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(54) **AXIAL PISTON PUMP**

AXIALKOLBENPUMPE

POMPE À PISTON AXIAL

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## Description

### Object of the invention

**[0001]** The present invention relates to an axial piston pump for supplying a fluid, wherein the pump is volumetric with regulation of the flow rate and with regulation of the maximum pressure that it is capable of giving during the discharge at the outlet of the pump; and wherein the pump is applicable to chemical product fluids, and also to oil-hydraulic plants, without ruling out the application thereof to other fluids. Moreover, the pump includes a characteristic regulable movement transmission system through which it is possible to vary the flow rate of the fluid at the outlet of the pump; wherein the fluid can be a liquid such as hydraulic oil, or a gaseous fluid.

### Technical problem to be resolved and background of the invention

**[0002]** Currently, pumps with several membranes or pistons are known, wherein the flow rate or the pressure of the liquid fluid they supply cannot be mechanically regulated (it could be electrically regulated with a frequency variator to the motor).

**[0003]** Radial piston and axial piston pumps are also known, wherein at least the latter have the drawback that they do not enable the flow rate of liquid fluid to be regulated.

**[0004]** Single axial piston pumps have the drawbacks of supplying a liquid fluid flow with pulsations and a very low efficiency.

**[0005]** Vane pumps and gear pumps are also known, wherein none of them enables the flow rate of liquid fluid that they provide to be regulated.

**[0006]** Moreover, axial piston oil-hydraulic pumps can be swash-plate or bent-axis. They are multi-piston pumps that provide a flow rate of liquid fluid without pulsations, while they can be regulated in flow rate and pressure, but they are not volumetric, they do not work with check valves and unlike the pump of the invention, the axial pistons, in addition to having a reciprocating movement (axial movement in both directions), rotate as a grouped assembly by way of a rotating revolver mechanism. Patent document US-2737894-A discloses an axial piston pump with the features of the preamble of claim 1.

**[0007]** Volumetric piston pumps (excluding oil-hydraulic ones) are known: on the one hand, pumps with a single axial piston with flow rate and pressure regulation; and on the other hand, the pumps with several axial pistons, but without mechanical regulation of flow rate and pressure.

**[0008]** The theoretical flow generated in the pumps with a different number of pistons with respect to the rotation of the shaft thereof, generates pulsations, so that as the number of pistons increases, said pulsations decrease; noting that there is a marked loss of efficiency in a single piston pump.

### Description of the invention

**[0009]** In order to achieve the objectives and avoid the drawbacks in the previous sections, the invention proposes an axial piston pump comprising a static head with parallel cavities in which the pistons are housed, which are configured to move axially in both directions within said cavities to supply a flow rate of fluid at the outlet of said cavities that are distributed in a circumferential path.

**[0010]** The invention causes the multi-piston, volumetric and regulable flow rate and pressure concepts to be simultaneously fulfilled for the first time.

**[0011]** The pump of the invention comprises a regulable movement transmission system that includes at least a first rotary plate, a second rotary plate that can be tilted with respect to the first rotary plate, a third rotary plate, a mobile runner with linear movement and a ball joint support in which ends of the pistons are coupled by means of end heads with double joints.

**[0012]** Each double joint of the end heads that link the pistons with the ball joint support comprises a ball joint coupled between pairs of fins that form part of the ball joint support by means of a shaft, and an intermediate joint that attaches each end head to the piston by means of another shaft.

**[0013]** The third plate is coupled to the mobile runner by means of an idle rotation coupling perpendicularly to the linear movement of the mobile runner; wherein the first plate drags in the rotation thereof the second plate and the third plate; and wherein the first, second and third plates, as well as the mobile runner, together with a tensioning device of the transmission system are located inside a main casing, which may contain an oil bath for lubrication.

**[0014]** The second plate is linked to the third plate by means of a crank mechanism that hinges at a first end on the third plate by means of a first hinged connection, while a second end of the crank mechanism, opposite the first end, hinges on the second plate by means of a second hinged connection.

**[0015]** The first plate includes curved-concave female front seats on which complementary curved-convex male front seats of the second tiltable plate rest; wherein the curvature of the first and the second front seats are equidistant from a shared centre located inside the main casing and coinciding with the centre of the crosshead on which the ball joint support also rotates.

**[0016]** The ball joint support rests frontally on a second axial bearing coupled to an extension of the second plate; wherein said ball joint support adopts the tilt of said second plate at all times, without rotational movement of the ball joint support.

**[0017]** With this arrangement described, the regulable movement transmission system is configured to be able to vary the stroke of the pistons in order to vary the flow rate of the fluid at the outlet of the cavities; wherein said variation is carried out by means of the linear movement of the mobile runner that modifies the tilt of the second

plate and the ball joint support through the third plate and the crank mechanism.

**[0018]** A crosshead mechanism that includes two pairs of axes hinges on the ball joint support; wherein a first pair of axes hinges on two aligned holes of two tabs solidly attached to the ball joint support, while the tensioning device that includes a longitudinal axis in parallel with the cavities in which the axial pistons are guided and run hinges on the second pair of axes of the crosshead mechanism; wherein the longitudinal axis is guided inside the head.

**[0019]** The rotary motion transmission to the first plate is carried out by means of a planetary gear device that is coupled to a shaft connected to the first plate; wherein said planetary gear receives the rotary movement from an output shaft of an external motor element.

**[0020]** The planetary gear device comprises a fixed support with an internal toothed gear and a planetary assembly that rotates coupled to the internal toothed gear. Said planetary assembly includes a cross-shaped mobile support and several radial pinions that rotate idly coupled to said mobile support; and wherein said radial pinions mesh on the one hand with the internal toothed crown, and on the other hand they mesh with a central pinion embedded in the output shaft of the motor element.

**[0021]** The mobile runner includes threaded rods that are coupled to pinions that mesh with an external toothing of a toothed ring; wherein one of said pinions meshes with an intermediate pinion and this one with a drive pinion solidly attached to a shaft to which a control wheel is attached, which is configured to carry out the movement of the mobile runner in one or another direction, depending on the direction of rotation of said control wheel. A reduction gear may or may not be necessary to reduce the manual force required for actuation. All these toothed elements configure a regulation mechanism that is housed inside a front casing that is closed by means of a cover; wherein the front casing and the cover include centered and facing through hollows.

**[0022]** The front casing includes an annular recess around the centered through hollow thereof wherein a first axial bearing sits frontally on which a portion of the first plate is embedded with interposition of an internal bearing embedded in one of the two tracks of said first axial bearing, while another portion of the first plate fits directly into the other paired track of said first axial bearing.

**[0023]** The second plate comprises parallel walls that include the male front seats, while the first plate includes parallel hollows which the complementary parallel walls of the second plate fit in; wherein front bottoms of said parallel hollows constitute the curved-concave female front seats; and wherein the two hinged connections of the crank mechanism are perpendicular to the planes in which the parallel walls of the second plate are contained.

**[0024]** The second axial bearing comprises two opposing tracks, one of which is coupled on a second internal bearing and this is embedded in one portion of the extension, while the other paired track of the second axial bearing is embedded directly in another portion of the extension abutting against a front seat of the second plate itself; wherein the ball joint support rests frontally on the track that is coupled on the second internal bearing.

**[0025]** Each one of the cavities of the head opens leads into an outlet area that includes a first passageway and a second passageway in which a first check valve and a second check valve have been inserted; wherein the first and second passageways lead separately into a first fluid outlet slot during the propulsion thereof and into a second fluid inlet slot during the aspiration/suction thereof to fill the cavities.

**[0026]** The main casing includes a side opening that is closed by a cover; wherein the main casing has two opposing end bases: first and second. The head is fixed outside the main casing and on the second base. However, inside the main casing the entire regulable movement transmission system is housed, as well as the rest of the elements related to said transmission system.

**[0027]** The shared centre of the curved-concave male front seats of the second plate and the curved-convex female front seats of the first plate is located at the centre of the crosshead mechanism. The crosshead moves when the tensioning device is actuated, and reaches its final position in which its centre is equidistant from the first male front seat and the second female front seat, once the tensioning device has been fully actuated.

**[0028]** The tensioning device comprises a support structure in which two parallel collateral wings are guided with curved recesses in which the crosshead mechanism hinges through the second shafts thereof. The tensioning device further comprises a longitudinal axis solidly attached to a central pinion that meshes with two lateral pinions coupled by means of threading on two immobilised screws in parallel to the two collateral wings by means of the heads thereof; wherein said pinions are axially retained; and wherein the longitudinal axis includes a hexagonal end section for being able to comfortably rotate said longitudinal shaft to axially adjust said tensioning device in order to axially adjust the transmission system assembly inside the main casing.

**[0029]** The third plate comprises an outer portion formed by an annular body that is punctually coupled by tangential contact on bearings of the mobile runner with idle rotation, and an internal portion which comprises a central structure with hollows in which the first front fins of the first plate fit in.

**[0030]** In one embodiment of the invention, the support structure of the tensioning device is screwed to an intermediate sheet that forms part of the main casing, while it is located parallel to and close to the second end base.

**[0031]** An annular body arranged around the support structure is fixed on the intermediate sheet; wherein said annular body includes quadrangular holes in which the parts solidly attached to the pistons are fitted and guided; wherein the cross section of said parts coincides with the passageway cross section of the quadrangular holes; all

this to prevent the rotation of the pistons.

**[0032]** The pistons are axially guided and adjusted in holes located in a front plate that is screwed to a front area of the head opposite to a rear area wherein the outlet of the cavities is found; wherein said holes serve as a guide for the pistons.

**[0033]** The inner bearings are to support the radial loads or forces, while the axial bearings are to support the axial loads or forces. However, in substitution for each pair of axial and radial bearings, a single bearing could be mounted that would support both axial as radial loads.

**[0034]** In a conventional oil-hydraulic pump such as the swash-plate, the plate tilts but does not rotate and it is the pistons that rotate, while in the pump of the invention it is the other way around, i.e., the pistons do not rotate and the tilted plate is the one that rotates. Unlike the swash-plate pump wherein the suction and discharge of the fluid is done by the pistons facing one or another outlet slot (chamber), in the pump of the invention there is a check valve for each piston, which makes it a volumetric one.

**[0035]** When the pump of the invention is applicable to chemical products, two important requirements must preferably be fulfilled:

- That the pump is volumetric, i.e., that regardless of the pressure it has to overcome, it always pumps the same volume of fluid in each revolution.
- That the portions of the pump in contact with the fluid are made of chemically resistant materials.

**[0036]** Obviously, the pump of the invention perfectly fulfils these two conditions, for which reason it is a dosing pump for chemical products.

**[0037]** When the pump is applicable to an oil-hydraulic power plant, it is perfectly capable of giving high pressures, so it could also work as a pump in hydraulic circuits. In this application of the invention, the head would be inside the main casing and the lubricating fluid would be the same as the driven fluid.

**[0038]** Instead, when the pump of the invention is applicable to a gaseous fluid, this gaseous fluid provided by the pump accumulates in a tank that forms part of a compressor, just like the pump itself.

**[0039]** In case of oleohydraulic or compressor application, the head would be inside the main housing.

**[0040]** The technical advantages of the pump of the invention with respect to single piston pumps are that it is much more efficient, that it gives a flow rate without pulsations, it has a much lower and constant decibel level, and it is mechanically balanced, i.e., the inertial and centrifugal forces of the mobile elements are very low.

**[0041]** The technical advantage over multi-piston volumetric pumps is that it has flow rate and pressure regulation, and the technical advantage over oil-hydraulic pumps is that it is volumetric.

**[0042]** Next, to help better understand this specification and as an integral part thereof, a series of figures is attached in which the object of the invention is depicted in an illustrative and non-limiting manner.

## Brief description of the figures

**[0043]**

**Figure 1** shows an exploded perspective view of the axial piston pump, object of the invention.

**Figure 2** shows an elevation view of the pump of the invention.

**Figure 3** shows a plan view of the pump of the invention.

**Figure 4** shows a cross sectioned elevation view according to the A-A section of figure 3, wherein a regulable movement transmission system is located in a position of low or null flow rate of the pump.

**Figure 5** shows another plan view of the pump.

**Figure 6** shows another cross-sectional elevation view according to the B-B section of Figure 5, wherein the transmission system is located in an active position in which the pump provides a high fluid flow rate.

**Figure 7** shows a cross-sectional view according to the C-C section of Figure 3.

**Figure 8** shows a cross-sectional view according to the D-D section of Figure 3.

**Figure 9** shows another plan view of the pump of the invention.

**Figure 10** shows a cross section profile view according to the F-F section of Figure 9.

**Figure 11** shows a cross section profile view according to the G-G section of Figure 9.

**Figure 12** shows a cross section profile view according to the section H-H of Figure 9.

**Figure 13** shows a cross section profile view according to the section J-J of Figure 9.

**Figure 14** shows a perspective view of a tensioning device that forms part of the pump of the invention.

**Figure 15** shows a perspective view of a third plate coupled with idle rotation on a mobile runner.

## Description of an exemplary embodiment of the invention

**[0044]** Considering the numbering adopted in the figures, the axial piston pump for supplying fluid comprises a regulable movement transmission system that enables the flow rate of the fluid at the pump outlet to be varied; wherein by means of said transmission system the stroke of the pistons 3 that move axially within respective cavities 16 without rotational mobility can be varied; and wherein the variation of the flow rate of fluid is carried out by means of the linear movement of a mobile runner 9 that can move in both directions in a direction parallel to the direction of the movement of the pistons 3.

**[0045]** The regulable movement transmission system comprises a first rotary plate 15 associated with a second

rotary plate 17 that can be tilted with respect to the first plate 15, and a third intermediate plate 11 that is also rotary; wherein the second plate 17 is linked to the third plate 11 by means of a crank mechanism 10, while the third plate 11 externally comprises an annular configuration and is coupled to the mobile runner 9 by means of an idle rotation coupling.

**[0046]** The third plate 11, as shown more clearly in figure 15, comprises an outer portion formed by an annular body 11a that is punctually coupled by tangential contact on several bearings 54 of the mobile runner 9, and an internal portion which comprises a central structure 11b with hollows in which first front fins 32 fit in parallel with the first plate 15, the rotation of which drags both the second plate 17 and the third plate 11.

**[0047]** This third plate 11 includes two opposing annular stops 45 that delimit the width of a circular surface of the annular body 11a of the third plate 11 in which the bearings 54 of the mobile runner 9 fit, so that by means of said annular stops 45 the second plate 17 is mobilised axially and relative to the first plate 15 when the mobile runner 9 is axially moved; wherein said movement causes the variation of the tilt of the second plate 17.

**[0048]** The crank mechanism 10 that links both plates 15 and 17, hinges at a first end on the third plate 11 by means of a first hinged connection 10a, while a second end of the crank mechanism 10, opposite to the first end, hinges on the second plate 17 by means of a second hinged connection 10b.

**[0049]** The mobile runner 9 includes threaded rods 23 that are coupled to pinions 24 that mesh with an external toothing of a toothed ring 25; wherein one of said pinions 24 meshes with an intermediate pinion 26 and this one with a driving pinion 27 solidly attached to a shaft to which a control wheel 28 is attached, by means of which the movement of the mobile runner 9 is carried out in one or the other direction, depending on the direction of rotation of said control wheel 28.

**[0050]** As shown more clearly in figure 15, the bearings 54 on which the third plate 11 rotates freely, are coupled on opposing screws as an axial continuation of the threaded rods 23, while the mobile runner 9 includes a wide centered opening 9a.

**[0051]** All these toothed elements described in the preceding paragraph configure a regulation mechanism 6 (to mobilise the mobile runner 9) that is housed inside a front casing 21 that is closed by means of a cover 20; wherein the front casing 21 and the cover 20 include centered and facing through hollows.

**[0052]** The front casing 21 includes an annular recess around the centered through hollow thereof wherein a first axial bearing 7 frontally sits on which a portion of the first plate 15 is embedded with interposition of an internal bearing 33 embedded in one of the two tracks of said first axial bearing 7, while another portion of the first plate 15 fits directly into the other paired track of said first axial bearing 7.

**[0053]** The transmission of rotary movement to the first plate 15 is carried out by means of a planetary gear device 1 which is connected on one side to an output shaft 12a of a motor 12 (it could be electric or of any other type, also hydraulic), and on the other side, said planetary gear device 1 is connected to a shaft 14 connected to the first plate 15.

**[0054]** The planetary gear device 1 comprises a fixed support 22 with an internal toothed gear 22a and a planetary assembly 29 that rotates coupled to the internal toothed gear 22a; wherein said planetary assembly 29 includes a mobile support 29a in the shape of a cross and several radial pinions 29b that rotate coupled to said mobile support 29a. In turn, said radial pinions 29b mesh on the one hand with the internal toothed gear 22a, and on the other hand mesh with a central pinion 30 embedded in the output shaft 12a of the motor 12; wherein said central pinion 30 also forms part of the planetary assembly 29.

**[0055]** The first platform 15 includes curved-concave female front seats 15a by way of a cradle on which complementary curved-convex male front seats 17a of the second tiltable platform 17 rest; wherein the curvature of the first and the second front seats are equidistant from a shared geometric centre 46 of a crosshead mechanism 4 that will be described later. The linear movement of the runner 9 drags the second plate 17 by means of the connecting rod mechanism 10, so that said second plate 17 can adopt different inclinations guided in the front seats 15a of the first plate 15.

**[0056]** The first plate 15 includes a centered central extension 47 on which the first axial bearing 7 is mounted with the interposition of the second internal bearing 33.

**[0057]** The second plate 17 comprises second front fins 31 in parallel that include the male front seats 17a that rest on the female front seats 15a that are located in the first front fins 32 of the first plate 15; wherein the two hinged connections 10a and 10b of the crank mechanism 10 are perpendicular to the planes in which the second front fins 31 of the second plate 17 and the first front fins 32 of the first plate 15 are contained.

**[0058]** The second plate 17 includes a centered extension 34 in which a second axial bearing 35 is mounted with the interposition of a second internal bearing 8, such that one of the tracks of said second axial bearing 35 is coupled on said second internal bearing 8 and this is embedded in one portion of the extension 34, while the other paired track of the second axial bearing 35 is embedded directly in another portion of the extension 34, abutting against a front seat of the second plate 17 itself.

**[0059]** On a front surface (track with the second internal bearing 8) of the second axial bearing 35 rests a first front face of a ball joint support 5 which includes, on the second front face thereof (opposite the first front face), pairs of fins 5a distributed in a circumferential contour, such that said pairs of fins 5a are coupled to end heads 3a with double joint that connect with the axial pistons 3.

**[0060]** Each double joint of the end heads 3a that link the pistons 3 with the ball joint support 5 comprises a ball

joint 36 coupled between pairs of fins 5a that form part of the ball joint support 5; and an intermediate joint 43 that attaches each end head 3a to the piston 3; wherein due to this intermediate joint 43 the piston 3 can rotate with respect to the respective end head 3a. The ball joints 36 are coupled to the pairs of fins 5a by means of shafts.

**[0061]** As shown more clearly in figures 4 and 6, a part 44 is attached to the piston 3, part on which the end head 3a is in turn attached by means of the intermediate joint 43 which includes a shaft. Said part 44 is that which enables the ball joint 36 to go up and down, but without the piston 3 being affected, i.e., this part 44 is totally guided and only has one degree of freedom, being able to move only axially accompanying the piston 3.

**[0062]** The crosshead mechanism 4 hinges on this second front face of the ball joint support 5, crosshead mechanism which includes two pairs of shafts; wherein a first pair of shafts 4a hinge on two aligned holes of two tabs 5b solidly attached to the ball joint support 5, while a tensioning device 13 hinges on the second pair of axes 4b of the crosshead mechanism 4.

**[0063]** The tensioning device 13 comprises a support structure 48 in which two mobile collateral wings 48a are guided in parallel with curved recesses 49 in which the crosshead mechanism 4 fits/hinges by means of the second shafts 4b thereof. The tensioning device 13 further comprises a longitudinal axis 50 solidly attached to a central pinion 51 that meshes with two lateral pinions 52 solidly attached to two coaxial nuts coupled on two screws 53 immobilised in parallel to the two collateral wings 48a by means of the heads thereof; wherein said pinions 51, 52 are axially retained to the support structure 48. The longitudinal axis 50 includes a hexagonal end section 50a for being able to comfortably rotate said longitudinal shaft 50 to axially adjust said tensioning device 13 in order to axially adjust the transmission system assembly inside a prismatic main casing 19, so that during the rotation of said longitudinal axis 50 the two collateral wings 48a move axially backwards or forwards.

**[0064]** In one embodiment of the invention, the support structure 48 is screwed to an intermediate sheet 55 that forms part of the main casing 14, while it is located in parallel to and in proximity to the second end base 19b.

**[0065]** An annular body 56 arranged around the support structure 48 is also fixed on said intermediate sheet 55; wherein said annular body 56 includes quadrangular holes 56a in which the parts 44 solidly attached to the pistons 3 are fitted and guided in order to prevent them from rotating. Obviously the cross section of said parts 44 coincides with the cross section of the quadrangular holes 56a, wherein said cross sections could have any configuration other than circular to prevent the pistons 3 from rotating.

**[0066]** An end part of the longitudinal axis 50 in which the hexagonal end section 50a is found is located in a hollow inside the head 2.

**[0067]** The pump of the invention further includes the main casing 19 with a lateral opening that is closed by a cover 18, so that the main casing 19 has two opposing end bases: first 19a and second 19b.

**[0068]** Outside the main casing 19, the motor 12 is fixed on the first base 19a thereof by means of first screws 38 and nuts not shown in the figures, while on the second base 19b and also outside the casing 12, a head 2 is fixed by means of second screws 39a and nuts 39b; wherein the head 2 that includes the cavities 16 in which the axial pistons 3 are guided and run.

**[0069]** Instead, the entire regulable movement transmission system is housed inside the main casing 19, as well as the ball joint support 5, the transmission mechanism for moving the mobile runner 9 and the end heads 3a of the pistons 3, the tensioning device 13, as well as the rest of the elements related thereto; wherein said adjustable movement transmission system comprises the planetary gear device 1, the first plate 15, the second plate 17, as well as the other elements related thereto.

**[0070]** Both the second base 19b and the intermediate sheet 55 of the main casing 19 include holes through which the pistons 3 pass to the outside, and centered holes through which the longitudinal shaft 50 of the tensioning device 13 passes.

**[0071]** Likewise, the first base 19a of the main casing 19 includes a centered through hole through which the output shaft 12a of the motor 12 passes inside the casing 12 to connect to the planetary gear device 1.

**[0072]** Furthermore, each one of the cavities 16 of the pump head 2 leads into an output area that includes a first passageway 41a and a second passageway 41b in which a first check valve 40a and a second check valve 40b have been inserted; wherein the first and second passageways lead separately into a first slot 37a and into a second slot 37b.

**[0073]** In the propulsion phase of the liquid fluid with the advance of the pistons 3 during the operation of the pump, said fluid comes out through the first passageways in which the first check valves 40a are, these being open, while the second check valves 40b will be closed.

**[0074]** Furthermore, in the aspiration or suction phase of the fluid with the return of the pistons 3, said fluid is sucked through the second passageways in which the second check valves 40b are open, while the first check valves 40a will be closed.

**[0075]** Thus, the pistons 3 move axially inside the cavities 16 in the forward direction to supply the fluid and in the return direction (opposite to the forward direction) to suck the fluid at least partially filling the cavities 16, to then go back to push said fluid towards the outlet and so on.

**[0076]** The pistons 3 are axially guided and adjusted in holes 57a located in a front plate 57 that is screwed to a front area of the head 2 opposite to a rear area wherein the check valves 40a, 40b are found; wherein said holes 57a serve as a guide for the pistons 3, so that the movement of the pistons 3 in any other direction than the axial one, would be limited by said front plate 57 and by the annular body 56 with its quadrangular holes 56a.

**[0077]** With this described arrangement, the variation of the flow rate provided by the pump of the invention at the outlet of the head 2 thereof through its first slot 37a, is achieved by varying the tilt of the second plate 17, and therefore an angle β that the imaginary axis 41 of said second plate 17 forms with respect to the horizontal supports 42 of the end bases 19a, 19b of the casing 19, as shown more clearly in figure 5.

**[0078]** The variation of the tilt of the second plate 17 is achieved by moving the mobile runner 9 which is linked to said second plate 17 by means of the crank mechanism 10 and the third plate 11 coupled to the mobile runner 9 by means of an idle rotation coupling.

**[0079]** In line with what was said in the two preceding paragraphs, the greater the inclination of the second plate 17, the greater the angle β and therefore the greater the flow rate of fluid provided by the pump of the invention. Proportionally, the longer the strokes of the pistons 3 within their cavities 16, the higher the flow rates of fluid and the shorter the strokes of the pistons 3, the lower the flow rates.

**[0080]** When the angle β is zero degrees, the pump will provide a minimum flow rate, although depending on the specific design of the pump, said flow rate could be zero, so that in this case the ball joint support 5 would be arranged in a plane perpendicular to the direction of the imaginary axis 41 of the second plate 17 and the pistons 3 would remain static without any mobility.

## Claims

1. An **axial piston pump**, comprising:

a static head (2) with parallel cavities (16) in which the pistons (3) are housed, which are configured to move axially in both directions within said cavities (16) to supply a flow rate of fluid at the outlet of said cavities (16) that are distributed in a circumferential path; and
a regulable movement transmission system that includes at least a first rotary plate (15), a second rotary plate (17) that can be tilted with respect to the first plate (15), and a ball joint support (5) wherein ends of the pistons (3) are coupled by means of end heads (3a) with double joints;

- the first plate (15) including curved-concave female front seats (15a) on which complementary curved-convex male front seats (17a) of the second tiltable plate (17) rest; wherein the curvature of the first and the second front seats are equidistant from a shared centre (46) located inside a main casing (19) and
- the ball joint support (5) resting frontally on a second axial bearing (35) coupled to an extension (34) of the second plate (17); wherein said ball joint support (5) adopts the tilt of said second plate (17) at all times, without rotational movement of the ball joint support (5);

wherein the regulable movement transmission system is configured to be able to vary the stroke of the pistons (3) in order to vary the flow rate of the fluid at the outlet of the cavities (16);
**characterized in that**
the regulable movement transmission system further includes a third rotary plate (11) and a mobile runner (9) with linear movement; wherein the third plate (11) is coupled to the mobile runner (9) by means of an idle rotation coupling in a plane perpendicular to the linear movement of the mobile runner (9); wherein the first plate (15) drags the second plate (17) and the third plate (11) with its rotation; and wherein the first (15), second (17) and third (11) plates, as well as the mobile runner (9) together with a tensioning device (13) of the transmission system are located inside the main casing (19);
the second plate (17) is linked to the third plate (11) by means of a crank mechanism (10) that hinges at a first end on the third plate (11) by means of a first hinged connection (10a), while a second end of the crank mechanism (10), opposite the first end, hinges on the second plate (17) by means of a second hinged connection (10b); and
wherein the variation of the stroke of the pistons is carried out by means of the linear movement of the mobile runner (9) that modifies the tilt of the second plate (17) and of the ball joint support (5) through the third plate (11) and the crank mechanism (10).

2. The **axial piston pump,** according to claim 1, **characterised in that** a crosshead mechanism (4) that includes two pairs of axes hinges on the ball joint support (5); wherein a first pair of axes (4a) hinge on two aligned holes of two tabs (5b) solidly attached to the ball joint support (5), while the tensioning device (13) that includes a longitudinal axis (50) in parallel with the cavities (16) in which the axial pistons (3) are guided and run hinges on the second pair of axes (4b) of the crosshead mechanism (4); wherein the longitudinal axis (50) is guided inside the head (2).

3. The **axial piston pump,** according to any one of the preceding claims, **characterised in that** the transmission of rotary movement to the first plate (15) is carried out by means of a planetary gear device (1) that is coupled to a shaft (14) connected to the first plate (15).

4. The **axial piston pump,** according to claim 3, **characterised in that** the planetary gear device (1) comprises a fixed support (22) with an internal toothed gear (22a) and a planetary assembly (29) that rotates coupled to the internal toothed gear (22a); wherein said planetary assembly (29) includes a mobile support (29a) in the shape of a cross and several radial pinions (29b) that rotate idly coupled to said mobile support (29a); and wherein said radial pinions (29b) mesh on the one hand with the internal toothed gear (22a), and on the other hand they mesh with a central pinion (30) configured to receive a transmission of rotational movement from the outside.

5. The **axial piston pump,** according to any one of the preceding claims, **characterised in that** the mobile runner (9) includes threaded rods (23) that are coupled to pinions (24) that mesh externally with the external toothing of a toothed ring (25); wherein one of said pinions (24) meshes with an intermediate pinion (26) and this with a driving pinion (27) solidly attached to a shaft to which a control wheel (28) is attached, which is configured to carry out the movement of the mobile runner (9) in one or another direction, depending on the direction of rotation of said control wheel (28); wherein all these toothed elements configure a regulation mechanism (6) that is housed inside a front casing (21) that is closed by means of a cover (20); wherein the front casing (21) and the cover (20) include centered and facing through hollows.

6. The **axial piston pump,** according to claim 5, **characterised in that** the front casing (21) includes an annular recess around the centered through hollow thereof wherein a first axial bearing (7) sits frontally on which a portion of the first plate (15) is embedded with interposition of an internal bearing (33) embedded in one of the two tracks of said first axial bearing (7), while another portion of the first plate (15) fits directly into the other matching track of said first axial bearing (7).

7. The **axial piston pump,** according to any one of the preceding claims, **characterised in that** the second plate (17) comprises second parallel fins (31) that include the male front seats (17a), while the first plate (15) includes first parallel fins (32) that include the female front seats (15a); wherein the two hinged connections (10a) and (10b) of the crank mechanism (10) are perpendicular to the planes in which the second front wings (31) of the second plate (17) and the first front wings (32) of the first plate (15) are contained.

8. The **axial piston pump,** according to any one of the preceding claims, **characterised in that** the second axial bearing (35) comprises two opposing tracks, one of which is coupled on a second internal bearing (8) and this is embedded in a portion of the extension (34), while the other paired track of the second axial bearing (35) is embedded directly in another portion of the extension (34) abutting against a front seat of the second plate (17) itself; wherein the ball joint support (5) rests frontally on the track that is coupled on the second internal bearing (8).

9. The **axial piston pump,** according to any one of the preceding claims, **characterised in that** each one of the cavities (16) of the head (2) leads into an outlet area that includes a first passageway and a second passageway in which a first check valve (40a) and a second check valve (40b) have been inserted; wherein the first and second passageways lead separately into a first fluid outlet slot (37a) during the propulsion thereof and into a second fluid inlet slot (37b) during the aspiration/suction thereof to fill the cavities (16).

10. The **axial piston pump,** according to any one of the preceding claims, **characterised in that**:

    - the main casing (19) includes a lateral opening that is closed by means of a cover (18); wherein the main casing (19) has two opposing end bases: first (19a) and second (19b);
    - the head (2) is fixed outside the main casing (19) and on the second base (19b).

11. The **axial piston pump,** according to any one of the preceding claims, **characterised in that** each double joint of the end heads (3a) that link the pistons (3) with the ball joint support (5) comprises:

    - a ball joint (36) coupled between pairs of fins (5a) that form part of the ball joint support (5) by means of a shaft;
    - an intermediate joint (43) that attaches each end head (3a) to the piston (3) by means of another shaft.

12. The **axial piston pump,** according to claim 2, **characterised in that** the shared centre (46) of the curved-concave male front seats (17a) of the second plate (17) and the curved-convex female front seats (15a) of the first plate (15) is located at the centre of the crosshead mechanism (4); wherein said shared centre (46) is equidistant from said front seats (15a, 17a) after the crosshead mechanism (4) is fully positioned and axially tightened by the tensioning mechanism (13).

13. The **axial piston pump,** according to any one of the preceding claims 2 or 12, **characterised in that** the tensioning device (13) comprises:

- a support structure (48) wherein two parallel collateral wings (48a) are guided with curved recesses (49) in which the second pair of axes (4b) of the crosshead mechanism (4b) hinges;
- a longitudinal axis (50) solidly attached to a central pinion (51) that meshes with two lateral pinions (52) coupled by threading on two screws (53) that are immobilised in parallel to the two collateral wings (48a) by means of the heads thereof; wherein said pinions (51, 52) are axially retained to the support structure (48); and wherein the longitudinal axis (50) includes a hexagonal end section (50a) to rotate said longitudinal axis (50) to axially adjust said tensioning device (13) in order to axially adjust the transmission system assembly inside the main casing (19).

**14.** The **axial piston pump,** according to claim 13, **characterised in that** the support structure (48) of the tensioning device (13) is screwed to an intermediate sheet (55) that forms part of the main casing (14), while it is located in parallel and in proximity to the second end base (19b).

**15.** The **axial piston pump,** according to claim 14, **characterised in that** an annular body (56) arranged around the support structure (48) is fixed on the intermediate sheet (55); wherein said annular body (56) includes quadrangular holes (56a) in which the parts (44) solidly attached to the pistons (3) are fitted and guided; wherein the cross section of said parts (44) coincides with the passageway cross section of the quadrangular holes (56a).

**16.** The **axial piston pump,** according to the preceding claims 1 and 7, **characterised in that** the third plate (11) comprises an outer portion formed by an annular body (11a) that is punctually coupled by tangential contact on bearings (54) of the mobile runner (9) with idle rotation, and an internal portion comprising a central structure (11b) with hollows in which the first front fins (32) of the first plate (15) fit.

**17.** The **axial piston pump,** according to any one of the preceding claims, characterised the pistons (3) are guided and adjusted axially in holes (57a) located in a front plate (57) that is screwed in a front area of the head (2) opposite to a rear area wherein the outlet of the cavities (16) is found; wherein said holes (57a) serve as a guide for the pistons (3).

**Patentansprüche**

**1.** Axialkolbenpumpe, die umfasst:

einen statischen Kopf (2) mit parallelen Hohlräumen (16), in denen die Kolben (3) aufgenommen sind, die so ausgeführt sind, dass sie sich im Inneren der Hohlräume (16) axial in beide Richtungen bewegen, um an dem Auslass der Hohlräume (16), die auf einem Umfangsweg verteilt sind, Fluid in einer Durchflussmenge zuzuführen; sowie
ein regulierbares Bewegungs-Übertragungssystem, das wenigstens eine erste Drehplatte (15),
eine zweite Drehplatte (17), die in Bezug auf die erste Platte (15) geneigt werden kann,
sowie einen Kugelgelenk-Träger (5) enthält, wobei Enden der Kolben (3) über Endköpfe (3a) mit Doppelgelenken gekoppelt sind;

- die erste Platte (15) gekrümmt-konkave, nach innen gewölbte vordere Sitze (15a) enthält, auf denen komplementäre gekrümmt-konvexe, nach außen gewölbte vordere Sitze (17a) der zweiten neigbaren Platte (17) aufliegen; wobei die Krümmung der ersten und der zweiten vorderen Sitze gleich weit von einem gemeinsamen Mittelpunkt (46) entfernt sind, der sich im Inneren eines Hauptgehäuses (19) befindet, und
- der Kugelgelenk-Träger (5) frontal auf einem zweiten Axiallager (35) aufliegt, das mit einer Verlängerung (34) der zweiten Platte (17) gekoppelt ist; wobei sich der Kugelgelenk-Träger (5) ohne Drehbewegung des Kugelgelenk-Trägers stets an die Neigung der zweiten Platte (17) anpasst;

das regulierbare Bewegungs-Übertragungssystem so ausgeführt ist, dass es in der Lage ist, den Hub der Kolben (3) zu variieren, um die Durchflussmenge des Fluids an dem Auslass der Hohlräume (16) zu variieren;
**dadurch gekennzeichnet, dass**
das regulierbare Bewegungs-Übertragungssystem des Weiteren eine dritte Drehplatte (11) sowie einen beweglichen Läufer (9) mit linearer Bewegung umfasst; wobei die dritte Platte (11) mit dem beweglichen Läufer (9) mittels einer Freischaltkupplung in einer Ebene senkrecht zu der linearen Bewegung des beweglichen Läufers (9) gekoppelt ist; die erste Platte (15) die zweite Platte (17) sowie die dritte Platte (11) mit ihrer Drehung mitzieht; und wobei sich die erste Platte (15), die zweite Platte (17) und die dritte Platte (11) sowie der bewegliche Läufer (9) zusammen mit einer Spannvorrichtung (13) des Übertragungssystems im Inneren des Hauptgehäuses (19) befinden;
die zweite Platte (17) mit der dritten Platte (11) mittels eines Kurbelmechanismus (10) verbunden ist, der an einem ersten Ende an der dritten

Platte (11) über eine erste gelenkige Verbindung (10a) angelenkt ist, während ein zweites Ende des Kurbelmechanismus (10), das dem ersten Ende gegenüberliegt, an der zweiten Platte (17) über eine zweite gelenkige Verbindung (10b) angelenkt ist; und
wobei die Veränderung des Hubs der Kolben mittels der linearen Bewegung des beweglichen Läufers (9) erfolgt, der die Neigung der zweiten Platte (17) und des Kugelgelenk-Trägers (5) über die dritte Platte (11) und den Kurbelmechanismus (10) abgewandelt.

2. Axialkolbenpumpe nach Anspruch 1, **dadurch gekennzeichnet, dass** ein KreuzkopfMechanismus (4),der zwei Paare von Achsen enthält, an dem Kugelgelenk-Träger (5) angelenkt ist; wobei ein erstes Paar von Achsen (4a) an zwei fluchtenden Löchern zweier fest an dem Kugelgelenk-Träger (5) angebrachter Ösen (5b) angelenkt ist, während die Spannvorrichtung (13), die eine zu den Hohlräumen (16), in denen die Axialkolben (3) geführt werden und laufen parallele Längsachse (50) enthält, an dem zweiten Paar von Achsen (4b) des Kreuzkopf-Mechanismus (4) angelenkt ist, wobei die Längsachse (50) im Inneren des Kopfes (2) geführt wird.

3. Axialkolbenpumpe nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Übertragung von Drehbewegung auf die erste Platte (15) mittels einer Planetengetriebe-Vorrichtung (1) ausgeführt wird, die mit einer mit der ersten Platte (15) verbundenen Welle (14) gekoppelt ist.

4. Axialkolbenpumpe nach Anspruch 3, **dadurch gekennzeichnet, dass** die Planetengetriebe-Vorrichtung (1) einen festen Träger (22) mit einem Innenzahnrad (22a) und eine Planetenanordnung (29) umfasst, die sich mit dem Innenzahnrad (22a) gekoppelt dreht; wobei die Planetenanordnung (29) einen beweglichen Träger (29a) in Form eines Kreuzes und mehrere radiale Ritzel (29b) umfasst, die mit dem beweglichen Träger (29a) gekoppelt frei rotieren; und wobei die radialen Ritzel (29b) einerseits mit dem Innenzahnrad (22a) kämmen und andererseits mit einem mittigen Ritzel (30) kämmen, das so ausgeführt ist, dass es eine Übertragung von Drehbewegung von außen empfängt.

5. Axialkolbenpumpe nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der bewegliche Läufer (9) Gewindestangen (23) enthält, die mit Ritzeln (24) gekoppelt sind, die außen mit der Außenverzahnung eines Zahnkranzes (25) kämmen; wobei eines der Ritzel (24) mit einem Zwischenritzel (26) kämmt und dieses mit einem Antriebszahnrad (27) kämmt, das fest an einer Welle angebracht ist, an der ein Stellrad (28) angebracht ist, das so konfiguriert ist, dass es die Bewegung des beweglichen Läufers (9), in Abhängigkeit von der Drehrichtung des Stellrades (28), in der einen oder der anderen Richtung ausführt; wobei alle diese verzahnten Elemente einen Regulierungsmechanismus (6) bilden, der im Inneren eines vorderen Gehäuses (21) aufgenommen ist, das mittels eines Deckels (20) geschlossen ist; wobei das vordere Gehäuse (21) und der Deckel (20) zentrierte und einander zugewandte durchgehende Hohlräume enthalten.

6. Axialkolbenpumpe nach Anspruch 5, **dadurch gekennzeichnet, dass** das vordere Gehäuse (21) eine ringförmige Vertiefung um seinen zentrierten durchgehenden Hohlraum herum aufweist, in dem ein erstes Axiallager (7) frontal sitzt, an dem ein Abschnitt der ersten Platte (15) mit einem dazwischen angeordneten Innenlager (33) eingebettet ist, das in eine der zwei Laufbahnen des ersten Axiallagers (7) eingebettet ist, während ein anderer Abschnitt der ersten Platte (15) direkt in die andere passende Laufbahn des ersten Axiallagers (7) passt.

7. Axialkolbenpumpe nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die zweite Platte (17) zweite parallele Rippen (31) enthält, die die nach außen gewölbten vorderen Sitze (17a) umfassen, während die erste Platte (15) erste parallele Rippen (32) enthält, die die nach innen gewölbten vorderen Sitze (15a) einschließen; wobei die zwei gelenkigen Verbindungen (10a) und (10b) des Kurbelmechanismus (10) senkrecht zu den Ebenen sind, in denen die zweiten vorderen Flügel (31) der zweiten Platte (17) und die ersten vorderen Flügel (32) der ersten Platte (15) aufgenommen sind.

8. Axialkolbenpumpe nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das zweite Axiallager (35) zwei gegenüberliegende Laufbahnen umfasst, von denen eine an ein zweites Innenlager (8) gekoppelt ist und dieses in einen Abschnitt der Verlängerung (34) eingebettet ist, während die andere paarige Laufbahn des zweiten Axiallagers (35) direkt in einen anderen Abschnitt der Verlängerung (34) eingebettet ist, der an einem vorderen Sitz der zweiten Platte (17) selbst anliegt; wobei der Kugelgelenk-Träger (5) frontal auf der Laufbahn aufliegt, die an das zweite Innenlager (8) gekoppelt ist.

9. Axialkolbenpumpe nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder der Hohlräume (16) des Kopfes (2) in einen Auslassbereich führt, der einen ersten Durchlass und einen zweiten Durchlass enthält, in den ein erstes Rückschlagventil (40a) und ein zweites Rückschlagventil (40b) eingeführt worden sind; wobei der erste und

der zweite Durchlass während des Ausstoßens derselben getrennt in einen ersten Fluid-Auslassschlitz (37a) und während des Ansaugens derselben in einen zweiten Fluid-Einlassschlitz (37b) führen, um die Hohlräume (16) zu füllen.

**10.** Axialkolbenpumpe nach einem der vorangehenden Ansprüche,
**dadurch gekennzeichnet, dass**:

- das Hauptgehäuse (19) eine seitliche Öffnung enthält, die mittels eines Deckels (18) verschlossen wird; wobei das Hauptgehäuse (19) zwei, d. h. einen ersten Endsockel (19a) und einen zweiten Endsockel (19b), aufweist, die einander gegenüberliegen;
- der Kopf (2) außerhalb des Hauptgehäuses (19) und an dem zweiten Sockel (19b) befestigt ist.

**11.** Axialkolbenpumpe nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** jedes Doppelgelenk der Endköpfe (3a), die die Kolben (3) mit dem Kugelgelenk-Träger (5) verbinden, umfasst:

- ein Kugelgelenk (36), das mittels einer Welle zwischen paarige Rippen (5a) gekoppelt ist, die Teil des Kugelgelenk-Trägers (5) sind;
- ein Zwischengelenk (43), über das jeder Endkopf (3a) mittels einer weiteren Welle an dem Kolben (3) angebracht ist.

**12.** Axialkolbenpumpe nach Anspruch 2, **dadurch gekennzeichnet, dass** sich der gemeinsame Mittelpunkt (46) der gekrümmt-konkaven, nach außen gewölbten vorderen Sitze (17a) der zweiten Platte (17) und der gekrümmt-konvexen, nach innen gewölbten vorderen Sitze (15a) der ersten Platte (15) in der Mitte des Kreuzkopfmechanismus (4) befindet, wobei der gemeinsame Mittelpunkt (46) von den vorderen Sitzen (15a, 17a) gleich weit entfernt ist, nachdem der Kreuzkopfmechanismus (4) vollständig positioniert und durch den Spannmechanismus (13) axial angezogen ist.

**13.** Axialkolbenpumpe nach einem der vorangehenden Ansprüche 2 oder 12, **dadurch gekennzeichnet, dass** die Spannvorrichtung (13) umfasst:

- eine Tragestruktur (48), in der zwei parallele seitliche Flügel (48a) mit gekrümmten Aussparungen (49) geführt werden, in denen das zweite Paar von Achsen (4b) des Kreuzkopfmechanismus (4b) angelenkt ist;
- eine Längsachse (50), die fest mit einem mittigen Ritzel (51) verbunden ist, das mit zwei seitlichen Ritzel (52) kämmt, das durch Aufschrauben auf zwei Schrauben (53) gekoppelt wird, die mittels ihrer Köpfe parallel zu den zwei seitlichen Flügeln (48a) fixiert werden, wobei die Ritzel (51, 52) axial an der Tragestruktur (48) gehalten werden; und wobei die Längsachse (50) einen sechseckigen Endabschnitt (50a) enthält, um die Längsachse (50) zu drehen und die Spannvorrichtung (13) axial einzustellen, um die Übertragungssystem-Anordnung im Inneren des Hauptgehäuses (19) axial einzustellen.

**14.** Axialkolbenpumpe nach Anspruch 13, **dadurch gekennzeichnet, dass** die Tragestruktur (48) der Spannvorrichtung (13) an einer Zwischenplatte (55) angeschraubt ist, die Teil des Hauptgehäuses (14) ist, wobei sie parallel zu dem zweiten Endsockel (19b) und in dessen Nähe angeordnet ist.

**15.** Axialkolbenpumpe nach Anspruch 14, **dadurch gekennzeichnet, dass** ein ringförmiger Körper (56), der um die Tragestruktur (48) herum angeordnet ist, an der Zwischenplatte (55) befestigt ist; wobei der ringförmige Körper (56) viereckige Löcher (56a) enthält, in die die fest mit den Kolben (3) verbundenen Teile (44) eingepasst sind und darin geführt werden; wobei der Querschnitt der Teile (44) mit dem Durchlass-Querschnitt der viereckigen Löcher (56a) übereinstimmt.

**16.** Axialkolbenpumpe nach den vorangehenden Ansprüchen 1 und 7, **dadurch gekennzeichnet, dass** die dritte Platte (11) einen äußeren Abschnitt, der von einem ringförmigen Körper (11a) gebildet wird, der durch tangentialen Kontakt mit Lagern (54) des beweglichen Läufers (9) frei rotierend punktuell gekoppelt ist, sowie einen inneren Abschnitt umfasst, der eine mittige Struktur (11b) mit Hohlräumen umfasst, in die die ersten vorderen Rippen (32) der ersten Platte (15) passen.

**17.** Axialkolbenpumpe nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Kolben (3) in Löchern (57a) axial geführt und eingestellt werden, die sich in einer vorderen Platte (57) befinden, die in einem vorderen Bereich des Kopfes (2) gegenüber einem hinteren Bereich, in dem sich der Auslass der Hohlräume (16) befindet, angeschraubt ist; wobei die Löcher (57a) als eine Führung für die Kolben (3) dienen.

**Revendications**

**1.** Pompe à piston axial comprenant :

une tête statique (2) avec des cavités parallèles (16) dans lesquelles sont logés les pistons (3), qui sont configurés pour se déplacer de manière axiale dans les deux directions à l'intérieur des-

dites cavités (16) pour fournir un débit de fluide à la sortie desdites cavités (16) qui sont réparties dans une trajectoire circonférentielle ; et
un système de transmission de mouvement réglable qui comprend au moins :

une première plaque rotative (15), une deuxième plaque rotative (17) qui peut être inclinée par rapport à la première plaque (15),
et un support de joint à rotule (5), dans laquelle les extrémités des pistons (3) sont couplées au moyen des têtes d'extrémité (3a) avec des joints doubles ;

- la première plaque (15) comprenant des sièges avant femelles à courbure concave (15a) sur lesquels s'appuient des sièges avant mâles à courbure convexe complémentaires (17a) de la deuxième plaque (17) inclinable ; dans laquelle la courbure du premier et du deuxième siège avant est à équidistance d'un centre (46) partagé situé à l'intérieur d'une carcasse principale (19), et
- le support de joint à rotule (5) s'appuyant frontalement sur un deuxième palier axial (35) couplé à une extension (34) de la deuxième plaque (17) ; dans laquelle ledit support de joint à rotule (5) adopte l'inclinaison de ladite deuxième plaque (17) à tout moment, sans mouvement de rotation du support de joint à rotule (5) ;

dans laquelle le système de transmission de mouvement réglable est configuré pour pouvoir modifier la course des pistons (3) afin de modifier le débit du fluide à la sortie des cavités (16) ;
**caractérisée en ce que** :

le système de transmission de mouvement réglable comprend en outre une troisième plaque rotative (11) et une roue mobile (9) avec mouvement linéaire ; dans laquelle la troisième plaque (11) est couplée à la roue mobile (9) au moyen d'un couplage à rotation folle dans un plan perpendiculaire au mouvement linéaire de la roue mobile (9) ; dans laquelle la première plaque (15) entraîne, avec sa rotation, la deuxième plaque (17) et la troisième plaque (11) ; et dans laquelle les première (15), deuxième (17) et troisième (11) plaques, ainsi que la roue mobile (9) conjointement avec un dispositif de tension (13) du système de transmission, sont positionnées à l'intérieur de la carcasse principale (19) ;
la deuxième plaque (17) est reliée à la troisième plaque (11) au moyen d'un mécanisme de manivelle (10) qui s'articule, au niveau d'une première extrémité, sur la troisième plaque (11) au moyen d'un premier raccordement articulé (10a), alors qu'une deuxième extrémité du mécanisme de manivelle (10), opposée à la première extrémité, s'articule sur la deuxième plaque (17) au moyen d'un deuxième raccordement articulé (10b) ; et
dans laquelle la variation de la course des pistons est réalisée au moyen du mouvement linéaire de la roue mobile (9) qui modifie l'inclinaison de la deuxième plaque (17) et du support de joint à rotule (5) par le biais de la troisième plaque (11) et du mécanisme de manivelle (10).

**2.** Pompe à piston axial selon la revendication 1, **caractérisée en ce qu'**un mécanisme de traverse (4) qui comprend deux paires d'axes, s'articule sur le support de joint à rotule (5) ; dans laquelle une première paire d'axes (4a) s'article sur deux trous alignés de deux languettes (5b) solidement fixées sur le support de joint à rotule (5), alors que le dispositif de tension (13) qui comprend un axe longitudinal (50) parallèle aux cavités (16), dans lesquelles les pistons axiaux (3) sont guidés et étendent des charnières sur la deuxième paire d'axes (4b) du mécanisme de traverse (4) ; dans laquelle l'axe longitudinal (50) est guidé à l'intérieur de la tête (2).

**3.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la transmission du mouvement de rotation à la première plaque (15) est réalisée au moyen d'un dispositif à train planétaire (1) qui est couplé à un arbre (14) raccordé à la première plaque (15).

**4.** Pompe à piston axial selon la revendication 3, **caractérisée en ce que** le dispositif à train planétaire (1) comprend un support fixe (22) avec un engrenage denté interne (22a) et un ensemble planétaire (29) qui tourne en étant couplé à l'engrenage denté interne (22a) ; dans laquelle ledit ensemble planétaire (29) comprend un support mobile (29a) se présentant sous la forme d'une croix et plusieurs pignons radiaux (29b) qui sont couplés en rotation folle audit support mobile (29a) ; et dans laquelle lesdits pignons radiaux (29b) s'engrènent d'une part avec l'engrenage denté interne (22a), et d'autre part, ils

s'engrènent avec un pignon central (30) configurés pour recevoir une transmission de mouvement de rotation depuis l'extérieur.

**5.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la roue mobile (9) comprend des tiges filetées (23) qui sont couplées aux pignons (24) qui s'engrènement extérieurement avec la denture externe d'un anneau denté (25) ; dans laquelle l'un desdits pignons (24) s'engrène avec un pignon intermédiaire (26) et ce dernier avec un pignon d'entraînement (27) solidement fixé à un arbre auquel est fixée une roue de commande (28), qui est configurée pour réaliser le mouvement de la roue mobile (9) dans une direction ou dans une autre, en fonction de la direction de rotation de ladite roue de commande (28) ; dans laquelle tous ces éléments dentés configurent un mécanisme de régulation (6) qui est logé à l'intérieur d'une carcasse avant (21) qui est fermée au moyen d'un couvercle (20) ; dans laquelle la carcasse avant (21) et le couvercle (20) comprennent des creux débouchants centrés et se faisant face.

**6.** Pompe à piston axial selon la revendication 5, **caractérisée en ce que** la carcasse avant (21) comprend un évidement annulaire autour de son creux débouchant centré, dans laquelle se trouve, frontalement, un premier palier axial (7), sur lequel une partie de la première plaque (15) est encastrée, avec l'interposition d'un palier interne (33) encastré dans l'une des deux pistes dudit premier palier axial (7), alors que l'autre partie de la première plaque (15) se monte directement dans l'autre piste correspondante dudit premier palier axial (7).

**7.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la deuxième plaque (17) comprend des deuxièmes ailettes parallèles (31) qui comprennent des sièges avant mâles (17a), alors que la première plaque (15) comprend des premières ailettes parallèles (32) qui comprennent les sièges avant femelles (15a) ; dans laquelle les deux raccordements articulés (10a) et (10b) du mécanisme de manivelle (10) sont perpendiculaires aux plans dans lesquels sont contenues les deuxièmes ailes avant (31) de la deuxième plaque (17) et les premières ailes avant (32) de la première plaque (15).

**8.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** le deuxième palier axial (35) comprend deux pistes opposées, dont l'une est couplée sur un deuxième palier interne (8) et cette dernière est encastrée dans une partie de l'extension (34), alors que l'autre piste en paire du deuxième palier axial (35) est encastrée directement dans une autre partie de l'extension (34) venant en butée contre un siège avant de la deuxième plaque (17) elle-même ; dans laquelle le support de joint à rotule (5) s'appuie frontalement sur la piste qui est couplée sur le deuxième palier interne (8).

**9.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** chacune des cavités (16) de la tête (2) mène à une zone de sortie qui comprend une première voie de passage et une deuxième voie de passage dans lesquelles un premier clapet anti-retour (40a) et un deuxième clapet anti-retour (40b) ont été insérés ; dans laquelle les première et deuxième voies de passage mènent séparément à une première fente de sortie de fluide (37a) pendant sa propulsion et dans une deuxième fente d'entrée de fluide (37b) pendant son aspiration/succion afin de remplir les cavités (16).

**10.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** :

- la carcasse principale (19) comprend une ouverture latérale qui est fermée au moyen d'un couvercle (18) ; dans laquelle la carcasse principale (19) a deux bases d'extrémité opposées : une première (19a) et une deuxième (19b) ;
- la tête (2) est fixée à l'extérieur de la carcasse principale (19) et sur la deuxième base (19b).

**11.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** chaque double joint des têtes d'extrémité (3a) qui relient les pistons (3) avec le support de joint à rotule (5), comprend :

- un joint à rotule (36) couplé entre des paires d'ailettes (5a) qui font partie du support de joint à rotule (5) au moyen d'un arbre ;
- un joint intermédiaire (43) qui fixe chaque tête d'extrémité (3a) au piston (3) au moyen d'un autre arbre.

**12.** Pompe à piston axial selon la revendication 2, **caractérisée en ce que** le centre partagé (46) des sièges avant mâles à courbure concave (17a) de la deuxième plaque (17) et les sièges avant femelles à courbure convexe (15a) de la première plaque (15) est situé au centre du mécanisme de traverse (4) ; dans laquelle ledit centre partagé (46) est à équidistance desdits sièges avant (15a, 17a) après que le mécanisme de traverse (4) a été complètement positionné et axialement serré par le mécanisme de tension (13).

**13.** Pompe à piston axial selon l'une quelconque des

revendications 2 ou 12, **caractérisée en ce que** le dispositif de tension (13) comprend :

- une structure de support (48), dans laquelle deux ailes collatérales parallèles (48a) sont guidées avec des évidements courbés (49), dans lesquels la deuxième paire d'axes (4b) du mécanisme de traverse (4b) est articulée ;
- un axe longitudinal (50) solidement fixé à un pignon central (51) qui s'engrène avec deux pignons latéraux (52) couplés en vissant deux vis (53), qui sont immobilisés parallèlement aux deux ailes collatérales (48a) au moyen de leurs têtes ; dans laquelle lesdits pignons (51, 52) sont axialement retenus sur la structure de support (48) ; et dans laquelle l'axe longitudinal (50) comprend une section d'extrémité hexagonale (50a) pour faire tourner ledit axe longitudinal (50) afin de régler axialement ledit dispositif de tension (13) pour régler axialement l'ensemble de système de transmission à l'intérieur de la carcasse principale (19).

**14.** Pompe à piston axial selon la revendication 13, **caractérisée en ce que** la structure de support (48) du dispositif de tension (13) est vissée sur une feuille intermédiaire (55) qui fait partie de la carcasse principale (14), alors qu'elle est positionnée en parallèle et à proximité de la deuxième base d'extrémité (19b).

**15.** Pompe à piston axial selon la revendication 14, **caractérisée en ce qu'**un corps annulaire (56) agencé autour de la structure de support (48) est fixé sur la feuille intermédiaire (55) ; dans laquelle ledit corps annulaire (56) comprend des trous quadrangulaires (56a) dans lesquels les parties (44) solidement fixées aux pistons (3) sont montées et guidées ; dans laquelle la section transversale desdites parties (44) coïncide avec le section transversale de voie de passage des trous quadrangulaires (56a).

**16.** Pompe à piston axial selon les revendications 1 et 7, **caractérisée en ce que** la troisième plaque (11) comprend une partie externe formée par un corps annulaire (11a) qui est ponctuellement couplé par contact tangentiel sur des paliers (54) de la roue mobile (9) avec rotation folle, et une partie interne comprenant une structure centrale (11b) avec des creux dans lesquels les premières ailettes avant (32) de la première plaque (15) sont montées.

**17.** Pompe à piston axial selon l'une quelconque des revendications précédentes, **caractérisée en ce que** les pistons (3) sont guidés et réglés axialement dans des trous (57a) situés dans une plaque avant (57) qui est vissée dans une zone avant de la tête (2) opposée à une zone arrière, dans laquelle on trouve la sortie des cavités (16) ; dans laquelle lesdits trous (57a) servent de guide pour les pistons (3).

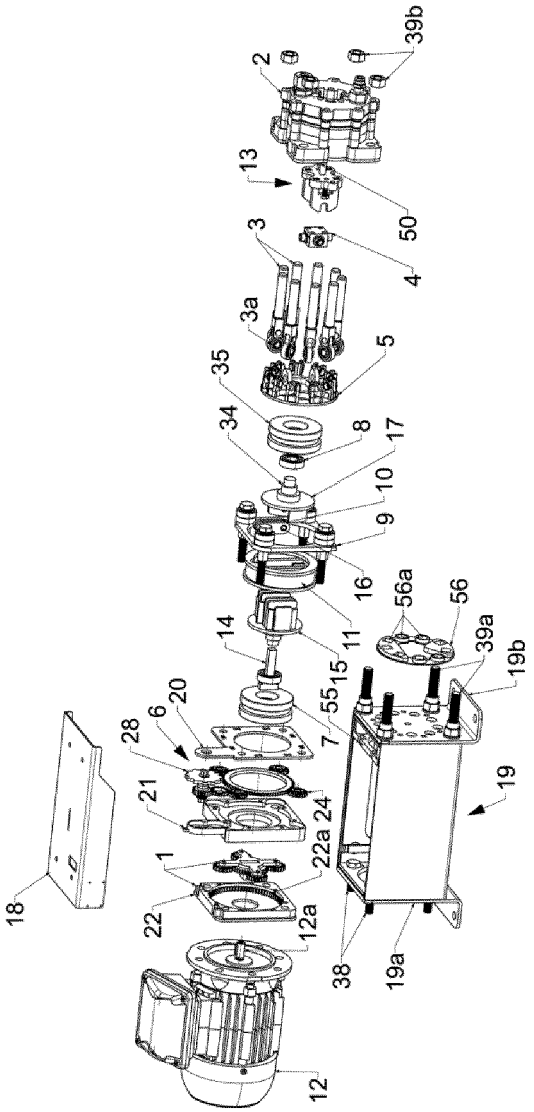
39b
2
13
50
3
4
3a
5
35
34
8
17
10
9
16
56a
56
14
11
39a
19b
15
55
20
6
7
28
21
24
19
22a
1
22
12a
18
38
19a
12

FIG. 1

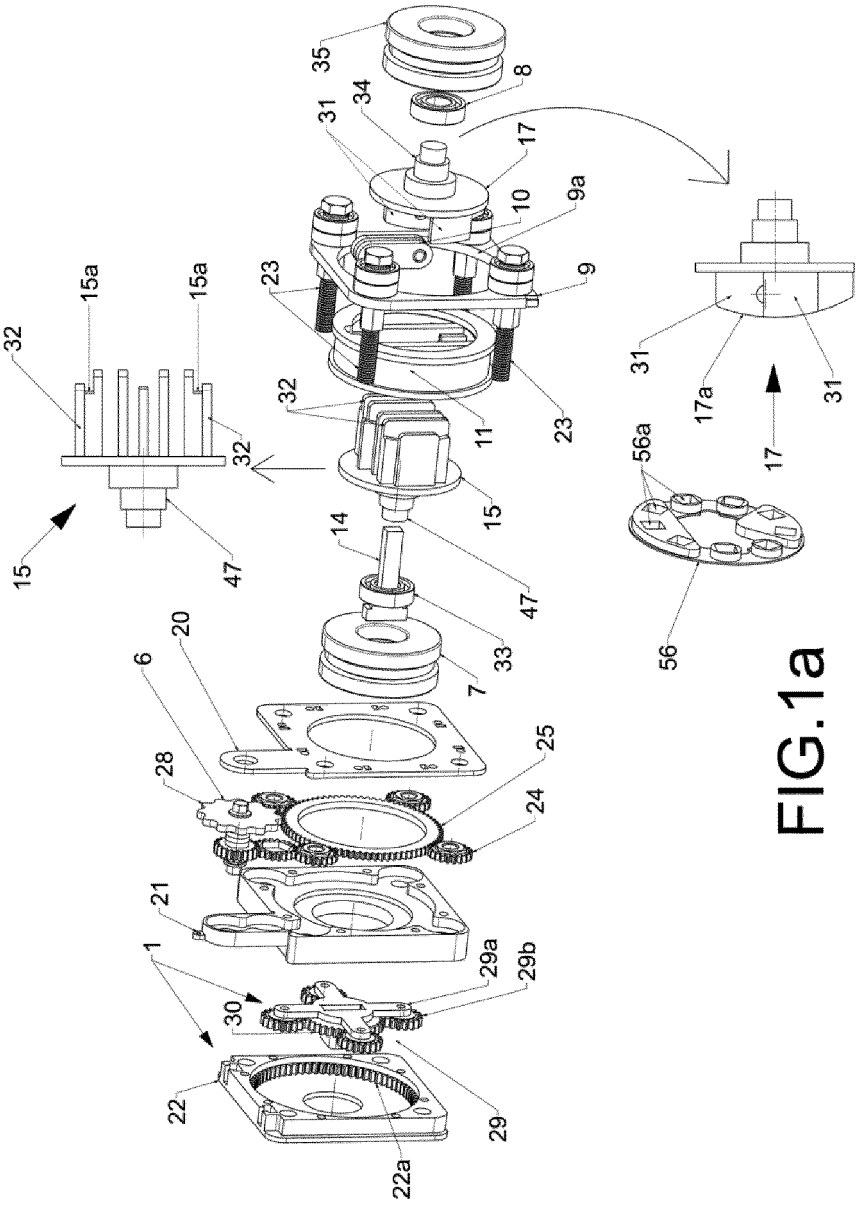
35
8
34
31
17
10
9a
9
23
15a
15a
32
32
32
11
23
15
14
47
47
15
33
7
6
20
28
25
24
21
1
29a
29b
30
22
29
22a
31
17a
31
56a
17
56

FIG.1a

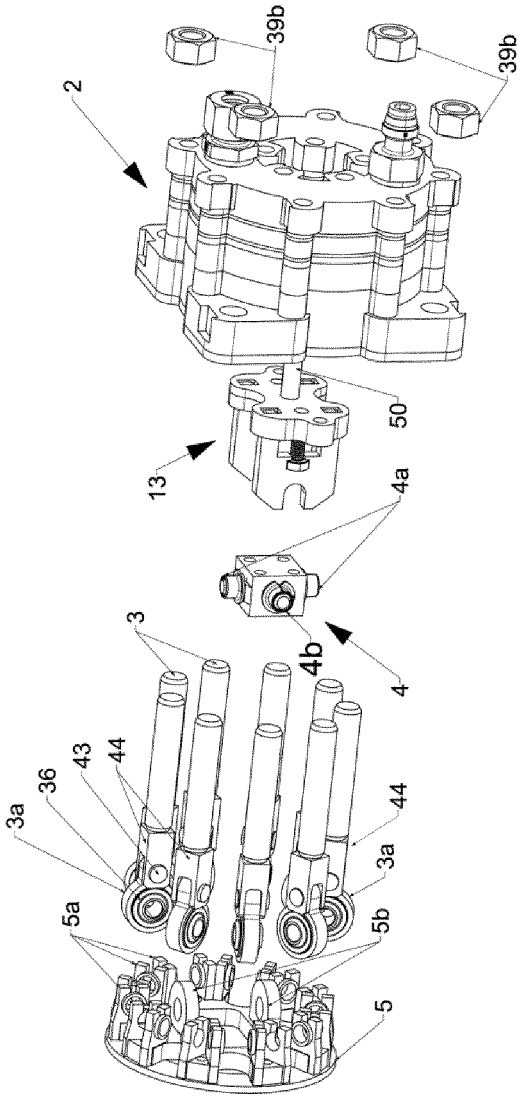


FIG. 1b

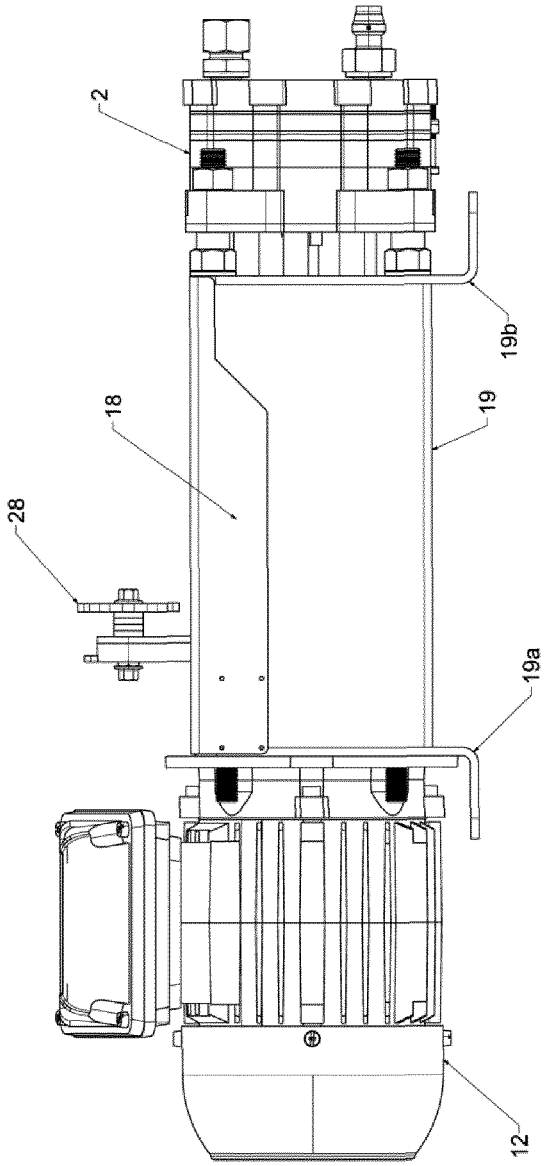


FIG. 2

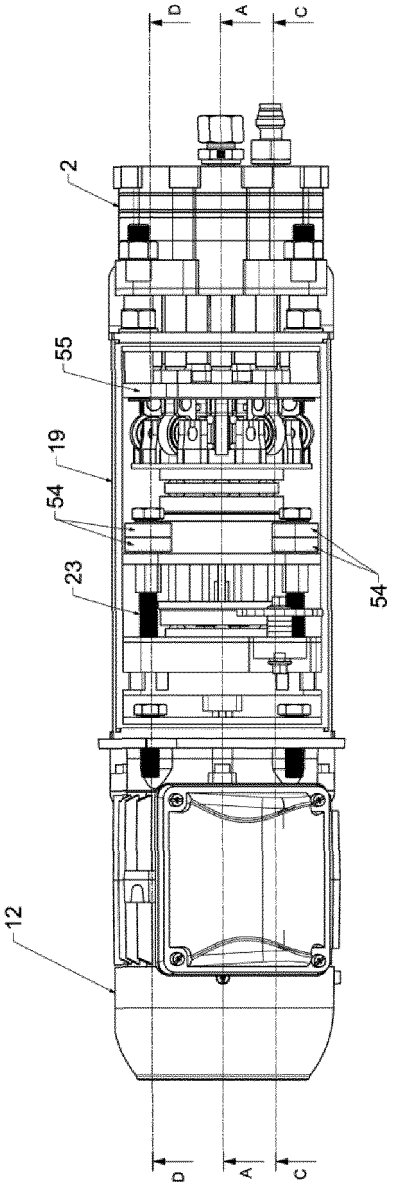


FIG. 3

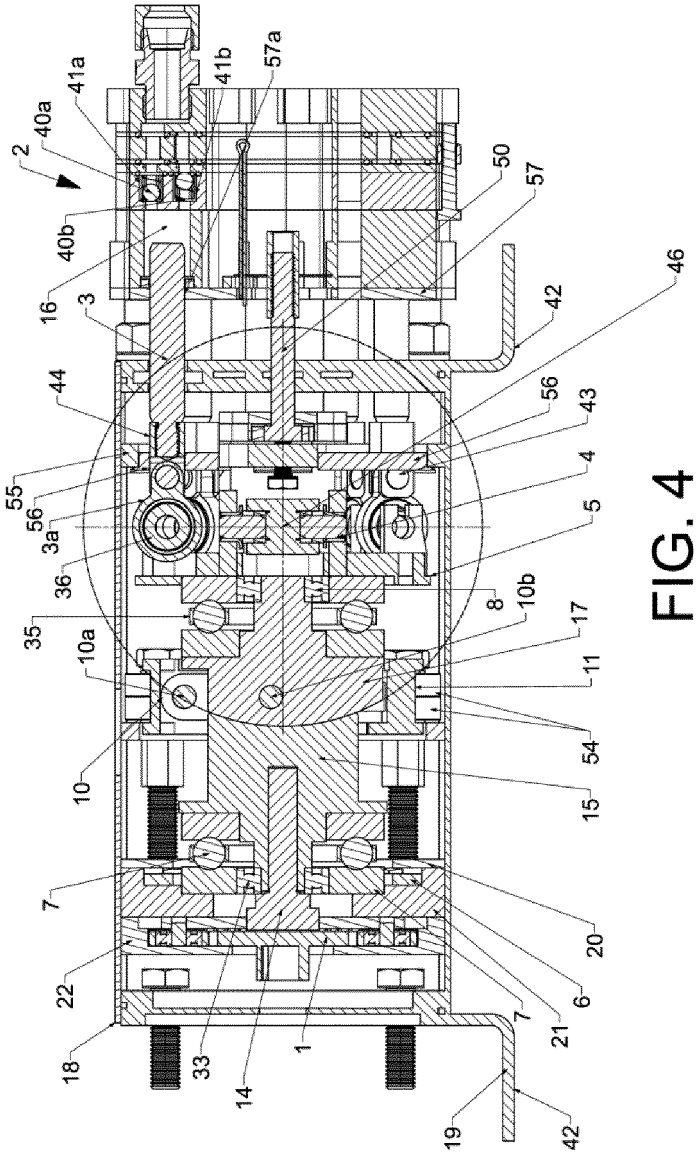


FIG. 4
A-A SECTION

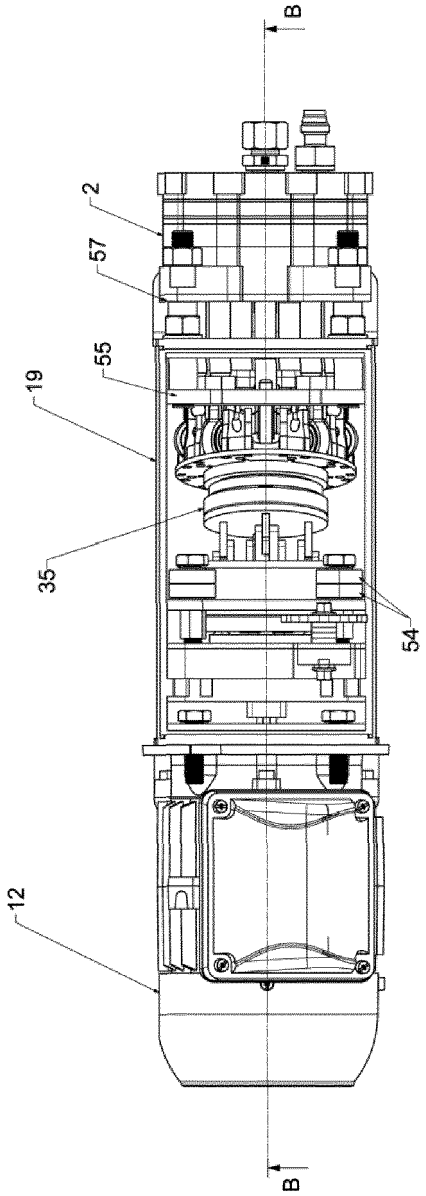


FIG. 5

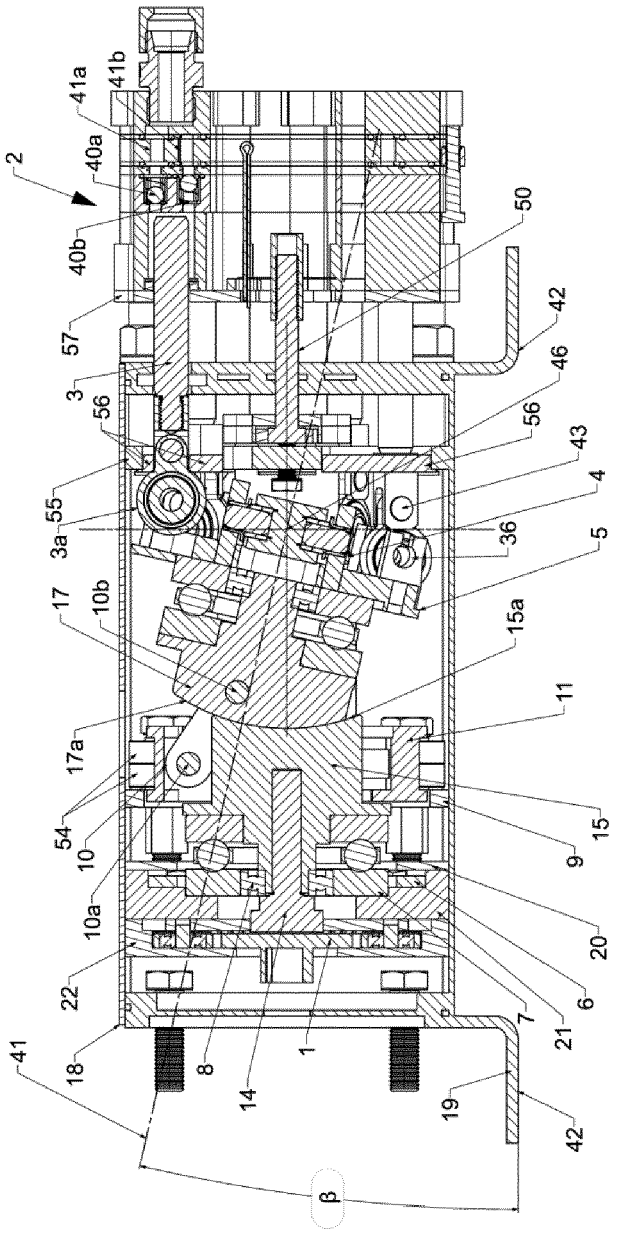


FIG. 6
B-B SECTION

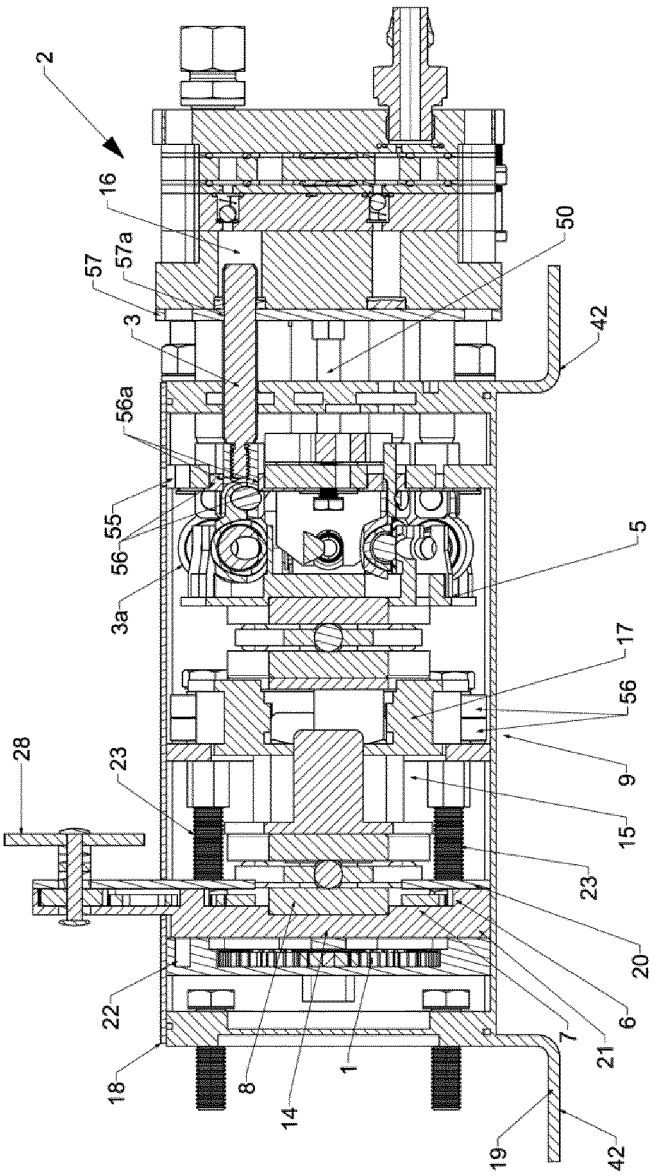


FIG. 7
C-C SECTION

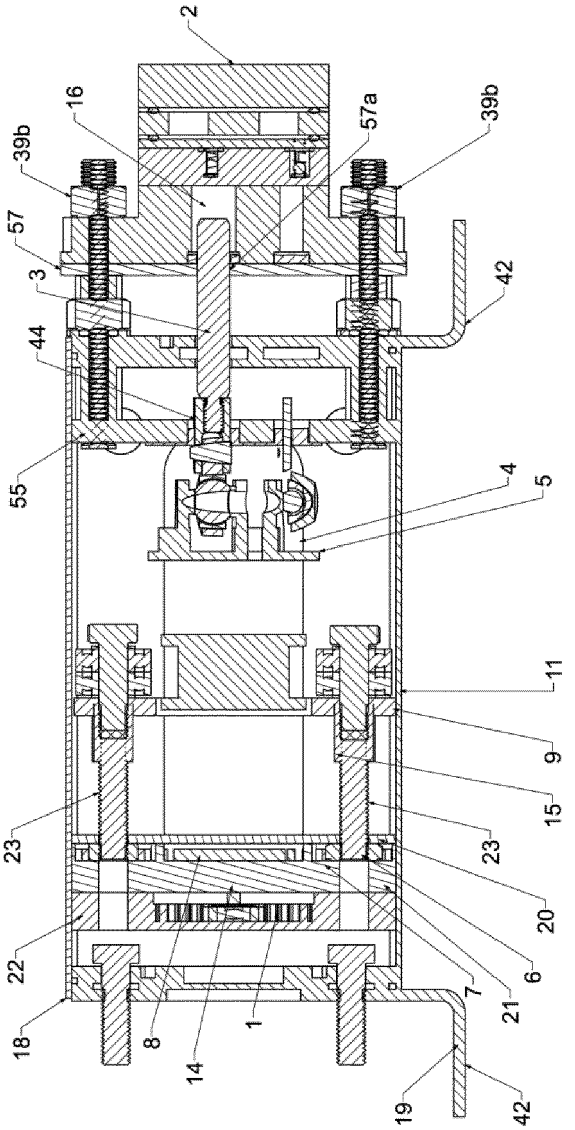


FIG. 8
D-D SECTION

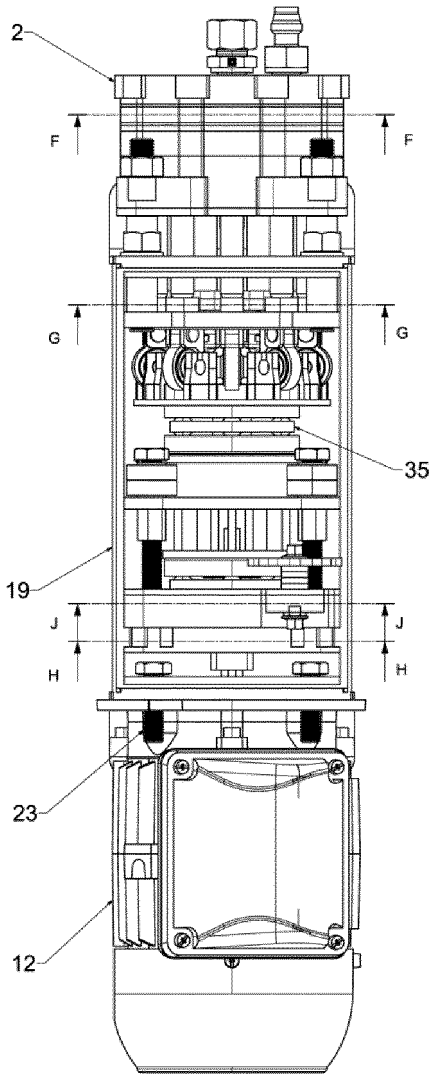


FIG. 9

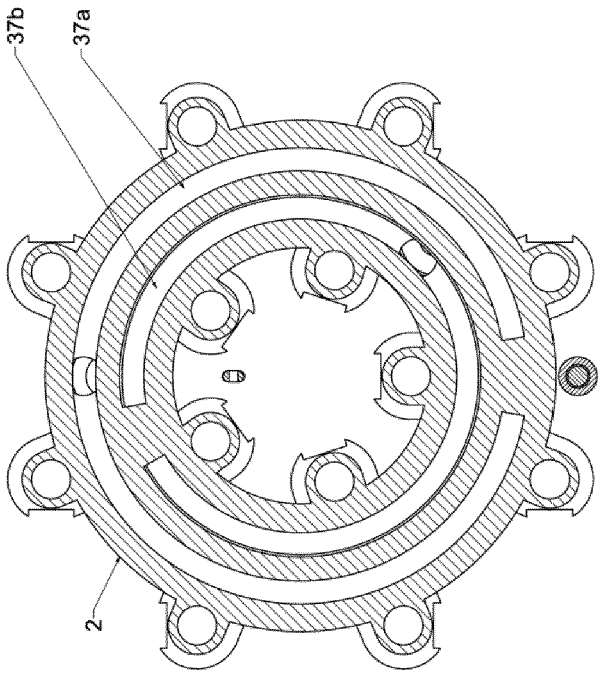


FIG. 10
F-F SECTION

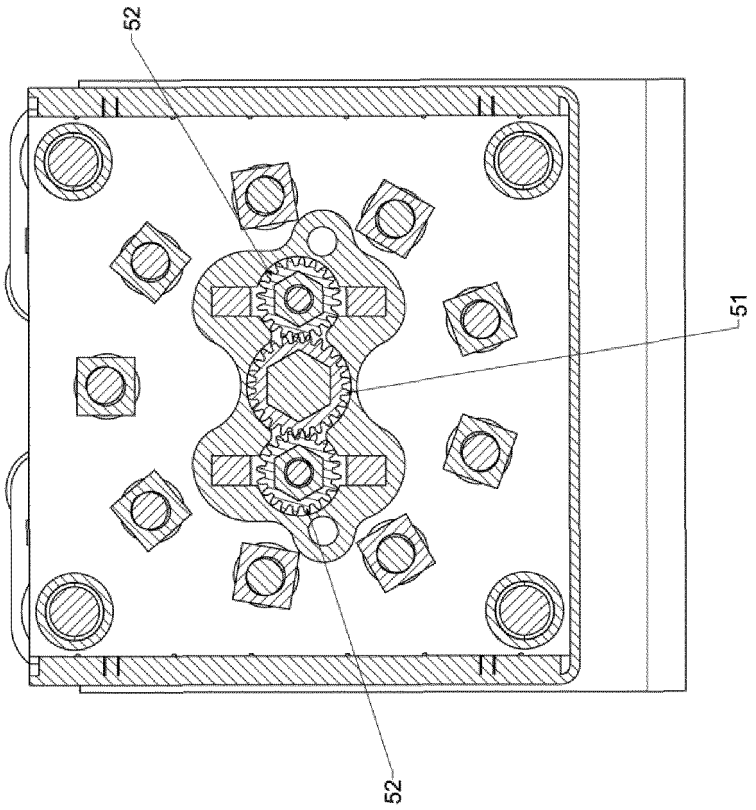


FIG. 11
G-G SECTION

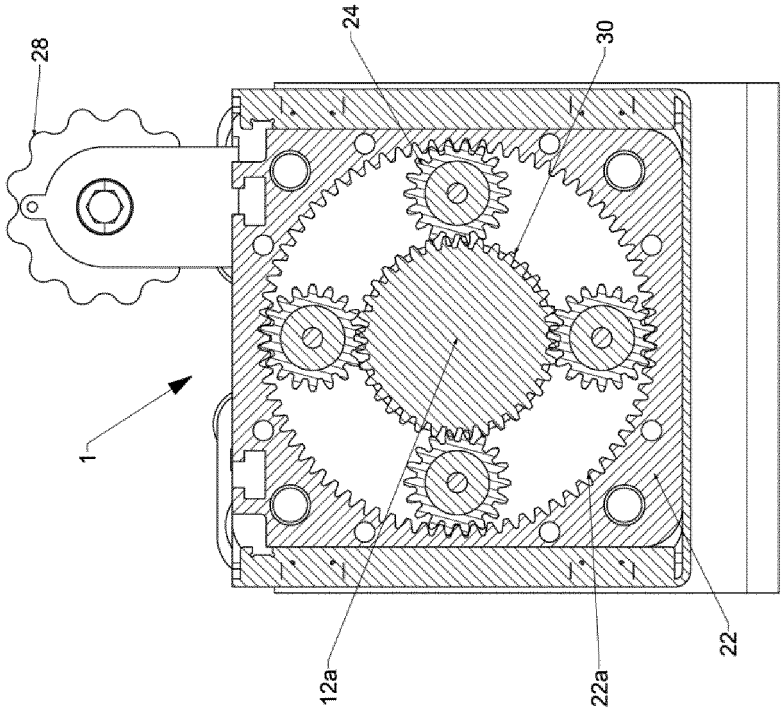


FIG. 12
H-H SECTION

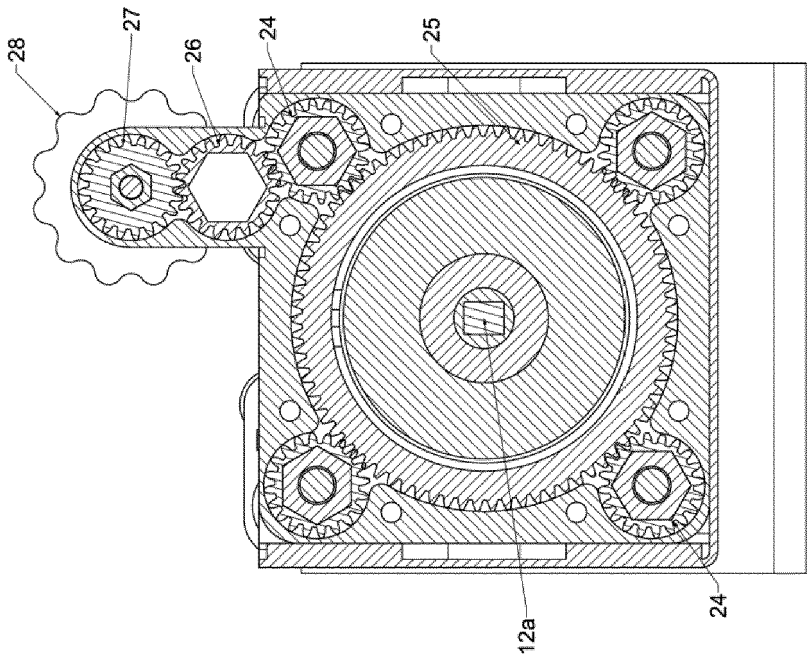


FIG. 13
J-J SECTION

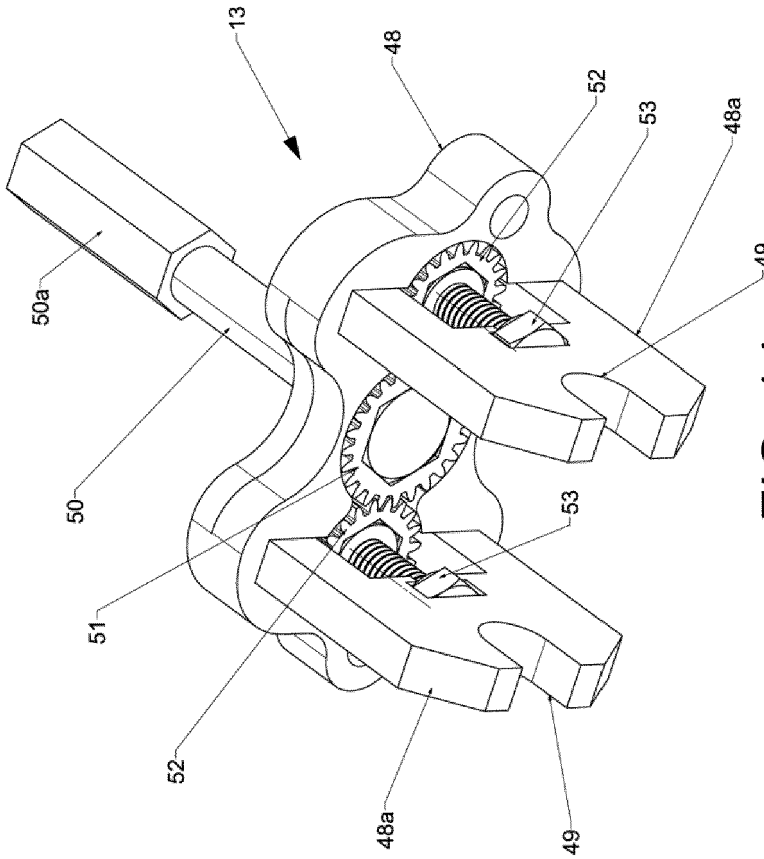


FIG. 14

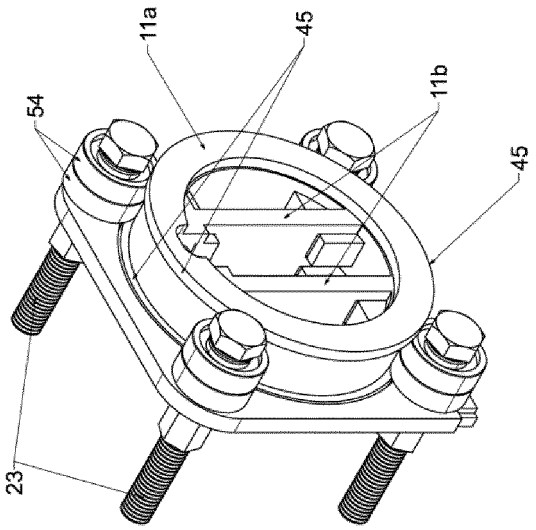


FIG. 15

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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