March 7, 1950 W. T. LIVERMORE 2,499,763

LOOSE SLIPPER ROTARY PUMP

Filed July 27, 1945

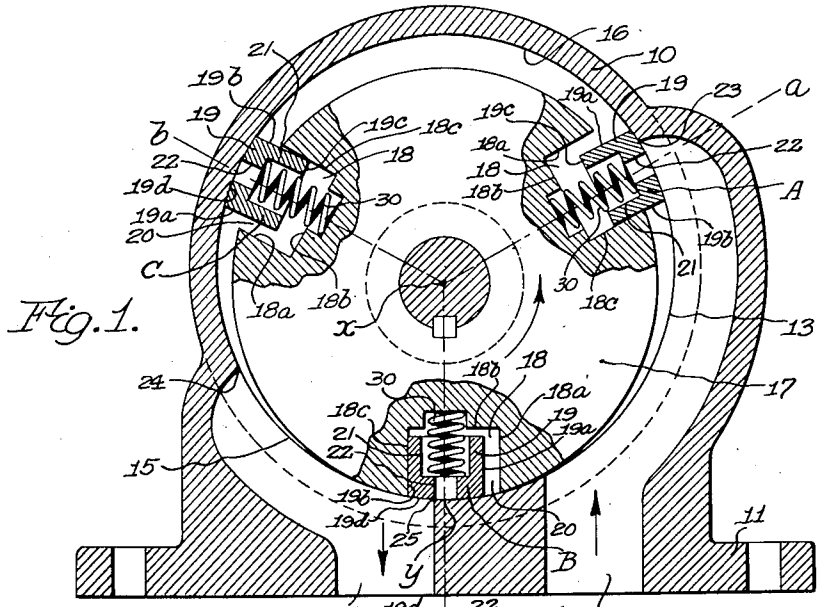


Fig. 1.

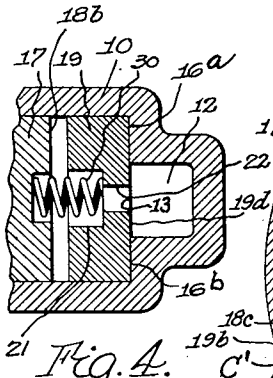


Fig. 4.

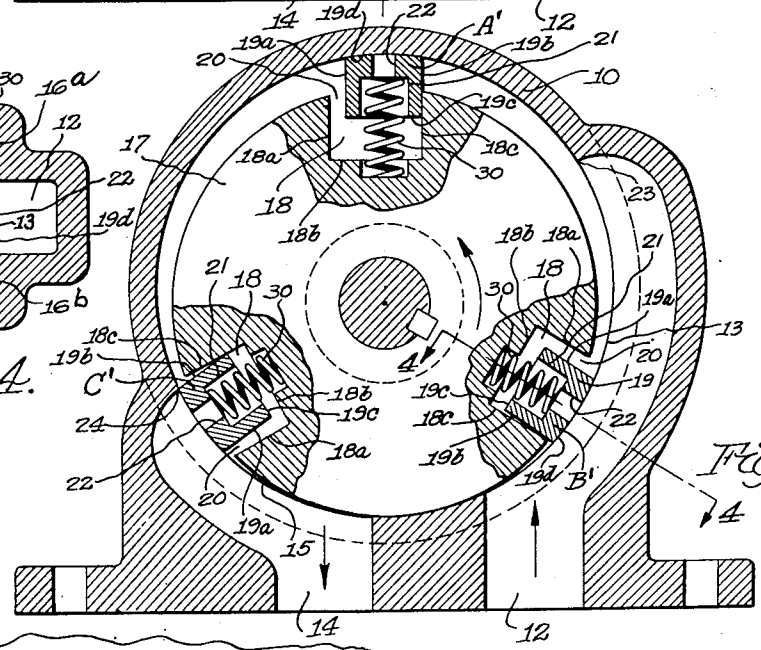


Fig. 2.

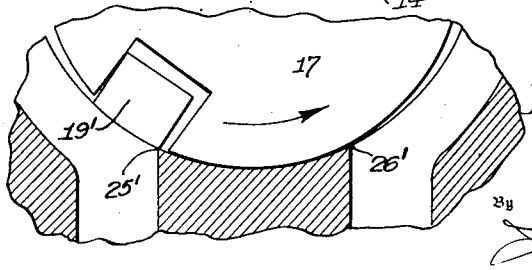


Fig. 3.

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Patented Mar. 7, 1950 2,499,763

UNITED STATES PATENT OFFICE

2,499,763

LOOSE SLIPPER ROTARY PUMP

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Application July 27, 1945, Serial No. 607,366

11 Claims. (Cl. 103—136)

1

This invention relates to slipper type pumps by which is meant that type of pump wherein a rotor is provided with a plurality of spaced radially extending relatively shallow notches in each of which is loosely mounted a liquid impelling member called a slipper; the rotor and slippers carried thereby being mounted for rotation in a casing having a working chamber or bore, which bore in the simplest form is cylindrical and with its center offset or eccentric to the axis of rotation of the rotor, and so that the rotor is tangent to the bore at one side of the rotor and a crescent-shaped working arc is formed having its greatest width at a point diametrically opposite to the line of tangency between the rotor and chamber. By slipper type of pump is further meant that type of pump in which the liquid impelling members are relatively shallow in depth or thickness as compared to their width, i. e., that dimension of the slipper measured in the direction of the slipper's rotation as it is carried along by the rotor.

The present invention has for its object to provide an improved type of construction for a slipper type of pump in which the slippers are carried in notches, the width of which is appreciably greater than the width of the slippers so that when a slipper is passing through the working arc of the pump, the pressure of the fluid on the front or leading edge of the slipper will hold the slipper in contact with the back edge of the slot or notch in the rotor and a sufficient clearance will exist between the front edge of the slipper and the front edge of the notch in the rotor to permit the passage of fluid under pressure to the underside of the slipper thereby to assist the centrifugal force to hold the outer sealing face of the slipper firmly in contact with the inner working surface of the pump chamber or bore.

Another one of the principal objects of the present invention is to so locate the inlet and outlet ports of the pump that there will be no sudden reversals in the direction of flow of the fluid being pumped which would otherwise tend to result in a loss of efficiency and to produce objectionable hydraulic hammering in the outlet conduit.

A further object is to so locate the outlet and inlet ports of the pump as to obviate the presence of any air bubbles or unfilled spaces in the working arc of the pump in advance of any slipper when the rear end of the preceding slipper passes the leading edge of the outlet port.

Another object is to provide an improved pump

2

of the slipper type wherein the slippers are provided with a through hole extending from the outer to the inner face of the slipper for the purpose of insuring equalization of the fluid pressure on such inner and outer faces and to so locate the cut-off edge of the outlet port with respect to the line of tangency between the rotor and pump chamber and with respect to said through hole that any fluid trapped in a notch of the rotor in front of a slipper and below the inner face thereof will be led to the outlet port before the slipper reaches the said line of tangency whereby to avoid trapping of the fluid at said point of tangency with a resultant noise, power loss and excessive wear.

The above and other objects of the present invention will appear more fully from the following more detailed description and by reference to the accompanying drawings.

Fig. 1 is a central cross-section through a slipper type pump constructed in accordance with the principles of the present invention;

Fig. 2 is a view similar to Fig. 1 showing the pump and slippers thereof in a different position in the pump's rotation from that shown in Fig. 1;

Fig. 3 is a diagrammatic view showing the manner in which fluid is trapped when the pump is provided with the conventional symmetrical arrangement of the outlet port and

Fig. 4 is a section on the line 4—4 of Fig. 2.

As shown in the drawings, the numeral 10 indicates a pump casing provided with a suitable attachment flange 11, for the purpose of connecting the pump to any suitable supporting surface. The casing 10, preferably constructed as a casting, is cored to provide an inlet conduit 12, the inner end of which terminates in an inlet port 13 and an outlet conduit 14, the inner end of which terminates in an outlet port 15. The casing 10 is provided with a working chamber or bore 16 which, in the form shown, is cylindrical in configuration and is of larger diameter than and eccentric to a cylindrical rotor 17 which is mounted for rotation about an axis x so arranged with respect to the axis of the working chamber 16 that the cylindrical surface of the rotor 17 is tangent to the working chamber 16 along the line of tangency indicated by reference character y.

The rotor 17 is provided with a plurality of notches 18 in each of which is mounted a slipper 19. As each of the notches 18 and slippers 19 is of similar configuration, a description of one will suffice for all. Each of the slippers 19 has

a forward or leading edge 19—*a*, a following edge 19—*b*, an inner face 19—*c* and an outer face or working surface 19—*d*. As is clearly shown in the drawing, the width of each slipper, that is, the distance between the leading edge 19—*a* and following edge 19—*b*, is much greater than the thickness of the slipper, that is, the distance between the inner face 19—*c* and the outer working surface 19—*d* thereof. The outer working surface 19—*d* of each slipper is preferably curved upon an arc having the same radius of curvature as the surface of the working chamber 16 of the casing so as to insure a surface area of sealing contact between the working face 19—*d* of the slipper and the working chamber at all points of the slipper's rotation. As will be seen from Fig. 4, the transverse width of the rotor and of each slipper is appreciably greater than the width of the inlet or outlet ports 13, 15, which are in the form of elongated slots that extend centrally around the working surface of the bore 16 so as to provide lands 16—*a*, 16—*b* against which the working surface 19—*d* of each slipper bears as it sweeps past the ports.

The leading edge 18—*a* of each notch is spaced from the rear wall 18—*c* thereof a distance greater than the width of a slipper so as to provide a clearance space 20 between the wall 18—*a* and the leading edge 19—*a* of the slipper. The rear wall 18—*c* of each notch preferably extends parallel to the radius of the rotor 17 that passes through the center of the slipper when said slipper is in contact with the rear wall 18—*c* of the notch. The thickness of each slipper, that is, the distance between the inner face 19—*c* and the outer working surface 19—*d* thereof, is slightly less than the depth of the notch, that is, the distance between the outer surface of the rotor and the inner wall 18—*b* of each notch. Consequently when the pressure between slippers A' and C' is increased sufficiently to be equal to or greater than that ahead of slipper C', slipper C' will move ahead, away from sealing edge 18—*c* of notch 18, and permit any excess fluid between slippers A' and C' to by-pass to the outlet port, thus equalizing the pressure on both sides of slipper C'.

Each slipper 19 is provided on the inner face thereof with a counterbore 21 which serves as a seat for a spring 30 that serves to hold the slipper in contact with the inner wall of the working chamber 16. Counterbore 21 communicates with a through hole 22 that extends from the bottom of said counterbore to the outer working surface 19—*d* of said slipper. It is customary in the conventional type of pump to locate the opening edge of the outlet port at an angular distance from the line of tangency of the rotor with the cylindrical working surface approximately equal to the angular spacing of the vanes or slippers and to locate the cut-off edge of the inlet port at a distance from said outlet port approximately equal to the distance between adjacent sealing edges of adjacent slippers. I found, however, after considerable experimentation with pumps of this character that the spacing above referred to results in many objectionable characteristics in the operation of the pump.

For example, with the porting above described, if for any reason the space between slippers A and C is not completely filled with liquid, fluid under pressure in the outlet conduit 14 and port 15 tends to rush backwardly into the working chamber of the pump to fill space. This obviously will tend to reduce the efficiency of the pump and to cause objectionable shock and noises.

From an examination of Fig. 1, it will be seen that in the present construction the outlet port 15 is advanced considerably in the direction of rotation as compared with the conventional location. It will also be seen that the volume of the space in the working arc of the pump between the slippers indicated at the positions A and C represents substantially the maximum volume that will exist at any time between two adjacent slippers and that this volume is much greater than that between the two slippers indicated at the positions A' and C' in Fig. 2. Consequently, as a slipper moves from the position A in Fig. 1 to the position A' in Fig. 2, any unfilled space between the slippers will be closed in and the fluid ahead of the leading edge 19—*a* of the slippers will tend to be compressed to raise the pressure thereof before the following edge 19—*b* of the slipper at C' (Fig. 2) reaches the opening edge 24 of the outlet port 15. As a result of the advanced positioning of the opening edge 24 and the consequent increase in the pressure of the fluid, there will be no tendency of the fluid within the outlet conduit to surge backwardly into the working arc of the pump.

As will also be seen from Fig. 1, the cut-off edge 25 of the outlet port 15 is spaced from the line of tangency *y* of the pump a distance equal to one-half of the diameter of the hole 22 provided in each slipper. This construction is provided to prevent the objectionable trapping of fluid that would otherwise occur if the conventional symmetrical arrangement of the inlet and outlet ports were employed. This objectionable trapping effect of the fluid can best be understood by reference to Fig. 3 of the drawing wherein the cut-off edge 25' of the outlet port is indicated as spaced the same distance from the line of tangency *y* as the opening edge 26' of the inlet port. If this conventional spacing is employed, it will be seen that when the leading edge of the slipper reaches the cut-off edge 25', a small crescent-shaped slice of fluid will be trapped in advance of the leading edge of the slipper 19' and between the wall of the working chamber of the pump and the periphery of the rotor and also within the notch of the rotor in advance of the leading edge of the slipper and in the bottom of the notch below the inner face of the slipper. Obviously, if this trapping of fluid occurs, unnecessary work has to be done in attempting to compress this fluid or squeezing it out through the various clearances. In this event, as the slipper moves inwardly towards the bottom of the notch, in sweeping past the tangent point, the pressure of the fluid on the inner face of the slipper tends to press the slipper with a heavy force against the surface of the working chamber in the region of the tangent line, thus causing undue wear upon the working face of the slipper and on the bore of the working chamber.

With the construction shown in Figs. 1 and 2, this trapping of the fluid in advance of the slippers as they approach the tangent line is substantially completely eliminated, because, as the forward edge of each hole 22 reaches the line of tangency, one-half of the hole 22 is still in communication with the outlet conduit 14, thus permitting the venting, as it were, of pressure built up in advance of the leading edge of the slipper and within the notch below the slipper, to the outlet conduit as the slipper is approaching the line of tangency.

Because of the advanced location of the outlet port 15, as described, the flow of the fluid moved

by each slipper as it passes through the working arc and until such fluid is delivered into the outlet conduit 14 is in the same general direction. Consequently, there are no sudden reversals in the direction of the fluid such as occur when the customary symmetrical locations of inlet and outlet ports of the pump are employed.

While I have illustrated and described a satisfactory constructional example, it will be understood that many changes, variations and modifications may be resorted to without departing from the spirit of the invention as set forth in the claims hereunto appended.

I claim:

1. A rotary pump of the type wherein a plurality of slippers are loosely mounted in spaced notches in a rotor mounted for rotation within a substantially cylindrical bore formed in a stationary pump casing, which bore is of larger diameter than the periphery of said rotor to form an arcuate working chamber and with said rotor tangent to said bore to form a sealing contact between said rotor and bore along the line of tangency between them, the said casing being provided with inlet and outlet conduits terminating in inlet and outlet ports respectively, characterized by said inlet and outlet ports being unsymmetrically disposed in said casing with respect to said line of tangency, said outlet port being advanced in the direction of rotation of said rotor and having its opening edge so disposed with respect to said working arc that the space in which the fluid is confined between two adjacent slippers of said pump as the forward slipper opens communication between said working arc and outlet port will be considerably less than the maximum space between said adjacent slippers before the leading slipper reaches said opening edge.

2. A rotary pump of the type wherein a plurality of slippers are loosely mounted in spaced notches in a rotor mounted for rotation within a substantially cylindrical bore formed in a stationary pump casing, which bore is of larger diameter than the periphery of said rotor to form an arcuate working chamber and with said rotor tangent to said bore to form a sealing contact between said rotor and bore along the line of tangency between them, the said casing being provided with inlet and outlet conduits terminating in inlet and outlet ports respectively, characterized by said outlet and inlet ports being unsymmetrically disposed with respect to the line of tangency, with the opening edge of said outlet port advanced in the direction of rotation of said pump and having its cut-off edge located closely adjacent to said line of tangency to prevent trapping of fluid as the fluid is being swept in advance of the slipper through said outlet port from said working arc of said pump.

3. A rotary pump of the type wherein a plurality of slippers are loosely mounted in spaced notches in a rotor mounted for rotation within a substantially cylindrical bore formed in a stationary pump casing, which bore is of larger diameter than the periphery of said rotor to form an arcuate working chamber, and with said rotor tangent to said bore to form a sealing contact between said rotor and bore along the line of tangency between them, the said casing being provided with inlet and outlet conduits terminating in inlet and outlet ports respectively, characterized by each of said slippers being of considerably less width that the notch in the rotor in which it is mounted so as to provide a clearance space between the leading edge of each slipper and the forward face of its respective notch to permit flow of the fluid being pumped to the underside of said slipper whereby said fluid will force the outer working face of said slipper into sealing contact with the inner surface of said working chamber as said slipper sweeps through the working arc thereof, said slipper being provided with an aperture extending from the inner face to the outer working surface thereof, and the outlet port of said casing being advanced in the direction of rotation of said rotor so that the cut-off edge of said outlet port is spaced from said line of tangency a distance substantially equal to the distance from the center of the slipper to the cut-off edge of said aperture thereby to maintain communication between the inner face of said slipper and said outlet port until the center of said slipper reaches a position approximately in line with said line of tangency thereby to prevent trapping of fluid within said notch inside said slipper as it approaches said line of tangency.

4. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, a plurality of loosely mounted slipper impellers in said rotor adapted to contact said bore during the rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet and outlet ports being unsymmetrically arranged to effect delivery through substantially two-thirds of the rotative cycle of each impeller and to effect an intake of fluid through substantially one-third of said rotative cycle.

5. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, three equally spaced, loosely mounted slipper impellers in said rotor adapted to bear against said bore during the rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet and outlet ports being arranged unsymmetrically to effect a fluid delivery through substantially two-thirds of the rotative cycle of each impeller and to effect an intake of fluid through substantially one-third of said rotative cycle.

6. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, a plurality of loosely mounted slipper impellers in said rotor adapted to bear against said bore during the rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet port being arranged to effect a cut-off of intake for a given impeller when the working volume between said impeller and the next preceding adjacent impeller is substantially at a maximum value, and said outlet port being arranged to provide a substantial travel for said next preceding adjacent impeller beyond said maximum volume position before it passes the opening edge of said outlet port.

7. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor

being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, a plurality of loosely mounted slipper impellers in said rotor adapted to bear against said bore during rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet and outlet ports being arranged to provide a cut-off in delivery by each impeller at approximately said line of tangency, and a cut-off of intake for each impeller at a point whereat the instantaneous rate of change of volume between said impeller and the next preceding impeller is substantially zero.

8. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, a plurality of loosely mounted slipper impellers in said rotor adapted to bear against said bore during rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet and outlet ports being arranged to provide a cut-off in delivery by each impeller at approximately said line of tangency, and a cut-off of intake for each impeller at a point whereat the instantaneous rate of change of volume between said impeller and the next preceding impeller is substantially zero, and whereat the continued movement of said impeller results in a continuous decrease in said volume, said next preceding impeller having a substantial travel from said point before reaching the opening edge of said outlet port.

9. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, three equally spaced loosely mounted slipper impellers in said rotor adapted to bear against said bore during the rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet port being arranged to effect a cut-off of intake for a given impeller when the working volume between said impeller and the next preceding adjacent impeller is substantially at a maximum value, and said outlet port being arranged to provide a substantial travel for said next preceding adjacent impeller beyond said maximum volume position before it passes the opening edge of said outlet port.

10. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, three equally spaced loosely mounted slipper impellers in said rotor adapted to bear against said bore during rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet and outlet ports being arranged to provide a cut-off in delivery by each impeller at approximately said line of tangency, and a cut-off of intake for each impeller at a point whereat the instantaneous rate of change of volume between said impeller and the next preceding impeller is substantially zero.

11. A rotary pump employing a cylindrical rotor, a casing provided with a cylindrical bore of a diameter greater than said rotor, said rotor being mounted for rotation with its perimeter against one side of said bore to form a fluid seal at the line of tangency, three equally spaced loosely mounted slipper impellers in said rotor adapted to bear against said bore during rotation of said rotor, and inlet and outlet ports in said casing communicating with said bore, said inlet and outlet ports being arranged to provide a cut-off in delivery by each impeller at approximately said line of tangency, and a cut-off of intake for each impeller at a point whereat the instantaneous rate of change of volume between said impeller and the next preceding impeller is substantially zero, and whereat the continued movement of said impeller results in a continuous decrease in said volume, said next preceding impeller having a substantial travel from said point before reaching the opening edge of said outlet port.

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