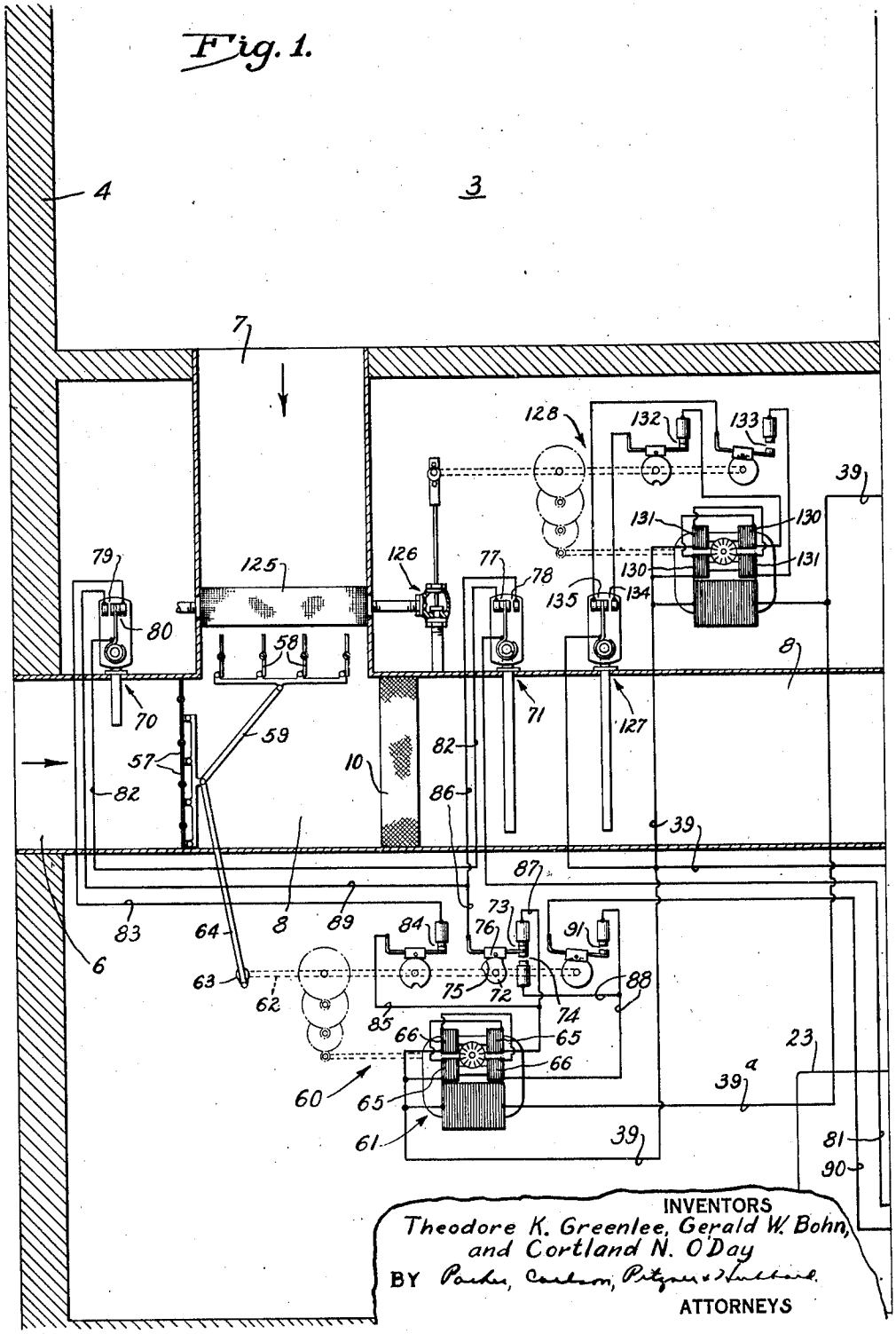
April 6, 1943. T. K. GREENLEE ET AL 2,315,517

CONDITION CONTROL SYSTEM

Filed March 7, 1936 2 Sheets-Sheet 1

Fig. 1.



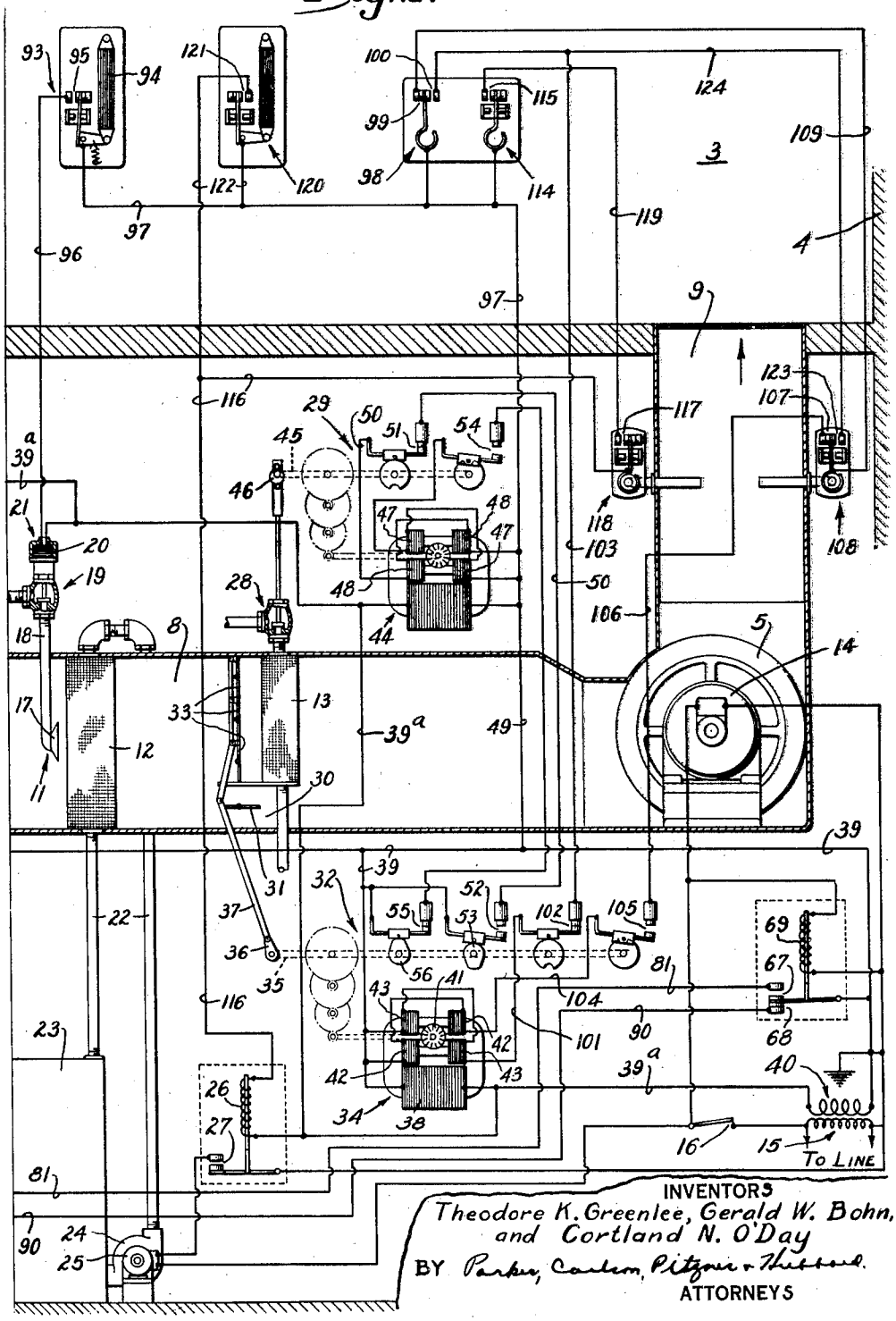
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ATTORNEYS

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Fig. 2.



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UNITED STATES PATENT OFFICE

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CONDITION CONTROL SYSTEM

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Application March 7, 1936, Serial No. 67,612

10 Claims. (Cl. 257—3)

This invention relates generally to condition control systems and in some of its aspects has to do more particularly with the control of air conditioning systems of the type in which a mixture of fresh and return or recirculated air is exposed to the action of one or more conditioning units preparatory to being discharged into the space to be conditioned.

The general object of the invention is to provide in a combined heating, cooling, humidifying and dehumidifying system a new and improved automatic control which is simple in construction, which is positive and reliable in operation, which maintains the desired condition of the delivered air with a high degree of accuracy, which insures optimum economy in operation, and which adapts itself quickly and automatically to the requirements of the space being conditioned.

Another object is to provide a novel air cooling system and method of control therefor in which the air outside of the building is utilized to carry at least a part of the cooling load when its temperature is low enough for that purpose.

A further object is to provide an all weather air conditioning system incorporating a novel control for insuring maintenance of the delivered air at the proper temperature even though it must be pre-cooled, for the purpose of removing excess moisture, to a temperature which would be uncomfortable to the room occupants.

Still another object is to provide a novel arrangement for preheating the mixture of fresh and return air preparatory to conditioning the same.

It is also an object to provide a novel mechanism for effecting actuation of a condition regulating member under the control of separate condition responsive devices.

The invention also resides in the novel manner in which the opening and closing of the fresh air inlet is controlled to insure a minimum degree of opening thereof whenever the system is in operation.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings in which

Figures 1 and 2, when laid side by side, constitute a schematic view and wiring diagram of an air conditioning system embodying the novel features of the present invention.

While the invention is susceptible of various modifications and alternative constructions, we have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that we do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

In the drawings, the invention is embodied for purposes of illustration in a combined ventilating, heating, cooling, humidifying and dehumidifying system for discharging a mixture of fresh and return or recirculated air into a space 3 within a building having walls 4 and conditioning the mixture thus discharged so as to maintain predetermined conditions of temperature and humidity in the space. A blower 5 induces the flow of fresh and return air through inlet ducts 6 and 7 into a duct 8 having an outlet 9 from which the air is discharged into the space 3. Within the duct 8, the air mixture passes through a filter 10 and then is exposed to an humidifier 11, a cooler 12, and a heater 13 which act singly or in combination to condition the air properly. The blower is driven by an electric motor 14 supplied with current from a high voltage power source 15 under the control of a switch 16.

The humidifier shown comprises a nozzle 17 communicating through a pipe 18 having a valve 19 therein with a source of water under pressure and arranged to discharge a spray of water into the air current whenever the valve is opened as will be the case when the winding 20 of a solenoid 21 thereof is energized. The humidifier will remain idle when the solenoid is deenergized.

While any preferred form of artificial refrigeration means may be employed, the cooler 12 shown herein comprises a coil communicating through pipes 22 with a source 23 of cooling fluid which is circulated through the coil during operation of a pump 24 driven by an electric motor 25. The motor is excited from the high voltage source whenever the winding 26 of a relay switch 27 is energized.

The heater 13 selected for illustration comprises a coil extending partially across the duct 8 and supplied with heating fluid such as steam through a valve 28 arranged to be opened and closed with a modulating action by an operator 29. Interposed in the by-passage 30 around the heater coil 13 is a damper 31 which is moved progressively between closed position and the open position shown by an operator 32. The damper is linked to face dampers 33 so that the passage through the coil 13 will be closed progressively as the damper 31 is opened, and opened as the damper is closed.

Preferably, though not necessarily, the operator 32 is of the electric type comprising a reversible electric motor 34 operating through appropriate speed reduction gearing to drive a shaft 35 which carries a crank 36 connected by a link 37 to the damper 31. The motor is of the shaded pole type having a main winding 38 with terminals connected to power conductors 39 and 39a leading to a low voltage source 40. Mounted on the poles of the motor and arranged in pairs on diametrically opposite sides of the rotor 41 are multiple turn shading coils 42 and 43 which are arranged to be short-circuited selectively to cause the rotor to turn in opposite directions in a manner well understood in the art.

The valve operator 29 is constructed similar to the operator 32 and comprises an electric motor 44 having a main winding connected to the power conductors 39 and 39a and arranged to drive a shaft 45 carrying a cam 46 by which the member of the valve is reciprocated. When shading coils 47 of the motor are short-circuited with the valve partially open, the rotor turns in a clockwise direction causing the valve to be closed slowly. Similarly, the valve is opened progressively while shading coils 48 are short-circuited and the coils 47 open-circuited. When both sets of shading coils are open-circuited, the position of the valve is maintained frictionally.

In the present instance, the position of the valve 28 is shifted to correspond to the heating requirements under different conditions. To this end, the operator 29 is controlled in accordance with the position of the by-pass damper 31, the arrangement being such that the valve will be moved toward closed position when the by-pass damper reaches the full cooling position shown, will move toward open position while the damper is disposed in closed or full-heating position, and will be held in fixed position when the damper is in any intermediate position. For the purpose of effecting such control, the circuit for the shading coils 48 is extended from the coils through a conductor 50 having therein a limit switch 51 which is closed except when the valve is in fully open position, a switch 52, the conductor 39, and an extension 49 of the conductor 39. A cam 53 on the shaft 35 is shaped to close the switch 52 when the by-pass damper 31 reaches closed position, the coils 48 being thereby short-circuited so that the valve member will be moved away from its seat until it reaches fully open position as evidenced by opening of the limit switch 51 or until the switch 52 is opened by movement of the by-pass damper away from closed position. Similarly, the short-circuit for the shading coils 47 is controlled by a limit switch 54 which is closed except in the closed position of the valve 28 and by a switch 55 which is held closed by a cam 56 when the by-pass damper 31 is in the open position shown.

The flow of air through the fresh and return inlets is controlled by dampers 57 and 58 disposed in the respective inlets and connected by a link 59 for movement in unison, the fresh air damper being fully closed when the return damper is fully open as shown and vice versa. Progressive movement of the dampers between their limit positions is effected by a power operator 60 which preferably comprises a reversible shaded pole motor 61 geared to a main operating shaft 62 which is connected by a crank 63 and a link 64 to the link 59. The range of movement of the dampers thus corresponds to a half revolution of the shaft 62.

The terminals of the main winding of the motor 61 are connected to the power conductors 39 and 39a, and the direction of rotation of the operating shaft 62 is determined by selectively short-circuiting pairs of shading coils 65 and 66, the arrangement being such that the fresh air damper will be moved toward open position when the coils 65 are short-circuited and toward closed position when the coils 66 are short-circuited.

In a system of the above character, the artificial cooling mechanism is the most costly part to operate. The present invention aims to reduce the time and therefore the cost of operation of the cooler 12 to a minimum by utilizing the outside air to carry all or part of the cooling load whenever its temperature is sufficiently low. For ventilating purposes, the invention also contemplates maintenance of the fresh air damper in at least a predetermined partially open position whenever the system is in operation. To these ends, means are provided which operate, when the outside air is below a predetermined useful value, for example 65 degrees F., to control the operator 60 and cause modulating movment of the damper between the minimum and fully open positions so as to maintain the temperature of the air mixture at a value approaching that desired for cooling purposes.

In the present instance, such operation is effected by controlling the circuits for the shading coils 65 and 66 by the combined action of switches 67 and 68 of a magnetic relay having a winding 69 which is energized whenever the fan motor 14 is running, by an insertion thermostat 70 responsive to temperatures in the fresh air inlet 6, and by a second thermostat 71 responsive to the temperature of the mixed air and having a thermostatic element which extends substantially across the duct 8 so as to respond to the average temperature of the mixture.

To maintain the fresh air damper open at least to its minimum position irrespective of the condition of the thermostats 70 and 71 whenever the system is in operation, the operating shaft 62 carries a cam 72 which operates switches 73 and 74. When the fresh air damper is in closed position as shown, the switch 73 is held closed and remains closed as the cam turns in a clockwise direction during initial opening of the fresh air damper. As the dwell surface 75 of the cam passes beyond the follower 76 as will be the case when the fresh air damper is opened beyond its selected minimum position, the switch 73 is allowed to open and the switch 74 is allowed to close. As will later appear, the switch 74 acts to limit the position to which the fresh air damper may be closed under the action of the thermostats 70 and 71 alone.

Assuming that it is desired, for cooling purposes, to maintain the air delivered to the room at a temperature not lower than 60 degrees, the thermostat 71 would be set so as to close its switch 77 when the mixed air temperature is above 60 degrees and to close the switch 78 when the temperature is below operating range of the thermostat. Since the fresh air should ordinarily be below 65 degrees F., in order to be useful for cooling purposes in the present system, the thermostat 70 is set to close its switch 79 above 65 degrees and to close its switch 80 below this value.

With the thermostats thus set, the fresh and recirculated air dampers operate in the following manner, assuming first that the temperature outside is below 65 degrees, that the duct tempera-

ture is above 60 degrees, and that the system is not operating, the parts being positioned as shown in the drawings. When the fan 5 is started by manual closure of the switch 16, the switch 67 is closed which completes a short circuit for the shading coils 65 of the damper operator 60. This circuit extends from the shading coils through the conductor 39, the switch 67, a conductor 81, the switch 77 of the thermostat 71, a conductor 82, the then closed switch 80 of the thermostat 70, a conductor 83, the limit switch 84, a conductor 85 back to the shading coils. The motor 61 thus runs in a direction to open the fresh air damper and close the return air damper. Since this circuit is closed independently of the cam operated switch 73, operation of the motor continues as the fresh air damper reaches the position of minimum opening, and the proportion of fresh air in the mixture will be increased above the minimum amount by continued opening of the fresh air damper until the temperature of the mixture falls below 60 degrees whereupon the short circuit for the coils 65 will be broken by opening of the switch 77.

If, at the time the blower is started, the outside temperature is above 65 degrees or the duct temperature is below 60 degrees, the shading coils 65 will nevertheless be short-circuited when the switch 67 is closed, the circuit extending through the conductor 87, the closed switch 73 and either the conductor 86 and the switch 78 or the conductor 89 and the switch 79. Likewise, when the switch 67 is closed, the outdoor air is sufficiently cool to reduce the duct temperature below 60 degrees before the damper 57 reaches its minimum position, the short circuit for the coils 65 will be maintained through the switch 78, the conductor 86, the switch 73 and the conductor 87. In any of the three cases last assumed, the operator will stop when the damper reaches its minimum open position, the switch 73 and either the switch 77 or the switch 79 being then open.

If the temperature of the mixture falls below 60 degrees with the damper 57 opened beyond its minimum position, the switch 78 will be closed, the coils 66 being thereby short-circuited through a circuit extending from the conductor 81 through the thermostat switch 78, the conductor 86, the then closed switch 74, and a conductor 88. The motor 61 then runs in a direction to close the fresh air damper and open the return air duct thereby increasing the temperature of the air mixture until 60 degrees has been attained or the minimum position of the fresh air damper reached. As the temperature of the mixture rises above 60 degrees, the movement of the damper will be reversed by closure of a short-circuit for the coils 65 through the switch 77, the conductor 82, the thermostat switch 80, and the conductors 83 and 85 and the switch 84.

It will be seen that while the fan is operated and the outside temperature is below 65 degrees, the fresh air damper will be oscillated back and forth under the control of the thermostat 71 between the full open and a predetermined partially open or minimum position thereby maintaining the temperature in the duct 8 at 60 degrees provided the outside temperature is below this value. If the latter is between 60 and 65 degrees, the fresh air damper will be moved to and remain in fully open position. If, due to a prolonged fall in the air temperature below 60 degrees, the switch 78 remains closed until the fresh air damper reaches its position of minimum opening, the switch 74 will be opened and the closing movement of the damper arrested.

When the outside temperature rises above 65 degrees as evidenced by opening of the switch 80 and closure of the switch 79 of the thermostat 70, the fresh air damper will be moved to its position of minimum opening in spite of the fact that the thermostat 71 will be calling for a lower duct temperature and therefore for more fresh air. Such movement is caused by closure of a circuit extending from the shading coils 66 through the conductor 88, the then closed switch 74, the conductor 86, the conductor 89, the switch 79, the conductor 82, the switch 77, which will then be closed, to the conductor 81. The operator 60 will thus close the fresh air damper until the minimum position is reached whereupon the switch 74 will be opened by the cam 72 thereby opening the shading coil circuit and arresting the closing movement of the fresh air damper.

The fresh air damper is moved to fully closed position independently of the thermostats 70 and 71 when the fan is stopped and operation of the system discontinued. This is effected by closure of the relay switch 68 which completes a short-circuit for the shading coils 66 extending from the coils through the conductor 88, the then closed limit switch 91, a conductor 90, the switch 65 and the conductor 39. The circuit is broken by opening of the limit switch as the damper becomes fully closed.

From the foregoing, it will be seen that the control by the switches 67 and 68 is superior to that of the thermostats 70 and 71 and that the thermostat 70 is capable of closing the fresh air damper to minimum position while the thermostat 71 is calling for cooler air. Accordingly, the fresh air damper is closed when the system is idle, is always open at least to a minimum position when the system is in operation, is modulated between the minimum and fully open positions when the temperature outside is sufficiently low, that is below 60 degrees, to enable the outdoor air to carry the entire cooling load, remains in fully open position when the outside air is sufficiently cool, that is below 65 degrees, to carry at least a part of the cooling load, and is maintained in the minimum or partially open position when the outside air is above 65 degrees. In this way, the cooler 12 will be called into operation to handle only that portion of the cooling load which cannot be supplied by the outside air under the conditions prevailing at the time. Maximum economy is thus obtained in the operation of the system for cooling purposes, and the service life of the artificial cooling equipment is prolonged.

In systems of the present character, it is desirable to maintain a relative humidity of at least thirty per cent in the space being conditioned. To accomplish this, means is provided for rendering the humidifier operative whenever the relative humidity in the room falls below the desired value. Herein, this means comprises an humidostat 93 having an element 94 disposed in the space 3 and arranged to actuate a control switch 95, maintaining the switch open when the relative humidity is above the value for which the humidostat is set and closed when the humidity falls below this value. The switch is arranged in the circuit by which the winding 20 of the solenoid valve 19 is energized and which extends from the power lead 39a through the winding 20,

a conductor 96, the switch 95, and a conductor 97 leading to the power conductor 39.

The operation of the heater 13 is governed in accordance with temperature changes within the space being conditioned which changes are detected by a thermostat 98 adjusted for the temperature to be maintained. Assuming that the thermostat is set for 72 degrees, its switches 99 and 100 will be closed respectively when the room temperature is above and below the operating range of the thermostat. A call for heat which will be evidenced by closure of the switch 100 completes a short-circuit extending from the coils 43 through a conductor 101, a limit switch 102, which is closed except when the damper 31 is fully closed, a conductor 103, the switch 100, the tongue of the thermostat 98, the conductor 97, and the conductors 49 and 39. With the coils 43 thus short-circuited, the motor 34 rotates in a clockwise direction to close the by-pass damper and thereby increase the amount of heat imparted to the air by the coil 13. If the switch 100 remains closed for a period of time sufficient to enable the damper to reach its fully closed position, then the resulting closure of the switch 52 will initiate operation of the motor 44 to open the steam valve 28 to a greater degree thereby increasing the capacity of the heater 13.

In response to closure of the switch 99 as the room thermostat ceases to call for heat, the shading coils 42 are short-circuited through a circuit which extends through a conductor 104, a limit switch 105 which is closed except when the damper 31 is fully opened, a conductor 106, a then closed switch 107 of an insertion thermostat 108 in the duct outlet 3, a conductor 109, the switch 99, and conductors 97, 49 and 39. With the coils 42 thus effective, the motor 34 runs counter-clockwise to open the by-pass damper 31 and thereby decrease the amount of heat imparted to the air current flowing through the duct 8. In this way, the damper will be oscillated back and forth under the control of the thermostat 98 whereby to cause the conditioned air to be heated to a temperature sufficient to maintain the desired room temperature. In addition, the operator 29 is controlled in response to the movements of the by-pass damper in a manner such as to adjust the position of the steam valve and throttle the flow of steam to the heating coil 13 so as to establish a rate of flow corresponding approximately to the prevailing heating requirements. The thermostatic control of the damper supplements the steam valve control and enables very accurate regulation of the conditioned air temperature to be obtained.

When the cooling requirements of the space being conditioned cannot be satisfied by supplying fresh air thereto, the cooler 12 is rendered operative under the control of a thermostat 114 located in the room and adjusted to the temperature which is to be maintained in the room when cooling is required. This temperature will be several degrees above the setting of the heat controlling thermostat 98 and ordinarily will be varied in any well known manner with changes in the outside temperature.

The thermostat 114 has a switch 115 which becomes closed as the room temperature rises above the value for which the thermostat is set. This switch controls an energizing circuit for the winding 26 of the relay switch 27 which circuit extends from the power conductor 39a through the winding 26, a conductor 116, a switch 117 of a thermostat 118 in the duct outlet 3, a conductor 119, the thermostatic switch 115, the conductors 97 and 49 to the power conductor 39. Thus, when both of the switches 115 and 117 are closed, the relay will be energized starting the pump and causing cooling fluid to be circulated through the coil 12. The cooler continues in operation until the room temperature has risen above the desired value or until the switch 117 of the duct thermostat is opened. The latter thermostat is arranged to respond to changes in the temperature of the air discharged through the outlet 9 and is set to respond to a limit value below which the discharged air would produce objectionable drafts in the room. If the thermostat 118 is set for 62 degrees F., for example, its switch would be opened and the operation of the cooler interrupted whenever the temperature of the conditioned air falls below this temperature even though the cooling requirements of the space as determined by the thermostat 114 have not been satisfied.

Preferably, the air stream thermostat 71 is adjusted to maintain a temperature of the mixed air slightly below the minimum limit to which the cooler 12 may reduce the conditioned air as determined by the thermostat 118. Thus, the artificial cooler is maintained idle by the action of the thermostat 118 so long as the outdoor air is cool enough to carry the entire cooling burden determined by the thermostat 114.

Whenever the relative humidity in the space being conditioned rises above a predetermined maximum value, usually about fifty-five percent, means is provided for operating the cooler 12 irrespective of the condition of the thermostat 114 so as to effect dehumidification of the air being discharged into the room. This means comprises an humidostat 120 in the room set to close a switch 121 whenever the humidity rises above the maximum limit desired. The switch 121 is interposed in a conductor 122 extending between the conductor 97 connected to the power conductor 39 and the conductor 116 leading to the winding 26 so that whenever the switch 121 is closed, the relay switch 27 will be energized and the flow of cooling medium to the coil 12 initiated.

In the event that the cooling effect of the coil 12 is increased under the independent control of the humidostat 120, to such an extent as to lower the temperature of the conditioned air below that which is desirable from the standpoint of avoiding drafts on the occupants, the heater 13 will be rendered effective to reheat the dehumidified air to the proper temperature. This is accomplished in the present instance by the action of the duct thermostat 108 which is adjusted so that its switch 123 will become closed in response to a minimum limit temperature slightly lower, for example 60 degrees, than the value for which the thermostat 118 is set to respond. When the switch 123 becomes closed, the shading coils 43 will be short-circuited through the conductor 101, the then closed switch 102, the conductor 103, a conductor 124, the switch 123, the conductor 109, the then closed thermostat switch 99 and the conductors 97, 49, 39 and 39a. As a result, the motor 34 will be started and the by-pass damper 31 moved toward closed position thereby causing heat to be supplied by the coil 13 and the rate of such supply to be increased until the desired minimum temperature of the conditioned air, as de-

termined by the thermostat **108**, has been attained.

By virtue of this arrangement, the cooler **12** may be employed to perform the additional function of dehumidifying the air, the heater **13** cooperating to prevent air, cooled to a low temperature for the purpose of dehumidification, from being discharged into the room at a temperature below 60 degrees. Such action is made possible in the present instance through the use of the independently operable thermostats **108** and **118** with the latter set to respond to a temperature slightly higher than that for which the thermostat **108** is adjusted.

Under conditions sufficiently severe to prevent the heater **13**, when operating at full capacity, from properly tempering the mixture of return air and the minimum amount of fresh air, provision is made for preheating the mixture before it reaches the heater. Preferably, this is accomplished by supplying heat to the return air passing through the inlet **7** by means of a heating coil **125** supplied with steam or other heating fluid under the control of a regulating valve **126**. The position of the latter is controlled by a thermostat **127** responsive to the average temperature of the air in the duct **8** and set to respond to a temperature several degrees, for example five, below the temperature for which the thermostat **71** is set. Thus, when the weather is not too severe, the air in the duct **8** will be maintained at 60 degrees under the control of the thermostat **71**, while in extremely cold weather, the thermostat **127** will render the heater **125** operative to maintain the duct temperature at 55 degrees.

In the present instance, the valve **126** is actuated by an electric operator **128** constructed similar to the operator **29** and having shading coils **130** and **131** adapted when short-circuited to cause the valve to be opened and closed respectively. The circuits for the coils are controlled by limit switches **132** and **133** and switches **134** and **135** of the thermostat **127**, the latter being closed respectively when the duct temperature is above and below the value for which the thermostat is set. Location of the preheat coil **125** in the return air duct is especially advantageous in that the coil is not exposed to the incoming fresh air, and therefore there is no danger of the coil becoming damaged when the outside temperature falls below freezing with the preheat coil inactive.

It will be apparent from the foregoing that the controls above described operate entirely automatically under all conditions to maintain the desired conditions of temperature and humidity in the space being conditioned and this in spite of the fact that the change from heating to cooling of the air may occur frequently in service. The various control mechanisms are interrelated in a manner such as to operate positively and reliably under all conditions and to enable the amount and complexity of the conditioning units and of the control mechanism itself to be reduced to a minimum. At the same time, the system utilizes whenever possible the cooling effect of the outdoor air thereby providing for optimum economy of operation.

In the appended claims, the terms "air condition" are used to refer to temperature and humidity conditions only.

We claim as our invention:

1. In an air conditioning system having an air duct communicating at its outlet end with the space to be conditioned and having fresh and return air inlets, damper means controlling the proportion of fresh air admitted to said duct, a power operator for said damper means, a thermostat responsive to the temperature of the mixture of fresh and return air and controlling said operator to modulate the position of a damper means between said minimum open position and fully open position and maintain a substantially uniform temperature of the mixture, a thermostat responsive to the temperature of the fresh air exercising control over said operator superior to said first mentioned thermostat and operating to cause movement of said damper means to said minimum open position in response to a deviation in the fresh air temperature to a predetermined value, and auxiliary control means operable independently of said thermostats to control said operator and cause complete closure of said fresh air inlet from any position in which the damper means is disposed at the time the auxiliary control means is rendered active.

2. In an air conditioning system having an air duct having fresh and recirculated air inlets, a damper controlling the proportion of fresh air admitted to said duct, a power operator for moving said damper in opposite directions, a thermostat responsive to the temperature of the air mixture and controlling said operator to modulate the movements of said damper between positions of full and minimum opening of said fresh air inlet to maintain the predetermined minimum temperature of said mixture, a thermostat responsive to the temperature of the fresh air and exercising a control over said operator superior to said first mentioned thermostat and causing movement of said damper toward closed position when the fresh air temperature rises above a predetermined value useful for cooling purposes, and means responsive to movement of the damper and operating to interrupt the closing movement thereof under the control of either of said thermostats when the damper reaches said position of minimum inlet opening.

3. In a combined ventilating and cooling system having an air duct and fresh and return air inlets, damper means controlling the proportions of fresh and return air delivered to said duct, means responsive to the temperature of the air mixture and regulating the movements of said damper means to maintain a substantially uniform temperature of the air mixture, means responsive to the temperature of the fresh air and regulating said damper means independently of said last mentioned means to maintain a fixed minimum proportion of fresh air in the mixture when the fresh air temperature is above a predetermined value useful for cooling purposes, and means controlling said damper means independently of said temperature responsive means to effect complete closure of the damper means from any position thereof.

4. In a combined cooling and ventilating system having a duct with fresh and return air inlets, damper means controlling the proportion of fresh air admitted to said duct, a power operator for said damper means, a thermostat controlling said operator to cause opening of the fresh air inlet beyond a minimum degree when the temperature of the mixture of fresh and return air is above a predetermined value whereby the outdoor air may be utilized for cooling purposes, thermostatically controlled means controlling said operator independently of said thermostat to cause movement of the damper and closure of said fresh air inlet to said minimum degree when the temperature of the fresh air rises above a predeter-

mined value, and other means independently controlling said operator to cause closing movement of said damper means.

5. In an air conditioning system, the combination of means for discharging a current of air into a space to be conditioned, a cooler and a heater each arranged in heat-exchanging relation with respect to said air current, a thermostat in said space controlling the operation of said heater to maintain a uniform temperature in the space when heating of the space is required, a second thermostat in said space controlling the operation of a cooler to maintain a predetermined higher temperature in the space when cooling thereof is required, an humidostat in the space adapted to render said cooler operative independently of said second thermostat when the relative humidity in the space rises above a predetermined value, a third thermostat responsive to changes in the temperature of the conditioned air and controlling said heater to prevent delivery of air to said space at a temperature below a predetermined minimum limit during operation of said cooler under the control of said humidostat, and a fourth independently operable thermostat controlling said cooler and operating to limit the temperature to which the conditioned air may be reduced to a value higher than said minimum limit.

6. In a combined ventilating and tempering system having an air duct with fresh and return air inlets, valve means controlling the proportion of fresh and return air admitted to said duct, thermostatic means regulating said valve means to admit varying amounts of fresh air and maintain a substantially uniform temperature of the fresh and return air mixture, thermostatic means exercising a control over said valve means superior to said first mentioned thermostatic means and regulating said valve means to reduce the proportion of fresh air in said mixture to a predetermined proportion sufficient for ventilating purposes when the prevailing temperature of the fresh air is such as to render the latter unsuited for tempering purposes, and means controlling said valve means independently of both of said thermostatic means to cause complete closure of said fresh air inlet from any degree of opening of the valve means.

7. A control for air conditioning systems having, in combination, valve means controlling a passageway adapted for the flow of a conditioning medium therethrough, a reversible power operator for actuating said valve means, means controlling said operator to cause uninterrupted opening of the passageway up to a predetermined degree or uninterrupted closing of the passageway from such degree, one temperature responsive device controlling said operator to modulate the further opening of said passageway beyond said predetermined degree of opening, and a second independently operable temperature responsive device controlling said operator to cause closing of said passageway toward said predetermined amount from any degree of opening beyond such degree.

8. An air condition control having, in combination, a valve controlling a passageway and actuated by a member movable between passage-closed and passage-open positions through a predetermined intermediate position, a reversible power operator for said member including electric motor driving means having valve-closing and valve-opening windings, a first switch which is respectively closed and open when the member is above and below said intermediate position and a second switch which is closed and open when said first switch is open and closed respectively, air condition responsive means having one switch controlling a circuit for said valve opening winding independently of said switches and another switch controlling said opening winding through the medium of said second switch and said closing winding through the medium of said first switch, and an automatic control device having one position in which said air condition responsive means is rendered operative and a second position in which said valve closing winding is rendered active to cause movement of said member to said closed position independently of said air condition responsive means.

9. An air condition control having, in combination, a valve controlling a passageway and actuated by a member movable between two limit positions through a predetermined intermediate position, a reversible power operator for said member including electric motor driving means having two windings respectively energizable to cause movement of said member in opposite directions, a first switch which is respectively closed and open and a second switch which is respectively open and closed when the member is above and below said intermediate position, air condition responsive means having third and fourth switches respectively closed by opposite movements of a reversibly movable control element, a circuit for one of said windings including said third switch, a second circuit for said one winding including said second and fourth switches, and a circuit for the other of said windings including said first and fourth switches.

10. An air condition control having, in combination, a valve controlling a passageway and actuated by a member movable between two limit positions through a predetermined intermediate position, an air condition responsive device having a control element movable between two positions, first and second switches respectively closed and open when said member is on one side of said intermediate position and respectively open and closed when the member is disposed on the other side of the intermediate position, a reversible power operator for said member operable to cause movement of the member from one limit position to said intermediate position independently of said switches when said element is in one of its positions and through the medium of said first switch when the element is in its other position, said device coacting with said other switch in causing reverse movement of the member when the latter is disposed beyond said intermediate position.

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CERTIFICATE OF CORRECTION.

Patent No. 2,315,517. April 6, 1943.

THEODORE K. GREENLEE, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, second column, line 5, for "a damper" read --said damper--; line 6, for "said minimum" read --a minimum--; page 6, first column, line 64, for "amount from any degree" read --degree from any amount--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of June, A. D. 1943.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.