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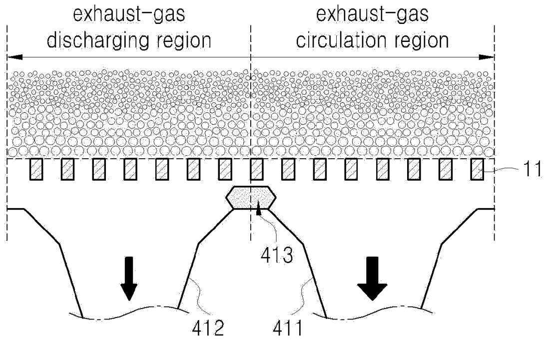
## (54) EXHAUST GAS PROCESSING APPARATUS AND PROCESSING METHOD

(57) Provided is an exhaust gas processing apparatus including a gas-suction array extending in a traveling direction of a truck and disposed below the truck which is disposed to move along a plurality of regions while receiving a raw-material, wherein the gas-suction array has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other, and a gas-blocking structure disposed at a boundary between the exhaust-gas circulation region and exhaust-gas discharging region so as to seal the spacing between the gas-suction array and the truck at the boundary, and an exhaust gas processing method applied to the exhaust gas processing apparatus, which may suppress or prevent interference between exhaust-gas flows due to a difference between negative pressures in regions of an equipment.

FIG. 2




EP 3 531 052 A1

# Description

## TECHNICAL FIELD

**[0001]** The present disclosure relates to an exhaust gas processing apparatus and processing method, and more particularly, to an exhaust gas processing apparatus and processing method capable of suppressing or preventing interference between exhaust-gas flows due to a difference between negative pressures in a plurality of regions of an equipment.

## RELATED ART

**[0002]** The sintered ore is produced by using fine iron ore, limestone, coke, and anthracite as raw materials and then is loaded into a blast furnace. In a blast furnace process for production of molten iron, the sintered ore is loaded together with iron ore and coke into the blast furnace. A sintered ore production process sinters fine iron ore into a size suitable for blast furnace use. The sintered ore production process involves preparation of mixture of raw materials and thermal treatment of the mixture into sintered ore. The latter is usually performed in a sintering machine.

**[0003]** The process of producing the sintered ore by heat-treating the mixture of raw materials is performed as follows: the mixture of raw materials is loaded, at a constant height, onto the sintering truck while the truck is moving in the direction of extension of the sintering machine. A surface layer of the mixture of raw materials is ignited by an ignition unit to create a raceway or combustion zone. Using an exhaust gas processing apparatus, air is forcedly inputted downwardly into the sintering truck to move the raceway downwardly, thereby sintering the mixture of raw-materials, that is, to produce the sintered ore. The sintered ore is then crushed and cooled via a crusher and a cooler provided in an unloading region of the sintering machine. The crushed and cooled sintered ore is classified into granules of 5 mm to 50 mm suitable for use in the blast furnace and then is transferred to the blast furnace.

**[0004]** A sintering exhaust-gas circulation technology for improving function of the sintering machine and reducing energy was published by Kinsey on AIME in US, 1975. In this publication, an on-strand cooling sintering machine is proposed, which has a structure in which a length of the sintering machine is extended and a cooler is added to the sintering machine. Such a configuration includes a sintering region and a cooling region. Gases are individually suctioned from the sintering zone and the cooling zone. Thus, an energy-reducing sintering model was proposed by circulating high-temperature exhaust gas discharged from the cooling zone into the sintering zone as hot air. Subsequently, similar studies or patent applications were filed in Japan and Europe during the 1970s and 1980s.

**[0005]** When the sintering exhaust-gas circulation technique is applied to the sintering machine process, the energy required for sintering may be reduced by recycling sensible heat of the exhaust gas for sintering. After the first oil shock, in Wakayama in Japan, 1984, four-sintering was modified via the on-strand cooling sintering machine, and, then, air in the cooling section of the sintering machine was recirculated for reuse as sintering air. Further, in Kyushu and Kashima, the sintering exhaust-gas circulation technology was used to circulate the exhaust gas from the cooler to the sintering machine. In NKK in 1991, in order to increase gas suction capacity and thus to improve productivity of Fukuyama 4-sintering, a second blower was installed, and the exhaust gas recovered by the second blower was recirculated toward a sintered ore discharge unit of the sintering machine, thereby to enhance sensible heat recovery ability by a boiler installed therein, together with increase of the gas suction capacity.

**[0006]** The above-mentioned approaches aim to reduce the amount of exhaust gas while aiming to reduce the energy, by transmitting the sensible heat of the exhaust gas to the sintered layer or the ignition furnace. To this end, the sintering exhaust-gas circulation technology was applied to the sintering machine process.

**[0007]** Meanwhile, due to the enforcement of environmental policy regulations, investment and operating costs for processing equipments for treating sulfuric oxides SOx and nitride oxides NOx have recently become burden. As a result, steel mills in each country are responding to greenhouse gas regulations and are reducing energy consumption by recycling exhaust gas from sintering machines to the maximum extent, together with reducing the investment cost for pollution-prevention equipments.

**[0008]** For example, NSC's Kitakyushu 3-sintering in 1992 reduced the amount of exhaust gas by 28% by improving a sintering machine to reduce the amount of exhaust gas while maintaining productivity and quality of the sintered ore. In 1994, Lurgi, Germany, developed EOS (Emission Optimized Sintering) technique and applied it to a Hoogovens sintering plant in the Netherlands to reduce the exhaust gas amount by about 40%. These cases are prepared to comply with international environmental regulations, but the technology thereof is not yet completed.

**[0009]** In addition, since 1994, NSC's FUTSU process lab, Voest-Alpine in Austria, BHP in Australia and Centro Sviluppo Materiali (CSM) in Italy have been working to adapt the sintering process to an environmentally friendly process. Sumitomo Corporation are studying a two-stage ignition sintering method in which, in an on-strand cooling sintering machine, the raw-material is loaded individually into upper and lower stages and the materials in the upper and lower stages are ignited and sintered, wherein exhaust gas from the upper stage is reused for sintering the material in the lower stage.

**[0010]** In order to increase the productivity of the sintered ore, there is an approach to increase the blower capacity in the exhaust gas processing apparatus to increase the sintering air volume, and an approach to increase the sintering air volume by enlarging the firing area of the sintering machine. In this connection, when the blower capacity of the exhaust gas processing apparatus is increased, a machine for cleaning the exhaust-gas must further be extended, and, further, the maintenance cost of the exhaust gas processing apparatus is increased.

**[0011]** Therefore, POSCO's Pohang 4-sintering has introduced the sintering exhaust-gas circulation technology. In this connection, to deal with increasing demand of the sintered ore due to increases in an inner capacity of the blast furnace and the high tapping process, the firing area of the sintering machine is extended and thus the sintering air flow volume correspondingly increase. Thus, in order to deal with the sintering air flow volume increase, a further blower for exhaust-gas circulation was added to the exhaust gas processing apparatus.

**[0012]** In this connection, while a position where the ventilation resistance of the sintered layer is the largest is defined as an exhaust-gas suction position, the added blower sucks the exhaust gas using a high pressure at the above-defined position, and supplies the same toward a rear end of the sintered layer where oxygen is relatively less consumed. Since the exhaust gas sucked into the added blower is circulated toward a top face of the sintered layer, the total amount of exhaust gas may be maintained constantly. Therefore, even when the firing area of the Pohang 4-sintering is increased and the blower is added thereto, the existing structure related to the exhaust-gas cleaning in the exhaust gas processing apparatus may be used as it is not modified.

(Related Art Document)

(Patent Document)

**[0013]**

(Patent Document 1) KR10-2002-0014877 A
(Patent Document 2) KR10-2016-0079240 A

(Non-Patent Document)

**[0014]**

(Non-Patent Document 1) F.W. Kinsey, Dravo co., , "Design parameters for strand cooling", AIME, vol.34, Ironmaking proceeding, p85, (1975)
(Non-Patent Document 2) D. Schlebusch, F. Cappel, "Optimization of pollution control in sinter plant", 6-th International symposium on agglomeration, p403-408, Nagoya, Japan, (1993)

## DISCLOSURE OF PRESENT DISCLOSURE

### TECHNICAL PURPOSES

**[0015]** The present disclosure provides an exhaust gas processing apparatus and method which may suppress or prevent interference between exhaust-gas flows due to a difference between negative pressures in a plurality of regions of an equipment.

**[0016]** The present disclosure provides an exhaust gas processing apparatus and method that can suppress or prevent interference between exhaust-gas flows of an equipment and thereby improve process efficiency of the equipment.

### TECHNICAL SOLUTIONS

**[0017]** In accordance with an exemplary embodiment, an exhaust gas processing apparatus includes: a gas-suction array extending in a traveling direction of a truck and disposed below the truck which is disposed to move along a plurality of regions while processing a raw-material, wherein the gas-suction array has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other; and a gas-blocking structure disposed at a boundary between the exhaust-gas circulation region and exhaust-gas discharging region so as to seal the spacing between the gas-suction array and the truck at the boundary.

**[0018]** The gas-suction array may include a plurality of wind-boxes arranged along the traveling direction of the truck, wherein the wind-boxes have respectively upper ends arranged side by side along the extension of the gas-suction array, wherein the upper ends are coupled to each other, wherein the gas-blocking structure is disposed on adjacent upper ends of some of the plurality of wind-boxes adjacent to the boundary between the exhaust-gas circulation region and the exhaust-gas discharging region, while the adjacent wind-boxes define the boundary therebetween.

**[0019]** A gap between a top face of the gas-blocking structure and a bottom face of the truck at the boundary may be greater than 0 and less than or equal to 100 mm, within a tolerance range.

**[0020]** In accordance with another exemplary embodiment, an exhaust gas processing apparatus includes: a plurality of wind-boxes arranged along a traveling direction of a truck and disposed below the truck, wherein the truck is disposed to move along a plurality of regions while processing a raw-material, wherein the plurality of wind-boxes has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other, wherein upper ends of some of the plurality of wind-boxes protrude more upwardly than upper ends of the remainder of the plurality of wind-boxes, wherein the upper ends of some of the plurality of wind-boxes are adjacent to the boundary between the exhaust-gas circulation region and exhaust-gas discharging region.

**[0021]** Some of the plurality of wind-boxes include first and second wind-boxes, and the first and second wind-boxes define the boundary therebetween, and are disposed in the exhaust-gas circulation region and exhaust-gas discharging region respectively, wherein a gap between the upper ends of the first and second wind-boxes and a bottom face of the truck may be greater than 0 and less than or equal to 100 mm, within a tolerance range.

**[0022]** The exhaust gas processing apparatus further includes a gas-blocking structure disposed at the upper ends of the first wind-box and the second wind-box so as to seal a gap between the truck and some of the wind-boxes at the boundary.

**[0023]** The gas-blocking structure may include a gas-blocking body extending in a direction crossing the traveling direction of the truck; and a flap protruding from the gas-blocking body in the traveling direction of the truck.

**[0024]** The flap may extend from at least one of an upper end and a lower portion of the gas-blocking body or from a portion between the upper and lower portion of the gas-blocking body. The flap may be disposed in at least one of the exhaust-gas circulation region and exhaust-gas discharging region. The flap may be disposed in a lower negative pressure region among the exhaust-gas circulation region and exhaust-gas discharging region. When a cross-sectional area of an upper end of a wind-box facing the flap is set to 1, an extension length of the flap may be greater than 0 and less than or equal to 2/3.

**[0025]** The gas-blocking structure may further includes at least one rib formed to protrude upwards from a top face of the flap. The rib may extend in the traveling direction of the truck, or the rib may extend in a direction crossing the traveling direction of the truck. The gas-blocking structure may include a plurality of ribs, wherein some of the plurality of ribs may extend in the traveling direction of the truck, while the remainder thereof may extend in a direction crossing the traveling direction of the truck.

**[0026]** The gas-blocking structure may further include a tip portion projecting downwardly in a tilted manner from a distal end of the flap in a direction from the body of the blocking structure to an end of the flap. When a cross-sectional area of an upper end of a wind-box facing the flap is set to 1, a sum of extension lengths of the flap and the tip portion in a traveling direction of the truck may be greater than 0 and less than or equal to 2/3.

**[0027]** In accordance with an exemplary embodiment, an exhaust gas processing method includes: loading a raw-material into a truck and thermally-processing the material in the truck while moving the truck along a plurality of regions; suctioning downwardly an interior of the truck using a gas-suction array, wherein the gas-suction array extends in a traveling direction of the truck and disposed below the truck, wherein the gas-suction array has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other; and suppressing exhaust-gas flowing from a lower negative pressure region among the exhaust-gas circulation region and exhaust-gas discharging region into a space between the gas-suction array and the truck.

**[0028]** Suppressing the exhaust-gas from flowing from the lower negative pressure region into the space may include using a gas-blocking structure disposed at a boundary between the exhaust-gas circulation region and exhaust-gas discharging region.

## ADVANTAGEOUS EFFECTS

**[0029]** In accordance with the exemplary embodiments of the present disclosure, it is possible to suppress or prevent interference between exhaust-gas flows due to a difference between negative pressures in a plurality of regions of an equipment, and thereby to improve process efficiency of the equipment.

**[0030]** For example, when the embodiments of the present disclosure is applied to a sintered ore production process, the gas-blocking structure is disposed on adjacent upper ends of wind-boxes of the plurality of the wind-boxes arranged in the traveling direction of the truck, adjacent to the boundary while the adjacent wind-boxes define the boundary between the exhaust-gas circulation region and the exhaust-gas discharging region. When the raw material is loaded on the truck which in turn travels along the plurality of regions while the raw-material is thermally treated, and the gas in the truck is suctioned downwards, the gas-blocking structure suppresses gas flowing from a lower negative pressure region among the exhaust-gas circulation region and exhaust-gas discharging region, through the spacing between the gas-suction array and the truck, to a higher negative pressure region among the exhaust-gas circulation region and the exhaust-gas discharging region.

**[0031]** Or, the upper ends of some of the plurality of wind-boxes arranged in the traveling direction of the truck protrude more upwardly than upper ends of the remainder of the plurality of wind-boxes, wherein some of the plurality of wind-boxes are adjacent to the boundary between the exhaust-gas circulation region and exhaust-gas discharging region. Further, the gas-blocking structure may be disposed on the adjacent upper ends of the adjacent wind-boxes. When the raw material is loaded on the truck which in turn travels along the plurality of regions while the raw-material is thermally treated, and the gas in the truck is suctioned downwards, the narrowed gap or the gas-blocking structure may suppress gas flowing from a lower negative pressure region among the exhaust-gas circulation region and exhaust-gas discharging region, through the spacing between the gas-suction array and the truck, to a higher negative pressure region among the exhaust-gas circulation region and an exhaust-gas discharging region.

**[0032]** Therefore, the exhaust gases respectively in the adjacent wind-boxes in the exhaust-gas circulation region and exhaust-gas discharging region respectively at the boundary exhaust-gas circulation region and exhaust-gas discharging region may not interfere with each other. Thus, exhaust-gas may be prevented from backflowing from the lower negative pressure region among the exhaust-gas circulation region and exhaust-gas discharging region to the higher negative pressure region among the exhaust-gas circulation region and exhaust-gas discharging region. Therefore, both the circulation-flow and discharge-flow efficiencies of the exhaust flow can be improved, and the overall exhaust-gas flow rate can be improved. As a result, the efficiency of the sintered ore generation process can be improved, and high-quality sintered ore can be produced.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0033]**

FIG.1 is a schematic diagram of a raw-material processing equipment according to an embodiment of the present disclosure.

FIG. 2 is a schematic diagram illustrating an exhaust gas processing apparatus according to an embodiment of the present disclosure.

FIG. 3 is a schematic diagram of a gas-blocking structure according to a first modified embodiment of the present disclosure.

FIG. 4 is a schematic diagram of a gas-blocking structure according to a second modified embodiment of the present disclosure.

FIG. 5 is a schematic diagram of a gas-blocking structure according to a third modified embodiment of the present disclosure.

FIG. 6 is a schematic diagram of a gas-blocking structure according to a fourth modified embodiment of the present disclosure.

FIG. 7 is a schematic diagram of a gas-blocking structure in accordance with a fifth modified embodiment of the present disclosure.

FIG. 8 is a schematic diagram of exhaust-gas flow for a gas-suction array according to a comparison example.

FIG. 9 is a graph illustrating numerical analysis of the exhaust-gas flow in the gas-suction array according to the embodiments of the present disclosure and the comparison example.

FIG. 10 shows photographs of results of a reduced modeling experiment on the exhaust-gas flow inside the gas-suction array, according to the comparison example and the embodiment of the present disclosure.

FIG. 11 shows a table indicating results of the reduced modeling experiment for exhaust-gas flow in the gas-suction array according to the comparison example and the embodiment of the present disclosure.

## DETAILED DESCRIPTIONS

**[0034]** Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. However, the present disclosure is not limited to the embodiments described below, but may be embodied in various forms. The embodiments of the present disclosure may be set forth to allow the descriptions of the present disclosure to be complete and to inform the skilled person to the art of the scope of the present disclosure. The drawings may be exaggerated to illustrate the embodiments of the present disclosure. Like numerals refer to like elements throughout the drawings.

**[0035]** Among terms used for describing the embodiments of the present disclosure, an 'upper portion' or 'lower portion" refers to an upper or lower portion of a component. In addition, 'above' or 'below' is used to indicate a space that directly or indirectly contacts an upper or lower portion of the component.

**[0036]** The present disclosure provides an exhaust gas processing apparatus and method configured to allow flow-interference between circulating flow gas and exhausted flow gas during exhaust-gas flow in a sintering machine to be suppressed in the sintering machine, which may otherwise occur due to a difference between negative pressures in a plurality of regions of an equipment, for example, a difference between negative pressures in wind-boxes. Hereinafter, embodiments will be described in detail with reference to a sintered ore producing process at a steelworks. Obviously, the present disclosure may be equally applied to exhaust-gas flow control of various processing equipments.

**[0037]** In setting forth the embodiments of the present disclosure, a raw-material processing equipment according to an embodiment of the present disclosure is first described so that understanding of the present disclosure is clear. With reference to the raw-material processing equipment, the exhaust gas processing apparatus and method according to embodiments of the present disclosure will be described in detail.

**[0038]** FIG. 1 is a schematic diagram of a raw-material processing equipment to which an exhaust gas processing apparatus according to an embodiment of the present disclosure is applied. FIG. 2 is a schematic diagram illustrating a gas-suction array and a gas-blocking structure of an exhaust gas processing apparatus according to an embodiment of the present disclosure.

**[0039]** In addition, FIGS. 3 to 7 are schematic diagrams of modifications of a gas-blocking structure according to embodiments of the present disclosure. In this connection, FIG. 3 is a schematic diagram of a gas-blocking structure according to a first modified embodiment of the present disclosure. FIG. 4 is a schematic diagram of a gas-blocking structure according to a second modified embodiment of the present disclosure. FIG. 5 is a schematic diagram of a gas-blocking structure according to a third modified embodiment of the present disclosure.

FIG. 6 is a schematic diagram of a gas-blocking structure according to a fourth modified embodiment of the present disclosure. FIG. 7 is a schematic diagram of a gas-blocking structure in accordance with a fifth modified embodiment of the present disclosure.

**[0040]** Referring to FIG. 1, the raw-material processing equipment according to an embodiment of the present disclosure includes a truck 10, a raw-material hopper 21, an upper-sintered ore hopper 22, an ignition furnace 30, and an exhaust gas processing apparatus 400.

**[0041]** The raw-material processing equipment may take a raw material and thermally process it while sequentially moving it along a plurality of regions. At least a portion of the exhaust gas generated from the plurality of regions may be circulated in at least a portion of the plurality of regions. In the context of this description, the raw-material processing equipment may be a sintering machine. For example, the sintering machine may be a downward suction type sintering machine having an exhaust-gas recirculation configuration.

**[0042]** The truck 10 may be configured to allow the raw material therein to be thermally processed in the plurality of regions. The raw-material processing equipment includes a plurality of trucks, which may be continuously arranged and coupled together in the direction of extension of the raw-material processing equipment. The truck 10 may be configured to run in the arrangement direction of the plurality of regions. The truck 10 is open at the top thereof and thus is loaded with the raw material within the interior space in each truck. The inner space of each of these trucks corresponds to a heat processing space. The raw material may be loaded inside the truck 10.

**[0043]** A bottom portion 11 of the truck 10 may have a configuration in which elongated bars(grate bars) are arranged in a grid structure. With this configuration, the inner space of the truck 10 may gas-communicate with a corresponding wind-box as described later, whereby the exhaust-gas in the inner space may be sucked downwards via the wind-box.

**[0044]** An upper end of the raw-material processing equipment may define a convey path of the truck 10, while a lower portion thereof may define a return path of the truck 10. The truck 10 travels in a first direction along the convey path, and, thus, the raw material loaded therein is moved in the first direction while being thermally treated. When the truck enters the return path, the heat treated sintered ore is discharged into the crushing unit (not shown), and, then, the truck travels along the return path in a second direction opposite to the first direction, and, then, may be returned to the convey path.

**[0045]** The convey path may include a plurality of regions. The plurality of regions includes: a loading region in which the raw material hopper 21 and the upper-sintered ore hopper 22 are located; an ignition region in which the ignition furnace 30 is located, downstream of the loading region; and a sintering region downstream of the ignition region. The loading region, the ignition region, and the sintering region may be sequentially arranged along the moving direction of the raw material.

**[0046]** The loading region may be located upstream of the convey path, where the raw material begins to move in the convey path. In the loading region, the raw material is loaded in the interior space of the truck 10, thereby forming a raw-material layer in the interior space of the truck 10. The ignition region is located downstream of the loading region in the movement direction of the raw material and may extend in the direction of movement of the raw material. In the ignition region, an upper end (hereinafter, an upper material layer) of the raw-material layer loaded in the truck 10 is ignited.

**[0047]** In the sintering region, a raceway is moved from the upper material layer of the raw material layer loaded on the truck 10 to a lower portion of the raw-material layer (hereinafter referred to as a 'lower material layer'). This sintering region is a region for sintering and cooling the raw material layer and is located downstream of the ignition region in the direction of movement of the raw material. The raw material in each truck 10 is subjected to thermal treatment while each truck is moving the raw material sequentially along the loading, ignition and sintering regions, thereby producing a sintered ore.

**[0048]** The raw-material hopper 21 receives the raw material therein and is located in the loading region above the truck 10. The raw-material hopper 21 may be provided with a loading chute and a drum feeder at the bottom opening thereof and, thus, may load the raw material within the truck 10. In this connection, before the loading, the raw material may be subjected to vertical segregation by the hopper 21.

**[0049]** The raw-material may contain a raw-material for sintered ore production. For example, the raw-material may have particles of sizes on the order of a few millimeters by mixing, humidifying, and granulating an iron source, additives, and solid fuel. In this connection, the iron source is a source with an iron component, and may include iron ores and fine iron ores. The additive may include limestone as a material containing calcium carbonate. The solid fuel may include coal-based solid fuels, including coke powders and anthracite.

**[0050]** The upper-sintered ore hopper 22 is located in the loading region and upstream of the raw-material hopper 21 in the direction of movement of the raw material. The upper-sintered ore may be provided by selecting a sintered ore having a particle size of, for example, 8 mm to 15 mm from the sintered ore. The upper-sintered ore may be loaded into the interior space of the truck 10 prior to loading the raw material thereto, so that the raw material is prevented from being attached to the bottom of the truck 10 or is prevented from passing downwardly through gap defined in the bottom of the truck 10.

**[0051]** The ignition furnace 30 is spaced apart from the raw-material hopper 21 in the traveling direction of the truck 10. The ignition furnace 30 may be located above the truck 10. That is, the ignition furnace 30 may be located in the ignition region of the convey path, downstream of the raw-material hopper 21, in the direction in which the truck 10 travels. The ignition furnace 30 is configured to inject a flame downwards, and serves to heat the upper material layer by spraying the flame onto the upper material layer. In this connection, the flame may ignite the solid fuel contained in the upper material layer.

**[0052]** The exhaust gas processing apparatus 400 according to an embodiment of the present disclosure may be configured to suck downwardly gas from the interior space of the truck 10 and to circulate at least a portion of the sucked gas between the plurality of regions while the raw material is heat-treated in the interior space of the truck 10 while each truck is moving along the plurality of regions.

**[0053]** Referring to FIG. 1 and FIG. 2, the exhaust gas processing apparatus 400 according to an embodiment of the present disclosure may include a gas-blocking structure 413, a gas-suction array, a gas ventilation pipe 420, an exhaust-gas circulation mechanism, and an exhaust-gas discharging mechanism.

**[0054]** The gas-suction array may be disposed on the bottom of the truck 10 and extend along the direction of travel of the trucks of the truck 10. For example, the gas-suction array may extend in the traveling direction of the truck 10 while wrapping, at its top end, the bottom of the truck 10. More specifically, the gas-suction array may include a plurality of wind-boxes 410 arranged along the traveling direction of the trucks of the truck 10. Adj acent ones of the plurality of wind-boxes 410 may have adjacent upper ends arranged side by side to each other in the extending direction of the gas-suction array. Each of the plurality of wind-boxes 410 gas-communicates with the interior space of the corresponding truck 10 via gaps defined in the bottom 11 of the corresponding truck 10. Each of the plurality of wind-boxes 410 creates a negative pressure in the interior space of the corresponding truck to suck downwardly the gas in the interior space of the corresponding truck 10, thereby allowing the raceway in the raw-material layer to be transferred to from the upper material layer thereof to the lower material layer thereof. In this process, the exhaust-gas is collected into the plurality of wind-boxes 410.

**[0055]** After the truck 10 is subjected to ignition from the ignition furnace 30, each truck travels in a first direction and travels along the gas-suction array. In this connection, the gas-suction array generates a suction force in the downward direction within the internal space of the corresponding truck 10. This suction force enables air outside the truck 10 to flow into the interior space of the corresponding truck 10 and then to enable the gas inside the inner space to be drawn downwards, thereby moving the raceway downwards. When the corresponding truck 10 passes through the sintering region, the raceway reaches the bottom 11 of the truck 10, thereby to complete the sintering of the raw-material layer. As the corresponding truck 10 moves toward an end point of the convey path, the sintered ore has been cooled. The cooled sintered ore may be discharged via a sintered ore discharger at the end point of the convey path.

**[0056]** The plurality of wind-boxes 410 are spaced apart from the bottom 11 of the truck 10 by a predetermined gap. This is to prevent the moving truck 10 from colliding with the wind-boxes 410 while the plurality of wind-boxes 410 suction downwards the gas in the internal space of the truck. Further, the ventilation resistance in the interior space of the truck varies, based on the sintered states of the raw-material, at various points of each region, as the corresponding truck passes through each region. For this reason, the plurality of wind-boxes 410 are spaced apart from the bottoms 11 of the truck 10 by a predetermined gap, in order to effectively suck the gas from the interior space of the truck 10. That is, the adjacent and contacting upper ends of the plurality of wind-boxes 410 are spaced apart from the bottoms 11 of the truck 10 by a predetermined distance.

**[0057]** On the other hand, the gas-suction array may have therein a gas circulation region and a gas discharging region which are separated from each other. Accordingly, the plurality of wind-boxes 410 may be divided into wind-boxes 411 disposed in the gas circulation region and wind-boxes 412 disposed in the gas discharging region.

**[0058]** The gas circulation region of the gas suction array may correspond to a portion of the gas-suction array extending from a first point in the sintering region to a second point in the sintering region. In this connection, the first point in the sintering region may correspond to a point at which the raceway in the raw-material layer reaches the bottom 11 of the truck 10, thus completing the sintering of the raw-material layer. The second point in the sintering region may correspond to a point at which a ventilation resistance value of the sintered raw-material layer begins to fall below a predetermined value.

**[0059]** Thus, the gas discharging region of the gas suction array corresponds to a combination of a portion of the gas-suction array that extends from the beginning of the convey path to the first point in the sintering region as described above, and a portion of the gas-suction array extending from the second point in the sintering region to the end point of the convey path. That is, the discharging region may correspond to the remainder of the gas-suction array except for the circulation region.

**[0060]** The first point and the second point in the sintering region as described above are merely an example for illustrating the present disclosure. The present disclosure is not limited thereto. The sintering region may be configured in various ways depending on the process requirements. Further, the above-defined division between the gas circulation region and the gas discharging region is merely an exemplary one of various configurations for circulating the exhaust gas. The gas circulation zone and the gas exhaust zone may be configured in a variety of ways, thus exhausting and circulating the exhaust gas in various ways.

**[0061]** Before describing the gas-blocking structure 413, the gas ventilation pipe 420, the exhaust-gas circulation mechanism, and the exhaust-gas discharging mechanism of the exhaust gas processing apparatus 400 according to an embodiment of the present disclosure will be illustrated first.

**[0062]** The processing apparatus includes a plurality of gas ventilation pipes, and the plurality of gas ventilation pipes are arranged so as to be spaced apart from each other along the extended direction of the gas-suction array. The plurality of gas ventilation pipes may communicate with the bottom of the gas-suction array, that is, the bottoms of the plurality of wind-boxes 410, respectively. The gas ventilation pipe 420 may be divided into gas ventilation pipes 421 communicating with the wind-boxes 411 disposed in the gas circulation region, and gas ventilation pipes 422 communicating with the wind-boxes 412 disposed in the gas discharging region.

**[0063]** The exhaust-gas circulation mechanism has a first end portion communicating with some of the gas ventilation pipes 420, for example, the gas ventilation pipes 421 communicating with the wind-boxes 411 disposed in the gas circulation region and a second end portion facing a predetermined position within the plurality of regions. Thus, the exhaust-gas circulation mechanism can circulate the exhaust-gas sucked from the points where the ventilation resistance of the sintered raw-material layer is greatest, toward predetermined points on the plurality of regions.

**[0064]** In this connection, the second end portion of the exhaust-gas circulation mechanism may be opened between the first point of the sintering region and the end point of the convey path. In one embodiment, the second end portion of the exhaust-gas circulation mechanism may be opened toward points downstream of the above-mentioned first point of the sintering region. This means that the second end portion of the exhaust-gas circulation mechanism is opened toward the downstream points of the sintering region, where relatively less oxygen is consumed. Obviously, the second end portion of the exhaust-gas circulation mechanism may be opened towards various points on the plurality of regions, in addition to the points described above. In the following, reference will be made to a configuration of the exhaust-gas circulation mechanism that is configured to circulate the exhaust gas suctioned from the points where the ventilation resistance of the sintered raw-material layer is maximum, toward the downstream points of the sintering region.

**[0065]** The exhaust-gas circulation mechanism may include a circulation pipe 430, a circulation blower 451, and a gas discharging hood 460. One end of the circulation pipe 430 communicates with the gas ventilation pipes 421 communicating with the wind-boxes 411 disposed in the gas circulation region. The other end of the circulation pipe 430 may communicate with the gas discharging hood 460. The circulation blower 451 is, for example, a blower for exhaust-gas circulation. The circulation blower 451 is mounted at one point of the circulation pipe 430 to allow flow of exhaust gas from one end of the circulation pipe 430 to the other end thereof. Due to this flow, an exhaust-gas circulation flow may be generated within the wind-boxes 411 disposed in the gas circulation region.

**[0066]** The gas discharging hood 460 may extend in the direction of travel of the truck 10 and above the truck 10. The gas discharging hood 460 may extend between the end point of the convey path and a certain point in the sintering region. The lower end of the gas discharging hood 460 is open and the lower end thereof faces the truck 10. The upper end of the gas discharging hood 460 may communicate with the other end of the circulation pipe 430. The gas discharging hood 460 receives the exhaust gas from the circulation pipe 430 and supplies the gas to the truck 10. Thereby, the exhaust gas may be circulated.

**[0067]** Among the gas ventilation pipes 420, the gas ventilation pipes 422, which is not connected to the exhaust-gas circulation mechanism, may communicate with the exhaust-gas discharging mechanism. The exhaust-gas collected into the wind-boxes 412 disposed in the gas discharging region may be discharged to the atmosphere through the exhaust-gas discharging mechanism.

**[0068]** The exhaust-gas discharging mechanism has a first end portion and a second end portion. The first end portion of the gas ventilation pipe 420 communicates with the second gas ventilation pipe group 422 communicating with the wind boxes 412. The second end portion may communicate with the atmospheric space. The exhaust-gas discharging mechanism may exhaust the exhaust-gas collected into the wind-boxes 412 disposed in the gas discharging region toward the atmospheric space. The exhaust-gas discharging mechanism may include an elongate discharging chamber 440, a contaminant collector 470, a main blower 452, and a gas discharging module 480.

**[0069]** The elongate discharging chamber 440 may be hollow. One end of the elongate discharging chamber 440 may be connected to the gas ventilation pipes 422 which communicate with the wind boxes 412 disposed in the gas discharging region. The other end of the elongate discharging chamber 440 may be connected to the gas discharging module 480. The main blower 452 is, for example, a blower for discharging the exhaust-gas and is mounted at a predetermined position of the discharging chamber 440. The main blower 452 may create flow of exhaust gas from one end of the discharging chamber 440 to the other end thereof. Via this flow, exhaust-gas flow may be generated in the wind-boxes 412 disposed in the gas discharging region. The exhaust gas may contain contaminants such as dust, nitrogen oxides and sulfur oxides. In order to filter these contaminants, there is the contaminant collector 470 upstream of the main blower 452 in the exhaust-gas flow direction. The contaminant collector 470 may be mounted at a predetermined position of the discharging chamber 440.

**[0070]** A crushing unit (not shown) may be provided downstream of the sintering region. The sintered ore discharged from the truck 10 is crushed into a predetermined size by the crushing unit and, then the crushed ores are screened at a screen (not shown). The screened sintered ores may be fed to other processes, such as a blast furnace process, may be used as the upper-sintered ore, or may be re-used as the raw-material, based on the particle sizes thereof.

**[0071]** Meanwhile, the main blower 452 and the circulation blower 451 have different suction-positions and suction-areas. That is, the main blower 452 and the circulation blower 451 are different in terms of the positions and numbers of wind-boxes that they must act on. In addition, a ventilation level of the raw-material layer within the truck 10 moving on and along the wind-boxes 412 connected to the main blower 452, and a ventilation level of the raw-material layer within the trucks of the array 10 moving on and along the wind-boxes 411 connected to the circulation blower 451 are also different. Due to these differences, the main blower 452 and the circulation blower 451 have different operating pressures.

**[0072]** Thus, the negative pressure applied by the main blower 452 to the wind-boxes 412 disposed in the gas discharging region, and the negative pressure applied by the circulation blower 451 to the wind-boxes 411 disposed in the gas circulation region are different from each other. An amount of exhaust gas sucked by the main blower 452 and an amount of exhaust gas sucked by the circulation blower 451 are also different. For example, the magnitude of the negative pressure applied by the circulation blower 451 to the wind-boxes 411 disposed in the gas circulation region may be greater than the magnitude of the negative pressure applied by the main blower 452 to the wind-boxes 412 disposed in the gas discharging region. Of course, the opposite may also be true. That is, the magnitude of the negative pressure in the gas discharging region may be greater.

**[0073]** In this case, the exhaust gas in the low negative pressure region may flow backward toward the high negative pressure region. That is, at the boundary between the gas circulation region and the gas discharging region having different negative pressures, interference between the exhaust-gas flows may occur, resulting in the back-flow of the exhaust gas to the region with a high negative pressure. The back-flowed exhaust-gas may flow into the high negative pressure region through the gaps between the bottoms 11 of the truck 10 and the gas-suction array.

**[0074]** In this way, due to the difference in at least one of the operating pressure and suction force between the main blower 452 and the circulation blower 451, a portion of the exhaust gas that has to be discharged to the gas discharging region may flow back into the gas circulation region having a higher negative pressure at the boundary between the gas discharging region and the gas circulation region of the gas-suction array. As a result, the exhaust-gas suction amount by the main blower 452 decreases. This phenomenon is called flow-interference between the main blower 452 and the circulation blower 451.

**[0075]** According to embodiments of the present disclosure, in order to suppress flow-interference between the main blower 452 and the circulation blower 451 at the boundary between the gas discharging region and the gas circulation region of the gas-suction array, the gas-blocking structure 413 may be formed at the boundary to seal the gap between the truck 10 and the gas-suction array.

**[0076]** Referring to FIG. 2, the gas-blocking structure 413 extends in a direction crossing the traveling direction of the truck 10. The gas-blocking structure 413 may be formed in a block shape, for example. The gas-blocking structure 413 may be disposed on adjacent upper ends of some of the plurality of wind-boxes adjacent to the boundary while the adjacent wind-boxes define the boundary between the exhaust-gas circulation region and the exhaust-gas discharging region.

**[0077]** In this connection, the gap between the top of the gas-blocking structure 413 and the bottom of the truck 10 may be greater than 0 but less than or equal to 100 mm within a tolerance range. Here, the tolerance range may refer to a tolerance due to a mechanical or electronic error of measuring means. Alternatively, the tolerance range may refer to a minimum clearance that may prevent structural collision between the truck 10 and the gas-blocking structure 413 due to structural deformations of the bottom portion 11 of the truck 10 and the gas-blocking structure 413.

**[0078]** The gas-blocking structure 413 may narrow the gap between the bottom 11 of the truck 10 and the upper end of the wind-box at the boundary between the gas discharging region and the gas circulation region. That is, the gas-blocking structure 413 may achieve a substantially gas-blocking effect through the gap. Therefore, the backflow of gas from the low negative pressure region to the high negative pressure region may be suppressed. At other locations without the gas-blocking structure 413, the exhaust-gas may flow freely through the spacing between the bottom 11 of the truck 10 and the top of the wind-boxes. Thus, in each of the gas discharging region and the gas circulation region, the suction of the exhaust gas may be stably achieved.

**[0079]** The gas-blocking structure 413 according to the embodiment of the present disclosure may include various modifications as described below.

**[0080]** Referring to FIG. 3, a gas-blocking structure 413A according to a first modified embodiment of the present disclosure may include a gas-blocking body 413' extending in a direction crossing the traveling direction of the truck 10, and a flap 414 in a form of a wing or plate extending from the gas-blocking body 413' in the traveling direction of the truck 10. In this connection, the flap 414 may extend horizontally from the upper end of the gas-blocking body 413' .

**[0081]** The flap 414 defines a gas flow blocking face above the wind-box where the flap 414 is located, such that it is possible to directly prevent the back-flow of the exhaust gas from the lower negative pressure region, for example, the gas discharging region, to the higher negative pressure region, for example, the gas circulation region. That is, the flap 414 has significant significance in terms of hydrodynamics. This will be described below in conjunction with numerical analysis of exhaust-gas flows within the gas-suction array according to the embodiment of the present disclosure and a gas-suction array according to a comparison example.

**[0082]** Also, The flap 414 may act to receive and support the raw material that falls down through openings defined in the bottom 11 of the truck 10, thereby to further narrow the gap between the truck 10 and the gas-suction array. In this way, more effective gas flow blocking may be realized at the boundary between the gas discharging region and the gas circulation region.

**[0083]** Referring to FIG. 5, a gas-blocking structure 413C according to a third modified embodiment of the present disclosure may differ from the gas-blocking structure 413A of the first modification as described above in terms of a height of the flap 414. That is, the gas-blocking structure 413C according to the third modified embodiment of the present disclosure may include a gas-blocking body 413' extending in a direction crossing the traveling direction of the truck 10, and a flap 414 in a form of a wing or plate extending from a lower portion of the gas-blocking body 413' in the traveling direction of the truck 10.

**[0084]** In this way, in various modifications of the present disclosure, the flap 414 may extend from the top or bottom portion of the gas-blocking body 413', or may extend from a middle portion between the top and bottom portion of the gas-blocking body 413'. That is, the flap 414 may extend from various heights of the gas-blocking body 413'.

**[0085]** Referring to FIG. 3 and FIG. 5, the flap 414 may be located in a wind-box in at least one of the gas circulation region and the gas discharging region. In this connection, the flap may be located in the wind box of the lower negative pressure region among the gas circulation region and gas discharging region. Further, in the gas-blocking structure 413D of a fourth modification as described later and a gas-blocking structure 413E of a fifth modification as described later, a flap 414 may located in the wind box of the region having the lower negative pressure among the gas circulation region and the gas discharging region. In this connection, the first, third, fourth, and fifth modifications of the present disclosure illustrate the flap 414 located in the wind-box of the gas discharging region as the lower negative pressure region.

**[0086]** To the contrary, Referring to FIG. 4, a gas-blocking structure 413B according to a second modification embodiment of the present disclosure may include a pair of flaps 414 respectively located in both a wind box of the gas circulation region and a wind box of the gas discharging region. In other words, the gas-blocking structure 413B according to the second modified embodiment of the present disclosure may include a gas-blocking body 413' extending in a direction crossing the traveling direction of the truck 10, a pair of flaps 414 in a form of a wing or plate and projecting from the gas-blocking body 413' in the traveling direction of the truck 10 and being disposed in the gas circulation region and the gas discharging region respectively.

**[0087]** Obviously, besides the modifications as described above, embodiments of the present disclosure may further include various modifications including a flap 414 located only in a wind box of the higher negative pressure region among the gas circulation region and the gas discharging region. That is, the flap 414 according to the modifications of the present disclosure may be located in a wind box of at least one of the gas circulation region and the gas discharging region.

**[0088]** According to the modifications of the present disclosure, when the width of the top of the wind-box facing the flap 414 is set to 1, the extension length of the flap may be greater than 0 and less than or equal to 2/3. If the extension length of the flap 414 exceeds 2/3 with respect to the width 1 of the top of the wind-box facing the flap 414, the effect of preventing the back-flow of the exhaust gas becomes large, but the exhaust-gas flow into the wind box facing the flap may be poor. For this reason, the extension length of the flap 414 is equal to or less than 2/3 with respect to the width 1 of the top of the wind-box facing the flap 414.

**[0089]** Referring to FIG. 6, a gas-blocking structure 413D according to the fourth modified embodiment of the present disclosure may further include at least one rib 415 protruding upwards from a top face of the flap 414. That is, the gas-blocking structure 413D according to the fourth modified embodiment of the present disclosure may include a gas-blocking body 413' extending in a direction crossing the traveling direction of the truck 10, a flap 414 extending from the gas-blocking body 413' in the traveling direction of the truck 10, and at least one rib 415 protruding upwards from a top face of the flap 414.

**[0090]** In this connection, in FIG. 6, the flap 414 is shown which is disposed only in the wind box of the gas discharging region and extends from the lower portion of the gas-blocking body 413'. The present disclosure is not limited thereto. The flap 414 according to the fourth modification of the present disclosure may be located only in the wind box of the gas circulation region, or may be located in each of the wind box of the gas discharging region and the wind box of the gas circulation region. In addition, the flap 414 as described above may extend from portions with different heights, including the upper and lower portions of the gas-blocking body 413 '.

**[0091]** The ribs 415 may be plural and may extend in the direction of travel of the truck or in a direction crossing both the vertical direction and the direction of travel of the truck. In this connection, some of the plurality of ribs 415 extend in the traveling direction of the truck, while the remainder thereof extend in a direction crossing both the vertical direction and the traveling direction of the truck, whereby a grid structure may be achieved. By using this grid structure, the raw material falling down onto the top surface of the flap 414 may be accommodated in the grid structure, thereby suppressing or preventing the back-flow of the exhaust gas.

**[0092]** In addition, the above-mentioned rib 415 imposes flow resistance toward the exhaust gas flowing on the top surface of the flap 414, and may suppress the exhaust gas from flowing from the low negative pressure region to the high negative pressure region.

**[0093]** Referring to FIG. 7, a gas-blocking structure 414E according to the fifth modification of the present disclosure may further include a tip portion 416 projecting downwardly in a tilted manner from a distal end of the flap 414. That is, the gas-blocking structure 414E may include a gas-blocking body 413' extending in a direction crossing the traveling direction of the truck 10, a flap 414 extending from the gas-blocking body 413' in the traveling direction of the truck 10, and a tip portion 416 formed to project downwardly in a tilted manner from a distal end of the flap 414 in a direction from the body 413' to an end of the flap 414.

**[0094]** Due to the tip portion 461, a larger gas flow blocking area in the wind-box facing the flap 414 may be ensured reliably while it is possible to prevent collision between the gas-blocking structure and the bottom 11 of the truck. For example, when the cross-sectional area of the upper end of the wind-box facing the flap 414 is set to 1, a total extension length of the flap 414 and the tip portion 416 in the direction of travel of the truck may be greater than 0 and less than or equal to 2/3.

**[0095]** The features of the gas-blocking structures according to the above modifications may be substituted each other or combined with each other to form various configurations of the gas-blocking structures.

**[0096]** An exhaust gas processing apparatus for a raw-material processing equipment according to another embodiment (second embodiment) of the present disclosure may be varied as follows: the exhaust gas processing apparatus may include a plurality of wind-boxes arranged along a movement direction of a truck and disposed below the truck, wherein the truck is disposed to move along a plurality of regions while receiving therein a raw-material, wherein the plurality of wind-boxes has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other, wherein upper ends of some of the plurality of wind-boxes protrude more upwardly than upper ends of the remainder of the plurality of wind-boxes, wherein some of the plurality of wind-boxes are adjacent to the boundary between the exhaust-gas circulation region and exhaust-gas discharging region.

**[0097]** In one embodiment, some of the plurality of wind-boxes include first and second wind-boxes, and the first and second wind-boxes define the boundary therebetween, and are disposed in the exhaust-gas circulation region and exhaust-gas discharging region respectively, wherein a spacing between the upper ends of the first and second wind-boxes and a bottom face of the truck may be in a range of 0 exclusive to 100 inclusive mm in an error range.

**[0098]** In this case, at the boundary between the gas discharging region and the gas circulation region, there is disposed a gas-blocking structure at and between the upper ends of the first wind-box and the second wind-box, in order to reduce the gap between the bottom of the truck and the wind-boxes, more specifically, the gap between the bottom of the truck and the upper ends of the first wind-box and the second wind-box. In this connection, the configuration of the gas-blocking structure may be the same as or similar to that of the gas-blocking structure according to the above-described embodiment of the present disclosure. The remaining components of the exhaust gas processing apparatus in this embodiment may be similar or identical to those of the above-described embodiment of the present disclosure.

**[0099]** The gas-blocking structure according to the second embodiment of the present disclosure may include various modifications. In this connection, configurations and operations of the gas-blocking structure in accordance with modifications of the second embodiment of the present disclosure may be identical or similar to those of the gas-blocking structure according to the above-described modifications of the first embodiment of the present disclosure.

**[0100]** FIG. 8 is a schematic diagram showing exhaust-gas flow for a gas-suction array according to a comparison example. In this connection, the gas-suction array according to the comparison example does not have a gas-blocking structure, and, thus, a gap between the gas-suction array and the truck is, for example, more than 100 mm, as in the conventional approach.

**[0101]** Referring to FIG. 8, in the comparison example, the gas-blocking structure is absent, so that exhaust gas may flow back through the boundary between the gas discharging region and the gas circulation region. Further, the exhaust-gas passing through the raw-material layer may be concentrated on the gas circulation region, which is a high negative pressure region. Thus, when such flow-interference occurs, the exhaust-gas suction amount by the main blower communicating with the gas discharging region is reduced, and, thus, the process efficiency may be lowered.

**[0102]** For example, as for a conventional sintering machine, there is a sufficient clearance between the wind-box and the truck to allow the exhaust-gas to flow therethrough, as shown in FIG. 8. When the sintering exhaust-gas circulation approach is applied to the sintering machine with this configuration, and the firing area of the sintering machine is increased, exhaust-gas control cannot be achieved reliably with a single blower, and therefore, additional blowers must be installed. When a plurality of blowers are operated, the exhaust gas may flow backward through the above-defined gap, and the exhaust gas control efficiency may be lowered. In a sintering machine operating the plurality of blowers, there should be no exhaust-gas transfer between wind-boxes connected to different blowers, so that exhaust-gas control is performed effectively.

**[0103]** In the embodiments and modifications thereof of the present disclosure, a sintering machine using two or more blowers can efficiently control the exhaust gas using the gas-blocking structure. In order to illustrate the effect of the gas-blocking structure according to the embodiments of the present disclosure, the exhaust-gas flow in the gas-suction array for the comparison example and the embodiments of the present disclosure will be numerically analyzed and the results thereof will be set forth.

**[0104]** FIG. 9 is a graph illustrating numerical analysis of the exhaust-gas flow in the gas-suction array according to the embodiments of the present disclosure and the comparison example. (a) of FIG. 9 shows a numerical analysis result of the exhaust-gas flow inside the gas-suction array at the boundary between the gas discharging region and the gas circulation region, according to the comparison example. (b) of FIG. 9 shows a numerical analysis result of the exhaust-gas flow inside the gas-suction array at the boundary between the gas discharging region and the gas circulation region, according to one embodiment of the present disclosure. (c) of FIG. 9 shows a numerical analysis result of the exhaust-gas flow inside the gas-suction array at the boundary between the gas discharging region and the gas circulation region when using a gas-blocking structure including a gas-blocking body and one flap, according to the first modification of the present disclosure.

**[0105]** That is, (a) to (c) of FIG. 9 show results of flow analysis of the exhaust-gas flow based on whether the gas-blocking body is present or not and whether the flap is present or not. In this connection, a pressure difference between the main blower and the circulation blower is set to 200 mmAq, and the circulation blower has a higher negative pressure. In comparison between (a) and (b) of FIG. 9, as for the comparison example, it may be confirmed that the exhaust gas from the gas discharging region flow-backs forcedly into the gas circulation region, while as for the embodiment of the present disclosure, it may be seen that this exhaust-gas flow-back is considerably reduced.

**[0106]** In this connection, the exhaust gas back-flow to the gas circulation region is considerably reduced, but a portion of the exhaust-gas on the gas-blocking structure is still biased toward the gas circulation region. In this connection, this exhaust-gas flow bias may start from inside the truck. This is because the raw-material layer in the truck has voids through which exhaust-gas in the raw-material layer may be easily biased toward the gas circulation region.

**[0107]** Meanwhile, since the truck keeps running, the gas-blocking structure must be spaced by a certain distance from the bottom of the truck. From inside the raw-material layer, the biased exhaust-gas may flow along the top face of the gas-blocking structure into the gas circulation region. In the modification of the present disclosure, to inhibit or prevent the bias, the gas-blocking structure has the flap. The flap extends in the direction of travel of the truck. Using this flap structure, the exhaust-gas flow along and on the gas-blocking structure is not biased, but is substantially equally divided into the gas discharging and circulation regions.

**[0108]** In comparison between (b) and (c) of FIG. 9, it may be seen that the gas-blocking structure with the gas-blocking body and flap suppresses the exhaust-gas backflow more effectively than the gas-blocking structure with only the gas-blocking body. That is, the gas-blocking structure according to the modification of the present disclosure may further include the flap to more effectively suppress the back-flow of the exhaust gas. In this way, the inventors confirmed that the embodiment of the present disclosure and its modification effectively suppress the back-flow of the exhaust-gas. On the other hand, in order to see whether at least one of the gas-blocking body of the present embodiment of the present disclosure and the flap of the modification thereof inhibits the exhaust-gas flow-back, changes in exhaust-gas quantity at the gas-blocking body and flap were measured.

**[0109]** FIG. 10 shows photographs of results of a reduced modeling experiment on the exhaust-gas flow inside the gas-suction array, according to the comparison example, the embodiment of the present disclosure, and its modifications, (a) of FIG. 10 shows a photograph of a result of the reduced modeling experiment according to the comparison example. (b) of FIG. 10 shows a photograph of a result of the reduced modeling experiment according to the embodiment of the present disclosure. (c) of FIG. 10 shows a photograph of a result of the reduced modeling experiment for a gas-blocking structure with a gas-blocking body and a single flap, according to the first modification of the present disclosure.

**[0110]** In this experiment, when a cross-sectional area of an upper end of a wind-box is set to 1, the extension length of the flap is set to 2/3. For the reduced modeling experiment, a geometrically reduced model modelling an internal structure of each gas-suction array corresponding to each of the comparison example, the embodiment of the present disclosure and the modification thereof is prepared. Each experiment was conducted for each reduced model using sintering conditions of the sintering machine.

**[0111]** The results of the reduced modeling experiment are shown in FIG. 11. FIG. 11 shows a table indicating results of the reduced modeling experiment for exhaust-gas flow in the gas-suction array according to the comparison example, the embodiment of the present disclosure, and the modification thereof. In this connection, in FIG. 11, the comparative example corresponds to the result of the reduced modeling experiment in according to the comparative example of the present disclosure, the embodiment 1 corresponds to the result of the reduced modeling experiment according to the embodiment of the present disclosure, while the embodiment 2 corresponds to the result of the reduced modeling experiment for the blocking structure including the gas-blocking body and the single flap, in accordance with the first modification of the present disclosure.

**[0112]** Referring to these results, it may be seen that as for the embodiment 1 having the gas-blocking body, the exhaust-gas flow rate is maintained reliably, as compared to the comparative example. It may be seen that as for the embodiment 2 further including the flap, the exhaust gas flow rate to the gas circulation region increases by 12%, and a total flow rate increases by 11%, as compared to the comparative example. In other words, the gas-blocking structure including only the gas-blocking body can maintain the flow rate of the exhaust gas while suppressing flow-interference. The gas-blocking structure, which further includes the flap, can simultaneously suppress the flow-interference and increase the exhaust-gas flow rate.

**[0113]** The reason why the presence of the flap allows both the total exhaust-gas flow rate and the exhaust-gas flow rate to the gas circulation region to increase is as follows. As the flow-interference between the gas discharging region and the gas circulation region is effectively suppressed or prevented by the flap, exhaust gas may be sufficiently sucked from the raw material layer in the gas circulation region, which has relatively high ventilation resistance.

**[0114]** Specifically, the negative pressure in the gas circulation region is not interfered by the negative pressure in the gas discharging region. Thus, the negative pressure in the gas circulation region acts on all or most of the raw-material layer in the gas circulation region with the higher ventilation resistance. This allows the exhaust gas flow rate in the gas circulation region to increase and, at the same time, allows the exhaust gas to be sucked smoothly in the gas discharging region. This may increase the overall exhaust-gas flow rate.

**[0115]** Hereinafter, a method of processing the exhaust gas using the exhaust gas processing apparatus according to the embodiment of the present disclosure is described. The exhaust gas processing method may include: loading a raw-material into a truck and thermally-processing the raw-material in the truck while moving the truck along a plurality of regions; suctioning downwardly an interior of the truck using a gas-suction array; and suppressing gas flowing from a lower negative pressure region among an exhaust-gas circulation region and an exhaust-gas discharging region into a space between the gas-suction array and the truck.

**[0116]** In this connection, suppressing the exhaust-gas from flowing from the lower negative pressure region into the space may includes: using a gas-blocking structure disposed at a boundary between the exhaust-gas circulation region and exhaust-gas discharging region.

**[0117]** First, the raw material is supplied to the raw-material hopper. In this connection, the raw material is prepared by mixing and humidifying fine iron ore, limestone, fine coke, and anthracite, and granulating them into several millimeters. The prepared raw material is loaded into the raw-material hopper. In this connection, sintered ores having a predetermined particle size is selected as the upper-sintered ores, and the selected upper-sintered ores are loaded in the upper-sintered ore hopper.

**[0118]** Afterwards, the raw-material is loaded on the truck. The raw-material is thermally treated while moving the truck along the plurality of regions.

**[0119]** Specifically, this heat treatment process includes: running the truck in the array direction of a plurality of regions; loading the raw material into the truck using the raw-material hopper; igniting the raw material with the ignition furnace to create a raceway in the raw material inside the truck, and sintering the raw material while moving the raceway from the upper end to the lower portion in the truck's interior space.

**[0120]** More specifically, when the raw-material and upper-sintered ore are fed to the corresponding hoppers respectively, the truck travels along the convey path in the array direction of a plurality of regions. Then, in the loading region among the plurality of regions, the upper-sintered ore is put on the bottom of the truck, and then the raw-material is put on a top face of the upper-sintered ore, thereby to form a raw-material layer.

**[0121]** When the raw-material layer is formed, the raw-material layer is sequentially moved along the ignition and sintering regions. In the ignition region, the raw-material layer is ignited to form a raceway therein. Then, in the sintering region, the raw-material layer is thermally treated at a high temperature of about 1300° C to 1400° C while moving the raceway from the upper material layer to the lower material layer in the raw-material layer, thereby to form a sintered ore.

**[0122]** At the same time as the above heat treatment process, the gas-suction array is used to suck the gas inside the truck and to circulate some of the exhaust gas through the truck and to exhaust the remaining gas. The gas-suction array is disposed below the bottom of the truck and extends along the direction of the trucks. The gas-suction array is divided into the gas circulation region and the gas discharging region. The gas-suction array may be the gas-suction array as described above in the exhaust gas processing apparatus according to the embodiments of the present disclosure. Via this gas suction, the raceway may move from the upper end to the lower portion in the raw-material layer, so that the raw-material is entirely sintered.

**[0123]** Together with suctioning the interior of the truck, the back-flow suppressing operation may occur. The back-flow suppressing operation may include suppressing gas flowing from a lower negative pressure region among the exhaust-gas circulation region and an exhaust-gas discharging region, through the spacing between the gas-suction array and the truck, to a higher negative pressure region among the exhaust-gas circulation region and an exhaust-gas discharging region. In this connection, suppressing the gas from flowing from the lower negative pressure region to the higher negative pressure region may include using the above-define gas-blocking structure disposed at the boundary between the exhaust-gas circulation region and exhaust-gas discharging region.

**[0124]** As described above, in the operation of suppressing the back-flow of the exhaust gas by using the gas-blocking structure, at least one rib protruding upward from the flap of the gas-blocking structure may be used to more effectively suppress the flow of the exhaust gas flowing on an upper surface of the flap.

**[0125]** On the other hand, the use of the gas-blocking structure according to the embodiment, and the use of flap and rib according to the modification thereof, to suppress or prevent the back-flow of the exhaust gas has been described above several times. Therefore, in order to avoid duplication of the description, the description thereof will be omitted.

**[0126]** The finished sintered ores are discharged to the crushing unit at the end of the convey path. The discharged sintered ores are crushed to a predetermined particle size by the crushing unit. The crushed ores are screened by a screener. Depending on the particle size, the screened ores may be fed to a blast furnace process, which is a subsequent process, or alternatively, may be used as the upper-sintered ore, or alternatively, may be considered as returned ores for reuse as the raw-material.

**[0127]** In accordance with the embodiments of the present disclosure, it is possible to decrease the spacing between the gas-suction array and the truck at the boundary using the gas-blocking structure disposed at the boundary between the exhaust-gas circulation region and exhaust-gas discharging region. Thus, during producing the sintered ore and circulating the exhaust gas, it is possible to suppress or prevent the gas flowing backward due to the negative pressure difference between the discharge region and the circulation region at the boundary between the discharge region and the circulation region. Thus, the flow rate of the exhaust gas may be stably secured during the operation.

**[0128]** In accordance with the modifications of the present disclosure, the gas-blocking structure has a flap or a combination of the flap and ribs, such that the total flow rate of the exhaust gas and the flow rate of the exhaust gas to be circulated may both be increased, whereby the efficiency of the operation can be further improved, and high-quality sintered ores can be obtained.

**[0129]** The above embodiments of the present disclosure is merely for the illustration of the present disclosure and is not for the limitation of the present disclosure. The features presented in the above embodiments of the present disclosure may be combined with or substituted with one another to form various modifications. It should be noted that these modifications may be regarded as falling into the scope of the present disclosure. The present disclosure will be embodied in various forms within the scope of the claims and their equivalents. Those skilled in the art will appreciate that various embodiments are possible within the scope or spirit of the present disclosure.

## Claims

**1.** An exhaust gas processing apparatus including:

a gas-suction array extending in a traveling direction of a truck and disposed below the truck which is disposed to move along a plurality of regions while processing a raw-material, wherein the gas-suction array has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other; and
a gas-blocking structure disposed at a boundary between the exhaust-gas circulation region and exhaust-gas discharging region so as to seal the spacing between the gas-suction array and the truck at the boundary.

**2.** The exhaust gas processing apparatus of claim 1, wherein the gas-suction array includes a plurality of wind-boxes arranged along the traveling direction of the truck,
wherein the plurality of wind-boxes have respectively upper ends arranged side by side along the extension of the gas-suction array, wherein the upper ends are coupled to each other,
the gas-blocking structure is disposed on adjacent upper ends of some of the plurality of wind-boxes adjacent to the boundary between the exhaust-gas circulation region and the exhaust-gas discharging region, while the adjacent wind-boxes define the boundary therebetween.

**3.** The exhaust gas processing apparatus of claim 1, wherein a spacing between a top face of the gas-blocking structure and a bottom face of the truck at the boundary is greater than 0 and less than or equal to 100 mm within a tolerance range.

**4.** An exhaust gas processing apparatus including:

a plurality of wind-boxes arranged along a traveling direction of a truck and disposed below the truck, wherein the truck is disposed to move along a plurality of regions while processing a raw-material, wherein the plurality of wind-boxes has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other,
wherein upper ends of some of the plurality of wind-boxes protrude more upwardly than upper ends of the remainder of the plurality of wind-boxes, wherein some of the plurality of wind-boxes are adjacent to a boundary between the exhaust-gas circulation region and exhaust-gas

discharging region.

5. The exhaust gas processing apparatus of claim 4, wherein some of the plurality of wind-boxes include first and second wind-boxes, and the first and second wind-boxes define the boundary therebetween, and are disposed in the exhaust-gas circulation region and exhaust-gas discharging region respectively, wherein a spacing between the upper ends of the first and second wind-boxes and a bottom face of the truck may be greater than 0 and less than or equal to 100 mm.

6. The exhaust gas processing apparatus of claim 5, wherein the exhaust gas processing apparatus further includes a gas-blocking structure disposed at and between the upper ends of the first wind-box and the second wind-box so as to seal a gap between the truck and some of the wind-boxes at the boundary.

7. The exhaust gas processing apparatus of one of claims 1 to 3, and 6, wherein the gas-blocking structure includes a gas-blocking body extending in a direction crossing the traveling direction of the truck; and a flap extending from the gas-blocking body in the traveling direction of the truck.

8. The exhaust gas processing apparatus of claim 7, wherein the flap extends from at least one of an upper end and a lower portion of the gas-blocking body or from a portion between the upper end and the lower portion of the gas-blocking body.

9. The exhaust gas processing apparatus of claim 7, wherein the flap is disposed in at least one of the exhaust-gas circulation region and exhaust-gas discharging region.

10. The exhaust gas processing apparatus of claim 7, wherein the flap is disposed in a lower negative pressure region among the exhaust-gas circulation region and the exhaust-gas discharging region.

11. The exhaust gas processing apparatus of claim 7, wherein when a cross-sectional area of an upper end of a wind-box facing the flap is set to 1, an extension length of the flap is greater than 0 and less than or equal to 2/3.

12. The exhaust gas processing apparatus of claim 7, wherein the gas-blocking structure further includes at least one rib formed to protrude upwards from a top face of the flap.

13. The exhaust gas processing apparatus of claim 12, wherein the rib extends in the traveling direction of the truck; or the rib may extend in a direction crossing the traveling direction of the truck.

14. The exhaust gas processing apparatus of claim 13, wherein the gas-blocking structure includes a plurality of ribs, wherein some of the plurality of ribs extends in the traveling direction of the truck, while the remainder thereof extends in a direction crossing the traveling direction of the truck.

15. The exhaust gas processing apparatus of claim 7, wherein the gas-blocking structure further includes a tip portion projecting downwardly in a tilted manner from a distal end of the flap in a direction from the gas-blocking body of the gas-blocking structure to an end of the flap.

16. The exhaust gas processing apparatus of claim 15, wherein when a cross-sectional area of an upper end of a wind-box facing the flap is set to 1, a sum of extension lengths of the flap and the tip portion in the traveling direction of the truck is greater than 0 and less than or equal to 2/3.

17. An exhaust gas processing method including:

loading a raw-material into a truck and thermally-processing the raw-material in the truck while moving the truck along a plurality of regions;
suctioning downwardly an interior of the truck using a gas-suction array, wherein the gas-suction array extends in a traveling direction of the truck and disposed below the truck, wherein the gas-suction array has an exhaust-gas circulation region and an exhaust-gas discharging region which are separated from each other; and
suppressing exhaust-gas flowing from a lower negative pressure region among the exhaust-gas circulation region and exhaust-gas discharging region into a space between the gas-suction array and the truck.

18. The method of claim 17, wherein suppressing the exhaust-gas from flowing from the lower negative pressure region into the space includes using a gas-blocking structure disposed at a boundary between the exhaust-gas circulation region and exhaust-gas discharging region.

FIG. 1

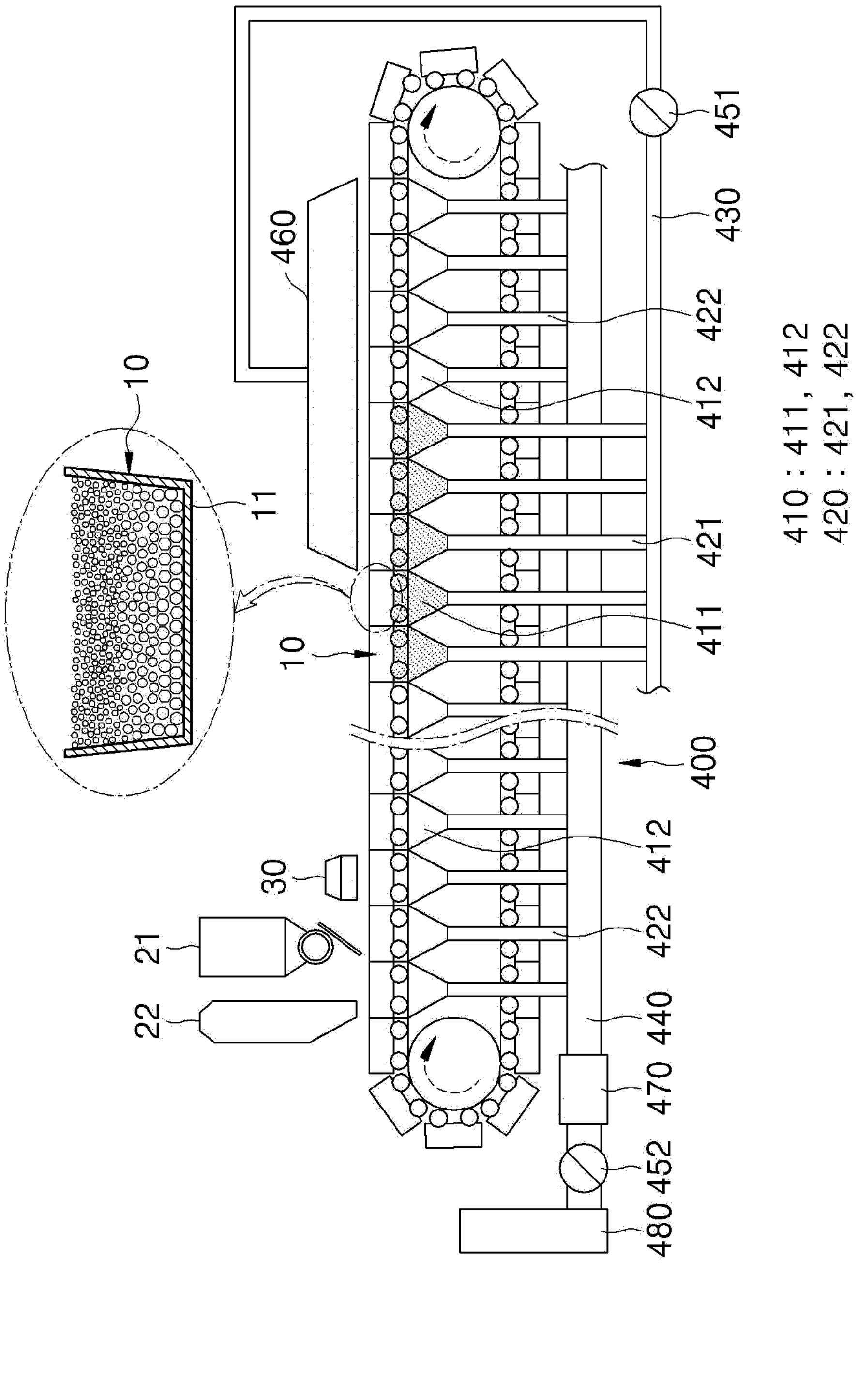

10
11
460
451
430
422
412
421
411
10
400
412
30
21
22
422
440
470
452
480
410 : 411, 412
420 : 421, 422

FIG. 2

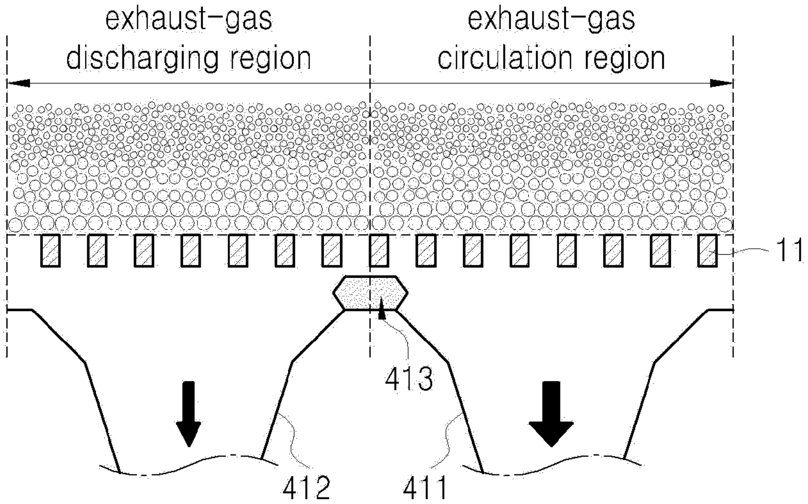
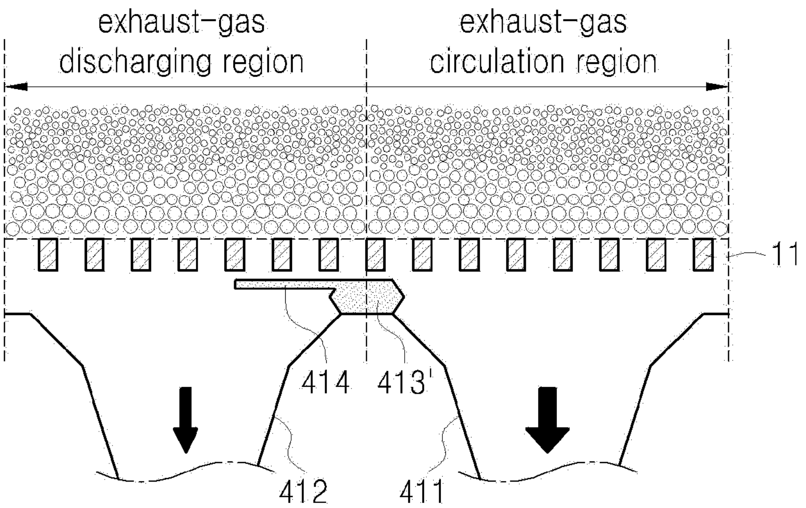



FIG. 3




413A : 413', 414

FIG. 4

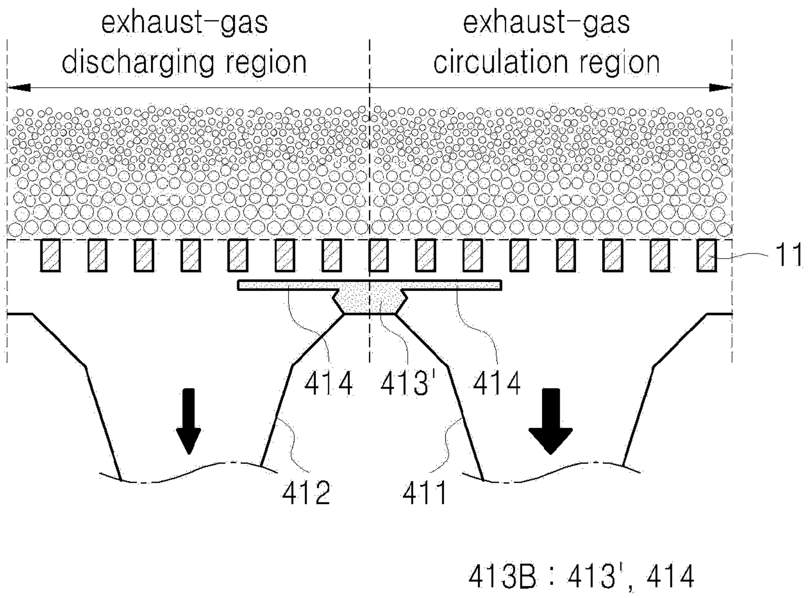

exhaust-gas
discharging region
exhaust-gas
circulation region
11
414
413'
414
412
411
413B : 413', 414

FIG. 5

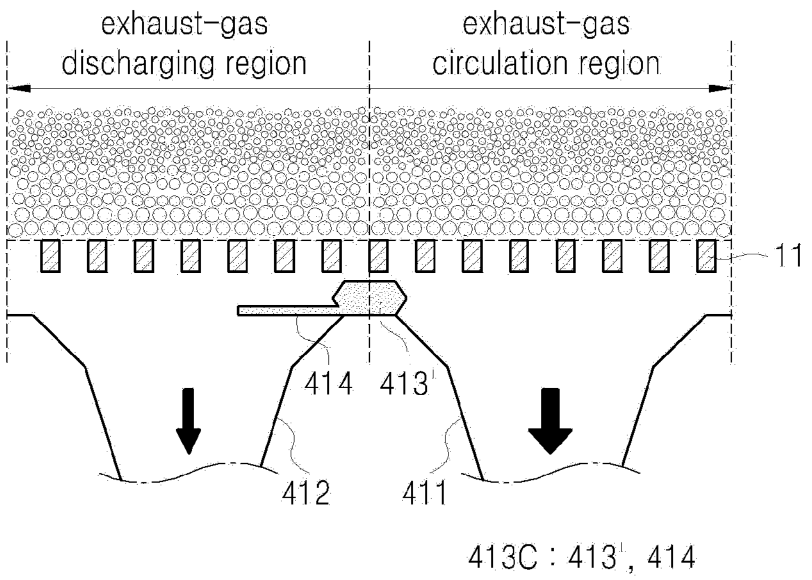

exhaust-gas
discharging region
exhaust-gas
circulation region
11
414
413'
412
411
413C : 413', 414

FIG. 6

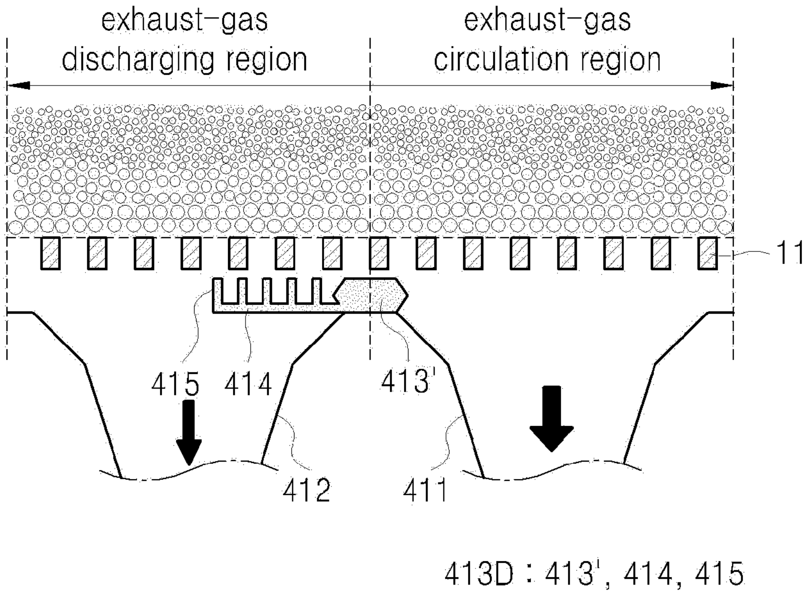

exhaust-gas
discharging region
exhaust-gas
circulation region
11
415
414
413'
412
411
413D : 413', 414, 415

FIG. 7

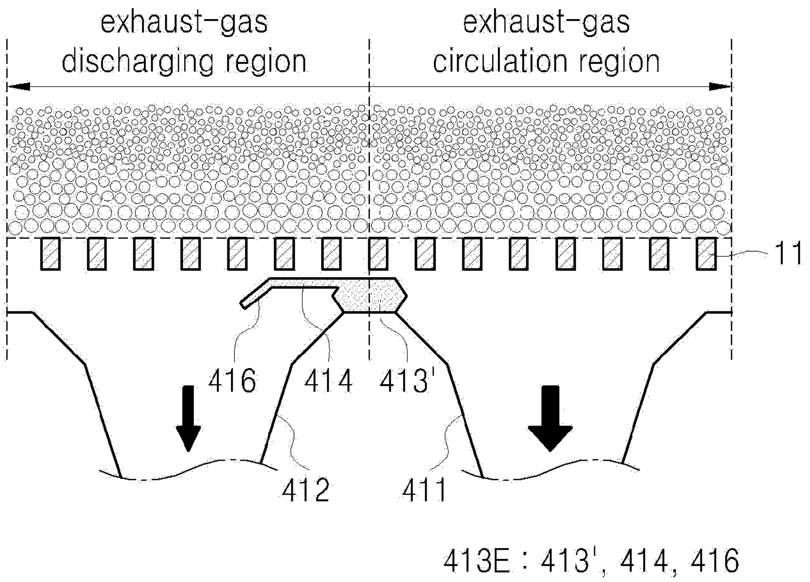

exhaust-gas
discharging region
exhaust-gas
circulation region
11
416
414
413'
412
411
413E : 413', 414, 416

FIG. 8

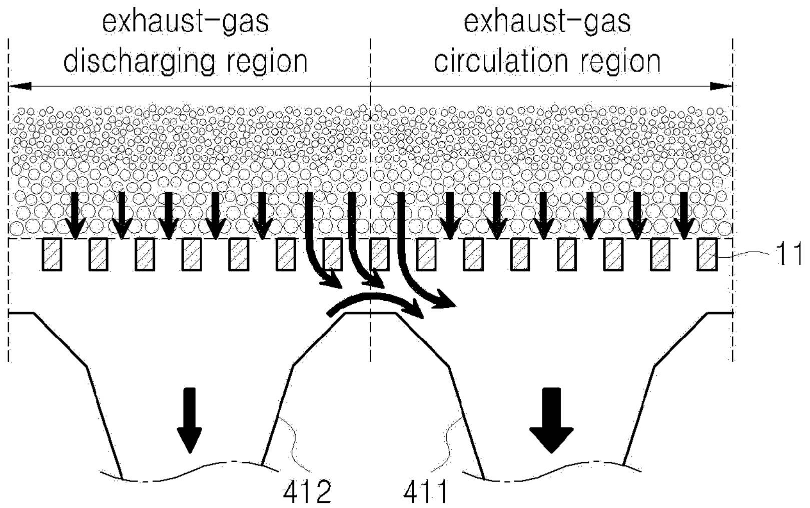

exhaust-gas
discharging region
exhaust-gas
circulation region
11
412
411

FIG. 9

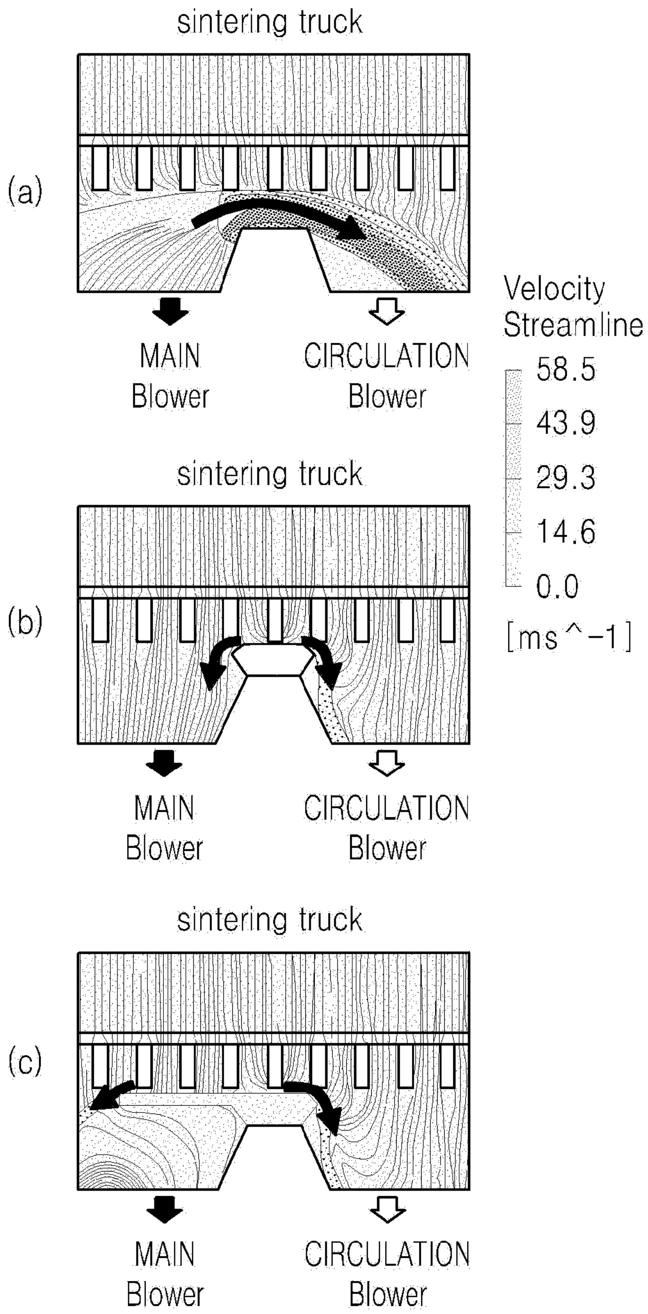

sintering truck
(a)
MAIN
Blower
CIRCULATION
Blower
Velocity
Streamline
58.5
43.9
29.3
14.6
0.0
[ms^-1]
sintering truck
(b)
MAIN
Blower
CIRCULATION
Blower
sintering truck
(c)
MAIN
Blower
CIRCULATION
Blower

FIG. 10

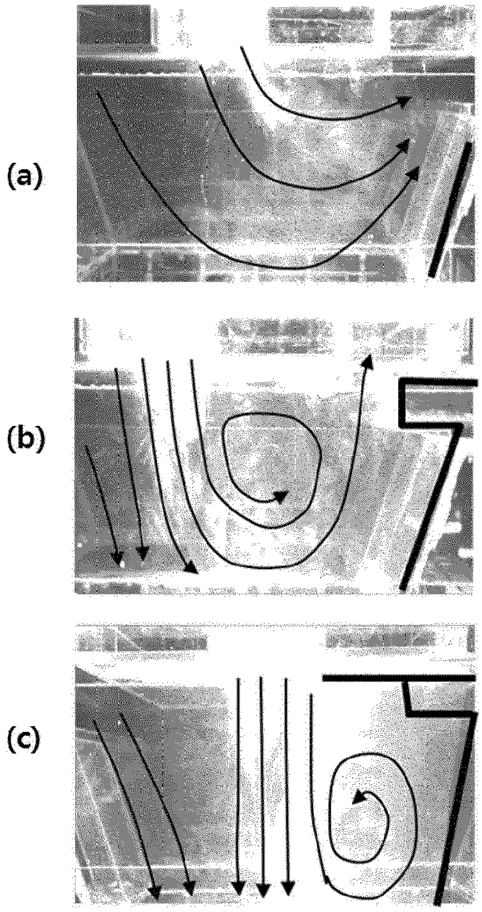
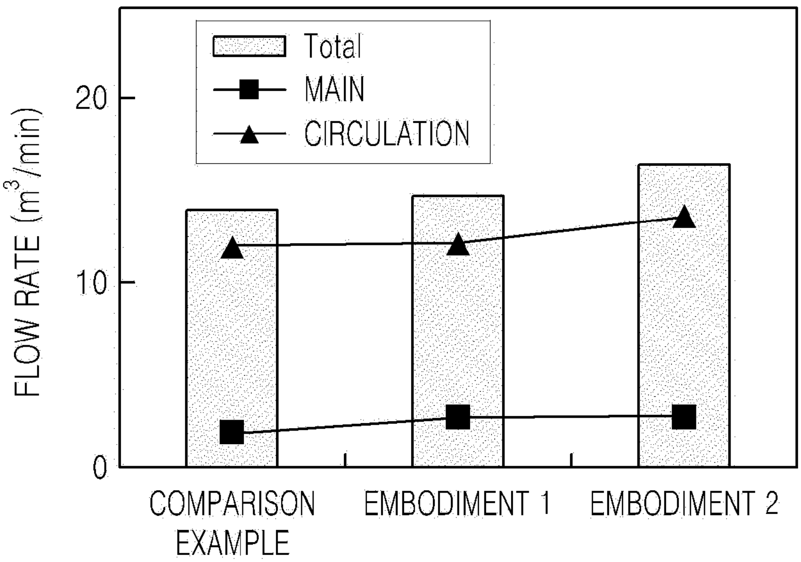

(a)
(b)
(c)

FIG. 11


Total
MAIN
CIRCULATION
FLOW RATE (m3/min)
20
10
0
COMPARISON EXAMPLE
EMBODIMENT 1
EMBODIMENT 2

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2017/011350

A. CLASSIFICATION OF SUBJECT MATTER

*F27D 17/00(2006.01)i, C22B 1/20(2006.01)i, F27B 21/06(2006.01)i, F27B 21/02(2006.01)i, F27D 7/06(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)
F27D 17/00; F27B 21/08; C22B 1/20; F27B 21/00; C22B 1/16; F27B 21/06; F27B 21/02; F27D 7/06

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: base material, bogie, suction part, blocking part, circulation zone, exhaust zone, flue gas processing device

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | KR 10-2016-0062288 A (POSCO) 02 June 2016<br>See paragraphs [0033], [0038]-[0039], [0081] and figure 3. | 1-11,15-18 |
| A | | 12-14 |
| Y | JP 07-012879 Y2 (HITACHI ZOSEN CORP.) 29 March 1995<br>See column 4, line 4-column 5, line 5 and figures 1-3. | 1-11,15-18 |
| A | JP 2000-065483 A (KAWASAKI STEEL CORP.) 03 March 2000<br>See paragraph [0016] and figures 1-2. | 1-18 |
| A | KR 10-1611365 B1 (POSCO) 14 April 2016<br>See paragraphs [0023]-[0031] and figures 2-3. | 1-18 |
| A | JP 06-063704 B2 (HITACHI ZOSEN CORP.) 22 August 1994<br>See column 4, line 39-column 6, line 1 and figures 1-4. | 1-18 |

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

* Special categories of cited documents:
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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 |
|---|---|
| 17 JANUARY 2018 (17.01.2018) | **18 JANUARY 2018 (18.01.2018)** |

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Facsimile No. +82-42-481-8578

Authorized officer

Telephone No.

**INTERNATIONAL SEARCH REPORT**
Information on patent family members

International application No.
**PCT/KR2017/011350**

| Patent document cited in search report | Publication date | Patent family member | Publication date |
|---|---|---|---|
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| | | TW 201621248 A | 16/06/2016 |
| | | WO 2016-080650 A1 | 26/05/2016 |
| JP 07-012879 Y2 | 29/03/1995 | JP 01-167598 U | 24/11/1989 |
| JP 2000-065483 A | 03/03/2000 | NONE | |
| KR 10-1611365 B1 | 14/04/2016 | KR 10-2016-0022468 A | 02/03/2016 |
| JP 06-063704 B2 | 22/08/1994 | JP 01-131889 A | 24/05/1989 |

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

## REFERENCES CITED IN THE DESCRIPTION

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- KR 1020160079240 A **[0013]**


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- **D. SCHLEBUSCH ; F. CAPPEL.** Optimization of pollution control in sinter plant. *6-th International symposium on agglomeration,* 1993, 403-408 **[0014]**