United States Patent

Liebert

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[54] HUMIDIFICATION SYSTEM

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[52] **U.S. Cl.**.....**219/273,** 122/379, 126/113

[51] **Int. Cl.**.....**F22b 1/28**

[58] **Field of Search**.....219/271–273, 275, 219/330–333; 122/379, 381–384; 126/113

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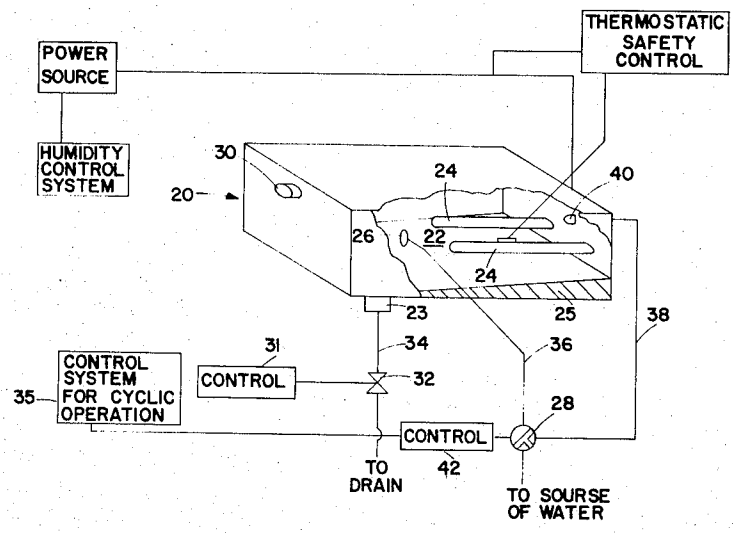
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[57] **ABSTRACT**

A method and apparatus for humidification characterized by a battery of low density stainless steel heaters which provide a band of radiant energy that evaporates water in an absolutely pure state without solids. An electronic control system provides automatic flushing, cleaning and fill cycles. The cleaning cycle includes the introduction of a spray of relatively cold water directed onto the heaters and the side walls of the reservoir to prevent the accumulation of deposits on the heaters and to clean precipitated solids from the walls of the reservoir.

10 Claims, 2 Drawing Figures



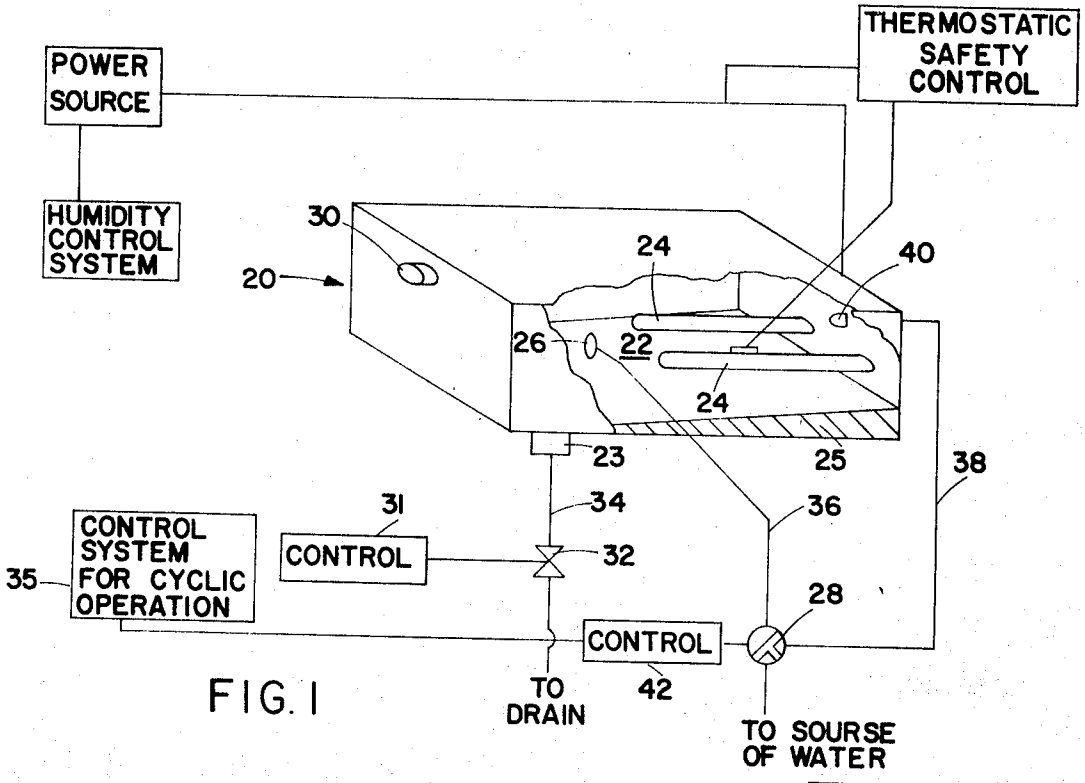


FIG. 1

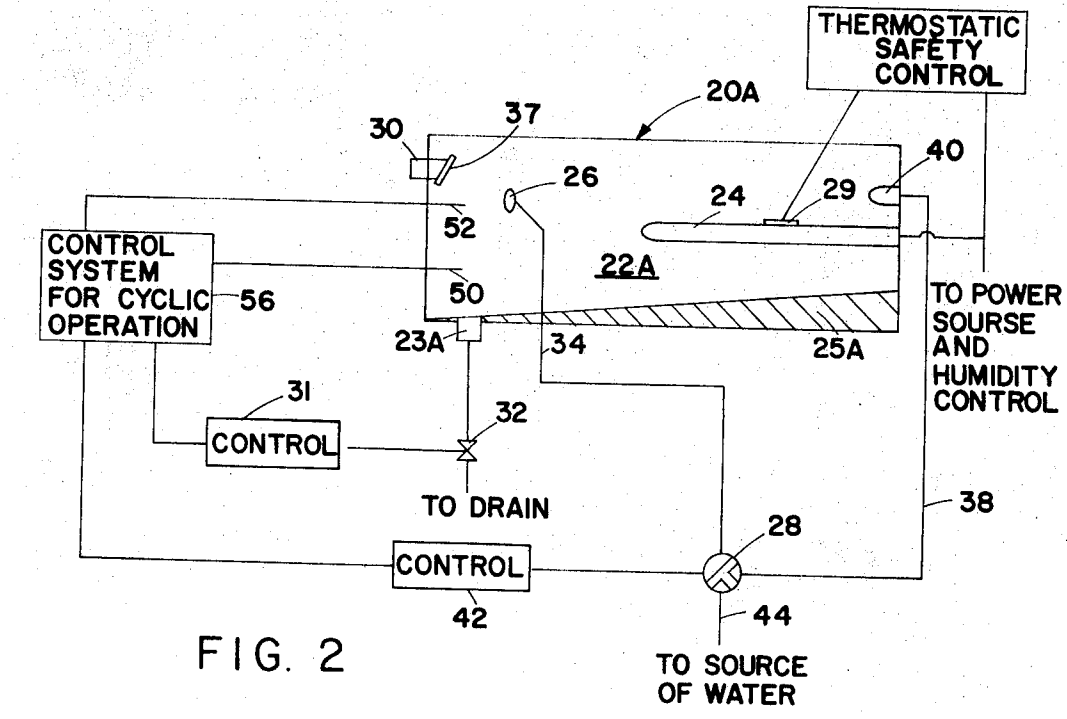


FIG. 2

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HUMIDIFICATION SYSTEM

BACKGROUND OF THE INVENTION

The prior art methods of humidification are numerous and each includes certain advantages and disadvantages relative to one another. One of the older and widely used forms of humidification employs submerged heating devices to supply the heat to evaporate the desire amount of water. This method has the advantage of introducing dust-free pure water vapor into the controlled atmosphere in addition to relatively low installation cost and simplicity of manufacture and operation. However, deposits of impurities from the water collect on the hot walls of the heating elements with a resulting insulation effect causing greatly reduce efficiency. The hard covering formed by these deposits was heretofore very difficult and costly to remove. Since this problem had been so troublesome for such a long period of time, other methods of humidification were eventually developed, such as, for example, the water spray method, the use of steam grid humidifiers, infrared lamps for heating and systems employing baffles or plates to evaporate by osmosis. However, each of these methods were subject to either a similar problem with deposits of impurities or other disadvantages which were substantially equally troublesome and costly. Therefore none of these methods have led to the total replacement of submerged heating elements or to a solution of the problem presented by the formation of these deposits. Another problem associated with all the above types of humidifiers relates to the precipitates formed during evaporation and commonly referred to as "mud" which accumulate on the side walls and bottom walls of the water reservoir. The higher the content of dissolved impurities in the water, the more troublesome the problem of flushing and cleaning the reservoir becomes.

This problem has two sides, the first being the inconvenience of removing the accumulated mud to a satisfactory degree; and the second being the possibility of small particles of the precipitates being carried out of the reservoir or evaporation pan with the air being humidified if such precipitates are permitted to accumulate excessively. The main approach by the prior art devices was to merely drain the evaporation pan periodically and permit the volume of water in the nearly full pan to carry out a portion of the "mud" that has formed. However, this approach leaves much to be desired and periodically the pan must be removed and cleaned manually if excessive mud build-up is to be avoided. Manual cleaning represents a very inconvenient, if not totally unsatisfactory, solution to this problem.

SUMMARY OF THE INVENTION

The present invention provides a humidifier which employs submerged heating elements and which solves the problem of removing the hard coating of deposits formed thereon in a unique, inexpensive, and simple manner.

The humidifier of the present invention incorporates automatic controls which actuate a periodic flushing cycle for the removal of the precipitates formed in the bottom of the water pan or reservoir. Additionally means are provided which are designed to spray relatively cold water onto the heating elements to remove any deposits formed on those elements. The control circuit in one preferred embodiment initiates the flushing cycle to prevent the deposits from building up to any degree that may cause an substantial loss of heating efficiency.

In addition to remedying the problem of deposits on the heating elements, the automatic feature of periodic flushing cycles eliminates the necessity of manually flushing and cleaning of the evaporation pan. Spray nozzles are disposed in the reservoir housing to not only direct water onto the heating elements, but also to direct streams of the spray against the side and bottom walls of the evaporation pan. The pan is designed with a gradient sloping toward the drain outlet and therefore the combination of the spray and the running water leaving through the drain provides superior removal of the "mud." The flushing cycle is automatically timed to prevent any substantial build-up of mud and the necessity to manually flush and clean the evaporation pan is therefore eliminated.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide a humidifier employing submerged heating elements which are automatically and periodically "cleaned" to prevent harmful build-up of deposits.

It is another object of the present invention to provide a humidifier of the type described which incorporates the removal of deposits from the submerged heating elements in a novel, simple manner coincident with the flushing of the precipitated "mud" in the evaporation pan.

It is another object of the present invention to provide a humidifier of the type described which provides an automatic flushing cycle which thoroughly cleans the evaporation pan to an extent which eliminates manual cleaning to avoid excessive accumulation of precipitated "mud."

It is a further object of the present invention to provide a humidifier of the type described that is readily adaptable to standard fixtures and employs readily available components, and further which is relatively simple and inexpensive in construction, operation and maintenance.

Other objects of the invention will become apparent when taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view partially in section and partially diagrammatic of a humidifier and associated control means constructed in accordance with the present invention.

FIG. **2** is a side sectional and partial diagrammatic view of a humidifier illustrating a modified embodiment of the present invention including sensing elements which upon a given signal associated with the accumulation of precipitated mud initiates a flushing cycle.

DETAILED DESCRIPTION OF THE DRAWINGS

A humidifier constructed in accordance with the present invention is illustrated in FIG. **1** and includes a housing indicated generally at **20** which forms a reservoir or evaporation pan **22**. Pan **22** is provided with a bottom wall **25** sloping downwardly from right to left as viewed in FIG. **1**.

A plurality of electrical heating units in the form of high density stainless steel submergible heaters **24** are mounted in parallel horizontal relationship on the side wall of housing **20** and are disposed below the normal water level in pan **22**. The water level is controlled by a conventional float and lever **26** operating a water inlet valve **28**. Heaters **24** are supplied with power in the conventional power source, however, they are controlled by an automatic control system **33** responsive to a humidity sensor. Any conventional type of control system could be used without departing from the spirit of the present invention; however, a preferred form is disclosed in copending patent application, Ser. No. 756,093, now U.S. Pat. No. 3,522,451, wherein a step function of control is utilized to eliminate "hunting" of the system about the set point to provide very accurate control.

A conventional thermostatic control system **29** is operatively connected to heaters **24** and control system **33** as a safety feature to prevent damage to the heaters due to overheating. Overheating could occur, for example, if a malfunction occurs which results in a loss of the normal water level in reservoir **22** during an evaporation cycle.

A water vapor outlet **30** in the form of an open tube disposed in the side wall of housing **20** above the normal water level introduces the water vapor into the closed controlled atmosphere. A filter **37** or impurity separation is preferably disposed over the opening of outlet **30** to assure that only pure water vapor is introduced into the controlled atmosphere.

Still referring to FIG. **1**, an automatic flushing and cleaning system is diagrammatically shown and includes a drain outlet **23** communicating with a solenoid actuated flush valve **32** via

line 34. Valve 32 is actuated by a control 31 between an open and closed position preferably dictated by a solidstate control system 35 which periodically calls for flushing of the system on a predetermined time basis. The time period is imperically determined by the individual circumstances of each application. Two important factors in this determination are the impurity content of the inlet water supplied to the pan 22 and the evaporation rate needed to maintain the humidity at the desired level in the controlled atmosphere.

Water inlet valve 28 is operatively connected mechanically to float 26 and communicates inlet tap water to pan 22 via line 36. Preferably valve 28 is a three-way valve which also communicates with housing 20 via line 38.

Line 38 is operatively connected to a water inlet in housing 20 which includes spray nozzle 30 or the like which is disposed adjacent to the heating elements 24.

Line 44 communicates inlet water to valve 28 and a conventional source of tap water, not shown. Therefore, a predetermined water level is maintained in pan 22, as dictated by float 26, during the humidification cycle. Inlet tap water is also communicated to line 38 and spray nozzle 40 through the action of valve 28 as dictated by control 42. Control 42 overrides the mechanical action of float 26 upon initiation of the flushing cycle to close line 36 and open line 38 to the supply of inlet water via line 44 independent of the water level in pan 22.

Control 42 is preferably operatively connected to the solidstate control circuit 35 as is control 31 and is timed to act in concert therewith such that when the flush valve 32 is opened to drain pan 22, valve 28 closes line 36 and opens line 38 to introduce water through nozzle 40.

The size of the drain outlet via line 34 is designed to permit water to drain out of pan 22 faster than the water entry rate through nozzle 40. This permits pan 22 to be substantially empty and therefore the spray of water from nozzle 40 is permitted to directly contact any deposits of mud which were not carried out with the original volume of water in pan 22.

Preferably nozzle 40 is designed to deliver a spray of water with substantial velocity to a major portion of the side and bottom walls of pan 22 with sufficient volume to effectively remove substantially all deposits of precipitates remaining therein.

However, in addition, the water spray is also directed onto the heating elements 24 which are exposed during the flushing cycle as the water level recedes in pan 22. The temperature of the inlet water is preferably in the normal ambient rang of approximately 65° to 85° F. The heating elements and the crust of deposits formed thereon are much hotter since the temperature of the original water volume was approximately that of the boiling point of water. It has been found that the relatively immediate delivery of water in the ambient temperature range to the "hot" crust of deposits is sufficient to cause these deposits to break off and crumble to an extent whereby the force of the spray removes substantially all of this crust. It is presumed that the temperature differential between the "hot" crusts and the spray is great enough to cause some form of shock to crack the crust and thereby enable the continued water spray to "wash" the elements clean. The deposits so removed fall to the bottom of pan 22 and are carried out through the drain opening with the flow of the water introduced through nozzle 40.

It is readily apparent from the foregoing description that this flushing and cleaning system eliminates not only manual cleaning of the system but prevents the formation of a crust on the heating elements to reach a degree where the efficiency of the elements is substantially affected. The elimination of this problem which has heretofore represented the greatest drawback to the otherwise desirable submerged heating elements method of humidifying, is an extremely important and valuable contribution.

It is important to point out that this very problem of deposits on submerged heating elements and the resulting insulation effect which causes a major loss in efficiency has been the prime factor which moved industry toward other means for creating water vapor for humidification. The tremendous advantages of low cost, simple construction and excellent efficiency of "clean" submerged heating elements were heretofore not sufficient to prevent the change over to other methods because of the great loss of efficiency due to the crusted deposits formed and the heretofore inconvenience and difficulty of their removal.

The present invention not only provides a method and means to solve this problem, but as previously described, concurrently solves the problem of excessive accumulation of precipitated "mud." Therefore submergible heater type humidifiers not only can compete with the other prior art types but it is believed that with the incorporation of the present invention they are superior in performance and less costly to fabricate and maintain.

Now referring to FIG. 2, a modified embodiment is illustrated which includes means for automatically initiating the flushing and cleaning cycle responsive to the level of accumulation of precipitated mud rather than on a specific time cycle as described in the embodiment of the present invention shown in FIG. 1.

An evaporation pan 22*a* is provided with a downwardly sloping bottom wall 25*a* which is provided with a drain outlet 23*a* at the lower end. A pair of temperature sensing means, preferably in the form of thermocouples 50 and 52 are mounted in pan 22*a*. Thermocouple 50 is disposed near the bottom wall of pan 22*a* adjacent to outlet 23*a* and thermocouple 52 is disposed above thermocouple 50 near the surface of the water in pan 22*a* at the normal level dictated by flush valve 32 as described in the embodiment of FIG. 1.

The precipitated mud formed by evaporation of tap water tends to accumulate in much heavier concentration at the lower end of the bottom wall near the drain outlet. Therefore a temperature differential develops between the water at a higher level in pan 22*a* which is relatively free of mud accumulation and the water-mud mixture near the bottom wall. This apparently occurs because a saturated solution of the dissolved impurities forms where the precipitates accumulate and the concentration of the dissolved impurities is less toward the upper portion of the water level. The boiling point of the water therefore varies because of this difference in the concentration of dissolved substances.

As the accumulation of mud grows this temperature differential increases and therefore provides a basis upon which the flushing and cleaning cycle may be initiated by actuation of appropriate control system 56 responsive to a predetermined temperature differential between thermocouples 50 and 52 which in turn is associated with the accumulation of precipitated "mud."

Upon reaching this predetermined temperature differential, a signal is developed to actuate the opening of flush valve 32, the closing of line 36 communicating inlet water to pan 22*a*; and the opening of line 38 to inlet water to deliver water to nozzle 40. Therefore, the operation of the system after actuation of the flush cycle responsive to the temperature differential signal is the same as previously described in the embodiment shown in FIG. 1. The heaters 24 are controlled by an automatic system 58 which is responsive to a predetermined humidity valve in the atmosphere being controlled.

It should be readily apparent from the foregoing that the apparatus and method described provides superior cleaning of the water reservoir for humidifiers in a simple, efficient and inexpensive manner as compared to prior art methods and means.

What is claimed is:

1. In a humidifier responsive to a humidity control means the combination of a housing means including a vessel for containing a predetermined level of water, a submerged heating element; said housing including a drain outlet, first and second water inlets, and a water vapor outlet; valve means operatively connected to said drain outlet and said water inlets; control means associated with said valve means to actuate the opening

and closing of said valve means responsive to predetermined signals; and means for forming a spray of water communicating with one of said water inlets and disposed in said housing to direct said spray on said heating element

2. The humidifier defined in claim 1 wherein said vessel includes side walls and a bottom wall sloping downwardly and wherein said drain outlet is disposed near the lower end of said bottom wall; and wherein said means for forming a spray of water is disposed to direct said spray on said heating element and on to said side and bottom walls of said vessel.

3. In a humidifier as set forth in claim 1 wherein said last-named means further includes means disposed in said housing and communicating with one of said water inlets for directing a stream of water onto said heating element; and wherein said valve means operatively connected to said water inlet and said drain outlet further includes actuating means operatively connected to said valve means to open and close the respective valve means in a predetermined relationship.

4. In a humidifier as set forth in claim 1 wherein said valve means includes a first valve means communicating with said first water inlet and a source of water to automatically introduce water to said vessel responsive to a predetermined level of water in said vessel; second valve means communicating with said drain outlet; third valve means communicating said second water inlet to a source of water; and actuating means operatively connected to said first, second and third valve means and responsive to predetermined signals to actuate said valve means between open and closed positions at predetermined intervals.

5. A method for humidifying a controlled atmosphere comprising the steps of supplying water to a reservoir; evaporating water from said reservoir at a predetermined rate with a heating element submerged below the surface of the water in said reservoir; draining the water from said reservoir at predetermined intervals to expose said normally submerged heating element; and introducing a spray of water onto said exposed heating element for a given time interval coordinated with the step of draining of said reservoir.

6. The method defined in claim 5 wherein the temperature of the water comprising said spray is less than approximately 100° F.

7. The method defined in claim 5 wherein said water spray is concurrently directed onto said heating element and the side walls and bottom walls of the reservoir being drained.

8. A method for humidifying a closed atmosphere as set forth in claim 5 further comprising initiating a flush cycle at predetermined intervals including draining the water from said reservoir and exposing the normally submerged heating elements; and directing a spray of water onto the exposed heating elements for a given time interval coordinated with the flush cycle to remove substantially all deposits formed thereon during the preceding humidifying cycle.

9. A method for humidifying a closed atmosphere as set forth in claim 5 wherein said step of supplying water to said reservoir further comprises the step of controlling the water supply to a reservoir responsive to a predetermined water level in said reservoir during a humidifying cycle.

10. A method for humidifying a closed atmosphere as set forth in claim 5 wherein said evaporating at a controlled rate further comprises responding to a predetermined humidity value in said closed atmosphere and communicating the water vapor created to said atmosphere.

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