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(54) Benævnelse: **Volumetrisk membranpumpe**

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EP-A1- 2 921 705
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DESCRIPTION

Technical field

[0001] The present invention relates to a volumetric membrane pump suitable for being used in the agricultural field, for example for spraying protective liquids, fertilizing liquids or liquids of other type over the crops.

Known technique

[0002] As is known, volumetric membrane pumps comprise a guide cylinder, a flexible membrane placed to close an axial end of the guide cylinder, a head suitable for cooperating with the membrane to define a pumping chamber, and a piston fixed to the membrane and slidingly housed in the guide cylinder.

[0003] The piston is connected to a drive kinematism, typically of the connecting rod-crank type, which allows it to slide between an upper dead centre position and a lower dead centre position.

[0004] By sliding towards the lower dead centre position, the piston performs a suction stroke in which it drags the membrane away from the head, thus increasing the volume of the pumping chamber and sucking liquid through an inlet valve.

[0005] By sliding vice versa towards the upper dead centre position, the piston performs a compression stroke in which it pushes the membrane close to the head, thus reducing the volume of the pumping chamber and pushing the liquid out through an outlet valve.

[0006] The drive kinematism generally is enclosed in a casing, which internal volume is filled with lubricating oil so as to keep lubricated the piston and the other movable parts of the pump.

[0007] To improve the thrust exerted on the membrane during the compression stroke, the guide cylinder has at least one passage which when the piston is in the lower dead centre position, is suitable for placing the internal volume of the casing in communication with an intermediate chamber defined inside the guide cylinder between the membrane and the top of the piston.

[0008] In this manner, the lubricating oil also fills the intermediate chamber of the cylinder and being incompressible, allows actively supporting the membrane during the compression stroke, thus transferring the thrust exerted by the piston to it in substantially uniform manner.

[0009] However, a drawback of this solution consists of the fact that small air locks may remain

trapped in the intermediate chamber of the cylinder, between the membrane and the piston, during the first filling of the casing with lubricating oil.

[0010] If this occurs, rather than simply moving the oil during the compression stroke, the piston also compresses the air inside the intermediate chamber, thus creating a vacuum in the volume of oil behind the membrane that affects the operation and duration thereof.

[0011] For this reason, one of the greatest difficulties in making a membrane pump currently is the one of succeeding in executing the best filling possible of the intermediate chamber of the cylinder, while trying to remove all the air locks that may remain trapped therein, for example by manually placing in movement the piston and simultaneously overturning and/or shaking the pump several times so that the air may leave through the passage that places the intermediate chamber in communication with the internal volume of the casing, possibly accumulating in areas where it does not create problems.

Description of the invention

[0012] It is an object of the present invention to resolve the mentioned drawback by making available a solution that allows avoiding a stagnation of the air in the intermediate chamber behind the membrane, or in any case, that allows a simpler evacuation of the air possibly accumulated.

[0013] Such objects are achieved by the features of the invention indicated in independent claim 1. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

[0014] In particular, one embodiment of the present invention provides a volumetric membrane pump, comprising:

- a guide cylinder,
- a flexible membrane placed so as to close an axial end of the guide cylinder,
- a head designed to define a pumping chamber with the flexible membrane,
- a piston fixed to the flexible membrane and slidable inside the guide cylinder between an upper dead centre position and a lower dead centre position,
- an intermediate chamber defined inside the guide cylinder between the flexible membrane and the piston,
- a casing defining an internal volume suitable for being filled with lubricating oil,
- at least one primary passage suitable for placing the intermediate chamber in communication with the internal volume of the casing, when the piston is in the lower dead centre position, and
- at least one secondary passage suitable for placing the intermediate chamber in communication with the internal volume of the casing, when the piston is in the upper dead centre position.

[0015] In this manner, the air possibly trapped inside the intermediate chamber may always and easily flow towards the internal volume of the casing through the secondary passage without stagnating and therefore without creating that vacuum in the volume of oil behind the membrane that could worsen the operation and duration thereof.

[0016] According to one aspect of the invention, the secondary passage may be made in the guide cylinder.

[0017] This solution provides a very simple construction method for placing the intermediate chamber of the guide cylinder in communication with the internal volume of the casing.

[0018] According to another aspect of the invention, the secondary passage may have a passing through cross-section which extension is less than 0.2 mm^2, and more preferably, less than 0.05 mm^2.

[0019] In this manner, the secondary passage generates a rather increased hydraulic resistance which even though it allows the outlet of the air, it allows keeping the lubricating oil inside the intermediate chamber also during the compression stroke of the piston, or it at least allows having only a minimum leak that does not affect the pressure of the lubricating oil in the intermediate chamber in an apparent manner.

[0020] For example, the secondary passage may be made in the shape of a through hole, which may have a diameter less than 0.5 mm, and more preferably, less than or equal to 0.2 mm.

[0021] According to a further aspect of the present invention, the pump may comprise a plurality of secondary passages, which may be for example, arranged angularly equidistant from one another about a longitudinal axis of the guide cylinder.

[0022] In this manner, the evacuation of the air advantageously is promoted from the intermediate chamber of the cylinder. See US3075468 disclosing a pump according to the state of the art, with differently shaped passages and seals and no annular gap around the cylinder.

Brief description of the drawings

[0023] Further features and advantages of the invention will be more apparent after reading the following description provided by way of a non-limiting example, with the aid of the accompanying drawings.

Figure 1 is a cross section of a membrane pump according to an embodiment of the present invention, shown with the piston in the upper dead centre position.

Figure 2 is the cross section of figure 1, shown with the piston in the lower dead centre position.

Detailed description

[0024] The invention relates to a volumetric membrane pump 100 for pumping fluids, in particular for pumping liquids. For example, the pump 100 may be used in the agricultural field for pumping protective liquids, fertilizing liquids or liquids of other type towards specific dispensing nozzles intended to spray or in any case dispense such liquids over the crops. However, it is not excluded for the pump 100 to also be used in other fields and/or for pumping other types of fluids.

[0025] The pump 100 may comprise a drive shaft 105 that is suitable for rotating on itself about its middle axis X.

[0026] The rotation of the drive shaft 105 may be obtained by means of direct or indirect connection with a thermic engine, for example with the motor of an agricultural tractor through a power take-off, or with an electric motor.

[0027] The pump 100 also comprises a guide cylinder or sleeve 110 having a longitudinal axis Y that may be oriented perpendicularly to the middle axis X of the drive shaft 105.

[0028] A piston 115 is slidingly housed inside the guide cylinder 110, which piston is connected to the drive shaft 105 through a kinematism 120 that is suitable for transforming the rotary movement of the drive shaft 105 into a linear and reciprocating movement of the piston 115 inside the guide cylinder 110.

[0029] In this manner, the piston 115 is cyclically suitable for moving between a lower dead centre position, in which it is at the minimum distance from the drive shaft 105 (see fig. 2) and an upper dead centre position, in which it is at the maximum distance from the drive shaft 105 (see fig. 1).

[0030] A coaxial sealing ring 200 is interposed between the outer side surface of the piston 115 and the inner side surface of the guide cylinder 12, which coaxial sealing ring is axially blocked inside a corresponding cavity made in the piston 115.

[0031] In the example shown, the kinematism 120 comprises an eccentric 125 rigidly fixed to the drive shaft 105, for example made in a single piece therewith, and a connecting rod 130

articulated to said eccentric 125 and to a transverse pin 135 of the piston 115.

[0032] The eccentric 125 may have a substantially cylindrical shape with axis parallel to but spaced apart from the middle axis X of the drive shaft 105.

[0033] In this manner, a thrust linkage is obtained capable of transforming the rotary movement of the drive shaft 105 into a reciprocating movement of the piston 115.

[0034] The pump 100 also comprises a casing 140 that cooperates with the guide cylinder 110 and with the piston 115 to define a closed internal volume 145 that contains the kinematism 120, i.e. in the example, at least the connecting rod 130, the eccentric 125 and the transverse pin 135.

[0035] The internal volume 145 may also contain bench bearings for the drive shaft 105 and/or a stretch of the drive shaft 105 comprised between said bench bearings.

[0036] The guide cylinder 110 is shaped so as to at least partially extend inside the casing 140, substantially in cantilevered manner, so that an annular gap belonging to the internal volume 145 is defined between the outer side surface of the guide cylinder 110 and the inner surface of the casing 140.

[0037] The internal volume 145 is completely filled with lubricating oil, a function of which is to keep the piston 115 and the kinematism 120 lubricated.

[0038] In the example shown, the casing 140 is made as a separate body with respect to the guide cylinder 110, to which it may be fixed by means of threaded members. However, other embodiments do not exclude for the guide cylinder 110 and the casing 140 to have a different geometry and/or to be made in a single piece.

[0039] The free end of the guide cylinder 110, i.e. the one placed at the maximum radial distance from the drive shaft 105, is closed by a flexible membrane 150 which may be made of elastomeric material (typically rubber).

[0040] In particular, the flexible membrane 150 is interposed and blocked between the free end of the guide cylinder 110 and a head 155, which may be fixed to said guide cylinder 110 and/or to the casing 140, for example by means of threaded members, and is suitable for cooperating with the flexible membrane 150 to define a pumping chamber 160.

[0041] The head 155 may be provided with an automatic inlet valve 165 suitable for selectively placing the pumping chamber 160 in communication with an inlet manifold 170, and with an automatic outlet valve 175 suitable for selectively placing the pumping chamber 160 in communication with a delivery manifold 180.

[0042] The piston 115 is positioned outside the pumping chamber 160 and is fixed to the

flexible membrane 150.

[0043] In particular, the outer surface of the flexible membrane 150, i.e. the one facing the drive shaft 105, may be placed in contact with and fixed to the thrust surface (or top) of the piston 115, for example by means of a screw 185 and a fixing washer 190 placed in middle position both with respect to the flexible membrane 150 and with respect to the piston 115.

[0044] When the piston 115 performs a suction stroke towards the lower dead centre (see fig. 2), the flexible membrane 150 is deformed towards the drive shaft 105, causing an increase of the volume of the pumping chamber 160 and therefore a reduction of the internal pressure that allows the opening of the inlet valve 165 and the inlet of the fluid to be pumped coming from the inlet manifold 170.

[0045] Vice versa, when the piston 115 performs a compression stroke towards the upper dead centre (see fig. 1), the flexible membrane 150 is deformed in opposite direction, causing a reduction of the volume of the pumping chamber 160 and therefore an increase of the internal pressure, up to causing the opening of the outlet valve 175 and the outlet of the high-pressure fluid towards the delivery manifold 180.

[0046] An intermediate chamber 195 is further defined inside the guide cylinder 110, between the flexible membrane 150 and the top of the piston 115.

[0047] When the piston 115 is in lower dead centre position (see fig. 2), the intermediate chamber 195 is in communication with the internal volume 145 of the casing 140 through one or more primary passages 205, each of which is be-made in the shape of a through hole that radially crosses the wall of the guide cylinder 110.

[0048] In the example shown, two primary passages 205 are shown, arranged on diametrically opposite sides of the guide cylinder 110. However, it is not excluded in other embodiments for there to be a larger number of primary passages 205, possibly arranged angularly equidistant from one another with respect to the longitudinal axis Y of the guide cylinder 110.

[0049] In any case, when the piston 115 is in the lower dead centre position, the sealing ring 200 is positioned below or at least at the aforesaid primary passages 205, thus allowing the latter to create a direct communication between the intermediate chamber 195 and the internal volume 145 of the casing 140. In this manner, when the internal volume 145 of the casing 140 is filled with the lubricating oil, the latter may also penetrate and completely fill the intermediate chamber 195, thus creating a lubricating oil cushion which concurs to transmitting the thrust exerted by the piston 115 during the compression stroke, to the flexible membrane 150.

[0050] In fact, while the piston 115 moves towards the upper dead centre position, the sealing ring 200 first moves above the primary passages 205, closing the communication with the internal volume 145 of the casing 140, and then pressurizes the lubricating oil contained in the intermediate chamber 195, which by being incompressible, transmits the pressure directly to

the flexible membrane 150, thus deforming it.

[0051] The pump 100 further comprises one or more secondary passages 210, each of which is suitable for placing the intermediate chamber 195 in communication with the internal volume 145 of the casing 140 also when the piston 115 is in upper dead centre position and, preferably, for any position of the piston 115 inside the guide cylinder 110.

[0052] Each of these secondary passages 210 is made in the guide cylinder 110, in the shape of a through hole which crosses the side wall of the guide cylinder 110 close to the flexible membrane 150.

[0053] In general, it is preferable for each secondary passage 210 to make available a sufficiently large cross section of passage to allow the evacuation of any air locks that may accumulate in the intermediate chamber 195, for example during the filling step with the lubricating oil, but sufficiently small enough to prevent the outlet of the lubricating oil during the compression stroke of the piston 115, or at least so as to allow only a minimum leak that does not affect the pressure of the lubricating oil in the intermediate chamber 195 in an apparent manner.

[0054] For this reason, it is preferable for the passing through cross-section of each secondary passage 210 to have an extension which is less than 0.2 mm^2, and more preferably less than 0.05 mm^2.

[0055] For example, each secondary passage 210 may be made like a through hole having a diameter less than 0.5 mm, and more preferably, less than or equal to 0.2 mm.

[0056] Such through hole may also have a rectilinear but inclined extension with respect to the longitudinal axis Y of the guide cylinder 110, for example with an efferent end in the intermediate chamber 195 that is placed closer to the flexible membrane 150 with respect to the opposite efferent end in the internal volume 145 of the casing 140.

[0057] In the example shown, two identical secondary passages 210 are shown, arranged on diametrically opposite sides of the guide cylinder 110. However, it is not excluded in other embodiments for there to be a greater number of secondary passages 210, possibly arranged angularly equidistant from one another with respect to the longitudinal axis Y of the guide cylinder 110.

[0058] In conclusion, it is worth noting that the cross section of passage of each primary passage 205 preferably is greater with respect to the cross section of passage of each secondary passage 210 so that during the filling step of the pump 100, the lubricating oil may easily flow into and fill the intermediate chamber 195, as explained above.

[0059] Obviously, an expert in the field may make several technical-applicative modifications to the above-described pump 100, without departing from the scope of the invention as

hereinbelow claimed.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US3075468A [0022]

PATENTKRAV

1. Volumetrisk membranpumpe (100), omfattende:

- en føringscylinder (110),
- en fleksibel membran (150), der er placeret således, at den lukker en aksial ende af føringscylinderen (110),
- et hoved (155), der er udformet til at definere et pumpekammer (160) med den fleksible membran (150),
- et stempel (115), som er fastgjort til den fleksible membran (150) og kan forskydes inden i føringscylinderen (110) mellem en øvre dødpunktposition og en nedre dødpunktposition,
- en koaksial tætningsring (200), som aksialt er blokeret inden i en dertil svarende kavitet i stemplet (115) med henblik på at blive indskudt mellem en ydersideflade af stemplet (115) og en indersideflade på føringscylinderen (110),
- et mellemliggende kammer (195), som er defineret inden i føringscylinderen (110) mellem den fleksible membran (150) og stemplet (115),
- et hus (140), som definerer et indre volumen (145), der er egnet til at blive fyldt med smøreolie, og
- mindst én primær passage (205), som er egnet til at placere det mellemliggende kammer (195) i kommunikation med det indre volumen (145) i huset (140), når stemplet (115) er i den nedre dødpunktposition,

hvorved det indre volumen (145) i huset (140) omfatter en ringformet spalte, der er defineret mellem en ydre sideflade for føringscylinderen (110), som mindst delvist strækker sig inden i huset (140), og en indre overflade for huset (140), og

hvorved den primære passage (205) er fremstillet i form af et gennemgående hul, som radialt krydser en sidevæg i føringscylinderen (110), hvorved den volumetriske membranpumpe omfatter mindst en sekundær passage (210), der er egnet til at bringe det mellemliggende kammer (195) i kommunikation med det indre volumen (45) i huset (140), når stemplet (115) er i den øvre dødpunktposi-

tion, hvilken sekundærpassage (210) er udført med form som et gennemgående hul, der krydser føringscylinderens (110) sidevæg nær ved den fleksible membran (150).

2. Pumpe (100) ifølge krav 1, **kendetegnet ved, at** den sekundære passage (210) er frembragt inden i føringscylinderen (110).

3. Pumpe (100) ifølge krav 1 eller 2, **kendetegnet ved, at** den sekundære passage (210) omfatter et gennemgående tværsnit, hvis udvidelse er mindre end 0,2 mm^2.

4. Pumpe (100) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den sekundære passage (210) er et gennemgående hul.

5. Pumpe (100) ifølge krav 4, **kendetegnet ved, at** det gennemgående hul har en diameter, som er mindre end 0,5 mm.

6. Pumpe (100) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** den omfatter en flerhed af de sekundære passager (210).

7. Pumpe (100) ifølge krav 6, **kendetegnet ved, at** de sekundære passager (210) er arrangeret med samme indbyrdes vinkel omkring en længdeakse (Y) for føringscylinderen (110).

DRAWINGS

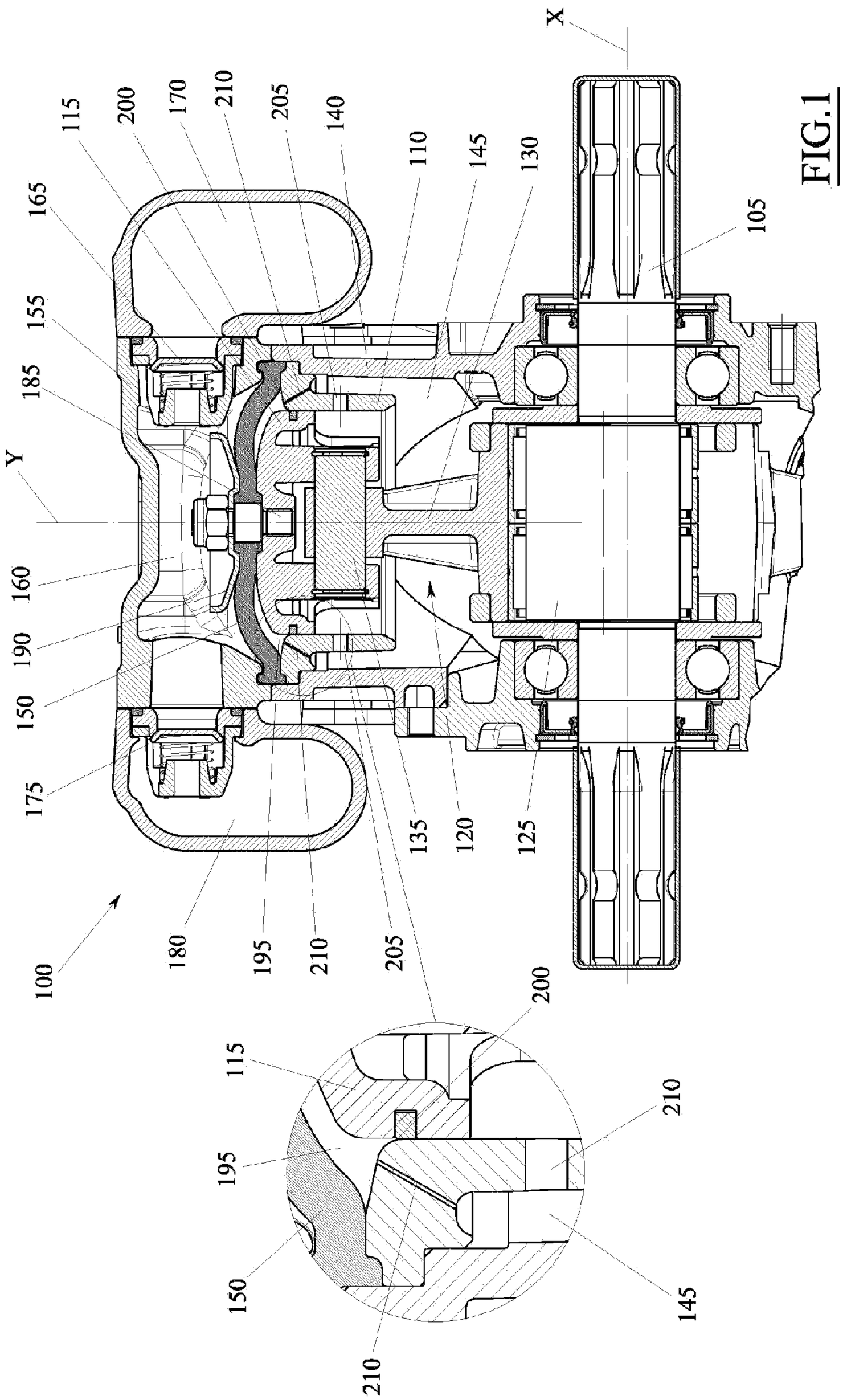

FIG.1

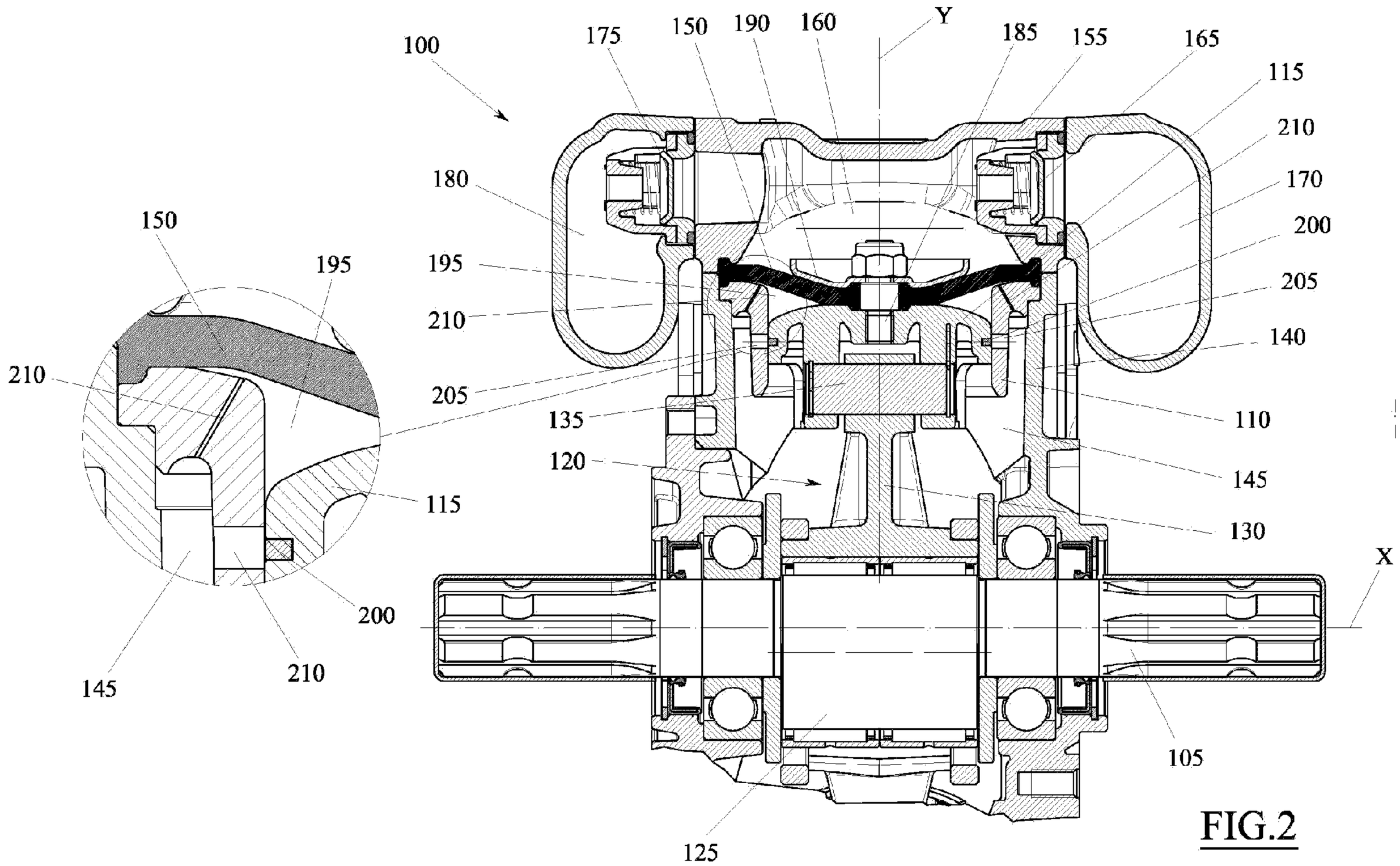

FIG.2

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