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ELECTROPLATING

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The invention relates particularly to the production of articles of metal which are electroplated and may then be coated with clear or transparent enamel sometimes referred to as cloisonné enamel. While not specifically confined thereto samples of such articles are compacts, vanity cases, cigarette cases, lighters, mirrors, brushes and similar articles. Such articles should be relatively light, ornamental, and conveniently handled. Because of their more or less continuous use it is desirable that they be somewhat sturdy and strong and more or less resistant to wear. In the past such articles have generally been made of more or less expensive metals. It has been impossible to obtain a relatively cheap metal base which would conveniently answer the needs of manufacture and use and take and hold satisfactorily the clear or transparent enamels applied thereto to produce the desired colors and ornamental effect.

One of the cheapest metals available is iron or steel. This metal is not only cheap but is also easily and readily worked and because of its strength allows of the manufacture of a relatively sturdy device from relatively thin sheets, being much thinner than a sheet of silver adapted for the same uses and much less expensive. Iron or steel, however, in their usual forms are not suitable or desirable for continuous use or handling especially of the character generally given to the articles of the type above referred to. Frequently it is desired that such articles have the appearance at least of a precious or semi-precious metal. In fact in the art they are frequently made of silver or silver substitute. Silver is generally employed when the article is to be coated with clear enamel and readily lends itself to the enamelling process in such a way as to produce a satisfactory product. Clear enamel cannot be directly applied to iron satisfactorily. The present invention in one aspect relates to the production of an enamelled device which makes a satisfactory substitute for an enamelled silver device.

The terms "enamel" and "clear enamel" will hereinafter be employed to indicate the clear or transparent enamel sometimes referred to in the art as cloisonné enamel as distinguished from opaque enamel commonly employed for rougher or heavier articles.

Iron or steel may form the base of the article. No specific composition of the iron or steel in general is essential to the present invention. Alloy steels may be used but preferably no steel having an appreciable chromium content will be employed. The term "iron" is used to refer to ferrous metals whether generally called iron or steel.

The cold rolled iron or steel may be given the form or shape it is to have in the finished article. When it is to carry a pattern or design such pattern or design may be struck or pressed into it in the form it is to appear underneath the enamel. The blank may then be cleaned in the usual way such as by being submerged in a solution of bi-chromate of potash in oil of vitriol (sulphuric acid). This will ordinarily take off the oxidation and clean the metal. When removed from the bath it may have a scummy surface which may be taken off with a scratch brush. The iron blank may be given a light coat of electrolytic deposit sometimes referred to as a strike. This may be produced by placing the article for a short time in a cyanide bath containing preferably substantially equal parts of silver and copper through which is passed electricity. The bath may be cold or at atmospheric temperature. This operation preferably takes place at a relatively high voltage and solution density. The specific details of this strike bath are not essential. A suitable strike bath may consist of an electrolyte containing for each gallon of water about 1½ Troy ounces of silver, 1½ Troy ounces of copper and 11 Troy ounces of sodium cyanide. This strike may not be essential for the success of the procedure but is desirable in most instances.

The article may then be submerged in an electrolytic bath from which will be deposited upon it a coat of clear silver. A suitable bath for this purpose may contain for each gallon of water 1 Troy ounce of silver, 4 Troy ounces of copper and 7 Troy ounces of sodium cyanide. This bath will preferably be raised to a temperature of 118° to 140° F. An electric current of from .22 to .25 volt may be used to cause the electrodeposition on the article.

The temperature and voltage of the bath may vary somewhat but preferably and advantageously may be kept within the limits above indicated. The metallic content of the bath may be changed from time to time for various purposes. Thus the ratio of silver to copper may differ in different baths from 1 to 3 to 1 to 5. The 1 to 4 ratio indicated above for illustrative purposes may be preferable for some uses. When the proportions desired in a bath have been determined the proportion will be very carefully controlled during the plating process. Specimens of the bath may be taken and ana-

lyzed from time to time and the content of copper and of silver in actual practice will preferably be controlled within ½ of a percent.

After the blank has been silver plated in this bath it may be scratch brushed rather gently so as to brighten the light silver deposit, and dried. A suitable quantity and character of powdered clear enamel mixed with water may then be distributed as desired on the surface and the article placed in a furnace to fuse the enamel. The temperature of fusing of the enamel is adjusted to the different types of enamel used which may run from 1200° to 1400° F., it being understood that no definite temperature will cover the large range of various colors or types of enamels employed.

Heretofore it has been suggested that silver may be electro-deposited as a base for enamel from a bath containing silver alone and attempts have been made to so operate. It has been found that such a deposit from an ordinary silver plating bath will not lend itself to satisfactory enamelling. When iron coated with such a silver plate has enamel applied to it and is raised to the high temperatures necessary for the fluxing and baking of the covering enamel there is a tendency for the plating to strip or form blisters coming loose from the base.

The iron or steel may be very thin and still have suitable strength to be adapted for the use desired and since the expansion produced in the iron at the temperatures employed is not excessive the cooling will not involve undesirable contraction. The surface coating of silver is very thin and the result is that the entire mass may conveniently cool without causing a cracking of the enamel and without causing the enamel to be separated from the metallic base nor will there be undesirable warping or deforming of the metal. Because of the way in which the silver coating has been formed and associated with the iron base, it does not separate therefrom during the heating and cooling incident to the enamelling process. The silver coating is so firmly set on the base plate that it may be shaped or deformed without breaking the coat at least to an undesirable extent.

Ordinarily the enamel coating itself may not be more than .005 of an inch in thickness and the compound metal sheet may be approximately .020 of an inch in thickness. These particular dimensions are not essential to the invention. It will be understood that the fused enamel is very brittle by nature and the enamel being exposed to the air cools faster than the metal and becomes set while the metal is still contracting. The result with many metals which have been proposed for use as a base is that the enamel is cracked, the adhesion destroyed and the enamel snaps out. In the case of steel where the contraction is relatively minute for the temperatures used, this may not occur and the coat of silver applied as herein explained does not cause the base metal to act substantially differently.

The scientific explanation of the results produced may not be definitely known but it is possible that the action of the copper in the silver plating bath is in the nature of a catalyst. It may be that it influences the shape of the crystals of silver deposited and thus produces a plate of silver having crystals of the shape and size particularly adapted to receiving and holding the enamelling deposit. There seems to be no fluxing action between the steel and silver nor is there apparently any fluxing action between the silver and enamel. The crystal size of the silver plated particles seems to be greatly influenced by the voltage impressed on the silver plating bath and also by the temperatures of operation of said bath so long as they are kept within the limits indicated above and so long as the copper content of the bath is maintained.

The usual process of plating steel with silver contemplates the employment of a first strike in a bath containing silver and copper the copper being very considerably in excess of the silver the proportions being sometimes as high as 10 copper to 1 silver. Following this there is deposited a layer of more or less pure silver from an electrolytic bath containing cyanide but no metal other than silver, especial efforts having been made to obtain a bath of pure silver free from other metals. The present invention in one aspect is based upon the discovery that it is not necessary to have such a pure bath. Indeed an electrolytic deposit from a pure silver bath does not lend itself satisfactorily to the application of clear or cloisonné enamel. It has been discovered that in order to produce a satisfactory base for such enamel it seems to be essential to have in the final bath from which the silver is deposited a considerable proportion of copper within the limits indicated above. A spectographic and microchemical analysis shows no trace of copper on the deposited plate of silver so that it may be reasonable to assume that the copper present acts as a catalyzer probably affecting the crystal or grain size of the deposited silver plate. It is possible also that the presence of copper in the proportions indicated above in the final electrolytic bath aids in the conductivity of that bath and so effects economies in operation by saving electric current and producing an even and smooth operation.

It has not been uncommon in the past to successfully deposit and bake opaque enamels upon steel. The oxidizing of the steel or iron under enamel fluxing temperatures when the enamel is baked does not show through the opaque enamel and so may produce a satisfactory result. When, however, it is attempted to place clear or cloisonné enamel on iron or steel the results are entirely unsatisfactory as the discoloration of the steel base under the enamel fluxing temperatures produces a more or less blotched black appearance rather than the design or pattern or color desired and produced in finer work by the present invention.

While not essential to the particular invention involved it will be understood that ordinarily the electroplated blank may have first applied to it a more or less rough coat of enamel in which if desired may be included a color or pigment. Enamels of different colors or different characters may be applied to different parts of the article. It may then be fired in the furnace until the enamel fluxes. This first coating when cool may be quite rough and then it may be stoned off smooth. When desired the enamel base may be decorated by hand or otherwise and then a thin coat of clear, transparent enamel or flux applied thereto and the article baked a second time. It seems that the enamel coating sometimes acts as an aid in retaining the layer of electrodeposited silver in its position and in adherence with the

underlying iron. It may be that the exposed plating in those portions of the article which have not been covered by enamel as well as on the back may blister or deteriorate somewhat during the heating and cooling. This may be removed by means of an acid solution and when cleaned the exposed parts may again be coated with nickel or silver or any other suitable base or precious metal to prevent rust or oxidation and to give the desired ornamental appearance to the article as a whole.

The above description is given as illustrative of the invention and one versed in the art will be able to use the invention making suitable changes in details when desired. The invention, therefore, is not confined to the specific matter presented by way of illustration.

I claim as my invention:

1. The method of preparing iron as a base for baking clear enamel comprising subjecting the iron to a strike in an electrolytic bath containing substantially equal parts of silver and copper and depositing on the result a layer of pure silver by a current of from .22 to .25 volt through an electrolytic bath maintained at from 118° to 140° F. and containing from 3 to 5 times as much copper as silver.

2. The method of preparing iron as a base for baking clear enamel comprising subjecting the iron to a strike in an electrolytic bath containing substantially equal parts of silver and copper and depositing on the result a layer of pure silver by a current of from .22 to .25 volt through an electrolytic bath maintained at from 118° to 140° F. and maintaining in the bath from 3 to 5 times as much copper as silver.

3. The method of preparing iron as a base for baking clear enamel comprising subjecting the iron to a strike in an electrolytic bath containing substantially equal parts of silver and copper and depositing on the result a layer of pure silver by a current of from .22 to .25 volt through an electrolytic bath maintained at from 118° to 140° F. and containing from 3 to 5 times as much copper as silver and maintaining the bath proportions within ½ of one percent.

4. The method of preparing iron as a base for baking clear enamel comprising depositing on the iron a layer of pure silver by a current of from .22 to .25 volt through an electrolytic bath maintained at from 118° to 140° F. and containing from 3 to 5 times as much copper as silver.

5. Electrolytically depositing on iron a layer of pure silver from a cyanide bath containing 3 to 5 times as much copper as silver maintained at a temperature of from 118° to 140° F. by means of an electric current of from .22 to .25 volt, and baking clear enamel over the coating at a temperature of from 1200° to 1400° F.

6. Electrolytically depositing on iron a layer of pure silver from a cyanide bath containing 4 times as much copper as silver maintained at a temperature of from 118° to 140° F. by means of an electric current of from .22 to .25 volt, and baking clear enamel over the coating at a temperature of from 1200° to 1400° F.

7. Electrolytically depositing on iron a layer of pure silver from a cyanide bath containing 4 times as much copper as silver maintained at a temperature of from 118° to 140° F. by means of an electric current of from .22 to .25 volt while maintaining the bath proportions within ½ of one percent, and baking clear enamel over the coating at a temperature of from 1200° to 1400° F.

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