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(54) SINTERING APPARATUS AND SINTERING METHOD

SINTERVORRICHTUNG UND SINTERVERFAHREN

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a sintering apparatus and a sintering method, and more particularly to a sintering apparatus and a sintering method capable of improving a quality and a productivity of a sintered ore and reducing an emission of pollutants.

RELATED ART

[0002] A sintered ore used as a raw material for making iron in a blast furnace is manufactured by mixing an iron ore with a fine coke or an anthracite binder and then combusting the coke and sintering the iron ore with the combustion heat.

[0003] A typical sintered ore manufacturing facility includes an upper ore hopper storing an upper ore therein, a surge hopper storing a mixed-raw material mixed with the iron ore, which is a raw material and the coke, which is a heat source therein, a plurality of vehicles arranged in a row, and provided with an upper ore and a mixed-raw material, and transferred in a process progressing direction, a conveyor configured for transferring the plurality of the vehicles in the process progressing direction, an ignition-furnace disposed above the vehicle transferred by the conveyor in the process progressing direction, and configured to firing a to-be-sintered material loaded on the vehicle, a plurality of a wind-boxes arranged on a transferring path in a row in the process progressing direction, and configured to suck an inside of the plurality of the vehicle, ducts connected to distal ends of the plurality of the wind-boxes, a blower (not shown) connected to the duct to generate a suction force.

[0004] A sintering process is performed by applying a suction power to the vehicle by generating a negative pressure by the wind-box disposed below the vehicle.

[0005] That is, when the blower is driven, the wind-box suck air at an upper portion of the vehicle, then an ignited flame on a top face of the to-be-sintered material is moved to a lower portion of the to-be-sintered material, therefore the sintering proceeds.

[0006] Conventionally, sintered exhaust gas, which is air sucked through the wind-box, is discharged to the outside. However, these gases contain pollutants. In addition, the sintered exhaust gas has a lot of heat energy because it is generated by passing through a high temperature sintered ore. Therefore, when the sintered exhaust gas is discharged to the outside, it may cause an environmental pollution and a lot of energy may be lost.

[0007] (Patent Document 1) KR2014-0016658 A. Patent Document KR 101 300 163 B1 relates to a circulating device of exhaust sintering gas in sintering plant and method for controlling the device.

[0008] US2410944 relates to a sintering apparatus according to the preamble of claim 1.

SUMMARY

[0009] The present invention provides a sintering apparatus and a sintering method capable of suppressing or preventing an environmental pollution by circulating an exhaust gas generated during a sintering process.

[0010] The present invention provides a sintering apparatus and sintering method capable of improving a combustion efficiency and increasing a productivity by providing the exhaust gas and air to a to-be-sintered material.

[0011] A sintering apparatus of the present invention is a sintering apparatus according to claim 1.

[0012] A method for producing a sintered ore of the present invention is a method according to claim 8.

[0013] Further developments of the invention are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Figure 1 shows a sintering apparatus according to an embodiment of the present invention.

Figure 2 shows a cross-sectional view of a sintering layer and characteristics of exhaust gas in a sintering process according to an embodiment of the present disclosure.

Figure 3 shows an example of a sintering apparatus.

Figure 4 shows a sintering apparatus according to another embodiment of the present disclosure.

Figure 5 shows a sintering method according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0015] In the accompanying drawings, the dimensions of the structure show an enlarged scale than actual for clarity of the invention. The same or similar reference numerals are used throughout the drawings and the description in order to refer to the same or similar constituent elements.

[0016] Referring to Figure 1, a sintering apparatus 100 according to an embodiment of the present disclosure includes a vehicle 110 disposed movably along a traveling path and having a to-be-sintered material loaded therein, an ignition-furnace 130 disposed above the traveling path for spraying a flame to an upper portion of the to-be-sintered material, a plurality of wind-boxes 140 disposed below the vehicle 110 along the traveling path to provide a suction power to the vehicle 110, a hood 150 disposed above the vehicle 110 and extending along the traveling path, a circulation unit 160 connected to a portion of a plurality of the wind-boxes 140 and supplying exhaust gas sucked into a portion of the wind-boxes 140 to the hood 150, and an air supply unit 170 connected to at least one of the hood 150 and the circulation unit 160 to supply air to the to-be-sintered material.

[0017] Further, the sintering apparatus 100 may include a charging unit 120 for charging the to-be-sintered material to the vehicle 110, a gas exhausting unit 50 connected to wind-boxes 140 not connected to the circulation unit 160 among the plurality of the wind-boxes 140, and a control unit 190 for controlling an operation of the air supply unit 170. In addition, the sintering apparatus 100 may include at least one of a pressure sensor 181 for measuring a pressure inside the hood 150 and an oxygen sensor 182 for measuring an oxygen concentration in the exhaust gas sucked into the circulation unit 160.

[0018] The vehicle 110 is arranged to rotate in an endless track manner, and a closed loop is formed so that a traveling path on an upper side of the closed loop, a rotation path on a lower side of the closed loop, and a switching path connecting the traveling path and the rotation path may be formed. In the traveling path, the to-be-sintered material is loaded and sintered in the vehicle 110, and in the rotation path, an empty vehicle 110, in which the sintered ore is discharged, travels.

[0019] For example, the traveling path may be extended in an anteroposterior direction, and may include a charging section located at the foremost position in the traveling path and in which the charging unit 120 is disposed, an ignition section located behind the charging section and in which the ignition-furnace is disposed, a sintering section located behind the charging section and in which the to-be-sintered material is sintered. That is, when the vehicle 110 is passing through the charging section, the to-be-sintered material is loaded into the vehicle 110, and when the vehicle 110 is passing through the ignition section, the flame is ignited to the to-be-sintered material in the vehicle 110. In the sintering section, the flame ignited to the to-be-sintered material is moved from an upper portion to a lower portion of the to-be-sintered material, therefore the sintered ore is produced. At this time, the vehicle 110 may travel from a front to a rear of the traveling path.

[0020] The vehicle 110 forms a space in which the to-be-sintered material is contained therein, and the plurality of the vehicle 110 are disposed in the endless track to travel the traveling path and the rotation path. Accordingly, the plurality of the vehicles 110 may travel from the traveling path to the rotation path, or from the rotation path to the traveling path, thereby continuously producing the sintered ore.

[0021] The charging unit 120 is disposed in the charging section of the traveling path. The charging unit 120 is disposed above the vehicle 110 so that the to-be-sintered material may be loaded into an open top of the vehicle 110. The charging unit 120 may include a hopper in which the to-be-sintered material is stored, and a charging chute disposed at a lower portion of the unit 120 and guiding the to-be-sintered material discharged from the hopper to the inside of the vehicle 110. Thus, the to-be-sintered material may be loaded into the vehicle 110 passing through the charging section.

[0022] The ignition-furnace 130 is disposed in the ig-

niton section of the traveling path. The ignition-furnace 130 is disposed behind the charging unit 120 and disposed above the vehicle 110 to spray the flame into the to-be-sintered material loaded in the vehicle 110. Thus, the loaded material in the vehicle 110 passing through the ignition section may be ignited.

[0023] The plurality of the wind-boxes 140 are disposed along the traveling path and disposed below the vehicles 110 passing along the traveling path to suck the exhaust gas. Thus, the air at the upper portion of the vehicle 110 may be sucked into the wind-box 140 through the to-be-sintered material in the vehicle 110. Accordingly, the flame ignited to a top face of the to-be-sintered material moves downward through the air, thereby sintering the entire to-be-sintered material.

[0024] The gas exhausting unit 50 provides the suction power to the wind-boxes 140, which are not connected to the circulation unit 160 among the plurality of wind-boxes 140, and discharges sucked exhaust gas to the outside. The gas exhausting unit 50 may include a suction pipe 51 connected to a lower portion of the wind-box 140 and having a space for receiving the exhaust gas sucked therein, a dust collector 52 connected to the suction pipe 51, a main blower 53, and a stack 54. When the main blower 53 generates the suction power, the exhaust gas flowing into the wind-box 140 is sucked by the suction pipe 51, filtered through the dust collector 52, and discharged to the stack 54. In this connection, the exhaust gas may be air sucked into the wind-box 140 passing through the to-be-sintered material.

[0025] The circulation unit 160 is connected to the portion of the plurality of wind-boxes 140 and circulates the sucked exhaust gas to supply the exhaust gas to the upper portion of the vehicle 110. The circulation unit 160 includes a circulation pipe 161 connected to the portion of the plurality of the wind-boxes 140 and defining a space for receiving the exhaust gas therein, a circulation line 162 defining a path along which the exhaust gas moves, and one end of the line 162 connected to the circulation pipe 161 and the other end connected to the hood 150, and a blower 163 disposed in the circulation line 162.

[0026] The circulation pipe 161 forms the space for receiving the exhaust gas therein, and is connected to the portion of the plurality of the wind-boxes 140. Specifically, the circulation pipe 161 is connected to the wind-boxes 140 between a transition point between increase and decrease of a flow rate of the exhaust gas, and a point where a temperature of the exhaust gas reaches a maximum.

[0027] Figure 2 shows a cross-sectional shape of a sintering layer and characteristics of exhaust gas in a sintering process according to an embodiment of the present disclosure.

[0028] A combustion zone has a high temperature due to an active combustion of the to-be-sintered material. Referring to Figure 2, the combustion zone is gradually moved downward by the air sucked from an upper portion to a lower portion of the combustion zone, and the upper

portion of the combustion zone is cooled by air at a room temperature. In this connection, since an air resistance of the combustion zone is larger than that of a non-sintered to-be-sintered material, an amount of the exhaust gas sucked into the wind-box 140 decreases as a thickness of the combustion zone increases. Accordingly, a transition point A between increase and decrease of a flow rate of the exhaust gas may be the point at which the air resistance inside the vehicle 110 increases (a point at which the thickness of the combustion zone increases).

[0029] In this connection, a high-temperature air passed through the combustion zone decreases in temperature as the hot air meets the non-sintered to-be-sintered material at the lower portion of the combustion zone. Vapor which is vaped in the combustion zone condenses to form a humid zone. When the combustion zone reaches the bottom of the vehicle 110, the humid zone and the non-sintered to-be-sintered material layer disappear. Thus, the hot air passed through the combustion zone is not cooled as the hot air passes through the non-sintered to-be-sintered material or the humid zone, and is sucked into the wind-box 140 at a high temperature. Accordingly, the temperature of the exhaust gas sucked into the wind-box 140 increases to a maximum temperature, and then the temperature decreases from a point where sintering of the to-be-sintered material is almost completed.

[0030] Because the air resistance increases at the wind-boxes 140 between the transition point between increase and decrease of a flow rate of the exhaust gas, and a point where the temperature of the exhaust gas reaches a maximum temperature (BTP: Burn Through Point), in order to suck the air smoothly only wind-boxes 140 in this region may be connected to the circulation pipe 161 separately to provide a greater suction power than that of the other wind-boxes 140. That is, as the thickness of the combustion zone increases, the air resistance increases, but the suction power of the wind-box 140 may be increased to increase the airflow. Accordingly, the sintering of the to-be-sintered material proceeds smoothly, and the productivity and quality of the produced sintered ore may be improved.

[0031] In addition, connecting the wind-box 140 and the circulation pipe 161 earlier the transition point A between increase and decrease of a flow rate of the exhaust gas, the combustion rate is accelerated but the air is cooled more rapidly. Therefore, a heat supplied to the sintering layer is insufficient, so that a strength of the sintered ore may be lowered. Therefore, the wind-box 140 and the circulation pipe 161 must be connected at or after the transition point between increase and decrease of a flow rate of the exhaust gas.

[0032] In this connection, the transition point A between increase and decrease of a flow rate of the exhaust gas is the point where SO_x is generated. SO_x may react with moisture in the exhaust gas to generate sulfuric acid and may corrode the inside of the circulation pipe 161.

Therefore, high temperature exhaust gas may be introduced into the circulation pipe 161 so that the temperature inside the circulation pipe 161 becomes higher than the acid dew point at which the sulfuric acid is generated.

Accordingly, the circulation pipe 161 is connected to the wind-box 140 as far as the point where the temperature of the exhaust gas becomes maximum, therefore the internal temperature of the circulation pipe 161 may be raised up by the high temperature exhaust gas.

[0033] Otherwise, the wind-boxes 140 from the transition point between increase and decrease of a flow rate of the exhaust gas to a point where a coal contained in the to-be-sintered material is exhausted, or to an inflection point of the exhaust gas temperature inclination (BRP: Burn Rising Point) may be connected to the circulation pipe 161.

[0034] In this connection, a flow rate sensor for measuring the flow rate of the exhaust gas and a temperature sensor for measuring the temperature of the exhaust gas may be installed in each wind-box 140. Therefore, it is possible to know the transition point between increase and decrease of a flow rate of the exhaust gas, and the point where the temperature of the exhaust gas becomes maximum among the plurality of the wind-boxes 140.

[0035] The circulation line 162 forms the path along which the exhaust gas travels. The circulation line 162 may be connected at one end to the lower portion of the circulation pipe 161 and at the other end to the upper portion of the hood 150. Therefore, the exhaust gas sucked into the circulation pipe 161 may travel along the circulation line 162 and may be supplied to the hood 150.

[0036] The blower 163 is disposed in the circulation line 162 and generates the suction power. Thus, the exhaust gas may be sucked in the wind-box 140 and the exhaust gas sucked in the wind-box 140 may be supplied to the hood 150 along the circulation line 162.

[0037] The blower 163 provides the suction power to the wind-boxes 140 connected to the circulation pipe 161 among the plurality of the wind-boxes 140, and the main blower 53 provides the suction power to the wind-boxes 140 connected to the suction pipe 51. Thus, a greater suction power may be provided to each of the wind-boxes 140 than in a case when one blower provides suction power to all of the wind-boxes 140. In this connection, the number of the wind-boxes 140 connected to the circulation pipe 161 may be lower than the number of the wind-boxes 140 connected to the suction pipe 51. Therefore, even if the blower 163 and the main blower 53 generate the same suction power, a greater suction power may be generated in the wind-boxes 140 connected to the circulation pipe 161. That is, by providing a greater suction power in regions where the air resistance is large, thereby suppressing or preventing a reduction of the flow rate of the exhaust gas.

[0038] The hood 150 is disposed above the vehicle 110 to supply the exhaust gas sucked into the circulation pipe 161 to the to-be-sintered material in the vehicle 110. The hood 150 may be extended in the anteroposterior

direction, and top and side faces may be closed to cover the upper portion of the wind-boxes 140, and a bottom may be opened. Therefore, the exhaust gas supplied into the hood 150 may be discharged to the bottom of the hood 150.

[0039] For example, the hood 150 may be extended to cover upper portions of the wind-boxes 140 from a combustion start point of a bottom layer of the to-be-sintered material (or a point where the combustion zone reaches a lower portion of the vehicle 110) to a rear end-point of the traveling path.

[0040] The exhaust gas is generated when the air passes along the to-be-sintered material, oxygen in the air combusts the to-be-sintered material. Therefore, the exhaust gas has a lower oxygen concentration than normal air. When such exhaust gas is supplied to the most active part of the combustion, the productivity and quality of the sintered ore are lowered.

[0041] Therefore, the exhaust gas may be circulated by supplying the exhaust gas to a region where the combustion is less frequent. That is, the hood 150 may be extended to supply the exhaust gas to the wind-boxes 140 between a point where the combustion starts to occur less (or the point where the combustion of the bottom layer of the to-be-sintered material begins) and a point where the combustion is completely completed (or the point where at the end of the traveling path).

[0042] In addition, the number of the wind-boxes 140 covered by the hood 150 may be greater than the number of the wind-boxes 140 connected to the circulation pipe 161. The exhaust gas sucked into the circulation pipe 161 is bulky than the normal air because it is at a high temperature. Since a volume of the exhaust gas that the wind-box 140 may suck in is limited, when the number of the wind-boxes 140 covered by the hood 150 is small or the area where the hood 150 supplies the exhaust gas decreases, some of the exhaust gas discharged from the hood 150 may not be sucked into the wind-box 140 and may leak out and cause an environmental pollution.

[0043] Lengthening a length of the hood 150 to increase the number of the wind-boxes 140 covered by the hood 150 allows all of the exhaust gas discharged from the hood 150 to be sucked into the wind-box 140, thus the exhaust gas discharged from the hood 150 may be blocked from flowing out to the outside. Therefore, the number of the wind-boxes 140 covered by the hood 150 may be increased more than the number of the wind-boxes 140 connected to the circulation pipe 161 so that the wind-box 140 may suck all of the exhaust gas discharged from the hood 150. In this connection, a front end of the hood 150 and a rear end of the circulation pipe 161 may overlap with each other with respect to the anteroposterior direction.

[0044] The air supply unit 170 according to an embodiment of the present invention includes a door unit 171 mounted on a top face of the hood 150. In this connection, an opening is defined in the top face of the hood 150, and the door unit 171 is mounted on the top face of the

hood 150 to open and close the opening. In addition, the air supplied from the air supply unit 170 may be normal air that does not pass through the to-be-sintered material, or external air.

[0045] For example, the opening of the hood 150 may be defined in a rectangular shape, and the door unit 171 may include a plate covering the opening and an actuator moving the plate.

[0046] The plate may be defined corresponding to the shape of the opening and slidably mounted on the hood 150. For example, the plate may be mounted on the top face of the hood 150 to be movable back and forth. Thus, when the plate is moved forward, the plate may be positioned corresponding to the opening, and the opening may be closed. Conversely, when the plate is moved rearward, the opening may be opened as the plate moves. Therefore, when the opening of the hood 150 is opened, the external air may be introduced into the hood 150, and when the opening of the hood 150 is closed, the external air may be prevented from flowing into the inside of the hood 150. However, a structure and a shape of the plate and a method for mounting the plate on the hood 150 may not be limited thereto and may vary.

[0047] The actuator acts to move the plate. For example, the actuator may be a cylinder, one end may be connected to the plate, and the other end may be fixedly mounted on the hood 150. Therefore, when the one end of the actuator moves forward, the plate moves forward to close the opening of the hood 150. When the one end of the actuator moves rearward, the plate moves rearward and the opening of the hood 150 may be opened. However, the way the actuator moves the plate may not be limited thereto, but may vary.

[0048] In this connection, the opening is defined closer to the ignition-furnace 130 than the location where the circulation line 162 and the hood 150 are connected to each other. That is, the opening is defined in front of the portion where the circulation line 162 and the hood 150 are connected. The opening is formed forwardly of (or at) a central point of the hood 150 in the anteroposterior direction thereof, while the circulation line 162 is connected to a rearward point from the central point of the hood 150 in the anteroposterior direction thereof. Accordingly, the air may be introduced into a wind-box 140 located forwardly of the wind-boxes 140 covered by the hood 150, and circulated gas may be supplied to a wind-box 140 located rearwardly. That is, the combustion is more actively performed in a vehicle 110 passing through the wind-box 140 located forwardly of the wind-boxes 140 covered by the hood 150 than a vehicle 110 passing through the wind-box 140 located rearwardly of the wind-boxes 140 covered by the hood 150. That is, more oxygen should be supplied to the vehicle 110 forwardly located in the anteroposterior direction thereof. Accordingly, the air may be supplied to the forwardly located vehicle 110 where the combustion is more active, and the exhaust gas having a small amount of the oxygen may be supplied to the rearwardly located vehicle 110.

[0049] In addition, a pressure sensor 181 may be installed in the hood 150. The pressure sensor 181 serves to measure a pressure inside the hood 150. A single pressure sensor 181 may be provided to measure the pressure only at one position within the hood 150 or a plurality of the pressure sensor 181 may be provided to measure the pressure at a plurality of positions within the hood 150.

[0050] The control unit 190 controls the operation of the door unit 171 based on the pressure inside the hood 150. The control unit 190 may include a transceiver 191 connected to the pressure sensor 181 to transmit and receive the pressure information inside the hood 150, a determiner 192 connected to the transceiver 191 to compare the pressure information inside the hood 150 received from the transceiver 191 with a preset pressure value, and a controller for controlling an operation of the actuator based on the determination of the determiner 192.

[0051] The determiner 192 compares the pressure inside the hood 150 with the preset pressure value, and when the pressure inside the hood 150 is below the preset pressure, the determiner 192 transmits a signal to the controller to open the opening of the hood 150. In this connection, the preset pressure value may be the atmospheric pressure. That is, in order for the air to flow into the hood 150, the pressure inside the hood 150 should be lower than the atmospheric pressure. Therefore, when opening the opening when the pressure inside the hood 150 is lower than the atmospheric pressure, the external air flows into the hood 150 through the opening by itself.

[0052] Conversely, when the pressure inside the hood 150 is higher than the preset pressure value, the controller closes the opening of the hood 150. That is, when the pressure inside the hood 150 is higher than the atmospheric pressure, the gas inside the hood 150 may be discharged to the outside. Therefore, the exhaust gas inside the hood 150 may be discharged to the outside, which may pollute the environment. Therefore, when the pressure inside the hood 150 is higher than the external pressure, the opening of the hood 150 may be closed to prevent the exhaust gas in the hood 150 from flowing out. However, the preset pressure value is not limited thereto and may vary.

[0053] Referring to Figure 3, an air supply unit 170 according to an example forms an air moving path. The air supply unit 170 may include an air supply line 175 connected to the circulation line, a control valve 176 installed at the air supply line 175, and a cooler (not shown) disposed at the air supply line 175 to cool the air.

[0054] The air supply line 175 is connected to the circulation line 162 at one end and the air may be injected at the other end. Thus, the air moving along the air supply line 175 may be supplied to the circulation line 162, mixed with the exhaust gas moving along the circulation line 162, and supplied to the hood 150.

[0055] The control valve 176 serves to open and close the air moving path defined in the air supply line 175. Therefore, the air is supplied to the circulation line 162

when the control valve 176 is opened, and the air is not supplied to the circulation line 162 when the control valve 176 is closed.

[0056] A cooler (not shown) is located between the control valve 176 and the other end of the air supply line 175 and cools the air moving along the air supply line 175. That is, the exhaust gas moving along the circulation line 162 is bulky because it is at a high temperature. Therefore, cooled air may be supplied to the circulation line 162 to lower a temperature of the high-temperature exhaust gas, thus the exhaust gas mixed with the air may be reduced in volume due to a decrease in temperature.

[0057] In the circulation line 162, the oxygen sensor 182 for measuring the oxygen concentration in the exhaust gas may be installed. The oxygen sensor 182 serves to measure the concentration of the oxygen passing along the circulation line 162.

[0058] In this connection, a control unit 190 may control an amount of the air supplied to the circulation line 162 based on the oxygen concentration inside the circulation line 162. The control unit 190 may include a transceiver 191 connected to the oxygen sensor 182 to transmit and receive the oxygen concentration information of the exhaust gas, a determiner 192 connected to the transceiver 191 to compare the oxygen concentration information received from the transceiver 191 with a preset oxygen concentration value, and a controller 193 for controlling an operation of the control valve 176 based on the determination of the determiner 192.

[0059] The determiner 192 may compare the oxygen concentration in the exhaust gas with the preset oxygen concentration value, and when the oxygen concentration in the exhaust gas is below the preset oxygen concentration value, the determiner 192 transmits a signal to the controller 193 to open the control valve 176. For example, the preset oxygen concentration value may be selected from among values between 13% to 16%. That is, the oxygen concentration in the exhaust gas is lower than that of the normal air. Therefore, the exhaust gas may lower a combustion efficiency of the to-be-sintered material compared to the normal air. Thus, when the oxygen concentration in the exhaust gas becomes too low, by supplying the air to the exhaust gas, the oxygen concentration may be increased. However, the preset oxygen concentration value may be not limited thereto and may vary.

[0060] Referring to Figure 4, an air supply unit 170 according to another embodiment of the present disclosure may include all of the door unit 171 opening and closing the opening defined in the hood 150, the actuator moving the door unit 171, the air supply line 175 connected to the circulation line 162 to supply the air, and the control valve 176 opening and closing the air supply line 175. The pressure sensor 181 may be installed in the hood 150, and the oxygen sensor 182 may be installed in the circulation line 162 to measure the oxygen concentration in the exhaust gas.

[0061] In this connection, a control unit 190 may control

the operation of the door unit 171 based on the pressure inside the hood 150, and may control the amount of the air supplied to the circulation line 162 based on the oxygen concentration in the circulation line 162. The control unit 190 may include a transceiver 191 connected to the pressure sensor 181 and the oxygen sensor 182 to transmit and receive the pressure information inside the hood 150 and the oxygen concentration information of the exhaust gas, a determiner 192 connected to the transceiver 191 to compare the pressure information inside the hood 150 and the oxygen concentration information of the exhaust gas respectively received from the transceiver 191 with the preset pressure value and the preset oxygen concentration value respectively, and a controller 193 for controlling the operation of at least one of the actuator and the control valve 176 based on the determination of the determiner 192.

[0062] The determiner 192 may compare the pressure inside the hood 150 with the preset pressure, and when the pressure inside the hood 150 is below the preset pressure, the determiner 192 may transmit the signal to the controller 193 to open the opening of the hood 150. Conversely, when the pressure inside the hood 150 is higher than the preset pressure value, the controller 193 closes the opening of the hood 150.

[0063] The determiner 192 may compare the oxygen concentration in the exhaust gas with the preset oxygen concentration value, and when the oxygen concentration in the exhaust gas is below the preset oxygen concentration value, the determiner 192 may transmit the signal to the controller 193 to open the control valve 176. In addition, when the oxygen concentration in the exhaust gas is below the preset oxygen concentration value, the opening of the hood 150 may be opened by controlling the operation of the actuator. Therefore, the air may be introduced into the hood 150 to increase the concentration of the oxygen supplied to the to-be-sintered material.

[0064] Referring to Figure 5, the sintering method according to an embodiment of the present invention is a method for manufacturing a sintered ore, and includes a step S100 for loading the to-be-sintered material into the vehicle traveling along the traveling path, a step S200 igniting the flame on the top face of the to-be-sintered material, a step S300 for sucking the exhaust gas downwardly of the to-be-sintered material, and a step S400 for supplying a portion of the air and the sucked exhaust gas via the hood disposed above the traveling path to the to-be-sintered material in the vehicle.

[0065] First, while the plurality of the vehicles 110 sequentially pass below the charging unit 120, the to-be-sintered material is loaded into each vehicle 110 and form the to-be-sintered material layer. When the plurality of the vehicles 110 sequentially pass below the ignition-furnace 130, the flame is sprayed from the ignition-furnace 130 and ignited on the top face of the to-be-sintered material layer. When the vehicles 110 pass through the wind-box 140, while the flame is moved downward by the air sucked from the upper portion to the lower portion,

the to-be-sintered material is sintered, and the sintered ore is produced. The sintered ore is supplied to the cooler (not shown) and cooled.

[0066] In this connection, the air (or the exhaust gas) sucked into a portion of the wind-boxes 140 may be supplied to the to-be-sintered material in the vehicle 110 traveling the traveling path. In particular, the exhaust gas in the wind-boxes 140 between the transition point between increase and decrease of a flow rate of the exhaust gas and the point where the temperature of the exhaust gas reaches the maximum may be circulated.

[0067] The air resistance of the to-be-sintered material in the vehicle 110 passing between the transition point between increase and decrease of a flow rate of the exhaust gas and the point where the temperature of the exhaust gas reaches the maximum, is greater than the air resistance of the be-sintered material in the vehicle 110 passing the other region. In a region where the air resistance is large, the amount of the air passing through the to-be-sintered material decreases, so that the sintering may not process smoothly.

[0068] When the circulation pipe 161 is connected to the wind-boxes 140 between the transition point between increase and decrease of a flow rate of the exhaust gas and the point where the temperature of the exhaust gas reaches the maximum, and when the blower 163 provides the suction power to the wind-boxes 140 connected to the circulation pipe 161, the wind-boxes 140 connected to the circulation pipe 161 may suck the air with higher suction power.

[0069] Thus, even though the air resistance of the to-be-sintered material passing between the transition point between increase and decrease of a flow rate of the exhaust gas and the point where the temperature of the exhaust gas reaches the maximum is large, the suction power supplied from the blower 163 also increases, so that the reduction of the amount of the air passing through the to-be-sintered material may be minimized. Thus, the sintering of the to-be-sintered material proceeds smoothly, and the quality of the sintered ore may be improved.

[0070] The exhaust gas sucked into the circulation pipe 161 is supplied to the hood 150 disposed above the vehicle 110 along the circulation line 162. The hood 150 may be extended to cover upper portions of the wind-boxes 140 from the sintering start point of a bottom layer of the to-be-sintered material (or the combustion zone reaches the bottom of the vehicle 110) to a rear end-point of the traveling path. That is, since the oxygen concentration in the exhaust gas is lower than that of the normal air, the hood 150 may supply the exhaust gas to a region where the combustion occurs less or a region where the oxygen is less required.

[0071] Below the hood 150, the wind-boxes 140 should be disposed in a number sufficient to suck the exhaust gas discharged from the hood 150. For example, when the wind-boxes 140 below the hood 150 do not sufficiently suck the air from the hood 150, air not sucked may be leaked to the outside and pollute the environment. There-

fore, it is necessary to adjust the length of the hood 150 in the front and rear directions or the number of the wind-boxes 140 covered by the hood 150 in consideration of the amount of the air sucked into the circulation pipe 161.

[0072] In addition, the external air may be supplied to the to-be-sintered material in the sintered vehicle 110 traveling the traveling path. The exhaust gas has a lower oxygen concentration than the normal air, so that the combustion efficiency of the to-be-sintered material may be reduced. Therefore, it is possible to improve the combustion efficiency of the to-be-sintered material by supplying air having an oxygen concentration higher than that of the exhaust gas together with the exhaust gas to the to-be-sintered material.

[0073] The air may be supplied directly to the to-be-sintered material via the hood 150 or the air may be mixed with the exhaust gas and provided to the to-be-sintered material. For example, the operation of the door unit 171 that opens and closes the opening of the hood 150 may be controlled.

[0074] First, the pressure inside the hood 150 is measured. When the internal pressure of the hood 150 is lower than the preset pressure value, the opening of the hood 150 is opened. In this connection, the preset pressure value may be the atmospheric pressure. That is, in order for the air to flow into the hood 150, the pressure inside the hood 150 should be lower than the atmospheric pressure. Accordingly, when the pressure inside the hood 150 is lower than the atmospheric pressure, opening the opening allows the outside air to flow into the hood 150 through the opening, and the air may be supplied to the to-be-sintered material.

[0075] Conversely, when the pressure inside the hood 150 is higher than the preset pressure value, the opening of the hood 150 is closed. That is, when the pressure inside the hood 150 is higher than the atmospheric pressure, the gas inside the hood 150 may be discharged to the outside. Therefore, the exhaust gas inside the hood 150 may be discharged to the outside, which may pollute the environment. Therefore, when the pressure inside the hood 150 is higher than the external pressure, the opening of the hood 150 may be closed to prevent the exhaust gas in the hood 150 from flowing out.

[0076] In this connection, the air may be sprayed from the front end of the hood, and the exhaust gas may be sprayed from the rear end of the hood. For example, air may be sprayed in a region forwardly of (or at) a central point of the hood 150 in the anteroposterior direction thereof, and the exhaust gas may be sprayed in a region rearwardly of (or at) a central point of the hood 150 in the anteroposterior direction thereof. That is, the opening may be formed forwardly of the central point of the hood 150 in the anteroposterior direction thereof, and the rearward point from the central point of the hood 150 in the anteroposterior direction thereof may be connected to the circulation line 162 and supplied the exhaust gas.

[0077] The combustion is more actively performed in the vehicle 110 passing the wind-box 140 covered by the

hood 150 and positioned forwardly of the central point of the hood 150 than the vehicle 110 passing the wind-box 140 covered by the hood 150 and positioned rearwardly of the central point of the hood 150. Accordingly, the combustion efficiency may be improved by supplying more oxygen to the front vehicle 110. Accordingly, the air may be supplied to the front vehicle 110 where the combustion is more active, and the exhaust gas having a small amount of the oxygen may be supplied to the rear vehicle 110.

[0078] In this connection, the oxygen concentration in the exhaust gas moving along the circulation line 162 may be measured. Then, the oxygen concentration in the exhaust gas may be compared with the preset concentration value, and when the oxygen concentration in the exhaust gas is below the preset concentration value, the control valve 176 may be opened. For example, the preset concentration value may be selected from among values between 13% to 16%. Thus, when the oxygen concentration in the exhaust gas becomes too low, by supplying the air to the exhaust gas, the oxygen concentration may be increased. Therefore, a gas mixed with the exhaust gas and the air may be supplied to the to-be-sintered material.

[0079] Alternatively, when the oxygen concentration in the exhaust gas is below the preset concentration value, the opening of the hood 150 may also be opened. Accordingly, the air may be introduced into the hood 150 to increase the concentration of the oxygen supplied to the to-be-sintered material. However, a point of time when the opening is opened is not limited to this and may be open at all times.

[0080] Thus, the exhaust gas generated during the sintering process with the air may be supplied to the to-be-sintered material to be involved in the sintering process. Therefore, the exhaust gas may be circulated and re-used, thereby suppressing or preventing the environmental pollution caused by the exhaust gas.

[0081] Further, since the exhaust gas has a lower combustion efficiency than the normal air, the oxygen concentration may be deteriorated. Therefore, it is possible to suppress or prevent the deterioration of the combustion efficiency by supplying the exhaust gas together with the air having a high oxygen concentration to the to-be-sintered material. That is, the combustion efficiency of the to-be-sintered material may be improved by supplying the air, and the productivity of the sintering process may be increased.

[0082] In addition, as the sintering of the to-be-sintered material proceeds, the air resistance increases and the amount of the air passing along the to-be-sintered material may decrease. Therefore, in the region where the air resistance increases, the air may be sucked with a greater suction power. Accordingly, the amount of the air passing through the to-be-sintered material is prevented from being reduced so that the combustion of the to-be-sintered material may be stably performed. Thus, the quality of the produced sintered ore may be improved.

Claims

1. A sintering apparatus comprising:

a vehicle (110) disposed movably along a traveling path and having a to-be-sintered material loaded therein, the travelling path extending in an anteroposterior direction;
 a charging unit (120) for charging the to-be-sintered material to the vehicle;
 an ignition-furnace (130) disposed above the traveling path for spraying a flame to an upper portion of the to-be-sintered material;
 a plurality of wind-boxes (140) disposed below the vehicle (110) along the traveling path to provide a suction power to the vehicle;
 a hood (150) disposed above the vehicle (110) and extending along the traveling path, the hood extending in the anteroposterior direction;
 a circulation unit (160) connected to some of a plurality of the wind-boxes (140) and supplying exhaust gas sucked into said some of the wind-boxes (140) to the hood (150); and
 an air supply unit (170) connected to the hood (150) or connected to the hood (150) and the circulation unit (160) to supply air to the to-be-sintered material,
 wherein the circulation unit (160) includes:

a circulation pipe (161) connected to said some of the plurality of the wind-boxes (140) and having an inner space for receiving the exhaust gas therein;

a circulation line (162) defining a path along which the exhaust gas moves, wherein one end of the circulation line (162) is connected to the circulation pipe (161) and the other end thereof is connected to the hood (150); and

a blower (163) disposed in the circulation line (162),

characterized in that

an opening is defined in a top portion of the hood (150),

wherein the air supply unit (170) includes a door unit (171) mounted on the hood (150) to open and close the opening,

wherein the opening is defined forwardly of a central point of the hood (150) in the anteroposterior direction thereof, and the circulation line (162) is formed rearwardly of the central point of the hood (150) in the anteroposterior direction thereof.

2. The sintering apparatus of claim 1, wherein the circulation pipe (161) is connected to the wind-boxes (140) between a transition point between increase and decrease of a flow rate of the exhaust gas, and

a point where a temperature of the exhaust gas reaches a maximum.

3. The sintering apparatus of claim 1, wherein the hood (150) is extended to cover upper portions of the wind-boxes (140) from a sintering start point of a bottom layer of the to-be-sintered material to a rear end-point of the traveling path.

4. The sintering apparatus of claim 1, wherein a number of wind-boxes (140) covered by the hood (150) is greater than a number of wind-boxes (140) connected to the circulation pipe (161).

5. The sintering apparatus of claim 1, wherein the sintering apparatus includes:

a pressure sensor (181) installed in the hood (150); and

a control unit (190) for controlling an operation of the door unit (171) based on a pressure inside the hood (150).

6. The sintering apparatus according to one of claims 2 to 5, wherein when the air supply unit (170) is connected to the hood (150) and the circulation unit (160), the air supply unit defines an air moving path, wherein the air supply unit includes an air supply line (175) connected to the circulation line.

7. The sintering apparatus of claim 6, wherein the sintering apparatus includes:

an oxygen sensor (182) installed in the circulation line (162); and

a control unit (190) for controlling an amount of air to be supplied to the circulation line (162) based on an oxygen concentration inside the circulation line (162).

8. A method for producing a sintered ore, the method comprising:

loading to-be-sintered material into a vehicle (110) traveling along a traveling path;

igniting a flame onto a top face of the to-be-sintered material;

sucking exhaust gas downwardly of the to-be-sintered material; and

supplying a portion of air and the sucked exhaust gas via a hood (150) disposed above the traveling path to the to-be-sintered material in the vehicle,

characterized in that supplying the air to the to-be-sintered material includes:

measuring a pressure inside the hood; and
 supplying the air to the to-be-sintered ma-

terial when a pressure inside the hood is lower than a preset pressure value,

wherein supplying the portion of the air and the sucked exhaust gas to the to-be-sintered material includes:
spraying the air from a front end of the hood and spraying the exhaust gas from a rear end of the hood.

9. The sintering method of claim 8, wherein supplying the air to the to-be-sintered material includes:

measuring an oxygen concentration in the sucked exhaust gas; and
supplying the air to the to-be-sintered material when the oxygen concentration in the sucked exhaust gas is lower than a preset oxygen concentration value.

Patentansprüche

1. Sintervorrichtung, umfassend:

ein Vehikel (110), das entlang eines Laufweges beweglich angeordnet ist und in das ein zu sinterndes Material geladen ist, wobei sich der Laufweg in eine anteroposteriore Richtung erstreckt;
eine Beschickungseinheit (120) zum Beschicken des Vehikels mit dem zu sinternden Material;
einen Zündofen (130), der über dem Laufweg angeordnet ist, um eine Flamme auf einen oberen Abschnitt des zu sinternden Materials zu sprühen;
eine Vielzahl von Windkästen (140), die unter dem Vehikel (110) entlang des Laufweges angeordnet ist, um dem Vehikel eine Saugleistung bereitzustellen;
eine Haube (150), die über dem Vehikel (110) angeordnet ist und sich entlang des Laufweges erstreckt, wobei sich die Haube in die anteroposteriore Richtung erstreckt;
eine Zirkulationseinheit (160), die mit einigen von einer Vielzahl der Windkästen (140) verbunden ist und Abgas, welches in die einigen der Windkästen (140) eingesaugt wird, der Haube (150) zuführt; und
eine Luftzufuhreinheit (170), die mit der Haube (150) verbunden ist oder mit der Haube (150) und der Zirkulationseinheit (160) verbunden ist, um dem zu sinternden Material Luft zuzuführen, wobei die Zirkulationseinheit (160) Folgendes beinhaltet:

ein Zirkulationsrohr (161), das mit den einigen von der Vielzahl der Windkästen (140) verbunden ist und einen Innenraum aufweist, um das Abgas darin aufzunehmen;
eine Zirkulationsleitung (162), die einen Weg definiert, entlang dem sich das Abgas bewegt, wobei ein Ende der Zirkulationsleitung (162) mit dem Zirkulationsrohr (161) verbunden ist und das andere Ende davon mit der Haube (150) verbunden ist; und
ein Gebläse (163), das in der Zirkulationsleitung (162) angeordnet ist,
dadurch gekennzeichnet, dass
eine Öffnung in einem oberen Abschnitt der Haube (150) definiert ist,
wobei die Luftzufuhreinheit (170) eine Türeinheit (171) beinhaltet, die an der Haube (150) montiert ist, um die Öffnung zu öffnen und zu schließen,
wobei die Öffnung vor einem mittleren Punkt der Haube (150) in der anteroposterioren Richtung davon definiert ist und die Zirkulationsleitung (162) hinter dem mittleren Punkt der Haube (150) in der anteroposterioren Richtung davon gebildet ist.

2. Sintervorrichtung nach Anspruch 1, wobei das Zirkulationsrohr (161) mit den Windkästen (140) zwischen einem Übergangspunkt zwischen der Erhöhung und der Verringerung einer Strömungsrate des Abgases und einem Punkt, an dem eine Temperatur des Abgases ein Maximum erreicht, verbunden ist.
3. Sintervorrichtung nach Anspruch 1, wobei die Haube (150) verlängert ist, um obere Abschnitte der Windkästen (140) von einem Sinterstartpunkt einer unteren Schicht des zu sinternden Materials zu einem hinteren Endpunkt des Laufweges abzudecken.
4. Sintervorrichtung nach Anspruch 1, wobei eine Anzahl an Windkästen (140), die von der Haube (150) abgedeckt sind, größer ist als eine Anzahl an Windkästen (140), die mit dem Zirkulationsrohr (161) verbunden sind.
5. Sintervorrichtung nach Anspruch 1, wobei die Sintervorrichtung Folgendes beinhaltet:
einen Drucksensor (181), der in der Haube (150) installiert ist; und
eine Steuereinheit (190) zum Steuern eines Vorgangs der Türeinheit (171) basierend auf einem Druck innerhalb der Haube (150).
6. Sintervorrichtung nach einem der Ansprüche 2 bis 5, wobei, wenn die Luftzufuhreinheit (170) mit der Haube (150) und der Zirkulationseinheit (160) verbunden ist, die Luftzufuhreinheit einen Luftbewe-

gungsweg definiert, wobei die Luftzufuhreinheit eine Luftzufuhrleitung (175) beinhaltet, die mit der Zirkulationsleitung verbunden ist.

7. Sintervorrichtung nach Anspruch 6, wobei die Sintervorrichtung Folgendes beinhaltet:
- 5 einen Sauerstoffsensor (182), der in der Zirkulationsleitung (162) installiert ist; und
 10 eine Steuereinheit (190) zum Steuern einer Menge an Luft, die der Zirkulationsleitung (162) zuzuführen ist, basierend auf einer Sauerstoffkonzentration innerhalb der Zirkulationsleitung (162). 15
8. Verfahren zum Herstellen eines Sintererzes, wobei das Verfahren Folgendes umfasst:
- Laden des zu sinternden Materials in ein Vehikel (110), das sich entlang eines Laufweges bewegt; 20
 Zünden einer Flamme auf einer Oberseite des zu sinternden Materials;
 Absaugen von Abgas des zu sinternden Materials nach unten; und 25
 Zuführen eines Teils von Luft und des abgesaugten Abgases über eine Haube (150), die über dem Laufweg angeordnet ist, zu dem zu sinternden Material in dem Vehikel, 30
dadurch gekennzeichnet, dass das Zuführen der Luft zu dem zu sinternden Material Folgendes beinhaltet:
- Messen eines Drucks innerhalb der Haube; und 35
 Zuführen der Luft zu dem zu sinternden Material, wenn ein Druck innerhalb der Haube niedriger ist als ein voreingestellter Druckwert, 40
- wobei das Zuführen des Teils der Luft und des abgesaugten Abgases zu dem zu sinternden Material Folgendes beinhaltet:
 Sprühen der Luft von einem vorderen Ende der Haube und Sprühen des Abgases von einem 45
 hinteren Ende der Haube.
9. Sinterverfahren nach Anspruch 8, wobei das Zuführen der Luft zu dem zu sinternden Material Folgendes beinhaltet: 50
- Messen einer Sauerstoffkonzentration in dem abgesaugten Abgas; und
 Zuführen der Luft zu dem zu sinternden Material, wenn die Sauerstoffkonzentration in dem abgesaugten Abgas niedriger ist als ein voreingestellter Sauerstoffkonzentrationswert. 55

Revendications

1. Appareil de frittage comprenant :

un véhicule (110) disposé mobile le long d'un chemin de déplacement et dans lequel est chargé un matériau à fritter, le chemin de déplacement s'étendant dans une direction antéropostérieure ;
 une unité de chargement (120) pour charger le matériau à fritter dans le véhicule ;
 un four d'allumage (130) disposé au-dessus du chemin de déplacement pour pulvériser une flamme sur une portion supérieure du matériau à fritter ;
 une pluralité de boîtes à vent (140) disposées en dessous du véhicule (110) le long du chemin de déplacement pour fournir une puissance d'aspiration au véhicule ;
 une hotte (150) disposée au-dessus du véhicule (110) et s'étendant le long du chemin de déplacement, la hotte s'étendant dans la direction antéropostérieure ;
 une unité de circulation (160) raccordée à certaines d'une pluralité des boîtes à vent (140) et alimentant la hotte (150) en un gaz d'échappement aspiré dans lesdites certaines boîtes des boîtes à vent (140) ; et
 une unité d'alimentation en air (170) raccordée à la hotte (150) ou raccordée à la hotte (150) et à l'unité de circulation (160) pour alimenter le matériau à fritter en air, dans lequel l'unité de circulation (160) comporte :

un tuyau de circulation (161) raccordé auxdites certaines boîtes de la pluralité des boîtes à vent (140) et ayant un espace intérieur pour y recevoir le gaz d'échappement ;
 une conduite de circulation (162) définissant un chemin le long duquel se déplace le gaz d'échappement, dans lequel une extrémité de la conduite de circulation (162) est raccordée au tuyau de circulation (161) et son autre extrémité est raccordée à la hotte (150) ; et
 une soufflante (163) disposée dans la conduite de circulation (162),
caractérisé en ce que
 une ouverture est définie dans une portion haute de la hotte (150), dans lequel l'unité d'alimentation en air (170) comporte une unité de porte (171) montée sur la hotte (150) pour ouvrir et fermer l'ouverture, dans lequel l'ouverture est définie vers l'avant d'un point central de la hotte (150)

- dans sa direction antéropostérieure, et la conduite de circulation (162) est formée vers l'arrière du point central de la hotte (150) dans sa direction antéropostérieure.
2. Appareil de frittage selon la revendication 1, dans lequel le tuyau de circulation (161) est raccordé aux boîtes à vent (140) entre un point de transition entre une augmentation et une diminution d'un débit du gaz d'échappement, et un point où une température du gaz d'échappement atteint un maximum.
3. Appareil de frittage selon la revendication 1, dans lequel la hotte (150) est étendue pour couvrir des portions supérieures des boîtes à vent (140) depuis un point de démarrage de frittage d'une couche basse du matériau à fritter jusqu'à un point de fin arrière du chemin de déplacement.
4. Appareil de frittage selon la revendication 1, dans lequel un nombre de boîtes à vent (140) couvertes par la hotte (150) est supérieur à un nombre de boîtes à vent (140) raccordées au tuyau de circulation (161).
5. Appareil de frittage selon la revendication 1, dans lequel l'appareil de frittage comporte :
- un capteur de pression (181) installé dans la hotte (150) ; et
- une unité de commande (190) pour commander un fonctionnement de l'unité de porte (171) d'après une pression à l'intérieur de la hotte (150).
6. Appareil de frittage selon l'une des revendications 2 à 5, dans lequel, lorsque l'unité d'alimentation en air (170) est raccordée à la hotte (150) et à l'unité de circulation (160), l'unité d'alimentation en air définit un chemin de mouvement d'air, dans lequel l'unité d'alimentation en air comporte une conduite d'alimentation en air (175) raccordée à la conduite de circulation.
7. Appareil de frittage selon la revendication 6, dans lequel l'appareil de frittage comporte :
- un capteur d'oxygène (182) installé dans la conduite de circulation (162) ; et
- une unité de commande (190) pour commander une quantité d'air devant alimenter la conduite de circulation (162) d'après une concentration en oxygène à l'intérieur de la conduite de circulation (162).
8. Procédé de production d'un minerai fritté, le procédé comprenant :
- le chargement d'un matériau à fritter dans un véhicule (110) se déplaçant le long d'un chemin de déplacement ;
- l'allumage d'une flamme sur une face haute du matériau à fritter ;
- l'aspiration d'un gaz d'échappement vers le bas du matériau à fritter ; et
- l'alimentation du matériau à fritter dans le véhicule en une portion d'air et le gaz d'échappement aspiré via une hotte (150) disposée au-dessus du chemin de déplacement,
- caractérisé en ce que** l'alimentation du matériau à fritter en air comporte :
- la mesure d'une pression à l'intérieur de la hotte ; et
- l'alimentation du matériau à fritter en air lorsqu'une pression à l'intérieur de la hotte est inférieure à une valeur de pression préétablie,
- dans lequel l'alimentation du matériau à fritter en la portion de l'air et le gaz d'échappement aspiré comporte :
- la pulvérisation de l'air depuis une extrémité avant de la hotte et la pulvérisation du gaz d'échappement depuis une extrémité arrière de la hotte.
9. Procédé de frittage selon la revendication 8, dans lequel l'alimentation du matériau à fritter en air comporte :
- la mesure d'une concentration en oxygène dans le gaz d'échappement aspiré ; et
- l'alimentation du matériau à fritter en air lorsque la concentration en oxygène dans le gaz d'échappement aspiré est inférieure à une valeur de concentration en oxygène préétablie.

FIG. 1

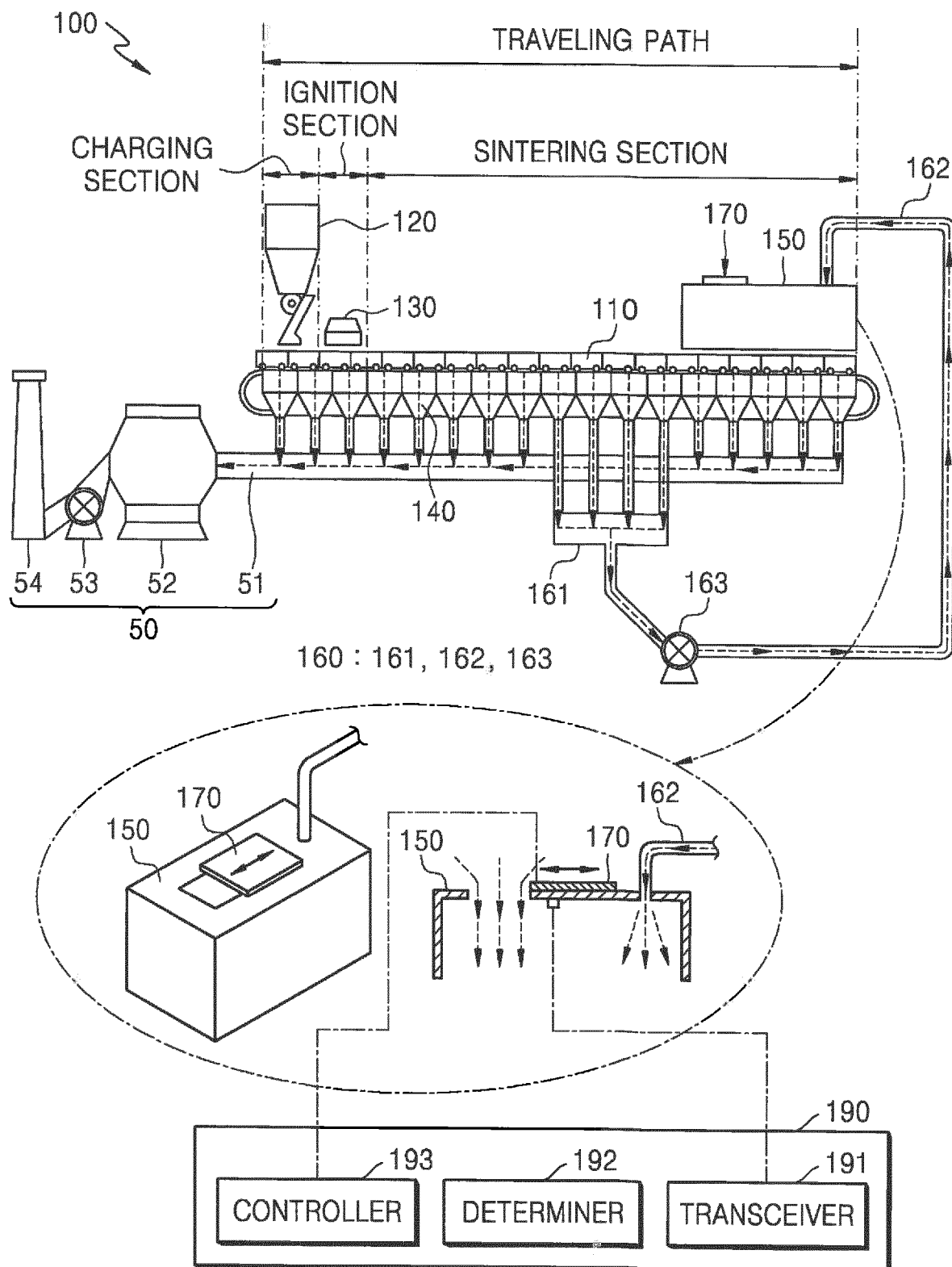


FIG. 2

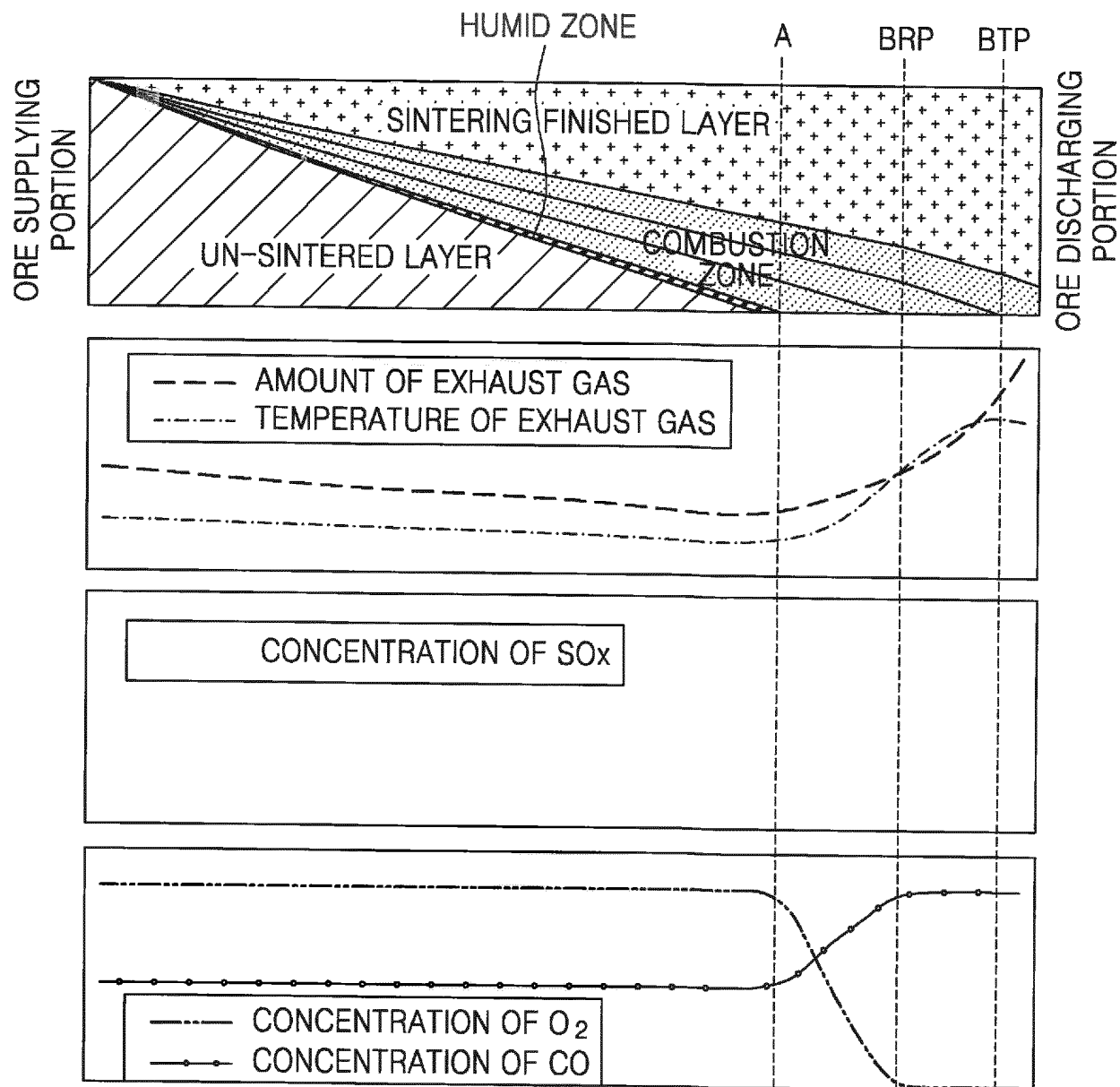


FIG. 3

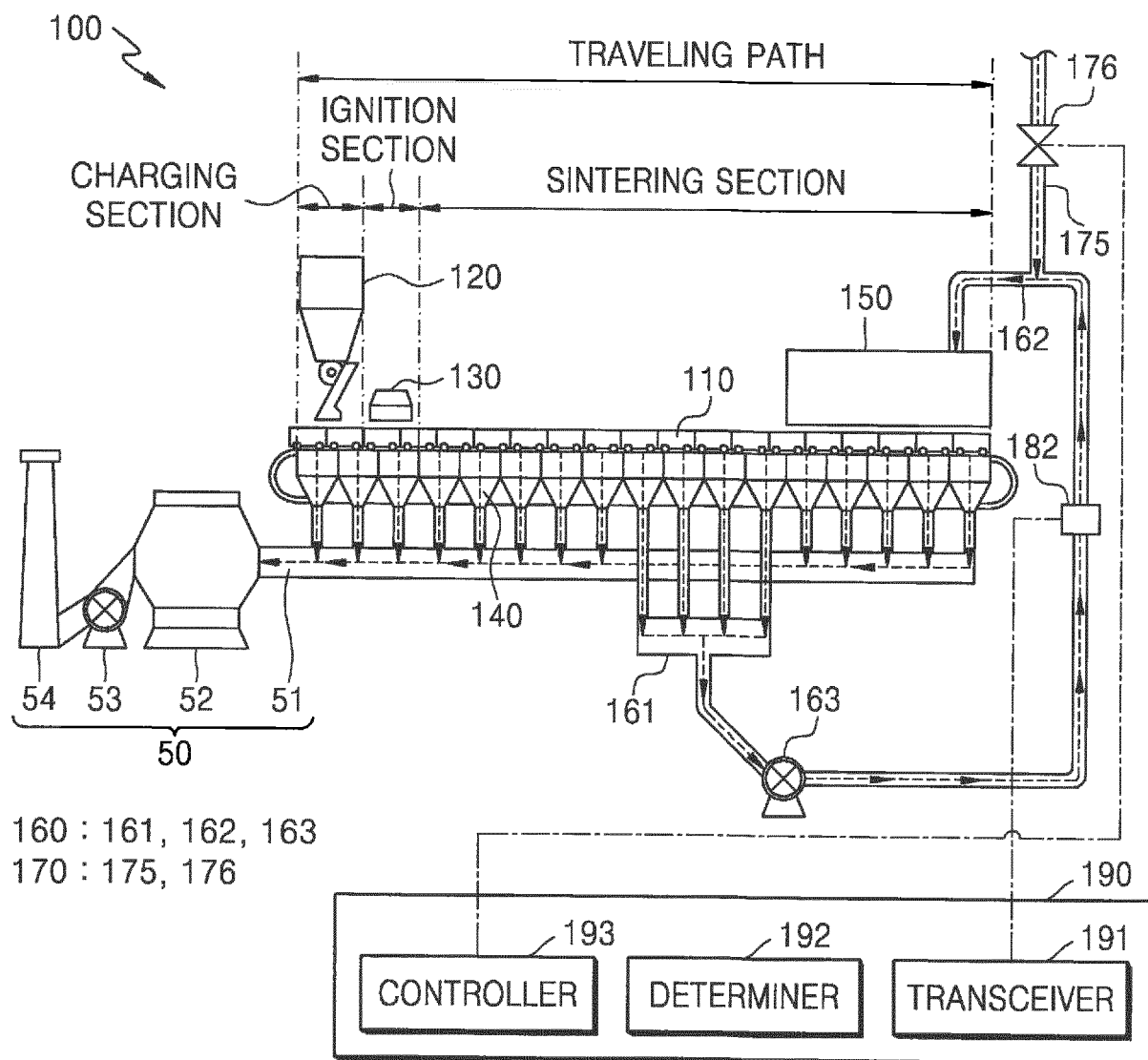


FIG. 4

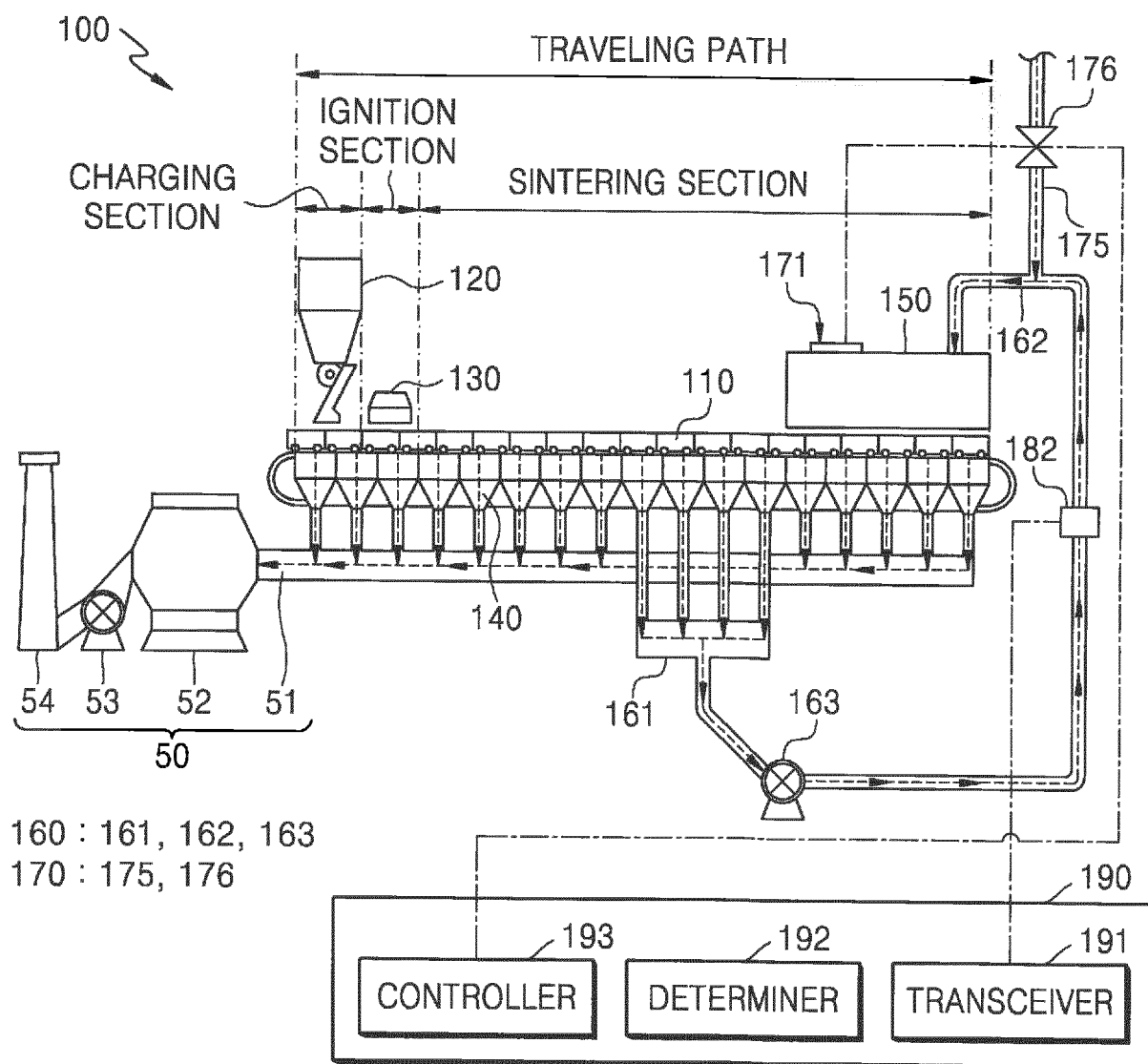
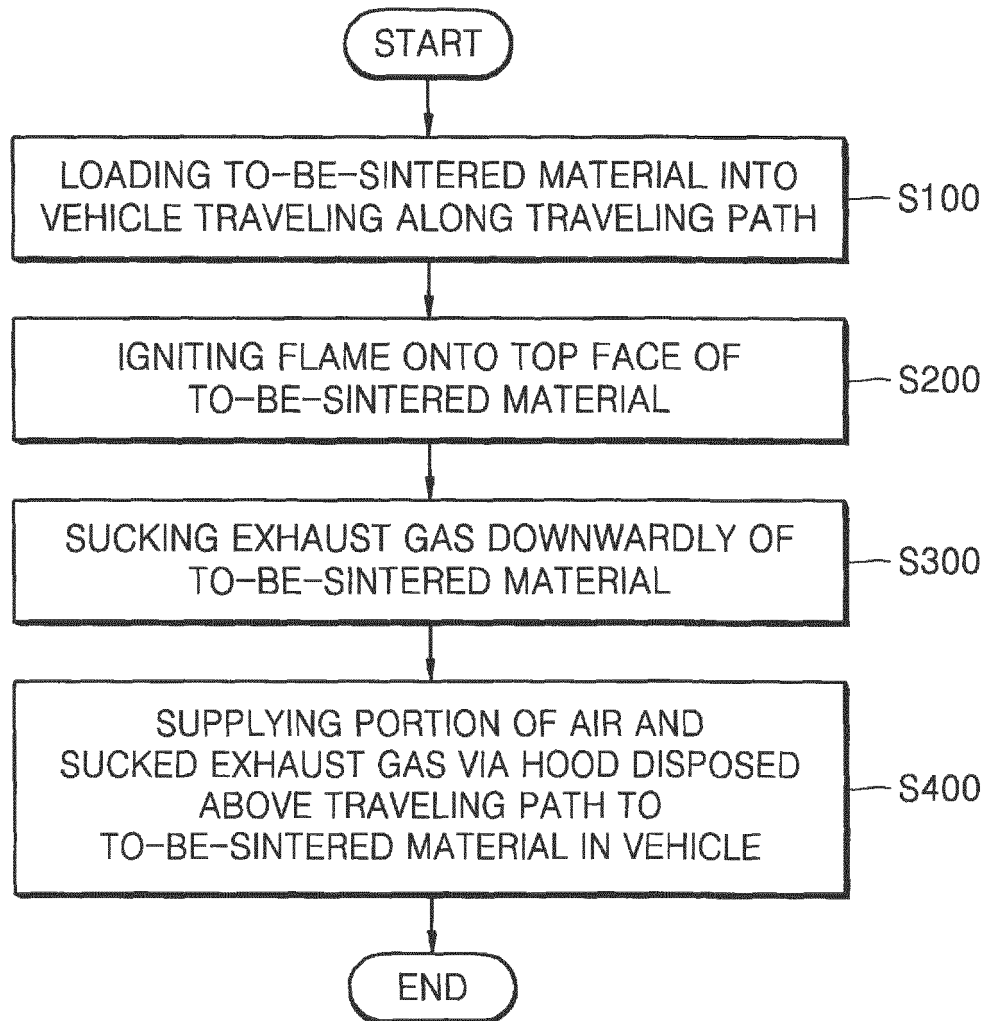


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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