

Nov. 26, 1940.

G. M. KINGSLAND

2,223,287

AIR CONDITIONING SYSTEM

Filed June 18, 1938

2 Sheets-Sheet 1

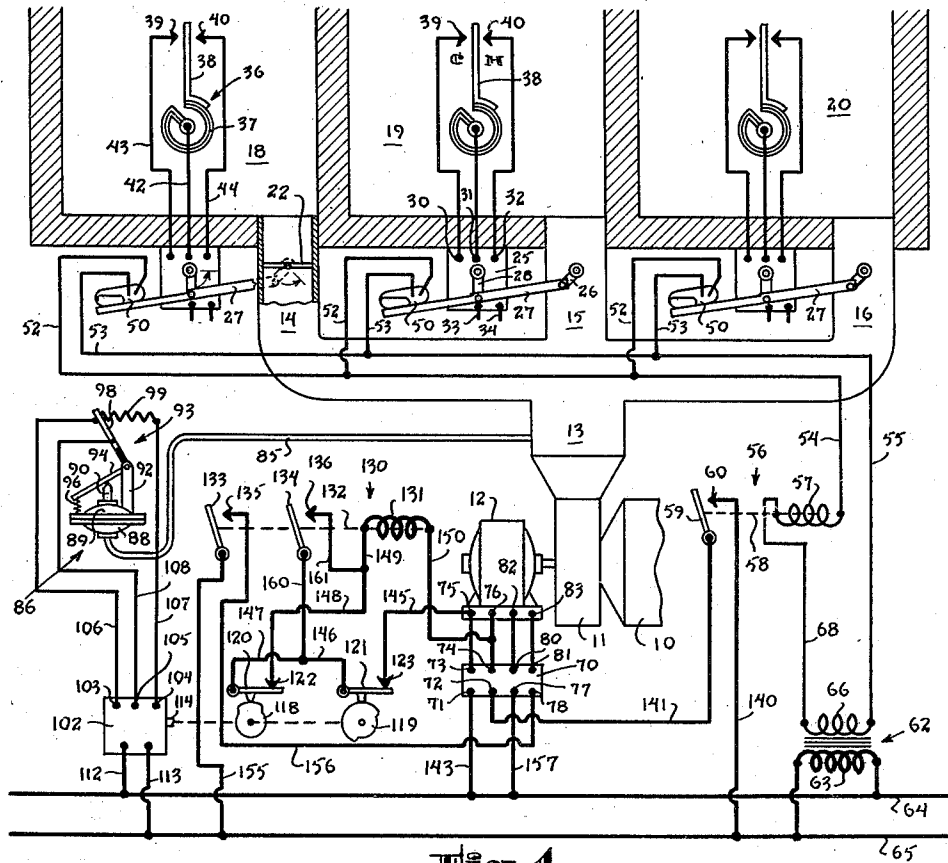


Fig. 1

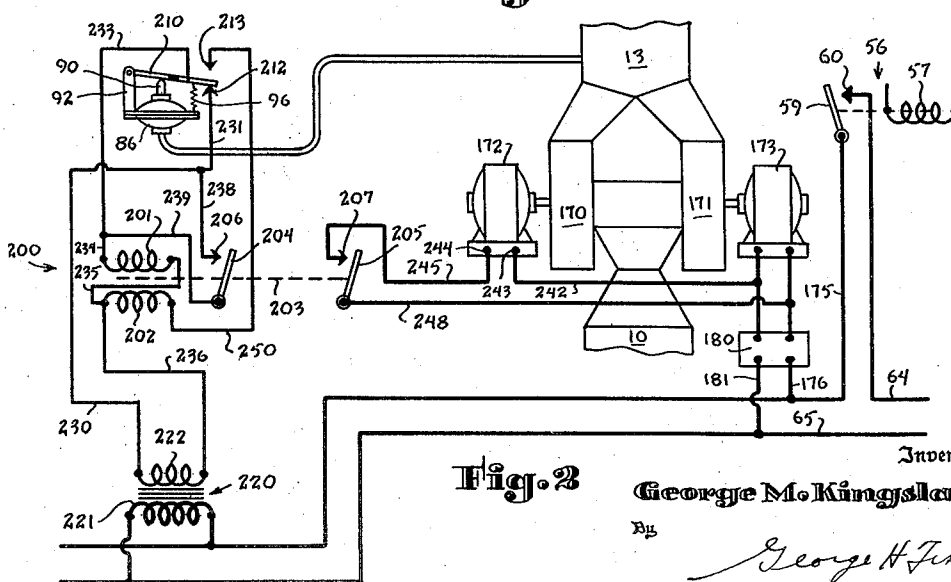


Fig. 2

Inventor
George M. Kingsland

By
George H. Fisher
Attorney

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2 Sheets-Sheet 2

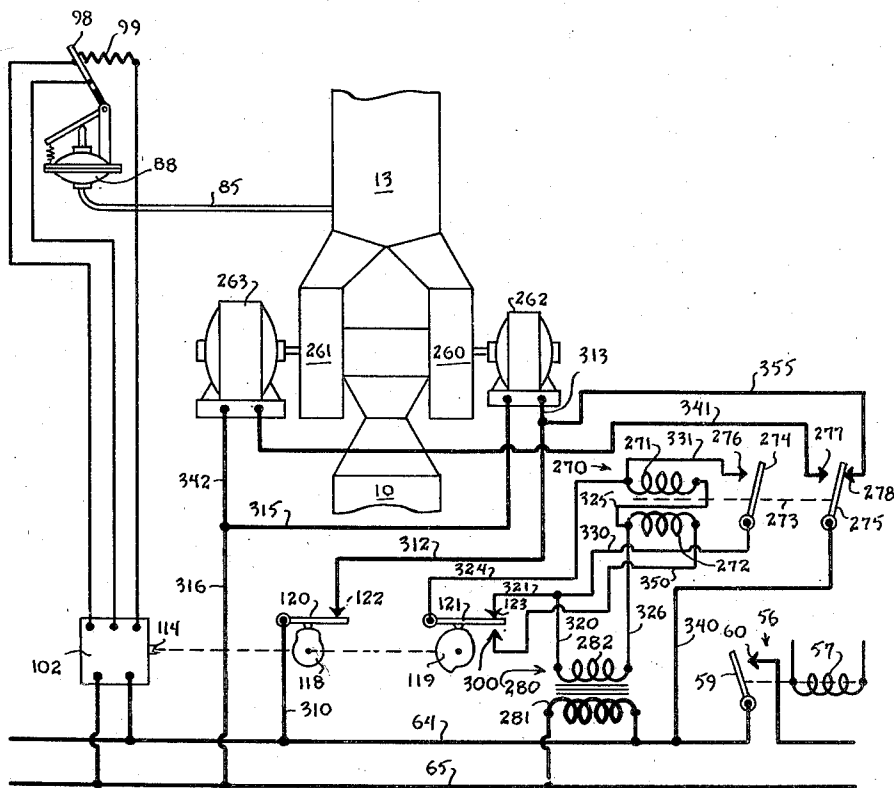


Fig. 3

Inventor
George M. Kingsland
By
George H. Fisher
Attorney

UNITED STATES PATENT OFFICE

2,223,287

AIR CONDITIONING SYSTEM

George M. Kingsland, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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12 Claims. (Cl. 236—1)

This invention relates to an air conditioning system and more particularly to a system wherein air is circulated through an air conditioning chamber and a space or spaces to be conditioned.

One of the objects of my invention is the provision of a system of the type above described wherein a variable capacity blower means is provided for circulating conditioned air through a space or spaces and the capacity of the blower means is regulated in accordance with the static pressure at the outlet of the pressure means.

More particularly it is an object of my invention to provide a zone air conditioning system wherein the flow of air into the various zones is controlled by means responsive to the condition of the air in the various zones, wherein a blower means is placed in operation whenever air is admitted into any one of the various zones, and wherein the capacity of the blower means is regulated in accordance with the pressure existing at the outlet of the blower means so that as the number of zones to which air is admitted increases the blower means will be caused to operate at increasing capacity.

Another object of my invention is the provision of a variable capacity blower means for causing a flow of conditioned air into a space or spaces to be conditioned, wherein means responsive to the pressure existing at the outlet of the blower means regulates the capacity of the blower means in such a manner that when the pressure drops to a predetermined low value the blower means will operate at high capacity and when the pressure rises to a high predetermined value the blower means will operate at low capacity, there being a substantial difference in the pressures at which the blower means goes from low to high capacity and vice versa so as to prevent hunting of the blower means.

Other objects and advantages will become apparent upon a study of the specification, claims, and appended drawings wherein like reference characters represent like parts in the various views, and wherein

Figure 1 is a schematic view of one form of system embodying my invention,

Figure 2 is a modification of the system shown in Figure 1, and

Figure 3 is a further modification of the system of Figure 1.

Referring now to Figure 1, a portion of an air conditioning chamber is represented by the reference character 10, this chamber containing any suitable form of air conditioning apparatus for conditioning air which flows therethrough, the

air being drawn through this chamber by a fan 11 driven by a variable speed motor 12, the air passing from the fan 11 through a duct 13 which communicates with branch ducts 14, 15, and 16 which direct the air into the spaces 18, 19, and 20 to be conditioned. While only three such spaces are shown it will be understood that any number of spaces may be connected to the outlet of the fan. Located in the outlet of the ducts 14, 15, and 16 are dampers such as the damper 22 for controlling the flow of air into the various spaces. These dampers are operatively connected to motors 25 by means of arm 26 connected to the damper, a link 27 and an arm 28 connected to the motor. These motors may be two positional reversible motors provided with terminals 30, 31, and 32. Power may be supplied to these motors by means of conductors 33 and 34 connected to any suitable source of power (not shown). The arrangement is such that when the terminals 30 and 31 are connected together the motor will rotate the arm 28 in a counter-clockwise direction, thus moving the damper 22 to open position as illustrated by the arrows shown in connection with the motor controlling the damper for the space 18. When the terminals 31 and 32 are connected together the motor will operate to rotate the arm 28 in the reverse direction thus moving the dampers 22 back to closed position.

Any suitable means responsive to the condition of the air in the various spaces may be provided for controlling the operation of these motors but for purposes of illustration I have shown thermostats 36 comprising bimetallic elements 37 carrying an arm 38 for movement between spaced contacts 39 and 40.

Assuming for the present that the system is a heating system, when the temperature of the air in the space drops to a predetermined value the arm 38 is moved by the bimetallic element 37 into engagement with the contact 39 and upon an increase in temperature in the space to a high predetermined value the arm 38 is moved into engagement with the contact 40. The arm 38 is connected by means of a conductor 42 with the terminal 31 of the motor and the contacts 39 and 40 are connected by means of conductors 43 and 44 with the terminals 30 and 32, respectively. It will now be apparent that upon a drop in temperature in any one of the spaces to a predetermined value the arm 38 of the thermostat in that particular space will move into engagement with the contact 39 and cause operation of the motor to move the damper 22 controlling

the flow of air into that space into open position. Upon a rise in temperature in the space the arm 38 moves into engagement with the contact 40 and the motor 25 then causes closing movement of the damper 22. If the system is to be used as a cooling system instead of a heating system the thermostat would be so arranged so as to cause movement of the arms 38 in the opposite direction in response to rise and fall of temperatures in the spaces or else the connections to the motors could be reversed, so that the dampers would be open when the space temperature rises too high and would close when the space temperature drops to a low enough value. It should also be understood that these thermostats may be replaced by humidity responsive devices or effective temperature control devices to cause operation of the dampers to move the same to open position whenever there is a need for supplying conditioned air to the various spaces.

Mercury switches 50 are carried by an extension of the links 27 and these switches are arranged so as to close when the dampers are moved to an open position, and these switches are all connected in parallel by means of the conductors 52 and 53 to the conductors 54 and 55, respectively, and control the energization of a relay generally indicated by the reference character 56. This relay comprises a relay coil 57, and an armature 58 connected to a switch arm 59 which cooperates with a fixed contact 60. The arrangement is such that upon energization of the coil 57 the arm 59 is moved into engagement with the contact 60 and when the relay coil 57 is deenergized, the arm 59 moves out of engagement with the contact 60 under the influence of gravity or any suitable biasing means. A step-down transformer 62 is provided for supplying power to the relay coil 57, this transformer including a high tension primary 63 connected across line wires 64 and 65 which are connected to a suitable source of power (not shown), and a low tension secondary 66. The conductor 55 is connected to one side of the secondary 66 and the conductor 68 connects the other side of the secondary with one side of the relay coil 57. The conductor 54 is connected to the other side of the relay coil 57 and it will now be apparent that whenever any one of the mercury switches 50 are moved to closed position by the opening of the damper controlled by the particular motor with which the switch is associated, the conductors 54 and 55 are connected together so that current flows through the relay coil 57 as follows: from one side of the secondary 66 through the conductors 55, 53, whichever one of the mercury switches 50 is closed, the conductor 54, relay coil 57, and conductor 68 to the other side of the secondary 66. It will now be apparent that whenever any one of the dampers 22 are opened the relay 56 is energized and contact between the arm 59 thereof and the contact 60 is established.

The motor 12 is illustrated as being a two-speed motor and a starting box 70 of any suitable construction is provided for causing the operation of the motor upon the establishment of certain circuit connections to be hereinafter described. Terminals 71 and 72 are connected to the source of power and form the low speed starter terminals for the motor 12. The terminals 73 and 74 on the load side of the starter 70 connect to the low speed terminal 75 and 76 of the motor. The terminals 77 and 78 form the

high speed terminals on the starter box 70 which are to be suitably connected to the source of power and the terminals 80 and 81 on the load side of this starter connect to the high speed terminals 82 and 83 of the motor 12.

Connected by means of a pipe 85 is a static pressure responsive device 86 which may be of any conventional construction but is shown as comprising a pair of chambers 88 and 89 which are separated by a suitable pressure responsive diaphragm (not shown) and to this diaphragm is connected a plunger 90 which moves through the top portion of the chamber 89 in response to variations in the static pressure in the outlet duct 13. Pivoted to a projection 92 which is formed on the outside of the casing of the pressure responsive member 86 is a bell crank lever 93 which includes an arm 94 biased by spring 96 into engagement with the plunger 90 and an arm 98 suitably insulated from the rest of the lever and arranged to sweep across a potentiometer resistance 99. Upon an increase in pressure in the discharge duct 13 the plunger 90 moves upwardly and causes movement of the arm 98 to the right as viewed in Figure 1 and upon a decrease in pressure the arm 98 will be caused to be moved to the left under the influence of the biasing spring 96.

The potentiometer 99 forms the control potentiometer for a proportioning motor 102. This motor may be of any suitable construction and may be of the type illustrated in Patent 2,026,110 issued to D. G. Taylor on Jan. 14, 1936. The motor 102 is provided with terminals 103, 104, and 105 connected by means of conductors 106, 107, and 108, respectively, to the left and right ends of the potentiometer resistance 99 and to the control arm 98, respectively. The motor 102 is connected to the line wires 64 and 65 by means of the conductors 112 and 113 and a shaft 114 is arranged to be driven by the motor 102. It will be understood upon a study of the Taylor patent above mentioned that the shaft 114 will rotate to positions corresponding to the position of the control arm 98 with respect to the potentiometer resistance 99.

Carried by the shaft 114 of the motor 102 are a pair of cams 118 and 119, these cams controlling the positions of switch arms 120 and 121, respectively. Switch arm 120 cooperates with a fixed contact 122 and the arm 121 cooperates with a fixed contact 123. The arrangement is such that as the arm 98 moves towards the right, the shaft 114 rotates the cams 118 and 119 in a clockwise direction and the switch arm 120 will drop out of engagement with the contact 122 after the cam has moved through a predetermined angle and subsequently upon continued rotation of the shaft 114 in the same direction the cam 119 will have rotated far enough to allow the arm 121 to move out of engagement with the contact 123. Movement of the arm 98 from the right end of the resistance 99 toward the left will cause reverse movement of the cams 118 and 119 and arm 121 will first be moved into engagement with the contact 123 and then the arm 120 will be moved into engagement with the contact 122.

A relay 130 is provided for controlling the high speed circuit to the motor 12, this relay being in turn controlled by the switch arms 120 and 121 as will be hereinafter set forth. This relay includes a relay coil 131 controlling the position of an armature 132 connected to arms 133 and 134 which cooperate with contacts 135 and 136, respectively, the arrangement being such that

the arms move into engagement with the respective contacts upon energization of the relay coil 131 and upon deenergization thereof they move out of engagement with their respective contacts under the influence of gravity or any suitable biasing means.

Operation

When the system is first started in operation and power is supplied to line wires 64 and 65, if the condition in all the spaces it at a desirable value and the various dampers are shut so that the mercury switches are in open position the motor 12 will be deenergized and the static pressure will be at a low value so that the control arm 98 will be in the position illustrated. The relays 56 and 130 will be deenergized and all the parts will be in the positions illustrated. Assume now that the condition in one of the spaces attains an undesirable value so that the damper 22 for that particular space moves to open position and the associated mercury switch 50 moves to closed position, relay 56 will then be energized as previously described and this in turn will cause energization of the low speed terminals of the motor 12 as follows: from the line wire 65 through conductor 140, contact 60, arm 59, conductor 141, terminal 72 of the starter box 70, terminal 71, and conductor 143 to the line 64. Power now being supplied to the terminals 71 and 72, the motor 12 will be caused to operate at low speed. When the fan is first started up it will be understood that the static pressure is low so that the arms 120 and 121 are in engagement with their respective contacts. Relay 130 is therefore energized through the following circuit: from the load side of the starter box 70 through conductor 145, contact 123, arm 121, conductors 146, 147, arm 120, contact 122, conductors 148, 149, relay coil 131, and conductor 150 back to the load terminal 74 of the starter box 70. Energization of the relay 130 causes movement of arms 133 and 134 into engagement with their respective contacts and power is now supplied to the high speed terminals 77 and 78 of the box 70 as follows: from the line wire 65 through conductor 155, arm 133, contact 135, conductor 156, terminal 78 of the starter box 70, terminal 77 and conductor 157 back to the line wire 64. The motor is now caused to operate at high speed. The movement of arm 134 into engagement with contact 136 energizes a maintaining circuit for the relay coil 131 which is independent of engagement of arm 120 with contact 122, this circuit being as follows: from terminal 73 through conductor 145, contact 123, arm 121, conductors 146, 160, arm 134, contacts 136, conductors 161, 149, relay coil 131 and conductor 150 back to the terminal 74 of the starter box 70. Accordingly the relay 130 will remain energized as long as the arm 121 is in engagement with the contact 123.

If only one of the dampers 22 has been opened, the pressure in the discharge duct 13 will rapidly increase and after it reaches a certain high value the cam 118 will have been rotated sufficiently far by the motor 102 to permit arm 120 to move out of engagement with the contact 122. As previously stated, however, the relay 130 will not be deenergized by this but will remain energized until the pressure builds up to a higher predetermined value whereupon the motor 102 causes cam 119 to move far enough to permit arm 121 to move out of engagement with the contact 123. The relay 130 is now deenergized and the circuit to the high speed terminals of the motor 12 is interrupted by reason of the arm 133 moving out of en-

gagement with the contact 135. The motor now drops back to low speed whereupon the static pressure in the discharge duct 13 begins to drop and arm 98 moves toward the left with respect to resistance 99 and the motor 102 will cause rotation of shaft 114 and the cams 118 and 119 in a counter-clockwise direction. Switch arm 121 will first move into engagement with contact 123 but the relay 130 cannot be energized until the other switch arm 120 moves into engagement with contact 122. This cannot take place until the pressure drops to a low predetermined value which may not take place as long as only one of the dampers 22 is open. If an increasing number of spaces require a flow of conditioned air thereto, the dampers for these spaces will open whereupon the pressure in the discharge duct will drop and when a sufficient number of these spaces are calling for conditioned air the pressure will drop sufficiently far so that the switch arm 120 will be moved by the cam 118 into engagement with the contact 122 and the relay 130 will be reenergized as set forth above thus causing operation of the motor 12 on high speed again and increasing the amount of air circulated by the fan 11.

By reason of the arrangement of switches 120 and 121 controlling the relay 130 the motor 12 goes on to high speed only when the static pressure drops to a low predetermined value and goes on to low speed only when the static pressure increases to a high predetermined value and there is a sufficient difference in pressure between these values so that the fan motor will not hunt by reason of small pressure variations in the discharge duct 13.

It will now be seen that the speed of the motor 12 will depend upon the pressure in the discharge duct 13 which in turn will depend upon the number of dampers in the ducts 14, 15, and 16 that are in open position and when all these dampers move to closed position indicating that no conditioned air is necessary in any of the spaces the relay 56 drops out thus deenergizing the motor 12 and shutting the fan down entirely. This is a distinct advantage over systems wherein the fan runs continuously regardless of the necessity for supplying conditioned air to the various spaces and wherein dampers placed ahead of the fan vary the amount of air circulated by the fan in accordance with the demand on the system since my arrangement results in increased economy and operating efficiency.

Description of Figure 2

Referring now to Figure 2 the zones or spaces to be conditioned have not been illustrated but the relay 56 is again provided and it will be understood that the energization of this relay is controlled by the dampers for the various spaces in exactly the same manner as in Figure 1. In other words, upon opening of any one of these dampers the relay coil 57 will be energized and the arm 59 will be moved into engagement with the contact 60.

In place of the two-speed motor 12 for operating a fan 13, a pair of fans 170 and 171 are connected in parallel to the discharge duct 13 and the air conditioning chamber 10 and motors 172 and 173 are provided for operating these fans. The amount of air that is circulated through the chamber 10 and the discharge duct 13 is controlled by controlling the number of these motors which is in operation. When the relay 56 is energized power is supplied to the motor 173 as

follows: from the line wire 64 through the contact 60, arm 59, conductors 175 and 176 to the starter box 180, and thence back to the line wire 65 by means of the conductor 181. Accordingly as long as any one space is demanding a supply of conditioned air the motor 173 will operate the fan 171. The operation of the motor 172 is controlled by means of a relay 200, this relay including a pair of opposed balanced coils 201 and 202. An armature 203 is controlled by these coils and this armature controls the position of arms 204 and 205 with relation to the contacts 206 and 207. Upon energization of the coil 201 the arms 204 and 205 move into engagement with their respective contacts and upon deenergization of the coil the arms move away from their respective contacts under the influence of gravity or any suitable biasing means.

The energization of the relay 200 is controlled by the pressure controller 86 which may be of the same construction as shown in Figure 1 except that in place of the bell crank lever 93 having the arm 98 moving over resistance 99, an arm 210 pivoted to the projection 92 and biased by means of the spring 96 into engagement with the plunger 90 is provided, this arm being movable between spaced contacts 212 and 213. When the pressure in the discharge duct 13 is low the arm 210 is in engagement with the contact 212 and when the pressure in the duct 13 increases to a high predetermined value the arm 210 is moved into engagement with the contact 213. Power is supplied to the relay 200 by means of a step-down transformer 220, this transformer including a high tension primary 221 connected across the line wires 64 and 65 and a low tension secondary 222. Power to the transformer 220 is controlled by the relay 56, this transformer being energized as will be readily apparent when the arm 59 operated by the relay moves into engagement with the contact 60.

When the transformer 220 is energized and the pressure in the discharge duct is sufficiently low so that the arm 210 of the pressure responsive device 86 is in engagement with the contact 212 the relay coil 201 will be energized through the following circuit: from the transformer secondary 222 through conductors 230, 231, contact 212, arm 210, conductors 233, 234, relay coil 201, conductors 235 and 236 to the other side of the secondary 222. Energization of this relay causes arms 204 and 205 to move into engagement with the contacts 206 and 207. Engagement of the arm 204 with contact 206 forms a maintaining circuit for the coil 201 which is independent of the engagement of arm 210 with the contact 212 so that the relay coil will not be deenergized upon a slight increase in pressure and movement of the arm 210 out of engagement with the contact 212. This maintaining circuit is as follows: from the transformer secondary 222 through conductors 230, 238, contact 206, arm 204, conductors 239, 234, relay coil 201, conductors 235 and 236 to the other side of the secondary 222. Accordingly, once the relay 200 is energized by engagement of arm 210 with the contact 212 it will remain energized even after the arm moves out of engagement with the contact 212.

When the arm 205 moves into engagement with the contact 207 the fan motor 172 is energized as follows: from the load side of the starter box 180 through conductor 242, motor terminal 243 through the motor which may have built into it a starter coil (not shown) similar to the starter box 180, through the motor to terminal 244, con-

ductor 245, contact 207, arm 205, and conductor 248 to the other terminal on the load side of the starter box 180. Operation of both of the fans 170 and 171 will now cause the pressure in the duct 13 to increase and if only one or a small number of the dampers 22 are opened the pressure will increase to such a value that the arm 210 of the pressure responsive device 86 will move into engagement with the contact 213 which will result in the deenergization of the relay 200 as follows: current flows from the transformer secondary 222 through the conductors 230, 238, contact 206, arm 204, conductors 239, 233, the arm 210, contact 213, conductor 250 through the coil 202 and conductor 236 to the other side of the secondary 222. The energization of coil 202 which has an opposing or bucking action with respect to the coil 201 permits movement of the armature 203 and the switch arms 204 and 205 to the right under the influence of gravity or any suitable biasing means, thus breaking the holding circuit for the coil 201 at the contact 206. It should be noted that the circuit through the relay coil 202 also included this contact 206 so that as soon as the arm 204 moves away from this contact both of the relay coils are deenergized and will remain deenergized until the pressure in the discharge duct 13 drops to a low enough value so that the arm 210 moves back into engagement with the contact 212.

It will thus be seen that the amount of air which is circulated through the discharge duct 13 is controlled in accordance with the static pressure therein in the same manner as in Figure 1 except that the variation in the amount of air circulated is controlled by providing two motor fan units instead of a two-speed motor as in Figure 1. The provision of the relay 200 in place of motor 102 and its associated cams and switches for controlling the operation of the motor 172 provides for a definite operating differential in the same manner as in Figure 1 but eliminates the necessity of providing a separate motor for controlling the motor 172. It should be understood of course that this relay could be substituted for the motor 102 and the associated cams and switches in the system of Figure 1 and conversely the two-speed motor of Figure 1 could be replaced by the two motors 172 and 173 of Figure 2. The operation of the systems in these two figures is substantially the same but utilizes different means for accomplishing the desired results.

Description of Figure 3

Referring now to the form of invention shown in Figure 3 the particular zones, the condition responsive device therein, and the dampers for controlling the flow of air into the various zones have been omitted in this figure as in Figure 2 for the sake of simplicity. A relay 56 similar to the relay of Figure 1 and operated in the same manner as in Figures 1 and 2 is provided for controlling the supply of power to the line wires 64 and 65. A pair of fans 260 and 261 connected in parallel to the discharge duct 13 and the air conditioning chamber 10 are provided, these fans being operated by a small low speed motor 262 and a larger high speed motor 263, respectively. When the motor 262 is alone operating the flow of air through the duct 13 is at its lowest value, when the motor 263 is operating alone, the flow of air through the duct 13 is at a higher value and if both motors are operating together the flow of air to the duct 13 is at a maximum value.

The motor 263 is controlled by a relay 270 which may be similar in construction to the relay 200 of Figure 2 this relay including opposed coils 271 and 272, an armature 273, and switch arms 274 and 275. Cooperating with the arm 274 is a contact 276 which is engaged thereby when the relay is energized and cooperating with the arm 275 is a contact 277 which is engaged thereby when the relay is energized. Upon deenergization of the relay, the arms move out of engagement with the contacts 276 and 277, respectively, and the arm 275 moves into engagement with a second contact 278. A step-down transformer 280 having a primary 281 connected across the line wires 64 and 65 and a secondary 282 is provided for energizing the relay 270.

The energization of the relay 270 is controlled by the cam 119 operating the switch arm 121 as in Figure 1, this arm moving between the spaced contacts 123 and the contact 300. This cam together with the cam 118 operating the switch arm 120 is mounted on the shaft 114 operated by the proportioning motor 102 which is in turn controlled by the pressure responsive device 98 which, for purposes of illustration, have been illustrated as being identical with those of Figure 1. When the pressure in the duct 13 is at a low value the cams 118 and 119 are in the positions illustrated and the arms 120 and 121 are in engagement with the contacts 122 and 123, respectively. As the pressure in the duct 13 increases the cams rotate clockwise and arm 120 is first moved out of engagement with contact 122. As the pressure in the duct 13 rises still further to a higher predetermined value, the cam 119 allows the arm 121 to move out of engagement with the contact 123 and by reason of the curvature of the cam, upon an increase in pressure to a still higher value, the arm 121 moves into engagement with the other contact 300.

Operation of Figure 3

As in Figures 1 and 2, upon a call for conditioned air in any one or more of the zones, the relay 56 is energized and the arm 59 is moved into engagement with the contact 60. With the pressure in the duct 13 at a low value, the cams 118 and 119 will be positioned as illustrated and the small motor 262 will be energized through the following circuit: from the line wire 64 through conductor 310, arm 120, contact 122, conductors 312, 313 through the motor 262 and back to the line wire 65 through the conductors 315 and 316. The arm 121 being at this time in engagement with the contact 123, the relay coil 271 of the relay 270 is energized as follows: from the transformer secondary 282 through conductors 320, 321, contact 123, arm 121, conductors 324, coil 271, conductors 325 and 326 to the other side of the secondary 282. Relay coil 271 being energized, the arms 274 and 275 are moved into engagement with the contacts 276 and 277. Engagement of contact 276 by the arm 274 completes a maintaining circuit for the relay coil 271 which does not depend upon engagement of the arm 121 with the contact 123, this circuit being as follows: from the transformer secondary 282 through conductors 320, 330, arm 274, contact 276, conductor 331, relay coil 271, conductors 325 and 326 to the other side of the secondary 282. The engagement of contact 277 by the arm 275 causes the large fan motor 263 to be energized as follows: from the line wire 64 through conductor 340, arm 275, contact 277, conductor 341, motor 263, and conductors 342 and 316 back to the line wire 65. Accordingly

with the pressure in the discharge duct at a low value both the contacts 122 and 123 are engaged by the arms 120 and 121 and the motors 262 and 263 are both energized thus causing a maximum flow of air through the discharge duct 13, it being understood of course that the relay 56 is energized by reason of the fact that one or more of the dampers 22 are in open position.

Should the pressure in the discharge duct 13 rise to a high enough value so that the motor 102 causes movement of cam 118 sufficiently far to cause the arm 120 to move out of engagement with the contact 122 the circuit to the motor 262 is interrupted since the previously described circuit for this motor included this contact and the small fan motor 262 is now placed out of operation. The amount of air flowing through the discharge duct 13 is now decreased as will be understood.

If the pressure in the discharge duct 13 continues to rise and the motor 102 moves the cam 119 sufficiently far so as to move the arm 121 into engagement with the contact 300 upon a rise in pressure to a predetermined value, the relay 270 is deenergized by first energizing the coil 272 through the previously described maintaining switch for this relay as follows: from the transformer secondary 282 through conductors 320, 330, arm 274, contact 276, conductors 331, 324, arm 121, contact 300, conductor 350, the coil 272, and conductor 326 to the other side of the secondary 282. Energization of the coil 272 counteracts the effect of the coils 271 on the armature 273 whereupon the arms 274 and 275 move out of engagement with contacts 276 and 277 and the arm 275 moves into engagement with the contact 278. The circuit to the motor 263 is interrupted but a new circuit is now established through the motor 262 as follows: from the line wire 64 through conductor 340, switch arm 275, conductors 355, 313 through the motor 262 and conductors 315 and 316 to the line wire 65. The small motor 262 is now again placed in operation while the large motor 263 is placed out of operation and the fan 280 now operates at its slower speed to discharge air through the duct 13 at a minimum rate.

It will therefore be apparent that the rate of flow of the air through the duct 13 will depend upon whether one or the other or both of the motors 262 and 263 are in operation and that these motors are controlled by the cams 118 and 119 which are operated by the motor 102 in response to the pressure air in the duct 13. When all the zone dampers are closed and relay 57 is deenergized neither of the motors 262 or 263 will operate. Whenever one or more of the zone dampers are open however and the relay 57 is energized the motors will operate in accordance with the pressure in the discharge duct. When the pressure is at a high value the motor 262 alone operates. When the pressure drops to a lower value as when additional zone dampers are opened the motor 263 will be placed in operation and the motor 262 will be placed out of operation. Upon a further drop in the static pressure in the duct 13 as may be occasioned by the opening of still more zone dampers, both of the motors 262 and 263 will operate to circulate a maximum flow of air through the duct 13.

It will therefore be seen that in all of the forms of the invention, the amount of air that is circulated through the air conditioning chamber and the discharge duct will depend upon the static pressure within the discharge duct which

in turn will be varied as the number of zone dampers varies but when all of the zone dampers are closed no air whatever will be circulated by the fan or fans so that there will be no expenditure of energy by the fan motor or motors when the condition in all of the zones is satisfactory and there is no need for the supply of conditioned air thereto.

Having described a preferred form of my invention many modifications may become apparent to those skilled in the art and I therefore wish it to be understood that my invention is limited only by the scope of the appended claims.

I claim as my invention:

1. In a zone air conditioning system, an air conditioning chamber, variable speed blower means for causing a flow of air from the air conditioning chamber into the various zones to be conditioned, damper means for controlling the flow of air into the various zones, motor means for moving the damper means for each zone into open or closed positions, a plurality of circuit controlling means, means responsive to movement of any of said circuit controlling means to a first position for causing operation of said blower means, means operatively connecting each of said circuit controlling means with one of said motors so that the circuit controlling means is moved to said first position when the respective motor means has moved its damper means to open position, means responsive to the condition of the air in the various zones for controlling the operation of the respective motor means, second circuit controlling means for controlling the speed of the blower means, and means responsive to the pressure of the air at the outlet of the blower means for controlling said second circuit controlling means.

2. In an air conditioning system, variable capacity air circulating means for circulating air into a space to be conditioned, a pair of switch means for controlling the capacity of said air circulating means, means responsive to movement of both of said switch means to a first circuit controlling position for causing operation of the air circulating means at high capacity, means responsive to movement of both of said switch means to a second circuit controlling position for causing operation of the air circulating means at low capacity, and means responsive to the pressure at the discharge side of said air circulating means for causing sequential movement of said switch means to the first circuit controlling position in response to a decrease in pressure to a first predetermined value and for causing sequential movement of said switch means to the second circuit controlling position in response to an increase in pressure to a second predetermined value.

3. In an air conditioning system, variable capacity air circulating means for circulating air into a space to be conditioned, a pair of switch means for controlling the capacity of said air circulating means, means responsive to movement of both of said switch means to a first circuit controlling position for causing operation of the air circulating means at high capacity, means responsive to movement of both of said switch means to a second circuit controlling position for causing operation of the air circulating means at low capacity, means responsive to the pressure at the discharge side of said air circulating means for causing sequential movement of said switch means to the first circuit controlling position in response to a decrease in pressure to a first pre-

determined value and for causing sequential movement of said switch means to the second circuit controlling position in response to an increase in pressure to a second predetermined value, damper means for controlling the flow of air into said space, and means responsive to movement of said damper means to open position to place said air circulating means under the control of said condition responsive means.

4. In an air conditioning system, an air conditioning chamber, means for circulating air through said chamber and through a space to be conditioned, said means including a plurality of blowers, damper means for controlling the flow of air into said space, means responsive to a condition of said space for controlling the operation of said damper means, means responsive to the opening of said damper means for causing operation of at least one of said blowers, and means responsive to the pressure at the outlet of said circulating means for controlling the number of said blowers in operation.

5. In a zone air conditioning system, an air conditioning chamber, means for causing a flow of air from said chamber into the various zones to be conditioned, said means comprising a low capacity blower and a high capacity blower, means responsive to the condition of the air in the various zones for controlling the supply of air into the respective zones, means for causing operation of the low capacity blower means in response to operation of the air supply controlling means to permit the flow of air into any one of said zones, means responsive to a drop in pressure at the outlet of the blower to a predetermined value for interrupting operation of said low capacity blower and causing operation of said high capacity blower, and means responsive to a drop in pressure at the outlet of the blower to a second predetermined value for causing operation of both of said blowers.

6. In an air conditioning system, variable capacity air circulating means for circulating air into a space to be conditioned, relay means controlling the operation of said air circulating means, means for controlling the admission of air into said space, means responsive to operation of said last named means in a manner to permit the admission of air into said space for placing the air circulating means under the control of said relay means, means for causing said air circulating means to operate at low capacity in response to the deenergization of said relay means, means responsive to energization of said relay means to cause operation of said air circulating means at high capacity, means responsive to the pressure at the outlet of said air circulating means, and means controlled by said pressure responsive means to cause energization of said relay means when the pressure drops to a low predetermined value and to cause deenergization of the relay means when the pressure rises to a high predetermined value.

7. In a zone air conditioning system, an air conditioning chamber, means for causing flow of air through said chamber and through a plurality of spaces to be conditioned, said means comprising a plurality of blowers, relay means controlling the number of blowers in operation, damper means controlling the admission of air into the various spaces, means responsive to the condition of the air in the various spaces controlling the respective damper means, means responsive to the opening of the damper means for any

of said spaces for placing said blowers under the control of said relay means, means responsive to energization of said relay means to cause operation of at least two blowers, means responsive to deenergization of said relay means to cause operation of a minimum number of said blowers, means responsive to the pressure at the outlet of said blowers, and means controlled by said pressure responsive means to cause energization of said relay means when the pressure drops to a low predetermined value and to cause deenergization of the relay means when the pressure rises to a high predetermined value.

8. In an air conditioning system, an air conditioning chamber, means for circulating air through said chamber and through a space to be conditioned, said means comprising a plurality of blowers of varying capacities, means responsive to the pressure at the outlet of the air circulating means for causing operation of different blowers and for controlling the number of blowers in operation according to a predetermined schedule, means for controlling the admission of air into said space, and means for placing the blowers under the control of the condition responsive means in response to operation of the air admission controlling means to permit the flow of air into said space.

9. A pressure control system comprising in combination, variable capacity delivery means for delivering a medium under pressure, pressure responsive means movable in response to pressure changes in said medium caused by said delivery means, and means including a pair of switches operated by said pressure responsive means for controlling the capacity of said delivery means, said two switches cooperating to change operation of said delivery means when in operation from a first capacity to a second capacity, and one of said switches being capable of maintaining said delivery means in operation at said second capacity independently of the other of said switches.

10. A pressure control system comprising, in combination, variable capacity delivery means for delivering a medium under pressure, pressure responsive means movable in response to pressure changes in said medium caused by said delivery means, a first switch operated by said pressure responsive means for closing a circuit to cause a change in capacity of said delivery means when in operation from a first capacity to a second capacity, a second switch for maintaining said second capacity operation of said delivery means after said first switch opens, said first

switch being incapable of initiating said second capacity operation of said delivery means independently of said second switch, and condition responsive means for opening and closing a circuit to render said delivery means operative and inoperative.

11. In an air conditioning system, in combination, an air conditioning chamber, variable capacity air circulating means for circulating air through said chamber and through a space to be conditioned, damper means for controlling the flow of air into said space, means responsive to the condition of the space for controlling the operation of said damper means, means responsive to the opening of said damper means for causing operation of said circulating means, means responsive to the pressure at the outlet of said circulating means for controlling the capacity of said circulating means, and means associated with said last named means for causing said circulating means to operate at a high capacity upon beginning operation thereof, at a low capacity when said circulating means is in operation and the pressure attains a predetermined high value, and at the high capacity when said circulating means is in operation and the pressure drops to a predetermined low value, there being a substantial difference in these two pressure values whereby hunting of the air circulating means is prevented.

12. In a zone air conditioning system, in combination, an air conditioning chamber, delivery means for circulating air through said chamber and through the various zones to be conditioned, damper means associated with each zone for controlling the delivery of air thereto, condition responsive means in each zone for controlling said damper means, first control means controlled by said condition responsive means for rendering said delivery means operative when at least one of said damper means is in open position and inoperative when all of said damper means are in closed position, pressure responsive means positioned in accordance with pressure changes caused by the closure of one or more of said damper means, a first control device operated by said pressure responsive means for varying the air supply to said zones from a first to a second capacity, said first control device being incapable of varying the air supply from said second to said first capacity, and a second control device for varying the air supply from said second to said first capacity, said second control device being incapable of varying the air supply from said first to said second capacity.

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