

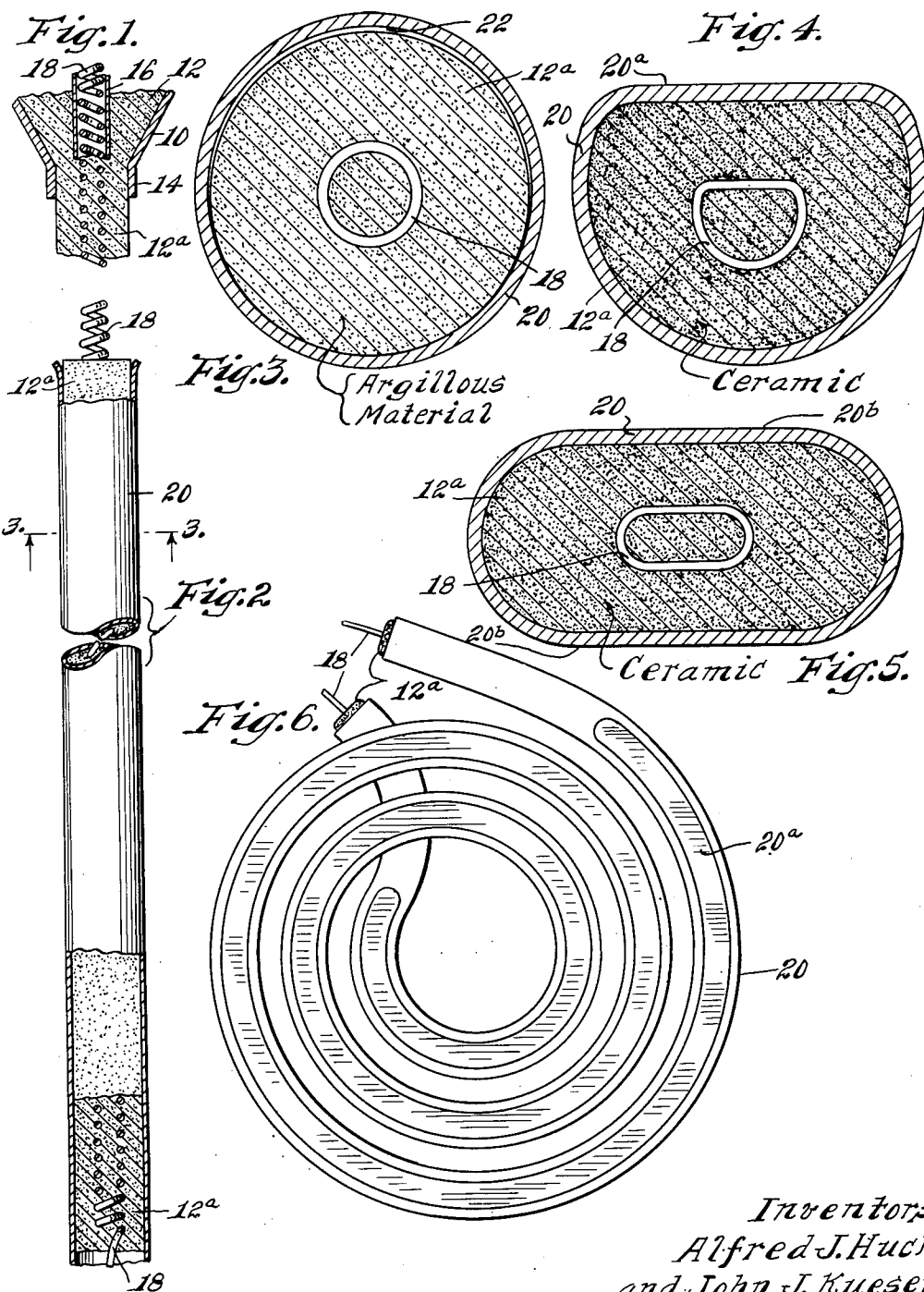
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METHOD OF PRODUCING ELECTRIC HEATING ELEMENTS

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METHOD OF PRODUCING ELECTRIC HEATING ELEMENTS

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This invention relates to a tubular heating element of the extruded, flattened type and particularly to a process for forming the same whereby an inexpensive heating element of high efficiency can be produced.

One object of the invention is to extrude a coil of resistance wire and a core therefor of argillous material, sheath the same, fire it for reducing the argillous material to ceramic and then increase the dielectric strength of the core and provide for good heating transfer from the resistance wire to the sheath by a flattening process which compresses the ceramic tightly and causes it to fill the entire interior of the sheath and physically reinforce the sheath so that less warpage is experienced as it heats.

A further object is to provide a heating element formed by a process which flattens a sheathed heating element after it is fired by great pressure that tightly compresses the ceramic produced by the firing and provides a heating element having a cooler wire operating temperature and longer life.

With these and other objects in view, our invention consists in a method of producing a flattened, extruded tubular heating element whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in our claims and illustrated in the accompanying drawings, wherein:

Figure 1 is a partial side elevation and partial sectional view of an extruded heating element being formed in accordance with Smith Patents No. 1,951,176 of March 13, 1934, and No. 1,987,915 of January 15, 1935.

Figure 2 is a partial side elevation and partial sectional view showing the heating element and its core being inserted in a metallic sheath.

Figure 3 is an enlarged sectional view on the line 3—3 of Figure 2.

Figure 4 is a similar sectional view showing the sheathed heating element after it has been fired and flattened in accordance with our present invention.

Figure 5 is a similar sectional view showing a different flattened shape for the heating element; and

Figure 6 is a plan view of the sheathed heating element embodying our invention and showing an intermediate step in the process, to wit, the heating element formed to a desired or required shape before it is flattened.

On the accompanying drawing we have used the reference numeral 10 to indicate a hopper for argillous material 12 which hopper has a discharge nozzle 14. The hopper and nozzle may be part of a heating element forming machine of the kind shown in the above identified Smith patents. As disclosed therein, the argillous material 12 is under pressure so that it is extruded from the nozzle 14.

Depending within the hopper 10 is a guide tube 16 for a coil of resistance wire 18, the lower end of which is filled with and imbedded in a core 12a of the argillous material 12 as the material is extruded from the nozzle 14. The extrusion pressure and movement also serve to draw the resistance coil 18 downwardly through the guide tube 16.

The resistance coil 18 as shown in Figure 1 and the core 12a are permitted to dry slightly, the argillous material 12 being moist and in a plastic condition when extruded from the nozzle 14. Drying is permitted just long enough to permit handling and subsequent insertion into a metallic sheath 20 as shown in Figure 2, the sheath being preferably straight and thus permitting free entry of the core and resistance wire, and the inside diameter

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of the sheath being slightly greater than the diameter of the core to permit ready assembly. The parts are then in relation to each other as illustrated in cross section in Figure 3, the space 22 representing the difference in diameters and being somewhat exaggerated in this figure. The foregoing steps for forming and sheathing a heating element are old in the Smith patents.

According to our invention, the sheathed heating element is then "fired" or heated to dry the moisture out of the argillous material 12 and reduce it to a ceramic. The firing process shrinks the core 12a which increases the space 22 and this space considerably reduces the efficiency of the heating element in operation. However, an extruded heating element of this type is inexpensive to produce as compared with heating elements of the type which imbed the resistance coil in powdered insulating material tamped into a sheath along with the resistance coil.

We have found that the efficiency of the heating element as disclosed in Figure 3 can be greatly increased however by flattening the sheathed element after it has been fired, the result being to tightly compress the ceramic thus resulting in good heat transfer from the resistance wire to the ceramic and from the ceramic to the sheath. This results in a cooler operating temperature of the resistance wire thus providing longer heating element life, and the dielectric strength is greatly improved as well as the physical strength of the entire sheathed element which then warps less than when the flattening process is omitted. We are aware that heretofore metallic sheaths containing powdered insulating material tamped in around resistance wires have been flattened but to our knowledge first firing an extruded, sheathed heating element and thereafter flattening thereof as here disclosed has not been done.

For this purpose, we find that the argillous material after firing must not be in the nature of porcelain, china or steatite but more of the order of common clay like that used in building bricks so that it will crumble somewhat during the flattening process. A fired material of this nature acquires additional denseness of structure under extreme pressures such as those between 2,000 and 10,000 p. s. i. produced by high pressures or high striking forces imparted to the dies in the flattening press. This results in holding the particles together whereas before flattening the bonding of the particles due to firing holds them together at a certain lesser density of structure. After flattening, the high dielectric characteristics of the fired ceramic are retained and considerably improved upon as we have determined by numerous tests because maturing of the ceramic has been accomplished.

The important order of steps in the practice of our process is first firing and thereafter flattening of the encased heating element. Between these two steps the initially straight sheathed element may be formed to any required or desired shape such as that shown in Figure 6 to fit the bottom of a cooking kettle or the like. If a "strip" heating element is desired, the forming step just referred to can be omitted and of course the heating element may be formed U-shaped or any other desired shape, Figure 6 showing merely an example.

In Figure 4 we show an element flattened suitably for contact with a cooking kettle as in electric stove elements and hot plates. In Figure 5 we show another form of flattening suitable for the sheath to be soldered or brazed to the bottom of a cooking kettle, coffee pot, or the like.

In actual tests we have found that a heating element flattened after firing as compared to the unflattened element shown in Figure 3 operates at a higher over-all temperature which indicates that more heat is drawn from the resistance wire whereas the unflattened heating element has a higher temperature in the resistance wire itself but conduction to ceramic and the sheath is not as efficient and therefore the resistance wire has a shorter life as well as being less efficient.

Due to firing causing some shrinkage of the core 12a, it is important that this shrinkage be taken up before the heating element is flattened. This is another reason that firing before flattening is desirable as if firing were accomplished after flattening, there would be shrinkage of the core that would reduce the efficiency as distin-

guished from increasing it by flattening after firing. In order to insert the core 12a into the sheath 20 initially the difference in diameters is necessarily about .003" to .007". The firing operation is desirably done at a relatively low temperature of about 1400° F. The flattening process then reduces the internal area and the fired ceramic becomes hard and dense and fills all interstices, thus increasing heat conduction through the ceramic to the sheath to a maximum.

Aside from excellent pressure bonding between the ceramic and the inside walls of the sheath for good heat transfer, the flattening process compacts the insulation so tightly that it provides uniform distortion of the resistance coil and accordingly proportionate insulation spacing is provided throughout the area of the coil as illustrated in Figures 4 and 5. The compressed ceramic fills any possible cracks that might be present because it has no place else to go and the area within the sheath is being reduced due to the flattening.

Our process permits the use of a relatively inexpensive extruded heating element to produce a highly efficient finished heating element of the sheathed type without the expense heretofore necessary in connection with heating elements of the type having tamped powdered magnesium oxide as an insulator and without the difficulty experienced with those types of heating elements in keeping the resistance wire centered during the tamping process. The extrusion process disclosed in the Smith patents accurately centers the heating element and after the core 12a is reduced by firing to a ceramic, any flattening of the sheathed element as we propose causes proportionate deformation of the resistance coil whereas flattening while the core is still soft (before it is fired) would permit the core to flow around the resistance wire and the resistance wire to retain its original circular shape instead of being proportionally flattened as necessary to prevent reducing the thickness of the insulation and to prevent the resistance wire from grounding against the sheath which of course cannot be tolerated. The sheath can then be further formed and even portions thereof twisted if desired without danger of the resistance coil shorting against the sheath.

Some variations in the steps of our process for producing the disclosed type of heating element may be tolerated without departing from the real spirit and purpose of our invention, and it is our intention to cover by our claims any modifications or use of mechanical equivalents which may be reasonably included within their scope.

We claim as our invention:

1. A method of producing a heating element comprising the steps of extruding an argillous core with a resistance element embedded therein into a tubular metallic sheath, said extruded core being essentially composed of a common clay of the type which, when fired, will yield a ceramic which upon compressing crumbles into a fine granular form capable of rearrangement of shape, firing the sheathed resistance element and core to transform the core to a ceramic, and flattening the resulting sheathed heating element under pressure and after firing

to reduce the area within the sheath and crumble the ceramic, thereby tightly compressing the ceramic around the resistance element and causing it to completely fill said sheath.

2. In a method for producing a heating element, the steps of extruding argillous material and a heating coil, said extruded material being essentially composed of a common clay of the type which, when fired, will yield a ceramic which upon compressing crumbles into a fine granular form capable of rearrangement of shape, sheathing the same in a metal sheath, heating said heating coil, argillous material and sheath to transform the argillous material to a ceramic, forming the resulting sheathed heating element to a desired shape substantially in one plane after it has been heated, and flattening the same under high pressure to crumble and tightly compress the ceramic in close contacting engagement with the confining walls of the sheath.

3. A method of producing a heating element comprising the steps of extruding an argillous core with a resistance element imbedded therein, said extruded core being essentially composed of a common clay of the type which, when fired, will yield a ceramic which upon compressing crumbles into a fine granular form capable of rearrangement of shape, encasing the same in a tubular metallic sheath, firing the encased resistance element and core to about 1400° F. to reduce the core to a ceramic, and flattening the sheathed heating element under a pressure between 2000 and 10,000 p. s. i. after it has been fired in order to crumble and tightly compress the ceramic around the resistance element and cause the same to completely fill said sheath.

4. A method of the character disclosed comprising the steps of extruding a plastic insulating core and a heating element imbedded therein, said extruded core being essentially composed of a common clay of the type, which, when fired, will yield a ceramic which upon compressing crumbles into a fine granular form capable of rearrangement of shape, placing them in a tubular metallic sheath, heating the sheathed heating element and core to reduce the core to a ceramic, and flattening at least one side of the sheathed heating element under high pressure to crumble and tightly compress the ceramic into close contacting engagement with said metallic sheath for maximum heat conduction from said heating element to said sheath.

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