

[54] MICROLITER FLUID DELIVERY APPARATUS

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[22] Filed: Oct. 24, 1972

[21] Appl. No.: 300,154

[52] U.S. Cl. 222/148, 222/340, 73/425.6,
141/90

[51] Int. Cl. B67d 1/08, G01n 1/14

[58] Field of Search 73/425.6; 92/130, 152;
222/340, 341; 128/234, 235, 218 F; 141/27,
90; 23/259; 222/148

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[57] ABSTRACT

This apparatus includes a cylindrical barrel having positioned therein a cylinder in which a piston is slideable longitudinally for drawing fluid into a sample-receiving member connected to the apparatus. A piston assembly engaged with one end of the piston is operable within the barrel to actuate the piston and to simultaneously compress the air within the barrel on the down stroke of the piston assembly. Movement of the first piston through the cylinder discharges the majority of the fluid from the sample-receiving member. Means are provided for sequentially admitting the compressed air to the sample receiving member to blow out any fluid droplets remaining in the member. The discharge of the fluid and blowing out of the sample-receiving member are effected in a single stroke of the piston assembly.

29 Claims, 15 Drawing Figures

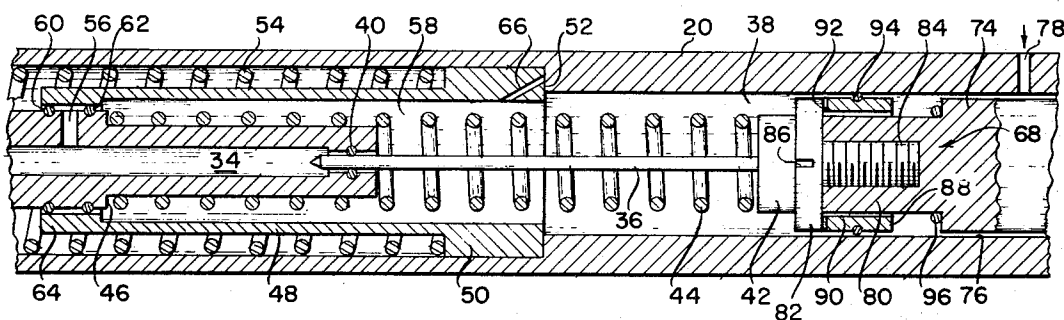


Fig. 1

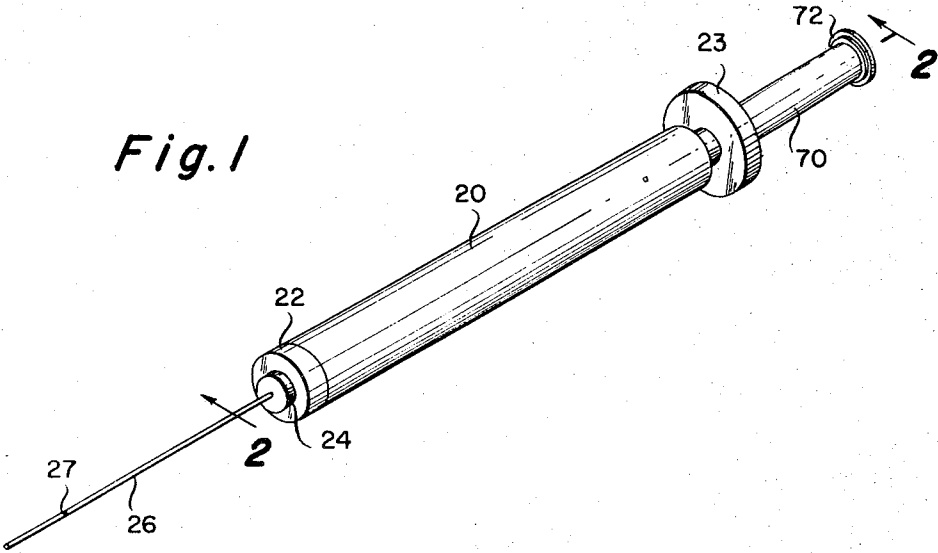


Fig. 2

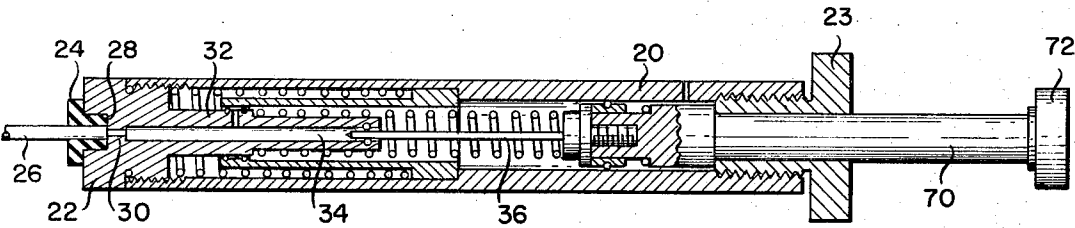


Fig. 3

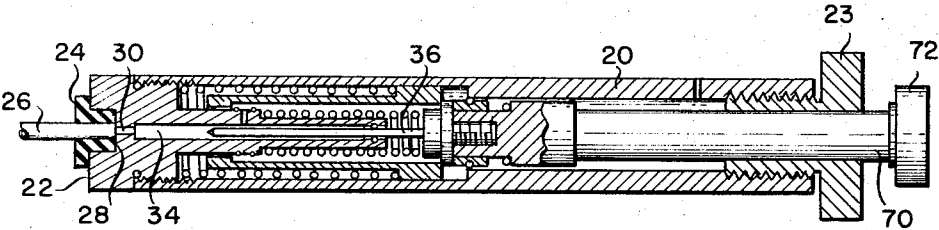


Fig. 4

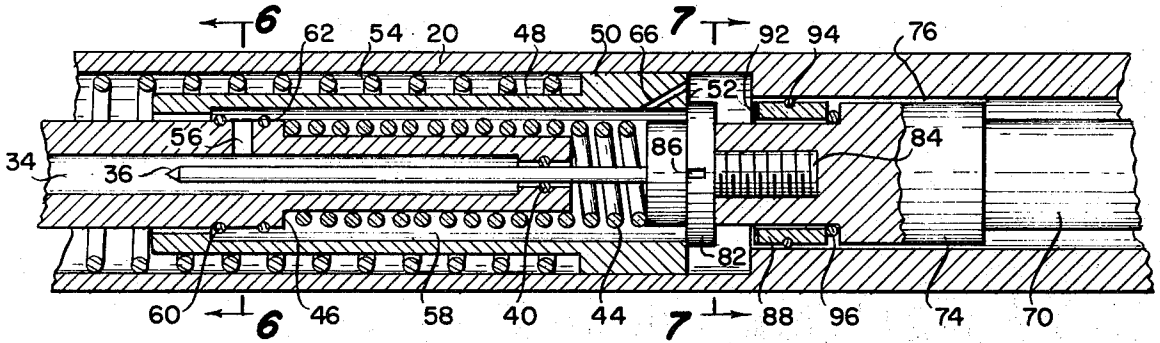
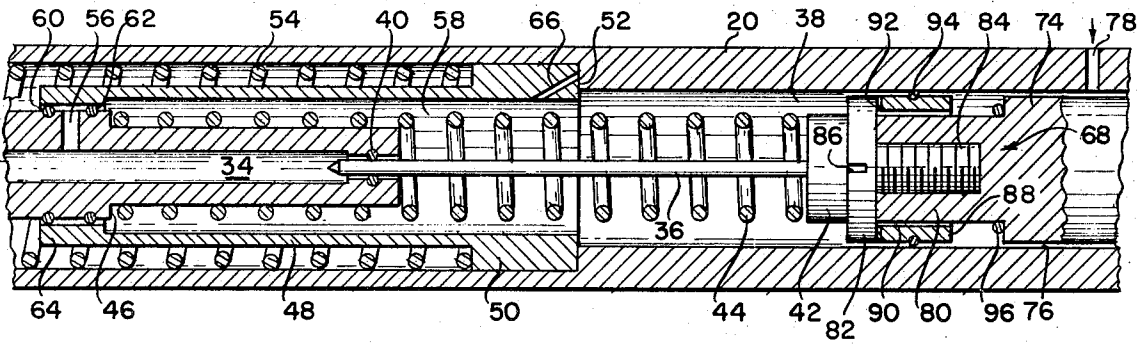


Fig. 5

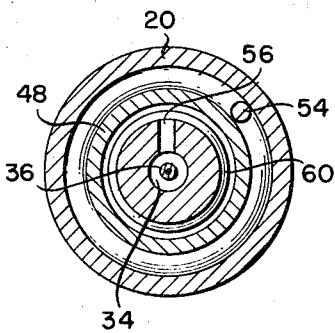


Fig. 6

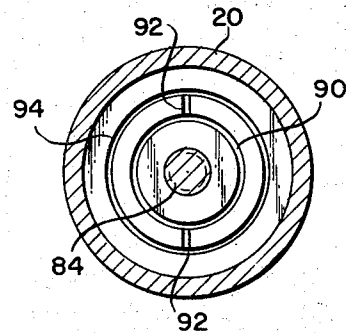


Fig. 7

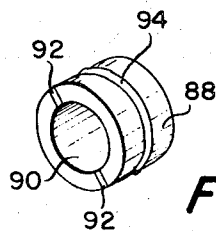


Fig. 8

Fig. 9

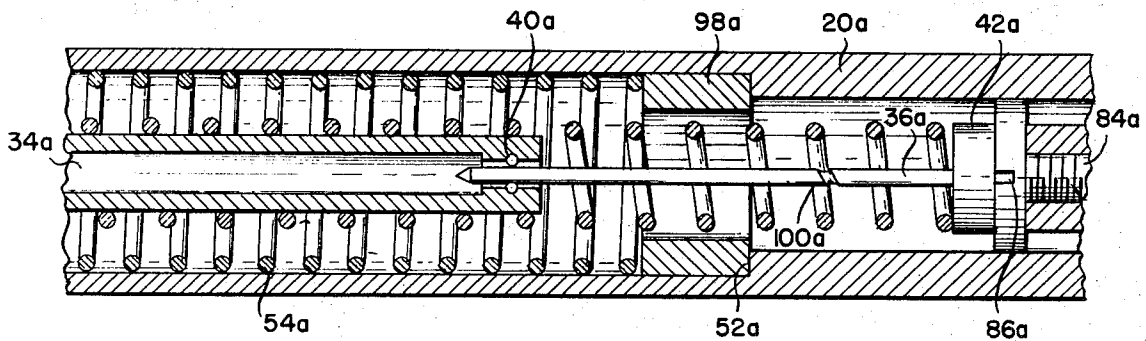
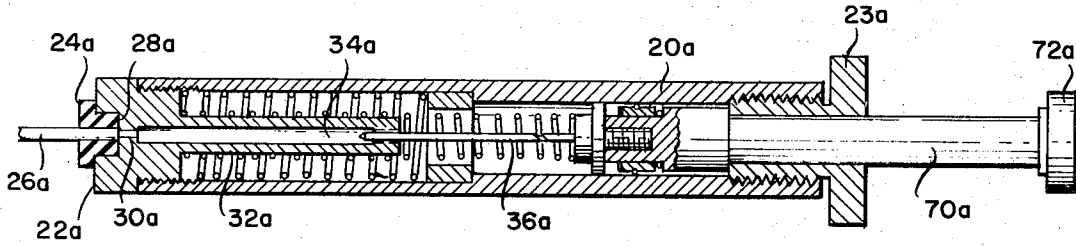


Fig. 10

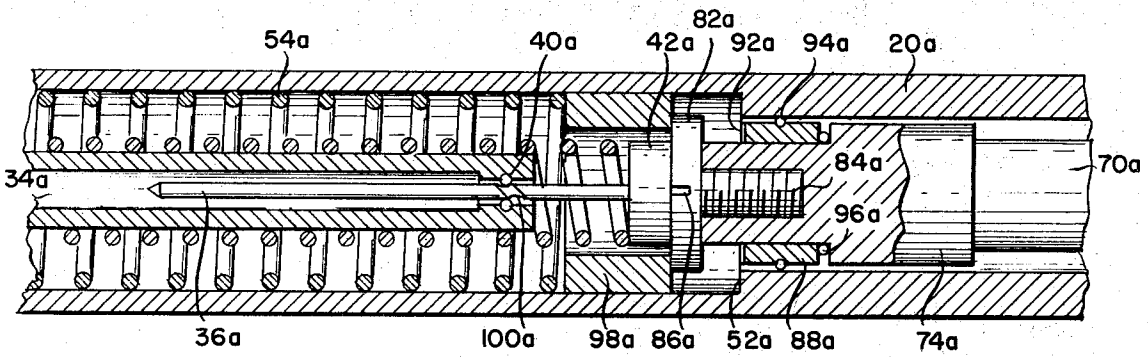


Fig. 11

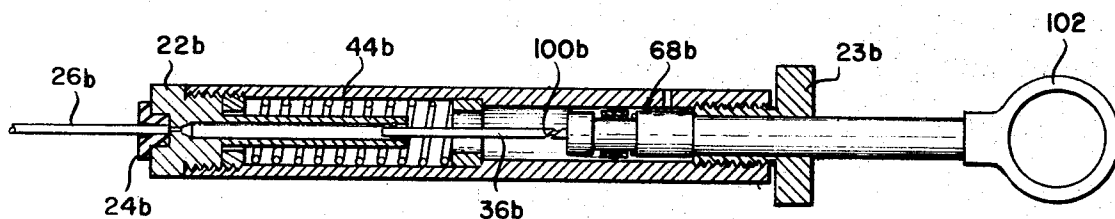


Fig. 12

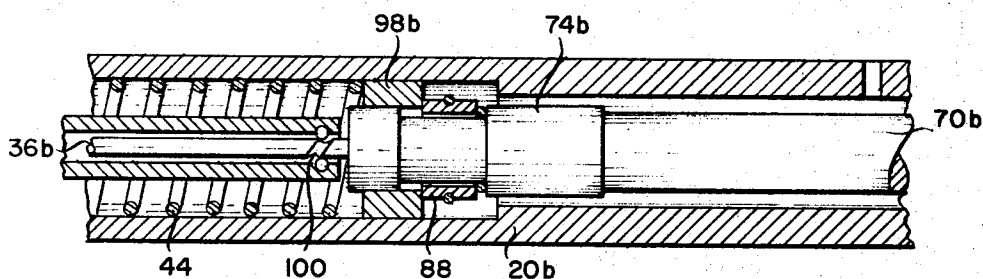


Fig. 13

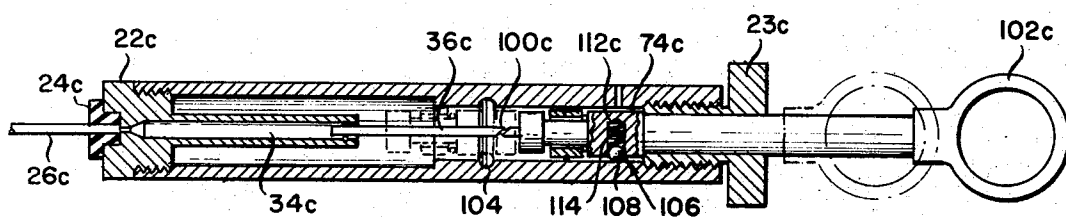


Fig. 14

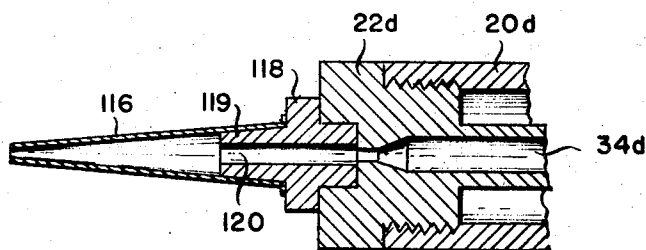


Fig. 15

MICROLITER FLUID DELIVERY APPARATUS

BACKGROUND AND OBJECTS

In the drawing of fluid samples into sample-receiving members, including capillary tubes and other volumetric devices, it is conventional practice to employ a barrel and plunger arrangement for creating a partial vacuum in the sample-receiving member for drawing the fluid therein. The fluid is then discharged by forcing a piston or plunger through the barrel. It frequently occurs, however, that droplets of the fluid remain in the sample-receiving member so that the full sample is not discharged, a factor which can be detrimental in those instances where precise quantities of the fluid must be delivered. It is very difficult to completely clear the sample-receiving members, and particularly, small bore tubing, of these droplets, and repeated operation of the piston within the cylinder usually has the effect of simply moving the droplets up and down within the member without discharging the same therefrom.

It is an object of this invention to provide a microliter fluid delivery apparatus wherein the entire sample contained within the sample-receiving member, including droplets adhering to the inner peripheral wall, is discharged from the member in a single continuous stroke.

Another object is to provide a microliter fluid delivery apparatus of the character described wherein fluid in the sample-receiving member is discharged therefrom under air pressure and any droplets adhering to the wall of the member are then blown out by compressed air.

A further object is to provide a microliter fluid delivery apparatus employing a cylindrical barrel in which a cylinder is positioned having a piston slideable longitudinally therein, the cylinder being in communication with a sample-receiving member for drawing fluid into the member, the apparatus further being provided with a piston assembly operable to compress air within the barrel, which air is sequentially delivered to the cylinder positioned in the barrel after the majority of the fluid has been discharged from the sample-receiving member, for blowing out any droplets of fluid clinging to the wall of the member.

A further object is to provide apparatus of the character described wherein a predetermined amount of fluid may be drawn into a volumetric device, the apparatus further being adjustable to permit drawing in a predetermined amount of a variety of fluids.

A still further object is to provide an apparatus which is of compact construction employing a minimum of parts which may be readily assembled and disassembled, the apparatus being operated by unskilled personnel with a minimum of instruction.

Further objects will be apparent from the following description of the presently preferred forms of this invention taken in connection with the appended drawings.

DESCRIPTION OF FIGURES OF THE DRAWINGS

FIG. 1 is a perspective view of the microliter fluid delivery apparatus of the present invention;

FIG. 2 is a longitudinal sectional view taken along the line 2—2 of FIG. 1, looking in the direction of the ar-

rows, and showing the apparatus in inoperative position;

FIG. 3 is a view similar to FIG. 2 showing the apparatus in operative position;

FIG. 4 is an enlarged fragmentary longitudinal sectional view of the present apparatus showing to advantage the cylinder and piston assembly illustrated in FIG. 2;

FIG. 5 is an enlarged longitudinal sectional view similar to FIG. 4 showing the piston and cylinder in operative position;

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a sectional view taken along the line 7—7 of FIG. 5 looking in the direction of the arrows;

FIG. 8 is a perspective view of a piston forming a part of the present invention;

FIG. 9 is a longitudinal sectional view of a modified form of the present invention;

FIG. 10 is an enlarged fragmentary longitudinal sectional view of the form of invention illustrated in FIG. 9, showing the apparatus in inoperative position;

FIG. 11 is a view similar to FIG. 10, showing the apparatus in operative position;

FIG. 12 is a longitudinal sectional view of another modified form of the present invention;

FIG. 13 is an enlarged fragmentary sectional view of the form of invention illustrated in FIG. 12, showing the apparatus in inoperative position;

FIG. 14 is a longitudinal sectional view of another modified form of the present invention; and

FIG. 15 is an enlarged fragmentary sectional view of another modified form of the present invention particularly adapted for use with a molded tip volumetric device.

DESCRIPTION OF FORM OF INVENTION
ILLUSTRATED IN FIGS. 1-8

In FIGS. 1 to 8, there is illustrated a microliter fluid delivery assembly constructed in accordance with one form of the present invention, the assembly generally including a cylindrical barrel 20 having end caps 22 and 23 threaded in the ends thereof. The central portion of end cap 22 is recessed for the reception of a rubber tip 24 having a central opening through which a sample-receiving member and preferably a volumetric device such as a capillary tube 26 is inserted, the capillary tube abutting recess wall 28 of end cap 22. Tube 26 is provided with a graduation marking 27 for indicating a predetermined quantity of fluid therein. End cap 22 is further provided with a bore 30, the cross sectional area of which is smaller than that of capillary tube 26 to limit the entry of the tube into the bore of cap 22.

End cap 22 is reduced and extended to provide a fixed cylinder 32 having a bore 34 which is of substantially the same cross sectional area as capillary tube 26, the bore being in communication with bore 30 of end cap 22 and capillary tube 26. It will be noted from a consideration of the drawings that cylinder 32 is coaxial with cylindrical barrel 20 and is spaced from the peripheral wall thereof.

As shown in FIGS. 4 and 5, a needle-like piston 36 is inserted into bore 34 of cylinder 32, the cross sectional area of the needle piston being substantially less than that of bore 34, thereby providing a space 38 between the piston and cylinder for purposes which will

be hereinafter more fully set out. An O-ring 40 is located at the end of cylinder 32 through which the piston is inserted to afford sealing means at that point between the piston and the cylinder.

The opposite terminal of piston 36 is connected to an enlarged head 42 and a convolute spring 44 is sleeved over cylinder 32 and piston 36, one end of the spring abutting head 42 and the opposite end thereof abutting a shoulder 46 formed by thickening an intermediate portion of piston 32. Spring 44 normally biases piston 36 to a retracted position.

In accordance with the present invention, there is provided a second cylinder 48 which is coaxially mounted within barrel 20 in concentric spaced relation to cylinder 32, which cylinder is movable longitudinally with respect to cylinder 32 and barrel 20. One end of cylinder 48 is thickened at 50, which thickened portion engages an abutment 52 in the wall of barrel 20 to limit longitudinal movement of cylinder 48 in a direction away from capillary tube 26. A second convolute spring 54 is interposed between cylinder 48 and barrel 20, the spring abutting end cap 22 at one end thereof and thickened portion 50 of the cylinder at the other end, to normally urge the cylinder to the position shown in FIGS. 2 and 4. Spring 54 is stronger than spring 38 for reasons which will be hereafter clarified.

Referring again to FIGS. 2 and 4, it will be noted that an opening 56 in the wall of cylinder 32 provides communication between bore 34 of cylinder 32 and bore 58 of cylinder 48. O-rings 60 and 62 are located in annular recesses in the outer periphery of cylinder 32 on both sides of air conduit 56, the O-rings being in contiguous engagement with a thickened portion 64 of the wall of cylinder 48 when in the operative position shown in FIG. 4, and in spaced relation to the main portion of the wall of cylinder 48, when in the inoperative position shown in FIG. 5. An air passageway 66 extends angularly through thickened portion 50 of cylinder 48, thereby providing communication between the bore of cylindrical barrel 20 and bore 58 of cylinder 48.

In accordance with the objects of the present invention, there is provided a blow-out piston assembly 68 which includes a piston shaft 70 extending through a central opening in cap 23 and provided with an end actuating button 72. Piston shaft 70 is enlarged at 74 which enlarged portion is spaced from the peripheral wall of barrel 20 to provide an air space 76 which is adapted to communicate with an air opening 78 extending through the wall of barrel 20 adjacent enlarged section 74 of the piston shaft.

Enlarged portion 74 issues into a piston shaft section 80 which is substantially the same cross sectional area as main body portion 70 of the shaft, and an enlarged circular end cap 82 is threaded into the end of shaft section 80 as indicated at 84. An end cap kerf is provided at 86 for facility in threading cap 82 into section 80.

An annular collar-like piston 88 is sleeved over shaft section 80 between end cap 82 and enlarged shaft portion 74, as shown to advantage in FIGS. 4 and 5. Piston 88 is spaced from piston section 80 to provide an air passageway 90 which communicates with slots 92 extending outwardly in the collar from air passageway 90. When the present apparatus is in the position shown in FIG. 4, this arrangement permits the passage of air through air opening 78, air space 76, air passageway 90

and slots 92 into the bore of barrel 20 where it may then pass through air passageway 66 into bore 58 of cylinder 48.

As shown in FIG. 7, the outer periphery of piston 88 is provided with an annular recess which is adapted for the reception of an O-ring 94 which engages the abutment 52 of barrel 20 and serves as an air tight seal between the piston and barrel. In conjunction with O-ring 94, there is a second O-ring designated 96 which surrounds shaft extension 80 at its point of juncture with enlarged portion 74 thereof.

It will be apparent from a consideration of the drawings and particularly FIGS. 4 and 5, that piston 88 is freely movable on shaft extension 80 between end cap 82 and enlarged section 74 of the piston shaft. Therefore, when the apparatus is in the inoperative position illustrated in FIG. 4, piston 88 is contiguous with end cap 82 and spaced from enlarged piston shaft portion 74 and O-ring 96, thereby permitting free passage of air through the assembly in the manner set out above. However, when the apparatus is actuated by depression of actuating button 72, the friction of O-ring 94 against the wall of barrel 20 effects relocation of the piston rearwardly into engagement with O-ring 96 as shown in FIG. 5, which effectively prevents air passing through opening 78 of barrel 20 from moving interiorly of the barrel or cylinders contained therein. At this point, as blow-out piston assembly 68 is moved longitudinally of barrel 20, piston 88 compresses air in advance thereof.

As piston 88 slides longitudinally through the barrel, end cap 82 engages head 42 to force piston 36 through bore 34 against the tension of spring 44 to compress the air within bore 34 and exert air pressure upon fluid within tubular member 26 in a direction to discharge fluid therefrom. During this period, O-rings 60 and 62 are operative to prevent the passage of air through opening 56 into bore 34.

Upon continued longitudinal movement of blow-out piston assembly 68, end cap 82 engages portion 50 of cylinder 48 forcing the latter to move longitudinally against the tension of spring 54. In view of the fact that spring 54 is stronger than spring 44, the operator will "feel" when longitudinal movement of the cylinder 48 occurs, since increased resistance to further movement will necessitate more force being exerted against actuating button 72.

When cylinder 48 is moved longitudinally towards cap 22, by continued depression of button 72, O-rings 60 and 62 which are located in recesses in cylinder 32 no longer engage thickened portion 64 of cylinder 48, and consequently an air passage is created between bore 34, opening 56 and bore 58 of cylinder 48. This causes the air which has been compressed by piston 88 to pass into space 38 between cylinder 48 and piston 36 under pressure and to exert this pressure against any fluid remaining in the tubular member 26, thereby blowing out any fluid remaining therein.

Upon release of button 72, movable cylinder 48 is returned to the position shown in FIG. 4 under urging of spring 54 and O-rings 60 and 62 once again are operative to seal opening 56 thereby preventing any air from being drawn from bore 34 through the opening into bore 58.

Similarly, the reversal of direction of blow-out piston assembly 68 effects movement of piston 88 to its original position shown in FIG. 4 to allow the passage of air

through air passageway 90, slots 92, into the bore 58 of cylinder 48.

OPERATION

In use of the apparatus of the present invention, capillary tube 26 is placed through rubber tip 24 into engagement with recess wall 28 of end cap 22. Actuating button 72 is then depressed until the operator "feels" end cap 82 of the blow-out piston assembly engage the end of cylinder 48. The free tip of the capillary tube is inserted into the fluid to be dispensed, and button 72 is released. Under spring pressure, piston 36 is retracted from bore 34 and fluid is drawn into the capillary tube by the suction created. Graduation marking 27 on the tube 26 indicates the proper volume capacity and the liquid level should coincide with this line. If the two do not coincide, such as for example, when dispensing liquids with very high specific gravities, an adjustment is made by loosening cap 23 of barrel 20 to change the length of the piston stroke.

To dispense the liquid, button 72 is depressed the length of its travel, thereby first forcing piston 36 through bore 38, and then sequentially moving cylinder 48 longitudinally to force air under pressure into bore 38, thereby producing an air blast therein to blow out fluid droplets remaining in the tube.

Upon release of button 72, the apparatus is returned to its initial inoperative position by spring actuation, and the apparatus is in readiness to perform the next dispensing operation.

DESCRIPTION OF FORM OF INVENTION ILLUSTRATED IN FIGS. 9 TO 11

In FIGS. 9 to 11, there is illustrated a modified form of the present invention which is basically the same as that illustrated in the form of invention shown in FIGS. 1 to 8. Accordingly, portions corresponding to that form of invention are identified by like numbers followed by the letter "a."

In this form of the invention, instead of providing an outer cylinder such as indicated at 48 in the form of invention illustrated in FIGS. 1 to 8, there is provided a collar 98 which is spaced from piston shaft head 42a, one end of which sleeve normally engages abutment 52a of barrel 20a. The other end of sleeve 98 engages a spring 54a. The opposite terminal of the spring engages cap 22a. In accordance with the present invention piston shaft 36a is fluted or grooved at 100a to provide an air passageway between the bore of cylindrical barrel 20a and bore 34a of cylinder 32a during the portion of the operation illustrated in FIG. 11.

The operation of the apparatus of this form of invention is similar to that set out above in connection with the form of invention illustrated in FIGS. 1 to 8, with the exception that upon longitudinal movement, enlarged head 82a engages collar 98a and increased force must be exerted on button 72a to activate the blow-out feature to clear capillary tube 26a. Upon continued longitudinal movement of piston 36a by depression of actuating button 72a, flute or groove 100 assumes the position shown in FIG. 11 with one portion of the groove communicating with the bore of barrel 20a and the other end thereof communicating with bore 34a of cylinder 32a. This effects a passageway between the two bores, and the air which has been compressed by piston-like collar 88a passes into bore 34a to blow out any fluid remaining in capillary tube 26a.

DESCRIPTION OF FORM OF INVENTION ILLUSTRATED IN FIGS. 12 TO 13

In FIGS. 12 and 13, there is illustrated another modification of the present invention which is also similar to the forms of invention illustrated in FIGS. 9-11. Accordingly, corresponding parts are identified by like numbers followed by the letter "b." In this form of the invention retraction of piston 36b and piston assembly 68b is not effected automatically under spring tension, but is performed manually. To facilitate the manual retraction, a finger loop 102 is employed in lieu of the actuating button of the other forms of the invention. The operation of this form of the invention is the same as in the forms of invention illustrated in FIGS. 1-11.

DESCRIPTION OF FORM OF INVENTION ILLUSTRATED IN FIG. 14

In FIG. 14, there is illustrated still another modified form of the present invention which is basically similar to the forms of the invention shown in FIGS. 1-13 and accordingly similar parts are identified by like numbers followed by the letter "c." In this form of the invention, however, no spring means are provided for automatically retracting piston 36c in cylinder 32c and there is no spring actuated cylinder or collar concentric with the piston. The assembly of this form of the invention includes a peripheral groove 104 at a predetermined point along the length of the barrel. In connection with groove 104 there is provided a detent assembly 106 in enlarged portion 74c of blow out piston assembly 68c. Detent assembly 106 include a ball 108, and a spring 110 positioned in a recess 112 in enlarged portion 74c. Ball 108 is urged outwardly from the recess by spring 114 in a well known manner and upon slideable movement of piston assembly 68c, ball 108 drops into groove 104, thereby indicating to the operator that piston 36c is in position within cylinder 32c for drawing fluid into tube 26c.

After piston 36c is retracted by operation of finger loop 102c, the fluid is discharged by reversing the direction of movement of piston 36c and piston assembly 68c. When ball 108 passes groove 104 the operator can "feel" this action and knows that the air compressed by piston assembly 68c is passing into bore 34c of cylinder 32c through flute 100c to blow out droplets of air from tube 26c.

DESCRIPTION OF FORM OF INVENTION ILLUSTRATED IN FIG. 15

In FIG. 15 there is illustrated fragmentarily another modified form of the present invention which may be basically similar to any of the forms illustrated in FIGS. 1-14. Accordingly, similar parts are identified by the same numbers followed by the letter "d." This modification is particularly adapted for use with a molded plastic tip volumetric device 116. For this purpose, a rubber tip 118 is positioned in a central recess in end cap 22d. Tip 118 includes a forward frusto-conical extension 119 which is adapted for frictional engagement with the inner peripheral surface of volumetric device 116. An axial bore 120 extends through rubber tip 118 to provide communication between device 116 and bore 34d.

The apparatus of the present invention affords simple but effective means of clearing volumetric devices, particularly of the small bore type such as capillary tubes,

of all fluid drawn therein. This apparatus further provides actuating means including a piston or plunger member which, in a single stroke, sequentially delivers substantially all of the fluid from the tube and then delivers compressed air to the volumetric device for completely clearing the same of fluid droplets. In the event droplets remain in the tube, the actuating means may be repeatedly operated to effect delivery of air under pressure in one direction only to the volumetric device while preventing movement of air in the opposite direction. The present apparatus, by virtue of its simplicity in structure and operation, further lends itself to operation by an unskilled person with a minimum of instructions.

While there has been herein shown and described the presently preferred forms of this invention, it is to be understood that such has been done for purposes of illustration only and that various changes may be made therein within the scope of the appended claims.

What is claimed is:

1. Microliter fluid delivery apparatus including:

- a. a cylinder barrel,
- b. a sample-receiving member engaged with one end of said barrel,
- c. a first cylinder coaxially fixedly positioned in said end of the barrel in communication with said sample-receiving member,
- d. a first piston movable longitudinally in said first cylinder for drawing fluid into and discharging fluid from, said sample-receiving member,
- e. said first piston being spaced from said first cylinder,
- f. sealing means between said first piston and first cylinder at the end thereof remote from said sample receiving member,
- g. a piston assembly positioned within said barrel in operative engagement with said first piston,
- h. said piston assembly including a second piston and a piston shaft,
- i. a portion of said piston assembly being engageable with said first piston for actuating the latter,
- j. said second piston being slideable longitudinally of said piston shaft and spaced therefrom to provide an air passageway,
- k. the wall portion of said cylindrical barrel spaced from one end thereof being provided with an air opening in communication with said air passageway,
- l. sealing means on said second piston engageable with the internal wall of said cylindrical barrel,
- m. sealing means on said piston shaft and engageable with said second piston upon longitudinal movement of the piston shaft in one direction, for preventing the flow of air from the air opening through the air passageway, whereby air pressure in advance of said piston assembly is increased upon longitudinal movement thereof through said barrel toward said sample-receiving member,
- n. means for selectively admitting the air under increased pressure to said first cylinder from said barrel, during the longitudinal movement of said piston assembly thereof, and
- o. actuating means for moving said piston assembly and first piston longitudinally of said barrel to effect passage of said first piston through said cylinder to discharge fluid from said sample-receiving member,

p. said actuating means being sequentially operative to activate said means for selectively admitting air under pressure to said first cylinder to blow out the sample receiving member after fluid has been discharged therefrom.

2. The microliter fluid delivery apparatus of claim 1, with the addition of:

- a. a member concentrically positioned with respect to said cylinder, and
- b. a spring engaged with said concentric member for normally urging the latter in a direction opposite the sample-receiving member,
- c. a part of said piston assembly being movable longitudinally through said cylindrical barrel and engageable with said concentric member for moving the latter longitudinally of said barrel against the tension of said spring.

3. The microliter fluid delivery apparatus of claim 2, wherein:

- a. said member comprises a second cylinder in spaced relation to said cylinder fixedly positioned in said barrel.

4. The microliter fluid delivery apparatus of claim 3, wherein:

- a. the cylinder fixedly positioned in said barrel includes an air opening in the wall thereof, and
- b. sealing members carried by the outer periphery of said cylinder on both sides of the air opening,
- c. said sealing members being normally in contiguous relation with the wall of said second cylinder,
- d. at least one of said sealing members being spaced from the wall of said second cylinder upon longitudinal movement of said second cylinder by said piston assembly to permit the passage of air from said second cylinder into the cylinder positioned in said barrel.

5. The microliter fluid delivery apparatus of claim 2, wherein:

- a. said member comprises a collar in spaced relation to said cylinder fixedly positioned in said barrel.

6. The microliter fluid delivery apparatus of claim 2, with the addition of:

- a. a second spring engaged with said first piston for normally urging the same to a retracted position.

7. The microliter fluid delivery apparatus of claim 6, wherein:

- a. the spring engaged with said concentric member is stronger than the spring engaged with said first piston, whereby it may be determined by "feel" when said actuating member initiates movement of said concentric member.

8. The microliter fluid delivery apparatus of claim 1, wherein:

- a. said first piston is provided with a flute at a predetermined point along its length for permitting the passage of air between said barrel and cylinder positioned therein during a portion of the stroke of said first piston.

9. The microliter fluid delivery apparatus of claim 1, with the addition of:

- a. a groove in the inner wall of said housing at a predetermined point, and
- b. a ball and spring detent carried by said piston shaft,
- c. said ball being engaged with said groove to indicate said piston is in position for drawing fluid into said sample-receiving member.

10. The microliter fluid delivery apparatus of claim 1, wherein:
- said sample-receiving member comprises a volumetric device.
11. The microliter fluid delivery apparatus of claim 5, wherein:
- said volumetric device is a graduated capillary tube.
12. The microliter fluid delivery apparatus of claim 10, wherein:
- said volumetric device is a disposable tip.
13. The microliter fluid delivery apparatus of claim 1, wherein:
- said actuating means comprises an actuating button connected to the outer end of said piston shaft.
14. The microliter fluid delivery apparatus of claim 1, wherein:
- said actuating means comprises a finger-engaging loop connected to the outer end of said piston shaft.
15. The microliter fluid delivery apparatus of claim 1, with the addition of:
- means for controlling the amount of fluid drawn into, and discharged from, said sample-receiving member.
16. The microliter fluid delivery apparatus of claim 15, wherein:
- said means for controlling the amount of fluid drawn into, and discharged from, said sample-receiving member includes an end cap threadedly engaged with an end of said cylindrical barrel,
 - said piston shaft with said actuating means connected to an end thereof extending through said end cap,
 - said end cap being threadedly adjustable relative to said cylindrical barrel and said actuating button to vary the distance between said cap and said actuating button to adjust the length of the stroke.
17. A microliter fluid delivery apparatus including:
- an elongated housing having an opening at one end,
 - a sample-receiving member positioned within the opening of said housing,
 - a cylinder within said housing adjacent the opening thereof,
 - said cylinder having a bore in communication with said housing opening,
 - a piston slideable longitudinally of said cylinder for suctioning fluid into, and discharging fluid from, said sample-receiving member,
 - a piston assembly connected with the end of said piston remote from said sample-receiving member,
 - said piston assembly including means for moving said piston longitudinally of said cylinder,
 - said piston assembly further including means for compressing air within said housing on the downstroke of said piston assembly, and
 - air passage means selectively admitting the compressed air within said housing to said cylinder after said piston has moved a predetermined distance in its downstroke, whereby the compressed air is directed into said sample-receiving member, for clearing the latter of fluid droplets remaining therein.

18. The microliter fluid delivery apparatus of claim 17, with the addition of:
- means for preventing the passage of air from said sample-receiving member into said housing upon the upstroke of said piston in said cylinder.
19. The microliter fluid delivery apparatus of claim 17, wherein:
- said piston is spaced from the wall of said cylinder to permit passage of air between the piston and cylinder into said sample-receiving member, and
 - sealing means between said piston and cylinder near the end thereof remote from said sample-receiving member, for suctioning fluid into, and discharging fluid from, said sample-receiving member.
20. The microliter fluid delivery apparatus of claim 17, wherein:
- said piston assembly includes a piston shaft and second piston,
 - said second piston being slideable longitudinally on said piston shaft and spaced therefrom to provide an air passageway,
 - the wall of said housing being provided with an air opening in communication with said air passageway,
 - sealing means on said second piston engageable with the wall of said housing, and
 - sealing means on said piston shaft engageable with said second piston upon longitudinal movement of the piston shaft in one direction, for preventing the flow of air from the air opening through the air passageway whereby air pressure in advance of said piston is increased upon longitudinal movement thereof through said housing.
21. The microliter fluid delivery apparatus of claim 17, wherein:
- said means for admitting the compressed air within said housing to said cylinder comprises an air opening in the wall of said cylinder,
 - sealing members carried by the outer periphery of said cylinder on both sides of the air opening,
 - a second cylinder in spaced relation to said cylinder and movable longitudinally of said housing,
 - said sealing members being normally in contiguous relation with the wall of said second cylinder to prevent the passage of air from said second cylinder through the air opening,
 - at least one of said sealing members being spaced from the wall of said second cylinder upon longitudinal movement of said second cylinder,
 - said second cylinder being connected to, and movable with, said piston assembly, to permit the passage of compressed air from said second cylinder into said cylinder.
22. The microliter fluid delivery apparatus of claim 17, wherein said means for admitting the compressed air to said cylinder comprises:
- a flute on said piston at a predetermined point along its length for permitting the passage of air between said housing and cylinder during the downstroke of the piston.
23. The microliter fluid delivery apparatus of claim 17, with the addition of:
- a groove in the inner wall of said housing at a predetermined point, along the length thereof, and
 - a ball and spring detent carried by said piston assembly,

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c. said ball being engaged with said groove to indicate said piston is in position for drawing fluid into said sample-receiving member.

24. The microliter fluid delivery apparatus of claim 17, wherein:

a. said sample-receiving member comprises a volumetric device.

25. The microliter fluid delivery apparatus of claim 24, wherein:

a. said volumetric device is a graduated capillary tube.

26. The microliter fluid delivery apparatus of claim 24, wherein:

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a. said volumetric device is a disposable tip.

27. The microliter fluid delivery apparatus of claim 17, with the addition of:

a. actuating means engaged with the outer end of said piston assembly.

28. The microliter fluid delivery apparatus of claim 27, wherein:

a. said actuating means comprises an actuating button.

29. The microliter fluid delivery apparatus of claim 27, wherein:

a. said actuating means is a finger-engaging loop.

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