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PROCESS OF ENAMELING METAL ARTICLES

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This invention relates to processes of enameling metal articles; and it comprises heating an article in a non-oxidizing atmosphere in a furnace to an enamel-fusing temperature and applying one or more coatings of dry powdered vitrifiable enamel material, by means of a jet, to the article in the furnace, the temperature remaining at an enamel-fusing point throughout the process; all as more fully hereinafter set forth and as claimed.

In enameling metal articles, it is customary to apply a coating of a fusible enameling composition to the metal, at atmospheric temperatures, and then place the article in a furnace and heat it until the coating fuses; this operation forming what is called a ground coat. The coating may be applied either as a dry powder or in liquid suspension. If additional coatings are desired, the article is removed from the furnace after the coating is fused in place, and, in the dry powdering process, a powder is sifted on to the hot surface, and the article is then returned to the furnace and heated until the second coat fuses. This operation can be repeated to obtain the desired number of coatings. Where the wet process is used, the ground-coated article coming from the furnace is allowed to cool to atmospheric temperature, then a suspension of enamel in a liquid vehicle, generally water, is sprayed or spread over the surface, after which the article is returned to the furnace and heated until the second coat fuses. This procedure also can be repeated to obtain the desired number of coatings.

The presence of a ground coat on a metal surface to be enameled has been considered necessary to protect the surface from oxidation during the heating to an enamel-fusing temperature. In the art all coatings are heated in the furnace after application.

I have now discovered that if metals are heated to enamel-fusing temperatures in furnaces in which the atmosphere is kept neutral or reducing, i. e. non-oxidizing, the use of such a ground coat is not necessary. The untreated or naked heated surface is in satisfactory condition for directly receiving a coating of vitrifiable enamel. I have found that enamel can be applied to these naked heated surfaces while still in the furnace, and can be fused to produce an adherent and satisfactory coating. I have also found that after this coating has fused, as many additional successive coatings as are desired may be applied by the dry powder method without removal of the article from the furnace. Or, alternatively, the

article may be removed from the furnace and additional coats applied by either the dry powder or the wet process in the customary ways.

I have found it advantageous not to subject the enameled object subsequently to higher temperatures than those used in the first coating operation, as certain defects, such as hairlines, bubbles, blisters, and pinholes, due to changes in temperature during enameling, are thereby avoided.

My invention has many advantages over the old art, where the ware must be removed from the furnace between each successive coating, since I eliminate frequent reheating of the ware, thereby saving fuel; and frequent handling, thereby saving labor. Moreover, as I keep the temperature constant, the occurrence of several common defects is prevented. Hairlines, which are cracks in the first coating occurring when the cooled article is reheated, do not occur. Bubbles, formed by gases entrapped in the powdered enamel, are obviated, since the enamel is not applied until an enamel-fusing temperature is reached. Bubbles are not retained in the molten coating. Blisters and pinholes, being defects due to rupture of bubbles, do not occur.

In a specific embodiment of my process, an iron casting to be enameled with two coats of dark blue enamel, was placed in a furnace in which the furnace gases were neutral or slightly reducing. The temperature of the casting was allowed to reach that of the furnace atmosphere; approximately 1600° F. In the meantime, a batch of dry, powdered enamel of the following composition has been prepared (all parts being by weight):

Silica.....	49.0
Alumina.....	6.5
Boric oxide.....	14.0
Alkalies.....	20.0
Fluorspar.....	7.5
Cobalt oxide.....	3.0
	100.0

When the casting reached the temperature of the furnace, a sufficient amount of this dry, powdered enamel was deposited in an even layer over the surface to be enameled, by means of an air-jet and suitable piping. The coating means was then withdrawn from the furnace and the enamel coating exposed to heat for about two minutes, care having been taken that the temperature of the furnace remained the same as it was upon the completion of the coating process.

This sufficed to produce an even homogeneous coat. The second coat was then applied in the same manner but as a somewhat thinner layer and allowed to stand under substantially the same heat for about one and three-quarters minutes. The casting was then removed from the furnace and allowed to cool. It then carried a satisfactory two-layer coating.

My process may be combined with other enameling processes. For instance, the first coating may be applied by my method and then other methods may be used for applying and heating subsequent coats. Also, enamel may be applied to substances other than metal by my process.

The present process may be operated in any of the usual furnaces employed for enameling metalware, the only difference being that the atmosphere is maintained neutral or slightly reducing. It is advantageous to have as much reduction as is consistent with avoiding the danger of sooting or reduction of delicate oxides in the enamel. Too much CO in the furnace atmosphere is not desirable. Where enamels of different fusing points are employed, corresponding temperatures may be employed, but it is desirable that no succeeding coating be applied at a higher temperature than that used with the preceding coating. With proper firing, a layer of enamel powder applied to the surface fuses quickly into an even liquid layer with plenty of opportunity for extrication of gases. By avoiding subsequent high heating, any small bubble that may occur in an underlayer does not enlarge. By applying a first coating at a rather high temperature and dropping the temperature somewhat, the coating will solidify sufficiently to avoid intermixture or blending with a succeeding

coating to a greater extent than may be necessary to secure union. The second temperature should, of course, be high enough to fuse the glaze applied at that temperature.

What I claim is:

1. In the enameling of metal articles, heating the naked article to enamel-fusing temperature in a furnace having a non-oxidizing atmosphere and applying to the heated naked article in the furnace a coating of vitrifiable dry enamel powder, while keeping the furnace at said temperature and maintaining the non-oxidizing atmosphere.
2. In enameling metal articles with a plurality of successive layers, the process which comprises heating a naked metal article in a furnace having a non-oxidizing atmosphere and at an enamel-fusing temperature, applying to the naked heated article while in the furnace and while maintaining the non-oxidizing atmosphere a coating of enamel material in powdered form, allowing the coating to fuse in place and then applying another coating of enamel material to the coated surface.
3. In the process of claim 2, fusing the successive coating layers without elevation of temperature.
4. In the process of claim 2, fusing the successive coating layers at progressively decreasing temperatures.
5. In enameling metal articles, the process which comprises heating a metal article having a clean, naked surface in a furnace having a reducing atmosphere, heating being to an enamel-fusing temperature, and applying to the hot surface a coating of a powdered enamel-producing composition, application being by an air jet while maintaining the reducing atmosphere.

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