

June 12, 1928.

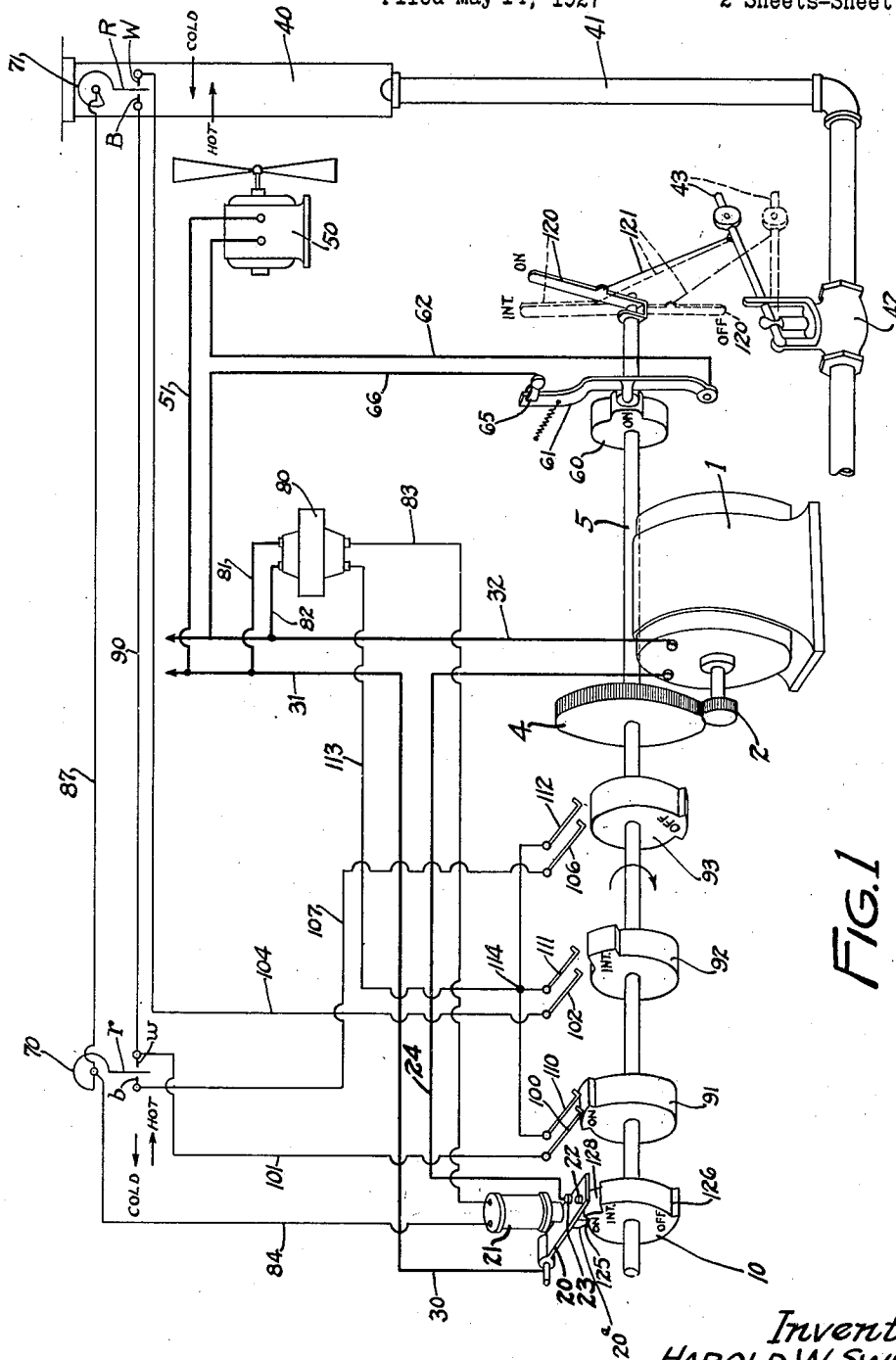
1,673,057

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UNIT HEATER CONTROL

Filed May 14, 1927

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

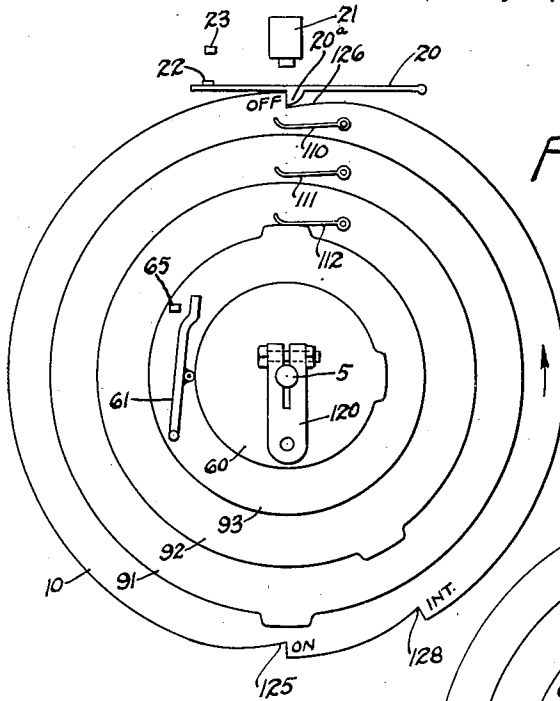


FIG. 3

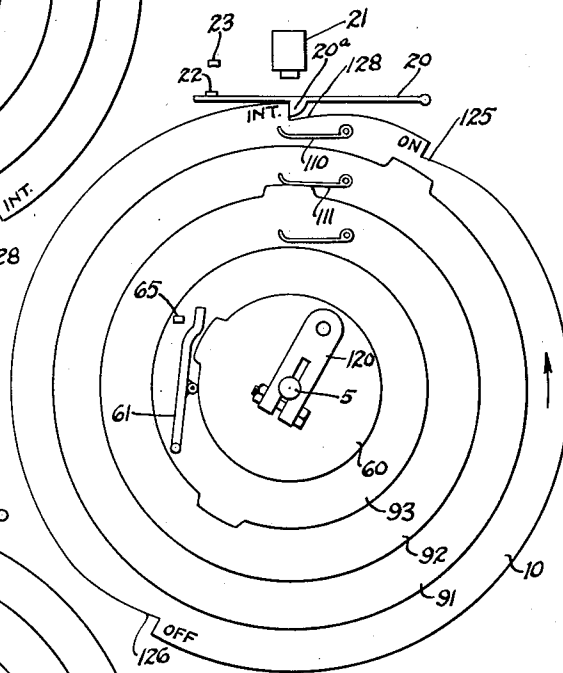


FIG. 4

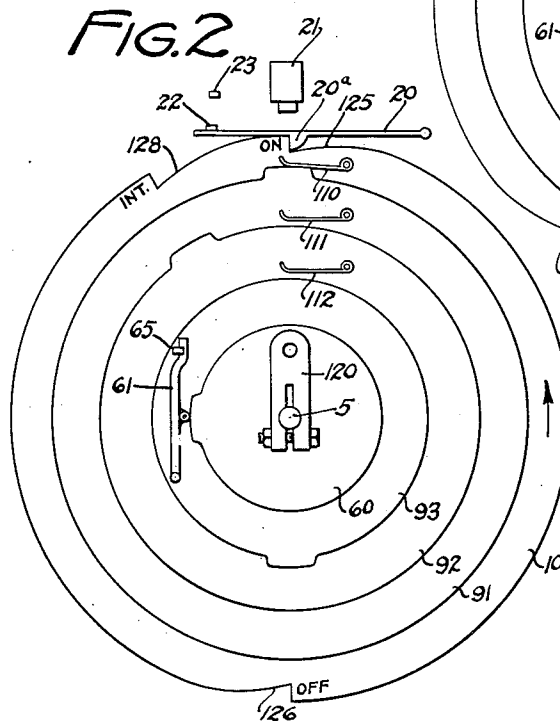


FIG. 2

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1,673,057

UNITED STATES PATENT OFFICE.

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UNIT-HEATER CONTROL.

Application filed May 14, 1927. Serial No. 191,456.

This invention relates generally to improvements in heat-regulation apparatus, and is particularly directed to the control of a circuit for a power driven fan, which fan is associated with a heating unit, such as a radiator, for the purpose of circulating and increasing the amount of heat given off by the radiator.

Advantages will be pointed out in the description of the drawings forming a part of this specification and in said drawings:

Figure 1 is a diagrammatic view showing the system in the normal operating or "on" position, with the fan running and the radiator receiving heat;

Figure 2 is a diagram showing the angular relation of the switch operating elements (in this instance cams) as well as the relations of these elements to the elements which they control. In order to show the angular relations of the cam contours the cams have been made successively of larger diameter. The elements are viewed as from the right in Figure 1;

Figure 3 is a diagram generally similar to Figure 2 but showing the cams and related elements positioned as when the system is in-operative, that is in the "off" position, with the radiator not receiving heat and the fan not running; and

Figure 4 is a diagram generally similar to those of Figures 2 and 3 but showing another position, herein designated "intermediate" position, in which the radiator is receiving heat but the fan is not running because the radiator is not sufficiently warm.

The numeral 1 designates a control motor having a gear 2, meshing with a companion gear 4 of an auxiliary shaft 5 mounted in suitable bearings, not shown, adapted to be slowly rotated when the motor is running. Upon this shaft are arranged in this instance five cams as switch controlling elements. Cam 10 is adapted to control the armature 20, as a switch arm, in turn controlling current to the control-motor 1. This armature is in turn controlled by the coil 21. The armature of this relay, as a switch arm, carries a contact 22 cooperable with a companion contact 23 connected by a wire 24 to one side of the control motor. A wire 30 connects the other side of the switch arm to one side of the main line by conductor 31. The other side 32 of the main line connects with the other side of the motor.

A radiator or heater is conventionally represented at 40, its supply line at 41, and a valve 42, controlling heat supply. This valve may be of any preferred construction but in this instance includes a weighted ele-

In the usual systems in which the fan of a unit heater is controlled by a room thermostat, it happens that the fan is frequently operated when the radiators or heaters are cold. Inasmuch as these heaters are sometimes arranged adjacent the outer wall of a building and, inasmuch as conduits are often provided so that cold outside air may be delivered to the radiator, operation of the fan when the radiator is cold would result in a cold draft being forced into the building, or the fan would create a cold draft which is also undesirable. Moreover, in hot water systems, or in steam systems in which the drainage is imperfect, it may happen that if the fan starts at a time when there is no heat in a radiator, the water of condensation may be frozen which might result and sometimes does result in cracking of the radiator. Also under these conditions, when thawing takes place, a considerable amount of damage may be done by leaking water.

The main object of the invention is to provide means which will obtain and allow operation of the fan in response to a room thermostat, only when the radiator has reached a predetermined heating temperature. Another object is to provide in conjunction with the above mentioned means additional means for controlling the opening and closing, for example, of a radiator valve, according as the radiator or heating unit is not or is at the desired heating temperature. This feature may or may not, however, be incorporated with the fan-control device. The combination of the fan with the radiator will sometimes be hereinafter referred to as a "unit heater", and it will be understood that when this term is used, both elements are included.

Features of the invention include the general idea of controlling the fan of a unit heater in the manner set forth, as well as the details of construction, herein shown as one means for carrying out the invention.

ment 43 which when raised opens, and when lowered closes, the valve. A fan motor 50 is arranged adjacent the heater 40, and together these constitute the unit heater. A fan motor is connected at one side of the main line by conductor 51. A cam 60 as a switch controlling device, or as part of a switch, on shaft 5, is arranged to control a switch arm 61. One terminal of this switch arm is connected by conductor 62 with the other side of the fan motor 50. The switch operates against a contact 65 which is connected by a conductor 66 with the other side of the main line. It will be seen that when the switch arm 61 is disengaged from the contact 65, current to the fan motor will be interrupted.

Current to the coil 21 is controlled by two heat responsive devices operable to control circuits as the result of temperature fluctuations, respectively in the room, and at the heater or radiator. For convenience, the devices have been shown as having substantially the same construction, but it will be understood that any equivalent devices may be used. One of these devices is generally designated 70, and is arranged in the room. The other device is designated 71 and is arranged adjacent or mounted upon the radiator or heater, or inserted in the supply line where it may be directly affected by the source of heat. The element 70 may be a room thermostat, and element 71 may be pressure-operable either by water or steam or by temperature fluctuations, according to the character of heating systems to be regulated. The room thermostat, as a convenient form of heat responsive device, is provided with a heat responsive bimetallic element *r*, alternately engaging with contacts *b*—*w*. The heat responsive device 71 has also a bimetallic element *R* alternately engaging with contacts *B*—*W*. A transformer is indicated at 80 and is connected to the main line by conductors 81—82. Conductor 83 connects one terminal of the low voltage side of the transformer with one terminal of the coil 21. The other terminal of the relay coil is connected by conductor 84 with bimetallic element *r*, and wire 87 connects *r*, with the corresponding element *R* of the radiator device. The contacts *w* and *B* are connected by conductor 90.

Upon the shaft 5 are arranged switch controlling devices, as cams, respectively 91, 92, 93. Associated with and controlled by each cam is a switch, in this instance represented as comprising two members which the corresponding cam acts to electrically connect when in a certain position. The switch closing portions of the cams have certain fixed angular relations best shown in Figures 2, 3 and 4. It will be understood that when both elements of any switch are engaged by the projecting portions of a corresponding

cam the relay circuit is made or is conditioned to be made in response to temperature fluctuations at the room or radiator device. Switch arm 100 for cam 91 is connected by conductor 101 with a contact *w* of the room thermostat. Switch arm 102 for cam 92 is connected by conductor 104 with contact *W* of the radiator device. Switch arm 106 of cam 93 is connected by a conductor 107 with contact *b* of the room thermostat. The other switch arms numbered respectively 110, 111, 112 are each connected as at 114 to a common conductor 113 leading to the other terminal of the low voltage side of the transformer. An arm 120 is connected by a suitable element 121 with the valve controlling arm 43, so that the valve is opened or closed according to the degree of rotation of the shaft 5. The cam 10 has three depressions, 125, 126, 128 which define or form three corresponding shoulders. Between these depressions and shoulders, the periphery of the cam is concentric to the axis of rotation of the shaft 5. Because of the depressions, the arm 20 can drop and open, and interrupt main line supply to the control motor 1. Further, the armature can be held mechanically closed by the intermediately disposed concentric portions of the cam, and substantially at all positions intermediate the depressions. Thus the armature is mechanically held substantially immediately after a depression passes away from the projection 20^a of the armature 20.

It should be noted that in this instance, there are three positions for the switch control shaft; an "on" position in which the fan is running and the steam valve is open; an "off" position in which the fan is not running and the steam valve is closed; and an "intermediate" position in which the fan is not running and the steam valve is open.

The controlling shaft 5 is slowly rotated by the control motor 1, and the main switch controlling cam 10 is arranged and contoured so that the relay armature 20 will be allowed to drop out, in this instance, after each half revolution of the shaft and also at one intermediate position. The main switch, as the armature 20 of the relay, is mounted for control by the elements 10 and 21 and this armature may be closed by the energization of the coil 21. The energization of this coil is in turn controllable under certain conditions by one of the heat responsive devices; under certain conditions by the other heat responsive device; and under certain other conditions by either device. Energization of the magnet 21 always furnishes energy to control motor 1.

The wires 87 and 90 are in parallel with respect to the secondary or relay circuit which includes the coil 21. For this reason when the cam 91 is controlling, or in other words, when the system is in "on" position,

either heat responsive device can control the energization or de-energization of the coil 21.

Let it be assumed that the apparatus is in "off" position, see Figure 3, in which the steam valve is closed and the fan motor control switch 61 is open (fan not running). In this "off" position a circuit control for the room thermostat is conditioned by cam 93 and elements 106, 112, for energizing the coil 21 when the room thermostat calls for heat or cools sufficiently to make at $r-b$. Under these conditions, therefore, the motor is controllable only by the room device. When $r-b$ make, the motor starts. The circuit being as follows: one side of the transformer, conductor 113, arm 112, cam 93, arm 106, conductor 107, contact b , element r , conductor 84, coil 21, conductor 83 to the opposite side of the secondary of the transformer. The motor under these conditions will run to "intermediate" position and will stop at "intermediate" position if the radiator is not sufficiently warm to make contact at $R-W$. We want the device to remain at "intermediate" position because we do not want to run to "on" position and, therefore, start the fan operating, while the radiator is cold. We will assume that the radiator is cold and that contact is broken at $R-W$. Inasmuch as the valve is open, the radiator should now be receiving heat and eventually $R-W$ will make and the motor will again start. That this is evident, will be seen by tracing the circuit from one side of the secondary of the transformer through conductor 113, switch element 111, cam 92, switch element 102, conductor 104, contact W , element R , conductor 87 to element r , conductor 84, to coil 21 and from coil 21 by conductor 83 to the opposite side of the secondary of the transformer. The motor will now run to the "on" position and will remain there-at, with the valve open and the fan running until the room becomes too hot or the radiator becomes too cold. It will be noted that in the "intermediate" position, the motor is controllable only by the heater device. Let us suppose that when the device is in "on" position that the radiator is at the proper temperature and that R is either making at $R-W$ or is disposed somewhere between $B-W$, and let us suppose that the room thermostat is either making at $r-b$ or is somewhere between $b-w$. Suppose that the room is too hot and $r-w$ make. The motor will run to "off" position closing the valve and stopping the fan. Under these conditions the circuit will be made as follows: one side of the transformer by conductor 113, arm 110, cam 91, arm 100, conductor 101, contact $w-r$, conductor 84, coil 21, by conductor 83 to the opposite side of the transformer. Under these conditions, the room and radiator will cool and when

the room becomes cool enough circuit $r-b$ will make, the motor will start and will run to "intermediate" position to open the valve, here it will stay until the radiator warms sufficiently to cause $R-W$ to make. When $R-W$ thus make, the motor will run to "on" position to start the fan because the radiator is then sufficiently hot. The device will remain in "on" position until the room is too hot or the radiator cools sufficiently.

To recapitulate: if the cam 91 is controlling, ("on" position) and if under these conditions the room gets too warm, we want to close the steam valve. Therefore, when the room is too warm $r-w$ make, and the motor runs to "off" position to close the valve, and stop the fan.

On the other hand, if, when cam 91 is controlling, ("on" position), the radiator becomes too cold, $R-B$ will make contact, and the motor will run to "off" position and stop, leaving the valve closed, and fan not running. However, if when the "off" position is reached $r-b$ are making, the device will continue to run to the intermediate position, in which the valve is open. Here it will remain until the radiator has warmed sufficiently to cause $R-W$ to make at which time it will run to the "on" position.

Suppose that the apparatus is in "off" position with cam 93 controlling. Under these conditions, the only way that the motor may be caused to run is for the room thermostat to cool and make at $r-b$. This making will cause the motor to run to "intermediate" position and stop, if the radiator is cold, that is if contact at the radiator device is broken at $R-W$. If, however, the radiator is sufficiently warm (under which conditions $R-W$ will be making) the motor will continue to run to "on" position at which position it will stop, and in which position the valve will be open and the fan will be running.

It will thus be seen that the operation of the fan in response to the room thermostat can only take place when the radiator is above a predetermined temperature.

I claim as my invention:

1. A device of the class described comprising a heater, a valve for controlling heat supply thereto, a fan motor arranged to circulate air warmed by the heater, a circuit for the fan motor including a switch, a control motor and a shaft rotatable thereby, a circuit for the control motor including a switch and a coil for operating the switch, means associated with the switch and operable by the shaft for holding the same in closed positions, and for allowing the switch to open, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, each device having contacts engageable by a movable member, switches adapted to close circuits to said

coil for control through the contacts of said room and radiator device, switch controlling elements rotatable with the shaft, one for each last mentioned switch, and for said fan switch, said elements arranged to close the switches to allow energization of the coil respectively by either device, by the radiator device only, and by the room device only.

2. A device of the class described comprising a heater, a valve for controlling heat supply thereto, a fan motor arranged to circulate air warmed by the heater, a circuit for the fan motor including a switch, a control motor and a shaft rotatable thereby, a circuit for the control motor including a switch and a coil for operating the switch, means associated with the switch and operable by the shaft for holding the same alternately in open and closed positions, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, each device having two contacts alternately engageable by a movable member, switches adapted to close circuits to said coil for control through the contacts of said room and radiator device, switch controlling elements rotatable with the shaft, one for each last mentioned conditioning switch, and for said fan switch, said elements arranged to close the switches sequentially to permit coil energization respectively by either device, by the radiator device only, and by the room device only.

3. A device of the class described comprising a heater, a valve for controlling heat supply thereto, a fan motor having its fan arranged to circulate air warmed by the heater, a circuit for the fan motor including a switch, a control motor and a shaft rotatable thereby, a circuit for the control motor including a switch and a coil for operating the switch, means associated with the switch and operable by the shaft, for holding the same in closed positions, and for allowing the switch to open, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, each device having contacts engageable by a movable member, switches adapted to close circuits to said coil for control through the contacts of said room and radiator device, switch controlling elements rotatable with the shaft, one for each last mentioned switch, and for said fan switch, said elements arranged to close the switches to allow coil energization respectively, by either device, by the radiator device only, and by the room device only, the arrangement being such that the fan switch is only closed when the control can be had by either device.

4. A device of the class described comprising a heater, a valve for controlling heat supply thereto, a fan motor, having its fan arranged to circulate air warmed by the heater, a circuit for the fan motor including

a switch, a control motor and a shaft rotatable thereby, a circuit for the control motor including a switch and a coil for operating the switch, means associated with the switch and operable by the shaft to alternately mechanically hold and to allow automatic opening of the switch, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, electrical connections for obtaining control of the coil by the room and heater devices, including switches adapted to close circuits to the coil to condition the circuits for control through the room and radiator devices, switch controlling elements operable by the shaft one for each last mentioned switch, and for the fan switch, said elements having portions adapted to close the switches sequentially to allow energization of the coil, those portions of the motor switch control means which allow opening of the control motor switch being so arranged as to respectively positionally correspond to the closing portions of the last mentioned switch controlling elements.

5. A device of the class described comprising a radiator, a valve for controlling heat supply thereto, a fan motor having its fan arranged to disseminate air warmed by the radiator, a circuit for the fan motor including a switch, a control motor and shaft rotatable thereby, a circuit for the control motor including a switch and a coil for operating the switch, means engageable with the switch for alternately holding the same in closed position and for allowing automatic opening thereof, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the radiator, each device having two contacts alternately engageable by a movable member, switches adapted to close circuits to said coil through the contacts of said room and radiator devices, and switch controlling elements rotatable with the shaft, one for each last mentioned switch and one for said fan motor switch, and arranged to close the switches to allow energization of the coil respectively by either device, by the radiator device only and by the room device only, and connections between said shaft and said valve whereby when the coil is energizable by either device, the valve will be open, and whereby when the coil is energizable by only a certain one of the devices, the valve will be closed.

6. A device of the class described comprising a heater, a valve for controlling heat supply thereto, a fan motor having its fan arranged to circulate air warmed by the heater, a circuit for the fan motor including a switch, a control motor and a shaft rotatable thereby, a circuit for the control motor including a switch and a coil for operating the switch, means associated with the switch

and operable by the shaft to alternately hold, and allow opening of the switch, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, each device having contacts sequentially engageable by a movable member, electrical connections for obtaining control of the coil by the room and heater device including switches adapted to close circuits to the coil to condition the circuits for control through the contacts of the room and radiator devices, switch controlling elements operable by the shaft one for each last mentioned switch, and for the fan switch, said elements having portions adapted to close the switches sequentially to allow energization of the coil, those portions of the motor switch control means which allow opening of the control motor switch being so arranged as to respectively correspond to the closed portions of the last mentioned switch controlling elements.

7. A device of the class described comprising a heater, a fan motor and circuit and switch therefor, a control motor and circuit and switch therefor including a coil for operating the switch, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, electrical circuit connections between the room and radiator devices and the coil, switches interposed in the said circuit connections and adapted, when closed, to respectively allow energization of the coil by either device, or by one of the devices only, and switch control elements movable by the motor to open and close the switches in such manner that when the system is in condition for control by either of the devices the fan switch is closed and when positioned for control only by one of the devices, the fan switch is open.

8. A device of the class described comprising a heater, and valve for controlling heat supply thereto, a fan motor and circuit and switch therefor, a control motor and circuit and switch therefor including a coil for operating the switch, connections by which the valve can be opened and closed by the motor, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, electrical circuit connections between the room and radiator devices and the coil, switches interposed in the said circuit connections and adapted when closed to respectively allow energization of the coil by either device or by one of the devices only, and switch control elements movable by the motor to open and close the switches in such manner that when the system is in condition for control by either of the devices the fan switch is closed and the valve is open, when in condi-

tion for control only by the heater device the fan switch is open and the valve is open, and when in condition for control only by the room device the valve is closed and the fan switch is open.

9. A device of the class described comprising a heater and means for controlling heat supply thereto, a fan motor having its fan arranged to circulate air warmed by the heater, a circuit for the fan including a switch, a control motor and circuit therefor including a switch, a device responsive to fluctuations in room temperature, a device responsive to fluctuations in heat supply to the heater, electrical connections between the room and heater devices and control motor switch including circuit controlling elements, and, means operable by the motor to control said elements, fan switch and control motor switch, the arrangement being such that the control motor will be started respectively by either device, by the heater device only, and by the room device only.

10. A device of the class described comprising, a heater and means for controlling heat supply thereto, a fan motor having its fan arranged to circulate air warmed by the heater, a circuit for the fan including a switch, a control motor and circuit therefor including a switch, a device responsive to fluctuations in room temperature, a device responsive to fluctuations in heat supply to the heater, electrical connections between the room and heater devices and control motor switch including circuit controlling elements and, means operable by the motor to control said elements, fan switch, control motor switch, and heat controlling means, the arrangement being such that the control motor can be started respectively by either device, by the heater device only, and by the room device only, and the arrangement further being such that the motor may be stopped independently of these devices.

11. A device of the class described comprising a heater, a fan motor arranged to circulate air warmed by the heater, a circuit for the fan motor including a switch, a valve for controlling the heat supply to the heater, a control motor for controlling the fan motor and valve, a circuit for the control motor including a device responsive to changes of room temperature, a device responsive to fluctuation of heat supply to the heater, switches in control circuit to close circuit through room and heater devices, switch elements arranged to close switches to allow control of control motor circuit respectively by either of the devices.

In witness whereof, I have hereunto set my hand this 7th day of May, 1927.

HAROLD W. SWEATT.