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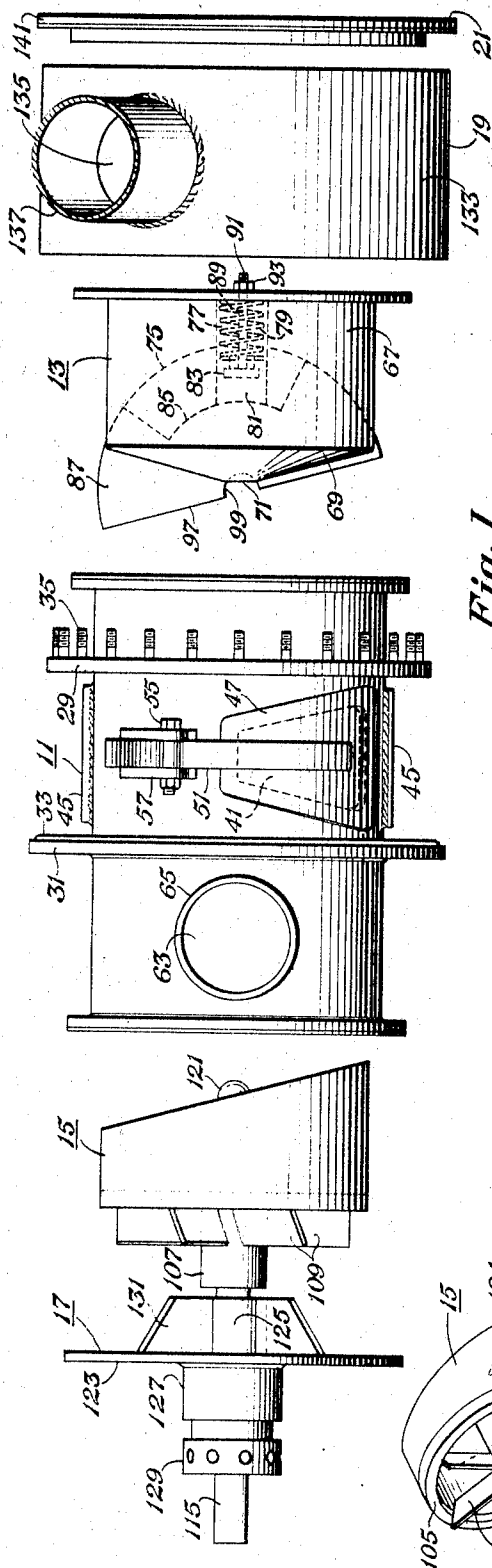


Fig. 1

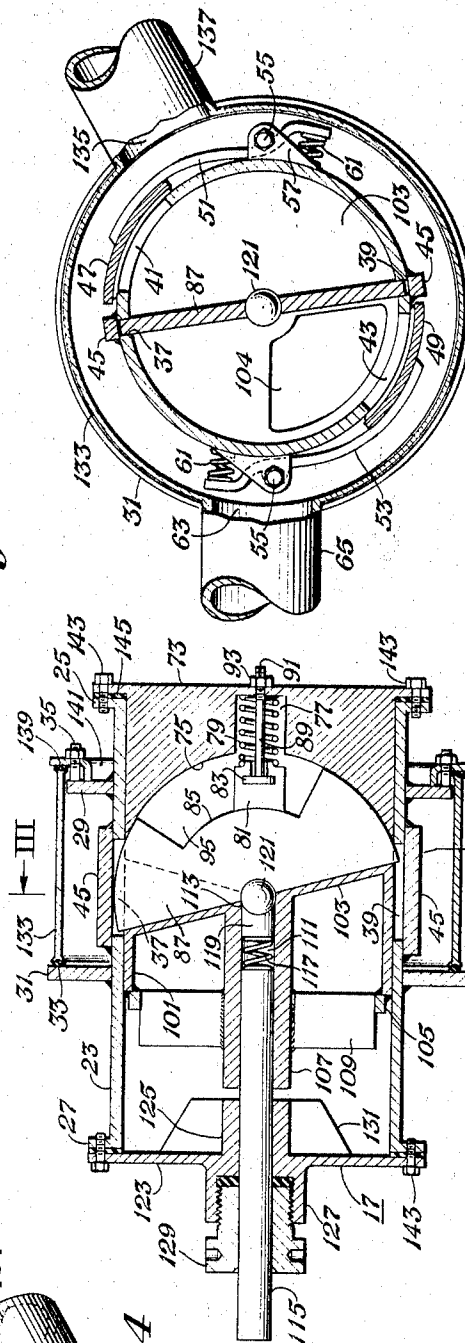


Fig. 3

Fig. 2

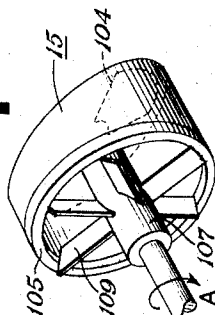


Fig. 4

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14 Claims

ABSTRACT OF THE DISCLOSURE

This specification discloses, for pumping slurries and other difficultly pumpable fluids, a rotary pump characterized by: (a) a cylindrical housing; (b) a stator fixed relative to one end of the housing and having a conical portion axially disposed within the housing, the conical portion having therein a transverse, semicircular diametral slot; (c) a hollow rotor axially disposed within the housing and having an oblique planar end surface which is in tangential contact with a lineal element of the conical surface, the rotor having a fluid port in its end surface; (d) a semicircular paddle disposed in the slot and pivotable about the axis of the housing; (e) means for maintaining the edge of the paddle in linear contact with the oblique planar surface; (f) a fluid inlet port in the housing for admitting fluid to the rotor; and (g) two discharge valves mounted on the housing. The specification also discloses a preferred embodiment in which the fluid port is located near the point of maximum thickness of the rotor, and covers about one-fourth the area thereof; and fan blades are mounted on the shaft of the rotor to urge the fluid therethrough. The pump combines the best features of a double acting positive displacement pump and a centrifugal pump, being able to pull a substantial vacuum, effect high discharge pressures, or pump large quantities of fluids, all without significant pulsations in pressure.

My invention relates to pumps and more particularly to rotary pumps.

In my co-pending application, Ser. No. 637,740, filed on even date herewith, there is disclosed a vane-type rotary pump which is similar, in some respects to the present invention, and which discloses and claims certain features which are employed in the rotary pump herein disclosed and claimed. Reference may be had to said co-pending application for detailed disclosure of the features therein claimed.

The main object of the present invention is to improve the operation of a vane-type rotary pump of the kind disclosed in said co-pending application.

Another object of the present invention is to provide a vane-type rotary pump that is simple, compact and efficient.

Another object of the present invention is to provide internal cooperative apparatus that urges fluid into a vane-type rotary pump.

Another object of the present invention is to provide a vane-type rotary pump that is double acting.

These and other objects are effected by my invention as will be apparent from the following description taken in accordance with the accompanying drawing, forming a part of this application, in which:

FIG. 1 is an exploded schematic elevational view of a rotary pump and in accordance with the principles of the present invention;

FIG. 2 is a longitudinal sectional view of the assembled pump unit of FIG. 1;

FIG. 3 is a sectional view at line III—III of FIG. 2; and

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FIG. 4 is a perspective view of the rotary member of the rotary pump unit of FIG. 1.

Referring to the drawing, the pump unit of FIG. 1 includes a main housing structure 11, a stator 13, a rotor 15, an end closure 17, an outer casing 19, and an outer casing locking ring 21.

The main housing structure 11 includes a cylindrical shell 23 which is provided with end flanges 25, 27. The end flanges 25, 27 are provided with a plurality of spaced apart bolt holes for a purpose that will be disclosed hereinafter.

The housing 11 also has flanges 29 and 31. Flange 31 has a slightly larger outside diameter than the other intermediary flange 29, and this is for a purpose that will become evident hereinafter.

The flange 31 is provided with an O-ring 33 in the surface facing the smaller intermediary flange 29. The smaller intermediary flange 29 is provided with a plurality of spaced apart stud bolts 35, which extend toward the right hand end (as viewed in FIG. 1) of the main housing structure 11, and these stud bolts are for a purpose that will be disclosed hereinafter.

Between the intermediary flanges 29, 31, there is provided in the wall of the shell 23 a pair of diametrically opposed longitudinally extending slots 37, 39 (FIG. 2), and a pair of diametrically opposed fluid discharge ports 41, 43 (FIG. 3). The fluid discharge port 41 is disposed adjacent the slot 37, and the port 43 is disposed adjacent the slot 39, as shown in FIGS. 2 and 3. The slots 37, 39 extend through the wall of the shell 23, and each slot is covered by an elongate bar member 45 which may be welded to the shell 23. The purpose of the slots 37 and 39 is to accommodate the paddle 87 as described hereinafter.

From FIG. 1, it will be observed that the fluid discharge ports 41, 43 have a generally trapezoidal shape and each is closed by a clapper valve. These are designated 47, 49 respectively.

Each clapper valve has an actuating arm mounted on pivot pins 55 connecting a respective pair of triangular shaped brackets mounted on the tubular member 23, as shown in FIGS. 1 and 3. Compression springs 61 urge the clapper valves closed.

The shell 23 has an additional circular opening 63, which is located between the flanges 27 and 31, and a fluid inlet conduit 65 is connected to this opening, as by welding.

The stator 13 includes a cylindrical body portion 67 and a conical shaped portion 69 which is integrally formed on one end of the cylindrical body portion 67. The apex region of the conical body portion is provided with a small generally hemispherical slot 71, to accommodate a thrust ball 121.

To the other end of the cylindrical body portion 67, there is fixed a plate member 73 wherein there are a plurality of holes that match the aforementioned holes in the flange 25, so the plate 73 can be bolted to the flange 25.

The stator 13 is also provided with a deep vertical semicircular slot 75, as shown in FIG. 1. Extending axially from the slot 75 is a cylindrical hole 77, wherein is disposed a compression spring 79 that bears against the plate 73 and against a feed shoe 81. The feed shoe 81 is generally rectangular in shape, so that it cannot rotate in the body portion 67, but its inner end is curved to match the arcuate edge 85 of a groove 95 in a semicircular paddle 87. An adjusting bolt 89 with its nut 93 may be adjusted to limit inward movement of the shoe 81.

The paddle 87, as may be noticed by referring to FIGS. 1 and 2, is generally semicircular. The diametrical linear edge 97 of the paddle 87 is provided with a semi-circular recess 99 at the mid-length thereof, so that it, as well as the main body 67 can accommodate a thrust ball 121.

The rotor 15 has a generally cylindrical ungulate shape; that is to say, it has a cylindrical shell 101 and an inner surface or oblique closure plate 103, at its inner end, which is elliptical. It will be noticed, by referring to FIGS. 3 and 4, that the elliptical inner surface or end closure plate 103 is provided with a relatively large opening or fluid inlet port 104. The inlet port 104 is located, preferably, as shown in FIGS. 3 and 4, just to the left of the point where the ungulate portion has the greatest thickness. It has an area that is about one-fourth the area of the inner surface 103.

The outer end of the cylindrical body portion 101 is open and is reinforced by a heavy ring member 105 that is preferably welded thereto. A central axial hub 107 is secured to the elliptical end closure 103 and extends therefrom in the direction of the open end, as shown in FIG. 2. Between the hub 107 and the heavy ring member 105, there are fixed a plurality of rectangular shaped fan blades 109 which serve as a spider, and which are preferably oriented, as may be noticed by referring to FIGS. 1 and 4, so that the blade surface is twisted or disposed obliquely to the central axis of the hub. The obliquity of the blades bears a functional relation to the direction of rotation of the rotary element 15, explained later on.

The hub 107 has a central axial passage 111 therethrough and the oblique inner surface or end closure 103 also has a hole 113 therein which coincides with the passage 111. A drive shaft 115 is secured in the passage 111, as shown in FIG. 2, and there is also provided therein a compression type spring 117 and a short spacer or plunger 119. The end of the plunger 119 which is disposed toward the oblique end closure 103 has therein a hemispherical depression or cup, in which is disposed thrust ball 121. The ball 121 has a diameter corresponding generally to the diameters of the hemispherical recess 71 and the semicircular recess 99. The cylindrical shell 101 has substantially the same diameter as the inner diameter of the shell 23 and it is substantially free to rotate therein. The ball 121 has certain special functions. The hollow rotating ungulate body is eccentric because of its shape, and hence is not balanced when it rotates. The ball acts as a stabilizing agent for the dynamic unbalance of the rotor. Also, the paddle oscillates about it and is held against lateral movement by it.

The end closure 17 comprises a generally circular flat plate 123 to which is fixed a hub 125 that has a central axial passage therethrough. Adjacent the periphery of the end closure plate 123, there are a plurality of holes which match the holes in the flange member 27, so that the end closure 17 can be bolted to the shell 23. One end of the hub 125 is enlarged to provide a stuffing box 127 around the shaft 115 and a gland 129 is threaded in the stuffing box 127, in the normal manner. A plurality of plate brackets 131 are fixed to the hub 125 and the closure plate 123 to provide local area reinforcing for the plate member and the hub.

The outer casing 19 comprises an outer cylindrical shell 133 in which there is a circular opening 135, and there may be connected to the circular opening 135, in any suitable manner, a fluid discharge conduit 137, as shown in FIG. 3. The inside diameter of the cylindrical shell 133 is slightly larger than the outside diameter of the intermediary flange 29, and the peripheral ends of the shell are suitably formed to abut and seal against the O-rings 33 and 139 when clamped in place by the lock ring 21.

The ring 21 has a plurality of holes which match the size and spacing arrangement of the stud bolts 35, mentioned hereinbefore.

The pump unit of FIG. 1 may be readily and easily assembled in the following manner: First, the clapper valves 47, 49 are pivotally and resiliently mounted on the shell 23, and then the stator 13 is inserted in the right hand end (as viewed in FIGS. 1 and 2) of the shell. Of course,

the paddle 87 and the shoe 81 and its adjusting apparatus will have been previously installed therein, in the positions shown and as described hereinbefore. The plate 73 may then be secured to the flange 25 with a plurality of bolts 143. A suitable gasket 145 may be disposed between the faying surfaces of the plate and flanges. Second, the rotor 15, which has been previously assembled as shown and described hereinbefore, may be inserted into the other end of the main housing structure. It is necessary to make sure that the ball 121 is properly seated in the cupped end of the plunger 119, in the hemispherical recess 71 and in the semicircular recess 99. The paddle 87 will, of course, be disposed with its extremities in the longitudinal slots 37, 39. The end closure 17 may then be installed on the drive shaft 115, and the plate member 123 may be secured to the flange 27 by means of bolts 143 mentioned previously. So, too, a similar gasket 145 may be installed between the faying surfaces of the plate 123 and flange 27. Next, the outer casing 19 may be installed around the main housing structure 11. This is readily accomplished by inserting the stud bolts 35 through respective holes in the locking ring, and installing and tightening nuts 147 on the stud bolts 35, to draw the locking ring into sealing relation with the O-ring 139. It may be mentioned that the fluid inlet conduit 65 is located in a fixed position with respect to the main housing structure. However, the fluid outlet conduit 137 may be oriented in any desirable manner with respect to the fluid inlet conduit 65. The orientation of the fluid outlet conduit 137, which is shown in FIG. 3, is merely typical and is not necessarily determinative.

To understand the operation of the pump, reference may be made to FIGS. 2 and 3. A suitable prime mover may be operatively connected to the drive shaft 115, and the rotor 15 may be rotated in the direction of the arrow A (see FIG. 4). Now, as the rotor turns about the horizontal axis of the shaft 115, the paddle 87 will be maintained in continuous linear contact with the sloping face of the ungulate portion of the rotor by means of the spring 79 and the feed shoe 81. There is also another continuous fluid seal along the line of tangency between the conical surface, which is fixed, and the oblique planar surface of the rotor 15. This sealing line, of course, rotates with the rotor. It should be noted also, that as the rotor turns, the paddle 87 oscillates about the ball 121, and in the plane of the slots 37, 39 and 75.

It will be convenient now to describe the action of the pump during one cycle, assuming that a cycle commences from the position shown in the drawing. It may be assumed also, that both the fluid inlet conduit 65 and the interior of the rotor 15 are filled with the fluid being pumped. Then, as the rotor 15 turns counterclockwise (as viewed in FIG. 3), the fluid inlet port 104 moves past the paddle 87, and the fan blades 109, because of their axial orientation, urge fluid through the port 104. Fluid flows into a first cavity on the right side of the paddle 87 (as viewed in FIG. 3), which is defined by the paddle, the rotating sealing line along the conical surface 69, and the wall of the housing structure.

As the port 104 passes the top of the paddle 87, a similar second cavity is formed on the left side (as viewed in FIG. 3) of the paddle 87, and this cavity commences to fill via the inlet port 104. By the time the rotary element has made one complete revolution, the two cavities are filled with fluid and discharged. The fluid in the first mentioned cavity, on the right side of the paddle 87, is urged therefrom via the discharge port 41 and valve 47, because as the rotor turns, this cavity becomes smaller. So, too, when the rotating seal passes the upper end of the paddle 87, the second mentioned cavity becomes smaller and the fluid therein is forced out via the discharge port 43 and valve 49. It will be evident then that in a revolution of the rotary element, or what is equivalent to a piston in other type of pumps, fluid is admitted

twice and expelled twice. That is to say, the pump of the present invention is double acting.

While only one embodiment of the invention is shown and described herein, it is obvious that changes may be made in the arrangement and construction of parts without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. A rotary pump comprising, in combination:
 - (a) a cylindrical housing;
 - (b) a stator fixed relative to one end of said housing and having a conical portion axially disposed within said housing, said conical portion having therein a transverse, semicircular diametral slot;
 - (c) a hollow rotor axially disposed within said housing and having an oblique planar end surface which is in tangential contact with a lineal element of said conical surface, said rotor having a fluid port in said end surface;
 - (d) a semicircular paddle disposed in said slot and pivotable about the axis of said housing;
 - (e) means for maintaining the edge of said paddle in linear contact with said oblique planar surface;
 - (f) a fluid inlet port in said housing for admitting fluid to said rotor; and
 - (g) two discharge valves mounted on said housing.
2. The combination defined in claim 1 in which fan blades are connected to said rotor to assist movement of fluid through the pump.
3. The combination defined in claim 1 in which the valves are clapper valves.
4. The combination defined in claim 1 in which the valves are diametrically disposed with respect to said housing.
5. The combination defined in claim 1 in which the port in said rotor is located near the point of maximum thickness thereof.
6. The combination defined in claim 1 in which the port in said rotor is located near the point of maximum thickness thereof and is of an area nearly one-fourth of the area of said oblique planar surface.
7. The combination defined in claim 1 in which there is provided an outer housing enclosing a portion of said cylindrical housing, fluid outlet conduit attached to said outer housing and having fluid-permeable connection with said discharge valves and said discharge valves are trapezoidal in shape and employed in conjunction with discharge ports that are trapezoidal in shape.
8. The combination defined in claim 1 in which the paddle is held in engagement with the flat inner surface of the ungulate member by a feed shoe and spring.

9. The combination defined in claim 1 in which a ball is mounted at the apex of the inner conical end of said stator to stabilize the ungulate member when it rotates.

10. The combination defined in claim 1 in which a ball is mounted at the apex of the inner conical end of said stator to serve as the point about which the paddle oscillates in the slot in the conical end.

11. A rotary pump including, in combination, a cylindrical housing, a hollow, ungulate member having a flat inner surface provided with an inlet port mounted for rotation in said housing, a stator fixed in said housing and having an inner conical end adapted to cooperate with the flat inner surface of said ungulate member, said inner conical end having a transverse slot, and a paddle mounted for oscillation in said slot and having an edge in engagement with the flat inner surface of said ungulate member, fan blades connected to said ungulate member to rotate with it and assist movement of the material being pumped to pass through the port in the flat inner surface of said ungulate member.

12. A rotary pump including, in combination, a cylindrical housing, a hollow, ungulate member having a flat inner surface provided with an inlet port mounted for rotation in said housing, a stator fixed in said housing and having an inner conical end adapted to cooperate with the flat inner surface of said ungulate member, said inner conical end having a transverse slot, and a paddle mounted for oscillation in said slot and having an edge in engagement with the flat inner surface of said ungulate member, said cylindrical housing having two discharge ports, each of which is provided with a clapper valve.

13. The combination defined in claim 12 in which the inlet port in the inner surface of said ungulate member is adjacent the point where the ungulate member has the greatest thickness.

14. The combination defined in claim 12 in which the inlet port in the inner surface of said ungulate member has an area of about one-fourth the area of the inner surface of said member.

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