

[54] MANUALLY ACTUATED LIQUID SPRAYING DEVICE	3,008,651	11/1961	Follain .....	239/353
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[75] Inventor: Carl E. Malone, Fort Lauderdale, Fla.	3,185,356	5/1965	Venus, Jr. ....	239/350 X
	3,396,874	8/1968	Malone .....	222/402.1
	3,514,017	5/1970	Malone .....	222/321

[73] Assignee: The AFA Corporation of Florida, Miami Lakes, Fla.

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[21] Appl. No.: 236,807

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[52] U.S. Cl. .... 239/350, 137/DIG. 2, 222/321, 239/573, 239/579

[51] Int. Cl. .... B05b 1/30

[58] Field of Search. .... 239/350, 353, 354, 239/573, 579; 222/384, 385, 321; 137/DIG. 2; 417/550, 554

[57] ABSTRACT

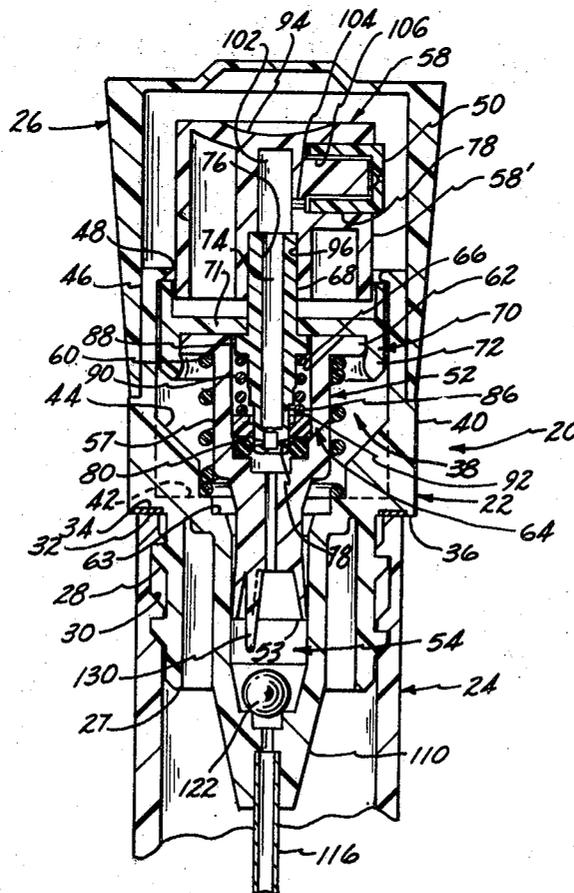
A spray device of the type adapted to be mounted as a closure on a container of liquid. The sprayer has a manually actuated pump with valve assemblies which discharge liquid through a spray nozzle substantially without dribble at the beginning and end of the spray cycle.

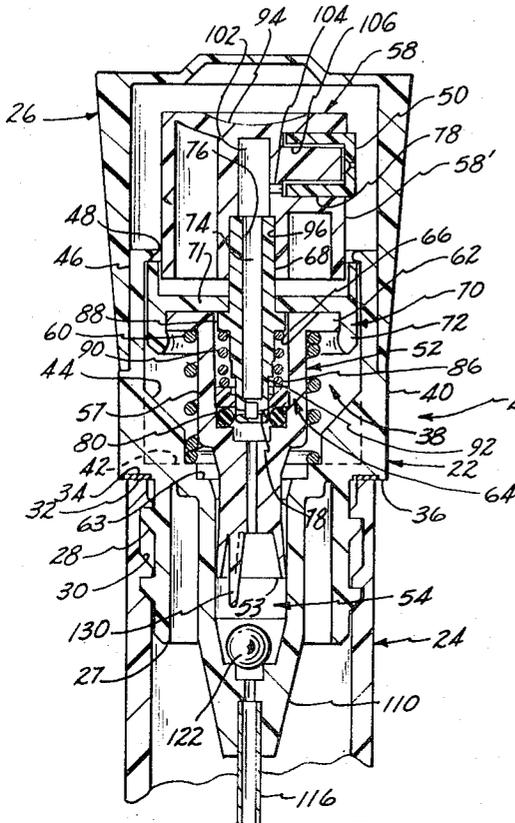
[56] References Cited

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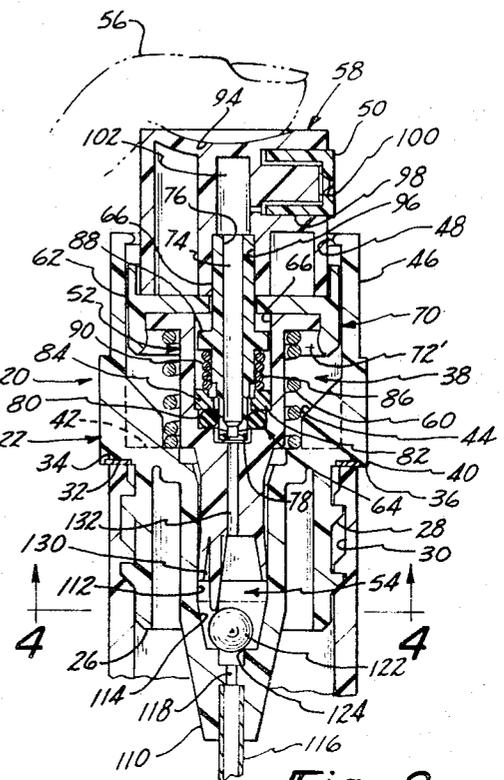
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28 Claims, 10 Drawing Figures

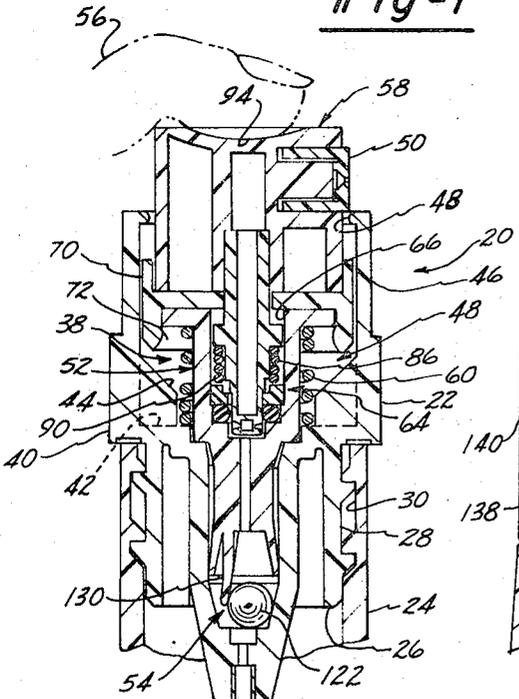




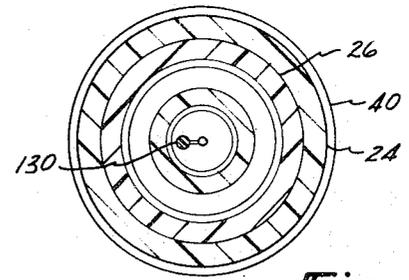
**Fig-1**



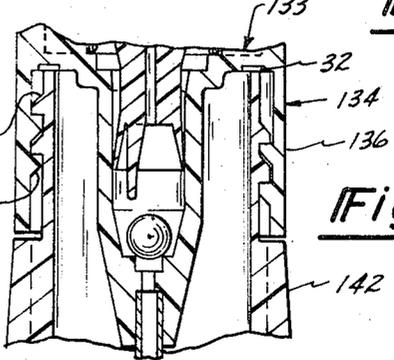
**Fig-2**



**Fig-3**



**Fig-4**



**Fig-5**

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Fig-6

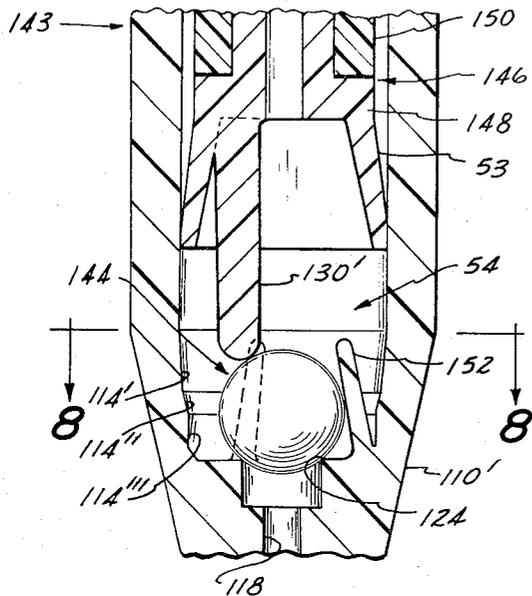


Fig-7

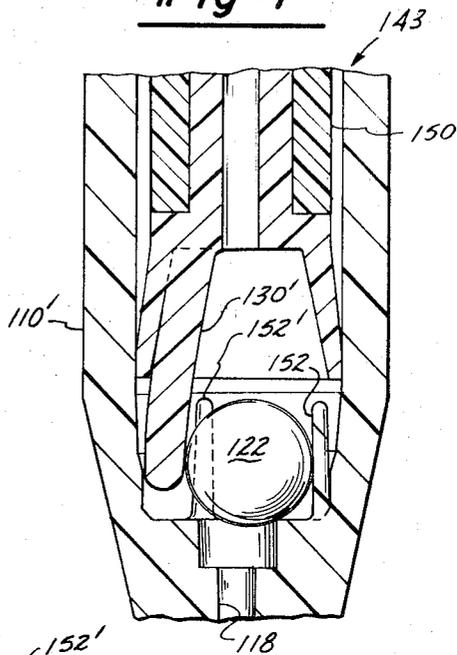


Fig-8

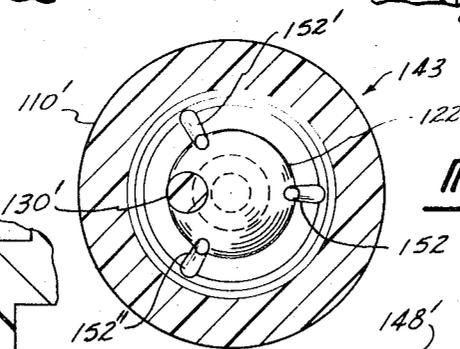


Fig-9

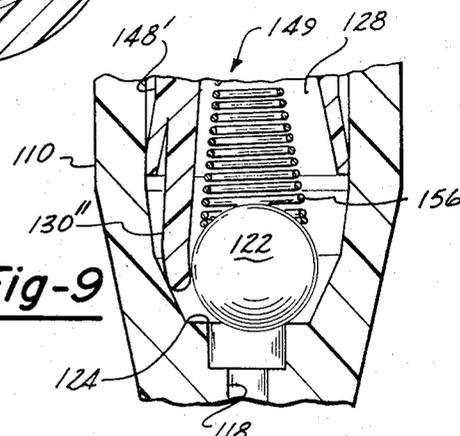
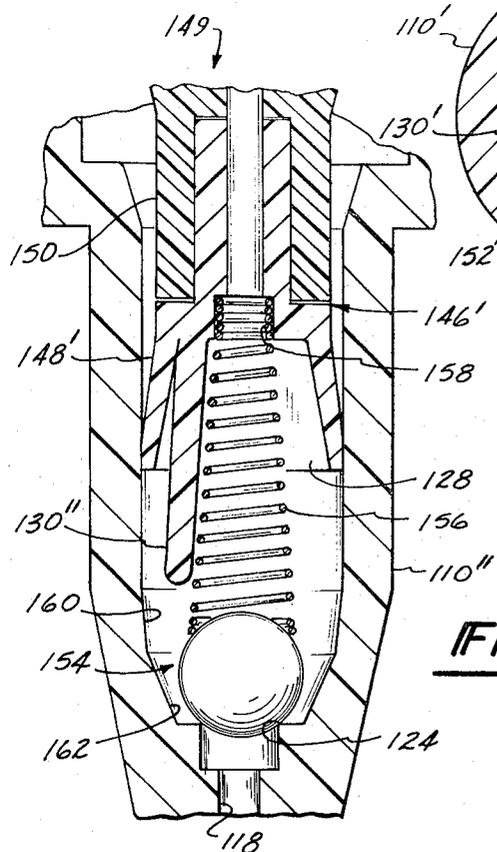


Fig-10



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## MANUALLY ACTUATED LIQUID SPRAYING DEVICE

This invention relates to spray devices and more particularly to a relatively small manually actuated pump and nozzle device of the type commonly mounted as a closure on a container of liquid, the liquid being discharged through the nozzle in the form of a spray by an operator manually depressing with one finger a button which actuates the pump of the spray device.

With many manually operated pump spray devices of the prior art, uniformity of spray is dependent upon the force applied by the operator to actuate the pump piston. Since the operator does not apply a uniform force in actuating the pump, a typical spray cycle starts with a dribble of liquid, rapidly rises to a full spray of nebulized liquid and ends in another dribble of liquid. The nonuniform force results from the reflexes of the operator and the inertia of the piston and actuator mechanism. The applied force overcomes the inertia of, and rapidly accelerates, the piston of the pump which causes the hydraulic pressure of the liquid to rapidly rise. The pressure then rapidly declines due to the normal muscular relaxation of the operator at the end of the stroke of the piston.

Objects of this invention are to provide a finger operated pump spray device which produces a spray of nebulized liquid substantially without dribbling of the discharge liquid which controls or meters the amount of liquid discharged, and in which most of the component parts are ideally suited for molding of plastic material of economical manufacture, and readily assembled.

These and other objects, features and advantages of this invention will be apparent from the following detailed description, appended claims and accompanying drawings in which:

FIG. 1 is a vertical sectional view along the longitudinal axis of one embodiment of a pump spray device of this invention shown mounted as a closure on the neck of a container for a liquid and having a protective cap thereon.

FIG. 2 is a vertical sectional view generally similar to FIG. 1 with the protective cap removed and illustrating the position of the component parts of the device when the piston of the pump is partially displaced along its dispensing stroke.

FIG. 3 is a vertical sectional view generally similar to FIG. 2 illustrating the component parts of the device when the piston of the pump is fully displaced to the end of its dispensing stroke.

FIG. 4 is a sectional view on line 4—4 of FIG. 2.

FIG. 5 is a fragmentary vertical sectional view of a second embodiment of the spray device of this invention with a modified housing connecting the device to a container with an externally threaded neck.

FIGS. 6 and 7 are fragmentary vertical sectional views of a third embodiment of the device of this invention illustrating a modification of a check valve assembly with some of the component parts of the device displaced to an extent corresponding generally with FIGS. 2 and 3 respectively.

FIG. 8 is a sectional view on line 8—8 of FIG. 6.

FIGS. 9 and 10 are fragmentary vertical sectional views of a fourth embodiment of the invention illustrating some of the component parts of the device displaced to an extent corresponding generally with FIGS. 1 and 3 respectively.

Referring in more detail to the drawings, FIGS. 1—4 illustrate a first embodiment of a manual pump spray device 20 embodying this invention with a generally cylindrical housing 22 mounted on the neck of a container 24 for a liquid to be nebulized and having a protective cap 26 frictionally received over its upper end. Housing 22 is secured to container 24 by an integral lower collar 27 with external threads 28 engaging internal threads 30 in the neck of container 24. Housing 22 is sealed to container 24 by a washer 32 of a resilient sealing material received in a circular groove 34 in a shoulder 36 of housing 22. The upper end of housing 22 has a cylindrical chamber 38 defined by an integral cylindrical side wall 40 and an end wall 42, the connection of these walls being reinforced by four upright ribs 44 spaced at 90° increments. Cap 26 is slidably received and frictionally retained on a reduced diameter shank 46 formed in the outer periphery of side wall 40. Shank 46 terminates at its free end in an inwardly directed rib 48 which encircles the open upper end of chamber 38.

A pump for supplying a liquid under pressure to a spray nozzle 50 is provided by a combined valve body and piston 52 having an outwardly flared integral cup seal 53 at its lower end which is slidably received in a pump cylinder or chamber 54, piston 52 being actuated on its dispensing stroke by a finger 56 manually depressing an actuator button 58. Piston 52 has a larger diameter hollow valve chamber portion 57 at its upper end which is received in chamber 38 of housing 22 and is yieldably urged axially upwardly by a compression coil spring 60 encircling piston 52 and interposed between a flange 62 thereof and end wall 42. The extent to which piston 52 can be displaced is limited by a recessed stop shoulder 63 in said wall 42.

A valve assembly 64 is received in a bore 66 in upper portion 57 of piston 52. Valve assembly 64 has a hollow valve stem 68 slidably received in bore 66 and retained therein by a retainer and guide ring 70. Ring 70 has a web 71 joined to a cylindrical flange 72 which has an internal rib 72' which cams over and snaps under flange 62 of piston 52 to retain ring 70 on the piston. Valve stem 68 has a liquid passageway 74 therein provided by a coaxial blind bore 76. Two ports 78 extend through the side wall of stem 68 adjacent its lower end and communicate with passageway 74. An O-ring 80 adapted for sealing engagement with ports 78 is received in a counterbore 82 in portion 57 of piston 52 and is retained therein by a stop collar 84 received in bore 66. Valve stem 68 is yieldably urged axially upwardly by a compression coil spring 86 encircling stem 68 and interposed between a flange 88 thereon and stop collar 84.

In accordance with one feature of this invention, a latch or detent restraining downward movement of stem 68 is provided. Preferably, this detent is constructed pursuant to my U. S. Pat. No. 3,396,874, issued Aug. 13, 1969. Thus, the bottommost turn of spring 86 has a terminal chordal portion 90 which is bent to extend straight for a sector angle of about 90° and into tangential contact with the side wall of valve stem 68. When valve stem 68 is axially extended as shown in FIG. 1, chordal portion 90 underlies a shoulder 92 of the valve stem to restrain downward movement thereof. The underface of shoulder 92 extends radially of valve stem 68 and its radial width is preferably slightly less than the radius of the circular wire stock of

spring 86. If desired, the outer edge of shoulder 92 may be chamfered to facilitate camming chordal portion 90 radially outward as valve stem 68 is urged downwardly. The junction of the inner edge of the chamfer with the underface of shoulder 92 should be located to strike chordal spring portion 90 slightly radially inwardly of the center high point of the chordal portion. The structure of valve assembly 64 and particularly the detent structure of spring 86 and shoulder 92 of valve stem 68 are more fully shown and described in my aforesaid U. S. Pat. No. 3,396,874 which is incorporated herein by reference, and hence this snap-action valve assembly will not be described in further detail.

Actuator button 58 protrudes upwardly from housing chamber 38, past rib 48, and has a dimple 94 in its top surface to receive the end of finger 56. Button 58 has a skirt 58' which is slidably received within the upwardly extending portion of flange 72 of ring 70. Button 58 is fixed to valve stem 68 by the upper end of stem 68 being press fit into a counterbore 96 in button 58. Spray nozzle 50 is press fit in a circular groove 98 in a side wall of button 58 and has a restricted orifice 100 which nebulizes a liquid supplied to the nozzle under pressure. Orifice 100 communicates with passage 74 in valve stem 68 through passages 102, 104 and 106 in button 58 as shown in FIG. 1.

Pump chamber 54 is formed in an integral nose projection 110 of housing 22 by a cylindrical bore 112 with a frustoconical portion 114 at its lower end. A dip tube 116 is frictionally received in the lower end of nose portion 110 and communicates at its upper end with pump chamber 54 through a passage 118.

In accordance with another feature of this invention, the pump has an end-of-stroke pressure cut-off inlet check valve provided in the lower end of pump chamber 54 to control fluid flow through passageway 118. A check ball 122 is retained by gravity on a right circular valve seat 124 and is dimensioned to have a predetermined lateral clearance with wall 114 at the lower end of pump chamber 54. A tapered, flexible kicker finger 130 is integrally joined to piston 52 and extends downwardly therefrom through the hollow interior of cup seal 53 and protrudes therefrom by a distance sufficient to engage and remove ball 122 from its seat 124 as piston 52 reaches the end of its dispensing stroke and thus is fully depressed as shown in FIG. 3. Pump chamber 54 communicates with the lower end of valve assembly 64 by a passage 132 extending generally axially through the lower portion of piston 52. Finger 130 is offset clear of passage 132 and is oriented so that the rounded nose at its lower end strikes ball 122 off center as shown in FIG. 2 to develop increasing side thrust on ball 122 as piston 52 travels downwardly from its position shown in FIG. 2 to its position shown in FIG. 3.

In operation, assuming pump chamber 54 is full of liquid and piston 52 is in its fully raised position, sprayer device 20 is actuated by applying a generally axially downwardly directed force on actuator button 58, as by holding container 54 in the palm of the hand and using the index finger 56 of the same hand as shown in FIG. 2. Initial application of this force tends to urge piston 52, via stem 68, chordal portion 90 and collar 84, axially downwardly to pressurize the liquid in pump chamber 54. However, since such pressure tends to seat check ball 122, and since ports 78 are closed by O-ring 80, the liquid trapped in chamber 54 will resist and prevent downward movement of piston 52. While

piston 52 is thus being held by this "hydraulic" locking action, the downwardly directed finger force is tending to cam chordal portion 90 of spring 86 out of engagement with shoulder 92 of valve stem 68. Once this occurs, valve stem 68 is suddenly released for axial downward displacement relative to piston 52. The amount of force required to disengage chordal portion 90 is primarily dependent upon the stiffness of the bottommost coil of spring 86 and the design of the camming surface of shoulder 90. In a typical sprayer device 20, these parameters are designed to require an application of a force of about four pounds to release valve stem 68. Typically, spring 60 urges piston 52 upwardly with a force of less than 10 ounces, and hence liquid in pump chamber 54 is substantially pressurized before valve stem 68 is released.

When valve stem 68 is released, it snaps or rapidly moves downwardly in relation to piston 52 to open ports 78 (as shown in FIG. 2) and thereby allows pressurized liquid in pump chamber 54 to flow to spray nozzle orifice 100 via piston passage 132, ports 78, passage 74, nozzle passage 102, port 104 and passage 106. Since the liquid in pump chamber 54 has already been pressurized when valve assembly snaps rapidly open above some given minimum value, the liquid initially supplied to nozzle 50 is also pressurized above some corresponding minimum value which is high enough to preclude dribbling at the beginning of the discharge of nebulized liquid from spray nozzle 50. Once ports 78 have been opened, stem 68 quickly completes its remaining travel relative to piston 52 and shoulder 92 bottoms on collar 84, whereupon the downward force exerted on stem 68 is directly applied to piston 52 to force it downwardly and initiate its downward movement on its dispensing stroke. As the pressurized liquid in pump chamber 54 is dispensed through spray nozzle 50, piston 52 moves axially downwardly through its dispensing stroke until, as it approaches the end of its compression stroke as shown in FIG. 2, kicker finger 130 engages check ball 122. Finger 130 is deflected by ball 122 until sufficient side force is built up to lift ball 122 slightly off its seat. This unseating action occurs while the liquid being supplied to nozzle 50 is still fully pressurized due to the force being applied by finger 56 to actuator button 58. Once ball 122 is opened slightly, it will then permit a much more rapid opening movement. This action suddenly relieves or substantially decreases the pressure of the liquid being supplied to spray nozzle 50 by allowing the remaining liquid in pump chamber 54 to escape through passage 118 and tube 116 into container 24 on which sprayer device 20 is mounted. This sudden decrease in pressure rapidly terminates the flow of liquid through orifice 100 and thus dribble at the end of the discharge of nebulized liquid from spray nozzle 50 is substantially eliminated.

When piston 52 bottoms on stop shoulder 63 of housing 22, the operator releases the force applied through finger 56 to button 58 which allows piston 52 and valve stem 68 to be returned upwardly to their respective original positions (as shown in FIG. 1) by the bias of their associates springs 60 and 86. Because of the smaller diameter of stem 68 and the ratio of spring 86 to spring 60, the upward movement of valve stem 68 will occur first so that ports 78 are closed prior to any substantial upward movement of piston 52. Upward movement of stem 68 relative to piston 52 also allows chordal portion 90 of spring 68 to shift due to its resil-

iciency so that it underlies shoulder 92 and thereby resets the yieldable detent or latch. Similarly, the upward movement of piston 52 disengages finger 130 from check ball 122. Hence, after chamber 54 has been re-filled with liquid from container 24 due to upward movement of piston 52 on its intake stroke, check ball 122 is free to return by gravity to seat 124 and thus re-close passage 118.

FIG. 5 illustrates a modified spray device 133 which has a housing 134 with a skirt 136 with internal threads 138 adapted for mating engagement with external threads 140 on a neck of a container 142 for a liquid. Except for skirt 136, housing 134 and the remaining parts of sprayer 133 are the same as spray device 20 and the operation of sprayer 133 is identical to sprayer 20.

FIGS. 6, 7 and 8 illustrate a third sprayer embodiment 143 with a modified inlet check valve assembly 144 and a modified piston 146. Piston 146 has the same general shape and configuration as piston 52. However, to facilitate the manufacture of piston 146, it is formed in two pieces with a lower head portion 148 and an upper body portion 150 which are telescoped and press fit together to provide a two-piece piston 146. Valve assembly 144 has the same check ball 122 and seat 124 as the valve assembly in sprayer 20. However, it is to be noted that valve assembly 144 also has (as shown in FIG. 8) three circumferentially spaced flexible fingers 152, 152' and 152'' integral with the lower neck portion 110' of housing 22 which yieldably urge check ball 122 into engagement with valve seat 124. Nose 110' is also modified in that, instead of one frustoconical wall 114, it has three surfaces; a slightly tapered frustoconical wall 114', a more severely tapered but axially shorter frustoconical wall 114'' and a cylindrical wall 114''' as shown in FIG. 6. The kicker finger 130' is also modified in that it is thicker than finger 130, its diameter exceeding the clearance space between ball 122 and wall 114'''. Thus, the rounded lower end of finger 130' strikes ball 122 during downward movement of piston 146, the finger end will slide downwardly along the spherical surface of ball 122, causing finger 130' to flex to the left as viewed in FIGS. 6 and 7 until its end slidably jams between wall 114'' and the ball. Further downward motion will cause wall 114'' to cam finger 130' back toward the right, thus positively forcing ball 122 off its seat and allowing the finger, despite its flexibility to overcome the bias of fingers 152, 152' and 152'' tending to keep ball 122 on its seat. Except for the structure noted above and hereinafter, sprayer 143 is the same as sprayer 20.

FIGS. 9 and 10 illustrate a fourth sprayer embodiment 149 with a further modified check valve assembly 154 in conjunction with a two-piece piston 146'. Valve assembly 154 has the same check ball 122 and valve seat 124 as the valve assembly in sprayer 20. Valve assembly 154 also has a compression spring 156 with one end bearing on ball 122 and yieldably urging it into engagement with seat 124 and the other end fixedly received in a pocket 158 in the head portion 148' of piston 146'. The finger 130'' of piston 146' is slightly narrower than finger 130' of piston 146 to provide clearance for spring 156. Otherwise, head portion 148' is identical to head 148 of piston 146. Nose 110'' of sprayer 149 has two frustoconical surfaces 160 and 162 which surround ball 122 with a predetermined clearance and form the lower end of pump chamber 54.

These surfaces 160 and 162 are progressively tapered, similar to surfaces 114' and 114'', to first allow the rounded lower end of finger 130'' to be cammed aside to the left by ball 122 as the finger is forced downwardly with piston 146' and then to cam the finger back toward the right as the piston reaches the end of its dispensing stroke to thereby lift ball 122 off its seat against the yieldable restraint of spring 156.

In sprayer 143 shown in FIGS. 6 and 7, check ball 122, when released by finger 130', is urged into sealing engagement with seat 124 by flexible fingers 152, 152' and 152'', thereby closing the check valve assembly. In sprayer 149 shown in FIGS. 9 and 10, check ball 122, when released by finger 130'', is urged into sealing engagement with seat 124 by the bias of spring 156, thereby closing the check valve assembly. The advantage of the modified inlet and relief check valve assemblies employed in sprayers 143 and 149 over the check valve assembly of sprayer 20 is that they will close regardless of the orientation of sprayers 143 and 149; whereas, check valve 122 only closes when spray device 20 is generally upright (i.e., tilted not more than about 12° from a vertical position).

When actuator button 58 has been fully depressed to complete a dispensing stroke of piston 52, 146 or 146', the time required for the operator to relax finger 56 to release the button keeps check valve 122 open for a sufficient length of time to allow any subatmospheric pressure created in the container 24 or 142 to become equalized and return to atmospheric pressure. The subatmospheric condition is relieved by air entering the container via spray nozzle 50, passage 106, port 104, passage 102, passage 74, ports 78, passage 132, pump chamber 54, passage 118 and dip tube 116. Typically, the pressure in container 24 becomes sufficiently subatmospheric for this venting to occur only after several pumping strokes of piston 52 and hence this venting action does not usually occur at the completion of each pumping stroke. Moreover, in some spray device and container assemblies the seal therebetween, while preventing the escape of liquid from the container, allows sufficient air to enter the container so that this venting through nozzle 50 will not occur during normal operation of the spray device.

If there is no liquid in pump chamber 54 when spray device 20 is initially actuated, a stroke or two of actuator button 58 may be required to completely prime the spray device. However, once spray device 20 has been initially primed, check valve 122 will usually prevent the spray device from losing its prime.

From the foregoing description it will now be evident that the use of the pressure build-up valve assembly 64 and the pressure relief kicker finger-check valve assure that the liquid supplied to spray nozzle 50 at both the beginning and end of the spraying cycle or period is fully pressurized and rapidly initiated and cut off. Hence, a spray device with a manually actuated pump is provided which substantially eliminates all dribble of liquid from the spray cycle so that liquid will always be dispensed in a highly nebulized very fine spray or mist regardless of variations in operator technique and manipulative ability. These valve assemblies also provide manually actuated pump spray devices in which the amount of liquid dispensed during each cycle is substantially the same, and hence the amount of liquid dispensed can be precisely metered. These features make this sprayer device ideal for dispensing medicants and

various cosmetic and mouth freshener liquids. The quantity of liquid dispensed by the spray device can be varied by changing the volumetric capacity per stroke of the pump. One way of changing this volumetric capacity is to change the stroke of piston 52, and other ways will be apparent to those skilled in the art. Such a mechanically actuated pump sprayer also eliminates the need for aerosol propellants which may be hazardous to the health and safety of people using such medicants, cosmetic and mouth freshener liquids.

Almost all of the component parts of this sprayer device are designed to be molded of a plastic material and hence are economical to manufacture. The piston member 52, 146 or 146' can be molded of a low density polyethylene plastic material to provide a suitable flexible cup seal 53 and flexible finger 130, 130' or 130'' for moving check ball 122 off its seat 124 when the piston is depressed; whereas, nose 110, 110' or 110'' can be molded from higher density, more rigid plastic materials such as DELRIN (Trademark). Even though fingers 152, 152' and 152'' are made of less pliable material, they will still have sufficient flexibility and resiliency to accommodate the unseating of ball 122 and to drive it back onto its seat. The very slight inclination of fingers 152, 152' and 152'' from the axis of nose 110' facilitates their being molded in relatively stiff plastic material since they need only flex slightly when being stripped from the mold. Also, it will be noted that piston 146 is restrained from rotation relative to nose 110' only by the frictional resistance offered by spring 60 bearing against its seats. Hence, should kicker 130' be initially oriented during assembly in angular alignment with a retaining finger 152, 152' or 152'', the kicker 130' will be cammed aside, thereby developing rotational torque on piston 146 to force it into a proper angular orientation relative to nose 110' so that kicker 130' will miss fingers 152, 152', 152'' on subsequent strokes.

The outer housing 22 or 134 also can be molded of a polypropylene or similar plastic material if desired to provide increased resiliency and flexibility in fingers 152, 152', 152'' in nose 110 for yieldably urging check ball 122 into engagement with its valve seat 124. The interfitting component parts of the sprayer device are designed so that when made of the aforementioned plastic materials, they can be either press fit or snapped into assembled relation with each other, thereby greatly facilitating and thus decreasing the cost of assembly of the component parts into a completed spray device.

It is to be understood that, except as specifically described hereinabove, the various embodiments 20, 133, 143 and 149 of spray devices constructed pursuant to the present invention may be identical in structure, function and operation. Hence, to the extent that the latter embodiments 133, 143 and 149 may be identical to sprayer 20, a detailed description of their construction would be repetitious and hence has been omitted.

From the foregoing description, it will also now be evident that a two-stage action occurs during initiation of the piston 52, 146 or 146' on its liquid pressurizing dispensing stroke. First there is the application of force via button 58, stem 68, portion 90 of spring 86 and collar 84 to the piston. If a hydraulic lock condition exists at this time (i.e., pump chamber 54 being full of liquid), very little or no motion of piston 42 will occur until sufficient finger force has been applied to cause the spring

detent 90 to release stem 68 whereupon stem 68 will move from its closed (FIG. 1) to its open (FIG. 2) position. This first stage of movement thus completes the relative motion between the valve stem and the piston and initiates the spray action via orifice 100 with a burst of finely nebulized liquid. During the second stage, finger pressure acting through the valve stem drives the piston on its dispensing stroke and maintains the valve stem in open position, the stem moving bodily as a unit with the piston through its dispensing stroke. The generation of the spray via orifice 100 thus continues during this second stage until the abrupt cut-off occurs due to unseating of the inlet check valve 122. Upon release of finger pressure after completion of the dispensing stroke of the piston due to the smaller diameter of the piston stem relative to the cup seal 53 of piston 52, spring 86 can move stem 68 back to its closed position prior to any significant retractal movement being imparted to piston 52 by its return spring 60. Hence, the communication between nozzle orifice 100 and pump chamber 54 will be cut off at the inception of the upward intake stroke of piston 52. Therefore, at the onset of upward motion of the piston, suction will be created in chamber 54 to draw liquid from the reservoir in container 24 upwardly via dip tube 116 and past the inlet check ball 122 so that chamber 54 will be refilled with liquid during the upstroke of the piston.

It is also to be understood that the end-of-stroke pressure cut-off valve of the invention may comprise a third valve supplemental to the usual intake check valve, in which case the pressure cutoff valve merely controls communication between pump chamber 54 and the head space of container 24. However, it is more economical and efficient to combine the function of the pressure cut-off valve with the inlet check valve in accordance with the principles of the present invention, and hence such dual function structure is preferred. Moreover, in lieu of a piston projection 130 and cooperative check ball 122, the end-of-stroke pressure cut-off valving may comprise a piston controlled groove arrangement somewhat similar to that disclosed in my U. S. Pat. No. 3,514,017 issued May 26, 1970. However, this would entail the provision of an axially extending groove in the side wall of the pump chamber 54, an additional sealing ring, a bypass passage or groove in the pump piston and a vent passage leading from chamber 54 to the head space of container 24. Since such modified structure is more expensive to manufacture than the simple kicker finger 130, the latter represents a presently preferred embodiment of the principles of my invention.

I claim:

1. A spray device with a manually actuated pump for nebulizing a liquid comprising a housing having a pump chamber therein, a first passageway communicating with said chamber and adapted to communicate with a container for liquid to be nebulized, a manually actuated piston slidably received in said chamber and adapted to pressurize a liquid in said chamber when manually moved in a dispensing stroke from a first position toward a second position in said chamber, a first valve received in said chamber for controlling the entry of all liquid from the container into said chamber and adapted to normally prevent the flow of a liquid from said chamber through said first passageway back to the container when the liquid in said chamber is pressurized by said piston, said first valve being yieldably

urged to its closed position by pressurized liquid in said chamber, a second passageway communicating with said chamber and with a spray orifice, and means operably associated with said piston and said first valve to open said first valve to dump pressurized liquid from said chamber into said first passageway when said piston nears completion of its dispensing stroke while said piston is being manually displaced from said first position and is still moving toward said second position and pumping liquid from said chamber through said second passageway under pressure to said spray orifice, whereby the liquid to be nebulized is discharged from said spray orifice substantially without any dribble of the discharged liquid at the end of said dispensing stroke.

2. The spray device of claim 1 wherein said first valve comprises a valve member received in said chamber and said means operably associated with said first valve and said piston comprises a projection extending from said piston and adapted to engage and displace said valve member in said chamber to open said first passageway when said piston approaches said second position.

3. The spray device of claim 2 further including a valve seat adapted to receive said valve member in sealing engagement therewith and means yieldably urging said valve member into engagement with said valve seat.

4. The spray device of claim 3 wherein said valve member comprises a check ball and said means yieldably urging said check ball into engagement with said valve seat comprises resilient finger means carried by said housing and yieldably urging said check ball into sealing engagement with said valve seat.

5. The spray device of claim 4 wherein said finger means carried by said housing are integral therewith and said finger means and said housing are made of a slightly flexible resilient plastic material.

6. The spray device of claim 5 wherein said finger means comprise a plurality of fingers spaced from one another around said valve seat, each of said fingers extending to a free end thereof positioned beyond the center of said check ball in both the seated and unseated conditions thereof, each of said fingers being inclined slightly toward said ball such that the free ends of said fingers are spaced apart by a distance less than the diameter of said ball.

7. The spray device of claim 6 wherein the axes of said valve seat and said piston are coaxial and said fingers are inclined slightly toward one another and spaced about said axes, the direction of travel of the piston being along its axis, said fingers being arranged with their free ends closest to said piston and said piston projection being offset laterally from the axis of said piston.

8. The spray device of claim 7 wherein said piston projection is offset from the axis of said piston by a distance less than the radius of said check ball, said piston projection having a rounded free end adapted to engage said check ball at a point offset from the axes of said piston and valve seat.

9. The spray device of claim 8 wherein said chamber has a wall surface spaced from said check ball and inclined in converging relation with said seat in the direction of travel of said piston on its dispensing stroke, said wall surface and said ball together defining a space for initially slidably receiving the free end of said piston

projection as the same is deflected by said check ball during movement of said piston toward said second position thereof, said wall surface converging with the surface of said check ball in the direction of travel of the piston on its dispensing stroke such that said projection is cammed by said wall toward said check ball to displace the same from said seat to thereby open said first passageway when said piston reaches said second position.

10. The spray device of claim 5 wherein said piston and projection means are integral with one another and made of plastic material having greater flexibility than said plastic material from which said finger means and said housing are made.

11. The spray device of claim 10 wherein said piston has an outwardly flaring open-ended cup seal portion at its leading end, said second passageway including a passage extending axially through said piston and communicating at one end with the hollow interior of said cup seal portion, said piston projection being integrally joined at its fixed end to the base of said cup seal portion adjacent said piston passage and protruding through the hollow interior of said cup seal beyond the leading end thereof.

12. The spray device of claim 5 wherein said piston is mounted in said housing so as to have at least limited freedom of rotation therein about the center line of the path of travel of said piston on its dispensing stroke, said projection and said finger means having rounded free ends whereby upon interengagement of free ends of said projection and any one of said finger means a force is developed tending to rotate said piston to an angular position in which said projection means clears said one finger.

13. The spray device of claim 1 wherein said first valve comprises an inlet check valve for said chamber with a check ball movable between open and closed positions in response to reversals of pressure differentials between said chamber and first passageway corresponding to forces applied to said piston tending to move it in opposite directions on its respective intake and dispensing strokes.

14. The spray device of claim 13 wherein said housing has a valve seat adapted to sealingly receive said check ball and which also comprises including a compression coil spring extending between said piston and said check ball adapted to yieldably urge said check ball into sealing engagement with said valve seat.

15. The spray device of claim 2 wherein said piston has separate head and body portions and said projection comprises a finger extending from and integral with said head portion.

16. The spray device of claim 1 wherein said piston has a passage extending generally longitudinally there-through forming part of said second passageway and the spray device also comprises a second valve having a valve stem carried by said piston and movable relative to said piston between open and closed flow controlling positions relative to said second passageway, said valve stem having a passage therein forming part of said second passageway and having an inlet port connecting said stem passage with said piston passage in the open position of said valve stem, sealing means carried by said piston and adapted to seal said inlet port when said valve stem is in said closed position, and biasing means interposed between said valve stem and said piston to yieldably urge said valve stem into said closed position,

said stem being oriented to move from said closed to said open position thereof in the direction of travel of said piston on its dispensing stroke.

17. The spray device of claim 16 further including detent means engageable with said valve stem to yieldably resist movement of said valve stem from said closed toward said open position, said detent means yielding to release said valve stem for movement to said open position upon application of a predetermined force thereto tending to move said valve stem toward said open position to thereby cause a snap acting opening motion of said valve stem to place said inlet port in communication with said second passage, said force being transmitted through said detent means to said piston to cause pressurization of liquid in said chamber before said detent means yields to release said valve stem.

18. The spray device of claim 17 wherein said means yieldably urging said valve stem into said closed position comprises a coil spring encircling said valve stem, said coil spring having a convolution thereof formed with a chordal portion adapted to slidably contact a side of said valve stem, said valve stem having a shoulder engageable with said chordal portion when said valve stem is in said closed position, said shoulder and said chordal portion having surfaces adapted to develop upon interengagement thereof a radially outwardly directed force on said chordal portion in response to a force exerted on said valve stem to thereby cam said chordal portion into disengagement with said shoulder to effect sudden release of said valve stem so that it is rapidly propelled to the open position thereof.

19. The spray device of claim 1 which also comprises a second valve associated with said second passageway and adapted to close all communication of said spray orifice with said chamber when said piston is in said first position and to automatically open communication of said spray orifice with said chamber when a predetermined minimum force is applied to said piston to urge it toward said second position and pressurize liquid in said chamber, whereby the liquid to be nebulized is discharged from said spray orifice substantially without any dribble of the discharged liquid at the beginning of said dispensing stroke.

20. A spray device with a manually actuated pump for nebulizing a liquid comprising a housing having a chamber therein, a first passageway in said housing in communication with said chamber and adapted to communicate with a container for liquid to be nebulized, a piston carried by said housing and having a head slidably received in said chamber and adapted for manual displacement from a first to a second position along a dispensing stroke in said chamber to pressurize and pump liquid therefrom, a second passageway communicating with a spray orifice and said chamber, said second passageway including a passage in said piston, an outlet valve carried by said piston for controlling the flow of liquid in said second passageway to said spray orifice and movable relative to said piston between open and closed flow controlling positions, release means associated with said outlet valve to automatically release said outlet valve to move from said closed position to said open position when a predetermined minimum force is manually applied to said piston to urge it toward said second position, an inlet check valve in said chamber movable to open and closed positions for controlling the flow through said first passage-

way and being normally closed when a liquid in said chamber is pressurized by said piston, and actuator means in said chamber operably associated with said piston and said inlet check valve to open said inlet check valve when said piston is displaced from said first position and is still moving toward said second position while a liquid in said chamber is being pressurized by said piston, whereby when a manual force is applied to said piston when in said first position liquid in said chamber is first pressurized and then said release means releases said outlet valve allowing opening of said outlet valve to supply a liquid under pressure from said chamber to said spray orifice whereupon said piston is displaced along its dispensing stroke toward said second position and while being displaced along said dispensing stroke said actuator means opens said inlet check valve to allow pressurized liquid in said chamber to escape through said first passageway, thereby substantially eliminating all dribble at initiation and termination of the nebulized liquid discharge through said spray nozzle.

21. The spray device of claim 20 wherein said housing has a valve seat in an end wall of said chamber and said inlet valve comprises a valve member adapted to be sealably received on said valve seat, and wherein said actuator means comprises a finger extending from said piston and adapted to engage and move said valve member to said open position of said inlet check valve when said piston reaches said second position thereof.

22. The spray device of claim 21 further including means yieldably urging said valve member into sealing engagement with said valve seat.

23. The spray device of claim 21 wherein said check valve yieldable urging means comprises cage means carried by said housing yieldably urging said valve member into engagement with said valve seat.

24. The spray device of claim 21 in which said valve means also comprises a spring extending between said piston and said valve member yieldably urging said valve member into engagement with said valve seat.

25. The spray device of claim 21 in which said housing comprises a slightly flexible and resilient plastic material and said valve means comprises a plurality of projections homogeneously integral with said housing, said projections yieldably urging said valve member into engagement with said valve seat.

26. A spray device with a manually actuated pump for nebulizing a liquid comprising a housing having a pump chamber therein, a first passageway communicating with said chamber and adapted to be connected to a source of liquid to be nebulized, a manually actuated piston slidably received in said chamber and adapted to pressurize a liquid in said chamber when manually moved in a dispensing stroke from a first position to a second position in said chamber, a second passageway communicating with said chamber and with a spray orifice, and a valve associated with said second passageway and adapted to close said second passageway to communication with said orifice when said piston is in said first position and to automatically open said second passageway when said piston has pressurized a liquid in said chamber, said piston having a passage extending generally longitudinally therethrough forming part of said second passageway, said valve having a valve stem carried by said piston and movable relative to said piston between open and closed flow controlling positions relative to said second passageway,

said valve stem having a passage therein forming part of said second passageway and having an inlet port connecting said stem passage with said piston passage in the open position of said valve stem, sealing means carried by said piston and adapted to seal said inlet port when said valve stem is in said closed position, and biasing means interposed between said valve stem and said piston to yieldably urge said valve stem into said closed position, said stem being oriented to move from said closed to said open position thereof in the direction of travel of said piston on its dispensing stroke, whereby substantially all dribble at the beginning of the nebulized liquid discharge is eliminated.

27. The spray device of claim 26 further including detent means engageable with said valve stem to yieldably resist movement of said valve stem from said closed toward said open position, said detent means yielding to release said valve stem for movement to said open position upon application for a predetermined force thereto tending to move said valve stem toward said open position to thereby cause a snap acting opening motion of said valve stem to place said inlet port in

communication with said second passage, said force being transmitted through said detent means to said piston to cause pressurization of liquid in said chamber before said detent means yields to release said valve stem.

28. The spray device of claim 27 wherein said means yieldably urging said valve stem into said closed position comprises a coil spring encircling said valve stem, said coil spring having a convolution thereof formed with a chordal portion adapted to slidably contact a side of said valve stem, said valve stem having a shoulder engageable with said chordal portion when said valve stem is in said closed position, said shoulder and said chordal portion having surfaces adapted to develop upon interengagement thereof a radially outwardly directed force on said chordal portion in response to a force exerted on said valve stem to thereby cam said chordal portion into disengagement with said shoulder to effect sudden release of said valve stem so that it is rapidly propelled to the open position thereof.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,779,464 Dated December 18, 1973

Inventor(s) Carl E. Malone

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

Column 2, line 58 - "1969" should be --1968--

Column 5, line 7 - "to" (first occurrence) should be --is--

Column 7, line 66 - "42" should be --52--

Column 10, line 45 - cancel "including"

Column 13, line 19 - "for" should be --of--

Signed and sealed this 11th day of June 1974.

(SEAL)  
Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

C. MARSHALL DANN  
Commissioner of Patents