Aug. 31, 1937. W. H. TANGEMAN 2,091,839

ELECTRIC HEATER

Filed Oct. 24, 1935

Fig. 1.

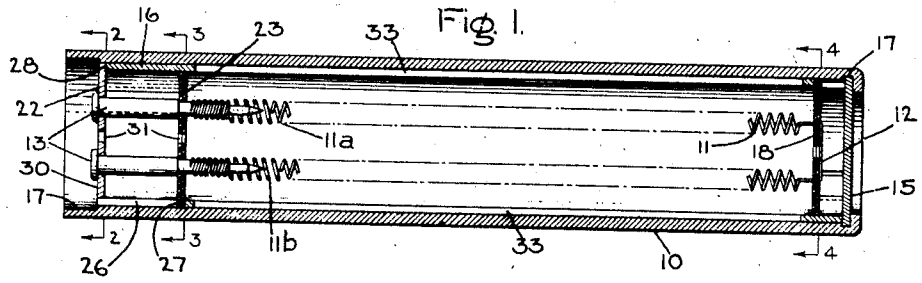


Fig. 2.

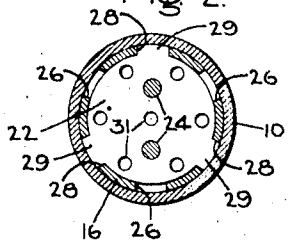


Fig. 3.

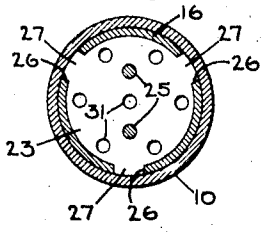


Fig. 4.

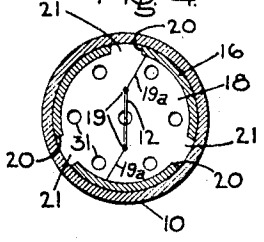


Fig. 5.

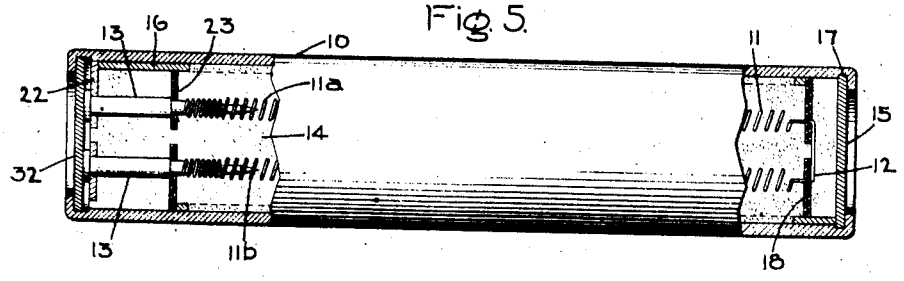
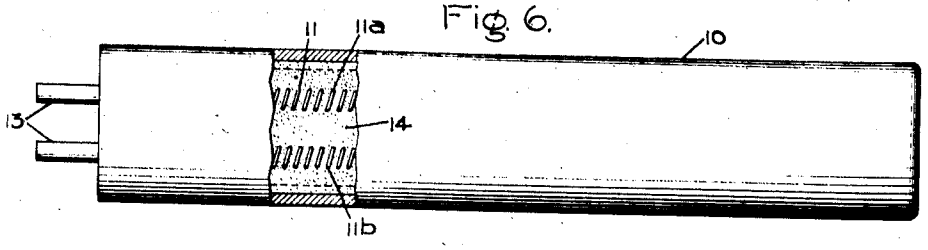


Fig. 6.



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UNITED STATES PATENT OFFICE

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ELECTRIC HEATER

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Application October 24, 1935, Serial No. 46,498

7 Claims. (Cl. 201—66)

This invention relates to electric heaters, more particularly to electric heaters of the sheathed type, and it has for its object an improved method of making a heater of this type.

More particularly this invention relates to electric heaters of the sheathed type wherein a resistance conductor is enclosed by a metallic sheath and is embedded in and supported in spaced relation with the sheath by a densely packed layer of heat conducting, electrically insulating material, such as magnesium oxide. A heater of this type is described and claimed in the U. S. patent to C. C. Abbott No. 1,367,341, dated February 1, 1921.

In many applications it is desirable to bring out both terminals of the resistance element at one end of the sheath, and it is an object of this invention to provide an improved method of making a heater of this character.

For a more complete understanding of this invention, reference should be had to the accompanying drawing in which Fig. 1 is a vertical central sectional view of an electric heater arranged in accordance with this invention and showing the heater in one stage of its construction; Figs. 2, 3 and 4 are sectional views taken through the lines 2—2, 3—3 and 4—4 respectively of Fig. 1 and looking in the direction of the arrows; Fig. 5 is an elevation partly in section illustrating the electric heater of Fig. 1, but at a more advanced stage of its construction; and Fig. 6 is an elevation partly in section illustrating the finished electric heater.

Referring more particularly to Fig. 6, the finished electric heater comprises a metallic sheath 10 encasing a sinuous helical resistance conductor 11. The resistance conductor 11, as shown, is formed into an elongated loop which extends lengthwise of the heater substantially throughout its length. As shown, the two legs 11*a* and 11*b* of this loop are arranged in substantially parallel relation with each other and are connected together by a nexus 12 adjacent one end of the heater, the right-hand end as viewed in Fig. 6. The lengths 11*a* and 11*b* extend from this nexus to substantially the opposite end of the heater where the two ends are electrically and mechanically connected to suitable terminal members 13. While the legs 11*a* and 11*b* of the resistance conductor may be connected with the terminals 13 in any suitable manner, I prefer to connect them in the manner described and claimed in United States Patent No. 1,494,938 to C. C. Abbott, dated May 20, 1924. As there described, the terminal members 13 have their inner ends threaded and are electrically and mechanically connected with the resistance conductor 11 by screwing a number of the end turns of the lengths 11*a* and 11*b* onto the threaded ends of the terminals.

As shown, the outer ends of the terminals 13 project somewhat from the sheath 10. The inner ends of the terminal 13 as well as the legs 11*a* and 11*b* and the nexus 12 of the resistance conductor 11 are embedded in and supported in spaced relation with reference to the sheath 10 by means of a densely compacted layer of heat conducting and heat refractory, electrically insulating material 14, such as powdered magnesium oxide.

The end of the sheath adjacent the nexus 12 is closed by means of a suitable metal washer 15 (Fig. 5).

In making the electric heater of Fig. 6, a suitable relatively thin metallic tube 16 is fitted within the metallic sheath 10. The outside diameter of the tube 16 is substantially equal to the inner diameter of the sheath 10 so that the tube 16 has a sliding fit with the sheath 10. The tube 16 is somewhat shorter than the sheath 10 and it is positioned within the sheath so that its ends are spaced somewhat from the corresponding ends of the sheath, as shown in Fig. 5. Preferably, the ends of the sheath 10 will be countersunk, as indicated by the numeral 17.

The resistance conductor 11 is formed by winding it in any suitable winding machine. It is then threaded through a suitable washer 18, which is provided with a pair of apertures 19 for the conductor spaced on opposite sides of the center of the washer, as shown in Figs. 1 and 4. The washer is provided with slits or sheared sections 19*a* extending from the apertures 19 to the edges of the washer to facilitate the assembly of the conductor with the washer. The conductor is so threaded that the two legs 11*a* and 11*b* of substantially equal length protrude through the washer. The part of the conductor lying in the washer is pulled straight to form the straight nexus 12. The washer 18 is formed of any suitable material which, while being strong enough to support the resistance conductor, is relatively weak mechanically so as to be deformed materially when the heating unit is swaged, as will be pointed out in greater detail hereinafter. A washer formed of mica has been found to be quite satisfactory.

When the conductor 11 has been assembled with the washer 18, this sub-assembly is ready

to be assembled with the sheath 10 and the tube 16.

The tube 16 is prepared for the reception of the washer 18 by providing a plurality of notches 20 in one end, the right-hand end, as shown in Fig. 1, spaced substantially 120° apart. The washer 18 has in general a diameter substantially equal to the outside diameter of the tube 16, but is provided with spaced ears 21 corresponding to the notches 20 in the tube. The washer is assembled with the sheath 10 and tube 16 by inserting it within the sheath with the ears 21 fitted within the notches 20 in the tube 16. When the parts are assembled in this manner, the tube 16 constitutes an abutment against which the washer 18 rests whereby movement of the washer inwardly of the tube is prevented. Rotation of the washer is prevented by the interengagement of the ears 21 with the tube 16.

To assist in the assembly of the conductor 11 and washer 18 with the tubes 10 and 16, two straight rods (not shown) having threaded ends similar to the threaded ends of the terminals may be threaded onto the resistance lengths 11*a* and 11*b*. These rods are then directed through the assembled tubes 10 and 16 so as to bring the washer 18 into its correct position in the tube assembly and so as to draw the ends of the resistance conductor out of the other end of the tube assembly—the left-hand end, as viewed in Fig. 1. The washer 18 holds the nexus 12 at the right-hand end of the tube assembly, thereby preventing movement of the nexus inwardly of the assembly and also rotational movement of the nexus relative to the tube assembly.

The terminals 13 before being assembled with the resistance conductor legs 11*a* and 11*b* are assembled with a pair of washers 22 and 23 which in general are similar to the washer 18 at the other end of the heater, with the exception that the washer 22 is formed of a suitable metal, such as steel, rather than of mica as is the washer 18; the washer 23 is also formed of mica. These washers 22 and 23, however, are provided with pair of relatively large spaced apertures 24 and 25 respectively on opposite sides of their centers arranged to receive and space the terminals 13, as shown in Figs. 1, 2 and 3. These washers, as pointed out above, will be assembled with the terminals before the terminals are applied to the resistance legs 11*a* and 11*b*. The terminals after assembly with their washers will be secured to the legs 11*a* and 11*b*. This is accomplished by grasping the end of one resistance leg, unscrewing the rod attached to it, and threading it on the terminal. The other terminal is applied in a similar manner. After this, the terminal assembly is slid into the left-hand end of the tube assembly.

The left-hand end of the tube 16 is provided with three relatively deep notches 26 spaced 120° apart, while the washer 23 is provided with three ears 27 similarly spaced and arranged to be received in the notches 26, whereby the washer 23 is secured against inward and rotational movement relative to the tubes. The left-hand end of the tube is also provided with a second set of notches 28 much shallower than the notches 26 and spaced 120° apart and also spaced from notches 26. These notches 28 receive ears 29 provided on the washer 22. The depth of the notches 26 is substantially equal to the distance between the washers 22 and 23.

In view of the foregoing construction, it will be observed that the resistance conductor 11 together with its terminals 13 are rigidly secured in the sheath 10. After the conductor and terminals have thus been assembled, a metallic washer 30 having a diameter substantially equal to the diameter of the recessed portion 17 at the right-hand end of the sheath 10 is fitted within this recessed portion over the end of the tubular member 16, and then the end of the sheath is peened or crimped over so as to lock the washer in place. The recess 17 has a depth sufficient to permit the washer 30 to bear against the adjacent end of the tube 16.

The heater assembly shown in Figs. 1, 2, 3 and 4 is now in condition to be loaded with the magnesium oxide 14, which preferably will be in finely powdered form. In order to provide for the loading of the sheath, each of the washers 18, 22 and 23 is provided with a plurality of spaced apertures 31 through which the powder may flow from the left-hand end of the sheath to the washer 30 at the right-hand end so that the sheath may be completely filled from end to end.

It will be understood that in loading the sheath, the heater assembly of Fig. 1 preferably will be supported in an upright position with its left-hand end uppermost, and that the powder will be loaded through the open upper end. While loading, it is preferable to vibrate the sheath somewhat so as to settle the magnesium oxide.

After the heater has been completely loaded with the magnesium oxide, the left-hand end of the heater is closed by a solid metallic washer 32 placed in the left-hand counter-sink 17 over the heads of the terminals 13, and this end of the sheath is peened or crimped over to rigidly secure the washer 32 in place.

The heater is then ready for the operation which compacts the magnesium oxide. For this purpose, the sheath is passed through a swaging machine which materially reduces its diameter and elongates its length.

After the heater has been swaged so as to compact the magnesium oxide, the left-hand end of the heater is trimmed away so as to remove the washer 32, the headed ends of the terminals 13 and the washer 22. The finished heater is shown in Fig. 6.

Preferably, and as shown, the tube 16 will be provided with a plurality of longitudinally arranged slots 33 spaced circumferentially of the tube. Two of these slots are positioned directly opposite the resistance legs 11*a* and 11*b*. The purpose of these slots is to provide greater clearance between the resistance conductor and the outer sheath 10. It will be observed that these slots are completely filled with the insulating material in the finished heater.

The washers 18, 22 and 23, it will be observed, function to support the resistance conductor 11 and its terminals 13 in their correct positions relative to each other and to the sheath 10 in the loading and swaging operations. Generally, the magnesium oxide will be sufficiently compacted during the first pass or two through the swaging machine to hold the resistance conductor 11 and its terminals 13 in their correct positions relative to the sheath. During the swaging process, the mica washers 18 and 23 are crumpled up and substantially destroyed so that in the finished heater, the resistance conductor 11, as well as the terminals 13, are supported by the compacted magnesium oxide 14 alone and by no other means.

While I have shown a particular embodiment of

my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States:

1. The method of making a sheathed electric heater which comprises inserting within a metallic sheath a tube having a length shorter than that of said sheath so that the ends of said tube are spaced from the ends of said sheath, forming a resistance conductor into a loop with its ends adjacent each other, securing terminals to said ends, assembling readily deformable relatively thin washer-like members formed of mica with said resistance conductor and terminals arranged to support them in a metallic sheath, mounting the assembly of said conductor and supporting members within said metallic sheath and tube so that the supports rest against the ends of said tube, interlocking said supports with said tube to prevent relative rotary motion between these members, the supporting members arranged to provide paths through them from one end to the other of said sheath, filling said sheath with an electrically insulating heat conducting material, the paths through said supporting members providing for the flow of said material from one end of said sheath to the other, and then reducing and elongating said sheath to compact said insulating material, said deformable washer-like members being substantially destroyed during said compacting operation so that in said finished heater, said resistance conductor and terminals are supported solely by said insulating material.

2. The method of making an electric heater which comprises inserting within a metallic sheath a tube having a length shorter than that of said sheath so that the ends of said tube are spaced from the ends of said sheath, winding a resistance conductor into a helical coil, threading the end portions of said coil through a readily destructible support, bringing said end portions adjacent each other to form a loop, the nexus of which is mounted in said support, providing apertures in said support, mounting terminals in a similar support, securing said terminals to said end portions of said resistance conductor, mounting said resistance conductor, terminals and supports within said metallic sheath, so that the supports rest against the ends of said tube, interlocking said supports with said tube to prevent rotary motion of the supports in said sheath, filling said sheath with a powdered heat conducting electrically insulating material, said opertures in said supports permitting said material to flow from one end to the other of said sheath, and then reducing and elongating said sheath to highly compact said insulating material, said supports being substantially destroyed during said compacting operation so that in said finished heater, said resistance conductor and terminals are supported solely by said insulating material.

3. The method of making an electric heater which comprises inserting within a metallic tubular sheath a metallic tube having a length shorter than that of said sheath so that the ends of said tube are removed from the ends of said sheath, winding a resistance conductor into a helical coil, threading the end portions of said coil through a readily destructible support, bringing said end portions adjacent each other to form a loop, the nexus of which is mounted in said support, providing apertures in said support, inserting said end portions through said sheath so that said support rests against said inner tube, mounting terminals in a similar support, securing said terminals to said end portions of said resistance conductor, mounting said terminals in the end of said sheath opposite said first support so that it rests against said inner tube at said other end of said sheath, filling said sheath with a powdered heat conducting, electrically insulating material, said apertures in said supports permitting said material to flow from one end to the other of said sheath, and then reducing and elongating said sheath and tube to highly compact said insulating material.

4. The method of making an electric heater which comprises inserting within a metallic tubular sheath a metallic tube having a length shorter than that of said sheath so that the ends of said tube are removed from the ends of said sheath, threading the end portions of a resistance conductor through a readily destructible support, bringing said end portions adjacent each other to form a loop, the nexus of which is mounted in said support, inserting said end portions through said sheath so that said support rests against one end of said inner tube, mounting terminals in a similar support, securing said terminals to said end portions of said resistance conductor, mounting said terminals in the end of said sheath opposite said first support so that it rests against the other end of said inner tube, providing interlocks between said supports and inner tube to prevent rotary and longitudinal movement of said supports in said sheath, filling said sheath with a powdered heat conducting electrically insulating material from one end to the other of said sheath and compacting said insulating material.

5. The method of making a sheathed electric heater having a resistance conductor formed into a loop with its terminal ends adjacent each other at one end of the sheath and supported solely by a mass of insulating material, which comprises providing a tubular member having an external diameter substantially equal to the internal diameter of said sheath, forming in one end of said tube a plurality of spaced notches, forming in its opposite end a plurality of spaced notches and in said opposite end a second set of spaced notches spaced from and deeper than the first set, assembling said tube within said sheath so that its ends are removed from the ends of said sheath, winding a resistance conductor into a helical coil, threading the end portions of said coil through a readily destructible support, bringing said end portions adjacent each other to form a loop, the nexus of which is mounted in said support, providing apertures in said support, giving said support a diameter substantially equal to the internal diameter of said sheath and providing a plurality of spaced projections on its periphery adapted to be received by the notches in said one end of said tube, mounting a pair of headed terminals in a pair of supports, one formed of metal adjacent the heads of said terminals and the other of a readily destructible material removed from said heads and each provided with projections arranged to be received in said first and second set of notches respectively in said other end of said tube, securing the ends of said resistance conductor to the ends of said terminals adjacent said destructible support, mounting said terminals in said tube so that said supports are received in their respective notches, closing said one end of said sheath

with a metallic washer, filling said sheath with said insulating material through said other end, closing said other end with a metallic washer, reducing and elongating said sheath and tube to compact said insulating material and then removing said last named washer, said terminal heads and said metallic support adjacent them to expose said terminals.

6. The method of making an electric heater which comprises inserting within a metallic tubular sheath a metallic tube having a length shorter than that of said sheath so that the ends of said tube are removed from the ends of said sheath, winding a resistance conductor into a helical coil, threading the end portions of said coil through a readily destructible support, bringing said end portions adjacent each other to form a loop, the nexus of which is mounted in said support, providing apertures in said support, inserting said end portions of said conductor through said sheath so that said support rests against said inner tube, mounting terminals in a similar support, securing said terminals to said end portions of said conductor, mounting said terminals in the end of said sheath opposite said first support so that said second support rests against said inner tube at said end of said sheath to prevent movement of said support relative to said sheath, providing in the walls of said tube a plurality of elongated longitudinally arranged slots opposite said end portions of said resistance conductor that form the legs of said loop, filling said sheath with a powdered heat conducting, electrically insulating material, said apertures in said supports permitting said material to flow from one end to the other of said sheath, and then reducing and elongating said sheath to highly compact said insulating material.

7. The method of making an electric heater which comprises inserting within a metallic tubular sheath a metallic tube having a length shorter than that of said sheath so that the ends of said tube are removed from the ends of said sheath, threading the end portions of a resistance conductor through a readily destructible support, bringing said end portions adjacent each other to form a loop, the nexus of which is mounted in said support, providing apertures in said support, inserting said end portions of said conductor through said sheath so that said support rests against one end of said inner tube, mounting terminals in a similar support, securing said terminals to said end portions of said conductor, mounting said terminals in the end of said sheath opposite said first support so that said second support rests against the other end of said inner tube, providing in the walls of said sheath a plurality of elongated, longitudinally arranged slots opposite the portions of said resistance conductor that form the legs of said loop, filling said sheath with a powdered heat conducting, electrically insulating material, said apertures in said support permitting said material to flow from one end to the other of said sheath, and compacting said insulating material.

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