Oct. 7, 1941. H. LEOPOLD ET AL 2,258,416

ROTARY PUMP

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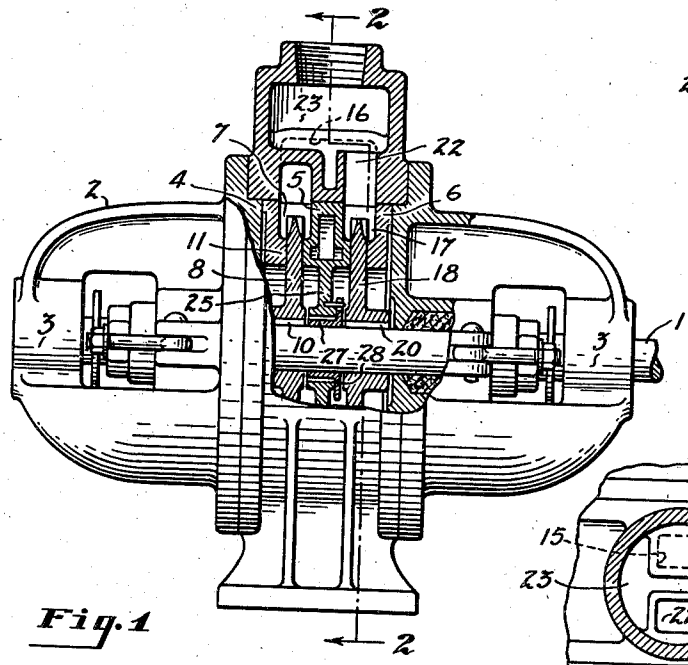


Fig. 1

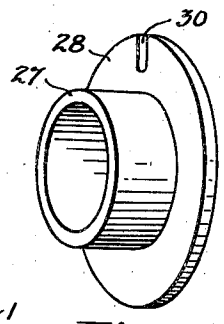


Fig. 3

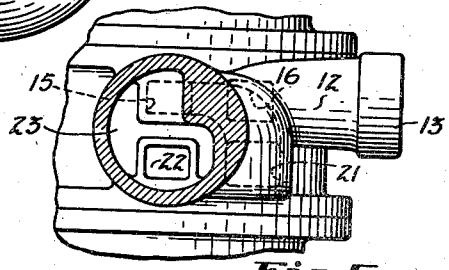


Fig. 5

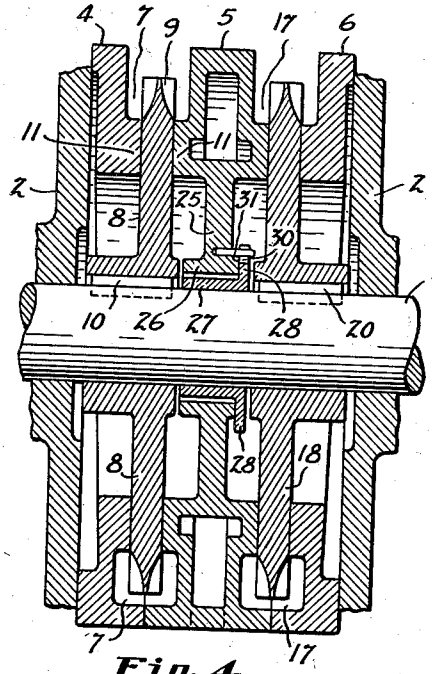


Fig. 4

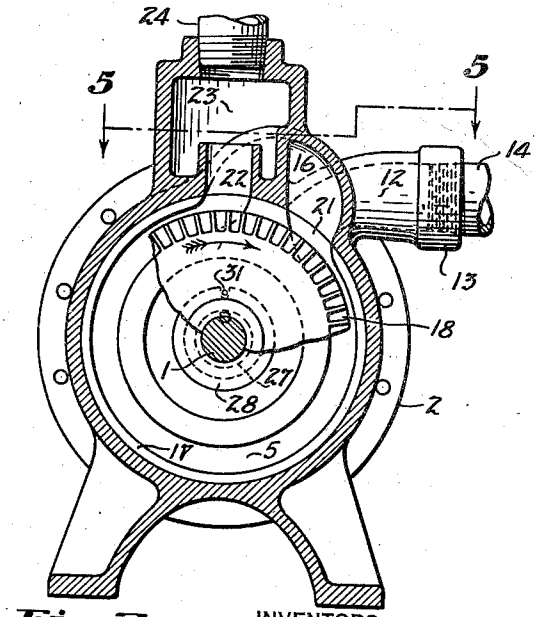


Fig. 2

INVENTORS
HUGO LEOPOLD
CHARLES V. COPELAND
BY Evans & Meloy
ATTORNEYS

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ROTARY PUMP

Hugo Leopold and Charles V. Copeland, Davenport, Iowa, assignors to Micro-Westco, Inc., Bettendorf, Iowa, a corporation of Delaware

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3 Claims. (Cl. 103—108)

This invention relates to improvements in rotary pumps, and in particular to an improved construction for a rotary, multi-stage, turbine-type pump.

A distinguishing feature of the turbine-type pump is that its pressure developing passage is disposed in an annular path and the inlet and outlet to the passage are usually adjacent each other, opening radially outwardly from the pressure developing passage, and are separated by a stop, which briefly is a portion of the passage closely fitting the impeller throughout the region between the inlet and the outlet. An inherent characteristic of such a pump is that the fluid pressure progressively increases as the fluid travels circumferentially through the annular passage from the inlet to the outlet. The increased fluid pressure in certain portions of the annular passage reacts on the impeller and causes the impeller shaft to deflect. This deflection does not cause the shaft to travel in an orbital path, but rather causes the shaft to assume a curved position with the bottom of the curve remaining in that position as the shaft rotates. This deflection is especially found in a multistage pump where the fluid pressure acts upon the impeller shaft at several locations and also where the supporting journals of the shaft are spaced farther apart due to the plurality of stages. In a multistage pump deflection of the shaft renders the sealing of adjacent stages one from the other very difficult. If a bushing is used which closely fits both the impeller shaft and the portion of the casing separating the stages, shaft deflection causes rapid wear, either of the shaft or the casing portion, and in a short time fluid may seep or leak past the bushing from one stage to another. Of course this materially reduces the efficiency and economy of the pump as well as diminishes the pressure which may be obtained.

It is, therefore, an object of the present invention to provide a sealing means for rotary pumps of the turbine-type, and particularly multistage rotary pumps, which will obviate the difficulty of sealing the shaft which is subject to deflection without resorting to a heavy shaft which will not deflect and to the use of large bearings for the heavy shaft, etc.

Another object is to provide a seal which is simple in design and construction and inexpensive to manufacture, and which will not diminish in efficiency with long and hard usage.

Another difficulty experienced in turbine-type pumps is that the impeller, although properly dimensioned and positioned to run true between the sides of the casing adjacent the pressure developing passage, may bind with such sides under operating conditions. Any binding of course increases the wear of the impeller or the casing and slows down the impeller, resulting in loss of power and increase in operating cost. Binding of the impeller shaft may be caused by the above mentioned shaft deflection.

It is, therefore, another object of the present invention to provide a shaft with impellers mounted thereon in which the impellers are permitted to move longitudinally to adjust themselves to operating conditions and thus obviate the binding effect.

Other objects and advantages of the present invention will become apparent from the following detailed description accompanied by the drawing, in which like parts throughout the several views are indicated by the same reference numerals.

In the drawing:

Figure 1 is an elevational view of a multistage, rotary, turbine-type pump embodying the present invention, with parts broken away to illustrate the impeller shaft and sealing means to seal adjacent stages;

Fig. 2 is an end elevational view, taken substantially on the line 2—2 of Fig. 1, with parts broken away and partially in section to show details of the interior of the pump;

Fig. 3 is an enlarged view in perspective of a suitable sealing means which may be used to seal adjacent stages of the pump shown in Fig. 1;

Fig. 4 is an enlarged, fragmentary, sectional view of a portion of the pump shown in Fig. 1 illustrating the impellers of adjacent stages and the sealing means between the stages; and

Fig. 5 is an enlarged, fragmentary plan view, partially in section, taken substantially on line 5—5 of Fig. 2 illustrating the inlet and outlet arrangement of the pump and the interconnection of the stages.

In Fig. 1, numeral 1 indicates an impeller shaft journalled in a casing 2 at the locations indicated by numerals 3 and connected to a suitable source of power (not shown), such as an electric motor. Mounted in the casing concentrically of the shaft is a plurality of ring members 4, 5 and 6. The rings 4 and 5 are provided with channels or grooves at the surfaces of the rings which face each other, which channels cooperatively form an annular pressure developing passage 7.

Mounted on the shaft and having a radially extending portion is an impeller 8 which is disposed between the rings 4 and 5 and is provided

with marginal buckets 9, which are adapted to move through the pressure developing passage 7. The impeller 8 is mounted for axial movement along the shaft but is caused to rotate with the shaft by means of a key 10. Radially inwardly of the pressure developing passage the rings 4 and 5 are provided with annular sealing portions 11 which engage the sides of the impeller with a running fit to minimize leakage of fluid from the pressure developing passage.

An inlet passage 12 to the pressure developing passage 7 is indicated in Figs. 2 and 5. Fig. 2 shows that the passage 12 terminates in an internally threaded portion 13 which is adapted to be secured to a tubing or pipe 14 which communicates with a suitable source of fluid supply (not shown). An outlet 15 of the passage 7 communicates with a substantially U-shaped passageway 16 which is in communication with the outlet 15 and also with the inlet of the adjacent stage.

In the adjacent stage the surface of the rings 5 and 6 which face each other are curved or channeled to provide a pressure developing passage 17 which is similar to the passage 7. Mounted on the shaft 1 is an impeller 18, which has a radially extending portion terminating in marginal buckets which are adapted to travel through the pressure developing passage 17. The impeller 18 is also mounted for axial movement longitudinally of the shaft and receives its rotative force through a key 20.

The rings 5 and 6 are provided with the sealing portions 11 disposed radially inwardly of the pressure developing passage 17 to seal the passage in the same way that the pressure developing passage 7 is sealed. An inlet 21 to the passage 17 is in communication with the passageway 16 leading from the outlet 15 of the pressure developing passage 7. An outlet 22 for the passage 17 is provided through the casing 2 and leads to a separating chamber 23, to which is connected a suitable discharge pipe 24.

As shown in the drawing, the pressure developing passage 7 receives the fluid to be pumped and after the fluid pressure of the fluid being pumped is increased by traveling through the passage 7, it is conducted through the passageway 16 to the pressure developing passage 17, where its fluid pressure is further increased before the fluid is discharged through the outlet 22 to the separating chamber 23 and the discharge pipe 24.

For the sake of brevity and simplicity, the pressure developing passage 7 and its associate parts will be called the low pressure stage, while the pressure developing passage 17 and its associate parts will be called the high pressure stage.

To provide a seal around the shaft 1 between the high pressure stage and the low pressure stage and thus minimize the passage of fluid which has leaked radially inwardly from the pressure developing passage 17 past the sealing portions 11 of the rings 5 and 6, the sealing means illustrated in Fig. 3 may be used. To aid in sealing the above mentioned fluid the ring 5 has an inwardly extending web 25 which terminates in a hub portion 26. The hub 26 encircles the shaft 1 but is spaced therefrom, as indicated in Figs. 1 and 4. The sealing means of Fig. 3 has a collar portion 27 which embraces the shaft 1 between the shaft and the hub 26 of the ring 5 with a running fit. The end of the collar 27 toward the high pressure stage is provided with a radially extending flange portion 28 which extends radially outwardly between the impeller 18 and the hub 26. The collar member 27 is adapted to move freely axially along the shaft in response to fluid pressure so that a face of the flange portion 28 may bear against and have sealing engagement with the face of the hub 26 disposed toward the high pressure stage.

To prevent rotational movement of the collar member 27 and the flange 28 with respect to the hub 26, without interfering with the axial movement of the collar 27, a radially extending slot is formed in the flange 28. Secured to the ring 5 in the region of the hub 26 and extending to the slot 30 is a pin 31, which cooperates with the slot 30 to prevent rotational movement of the flange but allows free axial movement of the flange and also free radial movement thereof. In this manner the sealing engagement between the flange 28 and the hub 26 can be maintained throughout movement of the shaft 1 and the collar 27.

Thus it may be seen that the present invention provides a multistage, turbine-type rotary pump in which the impellers may adjust themselves to operating conditions so as to avoid any binding effect with the sides of the pressure developing passage through which the impeller is rotating. This minimizes friction loss due to the impeller movement and increases the life of the impeller and the ring members. It also permits an increase in the efficeincy of the pump without a material increase in the cost of manufacture.

The sealing means found in the pump is very advantageous in that it minimizes leakage between the high and low pressure stages. An effective seal is obtained even though the impeller shaft deflects due to the operating pressure of the pump, and any fluid which has leaked radially inward past the sealing portions 11 in the high pressure stage cannot pass around the shaft to the low pressure stage. This enables the fluid pressure differential between the high and low pressure stages to be maintained substantially constant.

It is to be understood that variations and modifications from the specific devices herein shown and described for purposes of illustration and explanation may be made without departing from the spirit of our invention.

What we claim is:

1. In a multistage rotary pump a casing, a plurality of pressure developing passages in series to develop increasingly greater fluid pressures, a shaft journaled in the casing, an impeller mounted on the shaft for each pressure developing passage, dividing means between adjacent passages extending toward said shaft and terminating in an annular portion spaced from but adjacent the shaft, and sealing means to seal a passage in which a higher fluid pressure is developed from an adjacent passage in which a lower fluid pressure is developed, said sealing means including a collar embracing the shaft with a running fit, a flange member extending radially from the shaft and having sealing engagement with the side of said annular portion which faces the higher pressure passage, said sealing means being mounted for free axial movement along said shaft, and means extending between said annular portion and said sealing means which prohibits rotational movement of said sealing means relative to said annular portion without interfering with the axial movement of said sealing means, whereby said sealing means moves in response to fluid pressure.

2. In a multistage turbine-type rotary pump

a casing, a shaft journaled in said casing, a plurality of pressure developing passages, impellers for said passages mounted on said shaft for longitudinal movement therealong in response to fluid pressure forces, and a sealing means between adjacent pressure developing passages, said sealing means including a collar member embracing the shaft with a running fit, a radial flange disposed in the stage in which a higher fluid pressure is developed, said collar member adapted to move axially along the shaft in response to fluid pressure and bring said flange into sealing engagement with a member separating adjacent pressure developing passages, and a member between said sealing portions to prevent rotational movement of said collar member without interfering with axial movement thereof, said sealing means being capable of orbital movement with the shaft without interfering with said sealing engagement.

3. In a multistage rotary turbine-type pump a casing, an impeller shaft journaled in said casing, a plurality of annular pressure developing passages disposed in series in the casing to develop increasingly greater pressures, wall members between adjacent passages extending toward the shaft but terminating in an annular portion spaced from the shaft, a sealing member mounted on said shaft to allow axial movement therealong and to allow rotational movement of the shaft with respect to the sealing member, a radial flange carried by the sealing member for sealing engagement with the annular portion of the wall member on the side of the wall member nearest the passage which develops the higher pressure of the two adjacent passages, a radial slot in the radial flange of the sealing member, and a pin carried by the wall member and extending through said slot, whereby the sealing member although held against rotational movement with respect to the wall member may move freely in an axial direction along the shaft in response to fluid pressure.

HUGO LEOPOLD.
CHARLES V. COPELAND.