United States Patent [19]

McPhee

[11] **3,793,810**

[45] **Feb. 26, 1974**

[54] **DEFOAMING DEVICE FOR MEDICAL HUMIDIFIER**

[75] Inventor: **Charles J. McPhee,** Sylmar, Calif.

[73] Assignee: **American Hospital Supply Corporation,** Evanston, Ill.

[22] Filed: **June 19, 1972**

[21] Appl. No.: **264,350**

[52] **U.S. Cl.** **55/255,** 55/257, 128/194, 261/123, 261/DIG. 26

[51] **Int. Cl.** **B01d 45/04,** A61m 15/00

[58] **Field of Search** 55/248, 256–257, 55/255; 209/170; 261/DIG. 26; 128/188, 194

[56] **References Cited**

UNITED STATES PATENTS

1,920,437	8/1933	Sillers	55/255 X
2,297,586	9/1942	Steffensen	209/170
3,155,472	11/1964	Huppke	55/257 X
3,262,721	7/1966	Knight	285/DIG. 22
3,524,631	8/1970	Mare	55/257 X
3,572,660	3/1971	Mahon et al.	261/78 A
3,610,478	10/1971	Johnston	222/400.7
3,648,440	3/1972	Egan	55/257 X

Primary Examiner—Tim R. Miles
Assistant Examiner—Richard L. Chiesa

[57] **ABSTRACT**

A device for defoaming and separating liquid drops from a humidified gas supplied to a patient for breathing during inhalation therapy. The defoamer has a dual chambered partitioned housing with a separate window opening into each chamber. One chamber picks up foam and liquid drops and recycles them to a liquid reservoir in a supply bottle. The other chamber collects the defoamed humidified gas that is free of liquid drops and supplies it to a patient's breathing tube. The defoaming device fits inside the supply bottle and forms a connecting link between a gas-liquid mixing column in the bottle and an outlet port of the bottle.

17 Claims, 6 Drawing Figures

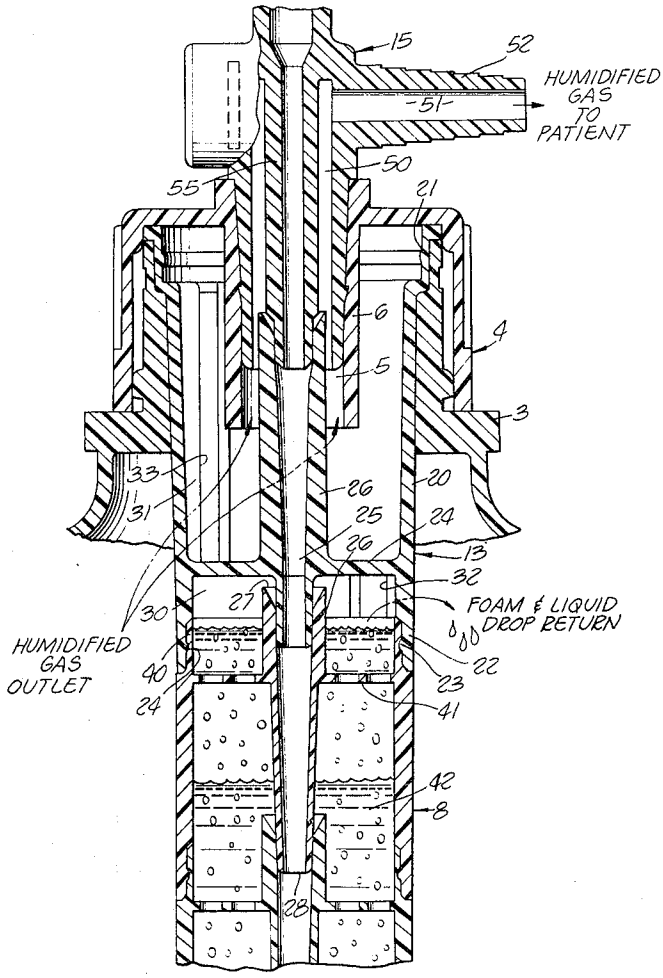


FIG. 2.

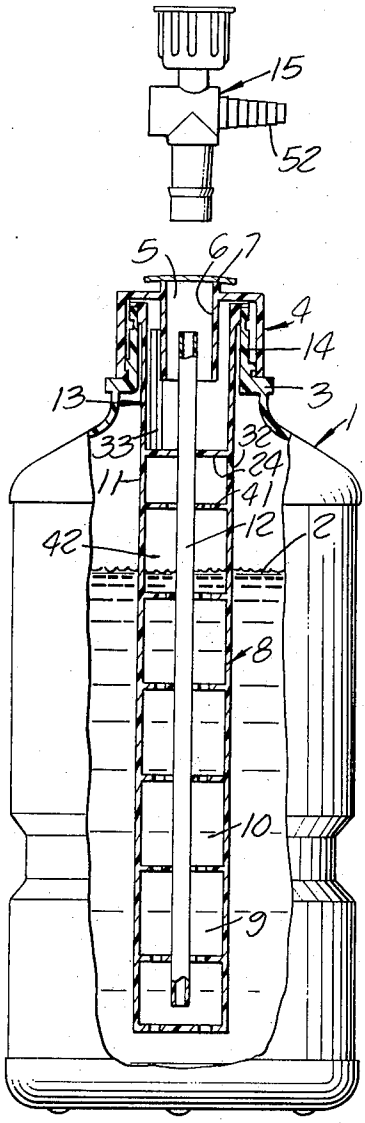


FIG. 1.

FIG. 4.

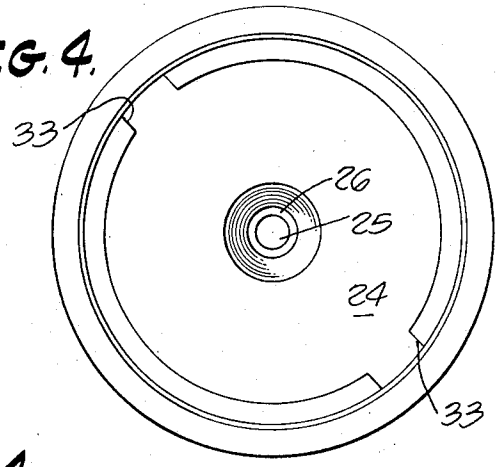


FIG. 3.

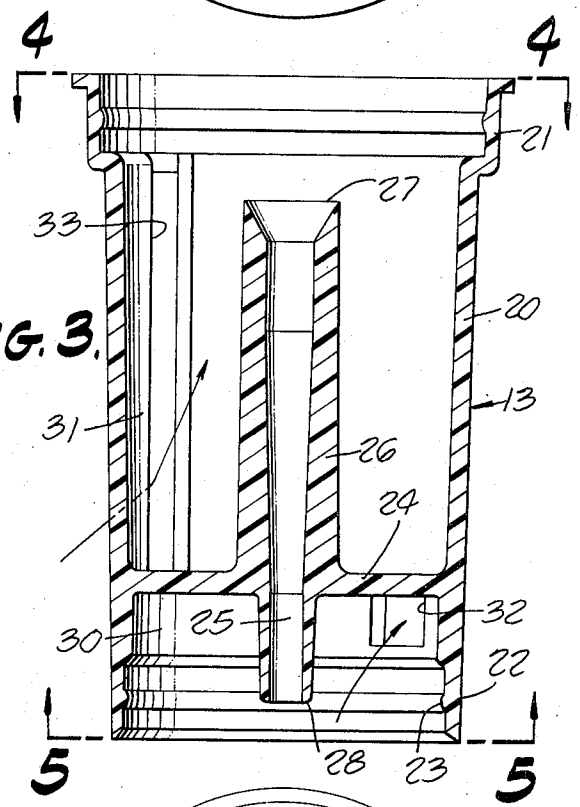
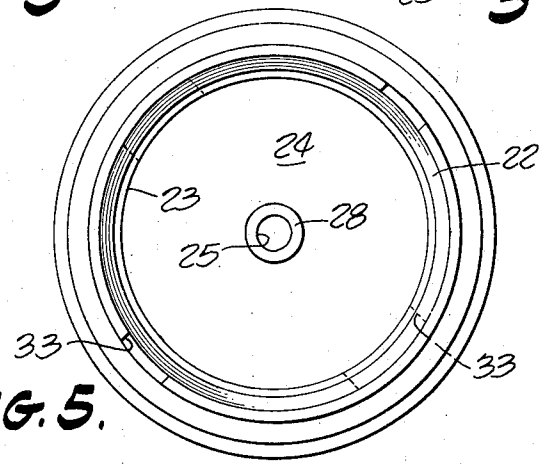


FIG. 5.



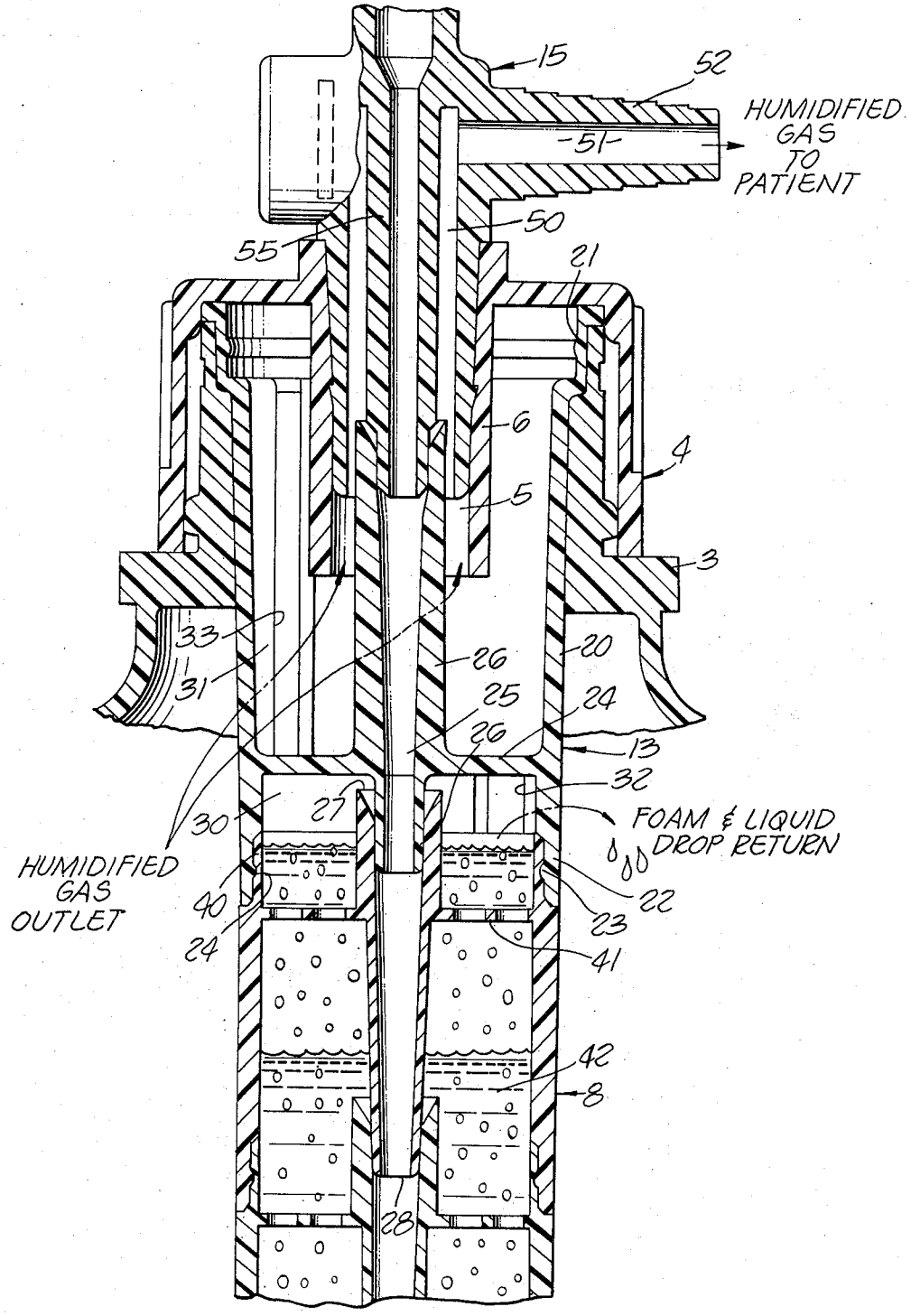

15
52
HUMIDIFIED GAS TO PATIENT
51
50
55
21
6
4
5
3
33
31
26
20
25
24
26
13
32
27
30
FOAM & LIQUID DROP RETURN
HUMIDIFIED GAS OUTLET
40
22
24
23
41
42
8
28

FIG. 6.

DEFOAMING DEVICE FOR MEDICAL HUMIDIFIER

BACKGROUND

In the last several years inhalation therapy has been used very extensively for treatment of emphysema and other lung and respiratory diseases as well as postoperative treatment and cardiac patient care. One form of inhalation therapy involves mixing a breathable gas such as air or oxygen with a liquid. This humidified gas is supplied to a mask, nasal cannula, or tent, where it is breathed by the patient. A conventional medical humidifier system includes a dry gas source such as a portable oxygen tank or central oxygen supply system of a hospital, coupled with a container of the humidifying liquid. Humidification is accomplished by atomizing the liquid into the gas or by bubbling the gas through the liquid.

These processes of mixing the gas and liquid to create a humidified breathable gas caused problems of getting liquid drops or foam entrained in the breathable gas. The problems were aggravated when the humidifying liquid contained such bacteriostatic preservatives as methyl paraben and propyl paraben. These parabens cause the liquid to foam and froth when violently churned by gas bubbling through it. Attempts to reduce the foaming and liquid drop formation in the humidified gas involved reducing the flow rate of gas bubbling through the liquid. This approach was not entirely satisfactory particularly when the physician desired a very high flow rate of breathable gas applied to the patient's tent, mask, etc.

SUMMARY OF THE INVENTION

I have overcome the problems of foaming and liquid drop formation in previous medical humidifiers for inhalation therapy. In my invention I have provided a tubular dual-chambered defoaming housing that fits inside a liquid supply bottle and connects a gas-liquid mixing column with an outlet port of the supply bottle. A first chamber at a lower end of the defoaming housing communicates with the gas-liquid mixing column. This first chamber picks up humidified gas with entrained foam and liquid drops from the mixing column. The foam and liquid drops hit against a transverse partition between the two chambers, exit through a first window of the defoaming housing, and return to a liquid reservoir in the liquid supply bottle for recycling. Humidified gas that exits through the defoamer housing's first window is collected in an upper portion of the liquid supply bottle. Here the humidified gas is picked up through a second window of the housing where the gas enters a second chamber adjacent an upper end of the housing. This second chamber also communicates with an outlet port of the bottle through which the humidified gas, separated from the foam and liquid drops, is fed to a patient's breathing tube.

DRAWINGS

FIG. 1 is a front elevational view partially in section showing the defoaming housing connecting a gas-liquid mixing column with an outlet port of the bottle;

FIG. 2 is a front elevational view of an adapter for connecting the outlet port of the bottle with a gas supply tube leading to a patient;

FIG. 3 is an enlarged sectional view of the defoaming housing before it is connected to the outlet port of the bottle and the gas-liquid mixing column;

FIG. 4 is a top plan view taken along line 4—4 of FIG. 3;

FIG. 5 is a bottom plan view taken along line 5—5 of FIG. 3; and

FIG. 6 is an enlarged fragmentary view, partially in section, showing the interrelationship between the defoaming housing, the gas-liquid mixing column, and the outlet port adapter on the bottle.

DETAILED DESCRIPTION

With reference to the attached drawings, FIG. 1 shows the liquid supply bottle **1** containing a liquid **2.** At a top of bottle **1** is a neck **3** with a passage that is closed off by an outer cap **4** permanently secured to the bottle neck. Cap **4** has an outlet passage **5** defined by a tubular sleeve **6.** The outer end of sleve **6** is sealed with a peel-off film **7.** The bottle shown in FIG. **1** is thus a closed system for liquid **2** when it is supplied to a hospital.

Within the bottle **1** is a gas-liquid mixing column **8.** This mixing column **8** is submerged in liquid **2** and includes a series of mixing compartments represented by **9** and **10.** The details of the mixing column are brought out in my copending application entitled "Mixing Column for a Medical Humidifier and Method of Humidifying Inhalable Gases" filed June 19, 1972, Ser. No. 264,314.

The submerged multi-chambered mixing column **8** has an upper end with a tubular outer wall **11** and a central dry gas tube **12.** Fitting directly to the upper end of humidifier column **8** is a defoaming housing **13** that has an upper end **14** permanently attached to the bottom or bottle cap. This defoaming housing supportingly suspends the mixing column while submerged in liquid **2,** as shown in FIG. **1.**

FIG. **2** shows a separate adapter **15** for joining the outlet passage **5** of the cap **4** with a dry gas supply source and a conduit leading to a patient's tent, mask, nasal cannula, etc. The term "dry gas" is used to distinguish from a humidified gas produced by the humidifier and exits through adapter **15.** This adapter is supplied with the bottle and is inserted into passage **5** after a nurse, inhalation therapist, or physician tears off film **7** immediately before attaching the adapter to the humidifier liquid supply bottle.

The defoaming housing separated from the gas-liquid mixing column and the cap of the bottle is shown in FIG. **4.** Here the defoaming housing includes an outer tubular wall **20** that has an external flange **21** at an upper end. This flange is of a configuration to mate with and permanently seal to either the cap **4** or a lip of the bottle. At a lower end of tubular wall **20** is a spring flange **22** of thinner wall construction than the remaining portion of wall **20.** Spring flange **22** includes an annular snap rib **23** on an internal surface and forms a snap fit with a top portion of a gas-liquid mixing column.

Between an upper and lower end of tubular outer wall **20** is a transverse partition **24.** This partition has a centrally located passage **25** extending therethrough. Directly surrounding passage **25** is a dry gas tube **26** that extends above partition **24** to an upper end **27** and below partition **24** to a lower end **28.** Except for passage **25** the partition **24** is imperforate. Thus partition

24 forms a separating barrier between a first chamber 30 below partition 24 and a second chamber 31 above partition 24. As shown in FIG. 3 the tubular outer wall 20 includes a window or aperture 32 below partition 24. It also includes a vertically elongated window or aperture 33 above partition 24. These windows 32 and 33 are rotationally offset about the circumference of the outer tubular wall which is generally cylindrical in form. The reason for this is so that foam and liquid drops collected in chamber 30 and sprayed out through window 32 have a reduced chance of being picked up through window 33 of chamber 31 as humidified gases are collected.

As shown in FIGS. 4 and 5 the dry gas tube 26 is preferably located along a common longitudinal axis with the cylindrical outer housing wall 20. Thus when connecting the defoaming housing to the gas-liquid mixing column and securing it to cap 4 no rotational orientation about the longitudinal axis of the defoaming housing is required.

Referring now to FIG. 6, the defoaming housing is shown joining to cap 4, adapter 15 and humidifier column 8. As shown in the dotted line at the top of FIG. 6, the tubular defoaming housing 20 fits inside the cap where it is permanently sealed either directly to the cap or to the bottle neck. The housing extends downwardly to its lower end where rib 23 engages with groove 24 in an upstanding flange 40 of the gas-liquid mixing column. This relationship creates a chamber 30 that is defined by the tubular wall 20, partition 24, dry gas tube 26, and an upper sieve plate 41 of the gas-liquid mixing column. The humidified gas with foam and liquid drops from a mixing chamber 42 of mixing column 8 proceeds upwardly through apertures and sieve plate 41 and collects in chamber 30. The humidifier gas of chamber 30 exits through window 32 along with foam and liquid drops. The humidified gas, however, is collected in an upper portion of the liquid supply bottle. The foam and liquid drops as shown schematically are returned to the reservoir of liquid 2 inside the bottle. Thus the foam and liquid drops are recycled through the gas-liquid mixing column.

The humidified gas thus separated from the foam and liquid drops is collected in an upper portion of the bottle and passes through window 33 and where it is collected in chamber 31. The humidified gas then proceeds upwardly through an annular passage 50 in adapter 15, and thereafter out through a passage 51 in a tubular side arm 52 of the adapter. Tubular side arm 52 is normally connected to a long flexible plastic tube leading to the patient's tent, mask, nasal cannula, etc., where the humidified gas is breathed by the patient.

As seen in FIG. 4 the adapter 15 has a center dry gas tube 55 that mates with and supplies dry gas tube 26 of the defoaming housing. The adapter 15 and its interconnection with the bottle and cap 4 is explained in more detail in my copending invention entitled "Port System for Medical Humidifier Container" filed June 19, 1972, Ser. No. 264,315.

The defoaming housing that forms an important connecting link between the outlet port system of the liquid supply bottle and the gas-liquid mixing chamber is preferably injection-molded as an integral one-piece thermoplastic part. I have found that polypropylene thermoplastic works very well in the defoaming housing construction. This injection molding technique for the one-piece defoaming housing construction makes it sufficiently inexpensive so it can be economically discarded after a single use on a single patient. This greatly reduces the chance of cross-contamination between patients.

In the foregoing specification I have used a specific embodiment to describe my invention. However, it is understood by persons skilled in the art that certain modifications can be made to this embodiment without departing from the spirit and scope of this invention.

I claim:

1. In a medical humidifier for inhalation therapy including a liquid-containing bottle with an inlet port and an outlet port, and a gas-liquid mixing column within the bottle, the improvement comprising: a defoaming housing connecting the gas-liquid mixing column with the outlet port, said defoaming housing having a first chamber communicating with the gas-liquid mixing column and a second chamber communicating with the outlet port of the bottle; both of said chambers including windows communicating with an interior of the bottle, whereby liquid drops and liquid foam from the mixing column are expelled through the first chamber window for return to a liquid reservoir in the bottle for recycling, and humidified gas is collected through the second chamber window for transfer through the bottle's exit port to a patient.

2. The combination as set forth in claim 1 wherein the first and second chambers are separated by a transverse partition.

3. The combination as set forth in claim 2 wherein the transverse partition includes a dry gas passage therethrough for communicating with the humidifier mixing column.

4. The combination as set forth in claim 3 wherein there is a dry gas source connected with the bottle's inlet port, the mixing column includes a dry gas tube, and the transverse partition has a tubular member connected to the partition, which tubular member connects with and forms a conduit between the dry gas source and the dry gas tube of the mixing column.

5. The combination as set forth in claim 4 wherein the bottle has a closure and the inlet and outlet ports of the bottle include two concentrically disposed tubes extending through the closure with the inner tube connecting with the dry gas source, and said outer tube is spaced outwardly from the inner tube to provide an annular outlet passage between the two tubes, said annular outlet passage having an opening in the second chamber.

6. The combination as set forth in claim 1 wherein the defoaming housing includes a tubular outer wall with retention means adjacent one end for coupling with the humidifier column.

7. The combination as set forth in claim 1 wherein the windows of the first and second chambers are offset from each other about the housing so as not to be directly aligned with each other.

8. The combination as set forth in claim 1 wherein the bottle contains a liquid having a bacteriostat which is subject to foaming action when a gas is bubbled through such liquid.

9. The combination as set forth in claim 1 wherein the defoaming housing is permanently bonded to the bottle so it will be discarded with the bottle.

10. For use in a medical humidifier, a defoaming housing including a tubular outer wall with ends; a dry

gas tube that is smaller than and fits within the outer wall; and an annular transverse partition wall concentrically connecting the dry gas tube and the tubular outer wall; said housing defining a foam return chamber on one side of the partition and a humidified gas collection chamber on an opposite side of the partition; and each of said chambers have at least one window through the outer tubular wall for communicating with an interior of a medical liquid supply bottle when said defoaming chamber is disposed within said bottle.

11. The combination as set forth in claim **10** wherein the defoaming chamber has means adjacent its opposite ends for connecting with a gas-liquid mixing column and a port system of a medical liquid supply bottle.

12. The combination as set forth in claim **11** wherein the combination also includes a medical liquid supply bottle; liquid within said bottle; and the defoamer housing is permanently secured to the bottle interiorly of said bottle.

13. The combination as set forth in claim **10** wherein the housing has a snap fit means adjacent the foam return chamber for connecting the foam return chamber with a gas-liquid mixing column.

14. The combination as set forth in claim **13** wherein the medical liquid includes a methyl paraben and propyl paraben which cause a foaming action when a liquid is subjected to bubbling gas therethrough.

15. In a medical liquid humidifier system including a gas-liquid mixing means within a liquid containing bottle having a port, the improvement of: a defoaming housing connecting the bottle outlet with the mixing means; said defoaming housing including a transverse partition separating the housing into two chambers which communicate respectively with the bottle outlet and mixing means, whereby the partition blocks passage of fluids from the mixing means to the bottle outlet; and said defoaming housing includes windows through the housing for recycling liquid drops and foam to a liquid reservoir within the bottle and for providing an outlet passage means for humidified air from the bottle's interior.

16. For use in inhalation therapy the combination of: a bottle having a neck opening thereon; a closure closing off this neck opening, said closure being permanently bonded to the bottle, and said closure having a port therethrough; an adapter with an outlet tube permanently secured in this closure port and having a passage through said outlet tube, an inlet tube of the adapter concentrically disposed within said outlet tube and defining an annular space between the inlet and outlet tubes, said inlet and outlet tubes forming an integral part of the adapter which is permanently secured to the closure; a multi-chambered mixing column disposed within said bottle; and a tubular defoaming housing have a lower end connected to said mixing column and having an upper end permanently secured to the bottle adjacent the closure; a transverse partition between ends of the defoaming housing, said partition separating the housing into upper and lower chambers; a dry gas tube connected with the partition to form a passage extending through said partition, said dry gas tube being smaller than and located within said tubular housing; said defoaming housing including a window through its wall above said partition and a window through its wall below said partition, said chamber below said partition collecting foam and large liquid drops returning them to a liquid reservoir within the bottle, and said chamber above the partition collecting humidified gases that exit the bottle through the annular outlet passage between the inner and outer tubes of the adapter connected to the closure of the container.

17. The combination as set forth in claim **16** wherein the tubular housing, transverse partition and dry gas tube are integrally formed of a thermoplastic material.

* * * * *