Aerosol apparatus is provided which is of the type wherein a liquid spray is propelled from spray jet means through an inlet neck which is open to the atmosphere and which is bordered at each end, respectively, by converging and diverging surfaces into a chamber so that the spray from said spray jet means impinges on a baffle member interposed between the inlet neck and an outlet. Features of the invention include the employment of cone-shaped baffle means having external surfaces stream-lined in substantial alignment with the periphery of the cone-shaped spray, said cone having an open ended hollow interior in proximate spaced relation to the outlet from the chamber. An outlet conduit is slidably disposed in said outlet so that its inner end may be adjusted in relation to the open end of the cone and the hollow interior thereof. Further disclosed features include means for closing and maintaining closed draining means which when open drains the chamber into a receptacle for receiving liquid collected from the spray in said chamber. There is a suction type pump for propelling liquid to said spray jet means from a container having an opening for the admission of air in combination with means for closing said opening and maintaining it closed when the apparatus is not in use. The means for closing the said draining means and the said opening are actuated responsive to the movement of a common manually actuated movable member which may be comprised in a pump for pumping liquid to said spray jet means and may be actuated responsive to closing the cover of a case for the apparatus which cover can be held closed by a fastener so as to maintain closed the said draining means and the said opening.

6 Claims, 7 Drawing Figures
AEROSOL APPARATUS FOR INHALATION THERAPY

FIELD OF INVENTION

This invention relates to aerosol apparatus for inhalation therapy.

BACKGROUND OF INVENTION

Hereinafter it has been proposed to treat certain ailments or malfunctioning of the respiratory tract by the inhalation of a nebulized or atomized liquid that is regarded as having remedial effectiveness. For this purpose various devices have been designed to atomize or nebulize such a liquid. Some of such devices are so constructed as to cause liquid to be atomized within a bubble-containing chamber having an outlet orifice through which the atomized liquid emerges.

In my U.S. Pat. Nos. 3,302,374; 3,404,843 and 3,522,806 I have disclosed improvements in aerosol apparatus of the character aforesaid. Said improvements are embodied in apparatus characterized by a casing having an inlet orifice communicating with the atmosphere, an outlet spaced from said inlet, a bubble structure disposed between said inlet and said outlet, the inner surface of said inlet presenting a neck bordered at each end by converging and diverging surfaces having a Venturi effect on gases passing therethrough, and spray jet means adapted to discharge therefrom a conical liquid spray. The spray jet means is located in the region of said converging surfaces of said inlet for passage through said neck into said chamber and into contact with said bubble structure with the periphery of said spray contiguous with respect to said neck whereby air is propelled through said neck by the action of the spray and with enhanced velocity during travel through said neck. The apparatus also comprises a receptacle for liquid, draining means adapted and arranged to drain liquid which collects in the said chamber into said receptacle, a container for liquid, and liquid propelling means adapted and arranged for selectively causing liquid in said container to be propelled to said spray jet means to be discharged therefrom in the form of a spray, residual atomized or nebulized liquid from which coarser liquid particles have been separated passing out of the chamber through the outlet so as to be available for inhalation by a user in accomplishing inhalation therapy.

GENERAL STATEMENT OF INVENTION

This invention is concerned with further improvements in apparatus of the character aforesaid.

A principal object of this invention is that of providing aerosol apparatus of the character aforesaid so constructed and organized as to provide a high degree of effectiveness in providing a minute state of atomization of the emitted atomized liquid notwithstanding the embodiment of the invention in aerosol apparatus of such small size that it can readily be carried in one's pocket. It is important in connection with apparatus intended for inhalation therapy that relatively coarse particles of spray be eliminated in order to avoid possible injury to the patient and in order to accomplish the objective of having the liquid carried deeply into the lungs.

A further objective of this invention is that of providing an aerosol apparatus of the character aforesaid which provides means whereby accidental leakage of liquid is effectively prevented notwithstanding that the apparatus may be carried in different positions in one's pocket.

A further object of certain embodiments of the invention is that of coordinating the functionality of the invention with a case in which the device is carried.

One of the features of this invention is that of obtaining a high degree of effectiveness notwithstanding compactness of structure by providing a baffle means within the chamber in the form of a cone having its axis in substantial alignment with the axis of the neck through which the liquid is sprayed into the chamber, the small end of the cone being rounded and facing toward the neck in proximate spaced relation therewith, the side wall of the cone being substantially aligned with respect to the conical spray emitted from the spray jet means. The cone has a hollow interior and the larger end which is open is in proximate spaced relation with respect to the outlet which is smaller in cross-section than the open end of the cone whereby only the most highly atomized liquid is carried through for passage outwardly through the outlet where it is available for inhalation. Preferably, the interior surface of the chamber comprises a portion that is in surrounding juxtaposed relation to the exterior surface of the cone with the maximum spacing from the exterior surface of the cone disposed in opposed relation to a longitudinally intermediate portion of the cone such that a secondary Venturi is provided in the region where the spray from the spray jet means impinges on the cone in the region of the smaller end.

According to a further feature of the invention, the baffle means, which preferably is in the form of a cone as aforesaid, presents not only the convex exterior surface against which the spray impinges but also a concave inner surface in opposed juxtaposition with respect to the outlet from the chamber and in combination with the so formed baffle means an outlet conduit which is adjustably mounted in the chamber outlet for adjusting the position of the inner end of the conduit relative to the concave inner surface of the baffle means. In this manner the device is adjustable so that the degree of atomization may be controlled by adjusting the position of the outlet conduit. Preferably, the conduit is adjustible so that the inner end of the conduit may be disposed in a plurality of different positions within the concave interior of the baffle means. The degree of atomization of liquid that is emitted through the outlet conduit can be increased by moving the conduit toward the concavity of the baffle means and decreased by moving it in the opposite direction.

The liquid to be atomized is propelled for ejection from the spray jet means by a manually actuable pump which preferably is of the suction type in that the propelling stroke of the pump is followed by a return stroke during which liquid from a container for the liquid is sucked into the cylinder for the pump piston or other compression chamber of the pump preferably having passed through a filter. The pump preferably is mounted on the cover for the container so that the suction end extends into the liquid. In order that air may get into the container so as to compensate for liquid that is removed from the container the cover for the container is provided with an opening that is in communication with the outside atmosphere. In normal use the container is held by the user in a substantially vertical position, and when in this position liquid cannot acci-
dentally escape from the container. However, when the device is being carried in one’s pocket, for example, liquid in the container may accidentally escape from the opening in the cover. It is a feature of preferred embodiments of the invention that any such accidental leakage when the device is not in active use is prevented by providing a closure for the opening which is movable into and away from position for closing the opening responsive to movement of a manually actuable member and which is comprised in means whereby the opening may be maintained closed by the closure when the device is not in use.

In my aforesaid prior patents apparatus is disclosed which comprises means whereby liquid which collects in the chamber in which the atomization is effected may be returned to the container for the liquid which is propelled to the spray jet means by the pump. It is a feature of preferred embodiments of this invention that means is provided for closing the drain means and for maintaining the drain means closed when the device is not being used. By so doing accidental leakage of liquid from the liquid container is effectively prevented when the device is not being used. This is especially important in connection with a small sized unit which can be carried in one’s pocket. The drain means is closed by a manually actutable, movable member which is movable between position at which the drain means is open to position at which the drain means is closed. Means also is provided for holding the drain closing means in closed position.

In the embodiment disclosed for illustrative purposes advantage is taken of the relative movement of the parts of the pump whereby movement of one of the relatively movable parts of the pump brings a member presented thereby into position for closing the drain means as, for example, by the flattening of a flexible rubber tube through which the liquid is drained into the container for the liquid. The relative movement of the parts of the pump also is taken advantage of according to the illustrated embodiment of the invention whereby when the parts of the pump are moved into position such that the drain means is closed a closure carried by the movable pump part is brought into position for closing the opening into the receptacle which admits air into the liquid container to compensate for liquid removed from the container by the action of the pump while the device is being used.

It is a further feature of certain embodiments of this invention that the aerosol device of the character aforesaid includes in cooperative combination there with a case in which the device may be carried and which is provided with a cover that upon being closed actuates the pump part or other movable member so as to move it into position for closing the drain means or for closing the opening into the liquid container, or both, the cover having latch means for maintaining the cover closed and thereby maintaining closed the drain means and the opening into the liquid container. In this way the aerosol device may be provided with a case for conveniently carrying it in one’s pocket, which case automatically serves the additional function of preventing accidental leakage of liquid from the container. It is to be understood, however, that the movable pump part or other movable member may be manually actuated so as to close the drain means and so as to close the opening into the liquid container without resort for this purpose to movement of the cover of a case for the device.

BRIEF DESCRIPTION OF THE DRAWINGS

Further purposes, features and advantages of this invention will become apparent in connection with the following description of a typical embodiment of this invention which is shown for purposes of illustration in the accompanying drawings, wherein:

FIG. 1 is a sectional elevation of the device with the parts in position at the instant of commencing the propulsion of liquid from the spray jet means;

FIG. 2 is similar to FIG. 1 showing the parts in position at the conclusion of the pumping stroke;

FIG. 3 is a section taken on the line 3—3 of FIG. 1;

FIG. 4 is an elevation partly in section taken on the line 4—4 of FIG. 3;

FIG. 5 is a perspective view on a small scale of a casing in which the device may be carried;

FIG. 6 is a sectional elevation on a larger scale on the line 6—6 of FIG. 5; and

FIG. 7 is a sectional elevation partially in section showing an alternative embodiment wherein the receptacle for receiving drained liquid is independent of the container for the liquid which is propelled by the pump through the spray jet means.

DETAILED DESCRIPTION OF THE INVENTION

Liquid to be atomized is propelled in the form of a spray from the spray jet means 10 into the chamber 11. The liquid is sprayed into the chamber through the inlet, which is indicated generally by the reference character 12 and which comprises the neck 13. The neck 13 is bordered on its entry end by the converging inner surface 14 and at the chamber end of the neck by the diverging inner surface 15, thereby producing a Venturi effect on air which is drawn through the neck 13 from the outside atmosphere. Access of entry of air into the neck of outside atmosphere is provided by the openings 16 in the disc-shaped member 17. Preferably there is a plurality of openings 16 such that free entry of outside air is permitted. However, in the region adjacent the bottom of the member 17 the member 17 may omit the openings, thereby providing a better assurance against escape of liquid from the chamber when the device is not being used. However, if any such escape of liquid is not a problem the member 17 may be omitted. The spray jet means is located in the region of the converging inner surface 14 so that the periphery of the spray 18 is in such contiguous relation with respect to the neck 13 as to propel air through the neck and into the chamber 11.

At the end of the chamber 11 which is opposite to the neck 13 there is an outlet which is indicated generally by the reference character 19. Between the inlet 12 and the outlet 19 there is a baffle structure 20 which is in the form of an elongated cone the axis of which is substantially in alignment with the axis of the spray. It is one of the features which lends efficacy to the device of this invention that the external surfaces of the cone are provided so as to include a side wall 21 which over a substantial distance is substantially aligned to the periphery of the conical spray 18. The smaller end of the cone is rounded and receives the particles in the spray 18 so that the particles impinge thereagainst. The particles in the central portion of the cone-shaped spray

...
tend to be larger than those in the periphery with the result that these particles which strike the rounded end 22 in substantial proportion tend to coalesce in the form of free liquid while the more highly atomized particles at the periphery of the cone-shaped spray 18 are free to pass along the exterior of the side wall 21 and be carried with the air which moves through the device during operation. In the embodiment shown some of the coarser particles impinge on the rounded end 22 of the cone and by this doing tend to be broken up into finer particles in the region 23 of the casing that is in advance of the concave portion 24 of the casing at which there is a secondary Venturi effect which is conducive to the carrying of minute particles, produced by the breaking up of larger particles, in the air that ultimately is discharged from the device.

The cone-shaped baffle may be carried inside of chamber 11 in any suitable manner as by brackets 25. The interior surface 26 of the cone-shaped baffle is concave so as to provide a hollow interior which is open at the larger end. It is one of the features of this invention that the outlet 19 comprises a conduit 27 which is axially slideable so that the inner end may be disposed by selective manual manipulation in a plurality of different positions relative to the cone 20. By causing the inner end of the conduit 27 to be moved inwardly with respect to the hollow interior of the cone 20 the minuteness is increased of such atomized liquid particles as are carried with air through the conduit 27. In this manner it is possible to control a degree of atomization of the liquid that is inhaled.

The liquid 28 which is to be atomized may be supplied in a container 29 which preferably is readily removable from the cover 30 thereon for which there is mounted the pump which is indicated generally by the reference character 31. In this way the liquid may be replaceably supplied in containers provided with a simple type of cover which may be removed and replaced by the cover 30 which is secured in place by any suitable means such as by the threads 32. A replacement container 58 provided with a conventional cover 59 is shown in FIG. 6 where it is conveniently carried along with the device within the case 52 to be more fully described hereinafter.

The pump comprises the piston 33 which is slidable within the cylinder 34 and normally is held in the position shown in FIG. 1 by the spring 35 which surrounds the rod 36 which at its lower end is provided with the spring abutment 37 having apertures 38 therein. The rod 36 is longitudinally movable within the hollow stem 39, the upper end of which is in communication with the spray jet means 10 through the one-way ball valve 40 which permits propulsion of liquid from the pump to the spray jet means 10 but prevents return flow of air or liquid. The upper end of the hollow stem is carried in the finger-piece 41 on which the spray jet means 10 is mounted. When the finger-piece 41 is depressed relative to the receptacle 29 by squeezing them together between the fingers and thumb as indicated in FIG. 2, the liquid within the cylinder 34 is propelled through the spray jet means 10. During compression the liquid is prevented from flowing back into the container by the one-way ball valve 42 which permits liquid to be sucked into the cylinder from the container but prevents return flow. Upon relief of the compression applied by the fingers and thumb the parts under the influence of spring 35 return to the position shown in FIG. 1 and in so doing an additional supply of liquid from the container is sucked into the cylinder 34. Preferably the lower end of the cylinder 34 is provided with a filter 43.

It is one of the advantages of this invention that liquid is sucked into the pump and forced from the spray jet means to forcefully produce a spray. It is not necessary to employ a propellant such as freon which, if it were present in the atmosphere of the atomized liquid, would be detrimental. In the device shown the chamber 11 is shown in secured relation to an extension 44 of the finger-piece 41 by means of the clamping screw 45. The chamber 11 adjacent the lowermost portion of the interior surface thereof is provided with a drain opening 46 to which there is connected a flexible drain line 47 which preferably is made of flexible rubber. The drain line 47 is connected to the drain opening 48 in the cover 30 so that liquid may be drained into the container 29.

The cover 30 for the container also is provided with the opening 49 whereby atmospheric air may be admitted into the container in an amount by volume corresponding with the volume of liquid removed from the container 29 during use of the device.

In the embodiment shown advantage is taken of the movement of the finger-piece 41 relative to the container 29 to close the drain line 47. As shown in FIG. 6, the finger-piece may be moved toward the container 29 until it is disposed in the position shown in this figure wherein the lower margin 50 compresses the drain line 47 so as to close it off. The finger-piece 41 also is provided with means for holding a closure 51 which preferably is made of resilient material and which serves as a closure for the opening 49 when the parts of the device are in the position shown in FIG. 6 and in FIG. 4.

It is a feature of certain embodiments of this invention that a case 52 is provided which is adapted to receive the aerosol device therein. The case 52 is provided with a hinged cover 53 which can be held in closed position by the fastener 54. The inner surface of the cover 53 is provided with a projection 54 which is dimensioned with reference to the base of the case so that when the device is placed in the case as shown in FIG. 6 the closing of the cover positions the finger-piece 41 so as to close the drain line 47 and likewise close the opening 49.

It is to be understood that the apparatus thus far described is merely illustrative and that apparatus embodying the features of this invention may be in many different forms. Thus, for example, the movable member for closing the drain line and for closing the opening into the container need not necessarily serve the additional purpose of a finger-piece for the pump. Moreover, the member which closes the drain line and the member which closes the opening into the container may be held in position so that the closure may be maintained by means other than the provision of a case having a cover which is utilized to hold the movable member or members in closed position. While it is preferable that all of the features of this invention be employed in combination, the advantages resulting from said features may be had when they are employed separately.

It is also apparent that the receptacle for receiving any liquid drained from the chamber 11 need not necessarily be the same as the container from which liquid
is propelled to the spray means. For certain applications it may be preferable not to drain the liquid collected in the chamber 11 in such a manner as to be reused. This is especially the case if it is believed that there may be some risk of contamination in the case of reused liquid. The employment of a separate receptacle for the collected liquid drained from the chamber 11 is illustrated in FIG. 7. As shown in this figure, a container 55 is provided which is constructed so that there is an inner chamber 56 for the liquid which is to be sprayed by pumping to the spray jet means. The container 55 also comprises an outer chamber 57 into which liquid collected in the chamber 11 of the aerosol device is drained by the drain line 47. Each of the chambers 56 and 57 would be provided with openings (not shown) therein corresponding with the opening 49 hereinabove described whereby change in liquid level may be compensated for by air. Moreover, the apparatus preferably would include the features of closing these openings and shutting off the drain line in the manner hereinabove described by actuating a movable member or movable members so that leakage of liquid from either chamber 56 or chamber 57 may be prevented when the device is not in use. While the chambers 56 and 57 are shown as comprised in a single container 55, it is apparent that if desired the reservoir for drained liquid may be separate and distinct from the container for the liquid that is atomized. In such case, the receptacle in which the liquid is drained could be of an inexpensive disposable type.

When using the device the outlet 19 is held in proximity to the mouth of the user, as illustrated in FIG. 2. By compressing the finger-piece relative to the container 29 the liquid is forcefully emitted from the spray jet means 10 in the form of a conical spray with concomitant propulsion of air through the neck 13 and thence through the chamber 11 and eventually through the outlet 19. By the employment of the expediens and features hereinabove described the liquid which is carried in the air is in the extremely highly atomized state which is essential for inhalation therapy. Moreover, the degree of atomization can be predetermined and controlled. Thus the size, shape and function of the baffle structure serves to determine the degree of atomization desired for a given device and the degree of atomization can be further adjusted and controlled by the user by adjusting the position of the outlet conduit 27 relative to the baffle structure 20 as hereinabove described. It also is an advantageous feature of this invention that the provision of the protruding conduit 27 serves as a mouth piece which insures proper usage because the complementary air must be drawn through the nebulizer as the patient inhales. It also is one of the advantages of this invention that the features hereinabove described may be afforded notwithstanding the small size of the device. Devices of such small size can be conveniently carried in the pocket of the user or in a small handbag and it is a further advantage of the device of this invention that when the device is carried in this manner there is no danger of leakage of liquid therefrom. It also is of advantage that when the case 52 is employed, the device may be used merely by opening the cover and without removing the device from the case. Merely upon closing the cover the parts are automatically moved to such position that accidental leakage is prevented.

I claim:

1. In an aerosol apparatus for inhalation therapy comprising a casing forming a chamber, said casing forming an axially extending inlet orifice arranged to communicate with the interior of the chamber and with the atmosphere about said casing, an outlet spaced from and in approximate axial alignment with said inlet and a wall structure disposed within said chamber and located between said inlet orifice and said outlet, spray jet means arranged to discharge therefrom a conical liquid spray, a container for liquid, and liquid propelling means arranged for selecting the rate at which said liquid is discharged to said spray jet means to be discharged therefrom in the form of a spray, the improvement which is characterized by said inlet orifice having a first end adjacent the outer surface of said casing and a second end within said chamber, the axially extending inner surface of said inlet orifice comprising a first annular surface extending in the axial direction of said orifice from the first end thereof with said first surface converging toward the axis of said inlet orifice toward said second end and a second annular surface extending from said first surface to said second end with said second surface diverging from the axis of said inlet orifice from said first surface to said second end thereof and said first and second surfaces providing a Venturi effect on gases passing therethrough, the axis of said jet means being in substantial alignment with the axis of said inlet orifice and the outlet from said spray jet means being located in said inlet orifice in the range of said first surface thereof for passage of said spray through said inlet orifice into said chamber for contacting said wall structure of said casing and the periphery of said conical liquid spray being contiguous with respect to said inner surface of said inlet orifice so that air is propelled therethrough by the action of said spray with enhanced velocity as it passes through said inlet orifice, baffle means positioned within said chamber and being in the form of a cone disposed with its axis in substantial alignment with the axis of said inlet orifice and the axis of said conical spray emitted from said spray jet means, the small end of said cone being arranged facing toward said inlet orifice in proximate spaced relation therewith and being rounded affording a convexly shaped surface directed toward said inlet orifice, the frusto-conical sidewall of said cone extending from its rounded small end being substantially aligned with respect to the periphery of the conical spray emitted from said spray jet means and said cone being hollow and open at its larger end which is arranged in proximate spaced relation to said outlet, the interior surface of said wall structure of said casing comprising a portion which is in surrounding spaced juxtaposed relation to the external surface of said cone and said portion is concave with the maximum spacing between said concave portion and the external surface of said cone being in opposed relation to an intermediate portion of said cone between its rounded small end and open larger end such that a secondary Venturi is provided in the space between the interior surface of said casing and said cone in the region where the spray from said spray jet means impinges on said cone adjacent its smaller end.

2. Apparatus according to claim 1 wherein the interior surface of said cone presents a concave inner surface in juxtaposition to and facing toward said outlet from said chamber, and an outlet conduit mounted in said outlet and being adjustable movable in the axial
3,838,686

direction between said inlet orifice and outlet for adjusting the position of the inner end of said conduit relative to the concave interior surface of said baffle means.

3. Apparatus according to claim 2, wherein said outlet conduit is axially adjustable so that the inner end of said conduit can be positioned in a plurality of different positions within the concavely surfaced hollow interior of said cone.

4. Apparatus, according to claim 1, wherein drain means are arranged to drain liquid from said chamber, means for closing said drain means and maintaining said drain means closed to prevent accidental return of liquid into said chamber, said means for closing said drain means associated with said liquid propelling means so that said drain means is closed when said liquid propelling means are displaced for propelling the liquid to said spray jet means.

5. Apparatus according to claim 1, wherein said liquid propelling means comprises a reciprocal pump mounted on said container and being manually operable for withdrawing liquid from said container and propelling it through said jet spray means in the form of a spray, said container having an opening therein affording the entry of air into said container when liquid is withdrawn therefrom, and means associated with said pump for closing the opening in said container and maintaining it closed to prevent accidental loss of liquid through the opening when the apparatus is not in use, said reciprocal pump comprises a manually actuable movable member, said means for closing the opening in said container being associated with said movable member and responsive to the movement thereof, means for holding said movable member in position in which the opening in said container is maintained closed, and means associated with said movable member and movable therewith for closing said drain means and for maintaining said drain means closed when said movable member is maintained in the position at which the opening in said container is closed.

6. Apparatus, according to claim 5, wherein said means for holding said movable member in position at which the opening in said container is maintained closed comprises a case arranged to receive therein said container and said casing, said case including a cover and means associated with said cover so that as said cover is moved said movable member on said container is displaced into position for closing the opening in said container and for closing said drain means, and a fastener associated with said cover for securing said cover in the closed position for maintaining the closure of the opening in said container and the closing of said drain means.

* * * * *