Sept. 25, 1956

H. J. RAND

2,764,101

HELICAL PUMP

Filed May 27, 1952

2 Sheets-Sheet 1

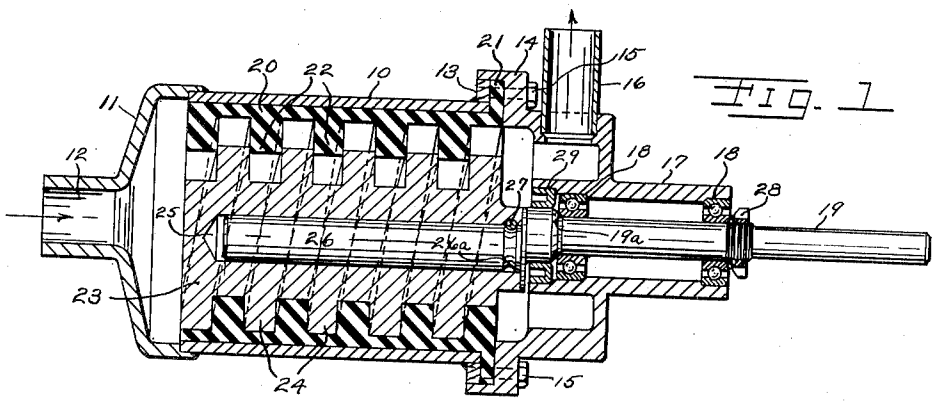


Fig. 1

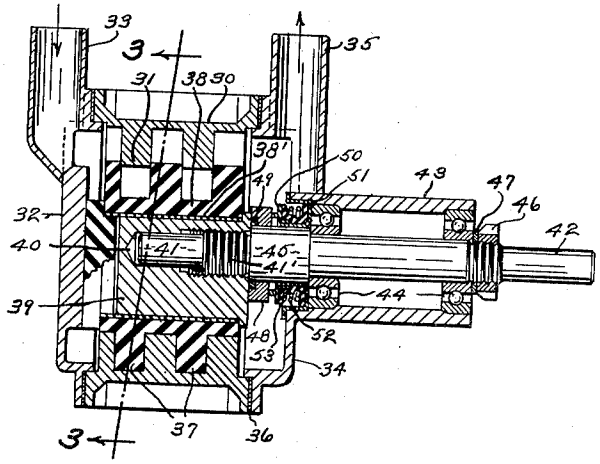


Fig. 2

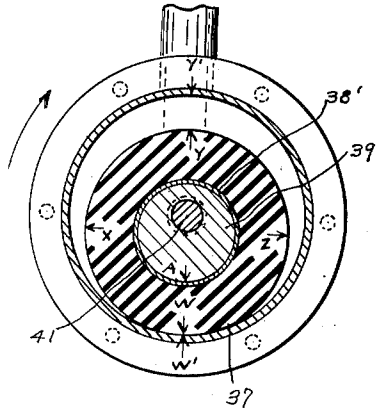


Fig 3

INVENTOR.
HENRY J. RAND

BY
Hyde, Meyer, Baldwin & Doran
ATTORNEYS

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H. J. RAND

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2 Sheets-Sheet 2

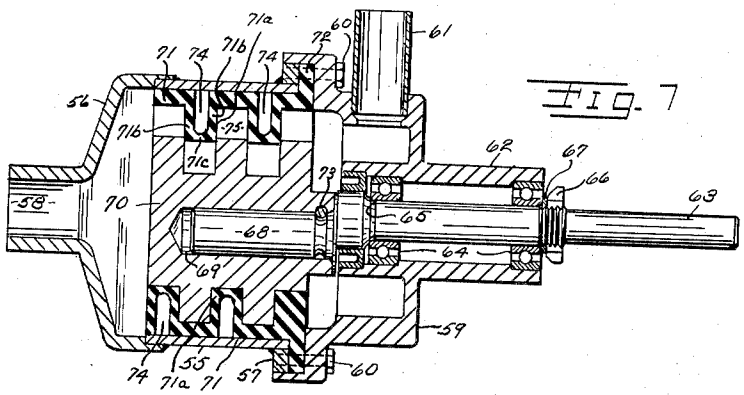


FIG. 7

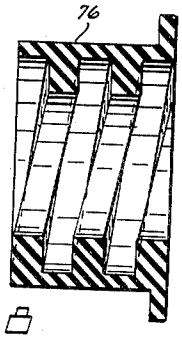


FIG. 8

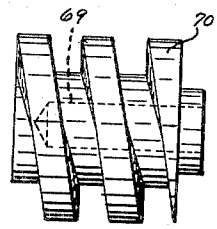


FIG. 9

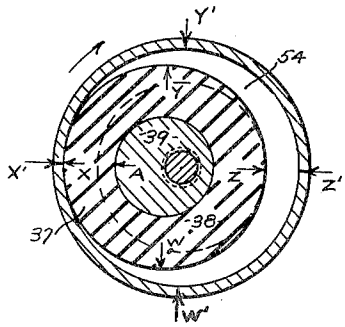


FIG. 4

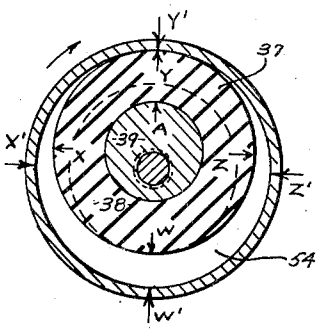


FIG. 5

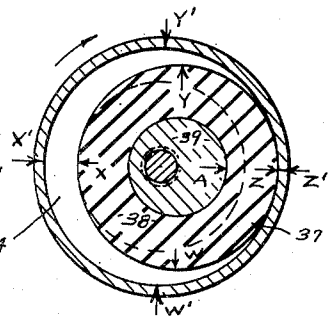


FIG. 6

INVENTOR.
HENRY J. RAND

BY
Hyde, Meyer, Baldwin & Doran
ATTORNEYS

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HELICAL PUMP

Henry J. Rand, Bratenahl, Ohio, assignor, by mesne assignments, to Rand Development Corporation, Cleveland, Ohio, a corporation of Ohio

Application May 27, 1952, Serial No. 290,309

6 Claims. (Cl. 103—131)

This invention relates to improvements in a helical pump, and more particularly to a pump comprising a fixed stator member having an internal helical square thread, inside of which snugly fits a rotor member of smaller diameter having an external helical square thread, and wherein the rotor oscillates, without rotating, eccentrically within the stator.

One of the objects of the present invention is to provide a helical pump of the type described wherein either the stator member of the rotor member is of substantially rigid material and the other of said members is of resilient rubber-like material.

Other objects and advantages of the present invention will be apparent from the accompanying drawings and description and the essential features thereof will be set forth in the appended claims.

In the drawings,

Fig. 1 is a central sectional view of one embodiment of my invention utilizing the said helical threaded rotor and stator members, and wherein the stator member is of rubber-like material and the rotor member is of metal or the like,

Fig. 2 is a central sectional view through a modified form of helical pump wherein the stator member is of rigid material such as metal and the rotor member is rubber or the like,

Fig. 3 is a fragmental sectional view taken along the line 3—3 of Fig. 2,

Figs. 4, 5 and 6 are views similar to Fig. 3 showing successive positions of the rotor member relative to the stator member during oscillation of the rotor member,

Fig. 7 is a central sectional view through still another modification of my pump where the rotor member is of rigid material and the stator member is of rubber-like material cored out to give greater flexibility in the helical threads of the stator member,

Fig. 8 is a central sectional view through a stator member of rubber-like material adapted to be interchangeable with the stator member shown in Fig. 7, while

Fig. 9 is a side elevational view of a rotor member adaptable to cooperate with the stator member of either Fig. 7 or Fig. 8.

One embodiment of my invention is shown in Fig. 1 wherein a pump housing is provided including a generally cylindrical body 10 having one end closed by the head member 11 welded to the cylindrical body, this member 11 being provided with an inlet opening 12 for fluid to be pumped. The other end of the cylindrical member 10 has welded thereto an annular flange 13 to which the head member 14 is secured by means of a plurality of bolts 15. The hollow head 14 communicates with a fluid outlet 16. The member 14 comprises an extension 17 for supporting bearings 18 in which the shaft 19 is rotatably mounted.

Within the cylinder 10, is mounted a fixed stator 20 snugly fitting against the interior surface of the cylinder 10 and having an integral flange 21 lying between the head 14 and the flange 13 and held firmly in place by the bolts 15. The stator 20 is provided with an internal helical square thread 22, the depth of each of the threads being slightly greater than the space between the threads. The space between the threads is about one-half the pitch of the threads.

Snugly fitting, but of smaller diameter, within the stator 20 is a rotor 23 having an external helical square thread 24 of substantially the same pitch and of the same hand as the internal thread 22 of the stator. The depth of the thread 24 and the space between the threads of the rotor member are approximately the same as those of the stator member. In the position shown in Fig. 1, the rotor member 23 is in its lowermost position and it will be noted that the threads 24 of the rotor member on the bottom substantially completely fill the threads of the stator member, while at the top of Fig. 1, the threads 24 of the rotor member are still in sealing engagement with the threads 22 of the stator member.

Axially of the rotor member 23 there is provided a cylindrical opening 25. Fitting within this opening 25 is a shaft portion 26 which is rigid with and eccentric of the shaft 19. The eccentricity of the shaft portion 26 relative to the shaft 19 is approximately equal to one-half of the space between the threads 22. The rotor member 23 is fixed against endwise movement on the shaft portion 26 by means of a snap ring 27 which fits in a groove 26a of the shaft portion 26. It will be understood that the rotor 23 is permitted to move arcuately about the shaft portion 26 but without endwise movement relative thereto. The shaft 19 is prevented from endwise movement by means of the shoulder 19a engaging against the left-hand bearing 18. while the collar 28 threaded on shaft 19 engages against the right-hand bearing member 18. It will be noted that the bearings 18 are inset into the extension 17 so that they do not move endwise. Leakage of the fluid being pumped along the shaft 19 is prevented by a resilient sealing member 29.

In the operation of the pump of Fig. 1, driving means is applied to the shaft 19 to rotate it. This causes oscillation of the shaft 26 in an eccentric circle with the axis of the rotor 23 always parallel to the axis of the stator 22 but with the rotor moving in a small circle so that the threads 24 of the rotor progressively fill the threads 22 of the stator moving from the lowermost position shown in Fig. 1 around a circle until the rotor completely fills the threads 22 at the upper portion of the stator after180 degrees revolution of shaft 19, at which time the threads 22 at the bottom of the stator are open and the threads at the top of the stator 22 are closed. As a result of this oscillation movement of the rotor 23, without actual rotation thereof, fluid entering at 12 is gradually forced along the threads of the stator by means of the threads of the rotor until the fluid is discharged at 16.

A modified form of my invention is shown in Figs. 2 to 6 inclusive. In the form of the invention, the stator member 30 is of rigid material such as metal and is provided with an internal helical square thread 31, preferably having the depth of each thread slightly greater than the space between the threads and the space between the threads is approximately one-half the pitch of the thread. Secured to opposite ends of the stator 30 are the head member 32, provided with inlet 33, and the head member 34, provided with the outlet 35. The heads 32 and 34 are secured to the stator by any suitable means and sealed against leakage as indicated at 36. Snugly fitting within the stator threads 31 are the rotor threads 37 provided on a body 38 of rubber-like material. The rubber-like material 38 is bonded to an internal sleeve 38' of metal or the like. The sleeve 38' is freely rotatable upon a cylindrical metal body 39 in which is provided an eccentric cylindrical opening 40 having an axis parallel to the cylindrical axis of the member 39. Fitting into the recess

40, is a cylindrical end 41 which is a portion of the shaft 42. This portion 41 is provided with threads 41' which thread into the body 39 so as to hold the eccentric 39 on the shaft 42. The shaft 42 is mounted for rotation in an extension 43 of the head member 34. For this purpose, a pair of bearings 44 are mounted in recesses in the projection 43 against endwise movement. A shoulder 45 on the shaft 42 rests against the left-hand face of the left-hand bearing 44 as seen in Fig. 2 and a nut 46 threaded on shaft 42 bears against a washer 47 which in turn bears against the right-hand face of the right-hand bearing 44. This prevents endwise movement of shaft 42 during its rotation.

Means is provided to seal the pump against leakage. This comprises a known kind of seal comprising a collar 48 surrounding a shaft portion 45 and carrying an annular ring of sealing material 49 which is pressed against the right-hand end of the member 39. Collar members 50 and 51 provide seats for a small helical spring 52 which presses the seat 50 against the ring 48 so as to maintain the seal 49. A rubber sleeve 53 extends continuously around the joint between the members 50 and 51, inside of the spring 52, and prevents leakage from the pump outwardly along shaft 42 to the right-hand side of the larger shaft portion 45 as viewed in Fig. 2.

The operation of the form of my invention shown in Fig. 2 is similar to that described in connection with Fig. 1. Means, not shown, is provided for rotating shaft 42 continuously in the same direction. The eccentric 39 rotating inside of the sleeve 38' causes the rubber block 38 to oscillate in a small circle without rotating. The position of the parts during 360 degrees of rotation is shown in Figs. 3 to 6 inclusive. The position of the parts in Fig. 3 is like that shown in Fig. 2. The external thread 37 is in its lowermost position where it completely fills the internal thread 31, these threads being tangential at the points W, W'. The unfilled portion of the grooves in communication with the inlet 33 then fills with liquid. After 90 degrees rotation, the parts have the position shown in Fig. 4 where the point A on the member 39 has rotated 90 degrees from the position of Fig. 3 to the position of Fig. 4. It will be noted that the position X on the external thread 37 has now moved into tangential position at the point X' of the thread 31 of the stator. This moves the liquid ahead of the advancing rotor along each of the helical threads in the chamber 54 as indicated in Fig. 4.

In Fig. 5, the member 39 has rotated another 90 degrees in a clockwise direction from the position of Fig. 4 and this carries the rubber block 38 and its thread 37 (without rotation) so that the point Y thereon comes into tangential relationship with the point Y' of the stator. This further drives the liquid in a clockwise direction around the empty space 54 of the helical threads.

In Fig. 6, the member 39 has rotated 90 degrees in a clockwise direction from the position of Fig. 5 carrying the point Z on the rotor into tangential relationship with the stator at the point Z'. This further drives the liquid through the helical space 54 of the unfilled portion of the threads.

A further 90 degrees rotation in a clockwise direction from Fig. 6 carries the parts to the starting position shown in Fig. 3. It will be noted that the external threads 37 of the rotor have slightly greater depth than the eccentric movement of the member 39 relative to the shaft 42 so that when the parts are in the position of Fig. 2, the threads 37 fill the lowermost portion of the helical grooves in the stator while the threads 37 at the top of the rotor still remain in engagement with the internal threads 31 of the stator so that liquid in the unfilled portion of helix is sealed therein and must move along the helix. Thus, during rotation of shaft 42, liquid is continuously taken in at the inlet 33 and discharged at the outlet 35.

It will be noted that the problem of sealing throughout the length of the helical pump in order to deliver a given pressure at 16 in Fig. 1 or at 35 in Fig. 2 is simplified according to the number of helical threads engaged. In other words, whatever the difference in pressure between the inlet 12 and the outlet 16 of Fig. 1, the pressure builds up step by step in the helical threads progressively through the pump. Thus each thread has to be sealed against the next succeeding only for a portion of the total difference in pressure between 12 and 16 and, therefore, the sealing problem is divided into steps according to the number of helical threads in my pump.

Another modification of my invention is shown in Fig. 7. The construction is quite similar to Fig. 1 except for the length of the helical members and the details of construction of the stator member. The pump housing comprises a cylindrical main portion 55 to which are welded the head 56 and a flange 57 to which the opposite head is secured. The head 56 is provided with a fluid inlet 58. Tht head 59 is secured to the flange 57 by means of bolts 60. The head 59 is provided with the outlet for fluid pump at 61. The head 59 also has a projection 62 in which is rotatably mounted a shaft 63 by means of the bearing 64. A shoulder 65 on the shaft and a nut 66 engaging against a washer 67 prevent endwise movement of shaft 63. A portion of shaft 63 eccentric thereto is indicated at 68. This is rotatably mounted in a recess 69 in a rotor member 70 which is provided with an outside helical square thread. The stator comprises a rubber-like member 71 having a flange 72 which is held between the flange 57 and the cover or head member 59 so as to prevent endwise movement of the stator. The stator is provided with an internal square thread of helical form adapted to fit snugly in the thread of the rotor 70. As in previous forms of my invention, the rotor 70 is oscillatable by means of the eccentric 68 when shaft 63 is rotated continuously in one direction. The rotor always has its axis parallel to the axis of the stator and the axis of the rotor moves around a small circle equal to the eccentricity of the member 68 with reference to shaft 63. The rotor is held against endwise movement by means of a snap ring 73 engaged between rotor 70 and shaft portion 68.

The modification to which I wish to call attention in Fig. 7 comprises the construction of the stator 71 wherein the threads 71*a* are cored out as indicated 74 so as to provide cheek portions 71*b* and interior diameter or root portions 71*c* which are of approximately the same thickness. In one form of my invention, where the stator is of a diameter between two and three inches, the thickness of the walls at 71*b* and 71*c* is about ⅛ of an inch. It should be understood that the cored portion 74 is helical in form and follows the contour of the threads 71*a* of the stator. It results from this construction of the stator, that I can use a fairly firm rubber and obtain more resiliency of the stator than in the form of my device shown in Fig. 1 where the threads 22 of the stator are of solid rubber-like material.

The operation of the form of my device shown in Fig. 7 is like that already described in connection with Figs. 1 and 2. As the rotor 70 oscillates about its circle, without actually rotating, the threads of the rotor fill the threads of the stator at the bottom, as shown in Fig. 7, and then gradually around 360 degrees as described in connection with Figs. 3 to 6 inclusive. The threads of the rotor are never completely disengaged between the spaces of the threads of the stator as clearly shown in Fig. 7 where the threads of these two members overlap slightly at the upper portion of the drawing. Fluid is thus forced through the pump from the inlet 58 to the outlet 61, moving through the open spaces 75 between the square helical threads of the rotor and stator, at all times being sealed against leakage from one thread to the next thread.

Fig. 8 shows a stator 76 exactly like the stator 71 of Fig. 7 except that the threads thereof in the rubber-like material are solid instead of cored out. The member

76 may be substituted for the member 71 in the combination of Fig. 7.

In Fig. 9 I have shown a side elevational view of the rotor 70 of Fig. 7 and, of course, this rotor may cooperate with the stator 71 of Fig. 7 or with the stator 76 of Fig. 8.

I find that for the stators 20, 71 and 76 or for the rotor 38 of Fig. 2, I may use natural or synthetic rubber having a durometer hardness between 50 and 85. Using the softer rubber-like material, fairly sizable solids may pass through my pump without injuring the same because these solids embed themselves in the rubber-like member, if the rubber material is not too hard. For this reason I do not like the harder durometer rubber between 70 and 85. I find that from 50 to 55 durometer hardness of rubber-like material will operate as a pump but this is subject to such deformation between the helical threads of the rotor and stator as to increase the friction and decrease the performance of the pump particularly at high pressures or at low vacuums. I, therefore, prefer rubber-like material of a durometer hardness between 55 and 70.

As mentioned previously, I can obtain a greater flexibility of a rubber having a durometer hardness between 55 and 70 by coring out the threads as described in connection with Fig. 7. I find I may obtain a similar result using the construction of Fig. 1 or using the stator 76 in Fig. 7, but in this case in order to reduce the friction between the helical threads of the rotor and stator I provide a clearance between the threads of the order of not more than two percent of the pitch of the threads. In other words, where the helical threads have a major diameter of 2⅞ inches and a minor diameter of 1¾ inches and a lead or pitch of 1 inch, I provide a clearance of not substantially more than .020 inch between the threads of the rotor and stator. I find that such a pump will operate efficiently and with less friction than where the rotor and stator threads fit snugly into each other.

My improved pump will work not only with liquids but also with other fluids such as air and gases and makes a very good vacuum pump. I find that when my pump when designed to pump 12 to 15 gallons per minute of water may be operated by a one-quarter horse power motor without any gear reduction. Such a pump will also pull a twenty-nine inch vacuum. Under such a heavy vacuum, a rubber stator as shown in Figs. 1, 7 and 8 will shrink toward the rotor under a heavy vacuum and thus increase the friction between the parts very greatly. I find I can cure this by using a rubber-like rotor and a steel stator as shown in Fig. 2.

In all forms of my pump, either the stator member or the rotor member is formed of rubber-like material. I find this is necessary because, during the motion of the parts as exemplified in Figs. 3 to 6 inclusive, one of the members must warp because of the rubbing of the helical thread surfaces upon each other when the threads are of different diameter and, therefore, have a different angle to their cheek surfaces. I find, however, that if the rubber is too soft or too hard, efficient pumping operation is not produced.

In all forms of my invention, it will be noted that the outside pump member, having the female thread, has a thread of larger diameter than the inside pump member, having the male thread. Since these two threads have the same pitch, it is obvious that the helix angles

of the two threads are different. It is to accommodate this difference in helix angles that I make either one or the other of these members, the stator or the rotor, of rubber-like material. Then as the stator and rotor partake of relative oscillation about a small circle (without rotation), whichever member is of rubber-like material takes up the distortion due to the difference in helix angles of the mating threads. This provides a tight pump with little leakage past the threads even during long use.

What I claim is:

1. A pump comprising a fixed stator member having an internal helical square thread, a rotor member having a body with an integral external helical square thread of the same pitch and hand as said internal thread, a housing surrounding said members and having a fluid inlet at one end of stator member and having a fluid outlet at the opposite end thereof, said housing sealed around the periphery of said stator member, the threads of said rotor member fitting snugly into the spaces between said stator member threads, the outside diameter of said external threads being less than the outside diameter of said internal threads and greater than the inside diameter of said internal threads plus the depth of the thread, a drive shaft coaxial with said stator and having an eccentric coaxial with said rotor member, said rotor member mounted on said eccentric with a cylindrical bearing between the interior of said rotor member body and the exterior of said eccentric for oscillation of said rotor member with its axis parallel to the axis of said stator member and with the axis of said rotor member following a circular path eccentric about the axis of said stator member with an eccentricity less than the depth of said threads, means preventing relative axial movement between said members so that said rotor member does not rotate but oscillates in a circular orbit, one of said members being of substantially rigid material, and the other of said members being of resilient rubber-like material.

2. The combination of claim 1 wherein said member of resilient rubber-like material has a durometer hardness of 50 to 85.

3. The combination of claim 1 wherein there is a clearance between the threads of said rotor and stator members, measured axially, of approximately two per cent of said pitch.

4. The combination of claim 1 wherein said rotor is of resilient rubber-like material.

5. The combination of claim 1 wherein said stator is of resilient rubber-like material.

6. The combination of claim 1 wherein said stator is of resilient rubber-like material having internal threads having a root diameter and thread sides approximately at right angles to said root diameter, said internal threads being cored out with a hollow center providing approximately equal thicknesses of said rubber-like material along said sides and along the said root diameter of said internal thread.

References Cited in the file of this patent

UNITED STATES PATENTS

2,028,407	Moineau	Jan. 21, 1936
2,293,268	Quiroz	Aug. 18, 1942
2,527,536	Enberg	Oct. 31, 1950

FOREIGN PATENTS

446,291	Great Britain	Apr. 27, 1936
699,642	France	Dec. 16, 1930