Dec. 7, 1937. G. E. PRICE 2,101,095

PROCESS OF MAKING ELECTRICAL HEATERS

Filed Oct. 12, 1934 2 Sheets-Sheet 1

Fig. 1.

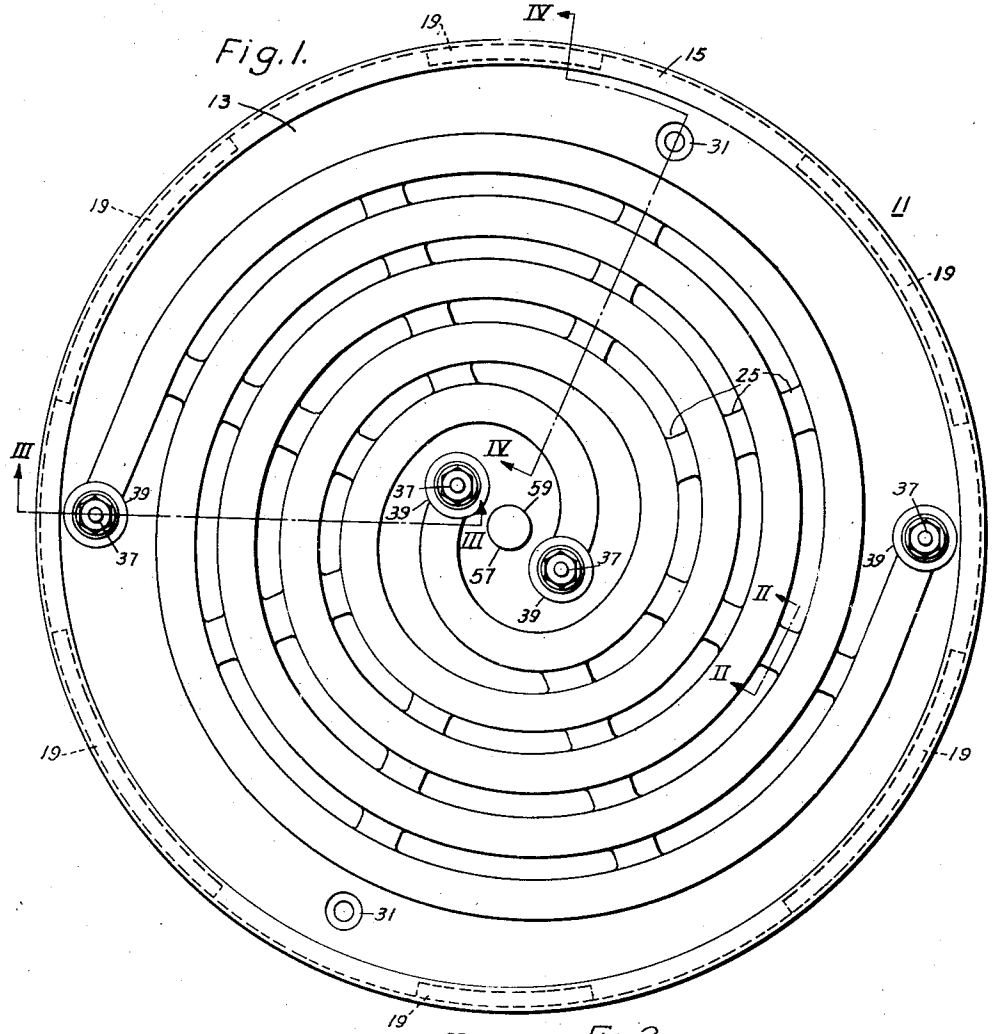


Fig. 2.

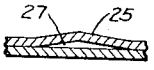


Fig. 3.

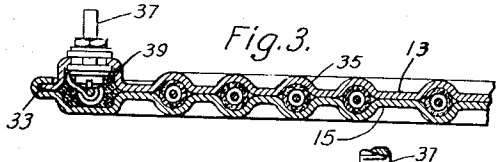


Fig. 4.

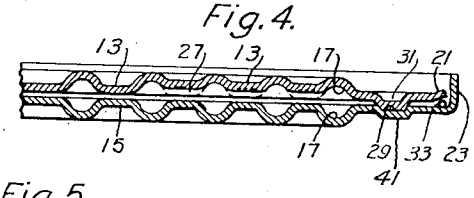
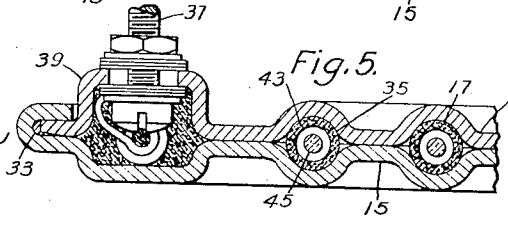


Fig. 5.



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Fig. 6.

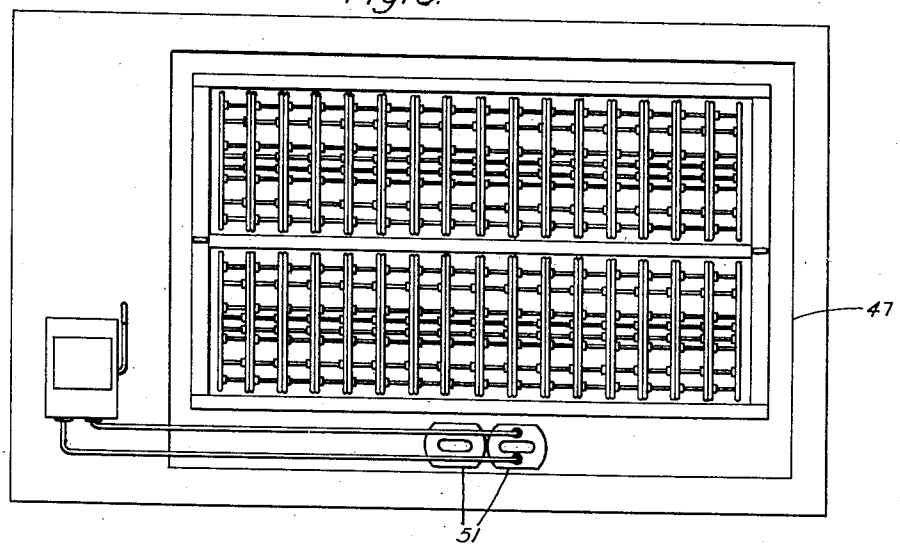
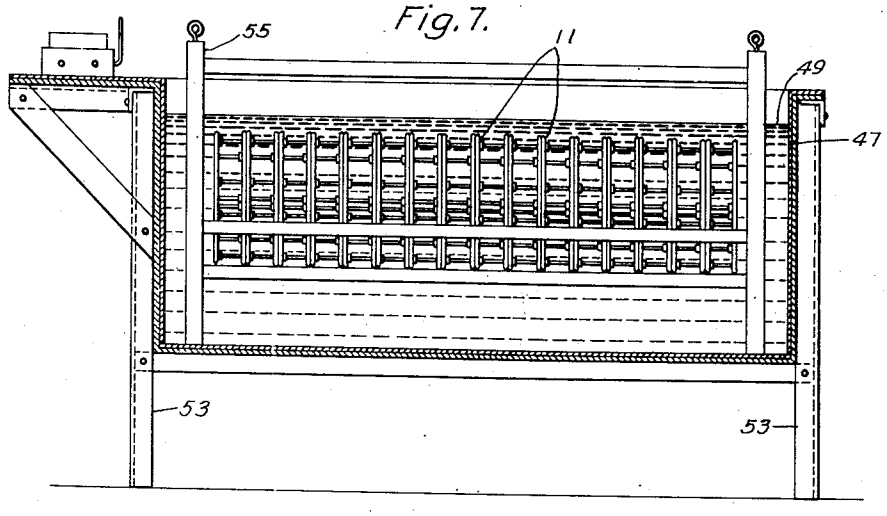


Fig. 7.



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Patented Dec. 7, 1937

2,101,095

UNITED STATES PATENT OFFICE

2,101,095

PROCESS OF MAKING ELECTRICAL HEATERS

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Application October 12, 1934, Serial No. 748,027

13 Claims. (Cl. 201—67)

My invention relates to electrical heaters and particularly to processes of making electrical heaters.

The main object of my invention is to provide a method for increasing the electrical resistance of a granular electric-insulating material holding a resistor within a metal casing.

Other objects of my invention will either be specifically pointed out hereinafter in the course of the description of my process as applied to a particular type of encased heating unit or will be apparent without further reference thereto.

In practicing my invention, I provide a metal-encased resistor element separated by a layer of granular electric-insulating material and immerse the assembly in a boiling solution of boric acid in such manner as to cause the solution to circulate through the metal casing, remove the assembly after a suitable time of immersion and then subject it to a relatively high temperature for a certain length of time to convert the deposited boric acid into an oxide.

In the drawings,

Figure 1 is a bottom plan view of one form of electric heating unit upon which the method embodying my invention may be practiced,

Fig. 2 is a fragmentary sectional view therethrough taken on the line II—II of Fig. 1,

Fig. 3 is a partial sectional view through the device shown in Fig. 1 and taken on the line III—III thereof,

Fig. 4 is a partial sectional view through the two plates constituting the casing of a heating unit, shown in proper operative positions, and taken on the line IV—IV of Fig. 1,

Fig. 5 is a fragmentary view, on an enlarged scale, showing particularly the left-hand end portion of the device shown in Fig. 3,

Fig. 6 is a top plan view of a device used in the method embodying my invention, and

Fig. 7 is a view in vertical section therethrough.

As has already been stated, my improved process is of particular value in connection with metal encased electric heating elements in which granular electric insulating material is located between a resistor element and the inside surface of the wall of the metal casing. I have found in one particular form of such device that the ohmic resistance of the electric insulating material between the resistor and the casing may be relatively low and my process has been designed and perfected with a view of increasing the value of the ohmic resistance of the layer of granular electric insulating material between the resistor and the enclosing metal wall, thereby ensuring a longer life of the heating unit.

Referring to Fig. 1 of the drawings, I have there illustrated an electric heating unit 11 such as is provided for the cooking platform of an electric range and which unit is shown as being substantially circular in shape.

The unit 11 includes a lower plate 13 of relatively thin sheet metal and an upper plate 15, also of relatively thin sheet metal, both plates being provided with a plurality of substantially concentric and substantially semi-circular grooves 17, which grooves 17 in the two plates cooperate to provide a substantially circular groove, as is shown more particularly in Figs. 3, 4 and 5 of the drawings.

The outer periphery of plate 13 is made substantially flat, except for certain portions designated by numeral 19 in Fig. 1 of the drawings where the extreme outer peripheral edge is bent upwardly as shown at 21 in Fig. 4 of the drawings, for a purpose to be hereinafter set forth in detail. The outer peripheral edge portion of plate 15 is made initially somewhat larger in diameter than the plate 13, which outer edge portion is bent laterally to provide a flange 23, as is also shown in its preliminary condition of manufacture at 23 in Fig. 4 of the drawings.

Plate 13 is also provided with a plurality of outwardly bent portions 25 shown more particularly in section in Fig. 2 of the drawings, these portions providing treating vents 27 on the inside of the plate which extend between adjacent grooves in the plate 13 to permit of an oxidizing agent, hereinafter to be described in detail, to flow from one groove to another.

In the manufacture of the heating unit shown more particularly in Figs. 1 and 3 of the drawings, two plates 13 and 15 are first operated on as has hereinbefore been described to provide the semi-circular co-operating grooves as well as a depression 29 in upper plate 15 and a projection 31 in lower plate 13, two such cooperating depressions and projections being provided which are located at diametrally opposed points in order that any two plates shall be fitted together in only one or two positions. The upper plate 15 has a sealing gasket 33, made of a relatively soft metal wire such as copper whose ends are welded together, secured to its inside surface as by welding or soldering the same thereto just within the flange portion 23.

The lower plate 13 is then located in its proper operative position, that is with the semi-circular grooves 17 uppermost, on a suitable

support and a helically wound resistor wire 35, surrounded by an open helix of initially metallic magnesium ribbon is located in the semi-circular groove 17 in plate 13 and if desired, an inner filler of initially metallic magnesium rod is located within the helix.

The ends of the respective sections of the heater 35 are then secured to terminal members 37, which are insulatedly mounted in depressed portions 39 in plate 13 in a manner well known in the art. Four such terminals are provided in the present structure.

After this, the upper plate 15 is located in proper operative position on the lower plate and a small number of tack welds are made between the two plates. Any desired additional number of welds may be provided or a relatively large number of points between the grooves as well as immediately outside thereof may be spot welded together to hold the two plates in closely adjacent positions relatively to each other and to provide a relatively strong heater structure, since it is desired to have cooking utensils to be heated by the unit located directly thereon.

The assembled heating unit is now placed in an autoclave or other closed chamber and subjected for a predetermined length of time to the action of high temperature water or steam, the temperature value being up to 1000° F. The steam or water can flow into the unit at the portion 19, the other flat parts of the periphery of plate 13 resting directly on the gasket 33, as is shown in Fig. 4 of the drawings. This converts the initially metallic magnesium surrounding the resistor 35, as well as that located inside thereof, into magnesium hydroxide which has a granular structure and which is shown in Fig. 5 of the drawings by numeral 43 for the outer layer and 45 for the inner filler. During this conversion of the metallic magnesium into magnesium hydroxide, its volume increases to about 180% of its initial volume, thereby securely holding the resistor within the opposed metal plates and providing also a heat path of high thermal conductivity between the resistor and the plates. This method is disclosed and claimed in U. S. Reissue Patent No. 16,340 to C. B. Backer.

It will be obvious that the hot steam or the hot water can enter between the outer peripheral edges of the two plates 13 and 15, more particularly at the bent-up portions 21 and that it will also flow through the treating vents 27 between adjacent grooves so that all of the initially metallic magnesium will be converted into a magnesium hydroxide.

However, magnesium hydroxide is not a good insulator, and it is necessary to raise the temperature of the heating unit to a value on the order of 700 to 800° F. for several hours to drive off the water of crystallization and to thereby change the magnesium hydroxide into magnesium oxide which is a good electric-insulating material.

I have found, after numerous experiments, that it is possible to very greatly increase the value of the electric-insulation characteristic of the magnesium oxide by subjecting the unit after the hereinbefore described step in the process, to the action of a boiling solution of boric acid. In making this solution, I have found that any desired degree of saturation may be used. That is, it is not necessary to use a fully saturated solution of boric acid in water. If a saturated solution of boric acid in water is used, the length of time necessary to materially increase the insulating value of the magnesium oxide can be reduced relatively to the length of time which may be required to obtain the same result with a solution of a lower degree of saturation.

I have found it important to make sure that the boiling solution flows or circulates through the heating unit and also through the electric-insulating material composed of magnesium oxide made as has hereinbefore been described. It is my opinion that while the structure of the mass of magnesium oxide is granular, it is also not entirely solid or homogeneous but it has a large number of interstices therein or to put it in other words, it is a substantially honeycomb structure. It is, therefore, apparent that by subjecting the mass of magnesium oxide produced in situ to the action of a circulating boiling solution of boric acid, a layer of boric acid will be deposited upon all of the walls of the interstices or pores or minute openings in the mass which can be reached by or traversed by the carrier.

Figs. 6 and 7 show one form of device which I may use in practicing the method embodying my invention, which device includes a tank 47 adapted to contain a solution 49 of boric acid in water, one or more electric heating units 51 being provided to raise the temperature of the solution. As shown in Fig. 7 of the drawings, the tank 47 may be provided with a plurality of supporting legs 53 in order to support the tank at a suitable elevation.

An open frame or perforated basket 55 may be used to hold a plurality of the heating units 11 in substantially vertical or upright position in order that the boiling solution of boric acid may enter at the portions 19 (see Fig. 1) and flow between the outer peripheral flanges of the two plates, then into the outermost groove along the same and through the plurality of treating vents 27 and then outwardly from the assembly so that the hot solution will come in contact with substantially all of the layer of electric insulating materials.

This treatment is continued for a length of time varying from one-half to six hours, the length of time being dependent upon among other things, the general character of the solution as to its saturation value.

The heating units thus treated are then removed from the boiling solution and subjected to a temperature on the order of 600 to 900° F. for a length of time sufficient to drive off the water and to change the boric acid into some form of oxide, either by itself, in which case the result is probably a boric acid or in combination with magnesium oxide, although I do not wish to be limited to any specific explanation as to what takes place. The length of time of drying may be on the order of 3 hours.

After this step of subjecting the heating unit to heat applied to the outside thereof, I again subject the electric-insulating material to heat generated at the interior thereof, as by connecting the resistor 35 to a suitable source of electric energy to cause the current traversing it to heat the same. This heat will be communicated to the adjacent granular material to more thoroughly dry out the same and to help in converting the boric acid into an oxide. The application of heat from the inside as well as from the outside of the unit ensures that all of the granular electric-insulating material is properly heated to the desired temperature to drive off the carrier of the boric acid and to convert the boric acid into an oxide.

Tests show that while the ohmic resistance of

the layer of magnesium oxide before treatment in a boric acid solution and subsequent drying may be relatively low under given conditions, the value of the electric insulation after subjection to the boiling boric acid solution and the drying will be greatly increased and will now be on the order of 500,000 ohms. I do not wish in giving this specific value to be limited thereto, since this value represents averages obtained in the tests of a large number of heating units treated this way, and wish to point out particularly that a very decided improvement has been made in the electric-insulating characteristics of the layer of granular material located between the resistor and the metal casing. As further steps in the manufacture of a heating unit of this kind, the projections **25** may now be planished to cause the treating vents to disappear and the lateral flange **23** may first be bent around over the outer edge portion of plate **13** and may then be hammered down thereagainst so that the initially round wire **33** is deformed and forced into tight engagement with the adjacent portions of plates **13** and **15**, as is shown more particularly in Fig. 5 of the drawings to thereby provide a hermetically sealed joint at the outer periphery of the unit. The central opening **57** may have a securing stud **59** welded therein to be used in securing the unit to a suitable support.

I wish to here point out that my invention relates only to the step of treating the heating unit in the course of its manufacture with a circulating solution of boric acid and its subsequent drying by external and internal heat and the heating unit itself. Its method of manufacture other than this are disclosed and claimed in a copending application filed as of even date herewith, Serial No. 748,024, by W. J. Russell and assigned to the same assignee as the present application.

I may utilize the step of subjecting the heating unit to the action of a boiling solution of boric acid twice during the manufacture of a heating unit, since I may subject the heating unit to immersion in the boiling solution immediately after the conversion of the initially metallic magnesium into magnesium hydroxide and before the water of crystallization has been removed by subjection to a high temperature as hereinbefore described.

While I have illustrated and described a specific form of heating element of the metal encased kind, in this case a flat heating element, my process is not limited thereto, but can be applied to all other forms of heating units of any shape whatsoever so long as provisions are made for permitting circulation of the boiling solution of boric acid through the heating unit whereby fresh particles of boric acid may be brought into contact with the granular electric-insulating material. Where the method disclosed and claimed in Reissue Patent No. 16,340 is used, the initial construction of the metal encased heating unit is such that circulation of the solution of boric acid through the unit is easily effected. In those cases where a granular electric-insulating material is introduced mechanically into a metal encased heating unit, it is obvious that the heating unit will permit of circulation therethrough of the solution of boric acid if this step is applied thereto before the sealing up of the metal casing at either those points where the terminal leads extend outwardly from the casing or at other additional places.

The process embodying my invention thus provides a relatively simple method for increasing the value of the ohmic resistance characteristic of a layer of electric-insulating material located between a resistor and the inner surface of a metal casing irrespective of its shape.

Various modifications may be made in the device embodying my invention without departing from the spirit and scope thereof, and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or are set forth in the appended claims.

I claim as my invention:

1. The method of increasing the value of the electric-insulation characteristic of a layer of magnesium oxide located around a resistor and inside of an open ended metal casing which includes the steps of locating the assembly in a substantially vertical position in a heated solution of boric acid for a length of time of from one-half hour to six hours to cause the solution to circulate through the casing and deposit a coating of boric acid on the magnesium oxide and then subjecting the assembly to a temperature on the order of 600° F. to 900° F. for a length of time on the order of three hours.

2. The method of increasing the electric-insulation resistance of a layer of magnesium oxide encircling a helically wound resistor and engaging the inside wall of an open-ended metal tube which includes the steps of locating the assembly in a substantially vertical position in a boiling solution of boric acid to cause the solution to circulate through the tube, permeate the layer of magnesium oxide and deposit boric acid on the oxide and then subjecting the assembly to a high temperature to convert the boric acid into boric oxide.

3. The method of increasing the value of the electric-insulation characteristic of a layer of magnesium oxide located between a resistor and an enclosing metal casing, which includes the steps of locating the assembly in a heated solution of boric acid, in such position therein that the heated solution will circulate through the assembly, for a time on the order of several hours and then subjecting the assembly to externally applied heat at a temperature of from 600° F. to 900° F.

4. The method of increasing the value of the electric-insulation characteristic of a layer of magnesium oxide located between a resistor and an enclosing metal casing, which includes the steps of locating the assembly in a heated solution of boric acid, in such position therein that the heated solution will circulate through the assembly, for a time on the order of several hours, subjecting the assembly to externally applied heat at a temperature of from 600° F. to 900° F. and then causing a current to traverse the resistor to provide internally applied heat.

5. The method of increasing the electric-insulation resistance of a layer of granular material encircling a resistor and engaging the inside walls of a metal tube structure having spiral convolutions laterally joined by passages which includes the steps of passing a solution of boric acid through said convolutions and passages to coat said granular material and then subjecting the granular material to temperature in excess of that necessary to evaporate the carrier to drive off the carrier and to convert the boric acid coating into an oxide having electric-insulating properties.

6. The method of making a heating element comprising heating its resistor at an elevated temperature initially in the presence of metallic magnesium and moisture and continuing said heating to produce an insulating covering of

magnesium oxide around the resistor, and boiling said magnesium oxide in a boric acid solution to increase the insulation value of said covering.

7. The method of making a heating element comprising heating its resistor at an elevated temperature initially in the presence of metallic magnesium and moisture and continuing said heating to produce an insulating covering of magnesium oxide around the resistor, and boiling said magnesium oxide in a boric acid solution for a period varying from one-half hour to six hours dependent upon the degree of saturation of the solution.

8. The method of making a heating element comprising heating its resistor at an elevated temperature initially in the presence of metallic magnesium and moisture and continuing said heating to produce an insulating covering of magnesium oxide around the resistor, boiling said magnesium oxide in a boric acid solution for a period varying from one-half hour to six hours dependent upon the degree of saturation of the solution, partially drying said covering by externally applied heat and completing such drying by supplying current to the resistor.

9. The method of making a heating element comprising heating its resistor at an elevated temperature initially in the presence of metallic magnesium and moisture and continuing said heating to produce an insulating covering of magnesium oxide around the resistor, boiling said magnesium oxide in a boric acid solution for a period varying from one-half hour to six hours dependent upon the degree of saturation of the solution, externally applying a temperature of 600° to 900° F. to said covering for a period of about three hours to effect partial drying thereof and completing such drying by supplying current to the resistor.

10. The method of making a heating element comprising surrounding its resistor with metallic magnesium, applying aqueous fluid at an elevated temperature to said resistor and magnesium to convert the latter into magnesium hydroxide, applying a temperature of 700° to 800° F. to convert said magnesium hydroxide into magnesium oxide, and boiling said magnesium oxide in a boric acid solution.

11. The method of making a heating element comprising surrounding its resistor with metallic magnesium, applying aqueous fluid at an elevated temperature to said resistor and magnesium to convert the latter into magnesium hydroxide, applying a temperature of 700° to 800° F. to convert said magnesium hydroxide into magnesium oxide, and boiling said magnesium oxide in a boric acid solution for a period varying from one-half hour to six hours dependent upon the degree of saturation of the solution.

12. The method of making a heating element comprising surrounding its resistor with metallic magnesium, applying aqueous fluid at an elevated temperature to said resistor and magnesium to convert the latter into magnesium hydroxide, applying a temperature of 700° to 800° F. to convert said magnesium hydroxide into magnesium oxide, boiling said magnesium oxide in a boric acid solution for a period varying from one-half hour to six hours dependent upon the degree of saturation of the solution, partially drying the resultant product by externally applied heat and completing such drying by supplying current to the resistor.

13. The method of making a heating element comprising surrounding its resistor with metallic magnesium, applying aqueous fluid at an elevated temperature to said resistor and magnesium to convert the latter into magnesium hydroxide, applying a temperature of 700° to 800° F. to convert said magnesium hydroxide into magnesium oxide, boiling said magnesium oxide in a boric acid solution for a period varying from one-half hour to six hours dependent upon the degree of saturation of the solution, externally applying a temperature of 600° to 900° F. to the resultant product for a period of about three hours to effect partial drying thereof, and completing such drying by supplying current to the resistor.

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