May 10, 1932. C. B. BACKER 1,857,615

TUBULAR HEATER

Filed Dec. 17, 1929

Fig. 1.

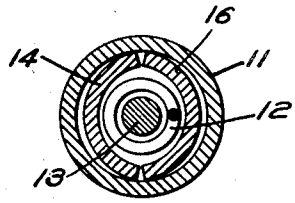


Fig. 2.

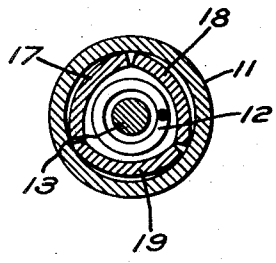
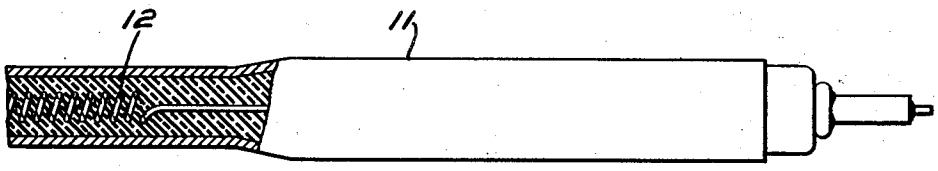


Fig. 3.



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UNITED STATES PATENT OFFICE

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TUBULAR HEATER

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My invention relates to electric heating units and particularly to tubular electric heating units.

An object of my invention is to provide a novel method of generating electric insulating material in crystalline form within a metal tube encasing a resistor member, the conversion being effected in situ.

Another object of my invention is to provide a method of and means for, insuring that a helically wound resistor wire shall be spaced uniformly from the inner surface of a tubular encasing wall and that the electric-insulating and heat-conducting material generated in situ shall be of the maximum possible hardness and density.

In my United States Reissue Patent No. 16,340, I have disclosed and claimed a novel method of generating a hard dense crystalline mass of electric-insulating and heat-conducting material which I have used in the manufacture of tubular heating elements in the following manner; a strip of initially metallic magnesium is wound into the form of an open or extended helix, the strip being wound flat into helical form, and a helically-wound resistor wire is located loosely within this open helix of metallic magnesium. One or more wires of metallic magnesium are located within the helix of resistor wire, which assembly is then located within a metal tube, the relative dimensions being such that the helically wound resistor wire is locately loosely within the open helix of magnesium strip and the latter fits loosely within the metal tube.

The assembly is then subjected to the action of high temperature steam for a predetermined time, say several hours, which results in the conversion of the initially metallic magnesium into magnesium hydroxide, the volume of the magnesium hydroxide being substantially twice that of the metallic magnesium. It is necessary to drive out the water remaining in the hydroxide, which is done by heating it at a relatively high temperature, and after suitable terminals have been provided, the heat unit is ready for use.

When using an open or extended helix of magnesium strip, it is evident that portions of the resistor wire may be pressed radially outwardly because of the space between adjacent turns of the helically wound magnesium strip. Such method sometimes results in the helically wound resistor having a sinuous form within the metal tube and if the radial deflections of portions of the resistor helix are large enough, the resistor may even touch the inner surface of the metal tube, thereby providing a substantially complete ground, or the distance may be so small that the insulation resistance is not sufficiently high.

In practicing my invention, I provide a tubular metal casing of the desired diameter and locate therein an assembly including a helically-wound resistor wire having one or more wires of metallic magnesium located therein, and a plurality of longitudinally extending strips of metallic magnesium, bent to arcuate form, the radius of curvature being greater than that of the inner surface of the tube. This assembly is then subjected to the action of high pressure steam and after suitably drying out, terminal members are provided and the unit is then ready for use.

In the single sheet of drawings;

Figure 1 is a view in lateral section of an assembly showing the elements of a heating unit ready for the high temperature treatment.

Fig. 2 is a view in lateral section of a modified form of assembly, and

Fig. 3 is a view, partially in side elevation and partially in longitudinal section, of a completed heating unit.

Referring more particularly to Figure 1 of the drawings, a substantially circular metal tube 11 is provided which may be made of any suitable material, but I prefer to make it of a high temperature and oxida-

tion resistant material, such as steel or an alloy steel or of an alloy including nickel and chromium. A resistor member 12 is wound into the form of an open helix, the diameter of the wire and the spacing between adjacent turns being so selected that a predetermined amount of energy will be translated into heat in a predetermined length of heating unit.

I have shown a single wire 13 of initially metallic magnesium located within the helix 12 and fitting loosely therein. Two strips 14 and 16, each of initially metallic magnesium are located around the helix 12 and are substantially coextensive therewith. Both strips are bent to arcuate form in lateral section, the radius of curvature of the strips being slightly larger than the radius of curvature of the inner surface of the tubular member 11. The lateral dimension of the two strips and their arcuate shapes are preferably so selected that the adjacent edges will either operatively engage each other as shown in the drawings or that they will be located but a relatively small distance apart.

Referring to Fig. 2 of the drawings, I have there illustrated a tubular member 11, a helix 12 and a single wire 13 of metallic magnesium located within the helix. I provide in this case three strips, 17, 18 and 19 of metallic magnesium, each bent to arcuate shape in lateral section, the radius of curvature being slightly greater than the radius of curvature of the inner wall surface of the tubular member 11. The same remarks as to the dimensions of the strip and the engagement, or separation of the adjacent edges as made in regard to the assembly of Fig. 1, will apply also to Fig. 2.

The assembly is now subjected for a predetermined length of time to the action of high pressure steam and I have found it advantageous to use relatively high pressure on the order of from 500 to 1,000 pounds pressure. This operation is best effected in an autoclave and I may cause the high pressure steam to flow through the tubular member 11 by mounting one end of the member 11 in a diaphragm having a plurality of openings therein within which a plurality of tubular members 11 may be fitted to effect heat treatment thereof simultaneously.

It may be noted by reference to Fig. 1 and 2 that there is an annular space, or substantially annular space between wire 13 and the helix 12, as well as a substantially annular space outside of the helix 12 and a plurality of lunar spaces outside of the plurality of strips of metallic magnesium located between the resistor wire and the inner surface of the tube 11. These spaces permit the high pressure and high temperature steam to flow through the tube and affect both sides of the strips and the outside of the wire 13 to effect conversion thereof to a dense, hard crystalline mass of magnesium hydroxide, whose volume is substantially twice that of the metallic material and which, when changed into magnesium oxide, by driving off the water, constitutes a highly efficient heat-conducting and electric-insulating layer of material between the resistor and the tubular member.

As has already been hereinbefore pointed out, the use of a helically-wound strip of initially metallic magnesium around the resistor helix may permit of disalignment of the resistor helix in the metal tube with the possibility of poor operation in actual use. The method hereinbefore described and including more particularly the use of a plurality of longitudinally extending strips, bent to arcuate shape in lateral section and located around the resistor helix, insures that each turn of the resistor helix will be coaxial with the tube. I have found it possible also to use a relatively larger amount of initially metallic magnesium so that when this is converted into magnesium oxide, with corresponding increase of considerably less than 100% in volume, the resultant crystalline mass will be under a much higher compressive stress, which stress is uniform for all of the turns of the resistor helix.

Such defects as may have resulted from the disalignment of the axes of the tube and of the resistor helix when using the old method have been found to be entirely wanting in the heating units manufactured by me according to the present method and it is, therefore, believed that the method here disclosed and claimed in the appended claims constitutes a distinct advance in the art relating to the manufacture of tubular heat units in which the electric-insulating material is generated in situ.

I have hereinbefore set forth the method which, as now known to me appears to embody the best method, but it is obvious that modifications thereof may be made within the scope of the appended claims.

I claim as my invention:

1. The method of making a tubular heater which includes placing a helically wound resistor located within a plurality of longitudinally-extending strips of metallic magnesium each bent to arcuate shape in lateral section, in a tubular metal casing, the radius of curvature of each strip being larger than that of the interior surface of the tube to provide open spaces at each side of each strip of magnesium, and passing steam at high pressure through said open spaces to effect expansive oxidation of the strips simultaneously from both sides.

2. The method of making a tubular heater which includes assembling within a metal tube a helically wound resistor and a plurality of longitudinally-extending strips of metallic magnesium, each bent to arcuate shape in lateral section the edges thereof

being located relatively close to each other and the radius of curvature being greater than the radius of the internal surface of the tube, subjecting the assembly to the action of high pressure steam, whereby to convert the metallic magnesium to a hard, dense layer of crystalline magnesium hydroxide and providing a longitudinally uniform radial thickness of such layer around the resistor.

In testimony whereof, I have hereunto subscribed my name this 9th day of December, 1929.

CHRISTIAN BERGH BACKER.