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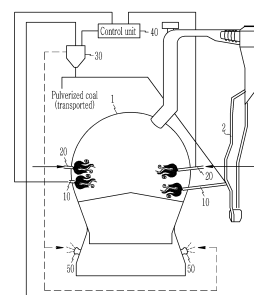
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(54) **APPARATUS FOR BLOWING DUST COAL OF MELTING FURNACE, AND BLOWING METHOD THEREFOR**

(57) To inject pulverized coal into an upper portion of a bed of a melting furnace to enhance an oxidation degree of reduced gas generated in the melting furnace and improve an ore reduction rate, thereby lowering a portion of carbon dioxide and increasing a portion of carbon dioxide in the melting furnace, provided are a pulverized coal injecting apparatus of a melting furnace including at least one pulverized coal injecting burner which is installed at an upper portion of a bed of a melting furnace; and a control unit which controls an injecting amount of pulverized coal supplied to the pulverized coal injecting burner and a pulverized coal injecting method including: injecting pulverized coal using a pulverized coal injecting burner installed in the melting furnace; and controlling an environment of injecting the pulverized coal

into the melting furnace.

FIG. 1



Description**[Technical Field]**

5 **[0001]** The present disclosure relates to a pulverized coal injecting apparatus which injects pulverized coal into an upper portion of a bed of a melting furnace and an injecting method thereof.

[Background Art]

10 **[0002]** Generally, a dust burner is equipment which collects iron ore dust and coal dust generated in the melting furnace using a hot cyclone and combusts the iron ore dust and coal dust to be reinjected into the upper portion of the bed in the melting furnace.

15 **[0003]** The dust generated in the melting furnace flows into the hot cyclone which is dust removal equipment and then is separated by a principle of the cyclone to flow in a lower pipe. The dust is transferred into the furnace by injection nitrogen in the dust burner and then meets oxygen injected from the front end of the dust burner to be combusted and reinjected into the furnace.

20 **[0004]** As described above, an amount of carbon monoxide (CO) gas which is reduced gas is increased due to carbon combustion phenomenon at the end portion of the dust burner and combustion heat which is generated during the combustion reaction raises a temperature of a dome of the melting furnace. However, there is a problem in that when an amount of dust which is reinjected into the melting furnace is reduced or a carbon content in the dust is reduced, oxygen is excessively injected more than a necessary oxygen amount to combust carbon in the dust so that carbon monoxide in gas which is generated from the bed of the melting furnace to rise is combusted and thus a content of carbon dioxide (CO₂) in the reduced gas is increased to lower ore reduction rate in a fluidizing furnace.

25 **[0005]** Further, there is a problem in that when carbon dioxide is rapidly increased within a short time, a reduction rate is decreased to lower a molten iron temperature.

30 **[0006]** Furthermore, a dust burner which decomposes and combusts dust and dry distillation gas generated in the melting furnace is installed in the dome of the melting furnace. When the dust burner is located too close to the bed, there is a risk that the flame of the dust burner hits an upper surface of the bed to be in contact therewith so that too much dust is generated and the dust burner is damaged. Further, when the dust burner is located too far away from the bed, there is a problem in that most of calorie generated in the dust burner is not used to raise a temperature of the bed, but is used to raise a temperature of the dome so that the temperature of the dome is unnecessarily raised and an operating efficiency of the melting furnace is deteriorated.

[DISCLOSURE]

35 **[Technical Problem]**

40 **[0007]** The present invention has been made in an effort to provide a pulverized coal injecting apparatus of a melting furnace and an injecting method thereof which inject pulverized coal into an upper portion of a bed of a melting furnace to enhance an ore reduction rate while improving an oxidation degree of a reduced gas, thereby simultaneously lowering a portion of carbon dioxide in the melting furnace and increasing a portion of carbon monoxide.

45 **[0008]** Further, the pulverized coal injecting burner which combusts the pulverized coal is installed between the dust burner of the melting furnace and the bed of the melting furnace to provide calorie to the upper portion of the bed of the melting furnace by injecting the pulverized coal and oxygen through the pulverized coal injecting burner.

[Technical Solution]

50 **[0009]** A pulverized coal injecting apparatus of a melting furnace includes: at least one pulverized coal injecting burner which is installed at an upper portion of a bed of a melting furnace; and a control unit which controls an injecting amount of pulverized coal supplied to the pulverized coal injecting burner.

[0010] The pulverized coal injecting burner may be connected to pulverized coal producing equipment to be supplied with pulverized coal or may be connected to the pulverized coal distributing valve which is installed between the pulverized coal producing equipment and a tuyere installed in the melting furnace to be supplied with the pulverized coal.

55 **[0011]** The pulverized coal injecting apparatus may further include: at least one dust burner which is provided below the pulverized coal injecting burner to selectively and additionally inject the pulverized coal into the upper portion of the bed of the melting furnace.

[0012] The dust burner may be connected to the pulverized coal producing equipment or a pulverized coal distributing valve provided between the tuyeres provided in the melting furnace to selectively and additionally inject the pulverized

coal to the melting furnace together with the dust.

[0013] The pulverized coal distributing valve may include a pulverized coal supply pipe equipped with a manual valve and an orifice which adjust an injection amount of pulverized coal.

[0014] In the pulverized coal supply pipe, a three-way valve which is remotely and automatically controlled by the control unit may be provided.

[0015] The three-way valve may have a structure of injecting inert gas to prevent the blockage of the pulverized coal supply pipe at the time of injecting the pulverized coal.

[0016] The pulverized coal injecting burner may further include an ejector which is provided at a rear end thereof to insert the inert gas into the supplied pulverized coal.

[0017] The pulverized coal injecting burner may further include a cooling water pipe into which cooling water is injected to prevent thermal damage of a front end of the pulverized coal injecting burner.

[0018] The cooling water pipe may further include an auxiliary pipe through which the inert gas is injected together with cooling water or independently.

[0019] The pulverized coal injecting burner may further include an inner pipe which is inserted therein to secure a flow rate of pulverized coal to be injected.

[0020] The pulverized coal injecting burner may have a structure in which one or more oxygen supply holes are formed therein so that the oxygen is in contact with the pulverized coal which passes through the inner pipe.

[0021] The inner pipe may be configured such that one or more supports are provided with an interval from an outer side of the inner pipe to be assembled.

[0022] The ejector may be configured such that a gas supply pipe is connected to a pulverized coal inflow pipe to insert inert gas into the supplied pulverized coal.

[0023] The cooling water pipe may be configured such that a cooling water inlet pipe and a cooling water outlet pipe connected to the pulverized coal injecting burner are separately provided in a pipe provided in the dust burner.

[0024] A pulverized coal injecting method of a melting furnace includes: injecting pulverized coal into an upper portion of a bed of a melting furnace using a pulverized coal injecting burner installed in the melting furnace; and controlling an environment of injecting the pulverized coal into the melting furnace.

[0025] The step of injecting pulverized coal and the step of controlling may further include a pipe installing step of connecting a dust burner using a separate pipe to inject the pulverized coal into the upper portion of the bed of the melting furnace; a pulverized coal injecting burner installing step of installing a pulverized coal injecting burner disposed in the same position as the dust burner above the dust burner; and a pulverized coal injecting step of injecting the pulverized coal into the upper portion of the bed of the melting furnace through the pipe and the pulverized coal injecting burner installed as described above.

[0026] In the pulverized coal injecting burner installing step, the pulverized coal injecting burner may be connected to the pulverized coal producing equipment to be supplied with the pulverized coal or connected to a pulverized coal distributing valve which is installed between the pulverized coal producing equipment and a tuyere installed in the melting furnace to be supplied with the pulverized coal.

[0027] In the pulverized coal injecting burner installing step, at least one dust burner may be installed below the pulverized coal injecting burner to selectively and additionally inject the pulverized coal into the upper portion of the bed of the melting furnace.

[0028] In the pulverized coal injecting step, the dust burner may be connected to the pulverized coal producing equipment or the pulverized coal distributing valve installed between the tuyeres provided in the melting furnace to selectively and additionally inject the pulverized coal into the melting furnace together with the dust.

[0029] In the pulverized coal injecting burner installing step, the cooling water pipe may be installed in the pulverized coal injecting burner and an auxiliary pipe may be connected to the cooling water pipe to prevent the injection of the pulverized coal at the time of leaking the cooling water and inject nitrogen for back-up.

[0030] In the step of injecting pulverized coal into the upper portion of the bed of the melting furnace, the pulverized coal may be injected by any one of processes of directly injecting the pulverized coal into the pulverized coal injecting burner, injecting the pulverized coal into the dust burner by splitting the pipe of the pulverized coal injected into the tuyere installed in the melting furnace, and injecting the pulverized coal by the dust burner through the pulverized coal injecting pipe.

[0031] In the step of injecting the pulverized coal into the upper portion of the bed of the melting furnace, a control unit which controls an injection amount of the pulverized coal may be installed to control the entire injection amount of the melting furnace by controlling a rotation speed of a rotating supply device included in the pulverized coal supply equipment to control an injection amount of the pulverized coal which is injected into the upper portion of the bed of the melting furnace.

[0032] In the step of injecting the pulverized coal into the upper portion of the bed of the melting furnace, whether the pulverized coal is injected to the dust burner and an injection amount may be calculated based on a changed amount of carbon dioxide in excess gas of the melting furnace to be measured through a flow meter.

[0033] In the meantime, a pulverized coal injecting apparatus of a melting furnace includes: a reducing furnace which

supplies reduced iron; and a melting furnace which is connected to the reducing furnace to be charged with the reduced iron and includes a bed formed of charged reduced iron, coal, and dried and distilled char formed therein and a dome filled with gas above the bed in which the melting furnace includes a dust burner which injects oxygen into the dome to decompose and combust the dust and the dried and distilled gas generated in the melting furnace and a pulverized coal injecting burner which injects the pulverized coal and oxygen into the melting furnace to combust the pulverized coal.

[0034] The dust burner may be located between the bed and the dome and may be located at a height of 2 m or higher and 3 m or lower from a surface of the bed.

[0035] A plurality of dust burners may be provided along an internal circumference of the melting furnace.

[0036] The pulverized coal injecting burner may be located between the dust burner and the bed.

[0037] The pulverized coal injecting burner may be located along an inner circumference of the melting furnace so as not to overlap the dust burner.

[0038] The pulverized coal injecting burner may be located at a height of 1.3 m or higher and 1.7 m or lower from the surface of the bed.

[0039] A ratio of oxygen injected into the dust burner and the pulverized coal injecting burner may be 6:4 to 7:3.

[0040] When the temperature of the dome is increased to approximately 1070 degrees or higher, the amount of oxygen injected into the dust burner may be adjusted to be reduced and an amount of oxygen injected into the pulverized coal injecting burner may be adjusted to be increased.

[0041] When the temperature of the dome is lowered to approximately 1030 degrees or lower, the amount of oxygen injected into the dust burner may be adjusted to be increased and an amount of oxygen injected into the pulverized coal injecting burner may be adjusted to be reduced.

[0042] The pulverized coal injecting burner may inject any one fuel of pulverized coal, liquefied natural gas, and coke oven gas to combust the pulverized coal.

[Advantageous Effects]

[0043] According to the apparatus of the exemplary embodiment of the present invention, when pulverized coal is injected into the upper portion of the bed of the melting furnace, an ore reduction rate of the fluidizing furnace is easily controlled by controlling the gas oxidation degree and thus rapid repetitive fluctuation of the molten iron temperature due to the lowering of the reduction rate may be reduced.

[0044] Further, a normal operation of the melting furnace is consistently maintained so that a quality of the molten iron may be stabilized and a molten iron producing cost may be saved.

[0045] Further, a pulverized coal injecting burner which injects pulverized coal and oxygen to combust the pulverized coal is installed between the dust burner and a surface of the bed to prevent the flame of the dust burner from hitting the upper surface of the bed to be in contact therewith to generate the dust and the dust burner from being damaged.

[0046] Further, the pulverized coal injecting burner is installed in an appropriate position so that the flame of the pulverized coal injecting burner may supply sufficient calorie to the surface of the bed without being in direct contact with the bed.

[0047] Further, an amount of oxygen injected to the dust burner at the upper portion is reduced as much as an amount of oxygen which is injected into the pulverized coal injecting burner, so that a supply amount to the dome may be constantly maintained.

[0048] Further, the combustion calorie generated in the pulverized coal injecting burner is transmitted to the bed to improve the operating efficiency of the melting furnace, thereby increasing a production amount of molten iron and reducing a ratio of a reducing agent.

[Description of the Drawings]

[0049]

FIG. 1 is a schematic view illustrating a pulverized coal injecting apparatus of a melting furnace according to the present exemplary embodiment.

FIG. 2 is a schematic view illustrating an arrangement state of a pulverized coal injecting burner according to the present exemplary embodiment.

FIG. 3 is a schematic view illustrating a structure of a pulverized coal injecting apparatus according to the present exemplary embodiment.

FIG. 4 is a schematic enlarged view illustrating an inside of a pulverized coal injecting burner according to the present exemplary embodiment.

FIG. 5 is a schematic view illustrating an internal lance of a pulverized coal injecting burner according to the present exemplary embodiment.

FIG. 6 is a schematic view illustrating a structure of an ejector of a pulverized coal injecting apparatus according to the present exemplary embodiment.

FIG. 7 is a schematic view illustrating a configuration of a cooling water pipe of a pulverized coal injecting apparatus according to the present exemplary embodiment.

FIG. 8 is a flowchart illustrating processes of a pulverized coal injecting method according to the present exemplary embodiment.

FIG. 9 is a view schematically illustrating a pulverized coal injecting apparatus of a melting furnace according to an exemplary embodiment of the present invention.

FIG. 10 is a view schematically illustrating a melting furnace according to an exemplary embodiment of the present invention.

FIG. 11 is an enlarged view of a portion "A" of FIG. 2.

FIG. 12 is a top plan view schematically illustrating a melting furnace according to an exemplary embodiment of the present invention.

FIG. 13 is a graph illustrating a temperature rising ratio of a bed of a melting furnace according to an exemplary embodiment of the present invention by comparing with a temperature rising ratio of the related art.

FIG. 14 is a graph illustrating a rising temperature of a bed of a melting furnace according to an exemplary embodiment of the present invention by comparing with a rising temperature of the related art.

FIG. 15 is a graph illustrating an effect of increasing a production amount of molten iron of a pulverized coal injecting apparatus of a melting furnace according to an exemplary embodiment of the present invention by comparing with that of the related art.

FIG. 16 is a graph illustrating an effect of reducing a coal usage rate of a pulverized coal injecting apparatus of a melting furnace according to an exemplary embodiment of the present invention by comparing with that of the related art.

[Mode for Invention]

[0050] It should be understood that the terminology used herein is for the purpose of describing particular exemplary embodiments only and is not intended to be limiting. It must be noted that, as used in the specification and the appended claims, the singular forms include plural references unless the context clearly dictates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated properties, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other properties, regions, integers, steps, operations, elements, components, and/or groups.

[0051] The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown so as to be easily understood by the person with ordinary skill in the art. As easily understood by the person with ordinary skill in the art to which the present invention pertains, the exemplary embodiments which will be described below may be variously modified without departing from the spirit and the scope of the present invention. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention and the present invention should not be construed as limited to the embodiments set forth herein.

[0052] FIG. 1 is a schematic view illustrating a pulverized coal injecting apparatus of a melting furnace according to the present exemplary embodiment.

[0053] FIG. 2 is a schematic view illustrating an arrangement state of a pulverized coal injecting burner according to the present exemplary embodiment.

[0054] As illustrated in FIGS. 1 and 2, a pulverized coal injecting apparatus which injects pulverized coal into an upper portion of a bed of a melting furnace includes a pulverized coal injecting burner 20 provided at an upper portion of a dust burner 10 installed in a melting furnace 1 to inject pulverized coal into an upper portion of a bed of the melting furnace.

[0055] To this end, the pulverized coal injecting apparatus includes a dust burner 10, a pulverized coal injecting burner 20, a pulverized coal distributing valve 30, and a control unit 40.

[0056] In the present exemplary embodiment, one or more dust burners 10 are provided along a circumferential direction of the melting furnace 1 to collect and combust the dust to reinject the dust to the upper portion of the bed of the melting furnace 1 and one or more pulverized coal injecting burners 20 are provided along a circumferential direction of the melting furnace 1 at an upper portion of the dust burner 10 to inject the pulverized coal into the upper portion of the bed of the melting furnace 1.

[0057] That is, the pulverized coal is injected to the upper portion of the bed of the melting furnace through the pulverized coal injecting burner 20 to control a gas oxidation degree through the injected pulverized coal and thus prevent the temperature of the melting furnace 1 from being lowered due to the lowering of reduction rate.

[0058] A combust medium such as LNG may be selectively injected into the pulverized coal injecting burner 20 together with the pulverized coal.

[0059] The dust burner 10 is connected to the pulverized coal distributing valve 30 through a separate pipe to inject the pulverized coal into the upper portion of the bed of the melting furnace.

[0060] Further, the pulverized coal distributing valve 30 is supplied with the pulverized coal from pulverized coal producing equipment 2 to supply an appropriate amount of pulverized coal to the pulverized coal injecting burner 20. The control unit 40 is electrically connected to the pulverized coal distributing valve 30 to control an amount of pulverized coal supplied to the pulverized coal injecting burner 20.

[0061] In the present exemplary embodiment, the pulverized coal injecting apparatus supplies the pulverized coal to the pulverized coal injecting burner 20 through the pulverized coal distributing valve 30 and controls the amount of injected pulverized coal through the control unit 40 during the process of supplying the pulverized coal.

[0062] The pulverized coal injecting burner 20 is connected to the pulverized coal producing equipment 2 to be supplied with the pulverized coal or is connected to the pulverized coal distributing valve 30 which is installed between the pulverized coal producing equipment 2 and a tuyere 50 installed in the melting furnace 1 to be supplied with the pulverized coal.

[0063] The control unit 40 is connected to the pulverized coal producing equipment 2 and the pulverized coal injecting burner 20 or the dust burner 10 through a connecting line or connected to the pulverized coal distributing valve 30 between the pulverized coal producing equipment 2 and the tuyeres 50 to control the injection of the pulverized coal.

[0064] Further, the pulverized coal injecting apparatus may further include at least one dust burner 10 which is provided below the pulverized coal injecting burner 20 to selectively and additionally inject the pulverized coal into the upper portion of the bed of the melting furnace.

[0065] The dust burner 10 may be connected to the pulverized coal producing equipment 2 or the pulverized coal distributing valve 30 provided between the tuyeres 50 provided in the melting furnace 1 to selectively and additionally inject the pulverized coal to the melting furnace 1 together with the dust.

[0066] Further, the pulverized coal injecting burners 20 are disposed with an interval of 90° along the circumferential direction of the melting furnace 1 to form the same direction as the installation position of the dust burner 10 and are installed at a height of 2.6 m to 3.2 m above the position of the dust burner 10.

[0067] As described above, the pulverized coal injecting burner 20 is installed in an optimized position of the melting furnace 1 to effectively inject the pulverized coal to the upper portion of the bed of the melting furnace.

[0068] In the meantime, the pulverized coal distributing valve 30 supplies the pulverized coal and oxygen to the tuyere 50 of the melting furnace through a pipe and splits a pipe of the pulverized coal injected to the tuyeres 50 into two branches to be connected to the dust burner 10 so that the pulverized coal may be injected into the upper portion of the bed of the melting furnace through the dust burner 10.

[0069] FIG. 3 is a schematic view illustrating a structure of a pulverized coal injecting apparatus according to the present exemplary embodiment.

[0070] As illustrated in FIG. 3, the pulverized coal distributing valve 30 may include a pulverized coal supply pipe 60 equipped with a manual valve 61 and an orifice 62 which adjust an injection amount of pulverized coal.

[0071] The orifice 62 adjusts the injection amount of pulverized coal which is injected into the melting furnace 1 by adjusting the amount of the pulverized coal supplied from the pulverized coal distributing valve 30 while passing through the orifice.

[0072] Further, in the pulverized coal supply pipe 60, a three-way valve 63 which is remotely and automatically controlled by the control unit 40 is provided. The three-way valve 63 may have a structure of injecting inert gas to prevent the blockage of the pulverized coal supply pipe 60 at the time of injecting the pulverized coal.

[0073] The inert gas may include nitrogen.

[0074] Since the pulverized coal needs to be selectively injected only when the oxygen degree of gas generated in the melting furnace 1 increases above a reference value, the three-way valve 63 which is remotely and automatically controlled by the control unit 40 is provided to inject nitrogen into the pipe when the pulverized coal is not injected.

[0075] In the present exemplary embodiment, the pulverized coal injecting burner 20 further includes an ejector 70 which is provided at a rear end thereof to insert the inert gas into the supplied pulverized coal and the ejector 70 discharges the nitrogen at a high speed to prevent blockage of the pipe.

[0076] Further, the pulverized coal injecting burner 20 further includes a cooling water pipe 80 into which the cooling water is injected to prevent thermal damage of a front end of the pulverized coal injecting burner 20 and the cooling water pipe 80 may further include an auxiliary pipe 81 through which the inert gas is injected together with cooling water or independently.

[0077] That is, the cooling water pipe 80 and the auxiliary pipe 81 installed around the pulverized coal injecting burner 20 are installed to secure the safety of the equipment. Particularly, when the cooling water is leaked from the cooling water pipe 80, the nitrogen may be injected to the cooling water pipe 80 through the auxiliary pipe 81 while automatically preventing the injection of the pulverized coal.

[0078] FIG. 4 is a schematic enlarged view illustrating an inside of a pulverized coal injecting burner according to the present exemplary embodiment.

[0079] FIG. 5 is a schematic view illustrating an internal lance of a pulverized coal injecting burner according to the present exemplary embodiment.

[0080] As illustrated in FIGS. 4 and 5, the pulverized coal injecting burner 20 may further include an inner pipe 21 which is inserted therein to secure a flow rate of pulverized coal to be injected. Further, one or more oxygen supply holes 22 are formed in the pulverized coal injecting burner 20 so that the oxygen is in contact with the pulverized coal which passes through the inner pipe 21.

[0081] Further, one or more supports are provided with an interval from an outer side of the inner pipe 21 to be assembled so that the inner pipe 21 may be easily assembled through the supports 23.

[0082] Here, the pulverized coal injecting burner 20 is provided with an inner pipe 21 whose diameter is reduced so that the flow rate of the pulverized coal which passes through the pulverized coal injecting burner 20 is increased and thus the pulverized coal and the oxygen may be easily in contact with each other.

[0083] FIG. 6 is a schematic view illustrating a structure of an ejector of a pulverized coal injecting apparatus according to the present exemplary embodiment.

[0084] As illustrated in FIG. 6, the ejector 70 has a structure in which a gas supply pipe 72 is connected to a pulverized coal inflow pipe 71 to insert the inert gas into the supplied pulverized coal. The ejector supplies the nitrogen through the gas supply pipe 72 at a high speed as if it pumps the nitrogen to prevent the blockage of the pulverized coal inflow pipe 71 into which the pulverized coal is supplied.

[0085] FIG. 7 is a schematic view illustrating a configuration of a cooling water pipe of a pulverized coal injecting apparatus according to the present exemplary embodiment.

[0086] As illustrated in FIG. 7, the cooling water pipe 80 has a structure in which a cooling water inlet pipe 80A and a cooling water outlet pipe 80B connected to the pulverized coal injecting burner 20 are separately provided in a pipe provided in the dust burner 10 so that a new cooling water pipe of the pulverized coal injecting burner 20 is further provided in addition to the cooling water pipe of the dust burner 10 which has been previously provided.

[0087] That is, the cooling water inlet pipe 80A and the cooling water outlet pipe 80B are provided with respect to the pulverized coal injecting burner 20 so that a cooling water inlet pipe 80a of the dust burner 10 and the cooling water inlet pipe 80A of the pulverized coal injecting burner 20 are connected to each other and a cooling water outlet pipe 80b of the dust burner 10 and the cooling water outlet pipe 80B of the pulverized coal injecting burner 20 are connected to each other.

[0088] The cooling water pipe 80 is provided to prevent the thermal damage of the front end of the pulverized coal injecting burner 20 so that the equipment stability is secured by injecting the cooling water.

[0089] FIG. 8 is a flowchart illustrating processes of a pulverized coal injecting method according to the present exemplary embodiment.

[0090] As illustrated in FIG. 8, a pulverized coal injecting method of a melting furnace may include a step of injecting pulverized coal into an upper portion of a bed of a melting furnace using a pulverized coal injecting burner 20 provided in the melting furnace 1 and a step of controlling an environment of injecting the pulverized coal into the melting furnace.

[0091] The step of injecting pulverized coal and the step of controlling may further include a pipe installing step S1 of connecting a dust burner 10 using a separate pipe to inject the pulverized coal into the upper portion of the bed of the melting furnace, a pulverized coal injecting burner installing step S2 of installing a pulverized coal injecting burner 20 disposed in the same position as the dust burner 10 above the dust burner 10, and a pulverized coal injecting step S3 of injecting the pulverized coal into the upper portion of the bed of the melting furnace through the pipe and the pulverized coal injecting burner 20 installed as described above.

[0092] The pulverized coal injecting method according to the present exemplary embodiment injects the pulverized coal into the upper portion of the bed of the melting furnace 1 and includes a process of installing a pipe in the dust burner 10 to use the dust burner 10, a process of independently installing the pulverized coal injecting burner 20 which injects the pulverized coal into the melting furnace 1, and a process of selectively injecting the pulverized coal into the upper portion of the bed of the melting furnace 1 using the dust burner 10 and the pulverized coal injecting burner 20 installed as described above.

[0093] Further, in the pulverized coal injecting burner installing step S2, the pulverized coal injecting burner 20 is connected to the pulverized coal producing equipment 2 to be supplied with the pulverized coal or is connected to a pulverized coal distributing valve 30 which is installed between the pulverized coal producing equipment 2 and a tuyere 50 installed in the melting furnace 1 to be supplied with the pulverized coal.

[0094] In the pulverized coal injecting burner installing step S2, at least one dust burner 10 is installed below the pulverized coal injecting burner 20 to selectively and additionally inject the pulverized coal into the upper portion of the bed of the melting furnace 1.

[0095] Further, in the pulverized coal injecting step S3, the dust burner 10 may be connected to the pulverized coal producing equipment 2 or the pulverized coal distributing valve 30 installed between the tuyeres 50 provided in the melting furnace 1 to selectively and additionally inject the pulverized coal into the melting furnace 1 together with the dust.

[0096] Further, in the pipe installing step S1, a pipe of the pulverized coal injected to the tuyeres 50 of the melting

furnace 1 is split into two branches to be connected to the dust burner 10 so that the pulverized coal may be injected through the dust burner 10.

[0097] In the pipe installing step S1, a pulverized coal injecting pipe is installed in the pulverized coal distributing valve 30 which supplies the pulverized coal to be connected to the dust burner 10 so that the pulverized coal is injected through the dust burner 10.

[0098] That is, as described above, the pulverized coal may be injected into the upper portion of the bed of the melting furnace 1 using the dust burner 10.

[0099] Further, in the pulverized coal injecting burner installing step S2, the pulverized coal injecting burner 20 are disposed with an interval of 90° along the circumferential direction of the melting furnace 1 at a height of 2.6 m to 3.2 m above the position of the dust burner 10. The pulverized coal injecting burner 20 is disposed along the circumferential direction of the melting furnace 1 in the same position as the dust burner 10 with a height difference above the dust burner 10.

[0100] Further, in the pulverized coal injecting burner installing step S2, the cooling water pipe 80 is installed in the pulverized coal injecting burner 20 and an auxiliary pipe 81 is connected to the cooling water pipe 80 to prevent the injection of the pulverized coal at the time of leaking the cooling water and inject nitrogen for back-up.

[0101] The cooling water pipe 80 and the auxiliary pipe 81 which are installed around the pulverized coal injecting burner 20 are installed to secure the safety of the equipment.

[0102] As described above, there are three methods for injecting pulverized coal into the melting furnace 1 in the present exemplary embodiment.

[0103] First, in the step S3 of injecting pulverized coal into the upper portion of the bed of the melting furnace, the pulverized coal is directly injected into the pulverized coal injecting burner 20.

[0104] Second, the pipe of the pulverized coal injected into the tuyere 50 is split to inject the pulverized coal into the dust burner 10.

[0105] Third, the pulverized coal is injected to the dust burner 10 through the pulverized coal injecting pipe.

[0106] Therefore, in the method of injecting pulverized coal into the upper portion of the bed of the melting furnace 1, the pulverized coal may be injected through any one of three processes.

[0107] In the meantime, in the step S3 of injecting the pulverized coal into the upper portion of the bed of the melting furnace, a control unit 40 which controls an injection amount of the pulverized coal is installed to control the entire injection amount of the melting furnace 1 by controlling a rotation speed of a rotating supply device included in the pulverized coal supply equipment to control an injection amount of the pulverized coal which is injected into the upper portion of the bed of the melting furnace.

[0108] Further, in the step S3 of injecting the pulverized coal into the upper portion of the bed of the melting furnace, whether the pulverized coal is injected to the dust burner 10 and an injection amount are calculated based on a changed amount of carbon dioxide in excess gas of the melting furnace 1 to be measured through a flow meter.

[0109] Here, a gas oxidation degree and an ore reduction rate in accordance with an injection amount of the pulverized coal of the dust burner 10 are represented in the following Table 1.

(Table 1)

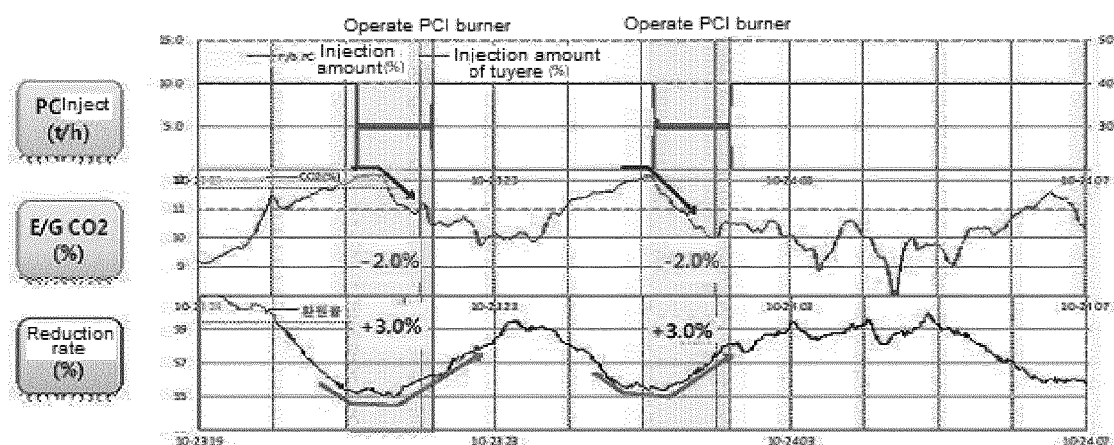
Dust Load to Hot cyclone	Recycled Dust	Carbon in dust	Comb - ution oxygen	Excess oxygen	Oxygen in PCI burner	PCI to PCI Burner (Two devices are applied)		Lowered CO ₂ in gas (oxidation degree)	increased rate of reduction rate
g/m ³	t/h	t/h	Nm ³ /h	Nm ³ /h	Nm ³ /h	t/h	(t/h) /EA	%	%
50	23	9	8,715	13,785	13,785	17.4	8.6	-5.9	9.1
					10,500	13.2	6.6	-4.5	7.0
					7,440	9.4	4.6	-3.3	5.0
					4,400	5.6	2.8	-2.0	3.0
					2,900	3.6	1.8	-1.3	2.0
					1,500	1.9	1.0	-0.7	1.0

[0110] With an equipment configuration of an injection quantity of PCI Burner oxygen of 4400 Nm³/h and PC (pulverized coal) of 5.6 t/h, it is expected to increase 3.0% of the reduction rate by lowering 2.0% of CO₂ in the reduced gas.

[0111] Further, a result of installing and operating a pulverized coal injecting apparatus in a dome of a melting furnace

is represented in the following Table 2 (a reduction rate increasing effect).

(Table 2)



[0112] It is confirmed that only when the reduction rate is lowered below 60%, the pulverized coal (PC) is selectively injected into the dome so that the lowering of the reduction rate is suppressed and when 2.0% of the E/G CO₂ is lowered, 3.0% of reduction rate is increased (a design criterion is satisfied).

[0113] Accordingly, as described above, the pulverized coal is injected into the upper portion of the bed of the melting furnace 1 to block combustion of carbon monoxide gas due to excessive oxygen and an amount of generated carbon monoxide gas is increased to drastically lower the oxidation degree of the reduced gas and thus increase the ore reduction rate of the fluidizing furnace.

[0114] Further, when the oxidation degree is rapidly increased, the injection amount of the pulverized coal is increased to supplement a content of carbon monoxide, thereby constantly maintaining the oxidation degree.

[0115] In the meantime, referring to FIG. 9, the pulverized coal injecting apparatus of a melting furnace includes a reducing furnace 7 and a melting furnace 1. In addition to this, the pulverized coal injecting apparatus of a melting furnace may further include other devices as needed. Iron ore is charged in the reducing furnace 7 to be reduced. The iron ore which is charged in the reducing furnace 7 is dried in advance and then produced as reduced iron while passing through the reducing furnace 7. The reducing furnace 7 is a packed bed type reducing furnace and is supplied with reduced gas from the melting furnace 1 to form a packed bed therein.

[0116] The melting furnace 1 is connected to the reducing furnace 7 to be supplied with reduced iron produced in the reducing furnace 7 and charged with coal briquette or coal produced in a coal briquette producing apparatus. The reduced iron and coal charged into the melting furnace 1 and dried and distilled char form a bed 3 in the melting furnace 1.

[0117] A dome 9 is formed in an upper portion of the melting furnace 1. The dome 9 is formed above the bed 3 and has a broader space than other parts of the melting furnace 1. In the dome, a reduced gas with a high temperature exists.

[0118] The coal briquette is charged into the dome 9 of the melting furnace 1 and then rapidly heated to fall down to a lower portion of the melting furnace 1. The char generated by thermal decomposition reaction of the coal briquette moves to the lower portion of the melting furnace 1 to exothermically react with oxygen supplied through the tuyere 50. As a result, the coal briquette may be used as a heat source which maintains the melting furnace 1 at a high temperature. In the meantime, since the char provides permeability, a large amount of gas generated in the lower portion of the melting furnace 1 and reduced iron supplied from the reducing furnace 7 may easily and uniformly pass through the bed 3 in the melting furnace 1.

[0119] In addition to the above-described coal briquette, bulk cinder or cokes may be charged in the melting furnace 1 as needed. The tuyere 50 is installed on an outer wall of the melting furnace 1 to inject oxygen. The oxygen is injected into the bed 3 to form a combustion zone 8. The coal briquette is combusted in the combustion zone 8 to generate reduced gas.

[0120] The melting furnace 1 includes a dust burner 10 and a pulverized coal injecting burner 20. The dust burner 10 injects oxygen into the dome 9 to decompose and combust the dust and the dried and distilled gas generated in the melting furnace 1. The dust burner 10 is located between the bed 3 and the dome 9. A plurality of dust burners may be provided along an internal circumference of the melting furnace 1.

[0121] The dust burner 10 may be installed with a predetermined distance from an upper surface of the bed 3, that is, at a height of approximately 2 m or higher and approximately 3 m or lower. When the dust burner 10 is located to be too close to the bed 3, the flame of the dust burner 10 hits the upper surface of the bed 3 to be in contact therewith so

that dust is excessively generated and a risk of damaging the dust burner 10 is increased.

[0122] In order to avoid the above-mentioned risk, the dust burner 10 is located to be approximately 2 m or higher and approximately 3 m or lower from the surface of the bed 3. In this case, most of the calorie generated in the dust burner 10 is not used to raise the temperature of the bed 3 but is used to raise the temperature of the dome 8 so that the temperature of the dome 9 is unnecessarily increased and the operating efficiency of the melting furnace 1 may be deteriorated. In order to prevent the above-described problem, the pulverized coal injecting burner 20 is located between the dust burner 10 and the bed 3.

[0123] The pulverized coal injecting burner 20 may be located at a height of approximately 1.3 m or higher and approximately 1.7 m or lower from the surface of the bed 3. The pulverized coal injecting burner 20 is located such that the flame of the pulverized coal injecting burner 20 supplies sufficient calorie to the surface of the bed 3 without being in direct contact with the bed 3. When the pulverized coal injecting burner 20 is too far away from the surface of the bed 3, heat is not effectively supplied to the bed 3. In contrast, when the pulverized coal injecting burner 20 is too close to the surface of the bed 3, the pulverized coal injecting burner 20 may be broken.

[0124] FIG. 11 is an enlarged view of a portion A of FIG. 2. The pulverized coal injecting burner 20 injects pulverized coal 5 and oxygen 6 into the melting furnace 1 to combust the pulverized coal 5. In this case, combustion heat generated in the pulverized coal injecting burner 20 by combustion flame 11 is transmitted to the bed 3 to raise the temperature of the bed 3.

[0125] In the meantime, the pulverized coal injecting burner 20 injects any one fuel of pulverized coal, liquefied natural gas, and coke oven gas to combust the pulverized coal.

[0126] FIG. 12 is a top plan view schematically illustrating a melting furnace according to an exemplary embodiment of the present invention. A plurality of dust burners 10 may be provided along an inner circumference of the melting furnace 1 and as illustrated in FIG. 12, four dust burners 10 may be installed in the dome 9. Further, the pulverized coal injecting burner 20 may be located along the inner circumference of the melting furnace 1 so as not to overlap the dust burner 10. That is, the pulverized coal injecting burner 20 may be located between dust burners 10 in a circumferential direction and four pulverized coal injecting burners 20 may be provided. When the pulverized coal injecting burners 20 are not located between dust burners 10, the dust burner 10 located above the pulverized coal injecting burner 20 may be damaged due to the combustion flame of the pulverized coal injecting burner 20.

[0127] In the meantime, the ratio of oxygen which is injected to the dust burner 10 and the pulverized coal injecting burner 20 is approximately 6:4 to approximately 7:3. When oxygen which is injected into the pulverized coal injecting burner 20 is too much, an amount of oxygen which is injected into the dust burner 10 is too small, so that volatile matter generated from the dust and coal in the dome 9 may not be sufficiently combusted or decomposed. In contrast, when an amount of oxygen injected into the pulverized coal injecting burner 20 is too small, a size of the combustion flame is reduced so that an effect of raising a temperature of the bed 3 is lowered.

[0128] The oxygen injection ratio of the pulverized coal injecting burner 20 is managed with respect to a temperature of the dome 9. When the temperature of the dome 9 is increased to approximately 1070 degrees or higher, the amount of oxygen of the dust burner 10 is reduced and an amount of oxygen of the pulverized coal injecting burner 20 is increased so that more combustion heat generated in the pulverized coal injecting burner 20 flows to the bed 3.

[0129] In contrast, when the temperature of the dome 9 is lowered to approximately 1030 degrees or lower, the amount of oxygen of the pulverized coal injecting burner 20 is reduced and an amount of oxygen of the dust burner 10 is increased so that the combustion heat generated in the dust burner 10 raises a temperature of a gas of the dome 9.

[0130] FIG. 13 is a graph illustrating a temperature rising ratio of a bed of a melting furnace according to an exemplary embodiment of the present invention by comparing with a temperature rising ratio of the related art, FIG. 14 is a graph illustrating a rising temperature of a bed of a melting furnace according to an exemplary embodiment of the present invention by comparing with a rising temperature of the related art, FIG. 15 is a graph illustrating an effect of increasing a production amount of molten iron of a pulverized coal injecting apparatus of a melting furnace according to an exemplary embodiment of the present invention by comparing with that of the related art, and FIG. 16 is a graph illustrating an effect of reducing a coal usage rate of a pulverized coal injecting apparatus of a melting furnace according to an exemplary embodiment of the present invention by comparing with that of the related art.

[0131] In order to prove the effect of the present invention, an interval between the dust burner 10 and the bed 3 of the melting furnace 1 is lowered from 3 m of the related art to 1.5 m to carry out a practical simulation test operation. As a result, as illustrated in FIG. 13, it is confirmed that a ratio of heat which raises a temperature of the dome 9, of the combustion heat generated in the dust burner 10 and the pulverized coal injecting burner 20, is reduced but a ratio of heat which raises the temperature of the bed 3 is increased from approximately 22% of the related art to approximately 31%. As a result, as illustrated in FIG. 14, the temperature of the bed 3 is increased from approximately 210 degrees of the related art to approximately 340 degrees.

[0132] A temperature rising effect of the bed 3 improves an operation performance. Therefore, it is understood that as illustrated in FIG. 15, a daily molten iron production amount is increased from approximately 5200 ton of the related art to approximately 5500 ton and as illustrated in FIG. 16, a coal usage ratio (fuel ratio) is lowered from approximately

860 kg/t-p of the related art to approximately 820 kg/t-p.

[0133] As described above, in the exemplary embodiment of the present invention, the pulverized coal injecting burner which injects pulverized coal and oxygen to combust the pulverized coal is provided between the dust burner and the surface of the bed to prevent the flame of the dust burner from hitting the upper surface of the bed to be in contact therewith to generate the dust and the dust burner from being damaged.

[0134] Further, the pulverized coal injecting burner is installed in an appropriate location so that the flame of the pulverized coal injecting burner may supply sufficient calorie to the surface of the bed without being in direct contact with the bed.

[0135] Furthermore, an amount of oxygen injected to the upper dust burner is reduced as much as an amount of oxygen which is injected into the pulverized coal injecting burner, so that a supply amount to the dome may be constantly maintained.

[0136] Further, the combust calorie generated in the pulverized coal injecting burner is transmitted to the bed to improve the operating efficiency of the melting furnace, thereby increasing a production amount of molten iron and reducing a ratio of reducing agent.

[0137] As described above, although the exemplary embodiment of the present invention has been illustrated and described, numerous variations and other exemplary embodiment can be made by those skilled in the art. All the variations and other exemplary embodiments are considered and included in the appended claims without departing from the gist and scope of the present invention.

[Industrial Applicability]

[0138] According to the apparatus of the exemplary embodiment of the present invention, when pulverized coal is injected into the upper portion of the bed of the melting furnace, an ore reduction rate of the fluidizing furnace is easily controlled by controlling the gas oxidation degree and thus rapid repetitive fluctuation of the molten iron temperature due to the lowering of the reduction rate may be reduced.

[0139] Further, a normal operation of the melting furnace is consistently maintained so that a quality of the molten iron may be stabilized and a molten iron producing cost may be saved.

Claims

1. A pulverized coal injecting apparatus of a melting furnace, the pulverized coal injecting apparatus comprising:

at least one pulverized coal injecting burner which is installed at an upper portion of a bed of a melting furnace; and a control unit which controls an injecting amount of pulverized coal supplied to the pulverized coal injecting burner.

2. The pulverized coal injecting apparatus of claim 1, wherein the pulverized coal injecting burner is connected to pulverized coal producing equipment to be supplied with pulverized coal or is connected to a pulverized coal distributing valve which is installed between the pulverized coal producing equipment and a tuyere installed in the melting furnace to be supplied with the pulverized coal.

3. The pulverized coal injecting apparatus of claim 1 or claim 2, further comprising: at least one dust burner which is provided below the pulverized coal injecting burner to selectively and additionally inject the pulverized coal into the upper portion of the bed of the melting furnace.

4. The pulverized coal injecting apparatus of claim 3, wherein the dust burner is connected to the pulverized coal producing equipment or a pulverized coal distributing valve provided between the tuyeres provided in the melting furnace to selectively and additionally inject the pulverized coal to the melting furnace together with the dust.

5. The pulverized coal injecting apparatus of claim 4, wherein the pulverized coal distributing valve includes a pulverized coal supply pipe equipped with a manual valve and an orifice which adjust an injection amount of pulverized coal.

6. The pulverized coal injecting apparatus of claim 5, wherein in the pulverized coal supply pipe, a three-way valve which is remotely and automatically controlled by the control unit is provided.

7. The pulverized coal injecting apparatus of claim 6, wherein the three-way valve has a structure of injecting inert gas to prevent the blockage of the pulverized coal supply pipe at the time of injecting the pulverized coal.

8. The pulverized coal injecting apparatus of claim 1, wherein the pulverized coal injecting burner further includes an ejector which is provided at a rear end thereof to insert inert gas into the supplied pulverized coal.
- 5 9. The pulverized coal injecting apparatus of claim 3, wherein the pulverized coal injecting burner further includes a cooling water pipe into which cooling water is injected to prevent thermal damage of a front end of the pulverized coal injecting burner.
- 10 10. The pulverized coal injecting apparatus of claim 9, wherein the cooling water pipe further includes an auxiliary pipe through which the inert gas is injected together with cooling water or independently.
- 15 11. The pulverized coal injecting apparatus of claim 1, wherein the pulverized coal injecting burner further includes an inner pipe which is inserted therein to secure a flow rate of pulverized coal to be injected.
- 20 12. The pulverized coal injecting apparatus of claim 11, wherein the pulverized coal injecting burner has a structure in which one or more oxygen supply holes are formed therein so that the oxygen is in contact with the pulverized coal which passes through the inner pipe.
- 25 13. The pulverized coal injecting apparatus of claim 11, wherein the inner pipe is configured such that one or more supports are provided with an interval from an outer side of the inner pipe to be assembled.
- 30 14. The pulverized coal injecting apparatus of claim 8, wherein the ejector is configured such that a gas supply pipe is connected to a pulverized coal inflow pipe to insert inert gas into the supplied pulverized coal.
- 35 15. The pulverized coal injecting apparatus of claim 9, wherein the cooling water pipe is configured such that a cooling water inlet pipe and a cooling water outlet pipe connected to the pulverized coal injecting burner are separately provided in a pipe provided in the dust burner.
- 40 16. A pulverized coal injecting method of a melting furnace, the pulverized coal injecting method comprising:
injecting pulverized coal into an upper portion of a bed of a melting furnace using a pulverized coal injecting burner installed in the melting furnace; and
controlling an environment of injecting the pulverized coal into the melting furnace.
- 45 17. The pulverized coal injecting method of claim 16, wherein the step of injecting pulverized coal and the step of controlling further include:
a pipe installing step S1 of connecting a dust burner using a separate pipe to inject the pulverized coal into the upper portion of the bed of the melting furnace;
a pulverized coal injecting burner installing step S2 of installing the pulverized coal injecting burner disposed
40 in the same position as the dust burner above the dust burner; and
a pulverized coal injecting step S3 of injecting the pulverized coal into the upper portion of the bed of the melting furnace through the pipe and the pulverized coal injecting burner installed as described above and a tuyere installed in the melting furnace.
- 50 18. The pulverized coal injecting method of claim 17, wherein in the pulverized coal injecting burner installing step S2, the pulverized coal injecting burner is connected to the pulverized coal producing equipment to be supplied with the pulverized coal or is connected to a pulverized coal distributing valve which is installed between the pulverized coal producing equipment and the tuyere installed in the melting furnace to be supplied with the pulverized coal.
- 55 19. The pulverized coal injecting method of claim 17, wherein In the pulverized coal injecting burner installing step S2, at least one dust burner is installed below the pulverized coal injecting burner to selectively and additionally inject the pulverized coal into the upper portion of the bed of the melting furnace.
20. The pulverized coal injecting method of claim 17, wherein in the pulverized coal injecting step S3, the dust burner is connected to the pulverized coal producing equipment or the pulverized coal distributing valve installed between the tuyeres provided in the melting furnace to selectively and additionally inject the pulverized coal into the melting furnace together with the dust.

21. The pulverized coal injecting method of claim 17, wherein in the pulverized coal injecting burner installing step S2, a cooling water pipe is installed in the pulverized coal injecting burner and an auxiliary pipe is connected to the cooling water pipe to prevent the injection of the pulverized coal at the time of leaking the cooling water and inject nitrogen for back-up.
22. The pulverized coal injecting method of claim 17, wherein in the step S3 of injecting pulverized coal into the upper portion of the bed of the melting furnace, the pulverized coal is injected by any one of processes of directly injecting the pulverized coal into the pulverized coal injecting burner, injecting the pulverized coal into the dust burner by splitting the pipe of the pulverized coal injected into the tuyere installed in the melting furnace, and injecting the pulverized coal by the dust burner through the pulverized coal injecting pipe.
23. The pulverized coal injecting method of claim 17, wherein in the step S3 of injecting the pulverized coal into the upper portion of the bed of the melting furnace, a control unit which controls an injection amount of the pulverized coal is installed to control the entire injection amount of the melting furnace by controlling a rotation speed of a rotating supply device included in the pulverized coal supply equipment to control an injection amount of the pulverized coal which is injected into the upper portion of the bed of the melting furnace.
24. The pulverized coal injecting method of claim 23, wherein in the step S3 of injecting the pulverized coal into the upper portion of the bed of the melting furnace, whether the pulverized coal is injected to the dust burner and an injection amount are calculated based on a changed amount of carbon dioxide in excess gas of the melting furnace to be measured through a flow meter.
25. A pulverized coal injecting apparatus of a melting furnace, the pulverized coal injecting apparatus comprising:
 - a reducing furnace which supplies reduced iron; and
 - a melting furnace which is connected to the reducing furnace to be charged with the reduced iron and includes a bed formed of charged reduced iron, coal, and dried and distilled char formed therein and a dome filled with gas above the bed,
 - wherein the melting furnace includes a dust burner which injects oxygen into the dome to decompose and combust the dust and the dried and distilled gas generated in the melting furnace, and
 - a pulverized coal injecting burner which injects the pulverized coal and oxygen into the melting furnace to combust the pulverized coal.
26. The pulverized coal injecting apparatus of claim 25, wherein the dust burner is located between the bed and the dome and is located at a height of 2 m or higher and 3 m or lower from a surface of the bed.
27. The pulverized coal injecting apparatus of claim 25, wherein a plurality of dust burners is provided along an internal circumference of the melting furnace.
28. The pulverized coal injecting apparatus of claim 25, wherein the pulverized coal injecting burner is located between the dust burner and the bed.
29. The pulverized coal injecting apparatus of claim 25, wherein the pulverized coal injecting burner is located along an inner circumference of the melting furnace so as not to overlap the dust burner.
30. The pulverized coal injecting apparatus of claim 25, wherein the pulverized coal injecting burner is located at a height of 1.3 m or higher and 1.7 m or lower from the surface of the bed.
31. The pulverized coal injecting apparatus of claim 25, wherein a ratio of oxygen injected into the dust burner and the pulverized coal injecting burner is 6:4 to 7:3.
32. The pulverized coal injecting apparatus of claim 31, wherein when a temperature of the dome is increased to approximately 1070 degrees or higher, an amount of oxygen injected into the dust burner is adjusted to be reduced and an amount of oxygen injected into the pulverized coal injecting burner is adjusted to be increased.
33. The pulverized coal injecting apparatus of claim 25, wherein when the temperature of the dome is lowered to approximately 1030 degrees or lower, the amount of oxygen injected into the dust burner is adjusted to be increased and the amount of oxygen injected into the pulverized coal injecting burner is adjusted to be reduced.

- 34.** The pulverized coal injecting apparatus of claim 25, wherein the pulverized coal injecting burner injects any one fuel of pulverized coal, liquefied natural gas, and coke oven gas to combust the pulverized coal.

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FIG. 1

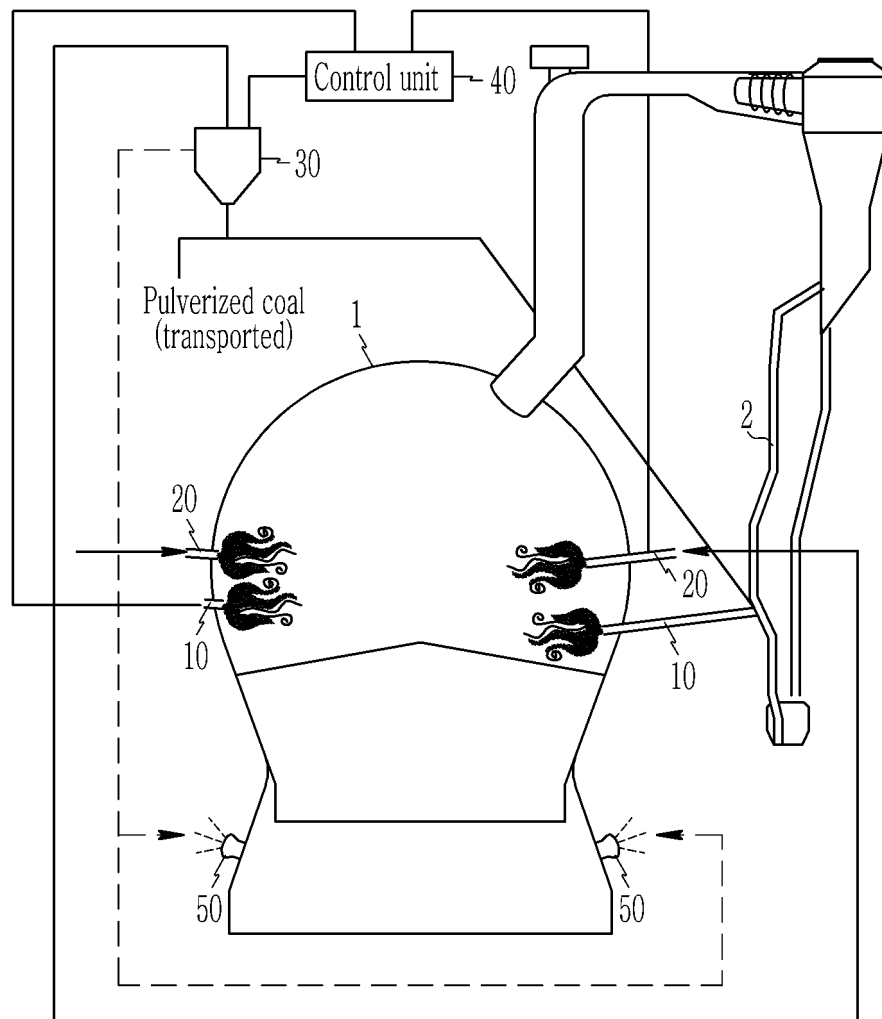


FIG. 2

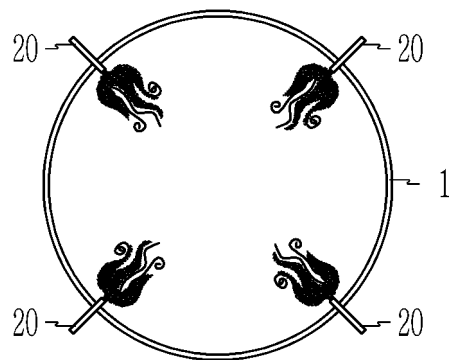


FIG. 3

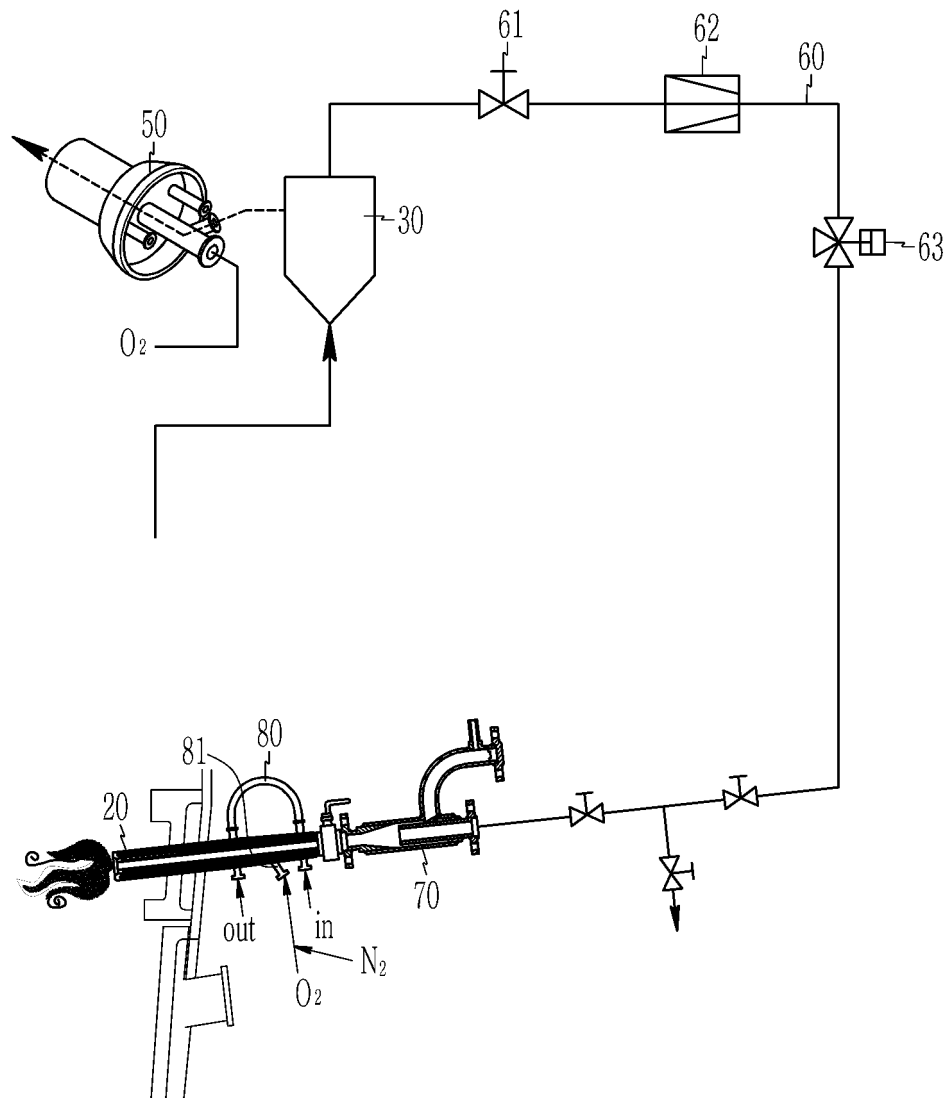


FIG. 4

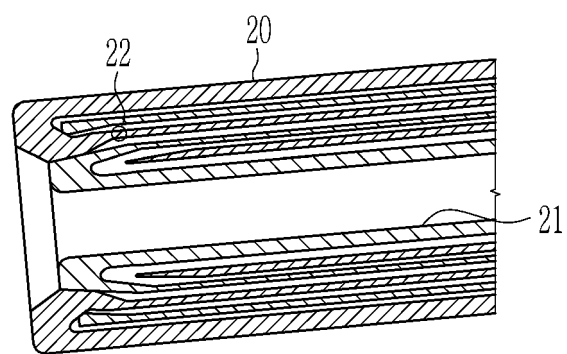


FIG. 5

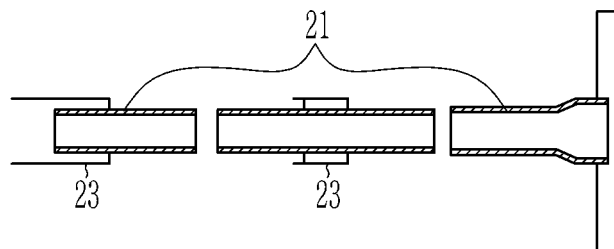


FIG. 6

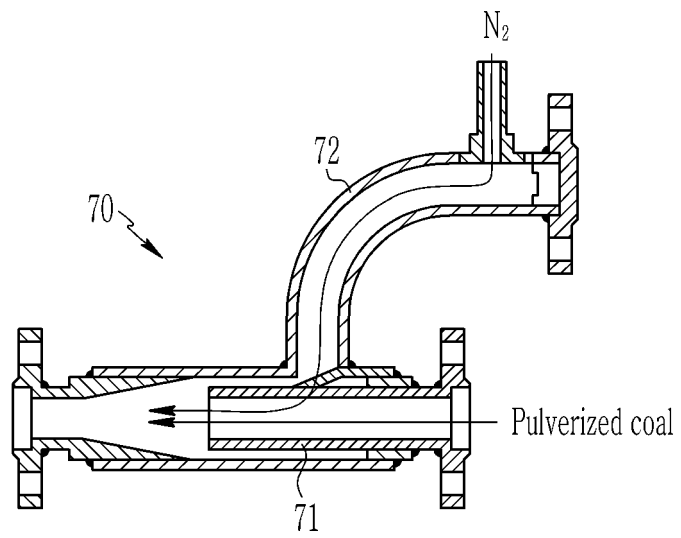


FIG. 7

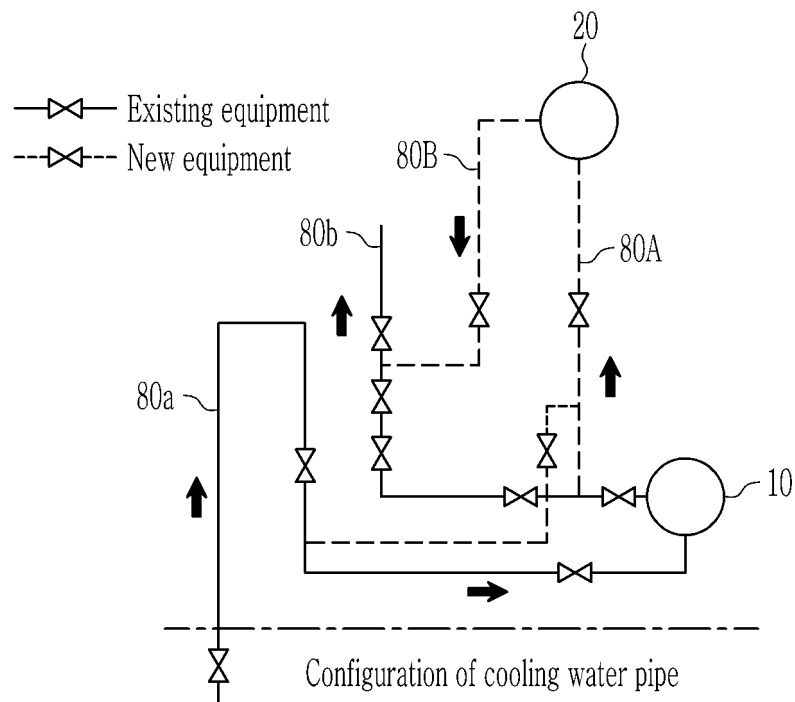


FIG. 8

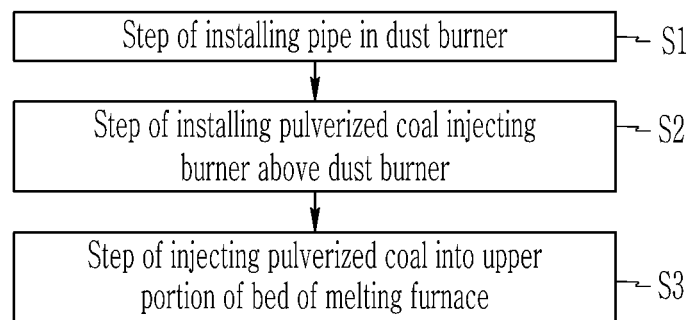


FIG. 9

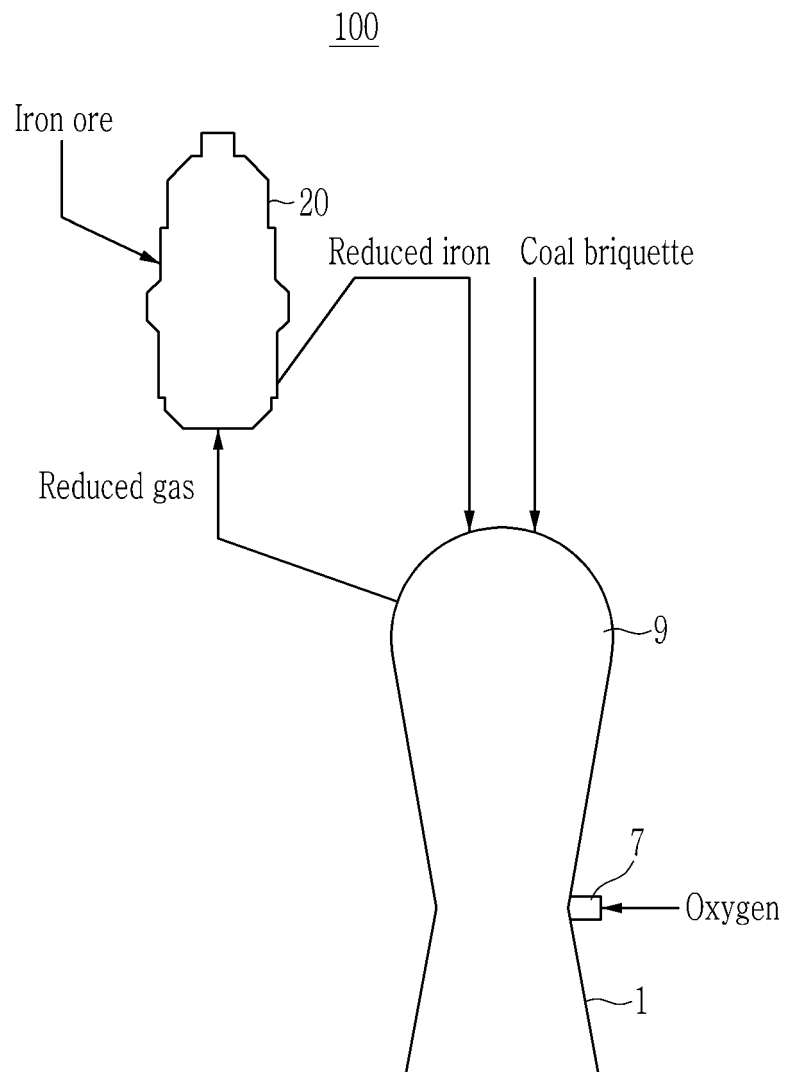


FIG. 10

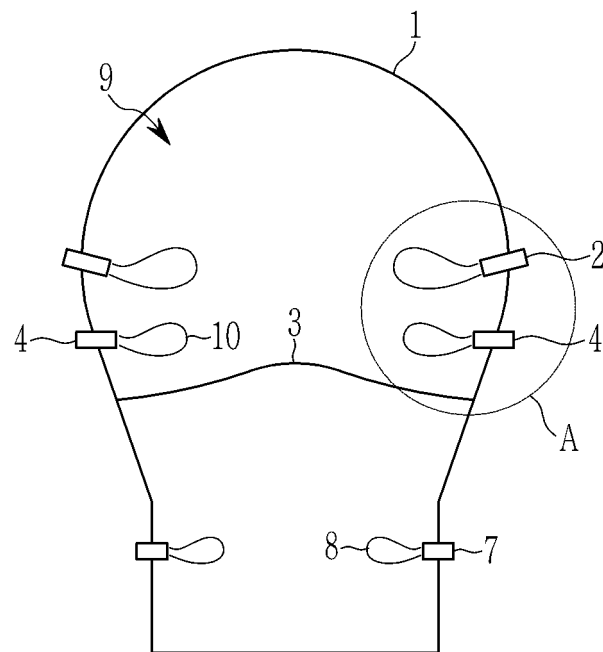


FIG. 11

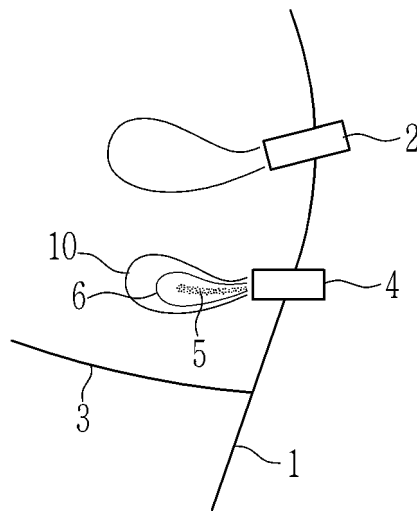


FIG. 12

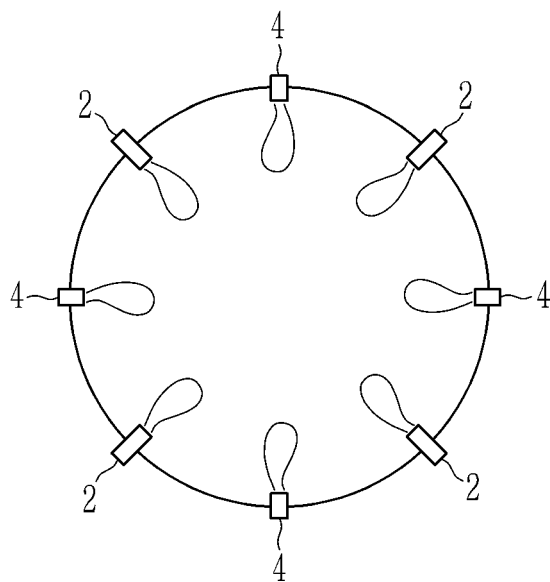


FIG. 13

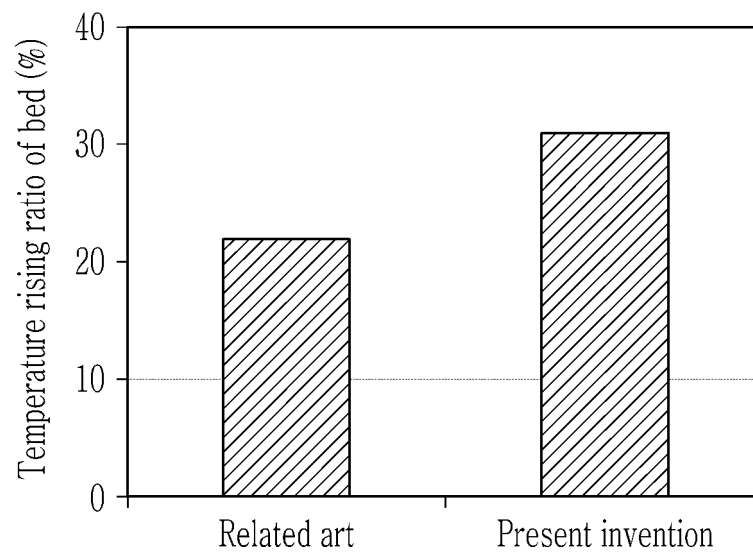


FIG. 14

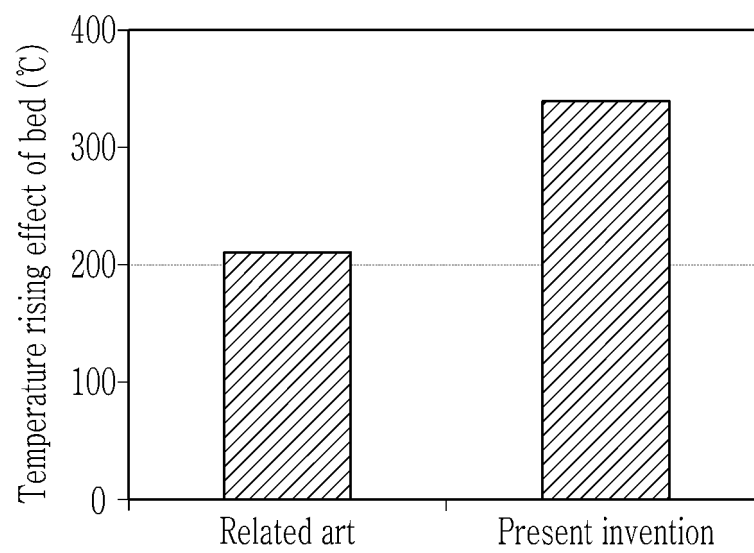


FIG. 15

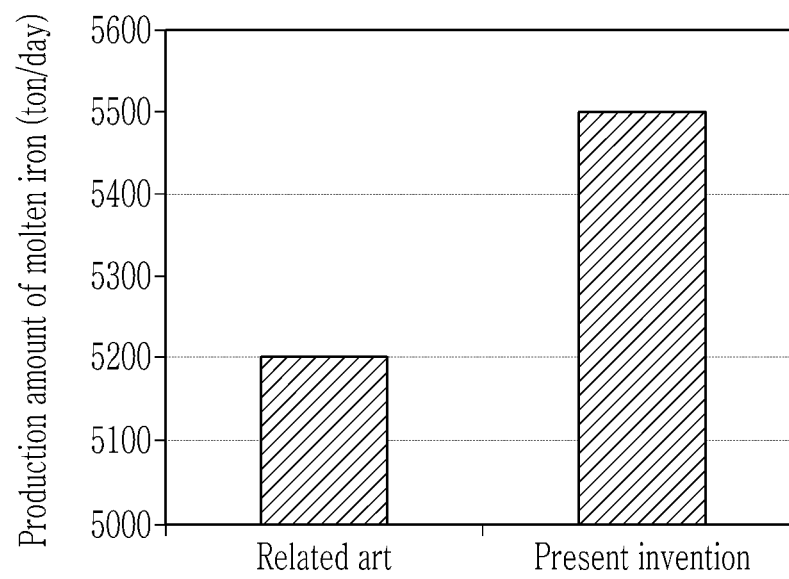
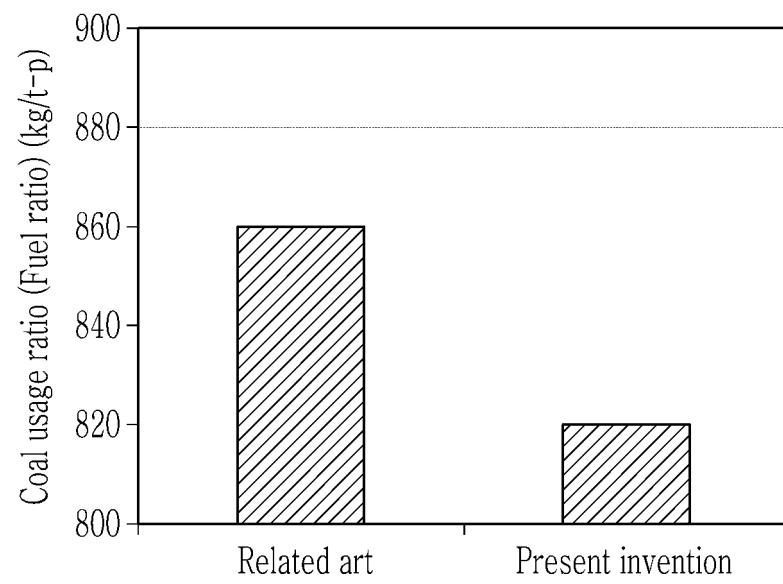


FIG. 16



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2016/008111

A. CLASSIFICATION OF SUBJECT MATTER

C21B 13/00(2006.01)i, C21B 5/00(2006.01)i, F27D 17/00(2006.01)i, F27D 99/00(2010.01)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 13/00; C21B 13/14; F23D 1/00; F23C 11/00; C21B 7/00; C21B 5/00; F27D 17/00; F27D 99/00

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: melting furnace, dust burner, pulverized coal injection burner, oxygen

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2003-0030495 A (POSCO) 18 April 2003	1-9,11-20,22
Y	See abstract, page 2, line 13-page 3, line 49, claims 1-3 and figures 2-5.	10,21,23-24
Y	JP 09-273715 A (MITSUBISHI HEAVY IND., LTD.) 21 October 1997	10,21
	See abstract, paragraphs [0013]-[0018] and figure 1.	
Y	KR 10-2005-0005984 A (POSCO) 15 January 2005	23-24
	See abstract and page 2, lines 17-35.	
X	WO 2015-000604 A1 (SIEMENS VAI METALS TECHNOLOGIES GMBH.)	25-34
	08 January 2015	
	See abstract, claims 1-4 and figure 1.	
A	KR 10-1992-0010525 B1 (POHANG IRON & STEEL CO.) 04 December 1992	1-34
	See claim 1 and figure 1.	

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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