METHOD AND APPARATUS FOR THE ADDITION OF TREATING AGENTS IN METAL CASTING

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FIG.3

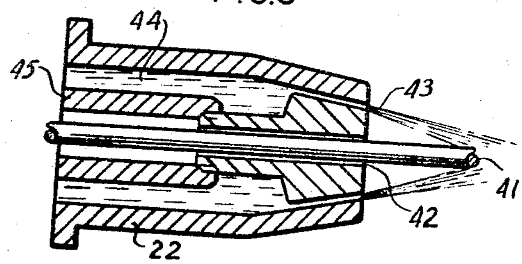


FIG.1

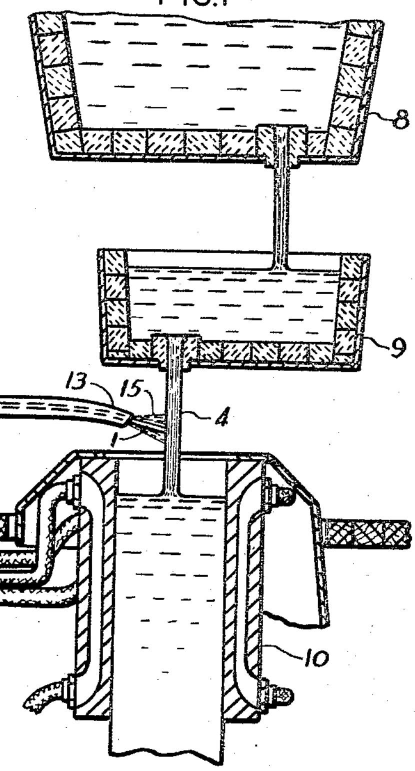
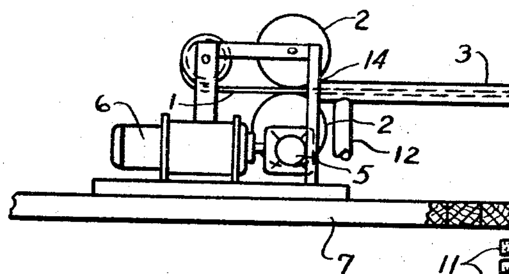



FIG.4

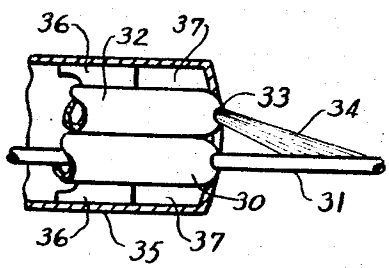
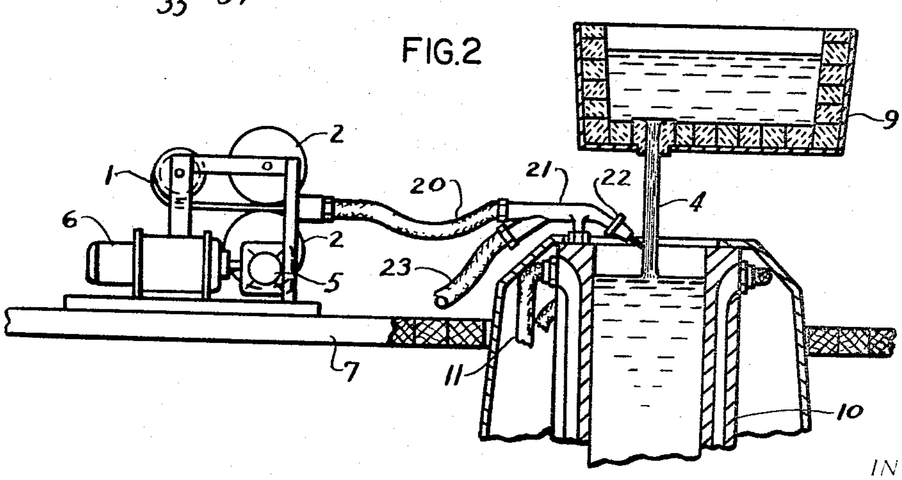


FIG.2



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METHOD AND APPARATUS FOR THE ADDITION OF TREATING AGENTS IN METAL CASTING

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This invention relates to an improved method and apparatus for the introduction of addition agents, for example, aluminum wire, into a melt or a casting jet during the casting of metal and, in particular, during the continuous casting of steel.

In many cases, it may be desirable to add addition agents, for example, inoculants, alloying elements and deoxidizers, only during casting of the metal. In such cases, two problems predominate; one, control of the exact dosaging of the addition agents; two, ensuring the uniform distribution of the addition agents or their reaction products in the casting.

Specifically, when continuously casting rimmed steels, fine-grain steels and aluminum killed steels, a precisely dosaged quantity of aluminum must be added to the melt. The aluminum is, in many cases, added to the molten steel in the casting vessel, for example, the ladle or pouring basin. The quantity added is, in general, limited to a maximum of 300 grams per ton when casting smaller billets. Larger quantities of aluminum additions caused both blockage of the ladle nozzles and impairment of the surface quality of the casting. Material having a poor cast surface must be subjected to a costly surface treatment before further use.

In order to avoid this closing of the casting nozzles and to attain a favorable distribution of the reaction product in the continuous casting, it has been proposed for continuous casting to feed the aluminum in the form of wire to the casting jet as it enters the mold. The casting jet carries the aluminum and the resultant reaction products along with it to augment distribution in the casting.

However, when the aluminum wire nears the molten metal, it is heated and softened. The softened part of the wire is pulled downward by its own weight. Precise feeding at the desired place in the casting jet is thereby made difficult. The flowing metal assists in the bending of the wire and, thus, causes the wire to bend away from the casting jet. This bending results in uncontrolled melting off of the wire in separate pieces. The introduction of the aluminum into the casting jet and the control of the quantity added become practically impossible. Bent pieces of wire which melt off are not introduced into the casting jet but fall onto the surface of the bath, melt and deposit on the surface of the casting. Such local deposits on the surface of the casting are, of course, extremely injurious. The further working of the casting into final products having suitable surfaces is made difficult or impossible. Furthermore, the local deposits on the surface favor dangerous breakouts. In addition, irregular adding of reaction agents causes a nonuniform distribution of the aluminum and of the resultant reaction products.

Further, as the aluminum wire is introduced into the casting jet, the melting or molten aluminum comes into contact with atmospheric oxygen. As a result, reaction products are produced which deposit on the surface of the casting or in it and impair its quality. The maximum addition of aluminum into the mold is thereby limited.

All of the above disadvantages limit the scope of use of the continuous casting process.

The object of the present invention is to avoid these disadvantages and to provide an improved method and apparatus to attain a dependable uniform addition or reaction agent in a desired quantity and the uniform distribution of these reaction agents or their reaction products in the casting.

In accordance with this object, the method of this invention contemplates surrounding the wire, whose cross section may have different geometrical shapes by a gas jacket of flowing gas at least in the vicinity of the molten metal. This flowing gas forms around the wire a gas jacket which effects a cooling of the wire and a partial screening off of the heat. Softening of the wire is avoided and the wire can be introduced into the liquid metal at the desired position and at a predetermined rate of feed to give precise dosages and desired distribution of the reaction products in the casting.

Upon the addition of oxide-forming reaction agents, there is formed on the surface of the bath an oxide layer which at the surface of the casting causes as mentioned oxide accumulations which impair the surface of the casting. In order to avoid this disadvantage, in accordance with a preferred feature of the invention, the surface of the melt between a casting vessel and the surface of the bath is protected from oxidation by the flowing gas.

In order to carry out the method, in accordance with the invention, at least one feed device for the gas should be associated with the feed device for the wire. Preferably, in this connection, the nozzles forming the feed device for the gas should be arranged around a nozzle from which the wire emerges.

In accordance with another embodiment of the apparatus of the invention, a protective gas nozzle has in its inside an opening for the feeding of the wire. This arrangement makes possible in a simple manner a dependable jacketing of the wire with gas. The gas emerging from the nozzle in this case simultaneously cools the feed nozzles.

In accordance with one embodiment of the invention, the feed devices are cooled preferably by the flowing gas. These devices make it possible to arrange the wire very close to the molten metal without being damaged by the action of the heat or the reaction agent in them being caused to melt. The accuracy of the local introduction of the wire into the casting jet is thereby further improved.

Having briefly described this invention, it will be described in greater detail in the following portion of the specification, which may best be understood by reference to the accompanying drawings, of which:

FIG. 1 is a partially sectioned, elevation view of a continuous casting arrangement using the present invention;

FIG. 2 is a partially sectioned, elevation view of a continuous casting plant using the present invention and showing a modified mounting arrangement;

FIG. 3 is a section through a gas-cooled nozzle; and

FIG. 4 is a section through a water-cooled nozzle of a supply head.

In FIG. 1, there is shown a continuous casting plant using the present invention in which wire **1** is withdrawn from storage means such as a wire roll by feeding means such as feed rollers **2** clamped on the wire and is fed through a guide such as a tube **3** to a casting jet **4**. The rollers **2** are driven via a gearing **5** from a motor **6**, the speed of which can be adjusted with infinite variation. By this infinitely variable control, there is possible an infinitely variable dosaging of the quantity added. The rollers **2**, the gearing **5** and motor **6** form a single unit which is arranged on a pouring platform **7**. The steel flows from a ladle **8** via a pouring vessel **9** into a mold

10. The mold 10 is fed cooling water via pipes 11. The casting which is formed in the mold 10 is pulled out in known manner by withdrawal rolls and is cooled in a secondary cooling zone until completely solidified. The pipe 3 has a gas connection 12 which is connected with a corresponding gas container, not shown in the drawing. As gas for the production of the protective jacket 15, there can be used nonoxidizing gas, for example, inert or reducing gas. This gas emerges together with the wire 1 through a nozzle 13 and cools the said wire as well as the pipe. This makes it possible to establish a small distance between the end 13 of the pipe and the casting jet 4, and thereby a guiding of the wire close to the casting jet. At the end 14, the wire enters the pipe 3. At this point, a seal is provided which prevents the emergence from the pipe 3 of the gas which enters through the connection 12.

The wire may be aluminum wire as, for example, in the production of rimmed steel. Also, the wire addition may comprise other materials, such as titanium, boron, aluminum, magnesium, depending on the application intended. The inert or reducing gas may, for example, be propane, butane, acetylene or argon.

In addition to the aforementioned cooling effect of the stream of gas emerging from the nozzle, the gas prevents atmospheric oxygen from arriving at the place of introduction of the wire 1 into the casting jet 4 whereby oxidation of the melting aluminum is prevented. The emerging gas distributes itself in addition over the surface of the bath and between the latter and the pouring vessel and prevents the admission of atmospheric oxygen to the melt. In the case of large size castings, an additional feeding of protective gas by known devices may be necessary in order to maintain a sufficient gas protection over the surface of the bath.

The method described makes it possible to feed oxidizing agents in quantities up to four times that known at the present time without the above mentioned disadvantages occurring.

In FIG. 2, the same parts are provided with the same reference numbers as in FIG. 1. The wire 1 is fed via a tube 20 to a supply head 21 arranged displaceably on the mold 10. This supply head can, for example, be formed in accordance with the system in the same manner as a cutting torch in which the wire is fed in the gas-oxygen channel and the gas is fed in the fuel-oxygen line. The supply head 21 has a nozzle 22. This nozzle is described in further detail in FIG. 3. A flexible line 23 provides the supply head 21 with the gas necessary for the cooling.

This arrangement makes it possible to arrange the nozzle 22 very close to the casting jet 4. In this way, a linear guiding of the wire 1 into the casting jet 4 and a uniform dosaging as well as a good distribution of the reaction agent or its products is possible. The inclined front part of the supply head 21 provides a good distribution over the surface of the bath of the protective gas emerging from the nozzle 22.

FIG. 3 shows the supply head 22 in which a wire 41 emerges from an opening 42 which is surrounded by a plurality of bore holes 43. These bore holes 43 are arranged concentric to the opening 42 and communicate with an annular channel 44. Through these bore holes 43, the gas flows for the cooling of the wire 41. The wire 41 is surrounded by a feed line 45 which is connected with the hose 20. The annular channel 44 is connected with the gas line 23.

FIG. 4 shows a section through the nozzle of another supply head. 30 is a tube for feeding a wire 31 while a feed tube 32 for the gas is provided. This gas flows through a correspondingly developed opening 33 from the tube 32 and forms a protective jacket 34 in which the wire 31 is fed to the casting jet. In this way, the wire is cooled and partially screened from the heat of the liquid metal. The lines 30, 32 are surrounded by a pipe 35 which is connected via longitudinal walls 36 with the pipes 30, 32. Through the walls 36 and the interconnected pipes 30, 32 the space formed by the jacket 35 is divided into two parts which are connected together by openings 37, the one part being provided at the end thereof not shown in the drawing with a cooling water feed and the other part with a water discharge. In this way, circulation of the water is made possible in the jackets 35 and, thus, a separate cooling of the head.

In the examples given, only one feed device for each casting jet has been provided. For certain purposes, a plurality of feed devices might also be provided.

This invention may be variously modified or embodied within the scope of the subjoined claims.

What is claimed is:

1. The method of adding agents in a continuous casting process in which molten metal is poured from a pouring vessel in a defined stream into an open-ended continuous casting mold within which the periphery of the molten metal is chilled to define the periphery of the formed strand, which comprises forming said agent in the form of a wire, feeding said wire into said molten metal stream at a location between said pouring vessel and said continuous casting mold, and blowing a jacket of protective gas around said wire to protect said wire against heat-induced distortion of the wire as said wire is fed towards said molten metal stream, thereby to control the entry of said wire into said stream and the rate of entry of said wire into said stream, wherein said wire is melted and comingled with the molten metal being poured.

2. The method in accordance with claim 1 which includes the step of blowing said gas in such direction that the gas will cover the surface of the molten metal in said continuous casting mold after passing along the axial length of the wire being fed into said molten metal stream.

3. The method in accordance with claim 1 in which the agent added is selected from the group consisting of titanium, boron, aluminum and magnesium, and in which the inert gas is selected from the group consisting of propane, butane, acetylene or argon.

4. The method in accordance with claim 1 in which rimmed steel is cast in said continuous casting process and in which said agent is aluminum.

5. Apparatus for introducing additional metallic agents in the form of a wire to the metal being cast in a continuous casting process in which molten metal is poured from a pouring vessel into an open-ended continuous casting mold which solidifies the periphery of the metal to define the continuously cast strand, which comprises storage means for said wire, a guide extending from said storage means toward said molten metal stream at a position between said pouring vessel and said continuous casting mold, a nozzle assembly positioned at the end of said guide nearest said molten metal stream, means for feeding said wire through said guide and nozzle to advance said wire into said molten metal stream, wherein said wire is melted by the heat of said stream and mixes with the molten metal in said stream, said nozzle assembly being provided with gas discharge orifices encircling said wire as it exits therefrom, and means for feeding gas to said gas discharge orifices in said nozzle assembly to blow inert gas around said wire to cool said wire and to prevent said wire from heat-induced deformations as it is advanced towards said molten metal stream, thereby to permit accurate control of the rate and amount of material added to said molten metal stream.

6. Apparatus in accordance with claim 5 in which said nozzle assembly is provided with a central opening for passage of said wire, a plurality of bore holes sur-

rounding said opening, and an annular channel communicating with said bore holes for feeding of said gas.

7. Apparatus in accordance with claim **5** in which said nozzle assembly comprises a wire tube, a gas tube, and a surrounding pipe, said wire tube and said gas tube being positioned in side-by-side relationship and being mounted within said surrounding tube to enable flow of cooling water between said surrounding tube and said wire and gas tubes.

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