ABSTRACT: An aerosol valve assembly is provided for mounting to an aerosol container holding a fluid under pressure. The assembly comprises a hollow cap having a flexible top portion and a downwardly extending continuous wall terminating into a peripheral attaching means, the cap having a nozzle associated therewith. The cap has an aerosol-receiving chamber within it communicating with the nozzle and with a centrally located sleeve depending downwardly therefrom through which a vertically movable stem passes with clearance. The cap has associated with it an annular cup which forms the bottom thereof and which has a fluid-coupling means extending therefrom, the cup being connected and sealed to the bottom of the cap. A valve is provided at the opening of the fluid-coupling means of said cup in sealing contact with the end of said sleeve such that when the flexible portion of the cap is depressed to move the stem downward against the valve, the valve is caused to move out of sealing contact with the sleeve, whereby aerosol fluid under pressure is caused to enter the space between the sleeve and the stem and into the aerosol-receiving chamber for expulsion through said nozzle.
LOW FORCE AEROSOL VALVE WITH METERING CAP

This invention relates to a low force aerosol valve and, in particular, to a low force aerosol valve capable of providing predetermined metered quantities of aerosol fluid.

Aerosol valve assemblies for dispensing pressurized fluids, particularly metered quantities of fluids are well known in the art. Generally, nonmetering valve assemblies comprise a housing with a finger-actuated cap and orifice coupled to a valve stem associated therewith, said housing having an aerosol-receiving chamber means including a valve number member capable of being actuated by the stem when finger pressure is applied to a cap. In the case of metering valve assemblies, two serially related valve means on either side of the chamber are employed. Finger pressure on the cap and hence on the valve stem causes the upper valve to open to dispense the product while closing the lower valve. Release of finger pressure closes the upper valve and opens the lower valve to refill the chamber. The chamber is therefore normally under the same pressure as the product container. As the pressure in the product container is generally high, for example as high as 40 lbs/sq in and higher, leakage is apt to occur through the upper valve of the chamber due to the continually acting high pressure, whereby the pressure may eventually spend itself. To avoid this as much as possible, biasing means, such as a spring, has been proposed to maintain the valve tightly in the closed position. However, the use of such springs generally means greater finger pressure to actuate the dispenser.

Another embodiment which has been proposed in U.S. Pat. No. 3,142,420 involves a valve assembly which dispenses a metered quantity of the product upon release of a downward force. As in the dispenser described above, there are two serially related valve means on either side of a chamber, such that on depressing a retractable valve-actuating discharge member, the lower high pressure valve, which is spring biased in the closed position, is opened to allow the product to enter the chamber while the upper valve is closed. Upon removing the finger pressure, the retractable valve-actuating discharge element releases itself from the lower valve which is immediately closed by its biasing spring, following which the retractable element on returning to its home position causes the upper valve to open and release the metered quantity of the product. Thus, the metering chamber is at atmospheric pressure except for the brief moment during actuation. As in the former device, because the lower valve is spring biased, generally high finger pressure is required to actuate the valves. It is not uncommon to employ a finger pressure exceeding one pound and ranging up to about six pounds.

A disadvantage of most conventional valve assemblies is that a plurality of elements or parts are usually employed. As the parts are generally very small, they must be precise in size in order to insure cooperation of the parts in the finally assembled structure. This adds to the cost of the item. It would be desirable in providing a low force aerosol valve assembly to employ a minimum number of parts to assure foolproof performance and to provide a means of easily filling the aerosol vessel or container.

It is the object of this invention to provide an improved valve assembly characterized in that a low force may be employed to effect actuation and characterized further in the use of a minimum number of assembled parts and in the case with which an aerosol vessel can be filled.

Another object is to provide a low force aerosol metering valve in which leaking is greatly minimized, which is simple in construction and which is economical.

A still further object of the invention is to provide an improved metering valve assembly having a high pressure valve that does not require the use of biasing means to maintain it in sealing engagement on the high pressure side of the metering chamber.

These and other objects will more clearly appear when taken in conjunction with the following disclosure and the accompanying drawings, wherein:

FIG. 1 is an exploded view in elevation of one embodiment of a low force nonmetering valve provided by the invention showing the parts making up the valve assembly;
FIG. 1A is a cross section of the valve stem taken along line A-A of FIG. 1;
FIG. 2 shows the parts of FIG. 1 in the assembled state, including a portion of an aerosol container;
FIG. 3 is an enlarged cross section of the valve assembly of FIGS. 1 and 2 showing the actuation of the valve on the downstroke;
FIG. 4 is an exploded view similar to FIG. 1 of a metering valve assembly provided by the invention;
FIG. 4A is a cross section of the valve stem taken along line B-B of FIG. 4;
FIG. 5 shows the parts of FIG. 4 in the assembled state, including a portion of an aerosol container;
FIG. 6 is an enlarged cross section of the valve assembly of FIGS. 4 and 5 showing actuation of the valve on the downstroke;
FIGS. 7 and 8 are illustrative of additional embodiments of a nonmetering valve assembly showing various forms of valve stems;
FIGS. 9 and 10 are other embodiments of metering valve assemblies utilizing forms of valve stems similar to FIGS. 7 and 8;
FIG. 11 is an embodiment similar to FIG. 8 illustrating the use of an annular rigidizing means for the cap;
FIG. 12 is an embodiment of a metering valve portion showing in enlarged cross section one means of assuring low force actuation; and
FIG. 13 is an embodiment similar to FIG. 3 except that the top of the cap is tapered to assure low force actuation.

According to the invention, an aerosol valve assembly is provided comprising a hollow cap having a flexible top portion and a downwardly extending continuous wall terminating into a peripheral attaching means or collar, a nozzle associated with the cap and an aerosol-receiving chamber associated with the inner surface of a cap, the cap being communicatively connected with the nozzle. A centrally located sleeve is provided which communicates with the aerosol-receiving chamber and which depends downwardly from beneath the top of said cap. The sleeve has within it extending from beneath the top of the cap a vertically movable member with clearance between it and the sleeve. Forming the bottom of the cap is an annular thin-walled cup having fluid coupling means extending therefrom, the cup being mechanically joined and sealed to the bottom of the cap. Within the cup, a valve is provided supported at the opening of the fluid-coupling means of said cup in sealing contact with the end of the sleeve such that when the flexible portion of the cap is depressed to move the stem downward against the valve, the valve is caused to move out of sealing contact with the sleeve, whereby aerosol fluid under pressure is caused to enter the space between the sleeve and the stem and into said aerosol-receiving chamber for expulsion through the nozzle.

In a preferred embodiment of the invention, an aerosol valve assembly is provided comprising a hollow cap having a flexible top portion and a downwardly extending continuous wall terminating into a peripheral attaching means, a nozzle associated with the cap, and a thin-walled annular chamber nesting within the cap and forming a housing therewith. The annular chamber is formed of a continuous outer wall conforming generally to the inner surface of the downwardly extending wall of the cap and has a centrally located sleeve integral therewith extending downwardly from the top of the cap and the chamber, the outer wall of the annular chamber extending downwardly coaxially with the sleeve and terminating into a flange circumferentially joined and sealed to the peripheral attaching means of the cap. A portion of the wall of the chamber is preferably slightly offset from the wall of the sleeve so as to provide an annular receiving chamber between the wall of the sleeve and the offset portion of the chamber. Confined within the sleeve is a vertically movable...
stem extending downwardly from beneath the top of the cap, clearance being provided between the stem and the wall of the sleeve to define a flow-through passageway for the aerosol fluid. An annular thin-walled cup having fluid-coupling means extending therethrough forms the bottom of the housing, the cup being mechanically connected or joined and sealed to the terminating flanges of the cap and annular chamber nested therein. A valve, e.g. a diaphragm valve, is supported at the opening of the fluid-coupling of the cup in sealing contact with the ends of the sleeve, such that when the flexible portion of the top of the cap is depressed the stem downwardly extends upwardly to move out of sealing contact with the end of the sleeve, whereby aerosol fluid under pressure is caused to enter the space between the sleeve and the stem for expulsion through the nozzle. The foregoing structure is particularly applicable to the use of a diaphragm valve of the type having a conically shaped centrally located protrusion disclosed in my aforementioned co-pending application Ser. No. 552,224.

Referring now to FIG. 1, the component parts making up one embodiment of a nonmetering valve assembly are shown comprising a cap 10, a thin-walled annular chamber or insert 11, a diaphragm valve 12 and a thin-walled annular cup 13. The cap 10 which may be molded from plastic or other suitable material has a flexible top portion 14 and a downwardly extending continuous wall 15 which has a shoulder 16 at which terminating in a turned up flange 21. A portion of the wall is slightly offset at 20a to provide a space between it and the wall of sleeve 22. The sleeve depends downwardly from the chamber and is adapted to receive valve stem 18 into it. The diaphragm valve 12 preferably has a conical protrusion 23 on each side thereof and a plurality of apertures 24 radially disposed about the periphery.

The annular chamber or insert 11 is preferably made of thin sheet metal and, as described for FIGS. 1 to 3, may be made by metal spinning, the chamber comprising a closed end wall 19 and downwardly depending side walls which terminates in a turned up flange 21. A portion of the wall is slightly offset at 20a to provide a space between it and the wall of sleeve 22. The sleeve depends downwardly from the chamber and is adapted to receive valve stem 18 into it. The diaphragm valve 12 preferably has a conical protrusion 23 on each side thereof and a plurality of apertures 24 radially disposed about the periphery.

The annular mounting cup 13 which is also preferably made of thin-walled sheet metal, has a continuous sidewall 25 and a bottom 26, the side rising to a turned in flange 27 for use in mechanically coupling it to the top of a container. The bottom of the cup has a centrally located fluid-coupling means 28 which flares upwardly into an annular shoulder 29 to which the assembled cup and chamber are coupled. A dip tube 30 is connected to the fluid-coupling means during assembly.

The parts of the nonmetering valve assembly are shown assembled in FIG. 2. The cap 10 is shown with annular chamber 11 nested within it, the sleeve 22 of the chamber extending down to and in sealing engagement with diaphragm valve 12. Valve stem 18 extending downwardly from the cap terminates just short of the conical protrusion 23 of valve 12, the end of the stem being contoured to conform sealingly to the conical protrusion of the stem. The stem has clearance between it and the sleeve to provide a passageway 33 (note FIG. 3) for the aerosol fluid. The turned up flange 21 of annular chamber 11 is crimped circumferentially against shouldered flange 16 of the cap in locking engagement therewith, the assembled cap and chamber being in turn mechanically connected or joined to mounting cup 13 at annular shoulder 29 of the cup. Annular shoulder 29 also serves as support means for valve 12. Cup 13 forms the top of container 31, the cup being mechanically joined to the container by means of rolled flange 32.

The operation of the nonmetering valve assembly is shown in enlarged FIG. 3. In FIG. 2, the annular chamber 11 is under aerosol fluid pressure via communication with the container through apertures 24 of valve 12, but the fluid is sealed off from orifice 17 by sleeve 22 which is in sealing engagement with diaphragm 12. In FIG. 3, a force F is shown applied to the flexible top 14 of the cap causing stem 18 to move against protrusion 23 of the valve and move it out of sealing engagement with the end of sleeve 22, whereby passageway 33 is opened and aerosol fluid flows into the passageway and into the space 34 between the wall of chamber 11 and the stem and thence through orifice 17.

The metering valve assembly is shown in FIGS. 4 to 6, the parts being similar to those of the nonmetering assembly except for the design of the cap. In FIG. 4, an exploded view in elevation is depicted showing cap 10a, a thin-walled annular chamber or insert 11a, a diaphragm valve 12a, and a thick-walled annular cup 13a. As in the previous embodiment, cap 10a has a thin flexible top portion 14a and a downwardly extending continuous wall 15a which terminates into a shoulder flange 16a. The cap has an orifice 17a which communicates with a central bore 18b of stem 18a integrally associated with the cap, the stem being preferably one having a triangular cross section (note FIG. 4A).

The annular chamber or insert 11a is preferably made of thin sheet metal and, as described for FIGS. 1 to 3, may be made by metal spinning, the chamber having a closed end wall 19a and downwardly depending side wall 20b which terminates into a turned up flange 21a. The wall may be slightly offset at 19a at the wall of sleeve 22a to provide a space between it and the wall of the cap. This is preferred so as to confine the area of pressure centrally of the cap to assure low force actuation. Sleeve 22a is adapted to receive valve stem 18a into it. The diaphragm valve 12a preferably has a conical protrusion 23a on each side thereof and a plurality of apertures 24a radially disposed about the periphery.

Annular cup 13a has a continuous sidewall 25a and a bottom 26a, the side rising to a turned in flange 27a for use in mechanically coupling it to the top of the container. The bottom of the cup has a centrally depending fluid-coupling means 28a which flares upwardly into an annular shoulder 29a to which the assembled cup and chamber are coupled. A dip tube 30a is connected to the fluid-coupling means during assembly.

The parts of the metering valve assembly are shown assembled in FIG. 5. Cap 10a has annular chamber 11a nested within it, the sleeve 22a of the chamber extending down to and in sealing engagement with diaphragm valve 12a. Valve stem 18a terminates short of valve 12a, the end of the stem being contoured to conform sealingly to the conical protrusion of the valve. The stem has clearance between it and the sleeve to provide a passageway 33a (note FIG. 6) for the aerosol fluid. The turned up flange 21a of chamber 11a is crimped circumferentially against shouldered flange 16a of the cap in locking engagement therewith, the assembled cap and chamber being in turn mechanically joined to mounting cup 13a at annular shoulder 29a of the cup, the shoulder also serving as support means for valve 12a. Mounting cup 13a forms the top of container 31a, the cup being mechanically joined to the container by means of rolled flange 32a.

The operation of the metered valve will be understood from enlarged FIG. 6. Referring first to FIG. 5, sleeve 22a is shown in sealing engagement with valve 12a thus cutting off access to orifice 17a, except that there is communication between annular chamber 11a and the contents of the container via apertures 24a and fluid-coupling tube 28a. As depicted in FIG. 6, when a force F is applied to the extension of hollow stem 18a thereby depressing flexible top 14a, the stem moves vertically downwardly against protrusion 23a of the valve and moves it out of engagement with the end of sleeve 22a, whereby passageway 33a is opened and aerosol fluid flows into passageway and then into space 34a between the wall of chamber 11a and the stem. However, when the hollow stem 18a makes contact with the valve, its open end is sealed off as a measured quantity of aerosol fluid flows into space 34a where it is confined until the pressure is released from the cap.

As the top 14a of the cap returns to its home position, the stem lifts away from the valve, which valve then returns to position shown in FIG. 5 is sealing engagement with sleeve 22a. The measured quantity of aerosol fluid in space 34a then flows through bore 18b of the stem and out through orifice 17a.
As will be appreciated by those skilled in the art, the inventive concept can take various forms. For example, the metering valve assembly can employ a floating valve stem in place of stem 18b. An example of a floating stem is shown in FIG. 7. There the stem 18b is designed to float within sleeve 22b. The upper end 35 of the stem is tapered to seal against conical bevel 36 of finger knob 37, while the lower end 38 of the stem is contoured to contact the top of valve 12b. As the knob is depressed to flex the top 146 of the cap, it contacts the upper portion 35 of the stem on the down stroke to seal off orifice 17b. The lower portion 38 moves valve 12b out of sealing contact with sleeve 22b, whereby aerosol fluid flows into space 34b where it is confined until finger pressure on knob 37 is released. Upon release of the pressure, the top of the cap returns to home position and disengages itself from stem 18b. In the meantime, valve 12b returns into sealing contact with sleeve 22b.

Another metering valve assembly is depicted in FIG. 8, wherein the valve stem 18b is integral with valve 12b. The upper end 35 of the stem cooperates similarly with knob 37 when the knob is depressed to seal off orifice 17b and move valve 12b out of sealing engagement with sleeve 22b.

Additional embodiments of the nonmetering valve assembly are shown in FIGS. 9 and 10. The embodiments are similar to those of FIGS. 7 and 8 in the use of a floating valve stem. In FIG. 9, the floating stem 18c is caused to move downward on applied pressure to 14c to contact valve 12c and disengage it from sleeve 22c. When this occurs, aerosol fluid flows into space 34c and out through orifice 217c. In FIG. 10, stem 18c is integral with valve 12c and operates in a similar manner as the embodiment of FIG. 9 to expel aerosol fluid through orifice 17c when flexible top 14c is depressed to apply force to stem 18c and move valve 12c out of sealing contact with sleeve 22c.

FIGS. 11 to 13 are illustrative of alternative designs that can be employed for the aerosol cap when it is desired to keep the actuation force as low as possible. FIG. 11, which is substantially the same as FIG. 8, the same numerals being employed to designate the same parts, shows an annular reinforcement of metal encompassing a portion of top 146 of the cap. The purpose of the reinforcement is to stiffen that portion of the cap against bending during applied finger pressure so that only the thin portion 146 of the cap flexes downwardly. This limits the area of applied pressure and hence the amount of actuation force. Annular stiffening members increase force fitted so that the elasticomic cap to firmly connect the member to the cap. In an alternative assembly, the annular member may be adhesively bonded to the cap. FIG. 11 is also illustrative of how the aerosol chamber 34b can be increased by flaring the sleeve outward at 22d centrally of the cap.

In FIG. 12, a fragmented portion of the cap is shown (metering valve) with a thickened tapered portion 14e employed at the rounded corner of the cap to stiffen that portion of the cap so that the thinner central portion 41 will selectively flex downwardly with applied pressure in preference to the thicker portion. Annular chamber 42 of sheet metal is fitted snugly within the cap and is configured at 43 to abut and support thickened portion 14e while leaving an annular space 44 beneath thin portion 41 of the cap. Sleeve 47 is flared at 48b to provide enlarged metering space 44. Thus, when force is applied to knob 45 of valve stem 46, the stem is displaced downward to effect actuation of the valve as described in FIG. 6. Thus, only the limited central portion of the top of the cap is flexed during actuation. Since this represents a small fraction of the total area of the cap under pressure of the aerosol fluid, the amount of force necessary for actuation is low.

In the nonmetering valve embodiment of FIG. 13, low force actuation can be achieved by tapering cap 49 to provide a small area at top 50 having confined beneath it aerosol-receiving chamber 51. In other words, the cap is tapered so that the top is smaller than the base of the cap. As will be apparent, when force is applied to the top of the cap, valve stem 52 moves downwardly to contact valve disc 53 to move it from contact with sleeve 54. Aerosol fluid under pressure flows through aperture 55 of valve 53 into annular chamber 56 and through passageway 57 into aerosol-receiving chamber 51, following which the fluid is expelled through orifice 58. Annular chamber 56 is closed at end 59 as shown.

An important advantage of the aerosol cap and valve assembly of the invention is that the vessel utilizing the assembly can be filled easily. For example, the parts making up the cap and valve assembly in the preassembled condition can be positioned relative to the fluid-coupling means at the filling station so that the aerosol fluid can flow around the positioned assembly into the vessel, following which the cap and valve assembly are pressed fitted and crimped to the fluid-coupling means (note fluid-coupling means 28 and annular shoulder 29 in FIGS. 1 and 2). The simple valve assembly arrangement provided by the invention thus enables rapid filling of the aerosol vessel.

As will be appreciated from the various embodiments described herein, the valve assembly is extremely simple and requires a minimum of parts as compared to the conventional valve assemblies.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and the appended claims.

1. An aerosol valve assembly adapted to be mounted to an aerosol container holding a fluid under pressure which comprises, a cap assembly comprising a hollow cap having a flexible top portion and a downwardly extending circumferentially continuous wall, a nozzle associated with said cap and an annular chamber means nested within said cap making up the cap assembly, said annular chamber means in combination with said cap defining an aerosol-receiving chamber which communicates with said nozzle, said annular chamber means having a centrally located sleeve communicating with said aerosol-receiving chamber depending downwardly from the top of said cap, a vertically moveable stem located within and extending downwardly through said sleeve with clearance therebetween, a cup forming the bottom of said cap and having fluid-coupling means extending therefrom, said cup being circumferentially connected to the bottom of said cap assembly in sealing relationship therewith, and a valve supported at the opening of the fluid-coupling means of said cap in sealing contact with the end of said sleeve such that when the flexible portion of the cap is depressed to move the stem downward against the valve, the valve is caused to move out of sealing contact with said sleeve, whereby aerosol fluid under pressure is caused to enter the space between the sleeve and the stem and flow into said aerosol-receiving chamber for expulsion through said nozzle.

2. The aerosol valve assembly of claim 1, wherein the wall of said annular chamber means is offset relative to the sleeve so as to locate the aerosol-receiving chamber centrally of said cap.

3. The aerosol valve assembly of claim 1, wherein the low cap is tapered at the flexible top portion.

4. The aerosol assembly of claim 1, wherein the supported valve is a diaphragm valve having a centrally located protrusion extending into the opening of said sleeve and at least one aperture in the periphery thereof.

5. The aerosol valve of claim 4, wherein the stem is integrally associated with the top of said cap.

6. The aerosol valve of claim 4, wherein the stem is a floating member supported within said sleeve.

7. The aerosol valve of claim 4, wherein the stem is centrally integral with the valve and extends upwardly through the sleeve to the top of said cap.

8. The valve assembly of claim 1, wherein the stem has a bore running through it which communicates with the orifice,
such that when the cap is depressed to cause the stem to sealingly engage and move the valve away from the end of the sleeve, the orifice is cut off as aerosol fluid enters the aerosol-receiving chamber, and such that when the stem is released from the valve, the aerosol fluid flows through the sleeve from the chamber, thence through the bore and out through the nozzle.