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⑤ **PROCESS AND DEVICE FOR REMOVING IMPURITIES CONTAINED IN MELTED IRON FLOWING FROM SHAFT FURNACE.**

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⑤ References cited:  
**DE-B-1 800 131**  
**FR-A-1 326 751**  
**FR-A-1 576 970**  
**JP-B-3 913 625**  
**JP-B-4 621 810**

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## Description

The present invention relates to an apparatus for removing at least two of such impurities as silicon, phosphorus and sulfur contained in molten pig iron in the middle of a hot-metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle, such as disclosed in the preamble of claim 1. A method is also provided to this effect, such as disclosed in the preamble of claim 5.

Methods are known for removing at least one of such impurities as silicon, phosphorus and sulfur contained in molten pig iron in the middle of a hot-metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle.

One of the above-mentioned conventional methods commonly applied so far for removing impurities contained in molten pig iron tapped from the blast furnace in the middle of the hot-metal runner, comprises charging a granular flux for removing impurities contained in molten pig iron from a hopper arranged above the hot-metal runner into molten pig iron flowing through the hot-metal runner. This method has however the disadvantage of a low removing efficiency of impurities because of the insufficient contact between molten pig iron and the granular flux as a result of the fact that the charged granular flux floats on the surface of molten pig iron and does not sufficiently penetrate into molten pig iron.

As a method for efficiently removing impurities contained in molten pig iron tapped from a blast furnace, which solves the above-mentioned disadvantage and enables a sufficient contact between molten pig iron and a granular flux, there is known a method, disclosed in Japanese Patent Provisional Publication No. 57-200,510 dated December 8, 1982, for removing silicon as one of impurities contained in molten pig iron tapped from a blast furnace, which comprises:

substantially vertically arranging a lance above a hot-metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle so that the lower end portion of said lance is immersed into molten pig iron flowing through said hot-metal runner; and blowing, through said lance, a granular flux for removing silicon as one of impurities contained in molten pig iron by means of a carrier gas, into molten pig iron flowing through said hot-metal runner, to cause said granular flux thus blown to combined with silicon contained in molten pig iron to form molten slag, thereby removing silicon from molten pig iron (hereinafter referred to as the "prior art 1").

The above-mentioned prior art 1 involves the following drawbacks:

(1) Since the lower end portion of the lance for blowing a granular flux by means of a carrier gas is immersed into molten pig iron, the lance is susceptible to a serious fusion. It is therefore necessary to frequently replace the lance, thus requiring much cost.

(2) Since the granular flux blown from the lance

by means of a carrier gas into molten pig iron seriously hits the bottom of the hot-metal runner, the bottom of the hot-metal runner is damaged. It is therefore necessary to frequently repair the bottom of the hot-metal runner, thus requiring much cost.

As a method for efficiently removing impurities contained in molten pig iron tapped from a blast furnace, which solves the above-mentioned drawbacks in the prior art 1 and enables to avoid the fusion of the lance or damage to the bottom of the hot-metal runner, there is known a method, disclosed in Japanese Patent Provisional Publication No. 58-130,208 dated August 3, 1983, for removing impurities contained in molten pig iron tapped from a blast furnace, which comprises:

substantially vertically arranging a lance above a hot-metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle so that the lowermost end of said lance is spaced apart by a prescribed distance from the surface of molten pig iron flowing through said hot-metal runner; and blowing, through said lance, a granular flux for removing impurities contained in molten pig iron by means of a carrier gas, into molten pig iron flowing through said hot-metal runner, to cause said granular flux thus blown to combine with impurities contained in molten pig iron to form molten slag, thereby removing said impurities from molten pig iron (hereinafter referred to as the "prior art 2").

The above-mentioned prior art 2 has the following drawbacks: in the prior art 2, there is only a single lance which is substantially vertically arranged above the hot-metal runner for blowing a granular flux. When both a granular flux for removing silicon and a granular flux for removing sulfur are blown through the single lance into molten pig iron, molten slag mainly comprising  $\text{SiO}_2$ , formed as a result of combination with silicon in molten pig iron reduces the removing efficiency of sulfur. Thus, at least two of the impurities contained in molten pig iron cannot be removed efficiently by the application of the prior art 2.

Finally, an arc furnace for producing half steel is known from the German Patent Publication DE—B—1800131 (prior art 3) in which half steel is introduced into a refining chamber having a bottom in the form of a trough such that only a small quantity of molten half steel or refined steel can flow over the higher border of weir of the trough from one refining chamber into another. According to prior art 3, flux material is introduced through another lance, thereby causing strong agitation of the molten metal bath. Prior art 3 thus concerns a continuous steel production furnace in which steel is refined by the removal of certain impurities, including carbon, by the injection of both oxygen and flux material.

Under such circumstances, there is strong demand for the development of an apparatus for simultaneously and efficiently removing at least two impurities contained in molten pig iron, in which at least one lance is arranged above a hot-

metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle so that the lowermost end of the at least one lance is spaced apart by a prescribed distance from the surface of molten pig iron flowing through the hot-metal runner, and a granular flux for removing impurities contained in molten pig iron is blown through the at least one lance by means of a carrier gas into molten pig iron flowing through the hot-metal runner. However, such an apparatus has not as yet been proposed.

#### Summary of the invention

An object of the present invention is therefore to provide an apparatus and a method for simultaneously and efficiently removing at least two impurities contained in molten pig iron, in which at least one lance is arranged above a hot-metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle so that the lowermost end of the at least one lance is spaced apart by a prescribed distance from the surface of molten pig iron flowing through the hot-metal runner, and a granular flux for removing impurities contained in molten pig iron is blown through the at least one lance by means of a carrier gas into molten pig iron flowing through the hot-metal runner. However, such an apparatus has not as yet been proposed.

The above object is attained in accordance with the present invention by the apparatus indicated in claims 1 through 4.

Another object of the present invention is to provide a method for removing impurities from molten pig iron tapped from a blast furnace and flowing through a hot-metal runner into a hot-metal ladle.

This second object is attained by the method set forth in claims 5 through 12.

Referring now to the drawings in which like reference numerals denote like elements throughout the several views,

Fig. 1 is a schematic plan view illustrating a first embodiment of the apparatus of the present invention;

Fig. 2 is a sectional view illustrating the apparatus of the first embodiment of the present invention cut along the line A—A in Fig. 1;

Fig. 3 is a schematic plan view illustrating a second embodiment of the apparatus of the present invention;

Fig. 4 is a sectional view illustrating the apparatus of the second embodiment of the present invention cut along the line B—B in Fig. 3;

Fig. 5 is a schematic plan view illustrating a third embodiment of the apparatus of the present invention;

Fig. 6 is a sectional view illustrating the apparatus of the third embodiment of the present invention cut along the line C—C in Fig. 5;

Fig. 7 is a schematic plan view illustrating a fourth embodiment of the apparatus of the present invention;

Fig. 8 is a sectional view illustrating the apparatus of the fourth embodiment of the present invention cut along the line D—D in Fig. 7;

Fig. 9 is a schematic plan view illustrating a fifth embodiment of the apparatus of the present invention;

Fig. 10 is a schematic plan view illustrating a sixth embodiment of the apparatus of the present invention; and

Fig. 11 is a schematic cross-sectional view of a hot-metal runner illustrating blowing of a granular flux through a lance into molten pig iron in the apparatus of the present invention.

#### Detailed description of preferred embodiments

From the above-mentioned point of view, we carried out extensive studies to develop an apparatus for simultaneously and efficiently removing at least two impurities contained in molten pig iron, in which at least one lance is arranged above a hot-metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle so that the lowermost end of the at least one lance is spaced apart by a prescribed distance from the surface of molten pig iron flowing through the hot-metal runner, and a granular flux for removing impurities contained in molten pig iron is blown through the at least one lance by means of a carrier gas into molten pig iron flowing through the hot-metal runner.

As a result, we obtained the following finding: it is possible to simultaneously and efficiently remove at least two impurities from molten pig iron tapped from a blast furnace by providing, in the downstream of a skimmer, which is provided in the middle of a hot-metal runner for directing molten pig iron tapped from a blast furnace into a hot-metal ladle and dams up molten blast furnace slag floating on the surface of molten pig iron flowing through the hot-metal runner to separate molten blast furnace slag from molten pig iron, relative to the flowing direction of molten pig iron in the hot-metal runner, at least two partitions at right angles to the flowing direction of molten pig iron in the hot-metal runner at prescribed intervals therebetween, of which the lower ends are immersed into molten pig iron with a distance from the bottom of the hot-metal runner sufficient to allow molten pig iron to pass through, to divide the hot-metal runner into at least two reaction zones; substantially vertically arranging at least one lance above each of the at least two reaction zones so that the lowermost end of the at least one lance is spaced apart from the surface of molten pig iron by a prescribed distance; blowing, through the at least one lance, a granular flux for removing impurities contained in molten pig iron into molten pig iron flowing through the at least two reaction zones by means of a carrier gas; providing each of a plurality of branch slag runners for each of the at least two reaction zones; damming up, by means of each of the at least two partitions, molten slag pro-

duced in each of the at least two reaction zones through combination of the granular flux with impurities contained in molten pig iron; separating the thus produced molten slag from molten pig iron; and discharging the thus produced molten slag from each of the at least two reaction zones through each of the branch slag runners.

The present invention was made on the basis of the above-mentioned finding. Now, the apparatus of the present invention is described with reference to the drawings.

Fig. 1 is a schematic plan view illustrating a first embodiment of the apparatus of the present invention, and Fig. 2 is a sectional view illustrating the apparatus of the first embodiment of the present invention cut along the line A—A in Fig. 1. As shown in Figs. 1 and 2, in the middle of a hot-metal runner 1 for directing molten pig iron 5 tapped from a blast furnace not shown into a hot-metal ladle not shown, a skimmer 3 for damming up molten blast furnace slag 7 floating on the surface of molten pig iron 5 flowing through the hot-metal runner 1 to separate molten blast furnace slag 7 from molten pig iron 5, is provided at right angles to the flowing direction of molten pig iron 5 between opposite side walls 1b and 1c of the hot-metal runner 1. The lower end of the skimmer 3 is immersed into molten pig iron 5 flowing through the hot-metal runner 1, and is spaced apart from the bottom 1a of the hot-metal runner 1 by a distance sufficient to allow molten pig iron 5 to pass through. A slag runner 2 for discharging molten blast furnace slag 7 separated from molten pig iron 5 by the skimmer, is provided in the hot-metal runner 1 in the upstream of the skimmer 3 relative to the flowing direction of molten pig iron 5 in the hot-metal runner 1.

A first partition 4a and a second partition 4b are provided in the hot-metal runner 1 at prescribed intervals therebetween at right angles to the flowing direction of molten pig iron 5 in the hot-metal runner 1 in the downstream of the skimmer 3 relative to the flowing direction of molten pig iron into the hot-metal runner 1 between the opposite side walls 1b and 1c of the hot-metal runner 1. The hot-metal runner 1 is divided by these two partitions 4a and 4b, from the upstream toward the downstream thereof, into a first reaction zone 6a and a second reaction zone 6b. The first reaction zone 6a is a reaction zone for removing silicon as one of impurities contained in molten pig iron, and the second reaction zone 6b is a reaction zone for removing phosphorus or sulfur as one of impurities contained in molten pig iron. The lower end of each of the first partition 4a and the second partition 4b is immersed into molten pig iron 5 flowing through the hot-metal runner 1 and is spaced apart from the bottom 1a of the hot-metal runner 1 by a distance sufficient to allow molten pig iron 5 to pass through.

Above the first reaction zone 6a, two first lances 8a for blowing, by means of a carrier gas, a granular flux for removing silicon as one of impurities contained in molten pig iron into mol-

ten pig iron 5 flowing through the first reaction zone 6a, are substantially vertically arranged so as to pass through a cover 10 covering the first reaction zone 6a. Above the second reaction zone 6b, two second lances 8b for blowing, by means of a carrier gas, a granular flux for removing phosphorus or sulfur as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the second reaction zone 6b, are substantially vertically arranged so as to pass through the cover 10 also covering the second reaction zone 6b. The lowermost end of each of the first lances 8a and the second lances 8b is spaced apart from the surface of molten pig iron 5 by a prescribed distance. A first branch slag runner 9a is provided in the first reaction zone 6a, and a second branch slag runner 9b is provided in the second reaction zone 6b. The downstream end of each of the first branch slag runner 9a and the second branch slag runner 9b communicates with the slag runner 2. In Fig. 1, 11a is a first tank for receiving a granular flux to be supplied through a conduit 11' to each of the two first lances 8a, and 11b is a second tank for receiving a granular flux to be supplied through a conduit 11' to each of the two second lances 8b.

Molten blast furnace slag 7 floating on the surface of molten pig iron 5 which is tapped from the blast furnace not shown and flows through the hot-metal runner 1, is dammed up by the skimmer 3, separated from molten pig iron 5, and discharged through the slag runner 2. Molten pig iron 5 after the separation of molten blast furnace slag 7 by the skimmer 3, flows through the first reaction zone 6a and the second reaction zone 6b. A granular flux for removing silicon as one of impurities contained in molten pig iron is blown through the two first lances 8a by means of carrier gas into molten pig iron 5 flowing through the first reaction zone 6a. As a result, molten slag 7a is produced in the first reaction zone 6a through combination of the granular flux blown from the two first lances 8a into molten pig iron 5 flowing through the first reaction zone 6a with silicon contained in molten pig iron, and thus silicon is removed from molten pig iron 5. Molten slag 7a thus produced is dammed up by the first partition 4a, separated from molten pig iron 5, and discharged through the first branch slag runner 9a from the first reaction zone 6a.

A granular flux for removing phosphorus or sulfur as one of impurities contained in molten pig iron is blown, in the second reaction zone 6b, through the two second lances 8b by means of a carrier gas into molten pig iron 5 from which silicon has been removed and molten slag 7a has been separated by the first partition 4a as described above. As a result, molten slag 7b is produced in the second reaction zone 6b through combination of the granular flux blown from the two second lances 8b into molten pig iron 5 flowing through the second reaction zone 6b with phosphorus or sulfur contained in molten pig iron, and thus phosphorus or sulfur is removed from molten pig iron 5. Molten slag 7b thus

produced is dammed up by the second partition 4b, separated from molten pig iron 5, and discharged through the second branch slag runner 9b from the second reaction zone 6b.

Molten pig iron 5 from which silicon has thus been removed in the first reaction zone 6a, and then, phosphorus or sulfur has thus been removed in the second reaction zone 6b, is directed through the hot-metal runner 1 into the hot-metal ladle not shown. On the other hand, molten slags 7a and 7b discharged respectively through the first branch slag runner 9a and the second branch slag runner 9b from the first reaction zone 6a and the second reaction zone 6b, are directed to the slag runner 2, and then further directed, together with molten blast furnace slag 7, through the slag runner 2 to a slag ladle or a slag disposal equipment not shown.

The following known fluxes are used as granular fluxes for removing impurities contained in molten pig iron:

(1) Granular flux for removing silicon:

At least one flux selected from the group consisting of granular iron ore, granular ferro-manganese ore, iron sand and granular mill scale.

(2) Granular flux for removing phosphorus:

Granular mixture of at least one flux selected from the group consisting of granular iron ore, granular ferro-manganese ore, iron sand and granular mill scale, on the one hand, and at least one flux selected from the group consisting of granular soda ash, granular calcined lime, granular limestone, granular converter slag and granular calcium carbide, on the other hand.

(3) Granular flux for removing sulfur:

At least one flux selected from the group consisting of granular soda ash, granular calcined lime, granular limestone, granular converter slag and granular calcium carbide.

Fig. 11 is a schematic cross-sectional view of a hot-metal runner illustrating blowing of a granular flux through a lance into molten pig iron in the apparatus of the present invention. As shown in Fig. 11, the lowermost end of the first lance 8a, for example, is spaced apart by a prescribed distance from the surface of molten pig iron 5 flowing through the hot-metal runner 1. This arrangement makes it possible to blow a granular flux 16 into molten pig iron 5 by means of a carrier gas without the fusion of the first lance 8a or damage to the bottom 1a of the hot-metal runner 1. In order to remove impurities contained in molten pig iron at a high and stable efficiency by means of such blowing of a granular flux through the lance, it is desirable to conduct blowing of a granular flux into molten pig iron so as to satisfy the following two Equations:

$$0.5 H \leq H_p < \quad (1)$$

$$H_p = M \cdot G \cdot \exp(-\bar{r}) / (D + 0.02 H_L)^2 \quad (2)$$

In Equations (1) and (2):

H: depth of molten pig iron in the hot-metal runner (mm),

$H_p$ : penetration depth of the granular flux into molten pig iron in the hot-metal runner (mm),

M: flow rate of the granular flux (kg/minute),

G: flow rate of the carrier gas (Nm<sup>3</sup>/minute),

$\bar{r}$ : average particle size of the granular flux (mm),

D: inside diameter of the lance (mm), and

$H_L$ : distance between the surface of molten pig iron in the hot-metal runner and the lowermost end of the lance (mm).

In the apparatus of the first embodiment, the two reaction zones may comprise, in addition to comprising the first reaction zone 6a for removing silicon as one of impurities contained in molten pig iron and the second reaction zone 6b for removing phosphorus or sulfur as one of impurities contained in molten pig iron as described above, the following reaction zones:

(1) The first reaction zone 6a is a reaction zone for removing sulfur as one of impurities contained in molten pig iron, and the second reaction zone 6b is a reaction zone for removing silicon as one of impurities contained in molten pig iron.

(2) In the case with a low silicon content in molten pig iron tapped from the blast furnace, the first reaction zone 6a is a reaction zone for removing phosphorus or sulfur contained in molten pig iron, and the second reaction zone 6b is a reaction zone for removing sulfur or phosphorus contained in molten pig iron.

When removing silicon and phosphorus as impurities contained in molten pig iron, it is necessary to remove silicon prior to removing phosphorus. More particularly, when silicon is present in molten pig iron, a granular flux blown into molten pig iron for removing phosphorus reacts preferentially with silicon, thus seriously reducing the removing efficiency of phosphorus.

Fig. 3 is a schematic plan view illustrating a second embodiment of the apparatus of the present invention, and Fig. 4 is a sectional view illustrating the apparatus of the second embodiment of the present invention cut along the line B—B in Fig. 3. As shown in Figs. 3 and 4, similarly to the apparatus of the first embodiment described with reference to Figs. 1 and 2, in the apparatus of the second embodiment, a first partition 4a and a second partition 4b are provided in the hot-metal runner 1 at prescribed intervals therebetween at right angles to the flowing direction of molten pig iron 5 in the hot-metal runner 1 in the downstream of the skimmer 3 relative to the flowing direction of molten pig iron in the hot-metal runner 1. The hot-metal runner 1 is divided by these two partitions 4a and 4b, from the upstream toward the downstream thereof, into a first reaction zone 6a and a second reaction zone 6b.

In the apparatus of the second embodiment, the first reaction zone 6a is a reaction zone for removing phosphorus as one of impurities contained in molten pig iron, and the second reaction

zone 6b is a reaction zone for removing sulfur as one of impurities contained in molten pig iron.

Above the first reaction zone 6a, two first lances 8a for blowing, by means of a carrier gas, a granular flux for removing phosphorus as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the first reaction zone 6a, are substantially vertically arranged so as to pass through a cover 10 covering the first reaction zone 6a. Above the second reaction zone 6B, two second lances 8b for blowing, by means of a carrier gas, a granular flux for removing sulfur as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the second reaction zone 6b, are substantially vertically arranged so as to pass through the cover 10 also covering the second reaction zone 6b. The lowermost end of each of the first lances 8a and the second lances 8b is spaced apart from the surface of molten pig iron 5 by a prescribed distance. A first branch slag runner 9a is provided in the first reaction zone 6a, and a second branch slag runner 9b is provided in the second reaction zone 6b. The downstream end of each of the first branch slag runner 9a and the second branch slag runner 9b communicates with the slag runner 2.

In the apparatus of the second embodiment, two third lances 8c for blowing, by means of a carrier gas, a granular flux for removing silicon as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the hot-metal runner 1, are substantially vertically arranged above the hot-metal runner 1 in the upstream of the skimmer 3 relative to the flowing direction of molten pig iron in the hot-metal runner 1 so as to pass through the cover 10 covering the hot-metal runner 1. The lowermost end of each of the third lances 8c is spaced apart from the surface of molten pig iron 5 by a prescribed distance. In Fig. 3, 11c is a tank for receiving a granular flux to be supplied through a conduit 11' to each of the two third lances 8c.

A granular flux for removing silicon as one of impurities contained in molten pig iron is blown, in the upstream of the slag skimmer 3, through the two third lances 8c by means of a carrier gas into molten pig iron 5 tapped from a blast furnace not shown and flowing through the hot-metal runner 1. As a result, molten slag 7c is produced through combination of the granular flux blown from the two third lances 8c into molten pig iron 5 flowing through the hot-metal runner 1 with silicon as one of impurities contained in molten pig iron, and silicon is thus removed from molten pig iron 5. Molten slag 7c thus produced is dammed up by the skimmer 3, separated from molten pig iron 5, and discharged from the hot-metal runner 1 through the slag runner 2, together with molten blast furnace slag 7 separated from molten pig iron.

A granular flux for removing phosphorus as one of impurities contained in molten pig iron is blown, in the first reaction zone 6a, through the two first lances 8a by means of a carrier gas into molten pig iron 5 from which silicon has thus

been removed and molten blast furnace slag 7 and molten slag 7c have thus been separated by the skimmer 3. As a result, molten slag 7a is produced in the first reaction zone 6a through combination of the granular flux blown from the two first lances 8a into molten pig iron 5 flowing through the first reaction zone 6a with phosphorus contained in molten pig iron, and phosphorus is thus removed from molten pig iron 5. Molten slag 7a thus produced is dammed up by the first partition 4a, separated from molten pig iron 5, and discharged through the first branch slag runner 9a from the first reaction zone 6a.

A granular flux for removing sulfur as one of impurities contained in molten pig iron is blown, in the second reaction zone 6b, through the two second lances 8b by means of a carrier gas into molten pig iron 5 from which phosphorus has thus been removed and molten slag 7a has thus been separated by the first partition 4a. As a result, molten slag 7b is produced in the second reaction zone 6b through combination of the granular flux blown from the two second lances 8b into molten pig iron 5 flowing through the second reaction zone 6b with sulfur contained in molten pig iron, and sulfur is thus removed from molten pig iron 5. Molten slag 7b thus produced is dammed up by the second partition 4b, separated from molten pig iron 5, and discharged from the second reaction zone 6b through the second branch slag runner 9b.

Molten pig iron 5 from which silicon has thus been removed in the hot-metal runner 1 in the upstream of the skimmer 3, then phosphorus has thus been removed in the first reaction zone 6a, and then sulfur has thus been removed in the second reaction zone 6b, is directed through the hot-metal runner 1 into the hot-metal ladle not shown. On the other hand, molten slags 7a and 7b discharged respectively through the first branch slag runner 9a and the second branch slag runner 9b respectively from the first reaction zone 6a and the second reaction zone 6b, are directed to the slag runner 2, and then further directed, together with molten blast furnace slag 7 and molten slag 7c, through the slag runner 2 to a slag ladle or a slag disposal equipment not shown. In the apparatus of the second embodiment, the first reaction zone 6a may be used as a reaction zone for removing sulfur as one of impurities contained in molten pig iron, and the second reaction zone 6b may be used as a reaction zone for removing phosphorus as one of impurities contained in molten pig iron.

In the apparatus of the second embodiment, as described above, the granular flux for removing silicon as one of impurities is blown through the two third lances 8c by means of the carrier gas into molten pig iron 5, on the surface of which molten blast furnace slag 7 floats, in the hot-metal runner 1 in the upstream of the skimmer 3. Because of the very high content of CaO, molten blast furnace slag 7 has a high basicity. Therefore, molten slag 7c mainly comprising SiO<sub>2</sub> and having a low basicity, which has been produced

through combination of the granular flux for removing silicon, blown through the two third lances 8c by means of the carrier gas, with silicon contained in molten pig iron, is mixed with the above-mentioned molten blast furnace slag 7 having a high basicity. Molten slag 7c of which basicity has thus been increased, is improved in fluidity, and is smoothly discharged from the hot-metal runner 1 through the slag runner 2 together with molten blast furnace slag 7. Furthermore the reaction of the granular flux for removing silicon, blown through the third lances 8c, with silicon contained in molten pig iron becomes more active under the effect of molten blast furnace slag 7 having a high basicity. It is consequently possible to efficiently remove silicon from molten pig iron 5 flowing through the hot-metal runner 1.

Fig. 5 is a schematic plan view illustrating a third embodiment of the apparatus of the present invention, and Fig. 6 is a sectional view illustrating the apparatus of the third embodiment of the present invention cut along the line C—C in Fig. 5. As shown in Figs. 5 and 6, similarly to the apparatus of the first embodiment described with reference to Figs. 1 and 2, in the apparatus of the third embodiment, a first partition 4a and a second partition 4b are provided in the hot-metal runner 1 at prescribed intervals therebetween at right angles to the flowing direction of molten pig iron 5 in the hot-metal runner 1 in the downstream of the skimmer 3 relative to the flowing direction of molten pig iron in the hot-metal runner 1. The hot-metal runner 1 is divided by these two partitions 4a and 4b, from the upstream toward the downstream thereof, into a first reaction zone 6a and a second reaction zone 6b.

In the apparatus of the third embodiment, the first reaction zone 6a is a reaction zone for removing silicon and phosphorus as impurities contained in molten pig iron, and the second reaction zone 6b is a reaction zone for removing sulfur as one of impurities contained in molten pig iron.

Above the first reaction zone 6a, two first lances 8a for blowing, by means of a carrier gas, a granular flux for removing silicon as one of impurities contained molten pig iron into molten pig iron 5 flowing through the first reaction zone 6a, and two second lances 8b positioned in the downstream of the two first lances 8a for blowing, by means of a carrier gas, a granular flux for removing phosphorus as one of impurities contained in molten pig iron, are substantially vertically arranged so as to pass through a cover 10 covering the first reaction zone 6a. Above the second reaction zone 6b, two third lances 8c for blowing, by means of a carrier gas, a granular flux for removing sulfur as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the second reaction zone 6b, are substantially vertically arranged so as to pass through the cover 10 also covering the second reaction zone 6b. The lowermost end of each of the first lances 8a, the second lances 8b and the third lances 8c is spaced apart from the surface of

molten pig iron 5 by a prescribed distance. A first branch slag runner 9a is provided in the first reaction zone 6a, and a second branch slag runner 9b is provided in the second reaction zone 6b. The downstream end of each of the first branch slag runner 9a and the second branch slag runner 9b communicates with the slag runner 2.

Molten blast furnace slag 7 floating on the surface of molten pig iron 5 which is tapped from a blast furnace not shown and flows through the hot-metal runner 1, is dammed up by the skimmer 3, separated from molten pig iron, and discharged through the slag runner 2.

A granular flux for removing silicon as one of impurities contained in molten pig iron is blown, in the first reaction zone 6a, through the two first lances 8a by means of a carrier gas, and a granular flux for removing phosphorus as one of impurities contained in molten pig iron is blown, also in the first reaction zone 6a, through the two second lances 8b by means of a carrier gas, into molten pig iron 5 from which molten blast furnace slag 7 has thus been separated by the skimmer 3. As a result, molten slag 7a is first produced in the first reaction zone 6a through combination of the granular flux blown from the two first lances 8a into molten pig iron 5 flowing through the first reaction zone 6a with silicon contained in molten pig iron, and silicon is thus removed from molten pig iron 5. Then, molten slag 7b is also produced in the first reaction zone 6a through combination of the granular flux blown from the two second lances 8b with phosphorus contained in molten pig iron, and phosphorus is thus removed from molten pig iron 5. Mixed molten slag comprising molten slag 7a and molten slag 7b is dammed up by the first partition 4a, separated from molten pig iron 5 and discharged from the first reaction zone 6a through the first branch slag runner 9a.

A granular flux for removing sulfur as one of impurities contained in molten pig iron is blown, in the second reaction zone 6b, through the two third lances 8c by means of a carrier gas into molten pig iron 5 from which silicon and phosphorus have been removed and molten slags 7a and 7b have been separated by the first partition 4a as described above. As a result, molten slag 7c is produced in the second reaction zone 6b through combination of the granular flux blown from the two third lances 8c into molten pig iron 5 flowing through the second reaction zone 6b with sulfur contained in molten pig iron, and sulfur is thus removed from molten pig iron 5. Molten slag 7c thus produced is dammed up by the second partition 4b, separated from molten pig iron 5, and discharged from the second reaction zone 6b through the second branch slag runner 9b.

Molten pig iron 5 from which silicon and phosphorus have thus been removed in the first reaction zone 6a and then sulfur has thus been removed in the second reaction zone 6b, is directed through the hot-metal runner 1 into the hot-metal ladle not shown. On the other hand, molten slags 7a, 7b and 7c discharged from the first reaction zone 6a and the second reaction

zone 6b through the first branch slag runner 9a and the second branch slag runner 9b, are directed to the slag runner 2, and then further directed, together with molten blast furnace slag 7, through the slag runner 2 to a slag ladle or a slag disposal equipment not shown. In the apparatus of the third embodiment, the first reaction zone 6a may be used as a reaction zone for removing sulfur as one of impurities contained in molten pig iron, and the second reaction zone 6b may be used as a reaction zone for removing silicon and phosphorus as impurities contained in molten pig iron.

In the apparatus of the third embodiment, as described above, for example, the granular flux for removing silicon as one of impurities is blown, in the first reaction zone 6a, through the two first lances 8a by means of the carrier gas into molten pig iron 5, and then, the granular flux for removing phosphorus as one of impurities is blown, also in the first reaction zone 6a, through the two second lances 8b by means of carrier gas into molten pig iron 5. Molten slag 7b mainly comprising  $P_2O_5$  has a high basicity, which molten slag 7b has been produced through combination of the granular flux for removing phosphorus, blown through the two second lances 8b by means of the carrier gas, with phosphorus contained in molten pig iron. Molten slag 7a mainly comprising  $SiO_2$  and having a low basicity, which has been produced through combination of the granular flux for removing silicon, blown through the two first lances 8a by means of the carrier gas, with silicon contained in molten pig iron, is mixed with the above-mentioned molten slag 7b mainly comprising  $P_2O_5$  and having a high basicity, to increase its basicity. Molten slag 71a of which basicity has thus been increased, is improved in fluidity, and is smoothly discharged from the first reaction zone 6a through the first branch slag runner 9a together with molten slag 7b. Furthermore, the reaction of the granular flux for removing silicon, blown from the first lances 8a, with silicon contained in molten pig iron becomes more active under the effect of molten slag 7b mainly comprising  $P_2O_5$  and having a high basicity. It is consequently possible to efficiently remove silicon from molten pig iron 5 flowing through the hot-metal runner 1.

Fig. 7 is a schematic plan view illustrating a fourth embodiment of the apparatus of the present invention, and Fig. 8 is a sectional view illustrating the apparatus of the fourth embodiment of the present invention cut along the line D—D in Fig. 7. As shown in Figs. 7 and 8, in the apparatus of the fourth embodiment, a first partition 4a, a second partition 4b and a third partition 4c are provided in the hot-metal runner 1 at prescribed intervals therebetween at right angles to the flowing direction of molten pig iron 5 in the hot-metal runner 1 in the downstream of the skimmer 3 relative to the flowing direction of molten pig iron in the hot-metal runner 1 between the opposite side walls 1b and 1c of the hot-metal runner 1. The hot-metal runner 1 is divided by

these three partitions 4a, 4b and 4c, from the upstream toward the downstream thereof, into a first reaction zone 6a, a second reaction zone 6b and a third reaction zone 6c.

The first reaction zone 6a is a reaction zone for removing silicon as one of impurities contained in molten pig iron, the second reaction zone 6b is a reaction zone for removing phosphorus as one of impurities contained in molten pig iron, and the third reaction zone 6c is a reaction zone for removing sulfur as one of impurities contained in molten pig iron. The lower end of each of the first partition 4a, the second partition 4b and the third partition 4c is immersed into molten pig iron 5 flowing through the hot-metal runner 1, and is spaced apart from the bottom 1a of the hot-metal runner 1 by a distance sufficient to allow molten pig iron 5 to pass through.

Above the first reaction zone 6a, two first lances 8a for blowing, by means of a carrier gas, a granular flux for removing silicon as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the first reaction zone 6a, are substantially vertically arranged so as to pass through a cover 10 covering the first reaction zone 6a. Above the second reaction zone 6b, two second lances 8b for blowing, by means of a carrier gas, a granular flux for removing phosphorus as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the second reaction zone 6b, are substantially vertically arranged so as to pass through the cover 10 also covering the second reaction zone 6b. Above the third reaction zone 6c, two third lances 8c for blowing, by means of carrier gas, a granular flux for removing sulfur as one of impurities contained in molten pig iron into molten pig iron 5 flowing through the third reaction zone 6c, are substantially vertically arranged so as to pass through the cover 10 also covering the third reaction zone 6c.

The lowermost end of each of the first lances 8a, the second lances 8b and the third lances 8c is spaced apart from the surface of molten pig iron 5 by a prescribed distance. A first branch slag runner 9a is provided in the first reaction zone 6a, a second branch slag runner 9b is provided in the second reaction zone 6b, and a third branch slag runner 9c is provided in the third reaction zone 6c. The downstream end of each of the first branch slag runner 9a, the second branch slag runner 9b and the third branch slag runner 9c communicates with the slag runner 2.

Molten blast furnace slag 7 floating on the surface of molten pig iron 5 which is tapped from a blast furnace not shown and flows through the hot-metal runner 1, is dammed up by the skimmer 3, separated from molten pig iron, and discharged through the slag runner 2. Molten pig iron 5 from which molten blast furnace slag 7 has thus been separated by the skimmer 3 flows through the first reaction zone 6a, the second reaction zone 6b and the third reaction zone 6c.

A granular flux for removing silicon as one of impurities contained in molten pig iron is blown,

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in the first reaction zone 6a, through the two first lances 8a by means of a carrier gas into molten pig iron 5 flowing through the first reaction zone 6a. As a result, molten slag 7a is produced in the first reaction zone 6a through combination of the granular flux blown from the two first lances 8a into molten pig iron 5 flowing through the first reaction zone 6a with silicon contained in molten pig iron, and silicon is thus removed from molten pig iron 5. Molten slag 7a thus produced is dammed up by the first partition 4a, separated from molten pig iron 5, and discharged from the first reaction zone 6a through the first branch slag runner 9a.

A granular flux for removing phosphorus as one of impurities contained in molten pig iron is blown, in the second reaction zone 6b, through the two second lances 8b by means of a carrier gas into molten pig iron 5 from which silicon has been removed and molten slag 7a has been separated by the first partition 4a as described above. As a result, molten slag 7b is produced in the second reaction zone 6b through combination of the granular flux blown from the two second lances 8b into molten pig iron 5 flowing through the second reaction zone 6b with phosphorus contained in molten pig iron, and phosphorus is thus removed from molten pig iron 5. Molten slag 7b thus produced is dammed up by the second partition 4b, separated from molten pig iron 5, and discharged from the second reaction zone 6b through the second branch slag runner 9b.

A granular flux for removing sulfur as one of impurities contained in molten pig iron is blown, in the third reaction zone 6c, through the two third lances 8c by means of a carrier gas into molten pig iron 5 from which phosphorus has been removed and molten slag 7b has been separated by the second partition 4b, as described above. As a result, molten slag 7c is produced in the third reaction zone 6c through combination of the granular flux blown from the two third lances 8c into molten pig iron 5 flowing through the third reaction zone 6c with sulfur contained in molten pig iron, and sulfur is thus removed from molten pig iron 5. Molten slag 7c thus produced is dammed up by the third partition 4c, separated from molten pig iron 5, and discharged from the third reaction zone 6c through the third branch slag runner 9c.

Molten pig iron 5 from which silicon has been removed in the first reaction zone 6a, then phosphorus has been removed in the second reaction zone 6b, and then, sulfur has been removed in the third reaction zone 6c, is directed through the hot-metal runner 1 into the hot-metal ladle not shown. On the other hand, molten slags 7a, 7b and 7c discharged respectively from the first reaction zone 6a, the second reaction zone 6b, and the third reaction zone 6c, respectively through the first branch slag runner 9a, the second branch slag runner 9b, and the third branch slag runner 9c, are directed to a slag runner 2, and further directed, together with

molten blast furnace slag 7, through the slag runner 2 to a slag ladle or a slag disposal equipment not shown.

In the apparatus of the fourth embodiment, the three reaction zones comprise, as described above, the first reaction zone 6a for removing silicon as one of impurities contained in molten pig iron, the second reaction zone 6b for removing phosphorus as one of impurities contained in molten pig iron, and the third reaction zone 6c for removing sulfur as one of impurities contained in molten pig iron. These reaction zones may also be used as follows:

(1) The first reaction zone 6a is a reaction zone for removing silicon as one of impurities contained in molten pig iron, the second reaction zone 6b is a reaction zone for removing sulfur as one of impurities contained in molten pig iron, and the third reaction zone 6c is a reaction zone for removing phosphorus as one of impurities contained in molten pig iron.

(2) The first reaction zone 6a is a reaction zone for removing sulfur as one of impurities contained in molten pig iron, the second reaction zone 6b is a reaction zone for removing silicon as one of impurities contained in molten pig iron, and the third reaction zone 6c is a reaction zone for removing phosphorus as one of impurities contained in molten pig iron.

In the apparatus of the fourth embodiment, as described above, silicon is removed from molten pig iron 5 in the first reaction zone 6a after molten blast furnace slag 7 floating on the surface of molten pig iron flowing through the hot-metal runner 1 has been dammed up by the skimmer 3, separated from molten pig iron 5, and discharged through the slag runner 2. Then, phosphorus is removed from molten pig iron in the second reaction zone 6b, and then, sulfur is removed from molten pig iron in the third reaction zone 6c. When, for example, a granular flux for removing silicon (such as granular mill scale) is blown into molten pig iron from which molten blast furnace slag 7 is not yet separated, sulfur compound (CaS) contained in molten blast furnace slag 7 reacts with iron oxide (FeO) contained in the above-mentioned granular flux to form sulfur (S), and sulfur thus formed may return into molten pig iron. According to the apparatus of the fourth embodiment, however, since the granular flux for removing silicon is blown in the first reaction zone 6a into molten pig iron after separation of molten blast furnace slag 7, as described above, the above-mentioned problem is never posed.

Fig. 9 is a schematic plan view illustrating a fifth embodiment of the apparatus of the present invention. The apparatus of the fifth embodiment is identical with those of the above-mentioned embodiments except that the downstream end of each of the branch slag runners 9a, 9b, 9c is independent of the slag runner 2. Fig. 9 illustrates the apparatus of the fourth embodiment described above with reference to Figs. 7 and 8, of which the downstream end of each of the

branch slag runners 9a, 9b, 9c is made independent of the slag runner 2. As shown in Fig. 9, slag ladles 12a, 12b and 12c for receiving molten slags discharged through the first branch slag runner 9a, the second branch slag runner 9b and the third branch slag runner 9c are arranged at respective ends of these branch slag runners. Therefore, molten slags discharged from individual reaction zones 6a, 6b, 6c are never mixed with molten blast furnace slag discharged from the hot-metal runner 1 through the slag runner 2. As a result, when manufacturing blast furnace slag as the by-product by cooling and solidifying molten blast furnace slag, it is possible to prevent the above-mentioned mixture of molten slags from causing decrease in quality of the blast furnace slag.

Fig. 10 is a schematic plan view illustrating a sixth embodiment of the apparatus of the present invention. The apparatus of the sixth embodiment is identical with those of the above-mentioned embodiments except that a hot-metal separator 13 for separating molten pig iron entangled into molten slag produced in each of the reaction zones 6a, 6b, 6c from these molten slag is provided in the middle of the branch slag runners 9a, 9b, 9c. Fig. 10 illustrates the apparatus of the third embodiment described above with reference to Figs. 5 and 6, which is provided with the above-mentioned hot-metal separator 13. As shown in Fig. 10, the hot-metal separator 13 is provided in the middle of the first branch slag runner 9a for discharging molten slag produced in the first reaction zone 6a therefrom. The second branch slag runner 9b for discharging molten slag produced in the second reaction zone 6b therefrom is also connected to the hot-metal separator 13. The hot-metal separator 13 is connected to the second reaction zone 6b through a branch hot-metal runner 15 for returning molten pig iron separated by the hot-metal separator 13 into the downstream of the second reaction zone 6b. A skimmer 14 is provided at the upstream end of the branch hot-metal runner 15. The lower end of the skimmer is spaced apart by a prescribed distance from the bottom of the branch hot-metal runner 15 so as to allow molten pig iron separated from molten slags to pass through.

Therefore, molten slag discharged from the first reaction zone 6a, which is the mixture of molten slag produced through combination of the granular flux for removing silicon with silicon contained in molten pig iron, on the one hand, and molten slag produced through combination of the granular flux for removing phosphorus with phosphorus contained in molten pig iron, on the other hand, is directed to the hot-metal separator 13 through the first branch slag runner 9a. Molten slag discharged from the second reaction zone 6b, which is produced through combination of the granular flux for removing sulfur with sulfur contained in molten pig iron, is also directed to the hot-metal separator 13 through the second branch slag runner 9b. Mol-

ten pig iron entangled into these molten slags is separated from molten slags through precipitation in the hot-metal separator 13. Molten pig iron thus separated from molten slags is returned from the hot-metal separator 13 through the branch hot-metal runner 15 to the second reaction zone 6b. Molten pig iron thus returned joins molten pig iron from the first reaction zone 6a in the second reaction zone 6b, and sulfur contained in molten pig iron is removed. On the other hand, molten slags from which molten pig iron has been separated are directed from the hot-metal separator 13 through the downstream portion 9a' of the first branch slag runner 9a to the slag runner 2, and then further directed, together with molten blast furnace slag, through the slag runner 2 to a slag ladle or a slag disposal equipment not shown. According to the apparatus of the sixth embodiment, therefore, it is possible to recover molten pig iron entangled in molten slags which are produced in the reaction zones 6a, 6b, and discharged through the branch slag runners 9a, 9b.

In the apparatus of the present invention, the number of the reaction zones formed by dividing the hot-metal runner 1 is not limited to two or three as described above, but may be four or more, in response to the number of impurities to be removed from the molten pig iron tapped from the blast furnace. By doing so, it is possible to remove impurities other than silicon, phosphorus and sulfur contained in molten pig iron tapped from the blast furnace.

According to the apparatus of the present invention, as described above in detail, it is possible to simultaneously and efficiently remove at least two of such impurities contained in molten pig iron as silicon, phosphorus and sulfur in the middle of the hot-metal runner for directing molten pig iron tapped from the blast furnace into the hot-metal ladle, without risk of damaging the bottom of the hot-metal runner, thus providing industrially useful effects.

#### Claims

1. An apparatus for removing impurities contained in molten pig iron tapped from a blast furnace, which comprises:

a hot-metal runner (1) for directing molten pig iron (5) tapped from a blast furnace into a hot-metal ladle;

a skimmer (3) provided in the middle of said hot-metal runner (1), for damming up molten blast furnace slag (7) floating on the surface of molten pig iron (5) flowing through said hot-metal runner (1) to separate molten blast furnace slag (7) from molten pig iron (5), the lower end of said skimmer (3) being immersed in molten pig iron (5) flowing through said hot-metal runner (1) and spaced apart from the bottom of said hot-metal runner (1) by a distance sufficient to allow molten pig iron (5) to pass through;

a slag runner (2) provided upstream of said skimmer (3) relative to the flow direction of

molten pig iron (5) in said hot-metal runner (1), for discharging molten blast furnace slag (7) separated from molten pig iron (5) by means of said skimmer (3); and

at least one lance (8a, 8b, 8c) arranged substantially vertically above said hot-metal runner (1), for blowing, by means of a carrier gas, a granular flux for removing impurities contained in molten pig iron (5) tapped from said blast furnace, into molten pig iron (5) flowing through said hot-metal runner (1), the lowermost end of said lance (8a, 8b, 8c) being spaced apart by a prescribed distance ( $H_L$ ) from the surface of molten pig iron (5) flowing through said hot-metal runner (1);

thereby causing combination of impurities contained in molten pig iron (5) with said granular flux blown from said lance (8a, 8b, 8c) into molten pig iron (5) flowing through said hot-metal runner (1) to form molten slag containing said impurities; characterized in that:

at least two partitions (4a, 4b, 4c) are provided in said hot-metal runner (1) at prescribed intervals at right angles to the flowing direction of molten pig iron (5) and downstream said skimmer (3), to divide said hot-metal runner (1) into at least two reaction zones (6a, 6b, 6c), the lower end of each of said partitions (4a, 4b, 4c) being immersed into molten pig iron (5) and being spaced apart from the bottom (1a) of said hot-metal runner (1) by a distance sufficient to allow molten pig iron to pass below the corresponding partition;

that said at least one lance (8a, 8b, 8c) is associated with each one of said reaction zones (6a, 6b, 6c);

and that a branch slag runner (9a, 9b, 9c) is provided for connecting each one of said reaction zones (6a, 6b, 6c) with a slag ladle or slag disposal equipment,

whereby molten slag produced in each of said reaction zones (6a, 6b, 6c) through combination of said granular flux (16) blown through the corresponding lance (8a, 8b, 8c) into molten pig iron (5) flowing sequentially through said reaction zones (6a, 6b, 6c), with impurities contained in molten pig iron (5), is dammed up by each of said partitions (4a, 4b, 4c), separated from molten pig iron (5), and discharged through the corresponding branch slag runner (9a, 9b, 9c) from the corresponding reaction zone (6a, 6b, 6c).

2. The apparatus as claimed in Claim 1, characterized in that:

the downstream end of each branch slag runner (9a, 9b, 9c) connected to a corresponding reaction zone (6a, 6b, 6c) of said hot-metal runner (1) communicates with said slag runner (2).

3. The apparatus as claimed in Claim 1, characterized in that:

the downstream end of each branch slag runner (9a, 9b, 9c) connected to a corresponding reaction zone (6a, 6b, 6c) of said hot-metal runner (1) is independent of said slag runner (2) and communicates with a corresponding slag ladle (12a, 12b, 12c).

4. The apparatus as claimed in Claim 1, characterized in that:

it further comprises a hot-metal separator (13) which is connected with each of at least two reaction zones (6a, 6b, 6c) via corresponding branch slag runner (9a, 9b, 9c) and with said slag runner (2), and

in that the hot-metal separator (13) is connected to the downstream portion of the most downstream one of said at least two reaction zones (6a, 6b, 6c) via a branch hot-metal runner (15), and that said branch hot-metal runner is provided at its upstream end with a skimmer (14) spaced apart by a prescribed distance from the bottom of said branch hot-metal runner (15) so as to allow molten pig iron separated from molten slag contained in said separator (13) to pass through towards said most downstream one of said at least two reaction zones (6a, 6b, 6c).

5. A method for removing impurities from molten pig iron (5) tapped from a blast furnace and flowing through a hot-metal runner (1) into a hot-metal ladle, said method comprising the steps of:

damming up molten blast furnace slag (7) floating on the surface of the molten pig iron (5) by means of a skimmer (3) provided in the middle of said hot-metal runner (1), so as to separate molten blast furnace slag (7) from molten pig iron (5);

discharging molten blast furnace slag (7) separated from molten pig iron (5) by means of a slag runner (2) provided upstream of said skimmer (3); and

blowing a granular flux by means of a carrier gas into molten pig iron (5) so as to create a reaction zone between the impurities contained in molten pig iron and said granular flux; characterized by:

providing behind said skimmer (3) from upstream toward the downstream side of said hot-metal runner (1) at least two partitions (4a, 4b, 4c) to divide said hot-metal runner (1) into at least two different reaction zones (6a, 6b, 6c),

removing from said pig iron (5) simultaneously at least two kinds of impurities by blowing an appropriate granular flux means in each one of said at least two reaction zones (6a, 6b, and 6c) and by damming up and then separately discharging from molten pig iron (5) contained in the corresponding reaction zone (6a, 6b, or 6c) the slag (7a, 7b, 7c) produced as a reaction between a determined impurity contained in molten pig iron (5) and a determined kind of granular flux.

6. The method as claimed in Claim 5, characterized by:

using two reaction zones comprising, from the upstream toward the downstream of said hot-metal runner (1), a first reaction zone (6a) and a second reaction zone (6b), as said at least two different reaction zones; and

using said first reaction zone (6a) for removing silicon as one of said impurities, and said second reaction zone (6b) for removing phosphorus or sulfur as another of said impurities.

7. The method as claimed in Claim 5, characterized by:

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using two reaction zones comprising, from the upstream toward the downstream of said hot-metal runner (1), a first reaction zone (6a) and a second reaction zone (6b), as said at least two different reaction zones; and

using said first reaction zone (6a) for removing sulfur as one of said impurities, and said second reaction zone (6b) for removing silicon as another of said impurities.

8. The method as claimed in Claim 5, characterized by:

using two reaction zones (6a, 6b) as said at least two different reaction zones; and

using one of said two reaction zones (6a, 6b) for removing phosphorus as one of said impurities, and the other of said two reaction zones (6a, 6b) for removing sulfur as another of said impurities.

9. The method as claimed in Claim 5, characterized by:

using two reaction zones (6a, 6b) as said at least two different reaction zones;

using one of said two reaction zones (6a, 6b) for removing phosphorus as one of said impurities, and the other of said two reaction zones (6a, 6b) for removing sulfur as another of said impurities, and by blowing, by means of a carrier gas, a granular flux into a molten pig iron (5) covered with molten blast furnace slag (7) and located upstream of said skimmer (3) so as to remove silicon as still another of said impurities.

10. The method as claimed in Claim 5, characterized by:

using two reaction zones (6a, 6b) as said at least two different reaction zones; and

using one of said two reaction zones (6a, 6b) for removing silicon and phosphorus as said impurities, and the other of said two reaction zones (6a, 6b) for removing sulfur as another of said impurities.

11. The method as claimed in Claim 5, characterized by:

providing, starting from said skimmer (3) toward the downstream side of said hot-metal runner (1), a first reaction zone (6a), a second reaction zone (6b) and a third reaction zone (6c) as said at least two different reaction zones, said first reaction zone (6a) being used for removing silicon as one of said impurities, said second reaction zone (6b) being used for removing phosphorus or sulfur as another of said impurities, and said third reaction zone (6c) being used for removing sulfur or phosphorus as still another of said impurities.

12. The method as claimed in Claim 5, characterized by:

providing, starting from said skimmer (3) toward the downstream side of said hot-metal runner (1), a first reaction zone (6a), a second reaction zone (6b) and a third reaction zone (6c) as said at least two different reaction zones, said first reaction zone (6a) being used for removing sulfur as one of said impurities, said second reaction zone (6b) being used for removing silicon as another of said impurities, and said third reaction zone (6c) being used for removing phosphorus as still another of said impurities.

## Patentansprüche

1. Vorrichtung zum Entfernen von Verunreinigungen, die in aus einem Hochofen abgestochener Roheisenschmelze enthalten sind, umfassend:

eine Schmelzenfüllrinne (1), die aus einem Hochofen abgestochene Roheisenschmelze (5) in eine Gießpfanne leitet;

eine Schlackenfalle (3), die in der Mitte der Schmelzenfüllrinne (1) vorgesehen ist und schmelzflüssige Hochofenschlacke (7), die auf der Oberfläche der durch die Schmelzenfüllrinne (1) fließenden Roheisenschmelze schwimmt, aufstaut, so daß schmelzflüssige Hochofenschlacke (7) von der Roheisenschmelze (5) getrennt wird, wobei das Unterende der Schlackenfalle (3) in die durch die Schmelzenfüllrinne (1) fließende Roheisenschmelze (5) eintaucht und vom Boden der Schmelzenfüllrinne (1) einen ausreichenden Abstand aufweist, so daß Roheisenschmelze (5) durchfließen kann;

eine Schlackenrinne (2), die in Fließrichtung der Roheisenschmelze (5) aufstrom von der Schlackenfalle (3) in der Schmelzenfüllrinne (1) vorgesehen ist, um schmelzflüssige Hochofenschlacke (7), die mittels der Schlackenfalle (3) von der Roheisenschmelze (5) getrennt ist, abzuleiten; und

wenigstens eine Blaslanze (8a, 8b, 8c), die im wesentlichen vertikal über der Schmelzenfüllrinne (1) angeordnet ist, um mittels eines Trägergases ein Flußmittelgranulat zum Entfernen von Verunreinigungen, die in aus dem Hochofen abgestochener Roheisenschmelze (5) enthalten sind, in die durch die Schmelzenfüllrinne (1) fließende Roheisenschmelze (5) einzublasen, wobei das unterste Ende der Blaslanze (8a, 8b, 8c) einen vorbestimmten Abstand ( $H_1$ ) von der Oberfläche der durch die Schmelzenfüllrinne (1) fließenden Roheisenschmelze (5) hat;

so daß eine Vereinigung von in der Roheisenschmelze (5) enthaltenen Verunreinigungen mit dem Flußmittelgranulat, das aus der Blaslanze (8a, 8b, 8c) in die durch die Schmelzenfüllrinne (1) fließende Roheisenschmelze (5) geblasen wird, erfolgt unter Bildung von diese Verunreinigungen enthaltender schmelzflüssiger Schlacke; dadurch gekennzeichnet, daß:

in der Schmelzenfüllrinne (1) wenigstens zwei Trennelemente (4a, 4b, 4c) in vorbestimmten Abständen rechtwinklig zur Fließrichtung von Roheisenschmelze (5) und abstrom von der Schlackenfalle (3) vorgesehen sind und die Schmelzenfüllrinne (1) in wenigstens zwei Reaktionszonen (6a, 6b, 6c) unterteilen, wobei das Unterende jedes Trennelements (4a, 4b, 4c) in Roheisenschmelze (5) eintaucht und vom Boden der Schmelzenfüllrinne (1) hinreichend weit beabstandet ist, so daß Roheisenschmelze unter dem jeweiligen Trennelement durchfließen kann;

daß die wenigstens eine Blaslanze (8a, 8b, 8c) jeder der Reaktionszonen (6a, 6b, 6c) zugeordnet ist;

und daß eine Abzweig-Schlackenrinne (9a, 9b,

9c) vorgesehen ist, die jede der Reaktionszonen (6a, 6b, 6c) mit einer Schlackenpfanne oder einer Schlackenbeseitigungseinheit verbindet,

so daß schmelzflüssige Schlacke, die in jeder Reaktionszone (6a, 6b, 6c) durch Vereinigung des aus der jeweiligen Blaslanze (8a, 8b, 8c) in Roheisenschmelze (5), die sequentiell durch die Reaktionszonen (6a, 6b, 6c) fließt, eingeblasenen Flußmittelgranulats mit in der Roheisenschmelze (5) enthaltenen Verunreinigungen von jedem der Trennelemente (4a, 4b, 4c) aufgestaut, von der Roheisenschmelze (5) getrennt und durch die jeweilige Abzweig-Schlackenrinne (9a, 9b, 9c) aus der jeweiligen Reaktionszone (6a, 6b, 6c) abgeleitet wird.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß:

das Abstromende jeder mit einer entsprechenden Reaktionszone (6a, 6b, 6c) der Schmelzenfüllrinne (1) verbundenen Abzweig-Schlackenrinne (9a, 9b, 9c) mit der Schlackenrinne (2) in Verbindung steht.

3. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß:

das Abstromende jeder mit einer entsprechenden Reaktionszone (6a, 6b, 6c) der Schmelzenfüllrinne (1) verbundenen Abzweig-Schlackenrinne (9a, 9b, 9c) von der Schlackenrinne (2) unabhängig ist und mit einer jeweiligen Schlackenpfanne (12a, 12b, 12c) in Verbindung steht.

4. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß:

sie ferner einen Schmelzabscheider (13) aufweist, der mit jeder der wenigstens zwei Reaktionszonen (6a, 6b, 6c) über eine entsprechende Abzweig-Schlackenrinne (9a, 9b, 9c) und mit der Schlackenrinne (2) verbunden ist, und

daß der Schmelzabscheider (13) mit dem Abstromteil der am weitesten abstrom befindlichen der wenigstens zwei Reaktionszonen (6a, 6b, 6c) über eine Abzweig-Schmelzenfüllrinne (15) verbunden ist und die Abzweig-Schmelzenfüllrinne an ihrem Aufstromende mit einer Schlackenfalle (14) versehen ist, die vom Boden der Abzweig-Schmelzenfüllrinne (15) einen vorbestimmten Abstand aufweist, so daß Roheisenschmelze, die von im Schmelzabscheider (13) enthaltener schmelzflüssiger Schlacke getrennt ist, in Richtung zu der am weitesten stromab befindlichen der wenigstens zwei Reaktionszonen (6a, 6b, 6c) durchfließen kann.

5. Verfahren zum Entfernen von Verunreinigungen aus Roheisenschmelze (5), die aus einem Hochofen abgestochen wird und durch eine Schmelzenfüllrinne (1) in eine Gießpfanne fließt, wobei das Verfahren folgende Schritte umfaßt:

Aufstauen von auf der Oberfläche von Roheisenschmelze (5) schwimmender schmelzflüssiger Hochofenschlacke (7) mittels einer Schlackenfalle (3), die in der Mitte der Schmelzenfüllrinne (1) vorgesehen ist, um so schmelzflüssige Hochofenschlacke (7) von Roheisenschmelze (5) zu trennen;

Ableiten von schmelzflüssiger Hochofenschlacke (7), die von Roheisenschmelze (5)

getrennt ist, mittels einer Schlackenrinne (2), die aufstrom von der Schlackenfalle (3) vorgesehen ist; und

Einblasen von Flußmittelgranulat mit Hilfe eines Trägergases in Roheisenschmelze (5) unter Bildung einer Reaktionszone zwischen den in der Roheisenschmelze enthaltenen Verunreinigungen und dem Flußmittelgranulat;

gekennzeichnet durch:

Vorsehen von wenigstens zwei Trennelementen (4a, 4b, 4c) hinter der Schlackenfalle (3) von der Aufstrom- zur Abstromseite der Schmelzenfüllrinne (1), um die Schmelzenfüllrinne (1) in wenigstens zwei verschiedene Reaktionszonen (6a, 6b, 6c) zu unterteilen,

gleichzeitiges Entfernen von wenigstens zwei Verunreinigungsarten aus der Roheisenschmelze (5) durch Einblasen eines geeigneten Flußmittelgranulats in jeder der wenigstens zwei Reaktionszonen (6a, 6b und 6c) und durch aufstauen und dann getrenntes Ableiten der als Reaktion zwischen einer bestimmten, in Roheisenschmelze (5) enthaltenen Verunreinigung und einer bestimmten Art von Flußmittelgranulat erzeugten Schlacke (7a, 7b, 7c) aus der in der jeweiligen Reaktionszone (6a, 6b oder 6c) enthaltenen Roheisenschmelze (5).

6. Verfahren nach Anspruch 5, gekennzeichnet durch:

Verwendung von zwei Reaktionszonen, die von der Aufstrom- zur Abstromseite der Schmelzenfüllrinne (1) eine erste Reaktionszone (6a) und eine zweite Reaktionszone (6b) als die wenigstens zwei verschiedenen Reaktionszonen umfassen; und

Verwendung der ersten Reaktionszone (6a) zum Entfernen von Silicium als eine der Verunreinigungen und der zweiten Reaktionszone (6b) zum Entfernen von Phosphor oder Schwefel als eine weitere Verunreinigung.

7. Verfahren nach Anspruch 5, gekennzeichnet durch:

Verwendung von zwei Reaktionszonen, die von der Aufstrom- zur Abstromseite der Schmelzenfüllrinne (1) eine erste Reaktionszone (6a) und eine zweite Reaktionszone (6b) als die wenigstens zwei verschiedenen Reaktionszonen umfassen; und

Verwendung der ersten Reaktionszone (6a) zum Entfernen von Schwefel als die eine Verunreinigung und der zweiten Reaktionszone (6b) zum Entfernen von Silicium als eine weitere Verunreinigung.

8. Verfahren nach Anspruch 5, gekennzeichnet durch:

Verwendung von zwei Reaktionszonen (6a, 6b) als die wenigstens zwei verschiedenen Reaktionszonen; und

Verwendung einer der beiden Reaktionszonen (6a, 6b) zum Entfernen von Phosphor als die eine Verunreinigung und der anderen der beiden Reaktionszonen (6a, 6b) zum Entfernen von Schwefel als eine weitere Verunreinigung.

9. Verfahren nach Anspruch 5, gekennzeichnet, durch:

Verwendung von zwei Reaktionszonen (6a, 6b) als die wenigstens zwei verschiedenen Reaktionszonen;

Verwendung einer der beiden Reaktionszonen (6ad, 6b) zum Entfernen von Phosphor als die eine Verunreinigung und der anderen der beiden Reaktionszonen (6a, 6b) zum Entfernen von Schwefel als eine weitere Verunreinigung, und

Einblasen eines Flußmittelgranulats mittels eines Trägergases in Roheisenschmelze (5), die von schmelzflüssiger Hochofenschlacke (7) bedeckt ist und sich aufstrom von der Schlacken-falle (3) befindet, um Silicium als eine weitere Verunreinigung zu entfernen.

10. Verfahren nach Anspruch 5, gekennzeichnet durch:

Verwendung von zwei Reaktionszonen (6a, 6b) als die wenigstens zwei verschiedenen Reaktionszonen; und

Verwendung einer der beiden Reaktionszonen (6a, 6b) zum Entfernen von Silicium und Phosphor als die genannten Verunreinigungen und der anderen der beiden Reaktionszonen (6a, 6b) zum Entfernen von Schwefel als weitere Verunreinigung.

11. Verfahren nach Anspruch 5, gekennzeichnet durch:

Vorsehen einer ersten Reaktionszone (6a), einer zweiten Reaktionszone (6b) und einer dritten Reaktionszone (6c) als die wenigstens zwei verschiedenen reaktionszonen, und zwar ausgehend von der Schlacken-falle (3) in Richtung zur Abstromseite der Schmelzenfüllrinne (1), wobei die erste Reaktionszone (6) zum Entfernen von Silicium als eine der Verunreinigungen, die zweite Reaktionszone (6b) zum Entfernen von Phosphor oder Schwefel als eine weitere Verunreinigung und die dritte Reaktionszone (6c) zum Entfernen von Schwefel oder Phosphor als eine weitere Verunreinigung verwendet wird.

12. Verfahren nach Anspruch 5, gekennzeichnet durch:

Vorsehen einer ersten Reaktionszone (6a), einer zweiten Reaktionszone (6b) und einer dritten Reaktionszone (6c) als die wenigstens zwei verschiedenen Reaktionszonen, und zwar ausgehend von der Schlacken-falle (3) in Richtung zur Abstromseite der Schmelzenfüllrinne (1), wobei die erste Reaktionszone (6a) zum Entfernen von Schwefel als eine der Verunreinigungen, die zweite Reaktionszone (6b) zum Entfernen von Silicium als eine weitere Verunreinigung und die dritte Reaktionszone (6c) zum Entfernen von Phosphor als eine weitere Verunreinigung verwendet wird.

## Revendications

1. Appareil pour éliminer les impuretés contenues dans la fonte en fusion soutirée dans un haut fourneau, qui comprend:

une rigole à fonte (1) pour envoyer dans une poche à fonte la fonte en fusion (5) soutirée d'un haut fourneau;

un écumeur (3) prévu au milieu de ladite rigole à fonte (1), pour retenir la scorie de haut fourneau en

fusion (7) flottant sur la surface de la fonte en fusion (5) qui s'écoule dans ladite rigole à fonte (1) pour séparer la scorie de haut fourneau en fusion (7) de la fonte en fusion (5), l'extrémité inférieure dudit écumeur (3) étant immergée dans la fonte en fusion (5) qui s'écoule dans ladite rigole à fonte (1) et étant espacée du fond de ladite rigole à fonte (1) d'une distance suffisante pour permettre à la fonte en fusion (5) de circuler dans celle-ci;

une rigole à scorie (2) prévue en amont dudit écumeur (3) par rapport à la direction d'écoulement de la fonte en fusion (5) dans ladite rigole à fonte (1), pour évacuer la scorie de haut fourneau en fusion (7) séparée de la fonte en fusion (5) au moyen dudit écumeur (3); et

au moins une lance (8a, 8b, 8c) disposée de façon sensiblement verticale au-dessus de ladite rigole à fonte (1), pour insuffler, au moyen d'un gaz porteur, un flux granulaire pour éliminer les impuretés contenues dans la fonte en fusion (5) soutirée dans ledit haut fourneau, dans la fonte en fusion (5) qui s'écoule dans ladite rigole à fonte (1), l'extrémité inférieure de ladite lance (8a, 8b, 8c) étant espacée d'une distance prédéterminée ( $H_L$ ) de la surface de la fonte en fusion (5) qui s'écoule dans ladite rigole à fonte (1);

provoquant ainsi la combinaison des impuretés contenues dans la fonte en fusion (5) avec ludit flux granulaire insufflé par ladite lance (8a, 8b, 8c) dans la fonte en fusion (5) qui s'écoule dans ladite rigole à fonte (1) pour former une scorie en fusion contenant lesdites impuretés; caractérisé en ce que:

au moins deux cloisons (4a, 4b, 4c) sont prévues dans ladite rigole à fonte (1) à des intervalles prédéterminés perpendiculairement à la direction d'écoulement de la fonte en fusion (5) et en aval dudit écumeur (3), pour diviser ladite rigole à fonte (1) en au moins deux zones de réaction (6a, 6b, 6c), l'extrémité inférieure de chacune desdites cloisons (4a, 4b, 4c) étant immergée dans la fonte en fusion (4) et étant espacée du fond (1a) de ladite rigole à fonte (1) d'une distance suffisante pour permettre à la fonte en fusion de passer sous la cloison correspondante;

au moins une lance (8a, 8b, 8c) est associée avec chacune desdites zones de réaction (6a, 6b, 6c); et une rigole à scorie de dérivation (9a, 9b, 9c) est prévue pour relier chacune desdites zones de réaction (6a, 6b, 6c) à une poche à scorie ou à un équipement de rejet de scorie,

de sorte que la scorie en fusion produite dans chacune desdites zones de réaction (6a, 6b, 6c) par la combinaison dudit flux granulaire (16) insufflé par la lance correspondante (8a, 8b, 8c) dans la fonte en fusion (5) qui s'écoule de façon séquentielle à travers lesdites zones de réaction (6a, 6b, 6c), avec les impuretés contenues dans la fonte en fusion (5), est retenue par chacune desdites cloisons (4a, 4b, 4c), séparée de la fonte en fusion (5) et évacuée de la zone de réaction correspondante (6a, 6b, 6c), par la rigole à scorie de dérivation correspondante (9a, 9b, 9c).

2. Appareil selon la revendication 1, caractérisé en ce que:

l'extrémité aval de chaque rigole à scorie de dérivation (9a, 9b, 9c) reliée à une zone de réaction correspondante (6a, 6b, 6c) de ladite rigole à fonte (1) communique avec ladite rigole à scorie (2).

3. Appareil selon la revendication 1, caractérisé en ce que:

l'extrémité aval de chaque rigole à scorie de dérivation (9a, 9b, 9c) reliée à une zone de réaction correspondante (6a, 6b, 6c) de ladite rigole à fonte (1) est indépendante de ladite rigole à scorie (2) et communique avec une poche à scorie correspondante (12a, 12b, 12c).

4. Appareil selon la revendication 1, caractérisé en ce que:

il comprend en outre un séparateur de fonte (13) qui est relié à chacune d'au moins deux zones de réaction (6a, 6b, 6c) par l'intermédiaire d'une rigole à scorie de dérivation correspondante (9a, 9b, 9c) et à ladite rigole à scorie (2), et

le séparateur de fonte (13) est relié à la partie aval de celle desdites au moins deux zones de réaction (6a, 6b, 6c) qui est située le plus en aval par l'intermédiaire d'une rigole à fonte de dérivation (15), et en ce que ladite rigole à fonte de dérivation est munie à son extrémité amont d'un écumeur (14) espacé d'une distance prédéterminée du fond de ladite rigole à fonte de dérivation (15) de façon à permettre à la fonte en fusion séparée de la scorie en fusion contenue dans ledit séparateur (13) de s'écouler en direction de celle desdites au moins deux zones de réaction (6a, 6b, 6c) qui est située le plus en aval.

5. Procédé pour éliminer les impuretés de la fonte en fusion (5) soutirée d'un haut fourneau et s'écoulant dans une poche à fonte par l'intermédiaire d'une rigole à fonte (1), ledit procédé comprenant les étapes de:

retenir la scorie de haut fourneau en fusion (7) flottant sur la surface de la fonte en fusion (5) au moyen d'un écumeur (3) prévu au milieu de ladite rigole à fonte (1), de façon à séparer la scorie de haut fourneau en fusion (7) de la fonte en fusion (5);

évacuer la scorie de haut fourneau en fusion (7) séparée de la fonte en fusion (5) au moyen d'une rigole à scorie (2) prévue en amont dudit écumeur (3); et

insuffler un flux granulaire au moyen d'un gaz porteur dans la fonte en fusion (5) de façon à créer une zone de réaction entre les impuretés contenues dans la fonte en fusion et ledit flux granulaire;

caractérisé en ce que:

l'on prévoit derrière ledit écumeur (3) depuis le côté amont vers le côté aval de ladite rigole à fonte (1) au moins deux cloisons (4a, 4b, 4c) pour diviser ladite rigole à fonte (1) en au moins deux zones de réaction différentes (6a, 6b, 6c),

l'on élimine de ladite fonte (5) simultanément au moins deux types d'impuretés en insufflant un flux granulaire approprié dans chacune desdites au moins deux zones de réaction (6a, 6b et 6c) et l'on retient puis l'on évacue séparément de la fonte en fusion (5) contenue dans la zone de

réaction correspondante (6a, 6b ou 6c) la scorie (7a, 7b, 7c) produite par suite d'une réaction entre une impureté déterminée contenue dans la fonte en fusion (5) et un type déterminé de flux granulaire.

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6. Procédé selon la revendication 5, caractérisé par:

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l'utilisation de deux zones de réaction comprenant, depuis l'amont jusqu'à l'aval de ladite rigole à fonte (1), une première zone de réaction (6a) et une seconde zone de réaction (6b), comme lesdites au moins deux zones de réaction différentes; et

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l'utilisation de ladite première zone de réaction (6a) pour éliminer le silicium en tant que l'une desdites impuretés, et de ladite seconde zone de réaction (6b) pour éliminer le phosphore ou le soufre en tant qu'une autre desdites impuretés.

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7. Procédé selon la revendication 5, caractérisé par:

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l'utilisation de deux zones de réaction comprenant, depuis l'amont jusqu'à l'aval de ladite rigole à fonte (1), une première zone de réaction (6a) et une seconde zone de réaction (6b), comme lesdites au moins deux zones de réaction différentes; et

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l'utilisation de ladite première zone de réaction (6a) pour éliminer le soufre en tant que l'une desdites impuretés, et de ladite seconde zone de réaction (6b) pour éliminer le silicium en tant qu'une autre desdites impuretés.

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8. Procédé selon la revendication 5, caractérisé par:

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l'utilisation de deux zones de réaction (6a, 6b) comme lesdites au moins deux zones de réaction différentes; et

l'utilisation de l'une desdites deux zones de réaction (6a, 6b) pour éliminer le phosphore en tant que l'une desdites impuretés, et de l'autre desdites deux zones de réaction (6a, 6b) pour éliminer le soufre en tant qu'une autre desdites impuretés.

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9. Procédé selon la revendication 5, caractérisé par:

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l'utilisation de deux zones de réaction (6a, 6b) comme lesdites au moins deux zones de réaction différentes;

l'utilisation de l'une desdites deux zones de réaction (6a, 6b) pour éliminer le phosphore en tant que l'une desdites impuretés, et de l'autre desdites deux zones de réaction (6a, 6b) pour éliminer le soufre en tant qu'une autre desdites impuretés, et

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l'insufflation, au moyen d'un gaz porteur, d'un flux granulaire dans la fonte en fusion (5) recouverte par la scorie de haut fourneau en fusion (7) et située en amont dudit écumeur (3) de façon à éliminer le silicium en tant qu'encore une autre desdites impuretés.

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10. Procédé selon la revendication 5, caractérisé par:

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l'utilisation de deux zones de réaction (6a, 6b) comme lesdites au moins deux zones de réaction différentes; et

l'utilisation de l'une desdites deux zones de

réaction (6a, 6b) pour éliminer le silicium et le phosphore en tant que lesdites impuretés, et l'autre desdites deux zones de réaction (6a, 6b) pour éliminer le soufre en tant qu'une autre desdites impuretés.

11. Procédé selon la revendication 5, caractérisé par:

le fait de prévoir, en partant dudit écumeur (3) en direction du côté aval de ladite rigole à fonte (1), une première zone de réaction (6a), une seconde zone de réaction (6b) et une troisième zone de réaction (6c) comme lesdites au moins deux zones de réaction différentes, ladite première zone de réaction (6a) étant utilisée pour éliminer le silicium en tant que l'une desdites impuretés, ladite seconde zone de réaction (6b) étant utilisée pour éliminer le phosphore ou le soufre en tant qu'une autre desdites impuretés, et ladite troisième zone de réaction (6c) étant utilisée

pour éliminer le soufre ou le phosphore en tant qu'encore une autre desdites impuretés.

12. Procédé selon la revendication 5, caractérisé par:

le fait de prévoir, en partant dudit écumeur (3) en direction du côté aval de ladite rigole à fonte (1), une première zone de réaction (6a), une seconde zone de réaction (6b) et une troisième zone de réaction (6c) comme lesdites au moins deux zones de réaction différentes, ladite première zone de réaction (6a) étant utilisée pour éliminer le soufre en tant que l'une desdites impuretés, ladite seconde zone de réaction (6b) étant utilisée pour éliminer le silicium en tant qu'une autre desdites impuretés, et ladite troisième zone de réaction (6c) étant utilisée pour éliminer le phosphore en tant qu'encore une autre desdites impuretés.

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FIG. 1

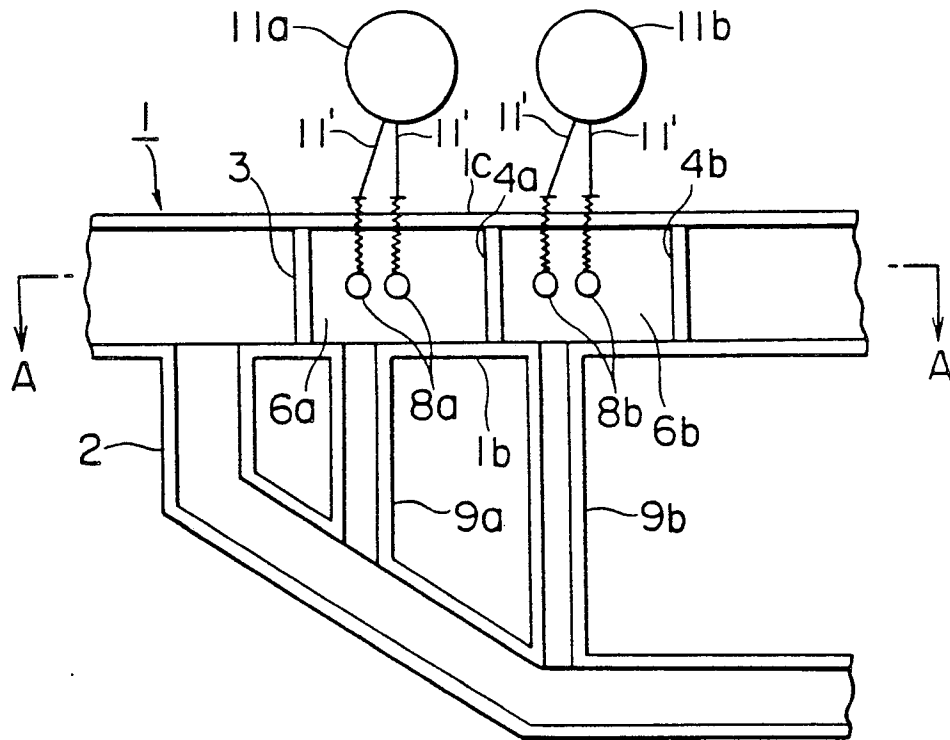


FIG. 2

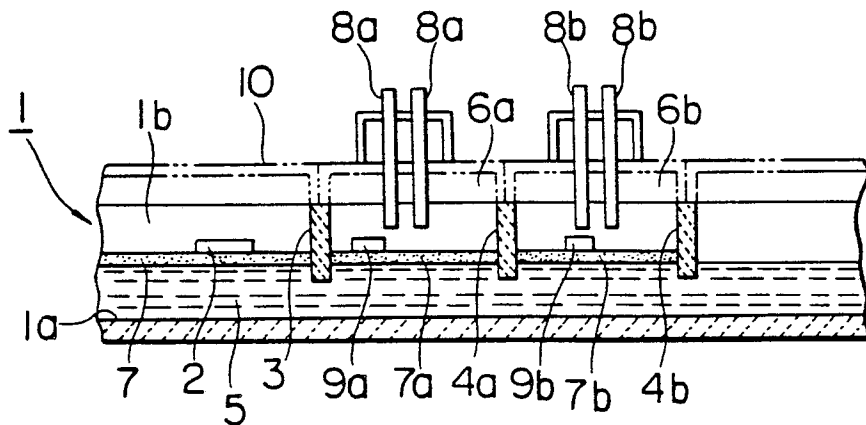


FIG. 3

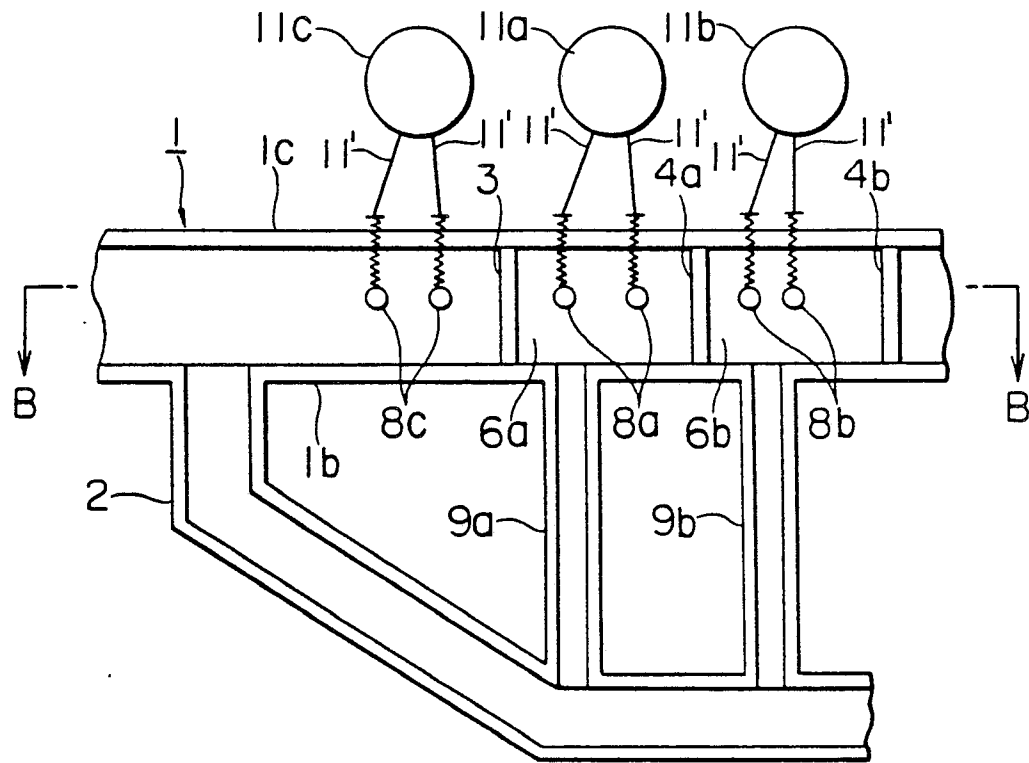


FIG. 4

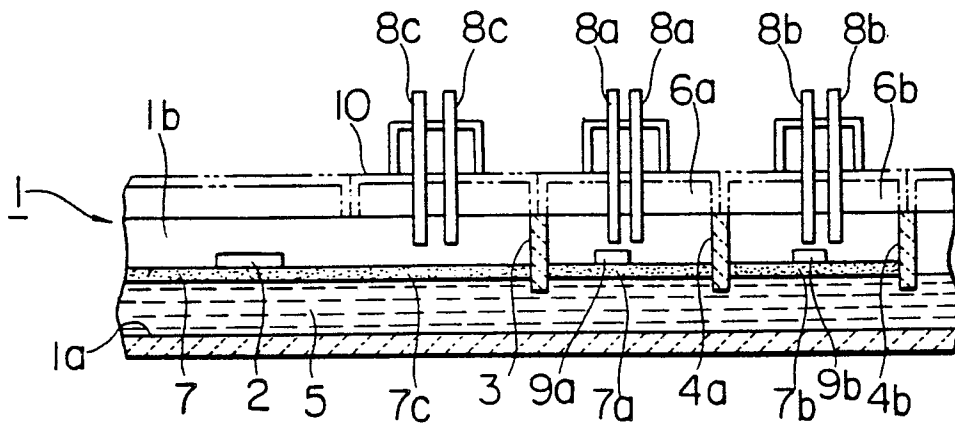


FIG. 5

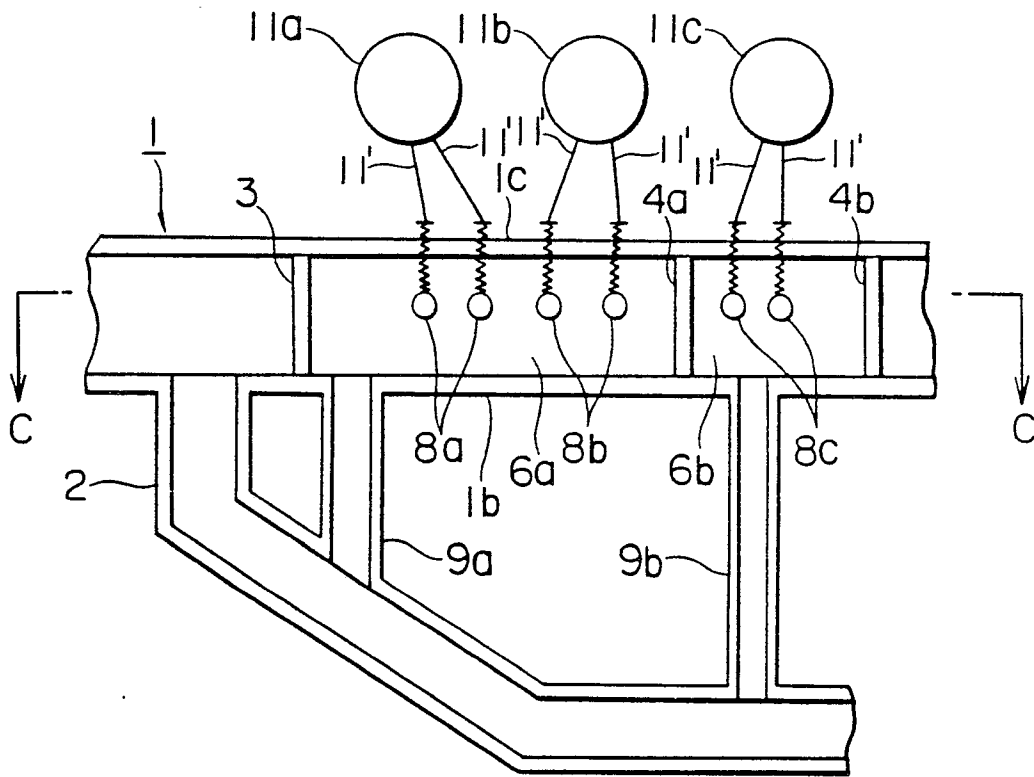


FIG. 6

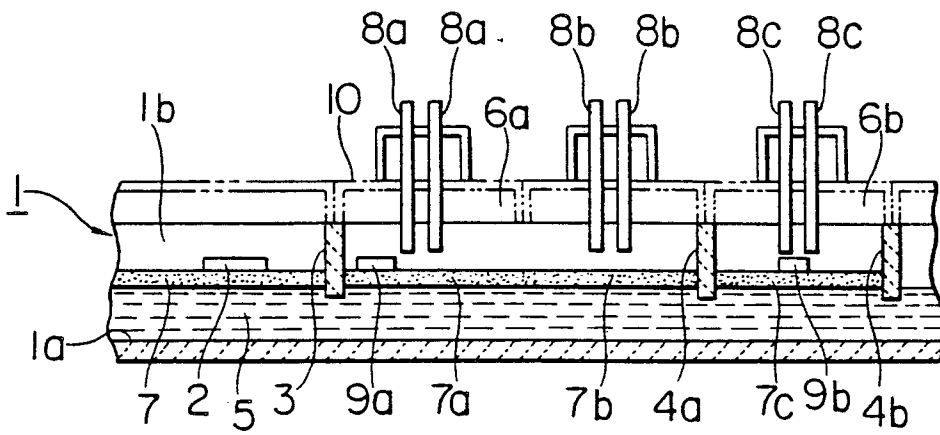




FIG. 9

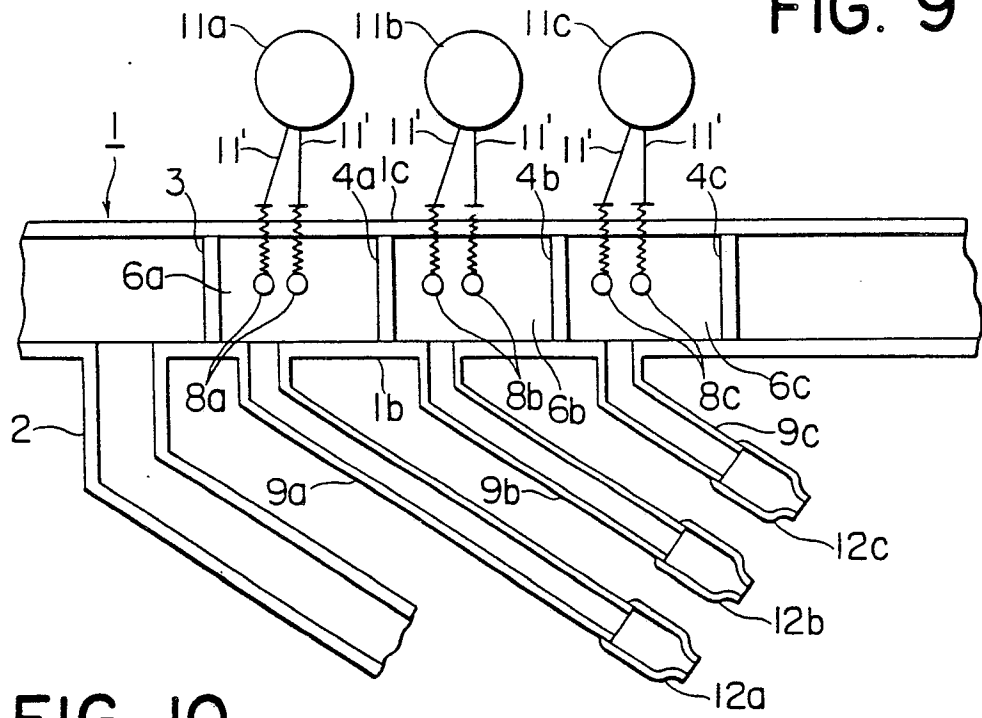


FIG. 10

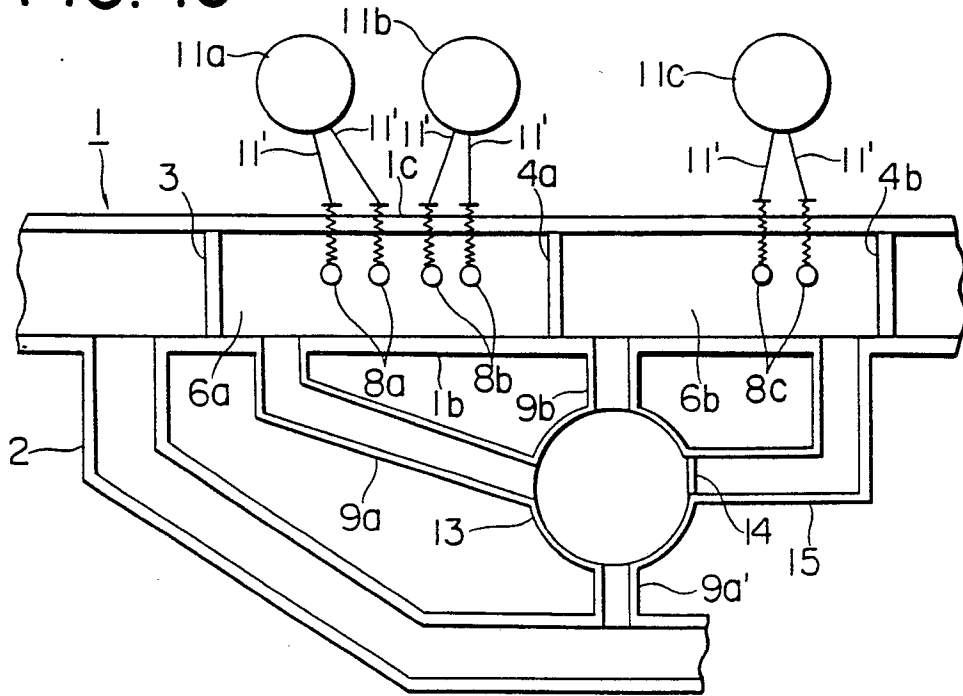


FIG. 11

