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(54) **Reciprocating pump**

(57) Reciprocating pump (1), comprising: several heads (3) mounted on a pump body (2) and each comprising a shaped body (4) which defines one main chamber (5), a suction duct (6) and an outlet duct (7); a pumping member (8) movable inside the main chamber (5) for suctioning a fluid to be pumped into the main chamber (5) and discharge it from the latter.

Furthermore, each head (3) comprises: a closing cover (10) fixed to the shaped body (4) and defining with the latter a secondary chamber (11) connected to the outlet duct (7) by means of at least one first opening (12) obtained on the shaped body (4); a sealing body (13), which is arranged inside the secondary chamber (11)

and defines with the closing cover (10) a compensation chamber (14) insulated from the outlet duct (7).

The sealing body (13) is movable between a first position approaching the closing cover (10), wherein it is pushed towards the closing cover (10) by the fluid which enters into the secondary chamber (11) through the outlet duct (7) by means of the first opening (12), when the pumping member (8) discharges the fluid from the main chamber (5), and a second position moving away from the closing cover (10), wherein the sealing body (13) discharges the fluid from the secondary chamber (11) through the first opening (12), when the pumping member (8) suction another fluid into the main chamber (5) through the suction duct (6).

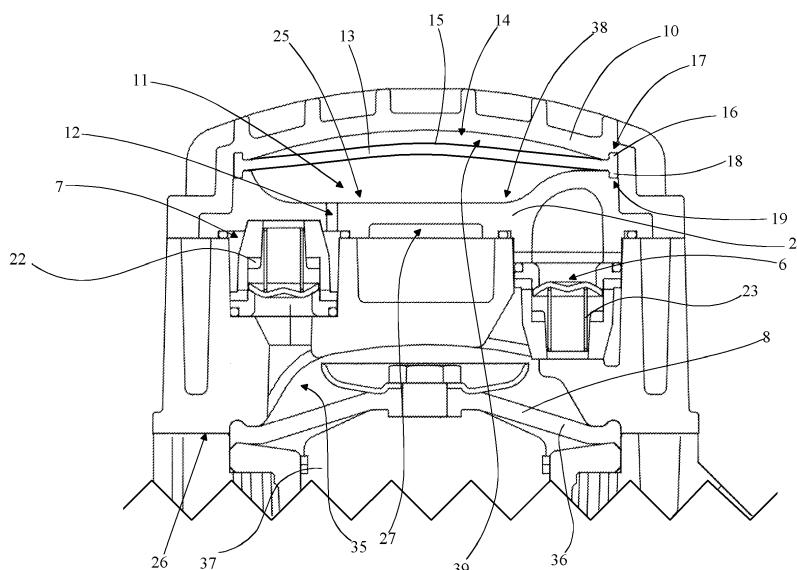


Fig. 4

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 liquid from a source, for example a cistern or a water reservoir, and convey it under pressure to a plurality of supply nozzles with the aim of spraying crops with liquid products, such as for example crop protection products.

State of the art

[0003] As known, the use of reciprocating pumps of the membrane type is widely spread in the farming industry.

[0004] For example, patent EP 2058517 discloses a reciprocating pump comprising, conventionally, a pump body on which a plurality of heads are mounted. Each head defines, alongside the pump body, one main pumping chamber connected to a suction duct and to an outlet duct, through which a fluid to be pumped (for example a liquid crop protection product) respectively enters and flows out from the main chamber.

[0005] More in detail, each main chamber is delimited by a semi-spherical concavity obtained on the head and it is closed towards the pump body by a first flexible membrane held between the head and the pump body.

[0006] Each first membrane is connected to suitable movement means, which displace them, with reciprocating motion, between a first position moving away from the head for suctioning the fluid from the suction duct, and a second position approaching the head for conveying the pressurised fluid to the outlet duct. More in detail, the movement means of the first membranes comprise several pistons, each of which is connected to the corresponding membrane and it is actuated to move with reciprocating motion from a transmission shaft arranged within the pump body. In particular, each piston is mechanically connected to the transmission shaft by means of a connecting rod actuated by an eccentric mounted on the transmission shaft.

[0007] Operatively, the operation of each head of the reciprocating pump provides for a suction step, in which the membrane is displaced by the piston in the first position thereof creating a vacuum in the main chamber for suctioning - into the latter - the fluid from the suction duct, and an outlet step, in which the membrane is displaced by the piston in the second position thereof creating an overpressure in the main chamber for discharging the fluid from the pumping chamber and convey it under pressure to the outlet duct.

[0008] The outlet channels of all heads of the pump

are connected to a common collector obtained on the pump body for conveying the fluid pumped into an outlet conduit of the pump connected for example to supply nozzles.

[0009] The reciprocating pump of known type briefly described above is not capable of supplying the fluid with a sufficiently constant flow, given that during the outlet step, the fluid is supplied by the outlet conduit of the pump with a high pressure, while during the suction step no amount of fluid is supplied, causing discontinuity in the distribution of the fluid and therefore also in the irrigation of the crops.

[0010] With the aim of overcoming such drawback, reciprocating pumps provided with a storage tank mounted on the pump body and connected to the outlet connector by means of a plurality of channels obtained on the collector are available in the market. Such storage tank has the function of collecting a given amount of the fluid coming from the outlet conduit of the heads during the outlet step so as to re-introduce such amount of fluid into the collector during the subsequent suction step. Thus, the fluid discharged by the pumping chamber is supplied by the outlet conduit of the pump, in part during the outlet step and in part (i.e. the amount of fluid that entered into the storage tank) during the subsequent suction step, reducing the discontinuity of supply of the fluid during the suction and outlet steps.

[0011] More in detail, within the storage tank a second membrane is arranged, which defines with the side walls and the bottom of the tank a secondary chamber filled with a pressurised gas and insulated from the collector of the pump.

[0012] Operatively, during the outlet step, the amount of the fluid which enters in the storage tank through the channels of the collector pushes the second membrane towards the walls of the storage tank reducing the volume of the secondary chamber and compressing the gas therein. During the outlet step, the pressure of gas inside the secondary chamber presses the membrane towards the collector pushing the fluid present in the storage tank once again into the collector to convey it to the outlet conduit of the pump.

[0013] However, also this solution for a reciprocating pump revealed drawbacks in practice.

[0014] A first drawback is related to the fact that the second membrane of the storage tank is subjected to frequent stresses, given that it is subjected to the pressure of the fluid coming from the outlet conduit of all heads. This contributes to the occurrence of malfunctions due to the breakage of the membrane due to wear or due to the continuous stresses received from the pumped liquid.

[0015] A further drawback is due to the fact that the storage tank obtained on the pump body considerably increases the dimensions of the pump making it cumbersome and difficult to install.

[0016] A further drawback is due to the fact that the flow rate of the fluid exiting from the pump is not suffi-

ciently constant, maintaining considerable variations during the suction and outlet steps.

Disclosure of the invention

[0017] 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 capable of pumping the fluid with a substantially constant outlet flow rate. Another object of the present invention is to provide a reciprocating pump entirely reliable operatively.

[0018] Another object of the present invention is to provide a reciprocating pump having small dimensions and easy to install.

Brief description of the drawings

[0019] 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

[0020] With reference to the attached drawings the reciprocating pump subject of the present invention is indicated in its entirety with 1.

[0021] According to 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 32, and it is provided with an inlet conduit 33, for drawing a fluid from a source (for example a well or a cistern mounted on the farming machine), and an outlet conduit 34 for conveying the pressurised fluid to supply nozzles mounted on the farming machine.

[0022] The fluid to be pumped is typically a liquid, such as for example water or more generally aqueous solutions, in which chemical compounds are dissolved with the aim of obtaining farming products, such as pesticides, fertilisers, etc.

[0023] With reference to figures 1 and 2, on the pump body 2 of the pump 1 a plurality of heads 3, for example four, are mounted arranged around a central axis X of the pump 1 and equally spaced with respect to each other.

[0024] More in detail, each head 3 comprises a shaped body 4 which is perimetally fixed by means of screws to the pump body 2 and defines with the latter a main pumping chamber 5. Furthermore, the shaped body 4 defines at least one suction duct 6, through which the fluid to be pumped enters into the main chamber 5, and at least one outlet duct 7, through which the fluid to be pumped flows out from the main chamber 5.

[0025] The reciprocating pump 1 further comprises several pumping members 8, preferably consisting of pistons or membranes as better specified hereinafter, each one of which is movable inside the main chamber 5 to vary volume thereof and thus suction the fluid through the suction duct 6 and discharge it through the outlet duct 7.

[0026] More in detail, each pumping member 8 is mechanically connected to actuation means 9 of the pump 1 adapted to move it, with reciprocating motion, moving away from the head 3 for suctioning the fluid into the main chamber 5 through the suction duct 6, and approaching the head 3 for discharging the pressurised fluid through the outlet duct 7.

[0027] The suction channels 6 of the heads 3 are connected, by means of a first collector obtained on the pump body 2, to the inlet conduit 33 of the reciprocating pump 1 for drawing the fluid from the source. The outlet channels 7 of the heads 3 are in turn connected, by means of a second collector also obtained on the pump body 2, to the outlet conduit 34 of the reciprocating pump 1 for conveying the pressurised fluid to the supply nozzles of the farming machine.

[0028] According to the idea on which the present invention is based, each head 3 comprises a closing cover 10, which is fixed to the shaped body 4 and defines with the latter a secondary chamber 11 connected to the outlet duct 7 by means of one or more first openings 12 obtained on the shaped body 4 itself, in particular by means of a plurality of first openings 12 as illustrated in the embodiment of figure 2.

[0029] Inside the secondary chamber 11 a sealing body 13, which defines with the closing cover 10 a compensation chamber 14, is arranged. Such sealing body 13 separates the compensation chamber 14 from the outlet duct 7, preventing the fluid pumped from the main chamber 5 during the operation of the pump 1 from entering into the compensation chamber 14.

[0030] Advantageously, the sealing body 13 consists of a first flexible membrane 15 held between the shaped body 4 and the closing cover 10.

[0031] The sealing body 13 of each head 3 is movable between a first position approaching the closing cover 10, in which the sealing body 13 is pushed towards the bottom of the closing cover 10 by the fluid which enters

into the secondary chamber 11 through the outlet duct 7 passing through the first openings 12, when the pumping member 8 discharges the fluid from the main chamber 5, and a second position moving away from the bottom of the closing cover 10, in which the sealing body 13 discharges the fluid in the secondary chamber 11 through the first openings 12, when the pumping member 8 suction another fluid into the main chamber 5 through the suction duct 6.

[0032] According to the embodiment illustrated in figures 3 and 4, the shaped body 4 of each head 3 is provided with two faces 25, 26, of which an outer face 25 is mechanically coupled with the closing cover 10 delimiting the secondary chamber 11 therewith, and an inner face 26 is mechanically coupled with the pump body 2 of the pump 1. In particular, between the two faces 25, 26 in the shaped body 4 first through holes 30 are obtained through which fixing means 29, such as for example bolts or screws fastened on corresponding female screws obtained on the pump body 2, are inserted for fixing the head 3 to the pump body 2.

[0033] Furthermore, with reference to figures 1 and 2, the closing cover 10 is fixed to the shaped body 4 by means of fixing means 29 which fix the shaped body 4 to the pump body 2. In particular, such fixing means 29 are inserted into second through holes 31 obtained on the closing cover 10 and aligned to the corresponding first through holes 30 of the shaped body 4.

[0034] Preferably, the shaped body 4 is made of thermoplastic material reinforced with glass fibre and it is obtained, for example, by means of die casting.

[0035] On the inner face 26 of the shaped body 4 a first substantially cap-shaped concavity 35, particularly semi-spherical, is obtained, which delimits the main chamber 5. The latter is intended to be closed by the pumping member 8 of the head 3, which consists for example of a second membrane 36, held between the shaped body 4 and the pump body 2 of the reciprocating pump 1.

[0036] According to a particular embodiment, the actuation means 9 of the second membranes 36 comprise several pistons 37, each of which is connected to the corresponding second 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 pump 1. In particular, each piston 37 is moved by a connecting rod mechanically connected to an eccentric fixed to the transmission shaft.

[0037] 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 5 by the inlet conduit 33 of the pump 1 through the suction duct 6, and it is conveyed under pressure in the outlet conduit 34 of the pump 1 through the outlet duct 6.

[0038] More in detail, each operating cycle provides

for a suction step, in which the second membrane 36 is displaced by the corresponding piston 37 in a third position moving away from the head 3, creating a vacuum inside the main chamber 5 for suctioning - into the latter - the fluid from the suction duct 6. Subsequently, an outlet step is provided, in which the second membrane 36 is displaced by the piston 37 in one fourth position approaching the head 3, creating an overpressure in the main chamber 5 for discharging the fluid from the latter through the outlet duct 7.

[0039] Within the outlet duct 7 and suction duct 6 of the shaped body 4 a first 22 and a second 23 check valve, for example, of the frusto-spherical type made of stainless steel, are respectively mounted.

[0040] More in detail, the second valve 23 in the suction duct 6 allows the fluid to flow from the inlet conduit 33 of the pump 1 to the main chamber 5 during the suction step and prevents the fluid from flowing into the inlet conduit 33 through the suction duct 6 during the outlet step; the first valve 22 in the outlet duct 7 allows the fluid to flow from the main chamber 5 to the outlet conduit 34 of the pump 1 during the outlet step and prevents the fluid from flowing into the main chamber 5 through the outlet duct 7 during the suction step.

[0041] Advantageously, the secondary chamber 11 of each head 3 is connected, through the first openings 12, to the outlet duct 7 downstream of the first check valve 22 so that the fluid discharged from the secondary chamber 11 during the suction step is conveyed to the outlet conduit 34 of the pump 1 without flowing back into the main chamber 5 of the head 3.

[0042] According to a particular embodiment illustrated in detail in figure 4, the shaped body 4 of each head 3 comprises a valve cover 24, which defines the outer face 25 facing towards the closing cover 10 and on which the first openings 12 which connect the secondary chamber 11 to the outlet duct 7 are obtained. The valve cover 24 is fixed on the remaining part of the shaped body 4 to hold the valves 22, 23 in the respective outlet channel 7 and suction channel 6. For such purpose, the valve cover 24 is provided with a closing face 27 facing towards the abovementioned remaining part of the shaped body 4 and which delimits the suction duct 6 and partly the outlet duct 7 leaving the first openings 12 which connect the secondary chamber 11 to the outlet duct 7.

[0043] More in detail, the valve cover 24 is shaped to provide - on the outer face 25 - a second concavity 38, which defines, alongside the closing cover 10, the secondary chamber 11 of the head 3.

[0044] According to the embodiment illustrated in the attached figures, the closing cover 10 has a substantially cap-shaped element, which defines a third concavity 39 which widens the secondary chamber 11 defined alongside the valve cover 24. The closing cover 10 is fixed on a peripheral edge of the shaped body 4 holding the valve cover 24.

[0045] Preferably, the closing cover 10 is made of aluminium, for example by means of a forming process.

[0046] Advantageously, the first membrane 15 arranged inside the secondary chamber 11 comprises at least one first perimeter projection 16 extending towards the closing cover 10 of the head 3 and inserted into a first groove 17 obtained on the closing cover 10 for holding the first membrane 15 inside the secondary chamber 11.

[0047] Furthermore, the first membrane 15 comprises a second perimeter projection 18 opposite to the first projection 16, extending towards the shaped body 4 of the head 3 and inserted into a second groove 19 obtained on the valve cover 24 of the shaped body 4. More in detail, the second groove 19 is obtained on an edge of the valve cover 24 of the shaped body 4 and it is delimited laterally by a portion of the closing cover 10.

[0048] Advantageously, the compensation chamber 14 defined by the first membrane 15 and by the closing cover 10 is filled with a pressurised gas, or a gas mixture, suitable to push the first membrane 15 moving away from the bottom of the closing cover 10. More in detail, during the suction step of the pump 1, the pressurized gas mixture keeps the first membrane 15 pressed against the outer face 25 of the shaped body 4 for discharging - from the secondary chamber 11 - the fluid that had entered therein during the outlet step of the previous operating cycle.

[0049] In particular, the gas mixture is constituted by compressed air injected into the compensation chamber 14, for example, during the step of assembling or installing the pump 1, or during the maintenance step. For such purpose, the closing cover 10 is provided with a second opening 20 in which a connector 21 suitable to be coupled with compression means, such as for example a compressor, is mounted, to inject the air into the compensation chamber 14 at a pressure, for example, equivalent to about a third of the pressure with which the fluid is pumped out of the main chamber 5 of the head 3 during the outlet step. As previously described, during the suction step of each operating cycle, the fluid is suctioned into the main chamber 5 of the head 3 by means of the suction duct 6. In this step, the first membrane 15 in the secondary chamber 11 is pressed by the air contained in the compensation chamber 14 against the outer face 25 of the shaped body 4.

[0050] During the subsequent outlet step, the fluid present in the main chamber 5 of the head 3 is discharged under pressure into the outlet duct 7. Such fluid, in part is conveyed through the outlet duct 7 to the outlet conduit 34 of the pump 1, and in part enters through the first openings 12 obtained on the shaped body 4 in the secondary chamber 11 and pushes the first membrane 15 towards the bottom of the closing cover 10 causing a further compression of the air inside the compensation chamber 14.

[0051] During the suction step of the subsequent operating cycle, the pressure of the air in the compensation chamber 14 displaces the first membrane 15 towards the outer face 25 of the shaped body 4. In this way, the first

membrane 15 discharges the fluid present in the secondary chamber 11 through the first openings 12, conveying it into the outlet duct 7 and thus to the outlet conduit 34 of the reciprocating pump 1.

[0052] The pressure that the air inside the compensation chamber 14 exerts on the first membrane 15 is such to allow accumulating in the secondary chamber 11, during the outlet step, an amount of fluid substantially equivalent to half the entirety of the fluid discharged by the main chamber 5 of the head 3. In this way, the reciprocating pump 1 subject of the present invention is capable of supplying the fluid from the outlet conduit 34 with a substantially constant flow rate.

[0053] In particular, given that each head 3 is provided with its own secondary chamber 11, the reciprocating pump 1 is capable of constantly supplying the fluid right from the outlet duct 7 of each head 3 regardless of the fluid pumped by the other heads 3, and therefore it is capable of supplying the fluid from the outlet conduit 34 with a particularly constant and regular flow rate without variations during the suction and outlet steps.

[0054] Therefore, the invention thus described attains the preset objects.

Claims

1. Reciprocating pump (1), comprising:

- a pump body (2);
- at least one head (3) mounted on said pump body (2) and comprising a shaped body (4) which defines:

- at least partly, one main pumping chamber (5),
- at least one suction duct (6), through which a fluid to be pumped enters into said main chamber (5),
- and at least one outlet duct (7), through which said fluid to be pumped flows out from said main chamber (5);

- at least one pumping member (8) moveable inside said main chamber (5);
- actuation means (9) mechanically connected to said pumping member (8) and suitable to move the latter with reciprocating motion moving away from said head (3) for suctioning said fluid into said main chamber (5) through said suction duct (6), and approaching said head (3) for discharging said fluid from said main chamber (5) through said outlet duct (7);

said reciprocating pump (1) being **characterised in that** said at least one head (3) comprises:

- a closing cover (10) fixed onto said shaped

body (4) and defining with the latter a secondary chamber (11) connected to said outlet duct (7) by means of at least one first opening (12) obtained on said shaped body (4);

- a sealing body (13), which is arranged inside said secondary chamber (11) and defines at least with said closing cover (10) a compensation chamber (14) insulated from said outlet duct (7);

said sealing body (13) being moveable between a first position approaching said closing cover (10), wherein said sealing body (13) is pushed towards said closing cover (10) by an amount of said fluid which enters into said secondary chamber (11) through said outlet duct (7) by means of said at least one first opening (12), when said pumping member (8) discharges said fluid from said main chamber (5), and a second position moving away from said closing cover (10), wherein said sealing body (13) discharges said amount of fluid from said secondary chamber (11) through said at least one first opening (12), when said pumping member (8) suctions said fluid into said main chamber (5) through said suction duct (6).

2. Reciprocating pump (1) according to claim 1, **characterised in that** said sealing body (13) comprises a first flexible membrane (15) held between said shaped body (4) and said closing cover (10).

3. Reciprocating pump (1) according to claim 2, **characterised in that** said first membrane (15) comprises a first perimeter projection (16) extended towards said closing cover (10) and inserted into a first groove (17) formed on said closing cover (10) for holding said first membrane (15) against said closing cover (10).

4. Reciprocating pump (1) according to claim 2, **characterised in that** said first membrane (15) comprises a second perimeter projection (18) extended towards said shaped body (4) and inserted into a second groove (19) formed on said shaped body (4) for holding said first membrane (15) against said shaped body (4).

5. Reciprocating pump (1) according to claim 1, **characterised in that** said compensation chamber (14) is filled with at least one gas under pressure suitable to push said sealing body (13) moving away from the bottom of said closing cover (10).

6. Reciprocating pump (1) according to claim 5, **characterised in that** said closing cover (10) is provided with at least one second opening (20) mounted in which is a connector (21) suitable to be coupled with compression means to inject said at least one gas under pressure into said compensation chamber

(14).

7. Reciprocating pump (1) according to claim 1, **characterised in that** the secondary chamber (11) of said at least one head (3) is connected, by means of said at least one first opening (12), to said outlet duct (7) downstream, of a first check valve (22) arranged in said outlet duct (7).

8. Reciprocating pump (1) according to claim 7, **characterised in that** said shaped body (4) comprises a valve cover (24) which defines an outer face (25) of said shaped body (4) facing towards the closing cover (10) and formed in which is said at least one first opening (12); said valve cover (24) being fixed onto the remaining part of said shaped body (4) to hold said first check valve (22) in said outlet duct (7) and to hold a second check valve (23) in said suction duct (6).

9. Reciprocating pump (1) according to claim 1, **characterised in that** said closing cover (10) is fixed onto said shaped body (4) by means of fixing means (29) inserted into first through holes (30) obtained on said shaped body (4) and aligned to corresponding second holes (31) formed on said closing cover (10); said fixing means (29) fixing said shaped body (4) onto said pump body (2) by insertion thereof into corresponding female screws obtained on said pump body (2) and aligned to said first (30) and second (31) through holes.

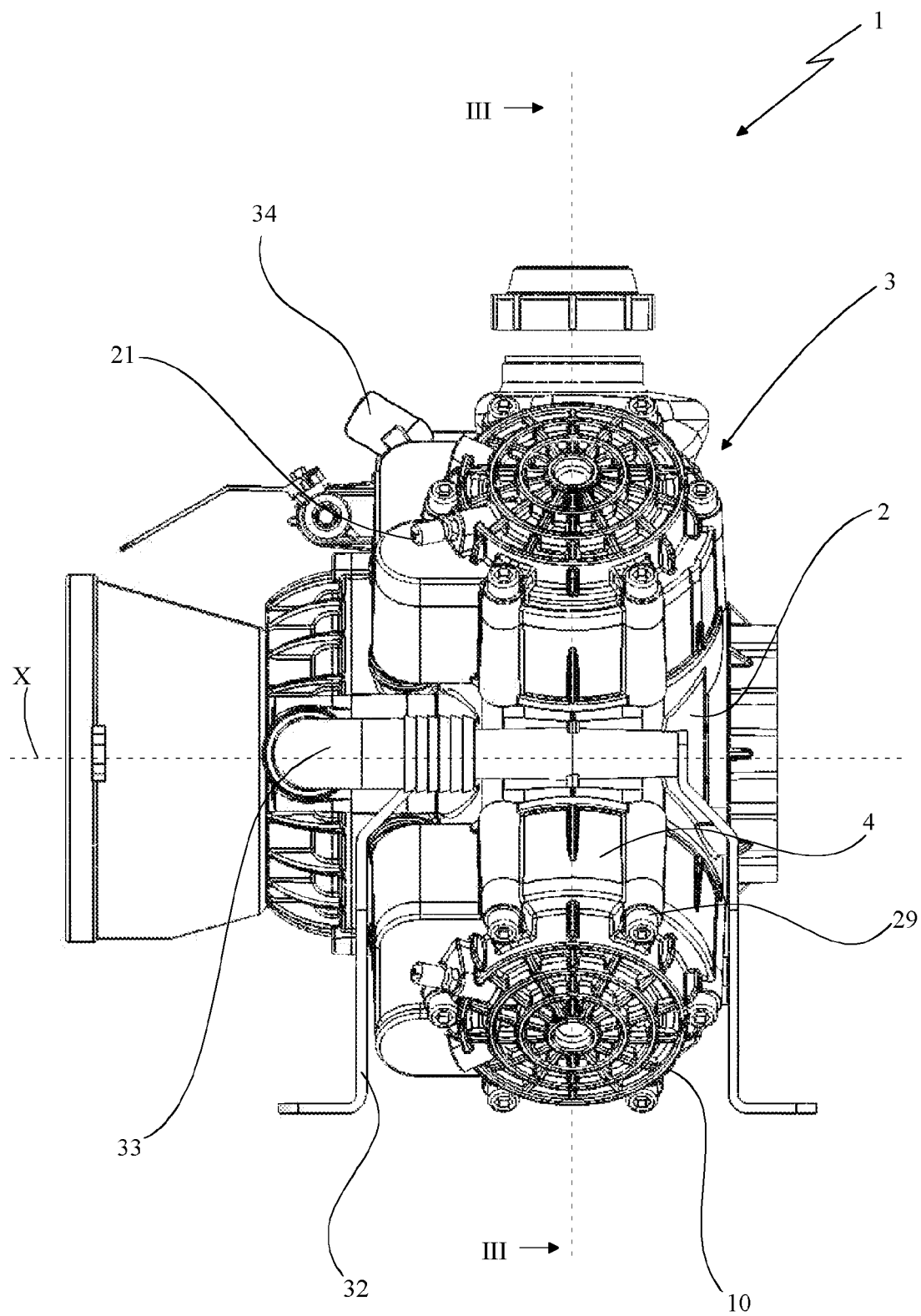


Fig. 1

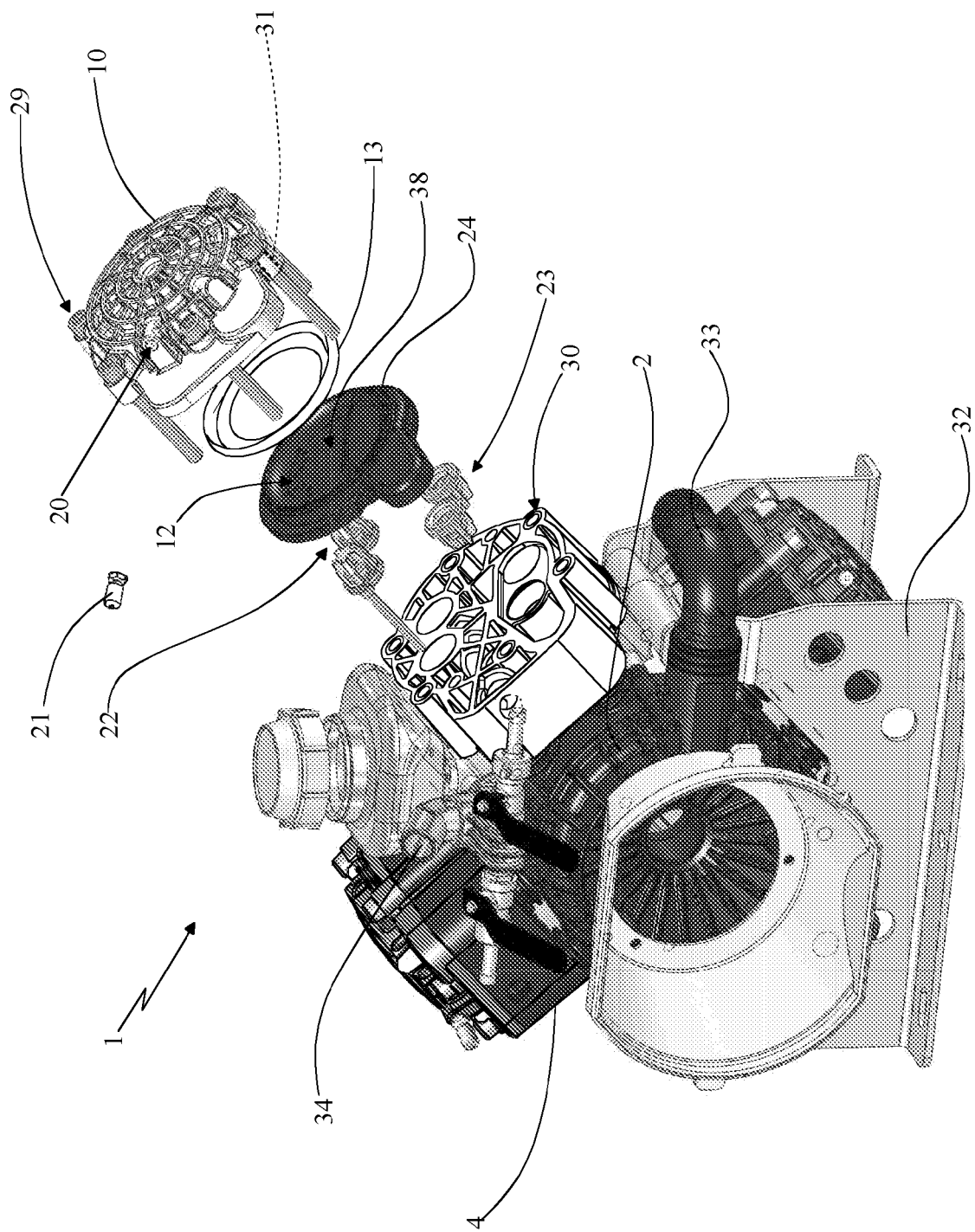


Fig. 2

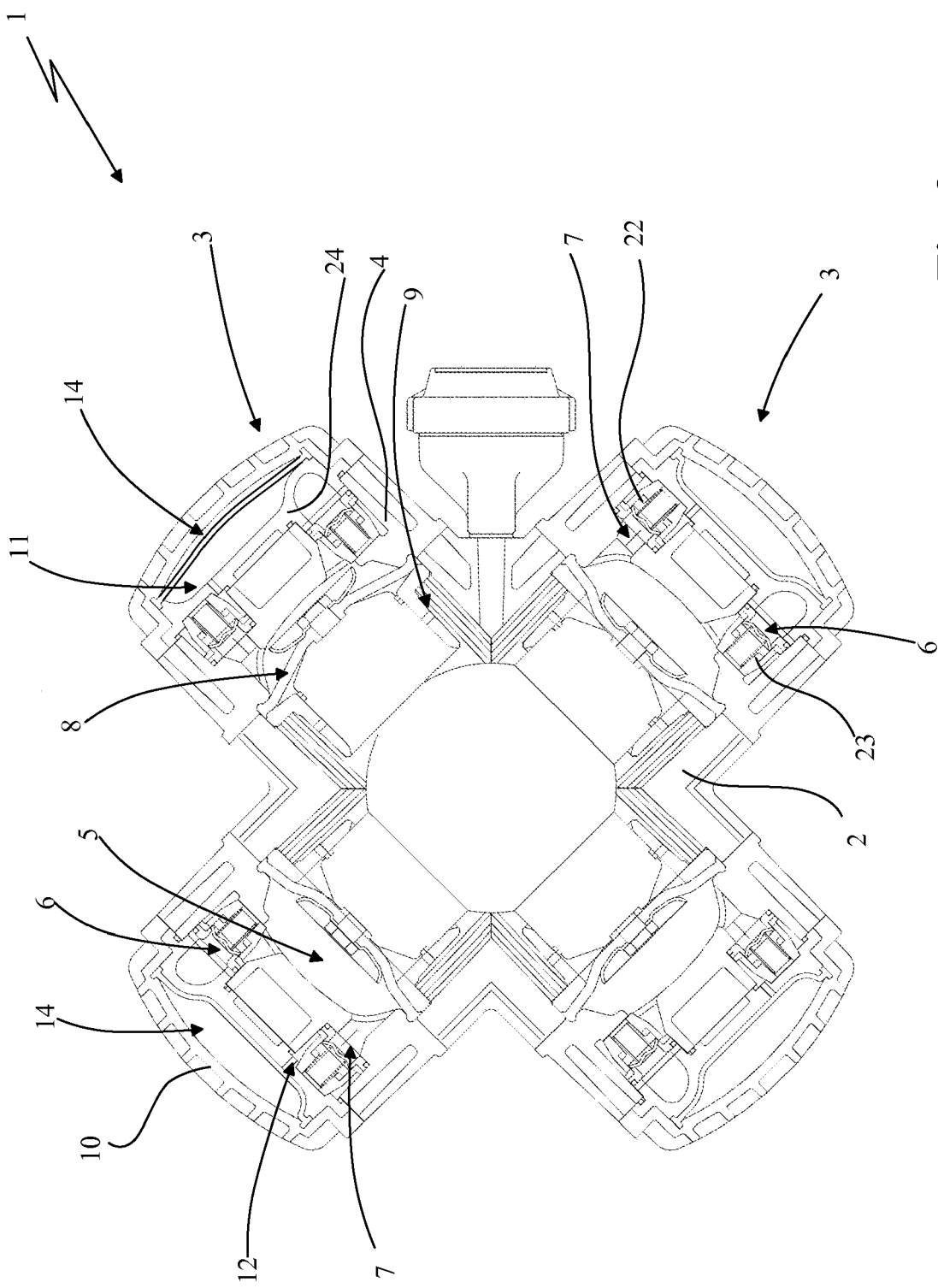
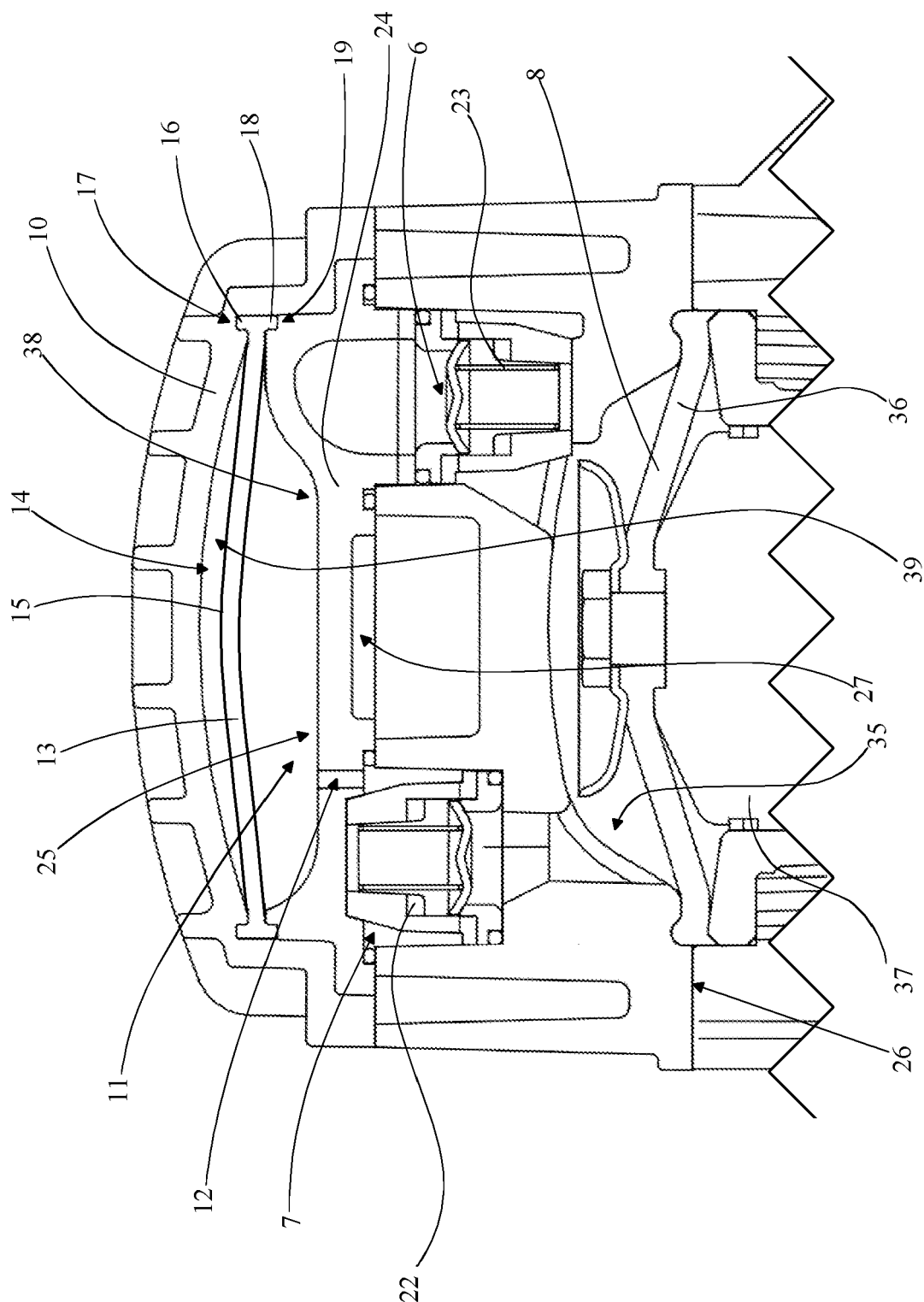


Fig. 3

**Fig. 4**



EUROPEAN SEARCH REPORT

Application Number
EP 11 16 3605

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 July 2011	Examiner Fistas, Nikolaos
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 16 3605

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12-07-2011

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REFERENCES CITED IN THE DESCRIPTION

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