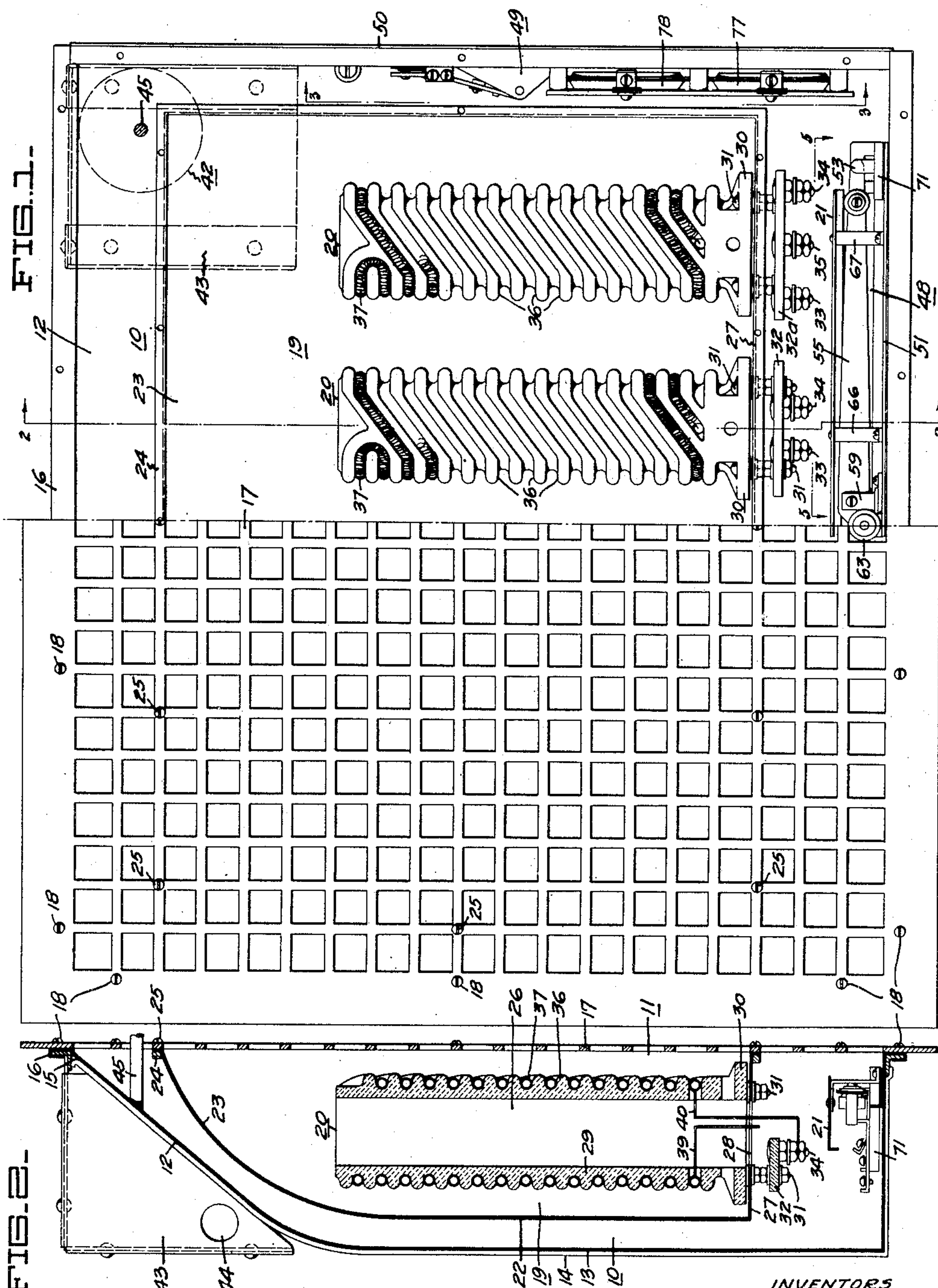
March 5, 1929. A. J. KERCHER ET AL 1,704,479

ELECTRIC AIR HEATER

Filed Oct. 3, 1925 4 Sheets-Sheet 1



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ELECTRIC AIR HEATER

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FIG. 3.

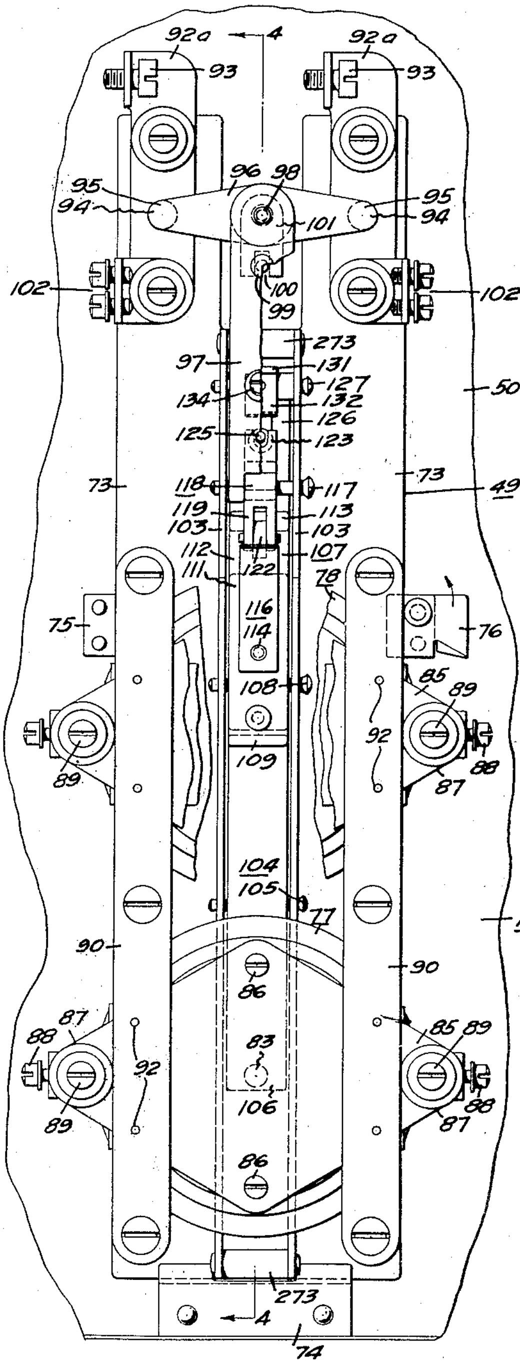
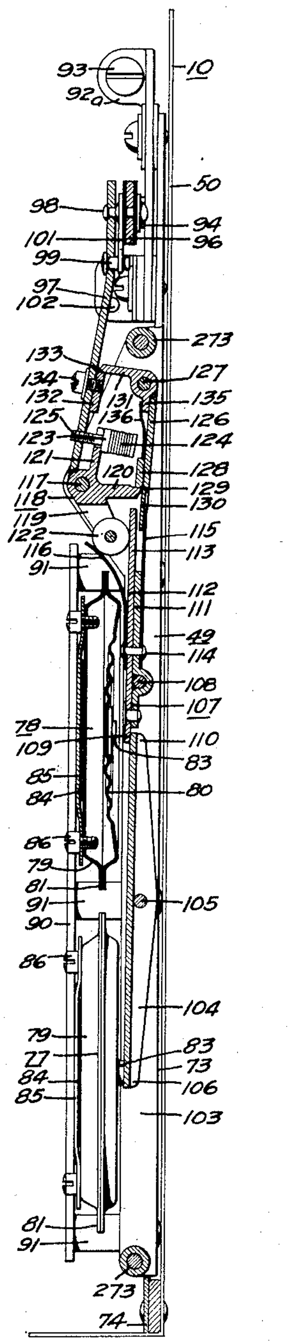


FIG. 4.



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ELECTRIC AIR HEATER

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FIG. 5.

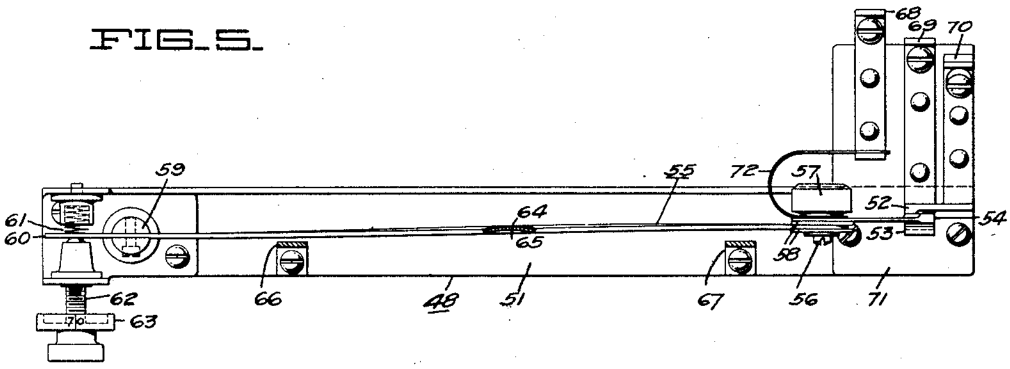
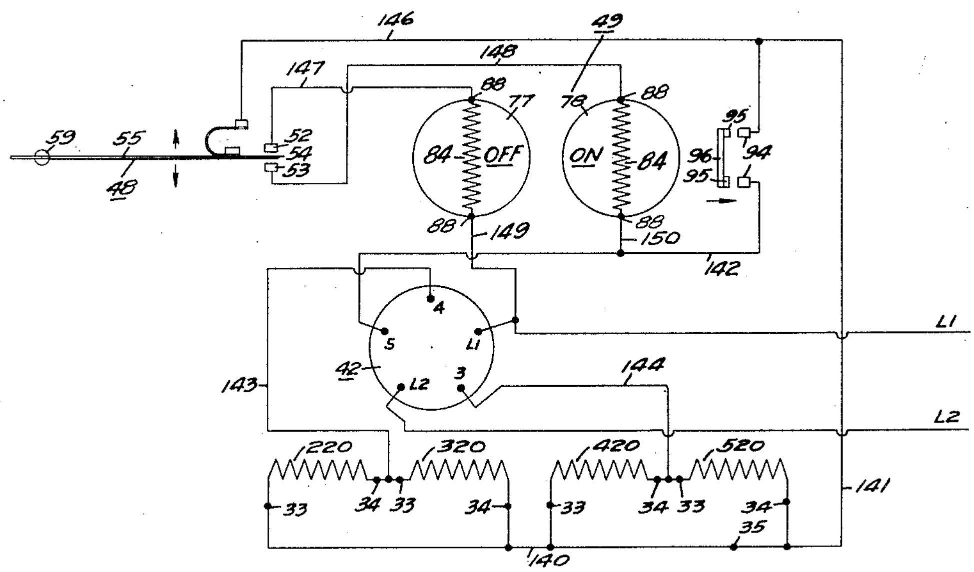


FIG. 6.



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ELECTRIC AIR HEATER

Filed Oct. 3, 1925 4 Sheets-Sheet 4

FIG_7_

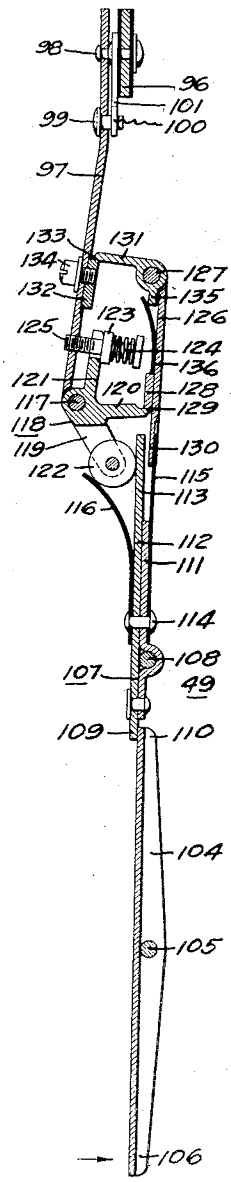


FIG_8_

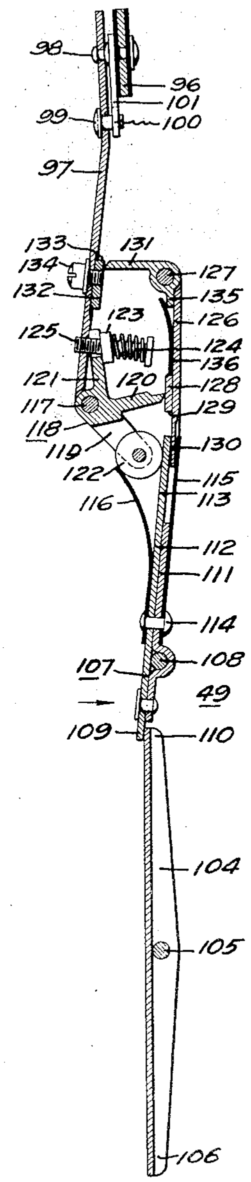
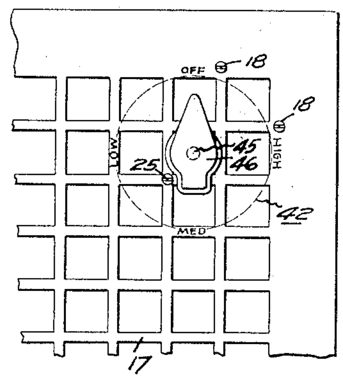


FIG_9_



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Patented Mar. 5, 1929. 1,704,479

UNITED STATES PATENT OFFICE.

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ELECTRIC AIR HEATER.

Application filed October 3, 1925. Serial No. 60,174.

This invention relates to electric heaters designed to heat the space in a room or a building, especially by the aid of convection air currents, which pass over elements serving to impart heat to the stream of air. One such heater for example is described and claimed in the patent of W. W. Hicks, No. 1,518,067, issued Dec. 2, 1924.

It has been customary, with room heaters, to arrange a thermostat somewhere in the space to be heated, for controlling the heaters. In this way, the variations in room temperature could be kept within narrow limits. However, such a system was difficult to install in a room, for conductors must be led through the walls, between the thermostat and the heaters. There is some danger that the electrician who installs the device and who is not usually very familiar with its construction may make improper connections. Furthermore, the cost of such an installation is relatively high.

It is an object of our invention to make it possible to provide a temperature controlled system that is easy to install; in fact with our invention the heater installation is so far simplified that the installing electrician need connect only a pair of conductors between the heaters and the source of supply.

It is a further object of our invention to provide an electric heater of the convection type in which a thermostat is subjected to the temperature of the incoming air. In this connection our invention is applicable to both the wall and portable type of heaters.

The above advantageous results have been facilitated by utilizing a convection heater of a type shown in the Hicks patent referred to above. In such heaters air from the room is taken in at one opening and is caused to traverse one or more passageways where heat is imparted to it. By placing a thermostat or temperature responsive device in position to be influenced by this incoming air, it is in effect subjected to the temperature of the room. Such an arrangement is not only compact but the installation is simplified as the thermostat and its accessories can be built into the heater at the factory, and the installing electrician need not concern himself with the temperature control circuit.

It is a further object of our invention to provide a manual controlling switch for a wall type room heater arranged in such a manner that the switch can be placed in the same recess as the heater without danger of the switch becoming overheated.

Further objects of the invention will appear from the following description in which we have set forth the preferred embodiment of our invention.

Referring to the drawings:

Figure 1 is a front view of the device with a portion of the guard removed.

Fig. 2 is a transverse sectional view along the line 2—2 of Fig. 1.

Fig. 3 is a plan view of the automatic controlling switch taken along the line 3—3 of Fig. 1.

Fig. 4 is a sectional view taken along line 4—4 of Fig. 3.

Fig. 5 is a plan view of the thermal control for the automatic controlling switch taken along the line 5—5 of Fig. 1.

Fig. 6 is a circuit diagram showing the connections between the various elements and the current supplying lines.

Figs. 7 and 8 are sectional views showing the operation of the automatic controlling switch, Fig. 7 showing the switch in its "on" position, and Fig. 8 showing the switch in its "off" position.

Fig. 9 is a fragmentary detail showing the arrangement of the manually controlled switch.

Referring to Figs. 1 and 2 of the drawings, in the particular form of air heater disclosed there is provided a housing 10 which is provided with an open front side 11 and a back wall 13. The top wall 12 is preferably inclined with respect to the back wall 13. This housing is constructed of sheet metal or other suitable material and is covered with a layer of asbestos 14 or other heat insulating material. The front edge of this housing is preferably bordered by a frame of angle iron 15 which is suitably connected to the sheet metal as by means of overlapping portions 16. The open front of the housing 10 is covered by a foraminous guard or grill 17 which is detachably secured to the angle iron 15 by any suitable means such as screws 18.

Arranged within the housing 10 and spaced from the inner walls of the same is a shell 19 within which are positioned the heating elements 20. This shell 19 also is provided with an open front lying in a plane contiguous to the plane of the open front of the housing 10. It also includes generally a shield wall 22 which shields the back wall 13 from the heat of the resistance or heating elements 20, and a top wall 23 which is preferably curved to correspond generally to the inclined top wall 12 of the housing 10. The front edge of the shell is provided with a reinforcing strip 24 which is secured to the foraminous guard by means of screws 25. Thus it is seen that the shell 19 is entirely supported by the guard or grill 17 and is spaced from the inner walls of the housing 10 to allow free passage of air around the shell.

The resistance elements 20 are preferably tubular in shape and are each provided with a central flue 26. The bottom wall 27 of the shell 19 is provided with a plurality of apertures 28 which register with the flues 26 to allow free passage of air up through these flues. Thus the air entering the lower part of the heater may circulate in two different paths, one between the shell 19 and the housing 10 and the other up through the flues 26 of the heating elements. At the upper part of the heater the heated air passes out through the foraminous guard. The air which circulates between the shell 19 and the housing 10 serves to keep the housing cool and thus minimize fire hazard.

The resistance elements 20 preferably each comprise a hollow tubular support 29 of suitable refractory material which is provided with a base flange 30 for securement to the bottom 27 of the shell 19. Bolts 31 extend through the flange 30 and the bottom wall 27 to securely clamp the support 29 to the shell. Two of the bolts 31 are extended to receive an insulating strip 32 upon which are disposed the binding posts 33 and 34. The strip 32^a which is provided for the heating element which is located at the right hand end of the shell 19 is made relatively longer than the strips 32 and is provided with a third binding post 35 for a purpose later to be described. The outer periphery of the support 29 is provided with double grooves 36 within which are disposed the doubled coiled resistance wires 37. This doubled resistance coil 37 is wound about the support 29 and has its free terminals 39 and 40 terminating at the bottom of the support and connected to the binding posts 33 and 34.

It has been found preferable to construct the grooves 36 in the peculiar form illustrated. That is, these grooves are disposed parallel to a plane substantially normal to the axis of the support 29 for the major portion of the periphery of the same. However, these grooves are joined together along the minor portion of the periphery by inclined grooves. Each inclined groove connects together one annular groove with a second succeeding groove. A support having grooves of this type possesses greater strength and may be more readily manufactured than one having helical grooves.

For manually controlling the current supplied to the heating elements there is provided a manually controlled switch which may be manipulated from a point in front of the heater. This switch is shown diagrammatically on Fig. 6 at 42 and preferably comprises a switch inclosing box 43 which is secured to the housing 10 adjacent the top wall 12 of the housing. The shape of the box 43 is preferably triangular so that when superposed upon the housing 10 upon the inclined wall 12 it completes the general rectangular contour of the housing. Apertures 44 provide for the passing of conductors to the switch 42. Extending from the switch box 43 is a control rod 45 which extends outwardly through the foraminous guard 17. The outer end of this rod carries a knob 46 by means of which the control rod and thus the switch 42 may be manually manipulated. The front of the guard 17 is suitably marked to indicate the different operating positions of the control knob 46. Thus, as shown in Fig. 9, the knob 46 has four different positions which are marked "Off", "High", "Medium", and "Low."

.We provide a temperature control for the heater that is formed in the heater itself, whereby upon installation it is merely necessary to connect a pair of wires to the heater without special treatment or difficulty with the thermostat. The arrangement is nevertheless such that the room temperature determines the operative conditions of the heater. This is accomplished by providing a thermal responsive control device which is positioned within the housing in such a manner as to be in the path of the air which is circulating into the heater. This thermal responsive device controls an electrically responsive mechanism which actuates a switch to either disconnect the current or to connect the current supplied to the heating elements. The thermal responsive device is designated generally at 48 and is positioned preferably at the bottom of the housing 10 behind the guard 17. In this position the thermal responsive device is in the path of the air which normally circulates below the shell 19 and up between the shield wall 22 and the back wall 13. Therefore, the thermal responsive device will be operated substantially in accordance with the temperature of the air in the room being heated. The electrically responsive mechanism 49 for operating the control switch is preferably located along the side wall 50 of the housing 10 between the side of the shell 19 and the housing.

The thermal responsive device may be of any desired character that is sufficiently rapid in responding to temperature changes. In this instance the thermostat is shown separately in Fig. 5 and comprises a base plate 51 upon which are mounted two spaced contacts 52 and 53 between which is positioned the movable contact 54. The movable contact 54 is suitably secured to a flexible arm 55 which is adapted to flex with a change in temperature. A bolt 56 extends through both the movable contacts 54 and the trip or the arm 55 and is provided with a nut 57 for securely clamping together these two members. Insulating discs 58 may be further provided to insulate the contact 54 from the arm 55. The arm 55 is secured adjacent its one end to the trunnion 59 which trunnion is pivotally connected to the base plate 51. The terminal 60 of the arm 55 is disposed between one end of a compression spring 61 and an opposed adjusting screw 62. By adjusting the screw 62 the position of the arm 55 and therefore of the movable contact with respect to the stationary contacts 52 and 53, may be adjusted. The screw 62 may be provided with a graduated head 63 which may be graduated in degrees of temperature. The arm 55 is of laminated construction, that is, it is made of two sheets or layers of dissimilar metals 64 and 65. These metals are selected so as to have different coefficients of expansion, so that upon a change in temperature of the arm 55 it will tend to flex in either one or another direction. The arm is also preferably transversely curved so as to add to its rigidity.

By proper adjustment of the screw 62 and by selecting suitable distances between the spring contacts 52 and 53, the movable contacts 54 will be moved into contact with the contact 52 when the temperature of the arm 55 reaches a predetermined maximum and will be moved into contact with the stationary contact 53 when the temperature of the arm 55 reaches a certain predetermined minimum value. Supports 66 and 67 are provided for a shield 21 to prevent the heat from coils 37 from affecting the operation of the thermal responsive device. Terminals 68, 69 and 70 are secured to an insulating block 71 mounted upon the base plate 51. These terminals communicate respectively with the movable contacts 54 and stationary contacts 52 and 53. The flexible conductor 72 connects between the terminal 68 and the movable contacts 54.

The electrically responsive mechanism for controlling the current automatically to the heating element is disclosed in detail in Figs. 3, 4, 7 and 8 of the drawings. This entire mechanism is preferably mounted as a unit upon two parallel strips 73, which are held in spaced relation by separators 273. These strips 73 are removably secured to the side wall 50 of the housing 10 by means of stationary overlapping lugs 74 and 75 engaging respectively an end and one side of the strips 73. The other side of the strips 73 is secured in place by means of a pivoted lug 76 which is adapted to be manually moved to disengage the edge of the adjacent strip 73, so that the strips 73 may be removed. The inclusion of this switch mechanism in the heater assists in the general purpose of making the installation simple and inexpensive.

Mounted at longitudinally spaced points upon the strips 73 are a pair of electrically responsive expansible cells 77 and 78. These cells are identical in construction and comprise inner and outer cup-shaped halves which are joined together along their rims as at 81. The inner cup 80 is in the form of a flexible diaphragm and is accordingly annularly corrugated. A central thrust member 83 is also provided on each diaphragm. The outer half 79 has superposed upon it an electrical heating coil or resistance 84 which is relatively flat and adapted to substantially cover the surface of the half 79. This heating resistance is strapped to the outer half by means of a diamond shaped plate 85 which is secured at opposite corners to the outer half 79 by means of screws 86. The corners 87 of the plate 85 are extended laterally beyond the edges of the cell and serve as a support for terminal connections 88. The terminal connections 88 are mounted upon the corners 87 by means of screws 89 and are also suitably insulated from the same. These terminal connections 88 are electrically connected with the terminals of the heating resistance 84. The cells 77 and 78 are mounted upon the parallel strip 73 by means of spaced parallel bars 90 which are supported on trunnions 91. These bars 90 are secured to the outer side of the plates 85 by any suitable means such as rivets 92. It will be seen that when a current is caused to pass through the electrical heating resistances 84 the temperature of the air within the cells will be increased and correspondingly the air will tend to expand and force inwardly the flexible diaphragm 80. The outer half 79 of the expansible cells is preferably made of some material which is a relatively good conductor of heat, such as for example, copper, brass or other metal.

The switch which the expansible cells are intended to actuate preferably comprises a pair of stationary contacts and a movable bridging member which carries two contacts for short-circuiting these stationary contacts. Thus on the ends of the strip 73 there are mounted two spaced bus bars 92[a]. These bus bars carry suitable terminal connections 93 and stationary contacts 94 and are of course insulated from the strips 73. These two stationary contacts cooperate with two movable contacts 95 which are carried by the movable bridge bar 96. The bridge bar 96 is loosely connected to the outer end of the pivoted arm 97 whereby it may be moved towards and away from the stationary contacts to electrically connect and disconnect these stationary contacts. The loose connection between the bridge bar 96 and the arm 97 is preferably formed by means of a pin

98 which is suitably secured to and insulated from the bridge bar 96 and extends into an aperture in the end of the arm 97. This pin 98 has a comparatively loose fit in the arm 97 so that the bridge bar is free to align itself to a certain extent. To keep the switch bar from rotating relative to the arm 97 there is provided a pin 99 which depends upon the inner side of the arm 97 and which engages in a slot 100 which is provided at the end of the lug 101 which lug is secured to the bridge bar 96 by means of the pin 98. For convenience, bus bars 92[a] are further provided with additional terminal connections 102.

The mechanism will now be described for transmitting the motion of the expansible cells 77 and 78 to the movable arm 97. The construction of this mechanism is such that the energy imparted to it by the cells 77 and 78 is stored up until a predetermined amount of motion has occurred, after which the energy is relieved to suddenly move the arm 97. The strips 73 are provided along their inner edges with up-standing flanges 103 which are formed as a continuation of these strips 73 and which provide means for supporting the various pivotal connections for the system of members to be described later. Mounted directly right of the expansible cells 77 and 78 is a rocker arm 104 which is pivotally mounted as at 105. One end 106 of this rocker lever is adapted to engage and be moved inwardly by the thrust member 83 of the expansible cell 77. Adjacent the rocker lever 104 there is an intermediate lever 107 which is pivotally mounted as at 108. One end 109 of this lever overlaps the outer side of the end 110 of the rocker lever 104. The outer side of the end 109 is adapted to be engaged by the thrust member 83 of the expansible cell 78. The intermediate lever is preferably formed out of two strips which are securely fastened together, for example, an inner strip 111 and an outer strip 112 which extends up beyond the inner strip 111, to form an end portion 113. The inner strip 111 is bent to form a suitable journal for the pivot 108. Secured to the outer and inner faces of the intermediate lever are the two leaf springs 116 and 115 respectively which extend up in proximity to the end portion 113. These leaf springs are preferably secured to the intermediate lever by means of a single rivet 114. From the arrangement of the rocker lever 104 and the intermediate lever 107 it will be seen that the intermediate lever will be rocked in a clockwise direction by expansion of the cell 77 and will be rocked in a counterclockwise direction by expansion of cell 78.

The switch arm 97 is pivotally mounted between the flanges 103 as at 117. Also pivotally mounted as at 117 is an actuator 118 which comprises a torque arm 119, a trigger arm 120 and a spring tensioning arm 121. The torque arm 119 extends between the spring 116 and the outer face of the portion 113 of the intermediate lever 107, and is preferably provided with roller 122 to minimize friction. The spring tensioning arm 121 is slotted at its outer end and adapted to engage the thrust washer 123 of a compression spring 124. This compression spring is carried by a threaded stud 125 which is threaded into the switch arm 97. By rotation of this threaded stud 125 the relative amount of tensioning of the compression spring 124 may be adjusted. Arranged beneath the actuator 118 there is a trigger lever 126 which is pivotally mounted between the flanges 103 as at 127. Carried by the outer side of this trigger lever there is a trigger plate 128 having an abutment face 129 adapted to cooperate with the inner extremity of the trigger arm 120. The lower end portion 130 of this trigger lever 126 is adapted to extend between the inner face of the end portion 113 of the intermediate lever 107, and the leaf spring 115. By this arrangement the trigger lever 126 is rotated in a counterclockwise direction to cause the trigger plate 128 to release the trigger arm 120 when the intermediate lever 107 is rotated in a clockwise direction and the rocker lever 104 is rotated in a counterclockwise direction. Also pivotally mounted at 127 is a latch 131 which is adapted to cooperate with a latch plate 132 which is secured to the inner side of the switch lever 97 by suitable means such as a screw 134. This latch plate 132 is provided with an abutment face 133 which is adapted to engage the end of the latch 131. The latch 131 is also provided with a lug 135 extending downwardly adjacent the outer side of the trigger lever 126 and pressed inwardly against the same by the spring 136.

The operation of this automatic control switch may be better understood by referring to Figs. 7 and 8 of the drawings in which Fig. 7 shows the switch in its closed or in position and Fig. 8 shows it in its off or out position. In its closed position the switch arm 97 is normally pressed inwardly by the tension of the spring 124 since in this position the trigger 120 engages its abutment 129 to cause the spring tensioning arm 120 to maintain the spring 124 in tensioned position, thus urging the arm 97 to rotate in a clockwise direction. Now suppose current is caused to flow in the heating element of the expansible cell 77 to cause the same to expand and press inwardly upon the end 106 of the rocker lever 104. The intermediate lever 107 will thereupon be caused to rotate in a clockwise direction. The only immediate effect of this rotation will be to increase the tension upon the leaf spring 116. However, as this rotation continues the end 113 of the intermediate lever will contact with the outer face of the end portion 130 of the trigger lever 126. Further movement of the intermediate lever will cause the trigger lever to be rotated in a counterclockwise direction to such an extent that finally the abutment 129 of the trigger plate 128 is moved out of engagement with the trigger 120. The actuator 118 being thus suddenly released will rotate rapidly in a counterclockwise direction under the tension of the springs 116 and 124 until the spring tensioning arm 121 comes into contact with the inner side of the switch arm 97. Further rotation of the actuator under the tension of the spring 116 will lift the switch arm 97 to open the circuit. When the switch arm 97 is moved to its outer or "off" position the abutment 133 of the latch plate 132 is moved out of engagement with the latch 131. While the trigger lever 126 was being rotated in a counterclockwise direction in the operation described above the latch 131 remained relatively stationary but was merely urged to rotate in a counterclockwise direction by means of the spring 136. However, after the arm 97 is moved to its "off" position the latch 131 is free to rotate in a counterclockwise direction until the lug 135 comes into contact with the outer face of the trigger lever 126. In this new position of the latch 131, the inner side of the latch plate 132 is engaged to retain the switch arm 97 in its "off" position. On the other hand, the trigger 120 in its new position engages the outer face of the trigger plate 128.

In order to again move the switch to its "on" position it will be assumed that the current is caused to flow in the heating element of the expansible cell 78 and that the current which formerly flowed in the heating element of the expansible cell 77 is now broken. The expansible cell 78 will thereupon push inwardly upon the outer portion 109 of the intermediate lever 107 to cause the same to be rotated in a counterclockwise direction. The first effect of this rotation is merely to cause the actuator 118 to also be rotated in a clockwise direction to cause the spring tensioning arm 121 to compress the tensioning spring 124. Also since the outer face of the trigger plate 128 now is in engagement with the trigger 120 the end portion 130 of the trigger lever 126 is maintained relatively stationary and therefore the leaf spring 115 will be tensioned. No immediate motion is transmitted to the switch arm 97 because the inner face of latch plate 132 is in engagement with the latch 131. However, as the rotation of the intermediate lever 107 proceeds the trigger 120 is moved over until it disengages with the outer face of the trigger plate 128. The trigger lever 126 is thereupon released and is caused to rotate in a clockwise direction under the tension of the spring 115. Rotation of the trigger lever 126 also causes the latch 131 to rotate with it to cause this latch to be moved up out of engagement with the inner face of the latch plate 132. Thus the switch arm 97 is free to move rapidly to its closed position under the tension of the spring 124. The mechanism in reality stores up the energy imparted to it by the expansible cells 77 and 78 until a predetermined amount of motion has occurred, after which the switch arm 97 is moved into one or the other position. Since the switch arm 97 always moves rapidly it will be seen that there will be little opportunity for arcing between the contacts.

The electrical connection for the system described above is shown in the circuit diagram of Fig. 6. In the particular arrangement that has been illustrated there are employed four of the electrical heating units 20 which have been designated by numerals 220, 320, 420 and 520. The parts of the manually controlled switch 42, the thermal responsive device 48, and the electrically responsive mechanism 49 have been shown diagrammatically. When four of the electrical heating elements are employed the switch 42 preferably comprises five electrical contacts which have been numbered 1 to 5 inclusive on the drawings. The current supplying lines L^1 and L^2 are connected to the two contacts 1 and 2 and when the switch 42 is in its "off" position then these contacts 1 and 2 are disconnected from the contacts 3, 4 and 5.

Corresponding binding posts 33 and 34 of the heating elements 220, 320 and 420 are connected together by the common conductor 140 to the central binding post 35 of the resistance element 520. The binding posts 34 and 35 of the heating element 520 are then electrically connected together and to the common conductor 141, which conductor connects to one of the stationary contacts 94. The other stationary contact 94 connects by means of the conductor 142 to the switch contact 5. The other corresponding binding posts 33 and 34 of the heating elements 220 and 320 are connected together to a common conductor 143 which connects to the contact 4. The other corresponding binding posts 33 and 34 of the elements 420 and 520 are connected together and to the switch contact 63 by means of the conductor 144. The thermal responsive device 48 has its movable contact 54 connected to one of the stationary contacts 94 by means of the electrical conductor 146, the conductor 146 connecting to the same stationary contact 19 as the conductor 141. The upper stationary contact 52 connects to the upper terminal of the heating resistance 84 of the expansible cell 77, the lower terminal of this heating resistance being connected to the line L^1 by means of the conductor 149. The lower stationary contact 53 is connected to the upper terminal of the heating resistance 84 of the expansible cell 78 by means of a conductor 148, the lower terminal of this heating resistance being connected to the conductor 142 by means of a conductor 150.

The operation of the circuit is as follows: When the switch 42 is turned from its "off" position to its high position then contacts 2 and 5 are connected together and to the line L^2, and contacts 1, 3 and 4 are connected together and to the line L^1. In this position all of the heating elements are connected in parallel and across the lines L^1 and L^2. When the switch is turned to its medium position then contacts 1 and 3 remain connected and contacts 2 and 5 remain connected but contact 4 is disconnected. In this position heating elements 220 and 320 will be disconnected from the line but heating elements 420 and 520 will remain connected in parallel across the line. When the switch is turned to its low position then the contacts 2 and 5 are connected and contacts 1 and 4 are connected but contact 3 is disconnected. In this position the heating elements 420 and 520 will be disconnected from the line but the elements 220 and 320 will be connected across the line. These latter elements may be of higher resistance than elements 420 and 520. Thus, by means of this switch either all of the heating elements will be connected in parallel across the line or only one pair of the elements will be connected across the line, or only the other pair will be connected. Since the stationary contacts 94 are connected in series with the conductors 141 and 142 therefore these contacts must be short circuited by the movable contacts 95 before a currrent can be supplied by the line L^1 to the conductor 140.

We will now assume a condition in which the heater has just been turned on to its high position and the air in the room which it is intended to heat is relatively cool. The movable contact 54 of the thermal responsive device 48 will initially take a position intermediate of the two stationary contacts 52 and 53 and the contacts 94, 95 will be closed. However, as the temperature of the air coming in contact with the arm 55 increases, this arm tends to flex upwardly toward the stationary contact 52. When the temperature reaches a certain predetermined maximum value then the movable contact 54 will contact electrically with the stationary contact 52 and complete the circuit including conductor 142, contacts 94, conductor 146, contact 54, stationary contact 52, conductor 147, heating resistance 84 of the expansible cell 77, conductor 149 and line L^1. Since at this time the contacts 94 are short circuited by the contacts 95 then the conductor 146 will be connected to the line L^2 through the conductor 142 and switch contacts 1 and 3. Current will therefore be supplied to the heating resistance 84 of the expansible cell 78. After the expansible cell 77 has become sufficiently heated it will actuate the automatic switch controlling mechanism and cause the switch arm 97, which carries the movable contact 95, to move outwardly and open the circuit between the stationary contact 94. This interrupts the current which previously was flowing to the heating elements 20 and also the current flowing in the heating resistance of the expansible cell 77 so that this cell may now cool.

After the air in the room has cooled down to a certain predetermined minimum value then the arm 55 will be flexed downwardly to bring the movable contact 54 into electrical contact with the stationary contact 53. The circuit which is closed when the movable contact 54 comes into electrical contact with the stationary contact 53 includes conductor 144, the resistance 520, conductor 141, conductor 146, contacts 54 and 53, conductor 148, the heating resistance 84 of the expansible cell 78, conductor 150 and conductor 142 which is connected to contact 3 of the switch 42. Therefore the heating resistance 84 of the expansible cell 78 will be connected across the lines L^1 and L^2 and will now be energized by the current and heated to a sufficiently high temperature to cause it to actuate the switch control mechanism reversely to close the movable contacts 55 upon the stationary contacts 94. The closing of these contacts 99 and 95 shunts out the heating resistance of the cell 78 and this cell is then allowed to cool. Thus the circuit which includes the electrical heating elements 20 is again closed and the process previously described is repeated. By adjusting the screw 62 the maximum and minimum temperatures may be raised or lowered as desired.

We claim:

1. In an electric heater, a housing for the heater arranged to be accommodated in a wall recess, electrical heating means in said housing, means within said housing forming a flue for convection currents entering and leaving the housing, and a switch for controlling the current supplied to the heating means mounted on the exterior of the housing immediately adjacent the flue and in such a position that it can be accommodated in the recess.

2. In an electric heater, a housing for the heater arranged to be accommodated in a wall recess, electrical heating means in said housing, said housing having a back wall serving to define a flue for convection currents, the upper portion of the back wall being sloped forwardly, and a switch for controlling current to the heating means secured to the exterior of the housing and positioned on the sloping portion of the back wall, whereby convection currents passing thru said flue serve to keep the switch cool and the positioning of the switch allows the heater to be readily accommodated in the wall recess.

3. In an electric heater, means forming a flue for convection currents entering and leaving the heater, and temperature responsive means for controlling the heating means,

said temperature responsive means being located in the flue so as to be influenced by air entering the heater.

4. In an electric heater, a housing, an electrical heating element in said housing for producing heat by convection currents of air, and means for controlling said element in accordance with the temperature of the air that is to be acted upon by the heater, said means being located in the housing whereby installation of the heater is facilitated.

5. In combination, an electrical heater, means for circulating air into and out of said heater, and means responsive to the temperature of the air entering said heater for controlling the current supplied to said heater.

6. In combination, a housing, electrical heating means mounted within said housing, means allowing passage of air into and out of said housing, and a thermal operated electrical control mounted in the path of incoming air to control the current supplied to said heating means.

7. In combination, a housing, electrical heating means mounted within said housing, means allowing free passage of air into the lower and out the upper part of said housing, and a thermal operated electrical control mounted within the lower part of said housing for controlling the current to said heating means.

8. In combination, an electrical heater adapted to allow free passage of air into and out of the same, and a thermal operated electrical switch mounted in the path of incoming air for opening the electrical circuit to said heater when the temperature of said incoming air attains a predetermined maximum value and for closing said circuit when the temperature of said incoming air attains a predetermined minimum value.

9. In an electrical heater, a housing, electrical heating means disposed within said housing, means forming an open ended flue for convection currents of air entering and leaving said housing, and means for controlling the current supplied to the heating means in accordance with the temperature of a room being heated comprising a thermal responsive device disposed in the path of convection currents traversing said flue.

In testimony whereof, we have hereunto set our hands.

ARTHUR J. KERCHER.
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