June 25, 1929. C. C. ABBOTT ET AL 1,718,676

ELECTRIC HEATING UNIT

Filed Jan. 7, 1926

Fig. 1.

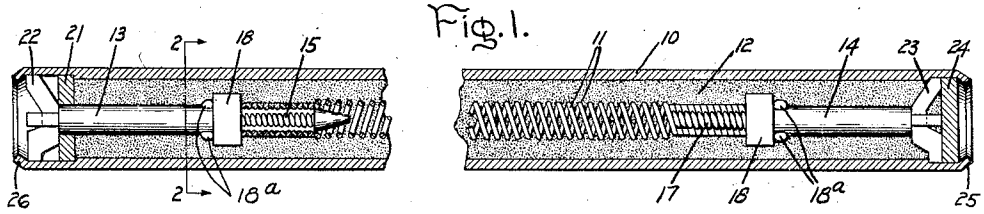


Fig. 3.

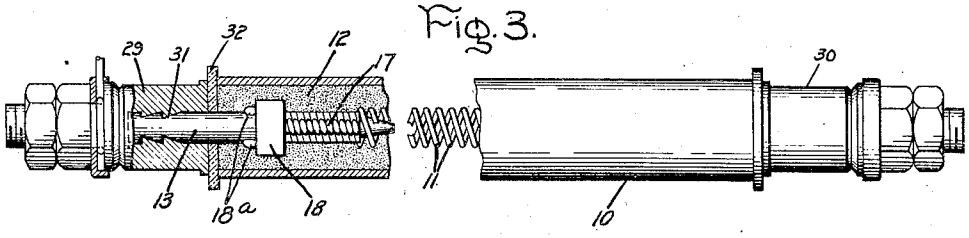


Fig. 4.

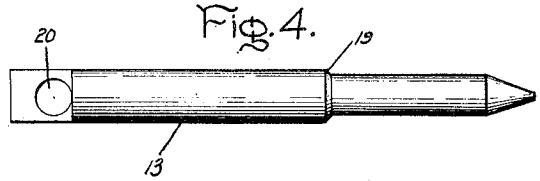


Fig. 2.

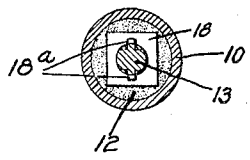


Fig. 5.

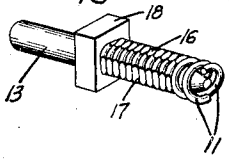
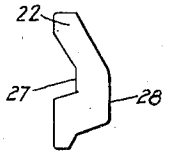


Fig. 6.



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Patented June 25, 1929. 1,718,676

UNITED STATES PATENT OFFICE.

CHARLES C. ABBOTT AND GEORGE D. MILNES, OF PITTSFIELD, MASSACHUSETTS, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC HEATING UNIT.

Application filed January 7, 1926. Serial No. 79,878.

Our invention relates to electric heating units and has for its object the provision of a simple, reliable and efficient device of this character.

More specifically our invention relates to electric heating units of the type provided with a protective sheath, although it has obvious application to various other types of electric heating units. In one form of sheathed heating unit the resistance conductor is embedded in a mass of heat insulating material inside a metallic sheath. In order to increase the rate of heat generation the resistance conductor is sometimes given a sinuous form, such as the form of a helix, as described and claimed in Patent No. 1,367,341 to Abbott dated February 1, 1921. This helix extends substantially throughout the full length of the sheath and has its ends secured to metallic terminal members which project from the ends of the sheath.

In one of its aspects our invention relates to the provision of a simple, reliable and inexpensive connection, and method of making it, between the resistance conductor and the metallic terminals, and to that end we insert the terminals in convolutions of the resistance conductor, and then compress the convolutions of the resistance conductor so as to secure them to the terminals.

For a more complete understanding of our invention reference should be had to the accompanying drawing in which Fig. 1 is a fragmentary view of a partially constructed electric heating unit embodying our invention; Fig. 2 is a sectional view along the line 2—2 of Fig. 1 looking in the direction of the arrows; Fig. 3 is a fragmentary view partially in section of an electric heating unit embodying our invention; while Figs. 4, 5 and 6 are views showing details of construction.

Referring to the drawing, a heating unit embodying our invention comprises in one form an outer metallic sheath 10, preferably cylindrical, in which a resistance conductor 11 is embedded in powdered heat refractory insulating material 12, such as magnesium oxide. The resistance conductor 11 is wound helically and extends substantially throughout the length of the sheath. It is electrically connected at its ends with metallic terminal members 13 and 14 which project from the ends of the sheath.

In the construction described and claimed in Patent No. 1,494,938, to Abbott dated May 20, 1924, the terminal members have their inner ends threaded and are mechanically and electrically secured to the resistance conductor by screwing a number of the end turns of the resistance conductor onto the threaded portions of the terminals, the terminals having substantially the same diameter as the turns of the resistance conductor. In accordance with our present invention we dispense with the threads on the terminal and secure the terminals to the resistance conductor by inserting their inner ends into the turns or convolutions of the resistance conductor, and then compressing these turns, for example, by swaging. This swaging has the effect of forcing the end turns of the resistance conductor into the metal of the terminal, and a good mechanical as well as electrical connection is thus formed. The partial embedding of the turns of the resistance conductor is clearly shown in Fig. 1 in which the bare inner end of the terminal 13 is shown after the compressing or swaging operation. It will be observed that slightly oblique crosswise depressions or grooves 15 are formed in the terminal by the turns of the resistance conductor. In effect, therefore, the turns lie in threads formed by the turns themselves during the compressing operation. A good mechanical and also electrical connection is, therefore, assured.

Preferably the pressure to secure the end turns to the terminal is applied at a number of points around the circumference of the turns. As indicated in Fig. 5, pressure may be applied at diametrically opposite points along diameters at right angles to each other. This may be accomplished by two pairs of swaging jaws. Two of the four points of application of pressure are clearly indicated at 16 and 17 where the turns are flattened somewhat. We have found that with this method of swaging there is no tendency for the turns to spring outward or rebound away form the terminal and thereby produce an unsatisfactory connection.

For the purpose of decreasing the resistance of the unit without using a resistance conductor of excessively large diameter, the resistance conductor may be wound into a plurality of helixes having the same axis, the turns of the respective helixes being placed between each other and wound together on an arbor, as described and claimed in a copending application of John C. Musgrove Serial

No. 92,280 filed March 4, 1926. As shown in the drawing two helically wound resistance conductors are provided, these conductors having substantially equal diameters and having their turns arranged alternately.

The unit is assembled in substantially the manner described in the aforesaid Patent No. 1,494,938. The terminals 13 and 14 are first attached to the resistance conductor and then the resistance conductor with the terminals is inserted in the sheath. A spacing block 18 made of a suitable refractory insulating material, such as lava, is provided on each terminal, this block being square and of such size that its corners engage with the inner surface of the sheath thus holding the inner end of the terminal in a central position. As shown in Fig. 4 the outer end of the terminal is somewhat larger than the inner end portion, which is of such size as to be inserted easily in the resistance conductor, so that a shoulder 19 is formed. The small inner end of the terminal is inserted in the helical resistance conductor until the end of the resistance conductor rests against the shoulder 19, and then these two parts are secured together by swaging as previously described. Thereafter the spacing block 18 is slipped over the larger outer end of the terminal and seated against the inner end of the resistance conductor, the outside diameter of the resistance conductor helix being somewhat greater than the diameter of the outer end of the terminal. The block 18 is secured in this position by forcing ears 18^a out of the sides of the terminal. The outer end of the terminal is also cut away at opposite sides to form a flat portion which is provided with an aperture 20.

Continuing with the assembly of the unit, one end of the sheath is closed by means of a washer 21 which is seated against a shoulder formed by countersinking the end of the sheath, and the terminal at that end, indicated by the reference number 13, is secured against longitudinal movement inward by inserting a pin 22 through its aperture 20. The other terminal 14 is secured by passing a pin 23 similar to pin 22 in an aperture in its outer end, this pin resting at its ends on a shoulder formed by countersinking the end of the sheath. Preferably, the resistance conductor will be wound on an arbor with the turns side by side in engagement with each other, and it will be observed that the turns are secured on the terminals in this relation. The helix is of such length, however, that when the terminals are secured in the sheath as previously described, the resistance conductor is stretched whereby its turns are separated, as shown in the drawing.

The unit as thus far assembled is next placed in a suitable vibrating machine, the end closed by the washer 21 being at the bottom, and powdered insulating material poured in at the upper end past the sides of the pin 23. After the sheath has been filled with the insulating material it is closed by means of a washer 24, the end being crimped over at 25 to secure the washer in place, and the opposite end may be likewise crimped as indicated by reference numeral 26 to prevent the terminals 13 from being forced outward. In the next step the unit, assembled as shown in Fig. 1, is passed through a suitable swaging or rolling machine whereby the insulating material is compacted. Preferably the insulating material is compacted to a hard dense mass which is a good electrical insulator, and also a good conductor of heat. This swaging operation reduces the diameter of the unit and also increases its length somewhat.

The pins 22 and 23 are off-set at the center as indicated in Fig. 6 so as to form a central recess 27 on one side and a corresponding extension 28 on the opposite side. This construction provides for centering the outer end of the terminal 14 while the sheath is being filled with insulating material since the flat outer end of the terminal seats itself in the recess 27, as shown. Another object of this irregular construction of the pins is to permit them to collapse readily during the swaging operation when the sheath is being reduced in diameter.

After swaging operation the unit is cut off at each end to remove the washers and the flattened ends of the terminals, and the sheath cut back at each end to expose short lengths of the terminals after which terminal lugs 29 and 30 are secured in the manner disclosed in the aforesaid patent to Abbott No. 1,494,938. Briefly, this operation consists in providing nicks 31 on opposite sides of the terminals and compressing the terminal lug into these nicks so as to secure it, each end of the unit being closed by an insulating washer 32 against which the terminal lug is seated.

Our connection between the resistance conductor and the terminals is of particular advantage where a plurality of resistance helixes are used, since it does away with the necessity of cutting multiple threads on the terminal to receive the helixes as would be required if a thread were provided for each helix.

While we have described our invention as embodied in concrete form and as operating in a specific manner in accordance with the provisions of the patent statutes, it should be understood that we do not limit our invention thereto, since various modifications thereof will suggest themselves to those skilled in the art without departing from the spirit of our invention, the scope of which is set forth in the annexed claims.

What we claim as new and desire to secure by Letters Patent of the United States, is,—

1. The combination with a terminal, of a resistance conductor wound in a series of convolutions about said terminal, said convolutions being compressed only at a plurality of circumferentially spaced points on said terminal so as to be secured thereto.

2. The combination with a metallic terminal, of a sinuous resistance conductor having convolutions surrounding said terminal, said convolutions being compressed on said terminal only at a plurality of circumferentially spaced points by swaging so as to be secured in good electrically conducting relation with said terminal.

3. The combination with a metallic terminal member having a cylindrical portion, of a helical resistance conductor having a plurality of end convolutions surrounding said cylindrical portion, said convolutions being compressed at a finite number of circumferentially spaced points so as to be secured to said terminal member.

4. The combination with a metallic terminal member, of a helical resistance conductor having convolutions surrounding said terminal member, said convolutions being compressed to varying degrees into the metal of said terminal so as to form a good electrical and mechanical connection between said resistance conductor and said terminal.

5. The combination with a metallic terminal member, of a helical resistance conductor having convolutions surrounding said terminal member, said convolutions being compressed into the metal of said terminal only at a plurality of circumferentially spaced points so as to form a good electrical and mechanical connection between said resistance conductor and said terminal.

6. The method of securing a terminal to a resistance conductor provided with convolutions which consists in inserting the terminal into said convolutions, and then compressing said convolutions only at a plurality of spaced points.

7. The method of securing a terminal to a helical resistance conductor, which consists in inserting the terminal into a plurality of end convolutions of said resistance conductor, and then compressing said convolutions to varying degrees into said terminal so as to form a good electrical and mechanical connection.

8. The method of securing a terminal to a helical resistance conductor, which consists in inserting the terminal into a plurality of end convolutions of said resistance conductor, and then compressing said convolutions only at a plurality of points so as to force said convolutions into said terminal.

9. The method of securing a metallic terminal to a helical resistance conductor which consists in inserting the terminal into a plurality of end convolutions of said resistance conductor, and then compressing said convolutions at finite number of circumferentially spaced points so as to force said turns into said terminal and thereby form a good electrical and mechanical connection.

In witness whereof, we have hereunto set our hands this 4th day of January, 1926.

CHARLES C. ABBOTT.
GEORGE D. MILNES.