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(54) PRESSURE REGULATOR

(57) A pressure regulator (12) adapted to be arranged in a fuel return circuit (18) of a high pressure fuel pump (14), the pressure regulator (12) comprising a viscosity controlled leak path, a fluid communication (F1) being limited to said viscosity controlled leak path when a piston is in rest position (RP).

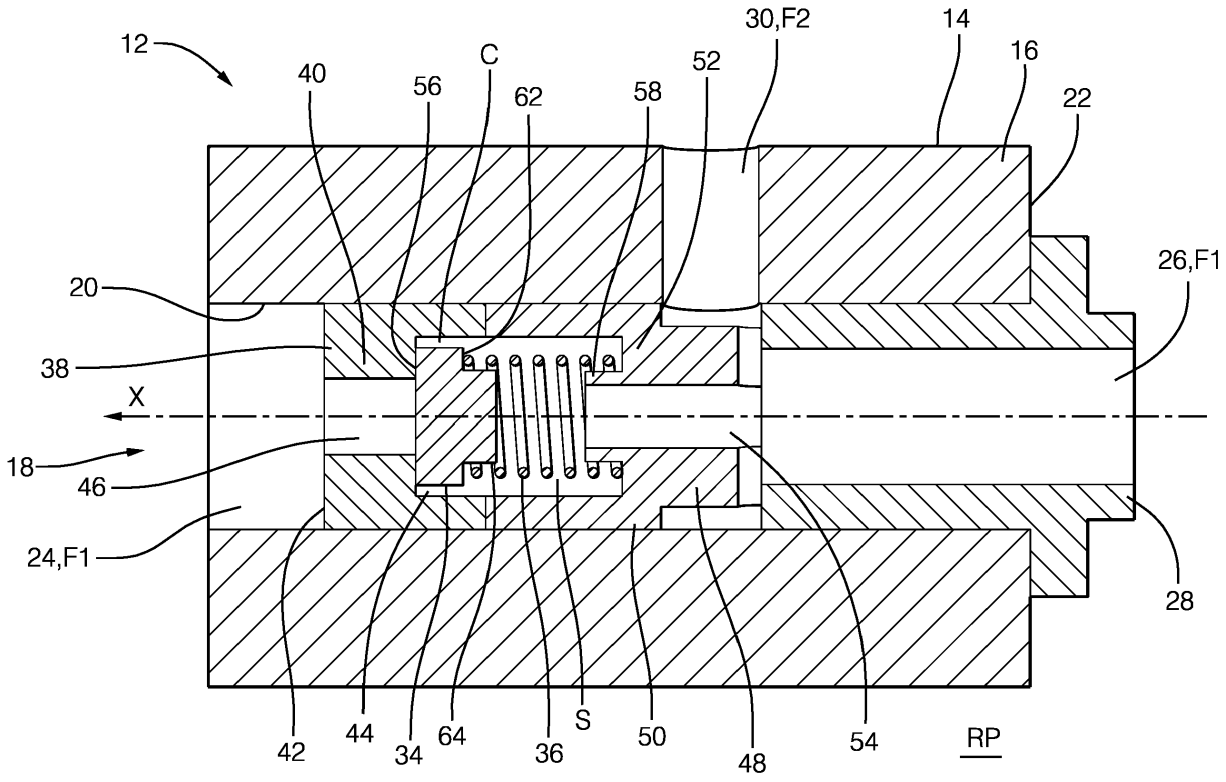

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a pressure regulator adapted to be arranged in the return circuit of a diesel high pressure pump.

BACKGROUND OF THE INVENTION

[0002] In a fuel injection equipment, a high pressure fuel pump is typically arranged downstream a lift pump and upstream a high pressure injection unit. The high pressure fuel pump typically comprises a pressurizing unit wherein fuel is pressurized by a piston reciprocating in a bore and varying the volume of a compression chamber, said piston cooperating with a camshaft rotating between aligned bearings set in the body of a cambox. The body is further provided with a plurality of internal conduit defining a lubrication circuit and a return circuit enabling lubricant to flow around the camshaft, along the bearings and flow toward return outlet. Furthermore, to amortize pressure spikes that would be detrimental to the lift pump and to the injection unit performance, a pressure regulator is arranged in said return circuit.

[0003] The regulator comprises a body arranged in a bore of the pump body and, a piston slidably arranged in an internal bore provided inside said regulator body. The piston is urged toward a first position by a spring and, said piston only moves under the influence of a pressure spike.

[0004] In use the cambox heats up. The regulator often closes the return circuit and to ensure some cooling during said closed phases very small holes have been provided to bypass the closure of the regulator. Unfortunately said holes tend themselves to close because of particles flowing in fuel.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is an object of the present invention to resolve the above mentioned problems in providing a pressure regulator adapted to be arranged in a fuel return circuit of a high pressure fuel pump, the pressure regulator comprising a body having a front seat member defining a front wall, a spring-stop member forming peripheral and rear walls. The body members defining an inner space surrounded by said walls and being in fluid communication with the return circuit via an inlet conduit arranged through the front wall and opening in the inner space in a seating face and, an outlet conduit arranged through the rear wall, the pressure regulator further comprising a piston moveable inside said inner space and permanently urged toward a rest position by a spring compressed between a rear face of the piston and the rear wall, wherein, in said rest position a seat face of the piston is in complementary abutment against the seating face of the front wall, said seat face of the piston covering the opening of the inlet conduit, the piston being pushed away from said rest position when pressure in the inlet conduit reaches a predetermined threshold.

[0006] The pressure regulator further comprises a viscosity controlled leak path, the fluid communication being limited to said viscosity controlled leak path when the piston is in rest position.

[0007] Also, the viscosity controlled leak path comprises a groove provided in the seat face of the piston.

[0008] Also, the viscosity controlled leak path comprises a groove provided in the seating face of the front wall of the regulator body.

[0009] Also, said groove radially extends from a first end opening in the inlet conduit to a second end opening in an annular space C surrounding the piston.

[0010] Also, the piston is cylindrical, said annular clearance being approximately of 200 μm to the diameter.

[0011] Also, the viscosity controlled leak path comprises a plurality of grooves.

[0012] Also, each groove forming the viscosity controlled leak path have a ratio L/D comprised between and, and preferably around where, L is the length of the groove and D is the depth of the groove.

[0013] Also, the depth D of the groove is comprised between 100μm and 300μm, preferably around 200μm..

[0014] Also, the seating face of the front wall and the seat face of the piston are both parallel flat disc faces, the inlet conduit centrally opening in the seating face of the front wall.

[0015] Also, the body members, and the piston are plastic moulded parts.

[0016] The invention further extends to a high pressure fuel pump having a body on which is fixed a pressurizing unit wherein a pumping cycle is performed by a piston cooperating with a camshaft, the body being provided with a return circuit in which is arranged a pressure regulator as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 is a section of a pressure regulator as per the invention, arranged in a body of a high pressure fuel pump.

Figure 2 is an exploded view of the regulator of figure 1.

Figure 3 is a magnified view of a piston of the regulator.

Figure 4 is an alternative embodiment of the piston.

Figures 5 and 6 are sections similar to figure 1, representing the regulator in two operation mode.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] In reference to the figures is described a new

arrangement of a pressure regulator 12 in a body 16 of a fuel pump 14. Although the arrangement can be implemented within many products for regulating pressure of many different fluid, for purpose of clarity and illustration, the description is done in the context of a diesel fuel high pressure pump 14 arranged in a fuel injection equipment, also known as a common rail system. Such fuel injection equipment comprises a low pressure system wherein a lift pump sucks fuel in a tank and delivers it to the high pressure pump 14. In turn said fuel is pressurized and delivered to a high pressure injection delivering system comprising a common rail and a plurality of fuel injectors.

[0019] The high pressure pump 14 typically comprises a pressurizing unit wherein a piston reciprocally translates in a bore thus performing a pumping cycle in varying the volume of a compression chamber. The pressurizing unit is fixed on a cambox having a body 16 wherein a camshaft rotates between aligned bearings and imparts said reciprocating displacements to the piston. In use, fuel leaks between the piston and the bore and gets in an inner volume defined in the cambox body 16. Said pump body 16 is further provided with conduits defining a return circuit 18 enabling fuel that, in use, fills said inner volume, to flow and return toward the low pressure system.

[0020] The pressure regulator 12 is arranged in said return circuit 18 and is adapted to damp pressure spikes generated by the piston displacements, said pikes (or peaks) being able to damage the lift pump and, to alter the injection performance.

[0021] The regulator 12 is arranged in a main bore 20 of said return circuit 18, the bore 20 extending along a main axis X and opening on the outer face 22 of the pump body, on the right of figure 1. The upstream portion of the return circuit 18 forms an inlet channel 24, on the left of figure 1 and, the downstream portion of the return circuit 18 forms an outlet channel 26 axially extending through a back leak connector 28 adapted to complementary receive a return hose or pipe. Also visible on the figure and vertically represented, the return circuit 18 comprises a bypass channel 30 opening in the bore 20, said bypass channel 30 enabling, in the specific arrangement of a high pressure pump, fuel flowing through the bearings of the camshaft to bypass the regulator 12 and to return directly toward the outlet.

[0022] More in details, the regulator 12 comprises a two-part cylindrical body 32 press fitted in the bore 20, the back leak connector 28 being in turn press fitted behind the regulator. The body 32 defines an inner space S, in which is arranged a moveable piston 34 biased by a spring 36 toward a rest position RP.

[0023] The regulator body 32 is the complementary arrangement in the bore 20 of a front seat member 38 and a spring stop member 48. The front seat member 38 defines a front wall 40 having an outer face 42 facing the inlet channel 24 and an inner face 44 forming a bottom face 44 of the inner space S. Said front wall 40 is further provided with an inlet conduit 46 extending throughout said front wall 40 from an outer opening in the outer face 42 to an inner opening in the center of said bottom face 44, the inlet conduit 46 creating a fluid communication F1 between said inlet channel 24 and the inner space S.

[0024] The spring stop member 48 that complementary adjusts in the bore 20 against the seat member 38 has a cylindrical peripheral wall 50 which outer face is in flush continuity with the peripheral wall of the seat member 38, and a transverse rear wall 52 which, symmetrically to the seat member 38, is provided with an outlet conduit 54 extending throughout the rear wall 52 thus continuing said fluid communication F1 of the return circuit 18 between the inner space S and the outlet channel 26 toward the back leak connector 28.

[0025] To accommodate a flow passage for the fuel flowing through the bypass channel 30, the spring-stop member 48 is further provided on its rear end, right on figure 1, with an annular groove opening in a radial slot, thus creating said bypass fluid communication F2.

[0026] In the inner space S, the area of the bottom face 44 surrounding the opening of the inlet conduit forms a seating face 56 which, in the embodiment represented in flat and transverse but could have a tapered shape, or a spherical shape. Opposite to said seating face 56, the rear wall 52 is provided with a small cylindrical protrusion 58 through which extends the outlet conduit 54 and which serves as a location means for the lasts turns of the spring 36.

[0027] The piston 34 is a thick disc shape member arranged in the inner space S and, as visible on the figure, the piston 36 is radially smaller than the inner space S defining around the piston 34 an annular clearance C. The piston 34 has a front seat face 60 adapted to cooperate with the seating face 56 of the front wall and, an opposite rear face 62 provided with another cylindrical protrusion 64 serving as a location means for the last turns of the other end of the spring 36, the spring 36 being compressed between the rear wall 52 and the piston 34 and, in absence of fluid pressure, as represented in figure 1, the piston 34 is biased by the spring 36 in the rest position RP where its seat face 60 lies against the seating face 56 of the front wall.

[0028] In reference to figures 3 and 4, the seat face 60 of the piston is further provided with radial grooves 66, four being represented on the embodiment of figure 3, only one on the embodiment of figure 4. The grooves 66 have a length L and radially extend from the center of the seat face 60 of the piston to the outer edge of said seat face. Since the inlet conduit 46 opens in the center of the seating face 56, when in rest position RP, said grooves 66 create a small permanently open fluid path between the opening of the inlet conduit 46 and the annular clearance C.

[0029] In a non-represented alternative, the groove 66 can be provided on the seat face 56 of the regulator body, or even on both the regulator body and the piston.

[0030] Model with grooves 66 having a depth comprised between 100μm and 300μm and a ratio length of

the groove over depth of 10 to 1 provided conclusive results. Further tests have been performed wherein the grooves 66 had a depth D of 200μm and the annular clearance was of 250 μm to the diameter. A further important characteristic for viscosity control is the ratio length L over depth D of the groove 66. A ratio comprised between 8 and 12, preferably around 10 has demonstrated good results.

[0031] A clearance C slightly smaller than 250μm, for instance about 200μm would be acceptable. Furthermore, the regulator body members and the piston can the plastic molded.

[0032] The major advantage of said grooves 66 is that in operation, when the piston is in rest position RP, the grooves 66 maintain open the fluid communication F1 and create a viscosity controlled leak path enabling fuel in the return circuit 18 to permanently flow from the inlet channel 24 to the outlet channel 26 and cool the pump. As operational temperature varies, a higher leak flow is enabled at high temperature than at low temperature. This advantageously provided a cooling flow to the pump 14, the flow increasing with temperature.

[0033] Furthermore, it is known than debris and particles may be present in the fuel and, an advantage provided by the grooves 66 is that as said particles may get trapped in a groove 66 when in rest position RP, figure 5, as soon as the piston 34 lifts of the seating face as represented in figure 6, the fuel flow cleans the grooves 66 and re-establish the viscosity controlled leak path.

LIST OF REFERENCES

[0034]

X	main axis - regulator axis
S	inner space
F1	fluid communication
F2	bypass fluid communication
C	annular clearance
RP	rest position
L	length of the groove
D	depth of the groove
12	pressure regulator
14	high pressure pump
16	pump body - cambox body
18	return circuit
20	main bore
22	outer face of the cambox
24	inlet channel
26	outlet channel
28	back leak connector
30	bypass channel
32	regulator hollow body
34	piston
36	spring
38	seat member of the regulator body
40	front wall
42	outer face of the cambox
44	inner face / bottom face
46	inlet conduit
48	spring-stop member
50	peripheral wall
52	rear wall
54	outlet conduit
56	seating face
58	protrusion
60	seat face of the piston
62	rear face of the piston
64	protrusion
66	radial groove

Claims

1. Pressure regulator (12) adapted to be arranged in a fuel return circuit (18) of a high pressure fuel pump (14), the pressure regulator (12) comprising a body (32) having a front seat member (38) defining a front wall (40), a spring-stop member (48) forming peripheral (50) and rear (52) walls, said body members (38, 48) defining an inner space (S) surrounded by said walls and being in fluid communication (F1) with the return circuit (18) via an inlet conduit (46) arranged through the front wall (40) and opening in the inner space (S) in a seating face (56) and, an outlet conduit (54) arranged through the rear wall (52), the pressure regulator (12) further comprising a piston (34) moveable inside said inner space (S) and permanently urged toward a rest position (RP) by a spring (36) compressed between a rear face (62) of the piston and the rear wall (52), wherein, in said rest position (RP) a seat face (60) of the piston is in complementary abutment against the seating face (56) of the front wall, said seat face (60) of the piston covering the opening of the inlet conduit (46), the piston (34) being pushed away from said rest position (RP) when pressure in the inlet conduit (46) reaches a predetermined threshold,
characterized in that
the pressure regulator (12) further comprises a viscosity controlled leak path (66), the fluid communication (F1) being limited to said viscosity controlled leak path when the piston is in rest position (RP).

2. Pressure regulator (12) as claimed in any the preceding claim wherein the viscosity controlled leak path comprises a groove (66) provided in the seat face (60) of the piston.

3. Pressure regulator as claimed in any one of the preceding claims wherein the viscosity controlled leak path comprises a groove (66) provided in the seating face of the front wall (40) of the regulator body.

4. Pressure regulator (12) as claimed in any one of the

claims 2 or 3 wherein said groove (66) radially extends from a first end opening in the inlet conduit (46) to a second end opening in an annular space (C) surrounding the piston (34).

5. Pressure regulator (12) as claimed in claim 4 wherein the piston (34) is cylindrical, said annular clearance (C) being approximately of 200 μm to the diameter.

6. Pressure regulator (12) as claimed in any one of the claims 4 or 5 wherein the viscosity controlled leak path comprises a plurality of grooves (66).

7. Pressure regulator (12) as claimed in any one of the claims 2 to 6 wherein each groove (66) forming the viscosity controlled leak path have a ratio L/D comprised between 8 and 12, and preferably around 10 where, L is the length of the groove 66 and D is the depth of the groove 66.

8. Pressure regulator (12) as claimed in claim 7 wherein the depth D of the groove 66 is comprised between 100μm and 300μm, preferably around 200μm.

9. Pressure regulator (12) as claimed in the preceding claim wherein the seating face (56) of the front wall and the seat face (60) of the piston are both parallel flat disc faces, the inlet conduit (46) centrally opening in the seating face (56) of the front wall.

10. Pressure regulator (12) as claimed in any one of the preceding claims wherein the body members (38, 42) and the piston (34) are plastic moulded parts.

11. High pressure fuel pump (14) having a body (16) on which is fixed a pressurizing unit wherein a pumping cycle is performed by a piston cooperating with a camshaft, the body (16) being provided with a return circuit (18) in which is arranged a pressure regulator (12) as claimed in any one of the preceding claims.

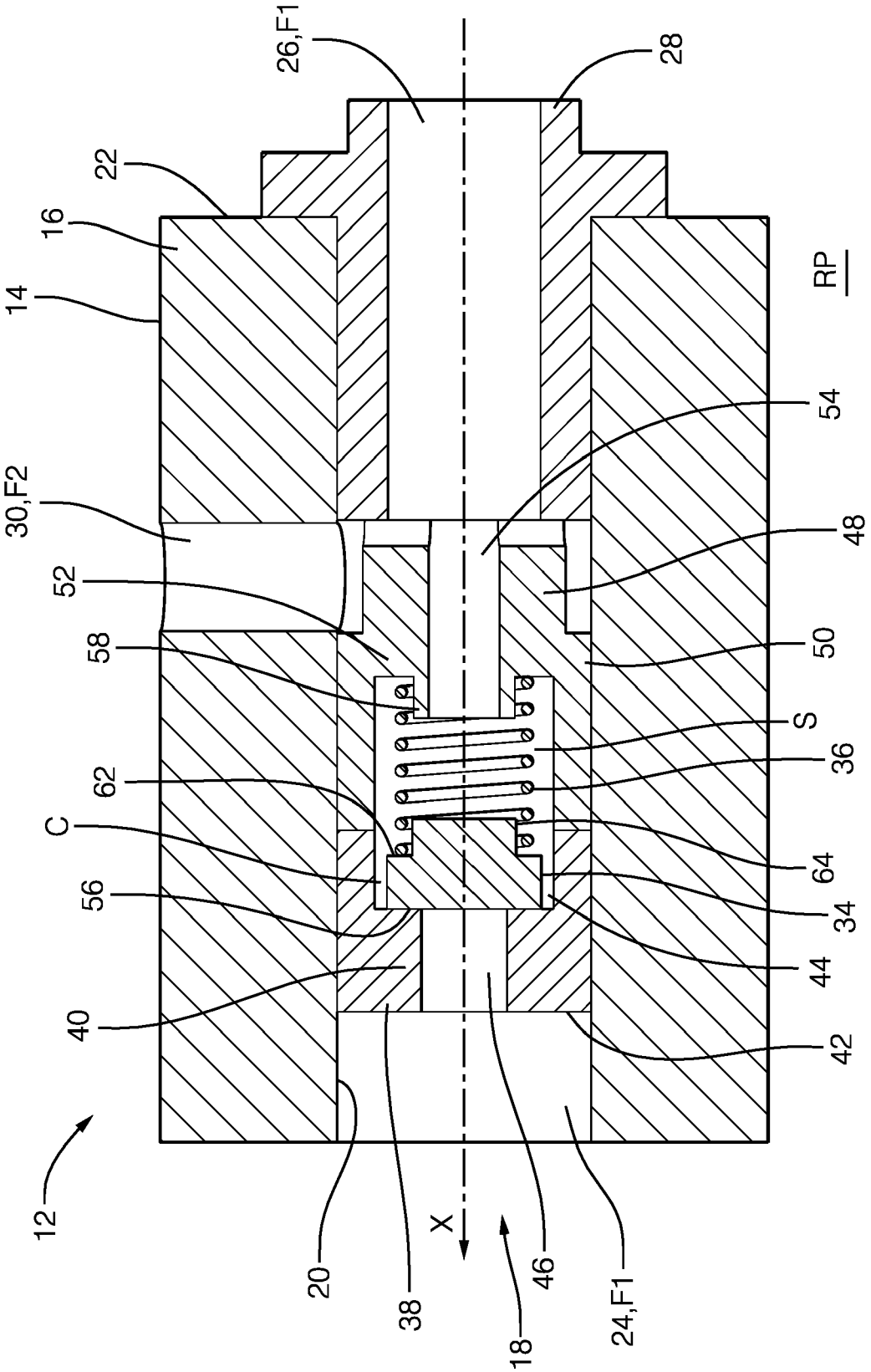
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FIG. 1

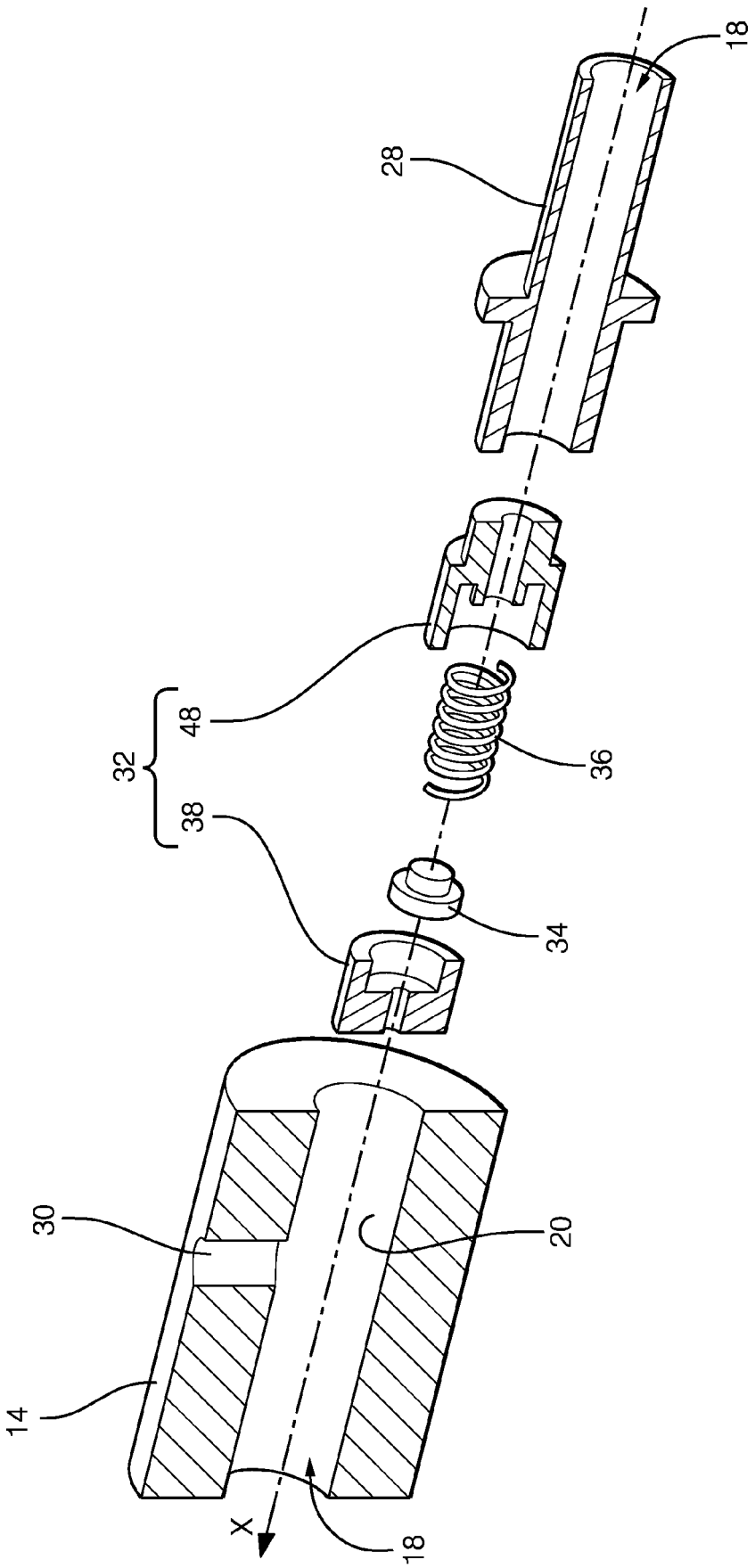

FIG. 2

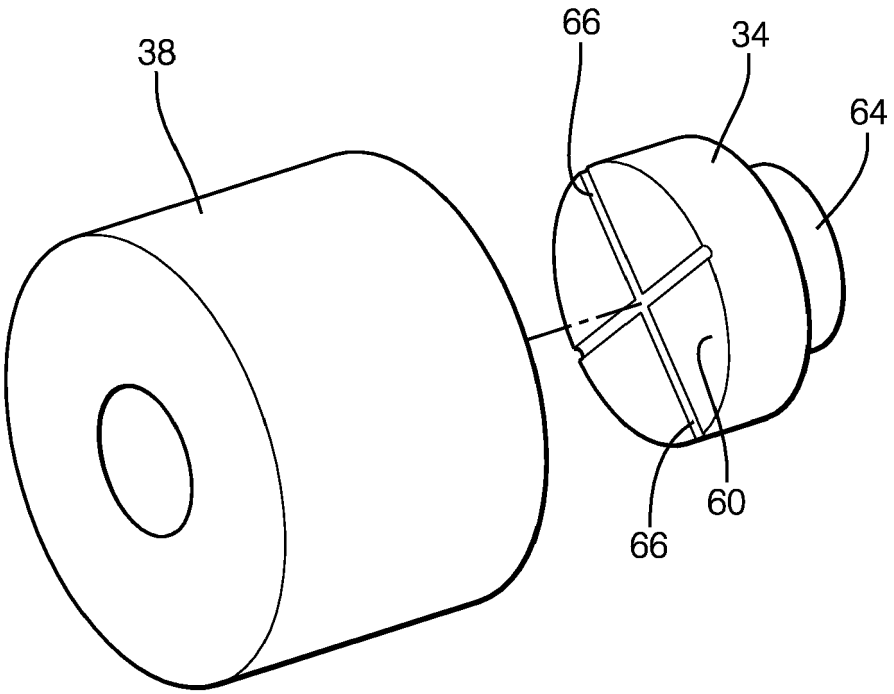

FIG. 3

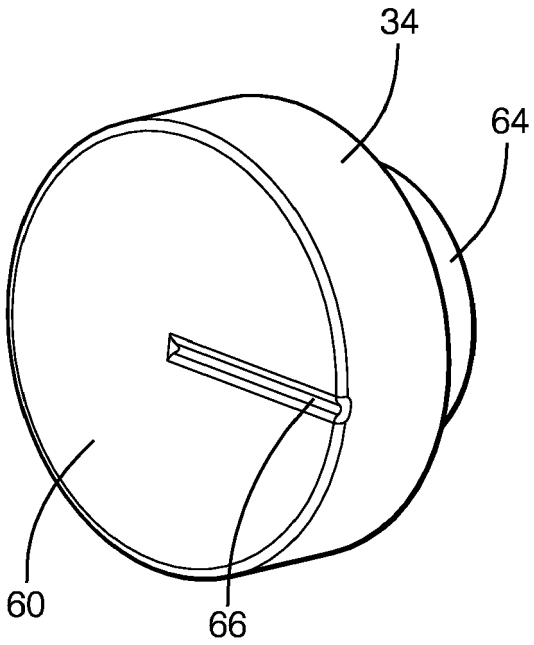

FIG. 4

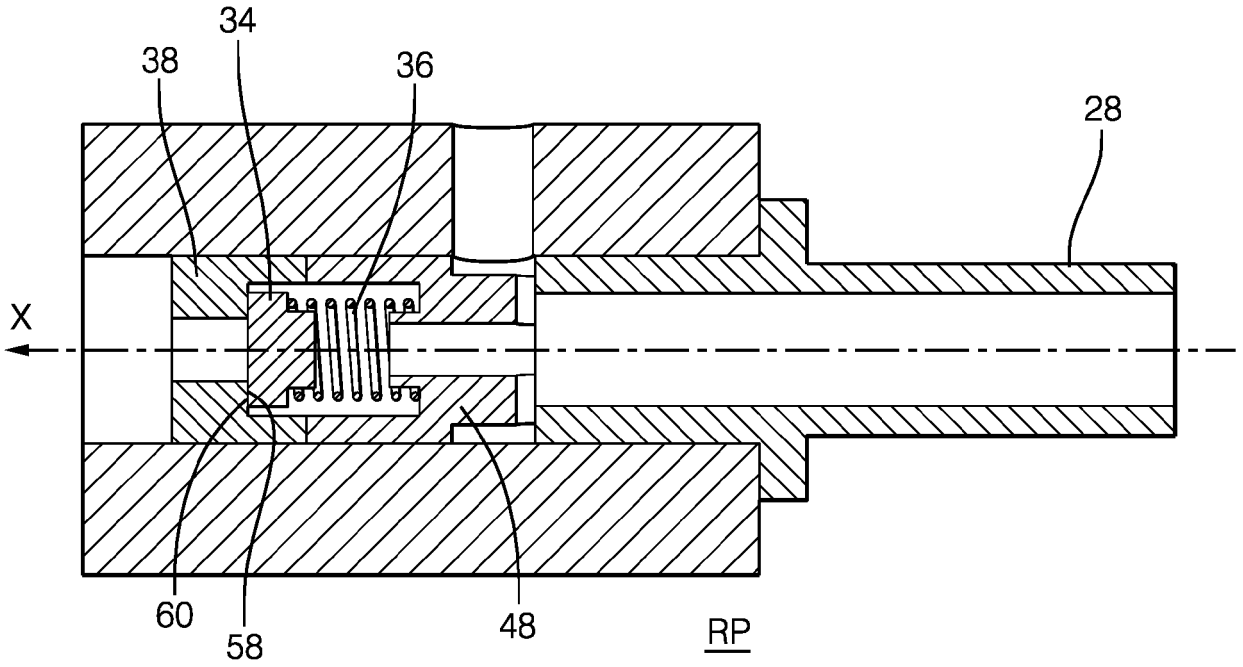

FIG. 5

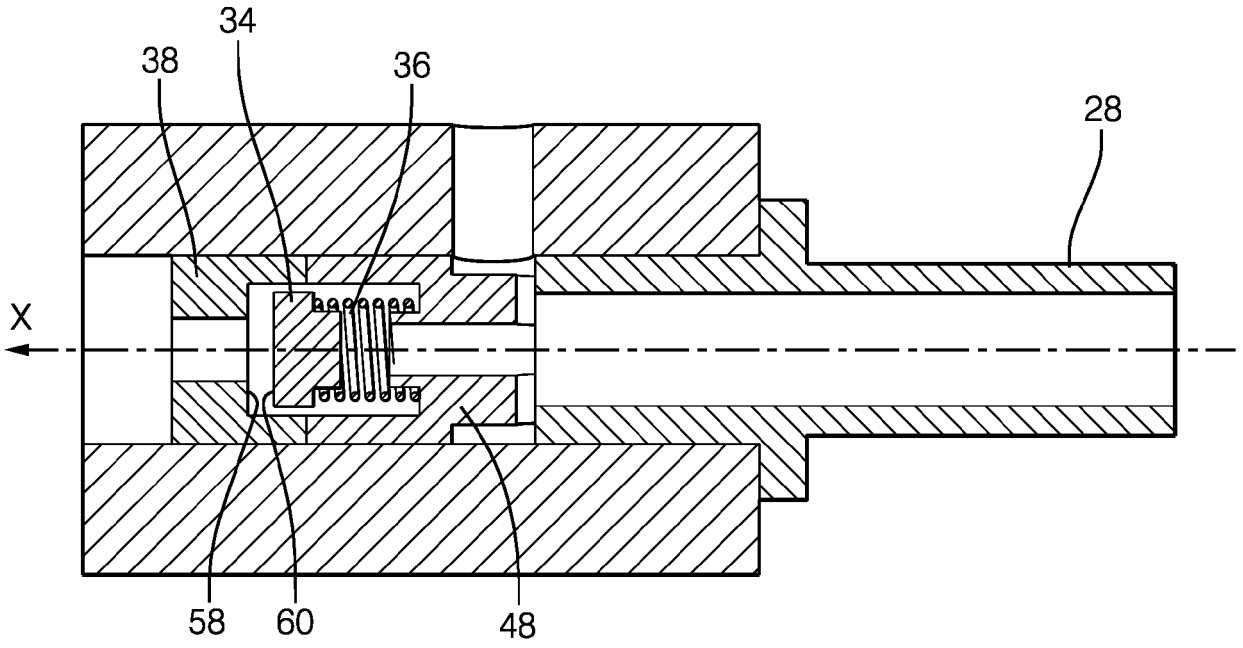

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 17 17 2571

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 October 2017	Barunovic, Robert

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
EP 17 17 2571

DOCUMENTS CONSIDERED TO BE RELEVANT

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