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MOLD FOR CASTING FERROUS METALS

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This invention relates to a new and improved method of casting steel, and to a new and improved mold employed in the production of such steel castings.

5 This invention also relates to the improved products resulting from the process and the use of the molds herein set forth.

10 It is an object of this invention to provide a process involving the use of permanent metallic molds or mold parts for casting steel and by which greatly improved results are obtained with the elimination of many difficulties heretofore encountered in the use of permanent metallic molds or metallic mold surfaces.

15 It is another object of this invention to provide a long-life metallic mold or mold part adapted for use in casting steel provided with a non-ferrous metallic molding surface as a coating, layer, or film applied to a body portion, which body portion is composed of a suitable ferrous or non-ferrous composition.

20 It is a further object of this invention to provide improved steel castings formed in a permanent metallic mold or mold part having smoother and better appearing surfaces free from imperfections such as irregularities, impurities, cracks and like results now common in steel castings produced in metallic molds.

25 Heretofore, it has been the practice to employ steel as the material from which permanent metallic molds were formed because iron and steel are considered the most satisfactory and practical metals. However, the use of iron or steel molds for pouring steel castings involves many difficulties, the most important of which are listed below.

30 First, unless the metal surfaces are protected, the life of the mold is short. It is known that any irregularities in the mold surface tend to promote cracks in the ingot or castings. Much work has been done and attempts made to provide a satisfactory coating for such molds. Coatings made up of various non-metallic materials or various forms of carbon and sometimes a combination of non-metallic materials and carbon have been found quite satisfactory and have been widely used in casting grey iron but such coatings have not been satisfactory for use in pouring steel castings.

35 The difference in results obtained with such prior molds when pouring iron and steel is attributable to the high pouring temperatures necessary for steel which is approximately between 2700 and 2800 degrees F. as compared with 2300 to 2400 degrees F. for iron. This additional heat is

found to produce gases from the carbon or organic coating materials with very detrimental results. Further, the carbon or organic material constituting the mold coatings are found to work into the surface of the casting to an undesirable extent.

40 A second objection is attributable to the dissipation of the binding material employed with these coatings which binding material burns out under the action of the heat of the molten metal, necessitating an expensive coating replacement treatment for each casting operation.

45 A third objection is the occurrence of cracks in steel castings which is partly attributable to the greater coefficient of contraction of steel as compared with iron and partly to the greater temperature range through which the steel must cool.

50 In practice therefore, it has been impossible to employ metallic molds with either of the above described types of coatings with any degree of satisfaction for pouring steel, because a large percentage of the final castings would be cracked as above pointed out.

55 Fourth, carbon and organic coatings of the above mentioned type are washed off of the mold surface when steel is poured and are either entrapped or absorbed by the molten metal. In some cases carbon and organic coatings are especially objectionable either from the standpoint of contaminating the steel with carbon or from carrying non-metallic material into the casting. Such coatings are difficult to apply and when washed off, after each pouring, the problem becomes an expensive one.

60 Many different methods have been tried in connection with the use of these coatings already mentioned, and an enormous amount of experimentation has been conducted in an effort to provide a more suitable refractory non-metallic coating. One great difficulty encountered has been that of providing a suitable binder for use in holding the non-metallic coating on the mold surfaces. All organic binders give off gases when subjected to the influence of molten steel, and such gases are especially objectionable. Also the gasification of the binder results in a disintegration of the coating, which, as noted above, necessitates replacement of the coating after each casting operation.

65 For the above stated reasons, non-metallic mold coatings for metallic molds or mold parts, for pouring steel, have been found to be unsatisfactory in commercial practice and therefore effort has now been made to discover whether or not metallic coatings can be applied to the surface of

metallic molds or mold parts with good results in pouring steel.

Tin, lead and zinc, all of which have low melting points, have been tried and these metals were found unsatisfactory for coatings for the purpose intended. The use of aluminum also has been tried, but results indicate that both its low melting point and its tendency to react with oxygen render it less desirable as a metal for these coatings, especially from a durability standpoint. Copper, or alloys of copper, such as brass or bronze, have been found to work most advantageously, and somewhat similar results have been obtained with both nickel and chromium coatings.

Accordingly, it is a further object of this invention to provide a process of casting steel, a mold therefor, and ferrous castings produced by said process, all of which are free from the difficulties and objections above enumerated and involve the casting of steel in molds having at least a portion thereof comprising a metallic body having its molding surfaces formed of a coating of copper, nickel or chromium.

It is well known and has been common practice for years to pour non-ferrous metals against metal surfaces in forming castings, and accordingly, it should be understood that the present invention is restricted to the pouring of steel in the manner hereinafter described and has nothing to do with casting non-ferrous metals. The invention is further restricted to the use of metallic mold surfaces as coatings of copper, nickel or chromium, and is not intended to include any of the non-metallic organic or carbon coatings above referred to.

This invention relates to what is hereinafter termed in the claims "all metal molds" for pouring steel castings, having their inner molding surface composed of a coating of one of the metals of the group of nickel, chromium and copper.

It is also conceivable that the coating may comprise two or more layers of various metals as hereinafter pointed out. By the term "all metal mold" is meant a mold of the permanent type as distinguished from molds of sand or similar destructible materials. It is conceivable that a mold having only a part thereof composed in accordance with this invention may be made and used within the scope hereof and therefore "all metal mold" is intended to mean a mold part such as a chill or the like, where the entire thickness of the mold part is made of metal. Also molds which may have small inserts of non-metallic materials for special purposes and reasons which are otherwise constructed in accordance with this invention are intended to come within the scope of the appended claims.

It is known that solid copper molds have been tried for casting steel ingots and therefore no claim is made to solid copper molds as a part of this invention. (See German Publication "Stahl und Eisen," May 9, 1929, magazine 19, pages 696 to 700 inc., an article entitled "Pouring of steel in water-cooled copper ingots" by Dr. W. Oertel.)

In practice, the coating may be applied in various ways, including any one of the following: Electro plating, metal spraying, coating with powdered or flaked metal by utilizing a suitable vehicle either organic or inorganic, of which a nitro-cellulose varnish has been found to serve satisfactorily. The metal spraying operation is often referred to as the "Schoop Process."

The present invention is based upon the discovery that steel, when cast against a surface of a coating of copper, nickel, or chromium on me-

tallic molds or mold parts, possesses distinctly different properties from castings obtained when poured against a smooth steel or iron plate. The most striking characteristic is the smoothness of the surface of the castings which smoothness is shown to be reflected in a greater freedom from cracks on the surface of the casting.

Another distinct difference is that the impressions on the metal mold such as very minute tool marks, are reflected on the castings poured against the steel surfaces but are not in evidence on castings poured against surfaces of a coating of copper, nickel, or chromium. The difference in the effect of these metals as coatings for mold surfaces appears to be attributable to the behavior of the molten ferrous metals when brought in contact therewith, as regards the fact as to whether or not the molten ferrous metal wets the mold surface.

According to known principles of physics, the wetting properties of a liquid in contact with a solid, are determined by the relationship of the cohesion of the liquid to the adhesion between the liquid and solid. If the cohesion of the liquid is less than the adhesion referred to the liquid will possess that property of "wetting" the solid surface.

With this understanding, it appears as though the cohesion of the molten steel is greater than the adhesion for any one of the coating materials of copper, nickel or chromium, wherefore in the casting operation, the steel does not act to wet the coating metal.

Irrespective of any supposition as to the probable cause for the difference in behavior, the applicant wishes to point out that the above metals, namely, copper, nickel or chromium, when applied as coatings for metal molds, or mold parts, exhibit markedly different characteristics from those of ferrous metal surfaces when used for pouring steel castings.

When ordinary ferrous metal molds are used there is a marked tendency for the casting to adhere to the walls of the mold and furthermore, the casting operation and final product are subject to the numerous disadvantages and objections above pointed out.

It is further believed that with the use of a coating of either copper, nickel or chromium, that their low adhesion for molten iron or steel, causes a film of gas to be created and maintained between the mold surface and the casting. Gas so formed is found to be a good heat insulator and therefore it retards the chilling influence of the mold on a molten metal and thereby prevents or materially reduces the cracks. Furthermore, the existence of a film of gas between the mold surface and the casting results in less possibility of adherence between the mold and the casting.

From the practical standpoint, the following advantages result from use of permanent metallic molds or mold parts having molding surfaces formed of a coating of either copper, nickel or chromium:

First, all of the known advantages for permanent metallic molds may be realized without the attendant disadvantages and troubles, heretofore encountered.

Second, the iron or steel mold when used, is given protection from the influence of the molten metal so as to prolong the life of the mold and reduce the expense of casting operations employing this type of mold.

Third, the surface of the castings obtained is

very smooth and requires but little machining to obtain the desired finished contour.

This process provides a four-layer coating embodying the features of heat resistance and smoothness and by the final layer of copper, gives the preferred effect on the surface of the finished castings.

From the above description, it will be noted that the essential characteristic of the metals constituting the molding surface, in addition to the non-wetting property referred to, is that they have relatively high melting points so as not to be fused during the pouring operation and also are relatively free from tendencies to oxidize to a degree that is objectionable in casting operations.

The applicant wishes to distinctly point out the difference between the teachings of this invention and those processes in the prior art, where coatings are applied to molds for the purposes of producing an alloy on the surface of the cast article by utilizing the heat of the molten metal to fuse the alloying ingredients.

In the practice of the present invention, the casting materials are not provided for the purpose of fusing or being taken up in the surface of the metal but are provided for their physical effect when maintained in contact with the molten ferrous metal in the casting forming process.

The term "castings" are used in this specification is intended to include ingots.

I claim:

1. An all metal mold or mold part for casting ferrous metal comprising a ferrous metal body portion having a molding surface composed of a coating of copper.

2. An all metal mold or mold part for casting ferrous metal including a ferrous metal body portion having a molding surface composed substantially entirely of copper.

3. An all metal mold or mold part for casting ferrous metal including a ferrous metal body portion having a molding surface composed of a coating having copper as its principal ingredient.

4. An all metal mold or mold part for casting ferrous metal including a ferrous metal body portion having a molding surface composed of a coating formed by a mixture of copper and a nitro-cellulose carrier.

5. An all metal mold or mold part for casting ferrous metal including a ferrous metal body portion having a molding surface composed of a coating formed of a mixture including finely divided copper and a carrier.

6. An all metal mold or mold part for casting ferrous metal including a ferrous metal body portion having a molding surface composed of a coating formed by a mixture of copper and nitro-cellulose carrier superimposed on a layer of harder material.

7. An all metal mold or mold part for casting ferrous metal including a ferrous metal body portion having a molding surface composed of a coating formed of a mixture including finely divided copper and a carrier superimposed on a layer of harder material.

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