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(71) Applicant: **Linde GmbH**
82049 Pullach (DE)

(72) Inventors:
- **Hibbitt, Ian**
  Hulland., Derbyshire DE6 3 FJ (GB)
- **Howard, Charlie**
  Sheffield, S37ER (GB)

(74) Representative: **Gellner, Bernd**
Linde GmbH
Intellectual Property EMEA
Dr.-Carl-von-Linde-Straße 6-14
82049 Pullach (DE)

(54) **METHOD AND SYSTEM FOR PROVIDING MOLTEN METAL**

(57) The present invention relates to a method and to a system (100) for providing molten metal, comprising a source (110) of molten metal configured to pour a flow (115) of molten metal out of an outlet (112) of the source (110) of molten metal, a receptacle (120) having an inlet (122) for receiving said flow (115) of molten metal, a channel (130) for guiding said flow (115) of molten metal from the outlet (112) of the source (110) of molten metal to the inlet (122) of the receptacle (120), the channel (130) being configured to provide a flow (135) of inert gas into the channel (130) for inerting the flow (115) of molten metal.

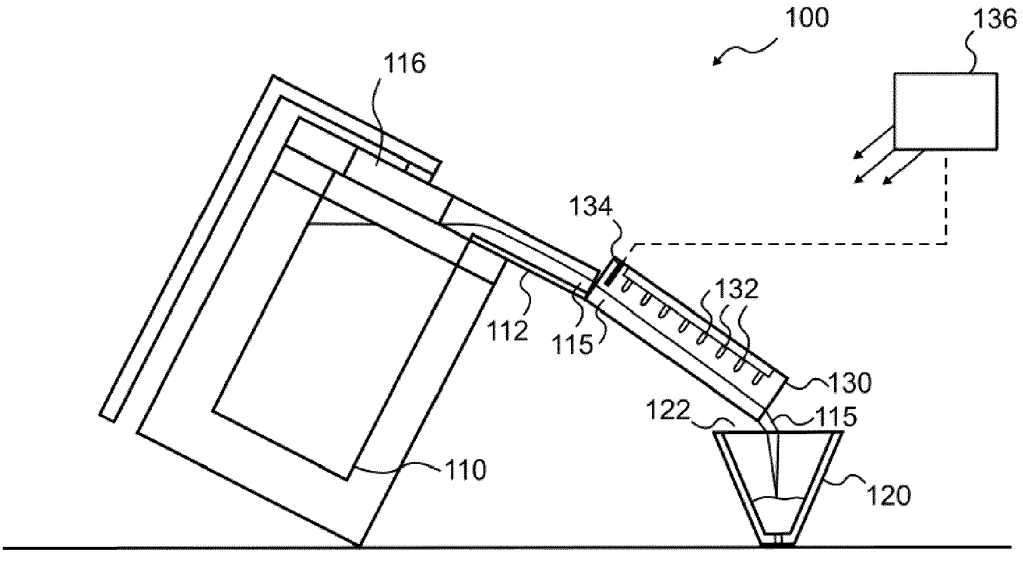

Fig. 2

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Description

Technical field

[0001] The present invention relates to a method and to a system for providing molten metal, a flow of molten metal being poured from a source of molten metal into a receptacle.

Prior art

[0002] In processes for producing metallic powder, molten metal or, more particularly, a molten metal alloy is transferred to a tundish from where it is delivered to an atomizer for atomizing the molten metal alloy by gas or water to generate metallic powder. The transfer of the molten metal alloy to the tundish prior to the atomization process is carried out by pouring the molten metal alloy through the air. This, however, allows the alloy to pick up oxygen from the surrounding atmosphere causing undesirable changes to the alloy chemistry. The resulting changes may produce increased slag formation in the tundish, which may result in blockages of the atomization nozzles in the atomizer which in turn reduces the efficiency of the process and increases the waste of material.

[0003] Currently, in many foundries, molten metal is poured through the air from the furnace into a mold or into a tundish. During the pour, the metal oxidizes with the air. This causes an undesirable change in the quality of the metal received in the mold or tundish. In addition, metal oxide may build up on the lining of the tundish which could result in the tundish nozzle becoming blocked.

Brief description of the invention

[0004] In view of the above drawbacks and disadvantages in the prior art, there is a need of improving the method of providing molten metal by pouring a flow of molten metal from a source of molten metal into a receptacle, particularly in casting processes or in processes of producing metallic powder.

[0005] The present invention provides a method and a system for providing a flow of molten metal into a receptacle according to the independent claims. Advantageous embodiments are the subject-matter of the respective dependent claims and the description as follows.

Advantages of the present invention

[0006] The present invention suggests a method of providing molten metal, wherein a flow of molten metal is poured from a source of molten metal into a receptacle. In this method, a channel (or duct, or conduit) is provided for guiding the flow of molten metal from an outlet of the source of molten metal to an inlet of the receptacle. Further, a flow of inert gas is provided inside the channel for inerting the flow of molten metal.

[0007] Advantageously, the channel or duct or conduit through which the flow of molten metal is guided, is circumferentially closed or almost closed as described further below. Alternatively, the channel can have an essentially semicircular form and be made of a refractory material for guiding a flow of molten metal, means for providing the flow of inert gas being provided at the open side of the channel directing the flow of inert gas onto the flow of molten metal. Without loss of generality, and only by way of example, the present invention is described in the following on the basis of a circumferentially almost closed channel having openings or apertures designed for supplying flows of inert gas into the interior of the channel and/or for supplying means for pre-heating the interior of the channel as will be described below.

[0008] By introducing a flow of inert gas inside the channel, the flow of molten metal is rendered inert as any air, particularly oxygen, is removed from the inside of the channel. Thus, the invention reduces the oxidation of molten metal during the pouring process and thus overcomes the disadvantages of the prior art.

[0009] In a preferred embodiment, the step of providing a flow of inert gas comprises delivering an inert gas through nozzles arranged along the length of the channel, particularly along an upper side of the channel. While a single nozzle arranged at the inlet side of the channel may be sufficient, it is preferred to arrange a plurality of nozzles along the length of the channel. As the flow of molten metal covers the lower side of the channel, it is preferred to arrange the nozzles along the upper side of the channel. Preferably, the interior of the channel is rendered inert prior to the pouring step.

[0010] In another preferred embodiment, the method comprises the step of pre-heating the channel prior to pouring the molten metal out of the source of molten metal. The step of pre-heating prevents the onset of solidification and enables a steady flow of molten metal through the channel. Furthermore, the step of pre-heating is preferably performed by using burner flames generated by burners located along the length of the channel. As burner flames reduce the presence of oxygen inside the channel, the step of pre-heating includes the step of rendering inert the interior of the channel before starting pouring molten metal into the channel.

[0011] In a particularly preferred embodiment, burner nozzles of the burners used for pre-heating can be used for delivering inert gas inside the channel. In this embodiment the effort can be reduced and the efficiency of the system can be improved.

[0012] Preferably, argon, nitrogen or a combination of these gases can be used as the inert gas.

[0013] In another preferred embodiment, the method automatically switches from the step of pre-heating to the step of inerting by detecting the presence of molten metal in the channel. To this end, the channel or the outlet of the source of molten metal may comprise a sensor for detecting the flow of molten metal being poured out of the outlet of the source of molten metal. The method can switch from pre-heating to inerting by starting to provide

a flow of inert gas inside the channel. This switching step is preferably done by means of a control unit connected to the sensor. If burners are used for both pre-heating and delivering the flow of inert gas, the control unit is preferably also connected to the burners or to the conduits supplying the burners with the gases required for pre-heating and delivering inert gas.

[0014] The present invention is particularly useful in furnaces for melting metal, particularly a metal alloy, where molten metal/metal alloy is poured in a tundish which latter is particularly connected to an atomizer for producing metallic powder.

[0015] The invention further relates to a system for providing molten metal, comprising a source of molten metal configured to pour a flow of molten metal out of an outlet of the source of molten metal, further comprising a receptacle having an inlet for receiving said flow of molten metal, and a channel (or a duct, or a conduit) for guiding said flow from the outlet of the source of molten metal to the inlet of the receptacle, the channel being configured to provide a flow of inert gas into the channel for inerting the flow of molten metal.

[0016] Features and embodiments of the system can be derived from the features and embodiments of the method according to the present invention as described above. Therefore, only the essential embodiments and features are described below.

[0017] In a preferred embodiment, the channel comprises (one or more) nozzles for delivering inert gas arranged along the length of the channel, particularly along an upper side of the channel.

[0018] In another preferred embodiment, the channel comprises (one or more) burners located (at or) along the length of the channel, particularly again along an upper side of the channel. The burners are configured for pre-heating the channel before the step of pouring molten metal inside the channel.

[0019] In a particularly advantageous embodiment, the burner nozzles are configured not only to deliver the flows of air/oxygen and fuel for the burning process but also to deliver the flow of inert gas.

[0020] In the following, preferred embodiments of the invention are described in connection with the figures. It should be noted that features of the invention as described herein can also be combined to other combinations as long as covered by the present invention as defined by the appended claims.

Brief description of the figures

[0021]

Figure 1 schematically shows the process of pouring molten metal from a source of molten metal into a receptacle according to the prior art; and

Figure 2 schematically shows the process of pouring molten metal from a source of molten metal into a receptacle according to a preferred embodiment of the present invention.

Detailed description of the invention

[0022] Figure 1 schematically shows a furnace 110 as a source of molten metal, the furnace 110 being used for melting a metal, particularly a metal alloy, the furnace having a lid 116 and an outlet 112 for pouring the molten metal out of the furnace 110. Hitherto, a flow 115 of molten metal is poured through the air from the furnace 110 into a mold or into a tundish 120 as depicted in Figure 1. In an atomization process, the bottom of the tundish 120 is connected to an atomizer for atomizing the molten metal alloy by gas or water to generate metallic powder. As the flow 115 of molten metal comes into contact with oxygen of the surrounding atmosphere, oxidation of molten metal occurs resulting in undesirable changes to the alloy chemistry. This increases slag formation in the tundish 120, which may result in blockages of the atomization nozzles in the atomizer which is connected to the tundish 120. Additionally, metal oxide may build up on the lining of the tundish 120 (or of a mold) which could result in the tundish nozzle becoming blocked.

[0023] Figure 2 schematically shows an embodiment of a system 100 according to the present invention. Same reference signs refer to the same components as in Figure 1. Insofar reference to the comments in connection with Figure 1 is made. As can be seen from Figure 2, a channel 130 in the form of a duct or conduit is provided for guiding the flow 115 of molten metal from the outlet 112 of the furnace 110 to the inlet 122 of the receptacle or tundish 120. In this embodiment, apart from the top part of the channel 130, the channel 130 is circumferentially closed. This avoids intrusion of oxygen from the surrounding atmosphere. The channel 130 comprises nozzles 132 along the length of the channel 130, the nozzles 132 being arranged on the upper side of the channel 130 to permit an undisturbed flow 115 of molten metal through the channel into the tundish 120.

[0024] Through the nozzles 132, inert gas is introduced into the interior of the channel 130 during the pouring process. Argon is used in this embodiment as inert gas.

[0025] In a preferred embodiment, burners (not shown) are arranged along the length of the channel 130, the burners having burner nozzles for providing flows of oxygen/air and fuel for producing flames inside the channel 130. The burner flames are used for pre-heating the inside of the channel 130 prior to the pouring step. This prevents the onset of solidification and thus enables a steady flow 115 of molten metal through the channel 130. At the same time, this serves to pre-inert the inside of the channel 130. A sensor 134 is arranged at the inlet of the channel 130 for detecting a flow 115 of molten metal. As soon as a flow 115 of molten metal is detected by the sensor 134, the process of pre-heating is switched to inerting. This can be controlled by a control unit 136 connected to the sensor 134. The control unit 136 receives

a signal from the sensor 134 that a flow 115 of molten metal is present. The control unit 136 then controls the burner nozzles to deliver inert gas instead of air/oxygen or fuel into the channel 130. Thus, the burner nozzles can be used both for pre-heating and inerting.

[0026] The system 100 shown in Figure 2 prevents undesirable changes of the alloy chemistry as well as formation of slag and metal oxides in the tundish 120.

Claims

1. A method of providing molten metal, wherein a flow (115) of molten metal is poured from a source (110) of molten metal into a receptacle (120),
and wherein a channel (130) is provided for guiding the flow (115) of molten metal from an outlet (112) of the source (110) of molten metal to an inlet (122) of the receptacle,
and a flow (135) of inert gas is provided inside said channel (130) for inerting the flow (115) of molten metal.

2. The method of claim 1, wherein the step of providing a flow of inert gas comprises delivering an inert gas through one or more nozzles (132) arranged along the length of the channel (130), particularly along an upper side of the channel (130).

3. The method of claim 1 or 2, wherein the method comprises pre-heating the channel (130) prior to pouring the molten metal out from the source (110) of molten metal.

4. The method of claim 3, wherein the step of pre-heating comprises using one or more burner flames for pre-heating, said burner flames being generated by burners located along the length of the channel (130).

5. The method of claims 4 and 2, wherein burner nozzles of the burners are used for delivering the inert gas inside the channel (130).

6. The method of any one of the preceding claims, wherein argon, nitrogen or a combination whereof is used as the inert gas.

7. The method of any one of the preceding claims as far as referring back to claim 3, wherein the method automatically switches from the step of pre-heating to the step of inerting by detecting the presence of molten metal in the channel (130).

8. The method of any one of the preceding claims, wherein a furnace for melting metal is used as the source (110) of molten metal, and a tundish is used as the receptacle (120), wherein the tundish is particularly connected to an atomizer for producing metallic powder.

9. A system (100) for providing molten metal, comprising
a source (110) of molten metal configured to pour a flow (115) of molten metal out of an outlet (112) of the source (110) of molten metal,
a receptacle (120) having an inlet (122) for receiving said flow (115) of molten metal,
a channel (130) for guiding said flow (115) of molten metal from the outlet (112) of the source (110) of molten metal to the inlet (122) of the receptacle (120), the channel (130) being configured to provide a flow (135) of inert gas into the channel (130) for inerting the flow (115) of molten metal.

10. The system (100) of claim 9, wherein the channel (130) comprises at least one nozzle (132) arranged along the length of the channel (130), particularly along an upper side of the channel (130), for delivering the inert gas.

11. The system (100) of claim 9 or 10, wherein the channel (130) comprises at least one burner located at or along the length of the channel (130) for pre-heating the channel (130).

12. The system (100) of claim 11, wherein one or more burner nozzles of the at least one burner are configured to deliver the flow of inert gas.

13. The system (100) of any one of claims 9 to 12, wherein the channel (130) and/or the outlet (112) of the source (110) of molten metal comprises a sensor (134) for detecting the flow (115) of molten metal being poured out of the outlet (112) of the source (110) of molten metal.

14. The system (100) of claim 13, comprising a control unit (136) connected to the sensor (134) for automatically providing a flow of inert gas when the sensor (134) detects the flow (115) of molten metal.

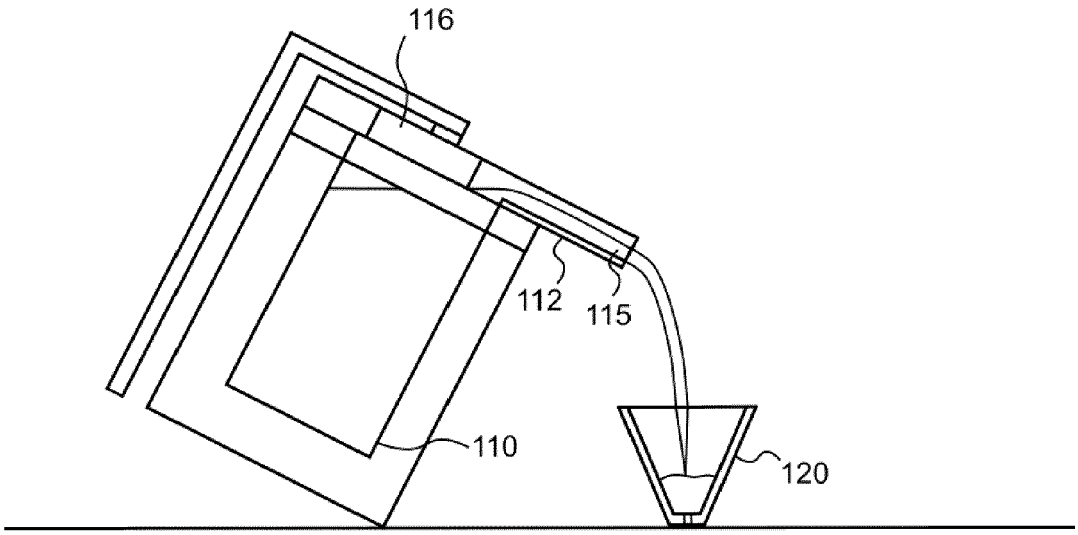

Fig. 1 (Prior Art)

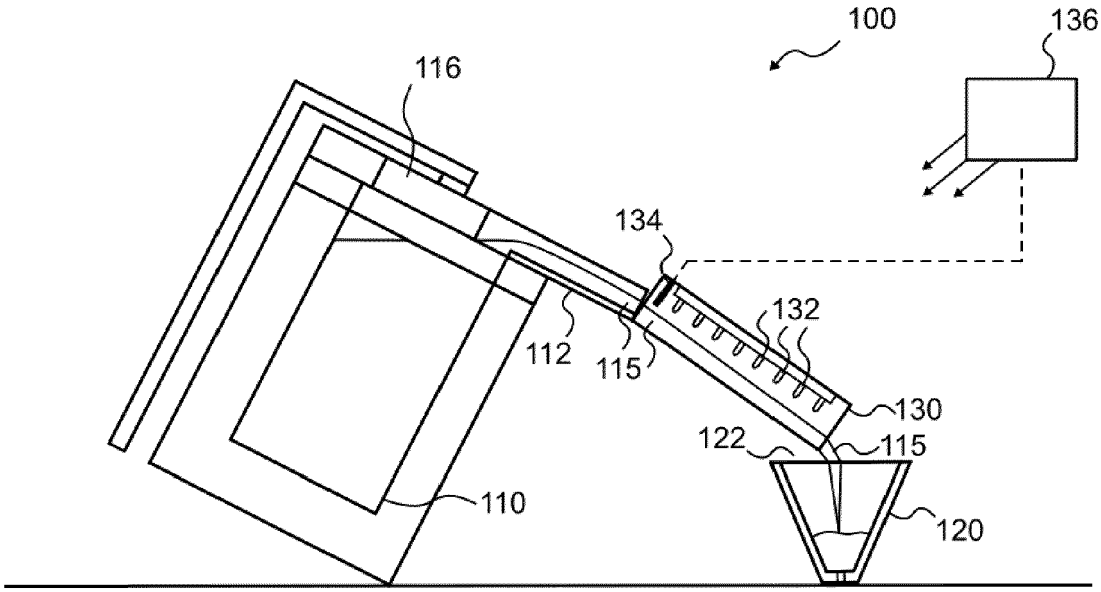

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 20 02 0646

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

B22D
C22C
B22F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 April 2021	Porté, Olivier

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