

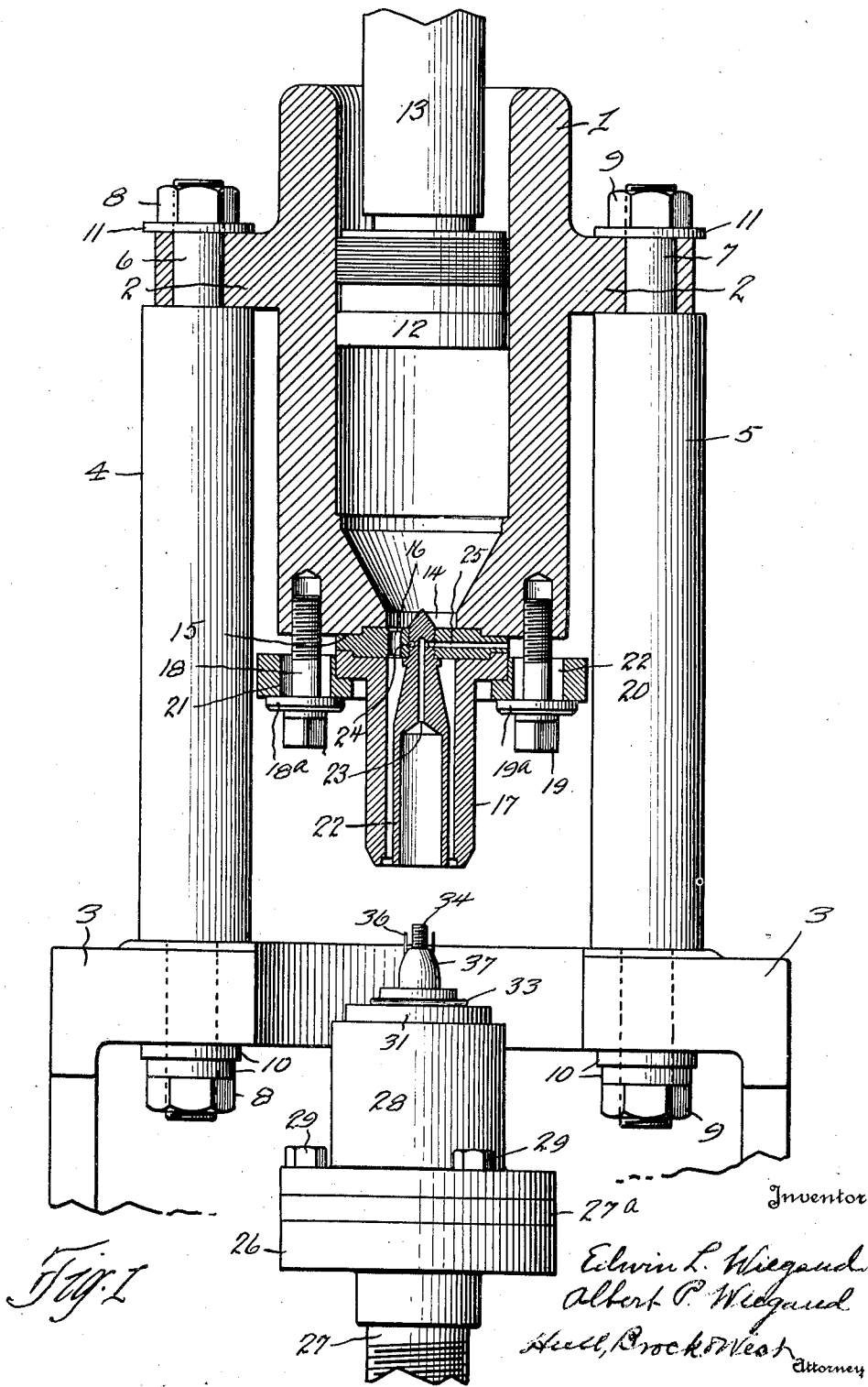
May 5, 1936.

E. L. WIEGAND ET AL

2,039,760

METHOD OF FORMING ELECTRICAL RESISTOR HEATING ELEMENTS

Original Filed Feb. 15, 1930 6 Sheets-Sheet 1.



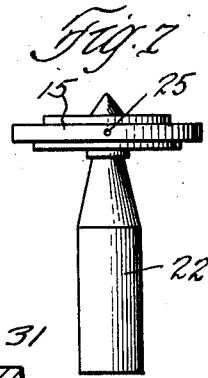
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METHOD OF FORMING ELECTRICAL RESISTOR HEATING ELEMENTS

Original Filed Feb. 15, 1930 6 Sheets-Sheet 2



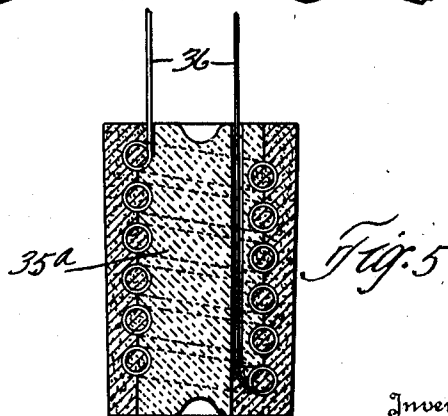
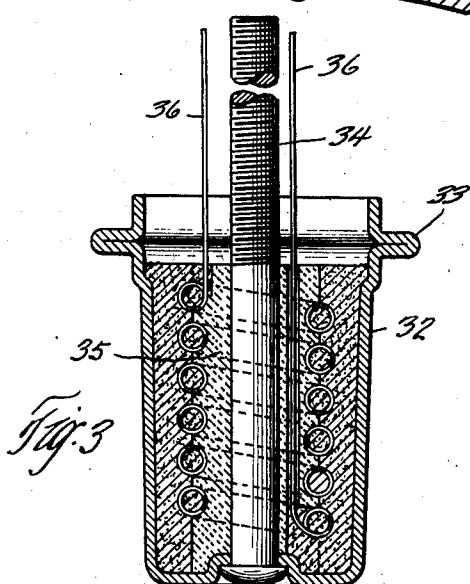
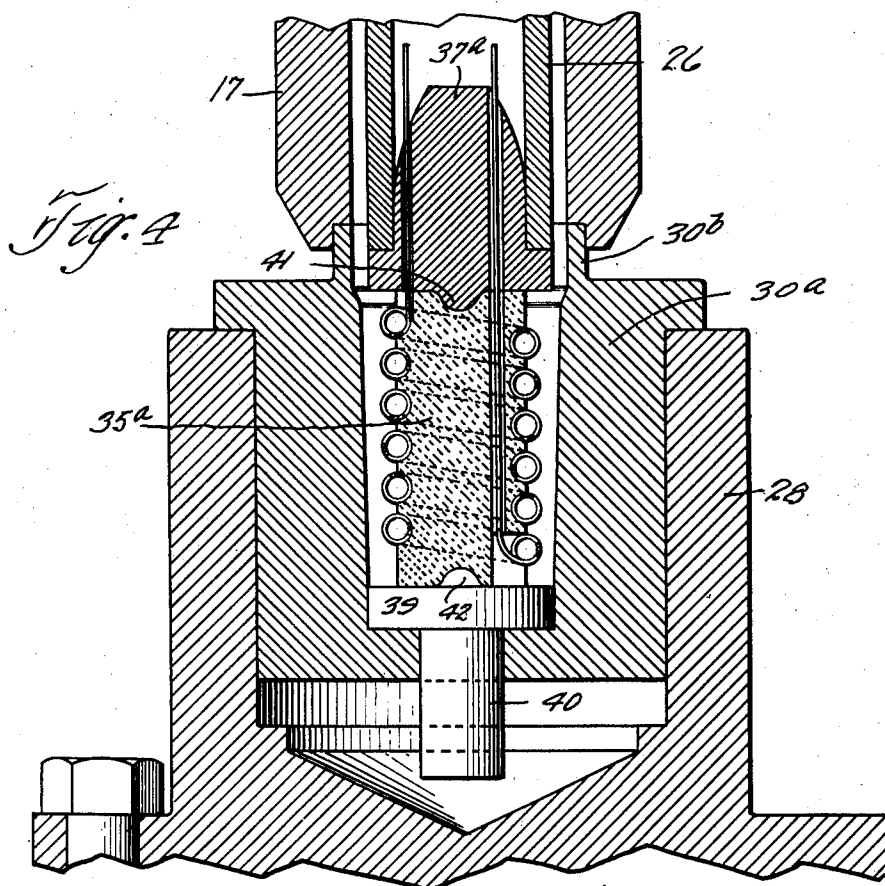
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METHOD OF FORMING ELECTRICAL RESISTOR HEATING ELEMENTS

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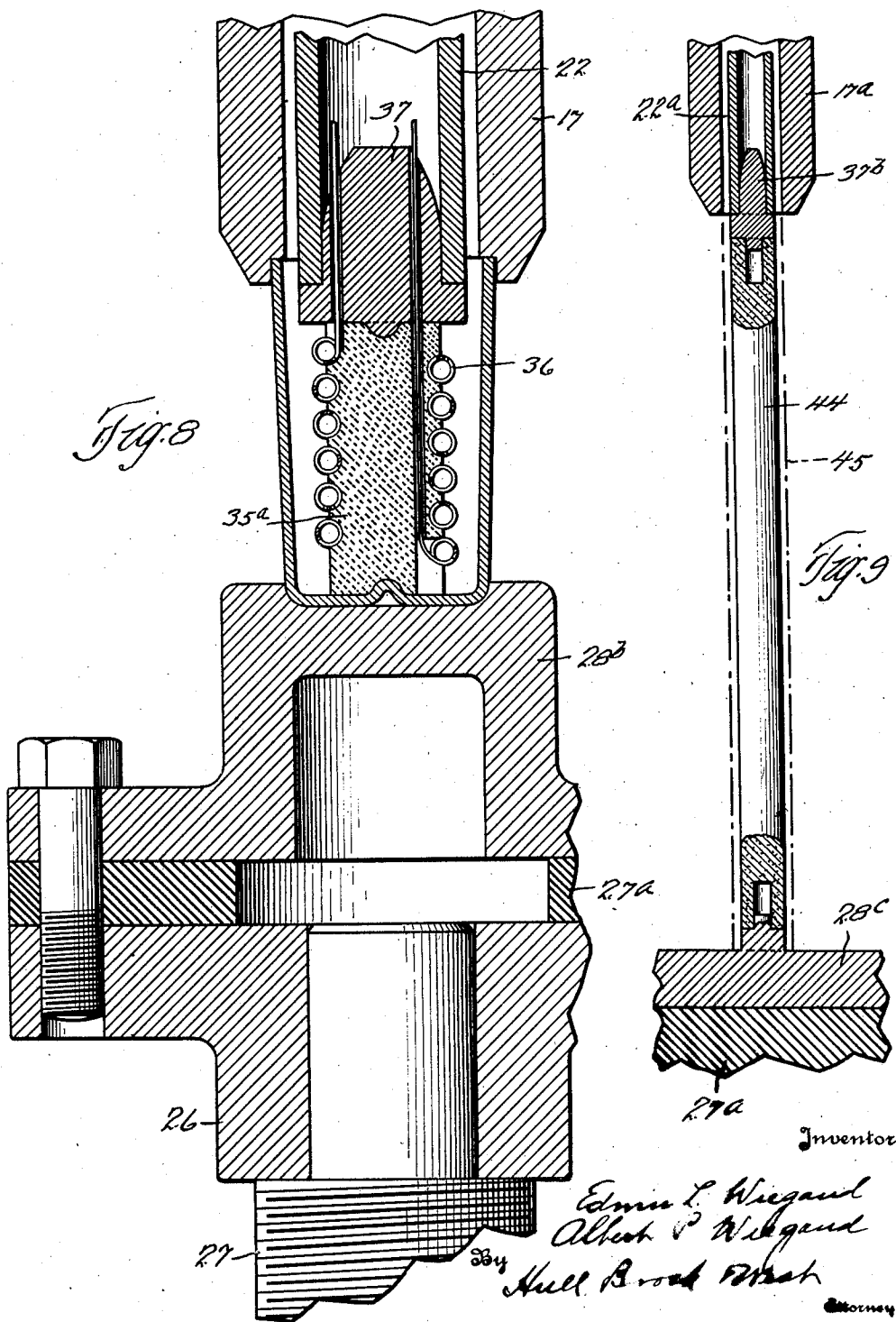
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METHOD OF FORMING ELECTRICAL RESISTOR HEATING ELEMENTS

Original Filed Feb. 15, 1930 6 Sheets-Sheet 4



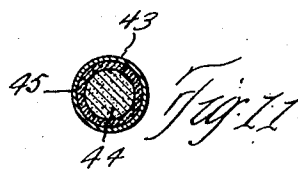
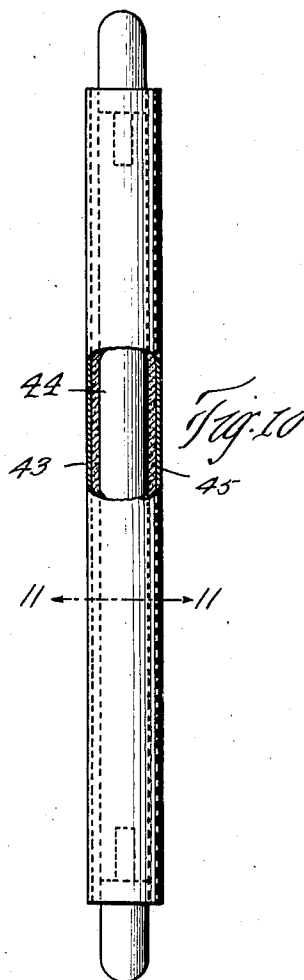
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METHOD OF FORMING ELECTRICAL RESISTOR HEATING ELEMENTS

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METHOD OF FORMING ELECTRICAL RESISTOR HEATING ELEMENTS

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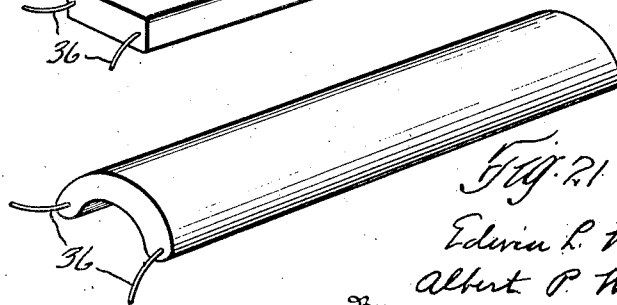
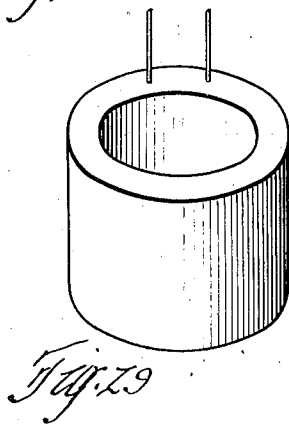
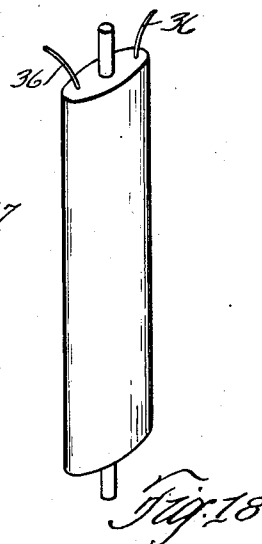
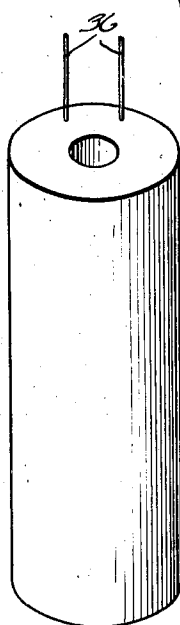
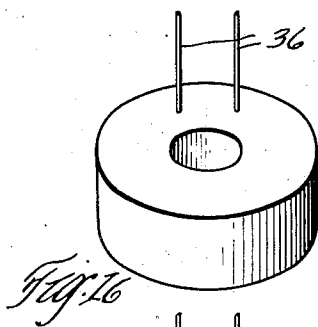
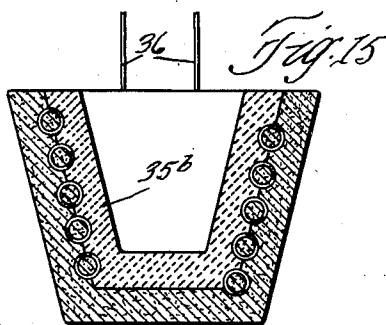
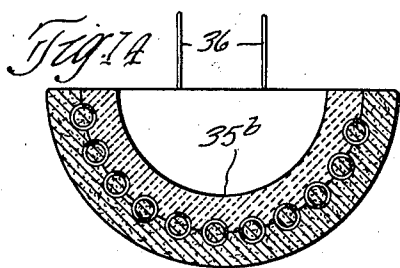


Fig. 21
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UNITED STATES PATENT OFFICE

2,039,760

METHOD OF FORMING ELECTRICAL RESISTOR HEATING ELEMENTS

Edwin L. Wiegand and Albert P. Wiegand,
Pittsburgh, Pa.Application February 15, 1930, Serial No. 428,665
Renewed January 8, 1935

10 Claims. (Cl. 201—67)

This invention relates to electrical resistors and a method of insulating the same.

One of the objects of the invention is to provide a resistor element of the character described which may contain a very massive resistor and in which the refractory insulating material surrounding the resistor is highly compacted and thoroughly intruded about the resistor so that the coils or convolutions of the resistor may be positioned close together without danger of short circuiting and/or burning out.

Another object of the invention is to provide a method of insulating an electrical resistor element in which the insulating material which is disposed about the resistor is highly refractory and comparatively infusible and also highly impervious to air and outside agents so as to enable a maximum energy delivery per unit of external area of resistor element without exceeding permissible resistor temperature.

Another object of the invention is to provide an electrical resistor element which will withstand a maximum input of energy per cubic inch of element displacement without dangerously high resistor operating temperature.

A further object of the invention is to provide a method of insulating resistors of the character described which is speedy and controllable and also well adapted for the filling of sheathed or cartridge type resistor elements, although the method is adapted for use with other type resistor or heater elements either sheathed or unsheathed.

A further object of the invention is to provide a method of insulating electric resistor elements which consists in positioning a resistor upon a form or core, placing the form or core with resistor thereon within a receptacle or mold, and extruding plastic refractory insulating material about the resistor.

A still further object of the invention is to provide an electrical resistor or heating unit of the character described and a method of insulating the same characterized by the fact that the insulating material is uniformly and effectually forced about a highly condensed resistor under pressure whereby the maximum length, mass and area of resistor may be used in a given sized unit.

Heretofore heating units of this general character have been formed by supporting the resistor on a suitable form or core and then compacting substantially dry or slightly moist insulating material around the resistor by tamping, platen-pressing or swaging. This method is satisfactory for certain types of heating elements,

but where a unit is desired which will, with safety to itself, produce a great amount of heat quickly, or where a unit is desired which will occupy very little space and yet, with safety to itself, generate and dissipate a great amount of heat in a very short time, the method herein described has been found most satisfactory and very efficient mainly because of the intrinsic nature of the method of insulating the same which is such as to cause the insulating material to effectively penetrate the very remote and minute spaces interstitial of the convolutions of the resistor and other spaces between the core and sheath, when such is employed. According to the method herein described, we are able to produce a heating unit which will rate in free air at 70° F. as high as 250 watts per cubic inch of element displacement without resistor fusion, or indeed without appreciable deterioration. The resultant insulated coil is also very homogeneous and compact. For the above reasons the coils or convolutions of the resistor may be positioned closer together than is possible by any other methods without danger of short circuiting or shifting of the resistor. Our method is also much simpler and better adapted for the rapid quantity production of heating units at a comparatively low cost.

Briefly stated, our process enables the effectual insulation of highly condensed resistors which in turn results in increased ratio of resistor area and mass to total heating unit area and mass resulting in favorable resistor temperature, a condition which endows a heating unit with increased capacity as expressed in ratios of energy input in watts to unit surface area and cubical displacement. Our process is also particularly well adapted for the production of elements for percolators, soldering devices, burning brands, immersion heaters, tubes, rods and hollow cylinders and other resistor or heating elements necessitating end filling.

Further and more limited objects of the invention will appear as the description proceeds and by reference to the accompanying drawings in which Fig. 1 is a view partly in vertical section and partly in elevation illustrating one type of equipment for carrying out our method; Fig. 2 is a fragmentary vertical sectional view illustrating one of the sheathed type heating units before the insulating material is inserted; Fig. 3 is a vertical sectional view of one of the sheathed type units completed; Fig. 4 is a fragmentary vertical sectional view illustrating a type of

equipment used for forming one of the unsheathed solid type units and with a form or core arranged within the mold; Fig. 5 is a vertical sectional view of a solid unsheathed type of unit completed; Fig. 6 is a top plan view of the die; Fig. 7 is a side elevational view of the die; Fig. 8 is a fragmentary sectional view illustrating the method and apparatus used in forming a sheathed type of unit where the insulating material is forced into the sheath and in which a mold is not necessary; Fig. 9 is a fragmentary sectional view illustrating the method of extruding insulation forming material about a straight resistor such as a carbon rod; Fig. 10 is a view in front elevation of a carbon rod type of unit having an insulating coating extruded thereover; Fig. 11 is a horizontal sectional view on the line 11—11 of Fig. 10; and Figs. 12 to 21 inclusive are views illustrating different types and forms of heating elements which may be insulated according to the method herein disclosed.

This invention is chiefly characterized by its adaptability to the end filling of resistor elements with extrudible insulating forming material, such as pulverant or comminuted refractory insulating material, for example, zirconium silicate or the oxides of aluminum or magnesium admixed with suitable material to enable the insulation forming material to flow or to be extruded under pressure and produce an efficient and dependable insulating medium.

The apparatus for carrying out the method herein disclosed consists essentially of a heavy walled cylinder 1 adapted to receive a quantity of more or less mobile insulation forming material. The cylinder 1 is provided with a peripheral flange of a shoulder 2 having openings therein. The cylinder is mounted on a suitable base 3 and is supported by standards 4 and 5 from which extend bolts 6 and 7 which project through the openings in the peripheral shoulder 2. Suitable nuts 8 and 9 and washers 10 and 11 serve to secure the cylinder 1 in such a manner that it may be pivoted about one of the standards so as to permit refilling of the cylinder, so as to facilitate refilling of the cylinder. Fitting within the cylinder 1 is a piston 12 having a piston rod 13 extending therefrom and by means of which the piston is forced into the cylinder. The interior of the cylinder tapers inwardly at its lower end, as shown in Fig. 2, and terminates in an opening 14. Positioned over the opening 14 is a circular die 15 having a plurality of openings 16 therein. The die 15 is provided with an annular shoulder which fits into an annular recess provided about the opening 14. Disposed below the die 15 is a nozzle 17 which engages the lower face of the die 15 and is clamped against the lower end of the cylinder 1 by means of screws 18 and 19, washers 18^a and 19^a, and a clamping collar or ring 20. The bolts 18 and 19 extend through apertures 21 and 22 provided in the ring or collar 20, and detachably secure the nozzle in place. Arranged within the nozzle 17 is an annular sleeve 22 which is tapered at its upper end and threadedly secured in the die 15. Extending axially of the sleeve 22 is a bore 23 which communicates with the annular bore 24 provided in the upper tapered end of the sleeve. Extending radially of the die 15 is a bore 25 which intersects the bore 24, the purpose of which will hereinafter appear.

Disposed below and in alignment with the nozzle 17 is a base block 26 which rests on the upper end of the shouldered screw 27. Disposed over the block 26 is an annular ring 27^a which is

preferably formed of rubber. Disposed above and resting on the ring 27 is a collet 28 having a peripheral shoulder 28^a which is clamped to the block 26 by means of bolts 29. Fitting within the collet 28 is a mold 30 having an overhanging peripheral flange 31 which rests on the upper edge of the collet. The mold 30 is provided with a central depression which is adapted to receive therein the metal sheath or casing which may form a part of the electrical resistor element.

In one mode of carrying out our method, we arrange within the mold 30 a metal sheath or casing 32 which in the form of the device illustrated in Fig. 2 is provided with an overhanging peripheral flange 33. The sheath is of the shape shown most clearly in Fig. 2 and extending therethrough is a bolt 34, the upper end of which is threaded. Positioned over the bolt 33 is a form or core 35 which may be formed of any suitable material, such as baked or unbaked lava or preformed refractory material. Before the form or core 25 is placed within the sheath, the resistor 36 is wound thereon so as to engage in depressions or grooves formed therein, which serve to hold the resistor in place. The ends of the resistor are inserted through openings provided in the core and extend upwardly therefrom, as shown in Fig. 2. Positioned over the bolt 34 is a tapered guide block 37 having openings or bores therein through which the upper ends of the resistor project. The form or core is then placed over the bolt 34 and the sheath or cartridge inserted within the mold. The mold is moved upwardly by means of the member 27 until the nozzle 17 engages the upper edge of the sheath or shell 32 and closes the same. The sleeve 26 engages over the shoulder 38 provided on the guide block 37, as shown in Fig. 2. The plunger or piston 12 is then actuated in any suitable manner to extrude the refractory insulating material through the opening 16 in the die 15 and thence into the sheath. The resistor coils being under some tension in the grooves formed in the core, the extruded material will pass down over the resistor and first fill the space between the resistor and the side walls of the cartridge or sheath. When this space has been substantially filled, the piston pressure being continued, hydrostatic pressure will develop within the cartridge and force the mobile insulating material around the remote ends of the core and resistor and also within and between the convolutions of the resistor, whether the resistor be a straight wire, a straight ribbon, or a coiled helix. When the larger spaces become filled, the resistance and hydrostatic pressure will increase, and the mobile refractory material will intrude within and around the resistor coils and into every space and crevice to which access is allowed. The pressure will cause the refractory material to be compacted within the shell or cartridge. The air within the shell or cartridge will escape through the sleeve 26, and bores 23, 24 and 25. After the shell or cartridge has been completely filled, the mold and nozzle will be separated and the shell or cartridge removed. The completed article is shown in Fig. 3. If desired, additional material may be added to completely fill the shell or cartridge. In most cases, it is also desirable to dry and in some cases bake the product thus formed in a manner well known to those skilled in the art.

In Fig. 4 there is disclosed a slightly modified form of apparatus for forming an unsheathed solid type of resistor or heating unit. In this form of the invention, the mold 30 is removed

and replaced by a mold 30^a, having an upstanding annular shoulder 30^b thereon which engages in a recess provided in the lower end of the nozzle 17. Arranged within the lower end of the mold 30^a is a plunger 39 having a stem 40 which projects through the lower end of the mold. The guide block 37 is also replaced by guide block 37^a having a projection 41 thereon. The piston 39 also has a projection 42 thereon. The form or core 35^a consists of a solid annular member formed of suitable material, such as baked or unbaked lava or preformed refractory material. The resistor is wound on the form or core, as shown most clearly in Fig. 4. The form or core is placed within the mold and is centrally positioned therein by means of the projections 41 and 42 which engage in corresponding depressions formed in the core. When the parts are in the position shown in Fig. 4, the plunger is actuated to extrude the plastic refractory material into the mold and about the resistor in a manner hereinbefore described. After the mold has been filled with the refractory material, the mold is removed and the unit forced out of the mold by means of the plunger 39. When permissible the sides of the mold may be slightly tapered so as to facilitate removal of the element. The completed element is shown in Fig. 5.

In Fig. 8 there is illustrated one manner of insulating a resistor of the sheathed type. In insulating this type of unit the collet 28 is replaced by resistor supporting member 28^b having a depression in its upper face adapted to receive the sheath therein. The form or core 35^a is positioned within the sheath with the resistor 36 wound thereon as shown. The nozzle 17 engages the upper end of the sheath and the sleeve 22 engages over the guide block 37 which in turn engages the form or core and serves to position the same within the sheath. After the parts are moved to the position shown in Fig. 8, the insulating material is extruded into the sheath and about the form or core in the manner hereinbefore described.

In Fig. 9 there is disclosed a slightly different form of nozzle and sleeve which is adapted for use in extruding a tube of insulation material over a straight resistor, such as a carbon rod of the "globar" type. A suitable resistor support 28^c is provided which has an upstanding portion which serves to position the resistor. A guide block 37^b is provided which has a projection thereon adapted to engage the upper end of the resistor and position the same. The nozzle of the sleeve 22^a engages over the end of the guide block 37^b as shown in Fig. 9. The insulation forming material is extruded through the nozzle 17^a as indicated by the dot-and-dash lines in Fig. 9. In Fig. 10 there is disclosed the insulated resistor arranged within a sheath 43. In Fig. 11 there is disclosed a horizontal sectional view in which the reference character 44 designates the carbon rod over which is extruded a tube or coating of insulation material 45 and which is enclosed within the sheath 43.

Figs. 12 and 13 disclose two types of units which may be insulated in accordance with our method.

Figs. 14 and 15 are sectional views of two other types of units which may be insulated according to the method herein disclosed. The reference character 35^b designates the form or core on which the resistor is positioned. Figs. 16 to 21 inclusive illustrate a few of the different types of resistor and heating elements which may be insulated according to our process and which may

be solid or hollow, sheathed or unsheathed or formed with or without a preformed core.

It is of course understood that the nozzle 17 and the sleeve 22 may be modified so as to be suitable for forming different types and shapes of units. The shell or cartridge may also be formed of any suitable material. The form or core may also be formed of any suitable material and in some cases entirely dispensed with, depending upon the particular type of unit. The apparatus for carrying out the method herein disclosed is merely illustrative and is not to be considered in a limited sense. The means for forcing the insulating material from the mold or for moving the mold into engagement with the nozzle may also be modified as desired. The cylinder 1 should be of considerable capacity and should be so mounted as to permit its being filled without entirely detaching the same from the apparatus. One type of apparatus is shown and described in our co-pending application Serial No. 428,666, filed of even date herewith.

Throughout the specification and claims we have referred to "insulation forming material" and "insulating material". By these expressions we mean to include any material which is already an electrical insulator, such as zirconium silicate, aluminum oxide or magnesium oxide in comminuted form admixed with a substance for contributing mobility to the mixture; or a material, such as metallic magnesium preferably in comminuted or powdered form for facilitating extrusion and which is adapted for subsequent treatment for changing it into a material having electrical insulating properties. We have also used the term "high pressure" and "highly condensed" with reference to the insulating material and the manner of applying the same to the resistor. These expressions are not to be considered in a limiting sense but are used broadly to mean a sufficient pressure to cause the insulating material to penetrate effectively the interstitial spaces of the convolutions or coils of the resistor, and other spaces; and to provide a dependable insulating medium. The actual pressure used in the method depends to a large extent upon the particular type or character of heating unit, resistor and insulating material.

It is therefore 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, and that our invention is limited only in accordance with the scope of the appended claims.

Having thus described our invention, what we claim is:

1. The method of forming electrical resistor units of the character described which consists in arranging within a mold a sheath in which is positioned a form to which is affixed a resistor, closing said sheath and extruding thereinto under high pressure sufficient insulating material to thoroughly insulate the resistor, and separating the mold and sheath with resistor therein and heating and drying the unit.

2. The method of forming electrical resistors of the character herein described which consists in arranging within a mold a sheath having a core of insulating material positioned therein and to which is affixed a resistor, closing the end of the sheath and extruding therein and about the resistor under high pressure a sufficient quantity of insulating material to thoroughly insulate the resistor and then separating the mold and sheath with resistor therein.

3. The method of forming electrical resistor units of the character herein described which consists in arranging the resistor in suitable form within a receptacle and then extruding insulation forming material about the resistor under high pressure.

4. The method of forming electrical resistor units of the character described which consists in arranging a coiled resistor in a receptacle and then extruding insulation forming material under high pressure about the resistor and through and between adjacent portions thereof so as to thoroughly insulate the resistor.

5. The method of forming electrical resistor units of the character herein described which consists in arranging within a mold a sheath having a core of insulating material positioned therein and to which is affixed a resistor which is partially embedded therein, closing the end of the sheath and extruding therein and about the resistor under high pressure a sufficient quantity of insulating material to thoroughly insulate the resistor and then separating the mold and sheath with resistor therein.

6. The method of forming electrical resistor units of the character herein described which consists in arranging a resistor in divers planes within a sheath and then extruding insulation forming material under high pressure into the sheath and about the resistor and through and between the coils thereof.

7. The method of making a sheathed electrical resistance heating unit of the character described which consists in arranging a resistor within a

sheath in a useful form and then enveloping the resistor with insulating material by extruding the insulating material into the sheath and about the resistor under sufficient pressure to compact the insulating material about the resistor in a highly condensed state.

8. The method of making electrical resistance heating units of the character described which consists in enclosing a resistor within a receptacle and enveloping the resistor with insulating material by extruding the insulating material into the receptacle and about the resistor under pressure and continuing such extruding operation until the receptacle is filled and the insulating material is compacted about the resistor in a highly condensed and compacted state.

9. The method of making electrical resistor units of the character described which consists in placing a resistor upon a stationary form within a receptacle and extruding insulation forming material about the resistor under high pressure.

10. The method of making electrical resistor heating elements of the character described which consists in positioning in a suitable receptacle a form having a resistor coiled thereon, the form being of such size as to leave a space between the resistor and the walls of the receptacle, closing the receptacle and extruding into said space and through and between the coils of said resistor sufficient insulating material to fill the receptacle and to insulate the resistor and to place the contents of the receptacle under high pressure.

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