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[54] **PUMP**

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[73] Assignee: **The Mec-O-Matic**

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[52] **U.S. Cl.** **417/502,** 417/568, 92/60.5

[51] **Int. Cl.....F04b 23/00,** F04b 41/00, F04b 21/02, F04b 39/04, F01b 31/14

[58] **Field of Search**......417/568, 502, 901, 489, 274, 417/289; 92/13.51, 60.5

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[57] **ABSTRACT**

A pump, comprising: a pumping chamber; reciprocating means associated with the pumping chamber so as to increase and decrease the volume thereof; an inlet passageway in fluid communication wit the pumping chamber; a discharge passageway in fluid communication with an upper portion of the pumping chamber so as to discharge substantially all gasses and excess liquid from the pumping chamber; an outlet passageway in fluid communication with the pumping chamber; and means associated with the reciprocating means for periodically collecting a predetermined quantity of liquid, substantially void of gases, from the pumping chamber and directing it through the outlet passageway.

21 Claims, 4 Drawing Figures

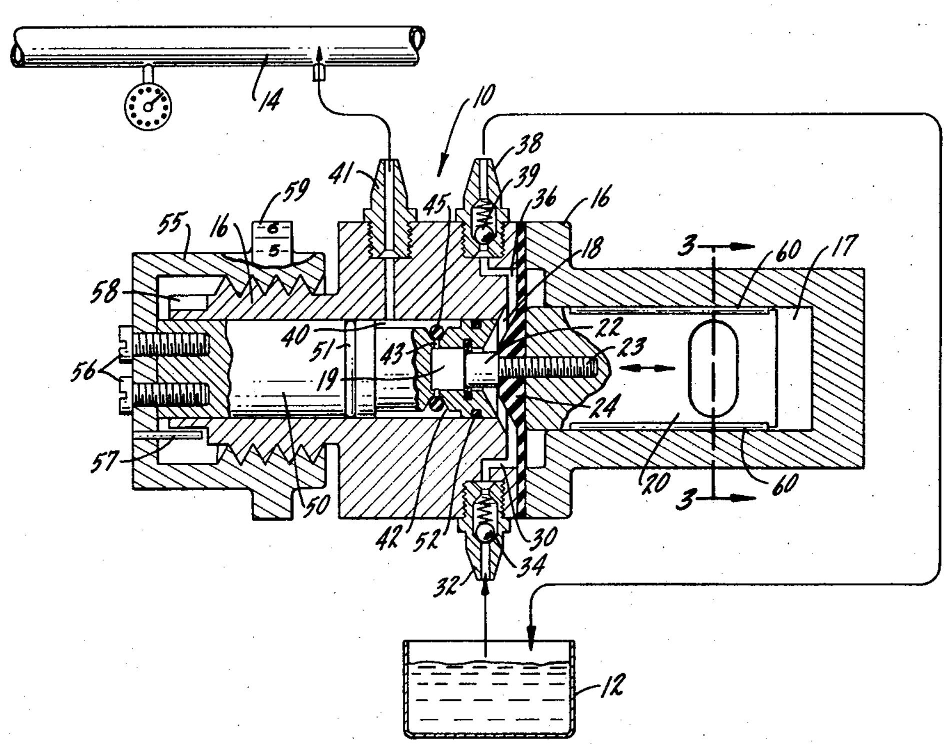
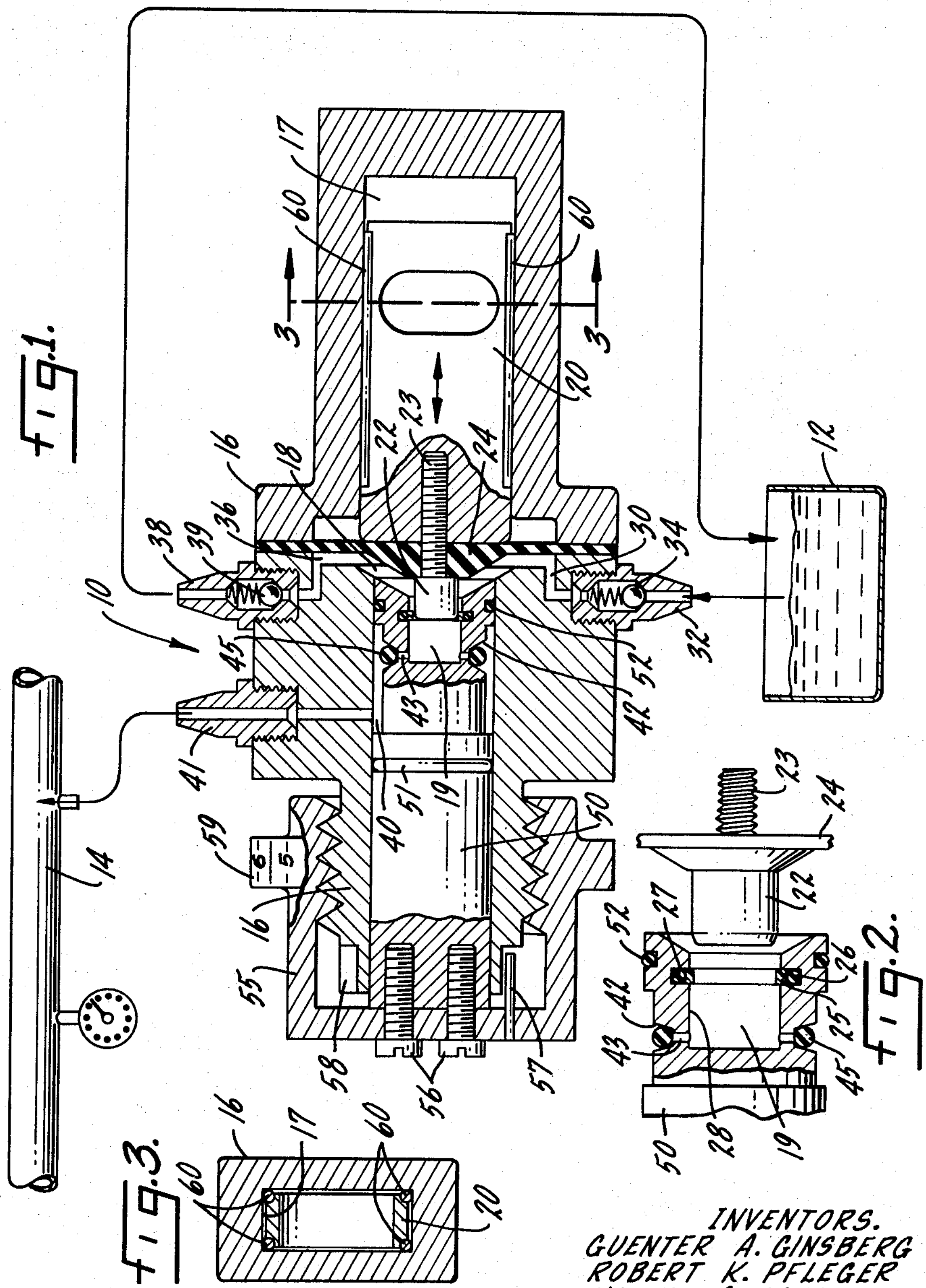


Fig. 1. Fig. 2. Fig. 3.



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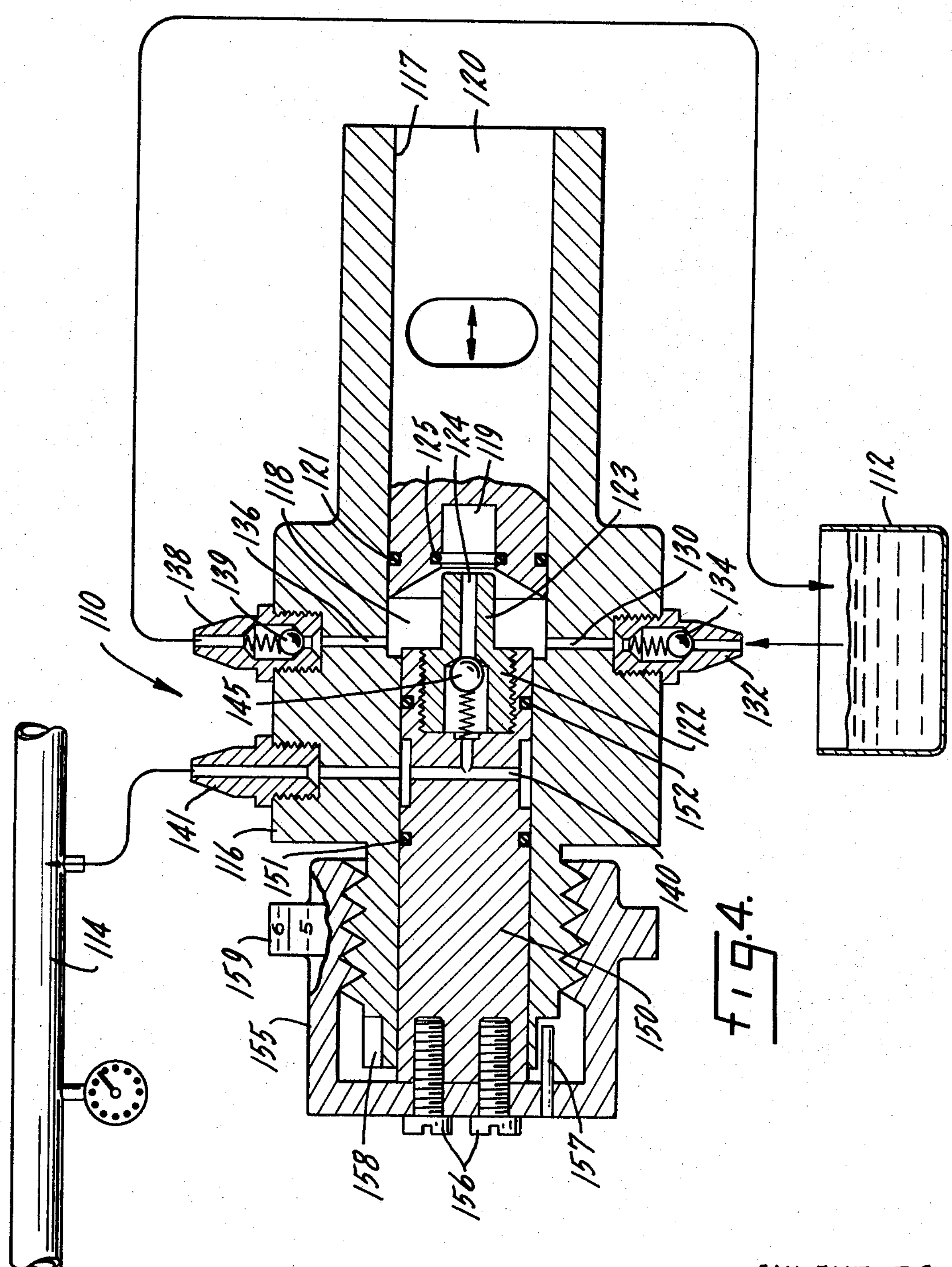

FIG. 4.

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PUMP

BACKGROUND OF THE INVENTION

This invention relates to reciprocating pumps for pumping fluids and more particularly it relates to pumps for pumping minute quantities of liquid for process requirements.

There are numerous problems in pumping small amounts of liquid (e.g., chemicals for water treatment) with conventional piston or diaphragm pumps. This is usually accomplished by the prior art pumps by using either a small diameter piston or a diaphragm having a very short stroke. Accurate adjustment of short stroke diaphragm mechanisms leads to complex design problems. On prior art small diameter piston units, the pumping accuracy has been sacrificed in order to obtain reliable priming and/or a variable output. Some pumps bypass a portion of the output back to the supply container; these units usually have a volumetric output which varies inversely with system pressure. Some success has been had with more complex designs for bypassing a portion of the output; however, by adding more components the overall accuracy is diminished and the cost increased.

A pump designed to deliver minute quantities of liquid should meet the requirements discussed briefly below. The pump is required to self prime against full rated output pressures at all settings. When the output is feeding a pressurized system or the stroke of a piston is reduced to obtain low output, the compressability of gasses makes priming impossible unless a means of discharging the gasses is provided. This degassing also ensures against the loss of prime during operation of the pump. The pump must self-degas to ensure against changes of output. When gases develop in the pumping chamber, the discharge volume drops by the rate of gas build-up in the cylinder area. This means, even though the gas accumulation is not sufficient to break the prime, it will change the output volume of the pump. The pump is required to remain operable with slight leakage of check valves due to precipitants from the liquid being fed. The pump is further required to run dry without damage to dynamic seals. No prior art pump presently known sufficiently meets these requirements.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide a pump unit to pump minute controllable quantities of liquids and solutions.

Another object is to provide a pump unit that self primes against full rated output pressure at all of its possible feed rate settings.

A further object is to provide a pump unit that self degasses to ensure against loss of prime and against changes in output due to gas accumulation.

Still another object is to provide a pump unit that maintains itself operable with slight leakage of check valves due to precipitants from the liquid being fed.

A still further object is to provide a pump unit that can run dry without damage to dynamic seals and employs a unique bearing system to ensure proper alignment and long life.

The present invention attains these and other objects by providing a pump including: a pumping chamber; reciprocating means associated with the pumping chamber so as to increase and decrease the volume thereof; an inlet passageway in fluid communication with the pumping chamber having check valve means associated therewith to prevent reverse fluid flow; a discharge passageway in fluid communication with an upper portion of the pumping chamber so as to discharge substantially all gasses and excess liquid from the pumping chamber, having a check valve associated therewith to prevent flow of fluid into the pumping chamber; an outlet passageway in fluid communication with the pumping chamber having check valve means associated therewith to prevent the flow of fluid into the pumping chamber; and mean associated with the reciprocating means for periodically collecting a predetermined quantity of liquid, substantially void of gases, from the pumping chamber and directing it through the outlet passageway. Special seals are provided to increase the life of the pump and decrease the maintenance requirements. Two embodiments are disclosed differing in structure but operating under the same inventive principles.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following description of preferred embodiments of the invention, as illustrated in the accompanying sheets of drawings, in which:

FIG. 1 is a vertical sectional view of one embodiment of the pump in conjunction with an outlet conduit and container shown in schematic;

FIG. 2 is an enlarged vertical sectional view of a portion of the pumping chamber in FIG. 1 showing the piston in the position most removed from the bore;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 1; and

FIG. 4 is a vertical sectional view of an alternative of the pump in conjunction with an outlet conduit and a container shown in schematic.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a pump, indicated generally at **10**, in conjunction with a container **12** containing the liquid to be pumped and a conduit **14** to receive the pumped liquid. Pump **10** includes a pump body **16** in which is formed a piston receiving rectangular shaped bore **17**, a pumping chamber **18**, and cylindrical bore **19**. Positioned within bore **17** is a reciprocating piston **20** which is linked to any suitable reciprocating power source (hydraulic, pneumatic, electromechanical, etc.), not illustrated. Plunger **22** and flexible diaphragm **24** are attached to piston **20**. Plunger **22** has a threaded portion **23** which passes through an aperture in diaphragm **24** and is received by piston **20** so as to sandwich diaphragm **24** between plunger **22** and piston **20**. Diaphragm **24** is secured about its outer periphery to body **16** in a manner so as to prevent fluid communication between bore **17** and chamber **18**. Reciprocating movement of piston **20** is thus translated directly to diaphragm **24** and plunger **22** to cause a reciprocating action of both parts.

Bore **19** is positioned so as to receive plunger **22**. As seen in FIG. 2, bore **19** has an O-ring **26** recessed into grove **27** in sidewall **28** of bore **19** adjacent pumping chamber 18. A ring 25, preferably of a material having a low coefficient of friction such as polytetrafluoroethylene, having a rectangular shaped cross-section, is partially recessed into groove 27 adjacent the inner periphery of O-ring 26 so as to protrude slightly into bore 19. This arrangement ensures a positive shut-off point when plunger 22 enters bore 19 which is vital for fine accurate feed rate settings. This arrangement further maintains the quality of sealing under dry conditions and thus enables the pump to run dry for a longer period of time without losing efficiency because of damaged seals.

Inlet passageway 30 is formed in body 16 and is in fluid communication with a lower portion of chamber 18 at one end and with a fitting 32, having a suction check valve 34 therein, at its other end. Check valve 34 is biased so as to prevent the reverse flow of fluid from chamber 18 through passageway 30. Fitting 32 is provided with conventional tubing (not shown) extending from its outer end to container 12.

Discharge passageway 36 is formed in body 16 and is in fluid communication with an upper portion of chamber 18 at one end and with a fitting 38, having a check valve 39 therein, at its other end. Check valve 39 is biased so as to prevent the backflow of fluid into chamber 18. Fitting 38 is provided with conventional tubing (not shown) extending from its outer end to container 12. It can thus be seen that liquid lifted from container 12 can flow through passageway 30 into pumping chamber 18, and, if undiverted into bore 19, out through passageway 36 and back to container 12.

Outlet passageway 40 is formed in body 16 and 19 is is in fluid communication with the outer end portion of bore 19 at one end, and with fitting 41 at its other end. Fitting 41 is provided with conventional tubing (not shown) extending from its outer end to conduit 14. As seen in FIG. 2, an O-ring check valve 45 is positioned in valve seat 42, recessed in member 50, so as to permit the flow of liquid from bore 19 via a plurality of openings 43 in member 50 into passageway 40 only when plunger 22 increases the liquid pressure in bore 19 to a predetermined level sufficient to displace O-ring 45 from seat 42 and thereby open fluid communication between bore 29 and passageway 40. The bias on check valve 39 tending to close off passageway 36 in less than the bias on O-ring 45 tending to close off passageway 40; thus the pressure in bore 19 can not reach the level sufficient to displace O-ring 45 until plunger 22 contacts seal 25.

In order to adjust the feed rate of pump 10 a moveable member 50 is provided to increase and decrease the effective penetration of plunger 22 into bore 19. Bore 19 is formed within member 50, thus movement of member 50 towards and away from plunger 22 respectively increases and decreases the penetration of plunger 22 and thereby changes the feed rate of pump 10. Conventional O-ring seals 51 and 52 prevent leakage of fluid from passageway 40 through the area where member 50 contacts body 16 and prevent fluid communication between chamber 18 and passageway 40 except via bore 19. An adjustment knob 55, attached to member 50 by fasteners 56, is threadedly received about body 16 such that rotation of knob 55 moves member 50 towards and away from plunger 22. The pitch of the thread on body 16 and knob 55 is such that within one full turn of knob 55 the feed rate is adjusted from zero to its maximum setting. A pin 57 attached to knob 55 moves against a stop member 58 on body 16 and thus prevents adjustment knob 55 from turning past the zero or maximum mark. It also prevents plunger 22 from bottoming out against member 50 in bore 19. A fine scale 59 is provided on knob 55 which enables very fine and consistant settings.

As seen in FIGS. 1 and 3, a unique bearing system is provided to assure alignment and minimum friction between piston 20 and body 16. Rectangular piston 20 is provided with rods 60, preferably of a material having a low coefficient of friction such as polytetrafluoroethylene, at its four edges so as to contact the corners of bore 17. Since no fluid enters bore 17, rods 60 act only to align piston 20 and reduce friction, and not as a fluid seal.

In operation, piston 20 is reciprocated at a sufficient stroke and speed (e.g. 75 strokes/minute) to ensure that the reciprocating action of diaphragm 24 rapidly creates sufficient suction to prime chamber 18 with liquid. The reciprocating action of diaphragm 24, along with the action of check valves 34 and 39, circulate the liquid from container 12, and any gasses present in chamber 18, in the direction noted by the arrows in FIG. 1. Piston 20 operates at sufficient speed and stroke to produce sufficient flow volume to cause check valves 34 and 39 to effectively stop reverse flow of fluids even with slight leakage due to foreign particles on the valve seats. When piston 20 is in its rear position (back stroke) diagram 24 and plunger 22 are situated as shown in FIG. 2. That is, plunger 22 is completely removed from bore 19 such that bore 19 is in fluid communication with chamber 18. Bore 19 is in communication with the center of chamber 18 so that gasses released from the liquid being pumped or air contained in chamber 18 before pumping will rise to the top of chamber 18, and be pumped out through passageway 36. When piston 20 is in its back stroke liquid from chamber 18 fills bore 19. The liquid in bore 19 is substantially void of gases due to the location of bore 19 in the center of chamber 18, such that the gasses at or moving to the top of chamber 18 do not enter bore 19. On its forward stroke plunger 22 enters bore 19 and comes in contact with seal 25 and continues forward increasing the pressure of the liquid in bore 19 and thus pushes an exact amount of liquid out of bore 19 thru opening 43 and past O-ring 45. O-ring 45 prevents any significant reverse flow of fluid into bore 19 when plunger 22 leaves bore 19 on its back stroke. Chamber 18 is filling on the back stroke and once plunger 22 clears seal 25, liquid from chamber 18 fills bore 19 and the pumping process continues. Varying the feed rate is accomplished by rotating knob 55 which moves member 50 towards or away from plunger 22. This changes the penetration depth of piston 22 into bore 19. To increase the feed rate, knob 55 is turned clockwise (when viewed from the left) so that it moves member 50 toward plunger 22. To decrease the feed rate, knob 55 is turned counterclockwise, so that it moves member 50 away from plunger 22.

Due to the reciprocating speed and large diameter of diaphragm 24 and the large volume of chamber 18 as compared to the diameter of plunger 22 and volume of bore 19, approximately 80 percent of the liquid passing through passageway 30 is eventually returned to container 12. This enables pump 10 to prime rapidly and remain operable even with slight leakage of check valves 34 and 38. Also, pump 10 does not include any external dynamic seals due to the use of diaphragm 24. Dynamic seals depend mainly on liquids being pumped for lubrication and therefore when a pump using same runs dry, the friction developed by the reciprocating piston can rapidly damage the seal; this may cause external leakage of hazardous chemicals.

An alternative embodiment, illustrated in FIG. 4, shows a pump indicated at 110 in conjunction with a container 112 containing the liquid to be pumped and a conduit 114 to receive the pumped liquid. Pump 110 includes a pump body 116 in which is formed a piston receiving cylindrical bore 117, a pumping chamber 118, and a cylindrical bore 119. Positioned within bore 117 is a reciprocating piston 120 which is linked to any suitable reciprocating power source (hydraulic, pneumatic, electro-mechanical, etc.), not illustrated. Bore 119 is cut-out of a central portion of piston 120. O-ring 121 is recessed about the outer periphery of piston 120 and acts as a seal to prevent fluid from pumping chamber 118 entering bore 117.

Member 150 is moveably positioned within body 116 and has a member 122 threadedly received therein. Member 122 includes a cylindrical stem portion 123, extending into pumping chamber 118, having a passageway 124 passing therethrough. Stem 123 is positioned opposite bore 119 such that as piston 120 reciprocates back and forth, stem 123 enters and leaves bore 119. An O-ring seal 125 is recessed into the sidewall of bore 119 adjacent its open end to prevent fluid from entering or leaving bore 119, when stem 123 is in contact with seal 125.

Inlet passageway 130 is formed in body 116 and is in fluid communication with a lower portion of chamber 118 at one end and with a fitting 132, having a suction check valve 134 therein, at its other end. Check valve 134, is biased so as to prevent the reverse flow of fluid from chamber 118 through passageway 130. Fitting 132 is provided with conventional tubing (not shown) extending from its outer end to container 112.

Discharge passageway 136 is formed in body 116 and is in fluid communication with an upper portion of chamber 118 at one end and with a fitting 138, having a check valve 139 therein, at its other end. Check valve 139 is biased so as to prevent the backflow of fluid into chamber 118. Fitting 138 is provided with conventional tubing (not shown) extending from its outer end to container 112. It can thus be seen that liquid lifted from container 112 can flow through passageway 130 into pumping chamber 118 and, if undiverted into bore 119, out through passageway 136 and back to container 112.

Outlet passageway 140 passes through member 122, member 150 and body 116, and is in fluid communication with passageway 124 at one end and with fitting 141 at its other end. Fitting 141 is provided with conventional tubing (not shown) extending from its outer end to conduit 114. Check valve 145 is positioned within member 122 adjacent passageway 124 so as to permit the flow of liquid from passageway 124 into passageway 140 only when the pressure of the liquid in passageway 124 increases to a predetermined level sufficient to displace check valve 145 from its seat. The bias on check valve 139 tending to close off passageway 136 is less than the bias on check valve 145 tending to close off passageway; thus the pressure in passageway 124 can not reach the level sufficient to displace check valve 145 until stem 123 enters bore 119.

In order to adjust the feed rate of pump 110 member 150 is selectively adjustable so as to increase and decrease the effective penetration of stem 123 into bore 119. An adjustment knob 155, attached to member 150 by fasteners 156, is threadedly received about body 116 such that rotation of knob 155 moves member 150 and member 122 attached thereto towards and away from bore 119. The pitch of the thread on body 116 and knob 155 is such that within one full turn of knob 155 the feed rate is adjusted from zero to its maximum setting. A pin 157 attached to knob 155 moves against a stop member 158 on body 116 and thus prevents adjustment knob 155 from turning past the zero or maximum mark. It also prevents stem 123 from bottoming out against the end of bore 119. A fine scale 159 is provided on knob 155 which enables very fine and consistant settings.

Conventional O-ring seals 151 and 152 prevent leakage of fluid from passageway 140 through the area where member 150 contacts body 116 and prevent fluid communication between chamber 118 and passageway 140 except via passageway 124. O-ring 125 may alternatively be exchanged for an O-ring and sealing ring combination as shown in FIG. 2 at 25 and 26.

In operation, piston 120 is reciprocated at a sufficient stroke and speed (e.g., 75 strokes/minute) to ensure sufficient suction to prime chamber 118 with liquid. The reciprocating action of piston 120, along with the action of check valves 134 and 139, circulate the liquid from container 112, and any gases present in chamber 118, in the direction noted by the arrows in FIG. 4. When piston 120 is in its rear position (back stroke) bore 119 and stem 123 are situated as shown in FIG. 4. That is, stem 123 is completely removed from bore 119 such that bore 119 is in fluid communication with chamber 118. Bore 119 is in communication with the center of chamber 118 so that gasses released from the liquid being pumped, or air contained in chamber 118 before pumping, will rise to the top of chamber 118 and be pumped out through passageway 136. When piston 120 is in its back stroke liquid from chamber 118 fills bore 119. The liquid in bore 119 is substantially void of gasses due to the location of bore 119 in the center of chamber 118, such that the gases at the top of chamber do not enter bore 119. On the forward stroke of piston 120, stem 123 enters bore 119 and comes in contact with seal 125; and then continues forward increasing the pressure of the liquid in bore 119, and thus pushes an exact amount of liquid out of bore 119 through passageway 124, past check valve 145, into passageway 140. Check valve 145 prevents any significant reverse flow of fluid through passageway 124 into bore 119 when stem 123 leaves bore 119 on the back stroke of piston 120. Chamber 118 is filling on the back stroke of piston 120 and once stem 123 clears seal 125, liquid from chamber 118 fills bore 119 and the pumping process continues. Varying the feed rate is accomplished in a similar manner as discussed above with respect to the embodiment shown in FIG. 1.

It should be understood, of course, that the foregoing disclosure relates to only preferred embodiments of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

What is claimed is:

1. A pump for pumping small quantities of liquid, comprising:
 a. a pump body;
 b. a pumping chamber in said body;
 c. reciprocating means associated with said pumping chamber so as to increase and decrease the volume thereof;
 d. an inlet passageway in fluid communication with said pumping chamber having check valve means associated therewith to prevent reverse fluid flow;
 e. a discharge passageway in fluid communication with an upper portion of said pumping chamber to discharge accumulated gases and excess liquid from said pumping chamber, said discharge passageway having check valve means associated therewith to prevent flow of fluid into said pumping chamber;
 f. An outlet passageway in fluid communication with said pumping chamber having check valve means associated therewith to prevent the flow of fluid into said pumping chamber; and
 g. means associated with said reciprocating means positioned below said discharge passageway for periodically collecting a predetermined quantity of liquid devoid of accumulated gasses from said pumping chamber and directing it through said outlet passageway while directing said excess liquid and accumulated gasses through said discharge passageway.

2. The invention of claim 1 wherein said inlet passageway is always in fluid communication with said discharge passageway.

3. The invention of claim 1 wherein said means is selectively adjustable so as to control the quantity of fluid directed through said outlet passageway.

4. The invention of claim 1 wherein said means includes a bore portion in fluid communication with said pumping chamber and plunger means to enter said bore portion and force a predetermine quantity of fluid from said bore portion through said outlet passageway.

6. The invention of claim 4 wherein the maximum penetration of said plunger means into said bore portion is selectively adjustable so as to control the quantity of fluid directed through said outlet passageway.

6. A pump for pumping small quantities of liquid, comprising:
 a. a pump body;
 b. a pumping chamber in said body;
 c. a small diameter bore in fluid communication with said pumping chamber;
 d. a flexible diaphragm dividing said chamber into first and second areas, said first area being in fluid communication with said bore;
 e. plunger means attached to said diaphragm and positioned within said first area so as to permit movement into and out of said bore;
 f. reciprocating means associated with said diaphragm so as to move said diaphragm and said plunger means back and forth and thereby increase and decrease the volume of said first area while moving said plunger means into and out of said bore;
 g. an inlet passageway in fluid communication with a portion of said first area, having check valve means associated therewith to prevent reverse flow of fluid;
 h. a discharge passageway in fluid communication with an upper portion of said first area having check valve means associated therewith to prevent the flow of fluid into said first area; and
 i. an outlet passageway in fluid communication with said bore having check valve means associated therewith to prevent the reverse flow of fluid into said bore.

7. The invention of claim 6 wherein when said plunger means is positioned within said bore said inlet passageway is not in fluid communication with said bore and when said plunger means is not positioned within said bore said inlet passageway is in fluid communication with said bore.

8. The invention of claim 6 wherein means is provided to increase and decrease the maximum penetration of said plunger means into said bore and thereby control the flow rate through said outlet passageway.

9. The invention of claim 6 wherein said inlet passageway is always in fluid communication with said discharge passageway.

10. A pump for pumping small quantities of liquid, comprising:
 a. a pump body;
 b. a pumping chamber in said body;
 c. a flexible diaphragm dividing said chamber into first and second areas;
 d. means positioned within said body having a surface in contact with said first area;
 e. a small diameter bore in said means in fluid communication with said first area;
 f. plunger means attached to said diaphragm and positioned within said first area so as to permit movement into and out of said bore;
 g. reciprocating means associated with said diaphragm so as to move said diaphragm and said plunger means back and forth and thereby increase and decrease the volume of said first area while moving said plunger means into and out of said bore;
 h. an inlet passageway in fluid communication with a portion of said first area having check valve means associated therewith to prevent reverse of flow of fluid;
 i. a discharge passageway in fluid communication with an upper portion of said first area having check valve means associated therewith to prevent the flow of fluid into said first area; and
 j. an outlet passageway in fluid communication with a portion of said bore spaced from said first area having check valve means associated therewith to prevent the reverse flow of fluid into said bore.

11. The invention of claim 10 wherein when said plunger means is at its forward stroke it is spaced a short distance from said outlet passageway and said bore is not in fluid communication with said first area

and when said plunger means is at its rearward stroke it is spaced from said bore and thereby permits fluid communication between said first area and said bore.

12. The invention of claim **11** wherein an O-ring is recessed in the bore sidewalls adjacent said first area so as to close off fluid communication between said first area and said bore when said plunger means contacts said O-ring.

13. The invention of claim **12** wherein a sealing ring having a rectangular cross section is provided inwardly from, and adjacent to, said O-ring.

14. The invention of claim **10** wherein said reciprocating means includes a reciprocating piston having a rectangular cross section positioned within a rectangular shaped bore; said piston having bearing rods at its four edges to contact the corners of said rectangular shaped bore and thereby reduce friction therebetween.

15. The invention of claim **10** wherein said means, and the bore positioned therein, are adjustably mounted to said body so as to permit said bore to be selectively moved towards and away from said plunger means and thereby adjust the maximum penetration of said plunger means into said bore.

16. A pump for pumping small quantities of liquid, comprising:

a. a pump body;

b. a pumping chamber in said body;

c. a reciprocating piston associated with said pumping chamber so as to increase and decrease the volume thereof;

d. a bore associated with said piston in a facing relationship to said pumping chamber;

e. a member positioned relative to said bore so as to move into and out of said bore in a closely fitting relationship;

f. an inlet passageway in fluid communication with a lower portion of said pumping chamber having check valve means associated therewith to prevent reverse flow of fluid;

g. a discharge passageway in fluid communication with an upper portion of said pumping chamber above said bore to discharge accumulated gasses and excess liquid from said pumping chamber, said discharge passageway having check valve means associated therewith to prevent flow of fluid into said pumping chamber; and

h. an outlet passageway passing through said member having check value means associated therewith such that only when said member enters said bore will the liquid contained in said bore be forced through said outlet passageway.

17. The invention of claim **16** wherein means is provided to increase and decrease the maximum penetration of said member into said bore and thereby control the flow rate through said outlet passageway.

18. The invention of claim **16** wherein said inlet passageway is always in fluid communication with said discharge passageway.

19. The invention of claim **16** where an O-ring is recessed in the bore sidewalls adjacent said pumping chamber so as to close off fluid communication between said bore and said pumping chamber when said member contacts said O-ring.

20. The invention of claim **19** wherein a sealing ring having a rectangular cross section is provided inwardly from, and adjacent to, said O-ring.

21. The invention of claim **16** wherein said member is adjustabley mounted to said body so as to permit said member to be selectively moved towards and away from said bore and thereby adjust the maximum penetration of said member into said bore.

* * * * *

(5/69)

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,680,985 Dated 8/1/72

Inventor(s) Guenter A. Ginsberg and Robert K. Pfleger and Harry A. Savage

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

In the Abstract, line 4 delete "wit" and insert --with--.

In column 3, line 33 delete "19 is".

In column 3, line 46 delete "29" and insert --19--.

In column 7, line 52 delete "6" and insert --5--.

Signed and sealed this 26th day of December 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents