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(54) **DEVICE FOR HEATING A MELT**

VORRICHTUNG ZUM WÄRMEN VON SCHMELZE

DISPOSITIF POUR CHAUFFER UNE MASSE EN FUSION

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Description

[0001] The present invention relates to a device for heating a metal melt, comprising a container, a rotor in the form of a hollow rotary body with an opening facing towards a bottom of the container and with laterally arranged openings through which the melt can pass from the hollow rotary body to the metal melt surrounding the hollow rotary body, and with a hollow drive shaft which holds an electrode for an electrical power supply to strike in operation an electric arc against a surface of the metal melt inside the rotor. The hollow rotary body of the rotor is arranged for accommodating the surface of the metal melt in such way that the electric arc is struck inside the hollow rotary body. Moreover, the hollow drive shaft is arranged for gas supply to the metal melt.

Background

[0002] It is well known to use an electric arc for heating a melt, either between fixed electrodes or between a fixed electrode and a melt. This results in large temperature differentials between the upper and lower layers of the melt. Also, differences in the chemical composition between upper and the lower layers can easily arise. In the upper layer, especially near the electrode, components in the melt will evaporate, synchronously materials are added by the electrode. Generally carbon is given off from the electrode and is absorbed in the melt.

[0003] Heating a melt by an electric arc thus leads to gradients in both the temperature and the chemical composition. It requires experience, time, and continuous analysis to gain the required metallurgical product.

[0004] These problems will be reduced, or completely eliminated, if there was a method for the continuous intermingling of gases and particles to the melt, while it is heated by an electric arc.

[0005] US 4568385 discloses a method for heating a melt by generating an electric arc, struck between a permanent mounted electrode and the melt, where a rotating hollow body, and a rotor, which is immersed in the melt, rotates in the melt and the electric arc is struck between the surface of the metal inside the rotor and the permanently mounted electrode.

[0006] The shortcomings of this proposal is that the surface of the melt is exposed to air in the container, such that unwanted oxidation of the metal may occur. In addition, the heat loss from the surface of the melt may be substantial.

[0007] EP 1081240 discloses the use of containers placed under vacuum, to effect removal of hydrocarbon from melts of aluminium. Thus, the influx of air onto the surface of the melt in the container is successfully avoided. However, this solution has no device for supply of energy.

[0008] US 3,373,240 relates to a method for operating an electric arc furnace by immersing a hollow electrode below the surface of the melt and passing an inert gas through the hollow electrode to form an envelope of inert gas between the electrode and the melt. By varying the flow rate of the inert gas and consequently varying the size of the gas envelope, the electrical resistance between the electrode and the bath is controlled thereby controlling the power to the electric arc furnace.

[0009] WO 02/095078 relates to a process for carbothermic production of aluminium where a molten bath comprising aluminium carbide and aluminium is produced in a low temperature compartment and continuously flows into a high temperature compartment where the aluminium carbide is reacted with alumina.

Object

[0010] The main object of the invention is to reduce or eliminate the aforementioned disadvantages and provide a device that is improved with regard to design, operation and maintenance. A particular object is to provide a device for heating a metal melt, which reduces oxidation and heat loss.

The invention

[0011] The invention is characterized in that the container has a cover and an inlet opening and an outlet opening for supplying and removing the metal melt, said inlet and outlet openings being arranged at a bottom level of the container and wherein a sub-atmospheric pressure is created in operation inside the container,

- an overflow wall is arranged inside the container, forming an outlet canal between an upper region of the metal melt in the container and the outlet, thereby ensuring that the heated metal melt flows upwards in the container and downwards through the outlet canal towards and out of the outlet of the container,
- the laterally arranged openings are arranged at a bottom edge of the rotor, and
- an outlet opening for gas is arranged in an upper part of the container for creating a sub-atmospheric pressure over the metal melt within the container.

[0012] Further features of the invention are defined in claims 2-4.

[0013] The invention can be used in

a) heating gas and particles which are supplied to the melt,
b) heating melt transferred between two sets of apparatus by an open or closed chute, and
c) heating metal in a melting pot or furnace.

[0014] The end of the electrode is arranged inside a hollow body which has opening facing towards the bottom of the container, the hollow body being arranged for spacing a surface of the melt, in such a way that the electric arc is struck inside the body, the container is

formed with outlet openings at the bottom level, and, in the upper part of the container, is arranged an outlet opening for gas for the creation of sub atmospheric pressure over the metal melt in the container.

Example

[0015] The present invention, will in the following, be described in more detail with reference to the drawings, wherein:

Figure 1 is a schematic drawing of the device in accordance with the invention, where Figure 1 a is a side view, and Figure 1b is a top plan view, while Figure 2 is a schematic drawing of an alternative design of the device in accordance with the invention, with two rotors and two reaction chambers, where Figure 2a is a side view, and Figure 2b is a top plan view.

[0016] Figure 1, as mentioned, is a schematic drawing of the device in accordance with the invention. The equipment comprises a cylindrical or rectangular upright container 1 with an outlet inside the container in the form of an outlet canal 2. The processed melt flows through an opening 3 at lower end of the outlet canal 2. The melt to be processed flows through an opening 4 at the lower end of the container 1 and is lifted up because of the sub atmospheric pressure in the container, which is obtained by a vacuum pump (not shown), connected to a connector 5. In the container 1 is a rotor 6 arranged which is powered by an engine 7, via a belt drive 8 or similar, to a pulley 9, which is mounted onto a tubular shaft 10, and connected to the rotor 6.The engine 7 is mounted on a bracket 11. The bracket 11 may be mounted onto the container 1 or to a separate structure. The seal between the rotor shaft 10 and the container 1 is achieved by a gasket 12. The bracket 11 carries a bearing 26 for the rotor shaft 10. Centrally in the shaft there is arranged an electrode 13, where in its upper end, is mounted a power cable via a cable contact 14. Through the electrode 13 a hole is drilled a centrally for the gas supply, which is connected to connector 15, mounted to the end of the electrode 13. The gas supplied via the electrode 13 is preferably argon or nitrogen, or mixture thereof. But other gases may also be used. The gas above the level 21 of the melt is a mixture of gas added to the rotor and gases possibly produced by the melt. This gas is removed via the pipe 5. Between the rotor shaft 10 and the electrode 13 there is a ring 16, which operates both for sealing and electrical insulation. The ring 16 has a connection for the passage of gases and particles via a pipe socket 17, connected to a powder dispenser 18. Connected to the equipment, there is a chute, in which is arranged a gate valve 19 and a gate valve 20 (the operation thereof is shown in further detail). In the lower end of the rotor 6 there are arranged several holes 25 leading from the periphery to the melt 23. The level of the melt 23 depends on the gas pressure inside the rotor 6. At start-up, gate valve 19 is closed, gate valve 20 is open, and chute 24 is filled to a certain level. When a vacuum is applied by a vacuum pump via connector 5, at the same time is gas supplied via the electrode 13 and/or via the ring 16 of the rotor. 6. The metal is sucked to the upper level 21. The rotor 6 starts rotating, and a voltage from a rectifier or transformer is applied. The current is connected by the cable contact 14 to the electrode 13, and to a switch connected to the melt, via the rotor shaft 10, by a sliding contact (not shown). An electric arc 22 is struck between the electrode 13 and the melt 23. The rotation of the rotor 6 results in the heated melt in the rotor 6 being pumped out through holes 25, and mixed with the melt in the container. The holes 25 may be round or polygonal in shape, and are arranged in the bottom edge of the rotor 6, to form recesses.

[0017] As the melt reaches the requested temperature, gate valve 19 opens and gate valves 20 closes. The metal leaves container 1 for further processing.

[0018] Figure 2 shows an alternative design which utilizes two rotors 6, and accordingly, two reaction chambers. The two chambers are connected in series, and a chamber 2 corresponds to the outlet canal 2 in the aforementioned example, as shown in Figure 1.

[0019] Figure 2 illustrates as mentioned, a schematic drawing of the device in accordance with the invention. The device consists of a cylindrical or rectangular upright container 1, divided into two chambers, each chamber having its own rotor 6, as described above. The melt to be processed enters through an opening 4 in the lower end of the container 1 and is lifted up by the sub atmospheric pressure in the container, which is provided by a vacuum pump (not shown), connected to a connector 5. The manner of operation of the device with two chambers is as described for Figure 1. The main difference is that the gas is rising via the rotor 6, parallel to the melt in the inlet plenum, while the gas is rising against the flow of the melt in chamber 2.

[0020] At start-up, gate valve 19 is closed, gate valve 20 is open, and the chute 24 is filled to a certain level. As a vacuum is created by a vacuum pump via a connector 5, gas is supplied simultaneously by the electrode 13 and/or by the ring 16 in the rotor 6. The metal melt is sucked up in both chambers to an upper level 21. The two rotors 6 start rotating, and the current obtained from a rectifier or a transformer is switched on. The current is connected to the electrode 13 via the cable connector 14 and to a switch, which is connected to the melt, or via the rotor shaft 10, by a sliding contact (not shown). An electric arc 22 is struck between the electrode 13 and against the metal melt 23. The rotation of the rotor 6 will pump the heated metal within the rotor 6 out through holes 25, thereby mixing with melt in the container. The invention is not limited by the description and examples shown in the Figures 1 and 2. Thus, the equipment may comprise, for instance three, four, or several containers, which are connected serially.

Claims

1. A device for heating a metal melt, comprising a container (1), a rotor (6) in the form of a hollow rotary body with an opening facing towards a bottom of the container (1) and with laterally arranged openings (25) through which the melt can pass from the hollow rotary body to the metal melt surrounding the hollow rotary body, and with a hollow drive shaft (10) which holds an electrode (13) for an electrical power supply to strike in operation an electric arc (22) against a surface (23) of the metal melt (23) inside the rotor (6), and the hollow rotary body of the rotor (6) being arranged for accommodating the surface (23) of the metal melt in such a way that the electric arc (22) is struck inside the hollow rotary body, and where the hollow drive shaft (10) is arranged for gas supply to the metal melt,
characterized in that

   - the container (1) has a cover and an inlet opening (4) and an outlet opening (3) for supplying and removing the metal melt, said inlet and outlet openings(4, 3) being arranged at a bottom level of the container (1) and wherein a sub-atmospheric pressure is created in operation inside the container (1),
   - an overflow wall is arranged inside the container (1), forming an outlet canal (2) between an upper region of the metal melt in the container (1) and the outlet (3), thereby ensuring that the heated metal melt flows upwards in the container (1) and downwards through the outlet canal (2) towards and out of the outlet (3) of the container (1),
   - the laterally arranged openings (25) are arranged at a bottom edge of the rotor (6), and
   - an outlet opening (5) for gas is arranged in an upper part of the container (1) for creating a sub-atmospheric pressure over the metal melt within the container (1).

2. A device according to claim 1, **characterized in that** the outlet opening (5) for gas is arranged in the cover of the container (1).

3. A device according to claim 1 or 2, **characterized in that** the device includes at least two containers which are connected in series in such a way that the container arranged downstream is operable to obtain a flow of metal melt down and towards the outlet opening.

4. A device according to any one of the claims 1 to3, **characterized in that** a cavity in the body of the rotor (6) diverges conically towards a free end of the body.

Patentansprüche

1. Vorrichtung zum Wärmen bzw. Erwärmen einer Metallschmelze, umfassend einen Behälter (1), einen Rotor (6) in Form eines hohlen Drehkörpers mit einer einer Unterseite des Behälters (1) zugewandten Öffnung und mit seitlich angeordneten Öffnungen (25), durch welche die Schmelze von dem hohlen Drehkörper zu der den hohlen Drehkörper umgebenden Metallschmelze gelangen kann, und mit einer hohlen Antriebswelle (10), welche eine Elektrode (13) für eine elektrische Stromversorgung hält, welche im Betrieb einen Lichtbogen (22) gegen eine Oberfläche (23) der Metallschmelze (23) in dem Rotor (6) schlägt, und wobei der hohle Drehkörper des Rotors (6) angeordnet ist, dass die Oberfläche (23) der Metallschmelze derart aufgenommen wird, dass der Lichtbogen (22) innerhalb des hohlen Drehkörpers geschlagen wird, und wobei die hohle Drehwelle (10) für die Gasversorgung zu der Metallschmelze angeordnet ist,
dadurch gekennzeichnet, dass

   - der Behälter (1) eine Abdeckung und eine Einlassöffnung (4) und eine Auslassöffnung (3) zum Zuführen bzw. Abführen der Metallschmelze aufweist, wobei die Einlass- und Auslassöffnungen (4, 3) an einem unteren Niveau des Behälters (1) angeordnet sind, und wobei im Betrieb ein atmosphärischer Unterdruck innerhalb des Behälters (1) erzeugt wird,
   - eine Überflusswand innerhalb des Behälters (1) angeordnet ist, welche einen Auslasskanal (2) zwischen einem oberen Bereich der Metallschmelze in dem Behälter (1) und dem Auslass (3) bildet, wodurch sichergestellt wird, dass die erwärmte Metallschmelze in dem Behälter (1) nach oben und durch den Auslasskanal (2) nach unten zu und aus dem Auslass (3) des Behälters (1) fließt,
   - die seitlich angeordneten Öffnungen (25) an einer unteren Kante des Rotors (6) angeordnet sind, und
   - eine Auslassöffnung (5) für Gas in einem oberen Teil des Behälters (1) angeordnet ist, um einen atmosphärischen Unterdruck über der Metallschmelze in dem Behälter (1) zu erzeugen.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Auslassöffnung (5) für Gas in der Abdeckung des Behälters (1) angeordnet ist.

3. Vorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Vorrichtung wenigstens zwei Behälter beinhaltet, welche in Serie bzw. in Reihe miteinander verbunden sind derart, dass der nachgeordnete Behälter betriebsfähig ist, einen

Fluss der Metallschmelze nach unten und zu der Auslassöffnung aufzunehmen.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** ein Hohlraum in dem Körper des Rotors (6) konisch zu einem freien Ende des Körpers auseinanderläuft.

Revendications

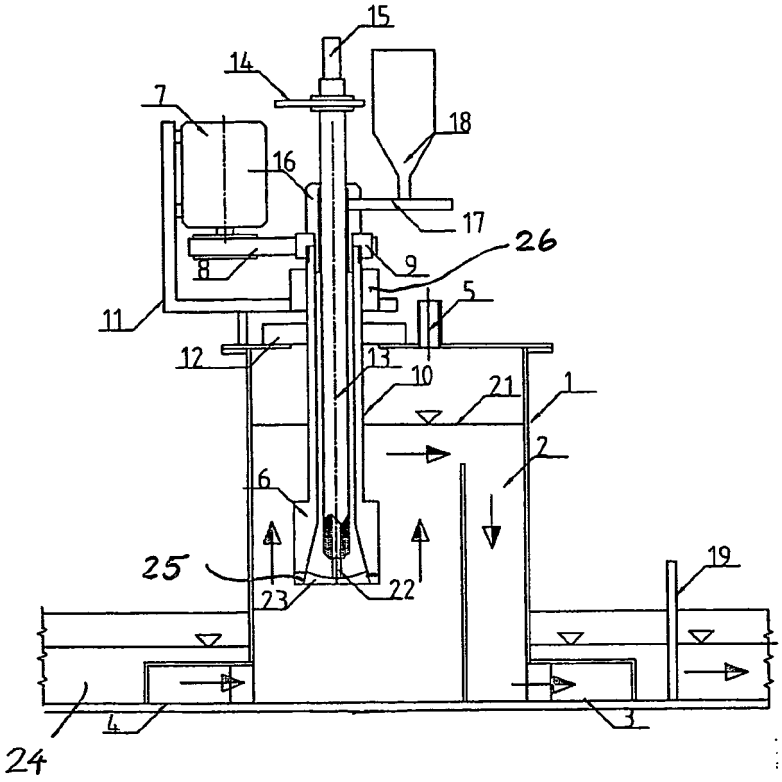
1. Dispositif pour chauffer une coulée métallique, comprenant un conteneur (1), un rotor (6) sous forme d'un corps rotatif creux pourvu d'une ouverture faisant face à un fond du conteneur (1) et avec des ouvertures (25) placées latéralement à travers lesquelles la coulée peut passer du corps rotatif creux à la coulée métallique entourant le corps rotatif creux, et avec un axe d'entraînement creux (10) qui contient une électrode (13) pour une alimentation en courant électrique devant créer quand elle fonctionne un arc électrique (22) contre une surface (23) de la coulée métallique (23) à l'intérieur du rotor (6), et le corps rotatif creux du rotor (6) étant disposé pour s'adapter à la surface (23) de la coulée métallique de manière à ce que l'arc électrique (22) soit frappé à l'intérieur du corps rotatif creux, et où l'axe d'entraînement creux (10) est disposé pour alimenter en gaz la coulée métallique,
caractérisé en ce que

- le conteneur (1) comporte un couvercle et une ouverture d'entrée (4) et une ouverture de sortie (3) pour amener et retirer la coulée métallique, les dites ouvertures d'entrée et de sortie (4, 3) étant disposées au niveau du fond du conteneur (1) et où une pression sous-atmosphérique est créée pendant le fonctionnement à l'intérieur du conteneur (1),
- une paroi de débordement est prévue à l'intérieur du conteneur (1), formant un canal de sortie (2) entre une région supérieure de la coulée métallique dans le conteneur (1) et la sortie (3), assurant ainsi que la coulée métallique chauffée coule vers le haut dans le conteneur (1) et vers le bas à travers le canal de sortie (2) vers et hors de la sortie (3) du conteneur (1),
- les ouvertures (25) prévues latéralement sont placées au niveau d'un bord du fond du rotor (6), et
- une ouverture de sortie (5) pour le gaz est prévue dans une partie supérieure du conteneur (1) afin de créer une pression sous-atmosphérique au-dessus de la coulée métallique à l'intérieur du conteneur (1).

2. Dispositif selon la revendication 1, **caractérisé en ce que** l'ouverture de sortie (5) pour le gaz est prévue dans le couvercle du conteneur (1).

3. Dispositif selon la revendication 1 ou 2, **caractérisé en ce que** le dispositif comprend au moins deux conteneurs qui sont connectés en série de telle manière que le conteneur placé en aval puisse fonctionner pour obtenir un flux de coulée métallique vers le bas et vers l'ouverture de sortie.

4. Dispositif selon l'une quelconque des revendications 1 à 3, **caractérisé en ce qu'**une cavité dans le corps du rotor (6) diverge de manière conique vers une extrémité libre du corps.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14
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18
16
17
26
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21
1
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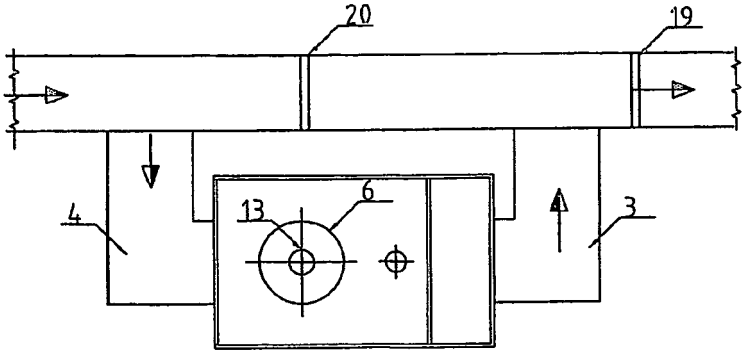
23
22
4
3
24

Fig.1a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19
6
13
4
3

Fig.1b

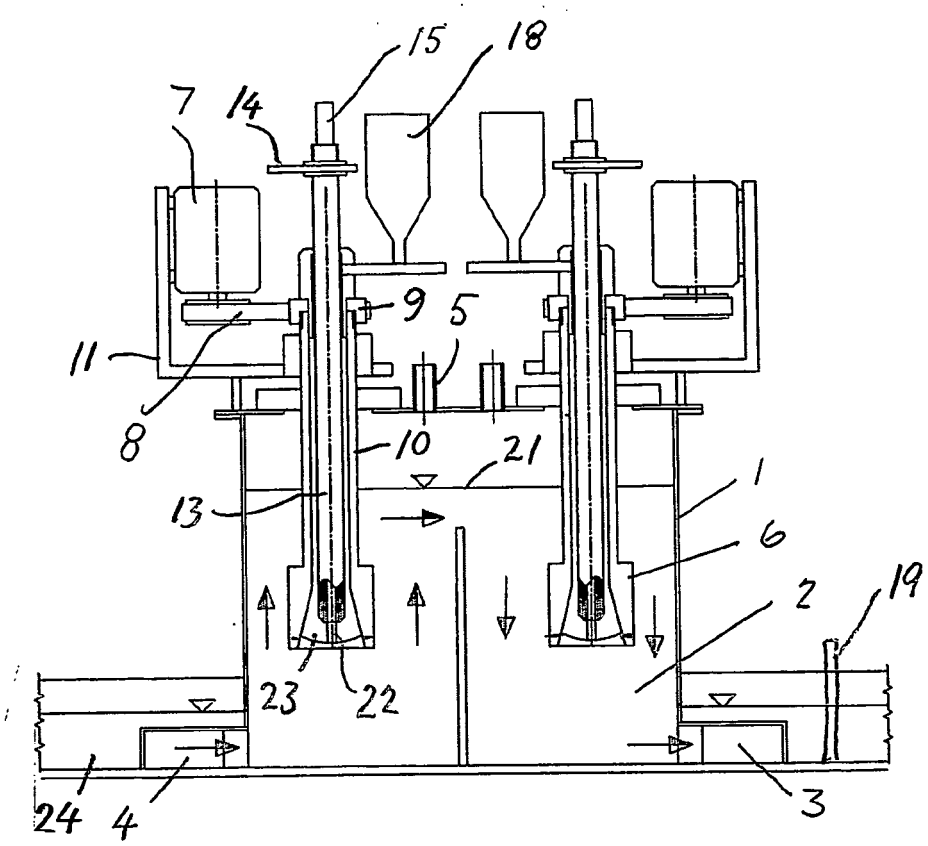

Fig.2a

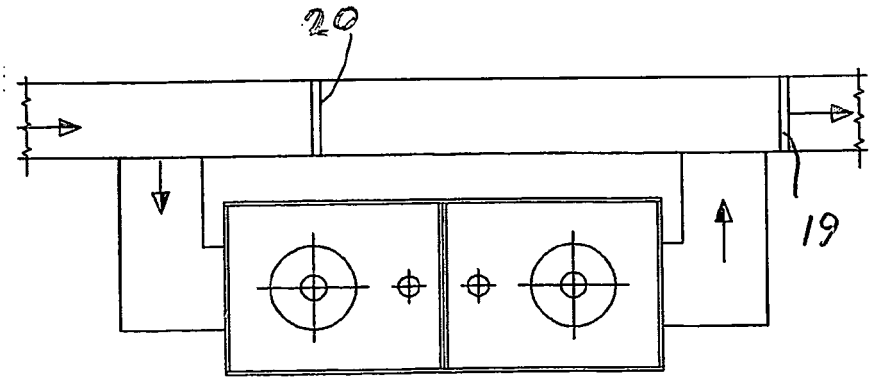

Fig.2b

REFERENCES CITED IN THE DESCRIPTION

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