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GLAZED ELECTRIC RANGE HEATING UNIT AND GLAZE THEREFOR

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Fig. 1.

Fig. 2.

Fig. 3.

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This invention relates to ceramic glazes, and more particularly it concerns glazes adapted for use in connection with electric heating units intended for domestic purposes wherein various cooking utensils come in direct contact with such units. It is of especial utility in connection with electric range heating units of the type disclosed in my copending patent application Ser. No. 561,227 filed June 1, 1931, wherein the work-carrying member, which has imbedded therein the electric resistor element, is made of molded refractory material of high heat conductivity.

The electric heating unit disclosed in my aforementioned co-pending application comprises at least two members or plates of refractory material, used and fastened intimately together by suitable bonding means. The top plate, which houses the electric resistor element and is intended to support the object to be heated, has a high thermal conductivity substantially greater than that of silicon carbide. It is made of refractory mixture containing silicon, with or without zircon and silicon carbide, bonded by a compound such as orthophosphoric acid, non-volatile at 2600°F.

The bottom plate of the said heating unit is made of a porous white or light-colored refractory having a very low conductivity and adapted to facilitate reflection of heat flowing thereto from the top member, and which is capable of reradiating to the upper plate most of the heat transmitted thereto through the latter. The light-colored plate is made of a suitable refractory aggregate, a small amount of finely divided metal, and a bonding agent capable of generating a gas when in contact with the said metal. An example of such composition is a mixture of native zirconium sand, approximately 1% of its weight of aluminum powder; 15% of rosin and 6% of PbO, half of the latter preferably being in the form of H2PO4 and half in the form of ammonium acid phosphate in aqueous solution. Each of these refractory elements or plates is baked or furnace at temperatures in the neighborhood of 2000°F, or at temperatures somewhat above those at which the refractory is subsequently to be employed.

Surface glazes for various kinds of electric heating units including those having a refractory work-carrying surface are already known to those skilled in the art. However, the glazes herefore employed for the purpose have been found unsatisfactory in service since they break down in use and fail to properly protect the refractory body and the electric resistor element embedded therein, the latter of which, as is well known, is subject to rapid deterioration at high temperatures in the presence of air and various other gases. The usual types of glaze employed heretofore for glazing have fusing points ranging up to somewhat less than 1500°F., and furthermore, they start to soften long before they reach that state of fusion where they properly flow and can be properly applied to the work-carrying surface of the heating unit. Such glazes have some utility in connection with heating units designed to operate well below the above-mentioned temperatures.

However, many series of tests conducted in connection with a wide variety of electric heating units have shown that for effective use of the electric current for heating purposes, heating element temperatures of approximately 1800°F. to 2000°F. are required. Furthermore, where certain cooking utensils are employed, particularly those made of aluminum), which have a pronounced concave contour on their bottom surface disposed next to the heating unit, the concavity serves to form a pocket for dead air which is not free to circulate,—with the result that the glazed surface of the electric range heating unit immediately below this air pocket reaches and is maintained at an abnormally high temperature well above that at which the balance of the surface of the heating unit is maintained,—temperatures of the order of 1450°F. to 1500°F. having been observed. As a result the usual commercial glazes blister and roughen and eventually the glaze fails. Thereafter any materials falling onto the surface of the unit may penetrate the refractory aggregate and may carbonize therein or react with the metals of the resistor element at the high temperature attained, seriously interfering with the heating efficiency of the resistor element and shortening its life.

It has been determined that this injury to the usual commercial glazes is due in considerable degree to the long range softening period which glazes undergo before flowing or melting.

The most desirable glaze for electric heating elements of the type wherein the electric resistor element is embedded within a refractory work-carrying member is one which will not soften at temperatures of the order of 1600°F. and yet will be perfectly cured and free-flowing at temperatures below the maximum operating temperatures of the resistor element,—which is around 2000°F.

Among the principal objects of the present invention are: to provide an electric range heating...
unit having a protective glaze adapted to resist softening at temperatures up to 1600° F., but which is liquid at temperatures of the order of 2000° F., to provide an electric range heating
5 unit having a high-melting surface glaze which will, however, melt and flow at temperatures subst-
stantially below that at which the electric re-
sistor element is injured by exposure to air; and
to provide a glaze for ceramics which will not
10 soften below 1550° F., but which is free-flowing
and fully cured at temperatures below 2100° F.
In its preferred form the glaze forming the
subject matter of the invention comprises a mix-
ture of potash, lime, alumina, iron oxide, silica
and boric oxide, or their equivalents in the fol-
15 lowing proportions:

- .3 parts by weight of potash
- .7 parts by weight of lime
- .3 parts by weight of alumina
- .2 parts by weight of iron oxide
- 3.5 to 3.75 parts of silica
- 45 to 26 parts of boric oxide (B₂O₃)

This mixture is melted in an oxidizing atmos-
phere within a furnace or hearth at temperatures
25 around 2100 to 2300° F., for a period of time
adapted to permit interaction of the ingredients
which may for example require three hours. The
melt is then cooled in well-known manner and is
30 finely ground.

The iron oxide component of the glaze tends
to produce a glaze having a slight coloration,
which for some purposes may be objectionable.
Where such is the case, the iron oxide may be
35 replaced by an equivalent amount of zinc oxide;
and this will give a glaze having the desired
physical properties here described.

An aqueous suspension of the finely ground
30 glaze material is sprayed over the surface of the
refractory plate, having embedded therein the
electric resistance element. The thus-coated re-
fractory plate or element is then placed in an
oxidizing atmosphere in a furnace and is brought
to a temperature of around 2000° F., after which
40 it is permitted to cool slowly in air.

If it is desired to color the glaze, without how-
ever reducing the desired high-softening tem-
perature possessed by the uncolored glaze, small
amounts of oxides adapted to provide the de-
sired color are added to the glaze before the lat-
ter is sprayed upon the refractory plate; or, al-
ternatively, an aqueous suspension of such color-
45 imparting oxides may first be sprayed upon the
refractory plate, following which, after evapora-
tion of the water, the spray of high-softening
point uncolored glaze is applied over the other
coat, and the coated plate is fired in the manner
described above.

Small amounts of manganese and iron oxide,
or cobalt and iron oxide when added to the glaze
50 give a bluish red color; cobalt oxide imparts a blue
color; chromium or nickel oxide gives a green
color; and potassium bichromate and alumina
give a red color to the high softening point glaze
described. Various other color combinations of
55 course may be effected by varying the amount
of the above-mentioned oxides or by combining
various of these color-imparting oxides, together,
or with other oxides.

Where it is desired to produce an electric range
60 heating unit having a glaze with an initial soften-
ing temperature of 1650° F. the above-mentioned
glaze formula employing 3.5 parts of silica and .45
parts of boric oxide is employed; while if it is de-
sired to produce a glaze having an initial soften-
ing temperature of around 1830° F., 3.75 parts of
silica and .25 parts of boric oxide are employed in
the manufacture of the glaze. Likewise, glazes
having still higher initial softening temperatures
may be produced by somewhat further increasing
the percentage of silica and/or reducing the
amount of boric oxide employed.

The spray of glaze-forming materials may be
applied to the electric-resistor-carrying refrac-
tory member immediately subsequent to its
formaton or it is subjected to any heat treat-
65 ing operation; or alternatively, after formation of the refractory plate the latter
may be fired to any suitable temperature prior
to spraying thereon the glaze-forming coating.
In the former case the high temperature firing of
70 the refractory plate, the spraying of the glaze,
and the thorough bonding thereof with the said
plate are simultaneously effected.

In the attached drawing showing a unitary
electric heater embodying the present invention,
75 Fig. 1 is a vertical section through one form
of such heater, and Figs. 2 and 3 are vertical sections
through certain modified constructions.

In the drawing, 10 designates a utensil-carrying
70 plate of refractory material having a high thermal
conductivity, preferably greater than that of silicon carbide, and of the composition heretofore
disclosed. The said plate forms the closed top of
an electric range heating unit,—and its lower
75 surface is provided with a spiral groove or grooves
12 adapted to house the usual electric resistor
element 14. The top member 10 is secured upon
the upper surface of a plate 20 of porous refrac-
tory material of low heat conductivity, already
80 described. The terminals of the electric resistor
14 extend through suitable apertures 22 formed
in the porous refractory plate 20 and are con-
ected in an electric circuit 24. A relatively thin
85 coating or layer of glaze 30 of the nature herein
to described covers at least the upper or ar-
ticle-carrying surface of the plate 10.

In the modification shown in Fig. 2, a metal re-
sistor wire or ribbon 32 is located in the plate
90 10 at a substantial distance above the porous refrac-
tory plate 20, and preferably near the upper sur-
face of the top plate 10. The coating of glaze
30 may be applied to the surface of the said plate
95 20 subsequent to its formation and before it has
been exposed to any heat treatment. In such
case the glaze is then materially thinner and
bonded to the plate at the time of the firing of
the latter.

According to the modification shown in Fig. 3,
each of a pair of members or plates 10 is mount-
90 ed on one of the respective sides of the porous
refractory plate 20. The resistor elements 14 may
be mounted in spiral grooves in each of the outer
plates 10 as shown or, in lieu thereof, the elements
14 may be mounted in grooves in the opposite sur-
faces of the porous member 20. Such a con-
struction is employed to advantage in work
requiring the simultaneous use of the top member
95 10 for baking and the bottom member 10 for
grilling. The exposed surfaces of the top mem-
ber 10, and preferably also of the bottom mem-
ber 10 are provided with thin layers of the glaze
30. It will be obvious to those skilled in the art
that the novel glaze described herein may be employed
for many uses in addition to that recited. The
invention is susceptible of modification within the
scope of the appended claims.

I claim:
1. In an electrical heating unit comprising a refractory work carrying member characterized
by high thermal conductivity and low electrical
conductivity wherein an electric resistor element is embedded in the refractory member which element is subject to rapid deterioration upon prolonged exposure to temperatures of 2100 degrees or above, the combination of said refractory work carrying member composed of silicon and zircon bonded with a phosphate reaction product formed by firing said mixture with a phosphoric acid binder, and a glaze comprising the heat reaction products of silicon, aluminum, iron oxide, lime, potash and boric acid, united with said member by heat fusion, said glaze having a glass-like appearance with a softening point not lower than 1550° F., and still being soft and free-flowing and thoroughly cured below 2100° F.

2. In an electrical heating unit comprising a refractory work carrying member characterized by high thermal conductivity and low electrical conductivity wherein an electric resistor element is embedded in the refractory member which element is subject to rapid deterioration upon prolonged exposure to temperatures of 2100 degrees or above, the combination of said refractory work carrying member composed of silicon and zircon bonded with a phosphate reaction product formed by firing said mixture with a phosphoric acid binder, and a glaze united with said member comprising a mixture of .3 parts by weight of potash, .7 parts by weight of lime, .3 parts by weight of aluminum, .2 parts by weight of iron oxid, 3.5 to 3.75 parts by weight of silicon and .45 to .25 parts by weight of boric acid, said glaze having a softening point not lower than 1550° F. and being free-flowing and fully cured at temperatures below 2100° F.

3. In an electrical heating unit comprising a refractory work carrying member characterized by high thermal conductivity and low electrical conductivity wherein an electric resistor element is embedded in the refractory member which element is subject to rapid deterioration upon prolonged exposure to temperatures of 2100 degrees or above, the combination of said refractory work carrying member composed of silicon and zircon bonded with a phosphate reaction product formed by firing said mixture with a phosphoric acid binder, and a glaze united with said member comprising a mixture of .3 parts by weight of potash, .7 parts by weight of lime, .3 parts by weight of aluminum, .2 parts by weight of iron oxid, 3.5 to 3.75 parts by weight of silicon and .45 to .25 parts by weight of boric acid, a small amount of metallic oxid coloring material, said glaze having a softening point not lower than 1550° F. and being free-flowing and fully cured at temperatures below 2100° F.

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