

Aug. 10, 1965

C. A. SMART

3,199,457

RECIPROCATING PUMP

Filed Sept. 26, 1963

FIG. 1

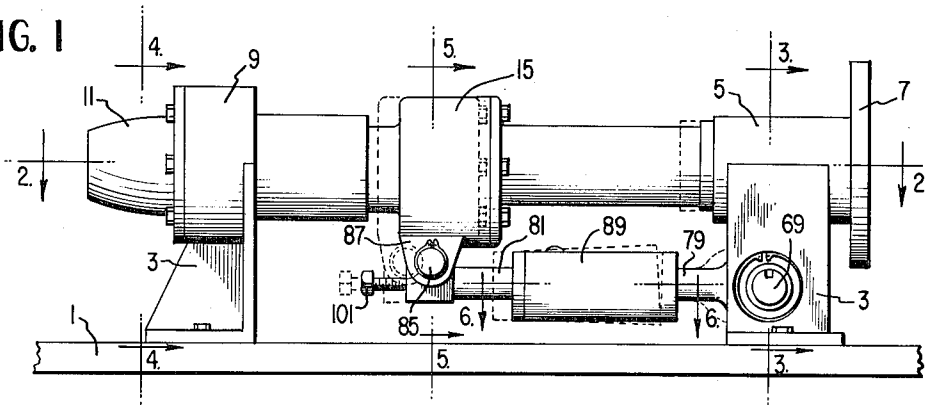


FIG. 2

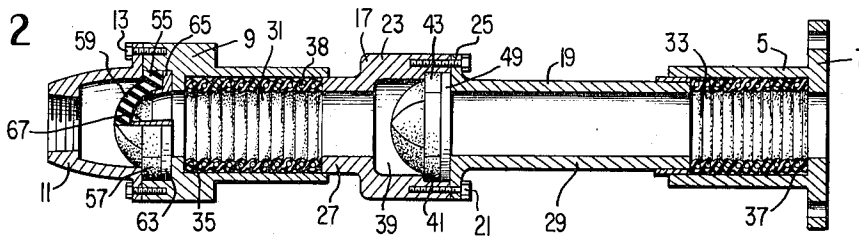


FIG. 3

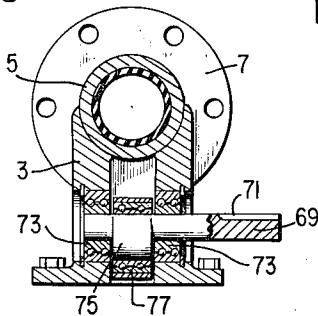


FIG. 4

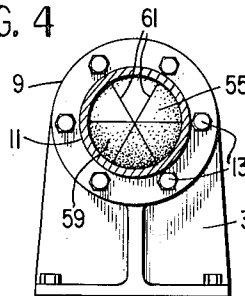


FIG. 5

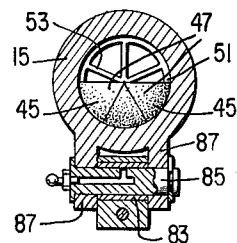


FIG. 6

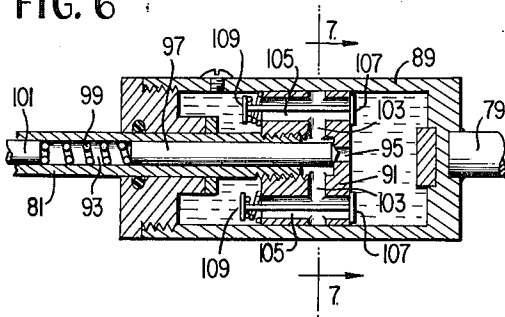
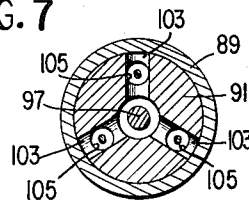


FIG. 7



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3,199,457

RECIPROCATING PUMP

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9 Claims. (Cl. 103-33)

The present invention relates to pumps, more particularly of the type in which a reciprocating impeller permits one-way movement of fluid through the impeller.

It is an object of the present invention to provide reciprocating pumps well adapted to pump slurries of abrasive materials.

Another object of the present invention is the provision of reciprocating pumps adapted to generate high pressure in the pumped fluid.

Another object of the present invention is the provision of pumps that are easy to clean and that offer a minimum of opportunity for clogging.

A further object of the present invention is the provision of a reciprocating pump of the straight-through flow type characterized by a minimum of pulsation.

A still further object of the present invention is the provision of a reciprocating pump having improved means for avoiding overloading the pump.

Finally, it is an object of the present invention to provide reciprocating pumps that will be relatively simple and inexpensive to manufacture, assemble and install, easy to operate, 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 side elevational view of a pump according to the present invention;

FIGURE 2 is a cross-sectional view taken on the line 2-2 of FIGURE 1;

FIGURE 3 is a cross-sectional view taken on the line 3-3 of FIGURE 1;

FIGURE 4 is a cross-sectional view taken on the line 4-4 of FIGURE 1;

FIGURE 5 is a cross-sectional view taken on the line 5-5 of FIGURE 1;

FIGURE 6 is an enlarged fragmentary cross-sectional view taken on the line 6-6 of FIGURE 1; and

FIGURE 7 is a cross-sectional view taken on the line 7-7 of FIGURE 6.

Referring now to the drawing in greater detail, there is shown a pump comprising a base 1 from which extend upwardly a pair of front and rear uprights 3. The rear upright 3 supports a rear conduit portion 5 which is of generally cylindrical shape and which terminates rearwardly in a radially disposed rear flange 7. A front conduit portion 9 is mounted on the front upright 3 in stationary relationship to rear conduit portion 5 and is of generally cylindrical configuration and is coaxial with rear conduit portion 5. A nipple 11 terminating rearwardly in a radially extending flange is secured to the front end of front conduit portion 9 by means of bolts 13 passing through the nipple flange. Nipple 11 at its forward end is internally screw-threaded for the reception of a further conduit (not shown) through which fluid may pass downstream of the pump; while the upstream or rear end of the pump may be secured to a discharge opening in a tank or the like or other container or conduit means by means of bolts (not shown) passing through rear flange 7. It is expressly to be understood, therefore, that when reference is had to front and rear conduit portions 5 and 9, these terms do not necessarily imply that the pump of the present invention must necessarily be positioned intermediate

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the length of a conduit. The pump of the present invention can pump into a receptacle or out of a receptacle or between receptacles, it being understood that the front and rear conduit portions referred to in this specification and the appended claims need perform no more than the function of adapters or connectors.

Positioned between and cooperable with front and rear conduit portions 5 and 9 is a reciprocable conduit section 15 comprising a front portion 17 and a rear portion 19 with regard to the direction of flow of fluid through the pump. Front and rear portions 17 and 19 are releasably secured together in coaxial relationship by means of bolts 21 that secure together radially outwardly extending flanges 23 and 25 on portions 17 and 19, respectively. Apart from flanges 23 and 25, the portions 17 and 19 of reciprocable conduit section 15 are characterized by reduced coaxial cylindrical ends 27 and 29, respectively, that are loosely slidably received within the adjacent ends of front and rear conduit portions 9 and 5, respectively, with regard to the direction of flow of fluid through the pump. Reciprocable conduit section 15 is thus mounted for coaxial reciprocatory movement within and relative to front and rear conduit portions 9 and 5, and it is preferred that the reciprocatory movement of conduit section 15 within the front and rear conduit portions be of such small stroke that both ends of section 15 are slidably disposed within an adjacent end of conduit portions 5 and 9 at all times. In other words, it is preferred that section 15 never be spaced endwise from either of end portions 5 and 9.

Reciprocable conduit section 15 may be only loosely slidably disposed in portions 5 and 9 because the sliding interfaces are never exposed to the material that is being pumped. This is because generally cylindrical sleeves 31 and 33 of rubber or other elastic deformable material are disposed in conduit portions 9 and 5, respectively, in effect as endwise continuations of reciprocable conduit section 15 so as to seal off the sliding joints between section 15 and portions 5 and 9 in all positions of section 15. To this end, front conduit portion 9 is provided with an internal rearwardly facing abutment shoulder 35 and rear conduit portion 5 is provided with internally forwardly facing abutment shoulder 37 against which the ends of sleeves 31 and 33 that face away from each other abut respectively. The other or adjacent ends of sleeves 31 and 33 are secured to the opposite ends of reciprocable section 15. The joint between sleeves 31 and 33 and the endwise adjacent metal parts may be effected by any of the usual means such as adhesive bonding, riveting, the use of snap rings, or the like.

Rubber sleeves 31 and 33 expand and contract axially as section 15 reciprocates. In order to maintain their orientation as shown in FIGURE 2, a plurality of metal loops coaxial with section 15 are embedded in the elastic deformable material of the sleeves. The loops may be in the form of the coils of a continuous coil or helix, but in the preferred embodiment they are spaced parallel rings disposed in planes perpendicular to the common axis of portions 5 and 9 and section 15.

Flange 23 defines within it an enlarged valve chamber 39 of a diameter substantially larger than the internal diameter of the rest of reciprocable conduit section 15. On the upstream side of valve chamber 39 is a one-way valve 41 which is largely of elastic deformable material such as rubber. Valve 41 comprises an annular outwardly projecting base flange 43 and a plurality of generally inwardly extending segments 45 arranged in orange-peel or clam-shell relationship. Preferably, the number of segments 45 is greater than two, so that the adjacent edges of segments 45 meet in a plurality of interfaces 47 that extend across from one side of base flange 43 to the other. This

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central portion of valve 41 is generally dome shaped and protrudes downstream into valve chamber 39. When the pressure upstream of valve 41 is substantially greater than that downstream of valve 41, segments 45 open by spreading apart. But when the pressure downstream of valve 41 is equal to or greater than the pressure upstream of valve 41, then segments 45 come together again to the position shown in FIGURE 2. Valve 41 is thus able to pump fluid in one direction upon reciprocation of section 15, for when section 15 moves to the right, the material upstream of valve 41 is forced by its inertia to spread apart segments 45 and pass through valve 41; but when section 15 moves to the left as seen in FIGURE 2, then segments 45 close behind the pumped material and propel it to the left as seen in FIGURE 2. Valve chamber 39 is thus important as increasing the area by which segments 45 will open upon passage of the material through valve 41, and the quantity of material pumped by the pump is significantly greater by virtue of the enlargement of valve chamber 39 than if the dome of valve 41 were simply of the same diameter as the major portion of the length of section 15.

To adapt the pump for relatively high pressure operation, reinforcing means may be provided for segments 45. The reinforcing means may take the form of solid nylon or metal inserts (not shown) embedded within or otherwise secured to segments 45, or they may take the form shown in the drawing, of a valve cage 49 immediately on the upstream side of valve 41. Valve cage 49 has an annular base flange or rim 51 and domed bars 53 bridging across between opposite sides of rim 51. Preferably, there is at least one bar 53 behind each segment 45, preferably centered relative to the segment. In this way, when section 15 moves to the left as seen in FIGURE 2, segments 45 are greatly reinforced against collapse to a flatter position than their intended domed position. Base flanges 43 and 51 of valve 41 and valve cage 49, respectively, are clamped together between internal abutment shoulders on adjacent ends of portions 17 and 19 of reciprocable section 15. Assembly of portions 17 and 19, therefore, assures that valve 41 and valve cage 49 will be securely located in the proper position relative to each other.

To the left of FIGURE 2, downstream of valve 41, toward the front or discharge end of the pump, is located a second one-way valve 55 comprising an annular base flange 57 and clamshell segments 59 which preferably come together in a plurality of arcuate interfaces 61. Valve 55 is preferably the same in structure as valve 41. A valve cage 63 is provided to back up valve 55, and valve cage 63 is preferably the same as valve cage 49 and includes a base flange or rim 65 with arcuate bars 67 immediately behind segments 59 to back up and reinforce segments 59. The interior of nipple 11 downstream of this second one-way valve 55 is preferably of greater diameter than the bore of most of the length of section 15, thereby to provide an enlarged valve chamber for the free movement and accommodation of enlarged segments 59 of valve 55.

Reciprocation of section 15 relative to stationary conduit portions 5 and 9 effects pumping of the fluid. To this end, a drive shaft 69 is provided for connection to an appropriate motor (not shown) by means of a keyway 71 formed in drive shaft 69. Drive shaft 69 is mounted for rotation in bearings 73 carried by the rear upright 3. The axis of drive shaft 69 is perpendicular to but spaced from the axis of conduit portions 5 and 9 and section 15. An eccentric 75 is carried by drive shaft 69 and is surrounded by a bearing sleeve 77 at one end of a rear pitman or connecting rod section 79. A front pitman or connecting rod section 81 is provided at its opposite end with a sleeve bearing 83 that encompasses a wrist pin 85 carried by depending ears 87 that are integral with flange 23 of section 15.

A fluid pressure cylinder 89 and a piston 91 mounted

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for sliding movement therein interconnect connecting rod sections 79 and 81. Cylinder 89 is fixedly secured to rear connecting rod section 79, while piston 91 is fixedly secured to front connecting rod section 81. Cylinder 89 slidably encompasses front connecting rod section 81 forwardly of piston 91 in fluid-tight sealing relation.

Connecting rod section 81 is provided with an axial bore 93 therethrough that terminates at its rear end, which is the right end as seen in FIGURE 6, in a valve port 95. A metering pin 97 is slidably disposed in bore 93 and is continuously urged in a direction to close valve port 95, toward the right in FIGURE 6, by a coil compression spring 99. At its other or forward end, coil compression spring 99 is backed up by an adjusting screw 101 that can be screwed in or out as seen in FIGURE 1 to vary the compression of spring 99 and accordingly to vary the pressure with which metering pin 97 presses against the marginal edges of valve port 95 to close port 95.

Piston 91 is also provided with a plurality of lateral passageways 103 that communicate with valve port 95 when metering pin 97 is spaced from valve port 95 and valve port 95 is accordingly open. Piston 91 also has a plurality of longitudinal passageways 105 extending there-through from front to rear. Longitudinal passageways 105 communicate between opposite sides of piston 91 and also communicate with lateral passageways 103. A check-valve 107 is individual to each longitudinal passageway 105 and is continuously urged in a direction to close its associated passageway 105 by a coil compression spring 109. Cylinder 89 is preferably filled with a hydraulic fluid such as any of the usual natural or synthetic hydraulic oils. Metering pin 95 thus provides a one-way valve through which fluid may pass only toward the left as seen in FIGURE 6, and then only when the pressure imposed on the right end of metering pin 97 by the fluid is greater than the pressure imposed on the left of metering pin 97 by spring 99. The minimum value of this greater pressure will hereinafter be referred to as "overload pressure," that is, a pressure at which the compressive force acting between connecting rod sections 79 and 81 is so great as to cause the fluid to the right of piston 91 to rise to such a pressure that metering pin 97 is forced back to permit flow of fluid through port 95 and through lateral passageways 103 to longitudinal passageways 105 and thence to the opposite or left side of piston 91 as seen in FIGURE 6.

Check valves 107, on the other hand, open at substantially less pressure than overload pressure, but they open in the direction opposite to metering pin 97. Thus, when the forces tending to move front and rear connecting rod sections 79 and 81 apart achieve a relatively low value, substantially less than overload pressure, the fluid to the left of the heads of check valves 107 attains sufficiently higher pressure than the fluid to the right of those heads as seen in FIGURE 6 that check valves 107 open against the influence of relatively weak coil compression springs 109 to permit the flow of fluid from the left of piston 91 to the right of piston 91 as seen in FIGURE 6.

The pumping thrust of the drive train 69-85 is thus limited by metering pin 97 so that only a maximum pumping pressure can be applied and the drive unit including the motor (not shown) can be protected against overload upon a blockage or stoppage in the conduit downstream from valve 41. In such case, rear connecting rod section 79 continues to reciprocate but front connecting rod section 81 does not. Piston 91 tends to remain stationary, while cylinder 89 reciprocates with the drive. Upon every forward stroke of rear pitman section 79, metering pin 97 is opened and fluid is forced through valve port 95. Upon every rearward movement of rear pitman section 79, fluid is drawn back through check valves 107. Strain on the motor is reduced by virtue of the fact that check valves 107 open easier than does metering pin 97.

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In operation, it is preferred that section 13 be reciprocatingly driven with a relatively short fast stroke so as to reduce pulsation. Material moves from the right to the left through the pump as seen in FIGURE 2, and the material in excess of that required to fill the space between valves 41 and 55 at the point of their closest approach is forced through valve 51 upon each forward stroke of section 15. The returning section 15, moving to the right as seen in FIGURE 2, does not tend to draw this material back with it, because valve 59 blocks such retrograde movement. The inertia of the material upstream of valve 41, however, assures that that material will pass through valve 41 upon such retrograde or retractive movement of section 15 to the right as seen in FIGURE 2.

From a consideration of the foregoing description, therefore, it will be obvious that all the initially recited objects of this invention have been achieved.

Although the present invention has been described and illustrated in connection with preferred embodiments, 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 reciprocating pump for pumping slurries, comprising a pair of coaxial stationary conduit portions having their adjacent ends spaced apart, a movable conduit section having its ends slidably disposed in said adjacent ends, one-way valve means disposed in the movable conduit section, housing means for said one-way valve means, said housing means being disposed in said movable conduit section and having a greater diameter than the remaining portion of said movable conduit section, and power means for reciprocating the movable conduit section axially of said conduit portions.

2. A reciprocating pump as claimed in claim 1, and flexible sleeve means sealing the interconnecting ends of said movable conduit section with said stationary conduit portions thereby to provide a closed conduit from one stationary conduit portion to the other.

3. A reciprocating pump as claimed in claim 2, the flexible sleeve means comprising elastic, deformable material, and a plurality of spaced parallel metal rings coaxial with the stationary conduit portions and embedded in the elastic, deformable material.

4. A reciprocating pump as defined in claim 1, said one-way valve means comprising a plurality of flexible members disposed in clamshell relationship.

5. A reciprocating pump for pumping slurries, comprising conduit means, piston means reciprocable in the conduit means for propelling liquid through the conduit means, one-way valve means carried by the piston means to promote unidirectional flow of liquid through the conduit means, power means for reciprocating the piston means relative to the conduit means, said power means including a connecting rod, the connecting rod including

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means permitting lost motion between the piston means and the connecting rod upon overload of the pump, the last-named means comprising a fluid cylinder having an overload piston therein, one of the cylinder and overload pistons being unitary with the reciprocable piston means and the other of the cylinder and overload pistons being unitary with at least a portion of the connecting rod, and means establishing fluid communication between opposite sides of the overload piston upon overloading the pump.

6. A reciprocating pump as defined in claim 5, the last-named means comprising one-way valve means opening through the overload piston in one direction at and above overload pressure and one-way valve means opening through the overload piston in the opposite direction at substantially less than overload pressure.

7. A reciprocating pump as claimed in claim 5, said one-way valve means comprising a plurality of flexible members disposed in a clamshell relationship.

8. A reciprocating pump for pumping slurries, comprising a pair of coaxial stationary conduit portions having their adjacent ends spaced apart, a movable conduit section having its ends slidably disposed in said adjacent ends, one-way valve means disposed in the movable conduit section, power means for reciprocating the movable conduit section axially of said conduit portions, said power means including a connecting rod, the connecting rod including means permitting lost motion between the movable conduit section and the connecting rod upon overload of the pump, the last-named means comprising a fluid cylinder having an overload piston therein, one of the cylinder and overload pistons being unitary with the movable conduit section and the other of the cylinder and overload pistons being unitary with at least a portion of the connecting rod, and means establishing fluid communication between opposite sides of the overload piston upon overloading the pump.

9. A reciprocating pump as claimed in claim 8, the last-named means comprising one-way valve means opening through the overload piston in one direction at and above overload pressure and one-way valve means opening through the overload piston in the opposite direction at substantially less than overload pressure.

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LAURENCE V. EFNER, *Primary Examiner*.

WARREN E. COLEMAN, *Examiner*.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,199,457 B1
DATED : March 13, 2001
INVENTOR(S) : Hoff et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 5,

Line 45, "number" should be -- member --.

Signed and Sealed this

Sixteenth Day of October, 2001

Attest:

Nicholas P. Godici

Attesting Officer

NICHOLAS P. GODICI
Acting Director of the United States Patent and Trademark Office