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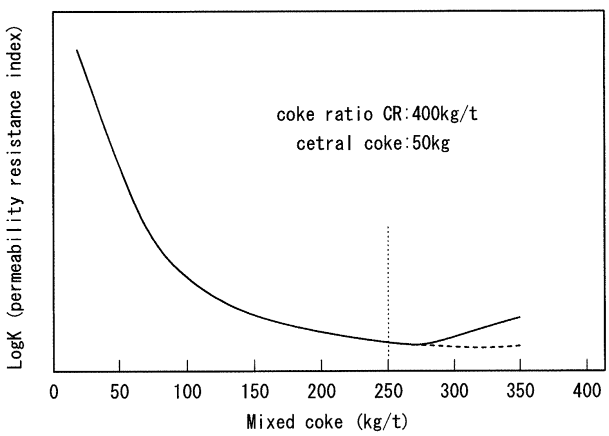
(54) METHOD FOR CHARGING STARTING MATERIAL INTO BLAST FURNACE

(57) A method for charging blast furnace raw material into a blast furnace, comprising, when charging blast furnace raw material including coke and ore material such as sintered ore, pellet, or lump ore into the blast furnace using a rotating chute: charging 60 mass% to 75 mass% of a total amount of coke into the blast furnace in the form of a mixed layer of coke and ore material, while allowing the remaining 25 mass% to 40 mass% of coke to remain as a coke slit. The method advantageously addresses the concern that gas permeability may deteriorate when charging ore material and coke in the form of a mixed layer into the blast furnace.

FIG. 4



EP 2 851 436 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a method for charging starting material (blast furnace raw material) into a blast furnace by charging blast furnace raw material into the furnace with a rotating chute.

BACKGROUND ART

[0002] Generally, ore material such as sintered ore, pellet, lump ore, and the like and coke are charged into a blast furnace from the furnace top in a layer state, and combustion gas is injected through a tuyere to yield pig iron. The coke and ore material that constitute the blast furnace raw material charged into the blast furnace descend from the furnace top to the furnace bottom, the ore reduces, and the temperature of the raw material rises. The ore material layer gradually deforms due to the temperature rise and the load from above while filling the voids between ore materials, and at the bottom of the shaft of the blast furnace, gas permeability resistance grows extremely large, forming a cohesive layer where nearly no gas flows.

[0003] Conventionally, blast furnace raw material is charged into a blast furnace by alternately charging ore material and coke. In the furnace, ore material layers and coke layers form alternately. At the bottom of the blast furnace, in the so-called cohesive zone, ore material layers with a large gas permeability resistance, where ore has softened and cohered, exist along with a coke slit, derived from coke, with a relatively small gas permeability resistance.

The gas permeability of the cohesive zone greatly affects the gas permeability of the blast furnace as a whole and limits the rate of productivity in the blast furnace. When performing a low coke operation, the amount of coke that is used is reduced, which is considered to cause significant thinning of the coke slit.

[0004] In order to improve the gas permeability resistance of the cohesive zone, mixing coke into the ore material layer is known to be effective, and much research has been reported for achieving an appropriate mixing state.

For example, JP H3-211210 A (PTL 1) discloses charging, in a bell-less blast furnace, coke into an ore hopper that is downstream among the ore hoppers, layering coke onto the ore on a conveyor, and charging the ore and coke into the furnace top bunker and then into the blast furnace via a rotating chute.

[0005] JP 2004-107794 A (PTL 2) discloses separately storing ore and coke in the furnace top bunker and mixing the coke and ore while charging them simultaneously in order to yield three batches at the same time: a batch for regularly charged coke, a batch for mainly charging coke, and a batch for mixed charging.

[0006] Furthermore, in order to prevent the cohesive zone shape from becoming unstable during blast furnace operation, to prevent a reduction in the gas utilization rate near the central region, and to improve operation safety and thermal efficiency, JP S59-10402 B2 (PTL 3) discloses a method for charging blast furnace raw material into a blast furnace whereby all of the ore and all of the coke are charged into the furnace after being completely mixed.

CITATION LIST

Patent Literature

[0007]

PTL 1: JP H3-211210 A

PTL 2: JP 2004-107794 A

PTL 3: JP S59-10402 B2

SUMMARY OF INVENTION

(Technical Problem)

[0008] In order to improve the gas permeability resistance of the cohesive zone, mixing coke into the ore layer as in the conventional example disclosed in PTL 3 is known to be effective.

[0009] Thus, the inventors of the present invention prepared mixed layers by completely mixing ore material layers with an amount of coke corresponding to the amount of coke layers that ware conventionally allowed to form alternately with ore material layers in the blast furnace, and attempted to charge the mixed layer into a blast furnace.

[0010] As a result, the inventors discovered that good gas permeability may not necessarily be obtained when only a mixed layer of ore material and coke is charged into the blast furnace.

[0011] The present invention has been developed in light of the above circumstances, and it is an object thereof to provide a method for charging blast furnace raw material into a blast furnace that advantageously addresses the concern that gas permeability may deteriorate when charging ore material and coke in the form of mixed layers into the blast furnace.

(Solution to Problem)

[0012] Specifically, main features of the present invention are as follows.

[1] A method for charging blast furnace raw material into a blast furnace, comprising, when charging blast furnace raw material including coke and ore material such as sintered ore, pellet, or lump ore into the blast furnace using a rotating chute:

charging 60 mass% to 75 mass% of a total amount of coke into the blast furnace in the form of a mixed layer of coke and ore material, while allowing the remaining 25 mass% to 40 mass% of coke to remain as a coke slit.

[2] The method for charging blast furnace raw material into a blast furnace according to the aspect [1], further comprising:

providing at least two furnace top bunkers at a top of the blast furnace;
storing, in either one or two of the furnace top bunkers, either one or both of the ore material and mixed material obtained by mixing the ore material and the coke with a mixing amount of coke being 30 mass% or less of a total amount of coke to be charged into the furnace;
storing only coke in the remaining one of the furnace top bunkers;
receiving the raw material discharged from each of the furnace top bunkers in a collecting hopper; and
then feeding the raw material to the rotating chute to charge the raw material into the blast furnace, wherein

(1) firstly, a coke slit is formed by discharging coke from the furnace top bunker, into which only coke has been charged,
(2) then, coke and ore material and/or mixed material are discharged simultaneously from the furnace top bunkers, mixed in the collecting hopper, and fed to the rotating chute to form a mixed layer of ore material and coke on the coke slit,
(3) the operations (1) and (2) are repeated,
(4) the amount of coke to form the coke slit is set to be 25 mass% to 40 mass% of the total amount of coke, and the amount of coke to form the mixed layer of ore material and coke is set to be 60 mass% to 75 mass% of the total amount of coke.

[3] The method for charging blast furnace raw material into a blast furnace according to the aspect [1] or [2] above, further comprising: forming a central coke layer at a shaft central portion of the blast furnace during charging of the blast furnace raw material into the blast furnace.

(Advantageous Effect of Invention)

[0013] According to the present invention, it is possible to control gas flow in a blast furnace by means of a slight coke slit left in the blast furnace, and thus to maintain satisfactory blast furnace gas permeability, allowing for stable blast furnace operation.

BRIEF DESCRIPTION OF DRAWINGS

[0014] The present invention will be further described below with reference to the accompanying drawings, wherein:

FIG. 1 schematically illustrates an embodiment of a method for charging blast furnace raw material into a blast furnace according to the present invention;
FIG. 2 is a diagram illustrating the order for charging blast furnace raw material from the furnace top bunkers;
FIG. 3 schematically illustrates the formation of a mixed layer, where the coke mixing ratio in the ore material layer is gradually increased to eventually form a complete mixed layer;
FIG. 4 is a graph showing the relationship between the amount of mixed coke and gas permeability;

FIG. 5 is a schematic configuration diagram of an experimental device for measuring high temperature properties of the ore material;

FIG. 6 is a graph showing the maximum pressure drop under the condition of coke ratio 350 kg/t, when coke is allocated to mixed coke and slit coke; and

FIG. 7 schematically illustrates the raw material charging condition including furnace top bunkers.

DESCRIPTION OF EMBODIMENTS

[0015] The following describes an embodiment of the present invention with reference to the drawings.

FIG. 1 schematically illustrates an embodiment of a method for charging blast furnace raw material into a blast furnace according to the present invention.

FIG. 1 illustrates the following: an ore material hopper 1 for storing ore material 2 composed of at least one of sintered ore, pellet, and lump ore; and a coke hopper 3 for storing coke 4. Ore material 2 and coke 4 that have been discharged from the ore material hopper 1 and from the coke hopper 3 in predetermined proportions are transported upwardly by an ore conveyor 5, then mixed and stored in a reserving hopper 6 as blast furnace raw material 7.

Blast furnace raw material 7 that has been discharged from the reserving hopper 6 is transported to the top of the blast furnace 10 by a charging conveyor 8, then charged via a receiving chute 11, and stored in one furnace top bunker, e.g., 12b among, e.g., three furnace top bunkers 12a to 12c. Note that the mixed material of ore material and coke is stored in the furnace top bunker 12b while adjusting the mixing amount of coke to be 30 mass% or less of a total amount of coke.

[0016] Here, the mixing amount of coke is adjusted to be 30 mass% or less of the total amount of coke for the following reasons. Ore material 2 and coke 4 that have been discharged from the ore material hopper 1 and the coke hopper 3 are transported on the ore conveyor 5 with the coke 4 being layered onto the ore material 2, charged into the reserving hopper 6, where the ore material 2 and the coke 4 are mixed to form mixed material. However, since coke 4 and ore material 2 are different in specific gravity and particle diameter, the mixed material stored in the reserving hopper 6 may segregate during transport to the receiving chute 11 on the charging conveyor 8, and furthermore, during charging via the receiving chute 11 into the furnace top bunker 12b.

At this point, if the amount of coke mixed with ore material is 30 mass% or less of the total amount of coke, coke and ore material are not significantly segregated when stored in the furnace top bunker 12b, and consequently, the mixing ratio of the mixed layer of ore material and coke formed by the rotating chute 16 may become substantially even.

[0017] In contrast, if the mixing amount of coke is more than 30 mass% of the total amount of coke, coke and ore material are more prone to segregation due to the differences in specific gravity and particle diameter and are largely segregated when stored in the furnace top bunker 12b, which causes regions where either one of ore material or coke alone is present.

Moreover, the mixed material is discharged from the furnace top bunker 12b in the order of, as shown in FIG. 2, upwards from a position near the outlet 12g close to the central shaft of the blast furnace, subsequently away from the central shaft of the blast furnace towards the outside, and finally the upper edge of the inclined sidewall 12h is discharged.

[0018] Thus, when either one of ore material or coke alone lies directly on the outlet 12g or on the upper end of the inclined sidewall 12h, only ore material or coke is discharged. In this case, although the ore material or coke will be mixed with coke and ore material to be discharged from the other furnace top bunkers 12a and 12c in the collecting hopper 14 to be stated later, the proportion of ore material or coke will increase, and the mixing ratio of the mixed layer of ore material and coke formed by the rotating chute 16 will be uneven.

Note that a mixing amount of coke being 30 mass% or less of the total amount of coke represents 7 mass% or less in terms of a ratio of (amount of coke / amount of ore material).

[0019] In addition, ore material and coke may be segregated when mixed together if the difference in their particle diameter is large, and furthermore, dependent on their particle diameter distributions.

[0020] Therefore, the inventors studied the gas permeability in a furnace when the coke mixing ratio in an ore material layer is gradually increased, as shown in FIG. 3(a), to eventually form a complete mixed layer in the furnace, as shown in FIG. 3(b), although ore material and coke were conventionally charged separately to form ore material layers and coke layers individually. FIG. 3 illustrates the following: a central coke layer 17, a coke slit 18, and a mixed layer 19.

Note that the experiment was conducted under the conditions of coke ratio 400 kg/t, with 50 kg of a central coke layer arranged in the furnace, while gradually mixing the remaining 350 kg of coke into the mixed layer. The gas permeability was analyzed using logK. K is the gas permeability resistance index, which is calculated by the following equation:

$$K = (P_B^{\,2} - P_T^{\,2})/\mu^{0.3}\rho^{0.7}V_B^{\,1.7}$$

where P_B is the blast pressure (in absolute pressure units), P_T is the blast pressure (in absolute pressure units), μ is the Bosch gas viscosity at standard temperature and pressure, ρ is the Bosch gas density at standard temperature and pressure, and V_B is the Bosch gas volume at standard temperature and pressure.

[0021] As a result, it was found that for seven of ten charges, as indicated by broken line in FIG. 4, gas permeability resistance gradually decreased and the gas permeability was as good as expected, whereas for the remaining three charges, as indicated by solid line in FIG. 4, the gas permeability resistance reached a minimum before coke can be mixed completely, then rose. That is, in some cases the gas permeability deteriorated.

The cause of such deterioration could be related to, as mentioned earlier, the occurrence of segregation during storage in a furnace top bunker, and/or the difference in particle diameter and particle diameter distributions of the charged raw material.

[0022] As indicated by solid line in FIG. 4, however, the gas permeability resistance gradually decreases and reaches a minimum up to a certain mixing amount, even if it will eventually rise afterwards due to the segregation of blast furnace raw material.

Therefore, it follows that coke can be mixed into the ore material up to a mixing amount by which the minimum is reached to form a mixed layer, while allowing the remaining coke to form as a coke slit, whereby good gas permeability is obtained.

[0023] The laboratory device illustrated in FIG. 5 was used to simulate the raw material reduction and elevated temperature process in a blast furnace and to test the change in gas permeability resistance.

In the laboratory device, a furnace core tube 32 is disposed on the inner peripheral surface of a cylindrical furnace body 31, and a cylindrical heater 33 is disposed on the outside of the furnace core tube 32. On the inside of the furnace core tube 32, a graphite crucible 35 is disposed at the upper edge of a cylindrical body 34 constituted by refractory material, and charged raw material 36 is charged inside the crucible 35. A load is applied to the charged raw material 36 from above by a load application device 38 connected via a punch rod 37, so that the charged raw material 36 adopts approximately the same state as the cohesive layer at the bottom of the blast furnace. A device 39 for sampling drops is provided at the bottom of the cylindrical body 34.

[0024] The gas adjusted by a gas mixing device 40 is fed to the crucible 35 through the cylindrical body 34 provided on its underside, and the gas passing through the charged raw material 36 in the crucible 35 is analyzed by a gas analysis device 41. A thermocouple 42 for controlling the heating temperature is provided in the heater 33, and by having a control device (not illustrated) control the heater 33 while measuring the temperature with the thermocouple 42, the crucible 35 is heated to 1200 °C to 1500 °C.

As the charged raw material 36, samples were prepared by mixing, in different proportions, coke with ore material formed from sinter and iron ore mixed in a predetermined ratio. Then, experiments were conducted to determine the maximum pressure drop under the condition of coke ratio 350 kg/t.

[0025] FIG. 6 is a graph showing the maximum pressure drop under the condition of coke ratio 350 kg/t, when coke used in the experiments is allocated to mixed coke and slit coke.

It can be seen that the gas permeability resistance reaches a minimum where the amount of mixed coke is in the range of 60 mass% to 75 mass% of the amount of coke charged into the blast furnace, and, to obtain the effect of improving the gas permeability of ore layers by mixing coke, it is preferred that the amount of mixed coke is 60 mass% to 75 mass% of the amount of coke charged into the furnace. In contrast, where the amount of mixed coke is more than 75 mass%, i.e., the amount of coke for coke slit is less than 25 mass%, the coke slit became thinner and less effective for maintaining the gas permeability of coke layers due to the cohesion and integration of ore layers and coke layers, leading to a rise in gas permeability resistance. In view of the foregoing, the inventors found out that charging 60 mass% to 75 mass% of the amount of coke charged into the furnace as a mixed layer of coke and ore material, while allowing the remaining 25 mass% to 40 mass% of coke to remain as a coke slit in the furnace, is effective for improving gas permeability in an advantageous manner. The present invention was completed based on this finding.

[0026] Then, the specific way of charging ore material and coke into a blast furnace is described based on FIG. 7.

In this example, it is assumed that the furnace top bunker 12b stores mixed material of ore material and coke, the furnace top bunker 12a stores coke alone, and the furnace top bunker 12c stores ore material alone.

In addition, the following describes raw material charging using a so-called reverse tilting control scheme, where the rotating chute 16 is controlled to be tilted from the shaft central portion of the blast furnace 10 towards the furnace wall, while simultaneously rotating about the shaft center of the blast furnace 10.

[0027] Raw material is charged from the furnace top bunkers in the order stated below. Coke is discharged from the furnace top bunker 12a, which stores coke alone, to form a coke layer (coke slit) 18, while setting the rotating chute 16 to be gradually tilted from the furnace wall towards the furnace central region, or from the furnace central region towards the furnace wall. The amount of coke used to form the coke slit 18 is set to be, as mentioned earlier, 25 mass% to 40 mass% of the amount of coke that is charged into the furnace per charge.

Then, the rotating chute 16 is set to charge raw material into the shaft central portion of the blast furnace, and by discharging only coke from the furnace top bunker 12a, into which only coke has been charged, a central coke layer 17 is formed in the shaft central portion of the blast furnace.

In other words, with the rotating chute 16 set to tilt in substantially vertical direction, the flow regulating gates 13 of the furnace top bunkers 12b and 12c are closed, the flow regulating gate 13 of only the furnace top bunker 12a is opened, and only the coke stored in the furnace top bunker 12a is fed to the rotating chute 16. In this way, a central coke layer 17 is formed in the shaft central portion of the blast furnace, as shown in FIG. 5.

[0028] At this point, it is desirable that coke falls at a position having a dimensionless radius of the blast furnace of 0 or more to 0.3 or less, in relation to the raw material stock line level, when 0 is the shaft central portion of the blast furnace and 1 is the furnace wall. The reason is that collecting some of coke in the shaft central portion of the furnace may be effective for improving the gas permeability at the shaft central portion, and thus the gas permeability of the blast furnace as a whole.

Note that the amount of coke charged to form a central coke layer is preferably approximately 5 mass% to 30 mass% of the amount of coke charged per charge. This is because if the amount of coke charged into the shaft central portion is less than 5 mass%, the gas permeability around the shaft central portion improves insufficiently, and if coke is collected in the shaft central portion by more than 30 mass%, not only does the amount of coke used to form a mixed layer decrease, but also too much gas passes through the shaft central portion, leading to increased heat removal from the furnace body. Preferably, the amount of coke charged into the shaft central portion is 10 mass% to 20 mass%.

Regarding the amount of coke used to form the coke slit 18 and the central coke layer 17, as mentioned earlier, 25 mass% to 40 mass% of the total amount of coke that is charged into the furnace is allocated to formation of the coke layer (coke slit) 18 and the central coke layer 17. Note that for formation of the coke layer (coke slit) 18, the amount of coke charged per charge may be set such that the resulting coke layer has a thickness of 100 mm or more, preferably 150 mm or more. Being formed from only coke, a layer may form as a coke slit that is capable of maintaining gas permeability.

[0029] Then, in other words, subsequent to the formation of the central coke layer, coke and ore material and/or mixed material are discharged simultaneously from each furnace top bunker, mixed in the collecting hopper 14, and then fed to the rotating chute 16 to form a mixed layer 19 of ore material and coke on the outside of the central coke layer 17 and on top of the coke slit 18.

In other words, in this case, not only the flow regulating gate 13 of the furnace top bunker 12a but also the flow regulating gates 13 of the remaining two furnace top bunkers 12b and 12c are opened to predetermined opening positions, coke discharged from the furnace top bunker 12a, mixed material discharged from the furnace top bunker 12b, and ore material discharged from the furnace top bunker 12c are simultaneously fed to the collecting hopper 14, where the coke and the ore material are completely mixed and fed to the rotating chute 16. As a result, a mixed layer 19, which is formed from coke and ore material mixed with a substantially even mixing ratio, is formed on the outside of the central coke layer 17 in the blast furnace 10 and on top of the coke slit 18.

Note that the coke ratio in the mixed layer 19 is set to be 60 mass% to 75 mass % of the amount of coke charged per charge.

[0030] The following describes the sizes of ore material and coke. Ore material does not show much variation in particle diameter, which is usually as small as 5 mm to 25 mm. In contrast, coke has large variation in particle diameter, which is in the range of 10 mm to 60 mm. Generally, coke with a particle diameter from approximately 30 mm to 60 mm is called "lump coke" and with a particle diameter from approximately 10 mm to 30 mm "small-and-middle lump coke." Therefore, to prevent segregation of raw material, it is desirable that the size of coke used is adjusted depending on the size of ore material used, and the particle diameter distribution of coke used is also adjusted accordingly.

In this case, to avoid the particle diameter of ore material and/or coke from impairing the gas permeability in the furnace, it is also desirable that ore material has a particle diameter of 10 mm to 30 mm and coke has a particle diameter of 30 mm to 55 mm. Moreover, the ratio of the particle diameters (particle diameter of coke / particle diameter of ore material) is preferably approximately 1.0 to 5.5.

[0031] As is the case with the present invention, however, allowing some of coke to remain as a coke slit, rather than mixing all of the coke into a mixed layer, may ensure good gas permeability in the furnace without having to particularly adjust the sizes of ore material and coke used.

[0032] In addition, a preferred coke ratio in a mixed layer for improving gas permeability, i.e., the ratio of (amount of coke / amount of ore material) is in the range of approximately 7 % to 25 %, more preferably in the range of 10 % to 15 %, in terms of mass ratio. The reason is that if the ratio of (amount of coke / amount of ore material) is less than 7 mass%, the effect of improving gas permeability by mixing coke is insufficient and the gas permeability of ore layers worsens, and if the ratio of (amount of coke / amount of ore material) is more than 25 mass%, the gas permeability of the coke layer deteriorates since insufficient coke forms as a coke slit.

[0033] Note that an advantageous operation is as follows: when a shaft pressure anomaly is detected while monitoring shaft pressure during blast furnace operation, in the course of continuous blast furnace charging according to the present invention, the raw material charging should be switched to a normal mode in which ore material layers and a coke slit are separately formed and, when the shaft pressure anomaly is resolved later, switched back to the charging scheme according to the present invention.

EXAMPLES

[0034] As Table 1 shows, blast furnace operations were performed with varying ratios of coke used to form a coke slit and to form a mixed layer based on the total amount of coke.
Table 1 compares the results of investigation of gas utilization rate, packed layer pressure drop ΔP/V, and packed layer pressure variation σΔP/V under different operation conditions.
Note that σΔP/V is the standard deviation of measurements ΔP/V taken every minute over a 30 minute period. A smaller σΔP/V represents a more stable gas flow in the furnace.

[Table 1]

	Comparartive Example 1	Comparative Example 2	Example 1	Example 2
productivity (t/m^3/day)	2.0	2.0	2.0	2.0
coke ratio (kg/t)	362	355	332	320
pulverized coal ratio (kg/t)	148	148	158	168
reducing agent ratio (kg/t)	510	503	490	488
coke slit ratio in total coke (mass%)	70	70	30	25
mixing ratio in total coke (mass%)	0	20	60	65
central coke ratio (mass%)	30	10	10	10
gas utilization rate (%)	48.1	49.3	50.5	51.0
pressure drop ΔP/V (kPa/(Nm^3/min))	25.8	23.8	22.7	22.5
pressure variation σΔP/V (kPa/(Nm^3/min))	0.30	0.25	0.20	0.20

[0035] As shown in the table, where 35 mass% (Example 1) or 25 mass% (Example 2) of coke was used to form a coke slit based on the total amount of coke according to the present invention, the gas utilization rate improved and the packed layer pressure drop ΔP/V and packed layer pressure variation σΔP/V were both less pronounced, despite lower coke ratios.

REFERENCE SIGNS LIST

[0036]

1	Ore powder hopper
2	Ore material
3	Coke hopper
4	Coke
5	Ore conveyor
6	Reserving hopper
7	Blast furnace raw material
8	Charging conveyor
10	Blast furnace
11	Receiving chute
12a to 12c	Furnace top bunker
13	Flow regulating gate
14	Collecting hopper
15	Bell-less charging device
16	Rotating chute
17	Central coke layer
18	Coke slit
19	Mixed layer

Claims

1. A method for charging blast furnace raw material into a blast furnace, comprising, when charging blast furnace raw material including coke and ore material such as sintered ore, pellet, or lump ore into the blast furnace using a rotating chute:

   charging 60 mass% to 75 mass% of the amount of coke that is charged into the furnace per charge in the form of a mixed layer of coke and ore material, while allowing the remaining 25 mass% to 40 mass% of coke to remain as a coke slit.

2. The method for charging blast furnace raw material into a blast furnace according to claim 1, further comprising:

   providing at least two furnace top bunkers at a top of the blast furnace;
   storing, in either one or two of the furnace top bunkers, either one or both of the ore material and mixed material obtained by mixing the ore material and the coke with a mixing amount of coke being 30 mass% or less of a total amount of coke to be charged into the furnace;
   storing only coke in the remaining one of the furnace top bunkers;
   receiving the raw material discharged from each of the furnace top bunkers in a collecting hopper; and
   then feeding the raw material to the rotating chute to charge the raw material into the blast furnace, wherein

   (1) firstly, a coke slit is formed by discharging coke from the furnace top bunker, into which only coke has been charged,
   (2) then, coke and ore material and/or mixed material are discharged simultaneously from the furnace top bunkers, mixed in the collecting hopper, and fed to the rotating chute to form a mixed layer of ore material and coke on the coke slit,
   (3) the operations (1) and (2) are repeated,
   (4) the amount of coke to form the coke slit is set to be 25 mass% to 40 mass% of the total amount of coke, and the amount of coke to form the mixed layer of ore material and coke is set to be 60 mass% to 75 mass% of the total amount of coke.

3. The method for charging blast furnace raw material into a blast furnace according to claim 1 or 2, further comprising: forming a central coke layer at a shaft central portion of the blast furnace during charging of the blast furnace raw material into the blast furnace.

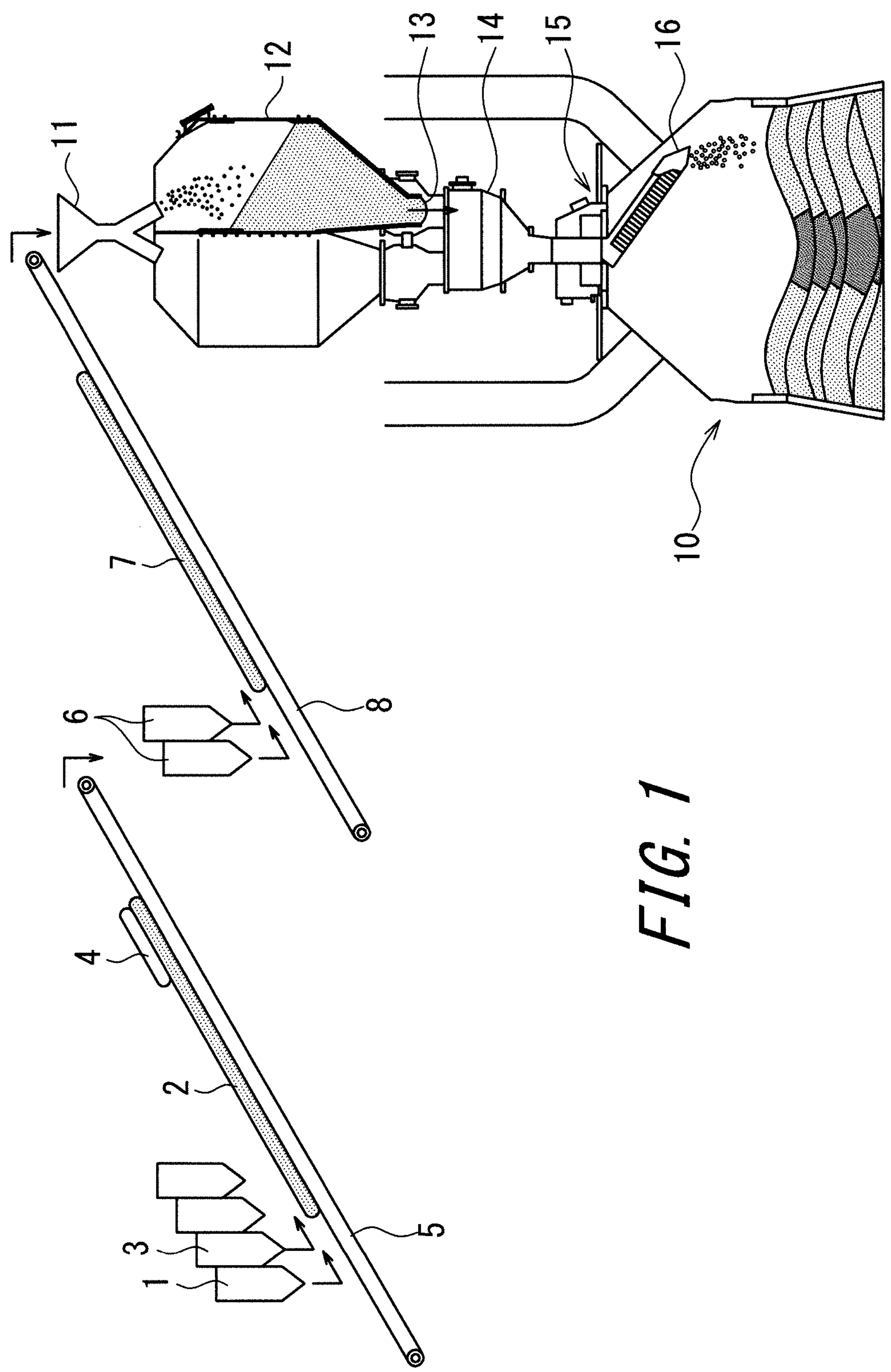


FIG. 1

FIG. 2

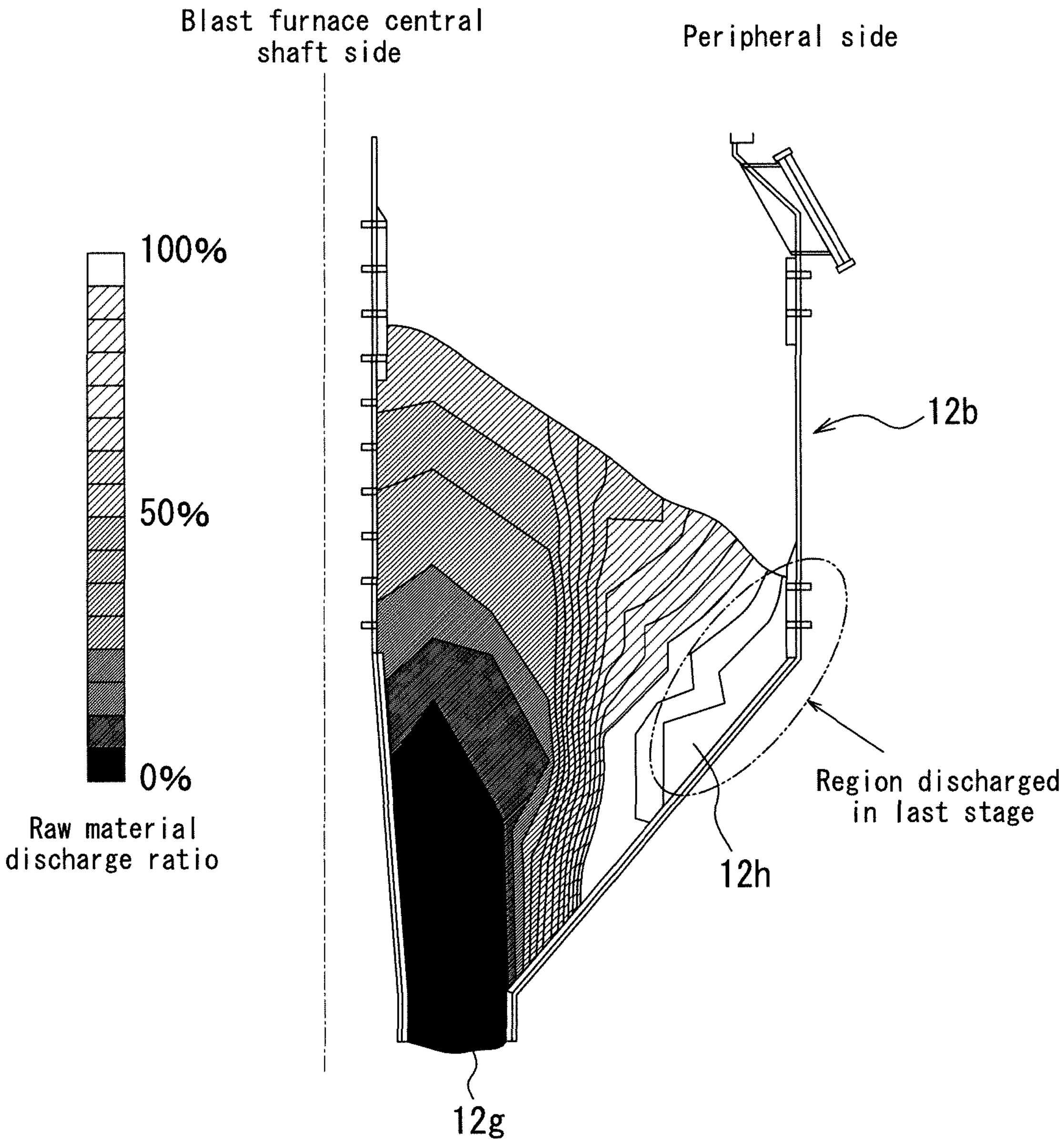

Blast furnace central shaft side
Peripheral side
100%
50%
0%
Raw material discharge ratio
12b
Region discharged in last stage
12h
12g

FIG. 3A

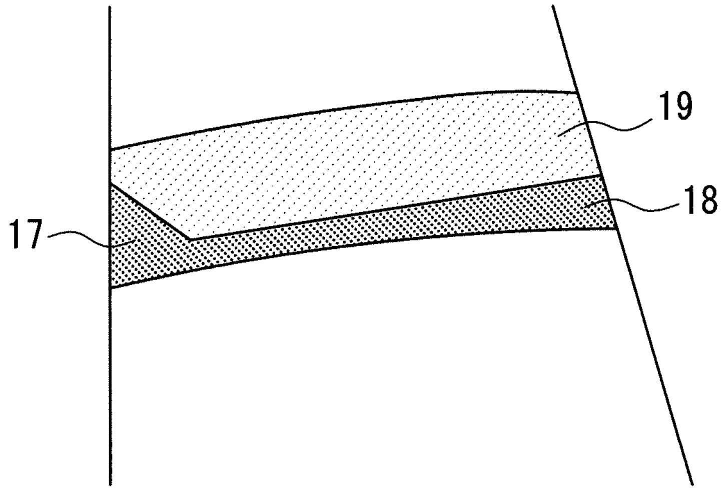


FIG. 3B

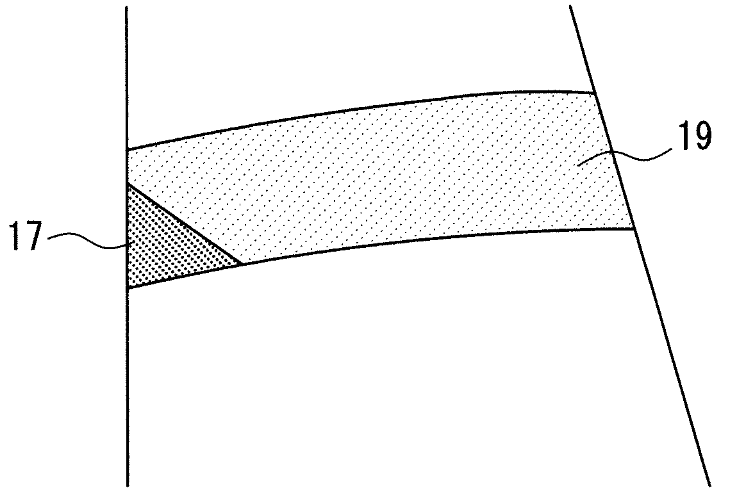


FIG. 4

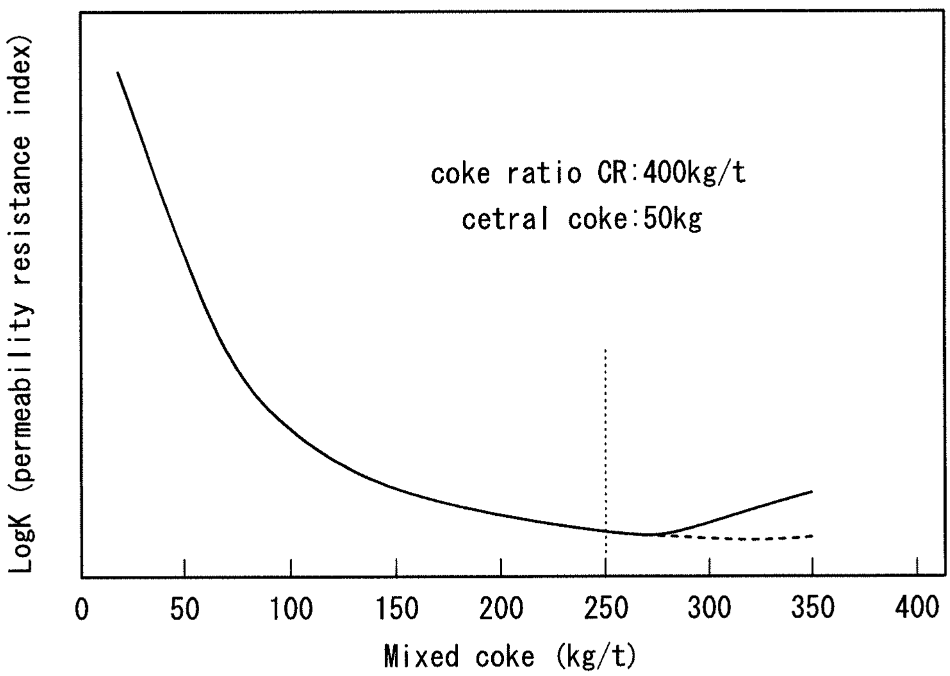

coke ratio CR:400kg/t
cetral coke:50kg
LogK (permeability resistance index)
0
50
100
150
200
250
300
350
400
Mixed coke (kg/t)

FIG. 5

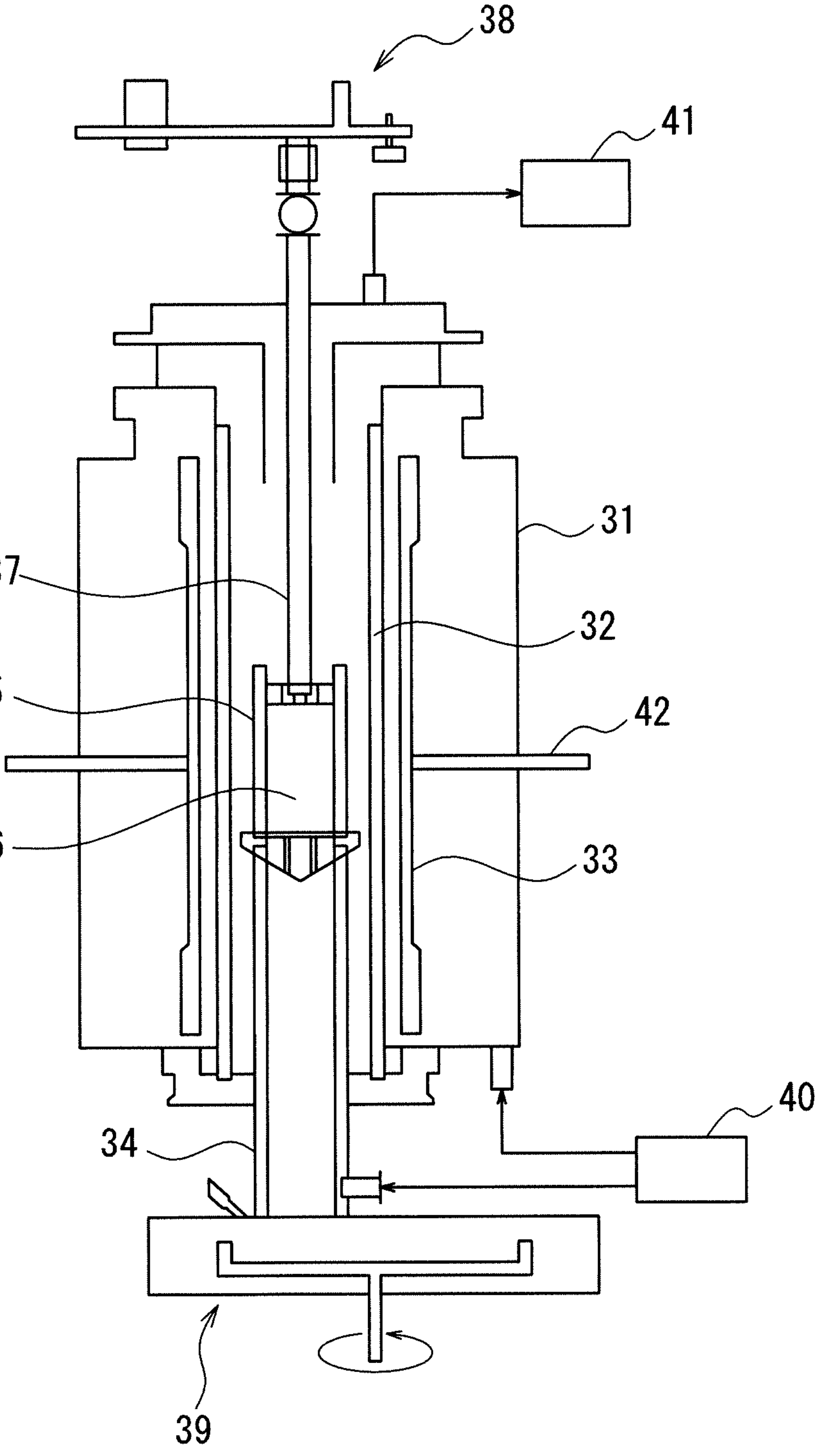


FIG. 6

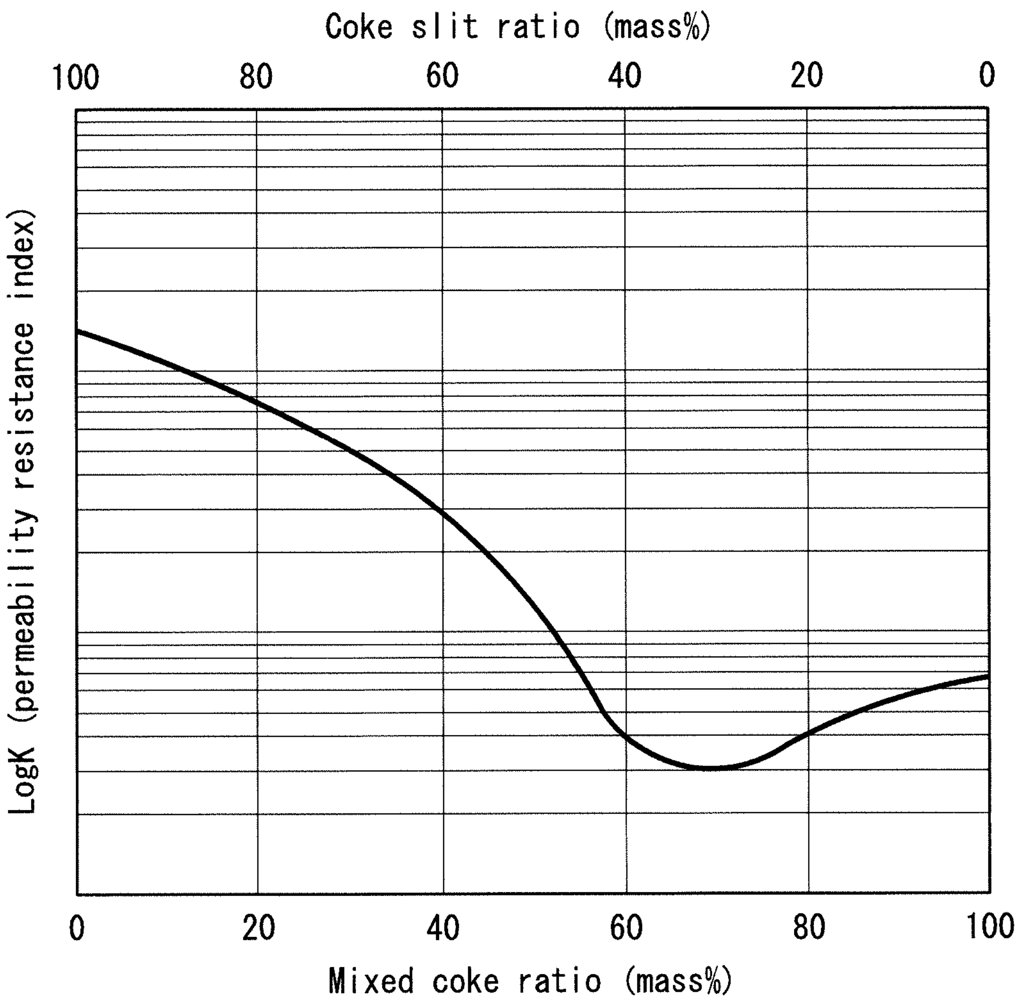
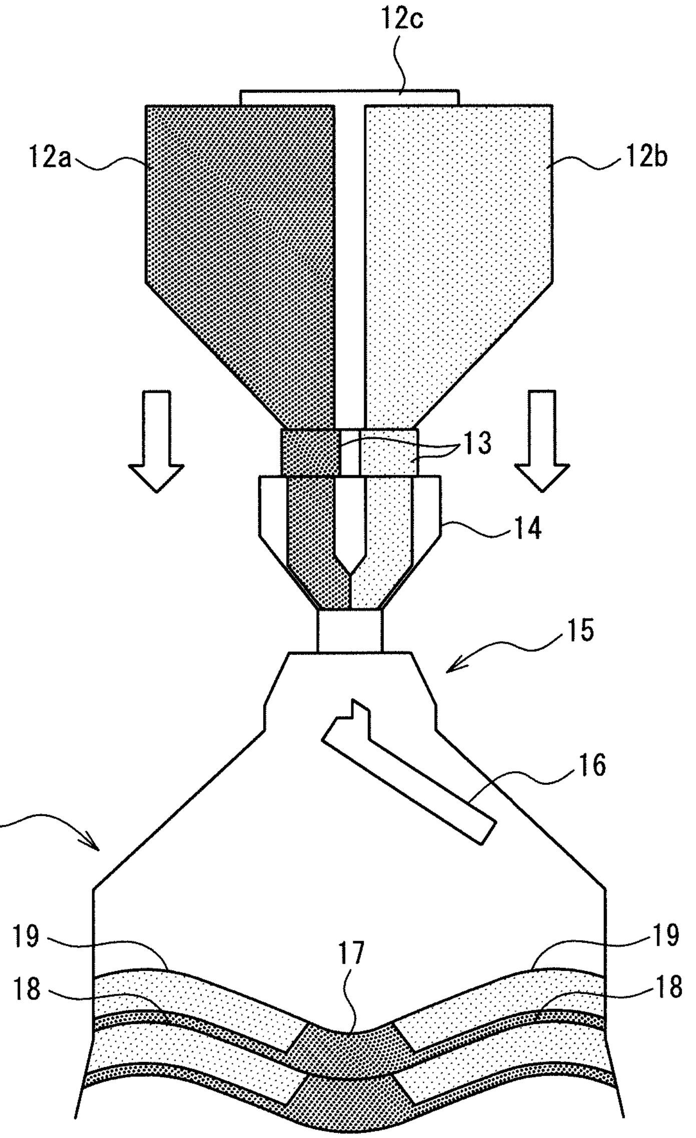

Coke slit ratio (mass%)
100
80
60
40
20
0
LogK (permeability resistance index)
0
20
40
60
80
100
Mixed coke ratio (mass%)

FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/003170

A. CLASSIFICATION OF SUBJECT MATTER
C21B5/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C21B5/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-137217 A (JFE Steel Corp.), 14 July 2011 (14.07.2011), paragraphs [0011] to [0036]; fig. 1 (Family: none)	1-3
A	JP 2006-265644 A (JFE Steel Corp.), 05 October 2006 (05.10.2006), paragraphs [0010] to [0024]; fig. 1, 4 (Family: none)	1-3
A	JP 2004-107794 A (JFE Steel Corp.), 08 April 2004 (08.04.2004), paragraphs [0007] to [0028]; fig. 1 to 3 & EP 1445334 A1 & WO 2004/027097 A1 & BR 306185 A & TW 239355 B & CN 1596315 A	1-3

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

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Date of the actual completion of the international search	Date of mailing of the international search report
09 August, 2013 (09.08.13)	20 August, 2013 (20.08.13)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/003170

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003-328019 A (Sumitomo Metal Industries, Ltd.), 19 November 2003 (19.11.2003), paragraphs [0013] to [0053]; fig. 1, 2 (Family: none)	1-3
A	JP 11-217605 A (Nippon Steel Corp.), 10 August 1999 (10.08.1999), paragraphs [0016] to [0038]; fig. 1 to 5 (Family: none)	1-3
A	JP 3-193806 A (Kawasaki Steel Corp.), 23 August 1991 (23.08.1991), examples; fig. 1 to 7 (Family: none)	1-3

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H3211210 A **[0004] [0007]**
- JP 2004107794 A **[0005] [0007]**
- JP 59010402 B **[0006]**
- JP S5910402 B **[0007]**