

May 30, 1939.

W. J. KING

2,160,592

TEMPERATURE REGULATING SYSTEM

Filed Dec. 8, 1936

3 Sheets-Sheet 1

Fig. 1.

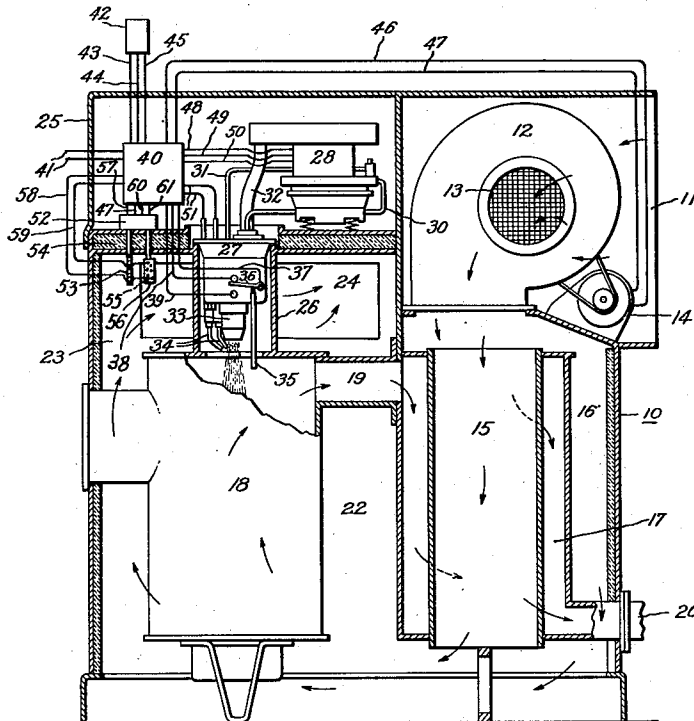
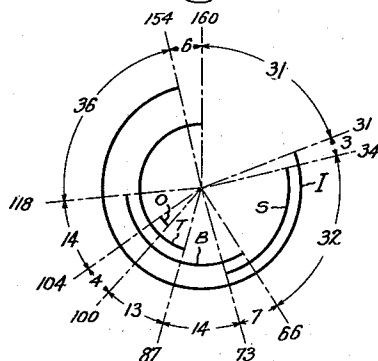


Fig. 6.



Inventor:
William J. King,
by *Harry E. Dunham*
His Attorney.

May 30, 1939.

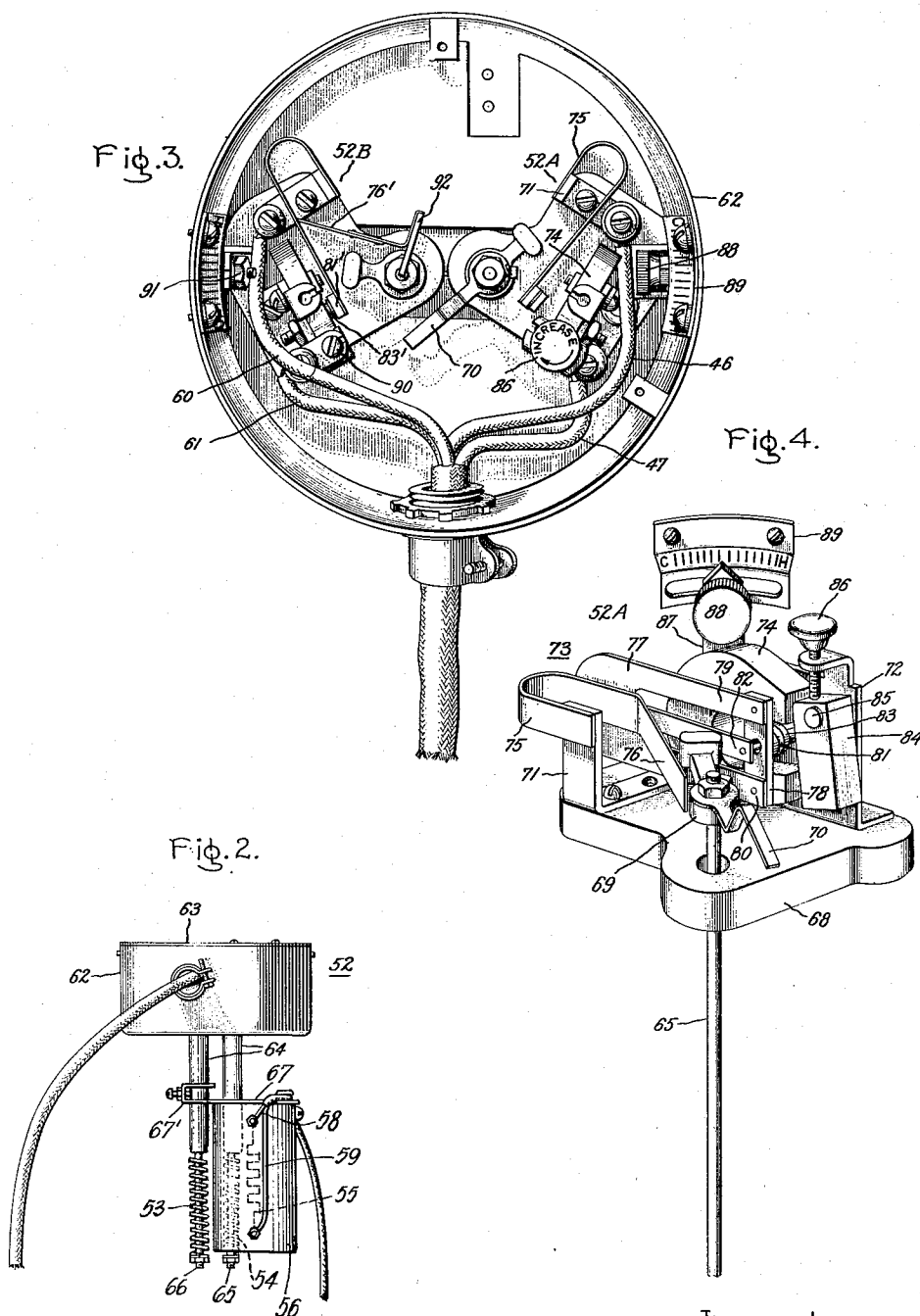
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3 Sheets-Sheet 2



Inventor:
William J. King,
by *Harry E. Dunham*
His Attorney.

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W. J. KING

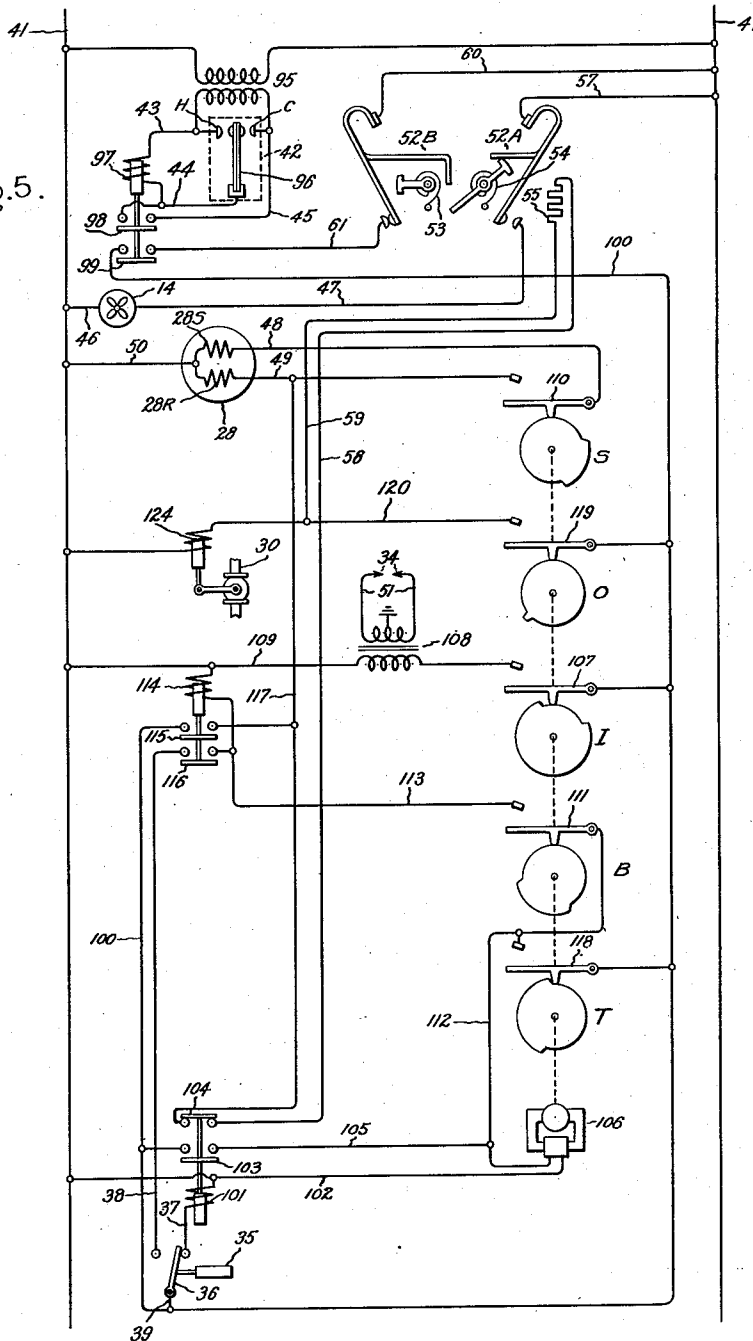
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Fig. 5.



Inventor:
William J. King
by *Harry E. Simham*
His Attorney.

UNITED STATES PATENT OFFICE

2,160,592

TEMPERATURE REGULATING SYSTEM

William J. King, East Orange, N. J., assignor to
General Electric Company, a corporation of
New York

Application December 8, 1936, Serial No. 114,802

5 Claims. (Cl. 236-11)

My invention relates to temperature regulating systems and particularly to systems utilizing forced circulation warm air furnaces.

In automatic direct fired warm air furnaces using forced air circulation it is desirable to control the blower or other air circulating means by means of a thermostatically operated switch responsive to the temperature of the air leaving the furnace so as to (1) prevent the simultaneous starting of the burner and blower and thereby prevent the delivery of cold air to the house; (2) prevent simultaneous stopping of the burner and blower and thereby utilize the heat stored in the furnace and prevent the overheating of the latter which would result from dissipation of the stored heat, and, (3) prevent the delivery of cold air to the house which would occur if the blower were allowed to run either continuously or too long after the burner is stopped.

The above mentioned thermostatic control is usually obtained by the use of a switch in the fan motor circuit operated in response to variations in the temperature of the air in the bonnet or plenum chamber, as it may be termed, of the furnace. Usually this switch is adjusted to start operation of the blower when the air temperature is between 120 and 150° F. and to terminate operation at a temperature of 90 to 110° F.

It would be very desirable to start the fan at a lower temperature of about 100° for two reasons; (1) warm air would be delivered to the house sooner after the thermostat calls for heat and less heat would be stored in the furnace before the thermostat began to respond in the other direction. This would reduce both the under- and overshooting of the house temperature; (2) it would reduce the tendency of adverse backdrafts or crossdrafts through the plenum chamber to retard the starting of the fan. In some instances natural drafts through the duct system will reverse the flow of air through the furnace or create cross drafts therethrough, cooling the fan switch thermostatic operating mechanism and making it difficult or impossible to heat it sufficiently to start the fan. In extreme cases this results in severe overheating and damage to other parts of the furnace.

On the other hand, it is ordinarily not practicable to start the fan at such low air temperatures for two other reasons: (1) As soon as the fan starts, the air temperature is reduced, due to the greater volume of flow, and may fall below the cut-out setting of the fan switch. This would cause the fan to stop and restart several times while the furnace is warming up. To avoid

this, the cut-in point must be set considerably higher than the cut-out point. (2) A wide differential between the two settings is also necessary to prevent frequent and prolonged re-cycling of the fan after the burner shuts down, due to the effect of stored heat in the furnace.

The latter effect is sometimes very disturbing to the home owner and increases the duty on the control as well as the load on the fan motor. When the furnace is very hot after a long run, the fan may re-cycle as many as thirty times at one minute intervals. Each time the fan starts, the fan switch helix is quickly cooled off by the blast of air through the furnace until it drops to the cut-out point. As soon as the circulation stops, the air rapidly heats up again and re-starts the fan. Obviously, the wider the differential between the cut-in and cut-out points the longer and fewer will be the fan cycles. But if the cut-out point is set too low the fan will blow cold air into the house, and if the cut-in point is set too high it may exceed the safe operating temperature at which the limit control switch is set to shut down the burner.

The best compromise that can be reached in these settings still leaves the fan switch sensitive to back drafts through the furnace, with an objectionable frequency of fan cycling after shutdown and poor temperature regulation due to the lag in response of the furnace to the thermostat.

It is the primary object of my invention to provide an improved control having a wide differential between the fan switch settings and in which the fan is started after the air has been warmed to a low but comfortable temperature.

A further object of my invention is to provide a control in which the effect of back drafts is minimized and the number and frequency of fan cycles is decreased. Briefly, the preferred embodiment of the invention consists in placing a heat resistant shield containing a small electric resistor heater around the helix of the conventional bimetallic member operating the fan switch. In the embodiment of the invention to be described hereinafter the resistor is connected in series with an electrical circuit through the solenoid of the oil valve but it may be connected in any manner so long as it is rendered effective during the firing period of the furnace. The shield, which is constructed with a closed upper portion, serves to protect the helix from back drafts and to retain the heat given off by the resistor so as to promote the heat transfer from the latter to the helix. The fan switch is set to operate at a wide differential but the heat from

the resistor serves to accelerate the closing of the fan switch after the burner is started and the removal of the heat upon termination of operation of the furnace permits the fan switch to open when the air temperature has fallen to the desired minimum. Thereafter the fan switch will not reclose, in response to the stored heat, until the air temperature has increased by the amount of the actual differential. The arrangement thus makes it possible to use a wide differential between the fan switch opening and closing settings and still have the fan start promptly as soon as the air is warmed to a comfortable temperature.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

Fig. 1 is a front elevation, partially in section, of a direct fired warm air heating unit; Fig. 2 is a side elevation of a fan switch and limit control embodying the shielded heater of my invention; Fig. 3 is a top view of the fan switch and limit control of Fig. 2 with the upper cover removed; Fig. 4 is a perspective view of part of the fan switch with the casing removed; Fig. 5 is a wiring diagram of a control embodying the invention, and, Fig. 6 is an operating sequence diagram for the cam contacts illustrated in Fig. 5.

Referring to Fig. 1, reference numeral 10 illustrates a temperature changing means such as a direct fired warm air furnace of any well-known construction. It is provided with an air inlet 11 through which a suitable heating medium, such as air, is admitted either from the space being conditioned or from outdoors, or in part from each. Within the inlet is positioned a blower 12 provided with inlets 13 (only one of which is shown) and suitably driven by a fan motor 14. The air is directed downwardly from the discharge of the blower to a secondary heat exchanger consisting of concentric air-passages 15 and 16 and an intermediate flue passage 17. The latter is connected near its upper end to a combustion chamber 18 through a connecting tube 19 and near its lower end to a chimney or the like, through an outlet 20. After the air passes through the secondary heat exchanger it is deflected by the bottom of the furnace and directed upwardly around the combustion chamber through a passageway 22 surrounding the combustion chamber and then to a plenum chamber 23 from which it is supplied to the space being conditioned through a pair of warm air outlets 24 (only one of which is shown).

Above the plenum chamber is provided a compartment 25 for the various controls and operative parts of the furnace. The compartment is connected to the combustion chamber by a downwardly extending cylindrical portion 26 suspending a burner head 27 of the type illustrated in Letters Patent No. 2,048,495 Eaton and Lum, granted July 21, 1936 and assigned to the assignee of the present application.

The burner head is supplied with fuel and air by a motor-compressor 28 resiliently mounted within the compartment, the fuel being supplied to the burner head through conduit 30, the atomizing air through conduit 31 and secondary combustion air through conduit 32. The resulting combustible mixture is directed downwardly into the combustion chamber by a nozzle 33 and ignited by ignition electrodes 34 extending into the path of flow of the mixture. The burner head

also comprises a suitable flame detector comprising a thermal responsive element 35 extending into the combustion chamber and a switch arm 36 actuable thereby, upon occurrence of combustion, from engagement with a contact connected to a conductor 37 into engagement with a contact connected to a conductor 38, the switch arm itself being connected to a conductor 39. These conductors lead to a master control 40 disclosed in detail in Patent No. 2,134,550 of Oct. 25, 1938 to John Eaton assigned to the assignee of the present application, supplied with electrical energy from any suitable source of supply indicated by conductors 41.

The operation of the furnace is controlled in response to requirements of the space being heated by a thermal responsive means 42 positioned within that space and connected by conductors 43, 44 and 45 to the control means. The blower motor 14 is connected to the master control by conductors 46 and 47. The motor-compressor 28 is connected to the master control by conductors 48, 49 and 50 and the ignition electrodes 34 are connected to the master control through conductors 51.

The novel limit and fan switch control mechanism of the present invention is diagrammatically illustrated by reference numeral 52. It consists of a pair of downwardly extending thermal responsive actuating elements 53 and 54 adapted to actuate the hereinafter to be described fan and limit switch, respectively. The fan switch actuating element 53 and the local heating means such as resistor 55 associated therewith are substantially surrounded by the shielding member 56 of my invention, illustrated in greater detail in Fig. 2. The fan switch is connected to the master control by conductors 47 and 57, the resistor by conductors 58 and 59, and the limit switch by conductors 60 and 61.

Referring now to Figs. 2, 3 and 4, there is illustrated a fan switch and double excess temperature limit control of the type disclosed and claimed in Patent No. 2,136,235 of Nov. 8, 1938 to Harry R. Crago assigned to the assignee of the present application. As illustrated in Fig. 2, the mechanism consists of a cup-shaped casing 62 provided with a suitable cover 63 and a pair of downwardly extending tubular members 64, each securely fastened to the casing 62. The helical bimetallic actuating elements 53 and 54 are each fastened at their upper ends to the tubular members 64 and at their lower ends by brackets and nuts to upwardly extending shafts 65 and 66, respectively, rotatably journaled in the casing. The shield 56 surrounding the lower extremity of one of the tubular members 64 and the bimetallic actuating element 54 is constructed in the form of a tube and is made of suitable fibrous heat-resistant material such that it will not deteriorate when subject to the temperature of the air passing thereby. It is provided with a cover 67 to which the tubular member is suitably attached and is held in place by a clamping means 67' consisting of an extended portion of the cover member 67 formed in the form of a reverse loop. The cover is also provided with an opening through which the bimetallic element and the tubular portion 64 protrude. Within the shielded portion is the temperature changing means, the previously described resistor 55 connected to the master control by conductors 58 and 59 and adapted to be energized whenever the furnace is placed in operation, as will be described in greater detail later.

In Fig. 3 is illustrated the manner of mounting the fan switch 52A and limit switch 52B within the casing 62 according to which each of the bimetallic actuating elements is adapted to operate the switch mechanism associated therewith and by means of which the fan switch is also adapted to open the limit switch in case the latter is not opened for any reason whatever upon occurrence of excessive temperature. The two switch mechanisms are identical in construction except for minor differences to be pointed out hereinafter and the means by which the double action by the fan switch actuating element is obtained.

In Fig. 4 is illustrated in perspective the assembly of the fan switch mechanism and it will be noted that it comprises the rotatably mounted shaft 65 adapted to be rotated with respect to an insulating base 68, that is also rotatably mounted within the casing 62 for a purpose to be hereinafter described. Fixedly mounted on shaft 65 is an operating arm of insulating material 69 for actuating the fan switch 52A. Also mounted on the shaft is a second operating arm 70 extending diametrically opposite to the arm 69 and adapted to extend into the plane of movement of a portion of switch mechanism 52B as will be pointed out more fully hereinafter. The insulating base 68 mounts a pair of brackets 71 and 72, the former carrying a contact mechanism 73 and the latter a permanent magnet 74. The contact mechanism 73 consists of a resilient spring metal portion 75 bent into U-shape and mounted at one end on bracket 71. The other end is provided with a projection 76 extending angularly therefrom. Attached to the U-shaped member is a resilient contact and armature carrying member 77 carrying a perforated armature 78 on a pair of fingers 79 and 80 and a contact 81 on a central finger 82 and extending through the perforation on the armature. It will be observed that the operating arm 69 actuated by the shaft 65 is adapted to fit in between the angularly extending portion 76 and finger 82 whereby the contact mechanism may be actuated in response to temperature variations. The movable contact 81 is cooperatively associated with a stationary contact 83 and the temperature differential necessary to open and close the contacts is adjustable by means of a shunting magnetic member 84 pivotally mounted at 85 on the bracket 72. The amount of flux shunted through the magnetic member 84 may be varied by means of the thumbscrew 86. Also fixedly mounted on the insulating base portion 68 is an upstanding arm 87 carrying a thumbscrew 88. The arm 87 is in cooperative relation with a scale carrying portion 89 securely fastened to the casing 62. By loosening the thumbscrew 88 the entire base 68 may be rotated in one direction or another thereby to adjust the temperature at which the contact mechanism is actuated by operating arm 69 upon rotation of shaft 65.

The construction of the limit control 52 is identical with the construction just described, with the exception of the fact that it is mounted for operation at a fixed temperature and at a fixed temperature differential. This arrangement is obtained by substituting for the thumbscrew 86 a screw 90 and for the thumbscrew 88 a nut 91. The angularly extending portion 76' of the limit switch 52B is also provided with a T-shaped extension 92 which is adapted to be engaged by operating arm 70 upon a predetermined movement of the fan switch actuating element. As

will be explained more fully hereinafter, the contacts are adapted to be operated in the following manner: Upon a predetermined rise in temperature within the plenum chamber the fan switch contacts 81 and 83 are brought into engagement. After the temperature rises to a certain maximum value that is excessively high then the limit control 52 is actuated to open contacts 81' and 83'. In case of failure of the actuating elements of the latter then, upon a further rise in temperature, the operating arm 70 engages the T-shaped projection 92 to thereby open the limit control.

The operation of the control system embodying the shielded heater of my invention will be clearer after a description of the operation of the control illustrated in Figs. 5 and 6. In describing the operation of the system in connection with the last two mentioned figures like parts will be given the reference numerals used in their description in Figs. 1 to 4, inclusive. Electrical energy is supplied to the control through a pair of supply conductors 41 and to the room thermostat 42 through the primary winding of a transformer 95. The room thermostat comprises a thermal responsive bimetallic element 96, a cold contact C and a hot contact H. The hot contact is connected by conductor 43 to one terminal of a relay winding 97, the thermal responsive element 96 is connected by conductor 44 to the other terminal of the winding and the cold contact by conductor 45 to a switch 98 controlling a holding circuit for the relay 97 that is closed whenever the relay is energized. The relay 97 also controls a second switch 99 closing a circuit from supply conductor 41 through conductor 60, the limit switch 52 normally in its closed position, and conductor 61 to a branch supply conductor 100. Thus, whenever the room thermostat engages its cold contact a circuit is closed through conductors 43 and 44 to energize the relay 97 and the relay thereupon effects operation of switches 98 and 99, the former closing a holding circuit for relay 97 through conductor 45 and the latter connecting the branch supply conductor 100 to the source of supply. When the temperature within the space is above a predetermined maximum value the room thermostat engages its hot contact thereby short circuiting the relay and effecting opening of the switches mentioned.

Whenever the room thermostat calls for heat and effects energization of relay 97 in the manner described the branch supply conductor 100 is energized. With the flame detector 35 maintaining switch arm 36 in the start position, i. e., closing a circuit across conductors 37 and 38, the connection of conductor 100 to conductor 39 results immediately in the energization of relay 101 through conductor 102. The relay effects closure of the normally open switch 103 and opening of the normally closed switch 104. Closure of switch 103 results in the closure of a circuit across conductor 100 and conductor 105 leading to a timing mechanism such as a small self-starting synchronous motor 106 driving a series of cams T, B, I, O and S. The cam T controls a circuit to the motor 106, the cam B controls a circuit to a relay controlling the energization of the motor-compressor 28, the cam I controls a circuit to the ignition transformer of the system, the cam O controls a circuit to an oil valve operating solenoid and the cam S controls a circuit conditioning the motor compressor 28 for starting.

Upon energization the cam motor 106 starts rotation of the cams and thirty-one seconds after initiation of rotation (see Fig. 6) the cam I operates its follower arm 107 to close a circuit to the primary winding of an ignition transformer 108 extending from conductor 100, cam follower arm 107, the primary of transformer 108 and conductor 109 to the supply conductor 41. A voltage is induced in the secondary winding of the transformer and sparking is effected across electrodes 34 connected to the secondary winding through conductors 51. Three seconds thereafter (thirty-four seconds after starting) cam S actuates its follower arm 110 upwardly to connect the starting and running windings 28S and 28R in parallel through conductors 48 and 49, thereby conditioning the motor 28 for starting in a manner to be described hereinafter. Thirty-two seconds thereafter (sixty-six seconds after the start) cam B actuates its follower arm 111 to close a circuit across conductors 112 and 113, the former connected to conductor 105 and the latter to a relay 114 connected at its other terminal to conductor 109. This energizes the relay 114 through the circuit just described because of the fact that conductor 105 is connected by switch 103 to the branch supply conductor 100 and conductor 109 is connected directly to the supply conductor 41. Relay 114 effects closure of switches 115 and 116 associated therewith. The former closes a circuit across conductors 100 and 117, the latter being in turn connected to conductor 49 leading to the winding of the motor 28 and to one of the contacts of the normally closed switch 104. The result of the closure of switch 115 is the starting of the motor 28 which is energized through a circuit including conductors 100, switch 115 in its closed position, conductors 117, 48 and 49 in parallel, the starting and running windings of the motor and conductor 50.

After a lapse of seven seconds (seventy-three seconds after starting) the cam S effects opening of its associated contacts and thereby disconnects winding 28S so that the motor 28 is now energized solely through its running winding. Fourteen seconds later (eighty-seven seconds after starting) the cam T effects closure of a circuit through its cam follower arm 118, thereby closing an independent energizing circuit for the motor 106 extending from conductor 100 through the cam follower arm 118 and conductor 112 to the motor and thence through conductor 102 back to one of the supply conductors 41. The motor is now energized and will complete a full revolution of the cam shaft irrespective of whether or not the initial energizing circuit through the flame detector 35 is open. Thirteen seconds after this operation (one hundred seconds after starting) cam O actuates its cam follower arm 119 to energize the oil valve operating solenoid 124 through conductor 120. The resistor 55 will not be energized at this time because its circuit is broken at switch 104.

The oil valve operating solenoid 124 will remain energized by cam O for a period of four seconds. If proper combustion takes place within this time the flame detector is moved off of its "start" position, disconnecting conductors 37 and 39 and deenergizing relay 101. The deenergization of relay 101 establishes a holding circuit for the valve operating solenoid through conductors 117, switch 104 now in its closed position, conductor 58, resistor 55, conductors 59 and 120. The resistor 55 is thus energized and

it performs the dual function of acting as a holding resistor in the oil valve solenoid circuit and as a heater for the fan switch thermal responsive actuating means.

Fourteen seconds after the last described operation cam B opens its contacts. Normally, if combustion is sustained within this time the flame detector will have moved to its "run" position, connecting conductors 38 and 39 and establishing a holding circuit for relay 114 through the previously closed switch 116. The opening of the B cam contacts therefore has no effect upon the energization of relay 114 because that relay will remain energized through the holding circuit just described. Thirty-six seconds after this operation the cam I will deenergize the ignition transformer 108 and six seconds thereafter the cam T will deenergize the running circuit for the telechron motor and the cam shaft will remain in its original starting position ready for the next starting cycle.

While the control of the starting of the burner unit is not part of the present invention except insofar as it is coordinated with the control of the blower motor (it forming the basis of Patent No. 2,085,577 of June 29, 1937 to John Eaton assigned to the assignee of the present application) it will be obvious that the control will limit the opening of the oil valve to a period of four seconds unless combustion has taken place in the combustion chamber because of the fact that in order for the oil valve operating solenoid to remain energized the flame detector must move off its "start" position to establish the holding circuit through switch 104 before the O cam contact opens. Likewise, if flame occurs prior to the closing of the T cam contact, because of the oil leakage or the like, the cam shaft and the motor compressor will be stopped because of the fact that relays 101 and 114 will be deenergized.

Upon the initiation of combustion the fan switch actuating thermal responsive means will be heated jointly by the heat generated by the furnace and the heat given off by the resistor. Upon its attaining a predetermined temperature it will close a circuit across conductors 47 and 57 to energize the fan motor 14 and circulate the heated air to the space being conditioned. When the space reaches the desired temperature the room thermostat short circuits relay 97 to open switch 99 and thereby terminate operation of the furnace and deenergize resistor 55. The fan, however, will continue to run until a predetermined low temperature is reached.

In order to explain more fully the advantages of the control described, operating temperatures for the thermal actuating mechanisms will be assumed. It will be assumed that the fan switch will be closed at 150° F. and opened at 90° F. thus giving a differential of operation of 60°. It will be further assumed that the limit switch will open at 165° and that the fan switch thermal responsive actuating mechanism will open the latter at 212° F. If it is desirable to start the fan in operation when the temperature of the air within the plenum chamber has reached a value of approximately 90°, then the heating element 55 is designed with a capacity such that the thermal actuating element 54 is raised to a temperature of 150° by the combined action of the heating element 64 and the action of the furnace when the air temperature has been raised to 90°. Therefore, when the air temperature does rise to this value the fan switch will

be actuated to its closed position and immediately start operation of the fan.

Usually the initiation of operation of the fan results in the movement of a considerably greater volume of air and results in a decrease in temperature of the air passing through the plenum chamber until the furnace has been heated sufficiently. Even though the air temperature does decrease to a considerable extent below 90° the fan will not stop because of the fact that the resistance heater 55 creates a false ambient about the thermostat and maintains its temperature well within the range in which it will remain closed.

After the requirements of the space being conditioned have been fulfilled, the room thermostat deenergizes its associated control relay to open switch 99 and thereby terminate operation of the furnace and at the same time deenergize the resistor 55. Thereafter, with the fan operating, the temperature of the air will decrease substantially rapidly, but at the same time the resistor being deenergized the wide differential in operation of the fan switch is effective in preventing objectionable recycling of the fan.

In actual use it has been found that this arrangement greatly improves the performance of the furnace as regards the effects of back-draft, the number and frequency of fan cycles, and enables the house temperature to be maintained within considerably closer limits.

The shield acts to concentrate the heat generated by the resistor near the thermal responsive element and also prevents the objectionable back and cross drafts from effectively reaching the element.

The amount of heat given off by the resistor may be varied to suit different installations. In some cases it may be desirable to design it so that in case the air circulation, due to reverse drafts, would otherwise keep the temperature adjacent the thermal element below its operating temperature, then the heat generated by the resistor is sufficient to actuate the fan switch in a length of time such as twenty minutes. In other cases it may be designed to supplement the effect of the furnace and not be sufficient to actuate the switch of itself. The former design has the advantage that if the supposed conditions do exist the fan will be started to prevent excessive temperatures within the furnace.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a heat medium circulating system, the combination including means operable for heating the medium, thermostatic means for starting and stopping operation of said heating means in accordance with predetermined temperature conditions, means for circulating the medium, means including a thermal responsive element jointly responsive to the temperature of said medium and the temperature of said heating means and having normal upper and lower temperature limits for respectively starting and stopping operation of said circulating means, an electric heater adjacent said thermal responsive element and connected to be energized under the control of said thermostatic means for lowering both said temperature limits only during operation of said medium heating means, and means including a heat regulating shield adjacent said electric heater and said thermal responsive means for modifying the relative effects of the temperature of said medium, the temperature of said heating means, and the temperature of said elec-

tric heater on said thermal responsive element upon the starting and stopping of operation of said heating means.

2. In combination, a warm air furnace having separately operable heating means and air circulating means, control means for said air circulating means having a thermal responsive element mounted in the furnace to be jointly responsive to the temperature of the air heated therein and the temperature of the furnace and having normal upper and lower temperature limits for respectively starting and stopping operation of said air circulating means, an electric heater mounted adjacent said thermal responsive element and connected to be energized only upon operation of the furnace heating means for lowering both said temperature limits only during operation of the furnace heating means, and means including a heat conserving shield partially surrounding both said heater and said thermal responsive element for determining the relative effect of the temperature of the air, the temperature of the furnace and the temperature of said heater on said element upon the starting and stopping of operation of said furnace heating means.

3. In a heat transfer medium circulating system, the combination including means for varying the temperature of the medium, means for starting and stopping operation thereof, separate means for circulating the medium, means including a thermal responsive element responsive jointly to the temperature of the medium and the temperature of said temperature varying means for controlling operation of said circulating means, and means including a local temperature varying means rendered effective upon operation of said medium temperature varying means and localized near said thermal responsive element for accelerating the response of said element to start operation of said circulating means and retarding the response of said element to stop operation of said circulating means upon the starting of operation of said medium temperature varying means and for accelerating the response of said element to control operation of said circulating means and retarding the response of said element to start operation of said circulating means upon the stopping of operation of said medium temperature varying means.

4. In a heated medium circulating system, the combination including means for heating the medium, thermostatic means controlling operation thereof, separate means for circulating the medium, means including a thermal responsive element jointly responsive to the temperature of the medium and the temperature of said heating means for controlling operation of said circulating means both during and after operation of said heating means, local heating means for said thermal responsive element having a heat conserving member, and means for simultaneously starting and stopping operation of said medium heating means and said local heating means for accelerating the response of said element to start operation of said circulating means and retarding the response of said element to stop operation of said circulating means upon the operation of said heating means and for accelerating the response of said element to stop operation of said circulating means and retarding the response of said element to start operation of said circulating means upon the stopping of operation of said heating means.

5. In combination a warm air furnace having separately operable heating means and air circulating means, thermostatic means for starting and stopping operation of said heating means, means including a thermal responsive element jointly responsive to the temperature of the furnace and the temperature of the air heated therein for starting and stopping operation of said air circulating means during and after operation of said heating means, an electric heater mounted adjacent said thermal responsive element and connected to be energized upon operation of said heating means and provided with a heat conserving shield partially surrounding both said heater and said thermal responsive element for accelerating response of said element to start operation of said circulating means and retarding the response of said element to stop operation of said circulating means upon the starting of operation of said heating means and for accelerating the response of said element to stop operation of said circulating means and retarding the response of said element to start operation of said circulating means upon the stopping of operation of said heating means.

WILLIAM J. KING.