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3,018,712

CONTROL SYSTEM FOR A ROOM CLOSING AIR CURTAIN

Filed May 12, 1958

2 Sheets-Sheet 1
TO STEAM
SOURCE

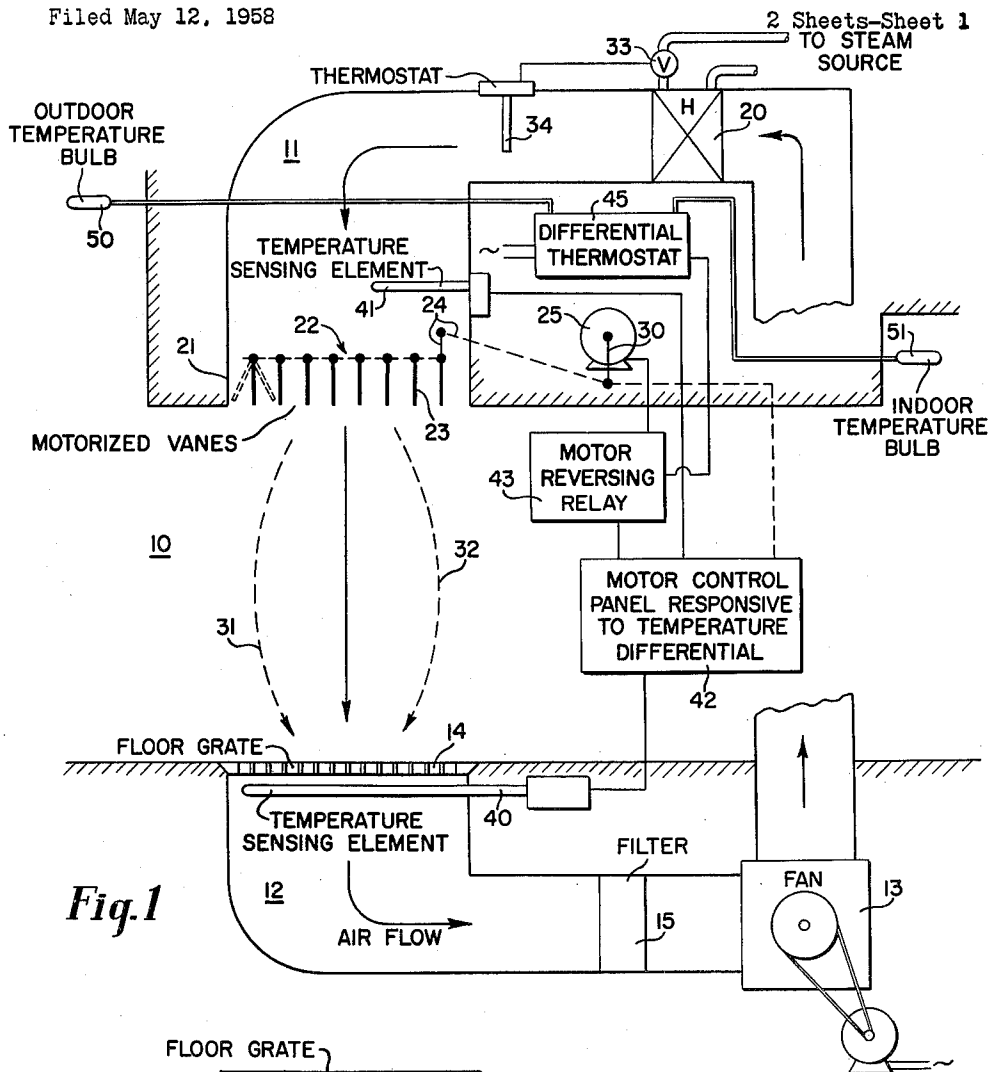


Fig. 1

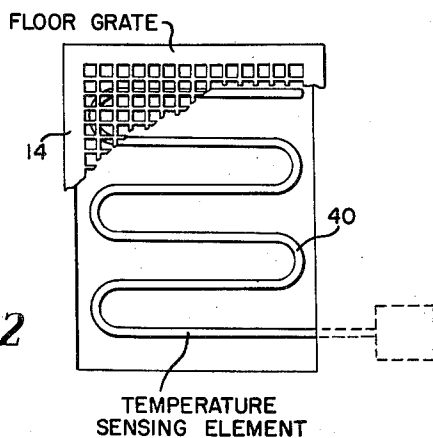


Fig. 2

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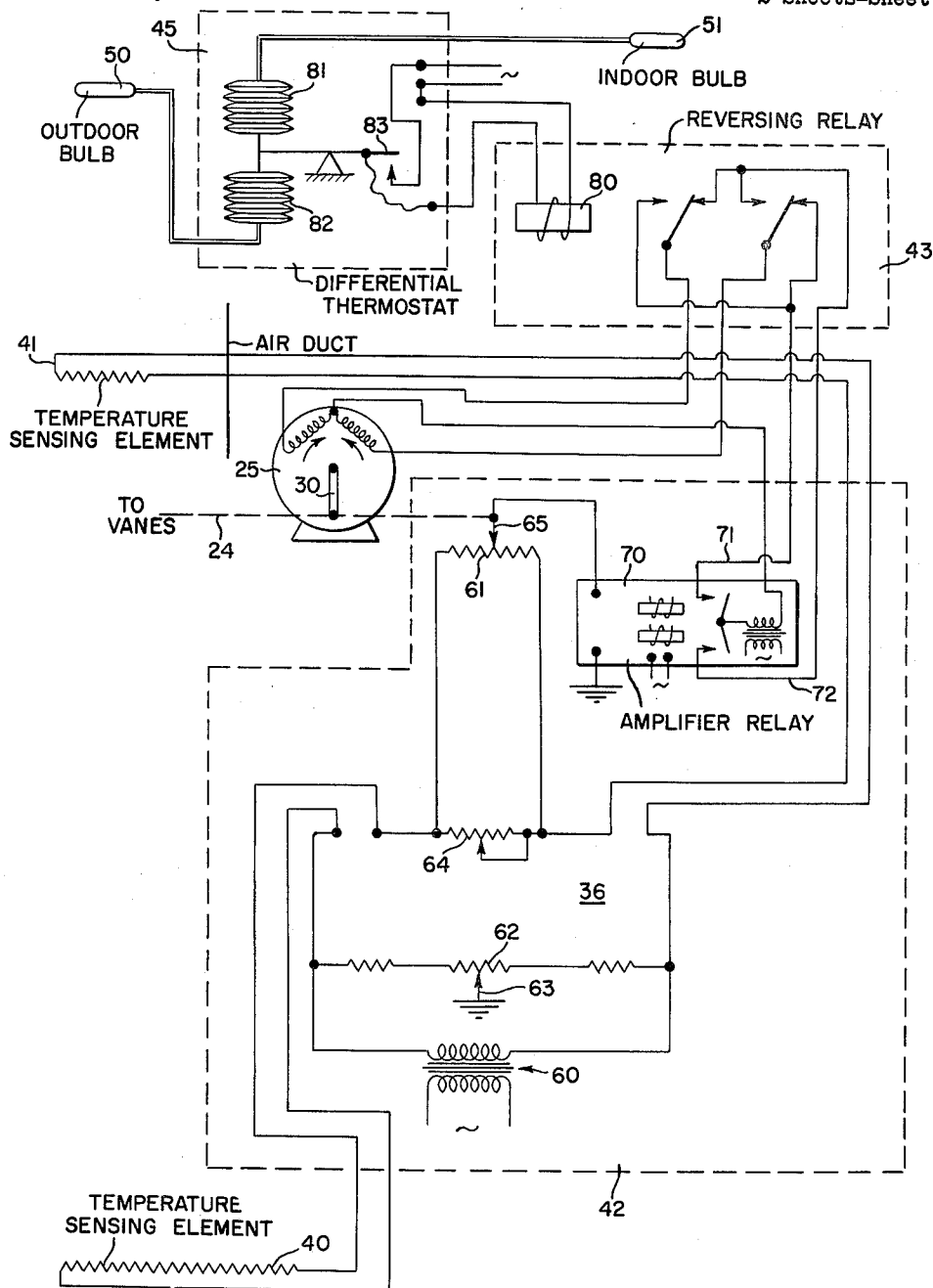


Fig. 3

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3,018,712 CONTROL SYSTEM FOR A ROOM CLOSING AIR CURTAIN

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3 Claims. (Cl. 98—36)

The present invention is concerned with an improved open doorway air curtain control system; in particular, a system having an average temperature responsive means located in the return duct for controlling the air flow control means in the supply duct and a differential thermostat for further controlling the air flow control means.

The use of mechanical doors at the entries and exits of buildings has presented numerous problems especially where a considerable amount of traffic exits through the doors. In recent years it has been found that the use of an air curtain or a stream of air flowing across the doorway is very effective for closing off the doorway. Generally, the air is discharged from an outlet above the open doorway to enter into a return passage through a floor grate. The air curtain has been shown to be very effective in preventing the loss or gain of heat through the open doorway, the entrance of dirt which is normally carried by wind blowing into a door, and the entrance of fowls, bugs and even dogs, and yet, such a barrier is not objectionable for people passing through the open door.

Air curtain doorways have been used for some time; however, until recent years, there has been little done in the control of such doors. Where it is desired to use such an air curtain door in colder climates or in localities with air conditioning, the air curtain door must be controlled to prevent the loss or gain of heat through the doorway. The present invention provides the improved control system to make the air curtain doorway as effective as possible with the minimum amount of equipment.

It is therefore an object of the present invention to provide an improved control system for an air curtain doorway.

Another object of the present invention is to provide a control system for an air curtain doorway in which the flow control device of the air curtain changes the direction of air flow in response to the average temperature of the air in the return passage.

Another object of the present invention is to provide an air curtain control system wherein the direction of air flow across the open doorway is varied from the normal in one direction or the other depending upon the temperature difference across the doorway.

These and other objects of the present invention will become apparent upon the study of the specification and drawings of which:

FIGURE 1 is a schematic drawing of the control system for the air curtain doorway;

FIGURE 2 is a top view of the floor grate of the doorway showing the average temperature element; and

FIGURE 3 is a schematic drawing of the circuit of the various components in the control system shown in FIGURE 1.

Referring to FIGURE 1 of the drawing, an open doorway 10 is shown. An air curtain or stream of air is maintained across an open doorway 10 as air exhausts from a supply duct 11 having a discharge opening 21 above the doorway and returns into a return duct 12 on the floor. The air is circulated through a conventional ductwork by a fan 13. After entering a floor grate 14, the air passes through a filter 15, fan 13, a cooling or heating coil 20, and back to the supply of discharge opening 21.

A flow control means 22 made up of a number of vanes

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or dampers 23 is mounted in discharge opening 21 to direct the flow of air across the open doorway. As difference conditions change the flow of air across the open door, the vanes are repositioned to maintain the flow to effectively close off the door. By means of a suitable linkage 24, the flow control means is connected to a two direction motor 25; so that, the position of the vanes 23 are changed depending upon the position of an output arm 30 connected to the motor. As shown, the vanes are vertical and the air flows directly downward across the open door into grate 14. Upon movement of vanes 23 to the left at varying degrees, the air flow across the open doorway follows a path somewhat as indicated by the dotted line 31. Obviously, upon movement of the vanes 23 in the opposite direction, to the right, the air flow is along a path as shown by dotted line 32.

The air passing across the open doorway is maintained at a temperature of approximately 70 degrees by the tempering heater 20. This heater might be a steam coil which has a supply of steam controlled by a conventional valve 33 which is controlled by a thermostat 34. Obviously when the building using the open doorway is air conditioned during the hot weather the use of such a tempering coil will be discontinued.

The control of the position of vanes 23 depends upon the pressure developed across the air curtain through the open doorway. For example, during the wintertime, if a wind is blowing from the left, the air curtain is deflected inward. To keep the air curtain effective in closing off the open doorway, the flow control means 22 is repositioned; so that, the air flow is to the left, as shown by the dotted line 31, to counteract the wind blowing from outdoors. To determine the degree of change in the air flow control means 22 or the position of dampers 23, an averaging temperature sensing element 40 is located below the floor grate. The average temperature of the air returning to the floor grate is compared with the temperature of the air discharging from opening 21 as measured by the temperature sensing element 41. Elements 40 and 41 are connected to a panel 42 having an output connected through a reversing relay 43 to motor 25. When the average temperature of the return air, as sensed by element 40, varies from the temperature of the supply air, the motorized vanes 23 are repositioned at varying degrees to the left. The air flow across the passage counteracts the outdoor wind, and the return of the outdoor air into the floor grate is lessened.

Obviously during the summer time, the air curtain must prevent the flow of cold air from indoors from passing into the floor grate. Reversing relay 43 is controlled by a differential thermostat 45 having an outdoor bulb 50 responsive to outdoor temperature and an indoor bulb 51 responsive to indoor temperature. When the outdoor temperature is lower than the indoor temperature, the reversing relay 43 is operated; so that, upon the energization of the motor by panel 42, the vanes move to the left a varying degrees. When the indoor temperature or bulb 51 is colder, during the summer or air conditioning season, the operation of motor 25 is in the range to position the dampers 23 to the right at varying degrees.

The averaging temperature sensing element 40 is shown in detail in FIGURE 2. The element is quite long and is wound back and forth to substantially cover the area below the grate 14.

Referring to FIGURE 3, the specific control system of FIGURE 1 is shown. While one specific embodiment of the control system is disclosed, it is obvious to one skilled in the art that other types of control systems to accomplish the applicant's invention are available. Panel 42 comprises a conventional resistance bridge circuit having a pair of branches connected to the secondary of a transformer 60. One branch comprises element 40, a resistor

61 of a follow-up potentiometer, and an element 41. The second branch is made up of several resistors and a potentiometer 62 having a movable wiper 63 connected to ground. Connected in parallel with resistor 61 is an adjustable resistor 64 which performs the function of a throttling resistor. A movable wiper 65 associated with resistor 61 is electrically connected to one input terminal of an amplifier relay 70; the other input terminal of the amplifier relay is connected to ground. Movable wiper 65 is mechanically connected to the output arm 30 of motor 25; so that, upon operation of motor 25, a rebalance is established in the bridge circuit. Motor 25 is connected to the output of amplifier relay through the reversing relay 43. The amplifier relay 70 is effective to drive motor 25 in one direction or the other depending upon the unbalance of bridge 36 and thus which lead or output connection 71 or 72 is connected to the power source. One typical amplifier relay and motor combination is shown in FIGURE 2 of the A. P. Upton Patent No. 2,423,534. Reversing relay 43 is added between the motor and the amplifier. For a given unbalance of the bridge circuit 36 the motor 25 will run in one direction; however, upon the energization of reversing relay 43, the same unbalance of bridge 36 will cause the motor to run in the opposite direction. The reversing relay has an actuator or coil 80 which is selectively energized by the differential thermostat 45. A pair of bucking bellows attached to the bulbs 51 and 50, respectively, forming liquid filled systems, control the operation of switch 83. When bulb 50 is colder than bulb 51, switch 83 is made to energize the reversing relay 43.

Operation

Let us assume fan 13 is operating and the air flow is as shown with the solid arrow in FIGURE 1. The air temperature is maintained at approximately 70° by the calibration of thermostat 34. As long as the average temperature in the return duct as sensed by element 40 is the same as the temperature of the air discharging from duct 11 as sensed by element 41, motor 25 remains as shown, and the dampers 23 remain vertical. During winter operation, the outdoor temperature is lower than the indoor temperature, and the differential thermostat 45 would not energize relay 43. As it is desired to keep the air curtain passing directly between discharge opening 21 and floor grate 14, any change in the temperature difference between elements 40 and 41 causes energization of motor 25. Let us assume, a cold wind develops causing the air curtain to move inward and to the right. The air from outdoors would begin to leak into the floor grate and the average temperature of sensing element 40 would drop. Referring to FIGURE 3, the lowering of the resistance of sensing element 40 unbalances bridge 36. Amplifier relay 70 is energized to energize motor 25 and the output arm 30 moves to the right and motorized vanes 23 move to the left. The air curtain is repositioned in the direction of the dotted arrow 31 to a degree depending upon the force of the wind previously mentioned. As soon as the average temperature of element 40 reached the temperature of 41, the bridge is again balanced and the vanes 23 would remain in the new position to keep the air stream directed outward to the left. When the wind previously mentioned stops, the air curtain moves to the left to allow the warmer indoor air to contact bulb 40. The average resistance of element 40 increases to cause motor 25 to reposition vanes 23 to the right. The bridge seeks to maintain a balanced condition by repositioning vanes 23 until the resistances of elements 40 and 41 are nearly equal. Obviously the amount of wind against the air stream from either direction varies the degree of change of the position of the vanes throughout the total range shown by the two dotted extreme positions.

Upon a changeover from winter to summer operation, the bulb 51 is cooler than the bulb 50. The reversing relay is then energized to reverse the operation of the

motor for a given unbalance of bridge 36. If we assumed the same wind was blowing from the left for the summer operation, the air curtain moves to the right, and the average temperature of the sensing element 40 increases. The vanes then move to the left as before to deflect the air stream along the dotted arrow 31.

While one modification of the present invention is shown in the drawing, it is obvious that variations might be made by one skilled in the art; therefore, it is intended that the present invention only be limited by the appended claims in which

I claim:

1. In an air curtain control system, fan means for circulating air from a discharge duct above an opening between two areas having two different air temperatures to a floor intake duct below said discharge duct and back through air circulating closed loop, rotatable flow control vanes in said discharge duct for changing the direction of the flow of air from a vertical flow to a flow direction at an angle with respect to the vertical, motor means, mechanical means connecting said motor means to said vanes, first temperature responsive means responsive to the temperature of the air leaving said discharge duct, second temperature responsive means responsive to the temperature of the air entering said intake duct, said air entering said intake duct normally comprising substantially air from said discharge duct, control means connecting said first and second temperature responsive means to said motor means so that the flow control vanes are positioned to increase said air flow angle in one direction in opposition to the infiltration of colder air from one of the areas as the temperature between said first and second means changes a predetermined amount due to the infiltration of colder air from one of the areas into said intake duct, motor reversing means connected between said control means and said motor for changing the direction of movement of said vanes to increase said air flow angle in a direction opposite said one direction and thus the flow of air to an opposite direction when an infiltration of colder air is from another of said areas to change the temperature between said first and second means said predetermined amount, third temperature responsive means responsive to outdoor temperature, fourth temperature responsive means responsive to indoor temperature, and means connecting said third and fourth responsive means to said reversing means to control said reversing means in response to whether the outdoor temperature is colder or warmer than the indoor temperature.

2. In an air curtain control system, a fan for circulating air at a relatively constant temperature through a closed air circulation loop including a space across an opening between two areas by air flowing from a discharge duct into a return duct above and below the opening respectively, said circulated air being maintained at a temperature different than the ambient air temperature of the areas, adjustable vanes mounted in said discharge duct for directing the flow of air at different air flow angles with respect to the vertical across the opening to maintain an air stream between said discharge and return duct, motor means connected to said vanes, temperature responsive means responsive to the temperature of the air entering said return duct, control means connecting said temperature responsive means to said motor means whereby said vanes are positioned to maintain a predetermined return air temperature, said air entering said return duct comprising air from said discharge duct and air from one of said areas, said return air having a temperature which varies depending upon the amount and temperature of the air from said one area mixing with the discharge duct air, second temperature responsive means responsive to the temperature differential between said areas, and means connecting said second temperature responsive means to said control means to control the direction of operation of said vanes for a predetermined change in said return duct air temperature as effected by the temperature of said

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air from said one area so that upon a drop in said return air temperature said flow of air is directed toward the area having air with the lowest air temperature to maintain said return air at a predetermined temperature.

3. In an air curtain control system, means for providing a flow of air across an opening between two areas having different air temperatures from a supply passage to a return passage on opposite sides of said opening, a first of said areas having a relatively constant air temperature, flow directing means for directing the flow of air from said supply passage in a direction to arrive at said return passage, air temperature responsive means in said return passage and responsive to the temperature of the return air, said return air comprising air from said supply passage and air from one of said areas, connection means connecting said responsive means to said flow directing means so that the angle of flow of air across said passage is maintained to keep said return air temperature at a selected value, said flow directing means changing the angle of flow to direct air toward a second of said areas to decrease

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the intake of air from said second area when said return air temperature drops below some selected value, second temperature responsive means responsive to the temperature of the air in second said area, and means connecting said second responsive means to said flow directing means to obtain a reversing operation to direct said air flow toward said first area when the temperature of the air in said second area rises above a predetermined value and the temperature of the return air drops below said selected value.

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