May 31, 1932. S. M. ANDERSON 1,860,377

AIR CONDITIONING CONTROL

Filed May 8, 1931 2 Sheets-Sheet 1

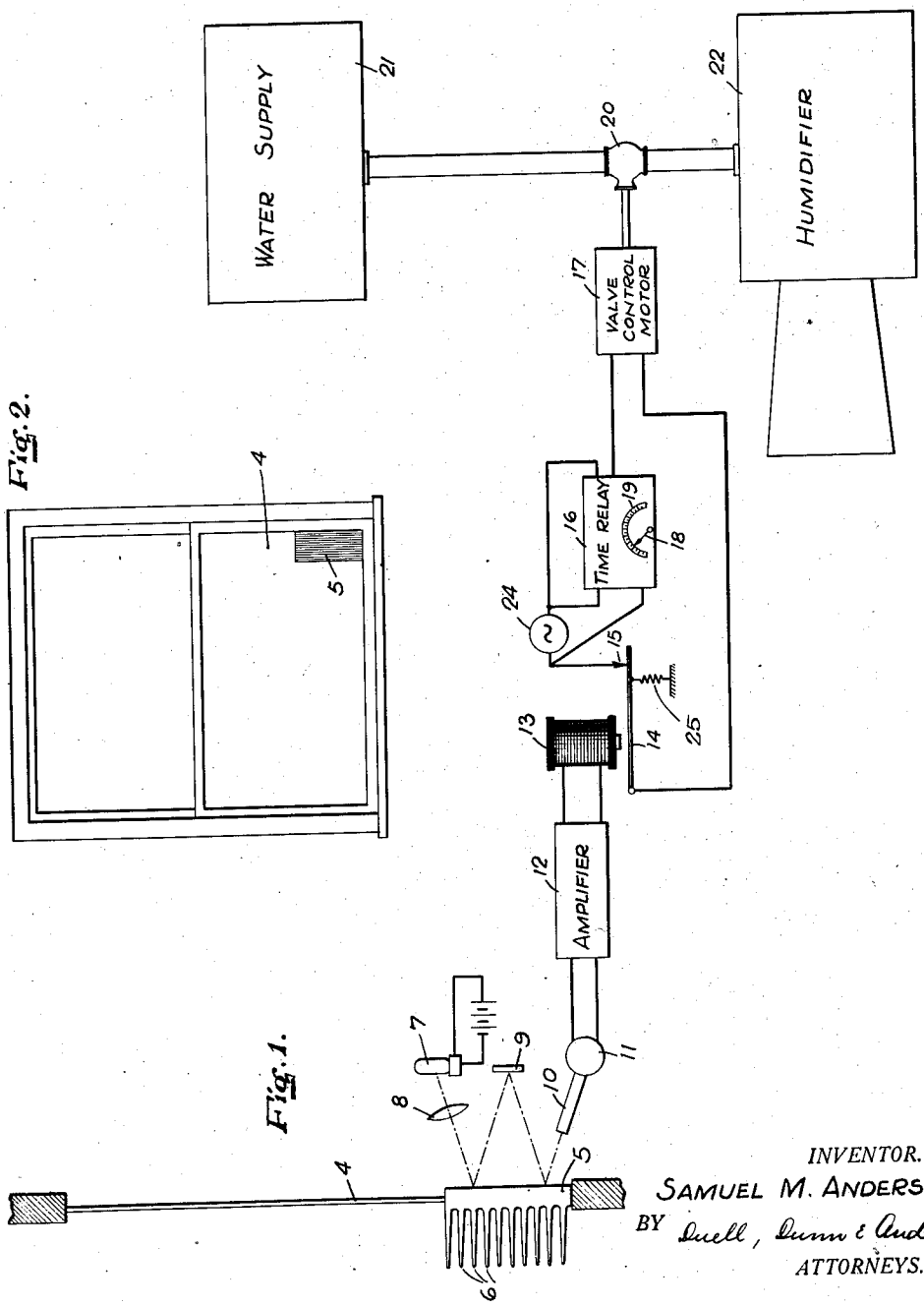

Fig. 2.

Fig. 1.

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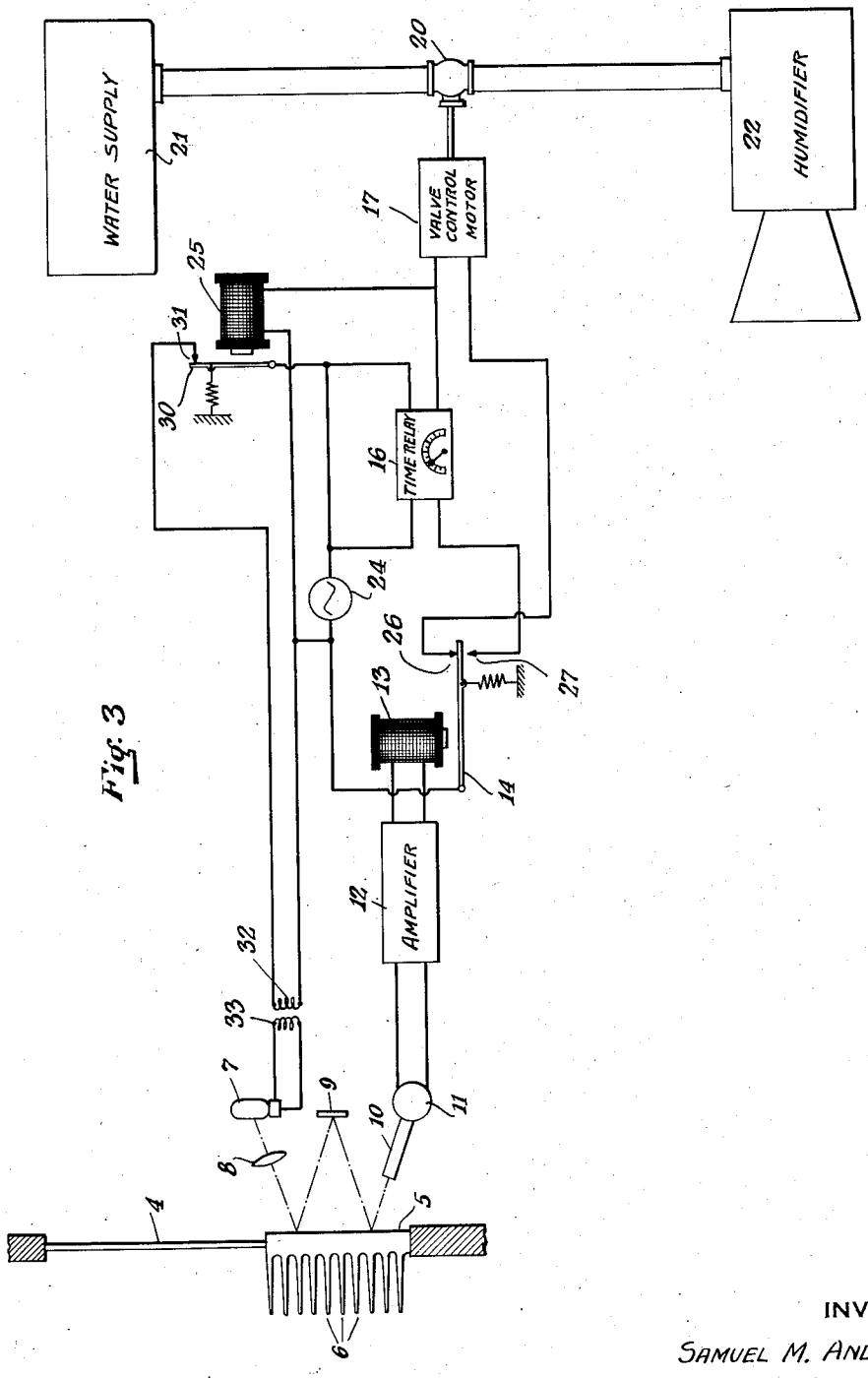

Fig. 3

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Patented May 31, 1932 1,860,377

UNITED STATES PATENT OFFICE

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AIR CONDITIONING CONTROL

Application filed May 8, 1931. Serial No. 536,059.

This invention relates to methods and apparatus for controlling the vapor content of fluids and relates more particularly to methods and apparatus for controlling the relative humidity of the air within an enclosure.

It is becoming better and better known that living conditions in heated rooms are greatly improved when the air within the rooms contains a substantial amount of moisture or water vapor which tends to prevent the drying of the nasal and throat passages of the occupants. This moisture also tends to prevent the circulation of dust, which in itself is undesirable and may be injurious. Also, in certain manufacturing processes, among which are the manufacture of paper and the manufacture of cloth, the presence of a certain amount of moisture is necessary in the air in which the processes are employed. The heating systems generally employed for heating buildings effectively reduce the relative amount of moisture in the air so that it has been found desirable to provide humidifying apparatus for introducing additional moisture to compensate for the loss of relative humidity through the heating process.

A relative humidity of from fifty (50%) to fifty-five (55%) percent is in many cases desirable, but in cold weather and especially in extremely cold weather, such a high degree of moisture in the air of a closed room is attended by a serious disadvantage, in that a low outdoor temperature chills the window panes of the room, causing the moisture in the air of the room to condense thereon, and if this condensation is excessive, the window pane becomes frosted or clouded and the view is obscured. In many cases it may be desirable that the moisture content of the air in a room be as high as possible without producing this condensation of the moisture on the window surface, but due to the wide range of outdoor temperatures during the winter months, and the resulting difference in temperature between the heated air in the room and the outside air, the relative amount of moisture which can be supplied to the room without causing condensation will correspondingly vary within wide limits.

An object of this invention is to control the vapor content of a fluid.

Another object of the invention is to automatically control the supply of moisture to the air within an enclosure, by observation of the condensation of the moisture from the air on a metal surface having a portion exposed to outside temperatures.

Another object of the invention is to automatically control the supply of moisture to the air within an enclosure, by observation of the condensation of the moisture from the air on a metal surface having a portion exposed to outside temperatures, said portion being provided with fins to more rapidly transmit changes in outside temperature to the inside metal surface.

Another object of the invention is to shut off the humidifier upon the appearance of condensation of moisture at an observation post adjacent one window, and to delay the restarting of the humidifier after the moisture has disappeared at the point of observation, until a sufficient period has elapsed for the condensed moisture to disappear from the other windows of an enclosure.

In one form of the invention, a photo-electric cell which has the properties of varying the current in its control circuit proportional to the light variations impressed upon it is subjected to the action of light reflected from a surface located in a heated enclosure, the air of which is being humidified, and having another portion exposed to outside temperatures. Any variation in light reflected against the photo-electric cell caused by the condensation of moisture on the surface of the metal is caused to actuate control apparatus for controlling the moisture supply. A portion of the metal having the reflecting surface is in contact with and therefore responsive to the outdoor temperatures and the inside surface is in contact with and subjected therefore to the action of the air within the room. When the inside reflecting surface has been cooled to a temperature corresponding to the dew point of the air within the room, moisture from the air precipitates upon the surface and shuts off

a portion of the light reaching the photo-electric cell.

According to a feature of the invention, as long as the humidity of the air within the room is below the condensation point, the photo-electric cell will be subjected to a maximum amount of light supplied by a light source and reflected by a metal surface, but as soon as condensation begins to take place upon the reflecting surface, the intensity of light directed upon the photo-electric cell decreases. This decrease in light actuates through the photo-electric cell, control circuits to automatically control the amount of moisture added to the air from the humidifier. When the condensation has disappeared from the metal surface, the light striking the photo-electric cell increases and actuates control circuits to increase, after a predetermined period of time, the amount of moisture supplied to the air.

According to a feature of the invention, the metal reflecting surface exposed to outside temperatures is provided with radiating fins which speed up the cooling action of the outside air upon the reflecting surface and thereby cause moisture to precipitate upon the metal reflecting surface before it will precipitate on the warmer window panes.

According to another feature of the invention, since the house having air conditioning equipment has a number of windows, one or more of which may be exposed to different outdoor temperatures due to shifting winds or different exposures, so that one window pane may have a lower temperature than another window pane, causing the condensation of moisture on one window while another is clear, provision is made for shutting off the humidifier when condensation of moisture occurs at the observation post and delaying the restarting of the humidifier after the condensation has disappeared at the observation post until time has elapsed for the coldest window pane of the house to become cleared up.

The invention will now be described with reference to the drawings, of which:

Fig. 1 is a diagrammatic view of a humidity control system;

Fig. 2 is a plan view of a window incorporating the metal reflecting surface of Fig. 1, and

Fig. 3 is a diagrammatic view of a humidity control arrangement which may be used to replace that shown by Fig. 1.

Referring now to Figs. 1 and 2, there is arranged in a portion of the window 4, a metal reflecting surface 5 which is provided with the radiating fins 6 in contact with the outdoor air, and is, therefore, responsive to outdoor temperatures. The light source 7, which is preferably of the neon gas type which will not radiate heat against the reflecting surface 5, has a portion of its produced light concentrated by the lens 8 and projected against the metal surface 5, which reflects the beam of light against the surface of the mirror 9, from which it is again reflected against the reflecting surface 5, and is finally reflected through the light limiting tube 10, against the photo-electric cell 11.

The photo-electric cell 11 is so connected through the amplifier 12 to the relay 13 that increases in light striking its photo-sensitive cathode, cause electrical current variations which are amplified sufficiently to energize the relay. When there is no moisture condensed on the metal surface 5, the light projected by the light source and reflected against the photo-electric cell 11 is a maximum. Maximum current therefore flows from the photo-electric cell through the amplifier 12 and the winding of the relay 13, causing the relay to pull up its armature 14 to complete the electrical circuit, including the armature 14, contact 15, and the control valve contacts of the time relay 16. These contacts are to complete the electrical circuit energizing the valve control 17. The closing of these contacts, which are not shown, is delayed for a period of time, adjustable by means of the pointer 18 on the scale 19, so that the valve control 17 is not actuated and the valve 20 is not opened, until a predetermined period of time has elapsed. The purpose of delaying the opening of the valve is to prevent the supply of water from the water supply 21 to the humidifier 22, until the condensed vapor has disappeared from other windows of the room or house which may be at lower temperatures than the metal surface 5.

The time relay 16 may be a General Electric definite time relay, the construction and operation of which is well known to those skilled in the art, and which is described in the "Relay Handbook", published by the National Electric Light Association, Graybar Building, New York city. The time relay 16 comprises a synchronous motor which rotates continuously and operates mechanism to close contacts periodically, keeping the contacts closed for a fixed period of time. For the purpose of illustration, the time relay 16 may be adapted to close its contacts every two hours, keeping them closed for ten minutes. Both of these time periods may be varied as conditions require. The contacts, which are closed within the valve control relay 16, are connected in series with the valve control motor 17, the alternating current source 24, the contact 15, and the armature 14 of the relay 13.

When the relay 13 is energized on the disappearance of moisture from the reflecting surface 5, the armature 14 pulls up and closes the valve circuit to the time relay 16, so that as the time relay functions, bringing the valve control contacts towards their closed position, the valve control motor 17 is ren-

dered operative. When they reach their closed position, if the relay 13 is still energized, a circuit including the armature 14, the contact 15, the alternating current source 24, the contacts in the time relay 16, and the valve control motor winding 17 will be completed causing the valve control mechanism to open the valve 20, permitting the supply of water from the water supply 21, to the humidifier 22, and the resulting supply of moisture by the humidifier to the room.

When moisture occurs on the reflecting surface 5, a portion of the light from the light source 7 to the photo-electric cell 11, is shut off. The relay 13 becomes de-energized sufficiently to permit the spring 25 to pull back the armature 14, causing the electrical current from the source 24, to the motor control valve 17, to be shut off by the separation of the contact 15 from the armature 14. The valve 20 then closes to shut off the supply of water to the humidifier until such time as the valve control circuit is energized through the disappearance of moisture from the reflecting surface 5. Before the moisture disappears, however, the time relay 16 has moved around to open the contacts in the valve circuit to the valve control motor 17, and the valve control motor 17 cannot be energized again until the predetermined period of time has elapsed, bringing the time relay contacts together again.

When the moisture does disappear from the reflecting surface 5, the photo-electric cell 11 is again energized by a strong light beam from the light source 7, the relay 13 is energized, the armature 14 pulls up against the contact 15, again rendering the valve circuit operative, and, after the predetermined period of time, the valve 20 is again opened to permit the humidifier 22 to supply moisture to the room.

The period of time required for the clock mechanism in the time relay 16 to close the contacts energizing the valve control motor 17, may vary from day to day, depending upon the outdoor temperature and the direction of wind, etc. If a cold wind is blowing against the window 4 with which is associated the observation reflecting surface 5, then the chances are that the window 4 will be the coldest window of the house, and that once the humidifier is shut down the moisture will disappear from the other windows before it disappears from the reflecting surface 5. If so, then the time relay mechanism may be adjusted to give instantaneous response once the relay 13 is energized to pull up its armature 14.

On the other hand, a window having a different exposure from that of the window 4 may have a cold wind blowing against it, causing this window to remain clouded up with moisture after the moisture disappears from the observation surface 5. Then the time delay mechanism of the time relay 16 should be adjusted so that the humidifier is not turned on after the disappearance of moisture from the observation surface 5 until the moisture has disappeared from the coldest window.

The control arrangement shown diagrammatically by Fig. 3 is particularly suitable for an installation where the light source used to actuate the photo-electric cell instead of being a source of cold light, as illustrated in Fig. 1, is a source such as an ordinary incandescent lamp which generates heat which acts to warm the metal reflecting surface. When an incandescent filament type of light source is used, it is desirable to have the heat emitting light source active as little as possible. This, the arrangement shown by Fig. 3 accomplishes. With this arrangement, the time relay instead of acting to open the humidity control valve after a predetermined period of time after the observation surface becomes clear, acts to energize the incandescent light source for a few seconds after the chosen predetermined period of time. Referring now to Fig. 3, the operation of the arrangement will be explained in detail. In both Figs. 1 and 3 identical apparatus has been given the same numbers.

Assuming the reflecting surface 5 to be fogged up, a portion of the light from the source 7 is shut off by the condensation, the light reaching the photo-electric cell 11 is reduced, the relay 13 is de-energized, the armature 14 falls back to open the circuit including the armature 14, the contact 26, the winding of the valve control motor 17, contacts in the time relay 16, and the alternating current source 24, permitting the valve control motor 17 to close the valve 20, shutting off the humidifier. At the same time a circuit is closed including the armature 14, the contact 27, the winding of the time relay 16, and the alternating current source 24, starting the clock mechanism of the time relay.

The time relay 16 has its internal mechanism so adjusted that at the end of a predetermined time after it starts, its contacts close for a few seconds, then open again, and remain open for the predetermined period of time at the close of which they close again for a few seconds. When the time relay contacts close, a circuit including the contacts of the time relay, the winding of the relay 25, and the alternating current source 24, is closed, energizing the relay 25, causing its armature 30 to pull up to contact with the contact 31 which closes the circuit including the armature 30, contact 31, transformer primary 32, and the alternating current source 24. Inductively coupled to the primary winding 32 is the secondary winding 33 which supplies current to energize the light source 7. As previously stated, at the end

of a predetermined period of time after the time relay 16 is started, the light source 7 is turned on for a few seconds. If the observation surface 5 is clear when the light source 7 is flashed on, the relay 13 is energized, its armature 14 is pulled up to break contact with the contact 27 to disconnect the time relay 16 and contact with the contact 26 to close the circuit of the valve control motor 17 which operates to close the valve 20. Since the flashing of the light source 7 only occurs after a predetermined period of time, the humidifier is not turned on at the moment the observation surface becomes free from moisture, but is delayed a time interval chosen to be sufficient to permit the coldest window of the house to become free from moisture before the humidifier is turned on.

The difference in time between the disappearance of moisture from the observation surface 5 and that of the other windows, even though another window may be colder, is reduced by constructing the observation surface 5 of metal with the radiating fins 6. With this type of construction, the heat from the room is radiated faster by the increased radiation surface and cooled to a lower temperature by the outside air so that it responds to the moisture within the room, to become clouded up at a much higher temperature than the windows of the house, due to the fact that the latter are kept at higher temperatures by the heated inside air.

Whereas a metal reflecting surface with radiating fins has been shown as comprising the observation surface for reflecting light against a photo-electric cell, it should be understood that the window pane may be provided with radiating surfaces and that a reflecting surface may be associated with such window pane, or that any other method of causing more rapid conduction of heat from an observation surface comes within the scope of the invention. Furthermore, while a time relay mechanism has been shown connected to the valve control motor to directly operate same, it should be understood that a time delay mechanism of any type may be associated with the relay 13, the amplifier 12, the photo-electric cell 11, the light source 7, or any other portion of the equipment to accomplish the desired results.

It should further be realized that all the equipment shown for accomplishing the desired results have been chosen for the purpose of illustration only and that many obvious departures or substitutions may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. Apparatus for controlling the amount of moisture in the air within a room comprising a moisture source, a reflecting surface within said room having a finned radiating portion exposed to outside temperatures, means for projecting a light beam against said surface, means for changing light variations from said surface caused by any condensation of moisture thereon into electrical variations, and means for controlling the addition of moisture from said source through said electrical variations.

2. Apparatus for controlling the amount of moisture in the air within a room comprising a moisture source, a reflecting surface having a portion exposed to outside temperatures, means for projecting a cold light beam against said surface, means for changing light variations from said surface caused by any condensation of moisture thereon into electrical variations, and means for controlling the addition of moisture from said source through said electrical variations.

3. Apparatus for controlling the amount of moisture in the air within a room comprising a moisture source, a reflecting surface having a portion exposed to outside temperatures, means for projecting a cold light beam against said surface, a photo-electric cell for changing light variations from said surface caused by any condensation of moisture thereon into electrical variations, and means for controlling the addition of moisture from said source through said electrical variations.

4. Apparatus for controlling the amount of moisture in the air within a room comprising a moisture source, a metal reflecting surface within said room having a finned radiating portion exposed to outside temperatures, means for projecting a cold light beam against said surface, a photo-electric cell for changing light variations from said surface caused by any condensation of moisture thereon into electrical variations, and means for controlling the addition of moisture from said source through said electrical variations.

5. The method of controlling the amount of moisture in the air in a building having a plurality of windows exposed to outdoor temperatures, which comprises, actuating moisture control apparatus upon the condensation of moisture on a surface within said building having a portion exposed to outdoor temperatures, to decrease the amount of moisture supplied to the air within said building, and upon the disappearance of condensation on said surface to increase the amount of moisture after a predetermined time sufficient to have permitted the disappearance of condensation from all the windows of said building.

6. Apparatus for controlling the amount of moisture in the air within a building having a plurality of windows exposed to outdoor temperatures, comprising a moisture source, means for decreasing the moisture from said source, on the cooling of an observation surface within said building to the dew point of the moistened air, when condensation appears upon said surface, means

acting to increase the amount of moisture from said source on the disappearance of condensation from said surface, and means for delaying the functioning of said last mentioned means for a predetermined period of time sufficient to permit the moisture to disappear from said windows.

7. Apparatus for controlling the amount of moisture in the air within a building having a plurality of windows exposed to outdoor temperatures, comprising a moisture source, a reflecting surface having a portion exposed to outdoor temperatures, means for projecting a light beam against said surface, means for changing light variations from said surface, caused by any condensation of moisture thereon into electrical variations, means actuated by said electrical variations for decreasing the supply of moisture from said source upon the appearance of condensation on said surface and for increasing the supply of moisture from said source when the condensation disappears from said surface, means for delaying the addition of moisture from said source upon the disappearance of moisture from said surface, for a predetermined time sufficient to permit the moisture to disappear from said windows.

8. Apparatus for controlling the amount of moisture in the air within a building having a plurality of windows exposed to outdoor temperatures, comprising a moisture source, a reflecting surface having a finned portion exposed to outdoor temperatures, means for projecting a light beam against said surface, means for changing light variations from said surface, caused by any condensation of moisture thereon into electrical variations, means actuated by said electrical variations for decreasing the supply of moisture from said source upon the appearance of condensation on said surface and for increasing the supply of moisture from said source when the condensation disappears from said surface, means for delaying the addition of moisture from said source, upon the disappearance of moisture from said surface, for a predetermined time sufficient to permit the moisture to disappear from said windows.

9. Apparatus for controlling the amount of moisture in the air within a building having a plurality of windows exposed to outdoor temperatures, comprising a moisture source, a metal reflecting surface having a portion exposed to outdoor temperatures, means for projecting a cold light beam against said surface, means for changing light variations from said surface, caused by any condensation of moisture thereon into electrical variations, means actuated by said electrical variations for decreasing the supply of moisture from said source upon the appearance of condensation on said surface and for increasing the supply of moisture from said source when the condensation disappears from said surface, means for delaying the addition of moisture from said source, upon the disappearance of moisture from said surface, for a predetermined time sufficient to permit the moisture to disappear from said windows.

In testimony whereof I affix my signature.

SAMUEL M. ANDERSON.