My invention relates to improvements in controllable humidifying apparatus and has to do, more particularly, with controllable humidifying apparatus suitable for use in connection with baby incubators and in like situations.

The principal object of my invention is to provide a simple and inexpensive humidifying apparatus that may be readily and easily controlled to vary the rate of evaporation of water and thereby control the humidity of a current of air circulating about the apparatus.

The apparatus of the present invention is an improvement upon the humidifying apparatus disclosed in U. S. Letters Patent of Gordon Armstrong, No. 2,417,962, patented March 25, 1947. That patent discloses a heating tube having a water reservoir mounted thereon and adjustable longitudinally of the tube, but such longitudinal adjustment of the reservoir did not provide an effective control of the evaporation of water from the reservoir, or the humidity of the air circulating about it, because the construction was such that no substantial temperature differential was created between end portions of the heating tube. The heating element in this prior apparatus was an electric lamp, located in one end of the tube, and convection currents substantially equalized the temperature in all parts of the interior of the tube, so that there was no substantial temperature differential between those portions of the wall thereof. It is an object of my present invention to provide an improvement on this prior apparatus, by means of which a substantial temperature differential is created between end portions of the surface of the tube, whereby to render the longitudinal adjustment of the water reservoir effective to control the rate of evaporation and the humidity of the circulating air.

Further objects, and objects relating to details and economies of construction and operation, will more definitely appear from the detailed description to follow. My invention is clearly defined and pointed out in the appended claims. A structure constituting a preferred embodiment of my invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a view in front elevation of a baby incubator embodying my improved humidifying apparatus.

Fig. 2 is a view of the baby incubator and the improved humidifying apparatus, in end elevation.

Fig. 3 is a transverse sectional view through the heating tube and water reservoir, taken substantially on the line 3—3 of Fig. 2.

Fig. 4 is a vertical sectional view through the incubator taken on the line 4—4 of Fig. 1, and

Fig. 5 is a wiring diagram of the electrical circuits including the heating element of said humidifying apparatus.

In general, the controllable humidifying apparatus of my present invention comprises a heating tube, a heating element for said tube, means for creating a temperature differential between end portions of the surface of said tube and a water reservoir adjustable longitudinally of the tube to vary the rate of evaporation of water in said reservoir. The water in the reservoir is evaporated by heat transmitted through the wall of the reservoir from the surface of the heating tube and, if all portions of said surface are at substantially the same temperature, longitudinal adjustment of the reservoir with respect to the tube will not vary the quantity of heat transferred per unit of time and, hence, will not vary the rate of evaporation substantially. However, if a temperature differential is created between different portions of the surface of the tube, so that one portion is at a substantially lower temperature than the other portion, the longitudinal adjustment of the reservoir on the tube will be effective to vary the rate of transmission of heat to the water and hence the rate of evaporation. Such a temperature differential may be provided by inserting a heat baffle within the tube, which restricts substantially the transmission of heat internally of the tube from one end to the other, and which divides the tube into two chambers, one of which includes the heating element. The other chamber might be packed with asbestos, for instance, or cooling coils might be introduced therein to give a sharper temperature differential on the surface of the tube. However, I have found that a very satisfactory temperature differential at the surface of the tube may be effected by providing it with an imperforate partition located therein as close as immediate the ends thereof. This prevents the transfer of heat from one end of the tube to the other by convection currents, and the only heat transferred must be by conduction through the wall of the imperforate partition and the surface wall of the tube. If desired, the sharpness of the temperature differential may be varied by providing the partition with a varying number of holes, so as to restrict but not entirely prevent convection currents between the two chambers. I prefer to use an electrical heating element located in one of the two chambers formed by the partition, which heating element is connected in an electrical circuit with a source of current. A current of air is caused to circulate about the tube and the reservoir and the electrical circuit for the heating element may include a thermostatic switch responsive to the temperature of the circulating air. I find it convenient and desirable to provide a humidity scale fixed with respect to the heating tube, and a pointer fixed to the reservoir and moveable with the reservoir with respect to said scale, to indicate the degree of humidity to be produced.

Referring to the numbered parts of the drawings, I have shown my improved controllable humidifying apparatus incorporated in a baby incubator indicated generally at 10, which has a bottom plate or floor 11 provided with air inlet openings 12 therethrough controllable by a damper 13. The interior of the incubator is divided into a treating compartment and a heating compartment by a partition 14, which terminates somewhat short of the top of the incubator, and the air inlet holes 12 are located in the bottom of the floor 11 beneath the heating compartment. Air entering through the openings 12 and passing around the heating tube is warmed thereby and rises, passing over the partition 14 to the treating compartment of the incubator from which it may leave by damper-controlled openings 16 in the top front rail 15. The front wall of the treating compartment of the incubator is closed by a transparent panel 17 and the rear wall of the incubator is closed by a transparent panel 18. The end wall of the incubator include transparent panels 20 and 21. The top of the incubator is closed by a hinged cover having a transparent panel 19 therein. The heating tube 23 is supported by a panel 22, forming part of the front wall of the heating compartment, and this heating tube is located in the heating compartment a short distance above the floor 11 thereof. The front end of the heating tube 23 is closed and sealed by a wall 25 and the rear end of the tube is closed by a wall 26 formed by a flanged disc,
having the flange secured to the rear end of the heating tube 23. A flanged metal disc 27 is located in the tube 23, intermediate the ends thereof, and secured to the wall of said tube, thus forming an imperforate partition dividing the interior of the heating tube into a rear dead air space or chamber 28 and a front chamber 29, in which an electrical resistance heating element 30 is located.

Z-shaped brackets 31 are secured to the heating tube 23 at diametrically opposite points, each having a downward flange 32 engaging the surface of the heating tube and an upwardly extending flange 33 spaced therefrom. A water reservoir 34, the bottom wall of which includes an arched portion 35 engaging the heating tube, is seated on the brackets 31 between the flanges 33, as shown in Fig. 3. The upper end of this water reservoir is open having an L-shaped flange 37 secured to the upper portion of the side wall thereof, which supports a covering grill 38. A handle 36 is secured to the upper portion of the walls of the reservoir by which it may be lifted from the tube, or moved longitudinally thereof. It is to be noted that the water reservoir 34 is movable or adjustable longitudinally of the heating tube 23 on the brackets 31. A scale 39 is secured to the bracket flange 33, adjacent the transparent panel 20, so that the markings on this scale will be visible through such panel. The scale has suitable graduations therein as indications of high, medium and low humidity and another indicating a humidity of 80 to 70° with oxygen, for use when the nebulizing apparatus forming a part of this incubator is employed. A plate 40 is fast to the side of the water reservoir 34 and has a pointer 41 terminating near the scale 39, as shown in Fig. 2. As this reservoir 34 is adjusted longitudinally of the tube 23, the pointer 41 will move with reference to the scale 39.

The electrical wiring diagram for the resistance heating element 30 is shown in Fig. 5. A cable 42 contains the two leads 43 and 44 for connecting the apparatus to a source of current. The lead 43 is connected in a connector 45, with a lead 46 running to the terminal 47 of the electrical resistance heating element 30. The opposite terminal 48 of that element is connected by a lead 49 to one terminal of a thermostatic switch 50, the thermostatic element of which is enclosed in a tube 51 shown in Fig. 4, located over the front end of the heating tube 23 where it will be responsive to the temperature of the air circulating about said tube. The opposite terminal of the thermostatic switch 50 is connected by a lead 52 to a connector 53, in which it is connected to the return lead 44. Wires 54 and 56 connect the said thermostat 50 across the terminals 47 and 48, in parallel with the electrical resistance heating element 30, so that the lamp 55 will burn when current is passing through the element 30. Wires 57 and 59 are connected across the leads 43 and 44 and to the signal lamp 58, so that it will be on when the leads 43 and 44 are connected to a source of current.

The operation of my improved controllable humidifying apparatus should be apparent from the description thereof given above. The water reservoir 34 rests on the heating tube 23 and heat from the element 30 is transmitted to the water in said reservoir through convection currents in the chamber 29, and conduction through the wall of the tube 23 and the wall of the reservoir 34. Imperforate partition 27 prevents the transfer of heat to the chamber 28 by convection, and the heat transferred to the rear end portion of the wall of the tube 23 must be by conduction through said wall and through the partition 27. The result is that a sharp temperature differential is maintained between the portion of the tube wall to the right of the partition 27 and that to the left thereof. When the reservoir 34 is adjusted forwardly, so that the pointer 41 is opposite the notation "High" on the scale 39, practically all of the reservoir will be above and in contact with the hot portion of the tube wall 23, so that the rate of heat transfer will be greatest and the rate of evaporation of water from the reservoir 34 will also be greatest. The result of this is to give high humidity to the air circulating about the tube 23 and the reservoir 34. When the reservoir is adjusted so that the pointer 41 is opposite the notation "Medium" on the scale 39, a part of the bottom of the reservoir will be adjacent to the low temperature portion of the tube 23, surrounding the chamber 28, and the rate of heat transfer and evaporation of the water in the reservoir will be medium. Adjustment of the reservoir still further to the rear, until the pointer 41 is opposite the notation "Low," reduces still further the rate of heat transfer to the water in the reservoir and the rate of evaporation therefrom, producing low humidity. When the nebulizer is in operation and the admission of oxygen is used to humidify the air in the apparatus, the reservoir is adjusted all the way to the rear, so that the pointer 41 is opposite the notation "With Oxygen" on the scale 39, and, since substantially all of the reservoir is over the portion of the tube 23 surrounding the chamber 28, the rate of heat transfer and the rate of evaporation of water in the reservoir 34 will be very low. In this way, the apparatus may be controlled to vary the amount of humidity in the air circulating about it by longitudinal adjustment of the reservoir with reference to the heating tube 23 and the partition 27 therein, because of the fact that this partition provides a sharp temperature differential between the two portions of the tube wall surrounding the chamber 28 and those surrounding the chamber 29.

I am aware that my invention may be changed and varied considerably without departing from the spirit of my invention and, therefore, I claim the invention broadly, as indicated by the appended claims.

Having thus described my invention, what I claim as new and useful and desire to secure by United States Letters Patent, is:

1. A controllable humidifying apparatus comprising the combination of a heating tube sealed at both ends, a heating element for said tube, means for creating a temperature differential between end portions of the surface of said tube, and a water reservoir seated upon said tube and adjustable longitudinally thereof to vary the rate of evaporation of water in said reservoir and thus control the humidity of air circulating over said tube.

2. A controllable humidifying apparatus comprising the combination of a heating tube sealed at both ends, a heating element in one end of said tube, a heat baffle located in said heating tube intermediate the ends thereof to create a temperature differential between end portions of the surface of said tube and a water reservoir seated upon said tube and adjustable longitudinally thereof to vary the rate of evaporation of water in said reservoir and thus control the humidity of air circulating over said tube.

3. A controllable humidifying apparatus comprising the combination of a heating tube sealed at both ends, an imperforate partition located in said heating tube intermediate the ends thereof dividing the interior of said tube into two chambers and preventing circulation of air between the chambers, a heating element in one of said chambers, and a water reservoir seated upon said tube and adjustable longitudinally thereof with respect to said partition to vary the rate of evaporation of water in said reservoir and thus control the humidity of the circulating air.

4. A controllable humidifying apparatus comprising the combination of a heating tube sealed at both ends, an imperforate partition located in said heating tube intermediate the ends thereof dividing the interior of said tube into two chambers and preventing circulation of air between the chambers, an electrical heating element in one of said chambers, an electrical circuit connecting said heating element with a source of current, and a water reservoir seated upon said tube and adjustable longitudinally of the tube with respect to said partition to vary the rate of evaporation of water in said reservoir and
thus control the humidity of air circulating about said tube.

5. A controllable humidifying apparatus comprising the combination of a heating tube sealed at both ends, an imperforate partition located in said heating tube intermediate the ends thereof dividing the interior of said tube into two chambers and preventing circulation of air between the chambers, means for causing circulation of the air about the exterior of said tube, an electrical heating element in one of said chambers, an electrical circuit connecting said heating element with a source of current, and a water reservoir seated upon said tube and adjustable longitudinally of the tube with respect to said partition to vary the rate of evaporation of water in said reservoir and thus control the humidity of the circulating air.

6. A controllable humidifying apparatus comprising the combination of a heating tube sealed at both ends, an imperforate partition located in said heating tube intermediate the ends thereof dividing the interior of said tube into two chambers and preventing circulation of air between the chambers, means for causing circulation of the air about the exterior of said tube, an electrical heating element in one of said chambers, an electrical circuit connecting said heating element with a source of current and including a thermostatic switch responsive to the temperature of the air circulating about said tube, and a water reservoir seated upon said tube and adjustable longitudinally thereof with respect to said partition to vary the rate of evaporation of water in said reservoir and thus control the humidity of the circulating air.

7. A controllable humidifying apparatus comprising the combination of a heating tube sealed at both ends, an imperforate partition located in said heating tube intermediate the ends thereof dividing the interior of said tube into two chambers and preventing circulation of air between the chambers, means for causing circulation of air about the exterior of said tube, an electrical heating element in one of said chambers, an electrical circuit connecting said heating element with a source of current and including a thermostatic switch responsive to the temperature of the air circulating about said tube, and a water reservoir seated upon said tube and adjustable longitudinally thereof with respect to said partition to vary the rate of evaporation of water in said reservoir and thus control the humidity of the circulating air.

8. A controllable humidifying apparatus comprising the combination of a heating tube having a portion sealed to provide a heating chamber separate from a portion of said tube which is not to be heated, a heating element for the heating chamber, and a water reservoir seated upon said tube and adjustable thereof to vary the rate of evaporation of water in said reservoir and thus control the humidity of air circulating over said tube.

9. A controllable humidifying apparatus comprising the combination of a heating tube having a portion thereof sealed at opposite ends to separate said portion from another portion and prevent the circulation of air between the separated portions, a heating element in the sealed portion, and a water reservoir disposed adjacent the sealed portion of the tube and adjustable with respect thereto to vary the rate of evaporation of water in said reservoir and thus control the humidity of the circulating air.

10. The controllable humidifying apparatus of claim 9 in which the tube is divided into a plurality of sealed chambers and the heating element is in one of said chambers for creating a heat differential between portions of the surface of the tube.

References Cited in the file of this patent

UNITED STATES PATENTS

1,712,204 Gibney ------------------ May 7, 1929
2,093,648 Rice ------------------ Sept. 21, 1937
2,417,962 Armstrong ------------------ Mar. 25, 1947