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(71) Applicant: **Posco**
Pohang-si, Gyeongsangbuk-do 790-300 (KR)

(72) Inventors:
• **JEONG, Hae Kwon**
Pohang-si
Gyeongsangbuk-do 790-826 (KR)
• **KWON, Gi Woong**
Pohang-si
Gyeongsangbuk-do 790-752 (KR)

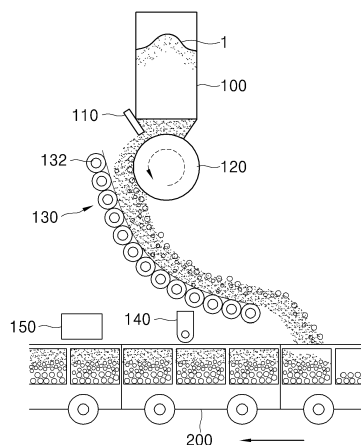
- **CHO, Byung Kook**
Pohang-si
Gyeongsangbuk-do 790-832 (KR)
- **SON, Sang Han**
Pohang-si
Gyeongsangbuk-do 790-752 (KR)
- **HWANG, Byung Woon**
Pohang-si
Gyeongsangbuk-do 791-738 (KR)
- **YANG, Young Cheol**
Pohang-si
Gyeongsangbuk-do 790-752 (KR)
- **LEE, Jong nam**
Gwangyang-si
Jeollanam-do 545-875 (KR)
- **WOO, Jong Soo**
Pohang-si
Gyeongsangbuk-do 790-751 (KR)

(74) Representative: **Zech, Stefan Markus**
Meissner, Bolte & Partner GbR
Postfach 86 06 24
81633 München (DE)

(54) **APPARATUS FOR CHARGING AND METHOD FOR CHARGING RAW MATERIAL**

(57) The present disclosure relates to an apparatus of charging a raw material and a method of charging a raw material, and the method includes preparing the raw material; supplying the raw material to a charging chute; and charging the raw material into a storage container by transporting the raw material supplied to the charging chute along a path having a cycloid curve shape, thereby increasing a horizontal separation speed of the raw materials having various densities and sizes separated from the charging chute to improve air permeability of the raw materials.

FIG. 4



Description**TECHNICAL FIELD**

5 **[0001]** The present disclosure relates to an apparatus of charging a raw material and a method of charging a raw material, and more particularly, to an apparatus of charging a raw material and a method of charging a raw material, which improve air permeability of the raw material

BACKGROUND ART

10 **[0002]** Generally, in a sintering factory, a sinter raw material is charged into a sintering truck of a sintering machine by using a charging apparatus to manufacture sintered ore. FIG. 1 shows a general apparatus for charging a sinter raw material. The apparatus for charging the sinter raw material includes a raw material supply unit including a sinter raw material hopper 2 in which a sinter raw material 1 having pulverized iron pulverized iron ore, sub-materials such as
15 limestone, and pulverized coke as fuel mixed with each other is stored, and a drum feeder 3 configured to supply the sinter raw material through a hopper gate 4 of the sinter raw material hopper to a lower portion by rotation, and a chute 9 configured to charge the supplied sinter raw material over bottom ore provided in advance in a sintering truck 8. The chute 9 is comprised of an inclined plate 11 to sort the sinter raw material so that small particles are charged onto an upper portion of the sintering truck 8 and large particles are charged onto a lower portion (vertical segregation is facilitated).
20 When the sinter raw material 1 is charged into the sintering truck 8, the surface of the sinter raw material is made even by a surface leveling plate 6 and ignited in an ignition furnace 7, and a sintering reaction is performed due to combustion of coke included in the sinter raw material by air sucked from a wind box to the lower portion by a suction blower (not shown) to manufacture sintered ore.

25 **[0003]** In this sintering operation, a charging state of the raw material in the sintering truck needs to be set so that the large particles are positioned at the lower portion and the small particles are positioned at the upper portion (vertical segregation is facilitated), thus artificially facilitating segregation so that coke as fuel is present in a great content at the upper portion. When vertical segregation is effectively facilitated, a heat quantity imbalance phenomenon in upper and lower directions of a sintering machine is suppressed, and resistance (ventilation resistance) of air flowing into a raw material layer in the sintering machine is reduced to improve productivity of sintered ore. In this case, if possible, as
30 known in the art, it is most desirable to continuously uniformly maintain a charge density of the raw material even in a width direction of the sintering machine.

[0004] However, an upper layer portion of a sinter raw material layer has limitations in that since a temperature in the layer is low and a maintaining time at high temperatures is short as compared to intermediate and lower layer portions, a melting bond of sintered ore of the upper layer portion is weak, and thus strength of sintered ore is low and yield is
35 reduced. In order to solve the aforementioned limitations, various charging apparatuses and methods of segregating and charging a mixed sinter raw material and introducing pulverized coke or pulverized ore into the uppermost layer of the raw material layer have been proposed.

[0005] For example, Japanese Patent Application Laid-Open No. 2000-160261 proposes a method where an auxiliary inclined chute is provided at the rear of an inclined chute to which a mixed raw material is transported to independently
40 release pulverized coke to an upper portion of a sinter bed layer, thereby increasing segregation efficiency. This method has a burden in that an additional apparatus is provided to increase segregation efficiency.

[0006] Similarly, in Korean Patent Application Laid-Open No. 2004-17540, in order to charge pulverized coke having a particle size of approximately 3 mm or less into a truck independently to charging of a mixed sinter raw material, a method of adding pulverized coke to a surface layer portion of the sinter raw material by providing a feeder configured
45 to transport pulverized coke at the rear of an inclined chute is adopted, thereby improving bonding strength and a recovery ratio of sintered ore. Further, Korean Patent Application Laid-Open No. 2002-7085 proposes a method of charging pulverized coke supplied from a bidirectional screw feeder into a truck by using a vibrator under the screw feeder by providing the screw feeder configured to add a heat source between intermediate and lower ends of a charge apparatus.

[0007] Further, Korean Patent Application Laid-Open No. 2000-41274 suggests a method of adjusting charging distribution of coke present in a mixed raw material in a thickness direction of a mixed raw material layer by providing chains
50 arranged downwardly at constant intervals in a drum feeder, such that a ratio of coke distributed in the uppermost layer of the raw material layer in a truck is 0.5% or more as compared to the lowermost layer. However, when the mixed raw material falls down from an inclined chute, since the mixed raw material or pulverized coke (particularly, fine coke) collides the chains to be introduced to an upper layer of a sintering truck, in the case of use over a long period of time,
55 it is difficult to maintain separation efficiency of pulverized coke due to attachment ore attached to the chains.

[0008] In addition, Korean Patent Application Laid-Open No. 2002-46070 adopts a method where in order to perform segregation charging of pulverized coke and a fine raw material into the uppermost end of a raw material layer by sorting and separating the raw material having a small particle size and pulverized coke using an air spraying unit, a second

sloping chute is provided at the rear of an inclined chute and an sortd raw material amount detection meter is provided therebeneath to move fine particles to the second sloping chute by air discharged from an air spraying nozzle and thus charge the particles onto the raw material layer. However, due to a characteristic of a sintering factory having much scattered dust, sorting of the raw material by injection of air worsens an operation environment and negatively affects a life-span of a peripheral apparatus. The similar method is suggested in Japanese Patent Application Laid-Open No. 1995-034142. In addition to this, various technologies for performing segregation charging of the raw material are suggested in the related art documents.

[0009] The charging apparatuses and methods have limitations in that since a method of injecting air into an entire inclined chute or a portion thereof or changing a direction of a flow of the raw material through vibration is adopted as a method of inducing segregation of pulverized coke, fine raw material (pulverized ore), and a sinter raw material on the raw material layer in the sintering truck to worsen an environment in the sintering factory or separately provide an additional apparatus, a provision cost is increased and maintenance is difficult.

[0010] Further, there is a limitation in that during a practical operation, a charging density, that is, the degree of segregation, of the raw material is reduced due to various variables such as occurrence of attachment ore on the chute or toppling of the raw material stacked in the sintering truck, and thus air permeability is reduced. Accordingly, there are limitations in that quality and productivity of sintered ore are reduced.

DISCLOSURE OF THE INVENTION

TECHNICAL PROBLEM

[0011] The present disclosure provides an apparatus of charging a raw material and a method of charging a raw material, which improve the degree of segregation of the charged raw material to improve air permeability.

[0012] The present disclosure also provides an apparatus of charging a raw material and a method of charging a raw material, which do not affect a flow of the raw material and induce segregation of pulverized coke and pulverized ore.

[0013] The present disclosure also provides an apparatus of charging a raw material and a method of charging a raw material, which improve quality and productivity of manufactured sintered ore.

TECHNICAL SOLUTION

[0014] In accordance with an exemplary embodiment, an apparatus for charging a raw material includes a raw material supply unit configured to supply the raw material, and a charging chute configured to transport the raw material supplied from the raw material supply unit to a storage container, in which in the charging chute, a transportation path of the raw material has a curved surface having a cycloid curve shape.

[0015] In accordance with another exemplary embodiment, an apparatus for charging a raw material includes a raw material supply unit configured to supply the raw material, and a charging chute configured to transport the raw material supplied from the raw material supply unit to a storage container, in which in the charging chute, a transportation path of the raw material has a curved surface having a prolate cycloid curve shape.

[0016] In accordance with yet another exemplary embodiment, an apparatus for charging a raw material includes a raw material supply unit configured to supply the raw material, and a charging chute configured to transport the raw material supplied from the raw material supply unit to a storage container, in which in the charging chute, a plurality of rolls are disposed in parallel to form a transportation path of the raw material, central axes of the plurality of rolls are positioned on a prolate cycloid curve, and the transportation path of the raw material formed on the plurality of rolls has a curved surface having a cycloid curve shape.

[0017] In the charging chute, an incident angle formed by a portion through which the raw material flows in and a vertical direction may be smaller than a departure angle formed by a portion through which the raw material is discharged and a horizontal direction.

[0018] The incident angle may be approximately 5° to approximately 50°, and the departure angle may be approximately 10° to approximately 60°.

[0019] The charging chute may be formed of the plurality of rolls or inclined plates.

[0020] The plurality of rolls may be disposed to have a diameter continuously increased from an upper portion to a lower portion in the charging chute.

[0021] The charging chute may be divided into a plurality of regions in a movement direction of the raw material, the plurality of rolls may be disposed to have the same diameter in each region, and the diameter may be increased from an upper region to a lower region in the charging chute.

[0022] In the charging chute, the plurality of rolls may be disposed in parallel to form the transportation path of the raw material, the plurality of rolls may include electrode-magnetic rolls including at least an electrically charged portion and at least a portion having a magnetic property, and the electrode-magnetic rolls may include a non-rotating fixed roll, a

rotation roll configured to surround an exterior of the fixed roll and rotate along an external circumferential surface of the fixed roll, and an electrode plate and a magnetic body disposed on at least a portion of the fixed roll.

[0023] The magnetic body may be provided on a portion corresponding to the transportation path through which the raw material is transported.

[0024] The magnetic body may be disposed to be biased toward an adjacent magnetic roll positioned in a progress direction of the raw material.

[0025] The magnetic body may be formed in a region of approximately 110° to 150° based on a center of a fixed roll.

[0026] A raw material supply unit may include an electrically charging apparatus configured to electrically charge the raw material, and the electrode-magnetic rolls may include a plurality of first electrode-magnetic rolls in which an electrically charged region having a polarity which is identical to the polarity of the raw material is formed on the transportation path adjacent to the raw material supply unit and the electrically charged region having the polarity which is contrary to the polarity of the raw material is formed beneath the transportation path, and a plurality of second electrode-magnetic rolls in which the electrically charged region having the polarity which is identical to the polarity of the raw material and the electrically charged region having the polarity which is contrary to the polarity of the raw material are formed on the transportation path adjacent to a storage container.

[0027] Electrode plates having the different polarities may be disposed on a fixed roll to be spaced apart from each other.

[0028] The electrode plates may be provided to at least partially overlap a magnetic body.

[0029] In a second electrode-magnetic roll, an electrically charged region having a polarity which is contrary to the polarity of a raw material may be formed in a transportation direction of the raw material.

[0030] The fixed roll may include an electromagnetic insulator.

[0031] An electromagnetic insulator may be provided in at least one space of spaces among the fixed roll, the electrode plate, and the magnetic body.

[0032] The plurality of electrode-magnetic rolls may be disposed to be spaced apart from each other at intervals of approximately 5 mm to approximately 8 mm.

[0033] A scrapper may be disposed beneath the electrode-magnetic rolls.

[0034] In accordance with still another exemplary embodiment, a method of charging a raw material includes preparing the raw material; supplying the raw material to a charging chute; and charging the raw material into a storage container by transporting the raw material supplied to the charging chute along a path having a cycloid curve shape.

[0035] During the charging of the raw material into the storage container, a surface of a raw material layer on the charging chute may form a locus having the cycloid curve shape.

[0036] During the supplying of the raw material to the charging chute, the raw material may be supplied to the charging chute having a prolate cycloid curve shape to transport the raw material supplied to the charging chute along the path having the cycloid curve shape and charge the raw material into the storage container.

[0037] During the charging of the raw material into the storage container, the raw material may be separated from the charging chute at a horizontal separation speed which is larger than a vertical separation speed.

[0038] The storage container may move in a direction which is contrary to a separation direction of the raw material in the charging chute.

[0039] During the charging of the raw material into the storage container, the raw material including particles having a large density or size may be first charged.

[0040] During the charging of the raw material into the storage container by transporting the raw material supplied to the charging chute along the path having the cycloid curve shape, the raw material having small particles may be sorted among the raw materials by using electric charging and magnetic properties of the raw material to be charged onto the raw material layer formed in the storage container.

ADVANTAGEOUS EFFECTS

[0041] In the exemplary embodiments, it is possible to increase the horizontal separation speed of the raw materials having various densities and sizes separated from the charging chute. Accordingly, it is possible to improve the degree of segregation of the raw material charged into the moving sintering truck. Further, it is possible to improve the degree of segregation of the raw material to improve air permeability in the raw material layer and thus improve quality and productivity of manufactured sintered ore. Further, there is an effect that the degree of segregation of the raw material can be improved while a device is not largely changed.

[0042] Further, segregation efficiency of the raw material charged into the storage container can be improved without influence on a flow of the raw material. That is, in the charging chute formed of a plurality of rolls, the electrode and the magnetic body are formed on a portion of the rolls to charge pulverized coke contained in the raw material by using electric attractive force and repulsive force and charge pulverized ore by using magnetic force through the space formed between the rolls into the storage container, and thus segregation efficiency can be improved while not disturbing the flow of the raw material. Accordingly, it is possible to improve the degree of segregation of the raw material charged into

the moving sintering truck. In addition, due to improvement of the degree of segregation of the raw material, it is possible to improve air permeability in the raw material layer, and to complement a heat quantity shortage phenomenon on the raw material layer and thus improve quality and productivity of manufactured sintered ore.

[0043] Particularly, since the roll is constituted so that the fixed roll and the rotation roll are separated, when any one of the fixed roll and the rotation roll is damaged, only the damaged roll can be drawn out and mended, and thus it is easy to perform maintenance. Further, since the electrode and the magnetic body are connected to the fixed roll, it is possible to prevent a damage to a connection portion between the roll and wires by the wires configured to apply electric power to the electrode or the magnetic body due to rotation of the roll.

BRIEF DESCRIPTION OF THE DRAWINGS

[0044]

FIG. 1 is a view schematically showing a general apparatus for charging a sinter raw material.

FIGS. 2 and 3 are views showing an operation principle of an apparatus for charging a raw material in accordance with an exemplary embodiment.

FIG. 4 is a view showing the apparatus for charging the raw material in accordance with the exemplary embodiment.

FIG. 5 is a view showing a charging chute of the apparatus for charging the raw material in accordance with the exemplary embodiment.

FIG. 6 is a view for comparing horizontal separation speeds in accordance with a path.

FIG. 7 is a graph showing a change in horizontal separation speed V_{Eh} in accordance with a change in height of the charging chute.

FIG. 8 is a view showing an operation principle of an apparatus for charging a raw material in accordance with another exemplary embodiment.

FIG. 9 is a view showing a charging chute of the apparatus for charging the raw material in accordance with another exemplary embodiment.

FIG. 10 is a view for comparing horizontal separation speeds in accordance with a path.

FIG. 11 is a view showing an operation principle of an apparatus for charging a raw material in accordance with yet another exemplary embodiment.

FIG. 12 is a view showing a charging chute of the apparatus for charging the raw material in accordance with yet another exemplary embodiment.

FIG. 13 is a view showing a modified exemplary embodiment of the charging chute.

FIG. 14 is a graph showing a change in horizontal drop distance in accordance with a type of the charging chute.

FIG. 15 is a view schematically showing a raw material supply unit of an apparatus for charging a raw material in accordance with still another exemplary embodiment.

FIG. 16 is a view schematically showing a charging chute of the apparatus for charging the raw material in accordance with still another exemplary embodiment.

FIG. 17 is a view showing a structure of an electrode-magnetic roll.

FIGS. 18 and 19 are views showing disposal of an electrode and a magnetic body.

FIG. 20 is a view showing a transportation state of the raw material transported in accordance with the charging chute.

MODE FOR CARRYING OUT THE INVENTION

[0045] Hereinafter, specific embodiments will be described in detail with reference to the accompanying drawings. The present invention 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 invention to those skilled in the art.

[0046] The present disclosure relates to an apparatus for charging raw materials including particles having various densities and sizes into a moving storage container, and the apparatus may be applied to separate the raw materials for each density and size of the particles and thus charge the raw materials in the storage container. As described above, the raw materials charged into the storage container may form a space between the particles of the raw materials to improve air permeability. Hereinafter, an apparatus of charging a raw material and a method of charging a sinter raw material, in which a mixed sinter raw material used to manufacture sintered ore used during an iron making process is charged into a moving sintering truck, will be described as an example.

[0047] FIGS. 2 and 3 are views showing an operation principle of an apparatus for charging a raw material in accordance with an exemplary embodiment.

[0048] The degree of segregation of the raw material in a raw material layer in the sintering truck is based on a principle of powder segregation. FIG. 2 is a graph for showing the principle of powder segregation, and particles of the raw material

released from an inclined chute are separated from an inclined surface at a speed of V and have a θ angle component. In accordance with a generally well known William's locus effect, as shown in the following Equation 1, a horizontal drop distance L of powder is proportional to a horizontal separation speed V_{Eh} of the particle, a density ρ of the particle, and the square of the size a of the particle.

Equation 1

$$L(m) = \frac{V_{Eh} \rho a^2}{18\mu}$$

[0049] That is, as the density and the diameter of the particle are increased and the horizontal separation speed V_{Eh} is increased, the drop distance is increased. For the particles having the same density ρ and the same diameter a , as the horizontal separation speed V_{Eh} is increased, the particles are layered beneath the raw material layer. Since many spaces are secured between the particles as the degree of segregation is increased, air permeability may be improved. That is, when the particles having the different densities and diameters are blended with each other to be layered, for example, the particles having the small diameter are mingled between the particles having the large diameter to remove the spaces between the particles and thus reduce air permeability.

[0050] Further, it can be seen that it is effective in segregation charging to increase the amount of horizontal speed components of the particles dropped and separated from an end of the charging chute. A horizontal direction speed of the particles separated from the charging chute represents dispersion caused by a difference in momentum of the particles and directly relates to segregation charging, and a vertical direction speed represents a pressure applied to the raw material layer and relates to a charging density.

[0051] As described above, in order to perform effective segregation charging of the raw material, the horizontal direction speed of the dropping particles needs to be increased. Of course, when the area and the height of the charging chute are increased, the horizontal direction speed may be increased, but the increase is not desirable in terms of manufacturing, controlling, and economic feasibility because a size of a device should be increased.

[0052] Accordingly, in the exemplary embodiment, when the mixed sinter raw material is separated from the charging chute, air permeability of the raw material layer in the sintering truck may be improved by maximally increasing the horizontal direction speed to increase a segregation charging effect into the sintering truck, thus improving quality and productivity of sintered ore.

[0053] In the apparatus for charging the raw material in accordance with the exemplary embodiment, in the constitution of the charging chute through which various mixed raw materials are introduced into the sintering truck, the charging chute may be formed to have a curved surface having a shape of a cycloid curve that is known as the shortest drop curve, thereby increasing the horizontal separation speed of the mixed sinter raw material.

[0054] The cycloid curve, as shown in FIG. 3, means a locus drawn by a predetermined point S on a circumference when a circle having a radius of r is rolled along a straight line on a plane, and is represented by the following Equations 2 and 3.

Equation 2

$$x = r(\theta - \sin\theta) \quad y = r(\cos\theta - 1)$$

[0055] (where r is a radius of a circle, and θ is an angle of rotation movement of the circle)

Equation 3

$$\theta_S = 2\Phi_S \cdot \theta_E = 2(\pi/2 - \Phi_E)$$

[0056] When a length d of the charging chute, an incident angle Φ_S at a position S at which the raw material is released from a drum feeder to the charging chute, and a departure angle Φ_E from the charging chute at a position E at which the raw material is separated from the charging chute are fixed, the radius r of the circle and the height h of the position S at which the raw material flows from the drum feeder into the charging chute may be drawn by using the following

Equations 4 and 5. The incident angle is an angle formed by the charging chute and a vertical direction straight line and an angle of an upper side of the charging chute into which the raw material flows from the drum feeder, and the departure angle is an angle formed by the charging chute and a horizontal direction straight line and an angle of a lower side of the charging chute from which the raw material is released to the sintering truck.

Equation 4

$$r = \frac{d}{\theta_E - \theta_S + \sin\theta_S - \sin\theta_E}$$

Equation 5

$$h = r(\cos\theta_E - \cos\theta_S)$$

[0057] A separation speed V_E , a horizontal direction separation speed V_{Eh} , and a vertical direction separation speed V_{Ev} of the mixed sinter raw material at a mixed sinter raw material separation position E may be represented by the following Equations.

Equation 6

$$V_E = \{2gr(\cos\theta_S - \cos\theta_E)\}^{\frac{1}{2}}$$

(where g is the acceleration of gravity)

Equation 7

$$V_{Eh} = V_E \cos\theta_E \cdot V_{Ev} = V_E \sin\theta_E$$

[0058] The charging chute has a path according to the curve shown in Equations 2 and 3, and the mixed sinter raw material released from the charging chute manufactured to have the path has the maximum horizontal speed with respect to the length d, the height h, the incident angle Φ_S , and the departure angle Φ_E of the charging chute set during separation from the charging chute.

[0059] FIG. 4 is a view showing the apparatus for charging the raw material in accordance with the exemplary embodiment, and FIG. 5 is a view showing the charging chute of the apparatus for charging the raw material in accordance with the exemplary embodiment.

[0060] The apparatus for charging the raw material includes a raw material supply unit including a raw material hopper 100 and a drum feeder 120, and a charging chute 130.

[0061] The raw material hopper 100 supplies a mixed raw material 1 such as pulverized iron, pulverized iron ore, sub-materials, and fine coke through a hopper gate 110 to the drum feeder 120, and the drum feeder 120 blends the mixed raw material 1 supplied therein while rotating and thus releases the mixed raw material to the charging chute 130.

[0062] The charging chute 130 functions to sort the raw materials 1 so that small particles are charged at an upper portion of a sintering truck 200 and large particles are charged at a lower portion (vertical segregation is facilitated) by forming an inclined side. When the raw material is charged into the sintering truck 200, the surface of the raw material is made even by a surface leveling plate 140 and ignited in an ignition furnace 150, and a sintering reaction is performed due to combustion of coke included in the raw material 1 by air sucked from a wind box to the lower portion by a suction blower (not shown) to manufacture sintered ore.

[0063] The charging chute 130 may be formed by disposing a plurality of rolls 132 in parallel or formed as an integrated inclined plate (not shown). The charging chute 130 has a transportation path formed as a curved surface having an area, and a transversal cross-section of the charging chute 130 has a cycloid curve shape. The separation speed V_E of the

raw material from the charging chute is determined in accordance with a change in length d , height h , incident angle Φ_S , and departure angle Φ_E of the charging chute 130 by Equation 6. In this case, assuming that the height of the charging chute 130 is fixed to approximately 1 m, the incident angle Φ_S of the charging chute 130 may be approximately 5° to approximately 50°, and the departure angle Φ_E may be approximately 10° to approximately 60°. When the incident angle and the departure angle of the charging chute 130 are within the aforementioned range, since the transportation path of the charging chute 130 may be formed to have a shape of an ideal cycloid curved surface, the horizontal separation speed V_{Eh} of the raw material may be increased to maximize the separation speed V_E of the raw material from the charging chute.

[0064] FIG. 6 is a view for comparing the horizontal separation speeds in accordance with the path, and FIG. 7 is a graph showing a change in horizontal separation speed V_{Eh} in accordance with a change in height of the charging chute.

[0065] FIG. 6(a) shows the separation speed of the raw material from the charging chute having a straight inclined surface. In the case of the charging chute having the straight inclined surface, when the length d and the height h of the charging chute are determined, an inclination angle Φ of the charging chute is determined.

[0066] FIG. 6(b) shows the separation speed of the raw material from the charging chute having an inclined surface having a shape of a cycloid curved surface. The transportation path of the charging chute is determined by the length d and the height h of the charging chute and the incident angle and the departure angle of the raw material.

[0067] Comparing FIGS. 6(a) and 6(b) to each other, it can be seen that when the length d and the height h of the charging chute are the same as each other, in the case where the transportation path of the charging chute has the shape of the cycloid curved surface, the horizontal separation speed V_{Eh} is increased and the vertical separation speed V_{Ev} is reduced as compared to the case where the charging chute has the straight line shape.

[0068] In order to perform precise comparison, when the length d of the charging chute is fixed to approximately 1 m and the height h is changed to approximately 0.8 m, approximately 1.0 m, and approximately 1.2 m, the separation horizontal speed V_{Eh} , the drop distance L , and variables of the raw material for each charging chute are described in the following Table 1. Embodiments 1 to 3 show the case of the charging chute having the shape of the cycloid curved surface, Comparative Embodiments 1 to 3 show the case of the charging chute having the straight line shape, and disturbance due to formation of attachment ore and an interaction due to a layer flow of the particles are not considered.

[Table 1]

	d/h (m)	Φ (°)	Φ_S (°)	Φ_E (°)	V_{Eh} (m/s)	L (m)
Embodiment 1	1.0/0.8		41.9	30	3.43	0.34
Embodiment 2	1.0/1.0		26.5	30	3.84	0.38
Embodiment 3	1.0/1.2		6.8	30	4.20	0.41
Comparative Embodiment 1	1.0/0.8	38.7			3.07	0.30
Comparative Embodiment 2	1.0/1.0	45			3.11	0.30
Comparative Embodiment 3	1.0/1.2	50.2			3.08	0.30

[0069] In accordance with Table 1, it can be seen that when the length and the height of the charging chute are the same as each other, the horizontal separation speed V_{Eh} and the distance L in Embodiments 1 to 3 are increased as compared to the horizontal separation speed V_{Eh} and the drop distance L in Comparative Embodiments 1 to 3. For example, comparing Embodiment 1 and Comparative Embodiment 1 to each other, it can be seen that in Embodiment 1, the horizontal separation speed V_{Eh} is approximately 3.43 m/s and the drop distance L of the raw material is approximately 0.34 m, but in Comparative Embodiment 1, the horizontal separation speed V_{Eh} is approximately 3.07 m/s and the drop distance L of the raw material is approximately 0.30 m, and thus in Embodiment 1, the horizontal separation speed V_{Eh} is increased by approximately 11.73% and the drop distance L is increased by approximately 13.3%. Further, entirely, it can be confirmed that the horizontal separation speed V_{Eh} is increased by approximately 12% to approximately 36% based on each d/h in the charging chute having the shape of the cycloid curved surface as compared to the charging chute having the straight line shape.

[0070] FIG. 7 shows a change in horizontal separation speed V_{Eh} of the raw material in accordance with a change in height of the charging chute while the length d of the charging chute is fixed to approximately 1 m. In accordance with FIG. 7, it can be seen that the horizontal separation speed of the raw material in the charging chute having the shape of the cycloid curved surface has a value that is higher than that of the horizontal separation speed in the charging chute having the straight line shape. Particularly, it can be seen that when the height of the charging chute is approximately 1.316 to approximately 1.417, the horizontal separation speed is highest and is increased by averagely approximately

24% and maximally approximately 66.7% as compared to the charging chute having the straight line shape.

[0071] As described above, when the horizontal separation speed of the raw material is increased, in the case where the density ρ and the size a are constant, the drop distance is increased by Equation 1. Further, when the horizontal separation speed is constant, the drop distance of the raw material having the large density ρ and size a may be increased to improve the degree of segregation.

[0072] Further, while the raw material is charged into the sintering truck, the sintering truck moves in a direction that is contrary to a separation direction of the raw material. In this case, the drop distance of the raw material having the large density and size is increased to first stack the raw material having the large density and size in the sintering truck and then stack the raw material having the small density and size thereon. Accordingly, the degree of segregation in a mixed sinter raw material layer in the sintering truck may be increased to increase air permeability and thus significantly increase productivity of sintered ore.

[0073] In another exemplary embodiment, when a mixed sinter raw material is separated from a charging chute, a horizontal direction speed of the raw material positioned on a surface of the charging chute, that is, the lowermost layer of a raw material layer, may be maximized, and in consideration of a height of the raw material layer on the charging chute, a separation speed of relatively large particles protruding from a surface of the raw material layer from the charging chute may be maximized by an inclined surface sorting action while the particles move along an inclined surface of the charging chute, thereby improving a segregation charging effect into a sintering truck. Accordingly, air permeability of the raw material may be improved to improve quality and productivity of sintered ore.

[0074] FIG. 8 is a view showing an operation principle of an apparatus for charging the raw material in accordance with another exemplary embodiment, FIG. 9 is a view showing the charging chute of the apparatus for charging the raw material in accordance with another exemplary embodiment, and FIG. 10 is a view for comparing horizontal separation speeds in accordance with a path.

[0075] In the apparatus for charging the sinter raw material in accordance with another exemplary embodiment, in the constitution of the charging chute through which various mixed raw materials are introduced into the sintering truck, the charging chute may be formed to have a curved surface having a shape of a prolate cycloid curve, such that the surface, that is, the uppermost layer, of the raw material layer moving along a movement path of the charging chute are fluidized while forming a locus having a shape of a cycloid curve that is known as the shortest drop curve, thereby increasing the horizontal separation speed of the mixed sinter raw material.

[0076] The prolate cycloid curve, as shown in FIG. 8, means a locus drawn by a predetermined point P on a circumference of an externally positioned large circle (circle having a radius of r_P) when an internally positioned small circle (circle having a radius of r) of two concentric circles having different radii r and r_P is rolled on a plane, and is represented by the following Equations 8 and 9.

Equation 8

$$x_P = r(\theta - (1+t)\sin\theta), y_P = -r(1 - (1+t)\cos\theta)$$

[0077] (where r is the radius of the small circle, and t is a difference between the radius of the large circle and the radius of the small circle ($r_P - r$))

Equation 9

$$\theta_{PS} = 2\Phi_{PS}, \theta_E = 2(\pi/2 - \Phi_E)$$

[0078] When a length d of the charging chute, an incident angle Φ_{PS} at a position P at which the mixed sinter raw materials are released from a drum feeder to the charging chute, a thickness t of a raw material fluidization layer on the charging chute, and a departure angle Φ_E from the charging chute at a position E at which the mixed sinter raw materials are separated from the charging chute are fixed, the radius r_P of the circle and the height h_P of the position P at which the mixed raw materials flow from the drum feeder into the charging chute may be drawn by using Equations 10 and 11.

Equation 10

$$r_P = \frac{d}{\theta_E - \theta_S + (1+t) \sin \theta_{PS} - (1+t) \sin \theta_E}$$

Equation 11

$$h_P = r_P (1+t) (\cos \theta_E - \cos \theta_{PS})$$

[0079] A separation speed V_{PE} , a horizontal direction separation speed V_{PEh} , and a vertical direction separation speed V_{PEv} of the raw material beneath the raw material fluidization layer (on the surface of the charging chute) at a raw material separation position E may be represented by the following Equations 12 and 13.

Equation 12

$$V_{PE} = \{2gr_P (\cos \theta_{PS} - \cos \theta_E)\}^{\frac{1}{2}}$$

Equation 13

$$V_{PEh} = V_{PE} \cos \theta_E \cdot V_{PEv} = V_{PE} \sin \theta_E$$

[0080] The charging chute has a path according to the curve shown in Equations 8 and 9, and the raw material released from the surface of the charging chute has the maximum horizontal speed with respect to the length d, the height h, the incident angle Φ_{PS} , and the departure angle Φ_E of the charging chute set during separation from the charging chute.

[0081] When the inclined locus of the charging chute has the prolate cycloid shape, a curve locus of the raw material particles on the uppermost portion (surface) of the raw material fluidization layer in consideration of the thickness t of the fluidization layer of the mixed sinter raw material has a typical cycloid curve equation.

[0082] The cycloid curve, as shown in FIG. 8, means a locus drawn by a predetermined point on the circumference when the circle (small circle) having the radius of r is rolled along a straight line on a plane, and is represented by Equations 2 and 3. In this case, the cycloid curve may seem to have a shape that is similar to that of the prolate cycloid curve, but it can be seen that a distance t (identical to the thickness of the raw material layer) between both curves is increased to the separation position E of the raw material from the charging chute.

[0083] When the departure angle Φ_E of the charging chute is fixed at the separation position E of the raw material from the charging chute while the length d and the height h of the charging chute are determined, the radius r of the circle, the height h of the position P at which the raw material is supplied from the drum feeder to the charging chute, and the incident angle Φ_S at the position P at which the raw material is released from the drum feeder to the charging chute may be drawn through repeated calculation by Equations 4 and 5. The incident angle Φ_S is an angle formed by the charging chute and a vertical direction straight line and an angle of an upper side of the charging chute into which the raw material is supplied from the drum feeder, and the departure angle is an angle formed by the charging chute and a horizontal direction straight line and an angle of a lower side of the charging chute from which the raw material is released to the sintering truck.

[0084] A separation speed V_E , a horizontal direction separation speed V_{Eh} , and a vertical direction separation speed V_{Ev} of the mixed sinter raw material at the separation position E of the raw material from the charging chute may be represented by Equations 6 and 7.

[0085] The charging chute has a path of the prolate cycloid curve according to the curve shown in Equations 8 and 9, and the raw material particles on the surface of the raw material layer are fluidized along the path of the cycloid curve. In this case, the particles have the maximum horizontal speed with respect to the set length d, height h, incident angle

Φ_{PS} , and departure angle Φ_E of the charging chute.

[0086] Referring to FIG. 9, the charging chute 130 may be formed by disposing a plurality of rolls 132 in parallel or formed as an integrated inclined plate (not shown). The charging chute 130 has a transportation path formed of a curved surface having an area, and a transversal cross-section of the charging chute 130 has the shape of the prolate cycloid curve like Equation 8. Further, the transversal cross-section of the surface of the raw material layer moving on the charging chute 130 has a cycloid curve-shaped locus like Equations 2 and 3. Thereafter, the raw material particles on the surface of the raw material layer separated from the charging chute 130 have the maximum horizontal separation speed V_{Eh} with respect to the set length d , height h , incident angle Φ_{PS} , and departure angle Φ_E of the charging chute 130 in order to form the curved surface locus of the charging chute.

[0087] FIG. 10(a) shows the separation speed of the raw material from the charging chute having a straight inclined surface. In the case of the charging chute having the straight inclined surface, when the length d and the height h of the charging chute are determined, an inclination angle Φ of the charging chute is determined.

[0088] FIG. 10(b) shows the separation speed of the raw material particles on the surface of the raw material layer from the charging chute having an inclined surface having a shape of a prolate cycloid curved surface. The transportation path of the charging chute is determined by a change in length d and height h of the charging chute and incident angle Φ_{PS} and departure angle of the raw material, and the separation speeds V_{PE} and V_E of the raw material from the charging chute are determined by Equations 12 and 6.

[0089] Comparing FIGS. 10(a) and 10(b) to each other, it can be seen that when the length d and the height h of the charging chute are the same as each other, in the case where the transportation path of the charging chute has the shape of the prolate cycloid curved surface, the horizontal separation speed V_{Eh} is increased and the vertical separation speed V_{Ev} is reduced as compared to the case where the charging chute has the straight line shape. Further, it can be seen that when the transportation path of the charging chute has the shape of the prolate cycloid curved surface, the separation speed V_{PE} on the surface of the charging chute and the separation speed V_E on the surface of the raw material layer are almost similar to each other.

[0090] In order to perform precise comparison, when the length d of the charging chute is fixed to approximately 1 m and the height h is changed to approximately 0.8 m, approximately 1.0 m, and approximately 1.2 m, the separation horizontal speed V_{PEh} , and variables of the raw material for each charging chute are described in the following Table 2. Embodiments 1 to 6 show the case of the charging chute having the shape of the cycloid curved surface, Comparative Embodiments 1 to 3 show the case of the charging chute having the straight line shape, and disturbance due to formation of attachment ore and an interaction due to a layer flow of the particles are not considered.

[Table 2]

	t (mm)	d/h (°m)	Φ (°)	Φ_{PS}/Φ_S (°)	Φ_E (°)	V_{PEh}/V_{Eh} (m/s)
Embodiment 1	10	1.0/0.8		42.4/41.9	30	3.43/3.43
Embodiment 2	10	1.0/1.0		32.5/26.5	30	3.7/3.84
Embodiment 3	10	1.0/1.2		9.4/6.8	30	4.2/4.2
Embodiment 4	50	1.0/0.8		44.3/41.9	30	3.43/3.43
Embodiment 5	50	1.0/1.0		30/26.5	30	3.84/3.84
Embodiment 6	50	1.0/1.2		15.7/6.8	30	4.2/4.2
Comparative Embodiment 1		1.0/0.8	38.7			3.07
Comparative Embodiment 2		1.0/1.0	45			3.11
Comparative Embodiment 3		1.0/1.2	50.2			3.08

[0091] In accordance with Table 2, it can be seen that when the length and the height of the charging chute are the same as each other, the horizontal separation speed V_{PEh} in Embodiments 1 to 6 is increased as compared to the horizontal separation speed V_{PEh} and V_{Eh} in Comparative Embodiments 1 to 3. For example, comparing Embodiment 1 and Comparative Embodiment 1 to each other, it can be seen that the horizontal separation speed V_{PEh} and V_{Eh} in Embodiment 1 is 3.43/3.43 m/s, but the horizontal separation speed V_{Eh} in Comparative Embodiment 1 is 3.07 m/s, and thus the horizontal separation speed V_{PEh} and V_{Eh} in Embodiment 1 is increased by approximately 11.73% as compared to Comparative Embodiment 1. Further, entirely, it can be confirmed that the horizontal separation speed V_{PEh} and V_{Eh} is increased by approximately 12% to approximately 36% based on each d/h in the case of the charging chute having the shape of the prolate cycloid curved surface as compared to the charging chute having the straight line shape.

[0092] When the horizontal separation speed of the raw material is increased, in the case where the density ρ and the size a are constant, the drop distance is increased by Equation 1.

[0093] Further, since the horizontal separation speeds of the raw material particles on the surface of the charging chute and on the surface of the raw material layer are almost the same as each other, when inclined surface sorting occurs in the raw material layer, the particles having the large size move to the upper portion of the raw material layer. Accordingly, when the horizontal separation speed is constant, the drop distance of the raw material having the large density ρ and size a , that is, the relatively large particles existing around the surface of the raw material layer fluidized on the charging chute, may be increased to improve the degree of segregation.

[0094] Further, while the raw material is charged into the sintering truck, the sintering truck moves in a direction that is contrary to a separation direction of the raw material. In this case, the drop distance of the raw material having the large density and size is increased to first stack the raw material having the large density and size in the sintering truck and then stack the raw material having the small density and size thereon. Accordingly, the degree of segregation in the mixed sinter raw material layer in the sintering truck may be increased to increase air permeability and thus significantly increase productivity of sintered ore.

[0095] In accordance with yet another exemplary embodiment, a plurality of rolls, that is, a transportation path of a raw material formed on a surface of a charging chute, may be formed to have a locus of a cycloid curve that is known as the shortest drop curve by positioning central axes of a plurality of rolls configured to form the charging chute on a locus of a prolate cycloid curve. Accordingly, a horizontal separation speed of the raw material charged into a sintering truck through the charging chute may be increased.

[0096] FIG. 11 is a view showing an operation principle of an apparatus for charging the raw material in accordance with yet another exemplary embodiment, FIG. 12 is a view showing the charging chute of the apparatus for charging the raw material in accordance with yet another exemplary embodiment, and FIG. 13 is a view showing a modified exemplary embodiment of the charging chute.

[0097] Referring to FIG. 11, the locus X of the prolate cycloid curve may seem to have a shape that is similar to that of the locus Y of the cycloid curve. However, it can be seen that a distance between the locus X of the prolate cycloid curve and the locus Y of the cycloid curve is increased from an upper portion to a lower portion in the charging chute, that is, to the separation position E of the raw material from the charging chute rather than a release position S of the raw material from a drum feeder. The distance between the locus X of the prolate cycloid curve and the locus Y of the cycloid curve is a radius of the roll. Accordingly, diameters (or radii) of a plurality of rolls configured to form the charging chute may be increased from the upper portion to the lower portion in the charging chute, that is, to the separation position E of the raw material from the charging chute rather than the release position S of the raw material from the drum feeder.

[0098] Referring to FIG. 12, the charging chute 130 may be formed by disposing a plurality of rolls 132 in parallel. The charging chute 130 has a transportation path formed as a curved surface having an area, and a transversal cross-section of the charging chute 130 has a cycloid curve shape. In this case, the charging chute 130, that is, central axes of a plurality of rolls 132 configured to form the transportation path of the raw material, are positioned on the prolate cycloid curve. The distance between the cycloid curve and the prolate cycloid curve is increased from the upper portion to the lower portion in the charging chute 130, and thus a plurality of rolls 132 may be formed to have different diameters (or radii). When the charging chute 130 is constituted as described above, the roll 132 of the lower portion of the charging chute 130 through which the raw material is discharged into the truck is formed to be relatively larger than the rolls 132 disposed at the upper portion. Accordingly, there is a merit in that a replacement time of the roll 132 can be delayed by suppressing or preventing a transportation speed of the raw material transported along the transportation path formed on the charging chute 130 and a reduction in life-span of the roll 132 disposed at the lower portion of the charging chute 130, which may be most significantly affected by a load.

[0099] As shown in FIG. 12, the charging chute 130 may be disposed so that the diameters of the rolls 132 are continuously increased in a movement direction of the raw material, that is, from the upper portion to the lower portion.

[0100] Alternatively, as shown in FIG. 13, the charging chute 130 may be divided into a plurality of regions in the movement direction of the raw material, for example, an upper region (I), an intermediate region (II), and a lower region (III), and rolls 1320a, 1320b, and 1320c having the same diameter may be disposed in the regions, respectively. In this case, the rolls may be disposed so that the diameters of the rolls 1320a, 1320b, and 1320c may be gradually increased from the upper region (I) to the lower region (III).

[0101] The separation speed V_E of the raw material from the charging chute is determined in accordance with a change in length d , height h , incident angle Φ_S , and departure angle Φ_E of the charging chute 130 by Equation 6. In this case, assuming that the height of the charging chute 130 is fixed to approximately 1 m, the incident angle Φ_S of the charging chute 130 may be approximately 5° to approximately 50° , and the departure angle Φ_E may be approximately 10° to approximately 60° . When the incident angle and the departure angle of the charging chute 130 are within the aforementioned range, since the transportation path of the charging chute 130 may be formed to have a shape of a curved surface having an ideal cycloid curve locus, the horizontal separation speed V_{Eh} of the raw material may be increased to maximize

the separation speed V_E of the raw material from the charging chute.

[0102] FIG. 14 is a graph showing a change in horizontal drop distance in accordance with a type of the charging chute, and a test result obtained by comparing layering distributions in accordance with a drop distance in the truck of the mixed sinter raw material.

[0103] The release test of the sinter raw material from a straight-line division deflector plate-type charging chute (hereinafter, referred to as "charging chute 1") and the charging chute in accordance with the exemplary embodiments (hereinafter, referred to as "charging chute 2") was performed.

[0104] The truck did not move but was in a stationary state, the height of the hopper was approximately 2.5 m, and the lower angle of the charging chute was approximately 40° , which were identically applied to the two charging chutes. A horizontal axis of FIG. 14 represents a drop distance (cm) of the mixed sinter raw material, and a vertical axis represents a layering height ratio on the basis of the total release amount of the raw material.

[0105] Referring to FIG. 14, in review of the layering height of the raw material released into the truck, when charging chute 1 is used, a portion A having the largest layering height is formed at a distance of approximately 35 cm, and when charging chute 2 is used, a portion B having the largest layering height is formed at a distance of approximately 45 cm. As described above, like the case where charging chute 2 in accordance with the exemplary embodiment is used, through the fact that the portion B having the largest layering height is formed to be far away from a discharging position of the raw material from the charging chute, it can be seen that the horizontal drop distance of the raw material discharged from the charging chute is increased.

[0106] In addition, in review of the degree of distribution in the truck, it can be seen that when the raw material is charged into the truck by using charging chute 1, most raw materials are distributed in a region C of approximately 20 cm to approximately 65 cm, and when the raw material is charged into the truck by using charging chute 2, most raw materials are distributed in a region D of approximately 28 cm to approximately 88 cm. That is, it can be seen that when the raw material is charged into the truck by using charging chute 2 in accordance with the exemplary embodiment, the raw materials are uniformly distributed over a wide region including even a point that is far away from the charging chute.

[0107] Through the aforementioned result, it can be seen that the horizontal drop distance is increased by approximately 33% and the degree of distribution of the sinter raw material is increased by approximately 26% in the constitution of charging chute 2 as compared to charging chute 1. Disturbance due to formation of attachment ore and an interaction due to a layer flow of the particles are not considered.

[0108] Accordingly, when the horizontal drop distance of the raw material is increased, since the drop distance of the raw material having the large density and size is increased and the degree of distribution is increased, drop points of the raw materials having significantly different sizes and densities are clearly distinguished, and thus the degree of segregation of the raw materials may be improved.

[0109] Further, while the raw material is charged into the sintering truck, the sintering truck moves in a direction that is contrary to a separation direction of the raw material. In this case, the drop distance of the raw material having the large density and size is increased to first stack the raw material having the large density and size in the sintering truck and then stack the raw material having the small density and size thereon. Accordingly, the degree of segregation in the mixed sinter raw material layer in the sintering truck may be increased to increase air permeability and thus significantly increase productivity of sintered ore.

[0110] As described above, in the constitution of the charging chute, in order to increase the horizontal separation speed of the raw material, a segregation charging effect of the raw material may be improved by controlling the curved surface formed on the upper surface of the charging chute or the transportation path of the raw material layer on the charging chute. Moreover, the segregation charging effect of the raw material may be further increased by using electrically charging and magnetic properties of the raw material. For example, pulverized coke and pulverized sintered ore as the pulverized raw material may be sorted from the raw material transported along the charging chute to be charged onto an upper layer of the sintering truck. The constitution of the charging chute as will be described below may be applied to all charging chutes in accordance with the exemplary embodiments.

[0111] FIG. 15 is a view schematically showing the raw material supply unit of the apparatus for charging the raw material in accordance with the exemplary embodiment, FIG. 16 is a view schematically showing the charging chute of the apparatus for charging the raw material in accordance with the exemplary embodiment, FIG. 17 is a view showing a structure of an electrode-magnetic roll, and FIGS. 18 and 19 are views showing disposal of an electrode and a magnetic body.

[0112] The apparatus for charging the raw material includes the raw material supply unit including the raw material hopper 100 and the drum feeder 120, and the charging chute 130.

[0113] The raw material hopper 100 supplies the mixed raw material 1 such as pulverized iron, pulverized iron ore, sub-materials, and pulverized coke through the hopper gate 110 to the drum feeder 120, and the drum feeder 120 blends the raw material 1 supplied thereto while rotating and thus supply the raw material to the charging chute 130.

[0114] Referring to FIG. 15, electrode plates 100a, 120a, and 110a are provided in at least one of the raw material hopper 100, the drum feeder 120, and the hopper gate 110 to electrically charge the raw material 1 supplied to the

charging chute 130. For example, the electrode plates 100a, 120a, and 110a may be a cathode or an anode, and are preferably formed of the same type of electrode, and thus pulverized coke of the raw material 1 is negatively or positively electrically charged by the electrode plates 100a, 120a, and 110a. Accordingly, pulverized coke is supplied to the charging chute 130 while electrically charged.

[0115] The charging chute 130 functions to sort the raw materials 1 so that small particles are charged at an upper portion of the storage container in which the mixed raw material 1 is stored, that is, the sintering truck 200, and large particles are charged at a lower portion (vertical segregation is facilitated) by forming an inclined surface. When the raw material is charged into the sintering truck 200, the surface of the raw material is made even by the surface leveling plate 140 and ignited in the ignition furnace 150, and a sintering reaction is performed due to combustion of coke included in the raw material 1 by air sucked from a wind box to the lower portion by a suction blower (not shown) to manufacture sintered ore.

[0116] Referring to FIG. 16, the charging chute 130 may be formed by disposing a plurality of rolls 132 in parallel so that the rolls are spaced apart from each other. The charging chute 130 may have a straight or curve type-transportation path having an area, and charges the mixed raw material 1 through the transportation path into the sintering truck 200.

[0117] The charging chute 130 includes electrode-magnetic rolls 132a and 132b including electrode plates 1324a, 1324b, 1324c, and 1324d electrically charging at least a portion of the rolls 132a and 132b and a magnetic body 1325 providing a magnetic property to at least a portion of the rolls 132a and 132b.

[0118] In the charging chute 130, a plurality of first electrode-magnetic rolls 132a are disposed at the drum feeder 120 to which the raw material 1 is supplied, that is, the upper portion, and a plurality of second electrode-magnetic rolls 132b are disposed at the sintering truck 200 into which the raw material 1 is charged, that is, the lower portion. In addition, a scrapper 139 attached to surfaces of the electrode-magnetic rolls 132a and 132b to remove remaining pulverized coke and pulverized sintered ore and thus charge pulverized coke and pulverized sintered ore into the sintering truck 200 may be provided beneath the electrode-magnetic rolls 132a and 132b. The scrapper 139 may be formed in a plate form in a longitudinal direction of the electrode-magnetic rolls 132a and 132b, and provided to have ends coming into contact with external circumferential surfaces of the electrode-magnetic rolls 132a and 132b. In this case, since the first electrode-magnetic roll 132a functions to electrically charge electrically charged pulverized coke again of the raw material 1 supplied through the drum feeder 120, the scrapper 139 may not be formed beneath the first electrode-magnetic roll 132a so that the raw material electrically charged in the first electrode-magnetic roll 132a is separated from the second electrode-magnetic roll 132b.

[0119] The electrode-magnetic rolls 132a and 132b include a fixed roll 1321 provided in a fixed state, a rotation roll 1323 formed to have a hollow cylinder shape, disposed to surround a circumferential surface of the fixed roll 1321, and rotating along the circumferential surface of the fixed roll 1321, and the electrode plates 1324a and 1324b and the magnetic body 1325 disposed between the fixed roll 1321 and the rotation roll 1323. In this case, the fixed roll 1321 and the rotation roll 1323 may be connected through a connection unit 1322 such as a bearing while an external circumferential surface of the fixed roll 1321 and an internal circumferential surface of the rotation roll 1323 are spaced apart from each other, thus allowing the rotation roll 1323 to roll while friction does not occur between the rotation roll 1323 and the fixed roll 1321. The electrode-magnetic rolls 132a and 132b function to screen electrically charged pulverized coke and pulverized sintered ore as a demagnetizing material to a space therebetween by using repulsive force (pushing force between materials) generated between materials having the same polarity and attractive force (pulling force between materials) generated between materials having opposite polarities.

[0120] Referring to FIG. 16, the electrode-magnetic rolls 132a and 132b include the fixed roll 1321 provided in a fixed state, the rotation roll 1323 formed to have a hollow cylinder shape, disposed to surround the external circumferential surface of the fixed roll 1321, and rotating along the external circumferential surface of the fixed roll 1321, and the electrode plates 1324a, 1324b, 1324c, and 1324d and the magnetic body 1325 disposed between the fixed roll 1321 and the rotation roll 1323. In this case, the fixed roll 1321 means a portion other than the electrode plates 1324a, 1324b, 1324c, and 1324d and the magnetic body 1325. The fixed roll 1321 and the rotation roll 1323 may be connected through the connection unit 1322 such as a bearing while the external circumferential surface of the fixed roll 1321 and the internal circumferential surface of the rotation roll 1323 are spaced apart from each other, thus allowing the rotation roll 1323 to roll while friction does not occur between the rotation roll 1323 and the fixed roll 1321.

[0121] Through the aforementioned structure, a magnetic region M, a nonmagnetic region N, a positive electric charge region X, a negative electric charge region Y, and a non-electric charge region Z are formed on the external circumferential surfaces of the electrode-magnetic rolls 132a and 132b. In this case, the magnetic region M, the nonmagnetic region N, the positive electric charge region X, the negative electric charge region Y, and the non-electric charge region Z are formed in a longitudinal direction of the electrode-magnetic rolls 132a and 132b.

[0122] Structures of the electrode plates 1324a, 1324b, 1324c, and 1324d and the magnetic body 1325 provided in the fixed roll 1321 will be specifically described below.

[0123] First, the magnetic body 1325 is disposed so that a portion of the fixed roll 1321 is formed in a longitudinal direction of the fixed roll 1321. For example, the magnetic body 1325, as shown in FIG. 17, may be formed so that a

portion of the external circumferential surface of the fixed roll 1321 is formed, or may be formed to have a pie shape so that a portion ranging from the center of the fixed roll 1321 to the external circumferential surface is formed. Since the magnetic body 1325 is formed in the fixed roll 1321 that does not rotate, the magnetic region M and the nonmagnetic region N are formed to be fixed in the electrode-magnetic rolls 132a and 132b. In this case, various magnetic bodies having a magnetic property, such as a permanent magnet and an electromagnet, may be used as the magnetic body 1325. As described above, the fixed roll 1321 may be formed of a nonmagnetic body in order to form the magnetic region M and the nonmagnetic region N by the magnetic body 1325.

[0124] In order to charge a demagnetizing raw material such as magnetite (Fe_3O_4) and hematite (Fe_2O_3) contained in the raw material 1 onto the raw material layer of the sintering truck 200 by using the electrode-magnetic rolls 132a and 132b constituted as described above, it is important to dispose the magnetic body 1325 at an appropriate position of the fixed roll 1321.

[0125] The magnetic body 1325 may be disposed at a position at which it is easy to attach the demagnetizing raw material from the mixed raw material 10 transported along the transportation path of the charging chute 130 and a mutual interference does not occur between the adjacent electrode-magnetic rolls 132a and 132b. Accordingly, the magnetic body 1325 may be disposed at a position corresponding to the transportation path in the fixed roll 1321, and may be formed not to overlap the magnetic body 1325 disposed in the adjacent electrode-magnetic rolls 132a and 132b so that the nonmagnetic region N is formed on the transportation path.

[0126] Meanwhile, the electrode plates 1324a, 1324b, 1324c, and 1324d may be each an anode (+) and a cathode (-), and regions electrically charged by different electric charges are present together in one electrode-magnetic roll 132a and 132b. In this case, the fixed roll 1321 may be formed as an electric insulator, and the two electrode plates 1324a and 1324b or 1324c and 1324d are spaced apart from each other to be formed in a longitudinal direction of the fixed roll 1321. The electrode plates 1324a, 1324b, 1324c, and 1324d may be formed to be attached to the surface of the fixed roll 1321, or may be formed to be inserted into a groove formed in a predetermined depth in the fixed roll 1321. In this case, the electrode plates 1324a, 1324b, 1324c, and 1324d may be provided on the upper portion, in other words, the external side, of the magnetic body 1325, that is, in the outside in the region where the magnetic body 1325 is formed. Since the region where the electrode plates 1324a, 1324b, 1324c, and 1324d are formed is widely distributed as compared to the magnetic body 1325, in order to apply predetermined attractive force and repulsive force to the electrically charged raw material particles of the raw material 1 transported along the transportation path, the electrode plates 1324a, 1324b, 1324c, and 1324d having a wide forming area may be formed on the external side of the fixed roll 1321. However, a disposal structure of the magnetic body 1325 and the electrode plates 1324a, 1324b, 1324c, and 1324d is not limited thereto, and of course, the magnetic body 1325 may be provided outside at least a portion of the electrode plates 1324a, 1324b, 1324c, and 1324d. Further, the electrode plates 1324a, 1324b, 1324c, and 1324d may be formed to partially overlap on the magnetic body 1325, or may be formed to directly come into contact with the external circumferential surface of the rotation roll 1321. Accordingly, an electromagnetic insulator as an electric insulator and a nonmagnetic body may be interposed between the magnetic body 1325 and the electrode plates 1324a, 1324b, 1324c, and 1324d, and among the fixed roll 1321, the magnetic body 1325, and the electrode plates 1324a, 1324b, 1324c, and 1324d, thus suppressing or preventing an effect that may occur between the electrode plates 1324a, 1324b, 1324c, and 1324d and the magnetic body 1325.

[0127] The electrode plates 1324a, 1324b, 1324c, and 1324d provided in the electrode-magnetic rolls 132a and 132b are formed to have a plate shape herein, but the shape is not limited thereto.

[0128] Through the aforementioned constitution, in the electrode-magnetic rolls 132a and 132b, in the fixed roll 1321, the positive electric charge region X electrically charged by positive electric charges may be formed in the region where the anode is disposed, the negative electric charge region Y electrically charged by negative electric charges may be formed in the region where the cathode is disposed, and the non-electric charge region Z having no positive and negative electric charges may be formed in a space where the electrode plates 1324a, 1324b, 1324c, and 1324d are not formed between the positive electric charge region X and the negative electric charge region Y. In addition, the magnetic region M may be formed in a region where the magnetic body 1325 is disposed, and the nonmagnetic region N may be formed in a region where the magnetic body 1325 is not provided. In this case, the electrically charged and non-electric charge regions X, Y, and Z and the magnetic and nonmagnetic regions M and N may be formed to partially overlap each other, and each region X, Y, X, M, and N is formed in a longitudinal direction of the electrode-magnetic rolls 132a and 132b. Hereinafter, for the convenience of description, the X region is called the positive electric charge region, and the Y region is called the negative electric charge region.

[0129] In order to charge pulverized coke and pulverized sintered ore contained in the raw material 1 onto the raw material layer of the sintering truck 200 by using the electrode-magnetic rolls 132a and 132b constituted as described above, it is important to dispose the electrode plates 1324a, 1324b, 1324c, and 1324d at an appropriate position of the fixed roll 1321. The pulverized sintered ore as the demagnetizing raw material is attached to the surface of the rotation roll 1323 in the region where the magnetic body 1325 is provided while transported along the charging chute 130, and pulverized sintered ore attached to the surface of the rotation roll 1323 moves together with rotation of the rotation roll

1323 to be separated from the surface of the rotation roll 1323 in the region where the magnetic body 1325 is not provided. However, pulverized coke is supplied to the charging chute 130 in an electrically charged state to be attached to the surface of the rotation roll 1323 in the region where the electrode plate electrically charged to have the opposite polarity is provided, and moves together with rotation of the rotation roll 1323 to be separated from the surface of the rotation roll 1323 in the region where the electrode plate electrically charged to have the same polarity is provided. However, since the raw material 1 is electrically charged in a large amount in the raw material hopper 100 and the drum feeder 120 through which the raw material 1 is supplied, pulverized coke of the raw material 1 may not be smoothly electrically charged. Accordingly, a portion of the charging chute 130 needs to form the electrode-magnetic roll 132a (referred to as first electrode-magnetic roll) to complement electric charging of pulverized coke, and the remain needs to form the electrode-magnetic roll 132b (referred to as second electrode-magnetic roll) to filter electrically charged pulverized coke.

[0130] The magnetic body 1325 may be formed to have the same shape as the first electrode-magnetic roll 132a and the second electrode-magnetic roll 132b. The magnetic body is disposed so that the nonmagnetic region Y is formed between the magnetic body and the adjacent electrode-magnetic rolls 132a and 132b to prevent occurrence of interference between the magnetic body and the adjacent electrode-magnetic rolls 132a and 132b. A virtual oblique line is drawn by connecting centers of the adjacent electrode-magnetic rolls 132a and 132b to each other. The magnetic body 1325 is disposed on the thusly formed virtual oblique line. In this case, the magnetic body 1325 is formed to have a predetermined angle, for example, an angle of approximately 110° to approximately 150° so that the nonmagnetic region N is formed between the adjacent electrode-magnetic rolls 132a and 132b. The magnetic body 1325 may be formed to be biased toward the electrode-magnetic rolls 132a and 132b at the lower side rather than the electrode-magnetic rolls 132a and 132b at the upper side. That is, the demagnetizing raw material of the raw material 1 is attached to the external circumferential surface of the rotation roll 1323 in the magnetic region M and separated in accordance with rotation of the rotation roll 1323 in the nonmagnetic region (N) to be charged into the sintering truck 200, such that filtering of the demagnetizing raw material is smoothly performed even in the electrode-magnetic roll 132b at the lower side, in which the sintering truck 200 is disposed, that is, the second electrode-magnetic roll 132b. Accordingly, segregation efficiency of the demagnetizing raw material may be improved without interference between the adjacent electrode-magnetic rolls 132ba and 132bb.

[0131] Through the aforementioned constitution, the electrode-magnetic rolls 132a and 132b acts as a screen sorting the demagnetizing raw material from the raw material 1 transported along the charging chute 130. That is, the electrode-magnetic rolls 132a and 132b are disposed to be spaced apart from each other on the transportation path of the charging chute 130 to alternately and repeatedly form the magnetic region M and the nonmagnetic region N. While the demagnetizing raw material is attached to and separated from the external circumferential surface as described above, an interval t between the electrode-magnetic rolls 132a and 132b may be set so that the demagnetizing raw material attached to the external circumferential surface of the rotation roll 1323 of the electrode-magnetic rolls 132a and 132b does not come into contact with the external circumferential surface of the adjacent electrode-magnetic rolls 132a and 132b. Typically, an interval between general rolls configured to form the charging chute is approximately 3 mm to approximately 5 mm, and the interval t between the electrode-magnetic rolls 132a and 132b may be set to be approximately 5 mm to approximately 8 mm that is slightly larger than the interval between the general rolls and thus smoothly move the demagnetizing raw material attached to the external circumferential surface of the electrode-magnetic rolls 132a and 132b. In this case, there are limitations in that when the interval t between the electrode-magnetic rolls 132a and 132b is smaller than the proposed range, it is difficult to move the demagnetizing raw material attached to the external circumferential surface of the electrode-magnetic rolls 132a and 132b to a space between the electrode-magnetic rolls 132a and 132b, and when the interval is larger than the proposed range, the raw material having the particle size that is larger than that of the demagnetizing raw material is discharged between the electrode-magnetic rolls 132a and 132b to be charged onto the raw material layer in the sintering truck 200 and thus reduce segregation efficiency.

[0132] Of course, the interval between the electrode-magnetic rolls 132a and 132b and the forming range of the magnetic body 1325 may be variously changed in accordance with the shape of the transportation path formed by the electrode-magnetic rolls 132a and 132b.

[0133] For the electrode plates 1324a, 1324b, 1324c, and 1324d, in the first electrode-magnetic roll 132a of the fixed roll 1321, a first electrode plate 1324a having the polarity which is identical to that of pulverized coke electrically charged in the raw material supply unit may be formed at the upper side where the mixed raw material is transported, and a second electrode plate 1324b having the polarity which is contrary to that of power coke may be formed at the lower side.

[0134] The first electrode plate 1324a functions to increase electric charging of electrically charged pulverized coke of powder coke supplied from the raw material supply unit and electrically charge pulverized coke that is not electrically charged. The first electrode plate 1324a may be formed on a virtual line S based on the virtual line S (the virtual line may be formed to be parallel to the transportation path) formed by connecting centers of a plurality of first electrode-magnetic rolls 132a to each other, and may be formed in a range where mutual interference with the adjacent other electrode plate does not occur. For example, the first electrode plate 1324a may be formed in the range ($\theta 2$) of approx-

imately 110° to 150° from the center of the fixed roll 1321.

[0135] The second electrode plate 1324b functions to attach pulverized coke electrically charged by the first electrode plate 1324a to the surface of the first electrode-magnetic roll 132a due to attractive force to discharge pulverized coke into a space between the first electrode-magnetic rolls 132a and thus charge pulverized coke onto the raw material layer of the sintering truck 200. In this case, pulverized coke attached to the first electrode-magnetic roll 132a may come into contact with the scrapper 139 provided at the lower portion in accordance with rotation of the first electrode-magnetic roll 132a to be removed, or may be removed from the surface of the first electrode-magnetic roll 132a due to repulsive force applied to the non-electric charge region Z or the electrically charged positive electric charge region X in which the electrode plate is not formed. The second electrode plate 1324b may be formed beneath the virtual line to be spaced apart from the first electrode plate 1324a by a predetermined distance based on the virtual line. FIG. 18 shows that the second electrode plate 1324b is formed to have a length that is smaller than that of the first electrode plate 1324a, but when mutual interference with the adjacent electrode plate does not occur, the length may be identical to or larger than that of the first electrode plate.

[0136] The second electrode-magnetic roll 132b acts as a screen configured to discharge pulverized coke not discharged between the first electrode-magnetic rolls 132a and transported along the transportation path formed by the first electrode-magnetic roll 132a between the second electrode-magnetic rolls 132b by using electric attractive force. Accordingly, a third electrode plate 1324c and a fourth electrode plate 1324d are present together on the transportation path formed by the second electrode-magnetic roll 132b. In the second electrode-magnetic roll 132b, the third electrode plate 1324c having the polarity which is identical to that of pulverized coke may be provided in a direction which is contrary to a transportation direction of the mixed raw material to electrically charge electrically charged pulverized coke, and the fourth electrode plate 1324d having the polarity which is contrary to that of electrically charged pulverized coke may be provided in the transportation direction of the mixed raw material to separate pulverized coke attached to the surface of the second electrode-magnetic roll 132b.

[0137] Referring to FIG. 19, the third electrode plate 1324c and the fourth electrode plate 1324d may be disposed to be spaced apart from each other by a predetermined distance so that interference with the electrode plate formed on the adjacent electrode-magnetic rolls 132a and 132b does not occur. The disposal may be changed in accordance with various installation conditions of the charging chute, such as a diameter and a spacing distance of the electrode-magnetic roll. In the second electrode-magnetic roll 132b, the positive electric charge region X formed by the third electrode plate 1324c functions to electrically charge pulverized coke of the mixed raw material transported along the first electrode-magnetic roll 132a, and the negative electric charge region Y formed by the fourth electrode plate 1324d functions to attach electrically charged pulverized coke to the surface of the second electrode-magnetic roll 132b, that is, the surface of the rotation roll 1323 by using attractive force. As described above, since attractive force as pulling force between the materials is applied between the materials having different polarities, in the negative electric charge region Y electrically charged to have the polarity which is contrary to that of electrically charged pulverized coke, pulverized coke is attached to the surface of the rotation roll 1323, and pulverized coke attached to the surface of the rotation roll 1323 moves through the space between the second electrode-magnetic rolls 132b to the lower side of the transportation path in accordance with rotation of the rotation roll 1323. Pulverized coke moving to the lower side of the transportation path is removed from the surface of the rotation roll 1323 by the scrapper 139 provided on the lower portion of the second electrode-magnetic roll 132b to be charged onto the raw material layer of the sintering truck 200.

[0138] Through the aforementioned constitution, the electrode-magnetic rolls 132a and 132b acts as a screen sorting pulverized coke and pulverized sintered ore from the mixed raw material 1 transported along the charging chute 130. That is, the charging chute 130 may be formed of the electrode-magnetic roll where the electrode plate and the magnetic body are formed to electrically charge pulverized coke from the mixed raw material supplied from the raw material supply unit and transport pulverized coke, and charge pulverized coke onto the raw material layer of the sintering truck 200 by using electric attractive force and repulsive force and magnetic force during transportation.

[0139] Hereinafter, a method of charging a raw material in accordance with the exemplary embodiment will be described.

[0140] FIG. 20 is a view showing a transportation state of the raw material transported in accordance with the charging chute.

[0141] Referring to FIG. 20, when the prepared raw material 1 including pulverized coke and sintered ore mixed with each other is supplied through the drum feeder 120 to the charging chute 130, the mixed raw material 1 moves along the transportation path formed on the charging chute 130 to be charged into the sintering truck 200. In this case, pulverized coke of the raw material 1 supplied to the charging chute 130 is electrically charged as the cathode or the anode by the electrode plates 100a, 110a, and 120a formed in the raw material hopper 100, the drum feeder 03, and the hopper gate 110.

[0142] The raw material 1 supplied to the charging chute 130 is subjected to inclined surface sorting on the transportation path to be transported so that the raw material having the small particle size, for example, pulverized coke and pulverized sintered ore, is positioned at the lower portion of the transportation path and the raw material having the large particle

size, for example, sub-materials, is positioned at the upper portion. In addition, while pulverized coke of the mixed raw material 1 is transported along the transportation path (upper side of the charging chute) formed by the first electrode-magnetic roll 132a, an electric charging amount of electrically charged pulverized coke is increased in the raw material supply unit, and pulverized coke that is not electrically charged in the raw material supply unit is electrically charged to

have the polarity which is identical to that of pulverized coke electrically charged in the raw material supply unit.
[0143] Meanwhile, while pulverized sintered ore as the demagnetizing raw material of the raw material 1 is transported along the transportation path formed by the electrode-magnetic rolls 132a and 132b, pulverized sintered ore is attached to the surface of the rotation roll 1323 on the transportation path having the magnetic body 1325. Thereafter, pulverized sintered ore moves to the lower side of the transportation path while attached to the rotation roll 1323 in accordance with rotation of the rotation roll 1323, and when pulverized sintered ore reaches the region where the magnetic body 1325 is not formed, that is, the nonmagnetic region N, pulverized sintered ore is separated from the surface of the rotation roll 1323 to be charged onto the raw material layer of the sintering truck 200.

[0144] Thereafter, while the raw material 1 is transported along the transportation path (lower side of the charging chute) formed by the second electrode-magnetic roll 132b, pulverized coke electrically charged by the raw material supply unit and the first electrode-magnetic roll 132a is discharged to a space between the second electrode-magnetic rolls 132b due to electric repulsive force to be charged onto the raw material layer of the sintering truck 200. Pulverized coke electrically charged in the raw material supply unit is attached to and separated from the surface of the electrode-magnetic rolls 132a and 132b while passing through the region electrically charged to have the polarity which is identical to that of pulverized coke and the region electrically charged to have the polarity which is contrary to that of pulverized coke, and thus segregated and charged onto the raw material layer of the sintering truck 200 through the space between the electrode-magnetic rolls 132a and 132b and an end of the charging chute 130 (second electrode-magnetic roll at the sintering truck). For example, while pulverized coke electrically charged to have a positive (+) electric charge in the raw material supply unit is transported along the transportation path formed by the first electrode-magnetic roll 132a, a positive electric charge amount is increased or pulverized coke is electrically charged to have the positive electric charge on the transportation path. Pulverized coke electrically charged to have the positive electric charge is transported along the transportation path by rotation of the first electrode-magnetic roll 132a, and a portion thereof is discharged to the space between the first electrode-magnetic rolls 132a. In this case, a portion of pulverized coke discharged between the first electrode-magnetic rolls 132a is attached to the negative electric charge region Y in the first electrode-magnetic roll 132a, and comes into contact with the scrapper 139 provided at the lower portion of the first electrode-magnetic roll 132a while the rotation roll 1323 of the first electrode-magnetic roll 132a rotates to be separated from the surface of the first electrode-magnetic roll 132a and thus be charged onto the raw material layer of the sintering truck 200.

[0145] Further, the demagnetizing raw material (pulverized sintered ore) not attached by the first electrode-magnetic roll 132a and transported to the second electrode-magnetic roll 132b is attached to the surface of the rotation roll 1323 in the magnetic region M of the second electrode-magnetic roll 132b, and separated in the nonmagnetic region N to be charged onto the raw material layer of the sintering truck 200.

[0146] In order to effectively attach pulverized coke and pulverized sintered ore (demagnetizing raw material) to the surface of the rotation roll 1323 of the electrode-magnetic rolls 132a and 132b, a rotation speed of the rotation roll 1323 may be lower than a transportation speed of the raw material 1. That is, this is because when the rotation roll 1323 rotates at a speed which is higher than the transportation speed of the raw material 1, an amount of pulverized coke and pulverized sintered ore attached to the surface of the rotation roll 1323 is very small, and thus segregation efficiency may be reduced. Accordingly, segregation efficiency of the raw material 1 charged into the sintering truck 130 may be improved by controlling the rotation speed of the rotation roll 1323 to be lower than the transportation speed of the raw material 1. In addition, when the transportation speed of the mixed raw material 1 is excessively high, the transportation speed of the mixed raw material 1 may be reduced by allowing the rotation roll 1323 to rotate in a direction which is contrary to a transportation direction of the mixed raw material 1.

[0147] Although the apparatus and the method of charging the raw material have been described with reference to the specific embodiments, they are not limited thereto. Therefore, it will be readily understood by those skilled in the art that various modifications and changes can be made thereto without departing from the spirit and scope of the present invention defined by the appended claims.

INDUSTRIAL APPLICABILITY

[0148] In an apparatus of charging a raw material and a method of charging a raw material in accordance with exemplary embodiments, it is possible to increase segregation charging efficiency of a raw material charged into a moving sintering truck and thus improve air permeability of a raw material layer. Accordingly, it is possible to improve quality and productivity of sintered ore.

Claims

1. An apparatus for charging a raw material, the apparatus comprising:

a raw material supply unit configured to supply the raw material, and
 a charging chute configured to transport the raw material supplied from the raw material supply unit to a storage container,
 wherein in the charging chute, a transportation path of the raw material has a curved surface having a cycloid curve shape.

2. An apparatus for charging a raw material, the apparatus comprising:

a raw material supply unit configured to supply the raw material, and
 a charging chute configured to transport the raw material supplied from the raw material supply unit to a storage container,
 wherein in the charging chute, a transportation path of the raw material has a curved surface having a prolate cycloid curve shape.

3. An apparatus for charging a raw material, the apparatus comprising:

a raw material supply unit configured to supply the raw material, and
 a charging chute configured to transport the raw material supplied from the raw material supply unit to a storage container,
 wherein in the charging chute, a plurality of rolls are disposed in parallel to form a transportation path of the raw material, central axes of the plurality of rolls are positioned on a prolate cycloid curve, and the transportation path of the raw material formed on the plurality of rolls has a curved surface having a cycloid curve shape.

4. The apparatus of any one of claims 1 to 3, wherein in the charging chute, an incident angle formed by a portion through which the raw material flows in and a vertical direction is smaller than a departure angle formed by a portion through which the raw material is discharged and a horizontal direction.

5. The apparatus of claim 4, wherein the incident angle is approximately 5° to 50°, and the departure angle is approximately 10° to approximately 60°.

6. The apparatus of claim 3, wherein the plurality of rolls are disposed to have a diameter continuously increased from an upper portion to a lower portion in the charging chute.

7. The apparatus of any one of claims 1 to 3, wherein in the charging chute, the plurality of rolls are disposed in parallel to form the transportation path of the raw material, the plurality of rolls comprises electrode-magnetic rolls comprising at least an electrically charged portion and at least a portion having a magnetic property, and the electrode-magnetic rolls comprise a non-rotating fixed roll, a rotation roll configured to surround an exterior of the fixed roll and rotate along an external circumferential surface of the fixed roll, and an electrode plate and a magnetic body disposed on at least a portion of the fixed roll.

8. The apparatus of claim 7, wherein the magnetic body is provided on a portion corresponding to the transportation path through which the raw material is transported.

9. The apparatus of claim 8, wherein the magnetic body is disposed to be biased toward an adjacent magnetic roll positioned in a progress direction of the raw material.

10. The apparatus of claim 9, wherein the magnetic body is formed in a region of approximately 110° to approximately 150° based on a center of a fixed roll.

11. The apparatus of claim 7, wherein a raw material supply unit comprises an electrically charging apparatus configured to electrically charge the raw material, and the electrode-magnetic rolls comprise a plurality of first electrode-magnetic rolls in which an electrically charged region having a polarity which is identical to the polarity of the raw material is formed on the transportation path adjacent to the raw material supply unit and the electrically charged region having the polarity which is contrary to the polarity of the raw material is formed beneath the transportation path, and a

plurality of second electrode-magnetic rolls in which the electrically charged region having the polarity which is identical to the polarity of the raw material and the electrically charged region having the polarity which is contrary to the polarity of the raw material are formed on the transportation path adjacent to a storage container.

- 5 **12.** The apparatus of claim 11, wherein electrode plates having the different polarities are disposed on a fixed roll to be spaced apart from each other.
- 13.** The apparatus of claim 12, wherein the electrode plates are provided to at least partially overlap a magnetic body.
- 10 **14.** The apparatus of claim 13, wherein in a second electrode-magnetic roll, an electrically charged region having a polarity which is contrary to the polarity of a raw material is formed in a transportation direction of the raw material.
- 15.** The apparatus of claim 7, wherein the fixed roll comprises an electromagnetic insulator.
- 15 **16.** The apparatus of claim 7, wherein an electromagnetic insulator is provided in at least one space of spaces among the fixed roll, the electrode plate, and the magnetic body.
- 17.** A method of charging a raw material, the method comprising:
20 preparing the raw material;
 supplying the raw material to a charging chute; and
 charging the raw material into a storage container by transporting the raw material supplied to the charging chute along a path having a cycloid curve shape.
- 25 **18.** The method of claim 17, wherein during the charging of the raw material into the storage container, a surface of a raw material layer on the charging chute forms a locus having the cycloid curve shape.
- 19.** The method of claim 17, wherein during the supplying of the raw material to the charging chute, the raw material is supplied to the charging chute having a prolate cycloid curve shape to transport the raw material supplied to the
30 charging chute along the path
 having the cycloid curve shape and charge the raw material into the storage container.
- 20.** The method of any one of claims 17 to 19, wherein during the charging of the raw material into the storage container, the raw material is separated from the charging chute at a horizontal separation speed which is larger than a vertical
35 separation speed.
- 21.** The method of any one of claims 17 to 19, wherein during the charging of the raw material into the storage container by transporting the raw material supplied to the charging chute along the path having the cycloid curve shape, the raw material having small particles is sorted among the raw materials by using electric charging and magnetic
40 properties of the raw material to be charged onto the raw material layer formed in the storage container.

FIG. 1

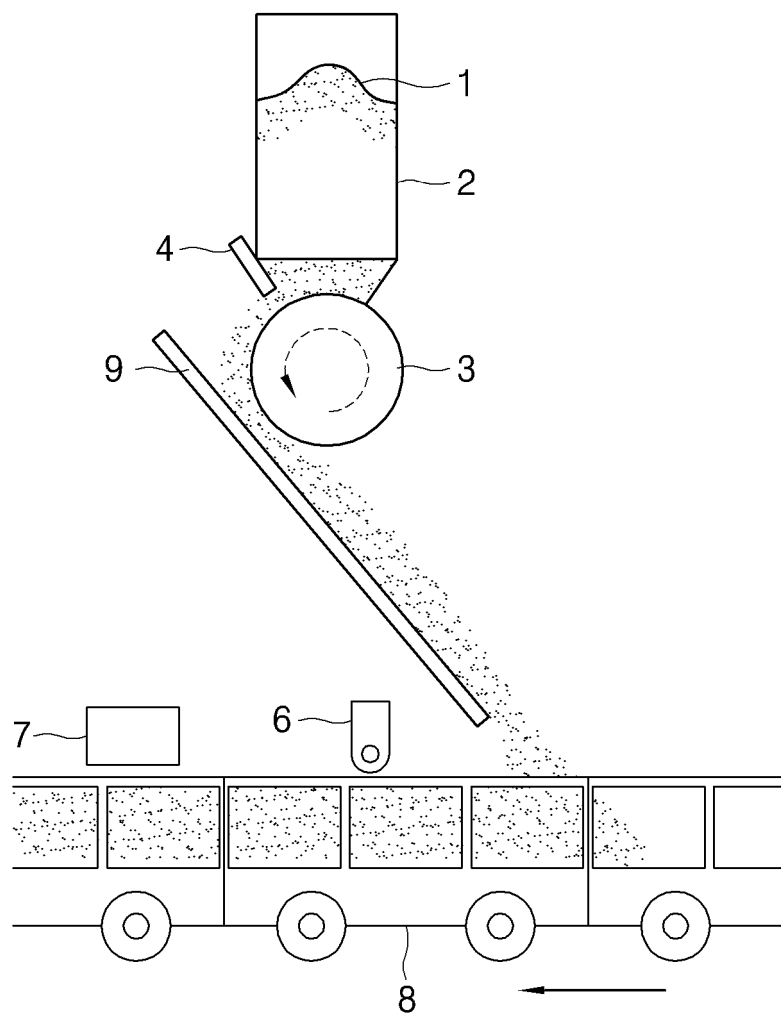


FIG. 2

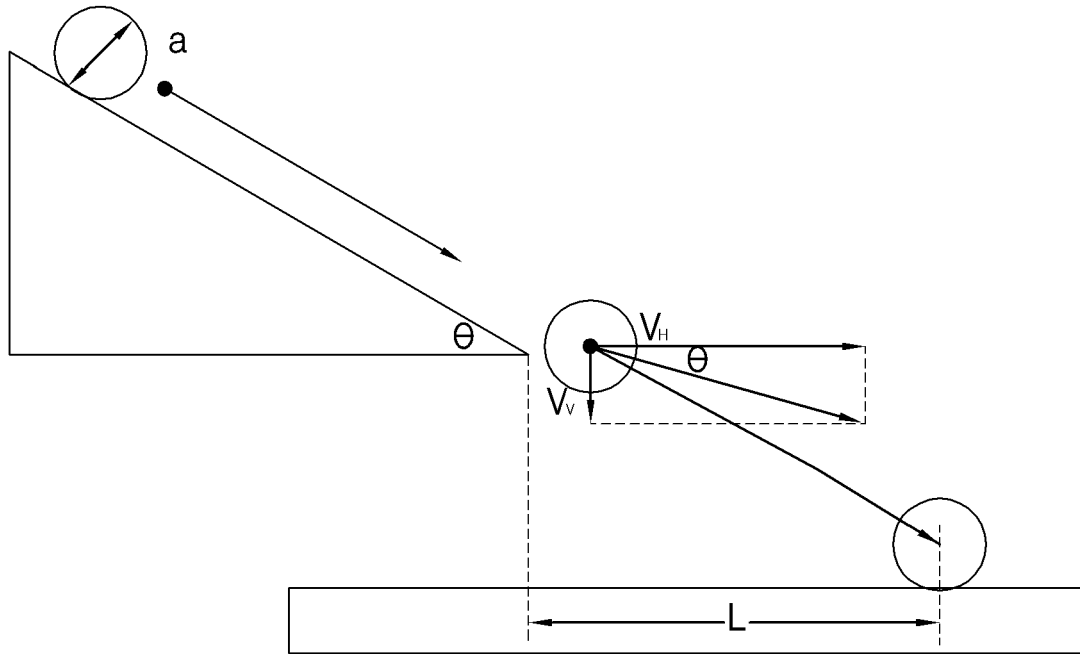


FIG. 3

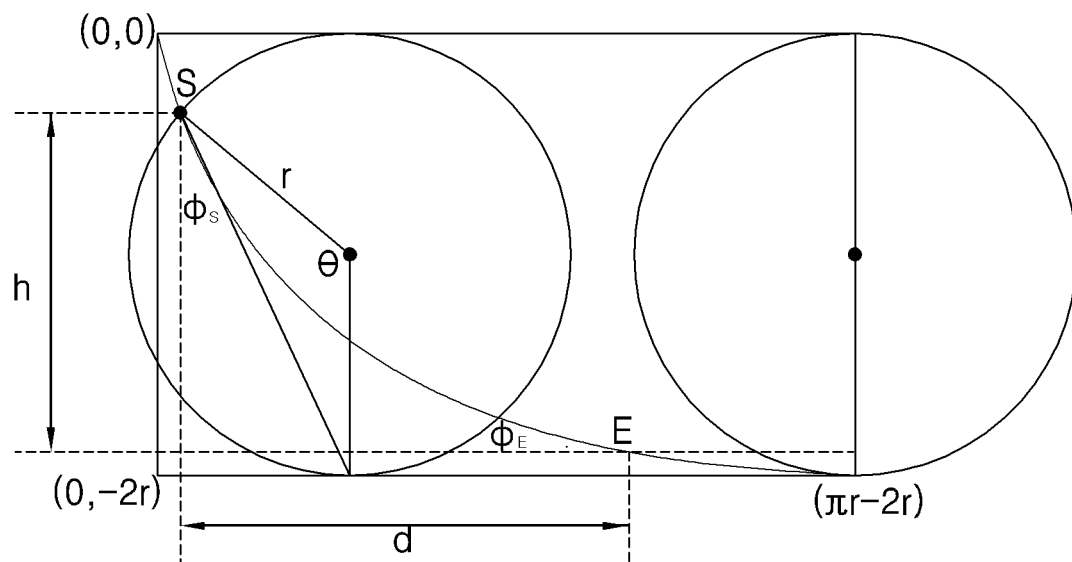


FIG. 4

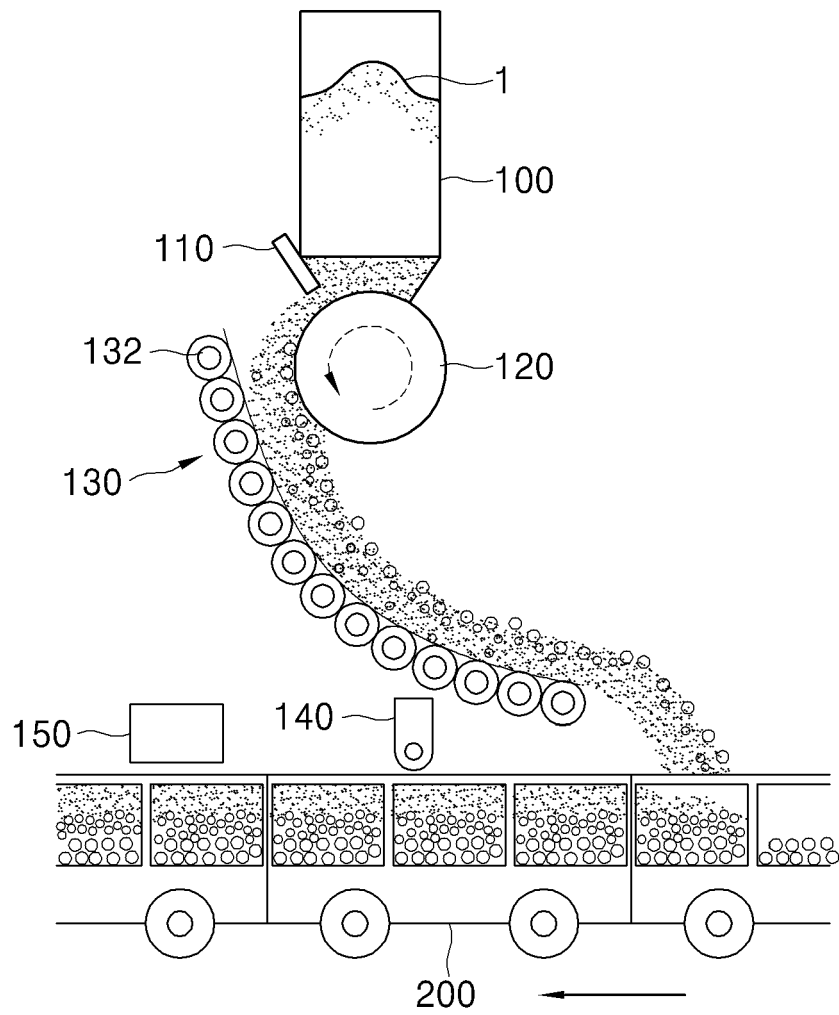


FIG. 5

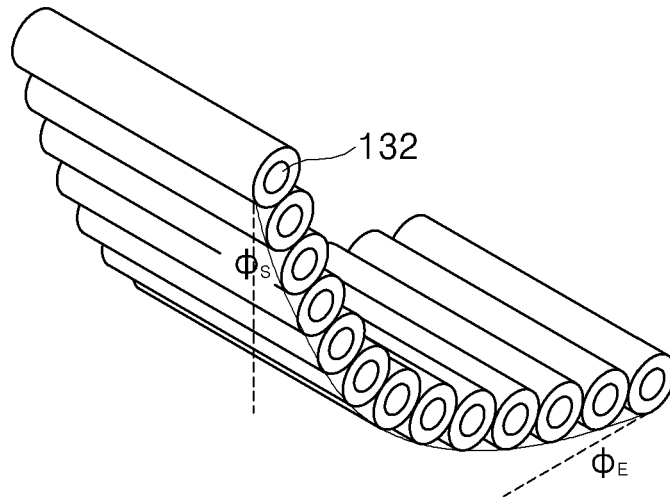


FIG. 6

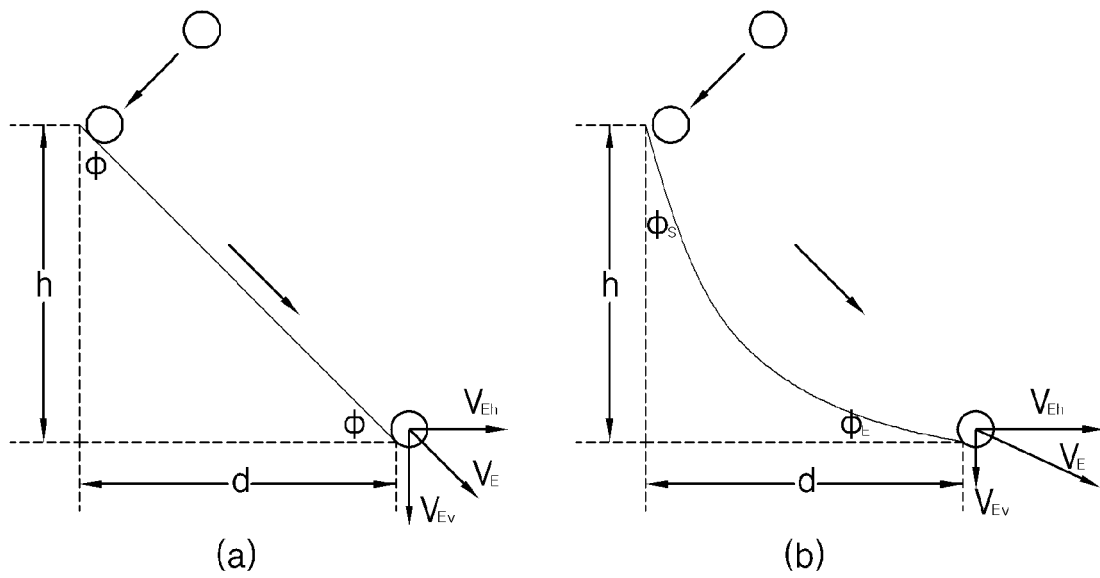


FIG. 7

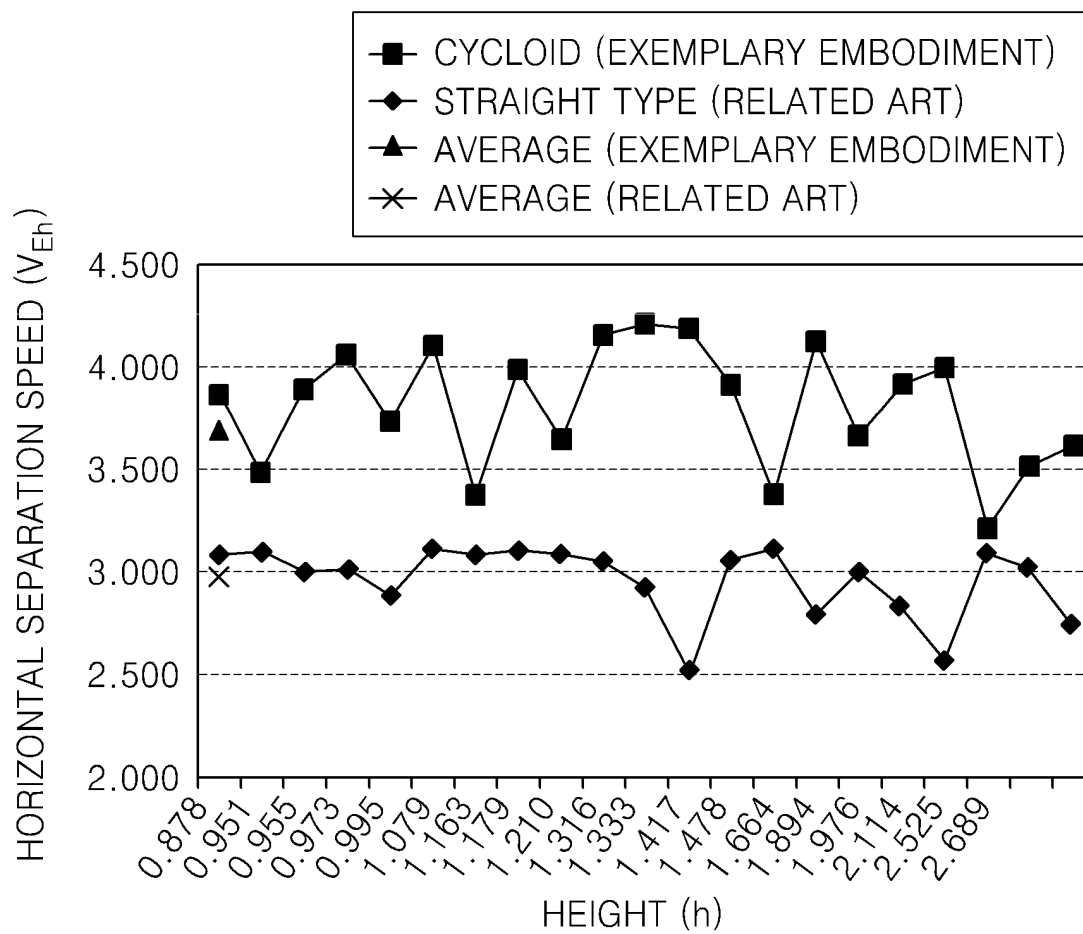


FIG. 8

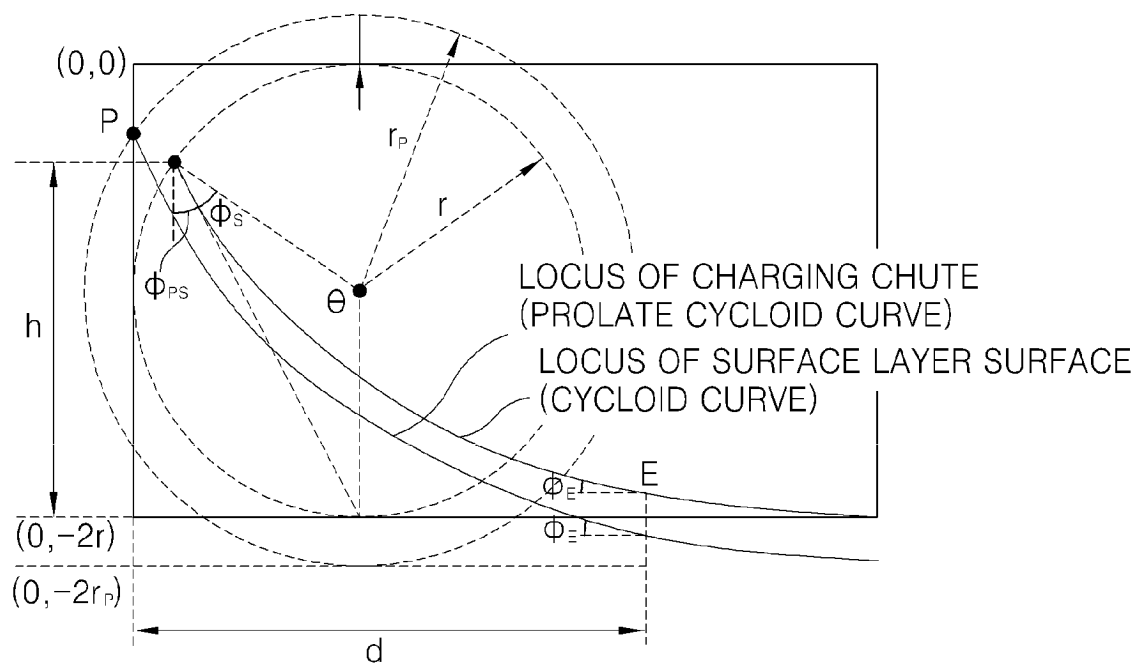


FIG. 9

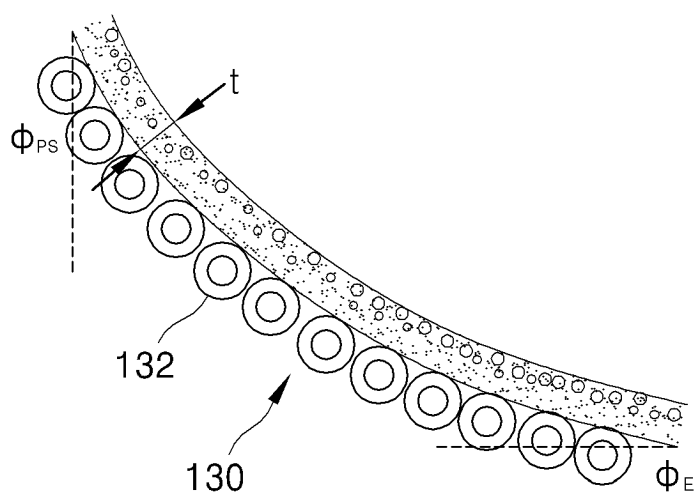


FIG. 10

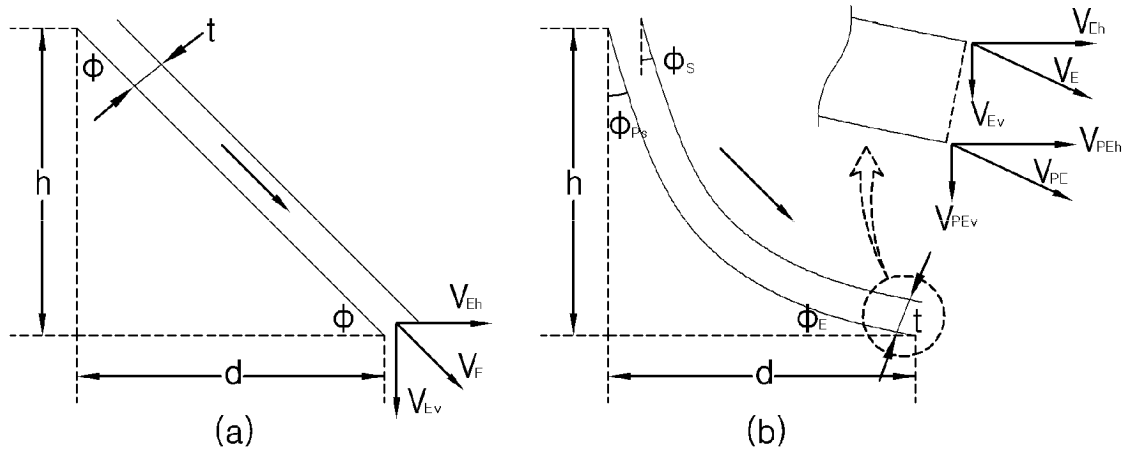


FIG. 11

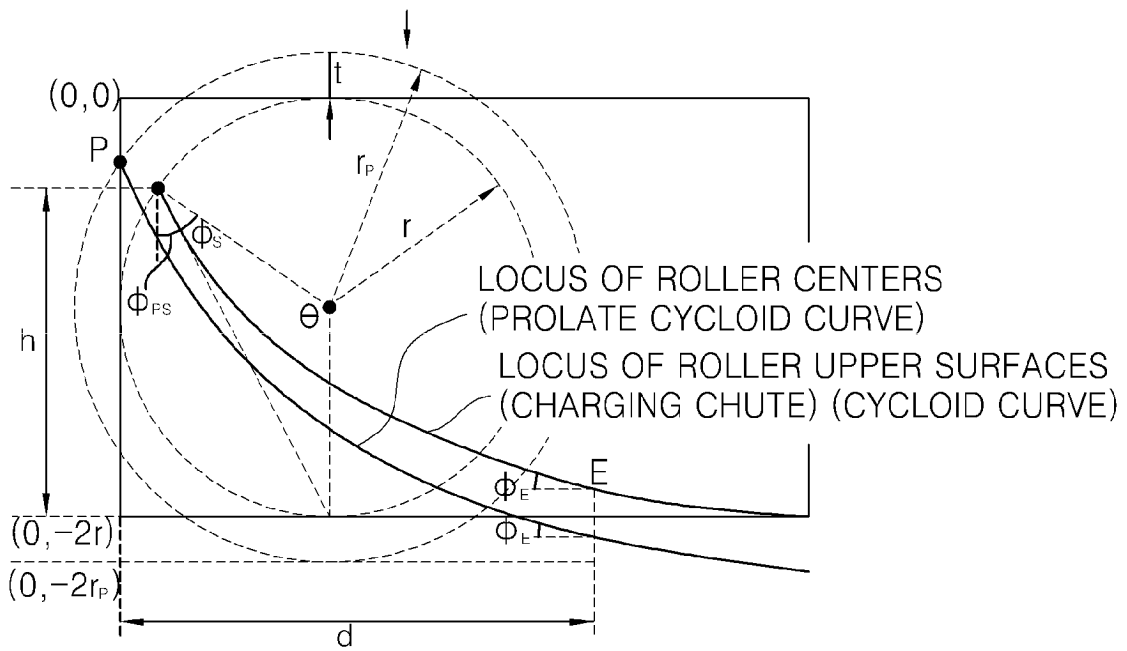


FIG. 12

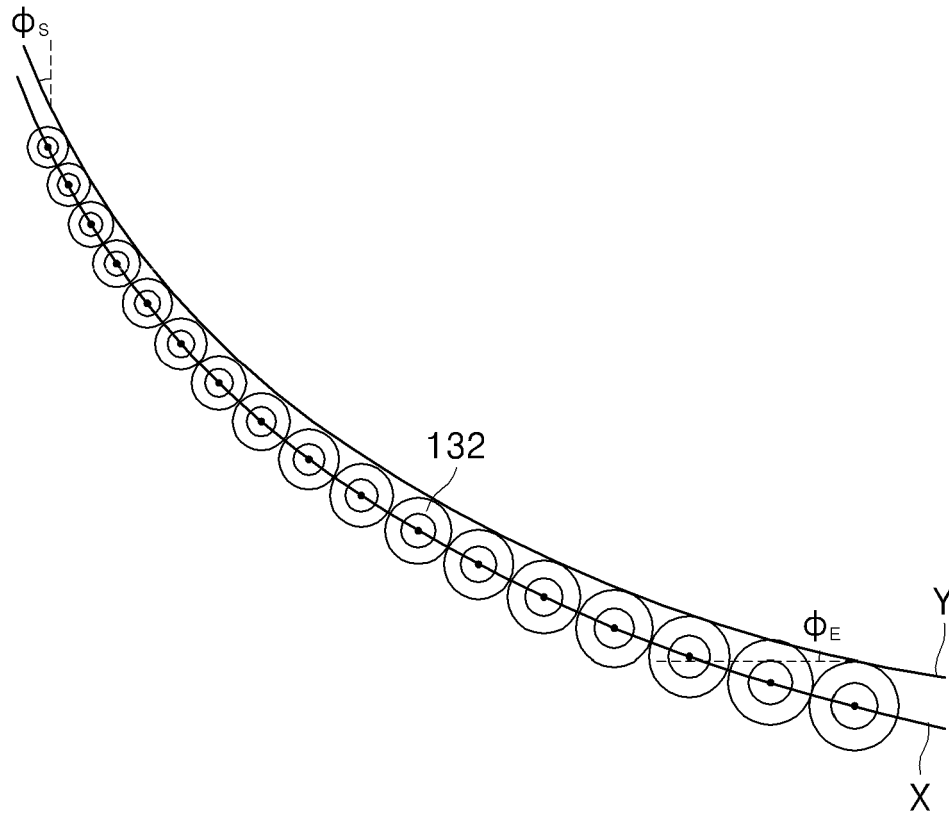


FIG. 13

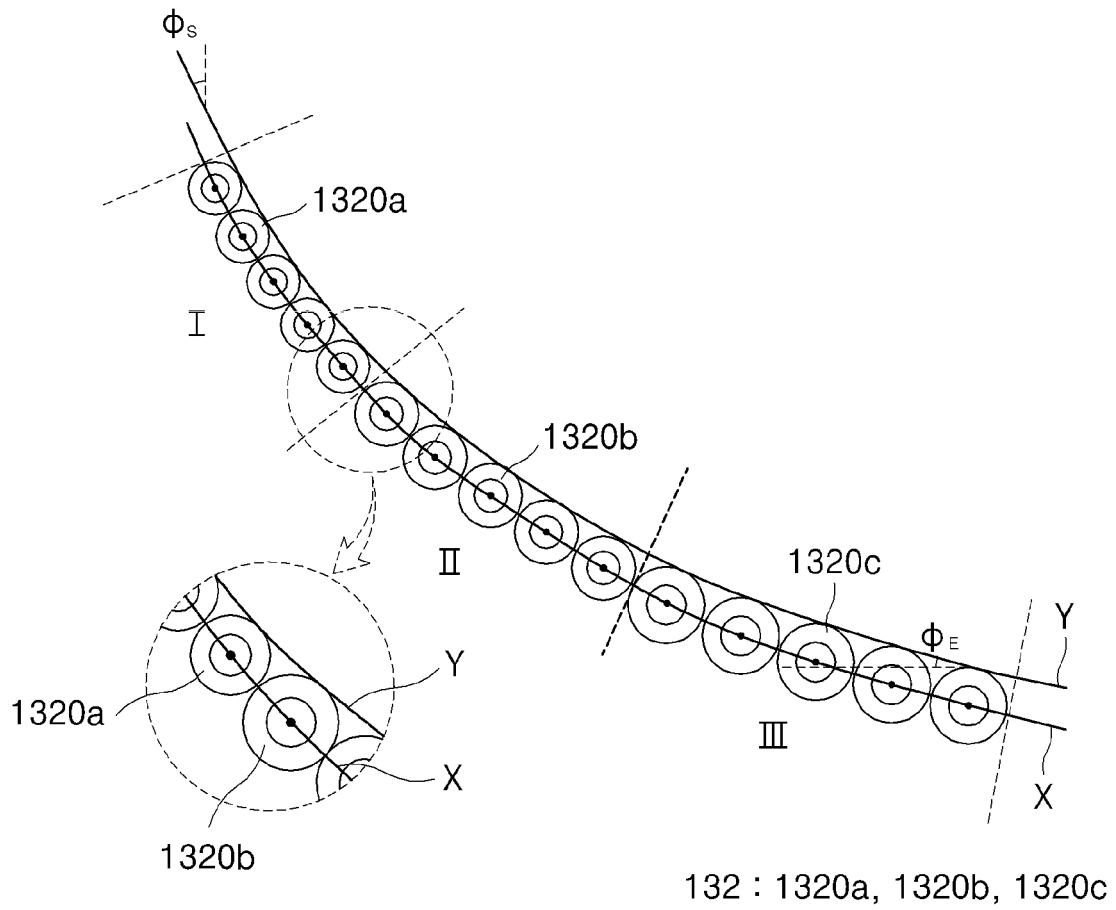


FIG. 14

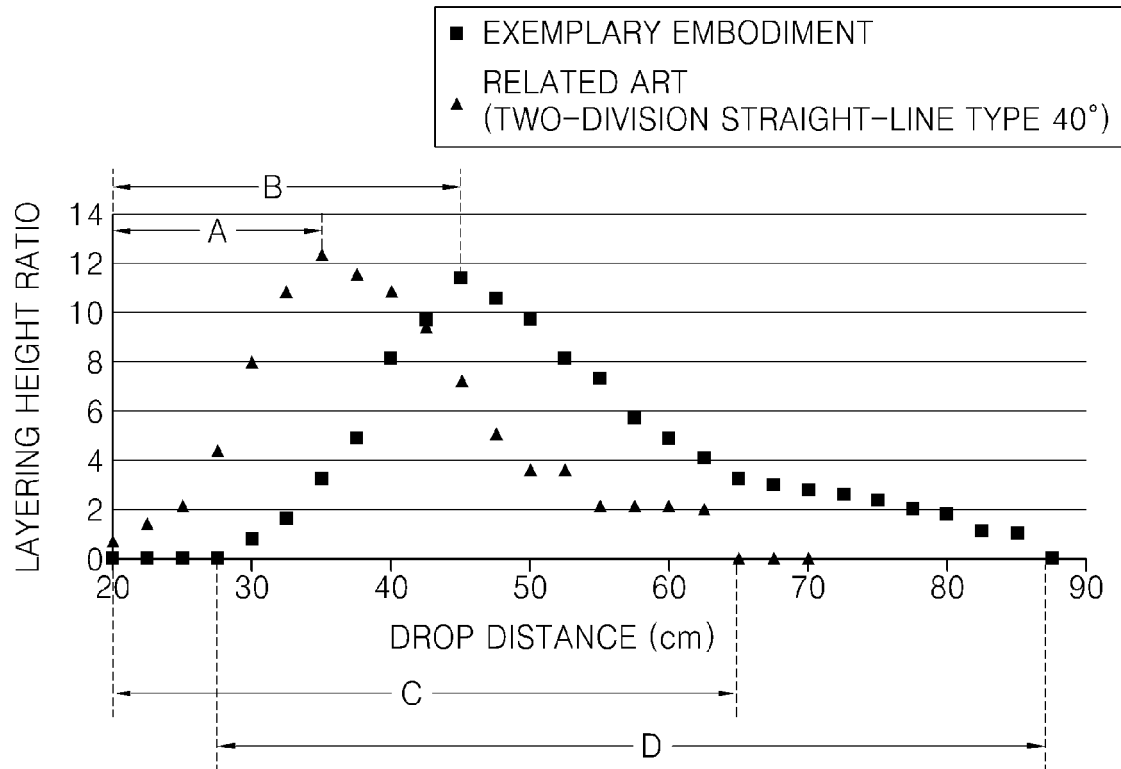


FIG. 15

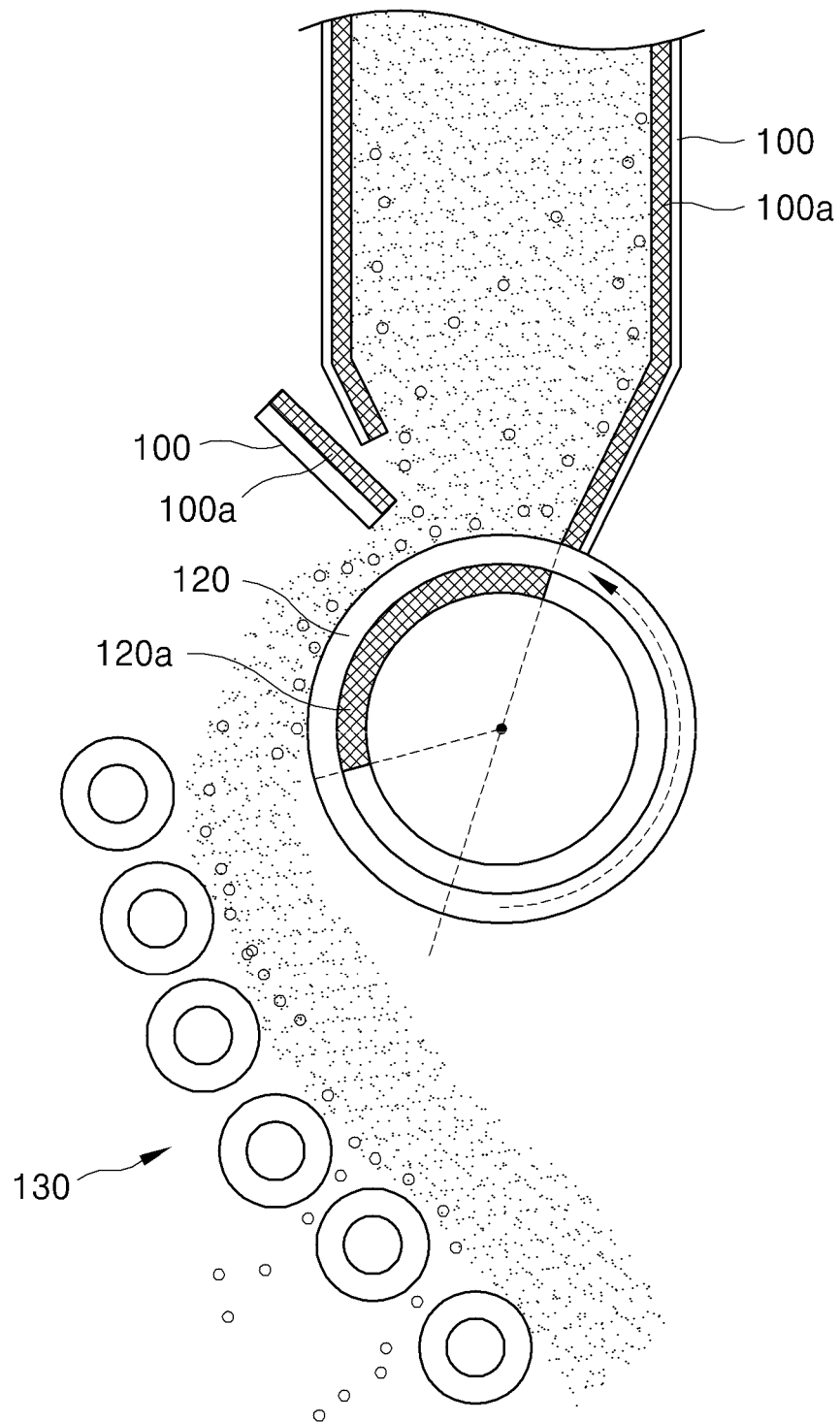


FIG. 16

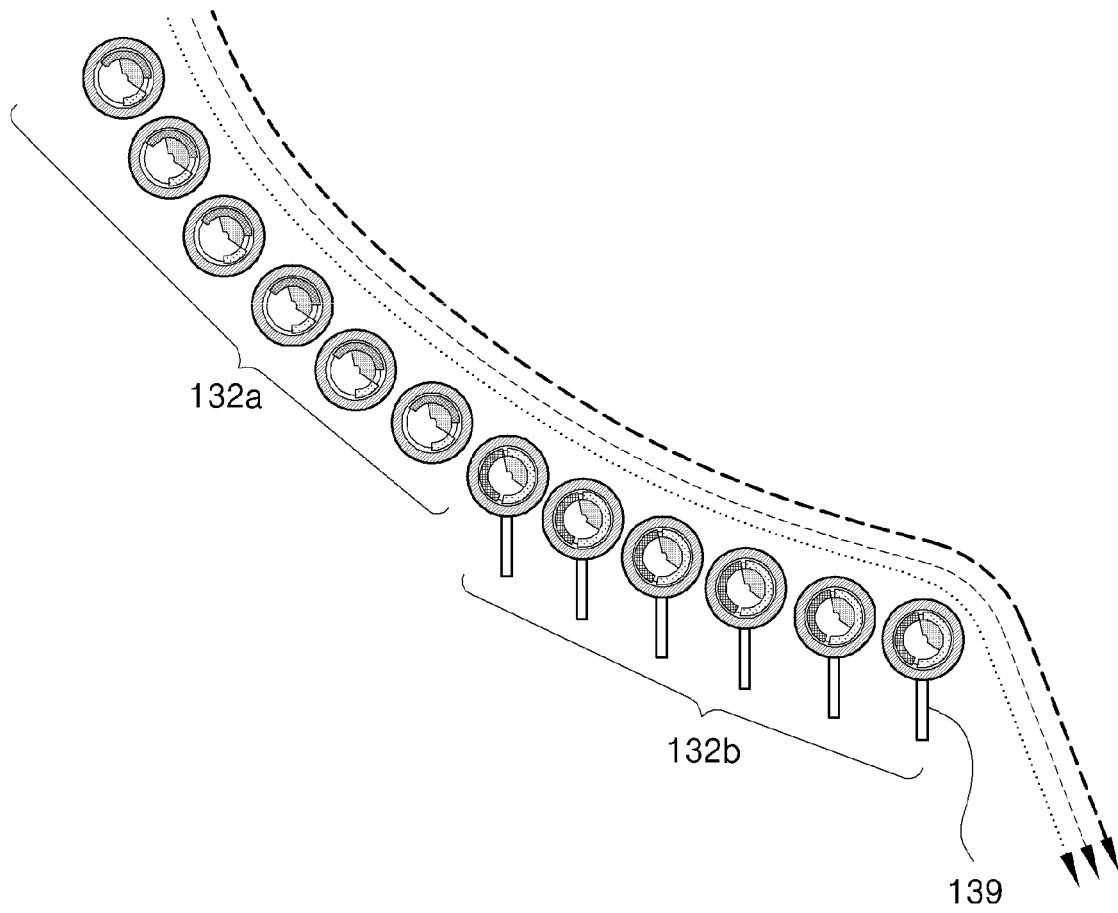


FIG. 17

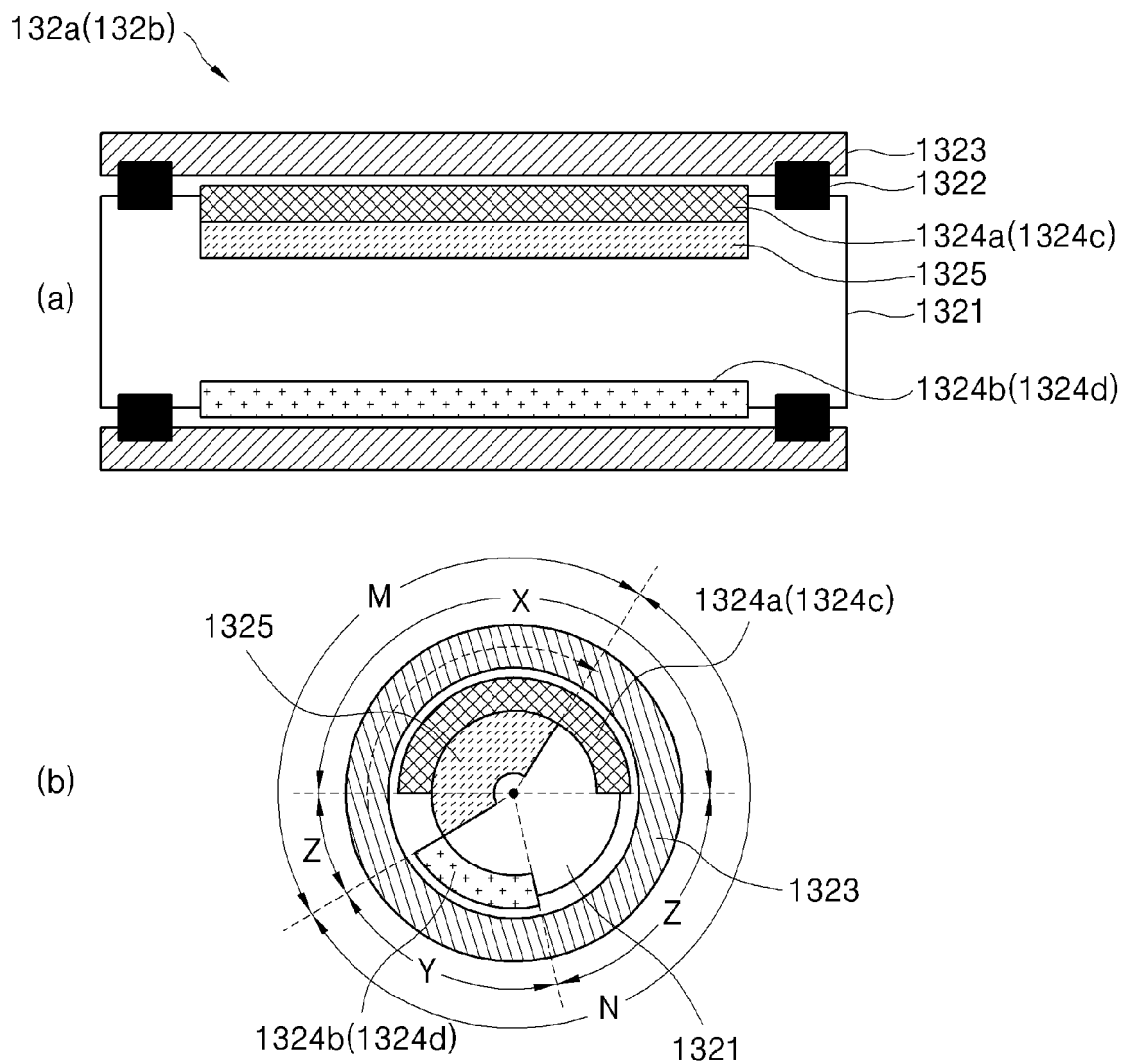


FIG. 18

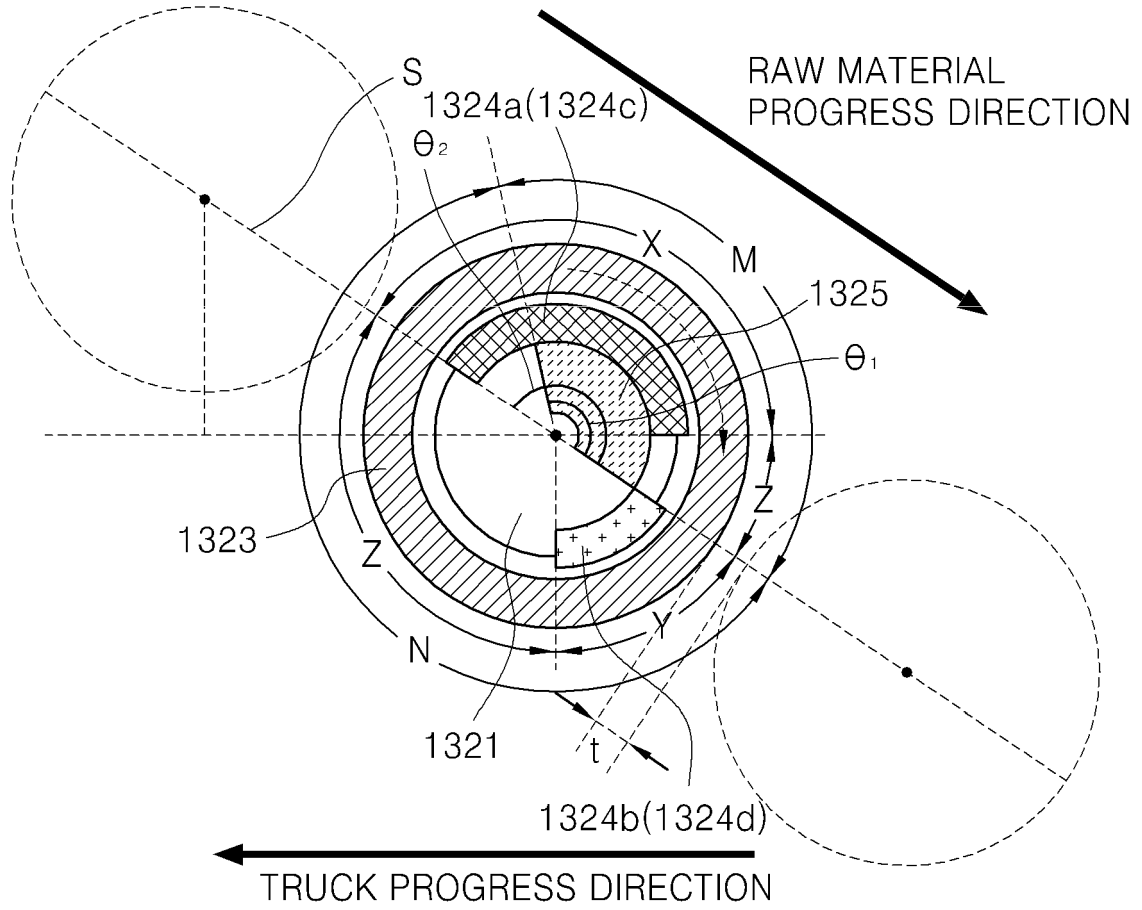


FIG. 19

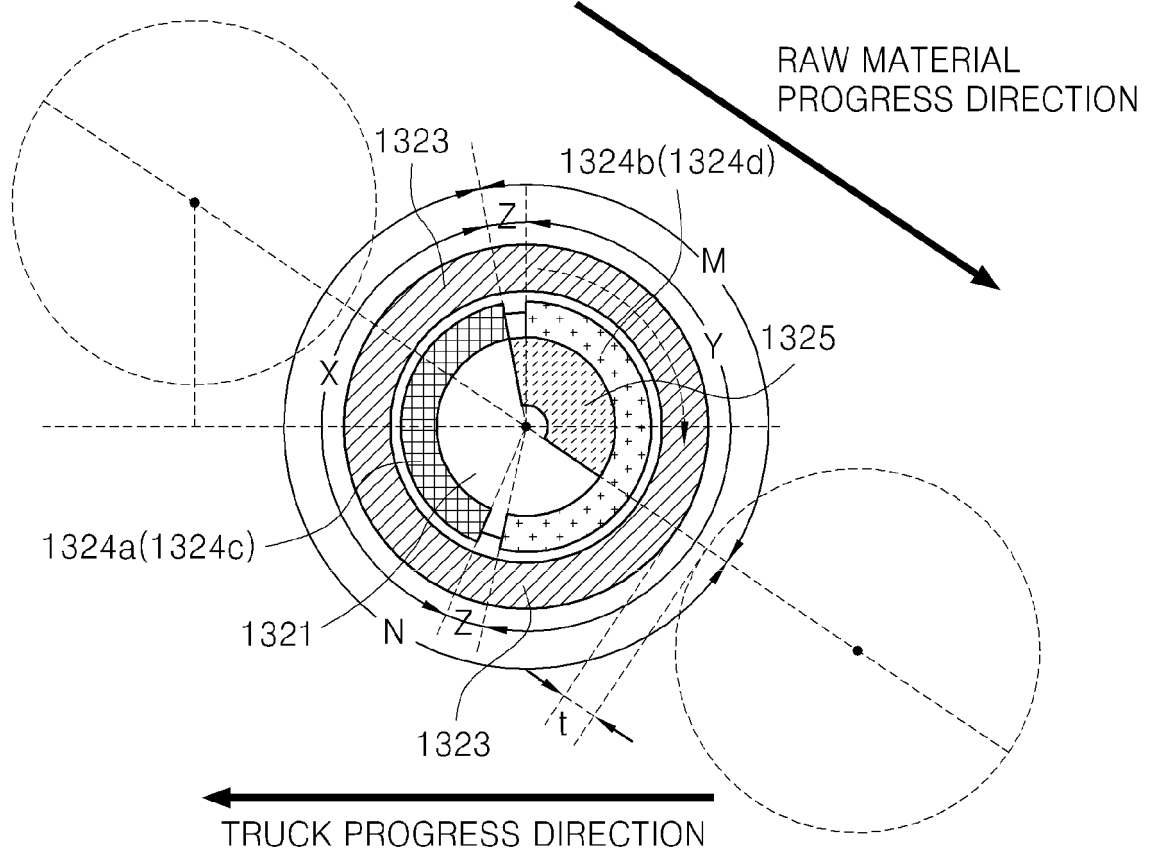
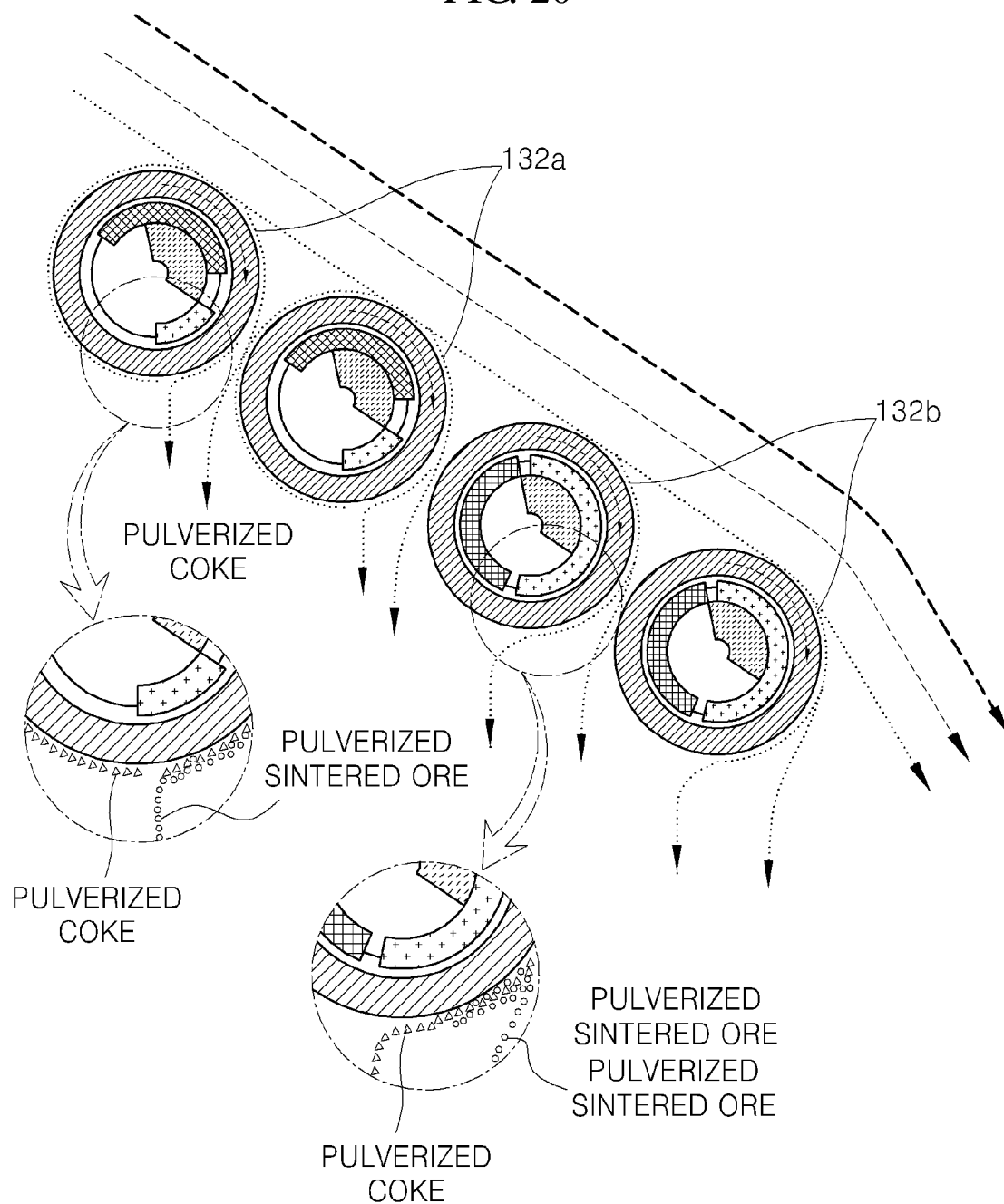


FIG. 20



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2013/004920

A. CLASSIFICATION OF SUBJECT MATTER

F27B 21/10(2006.01)i, C22B 1/20(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F27B 21/10; F27B 3/08; C21B 13/12; C22B 1/20; F27B 21/00

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

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

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

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

eKOMPASS (KIPO internal) & Keywords: , ,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2001-0016797 A (POSCO) 05 March 2001 Claims 1-3, figure 3	1-5,17-20
Y	JP 2002-206859 A (NKK CORP) 26 July 2002 The detailed description paragraph 9	1-5,17-20
Y	WO 0106-7017A1 (NKK CORPORATION) 13 September 2001 Figure 1	3
A	JP 07-110194A (NKK CORP) 25 April 1995 Figure 1	1-21

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

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Date of the actual completion of the international search

25 SEPTEMBER 2013 (25.09.2013)

Date of mailing of the international search report

01 OCTOBER 2013 (01.10.2013)

Name and mailing address of the ISA/KR


 Korean Intellectual Property Office
 Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701,
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2013/004920

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JP 07-110194A	25/04/1995	NONE	

REFERENCES CITED IN THE DESCRIPTION

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