# United States Patent [19]

**Piccino et al.**

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[54] **MIST GENERATOR**


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June 20, 1973 Switzerland ..... 8948/73

[52] **U.S. Cl.** ..... **239/4;** 239/102; 239/323; 239/338; 128/DIG. 2

[51] **Int. Cl.**[2] ..... **B05B 17/06**

[58] **Field of Search** ..... 128/194, 173 R, DIG. 2; 239/4, 8, 11, 67, 70, 101, 102, 323, 327, 330, 338; 222/209, 214



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[57] **ABSTRACT**

A mist generator comprises a generally closed vessel formed with an elastically deflectable wall and with an aperture in its side. An inverted-bottle filler is provided to maintain a liquid level in the vessel below the wall and below the aperture and a piezoelectric transducer having a concave upper surface focused on the liquid level is provided in the vessel below the liquid level so as to vaporize this liquid and form a cloud of mist in the vessel. A motor is provided to periodically deflect the vessel wall and expell the cloud of mist from the vessel. This motor can have a lever actuated by a cam arrangement or can be a simple solenoid.


**8 Claims, 3 Drawing Figures**

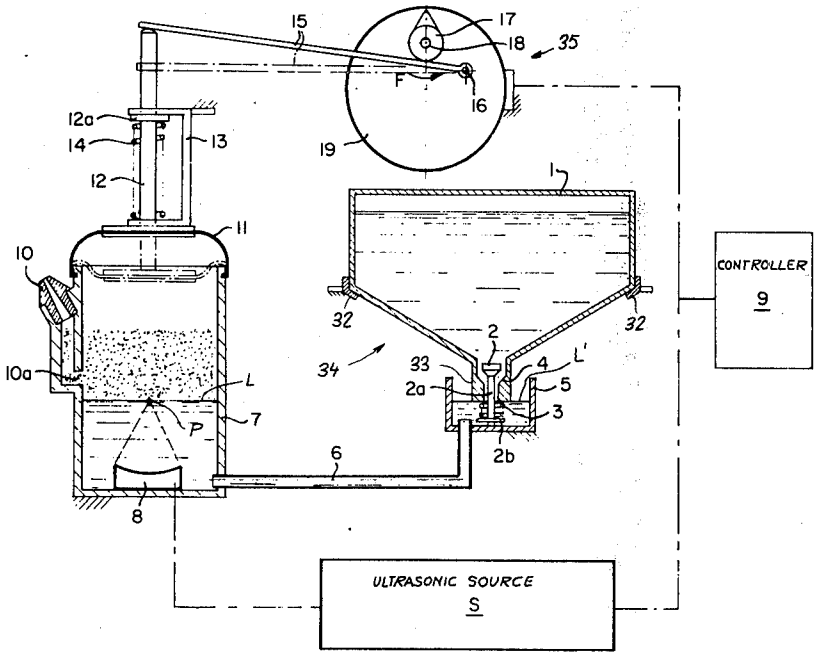
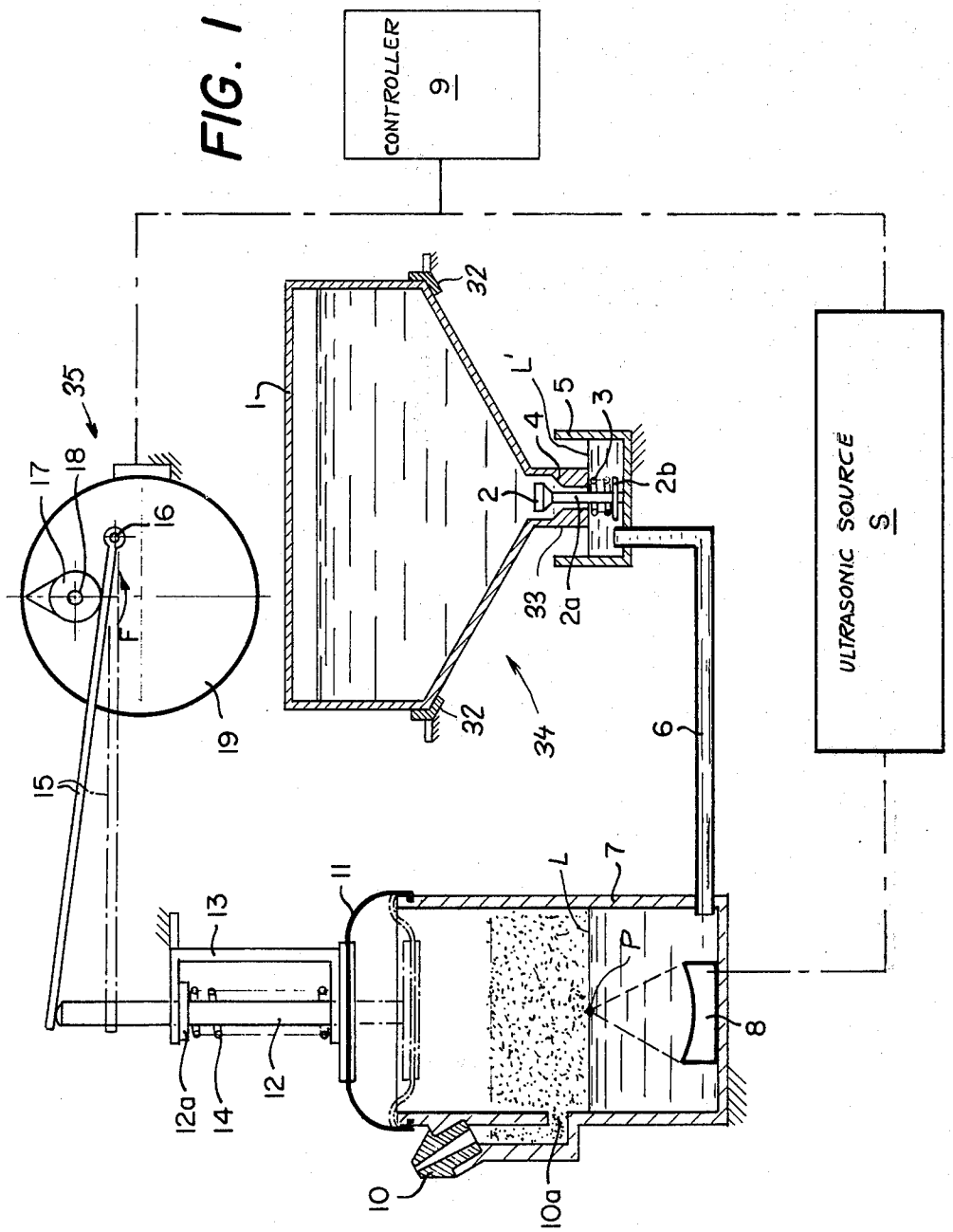


FIG. 1


CONTROLLER
9
ULTRASONIC SOURCE
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1
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2a
2b
3
4
5
6
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8
10
10a
11
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12a
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18
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32
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L
L'
P
F

FIG. 2

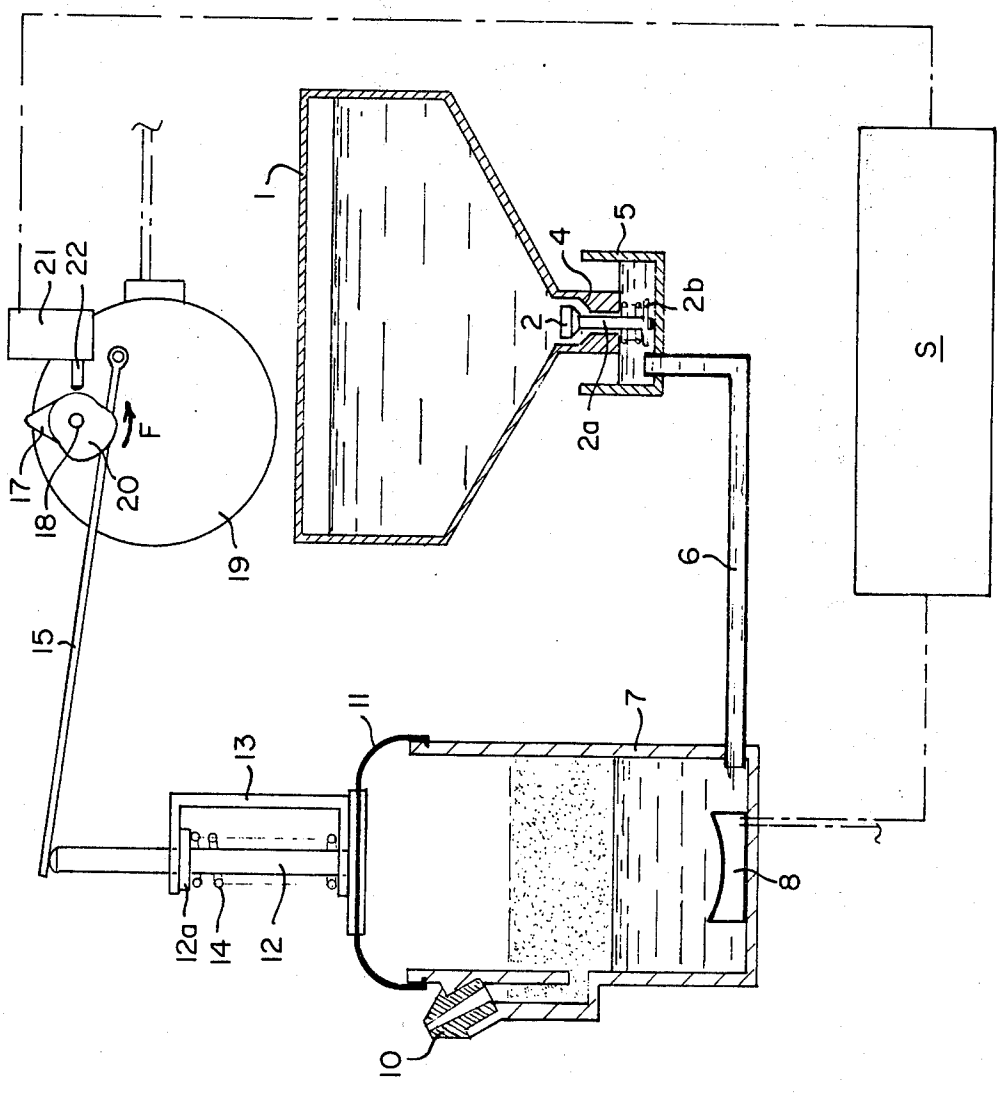
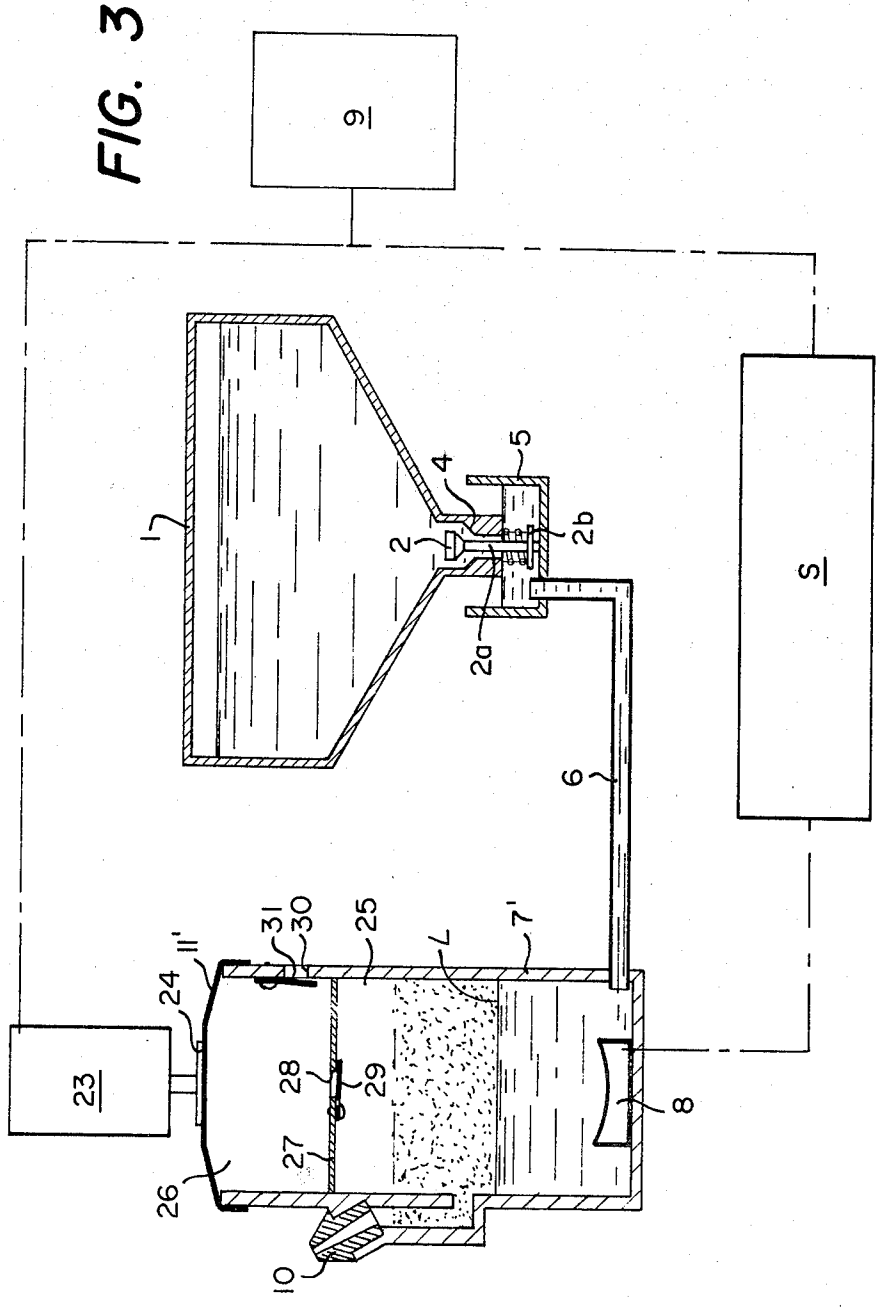


FIG. 3



# MIST GENERATOR

## FIELD OF THE INVENTION

The present invention relates to a mist generator. More particularly this invention concerns a so-called cold-mist generating system usable for humidifying the air.

## BACKGROUND OF THE INVENTION

It is known to provide a piezoelectric transducer in a body of liquid, the transducer having a concave surface focused at the liquid level so that when energized with alternating current of ultrasonic frequency the liquid is broken into very fine droplets that are readily airborne. Such an arrangement is advantageous in that the droplet size is very uniform and much smaller than is obtainable by virtually any other method. It is known to use this arrangement for a carburetor or the like in a combustion engine. In such an arrangement a venturi is used to suck the mist so formed out of the vessel in which it is formed.

It is also known to generate mist by means of an aerosol propelling agent or gas which is used to break the liquid up into a mist and expel it into the air. Such arrangements are quite disadvantageous since frequently the propelling gas deleteriously affects the liquid being misted and distributed. Furthermore in such a container there is frequently in excess of **70%** propelling agent in comparison to only **30%** by volume of the liquid being misted. Furthermore such aerosol arrangements rarely give a sufficiently fine droplet size so that the droplets so formed frequently fall rapidly to the ground and are, therefore, useless.

The use of a piezoelectric transducer has never been applied to household misters and the like as no convenient system has been found to distribute the mist. Small fans and the like are disadvantageous in that they mix the mist with such a large quantity of air that the desired effect is almost completely lost. Furthermore all of the known systems are relatively noisy, a disadvantage particularly to be avoided when such an arrangement is used to treat an ill person.

### Objects of the Invention

It is therefore an object of the present invention to provide an improved mist generator.

Another object is the provision of a method of making an extremely finely divided and dense mist.

A further object is the provision of a mist generator which operates efficiently and silently.

### Summary of the Invention

These object are attained according to the present invention in an arrangement where a generally closed vessel which is filled to a predetermined level with a liquid and is formed above this level with a deflectable wall and with an aperture. A transducer is provided in the vessel below the level of the liquid and is focused generally at the level of the liquid. Motor means is provided to periodically deflect the wall of the vessel so that the mist formed by the ultrasonic transducer is expelled through the aperture in the side wall of the vessel.

Such an arrangement functions very simply and almost completely silently. The mist formed is cool and very dense.



In accordance with further features of this invention the deflectable wall of the vessel is an elastic membrane constituting the top of the vessel and is vertically displaceable by means of an electrically operated motor.

The operating motor according to the present invention comprises a lever connected at one end to the deflectable wall of the vessel, another end pivoted at a fixed point, and a rotatable eccentric cam engageable with this arm so as to pivot it back and forth thereby deflecting the wall of the vessel. Control means is provided which cycles the pump and energizes the piezoelectric transducer with ultrasonic-frequency alternating-current electricity for a time period sufficient to generate in the vessel a body of mist having a volume corresponding to the displacement volume of the pump on one cycle. Thus the transducer is energized to form a body of mist having a volume corresponding to the displacement volume of the pump on one cycle. Thus during each cycle the transducer is energized to form a body of mist, then the pump is operated to expel this body of mist from the vessel. The arrangement is cycled continuously, or is controlled by a humidistat or the like so as to humidify the surrounding air to a predetermined extent.

In accordance with yet another feature of this invention the arrangement for maintaining the vessel filled to a predetermined level comprises an inverted-bottle feeder having a reservoir provided with a nozzle which is the sole opening between the interior and exterior of the reservoir. This nozzle projects down into an upwardly open feed vessel so that when the feed vessel is filled up to the level of the nozzle, fluid flow out of the nozzle is arrestd. This feed vessel is arranged next to the mist-generating vessel and is connected thereto via a conduit so that the levels in the two vessels are the same.

### Brief Description of the Drawing

The above and other objects, features and advantages will become more readily apparent from the following description, reference being made to the accompanying drawing, in which:

FIG. **1** is a side diagrammatic view of an installation in accordance with this invention;

FIG. **2** is another mist generator according to the present invention adapted for continuous mist generation; and

FIG. **3** is a further generator according to this invention.

### Specific Description

As shown in FIG. **1** an inverted bottle **1** supported on a pair of fixed rails **32** is arranged upside down with its neck **33** received in an upwardly open filling vessel **5.** A valve body **2** in this neck **33** is urged downwardly by a spring **3** surrounding the stem **2*a*** of the body and braced between a washer **2*b*** carried on the stem **2*a*** and the neck **33** and serves to pull the body **2** down onto a seat **4** in the neck **33.** When the inverted bottle is plunged upside down in the vessel **5** the stem **2*a*** presses against the bottom of this vessel **5** to lift the valve body **2** from the seat **4** thereby allowing liquid in the bottle **1** to flow out into the vessel **5,** filling it to a level L'. Another vessel **7** is fixed adjacent the filling vessel **5** and is connected thereto by a conduit or tube **6** which is located entirely beneath the level L' so that the vessel **7** is also filled to a level L identical to the level L'. Thus

this bottle **1**, together with the vessel **5** and conduit **6** form an inverted-bottle feeder **34** which functions to maintain the liquid level in the vessel **7** at a constant level L.

The vessel **7** is formed with a lateral aperture **10***a* connected to an upwardly directed nozzle **10**. This aperture **10***a* is above the level L. Below the level L is a piezoelectric transducer **8** which is focused at a point *p* lying at the level L. Energization of this transducer with alternating-current voltage at an ultrasonic frequency from a source S serves to form mist **8** in the vessel **7** above the level L.

The vessel **7** is rigid except for its upper wall **11** which is formed by a deflectable elastic membrane connected to a rod **12** vertically reciprocal in a fixed yoke **13**. A spring **14** is braced at its lower end against the yoke **13** and at its upper end against a washer **12***a* fitted to the rod **12** so as to urge this rod upwardly, also pulling the wall **11** up into the solid-line position of FIG. **1**.

A drive arrangement **35** comprises a motor **19** provided with a shaft **18** on which is carried a noncircular cam **17**. A lever **15** has one end resting on the upper end of the rod **12** and the other end pivoted at **16** on the motor. This lever **15** rests against the cam **17** so that on rotation of this cam **17** it is deflected between the upper solid-line position of FIG. **1** and the lower dot-dash position of FIG. **1**, thereby also vertically deflecting the wall **11**.

Control means **9** is provided to connect the source S to the transducer **8** for a period of time sufficient to generate a predetermined volume of mist B. Meanwhile the cam **17** is rotated so that each time this predetermined quantity of mist is generated the wall **11** is deflected once to drive it out of the nozzle **10**. Thus each revolution of the cam **17** in direction S about its axis **18** takes slightly more time than the time necessary to generate the requisite quantity of mist. Thus the mist is generated in a volume at least equal to the displacement of the deflectible wall. Such an arrangement is usually provided at its controller **9** with a humidistat or the like which cycles it periodically until the humidity in the room is at the desired level. It is noted that when the device runs out of liquid in the bottle **1** there is no danger of overheating or damage, as the liquid level will drop from level L thereby making the transducer almost totally ineffective so that the device will merely cease to function.

The arrangement in FIG. **2** is similar to that shown in FIG. **1** with identical reference numerals used for identical structure. Here the shaft **18** is fitted with a second cam **20** in addition to the cam **17**. This second cam **20** is engageable with the actuating arm **22** of a fixed switch **21** that is connected to the source S and replaces the controller **9**. The cam **20** serves to close the switch **21** thereby connecting the source S to the transducer **8** immediately after the cam **17** has allowed the lever **15** to rise to its uppermost position. This switch remains closed for approximately **200°** of rotation of the shaft **18**, thereby allowing the transducer to generate a predetermined quantity of mist in the vessel **7**. Then the operating arm **22** falls off the cam **20**, disconnecting the source S and the transducer **8** and shortly thereafter the cam **17** depresses the lever **15** and pumps the newly formed mist out the nozzle **10**. Such an arrangement is intended for continuous operation.

The device of FIG. **3** again uses the reference numerals of FIGS. **1** and **2** for identical structure. Here the upper wall **11'** is connected to a plate **24** carried by a simple fast-acting solenoid or vibrator **23** operated by the controller **9**. In addition a partition wall **27** provided with a hole **28** covered by a flap-type check valve **29** is provided across the vessel **7'** above the mist B and the level L so as to define an upper compartment **26** and a lower compartment **25**. In addition the rigid wall of the vessel **7'** is formed at the compartment **26** with a hole **30** again provided with a flap-type check valve **31** allowing entrance of air only into the chamber **26**. Such an arrangement is necessary because of the fast-acting operation of the motor **23**. Thus the motor **23** rapidly presses down the membrane **11'**, causing air in the chamber **26** to be driven past the check valve **29** into the chamber **25**, thereby expelling a predetermined quantity of mist B from the nozzle **10**. At the same time the valve **31** is closed.

As the membrane **11'** is drawn back to the illustrated position the valve **29** closes to prevent the mist B from being sucked back into the nozzle **10**, while at the same time the valve **31** opens to allow a new mass of air to be drawn into the upper chamber **26**. The partition **27** as well as the check valves **29** and **31** prevent the apparatus from merely expelling a quantity of mist and then sucking it back in again as the membrane is drawn back to its starting position. In the arrangements of FIGS. **1** and **2** the relatively slowly acting piston rod **12** does not have this effect as the expulsion through the nozzle **10** and later aspiration of air back into the nozzle **10** takes place slowly enough to allow proper dissemination of the mist B.

We claim:

**1.** A mist generator comprising:

a generally closed vessel;

means for supplying a liquid to said vessel;

means for maintaining in said vessel a predetermined liquid level, said vessel being formed above said level with a throughgoing outwardly open aperture and having at least one deflectible wall;

means including a transducer below said level in said vessel for generating and focusing ultrasonic vibration on a location in said liquid at substantially said level to generate a homogeneous body of mist above said level, said aperture communicating with said vessel by a passage opening within said body of mist; and

means for deflecting said wall inwardly into said vessel to reduce the volume enclosed by said wall at most by the volume of said body for expelling a cloud of mist above said liquid out of said vessel through said aperture.

**2.** The generator defined in claim **1**, further comprising control means connected to said transducer and to said means for deflecting for operating said transducer for a predetermined length of time and thereafter deflecting said wall.

**3.** The generator defined in claim **2** wherein said control means includes a motor and at least one cam mounted on and rotatable by said motor.

**4.** The generator defined in claim **1**, further comprising a partition across said vessel between said level and said deflectable wall, said vessel being provided with a first check valve permitting air flow into the region between said partition and said wall and a second check valve permitting air flow from said region through said partition to the region between said partition and said level.

5. The generator defined in claim 1 wherein said deflectable wall is formed of a deformable membrane.

6. The generator defined in claim 5, further comprising a spring urging said membrane into a position wherein said vessel contains a predetermined volume, said membrane being deflectable inwardly from said position into a position wherein said vessel contains a lesser volume.

7. A method of generating mist comprising the steps of:

filling a generally closed chamber having a predetermined volume with a liquid to a predetermined level;

focusing ultrasonic vibration on said liquid at said level to form in said chamber above said level a body of mist;

inwardly deflecting a wall of said chamber to force said body of mist out a hole in said chamber above said level; and

maintaining said level at a predetermined height in said chamber, said ultrasonic vibration being focused on said level for a time sufficient to form a mist body having a predetermined volume, and said wall being deflected inwardly to an extent that reduces said predetermined volume of said chamber by a volume at most equal to the volume of said mist body.

8. The method defined in claim 7 wherein said wall is deflected inwardly by a lever in turn operated by a rotating cam.

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