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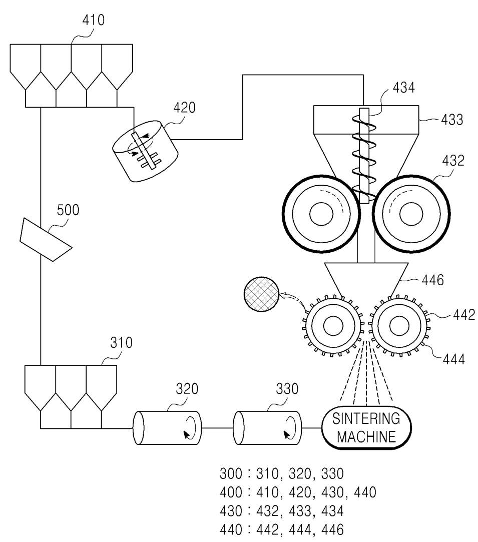
(54) **GRANULATED PRODUCT MANUFACTURING APPARATUS, SINTERED ORE MANUFACTURING APPARATUS COMPRISING SAME, AND SINTERED ORE MANUFACTURING METHOD**

(57) The present disclosure relates to a sintered ore producing apparatus for producing sintered ores, the apparatus comprising: a first preprocessing part configured to produce a first raw material mixture by mixing first iron ores, additives, and fuels and capable of producing first granules by combining the first raw material mixture; and a second preprocessing part configured to produce molded bodies by compressing and forming a second raw material mixture containing second iron ores, powder raw materials, and fuels, and capable of pulverizing the molded bodies to produce into second granules, wherein the air permeability inside the raw material can be ensured and thus the productivity and quality of the sintering may be improved.

Fig.2



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Description

TECHNICAL FIELD

[0001] The present disclosure herein relates to a granule producing apparatus and a sintered ore producing apparatus and a sintered ore producing method provided with the same, and more particularly, to a granule producing apparatus, and a sintered ore producing apparatus and a sintered ore producing method which are provided with the same and capable of improving the quality and productivity of sintered ores.

BACKGROUND ART

[0002] In a sintered ore producing process, in which fine iron powder ores are sintered to be produced in sizes suitable to be used in a blast furnace, a Dwight-Lyoid (hereinafter referred to as "DL")-type sintering process capable of mass production is mainly used. In such a DL-type sintering process, iron powder ores, additives, fuels (powder coke and hard coal), and the like are charged in a drum mixer, and blending and watering (raw material weight ratio of approximately 7-8%) are performed, so that a sintering raw material mixture is changed into pseudo particles and is charged into a sintering trailer at a certain height. In addition, after igniting a surface by using an ignition furnace, firing of the sintering raw material mixture is performed while forcibly suctioning air from below, so that sintered ores are produced. The sintered ores that have been completely sintered are cooled in a cooler via a crusher of a discharge unit, are screened into particle sizes of 5-50mm which are easily charged and reacted in a blast furnace, and are transported to the blast furnace.

[0003] Meanwhile, in producing sintered ores, as high-grade iron ores having high iron contents and relatively large particle sizes are reduced, the use amount of low-grade iron ores having a high fine powder ratio of at most 0.15 mm has been gradually increasing. However, in the DL-type sintering process, in order to improve the productivity and produce superior quality sintered ores by efficiently performing a sintering reaction, it is important to ensure air permeability so that a suitable amount of air flows inside the raw material layer. Thus, it is necessary to minimize the fine powder ratio in sintering materials, and when using iron ores, such as fine powder ores produced via a separation process of iron ores, having a very high fine powder ratio, iron ores should be produced in granules through a separate preprocessing to be used as a sintering raw material.

[0004] In addition, in a sintering process, the strengths of the granules aside from particle size distribution of the granules substantially affect the air permeability of a sintered layer. Thus, a method is being demanded with which the granules can be produced so as to have strengths that can endure mechanical and thermal shocks and the like experienced during a firing process.

DISCLOSURE OF THE INVENTION

TECHNICAL PROBLEM

[0005] The present disclosure herein provides a granule producing apparatus, which is capable of ensuring the strengths of granules and the air permeability inside a raw material layer, and a sintered ore producing apparatus and a sintered ore producing method which are provided with the same.

TECHNICAL SOLUTION

[0006] In accordance with an exemplary embodiment, a granule producing apparatus includes: a molding machine including a pair of first rolls provided to be spaced apart from each other so as to form a space for injecting a raw material and producing plate-shaped molded bodies; and a pulverizer including a pair of second rolls provided to be spaced apart from each other so as to form a space for introducing the molded bodies.

[0007] The molding machine may include an injector configured to pressurize and inject the raw material between the pair of first rolls.

[0008] Protrusions may be formed on outer circumferential surfaces of the second rolls.

[0009] A spacing between the second rolls may be smaller than a spacing between the first rolls.

[0010] The pulverizer may be provided directly under the molding machine, and the pair of first rolls and the pair of second rolls may be arranged side by side so that the molded bodies produced by the molding machine are inserted between the pair of second rolls.

[0011] In accordance with another exemplary embodiment, a sintered ore producing apparatus includes: a first preprocessing part configured to produce a first raw material mixture by mixing first iron ores, additives, and fuels and capable of producing first granules by combining the first raw material mixture; and a second preprocessing part configured to produce molded bodies by compressing and forming a second raw material mixture containing second iron ores, additives, and fuels, and capable of pulverizing the molded bodies to produce into second granules.

[0012] The sintered ore producing apparatus may include a sorter capable of sorting the first iron ores by particles sizes.

[0013] The second preprocessing part may include a first mixer configured to produce a second raw material mixture by mixing the second iron ores, additives, and fuels.

[0014] The second preprocessing part may include: a molding machine comprising a pair of first rolls provided to be spaced apart from each other so as to form a space for injecting the second raw material mixture; and a pulverizer including a pair of second rolls provided under the molding machine so as to be spaced apart from each other.

[0015] The molding machine may include an injector configured to pressurize and inject the second raw material mixture between the pair of first rolls.

[0016] Protrusions may be formed on outer circumferential surfaces of the second rolls.

[0017] A spacing between the second rolls may be smaller than a spacing between the first rolls.

[0018] The sintered ore producing apparatus may include a second mixer configured to mix the first granules and the second granules.

[0019] In accordance with still another exemplary embodiment, a sintered ore producing method may include: producing first granules by combining a first raw material mixture containing first iron ores, additives, and fuels; producing second granules by forming and pulverizing a second raw material mixture containing second iron ores, additives, and fuels; and charging the first granules and the second granules into a sintering trailer.

[0020] The sintered ore producing method may include sorting the first iron ores by particle sizes, and allowing the iron ores having particle sizes of at most approximately 3 mm to be contained in the second raw material mixture during the sorting of the first iron ores by particle sizes.

[0021] The sintered ore producing method may include injecting binders during the producing of the second raw material mixture.

[0022] The producing of the second granules may include: producing plate-shaped molded bodies by compressing and forming the second raw material mixture; and producing the second granules having particle shapes by pulverizing the plate-shaped molded bodies.

[0023] The sizes of the second granules may be adjusted while pulverizing the molded bodies.

[0024] The sintered ore producing method may include mixing the first granules and the second granules before the charging into the sintering trailer.

ADVANTAGEOUS EFFECTS

[0025] According to exemplary embodiments, molded bodies are produced by compressing and forming a raw material mixture containing powder iron ores, and the molded bodies are pulverized to produce particle-shaped granular products, and thus, the productivity of the granules may be improved, and the physical characteristic suitable to produce sintered ores may be ensured. In addition, when producing sintered ores using the granules produced as such, the air permeability inside a raw material layer may be ensured, and the productivity and quality of sintering may be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

FIG. 1 is a schematic view illustrating a configuration of a sintering ore producing apparatus in accordance with an exemplary embodiment.

FIG. 2 is a schematic view illustrating a configuration of a granule producing apparatus in accordance with an exemplary embodiment.

FIG. 3 is a flow chart sequentially illustrating a sintered ore producing method in accordance with an exemplary embodiment.

FIG. 4 is a conceptual view illustrating a method for producing granules using a granule producing apparatus in accordance with an exemplary embodiment.

FIG. 5 is a graph comparing and showing productivity according to the types of granules.

FIG. 6 is a graph showing the distribution of particle sizes of granules according to a spacing between rolls of a pulverizer.

FIG. 7 is a graph comparing and showing compressive strengths according to the types of granules.

FIG. 8 is a graph comparing and showing compressive strengths according to the types of granules.

FIG. 9 is a graph comparing and showing moisture resistant strengths according to the types of granules.

FIG. 10 is a graph comparing and showing flow speed of air passing through a raw material layer according to the types of granules.

MODE FOR CARRYING OUT THE INVENTION

[0027] Hereinafter, exemplary embodiments will be described in detail. The present disclosure may, however, be embodied in 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 present disclosure to those skilled in the art.

[0028] FIG. 1 is a schematic view illustrating a configuration of a sintering ore producing apparatus in accordance with an exemplary embodiment, and FIG. 2 is a schematic view illustrating a configuration of a granule producing apparatus in accordance with an exemplary embodiment.

[0029] Referring to FIG.1, a sintered ore producing apparatus in accordance with an exemplary embodiment may include: a plurality of sintering trailers 200 movably provided by being arranged in one direction, and provided therein with a space in which a raw material mixture can be heat-treated; a moving path 120 which forms a closed loop so that the sintering trailers 200 rotates in a caterpillar-like manner; and an ignition furnace 130 configured to inject a flame to the raw material mixture charged in the sintering trailers 200. In addition, the sintering ore producing apparatus may include: a first preprocessing part 300 configured to produce first granules using a first raw material mixture containing first iron ores; a second preprocessing part 400 configured to produce second granules using a second raw material mixture containing second iron cores; and a raw material supply part 110 configured to charge the first granules and the second granules into the sintering trailers 200.

[0030] The moving path 120 forms the closed loop so that the sintering trailers 200 rotates in a caterpillar-like manner, and may include an upper movement path in which charging and sintering of the raw material are performed, and a lower movement path in which a sintering trailer 200 that has completely discharged completely-sintered sintered ores moves to the upper movement path for a sintering process. The upper movement path may be provided with a raw material supply section in which the raw material is charged to the sintering trailers 200, an ignition section and a sintering section, and the lower movement path may be a trailer returning section in which the sintering trailers 200 move for the next sintering process. Here, the section transiting from the upper movement path to the lower movement path may be an ore discharge part 126 configured to discharge completely-sintered sintered ores. There may be provided on one side of the ore discharge part 126, a crusher 140 configured to crush sintered ores discharged from the sintering trailers 200 and a cooling apparatus 150 configured to cool the crushed sintered ores. The raw material supply part 110 may be provided on one side of the upper movement path, and the ignition furnace 130 may be provided downstream of the raw material supply part 110 with respect to the movement direction of the sintering trailers 200. In addition, a plurality of wind boxes 121 may be provided under the upper movement path so as to suction the insides of the sintering trailers from the lower portion of the ignition section to the sintering section. The wind boxes 121 may form a negative pressure to suction the insides of the sintering trailers 200, and thus may form a downward flow of air from an upper portion to a lower portion of the raw material layer inside the sintering trailers 200 and sinter the raw material.

[0031] A duct 122 is connected to the end of the wind boxes 121, and a blower 124 is installed on the end of the duct 122, forms a negative pressure inside the wind boxes 121, and allows the insides of the sintering trailers 200 to be suctioned. In addition, a dust collector 123 is installed upstream of the blower 124 and may filter foreign substances in exhaust gas suctioned through the wind boxes 121 and discharge the exhaust bas through a smokestack 125. The wind box 121 allows the surface layer of the sintered raw material layer to be ignited and allows the sintering raw material to be burnt by suctioning external air, thereby allowing sintered ores to be produced.

[0032] The first preprocessing part 300 and the second preprocessing part 400 may function to granulate the sintered ores in sizes suitable to manufacture the sintered ores according to the particle sizes of iron ores among the raw materials for producing the sintered ores. At this point, the first preprocessing part 300 may produce the first granules, for example, pellets, by combining a first raw material mixture containing first iron ores of approximately 10 cm or less, and the second preprocessing part 300 may produce the second granules by compressing, forming and then crushing a second raw material mixture containing second iron ores of approximately 100 μm or less. The first preprocessing part 300 may include: a plurality of first hoppers 310 configured to store the first iron ores, additives, and fuel materials; a first mixer 320 configured to produce the first raw material mixture by mixing the first iron ores, additives, and the fuel materials; and a granulator 330 configured to produce the first granules by combining the first raw material mixture. The first preprocessing part 300 may be almost similar to an existing apparatus that produces granules while mixing and stirring the raw material mixture. That is, the first preprocessing part 300 may produce the first raw material mixture by uniformly mixing, in the first mixer 320, the first iron ore having a particle size of approximately 10 cm or less, additives such as lime stone, and fuel materials such as coke, and may produce the first granules such as pellets by combining, with each other, the first iron ores, additives, and fuel materials by stirring while adding moisture to the first raw material mixture in the granulator 330.

[0033] In addition, the second preprocessing part 400 may include: a plurality of second hoppers 410 configured to store the second iron ores, additives, fuel materials, and binders; a second mixer 420 configured to produce the second raw material mixture by mixing the second iron ores, additives, and the fuel materials; and a granulating apparatus configured to produce the second granules by combining the second raw material mixture.

[0034] Referring to FIG. 2, the granulating apparatus may include: a molding machine 430 configured to compress and form the second raw material mixture and produce plate-shaped molded bodies; and a pulverizer 440 configured to produce the second granules having particle shapes by pulverizing the plate-shaped molded bodies produced by the molding machine 430.

[0035] The molding machine 430 may include a dual roll-type compressor including a pair of first rolls 432. At this point, the pair of first rolls 432 may be provided side by side to be spaced apart from each other so as to form a space into which the second raw material mixture is injected therebetween. In addition, the molding machine 430 may include a container 433 configured to store the second raw material mixture; and an injector 434 provided inside the container 433 and configured to inject the second raw material mixture between the first rolls 432. The injector 434 may pressurize and inject the second raw material mixture between the first rolls 432 so as to produce high-density molded bodies in the molding machine 430. For example, the injector 434 may include a screw feeder capable of pressurizing and injecting the second raw material mixture between the first rolls 432 above the molding machine 430. The pulverizer 440 may include a pair of second rolls 442 which are provided side by side to be spaced apart from each other so as to form a space into which the molded bodies are inserted.

[0036] The pulverizer 440 may be provided directly below the molding machine 430 so as to pulverize in real time the molded bodies produced in the molding machine 430. In this case, the second rolls 442 of the pulverizer 440 may be installed side by side with the first rolls 432 so that the molded bodies produced through the first rolls 432 of the molding machine 430 are inserted therebetween. A guide plate 446 configured to prevent deviation of the molded bodies may be provided above the second rolls 442. At this point, since the molded bodies cannot be pulverized when the spacing D2 between the second rolls 442 is wider than or equal to the spacing D1 between the first rolls 432, the spacing between the second rolls 442 is favorably set to be smaller than the spacing between the first rolls 432. The molded bodies produced by the molding machine 430 have the thicknesses which may be reduced while being inserted in a non-cured state between the second rolls 442 that constitutes the pulverizer 440. The second granules produced as such are pressurized two times and may thereby have a greater strength than the molded bodies. Using such a principle, a compressor (not shown) for pressing the molded bodies produced in the molding machine 430 may be further provided between the molding machine 430 and the pulverizer 440. In this case, the compressor may be provided with a pair of rolls disposed to be spaced apart from each other as in the molding machine 430, and the inter-roll spacing at this point may be smaller than the spacing between the first rolls 432 and greater than the spacing of the second rolls 442.

[0037] In addition, the second rolls 442 may be provided with protrusions 444 on the outer circumferential surfaces thereof so as to easily pulverize the molded bodies. The protrusions 444 may be provided on the outer circumferential surfaces of the second rolls 442 so as to have a certain spacing D3, and the spacing between the protrusions may affect the sizing of the second granules produced by pulverizing the molded bodies. The protrusions 444 may be formed in various shapes, for example, in a lattice shape so as to produce the second granules having particle shapes each having a length, a width and a thickness by pulverizing the molded bodies. The sizes of the second granules may be adjusted by the spacing between the second rolls 442 and the sizes of the protrusions 444 formed on the outer circumferential surfaces of the second rolls 442.

[0038] Meanwhile, the sintered ore producing apparatus in accordance with an exemplary embodiment may further include a sorter 500. The sorter 500 may sort, from the first iron ores, iron ores having specific particle sizes, such as particle sizes of at most approximately 1 mm or 3mm. The iron ores sorted by the sorter 500 may be provided to the second preprocessing part 400 and be used together with the second iron ores to produce the second granules.

[0039] In addition, the raw material supply part 110 may include a surge hopper 114 configured to store the first granules produced in the first preprocessing part 300 and the second granules produced in the second preprocessing part 400; an upper ore hopper 112 configured to store upper ores; and a charging apparatus 116 configured to charge the raw material mixture and the upper ores into the sintering trailers 200. At this point, the first granules and the second granules are mixed in a separate mixer (not shown) and are then stored into the surge hopper 114.

[0040] Hereinafter, a sintered ore producing method in accordance with an exemplary embodiment will be described.

[0041] FIG. 3 is a flow chart sequentially illustrating a sintered ore producing method in accordance with an exemplary embodiment, and FIG. 4 is a conceptual view illustrating a method for producing a granule using a granule producing apparatus in accordance with an exemplary embodiment.

[0042] Referring to FIG. 3, a sintered ore producing method in accordance with an exemplary embodiment may include: a step for preparing first iron ores (S110); a step for producing a first raw material mixture by mixing the first iron ores, additives, and fuel materials (S114); a step for producing first granules by combining the raw material mixture (S116); a step for preparing second iron ores (S120); a step for preparing a second raw material mixture by mixing the second iron ores, additives, fuel materials, and a binder (S122); a step for producing plate-shaped molded bodies by compressing and forming the second raw material mixture (S124); a step for producing second granules having particle shapes by pulverizing the molded bodies (S126); and a step for sintering by charging the first granules and the second granules into a sintering trailer (S140). At this point, a step S112 for sorting the first iron ores by particle sizes of specific sizes, for example, at most approximately 3 mm from the first iron ores may be provided after the step for preparing the first iron ores. Here, the first iron ores having sizes of at most approximately 3 mm may also be used to produce the second granules.

[0043] First, the first iron ores may be powder iron ores having at most approximately 10 cm. The first iron ores may be used to produce the first granules, and if necessary, may also be transferred to a second preprocessing part 400 for producing the second granules by sorting the particle sizes of the iron ores having sizes of at most approximately 1 mm or 3 mm from the first iron ores. When being prepared, the first iron ores are charged into a first mixer 320 together with additives, such as limestone, and fuel materials, and are uniformly mixed to produce a first raw material mixture. When being produced, the first raw material mixture is charged into a granulator 330, is stirred while adding moisture to produce the first granules such as pellets by combining the first iron ores, additives and fuel materials with each other.

[0044] The second iron ores may be powder iron ores having at most approximately 100 μm. The second iron ores may be used to produce the second granules, and may be produced into the second granules by being mixed with iron ores having particle sizes of at most approximately 1 mm or 3 mm which are sorted by particle sizes from the second iron ores only or from the second iron ores and the first iron ores. When prepared, the second iron ores are charged into a second mixer 420 together with additives such as limestone, fuel materials such as coke, and binders, and are uniformly mixed to produce the second raw material mixture. At this point, the binders may include at least any one among syrup, quicklime (CaO), or moisture.

[0045] When the second raw material mixture is produced, the second granule having undetermined particle shapes may be produced in a granule producing apparatus. The second raw material mixture is injected by pressure into a molding machine 430 using an injector 434, and the molding machine 430 may produce plate-shaped molded bodies by compressing and forming the second raw material mixture using second rolls 442. The molded bodies produced as such may have thicknesses of about the spacing between the second rolls 442. When producing the molded bodies via such a method, an action of force is not required in the opposite direction of the rotation direction of the forming rolls during producing briquettes, and therefore plate-shaped molded bodies having uniform strength may be produced with a production speed faster than that when manufacturing the briquettes. The molded bodies are supplied to a pulverizer 440 below the molding machine 430, are pulverized by protrusions 444 formed on the outer circumferential surfaces of the second rolls 442 while passing between the second rolls 442 of the pulverizer 440, and are thereby produced into the second granules having particle shapes. At this point, since the molded bodies are pulverized while pressurized once more by the second rolls 442, the second granules may have higher compressive strengths than the molded bodies.

[0046] When produced, the second granules may be stored in a surge hopper 114 of a raw material supply part 110 together with the first granules produced by the first preprocessing part 300. At this point, the first granules and the second granules may be mixed in a separate mixer and stored in the surge hopper 114, and may also be stored in surge hoppers different from each other.

[0047] Subsequently, a raw material layer is formed by charging upper ores, the first granules, and the second granules into a sintering trailer 200 moving along a moving path 120 using a charging apparatus 116. In addition, the surface layer portion of the raw material layer is ignited while the sintering trailer 200 passes the moving path 120, and sintering of the raw material layer may be performed.

[0048] When producing sintered ores using such a method, the following test was performed to check the possibility of improving the efficiency and productivity of the process, and the test results are as shown in FIGS. 5 to 10.

[0049] FIG. 5 is a graph comparing and showing productivity according to the types of granules, FIG. 6 is a graph showing the distribution of particle sizes of granules according to a spacing between rolls of a pulverizer, FIG. 7 is a graph comparing and showing compressive strengths according to the types of granules, FIG. 8 is a graph comparing and showing compressive strengths according to the types of granules, FIG. 9 is a graph comparing and showing moisture resistant strengths according to the types of granules, and FIG. 10 is a graph comparing and showing flow speed of air passing through a raw material layer according to the types of granules.

[Preparation of iron ores]

[0050] For a test, iron ores to be used as raw materials for sintered ores were prepared. The chemical components and particle sizes of the iron ores used in the test were shown in Table 1 below.

[Table 1]

Iron ores	Chemical components (wt%)						Particle size	
	T.Fe	FeO	SiO_2	Al_2O_3	CaO	MgO	Average particle size (mm)	At most 0.15mm (wt%)
A	58.70	0.22	4.49	1.51	0.05	0.05	2.68	5.3
B	66.74	0.47	2.41	0.40	0.02	0.03	0.09	92.0

[0051] The iron ores A are typical sintering powder iron ores, and may correspond to the above-mentioned first iron ores. In addition, the iron ores B are red iron ore-based powder ores (or pellet feed) with a very high fine powder ratio (particle sizes of at most approximately 0.15 mm) of approximately 90 wt%. The iron ores B may correspond to the second iron ores.

[Production of granules]

[0052] The iron ores A were produced into the first granules through a first preprocessing part 300, and the iron ores B were produced into the second granules through a second preprocessing part 400. At this point, the first granules produced by the first preprocessing part 300 were referred to as STD. When manufacturing the first granules and the second granules, additives, fuel materials, and at least any one among moisture and the binders were used. The second granules were produced by using the second preprocessing part 400 in accordance with an exemplary embodiment, and at this point, the spacing between first rolls 432 of a molding machine 430 was adjusted to approximately 1 cm and 2 cm to produce plate-shaped molded bodies, and then, the spacing between second rolls 442 of a pulverizer 440 was adjusted to be in a range of approximately 1 cm to 2 cm to pulverize the molded bodies, and thus, the second granules were produced. At this point, the granules were referred to as PA1 which were produced by pulverizing the molded bodies produced by adjusting the first rolls 432 to approximately 1 cm, and the granules were referred to as PA2 which were produced by pulverizing the molded bodies produced by adjusting the first rolls 432 to approximately 2 cm.

[0053] In addition, in order to check the physical characteristics of the second granules and the possibility of improving the sintering operation using the same, briquettes and pellets were produced by using the iron ores B.

[0054] The briquettes were produced to have volumes of approximately 0.5 cc, 1.0cc and 2.0 cc which were referred to as B1, B2, and B3, respectively. In addition, the pellets were produced to have diameter sizes of approximately 1 cm and 2 cm which were referred to as P1 and P2, respectively.

[Production of sintered ores]

[0055] Samples were produced by using the first granules and the second granules, and sintered ores were produced using the products.

[0056] Sample 1 was produced into approximately 30 Kg of the first granules. In addition, sample 1 was charged in a sintering port having the diameter of approximately 150 mm to form a raw material layer, and the surface layer portion of the raw material layer was ignited, and then, sintering was performed while suctioning with a pressure of approximately 1,500 mmAq under the sintering port. Sample 2 was produced into approximately 30 Kg of a mixture of the first granules and briquettes B1. In addition, sample 2 was charged in a sintering port having the diameter of approximately 150 mm to form a raw material layer, and the surface layer portion of the raw material layer was ignited, and then, sintering was performed while suctioning with a pressure of approximately 1,500 mmAq under the sintering port.

[0057] Sample 3 was produced into approximately 30 Kg of a mixture of the first granules and briquettes B2. In addition, sample 3 was charged in a sintering port having the diameter of approximately 150 mm to form a raw material layer, and the surface layer portion of the raw material layer was ignited, and then, sintering was performed while suctioning with a pressure of approximately 1,500 mmAq under the sintering port.

[0058] Sample 4 was produced into approximately 30 Kg of a mixture of the first granules and briquettes B3. In addition, sample 4 was charged in a sintering port having the diameter of approximately 150 mm to form a raw material layer, and the surface layer portion of the raw material layer was ignited, and then, sintering was performed while suctioning with a pressure of approximately 1,500 mmAq under the sintering port.

[0059] Sample 5 was produced into approximately 30 Kg of a mixture of the first granules and the second granules PA1. In addition, sample 5 was charged in a sintering port having the diameter of approximately 150 mm to form a raw material layer, and the surface layer portion of the raw material layer was ignited, and then, sintering was performed while suctioning with a pressure of approximately 1,500 mmAq under the sintering port.

[0060] Sample 6 was produced into approximately 30 Kg of a mixture of the first granules and the second granules PA1. In addition, sample 6 was charged in a sintering port having the diameter of approximately 150 mm to form a raw material layer, and the surface layer portion of the raw material layer was ignited, and then, sintering was performed while suctioning with a pressure of approximately 1,500 mmAq under the sintering port. The iron ores A and iron ores B which were used in producing samples 2 to 6 above were used in a weight ratio of approximately 8:2.

[Test results]

[0061] First, the case in which the granules were produced into briquettes by using the iron ores B, and the case of being produced into the second granules in accordance with an exemplary embodiment were compared.

[0062] Referring to FIG. 5, when manufacturing the briquettes using the iron ores B, the greater the volume of the briquettes, the greater the production amount per time. In addition, it may be found that the production amount per time increases when plate-shaped molded bodies were produced and the second granule was produced by pulverizing the molded bodies in accordance with the exemplary embodiment, compared to the case in which the briquettes were produced by using the iron ores B. In addition, it may be found that when the spacing between the first rolls of the molding machine when producing the second products, the production amount thereof rapidly increases.

[0063] Accordingly, it may be found that the productivity when powder iron ores were produced into plate-shaped molded bodies and particle-shaped granules were produced by pulverizing the molded bodies in accordance with the exemplary embodiment is better than the productivity when the briquettes having predetermined shapes were produced by powder iron ores.

[0064] Next, when the spacing between the second rolls 442 of the pulverizer 440 was adjusted when producing the second granules using the iron ores B, weight ratios according to the particle sizes of the second granules were checked. Referring to FIG. 6, it may be found that from the result of producing the second granules by pulverizing the molded bodies while changing the spacing between the second rolls 442 in a range of approximately 1 cm to 2 cm, the average particle diameters and the distribution thereof may be adjusted according to the spacing between the second rolls 442. For example, when increasing the spacing between the second rolls 442, the sizes of the second granules may be increased corresponding to the spacing between the second rolls 242. However, the spacing between the second rolls 242 and the sizes of the second granules are not proportional to each other.

[0065] The initial strengths of the granules produced by using the iron ore B, that is, the briquettes and the second granules were compared. Referring to FIG. 7, it was exhibited that the briquette strength of briquettes B1 having the smallest briquette volume was greater than that of briquettes B2 having a relatively greater briquette volume. However, it is not true that the greater the volumes of briquettes, the greater the initial strengths of the briquettes. In addition, the second granules produced in accordance with an exemplary embodiment have higher initial strengths when the spacing between the first rolls 432 is approximately 1 cm, than when the spacing between the first rolls 432 is approximately 2 cm. Here, it may be found that the second granules produced in accordance with an exemplary embodiment have similar or high initial strengths regardless of the volumes of briquettes, and when the spacing between the first rolls 432 is appropriately adjusted, the strengths of the second granules may be remarkably increased.

[0066] Next, the compressive strengths of the second granules having sizes of approximately 10 mm among the second granules produced by using the iron ore B and the compressive strength of the briquettes B1, B2 and B3 were compared. Referring to FIG. 8, it is shown that the compressive strengths of the second granules PA1 and PA2 are higher than those of the briquettes B1 having the smallest volume and show compressive strengths similar to those of the briquettes B2 and B3. At this point, it may be found that the second granules PA2, which were produced by using the molding machine 430 with a relatively wide spacing between the first rolls 432, exhibit compressive strengths lower than the compressive strengths of the second granules PA1, but have compressive strengths higher than or similar to those of the briquettes B2 and B3.

[0067] In addition, the moisture resistant strengths of the pellets P1 and P2, the briquettes B1, B2, and B3, and the second granules PA1 and PA2 which were produced by using the iron ores B were measured. The moisture resistant strength exhibits whether the pellets, the briquettes, and the second granules maintain the strengths in a slurry region in which moisture is condensed in a process of producing sintered ores. Referring to FIG. 9, the briquettes B1, B2, and B3 and the second granules PA1 and PA2 exhibit moisture resistant strengths higher than the pellets P1 and P2. At this point, it may be found that the second granules PA1 and PA2 have lower moisture resistant strengths than the briquettes B1, B2 and B3, but have almost similar and high moisture strengths.

[0068] In addition, air permeability was measured inside a raw material layer charged into a sintering trailer when producing sintered ores using the first granules, produced by using the iron ores A, and the pellets, briquettes and second granules which were manufactured by using the iron ores B.

[0069] Referring to FIG. 10, it may be found that the air permeability inside the raw material layer when producing sintered ores using the first granules, which were produced by using the iron ore A, is remarkably lower than that when producing sintered ores using the first granules, the briquettes B1, B2 and B3, and the second granules PA1 and PA2. That is, when performing a sintering process by mixing the briquettes and the second granules together with the first granules, the air permeability may be improved by ensuring more voids inside the raw material layer than when performing the sintering using the first granules. In addition, it may be found that when performing sintering using the first granules and the second granules PA1 and PA2, the air permeability inside the raw material layer is proved compared to that when performing sintering using the first granules and briquettes B1 having the smallest volume. In addition, it may be found that the air permeability is further improved when performing the sintering using the first granules and the second granules PA2 compared to that than when performing the sintering using the first granules and the second granules PA1. Such results are caused because the volumes of the second granules PA1 and PA2 are larger than those of the briquettes B1, and the sizes of the second granules PA2 are larger than those of the second granules PA1, and exhibit that it is advantageous to ensure the air permeability inside the raw material layer as the particle size and the volume of the raw material used for sintering increase.

[0070] Through such results, when producing sintered ores using a sintered ore producing method in accordance with an exemplary embodiment, the production efficiency of granules, obtained by using powder iron ores, that is, the second granules, may be improved. In addition, the powder iron ores are produced into the second granules having compressive strengths, moisture resistant strengths, and the like, which are suitable to produce sintered ores, and the sizes of the second granules may be adjusted, and thus, the sintering productivity and the quality of sintered ores may be improved by improving the air permeability during a sintering process.

[0071] So far, in the detailed description of the present disclosure, specific exemplary embodiments have been described, but various modifications can be made thereto without departing from the spirit and scope of the present disclosure. Therefore, the scope of the invention is defined not by the detailed description of the invention but by the appended claims, and all differences within the scope will be construed as being included in the present invention.

INDUSTRIAL APPLICABILITY

[0072] It is possible to ensure air permeability inside a raw material layer when manufacturing sintered ores using a granule producing apparatus, a sintered ore producing apparatus, and a sintered ore producing method in accordance with exemplary embodiments, and thus, the productivity and quality of sintering may be improved.

Claims

1. A granule producing apparatus comprising:

   a molding machine comprising a pair of first rolls provided to be spaced apart from each other so as to form a space for injecting a raw material and producing plate-shaped molded bodies; and
   a pulverizer comprising a pair of second rolls provided to be spaced apart from each other so as to form a space for introducing the molded bodies.

2. The granule producing apparatus of claim 1, wherein the molding machine comprises an injector configured to pressurize and inject the raw material between the pair of first rolls.

3. The granule producing apparatus of claim 2, wherein protrusions are formed on outer circumferential surfaces of the second rolls.

4. The granule producing apparatus of claim 3, wherein a spacing between the second rolls is smaller than a spacing between the first rolls.

5. The granule producing apparatus of claim 4, wherein
   the pulverizer is provided directly under the molding machine, and
   the pair of first rolls and the pair of second rolls are arranged side by side so that the molded bodies produced by the molding machine are inserted between the pair of second rolls.

6. A sintered ore producing apparatus comprising:

   a first preprocessing part configured to produce a first raw material mixture by mixing first iron ores, additives, and fuels and produce first granules by combining the first raw material mixture; and
   a second preprocessing part configured to produce molded bodies by compressing and forming a second raw material mixture containing second iron ores, additives, and fuels, and pulverize the molded bodies to produce second granules.

7. The sintered ore producing apparatus of claim 6 comprising a sorter configured to sort the first iron ores by particle sizes.

8. The sintered ore producing apparatus of claim 7, wherein the second preprocessing part comprises a first mixer configured to produce a second raw material mixture by mixing the second iron ores, additives, and fuels.

9. The sintered ore producing apparatus of claim 8, wherein the second preprocessing part comprises:

   a molding machine comprising a pair of first rolls provided to be spaced apart from each other so as to form a

space for injecting the second raw material mixture; and
a pulverizer comprising a pair of second rolls provided under the molding machine so as to be spaced apart from each other.

10. The sintered ore producing apparatus of claim 9, wherein the molding machine comprises an injector configured to pressurize and inject the second raw material mixture between the pair of first rolls.

11. The sintered ore producing apparatus of claim 10, wherein protrusions are formed on outer circumferential surfaces of the second rolls.

12. The sintered ore producing apparatus of claim 11, wherein a spacing between the second rolls is smaller than a spacing between the first rolls.

13. The sintered ore producing apparatus of claim 12, comprising a second mixer configured to mix the first granules and the second granules.

14. A sintered ore producing method comprising:

producing first granules by combining a first raw material mixture containing first iron ores, additives, and fuels;
producing second granules by forming and pulverizing a second raw material mixture containing second iron ores, additives, and fuels; and
charging the first granules and the second granules into a sintering trailer.

15. The sintered ore producing method of claim 14, comprising sorting the first iron ores by the particle sizes, and allowing the iron ores having particle sizes of at most approximately 3 mm to be contained in the second raw material mixture during the sorting of the first iron ores by particle sizes.

16. The sintered ore producing method of claim 15, comprising injecting a binder during the producing of the second raw material mixture.

17. The sintered ore producing method of claim 16, wherein the producing of the second granules comprises:

producing plate-shaped molded bodies by compressing and forming the second raw material mixture; and
producing the second granules having particle shapes by pulverizing the plate-shaped molded bodies.

18. The sintered ore producing method of claim 17, wherein the sizes of the second granules are adjusted while pulverizing the molded bodies.

19. The sintered ore producing method of claim 18, comprising mixing the first granules and the second granules before the charging into the sintering trailer.

Fig.1

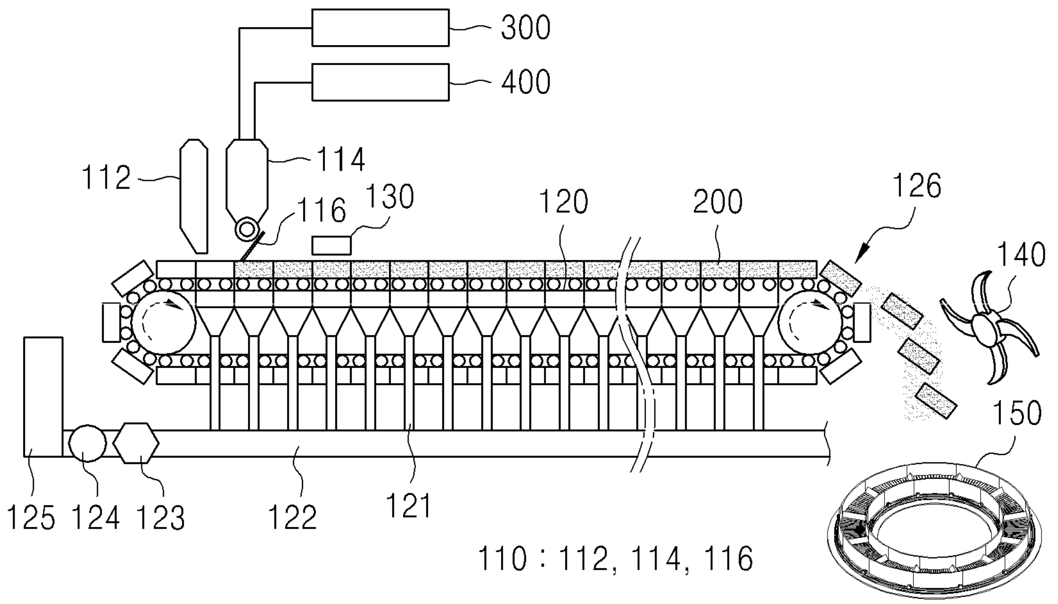

300
400
114
112
116
130
120
200
126
140
150
125
124
123
122
121
110 : 112, 114, 116

Fig.2

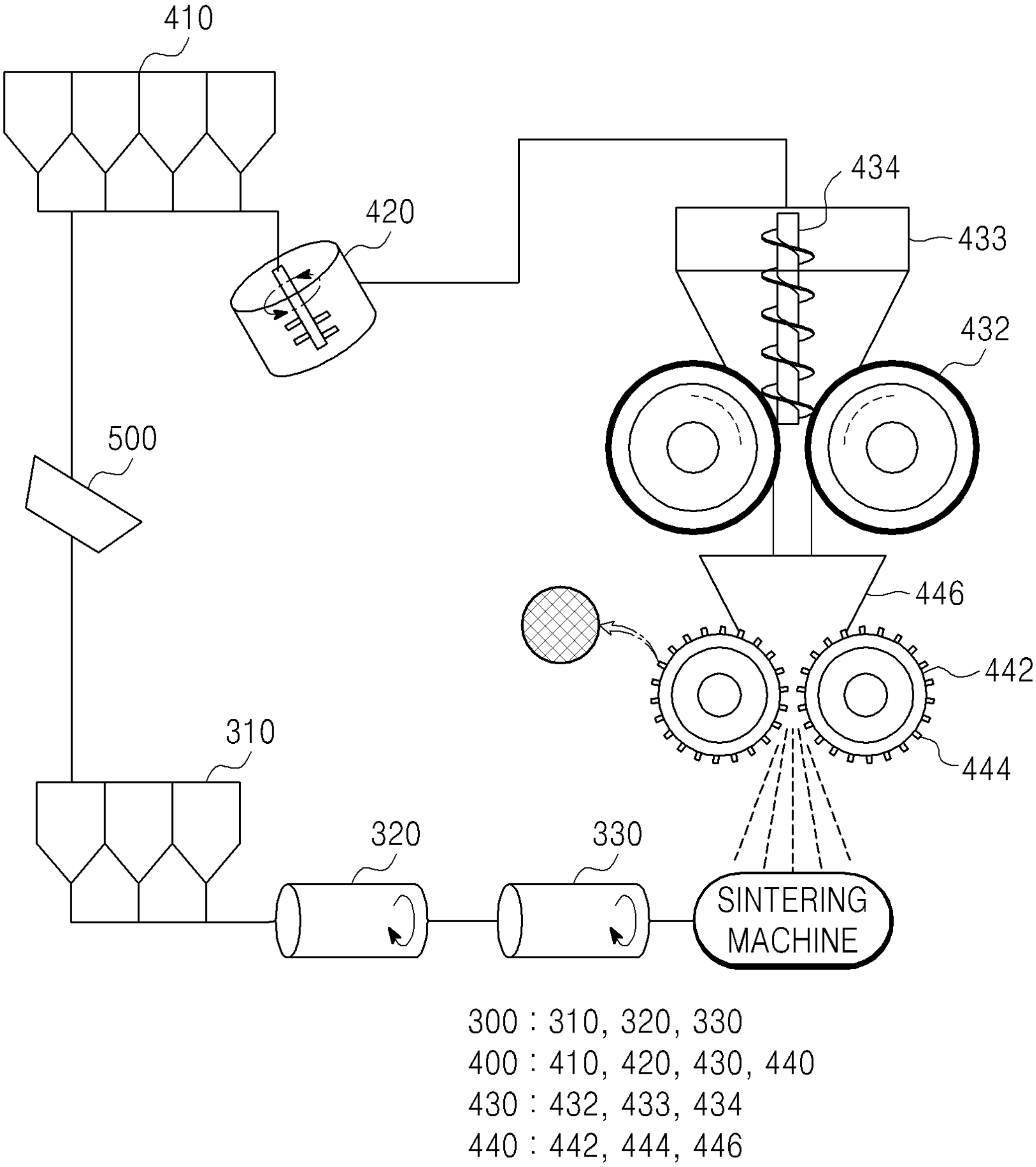

410
420
434
433
432
500
446
442
444
310
320
330
SINTERING MACHINE
300 : 310, 320, 330
400 : 410, 420, 430, 440
430 : 432, 433, 434
440 : 442, 444, 446

Fig.3

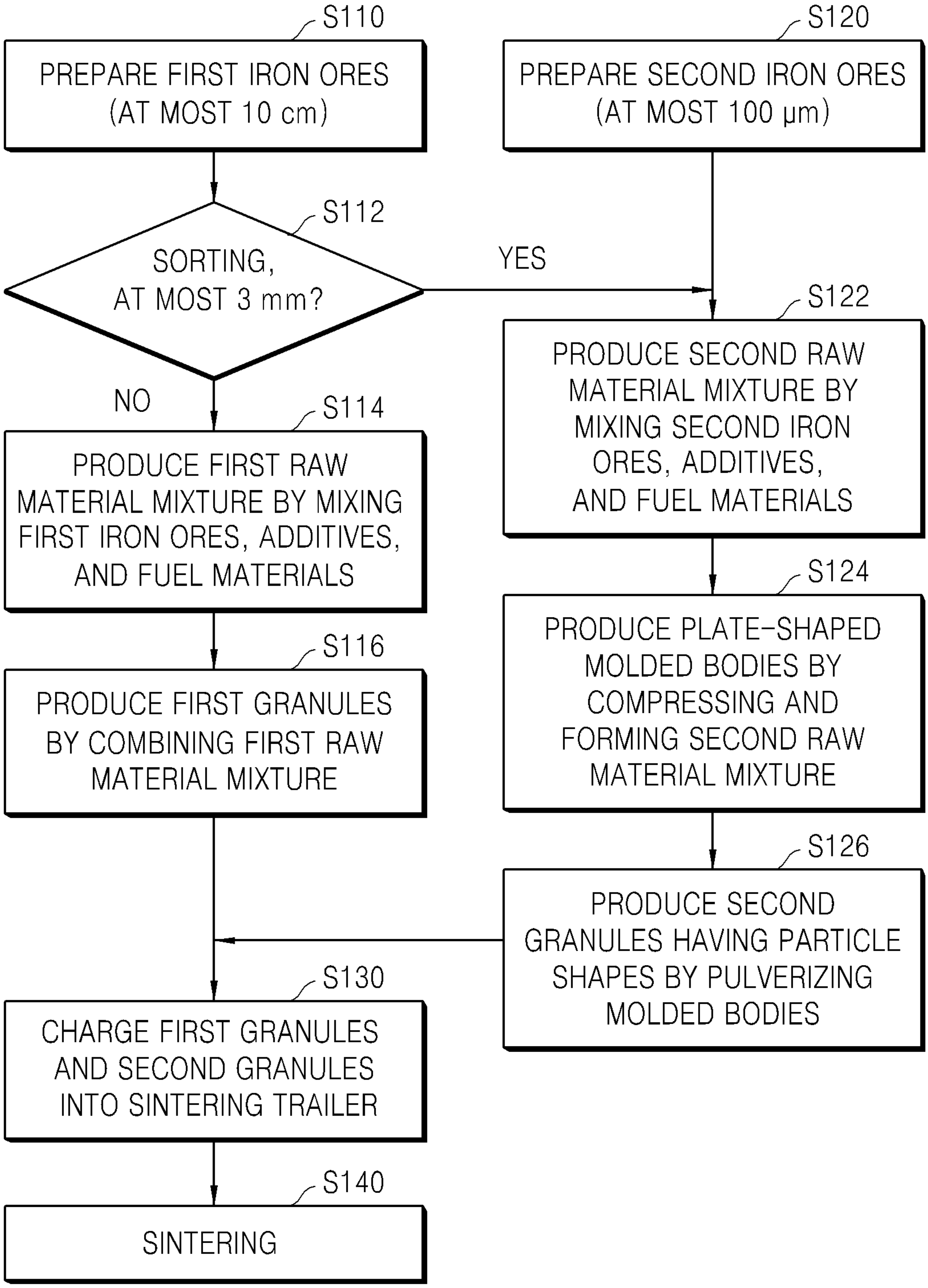

S110
PREPARE FIRST IRON ORES (AT MOST 10 cm)
S120
PREPARE SECOND IRON ORES (AT MOST 100 μm)
S112
SORTING, AT MOST 3 mm?
YES
NO
S122
PRODUCE SECOND RAW MATERIAL MIXTURE BY MIXING SECOND IRON ORES, ADDITIVES, AND FUEL MATERIALS
S114
PRODUCE FIRST RAW MATERIAL MIXTURE BY MIXING FIRST IRON ORES, ADDITIVES, AND FUEL MATERIALS
S124
PRODUCE PLATE-SHAPED MOLDED BODIES BY COMPRESSING AND FORMING SECOND RAW MATERIAL MIXTURE
S116
PRODUCE FIRST GRANULES BY COMBINING FIRST RAW MATERIAL MIXTURE
S126
PRODUCE SECOND GRANULES HAVING PARTICLE SHAPES BY PULVERIZING MOLDED BODIES
S130
CHARGE FIRST GRANULES AND SECOND GRANULES INTO SINTERING TRAILER
S140
SINTERING

Fig.4

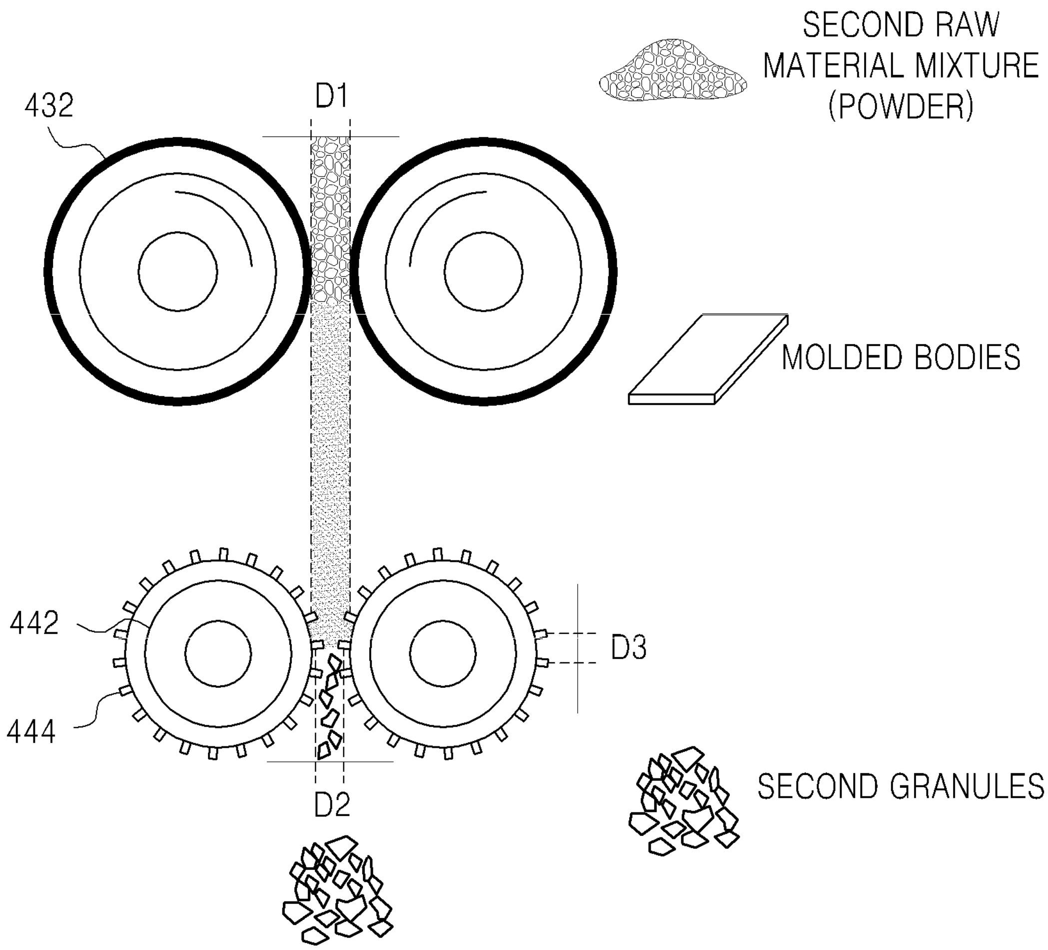

SECOND RAW
MATERIAL MIXTURE
(POWDER)
432
D1
MOLDED BODIES
442
D3
444
D2
SECOND GRANULES

Fig.5

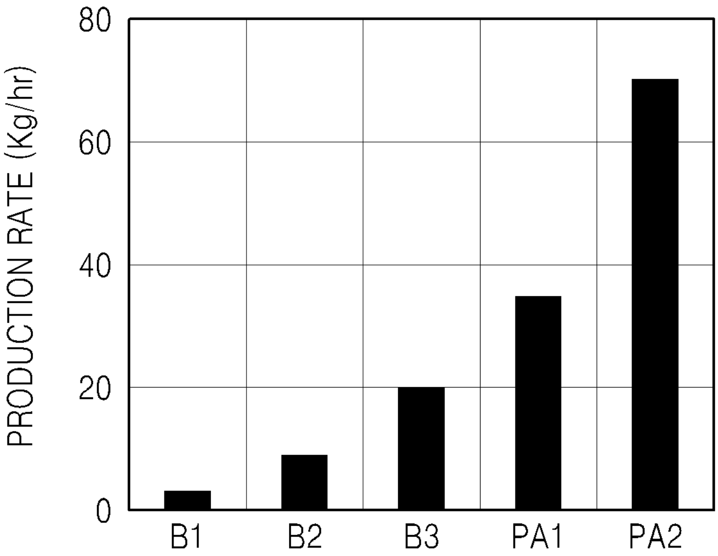

PRODUCTION RATE (Kg/hr)
80
60
40
20
0
B1
B2
B3
PA1
PA2

Fig.6

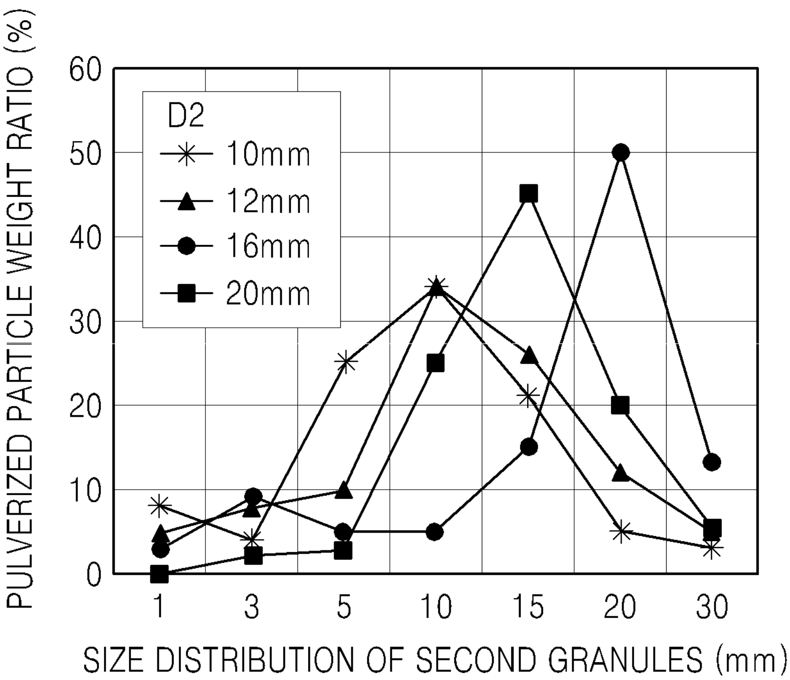

PULVERIZED PARTICLE WEIGHT RATIO (%)
60
50
40
30
20
10
0
D2
10mm
12mm
16mm
20mm
1
3
5
10
15
20
30
SIZE DISTRIBUTION OF SECOND GRANULES (mm)

Fig.7

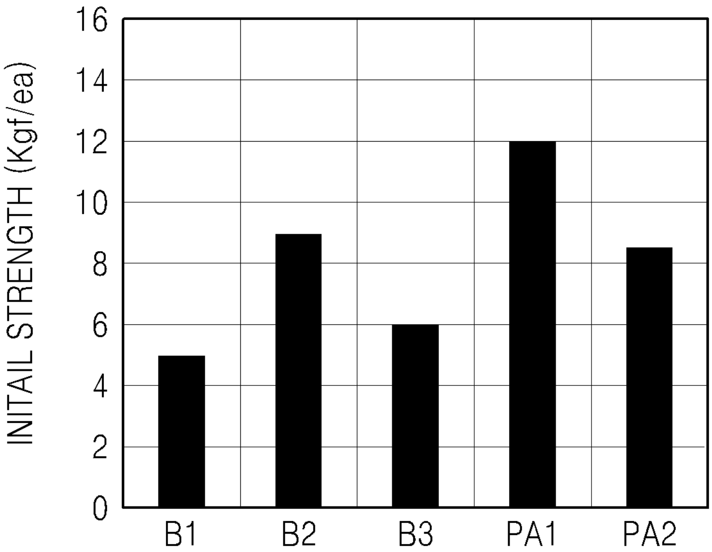

INITAIL STRENGTH (Kgf/ea)
16
14
12
10
8
6
4
2
0
B1
B2
B3
PA1
PA2

Fig.8

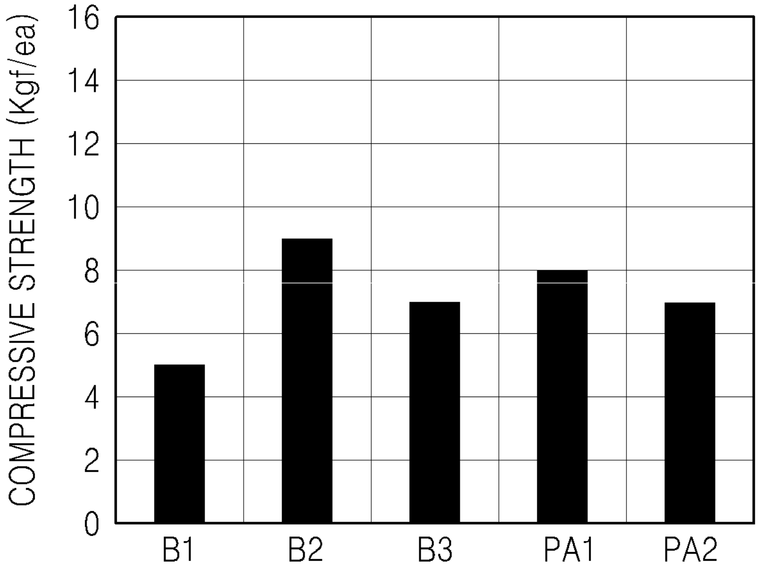

COMPRESSIVE STRENGTH (Kgf/ea)
16
14
12
10
8
6
4
2
0
B1
B2
B3
PA1
PA2

Fig.9

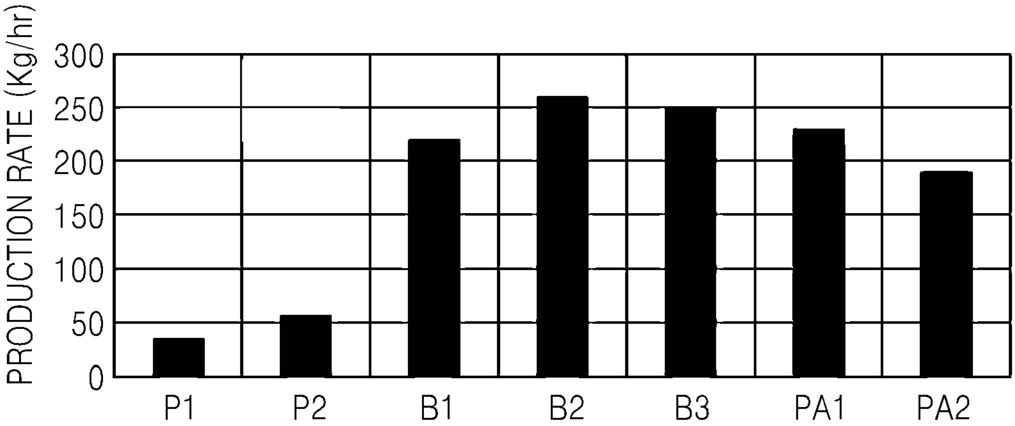
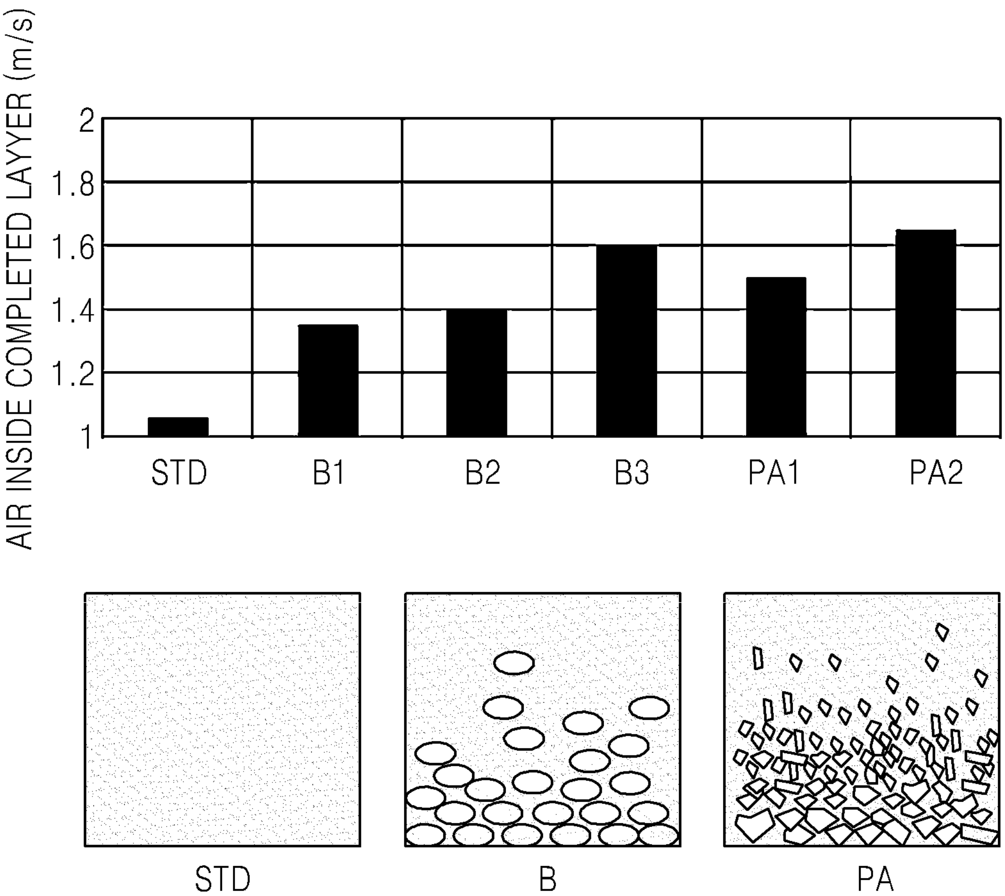

PRODUCTION RATE (Kg/hr)
300
250
200
150
100
50
0
P1
P2
B1
B2
B3
PA1
PA2

Fig.10


AIR INSIDE COMPLETED LAYYER (m/s)
2
1.8
1.6
1.4
1.2
1
STD
B1
B2
B3
PA1
PA2
STD
B
PA

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/014843

A. CLASSIFICATION OF SUBJECT MATTER
C22B 1/16(2006.01)i, B30B 11/16(2006.01)i, B30B 15/00(2006.01)i, B30B 15/30(2006.01)i, B30B 15/32(2006.01)i, C22B 1/248(2006.01)i, C22B 1/242(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)
C22B 1/16; C22B 1/24; C22B 1/14; B30B 11/16; B30B 15/00; B30B 15/30; B30B 15/32; C22B 1/248; C22B 1/242

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: sintered ore, iron ore, binder, grinding, crushing, molding, compression, pressurization

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 06-212291 A (SUMITOMO METAL IND. LTD.) 02 August 1994 See paragraphs [0013]-[0015], [0023], claim 1 and figure 1.	1-5 6-19
Y	JP 2016-191122 A (NIPPON STEEL & SUMITOMO METAL) 10 November 2016 See paragraphs [0017]-[0020], [0042] and claim 1.	6-19
A	KR 10-2013-0110591 A (HYUNDAI STEEL COMPANY) 10 October 2013 See paragraphs [0020], [0023]-[0026] and figures 1, 2.	1-19
A	KR 10-2013-0034296 A (HYUNDAI STEEL COMPANY) 05 April 2013 See paragraphs [0019], [0043]-[0048] and figure 1.	1-19
A	KR 10-2015-0071388 A (POSCO) 26 June 2015 See paragraph [0029] and claims 1, 6.	1-19

☐ 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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
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"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
23 AUGUST 2017 (23.08.2017)	**23 AUGUST 2017 (23.08.2017)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. +82-42-481-8578	Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2016/014843

Patent document cited in search report	Publication date	Patent family member	Publication date
JP 06-212291 A	02/08/1994	NONE	
JP 2016-191122 A	10/11/2016	NONE	
KR 10-2013-0110591 A	10/10/2013	NONE	
KR 10-2013-0034296 A	05/04/2013	KR 10-1299376 B1	22/08/2013
KR 10-2015-0071388 A	26/06/2015	NONE	

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