

[54] **FLUX COMPOSITION AND A CENTRIFUGAL CASTING PROCESS USING THE SAME**

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[22] Filed: **Dec. 15, 1972**
[21] Appl. No.: **315,499**

[52] **U.S. Cl.**..... **75/94, 75/27, 75/53**
[51] **Int. Cl.**..... **C22b 9/10**
[58] **Field of Search** **75/94, 27, 58, 53, 55,**
75/57; 148/26

[56]		References Cited	
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[57] **ABSTRACT**
There are provided a flux of a novel composition adapted for use in a centrifugal casting process for the production of a composite roll and the process comprising the step of adding the flux at a specific stage thereof. This flux contains, in weight percent, from 5 to 20% a metallic element such as aluminum which causes an exothermic reaction with the melt when in contact, thus aiding in the heat generating on the innermost surface of the melt to define the shell portion of the roll during the casting. This improves the characteristic of the temperature distribution gradient over its cross-section taken radially of the shell portion of the roll, thereby precluding the cause of the formation of cracks or other defects which tend to appear in the form of a circumferential layer in the formed roll but at a position close to its outermost surface in its cross-section.

1 Claim, 4 Drawing Figures

FIG. 1

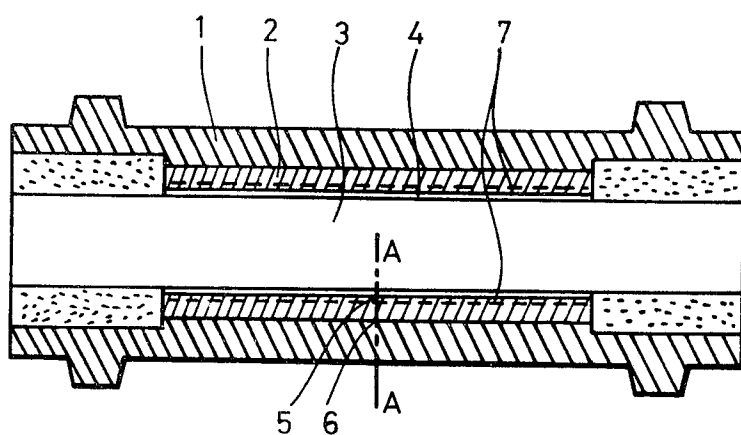
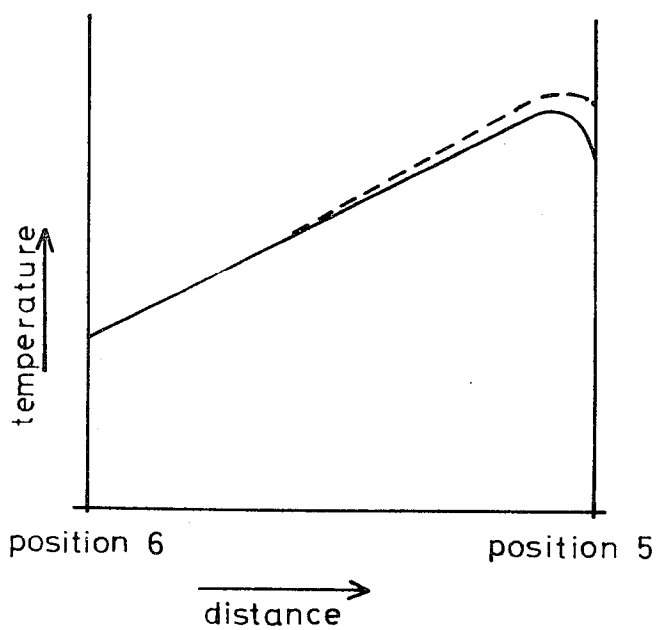
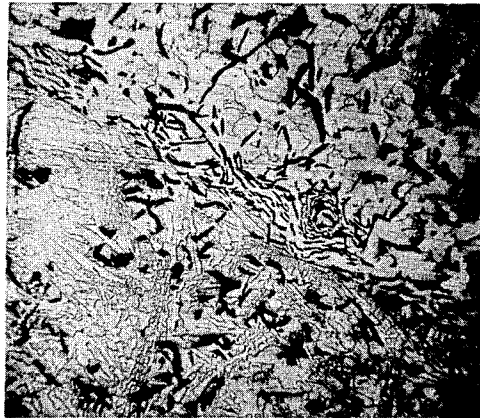


FIG. 2





(PRIOR ART)

FIG. 3.

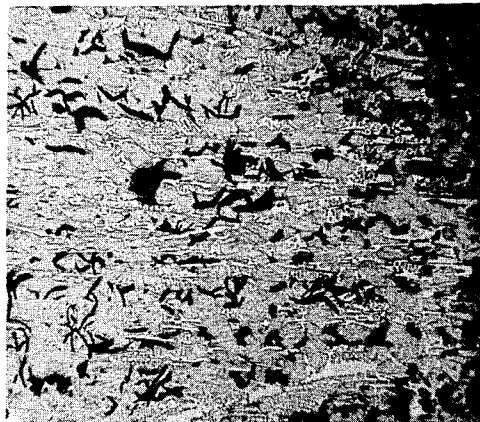


FIG. 4.

FLUX COMPOSITION AND A CENTRIFUGAL CASTING PROCESS USING THE SAME

BACKGROUND OF THE INVENTION

This invention relates to a flux composition and a centrifugal casting process for use in the production of a composite roll, which comprises the step of adding said flux at a specific stage of the casting, and more particularly to a flux which leads to an exothermic reaction with the steel melt when in contact.

In conventional, horizontal type centrifugal casting process for use in the production of a composite roll, a cylindrical casting mold having open ends is placed in a horizontal direction and rotated. Then, alloy melt is introduced therein to form the outer layer or shell portion of a roll, while charging thereafter an oxidation-preventive flux to cover the radially innermost surface of the melt to define the shell portion of the roll. After the solidification of the shell portion, the rotation of the casting mold is ceased, then one end of the mold is closed with a conventional means, followed by the erection of the casting mold on a suitable base, with said closed end placed to form the bottom thereof. Subsequently, alloy melt is poured into said mold from top or bottom to fill the hollow portion or core portion defined by said shell portion of the roll. At this time, the flux coating covering the radially innermost surface of the shell portion will float on the top surface of the melt which has been cast. Naturally, the addition of the flux is directed to improving the surface condition of the radially innermost surface of the shell portion, thereby providing satisfactory metallurgical bonding between the shell and core portions of the roll.

However, this process suffers from the inherent disadvantages resulting from the solidification mode, that is to say, from the unsuitable temperature distribution or gradient throughout its cross section taken radially of said shell portion.

More specifically, referring to the solidification phase of the shell portion after addition of the flux, the cooling of the shell portion from the radially outermost surface thereof, i.e., the cooling through the metal mold, with which the shell portion is in contact, is greater than that from the radially innermost surface of the shell portion which is covered with the flux layer. This is partly because the thermal conductivity of the flux is appreciably less than that of the metal mold and partly because of the bulky mass of the metal mold which is maintained at a considerably lower temperature as compared with that of the melt. This results in the formation of a temperature distribution or gradient having the peak whose position is biased towards the innermost surface of the shell. In other words, this portion or layer biased toward the innermost surface of the shell extends circumferentially of the shell portion and is the layer which will be solidified last. In such a location of the shell where solidification occurs last, there tends to take place segregation of impurities such as phosphide, sulfide and the like, and the formation or the growth of large crystal grains which produce adverse effects in the mechanical properties of the roll.

The metallurgical structure depends on the cooling rate. For instance, when a case alloy such as high alloy chilled cast iron, alloy grain cast iron, or plain chilled cast iron is cast to form the shell portion of the roll, then a normal structure is not obtained as expected in the aforesaid layer where solidification last takes place.

The result is abnormal and aggregating structure in precipitated graphites of a considerably great amount.

The phenomena such as the segregation of the impurities, the growth of the crystal grains and the segregation of the graphite are even more evident in the shell portion of a roll of a considerably great diameter, and such phenomena are likely to occur along the circumferential direction of the shell therein but in a position radially adjacent to or in the vicinity of the radially innermost surface of the shell portion when solidified.

Since the shell portion of the roll is important in that it directly contacts the material to be rolled and thus is frequently subjected to thermal and mechanical stresses, such a defect assuming the form of thin circumferential layer in the shell portion is critical, because it presents the cause for the fatal failure of the roll during its service.

Hitherto, to avoid such a drawback, for instance, a burner is introduced into the casting mold, after casting shell portion, to heat the innermost surface thereof in an attempt to adjust or improve the aforesaid temperature distribution or gradient over its cross-section. In other words, the peak of the temperature gradient is shifted inwardly to give a smooth curvature of the temperature distribution or gradient which will be described in more detail hereinafter.

Nevertheless, such an operation using a burner necessitates providing complicated devices and is time-consuming, thus only partially solving the problem.

Accordingly, it is an object of the present invention to provide a flux of a novel composition which improves the temperature distribution or gradient over the cross-section of the shell portion during the solidification phase thereof, while preventing re-oxidation of the radially innermost surface of the melt to define the shell portion, which has been spoiled due to oxidation before the flux is applied and thus purifying said surface.

It is another object of the present invention to provide a centrifugal casting process for use in the production of a composite roll, said process comprising the addition of aforesaid flux at a specific stage of the process.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a flux containing, in weight percent, from 5 to 20% of a metallic element such as aluminum which causes an exothermic reaction with the alloy melt when in contact, thus leading to the heat generation on the radially innermost surface of the melt of the shell portion of a composite roll. This avoids the use of a conventional burner and provides satisfactory temperature distribution or gradient throughout the cross-section of the shell portion.

Furthermore, according to the invention, the flux consists, for example, of from 30 to 45% by weight of a mixture of borax and silica sand, from 5 to 20% by weight of aluminum in the form of powder and the balance being soda compounds, fluoride, etc. as fusing agents. In operation, the flux should be scattered over the radially innermost surface of the melt to define the shell portion, immediately after the casting of the melt for the shell portion or at least prior to the commencement of the solidification of the shell portion, and then the melt to define the core portion thereof is cast,

thereby improving the metallurgical bonding between the shell portion and the core portion.

However, it is preferably to add the flux, immediately after the completion of the casting of the melt in an attempt to retard or suppress the cooling of the innermost surface of the shell portion due to the exothermic reaction and the heat retaining capability of the flux, thereby smoothing or blunting the peak configuration of the curve representing the temperature distribution, while shifting the peak toward the innermost surface of the shell portion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a casting mold and shell portion, after the casting of the shell portion has been completed;

FIG. 2 is a plot showing the temperature distribution or gradient over the cross-section taken along the line A—A of FIG. 1;

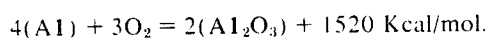
FIG. 3 is a microscopic view of the structure of the shell portion which has been cast according to the conventional centrifugal casting process; and

FIG. 4 is a microscopic view of the structure of the shell portion which has been cast according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The flux of the present invention has a composition consisting essentially of, in weight percent, from 5 to 20% of a metallic element such as aluminum which leads to exothermic reaction when in contact with a melt, from 30 to 45% mixture of borax and silica sand and from 65 to 35% sodium compound such as soda ash and/or fluoride such as fluorite.

i. The amount of aluminum can vary between 5 and 20%. Aluminum in the form of metal powder affords a strong deoxidizing effect and forms Al_2O_3 with a great amount of heat which generates according to the following reaction formula;



This results in the deoxidation of the iron oxide existing prior to charging of the flux on the radially innermost surface of the melt to define the shell portion of a roll, while resulting in a great amount of heat due to the reaction with oxygen, thus raising the temperature of the flux itself and at the same time heating the radially innermost surface of the shell portion to thereby improve the temperature distribution or gradient over the cross-section thereof. The Al_2O_3 thus produced will be mixed with the additives such as borax, silica sand, sodium compound and fluoride which form a thin coating layer over the radially innermost surface of the shell, serving the oxidation-preventive purpose. Amounts of aluminum less than 5% reduce the exothermic effect, while amounts of aluminum greater than 20% increase the viscosity of the fused additives due to the increase in amount of the Al_2O_3 having a high melting point, resulting in the incomplete formation of the thin coating layer of the flux.

ii. A mixture of borax and silica sand is present in the range from 30 to 45%. This mixture serves to give non-crystalline viscosity (vitreous viscosity) to the flux in a wide temperature range, such as from 800°C to 1,300°C. The optimum level of the mixture is in the range of 30 to 45% from the viscosity standpoint. How-

ever, best results are obtained by decreasing the amount of silica sand with increasing amounts of aluminum.

iii. The amount of sodium compound, fluoride and the like is between 65 and 35%, the sodium compound such as soda ash serving to provide fluidity to the flux at a lower temperature, while the fluoride such as fluorite serves to provide fluidity to the flux at a relatively higher temperature and enhance the solubility of oxide. However, the amounts of the sodium compound and/or fluoride should depend on the amounts of aluminum and borax and silica sand added for adjustment of the fluidity of the flux.

Referring now to FIG. 1, shown at (1) is a wall of a rotating casting metal mold, at (2) the shell portion of a roll and at (3) the core portion of the composite roll. Shown at (4) is a coating of a flux which has been supplied in the form of powder over the radially innermost surface of the melt to define the shell portion of the composite roll. Numerals (6) and (5) represent intersections of the line A—A with the innermost surface of the mold and the innermost surface of the shell portion, respectively.

FIG. 2 shows a plot of the temperature distribution or gradient over the cross-section taken along the line A—A of FIG. 1, in which the peak in the temperature is biased towards the ordinate side, appearing immediately above the position (5), then gradually lowered towards the ordinate of the position (6). The solid line represents the temperature distribution created according to the convention centrifugal casting process, while the broken line represents the temperature distribution created according to that of the present invention which gives a smooth curvature particularly at the peak which should have existed in the conventional castings.

As has been described, the peak in the temperature means the position in the shell portion whose cooling rate is last retarded. The broken line (7) in FIG. 1 corresponds to the peak shown in FIG. 2, where impurities such as phosphide, sulfide and the like tend to segregate in the shell portion of the roll.

EXAMPLE 1

A composite roll was cast having a shell portion of 650 mm in outer diameter, 1,600 mm in length and 50 mm in wall thickness. The melt used for the shell portion was high alloy grain chilled cast iron, while the melt used for the core portion was high-tensile cast iron. The composition of the flux used consists, in weight percent, of 40% borax, 5% silica sand, 35% soda ash, 10% fluorite and 10% aluminum in the form of powder.

FIG. 3 and FIG. 4 compare the structures of the shell portions cast according to the conventional process and present invention respectively.

Both photographs were taken at a magnification of 50, the samples being etched with 3% alcohol nitrate for 15 to 20 seconds.

The material used for the shell portion was high alloy grain iron.

FIG. 3, the segregated layer of graphite was observed running along the diagonal direction of the picture, while the direction of the segregated layers of graphites are shown normal to the surface of the photograph.

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FIG. 4 shows normal distribution of the graphites which has been improved by the addition of the exothermic additives or flux of the present invention.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific examples thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims they shall not be limited to the specific examples of the invention described herein.

What is claimed is:

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1. A flux composition adapted for use in the Centrifugal casting of a composite roll from a metal melt, said composite roll having a core portion and a shell portion directly bonded to said core portion, said flux consisting essentially of, in weight percent of the total, from 5 to 20% of a metallic element selected from aluminum, silicon and magnesium, from 30 to 45% of a mixture of borax and silica sand and from 65 to 35% of a fluidizing agent selected from sodium compounds, fluorides and mixtures thereof.

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