

[54] **COATED WIRE FEEDING TECHNIQUE FOR MAKING ADDITION OF COMPONENTS TO MOLTEN METALS**

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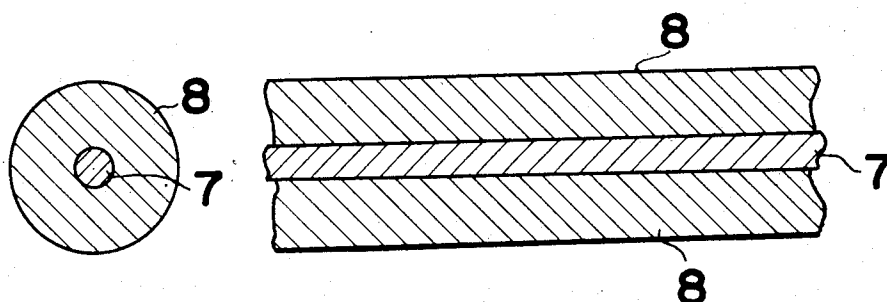
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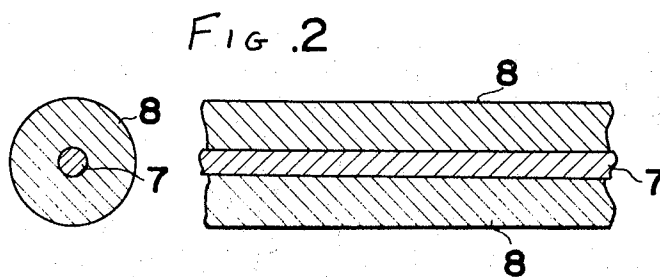
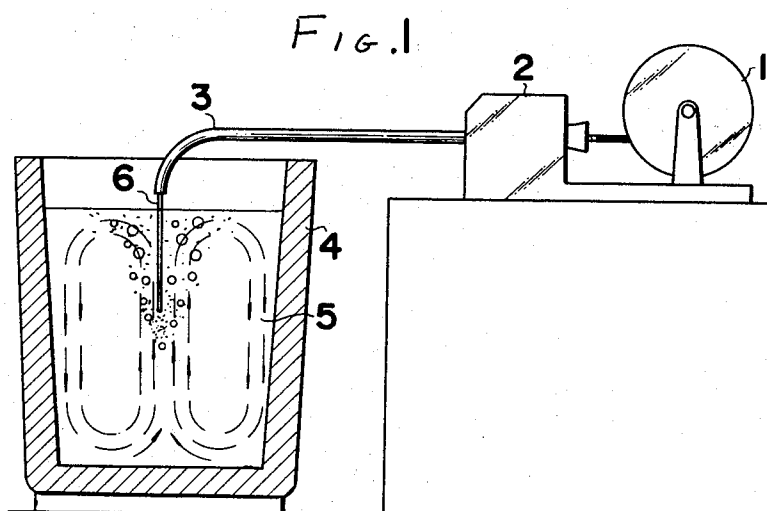
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[57] ABSTRACT

The invention relates to the addition of components such as deoxidizing agents, alloying elements and the like to molten metals, particularly molten steel. This is accomplished according to the invention by feeding a wire rod into the molten metal, the wire rod carrying thereon additive components for the molten metal and an organic binder which is not harmful to the molten metal and which decomposes to gaseous products in the molten metal so that the generated gas stirs the molten metal and thus uniformly incorporates the added components throughout the molten metal.

9 Claims, 2 Drawing Figures





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COATED WIRE FEEDING TECHNIQUE FOR MAKING ADDITION OF COMPONENTS TO MOLTEN METALS

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of our co-pending application Ser. No. 867,758, filed Oct. 20, 1969, for "Method for Adding Elements to Molten Metals", now abandoned.

BACKGROUND OF THE INVENTION

Many different methods are used to add components to molten metals, particularly molten steel, for alloying purposes, for deoxidation purposes, etc. The various methods include the following:

In the case of a deoxidizer, this has been added in the form of a single lump. This suffers from the defect of causing a loss of mechanical properties because of air oxidation or slag oxidation.

A method has been proposed wherein granular or powdery additive agents are blown by means of a gas through a heat resisting pipe inserted into the molten steel. This method does not permit the insertion of additive agents into the molten steel deeper than the length of the pipe. In addition, the control of the speed of addition is difficult and inaccurate.

Elements have been added to molten steel by the insertion of a phosphorizer into the molten steel. This reaction is difficult to control and is also dangerous.

A gaseous additive agent such as nitrogen have been blown through porous refractory materials provided in the bottom of the ladle. This method requires complicated installations and subsequent removal of the porous refractory material.

Elements have been added from a container into a ladle, but this method results in air oxidation and slag oxidation.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, a wire rod which carries, for example by means of a coating, additives for molten metal, e.g. molten steel, and an organic binder, for example a resin binder, which decomposes to gaseous products in the molten metal but which does not contain components harmful to the molten metal is fed into a molten metal bath at a conventional speed, for example 0.1 to 15 m/sec. The organic binder decomposes rapidly with the generation of gas, the additive is released and the molten bath is stirred by the gas so that the additive is uniformly and thoroughly distributed throughout the molten metal.

It is accordingly a primary object of the present invention to provide a method which permits the addition of components to molten metals such as molten steel while avoiding all of the disadvantages of the known methods for the addition of such components.

It is another object of the present invention to provide a method for the addition of components such as deoxidizing agents, alloying agents, etc. to molten metals, particularly molten steel under conditions whereby the components are added deep into the molten metal bath at controlled speed of addition and under optimum conditions of reaction and distribution throughout the molten metal bath.

Other objects and advantages of the present invention will be apparent from a further reading of the specification and of the appended claims.

With the above and other objects in view, the present invention mainly comprises the introduction into a molten metal bath of a wire rod which carries thereon additive components for the molten metal and an organic binder which decomposes to gaseous products in the molten bath, the amount and composition of the organic binder being such that the same does not harm the molten metal. The speed of feeding the wire rod into the molten metal bath may vary or may remain constant, and is generally maintained at between about 0.1 and 15 m/sec.

BRIEF DESCRIPTION OF THE DRAWING

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawing, in which:

FIG. 1 is a schematic representation of the insertion of a wire rod into a molten metal bath in a ladle; and

FIG. 2 shows on the left a transverse cross section and on the right a longitudinal cross section of a coated wire rod of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. 1, a wire 6 is fed into a bath of molten steel 5 in a ladle 4, from a wire drum 1 by means of a wire feeding device 2 and a guide pipe 3. The wire feeding device 2 is conventional.

As shown in FIG. 2, a wire core 7 is covered with a coating 8 which comprises the additive component or components for the molten metal plus a binder, for example a synthetic resin binder 8. The wire 6, comprising the core 7 and coating 8 is fed into the molten metal bath at a speed of 0.1 to 15 m/sec and at the same time a gas, for example, an inert gas, is blown over the surface of the molten metal, if necessary, in order to eliminate slag on the surface and to prevent air oxidation.

The molten metal bath is shown in the drawing to be in a ladle. However, it may be in a furnace, tundish, pouring stream or mold instead of in a ladle.

The wire body is shown to consist of a wire reinforcing center core 7 and the coating comprising powdery additive agents bound by synthetic resins which give flexibility to the wire in the molten steel, in addition to decomposing into gaseous products.

The reason for the use of granular or powdery additive agents is that these can very easily be packed onto the wire core by means of the binder, and the resulting wire body can thus be very easily introduced into the molten bath and thereby provide a high efficiency of the added components.

The method of the present invention may be used for the addition of all types of additive elements commonly added to molten metals, and the following are among the examples of suitable additive agents to be used for particular types of additions:

1. Nitrogen addition:

Calcium cyanamide (CaCN_2)

Ammonium salts (NH_4NO_3)

(NH_4Cl)

Aluminium nitride (AlN)

Ferromanganese nitride (Mn-N)

or the above agents also containing iron (Fe).

2. Calcium addition

Calcium silicon group (Ca-Si group)

Calcium silicon manganese group (Ca-Si-Mn group)

Calcium silicon aluminium group (Ca-Si-Al group)

Calcium silicon magnesium group (Ca-Si-Mg group) or the above also containing iron (Fe).

3. Magnesium addition

Magnesium calcium silicon group (Mg-Ca-Si group)

Magnesium aluminium group (Mg-Al group)

Magnesium silicon group (Mg-Si group)

or the above alloys also containing iron (Fe).

4. Others

Boron group (B group)

Niobium group (Nb group)

Titanium group (Ti group)

Misch metal, lanthanum, cerium or the above also containing iron (Fe).

5. General deoxidizer:

Silicon group (Si group)

Lithium group (Li group)

Manganese group (Mn group)

Phosphorus group (P group)

Silicon manganese group (Si-Mn group) or the above alloys also containing iron (Fe).

The core wire for the wire rod is desirably made of iron, aluminum, nickel, chromium, molybdenum, magnesium, titanium and alloys thereof.

The binding agent for binding the additive agent to the wire rod should not only decompose to gaseous products at the temperature of the molten metal bath, but it should be of a material which does not adversely affect the molten metal, i.e. molten steel. The most suitable synthetic resins for this purpose are polytetrafluoroethylene and polymonochlorotrifluoroethylene. In general, any synthetic resin may be used provided that its hydrogen content is such that it will not adversely affect the steel. This will of course depend not only on the particular type of resin, but also on the amount of resin used.

Other suitable synthetic resin binding agents include: polymerized vinyls and vinylidenes such as polyvinyl chloride and polyvinylidene chloride; polyesters such as the esters of adipic acid with polyalcohols such as ethylene glycol; phenolic resins such as phenol formaldehydes; rubbery polymers such as polymerized butadiene and chlorobutadiene; cellulose esters such as cellulose acetate; polyamides, e.g. the condensation product of hexamethylene diamine with a dicarboxylic acid such as adipic acid; etc.

The speed of addition and the amount of addition are easily controlled by means of the present invention so that the reaction is carried out over a wide area of the molten steel, with a high degree of stability. As a result, air oxidation and slag oxidation, as well as mechanical loss, are substantially eliminated and a high yield of the added material can be regularly attained. Furthermore, it is possible in a continuous casting process to reduce denaturization of the elements in the molten steel caused by the acceleration of the reaction in a ladle where elements are added beforehand in a tundish or a mold.

In the conventional methods the molten steel has to be stirred by means of a gas pumping process or the like in order to avoid the uneven presence of elements in a stationary pool such as a ladle or a mold. Contrary thereto, in accordance with the method of the present

invention, the molten steel is stirred by the gas generated by decomposition of the organic binder, e.g. the synthetic resin so that the additive agents are thus uniformly distributed. In addition, the proportion of additive agents to be contained in the mixture of synthetic resin and additive agent can be adjusted as desired because the necessary strength of the wire rod is produced by the wire core.

The following example further illustrates the invention, reference being had to the drawing in the description of the example.

An iron core 7 is coated with granular aluminum nitride and silicon distributed through polytetrafluoroethylene. The core 7 and the coating 8 thus forming the wire 6. This wire 6 is wound on a wire drum 1 and is fed by means of a wire feeding device 2 and guide pipe 3 into a molten steel bath 5 contained in a ladle 4 at a constant rate of 10 m/sec. The decomposition of the polytetrafluoroethylene results in gas generation which distributes the granular aluminum nitride and silicon throughout the molten metal bath in a uniform manner.

While the invention has been illustrated in particular with respect to specific additive and coating agents, it is apparent that variations and modifications of the invention can be made.

What is claimed is:

1. Method of distributing additive components in a molten metal bath, which comprises introducing at a speed of about 0.1 - 15 m/sec into said molten metal bath a flexible metal wire consisting essentially of a metal core, a particulate coating of an additive agent for said metal bath on said metal core and a synthetic resin binder binding said additive agent to said metal core and giving flexibility to said metal wire, said synthetic resin binder decomposing with generation of gas at the temperature of the molten metal bath, the thus generated gas stirring said molten metal bath and thus uniformly distributing said additive agent throughout said molten metal bath.

2. Method according to claim 1 wherein said flexible metal wire is continuously unwound from a wire drum and continuously introduced into said molten metal bath.

3. Method according to claim 1 wherein said molten metal is steel.

4. Method according to claim 1 wherein an inert gas is blown over the surface of the molten metal bath to prevent air and slag oxidation.

5. Method according to claim 1 wherein said additive agent is in granular form.

6. Method according to claim 1 wherein said synthetic resin is selected from the group consisting of polytetrafluoroethylene and polymonochlorotrifluoroethylene.

7. Method according to claim 1 wherein said additive agent is a deoxidizer for the molten metal.

8. Method according to claim 1 wherein said additive agent is an alloying element for said molten metal.

9. Method according to claim 8 wherein said molten metal is steel.

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