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(54) CONTROL VALVE ASSEMBLY OF A FUEL INJECTOR

STEUERVENTILANORDNUNG EINES KRAFTSTOFFINJEKTORS

ENSEMBLE SOUPAPE DE COMMANDE D'INJECTEUR DE CARBURANT

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Description

TECHNICAL FIELD

[0001] The present invention relates to a fuel injector and more particularly to means improving the gain curve linearity.

BACKGROUND OF THE INVENTION

[0002] In hydraulically controlled fuel injectors, typically diesel injectors having an electro-valve with a solenoid cooperating with a magnetic armature integral to a valve spool, fuel event are indirectly commanded by energizing said solenoid attracting the armature-and-spool assembly. This opens a control chamber spill orifice through which fuel pressurized expels enabling lift of a needle valve and spray of fuel via injection holes. A theoretical linear gain curve rules the fuel injection quantity as a function of solenoid power timing and duration. Problem occurs as unequal fuel pressures around armature generate forces disrupting the displacements and said theoretical linearity of the gain curve. EP1923564 discloses a fuel injector of the prior art.

SUMMARY OF THE INVENTION

[0003] Accordingly, it is an object of the present invention to resolve the above mentioned problems in providing a control valve assembly of a fuel injector adapted to be arranged between a nozzle assembly and an actuator assembly. The control valve assembly has a body extending along a main axis between a transverse first face and an opposed transverse second face and being provided with a recess dug in said second face and a bore opening in the bottom face of said recess and axially extending to the first face of the body. The control valve assembly further comprises an armature-and-stem-assembly arranged within said recess and bore, the stem forming a valve seat actionable between open and closed positions of a fuel return circuit via a magnetic field generated by a powered solenoid arranged in the body of the actuator assembly. The recess forms a chamber in which the armature is, the stem forming a sliding valve spool in the bore.

[0004] The control valve assembly further comprises a check valve arranged to prevent flow between the first face of the body and the bottom face of the recess and, to enable flow in the opposite direction.

[0005] Said check valve comprises a valve member biased by a spring against a seating face that controls a narrow passage.

[0006] Also, said valve member is a ball and the seating face is a conical face and, said narrow passage extending from the tip of said conical face to the bottom face of the recess.

[0007] The invention further extend to a solenoid of a fuel injector provided with a control valve assembly as described above, the solenoid having an over-moulded core around which is wand a coil defining a central bore axially extending from a transverse lower face of the solenoid toward an end-shoulder face adapted to receive in abutment a pin against which, in use, a valve spring compresses.

[0008] The solenoid is further provided with a channel extending inside the over-moulding from said end-shoulder face toward a lateral face of the solenoid.

[0009] A second check valve is provided within said channel said check valve preventing, in use fuel flow from said central bore toward the outer lateral face of the solenoid.

[0010] The channel comprises an axial portion, and a radial portion joining together in a substantially right angle elbow, the axial portion extending from the end-shoulder face toward said elbow and the radial portion extending from said elbow to said outer lateral face of the solenoid.

[0011] Said second check valve comprises a valve member biased by a spring against a valve seat controlling a narrow passage joining said elbow.

[0012] Said valve member is a ball and the seat is a conical face and wherein, said narrow passage joining said elbow extends from the tip of said conical face.

[0013] The invention further extends to a fuel injector comprising a control valve assembly as described previously.

[0014] Also, the fuel injector further comprises a solenoid as described previously.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] 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 diesel fuel injector according to a first embodiment not part of the invention.

Figure 2 is similar to figure 1 with a second embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] In reference to the figures is described a fuel injector 10 comprising a nozzle assembly 12, a control valve assembly 14 and an actuator assembly 16 firmly held together by a capnut 18 that engages and bears on the body 20 of the nozzle assembly 12 and that is tightened on the body 22 of the actuator assembly 16.

[0017] The nozzle assembly 12 comprise the body 20 and an upper guide member 24 provided having a bore 26 defining an upper guiding means aligned with a lower guide means, not represented, and defined directly in said body 20.

[0018] For clarity and simplification purposes, the orientation of the figures is utilized to support the description and so, without any limiting intention words such as "up-

per, lower, above," are utilized.

[0019] A needle valve member 28, extending from a head 30 to a tip end, not represented, is slidably arranged between said two guiding means and adapted to translate about a main axis X between a closed position CP and, an open position OP. In use, the needle 28 translates under the influence of pressure variations in a control chamber 32 that is defined in the bore 26, above the needle head 30. When pressure in said control chamber 32 is high, the needle 28 is urged in the closed position CP and, when said pressure drops the needle 28 lifts in open position OP further compressing a needle spring 34 arranged between a shoulder face of the needle 28 and an under face of the upper guide member 24.

[0020] The control valve assembly 14 has a body 36 axially X extending from an lower face 38 that is in surface contact against the upper guide member 24 to, an opposed upper face 40 that is in surface contact against the lower face 42 of the body 22 of the actuator assembly. Although the body 36 of the control valve could be in arranged in direct contact against the upper guide member 24, in the embodiment presented on the figures, an intermediate plate member 44 is arranged between said body 22 and member 24. The body 36 is provided with a recess 46 dug in its upper face 40 and also with a hydraulic bore 48 extending between the bottom face 50 of said recess 46 and the lower face 38 of the body. In the embodiment presented said hydraulic bore 48 further extends through the intermediate plate member 44 to open right above the opening of a return conduit 52 provided in the upper guide member 24. The return circuit 52 extends from the guide member 24 to an outlet provided in the head of the injector.

[0021] In said recess and hydraulic bore is arranged an armature-and-stem-assembly 54, the stem 56 forms a valve spool 56 slidably arranged in the hydraulic bore 48 and, the armature 58 is a thick disc crimped on said stem 56 and arranged in the recess 46 that forms an armature chamber 46.

[0022] In the embodiment presented the stem 56 extends above the armature 58. The lower end the stem forms a valve seat 60 cooperating with the opening of the return conduit 52.

[0023] Parallel to said hydraulic bore 48, the control valve assembly 14 is provided with a check valve 62 arranged between the bottom face 50 of the armature chamber 46 and the body's lower face 38. Said check valve 62, or non-return valve, enables downward flow and prohibits upward flow and, it comprises a channel having an upper narrow portion 64 that joins, via a enlarging tapered seating face 65, a lower wider portion 66. In said wider portion 66 are arranged a compression spring 68 biasing a ball 70 against said seating face 65. Alternatively to this spring and ball arrangement, the check valve 62 can be of a different embodiment such as a reed valve, or the ball replaced by a plate...

[0024] The intermediate plate 44 is provided with several grooves dug in its upper face and also through channels creating necessary fluid communications for the operation of the injector.

[0025] The actuator assembly 16 has its body 22 axially X extending from a lower face 42, that is in surface contact with the upper face 40 of the control valve, to an injector head, not represented, wherein are arranged a fuel inlet, the fuel return outlet and an electric connector. Said body 22 is provided with a bore 74 opening in said lower face 42 and upwardly extending right above the armature 58.

[0026] Through the body's 20, 22, 36 of the injector extend a high pressure (HP) channel 76 from the fuel inlet to spray holes provided in the lower end of the nozzle body.

[0027] In the bore 74 of the actuator body 22 is arranged an over-moulded solenoid 78 having a coil wand around a core, said over-moulded solenoid extending in the bore 74 from a lower face 80, flush in surface with the lower face 42 of the actuator's body and in abutment against the body 36 of the control valve, to a top end wherefrom electrical leads upwardly extend and electrically connect the coil to the connector.

[0028] Said over-moulded solenoid 78 further defines an inner bore 82 in which a coil spring 84 is compressed between a pin 86 urged against the top end of the bore 82 and, the armature 58. The upper part of the stem 56 extending above the armature 58 and axially engaging in the coil spring 84 inside said bore 82.

[0029] In operation, fuel pressurized at to a level higher than 2000 bar enters the injector via the inlet and flows in the HP channel 76 toward the spray holes. The HP fuel fills all possible empty spaces and, via grooves and channels arranged in the intermediate plate 44, the fuel fills the control chamber 32. When the solenoid is not energized, the stem downwardly pushed by the coil spring 84 closes the valve seat 60 and the return conduit. Fuel at high pressure then leaks through the functional clearance provided between the stem 56 and the hydraulic bore 48 and, said leaks enter and fill the armature chamber 46 as well as the bore 82 arranged in the solenoid. When the solenoid is energized it generates a magnetic field that upwardly attracts the armature 58, further compressing the coil spring 84 and also lifting the valve seat 60. This opens the return conduit 52 and HP fuel contained in the control chamber 32 is enabled to expel said chamber 32 and flow in the return conduit 52, via other grooves and channels of the intermediate plate 44. Also, because of the armature 58 lifting up, fuel contained in the solenoid bore 82 is forced to exit said bore 82 and to flow around the armature wherefrom it can exit the armature chamber 46 by pushing the ball 70 of the check valve 62, and then the fuel can return to the return circuit 52. Thanks to said check valve 62 pressure around the armature tend to equalize cancelling forces on said armature.

[0030] In use, as mentioned above, all empty spaces are filled with fuel and, the fuel not sprayed via the injection holes has to return to the outlet. For instance, inside

the capnut 18 the annular space S1 surrounding the control valve 14 and, the second annular space S2 around the solenoid 78 and inside the bore 74 provided in the actuator body are filled with the fuel and are fluidly connected to the outlet.

[0031] In a second embodiment of the invention represented on figure 2, in addition to the check valve 62 provided in the body's 36 control valve, a second check valve 88 is arranged inside the solenoid 78 for controlling a fluid connection provided between the inner bore 82, wherein is compressed the coil spring 84, and said second annular space S2. Said second check valve 88 forbids a flow from the bore 82 to said second annular space S2 while enabling flow in the opposite direction.

[0032] Models and conclusive tests have been performed with check valves having balls of 1.5 mm diameter and springs compressed to generate a force of 0.5 N.

[0033] As visible on the figure, said fluid communication arranged in the solenoid 78 comprises a upward channel having a wide portion 90 extending from the top end of the inner bore 82 and which end tapers forming a valve seat 92 at the tip of which is a narrow portion 94 that connects into a radial channel 96 extending to the lateral face of the solenoid so that it opens in said second space S2. Similarly to the first check valve 62 provided in the body's 36 control valve, in said wide portion 90 are arranged a compression spring 98 biasing a ball 100 against said seating face 92. In the embodiment presented, said controlled fluid communication further comprises an orifice 102 axially arranged in the pin 86.

[0034] Alternatively to this spring and ball arrangement, the check valve 88 can also be of a different embodiment such as a reed valve, or the ball replaced by a plate. Also, alternatively to the representation of the figure, the radial channel 94 can be made at an angle

[0035] In use, said second check valve 88 maintains a pressure in the inner bore 82 and tends to further maintain the equal pressures around the armature 58 so that when said armature moves it does not have to overcome additional forces generated by fuel having unequal pressures and that is captured in the inner bore 82 or in the armature chamber 46. Thanks to said check valves 62, 88, the gain curve linearity improves.

LIST OF REFERENCES

[0036]

X	main axis
CP	closed position
OP	open position
S1	first annular space
S2	second annular space
10	fuel injector
12	nozzle assembly
14	control valve assembly
16	actuator assembly
18	capnut
20	body of the nozzle assembly
22	body of the actuator assembly
24	upper guide member
26	bore
28	needle valve member
30	neede head
32	control chamber
34	needle spring
36	body of the control valve
38	lower face, first face, of the body of the control valve
40	upper face, second face, of the body of the control valve
42	lower face of the body of the actuator assembly
44	intermediate plate member
46	recess - armature chamber
48	hydraulic bore
50	bottom face of the recess
52	return conduit
54	armature-and-stem-assembly
56	stem - valve spool
58	armature
60	valve seat
62	check valve in the control valve
64	upper narrow portion
65	seating face
66	lower wider portion
68	spring
70	ball
74	bore
76	high pressure channel
78	solenoid
80	lower face of the solenoid
82	bore in the coil
84	coil spring
86	pin
88	second check valve
90	wide portion
92	valve seat
94	narrow portion
96	radial channel
98	compression spring
100	ball

Claims

1. Fuel injector (10) comprising a control valve assembly (14) arranged between a nozzle assembly (12) and an actuator assembly (16), said control valve assembly (14) having a body (36) extending along a main axis (X) between a transverse first face (38) and an opposed transverse second face (40), and being provided with a recess (46) dug in said second face (40) and a bore (48) opening in the bottom face (50) of said recess and axially extending to the first face (38) of the body, the control valve assembly (14)

further comprising an armature-and-stem-assembly (54, 56, 58) arranged within said recess and bore, the stem forming a valve seat (60) actionable between open and closed positions of a fuel return circuit (52) via a magnetic field generated by a powered solenoid (78) arranged in the body (22) of the actuator assembly, the recess (46) forming a chamber in which the armature (58) is and, the stem (56) forming a sliding valve spool in the bore (48), wherein the control valve assembly (14) further comprises a check valve (62) arranged to prevent flow between the first face (38) of the body and the bottom face (50) of the recess and, to enable flow in the opposite direction, and wherein

the solenoid (78) has an over-moulded core around which is wound a coil defining a central bore (82) axially extending from a transverse lower face (80) of the solenoid toward an end-shoulder face adapted to receive in abutment a pin (86) against which, in use, a valve spring (84) compresses, wherein
the solenoid (78) is further provided with a channel (90, 94, 96) extending inside the over-moulding from said end-shoulder face toward a lateral face of the solenoid and,
wherein said check valve (62) comprises a valve member (70) biased by a spring (68) against a seating face (65) that controls a narrow passage (64) and,
wherein said valve member (70) is a ball and the seating face (65) is a conical face and, said narrow passage (64) extending from the tip of said conical face to the bottom face (50) of the recess and,
characterized in that a second check valve (88) is provided within said channel (90, 94, 96), said check valve (88) preventing, in use fuel flow from said central bore (82) toward the outer lateral face of the solenoid.

2. Fuel injector (10) as claimed in claim 1 wherein the channel (90, 94, 96) comprises an axial portion (90, 94) and a radial portion (96) joining together in a substantially right angle elbow, the axial portion (90, 94) extending from the end-shoulder face toward said elbow and, the radial portion (96) extending from said elbow to said outer lateral face of the solenoid.

3. Fuel injector (10) as claimed in claim 2 wherein said second check valve (88) comprises a valve member (100) biased by a spring (98) against a valve seat (92) controlling a narrow passage (94) joining said elbow.

4. Fuel injector (10) as claimed in claim 3 wherein said valve member is a ball (100) and the seat (92) is a conical face and wherein, said narrow passage (94) joining said elbow extends from the tip of said conical face (92).

Patentansprüche

1. Kraftstoffinjektor (10), der eine Steuerventilanordnung (14) aufweist, die zwischen einer Düsenanordnung (12) und einer Aktuatoranordnung (16) angeordnet ist, wobei die Steuerventilanordnung (14) einen Körper (36) hat, der sich entlang einer Hauptachse (X) zwischen einer ersten Querfläche (38) und einer gegenüberliegenden zweiten Querfläche (40) erstreckt und mit einer in der zweiten Fläche (40) vorgesehenen Aussparung (46) und einer Bohrung (48) versehen ist, die in der unteren Fläche (50) der Aussparung mündet und sich axial zu der ersten Fläche (38) des Körpers erstreckt, wobei die Steuerventilanordnung (14) weiter eine Anker-und-Schaft-Anordnung (54, 56, 58) aufweist, die innerhalb der Aussparung und Bohrung angeordnet ist, wobei der Schaft einen Ventilsitz (60) bildet, der zwischen offener und geschlossener Position einer Kraftstoffrücklaufschaltung (52) über ein Magnetfeld betätigbar ist, das von einem angetriebenen Solenoid (78) erzeugt wird, der in dem Körper (22) der Aktuatoranordnung angeordnet ist, wobei die Aussparung (46) eine Kammer bildet, in der sich der Anker (58) befindet, und der Schaft (56) einen verschiebbaren Ventilschieber in der Bohrung (48) bildet, wobei die Steuerventilanordnung (14) weiter ein Rückschlagventil (62) aufweist, das angeordnet ist, um einen Fluss zwischen der ersten Fläche (38) des Körpers und der unteren Fläche (50) der Aussparung zu verhindern und einen Fluss in die entgegengesetzte Richtung zu ermöglichen, und wobei

der Solenoid (78) einen umspritzten Kern hat, um den herum eine Spule gewunden ist, die eine zentrale Bohrung (82) definiert, die sich axial von einer unteren Querfläche (80) des Solenoids zu einer Endschulterfläche erstreckt, die ausgebildet ist, um einen Stift (86) anliegend aufzunehmen, gegen den in Betrieb eine Ventilfeder (84) zusammendrückt wird, wobei
der Solenoid (78) weiter mit einem Kanal (90, 94, 96) versehen ist, der sich innerhalb der Überspritzung von der Endschulterfläche zu einer Seitenfläche des Solenoids erstreckt, und
wobei das Rückschlagventil (62) ein Ventilelement (70) aufweist, das durch eine Feder (68) gegen eine Sitzfläche (65) vorgespannt ist, das einen schmalen Durchlass (64) steuert, und
wobei das Ventilelement (70) eine Kugel ist und die Sitzfläche (65) eine konische Fläche ist und sich der schmale Durchlass (64) von der Spitze der konischen Fläche zu der unteren Fläche (50) der Aussparung erstreckt, und

dadurch gekennzeichnet, dass ein zweites Rückschlagventil (88) innerhalb des Kanals (90, 94, 96) vorgesehen ist, wobei das Rückschlagventil (88) in Betrieb einen Kraftstoffffluss von der zentralen Bohrung (82) zu der äußeren Seitenfläche des Solenoids verhindert.

2. Kraftstoffinjektor (10) gemäß Anspruch 1, wobei der Kanal (90, 94, 96) einen axialen Teil (90, 94) und einen radialen Teil (96) aufweist, die in einer im Wesentlichen rechtwinkligen Krümmung verbunden sind, wobei sich der axiale Teil (90, 94) von der Endschulterfläche in Richtung der Krümmung erstreckt und sich der radiale Teil (96) von der Krümmung zu der äußeren Seitenfläche des Solenoids erstreckt.

3. Kraftstoffinjektor (10) gemäß Anspruch 2, wobei das zweite Rückschlagventil (88) ein Ventilelement (100) aufweist, das durch eine Feder (98) gegen einen Ventilsitz (92) vorgespannt ist, das einen schmalen Durchlass (94) steuert, der mit der Krümmung verbunden ist.

4. Kraftstoffinjektor (10) gemäß Anspruch 3, wobei das Ventilelement eine Kugel (100) ist und der Sitz (92) eine konische Fläche ist und wobei sich der schmale Durchlass (94), der mit der Krümmung verbunden ist, von der Spitze der konischen Fläche (92) erstreckt.

Revendications

1. Injecteur de carburant (10), comprenant un ensemble à soupape de commande (14) agencé entre un ensemble à gicleur (12) et un ensemble à actionneur (16), ledit ensemble à soupape de commande (14) ayant un corps (36) s'étendant le long d'un axe principal (X) entre une première face transversale (38) et une seconde face transversale opposée (40), et étant pourvu d'un évidement (46) creusé dans ladite seconde face (40) et d'un alésage (48) s'ouvrant dans la face de fond (50) dudit évidement et s'étendant axialement jusqu'à la première face (38) du corps, l'ensemble à soupape de commande (14) comprenant en outre un ensemble à induit et à tige (54, 56, 58) agencé à l'intérieur desdits évidement et alésage, la tige formant un siège de soupape (60) actionnable entre des positions ouverte et fermée d'un circuit de retour de carburant (52) par l'intermédiaire d'un champ magnétique généré par un solénoïde alimenté (78) agencé dans le corps (22) de l'ensemble à actionneur, l'évidement (46) formant une chambre dans laquelle l'induit (58) est, et la tige (56) formant un tiroir de soupape coulissant dans l'alésage (48), dans lequel l'ensemble à soupape de commande (14) comprend en outre une soupape de non-retour (62) agencée pour empêcher l'écoulement entre la première face (38) du corps et la face de fond (50) de l'évidement, et pour permettre l'écoulement dans la direction opposée, et dans lequel

le solénoïde (78) a un noyau surmoulé autour duquel est enroulé une bobine définissant un alésage central (82) s'étendant axialement depuis une face inférieure transversale (80) du solénoïde vers une face d'épaulement d'extrémité adaptée pour recevoir en butée une goupille (86) contre laquelle, durant l'utilisation, un ressort de soupape (84) se comprime, dans lequel
le solénoïde (78) est en outre pourvu d'un canal (90, 94, 96) s'étendant, à l'intérieur du surmoulage, depuis ladite face d'épaulement d'extrémité vers une face latérale du solénoïde et,
dans lequel ladite soupape de non-retour (62) comprend un élément de soupape (70) sollicité par un ressort (68) contre une face de siège (65) qui commande un passage étroit (64), et
dans lequel ledit élément de soupape (70) est une bille et la face de siège (65) est une face conique, et ledit passage étroit (64) s'étend depuis l'embout de ladite face conique jusqu'à la face de fond (50) de l'évidement, et
caractérisé en ce qu'une seconde soupape de non-retour (88) est prévue à l'intérieur dudit canal (90, 94, 96), ladite soupape de non-retour (88) empêchant, durant l'utilisation, l'écoulement de carburant depuis ledit central alésage (82) vers la face latérale extérieure du solénoïde.

2. Injecteur de carburant (10) selon la revendication 1, dans lequel le canal (90, 94, 96) comprend une partie axiale (90, 94) et une partie radiale (96) se joignant dans un coude sensiblement à angle droit, la partie axiale (90, 94) s'étendant depuis la face d'épaulement d'extrémité vers ledit coude, et la partie radiale (96) s'étendant depuis ledit coude jusqu'à ladite face latérale extérieure du solénoïde.

3. Injecteur de carburant (10) selon la revendication 2, dans lequel ladite seconde soupape de non-retour (88) comprend un élément de soupape (100) sollicité par un ressort (98) contre un siège de soupape (92) commandant un passage étroit (94) joignant ledit coude.

4. Injecteur de carburant (10) selon la revendication 3, dans lequel ledit élément de soupape est une bille (100) et le siège (92) est une face conique, et dans lequel ledit passage étroit (94) joignant ledit coude s'étend depuis l'embout de ladite face conique (92).

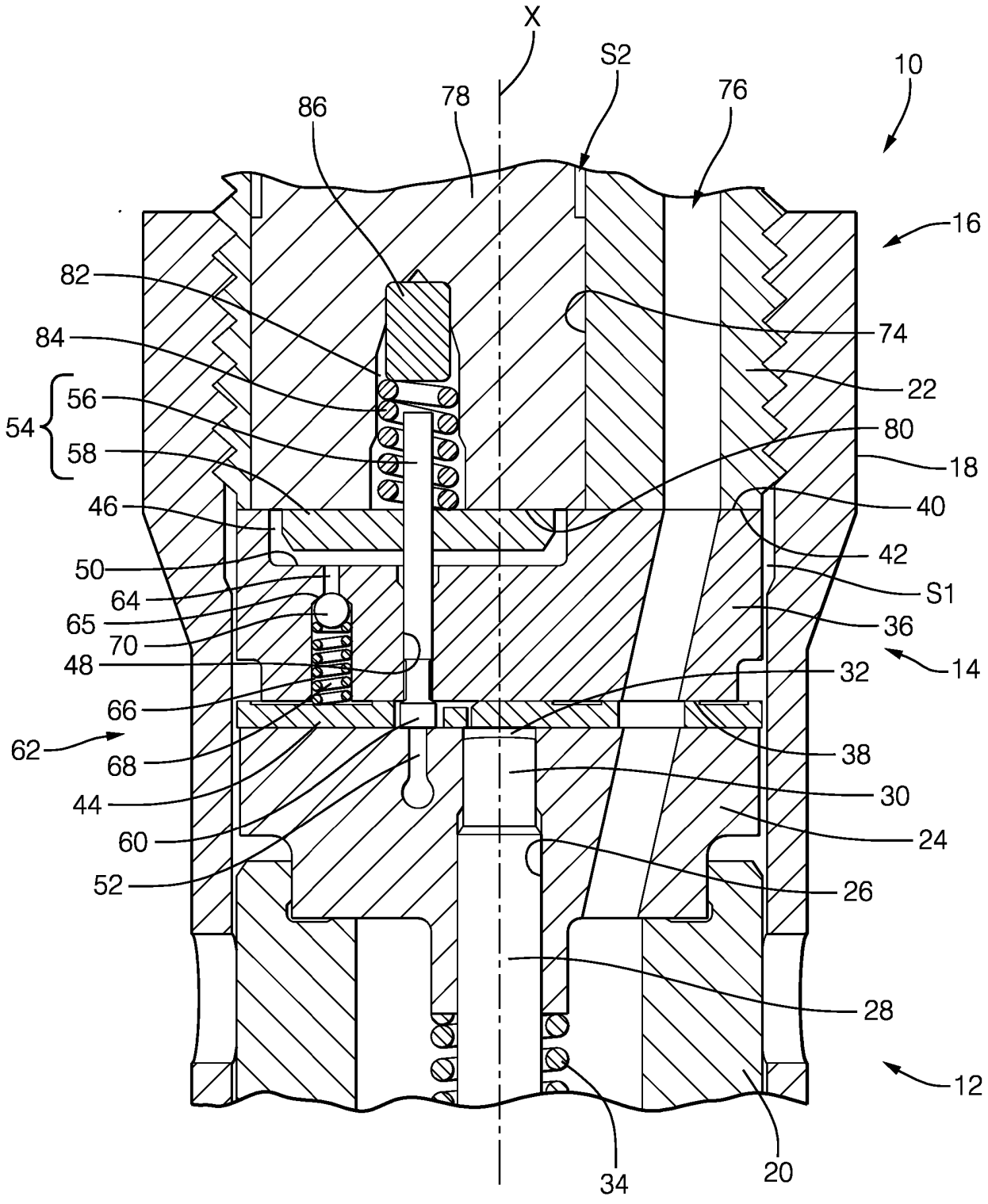
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FIG. 1

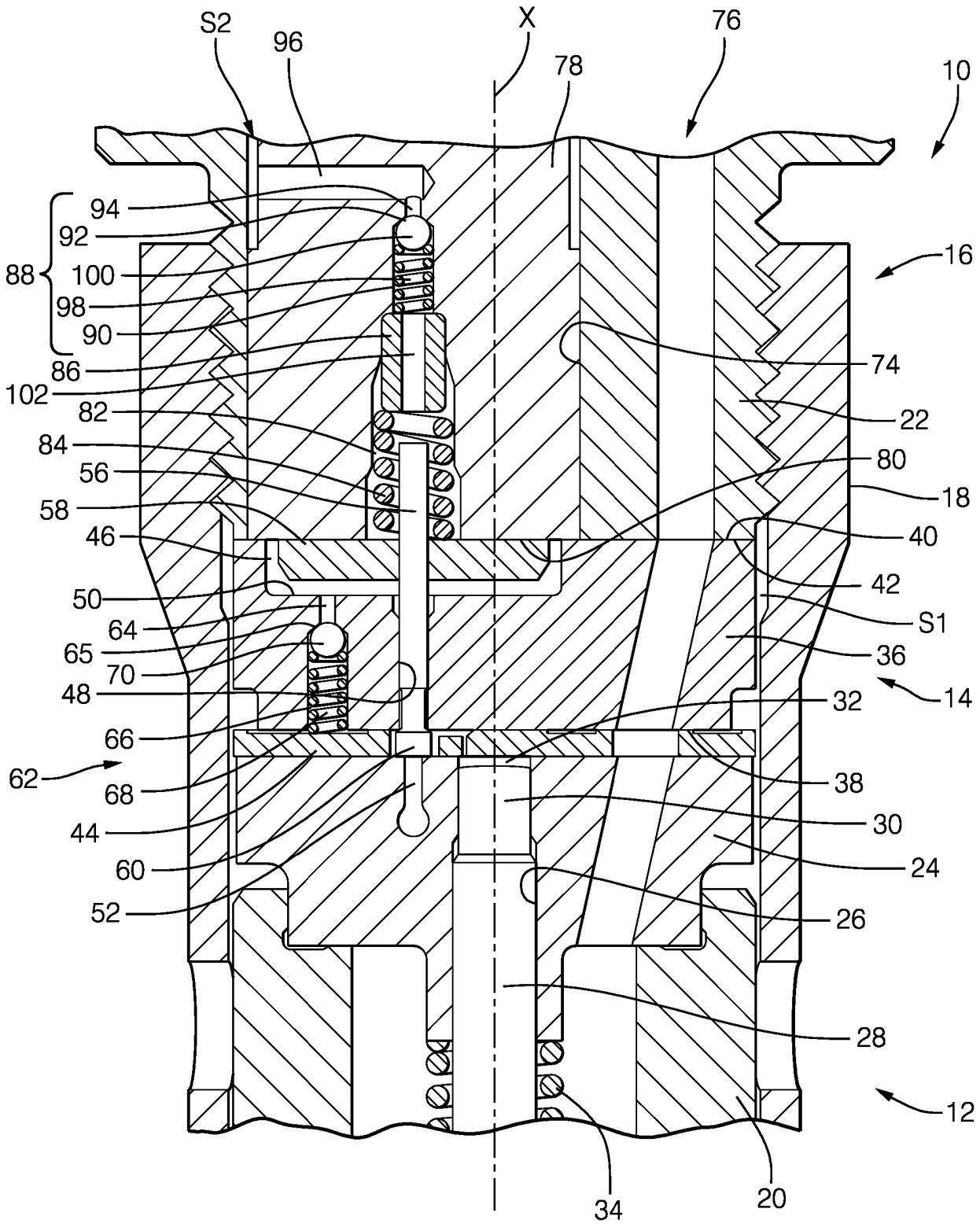
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FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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