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PROCESS OF CASTING METAL ON GLASS FIBER MAT

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This invention relates to the casting of metals and in particular to the casting of ingots.

As is well known in the art, in the making of steel mill products such as bar, rod, plate, sheet and strip, the yield obtained is usually a direct function of the freedom of the surface of the ingot from surface imperfections such as scabs, cracks, cold shuts, pits, occlusions and others, which impair the fabrication of the ingot into the form of the steel mill product. In practice, it is usually necessary to remove the surface defects from the ingot by chipping or grinding or otherwise where possible during the processing of the ingot, thereby greatly increasing the production costs of the steel mill products.

Usually when molten metal is cast into a cast iron ingot mold, whether big end up or big end down type, the poured metal which strikes the bottom of the mold or stool splashes or spatters onto the side walls of the mold and freezes thereon with the result that when the mold is filled and the ingot is solidified, at least the lower end of the ingot has a very poor surface and includes the scabs of metal previously splashed and frozen onto the walls of the mold. This condition has been particularly noticeable in making silicon-iron magnetic strip material which is often processed directly from the ingot into hot rolled strip without any intermediate slabbing and cleaning up with reheating for rerolling, as the scabs are carried through the processing of the ingot into strip with the result that the last 150 to 300 feet of strip formed from a given ingot has so many defects therein as to require scrapping of such section of the strip. This condition is particularly bad where the strip is being processed on a continuous tandem strip mill, for the defects often cause breakage or tearing of the strip with the result that the mill must be stopped and in many cases the rolls of the mill are so badly damaged by the broken strip that they must be replaced.

Heretofore, many attempts have been made to improve the top pouring ingot casting practices, but without too much success. Mold washes of carbonaceous materials, sodium silicate and other materials which usually embody hydrocarbons and which may tend to impart hydrogen to the metal being poured, have been employed as well as the practice of pouring through a fused alkali silicate. Recently it has been proposed to utilize a silicate shell cast in the mold prior to pouring the molten metal therein. In most cases the known improvements have not given consistently good results whereas in others, for example with the cast-in silicate shell, the improvement has necessitated an additional time consuming operation with accompanying additional costs. Further, with a cast-in shell it is difficult to maintain a continuity of the shell and/or the thickness thereof with the result that while a large portion of the ingot may have a surface free from imperfections, spotty sections will have surface imperfections which must be removed before processing the ingot.

An object of this invention is to provide a process for casting metal in an ingot mold to form an ingot free from surface imperfections which impair the working of the ingot into steel mill products.

Another object of this invention is to provide a process of casting metal through a mass of fiber glass in an ingot mold to prevent splashing and spattering of the metal onto the mold wall while providing for wetting the mold wall with fluid glass as the metal rises in the mold to provide a solidified ingot free from surface imperfections which impair the working of the ingot.

Other objects of the invention will become apparent from the following description and the appended claims.

In practicing this invention, molten metal is cast into a conventional cast iron ingot mold. The ingot mold is prepared in accordance with standard steel mill practice, having dust, dirt and the like removed therefrom after which it is preheated to a temperature of between 225 and 300° F. to insure that the mold cavity is free of moisture.

In accordance with this invention, a mass of fiber glass is introduced into the preheated mold and is lightly rammed or pushed to the bottom thereof to provide a layer of the fiber glass over the entire bottom of the mold. The fiber glass employed is of the usual commercial form being of fibers having a diameter of about 0.005 inch or less and preferably of about 0.0005 inch and may be of the continuous or staple fiber type in the form of loosely compacted fibers in bulk, shredded or wool form or loosely woven or formed bats, mats, blankets and the like. The fiber glass is preferably one free from resin contaminant with not more than ½% of mineral oil on the surfaces of the fibers thereof and having a density of about 2½ to 4 pounds and preferably about 3 pounds per cubic foot. Preferably the fiber glass has a viscosity of between 100 and 375 poises at a temperature of 2275° F. for reasons given hereinafter and may have different formulations. One formulation which is particularly good for use in practicing this invention with the different steels and alloys is known to the trade as T. W. F. fiber glass and has a composition of 58.7% SiO_2, 4.3% Al_2O_3, 15.7% CaO, 5.5% MgO, 3.9% B_2O_3, 11.3% Na_2O, 0.4% K_2O and 0.2% Fe_2O_3. Such fiber glass has a viscosity ranging from 600 poises at 2000° F. to 100 poises at 2275° F., and is particularly useful in the casting of metals which are normally cast at temperatures of from 2400° F. up to about 3100° F. Other fiber glasses can, however, be used provided they have a viscosity of no loss than 100 poises at temperatures in the range of 2275° F. to 2500° F. and such temperature is below the pouring temperature of the metal being cast. Thus where stainless steel is to be cast, usually at a pouring temperature of about 3000° F., a fiber glass known to the trade as Fiberglas C having a viscosity ranging from about 375 poises at a temperature of 2275° F. to 100 poises at a temperature of 2500° F. can be used to good advantage.

In practice, a mass of the fiber glass in bulk, wool, mat, bat or other lightly compacted form is placed in the bottom of the preheated mold to completely cover the bottom thereof to a depth of from about 12 to 24 inches or higher depending upon the size of the mold. The fiber glass is preferably used in an amount ranging from 2 to 7 pounds per ton of metal to be poured, good consistent results having been obtained with as low as 4 pounds per ton of metal. No advantage is obtained where more than 7 pounds of fiber glass per ton of metal is used other than that of making sure that an adequate supply is maintained in the fiber form throughout the pouring of the metal. The fiber glass is loosely rammed, care being taken not to compact the fibers of the layer

as it is desired to have as much surface area of the fibers exposed as possible while still maintaining a thorough coverage of the bottom of the mold.

After the fiber glass is placed in the preheated mold, the refined metal which is to be cast is poured through the mass of fiber glass into the mold. When the metal strikes the bottom of the mold or the molten metal beneath the layer of fiber glass, the stream of molten metal is broken up but the splashing or spattering of the metal is completely absorbed by the layer of fiber glass. The splashes and spattering of the metal normally accompanying top pouring of ingots as practiced prior to this invention created noise audible at a considerable distance from the ingot mold. With this invention, such splash and spatter is so completely absorbed by the fiber glass and the splash and spatter is so dampened that the noise is barely audible. As the metal passes through the layer of fiber glass and spreads over the bottom of the mold and the splashes of metal are absorbed by the layer of fiber glass, the fibers of glass in contact with the molten metal change from the solid state to become viscous and from thence to a less viscous or more fluid state to cover the surface of the poured metal and wet the surface of the wall of the mold as the metal rises therein. The bulk of the layer of fiber glass remains in its solid state or at least does not become sufficiently viscous to lose its fiber form and since the density of the fiber glass is less than that of the poured metal, the layer of solid fiber glass floats on the surface of the poured metal to rise in the mold as the metal rises therein.

Throughout the pouring of the molten metal additional quantities of the fiber glass come into contact with, and are affected by the high temperature of, the cast molten metal with the result that the layer of the fiber glass adjacent the surface of the cast molten metal progressively becomes viscous to provide an adequate supply of substantially fluid glass which covers the surface of the cast metal and wets the surface of the mold as the metal rises therein. While it has been indicated hereinbefore that successful casting can be performed with only 2 pounds of fiber glass per ton of molten metal to be cast, it is preferred to employ 4 pounds or more of the loosely compacted fiber glass per ton of metal so as to insure maintaining a layer of the fibers of the fiber glass on the cast molten metal throughout the pouring operation to thereby provide for absorbing all splashes and spattering of the poured metal and to provide an adequate supply of fluid glass for wetting all the surface of the mold which will be contacted by the molten metal as the metal rises in the mold.

In practice, it is found that the layer of fiber glass and the fluid glass on the surface of the poured molten metal prevents or precludes air in the mold from oxidizing the surface of the molten metal in the mold with the result that no scummy meniscus is formed to prevent the fluid glass from wetting the surfaces of the mold. Further, the fluid glass on the surface of the molten metal tends to absorb any oxides as the molten metal is poured therethrough and causes a mixing of the fluid glass with the metal with the result that as the fluid glass separates and floats to the surface of the cast metal it carries such oxides to the surface to prevent occlusions from pouring. In practice, it is also found that the layer of fiber glass, which is inherently a heat insulating material, effectively insulates the cast metal to prevent heat radiation losses from the upper surface thereof to maintain the heat of the cast metal and fluidity thereof whereby an excellent surface is obtained without the presence of a chilled surface skin effect thereon.

After the mold is filled and the cast metal has become solidified, the ingot can be readily and easily stripped from the mold. An examination of the ingot reveals that in all cases the layer of fiber glass in the mold was successful in so preventing or absorbing the splashes and spattering and in wetting the inner surface of the mold when in the fluid state as to form a layer thereon and give an ingot free from surface imperfections which would normally interfere with the working of the ingot into the form of steel mill products. The glass apparently so successfully wets the surface of the mold as to fill pits, burns and other imperfections normally found in a mold which has been used repeatedly.

As stated hereinbefore, it is preferred to employ a fiber glass having a viscosity of not less than 100 poises and preferably in the range of 100 to 375 poises at a temperature of 2275° F. If a less viscous fiber glass is employed, it is found that the glass becomes too fluid when exposed to the high heat of the molten metal being poured with the result that the fluid glass and fluid metal may become so intermixed by reason of the miscibility of the two fluids as to result in the entrapment of inclusions in the cast metal. On the other hand, with a fiber glass of the viscosity specified, the fluid glass is not entrapped in the cast metal but instead functions to give a perfect coating on the mold wall which makes possible the production of an ingot free from surface imperfections which impair the working thereof and which also enables the operator to readily strip the solidified ingot from the mold. Such stripped ingot is often found to have a very thin layer of the glass on its surface indicating that an exceptionally good wetting of the surface of the mold by the fluid glass had been obtained during the pouring operation. In all cases, however, whether or not a thin layer of glass is formed on the ingot surface, it is found that at least the bottom half, and in most cases, all the ingot surface formed adjacent the mold, has a shiny surface and gives the appearance of having been polished. Further, it has been found possible to reduce the pouring rate to thereby greatly increase the time required to fill the mold where the layer of fiber glass is used since such fiber glass makes it possible to pour without danger of cold shuts or the inclusion of scabs or the like. Such slower pouring results in an ingot having an improved dendritic structure with an exceptionally clean surface.

This invention is useful in casting ingots of both ferrous and nonferrous high melting alloys, including alloy steels, silicon-iron alloys, stainless steels, chromium steels, nickel base and cobalt base alloys which are to be worked into steel mill products. It is of particular benefit where such metal ingots are to be worked into sheet and strip where surface imperfections from the ingot will cause scrapping of material, breakage of the strip and/or damage to the mill. Specific examples of metal which has been cast into ingots free from surface imperfections which will impair the working thereof are the 1½% to 4½% silicon-iron magnetic alloys, stainless steels of the 18–8, 25–12 and 25–20 types, the 17% chromium steel type, 15 to 19% manganese–15 to 17.25% chromium type, nickel base alloys and nickel-cobalt base alloys. In all cases the metals are poured at their optimum pouring temperatures, as the layer of fiber glass functions to give perfect protection to the mold wall and prevents damage thereto. Ingots as large as 10 tons have been successfully cast by this process.

This invention is also useful in bottom pouring practice, for when the metal is poured through the runner or gate into the bottom of the mold, the molten metal fountains or spouts into the layer of fiber glass and the fiber glass effectively absorbs the splash and spatter as the metal falls back to the bottom of the mold. All of the other advantages of the layer of fiber glass described hereinbefore with respect to the top pouring of an ingot are also found where the invention is used in connection with bottom pouring of a mold.

This invention makes possible considerable savings in the preparation of molds and effects a reduction in processing time. Further, because of the excellent surface imparted to the ingots, considerable savings in time and equipment as well as in scrap material are effected. The

process is relatively simple but highly efficient and can be readily followed by anyone skilled in the trade.

We claim:

1. The process of casting a molten metal in an ingot mold to form an ingot free from surface imperfections which impair the working of the ingot into strip, comprising in combination, the steps of, depositing a mass of relatively loosely compacted fiber glass having a viscosity of not less than 100 poises at 2275° F. and a density of between 2½ to 4 pounds per cubic foot over the bottom of the mold in an amount ranging from 2 to 7 pounds per ton of metal to be poured to form a substantial layer therein, the fibers of the fiber glass having a diameter not greater than 0.005 inch, and pouring the molten metal into the mass of fiber glass to fill the mold and float the fiber glass on the surface of the poured metal, the fiber glass absorbing the splashing and spattering of the molten metal as the metal is poured therethrough to prevent scabbing of the walls of the mold, the molten metal rendering the fiber glass fluid adjacent the surface of the metal as the mold is filled whereby the fluid glass wets the walls of the mold as the metal and floating fiber glass rise therein to form a thin layer of glass on the surface of the mold and provide a good surface on the ingot as the metal solidifies in the mold.

2. The process of casting a molten ferrous base metal in an ingot mold to form an ingot free from surface imperfections which impair the working of the ingot into strip, comprising in combination, the steps of, depositing a mass of relatively loosely compacted fiber glass having a viscosity of between 100 and 375 poises at a temperature of 2275° F. and a density of between 2½ to 4 pounds per cubic foot over the bottom of the mold in an amount ranging from 2 to 7 pounds per ton of metal to be poured to form a substantial layer therein, the fibers of the fiber glass having a diameter not greater than 0.005 inch, and pouring the molten ferrous base metal at a temperature above 2275° F. into the mass of fiber glass to fill the mold and float the fiber glass on the surface of the poured metal, the fiber glass absorbing the splashing and spattering of the molten metal as the metal is poured therethrough to prevent scabbing of the walls of the mold, the molten metal rendering the fiber glass fluid adjacent the surface of the metal as the mold is filled whereby the fluid glass wets the walls of the mold as the metal and floating fiber glass rise therein to form a thin layer of glass on the surface of the mold and provide a good surface on the ingot as the metal solidifies in the mold.

3. The process of casting a molten ferrous base metal in an ingot mold to form an ingot free from surface imperfections which impair the working of the ingot into strip, comprising in combination, the steps of preheating the mold to a temperature between 225 and 300° F., depositing a mass of relatively loosely compacted fiber glass having a viscosity of not less than 100 poises at 2275° F. and a density of between 2½ to 4 pounds per cubic foot over the bottom of the mold in an amount ranging from 2 to 7 pounds per ton of metal to be poured to form a substantial layer therein, the fibers of the fiber glass having a diameter not greater than 0.005 inch, and pouring the molten ferrous base metal through the mass of fiber glass to fill the mold and float the fiber glass on the surface of the poured metal, the fiber glass absorbing the splashing and spattering of the molten metal as the metal is poured therethrough to prevent scabbing of the walls of the mold, the molten metal rendering the fiber glass fluid adjacent the surface of the metal as the mold is filled whereby the fluid glass wets the walls of the mold as the metal and floating fiber glass rise therein to form a thin layer of glass on the surface of the mold and provide a good surface on the ingot as the metal solidifies in the mold.

4. The process of casting a molten metal in an ingot mold to form an ingot free from surface imperfections which impair the working of the ingot into strip, comprising in combination, the steps of, preheating the mold to a temperature between 225 and 300° F., depositing a mass of relatively loosely compacted fiber glass having a viscosity of between 100 and 375 poises at a temperature of 2275° F. and a density of between 2½ to 4 pounds per cubic foot over the bottom of the mold in an amount ranging from 2 to 7 pounds per ton of metal to be poured to form a substantial layer therein, the fibers of the fiber glass having a diameter not greater than 0.005 inch, and pouring the molten metal at a temperature above 2275° F. through the mass of fiber glass to fill the mold and float the fiber glass on the surface of the poured metal, the fiber glass absorbing the splashing and spattering of the molten metal as the metal is poured therethrough to prevent scabbing of the walls of the mold, the molten metal rendering the fiber glass fluid adjacent the surface of the metal as the mold is filled whereby the fluid glass wets the walls of the mold as the metal and floating fiber glass rise therein to form a thin layer of glass on the surface of the mold and provide a good surface on the ingot as the metal solidifies in the mold.

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