Feb. 10, 1942. W. L. DAVIS 2,272,635

BALANCED ROTARY PUMP

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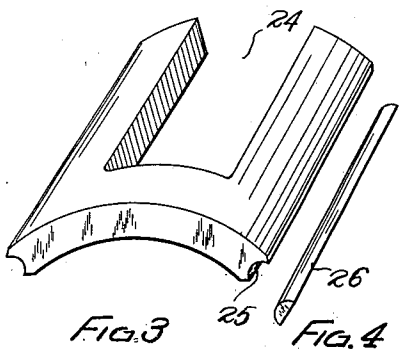


FIG. 3 FIG. 4

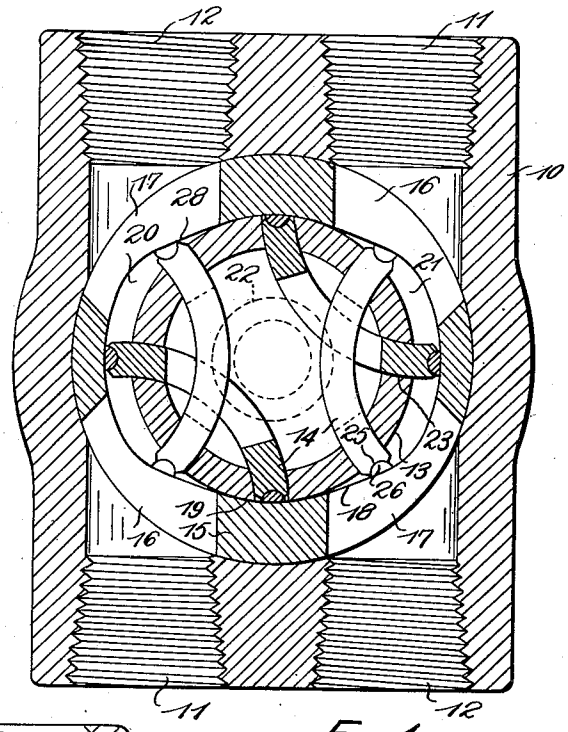


FIG. 1

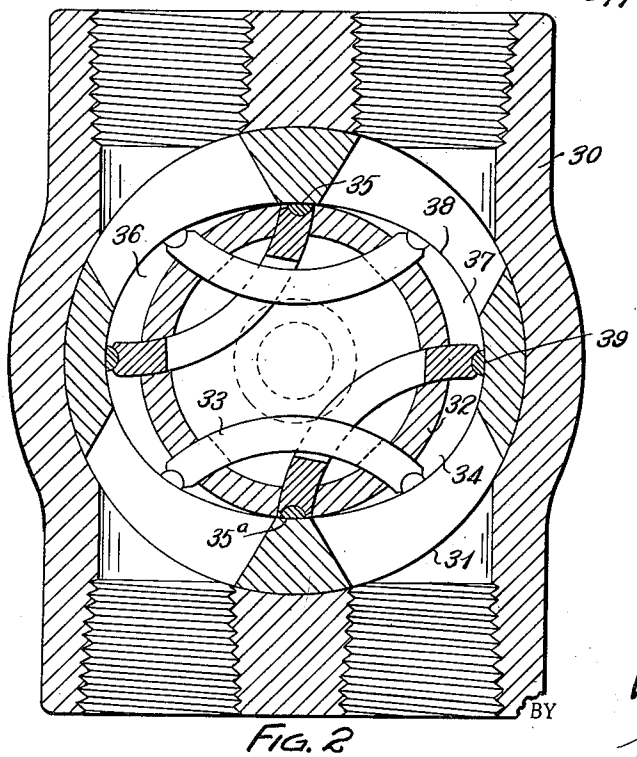


FIG. 2

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BALANCED ROTARY PUMP

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2 Claims. (Cl. 103—135)

This invention relates to rotary pumps of the type having vanes which extend through the piston, and as its principal object, aims to provide an improved rotary pump of this type in which the cylinder is of non-circular contour and the vanes are of curved or arcuate shape and cooperate therewith in a manner to produce a smooth and efficient pumping operation.

Another object of my invention is to provide an improved rotary pump having a cylinder of non-circular but symmetrical contour, and a piston rotatable in the cylinder so as to divide the same into working chambers of substantially equal volume and having curved slidable vanes whose opposite edges are continuously in engagement with the non-circular contour of the cylinder and cooperate therewith to produce a smooth and efficient pumping action in which the loads on the piston are in opposed substantially balanced relation.

Still another object of my invention is to provide an improved rotary pump, of the type mentioned, in which the non-circular contour of the cylinder is of such shape that the fluid delivery of the pump will be a substantially constant-velocity of non-pulsating flow.

A further object of my invention is to provide an improved rotary pump, of the type mentioned, in which the non-circular contour of the cylinder is of a shape such that the movement of the curved vanes relative to the piston will take place with a substantially constant acceleration.

Other objects and advantages of my invention will be apparent from the following description when taken in conjunction with the accompanying sheet of drawings in which:

Fig. 1 is a transverse sectional view taken through a balanced rotary pump embodying my invention;

Fig. 2 is a similar transverse sectional view taken through another form of my improved pump;

Fig. 3 is a perspective view showing one of the curved vanes in detached relation; and

Fig. 4 is a perspective view of one of the contact elements of the curved vanes.

My invention will now be described in greater detail, and in so doing, reference will be made to the particular embodiments illustrated in the drawing, but it should be understood that my invention is not limited to the particular pumps illustrated because it can be embodied in various other pumps and similar or analogous devices.

My improved pump, as shown in Fig. 1, comprises a housing 10 of suitable shape having pairs of inlet and discharge passages 11 and 12 therein, and a piston 13 carrying a plurality of curved vanes 14 and rotatable in the housing for causing a flow of fluid through said inlet and discharge passages. The piston 13 may operate directly in the housing 10, or preferably as shown in this instance, operates in a cylinder liner 15 which is mounted in the housing and has pairs of openings or ports 16 and 17 therethrough which communicate respectively with the pairs of inlet and discharge passages 11 and 12 of the housing. The outer surface of the liner 15 may be cylindrical in shape for convenient mounting in the housing 10 and, as will be explained hereinafter, its inner surface defining the cylinder chamber 18 is non-circular but has a cross-sectional shape which is substantially symmetrical with respect to its major and minor axes. In other words, the internal contour of the liner 15 forming the outer wall of the cylinder chamber 18 is of a generally elliptical shape.

The piston 13 may comprise an elongated body of substantially circular cross-section which is mounted for rotation in the housing and liner with substantially diametrically opposed sections thereof in arcuate running contact with the liner as indicated at 19. The piston thus divides the cylinder 18 into two opposed working chambers 20 and 21 of substantially equal volume. An inlet passage or port 16 and a discharge passage or port 17 communicates with each of these working chambers. The piston may be rotatably supported by means of an axial projection or shaft member 22, on one or both ends thereof, which is journaled in a suitable bearing of the housing 10 or of the end wall of the liner 15.

The body of the piston 13 is provided with a plurality of pairs of arcuately extending slots 23 corresponding in number with the number of vanes to be mounted in the piston. In this instance the piston is provided with four pairs of such arcuate slots 23 which accommodate the four curved vanes 14. These curved vanes are so constructed that when arranged in the piston in their respective pairs of slots 23, each vane will have a constant chord length, that is, will span a section of the wall of the cylinder with its opposite side edges in running engagement with such wall and will slide in the piston slots as the piston rotates. The angular distance or section of the cylinder wall spanned by each vane will depend upon the number of vanes mounted in the piston and, in the arrangement

illustrated where the piston is provided with four of these curved vanes, each vane may span approximately a 90° section of the cylinder wall.

From the arrangement thus far described, it will be seen that as the piston 13 rotates, the opposite edges of the vanes 14 will be in continuous contact with the non-circular inner wall of the cylinder chamber and that the edge sections of the vanes will be projected in succession from the piston so as to sweep through the lobular working chambers 20 and 21 thereby causing fluid to be drawn in through the inlet passages and delivered through the discharge passages. With the working chambers 20 and 21 arranged on opposite sides of the piston 13, as shown in the drawing, the pressures built up in these chambers will act on the piston substantially in opposition to each other and the loads on the piston and its bearing or bearings will be substantially balanced.

When two pairs of curved vanes are provided in the piston 13 as shown in the present embodiment, it is desirable to arrange the vanes in intersecting relation to each other and to this end I construct the vanes 14 of substantially C-shape or U-shape, as shown in Fig. 3, or in other words, with a recess 24 extending axially thereof and opening through one end of the vane. To permit assembly of the vanes in the piston 13 in this intersecting or interfitting relation, the body of the piston may have the slots 23 open through an end thereof as could be the case when the shaft member 22 is provided on one end only, or it may be formed of sections which are suitably connected together after the vanes have been inserted. As will be seen from Figs. 1 and 3, the vanes each have a body formed of one piece of material and the vanes may, therefore, be referred to as of one-piece construction. The vanes may operate with the edges thereof in direct contact with the cylinder wall, or as shown in this instance, their edges may have longitudinal arcuate grooves 25 formed therein and contact elements 26 may be mounted in these grooves for sealing and bearing engagement with the inner wall of the cylinder.

I have stated above that the wall of the cylinder chamber 18 is of non-circular but symmetrical contour and that diametrically opposed sections of the piston are in running contact with the cylinder wall and also that the curved vanes 14 have their opposite edges in continuous engagement with the wall of the cylinder during rotation of the piston. The non-circular cylinder contour providing for this arrangement and operation may be obtained from various specific shapes, but, in the pump illustrated in Fig. 1, the non-circular contour is of a shape which will result in a substantially constant-velocity flow of the liquid being delivered through the discharge passages. In other words, I make the non-circular contour of the cylinder chamber 18 of such shape that the piston and curved vanes will operate therein in the manner above explained and such that the stream of fluid delivered by the pump will be a substantially non-pulsating stream.

One way of obtaining this desired shape for the cylinder chamber is to construct the liner 15 so that the end portions of the working chambers 20 and 21 are arcs struck with the same radius from a common center lying on the axis of rotation of the piston. The contact sections 19 between the piston and the liner are also arcs which are struck from the same center as the arcs defining the ends of the working chambers 20 and 21 but with a shorter radius. The curved sections 28 of the cylinder wall joining these pairs of arcs are so formed or generated that they connect the arcs smoothly with each other and accommodate the curved vanes in a manner such that the opposite edges thereof remain continuously in contact with the non-circular wall of the cylinder during rotation of the piston.

In Fig. 2 I show another form of my balanced rotary pump which embodies the same principles as those explained above but in which the non-circular contour of the cylinder chamber has a different shape, as will be presently explained. This modified form of my rotary pump includes a housing 30 having a cylinder liner 31 therein, and a piston 32 rotatable in the liner and carrying pairs of curved vanes 33 of constant chord length. The inner face of the liner 31 defines a cylinder chamber 34 which is of non-circular contour but substantially symmetrical in cross-section and of generally elliptical shape.

The body of the piston 32 may be of substantially circular shape and the piston may be mounted for rotation in the housing with diametrically opposed sections thereof in running contact with the liner, as indicated at 35, so that the piston divides the cylinder chamber into two lobular or crescent-shape working chambers 36 and 37 of substantially equal volume.

The pump illustrated in Fig. 2 being similar to that of Fig. 1 need not be described in greater detail except for the shape of the non-circular contour of the cylinder chamber 34 which is different and produces a different result in the operation of the pump. The non-circular wall of the cylinder chamber 34 is so shaped that the curved vanes 33 will have constant acceleration during their movement in the curved slots of the piston 32. To obtain this desired result the shape of the non-circular contour of the cylinder chamber 34 should be such that the curves 38, defining the four quadrantal wall sections intercepted by the minor and major axes, are parabolic curves or are curves or arcs having a shape or curvature approaching or approximating that of parabolic curves. The adjacent ends of the curved sections 38 may merge smoothly into each other or may be smoothly connected by generated sections or arcs 35a and 39.

It will be understood, of course, that the two inlet passages and the two discharge passages of the pumps illustrated can be suitably connected together by piping, or otherwise, so as to provide a common inlet and a common discharge. On the other hand my pump could be operated to handle two separate streams of fluid if this were desirable.

From the foregoing description and the accompanying drawing, it will be readily understood that I have provided an improved construction for balanced rotary pumps in which the cylinder chamber is of non-circular contour and curved one piece vanes carried by the piston have their opposite edges in continuous engagement with the non-circular wall of the cylinder during the rotation of the piston. It will be seen furthermore that in a balanced pump embodying this construction, the forces on the piston will act in opposition to each other thereby reducing the bearing loads. Moreover, it will be seen that by forming the non-circular cylinder chamber with a contour having either of the specific shapes described above, a desired new operating function can be obtained. With one of these

shapes a constant-velocity or non-pulsating flow of the liquid being delivered is obtained and with the other shape the movement of the vanes relative to the piston takes place with a constant acceleration.

While I have illustrated and described my improved rotary pump in a more or less detailed manner, it will be understood, of course, that I do not wish to be limited to the specific constructions and arrangements herein disclosed, but regard my invention as including such changes and modifications as do not constitute a departure from the spirit of the invention and the scope of the appended claims.

Having thus described my invention, I claim:

1. In a rotary pump, a housing having inlet and outlet passages and a cylinder of generally elliptical contour, a substantially circular piston rotatable in the housing with substantially diametrically opposed sections thereof in contact with the wall of said cylinder, and a plurality of pairs of curved vanes operably mounted in the piston so that opposite edges of each vane continuously engage and follow said contour of the cylinder, the vanes of each pair being arranged in intersecting relation to each other.

2. In a rotary pump, a housing having inlet and outlet passages and a cylinder of non-circular but substantially symmetrical contour, a substantially circular piston rotatable in the housing and dividing the same into opposed working chambers of substantially equal volume, and a plurality of pairs of curved vanes slidable in the piston and having their opposite edges in continuous engagement with the non-circular cylinder contour during rotation of the piston, said vanes having a one-piece body of substantially C-shape and the vanes of each pair being arranged in intersecting relation to each other.

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