

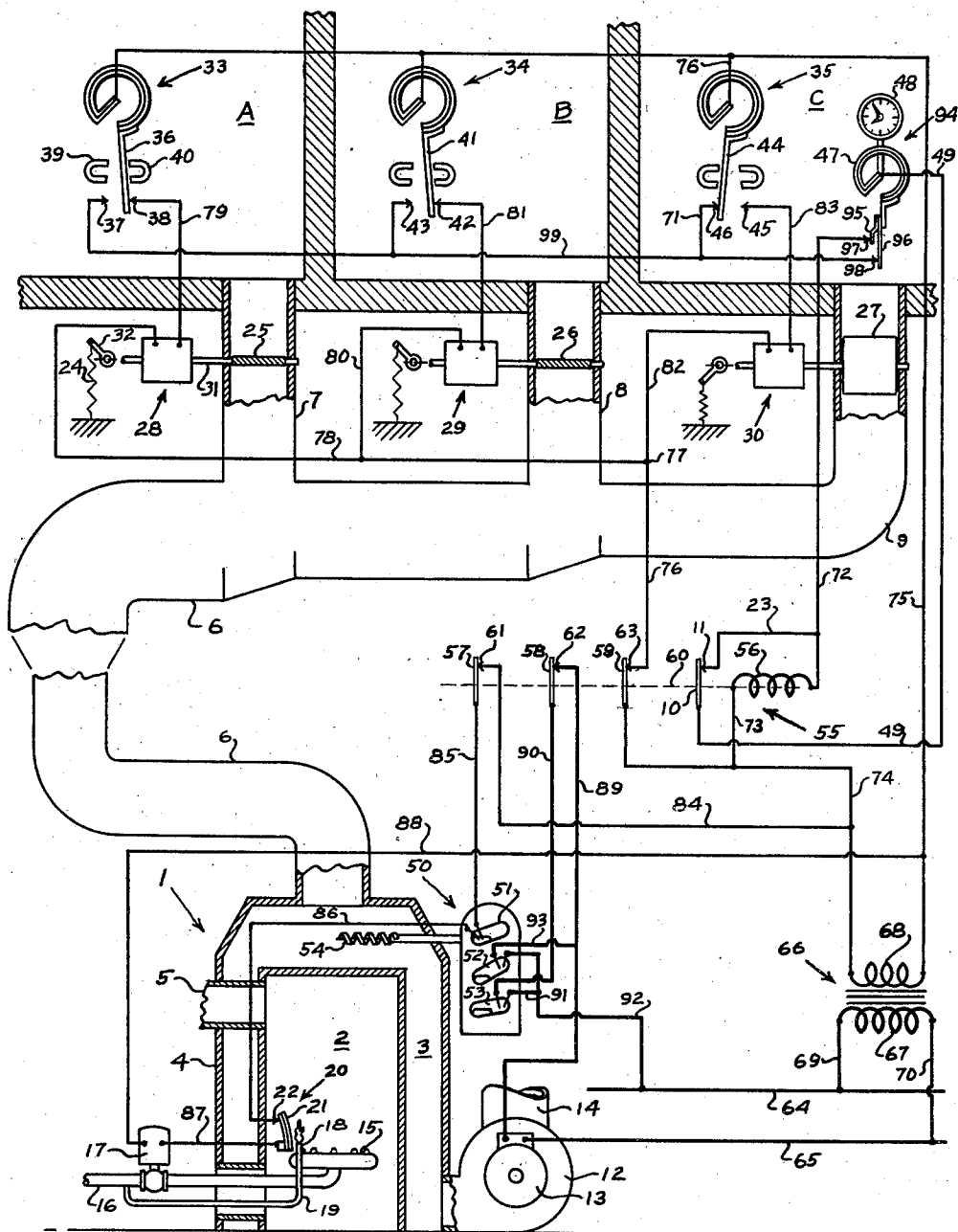
June 3, 1941.

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2,244,631

TEMPERATURE REGULATION

Filed Sept. 29, 1930



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UNITED STATES PATENT OFFICE

2,244,631

TEMPERATURE REGULATION

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Application September 29, 1938, Serial No. 232,367

5 Claims. (Cl. 236—11)

The present invention relates to temperature regulation in heating, ventilating, and air conditioning and the like, the invention being directed to improvements particularly in control of 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.

The object of my invention is to provide a novel control arrangement for systems of the type mentioned above and analogous systems wherein zones are individually controlled and wherein all zones are open to admit heat or fluid medium when the condition in all zones is satisfactory. This being the principal object of my invention, its ultimate purpose is to make it possible to distribute any surplus heat or conditioning medium to all of the zones after the control instruments all become satisfied or to relieve any excess pressure or the like at the fluid treating apparatus. In the past it was customary to provide what is commonly known as a relief zone to accomplish these purposes, this practice entailing usually an overrun of temperature in the relief zone and needless wastage of energy expended in the fluid medium treating apparatus.

Other objects of my invention are to eliminate the need of a relief zone in zone type heating and conditioning systems but at the same time to accomplish the functions of a relief zone in an improved manner whereby the disadvantages characteristic of a relief zone are avoided.

Another object is to provide a control arrangement for zoned systems of the character described wherein individual zone control instruments control their respective zones and a common source of fluid medium for conditioning purposes, all the zones being opened to admission of fluid medium when all the instruments are satisfied.

Another object is to provide a control arrangement for zoned systems of the character described having individual normally open control devices for each zone and individual control instruments, each instrument being effective to open and close its respective zone provided another instrument is calling for conditioning medium.

Another object is to provide a control arrangement for zoned systems of the character described having individual normally open control devices for each zone, and individual control instruments in each zone controlling a primary

source of fluid medium and effective to open and close their respective zones whenever any instrument is calling for fluid medium, fluid medium being circulated to all the zones when they are satisfied depending on a condition at the primary source of fluid medium.

A further object is the provision of a zone control system having air distributing ducts with dampers therein, and individual zone control instruments, the dampers being so constructed and controlled that they remain open unless their respective control instruments are satisfied and at the same time at least one other control instrument is calling for conditioned air.

A further object is the provision of a zone control system having an air heating device, air distributing ducts with dampers therein, and individual zone control instruments controlling the dampers, in combination with an air circulating fan for forcing air to all zones when all control instruments are satisfied, all the dampers being open under such conditions.

A further object is the provision of a zone control system wherein individual zone control obtains during daytime operation, all zones opening when all are satisfied and wherein all zones remain open during the night, control of the system being from a single instrument.

Another object is to improve the efficiency of air conditioning systems generally.

The single figure of the drawing represents diagrammatically a zone control system embodying my invention therein.

While I have chosen to describe as a representative form of my invention its embodiment in a warm air type heating system, it is expressly understood that it is equally applicable to other types of systems as referred to above.

Referring to the drawing, the letters A, B, and C designate various zones of a building which may be individual rooms or which may be groups of rooms. Numeral 1 indicates generally a warm air furnace which may be of conventional type having a combustion chamber 2 and an air heating space 3 formed by a jacket 4, the upper part of which forms the furnace bonnet. The combustion chamber 2 has a stack 5 for conveying burnt gases of combustion therefrom and an air distributing duct 6 communicates with the furnace bonnet for conveying heated air therefrom. The distributing duct 6 has branch conduits 7, 8, and 9 connected therewith for conveying air to the zones A, B, and C respectively of the building. Air may be circulated through the system by a furnace fan 12 driven by an electric motor

13, the fan having a suction conduit 14 which may connect with a return air duct from the various zones of the building, and the fan discharges into the air heating space 3 for forcing air therethrough and into the duct 6 as shown.

In the particular embodiment of the invention disclosed, heat may be supplied by a conventional gas burner 15, the gas being supplied through a conduit 16 which may connect with a gas main, not shown. Interposed in the conduit 16 is a gas control valve 17 which preferably is of the electric solenoid type as I have shown, but which may take other forms of conventionally used valves. Numeral 18 indicates a constantly burning pilot burner which is at all times fed with gaseous fuel through a tube 19 communicating with the conduit 16 ahead of the valve 17. Adjacent the flame of pilot burner 18 is a safety pilot device 20 comprising a strip of bimetal 21 cooperating with a fixed electrical contact 22 so as to form a switch. The safety pilot 20 may be of a type well known in the art and has for its purpose to shut down the system in the event of extinguishment of the pilot flame as I will explain more in detail during the description of operation following.

Disposed in the branch conduits 7, 8, and 9 are automatic dampers 25, 26, and 27, respectively. These dampers 25, 26, and 27 are operated by electric spring return type damper motors indicated respectively at 28, 29, and 30. Referring to the operating motor 28, it comprises a shaft 31 upon which the damper 25 is mounted for rotation thereby, the other end of the shaft carrying a lever arm 32 which is biased in the opening direction of the damper shaft 31 by the coil spring 24. The construction and arrangement of the damper motor is such that upon energization of the motor the damper is moved to closed position as indicated by the damper 25, the arm 32 moving against the tension of spring 24. The damper remains in fully closed position as long as the motor is energized and immediately upon deenergization of the motor the spring 24 rotates the motor and shaft 31 so as to move the damper to open position as indicated by the position of damper 27 associated with zone C. Inasmuch as the damper motors 29 and 30 and their various associated structures may preferably be identical with motor 28 they need not be described in detail.

Primary control of my system is provided by thermostats 33, 34, and 35 located in the zones A, B, and C, respectively. Referring to the thermostat 33, it may be one of the conventional bimetallic type having a bimetal element secured to a movable switch contact blade 36 cooperating with fixed electrical contacts 37 and 38. The switch blade 36 cooperates with permanent magnets 39 and 40 so that the blade moves with a snap action from engagement with one of the fixed electrical contacts to the other, that is, the blade 36 moves with a snap action in both directions. Contact 38 is the hot contact and with which the blade 36 engages at a predetermined temperature, and contact 37 is the cold contact to which the blade 36 snaps at a predetermined lower temperature, the difference between the two temperatures being some suitably chosen differential such as 2° or the like. The thermostats 34 and 35 are preferably identical with the thermostat 33 and need not be described in the same detail. The thermostat 34 has a movable blade 41 which cooperates with fixed electrical contacts 42 and 43 and the thermostat 35 has a

movable blade 44 which cooperates with fixed electrical contacts 45 and 46.

Numeral 94 indicates a day-night thermostat having a clock or other timing mechanism 48. Thermostat 94 consists of a conventional bimetal element 47 for actuating flexible switch blades 95 and 96 cooperating with fixed electrical contacts 97 and 98. Thermostat 94 is set at a relatively high setting during the day so as to normally remain closed and its setting is automatically changed to 60° for example for night operation.

Further control of the system is provided by a control instrument generally indicated at 50 comprising mercury switches 51, 52, and 53, all of which are actuated by a helical thermostatic element 54 responsive to temperature of air being heated within the bonnet 4. The thermostatic element 54 is mechanically connected to the mercury switches so that they are sequentially operated in order, the switch 53 being actuated first, the switch 51 next and the switch 52 last from their positions as shown in the drawing as the temperature within the bonnet 4 rises.

Numeral 55 indicates generally an electrical relay which I have disclosed as comprising a coil winding 56 which cooperates with an armature or a solenoid for actuating electric switch blades 57, 58, 59 and 60 respectively, the switch blades being mechanically connected to the armature or solenoid as indicated by the broken line 60. The switch blades 57, 58, 59 and 60 cooperate with fixed electrical contacts 61, 62, 63 and 64 respectively.

Power for my entire system may be supplied through line conductors 64 and 65 connected to a suitable source of external alternating current power, not shown, and power at suitable voltage for the various control instruments and devices may be supplied by a step-down transformer indicated generally at 66. The transformer 66 comprises a primary winding 67 and a secondary winding 68, the primary winding having a greater number of turns than the secondary as conventional in this type of transformer. The transformer 67 is connected to the line conductors 64 and 65 by wires 69 and 70, respectively. I will next describe the complete operation of my system, tracing the various electrical circuits which I employ to bring about the various sequences and results which constitute in part the novelty of my invention.

With the parts in the position shown, the thermostats 33 and 34 in zones A and B are satisfied and the thermostat 35 in zone C is shown as calling for heat to be supplied to that particular zone. The movable blade 44 of thermostat 35 is engaged with fixed contact 46, thereby completing an electrical energizing circuit for the coil winding 56 as follows: from the fixed contact 46 through a wire 71, wire 98, contact 98, blades 96 and 95, contact 97, a wire 72, coil 56, wire 73, wire 74, secondary winding 68, wire 75, and wire 76 back to the thermostat 35. Energization of the coil winding 56 causes closure as shown of all of the switches 57, 58, 59, and 60. Closure of switch 59, as will presently be seen, controls an electrical circuit whereby all of the motors 28, 29, and 30 may be energized. The energizing circuits for motors 28, 29, and 30 have a portion in common comprising the wire 75 (which is connected to all the thermostats), the secondary winding 68, wire 74, switch 59, and a portion of wire 76 to the juncture 77. Now with the parts in the position shown, the motor 28

is energized through the following circuit: wire 75 which connects to the thermostat 33, through secondary 68, wire 74, switch 59, wire 76, wire 78, motor 28, wire 79, fixed contact 38, switch blade 36, and through the thermostat 33 back to wire 75. Motor 29 is energized by a similar parallel branch circuit comprising the common circuit portion traced above, through wire 78, wire 80, motor 29, wire 81, fixed contact 42, and blade 41 of thermostat 34. Thus it is seen that switch 59 controls the energizing circuits of both motors 28 and 29 as well as the motor 30. As will be seen by reason of the fact that the blade 44 of thermostat 35 is in engagement with contact 46 rather than contact 45, a circuit through the motor 30 is not completed through the wires 82 and 83. From the above description, it will be seen that dampers 25 and 26 are in their closed positions as shown and the damper 27 is in its open position.

Switch 57 being closed, a circuit causing opening of the valve 17 and supply of fuel to the burner 15 is completed which is as follows: from wire 74 through wire 84, through switch 57, wire 85, mercury switch 51, wire 86, safety pilot 20, wire 87, valve 17, and wire 88 back to the wire 75. As soon as the valve 17 opens, burner operation begins and heat is supplied as long as any one thermostat is calling for heat as will presently be made clear. As soon as the temperature within the space 3 has risen to a high enough value for suitable heating in a zone or zones calling for heat, mercury switch 53 will be operated to its closed position by element 54 completing the circuit for the fan motor which is as follows: from line conductor 65 through the fan motor, wire 89, switch 58, wire 90, mercury switch 53, wire 91, and wire 92 back to line conductor 64. A forced circulation of heated air is supplied by the fan 12 as soon as the mercury switch 53 is closed, and continues thereafter as long as any thermostat is calling for heat to be supplied to its respective zones. With the parts in the position shown on the drawing the bonnet temperature has not risen enough to close switch 53.

The mercury switch 51, as above described, is in the circuit of the control valve 17 and forms a high limit switch which will be opened by the element 54 so as to discontinue heating at a predetermined relatively high value of temperature within the bonnet 4 which may be adjusted as desired.

With the parts in the position shown for operating as just described, heat is being supplied only to zone C and the operation so far described will continue until thermostat 35 becomes satisfied and blade 44 moves into engagement with contact 45. If before thermostat 35 becomes satisfied either (or both) of the thermostats 33 and 34 indicate a need for heat in their respective zones, it will cause its respective damper to be opened. For example, should thermostat 34 call for heat, blade 41 will move into engagement with fixed contact 43. The above described energizing circuit for motor 29 will now be interrupted and, as previously described, the spring return arrangement will move the damper 26 to the open position so that heated air will be supplied to zone B as well as zone C. The thermostat 34 calling for heat at this time will bring about no change in the present operation of the heating equipment.

Now assuming that thermostats 33 and 34 have remained satisfied and thermostat 35 also becomes satisfied, blade 44 will move out of en-

gagement with contact 46 and into engagement with contact 45 interrupting the above described circuit through coil winding 56 and causing all of the switches 57, 58, 59 and 10 to open. Opening of switches 57 and 58 will interrupt the above described circuits which control the valve 17 and the fan 12, thereby terminating the supply of fuel to burner 15 and stopping the fan 12. Opening of switch 59 will create a gap in that portion of the energizing circuits for motors 28, 29, and 30 which is common to all of them as above described. All of the motors will now be deenergized and the dampers 25, 26, and 27 will be moved to their open positions. Thus upon all of the zone thermostats becoming satisfied, all the zone dampers are immediately moved to their open positions.

In apparatus of this particular type, when the heating plant is shut off and the fan stopped upon all of the thermostats becoming satisfied, there may be a substantial amount of residual heat in the combustion chamber, for example the combustion chamber 2. Inasmuch as no air is being circulated by the fan 12 to carry away this residual heat, the temperature in the space 3 may rise to a relatively high value even higher than the temperature at which mercury switch 51 is operated. In my particular arrangement, at a relatively high value of temperature affecting the element 54, the mercury switch 52 will be closed completing an auxiliary circuit for the fan motor 13 as follows: from line conductor 65 through the motor 13, wire 89, wire 93, mercury switch 52, and wire 92 back to the line conductor 64. The fan 12 will now be operated so as to force air to circulate through the space 3 carrying away the residual heat therefrom and distributing it to all of the zones through the various branch conduits 7, 8, and 9. Thus not only will the temperature within the bonnet 4 be prevented from rising to an undesirable and unsafe value, but the residual heat will, instead of being wasted, be evenly distributed to the various zones whereby the thermostats therein will remain at the satisfied position for a longer time. In this manner, I successfully utilize the residual heat at the furnace in all the zones rather than disposing of it by wasting it in causing a great overrun of temperature in a relief zone as was commonly done in the past. Thus I avoid the additional equipment necessary for a relief zone used for disposal of surplus heat and instead I promote economy by advantageously using this surplus heat. It is to be appreciated that my invention may be applied to a system having any number of zones and by reason of the fact that I distribute the surplus heat to all of the zones, there is no appreciable overheating of any of them such as would take place in a single relief zone.

Assuming now that all of the thermostats having remained satisfied for a period of time, a single thermostat, for example thermostat 35, calls for heat, again taking its position as shown in the drawing. Burner and fan operation will now be initiated in the manner already described and at the same time closure of switch 59 will complete energizing circuits for the motors 28 and 29 through the satisfied thermostats 33 and 34 respectively, as has already been described above. Thus upon thermostat 35 calling for heat the dampers 25 and 26 will immediately be moved into their closed positions as shown on the drawing so that heated air will be supplied only to the zone C as set forth at the beginning of the de-

scription of operation. Similarly, upon any zone thermostat calling for heat, coil 56 will be energized through the cold contact of that thermostat bringing about the above described sequence, it being apparent of course that the cold contacts of all the thermostats are connected to wire 99 so that the thermostats may be connected in parallel between wires 99 and 75.

During daytime operation the clock thermostat 94 at its relatively high setting has remained in a position with both of its pairs of contacts closed, at a predetermined time in the evening determined by the setting of the clock 48, the setting of thermostat 94 is automatically changed to a relatively low setting of 60° or in the neighborhood thereof, for example, for night operation. When this resetting of thermostat 94 is made the temperature at the time will be substantially that of the settings of the thermostats 33, 34 and 35 so that at this time the thermostat 94 will open its contacts. Obviously, therefore, none of the zone thermostats 33, 34 or 35 energizes the relay 55 because of the interruption in the circuit connections between wires 72 and 99 occasioned by the opening of both pairs of contacts of thermostat 94. Thermostat 94 controls the heating of the entire building during the night, and when the temperature of the building has fallen to a value which may be 60°, blade 96 will engage fixed contact 98. When the temperature has fallen to a value which may be 1° or 2° lower for example, blade 95 will engage contact 97, it being understood that the two pairs of contacts of thermostat 94 are operated sequentially. When both pairs of contacts have been made a circuit is completed for energizing the relay 55 which is as follows: from blade 95, through contact 97, wire 72, winding 56, wire 73, wire 74, secondary winding 68, wire 75, wire 76, blade 44 of thermostat 35, contact 46, wire 71, wire 99, contact 98 and blade 96 back to blade 95 of thermostat 94. It will be seen that this circuit just described extends through the thermostat 35, which will be in closed position because the temperature of the building has fallen to substantially 60° which is materially below the setting of the zone thermostats. It will be understood of course that in addition to this circuit last described, parallel circuits for energizing the relay 55 would be formed through each of the zone thermostats, each controlled by the thermostat 94. Upon completion of the said circuit the relay 55 is energized, moving all of the switches 57, 58, 59 and 10 into closed position. Heating will be initiated and will proceed in the same manner as has already been described in connection with control from the individual zone thermostats. Inasmuch as all of the zone thermostats are in engagement with their cold contacts, none of the zone damper motors will be energized and the zone dampers will remain open and they will so remain all during the night, that is, during the time that the thermostat 94 is in control. At the time that relay 55 is energized and switch blade 10 engages contact 11, a maintaining circuit for relay 55 is completed as follows: from element 47 of thermostat 94, through wire 49, switch blade 10, fixed contact 11, wire 23, wire 72, winding 56, wire 73, wire 74, secondary winding 68, wire 75, wire 76, blade 44 of thermostat 35, fixed contact 46, wire 71, wire 99, contact 98, blade 96 back to element 47 of thermostat 94. It will be seen that this last described circuit is independent of blade 95 and contact 97 of thermostat 94, and that therefore relay 55 will not be deenergized until

the building temperature rises to a value above 60°, the temperature at which blade 96 engaged fixed contact 98. Obviously, therefore, the thermostat 94 has a fixed operation differential by reason of which chattering of the relay 55 is eliminated and which might otherwise result from vibration of the contacts of ordinary type thermostats having only one pair of contacts. Whenever the temperature does rise above 60°, relay 55 will be deenergized and heating will be discontinued in the same manner as described in connection with individual zone control operation, all zones as previously pointed out remaining in open position all during day operation.

From the foregoing the unique and advantageous results which I gain by use of my invention and which I have particularly pointed out, should be clearly apparent to those skilled in the art. I reduce the amount of equipment which is generally necessary in similar systems known to the prior art and in doing so I at the same time gain results whereby substantial economies of operation are effected. All of the equipment which I employ is of a type well known by those skilled in the art to be of a simple and sturdy nature and not likely to get out of order or to require the need of servicing by expert technicians or the like.

While I have disclosed a single embodiment and application of my invention, it is to be appreciated that the fundamental concept thereof is capable of a wide range of structural manifestations and applications. I therefore desire protection by Letters Patent of the United States limited not by my disclosure but only as determined by the scope of the appended claims.

I claim as my invention:

1. In a temperature control system for a building having a plurality of zones, in combination, means for heating a fluid heat transfer medium, means for conveying said heated fluid medium to said zones, an electrical device controlling the supply of fluid medium to each zone, each device permitting the passage of fluid when deenergized, and preventing the passage of fluid when energized, a thermostat in each zone responsive to the temperature of the air therein having a pair of stationary contacts and a movable contact, said movable contact engaging a first stationary contact when calling for heat, and engaging a second stationary contact when said thermostat is satisfied, a relay for controlling said heating means and said devices, said relay when energized permitting operation of said heating means and energization of said devices, and when deenergized preventing operation of said heating means and energization of said devices, a source of electrical energy, an energizing circuit for said relay including said source of energy, said relay, any of said first contacts and its cooperating movable contact, a switch operated by said relay, and an energizing circuit for each controlling device including said source of energy, said relay-operated switch, said controlling device, the second contact and the movable contact of the thermostat in the zone whose supply of fluid is controlled by said device.

2. In a temperature control system for a building having a plurality of zones, in combination, means for heating a fluid heat transfer medium, means for conveying said heated fluid medium to said zones, an electrical device controlling the supply of fluid medium to each zone, each device permitting the passage of fluid when deenergized, and preventing the passage of fluid when energized, a thermostat in each zone re-

sponsive to the temperature of the air therein, a pair of switches associated with each said thermostat, and selectively operable thereby, energizing circuits for said control devices, a relay for controlling all said energizing circuits, a relay energizing circuit, one of said pair of switches being effective to close said relay energizing circuit, and the other of said pair of switches being effective to close the energizing circuit for its associated control device, and circuit connections such that each of said device energizing circuits includes only one of said thermostatically operated switches, and each of said thermostatically operated switches carries energizing current for only one of said devices.

3. In an air conditioning system of the zone type, in combination, a building divided into a plurality of zones, a source of conditioned air, electrically controlled damper means for each zone controlling the supply of air thereto, each said damper means assuming open position when deenergized, switch means in each of said zones movable between two controlling positions, a relay, a switch controlled by said relay, an energizing circuit for said relay, means whereby each zone switching means is operable when in one of said two controlling positions to close said energizing circuit, and an energizing circuit for each damper means including said relay controlled switch and only one of said zone switch means, each zone switch means being in the energizing circuit of its associated zone damper means and being operable when said circuit is otherwise closed to complete closure of said circuit when said switch means is in its second circuit controlling position.

4. In a temperature control system for a building having a plurality of zones, in combination, means for heating a fluid heat transfer medium, means for conveying said heated fluid medium to said zones, an electrical device controlling the supply of fluid medium to each zone, each device permitting the passage of fluid when

deenergized, and preventing the passage of fluid when energized, a thermostatic switch in each zone responsive to the temperature of the air therein and movable between two controlling positions in accordance with the value of said temperature, relay means for controlling said heating means and said devices, a. energizing circuit for said relay means, means whereby each zone switching means is operable when in one of said two controlling positions to close said energizing circuit, and an energizing circuit for each said controlling device including only one of said thermostatic switches, each thermostatic switch being in the energizing circuit of the controlling device in its associated zone and being operable when said circuit is otherwise closed to complete closure of said circuit when said thermostatic switch moves to its second circuit controlling position.

5. In a temperature control system for a building having a plurality of zones, in combination, means for heating a fluid heat transfer medium, means for conveying said heated fluid medium to said zones, and electrical device controlling the supply of fluid medium to each zone, each device permitting the passage of fluid when deenergized, and preventing the passage of fluid when energized, a thermostat in each zone responsive to the temperature of the air therein, each thermostat comprising a pair of switches a first of which is closed on a rise in temperature to a predetermined value and the second of which is closed on a fall in temperature to a predetermined value, a control switch, a relay for closing said control switch when said relay is energized, an energizing circuit for each said device including said control switch and the first switch of the thermostat in its associated zone, said thermostat being the only one of said thermostats in said energizing circuit, and an energizing circuit for said relay including all of the second switches of said thermostats in parallel.

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