United States Patent

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[54] **LIQUID DISPENSING PUMP**
6 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **222/321,** 222/383, 417/470, 417/550
[51] **Int. Cl.** **G01f 11/36**
[50] **Field of Search** ..... 222/321, 383—385; 417/470, 550

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ABSTRACT: A liquid dispensing pump for a portable container in which the pump piston is disposed for lost motion in the pump cylinder between the plunger rod and a discharge valve carried by a stem affixed to the plunger rod and extending through the piston. The piston has upwardly and downwardly presented elastomeric skirts of which the lower skirt seats against the discharge valve on the piston upstroke and the upper skirt seats against a venting valve at the termination of the upstroke. Both the discharge valve and the venting valve exert an expanding action on the respective piston skirts incident to their seating relation with the skirts under the resilient pressure of the pump spring, to counteract any shrinking tendency of the skirts, and means are provided for limiting the expansion of the skirts. The upper and lower ends of the piston are symmetrically arranged to permit reversal of its position in the pump.

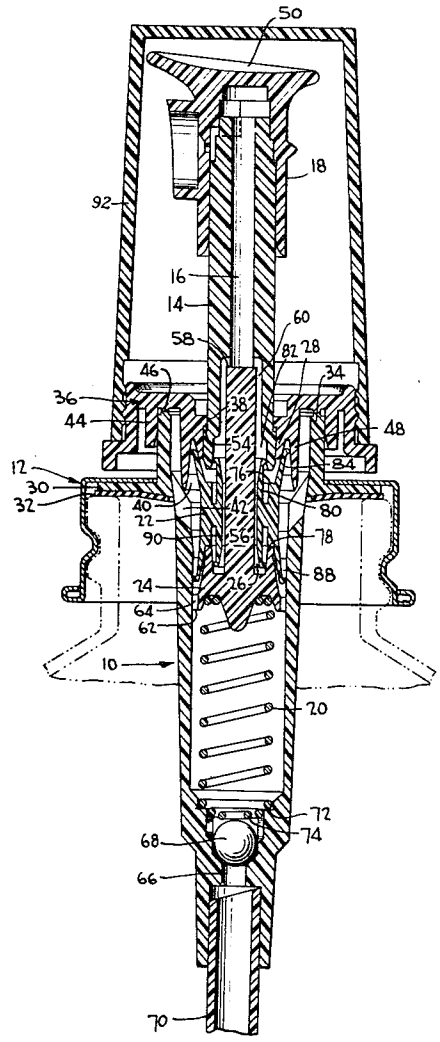

FIG. 1

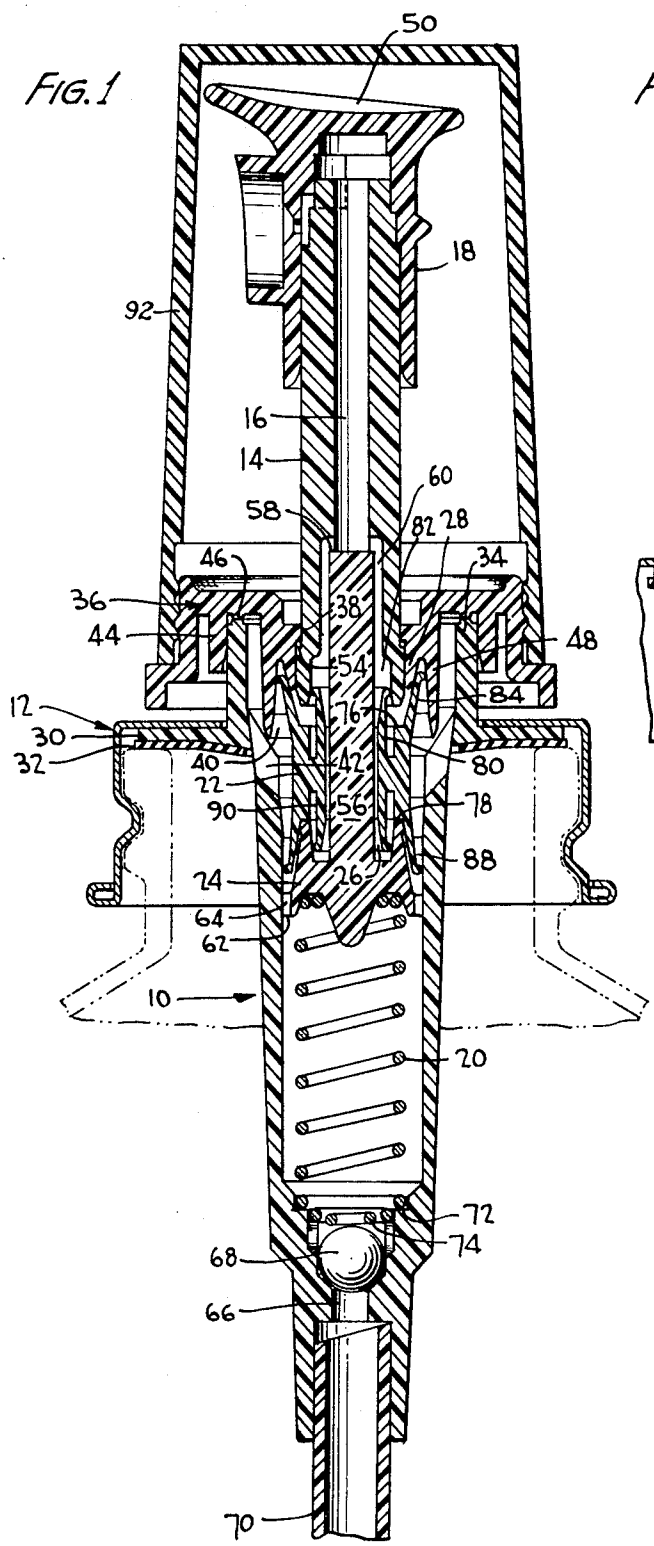

FIG. 2

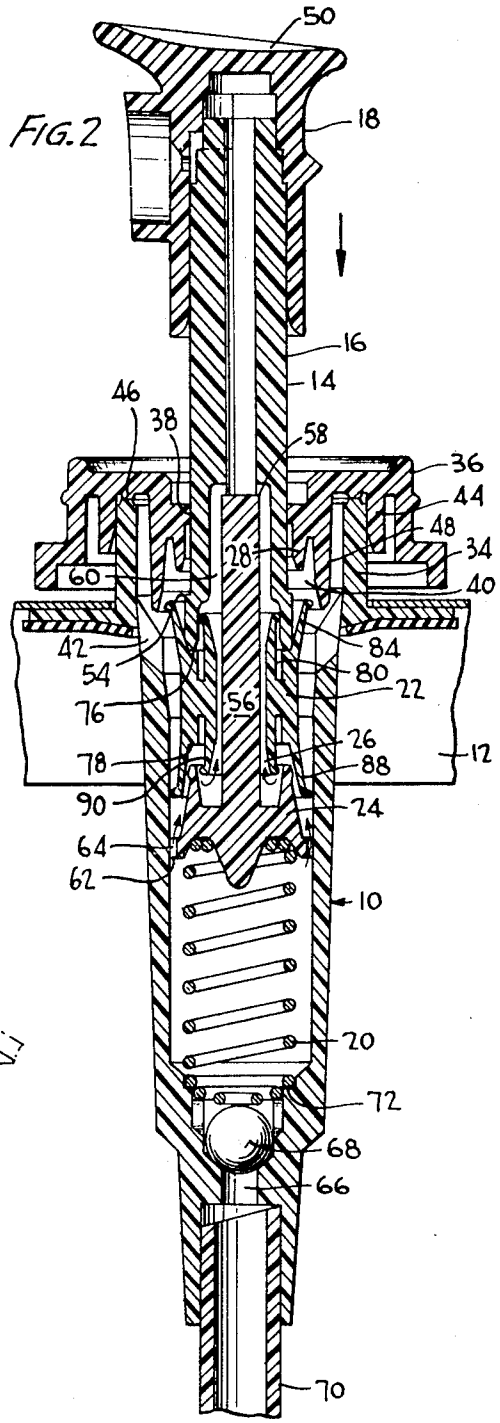

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FIG. 3

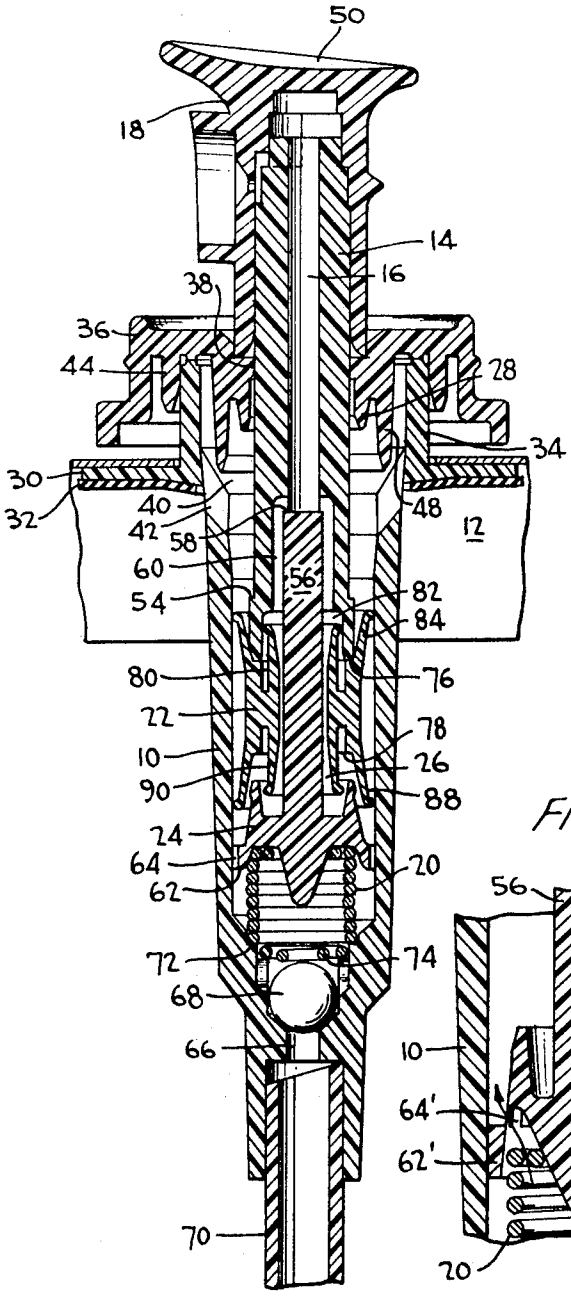

FIG. 4

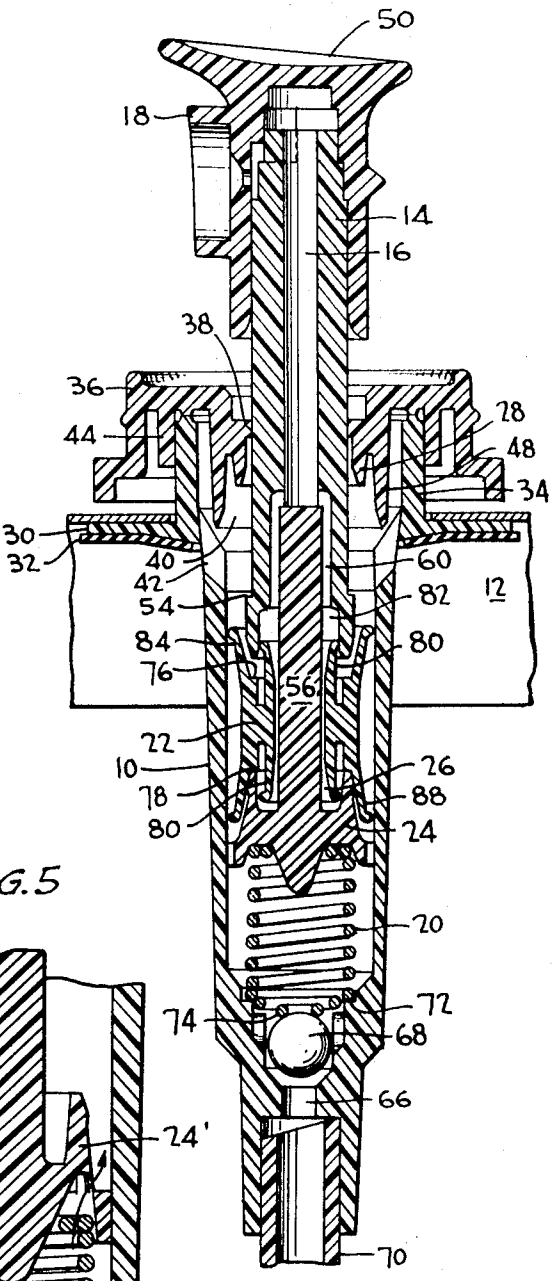

FIG. 5

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LIQUID DISPENSING PUMP

This invention relates to improvements in a reciprocating liquid dispensing pump of the type such as is customarily fabricated of plastic materials for use with a portable liquid container.

More particularly, the invention relates to improvements in such a pump of the class in which the pump piston performs a valving action, and for this purpose is capable of a limited degree of movement with respect to the plunger rod into and from seating relation with a discharge valve fixed to the plunger rod to control the communication between the pump chamber and a discharge passage leading through the plunger to the atmosphere. In such a pump when the plunger is projected to its fully raised position by its spring, the piston is axially compressed between and in sealing engagement at its lower and upper ends, respectively, with the discharge valve aforementioned and with a venting valve which controls the communication between the interior of the liquid container and the atmosphere.

In accordance with the present invention, the piston is provided with outwardly flaring upper and lower piston skirts for operative engagement with the cylinder wall on the upward or suction stroke and the downward or compression stroke of the piston, respectively.

In accordance with one feature of the invention, the lower piston skirt cooperates with the discharge valve throughout the upward or suction stroke of the plunger, as well as in the raised position of the plunger, to seal of the plunger discharge passage from the pump chamber, while in the raised position of the plunger, the upper piston skirt cooperates with the venting valve to seal the vent passage leading from the container to the atmosphere.

The piston is customarily formed of a conventional elastomeric plastic material and such material generally is subject to shrinkage due to aging. Shrinkage of the piston skirts is manifestly undesirable as adversely affecting the sealing and wiping relationship between the piston skirts and the cylinder wall.

In the present invention, such shrinking tendency is effectively counteracted by mutually conforming and arranging the piston skirts and their associated valves so that when the plunger is fully raised by the action of its spring, the ensuing seating of the piston skirts relative to their respective valves produces an expansion force on the respective skirts. Each of the generally conically flaring piston skirts is provided with an internal seal where it is engaged and expanded by the valve. Also in the preferred embodiment, such expanding action urges the periphery of at least one such skirt into firm engagement with a surrounding sealing surface to provide an external seal.

Further important features consist in facilitating the assembly of such a pump by forming the piston and its associated parts in a manner such that the opposite ends of the piston are symmetrically formed, thereby permitting reversal or inversion of the piston without affecting its operation; and in arranging the plunger discharge valve for engagement with the cylinder wall in advance of the piston, whereby to serve as a combined pilot and protector for the downwardly directed piston skirt during its assembly into the cylinder and thereafter, during use of the pump, to remove from the wall of the cylinder any solid materials which may have been prepicitated or coated thereon from the product being dispensed.

In accordance with a still further feature of the invention, the piston, though it encircles the valve stem of the discharge valve, is relatively spaced therefrom to permit free flow of liquid upwardly into the plunger discharge passage during the plunger compression stroke and also to permit a free floating action of the piston with respect to the valve stem whereby the piston may readily accommodate itself to positions in which it effectively achieves its valving and sealing functions.

The foregoing features and advantages are incorporated in and attained by the preferred embodiment of the invention illustrated in the accompanying drawings in which:

FIG. 1 is a vertical cross section through a liquid dispensing pump in accordance with the invention, the pump plunger being shown in its fully raised position in which both the discharge passage through the plunger and the vent passage externally of the plunger are sealed to prevent escape of the contents from the container, (the latter being shown fragmentarily in broken lines).

FIG. 2 is a view similar to FIG. 1, but with the plunger shown at the start of its downward or discharge stroke in which the vent passage and also the plunger discharge passage are open.

FIG. 3 is a view similar to FIG. 2, but with the plunger fully depressed at the end of its discharge stroke.

FIG. 4 is a view similar to FIGS. 2 and 3, but with the plunger at the start of its upper or suction stroke with the piston seated on the discharge valve to close the discharge passage while leaving the vent passage open.

FIG. 5 is a detailed cross section in the same plane as the other Figures showing a modified arrangement of the discharge valve.

Referring now in detail to the accompanying drawings, and referring first to FIG. 1, it will be seen that the pump of the invention is adapted for application to a portable container such as a bottle, the upper end of which is depicted in broken lines in FIG. 1. The pump structure comprises a pump cylinder **10** which is supported through an opening in the container cap **12** and depends into the container interior. The pump plunger or plunger assembly comprises a tubular plunger rod **14** defining a discharge passage **16** leading to a suitable external discharge head **18** through which the plunger is adapted to be reciprocated by intermittent downward pressure on the plunger head. Return or upward movement of the plunger is produced by the usual plunger spring **20**.

The plunger includes a combination valve and piston **22** which is in frictional wiping engagement with the cylinder wall and which has a limited degree of longitudinal movement relative to the plunger rod for movement into and from operative engagement with a discharge valve **24** affixed to the plunger rod **14** and controlling the discharge port **26** through the piston **22**. When the plunger is fully projected to its raised position by its spring **20**, the valve piston **22** is compressed between and thus operatively engaged or seated against both the discharge valve **24**, and a venting valve **28**. In this position the discharge valve prevents passage of the product through the plunger discharge passage to the atmosphere, and the venting valve prevents passage of the product externally of the plunger to the atmosphere.

Referring now in more detail to the various parts and their interrelationships, the pump cylinder **10** depends into the container through its neck and is encircled by an annular flange **30** through which the cylinder is positioned and supported on the upper end of the neck. The flange **30** is secured against the neck by means of the top wall **32** of the conventional container cap **12** which is threaded on or otherwise applied to the container. Preferably, a sealing liner or gasket **32** is interposed between the supporting flange and the container neck.

The housing also comprises a radially enlarged annular wall **34** which projects upwardly through an opening in the container cap and which has applied thereto a collar **36** defining a centrally located guide opening **38** through which the plunger rod is guided for reciprocation and having sufficient clearance with the plunger rod to avoid binding thereof as well as to permit a flow of air from the atmosphere inwardly into a venting or breather chamber **40** jointly defined by the wall and collar. In the operation of the pump, atmospheric air is admitted through the guide opening **38** and breather chamber **40** and thence through one or more vents **42** in the upper portion of the cylinder wall into the container interior to replace the liquid product which is withdrawn from the container by the pump.

The collar **36** in the instant embodiment is provided with a wall **44** encircling and fitted around the upwardly projecting wall **34** of the breather chamber and has an annular rib **46**

abutting against and preferably welded or cemented to the upper end of the wall 44. The concentric walls 44, 34 also may be cemented or welded together in fluidtight manner.

Depending from the collar 36 around the guide opening 38 is the venting valve 28 which may also include an auxiliary annular seal 48 which depends into the breather chamber 40 for cooperation with the piston in a manner hereinafter described. The tubular plunger rod 14 as above mentioned, is guided for reciprocation through the guide opening 38 with substantial clearance to permit the inflow of air through said opening. The plunger rod 14 defines an internal discharge passage 16 for the product extending from the discharge port 26 through the piston upwardly to the generally conventional discharge head 18 on its upper or exterior end and through which the product is discharged, as by spraying into the atmosphere. The discharge head illustrated in the instant embodiment is a spray head of the type more fully disclosed in the U.S. Pat. to Rex C. Cooprider No. 3,319,894, granted May 16, 1967. Such a spray head generally is provided with an upwardly presented finger piece 50, conveniently conform to receive intermittent finger pressure, the pressure being alternately applied to depress the plunger and then to permit its upward return projection by virtue of the action of the plunger spring 20. Upward projection of the plunger rod is suitably limited as by means of upwardly presented shoulder 54 around the plunger rod disposed for abutting engagement with a downwardly presented shoulder within the guide opening 38 of the plunger.

Affixed to and projecting downwardly from the plunger rod is a valve stem 56 which carries the discharge valve 24 at its lower end in spaced relation from the lower end of the plunger rod 14. In the preferred embodiment, the valve stem 56 is frictionally fitted into the downwardly opening plunger discharge passage into engagement with a positioning shoulder 58 in such passage and the discharge passage, in turn, comprises a series of bypass grooves 60 extending downwardly around the valve stem.

The discharge valve 24 is of downwardly diverging frustoconical external configuration and is provided with radially outwardly projecting base 62 in operative sliding engagement with the cylinder wall, but arranged to permit the free flow of product therepast into the piston discharge port 26.

Thus in the arrangement shown in FIGS. 1 through 4, the annular base or pilot portion 62 of the discharge valve 24, though adapted for wiping engagement with the inner wall of the piston, is interrupted by one or more grooves 64 through which liquid product is free to pass upwardly for entrance into the discharge port 26 and passage 16 during the downstroke of the piston, all as indicated by the arrows in FIG. 2.

In an alternative arrangement as shown in FIG. 5, the base or pilot portion 62' of the discharge valve is of complete annular configuration and there are provided one or more passages 64' extending upwardly through the interior of the valve and opening radially outwardly into the pump cylinder between the pilot portion 62 and the piston 22.

It will be noted that the plunger spring 20 is compressed between the discharge valve 24 and the lower end of the pump cylinder around the intake port 66. The intake port 66 is controlled by a usual check valve 68 and communicates with the bottom of the container by way of a dip tube 70 of which only the upper end portion is illustrated. Preferably the lower end of the spring rests on an annular ledge 72 in the cylinder concentric to the inlet port 66 and is provided with a constricted lower end convolution 74 positioned to permit but a limited amount of unseating of the check valve.

The discharge port 26 of the piston is defined by a bore therethrough through which the discharge valve stem 56 is received with substantial clearance so as to permit a flow of the product upwardly between the stem and the wall of the bore into the hollow piston rod 14 and to permit a limited amount of floating movement or displacement of the piston relative to the valve stem. The frictional engagement between the piston 22 and cylinder wall causes the piston to lag behind the piston rod at the inception of each stroke, until the lost motion between the piston and piston rod is taken up.

The range of relative lost motion between the piston and piston rod is determined and limited by the oppositely axially presented stop shoulders 76 and 78 of the piston, adapted for alternate abutting engagement with the lower end of the plunger rod and the discharge valve, respectively.

Sealed communication between the discharge port 26 of the piston and the plunger discharge passage 16 is maintained at all times through a sealed telescoping connection between the piston and plunger rod, and defined in the present instance by an upwardly projecting sleeve 80 carried by the piston around the discharge port 26 and preferably formed with a radially projecting lip which is received in snug fluidtight sliding relation within an enlarged cylindrical socket 82 constituting the lower end of the discharge passage through the plunger rod.

The inner sealing rib 28 of the annular venting valve is proportioned for wedging reception within the conically upwardly flaring piston skirt 84 to exert a radial expansive force on this skirt when the skirt is urged upwardly by the discharge valve and plunger spring in the fully raised position of the plunger. The inner surface of the skirt thus is in sealed relation with the annular sealing rib around its entire circumference. At the same time, the expansive action of the rib on the skirt urges its outer peripheral outer edge portion into sealing engagement with the encircling outer or auxiliary sealing rib 48 of the vent valve. The coaction between the venting valve and the piston therefore, is such as to effect an efficient fluidtight seal preventing communication of the breather chamber 40 and vent 42 with the guide opening 38 through the collar 36. Also throughout the upward stroke of the piston the upper annular end of the exteriorly conical discharge valve 24 will abut against the downwardly directed annular stop shoulder 78 of the piston, while the downwardly flaring outer surface portion of the valve will be in wedging sealed engagement with the inner conical surface of the conically downwardly flaring lower piston skirt 88. At the same time, the depending lower sleeve 90 of the piston will have its radially outwardly projecting lip disposed in sealed engagement with the downwardly converging inner conical wall of the discharge valve 24. Thus it will be apparent that a double seal is effected between the piston and the discharge valve throughout and at the conclusion of the upward stroke of the piston.

The annular abutment shoulders 76 and 78 within the piston are axially located for alternate axial abutment with the annular lower end of the piston rod and the annular upper end of the discharge valve respectively, to transmit reciprocation from the plunger to the piston with a limited degree of lost motion sufficient to effect the desired valving action of the piston. The respective stop shoulders are located to engage the associated ends in time to prevent direct axial abutment of the outwardly flaring end edges of the piston skirts 84 and 88 with either the collar or the pilot portion 64 of the discharge valve 24, thereby avoiding possible damage to the skirts and impairment of their sealing engagement with the cylinder wall.

During shipment and storage of the filled containers equipped with the dispensing pump of the invention, the upper external end of the plunger including its discharge head will normally be covered by a protective overcap 92 (shown in FIG. 1) removably affixed to the collar in conventional manner to avoid inadvertent depression or reciprocation of the fully projected or raised plunger and to protect same against damage. In the fully raised position of the plunger with the protective overcap 92 applied in the manner shown in FIG. 1, the pressure of the plunger spring 20 against the discharge valve 24 will have fully projected the discharge valve 24 and plunger rod 14 to the full limit permitted by the stop shoulders 54 of the plunger rod and will thus have axially compressed the piston 22 between and in seated relation with respect to both the discharge valve 24 and the venting valve 28. The discharge valve will thus bar the admission of the liquid product from the pump chamber into the discharge port 26 and passage 16. The seating of the piston 22 with respect to the venting valve 28 will bar the escape of the liquid product from the container upwardly through the vent 42 and breather chamber 40 for escape or leakage through the collar guide opening 38 around the plunger rod.

At the commencement of the downward plunger stroke as shown in FIG. 2, the initial downward movement of the plunger rod 14 and discharge valve 24 will serve first to unseat the discharge valve from the piston 22, the latter remaining stationary within the cylinder until such time as its upper stop shoulder 76 is engaged by the downwardly presented end of the plunger rod, whereupon the upper skirt 84 of the piston is unseated from the vent valve 28 to commence its downward movement with the rest of the plunger assemble. Unseating of the discharge valve 24 will permit upward flow of the produce from the pump chamber (as shown by the arrows in FIG. 2) between the lower piston skirt 88 and the exterior conical face of the discharge valve 24, thence, over the upper end of the discharge valve and back downwardly on the inner face thereof, around and beneath the beaded lower edge of the depending piston sleeve 90 and thence upwardly through the piston discharge port 26 between the piston and valve stem 56 and upwardly through the discharge passage 16 to be expelled into the atmosphere through the discharge head 18.

The ensuing opening of the venting valves 28, 48 will then permit airflow either inwardly through the collar guide opening 38, thence through the chamber 40 and vent 42 to the container interior or vice versa, as necessary for pressure equalizing purposes.

The discharge valve 24 will remain unseated throughout the continuation of the downward or compression plunger stroke, until the plunger is in its fully depressed position, substantially as shown in FIG. 3 of the accompanying drawings, to permit discharge of the contents of the pump chamber until the completion of such stroke.

In FIG. 4, the plunger is shown shortly after it has commenced its return or upward stroke under the influence of the plunger spring 20. It will be understood that at the very inception of such stroke, the piston 22 will have remained stationary until the discharge valve 24 has moved upwardly sufficiently to engage the downwardly presented piston stop shoulder 78, following which the piston will be caused to move upwardly together with the rest of the plunger assembly. Such initial lost motion or upward movement of the plunger rod 14 and discharge valve 24 relative to the piston 22, will have brought the outer conical surface of the discharge valve into sealing engagement with the inner conical surface of the lower piston skirt 88 and, at the same time, will have caused the downwardly converging inner conical surface of the discharge valve to sealingly engage the lower end of the lower piston sleeve 90 to afford a second seal, whereby the entry of fluid into the downwardly opening discharge port 26 through the piston will be effectively prevented.

Throughout the entire upward or suction stroke of the plunger, the discharge port and passage will thus remain closed so that the piston may suck the liquid product upwardly through the dip tube 70 and intake port 66 past the check valve 68 and into the pump chamber, to be expelled on the next downward or compression stroke of the plunger assembly.

At the conclusion of the upward stroke, the various parts will again be in the position illustrated in FIG. 1, with both the discharge valve 24 and the venting valve 28, 48 in seating relation with the piston.

It is to be noted that in the preferred embodiment of the invention as herein illustrated, the opposite axial ends of the piston are symmetrically arranged with respect to a radial plane bisecting the piston, so that when the various piston parts are assembled by sliding the piston 22 on to the valve stem 56 and then press fitting the upper end of this stem into the lower end of the discharge passage 16 of the plunger rod, it is immaterial which end of the piston is first placed on the valve stem, due to their identical construction and proportioning.

It will be noted that the upwardly projecting sealing sleeve 80 of the piston cooperates with the enlarged cylindrical socket 82 in the lower end of the piston rod to maintain a telescoping sliding seal effective in all relative positions of the piston and plunger rod to prevent leakage therethrough from the plunger discharge passage 16 into the breather chamber 40. Thus, when the plunger is in its fully raised position and loaded with the liquid product, following the completion of a dispensing operation, the product is barred from escaping into the annular space then existing between the lower end of the plunger rod and the upper piston skirt 84 to leak upwardly and outwardly through the plunger guide opening 38 of the collar.

In the sealing or closed position of the venting valve 28, 48 shown in FIG. 1, the outer conical surface of the inner sealing sleeve 28 of the collar is wedgingly received in the inner conical face of the upper piston skirt 84, forcing it radially outwardly into engagement with the surrounding outer collar sleeve 48, thus effecting inner and outer seals, while, at the same time, limiting undesired stretching of the skirt 84. The upper skirt is thus retained at the desired dimensions for proper cooperation with the cylinder wall throughout each upward stroke of the plunger.

At the same time, the outer sealing surface of the discharge valve 24, by virtue of being thrust upwardly by spring pressure into the downwardly converging conical lower piston skirt 88, will tend to resiliently expand the latter until such time as the upper end of the discharge valve is engaged by the downwardly presented stop shoulder 76 of the piston, thereby providing a tight seal and urging the lower edge of the piston skirt 88 outwardly into sealing engagement with the cylinder wall.

The expansive force of the spring 20, therefore, will be utilized as long as the plunger is in its fully raised position to maintain both skirts of the piston in fully expanded condition and thus, to counteract any tendency toward shrinking through aging of the plastic as well as to maintain over long periods of time an efficient fluidtight seal between the piston and its respective cooperative valves.

The annular guide portion 62 or 62' of the discharge valve, being of comparatively stiff structure as compared to the wiping edges of the piston skirts, prevents undue buildup of precipitates or coatings on the cylinder wall arising from product aging or instability and, further, such guide or pilot portion serves as a guard and lead-in for the piston during insertion of the plunger into the cylinder incident to assembly of the pump. Thus, damage and/or deformation of the comparatively frail lower edge of the piston skirt are avoided during assembly of the pump components. Moreover, when the various components of the plunger are assembled prior to insertion of the plunger into the cylinder, the leading or lower end edge of the plunger skirt will similarly be protected by the pilot portion of the discharge valve during handling and storage of such subassemblies.

Not only does the lower piston sleeve 90 engage and disengage the conical inner surface of the discharge valve 24 to thus perform its valving function in concert with the piston lower skirt 78, but, in addition, it provides an especially positive seal on the upward or suction stroke of the plunger, at which time the greater pressure above the plunger tends to expand the sleeve radially outwardly into sealing engagement with the valve. Moreover, because of its expansive action as above described, the said sleeve will serve efficiently to bar the ingress of atmospheric air from the discharge passage 16 into the container due to increases in barometric pressure or to decreases of the internal pressure within the container.

Having thus described my invention, I claim:

1. In a liquid dispensing pump, a housing defining a pump cylinder, a breather chamber and a vent communicating with said chamber, said cylinder being formed with an inlet port into the lower end thereof and having a check valve operatively associated with said port, a collar defining the upper end of said housing and formed with a plunger guide opening therethrough in axial alignment with the cylinder, an annular venting valve depending from said collar around said opening, a tubular plunger rod guided for reciprocation through said opening and defining a discharge passage for the pump, means for limiting the upward movement of said plunger rod through the collar, a valve stem affixed to and depending axially from

the plunger rod, a discharge valve carried by said stem in fixedly spaced relation below the said plunger rod, a spring compressed between said discharge valve and the lower end of the cylinder to resiliently urge the plunger rod and discharge valve to fully raised position, a piston of elastomeric plastic material having a bore therethrough slidably receiving said stem and defining a discharge port for the pump in communication with said discharge passage, said piston having limited axial movement between said plunger and the discharge valve, the piston having annular conically tapered upper and lower skirts diverging in opposite axial directions, respectively, for frictional wiping engagement with the cylinder wall during the operative piston stroke, said discharge valve being shaped and proportioned for wedging sealing reception within said lower piston skirt during and at the conclusion of the upstroke of the piston whereby to close said discharge port against back flow of liquid, and said venting valve being shaped and proportioned for wedging sealing reception within said upper piston skirt at the conclusion of the piston upstroke, whereby to seal off said breather chamber from said guide opening, there being an annular auxiliary seal depending from the said collar concentrically to said venting valve, said venting valve expanding said upper piston skirt into sealing engagement with the auxiliary seal in the fully raised position of the piston.

2. A liquid dispensing pump as defined in claim 1, including an annular auxiliary seal depending from the said collar concentrically to said venting valve, said venting valve expanding said upper piston skirt into sealing engagement with the auxiliary seal in the fully raised position of the piston.

3. A liquid dispensing pump as defined in claim 1, in which said upper and lower piston skirts are arranged symmetrically to each other so that said piston will be operative when assembled within the cylinder with either of its skirts directed upwardly.

4. A liquid dispensing pump as defined in claim 1 in which said piston further includes a downwardly projecting sleeve surrounding said discharge port, said discharge valve including an upwardly directed skirt having upwardly diverging conical inner surface around and spaced from the valve stem to function as a valve seat for sealing engagement with said sleeve on the upstroke of said piston whereby to prevent the backflow of liquid through the discharge port, and for unseating during the downward stroke of said piston to permit free passage of the liquid upwardly from the cylinder into the discharge port.

5. A liquid dispensing pump as defined in claim 4, in which said upwardly and downwardly directed sleeves as well as said upper and lower piston skirts are all symmetrically arranged with respect to each other whereby to permit inversion of the piston during its assembly with the other parts of the pump, without adversely affecting operation of the pump.

6. A liquid dispensing pump as defined in claim 1, in which said discharge valve is of greater maximum diameter than the piston whereby to function as a pilot for the piston during its assembly within the pump cylinder and to prevent damage to the lower piston skirt during such insertion.