Aug. 16, 1966 S. W. WORTLEY 3,266,432

PUMP

Filed Dec. 17, 1964

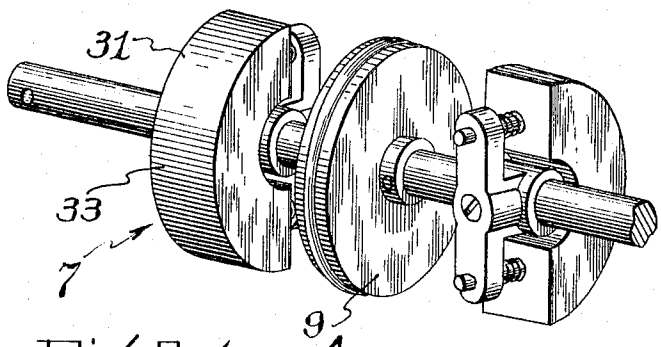


Fig. 1

Fig. 2

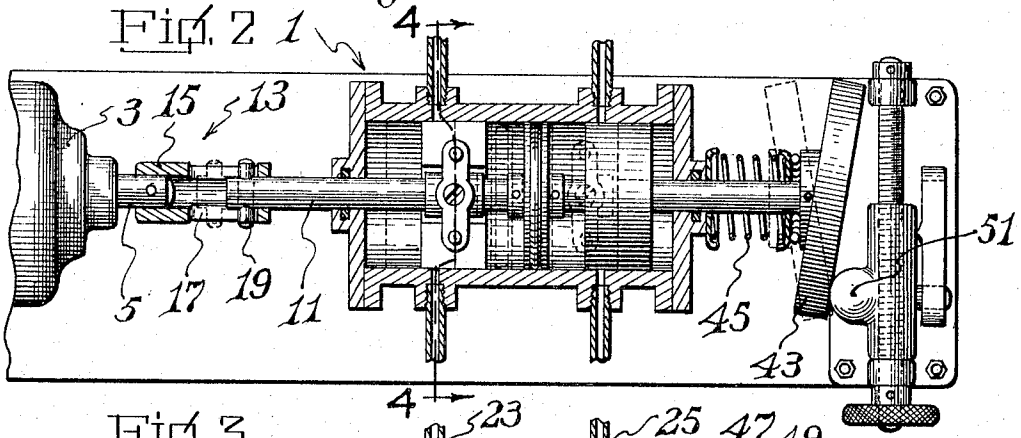
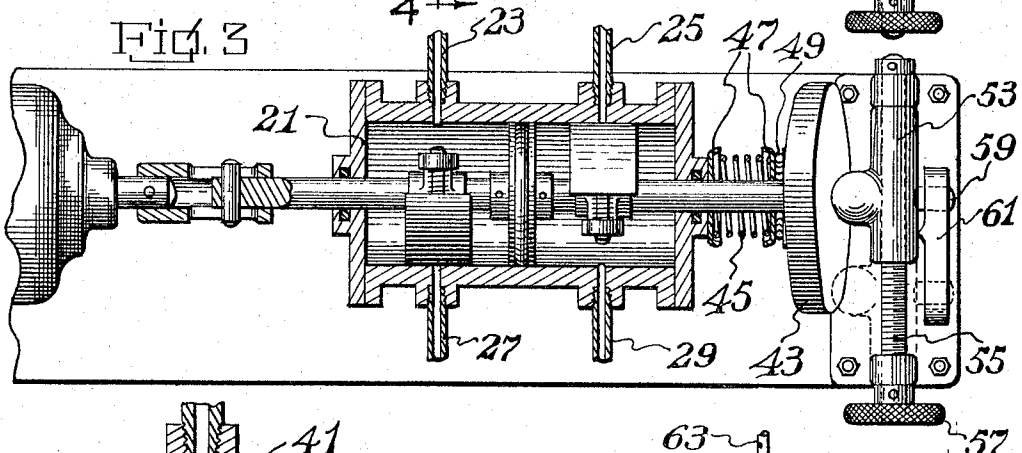


Fig. 3



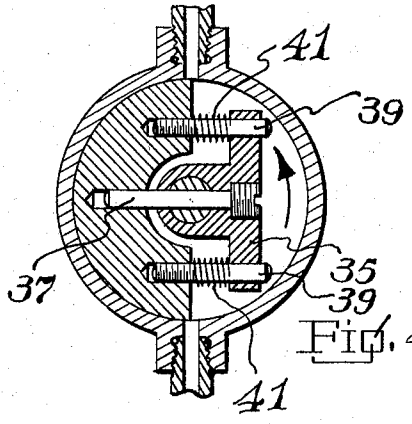


Fig. 4

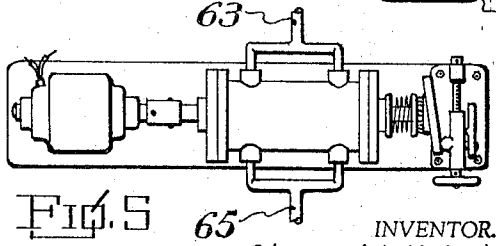


Fig. 5

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The present invention relates to pumps, more particularly of the reciprocating piston type.

Although the term "pump" is applied to the present invention, the term "compressor" might equally well be used, as the present invention is equally well adapted to impel liquids or gases. Accordingly, despite the use of the term "pump" in the following specification and the appended claims, it is to be understood that use of the present invention as a compressor for gases is also within the contemplation of the present invention.

It is an object of the present invention to provide a pump that will have a smooth and regular intake and exhaust without pulsing.

Another object of the present invention is the provision of a pump the delivery of which is adjustable over a wide range including idling or no delivery.

Finally, it is an object of the present invention to provide a pump which will be relatively simple and inexpensive to manufacture, easy to assemble, install, maintain and repair, and rugged and durable in use.

Other objects and advantages of the present invention will become apparent from a consideration of the following description, taken in connection with the accompanying drawing, in which:

FIGURE 1 is a perspective view of the piston means and valve means of a pump according to the present invention;

FIGURE 2 is a plan view of a pump according to the present invention with parts in section;

FIGURE 3 is a view similar to FIGURE 2 but showing the parts in another adjusted position;

FIGURE 4 is a transverse cross-sectional view taken on the line 4—4 of FIGURE 2 through a pump according to the present invention; and

FIGURE 5 is a plan view on a reduced scale of a pump according to the present invention.

Referring now to the drawing in greater detail, there is shown a pump indicated generally at 1 and comprising an electric motor 3 having a drive shaft 5 for rotating and reciprocating piston means indicated generally at 7. Piston means 7 includes a piston 9 carried on a piston rod 11. Piston rod 11 is interconnected with drive shaft 5 by a lost motion connection 13 including a cylindrical sleeve 15 having a pair of diametrically opposed elongated axially extending slots 17 through the side walls thereof, in which slide pins 19 carried by the adjacent end of piston rod 11. Rotation of piston means 7 by motor 3 thus causes piston means 7 to be rotated and permits piston means 7 to reciprocate axially relative to drive shaft 5.

Piston means 7 is principally disposed in a chamber 21 having a cylindrical interior. Piston 9 is in slidable sealing contact with the interior of chamber 21. Chamber 21 has a pair of intake openings 23 and 25 on the same side thereof but spaced apart lengthwise of chamber 21 and spaced from the ends of chamber 21. Chamber 21 also has a pair of exhaust openings 27 and 29 each of which is diametrically opposed to and coaxial with an intake opening 23 or 25.

Piston means 7 also includes valve means 31 including two valve members 33 of substantial axial extent disposed on opposite axial sides of piston 9 and each having a cylindrical outer periphery that extends through 180° of arc. Each valve member 33 is carried by a bracket 35 that includes a collar surrounding and fixed on piston rod 11. A pin 37 is screw-threadedly secured to bracket 35 and extends through bracket 35 and through a hole in

piston rod 11, thereby to secure bracket 35 to piston rod 11 against displacement in any direction. The free end of pin 37 extends radially outwardly and is slidably disposed in a complementary recess in valve member 33. A pair of pins 39 are screw-threadedly secured to valve member 33 and extend away from valve member 33 in a direction opposite that of pin 37 and are slidably received in complementary openings through bracket 35. Coil compression springs 41 encircle pins 39 and act between valve member 33 and bracket 35 continuously yieldably to urge valve member 33 away from bracket 35, that is, radially outwardly of piston rod 11. For stability, pins 39 are spaced equal distances on opposite sides of piston rod 11. When valve member 33 is disposed with its cylindrical outer periphery coaxial with piston rod 11, springs 41 will be under moderate compression. When piston rod 11 is mounted in chamber 21 coaxial with the cylindrical interior of chamber 21, therefore, valve members 33 will be continuously yieldably urged against the inner periphery of chamber 21 in sealing relationship therewith. Valve members 33 are 180° out of phase with each other.

A drive plate 43 is carried by and is fixed relative to an end of piston rod 11 that projects axially beyond chamber 21 in the opposite direction from motor 3. Drive plate 43 is disposed in a plane that is intersected by the axis of piston rod 11 at an acute angle. In other words, the plane of the face of plate 43 remote from chamber 21 is quite a bit turned from perpendicular relationship to the axis of piston rod 11. A coil compression spring 45 encircles the portion of piston rod 11 that extends axially beyond chamber 21, between chamber 21 and drive plate 43. Retainers 47 encircle piston rod 11 and contact the opposite ends of spring 45. The retainer 47 adjacent drive plate 43 is spaced from drive plate 43 by a thrust bearing 49 in the form of a series of roller balls or other antifriction thrust bearing means, so that spring 45 and retainers 47 tend to remain stationary with chamber 21. Coil compression spring 45 thus acts continuously to urge drive plate 43 to the right as seen in FIGURES 2 and 3.

The face of drive plate 43 opposite chamber 21 contacts a ball 51 carried by a sleeve 53 whose axis is perpendicular to and intersects the axis of piston rod 11. Sleeve 53 is internally screw-threaded and is in screw-threaded engagement with a screw-threaded spindle 55 which is axially fixed but is rotatable by means of an adjustment knob 57 thereby to move ball 51 between the positions shown in FIGURES 2 and 3. A pin 59 carried by sleeve 53 rides in a rectilinear guide 61 parallel to spindle 55 thereby to prevent rotation of sleeve 53 and to limit adjustive movement of ball 51 to rectilinear movement perpendicular to the axis of piston rod 11.

As can be seen in FIGURE 5, the intake openings 23 and 25 communicate in common with an intake conduit 63; while the exhaust openings 27 and 29 communicate in common with an exhaust conduit 65, for the supply and exhaust, respectively, of fluid to and from the pump.

In operation, when motor 3 is actuated to rotate drive shaft 5 in the direction of the arrow of FIGURE 4, piston rod 11 will be rotated through connection 13. Drive plate 43 will be continuously urged by spring 45 against ball 51. But as the contact surface of drive plate 43 is inclined relative to its axis of rotation, drive plate 43 will function somewhat in the manner of a wobble plate and upon rotation will move back and forth between the full and phantom line positions shown in FIGURE 2. This gyratory movement of drive plate 43 will in turn cause the piston rod 11 and with it the entire piston means 7 to reciprocate axially as it rotates, this axial reciprocation being accommodated by the lost motion connection 13, specifically, by reciprocation of pins 19 in slots 17.

The reciprocatory and rotary motion of piston means **7** causes piston **9** to reciprocate as it rotates, thereby alternately to enlarge and decrease the size of the chambers on either side of piston **9** within chamber **21**. At the same time, the valve members **33** rotate and reciprocate with generally helical movement in paths of closed configuration. The valve members **33** are of such axial extent, however, and are so located on piston rod **11**, that they axially overlie the openings **23**, **25**, **27** and **29** at all times. By "axially overlie" is meant that the openings **23**, **25**, **27** and **29** are always disposed between the ends of a valve member **33** regardless of whether those openings are open or are closed by the valve members **33**.

The piston means **7** is at its extreme right-hand position as shown in FIGURE 2. Assuming the piston means **7** to be rotating in the direction of the arrow in FIGURE 4, the right-hand valve member **33** as shown in FIGURE 2 will have just uncovered intake opening **25** and will be just starting to close exhaust opening **29**. Upon further rotation of the piston means in that direction, the drive plate **43** will force piston rod **11** to the left as shown in FIGURE 2, so that piston **9** will suck fluid in through intake opening **25** while exhaust opening **29** is closed. At the same time, however, the left-hand valve member **33** as seen in FIGURE 2 will be just exposing the exhaust opening **27** and just closing the intake opening **23**, so that movement of piston **9** to the left as seen in FIGURE 2 will force fluid out of exhaust opening **27**, until piston **9** reaches its extreme leftmost position with reference to FIGURE 2. Throughout this time, the intake opening **23** and the exhaust opening **29** will be tracing semicircular helical paths on the cylindrical outer peripheries of their respective valve members **33**.

When the piston means **7** has rotated 180° from its position shown in FIGURE 2, the right hand valve member **33** will be just closing the intake opening **25** and just exposing the exhaust opening **29**; while the left-hand valve member **33** will be just exposing the intake opening **23** and just closing the exhaust opening **27**. There will follow movement of the piston means **7** to the right as shown in FIGURE 2 through 180° of rotation until the parts resume the very position shown in FIGURE 2; and during this rightward movement of piston means **7**, intake opening **23** will supply fluid to the chamber which is to the left of piston **9** while exhaust opening **29** will let fluid out of the chamber which is to the right of piston **9**, after which the above operation will be repeated.

It will therefore be appreciated that fluid will always be flowing in through one of intake openings **23** and **25** and fluid will always be exhausted through one of exhaust openings **27** and **29**. The result is that a steady flow of fluid both into and out of the pump is achieved, with no pulsation or other undesirable flow characteristics, thanks to the 180° out-of-phase relationship of the valve members **33** to each other.

It will also be recognized that the throw or stroke of the pump can be adjusted by rotation of spindle **55** thereby to move ball **51** axially therealong. In the position of ball **51** shown in FIGURE 2, the pump has maximum stroke, thereby to handle a maximum quantity of fluid. But in the position of FIGURE 3, in which the contact point of ball **51** with drive plate **43** lies on the axis of piston rod **11**, rotation of piston rod **11** will be accompanied by no axial movement, so that the pump will be in neutral and no fluid will flow.

From a consideration of the foregoing disclosure, therefore, it will be evident that all of the initially recited objects of the present invention have been achieved.

Although the present invention has been described and illustrated in connection with a preferred embodiment, it is to be understood that modifications and variations may be resorted to without departing from the spirit of the invention, as those skilled in this art will readily understand. Such modifications and variations are considered to be within the purview and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A pump comprising a chamber having a cylindrical inner periphery, intake and exhaust openings through said periphery spaced from the ends of said periphery, piston means axially reciprocable in the chamber to vary the volume of the chamber, valve means in the chamber rotatable about the axis of the chamber alternately to open one of said intake and exhaust openings and to close the other of said intake and exhaust openings, said valve means being secured to said piston means against axial movement relative to said piston means, and means for rotating and reciprocating said piston means thereby to move said valve means in a helical path of closed configuration.

2. A pump as claimed in claim **1**, said valve means having an axial extent greater than the stroke of the piston means so as axially to overlie said intake and exhaust openings in all positions of said piston means.

3. A pump comprising a chamber having a cylindrical inner periphery, intake and exhaust openings through said periphery spaced from the ends of said periphery, piston means axially reciprocable in the chamber to vary the volume of the chamber, valve means in the chamber rotatable about the axis of the chamber alternately to open one of said intake and exhaust openings and to close the other of said intake and exhaust openings, and means continuously yieldably urging said valve means radially outwardly into sealing contact with said inner periphery.

4. A pump comprising a chamber having a cylindrical inner periphery, intake and exhaust openings through said periphery spaced from the ends of said periphery, piston means axially reciprocable in the chamber to vary the volume of the chamber, valve means in the chamber rotatable about the axis of the chamber alternately to open one of said intake and exhaust openings and to close the other of said intake and exhaust openings, said piston means including a piston rod, and means for rotating and reciprocating the piston rod, the last-named means including lost-motion connection means having lost motion lengthwise of the piston rod.

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