Nov. 7, 1944. A. M. MARTIN 2,362,081

PUMP UNIT FOR SPRAY OR JET DEVICES

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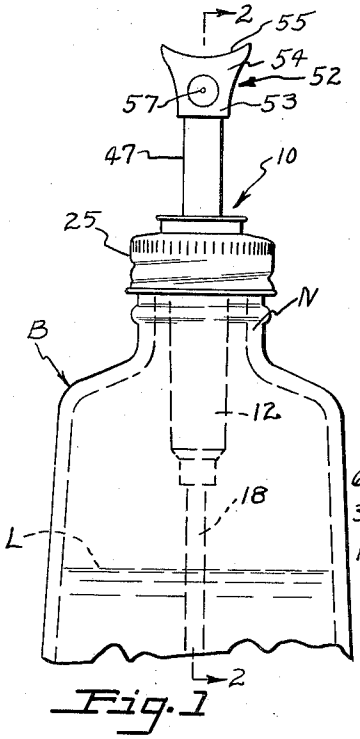


Fig. 1

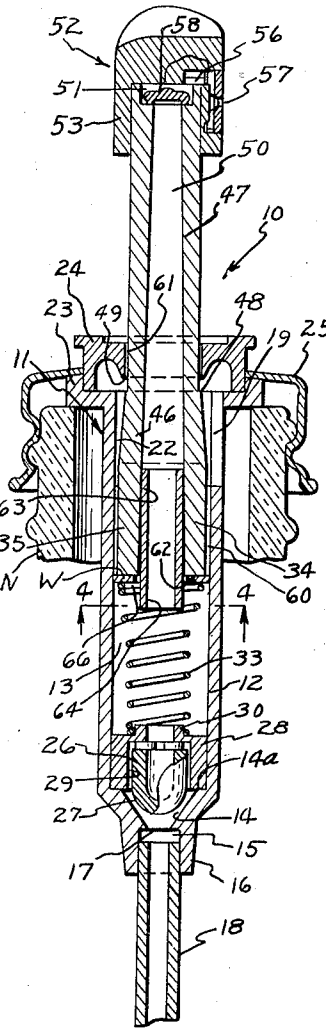


Fig. 2

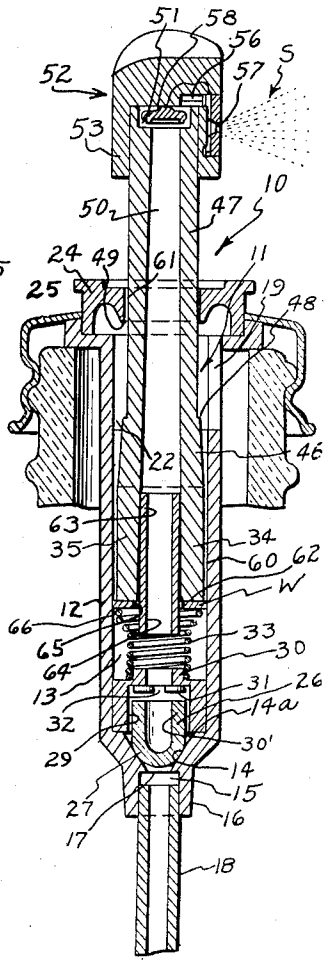


Fig. 3

Fig. 5

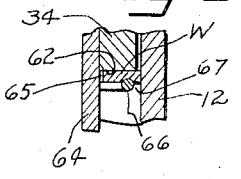
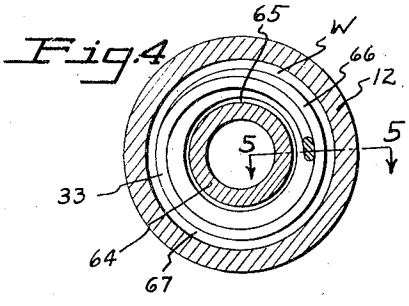


Fig. 4



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PUMP UNIT FOR SPRAY OR JET DEVICES

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Application April 26, 1943, Serial No. 484,533

9 Claims. (Cl. 103—188)

This invention has to do generally with pump units for spray or jet devices and is more particularly concerned with units adapted to be applied to liquid containers such as bottles or cans.

This application is a continuation in part of my copending application Ser. No. 463,420, filed October 26, 1942, on Spray or jet device.

In one aspect, the invention may be considered as in the nature of an improvement in the pumping unit illustrated, described, and claimed in my copending application, Ser No. 463,420, filed Oct. 26, 1942. In that application I have set forth at some length certain structural features whereby it is made possible to construct by far the major portion of the pumping unit of thermoplastic material, the advantage of this being particularly significant in view of the current shortage of metallic materials. In that application I have specified Vinylite resins as particularly well suited plastics, due to the fact that this material resists attack and deformation by the liquid being pumped, particularly resisting deformations in the nature of harmful expansions and contractions.

Recently, however, restrictions have been put upon the use of Vinylite resins and it has become necessary to turn to other thermo-plastics. It is found that certain of these plastics distort harmfully when exposed to the liquid being pumped. The pump is of such nature that at the end of an operation the pump barrel and plunger both are charged with fluid. On the other hand, when the liquid in the container drops below the exterior of the pump barrel, the outer face of the barrel remains dry. It follows that the inner and outer faces of the plunger are wet while only the inner face of the barrel is wet, resulting in differential expansion and shrinkage of the plunger and barrel. Since in the disclosure of the copending application, the plastic plunger and barrel originally have piston and cylinder fit, the differential shrinkage causes the barrel to radially shrink to an extent which prevents subsequent reciprocation of the plunger, or at least to cause the plunger to bind objectionably.

It is therefore among the objects of the present invention to provide a barrel and plunger arrangement whereby such differential shrinkage will not result in conditions which will interfere with plunger reciprocation. Generally, this is accomplished by the provision of a plunger and piston which are of such relative size that there is originally appreciable annular clearance between them, it following that relatively great shrinkage of the barrel, with relation to the plunger, may occur without causing the plunger to bind. Then, to close off this annular clearance during pumping operations, I provide a relatively soft and radially resilient washer applied to the lower end of the plunger. This washer is adapted to engage the barrel peripherally under all conditions of relative expansion or contraction between the barrel and plunger.

It is also among the objects of the invention to provide a fully efficient washer of the simplest possible type and to provide retaining means for that washer of such a nature that the assembly of the unit may be accomplished with ease and dispatch and consequently at very little cost—an item of decided importance in connection with the manufacture of this type of appliance.

While the invention is particularly significant as an improvement over the structure of the copending application, it will be understood it may be incorporated with advantage in pump units having characteristics other than those of the application structure.

Other objects and features of novelty will be made apparent in the following detailed description, wherein reference will be had to the accompanying drawing, in which:

Fig. 1 shows an embodiment of the pumping unit mounted in a bottle;

Fig. 2 is an enlarged section on line 2—2 of Fig. 1, showing only the pumping unit and a portion of the bottle neck. The parts are in the positions they occupy during the up stroke of the plunger and near the upper limit of that stroke;

Fig. 3 is a view similar to Fig. 2, but showing the positions occupied by the parts during the down stroke of the plunger and at a point just short of the limit of that stroke;

Fig. 4 is an enlarged section on line 4—4 of Fig. 2; and

Fig. 5 is a fragmentary section on line 5—5 of Fig. 4, but showing only the uppermost coil of the spring.

In order to make clear the nature and advantages of my improvements, I will first describe the structural environment thereof. For this purpose I have chosen to show the pumping unit illustrated and described in the said copending application, but it will be understood this choice is in no way to be considered as limitative on the broader aspects of the present invention.

A standard bottle is indicated at B, the bottle having the usual threaded neck N and containing a body of liquid L. The pumping and liquid ejecting unit applied to bottle B is generally indicated at 10.

While the elements of unit 10 may, under the broader aspects of the invention, consist of any suitable material, it is preferable from certain standpoints as heretofore outlined and as enlarged upon in said copending application, to make practically all such elements of thermo-plastic material. Thus, with the exception of the pump spring and washer, all elements may be made of such a plastic, their shape and form all being such that they are producible by well known die casting operations.

While I have found that thermo-plastics such as Vinylite resins particularly well serve the purpose, Vinylite is not now available for this particular use, and, while the features of the present invention may be advantageously incorporated with a pump made up of Vinylite, as soon as that material again becomes available, the invention makes it possible to use other thermo-plastics, such as Tenite, which do not have all the attack-resistant qualities that are possessed by Vinylite. Therefore, from this point on, it will be assumed that the pump plunger and barrel, at least, are made of a suitable thermo-plastic such as Vinylite or Tenite, though such assumption is not to be considered as limitative on the broader aspects of the invention.

Pump 11 is made up of cylindrical barrel 12 having a plunger-taking bore 13 which terminates in a lower, conical seat 14, there being a square cut annular shoulder 14a at the upper end of the seat. Bore 15 in the reduced tip 16 of the barrel opens to inlet 17 at the lower end of seat 14, while extension tube 18 is secured in the lower end of the bore.

Barrel 12 has a longitudinally extending spillage slot 19 in one side of the upper end thereof, and the plunger bore may flare slightly at 22, the flare starting at the lower end of slot 19.

A head 23 is formed integrally with the upper end of barrel 12, and to this head is secured a plastic retainer ring 24, the bottle cap 25, which may be of metal or plastic, being secured to pump unit 10 by head 23 and ring 24 in the manner fully set forth in said copending application. It is unnecessary here to treat further of this feature, since it does not directly concern the present invention.

Adapted to control the flow of fluid through inlet 17 is a standing or inlet valve 26 in the form of a cylindrical plug, having a semi-spherical seating end 27, which is movable to and from seat 14. A cage 28 of inverted cup-shape form has a bore 29 which loosely takes the upper, cylindrical portion 30' of valve 26. The cage limits the upward movement of the valve and also guides it to the extent that it is prevented from tipping out of substantial axial alinement with seat 14 and inlet 17.

Cage 28 has an upwardly extending, central and tubular neck 30 and downwardly extending lugs 31, the latter defining passageways 32 which allow communication, when valve 26 is in its uppermost position, between inlet 17 and barrel bore 13 (Fig. 2). Neck 30 forms an up-standing projection for receiving, preferably with tight fit, and centering the lower end of coil spring 33, said lower end bottoming on the top of cage 28 which, in turn, bottoms on shoulder 14a.

Pump plunger 34 has a cylindrical portion 35 and an inwardly and upwardly tapering portion 46 which extends from portion 35 to cylindrical stem 47. At the junction of taper 46 and stem 47 there is formed an annular shoulder 48 which is adapted to engage the cap flange 49 to establish the upper limit of the plunger stroke. The plunger has an axial bore 50 which preferably tapers upwardly and inwardly, the bore terminating in the counterbore 51.

Spring 33 engages, in effect, the underside of plunger 34, serving normally to hold the plunger yieldingly at the limit of its upward movement. The particular nature of the spring and of the washer interposed between that spring and the plunger will be described in detail later.

Stem-head or finger piece 52, by which plunger 34 is manually depressed to cause pump discharge, comprises a cylindrical portion 53 and a flaring portion 54, the latter having a saddle shaped upper face 55 to receive the operator's finger whereby pressure may be exerted to depress the pump plunger. Passageways generally indicated at 56 lead from counterbore 51 to jet orifice 57, while a disk valve 58 is located in counterbore 51.

Without considering the features which will later be described, the general operation of the pump will now be set forth, first noting that on the down stroke of the plunger, against the resistance of spring 33, check valve 58 rises to allow the passage of liquid through the upper end of bore 50 into counterbore 51 and thence through passageways 56 and orifice 57 (Fig. 3) while, on the up stroke of the plunger, valve 58 closes (Fig. 2) to prevent external air from being drawn into the pump barrel in lieu of liquid from the bottle.

Assuming the unit is in the condition of Fig. 1, liquid from body L will have been drawn, by the previous upstroke of the plunger, into barrel 12 between cage 28 and plunger 34 and will also stand in bore 50. Valve 26 will, of course, be seated. When the plunger is depressed by finger pressure on head 52 (Fig. 3) the liquid within bore 50 rises, in effect, through that bore, forcing check valve 58 open and thence passes through counterbore 51, passageways 56 and orifice 57, the liquid being discharged from this orifice in a fine, even spray as at S in Fig. 3.

During the up-stroke of the plunger as forced by spring 33 upon relief of finger pressure (Fig. 2) check valve 58 closes while plunger 34 draws liquid into barrel 12 to replace that which has been discharged, valve 26 opening to permit the upward flow from tube 18 through inlet 17 and the bore of cage 28.

It will be seen that when the plunger is at the top of its stroke, which position it occupies during all periods of non-use, liquid will stand in barrel 12 and bore 50 and that some liquid will remain on the outer peripheral face of the plunger. On the other hand, when the level of the liquid in the bottle is below barrel 12, the exterior of that barrel will be dry. Thus, the plunger is exposed to the liquid at both inside and outside while the barrel is exposed to the liquid only internally. Under these conditions, when certain types of plastic are used and certain types of liquids are being dispensed, the barrel and plunger have differential distortion characteristics. It has been found, for instance, with certain types of plastics and liquids, the differential expansion and shrinkage characteristics cause the barrel to diametrically contract to an extent that binds the plunger against reciprocation.

To overcome this effect, I have made the following provisions, but it will be also understood that these provisions are of advantage even in situations where the described differential does not exist and irrespective of the type of plastic

used, for such provisions make it possible to increase appreciably certain clearance tolerances without reducing the efficiency of the pump, thus greatly simplifying manufacturing problems, as will be readily understood.

As compared with the structure in my copending application, plunger portion **35** is reduced in diameter so there is annular clearance **60** between it and barrel **12**. Likewise, stem **47** is reduced in diameter to provide annular clearance **61** between it and ring **24**. These clearances are exaggerated in the drawings in order to make their presence well defined—actually they will usually be of the order of about .012". It follows that barrel **12** and cap **24** may shrink an appreciable extent with respect to the associated plunger parts without causing the plunger to bind.

With clearance **60** originally existing, it becomes necessary to provide means for effecting a piston seal between the plunger and barrel, and this means must be one which is capable of responding to variations in clearance due to variational expansion and shrinkage effects. For this purpose I provide the relatively soft and radially resilient, flat washer W which is applied against the flat end face **62** of the plunger, face **62** preferably being normal to the longitudinal axis of the plunger. While various substances are suitable for washer material, I find that leather, having proper characteristics, may be used with particular advantage, it being essential that the material be such as will peripherally engage the wall of bore **13** under all conditions of relative radial expansion or contraction of the plunger and barrel, and yet will not score or mutilate that bore wall during plunger reciprocation. Goat skin has been found to serve the purpose well, as has also "chrome-tanned" leather—though it is preferable that the latter be treated with a softening oil, free of plastic solvents, before installation in the pump.

Washer W is held liquid-tight to end face **62** by coil spring **33**, it being remembered the latter is used as a plunger actuator. The spring is originally tensioned so it holds the washer tightly against face **62** and holds cage **28** tightly on shoulder **14***a* even when the plunger is at the top of its stroke.

In the absence of preventive means there is a tendency for washer W to shift bodily laterally along face **62** even to the extent that it may creep into clearance space **60**, particularly when the washer becomes softer than normal. To prevent such an occurrence, I provide a tube **63**, "welded" by a solvent or otherwise secured to the plunger, the end **64** of the tube projecting below face **62**, through washer W and through the upper coils of the spring. Tube end **64** serves as an annular flange extending, in effect, marginally about the plunger bore, and may be considered as washer-retaining or centering means. The bore of the washer is sufficiently larger than flange **64** as to provide an annular clearance space **65** between the washer and flange. This clearance space accommodates any excessive inward radial swelling or displacement of washer W, but it is sufficiently small that it prevents any appreciable bodily lateral shifting of the washer with respect to the plunger.

It is essential that spring **33** annularly clear the wall of bore **13** at all times, so there may be no danger of spring-scoring that wall during plunger reciprocation. The lower part of the spring is of appreciably less diameter than bore **13** and its lower end is centered, and thus maintained annularly clear of wall of bore **13**, by the fit of said spring over neck **30**. On the other hand, the uppermost coil **66** of the spring is radially expanded to give it increased diameter so it bears on washer W at points close to the periphery of plunger portion **35**, thus assuring support for the washer near its peripheral, wiping edge. Coil **66** partially embeds itself in the relatively soft washer W, as illustrated in Fig. 5, said coil and the washer being thus held against relative lateral movement. Thus the washer, since it is centered within barrel **12**, serves to hold the upper end of the spring centered in and annularly spaced from the barrel. The annular clearance **67** between coil **66** and barrel **12** is, however, greater than the annular clearance **65** between flange **64** and the washer, so if the washer shifts laterally to its full limit with respect to the plunger, coil **66** will still clear barrel **12**.

Spring **33** not only pressurally engages washer W against the face **62** in a manner to maintain a liquid-seal between those opposed elements, but also, by reason of its embedding effect, tends to radially expand the washer so as to aid in maintaining peripheral sealing engagement between the washer and barrel **12**, though it will be understood the inherent radial resilience of the washer is depended upon mainly for expanding it radially sufficiently to peripherally engage the barrel whenever the barrel expands with respect to plunger portion **35**.

In recapitulation, it will be seen that spring **33** not only functions to move the plunger upwardly and to hold cage **28** down, but it also retains the washer in proper sealing relationship with cooperating parts, while the washer, in addition to its sealing function, positions the upper end of the spring so that it will be maintained annularly clear of the wall of bore **13**. This provision of multiple function for both spring and washer, reduces the number and complexity of elements to a minimum and correspondingly decreases manufacturing difficulty and cost. The arrangement also has the general overall effect of eliminating the necessity for close tolerances between the plunger and barrel irrespective of the material of which they may be made, while it makes possible the use of some materials which would be entirely unsatisfactory if such tolerances were decreased.

While I have shown and described a preferred embodiment of my invention, it will be understood that various changes in design, structure and arrangement may be made without departing from the spirit and scope of the appended claims.

I claim:

1. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and slightly annularly spaced from the barrel, the barrel and plunger being made of relatively hard material, and a relatively soft and pliable sealing circular washer applied to the lower end face of the plunger and extending into peripheral engagement with the barrel.

2. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and slightly annularly spaced from the barrel, the barrel and plunger being made of relatively hard material, the lower end face of the plunger being flat and lying in a plane normal to the plunger axis, and a relatively soft, flat and radially resilient sealing wash-

er applied to said end face and extending into peripheral engagement with the barrel.

3. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and annularly spaced from the barrel, the barrel and plunger being made of relatively hard material, a relatively soft, circular washer applied to the lower end face of the plunger and extending into peripheral engagement with the barrel, and a coil spring in the barrel bore beneath the washer, the outside diameter of the spring being appreciably less than the bore diameter, the lower end of the spring being bottomed and centered in the barrel and the upper end of the spring pressurally engaging the washer and pressing it against the lower end face of the plunger throughout the plunger stroke, means holding the washer against excessive bodily shift in the direction of its plane, means carried by the barrel and coacting with the spring to hold the lower end of the spring annularly spaced from the barrel, the upper end of the spring being partially embedded in the washer whereby the washer holds the upper end of the spring annularly spaced from the barrel.

4. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and annularly spaced from the barrel, the barrel and plunger being made of relatively hard material, a relatively soft, circular washer applied to the lower end face of the plunger and extending into peripheral engagement with the barrel, and a coil spring in the barrel bore beneath the washer, the outside diameter of the spring being appreciably less than the bore diameter, the lower end of the spring being bottomed and centered in the barrel and the upper end of the spring pressurally engaging the washer and pressing it against the lower end face of the plunger throughout the plunger stroke, means carried by the barrel and coacting with the spring to hold the lower end of the spring annularly spaced from the barrel, the uppermost coil of the spring being of greater diameter than underlying coils but of less outside diameter than is the plunger, the uppermost coil being partially embedded in the washer whereby the washer holds the upper end of the spring annularly spaced from the barrel.

5. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and slightly annularly spaced from the barrel, the plunger having an axial bore extending upwardly from the lower end thereof, the barrel and plunger being made of relatively hard material, and a relatively soft, annular washer applied to the annular, lower end face of the plunger and extending into peripheral engagement with the barrel, the diameter of the washer bore being at least as great as the diameter of the plunger bore at its lower end.

6. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and slightly annularly spaced from the barrel, the plunger having an axial bore extending upwardly from the lower end thereof, the barrel and plunger being of relatively hard material, a tube in the plunger bore, the lower end of the tube extending below the lower end of the plunger, and a relatively soft, annular washer applied to the annular, lower end face of the plunger around said lower end of the tube, the washer extending into peripheral engagement with the barrel.

7. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and annularly spaced from the barrel, the plunger having an axial bore extending upwardly from the lower end thereof, the barrel and plunger being of relatively hard material, an annular flange depending from the lower end of the plunger about its bore, and a relatively soft, annular washer applied to the annular, lower end face of the plunger around said flange, there being annular clearance between the washer and the flange, and the washer extending into peripheral engagement with the barrel.

8. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and annularly spaced from the barrel, the plunger having an axial bore extending upwardly from the lower end thereof, the barrel and plunger being of relatively hard material, an annular flange depending from the lower end of the plunger about its bore, a relatively soft, annular washer applied to the annular, lower end face of the plunger around said flange, there being annular clearance between the washer and the flange, and the washer extending into peripheral engagement with the barrel, and a coil spring in the barrel bore beneath the washer, the outside diameter of the spring being appreciably less than the bore diameter, the lower end of the spring being bottomed and centered in the barrel and the upper end of the spring pressurally engaging the washer and pressing it against the lower end face of the plunger throughout the plunger stroke, the annular clearance, as radially measured, between the upper end of the spring and the barrel being greater than the annular clearance, as radially measured, between the washer and the flange.

9. In a pump unit of the character described, a vertically extending, cylindrical pump barrel, a pump plunger within and annularly spaced from the barrel, the plunger having an axial bore extending upwardly from the lower end thereof, the barrel and plunger being of relatively hard material, an annular flange depending from the lower end of the plunger about its bore, a relatively soft, annular washer applied to the annular, lower end face of the plunger around said flange, there being annular clearance between the washer and the flange, and the washer extending into peripheral engagement with the barrel, and a coil spring in the barrel bore beneath the washer, the outside diameter of the spring being appreciably less than the bore diameter, the lower end of the spring being bottomed and centered in the barrel and the upper end of the spring pressurally engaging the washer and pressing it against the lower end face of the plunger throughout the plunger stroke, the upper end of the spring being partially embedded in the washer whereby the washer holds the upper end of the spring annularly spaced from the barrel, the annular clearance, as radially measured, between the upper end of the spring and the barrel being greater than the annular clearance, as radially measured, between the washer and the flange.

ANDREW M. MARTIN.