April 21, 1970 E. W. GRONEMEYER ET AL 3,507,586

PUMP

Filed April 4, 1968 3 Sheets-Sheet 1

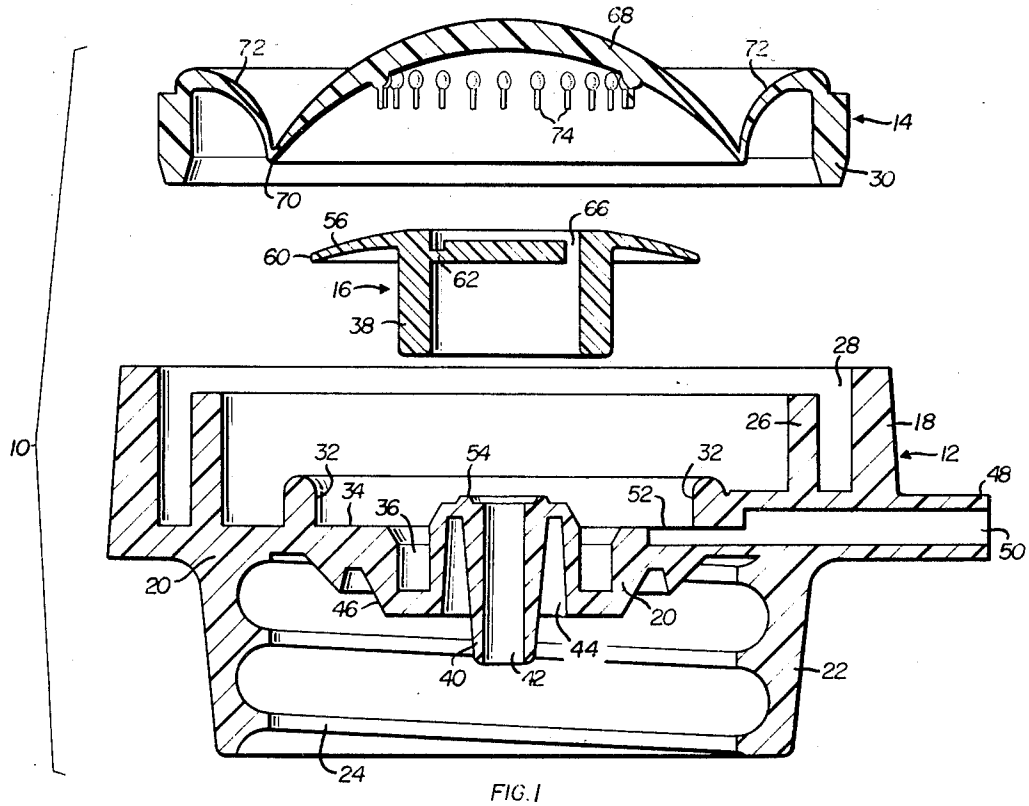

FIG. 1

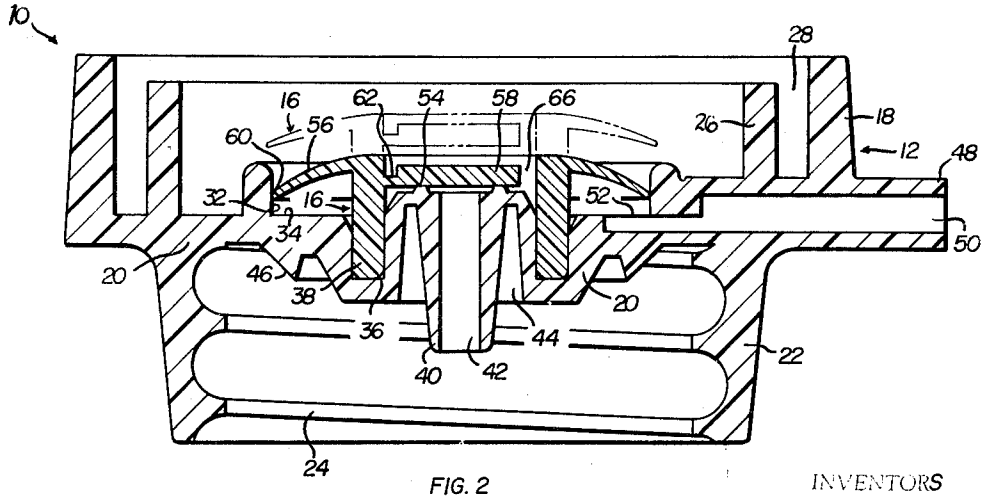

FIG. 2

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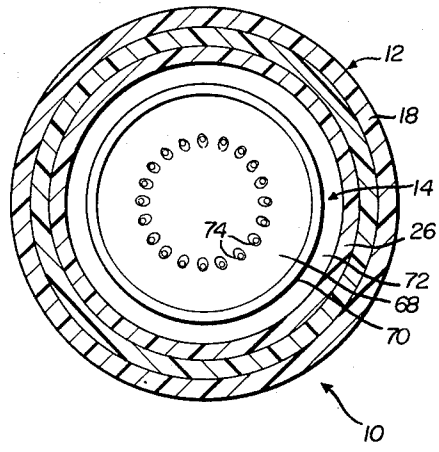

FIG. 4

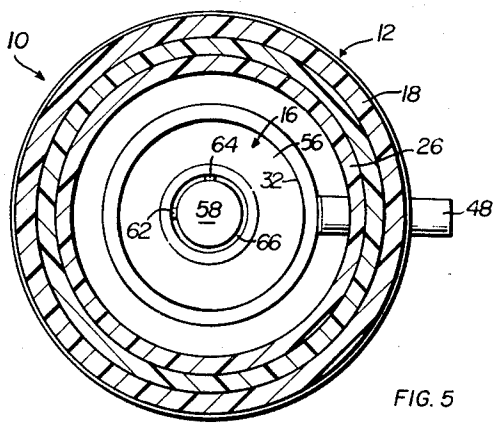

FIG. 5

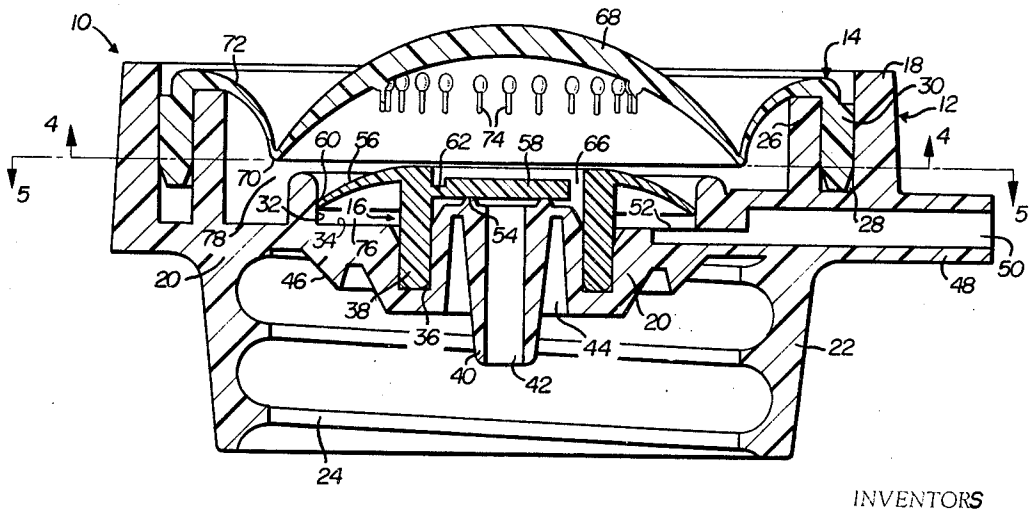

FIG. 3

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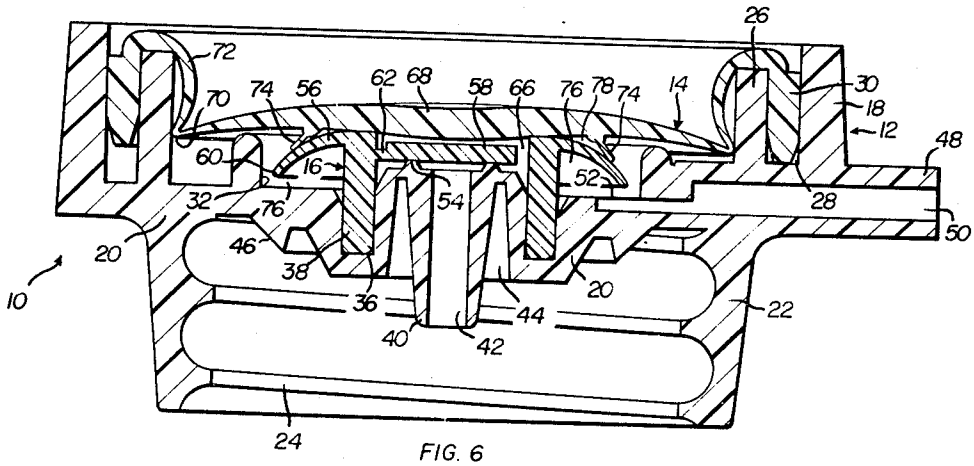

FIG. 6

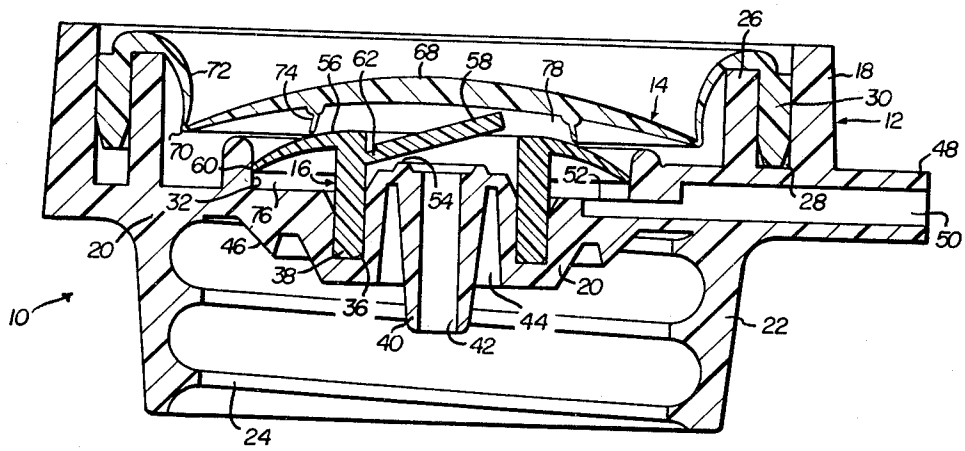

FIG. 7

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PUMP

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U.S. Cl. 417—480 10 Claims

ABSTRACT OF THE DISCLOSURE

A pump for dispensing liquids and semi-liquids formed entirely from three parts including a housing and a closure joined together to form a compartment, and a valve unit including an intake valve portion and an exhaust valve portion. The housing has an inlet passage and an outlet passage, both communicating with the interior of the compartment, and the intake valve controls flow through the inlet passage and the exhaust valve controls flow through the outlet passage. The closure includes a diaphragm which may be pushed inwardly of the compartment to expel fluid therefrom through the exhaust valve while closing the intake valve, and release of the actuating force allows return of the diaphragm to suck fluid into the compartment through the intake valve while closing the exhaust valve. In a preferred embodiment, the housing has a circular surface like a counterbore. The valve unit includes a circular flap having its edge in contact with the circular surface to divide the compartment into two chambers. The outlet passage communicates with one chamber, and the inlet passage communicates with the other chamber through the valve unit. The circular flap constitutes an exhaust valve, and the valve unit also has another flap constituting the intake valve adapted to block the inlet passage when closed. All three parts of the pump may be made of injection molded plastic material.

Background of the invention

The type of pump with which the invention is concerned is often used to dispense liquid or semi-liquid materials from a bottle or other container. By way of example, such pumps are sometimes used to dispense lotions, liquid detergents, syrups and similar materials. Known pumps of this type, however, have been sufficiently expensive to limit their use to some extent. One of the reasons for the relatively high cost of known pumps is that they have been made up of a large number of component parts, sometimes involving ball valves, springs, and mechanisms of various kinds. Not only are the parts costly to manufacture, but assembly of the parts to fabricate a complete pump involves considerable labor, and of course this also adds to manufacturing cost.

Summary of the invention

The present invention provides a pump for dispensing liquid or semi-liquid material from a small container, the pump consisting of relatively few parts, all of which may be made from injection molded plastic material. In a preferred embodiment, the pump consists of only three parts which can be assembled together by vertical stacking in a very simple manner to form a complete pump. In this embodiment, the parts are a housing and a closure for the housing joined together to form a compartment, the closure including a diaphragm in the nature of a suction cup which can be depressed to expel fluid from the compartment, and which recovers or returns due to its elasticity to suck fluid into the compartment. The third part of the pump is a valve unit which has an intake valve portion and an exhaust valve portion. The housing has a bottom wall with a central opening therein forming an inlet passage, and also has a circular surface in the nature of a counterbore with an outlet passage communicating with the interior of this circular surface. The valve unit fits into the housing and has a circular flap constituting the exhaust valve with its edge contacting the circular surface to divide the compartment into two chambers. The inlet passage communicates through the valve unit with one of these chambers, and the outlet passage communicates with the other chamber. The intake valve is a flap located centrally within the exhaust valve in a position to cover the inlet passage. The two valves are separated by a seal portion of the valve unit.

When the diaphragm is depressed, it increases pressure in the first chamber to expel fluid therefrom past the circular edge of the exhaust valve flap and out through the outlet passage while at the same time closing the intake valve. When the diaphragm is released, it returns to its normal position and, in doing so, sucks liquid past the intake valve into the first chamber while simultaneously closing the exhaust valve. Thus, not only does the pump consist of relatively few parts, but its operation is simple and very reliable.

Accordingly, it is an object of the present invention to provide an improved pump of the diaphragm operated type.

Another object of the invention is to provide a diaphragm operated pump consisting of a minimum number of parts.

Another object of the invention is to provide a pump for dispensing liquid or semi-liquid materials, all of the parts of which can be made entirely from plastic material.

Another object of the invention is to provide a diaphragm operated pump in which the valves thereof are integral portions of a single valve unit.

Another object of the invention is to provide a pump which can be assembled easily by a vertical stacking method.

Among the other objects of the invention are to provide a pump which is inexpensive, rugged, reliable in operation, and readily manufacturable on a mass production basis.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

On the drawings

FIGURE 1 is an exploded view of a pump in accordance with one embodiment of the invention showing the parts of the pump in section as they might be arranged just prior to assembling them to form a complete pump;

FIGURE 2 is a vertical sectional view showing a housing part and a valve unit of the pump, the valve unit being shown in dashed lines as it is positioned for assembly with the housing and in solid lines after it has been forced into place within the housing;

FIGURE 3 is a vertical sectional view of the complete pump showing in particular a closure and diaphragm part of the pump;

FIGURE 4 is a cross-sectional view of the pump taken along line 4—4 of FIGURE 3 looking in the direction of the arrows;

FIGURE 5 is a cross-sectional view of the pump taken along line 5—5 of FIGURE 3 looking in the direction of the arrows;

FIGURE 6 is a vertical sectional view of the pump showing the diaphragm of the closure part in a depressed position as it appears after dispensing liquid from the pump; and

FIGURE 7 is a vertical sectional view of the pump showing the diaphragm of the closure part after it has risen somewhat and also showing a changed condition of the valve.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

As shown on the drawings

Referring to FIGURES 1–5 of the drawings, it may be seen that the pump **10** consists of a housing **12**, a closure **14**, and valve unit **16**, these parts being shown in exploded relation in FIGURE 1 and in assembled relation in FIGURE 3. FIGURE 2 shows just the housing **12** and the valve unit **16** as assembled.

The housing **12** includes an annular side wall **18** and a bottom wall designated generally as **20**. Depending downwardly from bottom wall **20** is an annular coupling portion **22** which has internal screw threads **24** adapted to be screwed on to a threaded neck of a bottle or other container. It will be understood that the threaded coupling portion **22** is shown by way of example, and it is possible to provide other types of couplings for the pump as needed.

Extending upwardly from bottom wall **20** is an inner annular side wall **26** spaced radially inwardly from outer side wall **18**, and the circular recess **28** between inner and outer walls **18** is dimensioned to receive a rim portion **30** of closure **14** with a tight fit as will be explained further.

Bottom wall **20** has a vertical cylindrical or circular surface **32** formed therein in the nature of a counterbore. This surface cooperates with the unit **16** as will be described further. Bottom wall **20** also includes a flat surface **34**, and a circular cavity **36** recessed downwardly from surface **34**, the cavity **36** being dimensioned to receive a hollow stem portion **38** of valve unit **16** with a close fit. Formed integrally with bottom wall **20** is a downwardly extending tube **40** which has a bore **42** extending through it. Bore **42** is an inlet passage which leads to the interior of the pump, and fluid is sucked into the pump through this passage in the operation of the pump. A separate hose-like tube (not shown) may be attached to tube portion **40** so that the hose-like tube can extend into liquid within a container for the purpose of sucking liquid out of the container into the pump. An upwardly extending recess **44** is formed about tube **40** to receive the end of the hose-like tube when it is attached to tube portion **40**.

Also formed integrally with bottom wall **20** is an annular slanting surface **46** which acts to seal the bottom wall with the lip of a bottle to which the pump is attached. A nozzle **48** projects outwardly from the side of the pump, and the nozzle **48** has a bore **50** extending through it and extending through circular wall **32** and opening at **52** into the space within wall **32**. The bore **50** thus communicates with the interior of the pump and provides an outlet passage through which fluid is expelled from the pump.

Surrounding the top of inlet passage **42** is a raised circular seat surface **54**. This surface receives the inlet valve of valve unit **16** as will be explained further.

Valve unit **16** includes the hollow stem portion **38** as previously mentioned, and also includes an exhaust valve **56** and an intake valve **58**. The exhaust valve **56** is in the form of a concavo-convex flap which has a circular edge **60** and which is formed integrally with the top end of stem portion **38**. As may be seen, flap **56** curves downwardly slightly, and has a shape something like the head of a mushroom. Intake valve **58** is a flat, disk-shaped flap which is connected to stem **38** by two small joints **62** and **64** which are formed integrally with the inside of hollow stem **38**. There is an annular space at **66** between the edge of flap **58** and the inner surface of stem **38**, the space **66** being interrupted only by the small joints **62** and **64**. The joints **62** and **64** are thin enough to bend readily, and thus flap **58** can swing upwardly from a horizontal position after the pump is assembled as will be described.

Closure **14** includes the annular rim **30** mentioned previously, and also includes a diaphragm portion **68** which is shaped like a suction cup. Diaphragm **68** curves downwardly and outwardly to a circular corner **70**, and then curves outwardly and upwardly to the top of rim **30**. The portion **72** of the diaphragm acts like a hinge, and when diaphragm **68** is pushed downward, corner **70** moves radially outwardly toward rim **30**. Diaphragm **68** is elastic and has good recovery so that it will return by itself to its normal position after being depressed. Underneath diaphragm **68** are downwardly extending protrusions **74** arranged in a circular pattern, the protrusions being engageable with the flap **56** of valve unit **16** when diaphragm **68** is depressed. The action of protrusions **74**, will be explained more fully in connection with the operation of the pump.

As shown in FIGURE 2, the valve unit **16** is assembled with the housing **12** by placing the hollow stem **38** in the top of the recess **36**, the valve unit **16** then being in the position shown in dashed lines in FIGURE 2. After thus assembling, valve unit **16** is pushed downwardly to force hollow stem portion **38** into recess **36** until the bottom of stem **38** butts against the bottom surface of recess **36**. The circular edge **60** of flap **56** is inserted inside circular surface **32** of bottom wall **20**. The diameter of surface **32** is slightly smaller than the normal diameter of edge **60**, and consequently flap **56** bends downwardly slightly when edge **60** is inserted into surface **32**. Thus, flap **56** cannot easily be bent upwardly from the position shown in FIGURE 2, but it can bend downwardly from the position shown in FIGURE 2. As mentioned previously, flap **56** constitutes an exhaust valve, and the exhaust valve is closed with flap **56** in the position shown in FIGURE 2.

The closure **14** is assembled with housing **12** in the manner shown in FIGURE 3. Rim portion **30** is placed in the top of recess **38**, and rim portion **30** is then forced downwardly until its bottom end butts against the bottom surface of recess **28** as shown in FIGURE 3. As thus assembled, the closure **14** and the housing **12** form a compartment which has a hollow interior. The interior of the compartment is divided by flap **56** into a lower chamber **76** and an upper chamber **78**. Inlet passage **42** communicates with upper chamber **78** through valve flap **58** when the latter flap is open, and outlet passage **50** communicates with the lower chamber **76**.

In connection with the assembling of the parts of the pump, it may be noted at this point that the assembling of the valve unit **16** and the closure unit **14** with the housing **12** may be accomplished in the following manner. Valve unit **16** may be placed over recess **36** with the stem **38** inserted therein, and closure **14** may be placed on the top of housing **12** with the rim **30** inserted slightly in recess **28**. A plunger may then be brought down on rim portion **14** to force it fully into recess **28**. Another plunger, concentrically within the first plunger, may then be brought down to depress diaphragm **68**. As diaphragm **68** is depressed, protrusions **74** are directed outwardly at an angle, and they are also brought into contact with flap **56** of valve unit **16**. The diaphragm contacts valve unit **16** and forces it into recess **36**. At the same time, protrusions **74** force edge **60** of valve unit **16** inside circular surface **32**. The pump is then fully assembled, and the plunger may be raised so that diaphragm **68** returns to its normal position.

Housing **12**, closure **14** and valve unit **16** are each molded integrally by injection molding of plastic mate-

rial. Housing **12** is preferably molded of a relatively stiff plastic material such as polyethylene or linear polyethylene. On the other hand, closure **14** and valve unit **16** are preferably molded of a softer polyethylene material such that the valves **56** and **58** and the diaphragm **68** are resiliently flexible. Diaphragm **68** in particular should have good elasticity and recovery so that it can be depressed and will return to its normal position. Seating ring **54** which extends about inlet passage **42** and also circular edge **60** of valve flap **56** must be formed accurately to insure that good seals are provided at these points. In the molding of valve unit **16**, it is thus preferable that the molds not part at the circular edge **60**, because this would leave a mold line at edge **60**. Rather, the mold may be undercut so that edge **60** is formed accurately, and the mold may part somewhere along a surface of flap **56** removed from edge **60**. Similarly, the seating ring **54** should be formed by a continuous surface of the mold.

It may be noted that there are no springs or other metal parts in the pump. The only spring action of the valves **56** and **58** is derived from the resiliency of the plastic material from which the valve unit **16** is molded.

As has been pointed out, the rim **30** of closure **14** in the illustrated embodiment fits tightly with walls **18** and **26** in the recess **28** of housing **12**. The closure may be secured to the housing in other ways. For example, the top of wall **18** may be riveted or spun over the top of rim **30** to hold the rim in place. Alternatively, a ring-shaped recess may be formed in wall **18** and a matching protruding ring may be formed on the side of rim **30** so that the protruding ring snaps into the recess when the closure is assembled with the housing. Snap fitting closures of this type are well known.

Operation

FIGURES 6 and 7 illustrate the manner in which the pump **10** operates. FIGURE 6 shows how fluid is expelled or dispensed from the pump. It will be assumed that the upper chamber **78** inside housing **12** is initially filled with liquid. Actuating force applied to the exterior of diaphragm **68**, as by pressing on the diaphragm with one's finger, applies increased pressure to the liquid in chamber **78**. This pressure forces yieldable circular edge **60** downwardly and away from cylindrical surface **32**. Thus, liquid is expelled from chamber **78** past edge **60** of valve flap **56** into chamber **76** and from there through outlet passage **50** and out of nozzle **48**. At the same time, the pressure in chamber **78** forces intake valve flap **58** against seating ring **54** to close the inlet passage **42**.

It may be seen from FIGURE 6 that when diaphragm **68** is fully depressed, the center of the diaphragm pushes stem **38** of valve unit **16** downwardly, and projections **74** slant outwardly and engage flap **56**. Thus, if valve unit **16**, or just the flap **56** thereof, were out of position prior to a dispensing stroke, diaphragm **68** will push the valve unit or just flap **56** back into place as the diaphragm is depressed.

When the actuating force is released, diaphragm **68** moves outwardly in the manner shown in FIGURE 7 and returns to its original position. This produces suction or vacuum in chamber **78** which pulls intake valve flap **58** upwardly off seating ring **54** to thereby open inlet passage **42**. The reduced pressure in chamber **78** sucks liquid from the container with which the pump is associated through inlet passage **42** into chamber **78**, thus refilling this chamber. The suction in chamber **78** also pulls exhaust valve flap **56** upwardly and urges circular edge **60** against cylindrical surface **32**. This closes the exhaust valve so that no liquid escapes through outlet passage **50**. It may be noted that hollow cylindrical stem **38** of valve unit **16** forms a seal between intake valve **58** and exhaust valve **56** so that there is no way for liquid to leak directly from inlet passage **42** to outlet passage **50**.

Hinge portion **72** of diaphragm **68** swings outwardly as diaphragm **68** is depressed, thus allowing diaphragm **68** to flatten out when it is fully depressed, or at least become flatter. Hinge **72** is resilient, and so returns to its initial position when actuating force is released from the diaphragm.

It may be seen from the foregoing description, that pump **10** consists of a minimum number of parts, only three parts being provided in the illustrated embodiment. These parts can all be molded by injection molding in an economical manufacturing process. The pump is simple and it operates reliably despite the fact that it is inexpensive.

Having thus described our invention, we claim:

1. A pump for expelling fluid from a container, said pump including in combination:

(1) first and second parts assembled together and forming at least one compartment therein,

(a) said compartment having an inlet passage and an outlet passage communicating therewith,

(b) said first part being an actuator part at least a portion of which is movable toward said compartment relative to said second part,

(c) and said second part being a housing part having a bottom wall with an aperture therein forming said inlet passage and having an annular upstanding surface about said aperture through which said outlet passage extends,

(2) and a third part made of injection molded plastic and located inside said compartment, said third part having:

(a) an integral portion forming an intake valve for said inlet passage,

(b) another integral portion which is resilient and deflectible and has a circular sealing edge yieldably engaging and biased against said annular surface to form an outlet valve for said outlet passage located between said outlet passage and said actuator part, and

(c) still a further portion forming with said housing part a seal blocking flow along a bypass path between said valves when one of said valves is open,

(3) said annular surface having a smaller diameter than the diameter of said circular sealing edge of said outlet valve portion before assembly thereof to contract said sealing edge as assembled inwardly slightly by bending, with the resilience of said outlet valve portion causing said sealing edge to be biased against said annular surface to form a peripheral seal,

(4) said circular sealing edge being free of any significant irregularity which would impair said peripheral seal and decreasing in diameter to open said outlet valve in response to operation of said actuator part to expel fluid,

(5) and said actuator part being returnable to suck fluid through said inlet passage past said intake valve into said compartment.

2. A pump as claimed in claim **1** in which said outlet valve is a flap which divides said compartment into an input chamber and an output chamber, said inlet passage communicates with said input chamber and said outlet passage communicates with said output chamber.

3. A pump as claimed in claim **2** in which all of said parts are made of injection molded plastic, and said sealing edge is free of any mold parting line.

4. The pump as claimed in claim **3** in which said diaphragm portion is engageable with said outlet valve flap when said diaphragm portion is depressed, thereby assuring that said flap is positioned inside said cylindrical surface.

5. The pump as claimed in claim **2** in which said actuator part includes a diaphragm portion.

6. The pump as claimed in claim **5** in which said actuator part also includes a rim portion compressed between

wall portions of said housing part, and a hinge portion connecting said diaphragm portion to said rim portion.

7. The pump as claimed in claim 4 in which said diaphragm portion has projections for engaging said outlet valve flap.

8. A pump for expelling fluid from a container, said pump comprising a compartment having an inlet passage and an outlet passage both communicating therewith, an intake valve for said inlet passage, an exhaust valve for said outlet passage, said compartment having a cylindrical surface therein, said exhaust valve comprising a resiliently flexible flap having a circular sealing edge engaging said cylindrical surface and slightly larger in diameter before assembly than the diameter of said cylindrical surface so that said flap bends slightly and is self biased against said cylindrical surface, said flap dividing the interior of said compartment into an input chamber with which said inlet passage communicates and an output chamber with which said outlet passage communicates, and said flap being made of injection molded plastic with said sealing edge being free of any mold parting line, said compartment including an actuator depressible into said input chamber to expel fluid therefrom past said sealing edge through said output chamber and out said outlet passage, and said actuator being returnable to suck fluid through said inlet passage past said intake valve into said input chamber.

9. In a displacement pump adapted to be attached to a container and having a variable volume compartment selectively communicable with valved inlet and outlet passages, said compartment being defined by a housing member, an actuator member and a flexible resilient valve member, said actuator member being assembled with the housing member, and said valve member having inlet and outlet valve passage closing portions, the improvement comprising a portion of the housing member in the form of an interior annular surface extending upwardly relative to the bottom of the housing member and above the outlet passage, and the valve member including a portion sealingly affixed to the housing, with said outlet valve passage closing portion comprising an annular deflectible flange extending radially from the sealingly affixed portion and said inlet valve passage closing portion being located centrally of said flange, said flange being of greater diameter than the interior diameter of said annular surface and being normally deflected inwardly with its upper surface biased outwardly against the annular surface thereby forming an annular seal and separating the variable volume compartment from the outlet passage, said valve member being made of injection molded plastic and said flange being free of any significant irregularity which would impair said annular seal.

10. A pump for expelling fluid from a container, said pump comprising a compartment having an inlet passage and an outlet passage both communicating therewith, an intake valve for said inlet passage, an exhaust valve for said outlet passage, said compartment having a cylindrical surface therein, said exhaust valve comprising resiliently flexible flap slightly larger in diameter than said cylindrical surface so that said flap bends inwardly and is self-biased outwardly against said cylindrical surface, said flap dividing the interior of said compartment into an input chamber with which said inlet passage communicates and an output chamber with which said outlet passage communicates, and said compartment including an actuator depressible into said input chamber to expel fluid therefrom past said flap through said output chamber and out said outlet passage, said actuator having a depressible portion resiliently connected to the remainder of the actuator by an annular pleat whereby said depressible portion is resiliently returnable to suck fluid through said inlet passage past said intake valve into said input chamber.

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U.S. Cl. X.R.

92—96; 137—525.1, 525.3; 222—321