

Aug. 18, 1942.

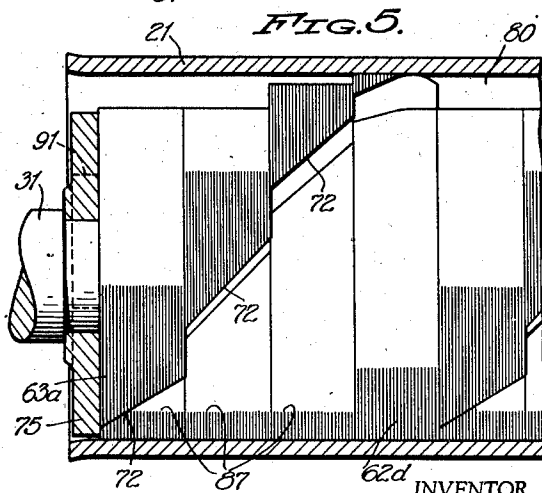
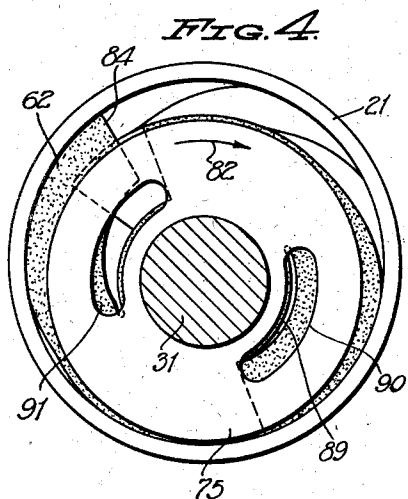
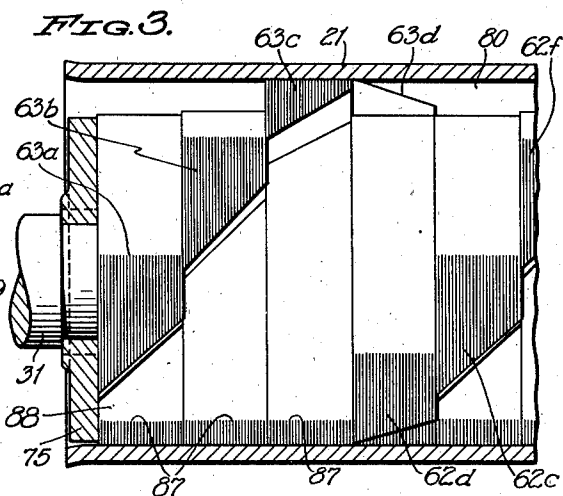
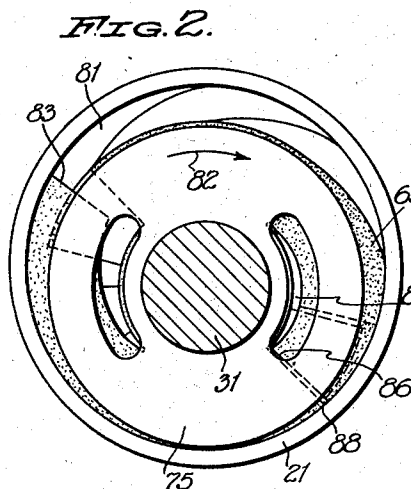
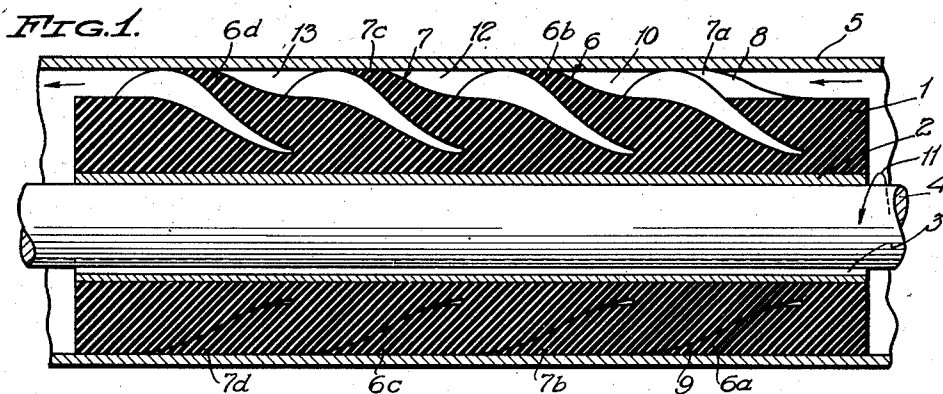
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2,293,268

ROTARY PUMP

Filed April 21, 1941

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

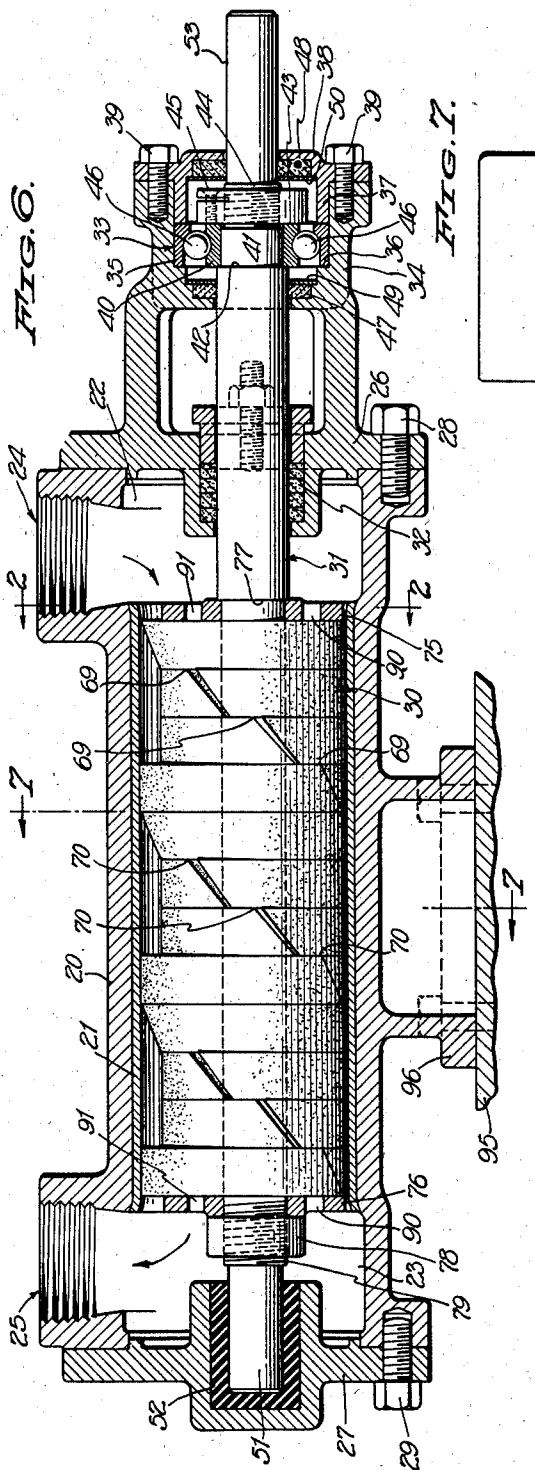


FIG. 7.

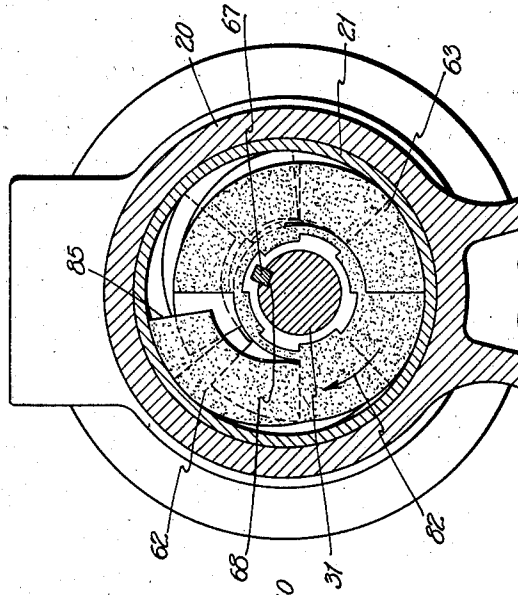


FIG. 9.

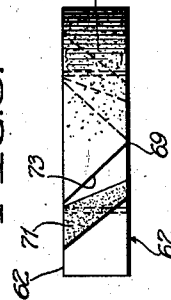
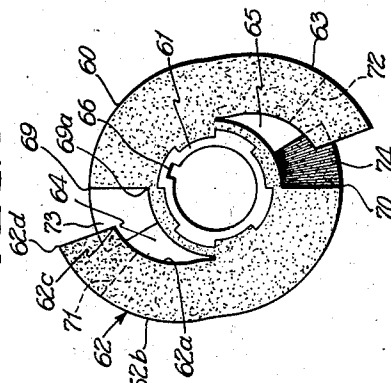


FIG. 8.



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ROTARY PUMP

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Application April 21, 1941, Serial No. 389,521

9 Claims. (Cl. 103—117)

This invention relates to rotary pumps and its principal object is to provide an efficient single screw rotary pump of simple construction, to pump clear and thin liquids as well as viscous and thick liquids, and liquids which may contain

solid and abrasive material and may be corrosive. Another object is to provide a pump of relatively large capacity and of compact design suited for operation in a reduced space, particularly in the cylindrical space of the casing of a deep well.

A further object is to provide a pump of the rotary type which is silent in operation, inexpensive to manufacture, easy to repair and highly resistant to wear, regardless of the nature of the liquid to be pumped.

Rotary pumps in use today whether they are of the screw, gear, or vane type, are suitable only for pumping clean and non-corrosive liquids, mainly viscous oils and lubricants. They are not suited for pumping gritty liquids, because of the grinding action that takes place where the impellers interengage, resulting in rapid wear, loss of efficiency, and noisy operation. My improved pump is not seriously affected by abrasive matter in the liquid, because it operates on such matter with a wiping action, rather than a crushing action. The impeller of my pump being of elastic composition, thin liquids lubricate it as well as viscous liquids.

Other advantages of my invention will become apparent to those skilled in the art, from the following specification wherein I shall first describe an elementary form of pump embodying my invention, to show its principle of operation, and then describe a form of my pump showing the best mode in which I have contemplated applying that principle.

In the drawings—

Fig. 1 is a longitudinal section of the impeller and part of the cylinder of an elementary form of pump embodying my invention;

Fig. 2 is a cross section of an improved form of pump embodying my invention, on the line 2—2 of Fig. 6, only the liner of the cylinder being shown;

Fig. 3 is a longitudinal section of that part of the pump shown in Fig. 2, the impeller appearing in side elevation and in the same position as in Fig. 2;

Fig. 4 is a cross section similar to Fig. 2, but with the impeller advanced one-sixteenth of a turn;

Fig. 5 is a longitudinal section similar to Fig. 3,

but with the impeller in the same position as shown in Fig. 4;

Fig. 6 is a longitudinal section of a complete pump of the kind shown in Figs. 2 to 7, the impeller appearing in side elevation, from the opposite side to that shown in Figs. 3 and 5;

Fig. 7 is a cross section on the line 7—7 of Fig. 6;

Fig. 8 is an elevation of one section of the impeller shown in Fig. 6, looking at a side face of the section; and

Fig. 9 is a plan view of the impeller section shown in Fig. 8.

In its construction and principle of operation, my improved pump might be described as a modified Archimedean screw, since it employs a single screw impeller operating in a cylinder. It is distinguished from the Archimedean screw by the fact that its screw impeller is eccentric in the cylinder and has one or more resilient helical vanes which are pressed against the body of the impeller as they traverse that part of the cylinder wall nearest the impeller axis, thereby completely closing the helical channels formed by the groove or thread of the impeller, along a line parallel to the axis of the cylinder. Thus, in Fig. 1, which shows an elementary form of my invention, an impeller 1, of elastic composition, molded onto a bushing 2, which is keyed at 3 to a shaft 4, is mounted eccentrically in a cylinder 5, so that its helical vanes 6 and 7 are pressed tight against the body of the impeller at the bottom of the cylinder, which is nearest the axis of the impeller shaft 4. For convenience of description, the part of the cylinder space between the impeller axis and the bottom of the cylinder will be referred to as the narrower part of the cylinder space while that between the impeller axis and the top of the cylinder will be referred to as the wider part of the cylinder space. The right end of the cylinder 5 is connected with the inlet opening (not shown) of the pump, while the left end is connected with the delivery pipe (not shown). The vanes, being of elastic material, and, in their free condition, standing out from the body of the impeller, expand from the axis of the impeller shaft as they move away from the narrower part of the cylinder space, maintaining contact with the cylinder wall at all times. The bearings in which the shaft 4 is journaled and held eccentrically in the cylinder do not appear in the drawing.

In the form of pump shown in Fig. 1 the impeller has a two-thread screw; that is, there are two distinct helical vanes, convolutions of which

appear alternately along any line parallel to the axis of the impeller. The convolutions of the vane 6 bear the reference numbers 6a, 6b, 6c, and 6d, while those of the vane 7 have the reference numbers 7a, 7b, 7c, and 7d. The vane 7 has its inlet end at 8, where it is expanded into the wider part of the cylinder space, as shown in Fig. 1. The vane 6 has its inlet end at 9, compressed against the body of the impeller in the narrower part of the cylinder space. There is a helical channel 10 formed between the vane portions 7a and 6b, which is open at the inlet end of the cylinder space and which extends around the far side of the impeller, being dammed in the narrower part of the cylinder space by the compression of the vane portion 7b against the body of the impeller. The direction of rotation of the impeller is indicated by the arrow 11. As the vane portion 7a approaches the bottom of the cylinder, it is pressed into the same position represented by the vane portion 6a in Fig. 1, thus sealing the inlet end of the helical channel 10. Meanwhile, the dammed end of the helical channel 10 nearest the delivery end of the pump has progressed from the position 7b to the position 6c, the vane portion 7c having assumed the position of the vane portion 6c shown in Fig. 1. Upon further rotation of the impeller, the sealed helical channel 10 progresses toward the left and eventually opens into the space at the delivery end of the cylinder. Further rotation of the impeller continues the movement of the rear seal of the channel 10 toward the left and eventually the fluid which was contained in this channel is forced into the cylinder space at the delivery end. Two other helical channels, 12 and 13, move leftward simultaneously with the channel 10, conveying their charges of fluid in the same way.

The form of the impeller shown in Fig. 1 leads to practical difficulties, due to the continuity of the vanes, which causes buckling of the vanes as they pass through the narrower part of the cylinder space, with resultant loss of efficiency and hard and irregular action. This difficulty is removed by the construction shown in the other figures of the drawings, which will now be described, referring first to Figs. 6-9.

A cylinder casting 20 is provided with a liner 21 and has an inlet chamber 22 and an outlet chamber 23. An inlet opening 24 is provided with screw threads for connection of a suction pipe, but the whole pump can be immersed in the fluid to be pumped and the suction pipe omitted. A delivery opening 25 is provided with threads to receive the threaded end of a delivery pipe, which is not shown in the drawing. The inlet chamber 22 is closed by the cover plate 26 and the delivery chamber 23 is closed by a cover plate 27, the former being held in place by screws 28 and the latter by screws 29. An impeller, indicated generally by the reference character 30, is eccentrically mounted in the cylinder 20. The impeller has a shaft 31, one end of which extends through a packing box 32 on the cover plate 26, to a thrust bearing indicated generally by the reference character 33. The thrust bearing is secured in a cup-shaped extension 34 of the cover plate 26, the outer race 35 of the thrust bearing being pressed against a shoulder 36 of the cup 34 by a flange 37 of a cap 38. The cap 38 is secured to the cup 34 by screws 39. The inner race 40 of the thrust bearing 33 is fixed to a reduced portion 41 of the shaft 31,

being held against shoulder 42 by a nut 43 screwed onto a threaded portion 44 of the shaft. A setscrew 45 holds the nut 44 against loosening. The balls of the thrust bearing are shown at 46. Felt washers 47 and 48 are retained by rings 49 and 50 at the extremities of the bearing box. The opposite end 51 of shaft 31 is held in a plain bearing 52 on cover plate 27. The shaft 31 can be driven by any suitable means (not shown) connected to its protruding end 53.

In order to avoid the difficulties attending an impeller with continuous vanes, the impeller of the pump shown in Fig. 6 is made up in sections. This has the additional advantage that the molding of the impeller becomes much easier. The detailed form of the sections, in their natural condition, is shown most clearly in Figs. 8 and 9. An elastic body 60 is cast upon a keyed bushing 61. Each section has two elastic fingers 62 and 63, which are molded so that they normally stand out from the body of the section. The latter has recesses 64 and 65 adapted to receive the fingers 62 and 63, when they are pressed against the body of the section. Series of fingers 62 and 63 of the assembled sections combine to form helically disposed propulsion means, which have the same function as the vanes 6 and 7 in Fig. 1, and which are herein also referred to as vanes. Theoretically the impeller can be composed of a large number of sections, but as a practical matter each section should be sufficiently thick to prevent it from buckling and losing its operative position in the cylinder. In the pump shown in Fig. 6, eight sections complete one turn of a single vane. Since there are two fingers 62 and 63 on each section, and consequently two vanes on the assembled impeller, there are four different sections required for the manufacture of the impeller. These sections differ only in respect to the angular position in which they are keyed on the impeller shaft. The position is determined by a key way 66 in the bushing 61, into which fits a key 67 held in a key way 68 of the shaft 31. To provide the four different angular positions of the sections on the shaft 31, the bushings 61 are molded into the sections in different angular relations to the fingers 62. When the sections are assembled on the shaft, corresponding index points, such as 69 and 70, of successive sections are disposed around the axis of the shaft 31 along two helical lines, as shown in Fig. 6. The fingers 62 and 63 have chamfered end faces 71 and 72, which face toward the delivery end of the pump. The end faces 73 and 74 of the body part of the section are chamfered to match the end faces 71 and 72. The sections are packed on the shaft 31 between end plates 75 and 76, the plate 75 bearing against a shoulder 77 of the shaft and the plate 76 being pressed in by a nut 78 screwed onto a threaded portion 79 of the shaft 31.

The operation of the pump will now be described, with particular reference to Figs. 2 to 5 and 7. Figs. 3 and 5 have vertical hatching to show the surfaces of the impeller which are in contact with the cylinder wall. Fig. 3 shows the condition of the impeller just before one of the helical channels 80 is sealed at the inlet end of the cylinder, while Fig. 5 shows the condition of the impeller just after the helical channel 80 has been sealed, by rotation of the impeller through $22\frac{1}{2}^\circ$ from the position shown in Fig. 3. Figs. 2 and 4 show the angular positions of the impeller in Figs. 3 and 5, respectively. Fig. 7

shows still another angular position of the impeller. Let it be assumed that the impeller is starting in the position shown in Fig. 7 and is rotating in clockwise direction, as indicated by the arrow 82. The finger 63 will move outward as it travels upward along the left wall of the cylinder, passing through the positions shown at 83 in Fig. 2, at 84 in Fig. 4, and at 85 in Fig. 7, eventually arriving at the position shown at 86 in Fig. 2. During all this time the helical channel, which starts to open up as the finger 63 moves away from the position shown in Fig. 7, remains open to the inlet chamber 22. When the finger 63 has finally reached the position 86 of Fig. 2, the helical channel has assumed the position shown at 80 in Fig. 3. It is bounded at its rear end by overlapping fingers 63a, 63b, 63c and 63d, and by additional fingers continuing in the same helical line around the back side of the impeller shown in Fig. 3. It is also bounded by the dam 87 formed by the contact of the body portion of the first three sections of the impeller with the bottom part of the cylinder wall, as well as by the fingers 62d, 62e, 62f, and additional fingers of the same helical series, which do not appear in Fig. 3, and, finally, by another dam, similar to the dam 87, at the forward extremity of the channel, which does not appear in Fig. 3. The channel 80 is still open at the inlet end of the cylinder, as indicated at 88. Since the channel has a length equal to the pitch length, or one full turn of the helix, plus the width of the channel parallel to the impeller axis, this width being equal to one-half the pitch length, the pump cylinder and impeller must have a length at least one and one-half times the pitch length of the helix. As seen in Fig. 2, the finger 63a is being pressed toward the axis of the impeller and is in contact with the cylinder wall along somewhat more than 45°. The fingers 62 and 63 are preferably of arcuate shape, the radius of the arc being slightly greater than the radius of the arc of the recesses 64 and 65 into which they fit. Therefore, when a finger is pressed into its recess, it is curved to a smaller arc, and this results in compressing the material at the inner side 62a and expanding the material at the outer side 62b of the finger. The end 71 of the finger is accordingly shaped so that the points 62c and 62d will just meet the points 69 and 69a, allowing for the compression and expansion of the inner and outer sides of the finger. In other words, the inner side 62a of the finger is a little longer than it will be when the finger is pressed into the recess 64, while the outer side 62b is a little shorter than it will be when the finger is pressed into the recess. The length of the fingers may also be slightly exaggerated, in some cases, to compensate for shortening caused by back pressure of the liquid.

In Figs. 4 and 5 the impeller has turned one-sixteenth of a revolution from the position shown in Figs. 2 and 3 and the gap at 88 has been substantially closed up by the movement of the tip of finger 63a down to the dam line 87. The finger 63a is being pressed closer to the body of the impeller and the recess at 89 is being closed up. As the rotation if the impeller continues, the chamfered end faces 72 of the fingers 63 move down progressively to the dam line 87 and thus the rear end of the helical channel 80 travels toward the right, forcing the fluid in that direction.

Arcuate ports 90 and 91 are provided in the end plates 75 and 76 opposite the inner part of

the recesses 64 and 65 of the end sections 60. These ports afford passage for the liquid directly to and from the recesses under the fingers.

I have shown a pump adapted to be mounted on a foundation 95 by a pedestal 96 and having inlet and outlet openings directed transversely to the longitudinal axis of the pump, but it will be evident that by slight modification the pump can be adapted to fit into the inner space of a wall casing and utilize that space most efficiently.

I am aware that single screw rotary pumps are known comprising an eccentric impeller having radially movable non-elastic vanes. These have the disadvantage that such vanes cannot conform to the cylindrical wall surface throughout their rotation, due to the eccentricity of the impeller in the cylinder. Serious leakage is the result. The elastic vanes which characterize my invention adapt themselves to the cylinder wall at all times and maintain a close seal.

I claim:

1. In a pump, an impeller comprising a generally cylindrical body and resilient, helically disposed propulsion means resiliently joined to said cylindrical body and normally standing out therefrom, but adapted to be pressed flush with the surface of the cylindrical body of the impeller; a cylinder in which said impeller is eccentrically, rotatably mounted, with the body of the impeller in contact with a band of the cylinder wall parallel to the cylinder axis, whereby said propulsion means is pressed flush with the cylindrical surface of the body of the impeller, in passing said band of the cylinder wall as the impeller rotates, forming a dam parallel to the cylinder axis, at one side of the impeller; said propulsion means being adapted to move out from the body of the impeller, after passing said band of the cylinder wall, to form a helically disposed vane, the outermost surface of which remains in contact with the cylinder wall throughout the rotation of the impeller to maintain an uninterrupted helical seal against the cylinder wall.

2. A pump as described in claim 1, wherein said propulsion means is composed of a plurality of individually movable fingers having side faces in mutual contact in planes perpendicular to the impeller axis.

3. A pump as described in claim 1, wherein said propulsion means is composed of a plurality of individually movable fingers having side faces in mutual contact in planes perpendicular to the impeller axis, each finger being joined to the body of the impeller so that its outer end leads its juncture with the body of the impeller as the latter rotates.

4. A pump as described in claim 1, wherein said impeller is composed of sections having fingers which form said propulsion means, said sections and their fingers having flat side faces in mutual contact in planes perpendicular to the impeller axis.

5. A pump as described in claim 1, wherein said impeller is composed of a shaft and a plurality of sections mounted on said shaft, said sections having fingers which form said propulsion means, said sections and their fingers having flat side faces in mutual contact in planes perpendicular to the axis of the impeller, and end plates between which said sections are clamped together on said shaft.

6. A pump as described in claim 1, wherein said impeller is composed of a shaft and a plurality of sections mounted on said shaft, said sections

having fingers which form said propulsion means, said sections and their fingers having flat side faces in mutual contact in planes perpendicular to the axis of said shaft, said sections having recesses for their fingers to fit into when compressed toward the axis of the impeller, and end plates between which said sections are clamped on said shaft, said end plates having openings opposite the recesses of the end sections.

7. A pump as described in claim 1, wherein said impeller is composed of sections having fingers which form said propulsion means, said sections and their fingers having flat side faces in mutual contact in planes perpendicular to the impeller axis, said sections having recesses for their fingers to fit into when compressed toward the axis of the impeller.

8. A pump as described in claim 1, wherein said impeller is composed of sections having fingers which form said propulsion means, said sections

and their fingers having flat side faces in mutual contact in planes perpendicular to the impeller axis, said fingers having chamfered ends facing toward the delivery end of the pump.

9. A pump as described in claim 1, wherein said impeller is composed of sections having fingers which form said propulsion means, said sections and their fingers having flat side faces in mutual contact in planes perpendicular to the impeller axis, said sections having recesses for their fingers to fit into when compressed toward the axis of the impeller, said fingers and recesses being of arcuate shape and the radius of the arc of said fingers being greater than the radius of the arc of said recesses, the ends of said fingers being shaped to allow for a contraction of the inner part, and an expansion of the outer part, of each finger as it moves into its recess.

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