

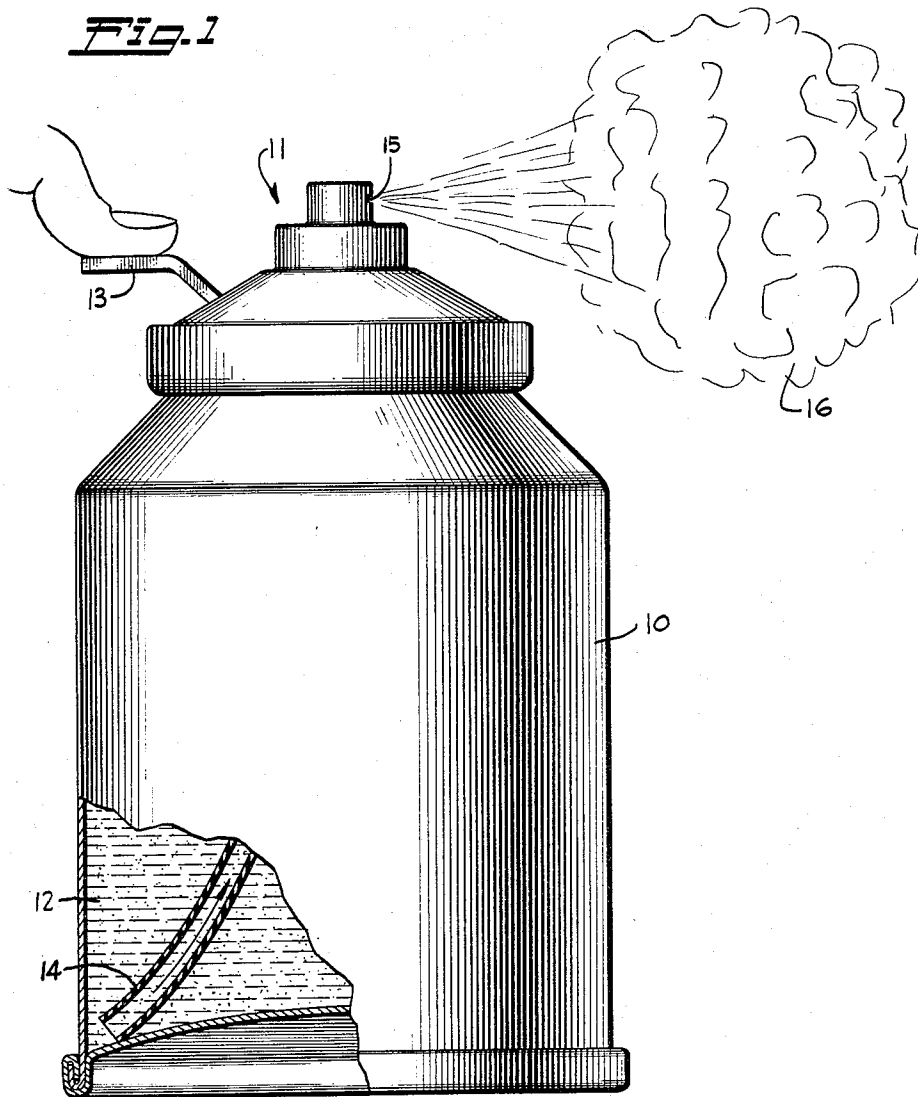
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METHOD AND APPARATUS FOR DISPENSING DRY POWDERS

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METHOD AND APPARATUS FOR DISPENSING DRY POWDERS

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This invention relates to the art of dispensing powders, and more particularly to a method and means for dispensing a dry powder of controlled particle size from a container, the said powder being transported by a stream of moving gas to the locality on which it is desired to deposit it.

It is an object of this invention to provide a method of propelling a stream of dry powder of controlled particle size against an object so as to coat it with a thin but uniform layer of the powder.

It is a further object of the invention to provide a method and means for propelling a dry powder in a stream of relatively low-pressure gas, so as to avoid the necessity of providing a thick-walled container for holding a propellant gas under high pressures.

It is still another object of this invention to provide a method for holding a powder in suspension in a normally gaseous propellant held in liquid phase in a container, whereby to prevent sedimentation and particle agglomeration.

It is still a further object of this invention to provide a package from which a dry powder may be dispensed in a stream of moving gas.

Another object of the invention is to provide a method for reducing difficultly grindable substances to pulverulent form preparatory to introducing the substance into a dispensing package.

Other objects and advantages of the invention will become apparent as the disclosure proceeds.

In its broader aspects the invention comprises a valved container, having contained therein a propellant liquid having a vapor pressure above atmospheric at ambient temperatures, and a powder which is substantially insoluble in the liquid, the specific gravity of the liquid being such as to prevent sedimentation and particle agglomeration of the powder. This type of sedimentation will be hereinafter referred to as agglomerative sedimentation. It is obvious that if such sedimentation does take place, the agglomerate may tend to clog the valve orifice, and render the dispensing device inoperative. Furthermore, what solid material is dispensed will not be of controlled particle size. The invention also comprises a method of dispensing powder by operating the valve of a container loaded with such a liquid-powder mixture, and is also directed to a new composition of matter comprising a powder dispersed in a liquid whose specific gravity is sufficiently close to that of the powder to prevent agglomerative sedimentation.

It has been found that agglomerative sedimentation may be prevented if the specific gravity of the propellant liquid is adjusted so that it approximates that of the powder. Ideally, of course, the liquid and the powder should have the same specific gravity, so that the powder will remain in permanent suspension throughout the body of the propellant. Tests have demonstrated, however, that considerable deviation from the ideal may be permitted, and generally speaking no agglomerative sedimentation will take place if the difference between the specific gravities of the powder is no greater than about 0.4 or 0.5, and that in some instances a difference of as much as 0.8 may be tolerated. If the powder is heavier than the propellant it will tend to settle to the bottom of the container, and if lighter, it will collect at the top, but if the difference in specific gravities is held within the foregoing limits, the powder will remain in a soft and flocculent condition, and may be readily dispersed throughout the propellant by a mild shaking or swirling action.

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As propellants the halogenated hydrocarbons known as "Freons" are preferred, since they are low boiling, relatively nonflammable and non-toxic, and may be obtained in quite a wide range of specific gravities at 30° C., ranging from 1.177 for monochlorodifluoro methane to 1.556 for trichlorotrifluoro ethane. Other suitable propellants in this class include trichloromonofluoro methane, sp. gr. 1.466, dichlorodifluoro methane, sp. gr. 1.294, and dichlorotetrafluoro ethane sp. gr. 1.443. By a judicious blending of these propellants it is possible to develop a compound propellant having a specific gravity close enough to the powder to be dispensed to prevent agglomerative sedimentation, and yet having sufficient vapor pressure to dispense the powder even though one or more of the components of the propellant may have a boiling point at atmospheric pressures above room temperature. Other halogenated hydrocarbons, such as methyl chloride and methylene chloride, may also be used in blending the propellant. While halogenated hydrocarbons are the preferred propellants, it should be understood that other normally gaseous liquids may be used as propellants under some circumstances, such as propane, butane, dimethyl silicane, trimethyl amine, methyl ether, or others, either alone or in combination with the preferred halogenated hydrocarbons, and that the use of such other propellants is within the purview of this invention, where their properties are such as to render them desirable for special applications.

It is also important that the powder be substantially insoluble in the propellant, since if it is soluble to any substantial degree, the particle size of the dispensed powder cannot be controlled, with consequent loss of material to fine particles which tend to float away from the object to be coated. Also, if the soluble component of the powder is a resinous material it will tend to deposit on the nozzle upon coming out of solution, eventually clogging it.

It is realized that proposals have heretofore been made for dispensing solid materials such as pigments, from a valved container under the influence of a propellant, but in all such instances another liquid of sufficient viscosity to hold the solid material in suspension has been associated with the propellant, and the solid material, when dispensed, is deposited on the object to be coated as a wet spray which dries only on evaporation of the other liquid or its curing, when the other liquid is a drying oil or resin. In no instance, prior to this invention, so far as it is known, has any disclosure been made of a device operative to discharge a powder, suspended in the container only in the propellant liquid, as a cloud of dry particles of controlled size which may be directed against the object to be coated so as to deposit thereon a thin but uniform coating of dry powder.

Referring now to the accompanying drawing, the single figure of which illustrates a valved container filled with a propellant liquid containing a powder in suspension, in dispensing a powder according to this invention a container 10, fitted with a suitable dispensing valve 11, for example the type shown in U.S. Patent 2,643,914 to Reswick, is loaded with a slurry of powder, which has been ground to a predetermined particle size, in liquid propellant 12, to form the dispensing package of the in-

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vention. The container may be filled by introducing the powder and propellant in normal cold filling manner, or a slurry of the powder in that component of the propellant which boils above room temperature may be placed in the container, the valve sealed in place, and the balance of the propellant may be introduced by pressure filling through the valve nozzle. Upon operating the valve by depressing actuator 13 as shown in the drawing, propellant and powder will flow out, under the influence of the pressure developed in the container by the propellant, through eductor tube 14 and the nozzle 15 to the atmosphere, where the propellant will vaporize to develop a moving gas stream in which a cloud 16 of the dry powder is carried. When the nozzle is directed toward the object to be coated, it will be found that a thin, even coat of dry powder may be thus applied.

It is of note that high pressures within the container are not necessary in dispensing powders according to the present invention. To the contrary, it usually appears desirable to keep the gas pressure as low as possible, within the limits imposed by the desired specific gravity of the propellant, since this prevents too wide a dispersal of the powder spray. It should be further noted that, since there is no necessity for breaking the propellant up into aerosol size droplets, the powder being of the desired particle size when dispersed in the propellant, valves of simple construction may be used, and there is no necessity for providing a plurality of nozzles and expansion chambers, as is usually required when dispensing materials which are dissolved in the propellant.

While the invention should be broadly construed, it is of particular utility in dispensing therapeutic powders to apply a thin, even, coating of the powder to the part to be treated. Thus, in surgery or in the treatment of burns, it has been the custom in the past to apply an antibiotic, such as penicillin, terramycin, or other therapeutic agent in powdered form, to an open wound or to a burn by dusting it on the part to be treated from a perforated container resembling an ordinary salt shaker. This results in the deposition of a rather thick, uneven film, so that it is necessary to dispense a considerably greater amount of valuable powder than is necessary in order to insure complete coverage. By directing a cloud of powder toward the wound in accordance with the present invention, however, complete coverage may be obtained without waste of material.

An even more important use for the present invention is in veterinary medicine. For example, in the treatment of cattle to prevent glaucoma, it has been the practice to herd the cattle through a chute, and, while they are passing through the chute, to dust an appropriate therapeutic powder into their eyes from the standard salt-shaker type container. It is very difficult to insure that sufficient powder reaches the eyes of the animals when dispensing the powder in this manner, since they will shy away from the powder dispenser; and blink to prevent entry of the powder to their eyes. Consequently, a great deal of powder is wasted, being deposited on the skin areas, where it is ineffective. When proceeding according to the method of the present invention, however, it is possible to project a stream of powder into the animals' eyes from a sufficient distance to minimize the shying of the cattle away from the container, and with sufficient rapidity to insure that the powder gets into their eyes before they have time to blink.

Another field in which the present invention is of great utility is in the treatment of poultry to prevent virus diseases. It has been the practice in the past to make up an aqueous solution of a protective virus, and to treat the poultry flock by injecting the proper amount of the virus into the wing of each chicken, or by placing a drop of the solution in the nostrils. This, of course, has the disadvantage that each chicken must be individually handled, a laborious and time-consuming process. It has a further disadvantage in that the protective virus rapidly

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loses its viability in water solution, so that a new batch must be made up immediately prior to treating a flock, and any solution left over after treatment must be discarded. When proceeding according to the present invention, however, a stream of dry virus powder may be projected against the nostrils of the poultry to enable the virus to be inhaled, and after treatment any protective virus left over may be stored for long periods without any substantial decrease in viability.

Some of the antibiotics, and other substances which may be dispensed according to this invention, are difficult, if not impossible to reduce to powder form by dry grinding due to their physical consistency. It has been found that ordinary grinding aids, such as water and oil, have a tendency to react with some of the substances to decrease the potency thereof, and even when grinding non-reactive substances with the use of a liquid grinding aid, the problem remains of separating the powder from the liquid after the grinding operation has been completed. In accordance with another aspect of the invention, it has been found that such substances may readily be reduced to pulverulent form by grinding the substance in the presence of the highest boiling component of the propellant mixture, and the slurry of powder in propellant may then be directly loaded into the container, without separation of the liquid from the powder. Since the Freons are almost completely non-reactive, and since the higher boiling members of the series, such as trichloromonofluoro methane and trichlorotrifluoro ethane boil at or above normal room temperatures, they form ideal media for the grinding of sensitive substances in the absence of refrigeration. However, if refrigeration is employed during the grinding operation, the lower boiling propellants may be utilized as the grinding aid.

In order that those skilled in the art may more fully comprehend the nature of my invention and the manner in which it is carried out, the following examples are given.

Example I

The problem involved the dispensing of terramycin hydrochloride powder, consisting of about .01% terramycin in powdered lactose. This powder had a specific gravity of 1.52. A mixture of 65% trichlorotrifluoro ethane and 35% dichlorodifluoro methane, which has a vapor pressure of 25 p.s.i.g. at 70° F. was made up, and the terramycin powder was added. This propellant mixture had a calculated specific gravity of 1.45 at 70° F., but the actual specific gravity was probably somewhat greater, since it is known that mixtures of liquids generally have a greater specific gravity than can be calculated from the specific gravity of each liquid. In any event, a mixture of 27% by weight of the terramycin powder in the 65%-35% propellant mixture of this example stood for eight months showing only slight precipitation of the powder, and what powder had precipitated was readily redispersed with only a slight swirling or shaking. When the mixture was placed in a can equipped with the valve shown in U.S. Patent 2,643,914, it was found that the powder could be readily sprayed out as dry cloud.

Example II

The same terramycin powder was used in this example but the propellant, for reasons of economy, was 65% trichloromonofluoro methane and 35% dichlorodifluoro methane. This mixture had a calculated specific gravity of 1.398, which, for the reasons given above, was probably somewhat below its true value. It was found that the powder mixed with this propellant did not undergo agglomerative sedimentation, and could be easily dispensed as a dry powder.

Example III

The problem here involved was the dispensing of certain proteinaceous materials as airborne suspensions. The

proteins were viri ordinarily used in water solutions to inoculate chickens against different virus diseases.

It was necessary to reduce the proteinaceous material, which was received in the form of flakes which had the appearance of broken corn flakes and was of the consistency of dried eggs, to a powder suitable for dispensing. The material could not be dry ground, due to its consistency, but it was found that if the material were immersed in trichlorotrifluoro ethane during the grinding operation, it could easily be reduced to a particle size of less than 150 microns. After a slurry of the virus in trichlorotrifluoro ethane had been prepared, refrigerated dichlorodifluoro methane was added in the amount of 35% by weight, to yield a powder-propellant mixture of sufficient vapor pressure to be dispensed. It was noted in this case that the virus was lighter than the propellant, and collected near the surface thereof. There was, however, no agglomeration. A quantity of the powder-propellant mixture was loaded into a can equipped with the previously mentioned valve, and the can was given a light shaking to disperse the material uniformly through the propellant. This was not strictly necessary, since ordinary handling plus the agitation caused by boiling of the propellant during discharge, would suffice to maintain a uniform dispersion during use. When the valve was actuated, the proteinaceous material was dispensed as a dry spray.

Subsequent tests in treating chickens with the virus packaged with the propellant liquid proved highly successful from the standpoint of (a) ease of treatment, (b) effectiveness of treatment, and (c) retention of viability of the virus during storage.

Example IV

In this test dry sodium bicarbonate in powdered form was dispersed as a slurry in a 50-50 mixture of trichloromonofluoro methane and dichlorodifluoro methane. The specific gravity of sodium bicarbonate is about 2.2, while that of the propellant at room temperature was about 1.4, but nevertheless it was possible to disperse the powder in the propellant with only slight agitation so that it could be dispensed from a valved container as a dry cloud of particles. Furthermore, even when the containers were unshaken, it was observed that as the propellant was discharged and the pressure within the can dropped momentarily, the propellant would begin to boil and give rise to bumping within what sodium bicarbonate had settled to the bottom, sufficient to disperse the settled bicarbonate through the propellant.

Example V

This example shows that it is necessary that the powder should contain no gummy constituents soluble in the propellant. An attempt was made to dispense a commercial flea powder in the manner described above. While from a visual inspection the powder appeared to be insoluble in the propellant, the nozzle clogged during use. It was found that while the greater portion of the constituents of the powder were insoluble in the propellant, it contained a small proportion of tetrachloroparabenzquinone, which was soluble, and built up on the valve nozzle during evaporation of the propellant to such a degree as to clog it.

While in the foregoing examples but three propellant mixtures have been disclosed, it will be apparent that mixtures of any of the propellants hereinbefore referred to may be used, and in any proportions, so long as the mixture has the desired vapor pressure, and has a specific gravity close to that of the powder to be dispensed. For example, in hospital operating rooms a low pressure propellant may be desired, say 5 to 8 p.s.i.g., since the application of antibiotic will be made from a point quite close to the wound, and a powerful gas stream is neither necessary nor desirable. On the other hand, in veterinary medicine pressures of from 25 to 50 p.s.i.g., or even

higher, may be desirable to create a gas stream of sufficient velocity to carry the powder to the part to be treated.

It will be appreciated that while the foregoing description has been directed chiefly to the use of the new process in dispensing materials of medical value, and to packages containing propellants carrying such materials in suspension, there are many other powders which may be dispensed in like manner, and the invention should not be construed as limited to the dispensing of medical products.

It should also be understood that while reference has been made to containers equipped with valves of the type described in U.S. Patent 2,643,914 the invention is not limited to the use of this valve alone, but that any valve adapted to discharge a liquid under pressure in a container may be used.

What is claimed is:

1. The method of dispensing solid materials directly in dry powder form which comprises maintaining in a valved container a suspension of a powdered material solely in a liquid in which the said material is not appreciably soluble, the specific gravity of said liquid being such as to inhibit agglomerative sedimentation of the powdered material in the container, and the said liquid having a vapor pressure above atmospheric at ambient temperatures, and operating the valve of said container to discharge into the atmosphere a stream of dry powdered material carried in a stream of moving gas, said gas being formed by volatilization of said liquid in said container upon release to atmospheric pressure by operation of the container valve.

2. The method according to claim 1 in which the powdered material is sodium bicarbonate and the liquid comprises a halogenated hydrocarbon.

3. The method according to claim 1 in which the liquid comprises a halogenated hydrocarbon, the hydrocarbon being selected from the group consisting of methane and ethane.

4. The method according to claim 1 in which the powdered material is a mixture of terramycin hydrochloride and lactose, and the liquid is a mixture comprising about 65% trichlorotrifluoro ethane and about 35% dichlorodifluoro methane.

5. The method according to claim 1 in which the powdered material is a mixture of terramycin hydrochloride and lactose, and the liquid is a mixture comprising about 65% trichloromonofluoro methane and about 35% dichlorodifluoro methane.

6. The method according to claim 1 in which the powdered material is a proteinaceous material and the liquid is a mixture comprising about 65% trichlorotrifluoro ethane and about 35% dichlorodifluoro methane.

7. In combination, a container having an opening therein, a liquid contained within the said container, said liquid having a vapor pressure above atmospheric at normal temperatures, and a solid material in powdered form also contained within said container, the said material being suspended solely in said liquid and being substantially insoluble therein, in said liquid having a specific gravity closely approximating that of the powder, and valve and nozzle means for controlling the flow of fluid and powder through said container opening.

8. As a new composition of matter, a powdered material suspended solely in a liquid in which said material is not appreciably soluble, the said liquid having a vapor pressure above atmospheric at ambient temperatures, and having a specific gravity such as to inhibit agglomerative sedimentation of the powdered material.

9. The composition according to claim 8 in which the powdered material is sodium bicarbonate and the liquid comprises a halogenated hydrocarbon, the hydrocarbon being selected from the group consisting of methane and ethane.

10. The composition according to claim 8 in which the liquid comprises a halogenated hydrocarbon, the hydro-

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carbon being selected from the group consisting of methane and ethane.

11. The composition according to claim 8 in which the powdered material is a mixture of terramycin hydrochloride and lactose and in which the liquid is a mixture comprising about 65% trichlorotrifluoro ethane and about 35% dichlorodifluoro methane.

12. The composition according to claim 8 in which the powdered material is a mixture of terramycin hydrochloride and lactose, and in which the liquid is a mixture comprising about 65% trichloromonofluoro methane and about 35% dichlorodifluoro methane.

13. The composition according to claim 8 in which the powdered material is a proteinaceous material and the liquid is a mixture comprising about 65% trichlorotrifluoro ethane and about 35% dichlorodifluoro methane.

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