(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 407 179 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
31.07.2024 Bulletin 2024/31

(21) Application number: **22741544.5**

(22) Date of filing: **10.06.2022**

(51) International Patent Classification (IPC):
F04B 1/14 *(2020.01)* ***F04B 1/146*** *(2020.01)*
F04B 1/295 *(2020.01)*

(52) Cooperative Patent Classification (CPC):
F04B 1/14; F04B 1/146; F04B 1/295

(86) International application number:
PCT/ES2022/070364

(87) International publication number:
WO 2023/047002 (30.03.2023 Gazette 2023/13)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **23.09.2021 ES 202130892**

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(54) **AXIAL PISTON PUMP**

(57) The axial piston pump for a 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 rotational transmission system, the stroke of the pistons (3) that move axially within respective cavities (16) can be varied to supply a flow rate of fluid to the outlet of said cavities (16) that are distributed in a circumferential path. The variation of the fluid flow rate 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 movement of the pistons (3); wherein by moving said mobile runner (9) the tilt of a ball joint support (5) in which the pistons (3) are coupled by one of the ends thereof is varied.

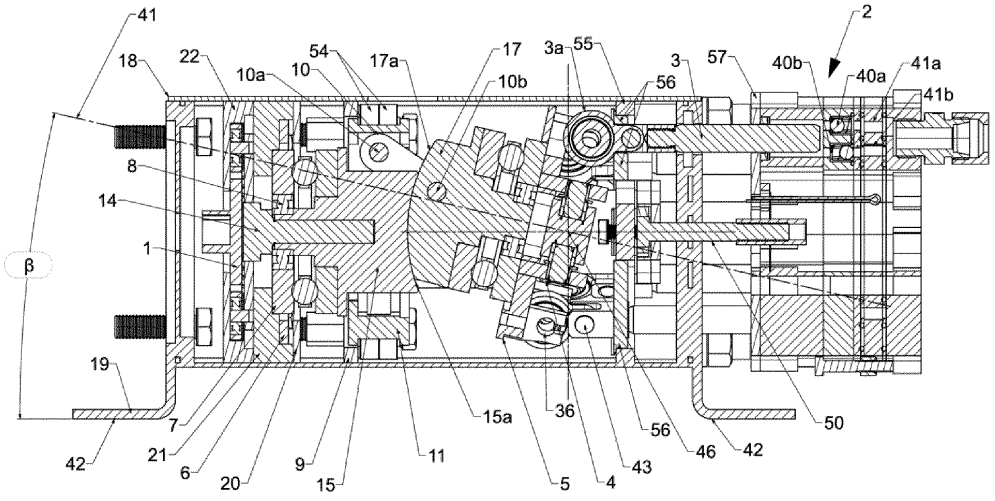

FIG. 6
B-B SECTION

EP 4 407 179 A1

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.

[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; **characterised in that**:

   - it comprises 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), a third rotary plate (11), a mobile runner (9) with linear movement and a ball joint support (5) wherein ends of the pistons (3) are coupled by means of end heads (3a) with double joints; 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 a 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);
   - the first plate (15) includes 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 the main casing (19);
   - the ball joint support (5) rests 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); and wherein said variation 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 sup-

port (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).

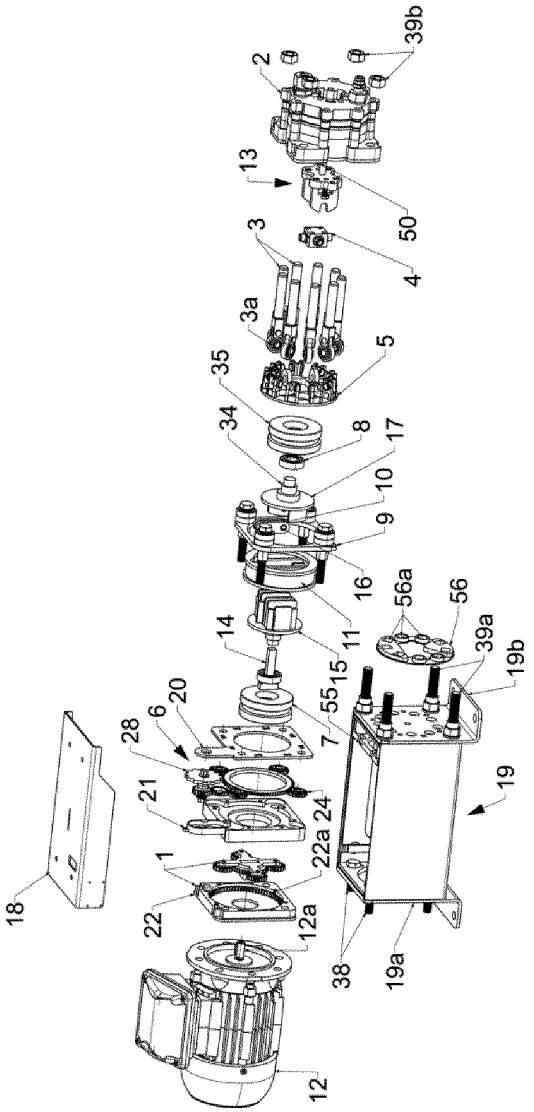
39b
2
13
50
3
4
3a
5
35
34
8
17
10
9
16
56a
56
14
11
39a
19b
15
55
20
6
7
28
21
24
19
22a
1
18
22
12a
38
19a
12

FIG. 1

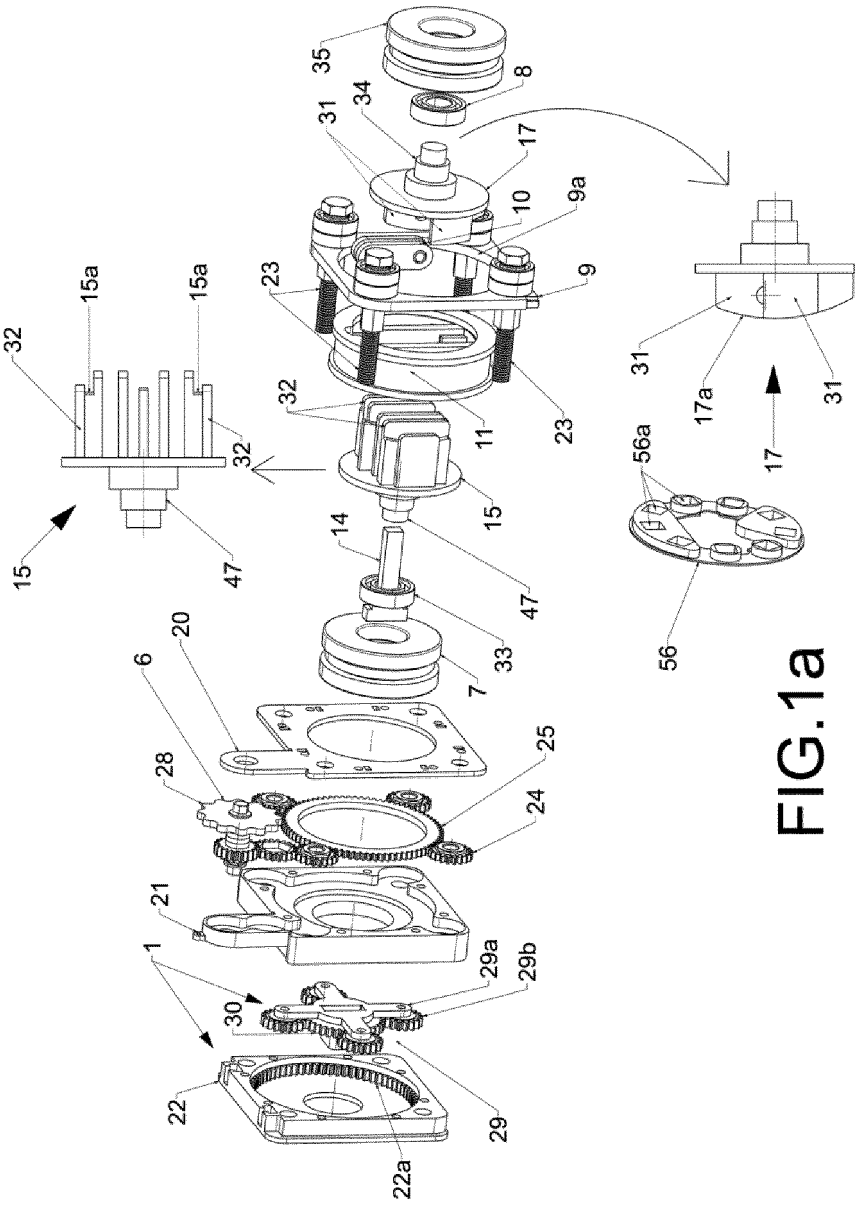
35
8
34
31
17
10
9a
9
23
15a
15a
32
32
11
23
32
15
14
47
47
33
7
20
6
28
25
24
21
1
29a
29b
30
22
29
22a
15
31
17a
31
56a
17
56

FIG.1a

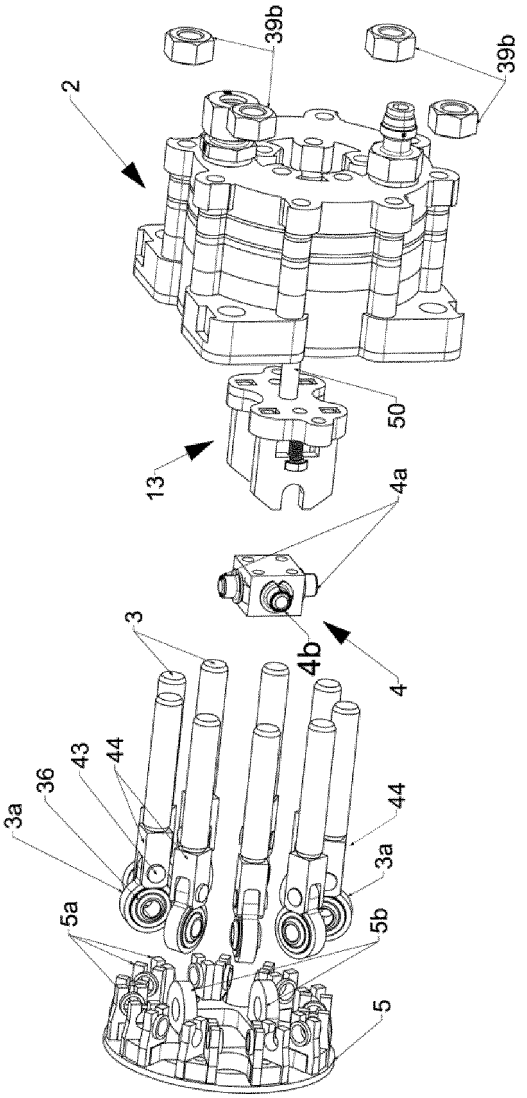

FIG. 1b

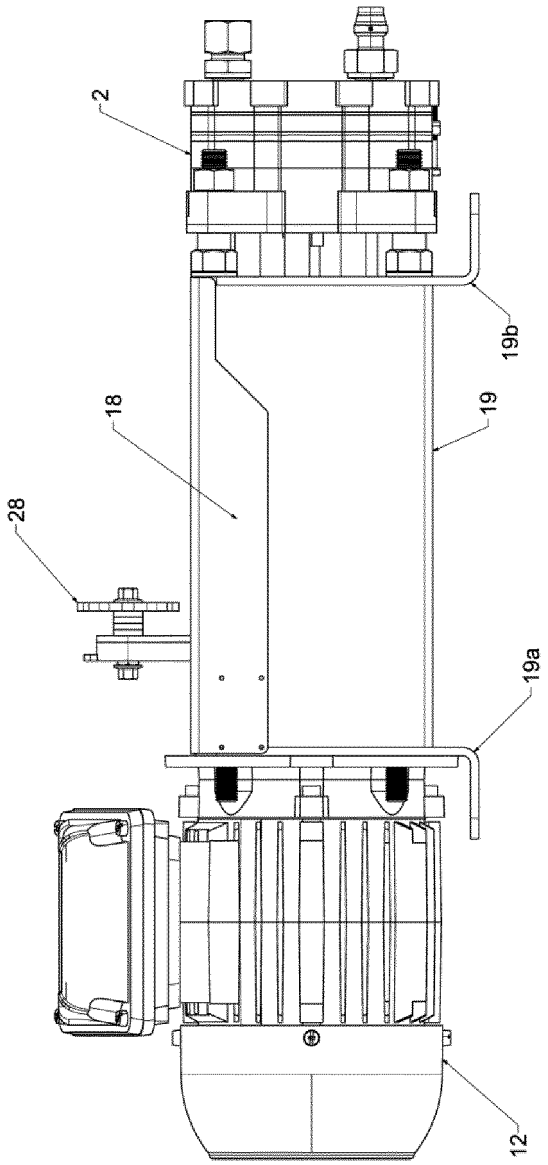

FIG. 2

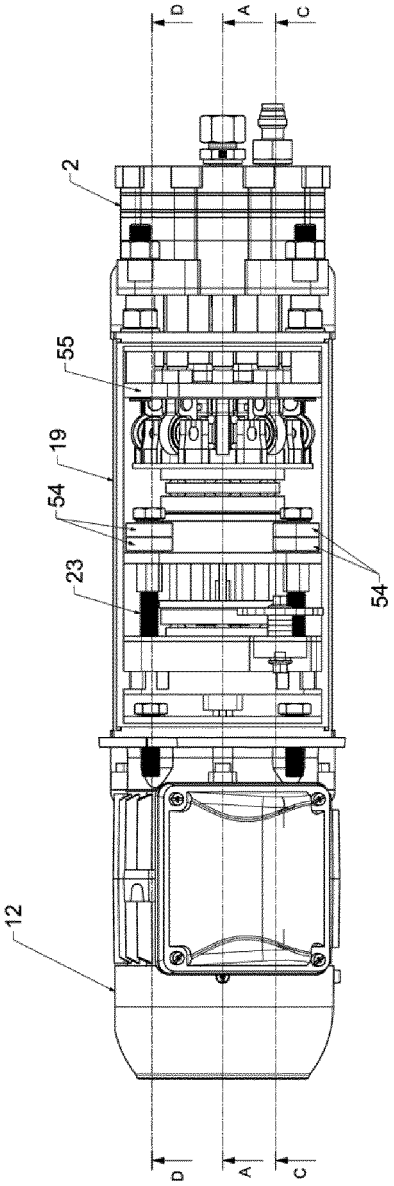

FIG. 3

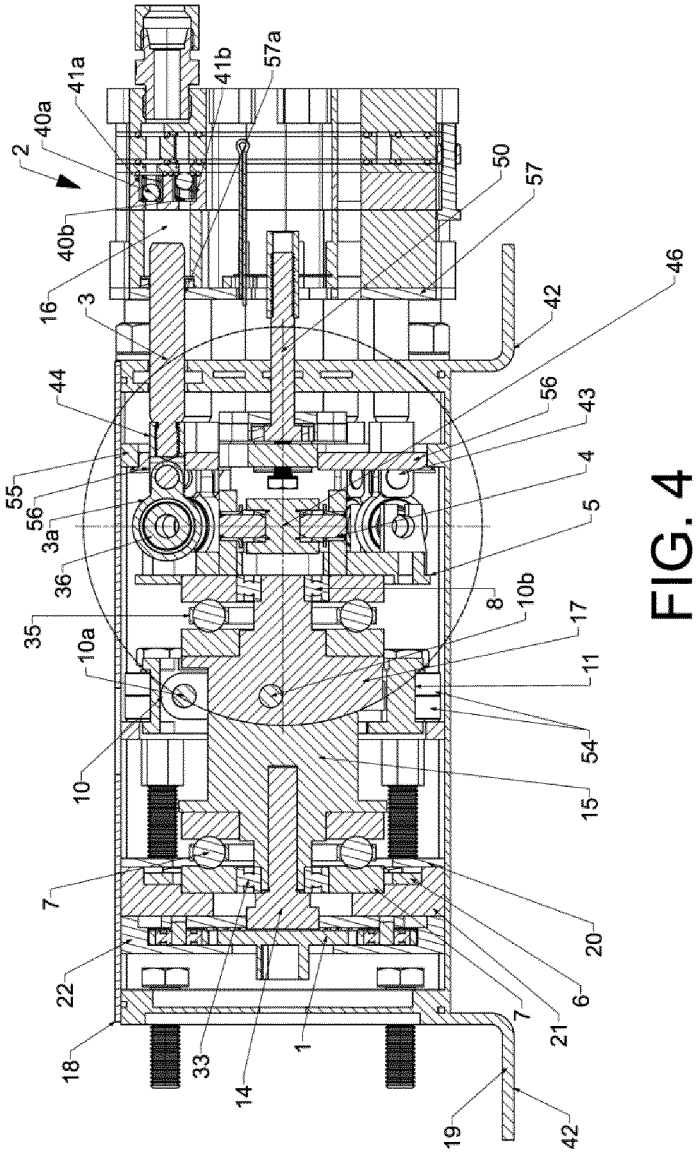

FIG. 4
A-A SECTION

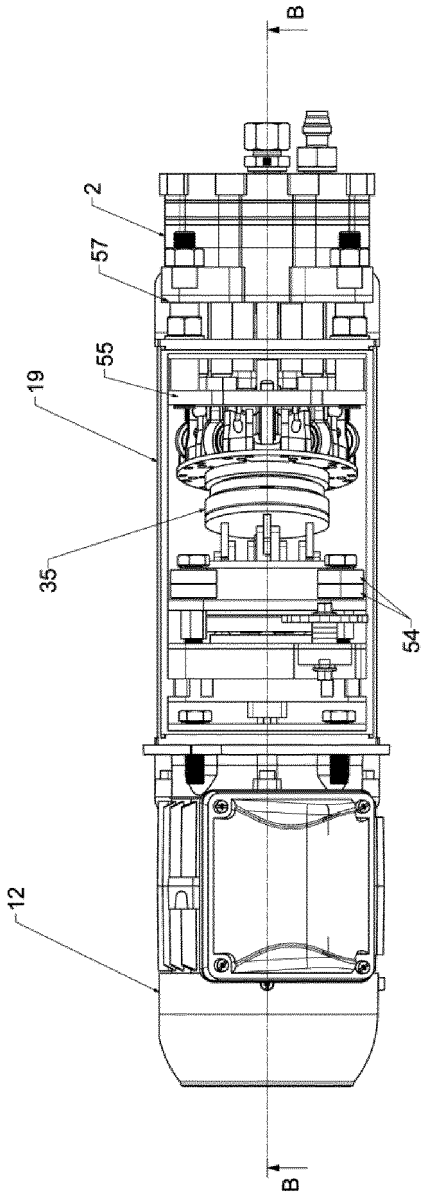

FIG. 5

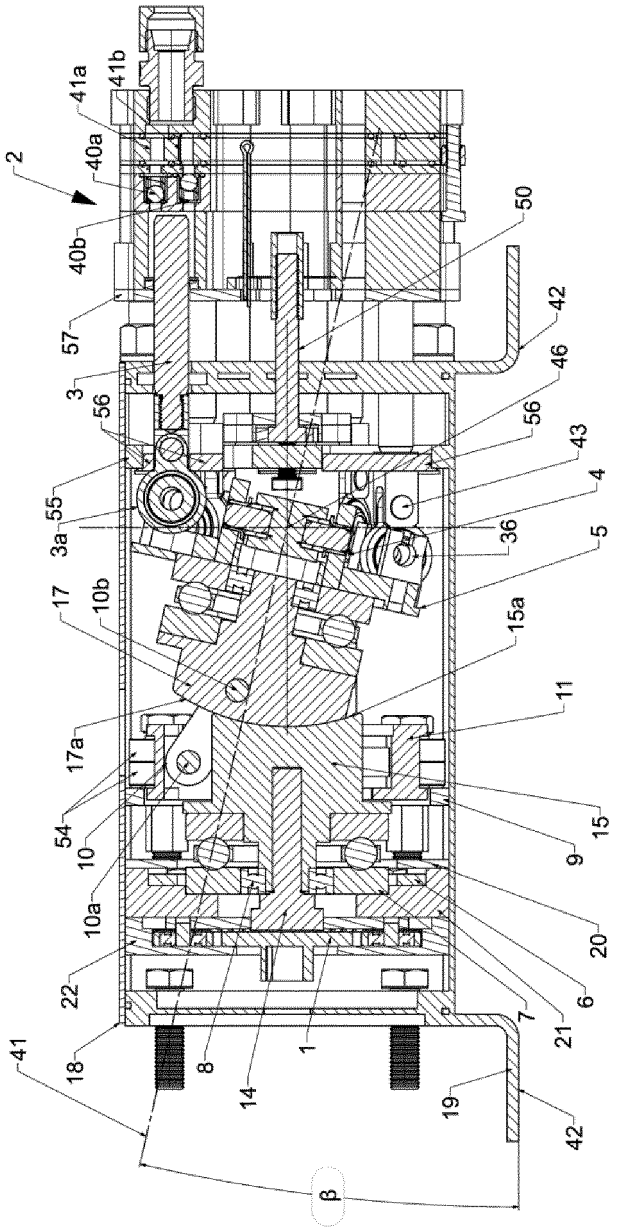

FIG. 6
B-B SECTION

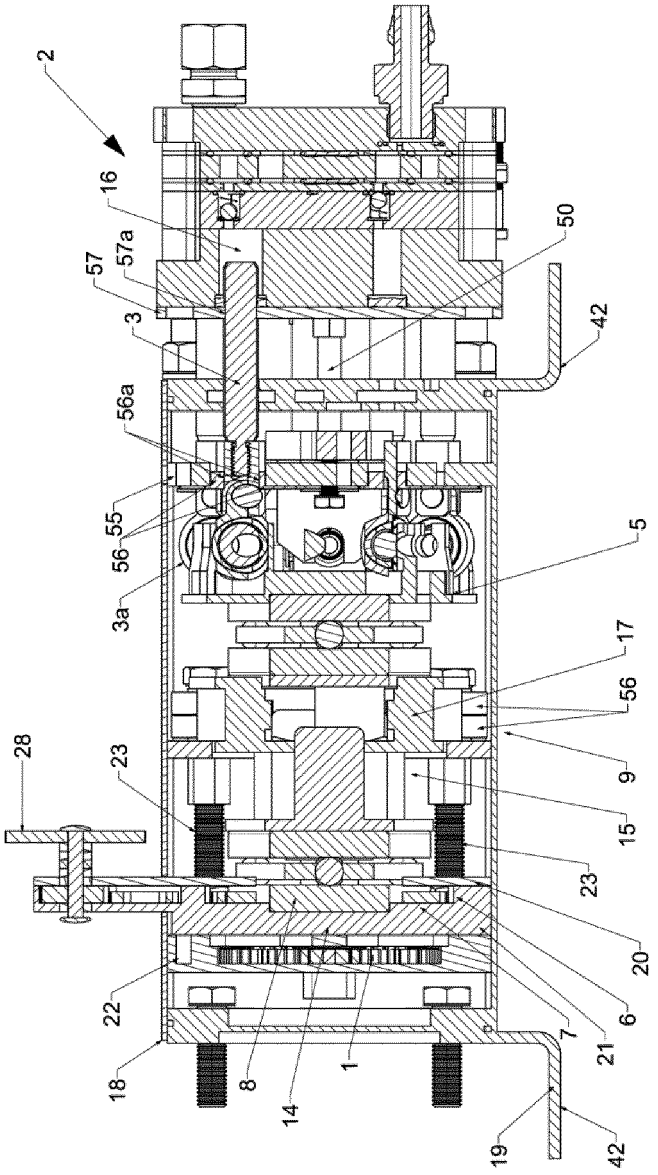

FIG. 7
C-C SECTION

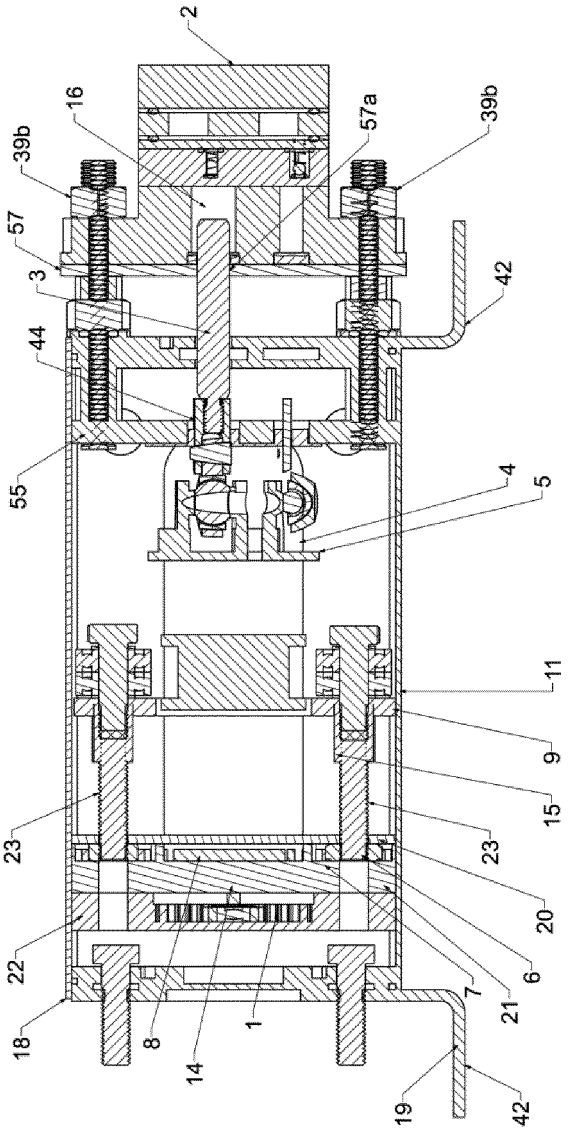

FIG. 8
D-D SECTION

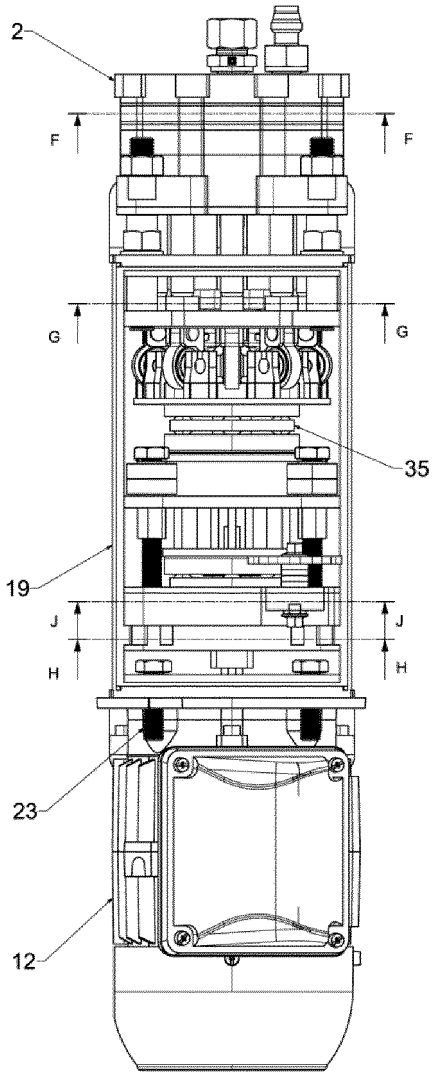

FIG. 9

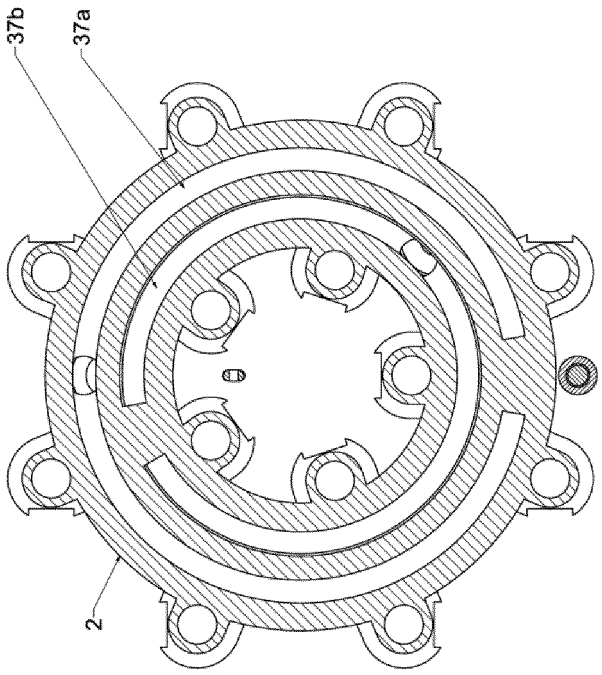

FIG. 10
F-F SECTION

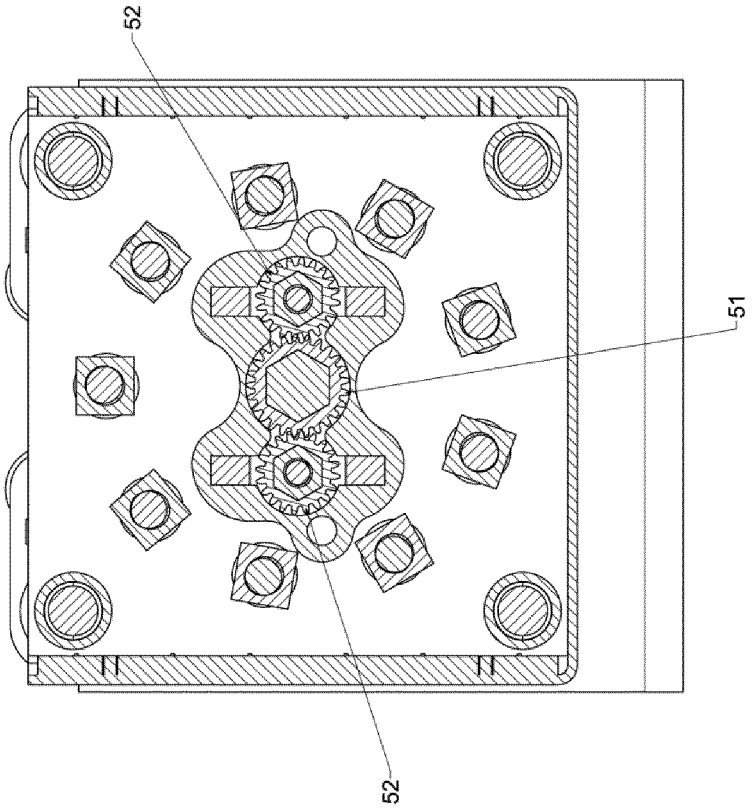

FIG. 11
G-G SECTION

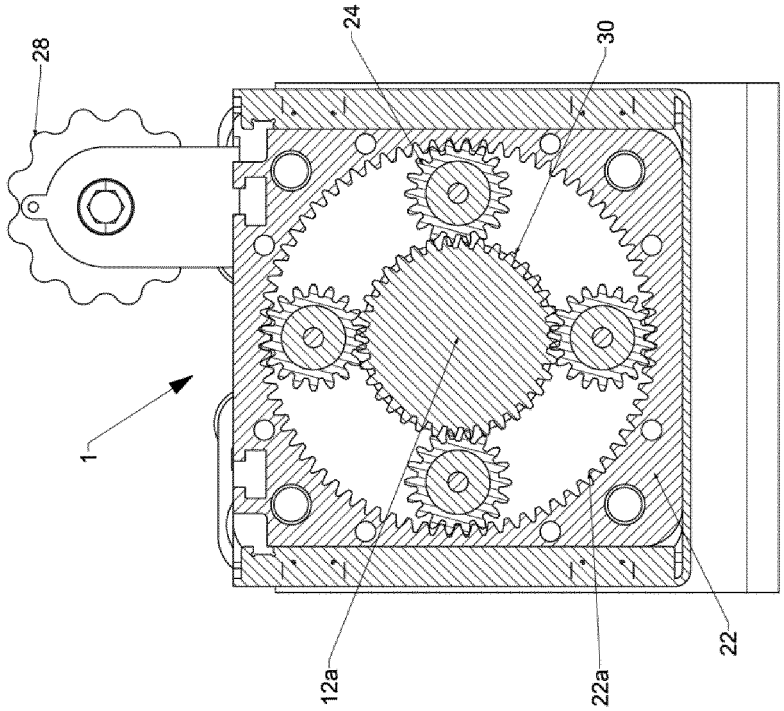

FIG. 12
H-H SECTION

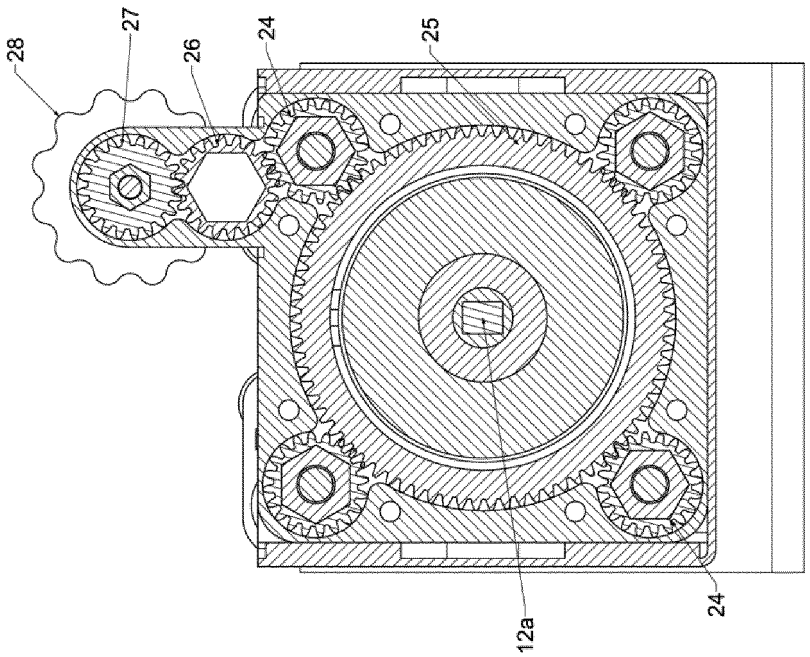

FIG. 13
J-J SECTION

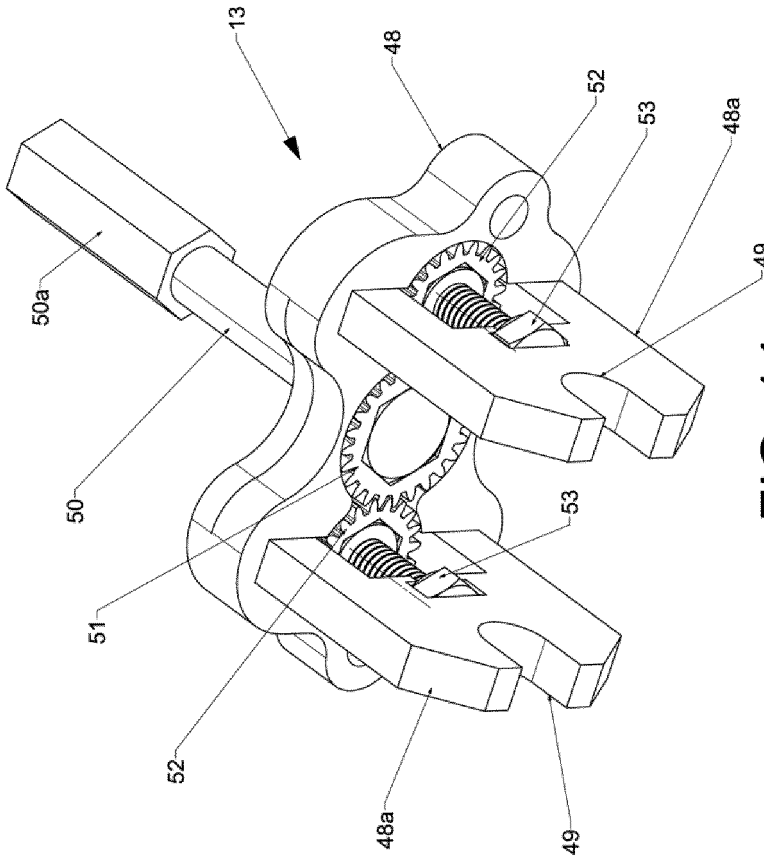

FIG. 14

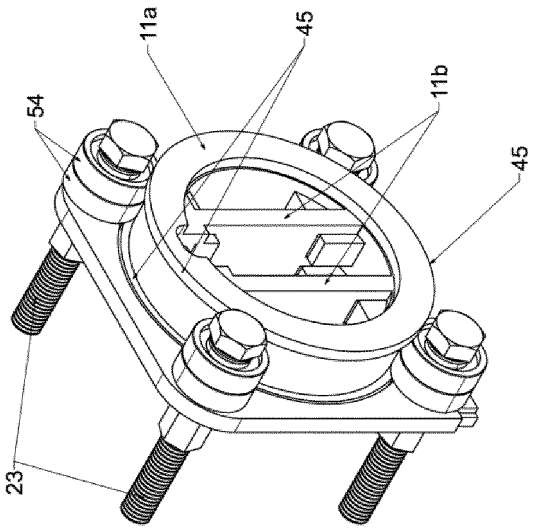

FIG. 15

INFORME DE BÚSQUEDA INTERNACIONAL

Solicitud internacional Nº

PCT/ES2022/070364

A. CLASIFICACIÓN DEL OBJETO DE LA SOLICITUD

INV. F04B1/14 F04B1/146 F04B1/295
ADD.

De acuerdo con la Clasificación Internacional de Patentes (CIP) o según la clasificación nacional y CIP.

B. SECTORES COMPRENDIDOS POR LA BÚSQUEDA

Documentación mínima buscada (sistema de clasificación seguido de los símbolos de clasificación)

F04B

Otra documentación consultada, además de la documentación mínima, en la medida en que tales documentos formen parte de los sectores comprendidos por la búsqueda

Bases de datos electrónicas consultadas durante la búsqueda internacional (nombre de la base de datos y, si es posible, términos de búsqueda utilizados) EPO-Internal

C. DOCUMENTOS CONSIDERADOS RELEVANTES

Categoría*	Documentos citados, con indicación, si procede, de las partes relevantes	Relevante para las reivindicaciones Nº
A	US 2 737 894 A (WALTER FERRIS) 13 de Marzo de 1956 (1956-03-13) columna 3 , lineas 18-75 ; figura 1	1-17
A	GB 551 384 A (FAWCETT PRESTON & CO LTD; ALFRED RHODES) 19 Febrero de 1943 (1943-02-19) todo el documento	1-17
A	DE 20 62 184 Al (MASCHINENFABRIK RUDOLF HAUSHERR & SOHNE GMBH) 22 de Junio de 1972 (1972-06-22) todo el documento	1-17
A	FR 60 486 E (SIAM) 3 de Noviembre de 1954 (1954-11-03) todo el documento	1-17
	--/---	

[X] En la continuación del Recuadro C se relacionan otros documentos [X] Los documentos de familias de patentes se indican en el Anexo

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"E" solicitud de patente o patente anterior pero publicada en la fecha de presentación internacional o en fecha posterior.

"L" documento que puede plantear dudas sobre una reivindicación de prioridad o que se cita para determinar la fecha de publicación de otra cita o por una razón especial (como la indicada).

"O" documento que se refiere a una divulgación oral, a una utilización, a una exposición o a cualquier otro medio.

"P" documento publicado antes de la fecha de presentación internacional pero con posterioridad a la fecha de prioridad reivindicada.

"T" documento ulterior publicado con posterioridad a la fecha de presentación internacional o de prioridad que no pertenece al estado de la técnica pertinente pero que se cita por permitir la comprensión del principio o teoría que constituye la base de la invención.

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"&" documento que forma parte de la misma familia de patentes.

Fecha en que se ha concluido efectivamente la búsqueda internacional.	Fecha de expedición del informe de búsqueda internacional
07 de Septiembre de 2022	26 de Septiembre de 2022
Nombre y dirección postal de la Administración encargada de la búsqueda internacional EPO	Funcionario autorizado
Nº de fax	Nº de teléfono

Formulario PCT/ISA/210 (segunda hoja) (Enero 2015)

INFORME DE BÚSQUEDA INTERNACIONAL

Solicitud internacional Nº

PCT/ES2022/070364

C (continuación). DOCUMENTOS CONSIDERADOS RELEVANTES

Categoría*	Documentos citados, con indicación, si procede, de las partes relevantes	Relevante para las reivindicaciones Nº
A	GB 1 327 192 A (NAT RES DEV) 15 de Agosto de 1973 (1973-08-15) todo el documento -----	1-17

Formulario PCT/ISA/210 (continuación de la segunda hoja) (Enero 2015)

INFORME DE BÚSQUEDA INTERNACIONAL

Información relativa a miembros de familias de patentes

Solicitud internacional Nº

PCT/ES2022/070364

US 2737894	A	13-03-1956	Ninguno
GB 551384	A	19-02-1943	Ninguno
DE 2062184	A1	22-06-1972	Ninguno
FR 60486	E	03-11-1954	Ninguno
GB 1327192	A	15-08-1973	Ninguno

Formulario PCT/ISA/210 (anexo_familia de patentes) (Enero 2015)