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(54) **METHOD AND APPARATUS FOR TREATING RETURN ORES USING PLASMA**

VERFAHREN UND VORRICHTUNG ZUR BEHANDLUNG VON RÜCKFÜHRUNGSERZ UNTER VERWENDUNG VON PLASMA

PROCÉDÉ ET APPAREIL DE TRAITEMENT DE MINÉRAIS DE RETOUR EN UTILISANT UN PLASMA

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Description

Technical Field

[0001] The present invention relates to a method and an apparatus for treating return ores, and more particularly, to a method and an apparatus for treating return ores using plasma, in which return ores of a predetermined grain size are fusion bonded and agglomerated by a flame of a plasma heating device, and the return ores are treated in a massive amount to enhance a fusion bonding process of the return ores, while a great amount of sintered return ores generated in a sintering process are subjected to a fewer number of re-treatment processes.

Background Art

[0002] Iron ore contains 30 to 70% iron (Fe), and good-quality iron ore is small in the amount of hazardous components such as sulfur (S), phosphor (P), and copper (Cu) and uniform in size. However, the iron ore produced in an original place is not uniform in components thereof and thus cannot be directly put into a blast furnace. Generally, the iron ore is charged into the blast furnace as a sintered ore by making the components thereof uniform, mixing the resultant iron ore with corks and sintering the same.

[0003] FIG. 1 illustrates a general method of manufacturing a sintered ore.

[0004] That is, as shown in FIG. 1, various kinds of iron ore as a major material of the sintered ore and silicastone, serpentinite, and limestone as a minor material, and stone coal and corks as a fuel are transferred from a storage bin 110 through a conveyor to a mixer 120.

[0005] Also, the material, fuel, and ores are mixed together in the mixer 120 and granulated with moisture added thereto, and then fed to a surge hopper 130.

[0006] Then, the surge hopper 130 supplies sintering materials fed from the mixer 120 to a sintering trolley 140 at a predetermined ratio. Sintering materials are supplied first by an upper ore hopper 150 installed behind the surge hopper 130 to be sintered before the sintering materials stored in the surge hopper 130 are supplied.

[0007] Moreover, an ignition furnace 160 disposed before the surge hopper 130 ignites an virtue of a suction force of a wind box 170 including an air exhauster 172 and a chamber 174 below the sintering trolley 140.

[0008] Then, the sintered materials are transported forward along the sintering trolley 140, thrown into a cooler 180 to be cooled in air, and then manufactured as a sintered ore.

[0009] Thereafter, the sintered ore produced is crushed by a crusher 190. The crushed sintered ore is separated into a return ore (sintered return ore) with a grain size of 6 mm or less and a sintered ore with a greater grain size by a hot screen 200.

[0010] For example, the sintered ore with a grain size

of 6mm or less is not sent to the blast furnace 210, but returned to the sintering process. Such a sintered ore is generally referred to as a "return ore".

[0011] That is, the sintered ore usable in the blast furnace has a grain size of about 6 to 50 mm, and thus the sintered ore with a grain size of 6 mm or less is re-thrown into the surge hopper 130 as indicated with line A of FIG. 1.

[0012] Meanwhile, even though not illustrated in detail in FIG. 1, the sintered ore having a grain size (diameter) of greater than 6 mm is cooled and then crushed at a predetermined ratio by a cutting feeder. Also, the sintered ore with a diameter of 50 mm or more is crushed up to 50 mm, which is a size allowing the sintered ore to be charged into the blast furnace. The sintered ore is finally put into the blast furnace 210 through several sorting processes using a screen, as indicated with line B of FIG. 1.

[0013] However, typically, the return ore having a grain size of 6mm or less accounts for a considerable proportion, i.e., about 40% of the sintered ores generated in an actual sintering process. But such a return ore can not be directly charged into the blast furnace to ensure permeability and is subjected back to the sintering process.

[0014] Therefore, the return ores (sintered return ores) may be agglomerated (fusion-bonded) to a grain size (diameter) of greater than 6 mm to be charged into the blast furnace. This accordingly precludes a need for a process of re-treating the return ores, which requires the return ores to be subjected back to the sintering process.

[0015] Meanwhile, to agglomerate the return ores to a grain size of greater than 6mm, a question of how to physically bond (fuse) the return ores should be solved. There are some known methods to be considered as follows.

[0016] To begin with, the return ores may be bonded using a binder, which is a medium for bonding the return ores. With this binder, the return ores can be advantageously bonded in a cooling state without a need for pre-heating the return ores. However, disadvantageously, the binder for bonding the return ores is typically weak to heat and lost when put into the blast furnace. Thus, the agglomerated return ores are very likely to be broken into small grains in the blast furnace.

[0017] Next, a commercially viable laser may be employed. However, the laser is capable of fusing a very small effective area (radius) of the return ores, thus not productively feasible when fusion-bonding the return ores. Besides, an actual test found that the return ores are weakly bonded by the laser.

[0018] Another alternative method involves thermal spray welding, in which spray power is sprayed onto an object to perform welding. In this case, the return ores are excellently bonded but the spray powder adversely affects molten iron components in the blast furnace process, thus hardly applicable in practice.

[0019] Finally, an ultrasonic metal pressing for bonding non-iron metal and plastic may be adopted. In the ultra-

sonic metal pressing, a friction force is generated on contact surfaces due to vibration to thereby bond the return ores. However, the bonded return ores have rough surfaces and may be fractured by a predetermined pressure imposed.

[0020] Thus, the applicant of the present invention has come to suggest a technology for agglomerating the return ores through more effective fusion binding. This technology allows the return ores to be agglomerated with a uniform size and the sintered ores to meet quality standard. Particularly, with this technology, the return ores remain strongly bonded even after fusion binding, posing no difficulty to a process flow until the return ores are charged into the blast furnace and the return ores can be treated in a massive amount.

[0021] Meanwhile, only sintered return ores have been described as an example of the return ores. However, the method of treating return ores of the present invention may be applied to other ironmaking process such as commercially viable FINEX or COREX which has overcome problems associated with manufacturing costs in sintering ores and environmental pollution in the blast furnace process, using non-coking coal and iron ores.

Disclosure of Invention

Technical Problem

[0022] The present invention has been made to solve the foregoing problems of the prior art and therefore an aspect of the present invention is to provide a method and and environmental pollution in the blast furnace process, using non-coking coal and iron ores.

Disclosure of Invention

Technical Problem

[0023] The present invention has been made to solve the foregoing problems of the prior art and therefore an aspect of the present invention is to provide a method and apparatus for treating return ores using plasma, capable of fusion binding and agglomerating the return ores to a predetermined grain size using a flame of a plasma heating device.

[0024] Another aspect of the present invention is to provide a method and apparatus for treating return ores using plasma, in which the return ores can be treated in a massive amount to enhance productivity of agglomerating the return ores through fusion-bonding and also a great amount of sintered return ores generated in the sintering process are subjected to a fewer number of re-treatment processes.

Technical Solution

[0025] The above problems are overcome by the method of treating return ores using plasma according to claim

1. The method includes providing return ores sorted out by a sorting process; and bonding the return ores by fusing and agglomerating the return ores using plasma.

[0026] The method may further include: pre-heating the return ores fed through the sorting process before bonding the return ores; heat-retaining agglomerated return ore lumps by slowly cooling the return ore lump after bonding the return ores to maintain bonding strength, and blocking the return ore lumps from contact with air to prevent oxidization thereof; and screening the return ore lump with a predetermined grain size while checking boning strength of the return ore lumps.

[0027] The return ores are successively transferred via a transfer unit and agglomerated by a plasma heating device to be treated in a massive amount.

[0028] The return ores may be sintered ores with a grain size of 6mm or less sorted through the sorting process after sintering is completed or return ores put into a melter-gasifier of an ironmaking process using non-coking coal and iron ore fines.

[0029] The plasma heating device may include a plurality of plasma heating devices arranged in rows to treat the return ores in a massive amount.

[0030] Further return ores may be covered over the return ore lumps after the bonding the return ores to retain heat and prevent oxidization thereof.

[0031] The return ores may be successively fed in multi-layers in such a way that the return ores are fusion-bonded step-wise from a lowermost layer to an uppermost layer to be treated in a massive amount.

[0032] The above problems are overcome by the apparatus for treating return ores using plasma according to claim 10. The apparatus includes a plasma heating device used to fuse and agglomerate sorted return ores.

[0033] The plasma heating device may include: a plasma generator; a gas supplier; and a plasma torch associated with the plasma generator and the gas supplier to generate a plasma flame for fusion-bonding the return ores.

[0034] The apparatus may further include a plasma torch protection tool comprising a guide hole guiding the flame generated from the plasma torch and a flame angle adjusting portion having a diameter increased toward an exit of the guide hole, the plasma torch protection tool configured to allow the plasma flame generated from the torch to be guided inwardly to pass therethrough.

[0035] The apparatus includes a transfer unit disposed below the plasma heating device to enable the return ores to be treated in a massive amount.

[0036] The transfer unit includes: a conveyor moved on an endless track from below the plasma heating device; and unit blocks disposed successively on the conveyor to house the return ores therein.

[0037] The plasma heating device may include a plurality of plasma heating devices disposed above the transfer unit in rows, and the transfer unit is increased in width correspondingly.

[0038] The plasma heating device may include a plu-

ality of plasma heating devices disposed in a step configuration to fusion-bond the return ores from a lowermost to an uppermost step of the transfer unit, and the transfer unit is increased in height correspondingly.

[0039] The apparatus may further include: a sealer having an external member disposed above the transfer unit to correspond to a length of the transfer unit and a fire-proof block layer disposed on a bottom of the external member and retains heat, wherein the plasma heating device is disposed through the sealer.

Advantageous Effects

[0040] As described above, according to a method and apparatus for treating return ores using plasma of the present invention, sintered return ores or ores of a predetermined grain size are easily fusion-bonded into a mass using plasma.

[0041] Particularly, according to the present invention, the return ores are successively charged and transferred so as to be agglomerated in a massive amount, thereby enhancing productivity of agglomerating the return ores overall.

[0042] In addition, the return ores are excellently fusion-bonded and thus prevented from being easily fractured when put into a blast furnace, thereby facilitating a blast furnace process.

Brief Description of the Drawings

[0043]

FIG. 1 is a schematic view illustrating a conventional process of treating sintered return ores generated during sintering;

FIG. 2 is a schematic view illustrating a process of treating return ores during sintering according to an exemplary embodiment of the invention;

FIG. 3 is a flow chart illustrating a basic process of treating return ores according to an exemplary embodiment of the invention;

FIG. 4 is an overall configuration view illustrating a process and apparatus for treating return ores in a massive amount according to an exemplary embodiment of the invention;

FIG. 5 is a configuration view illustrating a plasma heating device of the present invention;

FIG. 6 is a front elevational view illustrating return ores treated using a plurality of plasma heating devices in an apparatus for treating return ores of FIG. 4;

FIG. 7 is a plan view of FIG. 6;

FIGS. 8A and 8B are a side sectional view and a front sectional view illustrating a transfer unit of an apparatus for treating return ores of FIG. 4, respectively;

FIG. 9A and 9B are a side sectional view and a front sectional view illustrating a modified example of a

transfer unit of FIG. 8, respectively

FIG. 10 is a front sectional view illustrating return ores covered over agglomerated return ore lumps to retain heat and prevent oxidization in bonding return ores according to an exemplary embodiment of the invention;

FIG. 11 is a perspective view illustrating a return ore lump agglomerated by a method and apparatus for treating return ores according to an exemplary embodiment of the invention;

FIG. 12 is a reference picture illustrating a plasma torch and a plasma torch protection tool of a plasma heating device assembled together according to an exemplary embodiment of the invention; and

FIG. 13 is a reference picture illustrating a plasma heating device and a container according to an exemplary embodiment of the invention.

Best Mode for Carrying Out the Invention

[0044] Exemplary embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

[0045] First, FIG. 2 illustrates a process of treating return ores according to an exemplary embodiment of the invention, in view of a sintering process of FIG. 1.

[0046] In FIG. 2, the same sintering process and blast furnace as described in FIG. 1 will be designated with the same reference numeral and not be described in any further detail.

[0047] Also, description of FIG. 2 is based on return ores generated in the sintering process, i.e., sintering ores with a grain size of 6mm or less. However, as described above, a method (process) or an apparatus 1 for treating return ores, which will be described in detail later can be applied to other ironmaking process such as FIN-EX or COREX in which molten iron is produced using non-coking coal and iron ore fines.

[0048] In this case, not sintered return ores but return ores with a predetermined grain size or less may be employed.

[0049] Furthermore, according to a feature of the present invention, as described above, out of return ores manufactured in the sintering process, the sintered ores with a grain size of greater than 6mm are put into a blast furnace 210. Meanwhile, as for the sintered ores having a grain size of 6mm or less, the return ores are agglomerated by a treatment method of return ores including bonding of the return ores, in which the return ores are fusion-bonded and agglomerated. Here, such agglomerated return ore lumps are directly charged into the blast furnace 210.

[0050] Particularly, as shown in FIG. 4 which will be described in detail later, the process and apparatus for treating return ores enable the return ores to be agglomerated in a massive amount.

[0051] First, in the method for treating the return ores of the present embodiment, basically, out of the sintered

ores produced in the sintering process, the return ores with a grain size of 6mm or less are sorted out by a screen 200 of FIG. 2 to be treated.

[0052] Meanwhile, FIG. 3 illustrates a basic process for treating return ores according to an exemplary embodiment of the invention.

[0053] As shown in FIG. 3, the method for treating return ores of the present embodiment includes pre-heating the return ores (S2), bonding the return ores by fusion-bonding and agglomerating the return ores (S3), heat-retaining the agglomerated return ore lumps (S4, 5) to maintain strength (S4) of the return ore lumps and preventing oxidization (S5), and finally screening the return ore lumps with such a grain size as can be put into the blast furnace while maintaining strength (S7).

[0054] Here, referring to FIGS. 2 to 4, 'S6' is an integrated process of S3 to S5 and denotes a process of fusion-bonding the return ores.

[0055] In the meantime, in the preheating of the return ores (S2 of FIGS. 3 and 4), after the sintering process, the return ores sorted out by the sorting process are cooled to a room temperature. Thus, to enhance efficiency of a following process of bonding the return ores, the return ores need to be pre-heated using an additional device such as a rotary kiln.

[0056] However, as shown in FIG. 4 described later, the apparatus 1 for treating return ores (in a massive amount) of the present embodiment is capable of pre-heating the return ores without employing an additional rotary kiln.

[0057] For example, referring to FIG. 4, a fire-proof block layer 54 inside an external member 52 of a sealer 50 is heated by heat generated when the plasma heating device 10 is operated in bonding the return ores. Accordingly, the return ores are pre-heated by a heat-retaining environment between the sealer 50 and the transfer unit 30 while being transported from a position of the transfer unit 30 where the return ores are introduced to the plasma heating device 1. Then, the return ores are heated and fusion-bonded.

[0058] Therefore, as shown in FIG. 4, the return ores 2, when introduced to the transfer unit 30, are automatically pre-heated.

[0059] Next, in bonding the return ores (S3 of FIGS. 3 and 4), the pre-heated return ores are heated half-fused or fully fused using the plasma heating device (reference numeral 10 of FIGS. 4 and 5) which will be described in detail later.

[0060] Here, the return ores half-fused or fully-fused by plasma are fused together and agglomerated to a grain size of 6 to 50mm, which is the appropriate size enabling the return ores to be charged into the blast furnace.

[0061] For example, FIG. 11 illustrates return ore lump 2' by fusing and agglomerating the return ores generated by the process of returning the return ores of the present invention.

[0062] As shown in FIG. 5, the agglomeration of the

return ores by a plasma flame (F of FIG. 5) generated from a torch 12 of the plasma heating device 10 may be regulated by an amount of gas provided to the plasma torch 12 and an inclination angle θ of a flame angle adjusting portion 24 of a plasma torch protection tool 20.

[0063] This will be described again later in detail with reference to FIG. 5.

[0064] Next, in the heat-retaining (S4 and S5 of FIGS. 3 and 4), the return ore lumps (2' of FIGS. 4 and 11) agglomerated by the plasma heat source in the bonding of the return ores are not air-cooled or water-cooled to maintain strength but heat-retained and slowly cooled while not being in direct contact with external air.

[0065] For example, the agglomerated return ore lumps, when cooled using general air cooling or water cooling, may undergo decrease in strength such as crack occurrence due to rapid change in temperature. Therefore, the return ore lumps may be cooled in a space shielded from external air to maintain strength, using e.g., the sealer 50 or a warming container (see 'C' of FIG. 13).

[0066] The sealer functions as described in the pre-heating of the return ores.

[0067] Here, the heat-retaining for maintaining strength additionally serves to prevent oxidization by blocking the return ores from contact with external air.

[0068] Finally, in the screening (S7 of FIGS. 2 to 4), the slowly-cooled return ore lumps are screened using e.g., a screen. Here, the agglomerated return ore lumps having a grain size of greater than 6mm, which is a reference size for being put into the blast furnace, are directly charged into the blast furnace. Meanwhile, the return ore lumps having a grain size of 6mm or less are sent back to the sintering process as shown in FIG. 2 or subjected back to the process of treating the return ores in a massive amount as shown in FIG. 4.

[0069] However, as shown in FIG. 4, particularly, the return ore lumps having a grain size of 6mm or less may be subjected back to the process of supplying the return ores without being reverted to the sintering process.

[0070] FIG. 4 illustrates a method and apparatus 1 for treating return ores in a massive amount, capable of treating the return ores in a massive amount.

[0071] For example, as shown in FIGS. 3 and 4, the fusion-bonding of the return ores (S6), i.e., treatment of the return ores in a massive amount, includes the pre-heating (S2) of the return ores sorted out through the sorting process and the bonding (S3) of the return ores by fusing and agglomerating the pre-heated return ores using the plasma heating device (10 of FIG. 5). Also, the fusion-bonding of the return ores (S6) further includes heat-retaining the agglomerated return ore lumps (S4,5) **[0072]** That is, the return ores 2 generated in the sintering process of FIG. 2, when fed to the supply hopper 70 through a conveyer 72, can be successively transported therefrom to be subjected to the pre-heating (S2), thereby enabling the return ores to be treated in a massive amount.

[0073] Particularly, the method of treating return ores

in a massive amount according to the present embodiment further includes screening (S7) dropped return ores, i.e., screening the return ore lump 2' with a predetermined grain size while checking bonding strength of the return ore lump agglomerated in the bonding the return ores (S3).

[0074] That is, as shown in FIG. 4, in the method of treating the return ores in a massive amount according to the present embodiment, the return ore lumps 2' are dropped off onto a screening unit 80 from a predetermined height. Here, the agglomerated return ore lumps with a grain size of 6mm or less are returned to the supply hopper 70 and the agglomerated return ore lumps 2' with a grain size of greater than 6mm are collected on the premise that the return ore lumps 2' are to remain sufficiently strong when charged into the blast furnace again.

[0075] Subsequently, the method of treating the return ores of the present embodiment includes heat-retaining the return ores to maintain bonding strength of the agglomerated return ore lump 2' (S4) between the bonding the return ores (S3) and the screening (S7). Also the method includes preventing oxidization (S5) by blocking contact with air.

[0076] Meanwhile, as shown in FIG. 4, the return ores can be treated in a massive amount according to the present embodiment since the return ores 2 are agglomerated while being successively transported through the transfer unit 30 which will be described in detail, in the apparatus 1 for treating the return ores.

[0077] That is, as shown in FIG. 4, the return ores successively fed through the hopper in the supplying the return ores (S1) are successively transported to be fusion bonded by the plasma heating device, and the return ores are dropped off to be screened (S7), recovered or discharged, in a continuous process.

[0078] As shown in FIG. 10, when the return ores 2 are covered over the agglomerated return ore lumps 2' which have undergone the fusion-bonding of the return ores 2 (S3), the return ores serve as a surrounding wall of the agglomerated return ores. This may allow the agglomerated return ore lumps 2' to retain heat for maintaining strength and prevent oxidization by blocking contact with air.

[0079] Next, as shown in FIG. 9, the return ores 2 are successively fed in multi-layers to the transfer unit which will be described later. Here, the return ores 2 are fusion-bonded gradedly from a lowermost layer to an uppermost layer so that the return ore lumps 2' are treated in multi-layers.

[0080] In this case, as shown in FIG. 9B, waste heat among the agglomerated return ore lumps is retained in an 'H' area formed between the lowermost layer and an intermediate layer and between the intermediate layer and the uppermost layer. Therefore, the return ores can be further pre-heated and more smoothly fusion-bonded from the lowermost layer toward the uppermost layer.

[0081] Next, a description will be given of an apparatus 1 for treating return ores according to the present em-

bodiment shown in FIGS. 4 to 10, capable of treating the return ores in a massive amount.

[0082] First, FIGS. 4 and 5 illustrate a plasma heating device 10 of the apparatus 1 for treating return ores, which substantially enables the return ores to be fusion-bonded.

[0083] For example, as shown in FIG. 5, the plasma heating device 10 of the present embodiment largely includes a plasma torch 12 and a plasma torch protection tool 20.

[0084] FIG. 12 illustrates an actual assembling position of the plasma torch 12 and the plasma torch protection tool 20. FIG. 13 illustrates the plasma torch 12, the plasma torch protection tool 20 and a container C disposed thereunder.

[0085] The plasma torch 12 of the plasma heating device 10 is connected to a plasma generator 14 for generating a plasma arc and a gas supplier 16.

[0086] Therefore, the arc is generated from the torch 12 by the plasma generator 14. That is, referring to FIG. 5, the arc is generated between an anode 12a connected to the plasma generator 14 and the torch serving as a cathode 12b. When a gas is fed into the torch by the gas supplier 16, a plasma flame F is formed at a front end of the torch 12, and a length or intensity of the flame F may be adjusted by a feeding amount and intensity of the gas.

[0087] Here, the plasma torch 12 can generate heat of a high temperature of 10,000°C or more. Thus the plasma torch protection tool 20 is installed at a portion of the front end of the torch where the flame is generated in order to protect a tip portion (not shown) of the torch 12 from the high temperature heat and adequately control size and length of the flame F generated from the plasma torch 12.

[0088] For example, as shown in FIG. 5, the plasma torch 12 of the present embodiment is joined to a center of an upper part of a housing (not shown) for housing the plasma torch protection tool 20 therein. The plasma torch protection tool 20 is provided in a center with a guide hole 22 for guiding the flame F generated from the front end of the torch 12. Also, a flame angle adjusting portion 24 is formed at an exit of the guide hole of the tool to adjust spraying condition of the flame.

[0089] Moreover, a cooling line 26 may be embedded in the plasma torch protection tool 20 to prevent the tip portion of the torch from being impaired by the high temperature heat generated when the plasma heating device is continuously used.

[0090] As shown in FIG. 4, this cooling line 26 may be in communication with a cooling water supplier 26'.

[0091] Here, as shown in FIG. 5, the flame angle adjusting portion 24 is configured to be inclined at an angle θ of 30° to 70° particularly 40° to 60° with respect to a wall thereof in a direction where the exit of the guide hole 22 is widened.

[0092] This numerical limitation is based on the premise that with a smaller inclination angle, the return ores 1 are fuse by the flame in a narrower and deeper

extent while with a greater inclination angle, the return ores are fused in a wider and shallower extent, thereby lowering a maximum heating temperature.

[0093] That is, in a case where the inclination angle θ is 30° or less, the agglomerated return ores are fused in a small area, thus posing a problem to yield. On the contrary, in a case where the inclination angle θ is 70° or more, the plasma flame is generated in a wide area but relatively lowered in the heating temperature. Therefore, the return ores have less fusion efficiency from heating and are hardly agglomerated with a grain size of greater than 6mm. Also, the inclination angle θ of 70° or more prolongs a fusion-bonding time of the return ores. Therefore, the inclination angle θ may be in the range of 30° to 70°.

[0094] The return ores may have a bonding size, bonding amount and bonding time regulated by adjusting an amount and flow rate of gas fed to the plasma torch 12 and the inclination angle θ of the flame angle adjusting portion 24.

[0095] The heat-resistant container C shown in FIG. 13 contains the return ores heated in a half-fused condition. However, in the apparatus for treating return ores in a massive amount as shown in FIG. 4, the container is replaced with the transfer unit 30 for treating the return ores in a massive amount.

[0096] Then, as shown in FIG. 4, in the apparatus 1 for treating return ores, the transfer unit 30 substantially enables the return ores to be treated in a massive amount.

[0097] Therefore, the apparatus 1 for treating return ores of FIG. 4 basically includes the plasma heating device 10 described with reference to FIG. 5, and further includes the transfer unit 30 for enabling the return ores to be treated in a massive amount.

[0098] Meanwhile, FIGS. 4, 6 and 8 illustrate the transfer unit 30 of the apparatus of the present embodiment.

[0099] As shown in FIGS. 6 and 8, the transfer unit 30 of the present embodiment includes a conveyer 32 and unit blocks 34. The conveyer 32 is moved on an endless track from below the plasma heating device 10. The unit blocks 34 are installed successively on the conveyer 32 to house the return ores 2 therein.

[0100] Here, the conveyer 32 may include a conveyer portion 32b formed of a belt to maintain strength, a driving roll 32a and a transfer roll 32c for transferring the conveyer portion on an endless track.

[0101] Also, as shown in FIGS. 6 and 8, each of the unit blocks 34 may include a base plate 36 attached to the conveyer portion 32b of the conveyer 32, an external material 38 attached onto the base plate 36 to define a space for housing the return ores therein, and a fire-proof material 40 attached inside the external material 38.

[0102] The fire-proof material 40 prevents the unit blocks from being thermally damaged and blocks conduction of heat, thereby retaining heat of the agglomerated return ore lumps 2'.

[0103] In addition, as shown in FIG. 8A, the base plate

36 of the unit block 34 needs to have a length or width in accordance with a circumference of the driving roll 32a of the conveyer 32.

[0104] Accordingly, in the apparatus 1 for treating return ores, the return ores 2, when successively introduced from the supply hopper 70 into the unit blocks 34 assembled with the conveyer 32, are successively agglomerated while passing through the plasma heating device 10.

[0105] Meanwhile, as shown in FIGS. 6 and 7, the unit blocks 34 may have a width increased corresponding to a length of the plurality of plasma heating devices 10 arranged in a width direction, respectively.

[0106] For example, as shown in FIGS. 6 and 7, the nine plasma heating devices 10 may be arranged in three inclined rows each including three heating devices to successively fusion-bond the return ores charged into the unit blocks 34 in rows.

[0107] Here, a number of the plasma heating devices 10 are arranged adjacent to one another so as to protect heat generated from the plasma heating devices 10 and enhance fusion or heat-retention of the return ores.

[0108] Next, as shown in FIG. 9, the unit blocks 34 may be increased in height to accommodate the fed return ores in multi-layers from the lowermost layer to an uppermost layer sequentially. Then, equipment for supplying the return ores, i.e., the plurality of supply hoppers 70' and the plurality of plasma heating devices 10 may be installed at a gradually different height with respect to the return ores, respectively from the lowermost layer to the uppermost layer, corresponding to the return ores arranged in multi-layers.

[0109] That is, the supply hoppers 70' are arranged in a step configuration and at least one row of the plasma heating devices 10 is arranged behind the supply hoppers 70'. The return ores 2 are first supplied to a bottom of the unit blocks to allow the return ores to be fusion-bonded step-wise. This enables the return ores to be treated in a massive amount as shown in FIG. 9B.

[0110] Here, the return ore lumps 2' suffer less leakage of retained heat or waste heat, thereby easily retaining heat and maintaining strength.

[0111] Further, as shown in FIGS. 4 and 8B, the apparatus 1 for treating return ores of the present embodiment may further include a sealer 50 provided on a top of the transfer unit 30 to have a length adjusted corresponding to at least a length of the transfer unit 30.

[0112] Here, the sealer 50 may include an external member 52 and a fire-proof block layer 54 provided underneath the external member 52 to retain heat generated from plasma heating devices 10 and heat generated from the fused agglomerated return ores.

[0113] Therefore, the external member 52 is attached on both edges of the unit block, i.e., the transfer unit to suppress inflow of air and the fire-proof layer 54 inside the external member 52 is heated by heat generated from the plasma heating device.

[0114] In the end, as shown in FIG. 4, the return ores

2 introduced into the transfer unit 30 are preheated (S2) in a substantially sealed state initially, and then fusion-bonded via the torch flame F of the plasma heating device 10 to be agglomerated (S3). Accordingly, the return ore lumps, when transferred by the transfer unit during a pre-determined time retain heat inside the sealer to keep strength and are blocked from contact with external air to prevent oxidization (S4, 5).

[0115] Meanwhile, as shown in FIG. 4, the apparatus 1 for treating return ores 1 further includes a supply hopper 70, a screening unit 80 and a recovery conveyor 90. The supply hopper 70 is disposed above the transfer unit 30 to successively supply the return ores to the transfer unit. The screening unit 80 is disposed below the transfer unit 30 to screen the agglomerated return ore lumps 2' generated from the transfer unit. The recovery conveyor 90 is connected in a reverse direction from the screening unit 80 to the supply hopper 70.

[0116] Here, the screening unit 80 plays an important role. For example, the screening unit 80 may be formed of a screen provided with a predetermined height difference from a portion of the transfer unit 30 where the agglomerated return ore lumps are discharged. Accordingly, the return ore lumps 2' are dropped off to be checked in strength, and then the return ore lumps 2' with a grain size of greater than 6mm are collected.

[0117] As shown in FIG. 4, the agglomerated return ore lumps 2' are dropped off on the screens, i.e., the screening unit 80 at 1 to 2 m height from the portion of the transfer unit where the agglomerated return ores are discharged, that is, the position where the unit blocks 34 are shifted from a horizontal direction to a vertical direction by rotation of the driving roll 32a of the conveyor 32. The agglomerated return ore lumps sustain impact when dropped off on the screen. Here, the return ore lumps with a grain size of greater than 6mm are construed to have a high fusion bonding strength, and thus discharged to a discharge conveyor 84 and a collecting bath 86.

[0118] However, the fractured agglomerated return ores (2") with a grain size of 6mm or less can be hardly charged into the blast furnace. Therefore, as shown in FIG. 4, such agglomerated return ores are returned to the supply conveyor 72 by the recovery conveyor 72. Here, the return ores with a grain size of 6mm or less are subjected to the fusion-bonding of return ores (S6) (S2, S3, S4, 5) after going back through the supplying the return ores (S1).

[0119] In the apparatus for treating return ores of the present embodiment, once the return ores are fusion-bonded and then agglomerated, the return ores are successively cycled without going back to the sintering process or other processes. Therefore the apparatus of the present embodiment is more cost-effective than a conventional apparatus in which return ores are subjected back to the sintering process.

[0120] Meanwhile, as shown in FIG. 4, the constituents of the present embodiment may be installed based on vertical support columns 37 on the base 35.

[0121] Also, as shown in FIG. 4, a discharge chute 82 is disposed at a position where the transfer unit is changed in direction and an appropriate amount of the return ore lumps 2' are collected in the discharge chute 82 and then dropped off on the screen, which is the screening unit 80, to be screened, as described above.

[0122] Moreover, as shown in FIG. 4, a temperature sensor 42 and a charge coupled device (CCD) camera 44 for sensing a temperature and bonding condition of the return ore lumps 2' are provided at one side of the discharge chute 82. These sensor devices may be connected to an apparatus controller 46.

[0123] In addition, the apparatus controller 46 can be electrically connected to a driving source (not shown) of the driving roll 32a of the conveyor which is the transfer unit, a plasma generator 14 of the plasma heating device 10 and a gas supplier 16, as indicated with dotted lines denoting a connecting path with the device controller (46 of FIG. 4). Then, the apparatus controller 46 can be controllably driven according to each condition of the agglomerated return ore lumps.

Industrial Applicability

[0124] In the apparatus and method for treating the return ores of the present invention, the return ores are half-fused or fully-fused by plasma heating and then bonded and agglomerated to a predetermined grain size, i.e., 6mm or greater. Accordingly these return ores (return ore lumps) can be excellently fusion-bonded and thus are not easily fractured when put into the blast furnace.

[0125] For example, in a sintering plant of a steel-maker, 4000 to 5000 ton/day of return ores are produced. In view of this, the apparatus for treating return ores, particularly, the method and apparatus for treating the return ores according to the present invention, which are capable of treating the return ores in a massive amount, allow agglomerated return ores to be produced at a yield of 50%, thereby saving manufacturing costs and operational costs.

[0126] In addition, the apparatus and method for treating the return ores of the present invention are applicable to not only a blast furnace process but also an ironmaking process such as a commercially viable FINEX or COREX.

[0127] While the present invention has been shown and described in connection with the preferred embodiments, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the scope of the invention as defined by the appended claims.

Claims

1. A method of treating return ores using plasma, the method comprising:

- supplying return ores sorted through a sorting process; and
bonding the return ores by fusing and agglomerating the supplied return ores using plasma; wherein the return ores are successively transferred via a transfer unit and agglomerated by a plasma heating device to be treated in a massive amount.
2. The method of claim 1, further comprising pre-heating the return ores before bonding the return ores fed through the sorting process.
 3. The method of claim 1, further comprising heat-retaining an agglomerated return ore lump by slowly cooling the return ore lump after bonding the return ores to maintain bonding strength, and blocking the return ore lump from contact with air to prevent oxidation thereof.
 4. The method of claim 1, further comprising screening agglomerated return ore lumps with a predetermined grain size while checking strength of the return ore lump.
 5. The method of claim 1, wherein the return ores comprise sintered ores with a grain size of 6mm or less sorted through the sorting process after sintering is completed or return ores put into a melter-gasifier of an ironmaking process using non-coking coal and iron ore fines.
 6. The method of claim 4, wherein the screening the agglomerated return ore lumps comprises dropping the return ore lumps from a predetermined height onto a screen, determining bonding strength of the return ore lumps, collecting the return ore lumps with a grain size of greater than 6mm and recovering the return ore lumps with a grain size of 6mm or less for the providing return ores.
 7. The method of claim 1, wherein the plasma heating device comprises a plurality of plasma heating devices arranged in rows to treat the return ores in a massive amount.
 8. The method of claim 1, wherein further return ores are covered over agglomerated return ore lumps after the bonding the return ores to retain heat and prevent oxidization thereof.
 9. The method of claim 1, wherein the return ores are successively fed in multi-layers in such a way that the return ores are fusion-bonded step-wise from a lowermost layer to an uppermost layer to be treated in a massive amount.
 10. An apparatus for treating return ores using plasma,
- the apparatus comprising;
a plasma heating device provided to fuse and agglomerate sorted return ores; and
a transfer unit for transferring the return ores disposed below the plasma heating device to enable the return ores to be treated in a massive amount; wherein the transfer unit comprises a conveyor moved on an endless track from below the plasma heating device and unit blocks disposed successively on the conveyor to house the return ores therein.
11. The apparatus of claim 10, wherein the plasma heating device comprises:
 - a plasma generator;
 - a gas supplier; and
 - a plasma torch associated with the plasma generator and the gas supplier to generate a plasma flame for fusion-bonding the return ores.
 12. The apparatus of claim 11, further comprising:
 - a plasma torch protection tool having a guide hole guiding the flame generated from the plasma torch; and
 - a flame angle adjusting portion having a diameter increased toward an exit of the guide hole, the plasma torch protection tool configured to allow the plasma flame generated from the torch to be guided inwardly to pass therethrough.
 13. The apparatus of claim 12, wherein the flame angle adjusting portion of the plasma torch protection tool is inclined at an angle of 30° to 70°.
 14. The apparatus of claim 13, wherein the plasma torch protection tool further comprises a cooling line installed therein and is formed of a water cooling-type protection tool.
 15. The apparatus of claim 10, wherein each of the unit blocks of the transfer unit comprises:
 - a base plate attached to the conveyor;
 - an external material attached on the base plate to define a space for housing the return ores; and
 - a fire-proof material attached inside the external material.
 16. The apparatus of claim 10, wherein the plasma heating device comprises a plurality of plasma heating devices disposed above the transfer unit in rows, and the transfer unit is increased in width correspondingly.
 17. The apparatus of claim 10, wherein the plasma heating device comprises a plurality of plasma heating devices disposed in a step configuration to fusion-

bond the return ores from a lowermost to an uppermost step of the transfer unit, and the transfer unit is increased in height correspondingly.

18. The apparatus of claim 10, further comprising:

an external member disposed above the transfer unit to correspond to a length of the transfer unit; and
a sealer disposed on a bottom of the external member and formed of a fire-proof block layer to retain heat, wherein the plasma heating device is disposed through the sealer.

19. The apparatus of claim 10, further comprising:

a supply hopper disposed at one side of the transfer unit to successively supply the transfer unit with the return ores; and
a screening unit disposed below a discharge chute provided at another side of the transfer unit, with a predetermined height difference from each other to screen agglomerated return ore lumps dropped.

20. The apparatus of claim 10, further comprising a recovery conveyor connected in a reverse direction from the screening unit to the supply hopper.

Patentansprüche

1. Verfahren zur Behandlung von Rücklauferzen unter Verwendung von Plasma, wobei das Verfahren umfasst:

Zuführen von durch einen Sortierprozess sortierten Rücklauferzen; und
Binden der Rücklauferze durch Schmelzen und Agglomerieren der zugeführten Rücklauferze unter Verwendung von Plasma;
wobei die Rücklauferze sukzessive über eine Übertragungseinheit übertragen und durch eine Plasmabeheizungs Vorrichtung agglomeriert werden, um in einer großen Menge behandelt zu werden.

2. Verfahren nach Anspruch 1, darüber hinaus umfassend, die Rücklauferze vor einem Binden der durch den Sortierprozess zugeführten Rücklauferze vorzuheizen.

3. Verfahren nach Anspruch 1, darüber hinaus umfassend, die Hitze eines agglomerierten Rücklauferzstücks zu halten, indem das Rücklauferzstück nach dem Binden des Rücklauferzes langsam abgekühlt wird, um die Bindungsfestigkeit aufrechtzuerhalten, und das Rücklauferzstück vor einem Kontakt mit Luft

zu bewahren, um dessen Oxidierung zu verhindern.

4. Verfahren nach Anspruch 1, darüber hinaus umfassend, agglomerierte Rücklauferzstücke mit einer vorbestimmten Korngröße zu sieben und dabei die Festigkeit der Rücklauferzstücke zu prüfen.

5. Verfahren nach Anspruch 1, wobei die Rücklauferze gesinterte Erze mit einer Korngröße von 6 mm oder kleiner umfassen, die durch den Sortierprozess sortiert wurden, nachdem das Sintern abgeschlossen wurde, oder Rücklauferze in einen Schmelzvergaser eines Eisenherstellungsprozesses unter Verwendung von nicht verkokender Kohle und Feineisenerzen aufgegeben wurden.

6. Verfahren nach Anspruch 4, wobei das Sieben der agglomerierten Rücklauferzstücke umfasst, die Rücklauferzstücke aus einer vorbestimmten Höhe auf ein Sieb fallen zu lassen, die Bindungsfestigkeit der Rücklauferzstücke zu bestimmen, die Rücklauferzstücke mit einer Korngröße von größer als 6 mm zu sammeln, und die Rücklauferzstücke mit einer Korngröße von 6 mm oder kleiner zur Bereitstellung von Rücklauferzen rückzuführen.

7. Verfahren nach Anspruch 1, wobei die Plasmabeheizungs Vorrichtung mehrere Plasmabeheizungs Vorrichtungen umfasst, die in Reihen angeordnet sind, um die Rücklauferze in einer großen Menge zu behandeln.

8. Verfahren nach Anspruch 1, wobei weitere Rücklauferze über agglomerierte Rücklauferzstücke nach dem Binden der Rücklauferze, um deren Hitze zu halten und deren Oxidation zu verhindern, aufgegeben werden.

9. Verfahren nach Anspruch 1, wobei die Rücklauferze sukzessive in mehrfachen Schichten auf eine solche Weise zugeführt werden, dass die Rücklauferze schrittweise ausgehend von einer untersten zu einer obersten Schicht schmelzverbunden werden, um in einer großen Menge behandelt zu werden.

10. Vorrichtung zur Behandlung von Rücklauferzen unter Verwendung von Plasma, wobei die Vorrichtung umfasst:

eine Plasmabeheizungs Vorrichtung, die vorgesehen ist, um sortierte Rücklauferze zu schmelzen und zu agglomerieren; und
eine Übertragungseinheit zum Übertragen der unter der Plasmabeheizungs Vorrichtung angeordneten Rücklauferze, um zu ermöglichen, dass die Rücklauferze in einer großen Menge behandelt werden;
wobei die Übertragungseinheit eine sich auf ei-

ner Endlosspur von unter der Plasmabeheizungs-
vorrichtung bewegend. Fördereinrichtung und Einheitsblöcke umfasst, die nacheinander an der Fördereinrichtung angeordnet sind, um die Eisenerze darin aufzunehmen.

11. Vorrichtung nach Anspruch 10, wobei die Plasmabeheizungs-
vorrichtung umfasst:

einen Plasmagenerator;
eine Gaszuführeinrichtung; und
einen Plasmabrenner, der mit dem Plasmagenerator und der Gaszuführeinrichtung verbunden ist, um eine Plasmaflamme zum Schmelz-
verbinden der Rücklauferze zu erzeugen.

12. Vorrichtung nach Anspruch 11, darüber hinaus um-
fassend:

eine Plasmabrennerschutzeinrichtung mit einer
Führungsöffnung, die die vom Plasmabrenner
erzeugte Flamme leitet; und
einen Flammenwinklereinstellabschnitt mit ei-
nem zu einem Austritt der Führungsöffnung zu-
nehmenden Durchmesser, wobei die Plasmabrennerschutzeinrichtung dazu ausgelegt ist, zu-
zulassen, dass die vom Brenner erzeugte Plas-
maflamme nach innen geleitet wird, um durch
diesen hindurchzugehen.

13. Vorrichtung nach Anspruch 12, wobei der Flammen-
winklereinstellabschnitt der Plasmabrennerschutz-
einrichtung in einem Winkel von 30° bis 70° geneigt
ist.

14. Vorrichtung nach Anspruch 13, wobei die Plasmabrennerschutzeinrichtung darüber hinaus eine Kühl-
leitung umfasst, die in ihr eingebaut ist und aus einer
Schutzeinrichtung der wasserkühlenden Art be-
steht.

15. Vorrichtung nach Anspruch 10, wobei jeder der Ein-
heitsblöcke der Übertragungseinheit umfasst:

eine an der Fördereinrichtung angebrachte
Grundplatte;
ein an der Grundplatte angebrachtes außenlie-
gendes Material, um einen Raum zur Aufnahme
der Rücklauferze zu bilden; und
ein innen am außenliegenden Material ange-
brachtes feuerfestes Material.

16. Vorrichtung nach Anspruch 10, wobei die Plasma-
beheizungs-
vorrichtung mehrere in Reihen über der
Übertragungseinheit angeordnete Plasmabeheizungs-
vorrichtungen umfasst, und die Übertragungs-
einheit entsprechend in der Breite vergrößert ist.

17. Vorrichtung nach Anspruch 10, wobei die Plasma-
beheizungs-
vorrichtung mehrere in einer Stufenan-
ordnung vorgesehene Plasmabeheizungs-
vorrichtungen umfasst, um die Rücklauferze ausgehend
von einer untersten zu einer obersten Stufe der
Übertragungseinheit schmelzzuverbinden, und die
Übertragungseinheit entsprechend in der Höhe ver-
größert ist.

18. Vorrichtung nach Anspruch 10, darüber hinaus um-
fassend:

ein außenliegendes Teil, das über der Übertra-
gungseinheit angeordnet ist, um einer Länge
der Übertragungseinheit zu entsprechen; und
eine Abdichteinrichtung, die auf einem Grund
des außenliegenden Teils angeordnet ist und
aus einer feuerfesten Sperrschicht besteht, um
Hitze zurückzuhalten, wobei die Plasmabeheizungs-
vorrichtung durch die Abdichteinrichtung
hindurch angeordnet ist.

19. Vorrichtung nach Anspruch 10, darüber hinaus um-
fassend:

einen Beschickungstrichter, der auf einer Seite
der Übertragungseinheit vorgesehen ist, um die
Übertragungseinheit sukzessive mit Rück-
lauferze zu beschicken; und
eine Siebeinheit, die unter einem Auswurf-
schacht angeordnet ist, der auf einer anderen
Seite der Übertragungseinheit mit einem vorbe-
stimmten Höhenunterschied voneinander vor-
gesehen ist, um agglomerierte, fallen gelassene
Rücklauferzstücke zu sieben.

20. Vorrichtung nach Anspruch 10, darüber hinaus eine
Wiederaufnahmefördereinrichtung umfassend, die
in einer umgekehrten Richtung ausgehend von der
Siebeinheit zum Beschickungstrichter angeschlos-
sen ist.

Revendications

1. Procédé de traitement de minerais de retour par
plasma, le procédé comprenant :

la fourniture de minerais de retour triés via un
processus de triage ; et
la liaison des minerais de retour par fusion et
agglomération des minerais de retour fournis au
moyen de plasma ;
où les minerais de retour sont successivement
transférés via une unité de transfert et agglomé-
rés par un dispositif de chauffage par plasma
afin d'être traités dans une vaste quantité.

2. Le procédé de la revendication 1, comprenant en outre le préchauffage des minerais de retour avant liaison des minerais de retour délivrés via le processus de triage.
3. Le procédé de la revendication 1, comprenant en outre le fait de retenir la chaleur d'un morceau de minerai de retour aggloméré en refroidissant lentement le morceau de minerai de retour après liaison des minerais de retour afin de maintenir la résistance de liaison, et en empêchant le morceau de minerai de retour d'être en contact avec l'air pour éviter l'oxydation de celui-ci.
4. Le procédé de la revendication 1, comprenant en outre le tamisage de morceaux de minerai de retour agglomérés d'une grosseur de grain prédéterminée tout en contrôlant la résistance des morceaux de minerai de retour.
5. Le procédé de la revendication 1, où les minerais de retour comprennent des minerais frittés d'une grosseur de grain de 6 mm ou moins triés via le processus de triage après que le frittage est terminé ou que des minerais de retour ont été versés dans un dispositif de fusion-gazéification d'un processus d'élaboration de fer utilisant du charbon non cokéifiant et des fines de minerai de fer.
6. Le procédé de la revendication 4, où le tamisage des morceaux de minerai de retour agglomérés comprend le largage des morceaux de minerai de retour d'une hauteur déterminée sur un tamis, la détermination de la résistance de liaison des morceaux de minerai de retour, la collecte des morceaux de minerai de retour d'une grosseur de grain supérieure à 6 mm et la récupération des morceaux de minerai de retour d'une grosseur de grain de 6 mm ou moins pour la fourniture de minerais de retour.
7. Le procédé de la revendication 1, où le dispositif de chauffage par plasma comprend une pluralité de dispositifs de chauffage par plasma disposés en rangées pour traiter les minerais de retour dans une vaste quantité.
8. Le procédé de la revendication 1, où des minerais de retour supplémentaires sont versés par dessus des morceaux de minerai de retour agglomérés après la liaison des minerais de retour afin de retenir la chaleur et d'éviter l'oxydation de ceux-ci.
9. Le procédé de la revendication 1, où les minerais de retour sont successivement déversés en plusieurs couches de telle manière que les minerais de retour soient progressivement liés par fusion à partir d'une couche la plus basse vers une couche la plus haute afin d'être traités en vaste quantité.
10. Appareil de traitement de minerais de retour par plasma, l'appareil comprenant :
- un dispositif de chauffage par plasma destiné à faire fondre et à agglomérer des minerais de retour triés ; et
 - une unité de transfert destinée à transférer les minerais de retour, disposée sous le dispositif de chauffage par plasma, pour permettre aux minerais de retour d'être traités en vaste quantité ;
 - l'unité de transfert comprenant un convoyeur qui se déplace sur une bande sans fin de dessous le dispositif de chauffage par plasma et des blocs d'unité disposés successivement sur le convoyeur pour y loger les minerais de retour.
11. L'appareil de la revendication 10, où le dispositif de chauffage par plasma comprend :
- un générateur de plasma ;
 - un dispositif d'alimentation en gaz ; et
 - une torche à plasma associée au générateur de plasma et au dispositif d'alimentation en gaz pour générer un jet de plasma pour la liaison par fusion des minerais de retour.
12. L'appareil de la revendication 11, comprenant en outre :
- un outil de protection de torche à plasma présentant un trou de guidage guidant le jet généré par la torche à plasma ; et
 - un segment de réglage d'angle de jet ayant un diamètre s'accroissant vers une sortie du trou de guidage, l'outil de protection de torche à plasma étant configuré pour permettre au jet de plasma généré par la torche d'être guidé à l'intérieur afin qu'il passe à travers lui.
13. L'appareil de la revendication 12, où le segment de réglage d'angle de jet de l'outil de protection de torche à plasma est incliné selon un angle de 30° à 70°.
14. L'appareil de la revendication 13, où l'outil de protection de torche à plasma comprend en outre une conduite de refroidissement installée dans celui-ci et est constitué d'un outil de protection à refroidissement par eau.
15. L'appareil de la revendication 10, où chacun des blocs d'unité de l'unité de transfert comprend :
- une plaque de base fixée au convoyeur ;
 - un matériau externe fixé sur la plaque de base pour définir un espace destiné à loger les minerais de retour ; et
 - un matériau résistant au feu fixé à l'intérieur du

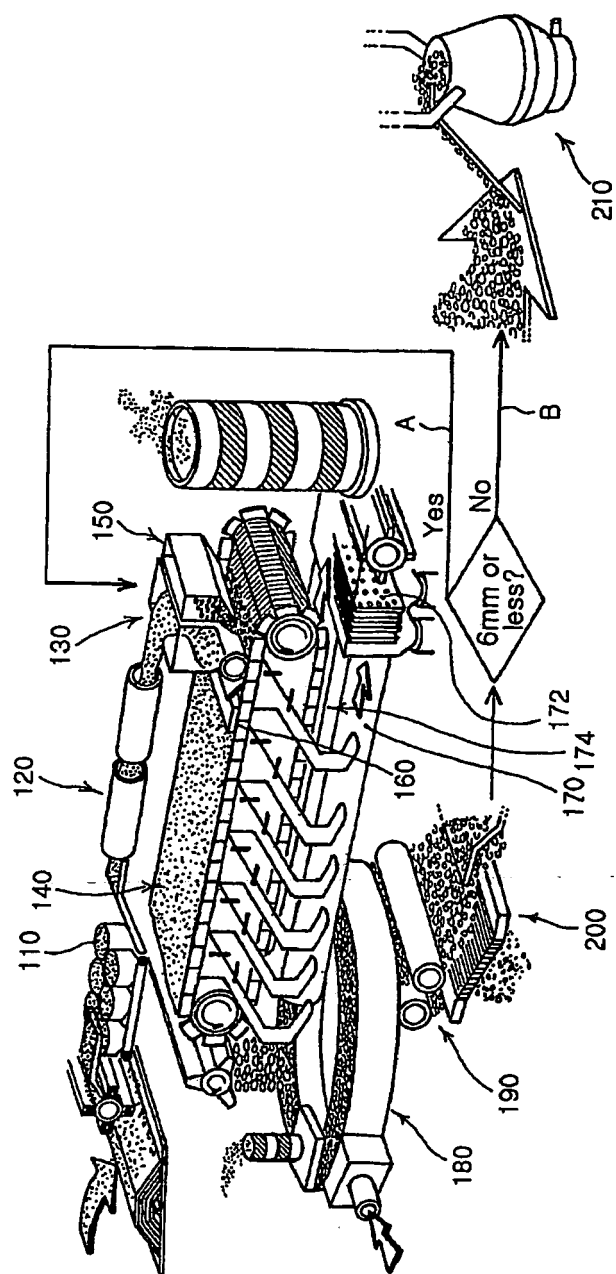
matériau externe.

16. L'appareil de la revendication 10, où le dispositif de chauffage par plasma comprend une pluralité de dispositifs de chauffage par plasma disposés au-dessus de l'unité de transfert en rangées, et l'unité de transfert est agrandie en largeur en conséquence. 5
17. L'appareil de la revendication 10, où le dispositif de chauffage par plasma comprend une pluralité de dispositifs de chauffage par plasma disposés selon une configuration à étages pour lier par fusion les minerais de retour depuis un étage le plus bas jusqu'à un étage le plus haut de l'unité de transfert, et l'unité de transfert est agrandie en hauteur en conséquence. 10 15
18. L'appareil de la revendication 10, comprenant en outre :
- un élément externe disposé au-dessus de l'unité de transfert pour correspondre à une longueur de l'unité de transfert ; et 20
- un élément d'étanchéité disposé sur un fond de l'élément externe et formé d'une couche de blocs résistante au feu pour retenir la chaleur, le dispositif de chauffage par plasma étant disposé au travers de l'élément d'étanchéité. 25
19. L'appareil de la revendication 10, comprenant en outre : 30
- une trémie d'alimentation disposée d'un côté de l'unité de transfert pour alimenter successivement l'unité de transfert en minerais de retour ; et 35
- une unité de tamisage disposée sous une goutte de déversement disposée d'un autre côté de l'unité de transfert, avec une différence de hauteur prédéterminée de l'une à l'autre pour tamiser des morceaux de minerai de retour agglomérés largués. 40
20. L'appareil de la revendication 10, comprenant en outre un convoyeur de récupération connecté en sens opposé, depuis l'unité de tamisage vers la trémie d'alimentation. 45

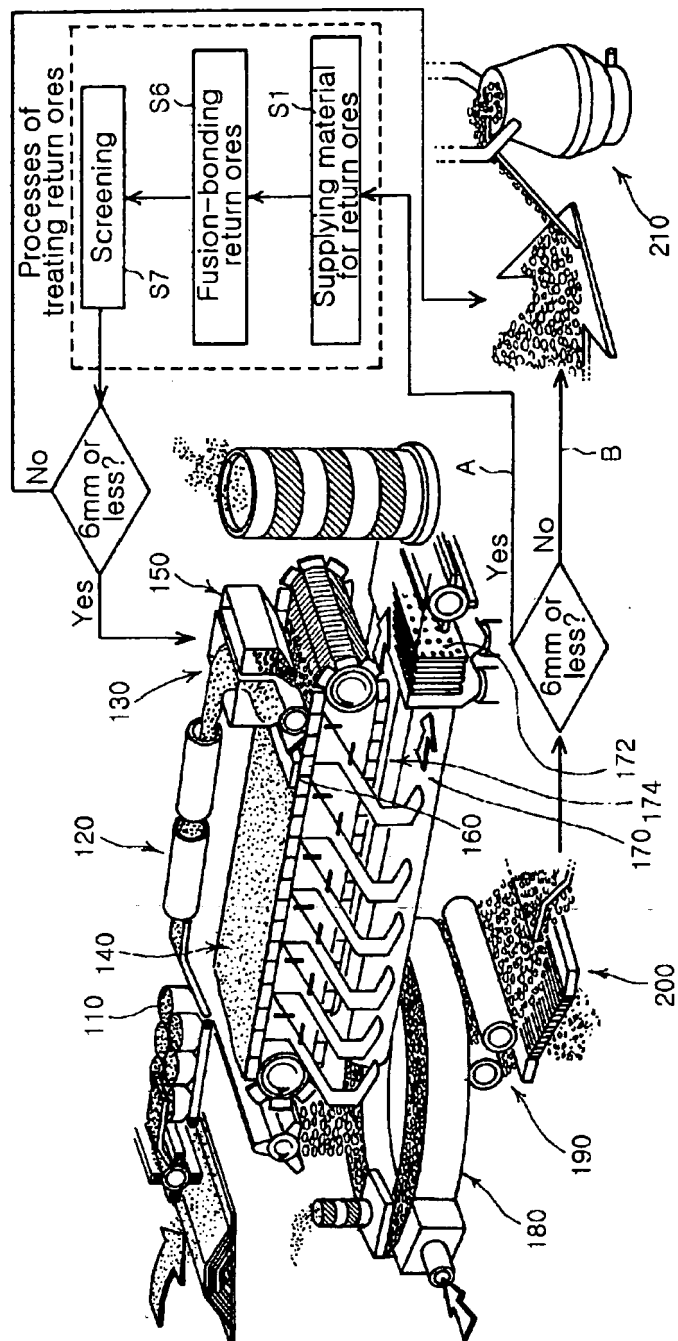
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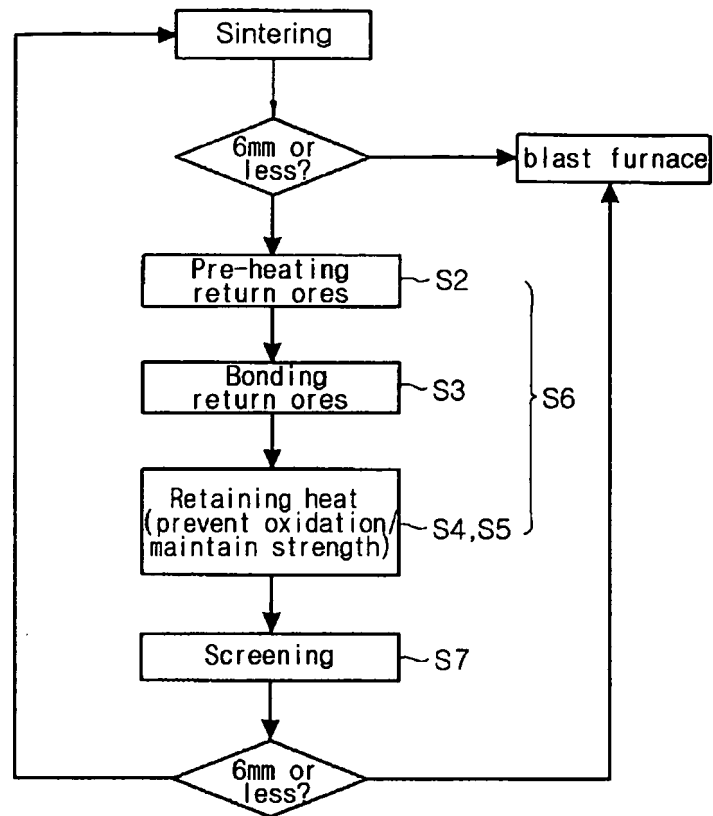
[Fig. 1]



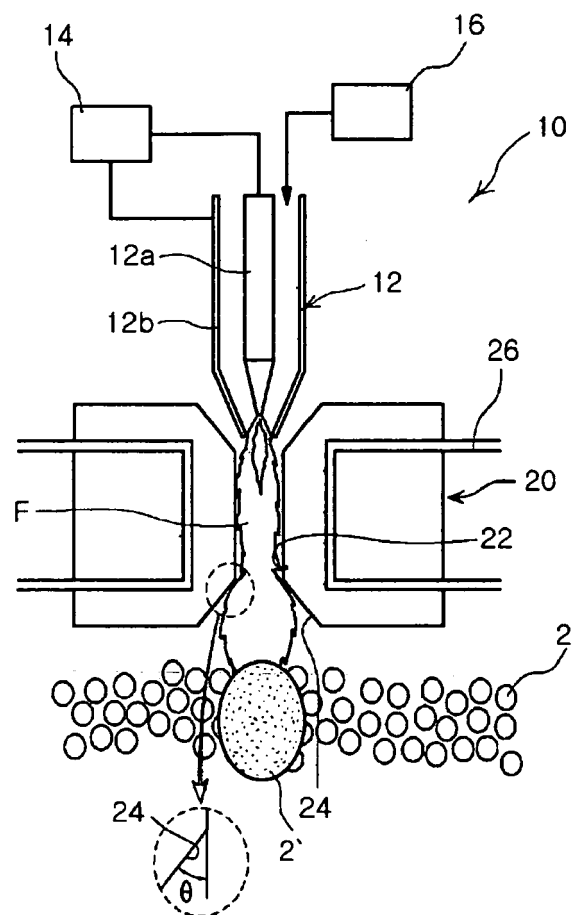
[Fig. 2]



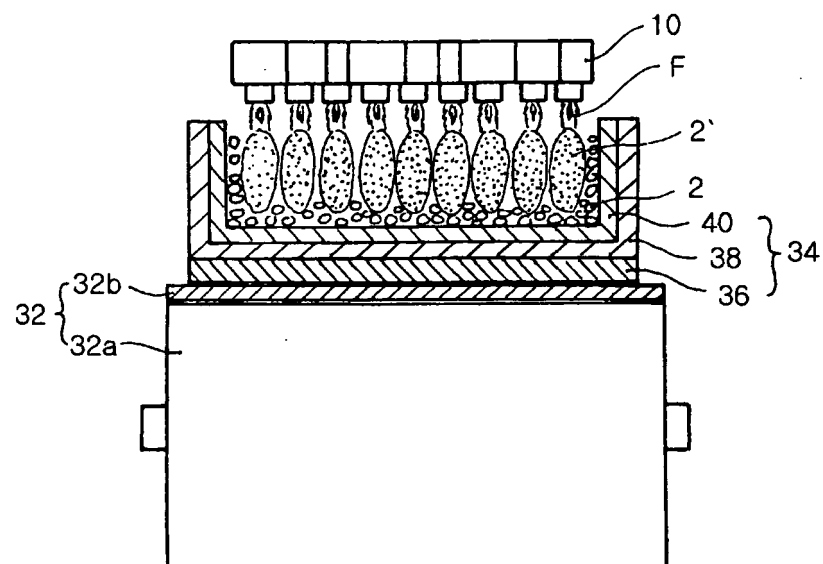
[Fig. 3]



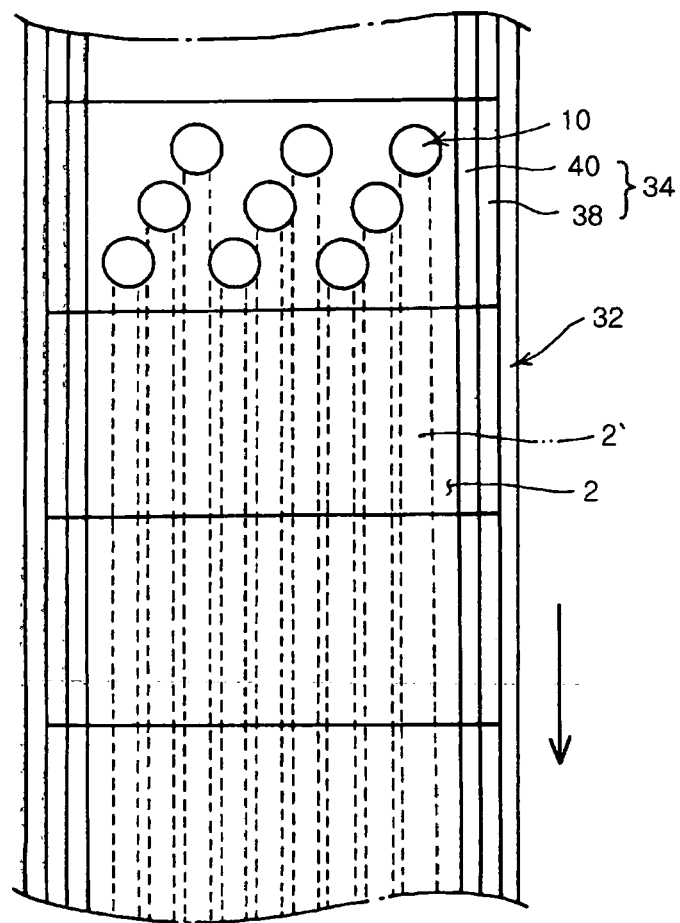
[Fig. 5]



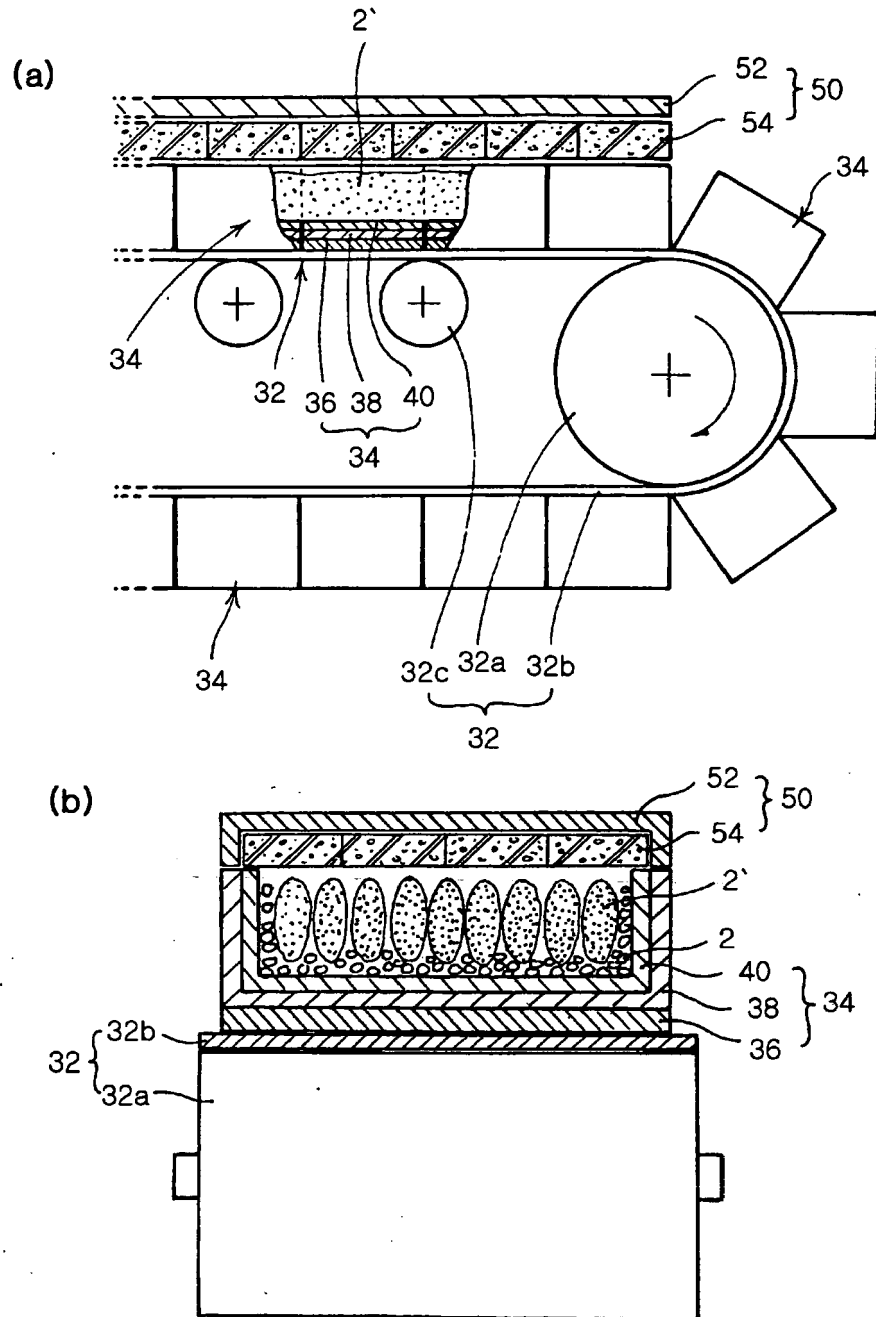
[Fig. 6]



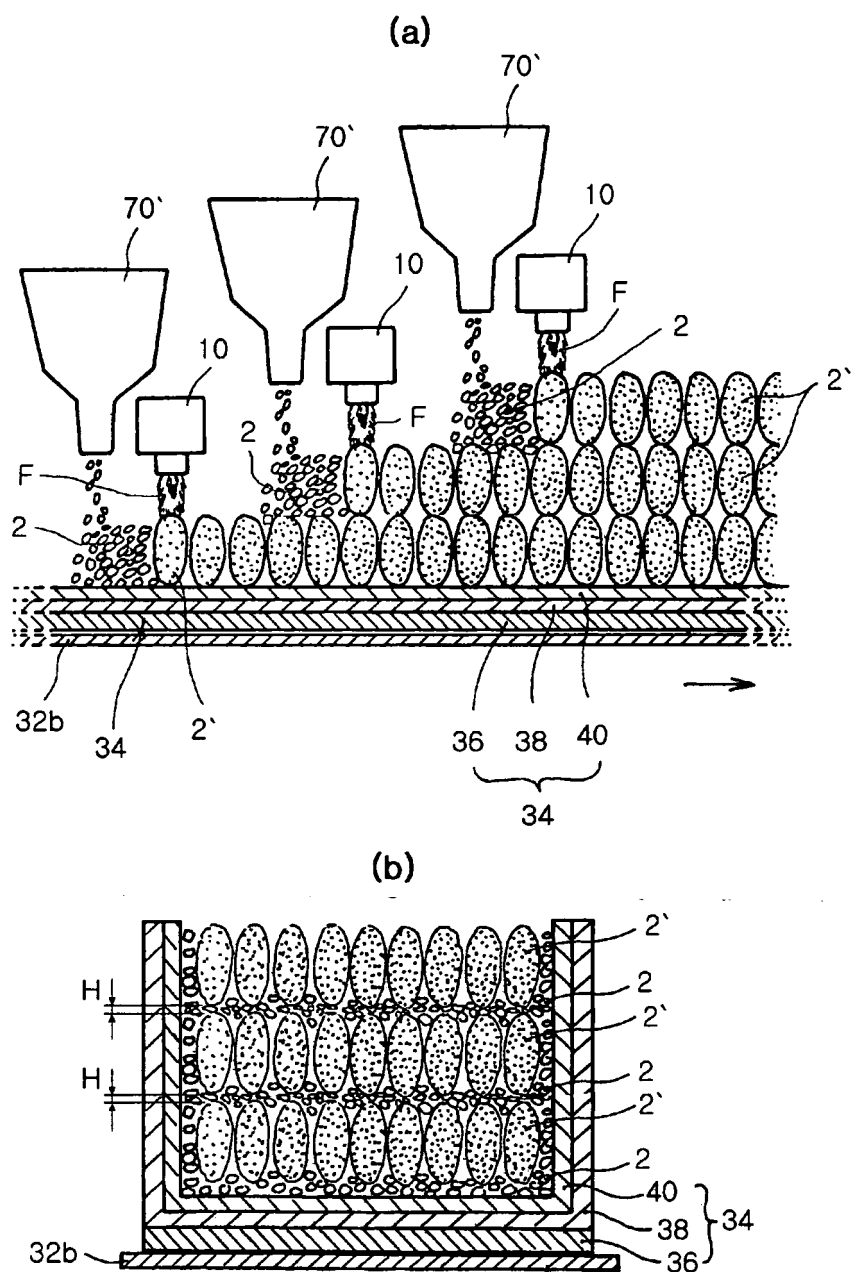
[Fig. 7]



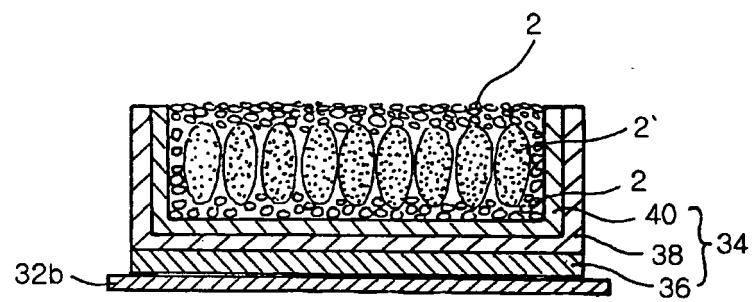
[Fig. 8]



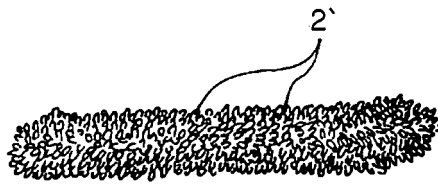
[Fig. 9]



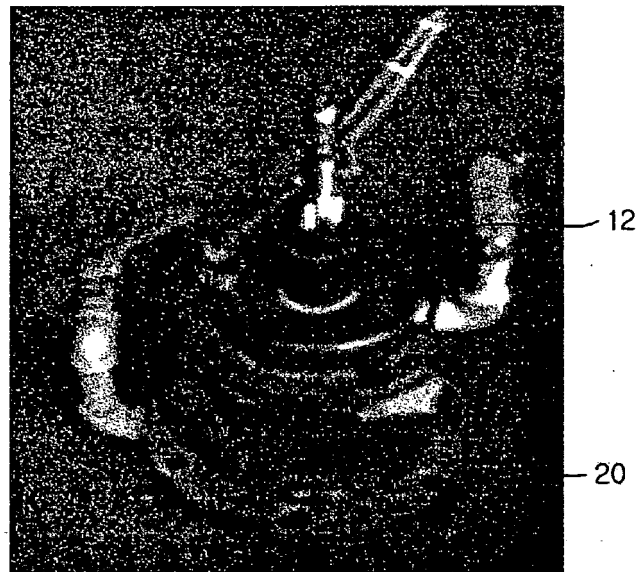
[Fig. 10]



[Fig. 11]



[Fig. 12]



[Fig. 13]

