May 16, 1939. E. N. CALHOUN 2,158,603

ELECTRIC HEATING APPARATUS

Filed April 13, 1937 2 Sheets-Sheet 1

Fig-1

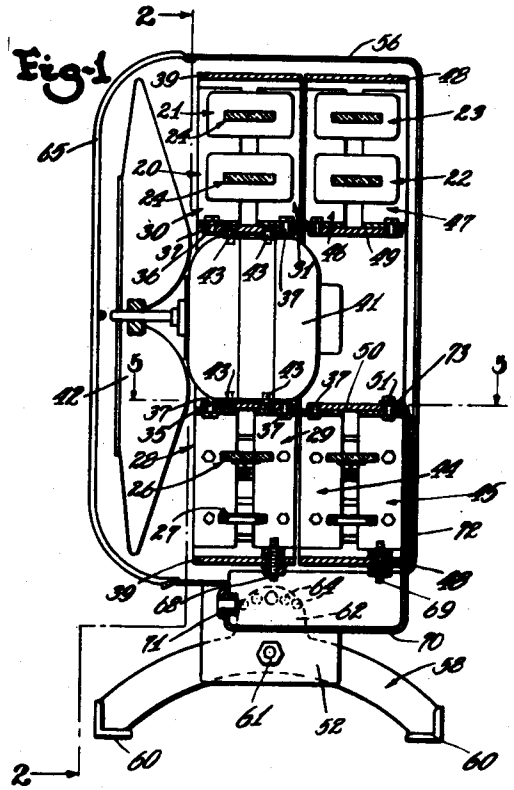


Fig-2

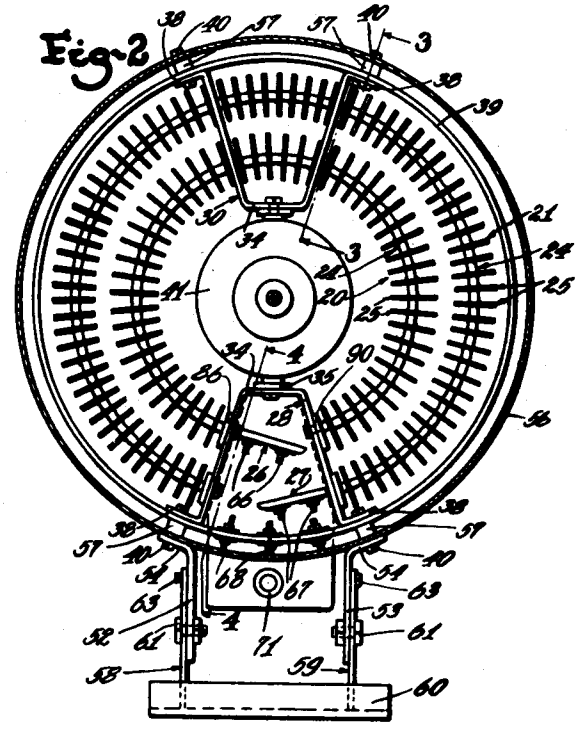


Fig-3

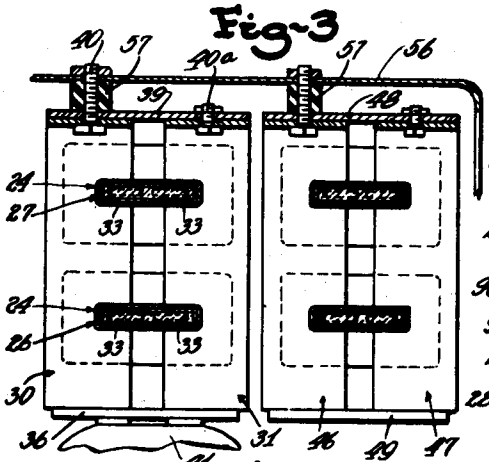


Fig-4

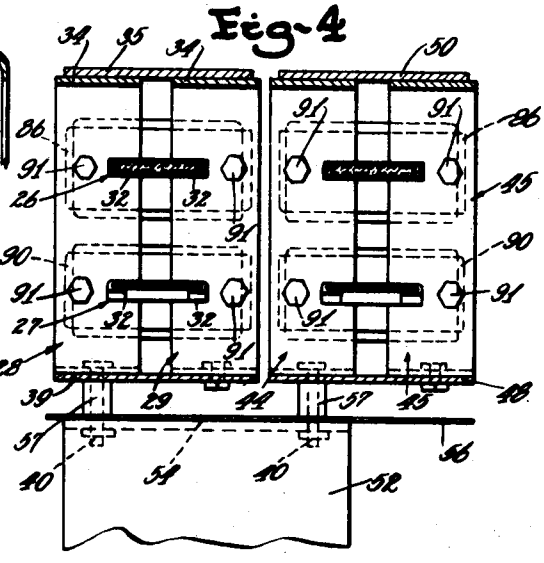
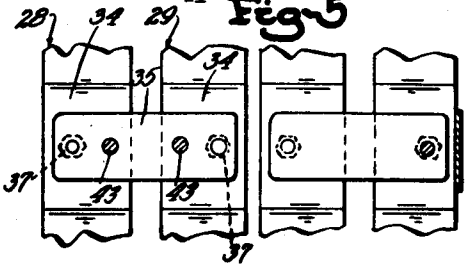


Fig-5



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May 16, 1939. E. N. CALHOUN 2,158,603

ELECTRIC HEATING APPARATUS

Filed April 13, 1937 2 Sheets-Sheet 2

Fig-6

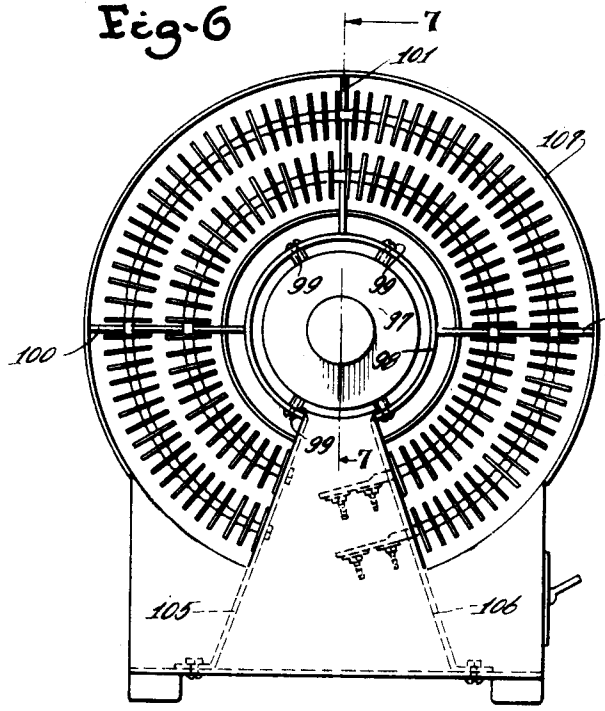


Fig-7

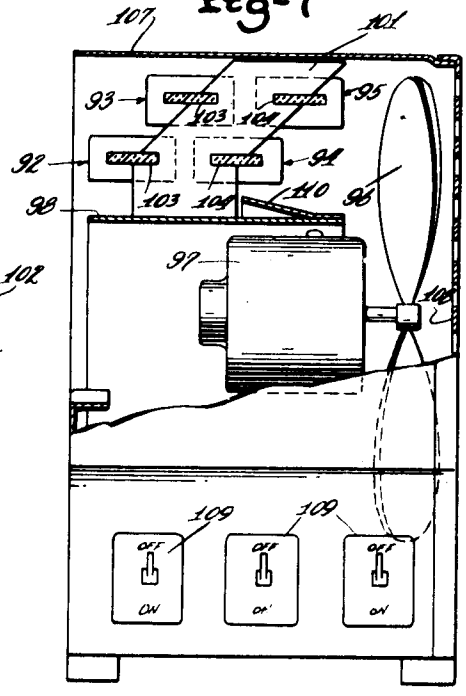


Fig-8

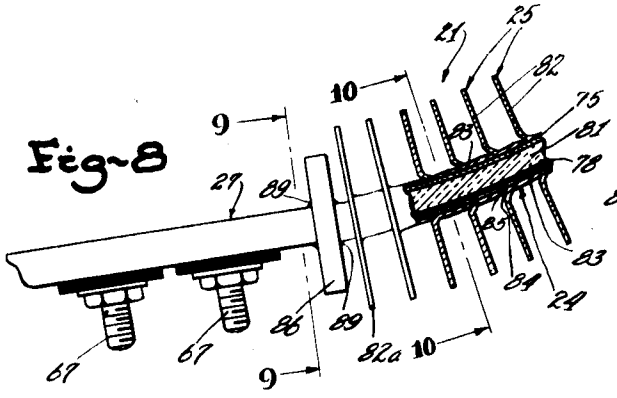


Fig-9

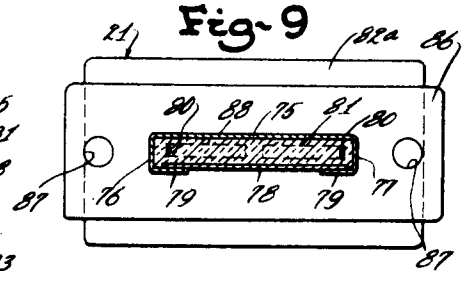


Fig-10

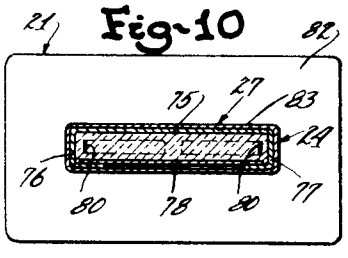
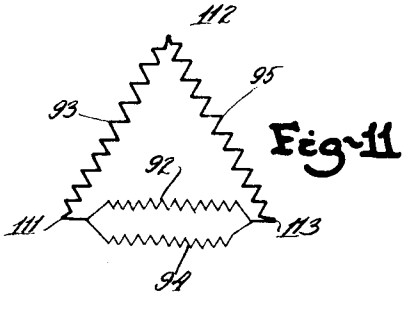


Fig-11



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UNITED STATES PATENT OFFICE

2,158,603

ELECTRIC HEATING APPARATUS

Ernest N. Calhoun, Pittsburgh, Pa., assignor, by mesne assignments, to Edwin L. Wiegand, Pittsburgh, Pa.

Application April 13, 1937, Serial No. 136,588

23 Claims. (Cl. 219—39)

My invention relates to electric heating apparatus, and more particularly to such apparatus of the forced convection or circulation type, and the principal object of my invention is to provide new and improved apparatus of these types. In the drawings accompanying this specification, and forming part of this application, I have shown, for purposes of illustration, several forms which my invention may assume. In these drawings:

Figure 1 is an axial sectional view of heating apparatus embodying my invention,

Figure 2 is a section on the line 2—2 of Figure 1, looking in the direction of the arrows,

Figure 3 is a fragmentary section taken on the line 3—3 of Figure 2, looking in the direction of the arrows,

Figure 4 is a fragmentary section taken on the line 4—4 of Figure 2, looking in the direction of the arrows,

Figure 5 is a fragmentary section taken on the line 5—5 of Figure 1, looking in the direction of the arrows,

Figure 6 is a front elevation of another embodiment of my invention,

Figure 7 is a section, partly in elevation, taken along the line 7—7 of Figure 6,

Figure 8 is a fragmentary view, partly in section, of one end of a heating unit embodying my invention,

Figure 9 is a section taken along the line 9—9 of Figure 8, looking in the direction of the arrows,

Figure 10 is a section taken along the line 10—10 of Figure 8, looking in the direction of the arrows,

Figure 11 is an electrical diagram of one way in which the heating units in the illustrated embodiments of my invention may be connected.

Referring to the embodiment of Figure 1, the heating apparatus here shown comprises four heating units, two of which 20, 21, are concentrically disposed in the same plane, and two others of which, 22, 23, are also concentrically disposed with respect to each other, but in a plane spaced axially from the plane of the first two units, 20, 21. Referring first more particularly to the two units 20, 21, each of these units comprises an arcuate, in this instance nearly circular, general body portion 24 of oblong cross-sectional outline provided with heat dissipating means 25. The primary body portions of each unit are in the form of electric heaters 26, 27 of strip type, bent to arcuate form.

The heating units 20, 21 are here shown as supported at their lower ends by a pair of generally U-shaped brackets 28, 29 disposed on opposite axial sides of the units 20, 21, and the units are also supported by another pair of generally U-shaped brackets 30, 31 here shown as disposed diametrically opposite the other pair of brackets.

Each leg of each of the brackets 28, 29 is provided with two open end slots 32 adapted to receive the bodies of the strip heaters 26, 27. Each leg of each of the brackets 30, 31 is similarly provided with two open end slots 33 to receive the general body portion 24 of the heating units 20, 21.

The bights 34 of the brackets 28, 29, and 30, 31 are here shown as flat and the pair of brackets 28, 29 is connected by a tie plate 35 engaging its bights 34, and the brackets 30, 31 are similarly held together by a tie plate 36, each tie plate being fastened to the engaged bights by threaded studs 37.

All of the brackets 28, 29, 30, 31 are here shown as provided with feet 38 which are fastened to a ring 39 by bolts 40 and 40a.

The brackets 28, 29, 30, 31 also serve to support an electric motor 41 for driving a fan 42. The stator of the motor 41 may be supported by the brackets 28, 29, 31, by screws 43 fastening the stator to the tie plates 35, 36, these tie plates being provided with holes for the passage of the screws, and those holes being countersunk at their radially outer ends, as shown in Figure 1, so that the heads of the screws 43 are disposed flush with the radially inner surface of the bights 34 of the brackets 28, 29, 30, 31.

The heating units 22, 23 are here shown as supported by a lower pair of brackets 44, 45, and an upper pair of brackets 46, 47 identical with the brackets 28, 29, 30, 31 for supporting the units 20, 21. The brackets 44, 45, 46, 47, supporting the units 22, 23 are in turn supported by an outer ring 48 similar to the manner already described in connection with the brackets 28, 29, 30, 31.

The upper pair of brackets, 46, 47, is held together at the bights by a tie plate 49 fastened by studs 37, and the lower pair of brackets 44, 45 is also held together by a tie plate, 50, fastened by a stud 37 through the bracket 44 and a bolt 51 through the bracket 45.

It will be evident that heating apparatus of the type shown in Figure 1 may be built up to include either one or more sets of axially spaced tiers of units, and moreover, each set need not

include two heating units but may include only one, or more than one.

The rings 39, 48 are here shown as supported by two plate brackets 52, 53, the upper ends 54 of which are bent, and these ends have holes through which the bolts 40 are adapted to pass, and in this instance these bolts 40 also serve to fasten the feet 38 of the brackets 28 and 44 to the rings 39 and 48 respectively. In this instance the rings 39, 48 are shown surrounded by a cylindrical housing 56, the housing being spaced somewhat from the rings 39, 48 and spacers 57 being provided around the bolts 40. The plate brackets 52, 53 are here shown as pivotally mounted between a pair of standards 58, 59, welded at their feet to a pair of angle irons 60 whereby the standards are adapted to rest on any suitable support. The pivotal mounting for the plate brackets 52, 53 comprises in this instance a pair of bolts 61. Each standard 58 is here shown as provided with an ear 62 through which threadedly extends a stud 63 adapted to fit freely in any one of a plurality of holes 64 provided in the respective plate brackets 52, 53, so that the heating apparatus may be maintained in the desired position and the blast directed in the desired direction.

The housing 56 may be provided with any suitable form of fan guard 65 and the air enters through this fan guard and is blown by the fan 42 against the heating units 20, 21, flowing against the narrow edges of the general body portions 24 of the heating units and along the wider sides of the body portions, between the fin elements of the heat dissipating means 25, continuing in like manner through other heating units, such as 22, 23, as may be disposed axially further away from the fan, and then emerges at the right hand end of the housing 56.

It will be noted that a sectoral shaped space is provided within the brackets 28, 29, 30, 31 and in this space are disposed the lead-in terminals of the heating units 20, 21, 22, 23. The terminals, 66, 67 of the units 20, 21 respectively are visible in Figure 2. The ring 39 is here shown as provided with three lead-in studs 68, disposed through the ring and insulated therefrom and suitably held by nuts. The terminals 66, 67 of the heating units 20, 21 may be connected in any suitable way to the lead-in studs 68 by conductors (not shown). The ring 48 is similarly provided with three lead-in studs 69, one of which is visible in Figure 1, and these lead-in studs may be in like manner connected to the terminals of the heating units 22, 23.

A connection box 70, hung below the rings 39, 48 is provided, and this connection box has an insulating bushing 71 through which conductors from a supply circuit may be led and connected to the lead-in studs 68, 69 carried by the rings 39, 48. The connection box 70 has one of its side walls, 72, extended upwardly, and is of such sectoral shape as to cover the right hand open end of the space defined by the bracket 45, thus preventing accidental or undesired contact from the outside with the terminals and conductors disposed within the space. The wall 72 is here shown as having its upper end portion 73 bent laterally, perforated, and fastened by the bolts 51.

Referring to one of the heating units 20, 21, 22, 23, in detail, and in particular the detail view of the unit indicated as 21 in Figures 8, 9, and 10, the primary body portion of each unit is in the form of an electric heater of the strip type, but not of rectilinear form, and is here shown as including a sheath comprising a sheet metal channel having a bottom wall 75 and side flanges 76, 77, along with a longitudinally extending strip of sheet metal 78 closing the open side of the channel, the free ends 79 of the flanges 76, 77 being bent against the outside of the closure strip 78.

Disposed within the sheet metal sheath of the strip heater 27 is a resistor 80 which is here shown as a strip of electrical resistance material, the strip being of undulating form and extending longitudinally within the sheath one or more times as may be desired. It will be understood that the resistor 80 may be of any other suitable form. The resistor 80 is insulated from the sheath by insulation 81 disposed within the sheath and in which the resistor 80 is embedded. The insulation 81 is desirably refractory and in particular highly compacted granular refractory material, which, while electrically insulating, is heat conducting.

The heat dissipating means 25 is here shown as comprising fin means. The fin means may be of any suitable form. In the illustrated embodiment the fin means includes a plurality of fin elements 82 spaced longitudinally of the general body portion 24 and extending transversely thereof. Each fin element 82 is, in this instance, integral with one end of an annular collar 83 which is of such form and dimensions as to fit snugly but slidably over the sheath of the strip heater 27. The end of each collar 83 at which the fin element 82 is provided has an opening which has a recess or outward flare 84, and the end 85 of the adjacent collar 83 is adapted to wedge into the recess or flare 84. If desired the end 85 may be slightly beveled to promote entrance of the end 85 into the recess or flare 84.

The fin elements 82 are here shown as of oblong rectangular outline.

The terminals 66, 67 are connected within the sheath to the resistor 80.

Disposed on the sheath of the heater 27, between the right hand terminal 67, as viewed in Figure 8, and the first fin element 82a, is a support member 86, in the form of a plate, in this instance of sufficient length to span the brackets 28, 29. The plate 86 is here shown as provided with two threaded holes 87. The plate 86 is provided with an aperture 88 of the same cross-sectional outline as that of the strip heater 27 and is desirably welded or brazed as at 89, or otherwise suitably fastened to the sheath of the heater 27.

In making such a heating unit 21 as shown in Figure 1 the primary body portion, constituted by the strip type heater 27, may be first completed in the form of a rectilinear strip heater, this strip heater being entirely complete and comprising all of the constructional features hereinbefore pointed out with respect to the strip type heater 27, with the exception that the body portion is rectilinear. The support member 86 is then telescoped over the heater sheath from the end thereof opposite from the terminals 67, until it assumes the position shown in Figure 8, and may be then fastened in position. The finned elements constituted by the collars 83 and fin elements 82 may be then telescoped over the strip heater, and, desirably, enough finned elements are telescoped onto the strip heater so that substantially the entire length of the strip heater is occupied by finned elements. The last, or both the first and last finned element telescoped onto the strip heater may, if desired, be brazed to

the sheath of the strip heater, or otherwise suitably fastened thereto. At the end of the strip heater opposite from the support member 86, the strip heater is desirably provided with another support member, 90, identical with the member 86. At this stage of the process the heating unit comprises a strip heater provided with support members and heat dissipating means, and the general locus of the heating unit, as determined by the strip heater, is rectilinear. The heating unit is then bent to the form shown in Figure 1 in which, as shown, the unit 21 forms nearly a complete circle.

The finned strip heater may be brought to the form shown in Figure 1, manually, by holding the finned strip heater at its ends and bending it around some round object, with its wider side against the round object. Another way is to place the finned strip heater between templates or jigs and press it into shape. Pads may be used on the templates in the form of a rubber coating, for example, to keep the fins from skidding and being bent out of proper spacing. Still another way is to pass the finned strip through bending rolls which may be covered with a padding such as rubber. On the other hand, the unit may also be produced by first bending a strip heater to the desired form and then applying the support members 86, 90 and the fin means thereto.

The support members 86 and 90 serve as a convenient and effective means to fasten the heating units 20, 21 securely to the brackets 28, 29, threaded studs 91 being disposed through holes in the legs of these brackets and engaging, at the other sides of the legs, in the threaded holes 87 of the support members 86 and 90. The units 22, 23 are similarly fastened to the legs of the brackets 44, 45.

Referring now to the embodiment shown in Figures 6 and 7, the heating apparatus here shown comprises two heating units 92 and 93 the planes of which are offset axially, and two heating units 94, 95, spaced axially from the units 92, 93 and the planes of which are similarly offset axially. The heating units may be the same form as the heating units 20, 21, 22, 23 and need not be further described. Air is adapted to be blown against the units 94, 95 and 92, 93 by a fan 96 driven by a motor 97. The motor 97 is here shown as disposed within an arcuate nearly cylindrical bracket 98 and this bracket also serves to support the heating units 92, 93, 94, 95. The motor stator is fastened to the arcuate bracket by means of screws 99.

Extending in a generally radial direction from the arcuate bracket 98 are three supporting plates 100, 101, 102, one of which 101 is visible in side elevation in Figure 7. The radially outermost portion of each supporting plate 100, 101, 102 extends rearwardly diagonally outwardly and the front side of each plate is provided with, in this instance, two open end slots 103 for receiving the general body portions of the heating units 92, 93, and similarly the rear margin of each supporting plate is provided with two open end slots 104 for receiving the general body portions of the units 94, 95, so that the four units are disposed as shown in Figure 7. If desired, the units may be brazed or otherwise fastened to the supporting plates 100, 101, 102. The arcuate bracket 98 may have integral therewithin legs 105, 106, or may be supported by U-shaped brackets such as the brackets 28, 29 of the embodiment of Figure 1, for example, and the lower ends of the heating units 92, 93, 94, 95 may, if desired, be fastened to these legs in the manner similar to that already described in connection with the embodiment of Figure 1.

The heating apparatus shown in Figures 6 and 7 is here shown as provided with a housing 107, and this housing may be provided at its rear end with any desired form of reticulated fan guard 108. In this instance switches 109 for controlling the heating units are shown as mounted on the lower portion of the housing 107.

If desired or necessary a deflecting means 110 may be provided for preventing the air from passing between the arcuate bracket 98 and the inner peripheries of the heating units 92, 94, without contacting these units, by providing, in this instance, a deflecting plate or baffle of frustro-conical form disposed around and fastened to the bracket 98.

Where, as in the illustrated embodiments, four heating units 92, 93, 94, 95 are provided and it is desired that these units be connectable to a three phase alternating current system to constitute a balanced load thereon, the two outer units 93, 95 may be each made so that when connected across a phase of a three phase system, at full voltage, these units will operate at their full capacity; on the other hand, the units 92, 94 may be so made that when each is connected across a phase of a three phase system, at full voltage, each unit will operate at a capacity, one-half that of the outer and longer units 93, 95. In such case connection may be made to the conductors of the three phase system 111, 112, 113, as diagrammatically shown in Figure 11, the unit 93 being connected across the phase 111, 112, and the unit 95 being connected across the phase 112, 113, and the two units 92, 94 being connected in parallel across the phase 111, 113.

From the foregoing it will be apparent to those skilled in the art that each of the illustrated embodiments of my invention provides a new and improved electric heating apparatus, readily and conveniently constructed and assembled, and accordingly, each accomplishes the principal object of my invention. On the other hand, it also will be obvious to those skilled in the art that the illustrated embodiments of my invention may be variously changed and modified, or features thereof, singly or collectively, embodied in other combinations than those illustrated, without departing from the spirit of my invention, or sacrificing all of the advantages thereof, and that accordingly, the disclosure herein is illustrative only, and my invention is not limited thereto.

I claim:

1. In combination: an electrical heating element having an arcuate body portion; means, including plates extending transversely of said body portion and respectively fastened to said body portion near its ends, constructed and arranged to support said heating element; said heating element having an end portion disposed between said plates and having means for receiving electric conductor terminals on said end portion; and removable cover means, extending transversely between said plates, constructed and arranged to prevent undesired access to said terminal receiving means and removable to permit desired access thereto.

2. In combination: an electrical heating element having an elongated body portion; two plates disposed at opposite sides of said body portion and in the same general plane transverse to said body portion; a support element unitary with and extending transversely of said body

portion, said support element being in abutment with said plates; and means fastening said support element to said plates.

3. In combination: an electrical heating element; a fan for directing a stream of air against said heating element; a motor for driving said fan; common means for directly supporting said motor and said heating element, said common means comprising a U-shaped bracket having legs and a web connecting said legs, said legs defining planes transverse to said heating element; and means directly fastening together the web of said U-shaped bracket and said motor.

4. In combination: an electrical heating element having an arcuate body portion comprising a metallic sheath; and means, including a U-shaped bracket the legs of which are respectively fastened to said body portion near its ends, constructed and arranged to support said heating element, said legs defining planes substantially radial with respect to the arc of said body portion.

5. In combination: a fan; a motor for driving said fan; and an arcuate electrical heating element disposed concentrically with the stator of said motor and in the general plane of said stator; said heating element including a resistor embedded in compacted granular refractory insulating material, and a sheet metal sheath having an oblong cross-sectional outline disposed about said insulating material; the narrow edge of said sheath being disposed toward said fan.

6. In combination: an electrical heating element; a fan for directing a stream of air against said heating element; a motor for driving said fan; and means having a portion fastened to the stator of said motor and including supports extending in a generally radially outward direction with respect to said stator, said portion and said supports being bent to form integrally from a single piece of flat metal stock, said means being so constructed and arranged that said supports support said heating element.

7. In combination: an arcuate electrical heating element provided with heat dissipating means including fin elements extending transversely of said heating element; a fan for directing a stream of air against said heating element transversely of the general plane of said heating element; a motor for driving said fan, said motor being concentric with said heating element; and common means for directly supporting said motor and said heating element.

8. In combination: an arcuate electrical heating element provided with heat dissipating means including fin elements extending transversely of said heating element; a fan for directing a stream of air against said heating element transversely of the general plane of said heating element; a motor for driving said fan said motor being concentric with said heating element; and means, fastened to the stator of said motor and including supports disposed across said heating element and between adjacent fin elements, said supports extending in a generally radially outward direction with respect to said stator, said means being constructed and arranged to support said heating element.

9. An electrical heating element, comprising: a body portion; heat dissipating means including longitudinally spaced fin elements provided on and extending transversely of said body portion; a mounting element, materially thicker than one of said fin elements, disposed on said body portion closer to an end of said body portion than any of said fin elements; and means so fastening said mounting elements to said body portion that said mounting element is unitary with said body portion.

10. An electrical heating element, comprising as a unit: a metallic sheath; a resistor disposed within said sheath; means insulating said resistor from said sheath; a metallic element extending transversely of said metallic sheath and fastened thereto, said element having a recess, extending transversely of said element, for receiving means constructed and arranged for fastening said element to a support.

11. In combination: a unitary eletrical heating element including a sheath, a resistor disposed within said sheath, and means insulating said resistor from said sheath; a support element extending transversely of said body portion; means so fastening said support element to said sheath that said support element is unitary with said sheath; a supporting plate extending transversely of said sheath and abutted by said support element; and means, extending through said supporting plate and into said support element, constructed and arranged to fasten together said support element and said supporting plate.

12. An electrical heating element, comprising: an elongated body portion; heat dissipating means including longitudinally spaced fin elements provided on and extending transversely of said body portion; and a mounting element fastened to said body portion closer to an end of said body portion than any of said fin elements, said mounting element extending transversely outwardly from said body portion and having in said outwardly extending portion, the axis of said recess extending in the direction of the said body portion at said mounting element, said recess being adapted to receive means constructed and arranged for fastening said mounting element to a support.

13. An electrical heating element, comprising: an elongated body portion; heat dissipating means including longitudinally spaced sheet metal fin elements provided on and extending transversely of said body portion; and a mounting element, materially thicker than one of said fin elements, disposed on and fastened to said body portion closer to an end of said body portion than any of said fin elements, said mounting element extending transversely outwardly from said body portion and having a recess in said outwardly extending portion, the axis of said recess extending in the direction of the said body portion at said mounting element, said recess being adapted to receive means constructed and arranged for fastening said mounting element to a support.

14. In combination: a fan; a motor for driving said fan; and an arcuate electrical heating element disposed concentrically with the stator of said motor and in the general plane of said stator; said heating element including a resistor embedded in refractory insulating material, and a sheet metal sheath having an oblong cross-sectional outline disposed about said insulating material; the narrow edge of said sheath being disposed toward said fan.

15. In combination: a fan; a motor for driving said fan; an arcuate electrical heating element disposed concentrically with the stator of said motor and in the general plane of said stator; said heating element including a resistor embedded in refractory insulating material, and

a sheet metal sheath having an oblong cross-sectional outline disposed about said insulating material; the narrow edge of said sheath being disposed toward said fan; and heat dissipating means including lonigtudinally spaced fin elements provided on and extending transversely to said sheath.

16. In combination: an electrical heating element having an elongated body portion; two plates disposed at opposite sides of said body portion and in the same general plane transverse to said body portion; said plates having recesses extending in a general plane transverse to said plates and respectively in opposite directions into juxtaposed margins of said plates respectively, opposite sides of said body portion being disposed in said recesses respectively; a support element unitary with said heating element and extending transversely of said body portion, said support element being in abutment with said plates; and means fastening said support element to said plates.

17. In combination: an electrical heating element; a fan for directing a stream of air against said heating element; a motor for driving said fan; common means for directly supporting said motor and said heating element, said common means comprising a U-shaped bracket having legs and a web connecting said legs, said legs being disposed transverse to said heating element and being so constructed and arranged that they engage and support said heating element at points of said legs intermediate said web and the ends of said legs; and means fastening together the web of said U-shaped bracket and said motor.

18. In combination: an electrical heating element; a fan for directing a stream of air against said heating element; a motor for driving said fan; and means having a portion fastened to the stator of said motor and including supports extending in a generally radially outward direction with respect to said stator, said portion and said supports being formed integrally from a single piece of metal stock, said means being so constructed and arranged that said supports engage and support said heating element at points on said supports radially outwardly of said portion.

19. An electrical heating element, comprising: a metallic body portion; a resistor disposed within said body portion, and means insulating said resistor from said body portion; a terminal connected to said resistor and mounted on said body portion; heat dissipating means including longitudinally spaced fin elements provided on and extending transversely of said body portion; a mounting element, materially thicker than one of said fin elements, disposed on said body portion intermediate said terminal and the nearest one of said fin elements; and means so fastening said mounting element to said body portion that said mounting element is unitary with said body portion.

20. An electrical heating element, comprising: a metallic body portion; a resistor disposed within said body portion, and means for insulating said resistor from said body portion; a terminal connected to said resistor and mounted on said body portion; heat dissipating means including longitudinally spaced fin elements provided on and extending transversely of said body portion; a mounting element disposed on said body portion intermediate said terminal and the nearest one of said fin elements; means so fastening said mounting element to said body portion that said mounting element is unitary with said body portion; and said mounting element having a recess extending in the general direction of said body portion at said mounting element.

21. In combination: an electrical heating element having an elongated metallic sheath; a resistor disposed within said sheath, and means insulating said resistor from said sheath; a support element extending transversely of said sheath intermediate the ends of said sheath so as to leave free a part of said sheath between said support element and the nearest end of said sheath; means so fastening said support element to said sheath that said support element is unitary with said sheath; a supporting plate extending transversely of said sheath and abutted by said support element; and means fastening together said support element and said supporting plate.

22. In combination: an electrical heating element having an elongated body portion; heat dissipating means including longitudinally spaced fin elements provided on and extending transversely of said body portion; a support element extending transversely of said body portion and disposed closer to an end of said body portion than any of said fin elements; means so fastening said support element to said body portion that said support element is unitary with said body portion; a supporting plate extending transversely of said body portion and abutted by said support element; and means fastening together said support element and said supporting plate.

23. An electrical heating element, comprising as a unit; an elongated metallic sheath; a resistor disposed within said sheath; means insulating said resistor from said sheath; a metallic element extending transversely of said metallic sheath and fastened thereto intermediate the ends of said sheath so as to leave free a part of said sheath between said metallic element and the nearest end of said sheath; and said metallic element having a recess, extending transversely of said element, for receiving means constructed and arranged for fastening said element to a support.

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