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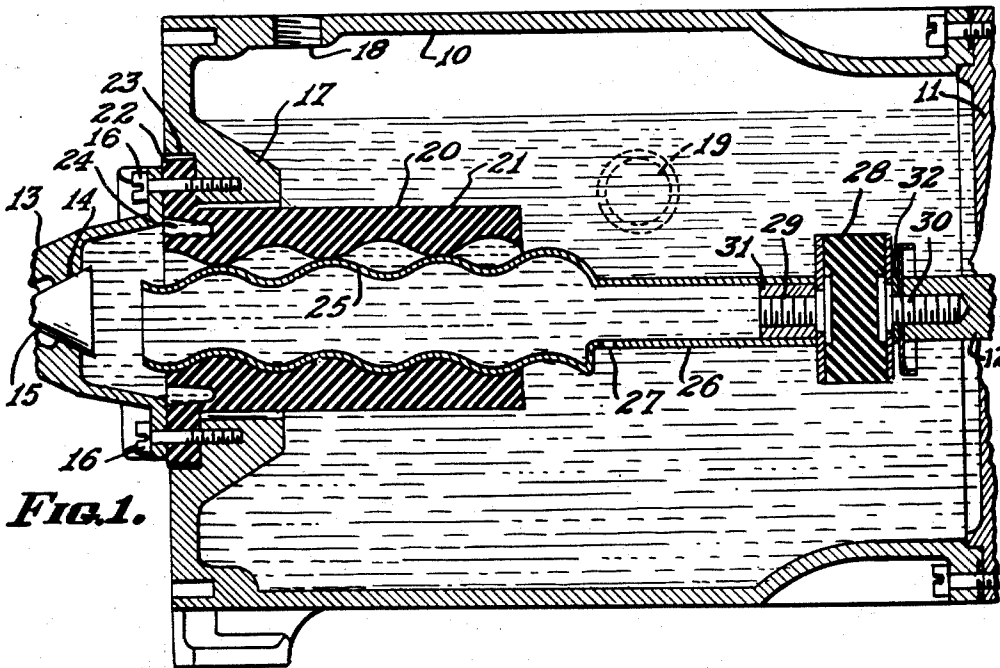


FIG. 1.

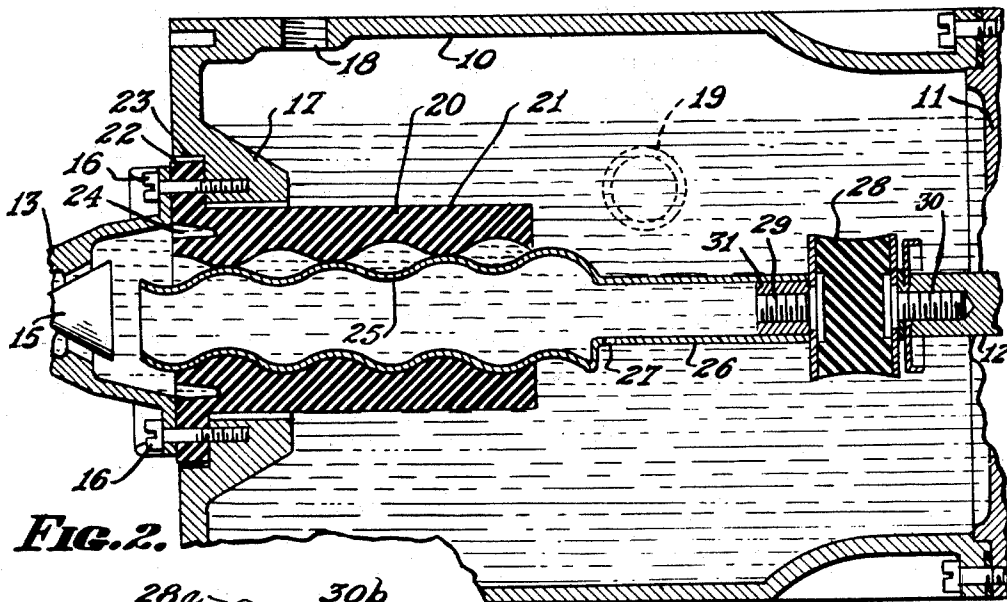


FIG. 2.

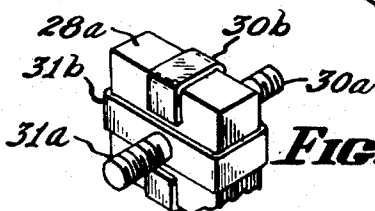


FIG. 3.

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12 Claims. (Cl. 103-117)

1 This invention relates to pumps, and more particularly to pumps in which the working elements comprise a rotor and a stator having respectively external and internal helical threads, the rotor having one less thread than the stator. The basic theory of such pumps has been disclosed and claimed in Moineau, United States Patents Nos. 1,892,217 and 2,028,407.

The present invention also utilizes certain additional members described in the co-pending application of Moineau Serial No. 777,431, filed October 2, 1947, as well as certain members described and claimed in my co-pending application Serial No. 707,956, filed November 5, 1946, now Patent No. 2,512,764 issued June 27, 1950; No. 717,401 filed December 20, 1946, now Patent No. 2,512,765 issued June 27, 1950 and No. 731,597 filed February 28, 1947, now Patent No. 2,527,673 issued October 31, 1950.

Reference is hereby made to the above named patents and applications as to various features which are not claimed herein. Experience in building pumps according to certain of the above named applications in which a rubber stator element is used, has proved that the critical fit and dimensional variation of the rubber stator element has prevented the use of volume production methods.

It is an object of the present invention to provide a pump of the type generally disclosed in my co-pending application Serial No. 707,956, but with certain improvements to be disclosed hereinafter which make it possible to provide such a pump more cheaply and by better production methods.

It is another object of my invention to provide a pump according to my said co-pending application employing therein certain features disclosed and claimed in said co-pending application of Moineau, Serial No. 777,431.

In said last mentioned application there is a disclosure of a rotor and stator element each flexibly mounted at one end so that when rotation is imparted to the rotor the rotor and stator both orbit in conical paths with said flexible mountings at their apices, the rotor additionally rotating during this orbitary movement.

It is yet another object of my invention, in a pump of the class described, to provide improvements upon the pumps of said applications whereby in combination with a tapered rotor and stator certain advantages of easy starting and variable seating of the rotor within the stator in accordance with the pressure differential within the pump are attained.

2 Yet another object of my invention is to provide improvements in connection with the stator element whereby to avoid a tendency toward binding against the rotor, which condition may be encountered in a pump according to my co-pending application Serial No. 707,956.

These and other objects of my invention which I shall point out hereinafter, or which will be apparent to one skilled in the art upon reading these specifications, I accomplish by that certain construction and arrangement of parts of which the following is an exemplary embodiment:

Reference is made to the drawings forming a part hereof and in which:

Figure 1 is a fragmentary cross-sectional view through a pump casing showing the conditions when the pump is at rest and showing certain features of construction.

Figure 2 is a view similar to Figure 1, showing the conditions when the pump is operating.

Figure 3 is a fragmentary perspective view of a modified form of coupling which may be used.

The pump to which the present invention is applied might be a pump such as that disclosed in my said co-pending application Serial No. 707,956, and Figures 1 and 2 hereof may be considered as substituting in the central portion of Figure 5 of said co-pending case.

Briefly in the practice of my present invention I provide a hollow rubber stator element having a fastening flange by means of which it is bolted to the casing and I provide means whereby excessive tightening of said bolts is prevented from causing binding of the stator and rotor. The stator, by means of its fastening flange, is non-rotatively secured to the housing but is free to orbit in a conical path under the influence of the rotating rotor.

The rotor is flexibly mounted to a motor drive shaft so that as said drive shaft is rotated, the rotor may also orbit in a conical path for the variations involved in the conical orbiting of rotor and stator, reference is made to the said Moineau application Serial No. 777,431.

In my present invention the rotor and stator are both slightly tapered with the big end at the discharge of the pumping elements. Furthermore, the flexible mounting of the rotor to the drive shaft is through a connection capable of being stretched, whereby the rotor is permitted a limited amount of axial movement within the stator. The mounting element thus takes the axial rotor thrust in tension and under operating conditions when there is a differential be-

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tween intake and discharge pressure the rotor is, as it were, sucked more firmly into the stator or is more tightly seated therein. The rotor is hollow and has in a region exposed to discharge pressures a bleed port. A check valve is provided at the intake whereby when said pump is stopped, said check valve closes and an equalization of pressures takes place through said bleed port. As the pressure differential of the two ends of the rotor becomes equal the said tension element can contract whereby the rotor is slightly withdrawn from the stator as the pump coasts to a stop after running. Thus there is a slight clearance all the way along between the rotor and stator so that easier starting of the pump is achieved.

Referring now in more detail to the drawings, I have indicated at 10 the central portion of a pump casing. It will be understood that there is secured to the right-hand end of the casing 10 a motor housing 11, and the drive shaft on said motor is shown approximately at 12. It will also be understood that an intake dome or housing is secured to the left-hand end of the housing 10, which housing contains a screen and a check valve mechanism as set forth in my co-pending application Serial No. 707,956.

The check valve has a seat in a dome shaped casting 13 as at 14. The valve itself is indicated at 15. The member 13 is bolted as by means of the bolts 16 to the casing 10, the bolts extending into an annular bored boss 17. The check valve 15 is biased to closed position by a spring (not shown). For details of the construction of the intake housing and the motor housing reference may be made to my said co-pending application Serial No. 707,956. The housing is provided with an aperture 18 for connection to a pressure gage as disclosed in my said co-pending application and the pump outlet is indicated at 19 below the level of liquid in the pump.

Coming now to specific details of the present invention, the stator which is made of a resilient material is indicated at 20, and has on its inside the helical threads 21. The stator is provided with a fastening flange 22 and the bolts 16, which fasten the member 13 to the casing, pass also through the flange 22 into the boss 17. Thus the flange 23 is seated in an annular recess 23 in the casing. I have found that if the bolts 16 are tightened too tightly in an endeavor to provide a leakproof seat, a sort of cold flow toward the inside contour was produced which had the effect of slightly pinching the rotor. This resulted in unreliable starting. I have overcome this difficulty in accordance with my present invention by the provision of a groove or moat 24 annularly of the flange end of the stator between the threaded bore 21 and the flange 22. I have found that with this construction any tendency toward cold flow of the molded stator is interrupted by the groove 24 and that regardless of how tightly the bolts 16 are turned down, no binding on the rotor occurs.

The threaded bore 21 of the stator preferably has a taper of from 3° to 5° from the center axis thereof.

The rotor, which has the helical threaded external contour indicated at 25, is also tapered and the rotor seats within the stator with the wide ends of both tapers at the discharge end. The rotor, according to the present invention is formed integrally with its connecting rod 26 from a single piece of internally expanded tubing. In the manufacture of this rotor and connecting rod

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a piece of suitable tubing is placed in a die having the desired contour and the tubing is expanded under pressure. This relatively high speed production method is rendered possible because of the tapered contour of the rotor, which makes it possible to remove the completed rotor from a non-parted contour die with considerable ease. The rotor of course is hollow and is provided in a region exposed to discharge pressures with a bleed aperture 27.

The flexible coupling between the drive shaft 12 and the connecting rod 26 comprises essentially a block of rubber or similar resilient material 28 which has bonded to opposite sides thereof the studs 29 and 30. The stud 30 is threaded into a threaded bore in the drive shaft 12 and the stud 29 is threaded into an internally threaded collar 31 in the end of the connecting rod 26. One or more washers is interposed as at 32. These washers 32 may be used in initial assembly adjustment and later on to compensate for wear in the parts 25 and 20.

In accordance with the teaching of said co-pending Moineau application Serial No. 777,431, when the drive shaft 12 is rotated, the connecting rod 26 and the rotor 25 rotating also, there is forced upon both the rotor and stator 20 an orbital movement. The orbital movement of the stator is in a conical path about substantially the center of the member 28 as an apex and the orbital path of the rotor 20 is in a conical path about the center of the flanged end thereof as an apex.

As the rotor turns within the stator and the pump begins to operate there is an axial thrust on the rotor toward the left of Figures 1 and 2 which results from the differential in pressure between the intake side and discharge side of the pump elements. The coupling member 28 is capable of being stretched so that the rotor is actually capable of a slight movement toward the left while the pump is running. The initial adjustment is such that when the pump is at rest and the member 28 is not under tension, as shown in Figure 1, the rotor 25 is not quite seated within the stator and there is a slight clearance between them. In Figure 1, where the check valve 15 is shown closed, there has been an equalization of pressures through the bleed port 27 so that the pressures within the casing 10, within the rotor 25, within the dome 13 and between the rotor 25 and stator 20, are all equal.

When the pump is started there is first a building up from substantially free rotation of the rotor, of a discharge and intake differential. As the pressure within the dome 13 drops the valve 15 is pulled open while concurrently the rotor is pulled toward the left, or into a tighter seating engagement with the stator, until under full running conditions as shown in Figure 2 the interior of the casing 10 is at the pump discharge pressure, while the interior of the dome 13 and the interior of the rotor are at intake pressure. The pressure between the rotor and stator in the various pockets between the two increases from intake pressure at the left, to discharge pressure at the right, the drawing of the rotor towards the left under the influence of the pressure differential causing stretching or distortion of the member 28 as clearly shown in Figure 2. Thus the member 28 acts in tension to take up the axial rotor thrust.

I have shown in Figure 3, a modified coupling member where the studs 31a and 30a are secured to C-shaped bands 31b and 30b respectively.

These bands grip a block of rubber or similar material 28c, as shown. The function of the coupling of Figure 3 is the same as that of the coupling 28, but is a simple illustration of a modified form thereof.

It will be observed from the foregoing that the casing member of the pump according to my present invention could be made more cheaply than the casing member shown in Figure 5 of my said co-pending application Serial No. 707,956, in that the internal boss 17 is much smaller and need not be provided with keyways.

By employing the teaching of the said Moineau application Serial No. 777,431 as to the conical movement the two universal joints of my said co-pending application are replaced by a single joint at 28. Furthermore, it now becomes feasible to make the rotor and its connecting rod from a single piece of pressure formed tubing which results in increased production and a less expensive product. The taper of the rotor simplifies the die problem immensely and with the relatively light weight rotor operating substantially in two rubber mountings at 28 and 22, quietness of operation is assured. The provision of tapered rotors and stators simplifies another operation: I have found that the inside and outside diameters of molded stators vary considerably in production lots so that it has become necessary to selectively fit rotors and stators. Furthermore, a formed rotor such as disclosed herein is not likely to be as accurate in its contours as one produced by turning on a lathe. By virtue of the taper, however, it will be possible to make any rotor operate properly with any stator by simply varying the washer thickness at 32.

By the present arrangement also the rotor and stator elements are substantially disengaged under stopped conditions so that easy starting is provided. Under running conditions the tightness of seating of the rotor within the stator increases with the increase in pressure, and thus pumping efficiency is improved at higher pressures where higher pumpage is desirable.

When the pump is shut off at high pressure the net pumpage drops off quickly as the pump slows down, and the check valve seats gradually until it is fully seated with zero forward pumpage. Actually there is no redistribution of pressure conditions within the pump until the net forward pumpage has become negative, and the contraction of the member 28 and the bleeding through the port 27 and the resulting pressure equalization takes place gradually.

From the foregoing description it will be understood that numerous modifications of minor nature may be made without departing from the fundamental spirit of my invention. I therefore do not intend to limit myself in any manner other than as set forth in the claims which follow.

What is claimed as new and is desired to be secured by Letters Patent is:

1. A pump having a casing with inlet and outlet parts, and having as working elements a stator having a helically threaded bore, and an externally helically threaded rotor, said rotor having one less thread than said stator, said stator being flexibly mounted at one end with reference to said casing, and said rotor being flexibly mounted at one end with reference to said casing, means for rotating said rotor whereby said rotor and stator are caused to orbit, rotatively and non-rotatively respectively, in conical paths, said stator bore and said rotor being tapered and

disposed with their larger ends toward that end of the casing at which said rotor is flexibly mounted.

2. A pump according to claim 1 having an intake provided with a check valve which closes when said pump is at rest, in which said rotor is hollow, and is provided, in a region exposed to discharge pressure, with a bleed perforation, whereby when said pump is at rest and said check valve is closed, the pressures on the two ends of the rotor are equalized.

3. A pump according to claim 1 having an intake provided with a check valve which closes when said pump is at rest, in which said rotor is provided with a connecting rod secured to said rotor mounting, said rotor and connecting rod being formed from a single piece of tubing, said tubing having a bleed perforation in a region exposed to discharge pressure, whereby when said pump is at rest and said check valve is closed, the pressures on the two ends of the rotor are equalized.

4. A pump according to claim 3, in which the flexible mounting of said rotor is resilient axially thereof and is of such dimension as to hold said rotor slightly withdrawn from said stator when said pump is at rest, and yielding under axial thrust when said pump begins to run whereby said rotor seats itself in said stator under the influence of said thrust in accordance with the pressure differential existing between the large end of the rotor and the small end of the rotor.

5. In a pump having pump elements with tapered external and internal helical threads respectively in mutual engagement, the wide ends of said elements being at the discharge end thereof, said elements having flexible mountings respectively at opposite ends and one of said mountings being secured to a drive shaft, said mounting secured to said drive shaft being capable of resilient tensile distortion and being initially adjusted to hold said rotor slightly withdrawn from said stator when said pump is at rest, whereby the tightness of seating of said pumping elements increases with the pressure differential existing between the large end of the rotor and the small end of the rotor when the pump is running.

6. A pump according to claim 5, in which said pumping element having external threads is hollow and is provided with a bleed perforation in a region exposed to discharge pressure, the intake of said pump being provided with a check valve which closes when said pump stops, whereby when said pump stops and the check valve closes, the pressures on the intake and discharge side of said inner element are equalized.

7. A stator for a pump of the class described, comprising a tubular member of molded resilient material having helical threads on its inner surface, one end of said member having an annular flange, there being a shallow annular groove in said flanged end between said flange and inner surface to provide flexibility between said flange and tubular member to allow conical movement of said tubular member, said inner surface being tapered, the small end of said taper being at the flanged end of said stator.

8. A pump according to claim 1, wherein said flexible rotor mounting is constituted of a resilient and elastic material, whereby it can transmit torque to said rotor, and can also yield axially in response to the tensional thrust imposed upon it by said rotor.

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9. A pump according to claim 1, in which said stator is made of resilient material and is mounted by means of a fastening flange seated in an annular recess in said casing, and intake check valve means having a body and a fastening flange, the flange of said valve body being bolted with the flange of said stator to said casing to provide a liquid-tight chamber within said body.

10. A pump according to claim 1, having an intake provided with a check valve closely associated with the mounted end of said stator to minimize the volume of the chamber between said valve and said stator, said rotor being hollow and having a bleed perforation adjacent its larger end, so that discharge pressure can equalize through said perforation and said hollow rotor to said chamber.

11. A pump according to claim 1, in which said stator is made of resilient material and is mounted by means of a fastening flange, said flange being seated in an annular recess in said casing and bolted thereto, said stator, at its flanged end only having an annular groove between said bolts and said bore to prevent distortion of said bore on account of excessive tightening pressure on said flange, and to permit conical movement of the contoured portion of said stator without distortion of said bore on account of the twisting of said contoured portion with respect to said flange resulting from the conical movement.

12. A rotor member for a pump of the class described, comprising a piece of thin walled tubing having deformation over a portion of its length to present externally a helical thread of tapering form, a portion of said tubing adjacent the large end being not substantially deformed and

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constituting the connecting rod for said rotor, said connecting rod portion being provided with a bleed port, said tubing at its small end being open to the fluid being pumped, said rotor and connecting rod having a substantially uniform wall thickness, and the taper of said helical thread form being only sufficient to provide a draft for molding purposes.

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