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METHOD OF TREATING MOLTEN METALS

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This invention relates, as indicated, to a method of treating molten metals, but has reference more particularly to the degasification of molten metals which contain appreciable amounts of at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum.

It has heretofore been proposed, as in Patent No. 285,786 to pass carbonic-acid gas over and through molten iron in an open hearth furnace, after the metal has been decarburized, in order to eliminate sulphur and phosphorus from the metal. It has been found impossible, however, to pass such gas through a molten mass of metal in sufficient quantities to either produce the high state of ebullition which can be produced by the use of solid carbon dioxide (Dry Ice), or to provide a sufficient reaction of the CO_2 for the removal of gases such as hydrogen from the metal.

It has also been proposed, as in Patent No. 2,008,731, to place Dry Ice on the surface of a molten charge of aluminum, prior to the addition of magnesium and similar readily oxidizable metals thereto, in order to provide a dry protective atmosphere above the aluminum to prevent burning of the added metals. The use of Dry Ice in this manner does not, however, produce any appreciable ebullition of the molten metal, nor is it effective to any appreciable degree in degasifying the molten metal.

I have discovered, however, that I can produce a violent ebullition of the molten metals, particularly molten metals, containing appreciable amounts of at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, a substantially complete degasification of such metals, and a desired metallographic structure of the metals, by introducing or associating the solid carbon dioxide or Dry Ice with the molten metals in various ways which have not been suggested or contemplated in the aforesaid patents. Among these are the following:

(*a*) Placing the Dry Ice, in amounts of from about 20 to about 1000 ounces per ton of molten metal to be treated, in the bottom of the ladle to be filled with the metal to be treated and pouring the molten metal thereover.

(*b*) Placing the Dry Ice in the bottom of the forehearth, and then pouring the molten metal thereover.

(*c*) Placing the Dry Ice in the runner leading from the furnace to the ladle or forehearth and then flowing thereover the molten metal to be treated.

(*d*) Placing the Dry Ice in a metallic container and causing the container to be submerged below the surface of the molten metal to be treated. In this case, however, precautions must be taken to insure that the container is not air-tight, else a violent explosion might occur.

(*e*) Placing the Dry Ice in the bottom of a mold into which the molten metal to be treated is poured for making castings, etc., care being taken that the mold is of such design that the gaseous CO_2 which is formed may be eliminated freely.

In all of the foregoing cases, the Dry Ice is so introduced into or associated with the molten metal to be treated that a substantial or violent ebullition of the molten metal occurs, due to the magnitude of the volume change of the Dry Ice from the solid to the gaseous state. The reaction is of such violence that the gases in the molten metal, particularly hydrogen, are completely and effectively removed.

It is important, moreover, particularly in the manufacture of steel, that the Dry Ice be used as near towards the end of the refining period as possible, but prior to the addition of deoxidizing agents, such as silicon, aluminum, calcium, zirconium, etc. The reason for this is that these so-called deoxidizing agents have a tendency to hold various gases in solution, so that the effectiveness of the Dry Ice treatment is partially lost if the Dry Ice is used after the addition of the deoxidizing agents. On the other hand, if the deoxidizing agents are added after the use of the Dry Ice, then any overoxidization which may have taken place is immediately corrected, but the detrimental gases, such as hydrogen, will have been eliminated.

I have found that the use of solid carbon dioxide or Dry Ice in the manner described is particularly effective in connection with the manufacture of high alloy castings, particularly nickel- or cobalt-containing castings of small size, where internal porosity is often found. By the use of Dry Ice in the various ways which have been described, such internal porosity is eliminated and a tougher, finer and denser-appearing structure is obtained.

The treatment which has been described has been found of especial value for ferrous-base alloys, for nickel-base alloys such as those described in my co-pending applications, Serial Nos. 519,889 and 543,047, for alloys of the nichrome and stellite types, and for cobalt-chromium-tungsten alloys which are relatively iron-free.

This application is a continuation-in-part of my co-pending application, Serial No. 533,393,

which was allowed January 17, 1945, but has now become abandoned.

While specific embodiments of my invention have been described in detail in order to furnish a clear conception of the invention, it is to be understood that the invention is not limited thereby but may have other embodiments within the limits of the prior art and the scope of the subjoined claims.

What I claim is:

1. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises treating the metal with solid carbon dioxide in such a manner as to cause substantial ebullition of the metal.

2. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises treating the metal with solid carbon dioxide in such a manner as to cause a violent ebullition of said metal.

3. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises treating the metal with solid carbon dioxide, the latter being disposed within and below the surface of the metal throughout said treatment.

4. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises flowing the molten metal over solid carbon dioxide.

5. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises placing solid carbon dioxide in amounts of from about 20 to about 1000 ounces per ton of molten metal to be degasified, in the bottom of a ladle to be filled with said metal, and pouring the molten metal thereover.

6. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises placing solid carbon dioxide, in small amounts, in the bottom of a forehearth to be filled with said metal, and pouring the molten metal into said forehearth.

7. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises placing solid carbon dioxide in the runner leading from a furnace to a ladle or forehearth, and then flowing thereover the molten metal to be degasified.

8. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises causing a non-air-tight container which contains solid carbon dioxide to be submerged below the surface of the molten metal to be degasified, the container being so maintained until degasification is substantially complete.

9. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises placing solid carbon dioxide in the bottom of a mold, and pouring the molten metal which is to be cast in said mold into said mold and over said carbon dioxide.

10. The method of degasifying molten metal containing at least one of the metals of the group consisting of nickel, cobalt, iron, chromium, tungsten and molybdenum, which comprises treating the molten metal with solid carbon dioxide in such a manner as to cause a substantial or violent ebullition of the molten metal, due to the magnitude of the volume change of the carbon dioxide from the solid to the gaseous state, the reaction being of such violence that the gases in the molten metal, particularly hydrogen, are completely and effectively removed.

11. The method of degasifying molten steel which comprises refining said steel, treating said steel substantially near the end of the refining period with solid carbon dioxide in a manner to cause a substantial ebullition of the molten steel, and then treating said molten metal with a deoxidizing agent.

12. The method of eliminating internal porosity from ferrous base castings, and obtaining a tougher, finer and denser-appearing structure therein, which comprises treating the molten metal from which said castings are to be made with solid carbon dioxide in such a manner as to cause substantial ebullition of said metal.

13. The method of degasifying ferrous base metals while in molten condition, which comprises bringing solid carbon dioxide into such association with the molten metal as to cause violent ebullition of the latter.

14. The method of improving the structure of ferrous base castings which comprises bringing solid carbon dioxide into such association with the molten metal from which the castings are to be made as to cause violent ebullition of said metal and a removal of the gases therefrom.

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