

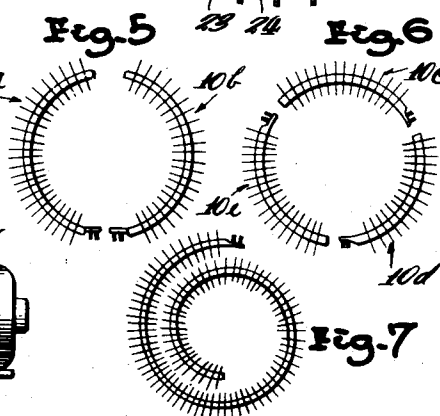
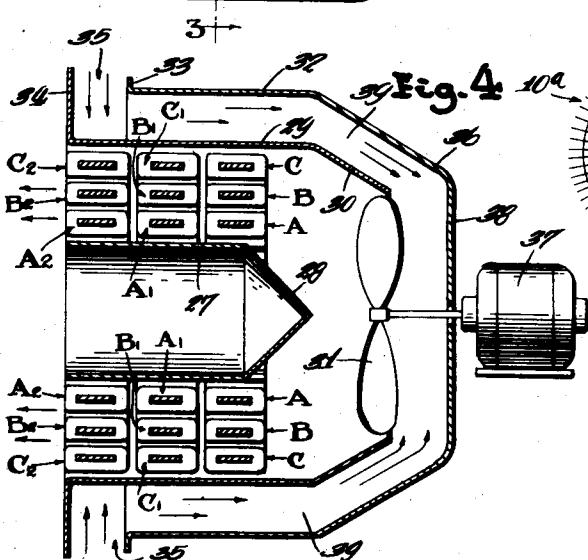
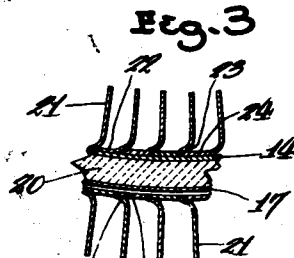
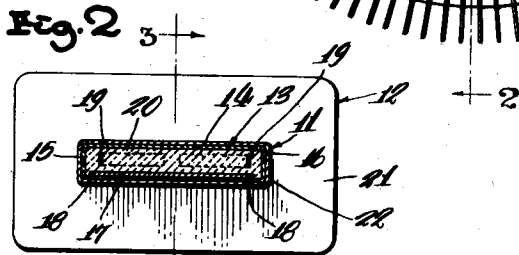
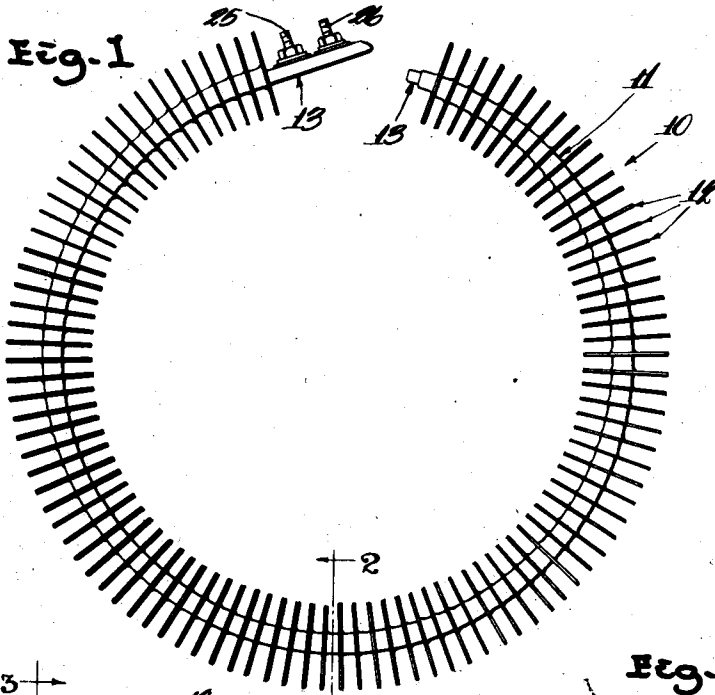
May 16, 1939.

E. L. WIEGAND

2,158,601

ELECTRICAL HEATING APPARATUS AND METHOD OF MAKING THE SAME

Filed April 13, 1937



Edwin L. Wiegand

INVENTOR

By *Freeman, Sweet, Kilbuck, and Wideman*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,158,601

ELECTRICAL HEATING APPARATUS AND
METHOD OF MAKING THE SAME

Edwin L. Wiegand, Pittsburgh, Pa.

Application April 13, 1937, Serial No. 136,590

29 Claims. (Cl. 219—33)

My invention relates to electrical heating apparatus and method of making the same, and is particularly adapted for embodiment in such apparatus of the convection or forced convection type, and the principal object of my invention is to provide new and improved electrical heating apparatus of these types and methods for making the same.

In the drawing accompanying this specification, and forming part of this application, I have shown, for purposes of illustration, several forms which my invention may assume. In this drawing:

Figure 1 is a plan view of heating apparatus in the form of an electrical heating unit embodying my invention,

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

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

Figure 4 is a diagrammatic view of an axial section of electrical heating apparatus, showing one way in which electrical heating units such as shown in Figure 1 may be utilized, and

Figures 5, 6, and 7 are diagrammatic plan views of other embodiments of the invention.

Referring to Figure 1 an electrical heating unit 10 is here shown as comprising a general body portion 11 provided with heat dissipating means 12. The general body portion 11 is of oblong cross-sectional outline, as may be best seen in Figure 2. The primary body portion is in the form of an electric heater 13 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 14 and side flanges 15, 16 along with a longitudinally extending strip of sheet metal 17 closing the open side of the channel, the free ends 18 of the flanges 15, 16 being bent against the outside of the closure strip 17.

Disposed within the sheet metal sheath of the strip heater 13 is a resistor 19 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 19 may be of any other suitable form. The resistor 19 is insulated from the sheath by insulation 20 disposed within the sheath and in which the resistor is embedded. The insulation 20 is desirably refractory and in particular highly compacted granular refractory ma-

terial, which, while electrically insulating, is heat conducting.

The heat dissipating means 12 here shown comprises fin means. The fin means may be of any suitable form. In the illustrated embodiment 5 the fin means includes a plurality of fin elements 21 spaced longitudinally of the general body portion 11 and extending transversely thereof. Each fin element 21 is, in this instance, integral with one end of an annular collar 22 which is of such 10 form and dimensions as to fit snugly but slidably over the sheath of the strip heater 13. The end of each collar 22 at which the fin element 21 is provided has an opening which has a recess or outward flare 23, and the end 24 of the adjacent 15 collar 22 is adapted to wedge into the recess or flare 23. If desired the end 24 may be slightly beveled to promote entrance of the end 24 into the recess or flare 23.

The fin elements 21 are here shown as of oblong 20 rectangular outline.

One end of the body portion of the strip heater 13 is here shown as provided with a pair of terminals 25, 26 connected within the sheath to the resistor 19.

In making such a heating unit 10 as shown in 25 Figure 1 the primary body portion, constituted by the strip type heater 13, may be first completed in the form of a rectilinear strip heater, this strip heater being entirely complete and 30 comprising all of the constructional features hereinbefore pointed out with respect to the strip type heater 13, with the exception that the body portion is rectilinear. The finned elements constituted by the collars 22 and fin elements 21 35 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 heater is occupied by finned elements. The last, or both the first and 40 last finned element telescoped onto the heater may, if desired, be brazed to the sheath of the heater, or otherwise suitably fastened thereto. At this stage of the process the heating unit comprises a strip heater provided with heat dis- 45 sipping 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 10 forms approximately a complete circle. 50 I have found that the rectilinear 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 55

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 fin means thereto.

The unit may be bent to other non-rectilinear forms, as for example in the form of a spiral, as shown in Figure 7, or to other forms not necessarily arcuate. In instances where it may become undesirable to provide a single unit, such as shown in Figure 1, by reason of the undue length of the circumference of a circle which it is desired to have occupied by heating means, two units 10a, 10b may be utilized, as shown in Figure 5, each of which is bent to the form of an approximate semi-circle. This form also has the advantage of reducing the amount of current which must be carried by the terminals of a given unit. In Figure 5 the terminal ends of the two units are shown as disposed adjacent each other so that they may be readily connected respectively to a single pair of lead-in conductors from a source of current (not shown).

In Figure 6 three arcuate units 10c, 10d, 10e, are shown, these units being so formed that together they approximately define a complete circle. The embodiment of Figure 6 may be advantageously used in connection with a three phase source of current (not shown), each one of the units being connected across a different phase of the three phase supply.

Obviously, any number of heating units may be used to complete a circle or define any other desired configuration.

Heating units in accordance with my invention are particularly adapted for use in heating apparatus of the air blast type or in general for forced circulation of fluid. One particular such embodiment is diagrammatically illustrated in Figure 4.

In the apparatus shown in Figure 4 there are three tiers A, B, C, of heating units, disposed in the same general plane, and each of these tiers may comprise a single substantially circular heating unit such as shown in Figure 1, or several heating units, such as shown in Figures 5 and 6. Two more sets of tiers A¹, B¹, C¹, and A², B², C² are shown in Figure 4 and each tier of each of these sets may be constructed and arranged similarly to the first set of tiers. It will be obvious that where there are three sets of tiers with three tiers in each set that the heating units may be most readily connected to a three phase source of current and the load on the three phases balanced. It will of course be understood that the arrangement shown in Figure 4 is merely illustrative, and that the number of units may range from one only to any desired number and any suitable arrangement; and that the source of supply may be alternating current single phase, two phase, three phase, or any other suitable supply of current, with any suitable control means, thermostats, safety cut outs (not shown) as desired and as will be understood by those skilled in the art.

It will be apparent that heating units of the type shown in Figure 7 may also be used in apparatus such as shown in Figure 4.

In Figure 4 the heating units are shown as disposed around and concentric with a cylindrical wall 27, and at the right hand end of the wall 27, as viewed in Figure 4, there is provided a baffle 28 which may be of conical form. Surrounding the outer periphery of the sets of tiers of units is a generally cylindrical housing 29, and within the right hand frusto-conical end 30 of this housing there is disposed a fan 31, driven by a motor 37, for blowing air through the annular passage provided by the cylindrical wall 27 and by the generally cylindrical housing 29. The stream of air directed against the heating units disposed in the annular passage meets the narrow edge of the general body portion of any given unit and passes axially along the wider side of the body portion and between the fin elements, the stream continuing to the next axially adjacent heating units, and so on depending upon the number of heating units disposed axially adjacent to each other.

If desired, the cylindrical housing 29 may have disposed thereabout a jacket including a generally cylindrical wall 32, the left hand end 33 of which is spaced from a flange 34 which may be provided on the cylindrical housing 29, to provide an inlet passage 35. The right hand end 36 of the outer cylindrical wall 32 may be spaced from the wall 30 and formed in any suitable way to house the right hand side of the fan 31, and may be so constructed that the fan motor 37 is outside of the end wall 38 of the jacket. Thus, a passage 39 is provided so that air may enter the inlet 35 and proceed through this passage to the inlet side of the fan 31 and through the fan be directed through the annular passage between the cylindrical wall 27 and the cylindrical housing 29. By passing the air, before it reaches the fan, through the passage 39, the air is pre-heated and at the same time serves as an insulating jacket for the housing 29.

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 electrical 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. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body portion including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; and heat dissipating means on said portion, including a plurality of annular members disposed axially adjacent each other about said portion, said annular members being respectively provided with a transversely extending flange.

2. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body including a heating element comprising a resistor, a sheet metal sheath for said resistor, and means for insulating said resistor from said sheath; and

heat dissipating means on said portion, including a plurality of annular members disposed axially adjacent each other about said portion, said annular members being respectively provided with a transversely extending flange.

second general plane spaced from said first plane and also transverse to said stream of fluid; each of said units having heat dissipating means forming a part thereof and comprising fin means extending transversely of said respective units.

3. The process of making an electrical heating unit which comprises: successively telescoping onto an elongated electrical heating element having a body including a sheet metal sheath the general longitudinal locus of which is substantially rectilinear, a plurality of annular members each provided with a transversely extending flange to form a finned heating element assembly and then bending at least a portion of said assembly so that the general longitudinal locus of said portion is non-rectilinear.

8. In combination: a plurality of electrical heating units the general longitudinal locus of the major portion of each of which is arcuate, said units being disposed in the same general plane with said locuses defining a circle; each of said major portions including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; means for directing a stream of fluid against said units in a direction transversely of said plane; each of said units having heat dissipating means forming a unitary part thereof and disposed on said portions of the respective units and comprising fin means extending transversely of said respective portions.

4. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body portion including a heating element comprising a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; and heat dissipating means on said body portion, including longitudinally spaced sheet metal fin means having elements of cross-section each defining a dihedral angle having a first leg in contact with said body portion and a second leg extending transversely to said first leg at one margin of said first leg so that said second legs of said elements extend transversely of and away from said body portion and are spaced by said first legs.

9. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element including a sheet metal sheath the general longitudinal locus of which is substantially rectilinear, with heat dissipating means including longitudinally spaced fin means by applying to said sheath sheet metal means having elements of cross-section defining a dihedral angle having a first leg and a second leg extending transversely to said first leg at one margin of said first leg, so that the first legs of said elements lie against said sheath and said second legs extend laterally away from said sheath and are spaced by said first legs, and then bending at least a portion of said assembled heat dissipating means and said heating element so that the general longitudinal locus of said portion is non-rectilinear.

5. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body portion including a resistor embedded in compacted granular refractory insulating material, and a sheet metal sheath for said insulating material; and heat dissipating means on said sheath, including longitudinally spaced sheet metal fin means having elements of cross-section each defining a dihedral angle having a first leg in contact with said sheath and a second leg extending transversely to said first leg at one margin of said first leg so that said second legs of said elements extend transversely of and away from said sheath and are spaced by said first legs.

10. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element including a sheet metal sheath the general longitudinal locus of which is substantially rectilinear, with heat dissipating means including longitudinally spaced fin means by applying to said sheath sheet metal means having elements of cross-section defining a dihedral angle having a first leg and a second leg extending transversely to said first leg at one margin of said first leg so that the first legs of said elements lie against said sheath and said second legs extend laterally away from said sheath and are spaced by said first legs, and then bending said assembled heat dissipating means and said heating element so that the general longitudinal locus of the major portion of said unit is arcuate.

6. In combination: a plurality of electrical heating units each having at least a portion the general longitudinal locus of which is non-rectilinear; said portion including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; means for directing a stream of fluid against said units; at least one of said units being disposed in a first general plane transverse to the general direction of said stream of fluid, and at least one other of said units being disposed in a second general plane spaced from said first plane and also transverse to said stream of fluid; each of said units having heat dissipating means forming a part thereof and disposed on said portions of the respective units and comprising fin means extending transversely of said respective portions.

11. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is arcuate; said portion including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; and heat dissipating means on said portion, including a plurality of annular members disposed axially adjacent each other about said portion, said annular members being respectively provided with a transversely extending flange.

7. In combination: at least two electrical heating units the general longitudinal locus of each of which is substantially circular and of substantially the same diameter; each of said units including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; means for directing a stream of fluid against said units; at least one of said units being disposed in a first general plane transverse to the general direction of said stream of fluid, and at least one other of said units being disposed in a

12. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body including a resistor embedded in compacted granular refractory insulating material, a sheet metal sheath for said insulating material; and heat dissipating means on said portion, including a plurality of annular members disposed axially adjacent each other about said sheath at said por-

tion, said annular members being respectively provided with a transversely extending flange.

13. In combination: a plurality of electrical heating units the general longitudinal locus of at least a portion of each of which is arcuate, said units being disposed with said arcuate locuses substantially concentric; each of said portions including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; means for directing a stream of fluid against said units; said units being disposed so that the general planes of said arcuate locuses are transverse to the general direction of said stream of fluid; said portions being respectively of oblong cross-sectional outline, the major axis of a cross-sectional outline corresponding to the general direction of said stream of fluid; and heat dissipating fin means on each of said portions and extending transversely of said respective portions.

14. In combination: an electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear, said body portion having an oblong cross-sectional outline the longer axis of which is transverse to the general plane of said locus; said body portion comprising a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; heat dissipating means mounted on said portion and forming a unitary part of said portion and extending transversely of the longitudinal locus of said portion; and means for directing a stream of air against said unit edgewise of said body portion.

15. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body portion including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath, said body portion having an oblong cross-sectional outline the longer axis of which is transverse to the general plane of said locus; and heat dissipating means on said body portion, including longitudinally spaced sheet-metal fin means having elements of cross-section each defining a dihedral angle having a first leg in contact with said body portion and a second leg extending transversely to said first leg at one margin of said first leg so that said second legs of said elements extend transversely of and away from said body portion and are spaced by said first legs.

16. The process of making an electrical heating unit which comprises: successively telescoping a plurality of annular members, each provided with a transversely extending flange, onto an elongated electrical heating element having a body portion the general locus of which is substantially rectilinear, said body portion including a heating element comprising a resistor, a metallic sheath for said resistor, and means, including refractory material, constructed and arranged to insulate said resistor from said sheath, to form a finned heating element assembly, and then bending at least a portion of said assembly so that the general longitudinal locus of said portion is non-rectilinear.

17. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element including a sheet-metal sheath the general longitudinal locus of which is substantially rectilinear and the cross-sectional outline of which is oblong, with heat dissipating means including longitudinally spaced fin means by applying, to said sheath,

sheetmetal means having elements of cross-section defining a dihedral angle having a first leg and a second leg extending transversely to said first leg at one margin of said first leg, so that the first legs of said elements lie against said sheath and said second legs extend laterally away from said sheath and are spaced by said first legs, and then bending at least a portion of said assembled heat dissipating means and said heating element so that the general longitudinal locus of said portion is non-rectilinear and the general plane of the non-rectilinear locus is transverse to the longer axis of said oblong cross-sectional outline.

18. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element including a sheet-metal sheath the general longitudinal locus of which is substantially rectilinear and the cross-sectional outline of which is oblong, with heat dissipating means including longitudinally spaced fin means by applying, to said sheath, sheet-metal means having elements of cross-section defining a dihedral angle having a first leg and a second leg extending transversely to said first leg at one margin of said first leg so that the first legs of said elements lie against said sheath and said second legs extend laterally away from said sheath and are spaced by said first legs, and then bending said assembled heat dissipating means and said heating element so that the general longitudinal locus of the major portion of said unit is arcuate and the general plane of said arcuate locus is transverse to the longer axis of said oblong cross-sectional outline.

19. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body portion including a heating element comprising a resistor, a sheet-metal sheath for said resistor, and means for insulating said resistor from said sheath, said insulating means including compacted granular refractory material; and heat dissipating means on said portion, including a plurality of annular members disposed axially adjacent each other about said portion, said annular members being respectively provided with a transversely extending flange.

20. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear, said body portion having an oblong cross-sectional outline the longer axis of which is transverse to the general plane of said non-rectilinear locus; said body including a resistor embedded in compacted granular refractory insulating material, a sheet-metal sheath for said insulating material; and heat dissipating means on said portion, including a plurality of annular members disposed axially adjacent each other about said sheath at said portion, said annular members being respectively provided with a transversely extending flange.

21. An electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body portion including a resistor embedded in compacted granular refractory insulating material, and a sheet-metal sheath for said insulating material, said body portion having an oblong cross-sectional outline the longer axis of which is transverse to the general plane of said locus; and heat dissipating means on said sheath, including longitudinally spaced sheet-metal fin means having elements of cross-section each defining a dihedral angle having a first leg in contact with said

sheath and a second leg extending transversely to said first leg at one margin of said first leg so that said second legs of said elements extend transversely of and away from said sheath and are spaced by said first legs.

22. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element the general longitudinal locus of which is substantially rectilinear, with heat dissipating means including longitudinally spaced fin means extending transversely of the longitudinal locus of said heating element, said heat dissipating means including portions integral with said fin means for spacing said fin means longitudinally, and then bending at least a portion of said assembled heat dissipating means and said heating element so that the general longitudinal locus of said portion is non-rectilinear.

23. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element the general longitudinal locus of which is substantially rectilinear, with heat dissipating means including longitudinally spaced fin means extending transversely of the longitudinal locus of said heating element, said heat dissipating means including portions surrounding said element and integral with said fin means for spacing said fin means longitudinally wedging said spacing portions telescopically into each other, and then bending at least a portion of said assembled heat dissipating means and said heating element so that the general longitudinal locus of said portion is non-rectilinear.

24. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element having an oblong cross-sectional outline and having a general longitudinal locus which is substantially rectilinear, with heat dissipating means including longitudinally spaced fin means extending transversely of the longitudinal locus of said heating element, said heat dissipating means including portions integral with said fin means for spacing said fin means longitudinally, and then bending at least a portion of said assembled heat dissipating means and said heating element so that the general longitudinal locus of said portion is non-rectilinear and the general plane of said non-rectilinear locus is transverse to the longer axis of said oblong cross-sectional outline.

25. The process of making an electrical heating unit which comprises: providing an elongated electrical heating element having an oblong cross-sectional outline and having a general longitudinal locus which is substantially rectilinear, with heat dissipating means including longitudinally spaced fin means extending transversely of the longitudinal locus of said heating element, said heat dissipating means including portions surrounding said element and integral with said fin means for spacing said fin means longitudinally, wedging said spacing portions telescopically into each other, and then bending at least a portion of said assembled heat dissipating means and said heating element so that the general longitudinal locus of said portion is non-rectilinear and the general plane of said

non-rectilinear locus is transverse to the longer axis of said oblong cross-sectional outline.

26. In combination: an electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear, said body portion having an oblong cross-sectional outline the longer axis of which is transverse to the general plane of said locus; said body portion including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; and heat dissipating means mounted on said portion and forming a unitary part of said portion and including fin means extending transversely of the longitudinal locus of said portion.

27. In combination: an electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear; said body portion including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; heat dissipating means mounted on said body portion and forming a unitary part of said portion and including longitudinally spaced fin means extending transversely of the longitudinal locus of said portion; and said heat dissipating means including portions surrounding said body portion and integral with said fin means so constructed and arranged as to space said fin means longitudinally, said spacing portions being so constructed and arranged that they are telescopically wedged into each other.

28. In combination: an electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear, said body portion having an oblong cross-sectional outline and including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; heat dissipating means mounted on said body portion and forming a unitary part of said portion and including longitudinally spaced fin means extending transversely of the longitudinal locus of said portion; and said heat dissipating means including portions surrounding said body portion and integral with said fin means so constructed and arranged as to space said fin means longitudinally, said spacing portions being so constructed and arranged that they are telescopically wedged into each other.

29. In combination: an electrical heating unit having a body having at least a portion the general longitudinal locus of which is non-rectilinear, said body portion having an oblong cross-sectional outline the longer axis of which is transverse to the general plane of said locus; said body portion including a resistor, a metallic sheath for said resistor, and means for insulating said resistor from said sheath; heat dissipating means mounted on said portion and forming a unitary part of said body portion and including longitudinally spaced fin means extending transversely of the longitudinal locus of said portion; and said heat dissipating means including portions surrounding said body portion and integral with said fin means for spacing said fin means longitudinally, said spacing portions being so constructed and arranged that they are telescopically wedged into each other.

EDWIN L. WIEGAND.