

[54] **MIST GENERATOR**

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Related U.S. Application Data

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abandoned.

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239/102, 21/122, 128/194, 259/DIG. 43,
261/DIG. 65, 261/DIG. 48

[51] Int. Cl. **B01f 3/04**

[58] Field of Search 261/1, DIG. 54, 76,
261/78 A, 116, 30, DIG. 65, DIG. 48;
239/102; 21/122, 123; 128/194, 188; 55/257;
259/DIG. 43

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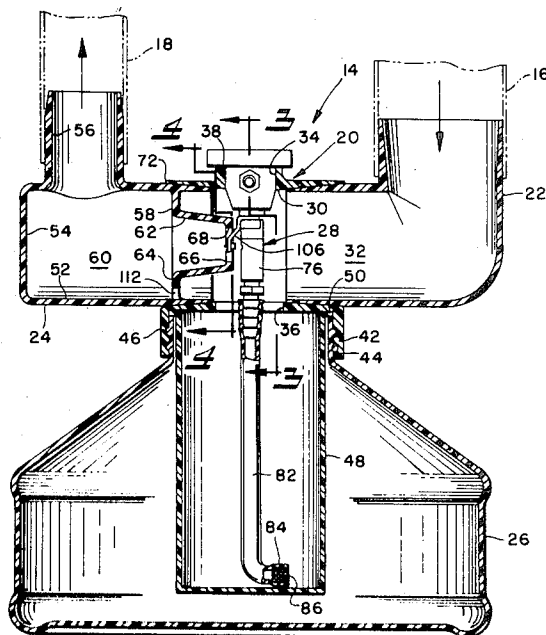
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[57] **ABSTRACT**

A generator is provided for producing a liquid aerosol mist of uniform dispersion characteristics that is circulated through an oxygen tent or the like. The generator includes a housing having a primary air passage therethrough which in an intermediate section is formed with an expanding venturi tube. A nebulizer is supported by the housing and functions to entrain a therapeutic liquid within a pressurized gas and subsequently to introduce the liquid-gas stream into the primary air passage upstream of the venturi tube. The expansion of the liquid-gas stream in the venturi creates a pressure differential in the passage to draw air through the same, whereby the liquid-gas stream uniformly is dispersed within the primary air stream.

6 Claims, 5 Drawing Figures



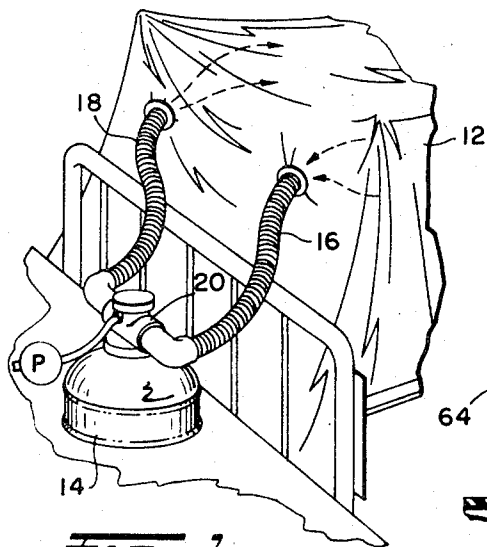


FIG. 1

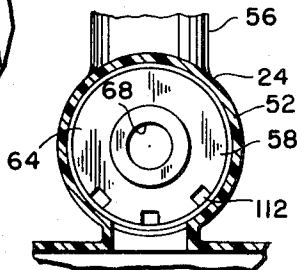


FIG. 4

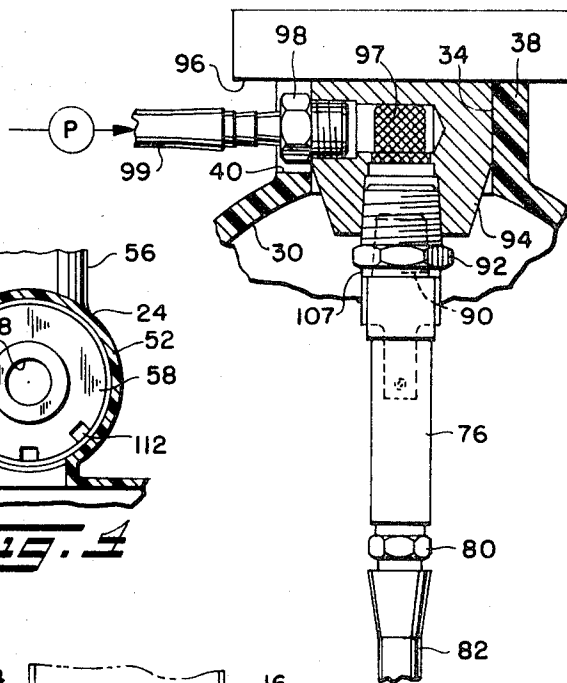


FIG. 3

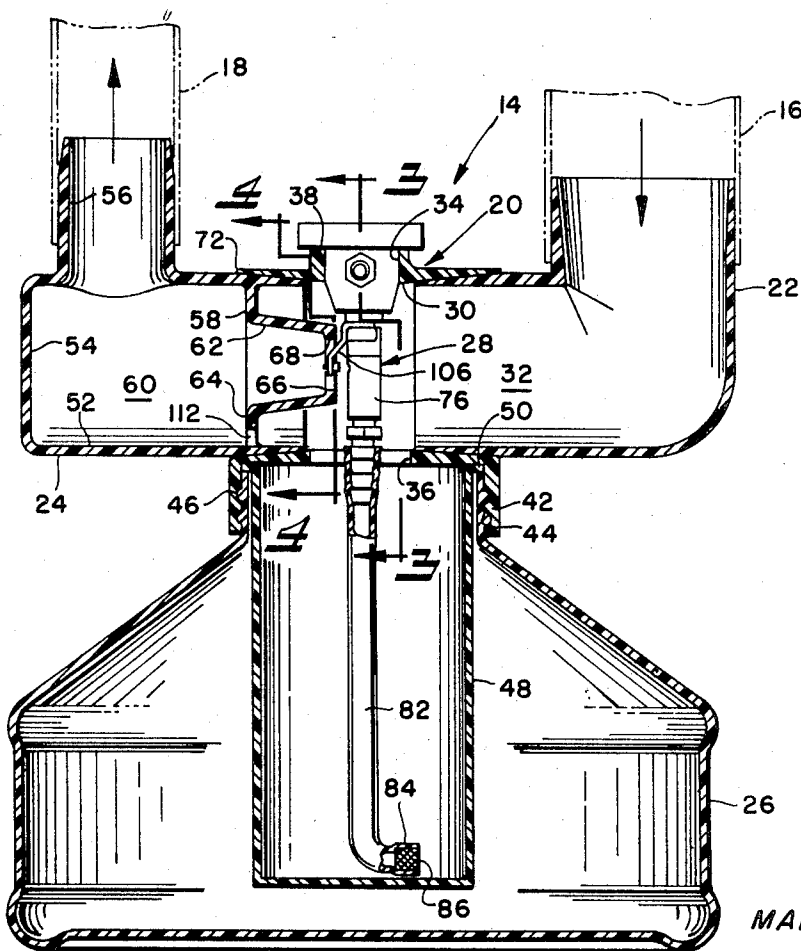


FIG. 2

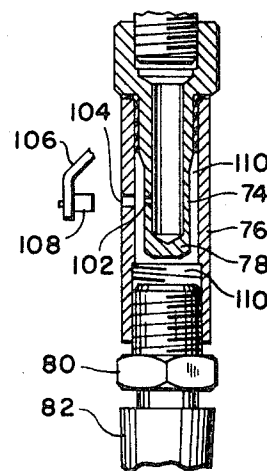


FIG. 5

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MIST GENERATOR

This is a continuation of application Ser. No. 11,943, filed Feb. 17, 1970, now abandoned.

The present invention relates to a mist generator, and in particular, to a generator for producing a saturated or supersaturated aerosol mist suitable for home and hospital therapeutic treatment.

The invention is particularly applicable to the production of a recirculated, controlled, mist atmosphere for a croup or oxygen tent, and will be described with reference thereto, although it will be apparent that the invention has other applications; for instance, in the production of a mist flow which can be used effectively with therapeutic masks, in line with respirators, or other therapeutic applications.

The invention is particularly useful in combination with an atomizer or nebulizer of the type illustrated in prior U. S. Pat. No. 3,326,538 issued to Marvin D. Merritt.

For purposes of the present application, a mist generator is defined as that component through which a primary air stream passes, an atomizer or nebulizer being a component part of the generator and designed to introduce an atomized or nebulized mist spray into the primary air stream.

In said prior patent, the atomizer which is defined and claimed comprises inner and outer concentric tubes, the inner tube being closed at the bottom. Openings are provided in the sides of the tubes, the opening for the outer tube being coaxial with and slightly larger than the opening for the inner tube. A small stream of air is caused to be expelled under pressure through the smaller opening of the inner tube, forcing atomized liquid from the larger opening. A reed or other flexible member is positioned opposite the larger opening and the atomized liquid droplets are impinged against the reed causing the reed to vibrate, further reducing the droplet size.

Although the atomizer of the prior patent is broadly claimed, and is described as useful for such purposes as humidifying, vaporizing medicaments, insect spraying and vaporization of liquid fuels, it is particularly described in combination with a carburetor for internal combustion engines in which the atomized liquid is introduced into a primary air stream transmitted through the carburetor.

It is an object of the present invention to provide a mist generator particularly suitable for therapeutic purposes in which the atomizer of said prior patent can be employed.

In particular, it is an object of the present invention to provide a mist generator in which the only source of motive power is compressed gas source employed in the atomizer or nebulizer.

It is further an object of the present invention to provide an improved mist generator for producing a very fine saturated or supersaturated mist flow suitable for use with therapeutic devices such as croup or oxygen tents, therapeutic masks, and therapeutic respirators.

It is also an object of the present invention to provide a mist generator for therapeutic uses in which a variable output can be obtained.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed

drawing setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principles of the invention may be employed.

In such annexed drawing:

FIG. 1 is a perspective view illustrating a croup or oxygen tent and associated therewith a vapor generator in accordance with the present invention;

FIG. 2 is a detailed, enlarged, section elevation view of the vapor generator of FIG. 1;

FIG. 3 is an enlarged partial section view taken along line 3—3 of FIG. 2 illustrating the atomizer or nebulizer in accordance with the present invention;

FIG. 4 is a section view taken along line 4—4 of FIG. 2; and

FIG. 5 is an enlarged elevation section view of the atomizer or nebulizer of FIG. 3.

Referring to the drawing, in particular FIG. 1, there is illustrated a croup or oxygen tent 12 and connected therewith a mist generator 14. The connections between the mist generator and the tent 12 include a corrugated inlet tube 16 (inlet to the mist generator) and a corrugated return tube 18, the flow of recycled air being through the two tubes, and through a nebulizer body 20 of the mist generator, connected between the two tubes.

Referring to FIG. 2, the mist generator 14, in addition to the nebulizer body 20, comprises a ninety degree inlet elbow 22, on the inlet side of the nebulizer body, a venturi adapter 24 on the exhaust side of the nebulizer body, a transparent plastic reservoir 26 connected beneath the body, and an atomizer or nebulizer 28 vertically supported in the body between the inlet and outlet sides thereof.

The nebulizer body 20 comprises a generally cylindrical horizontally extending conduit 30 defining a chamber 32. It is provided with aligned upper and lower openings 34 and 36, the axes of which extend transverse to the longitudinal axis of the chamber 32 intersecting the center of the chamber. The upper opening 34 is embraced by an annular lip 38 having in one side a downwardly extending cut-out or slot 40 (shown in FIG. 3). The bottom side of the nebulizer body defines a cylindrical cap 42 (which is a molded integral part of the body) embracing the lower opening 36. Internal threads 44 on the inside of the cap engage threaded surface 46 of the reservoir 26 holding the latter in position beneath the body.

In FIG. 2, there is shown a removable vial 48 of transparent plastic or glass positioned in the reservoir and provided with an upper flange 50. The vial is held in the reservoir by clamping the flange between an upper shoulder of the threaded surface 46 of the reservoir and the bottom side of cap 42. Either the reservoir or the smaller vial can be filled with a desired therapeutic liquid. Assembled as shown, the vial is employed. If it is desired to use the larger reservoir, it is a simple matter to remove the vial. The vial may be provided with a visible scale indicating the amount of liquid therein.

The venturi adapter 24 is a generally cylindrical member 52 having an end wall 54 molded integral therewith closing the end. An outlet tee connection 56 is provided on one side of the venturi adapter close to the wall 54, the tee connection being of lesser diameter than the cylindrical member. The end of the venturi adapter remote from the wall 54 contains an insert 58, the insert extending across the mouth of the adapter to

form on the downstream side thereof a chamber 60, hereinafter referred to as a venturi chamber. The insert has a generally frusto-conical portion 62 within the mouth of the adapter axially supported therein by means of an annular radial flange 64, the small diameter end of the frusto-conical portion 62 being the upstream end. An inwardly directed radial flange 66 at the upstream end defines an orifice or opening 68.

The outside surface of the venturi adapter 24 close to the upstream end thereof, in the area of insert 58, is slightly tapered permitting it to be inserted into the downstream end of the nebulizer body 20, such downstream end also being slightly beveled to receive the adapter. The two members are telescoped together until the nebulizer body abuts a shoulder 72 formed on the outside surface of the adapter.

Cooperating surfaces of the 90° inlet elbow and the inlet or upstream side of the nebulizer body are also beveled in a similar manner for telescopic insertion of the elbow open end into the body.

The atomizer or nebulizer 28 is similar to the atomizer means shown in prior U.S. Pat. No. 3,326,538. Referring to FIG. 5, the nebulizer comprises an inner tubular member 74 and concentric therewith an outer tubular member 76, the inner tubular member being closed at its lowermost end 78. The outer tubular member is open at its lowermost end and connected by coupling 80 with a flexible suction tube 82 (FIG. 2) which extends downwardly from the nebulizer into either the reservoir 26 or removable vial 48, whichever is employed. The suction tube terminates in an end 84 which is provided with a stainless steel mesh filter 86.

A mounting stud 90 (FIG. 3) is threaded into the upper end of the inner tubular member 74 and also is threaded into a mounting plug 92 which in turn is threaded into body 94 of the atomizer. The latter is shaped to slide downwardly into the annular lip 38 of the plastic nebulizer body, in an interference or tight fit therewith, the atomizer body 94 being provided with a shoulder 96 which seats on the upper surface of the lip. Both the stud and plug are hollow, as is the atomizer body accommodating filter 97, such body being provided with an air inlet coupling 98 which seats into the cut-out or slot 40 on one side of the lip 38, and to which is connected line 99 from a suitable source P of compressed gas such as a pump, pressure tank, etc.

Referring to FIG. 5, the inner and outer tubular members 74 and 76 are provided with aligned coaxial openings 102 and 104 in the sides thereof, the opening 104 of the outer tubular member being slightly larger in diameter than that of the inner tubular member. A flexible vibrating member or reed 106 is suspended downwardly along the side of the outer tubular member, having a flange piece 107 which is clamped between the mounting plug 92 and upper end of the inner tubular member 74, as shown in FIG. 3. The distal end of the reed is axially aligned with the two openings 102 and 104.

It is a preferred aspect of the present invention that the generator component parts of the primary air passage are constructed of molded polypropylene or other suitable plastic so that the generator can readily be disassembled, cleaned and sterilized or autoclaved. In this way, risk of contamination is avoided and the generator can be used with different medicants.

In operation, the connection 98 of the atomizer mounting body 94 is connected with the suitable source

of gas under pressure, and this gas under pressure is admitted into the inner tubular member 74, passing at a relatively high velocity through small opening 102 of the member. The air continues on through the larger opening 104 of the outer tubular member, establishing a vacuum in the annular space 110 between the two members. This vacuum is transmitted to the flexible suction tube 82, causing liquid in either the reservoir or vial, depending upon which is used, to be drawn upwardly in the tube. The liquid is entrained in the flow of gas passing through the aligned openings 102 and 104, impinging on the head 108 of the reed 106. This causes the reed to vibrate at a relatively high frequency, dispersing the liquid in the form of a cone of very fine droplets or a mist-like cone spray into the chamber 60 of the venturi adapter.

As shown in FIG. 2, the flange 64 of the insert 58 supports the insert within the open or upstream end of the venturi adapter so that the orifice 68 of the insert is positioned about the vibrating reed 106. This causes the conical spray of liquid to pass through the venturi orifice establishing a pressure differential on opposite sides of the orifice. It is this pressure differential which may provide the sole motive force for the primary air flow from the corrugated inlet tube 16 axially through the nebulizer body 20. At the same time, the venturi orifice causes the spray to be relatively uniformly dispersed in the primary air flow.

Referring to FIGS. 2 and 4, the insert 58 of the venturi adapter 52 is provided along the lower side thereof with a plurality of cut-outs or openings 112. The chamber 60 is large enough so that the heavier drops of liquid settle out of the primary air flow and collect in the chamber. The openings 112 permit the liquid so collected to flow back into the reservoir or vial, whichever is employed.

By varying the back pressure and flow rate of the compressed gas source P, the mist output can be increased or reduced with regard to the patient's requirements. For instance, the intake by the patient can be increased from a saturated flow to supersaturated simply by increasing the pressure from the compressed gas source.

In the example of the drawings, the nebulizer is shown as connected on the inlet side with a larger diameter tubing than on the return or exhaust side. In a particular example, the corrugated tube on the inlet side can be about 2½ inches in diameter, as compared with 1½ inches diameter for the exhaust or return side tube.

If it is desired to use a smaller diameter corrugated tube on the inlet side, this can be accomplished simply by using a reducing adapter connected to the inlet side of the nebulizer body, the adapter having a large diameter portion which telescopes into the nebulizer body inlet side, and a small diameter upstream portion which connects with the corrugated inlet tube.

The use of different sized corrugated tubing has an affect on output of the generator, the output with a 2½ inch tube being about twice that obtained with a 1½ inch tube. The size tubing seems to have little effect on particle size at higher pressures, although at lower pressures, there is a greater percentage of fine droplets using the larger diameter tubing.

Although the invention has been described with reference to a croup or oxygen tent, it should now be apparent that the invention can very effectively be em-

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ployed with other therapeutic devices, such as tracheotomy masks, aerosol masks, or laryngectomy masks where control over velocity flow and mist out-put are easily effected to suit the patient's requirements, or with inline respirators, the amount of humidity desired being increased simply by adjustment of the nebulizer output.

It is a particular advantage of the invention, that the generator can deliver a selective output, over a very large range.

Other advantages of the invention should also be apparent. In addition to producing a very fine uniform mist spray, the generator can be operated where the sole motive power is a relatively small capacity pump to produce the atomizer or nebulizer air. This latter aspect is particularly advantageous for home and hospital use. It also makes the generator easily movable for use with different patients, and of course the generator is easily cleaned and its output adjusted for such use.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A mist generator comprising a generator body having a generally horizontal primary air passage there-through, a tubular nebulizer extending vertically through said primary air passage, a liquid reservoir beneath said nebulizer, said nebulizer comprising concentric inner and outer tubular portions forming inner and outer concentric chambers, axially aligned openings in said inner and outer chambers, such axis of alignment extending generally along the centerline of said primary air passage, the inner chamber being connected to a source of gas under pressure while the outer cham-

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ber is in communication with said liquid reservoir whereby gas passing through said aligned openings will draw liquid from said reservoir and aspirate a liquid-gas stream into said primary air passage, a reed adapted to vibrate at high frequency mounted on said nebulizer having an inwardly projecting head thereon adapted to engage the liquid-gas stream and disperse the same into a cone of very fine droplets in the primary air passage.

2. A generator as set forth in claim 1 wherein said primary air passage includes an expanding frusto-conical venturi tube, the upstream end thereof being positioned about said reed on said nebulizer.

3. A generator as set forth in claim 2 wherein said primary air passage terminates in an elbow providing an enlarged chamber downstream of said venturi tube.

4. A generator as set forth in claim 3 including a plurality of openings in the bottom edge of said venturi tube to permit liquid to flow from said enlarged chamber downstream of said venturi tube back into the liquid reservoir.

5. The generator as set forth in claim 1 wherein both ends of the generator body passage are in fluid communication with an oxygen tent or the like, whereby a moisture laden gas may continually be cycled through the oxygen tent.

6. A mist generator as set forth in claim 1 wherein the inner of said axially aligned openings is relatively smaller than the outer, whereby the gas expelled through said inner opening expands in its passage through the outer chamber to draw the liquid from said reservoir through the outer opening into said primary air stream.

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