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(54) FUEL INJECTOR

KRAFTSTOFFEINSPRITZVENTIL

INJECTEUR DE CARBURANT

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Description

TECHNICAL FIELD

[0001] The present invention relates to a fuel injector and more particularly to a nozzle motion control feature arranged in said injector.

BACKGROUND OF THE INVENTION

[0002] Fuel injectors of the prior art are disclosed in EP0844383 and in EP0971118 and, a known embodiment is also partially presented on figures 1 and 2. This fuel injector 10 extends along a main axis A and it is provided with a nozzle assembly 12 comprising a hydraulically controlled valve needle 14 slidably arranged in a nozzle body 16. The valve needle 14 axially A displaces under the influence of fuel pressure differences inducing forces on upstream faces 18, 20, and downstream faces 22, 24, of the needle 14. To induce said pressure difference the injector 10 is provided with a control valve, not shown, closing or opening an outlet of a control chamber 26 wherein pressure alternatively builds-up and down, the upper part of the valve needle 14 protruding in said control chamber 26 and also, with a throttle orifice 28 through which the pressurized fuel flows toward injection holes 30, said throttle 28 generating a pressure drop.

[0003] In the injector of figures 1 and 2, the throttle 28 is an annular clearance between the inner face 32 of the nozzle body 16 and the outer edge 34 of a collar 36, also known as "boost flange" or "NMC" (nozzle motion control), radially extending from the valve needle 14.

[0004] In use, upon the operating condition of an internal combustion engine, the pressure of the fuel flowing in the injectors 10 varies in a large range extending from few bars to several thousands of bars and, consequently the nozzle body 16 expends slightly reducing or increasing the throttle 28 and, affecting the operating performances of the injector 10.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is an object of the present invention to resolve the above mentioned problems in providing anozzle body of a fuel injector having an inner space extending along a main axis and adapted to receive a slidably arranged valve needle. The inner space is divided in an upstream cylindrical chamber, wherein, in use, pressurized fuel flows-in and, a downstream cylindrical chamber provided with injection holes through which, in use, pressurized fuel is sprayed out of the injector.

[0006] The nozzle body is further provided with an inter-chambers portion arranged between the upstream and the downstream chambers. The inter-chambers portion has a cylindrical tubular wall axially protruding in the upstream chamber and being adapted to cooperate, in use, with the valve needle to define a throttle inducing a fuel pressure drop. The pressurized fuel induces opposed radial forces on the outer and inner cylindrical faces of the tubular wall so that advantageously, the throttle dimensions remains constant.

[0007] In one embodiment, the tubular wall is integral to the body. In an alternative embodiment, the nozzle body comprises a tubular sleeve fixedly arranged in the inter-chambers portion and axially protruding in the upstream chamber thus creating the cylindrical tubular wall.

[0008] The invention extends also to a nozzle assembly comprising a nozzle body, as described above and in which is arranged a needle valve extending through the tubular wall and slidably moveable between a closed position and a fully open position. The needle is provided with a collar radially extending from the axial stem of the needle, said collar having an upstream face oriented toward the upstream chamber and a downstream face oriented toward the downstream chamber. The collar is arranged to cooperate with the inner cylindrical face of said tubular wall to define a throttle that, in use, induces a fuel pressure drop between the upstream chamber and the downstream chamber.

[0009] The outer edge of the collar and the inner cylindrical face of the tubular wall define an annular clearance.

[0010] Alternatively, the outer edge of the collar and the inner cylindrical face of the tubular wall define axial guiding means of the valve needle, the collar, respectively the inner cylindrical face, being provided with slots or holes intersecting with its edge, respectively said face, and providing throttle means.

[0011] The invention further extends to a fuel injector provided with a nozzle assembly as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 is an axial section of a nozzle assembly of a fuel injector of the prior art.

Figure 2 is a magnified view of the nozzle motion control feature of the injector of figure 1.

Figure 3 is an embodiment of a nozzle motion control feature as per the invention.

Figure 4 is an alternative embodiment of a nozzle motion control feature as per the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] To ease and clarify the following description the top-down orientation of the figures is arbitrarily chosen and, words and expressions such as "above, under, over, below..." may be utilized without any intention to limit the invention. Also, similar features full filling similar functions in different embodiments may be identified with same reference numbers.

[0014] In reference to figure 3 is presented an embod-

iment of a nozzle assembly 12 wherein a nozzle body 16 extends along a main axis A and is provided with an internal cylindrical bore defining inner volume V in which is slidably arranged a valve needle 14.

[0015] The inner volume V of the nozzle body 16 comprises an upstream chamber 38, represented on the upper side of the figure, having an upstream diameter D38 and, a downstream chamber 40, on the lower side of the figure, having a downstream diameter D40 smaller than the upstream diameter D38. As can be observed on figure 3, in between said two chambers 38, 40, is an inter-chambers portion 42 that has a diameter D42 intermediate between the upstream D38 and the downstream D40 diameters. Alternatively, the inter-chambers portion 42 could have same or smaller diameter as the downstream chamber 40. The inter-chambers portion 42 has a cylindrical peripheral wall 44 which bottom part is integral to the nozzle body 16 and which upper part upwardly protrudes in the upstream chamber 38 such that the protruding part 46 has concentric cylindrical inner 48 and outer faces 50. The upstream chamber 38 is, as represented on figure 3, provided at its most bottom part with an annular peripheral recess 52, or annular groove, outwardly surrounding said protruding part 46.

[0016] As part of the nozzle assembly 12 is also represented a valve needle 14 axially A extending throughout the inner volume V of the nozzle body 16, from the upstream chamber 38 to the downstream chamber 40. The valve needle 14, slidably guided between upper and lower guides similar to the guides represented on figure 1, comprises an axially main elongated shaft 54 of relatively small diameter d54 provided in an intermediate portion with a collar 36. Here, "intermediate" is to be understood as indicating any needle portion that is between the upper and lower extremities of the needle. The collar 36 radially extends from said main shaft 54 to an outer edge 34 having an edge diameter d34 slightly smaller than the diameter of the inter-chambers portion D42.

[0017] As can be observed on the figures, when arranged in the body 16, said collar 36 is positioned in the protruding part 46 of the peripheral wall 44 and, a small annular throttle clearance 28 remains open between the outer edge 34 of the collar 36 and the inner cylindrical face 48 of said protruding peripheral wall 46.

[0018] The valve needle 14 is axially A guided and, in use, it displaces between two extreme positions and the collar 36 slides inside the inter-chambers portion 42, the amplitude of the displacements being such that the collar 36 stays in the inter-chambers portion 42.

[0019] The collar 36 represented to illustrate this invention has upstream 20 and downstream faces 22 symmetrically slopped and joining on a circular sharp edge 34. The term "sharp" is here to be understood as any joining shape smaller than 0.2 mm between upstream to downstream faces.

[0020] The collar 36 can take multiple other alternative shapes such as an upstream and downstream flat faces axially A distant from each other and joined by a peripheral vertical face. In such embodiment, the upstream downstream faces may intersect the peripheral face along a "sharp" edge with similar definition as above.

[0021] In such latter embodiment, the collar 36 can be further provided with annular grooves arranged on said intermediate face.

[0022] In use, pressurized fuel enters and fills the upstream chamber 38, the annular recess 52, the inter-chambers portion 42, flows through the throttle 28 than in the downstream chamber 40 where from it exits via injection holes 30. The pressurized fuel induces on the protruding part 46 of the peripheral wall 44 balanced radial forces preventing said protruding part 46 to distort under pressure variation. More specifically the pressure in the recess 52 generates on the outer face 50 of the protruding wall 46 radially inwardly oriented forces and, the pressure in the inter-chambers portion 42 generates on the inner face 48 of the protruding wall 46 radially outwardly oriented forces opposed in direction to the previously mentioned forces. As the protruding part 46 advantageously does not deform, the throttle clearance 28 remains identical whatever the fuel pressure is.

[0023] The throttle 28 induces a pressure drop to the fuel flowing through it and, relative to the high pressure in the upstream chamber 38, the lower pressure of the downstream chamber 40 induces in the downstream part of the inter-chambers portion 42, below the collar 36, radially outwardly oriented forces biasing the peripheral wall 44 in its part integral to the nozzle body 16 and in the very foot portion of the protruding part 46, none of which being of a sufficient magnitude to vary the throttle 28.

[0024] An alternative embodiment is now described, in reference to figure 4, by way of differences with the first embodiment. The main difference is that the protruding wall is now replaced by an independent cylindrical sleeve 56 that foot portion, previously integral to the body 16, is now fixed to the body 16, the head portion upwardly protruding in the upstream chamber 38. The fixation can be achieved by any known means such as laser welding, fretting or the sleeve 56 can be press-fitted with interference in a cylindrical face 58 of the body 16 so that the foot portion of the sleeve 56 is fixed to the body 16. This alternative embodiment has the advantage to be easy to manufacture.

[0025] The operation of this alternative embodiment is similar to the operation previously described so that, the throttle 28 remains constant.

[0026] In yet another embodiment, the collar 36 has its outer edge 34 slidably guided in the inner face 48 of the inter-chambers portion 42. The throttle 28, previously described annular, is now drilled through the collar 36 opening in the upstream 20 and downstream faces 22. Alternatively said throttle 28 can be drilled through the main shaft 54 of the needle and open above and below the collar 36.

[0027] Furthermore, instead of having a circular outer edge 34, the collar 36 can be provided with at least one

flat that defines a throttle passage between said flat portion of the edge and the cylindrical inner face 48. Alternatively to said flat portion, the edge 34 could be provided with an under-cut, a slot or a hole intersecting the edge of the collar, such as a semi-circular or triangular hole, defining the throttle passage 28. Alternatively, said slots can be arranged on the inner face of the sleeve.

[0028] In these alternative embodiments, the collar 36 and the inner cylindrical face 48 form an axial guide to the needle valve 14. The needle can either be axially guided by three guides or, alternatively to preserve isostatically guiding means said needle 14 could have just two guides, for instance in its upper part by the control chamber and, in the collar 36, the lower extremity of the needle being cantilevered.

[0029] In yet another alternative, both upper and lower needle guides could be kept as in the prior art of figure 1 and, to preserve isostatic guiding, the sleeve 56 previously described fixed to the nozzle body 16, can be set free to move self-centred by the collar 56. In this case, the free sleeve 56 is kept in axial position in abutment against a radial face of the nozzle body 16 thanks to the fuel pressure that induces on said sleeve downwardly oriented forces. Additionally, biasing means, such as a spring can also be added to secure the axial positioning of the free sleeve while still leaving it free to be radially self-centred by the collar 36.

[0030] The following references have been utilized in this description:

A	main axis
V	inner volume of the nozzle body
d34	edge diameter
D38	diameter of the upstream chamber
D40	diameter of the downstream chamber
D42	diameter of the inter-chambers portion
d54	diameter of the needle
10	fuel injector
12	nozzle assembly
14	valve needle
16	nozzle body
18	upstream face of the needle
20	upstream face of the collar
22	downstream face of the collar
24	downstream face of the needle
26	control chamber
28	throttle
30	injection holes
32	inner face of the body
34	outer edge of a collar
36	collar
38	upstream chamber
40	downstream chamber
42	inter-chambers portion
44	peripheral wall of the inter-chambers portion
46	protruding part of the peripheral wall
48	inner cylindrical face of the protruding part
50	outer cylindrical face of the protruding part
52	annular recess
54	needle shaft
56	sleeve
58	cylindrical face for press-fitting the sleeve

Claims

1. Nozzle body (16) of a fuel injector (10) having an inner space (V) extending along a main axis (A) and adapted to receive a slidably arranged valve needle (14), the inner space (V) being divided in an upstream cylindrical chamber (38), wherein, in use, pressurized fuel flows-in and, a downstream cylindrical chamber (40) provided with injection holes (30) through which, in use, pressurized fuel is sprayed out of the injector (10), **characterized in that**
the nozzle body (16) is further provided with an inter-chamber (42) portion arranged between the upstream (38) and the downstream (40) chambers, said inter-chamber (42) portion having a cylindrical tubular wall (44) axially protruding in the upstream chamber (38) and being adapted to cooperate, in use, with the valve needle (14) to define a throttle (28) inducing a fuel pressure drop, the pressurized fuel inducing opposed radial forces on the outer (50) and inner (48) cylindrical faces of the tubular wall (44) so that, the throttle (28) dimensions remains constant.

2. Nozzle body (16) as set in claim 1 wherein said tubular wall (44) is integral to the body (16).

3. Nozzle body (16) as set in claim 1 further comprising a tubular sleeve (56) fixedly arranged in the inter-chamber portion (42) and axially protruding in the upstream chamber (38) thus creating the cylindrical tubular wall (46).

4. Nozzle assembly (12) comprising a nozzle body (16) as set in any of the preceding claim, and in which is arranged a needle valve (14) extending through the tubular wall (44) and slidably moveable between a closed position and a fully open position, **characterized in that**
the needle (14) is provided with a collar (36) radially extending from the axial stem (54) of the needle, said collar (36) having an upstream face (20) oriented toward the upstream chamber (38) and a downstream face (22) oriented toward the downstream chamber (40), the collar (36) being arranged to cooperate with the inner cylindrical face (48) of said tubular wall (44) to define a throttle (28) that, in use, induces a fuel pressure drop between the upstream chamber (38) and the downstream chamber (40).

5. Nozzle assembly (12) as set in claim 4 wherein the

outer edge (34) of the collar (36) and the inner cylindrical face (48) of the tubular wall define an annular clearance.

6. Nozzle assembly (12) as set in claim 4 wherein the outer edge (34) of the collar (36) and the inner cylindrical face (48) of the tubular wall define axial guiding means of the valve needle (14), the collar (36), respectively the inner cylindrical face (48), being provided with slots or holes intersecting with its edge (34), respectively said face (48), and providing throttle means (28).

7. Fuel injector (10) provided with a nozzle assembly (12) as set in any of the claims 4 or 6.

Patentansprüche

1. Düsenkörper (16) einer Kraftstoffeinspritzeinrichtung (10) mit einem Innenraum (V), der sich entlang einer Hauptachse (A) erstreckt und ausgebildet ist zum Aufnehmen einer gleitbar angeordneten Ventilnadel (14), wobei der Innenraum (V) unterteilt ist in eine stromaufwärtige zylindrische Kammer (38), in die im Betrieb unter Druck stehender Kraftstoff einströmt, und eine stromabwärtige zylindrische Kammer (40), die mit Injektionslöchern (30) vorgesehen ist, durch die im Betrieb unter Druck stehender Kraftstoff aus der Einspritzeinrichtung (10) gesprüht wird, **dadurch gekennzeichnet, dass** der Düsenkörper (16) weiter mit einem Zwischenkammerteil (42) vorgesehen ist, der zwischen den stromaufwärtigen (38) und stromabwärtigen (40) Kammern angeordnet ist, wobei der Zwischenkammerteil (42) eine zylindrische rohrförmige Wand (44) hat, die axial in die stromaufwärtige Kammer (38) vorsteht und ausgebildet ist zum Kooperieren, in Betrieb, mit der Ventilnadel (14), um eine Drossel (28) zum Induzieren eines Kraftstoffdruckabfalls zu definieren, wobei der unter Druck stehende Kraftstoff entgegengesetzte Radialkräfte auf die äußeren (50) und inneren (48) Zylinderflächen der rohrförmigen Wand (44) induziert, so dass die Dimensionen der Drossel (28) konstant bleiben.

2. Düsenkörper (16) gemäß Anspruch 1, wobei die rohrförmige Wand (44) integral mit dem Körper (16) ist.

3. Düsenkörper (16) gemäß Anspruch 1, der weiter eine rohrförmige Hülse (56) aufweist, die fest in dem Zwischenkammerteil (42) angeordnet ist und axial in die stromaufwärtige Kammer (38) vorsteht, wodurch die zylindrische rohrförmige Wand (46) erzeugt wird.

4. Düsenanordnung (12), die einen Düsenkörper (16) gemäß einem vorhergehenden Anspruch aufweist, und in der ein Nadelventil (14) angeordnet ist, das sich durch die rohrförmige Wand (44) erstreckt und gleitbar zwischen einer geschlossenen Position und ein vollständig offenen Position bewegbar ist, **dadurch gekennzeichnet, dass**
die Nadel (14) mit einem Kragen (36) vorgesehen ist, der sich radial von dem axialen Schaft (54) der Nadel erstreckt, wobei der Kragen (36) eine stromaufwärtige Fläche (20) hat, die in Richtung der stromaufwärtigen Kammer (38) ausgerichtet ist, und eine stromabwärtige Fläche (22), die in Richtung der stromabwärtigen Kammer (40) ausgerichtet ist, wobei der Kragen (36) ausgebildet ist zum Kooperieren mit der inneren zylindrischen Fläche (48) der rohrförmigen Wand (44), um eine Drossel (28) zu definieren, die in Betrieb einen Kraftstoffdruckabfall zwischen der stromaufwärtigen Kammer (38) und der stromabwärtigen Kammer (40) induziert.

5. Düsenanordnung (12) gemäß Anspruch 4, wobei der Außenrand (34) des Kragens (36) und die innere zylindrische Fläche (48) der rohrförmigen Wand einen ringförmigen Zwischenraum definieren.

6. Düsenanordnung (12) gemäß Anspruch 4, wobei der Außenrand (34) des Kragens (36) und die innere zylindrische Fläche (48) der rohrförmigen Wand axiale Führungsmittel der Ventilnadel (14) definieren, wobei der Kragen (36) beziehungsweise die innere zylindrische Fläche (48) mit Schlitzen oder Löchern vorgesehen ist, die sich mit ihrem Rand (34) beziehungsweise der Fläche (48) schneiden, und Drosselmittel (28) vorsehen.

7. Kraftstoffeinspritzeinrichtung (10), die mit einer Düsenanordnung (12) gemäß einem der Ansprüche 4 oder 6 vorgesehen ist.

Revendications

1. Corps de buse (16) d'un injecteur de carburant (10) ayant un espace intérieur (V) s'étendant le long d'un axe principal (A) est adapté à recevoir un pointeau de valve (14) agencé en coulissement, l'espace intérieur (V) étant divisé en une chambre cylindrique amont (38) dans laquelle, en utilisation, un fluide sous pression s'écoule en entrant, et une chambre cylindrique aval (40) dotée de trous d'injection (30) à travers lesquels, en utilisation, du carburant sous pression est pulvérisé hors de l'injecteur (10), **caractérisé en ce que**
le corps de buse (16) est en outre doté d'une portion inter-chambre agencée entre la chambre amont (38) et la chambre aval (40),
ladite portion inter-chambre (42) ayant une paroi tubulaire cylindrique (44) qui se projette axialement

dans la chambre amont (38) et étant adaptée à coopérer, en utilisation, avec le pointeau de valve (14) pour définir un étranglement (28) qui induit une chute de pression du carburant, le carburant sous pression induisant des forces radiales opposées sur la face cylindrique extérieure (50) et la face cylindrique intérieure (48) de la paroi tubulaire (44), de telle façon que les dimensions de l'étranglement (28) restent constantes.

2. Corps de buse (16) selon la revendication 1, dans lequel ladite paroi tubulaire (44) est réalisée de manière intégrale avec le corps (16).

3. Corps de buse (16) selon la revendication 1, comprenant en outre un manchon tubulaire (56) agencé de manière fixe dans la portion inter-chambre et se projetant axialement dans la chambre amont (38), en créant ainsi la paroi tubulaire cylindrique (46).

4. Assemblage formant buse (12) comprenant un corps de buse (16) selon l'une quelconque des revendications précédentes, et dans lequel est agencée une valve à pointeau (14) qui s'étend à travers la paroi tubulaire (44) et déplaçable en coulissement entre une position fermée et une position totalement ouverte, **caractérisé en ce que**
le pointeau (14) est pourvu d'un collier (36) qui s'étend radialement depuis la tige axiale (54) du pointeau, ledit collier (36) ayant une face amont (20) orientée vers la chambre amont (38) et une face aval (22) orientée vers la chambre aval (40), le collier (36) étant agencé pour coopérer avec la face cylindrique intérieure (48) de ladite paroi tubulaire (44) pour définir un étranglement (28) qui, en utilisation, induit une chute de pression entre la chambre amont (38) et la chambre aval (40).

5. Assemblage formant buse (12) selon la revendication 4, dans lequel le bord extérieur (34) du collier (36) et la face cylindrique intérieure (48) de la paroi tubulaire définissent un jeu annulaire.

6. Assemblage formant buse (12) selon la revendication 4, dans lequel le bord extérieur (34) du collier (36) et la face cylindrique intérieure (48) de la paroi tubulaire définissent des moyens de guidage axiaux du pointeau de valve (14), le collier (36) et respectivement la face intérieure cylindrique (48) étant dotés de fentes ou de trous qui recoupent son bord (34) ou respectivement ladite face (48), et constituant des moyens formant étranglement (28).

7. Injecteur de carburant (10) pourvu d'un assemblage formant buse (12) selon l'une quelconque des revendications 4 à 6.

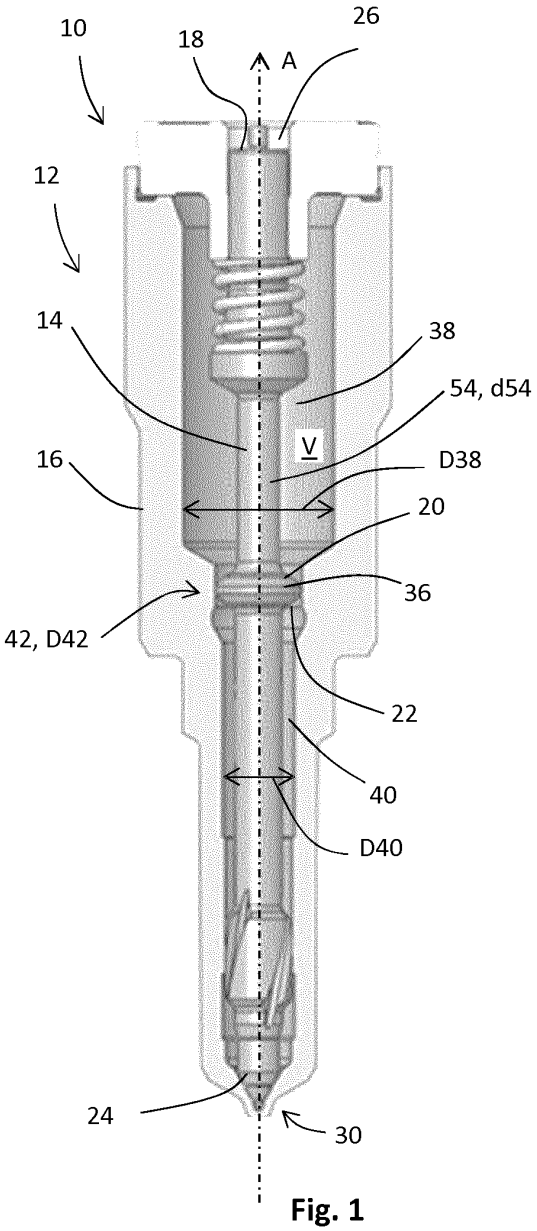

Fig. 1

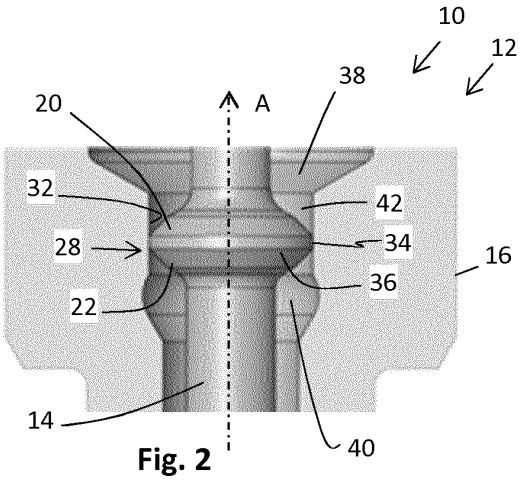

Fig. 2

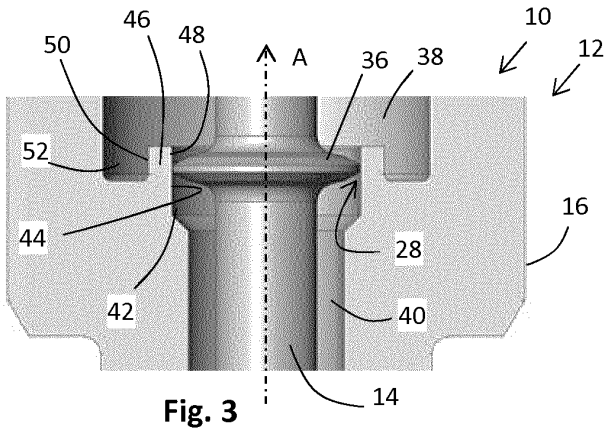

Fig. 3

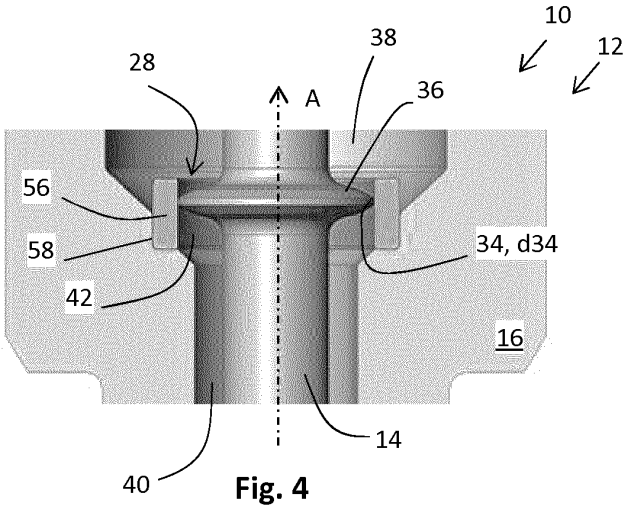

Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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