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(54)

Reciprocating pump

(57) Reciprocating pump (1) comprising at least one head (3) provided with a shaped body (4) wherein one main chamber (7), a suction conduit (9) and an outlet conduit (10) are obtained; the shaped body (4) is provided with an inner face (5) mechanically connected to the pump body (2), and an outer face (8) facing the opposite direction with respect to the inner face (5) and closed by a closing cover (25).

Furthermore, each head (3) comprises a first check valve (12), which is housed in a first seat (11) obtained in the shaped body (4) and arranged to intercept the suction conduit (9), and a second check valve (14), which is housed in a second seat (13) obtained in the shaped

body (4) and arranged to intercept the outlet conduit (10).

The first seat (11) and the second seat (13) are respectively provided with a first opening (16) and a second opening (17) obtained on the outer face (8) of the shaped body (4), through which the first check valve (12) and the second check valve (14) are accessible respectively in the first seat (11) and in the second seat (13).

Each head (3) further comprises a valve cover (18) fixed on the outer face (8) of the shaped body (4), being interposed between the outer face (8) of the shaped body (4) and the closing cover (25). The valve cover (18) ends up abutting against the first check valve (12) and the second check valve (14) for holding them respectively locked in the first seat (11) and in the second seat (13).

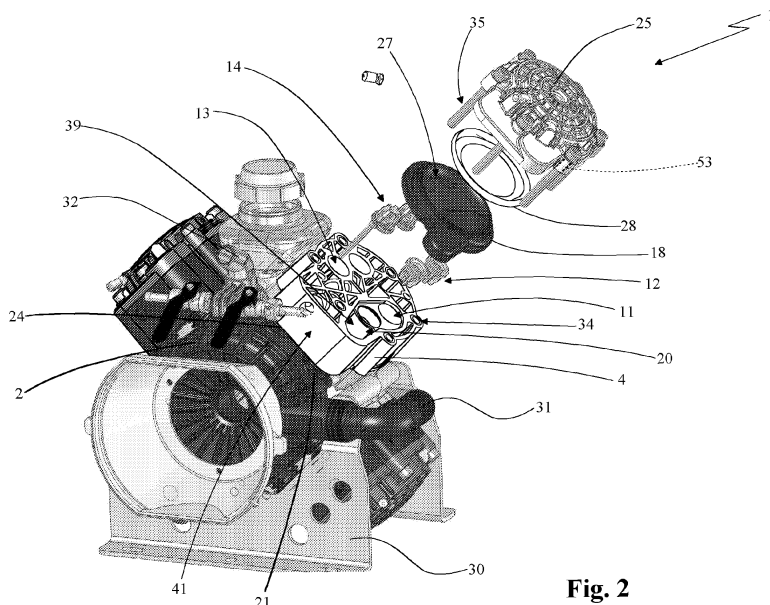


Fig. 2

Description

Field of application

[0001] The present invention regards a reciprocating pump according to the preamble of the independent claim.

[0002] The reciprocating pump in question falls within the industrial field for the production of pumps for farming machines, and it is in particular intended to be used for drawing a fluid from a source, for example a cistern or a water reservoir, and conveying it under pressure to a plurality of supply nozzles with the aim of spraying crops with liquid products, such as crop protection products, water, etc.

State of the art

[0003] As known, the use of reciprocating pumps, which comprise, conventionally, a pump body on which a plurality of heads are mounted, is widely spread in the agricultural sector. Each head defines, alongside the pump body, one main pumping chamber connected to a suction conduit and to an outlet conduit, through which a fluid to be pumped (for example a liquid crop protection product) respectively enters and flows out from the main chamber.

[0004] More in detail, each head comprises a shaped body provided with two opposite faces, of which an outer face facing towards the outer part of the pump and therefore intended to remain exposed, and an inner face intended to be mechanically coupled to the pump body.

[0005] On the inner face of the shaped body a semi-spherical concavity, which partly delimits the main chamber and it is closed by a membrane held between the shaped body of the head and the pump body, is obtained. Such membrane is actuated by suitable actuation means to move, with reciprocating motion, between a first position moving away from the head for suctioning the fluid from the suction conduit, and a second position approaching the head for conveying the pressurised fluid to the outlet conduit.

[0006] More in detail, the operation of each head of the reciprocating pump provides for a suctioning step, in which the membrane is displaced by the actuation means in the first position thereof creating a vacuum in the main chamber for suctioning - into the latter - the fluid from the suction conduit, and an outlet step, in which the membrane is displaced in the second position thereof creating an overpressure in the main chamber for discharging the fluid from the pumping chamber and conveying it under pressure to the outlet conduit.

[0007] The suction conduit and the outlet conduit of each head develop from the main chamber in opposite directions then proceed laterally to the main chamber with an orthogonal angle. More in detail, each conduit (suction and outlet conduit, respectively) has a first section connected to the main chamber and parallel to the

inner face of the head, and a second section, contiguous and orthogonal to the first, which terminates with a port (suction and outlet port, respectively) on the inner face of the head.

[0008] Furthermore, on the shaped body of each head two seats arranged to intercept the suction and outlet conduit are obtained, in which a first and a second check valve are respectively arranged. The first valve arranged in the suction conduit allows the entry of the fluid into the main chamber from the suction port, while the second valve arranged in the outlet conduit allows the fluid to flow from the main chamber towards the outlet port.

[0009] More in detail, the seat of each valve is arranged laterally with respect to the overall dimension of the main chamber at the angle of the conduit formed by the connection between the first section thereof and the second section thereof.

[0010] The reciprocating pump of known type briefly described above revealed some drawbacks in practice.

[0011] A first drawback derives from the fact that the first sections of the outlet and suction conduits which connect the main chamber to the corresponding check valves are relatively long. Such first sections, in practice, increase the volume of the main chamber, causing a reduction of the compression ratio of the pump, defined as the ratio between the maximum volume of the main chamber (assumed during the suctioning step) and the minimum volume thereof (assumed during the outlet step). More in detail, during the outlet step a considerable volume of liquid is not discharged by the head and remains in the first section of the outlet conduit between the valve and the main chamber. Such liquid volume is suctioned into the main chamber during the subsequent suctioning step causing a reduction of the amount of fluid that the pump can suction from the inlet conduit. This implies a reduction of the flow rate of the pump with an ensuing performance drop.

[0012] Furthermore, the high dimensions of the first sections of the outlet and suction conduits imply that during the step of starting the pump, there be - inside such first sections - a considerable amount of air that causes long periods of priming of the pump with the ensuing further performance drop.

[0013] A further drawback arises from the fact that the suction and outlet conduits of the pump of the known type briefly described above develop in a particularly twisted manner and have various blind angular areas. This facilitates stagnation - in the suction and outlet conduits - of air bubbles which cause a further reduction of the flow rate capacity of the pump.

[0014] A further drawback is related to the fact that the arrangement of the suction and outlet conduits and of the corresponding valves laterally to the main chamber of the head considerably increases the width of the head with an ensuing considerable increase of the overall dimensions of the pump.

[0015] With the aim of at least partly overcoming the abovementioned drawbacks, reciprocating pumps of the

membrane type, in which the check valves of each head are positioned within the overall dimension of the pumping chamber were introduced in the market.

[0016] For example, patents WO 99/20898, US 2,873,688, US 2,287,841, US 2,779,353 and US 2,964,029 describe reciprocating membrane pumps of the known type, in which each head comprises a shaped body provided with an outer face facing towards the outer part of the pump and an inner face intended to be coupled to a pump body of the reciprocating pump. On the inner face of the shaped body a concavity, defining partly one main pumping chamber and closed by a membrane held between the shaped body and the pump body, is obtained.

[0017] More in detail, the main chamber is connected to a suction conduit and to an outlet conduit respectively by means of a first opening and a second opening obtained on the inner face of the shaped body.

[0018] Furthermore, the head comprises a first check valve arranged to intercept the suction conduit to allow the entry of the fluid to be pumped into the main chamber, and a second check valve arranged to intercept the outlet conduit to allow the fluid to exit from the main chamber.

[0019] More in detail, the first check valve is housed in a first seat, which is obtained on the inner face of the shaped body inside the main chamber, at the abovementioned first opening which connects the main chamber to the suction conduit. The second check valve is housed in a second seat, which is obtained in the outlet conduit at the abovementioned second opening which connects the main chamber to the same outlet conduit.

[0020] A first drawback of the pumps of the known type described in patents WO 99/20898, US 2,873,688, US 2,287,841, US 2,779,353 and US 2,964,029 is due to the fact that the provision of the first check valve in the pumping chamber implies difficult access of the valve into the respective seat, with ensuing assembly problems during the step of producing the pump.

[0021] Furthermore, replacing the check valves requires disassembling the entire shaped body of the head from the pump body, with ensuing long periods of time to perform the replacement operations.

[0022] A further drawback is due to the fact that the check valves are not held sufficiently firmly within the corresponding seats, and therefore they are subject to easy dislodging from the seats thereof following the pressure exerted thereon by the flow pumped during the operation of the pump.

Disclosure of the invention

[0023] The main object of the present invention is therefore to overcome the drawbacks revealed by the solutions of known type, by providing a reciprocating pump that is simple to assemble, and which requires lower times to perform maintenance operations, in particular for replacing the check valves of the heads.

[0024] Another object of the present invention is to pro-

vide a reciprocating pump which is totally operatively reliable.

[0025] Another object of the present invention is to provide a reciprocating pump that is simple to construct and inexpensive to produce.

[0026] Another object of the present invention is to provide a reciprocating pump having small dimensions and being easy to install.

[0027] Another object of the present invention is to provide a reciprocating pump that is operatively efficient, in particular having considerably low starting times. Another object of the present invention is to provide a reciprocating pump capable of supplying, considering other conditions unvaried, a considerable fluid flow rate.

Brief description of the drawings

[0028] The technical characteristics of the invention, according to the abovementioned objects, are clearly observable from the content of the claims indicated below and the advantages thereof shall be more apparent from the following detailed description, provided with reference to the attached drawings, representing an embodiment thereof provided purely by way of non-limiting example wherein:

- figure 1 shows a side view of the reciprocating pump subject of the present invention;
- figure 2 shows a perspective view of the reciprocating pump illustrated in figure 1, with a detail in exploded view regarding a head of the pump;
- figure 3 shows a section of the reciprocating pump illustrated in figure 1 according to the line III - III of figure 1, with some parts removed for showing the others better;
- figure 4 shows a detail of the reciprocating pump illustrated in figure 3 regarding a head of the pump.

Detailed description of a preferred embodiment

[0029] With reference to the attached drawings the reciprocating pump subject of the present invention is indicated in its entirety with 1.

[0030] According to the embodiment illustrated in the attached figures, the reciprocating pump 1 in question comprises a pump body 2 intended to be fixed, for example, to the framework of a farming machine by means of two metal brackets 30. The pump body 2 is connected to an inlet conduit 31, for drawing a fluid from a source (for example a well or a cistern mounted on the farming machine), and to an outlet conduit 32 for conveying the pressurised fluid for example to supply nozzles mounted on the farming machine.

[0031] The fluid to be pumped is typically a liquid, such as for example water or more generally aqueous solutions, in which chemical compounds can be dissolved with the aim of obtaining farming products, such as pesticides, fertilisers, etc. With reference to figures 1 and 2,

on the pump body 2 of the reciprocating pump 1 a plurality of heads 3, for example four, arranged around a central axis X of the reciprocating pump 1 and equally spaced with respect to each other, are mounted.

[0032] Obviously, without departing from the scope of protection of the present patent, the number of the heads 3 may also be different from the represented one and the reciprocating pump 1 may be intended for any purpose even different from that of distributing farming products, mentioned above.

[0033] Each head 3 comprises a shaped body 4, which is fixed perimetally by means of fixing means 35 to the pump body 2 and defines with the latter one main pumping chamber 7. Furthermore, in the shaped body 4 at least one suction conduit 9, through which the fluid to be pumped enters into the main chamber 7, and at least one outlet conduit 10, through which the fluid to be pumped flows out from the main chamber 7, are defined.

[0034] The suction conduits 9 of the heads 3 are connected, by means of a first collector obtained on the pump body 2, to the inlet conduit 31 of the reciprocating pump 1 for drawing the fluid from the source. The outlet conduit 10 of the heads 3 are in turn connected, by means of a second collector obtained also on the pump body 2, to the outlet conduit 32 of the reciprocating pump 1 for conveying the pressurised fluid to the supply nozzles of the farming machine.

[0035] With reference to figures 3 and 4, the shaped body 4 of each head 3 is provided with two faces 5, 8, whose inner face 5 is mechanically coupled to the pump body 2 delimiting the main chamber 7 therewith, and an outer face 8 facing the opposite direction with respect to the inner face 5 and closed by a closing cover 25.

[0036] In particular, between the two faces 5, 8 - in the shaped body - first through holes 34 are obtained, through which the fixing means 35 are inserted, preferably comprising bolts or screws fastened on corresponding female screws obtained on the pump body 2, for fixing the head 3 to the pump body 2.

[0037] On the inner face 5 of the shaped body 4 a first substantially cap-shaped concavity 6, in particular semi-spherical, which delimits the main chamber 7, is obtained. The latter is intended to be closed by a first membrane 36 of the head 3 held between the shaped body 4 and the pump body 2 of the reciprocating pump 1.

[0038] Such first membrane 36 is actuated to move inside the main chamber 7 by actuation means 42, with reciprocating motion along a direction of movement Y, moving away from the head 3 for suctioning the fluid into the main chamber 7 through the suction conduit 9, and approaching the head 3 for discharging the pressurised fluid through the outlet conduit 10.

[0039] In the shaped body 4, furthermore, at least one first seat 11 is defined, arranged to intercept the suction conduit 9 and in which a first check valve 12 is housed, which allows the fluid to flow from the inlet conduit 31 of the reciprocating pump 1 towards the main chamber 7 of the head 3, and at least one second seat 13 is defined,

arranged to intercept the outlet conduit 10 and in which a second check valve 14 is arranged, which allows the fluid to flow moving away from the main chamber 7 towards the outlet conduit 32 of the reciprocating pump 1.

Advantageously, the first check valve 12 and the second check valve 14, arranged to respectively intercept the suction conduit 9 and the outlet conduit 10, are substantially positioned within the projection of the main chamber 7 in the direction of movement Y of the first membrane 36.

[0040] More in detail, with reference to figure 4, the projections d1 and d2, respectively of the first check valve 12 and of the second check valve 14, on a plane α orthogonal to the direction of movement Y fall within the projection D of the first concavity 6 of the main chamber 7 on the same plane α .

[0041] According to the present invention, each first seat 11 is provided with a first opening 16 obtained on the outer face 8 of the shaped body 4, through which the first check valve 12 is accessible in the corresponding first seat 11.

[0042] Furthermore, each second seat 13 is provided with a second opening 17 obtained on the outer face 8 of the shaped body 4, through which the second check valve 14 is accessible in the corresponding second seat 13.

[0043] The first opening 16 and the second opening 17 allow, advantageously, the insertion - respectively - of the first check valve 12 and of the second check valve 14 respectively in the first seat 11 and in the second seat 13, during the step of assembling the reciprocating pump 1, i.e. during the possible operations for replacing the check valves 12, 14.

[0044] Advantageously, the first seat 11 and the second seat 13 are respectively provided with a first base 37' and of a second base 37'', on which the first check valve 12 and the second check valve 14 respectively rest.

[0045] More in detail, with reference to the embodiment illustrated in figure 4, the first seat 11 and the second seat 13 are preferably cylindrical-shaped, are limited - at the lower part - respectively by the first base 37' and by the second base 37'', and are laterally limited by a corresponding first and second lateral wall 70', 70'' orthogonal to the first base 37' and to the second base 37'', respectively. Advantageously, the first and the second base 37', 37'' respectively of the first and of the second seat 11, 13 are arranged parallel to the inner face 5 of the shaped body 4, and are respectively aligned with the first opening 16 and with the second opening 17 respectively of the first and of the second seat 11, 13 to allow an easy insertion therein of the first and of the second check valve 12, 14 respectively.

[0046] According to the idea on which the present invention is based, each head 3 comprises a valve cover 18 fixed on the outer face 8 of the shaped body 4, being interposed between the outer face 8 of the shaped body 4 and the abovementioned closing cover 25.

[0047] The valve cover 18 ends up in abutment on the first check valve 12 and on the second check valve 14

at the first opening 16 and the second opening 17 respectively, for holding the first check valve 12 and the second check valve 14 locked in the first seat 11 and in the second seat 13, respectively.

[0048] More in detail, the valve cover 18 ends up in abutment on the first check valve 12 and on the second check valve 14 respectively keeping them pressed on the first base 37' of the first seat 11 and on the second base 37" of the second seat 13.

[0049] Advantageously, the valve cover 18 is provided with a closing face 38 facing towards the shaped body 4, which delimits - at least partly - the suction conduit 9.

[0050] Preferably, the valve cover 18 is provided with a connection concavity 40 obtained on the closing face 38 thereof and counterfaced with the first opening 16 of the first seat 11, to partly limit the suction conduit 9 allowing the passage of the fluid to be pumped into the first seat 11, as described in detail hereinafter. Advantageously, the first seat 11 of the first check valve 12 is interposed between the first section 19 of the suction conduit 9, connected to the main chamber 7, and a second section 20 of the suction conduit 9.

[0051] Such second section 20 comprises a first portion, which develops from a suction port 21 obtained on the inner face 5 of the shaped body 4 up to a third opening 39 obtained on the outer face 8 of the shaped body 4, and a second portion delimited by the connection concavity 40 of the valve cover 18 and which extends from the third opening 39 to the first opening 16 of the first seat 11. Advantageously, at least two first seats 11, which house two corresponding first check valves 12, are provided.

[0052] Preferably, two first sections 19 of the suction conduit 9 parallel to each other, and each of which develops from the corresponding first seat 11 to the first concavity 6 of the main chamber 7, are provided. Furthermore, only one second section 20 of the suction conduit 9, whose second portion is connected to both the first seats 11 by means of the first openings 16 of the latter, is provided. Preferably, with reference to the embodiment illustrated in figure 4, the first section 19 of the suction conduit 9 is connected to the corresponding first seat 11 by means of one fourth opening 71 obtained on the first lateral wall 70' of the first seat 11.

[0053] Advantageously, two second seats 13 are provided, which house two corresponding second check valves 14 and are interposed between a third section 22 of the outlet conduit 10, connected to the main chamber 7, and a fourth section 23 of the outlet conduit 10 which extends between the second seats 13 and an outlet port 24 obtained on the inner face 5 of the shaped body 4.

[0054] More in detail, two third sections 22 of the outlet conduit 10, parallel to each other and orthogonal to the inner face 5 of the shaped body 4, are provided. Each of the abovementioned third sections 22 develops between a fifth opening 72 obtained on the second base 37" of the corresponding second seat 13 and the first concavity 6 of the main chamber 7.

[0055] Preferably, the fourth section 23 develops between the two second seats 13 and it is connected to the latter by means of two corresponding sixth openings 73 obtained on the second lateral walls 70" of the second seats 13.

[0056] In particular, the fourth section 23 of the outlet conduit 10 comprises a first part connected to the two second seats 13 and which develops parallel to the inner face 5 of the shaped body 4, and a second part which develops orthogonally to the first part and which terminates on the inner face 5 with the outlet port 24, preferably in proximity of a lateral face 41 of the shaped body 4. Advantageously, the closing face 38 of the valve cover 18 closes the second openings 17 of the second seats 13, so that the fluid coming from the main chamber 7 converges into the fourth section 23 of the outlet conduit 10 through the sixth openings 73 obtained on the second lateral walls 70" of the second seats 13.

[0057] The reciprocating pump 1, as mentioned previously, comprises actuation means 42 adapted to move the first membrane 36 of each head 3 inside the corresponding main chamber 7 for suctioning the fluid from the inlet conduit 31 of the reciprocating pump 1 and conveying it under pressure to the outlet conduit 32.

[0058] According to a particular embodiment of the present invention, the actuation means 42 comprise several pistons 43, each of which is connected to the corresponding first membrane 36 and it is actuated to move, with reciprocating motion, inside a corresponding jacket obtained in the pump body 2 by a transmission shaft (not illustrated) mounted within the pump body 2 coaxially to the central axis X of the reciprocating pump 1. In particular, each piston 43 is moved by a connecting rod mechanically connected to an eccentric fixed to the transmission shaft.

[0059] Operatively, the operation of each head 3 of the reciprocating pump 1 provides for the succession of several operating cycles in which the fluid is suctioned into the main chamber 7 by the inlet conduit 31 of the reciprocating pump 1 through the suction conduit 9, and it is conveyed under pressure in the outlet conduit 32 of the reciprocating pump 1, through the outlet conduit 10.

[0060] More in detail, each operating cycle provides for a suctioning step, in which the first membrane 36 is displaced by the corresponding piston 43 in a first position moving away from the head 3. Following such movement of the first membrane 36, a vacuum is created inside the main chamber 7 adapted to suction - into the latter - the fluid from the suction conduit 9. Subsequently, an outlet step is provided, in which the first membrane 36 is displaced by the piston 43 in a second position approaching the head 3. Following such movement of the first membrane 36, an overpressure is created in the main chamber 7 adapted to discharge the fluid from the latter through the outlet conduit 10.

[0061] The first check valves 12 arranged in the first seats 11 of the suction conduit 9 allow the fluid to flow, during the suctioning step, from the inlet conduit 31 of

the reciprocating pump 1 to the main chamber 7 and prevent the fluid from flowing back, during the outlet step, into the inlet conduit 31 through the suction conduit 9; the second check valves 14 arranged in the second seats 13 of the outlet conduit 10 allow the fluid to flow, during the outlet step, from the main chamber 7 to the outlet conduit 32 of the reciprocating pump 1 and prevent the fluid from flowing back, during the suctioning step, into the main chamber 7 through the outlet conduit 10.

[0062] With reference to figure 4, each check valve 12, 14 comprises a retention body 44 made of plastic material, substantially concave-shaped. Such retention body 44 is formed by a plurality of webs 45, which are connected at the ends thereof to a ring 46 provided with a central through hole 47 to allow the entry of the fluid, and at the other end to a closing disc 48. The webs 45 are spaced from each other so as to define the fissures 49 to allow the exit of the fluid from the retention body 44.

[0063] Furthermore, each check valve 12, 14, comprises a metal plate 50 movable in a guide obtained within the retention body 44 and connected to a spring 51, which is fixed to the closing disc 48 of the retention body 44 and presses the metal plate 50 against the ring 46, to close the central hole 47.

[0064] Still with reference to figure 4, each first check valve 12 is inserted into the corresponding first seat 11 with the closing disc 48 of the retention body 44 resting on the first base 37' of the first seat 11 and with the ring 46 facing towards the first opening 16 of the first seat 11.

[0065] Advantageously, the valve cover 18 comprises an abutment portion 52 which develops projecting from the closing face 38 of the valve cover 18, partly fits into the first openings 16 of the first seats 11, abutting against the ring 46 of each first check valve 12 for holding the latter immobile in the corresponding first seat 11, leaving the gap of the central hole 47 free thus allowing the passage of the fluid.

[0066] Each second check valve 14 is inserted into the corresponding second seat 13 with the ring 46 resting on the second base 37" of the second seat 13, and with the central hole 47 of the ring 46 aligned with the third section 22 of the outlet conduit 10 connected to the main chamber 7.

[0067] The closing disc 48 of each second check valve 14 receives - in abutment - the closing face 38 of the valve cover 18, which holds the second check valve 14 immobile in the corresponding second seat 13 pressing it against the second base 37" of the latter.

[0068] Operatively, the fluid may pass through the check valve 12, 14 entering into the retention body 44 through the central hole 47 of the ring 46 and exiting through the fissures 49 defined between the webs 45.

[0069] More in detail, when the fluid presses on the surface of the metal plate 50 facing towards the outer part of the retention body 44 it moves the metal plate 50 towards the closing disc 48 compressing the spring 51 and thus causing the opening of the central hole 47 of the ring 46. The fluid can thus enter into the concavity of

the retention body 44 through the central hole 47 of the ring 46 and exit through the fissures 49.

[0070] When the fluid enters into the retention body 44 of the check valve 12, 14 through the fissures 49, the spring 51 maintains the metal plate 50 pressed against the ring 46 keeping the central hole 47 closed.

[0071] According to the embodiment illustrated in figure 4, the closing cover 25, which is fixed to the outer face 8 of the shaped body 4 of the head 3 abutting against the valve cover 18 to hold it integral with the shaped body 4, preferably rests on a peripheral edge of the shaped body 4 enclosing the valve cover 18 therein. Advantageously, with reference to the embodiment illustrated in figures 1 and 2, the closing cover 25 is fixed to the shaped body 4 by means of the fixing means 35 which fix the shaped body 4 to the pump body 2. In particular, such fixing means 35 consist of elongated screws inserted into second through holes 53 obtained on the closing cover 25 and aligned to the corresponding first through holes 34 of the shaped body 4.

[0072] Advantageously, the valve cover 18 is provided with an annular flange 56, which is held between the outer face 8 of the shaped body 4 and a peripheral shoulder 57 of the closing cover 25.

[0073] More in detail, the peripheral shoulder 57 of the closing cover 25 defines an undercut within which the annular flange 56 of the valve cover 18 is inserted. Such shoulder is preferably counter-shaped with respect to the annular flange 56 to allow the closing cover 25 to hold - particularly firmly - the valve cover 18 to the shaped body 4 of the head 3.

[0074] Advantageously, the closing cover 25 of each head 3 defines - with the valve cover 18 - a secondary chamber 26 connected to the outlet conduit 10 by means of one or more seventh openings 27 obtained on the valve cover 18.

[0075] Inside the secondary chamber 26 a sealing body 28 is arranged, which consists, for example, of a second flexible membrane 54. The latter is held between the valve cover 18 and the closing cover 25, and defines with the latter a compensation chamber 29. Such second membrane 54 separates the compensation chamber 29 from the outlet conduit 10, preventing the fluid pumped from the main chamber 7 from entering into the compensation chamber 29 during the operation of the reciprocating pump 1.

[0076] Advantageously, the valve cover 18 is provided with a first peripheral groove 58 obtained on the outer face 8, and inside which a first perimeter projection 59 of the second membrane 54 extended towards the valve cover 18 is inserted, so as to hold the second membrane 54 inside the secondary chamber 26. More in detail, the first peripheral groove 58 is obtained on an edge of the valve cover 18 and it is laterally delimited by a lateral portion of the closing cover 25. Preferably, the second membrane 54 comprises a second perimeter projection 60 extending towards the closing cover 25 of the head 3 and inserted into a second groove 61 obtained on the

closing cover 25.

[0077] Operatively, the sealing body 28 of each head 3 is movable between a third position approaching the closing cover 25, in which the sealing body 28 is pushed towards the bottom of the closing cover 25 by an amount of fluid which enters into the secondary chamber 26 from the outlet conduit 10 passing through the seventh openings 27, when the first membrane 36 discharges the fluid from the main chamber 7, and one fourth position moving away from the bottom of the closing cover 25, in which the sealing body 28 discharges the abovementioned amount of fluid from the secondary chamber 26 through the seventh openings 27, when the first membrane 36 suctions another fluid into the main chamber 7 through the suction conduit 9.

[0078] Thus, the reciprocating pump 1 is capable of pumping the fluid with a substantially constant outlet flow rate, without discontinuity when supplying the fluid between the suctioning step and the outlet step.

[0079] According to the embodiment illustrated in detail in figure 4, the closing cover 25 is substantially cap-shaped, which defines a second concavity 55 which widens the secondary chamber 26 defined alongside the valve cover 18.

[0080] The compensation chamber 29, defined by the second membrane 54 and by the closing cover 25, is filled with a pressurized gas, or a gas mixture (for example air), suitable to push the second membrane 54 moving away from the bottom of the closing cover 25. More in detail, during the suctioning step of the reciprocating pump 1, the pressurised gas mixture keeps the second membrane 54 pressed against the valve cover 18 for discharging - from the secondary chamber 26 - the fluid that had entered therein during the outlet step of the previous operating cycle.

[0081] Preferably, the secondary chamber 26 of each head 3 is connected, by means of the seventh openings 27 to the second seats 13 of the second check valves 14 downstream of the latter, in particular at the second openings 17 thereof for facilitating the entry of the fluid into the secondary chamber 26 during the outlet step.

[0082] Therefore, the invention thus described attains the preset objects.

[0083] More in detail, the provision of the valve cover 18 on the outer face 8 of the shaped body 4 of the head 3 and abutment against the check valves 12, 14, according to the present invention, allows holding the check valves 12, 14 in the respective seats 11, 13 in a simple and inexpensive manner from a construction point of view.

[0084] In particular, during the assembly of the reciprocating pump 1 in question, it is sufficient to arrange the check valves 12, 14 in the corresponding seats 11, 13 and then fixing the valve cover 18 to the outer face 8 of the shaped body 4, without requiring further operations for fixing the check valves 12, 14 into the seats 11, 13.

[0085] Furthermore, the provision of the valve cover 18 according to the present invention, allows an easy

and quick access to the check valves 12, 14, in particular to replace the latter, in that it is sufficient to remove the valve cover 18 and the closing cover 25, without requiring disassembling the entire shaped body 4 of the head 3 from the pump body 2.

[0086] Furthermore, the provision of the check valves 12, 14 inside the projection of the main chamber 7 along the direction of movement Y allows positioning the check valves 12, 14 very close to the first concavity 6 of the main chamber 7. This considerably reduces the dimensions of the first 19 and third 22 sections respectively of the suction 9 and outlet 10 conduits which connect the main chamber 7 to the seats 11, 13, determining a substantial reduction of the volume of the main chamber 7 and thus an ensuing increase of the compression ratio of the reciprocating pump 1. More in detail, the volume of the liquid, which - during the outlet step - remains in the third section 22 of the outlet conduit 10 and which is suctioned into the main chamber 7 during the suctioning step, is extremely small and therefore it does not substantially limit the volume of the fluid suctioned from the source through the suction conduit 9, with an ensuing improvement of the flow rate capacity of the reciprocating pump 1. Furthermore, the two first check valves 12 in the suction conduit 9 and the two second check valves 14 in the outlet conduit 10 have small dimensions with respect to the valves used in the pumps of known type. This allows further reducing the distance of the check valves 12, 14 from the main chamber 7 with a further improvement of the compression ratio and thus the flow rate capacity of the reciprocating pump 1 subject of the present invention.

[0087] Furthermore, during the step of starting the reciprocating pump 1, the small dimensions of the suction 9 and outlet 10 conduits allow the stagnation of a substantially negligible amount of air therein. This facilitates a quick priming of the reciprocating pump 1 without requiring long idle pumping times for discharging the air present in the suction 9 and outlet 10 conduits.

[0088] Furthermore, the provision of the check valves 12, 14 in the projection of the main chamber 7, and not laterally to the latter (as provided for in the pumps of known type), allows reducing, considering the same performance, the width of the heads 3.

Claims

1. Reciprocating pump (1), comprising:

- a pump body (2);
- at least one head (3), which is mounted on said pump body (2) by means of which it defines at least one main chamber (7), and it is provided with at least one suction conduit (9) through which a fluid to be pumped enters into said main chamber (7), and at least one outlet conduit (10) through which said fluid to be pumped flows out

from said main chamber (7);

said at least one head (3) comprising:

- a shaped body (4) wherein said suction conduit (9) and said outlet conduit (10), are at least partly obtained, such shaped body (4) is provided with an inner face (5) mechanically connected to said pump body (2) and defining with said pump body (2) said main chamber (7), and with an outer face (8) facing the opposite direction with respect to said inner face (5) and closed by a closing cover (25);
- at least one first check valve (12), which is housed in at least one first seat (11) obtained in said shaped body (4) and arranged to intercept said at least one suction conduit (9); through said at least one first check valve (12) said fluid flowing towards said main chamber (7);
- at least one second check valve (14), which is housed in at least one second seat (13) obtained in said shaped body (4) and arranged to intercept said at least one outlet conduit (10); through said at least one second check valve (14) said fluid flowing moving away from said main chamber (7);

said at least one first seat (11) being provided with at least one first opening (16) obtained on the outer face (8) of said shaped body (4), through whose first opening (16) said at least one first check valve (12) is accessible in said at least one first seat (11); said at least one second seat (13) being provided with at least one second opening (17) obtained on the outer face (8) of said shaped body (4), through such second opening (17) said at least one second check valve (14) is accessible in said at least one second seat (13);

said reciprocating pump (1) being **characterised in that** said at least one head (3) comprises a valve cover (18) fixed on the outer face (8) of said shaped body (4), being interposed between the outer face (8) of said shaped body (4) and said closing cover (25);

said valve cover (18) abutting against said at least one first check valve (12) and against said at least one second check valve (14) respectively at said at least one first opening (16) and said at least one second opening (17), for holding said at least one first check valve (12) and said at least one second check valve (14) respectively locked in said at least one first seat (11) and in said at least one second seat (13).

2. Reciprocating pump (1) according to claim 1, **characterised in that** said valve cover (18) is provided with a closing face (38) facing towards said shaped body (4), which delimits - at least partly - said suction

conduit (9).

3. Reciprocating pump (1) according to claim 2, **characterised in that** said valve cover (18) is provided with a connection concavity (40) obtained on said closing face (38) and counterfaced with said at least one first opening (16) of said at least one first seat (11) to limit - at least partly - said suction conduit (9).
4. Reciprocating pump (1) according to claim 3, **characterised in that** said at least one first seat (11) is interposed between a first section (19) of said suction conduit (9), connected to said main chamber (7), and a second section (20) of said suction conduit (9), which comprises a first portion which develops from a suction port (21) obtained on the inner face (5) of said shaped body (4) up to a third opening (39) obtained on the outer face (8) of said shaped body (4), and a second portion delimited by said connection concavity (40) and which extends from said third opening (39) to said at least one first opening (16) of said at least one first seat (11).
5. Reciprocating pump (1) according to claim 1, **characterised in that** said valve cover (18) comprises an abutment portion (52), which develops projecting from said closing face (38), partly fits into said at least one first opening (16) of said at least one first seat (11), and abuts against said at least one first check valve (12) for holding the latter immobile in said first seat (11), leaving the gap of a central hole (47) of said first check valve (12) free for allowing the passage of said fluid.
6. Reciprocating pump (1) according to claim 1 **characterised in that** at least two second seats (13) are provided, which house at least two corresponding said second check valves (14) and they are interposed between at least one third section (22) of said outlet conduit (10), connected to the main chamber (7), and a fourth section (23) of said outlet conduit (10) which extends between said second seats (13) and an outlet port (24) obtained on the inner face (5) of said shaped body (4).
7. Reciprocating pump (1) according to claim 6, **characterised in that** the fourth section (23) of said outlet conduit (10) develops between said two second seats (13) and terminates with said outlet port (24) obtained on said inner face (5).
8. Reciprocating pump (1) according to claim 1, **characterised in that** said at least one first seat (11) and said at least one second seat (13) are provided with a first base (37') and a second base (37'') respectively, substantially parallel to the inner face (5) of said shaped body (4) and respectively aligned with said first opening (16) and with said second opening

(17), on such bases (37', 37'') said at least one first check valve (12) and said at least one second check valve (14) respectively rest.

9. Reciprocating pump (1) according to claim 1, **characterised in that** said at least one head (3) comprises at least one first membrane (36) actuated to move inside said main chamber (7) by actuation means (42), with reciprocating motion along a direction of movement (Y), moving away and approaching with respect to said head (3), respectively for suctioning said fluid into said main chamber (7) through said at least one suction conduit (9) and for discharging said fluid from said main chamber (7) through said at least one outlet conduit (10);
said at least one first check valve (12) and said at least one second check valve (14) being substantially arranged within the projection of said main chamber (7) in the direction of movement (Y) of said first membrane (36).
10. Reciprocating pump (1) according to claim 1, **characterised in that** the closing face (38) of said valve cover (18) closes said at least one second opening (17) of said at least one second seat (13).
11. Reciprocating pump (1) according to claim 1, **characterised in that** said valve cover (18) is provided with an annular flange (56), which is held between the outer face (8) of said shaped body (4) and a peripheral shoulder (57) of said closing cover (25).
12. Reciprocating pump (1) according to claim 1, **characterised in that** said closing cover (25) defines with said valve cover (18) a secondary chamber (26) connected to said outlet conduit (10) by means of at least one seventh opening (27) obtained on said valve cover (18);
said at least one head (3) comprising a sealing body (28), which is arranged inside said secondary chamber (26) and defines with said closing cover (25) a compensation chamber (29) insulated from said outlet conduit (10);
said sealing body (28) being movable between a third position approaching said closing cover (25), wherein said sealing body (28) is pushed towards said closing cover (25) by an amount of said fluid which enters into said secondary chamber (26) through said outlet conduit (10) by means of said at least one seventh opening (27), and one fourth position moving away from said closing cover (25), wherein said sealing body (28) discharges said amount of fluid from said secondary chamber (26) through said at least one seventh opening (27).
13. Reciprocating pump (1) according to claim 12, **characterised in that** said sealing body (28) comprises a second membrane (54) held between said valve

cover (18) and said closing cover (25);
said valve cover (18) being provided with a first peripheral groove (58) obtained on said outer face (8), inside such first peripheral groove (58) being arranged a first perimeter projection (59) of said second membrane (54).

14. Reciprocating pump (1) according to claim 12, **characterised in that** the secondary chamber (26) of said at least one head (3) is connected, by means of said at least one seventh opening (27), to said at least one second seat (13) at said second opening (17).

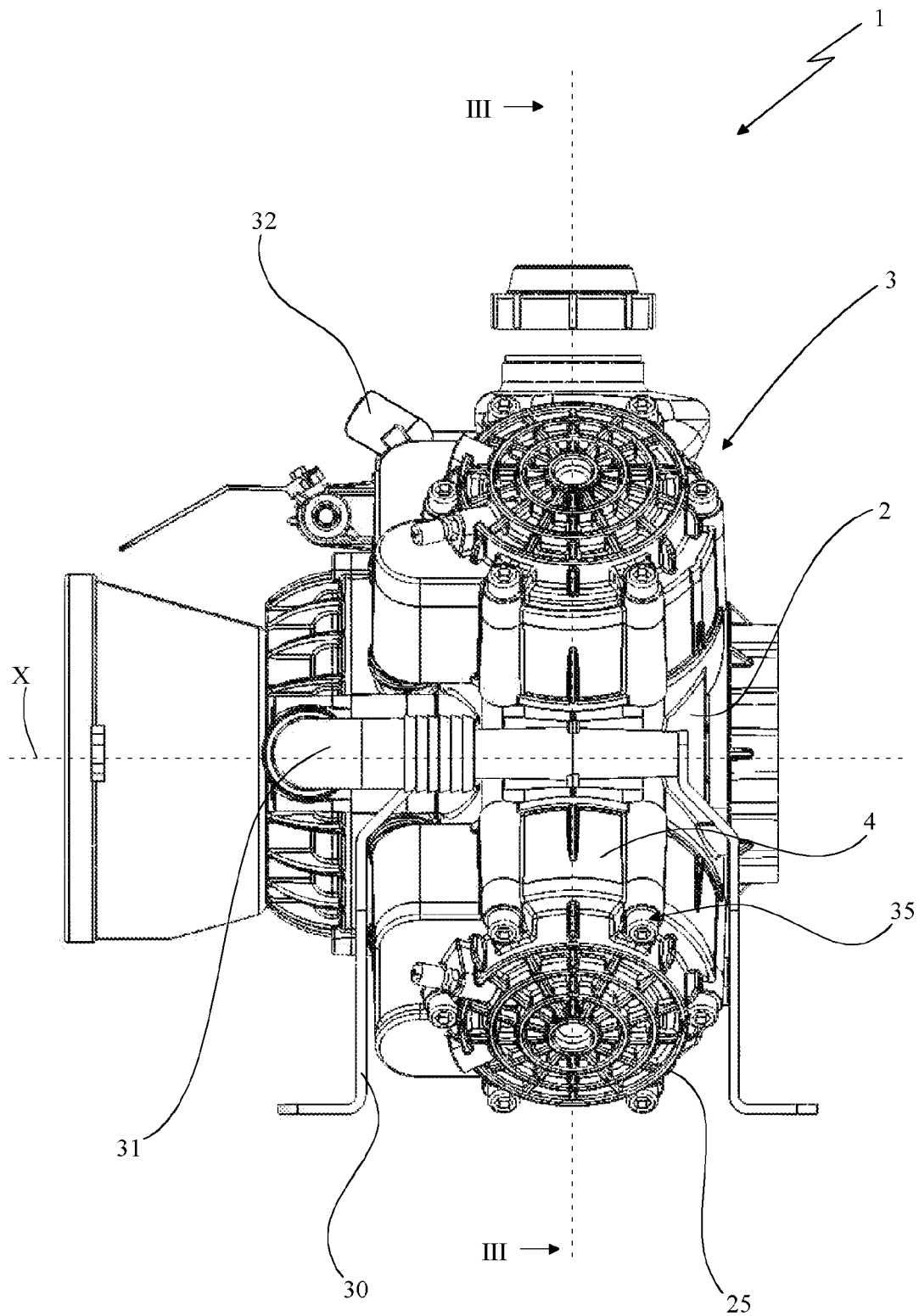


Fig. 1

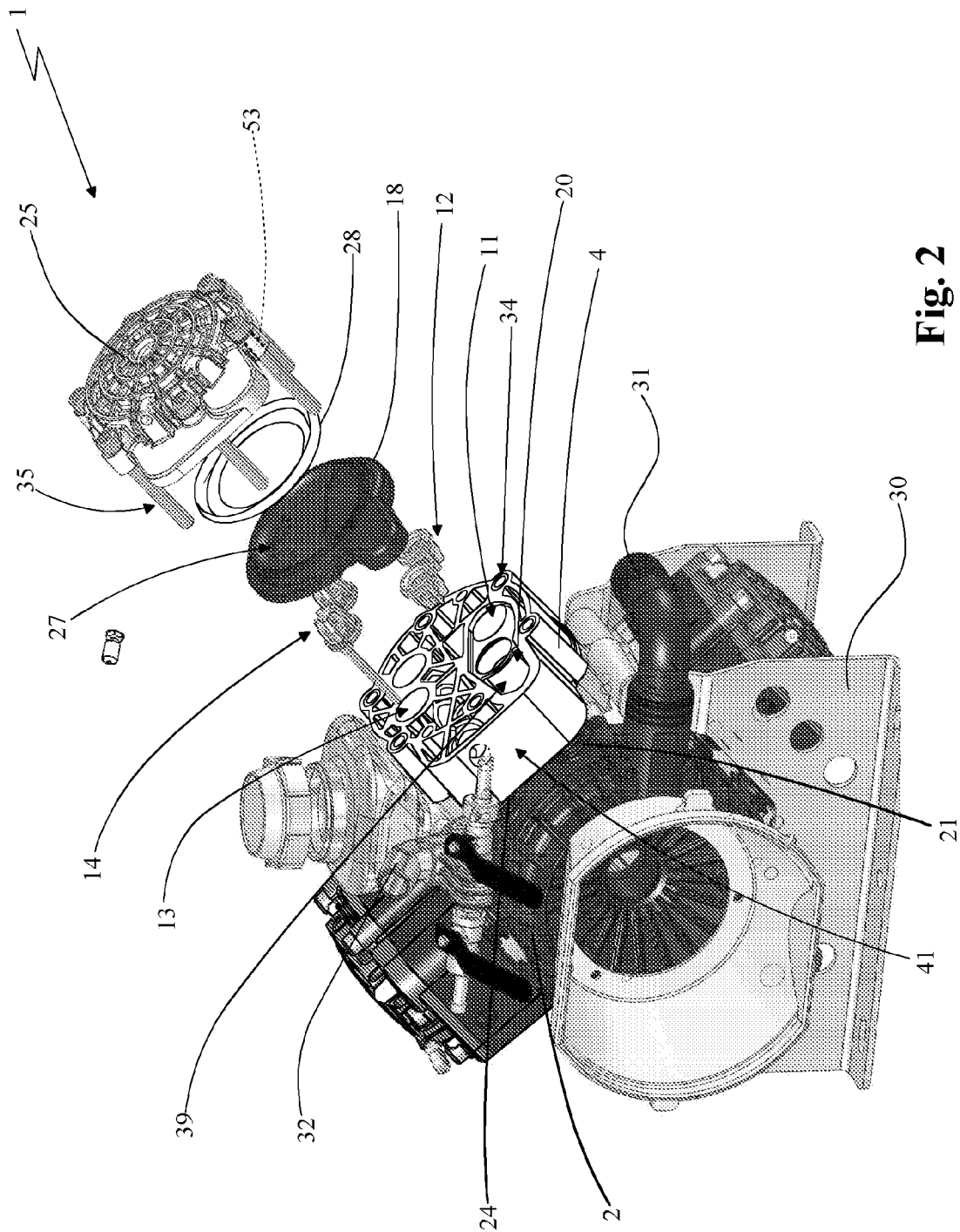


Fig. 2

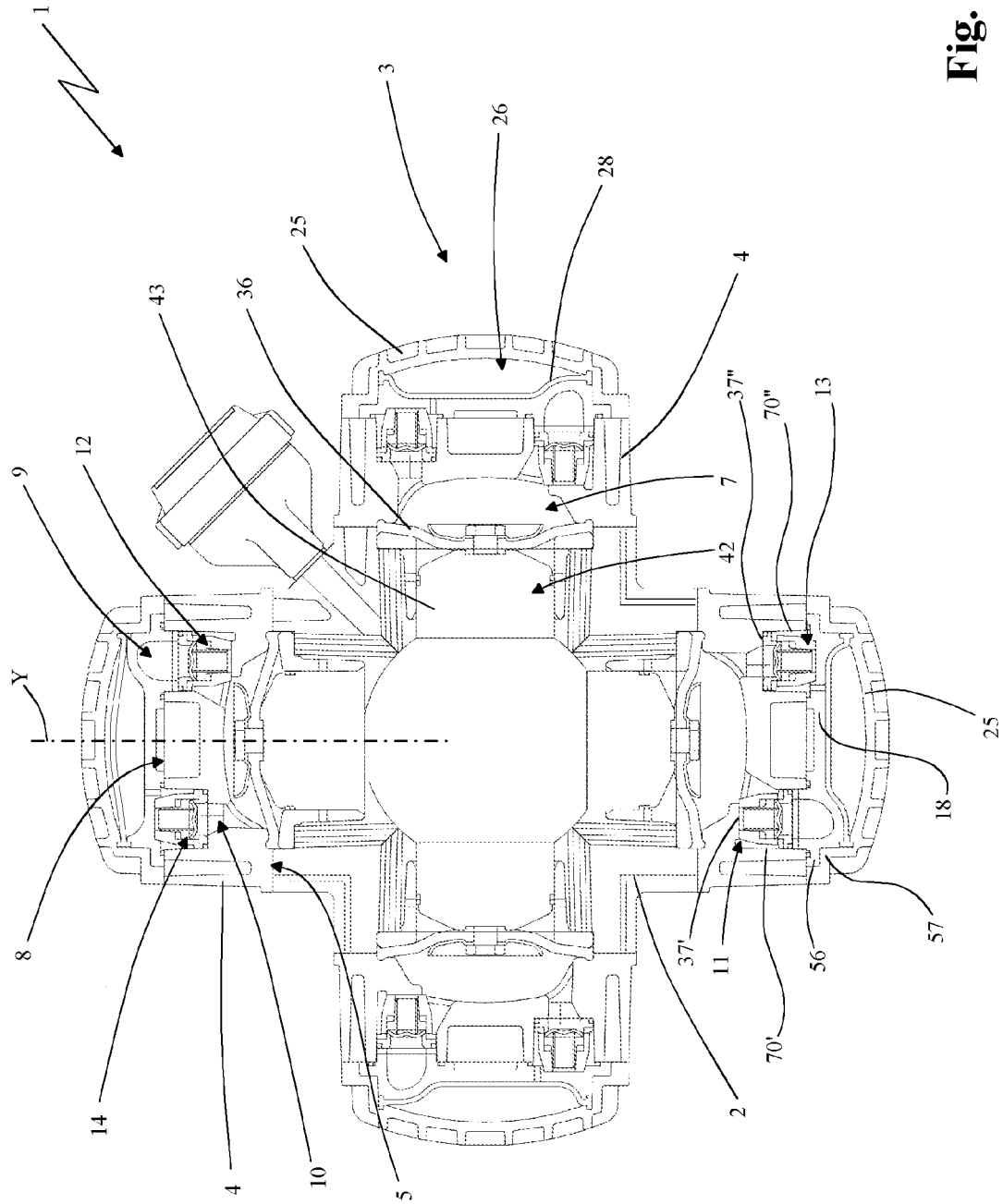
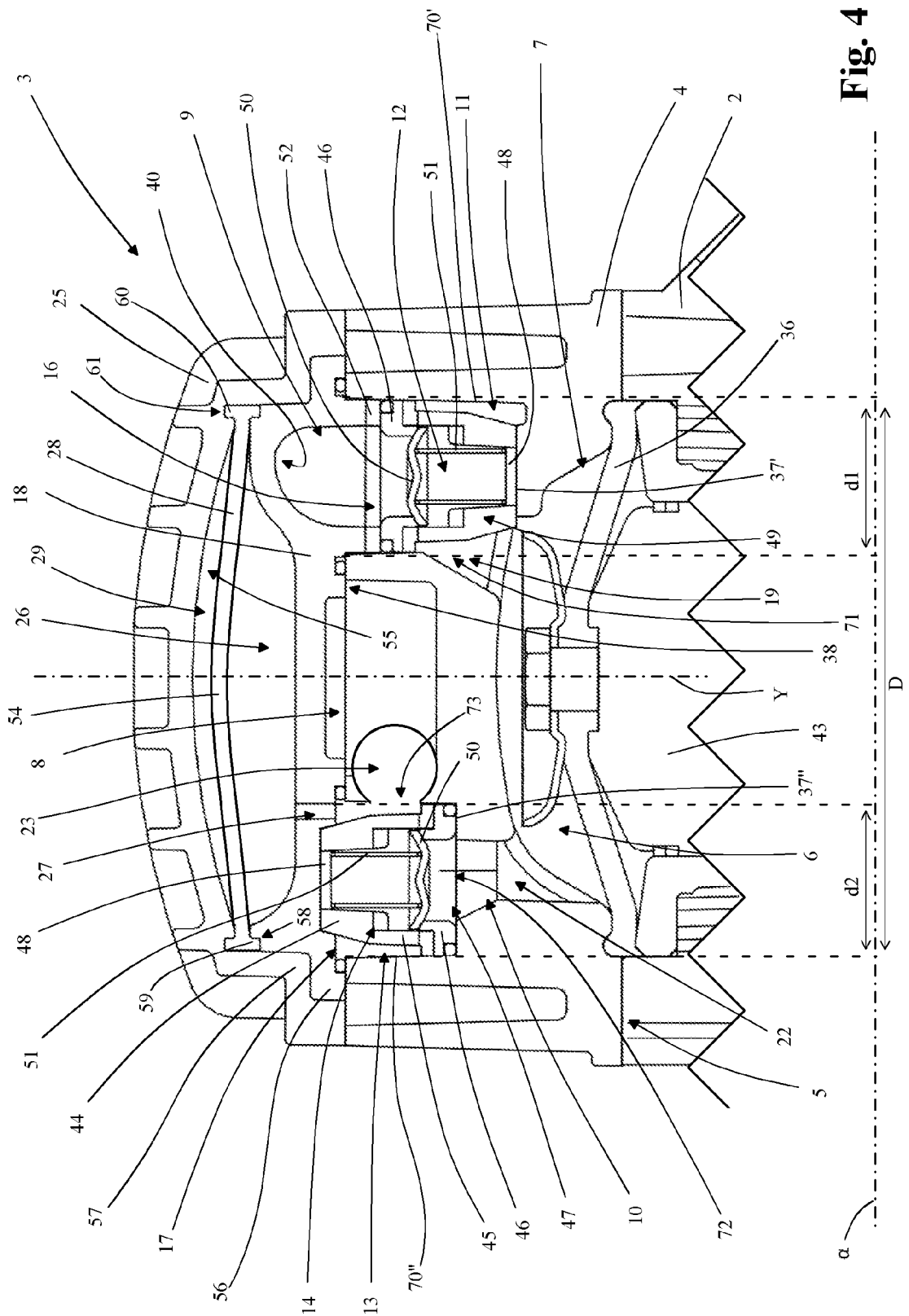


Fig. 3



REFERENCES CITED IN THE DESCRIPTION

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