Jan. 9, 1968 O. H. DUDA 3,362,343

LIQUID DISPENSER

Filed March 1, 1966

FIG. 1

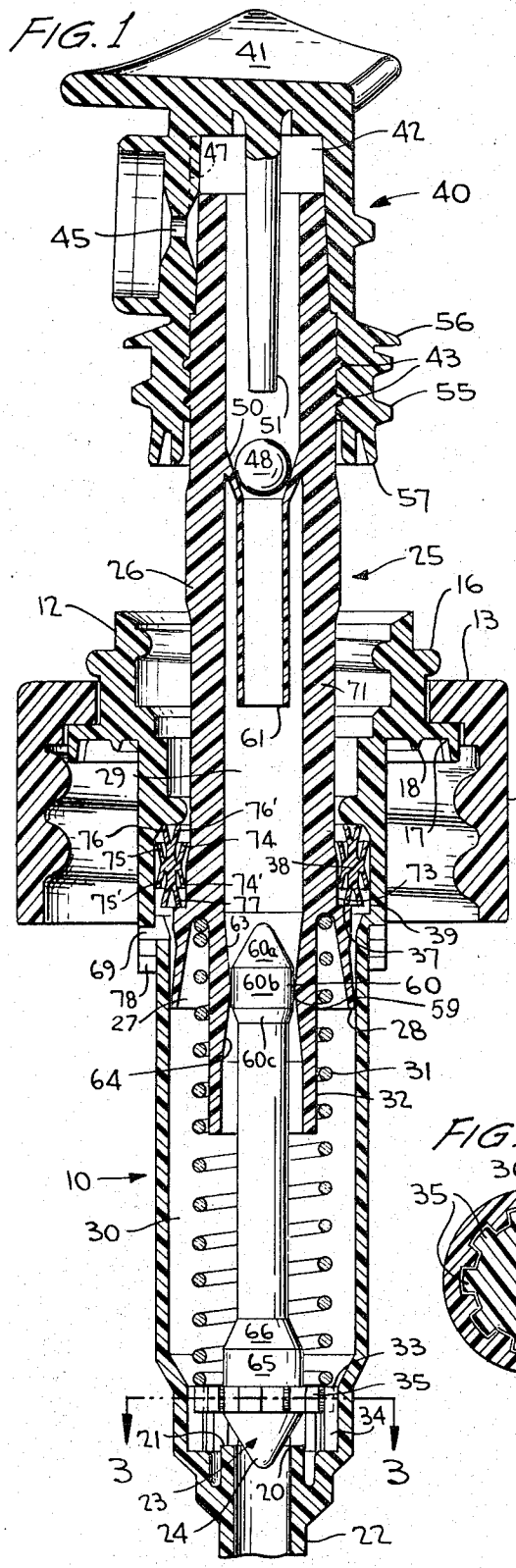


FIG. 2

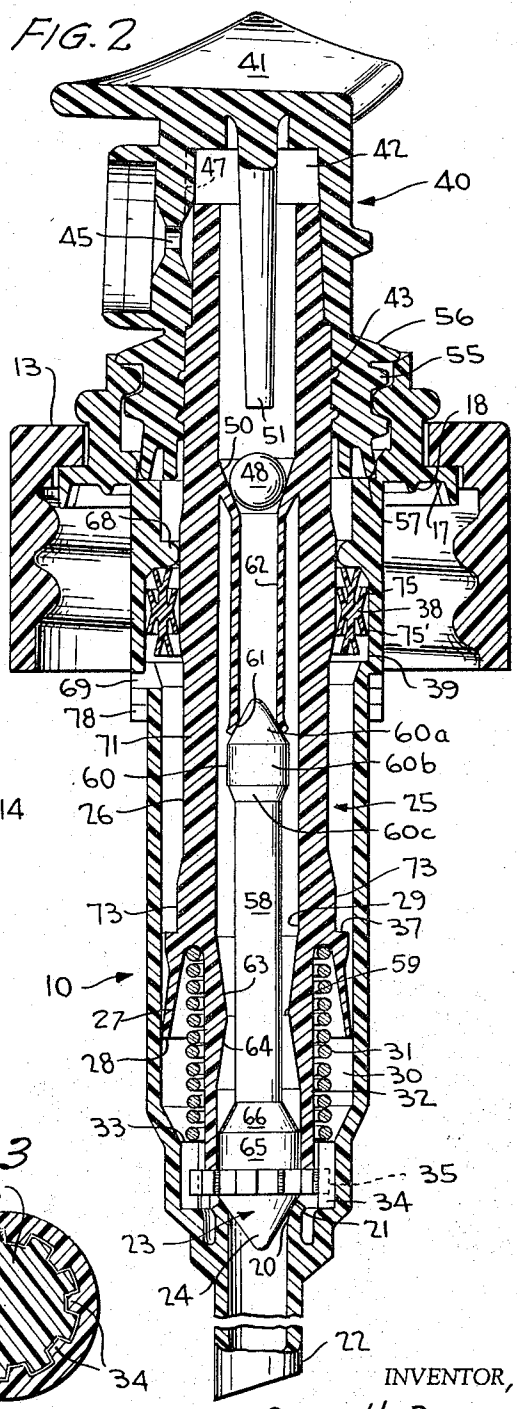
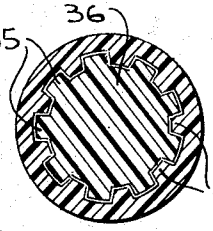


FIG. 3



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3,362,343

LIQUID DISPENSER

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This invention relates to improvements in liquid dispensing pumps of the type generally disclosed in the Corsette Patent No. 3,228,347, of common ownership herewith.

The aforesaid application disclosed dispensing pumps adapted for application to portable containers in which various liquid products are sold and in which the pumps are particularly adapted for application to the filled containers at the factory to be subsequently shipped with the filled containers to suitable sources of distribution.

It is particularly important, therefore, that such dispensers be equipped with suitable shipping seals adapted for preventing leakage of the liquid, either through the pump discharge passages or between the pump cylinder and plunger, incident to rough handling or inversion of the containers. It is also desirable that such shipping seals be effective in either the fully-projected or the fully-depressed position of the plunger so that the same basic pump structure may be shipped with the plunger in either position, except that where the pump and its associated container are to be shipped with the plunger in its fully-projected position, the usual means for locking it in a fully-depressed position may be omitted.

It is an object of the invention to render a reciprocating pump type dispenser capable of achieving the foregoing ends and also to adapt it for economical production and assembly. Also, it is an important object of the present invention to provide an improved pump structure capable of attaining the foregoing ends by means of a relatively-reduced number of parts, and also capable of other important advantages.

In accordance with the present invention, there is provided a frictional coupling or telescoping clutch connection between the plunger and the inlet valve stem. This connection is rendered operative only near the extremity of the plunger retraction movement (on its suction stroke) to transmit a seating force to the inlet valve upon inception of the next-ensuing compression stroke of the plunger. Such frictional coupling is established by frictional reception of an enlargement of the valve stem in a constricted portion of the plunger discharge passage.

It is a further important feature of the invention to make dual utilization of the said clutch structure, both for clutching purposes and also as a sealing valve which is automatically closed and open incident to the engagement and disengagement of the clutch, thus to automatically establish a shipping seal in the fully-projected plunger position.

Further, there is provided an additional frictional connection or coupling between the plunger and inlet valve, established only as the plunger nears its fully-depressed position. This coupling, which is established incident to the complete depressing of the plunger, operates to exert an unseating force on the pump inlet valve on the inception of the next suction stroke of the plunger and is automatically discontinued after but a brief projection movement of the plunger in order to avoid interference with the continued plunger movement.

It is a further feature of the invention that this additional frictional connection also may serve the function of a sealing valve or plug operative in the fully depressed position of the plunger.

Thus, where both of the dual-acting frictional couplings and sealing valves are employed, the inlet valve is both seated and unseated by movement of the plunger from either extremity of its movement; and, in addition, the plunger discharge passage is effectively sealed when the plunger is at either extremity of its movement.

Moreover, there is contemplated an advantageous disposition of the sealing valve for relative movement between axially-spaced ports in the discharge passage of the plunger, incident to reciprocation of the latter, and for alternate seating relative to these ports at opposite extremities of the plunger movement, to thus provide effective shipping seals at either extremity of the plunger movement.

In accordance with certain specific but advantageous features of the invention, the sealing valve is so associated with one of its said sealing ports as to be capable of being forced therethrough to an operative position between the alternate ports, thus facilitating assembly of these parts. Also, provision is made for simultaneously seating of the inlet valve and the sealing valve by direct engagement between the sealing valve and a plunger seat or port in the fully-depressed position of the plunger and for maintenance of a constant resilient seating pressure of both of these valves with their associated ports by forming either or both of the valve seats around said ports of elastically expansible material, to be expanded by seating therein of conical portions of the sealing and/or inlet valves.

The invention also provides an improved external seal (that is, a seal externally of the plunger between the plunger and cylinder) in which the seal is rendered operative only at the extremity of the plunger movement and is rendered inoperative throughout the major portion of the plunger stroke in either direction, both to avoid impeding the plunger stroke and also to establish communication of the container interior with the exterior atmosphere so as to permit the entry of air to take the place of liquid removed by the pump.

To this end, the invention employs a novel arrangement of sealing ring or gasket which encircles the plunger rod and is interposed between the plunger rod and cylinder. The plunger rod is formed to cooperate with the said sealing ring in the manner of a slide valve and, for this purpose, is formed with suitably-positioned enlargements adapted to enter the sealing ring, preferably at both extremities of the plunger movement, so as to compress the ring radially between the opposed wall portions of the cylinder and plunger. Between such enlargements, the plunger rod is formed to permit a sufficient flow or seepage of air for venting purposes.

A preferred embodiment of the invention, incorporating the various features and advantages above enumerated, is illustrated by way of exemplification in the accompanying drawings in which:

FIGURE 1 is a sectional view in an axial plane through a reciprocating pump structure in accordance with the invention wherein said structure is supported in a heretofore-known manner in a container closure. In this figure, the plunger of the pump is in its fully-projected position;

FIGURE 2 is a view similar to FIGURE 1, but with the plunger secured in its fully-depressed position; and

FIGURE 3 is a section on the line 3—3 of FIGURE 1 showing certain details of the inlet valve construction.

The accompanying drawings and the ensuing detailed description are by way of exemplification only for the purpose of disclosing what is presently contemplated as the best mode of practicing the invention. It will accordingly be understood that the description and accompanying drawings both will involve details which may be omitted or changed, as those skilled in the art will under-

stand, without departing from the spirit of the invention.

Referring now in detail to the structure shown in the accompanying drawing, same illustrates a reciprocating pump in which the several elements or components, broadly speaking, cooperate in conventional manner to achieve the pumping action, and, in addition, incorporate certain new structural features, advantages and modes of cooperation as later described.

Considering first the general organization of elements, the pump structure is adapted to be supported in the outlet of a liquid container to dispense the contents thereof. Accordingly, the pump cylinder **10**, which is here exemplified as the stationary portion of the pump, is provided with a conventional flanged collar **12** at its upper end. This collar **12** extends through and supports the pump cylinder within an opening defined by the top wall **13** of a container closure, here illustrated as provided with a depending internally-threaded skirt **14** for application in usual manner to the externally-threaded neck or spout of a bottle or other usual container, not here illustrated. The upper and lower flanges **16** and **17** respectively of the collar **12** project above and below the closure top wall **13** to secure the collar in place within the central opening of the closure wall **13**, the upper flange **16** being formed, preferably by a swaging action in known manner, after the collar has been inserted through the opening to bring the pre-formed flange **17** into abutment with the lower surface of the top wall. It will be apparent that the threading of the closure **13** onto the container will clamp to the lower flange **17** against the upper end of the container neck or spout. The annular sealing rib **18** of the lower flange exemplifies any conventional means for providing fluid-tight engagement of the flange **17** with the bottle neck.

It will thus be seen that the major portion of the pump cylinder **10**, as well as of the pump in its entirety, will normally be housed within the container with its lower end communicating with the container contents through an axially-directed inlet port **20** which, in the preferred embodiment, is defined by the elastically-stretchable or deformable upper end extension **21** of the dip tube **22** through which the inlet port **20** is placed in communication with the lower end portion of the container so as to be capable of withdrawing substantially the entire liquid contents therefrom. An inlet valve **23** permits the flow of liquid upwardly through the inlet port **20** and prevents its downward flow from the pump chamber **30**.

The reciprocable portion **25** of the pump here shown is exemplified by the tubular plunger, generally designated **25**, and including a hollow plunger rod **26** which is received with substantial clearance in the cylinder **10**, together with the anular piston **27** of relatively-greater diameter having an outwardly and downwardly-flaring skirt **28** in operative wiping engagement with the inner wall surface of the cylinder to define a variable volume pump chamber **30** in the lower end portion of the cylinder between the piston **27** and the inlet port **20** in the lower end wall of the cylinder. The passage **29** through the plunger opens upwardly thereinto from the pump chamber **30** into communication with other passages leading to the outlet or discharge orifice of the plunger, as hereinafter described.

The plunger **25** is resiliently projected upwardly on its suction stroke by the coil spring **31** which encircles the lower end extension **32** of its plunger rod **26** and is compressed between the piston **27** and a spring seat **33** jointly defined by the axially upwardly-presented ends of a series of annularly-arranged and relatively circumferentially spaced splines **34** formed integrally with and projecting radially inwardly from the inner wall of the cylidner concentrically to the inlet valve port **20**. Disposed for axial sliding movement between the respective splines **34** are the splines or keys **35** of a peripherally-splined disc **36** projecting radially outwardly beyond the base of the conical valve body **24** and preferably affixed thereto as an integral portion of the valve. The splines **35** thus extend

radially outwardly beneath the lower convolution of the plunger spring **31**, which thus serves as a stop for limiting the unseating movement of the inlet valve **24**.

Upward movement of the plunger on its suction stroke, under the expansive force of the spring **31**, is limited by engagement of the upwardly-directed annular shoulder or abutment **37** of the plunger with a suitable stop element such as the sealing ring **38**. The sealing ring **38** is secured against axial upward displacement in the cylinder by reception within the inwardly-opening groove or annular seat **39** internally of the cylinder.

The plunger rod **26** extends upwardly for axial movement through the sealing ring **38** and the open upper end of the cylinder **10** for actuation in conventional manner by intermittently-applied finger pressure against its upper end. The plunger **25** includes at its upper end a generally-conventional plunger discharge head **40**, which may be constructed in a manner heretofore known and formed to provide an upwardly presented button or fingerpiece **41** adapted to receive the actuating finger pressure. In the form here shown, the plunger discharge head **40** is fabricated separately from the rest of the plunger, as an integral plastic molding having a blind socket **42** to be fitted over the upper end of the plunger rod **26** in snug fluid-tight relation therewith and secured in place thereon, as for instance by means of cooperating snap rings and grooves **43**.

The plunger head here shown is in the form of a spray head and to this end is formed with a restricted spray discharge orifice **45** communicating with a swirl chamber **46** which, in turn, is supplied with fluid through a groove **47** from the inner end portion of the socket **42**. This groove or passage **47**, in turn, communicates with the axial passage **29** through the plunger. The said intercommunicating passages jointly define the plunger discharge passage leading from the pump chamber upwardly to and through the discharge orifice **45**.

It will be readily apparent that the inlet valve **23**, in addition to its modes of operation as hereinafter described, also is adapted to function in the manner of a conventional check valve, to open in response to suction created by the up-stroke of the plunger whereby to admit liquid through the inlet port **20** into the pump chamber **30** and to be seated by pressure created within the pump chamber on the compression stroke of the plunger.

While the function of an upper check valve may be served by the restricted orifice **45** of the spray head in a manner well known in the art, it will generally be desirable to achieve somewhat greater efficiency through provision of such a check valve **48**, in cooperation with the valve seat **50** within the plunger. The stop finger **51**, depending from the plunger head into the upper end of the axial plunger passage **29**, limits the unseating movement of the valve **48**.

In order that the hereinafter-described interior and exterior shipping seals may be securely maintained when the pump and its associated liquid container are conditioned for shipping with the plunger in its fully-depressed condition, there may be provided any suitable means for thus releasably holding the plunger fully depressed.

The means herein illustrated for purposes of exemplification are conventional, and comprise an externally-threaded plug **55** at the base of the plunger head **40** for cooperating reception in the internally-threaded collar **12** of the cylinder **10**.

The plug **55** is also illustrated as being provided with radially and axially-projecting annular seals **56** and **57** respectively for engagement with cooperating sealing surfaces of the collar, all in a manner now well known. However, since such seals and their function are merely cumulative to the function of the exterior sealing means more fully hereinafter described, it will be appreciated that the seals **56** and **57** are merely optional.

Referring now in more detail to the particular valve actuating and sealing features constituting the subject

matter of the instant invention, it will be noted that the inlet valve **23** is provided with an axially upwardly-directed and substantially-rigid valve stem **58** which projects axially into the discharge passage **29** of the plunger, and is freely movable in such passage through a sealing valve port **59**, through which it passes with sufficient clearance as to permit substantially unimpeded fluid flow. Carried at the free end of the valve stem **58** is a sealing valve **60** which is positioned for alternate seating at opposite extremities of the plunger movement with the sealing port **59** and with the further sealing port **61**. Port **61** is spaced axially along the passage from the port **59** at such a distance as to cause said ports to cooperate with the valve **60** at opposite extremities of the plunger movement, it being apparent that the latter is movable within predetermined limits governed by the engagement of the plunger with the inlet valve on the one hand and by the abutting engagement between the annular plunger stop surface **37** and sealing ring **38** on the other hand.

In order to adapt it for alternate cooperation with the specific types of valve ports designated at **59** and **61** respectively, the valve **60** is provided with a conical upper end portion **60***a* converging toward the port **61** and adapted for sealing reception therein. The port **61** in the present instance is defined by the lower end of a sleeve **62** depending from and constituting an integral portion of the valve seat **50**, and of an elastically-expansible material such that the valve seat defined by the lower end of the sleeve **62** at port **61** is circumferentially expanded by sealing reception of the conical valve portion **60***a*. The seating pressure between these parts is transmitted through the valve stem to the inlet valve **23**, and the oppositely-directed and elastically-expanded valve seats operate in similar manner in conjunction with their conical valve portions **60***a* and **24** respectively to maintain a constant resilient seating engagement with these portions as long as the plunger is locked in its fully-depressed position.

For cooperation with the valve port **59** (which may be seen to constitute a constriction defined by the mutually-converging conical passage portions **63** and **64** within the plunger passage **29**), the sealing valve **60** is provided with a substantially-cylindrical portion **60***b* proportioned for snug frictional sealing reception in the port or constriction **59**. A tapered pilot portion **60***c* of the sealing valve **60** extends from the cylindrical portion **60***b* toward the constriction **59** to guide the enlarged portion **60***b* into the constriction of port **59**.

It will be apparent that the sealing valve **60** will seat in the port **59** when the plunger is fully projected to the upper or outer limit of its stroke by action of the plunger spring **31**, the upward movement of the valve **60** having been previously arrested by cooperation of the spring **31** and splined disc **34**. Moreover, by virtue of the relationship of the sealing valve **60** and the constricted port **59**, it will be apparent that the valve **60** may be readily assembled in operative position for movement between the two ports or seats **59** and **61** simply by inserting it into the lower or inner end of the plunger passage and forcing it through the constriction **59**.

In addition to its valving function, the valve **60** cooperates with the constricted port or seat **59** to establish a frictional coupling between the plunger and the inlet valve at the end of each suction stroke of the plunger, so that, at the inception of a downward or compression stroke of the plunger, its movement is frictionally transmitted to the inlet valve **23** to seat same. The frictional coupling will be disengaged by continued downward movement of the plunger.

A further frictional coupling between the plunger **25** and valve **23** for unseating of the conical valve portion **24**, at the inception of the upward or suction stroke of the plunger from its fully-depressed position as shown in FIGURE 2, is provided by means of a cylindrical plug **65** carried by and preferably formed integrally with the valve **23**. This plug **65** is proportioned for snug frictional reception in the lower end of the plunger passage **29** below the piston **27**. This plug **65** also is preferably provided with a conical guide portion **66** to facilitate its entry into the passage incident to the downward movement of the plunger. Thereafter, when the plunger is released to commence its up-stroke, the frictional coupling thus established between it and the inlet valve **23** exerts an unseating force on the latter until such coupling is disengaged by abutment of the splined disc **36** with the plunger spring.

The thrusting engagement of the valve seat **61** at the lower end of sleeve **62** with the sealing valve **60** exerts a positive seating force which is transmitted to the inlet valve **24** through its stem **58**. However, it may be desirable in some instances to duplicate this seating thrust by extending the lower end of the plunger rod **26** to cause it to press axially against the upper face of the inlet valve disc **36** in the fully-depressed position of the plunger. In addition, it will be apparent that the relatively-thicker and heavier plunger extension **32** cooperates with the relatively lighter and resiliently or elastically expandable lower end of the sleeve **62** to gauge and limit the expansion of the latter by affording a positive limit for relative downward movement of the plunger onto the seated inlet valve **24**.

It will be apparent that the several parts of the pump other than the plunger spring itself may readily be formed by conventional plastic molding processes from various plastic materials, as for instance polyethylene, having sufficient qualities of flexibility and elasticity to function as above described. The construction and arrangement of the interior seals having thus been fully described, reference will now be made in greater detail to the preferred construction and operation of the exterior seals.

Such exterior seals comprises the combined sealing ring and plunger stop **38** which, as earlier mentioned, encircles the plunger **25** and is positioned in the cylinder **10** within a groove **39** by which it is secured against substantial axial displacement when engaged by the reciprocating plunger.

The upper end wall of the groove **39** preferably is of substantial radial extent to afford a positive limit for preventing upward displacement of the ring **38**, and, therefore, in the preferred embodiment, is formed by an integral inwardly projecting radial rib **68** within the pump cylinder adapted for reception of the plunger with a slight clearance.

In order to adapt the ring **38** for positioning within the groove **39**, the ring **38** may be formed of a material such as natural rubber, polyethylene, or the like, capable of being sufficiently deformed to permit its insertion downwardly through the rib **68** and adapted thereafter to expand outwardly into resilient sealing engagement with the bottom of the groove **39**.

The pump barrel is provided with a usual vent or opening **69** above the piston **28** and preferably just below the ring **38** to permit the escape back into the container of any liquid which might have become trapped in the cylinder above the piston **27** and such as might, in the absence of a vent, interfere with the movement of the plunger as well as cause upward leakage of liquid past the sealing ring **38**. For venting the interior of the container to the atmosphere so that it may normally be substantially at atmospheric pressure during the pumping operation, the portion **71** of the plunger which moves through the sealing ring **38** throughout the major part of the plunger stroke in either direction, is of sufficiently-reduced diameter relative to the ring as to have a slight clearance therewith, as is apparent in FIGURE 1. Accordingly, when the plunger is in various intermediate positions between the extremities of its stroke, communication is established between the vent **69** and the atmosphere between the inner periphery of the sealing ring **38** and the plunger rod, through the open upper end of the cylinder.

At opposite axial ends of the reduced plunger portion **71**, the plunger is formed with cylindrical enlargements **72** and **73** respectively positioned for sealing reception in the ring **38** at opposite extremities of the plunger movement.

The ring **38** is adapted for limiting and sealing engagement with the plunger in the upwardly-projected position of the latter, in the manner exemplified in FIGURE 1, in which the sealing ring is shown to be axially compressed between the annular stop rim or ledge **37** of the plunger and the stop rib **68** within the cylinder. While the stop ring **38** may assume various forms, it has been found that one suitable cross sectional shape of the ring is as illustrated, in which the same is provided with radially-inner and outer pairs of relatively upwardly and downwardly diverging conical skirts **74**, **74'**, **75**, **75'** respectively, connected to each other and to the main body of the ring **38** along a radial plane midway of the axis of the ring. These radially-opposed pairs of skirts are arranged so that the radially outer peripheries of the skirts **75**, **75'** will normally be deflected somewhat radially inwardly by and seal against the bottom of the groove **39**, while the inner peripheries of the respective skirts **74**, **74'** are proportioned for sealing engagement with the respective plunger enlargements **72** and **73** and for clearance with the reduced intervening plunger portion **71**. The ring also comprises oppositely axially-diverging pairs of conical skirts **76**, **76'** and **77**, **77'** of which the radially outer and radially inner such skirts **76** and **77** respectively are adapted for sealing engagement with the rib **68** and with the annular sealing ledge or shoulder **37** of the plunger. Thus, in the fully spring-projected position of the plunger, the sealing ring **38**, in addition to its function as a stop for determining such position, has both of its sealing skirts **75**, **75'** and also its skirt **74'** in resilient radial sealing engagement with the cylinder and plunger respectively, while its upper and lower skirts **76** and **77** are in axial sealing engagement with the stop rim **68** and stop ledge **77** respectively. Rather than form the ring with separate sets of skirts for separate radial and axial sealing engagement with the plunger, the sealing ring may be formed to omit the skirts **76**, **76'**, **77**, **77'**, and to utilize the remaining skirts **74**, **74'** and **75**, **75'** for both purposes. Obviously the sealing ring is capable of other cross sectional forms as will be obvious to those skilled in the art.

The invention in its preferred form is capable of assembly from a small number of parts which, except as to the plunger spring and ball check valve, are adapted to be molded in conventional manner of usual plastic materials.

The cylinder **10** may be formed of a comparatively rigid plastic material and assembled to the container cap in conventional manner by pressing or swaging the rib **16** therein after insertion of the collar portion through the opening within the container closure. The castellated shoulder **78** which is formed externally around the cylinder in accordance with conventional practice affords means for supporting the cylinder within the conventional tool both to withstand both axial thrust imposed thereon incident to the swaging of rib **16** and the torsional force incident to holding the cylinder **10** against rotation where, after assembly of the several parts, the pump plunger is locked in its fully-depressed position by simultaneously depressing and rotating same with its externally-threaded plug **55** engaged in the threaded collar **16**.

Although various modes and orders of assembly of the pump components will be apparent, it may be noted by way of illustration that inlet valve **23** is capable of assembly within the cylinder merely by dropping it downwardly into the cylinder through the open upper end thereof, following which the spring **31** may similarly be dropped into position around the stem of the valve **23**. After insertion of the stop ring **38** into position, same may be resiliently expanded to permit insertion of the plunger. The flexible piston skirt will at the same time be radially compressed to pass through the ring. Even though the splines or keys **35** may not initially have registered with the spaces between the splines **34** of the spring seat, the said splines will nevertheless be brought into registry with each other by rotation of the plunger, which will be transmitted through the frictional connections established between the plunger and inlet valve at either extremity of the plunger movement.

Formation of the internal stop rib **68** within the cylinder is preferably deferred until after insertion of the plunger. The plunger components, namely the ball check valve **48** and plunger discharge head **40**, may be assembled after the assembly of the plunger and cylinder, and the swaging of the stop rib **68**.

OPERATION

Plunger fully depressed and locked

When the dispenser of the invention is delivered to the ultimate consumer, it will in most instances be applied to the container of liquid to be dispensed thereby with the plunger either in its fully-depressed position, as in FIGURE 2, or in its fully-projected position, as in FIGURE 1. In either event, suitable shipping seals will have been established and maintained for preventing loss or leakage of the liquid both through the pump discharge passage of the plunger and between the plunger and cylinder walls.

Assuming that the dispenser is delivered with the plunger locked in its fully-depressed position, as in FIGURE 2, the discharge of liquid through the internal pump passages will have been barred by successive internal seals. To this end, it will be seen that the inlet valve cone **24** is thrust against its valve seat **21** around the inlet port **20** by the lower end of the plunger **25**. Plunger passage **29**, in turn, is sealed by frictional reception of the sealing plug portion **65** of the valve, while the sealing valve **60** carried at the upper end of the plunger stem is similarly in axially-thrusting sealing relation with the outlet valve port defined by the depending sleeve **62**. The seats around the ports **61** and **20** respectively are elastically expanded by the cooperating conical valve portions **60***a* and **24** so that the elastic contracting tendency of these ports, acting on the conical surfaces **60***a* and **24** maintains a constant resilient thrusting and seating force on both valve portions **60***a* and **24** against their respective ports.

Thus, liquid normally is unable even to enter the pump chamber **30** through the inlet port **20** prior to the initial use of the pump. However, where, after its initial use, the pump plunger is again locked in its fully-depressed position, any liquid then contained within the chamber **30** is barred from entry into the lower end of the plunger by means of the sealing plug **65**. Also, upward movement of liquid through the plunger is barred by the seated relation of the valve portion **60***a* in port **61**.

In addition to the internal seals thus established in the fully-depressed position of the plunger, the enlargement or upper valve portion **72** of the plunger is at this time received within the stop ring **38** to resiliently compress the said stop ring radially between the opposed faces of the enlargement **72** and the bottom of groove **39**. Thus, any liquid which may have entered the cylinder through the vent **69** or have leaked upwardly past the plunger skirt or piston **28**, will be confined against escape past the sealing ring **38** which thus coacts with the plunger and pump cylinder to define an effective external seal.

Pumping action

When the plunger and plunger head are rotated to release the threads **55** from the internally-threaded collar **12** of the plunger cylinder, the plunger spring **31** immediately expands to project the plunger upwardly and outwardly on its suction stroke. At the inception of the suction stroke, the frictional coupling provided by the interengaged plug portion **65** of the inlet valve and the plunger exerts a positive unseating force on the inlet valve to free

the latter in the event it should have become stuck in place. This function is augmented by the resiliently-contracting tendency of the expanded valve seat **21**. Similarly, the somewhat expanded valve seat of the port **61** and the sealing valve **60***a* cooperate in a manner to free themselves. As the inlet valve reaches the limit of its unseating movement, as determined by axial abutment of its disc-like portion **30** with the lower coil of spring **31**, continued upward movement of the plunger disengages it from the plug **65** while simultaneously unseating the valve portion **60***a* from port **61**. Thereafter, continued upward movement of the plunger, with the inlet valve **23** unseated, causes liquid to be drawn upwardly through the dip tube **22** from the container and through the inlet port **20** into the pump chamber **30**.

Moreover, in this upward or suction stroke of the plunger, the reduced diameter plunger portion **71** moves freely and with clearance through the sealing ring **38**, during which time air from the atmosphere is free to seep downwardly between the ring and the open end of the pump cylinder and thence into the container through the vent **69** to replace liquid withdrawn by the pumping action.

Throughout the upward or suction stroke of the plunger, the upper pump valve **48** will normally be seated to produce a relatively-reduced pressure or suction within the pump chamber **30**; or if the ball valve **48** is omitted, the discharge orifice **45** may be proportioned to produce a similar though less efficient function.

The upward unseating movement of the inlet valve **23** will have been arrested by the plunger spring, during the early portion of the suction stroke.

As the plunger nears the upper end or limit of its suction stroke, the sealing valve **16**, being restrained against upward movement by its connection to the inlet valve, will be frictionally received and seated in sealing relation within the constricted port **59** of the plunger, as shown in FIGURE 1. The suction stroke of the plunger will then be terminated by abutment between the plunger stop ledge or shoulder **37** and the sealing ring **38**. At this time, pump chamber **30** communicates freely with the container through the inlet port **20** and tube **22**, but the plunger passage is firmly sealed by seating of the valve **60** in port **59** of the plunger. At this time, an external seal is provided by the interengaged plunger ledge **37** and sealing ring **38** by virtue both of the axial sealing engagement aforementioned, as well as of the radial sealing engagement of the plunger enlargement **73** within the sealing ring.

Thus, the plunger cooperates with the sealing ring in the manner of a slide valve to seal off the vent opening **78** from communication with the atmosphere in either the fully-projected or fully-depressed positions of the plunger, while permitting such communication during normal operation of the plunger.

On the inception of each downward or compression stroke of the plunger by finger pressure on the plunger head, the frictional gripping or clutching engagement between the plunger constriction or valve seat **59** and its associated sealing valve **60** transmits a frictional seating thrust from the plunger to the inlet valve **23**. When the inlet valve is seated and no longer free to move with the plunger, continued plunger movement will afford a positive unseating of the sealing valve **60**.

The plunger may obviously be reciprocated repeatedly to eject the desired amount of liquid, following which it may either be left in its fully-projected position, under the action of the plunger spring **31**, or, if desired, may be locked in its fully-depressed position, in the manner shown in FIGURE 2. In either event, it will be quite apparent that the actuation of the inlet valve **23** and its associated sealing valve **60** will occur independently of gravity, through the transmission of frictional seating and unsealing forces from the plunger. If it is desired to free the pump structure completely from the action of gravity, the ball valve **48** may be eliminated and its function taken over, for instance, by a sufficiently-constricted discharge orifice **45** of the plunger head or by a spring-loaded valve. Also, the action of the sealing valve or plug **65** will similarly be controlled by the plunger position independently of gravity. Thus, the plunger will be effectively sealed internally in either its fully-projected or fully-depressed position and will be fully sealed externally by the coaction between the plunger rod and the sealing ring in the manner of a slide valve.

Having thus described my invention, I claim:

1. In a reciprocating liquid pump, including a pump cylinder having an inlet port through one axial end thereof, an inlet valve disposed in said cylinder for axial movement within pre-determined limits into and from seating relation with said inlet port, and a plunger disposed for axial movement within pre-determined limits in said cylinder on suction and compression strokes respectively away from and toward said inlet port, said plunger being provided with an axial discharge passage therethrough; the improvements comprising:

(A) a pair of relatively axially-spaced sealing valve seats within said plunger and around said passage, and respectively defining ports of smaller cross sectional area than the discharge passage;

(B) a substantially-rigid valve stem affixed to said inlet valve and extending axially therefrom into said passage for relative axial movement therein; and

(C) a sealing valve fixed to said valve stem within the passage for relative movement between said sealing valve seats and for alternate seating engagement with said sealing valve seats at opposite limits of the movement of the plunger.

2. In a reciprocating liquid pump as defined in claim **1**, the further improvement comprising means for limiting the unseating movement of said inlet valve, the seating of said inlet valve determining the limit of its seating movement.

3. In a reciprocating liquid pump as defined in claim **1**, the further improvement wherein said sealing valve seats are located relatively adjacent and remote from said inlet port respectively, the valve stem being disposed for free movement through the port defined by said relatively-adjacent valve seat, friction clutch means on said valve stem normally positioned for relative movement between said sealing valve seats and proportioned for axial reception in and frictional radial engagement with said relativly-adjacent valve seat at the limit of each suction stroke of the plunger to transmit a yieldable axial seating force from the plunger of the inlet valve on the inception of each compression stroke of the plunger.

4. The combination defined in claim **3**, in which said friction clutch means comprises the sealing valve, said sealing valve being proportioned for seating and sealing radially against the inner periphery of said adjacent sealing valve seat while frictionally engaging same.

5. The combination defined in claim **4**, in which said relatively-adjacent sealing valve seat is defined by oppositely-directed generally-conical surfaces diverging toward each other to define a port the inner periphery of which is proportioned for frictional sealing engagement with said sealing valve.

6. The combination defined in claim **4**, in which said relatively-remote sealing valve seat is positioned for positive axial thrusting engagement with said sealing valve to transmit a positive seating force through said sealing valve and said valve stem to the inlet valve as the plunger approaches the limit of its movement toward the inlet valve, and means for releasably interlocking said plunger to said cylinder to secure the plunger at the said last-mentioned limit of its movement.

7. The combination defined in claim **6**, in which said relatively-remote sealing valve seat is directed axially toward said sealing valve for positive seating abutment therewith.

8. In a reciprocating liquid pump as defined in claim **1**, the further improvement in accordance with which said

sealing valve is proportioned for axial movement completely through one of said sealing valve seats to facilitate assembly of the sealing valve and plunger, and for sealing and frictional engagement with the inner periphery of said one sealing valve seat during its passage therethrough.

9. In a liquid dispensing pump as defined in claim **1**, the further improvement in which said plunger includes a third downwardly-directed annular sealing valve seat, a second sealing valve being carried by said valve stem in position to seat against said third sealing valve seat near the limit of the compression stroke of the plunger.

10. In a liquid dispensing pump as defined in claim **1**, the further feature in which said inlet valve comprises a plug directed axially toward said plunger and positioned for snug liquit-tight reception in said plunger discharge passage near the limit of the compression stroke of said plunger.

11. In a liquid dispensing pump as defined in claim **10**, the further improvement in which said sealing plug is frictionally received in said plunger discharge passage to transmit a yielding frictional unseating force from the plunger to the inlet valve on retraction of the plunger from its position at the limit of its movement toward the inlet port.

12. In a reciprocating liquid pump as defined in claim **11**, the further improvement in accordance with which said inlet port and said relatively-remote sealing seat are defined by radially expansible annular means, said inlet valve and said sealing valve having conical portions for simultaneous sealing reception in the said inlet port and relatively-remote sealing seat, whereby the elastic contacting tendency of the respectively-annular means will maintain a constant resilient seating thrust of said annular means against the respective conical portions.

13. A fluid dispensing pump as defined in claim **1**, in which said cylinder is encircled internally with a radial groove adjacent its axial end remote from said inlet port and is open through said axial end, said plunger including an annular stop shoulder directed toward said open end, said cylinder being formed with a vent opening through its side wall on the side of said groove remote from the open end, an annular plunger stop and sealing ring received in said groove and encircling said plunger, said ring being resistant to axial compression for axial sealing abutment with said plunger shoulder and with one axial end of the groove to limit the plunger movement away from said inlet port, said plunger having a portion of reduced diameter positioned for movement through said element to permit flow of fluid between said plunger and said ring during the major portion of its stroke, and portions of relatively-larger diameter at opposite axial ends of said reduced diameter portion for sealing reception in said ring at the opposite limits of the plunger movement.

14. A fluid dispensing pump as defined in claim **13**, in which said ring is resiliently compressible radially between said plunger and said cylinder.

15. In a reciprocating liquid pump, including a pump cylinder having an inlet port through one axial end thereof, an inlet valve disposed in said cylinder for axial movement within pre-determined limits into and from seating relation with said inlet port, and a plunger disposed for axial movement within pre-determined limits in said cylinder on suction and compression strokes respectively away from and toward said inlet port, said plunger being provided with an axial discharge passage therethrough; the improvements comprising:

(A) a pair of relatively axially spaced sealing valve seats in said plunger along said passage;

(B) and a sealing valve supported from said inlet valve within said passage for alternate seating engagement with said sealing valve seats at opposite limits of the movement of the plunger.

16. In a reciprocating liquid pump as defined in claim **15**, the improvement in accordance with which said sealing valve includes a plug proportion for functional sealing reception in said discharge passage.

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