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(71) Applicant: **Interpump Engineering S.r.l.**
42100 Reggio Emilia (IT)

(72) Inventor: **Montipo', Fulvio**
42124 REGGIO EMILIA (RE) (IT)

(74) Representative: **Corradini, Corrado et al**
Ing. C. Corradini & C. S.r.l.
Via Dante Alighieri 4
42121 Reggio Emilia (IT)

(54) A pump with a piston guide

(57) A pump (10) comprising a casing (20) to which at least an alternating piston (30) is slidably associated, which piston (30) is destined to delimit, internally of the casing (20), an operating chamber (21) communicating with an inlet (22) and with an outlet (23) for a fluid to be pumped, two annular seals (60, 61) being fixed to the casing (20) and inserted coaxially on the piston (30), and a guide ring (70) inserted coaxially on the piston (30) and fixed to the casing (20) between the annular seals (60, 61), the guide ring (70) comprising a layer (73) containing teflon, which layer (73) defines a cylindrical surface (74) of the guide ring (70) destined to be in contact with a cylindrical surface (36) of the piston (30), the teflon being inserted between the pores of a porous metal material.

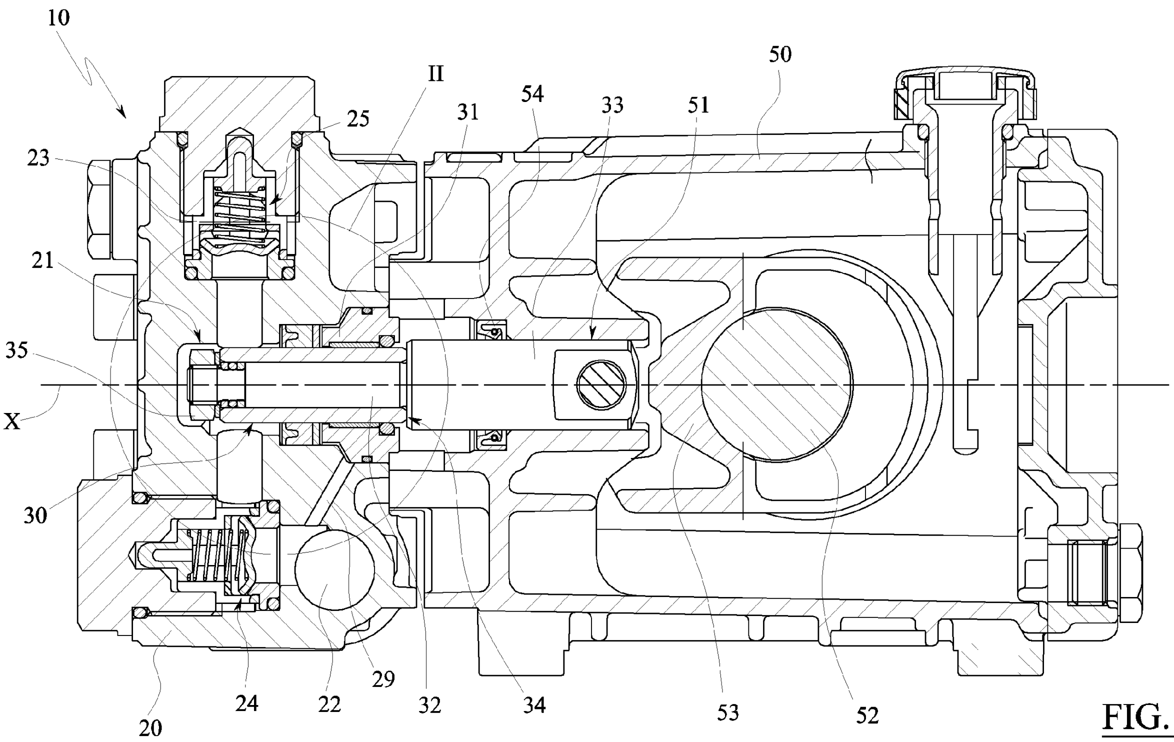

FIG.1

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Description

[0001] The present invention relates to a positive-displacement piston pump, in particular a high-pressure pump.

[0002] As is known, a high-pressure positive-displacement pump comprises an external casing, commonly known as a head, to which one or more pistons are slidably associated, which pistons have an alternating motion, each of which being destined to delimit, internally of the head, a variable-volume operating chamber having a substantially cylindrical shape and communicating with an inlet and an outlet for a fluid to be pumped, respectively via an aspirating valve and a delivery valve.

[0003] The pistons are connected, via respective con rods, to a single crankshaft, which is contained internally of a special casing fixed to the head and is activated in rotation by an external motor, such that each piston alternatively performs an aspiration run, in which it increases the volume of the relative operating chamber, recalling the fluid from the aspirating valve, and a delivery run, in which it reduces the volume of the operating chamber, forcing the fluid to exit in pressure from the delivery valve.

[0004] To ensure hermetic closure of each operating chamber, two annular seals are used in the prior art, which are fixed to the head of the pump, coaxially interposed between the skirt of the piston and the seating in which the piston is slidably housed.

[0005] The seals are reciprocally distanced along the direction defined by the longitudinal axis of the piston, such that the seal closer to the top of the piston is directly subjected to the pressure of the operating chamber and is commonly known as the high-pressure seal, while the more distant seal from the top of the piston is subjected to a lower pressure and is thus commonly known as the low-pressure seal.

[0006] The high-pressure seal has the aim of retaining the fluid internally of the operating chamber, while the low-pressure seal has the aim of preventing fluid leakage which can at times occur from the high-pressure seal; thus the leak is collected and recuperated.

[0007] A brass ring is generally interposed between the high-pressure seal and the low-pressure seal, which brass ring is fixed to the pump head and is inserted coaxially on the piston skirt, which the aim of guiding the alternating motion of the piston.

[0008] Owing to the con-rod-crank shaft activating system, the guide ring is, however, notoriously subject to radial thrusts by the piston, which progressively tend to cause wear thereon.

[0009] This wear leads to a gradual increase in the diameter of the guide ring, which compromises the guide effect of the piston, and further leads to the detachment of small particles of brass which, because of the repeated sliding of the piston, can damage the high- and low-pressure seals, compromising the seal of the operating chamber.

[0010] Some positive-displacement piston pumps also include the presence of rings made of a material having a low coefficient of friction, such as Teflon, which have the function of making the movement of the single pistons more fluent. Owing to the characteristics of the materials they are made of, these rings are however easily wearable and do not have in themselves sufficient rigidity for effectively guiding the pistons, especially in high-pressure pumps.

[0011] An aim of the present invention is to obviate, or at least significantly reduce, these drawbacks in the prior art, with a simple, rational and relatively inexpensive solution.

[0012] This and other aims are attained by the characteristics of the invention as reported in the independent claims. The dependent claims delineate preferred and/or particularly advantageous aspects of the invention.

[0013] In particular, in an embodiment of the invention a pump is provided which comprises a casing to which at least an alternating piston is associated, destined to delimit, internally of the casing, an operating chamber communicating with an inlet and an outlet for a fluid to be pumped, two annular seals fixed to the casing and inserted coaxially on the piston, and a guide ring inserted coaxially on the piston and fixed to the casing between the annular seals.

[0014] In this embodiment of the invention, the guide ring comprises a layer containing teflon, which defines a cylindrical surface of the guide ring destined to be in contact with a cylindrical surface of the piston.

[0015] In particular, the layer containing teflon is made of a porous metal material, for example bronze, and the teflon is inserted between the pores of the said porous metal material.

[0016] Perferably the metal material of the layer containing teflon is in turn unremovably joined to an external cylindrical armature which can be made of plastic or metal, for example brass, aluminium, bronze or more preferably steel, which gives the guide ring a cylindrical bushing conformation. Alternatively, the bushing could be realised entirely of a porous metal material comprising teflon at least at the layer destined to be in direct contact with the piston, or even the whole thickness.

[0017] Thanks to the structure, the bushing facilitates the sliding of the piston and is also more rigid and less subject to wear with respect to the usual guide rings. This bushing is therefore able better to support the radial thrusts of the piston, which is guided more stably to slide along the longitudinal axis thereof, thus reducing the radial oscillations which, as is well-known, can also damage the annular seal rings.

[0018] Further, the dragging between the piston and the teflon-coated layer of the bushing means that particles of teflon are released onto the piston, contributing also to reducing the friction relating to the annular seal rings and thus improving the working duration of the seals themselves.

[0019] In an aspect of the invention, the bushing is coaxially inserted in a support ring, which is housed in a seating in the casing of the pump.

[0020] This support ring has the advantage of further stiffening the bushing, thus also facilitating the mounting and demounting thereof with respect to the pump casing.

[0021] In a further aspect of the invention, the support ring is destined to axially block a first of the annular seals against an abutment of the housing seating. Thanks to this solution, the removal of the support ring also enables easy replacement of the first annular seal ring.

[0022] In a further aspect of the invention, a ring is interposed between the support ring and the first annular seal, which ring has one or more radial grooves, which grooves are in communication with a collecting chamber defined between the support ring and the housing seating, which is further in communication with the inlet of the pump upstream of an aspirating valve.

[0023] In this way, the fluid leakage which can possibly pass through the first annular seal flows into the radial grooves of the intermediate ring towards the collecting chamber, from which the leaked fluid is sent back to the pump aspiration.

[0024] Further, the collecting chamber always contains a certain quantity of fluid in arrival from the aspirating conduit, which facilitates cooling or lubrication of both the bushing and a low-pressure seal.

[0025] In an aspect of the invention, seal means for the collecting chamber are interposed between the support ring and the housing seating.

[0026] Thanks to this solution, the fluid leaks which reach the collecting chamber cannot exit externally but are constrained to return to the pump aspiration.

[0027] In a further aspect of the invention, the support ring further comprises a seating for receiving the second of the annular seals.

[0028] Thanks to this solution, the removal of the support ring also enables easy replacement of the second annular seal ring.

[0029] Further characteristics and advantages of the invention will fully emerge from a reading of the following description, provided by way of non-limited example, with the aid of the accompanying figures of the drawings, in which:

figure 1 is a section of a positive-displacement pump made along a plane containing the axis of a piston;
figure 2 detail II of figure 1;
figure 3 is detail III of figure 2.

[0030] The positive-displacement pump 10 comprises an external casing 20, commonly called a head, to which an alternating piston 30 is associated, which piston is destined to delimit, internally of the head 20, a variable-volume operating chamber 21 having a substantially cylindrical shape.

[0031] The head 20 is further provided with an inlet 22 and an outlet 23 for a fluid to be pumped, which are in communication with the operating chamber 21 respectively via an aspirating valve 24 and a delivery valve 25.

[0032] The piston 30 comprises a cylindrical skirt 31, typically made of a ceramic material, which is coaxially inserted on a support stem 32, typically made of a metal material such as steel.

[0033] The support stem 32 is coaxially fashioned in a single body with a rear cylindrical skirt 33 with a larger diameter, from which it is separated by an abutment 34.

[0034] The cylindrical skirt 31 is axially blocked between the abutment 34 and a locknut 35 screwed to the free end of the support stem 32.

[0035] The rear skirt 33 is located externally of the head 20 and is slidably inserted in a cylindrical guide seating 51, which is afforded in a casing 50 fixed to the head 20.

[0036] The casing 50 houses a crankshaft 52 and a con rod 53, which con rod 53 is hinged to both the rear skirt 33 and to the crankshaft 52, such as to realise a thrust crank mechanism destined to transform the rotary movement of the crankshaft 52 into an alternating motion of the piston 30 along the direction defined by the longitudinal axis X thereof.

[0037] The rotation of the crankshaft 52 is activated by a motor (not illustrated) located externally of the casing 50.

[0038] An annular lip seal 54 is coaxially interposed between the rear skirt 33 and the cylindrical guide seating 51, solidly constrained thereto, such as to retain, internally of the casing 50, the lubricating oil for the joints of the con rod 53 with the crankshaft 52 and the rear skirt 33.

[0039] As illustrated in figure 2, the seal of the operating chamber 21 is achieved by means of two annular seals which are fixed to the head 20 and which are coaxially inserted on the cylindrical skirt 31 of the piston 30, which are a first annular seal 60, known as the high-pressure seal, which is directly subjected to the pressure of operating chamber 21, and a second annular seal 61, called the low-pressure seal, which is located at a greater distance from the top of the piston 30 with respect to the first seal 60.

[0040] The first seal 60 has the aim of retaining the fluid to be pumped internally of the operating chamber 21, while an aim of the second seal 61 is to retain the fluid leakage which might occasionally pass by the first seal 60, and enable it to be recuperated.

[0041] In the illustrated example, the first seal 60 is a lip-seal, while the second seal 61 is a simple o-ring.

[0042] Alternatively, the second seal 61 might also be a more common lip seal.

[0043] A cylindrical guide bushing 70 is located in the space comprised between the first seal 60 and the second seal 61, which guide bushing 70 is fixed to the head 20 and is inserted coaxially snugly on the cylindrical skirt 31, with the aim of guiding the alternating motion of the piston 30.

[0044] As illustrated in figure 3, the guide bushing 70 comprises three cylindrical layers coaxially inserted one in another and joined to one another inseparably, of which an external layer 71 made of stainless steel, which functions as an armature, an intermediate layer 72 made of porous bronze (for example tin bronze or leaded tin bronze), and an internal layer 73, known as a dragging layer, which contains polytetrafluoroethylene (teflon) and defines the internal cylindrical surface 74 of the guide bushing 70 which is destined to be directly in contact with the external cylindrical surface 36 of the skirt 31 of the piston 30.

[0045] In more detail, the guide bushing 70 is obtained starting from the armature 71, made of stainless steel, on which the intermediate layer of porous bronze 72 is sintered. During the stage of lamination, a mixture of polytetrafluoroethylene and lead is inserted in the pores of the layer of porous bronze, such as to realise the dragging layer 73.

[0046] In practice, the dragging layer 73 comprises a polytetrafluoroethylene matrix which permeates and surrounds the surface particles of the intermediate layer of porous bronze 72, such as to be anchored thereto.

[0047] The overall thickness of the guide bushing 70 essentially depends on the piston diameter 30.

[0048] In general, the overall thickness of the guide bushing 70 is comprised between 0.7 and 2.5 mm, of which an intermediate layer 72 of porous bronze occupies a thickness comprised between 0.1 and 0.35 mm, while the dragging layer 73 containing polytetrafluoroethylene occupies a thickness comprised between 0.01 and 0.03 mm.

[0049] Thanks to this structure, the guide bushing 70 facilitates sliding of the piston 30 and is further especially rigid and resistant to wear.

[0050] The guide bushing 70 is therefore able to stably guide the piston 30 to slide along the longitudinal axis X, effectively supporting the radial thrusts and reducing the oscillations of the piston 30 which might damage the annular seals 60 and 61.

[0051] Further, the dragging between the cylindrical skirt 31 and the dragging layer 73 brings about the detachment of particles or microparticles of teflon which also reduce the sliding friction of the piston 30 with respect to the annular seals 60 and 61, thus increasing the working life of the seals 60 and 61.

[0052] In more detail, the guide bushing 70 is coaxially inserted internally of a support ring 80, typically made of brass, which further comprises an annular seating 81 destined to house the second seal 61.

[0053] The support ring 80 is housed in a corresponding housing seating 26, which is afforded in the head 20, in a coaxial position with the opening through which the piston 30 penetrates into the operating chamber 21.

[0054] The housing seating 26 also houses the first seal 60, which is axially blocked between the support ring 80 and an abutment 27 which separates the housing seating 26 from the operating chamber 21.

[0055] In particular, a further intermediate ring 82 is interposed between the support ring 80 and the first seal 60, a flat surface of which ring 82 is grooved by a plurality of fully-developing radial grooves 83.

[0056] As illustrated in figure 2, the support ring 80 is further conformed and dimensioned such that a narrow annular space 28 is defined between the external lateral surface of the support ring 80 and the internal lateral surface of the housing seating 26.

[0057] The space 28 is separated from the operating chamber 21 by the first seal 60; it is separated from the external environment by means of a further annular seal 62, in the example an o-ring, coaxially interposed between the support ring 80 and the housing seating 26; and it is in communication with the inlet 22 of the fluid to be pumped via a conduit 29 which opens upstream of the aspiration valve 24 (see also figure 1).

[0058] In this way, should small quantities of fluid contained in the operating chamber 21 pass beyond the first seal 60, the leaked fluid can flow along the radial grooves 83 of the intermediate ring 82 and reach the space 28, which thus functions as a collecting chamber, such as to be returned to the aspiration of the pump 10.

[0059] Naturally via the conduit 29 the space 28 always contains a certain quantity of fluid coming from the pump 10 aspiration, which fluid is retained internally of the space 28, thanks also to the second seal 61, and facilitates cooling and lubrication of both the bushing 70 and the low-pressure seal 61.

[0060] Note that although in figure 1 a single alternating piston 30 is visible, the positive-displacement pump comprises a plurality of alternating pistons 30, each of which is destined to delimit a respective operating chamber 21 communicating with the inlet 22 and with the outlet 23 via respective aspirating 24 and delivery 25 valves.

[0061] Obviously a technical expert in the second might make numerous modifications of a technical-applicational nature to the pump, without its thus forsaking the ambit of the invention as claimed herein below.

Claims

1. A pump (10) comprising a casing (20) to which at least an alternating piston (30) is slidably associated, which piston (30) is destined to delimit, internally of the casing (20), an operating chamber (21) communicating with an inlet (22) and with an outlet (23) for a fluid to be pumped, two annular seals (60, 61) being fixed to the casing (20) and inserted coaxially on the piston (30), and a guide ring (70) inserted coaxially on the piston (30) and fixed to the casing (20) between the annular seals (60, 61), wherein the guide ring (70) comprises a layer (73) containing teflon, which layer (73) defines a cylindrical surface (74) of the guide ring (70) destined to be in contact with a cylindrical surface (36) of the piston (30), **characterised in that** the teflon is inserted between the pores of a porous metal material.

2. The pump (10) of claim 1, **characterised in that** the porous metal material is sintered.

3. The pump (10) of claim 1, **characterised in that** the porous metal material is bronze.

4. The pump (10) of claim 1, **characterised in that** the porous metal material is unremovably joined to an external cylindrical armature (71).

5. The pump (10) of claim 4, **characterised in that** the external armature (71) is made of a material selected from among: brass, aluminium, bronze and steel.

6. The pump (10) of claim 1, **characterised in that** the guide ring (70) is conformed as a cylindrical bushing.

7. The pump (10) of claim 6, **characterised in that** the bushing (70) is coaxially inserted in a support ring (80), which is housed in a housing seating (26) of the casing (20).

8. The pump (10) of claim 7, **characterised in that** the support ring (80) is destined to axially block a first seal (60) of the annular seals against an abutment (27) of the housing seating (26).

9. The pump (10) of claim 8, **characterised in that** an intermediate ring (82) is interposed between the support ring (80) and the first annular seal (60), which intermediate ring (82) has one or more annular grooves (83) which are in communication with a collecting chamber (28) defined between the support ring (80) and the housing seating (26), which collecting chamber (28) is further in communication with the inlet (22) of the pump (10) upstream of an aspirating valve (24).

10. The pump (10) of claim 9, **characterised in that** seal means (62) for the collecting chamber (28) are interposed between the support ring (80) and the housing seating (26).

11. The pump (10) of claim 7, **characterised in that** the support ring (80) comprises a seating (81) destined to house a second annular seal (61) of the annular seals.

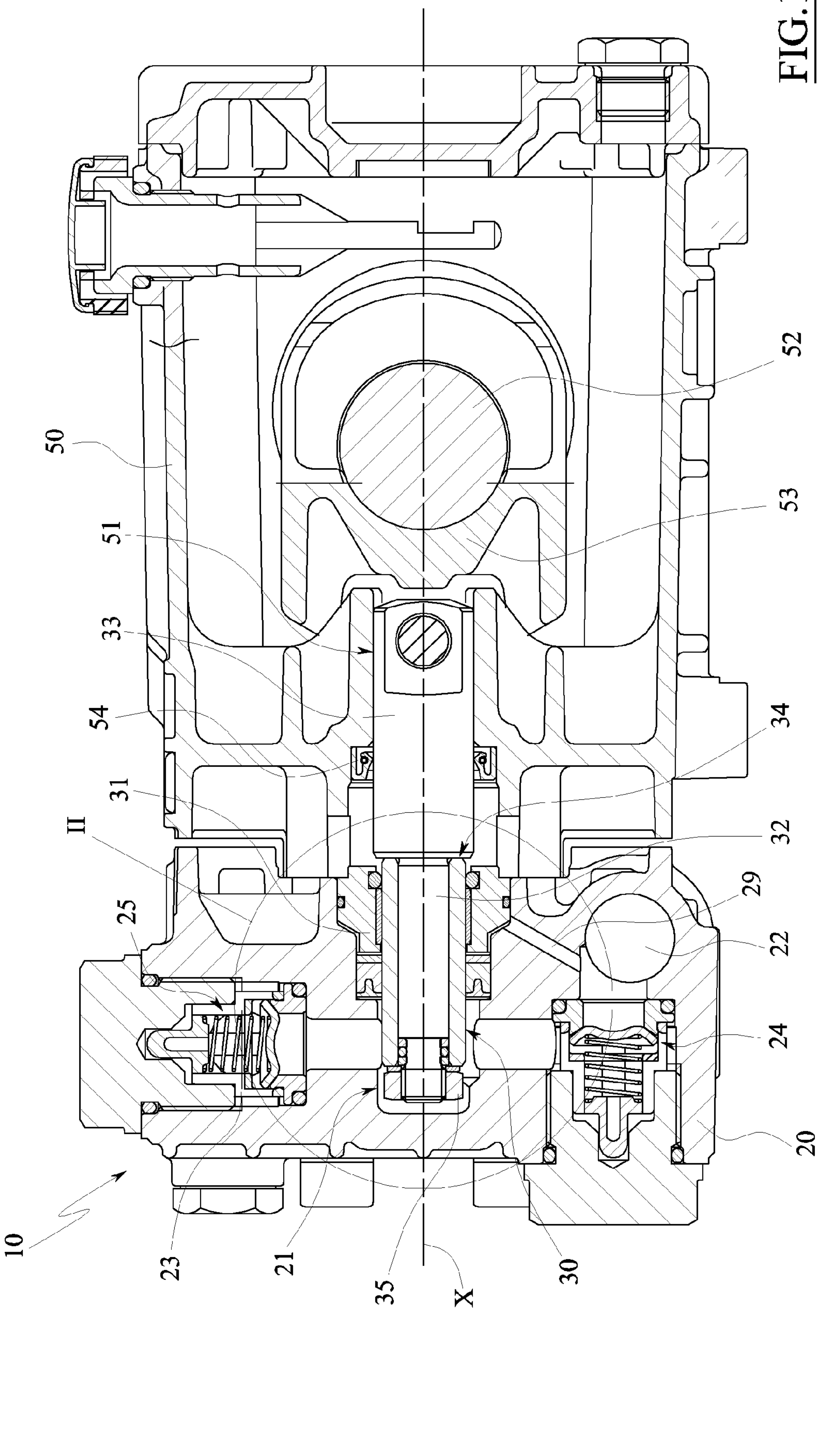

FIG.1

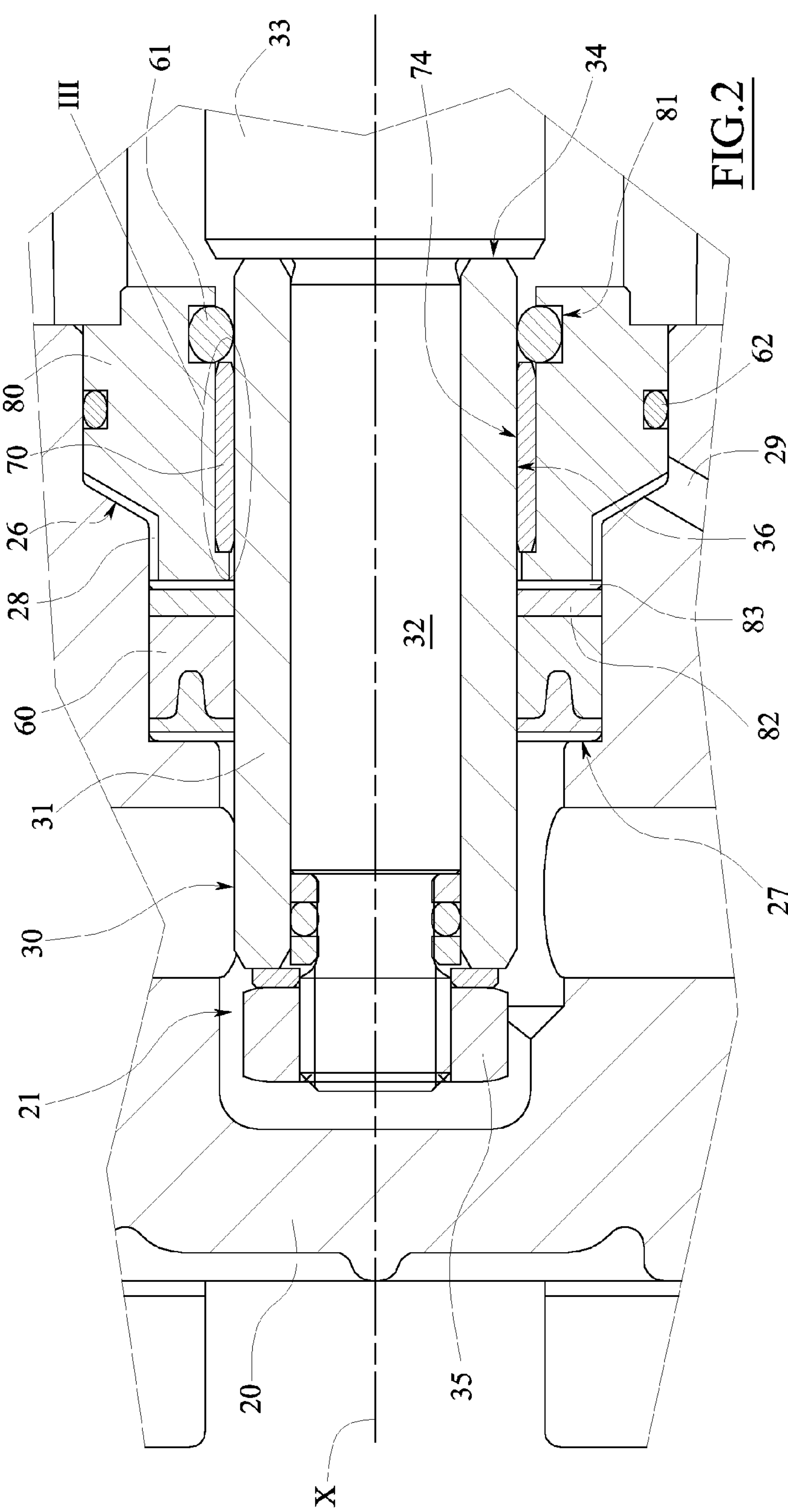
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FIG.2

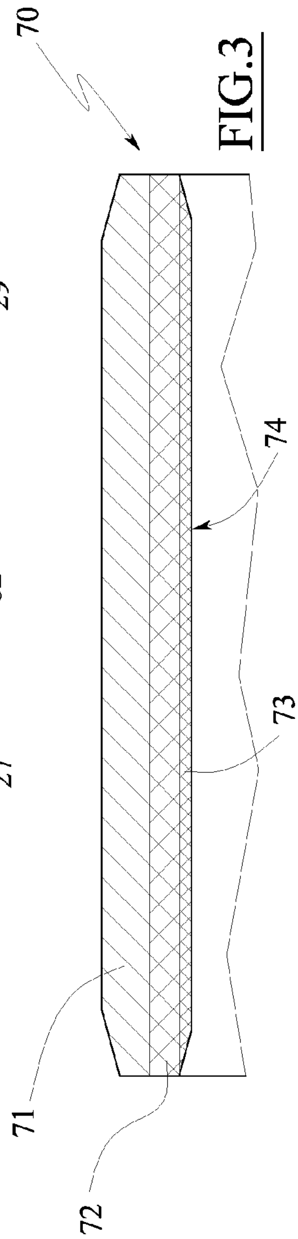
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FIG.3

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EUROPEAN SEARCH REPORT

Application Number
EP 11 19 2008

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	5 April 2012	Jurado Orenes, A

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