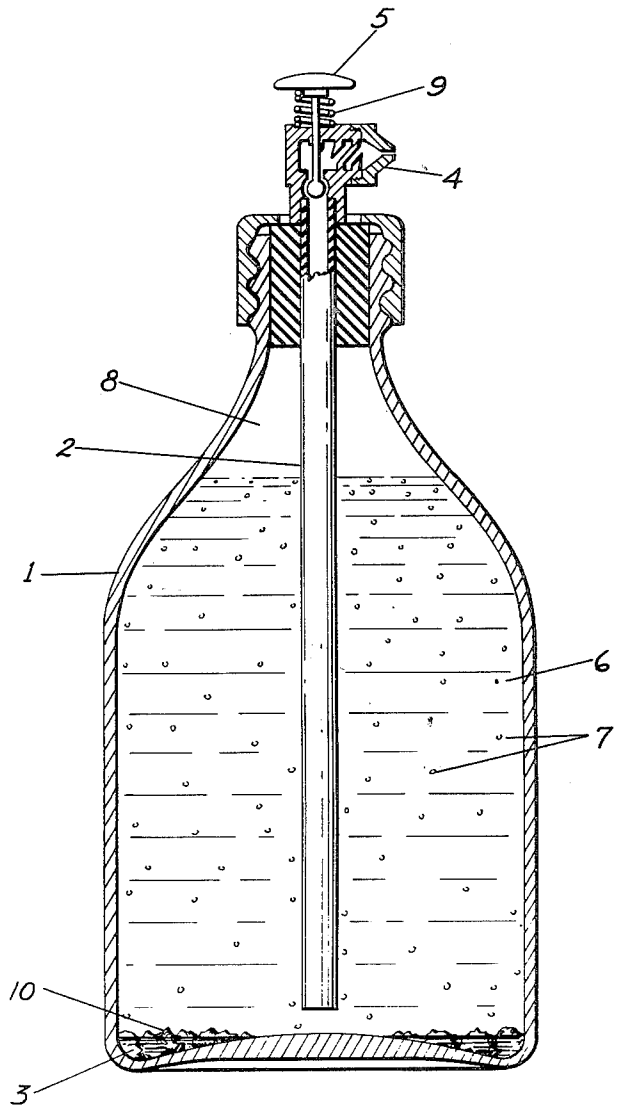
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LIQUID DISPENSING SYSTEM EMPLOYING INTERNALLY-GENERATED GAS PRESSURE

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LIQUID DISPENSING SYSTEM EMPLOYING INTERNALLY-GENERATED GAS PRESSURE

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This invention relates to the art of dispensing liquids from containers by internally-generated gas pressure, for example to self-propelled sprays and the like, and in particular to promoting the generation and the effective maintenance of said gas pressure. More specifically, this invention relates to improvements in systems such as those described in copending application Serial No. 221,759, filed April 19, 1951, by Samuel Edward Eaton, and assigned to the assignee of the present application—as well as to other systems within the class referred to above—wherein special means are provided to promote or catalyze the vaporization or boiling of the propellant liquid.

The liquid composition or product to be dispensed may be any of those which commonly are, or conveniently can be, dispensed by atomizing or spraying means, i. e. generally, liquid materials which are to be applied so as to adhere to and/or soak into surfaces and hence are ejected mainly as coarse sprays or jets rather than with fine atomization or vaporization of the spray or jet.

In the copending application referred to above, there is described inter alia a liquid dispensing device containing three fluids, a liquid propellant, a liquid to be propelled, and the gaseous, pressure-exerting phase of the propellant. The liquid propellant there described is of greater specific gravity than that of the liquid to be propelled, which latter accordingly floats on the former. The propellant is there preferably in a small amount, e. g. such that when entirely gaseous and calculated at 0° C. and one atmosphere pressure, absolute, it will occupy a volume from about 1.2 to about 5 times that of the container. The amount by weight which such a volume of propellant represents is of course dependent upon the characteristics of both the propellant and the liquid to be dispensed. In the said copending application, however, this weight of propellant is in the order of 1¼ to 5% of the weight of the liquid to be propelled. The system described in said copending application permits the use of glass containers, and relatively small amounts of propellant. Pressures within the container remain relatively low, yet effective dispensing is attained under ordinary conditions of operation and use.

I have found, however, that under some conditions of use—particularly when the liquid to be dispensed is ejected continuously and without interruption until the container has been emptied of say ¾ of its contents—the pressure of the propellant gas tends to drop to a point below which the ejection of liquid either becomes unsatisfactory or in some cases stops entirely. This difficulty is not as likely to arise during intermittent spraying, since the pressure within the container builds up towards its original value during the periods when spraying is not occurring.

The aforementioned difficulties may arise not only in systems such as those described in the said copending application, but also in systems wherein the propellant liquid floats upon the liquid to be propelled, and even in systems wherein those two liquids are miscible and form a single phase.

In accordance with the present invention, a promoter or catalyst of vaporization is provided, in the form of extended surfaces having many small points and cavities, so positioned as to be in contact with the propellant liquid and such as to promote vaporization thereof. Suitable surfaces for this purpose are unglazed porous ceramic chips or fragments, and chips of soft glass or of Pyrex glass. It would also be possible to provide roughened inside surfaces of the container, or suitable rough and

sharp projections on said surfaces, although such an arrangement is not as advantageous as are the separate chips or pieces when the propellant liquid floats on, or is mixed with, the liquid to be propelled, since the desired contact is not as good. When the propellant liquid floats on, or is mixed with, the liquid to be propelled, the objects or pieces should float to be in contact with the propellant liquid. Hence such objects should be so selected as to specific gravity that they will float under such circumstances. Alternatively, the said extended surfaces may comprise sheets or rods attached to the bottom and/or sides of the container and provided with the many small points and cavities as above referred to; such an arrangement is especially suitable when the propellant liquid and the liquid to be dispensed form a single phase.

The addition of vaporization promoters or catalysts is particularly effective when using the relatively small amounts of propellant called for in said copending application. However, these promoters are likewise useful in conventional systems and devices wherein larger amounts of a boiling liquid propellant expel, by gas pressure, a liquid from the container in which they are placed.

For optimum conditions of operation, certain factors should be borne in mind when carrying out the present invention. The liquid to be dispensed may contain a number of ingredients, including wetting agents. Care should be taken that these ingredients do not coat, plug, or otherwise "poison" the promoter or catalyst. For example, some wetting agents of the alkyl aryl sulfonate type have a tendency to change the wettability of the promoters or catalysts by the two liquids within the container. The promoter or catalyst should be readily wet by the propellant liquid, and the latter should not be displaceable from the surface of the promoter or catalyst by contact of the latter with the liquid to be propelled.

Furthermore, while the presence of even very small quantities of the promoters or catalysts is effective in carrying out the present invention, larger quantities are more effective up to a rather rough limit beyond which no particular improvement takes place. This is shown by the following illustration which serves to show the general order of magnitude of the relative effect of larger or smaller quantities of the promoter or catalyst: Employing about one percent of $(CClF_2)_2$ as the propellant for a mothproofing solution, and no promoter or catalyst, only 12% of the solution could be forced out of the container with a satisfactory spray at one time. Using the same conditions with various numbers of glass chips of substantially uniform size (corresponding approximately to 4 mesh) the per cent of the solution sprayed out satisfactorily at one time is increased as shown in the table below:

No. glass chips:	Percent solution sprayed
0	12
1	16
2	22
4	52
8	91
45	100

The preferred amount of promoter or catalyst of this type is about 15 grams of washed and screened chips (through 4 on 8 mesh per inch screen) per pint of solution to be sprayed.

The size of the promoter or catalyst does not seem to be critical; it may vary from pieces just small enough to be easily put into the container, down to pieces just large enough not to plug the exit tube and the valve and nozzle passages during operation. As a practical matter a uniform and small size is usually desirable so that the pieces or chips will tend to tumble and remain in contact with the propellant in the bottom of the container if it is tipped during spraying. When employed in a container of the type herein illustrated, the pieces or chips of promoter or catalyst may conveniently be of such size that all of them pass through a No. 4 sieve. It is preferable to wash these pieces or chips with water while on the No. 8 sieve so as to remove all small particles adhering to the larger chips which might cause plugging of the exit tube, valve or nozzle.

The propellant liquid, whether or not a separate phase

from the liquid to be dispensed, must have a boiling point low enough that it will vaporize sufficiently readily under conditions of use. For this purpose, the boiling point must be below about 20° C.

As described in the said copending application, a suitable propellant for use when the propellant is the bottom (heavier) liquid and the liquid to be dispensed is lighter and rests above the propellant liquid, is a fluorinated hydrocarbon, usually also chlorinated, of the types commonly sold under the trade names "Freon" or "Genetron." Compounds of these types suitable for such use (aside from any diluents which they may contain) all have the general formula $C_nH_xCl_yF_z$, wherein n is a whole number (usually 1 or 2), x is zero or a whole number, y is zero or a whole number, and z is a whole number, and the sum of x, y and z is equal to $2n+2$. Typical of such compounds which are suitable are the following, with their boiling points in degrees centigrade:

CCl_2F_2	−29°
$CClF_3$	−82°
$CHCl_2F$	8°
$CHClF_2$	−41°
$(CClF_2)_2$	4°
CH_3CHF_2	−26°
CH_3CClF_2	−10°

Mixtures of these halogenated compounds may be used. These compounds are preferably substantially immiscible with the liquid compositions to be dispensed.

It should be pointed out that the addition of the promoters or catalysts does not increase the pressure within the container above the maximum which could be attained without them; the effect, rather, is to maintain that pressure more nearly at the level at which it would normally be under what might be termed "equilibrium" conditions. Such conditions are where the contents of the container, at whatever stage between full and empty, are allowed to reach equilibrium pressure by standing for a period without spraying. This equilibrium pressure is generally below the theoretically perfect presure conditions, due to such effects as the solubility of some of the ingredients of the liquid to be dispensed in the propellant liquid, i. e. to the Raoult's law effect.

The container may be filled in any suitable manner, as by introducing the promoter or catalyst and the various liquids, all cooled below the boiling point of the propellant liquid, into the container which may have been similarly cooled. Alternatively, the propellant, under pressure sufficient to maintain it in liquid state, may be introduced through the dispensing nozzle of the container in which the liquid to be dispensed, and the promoter or catalyst, have already been placed.

This invention will be more fully understood by reference to the accompanying drawing, which shows a typical container in vertical section. The drawing shows a container **1** having walls of suitable strength for the intended purpose, and provided with a discharge tube or eduction conduit **2** forming a passage having an intake opening near the bottom of the container but somewhat above the top level of the propellant liquid **3**. Tube **2** terminates at the top in a nozzle **4**, the fluid flow to which is controlled by valve **5**. Nozzle **4** is any suitable low pressure atomizing or spraying nozzle or simply an orifice capable of forming a jet; it requires no auxiliary air or gas flow through it to atomize or distribute or eject the escaping liquid. Pressure of one's finger or thumb on valve **5** opens the valve so that the liquid to be sprayed is driven through and is broken up into droplets or finer bodies by nozzle **4**. When this pressure on valve **5** is removed, the valve is automatically closed by a spring **9**, or by the pressure within the container, or both. The discharge controlling orifice means need not be a valved nozzle since where discharge of the entire contents of the container at one time is to be had, the discharge orifice at the outer end of the passage may be closed by a breakable seal to serve as the sole discharge control. The body of liquid composition or product to be sprayed is indicated by the numeral **6**, and the chips or pieces of promoter or catalyst by the numeral **10**. As the propellant **3** vaporizes, under the influence of chips or pieces **10**, bubbles **7** of the resulting vapor rise through the body of the liquid composition or product **6** to form gaseous phase **8** which is under pressure. As the liquid composition is sprayed out through nozzle **4**, more of propellant **3** vaporizes under the promotive action of the chips to fill the additional space above the body of liquid **6**. The amount vaporized in any case is sufficient to create gaseous pressure enough to expel the liquid composition **6** from the container through tube **2** and nozzle **4**.

The following examples will seve to show further the several features of the present invention, and are to be construed as illustrative rather than limiting.

Example I

350 milliliters of an aqueous mothproofing solution containing sodium aluminum and ammonium silico-fluorides are introduced into a 12 ounce glass container to which has been added about 15 grams of washed and screened (through 4 on 8 mesh) glass chips. The container and contents are chilled to a temperature of 33° to 35° F. and 3.5 milliliters (1% by volume) of chilled (33° to 35° F.) $(CClF_2)_2$ liquid added. The container is immediately capped with a closure which has an attached valve nozzle and eduction tube for the liquid which reaches nearly to the bottom of the container. The $(CClF_2)_2$ liquid propellant which has a higher specific gravity than that of the aqueous solution sinks to the bottom of the container and comes in contact with the glass chips. The temperature of the container and contents is allowed to rise to at least 60° F. to permit some of the propellant to vaporize. At about this temperature, or above, the entire liquid contents may be satisfactorily sprayed out at one time. At 60° F. the initial equilibrium pressure will be 8 p. s. i. g.

Example II

The procedure of Example I is followed, but with the substitution of 15 grams of screened (through 4 on 8 mesh) porous clay chips for the glass chips. The clay chips are particularly effective in maintaining sufficient spray pressure.

In comparison, if the procedure of Example I is followed but with no chips, only part of the contents may be sprayed out at one time as the pressure falls off to essentially zero before the entire content is ejected. If the spray is stopped and the container allowed to stand for some time the pressure will increase the equilibrium value, but on respraying the progressive decrease in pressure occurs again. This can be repeated but at successively lower pressures so that it is difficult or impossible to maintain a satisfactory spray over any considerable period of time during the discharge of the contents.

Example III

The procedures of Examples I and II are followed, but with the substitution of the same quantity (1% by volume) of CH_3CClF_2 as the propellant instead of $(CClF_2)_2$, and by adding it either under pressure through the valve or as a liquid chilled to 0° F. or below. The equilibrium pressure at 60° F. will be about 22 p. s. i. g. Although the initial pressure with CH_3CClF_2 is higher than with $(CClF_2)_2$ the same phenomenon takes place—i. e. without the catalyst or promoter the complete contents of the container cannot be sprayed out satisfactorily at one time.

Example IV

The procedure of Example I is followed, except that 400 milliliters of mothproofing solution and 16 milliliters (4% by volume) of $(CClF_2)_2$ are used. The chips in this case consist of only two Pyrex glass chips, each about 4 mesh. At a temperature of 85° F., the entire contents can be sprayed out satisfactorily in one continuous operation.

What is claimed is:

1. A self-propelled liquid dispensing device comprising a gas-tight container, a conduit extending from a point therewithin and leading out of said container to a discharge orifice, means controlling the flow of liquid from within said container through said conduit to said discharge orifice, and a contained fluid system comprising a liquid medium to be dispensed and a propellant therefor in both liquid and gaseous phase, said propellant being immiscible with said liquid medium and having a boiling point not greater than about 20° C., and a promoter of the vaporization of said propellant, said promoter being in contact with said propellant and being insoluble in said propellant and in said liquid medium and comprising extended surfaces having many small points and cavities.

2. A self-propelled liquid dispensing device as defined

in claim 1 wherein said promoter comprises chips of unglazed porous ceramic.

3. A self-propelled liquid dispensing device as defined in claim 1 wherein said promoter comprises chips of glass.

4. A self-propelled liquid dispensing device comprising a gas-tight container, a contained three-phase system comprising a liquid medium to be dispensed, a propellant which in liquid form is substantially immiscible with and of greater specific gravity than said liquid medium, said propellant having a boiling point not greater than about 20° C. and being present in an amount such that when entirely in the gaseous state and calculated at 0° C. and one atmosphere absolute pressure it will occupy a volume from about 1.2 to about 5 times the volume of the container, and a gaseous phase of said propellant, under pressure, above said liquid medium, a conduit having a passage extending from a point normally within the contained body of liquid medium to be dispensed to a low pressure discharge orifice at a point outside of said container, means for controlling the flow of liquid from within said container through said conduit passage to said discharge orifice, and a promoter of the vaporization of said propellant liquid, said promoter being insoluble in said propellant and in said liquid medium and being in the form of solid bodies presenting surfaces having many small points and cavities.

5. A self-propelled liquid dispensing device as defined in claim 4 wherein the propellant is a low boiling point propellant selected from the group consisting of fluorinated, and chlorinated and fluorinated, low molecular weight saturated aliphatic hydrocarbons containing not more than two carbon atoms.

6. A self-propelled liquid dispensing device as defined in claim 5, wherein said liquid medium to be dispensed is an aqueous medium containing a silicofluoride as an active ingredient.

7. A composition comprising an aqueous medium containing a water-soluble silicofluoride salt, a propellant therefor consisting of a fluorinated hydrocarbon substantially immiscible with and of greater specific gravity than said aqueous medium, and having a boiling point not greater than about 20° C., and a plurality of fragments of unglazed porous ceramic material in said propellant, said propellant being present in an amount of between about 1¼% and about 5% of the weight of said aqueous medium, said composition being held under sufficient pressure in a confined space to maintain a portion of said propellant in the liquid phase while so confined.

8. A composition comprising a liquid medium, a propellant therefor in liquid form, and a promoter of the boiling of said propellant, said propellant being substantially immiscible with and of greater specific gravity than said liquid medium and having a boiling point not greater than about 20° C., said promoter being in contact with said propellant and being insoluble in said propellant and in said liquid medium and being in the form of solid bodies presenting surfaces having many small points and cavities, said composition being maintained under sufficient pressure in a confined space to keep at least a part of said propellant in the liquid phase while in said space, said promoter being preferentially wet by said propellant and said propellant being present in an amount of between about 1¼% and about 5% of the weight of said liquid medium.

9. A composition comprising a liquid medium, a propellant therefor in liquid form, and a promoter of the boiling of said propellant, said propellant being substantially immiscible with said liquid medium and having a boiling point not greater than about 20° C., said promoter being in contact with said propellant and being insoluble in said propellant and in said liquid medium and being in the form of solid bodies presenting surfaces capable of promoting the boiling of said propellant, said composition being maintained under sufficient pressure in a confined space to keep at least a part of said propellant in the liquid phase while in said space, said promoter being preferentially wet by said propellant and said propellant being present in an amount of between about 1¼% and about 5% of the weight of said liquid medium.

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