Dec. 10, 1968 F. J. KNIGHT ET AL 3,415,425

AEROSOL DISPENSER

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Fig. 1.

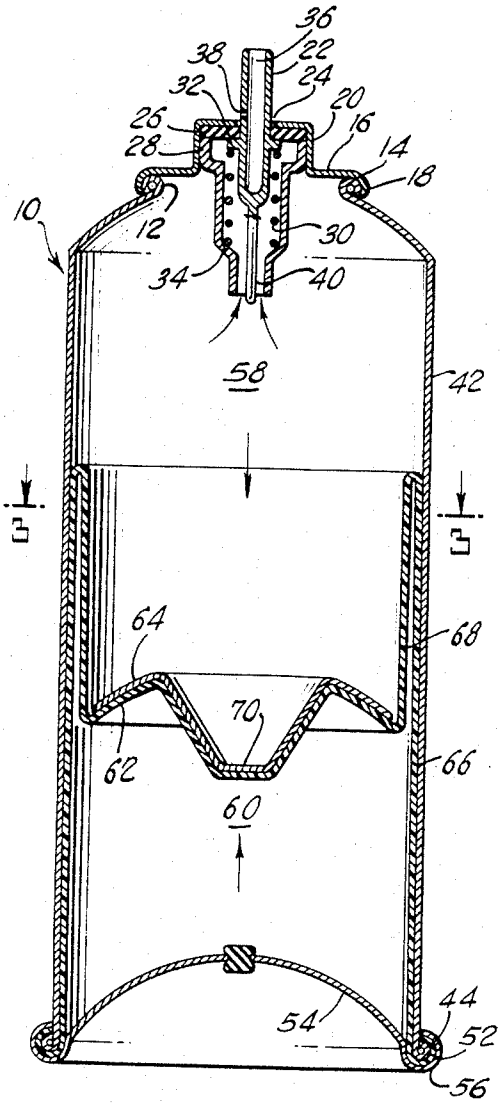


Fig. 2.

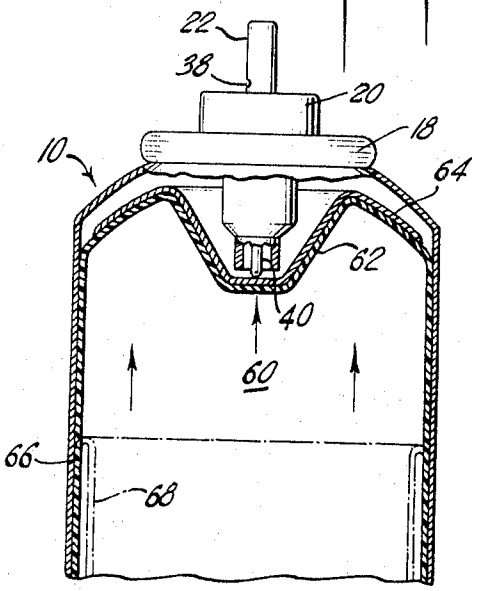


Fig. 3.

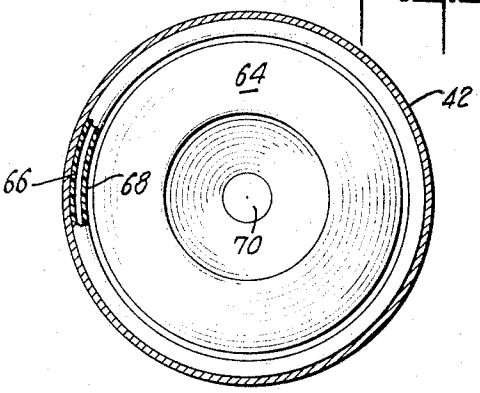
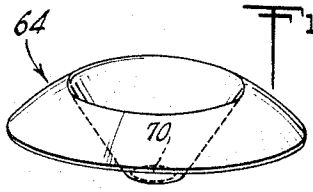


Fig. 4.



INVENTORS:
FRANCIS J. KNIGHT
FRANK J. MACK
BY
M. Frederick Mayer, Jr.
ATTORNEY

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AEROSOL DISPENSER

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Fig. 5.

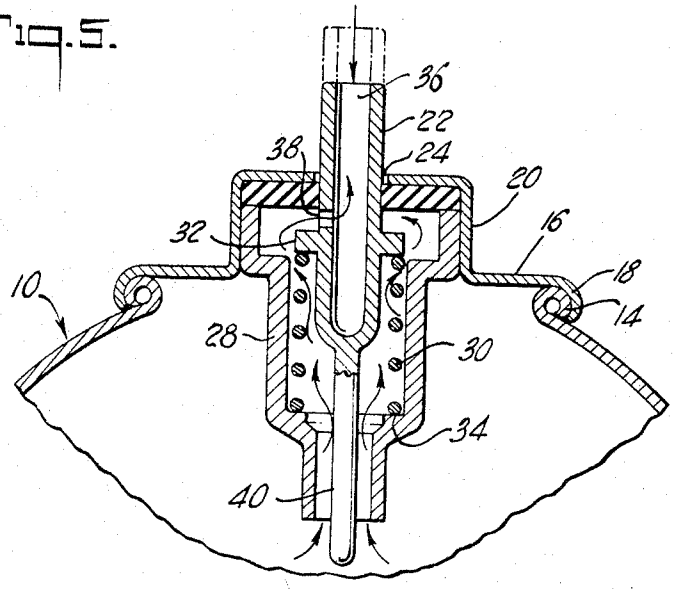
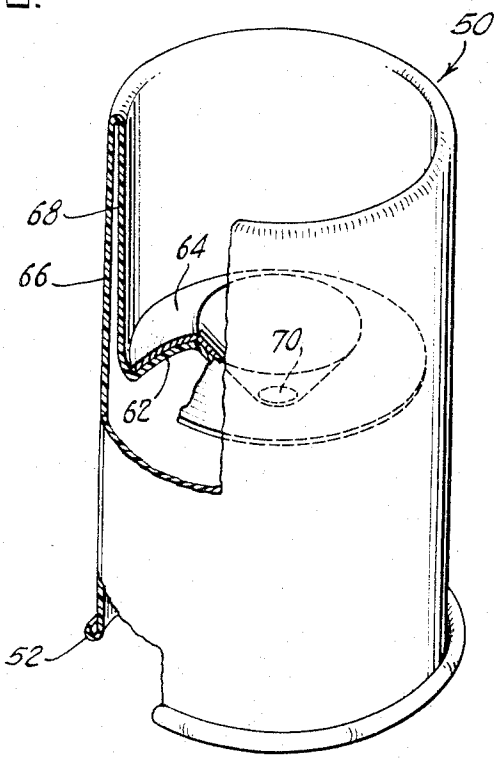


Fig. 6.



INVENTORS:
FRANCIS J. KNIGHT
FRANK J. MACK
BY
W. Frederick Rayer, Jr.
ATTORNEY

Dec. 10, 1968 F. J. KNIGHT ET AL 3,415,425

AEROSOL DISPENSER

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FIG. 7.

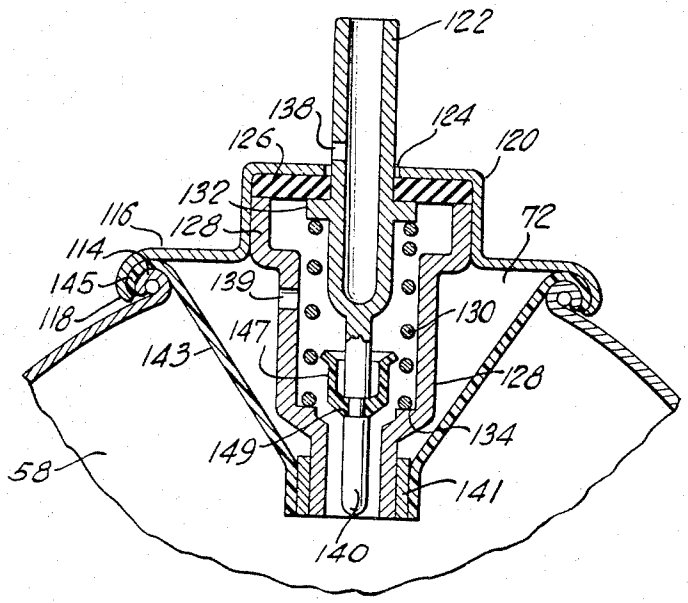
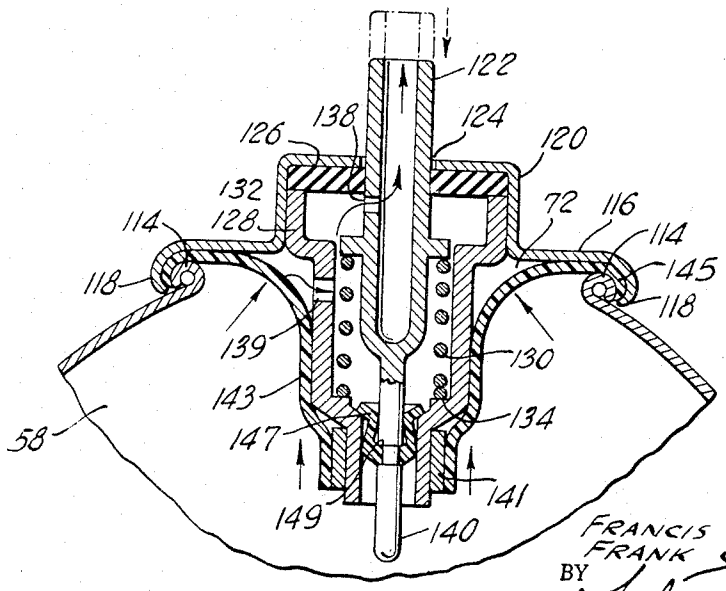


FIG. 8.



INVENTORS:
FRANCIS J. KNIGHT
FRANK J. MACK
BY
W. Frederick Cramer, Jr.
ATTORNEY

United States Patent Office 3,415,425
Patented Dec. 10, 1968

3,415,425

AEROSOL DISPENSER

Francis J. Knight, New Brunswick, and Frank J. Mack, New Shrewsbury, N.J., assignors to Johnson & Johnson, a corporation of New Jersey

Filed Nov. 15, 1966, Ser. No. 594,561
3 Claims. (Cl. 222—386.5)

ABSTRACT OF THE DISCLOSURE

This application discloses an aerosol dispenser particularly useful for dispensing products in a closed system, i.e., medications through a hypodermic needle, that employs a flexible bag-like diaphragm for separating the container into two chambers, one containing the product and the other containing the propellant. The diaphragm is equipped at its closed end with a rigid disk-like member which by its configuration conforms to the top of the aerosol container and is adapted to accommodate the valve located at the top of the container in such a manner as to permit tactile discernment and inactuation of the valve mechanism upon exhaustion of the contents from the container.

Background of the invention

This invention relates to aerosol dispensers and more particularly, is directed to improvements in aerosol dispensers of the so-called diaphragm type, i.e., aerosol dispensers using a flexible diaphragm for separating the dispenser into variable lower and upper chambers for containing a propellant and the material to be dispensed respectively.

Packaging of materials in aerosol dispensers has become very popular primarily because of their convenience to the consumer and the ease with which such products can be dispensed. Generally such aerosol dispensers have been of two basic types. In the packaging of some products a propellant, such as a low boiling liquid or a gas under pressure, can be mixed with the product to be dispensed such that the containers do not require separate chambers for containing the products to be dispensed and the propellant. However, in many instances the product to be dispensed is not compatible with useful propellants or the particular application of the product to be dispensed dictates that the propellant cannot be dispensed therewith. In these latter instances, separate noncommunicating chambers are required for containing the product to be dispensed and the propellant used to dispense the product under pressure.

Two basic types of containers have been provided for aerosol dispensers employing noncommunicating chambers for containing the product to be dispensed and the propellant. There is the piston type aerosol dispenser which employs a circular piston closely fitted transversely within the interior of a cylindrical container dividing the same into upper and lower chambers. To assure that there is no communication between the lower propellant chamber and the upper product containing chamber, the piston is often fitted with a sealing ring about its circumferential surface. While such containers have met with some amount of success, considerable improvement is yet to be desired. For example, during packaging, transportation and general handling, the cylindrical aerosol containers, which are generally made of metal, frequently become dented or deformed such that the close fitting piston binds within the container and is not free to move upwardly under the influence of the propellant to dispense the product from the upper chamber. Accordingly, it is seen that often times the aerosol

dispensers of the piston type fail to dispense all of the product contained therein.

The second basic type of separate chamber aerosol dispenser employs a flexible diaphragm member separating the container into an upper product chamber and a lower propellant chamber. As the product is gradually dispensed from the product chamber, the flexible diaphragm under the influence of the propellant contained within the lower chamber is forced into the void created by the depletion of material from the upper chamber. In general, the flexible diaphragm is formed such that when all the contents of the aerosol dispenser have been depleted, the lower chamber will conform to the total volume of the aerosol container. Such diaphragm containers have also met with a reasonable amount of success but one serious drawback remains. Because of the flexible nature of the diaphragm, there is a tendency for the contents of the upper chamber to become trapped in pockets between the diaphragm and the inner side walls of the container as the diaphragm distends to fill voids created by the exhaustion of the upper chamber. Again, it is seen that such aerosol dispensers often times fail to dispense the total quantity of material contained in the dispensing chamber.

A further limitation inherent in the so-called diaphragm aerosol dispensers heretofore available has been the inability to determine when the contents of the dispensing chamber have been completely exhausted when the aerosol dispenser is used in a closed system. Such a system, for example, is the injection of a medication from the aerosol container through a hypodermic needle into the cutaneous, subcutaneous, muscular, or vascular system of animals or humans. Without being able to observe visually the ejection of the contents of the aerosol container, subjects or patients are sometimes needlessly subjected to fruitless hypodermic punctures.

By the present invention, we have now provided improvements in aerosol dispensers of the so-called diaphragm type which overcome the above difficulties and objections inherent in both the diaphragm dispensers and piston dispensers heretofore available.

Summary of the invention

According to the present invention, there is provided an aerosol dispenser container having an upper product containing chamber and a lower propellant containing chamber separated from one another by a flexible diaphragm of bag-like configuration. The bag-like flexible diaphragm is secured circumferentially at its open end to the inner side wall of the container at the base thereof. Communicating with the upper product containing chamber through the top of said container is a dispensing aperture with actuatable valve means positioned therein for selectively opening and closing the dispensing aperture. Secured to the flexible bag-like diaphragm at its inner closed end is a rigid disk-like member having a diameter less than the internal diameter of the aerosol container.

The disk-like member secured to the flexible bag-like diaphragm is disposed transversely in the aerosol container and is movable longitudinally upward therein as the product is dispensed from the product containing chamber. Further, the rigid disk-like member must have a diameter less than the internal diameter of the aerosol container by an amount equal to at least four times the thickness of the flexible diaphragm but by no more than an amount equal to ½ the internal diameter of the aerosol container.

These and other features of the improved aerosol container of the present invention and the advantages obtained thereby, will be even more apparent from the following description when read in conjunction with the accompanying drawings in which:

FIGURE 1 is a plan view of the improved aerosol container of the present invention shown in its nondispensing, filled condition;

FIGURE 2 is a plan view, shown partly in elevation, of the top portion of the aerosol container in its nondispensing, empty condition;

FIGURE 3 is a cross sectional view of the container shown partly in elevation and taken approximately along line 3—3 of FIGURE 1;

FIGURE 4 is an elevational view of the rigid disk-like member employed in the aerosol container of the present invention;

FIGURE 5 is an enlarged plan view of the improved valve means of the present invention shown in its dispensing position;

FIGURE 6 is an elevational view, partly broken away for clarity, of the flexible diaphragm-rigid disk assembly as it is formed and used in the improved aerosol container of the present invention;

FIGURE 7 is an enlarged plan view of another type of aerosol valve assembly used in the improved aerosol dispenser of the present invention and shown in its nondispensing position; and

FIGURE 8 is a plan view of the valve assembly of FIGURE 7 showing the aerosol dispenser in its dispensing position.

Referring now to the drawings, first particularly to FIGURE 1, the invention in its preferred form contemplates a cylindrical container **10** having an open neck **12** surrounded by an external bead **14** and a cap **16** fitted onto the container neck **12**. The cap **16** includes a flange **18** which snaps over the bead **16** on the container **10** and is permanently secured to the container **10** to provide a pressure tight seal.

The cap **16** includes a raised central portion **20** for mounting a hollow tubular valve member **22**. The top of the raised portion **20** has a circular dispensing aperture **24** positioned at the center thereof, and the valve member **22** passes through the aperture **24** in slidable relation therewith. An annular sealing gasket **26** is positioned internally at the top of the raised portion **20** and has a central cylindrical opening of a diameter equal to or slightly less than the outer diameter of the tubular valve member **22** and is formed of a resilient material, such as valve rubber, which is flexible yet durable. The gasket **26** is held in position against the internal top surface of the raised portion **20** by a depending cylindrical fitting **28** which is secured within the internal dimensions of the raised portion **20** of the cap **16** by a force fit.

The valve member **22** is normally urged upwardly into contact with the annular gasket **26** to seal the unit by a spring **30** fitted under compression against the underside of an annular sealing flange **32** integral with the valve member **22** and against the upper side of an inwardly directed ridge **34** near the inner end of the dependent cylindrical fitting **28**. The valve member **22** defines an axial passage **36** which is closed at the inner end thereof and normally not in communication with the interior of the cylindrical container **10**. Providing an internal opening into the axial passage **36** of the tubular valve **22** is an inlet opening **38** passing through the side wall of the valve **22** above the annular sealing flange **32**. As shown in FIGURE 1, when the valve member **22** is normally urged upwardly with the sealing flange **32** pressed against the annular gasket **26**, the inlet opening **38** is positioned well above the annular sealing gasket **26**. In this position, the valve member **22** seals the interior of the cylindrical container **10** from the atmosphere. To actuate the valve member **22** and open the interior of the aerosol container **10** to the atmosphere, the tubular valve **22** is merely depressed against the pressure of the spring **30** until the inlet opening **38** moves below the sealing gasket **26**. The contents within the aerosol container **10**, if under pressure, will enter the axial passage **36** in the valve member **22** through the inner open end of the dependent cylindrical fitting **28** and thence through the inlet opening **38** as soon as the inlet opening **38** is depressed below the annular sealing gasket **26**.

The above merely describes, in essence, a standard aerosol valve mechanism but as is explained more fully hereafter, the valve mechanism is further provided in accordance with the present invention with means for indicating when the contents of the aerosol container are exhausted. Referring particularly to FIGURES 1, 2 and 5, it is seen that the tubular valve **22** is provided on its inner closed end with a rigid rod-like extension **40** projecting axially and centrally within the bore of the depending cylindrical fitting **28**. When the valve member **22** is in its inoperative position, the rigid extension **40** terminates approximately flush with the inner end of the depending cylindrical fitting **28**. Upon actuation of the valve member **22** by depressing the same, the rigid extension **40** projects below the inner end of the depending cylindrical fitting **28** into the interior of the aerosol container **10** (FIGURE 5). The manner in which the rod-like projection **40** on the valve member **22** operates to indicate exhaustion of the container contents will be explained more fully hereafter.

The cylindrical container **10** includes a vertical, circular side wall **42** that terminates at its base in a circumferential external bead **44**. Extending inwardly from th base of the container **10** is a flexible diaphragm **50** which is, in essence, a cylindrical bag-like structure formed at its open end with a circumferential, external flange **52** that fits over the external bead **44** at the base of the container wall **42**. Securing the diaphragm **50** within the container **10** is a base plate **54** also provided with a circumferential, external flange **56** which is crimped over the external bead **44** of the container wall **42** with the diaphragm flange **52** pressed therebetween.

Referring now particularly to FIGURES 1, 3, 4 and 6, there is shown the various components and configuration of the flexible diaphragm member **50** employed in the aerosol container **10** for dividing the same into a variable upper product containing chamber **58** and a variable lower propellant containing chamber **60**. The diaphragm **50** is made of flexible material which can be elastomeric, such as rubber, or can be made of a flexible inelastic material, such as polyethylene, polypropylene, and the like. While generally of bag-like structure, the diaphragm **50** is formed with the inner closed end **62** thereof involuted to provide for the expansion of the diaphragm **50** upwardly as the contents are dispensed from the upper contents containing chamber **58**.

At the inner closed end **62** of the diaphragm **50** is secured a rigid disk-like member. It can be made of metal or any plastic material that is relatively nondeformable. Being rigid, the disk imparts form stability to the area of the diaphragm defined as its inner closed end **62**. The outer circumference of the rigid disk **64** is less than the inner circumference of the aerosol container **10** so that the disk is free to move longitudinally therein.

Because the closed end **62** of the diaphragm **50** is involuted, it is seen that diaphragm **50** includes an ascending outer side wall **66** and an inner descending side wall **68**. The outer and inner walls **66** and **68** respectively, merge circumferentially along the inner surface of the container wall **42** within the upper product containing chamber **58**. As the closed end **62** of the diaphragm **50** and also the rigid disk-like member secured thereto are forced upwardly by the propellant contained in the lower chamber **60** when the product is being dispensed, the inner wall **68** converges into the outer side wall **66** such that the circular line of merger therebetween raised upwardly in the upper chamber at one half the rate that the disk **64** rises. Thus, the disk **64** must have a diameter less than the internal diameter of the container **10** by an amount equal to at least four times the thickness of the flexible diaphragm to accommodate for the inner wall **68** moving upwardly relative to the fixed outer wall **66**.

It is also found that the rigid disk **64** can be substantially smaller in diameter relative to the internal diameter of the container **10** which further enhances the ease with which it can be moved longitudinally upwardly under the influence of the propellant. By being substantially smaller, greater clearance is provided between the periphery of the disk **64** and the wall **42** of the container **10**. With the greater clearance therebetween, the disk **64** remains free to move longitudinally under the influence of the propellant even if the container **10** becomes dented or otherwise deformed during its manufacture, shipment or storage. Such clearance can be provided because the diaphragm **50** to which the rigid disk **64** is secured prevents leakage of propellant from the lower chamber **60** into the upper chamber **58**.

The maximum amount of clearance that can be provided, however, in accordance with the invention, is that which exists when the diameter of the disk **64** is equal to ½ the internal diameter of the container **10**. If the diameter of the disk **64** is less than ½ the internal diameter of the container **10**, there is a tendency for the disk to tilt from its transverse, horizontal position during its longitudinal travel upwardly under the influence of the propellant. In so doing, the outer wall **66** of the diaphragm **50** would tend to separate from the internal surface of the container wall **42** particularly along the portion of the container wall **42** existent in the upper chamber **58** as the inner wall **68** of the diaphragm **50** converges to form the outer wall **66** as the disk **64** moves upwardly. If the diaphragm **50** is thus prevented from conforming to the internal surface of the container wall **42**, some of the product contained in the upper chamber **58** becomes trapped in the pockets thus formed and will not be dispensed from the aerosol container. Further, if the disk **64** is too small and accordingly, tilts out of its horizontal position, it will fail to mate with the internal surface presented at the top of the container **10** again causing a considerable amount of product to become trapped and nondispensable therefrom.

The rigid disk-like member **64** is provided with a central recessed portion **70** which accommodates the depending cylindrical fitting **28** that extends downwardly into the product containing chamber **58** from the top **16** of the container **10** when the rigid disk member **64** has been moved to the top of the container upon all the contents thereof having been dispensed under the influence of the propellant in the lower chamber **60**. Also, since the internal surface at the top of the container as shown has a domed configuration, the rigid disk-like member **64** is of similar domed configuration with the above mentioned recess **70** centrally disposed. In essence, it is seen that the top surface of the rigid disk-like member **64** is shaped generally to conform to the shape of the internal surface of the aerosol container at the top thereof, so that the diaphragm **50**, while being rigid and inflexible in the area of its inner closed end, will still be capable of fitting substantially into the volume defined by the top of the container when the contents are exhausted or nearly exhausted therefrom. This then, assures, first that little of the contents within the aerosol container will fail to be dispensed therefrom.

Further, the recessed portion **70** of the rigid disk-like member **64** is formed to engage and close off the inner end of the dependent cylindrical fitting **28** when the diaphragm reaches its uppermost extension (FIGURE 2). As described earlier, the rod-like projection **40** on the valve member **22** terminates approximately flush with the innermost end of the dependent cylindrical fitting **28** when the valve member is in its nondispensing or closed position. If the contents of the upper product containing chamber **58** are exhausted, the rigid disk-like member **64** forming the closed inner end of the flexible diaphragm **50** will be held securely against the inner end of the depending cylindrical fitting **28** by the pressure exerted by the propellant in the lower propellant containing chamber **60**. With the rigid disk-like member **64** so disposed, depression of the valve member **22** is resisted by the rod-like projection **40** on the valve member **22** resting against the disk **64**, and accordingly, the operator will be able to determine tactilely that the aerosol container is empty even if its contents are being dispensed in a closed system.

Referring now particularly to FIGURES 7 and 8, a modified valve mechanism can be employed in accordance with the present invention and is particularly useful when the aerosol container is used to dispense medications that are to be injected by a hypodermic into the tissues of animals or humans. The modified valve is, in essence, a metering valve which provides for predetermined quantities of medicated product to be dispensed upon any single actuation of the valve mechanism. While the metering valve, per se, is generally well recognized in the art, the valve assembly employed in accordance with the present invention is modified so as to provide means for determining when the contents of the aerosol container have been exhausted when the aerosol container having a metering valve is used in such a closed system.

The metering valve assembly is essentially the same as the valve assembly depicted in FIGURES 1, 2 and 5 but includes in addition a reservoir chamber **72** which meters a predetermined quantity of medication upon actuation of the valve assembly.

Thus it is seen, the valve assembly, as in the previously described embodiment, consists of a cap **116** that includes a raised central portion **120** with a circular dispensing aperture **124** in the center thereof, through which passes the tubular valve member **122** in slidable relation therewith. An annular sealing gasket **126** formed of a resilient material which is flexible yet durable is secured internally at the top of the central raised portion **120** by a depending cylindrical fitting **128** which is force fitted within the central raised portion **120**.

The valve member **122** is provided with an annular sealing flange **132** which is normally urged upwardly into sealing engagement with the annular sealing gasket **126** by a spring member **130** compression fitted between the under surface of the sealing flange **132** and the upper surface of an inwardly directed ridge **134** near the inner end of the dependent cylindrical fitting **128**. Above the annular sealing flange **132** is an inlet opening **138** in the side wall of the tubular member **122**. The inlet opening **138** in the side wall of the tubular valve member **122**, when the latter is normally urged upward into sealing engagement with the sealing flange **132** pressed against the annular sealing gasket **126**, is positioned well above the annular sealing gasket **126**.

The dependent cylindrical fitting **128** is also provided with an opening **139** in the side wall thereof. Fitted about the internal end of the dependent cylindrical fitting is a collar **141** which is adapted to slide longitudinally in close fitting engagement with the internal end of the dependent cylindrical fitting **128**. Tightly fitted on the slidable collar **141** is a funnel-shaped diaphragm member **143** of flexible material, the top circumferential edge of which is provided with a circumferential external flange **145** which is force fitted between the circumferential external bead **114** at the top of the cylindrical aerosol container and the circumferential external flange **118** of the cap member **116** which is crimped over the external bead **114** in the container wall.

The tubular valve member **122** of the metering valve assembly, as in the previously described unmetered valve assembly, is provided with a rigid rod-like extension **140** on its inner closed end which projects axially and centrally within the bore of the depending cylindrical fitting **128**. The length of the rod-like extension is such that when the valve member **122** is in its inoperative position, the rigid extension **140** terminates approximately flush with the inner end of the depending cylindrical fitting **128**. In the metering valve assembly, the rod-like projection **140** on the tubular valve member **122** has fitted thereon

a cup-shaped annular seal **147** of flexible material such as, valve rubber, which, when the valve member **122** is normally urged upwardly in an inoperative position, is out of sealing engagement with the inner end of the depending cylindrical fitting **128**. The annular cup-shaped seal **147** is prevented from moving axially with respect to the rod-like extension **140** on the valve member **122** by fitting into a circumferential rectangular groove **149** located on the rod-like extension **140**.

The interior of the funnel-shaped, flexible diaphragm **143** around the valve assembly defines a reservoir chamber **72**. When the tubular valve member **122** is in its non-operative position, it is seen that the pressures existent within the reservoir chamber **72** and the upper product containing chamber **58** are equal by virtue of the opening through the inner end of the dependent cylindrical fitting **128** and the opening provided in the side wall thereof. When the tubular valve member is depressed to dispense the product from the aerosol container (FIGURE 8), the cup-shaped seal **147** closes off the opening at the inner end of the dependent cylindrical fitting **128**, and the inlet opening **138** in the side wall of the tubular valve member **122** becomes positioned below the annular sealing gasket **126**. In this position, under the pressure exerted by the propellant contained within the lower propellant containing chamber of the aerosol container, the funnel-shaped diaphragm **143** is forced inwardly toward the outer side walls of the dependent cylindrical fitting **128**. To accommodate for the inward flexing of the diaphragm **143**, the collar **141**, to which the inner end of the diaphragm **143** is secured, is free to slide longitudinally upwardly on the inner end of the dependent cylindrical fitting **128**. In this manner, the volume within the reservoir chamber **72** is decreased thus forcing the product contained within the reservoir chamber **72** to flow through the opening **139** to the interior of the dependent cylindrical fitting **128**, then through the inlet opening **138** in the side wall of the tubular valve member **122**, and thence outwardly to the atmosphere until all of the product contained within the reservoir chamber **72** has been dispensed. Since the tubular valve member **122** in its operative position places the cup-like seal **147** in a position to close off the opening at the inner end of the dependent cylindrical fitting **128**, no additional product can enter the reservoir chamber **72** as long as the tubular valve member **122** is maintained in its open position. Upon release of the tubular valve member **122**, the inlet opening **138** in the side wall thereof moves above the annular sealing gasket **126** while at the same time the cup-shaped annular seal **147** moves out of sealing engagement with the inner end of the dependent cylindrical fitting **128**, once again permitting the pressures in the reservoir chamber **72** and in the product containing chamber **58** to equalize, returning the flexible diaphragm **143** to its normal unflexed state.

As with the earlier described embodiment of the valve assembly, it is seen that the rigid rod-like extension **140** provides a means for tactilely determining when the contents within the aerosol container of the present invention are exhausted. The rigid disk-like member **64** secured on the inner end **62** of the flexible diaphragm **50** that separate the product containing chamber **58** and the propellant containing chamber **60**, and which is shaped generally to conform to the interior configuration at the top of the container, is urged into fitting engagement with the inner end of the dependent cylindrical fitting **128** when the product within the upper product containing chamber **58** has been exhausted. With the rigid disk-like member **64** in this position, depression of the tubular valve member **122** is opposed by way of the rigid rod-like extension **140** resting against the upper central surface **70** of the rigid disk-like member **64** (FIGURE 2). As mentioned earlier, this means for tactilely determining when the contents of the aerosol container of the present invention have been depleted is particularly useful and advantageous when the aerosol container is used in a closed system such as when medications are injected by way of a hypodermic needle fitted to the tubular valve member **122**.

While we have described our invention in detail as it is incorporated in preferred embodiments, it is to be understood that many changes, alterations, and modifications can be made therein without departing from the spirit and scope of the invention as defined in the following appended claims.

We claim:

1. In an aerosol dispenser container having an upper product containing chamber and a lower propellant containing chamber separated from one another by a flexible diaphragm of bag-like configuration, said diaphragm being secured circumferentially at its open end to the inner side wall of said container at the base thereof, a dispensing aperture communicating with the upper product containing chamber through the top of said container and actuatable valve means in said dispensing aperture extending into said product containing chamber for the selective opening and closing of said dispensing aperture, the improvement comprising:

(a) A rigid disk-like member secured to said flexible bag-like diaphragm at the inner closed end thereof and having a diameter less than the internal diameter of said container by an amount equal to at least four times the thickness of said flexible diaphragm but by no more than an amount equal to ½ the internal diameter of said container,

(1) said rigid disk-like member being disposed transversely in said container and movable longitudinally upwardly therein as said product is dispensed from said product containing chamber, and

(2) said rigid disk-like member having a centrally disposed recessed portion for accommodating that portion of said valve means extending into said product containing chamber when substantially all of said product has been dispensed therefrom.

2. The improved aerosol dispenser container as defined in claim **1** wherein the improvement comprises, in addition, a product reservoir chamber interposed between said dispensing aperture and said product containing chamber for limiting the amount of product dispensed from said container upon any single actuation of said valve means.

3. The improved aerosol dispenser as defined in claim **1** wherein said valve means includes a rigid extension that projects into said product containing chamber upon actuation thereof and which rigid extension is prevented from projecting into said product containing chamber by said rigid disk-like member when the product is exhausted from said product containing chamber thereby also preventing actuation of said valve means to open said dispensing aperture.

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ROBERT B. REEVES, *Primary Examiner.*

HADD S. LANE, *Assistant Examiner.*

U.S. Cl. X.R.

222—387, 402.20