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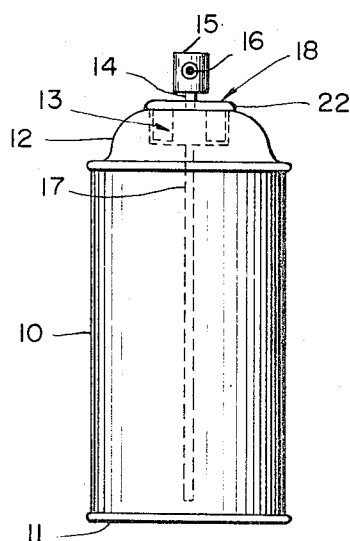


FIG. 1

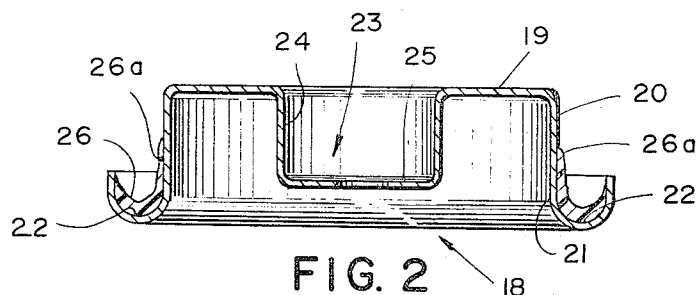


FIG. 2

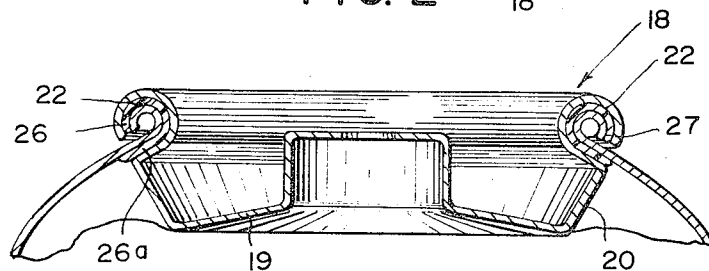


FIG. 3

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AEROSOL CONTAINER CLOSURES WITH PLASTISOL SEALING GASKETS

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This application is a continuation-in-part of application Ser. No. 423,136, filed on Jan. 4, 1965, now abandoned.

This invention relates to closure elements. More particularly, this invention relates to closure elements for aerosol containers.

The use of pressurized aerosol containers in the packaging and dispensing of both liquid and powdered particulate material has grown considerably in recent years. Currently, a wide variety of products such as insecticides, paints, cosmetics, food products and pharmaceuticals are being marketed in aerosol-type packages. As is well known in the art, these dispensing packages are provided with a valve-controlled discharge orifice and operate by the action of a volatile propellant which is confined within the container together with the fluid product to be dispensed. Since the propellant has an appreciable vapor pressure at room temperature, the fluid is forced upward through the discharge orifice when the valve is opened and emerges as a spray. The propellants employed are gases which have been liquefied either by cooling the gas below its boiling point or by compressing the gas at ordinary temperatures. Commonly used propellants include isobutane, carbon dioxide, nitrous oxide and halogenated lower alkanes, e.g., trichloromonofluoromethane ("Freon 11"), dichlorodifluoromethane ("Freon 12") and dichlorotetrafluoroethane ("Freon 114").

A typical aerosol unit comprises a hollow cylindrical container tightly closed at one end and is provided with an opening at its opposite end for receiving a dispensing valve assembly. A metal mounting cup serves as a closure for the container and also as a support for the valve assembly which is tightly fitted within an aperture centrally located in the cup. At its outer edge, the mounting cup is adapted to be rolled and crimped to the walls forming the opening in the container and carries an annular gasket which forms a seal in the seam produced upon crimping.

The gaskets previously employed in aerosol mounting cups have consisted primarily of two types, namely, cut rubber rings and "flowed-in" elastomeric gaskets. In the manufacture of closures fitted with cut rubber rings, the annular gaskets are blanked from a vulcanized rubber sheet of the desired thickness and then inserted individually into each cup. In preparing flowed-in gaskets, an elastomer dispersed or dissolved in a volatile liquid vehicle is deposited in the sealing area of the mounting cup while the cup is being rotated beneath a metering nozzle through which the composition flows. Thereafter, the deposit is converted into a dry solid sealing mass by expelling the liquid vehicle at elevated temperatures.

In general, gaskets of the "flowed-in" type have been preferred because of their superior over-all sealing performance. This has been due in large measure to the greater accuracy that may be obtained in placing the gasketing material in the effective sealing area of the cup. However, certain difficulties have been encountered in preparing "flowed-in" gaskets from the solvent-based rubber compositions conventionally employed for this purpose. Since a typical aerosol gasket has a comparatively small surface area in relation to its thickness, drying and curing of the wet deposit has tended to be a lengthy procedure requiring several hours. Because of the prolonged

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dry-cure times and because the cups are lined at high speeds, considerable oven capacity must be provided to accommodate large batches of lined cups. Also, the temperature during drying must be carefully maintained within certain ranges so that the solvent will not volatilize too rapidly, especially from the deeper layers of the deposit. Otherwise, blisters, pinholes and other imperfections will form in the dried mass and persist during the subsequent curing step to give gaskets unsuitable for use.

It is, therefore, the main object of the present invention to provide aerosol mounting cups with "flowed-in" gaskets which do not require prolonged dry-cure cycles and which are not subject to blistering at elevated temperatures. This object is accomplished by using a plastisol as the gasket-forming composition and applying a certain volume of the plastisol to the cup in a particular sealing configuration. More specifically, the present invention provides a closure for pressurized aerosol containers comprising a panel, a skirt depending from the periphery of the panel, an annular channel extending outwardly from the bottom portion of the skirt, and a gasket of a fluxed plastisol disposed within said channel and extending upwardly a distance on said skirt, said gasket having a total film volume of at least about 210 cubic millimeters.

The present invention will be more clearly understood from a reference to the attached drawings and the discussion relating thereto:

FIGURE 1 is a side elevational view of a typical aerosol container provided with a mounting cup and valve unit.

FIGURE 2 is an axial sectional view of the aerosol mounting cup of FIGURE 1 carrying a fluxed plastisol gasket of the present invention.

FIGURE 3 is a fragmentary axial sectional view of the upper portion of the aerosol container of FIGURE 1 showing the gasketed mounting cup of FIGURE 2 crimped in position over the mouth of the container.

Referring more particularly to FIGURE 1, a typical aerosol container is illustrated which comprises a cylindrical body portion 10 fitted with a domed top portion 12 and a bottom closure 11. The container is provided with a metering valve generally designated at 13 which is actuated by button 15. The actuator button is carried on a hollow valve stem 14 and is provided with an orifice 16 through which the container contents are discharged when valve 13 is opened. Communicating with valve 13 is a dip tube 17 which is of sufficient length to allow the liquid or particulate contents to be discharged from the container. The valve unit, which may be any of the various types known to the art, is supported by a mounting cup, generally designated at 18, which is adapted to receive the valve stem 14. The mounting cup also serves as a closure for the container and carries a sealing gasket in the annular channel 22 which is applied over the opening in the domed top portion 12 of the container.

An axial sectional view of mounting cup 18 is shown in FIGURE 2 in inverted position relative to its placement in the assembled container. The cup comprises a circular panel 19 having an integral skirt 20 depending from its periphery. The free edge of skirt 20 is outwardly flanged at 21 to form an annular gasket-receiving channel 22. The inner portion of panel 19 is countersunk to form a tubular recess, generally designated at 23, which has a dependent circular wall 24 integrally joined with an apertured horizontal wall 25. When the cup is placed in sealing position, the tubular recess 23 acts as a pedestal for the valve unit and the valve stem is admitted into the container through apertured wall 25.

An annular fluxed plastisol gasket 26 is disposed predominantly in the annular channel 22 of the cup with comparatively thin, film-like continuum portion 26a extending upwardly for a distance on the skirt 20, preferably

to approximately the midpoint between the top panel 19 and the skirt-channel juncture 21. This portion of the cup between the midpoint of skirt 20 and its juncture 21 with the channel 22 is commonly referred to in the aerosol art as the shoulder of the cup and accordingly, the film-like portion 26a of the gasket which is coextensive therewith is usually referred to as the shoulder film.

FIGURE 3 shows the gasketed mounting cup of FIGURE 2 crimped in position over the mouth of an aerosol container. As illustrated in FIGURE 3, the open end of domed portion 12 of the container is provided with an outwardly curled peripheral bead 27 which defines the container mouth. The annular channel 22 of the mounting cup embraces the bead 27 of the container so that the gasket 26 carried by channel 22 is positioned on bead 27. The lower portion of skirt 20 is flared outwardly against the wall of domed portion 12 adjacent to the bead 27. Thus, the film-like portion 26a of the gasket disposed on the shoulder or lower portion of the skirt forms a seal between the skirt and the wall adjacent to the container mouth.

An acceptable seal is dependent on its ability to retain propellant in the container which is sufficient to discharge the contents therefrom in the manner intended when the sealed container is stored for a prescribed period of time. For example, a seal is faulty if hairspray is dispensed as droplets of liquid instead of as a fine mist. This fault is due to loss of propellant through leaks in the assembled container. These leaks may be divided into two groups: (1) gross leakage and (2) microleakage.

Gross leakage is defined as a mechanical leak in which the gasket no longer maintains adequate contact with the container opening and the mounting cup in seamed relationship and results in a rapid loss of propellant. Such leakage may result from wrinkles or other imperfections in the metal which are not compensated for by the gasket, or as a result of gasket shrinkage which is due to extraction of plasticizer from the fluxed plastisol by solvents in the contained product. Gross leakage is not evident when the aerosol container is initially sealed, but it may occur at any time during its storage period.

Microleakage maintains a good mechanical seal, but the propellant slowly and steadily permeates through the gasket. However, such leakage is minor over a 1-year period and does not affect the performance of the container in dispensing the contents in the manner intended.

To establish an acceptable seal against gross leakage, the quantity of plastisol which is deposited in the effective sealing area of the cup must be sufficient to give a fluxed gasket having a total film volume of at least about 210 cubic millimeters and the crimp dimensions must be closely held. However, a satisfactory seal at standard crimps may be obtained by employing a fluxed gasket having a total film volume of at least 260 cubic millimeters. As the film volume is increased up to about 310 cubic millimeters at standard crimps, the plastisol gaskets seal aerosol packs better than prior gaskets. Above 310 cubic millimeters, no significant improvement in sealing performance is achieved.

The configuration of the fluxed gasket, like the film volume, is also critical for establishing an effective seal. More specifically, the gasket must have a thin, film-like portion extending upwardly from its main body portion in the channel to about or slightly below the midpoint of the skirt. Without this shoulder film, effective sealing is difficult if not impossible to attain regardless of the volume of material disposed in the annular channel. The thickness of the film should range between about 0.25 and 5.0 mils and preferably, is between about 0.5 and 1.0 mil. Below about 0.25 it is difficult to obtain a continuous void-free film which, of course, is essential for good over-all sealing performance. Otherwise, metal to metal contact may occur as well as high leakage rates which inevitably results in a large percentage of failures among the assembled packs. However, above about 5.0 mils

thickness no further advantage with respect to sealing is apparent.

The aerosol mounting cups employed in carrying out the present invention may be any of those used in the art. Customarily, the outside diameter of the skirt closely approaches one inch since the metal aerosol containers in common use have a standard filling opening or mouth measuring 1.000 ± 0.004 inch (internal diameter). Therefore, the limits with respect to the total film volume of the plastisol gasket as described herein are related to use in a one-inch diameter mounting cup. The cups are made in a known manner by blanking the closure from a rigid sheet of aluminum, tinplate or other sheet metal, and then the blanks are drawn into the desired shape. Though the cup illustrated in the attached drawings has a recessed center panel or pedestal, a pedestal is not always necessary and also, the pedestal height may vary depending upon the valve unit employed and the type of spray pattern desired. Where cups without a pedestal are employed, the valve stem is received by an aperture provided in the top panel of the closure.

In carrying out the present invention, any conventional plastisol composition may be used. The term "plastisol" refers to dispersions of finely divided thermoplastic resin particles in a liquid non-volatile plasticizer in which the resin is insoluble or only very slightly soluble at room temperature. However, at elevated temperatures the resin is substantially completely solvated by the plasticizer so that a homogeneous solution is obtained which forms a rubbery thermoplastic mass upon cooling. In addition to the resin and the plasticizer, the composition may also contain fillers, pigments, stabilizers, and various other conventional compounding ingredients.

Typical of the plastisol compositions which may be used are those containing 100 parts by weight resin, such as a polymer of vinyl chloride, between about 50 and 250 parts by weight plasticizer for the resin and between about 0 and 150 parts by weight filler. When stabilizers, wetting agents, and other ingredients are employed, they are used in conventional amounts to achieve the desired effect.

Among the resins which may be employed in the present invention are any of the plastisol grade resins commonly used in the plastisol art and conventionally prepared by emulsion polymerization techniques. Such resins include high molecular weight homopolymers of vinyl chloride and copolymers of vinyl chloride with up to 20% and preferably, less than 10% of acrylonitrile, vinylidene chloride, vinyl acetate, dialkyl maleates or other monomer copolymerizable therewith. Suitable plastisol grade resins which are homopolymers of vinyl chloride include Geon 121, Exon 654, Opalon 410 and 444, Marvinol VR-50, and the like. Other plastisol grade resins which may be employed are Vinylite VYNV, a copolymer of 95% vinyl chloride and 5% vinyl acetate, and Pliovic AO, a copolymer of vinyl chloride and 5% dialkyl maleate. Also useful are blends of plastisol resins with suspension grade resins which are prepared by suspension polymerization techniques. The suspension resins like the plastisol resins, may be homopolymers of vinyl chloride, such as Geon 101, Vinylite QYNA, Marvinol VR-10, and Exon 500, or copolymers of vinyl chloride containing minor amounts of comonomer. Examples of suitable suspension grade resins which are copolymers of vinyl chloride include Geon 202 (94% vinyl chloride copolymerized with 6% vinylidene chloride), VC-265 (95% vinyl chloride copolymerized with 5% vinyl acetate), and Vinylite VYNW (96% vinyl chloride copolymerized with 4% vinyl acetate).

Among the plasticizers which may be used in preparing the plastisol compositions are dialkyl phthalates, alkyl phthalyl alkyl glycolates, dialkyl esters of alkane dicarboxylic acids, acetyl trialkyl citrates, and trialkyl and triaryl phosphates. Particular plasticizers which may be employed include dioctyl phthalate (di-2-ethylhexyl phthalate), octyl decyl phthalate, ethyl phthalyl ethyl glycol-

ate, butyl phthalyl butyl glycolate, diisobutyl adipate, dibutyl sebacate, acetyl tributyl citrate, trioctyl phosphate and tricresyl phosphate. Other useful plasticizers include alkyl esters of fatty acids, such as, octyl stearate; epoxy derivatives, such as, epoxidized soybean oil; and polymeric polyester plasticizers, such as, polyethylene glycol adipate. While any of the primary plasticizers may be used alone, mixtures of primary plasticizers may be employed and mixtures of one or more primary plasticizers with one or more secondary plasticizers may be used.

Other ingredients which may be incorporated into the plastisols, if desired, are fillers, e.g., whiting, talc, clays, barytes, asbestos; pigments, e.g., carbon blacks, iron oxides, titanium dioxide; stabilizers, e.g., zinc and calcium stearates, thio-organic tin compounds, cadmium and barium laurates and wetting agents, e.g., zinc resinate and polyethylene glycol fatty acid esters.

The plastisol is applied to the mounting cup in a conventional manner using standard automatic nozzle-lining machinery. After lining, the cups carrying the plastisol deposit are conveyed to an oven where fluxing of the composition is carried out at conventional temperatures, e.g., in the range of 350° to 425° F. for a time sufficient to permit substantially complete solvation of the resin particles.

An example of a plastisol composition used to prepare the gasketed aerosol mounting cups of the present invention is as follows.

Example

Ingredients:	Parts by wt.
Polyvinyl chloride resin (plastisol grade)-----	100.0
Diocetyl phthalate (plasticizer) -----	100.0
Barytes (filler) -----	100.0
Titanium dioxide (pigment) -----	2.0
Carbon black (pigment) -----	0.032
Polyethylene glycol monoleate (wetting agent) -----	2.0

In preparing the above composition, the resin was added to the plasticizer in small increments while stirring at low speeds. After resin addition was complete, the filler, pigments and wetting agent were added, and stirring was continued until a homogeneous blend was obtained. Prior to lining, the composition was vacuum stirred for a short time to remove entrapped air.

The above plastisol was used to line several batches of mounting cups at varying film volumes. The cups were lined on automatic nozzle-lining equipment, and the closures employed were those commonly used for test purposes where the aperture in the panel or pedestal wall is omitted. After lining, the composition was fluxed by placing the cups in an oven maintained at a temperature of about 400° F. for approximately 2 minutes.

remaining gaskets at each film volume were lined without a shoulder film by depositing all of the plastisol directly into the annular channel.

The performance of the gaskets was tested on standard Freon 12/Freon 11/methylene chloride packs at both tight commercial and loose commercial crimp depths (measured to collet toe centerline) of about 0.200–0.205 inch and about 0.210–0.215 inch, respectively. A standard air crimper equipped with a $\frac{3}{64}$ inch toe radius collet was used to apply the cups to the containers at a crimp diameter of about 1.07 inches.

The Freon 12/Freon 11/methylene chloride packs used as the control were closed with mounting cups provided with conventional flowed-in gaskets derived from neoprene solutions. The total film volume (dry) in each cup was 210 cubic millimeters at which level neoprene gaskets exhibit optimum sealing efficiency. The shoulder film of the neoprene gaskets was about 2 mils thick (dry) and extended to about the midpoint of the skirt.

Upon determining the weight loss of the packs at the end of eight weeks, it was found that all of the plastisol gaskets which partially filled the channel but without shoulder films failed at both tight and loose crimps over the entire range of film volume tested. Further studies revealed that fluxed gaskets completely filling the annular channel but without a shoulder film also failed under the test conditions described above.

In comparison, the plastisol gaskets having an integral shoulder film showed a decrease in loss rate as the film volume increased up to about 310 cubic millimeters. At tight crimps, plastisol gaskets having a film volume of 260 cubic millimeters sealed as well as the control, and sealing performance slightly better than that of the control was evident with further increases in film volume. At loose crimps, sealing comparable to the control was obtained with gaskets having a film volume of 270 cubic millimeters; and at film volumes above 270 millimeters, the plastisol gaskets performed significantly better than the neoprene gaskets.

Another set of experiments was carried out to determine the minimum film volume of gasket necessary to obtain a satisfactory seal against gross leakage where the crimp dimensions (measured to collet toe centerline) were closely held at about 0.190–0.195 inch. An air crimper equipped with $\frac{3}{64}$ inch toe radius collet was used to apply the gasketed cups to the containers at a crimp diameter of about 1.07 inches. The gasket used was the fluxed plastisol as described under the example. The shoulder film on the mounting cup had a thickness of between about 0.25 and 1.0 mil and extended to about the midpoint of the skirt. Each package was stored for about 1 year. The results were as follows:

Experiment	Propellant	Packaged Product	Total film volume (mm. ³)	Gross leakage rate, percent
1-----	Freon 12-Freon 11-methylene chloride mixture in a ratio of 30-33-37 parts by weight.	Oil base paint-----	100	88
			150	93
			210	0
2-----	Isobutane-----	Propellant only-----	100	100
			150	100
			210	10
			235	0
3-----	Freon 12-Freon 11-Denatured anhydrous Ethanol mixture in a ratio of 35-35-30 parts by weight.	Hair spray-----	210	28
			230	13
			250	0
4-----	Freon 12-Freon 11 mixture in a ratio of 50-50 parts by weight.	Propellant only-----	210	5
			235	0

The total film volume of the gaskets produced in each batch was 210, 230, 250, 260, 270 and 310 cubic millimeters, respectively. One half of the gaskets prepared at each film volume had a shoulder film extending upwardly to about the skirt midpoint. The thickness of the shoulder film in all cases was between about 0.25 to 1.0 mil. The

It is noted that the use of a gasket having a total film volume of 210 mm.³ in Experiment 1 produces a gross leakage rate of zero percent. It is to be further noted that the type of propellant used has some influence on the minimum volume of gasket necessary to yield a zero percent gross leakage rate.

From the above example and the result obtained, it is readily apparent that fluxed plastisol gaskets having an integral shoulder film and a total film volume between about 210 and 310 cubic millimeters perform as well and, in many instances, perform better than prior flowed-in gaskets. Though slightly high film volumes of plastisol are required to effect sealing comparable to conventional gaskets, the use of plastisols is considerably more economical even at the higher volumes. For example, the preparation of rubber-based gasketing compositions is time-consuming and entails the use of expensive equipment for milling the elastomer with other ingredients and for mixing the rubber batch with the solvent. When applied in thick deposits, as in aerosol mounting cups, several hours are required for removing the solvent which generally is not recovered. In comparison, plastisol compositions may be prepared rapidly and easily since mixing of the components may be accomplished with simple stirring. Moreover, fluxing of the composition may be carried out in a few minutes at elevated temperatures without blistering, and there is no volatile component lost during heating, since the composition is 100% solids.

We claim:

1. A closure for aerosol containers comprising a panel, a skirt depending from the periphery of the panel, an annular channel extending outwardly from the bottom portion of the skirt and a gasket of a fluxed plastisol disposed within the channel and having a film portion at least 0.25 mil thick extending upwardly a distance on the skirt, gas gasket having a total film volume of at least about 210 cubic millimeters, total film volume being related to a one-inch diameter mounting cup closure.

2. A closure according to claim 1 wherein the gasket has a total film volume of between about 260 and 310 cubic millimeters.

3. A closure according to claim 2 wherein the film portion of the gasket extends upwardly to about the midpoint of the skirt.

4. A closure according to claim 2 wherein the film portion of the gasket has a thickness of between about 0.25 and 5.0 mils.

5. A closure according to claim 4 wherein the gasket comprises 100 parts by weight of a vinyl chloride polymer resin, between about 50 and 250 parts by weight of a liquid, non-volatile plasticizer for said resin, and between about 0 and 150 parts by weight of a filler.

6. A closure according to claim 5 wherein the panel has a central tubular recess comprising a depending circular wall integrally joined with an apertured horizontal wall.

7. A pressurized container having a fluid composition and a propellant confined therein, a valve controlled opening for dispensing the contents therefrom, said valve being supported by a one-inch diameter mounting cup and communicating with the interior of said container, said mounting cup comprising a panel, a skirt depending from the periphery of the panel, an annular channel extending outwardly from the bottom portion of the skirt and a gasket of a fluxed plastisol disposed within the channel and having a film portion at least 0.25 mil thick extending upwardly a distance on the skirt, said gasket having a total film volume of at least about 210 cubic millimeters.

8. A pressurized container according to claim 7 wherein the gasket has a total film volume of between about 260 and 310 cubic millimeters.

9. A pressurized container according to claim 8 wherein the film portion of the gasket extends upwardly to about the midpoint of the skirt.

10. A pressurized container according to claim 9 wherein the film portion has a thickness of between about 0.25 and 5.0 mils.

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