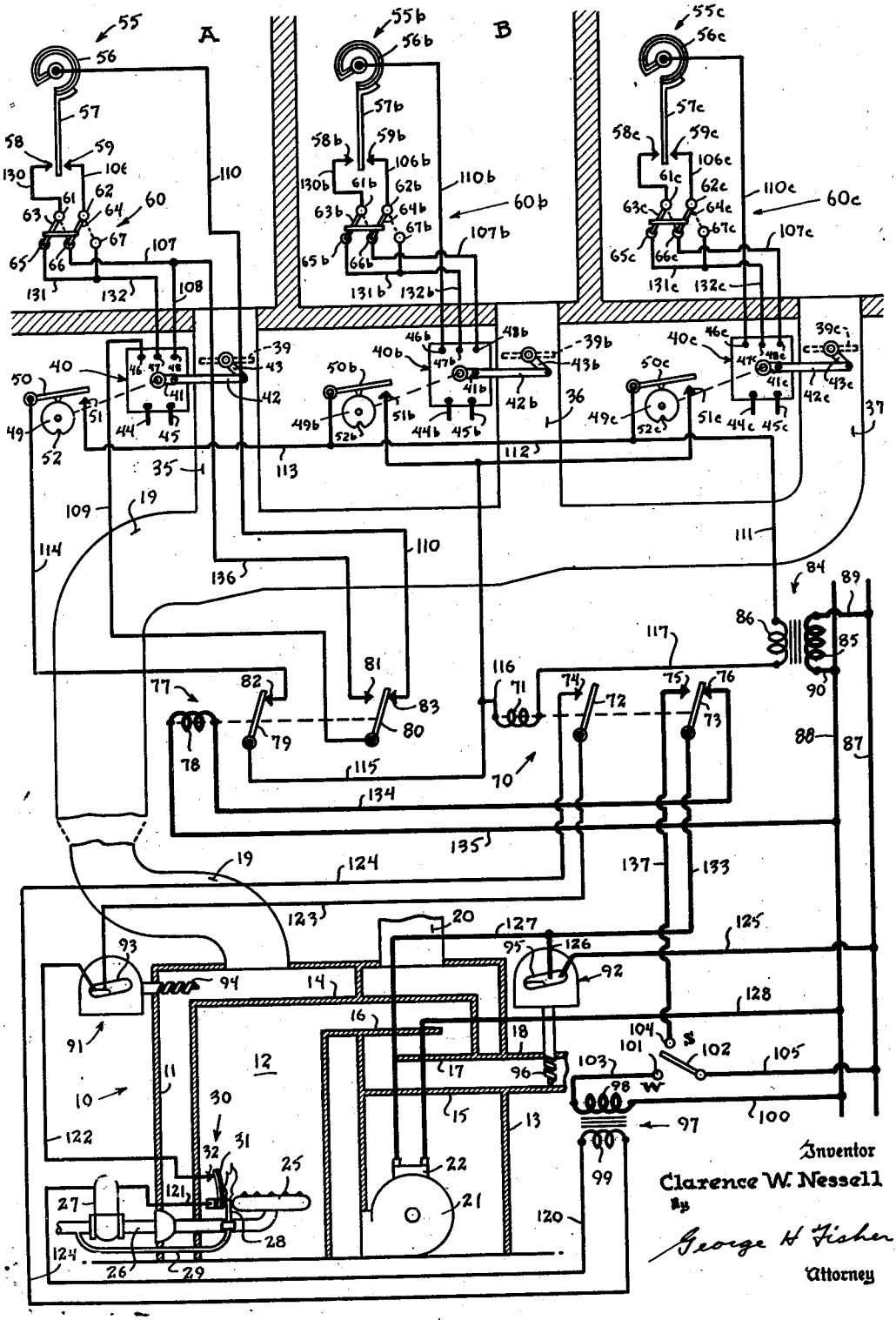
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ZONE AIR CONDITIONING SYSTEM

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ZONE AIR CONDITIONING SYSTEM

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My invention as herein disclosed relates to control, particularly of temperature, in heating, ventilating, and air conditioning installations and the like, the invention being directed more especially to zone type systems. In such systems individual control instruments are used to control particular sections or zones of a building enclosure and the instruments usually also control equipment for treating or circulating air or other fluid medium such as steam or water. When all the control instruments are satisfied, all the zones are ordinarily closed off and due to the sudden interruption in flow of fluid medium away from the source a dangerous condition may quickly develop particularly if the source is a warm air furnace or a boiler, requiring that warm air or steam be released. My system comprehends opening one or at least one zone as soon as all the control instruments are satisfied thus preventing the development of such a condition and thereby eliminating the need of means for relieving it.

My invention is particularly adaptable to warm air systems employing an economizer, the temperature of which may quickly rise to a dangerously high value if air circulation is suddenly stopped at the same time that the control instruments become satisfied.

An object of my invention is to provide improved means for disposing of surplus fluid conditioning medium available in zone type conditioning systems when all the zones are satisfied to prevent the development of a dangerous condition at the source of the conditioning medium.

Another object is to cause at least one zone of a zone type conditioning system to open when all zones are satisfied to prevent the sudden and immediate interruption of flow of conditioning medium away from the source.

Another object is the provision of a zone type warm air conditioning system having means for automatically opening one zone as soon as all zones are satisfied and continuing to circulate air away from the furnace to prevent the temperature rising too high.

Another object is the provision of zone type warm air conditioning system including a furnace having an economizer, a fan responsive to temperature of the economizer, and means to open at least one zone as soon as all zones are satisfied so that the fan can continue to circulate air away from the furnace until the economizer has cooled. It is also an object of my invention to again close all the zones when the economizer has cooled.

Another object of my invention is to provide a warm air heating system of the zone type wherein one zone opens immediately after all zones are satisfied, the said one zone being controlled from a furnace temperature responsive switch so that in the summer time when the furnace is not heated the zones all operate normally, the furnace fan operating whenever any zone is demanding fan operation.

The single figure of the drawing represents diagrammatically a zone type gas fired warm air heating system having my invention embodied therein.

Referring to the drawing, I have shown at 10 a warm air furnace of a known type comprising an outer casing 11 forming a casing surrounding a combustion chamber 12, the upper part of the casing 11 forming a furnace bonnet. A second casing 13 may be formed as a part of the casing 11 and form an inlet chamber for air to be circulated through the casing 11 and heated therein. The combustion chamber 12 has a flue 14 connecting with an economizer 15 located within the return air chamber or casing 13. The economizer 15 has internal baffles 16 and 17 by means of which three passes are formed which must be traversed by the gases of combustion in passing through the economizer before being educted therefrom through a stack 18. A distributing duct 19 for conveying warm air from the casing 11 leads to spaces being heated and air may be returned from the spaces being heated to the casing 13 through a return air duct 20. A fan 21 driven by an electric motor having a terminal box 22 is located within the return air chamber 13 and discharges into the casing 11. Air returned through the return air duct 20 passes over the economizer 15 to be pre-heated thereby and is then forced through the casing 11 by the fan 21.

The particular furnace which I have disclosed is a gas fired furnace and within the combustion chamber 12 is a gas burner 25 which is supplied with fuel through a conduit 26. Interposed in the conduit 26 is an electric gas control valve 27. Adjacent the burner 25 is a constantly burning pilot burner 28 which is continuously supplied with fuel through a tube 29 communicating with the conduit 26 ahead of the valve 27. Numeral 30 designates a safety pilot comprising a bimetal element 31 which is normally flexed into engagement with a fixed electrical contact 32 by heat from the flame of the pilot burner.

The air distributing duct 19 has a number of branch ducts 35, 36 and 37 which lead to differ-

ent sections or zones of the building which I have designated as zones A, B and C. The supply of heated air to each zone is controlled by a separate thermostat and zone damper. The supply of air to zone A is controlled by a damper 39 located in the branch conduit 35. The damper 39 is driven by means of an electric damper motor 40 which may be constructed similarly to the damper motor disclosed in the patent of R. W. Johnson No. 1,835,307. The motor 40 drives a crank-arm 41 which is connected by means of a link 42 to an operating lever 43 which directly actuates the damper. The connections between the damper motor and the damper are such that when the motor 40 turns the crank-arm 41 through 180°, the damper 39 is moved through 90°, the damper requiring a movement through 90° to adjust it from open to closed position or vice versa. Power for the motor 40 is supplied by wires 44 and 45 and it is controlled by wires connecting to terminals 46, 47 and 48. Motor 40 is of the type which always rotates in the same direction and each time it is energized, it moves the crank-arm 41 through 180° before stopping. Motor 40 also drives a cam 49 which actuates a switch blade 50 cooperating with a fixed electrical contact 51. The cam 49 has a notch 52 so arranged that whenever the motor 40 moves the damper 39 into open position, the switch blade 51 drops into the notch so as to come into engagement with the electrical contact 51. The switch 50 forms an auxiliary switch from which the operation of the furnace is controlled as will presently be described.

The motor 40 associated with zone A is controlled by a thermostat 55 located in zone A. The thermostat 55 comprises a bimetal element 56 arranged to operate a switch arm 57 cooperating with fixed electrical contacts 58 and 59. The thermostat 55 is of a known type which operates to cause the blade 57 to engage the contact 58 at a predetermined temperature which may be 72°, for example, and to engage the contact 59 at a predetermined temperature which may be one or two degrees lower as 70°, for example. The contact 58 may be called the hot contact and contact 59 may be called the cold contact. When the blade 57 engages either the hot or cold contact, the motor 40 may be operated to either its open or closed position, depending upon the position of the pole changer 60. The pole changer 60 performs the function of a reversing switch, comprising poles 61 and 62 which are connected to switch blades 63 and 64 and poles 65, 66 and 67. The blades 63 and 64 are connected so as to move together and they have one position wherein they are in contact with poles 65 and 66, respectively, and they have another position as shown in dotted lines wherein they are in contact with poles 66 and 67, respectively. During the winter time, the pole changer 60 is in the position shown and in this position contact 58 is connected to motor terminal 47 and contact 59 is connected to motor terminal 48, as will become apparent later when the electrical circuits are traced. When the pole changer is in its summer or dotted line position, contacts 58 and 59 are connected to motor terminals 48 and 47, respectively. In the winter time when blade 57 engages contact 59, motor 40 is operated so as to move damper 39 to open position and when blade 57 engages contact 58 motor 40 operates damper 39 to closed position. In the summer time, the action is the opposite, the motor 40 operating the damper 39 to open position when blade 57 engages the hot contact, that is, contact 58.

The damper, auxiliary switch, and thermostat of zones B and C are identical with those of zone A and therefore they need not be described again, corresponding elements in zones B and C being numbered the same as in zone A but having a distinguishing letter identifying the zone with which they are associated.

Numeral 70 designates an electrical relay comprising a coil winding 71 cooperating with an armature arranged to actuate a pair of switch blades 72 and 73, the blades being moved to the left when the coil 71 is energized so as to engage the fixed electrical contacts 74 and 75, respectively. When the coil 71 is deenergized, the blade 73 engages a fixed electrical contact 76. Numeral 77 designates a second relay comprising a coil winding 78 cooperating with an armature arranged to actuate a pair of switch blades 79 and 80 which are moved to the left when the coil is energized, the blade 80 engaging a fixed contact 81 when coil 78 is energized. When coil 78 is deenergized blade 79 engages a fixed contact 82 and blade 80 engages a fixed contact 83. Power for operation of the relay 70 is supplied by a step-down transformer 84 comprising a primary winding 85 and a secondary winding 86. Numerals 87 and 88 designate a pair of line conductors which may be connected to any suitable source of power and primary winding of transformer 84 is connected to line conductors 87 and 88 by wires 89 and 90, respectively.

Cooperating in the control of my system are thermostatic switches 91 and 92. These switches are of a known type, the switch 91 comprising a mercury switch tube 93 which is actuated by a helical thermostatic element 94 located in the bonnet of the furnace 10 so as to be responsive to the temperature therein. Mercury switch 93 is normally closed and is only opened when a relatively high temperature occurs within the bonnet at which it is no longer desired that fuel be supplied to the burner 25. The switch 91 forms a high limit switch as will presently become apparent. The switch 92 is of the same type comprising a mercury tube 95 which is operated by a helical thermostatic element 96 located in the stack 18 in a position so as to be responsive to the temperature of the products of combustion passing through the economizer 15. The mercury switch 95 is moved to closed position whenever the temperature to which element 96 responds is at a high enough value to insure that the air passing through the furnace has been heated sufficiently so as to heat the space when admitted thereto.

Power for operation of the valve 27 is supplied by a transformer 97 which is similar to the transformer 84 having a primary winding 98 and a secondary winding 99. One end of the primary winding 99 is connected to the line conductor 88 by a wire 100 and the other end of the primary winding is connected to one terminal 101 of a manual switch 102 by means of a wire 103. The switch 102 is a summer-winter switch and has another contact 104, the switch blade being movable between the contacts 101 and 104. The switch blade is connected to line conductor 87 by a wire 105.

For winter operation switch blade 102 is in its winter position engaging contact 101 and the pole changers 60 are in the position shown. Whenever the blade of any one of the zone thermostats engages with its cold contact, its associated damper

is opened and the furnace is started in operation. Assuming that the temperature in zone A, for example, falls to 70° causing blade 57 to engage with contact 59, a circuit for energizing motor 40 so as to cause it to move damper 39 to an open position is completed as follows: from thermostat blade 57 to contact 59, wire 106, pole 62 of the pole charger, blade 64, pole 66, wire 107, wire 108, motor terminal 48, motor terminal 46, wire 109, switch blade 80, contact 83, wire 110 back to thermostat 55. When this circuit is completed connecting terminals 46 and 48 of motor 40, the motor operates through 180 degrees so as to move the damper 39 through 90 degrees into its open position. Cam 49 is also moved through 180 degrees so as to close switch 50 which completes a circuit energizing relay 70, this circuit being as follows: from secondary winding 86 of transformer 84 through a wire 111, wire 112, wire 113, contact 51, blade 50, wire 114, contact 82, blade 79, wire 115, wire 116, coil 71, and wire 117 back to secondary winding 86. Energization of coil 71 causes blade 72 to move into engagement with contact 74 and blade 73 moves into engagement with contact 75. Closure of switch 72 energizes and opens the electric valve 27 through the following circuit: from secondary winding 99 of transformer 97, through a wire 120, valve 27, wire 121, safety pilot 30, wire 122, mercury switch 93, wire 123, switch blade 72, contact 74, wire 124 back to secondary winding 99. As soon as valve 27 opens, fuel is supplied to the burner 25 where it is ignited by the pilot burner and heating of the furnace begins. As soon as the temperature of the stack 18 has risen to a sufficiently high value to cause closure of mercury switch 95, the motor of fan 21 is placed directly across the line so as to start operation of the fan and circulation of warm air through the zone A. The circuit for starting the fan is as follows: from line conductor 87 through a wire 125, mercury switch 95, wire 126, wire 127, motor terminal box 22, and wire 128 back to line conductor 88. Warm air is forced through the duct 19 and branch duct 35 into the zone A until the temperature in zone A rises to 72° at which thermostat blade 57 will engage the contact 58. However, before the thermostat of zone A becomes satisfied, the thermostats of the other zones may call for heat opening their respective dampers in the same manner that the damper of zone A was opened.

The wiring of zone A is slightly different than that of zones B and C inasmuch as the relay 77 is associated with the control of zone A. It will be noted that in zone A motor terminal 46 is connected to the thermostat 55 by a circuit extending through relay switch 80 while in zones B and C, the motor terminal 46 is connected directly to the thermostat 56. The circuits whereby the thermostats of zones B and C control their respective damper motors are obvious in view of the description of zone A. The auxiliary switch of either zone B or C may energize relay 70 through circuits which are obvious. The furnace will be kept in operation as long as any one thermostat is calling for heat. Let it be assumed that the thermostats of all the zones are satisfied and that the thermostat of zone A was the last to become satisfied having just caused blade 57 to engage with contact 58. This will complete a circuit for motor 40 as follows: from blade 57 of thermostat 56 to contact 58, wire 130, pole 61, blade 63, pole 65, wire 131, wire 132, motor terminal 47, motor terminal 46, wire 109, blade 80, contact 83, and wire 110 back to thermostat 56. Completion of this circuit will cause motor 40 to move the damper 39 into the position shown and open the switch 50. Opening of switch 50 will deenergize the relay 70. Deenergization of relay 70 will cause closure of valve 27 and termination of operation of the burner 25. The temperature within the stack 18 and in the economizer 15 will, however, not immediately drop due to the residual heat remaining in the furnace and therefore the fan 21 will remain in operation for an appreciable time. To provide for disposal of this residual heat remaining in the furnace and to prevent the economizer from becoming too hot, I provide an arrangement whereby one damper which happens to be the damper of zone A moves to open position as soon as the thermostats become satisfied. Thus when relay 70 is deenergized, blade 73 moves into engagement with contact 76 completing a circuit energizing relay 77 as follows: from line conductor 87 to wire 125, mercury switch 95, wire 126, wire 133, blade 72, contact 76, wire 134, coil 78, and wire 135 back to line conductor 88. Energization of relay 77 causes blade 79 to move out of engagement with contact 82 and causes blade 80 to move into engagement with contact 81 completing a circuit connecting terminals 46 and 48 of motor 40 as follows: from blade 80 through contact 81, wire 136, wire 108, motor terminal 48, motor terminal 46, and wire 109 back to blade 80. This causes motor 40 to again operate damper 39 into an open position so that the warm air being forced out of the furnace by the fan 21 can pass through the branch duct 35 into zone A. Relieving the furnace of its residual heat in this manner prevents the temperature therein and particularly the temperature of the economizer from rising to an undesirably high value as it would do if the fan were suddenly stopped at the same time that burner operation is discontinued when all the thermostats become satisfied. The additional heat supplied to zone A will cause the thermostat blade 57 to remain in engagement with the hot contact for a longer time. Closure of switch 50 when the damper 39 was opened in response to energization of relay 77 will not now cause energization of relay 70 because the original circuit whereby relay 70 was energized through switch 50 is now interrupted due to the fact that blade 79 is now out of engagement with contact 82. The fan will now continue in operation until the temperature of the stack has fallen to a low enough value to cause opening of mercury switch 95. When mercury switch 95 opens, relay 77 will be deenergized placing motor 40 back under control of the thermostat 56. Blade 57 may be in engagement with contact 58 at this time inasmuch as heat has been supplied to zone A up until the time that mercury switch 95 opens so that when relay 77 is deenergized and blade 57 engages contact 58, a circuit is completed connecting terminals 47 and 46 of motor 40 in the same manner as previously described when damper 39 was originally opened.

It is to be noted that should zone B or C demand heat while zone A is open, having been opened in response to switch 95, relay 70 will be energized, relay 77 will be deenergized and normal zone control operation will be resumed.

During the foregoing operation, the summer-winter switch 102 was in engagement with contact 101, and each of the pole changers 60 were in the position shown in the drawings. For summer operation each of the pole changers 60 are

moved into their summer positions and switch 102 is moved into engagement with contact 104. Obviously, transformer 97 is not now energized and therefore inasmuch as valve 27 cannot be energized and opened, the heating equipment will not operate in the summer time. When the pole changers 60 are in their positions as shown in broken lines, operation of the damper motors in response to the thermostats is reversed, as previously described. For example, when the temperature in zone A rises to 72°, blade 57 will engage contact 58 and motor terminals 48 and 46 will now be connected as follows: from blade 57 through contact 58, wire 130, pole 61, blade 63, pole 66, wire 107, wire 108, motor terminal 48, motor terminal 46, wire 109, blade 80, contact 83, wire 110, back to thermostat 56. Completion of this circuit will cause motor 40 to open the damper 39 and close switch 50. Closure of switch 50 will cause energization of relay 70 in the same manner as previously described. Upon energization of relay 70, blade 73 will be moved into engagement with contact 75 which will place the motor of fan 21 directly across the line as follows: from line conductor 87 through wire 105, switch blade 102, contact 104, wire 137, contact 75, blade 73, wire 133, wire 127, motor terminal box 22, and wire 128 back to line conductor 88. The fan will now continue in operation as long as relay 70 is energized and relay 70 will be energized whenever the thermostat of any one zone has caused its associated damper to move to open position. Relay 77 will never be energized in the summer time because as there is no heating in the furnace the mercury switch 95 will not become closed, energization of relay 77 depending upon mercury switch 95. It is to be noted, however, that should the mercury switch 95 become short circuited in the summer time so as to cause fan operation when all the zone dampers are closed, the damper of zone A will automatically open to release the air being circulated by the fan. Short circuiting of switch 95 will cause energization of relay 77 as well as operation of the fan, the circuit being as previously pointed out. Energization of the relay 77 will cause motor 40 to move damper 39 to open position as has also been described. Thus the contingency of the fan operating at an undesirable time is taken care of by causing a damper to automatically open at such time.

Summarizing the operation of my complete system, it is to be seen that during the winter time any zone thermostat may open its associated damper in response to a demand for heating which will in turn cause operation of the furnace. Operation of the furnace will continue as long as any one thermostat is demanding heating and when all of the thermostats are satisfied, operation of the fan will continue under control of the mercury switch 95. As soon as all the thermostats are satisfied, the damper of zone A will open so that the residual heat being forced away from the furnace by the fan will be conveyed to zone A. As soon as the temperature of the stack has dropped to a predetermined value, mercury switch 95 will open stopping the fan and causing reclosure of the damper of zone A so that all zones will now remain closed until there is another demand for heating by one or more of the zones. In the summer time, the heating equipment is rendered inoperative and control of the dampers in response to the thermostats is reversed so that the dampers are opened when the temperatures in their respective zones rise to a predetermined value. Each damper controls its individual zone and the fan operates whenever any one zone is demanding cooling. In the summer time when all the thermostats are satisfied, the fan immediately stops. However, if the fan switch should become short circuited in the summer time so as to cause fan operation when all the dampers are closed, the shorting of the fan switch will as well cause opening of the damper of zone A so as to take care of the air being circulated by the fan in this event.

It should be apparent to those skilled in the art from the foregoing that I have provided a novel and useful system whereby the adaptability of a zone type system is increased. With my arrangement a large overrun of temperature at the heat source is avoided when all of the zones become satisfied inasmuch as one zone opens as soon as all of them are satisfied. Instead of waiting for an undesirably high temperature to occur at the source of heat before relieving it, my system operates in a manner to preclude such a dangerous condition ever occurring and there is therefore no need of special means for relieving it.

The single representative embodiment of my invention which I have disclosed is illustrative and my invention is to be limited only in accordance with the scope of the appended claims.

I claim as my invention:

1. In a fluid distributing system, in combination, a source of fluid medium supply, means for circulating fluid medium to a plurality of different regions, a condition responsive control device associated with each region and controlling the supply of fluid medium thereto so as to shut off the supply whenever said condition exceeds a limiting value, an electrical relay controlling said source of fluid medium supply and energizable in response to opening of each of said devices, means responsive to a condition at said source of fluid medium operable to control said circulating means, and means controlled by said relay for placing said last named condition responsive means in control of at least one of said devices when said relay is deenergized.

2. In a heating system for a building having a plurality of zones, in combination, a source of heating medium supply, means for circulating said medium to said zones including a device for forcing such circulation, means responsive to a condition at said source for controlling said device, thermostatically controlled means in each zone for controlling the supply of said medium thereto so as to shut off the supply whenever the zone temperature is above a predetermined value, and means operative upon closure of all said zone supply controlling means to transfer at least one of said zone supply controlling means from its associated thermostatic control to control of said condition responsive means.

3. In a heating system for a building having a plurality of zones, in combination, a source of heating medium supply, means for circulating said medium to said zones including a device for forcing such circulation, means responsive to a condition at said source for controlling said device, thermostatically controlled means in each zone for controlling the supply of said medium thereto, said zone supply controlling means moving to closed position wherever the zone temperature is above a predetermined value, relay means responsive to each of said zone supply controlling means for controlling said source, and means operated by said relay means upon closure

of all said zone supply controlling means to transfer at least one of said zone supply controlling means from its associated thermostatic control to control of said condition responsive means.

4. In a fluid distributing system, in combination, a source of fluid medium supply, means for circulating said medium to a plurality of different regions, a condition responsive control device associated with each region and controlling the supply of fluid medium thereto, an electrical relay controlling said source and energizable in response to opening of each said device, means responsive to a condition at said source operable to control said circulating means, a second electrical relay controlling one of said devices, and a circuit for energizing said second relay including a switch controlled by said first-mentioned relay and a second switch controlled by said condition responsive means.

5. In a fluid distributing system, in combination, a source of fluid medium supply, means for circulating said medium to a plurality of different regions, damper means associated with each region for controlling the supply of fluid medium thereto, means in each region responsive to a condition indicative of the need for supply of said medium for controlling said damper means, an electrical relay controlling said source and energizable in response to opening of each said damper means, means responsive to a condition at said source operable to control said circulating means, a second relay operable to control certain of said damper means to open position and simultaneously interrupt control of said certain damper means by said regional condition responsive means, and an energizing circuit for said second relay controlled by said source condition responsive means and said first relay.

6. In a fluid distributing system, in combination, a source of fluid medium supply, means for circulating said medium to a plurality of different regions, damper means associated with each region for controlling the supply of fluid medium thereto, means in each region responsive to a condition indicative of the need for supply of said medium for controlling said damper means, an electrical relay controlling said source and energizable in response to opening of each said damper means, means responsive to a condition at said source operable to control said circulating means, a second relay operable to control certain of said damper means to open position and simultaneously interrupt control of said certain damper means by said regional condition responsive means, and an energizing circuit for said second relay including a switch controlled by said condition responsive means and a second switch operated by said first-mentioned relay so as to close upon deenergization thereof.

7. In a warm air heating system for a building having a plurality of zones, in combination, a warm air furnace having a stack and including an economizer arranged to give up heat to air being heated at the furnace, said economizer conveying gases of combustion of the furnace to the stack, means comprising a fan for circulating air to the zones, damper means controlling the air supply to each zone, a thermostat controlling each damper means, means responsive to a condition indicative of the temperature in said economizer, said last means controlling said fan whereby said fan is operated to force air over said economizer whenever said economizer is hot, an electrical relay for controlling said furnace and energizable upon opening of each said damper means, and means operable upon deenergization of said relay to remove certain of said damper means from control of the respective thermostats and place said certain damper means under control of said last named condition responsive means.

8. In a warm air heating system for a building having a plurality of zones, in combination, a furnace, a fan for circulating warm air from said furnace to said zones, damper means for regulating the supply of air to each zone, a thermostat in each zone for controlling its associated damper means, a relay for controlling said furnace, switches operatively connected to said damper means so as to be closed when said damper means are opened, an energizing circuit for said relay including said switches in parallel, a thermostat at said furnace for controlling operation of said fan, a switch operated to closed position by said relay upon deenergization thereof, a circuit including said last-mentioned switch, and effective when energized to transfer control of certain of said damper means from said zone thermostats to said furnace thermostat.

9. In a warm air heating system for a building having a plurality of zones, in combination, a furnace, a fan for circulating warm air from said furnace to said zones, a thermostat at said furnace for controlling operation of said fan, damper means for regulating the supply of air to each zone, thermostatic means in each zone for controlling its respective damper means, and means operable upon closure of all said damper means in response to said thermostatic means to transfer control of certain of said damper means from said zone thermostatic means to said furnace thermostat.

10. In a system for distributing a temperature changing fluid among a plurality of zones, damper means for controlling the supply of fluid to each zone, means for forcing circulation of said fluid, temperature responsive means in each zone for controlling said damper means, means for energizing said circulation forcing means, and means effective upon closure of all said damper means to transfer control of certain of said damper means from said temperature responsive means to said energizing means.

11. In a warm air heating system for a building having a plurality of zones, in combination, a furnace, a fan for circulating warm air from said furnace to said zones, a thermostat at said furnace for controlling operation of said fan, damper means for regulating the supply of air to each zone, thermostatic means in each zone for controlling its respective damper means, relay means responsive to each of said damper means for controlling said furnace, means operable upon closure of all said damper means in response to said thermostatic means to transfer control of certain of said damper means from said zone thermostatic means to said furnace thermostat, and means effective upon opening of said damper means under control of said furnace thermostat to interrupt control of said relay means by said certain damper means.

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