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CAST IRON AND METHOD OF MAKING THE SAME

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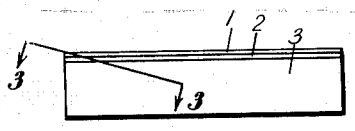


Fig. 1

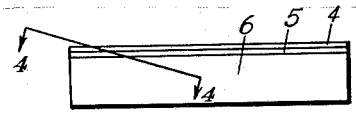


Fig. 2

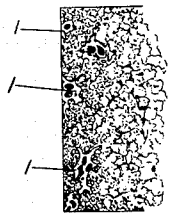


Fig. 3

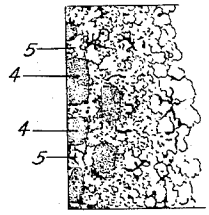


Fig. 4

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CAST IRON AND METHOD OF MAKING THE SAME

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Our invention relates to cast iron and method of making the same. It has to do particularly with the production of cast iron that is particularly suitable for the reception of enamel and that has other advantageous characteristics such as being readily machinable.

In the prior art, the application of porcelain or vitreous enamels to cast iron articles, as in the manufacture of sanitary ware, stoves, ranges, et cetera, has hitherto been subject to serious trouble because of the occurrence of "blisters" in the enamel coating which impair their quality and often render the enameled article unfit for use. Those familiar with the art are not in complete accord as to the origin of these blisters. However, it is obvious that they are caused by gases which are entrapped in the enamel.

It is generally recognized in the art that practically all cast iron enamels undergo a certain amount of blistering at the time the enamel starts to fuse. In some cases, these blisters rise to the surface and break while the enamel is still sufficiently fluid to permit healing of the craters before the maturing temperature of the enamel is reached. When this occurs, the blistering is not harmful and the product is ordinarily of sufficiently high quality to be serviceable.

There are certain cast irons, however, that blister severely throughout the firing period during which the enamel is matured. The result is that some of the gases thus formed are not released early enough for them to be harmless. Instead, they leave blisters and pin holes behind.

It seems to be rather well established that there is no interaction between the surface of the iron and the enamel and that the enamel itself, when it strikes a hot surface, does not evolve gases. It follows from this that the cause for blistering is to be found in the cast iron itself. Though no single cause for blistering has been found, a preponderance of the accumulated evidence indicates that the major source of the gases which cause blistering comes from the oxidation of carbon on the surface of the cast iron by the air in the furnace which is used for maturing the enamel. The opinion seems to be that the rate at which the oxidation occurs is partially determined by the type, size, distribution, and availability of the carbon and graphite adjacent the surface of the cast iron, by the rate of the diffusion of the oxygen in the furnace, and by the rate of decompostion of the microscopically or sub-microscopically thin layer rich in iron carbide which exists on the cast surfaces of most cast irons and which is technically known as "microchill". There is some belief, also, that the occurrence of blisters, if caused by the iron, is governed to some extent by the condition and size of the graphite carbon in the iron. Some investigations indicate that blistering is due primarily to an evolution of carbon monoxide and carbon dioxide at such time and temperature that the gas bubbles are securely held in the enamel and cannot escape.

Several suggestions have been offered as to methods of overcoming the formation of harmful blisters. One such method is termed the "burning-out" process. This involves a simple annealing treatment wherein the cast iron is heated to a graphitizing temperature for an interval of time adequate to permit the microchill to decompose and the carbon or graphite formed to oxidize. Another method is deep sand blasting which, of course, removes the chill by abrasive wear. Neither method has proved successful in every case where blistering in the enameling of cast iron is encountered. Both methods involve added expense and time in the production of the finished article.

Various other steps have been resorted to for preparing sheet steel or cast iron articles for enameling. Some of these methods have involved the placing of a copper coating upon the steel sheet or cast iron article before the enamel is applied. These methods have usually involved first cleaning the article and then putting on the copper by immersion coating, electroplating, beating copper particles into the steel or cast surface, spreading copper particles on in some vehicle or flux and then heating, or rolling a thin sheet of copper onto the surface. In some cases, the copper has been applied by processes analogous to the sherardizing process. These prior art processes relate chiefly to the coating of sheet steel, rather than cast iron. These methods, however, contemplate the placing of a continuous coating of copper upon the cast iron, which coating merely serves to cover the microchill rather than prevent its formation.

Some suggestion has also been made that a comparatively heavy coating of copper be applied to a cast iron article by cementing a coating of copper powder to the interior surfaces of the mold on the theory that the pouring of the casting will result in superimposing upon the casting an outer layer or copper. This method, however, is not practicable in the manufacture of cast iron articles of thin section, such as are normally used for the manufacture of sanitary ware, bathtubs, stoves, ranges, et cetera. The casting is of

such thin section and freezes so rapidly in the pouring of the molten metal into the mold that the copper layer upon the inner surfaces of the mold cannot be fused into a homogeneous mass by the heat given up by the casting. Furthermore, the use of a cemented layer of copper upon the internal walls of the mold seriously interferes with the venting of the gases from the mold interior.

One of the objects of this invention is to provide cast iron which will be free from harmful blistering in all normal enameling operations.

Another object of this invention is to provide cast iron having a surface particularly adapted for the reception of one or more white enamel cover coats with or without the initial application of a ground coat.

Another object of this invention is to provide a cast iron which may be more readily machined than the usual type of cast iron known to the prior art.

Our invention contemplates the alteration of the surface and subsurface structure of cast iron by the absorption of copper in the cast iron surface for the purpose of producing a non-blistering cast iron. The method by which we preferably accomplish this contemplates the application of the copper to the cast iron and the absorption therein during the usual casting operation, so that this application automatically occurs in the single casting operation, requiring no extra handling and no cleaning of a previously-formed cast iron article. In the application of copper to the cast iron, we have had success with metallic copper and copper-alloy powders, and finely granulated cuprous and cupric oxides. Hereafter, the term "copper powder" is understood to embrace all these and other forms of copper-producing substances. Furthermore, though we apply copper powder to the interior surface of the casting mold in sufficient quantities to prevent the formation of the microchill and to alter the nature of the material immediately beneath the surface of the casting, we preferably do not use a heavy coating of copper powder upon the mold. On the contrary, we merely use such a quantity of the copper powder as will be melted and absorbed throughout the surface of the cast iron article without producing an impervious or continuous layer of copper thereon. Likewise, the amount of copper powder applied by us to the mold interior is so small that it will not interfere with the venting of the gases from the mold.

The copper powder which we apply to the mold surface for subsequent absorption in the cast iron may be so applied in any one of several different ways. A simple method is to apply the powder dry by a dusting operation. In such a method, it is sometimes advisable to bind the copper to the sand with a liquid bond, applying this liquid with a spray, either before or after the copper is dusted on the surface.

A method which we prefer, however is to suspend the copper in a suitable liquid vehicle and to spray this mixture on the mold. Such a liquid vehicle may take the form of a mixture containing 5.0% molasses in water containing 2.0% bentonite and carrying enough copper to give the desired thickness to the sprayed layer. The bentonite aids in keeping the copper in suspension while the molasses serves as a bond. Copper powder of flake form under 50-mesh size is preferred. Other types of liquid vehicles and other proportions of ingredients have proved satisfactory and, for this reason, we do not wish to limit ourselves to the use of a given mixture.

We may, if desired, apply the copper powder to the casting by adding this powder to the sand rammed next to the pattern, though this is not our preferred method. However, if such method is used, we preferably introduce about 5.0% to 10.0% of copper powder in the sand.

Our process may be applied in either dry or green sand molding operations. In green sand molding operations, excessive moisture from very liquid spray mixtures should be avoided, though this may be corrected by skin-drying the mold. The necessity for skin-drying may be avoided, however, by properly proportioning the copper powder to the liquid in the mixture.

It will be recognized that the foundry procedure and preparation of the cast iron product is not altered by the application of our process. The only additional step is to lightly spray the surface of the mold with copper powder, with the result that this copper will fuse and be transferred to the surface of the casting when it is poured. The lightly coated surfaces do not interfere with the venting properties of the sand. Furthermore, the copper is sufficiently fixed to the surface of the mold so that it is not washed away by the flow of the metal. Since none of the copper is lost through oxidation or otherwise, the depth of the copper applied may be controlled with accuracy. Likewise, no fluxes are needed to effect the absorption of the copper in the casting. The layer of copper applied to the mold is so thin that it readily adheres to all parts of the mold and no cement is needed to effect this adherence against the action of gravity, since a continuous coating or layer is not sought.

Our method effectively prevents the formation of a microchill on the cast iron article, which greatly decreases the tendency toward blister formation, though it does not interfere with the smoothness and soundness of the casting surface. However, it also produces other changes in the structure of the cast iron article of such a nature as to make the formation of blisters very unlikely. This is made evident by examination under a microscope of sections of cast iron made with and without our method, which sections have been polished along a plane cutting the surface at a very flat angle.

Specimens of uncoated cast iron, when examined in this way, showed a thin microchill layer at the surface which graded into a sorbitic-graphitic region and finally into the normal cast iron structure. Specimens of the same cast iron coated with copper in accordance with our process showed a microscopically thin region with copper absorbed therein at the surface underneath which was a ferritic-graphitic region that finally graded into the normal cast iron structure.

The preferred form of our invention is shown in the accompanying drawing wherein similar characters of reference designate corresponding parts and wherein:

Figure 1 is a side elevation of a cast iron article made by the prior art method.

Figure 2 is a side elevation of a cast iron article made by our method.

Figure 3 is a magnified view of a cross-section taken on the line 3—3 of Figure 1 and illustrating the structural characteristics of the cast iron article made by the prior art method.

Figure 4 is a magnified cross-section taken on line 4—4 of Figure 2 and showing the structure of a cast iron article made by our method.

In the drawing, it will be noted, by reference to Figures 1 and 3, that the structure of the cast iron article produced by the prior art method embodies a microchill, indicated at 1, a sorbitic-graphitic region, indicated at 2, and the normal cast iron structure 3 into which the sorbitic-graphitic region grades. Then, by reference to Figures 2 and 4, it will be noted that the microchill has been eliminated and replaced by a surface layer 4 of copper-iron alloy, and a subsurface region 5 which is of ferritic-graphitic nature and which grades into the normal cast iron structure 6.

It has been found that cast irons made in accordance with our method do not blister when enameled in accordance with the normal enameling practice. The non-existence of the microchill is apparently partly responsible for this freedom from blistering and the existence of the completely graphitized zone beneath the copper-impregnated surface undoubtedly materially contributes to this freedom from blistering, since completely graphitized cast irons are non-blistering.

Our method and the product thereby produced has other advantages, with particular relation to the enameling thereof. For example, the preparation of the surface of the cast iron for enameling requires thorough sand-blasting. Dirt and adhering impurities which may escape detection on the uncoated cast iron are prominently visible against the copper background of coated iron. For this reason, dirty castings and defective cleaning are less likely to escape inspection in the cast iron ware made by our method.

A still more important advantage arises from the fact that, when a ground coat is fired to cast iron in which copper has been absorbed by our method, most of the copper disappears by solution in the metal. Whatever the particular reason may be, our operations have shown that little iron oxide is formed beneath the ground coat during firing. Thus, the ground coat does not, as in the enameling of the usual cast iron, absorb a large quantity of iron oxide and is, therefore, not materially darkened in color. It remains colorless, or relatively so. This makes possible the use of white cover coat enamels with less opacifying agents therein, at the same time, permitting attainment of the highest type of finish and color.

As a matter of fact, due to the superiority of our copper-impregnated cast iron surface and its freedom from the formation of iron oxide beneath the enamel during firing, we have been able to attain the highest type of finish by applying white cast iron enamel directly upon the surface of the cast iron, something not hitherto attainable without the use of a ground coat. The saving in labor and expense resulting from this advantage will be readily recognized.

We have also found that the use of copper for the elimination of the microchill has distinct advantages beyond the fields of enameling. Thus, it has been found that copper absorbed in the cast iron as a result of our method will eliminate the microchill from ¼-inch sections of iron containing 2.90% carbon and 2.40% silicon as effectively as from the higher silicon and carbon irons. Even a mottled iron will show a ferritic skin when copper is applied in accordance with our invention. This surface-softening effect justifies the use of copper on low-silicon cast irons as well as on high-silicon cast irons to facilitate cleaning and machining.

A good example of this would be in the production of cylinder blocks for automotive use. It is believed that the saving on tools used in milling the top of the block and boring the cylinder would more than offset the cost of applying the copper to the cast iron. Cylinder blocks are usually cast in dry sand which would simplify the use of our method. Hard corners and a hard skin would thereby be eliminated.

It should be understood that our invention does not contemplate the placing of a thick layer of copper on the casting, such as would be required for protecting against corrosion. We do not even aim to produce a visible and continuous film of unalloyed copper on the surface of the casting. Ordinarily, such a continuous layer is not produced, since a large portion of the copper is absorbed in the iron with the result that the microchill is eliminated and the usual sorbitic-graphitic region is displaced by a ferritic-graphitic region. Apparently, the elimination of the microchill is due, first, to the graphitizing action of the copper in the cast iron, with a resultant reduction of stability of iron carbide, so that its formation on the surface becomes more difficult and, second, to the production of a subsurface region embodying an alloy predominantly of copper in which the elements iron and carbon are present and in which iron carbide is practically insoluble. Such an alloy is apparently present at the surface of a casting made in accordance with our method, though we do not desire to be bound by this more or less theoretical explanation.

It will be seen from this that we have provided a simple and economical method for producing a superior type of cast iron which is especially suitable for subjection to enameling and which has other marked advantages. Many of these advantages have been described above and some will be made clear by the claims appended hereto.

Having thus described our invention, what we claim is:

1. The method of producing enameled cast iron which comprises coating the contacting surface of the mold with copper or copper alloy and then pouring the cast iron into said mold in contact with such impregnated surface to produce a surface which will not blister under the enameling heat, and then enameling such surface.

2. The method of producing enameled cast iron which comprises coating the contacting surface of the mold with copper, then pouring the cast iron into said mold in contact with such impregnated surface to produce a discontinuous layer of copper or copper alloy, and then enameling such surface.

3. The method of producing enameled cast iron which comprises coating a contacting surface of the mold with a copper powder, then pouring the cast iron into said mold in contact with such impregnated surface to produce a discontinuous layer of copper or copper alloy, and then enameling such surface.

4. An enameled cast iron product comprising a cast iron body having a surface of copper-iron alloy and a ferritic-graphitic region immediately therebeneath, and a layer of enamel on said surface.

5. A enameled cast iron product comprising a cast iron body having a microscopically thin copper-iron alloy surface with a ferritic-graphitic region immediately therebeneath, and a layer of enamel on such surface.

6. An enameled cast iron product comprising a cast iron body having a discontinuous surface of copper or copper alloy and a ferritic-graphitic region immediately therebeneath, and a layer of enamel on said surface.

7. An article of manufacture comprising cast iron having a main body portion of normal structure, a surface section of ferritic-graphitic nature and a coating of enamel thereon.

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