

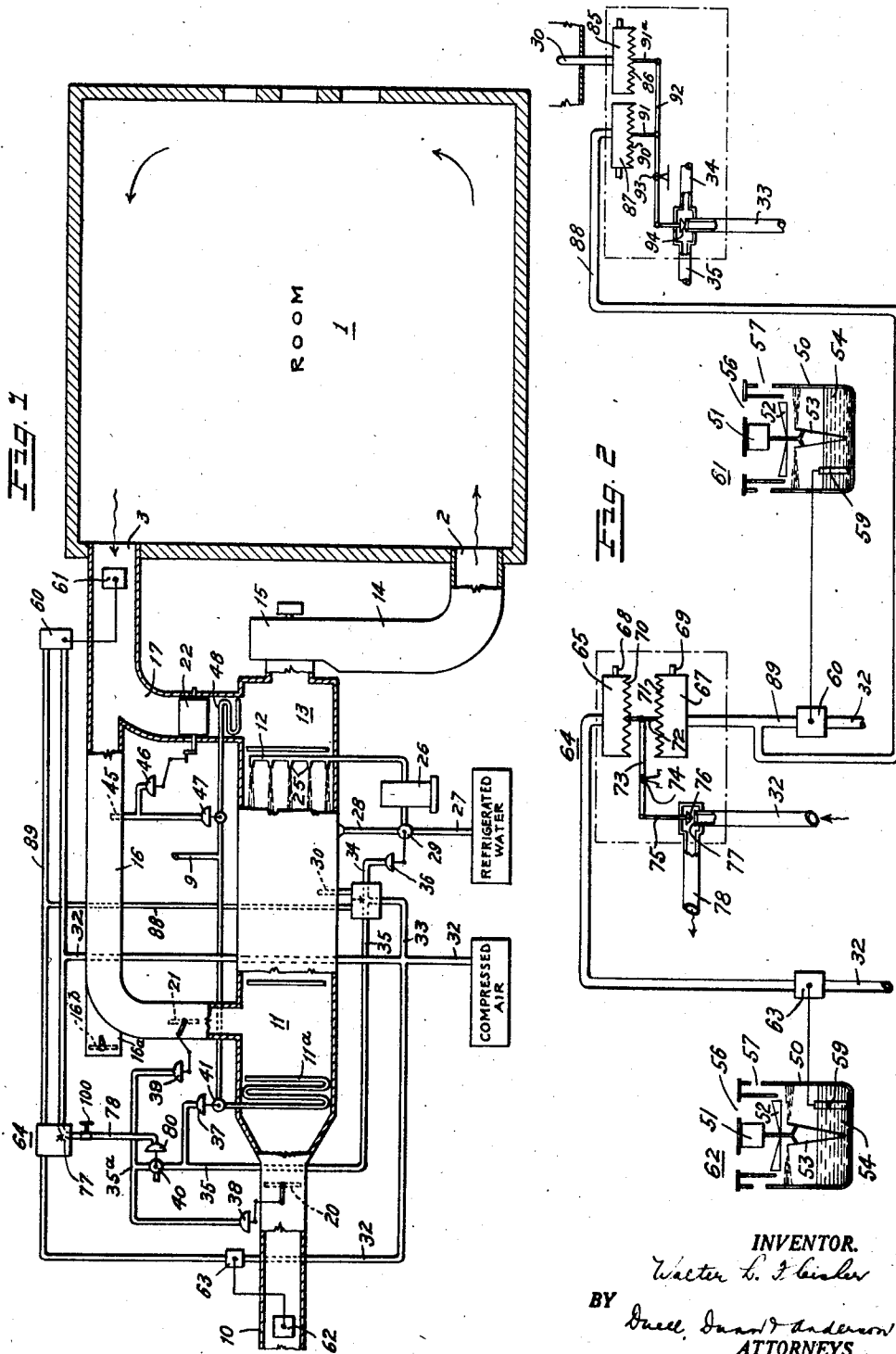
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PROCESS OF VENTILATING

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UNITED STATES PATENT OFFICE

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PROCESS OF VENTILATING

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This invention relates to ventilating systems and more particularly to systems designed to maintain certain standards of conditions within an enclosure. It is an object of this invention to provide a system in which the desired standards may be maintained with the greatest economy and efficiency.

The invention is of widespread application but as many of its features are particularly applicable to the ventilation of public enclosures such as theaters, it will be specifically illustrated as applied to such a system.

In the ventilation of public theaters where large groups of people are brought together, the ventilating question is primarily one of cooling and dehydration both winter and summer.

Satisfactory ventilation requires the circulation through the building of large quantities of air, considerably in excess of the quantity required to make up for what is lost to the system through doors, windows and direct discharge. The most obvious source for this air is the air of the enclosure itself since it is generally near the standard of temperature and humidity desired but it can not serve as the only source, under normal circumstances unless special provision be made for the dehydration and cooling referred to.

In the winter time, the dehydration and cooling of the enclosure is a comparatively simple matter because of the low temperature and absolute humidity of the outer air. It is possible, therefore, to correct the humidity in the enclosure by the introduction of a proper quantity of fresh air and to maintain control thereof within narrow limits by passing the air or a portion of it through an air washer under controlled conditions. In the summer time, however, conditions normally arise where the external conditions can not be so simply corrected. Under such circumstances, artificial refrigeration may be required either artificially to lower the temperature within the spray chamber or to lower the temperature of the water of the sprays. This increases the cost of the ventilation since it is in the use of refrigeration, that the operation becomes most expensive. Economy of operation, therefore, demands that the

quantity of refrigeration be reduced to a minimum. It is an object of this invention automatically to effect such an economy.

On the humid days of summer, it may well be found that air taken from the enclosure itself is cooler and less humid than the external atmosphere. Under such conditions, it will be obvious that the most economical operation will be that which uses the minimum quantity of external air and the maximum quantity of return air. When, however, the evaporation temperature of the outer air falls until it is below that of the return air, greater economy of refrigeration can be effected by discontinuing the use of return air by discharging it to the outer atmosphere and utilizing only fresh air as the source of air to be dehumidified. It is an object of this invention automatically to select the one or the other of these two sources which is at the moment most suitable for dehydration.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic view of a ventilating system embodying this invention; and

Fig. 2 is a diagrammatic view of the control system employed.

In the drawings, the numeral 1 designates a room or chamber to be ventilated having an air inlet at 2 and an air outlet at 3 suitably located to secure proper circulation of air within the room. It will be understood that in practice, a plurality of properly distributed inlets and outlets may be employed which are in this diagrammatic view represented as single orifices.

The air supply and conditioning system employed in this illustrative embodiment comprises a conduit 10 open to the outer air and leading to a mixing chamber 11 having a tempering coil 11^a therein which is connected to a steam pipe 9. The mixing chamber 11 leads to an air washer 12 which in turn leads to a second mixing chamber 13 which is connected to the air inlet 2 by a conduit 14 having a fan 15 located therein. A conduit 16 affords communication between the

air outlet 3 and the mixing chamber 11, and a branch of this conduit 17 admits return air to the mixing chamber 13. Dampers 20 and 21 control the flow of air through the fresh air intake 10 and the return air conduit 16, and a damper 22 controls the flow of recirculated air through the conduit 17. The dampers 20 and 21 are normally positioned closed and open respectively and both are operated to the reverse position by their respective motors. The thermostat 30 is arranged to cause this operation, to open the fresh air and close the return air dampers, when the temperature in the washer rises. A relief opening 16^a may be provided in the conduit 16 controlled by a relief damper 16^b to allow the discharge of the air coming from the room under conditions where the full amount of exit air is not utilized as recirculated or return air.

The washer 12 is provided with spray heads 25 supplied with water by a pump 26. This water may be supplied either from a refrigerated source 27, or through conduit 28 from the water collecting at the bottom of the spray chamber itself. The proportion of circulated water and refrigerated water which is supplied by the pump 26 to the sprays is under the control of a three-way valve 29.

In ventilation where definite humidity control is to be effected, it may be accomplished either by bringing a portion of the air to a fixed humidity content, that is a fixed dew point, and mingling it with varying proportions of unconditioned air to maintain the conditions within the enclosure, or the humidity may be controlled by exercising a direct control upon the conditions within the humidifier itself. Either system is within the general scope of this application but the latter has been chosen for specific illustration.

In the spray chamber where recirculated water comes into intimate contact with the air, the water assumes the wet bulb temperature of the air entering the spray chamber and the air leaves that chamber substantially at the dew point and with a fixed quantity of moisture in it. It is thus possible to insert a thermostat directly in the water collecting in the bottom of the spray chamber, and by using it to control the temperature within the spray chamber it is possible to regulate the quantity of moisture carried by the air leaving the washer. Arrangements are also made whereby the moisture content of the air in the enclosure will alter the setting of the thermostat which is in the spray chamber in order to vary the temperature which that thermostat is adjusted to maintain.

In so far, therefore, as the moisture content of the return air does not vary, the thermostat within the spray chamber will operate to maintain a definite standard of conditioning of the air leaving the spray cham-

ber. This may be largely controlled by varying the proportion of fresh and return air which are mingled in the spray chamber in such a manner as to increase the proportion of the return air as the wet bulb temperature of the spray chamber decreases. When this proves insufficient to bring up the wet bulb temperature, heat may be added directly through the medium of coil 11^a.

When the external temperature and humidity rise, however, to a dew point greater than that which may be maintained within the spray chamber to produce the desired conditions in the room, the spray chamber may be artificially cooled either by refrigerating coils within it or by supplying fresh cold or refrigerated water to it.

The means provided for controlling the temperature of the spray chamber comprises a thermostat 30 mounted within the chamber and arranged through a mechanism which will be later described to control a needle valve to admit compressed air from a compressed air source 32 through a supply pipe 33 to conduits 34 and 35, only 34 communicating with the motor valve 36 to operate the three-way valve 29; the other pipe 35 connects with a motor valve 37 directly, and indirectly through the medium of a three-way valve 40 with damper motors 38 and 39.

The valve 40 serves to disconnect the operation of the dampers 20 and 21 to discontinue the flow of air through the conduit 16 and utilize only fresh air under certain conditions, as will be hereafter described. But when the valve 40 is open, the arrangement of the thermostat 30 is such that the rise in temperature of the wash water in the washer 12 which as will be understood, means a rise in the dew point within the washer, will result first in shutting off the steam from the coil 11^a through the medium of the valve 41. A further tendency to rise would then be checked by the operations of the dampers 20 and 21 to close the return air conduit and utilize through the conduit 10 a greater proportion of fresh air. Should this be inadequate to bring down the dew point, a further tendency to rise would be met by operation of the valve 29 to discontinue in whole or in part the use of water from the bottom of the spray chamber and to substitute therefor, water from the refrigerating system.

The above system as thus described, as will be seen, automatically discontinues the use of refrigeration during the winter months since under those conditions, the desired standard of humidity can be readily attained without the use of refrigeration. At such times, the system will utilize the proportioning between the fresh air and the return air, and the use of the heater 11^a, as the control means to maintain the spray chamber temperature.

The temperature within the room may be maintained by a thermostat 45 provided in the

return air duct arranged to control a motor 46 to operate the damper 22 by a suitable lever mechanism, and a motor 47 to shut off the steam supply from heater 48 located within the duct 17. The connections of these motors is such that as the temperature in the return air duct rises, steam is first cut off from the heater 48 and if this be insufficient to correct the temperature, a further rise will close the damper 22 to cause a greater proportion of conditioned air to be furnished to the room.

As the summer months approach with the rise in the humidity and temperature of the external air and the consequent rise in the dew point in the washer, the ventilating system as above described, if left to itself would discontinue the use of return air altogether. Such discontinuance would be satisfactory upon dry days where the external dew point is low, but on the more humid days greater economy would be effected by utilizing the return air and confining the fresh air supply to the small amount required to make up the losses to the system.

In order to utilize return air on those summer days in which the return air has less total heat than the outside fresh air, means are provided for comparing the wet bulb temperatures of these two and for automatically changing the operation of the valves to utilize return air when this proves to be the most suitable source. There is thus provided in the return air duct a wet bulb thermostat responsive to the return air conditions and in the fresh air duct a wet bulb thermostat responsive to the fresh air conditions.

Since both of the systems above referred to employ a thermostat in the return air duct, the system may be arranged to utilize the same thermostat for both controls. To this end there is provided a wet bulb thermostat 61 in the return air duct 3 and a wet bulb thermostat 62 in the fresh air duct 10 which are so connected together as jointly to show the difference in wet bulb temperature in their respective locations and automatically to disconnect the dampers 21 and 20 from control by the thermostat 30 whenever the external wet bulb temperature rises above the wet bulb temperature of the return air thereby closing the fresh air dampers and opening the recirculating dampers. At the same time, the wet bulb thermostat 61 is arranged inversely to effect the setting of the thermostat 30 so that as the wet bulb temperature at 61 rises the thermostat 30 will be adjusted to lower the temperature.

A convenient and reliable form of wet bulb thermostat which may be effectively utilized in control apparatus of this character is shown in my co-pending application, Serial No. 235,357, filed November 23, 1927. It is preferred that such apparatus be employed in this system because of its greater reliability, and it is herein diagrammatically illus-

trated. In general, it embodies an apparatus designed to bring a small recirculated body of water into intimate contact with the air to be measured whereby the water itself is brought to the wet bulb temperature of the air, regardless of whether the air itself reaches that temperature or not. In this manner, an accurate reading of the wet bulb temperature may be obtained even though the contact between air and water be imperfect.

These devices 61 and 62 are alike and a description of one of them alone will therefore be sufficient. They are shown diagrammatically in Fig. 2, in greater detail in their relationship to the control mechanism. Each comprises a container 50 housing a motor 51 carrying upon its shaft a fan 52 and a cone pump 53 dipping into a sump 54 in the bottom of the container. A sleeve baffle extends downwardly from the top of the container to separate the air inlet 56 from the air outlet 57 whereby the action of the fan causes air to be drawn inwardly through the inlet forced downwardly through the spray issuing from the pump and outwardly from the outlet. A thermo-responsive device 59 is provided within the air chamber adapted to control a needle valve 60 or 63 for purposes to be hereinafter described.

The apparatus 62 is arranged to control a needle valve 63 admitting air from the compressed air supply 32 to chamber 65 of a differential motor 64. The apparatus 61 is similarly arranged to control a needle valve 60 which controls a supply of compressed air to a chamber 67 of the differential motor. The chambers 65 and 67 are respectively provided with leak openings 68 and 69 whereby the pressure maintained within the chambers is responsive to the opening of the respective needle valves 63 and 60. Each of these chambers 65 and 67 has a flexible wall diagrammatically herein shown as corrugated walls 70 and 71 respectively, these walls being connected together by a suitable link 72 to which is pivoted a lever 73 fulcrumed as at 74 and having its other end 75 controlling a needle valve 76 admitting air from the compressed air supply 32 through a port 77 to the conduit 78. The conduit 78 connects with a valve motor 80 which controls the position of a three-way valve 40.

The three-way valve 40 in one position affords communication between the conduit 35 and the conduit 35^a which communicates with the valves 38 and 39. In the other position, the valve closes the conduit 35 and connects the conduit 35^a to the atmosphere. It will thus be seen that in the first position, the dampers 20 and 21 are under the control of the thermostat 30 and during the second position, these valves are disconnected from operation and are controlled by their normal bias which is such that the valve 20 will be

substantially closed and the valve 21 will be open.

In this manner, it will be evident that the system automatically selects whichever available source of air has the lower humidity. As a consequence, the refrigeration required by this system is reduced to a minimum.

The thermostat 30 is diagrammatically illustrated in the drawing as a closed air chamber 85 exposed to the temperature of the water within the sump at the bottom of the spray chamber and having a flexible wall 86, whereby the fluctuations in pressure within the chamber 85 due to the expansion of the enclosed gas will tend to move the flexible wall.

A second chamber 87 communicates with a pipe 88 with the conduit 89 leading from the needle valve 60 to the chamber 67 of the return air wet bulb thermostat whereby there is maintained within the chamber 87 the same pressure as is maintained within the chamber 67. The links 91 and 91^a are both connected to a lever 92 fulcrumed at 93 to operate the needle valve 94 to control the flow of compressed air to the conduits 34 and 35 as has been described. In general, it may not be desirable to cause a change in the wet bulb temperature of the return air to effect an equal change in the dew point within the spray chamber. Any proportioning desired may be effected by a proper interconnection between the thermostat 30 and the wet bulb thermostat. A practical form of such adjustment with the particular embodiment herein illustrated may be effected by varying the relative length of the lever arm by which the diaphragms are connected to the needle valve.

With the above construction, it will be clear that so long as the humidity of the return air does not vary, the needle valve 94 will be under the sole control of the thermostat 30 to maintain a uniformity in the humidity of the air delivered from the washer. Any humidity change, however, in the return air will effect the pressure within the chamber 87 and thereby effect the resistance which the flexible diaphragm 90 offers to the operation of the flexible diaphragm 86 and a new balance will be struck between them corresponding to a higher or lower temperature within the spray chamber.

Similarly, the needle valve 76 will remain open so long as the pressure within the air chamber 67 is in excess of that in the air chamber 65. The result is the flow of the compressed air to the motor 80 will operate the valve 40 but when these are reversed, the needle valve will be closed and the valve 40 will return to its normal condition.

During the winter time, the conduit 78 may be closed by a valve 100 to discontinue the differential effect of the thermostats 61 and 62 upon the dampers 20 and 21. Under such

conditions, the temperature is maintained within the room by the thermostat 45 which increases the temperature when too low by increasing the return air through the duct 17 and if necessary by artificial heat through heater 48. The air drawn through the washer is of a fixed humidity content under the control of the thermostat 30 and ordinarily no great fluctuations in the humidity content of the room will occur. Should, however, correction be necessary as determined by the thermostat 61, it is accomplished by a change in the dew point in the washer. The thermostat 30 under such circumstances, exercises its control by varying the proportions of return and fresh air admitted to the washer and since by this means alone a combination can ordinarily be obtained which has a dew point below that which must be maintained if no artificial refrigeration is required.

With the advent of the season, however, when artificial refrigeration is required, the valve 100 will be opened and the differential control of the thermostats 61 and 62 upon the fresh air supply will come into play to close the valve 40 and thereby close the damper 20 and open the damper 21 whenever the fresh air supply has a higher wet bulb temperature than the return air. It will thus be clear that in the summer months at the more humid times, the washer will receive the maximum quantity of return air and only that quantity of fresh air which is required to supply the losses while as soon as the outside wet bulb temperature falls, the return air duct will be closed and all fresh air will be supplied to the washer.

Since certain changes in carrying out the above process and in the constructions set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

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

1. A ventilating system comprising, in combination, means for supplying air to an enclosure, means for conditioning said air, means for supplying outdoor air and return air to the conditioning apparatus, differential means responsive to the condition of the outdoor air for varying the proportions of outdoor and return air.

2. A ventilating system comprising, in combination, means for supplying air to an en-

closure, means for conditioning said air, means for supplying fresh air and return air to the conditioning apparatus, differential means responsive to the wet bulb temperature of the fresh air for proportioning fresh and return air for conditioning.

3. A ventilating system comprising, in combination, means for supplying air to an enclosure, means for conditioning said air, means for supplying fresh air and return air to the conditioning apparatus, means differentially responsive to the condition of the fresh air and of the return air for determining the proportions of fresh air and return air for conditioning.

4. A ventilating system comprising, in combination, means for supplying air to an enclosure, means for conditioning said air, means for supplying fresh air and return air to the conditioning apparatus, means differentially responsive to the wet bulb temperature of the fresh air and of the return air for selecting the fresh air or return air for conditioning.

5. A ventilating system including means for varying the humidity conditions within a room, regulating means responsive to the conditions within the room for controlling the condition effected by said first mentioned means and a differential control responsive to external conditions for controlling said regulating means until the wet bulb temperature of the room is lower than the wet bulb temperature without the room.

6. A ventilating system including means for introducing air into a room, means for conditioning said air, controlling means for governing the relative humidity and temperature of the air responsive to conditions in the room, and means responsive to the wet bulb temperature outside the room for regulating said controlling means.

7. A ventilating system of the character described including means for introducing fresh air, means for maintaining predetermined humidity conditions within the room and differentiating means for controlling the inflow of fresh air responsive to the difference in wet bulb depression between the air in the room and the fresh air.

8. A ventilating system comprising, in combination, means for circulating air into a room, a washer for conditioning said air, means for supplying fresh air to said washer, a thermostat responsive to the wet bulb temperature within the washer for operating a damper to control fresh air and a thermostat responsive to the outside wet bulb temperature for disconnecting said first mentioned thermostat from said fresh air damper.

9. A ventilating system comprising, in combination, means for circulating air into a room, a washer for conditioning said air, means for supplying fresh air and return air

to said washer, a thermostat responsive to the wet bulb temperature within the washer for operating dampers to control inversely the fresh air and return air, and a thermostat responsive to the outside wet bulb temperature for disconnecting said first mentioned thermostat from said fresh air and return air dampers.

10. A ventilating system comprising, in combination, means for introducing air into a room, means for conditioning said air, means for supplying fresh air and return air to said conditioning means, and means responsive to the wet bulb temperature of the outside air for changing the connection from return to fresh air when the outside wet bulb temperature falls below the wet bulb temperature of the return air.

11. A ventilating system comprising, in combination, means for introducing air into a room, means for conditioning the air, means for supplying fresh air and return air to the conditioning means, means for varying the proportions of fresh and return air and means responsive to outside wet bulb temperatures and connected to said varying means and controlling the latter to utilize only fresh air within said system when the outside wet bulb is below that of the return air.

12. A ventilating system comprising, in combination, means for supplying air to an enclosure, means for conditioning said air, thermostatic means for maintaining a standard of conditioning of air fed to the enclosure, means for supplying fresh air and return air to the conditioning apparatus, means responsive to the wet bulb temperature of the outside air for selecting the fresh or return air for conditioning, and means responsive to the wet bulb temperature of the air within the enclosure for altering the standard of conditioning to maintain desired conditions within the room.

13. A ventilating system comprising, in combination, means for supplying air to an enclosure, means for conditioning said air, thermostatic means for maintaining a standard of conditioning of air fed to the enclosure, means for supplying fresh air and return air to the conditioning apparatus, and means differentially responsive to the condition of the fresh air and of the return air for selecting the fresh or return air for conditioning and for varying the standard of said conditioning to maintain a standard of conditions within the enclosure.

14. A ventilating system comprising, in combination, means for supplying air to an enclosure, means for conditioning said air, means for recirculating unconditioned air in said room, means responsive to the temperature within the room for varying the proportions of conditioned and recirculated air, means for maintaining a standard of

conditioning of air fed to the enclosure, means responsive to the wet bulb temperature within the enclosure for varying the standard of conditioning to maintain a standard of humidity within the room, means for feeding fresh air or return air to said conditioning apparatus, means responsive to the outside wet bulb temperature for determining the proportions of fresh and return air for conditioning.

15. A ventilating system comprising, in combination, means for supplying air to an enclosure, means for conditioning said air, means for recirculating unconditioned air, means responsive to the dry bulb temperature within the room for varying the proportions of recirculated and conditioned air, means for maintaining a standard of conditioning of air fed to the enclosure and means responsive to the wet bulb temperature of the air in the enclosure and connected to said varying means for regulating and maintaining said standard.

16. A method of ventilating an enclosure consisting in returning air from the enclosure for conditioning, admitting outside air for conditioning and controlling the volumes of returned air and outside air responsive to the differences in their wet bulb temperatures.

17. In a ventilating system, in combination, a conditioner, means for supplying outside air and air from an enclosure to the conditioner means for mixing air from the conditioner with air from the enclosure and delivering said mixture to the enclosure, means responsive to conditions within the conditioner for varying the amount of outdoor air and return air supplied to the conditioner and differential means responsive to the difference in wet bulb temperatures of outdoor and return air for rendering inoperative the means in the conditioner.

18. A system of the character described, comprising, in combination, a conditioner, means for supplying air to an enclosure from the conditioner, thermostatic means for maintaining a desired dew point of air fed to the enclosure, said means controlling the character of the water fed the conditioner and the proportions of outside and return air fed the conditioner, and means responsive to the differential in wet bulb temperatures of the outdoor and return air for varying the control of said thermostatic means.

In testimony whereof I affix my signature.

WALTER L. FLEISHER.