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L. A. MICALLEF

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SELF-SEALING LEAK-PROOF PUMP

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Sheet 2 of 3

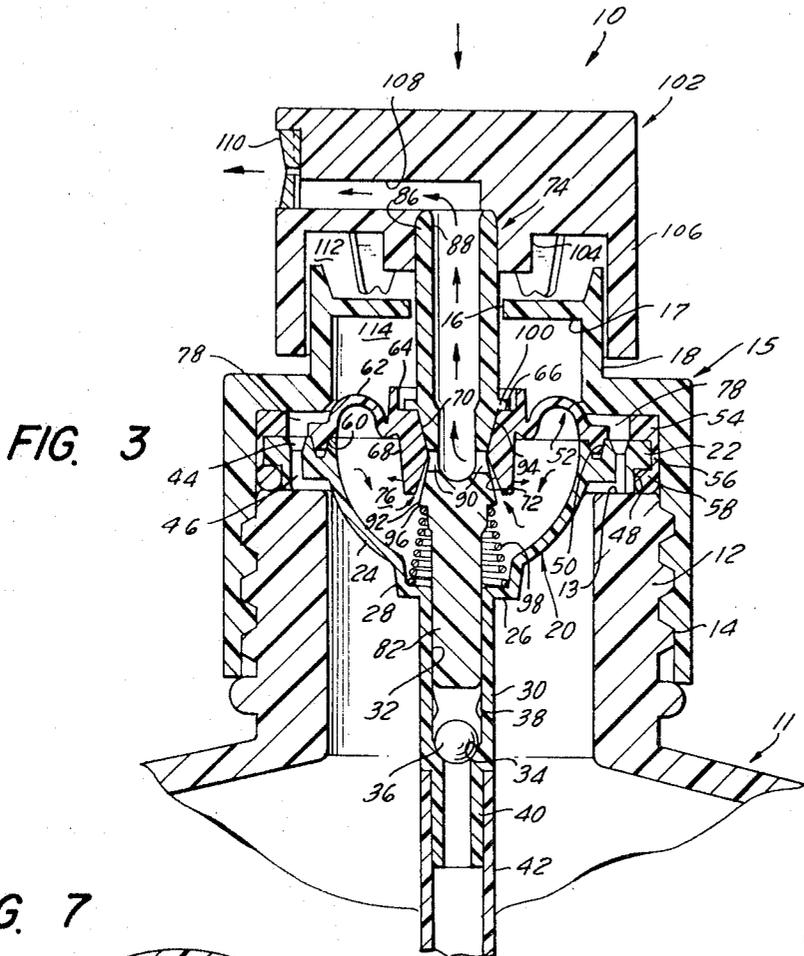


FIG. 7

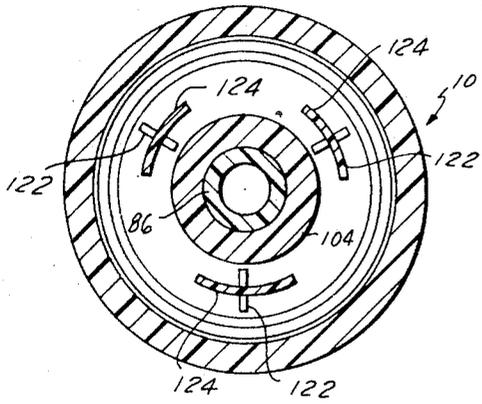
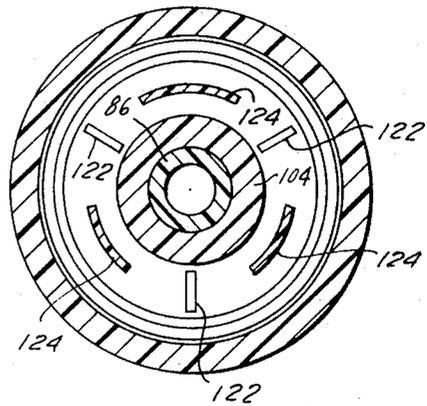


FIG. 8



INVENTOR

LEWIS A. MICALLEF

BY

Gene Palmer, Gene Sullivan
ATTORNEYS

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SELF-SEALING LEAK-PROOF PUMP

Lewis A. Micallef, New York, N.Y., assignor to Leeds and Micallef, New York, N.Y., a partnership of New York

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Int. Cl. B65d 47/34; G01f 3/20

U.S. Cl. 222—207

15 Claims

ABSTRACT OF THE DISCLOSURE

A fluid dispensing pump is provided for a container of liquid and includes a base adapted to be supported across the opening of the container. The lower end of the base is coupled with a dip tube and a valve which controls this access to the container interior. A diaphragm extends across the top of the base and defines a pump chamber therewith. The diaphragm includes a central boss having inner conical surfaces which mate with complementary shaped surfaces of a plunger. The boss of the diaphragm extends across a radial opening in the plunger which communicates with an axial passageway through the plunger for directing liquid to be dispensed out through a discharge opening. An air network permits air from the ambient into the container to replenish the material dispensed from the container interior into the pump chamber. When the plunger is depressed, the diaphragm is flexed to reduce the volume of the pump chamber. This movement causes the boss to open the radial opening of the plunger whereupon material in the pumping chamber flows into the plunger passage and eventually out through the discharge opening of the pump. Upon release of the plunger, the diaphragm moves in an opposite direction closing the plunger opening and permitting liquid in the container interior to pass through the valve in the base to thereby fill the pumping chamber with the liquid to be dispensed.

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of commonly assigned application Ser. No. 666,331, filed Sept. 8, 1967, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to fluid dispensing pumps for containers and, more particularly, to plunger actuator pumps of the type that are used for discharging liquid or gaseous or pasty substances from containers, such as bottles.

Reciprocal pumps of one type or another have been proposed for dispensing material from a container. Containers of this type have been used for handling and dispensing materials of a wide variety as those commonly marketed in the cosmetic, toiletry, food and household products industries. Although these prior pumps were generally satisfactory and acceptable, there has always been an ever-increasing need insofar as consumer products are concerned for pumps of better construction and superior as well as efficient performance but, most important of all, an urgent need presently exists for pumps having such characteristics but of significantly simple design and construction that are materially lower in cost of construction, manufacture and assembly.

SUMMARY OF THE INVENTION

It is, accordingly, among the principal objects of the present invention to provide a reciprocal dispensing pump which is leak-proof in substantially all positions and conditions of storage, transit and use, yet performs and

operates reliably and efficiently while being of simple construction and being relatively inexpensive to manufacture and assemble.

Other objects and advantages will become apparent from the following detailed description which is to be taken in conjunction with the accompanying drawings illustrating a somewhat preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWING

In the drawings:

FIG. 1 is an elevational view of a capped container incorporating a reciprocal dispensing pump in accordance with the present invention;

FIG. 2 is an enlarged fragmentary longitudinal sectional view taken along line 2—2 of FIG. 1 through the neck and cap of the container as well as the reciprocal dispensing pump showing the pump parts in a releasably locked fully extended retracted position;

FIG. 3 is a similar view showing the pump unlocked and the pump during the pumping stroke during which liquid to be dispensed is forced out of the pump chamber through the discharge passageways;

FIG. 4 is again a similar view showing the pump during its retraction stroke at which liquid in the container is adapted to be forced up into the pump chamber and ambient air permitted to replace the liquid drawn upwardly from the container;

FIG. 5 is a bottom plan view of the flexible wall of the pump;

FIG. 6 is a top plan view of the bottom substantially rigid wall of the pump;

FIG. 7 is a cross-sectional view taken along the line 7—7 of FIG. 2 showing the releasable lock for the pump actuator in a fully locked position;

FIG. 8 is a similar cross-sectional view showing the lock in a released position at which the pump is adapted to be actuated; and

FIG. 9 is an enlarged cross-sectional view taken along the line 9—9 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawings, the reciprocal dispensing pump 10 of this invention is shown disposed across the opening of a container 11 which may assume the form of any conventional bottle or similar receptacle, made of glass, plastic or other suitable materials. The container may be used for holding and dispensing a wide variety of materials generally in liquid form as may be found on the market today. These liquids may possess different degrees of viscosities and may include oil, perfume or the like, or pasty substances such as creams or the like, or gaseous substances.

The container 11 includes a neck 12 terminating in an upper end 13 defining an opening into the container interior. Threads 14 on the exterior of the neck 12 conveniently support a cap 15 having a substantially coaxial opening 16 in top wall 17 which extends inwardly from the reduced substantially cylindrical skirt 18. Obviously, any other form of securing means between the cap 15 on the neck 12 may be employed either as a permanent or temporary nature.

The pump 10 is conveniently mounted across the opening defined by the neck 12 of the container by means of the cap 15. The pump 10 includes a bottom substantially rigid wall defined by member 20 having a substantially circular peripheral flange 22 and a substantially dished shaped body portion 24 inwardly thereof. The base or bottom member 20 includes a substantially flat base 26 extending inwardly of the substantially conical wall 28 which forms an extension of the dished body portion 24.

A substantially cylindrical tube 30 extends downwardly and integrally from the base 26 which, together with the tube, defines a substantially coaxial bore 32 serving as a liquid passage. The tube 30 is provided with a valve seat 34 for defining a sealing zone along with a ball check valve 36. The interior of the tube 30 may also be furnished with retaining elements 38 for preventing undue displacement vertically of the ball check valve 36. The lower end of the tube 30 is provided with a reduced boss 40 for receiving a conventional dip tube 42 for conducting liquid to be dispensed from the container interior.

The peripheral flange 22 of the bottom member 20 is provided with a substantially circular air passage in the form of recess 44. This recess has extending therefrom passage 46 which communicates with the container interior and which, as will become evident shortly, forms part of an air passage network for replenishing the container with air as the liquid therein is dispensed. The flange 22 is also provided with a circumferentially extending recess 48 and another substantially circular recess 50 for mating with surfaces of the flexible top member 52 for interconnecting the bottom member 20 and top flexible member 52 in a substantially sealed manner.

Reference is now made to the flexible top member 52 which operates as a pump diaphragm. The diaphragm 52 includes a peripherally extending flange 54 resting on the flange 22 of the bottom member 20 in a substantially liquid tight manner while under the pressure exerted by the associated surfaces of the cap 15 the tightening of which serves to seal in a liquid tight manner the peripheral junction between the top member 52 and the bottom member 20 as well as the neck 12 of the container through the sealed interengagement between the bead 58 and top edge 13 of the container 11. A depending skirt 56 extends downwardly from the flange 54 and it terminates in an inwardly extending bead 58 which is conveniently received by the recess 48 for purposes of maintaining the top member 52 and bottom member 20 associated and in an assembled condition following pump assembly and prior to placement across the opening in the neck of the container 11. Of course, the association of the bead 58 in the recess 48 cooperates in sealing the mating and associated surfaces of the top member 52 and bottom member 20. This seal is perfected and optimized as a result of the interengagement of surfaces of the downward projection 60 on the flange 54 and the recess 50 in the flange 22.

The diaphragm 52 further includes a flexible body portion 62 extending inwardly of the flange 54. An upstanding circular rib 64 is disposed interiorly of the flexible portion 62 and operates to seal against the bottom face of the top 17 of the cap 15 when the pump 10 is in a fully retracted position. A flat transverse shoulder 66 extends inwardly of the rib 64 and serves as a bearing surface against which pressure is applied to subject the pump to its pumping cycle for purposes of dispensing liquid. A downwardly depending enlarged boss 68 serving as a valve extends downwardly of the shoulder 66 interiorly of the flexible portion 52. The interior of the boss 68 includes a substantially inverted conical surface 70 joined with a conical surface 72 for association with the complementary surfaces of a plunger generally designated by numeral 74 which, together with the bottom substantially rigid member 20 and flexible diaphragm 52, defines a pump chamber 76. As part of the air passage network mentioned in the above, the flange 54 of the diaphragm 52 is provided with one or more openings 78 which communicate with the circular recess 44 and the ambient atmosphere particularly when the pump is actuated through its pumping cycle and during its retraction cycle.

Reference is now made to the plunger 74 which cooperates in deflecting the diaphragm 52 during the pumping cycle whereby the capacity of the pump chamber 76 is varied and also in providing passage of liquid during dispensing and filling of the pump chamber 76. In this

connection, the plunger 74 includes a lower end 82 provided with at least one flat section 84 which cooperates with the adjacent surfaces of the inner surfaces 32 of the tube 30 in defining a liquid passage therebetween. Of course, the lower end or stem 82 serves to define the path of reciprocation of the plunger 74 through its cooperation with the associated surfaces of the tube 30. The upper end of the plunger 74 includes a tubular portion 86 defining a bore 88 which is open at the upper end of the tubular portion 86 and terminates approximately midway between the ends of the plunger 74. The inner end of the bore 88 communicates with radial or transverse holes 90 which, during the pumping stroke, communicates with the liquid pump chamber 76. The opening 90 is adapted to be closed or sealed by opposed surfaces of the boss 68 of the diaphragm 52 during the retraction of the plunger 74 while, on the other hand, this valving arrangement is adapted to be opened under the influence of the internal liquid pressure built up in the pump chamber 76 as a result of the downward stroke of the plunger 74. Towards this end, the central section of the plunger 74 is provided with a conical portion 92 and an inverted conical portion 94 both of which are complementary with the conical surfaces 70 and 72 of the boss 68 of the diaphragm 52. The base of the conical portion 92 defines a shoulder 96 with the lower end of the plunger. A spring 98 is disposed against this shoulder 96 as well as the flat face 26 of the base member 20; and in this manner, the plunger 74 is biased upwardly whereby the spring will be compressed during the pumping stroke and the plunger 74 will be urged towards its extended upward position during the retraction stroke. A radially extending rib 100 is disposed between the upper conical portion 94 and tubular end 86 of the plunger 74 for engaging with the shoulder 66 of the central enlarged boss 68 of the diaphragm 52 during the pumping stroke to thereby assure downward deflection of the diaphragm 52 as the plunger is shifted downwardly. The radial rib 100 is also adapted to serve as a stop by engaging the wall 17 to thereby limit the extent of retraction of the plunger 74. Ordinarily, the rib 100 will be disposed as shown in FIG. 2 prior to actuation of the pump.

In order to facilitate depression of the plunger 74 and to direct the liquid to be dispensed in the desired direction and with the desired dispensing pattern, a plunger actuator 102 is advantageously fixed to the upper end 86 of the plunger 74. Thus, the actuator 102 includes an inner concentrically disposed apron 104 which is adapted to assume a substantially friction fit with the upper end 86 of the plunger 74. An outer concentric skirt 106 is disposed about the exterior of the skirt 18 of the cap for cooperating in guiding the path of travel of the actuator 102 and its general disposition on the plunger 74. A duct 108 is provided in the actuator 102 and advantageously communicates with the bore 88 of the plunger 74 as well as with a dispensing opening or, as shown in the illustrated embodiment, a break-up nozzle 110. It should be understood that either sufficient clearance is present between the skirt 106 and skirt 18 to permit air flow therebetween or air passages of conventional form between the skirts are provided for this purpose.

The passage of air during the retraction stroke of the plunger 74 is generally indicated by arrows in FIG. 4. Thus, as the pump chamber 76 is filled with the liquid to be dispensed during the retraction stroke of the plunger 74, air will pass through the space between skirts 18 and 106 from the ambient into the annular space 112 between the cap 15 and actuator 102. Air will pass between the upper tubular portion 86 of the plunger 74 and the inner periphery 16 of the flat top 17 of the cap 15 and then into the annular space 114 between the cap 15 and the diaphragm 52. Air within the annular space 114 will pass through the opening 78 at the periphery of the diaphragm 52 into the annular recess 44 of the base member 20 through the passageway 46 into the head space within the interior of the container 11. Upon attainment of the fully

retracted position during the pumping cycle, the disposition of parts is essentially depicted in FIG. 2 at which point a seal will be provided between the upper edge 64 of the diaphragm 52 and the lower face of the substantially flat plate 17 to thereby provide an essentially fluid-tight engagement which will prevent leakage of the container contents during shipment or inadvertent tilting, inclining or dropping of the container. In addition, an airtight seal is provided to prevent undesirable penetration to the container interior of any foreign borne particulate matter.

The stroke of the plunger 74 may be regulated by one of a number of conventional means; and, as shown in the illustrated embodiment, the end of the pumping stroke is controlled by the permissible compression of the spring 98.

Of course, each of the conical surfaces 70 and 72 and their associated surfaces 94 and 92, respectively, may assume different angular relations relative to the axis of the plunger 74 and may be of a shape other than conical as, for example, hyperbolic or parabolic. In this connection, the selected design should, as in the illustrated embodiment, provide for a substantially liquid type seal closing the radial openings 90 in the plunger 74 during the rest or non-use position of the pump 10 and particularly during the retraction stroke of the plunger 74. Naturally, the seal should provide a substantially leak-proof juncture at all times between the diaphragm 52 and the plunger 74 while permitting during the pumping stroke the separation of the conical face 72 and the opposed conical face 92 to thereby permit passage therebetween of the liquid within the pump chamber 76 through the opening 90 and eventually out through the nozzle or opening 110.

The container 11, as previously stated, may be either metal, glass or plastic or similar material. The material of the base member 20, cap 15 and the actuator 102 together with the plunger 74 is preferably selected from a wide range of rigid materials such as metal, plastics, hard rubber or the like. The material of the diaphragm 52 should, preferably, possess flexibility and may be selected from a wide range of natural or synthetic elastomeric materials such as polyethylene, rubber, Buna, or any other flexible elastic material.

Locking means are provided for preventing the accidental operation of the pump 10 either through inadvertence or during shipment or storage. The locking means may assume one of a number of constructions and, as shown in the illustrated embodiment, locking means 120 releasably locks the actuator 102 relative to the cap 15 to prevent initiation of the pumping cycle at times other than during actual use of the dispenser. This locking means 120 includes concentrically disposed ribs 122 projecting upwardly from the substantially flat top 17 of the cap 15. These ribs 122 may converge from their base to their upper end substantially as shown. Similar ribs or lugs 124 are disposed concentrically and extend downwardly from the actuator 102. While the lugs 122 may be of substantially flat configuration, the lugs 124 are arcuate as shown in plan in FIGS. 7 and 8. The lugs 124 similarly converge from their base to their lower ends and also include at these ends a recess 126 which is so dimensioned that in the locked position (see FIG. 2) the recess 126 of the lugs 124 will engage and accommodate the upper end of the ribs 122. By simply turning the cap in either a clockwise or counterclockwise direction, this engagement will be released (see FIG. 8) to permit initiation of the pumping cycle. Of course, the depth of the recesses 126 may be sufficient to provide for snapping into place of the lugs 122 and 124 thereby indicating to the operator that the locked position has been reached while, at the same time, reducing the tendency of the part from inadvertently or accidentally unlocking. The resiliency and elasticity of parts permit deliberate and intended releasing of the locking means 120 when the actuator 102 is turned either in a clockwise or counterclockwise direction.

After the locking means 120 has been released, the dispensing of the container contents may be summarized as

follows. Assuming for purposes of this description that the liquid to be dispensed is contained in the pump chamber 76, the actuator 102 is manually depressed downwardly to initiate the pumping stroke. If, on the other hand, liquid is not present in the chamber 76, the following pumping cycle should be repeated until the pump is primed and liquid to be dispensed is present in the chamber 76. During the pumping cycle, the plunger 74 is forced downwardly. The rib 100 will engage the substantially flat face 66 of the diaphragm 52 to cause the diaphragm to deflect downwardly. Substantially simultaneously therewith, the lower conical face 72 of the boss 68 of the diaphragm 52 will, under the influence of the internal pressure built up within the pump chamber 76, separate from the conical face 92 to permit access to the openings 90.

As the actuator 102 and plunger 74 are depressed, the volume of the pump chamber 76 will be reduced to force the liquid therein under pressure out through the openings 90 through the bore 88 of tube 86 to passage 108 out through the discharge opening or selected nozzle 110. The maximum pumping stroke of the plunger 74 is determined by the permissible compression of the spring 98. Upon release of the actuator 102 and consequent retraction of the plunger 74 under the influence of spring 98, the pumping chamber 76 will start to expand thereby creating a suction which will draw liquid from the interior of the container 11 up through the tube 42 through the bore of boss 40 past the check valve 36 which will at this stage be forced to unseat. The liquid will be drawn through bore 32 into the pumping chamber 76. As the pumping chamber 76 is filled, the ambient air will flow between the actuator 102 and cap 15 into the annular space 112 and then between the cap plate 17 and plunger 74 into annular space 114 and eventually through the opening 78 into the annular recess 44 through passage 46 into the head space of the container to replenish the volume of liquid drawn into the chamber 76. The spring 98 will eventually cause the annular lip 64 of the diaphragm 52 to seat against the lower face of the plate 17 whereupon the diaphragm 52 will come to rest. The plunger 74 and actuator 102 will assume the position shown in FIG. 2 at which the pumping cycle may be repeated. During the retraction of the plunger 74 and until such time as it is depressed once again, the openings 90 will have been sealed by the engagement of the conical surface 72 of the diaphragm 52 and the conical surface 92 of the plunger 74. When the deflection of the diaphragm 52 has stopped, the check valve 36 will be seated against the valve seat 34 to trap the liquid to be dispensed in the chamber 76. The above pumping cycle need only be repeated for further dispensing of the liquid.

Thus, the aforementioned objects and advantages are most effectively attained. In addition, it is important to allude particularly to the great saving of the number of parts of the pump and the attendant cost of pump components and assembly. Most important is the provision of a leak-proof evaporation-proof pump of but a few parts that are easily manufactured and assembled at a relatively low cost. Although a single somewhat preferred embodiment of the invention has been disclosed herein, it should be understood that this invention is in no sense limited thereby and its scope is to be determined by that of the appended claims.

I claim:

1. A dispensing pump for use and incorporation on a container for a material to be dispensed comprising in combination:

a relatively rigid base member adapted to be supported across the opening of a container, said member having an opening and means for communicating said opening with the material to be dispensed, first valve means for closing the opening during the dispensing of said material and unseating to provide communication between the opening and the material to be dispensed in the container;

a relatively flexible diaphragm having peripheral portions thereof in fluid-tight engagement with associated peripheral portions of the base member, said diaphragm including a central boss defining a central opening;

a reciprocal plunger extending into the central opening of the diaphragm, said plunger having surfaces cooperable with associated surfaces of the diaphragm boss in providing means for attaching the plunger to the diaphragm for permitting flexing of the diaphragm upon reciprocation of the plunger, the plunger having an interior passage for the dispensing of the material to be dispensed, said plunger and said base member and said diaphragm cooperating with one another in defining a pump chamber for containing the material to be dispensed, the plunger having an opening communicating with the plunger passage and adapted to communicate with the pump chamber for permitting flow of the material from the pump chamber into the plunger passage, surfaces of the plunger adjacent the plunger opening and associated surfaces of the boss defining a second valve means for sealing the plunger opening during filling of the pump chamber and for opening the plunger opening during the dispensing of the material to be dispensed from the pump chamber into the plunger passage, the diaphragm boss including a double cone surface defining the central opening of the diaphragm, the upper portion of the double cone surface being a substantially inverted truncated cone associated with a complementary shaped conical surface of the plunger for providing said connection means, and the lower portion of the double cone surface defining an upright truncated cone in association with a complementary shaped cone forming part of the plunger in providing said second valve means;

air network means for permitting the passage of air from the ambient into the container to replenish the volume of the material to be dispensed which is drawn from the container interior into the pump chamber;

the diaphragm when moved by the plunger in one direction, for pumping, towards the base member being adapted to reduce the volume of the pump chamber thereby pressurizing the material to be dispensed in the pump chamber and at the same time causing the second valve means to open the plunger opening whereupon the material in the pump chamber is adapted to flow into the plunger passage and be dispensed therefrom; and

the diaphragm when moved in the opposite direction away from the base member upon retraction of the plunger increasing the volume of the pump chamber and closing the plunger opening by the second valve means and causing the unseating of the first valve means to open the base member opening to the material to be dispensed in the container thereby permitting the material to be dispensed in the container to enter the pump chamber with the first valve means closing the base member opening upon termination of the retraction of the plunger and flexing of the diaphragm away from the base member as well as during pumping and dispensing of the material to be dispensed.

2. A dispensing pump for use and incorporation on a container for a material to be dispensed comprising in combination:

a relatively rigid base member adapted to be supported across the opening of a container, said member having an opening and means for communicating said opening with the material to be dispensed, first valve means for closing the opening during the dispensing of said material and unseating to provide communication between the opening and the material to be dispensed in the container;

a relatively flexible diaphragm having peripheral portions thereof in fluid-tight engagement with associated peripheral portions of the base member, said diaphragm including a central boss defining a central opening;

a reciprocal plunger extending into the central opening of the diaphragm, said plunger having surfaces cooperable with associated surfaces of the diaphragm boss in providing means for attaching the plunger to the diaphragm for permitting flexing of the diaphragm upon reciprocation of the plunger, the plunger having an interior passage for the dispensing of the material to be dispensed, said plunger and said base member and said diaphragm cooperating with one another in defining a pump chamber for containing the material to be dispensed, the plunger having an opening communicating with the plunger passage and adapted to communicate with the pump chamber for permitting flow of the material from the pump chamber into the plunger passage, surfaces of the plunger adjacent the plunger opening and associated surfaces of the boss defining a second valve means for sealing the plunger opening during filling of the pump chamber and for opening the plunger opening during the dispensing of the material to be dispensed from the pump chamber into the plunger passage, the base member being substantially cup shaped and the base member opening being defined by a concentric centrally disposed tube extending downwardly away from the diaphragm, and the tube having means for receiving a dip tube adapted to be immersed in the material to be dispensed in the container, the first valve means including a valve seat defined by interior surfaces of the tube and a ball check valve adapted to be seated on the valve seat during pumping and dispensing of the material to be dispensed and to be unseated from the valve seat during filling of the pump chamber, the plunger including a downwardly depending extension extending into the tube for guiding the path of reciprocation of the plunger, the plunger extension and tube cooperate in providing a passageway for the material to be dispensed as it flows from the container interior into the pumping chamber;

air network means for permitting the passage of air from the ambient into the container to replenish the volume of the material to be dispensed which is drawn from the container interior into the pump chamber;

the diaphragm when moved by the plunger in one direction, for pumping, towards the base member being adapted to reduce the volume of the pump chamber thereby pressurizing the material to be dispensed in the pump chamber and, at the same time, causing the second valve means to open the plunger opening whereupon the material in the pump chamber is adapted to flow into the plunger passage and be dispensed therefrom; and

the diaphragm when moved in the opposite direction away from the base member upon retraction of the plunger increasing the volume of the pump chamber and closing the plunger opening by the second valve means and causing the unseating of the first valve means to open the base member opening to the material to be dispensed in the container thereby permitting the material to be dispensed in the container to enter the pump chamber with the first valve means closing the base member opening upon termination of the retraction of the plunger and flexing of the diaphragm away from the base member as well as during pumping and dispensing of the material to be dispensed.

3. A dispensing pump for use and incorporation on a container for a material to be dispensed comprising in combination:

a relatively rigid base member adapted to be supported across the opening of a container, said member hav-

ing an opening and means for communicating said opening with the material to be dispensed, first valve means for closing the opening during the dispensing of said material and unseating to provide communication between the opening and the material to be dispensed in the container;

a relatively flexible diaphragm having peripheral portions thereof in fluid-tight engagement with associated peripheral portions of the base member, said diaphragm including a central boss defining a central opening, the base member and the diaphragm including interengaged substantially circular peripheral portions and connection means defined by the interengaged peripheral portions of the base member and the diaphragm structurally connecting the base member to the diaphragm and sealing means defined by the interengaged peripheral portions of the base member and diaphragm for providing a fluid-tight connection between the base member and the diaphragm;

a reciprocal plunger extending into the central opening of the diaphragm, said plunger having surfaces co-operable with associated surfaces of the diaphragm boss in providing means for attaching the plunger to the diaphragm for permitting flexing of the diaphragm upon reciprocation of the plunger, the plunger having an interior passage for the dispensing of the material to be dispensed, said plunger and said base member and said diaphragm cooperating with one another in defining a pump chamber for containing the material to be dispensed, the plunger having an opening communicating with the plunger passage and adapted to communicate with the pump chamber for permitting flow of the material from the pump chamber into the plunger passage, surfaces of the plunger adjacent the plunger opening and associated surfaces of the boss defining a second valve means for sealing the plunger opening during filling of the pump chamber and for opening the plunger opening during the dispensing of the material to be dispensed from the pump chamber into the plunger passage;

air network means for permitting the passage of air from the ambient into the container to replenish the volume of the material to be dispensed which is drawn from the container interior into the pump chamber, the interengaged peripheral portions of the base member and the diaphragm defining part of the air passage network, the air passage network including at least one opening extending through the peripheral portions of the diaphragm and a substantially circular recess in communication therewith in the peripheral portions of the base member and a passage in the peripheral portions of the base member communicating with the recess and adapted to communicate with the interior of the container;

the diaphragm when moved by the plunger in one direction, for pumping, towards the base member being adapted to reduce the volume of the pump chamber thereby pressurizing the material to be dispensed in the pump chamber and, at the same time, causing the second valve means to open the plunger opening whereupon the material in the pump chamber is adapted to flow into the plunger passage and be dispensed therefrom; and

the diaphragm when moved in the opposite direction away from the base member upon retraction of the plunger increasing the volume of the pump chamber and closing the plunger opening by the second valve means and causing the unseating of the first valve means to open the base member opening to the material to be dispensed in the container thereby permitting the material to be dispensed in the container to enter the pump chamber with the first valve means closing the base member opening upon termination of the retraction of the plunger and flexing of the diaphragm away from the base member as

well as during pumping and dispensing of the material to be dispensed.

4. The invention in accordance with claim 1 wherein a cap is adapted to be supported in closure position on said container and having a central opening through which the plunger extends and the diaphragm including a substantially circular concentric upwardly extending lip adapted to engage with surfaces of the cap for providing a substantially fluid-tight and air-tight seal upon termination of the retraction of the plunger and prior to the pumping and dispensing of the material to be dispensed.

5. The invention in accordance with claim 1 wherein the connection means defined by the associated surfaces of the plunger of the diaphragm boss include a radial flange on the plunger adapted to engage with complementary surfaces of the diaphragm during the downward reciprocation of the plunger and the flexing of the diaphragm towards the base member.

6. The invention in accordance with claim 1 wherein a compression spring is biased between surfaces of the plunger and surfaces of the base member for urging the plunger away from the base member thereby facilitating the retraction of the plunger and consequently flexing of the diaphragm away from the base member and increase in volume of the pumping chamber and filling of the pumping chamber with the material to be dispensed.

7. The invention in accordance with claim 1 wherein the plunger opening is disposed near the center of the double cone surface.

8. The invention in accordance with claim 1 wherein a plunger actuator is connected with the upper end of plunger for facilitating the reciprocation of the plunger the actuator including a passage communicating with the passage of the plunger for directing the material to be dispensed.

9. The invention in accordance with claim 1 wherein the container comprises a neck defining an opening and having an upper end and said pump extending across the opening defined by the neck, and the peripheral portions of the base member and the diaphragm resting on the neck end, a cap connected with the container neck and supporting the pump across the neck opening, the cap having a center opening and the upper end of the plunger extending through the cap opening, a plunger actuator connected with the upper end of the plunger for facilitating the reciprocation of the plunger and having an opening for cooperating with the plunger passage for facilitating the dispensing of the material to be dispensed and directing it in accordance with the selected dispensing pattern, and a dip tube interconnecting the base member opening with the material to be dispensed in the container.

10. The invention in accordance with claim 9 wherein the pump includes means operable for locking said plunger relative to said cap against accidental pumping operation.

11. The invention in accordance with claim 10 wherein the locking means comprises a group of first locking members connected to said cap and a group of second locking members connected with relation to said plunger, the members of one group being movable together relative to the members of the other group in a path, each member of said one group having a free face making, when its member is moved through said path, contact with the free face of a member of the other group, and means operably for releasably interlocking said faces during said contact.

12. The invention in accordance with claim 11 wherein the members of one group forming radial ribs, and the members of the other group forming peripheral lugs.

13. The invention in accordance with claim 1 wherein the plunger is provided with a laterally extending flange and the boss of the diaphragm includes a shoulder which the flange is adapted to engage to assure a predetermined relationship and movement of the diaphragm with the

plunger during the pumping and dispensing of the material to be dispensed.

14. A dispensing pump for use and incorporation on a container for material to be dispensed comprising in combination:

- a relatively rigid base member adapted to be supported across the opening of a container, said member having an opening and means for communicating said opening with the material to be dispensed, first valve means for closing the opening during the dispensing of said material and unseating to provide communication between the opening and the material to be dispensed in the container;
- a relatively movable member movable relative to the rigid base having peripheral portions thereof in fluid-tight engagement with associated portions of the base member, said movable member including a central boss defining a central opening;
- a reciprocal plunger extending into the central opening of the movable member, said plunger having surfaces cooperable with associated surfaces of the boss in providing means for attaching the plunger to the movable member for permitting movement of the movable member upon reciprocation of the plunger, the plunger having an interior passage for the dispensing of the material to be dispensed, said plunger and said base member and said movable member cooperating with one another in defining a pump chamber for containing the material to be dispensed, the plunger having an opening communicating with the plunger passage and adapted to communicate with the pump chamber for permitting flow of the material from the pump chamber into the plunger passage, surfaces of the plunger adjacent the plunger opening and associated surfaces of the boss defining a second valve means for sealing the plunger opening during filling of the pump chamber and for opening the plunger opening during the dispensing of the material to be dispensed from the pump chamber into the plunger passage the boss including a double cone surface defining the central opening of the movable member of the upper portion of the cone surface being a substantially inverted truncated cone associated with the complementary shaped conical surface of the plunger for providing said connection means, and the lower portion of the double cone surface defining an upright truncated cone in association with a complementary shaped cone forming

part of the plunger and defining said second valve means;

air network means for permitting the passage of air from the ambient into the container to replenish the volume of the material to be dispensed which is drawn from the container interior into the pump chamber;

the movable member when moved by the plunger in one direction, for pumping, towards the base member being adapted to reduce the volume of the pump chamber thereby pressurizing the material to be dispensed in the pump chamber and, at the same time, causing the second valve means to open the plunger opening whereupon the material in the pump chamber is adapted to flow into the plunger passage and the dispensed therefrom; and

the movable member when moved in the opposite direction away from the base member upon retraction of the plunger increases the volume of the pump chamber and closing the plunger opening by the second valve means and causing the unseating of the first valve means to open the base member opening to the material to be dispensed in the container thereby permitting the material to be dispensed in the container to enter the pump chamber with the first valve means closing the base member opening upon termination of the retraction of the plunger and movement of the movable member away from the base member as well as during pumping and dispensing of the material to be dispensed.

15. The invention in accordance with claim 14 wherein the plunger opening is disposed near the center of the double cone surface.

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ROBERT B. REEVES, *Primary Examiner.*

FREDERICK R. HANDREN, *Assistant Examiner.*

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