July 3, 1956 E. B. OFFUTT 2,752,852

VARIABLE DISPLACEMENT PUMP

Filed Sept. 29, 1954 2 Sheets-Sheet 1

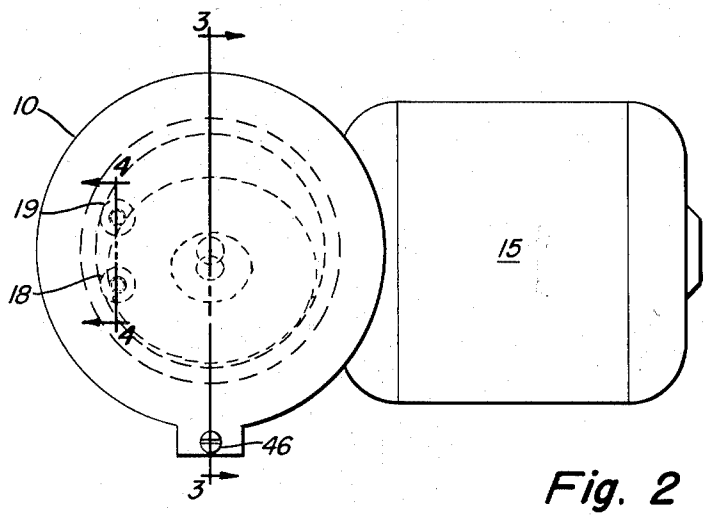


Fig. 2

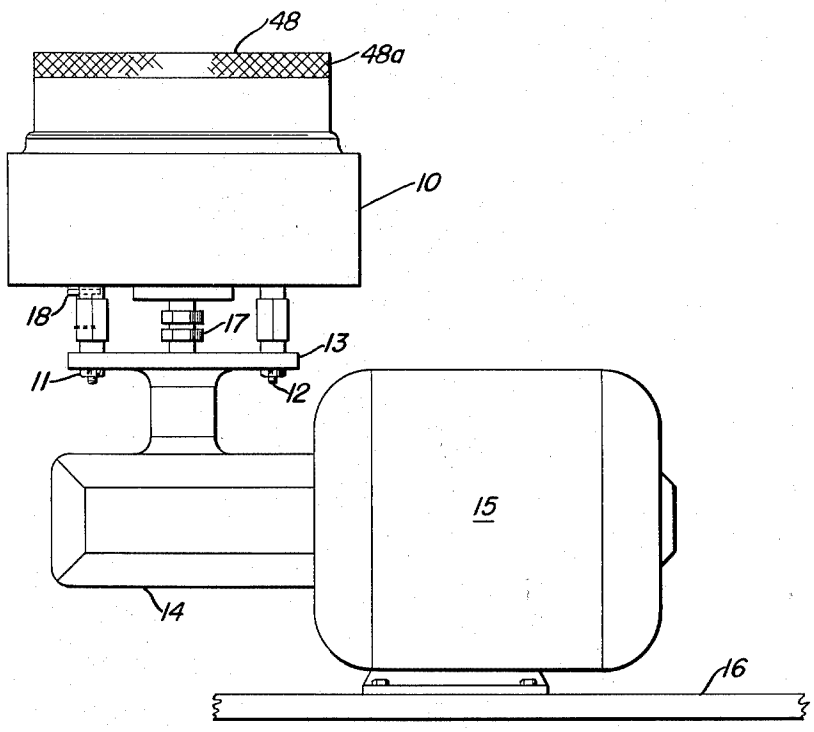


Fig. 1

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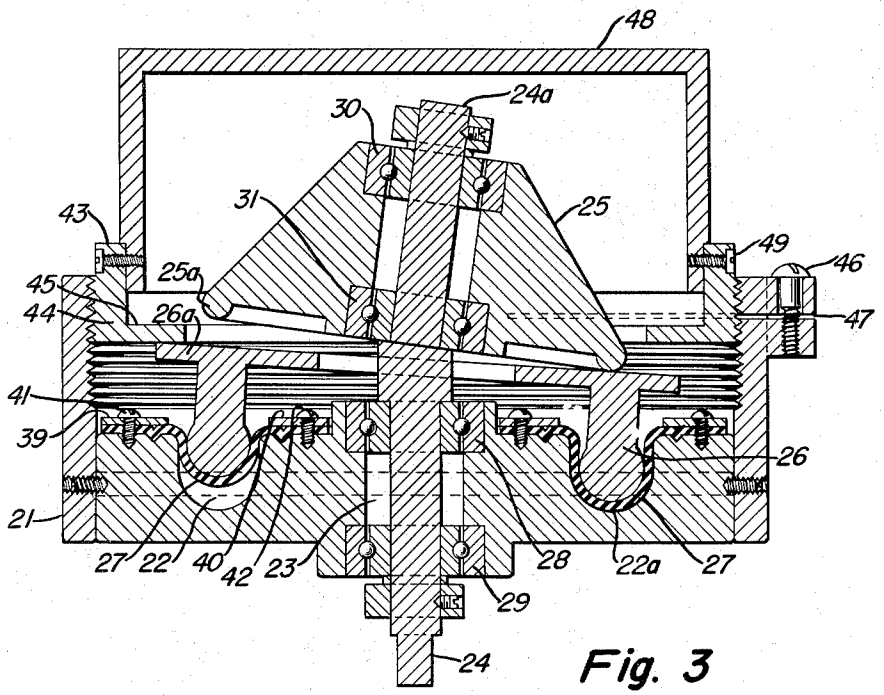


Fig. 3

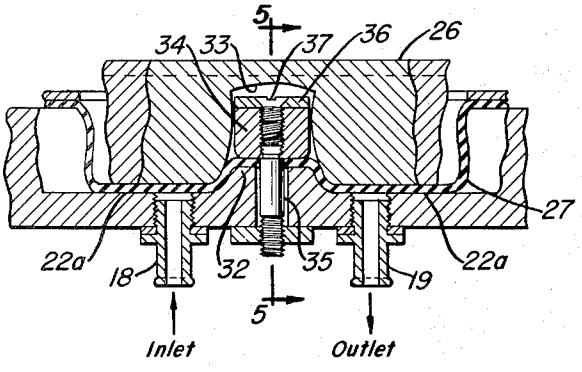


Fig. 4

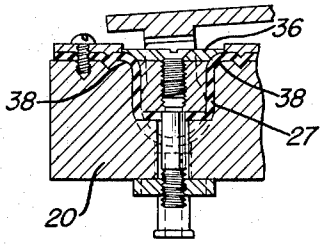


Fig. 5

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VARIABLE DISPLACEMENT PUMP

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Application September 29, 1954, Serial No. 459,099

5 Claims. (Cl. 103—37)

This invention relates to pumps, and particularly to pumps of the type wherein a flexible walled chamber carries the fluid being transferred.

Pumps employing flexible tubes have been proposed heretofore, and in the previously known forms of such pumps a flexible tube is progressively squeezed by a revolving roller or cam from an intake end to an outlet end to cause movement of the fluid therethrough. Several disadvantages of such pumps have been observed, one prime difficulty being that the displacement of the pump is not readily variable. Another difficulty is the fact that strains and abrasion prevent long operation of the pumps heretofore proposed.

It is, therefore, an object of the present invention to provide a commercially practicable pump which is capable of operating for long periods of time. A further object of the invention is to provide a pump of this type which has a variable displacement. An additional object is to provide a positive displacement pump which is adapted for continuous duty and wherein the output of which can be adjusted without interrupting the operation of the pump. Still another object is to provide a pump of this type which will withstand the effects of a corrosive fluid and which has a long operating life. These and other objects of the invention will appear hereinafter as the description of my invention proceeds.

Briefly, my invention comprises a small positive displacement pump including a flexible diaphragm operating in a channel within a pump body and having means for varying the output from nearly zero to a maximum value without stopping the pump. The pump contains no valves in the usual sense and may be used to pump fluid such as muddy water or dirty oils. A non-linear or bent shaft is rotated by a synchronous motor and propels a conical idler in a circular orbit, a lower peripheral edge of the idler contacting a floating ring adapted to depress the diaphragm progressively within the fluid-containing groove or channel in the pump body.

A flexible diaphragm is located between two opposed working surfaces having relative movement adapted to depress the diaphragm progressively along the length of the open-ended, annular groove or channel. Means are provided to adjust the extent to which the diaphragm deflector ring can withdraw from the channel, thereby providing for adjustment of the pump displacement. The deflector ring is mounted on shaft and caused to gyrate about a given center point and, as the ring gyrates about the center of gyration, it moves toward and away from the floor of the groove in a direction, substantially perpendicular to the plane of the channel floor. As the gyration of the deflector ring proceeds, a motion is produced and repeated which alternately depresses and withdraws the flexible diaphragm from the pump groove and advances the fluid through the groove progressively along its length from the inlet to the outlet therein.

Further details of construction and advantages of my pump will be described in connection with a preferred embodiment of the invention illustrated in the accompanying drawings wherein:

Figure 1 is an elevation of a pump and drive therefor embodying the invention;

Figure 2 is a plan view of the apparatus in Figure 1;

Figure 3 is a vertical section viewed along the line 3—3 in Figure 2;

Figure 4 is a section taken along the line 4—4 in Figure 2; and

Figure 5 is a section taken along the line 5—5 in Figure 4.

In Figures 1 and 2, the pump 10 is mounted by stud bolts 11 and 12 to the mounting plate 13 carried by the speed reducer gear boss 14. This speed reducer 14 is driven by a motor 15 which may be about ¼ H. P. and screwed to base plate 16. A shaft coupling 17 completes the assembly. In Figure 1, I have also shown the pump inlet and outlet ports 18 and 19 which will be described in more detail below.

The pump body 20 is surrounded by a pump housing 21 and is provided with a groove or channel 22 which is concentric with the bore 23 in the pump body 20 through which the drive shaft 24 is rotated. The shaft 24 is rotated by the synchronous electric motor 15, its upper end swinging in a circular orbit causing the conical idler 25 to swing in a similar orbit with its lower peripheral edge contacting and depressing the diaphragm deflector ring 26 which in turn presses the flexible rubber diaphragm 27 into the circular groove 22 of the pump body 20. The shaft 24 rotates in ball bearings 28 and 29 in the pump body 20 and in ball bearings 30 and 31 in the conical idler 25. The idler 25 itself does not rotate appreciably but swings in its circular orbit, the shaft 24 rotating in the ball bearings. Thus, the idler 25 merely serves to convey the "cranking" action of the bent portion 24*a* of the shaft 24 to the deflector ring 26 which moves diaphragm 27 up and down in piston fashion, the up-and-down movement travelling around the groove 22 in a undulating or wave-like pattern.

The diaphragm 27 is pressed into the circular groove 22 and actually contacts the bottom or floor 22*a* of the groove 22 over a relatively small area at any given point in its gyration; this area of contact travels around the groove 22 as the shaft 24 rotates thereby causing the fluid entering the groove 22 through the inlet port 18 to be pushed around the groove 22 and out through the outlet port 19 at the other end of the groove 22.

As shown in Figure 4, the inlet port 18 and outlet port 19 are separated by a barrier 32. This barrier 32 consists of a piece of metal shaped to fit into the groove 22 over the region of the diaphragm 27 between the ports 18 and 19. The deflector ring 26 is provided with a notch 33 which is adapted to receive the barrier 32 so that the deflector ring 26 may depress the diaphragm 27 immediately above the inlet port 18 and the outlet port 19. The barrier 32 stretches the diaphragm 27 down and holds it against the side and bottom 22*a* of the groove 22 thereby preventing pump fluid from passing directly between the inlet port 18 and outlet port 19. Once during each pumping cycle the diaphragm 27 closes both the inlet port 18 and outlet port 19 simultaneously to prevent "back slippage" of the pump fluid as the deflector ring 26 bridges and passes over the barrier 32.

Figures 4 and 5 show sectional views through the region of pure amber gum rubber, thiokol or other durable and the barrier 32 comprises two pieces, the lower piece 34 is held in the groove 22 by a screw 35 through the bottom of the pump body 20, and the upper section 36 is held to the top of the lower section 34 by a screw 37. The lower section 34 holds the diaphragm 27 against the sides and bottom 22*a* of the groove 22, whereas the upper section

36 holds the diaphragm 27 against the rounded corners 38 at the top edge of the groove 22 as shown in Figure 5.

With reference to the diaphragm 27, it may be made of pure amber gum rubber, Thiokol or other durable and elastic material. In any event, the diaphragm 27 comprises a continuous annular sheet of some such material and it is disposed over the groove 22 and held by means of an outside seal ring 39 and inside seal ring 40, these rings being fixed by screws 41 and 42 to the pump body 20 as shown in Figure 3.

The throughput of the pump 10 is controlled by the degree of displacement of the diaphragm 27 since the speed of rotation of the idler 25 is constant. Such pump displacement is determined by the position of the deflector ring 26 and, more particularly, by limiting the distance that the deflector ring 26 can rise when urged upward by the elastic force of the diaphragm 27; this is done by providing the adjustable stop ring 43 which is threaded into the housing 21. In a typical pump, it may be operating at about 20 cycles a minute with an output adjusted at about 100 ml. of fluid per minute.

It will be noted from Figure 3 that the idler 25 contacts the upper face of the deflector ring 26 at only one point in the circumference and that the deflector ring 26 is constantly urged upward by the elastic force of the diaphragm 27 until the outer edge of the deflector ring 26 is brought into contact with the stop ring 43. This places the deflector ring 26 in a gyrating plane oblique to the plane of the groove 22.

The stop ring 43 includes a threaded sleeve portion 44 and an annular flange 45 the underside of which contacts the top edge of the deflector ring 26. The displacement or stop ring 43 position may be altered by loosening clamp screw 46 and turning the stop ring 43 within the threaded portion of the housing 21 to bring the flange 45 into the desired position. A cover 48 is fixed to the stop ring 43, for example by means of screws 49, and is provided with a knurled outer edge 48*a* for ease in turning the stop ring 43 to adjust the displacement of the pump 10.

As will be apparent, turning the stop ring 43 down limits the extent to which the diaphragm 27 may retract from the groove 22 and thereby decreases the pump displacement, and raising the stop ring 43 increases the displacement. The housing 21 is provided with a horizontal slot 47 such that tightening clamp screw 46 distorts the threads inside the housing 21 thereby "jamming" against the threads around the outside of the stop ring 43 to prevent unintentional turning of the stop ring 43.

The adjustment of the displacement of the pump 10 may be made while it is in operation by following the above procedure and the output thereby becomes continuously adjustable from essentially zero to the maximum which is limted only by the ability of the diaphragm 27 to raise the deflector ring 26.

As the pumping action proceeds, the upper end of the drive shaft 24 and the upper end of the idler 25 travel in a circular orbit above the bed of the groove 22 in the pump body 20. A progressive segment of the lower edge 25*a* of the idler 25 gyrates in a plane substantially parallel to the bed of the groove 22. The edge 26*a* of the deflector ring 26 is in rolling contact with the lower face of the flange 45 on stop ring 43 allowing the diaphragm 27 to rise the allowable distance above the bed of the groove 22. At the same time, the idler 25 is contacting the deflector ring 26 at a diametrically opposed point to push the diaphragm 27 to the bottom of the groove 22. At intermediate points, the diaphragm 27 is being allowed to move out of the groove 22, and at others the diaphragm 27 is being moved into the groove 22. It will be understood that each portion of the diaphragm 27 progressively passes through these phases of depression and withdrawal.

It will be understood that various substitutions of materials of construction can be made in my pump without departing from the invention. However, I have found that for use on gasiform stream containing hydrogen sulfide a satisfactory pump may be provided by use of a pump body 20 made of aluminum, Bakelite, or the like with a flexible diaphragm 27 composed of pure amber gum rubber sheeting. The diaphragm deflector ring 26 may be made of aluminum and the housing 21 of brass. The conical idler 25 and the shaft 24 are suitably fabricated of steel and the deflector ring stop 43 of brass. The motor 15 may be about ¼ H. P. and mounted on a base plate 16.

It is contemplated that the deflector ring 26 may comprise a multiplicity of individually movable plungers, spring-loaded and held in an annular array by a suitable race. In this way, the upper ends of such plungers are exposed and are contacted by the idler 25, in the same manner as described in connection with the solid-type deflector ring 26. As the idler 25 gyrates, it moves the plungers downwardly toward the flexible diaphragm 27 and forces it into the groove 22. As each plunger recedes from the diaphragm 27 it rises until it comes in contact with the stop ring 43. Accordingly the upward displacement of the individual plungers is controlled by the position of the stop ring 43 (which is adjusted as described above in conneciton with the upward displacement of the deflector ring 26) and the throughput of the pump can be controlled continuously between zero and the maximum.

Although I have described my invention with reference to a preferred embodiment thereof, it should be understood that this is by way of illustration only. In any event, other modifications and techniques will become apparent to those skilled in the art and can be made without departing from the spirit and scope of the invention.

What I claim is:

1. A pump comprising in combination a pair of opposed surfaces, one of said surfaces being mounted for gyratory movement relative to the other, an annular groove in one of said surfaces, an elastic diaphragm across said annular groove, a barrier across said groove depressing a portion of said diaphragm into said groove whereby an open circular loop is provided, an inlet port on one side of said barrier and an outlet port on the other side of said barrier, said ports both being in the bed of said groove, one of said opposed surfaces comprising a diaphragm deflector ring adapted to enter said groove, said deflector ring normally contacting said diaphragm, a drive shaft extending through said pump body and concentric with said groove, a minor terminal portion of said shaft being non-axial with respect to the axis of the major portion thereof, an idler freely rotatable on said terminal portion, said idler contacting said deflector ring, and a deflector ring stop means arranged concentric of said shaft and said groove, said idler, stop ring and elastic diaphragm co-acting to drive said deflector ring in a gyratory motion through said groove whereby said diaphragm is progressively depressed into and withdrawn from said groove in a continuous and repeated manner to displace fluid from said inlet port to said outlet port.

2. A pump comprising in combination a pump body, an annular groove in said body, a transverse barrier dividing said groove into an open loop, an elastic diaphragm means disposed across said groove and under said barrier, an inlet port adjacent one side of said barrier under said diaphragm, an outlet port adjacent the other side of said barrier under said diaphragm, a diaphragm deflector ring disposed above said diaphragm and groove and adapted to be depressed into said groove, a gyratory idler means in contact with said deflector ring on a minor area thereof, a deflector ring stop means adjustably disposed about said idler and over said deflector ring, said stop means limiting the displacement of said deflector ring from said groove by said elastic diaphragm, whereby gyration of said idler means progressively and continuously depresses a portion of said deflector ring into said groove to pump fluid along said groove beneath said diaphragm from said inlet to said outlet.

3. A pump comprising in combination a pair of opposed elements, the first of said elements being mounted for gyratory movement relative to the other, an annular groove in the second of said elements comprising an open circular loop, an inlet port at one end of said loop and an outlet port at the other end of said loop, said ports both being in the bed of said groove, an elastic diaphragm covering said annular groove, a diaphragm deflector means between said first and second elements, a drive shaft extending through said second element and concentric with said groove, a bend in said shaft providing a non-axial terminal portion, an idler comprising the said first of said opposed elements and being freely rotatable on said terminal portion, said idler depressing said deflector means into said groove, and deflector stop means arranged concentric of said shaft and said groove, said deflector means travelling in a wave-like motion through said groove whereby said diaphragm is progressively depressed into and withdrawn from said groove in a continuous and repeated manner.

4. A pump comprising in combination a pump body, a groove in said body, an elastic diaphragm means disposed across said groove, an inlet port adjacent one end of said

groove under said diaphragm, an outlet port adjacent the other end of said groove under said diaphragm, a diaphragm deflector means disposed above said diaphragm and adapted to be depressed into said groove, eccentric shaft means for gyrating said deflector means, said shaft means including an idler means in contact with said deflector means and adapted to depress portions of said deflector means progressively in said groove, and deflector stop means adjustably disposed above said deflector means, said stop means limiting the travel of said deflector means when urged from said groove by said elastic diaphragm.

5. The pump of claim 4 wherein said deflector stop means comprises a ring member threaded into said body concentric of said groove and an annular flange carried by said member, the underside of said flange contacting the upper side of said diaphragm deflector means, and a cover for said pump fixed to said ring member, whereby turning the cover rotates the deflector stop means to adjust the displacement of the pump.

References Cited in the file of this patent

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