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3,208,392

REVERSIBLE GEAR PUMP WITH UNIDIRECTIONAL FLOW

Filed Oct. 15, 1962

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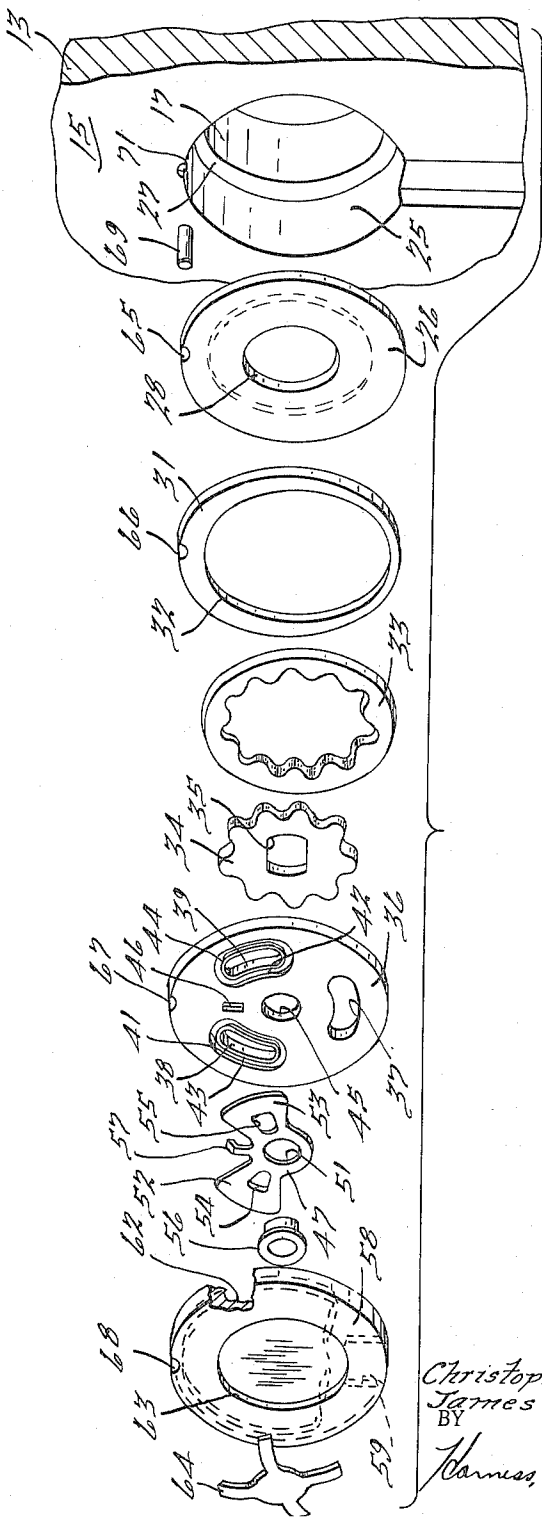


FIG. 1.

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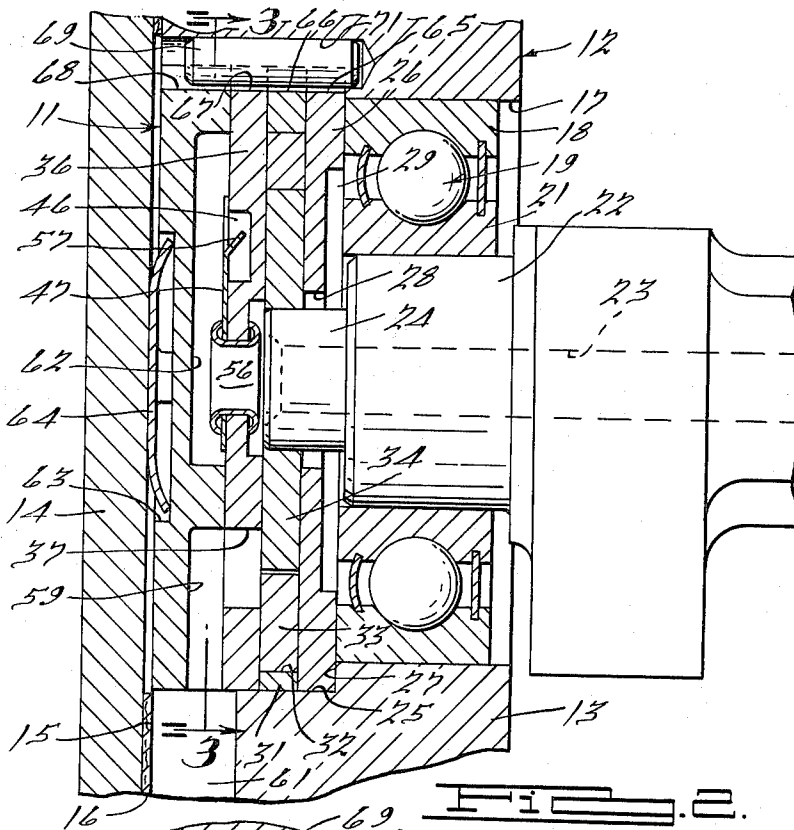
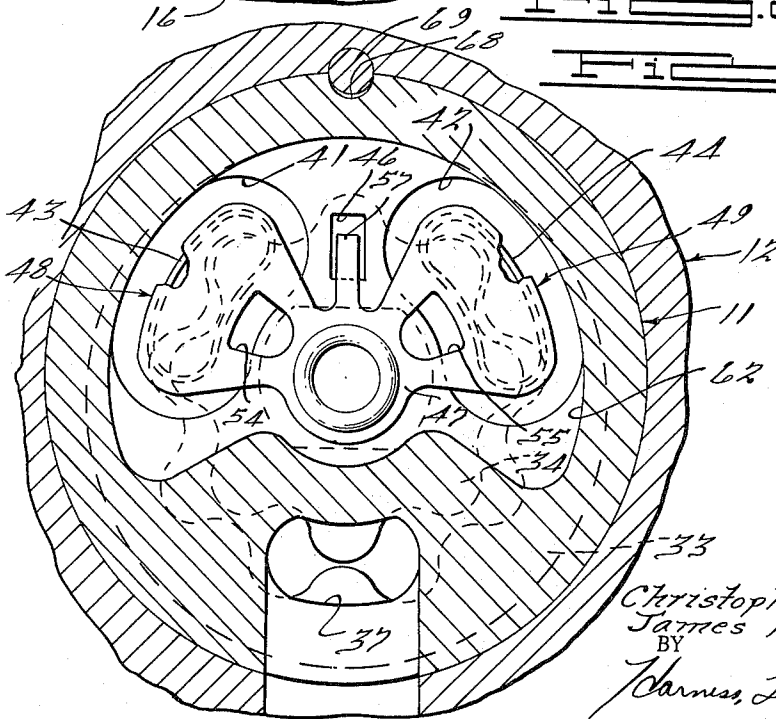


FIG. 2.

FIG. 3.



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REVERSIBLE GEAR PUMP WITH UNIDIRECTIONAL FLOW

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9 Claims. (Cl. 103-126)

This invention relates to pumps, and more particularly to gear pumps of the type which provide unidirectional flow regardless of reversals in the direction of rotation of the pump elements.

It is an object of the invention to provide a unidirectional flow reversible gear pump which eliminates the need for rocking or rotating parts other than the pump elements themselves, and thus avoids the necessity of reliance on frictional connections heretofore used for shifting such rotating parts.

It is another object to provide an improved unidirectional flow pump of this character which is of extremely compact and rugged construction, using relatively few parts and without bulky check valves or other components.

It is a further object to provide an improved unidirectional flow pump having these characteristics, which is especially adapted for use in circulating a shaft lubricant.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is an exploded perspective view of a preferred embodiment of the invention showing the various elements;

FIGURE 2 is a side elevational view in cross section of the pump assembly; and

FIGURE 3 is an end cross-sectional view in elevation taken along the line 3-3 of FIGURE 2 and showing further the configuration of the parts.

Briefly, the illustrated embodiment of the invention comprises inner and outer gear pump elements rotatable within an eccentric retainer by a shaft extending to one side thereof. A porting plate on the other side of the pump elements has two circumferentially spaced discharge ports leading to a common discharge chamber and an inlet port spaced from the discharge ports and located in the area of maximum separation of the pump elements. A reed of flat resilient material is secured to the side of the porting plate facing away from the pump elements and has a pair of flappers overlapping the discharge ports. When the pump elements are rotated in one direction, fluid will be drawn from the inlet port and discharged through that discharge port located in the area where the volume between the pump elements decreases, the corresponding flapper being lifted away from this discharge port by fluid pressure. The discharge port located in the area where the volume between the pump elements increases will be closed by the flapper. Reversal of the direction of pump rotation will cause the two discharge ports to reverse their functions, the fluid continuing to flow to the common discharge chamber.

Referring more particularly to the drawings, the pump is generally indicated at 11 in FIGURE 2 and is shown as mounted in a housing generally indicated at 12 having a vertical wall 13 and a cover 14 secured to one surface 15 of wall 13, a gasket 16 being disposed between the wall and cover. A bore 17 is formed in wall 13 and carries the outer race 18 of an anti-friction bearing generally indicated at 19. The inner race 21 of bearing 19 is secured to a shaft 22 which may be a crankshaft and through which an axial bore 23 extends. An end 24

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of reduced diameter and non-circular cross section is formed on shaft 22 and extends into a bore 25 in wall 13 which is of larger diameter than bore 17. Pump 11 is disposed within bore 25 and is arranged to pump fluid such as a lubricant into bore 23.

Pump 11 comprises a circular separator plate 26 engaging the shoulder 27 between bores 17 and 25 and having a clearance aperture 28 for shaft extension 24 as well as a flat circular recess 29 facing bearing 19. A retainer 31 is disposed adjacent separator plate 26 and comprises a ring having flat end surfaces of the same outer diameter as separator plate 26. A circular bore 32 is formed in retainer 31, the axis of this bore being offset with respect to the axis of shaft 22.

An annular outer gear pump element 33 and an inner gear pump element 34 are disposed within bore 32 of retainer 31. Each of these elements is flat and of the same thickness as retainer 32, outer element 33 having an outer diameter substantially the same as the diameter of bore 32 so that it is rotatable therein. Inner pump element 34 has outwardly formed teeth which mesh with but have a smaller pitch diameter than inwardly formed teeth on outer element 33, and has a non-circular aperture 35 mounted on shaft extension 24. The eccentricity of bore 32 relative to the major and minor diameters of the teeth of elements 33 and 34 is such that the gears will be in full meshing engagement directly above shaft extension 24, as seen in FIGURE 3. Depending upon the direction of rotation of shaft 22, the space between the element teeth will increase on one side or the other of the top position, and will decrease after the bottom position is reached. In the bottom position, the major diameter of the teeth on element 34 has a close running fit with the major diameter of the teeth on element 33, as seen in FIGURE 3.

A porting plate 36 is disposed on the side of pump elements 33 and 34 opposite separator plate 26. Porting plate 36 is of disc-like shape, having the same outer diameter as separator plate 26 and retainer 31, and is provided with an inlet port 37 at the lower portion thereof and two discharge ports 38 and 39 circumferentially and equidistantly spaced from port 37, ports 38 and 39 being symmetrically located with respect to a vertical plane passing through the pump axis. Ports 37, 38 and 39 are all of elongated arcuate shape as seen in FIGURE 1. Grooves 41 and 42 are formed in plate 36 surrounding and spaced from apertures 38 and 39 respectively, valve seats 43 and 44 being formed between the grooves and the apertures. A central clearance aperture 45 is formed in porting plate 36, and a small recess 46 is formed in the plate above aperture 45 and between ports 38 and 39 for purposes described below.

A reed 47 is disposed on the surface of porting plate 36 opposite pump elements 33 and 34, and together with porting plate 36 forms a pair of flapper type check valves generally indicated at 48 and 49 in FIGURE 3. Reed 47 is fabricated of thin resilient stock such as spring steel and comprises a circular hub portion having an aperture 51 coinciding in diameter with aperture 45 of plate 36, and a pair of outwardly flared flappers or ears 52 and 53 extending radially outwardly and spaced from each other the same angular distance as ports 38 and 39. The shapes of ears 52 and 53 are such that they will normally engage seats 43 and 44, respectively, their outer edges being spaced inwardly from the outer shoulders of grooves 41 and 42. A pair of apertured portions 54 and 55 are formed at the inner ends of ears 52 and 53 respectively. The positions of apertures 54 and 55 are such as to increase the flexibility of the ears, thus permitting them to be lifted away from their respective seats in response to fluid pressure within ports 38 or 39.

A hollow rivet 56 is used to secure reed 47 porting plate 36, rivet 56 extending through apertures 51 and 45, as seen in FIGURE 2. In their unstressed condition, ears 52 and 53 are slightly bent toward porting plate 36 so that when rivet 56 is secured in position, the ears will be held flat against seats 43 and 44. A retaining lug 57 is formed on reed 47 between ears 52 and 53 and is bent so as to enter recess 46, thus preventing rotation of reed 47 relative to plate 36.

A cover plate 58 of generally flat disc-like shape is disposed on the side of porting plate 36 to which reed 47 is attached. Cover plate 58 has a recess 59 at the lower end of the surface facing porting plate 36, recess 59 extending inwardly from the outer periphery of the cover plate and being connected at its outer end to a channel 61 in surface 15 of wall 13. Channel 61 is connected to a source (not shown) of fluid such as a lubricant reservoir. The inner end of recess 59 overlaps inlet port 37 of porting plate 36 as seen in FIGURE 2.

A discharge chamber 62 is formed on the side of cover plate 58 facing porting plate 36 above recess 59. Chamber 62 is of sufficient size to enclose reed 47, and is thus connected to check valves 48 and 49 as well as to the passage formed by hollow rivet 56.

A central recess 63 is formed on the side of cover plate 58 facing housing cover 14, and a retainer spring 64 having a plurality of outwardly extending resilient arms is disposed within recess 63. The unstressed shape of spring 64 is such that when cover plate 14 is mounted in position, spring 64 will exert sufficient axial force on the other components of pump 11 to prevent substantial leakage past their contacting flat surfaces. Separator plate 26, retainer 31, porting plate 36 and cover plate 58 are provided with notches 65, 66, 67 and 68 respectively, at the upper ends of their peripheral edges, and a pin 69 secured within an aperture 71 in wall 13 is disposed within these notches and holds the parts against rotation.

In operation of pump 11, rotation of shaft 22 will cause rotation of pump elements 33 and 34 within retainer 31. Assuming that the rotation is clockwise in FIGURE 3, the volume between the pump elements will increase as it passes valve 49, the suction created thus holding this valve in closed position. As inlet port 37 is passed, fluid will be drawn into the space between the pump elements and will be discharged toward the left in FIGURE 3. The decreasing volume between the pump elements as valve 48 is approached will cause the fluid to be discharged through port 38, lifting ear 52 from seat 43. The fluid will flow into chamber 62 and through rivet 56 to channel 23 of shaft 22.

Illustratively, shaft 22 may comprise the crankshaft of a truck refrigeration unit compressor (not shown) driven by a 3-phase electric motor. Since the motor will be connected from time to time to different sources of electrical power as the truck reaches different destinations, the direction of rotation of the 3-phase electric motor may vary. If the direction is such that pump 11 is rotated counterclockwise in FIGURE 3, ear 52 will be held tightly against seat 43 while ear 53 will be flexed away from seat 44. The flow of fluid will thus still be from inlet port 37 to discharge chamber 62, the only difference being that the fluid will pass through discharge port 39 instead of discharge port 38 as was the case with clockwise rotation. It should be clearly understood that the above example of a useful installation of pump 11 is merely illustrative.

It will be noted that there are no rocking or rotating parts in pump 11 other than pump elements 33 and 34, unidirectional flow being achieved by the use of reed 47 which is stationary except for the slight flexing of ears 52 and 53. The presence of grooves 41 and 42 surrounding seats 43 and 44 respectively, will permit the accumulation of dirt or other foreign matter at some distance from seats 43 and 44, thus enhancing the long-term effectiveness of check valves 48 and 49. The absence of rotatable or shiftable parts necessary to achieve unidirectional flow will eliminate difficulties encountered with such parts

in previously known pumps, such difficulties being caused by binding or locking of the parts since they must be shifted by frictional forces under varying temperature and other environmental conditions.

While it will be apparent that the preferred embodiment of the invention disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a unidirectional flow reversible gear pump, a pair of gear pump elements, means for rotating said elements in either of opposite directions, an inlet port adjacent said pump elements and adapted to deliver fluid thereto in response to rotation of the pump elements in either direction, a porting plate adjacent said pump elements, first and second circumferentially spaced discharge ports in said porting plate, and a reed comprising a resilient flat member having ears overlapping said first and second discharge ports, said ears being responsive to fluid flow created by rotation of said pump elements in one direction to open one discharge port and close the other, and responsive to fluid flow created by rotation of said pump elements in the other direction to open said other discharge port and close said one discharge port.

2. In a unidirectional flow reversible gear pump, a pair of gear pump elements, means for rotating said elements in either of opposite directions, an inlet port adjacent said pump elements and adapted to deliver fluid thereto in response to rotation of the pump elements in either direction, a porting plate adjacent said pump elements, first and second circumferentially spaced discharge ports in said porting plate, a reed comprising a resilient flat member having ears overlapping said first and second discharge ports, said ears being responsive to fluid flow created by rotation of said pump elements in one direction to open one discharge port and close the other, and responsive to fluid flow created by rotation of said pump elements in the other direction to open said other discharge port and close said one discharge port, and means for holding said porting plate and reed against relative rotation.

3. In a unidirectional flow reversible gear pump, a pair of gear pump elements, means for rotating said elements in either of opposite directions, an inlet port adjacent said pump elements and adapted to deliver fluid thereto in response to fluid flow created by rotation of the pump elements in either direction, a porting plate adjacent said pump elements, first and second circumferentially spaced discharge ports in said porting plate, a reed comprising a resilient flat member having ears overlapping said first and second discharge ports, and means adjacent said porting plate forming a discharge chamber enclosing said discharge ports and reed.

4. In a unidirectional flow reversible gear pump, an internal and an external gear pump element having flat sides, means for rotating said elements in either of opposite directions, a stationary porting plate adjacent one side of said elements, an inlet port in said porting plate, a pair of discharge ports in said porting plate circumferentially spaced from each other and from said inlet port, a reed comprising a flat resilient member secured to the side of said porting plate opposite said pump elements, a pair of ears on said reed overlapping said discharge ports, and a cover plate on the side of said porting plate opposite said pump elements and having a discharge chamber surrounding said discharge ports and reed.

5. The combination according to claim 4, further provided with a central passage through said porting plate connected to said discharge chamber, and a central passage in said internal pump element for receiving fluid flowing through said last-mentioned porting plate aperture.

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6. The combination according to claim 5, further provided with a hollow rivet securing said reed to said porting plate, the passage through said porting plate being formed in said hollow rivet.

7. The combination according to claim 4, said reed comprising a pair of outwardly flared radially extending ears overlapping said discharge ports, the inner portions of said ears being weakened to increase their flexibility, and a retaining lug on said reed engageable with said porting plate to prevent relative rotation therebetween.

8. The combination according to claim 7, said porting plate being further provided with grooves surrounding and spaced from said discharge ports, whereby foreign matter may be entrapped without interfering with the seating of said reed against either discharge port.

9. The combination according to claim 4, further provided with an inlet passage formed in said cover plate, said inlet passage being spaced from said discharge chamber and connected to said porting plate inlet port, and re-

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silient means axially engageable with said cover plate to hold said cover plate against said porting plate.

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