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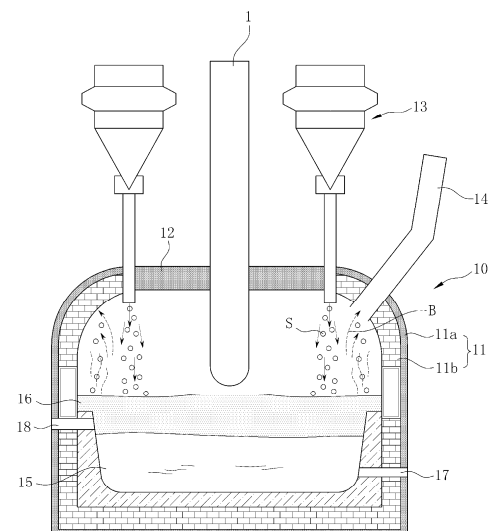
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(54) **FINE RAW MATERIAL FEEDING STRUCTURE OF ELECTRIC ARC FURNACE**

(57) A fine material charging structure for an electric furnace is disclosed. According to an aspect of the present disclosure, in a fine material charging structure for an electric furnace including a furnace body accommodating a raw material, a roof opening and closing an upper portion of the furnace body, at least one electrode rod inserted into the furnace body through the roof, and an exhaust gas duct provided in the roof, the fine material charging structure includes a supply pipe connected to a raw material hopper supplying a powder raw material and charging the powder raw material into the furnace body, wherein the supply pipe is vertically disposed toward a molten iron bath from the raw material hopper located at an upper portion of the furnace body, and a height from the molten iron bath to a distal end of the supply pipe discharging the powder raw material is provided to have a value of less than 100 times a maximum size of the powder raw material such that a loss rate of the powder raw material discharged from the supply pipe is included in a required target value.

FIG. 1



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Description

[Technical Field]

[0001] The present disclosure relates to a raw material charging structure, and more particularly, to a fine material charging structure for an electric furnace for charging a powder raw material into an electric furnace without loss.

[Background Art]

[0002] Generally, an electric arc furnace is used to melt raw materials such as scrap iron mainly using arc heat through electrode rods. On the other hand, a smelting reduction type electric furnace is configured to directly produce molten iron from raw materials in a powder state. In order to produce high-quality steel, direct reduced iron (DRI) or hot briquetted iron (HBI) is used as a raw material for the smelting reduction type electric furnace. In addition to DRI or HBI, limestone and coal in a powder state are injected and used to obtain a desired composition of molten iron. Limestone acts as a flux helping to remove impurities from steel, and coal is added to molten iron to increase the carbon content of the produced steel.

[0003] FIG. 1 illustrates a smelting reduction type electric furnace for producing molten iron by supplying a powder raw material.

[0004] Referring to FIG. 1, an electric furnace 10 includes a furnace body 11, a roof 12 opening and closing an upper portion of the furnace body 11, an electrode rod 1 inserted into the furnace body 11 through an electrode rod hole formed in the roof 12, a raw material charging chute 13 in contact with the roof 12 to inject a powder raw material S, and an exhaust gas duct 14 discharging exhaust gas generated during melting of the powder raw material S.

[0005] The furnace body 11 is composed of an iron shell 11a forming a skeleton of the furnace body 11 and a refractory layer 11b constructed inside the iron shell 11a. Inside the furnace body 11, a molten iron layer 15 (hereinafter referred to as a 'molten iron bath') formed by melting raw materials is formed, and a slag layer 16 floating on the molten iron bath 15 is formed. In addition, the furnace body 11 is provided with a slag taphole 18 penetrating a wall surface to discharge slag, and a molten iron taphole 17 discharging molten iron.

[0006] When the powder raw material S is injected into the furnace body 11 through the raw material charging chute 13, power is supplied to the electrode rod 1 to cause melting and reduction reactions.

[0007] However, when injecting the powder raw material S from the upper portion of the furnace body 11 to produce molten iron, a problem occurred in that the powder raw material S floated due to heat inside the electric furnace 10 and a suction force of the exhaust gas duct 14, and escaped to a dust collector (not shown) through an exhaust port in a direction of an arrow B

together with gas generated inside the electric furnace 10. Accordingly, loss of raw materials occurs, which not only lowers productivity but also increases raw material costs. In addition, the duct and the dust collector are clogged by the raw material escaped through the exhaust gas duct 14, thereby shortening a cycle of repair and replacement.

[Disclosure]

[Technical Problem]

[0008] An aspect of the present disclosure is to provide a fine material charging structure for an electric furnace capable of minimizing a loss of a raw material generated during molten iron production.

[Technical Solution]

[0009] According to an aspect of the present disclosure, in a fine material charging structure for an electric furnace including, a furnace body accommodating a raw material, a roof opening and closing an upper portion of the furnace body, at least one electrode rod inserted into the furnace body through the roof, and an exhaust gas duct provided in the roof, the fine material charging structure includes a supply pipe connected to a raw material hopper supplying a powder raw material and charging the powder raw material into the furnace body, wherein the supply pipe is vertically disposed toward a molten iron bath from the raw material hopper located at an upper portion of the furnace body, and a height from the molten iron bath to a distal end of the supply pipe discharging the powder raw material is provided to have a value of less than 100 times a maximum size of the powder raw material such that a loss rate of the powder raw material discharged from the supply pipe is included in a required target value.

[0010] A nozzle unit formed at a distal end portion of the supply pipe may be provided to have at least two or more nozzle holes.

[0011] A diameter of the nozzle hole may be formed to have a value of 10 times or more the maximum size of the powder raw material.

[0012] The supply pipe may be made of a graphite or ceramic material.

[0013] The supply pipe may be provided to inject an inert gas together with the powder raw material.

[0014] The supply pipe may be provided in a direction of a furnace wall of the furnace body so as to exceed 2/3 of a length from a center of the furnace body to a circular orbit connecting centers of a plurality of electrode rods.

[0015] The supply pipe may be provided to be arranged between 10° and 60° from a virtual line connecting a central portion of the furnace body and a center of the electrode rod.

[0016] When a plurality of electrode rods are provided and arranged in a line, the supply pipe may be provided to

be disposed at a position exceeding 2/3 of a distance between the electrode rod and a center of the electrode rod.

[Advantageous Effects]

[0017] The fine material charging structure for an electric furnace according to an embodiment of the present disclosure has an effect of minimizing the loss of the raw material generated during molten iron production, thereby improving the yield and quality of a final product.

[0018] In addition, the efficiency of the electric furnace facility is improved, thereby reducing operating costs, and it has an effect that can be used in various steel manufacturing application fields.

[Description of Drawings]

[0019]

FIG. 1 is a diagram showing a conventional smelting reduction type electric furnace.

FIG. 2 is a diagram showing a smelting reduction type electric furnace to which a fine material charging structure according to an embodiment of the present disclosure is applied.

FIG. 3 is a diagram showing a nozzle unit of a supply pipe provided in the fine material charging structure according to an embodiment of the present disclosure.

FIG. 4 is a graph showing a relationship of a loss rate of a raw material according to a disposition position of the supply pipe according to an embodiment of the present disclosure.

FIG. 5 is a graph showing a relationship between a size of a nozzle hole formed in the supply pipe and a nozzle clogging occurrence rate according to an embodiment of the present disclosure.

FIG. 6 is a diagram showing a state in which the supply pipe is disposed with respect to an electrode rod according to an embodiment of the present disclosure.

[Mode for Invention]

[0020] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. The following embodiments are presented to fully convey the spirit of the present disclosure to those skilled in the art to which the present disclosure pertains. The present disclosure is not limited to the embodiments presented herein but may be embodied in other forms. In the drawings, illustration of parts unrelated to the description is omitted to clarify the present disclosure, and sizes of components may be somewhat exaggerated for ease of understanding.

[0021] FIG. 2 is a diagram showing a smelting reduction type electric furnace to which a fine material charging

structure according to an embodiment of the present disclosure is applied, FIG. 3 is a diagram showing a nozzle unit of a supply pipe provided in the fine material charging structure according to an embodiment of the present disclosure, FIG. 4 is a graph showing a relationship of a loss rate of a raw material according to a disposition position of the supply pipe according to an embodiment of the present disclosure, FIG. 5 is a graph showing a relationship between a size of a nozzle hole formed in the supply pipe and a nozzle clogging occurrence rate according to an embodiment of the present disclosure, and FIG. 6 is a diagram showing a state in which the supply pipe is disposed with respect to an electrode rod according to an embodiment of the present disclosure.

[0022] Referring to FIGS. 2 to 6, a fine material charging structure according to an aspect of the present disclosure is a facility for charging a raw material S in a powder form into a smelting reduction type electric furnace (hereinafter referred to as an 'electric furnace'). Here, the electric furnace 10 is provided with the same configuration as the electric furnace 10 described above in the Background Art. However, it is different from the conventional raw material charging chute 13 for charging the powder raw material S. That is, reference numerals in the drawings shown in the present embodiment and the same reference numerals in the drawings shown in FIG. 1 indicate members performing the same functions.

[0023] The fine material charging structure according to an aspect of the present disclosure may include a supply pipe 100 inserted and installed to face the inside of the furnace body 11 to charge the powder raw material S into the furnace body 11.

[0024] One end of the supply pipe 100 may be connected to a raw material hopper 110 provided outside the furnace body 11, and the other end thereof may be provided to be close to a molten iron bath 15. At this time, a nozzle unit 120 through which the powder raw material S is discharged is provided at a distal end which is the other end of the supply pipe 100. Such a supply pipe 100 may be vertically disposed toward the molten iron bath 15 from the raw material hopper 110. Here, the molten iron bath 15 is a pool in which molten iron formed by melting raw materials is stored, and a slag layer 16 is formed on the molten iron.

[0025] The supply pipe 100 must adjust the position of the distal end of the supply pipe 100 from which the powder raw material S is discharged in order to solve the problem that the powder raw material S escapes to the exhaust gas duct 14 due to the heat inside the electric furnace 10 and the suction force of the exhaust gas duct 14 when charging the powder raw material S into the furnace body 11. This is to reduce the loss rate of the powder raw material S discharged to the exhaust gas duct 14 together with the exhaust gas. The height of the distal end of such a supply pipe 100 may be set according to the maximum size (diameter) of the powder raw material S. At this time, the powder raw material S may be

prepared as direct reduced iron (DRI) or hot briquetted iron (HBI), and limestone and carbonaceous material in a powder state.

[0026] More specifically, the height of the distal end of the supply pipe 100 refers to a distance spaced upward from the molten iron bath 15 based on the molten iron bath 15. Referring to FIG. 4, the height from the molten iron bath 15 to the distal end of the supply pipe 100 may be determined as "nozzle unit height/raw material maximum diameter". That is, the distance between the molten iron bath 15 and the distal end of the supply pipe 100 is preferably provided to have a value of less than 100 times the maximum size of the powder raw material. Setting the height of the distal end (nozzle unit) of such a supply pipe 100 may be set according to the maximum diameter of the raw material as described above. For example, when the diameter of the largest raw material among the powder raw materials S is 10 mm, the distance between the supply pipe 100 and the molten iron bath 15 may be set to 1,000 mm (1 m).

[0027] This is because, as shown in FIG. 4, when the distance between the molten iron bath 15 and the distal end of the supply pipe 100 is 100 times or more, the amount of the powder raw material sucked and discharged into the exhaust gas duct 14 increases, thereby increasing the raw material loss rate. In addition, when the distance between the molten iron bath 15 and the distal end of the supply pipe 100 is less than 100 times, the raw material loss rate is the same as 0%, so there is no need to unnecessarily dispose the supply pipe 100 close to the molten iron bath 15. This is because, in a case where the supply pipe 100 is unnecessarily disposed close to the molten iron bath 15, the probability of damage (thermal deformation, etc.) to the supply pipe 100 increases due to high temperature. Therefore, it is preferable that the loss rate of the powder raw material S is set to be included in a required target value (0%). Accordingly, it should be understood that the height of the supply pipe 100 also satisfies requirements for preventing damage to the supply pipe 100 provided in the high-temperature electric furnace 10.

[0028] Meanwhile, as the supply pipe 100 is disposed close to high-temperature slag and melt, it may be formed of a graphite or ceramic material capable of withstanding high temperature without melting. More specifically, it is preferable to form the material of the nozzle unit 120 formed at the distal end of the supply pipe 100 with a graphite or ceramic material capable of withstanding high temperature.

[0029] The nozzle unit 120 is formed at the distal end portion of the supply pipe 100 and may be provided to have at least two or more nozzle holes 121. The powder raw material S may be discharged through each nozzle hole 121. This is to prevent the raw material from accumulating in one place when charging the powder raw material S through the nozzle unit 120. This is because, in a case where the powder raw material S accumulates in one place and a portion exposed to the outside increases,

it is easy to be reoxidized. Accordingly, by injecting the powder raw material S through the plurality of nozzle holes 121 so as to spread widely, reoxidation properties can be minimized. In addition, by charging the raw material close to the molten iron bath 15 through the nozzle unit 120, the time exposed to the outside can be reduced.

[0030] The diameter of the nozzle hole 121 of such a nozzle unit 120 may be formed to have a set size. This is because, in a case where the size of the nozzle unit 120 is formed too small, the nozzle hole 121 is clogged, so that the powder raw material S cannot be smoothly injected. Referring to FIG. 5, the diameter (mm) of the nozzle hole 121 may be determined as "nozzle hole diameter/raw material maximum diameter". That is, the diameter of the nozzle hole 121 is preferably formed to have a value of 10 times or more the maximum size of the powder raw material. The diameter of such a nozzle hole 121 is set according to the clogging occurrence rate of the nozzle hole 121, and this is because when the nozzle hole 121 is 10 times or more the maximum diameter of the raw material, the nozzle clogging occurrence rate is less than 10%, which is included in the required target value. Accordingly, as shown in FIG. 5, the nozzle hole 121 is preferably formed to have 10 to 20 times the maximum diameter of the raw material.

[0031] Meanwhile, the supply pipe 100 may be provided to inject an inert gas such as argon, carbon dioxide, or nitrogen gas together with the powder raw material S. For example, the supply pipe 100 may be connected to be connected to a pneumatic conveying pipe (not shown) providing an inert gas. Accordingly, the inert gas may be provided to be discharged through any one of the plurality of nozzle holes 121.

[0032] In addition, the supply pipe 100 may be provided to be biased from the electrode rod 1 in a direction of a wall surface (refractory layer) of the furnace body 11. At this time, at least one electrode rod 1 is provided in the electric furnace 10, and usually, three 3-phase (RST) electrode rods 1a, 1b, and 1c are provided and used. These 3-phase electrode rods 1a, 1b, and 1c are radially disposed from the center of the furnace body 11 (refer to 'C' in FIG. 6). Referring to FIG. 6, the supply pipe 100 may be provided in the direction of the furnace wall of the furnace body 11 so as to exceed 2/3 of a length A from the center C of the furnace body 11 to a circular orbit O connecting centers of the plurality of electrode rods 1a, 1b, and 1c. In addition, the supply pipe 100 may be provided to be arranged between 10° and 60° from a virtual line connecting the center C of the furnace body 11 and the center of each electrode rod 1a, 1b, and 1c. This is to prevent the supply pipe 100 from being thermally deformed by arc heat generated when melting the raw material by receiving power. In addition, this is because, in a case where the raw material is injected into the same position as the electrode rod, the raw material contacts the electrode rods 1a, 1b, and 1c, causing a short circuit, and power supply may become unstable.

[0033] Meanwhile, although it has been illustrated and

described in FIG. 6 that three electrode rods 1a, 1b, and 1c are provided, the present disclosure is not limited thereto, and one electrode rod or a plurality of electrode rods may be arranged in a line and used. For example, when one electrode rod 1 is provided, the supply pipe 100 may be positioned between the electrode rod 1 and the furnace wall, but closer to the furnace wall than the electrode rod 1 to inject the powder raw material. In addition, when a plurality of electrode rods are arranged in a line, the supply pipe 100 may be configured to be disposed at a position exceeding 2/3 of a distance between the center of the electrode rod and the center of a neighboring electrode rod. At this time, the supply pipe 100 may be disposed between the electrode rod and the electrode rod.

[0034] As described above, a method for producing molten iron through the fine material charging structure according to an aspect of the present disclosure in the electric furnace 10 provided with at least one electrode rod 1 will be briefly described.

[0035] First, raw materials such as scrap are charged into the furnace body 11, and at the same time, fluxes such as lime and silica sand are charged.

[0036] Next, a 3-phase AC voltage is applied to the electrode rod 1 to form an arc between the electrode rod 1 and the scrap to melt the raw material. Accordingly, a molten iron bath 15 is formed in the furnace body 11, and a slag layer 16 is formed thereon.

[0037] When the molten iron bath 15 is formed, powder raw materials (DRI, limestone, coal, etc.) are injected together with an inert gas through the supply pipe 100. At this time, the charging speed of the powder raw material S is controlled to minimize exposure to an oxidizing atmosphere. For example, in a case where the speed of the powder raw material S injected through the supply pipe 100 is fast, the input amount also increases. This is because the speed of dissolving the powder raw material S through the electrode rod 1 becomes slow, thereby increasing the exposure time of the powder raw material S. Accordingly, by controlling the supply speed and supply amount of the powder raw material S in accordance with the speed of dissolving the powder raw material S through the electrode rod 1, reoxidation can be minimized.

[0038] As described above, power is supplied to the electrode rod 1 while continuously supplying the powder raw material S so that melting and reduction reactions of the powder raw material S occur, thereby producing molten iron having a saturated carbon concentration.

[0039] Meanwhile, while monitoring and adjusting the operation of the electric furnace 10, the power input value to the electrode rod 1, the flow rate of the powder raw material, and the position of the input port (height and disposition position of the supply pipe) can be adjusted.

[0040] As described above, although the present invention has been described by limited embodiments and drawings, the present invention is not limited thereto, and various modifications and variations are possible by

those of ordinary skill in the art to which the present invention pertains within the technical spirit of the present invention and the equivalent scope of the claims to be described below.

Claims

1. A fine material charging structure for an electric furnace including a furnace body accommodating a raw material, a roof opening and closing an upper portion of the furnace body, at least one electrode rod inserted into the furnace body through the roof, and an exhaust gas duct provided in the roof, the fine material charging structure comprising:

a supply pipe connected to a raw material hopper supplying a powder raw material and charging the powder raw material into the furnace body,

wherein the supply pipe is vertically disposed toward a molten iron bath from the raw material hopper located at an upper portion of the furnace body, and

a height from the molten iron bath to a distal end of the supply pipe discharging the powder raw material is provided to have a value of less than 100 times a maximum size of the powder raw material such that a loss rate of the powder raw material discharged from the supply pipe is included in a required target value.

2. The fine material charging structure for an electric furnace of claim 1, wherein a nozzle unit formed at a distal end portion of the supply pipe is provided to have at least two or more nozzle holes.

3. The fine material charging structure for an electric furnace of claim 2, wherein a diameter of the nozzle hole is formed to have a value of 10 times or more the maximum size of the powder raw material.

4. The fine material charging structure for an electric furnace of claim 1, wherein the supply pipe is made of a graphite or ceramic material.

5. The fine material charging structure for an electric furnace of claim 1, wherein the supply pipe is provided to inject an inert gas together with the powder raw material.

6. The fine material charging structure for an electric furnace of claim 1, wherein the supply pipe is provided in a direction of a furnace wall of the furnace body so as to exceed 2/3

of a length from a center of the furnace body to a circular orbit connecting centers of a plurality of electrode rods.

7. The fine material charging structure for an electric furnace of claim 1, wherein the supply pipe is provided to be arranged between 10° and 60° from a virtual line connecting a central portion of the furnace body and a center of the electrode rod. 5 10

8. The fine material charging structure for an electric furnace of claim 1, wherein, when a plurality of electrode rods are provided and arranged in a line, the supply pipe is provided to be disposed at a position exceeding $2/3$ of a distance between a center of one the electrode rod and a center of an adjacent electrode rod. 15 20

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FIG. 1

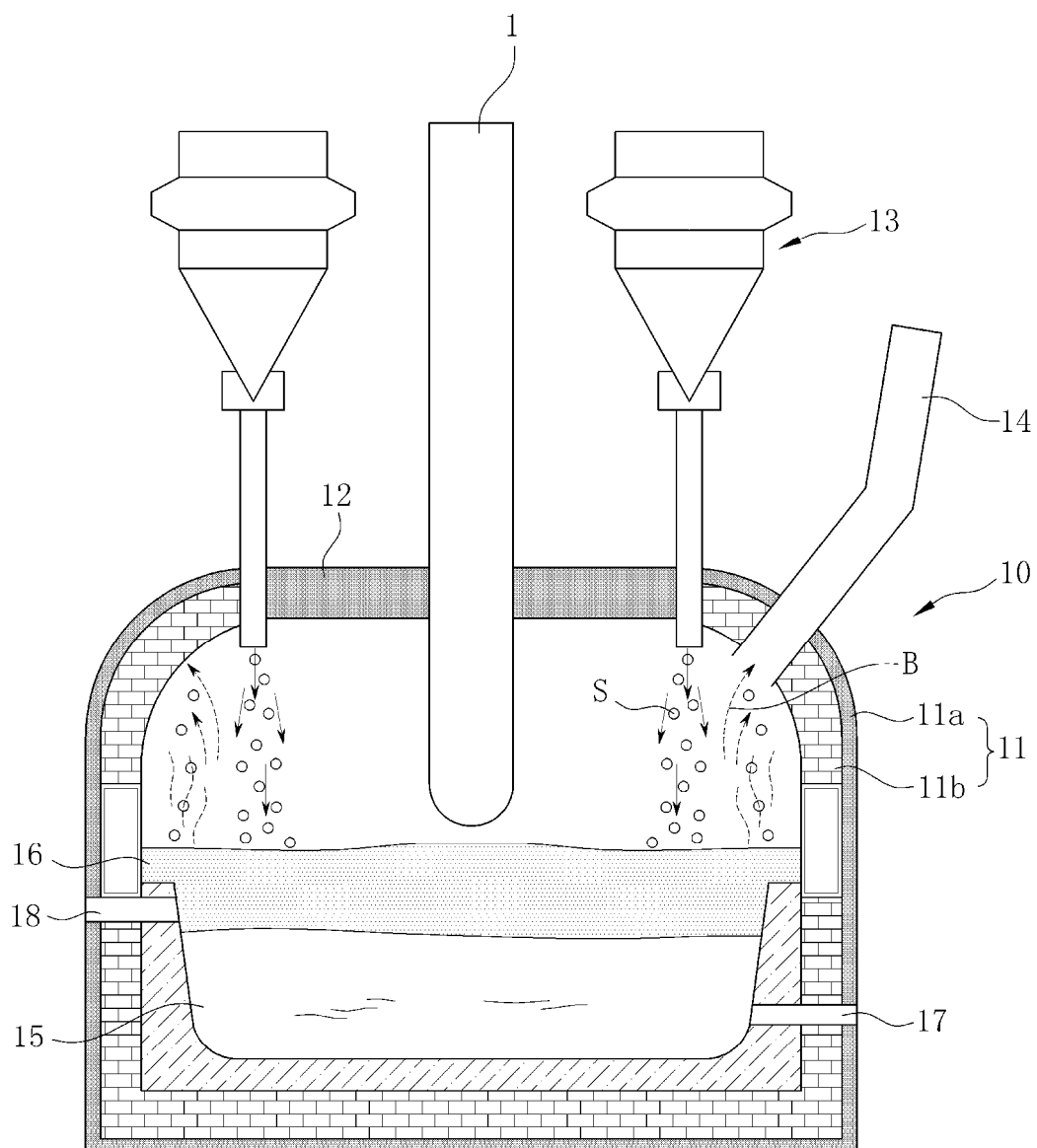


FIG. 2

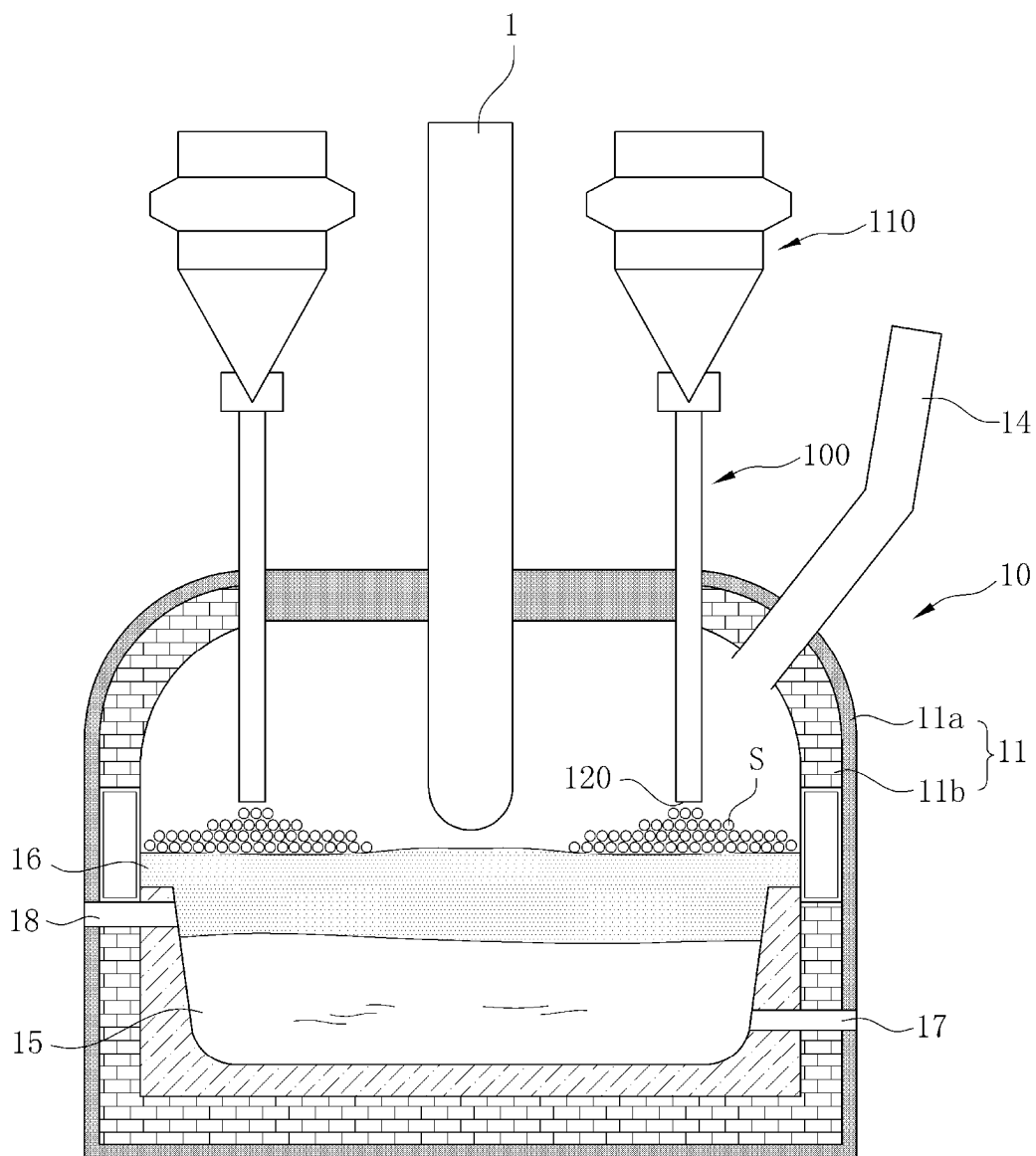


FIG. 3

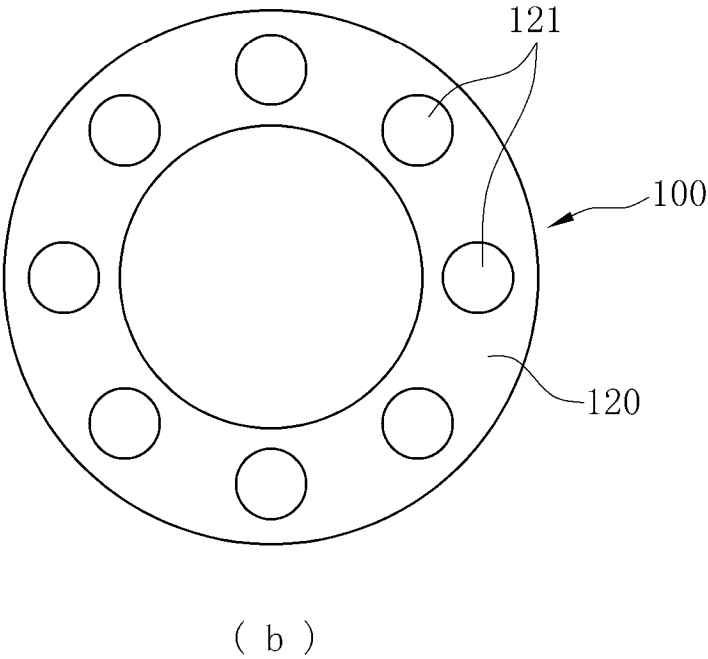
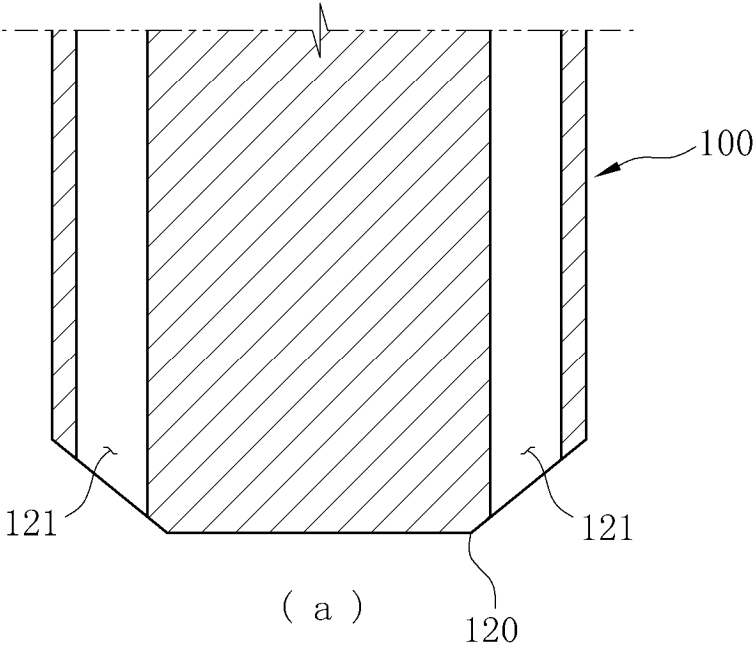


FIG. 4

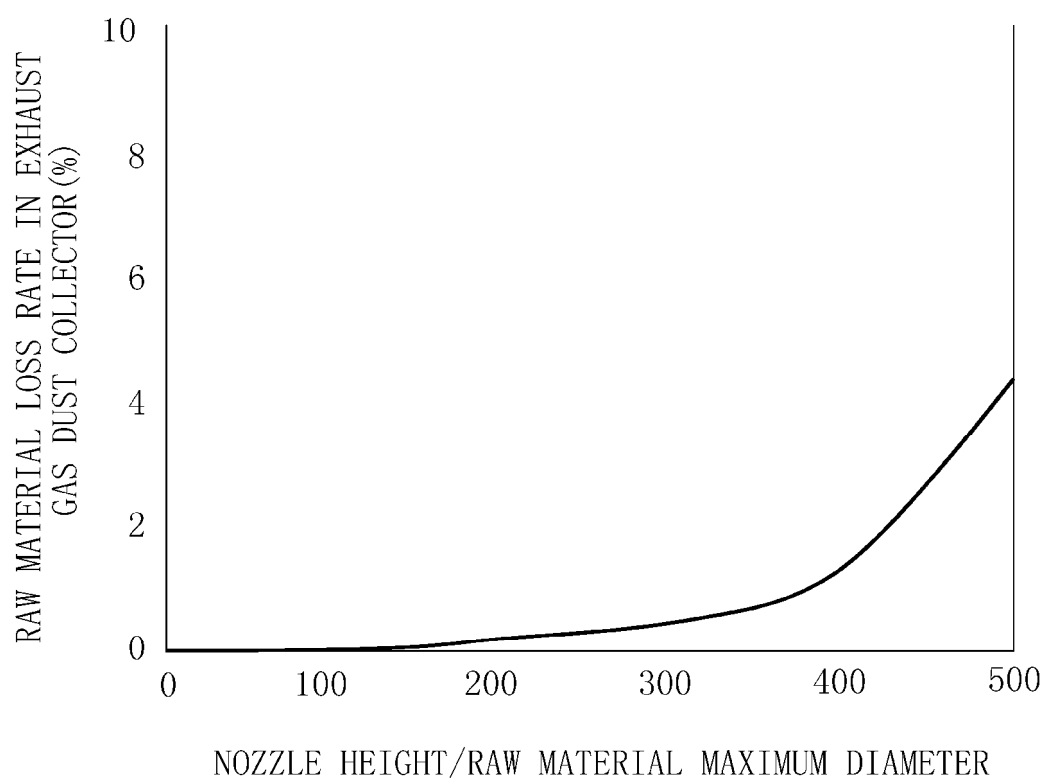


FIG. 5

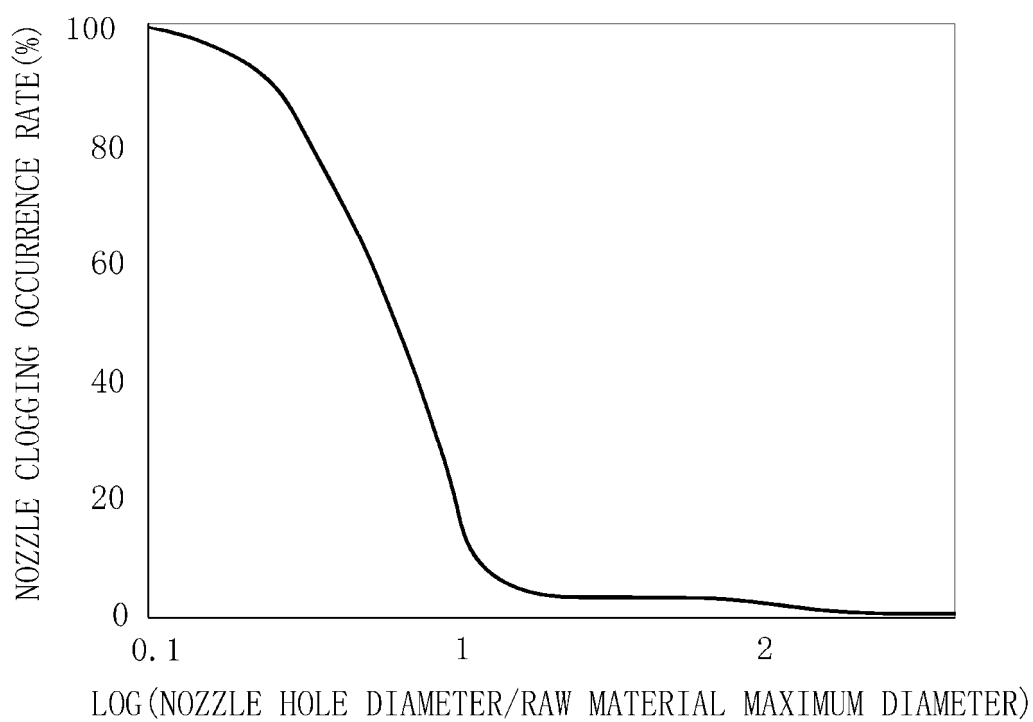
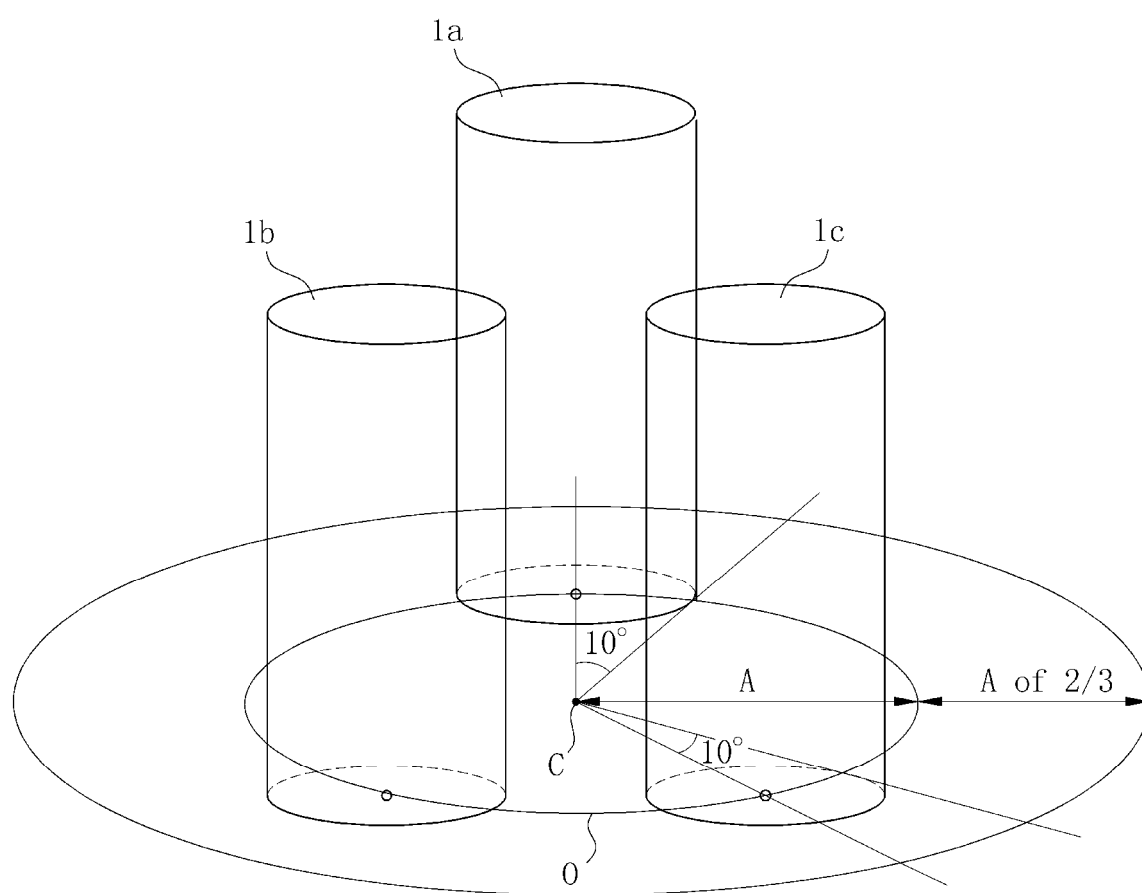


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER**C21B 5/00**(2006.01)i; **F27B 1/20**(2006.01)i; **F27D 3/00**(2006.01)i; **C21B 13/12**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C21B 5/00(2006.01); B05B 1/02(2006.01); C21B 11/00(2006.01); C21B 13/10(2006.01); C21C 5/46(2006.01);
C21C 5/52(2006.01); C22B 15/00(2006.01); F27D 1/16(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above

Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 전기로(furnace), 루프(roof), 파이프(pipe), 노즐 구멍(nozzle hole), 그래파이트(graphite), 세라믹(ceramic), 불활성 가스(inert gas)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	JP 07-218147 A (KAWASAKI STEEL CORP.) 18 August 1995 (1995-08-18) See paragraphs [0011]-[0012] and figures 1-4.	2-5
A	JP 2001-011514 A (NKK CORP.) 16 January 2001 (2001-01-16) See paragraphs [0027]-[0030] and figures 1-3.	1-8
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A	US 5366537 A (SCHLICHTING, Mark R.) 22 November 1994 (1994-11-22) See column 5, line 18 – column 6, line 59 and figures 3-5.	1-8

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

13 March 2025

Date of mailing of the international search report

14 March 2025

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2024/019116

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