

[54] **AEROSOL PACKAGE OF PRODUCT CONTAINING LIQUIFIED GAS**

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[57] **ABSTRACT**

An aerosol package includes a rigid container having a dispensing valve and a collapsible flexible container inside of this rigid container and internally fluid-connected to its valve, the flexible container containing an extrudable liquid product in which a liquified compressed gas is intimately widely dispersed or dissolved. The package features a liquified compressed gas propellant in the rigid container on the outside of the flexible container and having a vapor pressure greater than that of the product's liquified gas as it is dispersed or dissolved in the product. Therefore, when the product is dispensed through the valve, this propellant continuously maintains the product under compression, through its flexible container, to a degree preventing the formation of a vapor phase in the product while the latter is extruding under the pressure of the propellant. The result is that the product's gas remains intimately widely dispersed or dissolved in the liquid product until exposed to the atmosphere, at which time this gas converts to its vapor phase to provide an expanded product that is always of the same density until the product is completely forced from its container.

8 Claims, 3 Drawing Figures

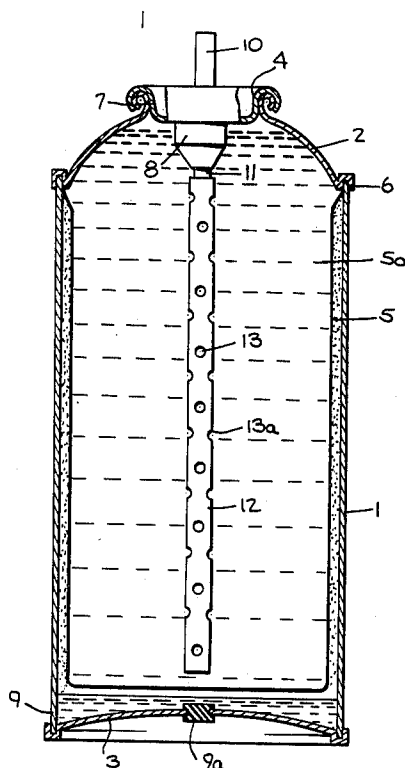
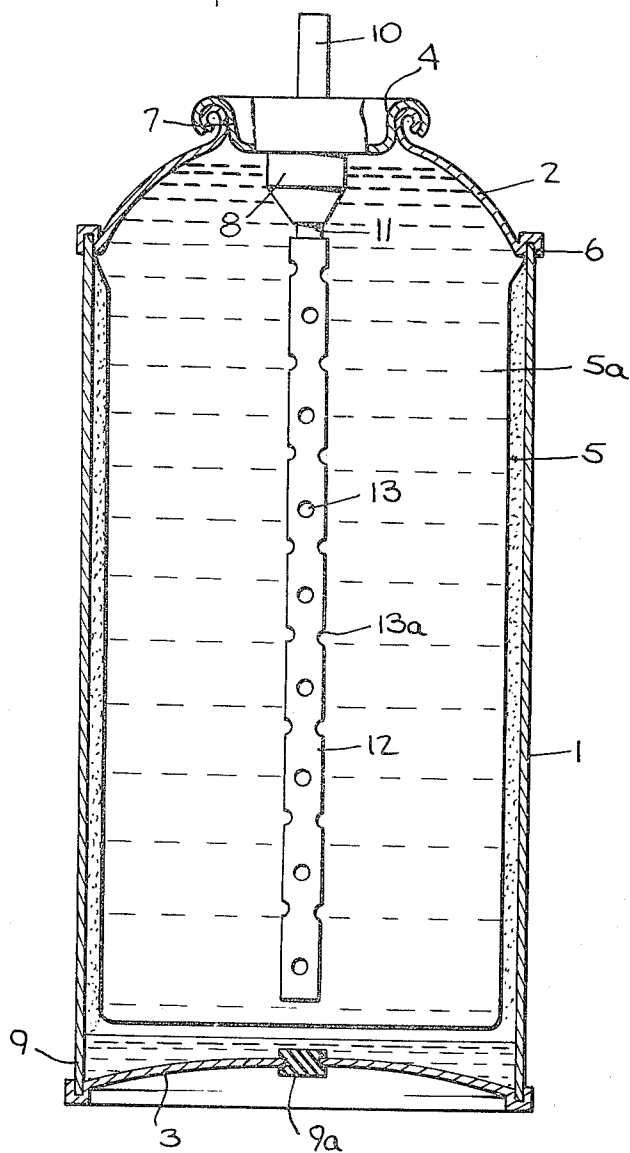
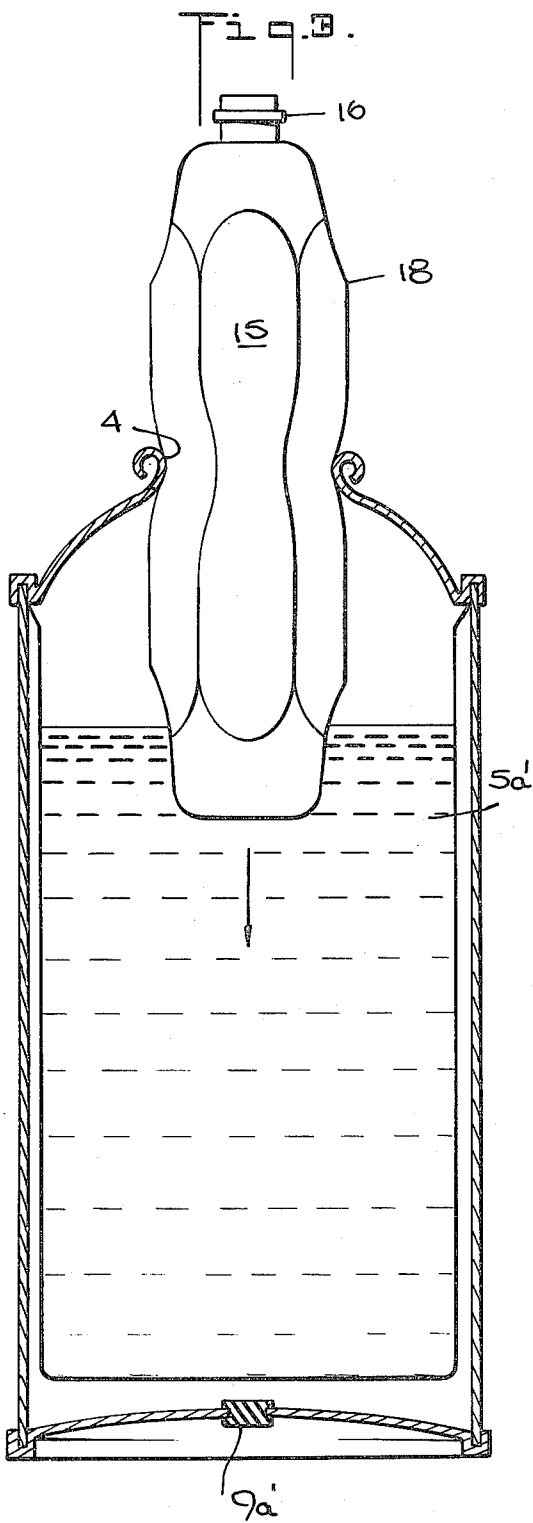
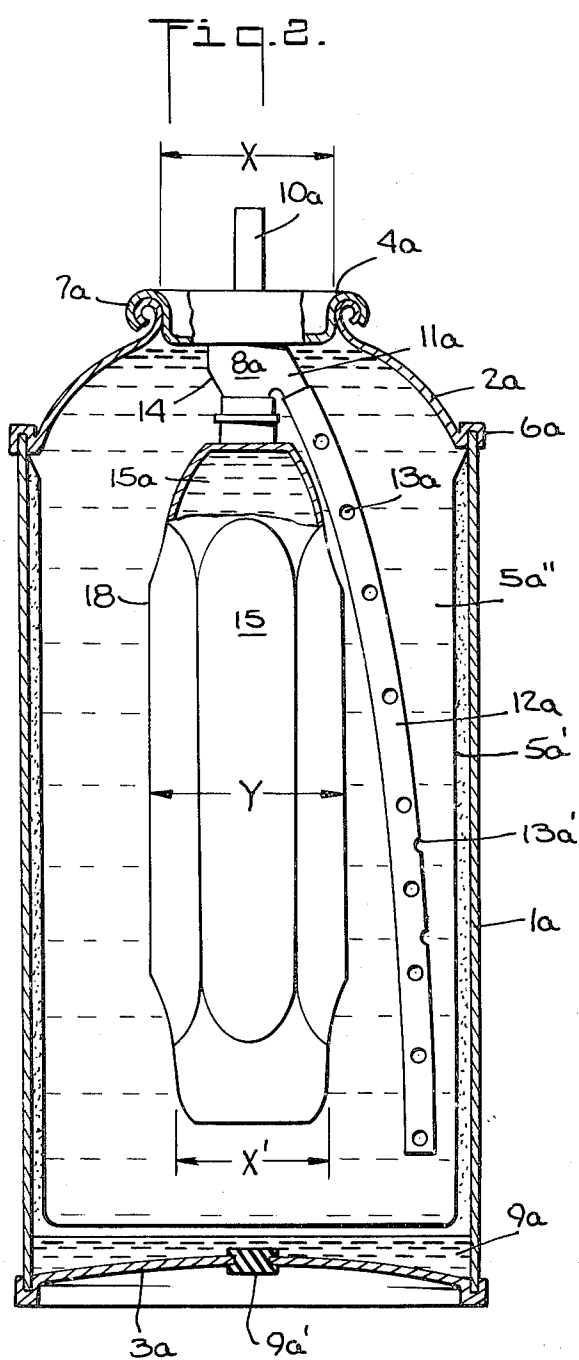


Fig. 1.





AEROSOL PACKAGE OF PRODUCT CONTAINING LIQUIFIED GAS

This is a division of application Ser. No. 270,560 filed July 10, 1972 now U.S. Pat. No. 3,788,521.

BACKGROUND OF THE INVENTION

This invention relates to aerosol packages, and it particularly concerns such packages when containing a liquid product in which a liquified compressed gas is intimately dispersed or dissolved.

For example only, aerosol packages of the shampoo, hair coloring and shaving cream type contain formulations which are usually oil-in-water type emulsions, with the liquified compressed gas intimately dispersed in the water solution. When the emulsion is discharged to the atmosphere, evaporation of the liquified gas to its vapor phase causes the development of foam. In the case of hair coloring formulations, the package may contain a collapsible flexible container containing a liquid peroxide solution and have a codispensing valve having two inlets respectively connected to the two liquids. The liquified gas in the hair coloring formulation acts as a propellant to both produce a foam and to discharge the formulation through this valve, and also to apply extrusion pressure to collapse the flexible container so that its contents are simultaneously discharged, the valve being designed to proportion the two liquids as required to produce the desired hair coloring effect.

DESCRIPTION OF THE PRIOR ART

A major part of the prior art is disclosed effectively by the text "Aerosol: Science and Technology", edited by H. R. Shepherd, and published in 1961 by the Interscience Publishers, Inc., New York, New York. The contents of this text are hereby incorporated into the present disclosure.

In the majority of aerosol packages, a liquified compressed gas propellant is intimately dispersed or dissolved in the product. Ordinarily, this propellant serves a dual purpose. First, it provides the self-contained force necessary to extrude or eject the product from the package container; and second, after the product has been extruded into the atmosphere, this propellant undergoes an almost instantaneous flash evaporation or conversion to its vapor phase intended to leave the product in a predetermined physical form.

Heretofore, such a package has comprised a rigid container which is usually a metal can, provided with an aerosol valve connecting with a standpipe inside of the can, with the latter containing the product in which the liquified compressed gas propellant is intimately dispersed or dissolved. As previously indicated, shampoo, hair coloring and shaving cream aerosol packages are examples.

Ordinarily, the user of such a package actuates it so as to discharge only a small percent of its contents per day, or otherwise at intermittent intervals over a long time period. With prior art packages, the physical characteristics, such as overrun and density in the case of foam products, present problems as the package approaches more or less closely the point where no more product can be extruded.

Overrun, in effect, means the amount of product remaining representing a loss of the product to the user. Density is of particular importance in the case of foam-

ing products, continued use of the package resulting heretofore in a continuous change in the density until finally usually with a large overrun, only a sputtering or erratic discharge is obtained. This changing density is annoying in the case of shampoo and shaving cream formulations, as examples, but it may be disastrous in the case of a codispensing package where the two products in the can must be dispensed with rather exact proportioning of the two.

Shampoos and shaving cream formulations are usually oil-in-water type emulsions, with the required compressed gas propellant intimately dispersed in the water solution; and in the case of this type of product, the prior art has provided no adequate solution to the above problems insofar as is known. In the case of certain codispensing packages, such as hair coloring packages, the only solution so far known has been to make the package in the form of a one-shot application package designed for a single usage as contrasted to a series of one-shot applications extending over a long time period. It is understood that another possibility might be to use a hair coloring package of larger size but actuated by professional hairdressers who from experience understand the varying hair color effects that will be obtained as the foam density changes and apply the coloring to different customers. This latter practice is unsuited for use by individuals, because after the initial coloring effect is obtained, further touch-up applications are unpredictable because different coloring effects are obtained.

As an incidental annoyance, common to all prior art aerosol packages, the package must be operated only in a mainly upright condition. This is because there is a vapor space above the product containing the liquified compressed gas propellant, so that when the package can is inverted, only vapor is ejected with no ejection of the desired product.

SUMMARY OF THE INVENTION

With the foregoing in mind, one of the objects of the present invention is to provide an aerosol package containing a product in which a liquified compressed gas is intimately dispersed or dissolved and which will smoothly extrude or eject the product with a negligible or greatly reduced overrun and without appreciable change in the density of the product, particularly when the package is intermittently used over a prolonged time period. In the event of a package containing a product in which a liquified or unliquified compressed gas is intimately dispersed or dissolved so as to involve the same kind of problems, another object is to achieve the same results as just described, in such instances also.

According to the invention, an aerosol package of the so-called diaphragm system type is used. In the prior art such a package has been used only to separate two incompatible formulations, or to separate a product from the propellant providing the extruding pressure. This type of package comprises a rigid outer container, such as the usual aerosol metal can, inside of which is located a collapsible flexible container which receives the vapor pressure of the propellant and thereby the product discharging force.

However, in the case of the present invention, the collapsible flexible container is charged with the liquid product in which the liquified compressed gas is intimately dispersed or dissolved for the purpose of con-

verting the product into a desired physical form when discharged into the atmosphere. Further, a liquified compressed gas propellant is charged in this can's rigid container between the latter's inside and the outside of the collapsible flexible container. This second propellant is selected as one having a vapor pressure substantially greater than that provided by the product's liquified gas as it is intimately dispersed or dissolved in the product. Preferably this second propellant should have a vapor pressure at least about 5 pounds per square inch gauge higher, plus the collapse pressure of the flexible container, than the vapor pressure imparted to the product by its liquified gas as it is widely dispersed or dissolved in the product.

The effect of the invention is to always maintain the liquified gas in the product in its liquid phase during the discharge of this product through the aerosol package valve when there would otherwise be a pressure drop resulting in the product's liquified gas converting to its vapor phase within the product and producing gas bubbles which have now been found to result both in undesirably high overruns and ejected product density changes.

Preferably the collapsible flexible container is one having the lowest possible collapse resistance pressure compatible with impermeability. In such an instance, the flexible container collapses and may block off the valve inlet, a standpipe ordinarily not being indicated for use with this invention because the flexible container has no air space since it is maintained under compression or pressure by the vapor pressure of the propellant on its outside between it and the rigid container's interior. The present invention solves this blockage problem by the use of a standpipe flexible enough to deform and prevent damage to the collapsing flexible container and which has a series of openings through its wall extending along its length. With this arrangement, it becomes impossible for the collapsing flexible container to block off the discharge of its contents.

In addition to the advantages described, a package made according to the invention can be operated in any position, including a completely inverted position. Vertical rotation in the axial plane of the package through 360° does not interfere with the discharge of the package contents in any way.

DESCRIPTION OF THE DRAWINGS

The above and other principles of the present invention are disclosed hereinafter with the aid of the accompanying drawings in which:

FIG. 1 is a vertical section of an aerosol package embodying some of the principles of the present invention;

FIG. 2 is a vertical section of another example showing more of the principles of the present invention; and

FIG. 3 shows the FIG. 2 construction during an assembly phase.

DETAILED DESCRIPTION OF THE DRAWINGS

In FIG. 1, the rigid container is shown as a commercially available aerosol package metal can having a cylindrical wall 1, a domed top 2, and an internally convex bottom 3 and a mouth 4, the internal collapsible flexible container 5 being in the form of a very thin-walled fluid-imperious bag 5 having its wall spaced only slightly inwardly from the can wall 1 and bottom 3, and with its upper peripheral edge clamped fluid-

tightly by the mechanical seam 6 of the can. Such a can is manufactured currently by the American Can Company and sold under the trademark "STERIGUARD". The collapsible flexible container 5 has a collapse pressure of not more than about 2 pounds per square inch gauge. The mouth 4 of the can is closed by a cup 7 mounting an aerosol dispensing valve 8 having an actuating and dispensing tubular stem 10 and an inlet 11, the latter being provided with the flexible standpipe 12 having a series of either holes 13 or notches 13a, or both, extending throughout its length.

An oil-in-water emulsion 5a in which a liquified compressed gas is widely distributed, and to some extent dissolved, completely fills the collapsible container 5; and a liquified compressed gas propellant 9 is inserted in the can by needle penetration of a rubber grommet 9a in the bottom 3. There is only a low level of this liquid propellant 9 in the can, but its vapor pressure extends throughout all of the space between the can and the flexible container 5, as is indicated by dots in FIG. 1. The vapor pressure of the propellant 9 on the collapsible flexible container 5 keeps the product 5a under compression or pressure so that the latter completely fills the container 5 and the can top 2, while keeping the product 5a under adequate compression or pressure to prevent any of its components from converting to gas or vapor phase. Also, this vapor pressure applies extrusion or discharge force to the product.

Depending on the formulation, the vapor pressure of the liquified compressed gas in the product might range from about 4 to about 40 pounds per square inch gauge, and the vapor pressure of the propellant 9 should be about 5 pounds per square inch gauge higher than the vapor pressure of the gas in the product as it is intimately dispersed or dissolved therein, plus, of course, the collapse resistance of the flexible container 5 which is, in this instance, about 2 pounds per square inch gauge. This assumes that the package is at room temperature or about 70°F. In any event the vapor pressure of the propellant 9 should be high enough to keep the product 5a under adequate pressure or compression, even when the valve 10 is opened when there would be a pressure drop in prior art packages, to prevent any portion of the product 5a from converting to its vapor or gas phase.

This new package has the great advantage that the discharged product is of uniform consistency and density throughout the life of the package, even when used intermittently during a long time period, and substantially all of the product 5a is finally ejected so that practically none remains in the package ultimately. The package is operative even if inverted.

To demonstrate the above advantage of consistent uniform density, two cans or packages, marked No. 1 and No. 2, were made up substantially like that illustrated by FIG. 1, and two other cans or packages, marked No. 3 and No. 4, were made up with the same can dimensions and the same flexible container 5 as cans No. 1 and No. 2, but with a standpipe that was solid throughout its length in the conventional fashion instead of being perforated as shown in the case of the standpipe 12. Further, no propellant was injected into the cans No. 3 and No. 4 such as would correspond to the propellant 9 in FIG. 1. In other words, cans No. 1 and No. 2 were made as shown by FIG. 1; and cans No. 3 and No. 4 were made up in substantial accord with the prior art, excepting for the flexible container 5

which was included to show that as a can-lining it could not affect testing procedures. Cans No. 3 and No. 4 had the usual head space above the liquid load existing in all corresponding prior art packages, this necessitating the use of the solid, unperforated, standpipes in these cans.

The inner flexible container 5 of all four cans in each instance was charged with 190 grams of a shaving cream formulation and 6½ grams of a liquified compressed gas propellant; namely, isobutane having a vapor pressure of 31 pounds per square inch gauge at 70°F. In each of the cans No. 1 and No. 2, in accordance with the present invention, 16.5 grams of a higher vapor pressure liquified compressed gas propellant, namely Propellant 12 (sold under the trademark "FREON 12"), having a vapor pressure of 72 lbs. per square inch gauge at 70°F., was introduced between the cans inside and the outside of the flexible container. All four cans were stored for 24 hours at 70°F. and thereafter were uniformly shaken and extruded in 20 gram increments every 24 hours until the cans could no longer effectively eject their contents.

The Propellant 12 was injected in cans No. 1 and No. 2 through the usual rubber grommet 9a in the cans without the use of a vacuum chamber, so some air was included with the propellant in these instances.

After each 20 gram extrusion, a portion of each extrusion was discharged into a 50 cc container to permit a density determination in the usual manner, this being done as to all four cans.

Under the foregoing conditions, the following results were obtained:

Grams Extruded	Present Invention				Prior Art			
	Can No. 1 PSIG.	Can No. 1 Dens. G/cc	Can No. 2 PSIG.	Can No. 2 Dens. G/cc	Can No. 3 PSIG.	Can No. 3 Dens. G/cc	Can No. 4 PSIG.	Can No. 4 Dens. G/cc
0-20	87	.075	85	.077	34	.080	35	.080
20-40	85	.075	84	.077	34	.080	34	.082
40-60	84	.075	82	.077	34	.082	34	.087
60-80	83	.075	81	.077	33	.081	33	.092
80-100	81	.075	79	.077	33	.097	33	.100
100-120	82	.075	78	.077	31	.117	31	.125
120-140	79	.075	76	.077	29	.135	30	.135
140-160	78	.075	75	.077	28	.160	28	.175
160-180	78	.075	76	.077	26	.242	27	.262
180-196	77	.075	75	.077	18	.242	17	.262

It can be seen from the above that in the case of the present invention, represented by cans No. 1 and No. 2, there was practically no change in the density of the product ejected during each 24-hour period. The pressure in pounds per square inch gauge dropped because the Propellant 12 included some air, as previously mentioned, so that the effect of this compressed but unliquified gas exerted its influence. However, throughout the test the vapor pressure of the Propellant 12 was adequate to keep the gasified soap formulation propellant from converting to vapor or gas phase, as to any or all of its components, so this pressure drop did not affect the uniform foam density of the product obtained throughout the test.

The importance of the above is highlighted by reference to the test data of the prior art cans No. 3 and No. 4. Here the density of the extruded product increased from 0.08 to 0.242 and 0.262, respectively, while the can package pressure reduced from 34 to 18 pounds per square inch gauge in the case of can No. 3 and from

35 to 17 in the case of can No. 4. These effects resulted from the fact that as the contents of the prior art cans No. 3 and No. 4 reduced, more and more of the propellant vapor was lost because of its converting to its vapor or gas phase in the can, the density of the ejected product correspondingly increasing throughout the life of the test. In the case of a shaving cream formulation, for example, this increase in density would result in the cream becoming runnier and runnier, and finally in the characteristic sputtering experienced with prior art packages and, consequently, a substantial amount of the product remaining in the can as waste.

In the case of a hair coloring foam formulation in co-dispensing hair coloring aerosol packages, this density increase would result in vast misproportioning in the foam dye formulation relative to the liquid peroxide solution simultaneously ejected.

As indicated by the tabulated data, the present invention avoids all of these problems because of the uniform density of the product extruded throughout the life of the package.

Macroscopic examination of the foam's product from the cans using the invention and the prior art cans, at 20x magnification, clearly showed that in the discharge of the present invention, there were no large gas bubbles, whereas such gas bubbles were very obvious in the case of the discharge from the prior art cans. These gas bubbles formed when the dispensing valve was operated and the product propelled solely by the propellant distributed or dissolved in the product, it appearing that the apparatus drop occurring when the valve was opened permitted the product's gas to convert to its

vapor or gaseous phase and form relatively large gas bubbles, resulting in the very large density change in the intermittently discharged product. These gas bubbles of necessity changed the density and thus altered its physical characteristics from that desired, and resulted in excessive loss of the propellant gas with a consequent large pressure reduction in the package preventing complete discharge of all of the contents of the package. In the case of the present invention a smooth discharge of constant density of foam throughout the life of the tests was obtained; the discharged product had a uniform density and maintained a predeterminable physical characteristic in every way insofar as was detectable. There was no waste possible, as an inherent advantage.

It is to be understood that a liquified compressed gas propellant, when dissolved in the liquid product, results in a lowered vapor pressure according to the law of partial pressures. When widely dispersed in the product, as in the case of an oil-in-water emulsion, the vapor pres-

sure that results substantially corresponds to that of the propellant, excepting that to the degree the propellant might go into solution even in such instances. It follows, therefore, that in some instances exactly the same propellant may be dissolved in the liquid product more or less, with a resulting overall lower vapor pressure, as is also used between the flexible container and the can where the propellant maintains its full inherent vapor pressure.

Normally the propellant dispersed or dissolved in the product to be discharged would be liquified compressed gas having a vapor pressure ranging from about 3 to about 40 pounds per square inch gauge, while the vapor pressure of the propellant on the outside of the flexible container 5 should be a liquified compressed gas having a vapor pressure at least about 5 pounds per square inch gauge higher than the vapor pressure of the gas in the product as or while the latter is intimately dispersed or dissolved therein, plus, of course, the collapse pressure of the flexible container itself. This collapse pressure must be deducted from the vapor pressure of the propellant outside of the flexible container when calculating the higher pressure required.

Because of safety regulations in general, the internal pressure of an aerosol package is limited, and, therefore, it is not believed that the collapse pressure of the collapsible flexible container 5, or its counterpart, should exceed 20 pounds per square inch gauge. Preferably, the collapse pressure of this flexible container should be kept as small as possible consistent with reliable impermeability and freedom from damage such as when the package is shaken.

Concerning shaking of the package, it is to be understood that most packages containing an emulsion or the like require shaking just prior to use. With the present invention the flexible container 5, or its counterpart or equivalent, is in equilibrium so far as fluid pressure is concerned. The vapor pressure of the propellant 9, indicated by dots, is applied throughout the outside of the flexible container 5 and the product 5a also in this container 5 exists under a corresponding fluid pressure regardless of its own vapor pressure. Therefore, the container 5 is capable of flopping about within the can during shaking when required and thus agitates its contents.

Because the propellant 9 is confined against any possible loss, there is no loss of this propellant as there is in prior art packages where the propellant must function not only to modify the discharged product but also to effect its discharge. The production of the previously described gas or vapor bubbles results in a constant loss of this propellant with a consequent density change and low value of overrun in the case of prior art packages. Because these prior art packages have a vapor space above the liquid product they cannot be operated except in a more or less upright position, whereas with the present invention there is no such limitation in the operating position.

FIGS. 2 and 3 illustrate the principles of this invention applied to an aerosol codispensing package, and because of the exacting demands of a hair coloring package that can be used intermittently over a prolonged time period without change in its coloring effect, which is beyond the ability of the prior art, such a package is chosen as an example.

Now having reference to FIGS. 2 and 3 of the drawings, a metal, and therefore relatively rigid, can is made

of sheet metal and has a cylindrical side wall 1a, a domed top 2a and a concave bottom 3a, the top having a valve mounting cup opening 4a which, according to today's standards, would usually be one inch in diameter. A flexible container 5a' is inside of the can and is in the form of an open-topped bag having its top periphery clamped in a mechanical seam 6a between the side wall 1a and the top 2a of the can. The can's top opening 4a is closed by a so-called one-inch valve cup 7a in which an aerosol codispensing valve 8a is mounted.

The container 5a contains the liquid or fluid product including the liquified gas, this product being indicated in the drawings at 5a''. In this instance it would be an oil-in-water emulsion containing the hair coloring and in which the liquified compressed gas is intimately distributed or dissolved. The valve mounting cup 7a is applied to the can's opening 4a after the container 5 is filled with the gasified product. The liquified compressed gas propellant 9a is injected in the can through the rubber plug or grommet 9a'. It is this propellant 9a that has the substantially greater vapor pressure than does the liquified gas as it is distributed or dissolved in the product in the container 5a, at least at usual room temperatures. The container 5a has adequate flexibility to transmit substantially all of the fluid pressure exerted by the vapor pressure of the fluid propellant 9a to the product inside of the container 5a.

The valve 8a is of the normally closed type and is opened by finger pressure on its tubular dispensing stem 10a, the product in the container 5a entering the valve 8a through an inlet nipple 11a. Opening of the valve to dispense the product results in the vapor pressure of the propellant 9a extruding the product through the stem 10a with the product functioning as intended in the atmosphere; its liquified gas, upon extruding, converting to its gaseous phase. By choosing as the propellant 9a a liquified compressed gas having an adequately high vapor pressure, this gas in the product is prevented from converting to its vapor phase within the container 5a, resulting in a smooth extrusion of the product through the stem 10a with all of the previously described advantages.

It is to be understood that the quantity of propellant 9a in the can must be enough to apply the desired high vapor pressure continuously to the outside of the container 5a until all of the product in the container 5a is extruded.

The container 5a must not only be impervious to the liquified gas propellant and to the product in the container 5a which includes that liquified gas, but also it must be as flexible as possible. As previously noted, aerosol cans are commercially available having the general configuration shown by the drawings and with a flexible bag made in the can, as indicated by the drawings; there are manufactured currently by the American Can Company and sold under the trademark "STERI-GUARD", also previously noted. The containers in these cans corresponding to the container 5a have adequate imperviousness to fluids and a collapsible pressure of less than 2 pounds per square inch gauge. In the practical sense, substantially all of the vapor pressure exerted by the vapor of the liquified gas propellant 9a is applied to the contents of the flexible container which corresponds to that shown at 5a in the drawings. These cans are normally charged with the liquified gas propellant through their bottoms.

In practicing the present invention, it was found that the great flexibility of the container 5a introduced the problem that as this container collapsed as the product was extruded, the container blocked or closed the inlet 11a to the valve 8a, as previously noted. However, when the flexible tube, shown at 12a in the drawings, is connected to the inlet nipple 11a of the dispensing valve, and is provided with a lengthwise series of openings, such as the holes or notches 13a and 13a', this trouble is corrected, even if the container 5a collapses inwardly and possibly actually folds around the tube 12a, and the tube 12a itself possibly became contorted. Always one or another of the openings remain effective to provide a passage for the product from the container 5a so that a positive extrusion of the product always results. More than one series of the openings may be used with one series circumferentially displaced relative to the other, or the lengthwise series of notches may be used.

The valve 8a is of the codispensing type, and therefore, has a second inlet 14 with which a second flexible container 15 is connected. This second container is located inside of the container 5a and receives the fluid pressure from the product in the container 5a and to which the vapor pressure created by the liquified gas propellant 9a is applied through the flexible container 5a. This pressure applied to the outside of the container 15 extrudes its contents also when the valve 8a is operated.

Assuming that the codispensing valve 8a is correctly designed to properly proportion the two extruded products, these proportions will be maintained throughout all or substantially all the life of the package because the extruded product always has substantially the same density and other predetermined characteristics, as previously noted.

As contrasted to the current one-shot package of aerosol hair coloring, required for home or personal use by the limitations of the prior art, the illustrated package may be made large enough to provide a multiplicity of one-shot applications and can be used to touch-up the hair after the initial application of coloring, for example, because the coloring effect is unchanging due to the consistent characteristics of the product 5a'' when extruded.

In this case of hair coloring, as an example, the hair coloring formulation contains the liquified compressed gas to produce a coloring foam while the inside container 15 contains a peroxide solution liquid, indicated at 15a, which normally does not contain a gas propellant. Therefore, this container 15 may be made of material which, although flexible, is stiff enough to permit its manipulation during assembly of the package as described hereinafter. However, its collapse pressure should not be so great as to prevent reliable extrusion of its contents under the fluid pressure applied to it by the contents of the container 5a. The tube 12a is made of material which is not excessively resistant to bending or other deformation such as might result in damage to the collapsing container 5a.

To demonstrate the practicality of the present invention, packages have been made using the principles disclosed by FIG. 2. 35 grams of a 10% water solution of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) was placed in the inner containers which corresponded to the container 15. In the outer container 5a, 155 grams of a soap solution was placed, this solution being outlined by the text

"Cosmetics Science and Technology", published by Interscience Publishers, Inc., New York, 1957 on page 832, Formula No. 16. The soap solution included 6.7 grams of isobutane having a vapor pressure at room temperature (approximately 70°F.) of about 31 pounds per square inch gauge. 10 grams of Propellant 12 (CCl_2F_2) were placed in the cans corresponding to the illustrated can between the inside of the cans and the outsides of the containers 5a. This liquified gas propellant, when the packages were at room temperature, provided a vapor pressure of about 72 pounds per square inch gauge. This liquified gas is sold under the trademark "FREON 12", as previously mentioned. The valves used were accurately operating codispensing valves designed to dispense at a 4:1 ratio between the soap or foam solution product and the non-foaming solution in the containers corresponding to the container 15.

To test the operation, a piece of aluminum was placed on a balance and tared for 100 grams net. The product from the package was partially extruded on one end of the aluminum plate initially and the last portions of the foaming product on the other end of the plate. In this manner it was possible to analyze the percent of sodium thiosulfate in the initial and final portions of the extruded product. Three of such packages were tested in the above manner with the results shown below:

	Cans		
	1	2	3
% $\text{Na}_2\text{S}_2\text{O}_3$ initially	1.74%	1.82%	1.94%
Last portion of 100 grams	1.83%	1.80%	2.04%

The above noted differences between the first and last portions of the extruded product are in each instance well within the demands of accuracy in the case of a foaming hair coloring composition containing the usual liquified gas, and the non-foaming peroxide solution which must be mixed with this product during the dispensing action. This accuracy was obtained because the foaming product did not experience the previous troubles, the liquified gas remaining in the product widely and intimately dispersed in liquid form until dispensed to the atmosphere through the dispensing valves.

It is to be understood that the foaming or other gasified product may contain any liquified or unliquified compressed gas which can be contained by the product in solution or dispersed from and if it presents the problems described hereinabove, as exemplified by oil-in-water emulsions in which a liquified compressed gas is widely and intimately dispersed, providing this gas does not provide an excessive vapor pressure at room temperature and keeping in mind that it must provide a lower vapor pressure than that of the liquified gas propellant. The vapor pressure of the latter must be higher so that it can perform its function of preventing the gasified product from converting to its vapor phase. At the same time the liquified gas propellant compressing the product must have a vapor pressure low enough to meet can safety and shipping requirements.

It is believed reasonable to state that the gas in the gasified liquid product, which may include various components and even two or more liquified or com-

pressed gases, should have a vapor pressure ranging from 3 to 40 pounds per square inch gauge at 70°F. The liquified gas acting as the compressor and propellant, and this may include two or more liquified gases, should have a vapor pressure at least 5 pounds per square inch gauge at 70°F., plus the collapse resistance of the flexible container, in excess of the particular vapor pressure of the liquified gas or gases as they are dispersed or in solution with the gasified liquid product in this container. Enough of this liquid gas propellant should be used so that until all or substantially all of the gasified product is extruded, this pressure differential continues.

In the previously noted tests of these cans, the flexible containers corresponding to the container 5a had a collapse pressure of less than 2 pounds per square inch gauge fluid pressure. Therefore, the reduction it made in the pressure applied to the gasified product by the liquified gas propellant was negligible. Obviously the use of a stiffer container would require a higher pressure differential between the liquified gas propellant vapor pressure and the vapor pressure of the liquified gas in the gasified product, keeping in mind that if in solution with the gasified liquid or liquids, the vapor pressure may be lowered.

A codispensing package could be made in accordance with the principles of this invention with a can containing two separate containers having the same degree of flexibility as the container 5a, and these could be arranged side-by-side in the can (not shown). However, there is at present no commercially available container of this type or one that is capable of being handled by present-day, commercial, necessarily high-production packaging equipment. With such two or more separate containers side-by-side, the package could be made to contain equal proportions of the fluid components if desired.

Recognizing the above, the package shown by the drawings incorporates in a generally accurate manner the commercially available can having the flexible bag 5a incorporated in its construction by the can manufacturer. As previously indicated, the diameter of the hole or mouth 4a in the top of the can has the standard one-inch diameter. During assembly of the package the container 5a may be charged with the gasified product through this hole by cold filling. The container 15 is inserted through this one-inch hole 4a, being held by the fingers of automatic machinery by a rib 16 formed on the neck of the container 15 to prevent the latter from dropping completely into the can. The container 15 is then filled, the inlet 14 of the valve 8a is inserted in its neck with a press fit or otherwise so as to be retained, and the valve assembly 8a has its mounting cup 7a crimped around the mouth of the can. The correct amount of liquified gas propellant is charged through the rubber grommet 9a' in the bottom of the can and the package thus is substantially completed. The above means that ordinarily the container 15 must have a diameter of less than one inch to permit its insertion through the hole or mouth 4a. In the drawings the mouth diameter is indicated at X, it being possible that the standard one-inch size may be varied. The length of the container 15 is, of course, limited in length by the can's length and, as just explained, its diameter is limited by the diameter of the can's mouth or top opening.

According to the present invention, the container 15 may be made with a diameter greater than that of the

mouth opening 4a, without sacrificing its degree of rigidity required to permit its being handled by automatic machinery.

As shown by the drawings the container 15 is made with its opposite ends 17 having a very slightly smaller diameter X' than the diameter of the top opening of the can. Between these extreme end portions 17, the container 15 has longitudinally extending, radially outwardly projecting ribs or bulges 18, each of substantial peripheral extent. As shown by the drawings, these ribs or outwardly projecting flutes provide the container with a diameter indicated at Y which is substantially greater than the diameter X. Therefore, when the container is in the package, the container 15 has a substantially greater volumetric capacity than if it were made with the typical prior art cylindrical shape with a maximum diameter of slightly less than one inch as required for its passage through the can's top opening.

As shown by FIG. 3, these outwardly extending bulges or ribs 18 deflect inwardly during insertion of the container 15 in the can. The container may be made of a plastic that is suitably inert to the liquids and fluids it must contact, and this plastic should be of such a character and thickness as to provide the container with the rigidity necessary to permit its being handled by the automatic machinery, while at the same time being flexible enough, as previously described, to result in dispensing of the product in the package. The container may be blow molded or otherwise formed with either the specific contour illustrated or otherwise to permit insertion of its lower end 17 in the can's mouth and by pressure forced to be pressed completely in the can.

After insertion in the can's mouth, as indicated by FIG. 3, the container's rib 16 may be or continues to be engaged by the automatic machinery fingers. The top one of the cylindrical portions 17 of the container permits the container to be held with its top at or above the can's mouth during filling of the container 15. It is to be understood that the container 15 may have any radial contour permitting its insertion through the mouth of the can while radially contracting, and which thereafter expands to a larger diameter.

Products containing a dissolved, non-liquified, compressed gas to any extent may involve the same problems as products containing a liquified compressed gas, and in such instances, the principles of the present invention are applicable. The propellant and compressed gas between the flexible and rigid containers may also be a compressed unliquified gas, but because of its decreasing pressure with expansion and the limited space available for its use, a liquified gas is definitely preferable.

As explained above, when the present invention is applied to a codispensing hair coloring package, the two components are extruded to provide exact proportioning between them even when the package is operated intermittently over a prolonged time period. However, since the propellant between the flexible container and the rigid container or can is preferably a liquified compressed gas, it follows that the rate of discharge will vary within somewhat wide limits when the intermittent operations occur at different temperatures. It is a characteristic of a liquified compressed gas that its vapor pressure is dependent on its temperature. In other words, when different one-shot applications are made with the hair coloring package of the present

invention, the extrusion rate of the two components, although the components are properly proportioned, is dependent on the temperature of the package. Because of the exact proportioning effected at the differing temperatures in the case of the present invention, it is possible to establish tabulated data showing the different time periods of discharge for different temperatures required to always extrude the same amount of the properly proportioned components.

For example, if with a particular hair coloring formulation and peroxide solution, a ten second discharge at 70° provides a predetermined coloring effect intended to be produced by the user of the package, the tabulated data might show that to produce the same effect a twelve second discharge at 68° and an eight second discharge at 75° would be required to produce the same exact hair coloring effect. The same principle would be applied to minor touch-up hair applications, only the time periods would be shorter. This tabulated data could be, for example, applied to the outside of the can so that the user, by reference to a thermometer and a timing device, could always produce the same coloring results. The time periods suggested are, of course, purely exemplary and may vary widely with differing formulations and with differing propellants.

What is claimed is:

1. An aerosol package comprising a substantially rigid container having a dispensing valve, a collapsible flexible container inside of said rigid container and internally fluid connected to said valve and containing an extrudable product in which liquified compressed gas is intimately dispersed or dissolved, said product being adapted to be dispensed through said valve, and liquified compressed gas propellant between said containers and applying fluid pressure to said flexible container and which is transmitted therethrough to said product to extrude said product upon operation of said valve, said propellant having a vapor pressure substantially greater than the vapor pressure of said gas in said product while intimately dispersed or dissolved therein, said liquified gas in said product normally tending to form gas bubbles interfering with a uniform extrusion of said product and the vapor pressure of said propellant being great enough to apply enough compression to said product through said flexible container to prevent formation of said bubbles, said package including a flexible tube by which said flexible container is connected to said valve, said tube extending from said valve a substantial distance within said flexible container and said tube having a lengthwise series of openings in its wall, said flexible container collapsing as said product is extruded therefrom and said openings preventing blockage of said tube by said collapsing container.

2. An aerosol package comprising a substantially rigid container having a dispensing valve, a collapsible flexible container inside of said rigid container and internally fluid connected to said valve and containing an extrudable product in which liquified compressed gas is intimately dispersed or dissolved, said product being adapted to be dispensed through said valve, and liquified compressed gas propellant between said containers

and applying fluid pressure to said flexible container and which is transmitted therethrough to said product to extrude said product upon operation of said valve, said propellant having a vapor pressure substantially greater than the vapor pressure of said gas in said product while intimately dispersed or dissolved therein, said liquified gas in said product normally tending to form gas bubbles interfering with a uniform extrusion of said product and the vapor pressure of said propellant being great enough to apply enough compression to said product through said flexible container to prevent formation of said bubbles, said rigid flexible containers forming therebetween a space and said liquified compressed gas having a volume substantially less than the volume of said space, said flexible container being capable of flopping about within said space when said rigid container is shaken and said dispensing valve having an inlet which the flexible container is capable of blocking as the flexible container collapses, the dispensing valve's said inlet having an extension in which a plurality of holes are formed and which prevents said blocking, said extension leaving said flexible container substantially free from restraint to its said flopping about within said space, said liquified compressed gas forming vapor in said space and thereby applying said fluid pressure to said flexible container.

3. The package of claim 1 in which the vapor pressure of said gas in said product ranges from about 3 to about 40 pounds per square inch gauge, and the vapor pressure of said propellant is at least about 5 pounds per square inch gauge higher than the vapor pressure of said gas while intimately dispersed or dissolved therein, plus the collapse resistance of said flexible container; when said package has a temperature of approximately 70°F.

4. The package of claim 1 in which said liquified gas in said product converts to gas or vapor phase when said product is dispensed to the atmosphere, and thereby alters the physical form of said product.

5. The package of claim 1 in which the vapor pressure of said gas in said product ranges from about 3 to about 40 pounds per square inch gauge, and the vapor pressure of said propellant is at least about 5 pounds per square inch gauge higher than the vapor pressure of said gas in said product while intimately dispersed or dissolved therein, plus the collapse resistance of said flexible container; when said package has a temperature of approximately 70°F.

6. The package of claim 3 in which said flexible container collapses when under an external pressure of less than 20 pounds per square inch gauge.

7. The package of claim 5 in which said flexible container collapses under an external pressure of less than approximately 20 pounds per square inch gauge.

8. The package of claim 2 in which said rigid container is a can having a side wall and a top, the peripheries of the side wall and top being clamped in a mechanical seam, and said flexible container is an open-topped bag having its top peripherally clamped in said mechanical seam.

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