Nov. 29, 1960 J. K. JAKUBOWSKI 2,962,683

ELECTRIC HEATING UNITS AND METHODS OF MAKING THE SAME

Filed Oct. 18, 1957

FIG 1

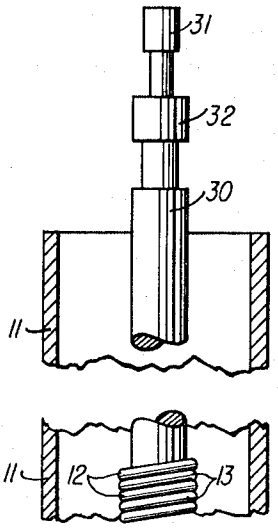


FIG 2

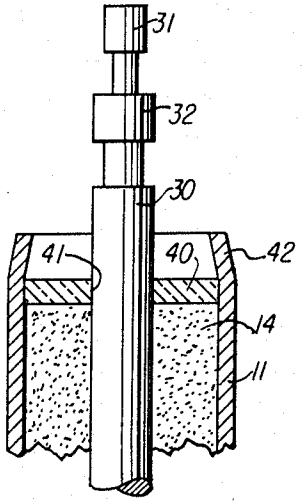


FIG 3

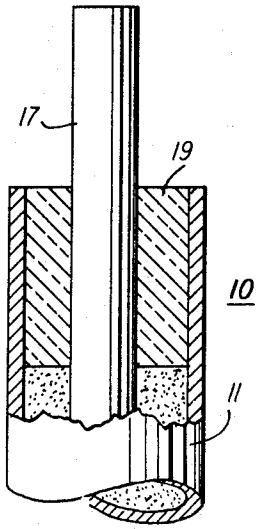


FIG 1A

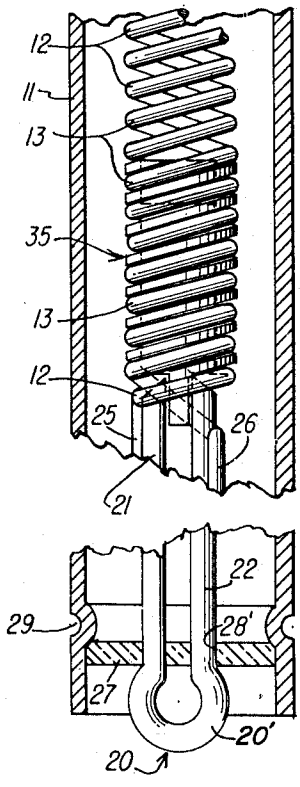
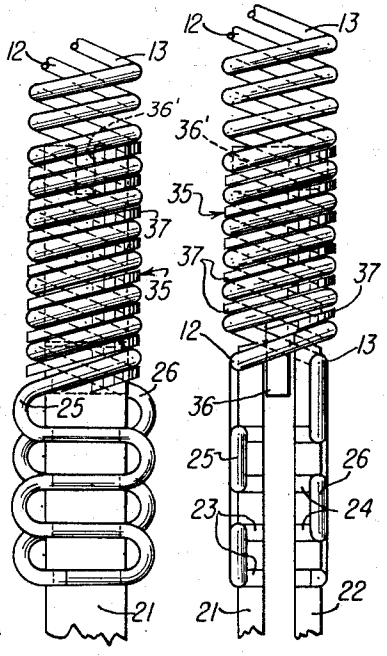
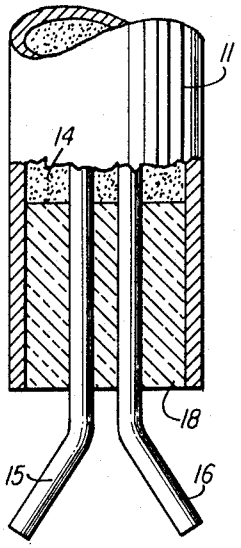


FIG 1B





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ELECTRIC HEATING UNITS AND METHODS OF MAKING THE SAME

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7 Claims. (Cl. 338—240)

The present invention relates to electric heating units of the sheathed resistance conductor type and to methods of making the same.

It is a general object of the invention to provide an improved electric heating unit of the sheathed resistance conductor type and comprising a pair of elongated helical resistance conductors arranged in bifilar spaced-apart relation, a corresponding pair of conductive terminals respectively electrically connected to the adjacent ends of the resistance conductors, an elongated metallic sheath enclosing the resistance conductors and the inner ends of the conductive terminals, with the outer ends of the conductive terminals projecting from the adjacent ends of the sheath, and a dense mass of highly compacted refractory material embedding the resistance conductors and the inner ends of the conductive terminals and retaining the resistance conductors and the conductive terminals in proper spaced-apart relation with respect to each other and with respect to the sheath.

Another object of the invention is to provide a method of making an electric heating unit of the sheathed resistance conductor type of the character described, wherein the method involves improved steps that positively insure maintenance of proper spacing of the turns of the helical resistance conductors and of the conductive terminals therefor incident to the manufacture of the heating unit, and particularly during a compacting step involved in the method of manufacture thereof.

A further object of the invention is to provide in an electric heating unit of the character described, an improved connection and arrangement between the inner ends of the conductive terminals and the outer ends of the helical resistance conductors that are wound in bifilar relation.

A still further object of the invention is to provide an improved method of making the electrical connections between the inner ends of the conductive terminals and the outer ends of the resistance conductors wound in bifilar relation in an electric heating unit of the character described.

Further features of the invention pertain to the particular arrangement of the elements of the electric heating unit and of the steps of the method, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawing, in which:

Figure 1 is an enlarged fragmentary sectional view of a partial assembly that is employed in making an electric heating unit of the sheathed resistance conductor type in accordance with the method of the present invention;

Fig. 1A is a greatly enlarged fragmentary plan view of the electrical connections between the inner ends of the pair of conductive terminals and the outer ends of the

pair of resistance conductors wound in bifilar relation, as shown in Fig. 1;

Fig. 1B is another greatly enlarged fragmentary side elevational view, similar to Fig. 1A, illustrating the electrical connections mentioned;

Fig. 2 is an enlarged fragmentary sectional view of the upper end of the complete assembly, similar to Fig. 1, that is employed in making the heating unit in the present method; and

Fig. 3 is an enlarged fragmentary sectional view of the finished heating unit embodying the features of the present invention.

Referring now to the drawing, the electric heating unit **10** there illustrated, and embodying the features of the present invention and made in accordance with the method thereof, fundamentally comprises an elongated tubular metallic sheath **11** that may be formed of a suitable nickel-chromium-iron alloy and having a substantially circular cross-section, and a pair of elongated helical resistance conductors **12** and **13** that may be formed of a suitable nickel-chromium alloy and arranged in bifilar relation and located substantially centrally within the sheath **11** and embedded in a body **14** of heat-conducting and electrical-insulating material that may be formed essentially of magnesium oxide. Also the unit **10** comprises a pair of elongated conductive terminals **15** and **16** (Fig. 3) arranged at one end of the sheath **11** and respectively electrically connected at the inner ends thereof to the adjacent outer ends of the resistance conductors **12** and **13**, as well as a single elongated conductive terminal **17** arranged in the other end of the sheath **11** and commonly electrically connected at the inner end thereof to the adjacent outer ends of the resistance conductors **12** and **13**. Thus the helical resistance conductor **12** extends between the terminals **15** and **17**, while the helical resistance conductor **13** extends between the terminals **16** and **17**. Accordingly, it will be understood that the resistance conductors **12** and **13** may be individually electrically energized between the terminal pairs **15—17** and **16—17**. Also the resistance conductors **12** and **13** may be energized in parallel relation between the terminals **15—16** and the terminal **17**, and may be energized in series relation between the terminals **15** and **16**.

Finally, suitable insulating plugs **18** and **19** (formed of glass, ceramic material, etc.) are respectively provided in the opposite ends of the sheath **11** so as respectively to seal the same against the entrance of moisture thereinto. In the arrangement, the plug **18** embeds the intermediate sections of the terminals **15** and **16**, while the plug **19** embeds the intermediate section of the terminal **17**.

In the manufacture of the heating unit **10**, as shown in Fig. 3, there is first produced the assembly illustrated in Fig. 1; and initially there is provided a lower conductive element **20**, from which the terminals **15** and **16** are ultimately fashioned, and an upper conductive element **30** from which the terminal **17** is ultimately fashioned. More particularly, the element **20** is of substantially U-shape and may comprise a structure resembling a cotter pin; that is to say, the element **20** is provided with a pair of elongated broad legs **21** and **22** arranged in substantially parallel spaced-apart relation, and a connecting junction **20'** having a general loop-like formation and extending between the outer ends of the legs **21** and **22**. The parts of the element **20** are formed integral with each other, and this element may be formed of carbon steel (S.A.E. 1020).

To obtain optimum contact area of the end portions of the resistance conductors **12** and **13** with the respective terminals **15** and **16**, while maintaining the end portions of the conductors **12** and **13** at maximum separation, one from the other, the legs **21** and **22** are arranged so that the end portions of the conductors **12**

and 13 are in electrical connection therewith only on the surfaces thereof which are facing the immediately adjacent portions of the wall of the sheath 11. Specifically, the terminal end of the conductor 12 is disposed wholly on the left-hand wall of the leg 21 and the terminal end of the conductor 13 is disposed wholly on the right-hand wall of the leg 22, as viewed in Fig. 1. Further to improve the connections of the conductors 12 and 13 with the terminal legs 21 and 22, and as best shown in Figs. 1A and 1B; a plurality of longitudinally spaced-apart serrations, or grooves, 23 are formed in the surface of the inner end of the leg 21 and a plurality of similarly complementary serrations, or grooves, 24 are formed in the surface of the inner end of the leg 22. In arrangement, the grooves 23 and 24 are complementary, and as illustrated, they are arranged in concentric alignment with respect to each other, but this detail of construction is not essential. In a preferred form of the invention, one terminal of the helical resistance conductor 12 terminates in a flat sinuous extension 25 of which the convolutions are arranged in back-and-forth relation through the outer portions of the respective grooves 23 formed in the leg 21, and staked and welded in place in any suitable manner. Likewise, one terminal of the helical resistance conductor 13 terminates in a flat sinuous extension 26 of which the convolutions are arranged in back-and-forth relation through the outer portions of the respective grooves 24 formed in the leg 22, and staked and welded in place in any suitable manner.

In producing the assembly of Fig. 1, the two elongated resistance conductors 12 and 13 are provided and then wound in bifilar relation upon an associated mandrel, not shown; and subsequently the adjacent outer ends thereof at the one end of the winding are separated and fashioned to form the respective convoluted extensions 25 and 26, as previously described.

The element 20 is preformed with the serrations 23 and 24 respectively provided in the legs 21 and 22 thereof, as previously described; thereafter a suitable washer 27 of substantially annular form and having a pair of holes 28 formed therethrough is threaded upon the legs 21 and 22 of the element 20. In the arrangement, the spacing between the holes 28 formed in the washer 27 are arranged to receive and position the junction 20' on the outer side of the washer 27. Also, there is provided a crushable plug or bushing 35 formed of a suitable electrical-insulating and heat-conducting refractory material, a suitable such refractory material being magnesia. The preformed bushing 35 is substantially of cylindrical configuration and comprises a tongue 36 disposed on one end thereof and a slot 36' disposed on the other end thereof, the tongue 36 being adapted to be inserted between the extreme outer ends of the legs 21 and 22 of the lower fixture 20, and the slot 36' being adapted to receive the tongue 36 provided on still another of the bushing 35, not shown. Also the bushing 35 is formed to have two bifilar threads 27 disposed in helical arrangement about the barrel thereof that are adapted to be arranged between the adjacent coil sides of the helical resistance conductors 12 and 13, as shown in Figs. 1A and 1B.

In producing the assembly, one or more of the bushings 35 are arranged in the one end of the composite winding of the helical resistance conductors 12 and 13 adjacent to the extensions 25 and 26, and with the threads 37 positioning the turns of the helical resistance conductors 12 and 13 in proper spaced-apart relation, as clearly shown in Figs. 1A and 1B.

The element 20 carrying the washer 27 is then arranged within the one end of the composite winding so that the legs 21 and 22 thereof cooperate with the convolutions of the respective extensions 25 and 26, and particularly so that the convolutions of the extension 25 fall within the grooves 23 formed in the leg 21 and so that the convolutions of the extension 26 fall within the grooves 24 formed in the leg 22. At this time, the extension 25 is suitably staked and welded in place upon the leg 21, and similarly the extension 26 is suitably staked and welded in place upon the leg 22. Also, at this time, the tongue 36 provided on the adjacent end of the bushing 35 occupies its position projected between the adjacent ends of the legs 21 and 22.

The element 30 is preformed and includes two knobs 31 and 32 disposed on the outer extremity thereof for cooperation with parts of a conventional loading machine, as described more fully hereinafter; while the inner end of the element 30 is inserted within the other ends of the resistance conductors 12 and 13 at the other end of the composite winding and suitably welded in place in any suitable manner.

At this time, a subassembly is produced that includes the composite winding of the resistance conductors 12 and 13 wound in bifilar relation, the lower element 20 carrying the washer 27, the upper element 30, and the bushing 35. The upper ends of the resistance conductors 12 and 13 are commonly connected to the inner end of the upper element 30, and the lower ends of the resistance conductors 12 and 13 are respectively connected to the inner end of the legs 21 and 22 of the lower element 20, in this subassembly.

The tubular metallic sheath 11 is provided; and the lower end thereof has an inwardly projecting annular bead 29 formed therein that is adapted to cooperate with the washer 27 carried by the lower element 20 of the subassembly, as previously described. The subassembly is pre-stretched to about three-quarters of the length of the sheath 11, whereupon the assembly of Fig. 1 is produced by threading the tubular sheath 11 over the upper end of the subassembly, previously described, so that the bead 29 provided on the lower end of the sheath 11 engages the periphery of the washer 27 carried by the lower element 20; and at this time, the upper end of the upper element 20 projects from the upper end of the sheath 11.

The assembly is then worked in to a suitable loading machine that may be of the character of that disclosed in U.S. Patent No. 2,316,659, granted on April 13, 1943, to John L. Andrews; whereby the parts 31 and 32 of the upper element 30 cooperate with the head, not shown, of this loading machine, so as to retain the composite bifilar winding in depending position from the upper head and substantially centrally within the tubular sheath 11 and spaced therefrom. More particularly, at this time, the assembly of Fig. 1 is arranged in a substantially vertical position in the loading machine; and the loading machine is operated in a conventional manner; whereby a charge of finely divided magnesia is introduced into the upper end of the sheath 11 adjacent to the upper element 30 and falls downwardly through the sheath 11 upon the washer 27 so as first to embed the legs 21 and 22 of the lower element 20 and the extensions 25 and 26 provided on the conductors 12 and 13. In the loading machine, the washer 27 serves the stopper function; and as the loading machine is operated, the sheath 11 is filled with the magnesia, thereby subsequently embedding the turns of the helical resistance conductors 12 and 13, the plug 35 and ultimately embedding the inner end of the upper element 30. As the loading machine is operated, the magnesia that is introduced into the sheath 11 is tamped in place so as to provide a firm packing of the magnesia embedding the elements of the assembly disposed within the sheath 11 and retaining the same in proper spaced-apart relation.

After filling of the sheath 11, the assembly is removed from the loading machine mentioned and the upper end of the sheath 11 is closed by an associated insulating washer 40 that is provided with a central hole 41 therethrough, through which the upper element 30 is threaded. More particularly, as shown in Fig. 2, after the washer 40 has been placed in the upper end of the sheath 11 to serve as a stopper for the packing of magnesia 14,

the extreme upper end of the sheath **11** is swedged inwardly as indicated at **42**, so as to retain the washer **40** in place. At this time, the lower end of the sheath **11** is closed by the washer **27** and the upper end of the sheath **11** is closed by the washer **40**; and the packing **14** of magnesia arranged within the sheath **11** between the washers **27** and **40** retains the elements of the assembly disposed within the sheath **11** in proper spaced-apart relation.

At this time, the assembly thus produced, as indicated in Fig. 2, is transferred to a suitable rolling machine that may be of the character of that disclosed in U.S. Patent No. 2,677,172, granted on May 4, 1954, to Sterling A. Oakley; and the rolling machine is operated in order to subject the assembly to a compacting step, during which the supported assembly moves through the several cold rolling passes of the rolling machine; whereby the diameter of the sheath **11** is substantially reduced in cross-sectional area, as respectively indicated in Figs. 2 and 3. Accordingly, the firm packing of magnesia **14** is substantially compressed, the highly compacted dense composite body of the refractory material **14** embedding the helical resistance conductors **11** and **12**, and retaining the same in spaced-apart relation with respect to each other and with respect to the sheath **11**. The dense mass **14** of compacted refractory material also positions and retains in place the lower element **20** in the lower end of the sheath **11** and the upper element **30** in the upper end of the sheath **11**.

In the rolling step, the bushing **35** is crushed, and forms a part of the body of magnesia that is highly compacted to produce the dense mass **13**, as previously described. In the rolling step, there is no damage to the rolls of the rolling machine by virtue of the fact that the bushing **35** is readily crushable so that the cushioned material thereof, along with the introduced body of magnesia, is ultimately productive of the dense mass **14**.

As previously noted, only one of the bushings **35** has been illustrated in the assembly in Fig. 1B, but it will be understood that a plurality of such bushings may be provided; and furthermore, if desired, one or more of such bushings may be disposed and arranged along the longitudinal extension of the composite winding and within the helical resistance conductors **12** and **13** wound in bifilar relation. However, the last-mentioned arrangement is not normally required, as the helical resistance conductors **12** and **13** normally retain their proper spacing in the rolling operation without the utilization of such bushings **35** in the intermediate extensions thereof, since the filling of magnesia introduced in the loading machine also occupies the central core area within the helical resistance conductors **12** and **13**, the spacing between the helical turns thereof, as well as the space between the composite winding and the adjacent wall of the tubular sheath **11**.

Following the rolling step, the assembly is removed from the rolling machine and the lower and upper ends of the sheath **11** are cut off; and also the junction **20'** of the lower element **20** is cut off and the extreme upper end of the upper element **30** is cut off. When the junction **20'** of the lower element **20** is thus cut off, the two distinct terminals **15** and **16** are produced, and they are bent outwardly in order to accommodate exterior electrical connections, as indicated in Fig. 3. Likewise, when the extreme upper end of the upper element **30** is thus cut off, the terminal **17** is produced. Ultimately the plugs **18** and **19** are cast into the opposite ends of the tubular sheath **11** so as to seal the same and to produce the finished heating unit, as shown in Fig. 3.

After manufacture of the heating unit **10**, it is ordinarily subjected to the usual electrical tests in order to determine the characteristics thereof (insulation resistance, heat distribution, etc.) that are pertinent to the performance and expected life thereof in service.

As a constructional example of the manufacture of the heating unit **10**, the tubular sheath **11** may have an initial diameter of 0.312" and a final diameter of 0.277"; the resistance conductors **12** and **13** may be formed of #31A (B. & S.) gauge wire having a diameter of about 0.0089"; the plug **35** may have a length of about ½" and a barrel diameter of about 0.150", the pins **37** projecting therefrom about 0.025"; and the legs **21** and **22** of the element **20** may have an initial length of about 3½", an overall outside diameter between the outer surfaces of the legs **21** and **22** of about 0.219". These dimensions are in no way particularly critical as long as suitable spacing is produced thereby; and it is not important that the resistance conductors **12** and **13** be of the same gauge resistance wire. In fact, it is conventional to form the resistance conductors **12** and **13** of different gauges of resistance wire (for example #30A and #31A) in order to obtain different wattages from the respective resistance conductors **12** and **13**.

The composite heating unit **10** is particularly well-suited to the manufacture of heating elements for electrical appliances, such, for example, as the surface cooking unit of an electric range. In forming such a cooking unit from the heating unit **10**, it is conventional to wind the unit **11** in a substantially helical form and then to flatten the upper surface of the sheath **11** so as to provide a plateau upon the resulting heating element for the support of a cooking vessel, or the like, to be heated. Also this flattening of the top surface of the sheath **11** of the unit **10** in the ultimate heating element effects further tightening and compacting of the dense mass of refractory material **14**, thereby eliminating any cracks or fissures that might be produced therein incident to the winding of the unit **10** in the helical form or configuration, as previously noted, in the formation of the ultimate heating element.

In the manufacture of the heating unit **10**, it will be appreciated that the bushing **35** is useful in the loading step in order to prevent any substantial bending of the resistance conductors **12** and **13** adjacent to the extensions **25** and **26** thereof, or other relative movement between this one end of the composite winding and the lower element **20**. This elimination of such bending of the resistance conductors **12** and **13** adjacent to the lower element **20** in the loading step is very advantageous as it prevents the possibility of damage to the electrical connections between the respective resistance conductors **12** and **13** and the respective legs **21** and **22** of the lower element **20**. Also the arrangement of the strong cotter pin-like construction of the lower element **20**, both in the loading step and in the subsequent rolling step, is very advantageous as it positively prevents displacement of the legs **21** and **22** with respect to each other and with respect to the sheath **11**, thereby positively to insure proper desired spacing of the ultimately fashioned terminals **15** and **16** in the finished heating unit **10**.

A modification of the heating unit **10** is contemplated in which the resistance conductors **12** and **13** are provided with individual terminals at both ends of the sheath **11**; in other words, each end of this finished heating unit of the modified construction mentioned is identical to the lower end thereof, as illustrated in Fig. 3. Of course, in this modified construction the two resistance conductors **12** and **13** are entirely electrically independent of each other, although they are wound in bifilar relation, as previously explained.

The manufacture of the modified form of the heating unit is in nowise particularly different from that previously described, except that the element **20** is employed at both ends of the composite bifilar winding and projects from both ends of the tubular sheath **11** during the carrying out of the loading and rolling steps. Of course, in the ultimate formation of the modified form of this heating unit, the severing of the junctions **20'** from the two elements **20** is productive of the two pairs of

terminals at the opposite ends of the tubular sheath 11, in an obvious manner.

In view of the foregoing, it is apparent that there has been provided both an electric heating unit of improved construction and arrangement and an improved method of making the same, that may be readily carried out upon a mass production basis for commercial purposes thereby materially contributing to the economical manufacture of such heating units.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electric heating unit comprising a pair of elongated helical resistance conductors arranged in bifilar relation with a turn of one of said resistance conductors arranged between each two adjacent turns of the other of said resistance conductors and with the turns of said resistance conductors in spaced relation, an elongated tubular metallic sheath enclosing said resistance conductors and spaced therefrom, a pair of elongated terminals arranged in one end of said sheath and projecting therefrom to the exterior, said terminals being spaced mutually from each other and from said sheath, the end of one of said resistance conductors terminating in a flat sinuous extension threaded back and forth through a number of grooves formed in the inner end of one of said terminals and welded in place to provide an electrical connection therebetween, the end of the other of said resistance conductors terminating in a flat sinuous extension threaded back and forth through a number of grooves formed in the inner end of the other of said terminals and welded in place to provide an electrical connection therebetween, the inner end of said one terminal being spaced from the adjacent end of said other resistance conductor and the inner end of said other terminal being spaced from the adjacent end of said one resistance conductor, and a dense mass of compacted refractory material arranged in said sheath and embedding said resistance conductors and the inner ends of said terminals, said refractory material retaining said resistance conductors and said sheath in mutually spaced-apart relation and also retaining said terminals and said sheath in mutually spaced-apart relation.

2. The electric heating unit set forth in claim 1, wherein the grooves formed in the inner end of each of said terminals are formed in the outer surface thereof disposed remote from the surface of the inner end of the adjacent terminal.

3. The method of making an electric heating unit of the sheathed resistance conductor type, which comprises: providing a pair of elongated resistance conductors, winding said resistance conductors into helical form in bifilar relation with a turn of one of said resistance conductors arranged between each two adjacent turns of the other of said resistance conductors, arranging common end portions of the respective conductors in parallel spaced relation, providing a conductive member of one-piece construction and having a U-shape including a pair of elongated rigid legs extending from a loop-like junction in spaced relation with respect to each other, interposing said legs between said common end portions and securing said end portions respectively to oppositely facing surfaces of said legs electrically to connect therewith over respective substantial surface areas thereof, providing an elongated tubular metallic sheath, enclosing said winding of said resistance conductors in said sheath and in spaced relation therewith and arranging said junction exteriorly of the adjacent one end of said sheath with the ends of said legs projecting thereinto and in spaced relation therewith, loading a charge of refractory material into said sheath in embedding relation with said resistance conductors and the ends of said legs and so as to retain the same in place in spaced relation with respect to said sheath, working the assembly of said elements named to reduce the cross-sectional area of said sheath in order to compact said charge of refractory material into a dense mass still embedding and retaining in place said resistance conductors and the ends of said legs, and then severing said junction from the portions of said legs projecting from the adjacent one end of said sheath to define a pair of separate and distinct terminal members for the adjacent ends of said resistance conductors at said one end of said sheath.

4. The method of making an electric heating unit of the sheathed resistance conductor type, which comprises: providing a pair of elongated resistance conductors, winding said resistance conductors into helical form in bifilar relation with a turn of one of said resistance conductors arranged between each two adjacent turns of the other of said resistance conductors, forming a pair of flat sinuous extensions on the respective ends of said resistance conductors at one end of said winding, providing a conductive member of one-piece construction and having a U-shape including a pair of elongated rigid legs extending from a loop-like junction in spaced relation with respect to each other and with each of said legs having a number of grooves formed in the surface of the end thereof remote from said junction, respectively connecting said pair of extensions to said pair of legs with each extension threaded back and forth through the grooves formed in the connected leg and welded in place, providing an elongated tubular metallic sheath, enclosing said winding of said resistance conductors in said sheath and in spaced relation therewith and arranging said junction exteriorly of the adjacent one end of said sheath with the ends of said legs projecting thereinto and in spaced relation therewith, loading a charge of refractory material into said sheath in embedding relation with said resistance conductors and the ends of said legs and so as to retain the same in place in spaced relation with respect to said sheath, working the assembly of said elements named to reduce the cross-sectional area of said sheath in order to compact said charge of refractory material into a dense mass still embedding and retaining in place said resistance conductors and the ends of said legs, and then severing said junction from the portions of said legs projecting from the adjacent one end of said sheath to define a pair of separate and distinct terminal members for the adjacent ends of said resistance conductors at said one end of said sheath.

5. The method of making an electric heating unit of the sheathed resistance conductor type, which comprises: providing a pair of elongated resistance conductors, winding said resistance conductors into helical form in bifilar relation with a turn of one of said resistance conductors arranged between each two adjacent turns of the other of said resistance conductors, forming a pair of sinuous extensions on the respective ends of said resistance conductors at one end of said winding, providing a conductive member of one-piece construction and having a U-shape including a pair of elongated rigid legs extending from a loop-like junction in spaced relation with respect to each other, respectively connecting said pair of extensions to said pair of legs with each extension extending over a substantial surface area of the connected leg and welded in place, providing an elongated tubular metallic sheath, enclosing said winding of said resistance conductors in said sheath and in spaced relation therewith and arranging said junction exteriorly of the adjacent one end of said sheath with the ends of said legs projecting thereinto and in spaced relation therewith, arranging the assembly of said elements named in an upstanding position with said one end of said sheath at the bottom thereof and with said resistance conductors upstanding from said legs into said sheath, introducing a charge of finely divided refractory material into the other end of said sheath in embedding relation with said resistance conductors and

the ends of said legs so as to retain the same in place in spaced relation with respect to said sheath, working the assembly of said elements named to reduce the cross-sectional area of said sheath in order to compact said charge of refractory material into a dense mass still embedding and retaining in place said resistance conductors and the ends of said legs, and then severing said junction from the portions of said legs projecting from the adjacent one end of said sheath to define a pair of separate and distinct terminal members for the adjacent ends of said resistance conductors at said one end of said sheath.

6. The method of making an electric heating unit of the sheathed resistance conductor type, which comprises: providing a pair of elongated resistance conductors, winding said resistance conductors into helical form in bifilar relation with a turn of one of said resistance conductors arranged between each two adjacent turns of the other of said resistance conductors, providing a conductive member of one-piece construction and having a U-shape including a pair of elongated rigid legs extending from a loop-like junction in spaced relation with respect to each other, providing a crushable refractory bushing, arranging said bushing between the legs of said member and projecting therefrom into the adjacent one end of said winding, respectively connecting the ends of said legs to the ends of said resistance conductors at said one end of said winding, providing an elongated tubular metallic sheath, enclosing said winding of said resistance conductors in said sheath and in spaced relation therewith and arranging said junction exteriorly of the adjacent one end of said sheath with the ends of said legs projecting thereinto and in spaced relation therewith and with said bushing disposed entirely within said one end of said sheath and in spaced relation therewith, loading a charge of refractory material into said sheath in embedding relation with said resistance conductors and said bushing and the ends of said legs so as to retain the same in place in spaced relation with respect to said sheath, working the assembly of said elements named to reduce the cross-sectional area of said sheath in order to crush said bushing and to compact said charge of refractory material into a dense mass still embedding and retaining in place said resistance conductors and the ends of said legs, and then severing said junction from the portions of said legs projecting from the adjacent one end of said sheath to define a pair of separate and distinct terminal members for the adjacent ends of said resistance conductors at said one end of said sheath.

7. The method of making an electric heating unit of the sheathed resistance conductor type, which comprises: providing a pair of elongated resistance conductors, winding said resistance conductors into helical form in bifilar relation with a turn of one of said resistance conductors arranged between each two adjacent turns of the other of said resistance conductors, forming a pair of sinuous extensions on the respective ends of said resistance conductors at one end of said winding, providing a conductive member of one-piece construction and having a U-shape including a pair of elongated rigid legs extending from a loop-like junction in spaced relation with respect to each other and with each of said legs having serrations formed in an external surface of the end thereof remote from said junction, providing a crushable refractory bushing, arranging said bushing between the legs of said member and projecting therefrom into the adjacent one end of said winding, respectively connecting said pair of extensions to said pair of legs with each extension occupying the serrations formed in the connected leg and welded in place, providing an elongated tubular metallic sheath, enclosing said winding of said resistance conductors in said sheath and in spaced relation therewith and arranging said junction exteriorly of the adjacent one end of said sheath with the ends of said legs projecting thereinto and in spaced relation therewith and with said bushing disposed entirely within said one end of said sheath and in spaced relation therewith, loading a charge of refractory material into said sheath in embedding relation with said resistance conductors and said bushing and the ends of said legs so as to retain the same in place in spaced relation with respect to said sheath, working the assembly of said elements named to reduce the cross-sectional area of said sheath in order to crush said bushing and to compact said charge of refractory material into a dense mass still embedding and retaining in place said resistance conductors and the ends of said legs, and then severing said junction from the portions of said legs projecting from the adjacent one end of said sheath to define a pair of separate and distinct terminal members for the adjacent ends of said resistance conductors at said one end of said sheath.

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