Nov. 9, 1965 W. H. KIBBEL, JR., ETAL 3,216,463

DISPENSING SYSTEM

Filed Nov. 15, 1961

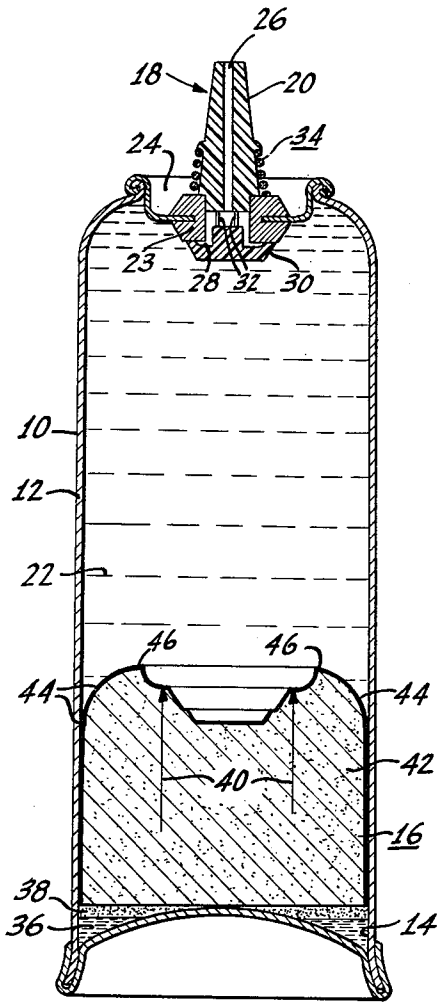


Fig. 1.

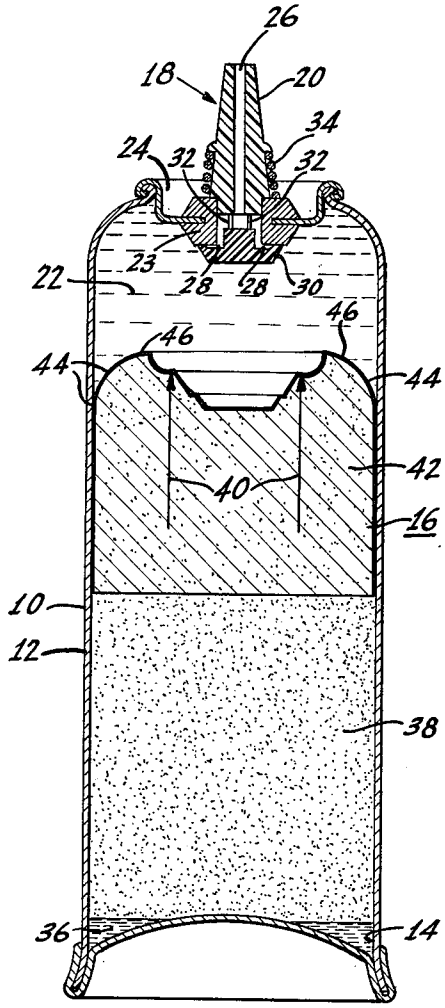


Fig. 2.

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United States Patent Office

3,216,463
Patented Nov. 9, 1965

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3,216,463

DISPENSING SYSTEM

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Filed Nov. 15, 1961, Ser. No. 152,415
1 Claim. (Cl. 141—3)

This invention relates to pressurized dispensing systems for liquid, pasty and the like products and particularly to such systems in which dispensing pressure is provided by a gas separated from the product to be dispensed.

Foodstuffs, cosmetics, insecticides and other consumer products have been packaged in pressurized dispensers, most frequently in systems in which a gas dispersed in the product, upon demand provides a pressure which forces the product and gas through an orifice in the dispenser. Another system which has been employed to provide the dispensing pressure locates the gas above and in contact with the product to be dispensed. In this system the product is forced through an orifice by way of a tube which dips into it.

These systems of dispensing have been suitable for many uses. However, some products are deleteriously affected by the pressurizing gas and therefore do not lend themselves to admixture, or even contact, with gases. Furthermore, the gas in such systems tends to be wastefully discharged, with the result that often a substantial amount of the product remains in the dispenser after the gas has dissipated. Likewise, loading of the dispenser with the product and pressurizing gas has been difficult, requiring either careful pressure or temperature control.

A new type of dispenser has been developed, which provides for separation of the pressurizing gas from the product to be dispensed. The two are separated by a piston means, which is forced against the product by the pressure of the gas. The product in turn is released on demand through an orifice in the chamber of the container in which it is held.

This new system is very useful, avoiding the problems of admixture of the gas with the product, and making it possible to dispense essentially all of the product; that is, the gas does not have access to the orifice, and therefore cannot be wastefully discharged. Furthermore, since the gas is not mixed with the product, foaming and other product modifications are avoided.

In the preferred means for introducing a gaseous pressurizing medium into the pressure chamber of the system, hydrogen peroxide is introduced into the container in an aqueous solution containing also a decomposition agent such as ferrous ammonium sulfate for liberating oxygen from the peroxide. The hydrogen peroxide is decomposed after the container is filled, and dispensing pressure is thereby established.

The hydrogen peroxide solution operates to provide pressure when it is desired, and avoids the necessity of filling the container under pressure or refrigeration, as is required with known pressurizing materials which are gases at room temperature. However, it has been found that the hydrogen peroxide solution causes corrosion of the container even when the container is lined with a protective coating, for example, with phenol formaldehyde resins, vinyl resins, and other materials. This corrosion is evidenced by erratic gas generation and by a serious and potentially dangerous pitting of the container by the solution which is present in the container over long periods of time under adverse temperature and other conditions of storage.

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It is a feature of this invention to provide an aqueous hydrogen peroxide solution for controllably pressurizing dispensers, which can be introduced into the dispenser at ambient pressures and temperatures and separated from the product to be dispensed, and may be housed in the container over long periods of time without hazardous corrosion of the container.

It is a further feature of this invention to provide such a solution which neither contains nor forms poisonous or otherwise harmful ingredients.

It has now been found that these objectives can be achieved and an easily filled and efficiently operating corrosion-resistant apparatus provided for dispensing liquid, pasty and like products from an enclosed cylindrical container having a product chamber containing a product to be dispensed, communication with a valve for discharge of the product to be dispensed, and a pressure chamber separated from the product chamber by a piston means which transmits dispensing pressure to the product in the product chamber, by introducing into the pressure chamber at ambient temperature and pressure, as a pressure-source material, an aqueous solution of hydrogen peroxide and a hydrogen peroxide-decomposition activator containing an alkali such as sodium hydroxide in an amount which will raise the pH of the aqueous solution of hydrogen peroxide and activator to about 4 to 5, and a stabilizing alkaline phosphate such as tetrasodium pyrophosphate in an amount which will raise the pH of the hydrogen peroxide-activator-alkali solution to about 6 to 7, the solution being one which will generate a gas exerting within the container containing the piston and product to be dispensed, a maximum pressure of 20 to 150 p.s.i.g. within about 15 minutes to 15 days after filling, and permitting the solution to generate the required gas for pressurization.

Since the gas-generating solution does not immediately release a substantial amount of pressurizing gas, no back pressure on the piston means, or other complicated filling techniques need to be provided during filling of the container, and the filling operation can be conducted at ambient temperature and pressure. By reason of this feature, it is possible to fill the container from one point, for example from the top of the container.

It has been found that when typical coated steel containers are employed, use of gas-generating solutions consisting only of aqueous hydrogen peroxide and catalysts for peroxide decomposition results in excessive corrosion of the container. Inclusion of the present alkalies and alkaline phosphates in the solution, and maintenance of the solution by this means at a pH of about 6.0 to 7.0 has been found to exert a two-fold effect on the system, both maintaining a proper pH and reducing active corrosion of the container by the gas-generating solution and its reaction products. Regardless of the mechanism by which they operate, however, their use results in a very important decrease in corrosion of the container by the solution of hydrogen peroxide, and makes use of this material possible with safety and economy.

The present gas-generating solution has other important advantages. Where ferrous ammonium sulfate is employed as the catalyst, for example, degradation products from the solution are innocuous, being mostly water and oxygen gas in addition to iron and other innocuous cations and phosphates, materials commonly used in foodstuffs and other consumer products. Thus, it is not harmful to most products, and in the unlikely event that some of it should escape into the product, no harmful contamination would occur. Furthermore, since normally the pres-

surizing gas has no access to the product in the container, essentially all of the product to be dispensed can be discharged from the container without the likelihood of exhaustion of the pressure gas, as is apt to occur with systems in which the pressure-generating gas has access to the dispensary orifice.

The invention will now be described more fully with reference to the attached drawings, in which FIG. 1 is a cross-sectional side view of a container which operates in accordance with the present system, after filling and after generation of pressurizing gas, and FIG. 2 is a cross-sectional side view of the container of FIG. 1 after the product has been partially dispensed.

In the drawings, **10** represents a container for the dispensing of products, such as toothpastes, creams, cosmetics, foodstuffs and other pasty and syrupy products. This container has a chamber **12** for housing the product to be dispensed, and a second chamber **14**, separated from chamber **12** by piston **16**, for containing the pressurizing system. The container is equipped with a dispensing valve **18** normally closed and adapted to be opened to permit controlled release of the product **22** in chamber **12**. The valve may be of any type desired, and in the case illustrated is a tube **20** mounted in a rubber eyelet **23** in the cap **24**, and having a central passage **26** communicating with a number of radial grooves **28** in the upper side of head portion **30** of the valve. Several separate pins **32** connect head **30** with tube **20**, such that when the tube is rocked against the outward pressure exerted by helical spring **34**, product **22** in the container under pressure will be dispensed through passages **28** and **26**.

As shown in FIG. 1 the container, which is filled from the top in the order of the herein pressure source hydrogen peroxide solution, piston, product to be dispensed and valve, is essentially free of gas pressure until after completion of the filling operation. Upon standing, hydrogen peroxide solution **36** undergoes decomposition and forms oxygen gas **38** which exerts a pressure on piston **16**, as shown by arrows **40** in FIG. 2. The piston comprises an open-celled foam cylinder **42**, suitably of natural rubber, having on its top and sides an impermeable film **44**, suitably of polyethylene. The pressurizing gas **38** permeates the foam cylinder **42** and exerts a pressure on the underside of film **44**, which is caused to press against product **22** in product chamber **12**.

The piston then seeks a level within the container at which a like pressure is exerted on it from above by the product to be dispensed, as shown by arrows **46**. When the valve **18** is opened, pressure from the pressure chamber **14** forces product **22** in chamber **12** against the top of container **10** and against valve **18**; upon opening of the valve, the product is forced through passages **28** and **26**, and discharged. It will be seen that the pressurizing gas in chamber **14** has no communication with valve **18**, and therefore will not be lost directly to the atmosphere, or dispensed with product **22**, so that pressure continues to be exerted on product **22** and it may be completely discharged from the container. The valve may be at any point in the container, it being necessary only that there be communication between the product to be dispensed and the valve. Where the valve does not communicate directly with the product, it may be connected with it, for example by a dip tube running from the valve into the product in the product chamber.

The container can be formed of any suitable material which will withstand the pressure of the gas within chamber **14**. The pressure will be at its highest point after decomposition of the hydrogen peroxide in pressure-source solution **36**, and before dispensing of any product, and normally will be no greater than about 100 p.s.i.g.; pressures as low as 20 p.s.i.g., and as high as 150 p.s.i.g., may be employed. Selection of a suitable pressure will depend largely upon the nature of the product being dispensed, with pasty products requiring a greater pressure

for dispensing than is required with low-viscosity liquid products. Normally, the container will be constructed of a metal such as steel, aluminum and the like. It may be coated internally with a corrosion resistant material such as tin, a phenol formaldehyde resin, an epoxy resin, an alkyd resin, a vinyl resin, and the like.

The piston **16** has a core or supporting structure of any inert material which is sufficiently resilient so that it will cause the piston to conform to the inner shape of the container and not permit leakage of gas around its edges, that is, to fit snugly and slideably within the container. Preferably, the core will be composed of foamed natural or synthetic rubber, plasticized vinyl resin, polyurethane resin, or other material which can be provided in the form of an open-celled foam, and will have an impermeable film on its sidewall surface and on the surface in contact with the product to be dispensed. The film will be formed of a resilient, low-friction material such as polyethylene, Teflon, nylon, and the like, in order that a gas-tight seal may be formed and the piston will be freely slideable within the container. In order that the piston will not tilt within the container and permit leakage of gas into product to be dispensed, the piston normally will be longer in its dimension which is lengthwise in the container than it is across the container. Other means may be employed to avoid tilting of the piston, for example, extensions on the piston running along the side of the container may be employed, or other suitable positioning devices employed.

The solution used herein to provide the pressurizing gas is a solution of hydrogen peroxide containing a material which is catalytic to decomposition of the hydrogen peroxide, and in addition, an alkali and a stabilizing alkaline phosphate. The hydrogen peroxide most suitably will be in aqueous solution, and may be introduced at any desired concentration, for example, as the commercially available 35% hydrogen peroxide, or at any other higher or lower concentration. It is important only that the final solution contain an amount of hydrogen peroxide which will generate the amount of oxygen gas required for adequate pressurization throughout the dispensing of all of the product.

The alkali preferably will be sodium hydroxide, although potassium hydroxide and other alkaline materials may be employed. The alkaline phosphate stabilizer suitably will be tetrasodium pyrophosphate, a material which stabilizes the system at a pH of on the order of 6 to 7. It also may be sodium tripolyphosphate or other pyrophosphates or polyphosphates such as the potassium salts and the like. The catalyst system will be one which will provide catalytic decomposition of hydrogen peroxide within the time desired, and where toxicity would be undesirable, which will not provide ingredients which are toxic or highly corrosive, in the system. Preferably, ferrous ammonium sulfate will be employed as catalyst, although other catalysts for decomposition of hydrogen peroxide may be used, such as ferric chloride, yeast, catalase, copper salts such as copper sulfate, copper chloride, copper nitrate, or other typical catalysts for hydrogen peroxide decomposition.

The solution will contain the hydrogen peroxide in an amount which, upon decomposition, will provide a pressure of about 20 to 150 p.s.i.g. in container chamber **14** and foam cylinder **42** of piston **16** initially, and will provide a sufficient volume of gas to exert a dispensing pressure on the product to be dispensed near the end of the dispensing operation. By way of example, in a substantially cylindrical container having a volume in the absence of a piston product, of about 13.5 cu. in., a height of 4 in. and a diameter of about 2 in., about 0.35 to 2.75 g. of hydrogen peroxide on a 100% basis, will provide gas at a pressure of 20 to 150 p.s.i.g. The amount of hydrogen peroxide required to provide a given pressure may be calculated readily, the volume of oxygen gas being provided by decomposition of a given amount of

hydrogen peroxide being well-known. Thus 1 cc. of 27.5 wt. percent hydrogen peroxide will yield 100 cc. of oxygen gas, while 1 cc. of 35 wt. percent hydrogen peroxide will yield 130 cc. of oxygen gas and 1 cc. of 50 wt. percent hydrogen peroxide will yield 197 cc. of oxygen. The amount liberated by other hydrogen peroxide solutions can be calculated readily. These volumes are measured at standard conditions, 0° C. and at 760 mm. of Hg pressure.

In a typical can for dispensing toothpaste, 36.6 cu. in. (600 cc.) of gas at standard conditions is generated from 4.6 ml. (5.188 g.) of 35% hydrogen peroxide. The can volume is 13.5 cu. in. when empty. With a typical piston in position, the product volume is 6.75 cu. in. and the piston-pressurizing gas volume is 6.75 cu. in. The solid material comprising the piston, and excluding its pore volume, occupies about 1.25 cu. in. When this can contains product (6.75 cu. in.) to be dispensed and piston (1.25 cu. in.), the pressure generated from 4.6 ml. of 35 wt. percent hydrogen peroxide is 100 p.s.i.g.

As the can valve is actuated and product is delivered, the pressure in the can drops. When essentially all the product has been dispensed, the pressure in the can is 42 p.s.i.g. These pressures have been established as being desirable for the dispensing of paste or slurry consistency products such as a typical toothpaste.

In the preferred embodiment, in which ferrous ammonium sulfate is employed as catalyst, an amount thereof which provides about 90 to 150 parts per million of ferrous iron based on the amount of solution will be used. This amount of catalyst decomposes the hydrogen peroxide at a properly slow rate to permit filling of the container, yet acts rapidly enough to provide the gas pressure in a useful time, e.g. up to about 1 to 2 weeks.

The present process has the particular advantage that the container may be filled with both the material to be dispensed, and the pressure-developing solution, without the need for complicated pressurizing and/or refrigeration systems. That is, the material to be dispensed and the pressurizing solutions may be introduced into the container from either the top or the bottom in either order desired, and no problems of loss of pressure, or spewing of materials during filling, are encountered.

The following examples are given by way of illustration of the present invention only, and are not to be deemed limitative thereof in any way.

EXAMPLE I

Present H_2O_2 solution with corrosin inhibition

Into an open topped, ¼ pound tin-plated cylindrical steel can, coated on its interior surface with a phenol formaldehyde lacquer and measuring 2 in. in diameter, and having a volume of 13.5 cu. in., was introduced 5.1 ml. of the solution described below. Introduction of the solution was carried out immediately after addition of the ferrous ammonium sulfate. Thereafter, a resilient polyurethane foam piston covered with a layer of polyethylene .005 in. in thickness was compressed and inserted into the can. The filling operation was conducted at a temperature of 72 to 75° F.; no difficulty was encountered in filling since the pressure during the operation was not elevated. Within 10 minutes after introduction of the pressure developing solution, 190 g. of a toothpaste formulation was placed on top of the piston, and the top of the can was capped with a cover containing a valve. The solution was as follows:

Ingredient	Percent Concentration	Amount, ml.
Hydrogen peroxide aqueous solution	35	92
Sodium hydroxide aqueous solution	6	0.15
Tetrasodium pyrophosphate aqueous solution	4	6.0
Ferrous ammonium sulfate solution	2	4.0

This solution had a pH of 6.05, and contained 120 p.p.m. of ferrous iron. The pressure of the gas in the container after decomposition of the hydrogen peroxide in 14 days was 100 p.s.i.g.

EXAMPLE II

H_2O_2 solution with no corrosion inhibitors

The experiment of Example I was repeated with the exception that the hydrogen peroxide solution contained no sodium hydroxide and no tetrasodium pyrophosphate.

It was found that the pressure in the ¼ pound tin-plated can employing the solution of this Example II, reached 100 p.s.i.g. in 3¾ days. This indicated excessive corrosion of the container, with consequent acceleration of the hydrogen peroxide decomposition by the corrosion products.

Following preparation of the pressurized system of Example I, the container was tested for discharge of toothpaste. The toothpaste was essentially all discharged, 188 g. of the toothpaste being recovered. Following dispensing of the toothpaste the cans were dismantled, and the interior surfaces of the gas-containing chambers were examined. The inside surfaces of the container from Example I in which the hydrogen peroxide solutions contained sodium hydroxide and tetrasodium pyrophosphate, showed essentially no attack by the solutions. The container of Example II, in which the solution did not contain the sodium hydroxide and phosphate, on the other hand, was seriously pitted, showing the effects of this unmodified acid-hydrogen peroxide solution.

Pursuant to the requirements of the patent statutes, the principle of this invention has been explained and exemplified in a manner so that it can be readily practiced by those skilled in the art, such exemplification including what is considered to be the best embodiment of the invention. However, it should be clearly understood that, within the scope of the appended claim, the invention may be practiced by those skilled in the art, and having the benefit of this disclosure, otherwise than as specifically described and exemplified herein.

What is claimed is:

In the method of providing a pressurized apparatus for dispensing liquid and pasty products and the like, in which there is provided an enclosed cylindrical, coated steel container having a product chamber containing product to be dispensed communicating with a valve for discharging said product and a pressure chamber separated from the product chamber by a piston means which transmits dispensing pressure from the pressure chamber to the product in the product chamber, and pressure is provided in said pressure chamber by introducing into said pressure chamber as a pressure-source material an aqueous solution of hydrogen peroxide containing a hydrogen peroxide decomposition activator, said solution containing (a) an amount of said hydrogen peroxide which, on decomposition, will provide a maximum gas pressure within said container of 20 to 150 p.s.i.g., and (b) an amount of said decomposition activator which will decompose said hydrogen peroxide within 15 minutes to 15 days, and permitting said solution to generate the pressurizing gas, the improvement of incorporating in said aqueous solution of hydrogen peroxide containing a hydrogen peroxide decomposition activator, as an inhibitor against corrosion of said container, an alkali from the group consisting of sodium hydroxide and potassium hydroxide in an amount to provide a pH when added to the aqueous hydrogen peroxide alone of about 4 to 5, and an alkaline phosphate from the group consisting of tetrasodium pyrophosphate, sodium tripolyphosphate, tetrapotassium pyrophosphate and potassium tripolyphosphate in an amount to raise the pH of the resulting alkali-hydrogen peroxide solution to about 6 to 7.

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