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J. L. GALLUP

2,175,689

ENAMELED MESH BASE ELECTRODE

Filed Dec. 10, 1936

Fig. 1

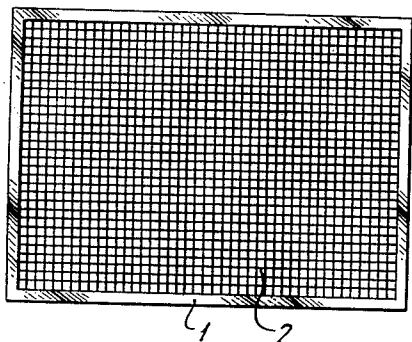


Fig. 2

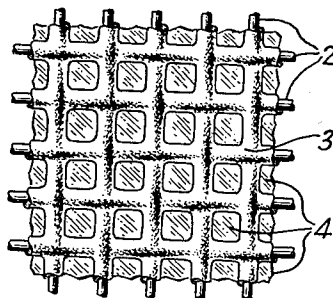


Fig. 5

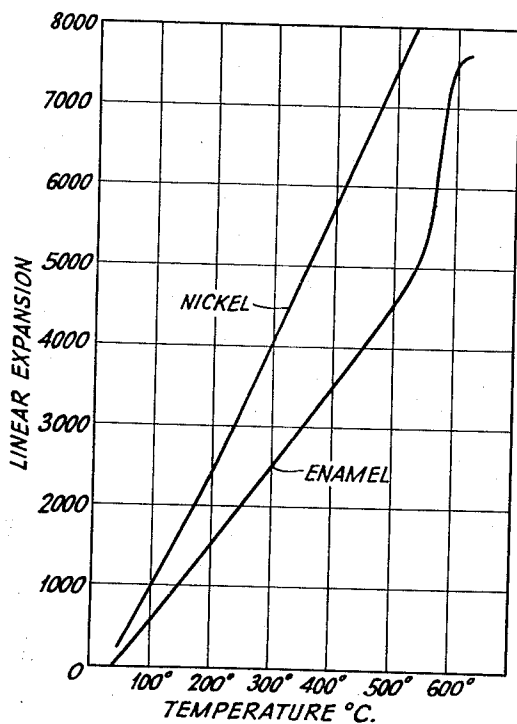


Fig. 3

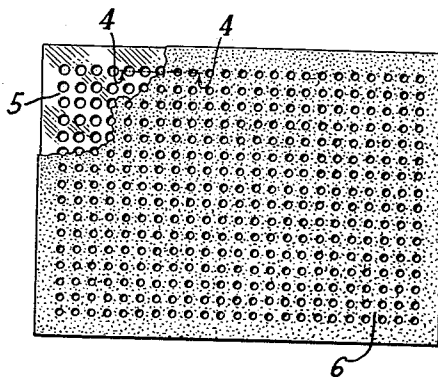


Fig. 4



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ENAMELED MESH BASE ELECTRODE

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Application December 10, 1936, Serial No. 115,192

3 Claims. (Cl. 250—167)

My invention relates to vitreous enamels for ferrous metals, such as nickel, and also to perforated metal screens with an insulating coating of vitreous enamel.

5 Vitreous enamels commonly used for enameling iron and other ferrous metals are, in general, low melting glasses containing up to about 19% of alkali, about 20% boric anhydrid, a percentage of silica which makes the melting or working
10 range of the enamel fall within the temperature range of 800° C. to 870° C. and small amounts of metal oxides, such as cobalt oxide, manganese oxide, or nickel oxide to improve the adherence of the enamel to the metal base. These enamels
15 are of low electrical resistivity as compared with lamp glass, and tend to start softening at temperatures considerably below 600° C., but these properties are not objectionable under the conditions existing where these enamels are generally
20 used.

Some types of television transmitting or receiving tubes, such as that shown in U. S. patent to Hickok, 2,047,369, July 14, 1936, utilize a target or mosaic electrode which consists in general
25 of a fine mesh screen base of nickel wire coated with a vitreous insulating enamel, the interstices of the insulated mesh containing a photoelectric silver compound. The nickel mesh base for such electrodes may be coated with
30 enamels such as are commonly used for ferrous metals, but I have found that greatly improved results may be obtained with enamels made in accordance with my invention.

The principal object of my invention is to provide an insulated mesh or perforated base of
35 nickel or similar metal coated with an enamel which has considerably greater electrical resistivity and a higher melting range than the enamels generally used for enameling sheets of ferrous
40 metals, and also has a coefficient of thermal expansion such that it remains firmly bonded to nickel or other ferrous metal over a range of temperature up to about 600° C. in order to secure a base which is useful for a mosaic electrode
45 of the type above referred to and by means of which a more efficient and more satisfactory electrode of this type may be obtained.

In accordance with my invention I coat a mesh or perforated base of nickel or similar metal with
50 a vitreous enamel in which the percentages of alkali and of silica are considerably higher and the percentage of boric anhydrid is lower than in the usual enamels and which is substantially like that disclosed and claimed in my application
55 Serial No. 278,323, entitled Ferrous metal enamel,

filed June 9, 1939, as a continuation in part of this application. As compared with the usual enamels for ferrous metals, the electrical resistivity of this enamel is much greater and its melting or working range about 100° C. higher, yet
5 it can be completely melted on the nickel mesh or similar base to form a continuous glassy coating which remains firmly bonded to nickel or similar metals up to about 600° C., which is higher than
10 the temperatures of about 500° C. to which mosaic electrodes of the about type are subjected during manufacture.

My invention will better be understood in connection with the following description of the
15 enamel and by reference to the accompanying drawing illustrating some forms of mesh or screen electrodes coated with my enamel and in which Figure 1 is a plan view of one form of nickel mesh mosaic electrode; Figure 2 is a greatly
20 enlarged view of a portion of the electrodes of Figure 1; Figure 3 is a plan view of such an electrode made with a perforated nickel sheet base; Figure 4 is a cross-section of the enameled electrode shown in Figure 3; and Figure 5 is a curve
25 showing the thermal expansion of nickel and of the enamel of my invention over a range of temperature up to about 600° C.

I have found that a vitreous enamel having a higher electrical resistivity and higher melting range than the usual enamels and yet having a
30 coefficient of thermal expansion such that it remains bonded to nickel over a wide range of temperature can be made from a batch in which the constituents are present in the following percentages by weight:

	Percent
Na ₂ O	15.0
K ₂ O	8.0
CaO	5.0
B ₂ O ₃	12.0
SiO ₂	60.0

This batch composition is within about ½% of each constituent as found in the enamel by analysis, if the constituents of the batch are as pure
45 as is commercially feasible. The enamel, which is somewhat more refractory than the usual enamel for ferrous sheet metals, has a firing range from 900° C. to 950° C. as compared with a firing range from 800° C. to 870° C. for the usual enamel,
50 and starts to soften at about 615° C. The coefficient of thermal expansion of the usual ferrous sheet metal enamel is about 10 or 11×10⁻⁶, while this coefficient of my enamel is higher and so close to that of nickel that the enamel will re-
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main firmly bonded to nickel over a temperature range from room temperature to 600° C., the average coefficient of linear thermal expansion over this temperature range being approximately 14×10^{-6} , while the coefficient for nickel over this range is about 15.5×10^{-6} .

The percentages of the constituents may be varied within the following ranges, the sum of the sodium oxide and potassium oxide being considered as alkali:

	Per cent
Alkali.....	From 20 to 25
Calcium oxide.....	From 4 to 10
Boric anhydrid.....	From 8 to 15
Silica.....	From 60 to 70

The ratio of sodium oxide to potassium oxide is not critical, since both of these oxides act in much the same way and may both be considered as alkali. Too much alkali decreases the electrical resistivity, and also increases the solubility of the enamel in water or alcohol, which, for some purposes, may be objectionable. Too much calcium oxide gives the enamel a tendency to crystallize and too little reduces its electrical resistivity below the desired value. Boric anhydrid in excess tends to make the enamel too fluid. An excess of silica raises the melting range beyond the desirable limit, and a deficiency makes the enamel too soft.

The enamel is prepared in accordance with the usual practice in making enamels. If finely powdered, it may be sprayed from an alcohol or water suspension, as it is relatively insoluble. For spraying, a good concentration is one gram of enamel to three cubic centimeters of the suspending liquid, and for obtaining very uniform coatings, the enamel should be powdered to a particle size under two microns. The enamel is so insoluble that it can be deposited by electrophoresis, which is not feasible with many of the usual enamels which are comparatively soluble and are decomposed to some extent by the electric current in an alcohol suspension.

While the enamel of my invention is useful for the enameling of any of the ferrous metals, particularly nickel, it is particularly useful in the manufacture of insulated screens for mosaic electrodes for television transmitting and receiving tubes. One form of such an electrode shown in Figure 1 consists of a fine mesh nickel wire base with all of the wire coated with the enamel of my invention and the interstices containing a silver compound. The particular base shown comprises a frame 1 on which the insulated or enameled nickel mesh 2 is held under slight tension. As best shown in Figure 2, all of the nickel wire of the mesh is covered with the enamel 3 so that the masses or plugs of silver compound 4 are held in place in the mesh base, but are thoroughly insulated from the metal of the base by the enamel coating.

Figure 3 shows a similar electrode with a base 5 of perforated sheet nickel covered with the enamel 6 of my invention which, as best shown in Figure 4, will line the apertures of the perforated base without filling them and thus provide a suitable insulating holder for the silver compound of the electrode.

In enameling the nickel mesh 2 or the perforated nickel base 5, I find it advantageous to clean the nickel thoroughly, then oxidize it slightly by heating in air until it assumes a greenish color, probably due to a film of nickel mon-

oxide, NiO, and then spray it with the enamel ground to a particle size under two microns and hold in suspension in either water or alcohol. The sprayed screen is then fired at about 900° C. in air in an electric furnace to fuse the enamel into a smooth glassy coating which completely covers all of the metal surface and adheres firmly to it. I prefer to build the enamel coating up to a thickness of approximately three mils on the surface of the electrode and to a thickness of one-half mil to one mil on the walls of the holes in the electrode by applying the enamel in several thin coats and firing the electrode after each coat is applied. I have found that in this way well insulated screen electrodes highly suitable for the production of mosaic electrodes for television transmitting or receiving tubes can be made with a nickel wire woven screen of 65 mesh to 150 mesh and that well insulated perforated electrodes, as shown in Figure 3, can be made from a sheet of electrolytic nickel between 1 and 3 mils thick, perforated to correspond to 65 to 150 mesh.

I have observed that in the manufacture of an electrode with a base of nickel wire mesh enameled with the usual enamels the silver from the silver compound in the interstices of the mesh base seems to react with or penetrate the enamel to some extent, as shown by a yellow discoloration of the enamel in contact with the silver compound. This discoloration is greatly reduced in intensity in electrodes made with a nickel wire mesh base insulated with the enamel of my invention, probably because of the greater hardness and higher melting point of my enamel. The electrical resistivity of the usual enamels is rather low for the best results with mosaic electrodes of the type described, and apparently this resistivity is decreased to some extent by the reaction of the silver compound with the usual enamels. The enamel of my invention has an initial electrical resistivity at room temperature of about 1×10^{13} ohm centimeters, which is from 5 to 10 times the resistivity of the usual vitreous enamels, and it maintains a high resistivity in the presence of the silver compounds commonly used in these electrodes during the manufacture of the electrode and during operation. As a result, the efficiency and the performance of such an electrode made with the enamel of my invention is much better than that of a similar electrode made with the usual enamels.

I claim:

1. A mosaic electrode including an enameled perforated base comprising a nickel wire mesh and a vitrified enamel completely covering the wires of said mesh with a dense glassy adherent coating firmly joined to said wires, said glassy coating consisting of alkali 23%, calcium oxide 5%, boric anhydrid 12%, and silica 60% and having an electrical resistivity of about 1×10^{13} ohm centimeters and starting to soften at about 615° C., and conductive plugs containing silver fitted into said apertures in contact with said glassy coating.

2. A mosaic electrode including an enameled perforated base comprising a nickel base having apertures and a vitrified enamel coating completely covering said base to provide apertures having enameled walls, said enamel consisting of an alkali lime glass base containing from 8% to 15% boric anhydrid and melting at about 900° C. and having an electrical resistivity of about 1×10^{13} ohm centimeters, and metallic plugs containing silver fitted into said apertures.

5 3. A mosaic electrode comprising a foraminous nickel base with a multiplicity of small apertures, a vitrified enamel coating on the walls of said apertures consisting of a lime base glass with from 20% to 25% alkali and 8% to 15% boric anhydrid and a melting range of about 900° C.

to 950° C. and conductive plugs comprising silver fitted into said apertures and insulated from said base by the enamel coating on the walls of said apertures.

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