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(54) **HIGH-PRESSURE PISTON VOLUMETRIC PUMP**

(57) A piston volumetric pump which comprises:
- a cylinder head provided with an inlet manifold of a fluid and a delivery manifold and a seat for accommodating a delivery valve,
- a cylinder jacket wherein an alternative piston slides, which delimits a compression chamber along with a cylinder,
- said delivery valve comprising a valve body which has a central portion accommodated in the seat and a first portion fitted inside the cylinder jacket,
- a high pressure gasket being interposed between the first portion of the valve body and an inner portion of the cylinder jacket, and a low pressure gasket between the cylinder head and the cylinder jacket, outside the seat,
- a chamber for supplying a low pressure fluid is delimited by at least an outer surface of the side wall of the central portion of the valve body, from at least an inner surface of the cavity and from a surface of the cylinder jacket, said supply chamber being in communication with the inlet duct of the low pressure fluid and with the inlet manifold.

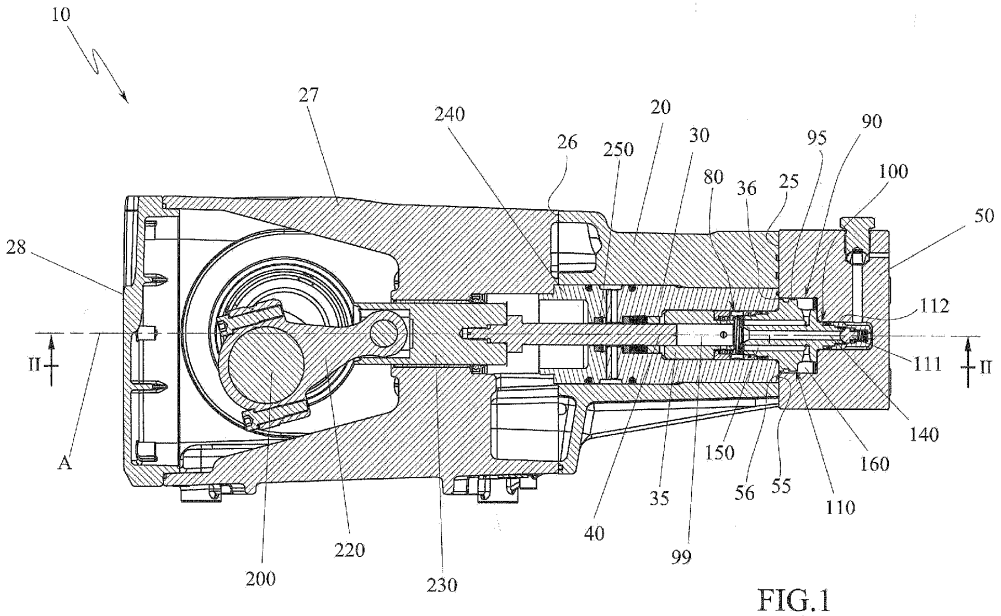

FIG.1

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of piston volumetric pumps which can be installed on high-pressure cleaners or other machines for distributing and/or delivering fluids at high pressure, for example pressures in the order of 1500 bar.

PRIOR ART

[0002] Piston volumetric pumps generally comprise an inlet manifold adapted to be connected to a tank containing the fluid to be pumped (typically water), a delivery manifold adapted to be connected to a fluid dispensing device (e.g. a lance or a dispensing gun) equipped with a terminal nozzle, and a regulating valve, hydraulically interposed between the delivery manifold and the dispensing device, which is designed to regulate the maximum delivery pressure of the fluid.

[0003] In addition, piston volumetric pumps generally comprise a pump casing, defining one or more cylinders, and a head, attached to the pump casing and closing one end of each cylinder. An alternative piston is slidably accommodated inside each cylinder, which, together with the corresponding cylinder and head, defines a respective variable volume compression chamber. The pistons are kinematically connected to a drive shaft (eccentric) via a respective connecting rod-crank mechanism, which is designed to transform the rotary movement of the drive shaft, given by a drive motor, into a linear alternative movement of the piston.

[0004] Each compression chamber is connected to the inlet manifold via a respective inlet check valve and to the discharge manifold via a respective delivery check valve.

[0005] The high pressure of the fluid delivered by the end nozzle is guaranteed by the fluid sealing system on the pistons and the materials used to ensure adequate durability of the sealing system.

[0006] A known sealing system consists, for each piston, of a high-pressure gasket of a stiffer material placed between the cylinder and the delivery valve body and a low-pressure gasket of a softer material placed between each cylinder and the pump head.

[0007] The double gasket system is not particularly efficient because the high-pressure gasket, due to the high pulsating loads, tends, as it wears out, to let high-pressure fluid leak out, which quickly wears out the low-pressure gasket, causing fluid leakage that flows outside the pump casing.

[0008] An object of the present invention is to overcome the mentioned drawbacks of the prior art, within the context of a simple and rational solution and at a contained cost.

[0009] These objects are achieved by the features of the invention set forth in the independent claim. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

DISCLOSURE OF THE INVENTION

[0010] An embodiment of the invention provides a piston volumetric pump comprising:

- a cylinder head provided with an inlet manifold of a fluid and a delivery manifold,
- a cylinder jacket wherein an alternative piston slides, which delimits a compression chamber along with a cylinder,
- said cylinder head comprising a seat for accommodating a delivery valve, which seat comprises at least a first cavity, preferably having a circular section, which has an opening at a cylinder head surface contacting the cylinder jacket,
- said delivery valve comprising a valve body, which has a central portion accommodated in the first cavity, and a first portion fitted inside the cylinder jacket,
- said valve body having a delivery duct of the fluid at high pressure and at least an inlet duct of the fluid at low pressure which has an opening at the compression chamber and an opening flowing onto a side wall of said central portion,
- a high pressure gasket being interposed between the first portion of the valve body and an inner portion of the cylinder jacket, and a low pressure gasket between the cylinder head and the cylinder jacket, outside said cavity,
- a chamber for supplying a low pressure fluid is delimited by at least an outer surface of the side wall of the central portion of the valve body, from at least an inner surface of the cavity and from a surface of the cylinder jacket, said supply chamber being in communication with the inlet duct of the low pressure fluid and with the inlet manifold.

[0011] Thanks to this solution, the flow of fluid from the high-pressure gasket pours into the low-pressure fluid supply chamber, reducing wear on the low-pressure gasket and thus increasing its service life (therefore reducing the need for maintenance work to replace the second gasket).

[0012] One aspect of the invention provides that the side wall of said central portion of the valve body of the delivery valve has an annular groove to increase the volume of the supply chamber.

[0013] This solution lowers the pressure inside the supply chamber by facilitating the entry of fluid flowing from the high-pressure gasket into the supply chamber.

[0014] One aspect of the invention provides that the valve body has a second portion whose free end comprises a valve seat of the delivery valve on which a shutter acts.

[0015] A further aspect of the invention is that the second end portion is accommodated in a second cavity,

preferably having circular section, which is derived from and coaxial with a back wall of the first cavity.

[0016] A further aspect of the invention is that the cylinder jacket is inserted into an outer casing. A further aspect of the invention provides that the cylinder head is fixed to the outer casing.

[0017] These aspects of the invention guarantee greater mechanical robustness for the pump. A further aspect of the invention provides for a low-pressure fluid inlet valve associated with the cylinder.

[0018] Combining the inlet valve with the cylinder makes the pump more compact in size. According to a further aspect of an embodiment of the invention, the inlet valve comprises a shutter having an annular shape for obstructing the opening of the inlet duct and a central hole at the delivery duct.

[0019] The annular shape of the delivery shutter has the advantage of making the shutter and therefore the inlet valve compact, and of being able to have the inlet ducts arranged circumferentially to the central delivery duct, which also makes the valve body of the delivery valve compact.

[0020] A further aspect of the invention provides that the volumetric pump comprises a casing, integral with the outer casing, and within which a thrust crank mechanism is housed associated with the piston.

[0021] This solution allows more efficient implementation of the pump and at the same time keeps the lubrication oil of the thrust crank mechanism separate from the fluid pumped by the pump.

[0022] A further aspect of an embodiment of the invention provides that the volumetric pump comprises a plurality of cylinders within which a respective alternative piston is accommodated.

[0023] This aspect of the invention makes it possible to make pumps with different fluid flow rates.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Further features and advantages of the invention will be more apparent after reading the following description provided by way of non-limiting example, with the aid of the illustrated figures in the accompanying drawings.

Fig.1 is a sectional view of an embodiment of a piston volumetric pump made in a plane containing the axis of a piston.

Fig.2 is a sectional view along the trace of section II-II of Figure 1.

Fig.3 is an enlargement of a portion of Fig.1.

Fig.4 is a further enlargement of a portion of Fig.1

BEST MODE TO IMPLEMENT THE INVENTION

[0025] With particular reference to these figures, a piston volumetric pump that delivers a fluid (typically water at high pressures, i.e. in the order of 1500 bar and above) has been globally referred to as 10.

[0026] The volumetric pump 10 has an outer casing 20, inside of which a cylinder jacket 30 is housed which contains a cylinder 35 in which at least one piston 40 slides which has alternative motion, thanks to a thrust crank mechanism associated with the piston itself. The cylinder 35 may be accommodated within the cylinder jacket 30, so that its axis A is parallel to or preferably coincides with the axis of the cylinder jacket 30 itself.

[0027] The cylinder jacket 30 comprises a first axial end 36, which may be defined by a flat surface oriented orthogonally with respect to the axis of the cylinder 35.

[0028] This first axial end 36 of the cylinder jacket 30 is closed by a cylinder head 50, in which at least one low pressure fluid inlet manifold 60 and at least one low pressure fluid delivery manifold 70 are obtained (Fig.2), a low pressure sealing gasket 55 being interposed between the head 50 and the cylinder jacket 30, which may have an annular shape with an axis parallel or coinciding with the axis A of the cylinder 35 and may be accommodated in a seat 56 obtained on a surface of the axial end 36.

[0029] In the illustrated embodiment, by way of example, an axial end 25 of the casing 20 is coplanar with the axial end 36 of the cylinder jacket 30 and the head 50 rests against both axial ends 25 and 36 and is made integral with the outer casing 20 by means of customary fixing screws, not illustrated.

[0030] The alternative piston 40, together with the corresponding cylinder 35 and cylinder head 50, defines a respective variable volume compression chamber 99.

[0031] In the embodiment illustrated in Fig.2, the positive displacement pump 10, within the casing 20, comprises a plurality of identical cylinders 35, in this case three, spaced apart and parallel to each other in which a respective piston 40 slides. This does not preclude other embodiments of the invention from comprising a different number of cylinders.

[0032] The cylinder head 50 has at the cylinder 35 a seat 90 for receiving a pressure fluid delivery valve 100, which comprises a valve body 110 and a shutter 111 acting on a valve seat 112 of the valve body 110.

[0033] The seat 90 has at least one first cavity 95 having a circular section, for example cylindrical, whose axis is parallel to or coincides with the axis A of the cylinder 35 and/or the cylinder jacket 30.

[0034] With particular reference to Fig. 3 the cavity 95 has an opening 96 at a contact surface between the cylinder head 50 and the first axial end 36 of the cylinder jacket 30.

[0035] The diameter of the opening 96 is smaller than the outer diameter of the cylinder jacket 30, so that between the diameter of the cavity 95, at the opening 96, and the outer diameter of the cylinder jacket 30, there is a seat 56 for accommodating the low-pressure gasket 55, as can be seen in Figs. 3 and 4.

[0036] The valve body 110 of the delivery valve 100 comprises a first portion 120, which is fitted inside the cylinder jacket 30 with the interposition of a high-pressure

gasket 130, and a central portion 115 accommodated inside the cavity 95.

[0037] In the illustrated example, the first portion 120 has two annular bands 121 and 122, of which the first annular band 121 functions as a seat for the sealing gasket 130, while the function of the second annular band 122, located at the free axial end of the first portion 120 will be clarified below.

[0038] The valve body 110 has a high pressure fluid delivery duct 140, preferably coaxial with the longitudinal axis A of the cylinder 35, and at least one low pressure fluid inlet duct 150.

[0039] The inlet duct 150 has an opening 151 at the compression chamber 99, and an opening 152 that flows into a side wall 116 of the central portion 115 of the valve body 110.

[0040] In the illustrated embodiment, by way of example, the first opening 151 is located on a surface of the free end of the first portion 120 of the valve body 110 at the compression chamber 99.

[0041] In the embodiment illustrated, the valve body has eight low-pressure fluid inlet ducts 150 equally angularly equidistant from each other, visible two by two in the figures.

[0042] The central portion 115 of the valve body 110 has a maximum outer diameter greater than the inner diameter of the cylinder jacket 30 and less than the diameter of the first cavity 95, such that a low pressure fluid supply chamber 160 is delimited at least by the side wall 116 of the central portion 115 of the valve body 110, by a portion of the inner surface of the first cavity 95 and by a portion of the surface of the axial end 36 of the cylinder jacket 30, said supply chamber 160 being in communication with each low pressure fluid inlet duct 150 and fluid inlet manifold 60.

[0043] As a result, the high-pressure fluid flowing from the high-pressure gasket 130 pours into the low-pressure fluid supply chamber 160, reducing wear on the low-pressure gasket 55 and thereby increasing its service life. This makes it possible to reduce the maintenance work required to restore the low-pressure gasket 55.

[0044] In the illustrated example on the outer surface of the side wall 116 of the central portion 115 of the valve body 110 at least one annular groove 127 is made to increase the volume of the feed chamber 160.

[0045] In the illustrated embodiment, the seat 90 comprises a second cavity 97, coaxial with the first cavity 95 and derived from the back wall of the first cavity 95, opposed to the opening 96, and accommodates a second portion 118 of the valve body 110.

[0046] The second portion 118 is distal to and opposite the first portion 120.

[0047] In the embodiment illustrated (Fig.3), the free end of the second portion 118 comprises the valve seat 112 on which the shutter 111 of the delivery valve 100 acts. In particular, the shutter 111 is accommodated and adapted to translate inside a support cage 113 which is inserted in an annular groove present at the free end of the second portion 118 of the valve body 110, a high-pressure gasket 119 of the usual type being interposed between the cage and a wall of said groove.

[0048] The shutter 111 is normally held against the valve seat 112 by a compression spring 114 inserted inside the cage 113.

[0049] As can be seen from the figures, the cylinder 35 is associated with a low-pressure fluid inlet valve 80 comprising a shutter 81 to obstruct the openings 151 of the inlet ducts 150. The shutter 81 is annular in shape and has a central hole at the delivery duct 140.

[0050] In particular, in the embodiment illustrated, the cylinder 35 has two respective opposite axial ends shaped like tangs 38 and 39.

[0051] The tang 38, with which the inlet valve 80 is associated, has an outer diameter smaller than the maximum outer diameter of the cylinder and is provided with 4 through-holes 380, angularly equidistant from each other, for the inlet of the fluid into the chamber 100. In the annular space between the outer surface of the shank 38 and an inner surface of the cylinder jacket 30 the supply valve 80 is inserted.

[0052] In detail, the supply valve 80 comprises a cup-shaped body 82 (Fig,4), which is inserted on the tang 38 and which has a hole on the bottom wall for the passage of the tang 38 itself. The open end of the cup-shaped body 82 is accommodated in the annular space defined between the inner surface of the cylinder jacket 30 and the annular band 122 of the first portion 120 of the valve body 110 and has the function of holding the high pressure gasket 130 in place.

[0053] Between the tang 38 and a lateral surface of the cup-shaped body 82 a compression spring 83 is inserted to which the shutter 81 is constrained, which is therefore normally maintained in a closed position, i.e. against the openings 151 of the delivery duct 150. The tang 39 (Fig.4) of the cylinder 35, on the other hand, is inserted in a perforated cavity 300 of the cylinder jacket 30 in which a bushing 180 of the piston 40 is housed, a sealing gasket 181 being interposed between the bushing 180 and the tang 39.

[0054] The outer casing 20 has a second axial end 26 to which a crankcase 27 is fixed, closed at the opposite end by a cover 28. The crankcase 27 houses a crankshaft 200 and three connecting rods 220, each of which is articulated both to the crankshaft 200 and to a rear shaft 230 fixed to a respective piston 40, in such a way as to form a thrust crank mechanism (of the connecting rod-crank type) adapted to transform the rotational movement of the crankshaft 200 into an alternative movement of the piston 40 along the direction defined by its longitudinal axis A.

[0055] The rotation of the crankshaft 200 is driven by a motor (not illustrated) located outside the crankcase 27.

[0056] Between the crankcase 27 and the cylinder jacket 30 there is a perforated clamping body 240 to allow the passage of the piston 40 and which has a seat for accommodating a lip gasket 250 whose function is to

prevent any water leakage from the high pressure gasket 181.

[0057] The invention thus conceived is susceptible to several modifications and variations, all falling within the scope of the inventive concept. Moreover, all the details can be replaced by other technically equivalent elements.

[0058] In practice, the materials used, as well as the contingent shapes and sizes, can be whatever according to the requirements without for this reason departing from the scope of protection of the following claims.

Claims

1. A piston volumetric pump (10) which comprises:

- a cylinder head (50) provided with an inlet manifold (60) of a fluid and a delivery manifold (70),
- a cylinder jacket (30) wherein an alternative piston (40) slides, which delimits a compression chamber (99) along with a cylinder (35) ,
- said cylinder head (50) comprising a seat (90) for accommodating a delivery valve (100), which seat (90) comprises at least a first cavity (95) which has an opening (96) at a cylinder head surface (50) contacting the cylinder jacket (30),
- said delivery valve (100) comprising a valve body (110), which has a central portion (115) accommodated in the first cavity (95), and a first portion (120) fitted inside the cylinder jacket (30),
- said valve body (110) having a delivery duct (140) of the fluid at high pressure and at least an inlet duct (150) of the fluid at low pressure which has an opening (151) at the compression chamber (99) and an opening (152) flowing onto a side wall (116) of said central portion (115),
- a high pressure gasket (130) being interposed between the first portion (120) of the valve body (110) and an inner portion of the cylinder jacket (30), and a low pressure gasket (55) between the cylinder head (50) and the cylinder jacket (30), outside said cavity (95),
- **characterised in that** a chamber (160) for supplying a low pressure fluid is delimited by at least an outer surface of the side wall (116) of the central portion (115) of the valve body (110), from at least an inner surface of the cavity (95) and from a surface of the cylinder jacket (30), said supply chamber (160) being in communication with the inlet duct (150) of the low pressure fluid and with the inlet manifold (60).

2. The volumetric pump (10) according to claim 1, wherein the side wall (116) of said central portion (115) has an annular groove (127) to increase the volume of the supply chamber (160).

3. The volumetric pump (10) according to claim 1, wherein the valve body (110) has a second portion (118) whose free end comprises a valve seat (112) of the delivery valve (100) on which a shutter (111) acts.

4. The volumetric pump (10) according to claim 3, wherein said second end portion is accommodated in a second cavity (97) which originates from a bottom wall before the cavity (95) and is coaxial thereto.

5. The volumetric pump (10) according to claim 1, wherein the cylinder jacket (30) is fitted inside an outer casing (20).

6. The volumetric pump (10) according to claim 5, wherein the cylinder head (50) is fixed to the outer casing (20).

7. The volumetric pump (10) according to claim 1, which comprises an inlet valve (80) of the low pressure fluid associated to the cylinder (35).

8. The volumetric pump (10) according to claim 7, wherein the inlet valve (80) comprises a shutter (81) which has an annular shape to obstruct the opening (151) of the inlet duct (150) and a central hole at the delivery duct (140).

9. The volumetric pump (10) according to claim 1 and 5, comprising a crankcase (27) integral with the casing 20, and within which a crank train associated to the piston 40 is housed.

10. The volumetric pump (10) according to claim 1, **characterised in that** it comprises a plurality of cylinders within which a respective alternative piston (40) is accommodated.

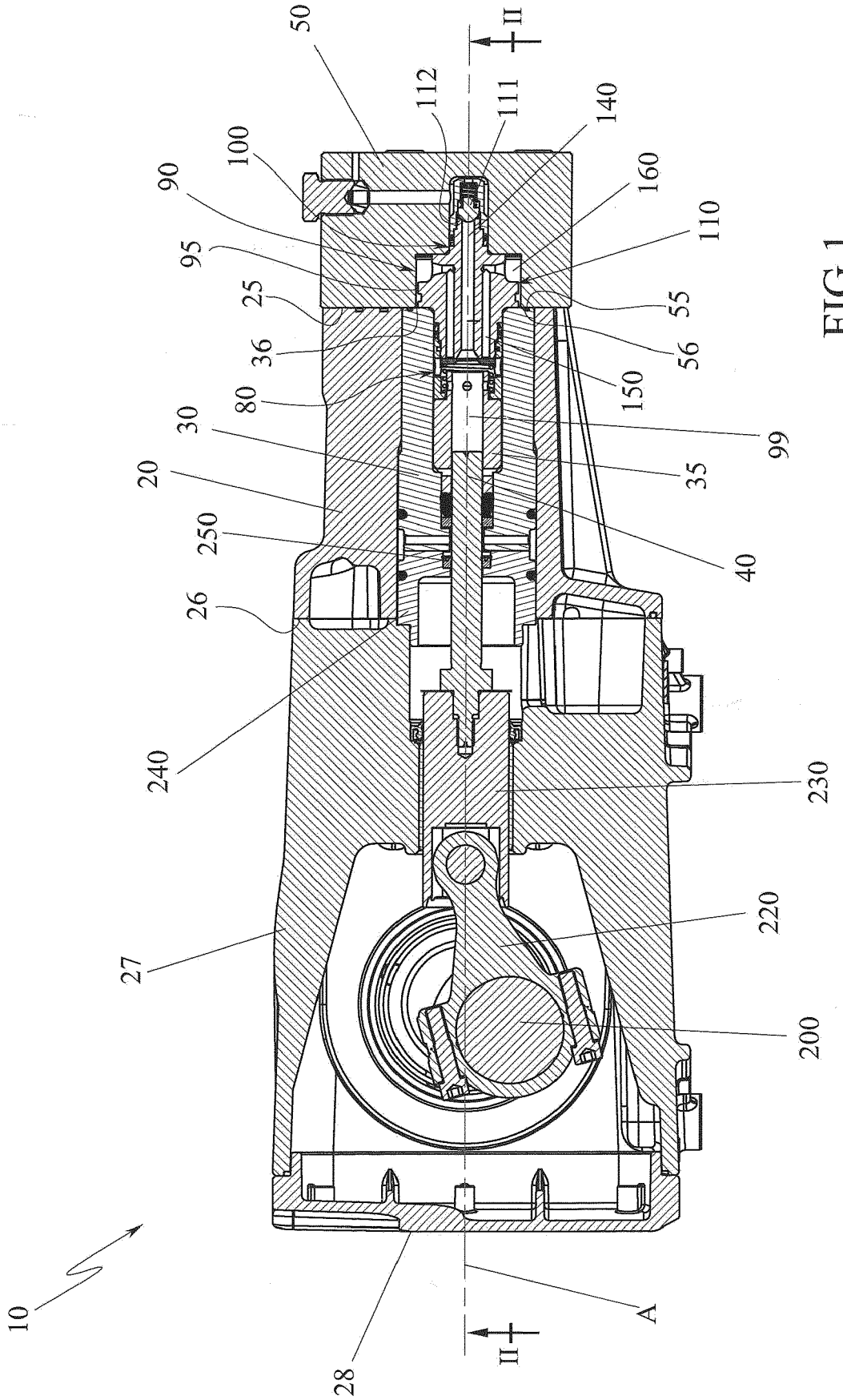
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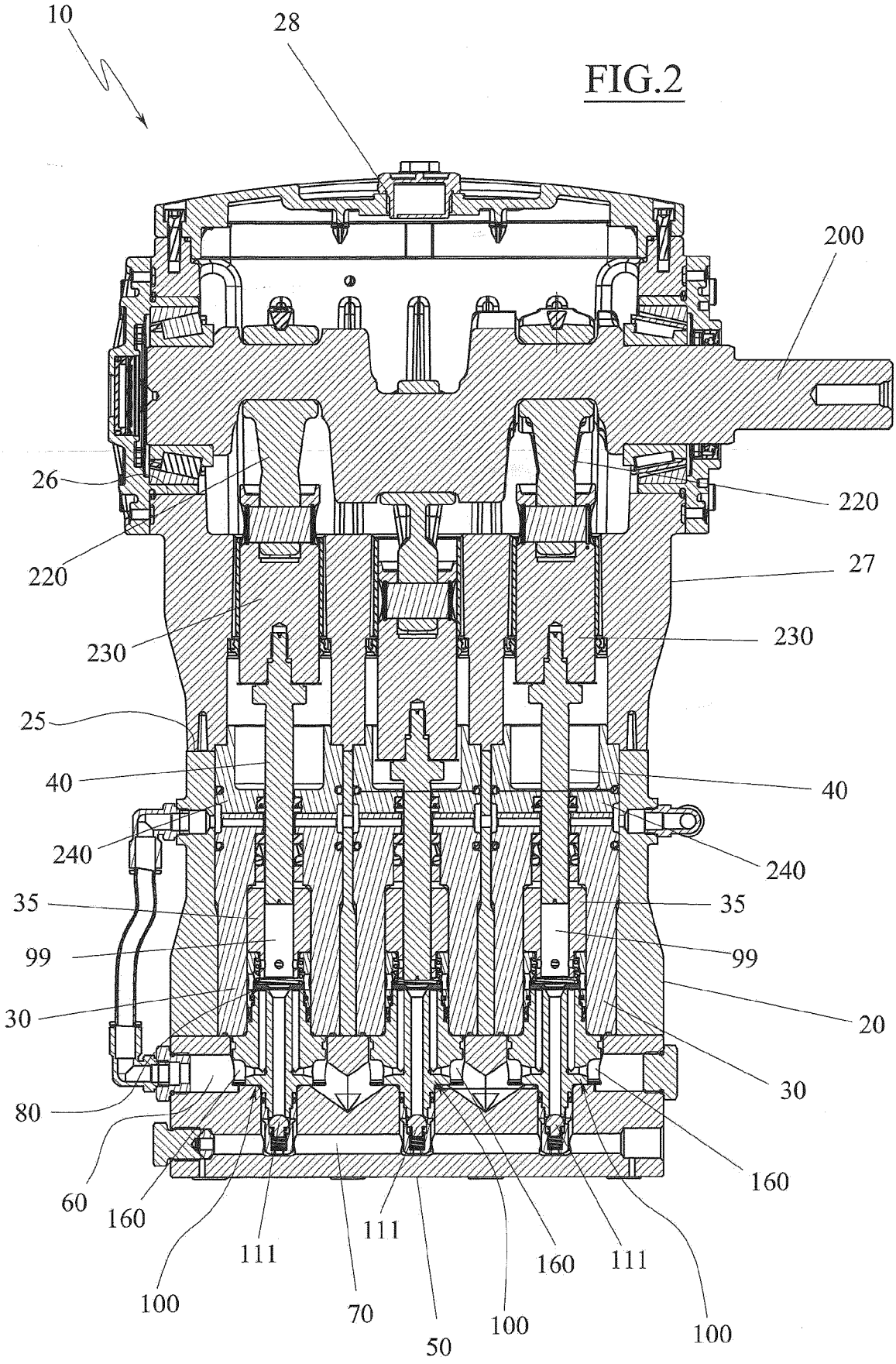
FIG.1

FIG.2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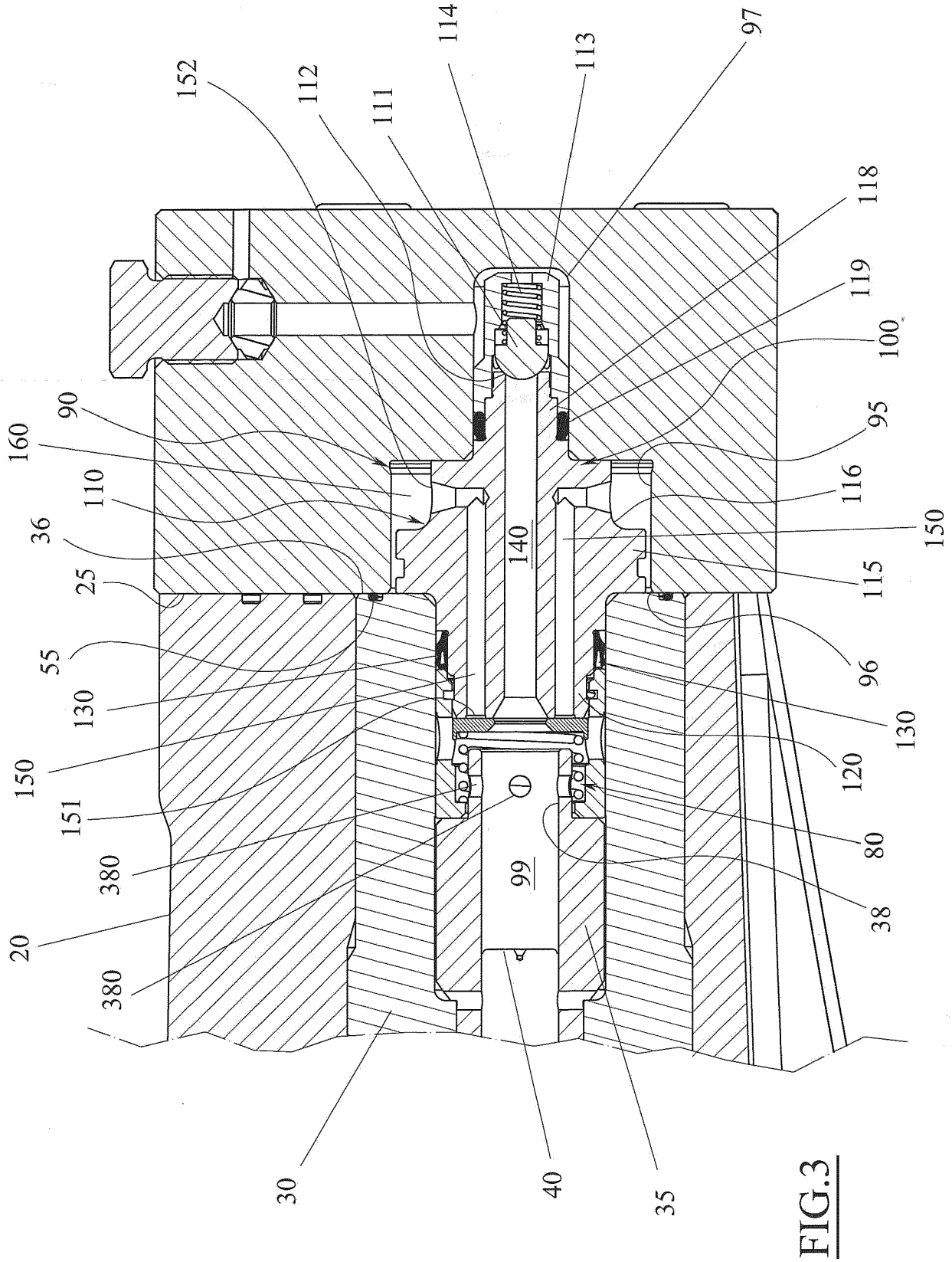
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FIG.3

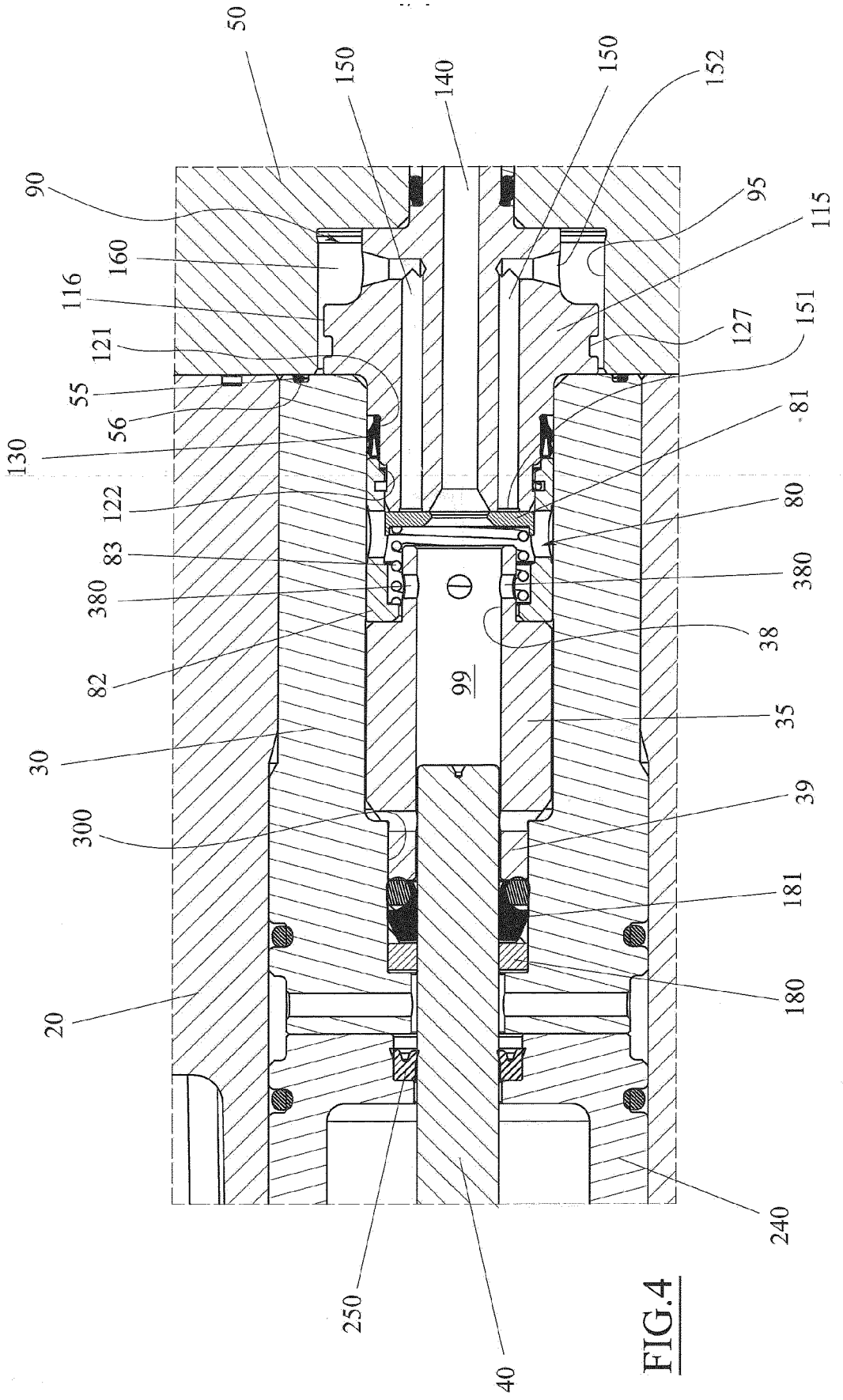
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FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 0445

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TECHNICAL FIELDS SEARCHED (IPC)

F04B
F16K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 July 2022	Gnüchtel, Frank

CATEGORY OF CITED DOCUMENTS

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