June 2, 1942. W. H. GINDER 2,284,862

HEATING UNIT AND METHOD OF MAKING SAME

Filed June 23, 1939

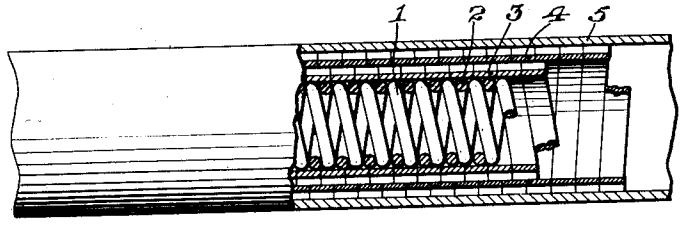


Fig. 1.

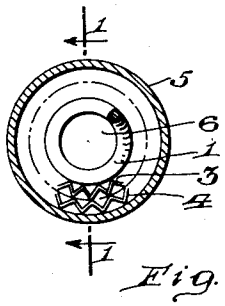


Fig. 2.

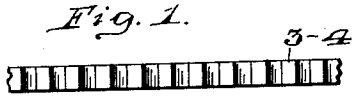


Fig. 3.

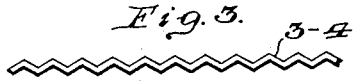


Fig. 4.

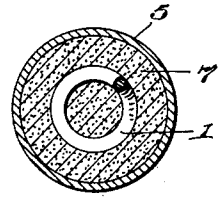


Fig. 6.

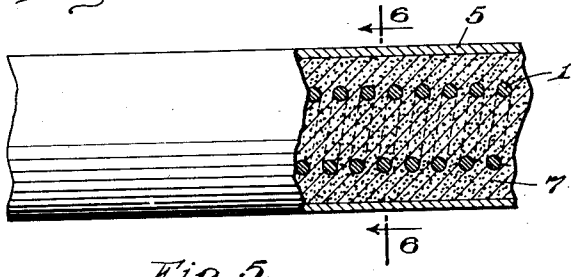


Fig. 5.

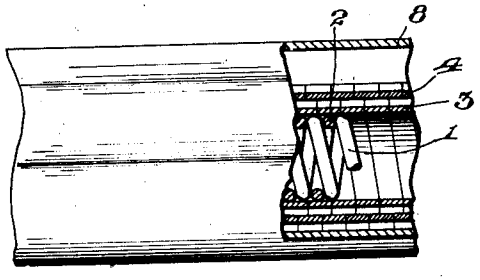


Fig. 7.

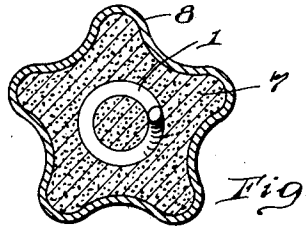


Fig. 8.

INVENTOR
William H. Ginder,
BY
J. Stuart Freeman
ATTORNEY

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HEATING UNIT AND METHOD OF MAKING SAME

William H. Ginder, Haddonfield, N. J.; Mabel Anna Ginder, executrix of William H. Ginder, deceased

Application June 23, 1939, Serial No. 280,795

2 Claims. (Cl. 201—64)

The object of this invention is to provide improvements in electric resistance units, and especially has to do with that type which is enclosed within metal tubing and is employed in and as a normally unitary part of electric cooking ranges, ovens, furnaces and immersion heating devices of various kinds, this application comprising a continuation-in-part of copending application Serial No. 201,661, filed April 13, 1938.

Another object is to provide a unit, in which there is initially positioned between the adjacent convolutions of the helical resistance wire a spacing wire of oxidizable metal such as magnesium, which when subjected to superheated steam is transformed into magnesium oxide, an exceedingly efficient insulation medium.

A further object is to provide in such a device the combination of a resistance wire helix with a surrounding metallic casing, said helix and casing being initially uniformly spaced apart by means of preferably transversely corrugated ribbons of magnesium wound rather closely in layers which, when two or more such spacing layers are used, are wound in angularly disposed helixes, with the aggregate heights of the corrugations in the case of either one or more of such spacer layers filling the distance between said resistance and said casing.

Still another object is to provide an improved process or method of producing the improved heating unit, which in addition to inserting spacer wires of an oxidizable metal between adjacent convolutions of the resistance wire, and one or more layers of equivalent oxidizable metal around such wires, consists in enclosing the same within a protective casing, and then transforming the oxidizable metal by means of heat as by superheated steam, and in addition thereto also comprises the filling of the axial space within said wires with an insulation paste, which upon setting completes the filling of the interior of the unit with thoroughly insulative material.

With the objects thus briefly stated, the invention comprises further details of construction, which are hereinafter set forth in detail, when read in conjunction with the accompanying drawing, in which Fig. 1 is an elevational view, partly in longitudinal diametrical section through the helix of electric resistance wire, the spacing wire, the oppositely wound layers of corrugated magnesium ribbon and the surrounding tubular casing, after these parts have been initially assembled, but prior to heat treatment of the same, the sectional portion of said figure being on the line 1—1 of Fig. 2; Fig. 2 is a transverse sectional view of the same; Figs. 3 and 4 are top plan and side elevational views, respectively, of the corrugated magnesium or equivalent ribbon shown in Figs. 1 and 2; Fig. 5 is a side elevational view, partly in section, showing the device after it has been heat treated; Fig. 6 is a transverse section on the line 6—6 of Fig. 5; Fig. 7 is a view similar to Fig. 1, but showing the several elements assembled in a longitudinally corrugated tube; and Fig. 8 is a transverse sectional view of the modified form of device shown in Fig. 7, but after the same has been heat treated.

Referring to Figs. 1 to 6, inclusive, the proper kind and size of electric insulating wire 1 (or ribbon or other form of resistance material) is first wound helically upon any suitable form of mandrel (not shown), so as to provide the helix shown in Figs. 1 and 5, while at the same time a second wire 2 of magnesium or equivalent substance is wound upon said mandrel, closely adjacent to and filling the space between adjacent convolutions of said resistance wire helix, thereby forming a positive means by which the said adjacent convolutions of resistance wire are temporarily maintained in fixed and definitely spaced relation. Then surrounding this composite helix of resistance and spacing wires is wound one or more layers 3 and 4 of magnesium or equivalent substance, in the form of a preferably transversely corrugated ribbon. As indicated in Fig. 1, when two or more such layers of ribbon are so wound, their winding is preferably carried on in opposite directions, in order to prevent the corrugations of the ribbon in one layer from at least partially nesting in the corrugations of the ribbon of the adjacent layer, as it is essential to keep the spaces and channels formed by said corrugations open for a purpose hereinafter described.

This composite set of elements thus formed is then inserted within the proper size of tubing 5, the diameter of said tubing preferably being such as to fairly closely receive said elements, as also indicated by Figs. 1 and 2. After these steps in the process or method of forming the heating unit have been completed, the resulting device is then placed within such an apparatus as an autoclave, in which is also placed a chemical agent, of such nature as will be vaporized under the heat and pressure within the autoclave, and with the steam penetrate the interstices of the magnesium wire and ribbon structure, and unite both chemically and physically with the said magnesium, as it is being transformed into magnesium oxide.

For purposes of illustration, commercial sodium silicate diluted with water to about 10% concentration of sodium silicate is treated with just enough phosphoric acid to precipitate the silicic acid. The resulting gel is then further diluted with 5% to 95% water, depending on how much of the reagent it is desired to combine with the magnesium oxide to be produced. A suffi-

cient amount of the reagent to cover the elements to be treated is introduced into the autoclave and heat applied. The steam generated under pressure converts the magnesium into magnesium oxide, and at the same time a reaction takes place between the magnesium oxide and the silicic acid and sodium phosphate present in the reagent, resulting in the production of some magnesium silicate and some magnesium phosphate. This combination forms a compact enamel-like product, which fills the spaces within the tubular shell and effectively insulates the resistance wire helix therefrom.

The broad principle involved in the foregoing illustrative method, essentially comprises the transformation of the magnesium to magnesium oxide in the presence of silicic acid and sodium phosphate, or in the presence of sodium phosphate alone. However, instead of the sodium phosphate, either alone or in combination with the silicic acid, ammonium phosphate can be similarly used, either alone or with the silicic acid, as well as may be used other soluble phosphates in the same manner.

Fundamentally, it was discovered that acidification of a solution of sodium silicate with phosphoric acid resulted in a gel, and that this gel in attenuated form, when placed in an autoclave with magnesium ribbon and wire and subjected to heat, resulted in a conversion of the magnesium to magnesium oxide, while the silicic acid and sodium phosphate produced the compact, enamel-like insulating medium hereinbefore referred to. That the presence of the silicic acid and the sodium phosphate was responsible for the bonding of the magnesium oxide, is apparent from the fact that water alone under the same conditions converts the magnesium into pulverulent magnesium oxide, while analysis of the product of this invention has shown that it comprises magnesium oxide, combined with some phosphate and some silicate. Silicic acid alone also produces a desirable result.

From experiments, it has also been found that a suitable reagent can be prepared by treating a solution of silicate of sodium with a sufficient amount of hydrochloric acid to completely precipitate the silicic acid, the gel so formed being washed to remove the sodium chloride from the reaction. A sufficient amount of the washed gel, depending upon the amount of magnesium to be treated, and the amount of silicate desired as a bond in the finished product, is dispersed in the water for use in the autoclave. Experiments have shown that as little as 0.25% silicic oxide in the combined insulating product manifests itself as a binder, though it is by no means the intention to limit the invention in any way to that figure or proportion. Similarly, silicic acid gel may be prepared from sodium silicate by using other acids and washing out the corresponding salts formed thereby. The resulting gel is substantially the same in each case.

In considering the present invention, while as before stated silicic acid alone produces quite a satisfactory result, the combination of silicic acid with sodium or other soluble phosphate produces a still better result, so that while not absolutely necessary in order to produce a commercial product, the presence of the phosphate radical in the reaction is considered to be desirable. Also, when the reagent contains both the silicic acid and a soluble phosphate, there is avoided the necessity of washing the gel to remove therefrom the undesirable salts.

Upon examining the composite resistance unit prepared in accordance with the foregoing method, it will be found that the resulting insulating medium has completely filled the spaces between the resistance wire and the surrounding tubular casing, thereby forming a solid enamel-like body 7, while the helix of spacer wire during oxidation is found to have simultaneously expanded in such manner as to permanently fill the spaces between adjacent convolutions of the resistance wire helix, and to have fixedly established the said initial, equally spaced relationship between them, also protruding into the axial space within said helix. In order to further and completely fill this said axial space, a paste is prepared of approximately 10% silicate of sodium, 10% phosphoric acid, 40% magnesium oxide and 40% water. This paste when thoroughly mixed is then forced into and axially through the center of the heating unit as removed from the autoclave, with the result that a completely unitary relationship is established between the resistance wire and the tubular casing, as indicated in Figs. 5 and 6, and from which all air and substantially all moisture is excluded, the slight residual moisture being eliminated by heating the completed unit, either extraneously or by energizing the resistance wire.

Referring to Figs. 7 and 8, the same numerals have been applied to the parts here shown, except that instead of the tubular casing of regular cross section shown in Figs. 1, 2, 5, and 6, a longitudinally corrugated casing 8 has been provided, and the resistance wire helix permanently positioned centrally therein, as clearly indicated by Fig. 8. Also, in this form of the device, if for any reason the magnesium or equivalent ribbon has failed during oxidation to completely fill the spaces within the corrugations of said tube, similar paste-like composition to that above described may be forced through said spaces, in order to insure exclusion of air and the provision of a uniform medium for heat transference from wire to tube or casing.

Having thus described my invention, what I claim as new and desire to protect by Letters Patent of the United States is:

1. The method of producing an electric heating unit, which consists in providing a core of electric resistance material, placing said core surrounded by magnesium within a casing, immersing said core surrounded by magnesium in a dispersion of silicic acid and a solution of a salt containing the phosphate radical, and then subjecting the whole to sufficient heat and pressure to produce between said core and said casing an insulating medium consisting essentially of magnesium oxide bonded with magnesium silicate and magnesium phosphate.

2. An electric heating unit, comprising the combination of an electric resistance element, a surrounding casing, and an insulating medium consisting essentially of magnesium oxide bonded with magnesium silicate and magnesium phosphate.

WILLIAM H. GINDER.