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NEBULIZER

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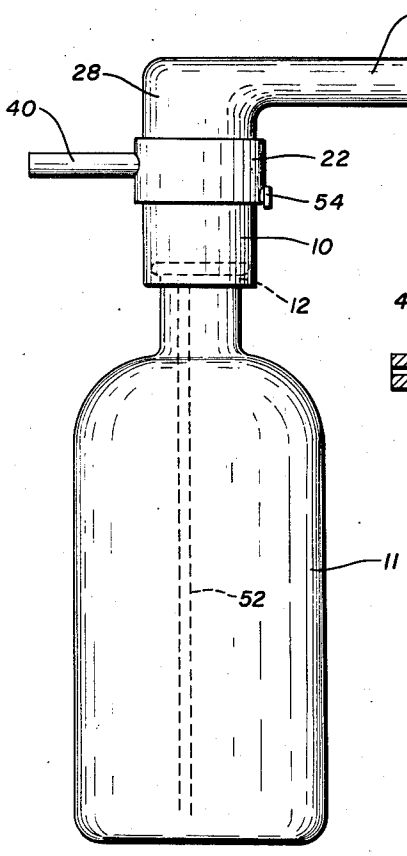


Fig. - 1

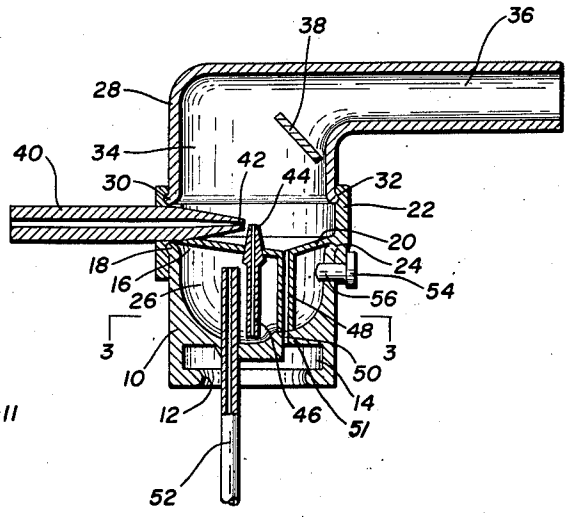


Fig. - 2

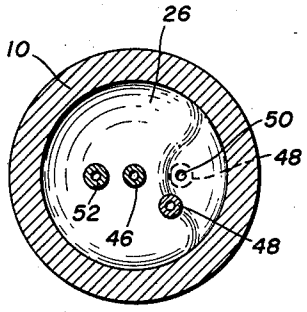


Fig. - 3

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NEBULIZER

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This invention relates to nebulizers and more particularly to a device for the nebulization or aerosolization of a liquid containing medicament, wherein very small, substantially uniform particles of the liquid are formed and entrained in a carrier gas for subsequent introduction into a patient's respiratory system.

Inhalation therapy is a well known and useful method of administration of various therapeutic agents, especially where a local effect of the medicament on the respiratory system is desired. Many types of medicaments may be administered as an aerosol of liquid particles entrained in a gas, including, for example, medicaments such as vasoconstrictors, bronchodilators, antihistamines, antibiotics, detergents, and the like. Aerosols may, in general, be produced by using a stream of oxygen, air, or other gas as the carrier agent. The choice of the gaseous medium is usually determined by clinical indications of the individual patient. Normally aerosol therapy is continued over a substantial period of time, and the main medicament container should be of large enough size to contain sufficient medicament for the desired period. In certain instances, it has been found desirable to use several medicaments for the treatment. Where several different medicaments are used, they are usually incompatible or at least unstable when mixed and stored.

The size of entrained liquid particles in the aerosol is of prime importance in determining which portion of the tracheobronchial tree the particles will contact and deposit carried medicament. It has been determined that particles of a size larger than about 30 microns will be baffled out or stopped in the trachea. The terminal bronchioles baffle out particles in the size range of from about 30 to 10 microns, the alveolar ducts baffle out particles in the size range of about 10 to 3 microns, and particles in the size range of about 3 to 0.5 microns are baffled out by the air sacs. When particles are smaller than about 0.5 micron, their extreme lightness prevents them from being utilized by the patient as they may be inhaled on one breath but will be exhaled with the next.

According to the present invention, a nebulizer is provided which produces an aerosol having particles of an adequate size range, wherein the mean particle size range is about 3 microns. The device provides means for easily and conveniently administering an aerosol of one or more medicaments, which may be under normal circumstances incompatible or at least unstable when mixed together. While the various medicaments may be administered together, they are not admixed in the bulk and the present device permits conjoint administration without mixing the bulk of the various compositions. The nebulizer of the present invention is easily and quickly assembled and disassembled for thorough cleaning of all parts to prevent contamination of the medicaments and to prevent the clogging of the small internal passages within the device.

Included among the objects and advantages of the present invention is a nebulizer adapted to produce an aerosol of at least one liquid, and means are provided to produce

an aerosol of two liquids without mixing the main supply of the liquids, and which prevents contamination of the bulk of the primary liquid with the secondary liquid. The device is quickly and easily taken apart, cleaned and assemled for subsequent use. The nebulizer is constructed so as to provide a nebulization chamber which may be continuously drained and prevent accumulation of medicament for maintaining a uniform aerosol throughout the period of use. The nebulizer produces a uniform, small particle aerosol which is effectively carried into the major components of the respiratory tract of the user.

These and other objects and advantages of the invention may be readily ascertained by referring to the following description and appended illustrations in which:

Fig. 1 is a side elevational view of a nebulizer according to the invention, assembled for use on a primary medicament supply;

Fig. 2 is a cross sectional view of a nebulizer of the invention; and

Fig. 3 is a cross sectional view taken along line 3—3 of the device of Fig. 2.

In the device illustrated, a base portion **10** having a bottom opening **12** and a recess **14** immediately thereabove is adapted to seat on a primary medicament container **11**, whereby the lip of the container seats in the recess **14** and the device is held securely on the medicament container. The hollow base **10** has an open top **16** with a peripheral flange **18** therearound, and it is closed by a partition **20** which is secured to an annular band **22**. The band **22** has a recess **24** for accommodating the lip **18** of the base **10** forming a tight seal therebetween. The partition **20** substantially closes the base forming a lower chamber **26** therein. A top **28** having a peripheral lip **30** around the bottom thereof seats in an upper recess **32** in the band **22** forming an upper chamber **34**. The chamber **34** has an upper outlet **36** for discharging an aerosol therefrom. A baffle **38** in the inlet to the outlet **36** prevents a free sweep of gas from the chamber **34**, and condenses or baffles large particles from the aerosol.

A gas inlet **40** provides means for introducing a gas into the chamber **34**, and the inlet **40** terminates in an orifice **42** internal of the chamber **34**. The orifice **42** releases the gas in a high velocity stream directed toward the chamber wall opposite the inlet. The gas orifice **42** terminates adjacent a liquid orifice **44** and it is directed perpendicularly thereacross so as to create a pressure differential in liquid tube **46** which extends to the bottom of the lower chamber **26**. The passage of gas across the orifice **44** decreases the pressure in lower chamber **26** since the conduit **46** provides access between the chambers, and any liquid in chamber **26** is picked up through the tube **46**. The liquid is discharged through orifice **44** and is atomized on entering the stream of gas from the jet **42**. The atomized liquid and gas is directed toward the wall opposite the gas orifice. The entrained particles of liquid impinge on the wall, and large particles are broken up on the contact. As the gas and entrained particles pass upwardly and toward the outlet **36**, the baffle **38** prevents the exit of any large particles of liquid. The large particles "condense" on the walls of the upper chamber and drain downwardly onto the partition **20**. Liquid passes from the partition **20** through a drain conduit **48** which communicates with the upper portion of the partition **20**. In one position, the drain conduit **48** communicates with a bore **50** on a raised portion **51** in the bottom of the chamber **26**, which opens into the opening **12** so that any liquid draining from the partition **20** passes back into medicament container **11**. The band **22** is movable on the base **10**, and on turning the band, the tube **48** moves from its position in register with the bore **50**, indicated in the dash

lines of Fig. 3, into a position out of register with the bore where liquid drains into chamber 26, indicated in the solid lines 48 of Fig. 3. A siphon tube 52 is secured in the bottom of the chamber 26 and extends at its lower portion to about the bottom of the medicament container 11 and at its upper portion into chamber 26. The upper end of conduit 52 is terminated in a position so that liquid in chamber 26 will not drain into the container 11. A stopper 54, closing a hole 56 in the side of the base 10, may be utilized for the addition of small portions of another medicament into chamber 26, where it is nebulized with the primary medicament.

When the device is to be used for making an aerosol of a single medicament, the band 22 is turned into position so that the drain conduit 48 registers with bore 50 in the bottom of the base 10. The nebulizer is then mounted on a medicament container 11, and air or oxygen or other carrier gas is forced through the gas inlet 40. A high velocity stream of gas issuing from the orifice 42 passes across the liquid orifice 44 creating a pressure differential between chamber 34 and chamber 36. The pressure in chamber 26 is reduced due to the siphon or ejector effect of the high velocity stream of gas passing over the orifice 44, and liquid from the medicament container 11 is drawn up the siphon tube 52 into the chamber 26. Liquid from the siphon tube flows to the bottom of chamber 26 where it is picked up and passed through conduit 46 into contact with the high velocity stream of gas. The liquid is picked up in the gas and nebulized. The nebulized liquid impinges on the wall 22 opposite the inlet of the gas, and large droplets are further broken up into smaller liquid particles. The nebulized liquid passes upwardly through chamber 34, the large particles impinging on baffle 38 where they are broken up into smaller particles or condense out and drop back onto partition 20. The liquid dropping back onto the partition 20 flows through the drain tube 48 back into the medicament bottle 11. The aerosol which issues from outlet 36 is a very fine particle size, having a mean size of about 3 microns.

When it is desired to use the nebulizer with two medicaments which are unstable in the presence of one another, the band 22 is rotated to the position indicated by the solid line 48, Fig. 3. The nebulizer is then mounted on a medicament container 11 and the carrier gas introduced through tube 40. The high velocity stream of gas issuing from orifice 42 passing across the orifice 44 causes a decrease in the pressure in chamber 26 drawing liquid from medicament chamber 11 into chamber 26. Additional medicament may be introduced into chamber 26 through the opening 56, by withdrawing the stopper 54, introducing the medicament, and then replacing the stopper 54. The medicament from chamber 26 is siphoned up and is mixed with the carrier gas and the aerosol is dispensed through the outlet 36. The liquid which condenses and drains from the upper chamber 34 does not pass back into medicament container 11, since the opening 50 leading to the container 11 is cut off. This prevents the liquid, which is a mixture of both medicaments, from passing back into the container 11, contaminating the entire contents. The mixed liquid is passed back into chamber 26 for continued nebulization of the medicaments. The liquid is then recycled until it is completely nebulized, permitting the addition of more medicament or until the secondary medicament is entirely used up, after which the band 22 may be turned back to a position where the liquid drains into the main medicament container 11.

The parts of the device may be made of substantially non-breakable materials, and due to the construction, the device may readily be taken apart and all the passages and orifices may be thoroughly cleaned and sterilized for subsequent use. The arrangement of the orifices and the baffle provide an aerosol of uniform particle size which is small and a very effective size range to be carried to the furthest points of the respiratory system.

While the invention has been described by reference to a specific device, there is no intent to limit the spirit and the scope hereof to the precise details so illustrated, except as set forth in the following claims.

I claim:

1. A nebulizer comprising a body arranged to be mounted on a medicament container, a first chamber in said body having an aerosol outlet and being otherwise imperforate, a second chamber in said body spaced and separate from said first chamber, means for draining liquid from said first chamber, a first liquid conduit between said chambers extending from a point adjacent the bottom of said second chamber and terminating in an orifice in said first chamber, a gas inlet in said first chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said first and second chambers, a second liquid conduit having one end terminating in said second chamber and the other end arranged to extend into said medicament container, and baffle means in said first chamber arranged to prevent the exit of large liquid particles.

2. A nebulizer comprising a body arranged to be mounted on a medicament container, a first chamber in said body having an upper aerosol outlet and being otherwise imperforate, a second chamber in said body spaced and separate from said first chamber, liquid passage means arranged to permit a gravity flow of liquid from said first chamber, a first liquid conduit between said chambers extending from a point adjacent the bottom of said second chamber and terminating in an orifice in said first chamber, a gas inlet in said first chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said first and second chambers, a second liquid conduit having one end terminating in the upper portion of said second chamber and the other end arranged to extend into said medicament container, and baffle means in said first chamber arranged to prevent the exit of large liquid particles.

3. A nebulizer comprising a body arranged to be mounted on a medicament container, a first chamber in said body having an upper aerosol outlet and being otherwise imperforate, a second chamber in said body spaced from said first chamber, liquid passage means arranged to permit a gravity flow of liquid from said first chamber, a first liquid conduit between said chambers extending from a point adjacent the bottom of said second chamber and terminating in an orifice in said first chamber, a gas inlet in said first chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said first and second chambers, a second liquid conduit having one end terminating in the upper portion of said second chamber and the other end arranged to extend into said medicament container, baffle means in said first chamber arranged to prevent the exit of large liquid particles, and means for introducing additional medicament into said second chamber.

4. A nebulizer comprising a body arranged to be mounted on a medicament container, a first chamber in said body having an upper outlet, a second chamber in said body spaced from said first chamber, liquid passage means arranged to permit a gravity flow of liquid from said first chamber into said second chamber, means for arranging the outlet of said liquid passage means to pass liquid from said first chamber in said medicament container, a conduit between said chambers extending from a point adjacent the bottom of said second chamber and terminating in an orifice in said first chamber, a gas inlet in said first chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said first and second chambers, a liquid conduit having one end terminating in the upper portion of said second chamber and the other end arranged to extend into said medicament container, baffle

means in said first chamber arranged to prevent the exit of large liquid particles, and means for introducing additional medicament into said second chamber.

5. A nebulizer comprising upper and lower hollow members detachably joined to form a chambered body, a partition dividing the interior of said body into upper and lower chambers, said upper chamber having an outlet, said lower member being arranged to be mounted on a medicament container, a liquid conduit having one end terminating in the lower chamber and the other end arranged to extend into said medicament chamber, a drain conduit passing through said partition and terminating in contact with a raised portion of the bottom of said lower chamber, a passage in the bottom of said lower chamber opening into said medicament container, means for moving said drain conduit in and out of register with said passage, conduit means extending through said partition and terminating in the upper chamber in an orifice and terminating adjacent the bottom of said lower chamber, a gas inlet in said upper chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said upper and lower chamber so as to draw liquid from said medicament container into said lower chamber and from said lower chamber into contact with said stream of gas in said upper chamber, said gas inlet being arranged to direct a stream of gas and liquid from said orifice into the wall of said upper chamber, and a baffle in the outlet of said upper chamber arranged to prevent the exit of large particles of gas entrained liquid.

6. A nebulizer comprising upper and lower hollow members detachably joined to form a chambered body, a partition dividing the interior of said body into upper and lower chambers, said upper chamber having an upper outlet, said lower member being arranged to be mounted on a medicament container, a liquid conduit having one end terminating in the upper portion of the lower chamber and the other end arranged to extend into said medicament chamber, a drain conduit passing through said partition and terminating in contact with a raised portion of the bottom of said lower chamber, a passage in the bottom of said lower chamber opening into said medicament container, means for moving said drain conduit in and out of register with said passage, conduit means extending through said partition and terminating in the upper chamber in an orifice and terminating in lower chamber adjacent the bottom thereof, a gas inlet in said upper chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said upper and lower chamber so as to draw liquid from said medicament container into said lower chamber and from said lower chamber into contact with said stream of gas in said upper chamber, said gas inlet being arranged to direct a stream of gas and liquid from said orifice into the wall of said upper chamber, and a baffle in the outlet of said upper chamber arranged to prevent the exit of large particles of gas entrained liquid.

7. A nebulizer comprising upper and lower hollow members detachably joined to form a chambered body, a partition dividing the interior of said body into upper and lower chambers, said upper chamber having an outlet, said lower member being arranged to be mounted

on a medicament container, a liquid conduit having one end terminating in the lower chamber and the other end arranged to extend into said medicament chamber, a drain conduit passing through said partition and terminating in contact with a raised portion of the bottom of said lower chamber, a passage in the bottom of said lower chamber opening into said medicament container, means for moving said drain conduit in and out of register with said passage for passing liquid into said container and said lower chamber, conduit means extending through said partion and terminating in the upper chamber in an orifice and terminating in lower chamber adjacent the bottom thereof, a gas inlet in said upper chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said upper and lower chamber so as to draw liquid from said medicament container into said lower chamber and from said lower chamber into contact with said stream of gas in said upper chamber, said gas inlet being arranged to direct a stream of gas and liquid from said orifice for impingement on the wall of said upper chamber, a baffle in the outlet of said upper chamber arranged to prevent the exit of large particles of gas entrained liquid, and means for introducing additional medicament into said lower chamber.

8. A nebulizer comprising upper and lower hollow members detachably joined to form a chambered body, a portion dividing the interior of said body into upper and lower chambers, said upper chamber having an upper outlet, said lower member being arranged to be mounted on a medicament container, a liquid conduit having one end terminating in the upper portion of the lower chamber and the other end arranged to extend into said medicament chamber, a drain conduit passing through said partition forming a communication between said chambers and terminating in contact with a raised portion of the bottom of said lower chamber, a passage in the bottom of said lower chamber opening into said medicament container, means for moving said drain conduit in and out of register with said passage for passing liquid into said container and said lower chamber, conduit means extending through said partition and terminating in the upper chamber in an orifice and terminating in lower chamber adjacent the bottom thereof, a gas inlet in said upper chamber arranged to pass a high velocity stream of gas across said orifice and thereby create a pressure differential between said upper and lower chamber so as to draw liquid from said medicament container into said lower chamber and from said lower chamber into contact with said stream of gas in said upper chamber, said gas inlet being arranged to direct a stream of gas and liquid from said orifice for impingement on the wall of said upper chamber, a baffle in the outlet of said upper chamber arranged to prevent the exit of large particles of gas entrained liquid, and means for introducing additional medicament into said lower chamber.

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