Oct. 16, 1956 F. VENUS, JR 2,767,023

SPRAY NOZZLES

Filed March 27, 1956

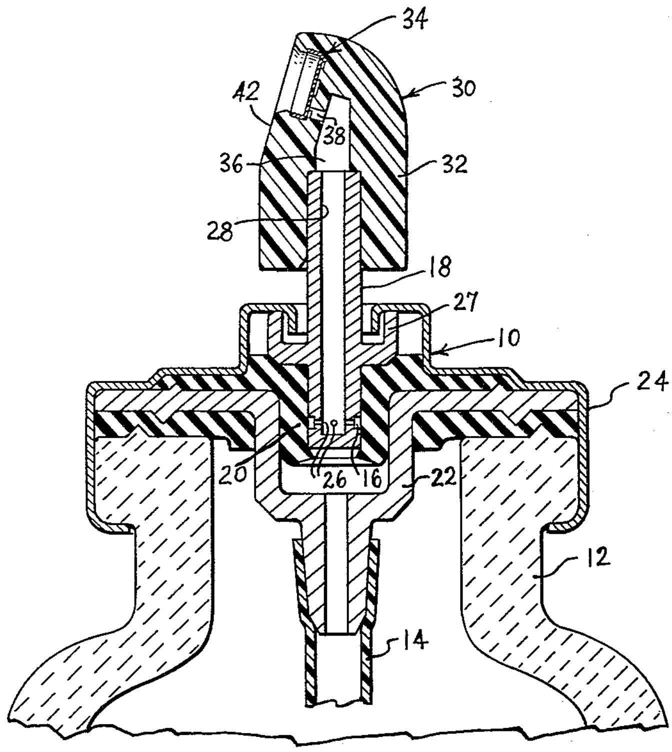

Fig. 1

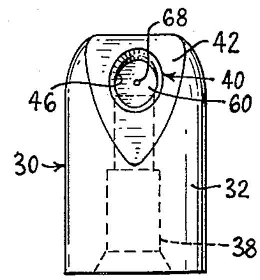

Fig. 4

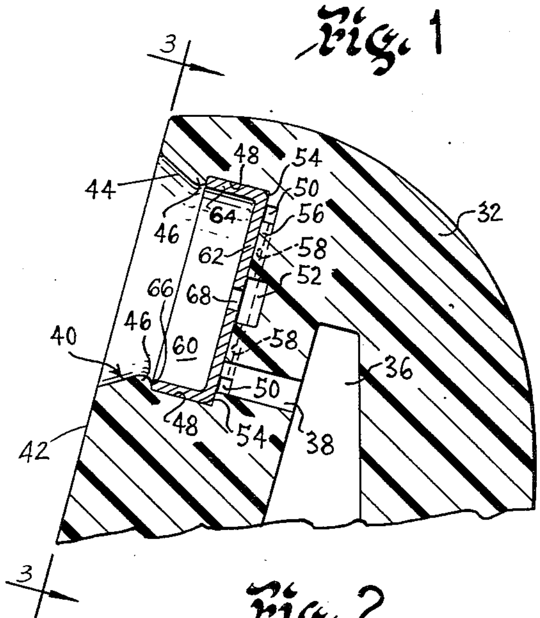

Fig. 2

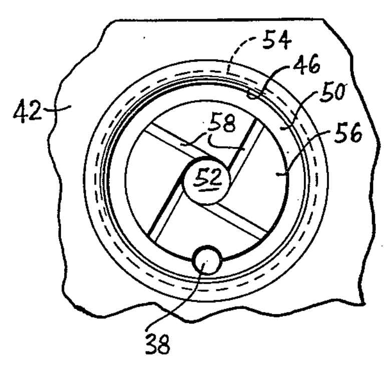

Fig. 3

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United States Patent Office 2,767,023
Patented Oct. 16, 1956

2,767,023

SPRAY NOZZLES

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Application March 27, 1956, Serial No. 574,263

8 Claims. (Cl. 299—114)

This invention pertains to spray nozzles for liquid dispensing devices, and more particularly to nozzles adapted to give good atomization of liquids which are substantially nonvolatile at ordinary ambient temperatures and which are propelled from such devices by means of pressure.

The atomization may be effected by supplying under pressure to a nozzle the liquid to be dispensed, which may be done by means of a manually operated pump, or preferably by means of gas pressure generated within a valved container in which such liquid is ordinarily held. In the latter case, the gas pressure is commonly produced by including in the container a low-boiling liquid which volatilizes at ordinary room temperature and acts as a propellant for the first liquid when the valve of the container is actuated.

While the nozzles of the invention find general applicability in dispensing any of various kinds of liquids, they are especially suited for use in dispenser devices of the last mentioned type wherein the liquid to be dispensed is essentially nonvolatile at ordinary ambient temperatures, is substantially immiscible in the propellent liquid and does not readily form an emulsion therewith. In such instances, there is present in the dispensing container a three-phase system consisting of two liquid phases and a gaseous phase. When a dispensing device of this character is used, the intake end of the conduit employed to deliver liquid to the nozzle is so positioned in the container that ordinarily only the non-volatile liquid is delivered to the nozzle. Unlike the so-called "aerosol spray" dispensing devices commonly used today for paints, insecticides and many other products in which the material to be dispensed forms a solution or emulsion with the propellant, i. e. in which there is a two-phase system in the container, the dispensing of a liquid in the form of a spray from a three-phase system as just described cannot rely on the volatilization of the propellent liquid as the container valve is actuated to assist in the dispersion of the liquid which it is the primary purpose to dispense. Good dispersion in the form of a fine mist of such liquid is accordingly dependent on the pressure applied to force the liquid from the container and mechanical means in the nozzle itself for breaking up the liquid into fine droplets. These two factors introduce troublesome problems to be considered in the production of dispensing devices which are economical to manufacture and yet really effective in operation.

Good atomization or fine dispersion of fluids at very low pressures is highly desirable in many practical applications, for example in the case of cosmetics and medicaments where great projection of the spray particles is neither necessary nor desirable. The use of low fluid pressures moreover makes possible the employment of inexpensive containers, as elaborate precautions against the dangers of explosion due to high internal fluid pressures are thus largely obviated. Owing to the fact that spray nozzles of the type here contemplated are designed for use more particularly with expendable containers

which are simply thrown away when emptied, cost of construction is of utmost importance. Still it is essential of course that the nozzle means provide effective atomization at the lowest possible pressure.

The nozzles of prior spray devices are generally characterized either by rather complicated constructions heretofore found necessary to get good results, or else they are subject to poor atomizing operation at the low pressures desired to be employed. It is accordingly a principal object of the present invention to provide a nozzle of extreme mechanical simplicity which nevertheless affords excellent atomization of a liquid at low pressures.

It is a further object of the invention to provide an atomizing nozzle consisting of a minimum number of parts of inexpensive construction which can be completely assembled by automatic machinery. In the spray nozzle here disclosed only two pieces are involved, and the assembly of these, aside from being adapted for accomplishment by automatic machines, does not rely upon separate securing means, such as adhesives, to retain them in assembled condition.

Nozzles embodying the inventive concept are illustrated in the accompanying drawings and are described hereinafter. In the drawings,

Fig. 1 is a partial view in vertical section of a spray nozzle and valve assembly secured to the mouth of a glass walled container adapted to hold a fluid under pressure and to dispense such fluid through the spray nozzle on actuation of the valve assembly;

Fig. 2 is a fragmentary view on an enlarged scale of the spray nozzle shown in Fig. 1;

Fig. 3 is a plan view taken along line 3—3 of Fig. 2; and

Fig. 4 is a front elevational view of the spray nozzle of Fig. 1.

The dispensing valve and spray nozzle assembly indicated generally at 10 in Fig. 1 is secured in the mouth of a container 12 adapted to hold the liquid to be dispensed. As is conventional in dispensing devices of the type here illustrated, this liquid is stored in the container 12 under pressure of a propellent fluid, such as one of the Freons, which is volatile at ordinary room temperatures and pressures. The propellant is used to force the liquid to be dispensed up through an eductor tube 14 leading up from adjacent the bottom of the container to the valve and nozzle assembly 10 and out through the latter in response to manual actuation of the valve to open it and allow dispensing of the fluid to take place.

For cosmetic materials it is highly desirable that glass containers be utilized, as unusual decorative effects can be most economically obtained to enhance the sales appeal of the item. In using such a container, however, unless special precautions are used to render the glass shatterproof, it is imperative for reasons of safety that very low pressures be employed in propelling the contents in order to avoid any liability of explosion due to defects in the container or accidental dropping of it. Then too, it is usually not necessary or desirable that the fluid contents be expelled from the container with great force or projected any great distance, but rather that a fine, uniform dispersion be obtained which may be directed upon a given area by placing the dispenser fairly close to the object upon which the spray is to be deposited. Accordingly if low pressures are to be used in propelling nonvolatile liquid contents, especially if they are substantially immiscible in the propellant, the mechanical means for effecting the dispersion into a fine mist becomes all the more significant as it is not possible to rely upon a high fluid velocity to accomplish this.

In the illustration in Fig. 1, the valve means employed for controlling the discharge of the fluid from the container is simply one of many different types which can be used and forms no part of the present invention. The particular construction of this valve is disclosed in my pending application Serial No. 438,543, and reference to that disclosure is made for fuller discussion of the various details of its construction. For purposes of the present disclosure it is sufficient to state that an annular groove **16** in the periphery of a hollow valve stem **18** which is closed at its inner end is normally sealed by encirclement of the lower end of the stem **18** by a resilient elastic gasket **20** confined within a flanged valve cup **22** by a metal cap portion **24**. Communicating passages **26** are provided in the valve stem between groove **16** and the bore **28** of the stem. In normal condition, fluid under pressure delivered to the valve cup **22** through eductor tube **14** is prevented by gasket **20** from escaping from the container **12**. When dispensing is desired, the valve stem **18** is pushed laterally at its upper end, whereby it pivots about a point determined by abutment of a flange **27** on the valve stem against the underside of cap **24**, and this causes the lower end of the valve stem to be tilted, compressing the grommet **20** against the side of valve cup **22**. This causes a portion of the annular groove **16** to be exposed at the side opposite from that at which the stem is pushed, and fluid in the valve cup **22** is accordingly allowed to enter into the groove **16** and bore **28** which, as seen in Fig. 1, is open at its upper end.

An actuator head **30** is secured on the open, upper end of valve stem **18**. As here shown, this comprises a stiff but resilient body member **32** formed of a suitable plastic material and having incorporated integrally within it a spray nozzle indicated generally at **34**. A feed passage **36**, into which the upper end of the valve stem **18** extends, provides communication between bore **28** of stem **18** and a lateral feed passage **38** leading to spray nozzle assembly **34**. As seen more particularly in Figs. 2 and 4, body **32** is formed to provide a recess or socket **40** opening onto a substantially flat face **42** of the body **32**. At the mouth or outer edge of this socket, the side walls **44** taper inwardly a short distance to provide a frusto-conical opening. At a point approximately midway of its depth, the side wall of the socket **40** is undercut to provide a lip **46** which overhangs a straight wall portion **48**. The bottom of socket **40**, as seen best in Fig. 3, is also formed to provide an annular groove **50** and a central depression **52**, groove **50** being spaced inwardly a short distance from side wall **48** to leave an annular land **54** in the bottom of the socket. Groove **50** is spaced from central depression **52** to leave a second annular land **56** disposed between the groove and the central depression. Feed passage **38** extends through the bottom wall of the socket **40** into communication with passage **36** as previously described, passage **38** intersecting groove **50** and providing communication therewith.

The bottom wall of socket **40** likewise has formed in it a number of slots or grooves **58** which radiate outwardly from the central depression **52** to intersect groove **50** and provide communicating channels between the groove and the central depression. As seen more particularly in Fig. 3, these grooves radiate tangentially from the periphery of the central depression.

A cup **60** is disposed in the socket **40** of the spray nozzle body **32**. In the illustration the cup is shown as being fabricated of relatively thin sheet metal. This cup has a bottom wall **62** and an upstanding side wall **64**, and is of a size and shape adapted to fit snugly and be retained within the lower portion of socket **40** without the aid of any supplemental securing means. To this end, the height of side wall **64** is made just slightly greater than the distance between the undersurface of overhang **46** and the bottom of socket **40** as defined by annular lands **54** and **56**. Owing to the ability of the plastic material from which the body member **32** is formed to undergo slight elastic deformation, cup **60** can be snapped into position by insertion into the tapered mouth of the socket by means of a punch, and once past the lip **46** it is firmly locked in seated position in the bottom of the socket by engagement of the lip on the rim **66** of the cup. This causes the cup to be continuously compressed against the upper surfaces of lands **54** and **56**. When fluid enters feed passages **36** and **38** and progresses into the annular groove **50**, it is thus prevented from leaking between the undersurface of the cup and the upper surface of lands **54** and **56**, and is constrained to enter the radiating grooves **58** leading to central depression **52**. This produces a swirling action of the liquid in depression **52** and a fine atomization of the liquid is thereby effected upon its emergence through the orifice **68** which is pierced in the bottom of cup **60** substantially centrally of the depression **52**.

Owing to the compressing effect of the overhanging lip **46** upon cup **60**, thus assuring a tight seal of its bottom surface on the upper surface of lands **54** and **56**, no adhesive or other securing means is necessary to hold the cup in place and prevent leakage of fluid into the central depression **52**, by-passing slots **58**.

It has been found that by carefully proportioning the size of the discharge orifice **68** and feed passage **38** with respect to the cross-sectional area of grooves or slots **58**, excellent atomization can be obtained at low fluid pressures. In speaking of low pressures, this term is used here to signify gauge pressures under 20 lbs. per square inch and as low as even 8 to 10 lbs. per square inch. Such low pressures are highly desirable, as explained hereinbefore, since they minimize the danger of damage or injury resulting from explosion in case a glass container is employed in the dispenser device.

By way of illustration, critical dimensions for a particularly suitable commercial spray nozzle for use at propellent pressures of around 12 to 18 p. s. i. g., are as follows: Using an orifice diameter of 0.016" for orifice **68** in cup **60**, four radial slots **58** each 0.008" wide by 0.008" deep, in combination with a feed passage **38** which has a diameter of 0.025", gives excellent results. In the foregoing example, the annular groove **50** is 0.010" deep by 0.008" wide.

Other dimensions proportional to these are useful, and it appears that the ratios indicated below are substantially critical in achieving optimum results at the low pressures mentioned. These ratios are as follows:

(1)

$$\frac{\text{Total cross-sectional area of tangential slots 58}}{\text{Area of terminal orifice 68}} = \text{approx. } 1.28$$

(2)

$$\frac{\text{Total cross-sectional area of tangential slots 58}}{\text{Minimum cross-sectional area of feed passage 38}} = \text{approx. } 0.52 \text{ to } 0.78$$

In fabricating the spray nozzle, a material which has been found excellent in practice for the body **32** is polyethylene (e. g. "Polythene") which is easily molded, has good rigidity and dimensional stability, yet possesses sufficient resiliency to allow the nozzle cup **60** to be forced into place without permanent deformation of the body. As an example, in the nozzle specifically described above, a metal cup of 0.175" outside diameter can be snapped into a socket **40** of the same inside diameter in which the lip **46** overhangs the wall **48** by 0.004 to 0.005". Making the inside diameter of the socket **40** below the lip **46** the same as the outside diameter of the cup **60** ensures a good tight seal at the sides of the socket. The same is obtained at the bottom of the socket by making the height of the cup wall slightly greater than the distance from the underside of lip **46** to lands **54**, **56**, as previously mentioned. For example, in the nozzle just described, this is obtained by using a cup 0.050" deep in a socket in which the distance between the lip **46** and land **54** is 0.045". The spray nozzle thus eliminates the necessity for using any adhesive to hold the orifice cup in place, as well as the difficulty encountered in trying to avoid partially blocking the various passages which arise when an excess of cement is used. Also of course, the arrangement greatly simplifies the assemblying operations and permits them to be done by completely automatic machinery.

What is claimed is:

1. The combination in a spray nozzle of a stiff but resilient plastic body member having a socket formed in one face thereof, the side wall of said socket being undercut below said body face to provide an overhang, an annular groove and a central depression formed in the bottom of said socket, said groove being spaced from said central depression to form an annular land in the bottom of the socket, slots radiating from said central depression across said land to intersect said groove and a feed passage formed through said head and communicating with said groove to supply fluid thereto from a supply under pressure, a cup snapped into position within said socket beneath said overhang, the bottom of said cup being continuously compressed against the land in the bottom of said socket by elastic deformation of said plastic head resulting from engagement of the underside of said overhang with the rim of said cup, said cup being pierced in its bottom wall to provide an orifice opening into said central depression.

2. The combination as defined in claim 1, wherein the side wall of said socket tapers inwardly substantially from said body face to the point of undercutting.

3. The combination as defined in claim 1, wherein said slots radiate tangentially from the periphery of said central depression to said groove, and said orifice in said cup overlies the center of said depression.

4. The combination as defined in claim 3, wherein the ratio of the combined cross-sectional area of said tangential slots to the area of said cup orifice is approximately 1.28.

5. The combination as defined in claim 4, wherein the ratio of the combined cross-sectional area of said tangential slots to the minimum cross-sectional area of said feed passage is approximately 0.52 to 0.78.

6. The combination as defined in claim 3, wherein the ratio of the combined cross-sectional area of said tangential slots to the minimum cross-sectional area of said feed passage is approximately 0.52 to 0.78.

7. The combination in a spray nozzle for low pressure atomization which comprises a spray head of resilient plastic, said head being formed to provide a cylindrical socket opening on one of its faces, the side wall of said socket having an overhanging lip adjacent the outer edge of the socket, an annular groove formed in the bottom wall of the socket, said groove being spaced inwardly from the side wall slightly to provide a peripheral shoulder in the bottom of the socket, a feed passage formed in said head to deliver fluid to be atomized from a supply under pressure through said head to said annular groove, a cylindrical depression located concentrically of said socket in the bottom wall thereof and spaced peripherally from said groove to form an annular land surrounding said depression, grooves radiating from said depression and extending across said land to intersect said annular groove, a cylindrical cup disposed in said socket, said cup being of a size to snugly engage the side and bottom walls thereof, being slightly greater in height than the distance from the bottom wall of the socket to the underside of said overhanging lip whereby the bottom of said cup is continuously pressed into contact with the bottom wall of the socket by the elastic deformation of the head resulting from engagement of said overhanging lip with the rim of said cup, said cup having an orifice in its bottom wall opening into said cylindrical depression.

8. The combination in a spray nozzle as defined in claim 7, wherein said grooves extending across said annular land radiate tangentially from said cylindrical depression.

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