May 14, 1968 R. D. PARRY 3,382,871

NEBULIZER

Filed Oct. 18, 1965 2 Sheets-Sheet 1

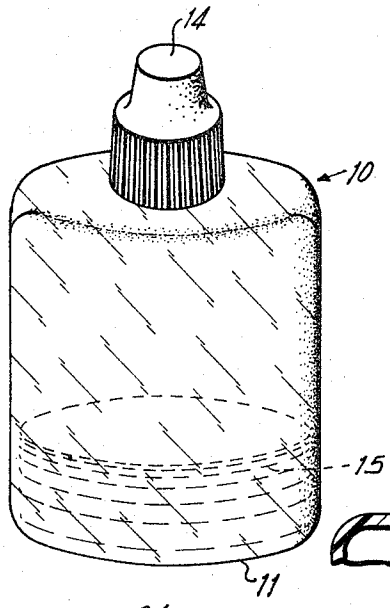

Fig. 1

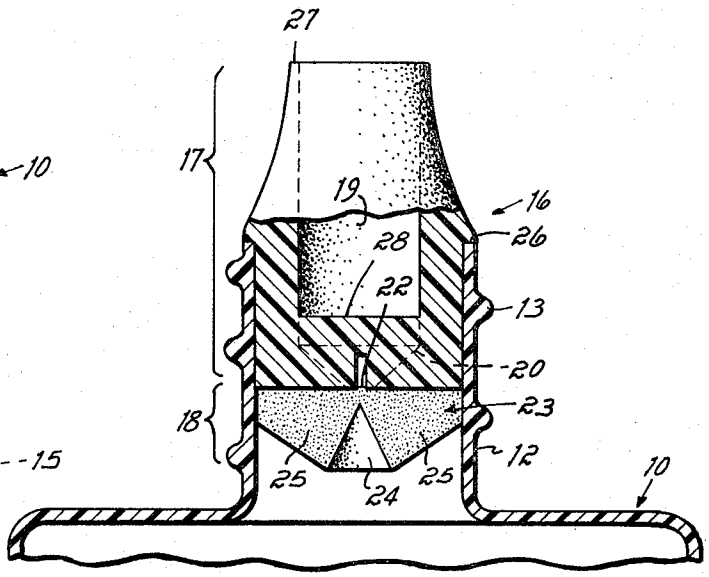

Fig. 2

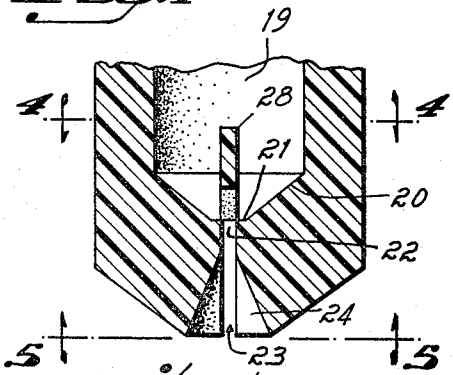

Fig. 3

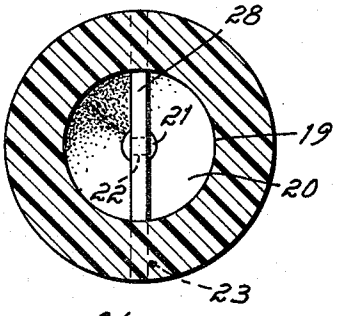

Fig. 4

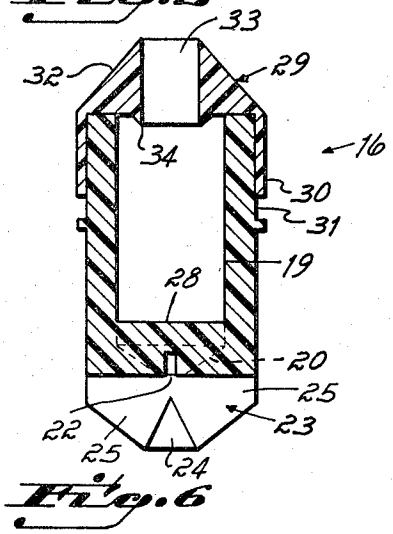

Fig. 6

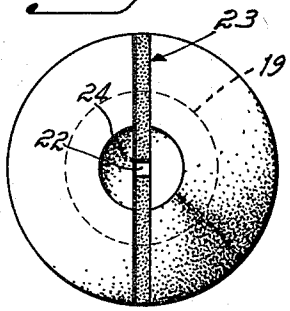

Fig. 5

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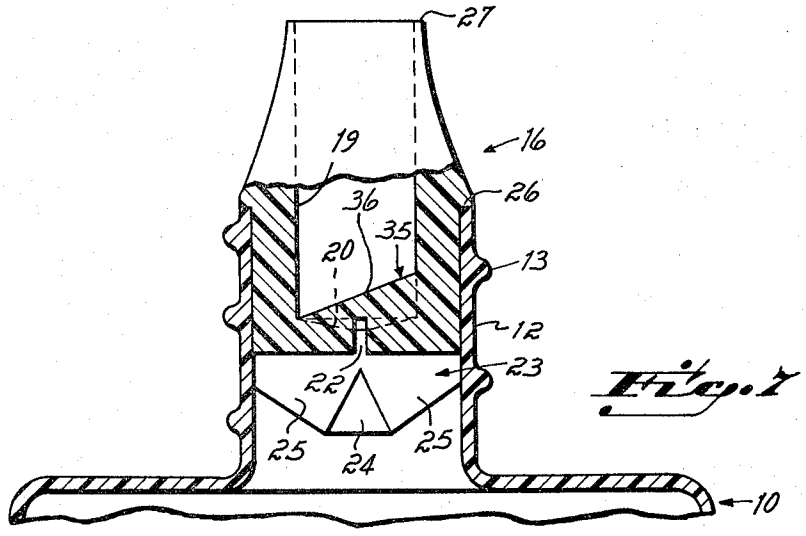

Fig. 7

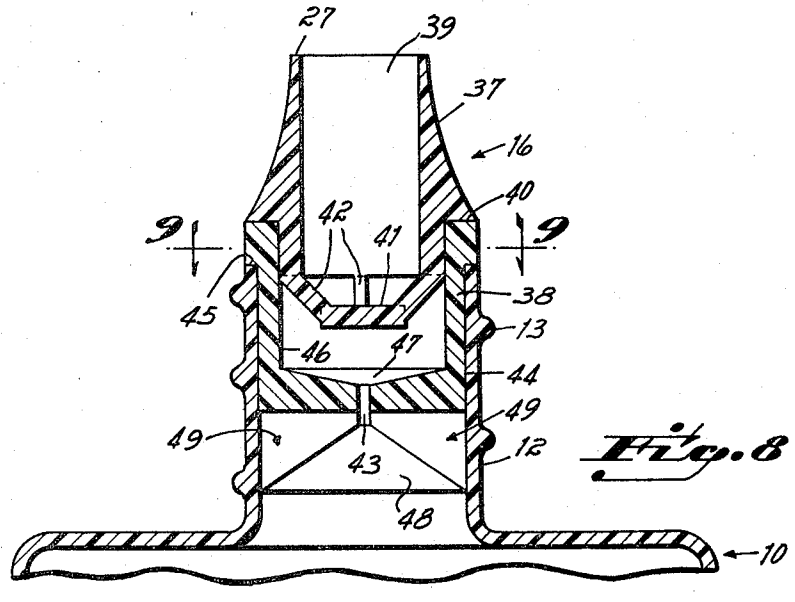

Fig. 8

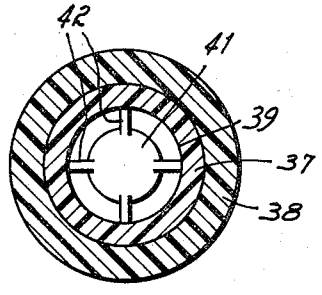

Fig. 9

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NEBULIZER

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ABSTRACT OF THE DISCLOSURE

A pocket size nebulizer is disclosed which is adapted to produce a smoke-like mist from an oil-based liquid. The nebulizer includes a resilient walled container having a neck projecting from the top into which is fitted a nebulizing device. The nebulizing device has an upper portion configured to provide a large diameter hollow barrel projecting from the neck and a lower portion configured to provide an inverted conical cavity, the apex of which communicates with the bottom of the hollow barrel via a straight small diameter passage. The nebulizing device further includes a diametrically extending cross-slot communicating with both the conical cavity and the passage, and having a width dimensioned to hold an oil-based liquid therein by capillary action. An impingement member is located in the hollow barrel providing an obstruction to flow from the passage through the barrel.

In operation, the nebulizer is momentarily tipped to allow a major supply of liquid contained in the container to be exposed to the diametral capillary cross-slot for the purpose of filling the cross-slot with liquid thereby establishing a minor liquid source. The container is then squeezed to produce an air stream flowing from the conical cavity through the passage into the hollow barrel. The air stream shears minute quantities of oil-based liquid from the liquid in the capillary slot entraining liquid in the stream. The high speed stream then strikes the impingement member. The striking of the high speed stream on the impingement member and the fact that the barrel is many times larger than the opening of the passage serves to insure that only a mist in the form of a cloud leaves the nebulizer. The minute quantity of liquid pulled from the capillary slot with each squeeze of the bottle is immediately replaced by capillary action.

This invention relates to nebulizers, and it is directed in particular to a pocket sized, economical nebulizer that is adapted to produce a smoke-like mist from an oil-based liquid such as the oil-based medicants used for the treatment of respiratory ailments. For this purpose, the mist produced must be so fine that it can be inhaled into the lungs.

Attention is directed to copending application Ser. No. 496,766, filed contemporaneously herewith.

There are presently available a number of inexpensive pocket sized atomizers, Patents Nos. 2,577,312 and 2,676,060, being representative of the prior art. A typical atomizer of this sort comprises a plastic squeeze bottle that holds a supply of liquid, a spray head seated in the neck of the bottle, a tube depending from the head to adjacent the bottom of the bottle, and a cap to seal the bottle. However, these atomizers produce comparatively coarse sprays and they are limited in use to the dispensing of low viscosity liquids only, such as water or alcohol based medicants and deodorants. Viscous, oil-based liquids issue from these atomizers in the form of a stream. The resistance to shear stresses of these oily liquids prevents their break-up into a spray in the comparatively low pressure airstream generated in these atomizers.

There are also presently available fairly expensive

nebulizers that are capable of producing a fine mist from oil-based medicants. In these nebulizers, the high pressure stream of air required to shatter the oil into a mist is generated by a squeeze bulb. These nebulizers, for the most part, are designed to be charged before use with an oil-based medicant from a separate container, the liquid being transferred to the nebulizer by means such as an eye dropper. Nebulizers of this type are designed primarily for use in the home; and although they can be carried on the person, they make bulky packages, particularly when a container of medicant must be carried along with them. By comparison, a pocket sized atomizer of the type to which reference has been made is no larger than the squeeze bulb of a nebulizer designed for home use.

It has been the primary objective of this invention to provide a nebulizer that produces as fine a mist from oil-based liquids as the expensive nebulizers designed for home use; and, further, one that is as small as and as inexpensive as the pocket sized atomizers to which reference has been made.

In the preferred embodiment, the nebulizer of this invention utilizes a plastic squeeze bottle that is the same general type as those used for the inexpensive, pocket sized atomizers of the past. This bottle holds a supply of the oil-based liquid to be nebulized, and a cap is provided so that the nebulizer may be carried in the pocket without spillage.

The novel feature of the nebulizer of this invention is a device that is seated within the neck of the bottle. There is no connection between this device and the supply of liquid in the bottom of the bottle, such as the tubes used in the atomizers of the past. This device, referred to as a "nebulizing device" for the purposes of this disclosure, has a lower portion that is exposed to the air inside the bottle above the supply of liquid that is contained therein. This lower portion has cavities therein configurated to hold a minor supply of liquid by capillary action. These cavities are charged by momentarily tipping the bottle to expose the lower portion of the nebulizer device to liquid. The upper portion of the nebulizing device is in the form of a barrel, preferably of a size to be inserted into a person's nostril. A small air passage extends up through the lower portion and opens into the barrel. The sides of this passage are open to liquid held in the nebulizer device by capillar action. An important consideration is, however, that only a minimal amount of liquid is exposed to the passage. For example, one form of nebulizing device incorporating the principles of this invention has a conical cavity centered in the bottom thereof. The small air passage to the barrel is at the top of this conical cavity. Liquid is held in the device in a capillar sized cross slot extending diametrically through the lower portion thereof. The upper edge of this cross slot cuts through the air passage just above the slanting wall of the conical cavity. This leaves two generally triangular capillary cavities at the sides of the conical cavity. Opposite sides of the wall of the conical cavity form the hypotenuses of the triangular cavities, the opposite sides of the outer wall of the lower portion of the nebulizer device form two vertical sides of the triangular cavities, and the upper edge of the cross slot forms the third, horizontal, sides of the triangular cavities. The two adjacent "corners" of the two triangular cavities are cut by the air passage, leaving only slight areas of the two triangular cavities exposed to an airstream passing through the passage. Thus, only a small fraction of the oil-based liquid held in the capillar cavities is exposed to the airstream.

The air passage itself is straight and unobstructed, and a high-speed stream of air can be generated in it by the

squeezing of a plastic bottle. This stream shears minute quantities of the oil-based liquid from the liquid in the capillary cavities at the sides of the passage. This liquid sheared from the cavities is entrained in the stream. There is provided an impingement bridge in the barrel having an undersurface presented toward the passage. The high-speed stream of air strikes this surface, and entrained oil in the form of droplets, as contrasted to oil entrained as a mist, is sheared on the impingement bridge. The striking of the high-speed stream on the impingement bridge and the fact that the barrel is many times larger than the opening of the passage serves to diffuse the airstream such that only mist in the form of a cloud issues from the nebulizer.

The minute quantity of oil-based liquid pulled from the cavities at the sides of the passage with each squeeze of the bottle is immediately replaced by capillary action of the liquid in the cavities. In one form of the device of this invention, the two capillary cavities are of a size to hold a total of approximately one drop of liquid. It is found that it takes as many as thirty to forty squeezes of the bottle to completely exhaust the drop of liquid, this being illustrative of the fineness of the mist that is produced by the nebulizer. In other forms of the invention, provision is made to increase the capacities of the capillary cavities.

Reference is now made to the drawings, in which:

FIGURE 1 is a perspective view showing a nebulizer incorporating the principles of this invention.

FIGURE 2 is an enlarged fragmentary cross sectional view of the upper portion only of the nebulizing device with the cap removed.

FIGURE 3 is a fragmentary cross sectional view illustrating the lower portion only of the nebulizing device of this invention.

FIGURE 4 is a cross sectional view taken along line 4—4 of FIGURE 3.

FIGURE 5 is a view taken along line 5—5 of FIGURE 3.

FIGURE 6 is a cross sectional view illustrating a modified form of the nebulizing device of this invention.

FIGURE 7 is a fragmentary cross sectional view illustrating another modified form of the invention.

FIGURE 8 is a cross sectional view similar to FIGURE 7 illustrating a further modification of the invention.

FIGURE 9 is a cross sectional view taken along the line 9—9 of FIGURE 8.

In FIGURE 1 there is shown a container 10 that preferably is made of a resilient plastic material such as polyethylene. It is preferred that the bottom 11 of this container be flat so that the nebulizer may be stood upright on a supporting surface. A neck 12 projects from the top center of the container. This neck preferably has external threads such as those illustrated at 13 formed thereon. These threads are designed to receive internal threads (not shown) of a cap 14 that serves as a closure and a seal for the nebulizer. The numeral 15 designates a supply of oil-based liquid such as the oil-based medicants that are used in the treatment of respiratory ailments. This liquid fills only the lower one-fourth to one-third of the container, leaving a comparatively large volume of air therein above the surface of the liquid.

The components thus described are similar to comparable components in the popular pocket sized squeeze bottle sprayers or atomizers that have been employed in the past for dispensing water or alcohol based medicants and deodorizers from a spray head seated within the neck of the bottle. It will be apparent to those skilled in the art that the nebulizer of this invention is not limited to the use of a container of the specific type illustrated but may employ resilient walled containers of many different configurations.

The inside diameter of neck 12 is cylindrical and adapted to receive a nebulizer device 16 preferably molded from a hard plastic. The nebulizer, as shown, is held in the neck frictionally in press fit relation. It will be obvious that detents or other locking devices may be employed to prevent removal of the device from the neck of the container. For the purpose of this disclosure, the nebulizing device is divided into an upper portion coextensive with the bracket 17, and a lower portion coextensive with the bracket 18 that appear in FIGURE 2. The upper portion of the nebulizing device has a central cylindrical bore 19 therein that constitutes a barrel. As will be explained, this barrel serves as a diffuser for the mist produced by the nebulizing device.

As best appears in FIGURE 3, the floor 20 of the barrel is in the shape of an inverted cone slanting from the inner wall of the barrel toward the central axis of the nebulizing device to a small, annular land immediately surrounding a passage 22. A cross slot 23 extends diametrically through the lower part 18 of the nebulizing device. Passage 22 opens from cross slot 23 into the hollow interior of the barrel defined by bore 19. Cross slot 23 preferably is approximately $\frac{1}{32}$ of an inch in width. It is found that this width for slot 23 permits it to satisfactoritly hold by capillary action a small amount of oil-based liquid. The lower central area of the nebulizing device has an inverted conical cavity 24 therein that divides cross slot 23 into two cavities 25—25 at the sides of the conical cavity 24. As is shown in FIGURE 3, passage 22 opens from the apex of conical cavity 24.

A shoulder 26 is provided around the outside of the nebulizing device to rest upon the upper rim of neck 12 of the container. As shown, the projecting part of the nebulizing device tapers inwardly so that it may be readily inserted into a person's nostril. Cap 14 is configurated such that when it is tightened down on threads 13, the underside of the top thereof rests tightly against the rim 27 surrounding the opening into bore 19 to seal it.

An impingement bridge 28 extends across the interior of the barrel or bore 19 in spaced relation to the upper end of passage 22 and in direct alignment with it. This bridge preferably is molded as an integral part of the nebulizing device. As an expediency in the molding operation, passage 22 is square in cross section with each side thereof being equal in length to the width of cross slot 23 and equal in width to the impingement bridge 28 that resides above it.

In the operation of the nebulizer, the container is tipped so that the capillary cavities 25—25 are exposed to the liquid within the container and a small amount of liquid runs in these capillary cavities. When the container is then turned to an upright position and the sides of the container are squeezed to compress the air within the container, a high-speed stream of air is forced through passage 22 to exit therefrom in direct alignment with the underside of impingement bridge 28. It is believed that the high-speed stream of air picks up minute quantities of liquid from the capillary cavities entraining it as a mist. This mist, although undoubtedly fairly fine as it issues from the passage 22, is further shattered upon striking the underside of impingement bridge 28. Further, the impingement bridge and the comparatively large area within bore 19 serve to diffuse the stream, slowing it down so that the mist issues from the nebulizer in the form of a cloud. The oil-based liquid entrained in this cloud is so fine that it may be inhaled.

The impingement bridge also insures that any fine droplets of oil that may become entrained in the stream of air issuing from passage 22 are deflected to collect on the sloping lower portion 20 of the barrel to drain back down toward passage 22. Any such amounts of oil thus collected are then sucked back into the capillary cavities through passage 22 when the sides of the container are released.

If desired, and as shown in FIGURE 6, a top 29 may be provided to serve as a baffle for the nebulizing device. This baffle has a circular skirt 30 thereon designed to engage an upper cylindrical outer wall 31 of the nebulizing device in press fit relationship. The upper part of top 29 is slanted inwardly as shown at 32 to permit insertion of the device into a person's nostril. A centrally located cylindrical bore 33 passes through the top. This bore is of a smaller diameter than the bore 19 that forms the barrel of the nebulizing device and a lip 34 depends from the top immediately surrounding bore 33. This lip is designed to catch any droplets of liquid that might possibly otherwise escape impingement bridge 28.

As shown in FIGURE 7, a different sort of impingement bridge is provided inside the nebulizing device as shown at 35. The nebulizing device of FIGURE 7 is otherwise the same as that shown in FIGURE 2. The main difference is that the upper surface 36 of the bridge slants from one side of bore or barrel 19 to the other side. Additionally, the floor 20 does not have as great a pitch as the floor illustrated in FIGURE 3. It is found that in prolonged use at any one time, some of the liquid tends to collect on the upper surface of the impingement bridge 28. After such prolonged use, this liquid builds up to a point where some of it hangs over the edge of the impingement bridge and that it is blown therefrom in the form of droplets rather than in the form of a mist. The slanting upper surface 36 of impingement bridge 35 prevents such a build up, liquid collecting on top of bridge 35 running down the sloping surface and thence down sloping floor 20 to collect at passage 22 where it is sucked back into the capillary cavities 25—25 upon the release of the sides of the container.

FIGURES 8 and 9 illustrate another form of the invention in which a different, larger type of impingement bridge is provided. In this instance the nebulizing device is molded in two parts. The upper part 37 has the outer slanting wall configuration of the embodiments illustrated in FIGURES 2 and 7. However, this upper part 37 is designed to be seated within a separate, lower part 38. In this instance, the upper part 37 has a cylindrical bore 39 running axially therethrough. A shoulder 40 limits inward movement of upper part 37 into lower part 38. In this instance, a circular impingement bridge 41 is provided. It is suspended from the underside of the upper part 37 by four arms 42 that radiate outwardly and upwardly from its perimeter to the outside of upper part 37. This impingement bridge is aligned axially with a passage 43 in lower part 38. Lower part 38 has a cylindrical outer wall 44 designed to be received in press fit relationship in the inside of neck 12. A shoulder 45 limits the inward movement of the nebulizing device, the shoulder engaging the upper rim of neck 12. The interior of the lower part 38 is cylindrical as shown at 46 and has a floor 47 that slopes downwardly toward a passage 43 that is at the center thereof. In this instance, a conical cavity 48 is provided, the circle at its lower end being coextensive with the outer periphery of the lower end of the nebulizing device. In this case, a cross slot extends diametrically through the lower portion of the nebulizing device to provide two capillary cavities 49—49 at the sides of passage 43. For a more detailed explanation of these capillary cavities, attention is directed to a copending application Ser. No. 496,766 filed contemporaneously herewith.

Having described my invention, I claim:

1. A nebulizer to produce a smoke-like mist of an oil-based liquid comprising a resilient container to hold a major supply of said medicant in the lower portion only thereof, there being air in said container above said major supply of medicant, said container having a neck extending from the top thereof, a nebulizing device seated within said neck portion, said device having a lower portion and an upper portion, said lower portion normally exposed to the air inside of said container and being configurated to hold a minor supply of medicant therein by capillary action, said minor supply being obtained and replenished by tipping said container to momentarily expose said major supply to said lower portion of said device, said upper portion configurated to provide a hollow barrel projecting from said neck, an air passage extending vertically axially of said device through said lower portion and being open at the sides thereof to said minor supply of medicant, whereby the squeezing of said container drives a stream of air upwardly through said passage to entrain medicant from said minor supply of medicant, the upper end of said passage opening into said barrel, said barrel having a substantially larger internal diameter than said passage and having impingement means therein presenting a surface toward said upper end of said passage such that oil entrained in a stream of air issuing from said passage is shattered to a fine mist on said surface to issue from said barrel as a smoke-like spray and any droplets of oil in said mist not so shattered are directed to the inner surface of said barrel to collect thereon.

2. A nebulizer to produce a smoke-like mist of an oil-based liquid comprising a resilient container to hold a major supply of said medicant in the lower portion only thereof, there being air in said container above said major supply of medicant, said container having a neck extending from the top thereof, a nebulizing device seated within said neck portion, said device having a lower portion and an upper portion, said lower portion normally exposed to the air inside of said container and being configurated to hold a minor supply of medicant therein by capillary action, said minor supply being obtained and replenished by tipping said container to momentarily expose said major supply to said lower portion of said device, said upper portion configurated to provide a hollow barrel projecting from said neck, an air passage extending vertically axially of said device through said lower portion and being open at the sides thereof to said minor supply of medicant, whereby the squeezing of said container drives a stream of air upwardly through said passage to entrain medicant from said minor supply of medicant, the upper end of said passage opening into said barrel, said barrel having a floor surrounding said passage and sloping downwardly and inwardly toward said passage, said barrel further having a substantially larger internal diameter than said passage and having impingement means therein presenting a surface toward said upper end of said passage such that oil entrained in a stream of air issuing from said passage is shattered to a fine mist on said surface to issue from said barrel as a smoke-like spray and any droplets of oil in said mist not so shattered are directed to the inner surface of said barrel to collect thereon.

3. A nebulizer to produce a smoke-like mist of an oil-based liquid comprising a resilient walled container, a supply of said liquid in the lower portion only of said container, there being air in said container above said supply of liquid, a nebulizing device, means seating said nebulizer device in the wall of said container in the upper portion thereof, said device having a lower portion and an upper portion, said lower portion normally exposed to the air inside of said container and having at least one cavity therein configurated to hold a small quantity of said liquid therein by capillary action, said liquid adapted to enter said cavity by tipping said container to momentarily expose said supply of liquid to said lower portion of said device, said upper portion of said device configurated to provide a hollow barrel projecting from said container, there being an air passage extending axially of said device through said lower portion and having an opening therefrom to said cavity, whereby the squeezing of said container drives a stream of air upwardly through said passage to entrain liquid from said cavity, the outer end of said passage opening into said barrel, said barrel

having a substantially larger internal diameter than said passage and having impingement means therein presenting a surface toward said outer end of said passage.

4. A nebulizer comprising a resilient walled container having a neck projecting from the top thereof, a nebulizing device seated within said neck and having an upper portion and a lower portion, said lower portion having a conical cavity centered therein with the base of said conical cavity open to the inside of said container, said upper portion of said device configurated to provide a hollow barrel projecting from said neck, there being a short, small passage opening from the top of said conical cavity into the bottom of said hollow barrel, there being at least one slot extending from a side of said conical cavity and from said passage toward a side of said device in said lower portion, said slot being of a size to hold an oil-based liquid therein by capillary action, said barrel having a substantially larger internal diameter than said passage and having impingement means therein presenting a surface toward said outer end of said passage.

5. A nebulizer comprising a resilient walled container having a neck projecting from the top thereof, a nebulizing device seated within said neck and having an upper portion and a lower portion, the said lower portion having a conical cavity centered therein, said upper portion of said device configurated to provide a hollow barrel projecting from said neck, there being a small, straight passage opening from the top of said conical cavity into the bottom of said hollow barrel, a cross slot extending diametrically through the lower portion of said nebulizing device, said cross slot being open to said conical cavity and to said passage, said slot being of a width to hold an oil-based liquid therein by capillary action, and impingement means in said hollow barrel presenting a flat surface toward said passage.

6. A nebulizer comprising a resilient walled container having a neck projecting from the top thereof, a nebulizing device seated within said neck and having an upper portion and a lower portion, the said lower portion having a conical cavity centered therein, said upper portion of said device configurated to provide a hollow barrel projecting from said neck, there being a small, straight passage opening from the top of said conical cavity into the bottom of said hollow barrel, a cross-slot extending diametrically through the lower portion of said nebulizing device, said cross-slot being open to said conical cavity and to said passage, said slot being of a width to hold an oil-based liquid therein by capillary action, and impingement means in said hollow barrel having an undersurface normal to the axis of said passage and an upper surface that is angulated with respect to the axis of said passage.

7. A nebulizer as set forth in claim 5 in which said passage is square and in which said impingement means is as wide as a side of said passage.

8. A nebulizer as set forth in claim 5 in which said impingement means is circular and substantially larger than the width of said passage.

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