

- [54] ELECTRIC HEATING UNIT FOR LIQUID
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[73] Assignee: Respiratory Care, Inc., Arlington Heights, Ill.
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[51] Int. Cl. H05b 1/02, B67d 5/62
[58] Field of Search 219/214, 296-309, 219/373, 328; 239/133-135; 222/146 HE, 146 R; 128/186, 192, 193

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Primary Examiner—A. Bartis
Attorney, Agent, or Firm—Eric P. Schellin

[57] ABSTRACT
An electric heating unit for heating a rising column of liquid and adapted to be interposed between the liquid supply receptacle and a nebulizer for use in inhalation therapy. The heating unit has an apertured pointed member for insertion through the breachable sealing membrane closing the liquid outlet of the receptacle. A tube extends from the pointed member to the inlet of the nebulizer and conveys the liquid from the receptacle to the nebulizer. A thermostatically controlled electric heater surrounds the tube to uniformly heat the fluid as it flows from the receptacle to the nebulizer. A safety switch, controllable by the orientation of the housing, provides means for checking whether the unit is properly grounded to prevent electric shock. A number of indicator bulbs, visible through the housing walls, are provided to indicate electrical conditions in the unit.

10 Claims, 8 Drawing Figures

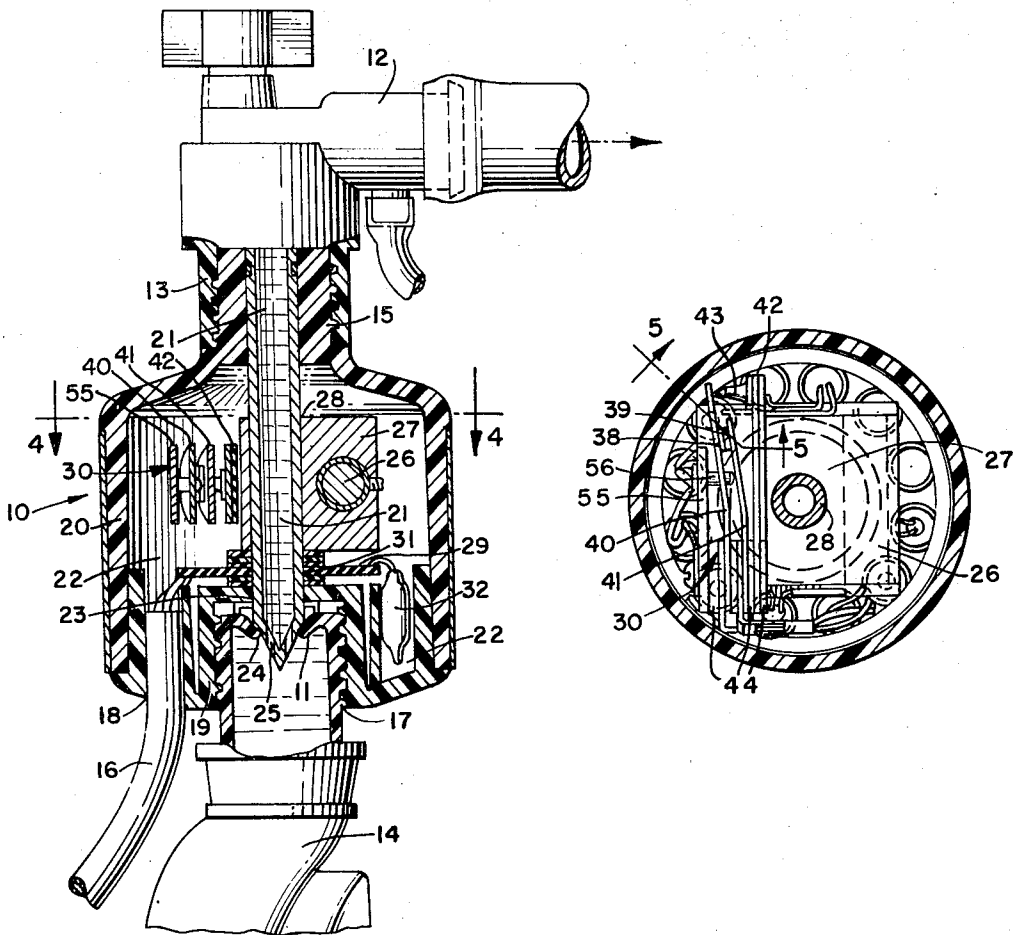


FIG. 1.

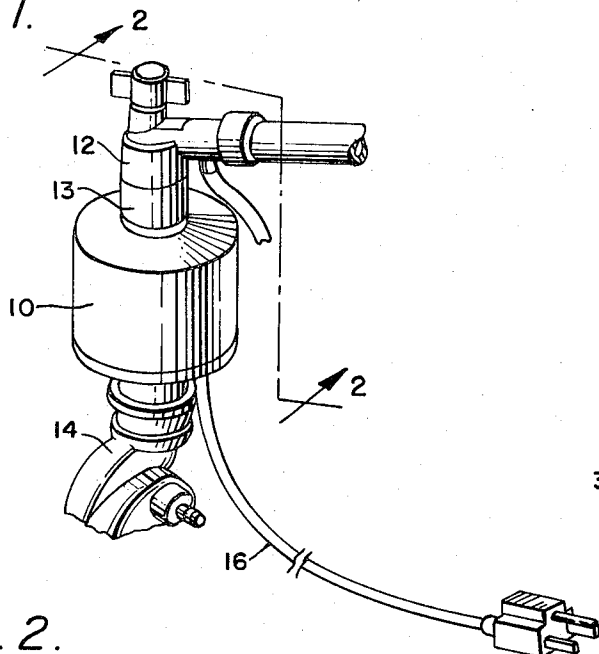


FIG. 3.

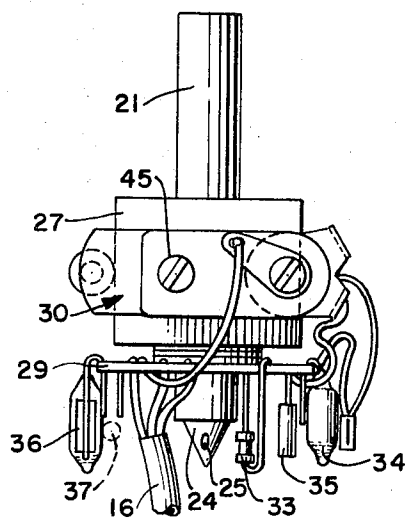


FIG. 2.

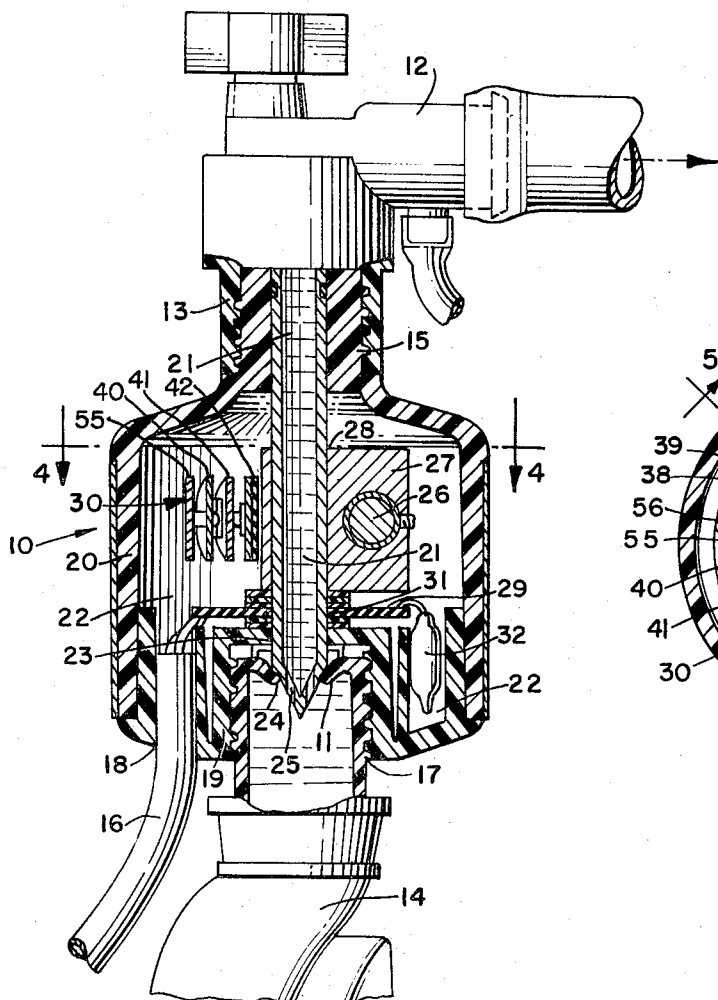


FIG. 4.

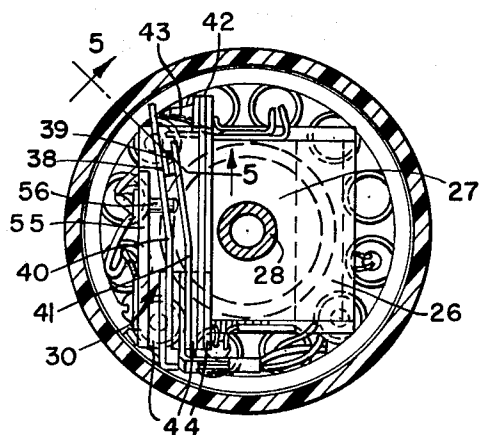


FIG. 5.

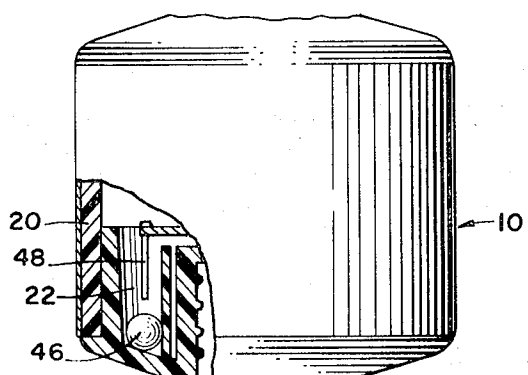


FIG. 6.

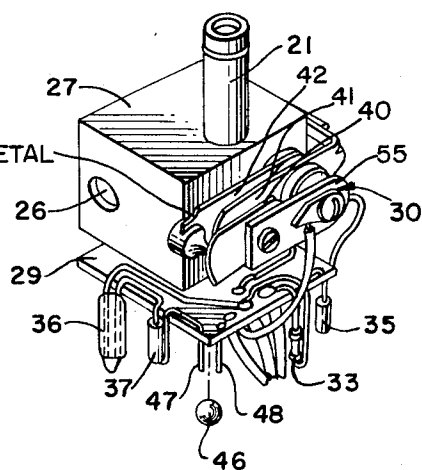


FIG. 7.

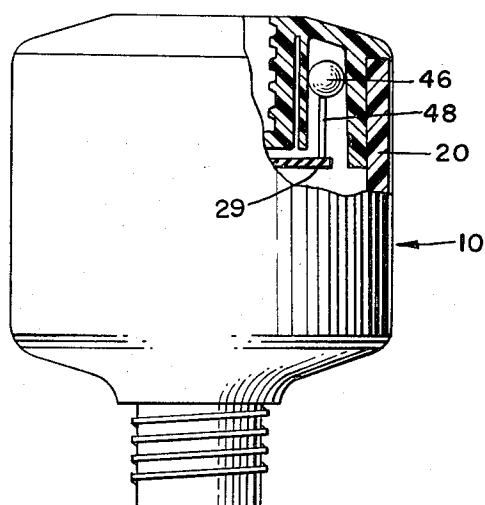
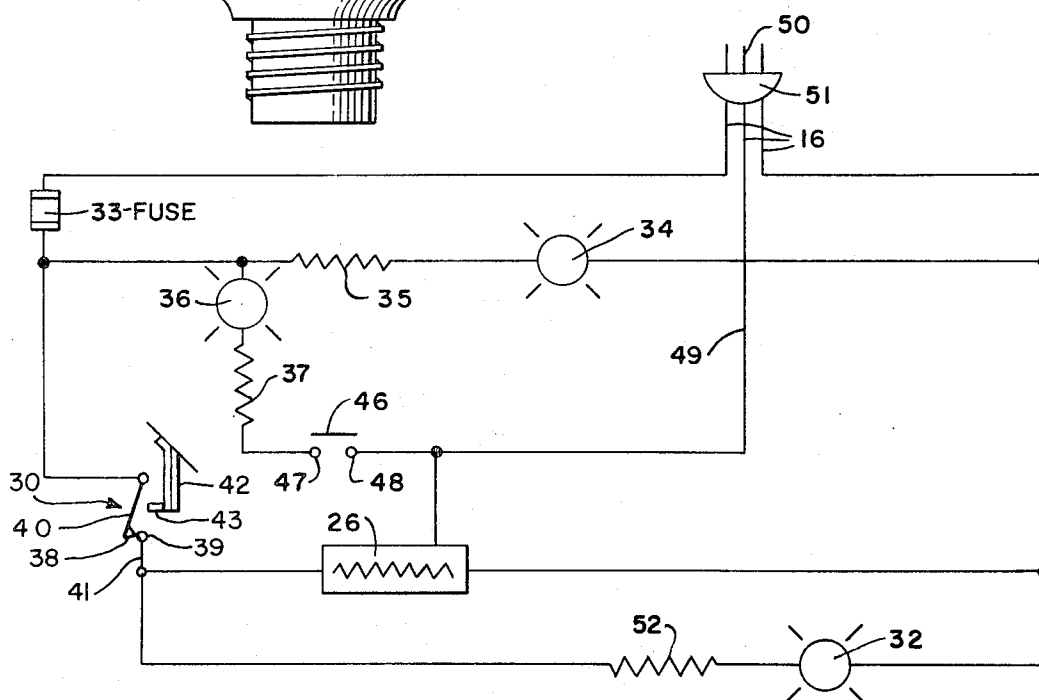


FIG. 8.



ELECTRIC HEATING UNIT FOR LIQUID

BACKGROUND OF THE INVENTION

The present invention relates generally to the field of inhalation therapy and more particularly to apparatus which humidifies oxygen before it is administered to a patient.

Inhalation therapy is the medical art of treating a patient with oxygen, or a mixture of air and oxygen, having a high moisture content. This is generally accomplished by atomizing or nebulizing pure water and causing the oxygen to come into contact with it, whereby the oxygen is humidified. A particular system for accomplishing this is disclosed in application Ser. No. 286,692, filed Sept. 6, 1972 by the present applicant for "Nebulizer." Briefly, the aforementioned application shows a system in which a receptacle containing water is adapted as a source of atomized liquid through the agency of a nebulizer which couples oxygen pressure to the receptacle. A venturi within the nebulizer draws water from the receptacle and directs atomized water and oxygen toward an outlet from which the humidified oxygen flows.

It has been found that the results of the inhalation therapy are improved if the humidified oxygen is warmed before it is administered to the patient. This has generally been accomplished by heating the water in the receptacle before it is atomized. The receptacle is placed in a heater which heats the water by heating the walls of the receptacle. This approach has many disadvantages. For one, it is very inefficient since the useful heat must flow through the walls of the receptacle, which are normally composed of a material having poor heat conductivity, before reaching the water. This results in bulky equipment and heavy power requirements. It is also difficult to maintain a desired temperature for the humidified oxygen stream by this method because the heated water flows a relatively long distance, during which its temperature can be affected by the environment, before coming into contact with the oxygen.

The present invention alleviates these problems by providing a heating unit which is compact, efficient, and capable of accurately maintaining the temperature of the humidified oxygen at the desired level.

SUMMARY OF THE INVENTION

According to the present invention, the water to be atomized is drawn through an electric heating unit which is placed between the receptacle and the nebulizer. The unit has a housing which is adapted for coupling to a receptacle of the closed end type and to a nebulizer such as the one disclosed in the above-mentioned U.S. patent application. Within the housing is an electric heating element which heats a tubular member which conducts the rising column of water from the receptacle to the nebulizer. The water is thus heated immediately prior to its introduction into the nebulizer. The housing also contains a thermostat which controls the electric current which flows into the heating element. A number of small bulbs, visible from outside the housing, are provided to indicate various electrical conditions within the housing. A switch, controllable by the orientation of the housing, provides a means of checking whether the unit is properly grounded to prevent electric shock.

Accordingly, it is an object of the present invention to provide a heating unit for use in inhalation therapy which is compact, efficient and accurate.

It is a further object of the invention to provide a heating unit for use in inhalation therapy which heats the water immediately prior to its entering the nebulizer.

It is another object of the invention to provide a heating unit for use in inhalation therapy which can be installed between a water receptacle and a nebulizer.

BRIEF DESCRIPTION OF THE DRAWING

These and other objects, advantages, and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof, and wherein:

FIG. 1 shows the unit connected for operation.

FIG. 2 shows a vertical section of the unit taken on line 2—2 of FIG. 1.

FIG. 3 shows a side elevation of the interior elements of the unit.

FIG. 4 shows a horizontal section of the interior elements taken on line 4—4 of FIG. 2 looking in the direction of the arrows.

FIG. 5 shows an elevation view of the unit with parts broken away on line 5—5 of FIG. 4.

FIG. 6 shows a perspective view of the interior elements of the unit.

FIG. 7 is the same view as FIG. 5 with the unit inverted.

FIG. 8 is a schematic wiring diagram of the unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, the unit 10 is connected to nebulizer 12 and water receptacle 14. The nebulizer 12 has a threaded hollow extension 13 which screws onto a threaded extension 15 of the unit. The receptacle 14 has a breachable membrane 11 sealing threaded extension 17 which is screwed into threaded portion 19 of the unit. A three conductor power cord 16 provides electric power to the unit and passes into the unit through hole 18.

The unit has a cylindrical housing 20 preferably composed of a transparent or translucent plastic or other electrically insulating material. The lower part of the housing has a plurality of tubes or bores 22, one of which accommodates power cord 16. Indicator bulbs such as bulb 32 are disposed in other tubes.

Coaxial with the housing 20 and threaded portions 15 and 19 is a metal tube 21. The upper end of the tube is sealed in a water tight manner within passage 21 of the threaded extension 15. The lower end is sealed at hole 23 in the bottom of the housing concentric with threaded portion 17. Also sealed at 23 and in fluid communication with tube 21 is a pointed tubular means 24 extending outwardly having holes 25 therein. As shown in FIG. 2, when the unit 10 is screwed onto the receptacle 14, the pointed tubular means 24 breaches the membrane 11 and enters into the receptacle. The tube 21 is thereby rendered in fluid communication with the interior of the receptacle, the fluid entering the tube through the holes 25 in the pointed tubular means 24. Although not specifically illustrated, the

upper end of the tube 21 is in fluid communication with the interior of nebulizer 12 when they are screwed together. Thus, when connected as shown and placed in operation, a rising column of liquid from receptacle 14 is drawn through tube 21 into the nebulizer by means of the pressure difference caused by oxygen flowing through the nebulizer.

In order to heat the liquid as it flows through the tube 21, an electric heater is provided adjacent the tube. A heating element 26 is disposed within a horizontal bore in metal block 27. The block also has a vertical bore 28 in which a section of tube 21 is disposed. The block 27 serves as a heat conducting means for conducting the heat from heating element 26 to tube 21. In operation, heat is transferred from tube 21 to the liquid flowing through the tube.

A printed circuit board 29 and a thermostat shown generally at 30 are also shown in FIG. 2. These elements are shown in more detail in FIGS. 3 and 4, respectively, and attention is directed to these figures. Printed circuit board 29 has a hole 31 in the center and is mounted on tube 21. The electrical circuit components, which will be further described below, such as fuse 33, bulb 34 and 36, and resistors 35 and 37, are mounted thereon. The tubes 34 and 36 extend downwardly from the board 29 into bores 22 in a manner similar to bulb 32 shown in FIG. 2.

The thermostat 30 is mounted on one side of block 27 and senses the heat emanating therefrom. Electrical contacts 38 and 39 are mounted on parallel metal blades 40 and 41, respectively. A bimetal strip 42 having an electrically insulating rod 43 is mounted parallel to the blades. The blades and bimetal strip are electrically insulated from each other and the block by insulating spacers 44. As can be seen more clearly in FIG. 8, the current for the heating element passes between contacts 38 and 39. In operation, the contacts are normally closed and current passes to the heating element 26 to heat the fluid in the tube, as described above. When a predetermined temperature is reached the bimetal strip 42 begins to bend away from the block. The rod 43 pushes against flexible blade 40 and opens the contacts, whereupon current flow through the heating element 26 is interrupted. When the temperature drops sufficiently, the bimetal strip returns to its original position and the contacts 38 and 39 are closed. In this manner, the temperature of the unit, and hence the temperature to which the flowing liquid is raised, is kept within a narrow range. In order to adjust this temperature, a rigid metal support strut 55 carrying a rotatable screw having a threaded section screwed into a hole 45 in the support strut. The screw extends through an aperture in blade 40 to contact blade 41 and can be adjusted to necessitate more or less movement required of the bimetal strip to open the contacts, thus adjusting the operating temperature.

Referring now to FIGS. 5-8, a switch for checking the ground connection comprises spaced contacts 47 and 48 and metal ball 46 which serves under proper conditions to electrically connect the contacts. The contacts 47 and 48 are stiff wires extending downward from the circuit board 29 a certain distance into one of the abovementioned bores 22. Within this bore, and resting on the bottom under normal operating conditions, is ball 46. The ball is of a diameter slightly smaller than the diameter of the bore and can move freely therein. Contact 48 is connected to ground or

neutral conductor 49 of power cord 16. Contact 47 is connected to one of the current carrying conductors by way of bulb 36 and resistor 37. To check that the unit is properly grounded, the unit is inverted from its normal position. The result, as shown in FIG. 7, is that the ball 46 rolls to the other end of bore 22 and electrically connects contacts 47 and 48, thereby placing bulb 36 between a current carrying conductor and neutral conductor 49. If the neutral conductor is grounded via prong 50 of plug 51, which it will be if a proper three conductor socket is used, the bulb will light, indicating proper grounding. If the bulb does not light, the unit is not properly grounded. When the unit is returned to its operating position, the ball will return to the bottom of the bore 22 and bulb 36 will extinguish.

Referring specifically now to FIG. 8, it can be seen that fuse 33 is inserted into one of the current carrying conductors to protect against excessive current draw. Bulb 34 and series resistor 35 are connected across the current carrying conductors and thus the bulb is lit whenever power is applied to the circuit. A bulb 32 and series resistor 52 is connected in parallel with heater 26. When contacts 38 and 39 are closed and current flows in the heating element, it also flows through and lights bulb 32 so that bulb 32 indicates the heating element is on or off at any particular time.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An electric heating unit for heating a rising column of liquid adapted to be screwed onto a liquid receptacle having an upwardly facing threaded portion adapted to receive the unit, the receptacle being closed at said threaded portion by a breachable membrane, and adapted to be screwed onto a nebulizer having a downwardly facing threaded portion adapted to receive the unit, so that the unit can be functionally disposed between the receptacle and the nebulizer, comprising:
 - a housing having an upwardly facing threaded portion which can be mated with the threaded portion of said nebulizer, and a downwardly facing threaded socket whereby the unit can be screwed onto the threaded portion of said receptacle, said socket having concentrically a tubular apertured breaching means adapted at one end to extend into the threaded portion of the receptacle when the unit is screwed thereon to breach said membrane;
 - a tubular member within said housing having one end in fluid communication with the other end of said tubular means and the other end disposed concentrically within the upward facing threaded portion of said housing;
 - an electric heater disposed in heat exchange relationship to the tubular member;
 - a thermostat disposed adjacent said heater and electrically connected to control said heater; and
 - an electric power cord passing into said housing through a hole therein and connected to the heater and the thermostat.
2. The unit of claim 1 wherein said electric heater comprises:
 - a block of material having a high heat conductivity having first and second bores therethrough, said

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tubular member lying within the first bore in good heat conducting relationship with the block; and
 a heating element disposed within the second bore in good heat conducting relationship with the block, whereby the heating element heats the block and the block heats the tubular member.

3. The unit of claim 1 wherein said thermostat comprises:

a pair of normally closed contacts, one connected to the electric power cord and the other connected to said heating element; and,

a bimetal member for sensing temperature having an insulating rod extending in the direction of the bimetal member movement adjacent said contacts and operable to open said contacts upon movement of said bimetal member at a predetermined temperature.

4. The unit of claim 3 wherein said thermostat further comprises a rigid metal support to which a rotatable screw is adjustably attached, the screw adjustment determining the amount of movement required of the bimetallic member to open said contacts, whereby the operating temperature of the thermostat is adjustable.

5. The unit of claim 1 wherein said one end of said breaching tubular means is pointed and has one or more holes communicating to its interior, whereby liquid can enter the tubular means.

6. The unit of claim 1 wherein said housing has at least one light transmissive part, further including at least one bulb within the housing adjacent the light transmissive part and electrically connected so as to indicate electrical conditions within the unit.

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7. The unit of claim 6 wherein:

said electric power cord has a pair of current carrying conductors and a neutral conductor;

said housing has a vertical bore;

a metal ball is disposed in said bore and has free vertical movement therein;

a pair of physically separated electrical wire contacts are disposed at the top of said bore and extend a distance therein; one contact being connected to said neutral conductor; and,

a bulb with two leads has one lead connected to one of said current carrying conductors and the other lead connected to the other of said wire contacts, whereby

the ball rests against both contacts when the unit is inverted and the bulb lights if the unit is properly grounded.

8. The unit of claim 7 wherein:

one of said bulbs is connected between the two current carrying conductors to indicate when the power is being applied to the unit; and

another of said bulbs is connected in parallel with said heater element to indicate when power is being applied to the heater element.

9. The unit of claim 8 further comprising a printed circuit board upon which said bulbs and wire contacts are mounted.

10. The unit of claim 9 further including a plurality of vertical bores in said housing below the circuit board, said bulbs extending into the bores from the circuit board.

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