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3,567,432 METAL CASTING

Anthony Charles Wardell, Nechells, Birmingham, England, assignor to Foseco International Limited, Birmingham, England

No Drawing. Filed July 31, 1967, Ser. No. 657,063
Claims priority, application Great Britain, Aug. 16, 1966, 36,626/66

Int. Cl. C22b 9/10; C23c 1/12
U.S. Cl. 75—94

7 Claims

ABSTRACT OF THE DISCLOSURE

In the production of steel ingots, the steel is poured into the ingot mould through a flux layer, the flux including at least one fluoride, and at least one alkali metal carbonate. Preferred flux compositions include calcium fluoride, sodium carbonate, anthracene, calcium oxide and ferrosilicon.

This invention relates to compositions for use in pouring molten metals, particularly to the casting of ferrous ingots.

A principal aim of casting pit practice is to produce ingots which have a minimum of surface and internal defects, such as cavities or inclusions. The former may be avoided, as is well known, by correct hot topping procedures. However, the removal of both surface and internal inclusions is still a major problem. The amount of inclusion depends on many factors, and much attention is at present paid to correct teeming speeds and temperatures, teeming nozzle diameters, and the correct use of suitable coatings on the internal walls of the mould. These measures, however, do not give wholly satisfactory ingots, though they do effect some improvements.

The well known work which has been carried out on electro slag remelting, and the Perrin process, have demonstrated well the advantages which may be gained in this field by pouring the molten metal through a slag cover. The surface quality is greatly improved by these methods, and the number of surface defects is lowered, together with the number of inclusions.

It is possible to produce a similar effect and an improvement in surface quality by bottom-pouring ingots, and letting the molten metal rise up under a slag cover. A further advantage of these methods is that the slag cover provides an insulating cover to the ingot and accordingly a reduction in the quantity of anti-piping insulation required. Such slags as are used for bottom pouring are, however, unsuitable for top pouring since their viscosity is too high and only partial melting occurs at steel making temperatures.

Thus, a suitable material for top pouring must have a low viscosity and a low melting point. The alkali and alkaline earth metal fluorides have these properties.

Advantages may be gained by top pouring through an alkali or alkaline earth metal fluoride flux. However, the fume level of this process is high. By using low fluoride content compositions the fume may be reduced and some surface quality improvement is still obtained. It has further been stated that benefits may be obtained by top pouring through a slag of stearic acid, fluoride and soda ash. However the reaction of this mixture with steel is somewhat violent, and the fume level remains unacceptable.

It is an object of the present invention to provide a process for the production of steel ingots with improved surface qualities and a low content of sub-surface inclusions which comprises top-pouring molten steel into an ingot mould containing a flux composition of low melt-

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ing point and viscosity at steel making temperatures, together with low fume producing propensity.

According to the present invention there is provided a process for the production of steel ingots which comprises top-pouring molten steel through a flux composition comprising one or more fluorides and one or more alkali metal carbonates.

Preferred fluorides are alkaline earth metal fluorides, notably calcium fluoride, possibly in admixture with only minor proportions of sodium aluminum fluoride (cryolite) or alkali metal fluorides in order to reduce fume to a minimum. These have melting points about 200° C. below steel making temperatures, and are thus very fluid at such temperatures. They also dissolve silica, alumina and manganese dioxide (common deoxidation products in steel) at this temperature, and on cooling a solid solution is formed, rather than the dissolved matter coming out of solution.

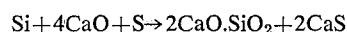
Of the alkali metal carbonates, sodium carbonate is preferred.

The flux compositions may contain other ingredients for special purposes. Thus for example, the inclusion is the flux of anthracene or other polynuclear aromatic compound (e.g. naphthalene, acenaphthene, diphenyl, diphenylmethane, indene, fluorene, or phenanthrene).

The addition of anthracene or other polynuclear aromatic compound, it has been found, has two important advantages. First its combustion leads to a reducing atmosphere over the molten metal, which protects the metal stream. In addition, anthracene vapour sublimes on the cold walls of the mould, ahead of the rising metal surface. If any splashes of molten metal impinge on the mould wall, they do not remain there to form "scabs" on the side of the finished ingot, but are blown off the wall by the immediate volatilisation of the anthracene on the wall. This leads to a much improved surface finish.

It is possible to include also calcium oxide and ferrosilicon in the flux composition, to improve sulphur removal.

The desulphurisation of the molten metal by the calcium oxide and ferrosilicon proceeds according to the formula



However, the extent of sulphur removal using this method is only about 10% at maximum.

The surface quality is further improved by the presence of the fluid flux. As the fluid layer rises up the mould walls ahead of the molten metal surface, the flux runs into and fills any imperfections such as cracks, or crazing in the mould walls, which prevents the metal entering into such cracks.

The fume level of the composition of the present invention is sufficiently low to allow normal foundry use.

The compositions are preferably applied in powdered form. It has been found that pelleted material, though effective, sometimes tends to become undesirably trapped in the molten metal.

It can be shown from analysis of the slag remaining on the ingot surface after solidification that it is a multiphase system, showing that non-metallic matter has been removed from the cast metal. The presence of small amounts of alumina and silica is generally detectable.

Preferred flux compositions for use in the process of the present invention include the following ingredients in the proportions by weight indicated:

	Percent
Alkaline earth metal fluorodide	25-90
Alkali metal carbonate	1-30
Alkali metal fluoride or complex fluoride	0-10

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	Percent
Anthracene or other polynuclear aromatic compound -----	0-20
Calcium oxide -----	0-35
Ferrosilicon -----	0-20

The following examples will serve to illustrate the invention. All parts and percentages are by weight.

EXAMPLE 1

The following ingredients were powdered and mixed together in the proportions given:

	Percent
Calcium fluoride -----	29
Sodium carbonate -----	3
Sodium aluminium fluoride -----	7
Ferrosilicon -----	12
Calcium oxide -----	46
Anthracene -----	3
	100

170 gm. of this composition was placed in the bottom of a 100 lb. ingot mould, and steel, of carbon content 0.35%, which had been melted in a high frequency furnace and deoxidized using 500 gm. aluminum, 500 gm. ferromanganese and 350 gm. ferrosilicon per 380 lbs. of steel, was poured in. A control 100 lb. ingot was also poured. After cooling, the ingots were inspected for surface finish. The treated ingot had a surface considerably freer from inclusions and scabs. The ingots were then sectioned and the inclusion level determined. The test ingot showed an inclusion level reduction of 70% over the control ingot.

EXAMPLE 2

	Percent
Calcium fluoride -----	75
Sodium carbonate -----	22½
Sodium fluoride -----	2½

The above composition was used to combat the incidence of surface defects arising from the occurrence of aluminous inclusions, at variable distances from the ingot skin, during the processing of aluminium-killed extra deep drawing steel. After application of the above composition to this grade of steel, at the rate of one pound per ton, subsequent inspection of the Cold Mill showed a reduction of the incidence of sub-surface aluminous inclusions by as much as 35%.

EXAMPLE 3

	Percent
Calcium fluoride -----	77.5
Sodium carbonate -----	20
Anthracene -----	2½

This type of recipe was successfully applied to the casting of 24-ton forging ingots where it became possible to teem at extremely low rates (vis 6" per minute) at a low temperature (1570° C.) in order to produce a sound ingot structure with a minimum of ingot cracking. Fol-

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lowing an application at the rate of one pound per ton of steel, ingots with excellent surfaces were produced, being free from laps and deoxidation product inclusions in the surface vicinity. Normally, in order to avoid lap formation it is necessary to teem at a higher temperature (say 1590° C.) at a rate measured in feet per minute (6' per minute). Naturally, such a procedure involves much greater turbulence and the risk of inclusions being carried within the body of the solidified ingot.

The method of the invention may of course be employed in continuous casting, giving cast strands of improved quality.

I claim as my invention:

1. In a process for the production of steel ingots, comprising the steps of top-pouring molten steel into an ingot mould through a flux composition, said flux composition including at least one fluoride, at least one alkali metal carbonate, and a polynuclear aromatic compound, and subsequently allowing the poured molten steel to solidify in the ingot mould.

2. A process according to claim 1 wherein at least some fluoride employed is alkaline earth metal fluoride.

3. A process according to claim 2 wherein the alkaline earth metal fluoride is calcium fluoride.

4. A process according to claim 1 wherein the carbonate employed is sodium carbonate.

5. A process according to claim 1, wherein the said aromatic compound is anthracene.

6. A process according to claim 1 wherein the flux further contains calcium oxide and ferrosilicon.

7. In the continuous casting of molten steel, the steps of pouring the molten steel into a continuous casting mould through a flux composition, said flux composition including at least one fluoride, at least one alkali metal carbonate, and a polynuclear aromatic compound, and subsequently allowing the molten steel to solidify in said mould.

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ALLEN B. CURTIS, Primary Examiner

P. D. ROSENBERG, Assistant Examiner

U.S. Cl. X.R.

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