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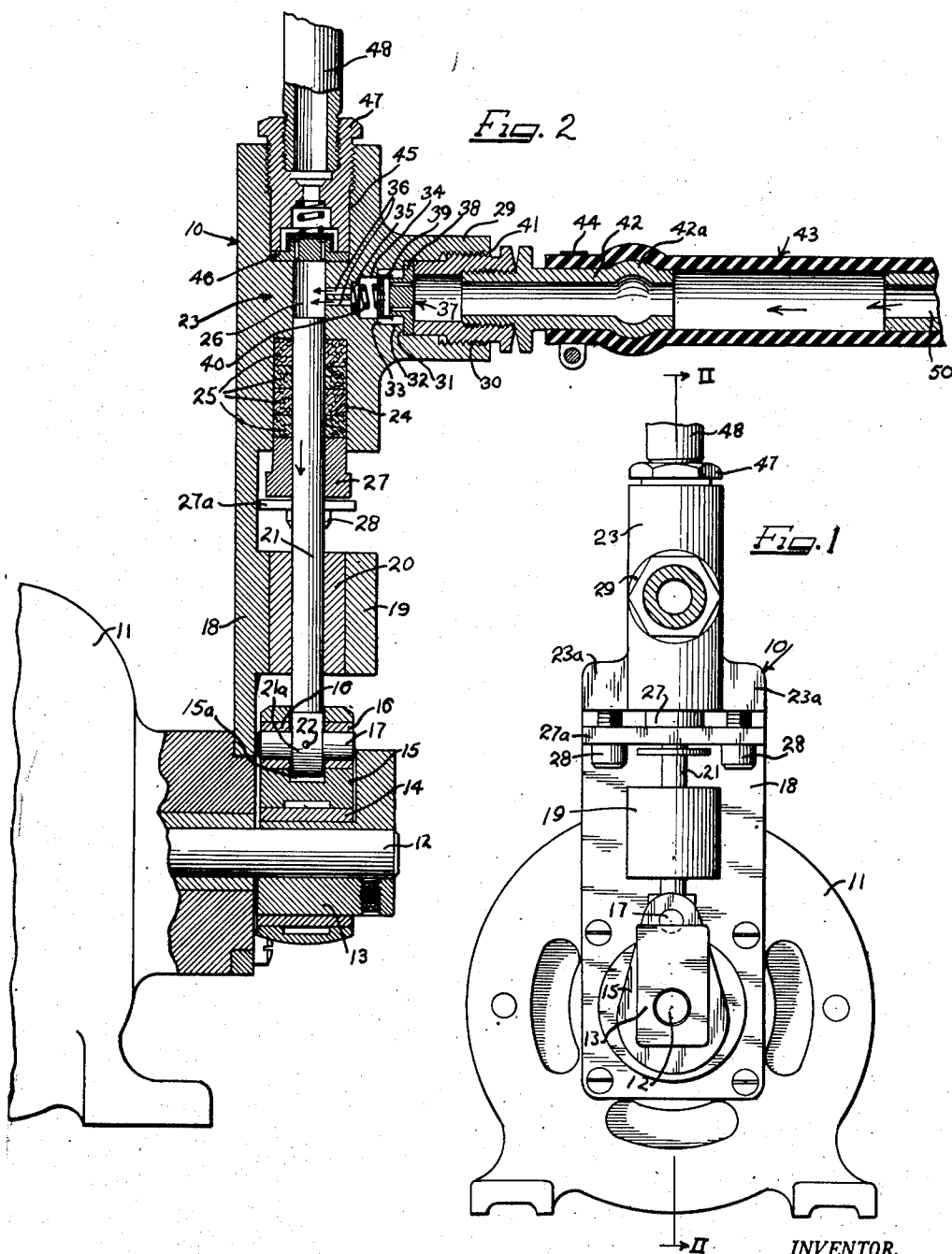
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2,593,316

RECIPROCATING PUMP ASSEMBLY

Filed Dec. 23, 1946

2 SHEETS—SHEET 1



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2 SHEETS—SHEET 2

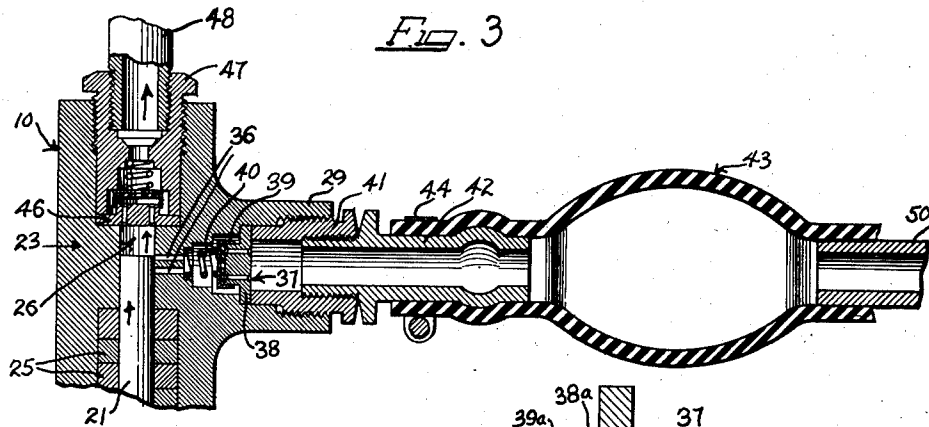


Fig. 3

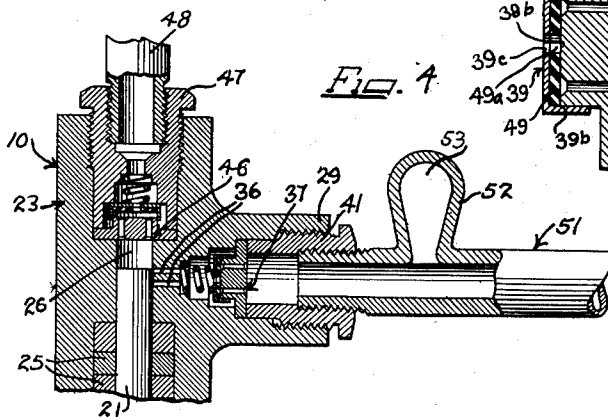


Fig. 4

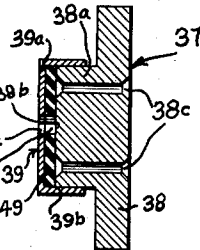


Fig. 6

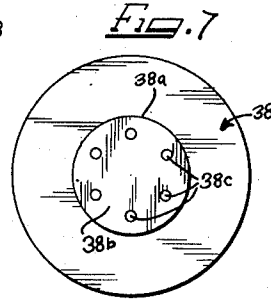


Fig. 7

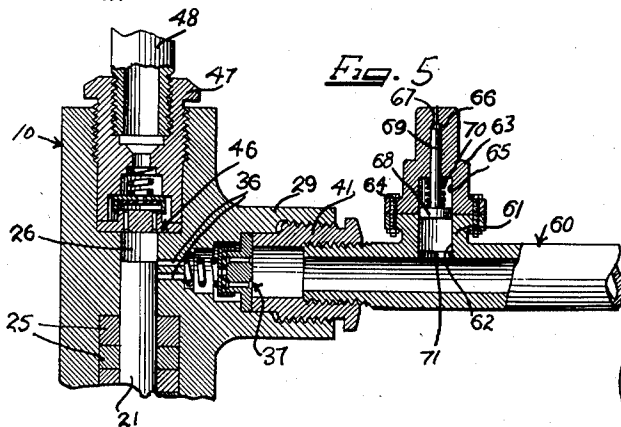


Fig. 5

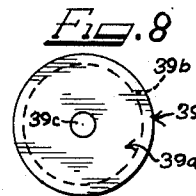


Fig. 8

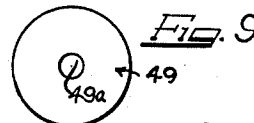


Fig. 9

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RECIPROCATING PUMP ASSEMBLY

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1 Claim. (Cl. 103-223)

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This invention relates to devices, such as reciprocating pumps, which have an intermittent fluid intake cycle adapted to develop kinetic flow energy in the fluid flowing to the inlet and wherein a surge chamber is provided in advance of the inlet for building up inlet pressure from the kinetic energy of the flowing fluid.

Specifically the invention deals with a reciprocating pump assembly equipped with a fast-acting intake check valve and a surge chamber arrangement in advance of the valve for absorbing the surge of fluid caused by cessation of flow in the feed conduit to the pump when the valve is closed, and arranged to eject pressured fluid from this surge into the pump as soon as the valve is opened.

Surge chamber arrangements to steady the discharge of reciprocating pumps are known, but heretofore surge chambers have always been on the discharge side of a reciprocating pump. According to this invention the surge chamber is provided on the intake side of a fast-operating reciprocating pump, not for the purpose of steadying the intake feed to the pump, but for the purpose of greatly increasing the capacity and pumping rate of the pump.

This invention provides an arrangement which momentarily absorbs the surge of liquid in the feed conduit to a reciprocating pump when the intake of the pump is closed during the pressuring cycle of the pump, and builds up inlet pressure from the kinetic energy of the flowing fluid for ejecting the pressured fluid into the inlet as soon as it is opened on the suction intake cycle of the pump.

Suitable surge chamber arrangements for carrying out the principles of this invention can take any one of a number of different forms. For example, a resiliently expansible hose section can be included in the intake conduit to the pump, a rigid hydraulic ram chamber can be provided on the intake conduit supplying the pump, or a spring-pressed piston slidably mounted in an expansion chamber communicating with the intake conduit for the pump can be used. The hose section will swell up due to the surge of liquid upon cessation of flow to the pump, thereby momentarily storing a slug of liquid under pressure adjacent the pump inlet for forced ejection into the pump on the next cycle of operation. The hydraulic ram chamber will be filled with air that is compressed when the surge of liquid causes some liquid to flow into the chamber, and the compressed air back of the liquid is effective to eject it into the pump on its next cycle of op-

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eration. The spring-pressed piston arrangement in an expansion chamber functions by receiving liquid forced into the chamber during the surge upon cessation of intake flow, and by pushing this liquid into the intake of the pump on its next cycle of operation.

A feature of the invention resides in the provision of a very fast-acting and efficient intake check valve for the pump. This check valve closes instantaneously upon change of the pump cycle from suction intake to pressure discharge so that flow of fluid in the intake conduit is instantaneously stopped, thereby enhancing the surge of fluid to create a greater pressure build-up from the kinetic energy thereof. Conversely, the intake valve opens immediately upon change of the pressure cycle to the suction cycle of the pump and makes possible the immediate utilization of the inlet pressure built up in the surge chamber arrangement.

Another feature of the invention resides in the provision of a surge chamber on the intake side of a pump having an interrupted intake operating through high speed cycles to develop kinetic energy in liquid flowing to the intake with a sufficient momentum to tend to maintain a continued flow while absorbing the flow or surge into the surge chamber during those portions of the interrupted flow cycle of the pump. The high speed of the pumps of this invention tends to build up a wave motion in the intake flow and the surge chamber absorbs the crests of the waves to utilize their force for ejecting the liquid into the pump on the next open cycle thereof.

It is, then, an object of this invention to provide a device having an interrupted flow intake with a surge chamber on the intake side thereof arranged to build up inlet pressure from the kinetic energy of the flowing fluid.

Another object of the invention is to provide a reciprocating pump assembly with a surge chamber on the intake side thereof.

A further object of the invention is to provide a device having an interrupted fluid intake cycle with a check valve operating in response to cycle conditions and means in advance of the valve for building up inlet pressure, when the valve is closed, from the kinetic energy of fluid flowing to the valve and for ejecting the pressured fluid into the inlet when the valve is opened.

A specific object of the invention is to provide an inexpensive, highly efficient quick-acting check valve including a body member having a plurality of passages radially outward from an axial center, together with a coacting cap mem-

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ber slidable on the body member and having an end face with an axial opening therein for receiving fluid from the passageways when the end face is spaced from the body member and for sealing the passageway when the end face is against the body member.

A still further object of the invention is to provide a check valve for pumps and the like composed of a disk with a thickened central portion having a plurality of passageways therethrough arranged in spaced relation from the axis thereof, together with a metal cap member slidable on the thickened portion of the disk and carrying a sealing liner for coacting with the end face of the thickened portion to close said passageway.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of preferred examples only, illustrate several embodiments of the invention.

On the drawings:

Figure 1 is an end elevational view of a pump assembly according to this invention.

Figure 2 is a vertical cross-sectional view, with parts in side elevation, taken along the line II-II of Figure 1, and showing the intake cycle of the pump assembly.

Figure 3 is a fragmentary view similar to Figure 2, but illustrating the discharge cycle of the pump.

Figure 4 is a view similar to Figure 3 but illustrating a hydraulic ram surge chamber arrangement in place of the resiliently expansible hose section.

Figure 5 is a view similar to Figure 3 but illustrating an expansion chamber having a spring-pressed plunger in place of the expansible hose of Figure 3 and the hydraulic ram of Figure 4.

Figure 6 is an enlarged axial cross-sectional view of the check valve in the pumps of Figures 1 to 5.

Figure 7 is a plan view of the body of the check valve.

Figure 8 is a plan view of the cap member of the valve.

Figure 9 is a plan view of the sealing liner for the cap of the valve.

As shown on the drawings:

In Figures 1 and 2, the reference numeral 10 designates generally a pump assembly according to this invention. An electric motor 11 is provided for driving the pump and, for this purpose, has a shaft 12 projecting therefrom and carrying an eccentric 13. A bearing 14 surrounds the eccentric and a strap member 15 surrounds the bearing. The strap member has a slot 15a in the top end thereof providing furcated arms which receive aligned bearing sleeves 16. A cross pin 17 is mounted in the sleeves 16.

A frame or bracket 18 is secured on the end of the motor 11 and has a boss portion 19 carrying a bearing 20 overlying the strap 15. A pump piston 21 is slidably mounted in the bearing 20 and has an eye end 21a in the slot 15a of the strap and receiving the cross pin 17 therein. The cross pin is locked in the eye end of the piston by means of a pin 22.

The bracket 18 has a cylindrical pump housing 23 on the upper end thereof above the boss 19. This housing 23 has a well 24 extending upwardly from the bottom thereof and receiving packing rings 25 therein. The piston 21 slides through the rings 25 into the pump bore 26. The piston

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fits freely in the bore 26 and operates to displace fluid therefrom. A packing plate 27 extends into the well 24 and is urged against the bottom packing ring 25 by means of bolts 28 extended through a flange 27a of the plate 27 and threaded into the bosses 23a on the pump housing 23. These screws 28 are tightened to force the member 27 into the well thereby compressing the packing material 25 and maintaining a leak-proof seal around the piston 21.

The body 23 has a side nipple 29 providing an intake port for the pump bore or chamber 26.

The nipple 29 has a stepped bore therethrough including an internally threaded outer end portion 30, a first shoulder 31, a first restricted bore portion 32, a second shoulder 33, a second restricted bore portion 34, and a blind bore portion 35 of smaller diameter than the portion 34. Passageways 36 join the bottom of the blind bore 35 with the interior of the pumping chamber 26. The pumping chamber thereby has a side intake.

An intake check valve 37 has the body portion 38 thereof bottomed on the shoulder 31, and has the cap portion 39 thereof confined for movement within the bore portion 32 because the shoulder 33 limits the movement of the cap 39 off of the body. A coil spring 40 is bottomed on the blind bore portion 35 and acts on the cap 39. A hollow fitting member 41 is threaded into the portion 30 of the bore and is internally threaded for receiving a hose nipple 42 in threaded relation therein. This nipple 42 has a bulbous portion 42a near the end thereof. A rubber hose 43 is stretched over the fitting 42 around the bulbous portion 42a thereof and a hose clamp 44 secures the hose on the fitting.

The top of the housing 23 has a well 45 therein and a second check valve assembly 46, identical with the assembly 37, has the body portion thereof seated in the bottom of the well. A hollow fitting member 47 is threaded into the well 45 against the body of the check valve 46 and has a stepped bore therein providing a chamber for the cap member of the valve as well as an abutment for the spring of this cap member. A discharge conduit 48 is threaded into the fitting 47.

The eccentric 13 rapidly reciprocates the piston 21 in the pump chamber 26 from the suction intake position shown in Figure 2 to the pressure discharge position shown in Figure 3. On the intake, or downstroke, shown in Figure 2, liquid from the hose 43 is sucked into the pumping chamber 26 through the inlet passages 36. On this suction stroke, the cap member 39 of the intake check valve 37 is drawn against the shoulder 33 thereby allowing fluid flow through the check valve.

As best shown in Figures 6 to 9, the check valve 37 has the body member 38 thereof in the form of a circular disk. A thick cylindrical central portion 38a of reduced diameter is formed integrally on the disk and projects from one face thereof. This thick portion 38a has a flat end face 38b. The cap member 39 of the valve 37 has a circular end wall 39a with a cylindrical skirt 39b projecting therefrom and slidable on the cylindrical thick portion 38a of the disk. The cap 39 has a liner disk 49 composed of rubber, fiber, plastic, or the like in the cylindrical skirt 39b thereof and bottomed on the end wall 39a.

The body member 38 has a plurality of longitudinal passages 38c extending through the thick portion 38a thereof in radially spaced relation from the axis of the body. As shown in Figure

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7. six passages 38c are provided, and they are equally spaced around the axial center of the body.

The cap member 39 has an aperture 39c in its end face 39a thereof at the axial center of the cap. An aligned aperture 49a is provided in the sealing disk liner 49.

When the liner 49 is bottomed on the end face 38b of the body member, the passageways 38c are effectively sealed. However, when the cap member 39 is moved to carry the liner 49 thereof away from the end face 38b, a flow path is opened up between the passage 38c and the apertures 49a and 39c, thereby accommodating fluid flow through the check assembly. The skirt 39b, in riding on the cylindrical portion 38a of the body 38, prevents cocking of the cap and insures full seating of the liner on the end face 38b whenever the valve is closed. The valve is very rapid in operation, has relatively high capacity for its size, and can be made very light in weight to eliminate heretofore-encountered inertia in check valve assemblies. As soon as the liner of the valve is cracked off of the end face of the body, fluid will rapidly flow through the valve, and conversely, as soon as this liner is pressed against the end face, all flow through the valve is stopped.

The pumping chamber 26 is filled with liquid on the intake stroke, shown in Figure 2, and the eccentric then reversely reciprocates the piston 21 to pressure the liquid in the pumping chamber and eject it from the pump. As shown in Figure 3, as soon as the piston starts on its up-stroke, the check valve 37 is closed and the check valve 46 is opened. Liquid in the pumping chamber 26 is thereby forced through the check valve 46 and into the discharge conduit 48.

The piston 21 is reciprocated very rapidly, so that the pump goes through its suction and discharge cycles at very high speed. During the intake or suction cycle of the pump liquid in the hose 43 flows rather rapidly because of the high speed of operation of the pump, and the flowing liquid builds up considerable kinetic energy. As soon as the intake valve 37 closes, however, the liquid, due to its kinetic energy and momentum, will produce a surge which, unless dissipated, would produce a water hammer effect in the intake pipe 50. According to this invention, however, the water hammer effect is entirely eliminated and the hose section 43 between the pipes 50 and intake fitting 42 is sufficiently yieldable so that it will expand to the position shown in Figure 3 thereby providing an enlarged chamber accommodating the surge of liquid. Of course expansion of the hose occurs by its ability to resiliently stretch, and, in its stretched position, the hose material such as rubber, is tensioned or loaded and will assume its untensioned or unloaded condition as soon as permitted. Thus, when the intake valve 37 is again opened on the next suction stroke of the pump, the liquid filling the stretched hose will be immediately expelled under the pressure developed by the tensioned or loaded condition of the hose and will be effectively forced into the pump chamber. As a result, therefore, charging of the pump on its suction stroke is speeded up and made easier because the liquid is actually injected into the pump instead of being drawn against the usual frictional drag occurring in an intake conduit.

The hose section 43 should be positioned immediately adjacent the intake of the pump and, of course, should be resiliently expansible to de-

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velop a tensioned pressure-producing condition. The hose section should be sufficiently short so that the surge chamber effect is obtained without dissipating the kinetic energy of the fluid.

In effect, the cycle reversals of the pump of this invention occur so rapidly that fluid flow in the conduit 50 is never completely stopped, and a wave motion is built up the crests of which are absorbed in the expansion of the hose to forcibly expel the liquid as soon as the intake valve is open.

The pump 10, instead of being equipped with the rubber hose intake arrangement of Figures 1 to 3 can, according to a modified embodiment of this invention, have an intake pipe 51 with a hydraulic ram 52 thereon defining a surge chamber 53 which is normally filled with air. On the suction stroke of the pump, liquid flows rapidly through the pipe 51 to build up an appreciable kinetic force. Upon reversal of the cycle of the pump to the discharge stroke, the valve 37 closes, and the kinetic energy or momentum of the fluid in the pipe 51 causes some fluid to flow into the chamber 53 of the hydraulic ram thereby compressing the air therein. This compressed air, acting directly on the fluid in the chamber 53, is thereupon effective to eject the fluid out of the chamber and into the pumping chamber 26 on the next suction stroke of the pump. The cycle reversals of the pump are so rapid that the hydraulic ram will absorb the surges of fluid occurring during the pressure strokes of the pump without stopping flow of the liquid in the pipe 51 and, at the same time, the kinetic energy in the surges is salvaged for ejecting the fluid during the next suction cycle of the pump.

In the embodiment of the invention shown in Figure 5, the pump 10 is equipped with a rigid, non-expansible inlet pipe 60 having a flanged nipple 61 thereon closely adjacent the pump inlet. This nipple 61 defines a cylindrical bore 62 in communication with the interior of the pipe 60. A housing 63 is secured on the flanged nipple 61 by means of bolts 64 and has a large bore 65 therein aligned with the bore 62 and of substantially the same diameter together with a small bore 66 extending upwardly from the upper end of the bore 65. A vent 67 joins the upper end of the bore 66 with the surrounding atmosphere. A piston head 68 is slidably mounted in the bores 62 and 65 and has an integral rod or stem portion 69 slidable in the bore 66. A coil spring 70 is held under compression between the bottom of the bore 65 and the piston head 68 to urge the piston head toward the interior of the pipe 60. A shoulder 71 in the bore 62 limits the inward travel of the piston.

On the suction stroke of the pump 10, liquid, of course, flows through the pipe 60, and the spring 70 plus the intake suction holds the piston 68 against its shoulder 71. Immediately upon termination of the suction intake stroke of the pump, the intake check valve 37, of course, closes, and the kinetic energy in the rapidly flowing liquid in the inlet pipe 60 causes the liquid to surge against the piston 68 thereby forcing it upwardly in the bore 62 and compressing the spring 70. Some liquid is thereupon momentarily stored in the bore 62 and is acted on by the spring-pressed piston which, of course, tends to force the liquid back into the pipe 60. Therefore, on the next suction intake stroke of the pump 10, the liquid is pushed by the piston 68 into the pipe 60 and thence, of course, into the pump inlet. The bore 62 and, if necessary, the bore 65 therefore define

an expansion chamber absorbing the surge of liquid caused by cycle reversals of the pump and utilizing the energy of the surge to load a spring for expelling the liquid on the next intake stroke of the pump.

The three embodiments of the invention illustrated herein show the use of different types of surge chambers on the intake side of a reciprocating pump for absorbing a surge of liquid upon reversal of the pump cycle from intake to compression, and for ejecting the absorbed liquid under pressure during the next intake stroke of the pump thereby increasing the pump capacity. The pump is operated at high speeds to produce rapid cycle reversals, and the incoming liquid to the pump, because of the surge chamber arrangement, actually keeps right on flowing even during the compression cycles of the pump. A wave-like motion of the liquid is developed with the surge chambers absorbing the crests of the waves to utilize the kinetic energy therein on the succeeding suction stroke of the pump.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claim.

I claim as my invention:

A reciprocating pump comprising a pump body having an open ended pumping chamber having a cylindrical wall, a fluid inlet leading through said wall into said chamber, a lightweight valve disk assembly including a disk reciprocable in said inlet to check back-flow from the chamber, a piston movable within said chamber and extending from one open end thereof, said other open end of the chamber providing a fluid outlet, a check valve in said other open end, an outlet fitting anchoring said check valve in said out-

let, an eccentric operatively connected with said piston to reciprocally move said piston within said pumping chamber, an inlet fitting anchoring said valve disk assembly in said inlet, and a nipple carried by said inlet fitting, a short elastic tube on said nipple forming a continuation thereof, said tube being resiliently expansible and contractible immediately adjacent the nipple to absorb surges in said inlet when the disk valve closes and to force fluid into said pumping chamber when the disk valve opens, the tube length being insufficient to dissipate the kinetic energy of the surges.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
57,412	Weyde	Aug. 21, 1866
204,747	Maxim	June 11, 1878
852,150	Whitney	Apr. 30, 1907
912,502	Squires	Feb. 16, 1909
1,075,322	Bargamin	Oct. 14, 1913
1,129,072	Conn	Feb. 23, 1915
1,204,898	Nichols	Nov. 14, 1916
1,266,658	Brandenberger	May 21, 1918
1,713,073	Carter	May 14, 1929
1,865,000	Goldberg	June 28, 1932
1,944,340	Zubatý et al.	Jan. 23, 1934
1,979,476	Labaw	Nov. 6, 1934
2,008,133	Farmer	July 16, 1935
2,261,948	Beach	Nov. 11, 1941
2,325,672	Groff	Aug. 3, 1943

FOREIGN PATENTS

Number	Country	Date
18,106	Norway	Dec. 14, 1907