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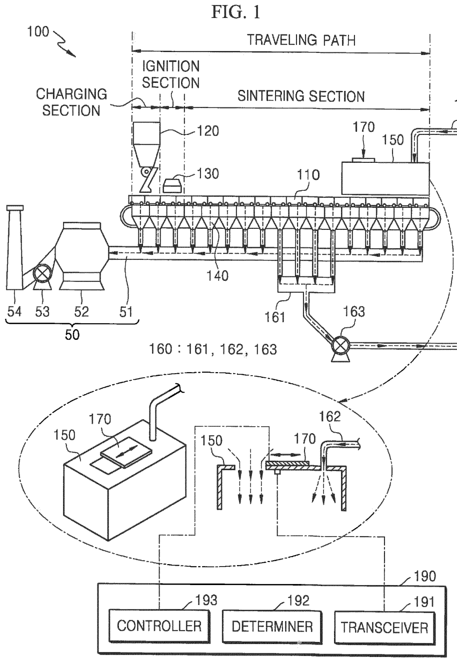
(54) ## SINTERING APPARATUS AND SINTERING METHOD

(57) The present disclosure includes: a vehicle disposed movably along a traveling path and having a to-be-sintered material loaded therein; an ignition-furnace 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 along the traveling path to provide a suction power to the vehicle; a hood disposed above the vehicle and extending along the traveling path; a circulation unit connected to some of a plurality of the wind-boxes and supplying exhaust gas sucked into said some of the wind-boxes to the hood; and an air supply unit connected to at least one of the hood and the circulation unit to supply air to the to-be-sintered material. The present disclosure may improve a quality and productivity of a sintered ore, and may reduce an emission of pollutants.

FIG. 1



EP 3 431 909 A1

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

SUMMARY

[0008] The present disclosure 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.

[0009] The present disclosure 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.

[0010] A sintering apparatus of the present disclosure includes: a vehicle disposed movably along a traveling path and having a to-be-sintered material loaded therein; an ignition-furnace disposed above the traveling path for spraying a flame to an upper portion of the to-be-sintered material; a plurality of wind-boxes disposed below the vehicle along the traveling path to provide a suction power to the vehicle; a hood disposed above the vehicle and extending along the traveling path; a circulation unit connected to some of a plurality of the wind-boxes and supplying exhaust gas sucked into said some of the wind-boxes to the hood; and an air supply unit connected to at least one of the hood and the circulation unit to supply air to the to-be-sintered material.

[0011] The circulation unit includes: a circulation pipe connected to said some of the plurality of the wind-boxes and having an inner space for receiving the exhaust gas therein; a circulation line defining a path along which the exhaust gas moves, wherein one end of the circulation line is connected to the circulation pipe and the other end thereof is connected to the hood; and a blower disposed in the circulation line.

[0012] The circulation pipe is connected to the wind-boxes 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.

[0013] The hood is extended to cover upper portions of the wind-boxes from a sintering start point of a bottom layer of the to-be-sintered material to a rear end-point of the traveling path.

[0014] A number of wind-boxes covered by the hood is greater than a number of wind-boxes connected to the circulation pipe.

[0015] An opening is defined in a top portion of the hood, and the air supply unit includes a door unit mounted on the hood to open and close the opening.

[0016] The opening is closer to the ignition-furnace than to a location where the circulation line and the hood are connected to each other.

[0017] The sintering apparatus includes: a pressure sensor installed in the hood; and a control unit for controlling an operation of the door unit based on a pressure inside the hood.

[0018] The air supply unit defines an air moving path and the air supply unit includes an air supply line connected to the circulation line.

[0019] The sintering apparatus further includes: an oxygen sensor installed in the circulation line; and a control unit for controlling an amount of air to be supplied to the circulation line based on an oxygen concentration inside the circulation line.

[0020] A method for producing a sintered ore of the present disclosure includes loading to-be-sintered material into a vehicle traveling along a traveling path; igniting a flame on 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 disposed above the traveling path to the to-be-sintered material in the vehicle.

[0021] 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 material when a pressure inside the hood is lower than a preset pressure value.

[0022] Supplying the portion of the air and the sucked exhaust gas to the be-sintered material includes: spraying the air at a front end of the hood and spraying the exhaust gas at a rear end of the hood.

[0023] Supplying the air to the to-be-sintered material includes: measuring an oxygen concentration in the 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.

[0024] According to the embodiments of the present disclosure, the exhaust gas generated during the sintering process with air may be supplied to the to-be-sintered material and be involved in the sintering process. Therefore, the exhaust gas is circulated and reused, thereby suppressing or preventing the environmental pollution caused by the exhaust gas.

[0025] In addition, since the oxygen concentration in the exhaust gas is lower than that of ordinary air, a combustion efficiency of the exhaust gas may be lowered. Therefore, since the exhaust gas and air having a high oxygen concentration are supplied to the to-be-sintered material together, a deterioration of the combustion efficiency may be suppressed or prevented. That is, by supplying the air, the combustion efficiency of the to-be-sintered material may be improved, and the productivity of the sintering process may be increased.

[0026] In addition, as sintering of the to-be-sintered material proceeds, an air resistance may increase and the amount of air passing through the to-be-sintered material may be reduced. In a region where the air resistance increases, the air may be sucked into a larger suction power. Thus, by preventing the amount of the air passing through the to-be-sintered material from decreasing, the combustion of the to-be-sintered material may proceed stably. Thus, a quality of the produced sintered ore may be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

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

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

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

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

DETAILED DESCRIPTION

[0028] Hereinafter, an embodiment of the present disclosure will now be described in detail with reference to the accompanying drawings. However, embodiments may be implemented in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the embodiments to those skilled in the art. In the accompanying drawings, the dimensions of the structure show an enlarged scale than actual for clarity of the disclosure. 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.

[0029] Figure 1 shows a sintering apparatus according to an embodiment of the present disclosure.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] The ignition-furnace 130 is disposed in the ignition 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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).

[0043] 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 vapored 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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).

[0056] 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.

[0057] 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.

[0058] The air supply unit 170 according to an embodiment of the present disclosure may include a door unit 171 mounted on a top face of the hood 150. In this connection, an opening may be defined in at least a portion of the top face of the hood 150, and the door unit 171 may be 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.

[0059] 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.

[0060] 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 limited thereto and may vary.

[0061] 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 limited thereto, but may vary.

[0062] 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. For example, the opening may be formed forwardly of (or at) a central point of the hood 150 in the anteroposterior direction thereof, while the circulation line 162 may be 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.

[0063] 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.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] Figure 3 shows a sintering apparatus according to another embodiment of the present disclosure.

[0068] Referring to Figure 3, an air supply unit 170 according to another embodiment of the present disclosure 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.

[0069] 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.

[0070] 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.

[0071] 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.

[0072] 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.

[0073] 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.

[0074] 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.

[0075] Figure 4 shows a sintering apparatus according to still another embodiment of the present disclosure.

[0076] Referring to Figure 4, an air supply unit 170 according to still 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.

[0077] 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.

[0078] 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.

[0079] 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.

[0080] Figure 5 shows a sintering method according to an embodiment of the present disclosure.

[0081] Referring to Figure 5, the sintering method according to an embodiment of the present disclosure 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.

[0082] 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.

[0083] 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.

[0084] 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.

[0085] 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.

[0086] 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.

[0087] 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.

[0088] 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. Therefore, 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.

[0089] 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.

[0090] 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.

[0091] First, the pressure inside the hood 150 may be measured. When the internal pressure of the hood 150 is lower than the preset pressure value, the opening of the hood 150 may be 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.

[0092] 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.

[0093] 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.

[0094] 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.

[0095] 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.

[0096] 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.

[0097] 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 reused, thereby suppressing or preventing the environmental pollution caused by the exhaust gas.

[0098] 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.

[0099] 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.

[0100] Thus, in the detailed description of the present disclosure, the specific embodiments have been described. However, the embodiments may be implemented in many different forms and should not be construed as limited to the embodiments set forth herein. Thus, the scope of the present disclosure should be determined by the appended claims and their legal equivalents will be described below, rather than by the described embodiments.

Claims

1. A sintering apparatus comprising:

a vehicle disposed movably along a traveling path and having a to-be-sintered material loaded therein;
an ignition-furnace disposed above the traveling path for spraying a flame to an upper portion of the to-be-sintered material;
a plurality of wind-boxes disposed below the vehicle along the traveling path to provide a suction power to the vehicle;
a hood disposed above the vehicle and extending along the traveling path; a circulation unit connected to some of a plurality of the wind-boxes and supplying exhaust gas sucked into said some of the wind-boxes to the hood; and
an air supply unit connected to at least one of the hood and the circulation unit to supply air to the to-be-sintered material.

2. The sintering apparatus of claim 1, wherein the circulation unit includes:

a circulation pipe connected to said some of the plurality of the wind-boxes and having an inner space for receiving the exhaust gas therein;
a circulation line defining a path along which the exhaust gas moves, wherein one end of the circulation line is connected to the circulation pipe and the other end thereof is connected to the hood; and
a blower disposed in the circulation line.

3. The sintering apparatus of claim 2, wherein the circulation pipe is connected to the wind-boxes 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.

4. The sintering apparatus of claim 2, wherein the hood is extended to cover upper portions of the wind-boxes from a sintering start point of a bottom layer of the to-be-sintered material to a rear end-point of the traveling path.

5. The sintering apparatus of claim 2, wherein a number of wind-boxes covered by the hood is greater than a number of wind-boxes connected to the circulation pipe.

6. The sintering apparatus of claim 2, wherein an opening is defined in a top portion of the hood,
wherein the air supply unit includes a door unit mounted on the hood to open and close the opening.

7. The sintering apparatus of claim 6, wherein the opening is closer to the ignition-furnace than to a location where the circulation line and the hood are connected to each other.

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

a pressure sensor installed in the hood; and
a control unit for controlling an operation of the door unit based on a pressure inside the hood.

9. The sintering apparatus according to one of claims 2 to 8, wherein the air supply unit defines an air moving path,
wherein the air supply unit includes an air supply line connected to the circulation line.

10. The sintering apparatus of claim 9, wherein the sintering apparatus includes:

an oxygen sensor installed in the circulation line; and
a control unit for controlling an amount of air to be supplied to the circulation line based on an oxygen concentration inside the circulation line.

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

loading to-be-sintered material into a vehicle 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 disposed above the traveling path to the to-be-sintered material in the vehicle.

12. The method of claim 11, wherein 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 material when a pressure inside the hood is lower than a preset pressure value.

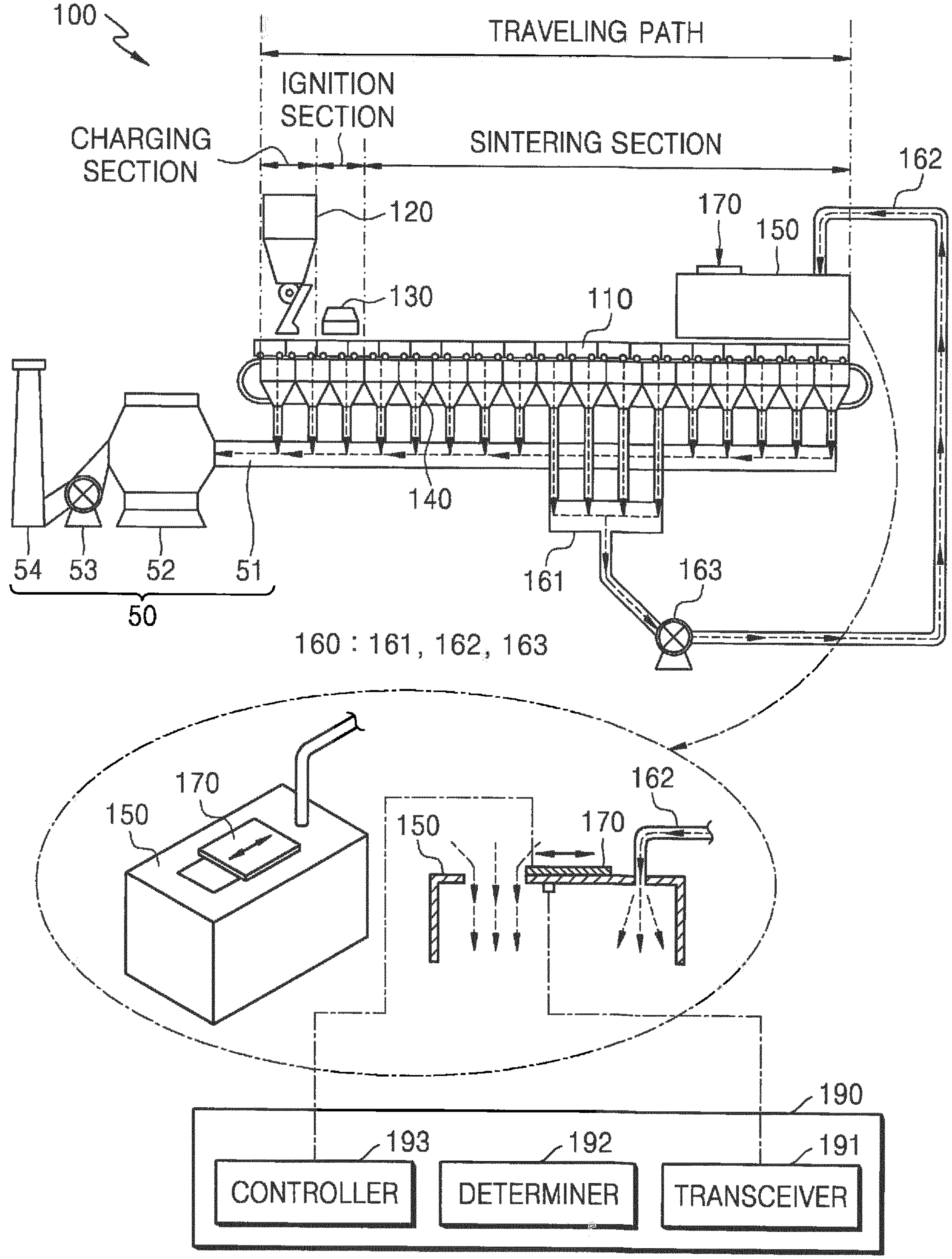
13. The method of claim 12, wherein supplying the portion of the air and the sucked exhaust gas to the to-be-sintered material includes:

spraying the air from a front end of the hood and spraying the exhaust gas from a rear end of the hood.

14. The sintering method of claim 11, 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.

FIG. 1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SINTERING SECTION
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163
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162
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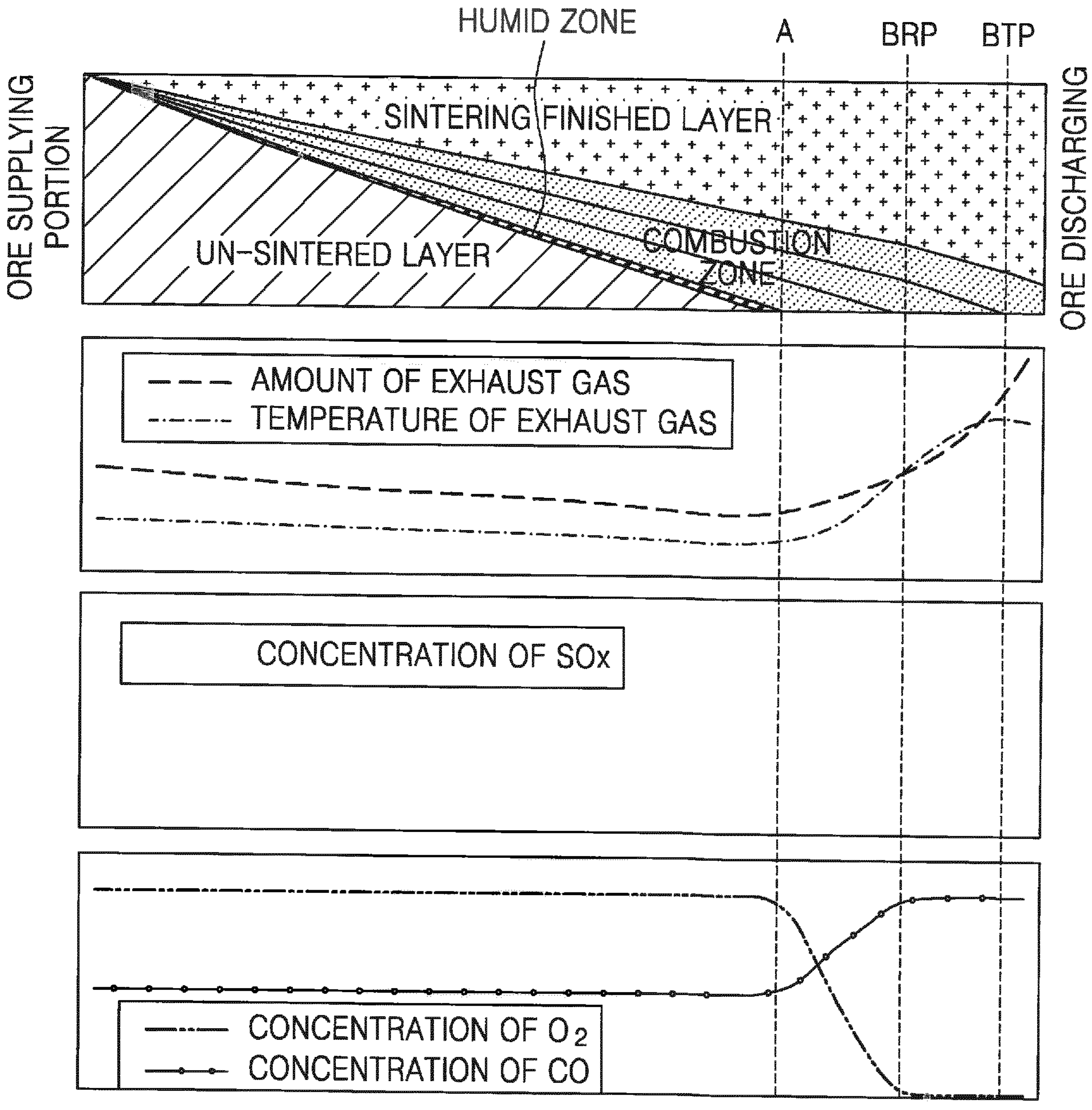
170
190
193
192
191
CONTROLLER
DETERMINER
TRANSCEIVER

FIG. 2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BRP
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SINTERING FINISHED LAYER
ORE DISCHARGING PORTION
UN-SINTERED LAYER
COMBUSTION ZONE
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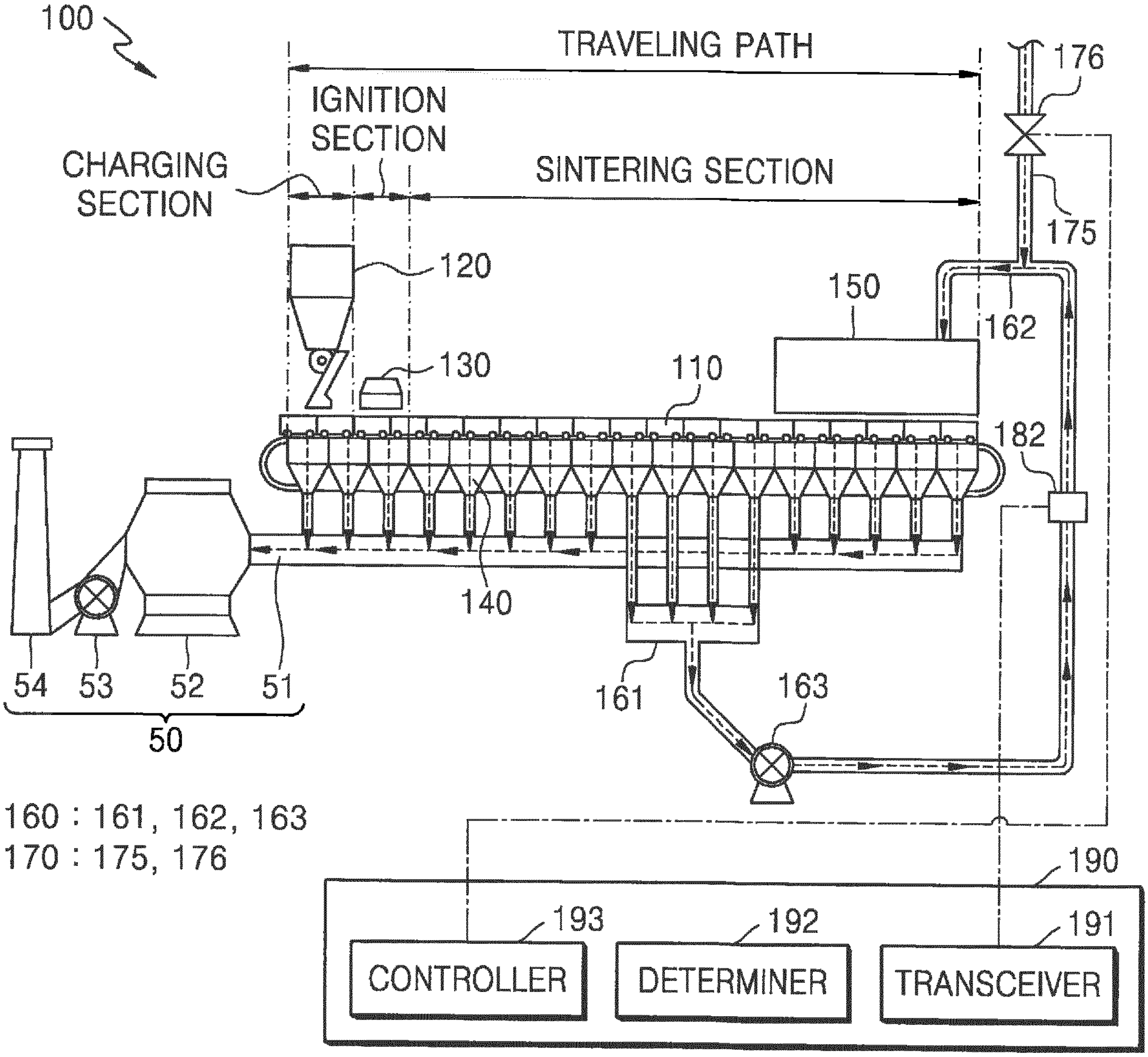
TEMPERATURE OF EXHAUST GAS
CONCENTRATION OF SOx
CONCENTRATION OF O2
CONCENTRATION OF CO

FIG. 3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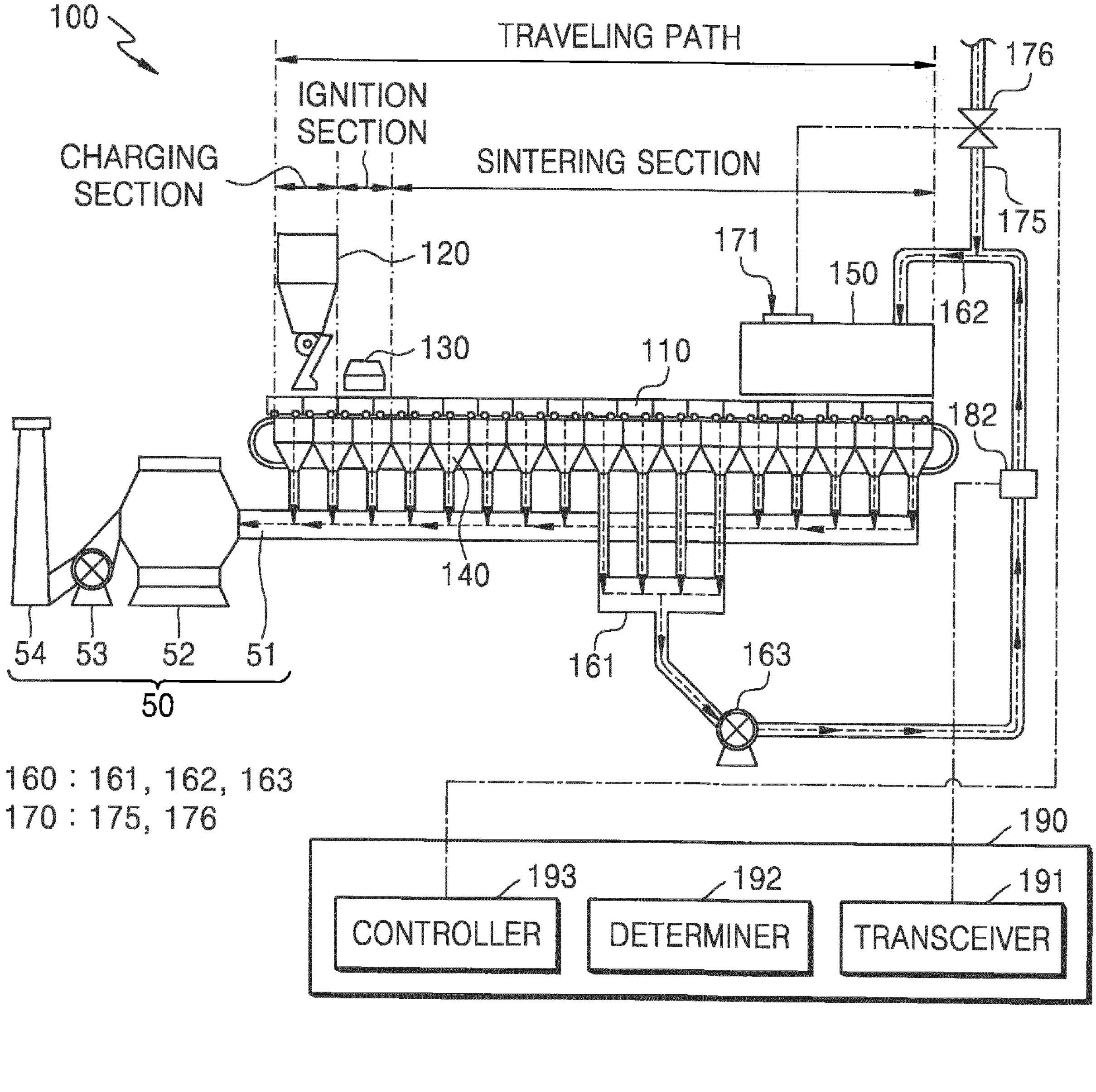
CONTROLLER
DETERMINER
TRANSCEIVER

FIG. 4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170 : 175, 176
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193
192
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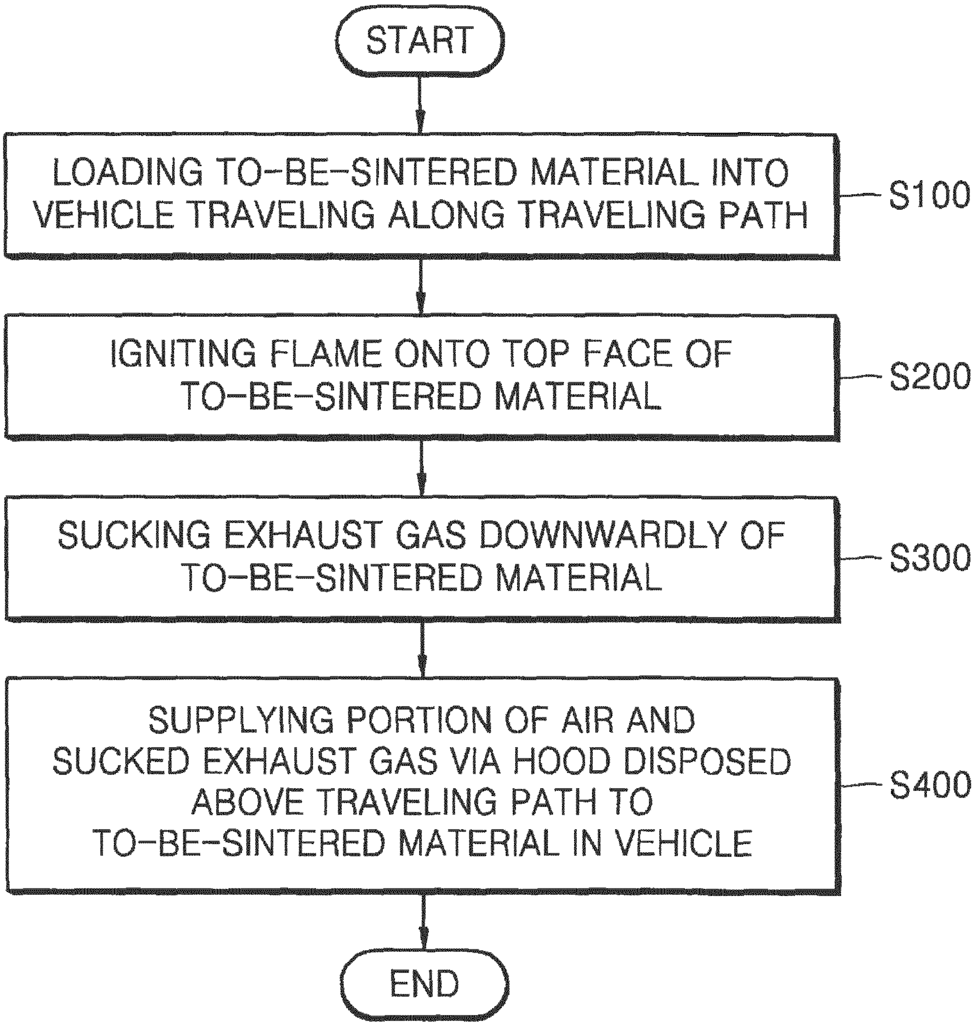
CONTROLLER
DETERMINER
TRANSCEIVER

FIG. 5


START
LOADING TO-BE-SINTERED MATERIAL INTO VEHICLE TRAVELING ALONG TRAVELING PATH
S100
IGNITING FLAME ONTO TOP FACE OF TO-BE-SINTERED MATERIAL
S200
SUCKING EXHAUST GAS DOWNWARDLY OF TO-BE-SINTERED MATERIAL
S300
SUPPLYING PORTION OF AIR AND SUCKED EXHAUST GAS VIA HOOD DISPOSED ABOVE TRAVELING PATH TO TO-BE-SINTERED MATERIAL IN VEHICLE
S400
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/013625

A. CLASSIFICATION OF SUBJECT MATTER

F27B 21/06(2006.01)i, F23H 11/10(2006.01)i, F27D 7/02(2006.01)i, F27D 1/18(2006.01)i, F27D 3/00(2006.01)i, F27D 19/00(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)

F27B 21/06; F27B 21/08; C22B 1/20; C22B 1/16; F23H 11/10; F27D 7/02; F27D 1/18; F27D 3/00; F27D 19/00

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

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

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

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

eKOMPASS (KIPO internal) & Keywords: sintering, gas and circulation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2013-0055055 A (POSCO) 28 May 2013 See paragraphs [0026]-[0030], [0034]-[0039], [0056] and figure 1.	11-12,14
Y		1-2,5-6,9-10
A		3-4,7-8,13
Y	KR 10-1461580 B1 (POSCO) 17 November 2014 See paragraph [0055] and figure 3.	1-2,5-6,9-10
A	KR 10-2004-0098469 A (POSCO) 20 November 2004 See page 3, lines 10-12 and figure 4.	1-14
A	KR 10-1990-0010025 A (METALLGESELLSCHAFT AG.) 06 July 1990 See claims 1 to 7 and figures 1-2.	1-14
A	KR 10-2002-0014877 A (POHANG IRON AND STEEL CO., LTD.) 27 February 2002 See page 3, lines 10-51 and figures 1-6.	1-14

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

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 FEBRUARY 2017 (09.02.2017)	**13 FEBRUARY 2017 (13.02.2017)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2016/013625

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		EP 3088825 A1	02/11/2016
		WO 2015-099212 A1	02/07/2015
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		EP 0378877 A1	25/07/1990
		EP 0378877 B1	16/06/1993
KR 10-2002-0014877 A	27/02/2002	KR 10-0515042 B1	15/09/2005

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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