AEROSOL DISPENSER WITH FLEXIBLE DIP TUBE

Filed May 15, 1963 2 Sheets-Sheet 1

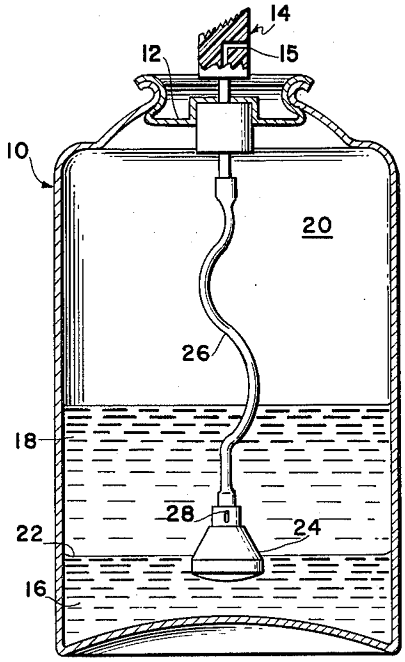

FIG. I

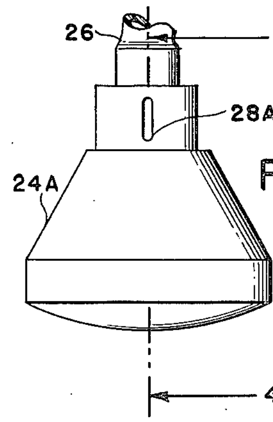

FIG. 3

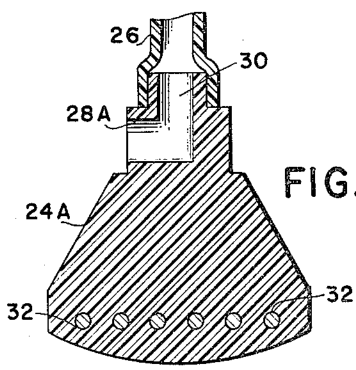

FIG. 4

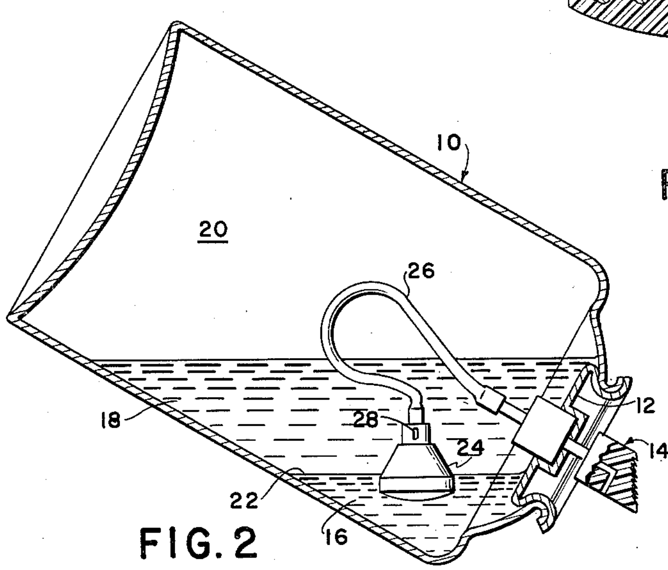

FIG. 2

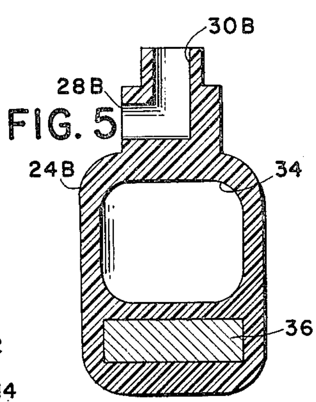

FIG. 5

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AEROSOL DISPENSER WITH FLEXIBLE DIP TUBE

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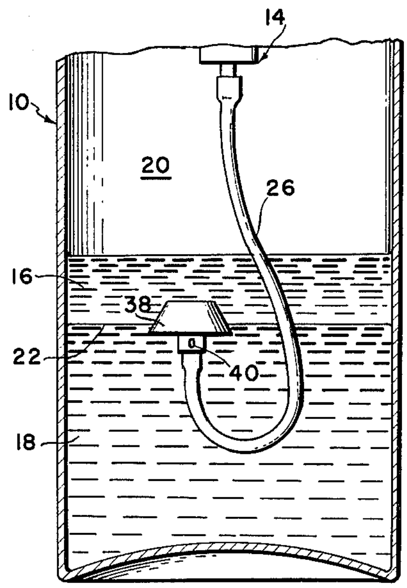


FIG. 6

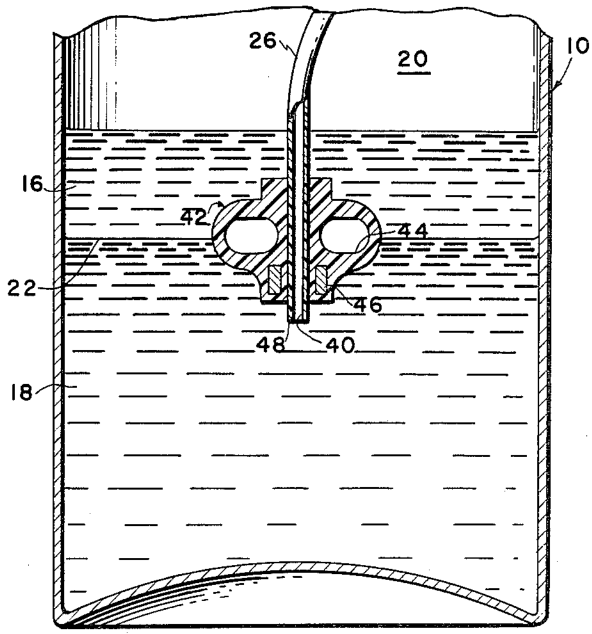


FIG. 7

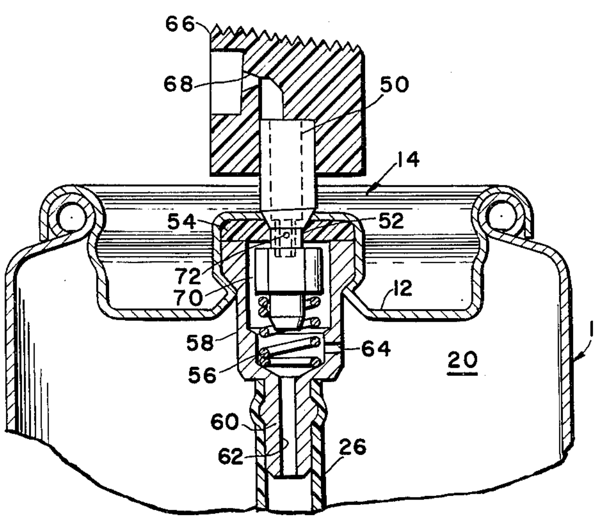
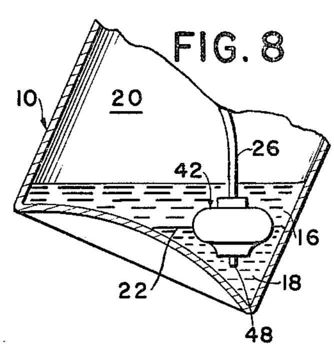


FIG. 9



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3,211,349
AEROSOL DISPENSER WITH FLEXIBLE DIP TUBE

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Our invention relates to aerosol dispensers. More particularly, our invention relates to a flexible dip tube and float for use with a three phase aerosol system.

Normally an aerosol system designed to yield a finely atomized mist consists of a two phase system, one phase of which is a liquid phase to be dispensed comprising a homogeneous solution or an emulsion of the active ingredient concentrate and liquefied propellent, and the second phase of which consists of propellent vapor. In operation, the mixture of active ingredient concentrate and liquefied propellent is expended, resulting in a decrease in the vapor pressure. The resultant decrease in vapor pressure permits an additional portion of the liquefied propellent in solution to be converted into gaseous state propellent in the head space above the liquid phase. It is evident that the spray pattern of such an aerosol will be a function of the pressure within the system, the valve mechanism and the concentration of propellent. Aerosol systems such as that described above are well known in the art. However, such systems possess certain disadvantages. One of the major disadvantages of such systems is the high cost of obtaining a suitable spray due to the extremely large quantity of propellent that is required. A quantity of propellent in excess of that required to expel a given quantity of active ingredient must be charged to the system since a substantial quantity of propellent, in solution or emulsion with the active ingredient, is expelled along with the active ingredient. Another disadvantage of such systems is their inability to employ any substantial amount of water in the active ingredient concentrate thus requiring the employment of other more expensive ingredients.

Another aerosol system, termed a three phase aerosol, permits the use of large amounts of water in the active ingredient concentrate. Such a system consists of a liquid phase to be dispensed, e.g., an aqueous concentrate phase containing the active ingredient, which is sufficiently immiscible with a second liquid propellent phase so that two distinct liquid phases or layers are present, rather than a single liquid phase comprising a solution or emulsion of liquid to be dispensed and liquefied propellent as in the two phase system. The third phase is a gaseous propellent phase or vapor phase. In such a system, the vapor phase will always be uppermost within the container while the liquid active ingredient and liquid propellent phases will be lower-most within the container. The two liquid phases, however, can be disposed in relatively different positions within the container depending on their relative densities or specific gravities. Thus propellents of greater density than the active ingredient concentrate will pool at the bottom of the container. Propellents of this nature, for the most part, consist of halogenated hydrocarbon propellents, for example, those sold under the trade names Freon, Genetron, Ucon or Isotron. On the other hand, if the propellent is less dense than the liquid concentrate it will float on the surface of the concentrate phase. Propellents of this nature include saturated hydrocarbons, e.g., propane or butane, and certain halogenated hydrocarbons such as difluoroethane sold under the trade name Freon 152*a*. In a three phase system where the liquid propellent is pooled at the bottom of

the container, the dip tube employed with such system is cut short of the bottom of the container so that the opening at the bottom of the dip tube extends into the upper liquid active ingredient phase but does not extend into the lower liquid propellent phase. It is evident that as the active ingredient is expelled from the container and more of the liquid propellent is vaporized to maintain the vapor pressure in the head space above the liquid phases, the level of the liquid phase propellent in the container drops. Obviously, as the level of the liquid propellent phase drops, it is replaced by the active ingredient concentrate. Due to this replacement of the propellent by the active ingredient concentrate it can be seen that there is a substantial loss of concentrate material which can never be removed from the container because of the shortness of the dip tube.

Our invention provides a novel dip tube apparatus for use in an aerosol dispenser containing a three phase system which permits substantially complete removal of the liquid active ingredient concentrate from the container. The three phase systems with which our apparatus is useful comprise, as described above, a vapor phase, a liquid phase to be dispensed and a liquid propellent phase of a different specific gravity or density than the liquid phase to be dispensed and sufficiently immiscible with the liquid phase to be dispensed so that two liquid phases or layers are present. The mechanical components of the aerosol dispenser with which our invention is to be used include any of the standard containers and valve members known in the art. The novel apparatus of our invention comprises a flexible dip tube with a float or bob connected at one end of the dip tube. The float employed has an inlet port and an outlet interconnected by an opening through the float. One end of the dip tube is connected with the outlet port of the float while the other end of the dip tube is connected to the valve member. The float employed in our invention is composed of a material having specific gravity or density greater than one of the two liquid phases and less than the other of the liquid phases whereby it is suspended at the interface between the two liquid phases. While the shape of our float can vary considerably, it must be of such configuration that its inlet port is always exposed to the liquid active ingredient phase to be dispensed as the float is suspended at the interface of the two liquid phases. The dip tube is of sufficient length to allow the float or bob to be suspended, i.e. to float, at the interface of the two liquid phases in any position of usage. While the dip tube can vary considerably in length it should be of a length at least substantially equal to, and preferably slightly greater than, distance between the tailpiece of the valve member and the most remote portion of the container.

When employing a propellent of greater density than the active ingredient concentrate, so that the liquid propellent layer is at the bottom of the container, the float of our invention is of such a shape that the center of gravity of the float is located within the liquid propellent phase and the inlet port is located within the liquid active ingredient phase. On the other hand, however, when a propellent is employed which is less dense than the liquid active ingredient phase, so that the liquid active ingredient layer is lowermost in the container, the float of our invention is of such a shape that both the inlet port and the center of gravity of the float are located in the liquid active ingredient phase.

The flexible dip tube and float provide for the substantially complete removal of the liquid active ingredient phase from the container since the slack in the tube permits the float to recede as the propellent is expended with the inlet port always exposed to the active ingredient phase and away from the liquid propellent phase regardless of position of usage.

Our invention will be further illustrated by reference to the accompanying drawings in which:

FIGURE 1 is a sectional view of a standard aerosol dispenser containing a three phase system having a liquid propellent phase of greater specific gravity than the liquid active ingredient phase in which an embodiment of our invention is incorporated.

FIGURE 2 is the device of FIGURE 1 shown in a partially inverted position.

FIGURE 3 is an enlarged view of a float of the same shape illustrated in FIGURES 1 and 2 showing an alternate embodiment thereof.

FIGURE 4 is an enlarged sectional view of the float of FIGURE 3 taken along the line 4—4 of FIGURE 3.

FIGURE 5 is another alternate embodiment of a float to be used with the type of three phase system shown in FIGURES 1 and 2.

FIGURE 6 is a partial, sectional view of an aerosol dispenser containing a three phase system in which the liquid propellent phase has a lesser specific gravity than the liquid active ingredient phase in which is incorporated another embodiment of our invention.

FIGURE 7 is an enlarged sectional view showing an alternate embodiment of a float that can be used with the type of aerosol system shown in FIGURE 6.

FIGURE 8 illustrates the same embodiment shown in FIGURE 7 in which the aerosol container is slightly tipped.

FIGURE 9 illustrates a particular type of valve for use with the dispensers of the preceding drawings.

FIGURE 1 shows a standard aerosol container **10** with a valve cap member **12** and a valve member **14** which interconnects the interior and exterior of aerosol container **10** through passageway **15**. As can be seen, the liquid propellent phase **16** is lowermost within the container **10**. Floating on the surface of liquid propellent phase **16** is the liquid active ingredient phase **18** to be dispensed above which is vapor phase **20**. The interface between liquid propellent phase **16** and liquid active ingredient phase **18** is designated by the reference numeral **22**. The aerosol container and system just described are known in the art.

In the particular embodiment of our invention illustrated in FIGURE 1, a float **24** having a specific gravity less than that of liquid propellent phase **16** and greater than that of liquid active ingredient phase **18** is shown suspended at the interface **22** between the two liquid phases **16** and **18**. Interconnecting the tailpiece of valve **14** and float **24** is a flexible dip tube **26** of a length greater than the distance between the tailpiece of the valve **14** and the bottom of the container **10**. Also shown in FIGURE 1 is an inlet port **28** located at the upper end of float **24** and exposed to active ingredient phase **18**.

The interior of dip tube **26** and inlet port **28** are interconnected by a passageway through float **24**, not shown in this figure.

FIGURE 2 shows the container **10** of FIGURE 1 in a partially inverted position. It will be noted that while liquid propellent phase **16** is still lowermost in the container, liquid active ingredient phase **18** next and vapor phase **20** uppermost, the liquid phases are now located in what would normally be considered the "top" of the container. It will also be noticed that float **24** is still suspended at the interface **22** between liquid propellent phase **16** and liquid active ingredient phase **18** and that the inlet port **28** is exposed to the active ingredient phase **18**.

FIGURES 3 and 4 show an alternate embodiment of a float **24*a*** of the same general shape as that shown in FIGURES 1 and 2. Also shown are one end of the dip tube **26** and inlet port **28*a***. Referring now to FIGURE 4, the passageway **30** interconnecting the interior of dip tube **26** and inlet port **28*a*** can be seen. Also shown in

FIGURE 4 are metal weights **32** embedded in the lower portion of float **24*a***. While a float having the shape of floats **24** and **24*a*** composed of a material having a specific gravity intermediate that of liquid propellent phase **16** and liquid active ingredient phase **18** will be suspended at the interface **22** with the inlet port **28** exposed to active ingredient phase **18**, as shown in FIGURES 1 and 2, the addition of "ballast" in the form of metal weights **32** near the bottom of float **24*a*** increases the total weight of float **24*a*** causing a greater portion of the float **24*a*** to be in propellent phase **16**. The presence of weights **32** also lowers the center of gravity of float **24*a*** which changes the relative distance between the center of gravity and the center of buoyancy thereby increasing the metacentric distance and increasing the stability of float **24*a***.

FIGURE 5 illustrates another alternate embodiment of a float. In this figure can be seen float **24*b***, inlet port **28*b*** and passageway **30*b***. Located near the upper portion of float **24*b*** is an air pocket or void **34** and located near the lower portion of float **24*b*** is a metal slug **36**. Thus, it can be seen that the construction of float **24*b*** is such that the lower portion has a much higher concentration of the weight distribution than the upper portion. It will be understood that the center of gravity of the float **24*b*** is lowered even more than in the embodiments shown in FIGURES 1 through 4 thereby further increasing the stability of float **24*b***.

In FIGURE 6 is shown a standard aerosol container **10** and a portion of valve member **14** which interconnects the interior and exterior of aerosol container **10**. As opposed to the aerosol system illustrated in FIGURES 1 and 2, the liquid active ingredient phase **18** is lowermost in the container **10**. Floating on the surface of liquid active ingredient phase **18** is the less dense liquid propellent phase **16** above which is vapor phase **20**. Again, the interface between liquid propellent phase **16** and liquid active ingredient phase **18** is designated by the reference numeral **22**. This aerosol container and system as just described is also known in the art.

In the particular embodiment of the invention illustrated in FIGURE 6, a float **38** having a specific gravity greater than that of liquid propellent phase **16** and less than that of liquid active ingredient phase **18** is shown suspended at interface **22** between the two liquid phases **16** and **18**. Interconnecting the tailpiece of valve **14** and float **38** is a flexible dip tube **26** of a length greater than the distance between the tailpiece of the valve **14** and the bottom of the container **10**. Also shown in FIGURE 6 is an inlet port **40** located at the lower end of float **38** and exposed to active ingredient phase **18**. The interior of dip tube **26** and inlet port **40** are interconnected by a passageway through float **38**, not shown in this figure. It will be noticed that the inlet port **40** is located at the lower end of float **38** and that dip tube **26** is connected to the lower end of float **38** in this embodiment of our invention rather than having such port and connection at the upper end of the float as illustrated in FIGURES 1 and 2.

FIGURE 7 illustrates an alternate embodiment of a float for employment in a three phase aerosol system similar to that of FIGURE 6. Shown in FIGURE 7 are aerosol container **10**, liquid propellent phase **16**, liquid active ingredient phase **18**, vapor phase **20**, interface **22** and dip tube **26**. Also shown in FIGURE 7 is float **42** having an annular air pocket or void **44** located near its upper end and an annular metal slug **46** located near its lower end. The purpose of the air pocket or void **44** and the metal slug **46** are the same as the air pocket or void **34** and the metal slug **36** shown in FIGURE 5, i.e., to lower the center of gravity and thereby increase the stability of the float. It will also be noticed in FIGURE 7 that the dip tube **26** extends vertically through float **42** and terminates at a point **48** below the lower end of float **42** providing inlet port **40** in active ingredient phase **18**.

In FIGURE 8 are shown aerosol container **10**, liquid propellent phase 16, liquid active ingredient phase 18, vapor phase 20, interface 22, dip tube 26 and float 42. It will be noticed that the aerosol container 10 is tipped slightly to one side and the quantity of propellent phase 16 and active ingredient phase 18 have been substantially reduced. It will also be noticed that float 42 is still suspended at the interface 22 between the two liquid phases 16 and 18 and that the terminal point 48 of dip tube 26 is still exposed to the active ingredient phase 18.

Thus, it can be seen that in operation the several embodiments of our invention illustrated in the figures of the drawings effect the same results. Thus, for example, in a three phase aerosol sysetem in which the liquid propellent phase has a greater specific gravity than that of the liquid active ingredient phase, such as illustrated in FIGURES 1 and 2 of the drawings, the float 24 is suspended at the interface 22 between the two liquid phases 16 and 18 such that the inlet port 28 is always exposed to the active ingredient phase 18. The dip tube 26 is of such construction that it is sufficiently flexible to be oriented by the forces exerted on and by the float 24. Therefore, when the aerosol container is completely filled by the initial charge of liquid active ingredient phase 18 and liquid propellent phase 16 and the aerosol container 10 is maintained in an upright position as shown in FIGURE 1, the buoyant force exerted by liquid propellent phase 16 is sufficient to suspend the float 24 at the interface 22. It will be obvious that a greater amount of slack will exist in dip tube 26 under such conditions than is shown in FIGURE 1 and may, therefore, exert some force on the float 24 which may have a tendency to tip the float 24. The configuration of float 24, however, is such that the metacentric distance is sufficiently great and properly oriented that the couple consisting of the force of gravity acting in a downward direction effective at the center of gravity of float 24 and the buoyant force acting in an upward direction effective at the center of buoyancy of the float 24 is sufficient to offset any force that may be exerted by dip tube 26. Thus, whether aerosol container 10 be completely filled or nearly empty, as shown in FIGURE 1, float 24 will always remain properly oriented so that inlet port 28 is always exposed to active ingredient phase 18. Thus, if aerosol container 10 is inverted or partially inverted, as shown in FIGURE 2, float 24 still remains suspended at interface 22 with the inlet port 28 exposed to active ingredient phase 18. Our invention thereby constantly provides the proper orientation and disposition of the inlet port 28 permitting the proper operation of the aerosol system in whatever position the container happens to be.

Referring now to FIGURE 7 one can see that the flexible dip tube and float of our invention can also operate in an aerosol system in which the liquid active ingredient phase has a greater specific gravity than that of the liquid propellent phase. Again, the float 24 is of such construction and configuration that the couple consisting of the force of gravity and the buoyant force act through their effective points to maintain constantly the proper orientation of the float 42 such that the inlet port 40 provided by terminal point 48 of dip tube 26 is always exposed to the active ingredient phase 18.

With dispensers containing three phase systems, the use of valves admitting only the liquid phase to be dispensed into the valve passageway results in a coarse, wet, spray pattern which is desirable for many uses. By the use of a valve provided with means for admixing the liquid phase to be dispensed with vapor from the vapor phase in the dispenser a finely atomized spray pattern is obtained. Such a valve is illustrated in FIGURE 9. In FIGURE 9, valve member 14 comprises a hollow stem 50 with the valve 52 normally seated against surface 54 by means of spring 56. Surrounding the valve is a housing 58 with a tail piece 60, with opening 62, to which flexible dip tube 26 is attached. The housing contains opening 64 exposed to the vapor phase 20 in the head space of the dispenser 10. The valve stem 50 has actuator or head 66 mounted thereon with passageway 68 therethrough. When actuated by pressing down head 66 the valve 52 is unseated and liquid phase to be dispensed is educted from dip tube 26 and vapor enters through opening 64 and are intermixed in chamber 70 formed by housing 58 and the mixture enters valve stem 50 through opening 72 and out through passage 68. The vapor mixed with the liquid phase to be dispensed atomizes the liquid and a finely atomized spray is obtained. Known mechanical break-up devices can also be used in the head to provide improved atomization, if desired. The use of the valve of FIGURE 9 in combination with the flexible dip tube and float and systems of FIGURES 1 to 8 provide substantially complete removal of the liquid phase to be dispensed as well as a finely atomized spray pattern. The liquid active ingredient concentrate replaces that volume of propellent which is expended because of its vaporization into the head space and subsequently out through the vapor tap orifice in the valve housing, and the liquid active ingredient concentrate and propellent are expended uniformly and completely. In the use of this valve with a system wherein the liquid propellent is of greater specific gravity than the liquid phase to be dispensed, the container must be used in the upright position to prevent loss of liquid propellent through the vapor tap opening in the valve housing which would occur if the container were inverted.

The flexible dip tube of our invention can be made of natural rubber or synthetic rubbers such as neoprene and buna. It can also be made of a wide variety of plastic materials such as modified vinyls (Tygon) and flexible polyethylene. As a practical matter, the employment of neoprene in the dip tube is preferred due to its solvent resistance. While the dimensions of the dip tube may vary considerably, it will be understood that there are practical limitations, the practical limitations being merely to provide a tube of sufficient flexibility to be oriented by the particular float employed and yet provide a dip tube having a sufficiently thick wall and hardness so as to prevent kinking or collapsing of the dip tube. For example, a tube having a bore diameter of about 0.1 inch, a wall thickness of about 0.015 inch and a hardness of 30 (Shore durometer) most nearly meets the flexibility requirements.

The float of our invention can be composed of a wide variety of materials including plastics such as polyamide polymers (nylon), polyethylene, polyvinyl chloride, linear acetal resin (Delrin), tetrafluoroethylene polymers (Teflon) and polyvinylidine chloride. The two main requirements of the float are mainly that it have a sufficient solvent resistance to withstand contact with the types of ingredients in the propellent and active ingredient phases and that it possess a specific gravity intermediate that of the two liquid phases. The float can be solid or, as illustrated in the drawings, the effective mass or average density of the float can be varied by the inclusion of ballast material or by the provision of an air space within the float.

The following examples illustrate one type of float that can be employed with a three phase aerosol system of the type shown in FIGURES 1 and 2 of the drawing.

Example 1

In this example a solid float composed of a polyamide polymer having the shape illustrated in FIGURE 1 of the drawings and having a density of 1.14 was employed. A simulated liquid active ingredient phase consisting of 59 percent alcohol and 41 percent water was employed. This mixture had a specific gravity of 0.92. A liquid propellent phase consisting of 40 percent Freon 12 (CCl_2F_2) and 60 percent Freon 114 ($CClF_2CClF_2$) was employed. This mixture had a specific gravity of 1.41. These two liquid phases were added to an aerosol container in the same proportion that is normally employed in such aerosol systems. Thus, of the total liquid charged, the simulated active ingredient phase comprised 55 percent by weight and the propellent phase comprised 45 percent by weight. The float when introduced into the system just described floated at the interface between the upper liquid active ingredient phase and lower liquid propellant phase. When the contents of the container are dispensed using flexible dip tube, as described above, the float remains suspended at the interface with the inlet port exposed to the liquid active ingredient phase.

Example II

In this example the same float as described in Example I was employed. A simulated liquid active ingredient phase consisting of 81 percent alcohol and 19 percent water was employed. This mixture had a specific gravity of 0.85. A propellent phase consisting of 55 percent Freon 12 (CCl_2F_2) and 50 percent Freon 11 (CCl_3F) was employed. This mixture had a specific gravity of 1.41. As in Example I, the two liquid phases were charged to an aerosol container such that the active ingredient phase constituted 55 percent by weight of the total liquid and the propellent phase constituted 45 percent by weight of the total liquid. When the float was introduced to this system, it was suspended at the interface between the two liquid phases. When the contents of the container are dispensed using a flexible dip tube, as described above, the float remains suspended at the interface with the inlet port exposed to the liquid active ingredient phase.

The basic systems of Examples I and II, can be adapted for use to a wide variety of products such as hair sprays, room deodorants, insecticides and colognes by inclusion of active ingredients in proper amounts. Liquid active ingredient phases can be formulated for use as hair sprays by the inclusion in the hydroalcoholic liquid phase of proper hydroalcoholic soluble resins such as polyvinylpyrrolidone, certain copolymers of polyvinylpyrrolidone anad vinyl acetate, dimethyl hydantoin formaldehyde, etc., properly plasticized and perfumed; for use as room deodorants by the inclusion of glycols, such as propylene glycol, dipropylene glycol, triethylene glycol, quaternary ammonium compounds, and fragrance; for use as insecticides by the inclusion of either hydroalcoholic soluble or emulsifiable toxicants, including pyrethrins and synergists; for use as colognes by inclusion of suitable fragrances, in proper amounts. It will be understood that while a hydroalcoholic phase is preferred, our invention is not limited to use in a system containing hydroalcoholic phase as the liquid phase to be dispensed, nor is it limited to the specific propellents described above as the liquid propellent phase, but includes liquid propellent phases having the described properties of specific gravity and immiscibility.

In addition to the other advantages of the dip tube and float of our invention described above, the float employed in an aerosol system such as that illustrated in FIGURES 1 and 2 of the drawing, has the additional advantage that the portion of the float immersed in the propellent phase serves as an equivalent to boiling chips permitting the propellent to boil up through the active ingredient phase and to establish pressure equilibrium within the vapor phase.

We claim:

1. In an aerosol dispenser for use with a three phase system comprising a vapor phase, a liquid phase to be dispensed, a liquid propellent phase of a different specific gravity than the liquid phase to be dispensed and sufficiently immiscible with the liquid phase to be dispensed so that two liquid layers are present, which dispenser includes a container and a valve member having a passageway therethrough providing communication between the interior and exterior of said container, the improvement which comprises a flexible dip tube attached to and communicating with the passageway through the valve member, a float connected to the dip tube, the float having a passageway therethrough communicating at one end only with the dip tube and at the other end only with the liquid phase to be dispensed to form an inlet port for the liquid phase to be dispensed, the dip tube being of a length at least substantially equal to the distance between the valve member and the portion of the container most remote from the valve member, the float having a specific gravity greater than one of the liquid phases and less than the other of the liquid phases whereby the float is suspended at the interface of the liquid phases, and the inlet port of the float disposed such that it is always and only in communication with the liquid phase to be dispensed.

2. The dispenser of claim **1** in which the liquid propellent phase is of a greater specific gravity than the liquid phase to be dispensed, the float is of a specific gravity less than the liquid propellent phase and greater than the liquid phase to be dispensed and the float is shaped and the inlet port disposed such that when the float is suspended at the interface between the liquid phases the center of gravity of the float is located in the liquid propellent phase and the inlet port is located in the liquid phase to be dispensed.

3. The dispeser of claim **1** in which the liquid propellent phase is of less specific gravity than the liquid phase to be dispensed, the float is of a specific gravity greater than the liquid propellent phase and less than the liquid phase to be dispensed and the float is shaped and the inlet port is disposed such that when the float is suspended at the interface between the liquid phases and the inlet port and the center of gravity of the float are located in the liquid phase to be dispensed.

4. The dispenser of claim **1** in which the valve member includes means for admixing liquid phase to be dispensed with vapor from the vapor phase in the container prior to discharge from the container.

5. The dispenser of claim **4** in which the valve member includes a mixing chamber provided with openings for the separate entry of the vapor phase and the liquid phase to be dispensed into the chamber and valve means for releasing the mixture of liquid and vapor from the chamber into the valve passageway communicating with the exterior of the container.

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