April 18, 1939. J. T. MIDYETTE, JR 2,154,523

UNIT VENTILATOR

Filed Oct. 14, 1935 2 Sheets-Sheet 1

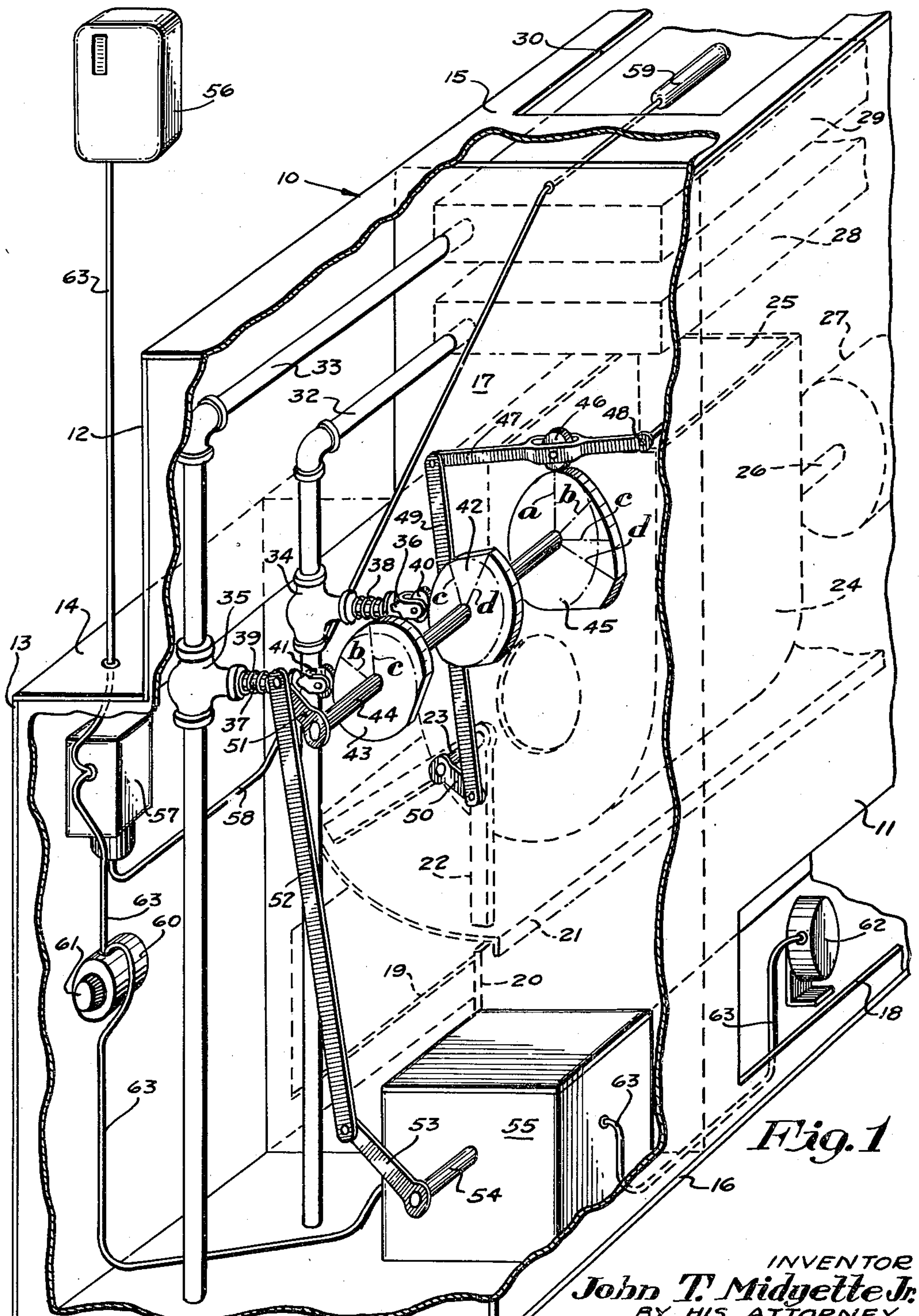

Fig.1

INVENTOR
John T. Midyette Jr.
BY HIS ATTORNEY
George H Fisher

UNIT VENTILATOR

Filed Oct. 14, 1935 2 Sheets-Sheet 2

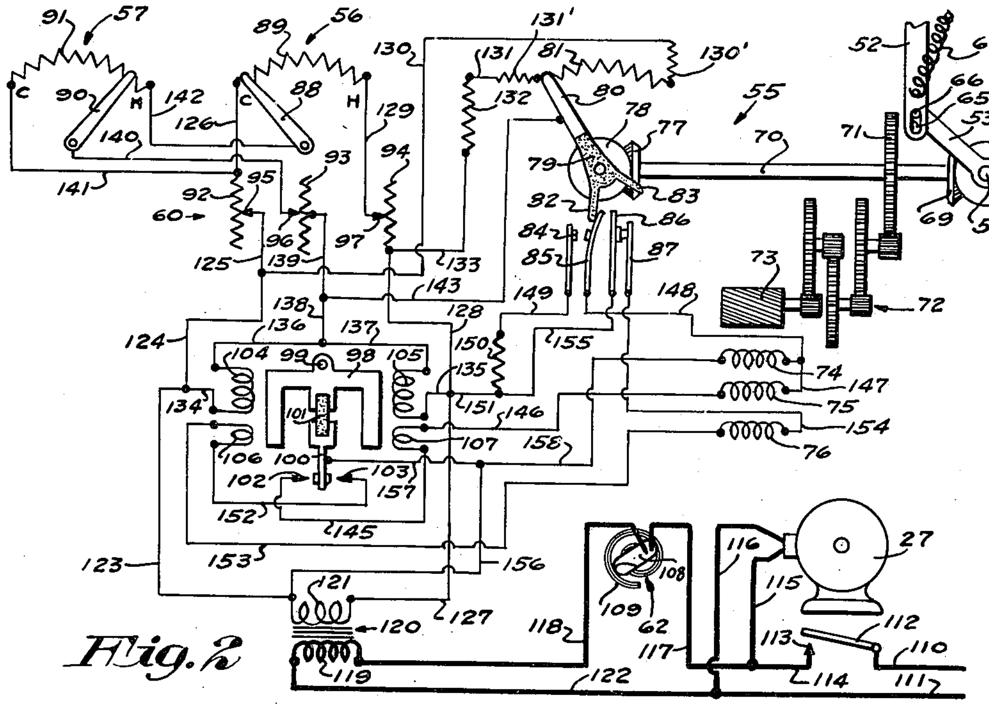

Fig. 2

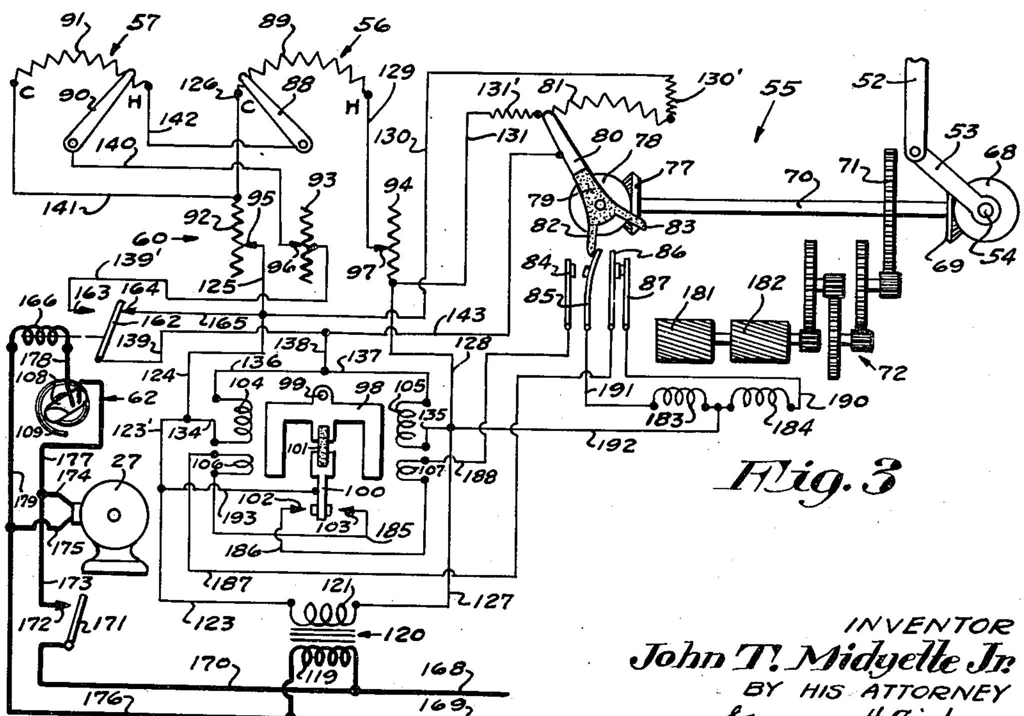

Fig. 3

INVENTOR
John T. Midyette Jr.
BY HIS ATTORNEY
George H Fisher

Patented Apr. 18, 1939 2,154,523

UNITED STATES PATENT OFFICE

2,154,523

UNIT VENTILATOR

John T. Midyette, Jr., Scarsdale, N. Y., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application October 14, 1935, Serial No. 44,899

10 Claims. (Cl. 236—38)

This invention relates to air conditioning devices in general and more specifically to those types of air conditioning systems generally termed unit ventilators.

It is an object of this invention to provide an air conditioning device or a unit ventilator having a damper and one or more banks of radiators, the damper and the radiators being controlled by a single motor.

Another object of this invention is to provide an air conditioning device, or a unit ventilator of the class described with control mechanisms responsive to space temperature and discharge temperature for positioning the damper and the radiator valves.

Another object of this invention is to provide a control system for a unit ventilator that is placed in operation when the room temperature reaches a predetermined value.

In various parts of the country the heating and ventilating codes call for a predetermined minimum amount of fresh air to be delivered to a space, and these predetermined minimum amounts of fresh air vary according to the requirements of the various localities. It is, therefore, an object of this invention to provide a means for admitting a minimum amount of fresh air to the space with means for easily adjusting this minimum amount of fresh air whereby the various heating and ventilating codes may be readily complied with.

Other objects and advantages will become apparent to those skilled in the art upon reference to the accompanying specification, claims and drawings, in which drawings:

Figure 1 is a perspective view of my control system applied to a unit ventilator with portions thereof broken away for purposes of illustration.

Figure 2 is a schematic wiring diagram of one form of the control system that may be applied to the unit ventilator shown in Figure 1.

Figure 3 is a schematic wiring diagram of another form of the control system that may likewise be applied to the unit ventilator disclosed in Figure 1.

Although my invention may be applied equally well to a plenary system, it is shown as applied to a unit ventilator generally designated at 10. The unit ventilator 10 comprises a front wall 11 and rear walls 12 and 13. The rear walls 12 and 13 are connected together by a horizontally extending wall 14. The top of the ventilator 10 is closed by a top wall 15, and likewise the bottom of the unit ventilator is closed by a bottom wall or base, 16. Located within the unit ventilator 10 is a vertically extending transverse partition 17 which divides the unit ventilator into two chambers, one chamber enclosing the air conditioning elements, and the other chamber enclosing the control elements.

Located in the front wall 11 is a return air opening 18, and likewise located in the rear wall 13 is a fresh air opening 19. These openings 18 and 19 may be provided with suitable grills, not shown. Located between the openings 18 and 19 is a vertically extending baffle 20, dividing the lower portion of the air conditioning chamber into a fresh air chamber and a return air chamber. A damper 21 is suspended above the baffle 20 by means of brackets 22 secured to shafts 23 so that when the damper 21 is moved into the position shown in Figure 1 the fresh air chamber is cut off, and when the damper 21 is moved to the right of the position shown in Figure 1 the return air chamber is cut off. The damper 21 is adapted to be positioned between either of these extreme positions in a manner to be described fully hereafter.

Located above the damper 21 is a fan 24, having an outlet opening 25. Fan 24 is driven through a shaft 26 by means of an electric motor 27. Located above the fan 24 are superimposed radiators 28 and 29. The top wall 15 is provided with a discharge opening 30 so that the fan 24 may draw either fresh air or return air, or a mixture thereof, as determined by the damper 21 over the radiators 28 and 29, to be discharged into the space to be conditioned through the discharge opening 30.

Heating fluid such as steam may be supplied to the radiators 28 and 29 by means of pipes 32 and 33, respectively. The flow of heating fluid through the pipe 32 is controlled by means of a valve 34, and likewise the flow of heating fluid through the pipe 33 is controlled by a valve 35. The valves 34 and 35 are provided with valve stems 36 and 37, respectively, which are forced outwardly by means of compression springs 38 and 39, respectively. The springs 38 and 39 bias the valves 34 and 35 to an open position. The valve stems 36 and 37 carry rollers 40 and 41, which are adapted to co-act with cams 42 and 43 located on a shaft 44. Cams 42 and 43 are adapted upon turning movement of the same to act against the rollers 40 and 41 to move the valves 34 and 35 towards a closed position.

Also mounted on the shaft 44 is a cam 45 co-acting with a roller 46 mounted on a lever 47, pivoted as at 48. Lever 47 acts through a link 49 and a crank 50 secured to the damper shaft 23 to actuate the damper 21. When the roller 46 rides upwardly on the cam surface of the cam 45, the draft damper 21 is moved from the fresh air restricting or closed position as shown in Figure 1 toward the right to a return air restricting or open position.

The shaft 44 carries a crank 51 which is connected by means of a link 52 to a crank 53 mounted on a shaft 54. The shaft 54 is rotated by a proportioning motor 55 in a manner to be described hereafter. The motor 55 may take the form of the motor disclosed in Patent No. 2,032,658 issued to W. H. Gille on March 3, 1936 or disclosed in application Serial No. 673,236 filed by Lewis L. Cunningham on May 27, 1933.

Located in the space to be conditioned is a thermostat 56 preferably of the potentiometer type shown and described in patent No. 2,041,050 issued to Lewis L. Cunningham.

Located in the control chamber of unit ventilator 10 is a controller 57, preferably of the potentiometer type. The controller 57 is connected by means of a capillary tube 58 to a bulb 59 located in the discharge opening 30 of the unit ventilator 10, so that the controller 57 is operated in response to changes in temperature of the discharge air from the unit ventilator. The controller 57 may take the form also shown in Lewis L. Cunningham Patent No. 2,041,050.

Also located within the control chamber is a variable resistance 60 operated by a knob 61.

Located in the return air opening 18 is a thermostat 62 which may be of the type shown in Patent No. 1,676,921, issued to L. A. M. Phelan et al., on July 10, 1928.

The space temperature controller 56, the discharge temperature controller 57, the variable resistance 60, the return air temperature controller 62 and the proportioning motor 55 are suitably connected together by means of conduits 63.

The manner in which these various control elements are associated and the manner in which they form the control function for the unit ventilator may be obtained by reference to Figure 2 of the drawings. In Figure 2 of the drawings I have shown the motor 55 to be of the type disclosed in the Willis H. Gille Patent No. 2,032,658. A lost motion connection of limited amount is shown to exist between the motor crank 53 and the associated link 52, this lost motion being accomplished by means of a slot 65 in the link 52 cooperating with a pin 66 carried by the crank 53. A spring 67 normally urges the link 52 upwardly and, consequently, urges the crank 53 in a clock-wise direction. However, when the link 52 is moved to its extreme upward position, which position corresponds to the position shown in Figure 1, the crank 53 is allowed to move in a clockwise direction a limited amount by reason of the lost motion connection for reasons to appear more fully hereafter.

The shaft 54 is operated through bevel gears 68 and 69 by means of a rotary shaft 70. The rotary shaft 70 carries a gear 71 which is rotated through a reduction gear train 72 by a motor rotor 73. The motor rotor 73 is operated by field windings 74, 75 and 76. The field winding 74 performs a holding function and is of sufficient strength to act against the spring 67 to maintain the shaft 70 in any given position but not sufficient to move the shaft. The field winding 76 is an operating winding but is not sufficiently strong in itself to cause operation of the shaft 70 against the tension of the spring 67. However, when both windings 74 and 76 are energized simultaneously the shaft 70 is rotated against the tension of the spring 67 to move the damper 21 from a fresh air restricting or closed position. The field winding 75 acts in opposition to the field winding 74 so that when the field windings 74 and 75 are energized, the maintaining or holding action of the field winding 74 is neutralized and the shaft 70 is allowed to be rotated by means of the spring 67 to move the damper 21 towards a fresh air restricting position as shown in Figure 1.

The shaft 70 also carries a bevel gear 77 engaging the bevel gear 78 to operate an abutment member 79. The abutment member 79 carries a slider 80 adapted to slide across a potentiometer coil 81. The abutment member 79 also carries fingers 82 and 83. The finger 82 co-acts with a limit switch comprising contacts 84 and 85 and in a like manner the contact finger 83 co-acts with a limit switch comprising contacts 86 and 87. When the damper 21 is moved to an extreme closed or fresh air restricting position the contact finger 82 breaks contact between the contacts 84 and 85 and when the draft damper 21 is moved to an extreme open or return air restricting position the finger 83 breaks contact between the contacts 86 and 87.

For purposes of illustration, the space temperature controller 56 is shown to comprise a slider 88 adapted to slide across a potentiometer coil 89 and the discharge temperature controller 57 is shown to comprise a slider 90 adapted to slide across a potentiometer coil 91. Upon increases in temperature the sliders 88 and 90 are moved to the right, and upon decreases in temperature the sliders 88 and 90 are moved to the left as shown by the characters H and C, respectively.

The variable resistance 60 operated by the knob 61 is shown to comprise three resistances 92, 93 and 94, adapted to be engaged by sliders 95, 96 and 97, respectively.

The motor 55 contains a relay having an armature 98 pivoted at 99. A contact arm 100 is carried by the armature 98 and insulated therefrom by an insulator member 101. The contact arm 100 is adapted to engage a contact 102 or a contact 103. The armature 98 is operated by relay coils 104, 105, 106 and 107, so that when the coil 104 is energized more than the coil 105, the contact arm 100 is moved into engagement with the contact 103, and when the coil 105 is energized more than the coil 104 the contact arm 100 is moved into engagement with the contact 102. When the coils 104 and 105 are equally energized, the contact arm 100 assumes a mid position as shown in Figure 2.

The return air thermostat 62 is shown to comprise a mercury switch 108 operated by a bimetallic member 109, so that upon an increase in return air temperature to a predetermined value the mercury switch 108 is moved to a circuit making position.

Line wires 110 and 111 lead from some source of power, not shown. A manually operated switch 112 co-acting with a contact 113 is connected to the line wire 110. The contact 113 is connected by wires 114 and 115 to the fan motor 27 which is in turn connected by a wire 116 to the other line wire 111. Therefore, when the switch arm 112 is moved into engagement with the contact 113 the fan motor 24 is placed in operation. One of the electrodes of the mercury switch 108 is connected by a wire 117 to the junction of the wires 114 and 115. The other electrode of the mercury switch 108 is connected by a wire 118 to one end of a primary 119 of a step-down transformer 120 having a secondary 121. The other end of the primary 119 is connected by a wire 122 to the junction of wires 111 and 116. By reason of these wiring connections when the manual switch 112 is closed and the mercury switch 108 is moved to a circuit making position the transformer 120 is energized.

One end of the secondary 121 of the step-down transformer 120 is connected by wires 123, 124 and 125, to the contact 95 of the variable resistance 60. The resistance 92 associated with the contact 95 is connected by a wire 126 to the left hand end of the potentiometer coil 89. The other end of the secondary 121 is connected by wires 127 and 128 to the resistance 94. The slider 97 associated with resistance 94 is connected by a wire 129 to the right hand end of the potentiometer coil 89. The junction of the wires 124 and 125 is connected by a wire 130 and a protective resistance 130′ to the right hand end of the balancing potentiometer 81, and the left hand end of the balancing potentiometer 81 is connected by a protective resistance 131′, a wire 131, a resistance 132 and a wire 133 to the junction of wire 128 and the resistance 94. The junction of wires 123 and 124 is connected by a wire 134 to the lower end of the coil 104, and likewise the junction of wires 127 and 128 is connected by a wire 135 to the lower end of the coil 105. The upper ends of the coils 104 and 105 are connected together by means of wires 136 and 137, and to the resistance 93 by means of wires 138 and 139. The slider 96 co-acting with the resistance 93 is connected by a wire 140 to the slider 90 of the discharge temperature controller 57. The left hand end of the potentiometer coil 91 is connected by a wire 141 to the junction of the resistance 92, and the wire 126 and the right hand end of the potentiometer coil 91 is connected by a wire 142 to the slider 88 of the space temperature controller 56. The slider 80 associated with the balancing potentiometer 81 is connected by a wire 143 to the junction of the wires 138 and 139.

From the above wiring connections it is seen that the left hand end of the secondary 121, the lower end of the coil 104, the left hand end of the potentiometer coil 89, and the right hand end of the balancing potentiometer coil 81 are connected together. Likewise, the right hand end of the secondary 121 and the lower end of the coil 105, the right hand end of the potentiometer coil 89 and the left hand end of the balancing potentiometer coil 81 are connected together. The upper ends of the relay coils 104 and 105, and the sliders 88 and 80 are connected together. Therefore, it is seen that the coils 104 and 105, and the potentiometer coils 89 and 81 are connected in parallel with respect to each other and across the secondary 121 of the step-down transformer 120. It is also seen that when the slider 88 is moved to its extreme right hand position the right hand end of the potentiometer coil 91 is directly connected to the left hand end of the balancing potentiometer 81 and the left hand end of the potentiometer coil 91 is connected to the right hand end of the balancing potentiometer coil 81. Therefore, with the slider 90 in its extreme right position as shown in Figure 2 the system is under the control of slider 88 and its potentiometer coil 89, and that when the slider 88 is in its extreme right hand position the system is under the control of the slider 90 and its potentiometer coil 91.

The contact 102 cooperating with the contact arm 100 is connected by a wire 145 to one end of the coil 107. The other end of the coil 107 is connected by a wire 146 to one end of the field winding 75. The other end of the field winding 75 is connected by wires 147 and 148 to the contact 85 of the limit switch. The associated contact 84 is connected by wire 149, resistance 150 and wire 151 to the junction of wires 127 and 128. The contact 103 cooperating with the contact arm 100 is connected by a wire 152 to one end of the coil 106. The other end of the coil 106 is connected by a wire 153 to one end of the field winding 76. The other end of the field winding 76 is connected by a wire 154 to the contact 87 of the other limit switch and the associated contact 86 is connected by a wire 155 to the junction of wire 151 and the resistance 150. The left hand end of the secondary 121 is connected by wires 156 and 157 to the contact arm 100 and by a wire 158 to one end of the field winding 74, the other end thereof being connected to the junction of wires 147 and 148.

With the parts in the position shown in the drawings the space or room is cold and the unit ventilator is shut down by reason of the switch 112 being open. The damper 21 is located in a closed or fresh air restricting position by means of the spring 67 and, consequently, the limit switch 84, 85 is open. The valves 35 and 34 are open to admit heating fluid to the radiators 28 and 29, and in response to the heated condition of the radiators 28 and 29, slider 90 is in the right hand position with respect to its potentiometer coil 91. Due to the fact that at this time the space or room is cold the slider 88 is at its extreme left hand position with respect to its potentiometer coil 89. Upon closing of the manual switch 112 the fan motor 24 is placed in operation and return air from the space is forced over the radiators 28 and 29 and heated thereby. When the space temperature and, consequently, the return air temperature, has risen to a given value, the mercury switch 108 is tilted to a circuit making position to supply energy to the step-down transformer 120. As the temperature in the space begins to rise the slider 88 is moved to the right to cause short circuiting or shunting of the coil 105 to increase the energization of the coil 104 and decrease the energization of the coil 105. This causes movement of the switch arm 100 into engagement with the contact 103 to complete a circuit from the secondary 121 through wires 156 and 157, contact arm 100, contact 103, wire 152, coil 106, wire 153, field winding 76, wire 154, contacts 87 and 86, and wires 155, 151 and 127, back to the secondary 121. Completion of this circuit causes energization of the field winding 76 to start movement of the damper 21 from the fresh air restricting position. This starting movement caused by energization of the field winding 76 is permitted by the lost motion connection between the crank 53 and the link 52. When this lost motion is taken up the finger 82 is moved out of engagement with the contact 85 to cause engagement of contacts 84 and 85. Engagement of these contacts 84 and 85 completes a circuit from the secondary 121 through wires 156 and 158, field winding 74, wire 148, contacts 84 and 85, wire 149, resistance 150, and wires 151 and 127, back to the secondary 121. Completion of this circuit causes energization of the field winding 74 and the field winding 74 will remain energized as long as the contacts 84 and 85 are in engagement. Since both the field windings 74 and 76 are energized in the manner pointed out above, the spring 67 is overcome and the damper 21 is moved further from the fresh air restricting position.

Movement of the damper 21 from the fresh air restricting position causes right hand movement of the slider 80 with respect to the balancing potentiometer coil 81. This causes short circuiting or shunting of the coil 104 to decrease the energization thereof and increase the energization of the coil 105, it being remembered that the coil 104 was energized more than the coil 105 by reason of the right hand movement of the slider 88. When the slider 80 has moved sufficiently far to the right, the coils 104 and 105 will become equally energized to move the contact arm 100 out of engagement with the contact 103 and into the mid position as shown in Figure 2. This causes de-energization of the field winding 76, it being remembered that the field winding 74 still remains energized. When the field winding 76 is thus de-energized the damper 21 is maintained in the newly adjusted position by the energization of the field winding 74. Since the circuit through the field winding 76 includes the coil 106 the contact arm 100 is moved forcibly in engagement with the contact 103 to prevent relay chatter.

Upon a decrease in space temperature, the slider 88 moves toward the left with respect to the potentiometer coil 89 to short circuit or shunt the coil 104 to increase the energization of the coil 105 and decrease the energization of the coil 104. This causes movement of the contact arm 100 into engagement with the contact 102. Movement of the contact arm 100 into engagement with the contact 102 completes a circuit from the secondary 121 through wires 156 and 157, contact arm 100, contact 102, wire 145, coil 107, wire 146, field winding 75, wires 147 and 148, contacts 85 and 84, wire 149, resistance 150 and wires 151 and 127 back to the secondary 121. Completion of this circuit causes energization of the coil 75 which neutralizes the holding action of the coil 74 to permit the spring 67 to move the damper 21 towards a fresh air restricting position. Movement of the damper 21 towards a fresh air restricting position causes left hand movement of the slider 80 with respect to its balancing coil 81 and when the slider 80 has moved sufficiently far to the left the coils 104 and 105 are again equally energized to move the contact arm 100 out of engagement with the contact 102 and to the mid position as shown in Figure 2. This causes de-energization of the field winding 75, it being remembered that the field winding 74 remains energized. Therefore, further movement of the damper 21 towards a fresh air restricting position is stopped. Since the circuit through the field winding 75 includes the coil 107, the contact arm 100 is forcibly held in engagement with the contact 102 to prevent relay chatter. The resistance 150 is included in the circuits through the field windings 74 and 75 to add resistance in the circuits to compensate for the decrease in resistance caused by the energization of the oppositely-acting field windings 74 and 75.

Movement of the slider 80 to the extreme left hand position shown in Figure 2 is caused by complete closing movement of the damper 21. Due to the use of the resistance 132 a complete re-balancing is not established by the complete left hand movement of the slider 80, whereby further movement of the damper 21 towards a closed position is permitted to insure that the finger 82 will break contact between the contacts 84 and 85 of the limit switch to completely shut off the supply of energy to the field windings 74 and 75 to prevent undue heating of the same.

From the above it is seen that I have provided a system for accurately positioning a damper in accordance with space temperatures which system is placed in operation when the space temperature or return air temperature rises to a predetermined value.

In some localities it is required to have a minimum amount of fresh air delivered to the space to be heated, and this amount may vary according to the various localities. To cause immediate partial opening of the damper 21 to provide this minimum amount of fresh air, I have provided in the circuit leading to the controllers 56 and 57 the variable resistance 60. Movement of the sliders 95, 96 and 97 downwardly from the position shown in the drawings increases the resistance on the left hand end of the potentiometer coil 89 and decreases the resistance on the right hand end of the coil 97. This produces the same effect as moving the slider 88 to the right with respect to the potentiometer coil 89, so that with the slider 88 in the extreme left hand position shown in the drawings, movement of the sliders 95, 96 and 97 downwardly causes opening movement of the damper 21, the amount of opening movement being determined by the distance through which the sliders 95, 96 and 97 are moved. Therefore, with the sliders 95, 96 and 97 located in a downward position, the damper 21 will be immediately moved to some intermediate position upon closing of the mercury switch 108.

Referring now to Figure 1, I have diagrammatically shown four positions which the cams 42, 43 and 45 may assume. In the position shown wherein line *a* coincides with the roller 46, the damper 21 is closed and the valves 34 and 35 are open. Movement of the cams 42, 43 and 45 to the position where line *b* coincides with the roller 46, the damper 21 is partially open and the valve 35 is about to be closed. Movement of the cams 42, 43 and 45 to the position where line *c* coincides with the roller 46 the damper 21 is moved to a further open position and the valve 35 is completely closed and the valve 34 is about to be moved towards a closed position. Movement of the cams 42, 43 and 45 to a position where the line *d* coincides with the roller 46 causes complete opening of the damper 21 and complete closing of the valves 34 and 35. Movement of the cams 42, 43 and 45 in the opposite direction causes exactly the same operation but in the reverse order. The cams 42, 43 and 45 are so designed, and the variable resistance 60 is so positioned, that when the thermostat 62 places the control system in operation the damper 21 is moved to a partially open position corresponding to the line *b*. Upon an increase in room temperature so as to move the slider 88 to the right with respect to the potentiometer coil 89, the damper 21 is positioned towards an open position and the valves 34 and 35 are positioned toward a closed position. Preferably, the thermostat 62 is set so that the mercury switch 108 is moved to a circuit making position at 65° and the slider 88 is started in its movement from the left hand position of the potentiometer 89 at 68° and arrives at the right hand position with respect to the potentiometer coil 89 when the space temperature has risen to 72°. By reason of the above settings, re-circulated air is heated until the temperature of the air becomes 65°, at which time the damper 21 is moved to a partially open position to admit a predetermined amount of fresh air to the space. When the temperature of the space begins to rise above 68° more fresh air is admitted and the amount of heat imparted to the air is decreased. When the temperature of the space has risen to 72°, 100 per cent fresh air is admitted to the space and no heat is imparted to the air since at this temperature the radiators 28 and 29 are cut off.

With the above operation, and with the room or space temperature at 72°, and if the outdoor temperature is cold, raw air may be delivered into the space or room. To prevent this delivery of raw air into the space or room, the discharge temperature controller 57 is provided and preferably this controller is adjusted so that when the temperature of the discharge air decreases below 65° the slider 90 is moved from its right hand position towards its left hand position with respect to the potentiometer coil 91. Since at this time the slider 88 is at the extreme right end of the potentiometer coil 89, and since the right hand end of the coil 91 is connected to the coil 105, and since the left hand end of potentiometer coil 91 is connected to the coil 104, movement of the slider 90 towards the left short circuits or shunts the coil 104 to increase the energization of the coil 105 and decrease the energization of the coil 104 to cause movement of the contact arm 100 into engagement with the contact 102. This causes energization of the field winding 75 to neutralize the action of the field winding 74 to allow the spring 67 to move the damper 21 towards a closed position, and to move the valve 34 towards an open position, the amount of movement of the damper, and, consequently, the valve 34 being determined by the position of the slider 90. In extremely cold weather the slider 90 may be moved sufficiently far to the left to completely open the valve 34 and partially open the valve 35.

From the above it is seen that I have provided a heating and ventilating system which positions a damper and valves according to space or room temperatures, and which also positions the damper and valves in accordance with discharge temperatures when the space temperature is satisfied. Also, the control system is placed in operation at a predetermined space temperature and provision is made for supplying a minimum amount of fresh air to the space and the means for supplying this minimum amount of fresh air may be regulated easily to comply with heating and ventilating codes that exist throughout the various localities of the country. Provision is also made for closing the damper when the unit ventilator is rendered inoperative or in case of power failure.

Referring now to Figure 3, a system is provided which gives exactly the same results as the system disclosed in Figure 2, but the manner for accomplishing these results is slightly different. This modification uses the same space temperature controller, the same discharge temperature controller, and the same relay mechanism, these various elements being connected together in the manner pointed out above. However, the wire 139 which connects the wire 138 to the resistance 93 in Figure 2 connects the wire 138 to a switch arm 162 in Figure 3. Switch arm 162 is adapted to engage a contact 163, which is connected by a wire 139' to the resistance 93. Therefore, when the switch arm 162 is in engagement with the contact 163 the operation of this portion of the control system of Figure 3 is identical with that of Figure 2. The switch arm 162 is also adapted to engage a contact 164, which is connected to the junction of wires 124 and 125 so that when the switch arm 162 is in engagement with the contact 164 the temperature controllers 56 and 57 are rendered inoperative to control the proportioning motor and the coil 104 is completely short circuited to move the contact arm 100 into engagement with the contact 102. The switch arm 162 is operated by means of a relay coil 166 so that when the relay coil 166 is energized the switch arm 162 is moved into engagement with the contact 163 to place the proportioning motor under automatic control, and when the relay coil 166 is de-energized the switch arm 162 is moved into engagement with the contact 164 in any suitable manner to prevent automatic operation of the proportioning motor and to cause the proportioning motor to assume one extreme position.

In this modification line wires leading from some source of power, not shown, are designated at 168 and 169. One end of the primary 119 of the step-down transformer 120 having the secondary 121 is connected to the line wire 168 and the other end thereof is connected to the line wire 169. Therefore, in this modification power is at all times supplied to the relay. The line wire 168 is also connected by a wire 170 to a switch arm 171, co-acting with a contact 172. Contact 172 is connected by wires 173 and 174 to the fan motor 27, and the fan motor 27 is in turn connected by wires 175 and 176 to the other line wire 169. The junction of wires 173 and 174 is connected by a wire 177 to one of the electrodes of the mercury switch 108. The other electrode of the switch 108 is connected by a wire 178 to one end of the relay coil 166. The other end of relay coil 166 is connected by a wire 179 to the junction of wires 175 and 176. Therefore, when the switch arm 171 is moved into engagement with the contact 172 the fan motor 27 is placed in operation, and when the room temperature, or return air temperature, reaches a predetermined value, say 65° as in the previous modification, the mercury switch 108 is moved to a circuit making position to cause energization of the relay coil 166. This moves the switch arm 162 into engagement with the contact 163 to place the unit ventilator under automatic control and to permit movement of the proportioning motor out of its extreme position.

The proportioning motor in the modification shown in Figure 3 is different from that disclosed in Figure 2, and may be of the type disclosed in application Serial No. 673,236, filed by Lewis L. Cunningham, on May 27, 1933. For purposes of illustration, this motor is shown to comprise rotors 181 and 182 operating through the reduction gear train 72, and the gear 71 for operating the shaft 70. The rotors 181 and 182 are operated by field windings 183 and 184, respectively, so that upon energization of the field winding 183 the damper is moved towards a closed or fresh air restricting position, and upon energization of the field winding 184 the damper 21 is moved towards an open or return air restricting position. The manner in which the slider 88 is moved with respect to the potentiometer balancing coil 81, and in which the limit switches 84, 85, 86 and 87 are operated, is identical as that pointed out above. Since the shaft 70 is positively driven in either direction by the motor rotors 181 and 182, the lost motion connection and the tension spring 67 of the preceding modification are omitted.

The contact 103 cooperating with the contact arm 100 is connected by a wire 185 to one end of the coil 106, the other end of which is connected by a wire 187 to the contact 86 of the right hand limit switch. In a like manner the contact 102 cooperating with the contact arm 100 is connected by a wire 186 to one end of the coil 107, the other end of which is in turn connected by a wire 188 to the contact 84 of the left hand limit switch. Contact 87 is connected by a wire 190 to one end of the field winding 84, and the contact 85 is connected by a wire 191 to one end of the field winding 83. The other ends of the field windings 183 and 184 are connected together and by a wire 192 to the junction of the wires 127 and 128. The contact arm 100 is connected by wires 193 and 123 to the secondary 121.

Assume that the space temperature has risen sufficiently high to cause movement of the switch arm 162 into engagement with the contact 163 in the manner pointed out above, an increase in space temperature causing movement of the slider 88 to the right with respect to its potentiometer coil 89 increases the energization of the coil 104 and decreases the energization of the coil 105. This causes movement of the switch arm 100 into engagement with the contact 103 to complete a circuit from the secondary 121 through wires 123 and 193, contact arm 100, contact 103, wire 185, coil 106, wire 187, contacts 86 and 87, wire 190, field winding 184 and wires 192 and 127 back to the secondary 121. This causes energization of the field winding 184 to move the damper 21 towards an open position. When the damper has moved sufficiently far towards an open position the slider 80 and the balancing potentiometer coil 81 cause re-balancing of the coils 104 and 105 to move the contact arm 100 away from the contact 103 and into the mid position shown in the drawings to stop movement of the damper. Likewise upon a decrease in space temperature to move the slider 88 towards the left with respect to its potentiometer coil 89 the coil 105 is energized more than the coil 104 to move the contact arm 105 into engagement with the contact 102. This causes completion of a circuit from the secondary 121 through wires 123 and 193, contact arm 100, contact 102, wire 186, coil 107, wire 188, contacts 84 and 85, wire 191, field winding 183 and wires 192 and 127 back to the secondary 121. Completion of this circuit causes energization of the field winding 183 to move the damper 21 towards a closed or fresh air restricting position, the amount of movement being determined by the slider 80 and the potentiometer coil 81. From the above, it is seen that the damper 21 is positioned according to space temperatures as in previous modification.

Movement of the sliders 95, 96 and 97 downwardly with respect to their resistances 92, 93 and 94 has the same effect as in the previous modification, so that when the switch arm 162 is moved into engagement with the contact 163 under the command of the return air thermostat 62, the damper 21 is moved to a minimum fresh air position, further movement of the damper being controlled by the movement of the slider 88 with respect to the potentiometer coil 89.

From the above it is seen that I have provided a control system for an air conditioning unit which may be of the plenary type but which finds particular utility in connection with a unit ventilator. The system is so arranged that at a given room temperature a predetermined amount of fresh air is admitted to the space to be conditioned, and that upon increases in space temperature the amount of fresh air delivered to the space is increased and the amount of heat delivered to the space is decreased. Provision is made whereby the amount of fresh air initially delivered to the space may be varied and provision is also made for controlling the damper and the valves, whereby raw air is prevented from being admitted to the space.

Although I have shown two exemplifications of my invention, it is apparent that modifications thereof may become apparent to those skilled in the art, and, therefore, I intend that my invention shall be limited only by the scope of the appended claims and the prior art.

I claim as my invention:

1. In a conditioning unit of the class described for discharging conditioned air to a space, damper means in said unit for controlling the supply of air to said unit, means in said unit for altering the temperature of the air discharged into the space, a motor in control of said damper means and said temperature altering means, a relay comprising series connected coils in control of said motor, said series connected coils being connected across a source of electrical energy, a space temperature responsive adjustable potentiometer, a discharge air temperature responsive adjustable potentiometer, connections between opposite ends of the series connected coils and opposite ends of the resistance of the first potentiometer, connections between one end of the resistances of each potentiometer, connections between the slider of the first potentiometer and the other end of the second potentiometer, and connections between the slider of the second potentiometer and the junction of the series connected coils, whereby when the discharge air temperature responsive potentiometer is in one extreme position the space temperature responsive potentiometer is in control of said motor and when the space temperature responsive potentiometer is in one extreme position the discharge air temperature responsive potentiometer is in control of said motor.

2. In an air conditioning device for conditioning a space, damper means for controlling the supply of fresh air and return air into said device, heat exchanger means for changing the temperature of the air discharged into the space, valve means for controlling the temperature changing effect of the heat exchanger means, an electric motor, operating means operated by the electric motor for operating the damper means and the valve means in a predetermined sequence, means for biasing said operating means to a position to open the valve means wide and to prevent the supply of fresh air, control means for controlling the operation of the electric motor including means responsive to space temperature to position said damper means and said valve means in accordance with variations in space temperature, means included in said control means for preventing movement of the damper means to the position which prevents the supply of fresh air, and means for interrupting the supply of energy to the electric motor whereby the biasing means moves the damper means to the extreme biased position.

3. In an air conditioning device for conditioning a space, damper means for controlling the supply of fresh air and return air into said device, heat exchanger means for changing the

temperature of the air discharged into the space, valve means for controlling the temperature changing effect of the heat exchanger means, an electric motor, operating means operated by the electric motor for operating the damper means and the valve means in a predetermined sequence, control means for controlling the operation of the electric motor, including means responsive to space temperature to increase the supply of fresh air and close the valve means as the space temperature increases, means responsive to discharge temperature to decrease the supply of fresh air and open the valve means as the discharge temperature decreases, and means included in said control means for preventing movement of the damper means to a fresh air preventing position regardless of the controlling action of the temperature responsive means.

4. In an air conditioning device for conditioning a space, damper means for controlling the supply of fresh air and return air into said device, heat exchanger means for changing the temperature of the air discharged into the space, valve means for controlling the temperature changing effect of the heat exchanger means, an electric motor, operating means operated by the electric motor for operating the damper means and the valve means in a predetermined sequence, means for biasing said operating means to a position to open the valve means wide and to prevent the supply of fresh air, control means for controlling the operation of the electric motor including means responsive to space temperature to position said damper means and said valve means in accordance with variations in space temperature, means included in said control means for preventing movement of the damper means to the position which prevents the supply of fresh air, means for interrupting the supply of energy to the electric motor whereby the biasing means moves the damper means to the extreme biased position, and means responsive to space temperature for controlling said last mentioned means.

5. In a conditioning unit of the class described for discharging conditioned air to a space, damper means in said unit for controlling the flow of air through said unit, a motor in control of said damper means, a relay comprising series connected coils in control of said motor, said series connected coils being connected across a source of electrical energy, a space temperature responsive adjustable potentiometer, a discharge air temperature responsive adjustable potentiometer, connections between opposite ends of the series connected coils and opposite ends of the resistance of the first potentiometer, connections between one end of the resistances of each potentiometer, connections between the slider of the first potentiometer and the other end of the second potentiometer, and connections between the slider of the second potentiometer and the junction of the series connected coils, whereby when the discharge air temperature responsive potentiometer is in one extreme position the space temperature responsive potentiometer is in control of said motor and when the space temperature responsive potentiometer is in one extreme position the discharge air temperature responsive potentiometer is in control of said motor.

6. In an air conditioning system, in combination, means for supplying fresh air to a space to be conditioned, damper means movable between closed and open positions for controlling the fresh air supply, electric motor means for moving said damper means to various positions, a control circuit for said electric motor means for controlling the operation thereof, a first temperature responsive electric current controlling means responsive to a temperature condition which is affected by the position of the fresh air damper means and being connected in said control circuit in a manner to position said electric motor means and hence said damper means to maintain said temperature condition substantially constant, a second temperature responsive electric current controlling means responsive to another temperature condition and being connected in said motor control circuit with said first temperature responsive electric current controlling means in a manner to render said first temperature responsive current controlling means substantially ineffective to position said electric motor means and to position substantially independently said electric motor means and hence said damper means whenever the temperature condition to which said second temperature responsive electric current controlling means responds varies to a predetermined value, means included in said control circuit for normally preventing either of said temperature responsive electric current controlling means from completely closing said fresh air damper means, and means for completely closing said fresh air damper means regardless of the controlling action of the temperature responsive electric current controlling means.

7. In combination, an air conditioning unit having temperature changing means and means for supplying fresh air to a space to be conditioned, damper means movable between open and closed positions for controlling the fresh air supply, motor means for moving said damper means to various positions, means including first temperature responsive means responsive to a temperature condition which is affected by the position of the fresh air damper for positioning said motor means and hence said damper means to maintain said temperature condition substantially constant, said means also including a second temperature responsive means responsive to another temperature condition to render said first temperature responsive means substantially ineffective to position said motor means and to position substantially independently said motor means and hence said damper means whenever the second temperature condition varies to a predetermined value, means for normally preventing either of said temperature responsive means from completely closing said fresh air damper means, and means operative as an incident to shutting down of a portion of the air conditioning unit for completely closing the fresh air damper means.

8. In combination, an air conditioning unit having temperature changing means, fresh air supplying means and fan means for circulating air through the unit to a space to be conditioned, damper means movable between open and closed positions for controlling the fresh air supply, motor means for moving said damper means to various positions, means including first temperature responsive means responsive to a temperature condition which is affected by the position of the fresh air damper for positioning said motor means and hence said damper means to maintain said temperature condition substantially constant, said means also including a second temperature responsive means responsive to another temperature condition to render said first temperature

responsive means substantially ineffective to position said motor means and to position substantially independently said motor means and hence said damper means whenever the second temperature condition varies to a predetermined value, means for normally preventing either of said temperature responsive means from completely closing said fresh air damper means, and means operative upon stopping of the fan means for completely closing said fresh air damper means.

9. In an air conditioning system, in combination, damper means for controlling the supply of fresh air to a space to be conditioned, electric motor means for operating said means, a three wire control circuit for said motor means, said three wire control circuit including a common wire, a first control wire which is adapted in cooperation with said common wire to cause said electric motor means to operate in one direction and a second control wire which is adapted in cooperation with said common wire to cause said motor means to operate in the opposite direction, thermostatic electric current controlling means responsive to a temperature influenced by the damper position, said last mentioned means including a movable member connected to said common wire and means contacted by said movable member and adapted to place said common and control wires in cooperation respectively, said thermostatic electric current controlling means acting normally to cause positioning of said damper means in a manner to maintain said temperature condition substantially constant, a second thermostatic electric current controlling means responsive to another temperature condition, said second thermostatic current controlling means including means connected to said common wire and one of said control wires for rendering said first current controlling means ineffective to control said motor means and to cause said motor means to operate in damper closing direction when the temperature at said second thermostatic electric current controlling means is at one value, while placing said first current controlling means in control of said motor means when the temperature at said second thermostatic electric current controlling means is at another value.

10. In an air conditioning system, in combination, electrically operated fan means for supplying fresh air to a space to be conditioned, an electric circuit for the fan means, damper means movable between open and closed positions for controlling the fresh air supply, electric motor means for moving said damper means to various positions, means for supplying power to the electric motor means from the electric circuit for the fan means, means for biasing the damper means toward a closed position, control means including first temperature responsive means responsive to a temperature condition which is affected by the position of the fresh air damper for positioning said electric motor means and hence said damper means to maintain said temperature condition substantially constant, said control means also including a second temperature responsive means responsive to another temperature condition to render said first temperature responsive control means substantially ineffective to position said electric motor means and to position substantially independently said electric motor means and hence said damper means whenever the second temperature condition varies to a predetermined value, means for normally preventing either of said temperature responsive means from completely closing said fresh air damper means, and means for interrupting the electric circuit for the fan means to stop the fan means and to stop the supply of power to the electric motor means whereby the biasing means moves the damper means to the complete closed position.

JNO. T. MIDYETTE, JR.