March 11, 1958 A. W. McCRAY 2,826,151

FLEXIBLE FLUID SEAL PUMP

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Fig. 1.

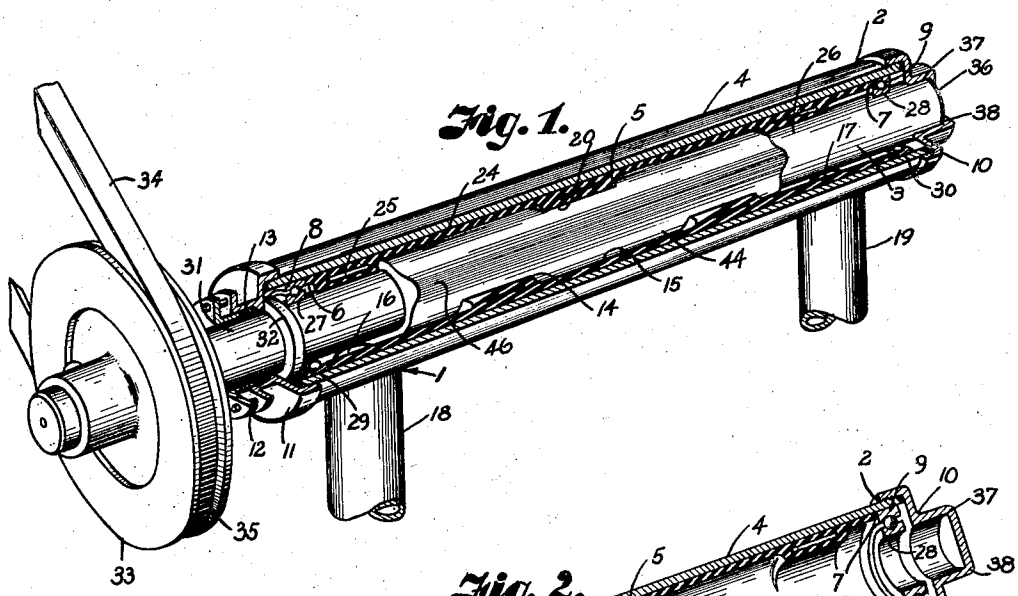


Fig. 2.

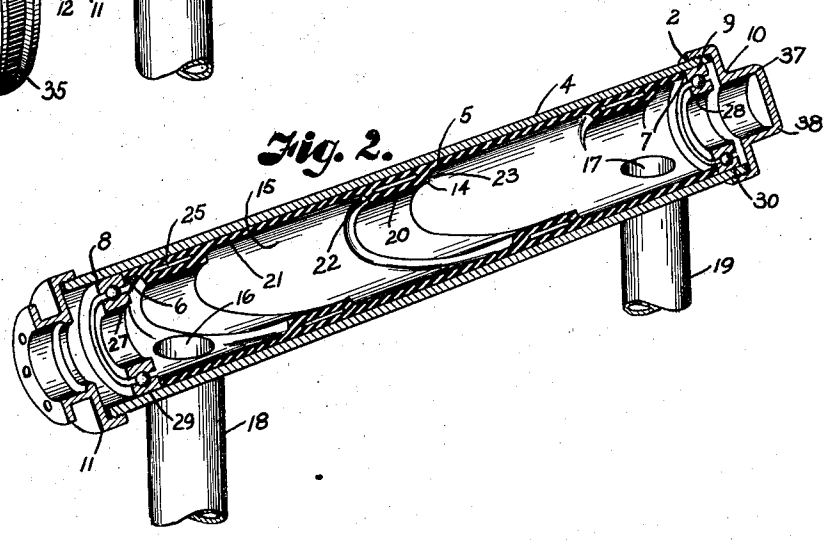
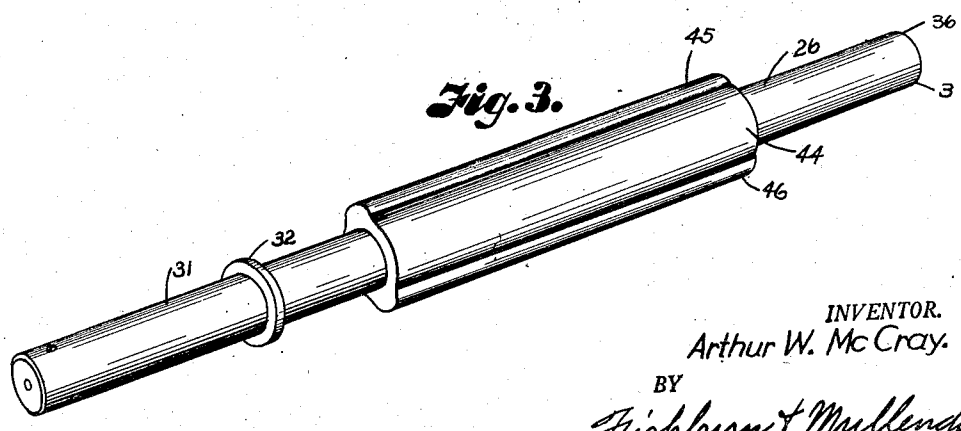


Fig. 3.



INVENTOR.
Arthur W. McCray.

BY
Fishburn & Mullendore
ATTORNEYS.

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Fig. 4.

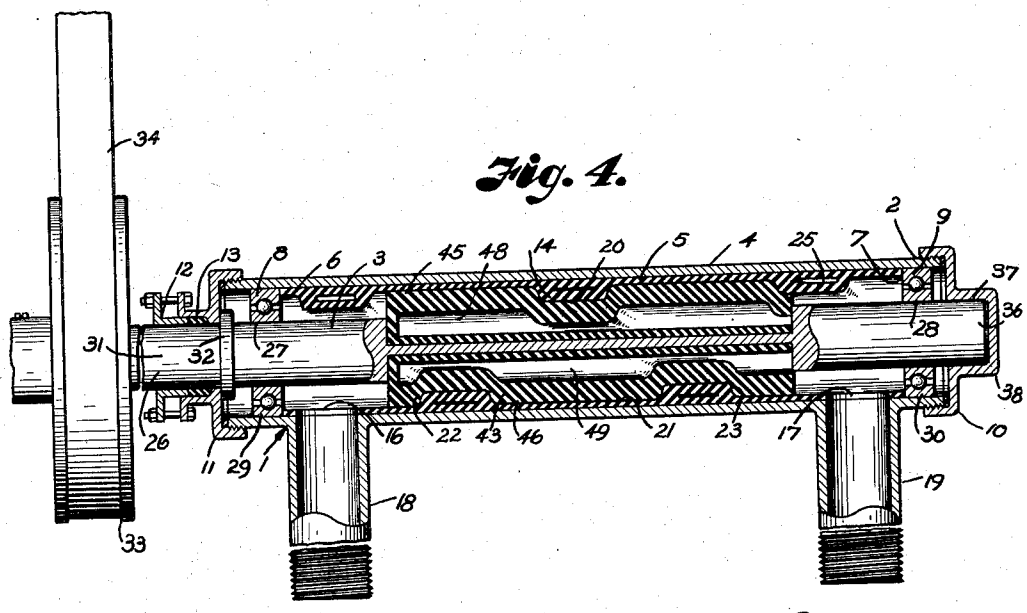


Fig. 5.

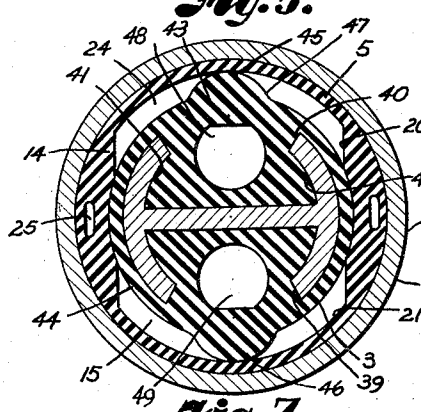


Fig. 6.

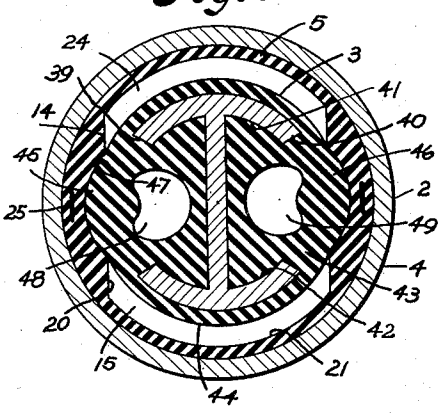
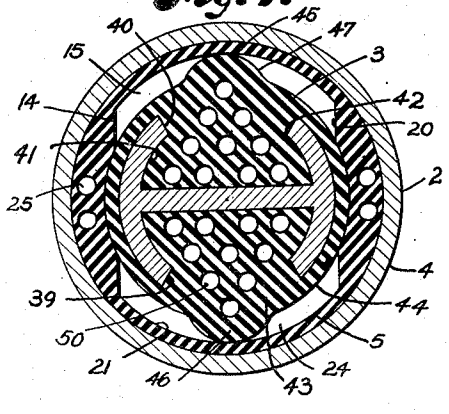


Fig. 7.



INVENTOR.
Arthur W. Mc Cray.
BY
Fishburn & Mullendore
ATTORNEYS.

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FLEXIBLE FLUID SEAL PUMP

Arthur W. McCray, Norman, Okla.

Application December 16, 1954, Serial No. 475,622

9 Claims. (Cl. 103—117)

This invention relates to a pump or motor of the type including a stator and a rotor operable about a fixed axis of the stator and having a fluid displacement element cooperating with the corresponding element of the stator for moving fluid under pressure and has for its principal object to provide a pump or motor of this character with with effective and efficient displacement elements at least one of which is formed of resilient material to make a fluid tight seal with respect to the other.

It is a further object of the invention to utilize the high pressure at the discharge of the pump in maintaining and/or transmitting a fluid pressure on one element to retain contact thereof with the other element.

Other objects of the invention are to provide a pump wherein one of the elements is of generally spiral formation and the other a transverse barrier which yields when in sliding contact with the spirals and expands into the spaces between the spirals thereby providing a plurality of sealing contacts for progressively moving the fluid ahead of the barriers from low to high pressure; to provide a pump or motor wherein the fluid will flow at a constant rate without volume or pressure surging of the fluid; to provide a pump or motor having a lightweight high-capacity ratio; to provide a structure free of the usual valves and associated passageways characteristic of the usual pump; and to provide a pump or motor wherein the yieldable elements provide a highly efficient seal between the rotor and stator.

In accomplishing these and other objects of the invention, as hereinafter pointed out, I have provided improved structure the preferred forms of which are illustrated in the accompanying drawings wherein:

Fig. 1 is a perspective view of a pump including a stator and a rotor constructed in accordance with the present invention, the wall of the stator being broken-away and shown in section to better illustrate the interior construction of the pump.

Fig. 2 is a perspective sectional view of the stator particularly illustrating the generally spiral or helical element thereof that forms a passageway or pressure chamber for the fluid.

Fig. 3 is a perspective view of the rotor.

Fig. 4 is a longitudinal section through the pump, to better illustrate the inlet and outlet connections.

Fig. 5 is an enlarged cross section through the pump showing the yieldable element on the rotor moving through the spiral pressure chamber of the rotor.

Fig. 6 is a similar section but showing the yieldable elements of the rotor sliding across the yieldable spirals of the stator.

Fig. 7 is a similar section through a modified form of the invention.

Referring more in detail to the drawings:

1 designates a pump constructed in accordance with the present invention and which includes stator and rotor members 2 and 3, one rotatably mounted within the other. In the illustrated instance the stator 2 includes a generally elongated cylindrical casing or housing 4 having a

flexible or resilient lining 5 that is formed of rubber, synthetic, plastic or other material capable of providing a sealing contact of the rotor as later described. The lining 5 has opposite ends 6 and 7 inset from corresponding ends of the cylindrical housing 4 to accommodate anti-friction bearings 8 and 9 for journalling the rotor. One end of the cylindrical housing is closed by a cap 10 which extends over and closes the corresponding end of the rotor. The opposite end of the housing is closed by a head 11 having a stuffing box 12 that maintains a liquid-tight seal 13 about a projecting end of the rotor. The lining 5 fits snugly within the housing 4 and is fixed from rotation therein in any suitable manner. The interior of the liner is provided with a rib 14 extending spirally along the length of the lining and forming a continuous spiral passageway 15 extending from a fluid inlet port 16 at one end to an outlet or discharge port 17 at the other end. The inlet and outlet ports 16 and 17 register with and connect to intake and discharge ducts 18 and 19 respectively that are suitably connected with the wall of the housing to provide fluid-tight joints. The spiral rib 14 is preferably provided with a generally cylindrical inner face 20 off-set inwardly toward the axis of the stator from a generally cylindrical face 21 of the spiral passageway 15, the face 20 being of adequate length to maintain a positive seal with the rotor, as later described, and the length of the face 20 being of a length relative to the side faces 22 and 23 of the spiral rib to provide a spiral pressure chamber 24 with the desired flow capacity of the pump. The spiral rib 14 is preferably provided with one or more passageways 25 extending the length of the spiral and closed at the end having the inlet port 16. The opposite end of the passageways 25 however, connects with the discharge port 17 to provide passage of pressure fluid thereinto for cooperating with the inherent resiliency of the lining material to maintain a seal with the rotor as later described.

The rotor 3 includes a shaft 26 of smaller exterior diameter than the internal diameter of the spiral rib. The shaft 26 carries the inner races 27 and 28 of the anti-friction bearings 8 and 9 respectively, and the outer races 29 and 30 are pressed into the ends of the housing 4 prior to application of the end closures 10 and 11, as best shown in Fig. 4. The end 31 of the shaft that extends through the stuffing box is preferably provided with a thrust collar 32 which engages the head 11 and cooperates with the anti-friction bearings in resisting axial thrust on the rotor.

The projecting end 31 of the shaft carries a driving member which in the illustrated instance is a pulley 33 that is adapted to be actuated from a suitable prime mover (not shown) through a belt 34 operating in a groove 35 of the pulley 33, as shown in Figs. 1 and 4. The opposite end 36 of the shaft may be contained within a recess 37 that is provided in a boss 38 of the closure cap 10.

Formed in opposite diametric sides of the shaft 26 and extending from a point adjacent the intake port 16 to a point adjacent the exhaust port 17 are longitudinal grooves or recesses 39 and 40 that are preferably undercut as at 41 and 42 to key a resilient material therein to form a resilient sheath 43 on the shaft of the rotor. The resilient sheath 43 is molded upon or otherwise applied to the shaft of the rotor so as to provide a cylindrical body 44 having sealing contact with the inner face 20 of the spiral rib 14 of the stator as best shown in Fig. 5. The resilient body or sheath portion of the rotor also includes spaced substantially parallel ribs 45 and 46 located on opposite diametric sides of the rotor and in registry with the grooves of the shaft. The ribs 45 and 46 are shown in the present instance as being of substantially semi-circular cross section and they tangentially contact the face 21 to form barriers 47 for propelling the fluid for-

wardly of the spiral and in the direction of rotation of the rotor as the rotor turns within the stator. When the ribs of the rotor move across the ribs of the spiral, the parts yield and are pressed together incidental to the inherent flexibility of the material and provide pressure seals to eliminate leakage of the fluid from the spiral pressure chambers that are thus formed between the spirals.

With this arrangement, the ribs 45 and 46 of the rotor 3 extend longitudinally and parallel with the axis of the housing 4 so that the contact points thereof, with the spiral or helical rib of the stator, shift progressively about the pressure chamber during rotation of the rotor. Pressure of the fluid is established at the discharge port and is preferably used to apply an internal pressure within the rotor to cooperate in facilitating retention of the ribs or longitudinal barriers in sealing contact with the inner surfaces of the rotor; this is effected by providing the rotor with longitudinal passageways 48 and 49 that extend longitudinally of the rotor and in registry with the ribs 45 and 46. The end of the passageways are open at the pressure end thereof whereby high pressure of the fluid acts within the passageways to support the ribs of the rotor and retain them in contact with the surfaces of the stator as shown in Fig. 5. However, as the ribs or barriers move across the rib portions of the spirals, the material flexes inwardly of the passageways, as shown in Fig. 6.

The form of the invention shown in Fig. 7 is similar to the form illustrated in Fig. 6 with the exception that the passageways 50 formed in the rotor for establishing the internal pressure are smaller and arranged through a larger cross sectional area of the rotor.

Assuming that the pulley 33 of the pump is connected through the belt 34, with the pulley of a prime mover, such as an electric motor (not shown), the rotor 3 rotates within the stator 2 and fluid at intake pressure enters the port 16 and passes longitudinally through the spiral chamber 24 of the stator 2 with the fluid being confined therein by the helical seals between the ribs 45 and 46 of the rotor 3 and the spiral rib 14 of the stator. As the rotor 3 turns within the stator 2 the ribs 45 and 46 contact the cylindrical faces between the spirals to provide the barriers whereby the fluid is propelled under pressure progressively through the spiral passage 15 with the space on the adjacent sides of the longitudinal rib being swept out by the barrier portions of the ribs, as shown in Fig. 5. Thus the fluid, which occupies the space between the barriers, is forced ahead as the spiral rib or helix progresses longitudinally and forwardly. Since the seals are hollow, with the up-stream ends thereof closed and the down-stream ends open to the discharge pressure, the passageways therein are filled with fluid whose pressure is substantially equal to the discharge pressure of the pump. Therefore, the pressure within the interior of the flexible seals assures that the flexible fluid seals maintain the shape of the portions of the stator over which they are moved. These forces are also supplemented by centrifugal forces developed through rotation of the rotor to further hold the seals and when the ribs of the rotor pass the rigid seals or ribs of the stator the ribs will flex but the pressure seal is maintained by the internal pressure effected through the discharge passage of the pump and the normal resilient action of the material from which the seals are formed.

While I have shown two longitudinal ribs on the rotor and a single spiral rib on the stator, it is obvious that one or more longitudinal ribs may be used with a greater number of spirals on the stator. It is also apparent that the number of longitudinal seals may be varied depending upon the pitch of the spiral and length of the pump desired.

While I have specifically described the invention in the form of a pump, it is obvious that it is also adapted to a motor when it is supplied with a pressure fluid.

While I have specifically described the stator and rotor as basically cylindrical in shape it is obvious that other shapes are adaptable to the invention, for example, that the stator or rotor or both could be conical with generally straight sides or curved, resembling a bell in shape.

Another variation within the scope of the invention is that the spiral ribs may be on the rotor and the longitudinal ribs on the stator instead of the rib arrangement as illustrated and described. Also it is obvious that generally spiral ribs may be used on both stator and rotor, provided only that the rib or ribs on one member extend across the space or spaces between the rib or ribs of the other member.

What I claim and desire to secure by Letters Patent is:

1. An apparatus of the character described, including generally cylindrical rotor and stator members, one positioned coaxially within the other and having spaced apart cylindrical faces, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a resilient spiral rib projecting from the cylindrical face of one member and contacting the cylindrical face of the other member and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a rib extending longitudinally of the other member and projecting from the cylindrical face thereof into compressing relation with the spirals of said spiral rib and into sealing contact with the cylindrical face between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor.

2. An apparatus of the character described, including generally cylindrical rotor and stator members, one positioned coaxially within the other and having spaced apart cylindrical faces, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a resilient spiral rib projecting from the cylindrical face of one member and contacting the cylindrical face of the other member and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a rib extending longitudinally of the other member and projecting from the cylindrical face thereof into compressing relation with the spirals of said spiral rib and into sealing contact with the cylindrical face between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor, said resilient rib having an internal passage in connection with the discharge port to establish discharge pressures within said rib.

3. An apparatus of the character described, including generally cylindrical rotor and stator members, one positioned coaxially within the other and having spaced apart cylindrical faces, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a spiral rib projecting from the cylindrical face of one member and contacting the cylindrical face of the other member and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a resilient rib extending longitudinally of the other member and projecting from the cylindrical face thereof in compressing relation with the spiral rib at crossing points of the spirals and in sealing contact with the cylindrical face between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor.

4. An apparatus of the character described, including generally cylindrical rotor and stator members, one positioned coaxially within the other and having spaced apart cylindrical faces, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a spiral rib projecting from the cylindrical face of one member and contacting the cylindrical face of the other member and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a resilient rib extending longitudinally of the other member and projecting from the cylindrical face thereof in compressing relation with the spiral rib at crossing points of the spirals

and in sealing contact with the cylindrical face between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor, and said resilient rib having an internal passage in connection with the discharge port to establish discharge pressures in said rib.

5. An apparatus of the character described, including generally cylindrical rotor and stator members, one positioned coaxially within the other and having spaced apart cylindrical faces, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a resilient spiral rib projecting from the cylindrical face of one member and contacting the cylindrical face of the other member and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a resilient rib extending longitudinally of the other member and projecting from the cylindrical face thereof, said ribs being in compressing relation with each other at crossing points of the spirals of said spiral and in sealing contact with the cylindrical faces between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor.

6. An apparatus of the character described, including generally cylindrical rotor and stator members, one positioned coaxially within the other and having spaced apart cylindrical faces, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a resilient spiral rib projecting from the cylindrical face of one member and contacting the cylindrical face of the other member and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a resilient rib extending longitudinally of the other member and projecting from the cylindrical face thereof, said ribs being in compressing relation with each other at crossing points of the spirals of said spiral and in sealing contact with the cylindrical faces between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor, and said resilient ribs having passageways in connection with the discharge port for establishing discharge pressure within said ribs.

7. An apparatus of the character described, including generally cylindrical rotor and stator members, one positioned coaxially within the other and having spaced apart cylindrical faces, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, antifriction bearings having support within ends of the stator member, a shaft journaled in the bearings for carrying the rotor member, means for closing ends of the stator member about the shaft, a resilient spiral rib projecting from the cylindrical face of one member and contacting the cylindrical face of the other member and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a rib extending longitudinally of the other member and projecting from the cylindrical face thereof into compressing relation with the spirals of said spiral rib and into sealing contact with the cylindrical face between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor.

8. An apparatus of the character described, including a generally cylindrical stator member, a shaft rotatable in the stator, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a resilient lining within the stator and having a resilient spiral rib projecting from an inner cylindrical face of the liner and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a fluid displacement means on the shaft and also of resilient material and having a cylindrical face in contact with the resilient spiral rib for closing the inner side of the spiral passageway, said displacement means having a resilient rib extending longitudinally thereof and projecting from a cylindrical face thereof into compressing relation with the spirals of said spiral rib and into sealing contact with the cylindrical face between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor.

9. An apparatus of the character described, including a generally cylindrical stator member, a shaft rotatable in the stator, the stator having a fluid inlet port and a fluid discharge port at respective ends thereof, a resilient lining within the stator and having a resilient spiral rib projecting from an inner cylindrical face of the liner and providing a spiral passageway extending from the fluid inlet port to the discharge port, and a fluid displacement means on the shaft and also of resilient material and having a cylindrical face in contact with the resilient spiral rib for closing the inner side of the spiral passageway, said displacement means having a resilient rib extending longitudinally thereof and projecting from a cylindrical face thereof into compressing relation with the spirals of said spiral rib and into sealing contact with the cylindrical face between said spirals, thereby providing fluid barriers across said passageway for propelling fluid from the intake port to the discharge port upon actuation of the rotor, said displacement means and lining having passageways connected with the fluid discharge port for equalizing the fluid pressure within said spiral passageway for enhancing effectiveness of the sealing contact of said resilient material.

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