United States Patent

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[54] ELECTRODE AIR HUMIDIFIER

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[51] **Int. Cl.** **H05b 3/60**

[58] **Field of Search** 219/271–276, 284–295, 219/362; 21/117, 119, 118

[56] **References Cited**

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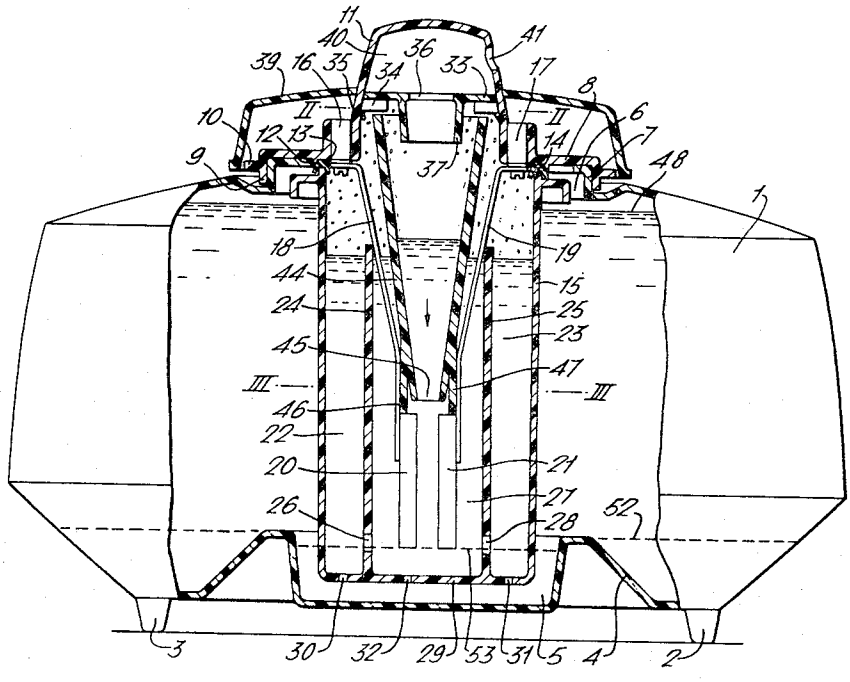
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[57] **ABSTRACT**

An electrode air humidifier is provided. The electrodes are suspended in an inner container with water flow contact with the outer container through a pocket chamber, whereby pulsation is greatly reduced or prevented. It is further provided for separation of water drops in the steam and means are provided to reduce the wear of the electrodes by bringing the apparatus to a rapid stop when relatively little water is left in the apparatus.

20 Claims, 4 Drawing Figures



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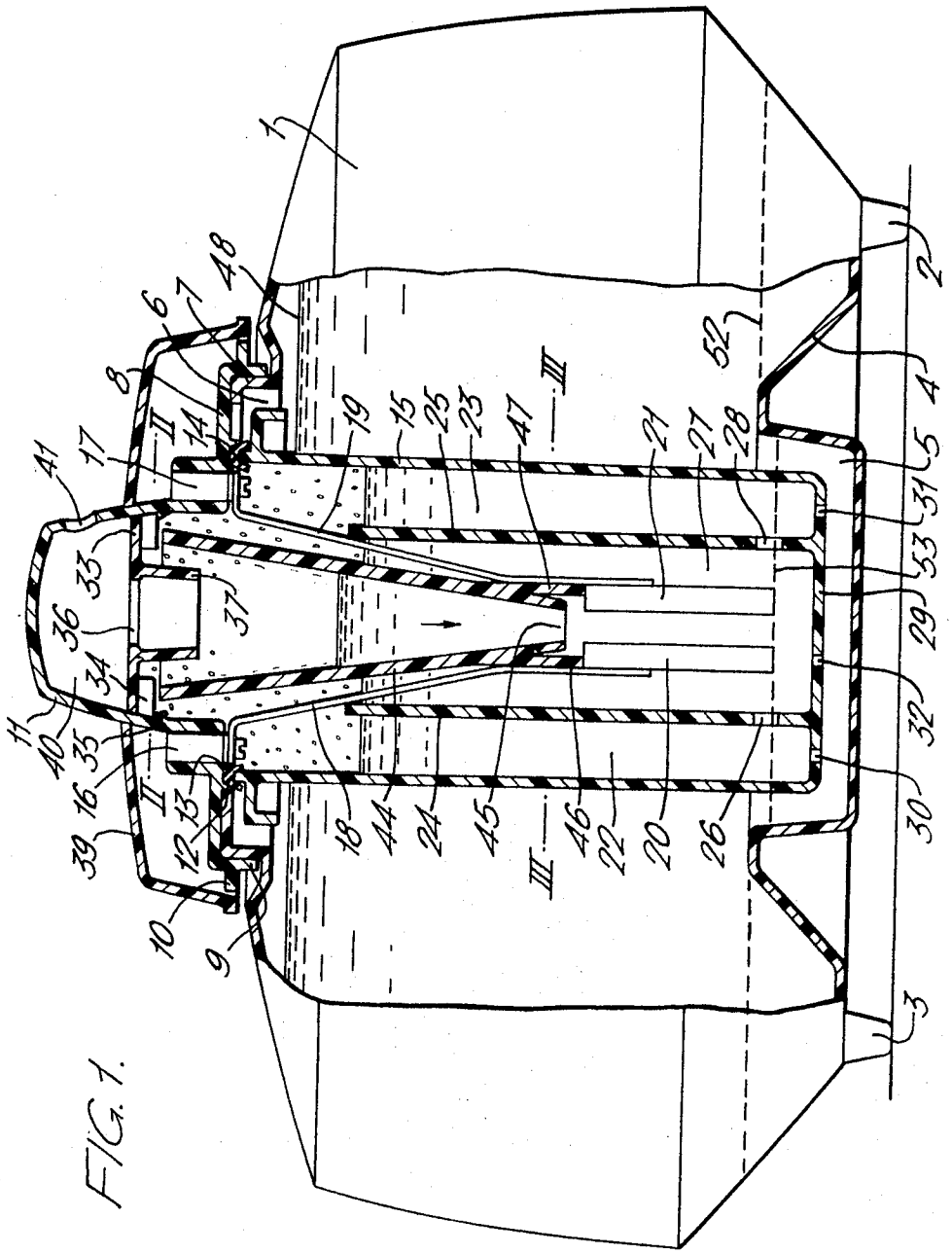


FIG. 1.

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FIG. 2.

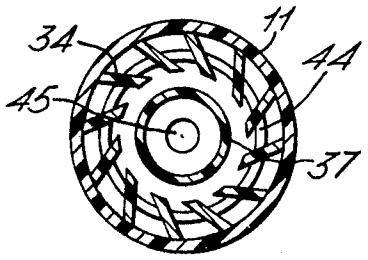


FIG. 3.

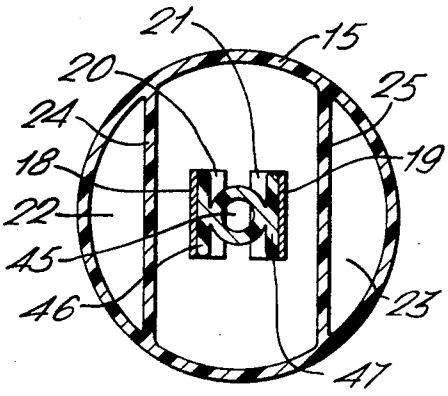
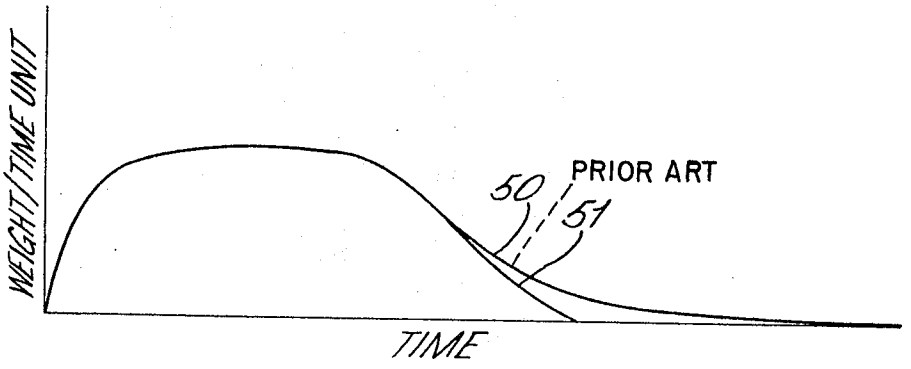


FIG. 4.



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ELECTRODE AIR HUMIDIFIER

The present invention relates to air humidifiers of the type utilizing electrodes for heating and evaporation of the water in a container, for distribution into a room where the humidity is to be controlled.

The electrodes are preferably arranged in a small inner container which is disposed in the actual water container and is in connection therewith by means of openings, so that a water flow contact exists between inner container and outer container. In this manner, the amount of water which is to be heated and evaporated by the electrodes is restricted, and fresh water is continuously supplied from the outer container. In conventional embodiments the inner container has an opening at the top end for discharge of steam and is provided with a plurality of openings at the bottom end to receive water.

A disadvantage of the known types of electrode air humidifiers is the strong pulsating rhythm at which the evaporation takes place. Immediately the water in the inner container or steam chamber reaches boiling point a steam pressure is generated which forces some of the water back into outer container. If the dimension of the opening at the bottom of the pressure chamber is large in relation to the opening for discharge of steam, the amount of water forced out of the steam chamber will be so great that the current bridge between the electrodes is reduced and this naturally leads to decrease in boiling, with the result that the water again begins to penetrate the steam chamber. Inasmuch as the temperature of the water entering the steam chamber is lower, the boiling stops until the electrodes have again been able to heat up the water to boiling point. Thereafter the cycle repeats itself.

It is an object of the present invention to provide an electrode air humidifier comprising measures for preventing pulsation or to reduce such pulsation substantially.

Experiments have shown that when the water in the outer container has a temperature of between 80° and 90° C pulsation substantially is eliminated, since the above described cooling in the steam chamber is prevented. This discovery has been utilized in the invention and a connection between the steam chamber and the outer container is therefore established via one or more pockets. The water in these pockets will be maintained at a temperature of say between 80° and 90° C and thus prevent pulsation, even though the water temperature in the outer container is lower.

In cases where the water contains a certain amount of lime, it is desirable to achieve a moderate pulsation in order to prevent the collection of lime in the pressure chamber.

It is thus an object of the invention to provide an electrode air humidifier which permits a controlled pulsation. In accordance with the invention this is achieved by providing at least one opening which leads directly from the outer container and into the steam chamber.

The water level in the outer container will gradually sink in time with the consumption of water which is converted to steam and discharged into the room. A curve showing the discharge of steam expressed in grams of water per time unit and drawn with amount of water distributed in grams per time unit on the ordinate and with the time along the abscissa, will be relatively steep to begin with, that is to say that the electrode air humidifier reaches its maximum discharge amount relatively quickly. The curve then extends approximately parallel to the ordinate and then falls with a relatively small incline, that is to say that at the termination of the operation there will be a longer period of time wherein the electrode air humidifier discharges only insignificant amounts of water.

It is an object of the invention to prevent this and to provide an electrode air humidifier where the terminating extent of the curve is steeper.

In accordance with the invention this is achieved by disposing at the bottom of the water container a partition wall which extends around the steam chamber. In this manner, a central, shallow well is formed into which the steam chamber projects. The opening or openings in the steam chamber which provide the water flow contact between outer container and steam

chamber are located in the part of the steam chamber which projects downwardly into the well. As soon as the level of water in the outer container sinks below the height of the partition wall, the electrodes will be capable only of boiling away the water located in the well, that is to say that the electrodes operate with a small amount of water and, therefore, despite the reduced electrode surface, are capable to evaporate the rest of the water in a shorter time and thereby bringing the apparatus to a stop.

The boiling effect in the steam chamber is frequently violent, and drops of water are thus readily entrained in the steam flowing out into the room.

An aim of the invention is to provide an electrode air humidifier where such entrainment of water drops is prevented to a substantial degree, and a special guide member is arranged in the steam outlet to this purpose, the said guide member imparting a turbulent effect to the steam which facilitates the separation of water drops, and an auxiliary chamber is also arranged over the steam chamber wherein the steam is retarded before being released to the room.

The separated water drops are due to the whirling effect thrown outwards towards the inner wall of a tube member which is connected with a vertical tube which leads the water back to the electrode area. The bottom opening of the tube has such a small diameter or is located in such a way that steam bubbles from the electrodes cannot penetrate the tube or at least have a reduced penetrance capability. This causes a circulation of the water from the interior of the tube member and out into the steam chamber.

It follows now a description of a preferred embodiment of the invention.

On the drawings,

FIG. 1 shows a section through an electrode air humidifier according to the invention,

FIG. 2 shows a section along the line II — II in FIG. 1,

FIG. 3 shows a section along the line III — III in FIG. 1,

FIG. 4 shows a curve of the water discharge from the electrode air humidifier.

In FIG. 1, the outer container of the electrode air humidifier is indicated by **1**. At the base thereof, the outer container **1** is provided with legs **2** and **3**, with which the outer container rests upon the surface, for example, the floor in a room wherein the electrode air humidifier is placed. The outer chamber **1** is circular and symmetric about the indicated main axis. The central portion **4** of the bottom of the outer container **1** is pressed upwardly, and is provided within this impression with a downwardly projecting well **5**.

The outer container **1** is provided at its top with an opening **6**, the said opening being surrounded by a neck portion **7**. A lid **8** is placed upon the said neck portion **7**. The lid **8** is provided with a peripheral edge **9** which sits around the neck **7**, and, from the edge **9**, a peripheral flange **10** extends. The lid **8** is provided centrally with an upwardly projecting portion **11**.

On the underside thereof, the lid **8** is provided with two downwardly projecting and encircling ridges **12** and **13** which form between them a groove for reception of a packing **14**. A generally cylindrical formed inner container **15** is attached to the lid **8** by means of securing members (not shown), the upper, circular edge of the inner container **15** being in sealing relationship with the packing **14** within the groove between the two annular ridges **12** and **13** on the underside of the lid **8**.

Two connecting screws **16** and **17** are further arranged in the lid **8** to secure two electrode holders **18** and **19** to the lid **8**. The electrode holders **18**, **19** are formed of a suitable electrically conductive band material and support at the lower portion thereof the two electrodes **20**,**21**. Supply of current to the electrodes takes place via the connecting screws **16**, **17**, in a manner not further illustrated, since this is known technique. A cover **39** is placed around the lid **8** as a current protection.

The electrodes **20**, **21** are, as is apparent from FIG. 1, arranged within the steam chamber **27**. In accordance with the invention, the inner container **15** is provided with two pockets **22**, **23**, by means of the respective partition walls **24**, **25**. In the

partition wall 24, an orifice 26 is provided, whereby the pocket 22 is in water-flow contact with the steam chamber 27 in the inner container 15 and, in the same way, the partition wall 25 is provided with an orifice 28. The inner container 15 is provided in the bottom 29 thereof with an opening 30 which permits water-flow contact between the pocket 22 and the well 5 in the outer container 1, a corresponding opening 31 being also provided which permits water-flow contact between the pocket 23 and the well 5 in the outer container 1. In the bottom 29 an opening 32 is also provided which gives direct contact between the well 5 and the steam chamber 27.

The lower portion of the inner container 15 and thereby also the steam chamber 27 extends downwardly into the well 5, as is apparent from FIG. 1. The purpose of this measure is explained herein below.

A disc-shaped member 33 is inserted into the central portion 11 of the lid 8. On the underside thereof, the disc-shaped member is provided with a plurality of guide wings 34 (see FIG. 2), and the disc 33 is disposed within the central portion of the lid 11 in that it is inserted form below and snapped past the thickened encircling portion 35 on the inner wall of the lid portion 11. The disc 33 has a central opening 36 which, on the underside of the disc, is surrounded by a short socket 37. The upper portion 11 of the lid portion provides for an annular space 40 between the disc 33 and the lid portion 11. This space 40 is open to the atmosphere in that an opening 41 is provided in the lid portion 11.

A recirculation element 44 is arranged in the inner container 15 and extends downwardly in the steam chamber 27. The said element is effected as a conical tube piece which, at the lowest part thereof, has a relatively narrow opening 45 arranged immediately above the electrodes 20, 21. The conical tube piece extends up to and around the socket 37 on the disc 33 inserted in the lid portion 11. At the lowest part thereof, the conical tube piece has two guide surfaces 46, 47 (see FIG. 3). The recirculation element 44 rests therewith upon the respective electrodes 20, 21, and against the electrode holders 18,19. The electrode holders 18,19 may preferably be pressed slightly apart one from the other by means of the guide surface 46, 47 on the recirculation element 44, so that the recirculation element is thereby held in place by the spring tension in the electrode holders 18,19.

The electrode air humidifier according to the invention operates in the following manner. The outer container 1 is filled with water to the level 48. When the inner container 15, which is secured to the lid 8, is put in place, the water will have the same height within the steam chamber 27 as in the outer container 1 as a result of the water-flow contact openings 30, 31, 32, 26, 28.

Current is then connected in manner known per se, and the electrodes 20, 21 begin to heat the water within the steam chamber 27 in the inner container 15. The water in the steam chamber 27 begins to boil. In FIG. 1, water level lines are drawn in the inner container, and it can be seen that the water level line within the recirculation element 44 is drawn higher than the water level line in the steam chamber 27, while both these water level lines are below the water level line 48 in the outer container 1. It should naturally be remarked here that, in the steam chamber 27 and in the recirculation element 44, no such defined water level line will exist during boiling. On the other hand there is present a water-steam phase. The intention of the water level lines drawn is merely to show that a greater force of water pressure is present in the recirculation element 44, so that the water circulation is as indicated by the arrow in the recirculation element 44, which is due to the fact that the steam bubbles formed between the electrodes are retarded in the narrow opening 45 in the recirculation element 44, so that the same concentrated bubble formation is not present within the recirculation element as is present outside this.

The pockets 22, 23 prevent pulsation to a great degree, since the water here is relatively hot, and is readily heated by the electrodes to boiling point. The water starts to boil, whereby water is pressed out of the steam chamber due to the rapidly increasing steam pressure. When the steam pressure decreases the water will flow back from the pockets where the water has a temperature of 80° – 90° C. The high temperature in the back flowing water reduces the non boiling period and the pulsation is therefore prevented or strongly reduced. A certain controlled pulsation is ensured, however, in order to prevent collection of lime within the steam chamber, which might disturb the effect of the electrodes and, to this purpose, a small opening 32 is provided in the bottom of the steam chamber 27. Relatively cold water from the outer container 1 can then flow into the steam chamber 27.

The steam developed is deflected by the guide blades 34 and is set in turbulent motion around the socket 37. At this point water is separated which, as indicated, runs down along the inner walls in the recirculation element 44.

The steam thus passes through the socket 37 and into the space 40, and thereafter out through the opening 41, to the room in which the air is to be conditioned as regards humidity.

The water in the outer container 1 will gradually sink, and, when the water level sinks so low that the electrodes 20, 21 are partially exposed, the effect of the electrodes will naturally decrease. A normal course of discharged amount of water per time unit is illustrated in FIG. 4 by means of the curve 50. The curve rises steeply to begin with, that is to say that the electrode air humidifier rapidly reaches its maximal distribution level. Gradually, as the water level sinks, the curve slowly declines, as is apparent at the righthand side of FIG. 4. Such a curve course is undesirable since as long as the current is present in the water between the electrodes the electrodes are subject to wearing, especially at the lower electrode ends. In accordance with the invention it is the aim to provide a curve course as indicated by the curve 51, that is to say that the electrode air humidifier stops sooner thus giving a more certain indication that refilling with water is required and resulting in a less wearance of the electrodes.

In accordance with the invention, the contact between the water in the outer container 1 and the water in the steam chamber 27 is interrupted as soon as the water level is so low that the effect of the electrodes is reduced to a great degree, and this is achieved by means of the impression 4, illustrated in FIG. 1, in the bottom of the outer container 1, with appurtenant well 5, wherein the inner container 15 projects. As soon as the water level in the outer container 1 reaches the level 52 indicated with the broken line, the contact between the greater part of the water amount in the outer container 1 and the steam chamber 27 is interrupted, and the electrodes now heat and boil away only the water located in the well 5. As soon as the water level in the well 5 reaches the level 53 (drawn with broken line in FIG. 1), the current supply is naturally disconnected entirely and the discharge of steam is stopped completely.

Without departing from the scope of invention the pockets may be arranged on the outside of the inner container, the steam chamber thus occupying the whole interior of the inner container.

I claim:

1. An electrode air humidifier comprising an outer liquid container

an inner container defining a steam chamber within said outer container

steam generating electrodes suspended in spaced relation within said steam chamber

a steam outlet at the top of the inner container

a pocket chamber between the steam chamber and the outer container

a liquid passage between the steam chamber and the pocket chamber

a liquid passage between the pocket chamber and the outer container

a tube element mounted vertically within the steam chamber above the electrodes and extending up to adjacent the steam outlet, the tube element having a restricted lower opening

and

means between the upper end of the tube element and the steam outlet for separating water droplets from the steam whereby the water droplets are returned through the tube element.

2. An electrode air humidifier as claimed in claim 1, and a direct liquid passage between the steam chamber and the outer chamber.

3. An electrode air humidifier comprising

an outer liquid container

an inner container defining a steam chamber within said outer container

steam generating electrodes suspended in spaced relation within said steam chamber

a steam outlet at the top of the inner container

a tube element mounted vertically within the steam chamber above the electrodes and extending up to adjacent the steam outlet, the tube element having a restricted lower opening

a partition in the inner container defining a pocket chamber within the steam chamber

a liquid passage between the steam chamber and the pocket chamber

a liquid passage between the pocket chamber and the outer container

and

means between the upper end of the tube element and the steam outlet for separating water droplets from the steam whereby the water droplets are returned through the tube element.

4. An electrode air humidifier as claimed in claim 3, and a direct liquid passage between the steam chamber and the outer container.

5. An electrode air humidifier as claimed in claim 3, and a steam guide member forming part of said separating means and imparting a turbulent effect to the steam and arranged in the steam outlet.

6. An electrode air humidifier as claimed in claim 5, and a direct liquid passage between the steam chamber and the outer chamber.

7. An electrode air humidifier comprising an outer liquid container

an inner container defining a steam camber within said outer container

steam generating electrodes suspended in spaced relation within said steam chamber

a steam outlet at the top of the inner container

a pocket chamber between the steam chamber and the outer container

a liquid passage between the steam chamber and the pocket chamber

a liquid passage between the pocket chamber and the outer container

a tube element mounted vertically within the steam chamber above the electrodes and extending up to adjacent the steam outlet, the tube element having a restricted lower opening

means between the upper end of the tube element and the steam outlet for separating water droplets from the steam whereby the water droplets are returned through the tube element

and

a steam guide member forming part of said separating means and imparting a turbulent effect to the steam and arranged in the steam outlet.

8. An electrode air humidifier as claimed in claim 7, and a direct liquid passage between the steam chamber and the outer chamber.

9. An electrode air humidifier comprising

an outer liquid container

an annular partition defining a shallow well in the bottom of said outer container

an inner container extending down in the well and defining a steam chamber within said outer container

steam generating electrodes suspended in spaced relation within said steam chamber

a steam outlet at the top of the inner container

a pocket chamber between the steam chamber and the outer container

a liquid passage between the steam chamber and the pocket chamber

and

a liquid passage between the pocket chamber and the well.

10. An electrode air humidifier as claimed in claim 9, and a direct liquid passage between the steam chamber and the well.

11. An electrode air humidifier as claimed in claim 9, and a tube element mounted vertically within the steam chamber above the electrodes and extending up to adjacent the steam outlet, the tube element having a restricted lower opening, and means between the upper end of the tube element and the steam outlet for separating water droplets from the steam whereby the water droplets are returned through the tube element.

12. An electrode air humidifier as claimed in claim 11, and a direct liquid passage between the steam chamber and the well.

13. An electrode air humidifier as claimed in claim 11, and a steam guide member forming a part of said separating means and imparting a turbulent effect to the steam and arranged in the steam outlet.

14. An electrode air humidifier as claimed in claim 13, and a direct liquid passage between the steam chamber and the well.

15. An electrode air humidifier comprising

an outer liquid container

an annular partition defining a shallow well in the bottom of said outer container

an inner container extending down in the well and defining a steam chamber within said outer container

steam generating electrodes suspended in spaced relation within said steam chamber

a steam outlet at the top of the inner container

a partition in the inner container defining a pocket chamber within the steam chamber

a liquid passage between the steam chamber and the pocket chamber

and

a liquid passage between the pocket chamber and the well.

16. An electrode air humidifier as claimed in claim 15, and a direct liquid passage between the steam chamber and the well.

17. An electrode air humidifier comprising

an outer liquid container

an annular partition defining a shallow well in the bottom of said outer container

an inner container extending down in the well and defining a steam chamber within said outer container

steam generating electrodes suspended in spaced relation within said steam chamber

a steam outlet at the top of the inner container

a tube element mounted vertically within the steam chamber above the electrodes and extending up to adjacent the steam outlet, the tube element having a restricted lower opening

a partition in the inner container defining a pocket chamber within the steam chamber

a liquid passage between the steam chamber and the pocket chamber

a liquid passage between the pocket chamber and the well

and

means between the upper end of the tube element and the steam outlet for separating water droplets from the steam whereby the water droplets are returned through the tube element.

18. An electrode air humidifier as claimed in claim 17, and a direct liquid passage between the steam chamber and the well.

19. An electrode air humidifier as claimed in claim 17, and a steam guide member forming a part of said separating means and imparting a turbulent effect to the steam and arranged in the steam outlet.

20. An electrode air humidifier as claimed in claim 19, and a direct liquid passage between the steam chamber and the well.

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