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HUMIDITY CONTROL DEVICE

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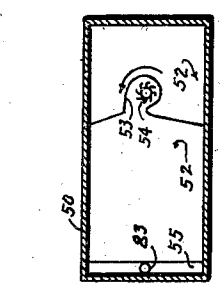


FIG. 2

FIG. 1

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HUMIDITY CONTROL DEVICE

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4 Claims. (Cl. 236—44)

This invention relates to a humidity control device which uses a hygroscopic solution in combination with temperature to control relative humidity in connection with air conditioning apparatus.

One object of the invention is to provide a means for using the density of a hygroscopic solution, having a vapor pressure equal to that of the air in contact therewith, combined with a compensating thermostatic element to control the relative humidity of air at variable temperatures.

Another object of the invention is to provide a means for controlling relative humidity that is not affected by freezing temperatures.

A further object of the invention is to provide a hygroscopic element that may be continuously renewed and which can be easily and cheaply changed in order to remove impurities which may be absorbed from the air.

This application is a continuation in part of my copending application Serial No. 294,584, filed September 13, 1939.

Referring to the drawing:

Figure 1 is a diagram of an assembly of air conditioning apparatus and the humidity control device to control the relative humidity of the air in a room.

Figure 2 is a plan section of the humidity control apparatus at the points marked (2—2).

Referring specifically to Figure 1; the case 10 encloses chemical dehumidifying apparatus comprising the cells 11, formed with wire cloth sides, tops and bottoms 12 for holding granulated or flake calcium chloride 13, separated by the air passages 14, supported by the rack 15 and all assembled within the container 16, the cells 11 being filled with calcium chloride through the door 17. Underneath the said container are placed the level pans 18 having the edges 19 turned up at an angle and the edge 20 turned down at an angle to form a drip. The calcium chloride is melted into a solution by means of moisture absorbed from the air and flows down the porous sides 12 of the cells 11 and drips onto to the level pans 18 which are horizontally spaced so that each pan has the same amount of surface exposed to the drippings of saturated or nearly saturated solution from the cells 11. This solution on the pans 18 absorbs additional moisture from the air and becomes more liquid and is required to flow from the turned up edge 19 across the pans 18 and down over the turned down drip edge 20 into the lower portion of the case 10 and out the drain pipe 21.

Air is drawn by the fan 22 driven by the motor 23 into the case 10 through the inlet 24 over and between the pans 18 in contact with and counter flow to that of the solution, then upward through the air passages 14, in contact with the flake calcium chloride 13, and in counter flow to that of the saturated or nearly saturated solution flowing down the porous sides 12 of the cells 11 and of the air passages 14, through the space 25 and the damper 26 into the space 27, or after passing between the pans 18, upward through the space 28, through the damper 29 and into the space 27, from which it is discharged through the outlet 30. The dampers 26 and 29 are connected by the link 31 and the two pivots 32 and open and close alternately. The damper 26 is normally held closed and the damper 29 is normally held open by the coil spring 33. The damper 26 is opened and the damper 29 is closed by the action of the damper motor 34 moving the damper motor arm 35 around the pivot 36, moving the bar 37 by means of the pivot 38, and the damper arm 39, attached to the damper 26, by means of the pivot 40.

The humidity control device comprises, in part, the case 50 having the partition 51, the sloping floor 52 having the volute 53 for the pump impeller 54, the gutters 55 and 58 and the splash screens 56, the latter composed of wire cloth. The pump impeller 54 draws calcium chloride solution into the center of the volute 53 through the inlet 57 and is discharged from the blades of the pump impeller 54 against the splash screens 56 dripping into the gutter 58 and into the gutter 55. The pump impeller 54 is attached to the end of the shaft 59 which also carries and drives the fan 60, the shaft 59 being driven by the motor 61, which is attached to the bracket 62, which is attached to the case 50 and to the partition 51.

The other part of the humidity control device comprises the hydrometer 63, floating in the calcium chloride solution which is held in the tube 64, and attached by the clamp 65, the bolt 66 and the pivot 67 to the lever 68. The opposite end of the lever 68 carries the mercury switch 69 and swings on the pivot 70, which is attached to the compensating thermostatic element 71 which slides up and down in the guides 72 which are attached by the bolts 73 to the standards 74. The height of the pivot 70 and the active length of the compensating thermostatic element 71 are regulated by the clamp 75 which is held in place by the set screw 76.

Under some conditions, the waste solution flows

from the chemical dehumidifying apparatus down the drain pipe 21, through the pipe 77, the valve 78 being closed and the valve 79 being opened, up through the tube 64, wasting through the pipe 80, the valve 81 being opened, and wasting away through the pipe 82. With a properly designed apparatus for dehumidifying air, the waste solution will have a vapor pressure in equilibrium with that of the air entering the inlet 24 and a corresponding specific gravity and temperature.

Under other conditions, the waste solution flows from the chemical dehumidifying apparatus down the drain pipe 21 and wastes away through the pipe 82, the valve 78 being opened and the valves 79 and 81 being closed. The solution is recirculated by the pump impeller 54 through the gutters 58 and 55, the pipes 83 and 77, the tube 64, the pipe 84 and the pump inlet 57.

Air is drawn by the fan 60 through the inlet 86, into the case 50, downward through the space 87, through the opening 88, over the solution, upward over the splash screens 56, through the space 89 and discharged through the outlet 90. The solution, being hygroscopic, will attain equilibrium conditions of vapor pressure with that of the air in contact therewith and a corresponding specific gravity and temperature.

The vertical position of the clamp 75 on the standard 74 should be at a height where, with the hydrometer set at the proper level, the mercury in the tube of the switch 69 begins to flow toward the hydrometer 63 and make a metallic contact between the ends of the two wires 91 and 92.

The active length of the compensating thermostatic element 71 from the clamp 75 to the pivot 70 should be such that the change in length, due to temperature, should be equal to the change in height of the hydrometer, due to the change in specific gravity, necessary to maintain the same relative humidity according to the following table; which shows the specific gravity of calcium chloride solutions in equilibrium conditions of vapor pressure with that of the relative humidity of air at the same temperature.

Temperature	Relative humidity				
	80%	70%	60%	50%	40%
100	1.212	1.270	1.318	1.358	1.400
90	1.211	1.269	1.317	1.357	1.398
80	1.210	1.268	1.316	1.356	1.396
70	1.208	1.266	1.314	1.354	1.393
60	1.205	1.263	1.312	1.351	1.390
50	1.202	1.260	1.309	1.348	1.387
40	1.199	1.257	1.306	1.344	1.383

Electric power is supplied to the motor 61 by the positive wire 93 controlled by the switch 94, and by the negative wire 95, to the fan motor 23 by the positive wire 96, controlled by the switch 97, and by the negative wire 98, and to the damper motor 34 by the positive wires 91 and 92, controlled by the mercury switch 69, and the negative wire 99.

Under conditions of low relative humidity of the air entering the inlet 86, the hygrometer 63 floats comparatively high in the tube 64 and the mercury in the tube of the switch 69 flows away from the ends of the wires 91 and 92 with the damper 26 closing and the damper 29 opening due to the tension of the spring 33.

On a rising relative humidity of the air entering the inlet 86, the hydrometer 63 begins to float lower in the tube 64, tilting the lever 68 so that the mercury in the tube of the switch 69 flows toward the hydrometer 63 and makes a metallic contact between the ends of the wires 91 and 92, thereby supplying power to the damper motor 34 by means of the positive wires 91 and 92 and the negative wire 99, thereby moving the damper motor lever 35 around the pivot 36 to move the bar 37 with the pivots 38 and 40 to move the damper arm 39 to open the damper 26 and to close the damper 29 by means of the bar 31 and the pivots 32.

Under conditions of comparatively high relative humidity and continuous or nearly continuous use, the apparatus will function with the waste solution flowing through the pipes 21, 77, 84, 80 and 82, with the valve 78 closed and the valves 79 and 81 opened, and through the tube 64, with the current in the positive wire 93 broken by opening the switch 107, thereby stopping the motor 61, the fan 60 and the pump impeller 54.

In order to prevent the relative humidity from going below some predetermined point, means is provided by the spray 100, supplied with water through the pipe 101 and controlled by the solenoid valve 102 for adding humidity to the air when passing through the space 28. The auxiliary mercury switch 103 is placed adjacent to the mercury switch 69 with the contact end tilted upward so as to cause a lag in time between breaking the contact in one mercury switch before making a contact in the other mercury switch due to a rising or lowering of the hydrometer 63 and the consequent tilting of the lever arm 68 in either direction. The solenoid valve 102 is normally closed and is opened when supplied with electric current through the positive wires 104 and 105 and the negative wire 106, when the hydrometer 63 rises sufficiently to cause the mercury in the tube of the switch 103 to make a metallic contact between the ends of the wires 104 and 105. On a rising relative humidity above the predetermined point, the hydrometer 63 floats lower in the tube 64, the mercury in the tube of the auxiliary switch 103 flows toward the hydrometer 63 and breaks the contact between the ends of the wires 104 and 105, thereby breaking the circuit through the positive wires 104 and 105 and the negative wire 106, closing the solenoid valve 102 and shutting off the water in the pipe 101 to the spray 100 to stop the increase in the relative humidity. The combination of these two means for decreasing and increasing relative humidity and the two mercury switches for controlling the action of both means provides for a very close control of relative humidity.

It is to be understood that minor changes can be made in the details of the invention in order to adapt it to practical use, including varying the degree of tilt of the auxiliary mercury switch in relation to that of the primary mercury switch, and the substitution of means other than electricity for operating the motors, valves and dampers.

What I claim is:

1. A method of conditioning air of an enclosure to maintain a substantially constant relative humidity within a relatively wide dry bulb temperature range, comprising the steps of chemically dehydrating air of said enclosure to form a waste hygroscopic solution having a vapor pressure substantially in equilibrium with that of the air being conditioned, determining

the density of said solution and controlling the rate of dehydration of the air in accordance with the density, and compensating the control due to density according to the temperature of the air of the enclosure.

2. A method of conditioning air of an enclosure to maintain a substantially constant relative humidity within a relatively wide dry bulb temperature range, comprising the steps of chemically dehydrating the air of said enclosure to form a waste hygroscopic solution having a vapor pressure substantially in equilibrium with that of the air being conditioned, and regulating the rate of dehydration of the air through the joint control of solution density and temperature of the air of the enclosure.

3. In humidity control apparatus for chemically dehydrating the air of an enclosure, comprising a source of hygroscopic solution, having had contact with the air being conditioned and having a vapor pressure in equilibrium condition with that of such air, a hydrometric element actuated by the density of said solution, a compensating thermostatic element actuated by the temperature of the air being conditioned and operatively associated with said hygroscopic element, and means under the control of said elements for regulating the humidity of the air being conditioned.

4. In an apparatus for conditioning air, a control for regulating relative humidity at variable temperatures comprising a source of hygroscopic solution having had contact with the air being conditioned and having a vapor pressure in equilibrium condition with that of such air, a hydrometric element actuated by the density of said solution, thermostatic means actuated by the temperature of the air being conditioned, and operative connections between said elements whereby the effective action of said hydrometric element is altered, and means under the control of the effective action of said hydrometric element for regulating the relative humidity of the air being conditioned.

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