Oct. 31, 1933. E. L. WIEGAND 1,933,128

METHOD OF PRODUCING SHEATHLESS ELECTRICAL HEATING ELEMENTS

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Fig. 1

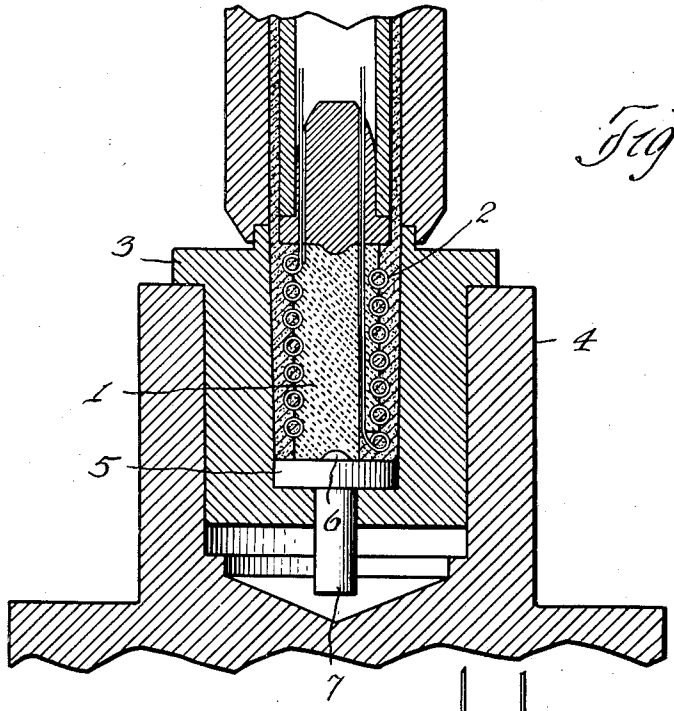


Fig. 2

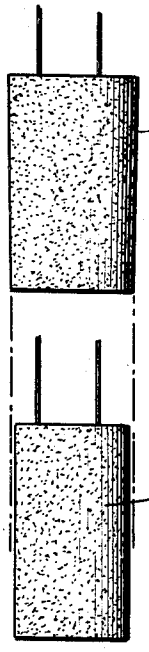


Fig. 3

Fig. 4

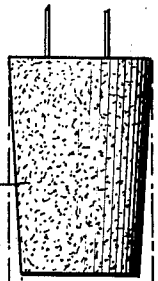
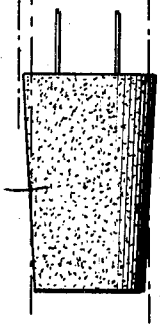


Fig. 5



Inventor

Edwin L. Wiegand

By Hull, Brock & Marsh

Attorney

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Fig. 6

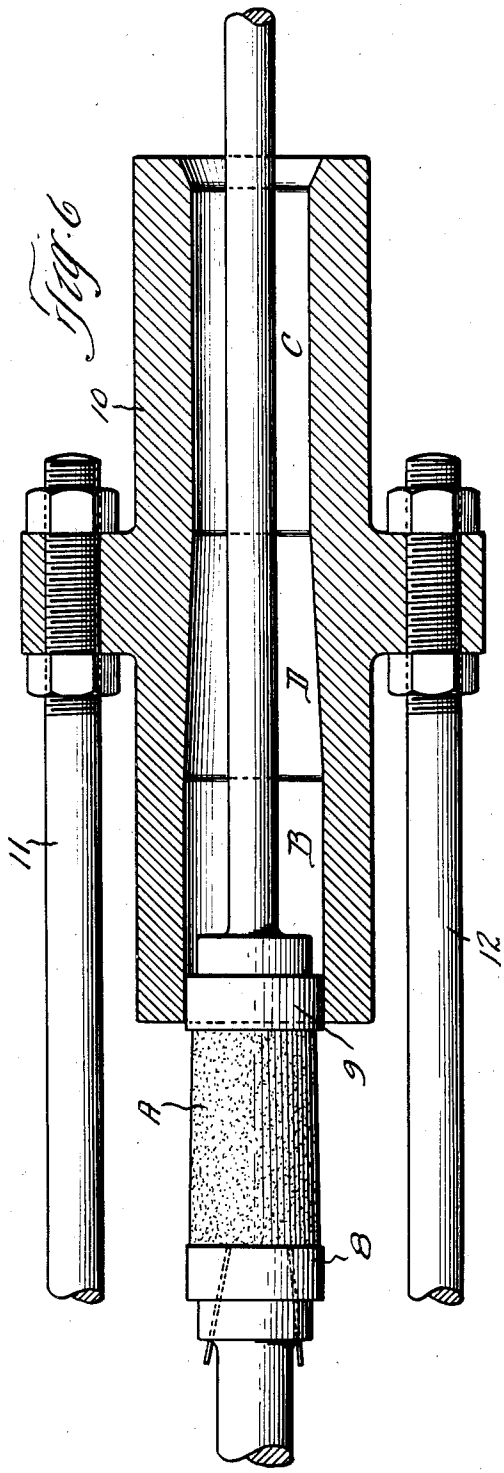
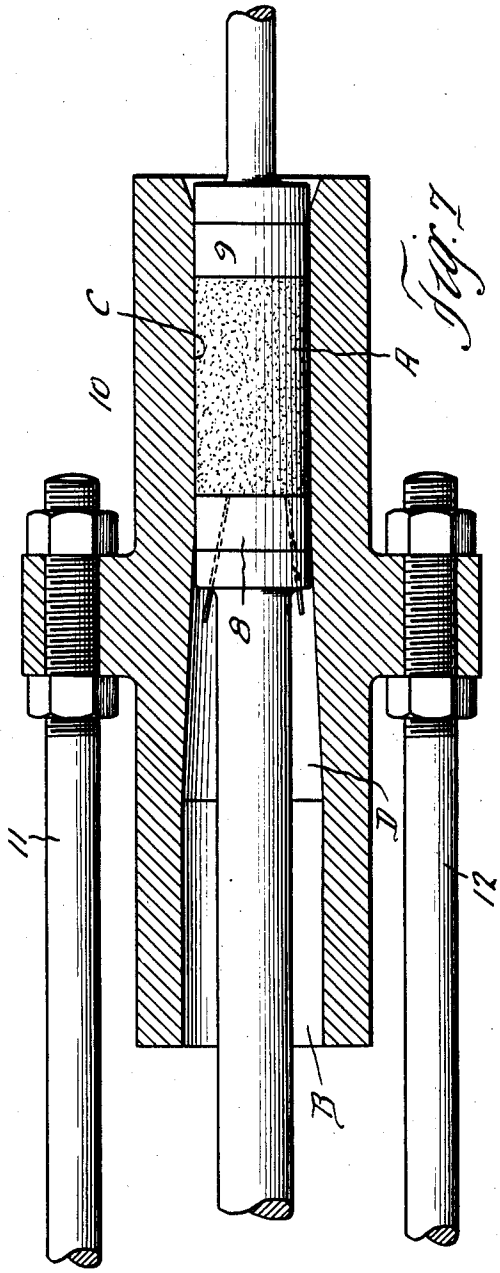


Fig. 7



Inventor

Edwin L. Wiegand

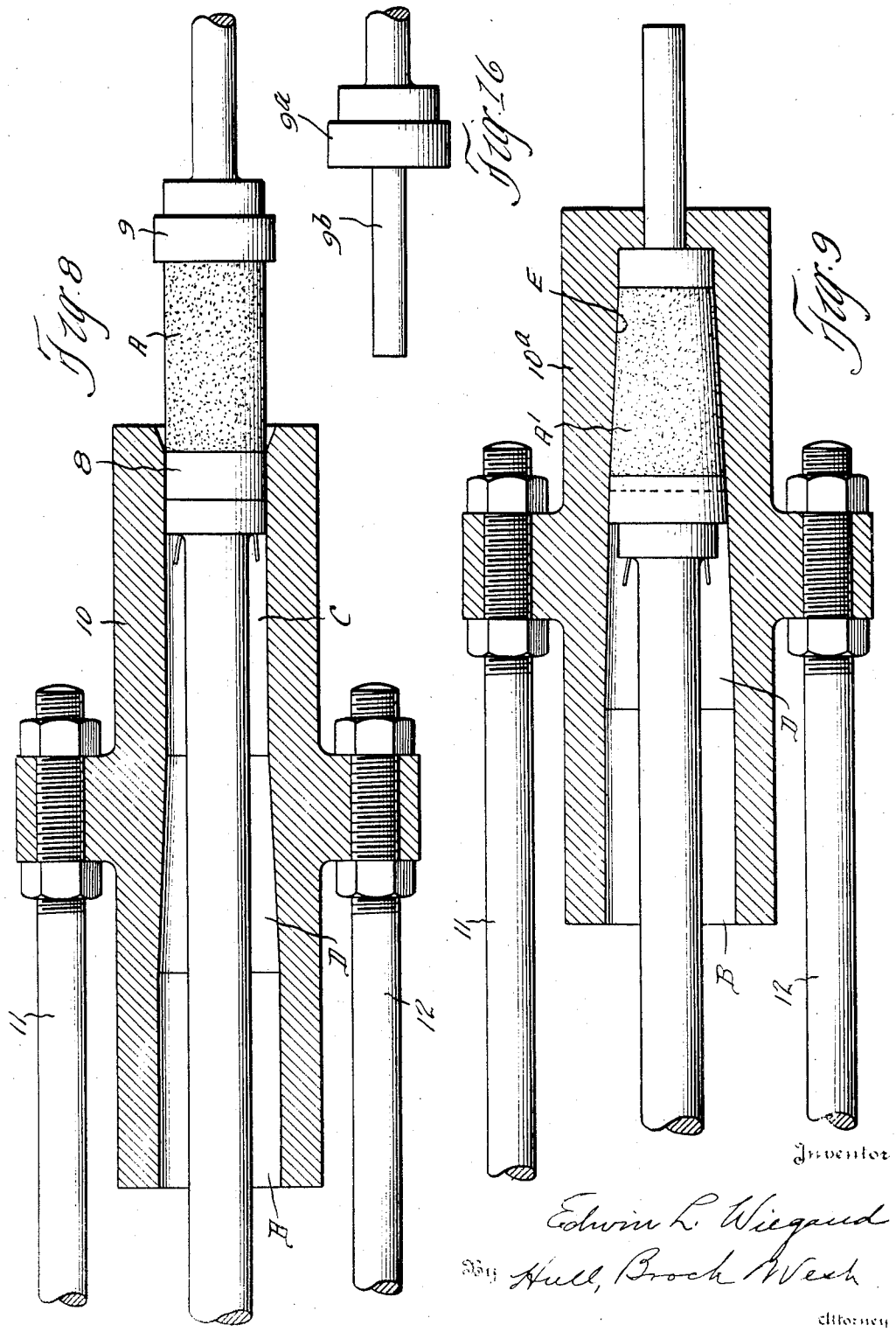
By Hull, Brock & Wash

Attorney

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METHOD OF PRODUCING SHEATHLESS ELECTRICAL HEATING ELEMENTS

Filed Jan. 5, 1931 4 Sheets-Sheet 3



Inventor

Edwin L. Wiegand

By Hull, Brock & Veach

Attorneys

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METHOD OF PRODUCING SHEATHLESS ELECTRICAL HEATING ELEMENTS

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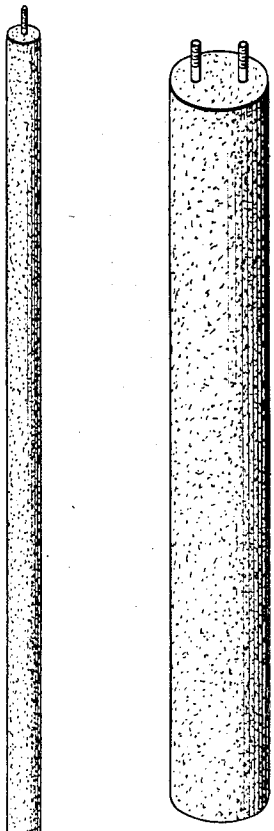


Fig. 11

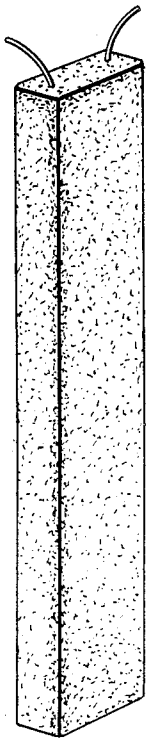


Fig. 12

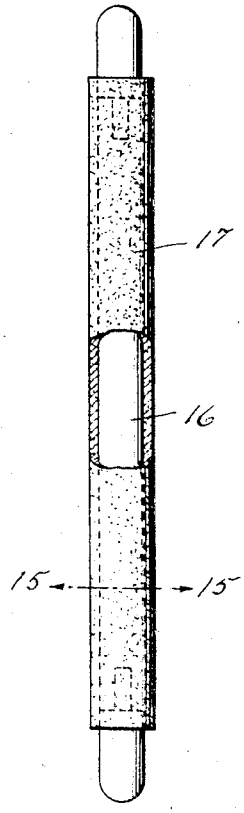


Fig. 14

Fig. 10

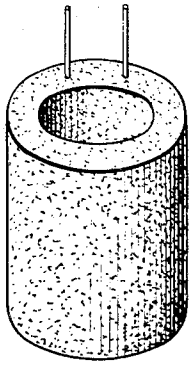


Fig. 13



Fig. 15

Inventor

Edwin L. Wiegand

By Hull, Brock & West

Attorneys

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1,933,128

UNITED STATES PATENT OFFICE

1,933,128

METHOD OF PRODUCING SHEATHLESS ELECTRICAL HEATING ELEMENTS

Edwin L. Wiegand, Pittsburgh, Pa.

Application January 5, 1931. Serial No. 506,528

3 Claims. (Cl. 201—64)

This invention relates generally to a method of producing electrical heating or resistance units, and more particularly to the method of making heating or resistance units which consists chiefly of a resistor element embedded in a mass of refractory electrical insulating material.

One of the main objects of the invention is the economical and accurate production of electrical heating or resistance units whose windings extend axially as exemplified by the cartridge, hollow cylindrical, and rod type elements well known to those skilled in the art and as distinguished from resistance heating elements having the windings disposed in or extending in substantially the same plane.

A further object of the invention is to provide a process of producing electrical resistance heating elements which will enable the production of such elements as will be economical of space occupied, which is often at a premium in certain types of resistance and heating applications.

A further object of the invention is to provide a process of producing electrical resistance heating elements which are self-contained and supported and of sufficient mechanical stability to dispense with an immediate undetachable sheath of metal.

A still further object of the invention is to provide a method or process of producing heating elements of the character described which are of accurate dimensions as to shape, section and length, and in which the refractory insulating material is densely compacted about the resistor and has a smooth hard unfriable exterior surface.

Heating elements produced by this process are particularly advantageous in connection with soldering irons, burning brands, metal melting devices, etc. which operate at or are likely to attain comparatively high temperatures. Elements produced according to the method herein disclosed are also especially adapted for insertion removably or irremovably into machined openings in heating devices or into the element receptacles of devices in which the receptacle forms a mechanical portion of the article to be heated.

Another object of the invention is to provide a heating element of the character described which has no metal sheathing attached thereto inasmuch as it may be desirable to furnish a separate sheathing with rare or special finishes, inconsistent with the present methods of producing the heating elements.

Those skilled in the design of electrical or heating apparatus are aware that anything interposed between a heat source and the object to be heated introduces an impediment to the heat transfer, and increases the temperature gradient and therefore should be foregone insofar as is dispensable from structural considerations. It has also been my experience that for applications where the surface of the heating element is liable to attain a temperature of from 1000° to 1800° F., or more, most sheathing material at present obtainable, if undetachably applied to a heating element, is liable to oxidize and burn off and/or distort and thus generate an impediment to heat transfer, not to mention the initial expense thereof in cases where sheathing is dispensable or the greater evil.

This process is therefore especially well adapted to the production of sheathless elements which may later be introduced into receptacles or locations provided therefor in objects to be heated.

Having now described some of the advantages of my process and the utility of elements produced by the process, I will now describe the process or method in more or less general terms.

In carrying out the process, I first provide a core, form or base member which is preferably formed of porcelain, lava or heater body. This member may be in the form of a cylindrical core, solid or hollow, and having grooves or threads of suitable size and pitch moulded or chased thereon. I next provide a resistor element of electrical and heat resisting qualities suitable to the conditions of use to be met; and this resistor may be round or square, wire, ribbon, rod or grid, depending upon the requirements of the design to be executed. If wire or ribbon, it may be wound directly onto the core body or it may be coiled in a helix suitable in diameter and pitch and this coil in turn wound upon the core, preferably in a thread of shape and size suitable thereto and of a pitch to allow of adequate insulation between the successive turns of the coils, which space incidentally, due to the effectiveness of the process, may be unusually small. Having mounted the resistor upon the form, core or base, and having provided projecting terminals therefor, I next coat or encase the resistor and core with refractory electrical insulating material of some suitable character. This insulating material is preferably composed of zirconium silicate or of the oxides of aluminum or magnesium, either simple or compounded, but in any case, having a modicum of binding material, such as ball clay or a fusible or other permanent binder which gives sufficient plasticity to enable working and which will integrate the entire unit when finished.

Various insulating materials may be used and various compounds may be dictated by the nature of the use to which the completed element is to be put; and while the invention is not limited to any particular mode of applying the insulating material to the resistor and core, I prefer the process described in my co-pending application Serial No. 428,665, filed February 15, 1930, as being especially expeditious and efficacious.

Having applied the insulating material, I next adjust the moisture content of the mass to the minimum degree suitable to succeeding steps. I next place the resultant mass into the end of a barrel, mold or tube having a bore which is of such size and shape as to allow ready entry of the entire mass thereinto and also having a final portion of the exact diameter desired in the finished article allowing for shrinkage. These two portions of the bore of the mold are connected by a gradually tapering portion which produces a gradual compacting of the insulating material about the resistor and core or base in a direction which is substantially radial to the axis of the product. This may be accomplished by holding the mold stationary and forcing the element into or through the bore or mold by means of a piston. A preferable mode, however, is to hold the element between two opposed pistons and either to force the mold over the element or the element into or through the mold. By this method the ends of the element may be formed concave, flat, or convex as desired by suitably shaping the faces of the pistons. This method also prevents the escape of insulating material and prevents excessive longitudinal flow of the material and promotes radial pressure on the mass. The insulating material hereinbefore mentioned being abrasive, I prefer to make the pressing mold of steel having its inner surface hardened and ground or electroplated with chromium, or preferably both. I also find that if the inside surface of the mold or the element, or both, are lubricated with a volatile lubricant such as petrolatum or oil, the compressing operation is facilitated, the lubricant being burned out of the element by subsequent firing.

I also have found that the compacting operation is facilitated by dusting the surface of the element with a pulverent refractory substance, such as powdered raw lava, or soapstone, which leaves no ill effect on the element and reduces attrition between the mold and parts being forced therethrough or therein.

It should also be understood that the bore of the mold may be of any sectional shape, and if the object to be compacted or formed be tapered, the mold is shaped accordingly; and the finished work removed from the end where entered; or the mold may be of split construction and opened to remove the work after compacting. After the final compacting operation, I dry out any remaining moisture in the element slowly and then fire the element to harden the insulating material. The element is then ready to be assembled into a sheath or receptacle removably or irremovably. The heating element thus obtained has a very hard smooth surface which will not crack or craze excessively from high temperatures; and also has sufficient mechanical stability to be used without a metal sheath when and if desired.

Further and more limited objects of the invention will appear as the description proceeds and by reference to the accompanying drawings, which disclose one form of apparatus employed in carrying out the process. However, the particular form of apparatus disclosed is not germane to the invention with the possible exception of a few essential tools. The mode of winding or forming the resistor or the manner of applying the insulating material to the resistor and/or the resistor supporting base, is not limited in any manner. However, the extrusion process disclosed in my co-pending application Serial No. 428,665, filed February 15, 1930, for Method of insulating electrical resistors has been found to be particularly applicable.

Referring now to the drawings, Fig. 1 is a fragmentary sectional view illustrating one manner of applying the insulating material to a resistor; Fig. 2 is a view in side elevation disclosing the heating element as it will appear after it has been removed from the mold shown in Fig. 1; Fig. 3 is a view in side elevation of the finished product; Fig. 4 is a view in side elevation similar to Fig. 2 of a slightly different form of heating element as it will appear before the last compressing operation is performed; Fig. 5 is a view similar to Fig. 4 showing the finished product; Fig. 6 is a view partly in side elevation and partly in vertical section disclosing the element as it is delivered into the mold; Fig. 7 is a view similar to Fig. 6 showing the heating element after it has received its final compression; Fig. 8 is a view similar to Fig. 7 showing the heating element in position to be removed from the mold; Fig. 9 is a view partly in side elevation and partly in vertical section disclosing the tapered form of element shown in Figs. 4 and 5 after it has received its final compression; Figs. 10, 11, 12 and 13 are views in front elevation illustrating several different forms of heating elements which may be formed according to my process; Fig. 14 is a view of still another form of resistor heating element which may be formed according to my process; Fig. 15 is a horizontal sectional view on the line 15—15 of Fig. 14 and Fig. 16 is a fragmentary view in elevation illustrating a modified form of piston to be used for making hollow or tubular elements.

In carrying out my process, I first provide a core, or base member 1 which is preferably formed of porcelain, lava or other suitable material and which has formed thereon in any suitable manner grooves or threads of the desired size and pitch. The resistor 2 may then be wound directly onto the form or core as shown in Fig. 1. The core or form with the resistor thereon is then placed within a collet 3 which is placed in a suitable mold 4. The insulating material of the desired constituency is then forced or extruded under pressure about the resistor and core and completely envelops the same. The apparatus for carrying out this step of the process is described in my co-pending application, Serial No. 428,666 and forms no part of this invention. The resultant mass is now removed from the mold 4 and the moisture contents reduced as desired, preferably by heating. The opening in the collet 3 is slightly tapered and arranged within the lower end of the mold is a piston 5 having a central projection or boss 6 thereon which serves to properly position the core within the mold. The piston is also provided with a projection 7 which projects through an opening in the lower end of the collet and serves to facilitate the removal of the article. Fig. 2 illustrates the article as it will appear when removed from the mold. For the purpose of identification, this mass is indicated by the reference character A. This mass A is then placed between two pistons 8 and 9 which may be supported in

any suitable manner, and preferably adjustable. The piston 8 is provided with suitable bores through which terminals may extend as shown in Fig. 6. Positioned adjacent the pistons 8 and 9 is a mold 10 which is preferably in the form of a barrel and which is adjustable with respect to the pistons by means of links or rods 11 and 12 which are secured to the mold in any suitable manner. The mold 10 is provided with a slightly tapered portion B of such size and shape as to permit ready entry of the mass A therein. The mold 10 also has a straight portion C of the exact size and shape desired in the finished article, allowing for shrinkage. The portions B and C of the mold are connected by a gradually tapered portion D which produces a gradual compacting of the insulating material about the resistor and core in a direction which is substantially radial to the axis of the mass. The mass A is held between the pistons 8 and 9 and, according to the preferred embodiment of my invention, the mold 10 is moved slowly over the mass by means of the rods 11 and 12, which may be operated in any suitable manner, preferably hydraulically. The movement of the mold toward the left as seen in Fig. 6 serves to compress the mass and to exert thereon a considerable pressure radially of the axis of the mass. When the mold is moved so that the mass A occupies the portion D, the mass will be given a considerable taper. Further movement of the mold to the left as seen in Fig. 6 still further compresses the insulating material about the resistor and core until the parts reach the position shown in Fig. 7 where the final compression is obtained. The mold 10 is finally moved to the position shown in Fig. 8 whereupon the mass may be removed from the mold. At this step in the process, the mass will have the shape shown in Fig. 3. After this final compacting operation, I dry out any remaining moisture in the element slowly and then heat the element to mature the insulating material. The element is now ready to be assembled into the element receptacle of the object to be heated, or, if desired, into a sheath either removably or irremovably.

In Fig. 9 there is disclosed a slightly different form of mold for forming a tapered heating element. In this form of apparatus, the mold 10^a is closed at one end and is provided with a final tapered portion E. In making this form of heating element, the mass A' cannot be forced through the mold and it is therefore necessary to remove the finished article from the end of the mold from which it was inserted. In other respects, the method and apparatus for forming this form of heating element is identical with that described in connection with the first form referred to. It is to be understood that this compression operation may, if desired, be accomplished by holding the mold stationary and forcing the element into or through the mold by means of the pistons. However, by moving the mold instead of the pistons, the ends of the element may be formed concave or convex or flat as desired by suitably shaping the faces of the pistons. The mold is preferably made of steel and the surfaces B, C and D are hardened or electro-plated with chromium, or preferably both. It is also to be understood that the portions B, C and D of the mold may be of any desired shape or size. The mold may also be of split construction and opened to remove the work after compressing, if desired. To facilitate the compressing operation, the mass or the mold or both are preferably lubricated by means of a volatile lubricant such as petrolatum or oil which will be burned out when the element is fired.

In Figs. 10 to 15 inclusive, there are disclosed several types of heating elements which may be formed or made according to this process. It is also to be understood that different forms and shapes of resistor elements as well as cores may be used. The element shown in Figs. 14 and 15 is in the form of a carbon rod 16 over which a mass of insulating material 17 is extruded. It is also to be understood that various other sizes and shapes of heating elements may be made according to this process.

In Fig. 16 there is disclosed a modified form of piston 9^a having a stem or projection 9^b thereon which may be substituted for the piston 9 when it is desired to form hollow or tubular heating elements.

It will now be clear that I have provided a process of forming electrical resistor heating elements which accomplishes the objects of the invention as hereinbefore stated.

It is to be understood that the several embodiments of the invention herein disclosed are merely illustrative and are not to be considered in a limiting sense as various changes may be made in details of the apparatus as well as in the process without departing from the spirit of the invention and the invention is limited only in accordance with the scope of the appended claims.

Having thus described my invention, what I claim is:—

1. The method of making electrical resistance heating elements which consists in enveloping a resistor with insulating material, then holding the element at the opposite ends thereof and subjecting the same to gradually increasing radial pressure while holding the insulating material against endwise displacement.

2. The method of making electrical resistance heating elements which consists in enveloping a resistor with insulating material, then holding the opposite ends of the element a fixed distance apart and subjecting the same to a radial pressure whereby to increase the density of the insulating material.

3. The method of making electrical resistance heating elements which consists in enveloping a resistor with insulating material, then placing the element so formed between pistons which are held a fixed distance apart and then passing the element through a tapered bore whereby to increase the density of the insulating material and to impart definite size and shape to the element.

EDWIN L. WIEGAND.