United States Patent

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[72] Inventors **Robert L. Weaver**
Toledo;
Frank D. Myrice, Perrysburg, both of, Ohio

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[73] Assignee **Chemetron Corporation**
Chicago, Ill.

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[54] **ULTRASONIC NEBULIZER**
3 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** ..... **128/194,** 128/191 A
[51] **Int. Cl.** **A61m 16/02**
[50] **Field of Search** ..... 128/24.05, 194, 193, 195, 196, 197, 173, 191, 191.1, DIG. 2; 103/26; 261/DIG. 48, 1; 239/338

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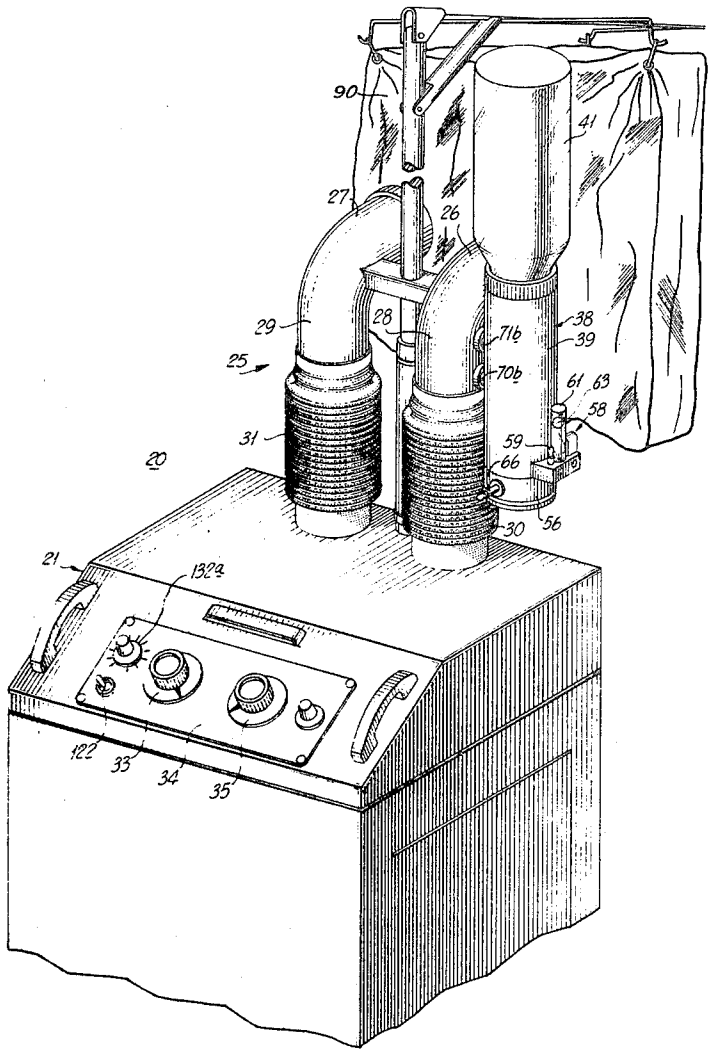
Primary Examiner—Richard A. Gaudet
Assistant Examiner—J. B. Mitchell
Attorney—Mason, Kolehmainen, Rathburn and Wyss

ABSTRACT: There is provided a nebulizer for use with oxygen tent equipment for controlled inhalation therapy. The nebulizer includes a vertical cylinder defining a liquid chamber with a piezoelectric transducer that closes the bottom of the chamber. A predetermined level of liquid is maintained in the chamber in direct contact with the transducer. A high frequency power source is connected to the transducer to provide ultrasonic vibrations thereof. The fluid in the chamber will be nebulized and suitable conduit means are provided for connecting the chamber to the gas flow from the oxygen tent equipment.



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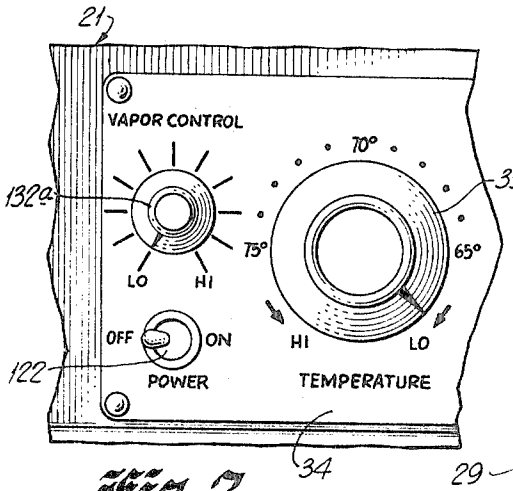


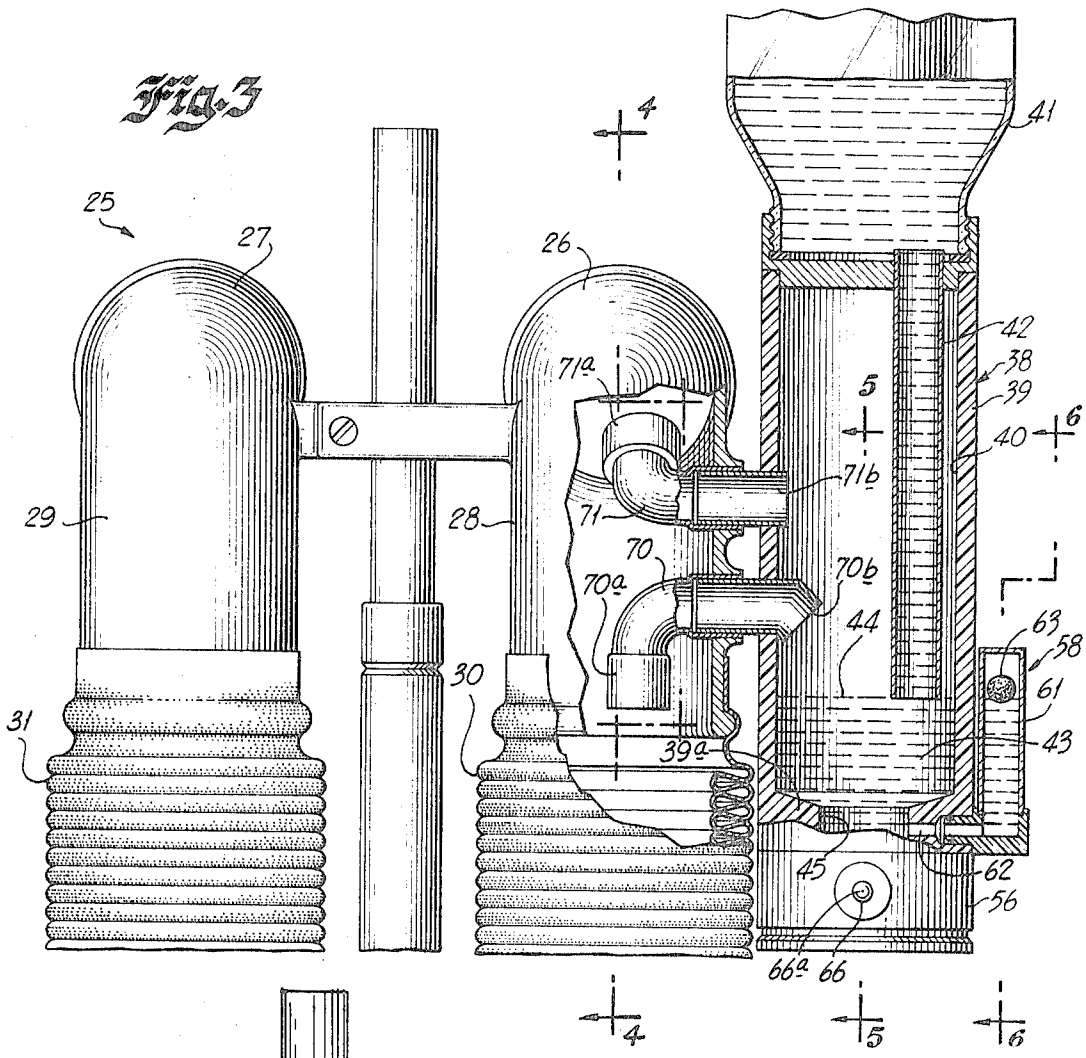
Fig. 2

Fig. 1

INVENTORS:
FRANK D. MYRICE
ROBERT L. WEAVER

Mason, Kolehmainen, Rathburn and Wyss
ATTORNEYS

Fig. 3



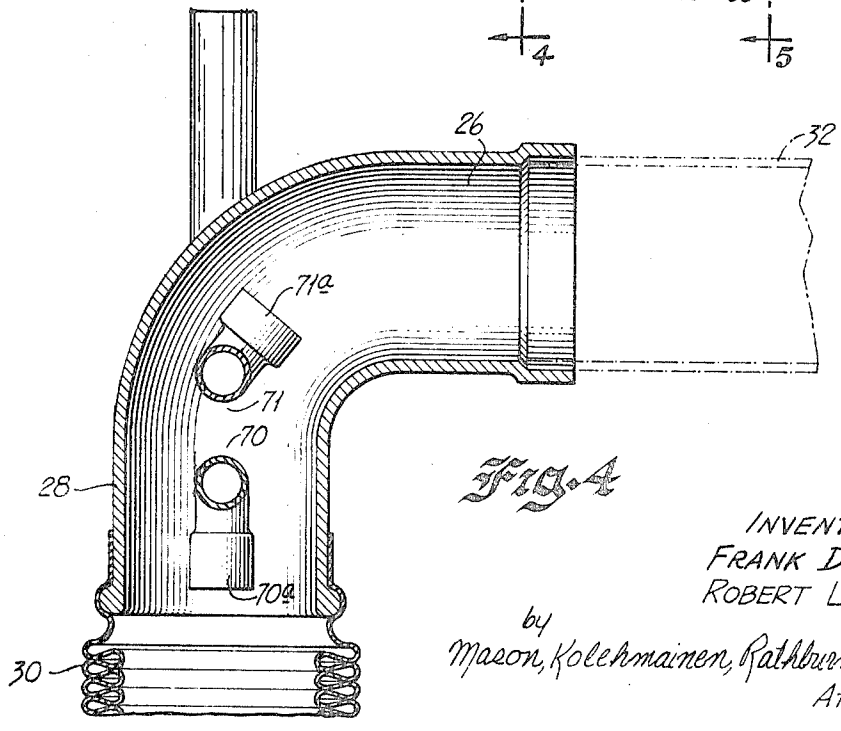


Fig. 4

INVENTORS:
FRANK D. MYRICE
ROBERT L. WEAVER

by
Mason, Kolehmainen, Rathburn and Wyss
ATTORNEYS.

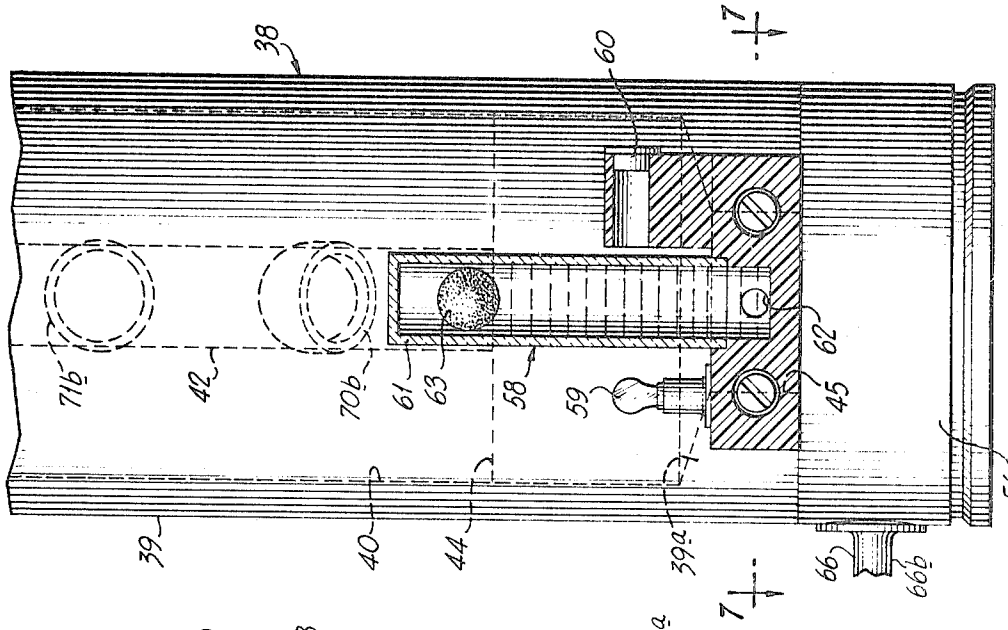


FIG. 6

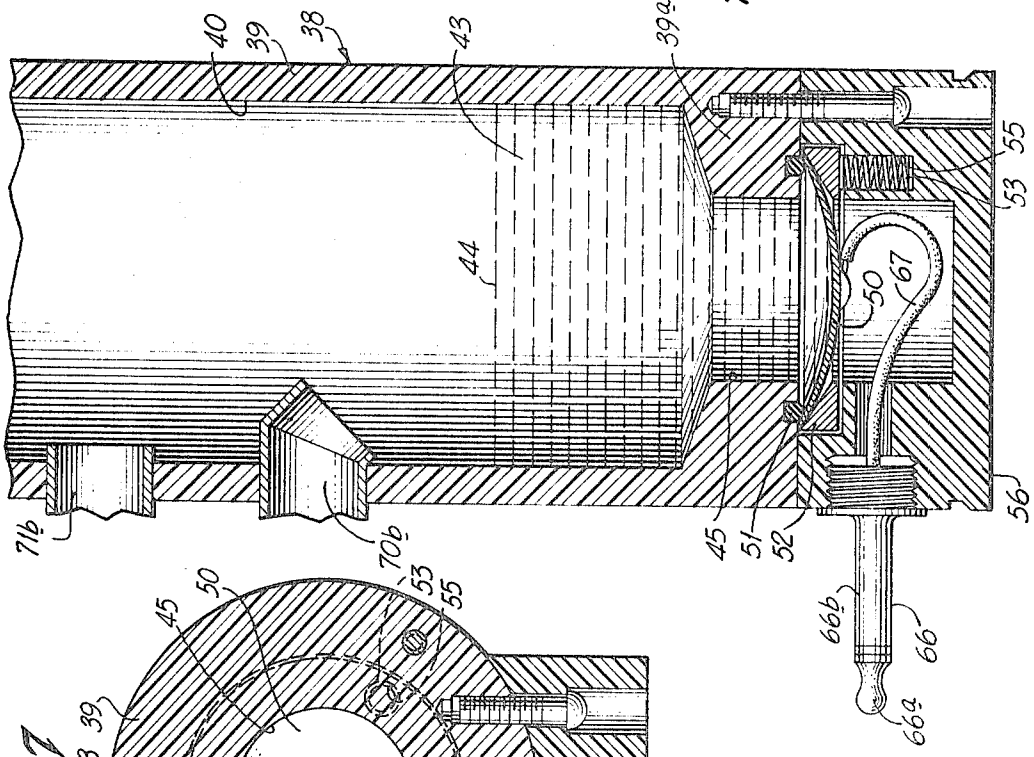


FIG. 5

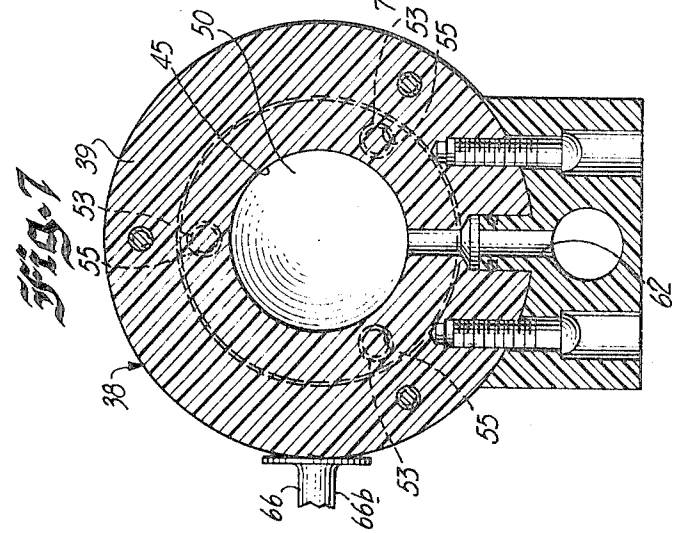


FIG. 7

INVENTORS:
FRANK D. MYRICE
ROBERT L. WEAVER

by

Mason, Kolehmainen, Rathburn and Wyss
ATTORNEYS

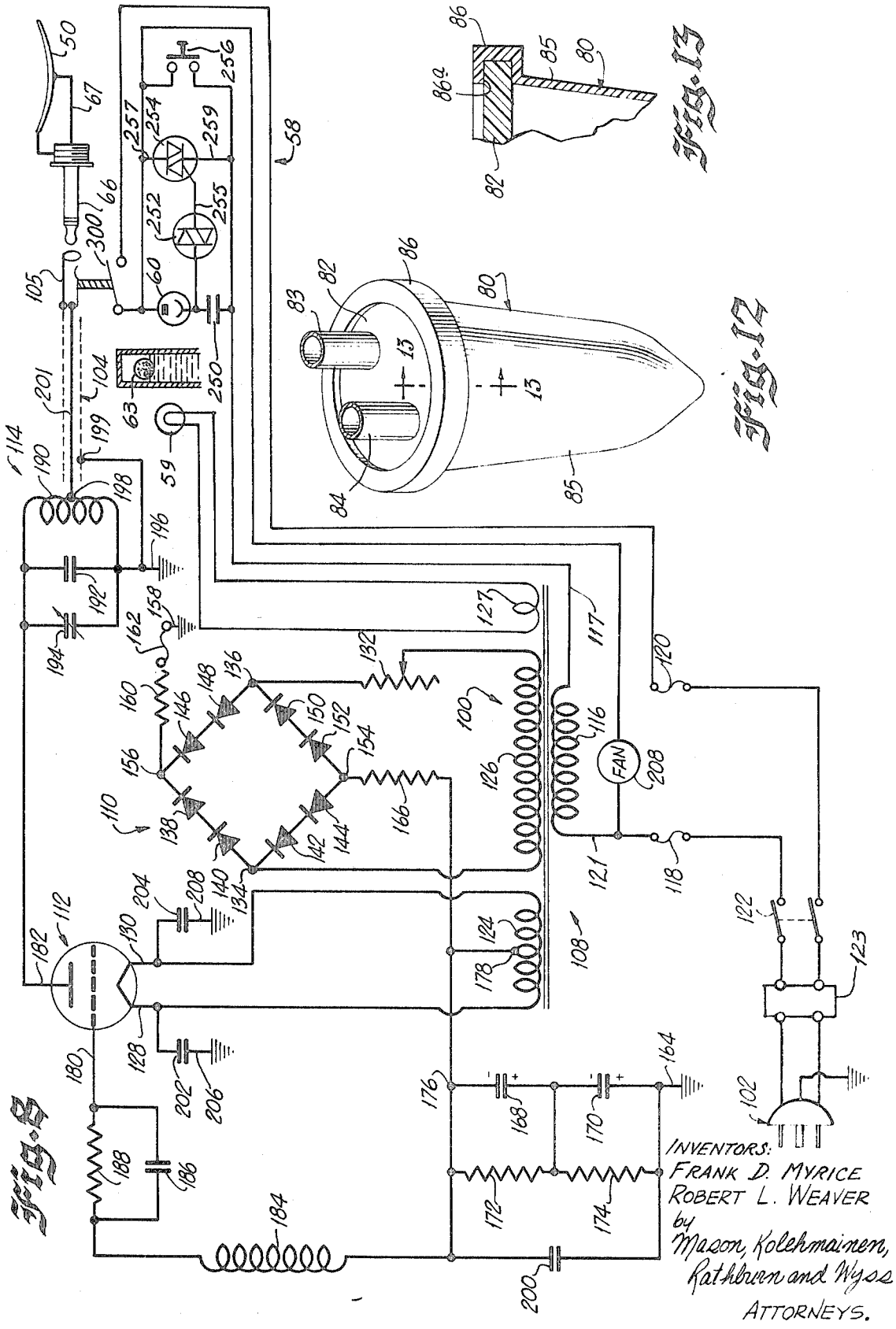


FIG. 8

FIG. 12

FIG. 13

INVENTORS:
FRANK D. MYRICE
ROBERT L. WEAVER
by
Mason, Kolehmainen, Rathbun and Wyss
ATTORNEYS.

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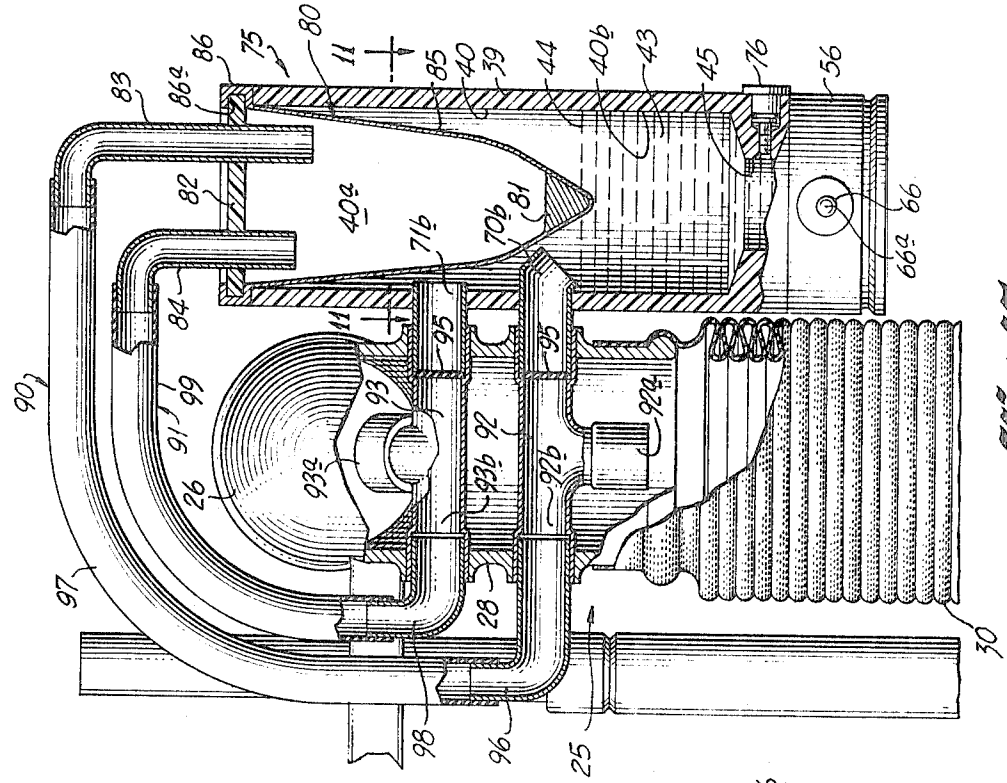

Fig. 10

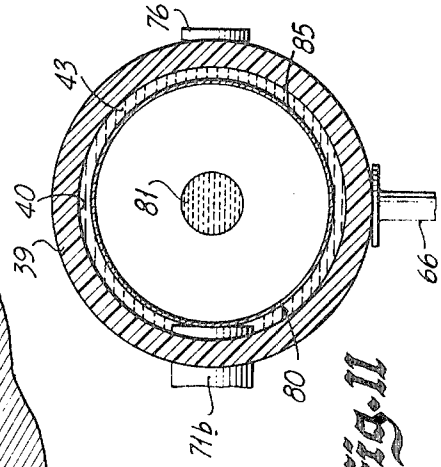

Fig. 11

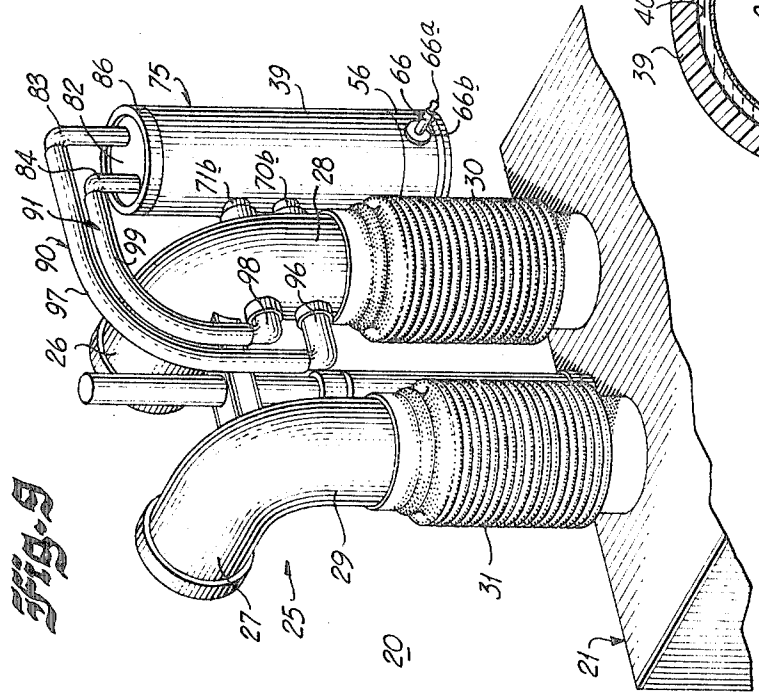

Fig. 9

INVENTORS:
FRANK D. MYRICE
ROBERT L. WEAVER
by Mason, Kolehmainen, Rathbun and Wyss
ATTORNEYS.

ULTRASONIC NEBULIZER

The present invention relates to an ultrasonic nebulizer, and to an oxygen tent apparatus for controlling inhalation therapy that utilizes an improved arrangement for nebulizing liquids. More specifically, the present invention relates to an ultrasonic nebulizer wherein ultrasonic vibrations are provided to entrain minute particles of liquid into a gaseous stream.

In many therapeutic applications, it is desirable to provide a high humidity atmosphere. This is frequently desirable in the circulation of oxygen to an oxygen tent used for therapeutic purposes. The temperature, rate of circulation, and concentration of the oxygen are controlled in a suitable control unit which may include refrigerating apparatus for maintaining a desired temperature of the oxygen containing medium. In the past, such an oxygen tent alone could not give 100 percent humidity atmosphere with uniform droplets in commercial installations. Moreover, a high humidity nebulizer, when used by itself, gives the patient 100 percent humidity but the temperature inside the canopy has an insulating effect on the body which precludes cooling of the body by means of perspiration and is likely to cause a hyperthermic condition of the patient.

Heretofore it has frequently been desirable to provide a medicated gas flow containing medication vapor for therapeutic purposes. In such flow it is necessary to obtain finely divided particles of medication dispersed within the gas flow.

Commercially available ultrasonic nebulizers generally provide a transducer driven by a suitable oscillator circuit in an ultrasonic range, as, for example, at 1.4 mc. Since transducers of this type were generally subjected to corrosion from saline solutions frequently dispensed thereby, it is common to cover the transducer with a layer of distilled water, which in turn is covered by a sealed, vibration transmitting diaphragm acting upon the solution to be dispersed. Such solution, which may be saline solution or other liquid, is then poured into the container on top of the diaphragm and subjected to supersonic vibrations. In the prior art device, the distilled water below the diaphragm was never nebulized and became very hot.

Moreover, difficulty has also been experienced with prior art nebulizers in transferring the nebulized vapors from the nebulizer to the gas stream.

Accordingly, it is an object of the present invention to provide a new and improved oxygen tent apparatus that results in a humidity atmosphere of 100 percent, with relatively uniform droplets.

A further object of the present invention is to provide a new and improved nebulizer which overcomes the above mentioned difficulties.

Yet a further object of the present invention is to provide a new and improved ultrasonic nebulizer.

Yet another object of the present invention is to provide a new and improved nebulizer for dispersing medication in finely divided particles into a gaseous flow.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with these and other objects, there is provided an improved oxygen tent apparatus for therapeutic purposes that has an improved nebulizer. As is known in oxygen tent apparatus, such apparatus includes a canopy for inhalation therapy, and a temperature and flow control unit for regulating the flow of a gaseous medium to the canopy. Gas conduit means interconnect the temperature and flow control unit with the canopy. In accordance with the present invention, an improved nebulizer is conveniently located at working height connected to disperse finely divided liquid particles into the gas flow from the temperature and control unit to the canopy. The improved nebulizer includes a vertical cylindrical housing which defines a liquid chamber and which is closed at the bottom by a piezoelectric transducer. Means are provided for maintaining a predetermined level of liquid in the liquid chamber in direct contact with the transducer. A high frequency power source capable of vibrating the transducer at ultrasonic speeds is provided. A portion of the gas flow from the control unit to the tent is directed into the chamber of the nebulizer to help remove the nebulized vapors.

In accordance with another feature of the present invention, means are provided for supplying a quantity of medication within the mechanical influence of the ultrasonic vibrations. Conduit means are connected to disperse the finely divided ultrasonic medication into the stream of the gas.

Advantageously, the nebulizer according to the present invention provides up to 100 percent humidity with controlled temperature inside of the canopy. The droplets are uniform in size and small enough to be fully utilized within the tent. Moreover, since the liquid above the transducer is continuously replenishing the liquid being nebulized, the transducer is maintained cool by the liquid. The movement of gas through the nebulizer chamber helps to remove the nebulized vapors.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein:

FIG. 1 is a fragmentary perspective view of a temperature and control unit for an oxygen tent apparatus equipped with an ultrasonic nebulizer according to the present invention;

FIG. 2 is a fragmentary section, drawn to a larger scale, of the control panel of the unit of FIG. 1;

FIG. 3 is a fragmentary elevational view of the gas flow system of the control unit of FIG. 1, fragmentarily illustrated, and drawn to a larger scale with sections thereof being broken away;

FIG. 4 is a cross-sectional side elevational view of the gas flow system of FIG. 3, taken along line 4–4 thereof;

FIG. 5 is a fragmentary cross-sectional view of the ultrasonic nebulizer, taken along line 5–5 of FIG. 3;

FIG. 6 is a cross-sectional elevational view of the ultrasonic nebulizer taken along line 6–6 of FIG. 3, illustrating a safety arrangement in more detail;

FIG. 7 is a cross-sectional plan view of the ultrasonic nebulizer taken along line 7–7 of FIG. 6;

FIG. 8 is a schematic representation of a typical high frequency oscillator source connected to drive the transducer of the ultrasonic nebulizer;

FIG. 9 is a fragmentary perspective view of the temperature and control apparatus, having a modified form of ultrasonic nebulizer secured thereto for dispersing medication into the gas flow;

FIG. 10 is a fragmentary elevational view, partially broken away, illustrating the modified nebulizer of FIG. 9;

FIG. 11 is a cross-sectional view of the ultrasonic nebulizer of FIG. 9, taken along line 11–11 of FIG. 10;

FIG. 12 is a perspective view of a medication bag for use with the ultrasonic nebulizer of FIG. 9; and

FIG. 13 is a fragmentary cross-sectional detail view of the medication bag of FIG. 12, taken along line 13–13 thereof.

Referring now to the embodiment of FIGS. 1 through 8, there is illustrated an oxygen tent apparatus, generally illustrated at 20 in FIG. 1, including a temperature and flow control unit 21 connected to a therapeutic canopy, such as an oxygen tent 90 by a suitable gas flow system of duct work 25. The duct work includes a gas supply conduit 26 and a gas return conduit 27. Each of the conduits 26 and 27 includes an elbow 28 and 29, respectively, connected to the control unit 21 through a flexible coupling 30 and 31, respectively, and adapted to be connected to the gas therapy canopy through a suitable connector conduit, illustrated fragmentarily in phantom in FIG. 4 as 32.

As is conventional with oxygen tent apparatus, the control unit 21 normally houses air conditioning or refrigerating apparatus, under the control of a temperature regulator 33, FIGS. 1 and 2, on a control panel 34 of the control unit 21. In addition, the control unit will house appropriate flow control equipment under the control of a flow regulator 35. Thus, the oxygen tent apparatus 20 will supply therapeutic gas, such as

oxygen, under regulated temperature and flow conditions to a suitable therapeutic canopy.

In accordance with the present invention, there is provided an improved ultrasonic nebulizer unit **38**. The nebulizer unit **38** includes a nebulizer housing **40**, open at its top for receiving a supply bottle **41** of liquid to be nebulized into the gas stream in the gas supply conduit **26**. The supply bottle **41** opens into a standpipe **42**, FIG. 3, designed to maintain the level of liquid **43** in the nebulizer chamber **40** at a desired height, as illustrated at **44**, FIG. 3. The liquid **43** may be distilled water, saline solution, or other desired therapeutic solution.

To provide for the ultrasonic vibration of the liquid **43** within the nebulizer chamber **40**, the bottom of the nebulizer chamber **40** has a reduced diameter cylindrical bore **45** closed by a concave transducer **50**, which may be suitable piezoelectric crystal, such as a tourmaline composition. It is resonant at the given frequency of the oscillator driving system, which in one embodiment was approximately 1.4 mc. The transducer **50** closes the bottom of the bore **45**, and an O-ring seal **51** forms a seal between the transducer **50** and the nebulizer chamber **40**.

To permit undampened vibrations of the transducer **50**, the transducer **50** is resiliently mounted by a wedge-shaped ring **52** bearing against its under surface through the bias of a plurality of compression springs **53** seated in recesses **55** in a closure cap **56**. The closure cap **56** and a large mass **39***a* of the nebulizer **39** forming the bore **45** together define a heat sink sufficient to dissipate undesirable heat.

To provide a solid state, fail-safe cutoff for the nebulizer unit **38**, in the event that the reservoir becomes empty and the liquid level in the transducer chamber falls below a predetermined level, there is provided a suitable photoelectric control, generally illustrated at **58**. The photoelectric control includes a light source **59** that is detected by a suitable photoconductive cell **60**. A transparent level gage **61** is connected to the nebulizer chamber **40** through a suitable fluid conduit **62**, FIGS. **6** and **7**, so that the level of liquid within the level gage **61** is the same as the liquid level **44** within the nebulizer chamber **40**, as best illustrated in FIG. **3**. A float **63** of cork or other suitable opaque material floats on the fluid in the level gage **61**. However, if the level of fluid within the nebulizer chamber **40** drops to a predetermined level, thus dropping the level of fluid in the level gage **61**, the float **63** will drop with the lowering fluid until such time as it blocks the light source **59** from the photoconductive cell **60**. At this time, the nebulizer unit **38** will automatically shut off. A suitable photoelectric control circuit **58** is described below.

To provide for electrical connection to the transducer **50**, there is provided a suitable electrical jack **66**, one terminal **66***a* of which is connected to the center of the transducer **50** by a suitable conductor **67**, and the other terminal **66***b* of which is electrically connected to the peripheral edges of the transducer **50** through the ring **52** and ground.

To provide for a positive flow of gas through the nebulizer chamber **40** to help remove the nebulized vapors, the nebulizing chamber **40** above the level of the fluid **44** is connected to the gas supply conduit **26** to pass a portion of the gas flowing therethrough into and through the nebulizer chamber. More specifically, there is provided a nebulizer gas inlet conduit **70** having an intake end **70***a* turned downwardly facing into the flow of gas to the supply conduit **26**, and having its outlet end **70***b* extending into the nebulizer chamber **40** at a slight downward angle. A nebulizer gas outlet conduit **71** is vertically spaced above the gas inlet conduit **70**, having a discharge end **71***a* facing downstream of the gas flow in the conduit **26**, as best illustrated in FIG. **4**, and having a gas inlet end **71***b* extending from the nebulizer chamber **40**. It will be understood that the dynamic effect of gas flow through the conduit **26** will effect a flushing of the nebulizer chamber **40** so as to remove the nebulized vapors therefrom and to discharge the nebulized vapors into the gas supply conduit **26**. Any suitable oscillator drive system may be used to drive the transducer **50** of the nebulizer unit. One suitable oscillator drive system which may be incorporated into the control unit **21** is illustrated schematically in FIG. **8**. An oscillator power supply system **100** is designed to provide radio frequency power for the ultrasonic nebulizer unit **38**. The power supply **100** includes a conventional three wire plug **102** that may be plugged into any suitable source of 117 volt alternating current. The power supply **100** is connected to the transducer **50** by a shielded cable **104** terminated by a phone jack **105** of a suitable size to match the phone plug **66** extending from the transducer, and includes a power line interlock switch **300** which prevents energization of the nebulizer when the power supply is not connected to the transducer.

The power supply **100** comprises generally a transformer **108**, diode bridge rectifier circuit **110**, a triode oscillator tube **112**, a tank circuit **114**, and associated circuitry. The transformer **108** includes a 117 volt primary winding **116**; a 6.3 volt, 6 ampere center tapped secondary winding **124**; and 800 volt, 200 milliampere secondary winding **126**; and a 6.3 volt, 1 ampere secondary winding **127**. One side **117** of the primary winding **116** connects to the photoelectric control **58**, the interlock switch **300**, the fuse **120**, one side of the switch **122**, the radio frequency interference filter **123**, and ultimately to the plug **102**. The other side **121** of the winding **116** connects to the fuse **118**, to the other side of the switch **122**, the radio frequency interference filter **123**, and ultimately to the plug **102**. The 6.3 volt secondary winding **124** is connected to the filament terminals **128** and **130** of the triode oscillator tube **112**, and supplies heating current to the filament of the tube **112**. The 800 volt secondary winding **126** is connected in series with a rheostat **132**, having a control knob **132***a* on the control panel **34**, and the resulting series circuit is connected across input nodes **134** and **136** of the rectifier circuit **110**. The 6.3 volt secondary winding **127** supplies power to the light source **59**.

The rectifier circuit **110** includes eight rectifier diodes **138**, **140**, **142** ..., and **152**. Each of these diodes has a current rating of one ampere and a reverse voltage rating of at least 800 volts. The diodes are used in series connected pairs so as to give each branch of the circuit **110** an effective reverse voltage rating of at least 1,500 volts. The circuit **110** includes the two input nodes **134** and **136**, and also two output nodes **154** and **156** that supply rectified current to the triode oscillator tube **112**. The node **154** is connected to each of the input nodes **134** and **136** by the two series connected pairs of diodes **142** and **144**, and **150** and **152**. These diodes are oriented so that their anodes face the node **154**. The node **156** is connected to each of the input nodes **134** and **136** by the two series connected pairs of diodes **138** and **140**, and **146** and **148**. These diodes are oriented so that their cathodes face the node **156**. The node **156** is connected to a ground potential point **158** by a low ohmage resistor **160** and by a fuse **162**. The node **154** is connected to a ground **164** by the series combination of a low ohmage resistor **166** and a pair of electrolic capacitors **168** and **170**. Resistors **172** and **174**, which are respectively connected in parallel with capacitors **168** and **170**, insure that the two capacitors **168** and **170** divide the rectifier circuit **110** output voltage equally between themselves. The rectifier circuit **110** output voltage appears as a negative potential at the node **176**.

The triode oscillator tube **112** includes a filament that connects to the filament leads **128** and **130**, a grid that connects to the grid lead **180**, and a plate that connects to the plate lead **182**. The filament leads **128** and **130** are connected to the negative potential node **176** through the 6.3 volt secondary winding **124** of the transformer **108**; the center tap **178** of the secondary winding **124** is connected directly to the node **176**. The grid lead **180** is also connected to the negative potential node **176** by a series circuit that includes an inductor **184** and the parallel combination of a capacitor **186** and a resistor **188**. The inductor **184** provides a direct current path between the negative potential node **176** and the grid lead **180**. The inductor **184** is transformer coupled to an inductor **190** within the

tank circuit 114, and therefore functions as a source of radio frequency feedback voltage for the grid of the tube 112. The parallel combination of the capacitor 186 with the resistor 188 self-biases the grid terminal 180 to a potential somewhat more negative than the potential of the tube 112 filament, thereby limiting the tube 112 plate current. A suitable tube for use in this circuit is an 812A.

The tank circuit 114 is a parallel combination of an inductor 190 with a fixed capacitor 192 and a variable capacitor 194. The tank circuit is connected between the plate lead 182 of the triode oscillator tube 112 and a ground potential point 196. The output signal from the tank circuit 114 is taken between the ground potential point 196 and a tap 198 upon the inductor 190. The ground potential point 196 is connected to the outer shield 199 of the cable 104, and the tap 198 is connected to the outer shield 199 of the cable 104, and the tap 198 is connected to the center conductor 201 of the cable 104. As noted above, the inductor 190 is transformer coupled to the inductor 184.

Three capacitors are included in this circuit to prevent high frequency signals from traveling between the triode oscillator tube 112 and the transformer 108. A first capacitor 200 connects the node 176 to a ground potential point 164 and prevents high frequency currents from flowing towards the transformer 108 from the inductor 184. A second capacitor 202 and a third capacitor 204 are connected respectively between the filament leads 128 and 130 and ground potential points 206 and 208. These two capacitors 202 and 204 prevent high frequency currents from flowing along the filament leads 128 and 130 towards the transformer 108.

A fan 208 may be provided to cool the triode oscillator tube 112.

A suitable photoelectric control system 58 is shown in FIG. 8. The control system 58 includes the light source 59 and the photoconductive cell 60, and also includes a capacitor 250, a four-layer switching diode 252, a triac semiconductor switch 254, and a pushbutton switch 256. The triac switch 254 is connected in series with the input lead 117 to the transformer 108 and therefore controls a flow of power to the nebulizer. The pushbutton switch 256 is connected in parallel with the triac switch. The photoconductive cell 60 and the four-layer diode 252 serially connect a control lead 255 on the triac switch 254 to one triac switch lead 257. The photoconductive cell 60 and the capacitor 250 serially connect the triac switch lead 257 to the triac switch lead 259, thus forming a potential dividing circuit.

The light source 59 normally illuminates the photoconductive cell 60 and maintains the photoconductive cell 60 in a conducting state. The capacitance of the capacitor 250 is only 0.1 microfarad, so its conductance may be ignored when the photoconductive cell 60 is fully illuminated. Each time the alternating current supply voltage swings through 0 volts, both the triac switch 254 and the four-layer diode 252 turn off. When the supply voltage rises above the characteristic voltage of the four-layer diode 252, the diode 252 again conducts and turns on the triac switch 254. For all practical purposes, the triac switch 254 appears to conduct continuously when the photoconductive cell 60 is fully illuminated.

When the float 63 partially blocks the photoconductive cell 60 from the light source 59, the conductivity of the photoconductive cell 60 drops. The conductance of the capacitor 250 can no longer be ignored, and the capacitor and the photoconductive cell now function as a potential divider circuit. When the conductivity of the photoconductive cell 60 drops to the point where the voltage developed across the capacitor 250 no longer exceeds the characteristic voltage of the four-layer diode 252, the diode 252 and the triac switch 254 will not turn on, and the nebulizer is deprived of power. The nebulizer thus turns off when the float 63 blocks the photoconductive cell 60 from the light source 59.

The light source 59 obtains energy from a secondary winding 127 on the transformer 108. When the nebulizer is turned off and the light source 59 is extinguished, it is quite impossible for the nebulizer to turn on, even after the float 63 returns to its normal position. The pushbutton 256 provides a means for momentarily bypassing the triac switch 254 and energizing the nebulizer, and thus functions as a "start" control.

The operation of the radio frequency power supply 100 is conventional. The oscillator tube 112 functions as a tuned plate oscillator. The particular frequency generated can be controlled by varying the capacitance of the variable capacitor 194, and in one embodiment was adjusted to 1.4 megacycles. The amount of radio frequency energy generated can be controlled by varying the setting of the rheostat 132.

In a particular embodiment of the invention it was found that a power output in the range of approximately 45 to 50 watts worked satisfactorily. The maximum plate dissipation of the tube 112 was 65 watts. The power supply was used to drive a piezoelectric crystal, of tourmaline composition, one and seven-eighths inches in diameter. It was resonant at the given frequency of the generator, which was approximately 1.4 mc. The heat sink was found sufficient to dissipate all undesirable heat. The transducer chamber was constructed of Lexan, and the cap forming a part of the heat sink was formed of aluminum. The reservoir bottle 41 had a capacity of 2,000 cubic centimeters, with a supply tube one-half inch in diameter. When the reservoir is inverted and placed into the transducer chamber, the liquid fills the chamber to the level determined by the length of the supply tube. Water will flow only when air is allowed to enter the reservoir through the supply tube. The fluid level in the transducer chamber 40 cuts off the air supplied to the reservoir.

It may be desirable to nebulize medication into the gas flow. An embodiment of the ultrasonic nebulizer and connections thereof to accomplish this result is illustrated in the embodiment of FIGS. 9 through 13. Similar parts of this embodiment, with the embodiments of FIGS. 1 through 8, are identified by the same reference numerals.

Referring now to the embodiment of FIGS. 9 through 13, there is illustrated an ultrasonic nebulizer unit 75 adapted to nebulize medication into the gas flow of an oxygen tent apparatus. As heretofore described, the oxygen tent apparatus includes the temperature and flow control unit 21 having the gas flow system 25 including the gas supply conduit 26 and the gas return conduit 27. The gas supply conduit and the gas return conduit respectively include an elbow 28 and 29 connected to the control unit 21 at a flexible coupling 30 and 31.

Referring now to the supersonic nebulizer unit 75 mounted on the gas supply conduit 26, the nebulizer unit 75 is similar to that heretofore described including the nebulizer housing 39 defining a nebulizer chamber 40 and opening into a bore 45 leading to the transducer (not illustrated). The lower end of the nebulizer chamber 40 is closed by the transducer and by the cap 56. An electrical jack 66 provides the connection to the oscillator power supply 100.

As in the embodiment of FIGS. 1 through 8, the nebulizer chamber 40 is filled with a suitable liquid 43, such as distilled water, to the liquid level 44 to be driven by the transducer 15. Since the liquid 43 in the chamber 40 does not escape therefrom, there is no need for a fail-safe device, such as the photoelectric control unit 58 heretofore described, and accordingly the fluid conduit 62 extending from the lower end of the nebulizer chamber 40 may be closed by a plug 76.

To hold the medication, a somewhat conically shaped plastic bag 80 is proportioned to hang into the water so that medication 81 contained in the bag 80 can be nebulized. The liquid 43 resting on the transducer is not nebulized, but a focal point of the liquid is effectively defined within the body of medication in the plastic bag 80. The plastic bag 80, as best illustrated in FIGS. 12 and 13, includes a cylindrical cap member 82 through which extend a gas inlet and gas outlet nipple 83 and 84, respectively. A bag member 85 of generally conical shape and formed of pliable material which will transmit the ultrasonic vibrations, such as of plastic film, is hung into the nebulizer housing 39 so as to effectively divide the housing 39 into an upper compartment 40*a* and a lower com-

partment 40*b*. The upper edge of the bag member 58 contains a molded flange 86 having an inwardly facing groove 86*a* receiving the peripheral edge of the cap member 82.

Since the medication 81 is contained within the upper compartment 40*a*, it is necessary that the gas flow through the gas supply conduit 26 passes through the upper compartment 40*a* to flush out the nebulized medication and entrain the same into the gas flow in the supply conduit 26. To this end the conventional gas inlet and gas outlet conduits 70 and 71 heretofore described are replaced by gas inlet and gas outlet conduits 90 and 91. The gas inlet conduit 90 includes an inlet tee 92 having one end thereof connected to the outlet 70*b* extending into the nebulizer housing 39, and the gas outlet conduit includes an outlet tee 93 also having one end connected to the inlet portion 71*b* extending into the nebulizer housing 39. The outlet portion 70*b* and the inlet portion 71*b*, however, are plugged by a suitable plug member 95 so that gas access into the lower compartment 40*b* is blocked and the lower compartment 40*b* is essentially a closed or sealed compartment. The inlet tee 92 has an inlet portion 92*a* facing upstream in the gas supply conduit 26, and the other end 92*b* of the tee 92 is connected through a suitable elbow 96 and flexible conduit line 97 to the gas inlet nipple 83 in the cap member 82. The outlet tee 93 has a discharge portion 93*a* facing downstream, and another leg 93*b* of the tee 93 is connected through an elbow 98 and flexible conduit 99 to the gas outlet nipple 84 extending through the cap member 82.

From the preceding brief description of the medication bag within the nebulizer unit 75, the operation thereof is believed clear. However, briefly, it will be understood that the liquid 43 resting on the transducer is not nebulized, but a focal point or vortex of the liquid is effectively defined within the body of medication 81 in the bag 80. The medication 81 in turn is nebulized in the upper compartment 40*a* of the nebulizer housing 39. The dynamic or impact effect of gas flow in the gas supply conduit 26 will be effective to circulate a portion of the gas stream through the upper compartment 40*a* to flush out the nebulized medication and to disperse the nebulized medication into the gas flow.

Advantageously, the disclosed modification, including the medication bag, has the advantage of being disposable so that each patient may have his own, and apparatus cleaning is substantially reduced. Moreover, it is a further advantage that when only small amounts of medication are required, such as 35 cc., that this is the total amount of medication that is used, rather than the greater amount, such as 150 cc., which would be required to operate without the medication bag. A bag proportioned to hold 35 cc. of medication will actually nebulize about 33 cc. thereof so that the waste is negligible.

Moreover, it is understood that the normal gas inlet and outlet into the nebulizer housing may be closed since the gas inlet and outlet now open into the bag.

Although the present invention has been described by reference to only a single embodiment thereof, it will be apparent that numerous other modifications and embodiments will be devised by those skilled in the art which will fall within the true spirit and scope of the present invention.

What we claim as new and desired to be secured by Letters Patent of the United States is:

1. In an oxygen tent apparatus comprising a canopy, a temperature and flow control unit for regulating the flow of a gaseous medium to said canopy, and gas conduit means for connecting said unit and said canopy to provide a flow of gaseous medium between said unit and said canopy, the improvement comprising:

an ultrasonic nebulizer for entraining minute particles of liquid into a gaseous medium including a housing defining a vapor chamber positioned adjacent said gas conduit means and in close proximity to the junction of said gas conduit means with said canopy,

a pair of conduits connecting said conduit means to the interior of said nebulizer housing, a first of which conduits opens into said gas conduit means facing upstream and a second of which conduits opens into said gas conduit means facing downstream, to direct a portion of the gaseous flow into said canopy through said vapor chamber.

2. The combination set forth in claim 1 wherein the nebulizer includes means for maintaining a level of liquid in the vapor chamber, a piezoelectric transducer at the bottom of the vapor chamber, and high frequency electrical power source means connected to said transducer for energizing said transducer.

3. The combination set forth in claim 1 including a reservoir of liquid connected to supply liquid to said chamber.