This invention relates to a reciprocating pump. More particularly, the invention relates to a system for reciprocating pumps. Still more particularly, the invention relates to a system of providing intake and discharge valves for a reciprocating pump arranged in a manner to achieve substantially complete displacement of fluid out of the pump cylinder on each stroke of the pump piston.

Reciprocating pumps have been used for many years and their general design, function and application are well known. Reciprocating pumps are the most frequently used pumps for producing high pressures in fluids, including both liquids and gases. Basically, a reciprocating pump consists of a cylinder having a piston reciprocating therein and, an intake valve and a discharge valve in communication with the cylinder. On the forward motion of the piston the intake valve closes and the discharge valve opens so that fluid contained within the cylinder is displaced by the forward movement of the piston to force fluid out of the cylinder. The heart of the mechanism making up a reciprocating pump is the valving system. When high pressures are to be pumped the valving system must be of a sturdy construction to withstand the high pressures.

Valving systems for high pressure pumps are normally arranged in the pump body structure in such a way that the valves are supported in the pump structure and in closed communication with the cylinder. In order to obtain the necessary strength to withstand high pressures, the valves have been required to be located at some distance from the portion of the cylinder in which the piston actually travels. This means that upon each forward motion of the piston only a portion of the total volume contained within the cylinder and the associated valving system is displaced by the piston. If non-compressible liquids are being pumped such partial displacement is not a particular problem since the quantity of liquid will be displaced equal to the displacement of the pump regardless of the additional quantity which is not displaced but which is trapped in the cylinder and valving system. When a compressible fluid, such as a gas, some types of liquids, and liquids having gas entrained therein, are pumped, and particularly where a high output pressure is desired, the quantity of fluid trapped in the cylinder and valving system which is not displaced by the forward movement of the piston results in a great diminution of the pump capacity and efficiency.

It is therefore an object of this invention to provide a reciprocating pump having an improved valving system. A more particular object of this invention is to provide a reciprocating pump having an improved valving system which reduces to a minimum the volume contained in a cylinder and valving system which is not displaced by the forward movement of the piston.

Another object of this invention is to provide a reciprocating pump having a valving system self-contained within a cylinder sleeve arrangement such that the cylinder sleeve and valving system of the pump may be easily removed from the pump for expedient repair or replacement.

Another object of this invention is to provide a reciprocating pump having a unitary cylinder sleeve and valving system arranged in such a way that the cylinder sleeves and valves of the pump may be completely removed and replaced without disturbing in any way the fluid inlet and discharge connections to the pump.

Another object of this invention is to provide a valving system for a reciprocating pump including an intake valve arrangement in such a manner that the pump piston may travel completely within the intake valve on the forward motion of the piston so that the non-displaced area within the cylinder of the pump is reduced to a minimum.

Another object of this invention is to provide a reciprocating pump having a valving arrangement which is simpler in construction and therefore less expensive to manufacture and assemble.

These and other objects and a better understanding of the invention may be had by referring to the following description and claims taken in conjunction with the attached drawings, in which:

FIGURE 1 is an isometric external view of a reciprocating pump having the valving system of this invention.

FIGURE 2 is a cross-sectional view of a complete reciprocating pump showing the valving system of this invention incorporated therein.

FIGURE 3 is an enlarged cross-sectional view of a portion of the pump shown in FIGURES 1 and 2 showing the arrangement of the valving system of this invention.

FIGURE 4 is a cross-sectional isometric view of a replaceable cylinder sleeve for a reciprocating pump including the valving system of this invention.

FIGURE 5 is an isometric view of a discharge valve cage as utilized in the valve system of this invention.

FIGURE 6 is a cross-sectional view taken along the line 6-6 of FIGURE 4.

FIGURE 7 is a cross-sectional view taken along the line 7-7 of FIGURE 4.

Briefly stated, this invention may be said to comprise a valving system for a reciprocating pump. More particularly, but not by way of limitation, the invention consists of a reciprocating pump comprising a cylinder, a cylinder reciprocally receiving said piston, said cylinder closed at one end, said cylinder having an axial annular groove adjacent said closed end, said groove in part defined by a forward wall adjacent said closed end, said forward wall having at least one fluid inlet opening therein, an inlet valve disc axially movably positioned in said annular groove, said valve disc unidirectionally closing said fluid inlet opening in said forward wall of said groove when said disc is in contact with said forward wall, said valve disc having an axial opening therein, said closed end of said cylinder having at least one fluid outlet opening therein at the portion of said closed end defined by said opening in said inlet valve disc, and a valve means external of said outlet opening unidirectionally closing said outlet opening against the passage of fluid there-through.

Referring now to the drawings, and first to FIGURE 1, a reciprocating pump is generally indicated by the numeral 10. The pump 10 is of a type known as a wobble plate pump having the arrangement such that when rotary energy is applied to shaft 12 reciprocal motion is applied to a multiplicity of pistons within the power end 14 of the pump. Fluid is drawn into the pump at inlet port 16 and is discharged out of the pump at the discharge port 18.

The pump 10 is shown merely by way of example as the valving system of this invention may be utilized with any type of reciprocating pump having a cylinder and a piston or plunger reciprocated in the cylinder. The pump 10 shown in FIGURE 1 is provided with seven cylinders and seven pistons, each having identical valving systems as will be described later.

Referring now to FIGURE 2, the pump of FIGURE 1
is shown in cross-section. Every reciprocating pump can normally be divided into two basic portions comprising the power end portion, generally indicated by the numeral 14, and the fluid end portion, generally indicated by the numeral 26. In every reciprocating pump the power end portion 14 converts energy supplied from some exterior power source, such as an electric motor or internal combustion engine, to the reciprocation of one or more pistons. In the pump 19 as shown in FIGURES 1 and 2 rotary energy is applied to shaft 12 which, by means of a suitable drive arrangement which is not a portion of this invention, reciprocation motion is applied to push rods 22, which in turn connect with pistons 24, only one of which is seen in the cross-sectional view of FIGURE 2. The view of FIGURE 2 shows one complete valving system as utilized in the invention, it being understood that the pump 19 would be provided with a similar valving system for each of the seven pistons utilized. Fluid is drawn into the pump through fluid inlet opening 16 and communicates by means of fluid passages 26 to each of the valving systems of the pump. The means wherein fluid passing through the pump inlet 16 and fluid passages 26 is drawn into the pump by the valving system of the invention will be described subsequently. In a similar manner, the discharge port 18 of the pump communicates by means of discharge fluid passages 28 with the valving system associated with each cylinder of the pump. All fluid displaced by each piston is discharged into a common discharge fluid passage system and out of the pump through discharge port 18.

Referring now to FIGURE 3, the valving system of the invention is best shown. Supported within the pump body 20 is a packing retainer member 32 within which the piston 24 is reciprocated. The valving system of this invention is contained within a removable sleeve, the sleeve, for purposes of simplicity of manufacturing and assembly, being divided into two portions identified as a rearward sleeve portion 34 and a forward sleeve portion 36. The sleeve portions 34 and 36 are mated together in such a way as to provide an annular groove 38. It can be seen that the rearward and forward sleeve portions 34 and 36 could be formed of an integral part and the annular groove 38 formed therein, or the two components could be mated together in a variety of ways to produce the annular groove 38.

The rearward sleeve portion 34 contains packing 40 surrounding the piston 24 by which leakage of fluid past the piston is prevented. A passageway 42 may be provided by which the piston is lubricated.

The fluid passages 28 and 29 are in the cylinder area 44 which functions as the cavity which is filled with fluid on the rearward motion of the piston 24. The fluid is then displaced by the forward motion of the piston. Formed in the forward sleeve portion 36 is a partition wall 46 which is the forward end of the cylinder cavity 44. Extending through the partition wall 46 are a multiplicity of inlet fluid passages 48. The annular groove 38 may be said to be defined in part by a forward wall 50. Inlet fluid passages 48 communicate with the annular groove 38 and thereby the fluid cavity 44 at the forward wall 50. Inlet fluid passages 48 are a means by which fluid flowing into the pump through fluid passages 26 to within the cylinder cavity 44.

Formed in the partition wall 46 are a multiplicity of fluid outlet openings 52. Axially movable supported in the annular groove 38 is an inlet valve disc 54 having an axial opening 56 therein. All of the fluid outlet openings 52 in the annular groove 38 are within the area defined by the opening 56 in the inlet valve disc 54. Spring means 58 may be provided within the annular groove 38 to retain the inlet valve disc 54 in normal engagement with the forward wall 50. In order to help maintain the spring 58 in proper relationship an annular recess 60 may be provided in the forward face 62 of the rearward sleeve portion 34.

The forward sleeve portion 36, in the area forward the partition wall 46, is provided with a multiplicity of discharge fluid passages 28 which communicate ultimately with the discharge port 18 by means of which fluid passes out of the pump. In normal engagement with the forward face 66 of the partition wall 46 of the fluid outlet openings 52 is an outlet valve disc 68. The outlet valve disc 68 is preferably located in an outlet valve cage 70, shown in FIGURE 5, to be described in greater detail subsequently. An outlet valve spring 72 retains within cage 70 the outlet valve disc 68 in normal contact with the forward face 66 of the partition wall 46. Outlet valve cage 70 is retained in the tubular opening of the forward sleeve portion 36 by means of a retaining ring 74.

Closing the tubular opening in the forward sleeve portion 36 is a plug member 76 and a sleeve retaining member 78. The plug member 76 is rotatably supported in the sleeve retaining member and held in such rotatable position by a key 80. Openings 82 in the sleeve retaining member 78 provide means by which a bar may be applied for removing the sleeve retaining member from the pump. As his flow passages 28 are formed in the sleeve of the pump is best formed by the cooperation of the rearward and forward sleeve portions 34 and 36. In the embodiment shown, the rearward sleeve portion 34 is provided with an extended reduced diameter tubular portion which terminates in the vertical face 62. The tubular portion 84 extends within a full diameter rearwardly extending tubular portion 86 of the forward sleeve portion 36. It can be seen that the pump could equally as well be constructed wherein the sleeve portions 34 and 36, rather than being removable sleeves, may be formed as a part of the basic pump body itself and that innumerable ways exist whereby the annular groove 38 may be provided adjacent the end of the cylinder cavity 44. In one sense, the partition wall 46 serves as a closed end of the pump cylinder forming the cavity 44, the closed end 46 having the annular groove 38 adjacent to it.

By the provisions of this invention wherein each sleeve is formed by sleeves, and particularly wherein each sleeve is formed of a rearward and forward portion 34 and 36, the valving assemblies may be removed from the pump by removal of the sleeve portions. The forward sleeve portion 36 is preferably provided with an extended fluid fluid inlet groove 88 so that the fluid passages 48 may be arranged circumferentially around the partition wall 46 and in like manner a fluid outlet groove 90 may be formed in the exterior of the sleeve portion so that the fluid passages 52 are spaced around the full circumference of the sleeve portion.

Referring to FIGURES 4 and 5, the valve cage 70 is best shown. The cage preferably consists of extending guide members 92 which are held in spaced position by a base ring 94 and a spacer ring 96, which are affixed to the guide members 92 such as by casting. Extending spring retainer portions 98 formed on the rearward ends of the guide members 92 maintain spring 72 in contact with the outlet valve disc 68. The valve disc 68 is free to move axially by sliding within the guide members as it is held in contact with the forward face 66 of the partition wall 46. A cage retainer ring 100 maintains the valve cage 70 in proper position within the forward sleeve portion 36.

FIGURES 6 and 7 show cross-sectional views of the forward sleeve portion 36. FIGURE 6 shows a cross-sectional view of the arrangement of the valve cage 70 in the forward sleeve portion 36. FIGURE 7 shows the fluid port arrangements in the partition wall 46.

Operation

Referring to FIGURE 3, the piston 24 of the pump is shown in rearward position. Assuming that the fluid cavity 44 is filled with a fluid, upon forward motion of piston 24 the fluid is displaced and forced through the fluid outlet openings 52 in the partition wall 46, displac-
ing the outlet fluid valve 65, and flows through the valve cage 70, through discharge fluid passages 28 and out of the pump through discharge port 18. Upon rearward movement of piston 24, the discharge valve disc 68 closes and fluid is drawn from within the inlet port 16, inlet passages 26, and the inlet passages 48 in partition wall 46 to within the cylinder cavity 44. Inlet valve disc 54 is axially displaced inwardly by the passage of fluid into cavity 44.

The axial opening 56 in inlet valve disc 54 is preferably of a diameter slightly greater than the diameter of piston 24. With this arrangement, piston 24 may travel completely to the forward face 50 of partition wall 46, that is, the piston 24 may extend completely within the axial opening 56 in the inlet valve disc 54. This arrangement makes possible the substantial total displacement of the cylinder cavity 44 when piston 24 moves forward. When compressible fluids are being pumped, such as gases or liquids having gases entrained therein, the efficiency of a pump to have such fluids at high pressures is materially diminished when the non-displaced volume within the cylinder cavity is large since this volume absorbs by increased pressure the effect of the pump displacement. One of the most important advantages of the valve system of this invention is the provision of a valve arrangement wherein the piston travels completely within the inlet valve disc 54 in its forward motion to reduce to a minimum the non-displaced area within fluid cavity 44.

Other advantages of the valve system of this invention are: (1) The arrangement is less expensive to manufacture than most types of valve systems utilized for pumps having completely separate inlet and outlet valve systems. (2) The arrangement provides a means whereby the wearing components of a reciprocating pump, that is, the packing 40 and both inlet and outlet valve systems, are removed from the pump by one simple operation of removing the sleeve retaining member 78 and pulling the forward and rearward sleeve portions 36 and 34 from the pump.

Valve discs 54 and 68 are preferably made of some strong plastic material although other materials capable of withstanding the pressure to which the pump will be subjected may be used. The term fluid as used herein includes both liquid and gas.

Although the invention has been described with a certain degree of particularity, it is manifested that many changes may be made in the details of construction and the arrangement of components without departing from the spirit and scope of this disclosure.

What is claimed:
1. A reciprocating pump comprising:
a pump body having a fluid inlet and a fluid outlet opening, and a cylindrical sleeve receiving opening in the forward end thereof;
a piston reciprocably supported in the pump body;
a removable cylinder sleeve positioned in the sleeve receiving opening, the sleeve having an intermediate diametric fluid partition wall therein dividing the sleeve into a forward and rearward portion, the rearward portion reciprocally receiving the piston, the sleeve having an internal annular groove in the rearward portion adjacent the partition wall, the partition wall having a multiplicity of fluid inlet openings therein, the inlet openings spaced from each other and adjacent the periphery of the annular groove, each of the sleeve inlet openings communicating with the pump body fluid inlet opening, the partition wall having at least one centrally positioned fluid outlet opening therein;
an inlet valve disc axially movably positioned in the sleeve internal annular groove, the inlet valve disc unidirectionally closing the fluid inlet openings in the partition wall, the inlet valve disc having an axial opening therein;
an outlet valve disc axially movably positioned in the sleeve forwardly of and in normal contact with the partition wall, the outlet valve disc unidirectionally closing the outlet openings in the partition wall, the sleeve having fluid outlet passages in the forward portion communicating with the pump body fluid outlet opening; and
means of retaining the sleeve in the pump body and closing the forward portion thereof.

2. A pump according to claim 1 including a stuffing box means in the rearward portion of the sleeve, the piston reciprocally received by the stuffing box means.
3. A pump according to claim 1 wherein the sleeve rearward portion is formed of a seversible rearward and forward part joined at and forming the said internal annular groove.
4. A pump according to claim 1 wherein the sleeve has an intermediate external annular groove therein communicating with the pump fluid inlet opening, each of the sleeve inlet openings communicating with the external annular groove.
5. A pump according to claim 1 wherein the sleeve has a second external annular groove therein spaced forwardly of the first mentioned annular groove, the second annular groove communicating with the pump fluid outlet opening, the fluid outlet passages in the forward portion of the sleeve communicating with the second mentioned external groove.

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