United States Patent

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[54] **ELECTRIC SPACE HEATER**
10 Claims, 6 Drawing Figs.

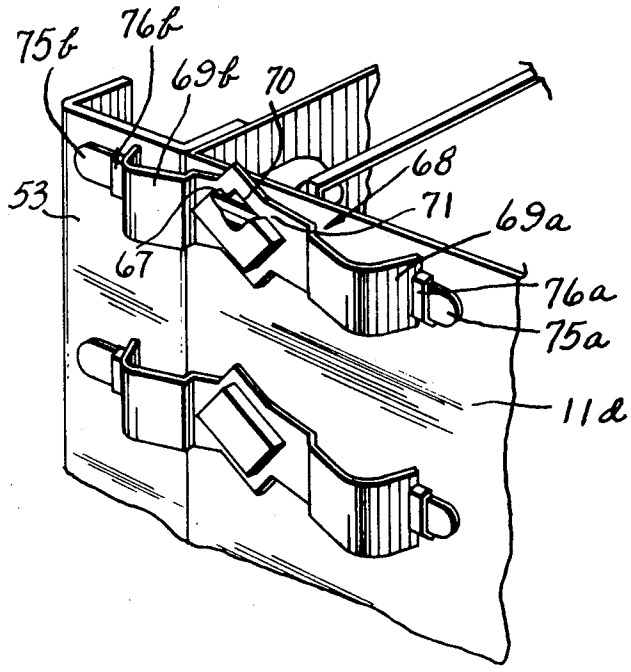
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[50] **Field of Search** 219/347–349, 355, 357, 377, 532, 536, 537, 542, 546, 548; 338/315–320

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ABSTRACT: An electric heater of the space heating type. The heater includes a housing containing an open-faced reflector. The reflector has within it a heating element suspended in front of a reflective surface between spaced opposing insulator members that pass through forwardly extending walls of the reflector. Some of the insulator members that pass through the reflector walls also pass through individual leaf springs located outside the reflector, which springs are secured within the heater in such a manner that the heating element can be positioned in close proximity to the reflective surface for maximum heat output.



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SHEET 1 OF 3

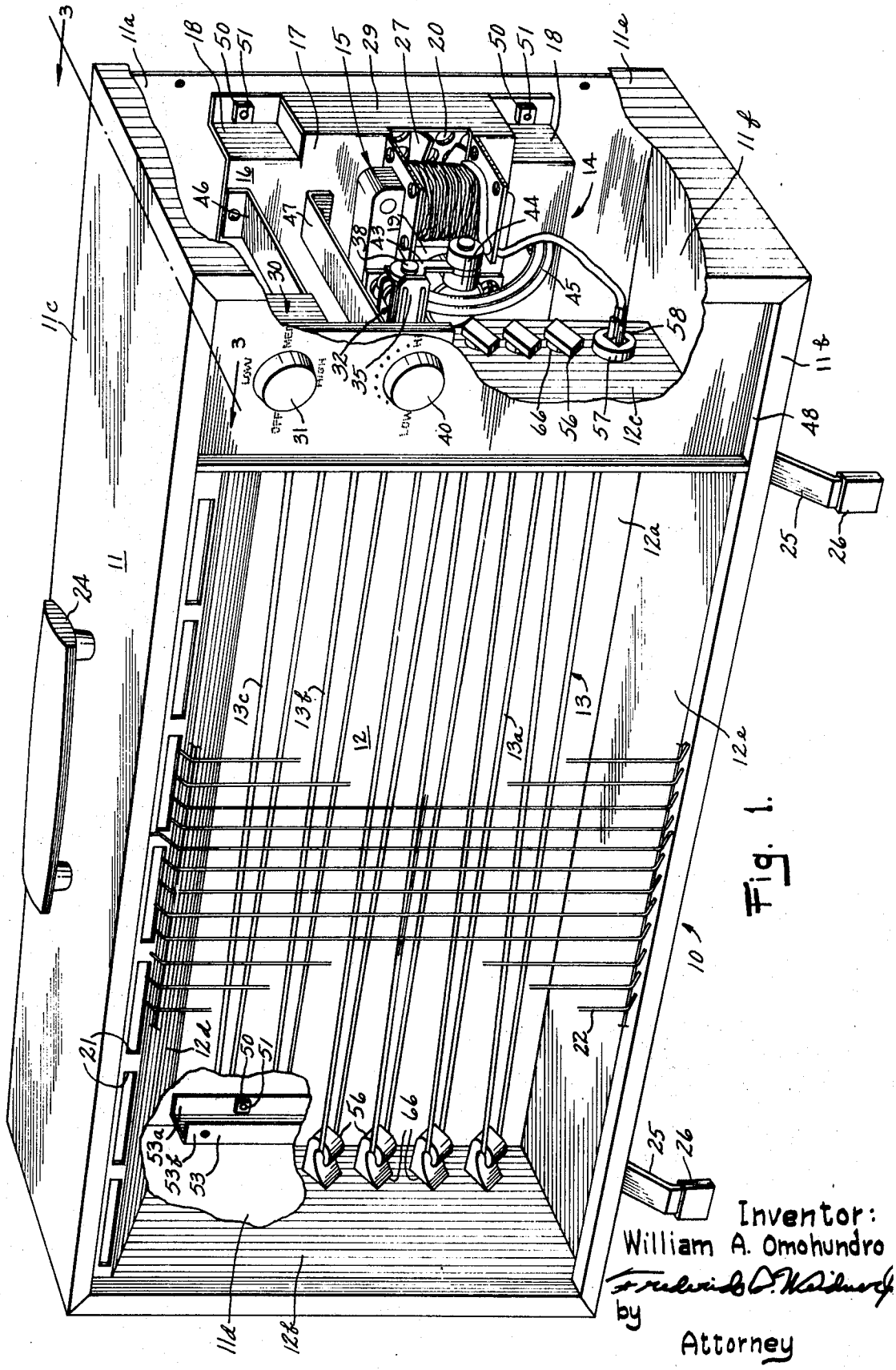


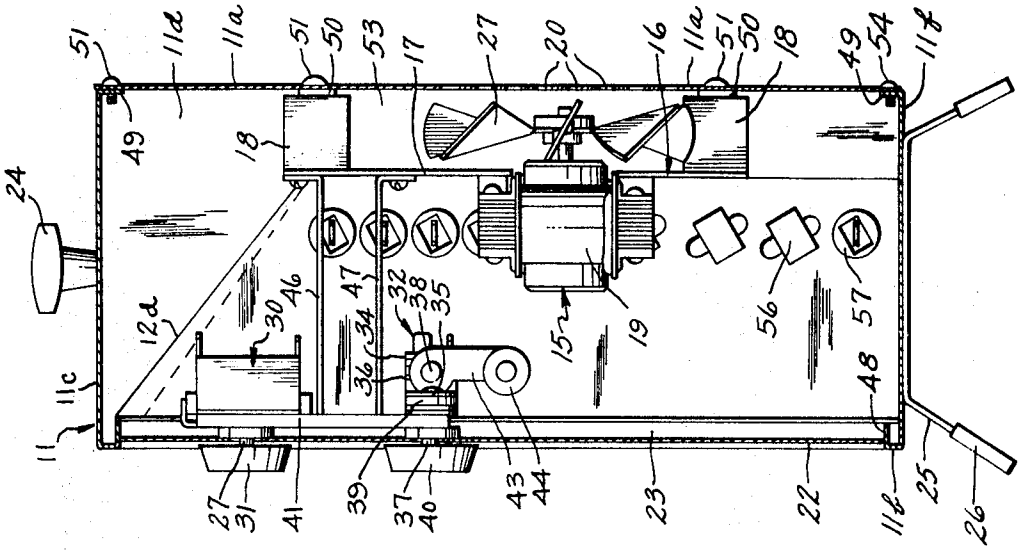
Fig. 1.

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Fig. 3.



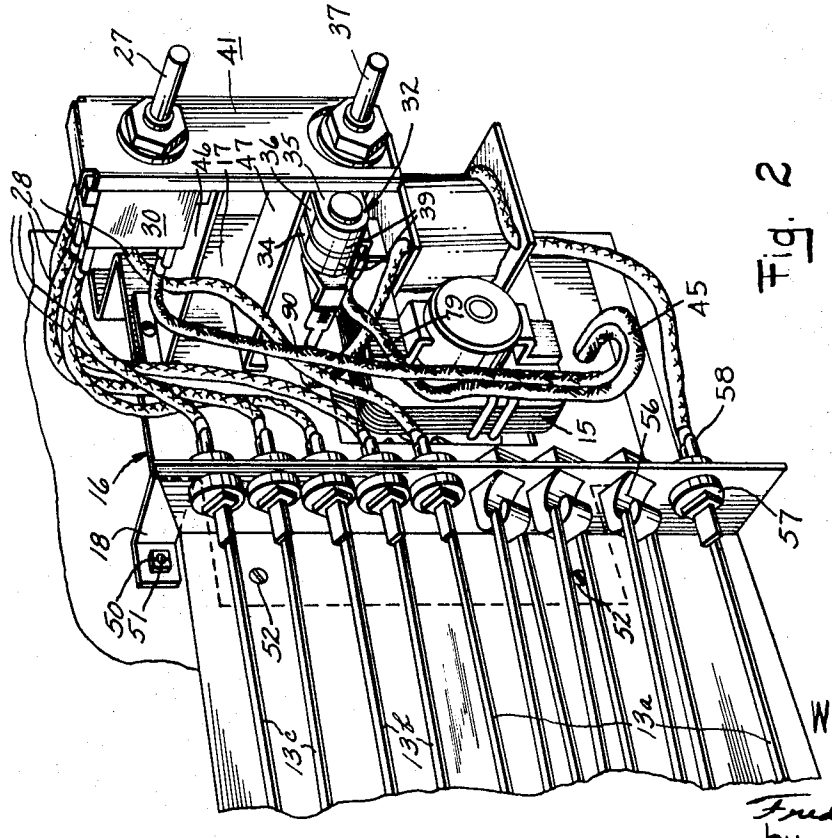


Fig. 2

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Fig. 4.

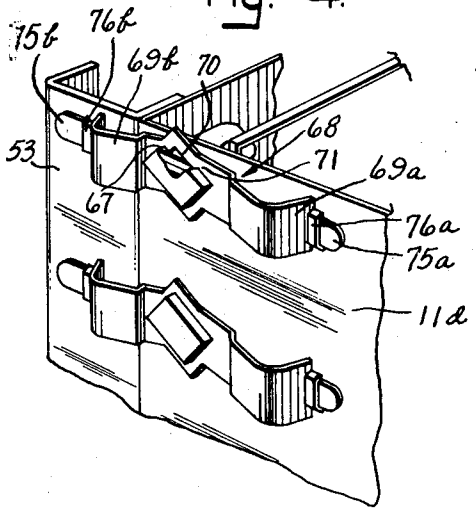


Fig. 5.

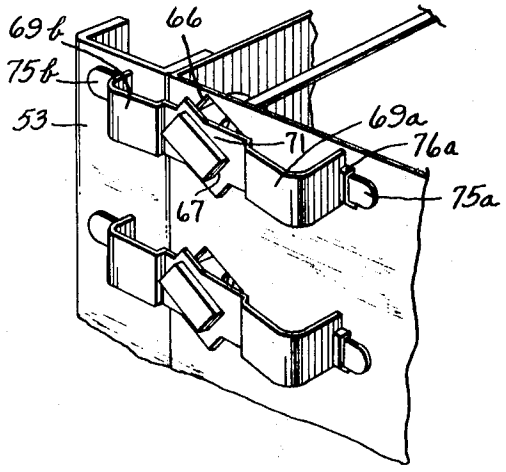
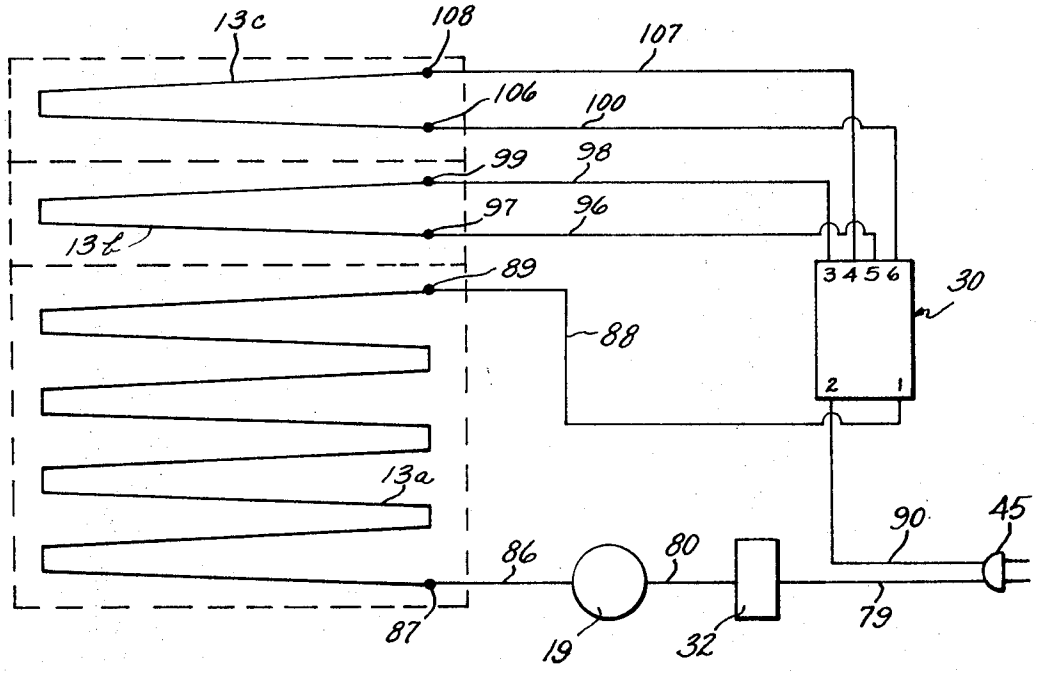


Fig. 6.



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ELECTRIC SPACE HEATER

BACKGROUND OF THE INVENTION

This invention relates to electric heaters, and more particularly to portable electric space heaters utilizing a suspended electrical resistance heating element.

Electric space heaters usually have a housing which has a major portion of its front open for receiving therebehind an open-faced reflector. Within the reflector is an electrical resistance element for supplying heat energy. These electric space heaters are usually small in size and designed to be readily and easily portable. In some heaters, the heating element is a helically wound resistance wire supported at short intervals across the reflector. Helical heating element wire is often wound around a ceramic rod that extends from one side of the reflector to the other. Many heaters use a metal ribbon-type heating element in which the heating element is suspended by means of insulators so that it traverses the reflector from one side to the other within the reflector in a serpentine pattern. The expansion of the heating element upon energization or heating and contraction upon deenergization or cooling can detrimentally affect the life of the suspended heating element as well as detract from the appearance of the heater due to the sagging of the heating element when it is energized to supply heat. Moreover, the movement of the heating element caused by the expansion and contraction makes satisfactory terminal connections difficult and often causes them to fail prematurely. This invention has particular application to electric heaters utilizing a heating element arrangement wherein the heating element is suspended within the reflector and supported only at the ends of the reflective surface such as is common practice in the case of ribbon-type heating elements. Various systems have been used in prior electric heater devices to compensate for the expansion and contraction of the heating element to retain the heating element taut at all times. Some prior electric heater devices use tensioned end walls of the reflector to keep the attached ribbon taut while others use various spring arrangements.

The desirability of keeping heating elements taut has been well recognized for years, however, a particular arrangement for achieving this result should contribute to the overall economy and optimum performance of the heater into which it is incorporated. Obtaining such an arrangement is made quite difficult by the relatively small size of these electric heaters.

By my invention, there is provided an improved electric heater utilizing a suspended heating element, particularly of the ribbon type that incorporates an arrangement for maintaining the heating element taut at all times and which cooperates with other features of the heater to provide a heater that is relatively small in bulk and size, neat in appearance and highly effective for space heating purposes.

SUMMARY OF THE INVENTION

In accordance with this invention, there is provided an electric heater that includes a reflector located behind an opening in the front of the heater. The reflector has a reflective surface and at least two walls projecting forwardly from opposite ends of the reflective surface. The reflector has within it a heating element suspended in a serpentine pattern to provide continuous runs of a heating element between spaced opposing insulators that pass through apertures in two of the forwardly projecting walls of the reflector. The heating element is electrically connected through terminals to a power source and all of said terminal connections are located on one of the forwardly projecting walls of the reflector. In the opposite forwardly projecting reflector wall each of the insulators which receive a run of the heating element connected to a terminal are moveable relative to said reflector wall and are cooperatively associated with leaf springs to maintain the heating element suspended thereon taut at all times. The leaf springs are located outside the reflector and they are arranged parallel with respect to each other. Each leaf spring is positioned within the heater by having one leg secured at a point forward of the reflective surface and the other leg secured at a point rearward of the reflective surface. By this arrangement relatively long leaf springs that afford maximum displacement with minimum tension force throughout the extent of spring displacement may be utilized in order to keep the runs of heating element suspended on each of the moveable insulators taut at all times and the suspended heating element may be positioned in close proximity to the rear wall reflective surface of the reflector for maximum heat output.

It is an object of this invention to provide an improved electric heater utilizing a suspended heating element.

It is also an object of this invention to provide an electric heater with a spring arrangement for maintaining the heating element taut at all times, which arrangement affords maximum spring displacement with minimum tension force throughout the extent of spring displacement.

It is another object of this invention to provide an electric heater with an open front, a reflective surface therebehind and a spring arrangement for maintaining a heating element suspended across the open front of the heater taut at all times with maximum spring displacement and minimum tension force throughout the extent of spring displacement and permitting the heating element to be positioned in close proximity to the reflective surface.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of my electric heater with a broken-away portion at one end showing the control compartment and another broken-away portion at the opposite end showing how the reflector is attached to the rear wall of the housing.

FIG. **2** is a fragmentary perspective view of the inside of the control compartment of my electric heater.

FIG. **3** is an end elevation view of my electric heater taken along line **3**—**3** of FIG. **1** with the housing and fan motor support member shown in section.

FIG. **4** is a fragmentary perspective view of the heating element suspension arrangement when the heating element is in a contracted condition.

FIG. **5** is the same as FIG. **4** showing the heating element suspension arrangement in its expanded condition.

FIG. **6** is a schematic diagram showing the electric circuit of my electric heater.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is illustrated in FIGS. **1** and **3** a portable electric heater, generally shown at **10** and including a case or housing **11**. The housing **11** is illustrated as a rectangular housing made from sheet metal and provided with rear wall **11***a*, front wall **11***b* with a large opening, top wall **11***c*, end walls **11***d* and **11***e* and bottom wall **11***f*. Secured within the heater housing behind the front wall opening is a reflector **12** also formed from sheet metal. The reflector has a reflective rear wall **12***a*, end walls **12***b* and **12***c*, top wall **12***d* and bottom wall **12***e*. An electrical resistance heating element **13**, preferably of the ribbon type, is suspended inside reflector **12**, so that the reflector is effective to emit radiant heat from the heating element **13** when it is energized. The heating element in this heater embodiment consists of three segments (**13***a*, **13***b* and **13***c*) which are connected in series circuit through switch means to obtain varying degrees of heat as will be discussed subsequently in connection with FIG. **6**.

The heater **10** includes a control compartment **14** at the end or portion of the housing opposite the reflector. The control compartment is defined by sections of the housing rear wall **11***a*, the bottom wall **11***f*, top wall **11***c*, front wall **11***b*, the entire end wall **11***e* and the end wall **12***c* of the reflector. Within the control compartment **14** is a motor **19** that operates impeller **27**. The motor **19** and impeller **27** comprise the fan assembly **15** which is secured by means of support structure **16**

to the housing rear wall 11*a*. The rotating impeller 27 draws air into the heater through a plurality of air inlet openings 20 in the housing rear wall 11*a* and by directing the air against baffle portion 17 of support structure 16 the air is forced under pressure into an open channel along the length of the heater from inlet openings 20 to the far end of heater. One sidewall of the channel is formed by the rear wall 12*a* and top wall 12*d* of the reflector and the other sidewall is formed by the housing rear wall 11*a*. The far end wall of the channel is a U-shaped support member 53 and the near end wall is spacing web 29 of support structure 16. The air, after sweeping the reflector rear wall 12*a*, passes through outlet openings 21 located at the top of the reflector 12 and out through grill 22 that protectively covers opening 23 in the front wall 11*b* of the housing. In this manner the heater 10 is effective to transmit heat by convection as well as by radiation. For ease of portability, a carrying handle 24 is secured to the housing top wall 11*c*. To provide stability of the heater, support feet 25 with cushioning tips 26 are secured at opposite ends of the housing bottom wall 11*f*.

To control the operation of the heater there is provided a switch assembly 30 located within the control compartment 14 which controls the motor 19 and the energization of the heating element. Operating knob 31 attached to switch stem 27 is accessible to the user from outside the heater housing for manually adjusting the switch. In the electric heater illustrated there are three attainable heating levels afforded by a three-segmented heating element which may be selectively energized by the switch means 30 as will be more fully discussed subsequently in connection with FIG. 6. Each of the heating element segments, designated 13*a*, 13*b* and 13*c*, are electrically connected to the switch 30 by wire leads 28. These wire leads are of minimum length between the switch terminals and the terminal connections of the heating element are covered on the exterior with a relatively stiff insulating material. In this manner should any of the connections become detached, the wire will not move sufficiently to contact any part of the heater that would present an electrical shock hazard to the user should he touch the heater housing.

Within the control compartment 14 there is also a thermostat and tipover switch assembly 32. The thermostat portion includes a temperature responsive bimetallic element 34 and a pair of relatively moveable contact blades 35 and 36 separated by ceramic washers 39. The switch assembly 32 may be adjustably controlled through rotatable stem 37 by means of control knob 40. The thermostat portion of the switch operates in the normal manner to deenergize the heating element responsive to adjustable temperature limitations built into the thermostat.

For the purpose of turning the heater off for safety purposes in the event it is accidentally tipped over, there is provided in switch assembly 32 a tipover switch portion including a pendulum 43 pivotably attached to contact blade 36 by rivet 38. When the weight 44 attached to the end of the pendulum opposite from the pivot end causes the pendulum to swing the contact blades are camed out of electrical contact with each other to thus break the circuit and deenergize both the heating element and the fan motor.

The thermostat and tipover switch assembly 32 and the switch assembly 30 are secured within control compartment 14 by appropriate attachment to mounting plate 41 which is attached by support brackets 46 and 47 to the motor and fan support member 16. Suitable indicia may be associated with both the switch operating knob 31 and the thermostat control knob 40 to indicate their settings.

With reference to FIGS. 1—3, the means of securing the reflector 12 to the housing 11 is shown. The opening 23 of the heater 10 is surrounded or framed by the housing front wall 11*b* which has an inturned flange 48. The protective grill 22 is secured to inturned flange 48 to cover the opening. The reflector 12 is not attached to the front portion of the heater case but is secured through appropriate means to the housing rear wall 11*a*. The housing rear wall, reflector, heating element, fan, controls, and necessary support members may be subassembled and placed into the housing as a unit. To secure the end of the reflector adjacent the control compartment to the rear wall 11*a* of the heater, the motor and fan support member 16 is utilized. The baffle portion 17 of the support member 16 is spaced from the housing rear wall 11*a* by forming L-shaped sections 18 in the support member 16 at all four corners and fastening these L-shaped sections to rear wall 11*a* through insulating grommets 50 by means of sheet metal screws 51. The reflective rear wall 12*a* of the reflector 12 is attached at both the top and bottom directly to the motor and fan support member 16 as by means of sheet metal screws 52. At the opposite end of the heater from the control compartment the reflector 12 is also secured to the rear wall 11*a* of the housing in a spaced relationship by using U-shaped support member 53. The U-shaped support member 53 is vertically disposed and has spaced parallel sides 53*a* and 53*b*. Side 53*a* is attached to the rear wall 11*a* of the housing and side 53*b* is attached to the rear wall 12*a* of the reflector. The attachments to the housing rear wall 11*a* are made through insulating grommets 50 and screws 51 in the same manner as described previously. When the subassembly is completed it can be inserted into the housing from the rear and retained in its correct position within the housing by attaching the rear wall 11*a* to flanges 49 of the housing by means of sheet metal screws 54, as most clearly shown in FIG. 3.

By the particular internal arrangement of the heater components a mixed air flow system is produced. With the baffle portion 17 of the motor and fan support member 16 being positioned a short distance in from the air intake openings 20 at the back of the heater the movement of most of the air towards the front of the heater is blocked, thus forcing it to move under pressure into the air passage channel behind the reflector that extends the length of the reflector. Once the air is in this open channel, the only opening for the air to exhaust from the heater is through the air outlet openings 21 at the top of the reflector. By this reflector assembly arrangement and air flow system the entire area of the reflector rear wall 12*a* is swept with moving air. This affords maximum heat transfer from the hot reflector rear wall to the surrounding atmosphere by convection.

The heating element 13, best illustrated in FIGS. 1 and 2 of the drawings, comprises an electrical resistance heating wire or ribbon made of suitable material suspended within the reflector 12 between insulators. The insulators are preferably made of porcelain or similar insulating material and in this heater there are two kinds, the hook-shaped type 56 and the round terminal type 57. The round terminal insulators 57 are used for connecting the end of each of the ribbon-type heating element segments 13*a*, 13*b* and 13*c* through connectors 58 to the wire leads 28 coming from the switch assembly 30. The hook-shaped insulators have the heating element looped over the hook portion to provide continuous runs of heating element across the interior of the reflector. In this heating element arrangement a plurality of nearly horizontal and parallel runs of heating element traverse the heater opening 23 and extend the length and height of reflector rear wall 12*a*.

For mounting the heating element 13 within the heater in a manner to maintain the heating element 13 under constant tension, the end walls 12*b* and 12*c* of the reflector 12 are provided with vertically aligned openings 66. These openings generally conform in shape to the cross section of the insulator body. The terminal insulators 57 are secured to the reflector end wall such that they are not moveable relative thereto. The hook-shaped insulators 56 pass through the openings and that portion of the insulator body inside the reflector assembly is slightly smaller so that the openings will receive the insulator during assembly. The hook-shaped insulators on the reflector end wall 12*b* are moveable relative to the reflector used. The portion of the insulator on the outside of the reflector assembly has a retaining flange 67. To keep the heating ribbon element taut at all times there is provided individual leaf springs 68 for each of the moveable insulators located in the

reflector end wall 12*b* furthest from the control compartment 14. The particular configuration of these springs are best illustrated in FIGS. 4 and 5 of the drawings. Leaf springs 68 have two leg portions 69*a* and 69*b* and an aperture 70 through the center body portion 71 of the spring. The hook-shaped insulators 56 are prevented from passing through the apertures 70 of the springs or the openings 66 in the reflector end wall 12*c*, as the case may be, by flange 67 of each of the insulators. One leg 69*a* of the spring is secured to the reflector end wall 11*d* by tang 75*a* being inserted under lanced section 76*a* of the reflector end wall and the other leg 69*b* is attached in the same manner to the support member 53 by means of tang 75*b* and lanced section 76*b* on the support member. FIG. 4 shows the springs in their compressed condition as when the heating element is not energized and is therefore in a contracted state. FIG. 5 shows the leaf springs when the heating element is energized and in its expanded state. The springs are made of suitable metal, such as stainless steel, and because of their relatively long length from the tang at one end to the tang at the other they have two important desirable characteristics. They afford maximum displacement of the center body portion 71 to compensate for the expansion of the heating element and they provide for applying minimum tension force to the heating element throughout the extent of spring displacement. These characteristics are particularly important in this heater because each spring must maintain two runs of heating element taut and these runs extend for a considerable unsupported distance across the heater opening 23. It should be noted that the lower the watts-density of the heating element the lower its operating temperature. Watts-density is the wattage of the heating element divided by the surface area of the heating element. Since the tensile strength of a heating element drops drastically as its operating temperature increases, it is advantageous to use a heating element with as great a surface area as practical thereby increasing the strength and life of the heating element. By using a long heating element this may be easily accomplished. However, with a long heating element there is a greater amount of thermal expansion that must be compensated for in order to keep the heating element taut. Therefore, maximum spring displacement is necessary. Coupled with obtaining maximum spring displacement is the need to minimize the tension force exerted on the heating element throughout the entire cycle of expansion and contraction because too much tension force would detrimentally affect the life of the heating element and would cause the ribbon heating element to break eventually. To obtain both of these desirable characteristics it is necessary that each of the leaf springs be relatively long in length which in itself presents a problem of arranging the springs so that the heating element is suspended in close proximity to the reflective rear wall 12*a*. By my spring arrangement each of the springs are horizontally parallel to each other and aligned vertically with one leg 69*a* and the center body portion 71 of each spring located at a point forward of the reflector rear wall 12*a* and the other leg 69*b* located at a point rearward of the wall whereby the heating element is suspended in close proximity to the front of the reflector rear wall.

The above-described spring arrangement provides for positioning the suspended heating element in close proximity to and traversing the entire area of the reflector rear wall 12*a* thus providing maximum radiant heating of the reflector rear wall 12*a* for any given heat energy level. It also allows the heating element to be suspended in runs nearly parallel to each other thereby obtaining efficient distribution of the heating element for maximum heat output. This spring arrangement also allows for maintaining all heating element segments taut at all times regardless of how many of the individual heating element segments are energized at any one time.

Moreover, by my spring arrangement I am able to use a heating element made of an alloy consisting of iron, chromium and aluminum. Iron-chromium-aluminum heating elements are less expensive, have a higher-electrical resistivity, and can operate at higher temperatures than heating elements made of nickel-chromium, which are more commonly used in electric heaters. The main drawback of using iron-chromium-aluminum heating elements in heaters as opposed to nickel-chromium is their lower tensile strength at elevated temperatures and greater permanent elongation characteristics. My spring arrangement adequately compensate for these heating element characteristics even when long runs of unsupported heating element are involved to achieve operation at a relatively low temperature as explained previously.

For a description of the electrical circuit of the heater and a more detailed discussion of its operation, reference is made to FIG. 6. It can be seen that three heating elements 13*a*, 13*b* and 13*c* are selectively connected through switch assembly 30 and are connected in series with the thermostat and tipover switch assembly 32 and fan motor 19. Conductor 79 of the line input from power cord plug 45 is connected to thermostat and tipover switch assembly 32. Conductor 80 connects thermostat and tipover switch assembly 33 to fan motor 19 and conductor 86 connects fan motor 19 to heating element segment 13*a* through first junction 87. Conductor 88 connects the opposite end of heating element segment 13*a* at second junction 89 to switch assembly 30 at terminal 1. Heating element segment 13*b* is connected to switch assembly 30 at terminal 5 by conductor 96 from third junction 97 and conductor 98 connects fourth junction 99 to terminal 3. Heating element segment 13*c* is connected to switch assembly 30 by conductor 100 from fifth junction 106 to terminal 6 and conductor 107 connects sixth junction 108 to terminal 4. Conductor 90 of the line input is connected to switch 30 at terminal 2. With the foregoing electrical circuit, a four position switch assembly may be employed and the following operation will be provided with the power cord plug 45 inserted into a wall receptacle. In the "off" position, neither the fan motor nor any of the heating element segments are energized. In the "low" position all six terminals of switch assembly 30 are in electrical contact with each other to provide a closed circuit with the result that the fan motor and all three heater element segments 13*a*, 13*b* and 13*c* are energized in electrical series. In the "medium" position terminals 1, 2, 3 and 5 of switch assembly 30 are in electrical contact to provide a closed circuit resulting in the fan motor and only heating element segments 13*a* and 13*b* being energized in electrical series. In the "high" position only terminals 1 and 2 of the switch assembly 30 are in electrical contact to provide a closed circuit and the fan motor and only heating element segment 13*a* are energized. It should be noted that the thermostat and tipover switch assembly 32 is connected in series with the above-described circuit, therefore, a safety factor and a heating level control is provided during operation of the heater. It should also be noted that by adding in series heating element segment 13*b* to heating element segment 13*a* and then segment 13*c* in series to both segments 13*a* and 13*b*, the additional length of heating element or added resistances reduces the amount of current passing through the heating element which results in the power correspondingly being reduced to produce the "medium" and "low" heat levels, respectively. This is a fundamental characteristic of a series circuit.

The foregoing is a description of the preferred embodiment of the invention, and variations may be made to the heater without departing from the spirit of the invention, as defined in the appended claims.

I claim:

1. An electric heater comprising;
   a. a housing having sides, a rear wall and an open front,
   b. a reflector located within the housing and secured by support means to the rear wall of the housing in spaced relationship, said reflector having a reflective surface and two opposing walls projecting forwardly from said surface with each of said walls having a plurality of apertures,
   c. a heating element suspended within the reflector to provide a plurality of runs, said heating element being electrically connected through terminals to a power source,

d. insulators supporting the suspended heating element, said insulators passing through the apertures in the reflector walls, and

e. individual leaf springs having a center body portion and legs extending outwardly therefrom cooperating with each of the insulators that receive a run of heating element electrically connected to a terminal to maintain the runs of the heating element suspended on said insulators taut at all times, said leaf springs being located outside the reflector and each having one leg secured at a point forward of the reflective surface and the other leg secured at a point rearward of the reflective surface and with said center body portion cooperating with said insulators whereby the heating element is positioned in close proximity to the reflective surface.

2. The electric heater of claim 1 wherein each spring biased insulator passing through the reflector end walls also passes through the center body portion of the leaf spring.

3. The electric heater of claim 1 wherein all of the terminal connections for the heating element are located on one of the forwardly projecting reflector walls.

4. The electric heater of claim 3 wherein only the insulators located in the reflector wall opposite the wall with the terminal connections are spring biased by a leaf spring and each of said insulators pass through the center body portion of the leaf spring.

5. An electric heater comprising;

a. a housing having sides, a rear wall and an open front,

b. a control compartment in one portion of the housing including switch means for operating the heater,

c. a sheet-metal reflector located in another portion of the housing and secured by support means to the rear wall of the housing in spaced relationship, said reflector having a reflective surface and two opposing walls projecting forwardly from said surface, each of said walls having a plurality of apertures,

d. a heating element suspended within the reflector to provide a plurality of runs, said heating element being electrically connected through terminals to said switch means,

e. insulators supporting the suspended heating element, said insulators passing through the apertures in the reflector walls, and

f. individual leaf spring having a center body portion and legs extending outwardly therefrom cooperating with each of the insulators located in the reflector wall furthest from the control compartment that receive a run of heating element electrically connected to a terminal to maintain the runs of the heating element suspended on said insulators taut at all times, said leaf springs being located outside the reflector and each having one leg secured at a point forward of the reflective surface and the other leg secured at a point rearward of the reflective surface and with said center body portion cooperating with said insulators whereby the heating element is positioned in close proximity to the reflective surface.

6. The electric heater of claim 5 wherein the leaf springs cooperating with the insulators located in the reflector wall furthest from the control compartment are arranged horizontally parallel to each other in vertical alignment.

7. The electric heater of claim 5 wherein the heating element consists of a plurality of heating element segments electrically connected to each other in series circuit through said switch means for selective energization.

8. The electric heater of claim 5 wherein all of the terminal connections from the heating element to the switch means are located on the side of the reflector closest to the control compartment.

9. The electric heater of claim 8 wherein only the insulators located in the reflector wall furthest from the control compartment are spring biased by a leaf spring and each insulator passes through the center body portion of the leaf spring.

10. A portable electric heater comprising;

a. a housing having sides, a rear wall and an open front,

b. a control compartment in one end of the housing including therein switch means for operating the heater,

c. a sheet-metal reflector located in the end of the housing opposite the control compartment and secured by support means to the rear wall of the housing in spaced relationship, said reflector having a generally planar reflective surface and opposing end walls projecting forwardly from said reflective surface each with a plurality of spaced vertically aligned apertures,

d. a heating element consisting of a plurality of ribbon-type heating element segments suspended within the reflector electrically connected to each other in series through said switch means to obtain varying amounts of heat by selective energization, all of said terminal connections being located on the wall of the reflector closest to the control compartment,

e. insulator members for supporting the suspended heater element passing through the apertures in the reflector end walls, and

f. individual leaf springs having a center body portion and legs extending outwardly therefrom, each of said leaf springs receiving through the center body portion thereof the insulator members passing through the reflector end wall furthest from the control compartment and cooperating with said insulators to maintain said heater element segments taut at all times, said leaf springs being located outside said reflector and each having one leg secured at a point forward of the reflective surface and the other leg secured at a point rearward of the reflective surface whereby the insulators and heater element are positioned forward of and in close proximity to the reflective surface.