Dec. 20, 1955 N. G. KLING ET AL 2,727,466

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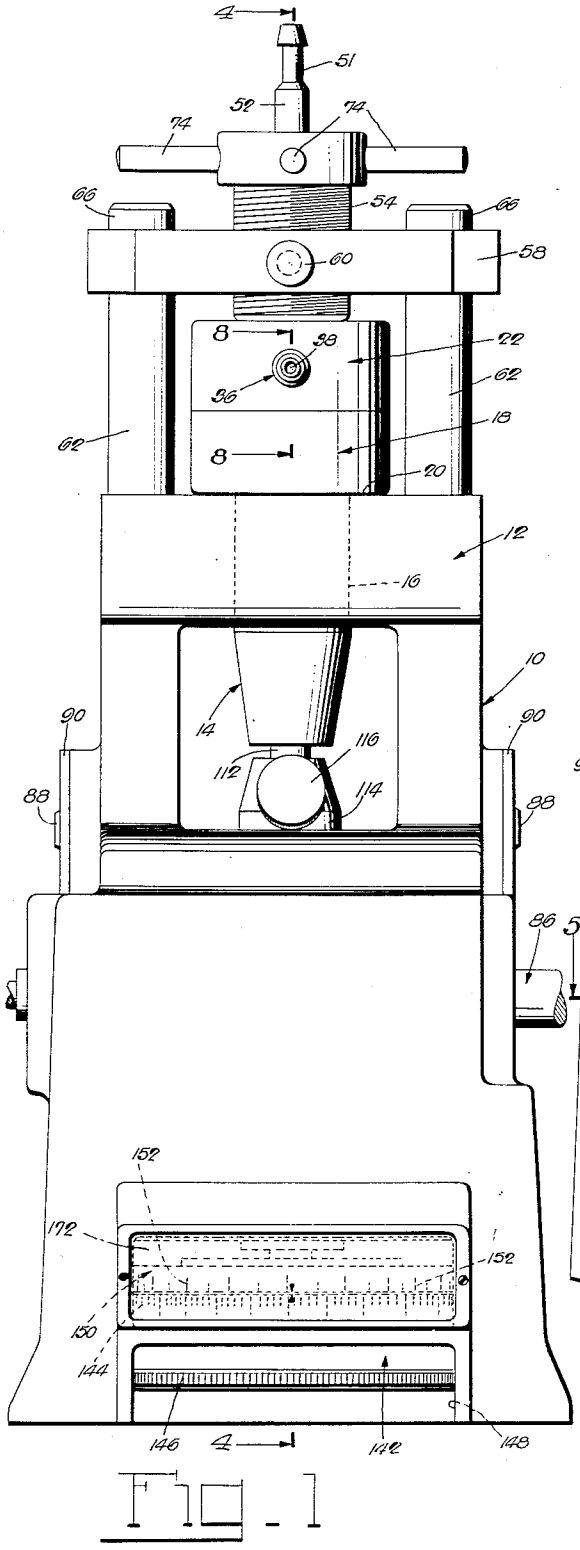


Fig. 1

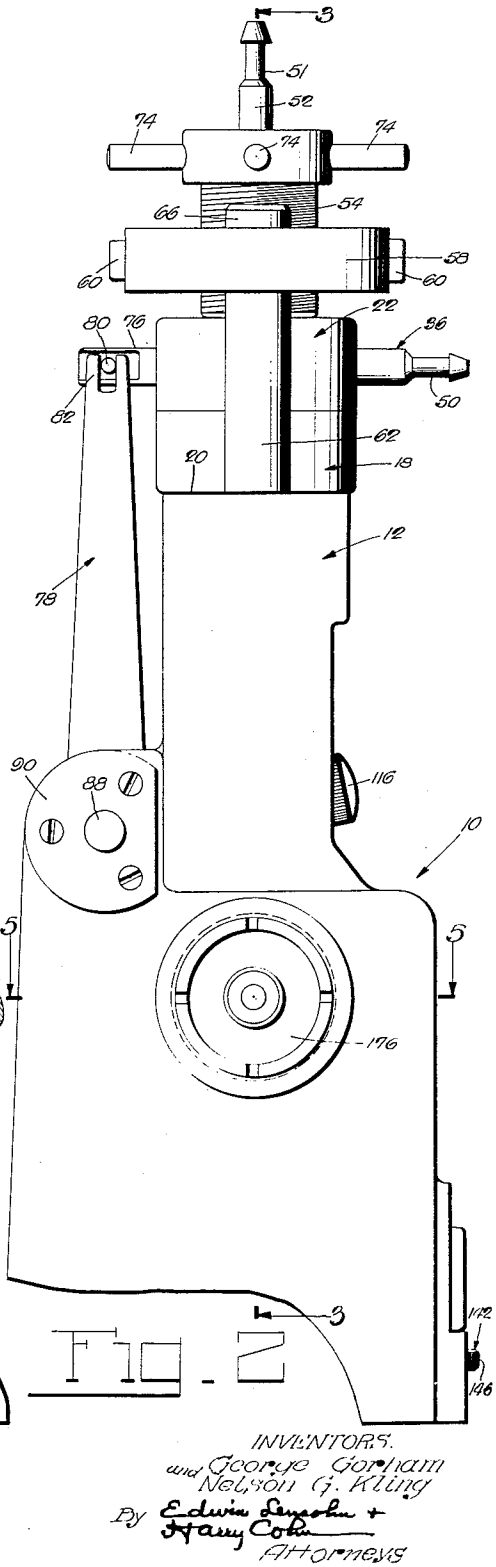


Fig. 2

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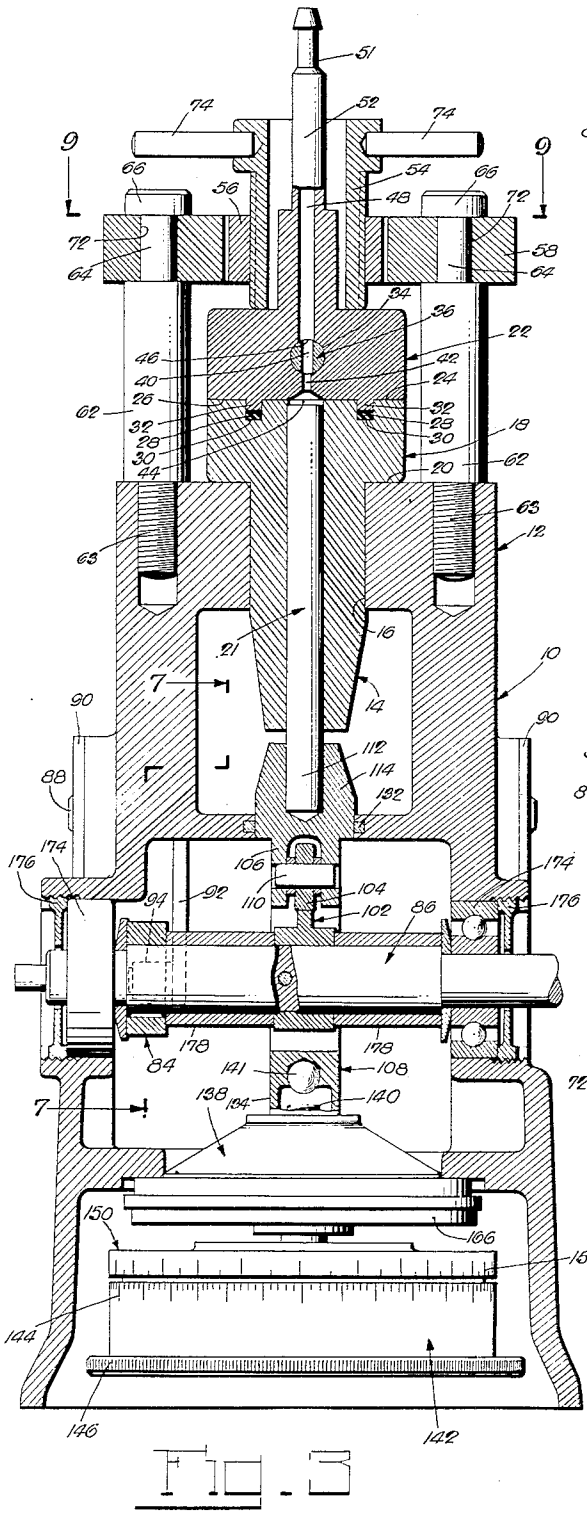


Fig. 3

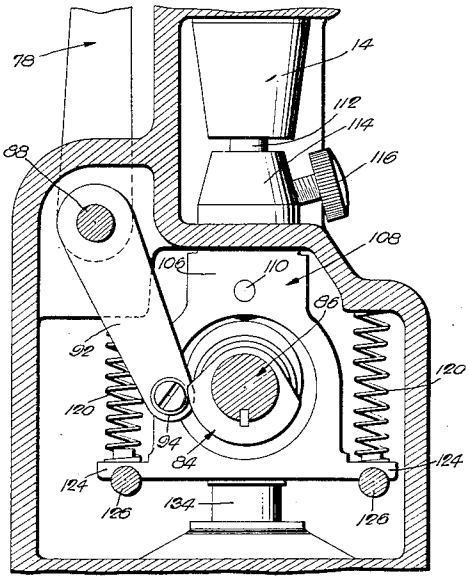


Fig. 7

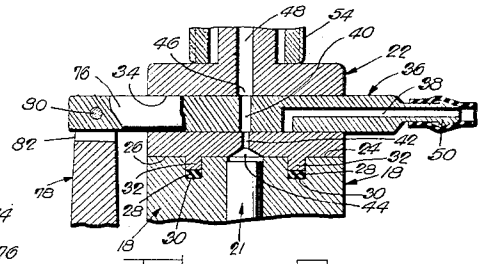


Fig. 8

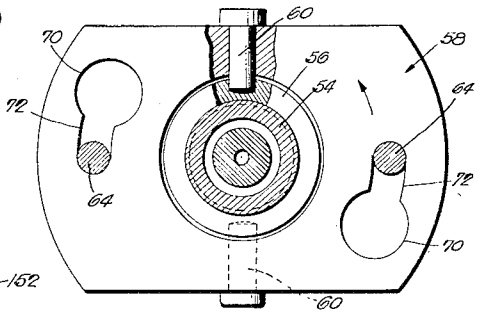


Fig. 9

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Filed March 1, 1950 3 Sheets-Sheet 3

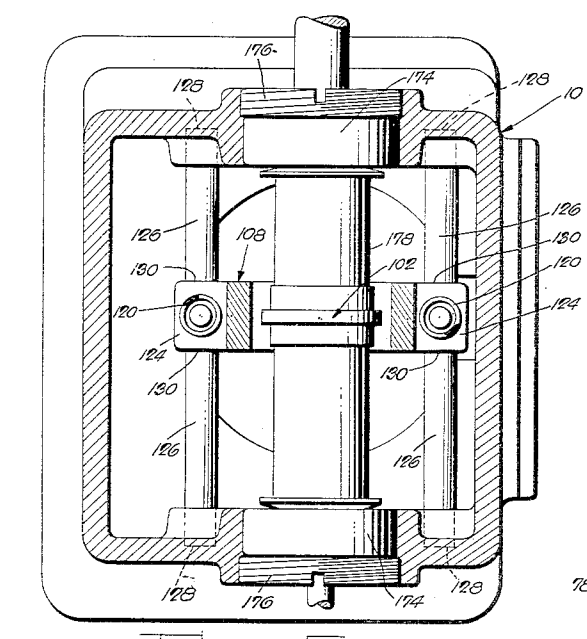


FIG. 5

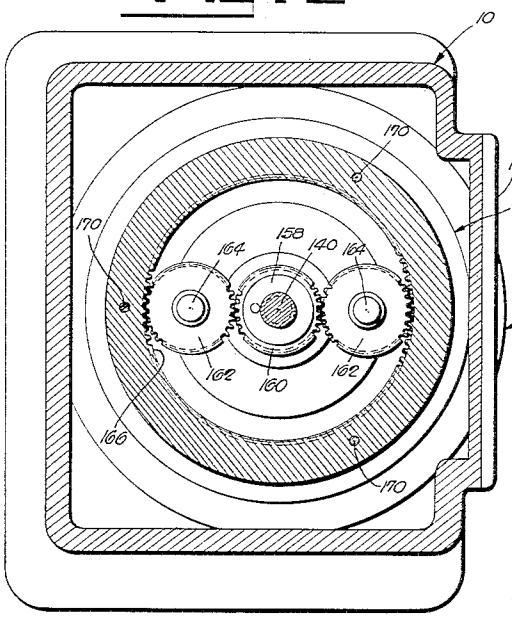


FIG. 6

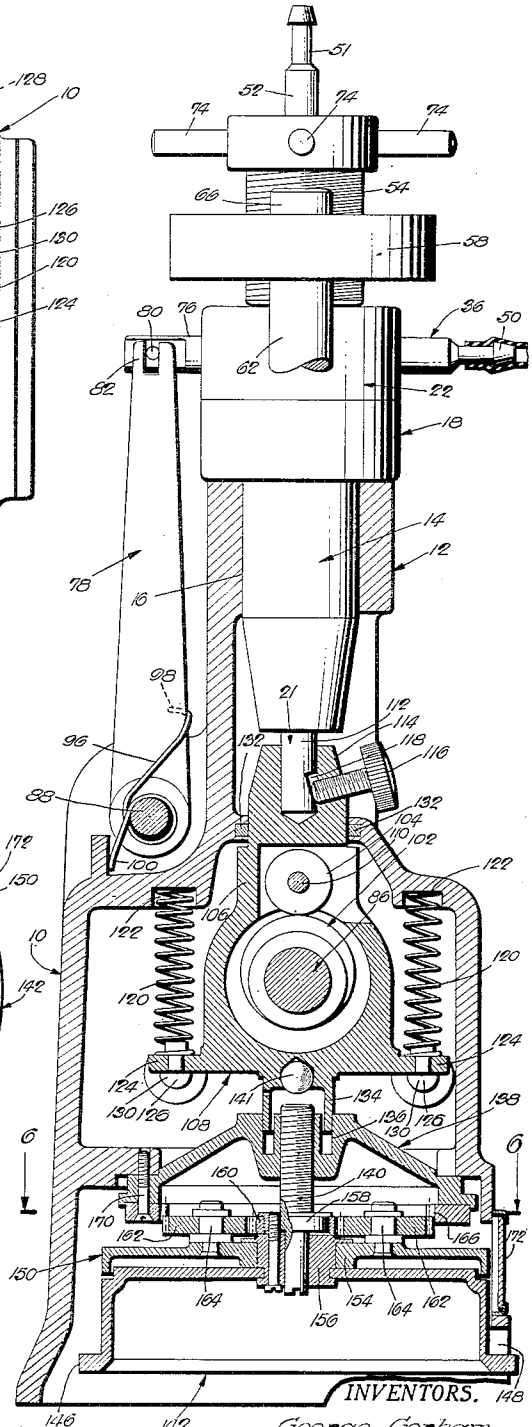


FIG. 4

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United States Patent Office 2,727,466 Patented Dec. 20, 1955

2,727,466

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Application March 1, 1950, Serial No. 146,956
18 Claims. (Cl. 103—38)

This invention relates to pumps.

One object of the invention is to provide a pump for dispensing, with a high degree of accuracy, a predetermined quantity of liquid during each liquid-dispensing operation of the pump.

Another object of the invention is the provision of a pump of the above described character with means for measuring accurately the quantity of liquid dispensed by the pump and for adjusting the pump to dispense variable predetermined quantities of liquid.

A further object of the invention is to provide a pump in which the cylinder and piston and valve are easily removable and replaceable, for cleaning, sterilizing, or repair, or for changing the pumping capacity.

A yet further object of the invention is generally to provide a pump which is well adapted to be used for pumping small quantities of fluids for various purposes, for example, but without limitation, for use in titration, for supplying liquids to chromophotographic columns, for use as medical pump, etc.

The above and other objects, features and advantages of the present invention will be apparent or will be more fully explained from the following description wherein reference will be made to the accompanying illustrative drawings.

In the drawings:

Fig. 1 is a front view of a pump embodying the present invention;

Fig. 2 is a side view thereof;

Fig. 3 is a vertical sectional view, partly in elevation, on the line 3—3 of Fig. 2;

Fig. 4 is a vertical sectional view, partly in elevation, on the line 4—4 of Fig. 1;

Fig. 5 is a horizontal sectional view on the line 5—5 of Fig. 2;

Fig. 6 is a horizontal sectional view on the line 6—6 of Fig. 4;

Fig. 7 is a vertical sectional view on the line 7—7 of Fig. 3;

Fig. 8 is a vertical sectional view on the line 8—8 of Fig. 1;

Fig. 9 is a horizontal sectional view on the line 9—9 of Fig. 3.

Referring now to the drawings in detail, the pump comprises a frame 10 having a part 12 in which the cylinder 14 of the pump is mounted. More particularly, said part 12 of the frame is provided with an opening 16 in which cylinder 14 has a removable fit, and said cylinder has an enlarged end portion 18 which is supported by the upper flat surface or abutment portion 20 of frame part 12. A piston 21 has a sliding fluid-tight fit in said cylinder 14 and is reciprocated therein as hereinafter described. A valve chamber 22 is seated on and has a fluid-tight engagement with the upper surface 24 of the cylinder part 18. For providing said fluid-tight engagement, surface 24 of cylinder part 18 and surface 26 of valve chamber 22 are ground and lapped and, if desired, a gasket 28 seated in a groove 30 may be provided in cylinder part 18, and an integral circular rib 32 may be provided on the lower surface of valve chamber 22 for engaging said gasket to provide a fluid-tight seal between the cylinder and the valve chamber.

The valve chamber 22 is provided with a bore 34 in which a valve 36 is slidable in fluid-tight engagement with the wall of said bore (Fig. 8). Said valve has an inlet passage 38 and an outlet passage 40 each adapted to register with the port 42 in the valve chamber which communicates with the combined inlet and exhaust opening 44 at the adjacent or upper end of cylinder 14. The outlet passage 40 of the valve also registers, during the dispensing stroke of the pump, with a port 46 in the valve chamber at the inner end of the outlet passage 48 of said valve chamber. A nipple 50 on one end of valve 36 and a nipple 51 on the outlet passage of valve chamber 22 provides means for connecting flexible or other suitable tubing (not shown) for the passage of liquid from a suitable source to the pump and from the pump under the control of said valve. It will be understood that by connecting a rubber, plastic, or other flexible tubing to valve nipple 50, the liquid to be pumped may be supplied directly to said valve without interfering with the reciprocation of the valve.

The valve chamber 22 is removably secured in position on cylinder part 18, in fluid-tight engagement therewith, by an adjustable clamping member 54 which is here shown as in the form of a hollow cylinder through which the outlet spindle 52 of the valve chamber projects. Said clamping member is externally screw threaded and is in screw-threaded engagement with an internally screw-threaded bushing 56 secured in stationary position in a block 58 and held against turning in said block in any suitable way as by pins 60 (Fig. 9). Bushing 56 has a small clearance in block 58 (Fig. 9) and can pivot about the axes of pins 60 so that the inner end of clamping member 54 will engage the upper surface of valve chamber 22 properly. Block 58 is releasably secured to the shouldered posts or studs 62, the lower ends 63 of which are threaded into and thereby secured to the part 12 of frame 10. Said posts have upper reduced portions 64 terminated in heads 66, and block 58 has a pair of openings each provided with a relatively large portion 70 communicating with a companion relatively smaller portion 72 as clearly shown in Fig. 9. Opening portions 70 are large enough to permit blocks 58 to be moved clear of the heads 66 of posts 62, while the smaller portions 72 of said openings when engaged with the reduced end portions 64 of said studs, as shown in Fig. 9, prevent said disconnecting movement of said block. It will be understood that by turning the block in the direction of the arrow shown in Fig. 9, when clamping member 54 is partly retracted, to register portions 70 with heads 66 of the posts, block 58 can be easily withdrawn from posts 62, and that when said block is removed from frame 10 the valve chamber 22 and the cylinder 14 can be removed from said frame. Also, it will be understood that after a cylinder 14 and a companion valve member 22 are mounted in position on frame 10, they may be quickly secured in that position by replacing block 58 on posts 62, turning said block in a direction opposite to the direction of the arrow of Fig. 9, and then screwing down the clamping member 54 into tight engagement with valve chamber 22. Thus it will be noted that block 58 and the parts associated therewith provide a quick detachable securing means for the cylinder 14 and the companion valve chamber 22. Handles 74 are provided on clamping member 54 for ease in turning the latter.

Valve 36 is provided with an integral stem portion 76 which is operatively connected to the valve actuating lever 78. Said connection comprises a transverse pin 80 fixed to valve stem 76 and engaging the open upper forked end portion 82 of the said lever 78. Transverse pin 80 in engagement with the sides of the forked end portion 82 positions the valve so that the inner end of passage 38 and the passage 40 of said valve will register with the

port 42 of the valve chamber, and will remain in said registry, during the operation of the pump. It will be noted that when it is desired to remove valve chamber 22, after block 58 is disconnected from posts 62, this can be readily accomplished by reason of the detachable connection of valve stem 76 with the upper forked end of the valve actuating lever 78.

Valve actuating lever 78 is operated by a cam 84 (Fig. 7) fixed to the main rotary shaft 86 which will hereinafter be described in further detail. It will be observed that lever 78 is secured to a shaft 88 journalled for turning movement in bearing members 90 releasably fastened to frame 10. An arm 92 fixed to shaft 88 is provided with a cam follower roller 94 which is engaged by cam 84 and against which it is held by a torsion spring 96. One end 98 of said torsion spring engages lever 78, at one side of the shaft, and the other end 100 of said torsion spring engages a fixed part of the frame. Thus it will be observed that during the rotation of shaft 86 valve 36 is moved to its fluid outlet position (Fig. 8) by the high point of cam 84 and that spring 96 is operable to move said valve to its inlet position corresponding to the engagement of cam follower roller 94 on arm 92 with the low point of cam 84. It will be understood however that it is within the scope of the present invention to operate valve-actuating lever 78 positively in both direction.

The piston 21 is reciprocated, during the rotation of shaft 86, by the mechanism which will now be described. Said mechanism comprises a cam 102 fixed to and rotated by shaft 86 and engageable with a cam follower roller 104 carried by part 106 of the piston-operating member 108. As shown more clearly in Fig. 3, cam follower roller 104 is mounted for rotation in part 106 by a pivot pin 110. The lower end 112 of the piston 21 is removably connected to the socket 114 formed as a part of piston-operating member 108. A removable screw 116 is secured in socket 114 and engages the side of lower end portion 112 of the piston in a groove 118 in the latter, so that when member 108 is lowered piston 21 moves downwardly therewith for the intake stroke of the pump. It will be noted however that during the fluid-expelling stroke of piston 21, which occurs when piston-operating member 108 is raised, the extreme lower end of said end portion 112 of the piston is engaged directly by the inner lower end of socket member 114, whereby the force of valve-operating member 108 is applied directly to piston 21. Compression springs 120 are interposed between the frame and piston-operating member 108 for holding cam follower roller 104 in engagement with cam 102 and for moving said piston-operating member 108 in its piston-retracting stroke. As clearly shown in Fig. 4, the upper ends of said springs are fitted in sockets 122 provided in frame 10 and the lower ends of said springs are connected to ears 124 on piston-operating member 108. Said piston-operating member is guided for rectilinear movement, as hereinafter disclosed, and is held against turning movement by pairs of bars 126 which are secured at their outer ends in frame 10 in any suitable way as indicated at 128 (Fig. 5), the inner ends 130 of the companion bars of each pair being in spaced confronting relation for engagement with the opposite flat sides of ears 124 of piston-operating member 108. Said piston-operating member is guided in its rectilinear movement by the guide ring 132 which is mounted in an opening in the frame and slidably engages the outer surface of socket 114 at the upper part of said piston-operating member, and by the depending sleeve 134 which slidably engages in the sleeve portion 136 of a member 138 which will be more particularly described presently. Therefore, it will be apparent that the shaft 86 constitutes means common to the operation of the piston as well as to the actuation of the valve.

The operating-length of the stroke of piston 21 is adjustable pursuant to one of the features of the present invention, whereby to vary the quantity of liquid dispensed by the pump, without varying the speed of rotation of shaft 86, and the latter may be driven by a synchronous or other constant-speed motor. For this purpose an adjustable stop device is provided to limit the intake stroke of piston 21. As here shown said adjustable stop device includes a micrometer screw 140 screw-threadedly engageable in the abovementioned member 138. A ball 141 is fixed in the lower part of piston-operating member 108 in position to engage the upper or inner end of micrometer screw 140 for limiting the downward movement of said piston-operating member 108 and thus limiting the intake stroke of piston 21. Provision is made for turning screw 140 by accurately measurable amounts whereby to accurately predetermine the intake stroke of piston 21. For this purpose screw 140 is connected to the operating or adjusting mechanism which will now be described.

The mechanism for turning screw 140 comprises the manually operable member 142 which, as here shown, is in the form of a drum having a suitable scale on its outer peripheral surface as indicated at 144. The lower edge of said drum is provided with a knurled circumferential flange 146 for convenience in turning said drum, said knurled portion being accessible externally of frame 10 through the opening 148 in the lower part of said frame (Fig. 1). A vernier member 150 is mounted for rotation coaxially with drum 142 and carries a vernier scale 152 on its peripheral outer surface complementary to the scale on member 142. More particularly, as more clearly shown in Fig. 4 the hub 154 of vernier member 150 is mounted for turning movement around the collar 156 which is fixed to and rotates with drum 142 coaxially of screw 140. Members 142 and 150 are connected by reducing gear mechanism, presently to be described, as a result of which member 150 has a smaller circumferential movement than that of member 142. Collar 156 is fastened to a collar 158 fixed to and rotatable with screw 140 so that the latter is turned when drum 142 is turned. A ring gear 160 is fixed on collar 158 and meshes with gears 162 journalled for rotation on the spindles or pins 164 which are carried by the vernier drum 150. Said gears 162 mesh with an internal gear 166 carried by the abovementioned member 138 (Figs. 4 and 6), said internal ring gear 166 being secured to said member 138 in any suitable way as by screws 170. It will be understood that while micrometer screw 140 is rotatable and thus adjustable longitudinally of its axis, directly by rotation of manually operated drum 142, the vernier drum 150 operable by screw 140 through the planetary gear mechanism constituted by gears 160, 162 and 166, provides for accurate measurements of the turning of screw 140 of the stop device for piston-operating member 108 and thus to provide for accurate measurement of the quantities of liquid dispensed during the operation of the pump. A transparent dial plate 172 is provided (Fig. 1) with an indication thereon for the reference mark for the scale on drum 142.

Although the capacity of pumps of the construction of the present invention may be varied between comparatively wide limits, the following is set forth, without limitation however, as an indication of the quantities of liquid for which a pump heretofore made and embodying the present invention was designed to pump. In said pump, the stroke of the piston is variable from $\frac{1}{1000}$ of one inch to $\frac{1}{10}$ of one inch, and the bore of cylinder 14 is such that a fluid-expelling stroke of piston 21 is operable to dispense $\frac{1}{1000}$ cc. of liquid for each $\frac{1}{1000}$ of one inch of the length of said stroke of the piston. Thus, by adjustment of the stop device, which comprises the screw 140, the pump, with this diameter of the cylinder bore, is adjustable to measure accurately from $\frac{1}{1000}$ cc. of liquid to $\frac{1}{10}$ cc. of liquid, to be dispensed upon each fluid-expelling stroke of the piston, depending upon the position of said screw 140 as determined by the adjust-

ment of drum **142**, with the aid of the vernier drum **150**. It is to be understood that the dimensions and quantities just referred to are set forth as indicative of the accuracy of the pump of the present invention and of the small quantities of liquid which the pump is intended primarily to dispsense, during each revolution of shaft **86**, but it will be understood that this invention is not limited to the size of the pump although, as indicated, the invention was primarily made with the purpose in view of providing a pump which is particularly well adapted to dispense an accurately measured small quantity of liquid during each fluid-expelling stroke of the piston of the pump, the intake and expelling strokes occurring during one revolution of the shaft **86**. In this pump, member **142** makes four revolutions for one revolution of vernier member **150**.

It will be noted that when it is desired to remove cylinder **14**, as explained above, the piston **21** can be removed at the same time provided that screw **116** is retracted out of engagement with the lower end **112** of said piston, and of course it will be understood that ordinarily piston **21** will be thus removed together with its cylinder **14**. Said cylinder and said piston can be made of any suitable material commensurate with the desired accuracy of the pump. For example, said piston and cylinder can be made of metal or of glass or of any other suitable material which will not interfere with the accuracy of the pump. With proper grinding and lapping of the inner surface of the cylinder, a good fluid-tight seal is provided between said cylinder and piston, so that piston rings or other fluid-packings are unnecessary.

It should be noted again that the capacity of the pump, that is the quantity of liquid dispensed by the pump in any adjustment of screw **140** between its limits of adjustment, can be varied by the provision of the cylinder of the proper bore diameter and a companion piston of corresponding diameter, and it will be noted that a group of cylinders and companion pistons can be provided and any one cylinder and a companion piston of said group can be mounted in frame **10**, so that substantially the same pump can be used for dispensing accurate quantities of liquid within the range of adjustment of the stop device and within the range of piston-bore and cylinder diameters. Also it will be observed that by reason of the provision in the pump of means described above for enabling the cylinder, its piston and valve chamber carrying its valve to be quickly and easily removed, a feature of the pump resides in the facility for cleaning or sterilizing the pump as may be necessary or desirable depending upon the use to which the pump is put.

For the sake of completeness of description, it may be noted that shaft **86** is journalled for rotation in anti-friction bearings **174** removably held in position by retaining nuts **176**. Also it will be noted that bushings **178** on the inner portion of shaft **86** serve to position cam **102** on said shaft in relation to the cam follower roller **104** of piston-operating member **108**.

It will be noted that in the rotation of drum **142** resulting in the longitudinal movement of screw **140** of the stop device, said drum moves in the direction of the axis of said screw and that gears **162** which mesh with ring gear **166** of the planetary gear mechanism similarly move in a direction parallel to the axis of screw **140** without disengagement of gears **162** and **166**.

It will be understood that while we have shown and described the presently preferred embodiment of our invention, the latter may be embodied otherwise than as here specifically illustrated or described, and that in the embodiment of the invention here shown or described various changes in the details of construction and in the form and arrangement of parts may be made without departing from the underlying idea or principles of this invention within the scope of the appended claims.

Having thus described our invention, what we claim and desire to secure by Letters Patent, is:

1. In a pump, a supporting frame, a cylinder removably mounted in position in said frame, a valve chamber for said cylinder, a valve operable in said chamber for controlling the admission of fluid to said cylinder and the expulsion of fluid therefrom, means carried by said frame and having a releasable connection with said valve for operating the latter in said chamber, a piston operable in said cylinder for drawing fluid into the latter and expelling the fluid therefrom under the control of said valve, and means carried by said frame and having a releasable operative connection with said piston for actuating the latter, said last mentioned means including a releasable member positioned externally of said supporting frame for direct accessibility thereto, said removable mounting of said cylinder in the frame and said releasable connections between said valve and valve-operating means and between said piston and piston-operating means, respectively, constituting means providing for the removal of said cylinder and the companion piston from the frame and the replacement thereof of a similar cylinder and companion piston in said frame, and means for releasably securing said cylinder in position in said frame.

2. In a pump, a supporting frame, a cylinder removably mounted in said frame, said cylinder having a port in one end thereof, a valve chamber removably secured to said end of the cylinder and having a port in registry with said port of the cylinder, means cooperating with said frame and accessible externally thereof for engagement with said valve chamber for releasably clamping the latter against said end of the cylinder for said releasable securement of the valve chamber to said end of the cylinder, a valve operable in said chamber for controlling said port thereof, a piston operable in said cylinder, means for operating said piston, means for actuating said valve, and means common to both said piston-operating means and said valve-actuating means for actuating said valve in timed relation to the operation of said piston, said means cooperating with said frame being effective to releasably clamp said cylinder in position when said valve chamber is releasably clamped by said cooperating means.

3. In a pump, a supporting frame, a cylinder removably mounted in said frame and having a combined inlet and exhaust port in one end thereof, a valve chamber removably secured to said end of the cylinder and having a port in registry with said cylinder port and having an outlet port, a valve operable in said chamber and provided with inlet and outlet passages individually registrable, in the operation of said valve, with said first mentioned port of said valve chamber, the outlet passage of said valve being in communication with said outlet port of said chamber when it is in registry with said first mentioned port thereof, means cooperating with said frame and accessible externally thereof for engagement with said valve chamber for releasably clamping the latter against said end of the cylinder for said releasable securement of the valve chamber to said end of the cylinder, a piston operable in said cylinder, means for operating said piston, and means operable in timed relation to said piston-operating means for actuating said valve.

4. In a pump, a supporting frame, a cylinder removably mounted in said frame and having a combined inlet and exhaust port in one end thereof, a valve chamber removably secured to said end of the cylinder and having a port in registry with said cylinder port and having an outlet port, a valve operable in said chamber and provided with inlet and outlet passages individually registrable, in the operation of said valve, with said first mentioned port of said valve chamber, the outlet passage of said valve being in communication with said outlet port of said chamber when it is in registry with said first mentioned port thereof, a piston operable in said cylinder and closing the opposite end thereof, means for operating said piston, means operable in timed relation to said piston-operating means for actuating said valve, and means

carried by said frame for releasably clamping said valve chamber and cylinder in position.

5. In a pump, a supporting frame, a cylinder removably mounted in said frame and having a combined inlet and exhaust port in one end thereof, a valve chamber removably secured to said end of the cylinder and having a port in registry with said cylinder port and having an outlet port, a valve operable in said chamber and provided with inlet and outlet passages individually registrable, in the operation of said valve, with said first mentioned port of said valve chamber, the outlet passage of said valve being in communication with said outlet port of said chamber when it is in registry with said first mentioned port thereof, said inlet passage of the valve extending longitudinally thereof and terminating at its inlet end externally of the valve chamber, said valve having provision at said inlet end thereof for securement thereto of a flexible fluid supply tube, said valve having a part opposite said inlet end thereof positioned externally of said valve chamber in all operating positions of the valve, and means releasably operatively connected to said last mentioned part of the valve for actuating said valve.

6. In a pump, a supporting frame, a cylinder mounted in said frame and having a combined inlet and exhaust port in one end thereof, a valve chamber secured to said end of the cylinder and having a port in registry with said cylinder port and having an outlet port, a valve operable in said chamber and provided with inlet and outlet passages individually registrable, in the operation of said valve, with said first mentioned port of said valve chamber, the outlet passage of said valve being in communication with said outlet port of said chamber when it is in registry with said first mentioned port thereof, said inlet passage of the valve extending longitudinally thereof and terminating at its inlet end externally of the valve chamber, said valve having provision at said inlet end thereof for the securement thereto of a flexible fluid supply tube, said valve having a part opposite said inlet end thereof positioned externally of said valve chamber in all operating positions of the valve, and means operatively connected to said last mentioned part of the valve for actuating said valve.

7. In a pump, a supporting frame having a part providing an abutment, a cylinder supported by said frame and having an external end part at one end thereof which engages said abutment, said cylinder having a port at said end thereof, a valve chamber removably secured to said end of the cylinder and having a port in registry with said port of the cylinder, means for releasably securing said valve chamber in said engagement with the cylinder, and means carried by and cooperating with said frame and engageable directly with said valve chamber for releasably clamping the latter against said end of the cylinder for said releasable securement of the valve chamber to said end of the cylinder, and thereby clamping said external end part of the cylinder against said abutment for the releasable securement of said cylinder on said frame, said cylinder being free of other operative securement to said frame whereby said cylinder and said valve chamber are removable from said frame upon operation of said clamping means to relieve the clamping action thereof upon said valve chamber.

8. In a pump having a cylinder, a piston reciprocable therein, and means for reciprocating said piston comprising a member movable to a projected position for moving said piston in its fluid-expulsion stroke and to a retracted position in the movement of said piston in its fluid-intake stroke, a variable stop device for limiting the movement of said member to its retracted position comprising a stop member adjustably movable to various positions longitudinally of the path of said piston-operating member, manually operable means movable to various positions for moving said stop member to adjust the position thereof, and means including a vernier device operatively connected to said manually operable means and operable thereby to indicate the adjusted position of said stop member, said stop member comprising a screw and said vernier device including a rotary member and planetary gear mechanism actuated by said screw and connected to said rotary member for turning the latter pursuant to the operation of said manually operable means, the latter having a scale and said rotary member having a vernier scale complementary to said first mentioned scale.

9. In a pump having a cylinder, a piston reciprocable therein, and means for reciprocating said piston comprising a member movable to a projected position for moving said piston in its fluid-expulsion stroke and to a retracted position in the movement of said piston in its fluid-intake stroke, a variable stop device for limiting the movement of said member to its retracted position comprising a stop member adjustably movable to various positions longitudinally of the path of said piston-operating member, manually operable means movable to various positions for moving said stop member to adjust the position thereof, and means including a vernier device operatively connected to said manually operable means and operable thereby to indicate the adjusted position of said stop member, said stop member comprising a screw and said vernier device including a rotary member and planetary gear mechanism actuated by said screw and connected to said rotary member for turning the latter pursuant to the operation of said manually operable means, the latter having a scale and said rotary member having a vernier scale complementary to said first mentioned scale, said manually operable means comprising a rotary member mounted for rotation co-axially with and in relation to said rotary member of said vernier device.

10. In a pump having a cylinder, a piston reciprocable therein, and means for reciprocating said piston comprising a member movable to a projected position for moving said piston in its fluid-expulsion stroke and to retracted position in the movement of said piston in its fluid-intake stroke, a variable stop device for limiting the movement of said member to its retracted position comprising a rotary screw longitudinally adjustable, by the turning thereof, to various positions longitudinally of the path of said operating member, a stationary member in which said screw is threaded for said movement thereof, a first rotary member connected to said screw for turning the latter, said rotary member being provided with a scale, a second rotary member mounted for rotation co-axially with said first rotary member and carried thereby and rotatable in relation thereto, said second rotary member having a scale thereon, and reducing gearing between said screw and said second rotary member whereby the circumferential movement of the latter is less than that of said first rotary member for the same longitudinal movement of said screw.

11. In a pump having a cylinder, a piston reciprocable therein, and means for reciprocating said piston comprising a member movable to a projected position for moving said piston in its fluid-expulsion stroke and to a retracted position in the movement of said piston in its fluid-intake stroke, a variable stop device for limiting the movement of said member to its retracted position comprising a rotary screw longitudinally adjustable, by the turning thereof, to various positions longitudinally of the path of said operating member, a stationary member in which said screw is threaded for said movement thereof, a first rotary member connected to said screw for turning the latter, said rotary member being provided with a scale, a second rotary member mounted for rotation co-axially with said first rotary member and carried thereby and rotatable in relation thereto, said second rotary member having a scale thereon, and reducing gearing between said screw and said second rotary member whereby the circumferential movement of the latter is less than that of said first rotary member for the same longitudinal movement of said screw, said reducing gearing comprising planetary gearing including a ring gear carried by said

stationary member, a gear operable by rotation of said screw and gears carried by said second rotary member and meshing with said ring gear and said screw-operated gear.

12. In a fluid pump having a cylinder and a piston reciprocable therein, means for reciprocating said piston comprising a reciprocable piston-operating member having a part to which one end of said piston is connected, mechanism for reciprocating said member including a rotary cam operable on said member for moving the piston in its fluid-expulsion stroke and spring means operable on said member for moving the piston in its fluid-intake stroke, said member including a second part open at its opposite sides, a shaft extending through said second part and carrying said cam and the latter being operable on said second part between said open sides thereof, and adjustable stop means for variably limiting the movement of said member in the fluid-intake stroke of the piston, said stop means being adjustable by manual means accessible externally of the pump, said stop means when adjusted being in stationary relation with the pump.

13. In a fluid pump having a cylinder and a piston reciprocable therein, means for reciprocating said piston comprising a reciprocable piston-operating member having a part to which one end of said piston is connected, mechanism for reciprocating said member including a rotary cam operable on said member for moving the piston in its fluid-expulsion stroke and spring means operable on said member for moving the piston in its fluid-intake stroke, said member including a second part open at its opposite sides, a shaft extending through said second part and carrying said cam and the latter being operable on said second part between said open sides thereof, said cylinder having a combined inlet and outlet port at one end thereof, valve means for controlling the admission and exhaust of fluid into and from said cylinder through said port, said valve means being reciprocable at right angles to the reciprocation of said piston, and means for reciprocating said valve means in timed relation to the reciprocation of said piston comprising a cam on said shaft and a pivoted lever operable by said cam and operatively connected to said valve means.

14. In a pump, a frame having an abutment and spaced studs projecting therefrom, a cylinder releasably supported by said frame and having a part engaging said abutment for holding the cylinder in position, said studs having outer headed portions and reduced portions adjacent the latter providing shoulders on said studs spaced inwardly of said headed portion, a block having openings and releasably engaged by said studs in said openings, said openings having large portions to clear said headed portions and smaller portions through which said headed portions and shoulders cannot pass, said block being held stationary between said headed portions and shoulders when the reduced portions of said studs are in said smaller portions of the openings and said block being turnable to register the large portions of said openings with said headed portions for the release of the block, and means adjustably movable in said block axially of said cylinder for releasably clamping said part of the cylinder against said abutment of the frame.

15. In a pump, a frame having an abutment and spaced studs projecting therefrom, a cylinder releasably supported by said frame and having a part engaging said abutment for holding the cylinder in position, said studs having outer headed portions and reduced portions adjacent the latter providing shoulders on said studs spaced inwardly of said headed portions, a block having openings and releasably engaged by said studs in said openings, said openings having large portions to clear said headed portions and smaller portions through which said headed portions and shoulders cannot pass, said block being held stationary between said headed portions and shoulders when the reduced portions of said studs are in said smaller portions of the openings and said block being turnable to register the large portions of said openings with said headed portions for the release of the block, and means adjustably movable in said block axially of said cylinder for releasably clamping said part of the cylinder against said abutment of the frame, means providing fluid passage said abutment of the frame, means providing fluid passage for said cylinder adjacent said clamping part thereof, said clamping means having an opening through which said fluid passage means extends.

16. In a fluid pump having a cylinder and a piston reciprocable therein and means for reciprocating said piston in said cylinder including mechanism for positively moving the piston in its fluid expulsion stroke and spring means for moving the piston in its fluid intake stroke, an adjustable stop device for limiting the movement of the piston in its fluid intake stroke comprising a stationary member, a screw rotatable in the latter for longitudinal movement to variably adjust the position thereof in relation to said piston longitudinally of the latter's movement, manually operable means for turning said screw for said adjustment thereof, said manually operable means having a scale for indicating the adjusted position of the screw, and a vernier member operable by said manually operable means and having a scale complementary to said first mentioned scale.

17. In a pump having a cylinder, a piston reciprocable therein, and means for reciprocating said piston comprising a member movable to a projected position for moving said piston in its fluid-expulsion stroke and to a retracted position in the movement of said piston in its fluid-intake stroke, a variable stop device for limiting the movement of said member to its retracted position comprising a stop member adjustably movable to various positions longitudinally of the path of said piston-operating member, manually operable means movable to various positions for moving said stop member to adjust the position thereof, and means including a vernier device operatively connected to said manually operable means and operable thereby to indicate the adjusted position of said stop member, said vernier device comprising planetary gear mechanism operatively associated with said stop member.

18. In a pump having a cylinder, a piston reciprocable therein, and means for reciprocating said piston comprising a member movable to a projected position for moving said piston in its fluid-expulsion stroke and to a retracted position in the movement of said piston in its fluid-intake stroke, a variable stop device for limiting the movement of said member to its retracted position comprising a stop member adjustably movable to various positions longitudinally of the path of said piston-operating member, a manually operable rotary member rotatable to various positions for moving said stop member to adjust the position thereof, and speed reduction mechanism including a rotary member mounted for rotation co-axially with said first mentioned rotary member and in relation thereto operatively connected to said first mentioned rotary member and said stop device for adjusting the position of the latter in response to actuation of said first mentioned rotary member.

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