Dec. 28, 1937. G. R. LINDBERG 2,103,474

REVERSIBLE PLANETARY PISTON PUMP

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Fig. 1.

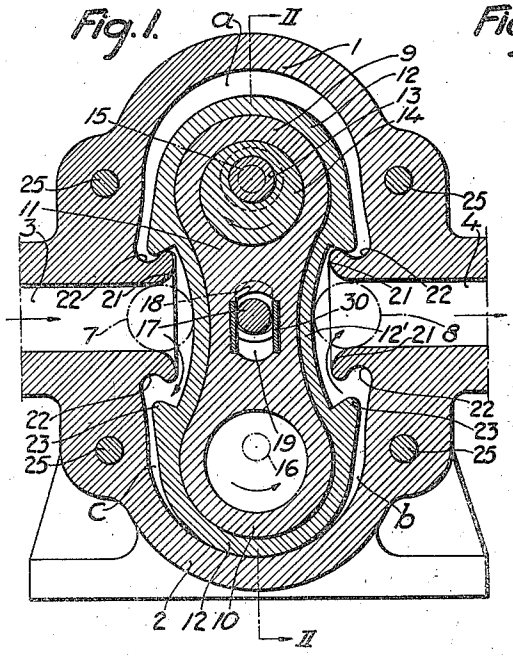

Fig. 2.

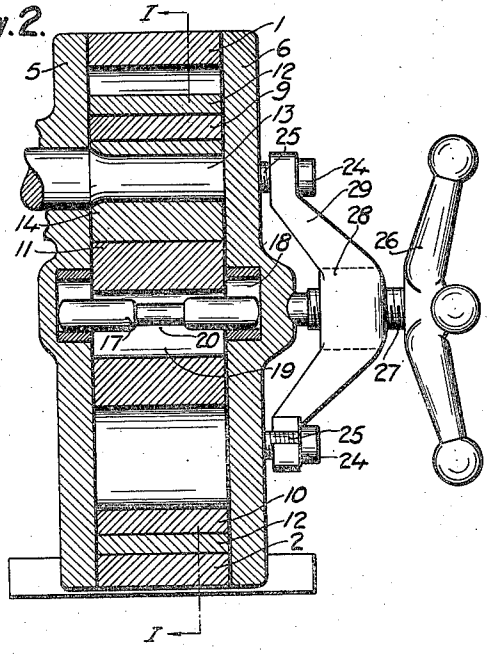

Fig. 3.

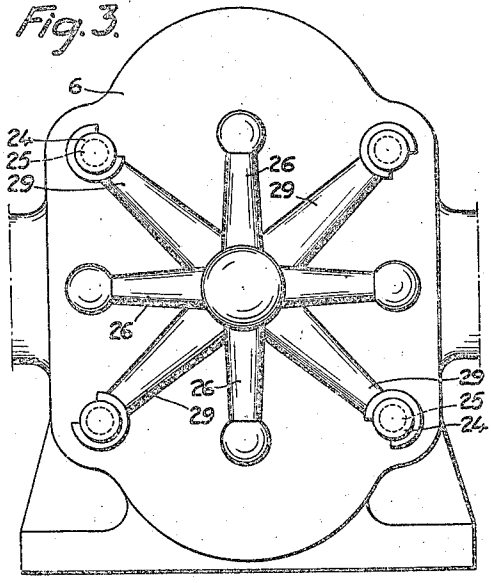

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Fig. 4.

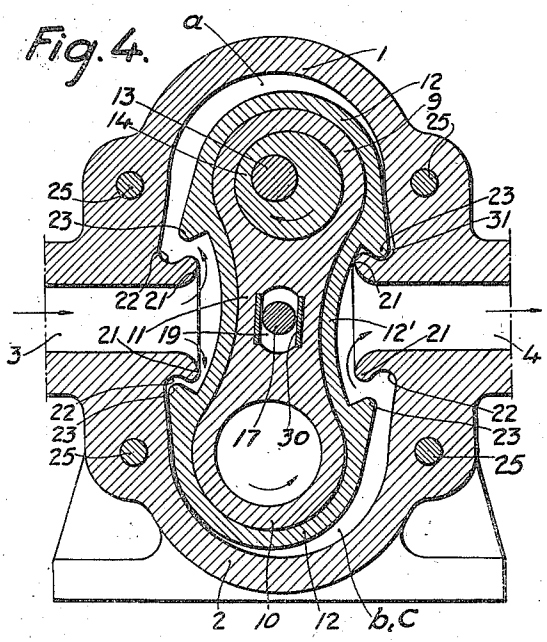


Fig. 5.

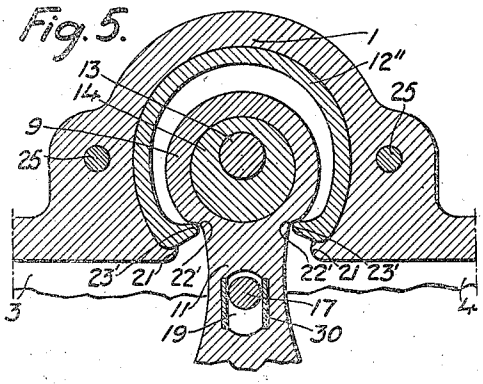
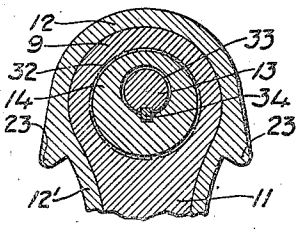


Fig. 6.



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Patented Dec. 28, 1937

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UNITED STATES PATENT OFFICE

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REVERSIBLE PLANETARY PISTON PUMP

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Application December 19, 1936, Serial No. 116,669
In Denmark February 11, 1936

7 Claims. (Cl. 103—131)

The present invention relates to an arrangement in a reversible planetary piston pump of the kind, whose pump casing has two pump cylinders, which are connected with each other and between which the suction and delivery openings are provided, and in which pump the impeller consists of two pump pistons, each provided in its cylinder, and an intermediate member radially connecting the said cylinders, the said impeller being adapted to be actuated by driving and guiding means so constructed that an eccentric motion can be imparted to either piston, so that they are caused to move synchronously with each other.

One object of the invention is, in a driving means, in which only one of the pistons is actuated to accentric motion on a shaft in its cylinder, to so shape the guiding means that an exactly corresponding eccentric motion is imparted to the other piston. Preferably the guiding means consists of a roller or cylindrical shaft extending through slots in the connecting portion and rotatably mounted in the casing.

A further object of the invention is to provide means of such a kind that an absolutely effective tightening is effected both between pistons and the walls of the working cylinders and between the said cylinders and the suction and delivery side after each stroke of the pistons, and that in the last mentioned positions cushioning means arise in connection with the sealing means so as to obtain a smooth and quiet run of the impellers during the strokes.

The pumping device may just as advantageously be used as a machine, a water motor or a compressor.

The accompanying drawings illustate, by way of example, a constructional form of the invention.

Figure 1 shows a section perpendicularly to the driving shaft, on line I—I of Figure 2.

Figure 2 a vertical section in the longitudinal direction of the driving shaft on line II—II of Figure 2, and

Figure 3 an end view of the pump,

Figure 4 a section corresponding with Figure 1, the impeller being in a different position, and

Figure 5 a section corresponding with Figure 1 with only half the pump and showing a detail on a modified scale.

Figure 6 shows a modified detail.

The pump casing comprises two cylinders 1, 2 located side by side, somewhat spaced with respect to one another and connected with each other by means of an intermediate portion, in which suction and delivery openings 3, 4 are provided right opposite to each other about perpendicularly to the driving shaft. If desired, the ducts opening into the suction and delivery openings may be arranged parallel with the driving shaft, as indicated in dashed circular lines, at 7 and 8, in Figure 1. In a constructional form of the said kind the outer ends of the openings 3, 4 are shut off, so that a suction and pressure chamber, respectively, is formed in the pump casing proper. The pump casing is provided with one stationary and one removable cover 5 and 6, respectively.

The impeller consists of two pistons 9 and 10, one in each cylinder and an intermediate member 11, rigidly connecting said pistons. The said member, with concave side faces merges with the cylindrical faces of the pistons. The pistons 9, 10 are coated with a coating 12 of yielding or elastic material, for example, a soft metal alloy, caoutchouc or the like, so as to facilitate smooth sliding of the pistons on the cylinder walls and to provide for an effective sealing effect against the walls, also in axial direction. Moreover, the pump pistons and the cylinder walls by this arrangement need not be made with the precision required in case metallic surfaces are to cooperate with each other. Preferably, also the intermediate member 11 is provided with such a coating 12', integral with the coating 12, so that the coating may be applied to the impeller without joints. These coatings, however, may be dispensed with, without the purpose of the invention being abandoned, or they may be varied in such a manner that a coating 12'' is applied to the cylinder walls, instead of being applied to the pistons, as shown in Figure 5.

A driving shaft 13 extends concentrically into the pump cylinder 1 and on the same there is provided a cam 14 to drive the piston 9 around. Said cam is so shaped that at the driving the center of the piston moves along a circular path 15 and its periphery rolls on the cylinder wall. In the member 11 there is provided a slot 19 and in the covers 5, 6 slots 18. A cylindrical shaft or roller 17 extends through the slot 19 and is loosely or rollably mounted in the slots 18. The slots have a larger extension in the plane through the piston axes and the longitudinal direction of the casing covers, respectively, than the shaft 17. Thus, the extension of the slots 18 is about equal to the sum of the shaft diameter and the radius of the circle about which the shaft center of the pistons oscillates, the central line of the said slots 18 coinciding with the transversal plane through

the center of the pump casing. Thus, during the pumping work, in addition to a rolling motion, also an up-and-down motion in the slots 18 may be imparted to the shaft 17, the connecting member 11 being swingable and displaceable relatively to the shaft.

The shaft 17 has an annular groove 20, so that liquid, which may enter the slot 19 is able to circulate in the same without resistance, and moreover the ends of the shaft may have convex shape, as shown in Figure 2, in order to admit of such circulation also in the slots 18. The slot may be replaced by holes or ducts. The walls of the slot 19 and, if desired, also those of the slots 18 are provided with a coating and a guiding surface, made of some material resistant to wear and tear, as indicated at 30.

At the limiting edges of the suction and delivery openings there are provided groove-shaped axial recesses 22 in the cylinder walls. On the impeller about at the place where the concave surfaces of the connecting member 11 merge with the cylindrical surfaces of the pistons 9, 10 there are provided rounded axial sealing edges 23 of a shape corresponding approximately to the shape of the recesses 22 and, for the purpose of sealing off the respective cylinder chamber, cooperating with the same in certain positions of the impeller.

In the piston 9 spring-acting roller or antifriction bearings may be provided between the cam 14 and the bearing surface of the piston, marked by a dash-and-dot line 32 (Figure 6), in order to obtain a yielding motion between the elements. Or also, a play may be provided between the shaft 13 and the cam, indicated at 33, by which also a certain spring-action can be obtained between said elements. 34 indicates a preferably square key, which may be used in this case for connecting the members 13 and 14 with each other and located substantially opposite said play.

The operation is as follows. In the position shown in Figure 1 the upper pump piston 9 has accomplished one stroke. The sealing edges 23 extend into the recesses 22 and block the cylinder chamber *a* from the suction and delivery openings, so that the liquid sucked into the chamber during an earlier stage of the stroke is kept enclosed there. The lower pump piston 10 with its outer end rests against the cylinder wall and, in a fluid-tight manner, blocks the two chambers *b* and *c*, from each other, i. e. the delivery side from the suction side. During this movement liquid present in the chamber *b* is expelled in the direction of the arrow in Figure 1 and sucking-in is effected in the chamber *c*, as is also clear from the drawn arrows. When the shaft 13 continues to move in the direction of the arrow the piston 9 is swung to the left, the piston 10 to the right, and the periphery of the piston 9 is caused to contact with the cylinder wall, the sealing engagement, at 22, being released. The liquid in the chamber *a* is pressed out through the opening 4, the volume of the chamber being successively reduced according as the rolling motion of the piston 9 on the cylinder wall continues. When the shaft has turned half a turn the piston 9 has the same position as the piston 10 of Figure 1. The liquid in the right part of the chamber *a* is still being pressed out, vacuum arising in the left part, so that sucking of liquid takes place. The more the piston 9 continues to the position shown in the figure the more the volume of the chamber *a* is increased and the more liquid is sucked until the shaft has rotated a whole turn, when the chamber is again completely blocked.

On account of the shapes of the guiding shaft 17 and of the slots the piston 10 will, of course, move in the indicated direction of the arrow, i. e. synchronously with and in a direction opposite to that of the piston 9 with its center of axis along the circle 16. Thus, if the piston 10 is moved in the direction of the arrow its surface rolls against the cylinder wall under permanent sealing between the suction and delivery side, during which the volume of the chamber *c* increases more and more at the cost of the chamber *b*. When the driving shaft has rotated half a turn from the shown position the piston 10 has reached a position which corresponds to that of the piston 9 in the drawings and seals the common chamber *b*, *c* from the suction and delivery openings.

As is seen from arrows marking the directions of flow the medium passes spirally through the pump.

When the piston 10 is moved towards and away from the position shown in Figure 1, the angular speed of the piston 10 is increased on account of the displacement of the shaft 17 upwards in the slots 18, so that the volume of the chamber *b* decreases more rapidly than the volume of the chamber *a*, by which the total outflow can be kept practically continuous. The reverse course of motion will take place when the piston 10 with its center moves within the upper half of the circle 16.

The depth of the recesses 22 is preferably made somewhat larger than the height of the sealing edges 23, so that chambers or cavities 31 are obtained (Figure 4). During the pumping movements the liquid remaining in the said cavities will act as liquid cushioning means, so that when the sealing edges 23 enter the recesses 22 a noiseless and quiet working without shocks and blows is obtained also in case of considerable suction heads.

The two cooperating portions 21 and 23 may be arranged in a contrary manner, as shown in Figure 5, recesses 22' thus being provided on the pistons and sealing edges 23' on the cylinder walls.

On account of the shown concave shape of the connecting member a smooth transition is obtained between the suction and delivery openings and the pump chambers. Therefore, the pumped out liquid moves through the pump in an even flow and on account of the double-acting construction substantially in a continuous flow without eddies being formed, which is of a special importance when pumping, for example, a liquid such as milk or the like, which, in case of eddies, easily may be subjected to separation. The efficiency is kept high thereby that the pump need never work with unreliable sealing between the suction and delivery sides.

The removable cover 6 is carried by bolts 25, which extend through the casing (see Fig. 1) and are provided with heads indicated by 24. The operating member 26 is provided with a screw 27, which extends through the hub 28 of the stirrup member 29. The point of the screw is guided in a recess in the cover 6. The ends of the arms of the stirrup member 29 are arranged as fastening members (claws or the like) which engage the body 25 of the respective bolts. When the cover 6 is to be removed from the position

shown in Figure 3 the operating member is turned in such a manner that there is no pressure on the stirrup member, after which the latter is turned in anti-clockwise direction, until it has been completely liberated and the cover can be removed so that the interior parts of the pump will be easily accessible for inspection, cleaning and repairing, if any.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a reversible planetary piston pump, a casing comprising two cylinders arranged side by side and having openings in their adjacent sides communicating with one another, inlet and outlet openings communicating with said cylinder openings at opposite sides, an impeller in said casing, said impeller comprising two rotary pistons, arranged one in each cylinder, and a rigid connecting member between said pistons constituting a partition between the inlet and outlet openings, a single eccentric drive operatively engaging the piston of one of the cylinders and imparting a rotary oscillation to said piston, and guiding means for said connecting member for causing the piston in the other cylinder to move synchronously with the piston in the first cylinder, said guiding means consisting of a shaft extending through a slot of the connecting member and being movably mounted in slots of the walls of the pump casing, the slot of the connecting member and the slots in the walls of the pump casing having a larger extension in the plane through the piston axes then said movable shaft, the latter receiving simultaneously a rolling motion relatively to its own axis and a longitudinal movement relatively to the slots in the walls of the pump casing.

2. A reversible planetary piston pump as claimed in claim 1, in which the connecting member merges with substantially concave sides into the cylindrical faces of the pistons.

3. A reversible planetary piston pump as claimed in claim 1, in which said shaft has a recess and convex axial end faces, the said recess and faces being so arranged as to make possible circulation of liquid, which may have entered all said slots.

4. A reversible planetary piston pump as claimed in claim 1, in which the slot of the connecting member and the slots of the walls of the pump casing are coated with guide and roll surfaces of a material resistant to rolling friction.

5. A reversible planetary piston pump as claimed in claim 1, in which groove-shaped recesses are provided at the inlet and outlet openings and the impeller carries an elastic coating having sealing edges thereon said sealing edges being so disposed that when the respective pump piston is in its inner position the respective edges are in a sealing position in the recesses, the said recesses being deeper than the height of said sealing edges, so that a space for liquid is obtained in order to moderate the motions of the pump elements.

6. A reversible planetary piston pump, as claimed in claim 1, in which the extension of the slots in the walls of the pump casing in the plane through the piston axes equals approximately the sum of the diameter of said shaft plus the radius of the circles about which the centers of the pistons oscillate, the central line of said slots coinciding with the transversal plane through the center of the pump casing.

7. A reversible planetary piston pump, as claimed in claim 1, in which groove-shaped recesses are provided at the inlet and outlet openings and the impeller carries an elastic coating having sealing edges thereon, said sealing edges being adapted to rest in a sealing position in said recesses when the respective pump piston is in its inner position.

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