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M. BROWN ET AL

2,399,094

ENAMEL COATED ARTICLE

Original Filed May 20, 1939

FIG. 1

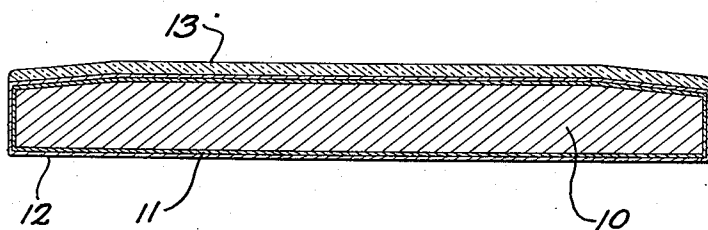
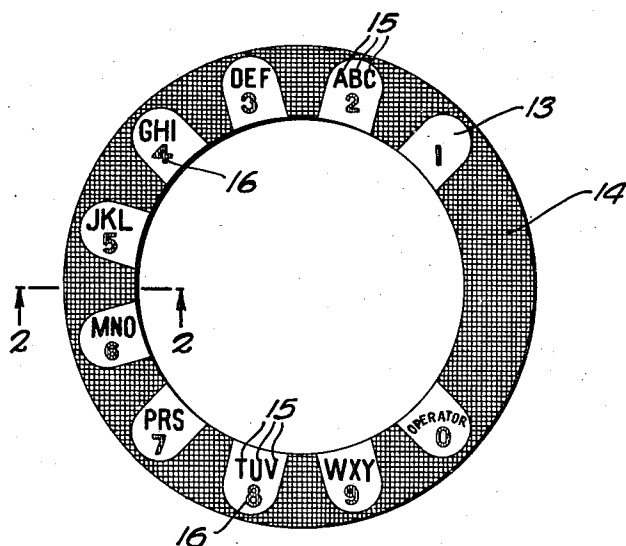


FIG. 2

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ENAMEL COATED ARTICLE

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5 Claims. (Cl. 204—38)

This invention relates to enamel coated articles and to methods of making enamel coated articles, and this application is a division of our copending application Serial No. 274,750, filed May 20, 1939, Patent 2,377,321 granted June 5, 1945.

Objects of the invention are the production of articles having a highly ornamental and serviceable enamel coating, and the provision of efficient and economical methods for making such articles.

The invention is particularly adapted to the production of enameled articles such as the number plates which are incorporated in telephone dials. These plates comprise a metal base with a coating of vitreous enamel on the portions of the base that are exposed in the dial assembly. A highly adherent enamel coating is required to withstand rough usage and it is especially desirable to provide a particularly smooth, even and unbroken surface on the enamel. The plates are often exposed to dirt-laden atmospheres in service and under these conditions even minute imperfections in the enamel surface may accumulate dust, dirt, lint and the like. These foreign materials are difficult to remove from surface cracks and pits, and the plate very soon becomes unsightly if any of these defects are present. Certain types of number plates receive a multi-color finish in which variously colored enamels are applied successively and fired after the application of each color. Under this practice, the repetitive firing tends to develop surface defects or to aggravate defects in previously matured enamel.

In one embodiment of the invention, an improved number plate having an adherent and unpitted enamel coating is produced by forming a base from inexpensive sheet iron, copper plating the base, electrodepositing on the copper a uniform layer of nickel alloyed with a metal selected from the group consisting of iron, cobalt and manganese, applying a vitreous enamel on the alloy layer, firing the base to fuse the enamel, applying a second enamel of contrasting color on portions of the fused enamel, and refiring the base to mature the second enamel.

A more complete understanding of the invention may be had by reference to the following detailed description taken in conjunction with the accompanying drawing, in which

Fig. 1 is a plan view of a number plate embodying the the invention, and

Fig. 2 is an enlarged sectional view of the number plate taken on the line 2—2 of Fig. 1.

In the first operation for producing a number plate in accordance with this invention, a ring or

base 10 is formed from sheet metal. Various grades of iron or steel are suitable for this purpose and the material is selected primarily on the basis of cost and formability.

After the ring-shaped base is formed, it is cleaned by the usual methods and then completely coated with a layer of copper 11. The copper can be applied conveniently in a conventional copper-cyanide electroplating process and a coating weight around 20 milligrams per square inch is generally satisfactory.

In the next operation an alloy 12 is applied over the copper in a uniform layer. Three types of alloy are suitable and good results are obtained by alloying nickel with iron, or cobalt, or manganese.

If a nickel-iron alloy is used, the iron content should be between .50% and 10.0% with the balance nickel and the best results are secured with an alloy having an iron content around 1.50%. This optimum composition can be obtained from an aqueous electroplating bath containing the following ingredients and operated under the following conditions:

Composition of bath

	Ounces per gallon of solution
Nickel sulphate.....	24.0
Sodium chloride.....	3.0
Boric acid.....	4.0
Ferrous sulphate.....	.0666

Sufficient sulphuric acid is added to keep the solution in a slightly acid condition, a pH of 5 being satisfactory. The process is operated cold at a current density around 10 amperes per square foot of cathode surface. Since a variation of this current density will affect the proportions of iron in the deposited alloy for the given solution and temperature, it is necessary to consider this interrelation of current density and alloy composition for different solution concentrations and operating temperatures. The ferrous sulphate can be added as such to initiate the process and then maintained by placing pure iron anodes in parallel with pure nickel anodes in the bath.

If the nickel is alloyed with cobalt, a cobalt content between 1.0% and 15.0% is operable and a cobalt content of 5.0% is preferred. If a nickel-manganese alloy is employed, the manganese percentage is held between .20% and 5.0%, and 1.0% manganese is optimum. The nickel-cobalt and nickel-manganese alloys can be electrodeposited on the copper in a plating bath containing appropriate salts and anodes of the respective

metals, corresponding to the elements employed for electrodepositing the nickel-iron alloy, as above described.

After the copper and the alloy coatings have been deposited, the base is ready to receive the enamel which is applied only on the face of the ring. The enamel is restricted to the face of the ring, which is the portion exposed in service, in order to minimize the cost of the article and also to facilitate the maintenance of over-all dimensional tolerances.

A coating of white enamel 13, such as a lead boro-silicate enamel opacified with arsenic oxide, is applied first. The enamel is distributed on the alloy surface either in the form of dry powder or by a wet process in which the enamel particles are mixed with water and a flotation agent, such as clay. The base is then fired at 1600° F. for four and one-half minutes to fuse the enamel.

Identifying characters in contrasting colors are usually required to complete the plate. One type of plate, shown in the drawing, has a background 14, letters 15 and numerals 16. These characters are produced with an ink suspension of colored metallic oxides or frits in a vehicle such as linseed oil and are applied on the surface of the white enamel by a printing operation. The background, which may be blue or black, is applied first and the plate is then baked at about 300° F. to harden the ink so that it will not be marred in subsequent printing operations. The letters, which are usually black, are then applied and the plate is then again baked at a temperature of about 300° F. The numerals are usually colored red and are applied in the same manner, after which the entire plate is again fired to fully mature the ceramic ink which requires a temperature around 1300° F. for approximately 4.5 minutes.

The resultant enamel coating is highly adherent and all portions thereof have a smooth, continuous surface that does not tend to accumulate foreign materials. In this type of product, pitting of the enamel is a serious source of trouble. The occurrence of very small pits is not easily detected when the plates are new, but after a period of service, dirt and other foreign particles tend to accumulate and become imbedded in the pits to form smudges. These smudges are very difficult to remove, particularly because the number plates are not readily accessible for cleaning after they are assembled in a dial. Use of the described combinations of copper and alloy undercoatings prevents the formation of pits in the enamel. The initially applied enamel is smooth, glossy and free of pits and these desirable surface character-

istics are preserved during any refiring operations and are reflected in all portions of the completed enamel coating. For most applications, a coating weight of 20 milligrams per square inch for both the copper and the alloy is satisfactory. It may be desirable to vary these values somewhat for different enamel compositions and, in general, the copper and alloy layers should be of about equal weight.

The combination of copper and alloy layers also adequately protects the portions of the base that are not covered with enamel against atmospheric corrosions.

Although the invention has been described in connection with the manufacture of number plates for telephone dials, it will be apparent that it is equally applicable to other ornamented enameled articles and it is to be understood that the invention is limited only by the scope of the appended claims.

What is claimed is:

1. An enamel coated article comprising an iron base, a copper plated coating of around 20 milligrams per square inch thereover, a layer of nickel-cobalt alloy over the copper plate, said alloy comprising from 1.0% to 15.0% cobalt and the balance nickel and being substantially the same thickness as the copper plate, and a fused enamel coating over the nickel-cobalt alloy.

2. In an enamel coated article, a ferrous base, a copper coating on the base, a layer of nickel-cobalt alloy comprising from 1.0% to 15.0% cobalt and the balance nickel on the copper, and a coating of fused enamel on the alloy.

3. In an enamel coated article, a ferrous base, a copper plate on the base, a nickel-cobalt alloy comprising substantially 5.0% cobalt and the balance nickel on the copper plate, and a vitrified enamel on the alloy.

4. In a method of forming an article, the steps of electrodepositing a copper coating on a ferrous metal base, electrodepositing a nickel-cobalt comprising 5.0% cobalt and the balance nickel on the copper, applying a vitreous enamel to the coated base, and firing the article to fuse the enamel and form an enameled coating.

5. A method of making an enamel coated article which comprises plating a copper coating of predetermined weight on a ferrous metal base, electrodepositing a layer of nickel-cobalt alloy of substantially 5.0% cobalt and the balance nickel on the copper plating, and applying a vitreous enamel coating over the alloy layer.

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