 7, 9. In the present embodiment the intermediate member 11 is a section of pipe which is press-formed to the required shape. As outlined above, the bend 16 is formed to define a relative angle θ between the first and second longitudinal axis X1, X2 of the first and second interface members 7, 9. The first and second bores 12, 13 are inclined at said relative angle θ. The first and second interface members 7, 9 are inserted into the first and second ends 14, 15 respectively of the intermediate member 11. The first and second interface members 7, 9 are welded to the intermediate member 11 to form sealed connections. In an alternative arrangement, the first and second interface members 7, 9 may be an interference fit in the first and second ends 14, 15 of the intermediate member 11. The assembled back leak interface assembly 1 is then ready for use with a fuel injector 2. Specifically, the first interface member 7 is inserted into the outlet 5 of the fuel injector 2 and the second interface member 9 is connected to the connector on the return line 6.

[0035] The intermediate member 11 is formed from a material which allows the bend 16 to be formed without adversely affecting the integrity of the back leak interface assembly 1.

[0036] A second embodiment of the back leak interface assembly 1 will now be described with reference to Figures 5 and 6. Like reference numerals will be used for like components.

[0037] The back leak interface assembly 1 according to the second embodiment comprises first and second interface members 7, 9 which are unchanged from those according to the first embodiment. However, the intermediate member 11 in the second embodiment is machined from a body 26. As shown in Figure 5, the body 26 is a circular machined puck of metal. As shown in Figure 6, the body 26 comprises a first radial aperture 27 and a second radial aperture 28 extending partway through the body 26. The first radial aperture 27 comprises a first outer bore 29 and a first inner bore 30 arranged concentrically about a first radial axis. The first outer bore 29 has a larger diameter than the first inner bore 30 and a first shoulder 31 is formed at the interface. The first coupling section 17 is an interference fit in the first outer bore 29 and abuts the first shoulder 31 to fasten the first interface member 7 to the intermediate member 11. The second radial aperture 28 comprises a second outer bore 32 and a second inner bore 33 arranged concentrically about a second radial axis. The second outer bore 32 has a larger diameter than the second inner bore 33 and a second shoulder 34 is formed at the interface. The second coupling section 22 is an interference fit in the second outer bore 32 and abuts the second shoulder 34. Alternatively, the first and second interface members 7, 9 may be welded to the intermediate member 11. A deburring operation is performed at an intersection of the first and second inner bores 30, 33 to form a central chamber 35.

[0038] As shown in Figure 6, the first and second radial apertures 27, 28 are inclined at an angle relative to each other to define the relative angle θ between the first and second longitudinal axes X1, X2 of the first and second interface members 7, 9. In the present embodiment, the first and second radial apertures 27, 28 are orthogonal such that that the relative angle θ is 90°. However, the first and second radial apertures 27, 28 may be larger than or smaller than 90°. In certain embodiments, the angle between the first and second radial apertures 27, 28 may be defined in the range 90° to 150°.

[0039] The fabrication and assembly of the back leak interface assembly 1 in accordance with the second embodiment will now be described. The first and second interface members 7, 9 are machined to form the first and second profiles P1, P2 respectively. The first and second radial apertures 27, 28 are machined in the body 26 to form the intermediate member 11. The relative orientation of the radial axes of said first and second radial apertures 27, 28 determines the relative angle θ between the first and second longitudinal axis X1, X2 of the first and second interface members 7, 9. The first and second interface members 7, 9 are press-fitted into the first and second outer bores 30, 33 respectively of the intermediate member 11. The first and second interface members 7, 9 are an interference fit and a seal is formed with the intermediate member 11. The assembled back leak interface assembly 1 is then ready for use with a fuel injector 2. Specifically, the first interface member 7 is inserted into the outlet 5 of the fuel injector 2 and the second interface member 9 is connected to the connector on the return line 6.

[0040] In certain embodiments, the body 26 may be a moulded component. The first and second radial apertures 27, 28 could, for example, be moulded into the body 26. The body 26 could be machined to provide the re-

quired internal diameters to receive and to press-fit the first and second interface members 7, 9.

[0041] It is not essential that the body 26 has a circular profile in section. The body 26 can comprise one or more flat surface (for example along a chord line).

[0042] It will be appreciated that the back leak interface assembly 1 may be adapted for particular applications. For example, by modifying the intermediate member 11 the relative angle θ between the first and second longitudinal axis X1, X2 may be changed. Alternatively, or in addition, the length of the first interface member 7 and/or the second interface member 9 may be modified. Alternatively, or in addition, the length of the intermediate member 11 may be altered. Alternatively, or in addition, the location of the bend 16 along the length of said intermediate member 11 may be altered for particular applications. For example, the bend 16 may be offset from the centre of the intermediate member 11.

[0043] In a further modification, the back leak interface assembly 1 may comprise more than one intermediate member 11.

[0044] A third embodiment of the back leak interface assembly 1 will now be described with reference to Figure 7. Like reference numerals will be used for like components.

[0045] The back leak interface assembly 1 according to the third embodiment comprises first and second interface members 7, 9. The intermediate member 11 in the third embodiment is formed integrally with the first interface member 7. The intermediate member 11 is machined into an end section of the first interface member 7. The second interface member 9 is mounted to the intermediate member 11 to form a sealed connection. The second interface member 9 comprises a second coupling section 22 which is mounted in a radial aperture 28 formed in the intermediate member 11. In the present embodiment the second interface member 9 is welded to the intermediate member 11 to form a seal. Alternatively, or in addition, the second interface member 9 may be an interference fit in the intermediate member 11.

[0046] The intermediate member 11 is adapted to define a relative angle θ between said first and second interface members 7, 9. In particular, the intermediate member 11 is configured to define the relative angle θ between the first and second longitudinal axis X1, X2 of the first and second interface members 7, 9. In the illustrated arrangement, the first and second longitudinal axis X1, X2 are perpendicular to each other. This arrangement reduces the assembly steps to assemble the back leak interface assembly 1.

[0047] A fourth embodiment of the back leak interface assembly 1 will now be described with reference to Figure 8. Like reference numerals will be used for like components.

[0048] The back leak interface assembly 1 according to the third embodiment comprises first and second interface members 7, 9. The intermediate member 11 in the fourth embodiment is formed integrally with the second interface member 9. The intermediate member 11 is machined into an end section of the second interface member 9. The first interface member 7 is mounted to the intermediate member 11 to form a sealed connection. The first interface member 7 comprises a first coupling section 17 which is mounted in a radial aperture 27 formed in the intermediate member 11. In the present embodiment the first interface member 7 is welded to the intermediate member 11 to form a seal. Alternatively, or in addition, the first interface member 7 may be an interference fit in the intermediate member 11.

[0049] The intermediate member 11 is adapted to define a relative angle θ between said first and second interface members 7, 9. In particular, the intermediate member 11 is configured to define the relative angle θ between the first and second longitudinal axis X1, X2 of the first and second interface members 7, 9. In the illustrated arrangement, the first and second longitudinal axis X1, X2 are perpendicular to each other. This arrangement reduces the assembly steps to assemble the back leak interface assembly 1.

[0050] It will be appreciated that various changes and modifications can be made to the back leak interface assembly 1 described herein without departing from the scope of the present application.

Claims

1. A back leak interface assembly (1) for connection to a back leak line of a fuel injector (2), the back leak interface assembly (1) comprising:

   a first interface member (7) having a first connector (8);
   a second interface member (9) having a second connector (10); and
   an intermediate member (11) that is a distinct component from at least one of the first or the second interface member;

   the intermediate member (11) defining a relative angle θ between said first and second interface members (7, 9), the relative angle θ being less than 180° and wherein,
   the intermediate member (11) comprises a body (26) having first and second bores (29, 32) for assembling the first and second interface members (7, 9).

2. A back leak interface assembly (1) as claimed in claim 1 wherein, the intermediate member (11) is integral to either one of said first and second interface members (7, 9), the other of said first and second interface members (7, 9) being coupled to said intermediate member (11).

3. A back leak interface assembly (1) as claimed in any one of claims 1 or 2, wherein said relative angle θ is

in a range from 90° to 150° inclusive.

4. A back leak interface assembly (1) as claimed in any one of the preceding claims, wherein the intermediate member (11) comprises a tubular member, the first and second interface members being disposed at respective first and second ends of the tubular member, said tubular member having a curved profile such that said first and second interface members (7, 9) are inclined at said relative angle θ relative to each other.

5. A back leak interface assembly (1) as claimed in any one of the preceding claims, wherein the first connector (8) comprises a first male connector or a first female connector.

6. A back leak interface assembly (1) as claimed in any one of the preceding claims, wherein the second connector (10) comprises a second male connector or a second female connector.

7. A combination of a fuel injector (2) and a back leak interface assembly (1) as claimed in any one of the preceding claims.

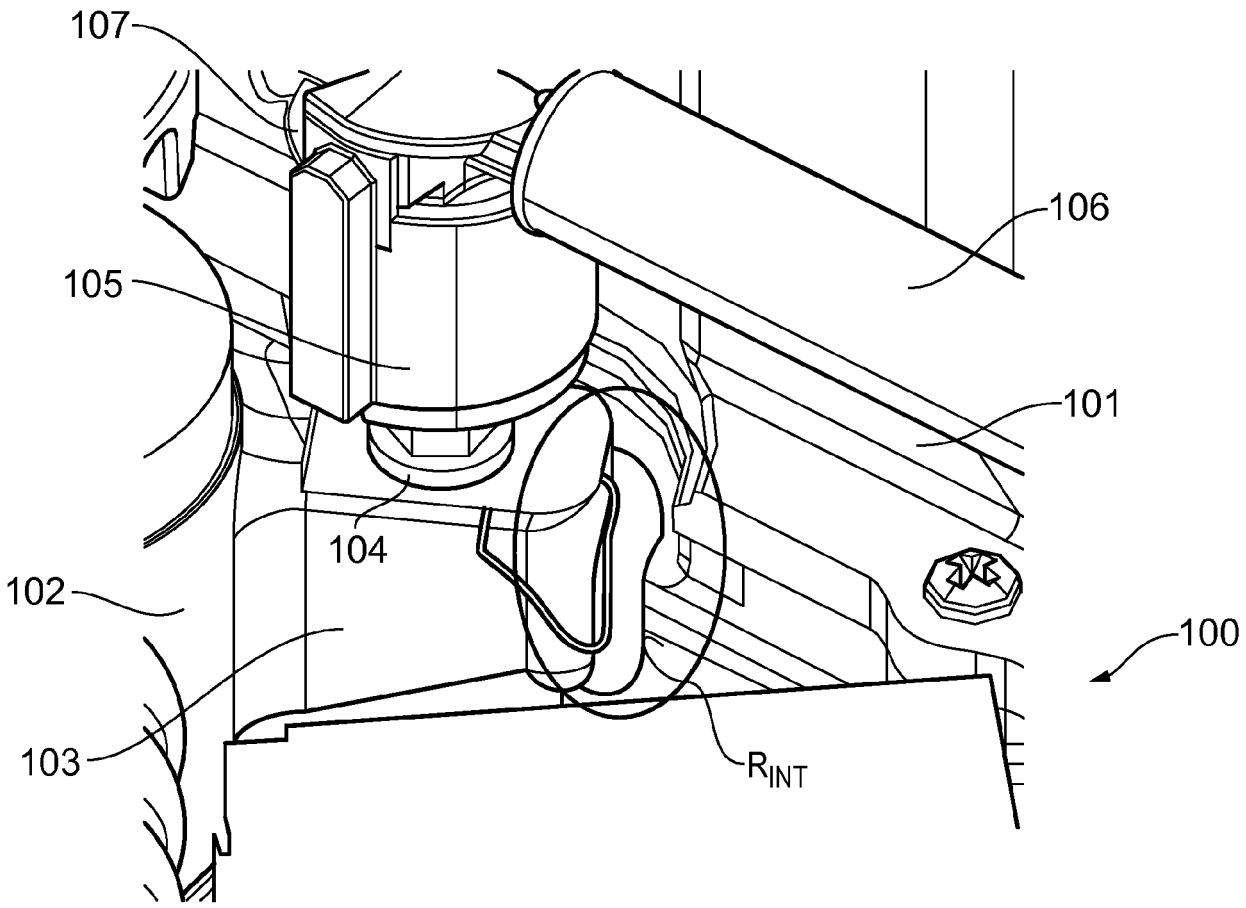

FIG. 1

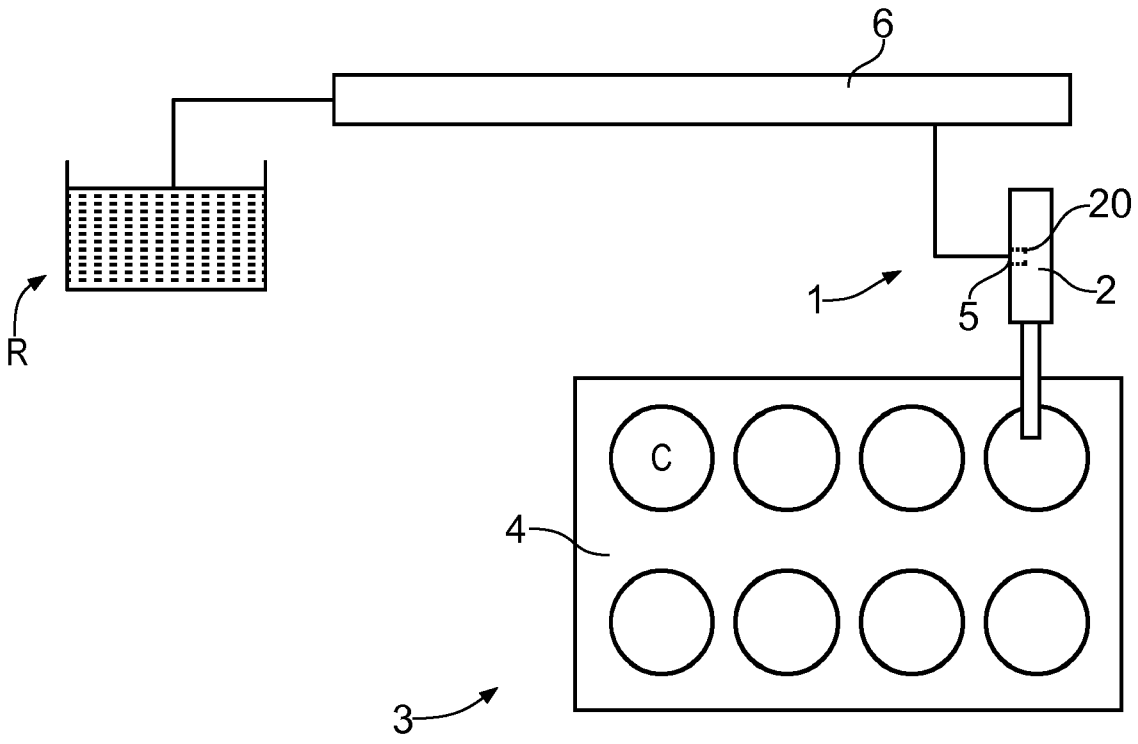

FIG. 2

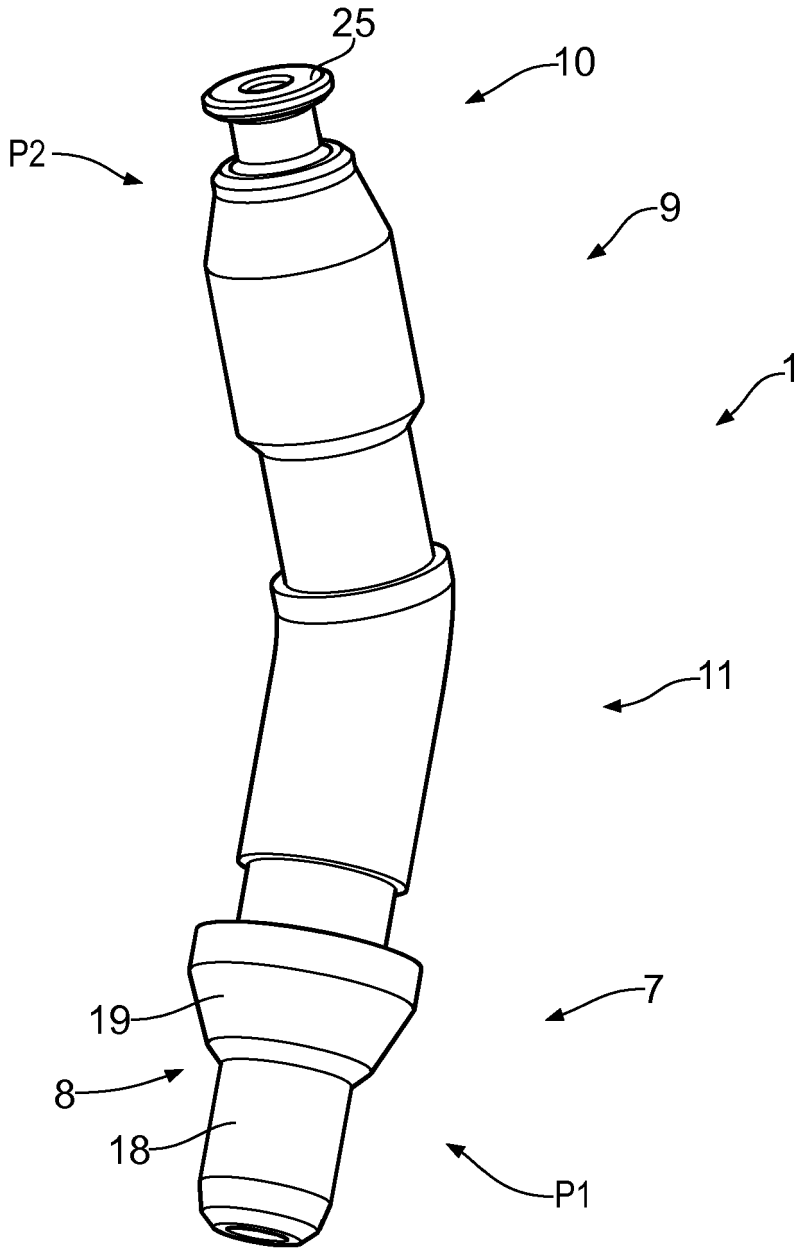

FIG. 3

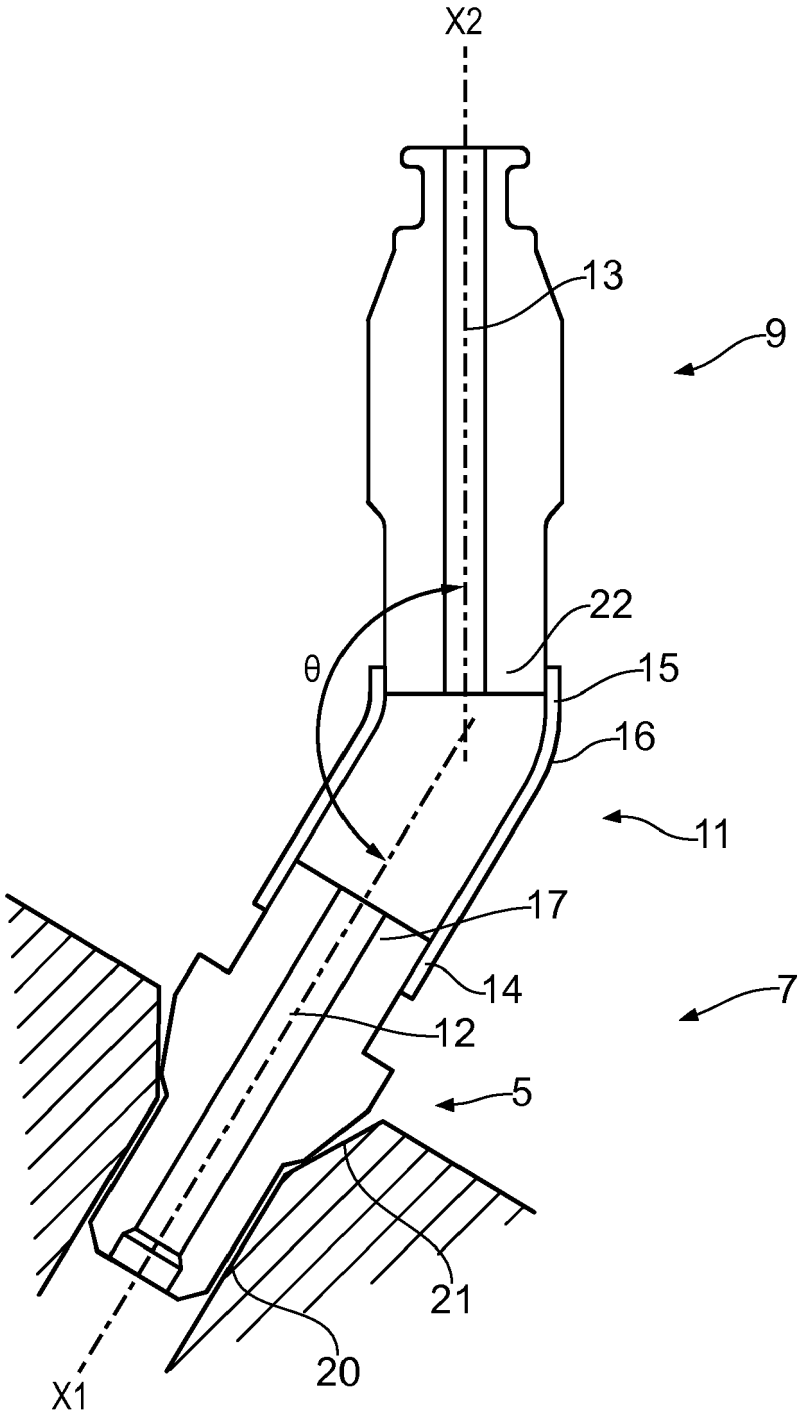

FIG. 4

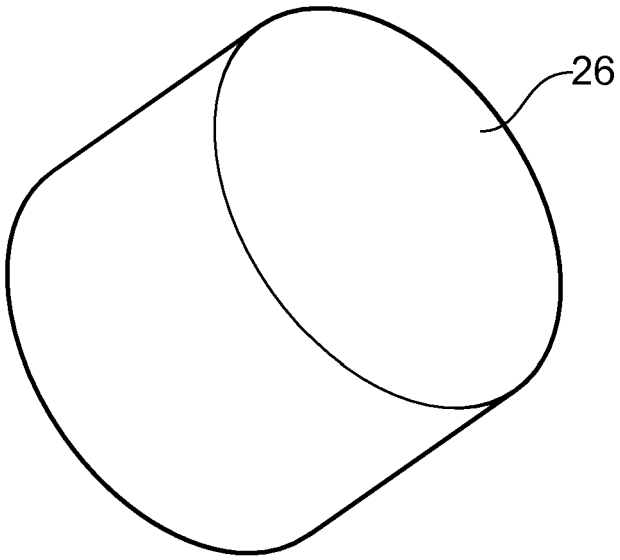

FIG. 5

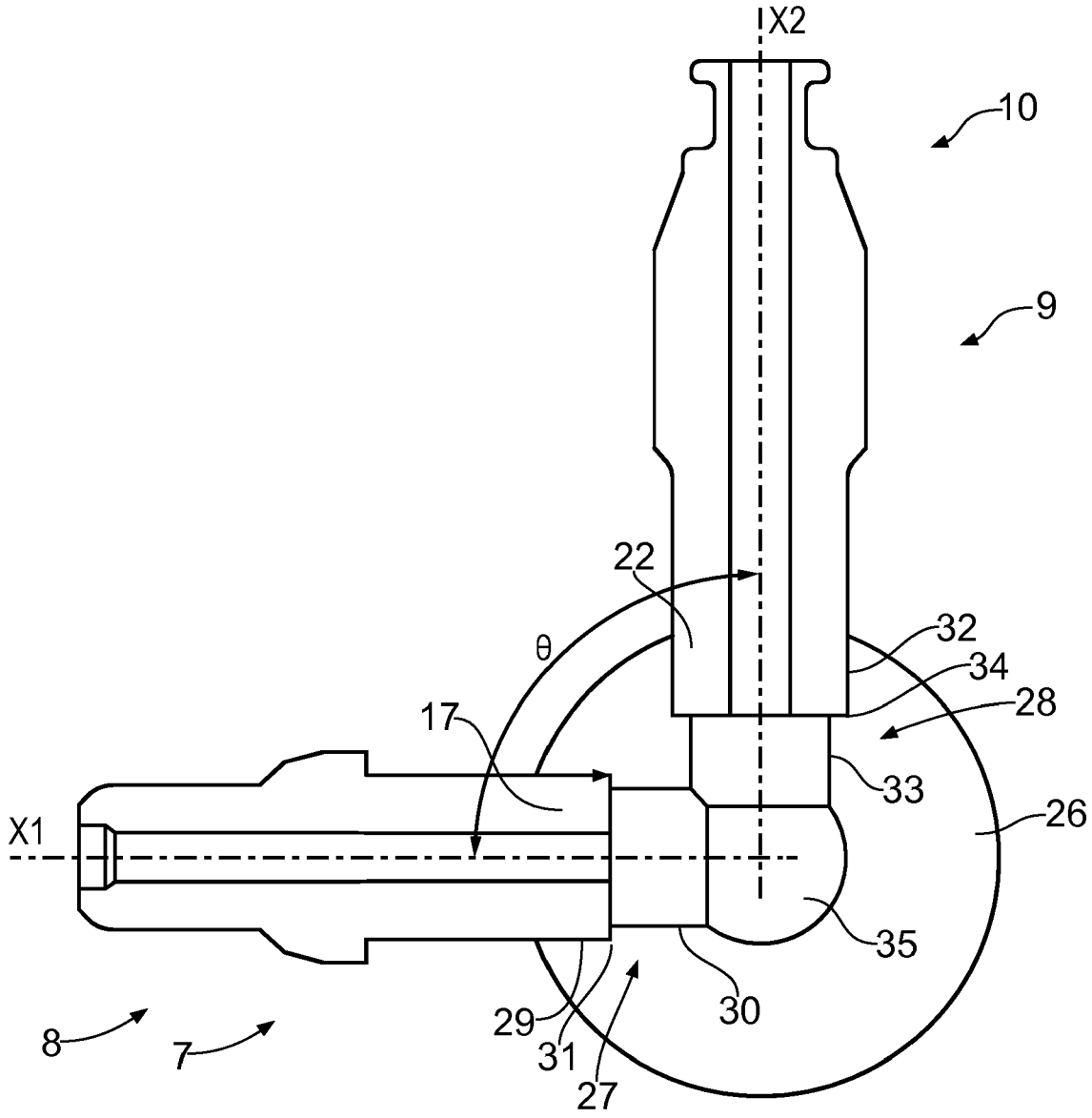

FIG. 6

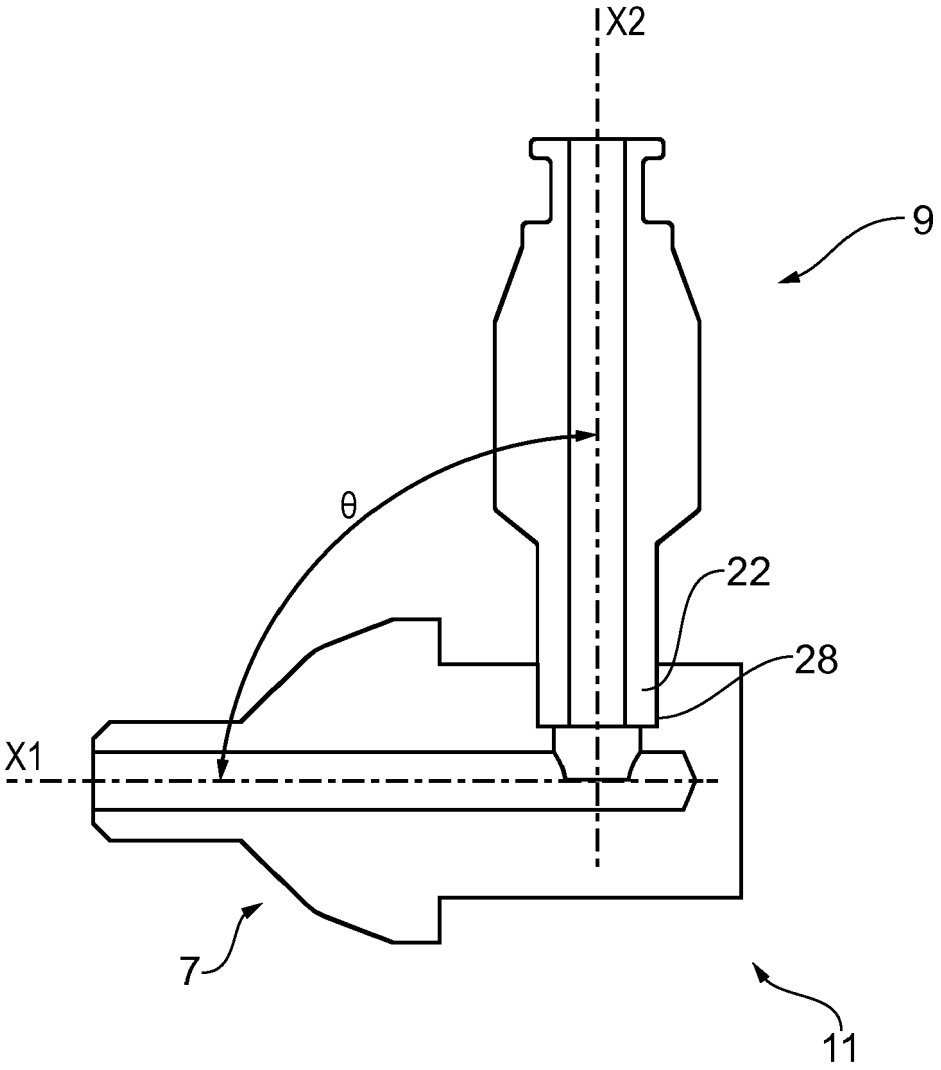

FIG. 7

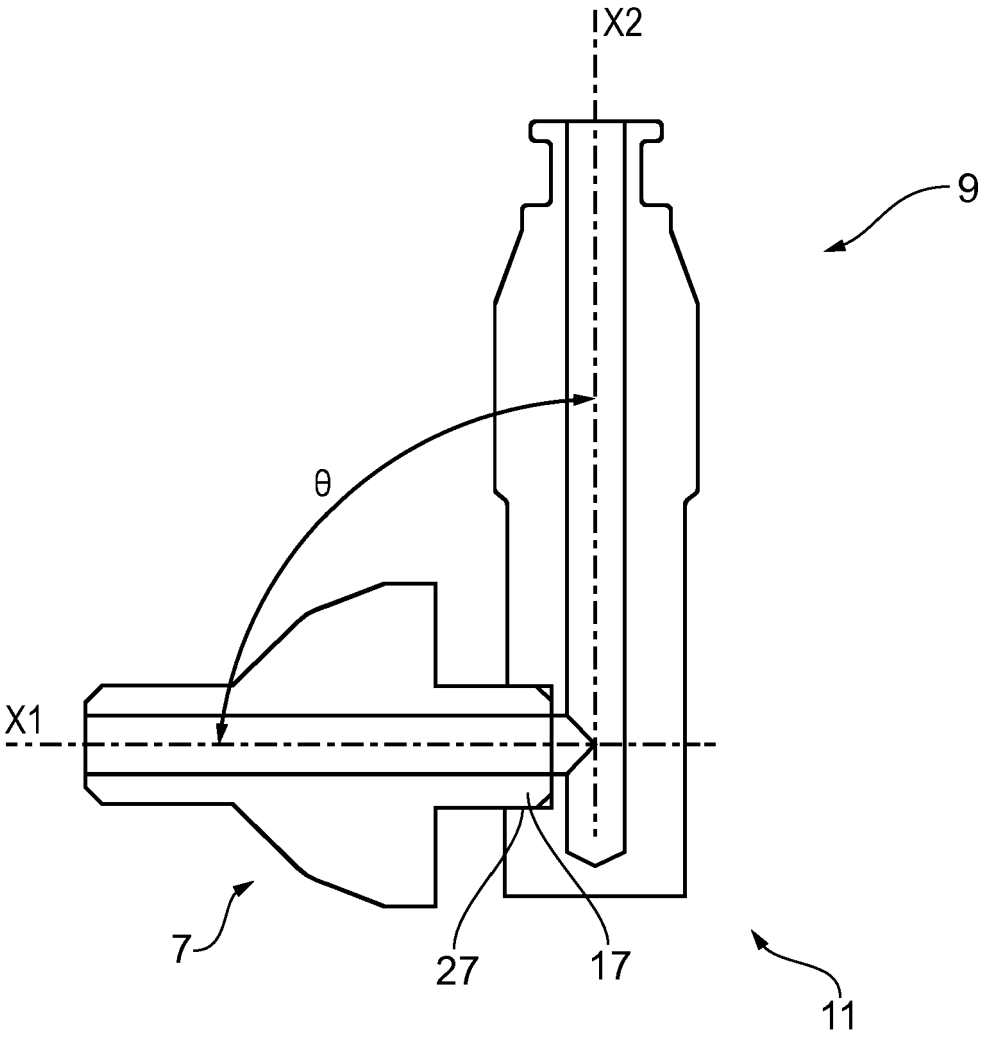

FIG. 8

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 7803

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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