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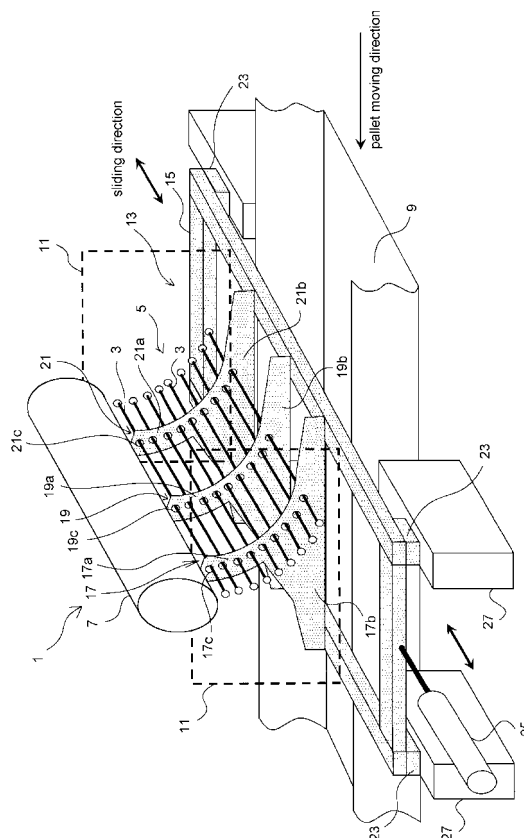
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(54) **METHOD AND APPARATUS FOR CHARGING RAW MATERIAL TO BE SINTERED**

(57) Provided is a technology that is capable of sorting raw material to be sintered by maintaining the gaps between the wire-like members which form a chute for charging raw material to be sintered in a sintering machine. In a method for charging raw material to be sintered in accordance with the present invention, raw material to be sintered is sorted and charged onto a pallet 9 below, by supplying the raw material to be sintered to a wire chute 5 in which a plurality of wires 3 are arranged, wherein the raw material to be sintered is supplied to the wire chute 5 while moving brackets 17, 19, 21 supporting the wires 3 back and forth in the axial direction of the wires 3.

Figure 1



Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a method and an apparatus for charging raw material to be sintered, in the manufacture of steel or iron.

BACKGROUND ART

10 **[0002]** In the operation of sintering machines, for example in the iron and steel manufacturing industry, raw material to be sintered of not more than about 10 mm is charged from a raw material supply machine through a raw material charging chute into a pallet of an endless moving sintering machine. Solid fuel such as coke powder and slag-forming flux such as lime powder is included within this raw material to be sintered, and after finishing the charging of the raw material, the coke powder included in the surface layer of the raw material is ignited in the ignition furnace, air is sucked
15 by a blower from below the pallet, and while combusting the coke powder within the raw material layer, the iron ore is fired from the top layer towards the bottom layer. For this reason, when charging the raw material to be sintered, it is important to maintain favorable aeration properties with respect to the raw material layer that is deposited in the pallet, and to ensure uniform aeration properties within the plane of the pallet.

20 **[0003]** With respect to the particle size distribution of the sintered ore in the pallet, coarse-grained raw material is deposited in a layer at the bottom of the raw material, and finely grained raw material is deposited in a layer at the top of the raw material, so that a suitable particle size distribution is achieved. Thus, a technology has been developed, in which an improved quality of the sintered ore as well as an improved yield and productivity has been achieved by improving the aeration properties of the entire sintered raw material layer in the pallet. As an apparatus for segregated charging of raw material to be sintered, which performs the charging while controlling the particle size distribution of the
25 sintered raw material in the pallet in the above-described manner, a screen-type raw material charging chute is used.

30 **[0004]** The structure of a screen-type raw material charging chute is such that a multitude of wires or rods (referred to as "wire-like members" below) are lined up in parallel to each other in the width direction of the pallet on a surface that is slanted downward while leaving a predetermined spacing between them, and these wires are supported by guide members (brackets). Thus, the rod spacing of the raw material charging chute that is formed in screen shape is set to be narrower on the upper side and wider towards the lower side. Here, the raw material charging chute is slanted
35 downward in a direction that is opposite to the direction in which the pallet advances forward. Consequently, the coarsely grained raw material passing through the wider screen gaps on the lower side of the raw material charging chute are deposited in a raw material bottom layer portion in the pallet, whereas the finely grained raw material passing through the narrower screen gaps on the lower side of the raw material charging chute are deposited in a raw material top layer portion in the pallet. Thus, the aeration properties of the material to be sintered in the pallet can be controlled favorably.

40 **[0005]** However, the pallet width is as much as 3 to 5.5 m, and the support span of the wire-like members is as wide as 4 to 7 m. Therefore, if there are no guiding members (brackets) supporting the wire-like members, then the wire-like members may sag or start to oscillate due to insufficient stiffness, so that they are shifted away from the positions at which they should actually be arranged, and the sorting capabilities will deteriorate.

45 For this reason, the guide members (brackets) supporting the wire-like members are provided sufficiently, in accordance with the pallet width and the diameters of the wires, in such a number that no sagging or shifting of the wire-like members will occur.

50 **[0006]** In the apparatus for charging raw material to be sintered having the above-described structure, it is important to maintain the gaps between the wire-like members (the screen gaps) uniform to support the sorting capabilities, but it is hindered by the following two factors .

The first factor is the presence of the guide-members (brackets), and the other factor is the adherence of raw material powder to the wire-like members. The following is a detailed discussion of the problems that arise due to these factors, as well as of how these problems are presently solved.

55 The Problem Caused by the Presence of the Guide Members (Brackets)

60 **[0007]** Due to the presence of the guide members (brackets), the raw material flow occurs in which the charged raw material is divided on both sides of the guide members (brackets), and the deposition amount of the raw material where the guide members (brackets) are arranged is smaller than the amount where there are no guide members (brackets),
65 so that groove-shaped portions are formed at the surface of the deposited raw material. While these groove-shaped portions are being formed, raw material from surrounding areas may flow in there to some extent, but since the falling distance is too small for the raw material to flow in, a deposition layer with low density is formed. Moreover, when the raw material flows in from the surrounding areas, in principle, relatively large particle size raw material is inclined to pile up.

[0008] In the groove-shaped portions thus formed, the aeration resistance in the raw material layer is smaller than that in the flat portions where no groove-shaped portions are formed. That is to say, there will be variations of the aeration resistance in the pallet width direction in the layer of the raw material to be sintered. When these variations in aeration resistance become large, then the suction of air concentrates in the groove-shaped portions where the aeration resistance is relatively small, and in the period in which these regions form a combustion belt in the raw material layer, the combustion speed of the coke powder becomes large in these groove-shaped portions, whereby insufficient combustion portions may occur in the flat portions, slowing the firing. This leads to a drop in the yield of the sintered ore, a drop in the product quality, and an increase in coke unit consumption, and furthermore brings about a drop in the productivity of the sintered ore.

The above is the problem due to the presence of the guide members (brackets).

[0009] To solve this problem, a technology has been proposed to make the thickness of the raw material layer to be sintered in the pallet constant, reducing the variations of the raw material density by placing a scraper which has a plurality of V-shaped raking members between the screen-type raw material charging chute and the cut-off plate (see Patent Document 1).

Another example of a technology has been proposed wherein, in a screw-type raw material raking apparatus acting in pallet width direction arranged downstream from the screen-type raw material charging chute, by attaching a screw blade lifting device and a screw blade revolution changing device, raw material is raked in from the surrounding portions of the groove-shaped portions and the groove-shaped portions are filled without applying pressure to the raw material layer surface portion across the entire width of the pallet, and furthermore the raw material is lifted at this position and pressure is applied only to this position, so that a raw material layer to be sintered that has substantially uniform aeration properties in the pallet width direction is attained (see Patent Document 2).

The Problem Caused by the Adherence of Raw Material Powder

[0010] The problem of the adherence of raw material powder is the problem that raw material powder such as coal powder, coke powder or the like adheres to the wire-like members, so that it becomes difficult to maintain the gaps between the wire-like members. When the gaps between the wire-like members cannot be maintained, then the sorting of the charged raw material cannot be properly performed, and as with the above-described problem due to the presence of the guide members (brackets), the raw material deposition layer cannot be formed appropriately, which leads to a drop in the yield of the sintered ore, a drop in the product quality, and an increase in coke unit consumption, and furthermore brings about a drop in the productivity of the sintered ore.

[0011] As a technology for solving this problem of the adherence of raw material powder, it has been proposed to provide a scraper that contacts the rods forming the chute and that moves in the chute width direction (see Patent Document 3).

In another example, it has been proposed to move the wire ropes forming the chute at low speed in the axial direction of the wire ropes (see Patent Document 4).

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0012]

Patent Document 1: JP H09-280741A

Patent Document 2: JP H11-211355A

Patent Document 3: JP S63-180079A

Patent Document 4: JP S61-60843A

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0013] In the above-described apparatuses for charging raw material to be sintered, there are two factors that hinder keeping the gaps between the wire-like members uniform and maintaining the sorting capabilities, namely, the problem caused by the presence of the guide members (brackets), and the problem caused by the adherence of raw material powder, for which respective solutions have been proposed.

However, the presently proposed solutions for these problems still leave the following issues.

Regarding the Presence of the Guide Members (Brackets)

[0014] Regarding the formation of groove-shaped portions due to the presence of the guide members (brackets), the solutions proposed in Patent Documents 1 and 2 recognize that groove-shaped portions are formed at the surface of the deposited raw material, and fill them by leveling the groove-shaped portions with a V-shaped or screw-type raking device.

However, when the formed groove-shaped portions are filled by leveling, the particle size distribution in the filled groove-shaped portions is not the same as that in other regions, and even though the groove-shape disappears, the problem of variations in the aeration resistance is not substantially solved. According to observations by the inventors, coarse particles are deposited within and around the groove-shaped portions, so that when they are leveled with a raking device, the groove-shaped portions are filled with coarse particles, and the problem that the aeration resistance of the groove-shaped portion is relatively small is not sufficiently solved.

Regarding the Adherence of Raw Material Powder

[0015] Regarding the adherence of raw material powder to the wire-like members, Patent Document 3 proposes to move scrapers inserted into the bars which constitute the chute, which may have some effect of scraping off the raw material powder adhered to the bars.

However, in the technology in Patent Document 3, it is assumed that thick bars having a certain stiffness are used as the wire-like members constituting the chute. Because if the bars were such thin wires, then guide members (brackets) supporting the wires in the chute width direction would be necessary, and if there were guide members (brackets), then the scraper would collide with the guide members (brackets), so that it could not move. Therefore, it seems that the technology in Patent Document 3 is based on an assumption that there are no guide members (brackets) in the chute width direction.

Thus, there is the problem that the technology of Patent Document 3 cannot be applied to chutes formed by wire-like members that are such that there are guide members (brackets) in the chute width direction. Moreover, there is the problem that there is a limit to the sorting properties and excellent sorting properties cannot be achieved when thick bars or the like are used as the wire-like members constituting the chute.

[0016] As for the technology described in Patent Document 4, in which the wires are moved at low speed in their axial direction, the mechanism for moving the wires at slow speed is complex, and it cannot be advisable in view of the space and costs required.

[0017] Thus, the two factors that hinder keeping the gaps between the wire-like members uniform and maintaining the sorting capabilities, that is, the problem caused by the presence of the guide members (brackets) and the problem caused by the adherence of raw material powder have not yet been solved effectively, and there is yet no technology for solving both.

[0018] The present invention has been devised in order to solve these problems, and it is an object of the present invention to provide a technology for keeping the spacing between the wire-like members even and maintaining the sorting possibilities when charging raw material to be sintered in a sintering apparatus.

MEANS FOR SOLVING THE PROBLEMS

[0019] In order to solve the above-noted problems, the inventors made the following considerations. Fig. 10 schematically shows the groove-shaped portions formed in the sintering bed. The influence that such groove-shaped portions have on the combustion surface was considered.

As described in the section Background Art, the groove-shaped portions were conventionally leveled with a screw or a scraper, and Fig. 11 is a diagram showing the leveled state of the groove-shaped portions. In Fig. 11, the regions A are portions that are unaffected by the brackets, whereas the regions B are regions where the groove-shaped portions that have occurred due to the brackets have been leveled. The particle size distributions in the regions A and the regions B are roughly as shown in Fig. 12, that is, the particle size is coarser in the regions B, where the groove-shaped portions are leveled, than in the regions A which are unaffected by the brackets. Moreover, the density of the regions B is lower than that in the regions A, so that there is higher aeration in the regions B.

[0020] Fig. 13 schematically shows the state in which the combustion surface of the sintering bed in a given cross section advances from the top to the bottom.

As shown in Fig. 13, since the combustion speed in the regions B where the grooved-shaped portions have been leveled is higher, its influence is higher and the difference to the regions A that are unaffected by the brackets becomes larger the more the combustion surface advances downward. Near the bottom of the bed, there is a step ΔF between the regions A and the regions B. Thus, the step ΔF in the combustion surface near the bed bottom is proportional to the depth of the regions B where the groove-shaped portions are leveled, that is, to the length in the depth direction of the

portions affected by the groove-shaped portions, and in this case it is proportional to the height H of the sintering bed.

[0021] Accordingly, there is a difference in the combustion speed between the portions that are affected and the portions that are unaffected by the groove-shaped portions, and moreover, the extent of this influence is proportional to the length in depth direction of the portions that are affected.

In order to mitigate the influence of the brackets, the inventors conceived the solution of moving the brackets back and forth along the wires constituting the chute.

Fig. 14 is a diagram showing the passage of time of the combustion surface at a given cross section in a sintering bed onto which raw material has been piled while moving the brackets along the wires at a predetermined speed. In Fig. 14, the regions enclosed by the oblique lines correspond to the regions B, which are affected by the brackets.

In the state shown in Fig. 14, when the combustion surface passes through the regions B, which are affected by the brackets, the combustion speed increases, and the combustion surface advances further downward than at the unaffected portions. Therefore, when the combustion surface moves downward, the way in which the regions B are passed determines the position of the combustion surface near the bed bottom, and can be classified into the three types of areas a' , b' and c' , in the example shown in Fig. 14. a' denotes areas that do not pass through the regions B. b' denotes areas that do pass through the regions B but the passage distance within the region gradually increases from 0 to h or gradually decreases from h to 0. c' denotes areas where the distance passing through the regions B is constant, this distance being h .

[0022] In the areas a' , the combustion surface advances at a predetermined speed. In the areas b' , there is a difference in the speed of the combustion surface between the portions where the distance passing through the regions B is long and the portions where this distance is short. In the portions where this distance is long, the combustion surface advances fast, and in the portions where this distance is short, the combustion surface advances slowly. Therefore, the combustion surface is slanted in the areas b' .

Furthermore, in the areas c' , the speed is faster by a predetermined speed that is proportional to the distance h passing through the regions B.

As can be seen from Fig. 14, in the areas c' , the maximum length passing through the regions B is h , so that the step to the areas a' that are unaffected by the brackets is proportional to h , namely the step ΔF shown in Fig. 14.

[0023] Comparing Fig. 13 with Fig. 14, it can be seen that in Fig. 13, a step ΔF in the combustion surface occurs that is proportional to the sintering bed height H , whereas in Fig. 14, a step ΔF in the combustion surface occurs that is proportional to the distance h passing through the regions B. As becomes clear from Fig. 13 and Fig. 14, h is much smaller than H , and therefore also ΔF is much smaller than ΔF .

As should become clear from the above, by moving the brackets, the influence of the brackets on the combustion surface can be effectively reduced.

[0024] Furthermore, the inventors also examined the quantitative relation between the moving speed of the brackets and the combustion surface.

Fig. 15 schematically shows the moving speed of the brackets and the range of influence of the brackets as well as the position of the combustion surface near the bottom of the sintering bed.

Fig. 15(a) shows the state when the brackets are halted, Fig. 15(b) shows the state when the bracket moving speed is slow, Fig. 15(c) shows the state when the bracket moving speed is medium, and Fig. 15(d) shows the state when the bracket moving speed is fast.

If the brackets are halted as in Fig. 15(a), the combustion surface becomes U-shaped near the bottom. If the speed is slow as in Fig. 15(b), it takes on the shape of an inverted triangle, where the position of the apex of the inverse triangle, that is, the lowermost location of the combustion surface, coincides with the bottom portion in Fig. 15(a). If the speed is intermediate as in Fig. 15(c), then the shape is that of an inverse trapezoid, and the position of the bottom edge of the inverse trapezoid has moved above the bottom portion in Fig. 15(a). If the speed is high as in Fig. 15(d), then the lowermost location of the combustion surface has moved even further above the bottom portion in Fig. 15(a), and is at a substantially constant position.

[0025] As can be seen from Fig. 15, as the moving speed of the brackets increases, the influence of the brackets on the combustion surface is reduced.

Accordingly, the inventors examined at which moving speed of the brackets, or in other words, at which inclination of the portion affected by the brackets in Fig. 15 the effect of mitigating the influence on the combustion surface is attained.

[0026] Fig. 16 shows the state, viewed in cross section in the pallet advancing direction, when the raw material is supplied from the drum chute 7 to the pallet 9 and piled onto it. In Fig. 16, θ_p denotes the pile angle of the raw material, and v_p denotes the moving speed of the pallet 9.

Moreover, Fig. 17 is an illustrative diagram to illustrate the relation between the pile speed and the pile angle θ_p (Fig. 17(a)), and the relation between the pile speed and the inclination angle θ_b of the portion affected by the brackets (Fig. 17(b)). Fig. 17(b) shows a sectional surface of the sintering bed taken at right angles to the direction in which the pallet advances, and in Fig. 17(b), H denotes the sintering bed height and W_b denotes the width of the portion affected by the brackets.

To confirm the used reference symbols, V_b denotes the bracket moving speed, v_p denotes the pallet speed, θ_p denotes

the pile angle when the raw material is charged onto the pallet, θ_b denotes the inclination angle of the portion affected by the brackets, W_b denotes the width of the portion affected by the brackets, and H denotes the sintering bed height. The pile speed in the H direction of the raw material is $v_p \tan \theta_p$ (see Fig. 17(a) and (b)), and on the other hand, the inclination angle θ_b of the portion affected by the brackets is determined by the relation to the bracket moving speed V_b . As can be seen from Fig. 17(b), $v_b \cdot \tan \theta_b = v_p \cdot \tan \theta_p$, so that solving for $\tan \theta_b$, the relation of the following Equation (1) is obtained:

$$\tan \theta_b = v_p \cdot \tan \theta_p / v_b \quad (1)$$

[0027] Here, when considering in which of the states shown in Figs. 15(a) to (d) the influence of the brackets can be mitigated, it can be appreciated that if the moving speed of the brackets is at least the slow speed shown in Fig. 15(b), then the influence on the combustion speed will be smaller than in the case that the brackets are halted.

Moreover, in the state of Fig. 15(b), $W_b = H / \tan \theta_b$, so that if the bracket speed is at least that of the state shown in Fig. 15(b), then the following Equation (2) holds:

$$W_b \leq H / \tan \theta_b \quad (2)$$

[0028] Inserting Equation (2) into Equation (1) gives $W_b \leq H \cdot V_b / V_p \cdot \tan \theta_p$, and solving this equation for v_b yields the following Equation (3):

$$v_b \geq W_b \cdot v_p \cdot \tan \theta_p / H \quad (3)$$

[0029] In a typical sintering machine, the values of v_p , θ_p , H and W_b are as follows:

$v_p = 2 \text{ m / min}$

$\theta_p = 40^\circ$

$H = 600 \text{ mm}$

$W_b = 200 \text{ mm}$

Inserting these numbers into Equation (3) yields $V_b \geq 0.56 \text{ m / min}$, so that if the bracket moving speed is about 0.6 m / min, the effect of the present invention is attained.

[0030] Next, the inventors considered conditions under which the influence of the brackets becomes even smaller. Fig. 18 is an illustrative diagram using these considerations. Fig. 18(a) is a diagram showing a portion affected by the brackets when the brackets are moved back and forth in the pallet width direction, seen in a top view. Fig. 18(b) is a diagram showing a sectional view in the pallet axis direction of the sintering bed corresponding to Fig. 18(a).

In Fig. 18, B denotes the lowermost pile portion (bottom) of the raw material, and T denotes the uppermost pile portion (top). Furthermore, Lb denotes the length of the projection portion when the line connecting B and T is projected onto the pallet surface, P denotes the movement pitch of the brackets, and Pt denotes the pitch of the portions affected by the brackets in the direction in which the pallet moves. θ_p denotes the pile angle of the raw material and θ_t denotes the inclination angle with respect to the line at right angles to the pallet moving direction at the point B or the point T. Furthermore, v_p denotes the moving speed of the pallet and V_b denotes the moving speed of the brackets.

[0031] In Fig. 18(a), the numbers enclosed by the square denote the number of times a region passes through a portion affected by the brackets, from the top surface to the bottom surface of the sintering bed, when a region associated with that number is viewed in a cross section perpendicular to the pallet moving direction. For example, in the cross section of the region marked by the number "1", this region passes once through a portion affected by the brackets from the top surface to the bottom surface of the sintering bed, and corresponds for example to the regions b' and c' in Fig. 14. The regions marked by the number "0" are unaffected by the brackets, and the regions marked by the number "2" are affected twice as the brackets move back and forth.

[0032] Looking at the cross section perpendicular to the pallet advancing direction, the fact that there are regions marked by the numbers "0" and "1" in this section means that within the same section, there are portions that are affected by the brackets and portions that are unaffected by the brackets. Considering that, as noted above, the influence on the combustion surface is proportional to the length in the depth direction that is affected by the brackets, it results that in the cross section perpendicular to the pallet advancing direction, if the number of times in which there is an influence of the brackets is constant, then it follows logically that the combustion surface near the bottom of the bed must be the same.

If for example the cross section perpendicular to the pallet advancing direction is affected twice by the brackets at any position in the pallet advancing direction, as shown in Fig. 19, then the combustion surface near the bottom of the bed can be made the same. The conditions for achieving this were determined to be as follows.

[0033] First, it can be seen from Fig. 18 that, as a precondition, the following relations must hold:

$$\tan\theta_t = v_p / v_b \quad (4)$$

$$\tan\theta_p = H / L_b \quad (5)$$

$$P_t = 2P \cdot \tan\theta_t = 2P \cdot v_p / v_b \quad (6)$$

In order to ensure that at any position in the pallet advancing direction the cross section perpendicular to the pallet advancing direction is affected twice by the brackets, the condition $L_b = P_t$ should hold, as shown in Fig. 19. Rearranging Equation (5) yields $L_b = H / \tan\theta_p$, and if the right side in this equation is taken to be equal to the right side in Equation (6), then the following equation is obtained:

$$H / \tan\theta_p = 2P \cdot v_p / v_b \quad (7)$$

Solving Equation (7) for v_b yields the following Equation (8):

$$v_b = 2P \cdot v_p \cdot \tan\theta_p / H \quad (8)$$

Inserting Equation (5) into Equation (8) yields the following Equation (9):

$$v_b = 2P \cdot v_p / L_b \quad (9)$$

[0034] As can be seen from Equation (8) and Equation (9), it is possible to reduce the influence of the brackets on the combustion surface to a minimum by determining the moving speed of the brackets in accordance with the moving speed of the pallet and the moving pitch of the brackets.

When the bracket speed is faster than that, then the number of times that areas are affected by the brackets becomes non-uniform again, as shown in Fig. 20, so that it can be seen that the above-noted condition is a special condition.

[0035] The foregoing has mainly shown the influence of the brackets on the combustion surface and the effect of the present invention on this, but the same considerations hold also for the surface shape of the sintering bed.

That is to say, in the case of fixed brackets, grooves as shown in Fig. 10 are formed, and when these grooves are schematically emphasized, the situation in Fig. 15(a) is attained. If the brackets are moved and their speed is changed from slow to fast, the groove depth decreases from Fig. 15(b) to Fig. 15(d). Incidentally, showing the state of Fig. 15(c) for a section of the entire sintering bed yields Fig. 5(b), with zig-zag-shaped shallow grooves as shown in Fig. 5(a) remaining in the top view. The depth of these zig-zag-shaped grooves is microscopically proportional to the number in the squares shown in Fig. 18(a). Consequently, if the bracket speed is maintained at the bracket speed of Equation (8) or Equation (9), which are given to address the combustion surface problem, then the groove depth of the zig-zag-shaped grooves becomes uniform across the entire sintering bed, as shown in Fig. 19. That is to say, it becomes possible to maintain a surface shape and a bed height that are as if there were no brackets at all.

[0036] The present invention is based on the foregoing observations and findings, and specifically encompasses the following configurations:

[0037] (1) In a method for charging raw material to be sintered in accordance with the present invention, raw material to be sintered is sorted and charged onto a pallet below, by supplying the raw material to be sintered to a chute in which

a plurality of wire-like members are arranged side by side, the raw material to be sintered being supplied to the chute while moving brackets supporting the wire-like members back and forth in an axial direction of the wire-like members.

[0038] (2) An apparatus for charging raw material to be sintered in accordance with the present invention, in which raw material to be sintered is sorted and charged onto a pallet below, by supplying the raw material to be sintered to a chute in which a plurality of wire-like members are arranged side by side, comprises a plurality of brackets supporting the wire-like members, and a bracket moving mechanism that moves the brackets back and forth in an axial direction of the wire-like members.

[0039] (3) In the apparatus according to (2), the brackets may have a function of scraping off raw material powder adhering to the wire-like members, when moving the brackets.

[0040] (4) In the apparatus according to (2) or (3), a supporting portion of the brackets that supports the wire-like members may have both a function of supporting the wire-like members, and a function of scraping off raw material powder or the like adhering to the wire-like members.

[0041] (5) In the apparatus according to any of (2) to (4), the distances between the plurality of brackets are set to predetermined distances, and the plurality of brackets are arranged to move while they keep the distances.

[0042] (6) In the apparatus according to any of (2) to (5), a movement range of a supporting portion of the brackets that supports the wire-like members may be set to cover an entire width of the chute formed by the wire-like members, when the brackets are moved by the bracket moving mechanism.

[0043] (7) In the apparatus according to any of (2) to (6), the bracket moving mechanism may comprise a moving mount that is placed slidably in a width direction of the pallet and to which the brackets are fixed, and a driving device for sliding the moving mount.

[0044] (8) In the apparatus according to (7), fixed lateral walls may be provided on both sides of the pallet, the brackets may be arranged to move between the two fixed lateral walls, and a distance over which the brackets can move may be set to at least a spacing between the plurality of brackets.

[0045] (9) The apparatus according to any of (2) to (8) may further comprise a driving device into which a pallet moving speed is entered, which calculates a bracket moving speed based on this entered value, and which moves the brackets based on the calculated value.

[0046] (10) In the apparatus according to any of (2) to (9), the relation

$$v_b = 2 P \cdot v_p \cdot \tan \theta_p / H$$

may be satisfied, where P is a movement pitch of the brackets, H is a pile height of the raw material, v_p is a pallet speed, θ_p is a pile angle of the raw material, and v_b is a bracket moving speed.

[0047] (11) In the apparatus according to any of (2) to (10), the wire-like members may be covered with a non-metallic organic substance.

[0048] (12) In the apparatus according to any of (2) to (11), the moving speed of the brackets may be set to 0.6 m/min or faster.

EFFECT OF THE INVENTION

[0049] In accordance with the present invention, the raw material to be sintered is supplied to the chute while moving the brackets supporting the wire-like members in the axial direction of the wire-like members, so that no groove-shaped portions are formed at the surface of the deposited raw material, adherence of raw material powder and the like to the wire-like members can be prevented, the gaps between the wire-like members can be kept uniform and the sorting capabilities of the wire-like members can be maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050]

Fig. 1 is an illustrative diagram of the main parts of an apparatus for charging raw material to be sintered in accordance with an embodiment of the present invention.

Fig. 2 is an illustrative diagram illustrating the apparatus for charging raw material to be sintered shown in Fig. 1 in detail.

Fig. 3 is an illustrative diagram illustrating a portion of the apparatus for charging raw material to be sintered shown in Fig. 1.

Fig. 4 is a diagram showing a conventional example to illustrate the effect of embodiments of the present invention.

Fig. 5 is an illustrative diagram to illustrate the effect of embodiments of the present invention.

Fig. 6 is an illustrative diagram to illustrate the effect of embodiments of the present invention.

Fig. 7 is an illustrative diagram to illustrate another embodiment of the present invention.

Fig. 8 is an illustrative diagram to illustrate another embodiment of the present invention.

Fig. 9 is an illustrative diagram to illustrate another embodiment of the present invention.

Fig. 10 is an illustrative diagram to illustrate a solution of the problem and schematically shows the conventional groove-shaped portions.

Fig. 11 is an illustrative diagram to illustrate a solution of the problem, which shows a state in which the conventional groove-shaped portions are leveled.

Fig. 12 is an illustrative diagram to illustrate a solution of the problem, which shows the particle size distribution in portions affected by and portions unaffected by the brackets.

Fig. 13 is an illustrative diagram to illustrate a solution of the problem, which illustrates the influence of the groove-shaped portions on the combustion surface in the case that the brackets are halted.

Fig. 14 is an illustrative diagram to illustrate a solution of the problem, which illustrates the influence of the portions affected by the brackets on the combustion surface in the case that the brackets are moved.

Fig. 15 is an illustrative diagram to illustrate a solution of the problem, which schematically illustrates the bracket moving speed and the range of influence of the brackets as well as the position of the combustion surface near the bottom of the sintering bed. Note that this figure also schematically shows the groove-shaped portions of the sintering bed.

Fig. 16 is an illustrative diagram to illustrate a solution of the problem, which shows the state, viewed in cross section in the pallet advancing direction, when the raw material is supplied from the drum chute to the pallet and piled onto it.

Fig. 17 is an illustrative diagram to illustrate a solution of the problem, which shows a section of the sintering bed in a direction perpendicular to the pallet advancing direction.

Fig. 18 is an illustrative diagram to illustrate a solution of the problem, which shows, in a top view, the portions affected by the brackets when the brackets are moved back and forth in the pallet width direction (Fig. 18(a)) as well as a section of the sintering bed in the pallet axis direction (Fig. 18(b)) corresponding to Fig. 18(a).

Fig. 19 is an illustrative diagram to illustrate a solution of the problem, which schematically shows a state in which the influence of the brackets is minimal.

Fig. 20 is an illustrative diagram to illustrate a solution of the problem, which schematically shows a state viewed from the top of the portions affected by the brackets when the bracket moving speed is faster than in the state of Fig. 19.

BEST MODE FOR CARRYING OUT THE INVENTION

Embodiment 1

[0051] Fig. 1 is an illustrative diagram of the main parts of an apparatus for charging raw material to be sintered in accordance with an embodiment of the present invention. This apparatus 1 for charging raw material to be sintered in accordance with the present embodiment sorts raw material to be sintered by supplying the raw material to be sintered from a drum chute 7 to a wire chute 5 made of a plurality of wires 3 arranged side by side in parallel, and charging it to a pallet 9 below. The apparatus 1 includes a moving support mechanism 13 that moves in a pallet width direction while intermediately supporting wires 3 that are spanned between fixed lateral walls 11 erected on both sides of the pallet 9. The following is a detailed explanation of the configuration of the moving support mechanism 13, which is a feature of the present invention.

[0052] The moving support mechanism 13 includes a rectangular sliding frame 15 that is arranged straddling the top of the pallet 9 in the pallet width direction, three brackets 17, 19 and 21 that are arranged on the sliding frame 15 and support the wires 3, linear movement bearings 23 that abut against the bottom surface of the sliding frame 15 and support the sliding frame 15 such that it is slidable in the pallet width direction, and a hydraulic cylinder 25 that moves the sliding frame 15 in the pallet width direction.

The following is a further detailed explanation of the individual elements constituting the moving support mechanism 13.

Brackets

[0053] The three brackets 17, 19 and 21 are placed on the sliding frame 15, spaced apart by a predetermined spacing. The brackets 17, 19 and 21 include curved portions 17a, 19a and 21a that are sloped in a circularly curved shape, and foot portions 17b, 19b, and 21b for fixing the brackets 17, 19 and 21 to the sliding frame 15. The curved portions 17a, 19a and 21 are provided with a plurality of holes 17c, 19c and 21c through which the wires 3 are inserted. Viewing the wires 3 inserted through the holes 17c, 19c and 21c provided in the curved portions 17a, 19a and 21a in a top view, the spacing between the wires widens from the uppers side towards the lower side of the slope of the curved portions 17a,

19a and 21a.

The wires 3 arranged between the fixed lateral walls 11 are inserted through the holes 17c, 19c and 21c in the three brackets 17, 19 and 21, and the wires 3 are supported at their two ends by the fixed lateral walls 11 and are furthermore supported in between by the brackets 17, 19 and 21. Moreover, the functionality is provided that when the brackets 17, 19 and 21 are moved, raw material powder and the like adhering to the wires 3 is scraped off by the edge of the holes 17c, 19c and 21c.

[0054] The spacing of the three brackets 17, 19 and 21 is set to an appropriate length, such that a force supporting the wires 3 can be applied that is large enough so that the wires 3 do not sag considerably, there are no excessive oscillations due to insufficient stiffness, and the wires 3 do not shift from the position at which they are supposed to be arranged. Such an appropriate length differs depending on the conditions, such as the thickness and the tensile force of the wires 3, so that it is set in accordance with these conditions.

It should be noted that the brackets 17, 19 and 21 are fixed to the sliding frame 15, so that the distance between the brackets 17, 19 and 21 does not change when the sliding frame 15 is moved, and as a consequence, also the supporting force with which the wires 3 are supported by the brackets 17, 19 and 21 does not change either.

However, the distance between the fixed lateral walls 11 and the brackets 17 and 21 placed at the two ends changes when the sliding frame 15 is moved. Therefore, it should be ensured that the wires 3 can be properly supported also in the case that the distance between the fixed lateral walls 11 and the brackets 17 and 21 at the two ends becomes longest, and therefore, the maximum distance between the fixed walls and the brackets 17 and 21 at the two ends, that is, the distance between the fixed lateral wall 11 and the bracket 17 on the one side when the bracket 21 on the other side abuts against the fixed lateral wall 11, is set such within a length range at which the wires 3 can be properly supported.

[0055] The foregoing was an explanation of the arrangement of the brackets 17, 19 and 21 from the viewpoint of properly supporting the wires 3, but for the arrangement of the brackets 17, 19 and 21 and their movable range, one should also consider the aspect of scraping off raw material powder adhering to the wires 3. That is to say, the raw material powder adhering to the wires 3 should be scraped off with the holes 17c, 19c and 21c of the brackets 17, 19 and 21 by moving the brackets 17, 19 and 21, and for this reason, it is preferable that when the sliding frame 15 is moved over one cycle to the left and right in the drawing, the entire width of the wires 3 passes through the holes 17c, 19c or 21c of any of the brackets 17, 19 or 21. For this reason, the movable distance of the brackets should be set to be equal to or larger than the distance between the brackets 17, 19 and 21. In the following, this aspect is explained with reference to Fig. 2.

[0056] Fig. 2(a) shows the state when the brackets 17, 19 and 21 are moved furthest to the right. Fig. 2(b) shows the state when the brackets 17, 19 and 21 are moved furthest to the left. In Fig. 2(a), the distance between the fixed lateral walls 11, that is, the entire width of the wires 3 is L, the distance between the leftmost bracket 17 and the fixed lateral wall 11 on the left, that is, the movable distance of the brackets 17, 19 and 21 is S, and the distance between the brackets 17, 19 and 21 is P.

When the brackets 17, 19 and 21 are moved from the state shown in Fig. 2(a) to the state in Fig. 2(b) by sliding the sliding frame 15, the brackets 17, 19 and 21 move by the distance S from the state shown in Fig. 2(a) to the left, so that the distance over which each of the brackets 17, 19 and 21 passes along the wires 3 becomes S, and the sum of the distances over which the three brackets 17, 19 and 21 pass along the wires 3 is 3S.

Consequently, if the relation $3S \geq L$ holds, the entire width of the wires 3 can be passed by any of the brackets 17, 19 and 21. On the other hand, the relation $L = S + 2P$ holds, as shown in Fig. 2(a), so that by inserting $3S \geq L$ into this relation and rearranging the resulting relation, $S \geq P$ is obtained as a condition that the entire width of the wires 3 can be passed by any of the brackets 17, 19 and 21, or in other words, "the movable distance S of the brackets is at least the distance P between the brackets 17, 19 and 21."

It should be noted that the maximally allowable length of the distance P between the brackets and the movable distance S of the bracket is the distance over which the wires 3 can be properly supported, and the most efficient supporting structure is attained when these lengths are both set to the maximally allowable length. In this case, $L = 3S = 3P$ results. Fig. 2 is a diagram illustrating this case.

Wires

[0057] A plurality of wires 3 are arranged between the two fixed lateral walls 11. The plurality of wires 3 are set such that when the wires 3 are projected into the horizontal plane, the distance between the wires widens from the obliquely upper side towards the lower side. Thus, the raw material to be sintered that is supplied from the drum chute 7 is sorted, and a particle size distribution is attained, in which coarsely grained raw material is deposited in the lower portion of the raw material layer on the pallet 9, whereas finely grained raw material is deposited in the upper portion.

It is preferable that the circumferential surface of the wires 3 is covered by a non-metallic organic material (for example, by rubber, plastic or the like), so that raw material powder does not adhere easily to the wires 3, and raw material powder can be easily scraped off by the brackets 17, 19 and 21.

Bearings for Linear Movement

[0058] As shown in Fig. 1, linear movement bearings 23 are placed on fixing mounts 27 that are placed on both sides of the pallets 9, and have the function of allowing smooth movement of the sliding frame 15.

It should be noted that the linear movement bearings 23 are merely an example, and it is also possible to use other components, as long as they have the function to allow for smooth movement of the sliding frame 15.

Hydraulic Cylinder

[0059] The rod of a hydraulic cylinder 25 is coupled to the sliding frame 15, and the sliding frame 15 can be moved by extending and retracting this rod.

In the present embodiment, the speed by which the rod is extended or retracted is controlled to be 0.6 m/min or faster. By setting the speed by which the rod is extended or retracted to 0.6 m/min or faster, the brackets 17, 19 and 21 are moved at a speed of 0.6 m/min or faster, so that the presence of the brackets 17, 19 and 21 tends not to exert an adverse influence on the sorting capability of the wire chute 5 when supplying the raw material to be sintered.

[0060] Furthermore, it is preferable that the hydraulic cylinder 25 controls the extending/contracting operation of its rod with a control device 29 as shown in Fig. 3.

The control device 29 receives the bracket movement pitch P , the pallet speed v_p and the raw material pile length L_b as input, and based on these parameters, calculates the bracket moving speed v_b with the following Equation (9), and gives out the calculated bracket moving speed v_b as an instruction.

$$v_b = 2 P \cdot v_p / L_b \quad (9)$$

It is also possible that the control device 29 receives the bracket movement pitch P , the pallet speed v_p , the raw material charging portion pile angle θ_b and the sintering bed height H as input, and based on these parameters, calculates the bracket moving speed v_b with the following Equation (8), and gives out the calculated bracket moving speed v_b as an instruction.

$$v_b = 2 P \cdot v_p \cdot \tan \theta_p / H \quad (8)$$

For example, when the values $v_p = 2\text{m/min}$, $\theta_p = 40^\circ$, $H = 600\text{ mm}$, $P = 1200\text{ mm}$ are used as typical values for a sintering machine, then $v_b = 6.7\text{ m/min}$ is attained.

[0061] It should be noted that in ordinary sintering machines, v_p is available in real-time as the pallet speed of the sintering machine, and this signal may be used.

Moreover, also for the height H of the sintering bed, a similarly available signal may be utilized. Needless to say, if such a signal is not available, a level sensor detecting the height of the sintering bed may be provided and the signal from this level sensor may be utilized.

Also the pile length L_b and the pile angle θ_p , may be determined by a level sensor or by image processing, and the resulting signals may be utilized. Needless to say, these values hardly change at all, so that once they have been measured, these values may also be manually entered. This is also the same for the height H of the sintering bed.

[0062] It should be noted that instead of the hydraulic cylinder 25, it is also possible to use an electric cylinder or a pneumatic cylinder.

[0063] The following is an explanation of a method for charging raw material to be sintered using the apparatus 1 for charging raw material to be sintered according to the present embodiment as explained above.

As shown by the arrows in Fig. 1, the pallet 9 moves in the opposite direction to the direction in which the raw material slides and falls down when viewed in a top view. Moreover, by driving the hydraulic cylinder 25, the sliding frame 15 is moved back and forth at constant speed in the pallet width direction.

[0064] When the raw material to be sintered is fed by the drum chute 7 to the wire chute 5 in this state, the supplied raw material to be sintered slides and falls down the oblique surface of the wire chute 5.

The gaps between the wires 3 forming the oblique surface of the wire chute 5 widen from the upper portion to the lower portion of the oblique surface, so that in the process of sliding and falling down the oblique surface of the wire chute 5, the raw material is charged from the gaps between the wires 3 onto the pallet 9 starting with the raw material of finer particle size and then gradually with the raw material of coarser particle size.

On the other hand, the pallet 9 moves in the opposite direction to the direction in which the raw material to be sintered

is supplied, so that first the raw material of coarser particle size is deposited onto the pallet 9, and the raw material of finer particle size is deposited on top of that, so that a raw material layer is formed that is segregated by particle size in the depth direction.

[0065] When the raw material to be sintered is supplied to the wire chute 5, the brackets 17, 19 and 21 are moved at a predetermined speed in the pallet width direction. Consequently, the brackets 17, 19 and 21 supporting the wires 3 are not stopped at a constant location, but constantly change their positions. For this reason, groove-shaped portions, which were a problem in the conventional technology, are not formed in the surface layer portion of the deposited raw material. Moreover, by moving the brackets 17, 19 and 21, raw material powder and the like adhering to the wires 3 is consistently scraped off by the brackets 17, 19 and 21, and the gaps between the wires 3 are held at a predetermined distance, so that the raw material is consistently sorted in a favorable manner.

[0066] Thus, in the present embodiment, as the raw material to be sintered is supplied while the wires 3 are supported by constantly moving brackets 17, 19 and 21, a deposition layer of raw material can be formed that has a suitable segregation by particle size, without forming groove-shaped portions in the surface layer portion of the deposited raw material caused by the presence of the brackets 17, 19 and 21, which used to be a problem in the conventional technology. Moreover, groove-shaped portions that have arisen are not leveled, as in the technology of the prior art documents 1 and 2, but such groove-shaped portions are not formed to begin with, so that also the problem that the particle size distribution of the groove-shaped portions differs from that at other locations when the arising groove-shaped portions are leveled does not occur.

[0067] Moreover, in the conventional examples in which the brackets do not move, the groove-shaped portions arising due to the brackets (see Fig. 4(b), which is a sectional view along the arrows A-A in Fig. 4(a)) are leveled, so that a scraper 31 having a V-shaped raking body as shown in Fig. 4(a) used to be necessary, but in the present embodiment, since the brackets are moved back and forth, the influence of the brackets is made as small as possible (see Fig. 5(b), which is a sectional view along the arrows B-B in Fig. 5(a)), so that to level the portions affected by the brackets, it is sufficient to provide a simple flat board as shown in Fig. 5(b). And such a flat board is usually provided anyway in order to achieve a final adjustment of the height of the sintering bed in ordinary sintering machines.

[0068] Moreover, by constantly moving the brackets 17, 19 and 21, the raw material powder and the like adhering to the wires 3 is constantly scraped off by the brackets 17, 19 and 21, and the gap between the wires 3 is kept at a predetermined gaps, so that raw material powder adhering to the wires 3 does not cause any adverse effects.

Moreover, the thinner the wires 3 are, the better the particle size distribution can be adjusted, but conventionally, when the wires 3 are made thin, more brackets had to be provided, and when more brackets are provided, more groove-shaped portions are formed, so that ultimately the sorting capabilities cannot be improved. However with the present embodiment, even though there is support by the brackets, the presence of the brackets does not exert any adverse influence on the sorting capabilities, so that it is possible to make the wires 3 as small as possible while increasing the number of brackets, and more suitable sorting can be realized.

[0069] Moreover, in the present embodiment, the moving support mechanism 13 is formed by a simple mechanism in which the brackets 17, 19 and 21 are fixed to the sliding frame 15, and the sliding frame 15 is moved back and forth, so that the effect is attained that maintenance becomes easy and there are few malfunctions, even in an adverse environment with a large amount of dust, namely the environment in which the raw material to be sintered is supplied.

[0070] It should be noted that, as shown in Fig. 6, if the combustion air would flow in the flow pattern A, the speed V_B of the air flowing along the regions B, which are the regions that are affected by the brackets, would be larger than the speed V_A of the air flowing in the regions that are unaffected by the brackets, that is, $V_B > V_A$, which would reduce the effect of the present invention.

However, in practice, the flow path length Z_A in the case of the flow pattern A is longer than the flow path length Z_B in the case of the flow pattern B, and it is clear that the flow pattern B is attained, in which the flow path length is short and the pressure loss is small, so that the effect of the present invention as described can be sufficiently attained.

As will be shown in the following, in a typical sintering bed, Z_A is several times larger than Z_B .

First of all, the flow path length Z_A in case of the flow pattern A and the flow path length Z_B in case of the flow pattern B are given as follows:

$$\begin{aligned} Z_A &= H / \sin\theta_b \\ Z_B &= H \end{aligned}$$

Furthermore, for a typical sintering bed, the bracket moving speed V_b , the pallet moving speed v_p , and the pile angle θ_p are as follows.

$$v_b = 6.7 \text{ m/min}$$

$$v_p = 2 \text{ m/min}$$

$$\theta_b = 40^\circ$$

$$Z_A / Z_B = 1 / \sin\theta_b = (1 + (1/\tan\theta_b)^2)^{1/2}$$

As shown in Equation (1) noted above, the relation $\tan\theta_b = v_p \cdot \tan\theta_p / v_p$ holds, so that $\tan\theta_b \approx 2 \cdot 0.84 / 6.7 = 0.25$. Consequently, $Z_A / Z_B = (1 + (1 / 0.25)^2)^{1/2} \approx 4.1$

[0071] It should be noted that there is no limitation to fixing the brackets to the sliding frame 15, as a way to hold the brackets, and it is also possible that for example the upper and lower ends of the brackets are fixed to separate wires or rods that are arranged parallel to the wires 3 above and below the wires 3 constituting the wire chute 5, and these wires or rods are moved in the pallet width direction.

[0072] In the above-noted example, an example was given in which the brackets 17, 19 and 21 are fixed to the sliding frame 15, and the three brackets 17, 19 and 21 are moved unitarily, but the moving support mechanism 13 is not limited to this structure, and a structure, in which the brackets 17, 19 and 21 are driven individually, is also possible.

Moreover, in the above-described example, an example was given, in which three brackets are provided, but the number of brackets is not limited to this, but can be set as appropriate in view of such factors as the chute width, such that the condition is satisfied that "the movable distance S of the brackets is at least the distance P between the brackets 17, 19 and 21."

[0073] Moreover, in the above embodiment, holes 17c, 19c and 21c are provided in the brackets 17, 19 and 21, which have both the function of supporting the wires 3 with the rims of the holes 17c, 19c and 21c and the function of scraping off raw material and the like adhering to the wires 3. However, it is also possible to provide the location supporting the wires 3 and the location having the function of scraping off raw material and the like adhering to the wires 3 separately from each other on the brackets.

Furthermore, in the foregoing embodiment, an example was explained, in which wires 3 are provided as the wire-like members constituting the wire chute 5. However, the wire-like members of the present invention may also be rods instead of wires.

[0074] Moreover, in the foregoing embodiment, an example was shown in which the hydraulic cylinder 25 is used as the means for driving the sliding frame 15, but the driving device according to the present invention is not limited to this. Fig. 7 is a drawing showing another form of a means for driving the sliding frame 15. Fig. 7(a) is a perspective view, and Fig. 7(b) is a diagram, in which the moving support mechanism 13 has been added to the sectional view taken in longitudinal direction of Fig. 7(a).

As shown in Fig. 7, it is also possible to provide a rack / pinion mechanism, in which a rack 35 is provided on the side of the sliding frame 15, and a pinion gear 37 rotated by a motor meshes with the rack 35.

[0075] Moreover, as another form of a means for driving the sliding frame 15, it is also possible to use a structure with a winch 43, having a structure in which ends of a wire 41 are fixed to two locations in the sliding direction of the sliding frame 15, and the wire 41 can be wound up and unwound with a wire drum 39 that is placed on the rotation axis of a motor 38, as shown in Fig. 8.

Furthermore, a structure is also possible, in which a pair of screw shafts 45 arranged in parallel are rotated by a motor 47, support portions 49 supporting the brackets 17, 19 and 21 are inserted onto the screw shafts, and the brackets 17, 19 and 21 are moved in the screw shaft direction by the rotation of the screw shafts 45, without using the sliding frame 15, as shown in Fig. 9, although this solution is inferior with regard to durability and simplicity, compared to the solution with the slide frame. Note that in the case of the structure shown in Fig. 9, it is preferable that an accordion-like cover is provided at the portion of the screw.

INDEX TO REFERENCE NUMERALS

[0076]

1	apparatus for charging raw material to be sintered
3	wires
5	wire chute
7	drum chute
9	pallet
11	fixed lateral walls
13	moving support mechanism
15	sliding frame
17, 19, 21	brackets
17a, 19a, 21a	curved portions of brackets
17b, 19b, 21b	foot portions of brackets
17c, 19c, 21c	bracket holes
23	linear movement bearings
25	hydraulic cylinder
27	fixing mounts

29	control device
31	scraper
33	flat plate
35	rack
5 37	pinion gear
38	motor
39	wire drum
41	wire
43	winch
10 45	screw shafts
47	motor
49	support portions

15 Claims

1. A method for charging raw material to be sintered, in which raw material to be sintered is sorted and charged onto a pallet below, by supplying the raw material to be sintered to a chute in which a plurality of wire-like members are arranged side by side,
20 wherein the raw material to be sintered is supplied to the chute while brackets supporting the wire-like members are moved back and forth in the axial direction of the wire-like members.
2. An apparatus for charging raw material to be sintered, in which raw material to be sintered is sorted and charged onto a pallet below by supplying the raw material to be sintered to a chute in which a plurality of wire-like members are arranged side by side,
25 comprising a plurality of brackets supporting the wire-like members, and a bracket moving mechanism that moves the brackets back and forth in the axial direction of the wire-like members.
3. The apparatus for charging raw material to be sintered according to claim 2, wherein the brackets have a function of scraping off raw material powder adhering to the wire-like members, when the brackets are moved.
30
4. The apparatus for charging raw material to be sintered according to claim 2 or 3, wherein a supporting portion of the brackets that supports the wire-like members has both functions of supporting the wire-like members and of scraping off raw material powder or the like adhering to the wire-like members.
35
5. The apparatus for charging raw material to be sintered according to any of claims 2 to 4, wherein the distances between the plurality of brackets are set to predetermined distances, and the plurality of brackets are arranged to move while they keep the distances.
- 40 6. The apparatus for charging raw material to be sintered according to any of claims 2 to 5, wherein a movement range of a supporting portion of the brackets that support the wire-like members is set to cover the entire width of the chute formed by the wire-like members, when the brackets are moved by the bracket moving mechanism.
- 45 7. The apparatus for charging raw material to be sintered according to any of claims 2 to 6, wherein the bracket moving mechanism comprises, a moving mount which is placed slidably in the width direction of the pallet and to which the brackets are fixed, and a driving device for sliding the moving mount.
8. The apparatus for charging raw material to be sintered according to claim 7, wherein fixed lateral walls are provided on both sides of the pallet, the brackets are arranged to move between the two fixed lateral walls, and the bracket movement range is set to at least a spacing between the plurality of brackets.
50
9. The apparatus for charging raw material to be sintered according to any of claims 2 to 8, provided with a driving device into which a pallet moving speed is inputted, and which calculates a bracket moving speed based on the inputted value, and which moves the brackets based on the calculated value.
55
10. The apparatus for charging raw material to be sintered according to any of claims 2 to 9, wherein the relation

$$v_b = 2 P \cdot v_p \cdot \tan\theta_p / H$$

is satisfied,

where P is a movement pitch of the brackets, H is a pile height of the raw material, v_p is a pallet speed, θ_p is a pile angle of the raw material, and v_b is a bracket moving speed.

11. The apparatus for charging raw material to be sintered according to any of claims 2 to 10, wherein the wire-like members are covered with a non-metallic organic substance.

12. The apparatus for charging raw material to be sintered according to any of claims 2 to 11, wherein the moving speed of the brackets is set to 0.6 m/min or faster.

Figure 1

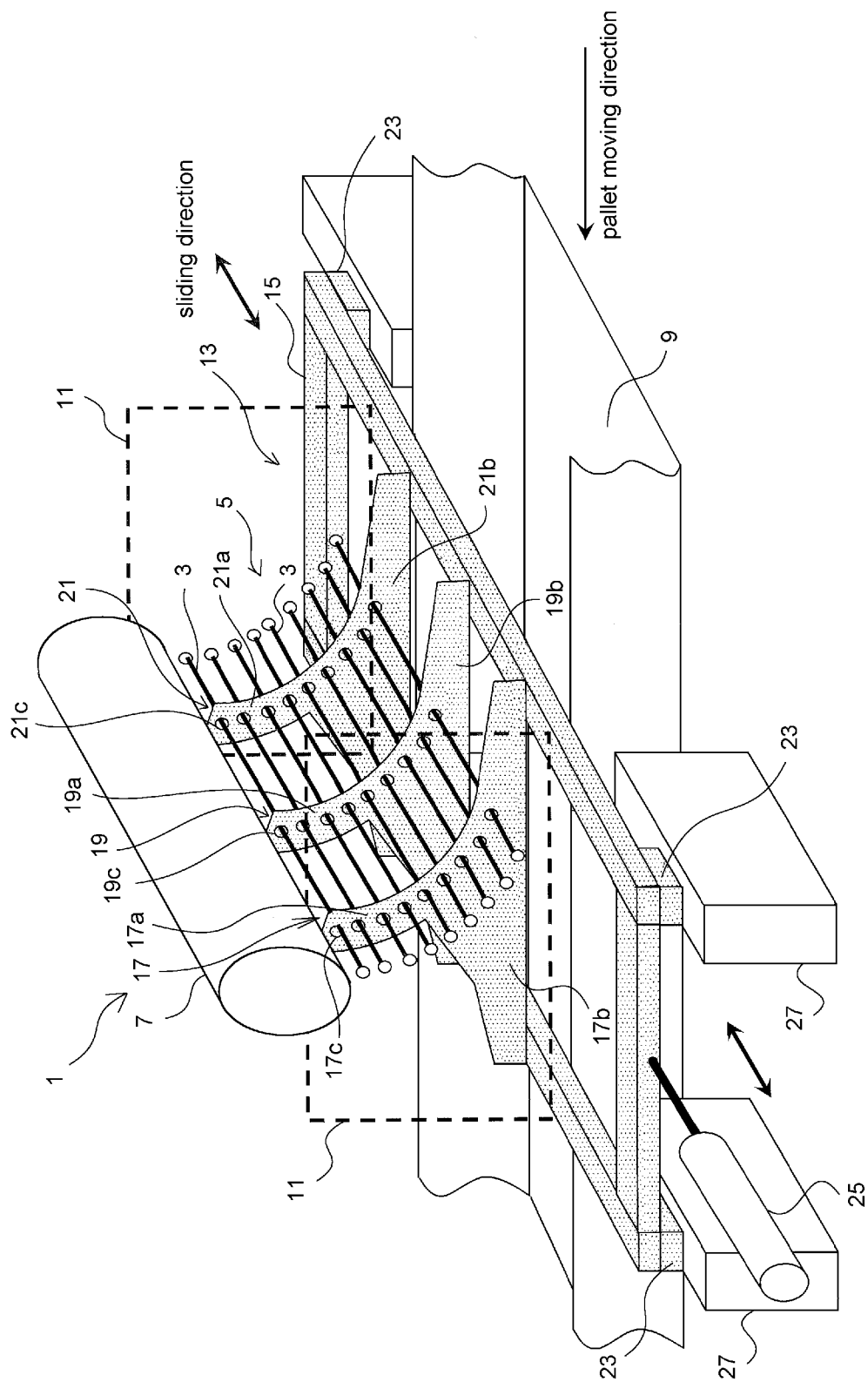


Figure 2

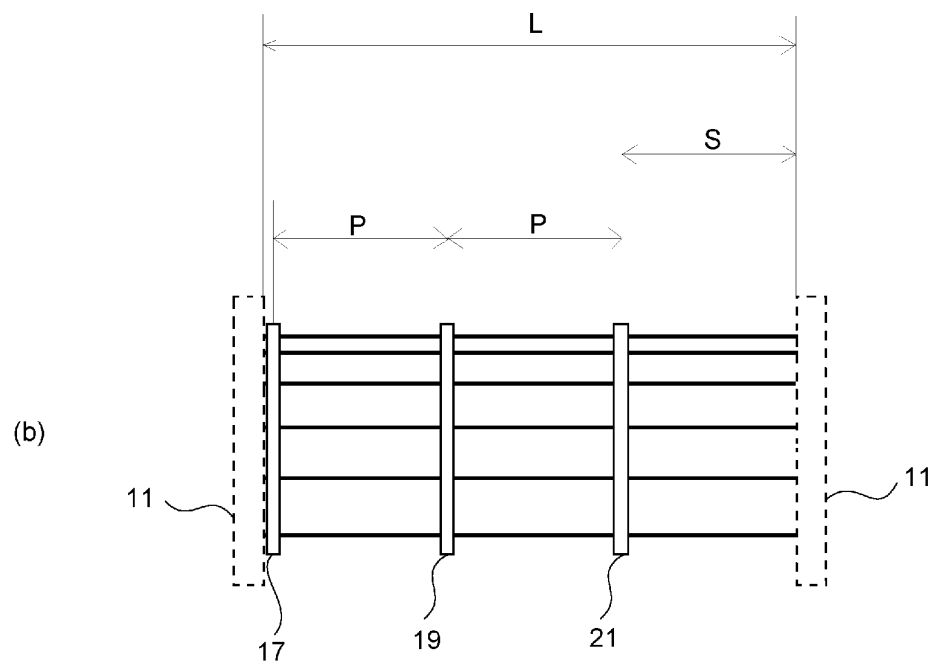
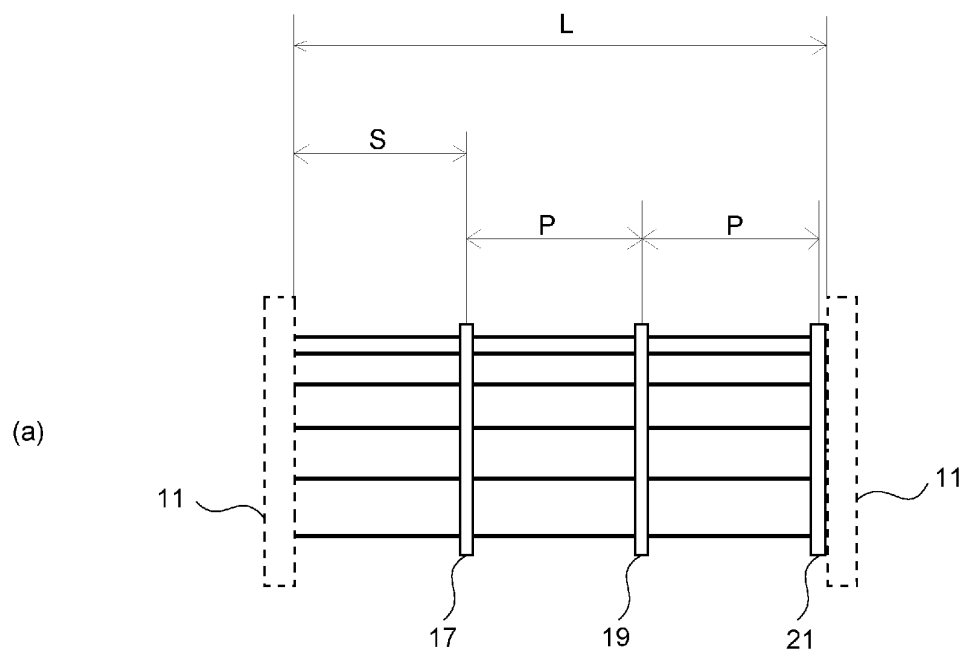


Figure 3

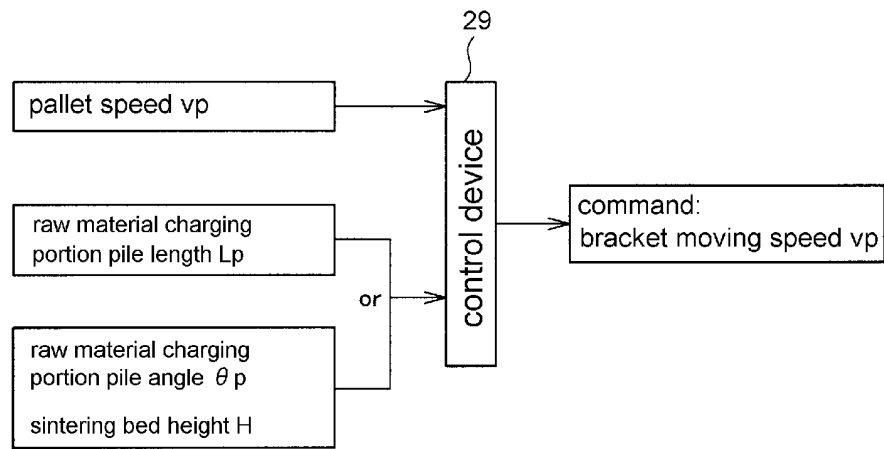


Figure 4

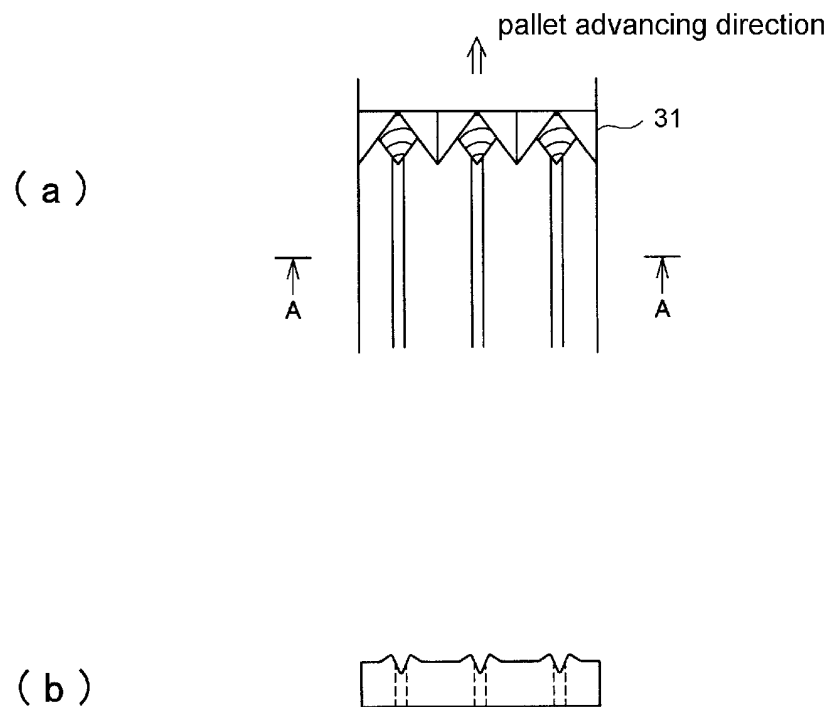


Figure 5

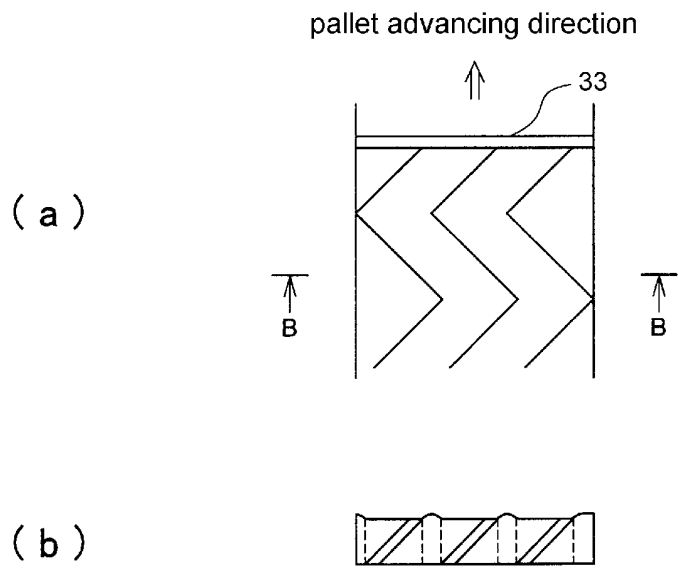


Figure 6

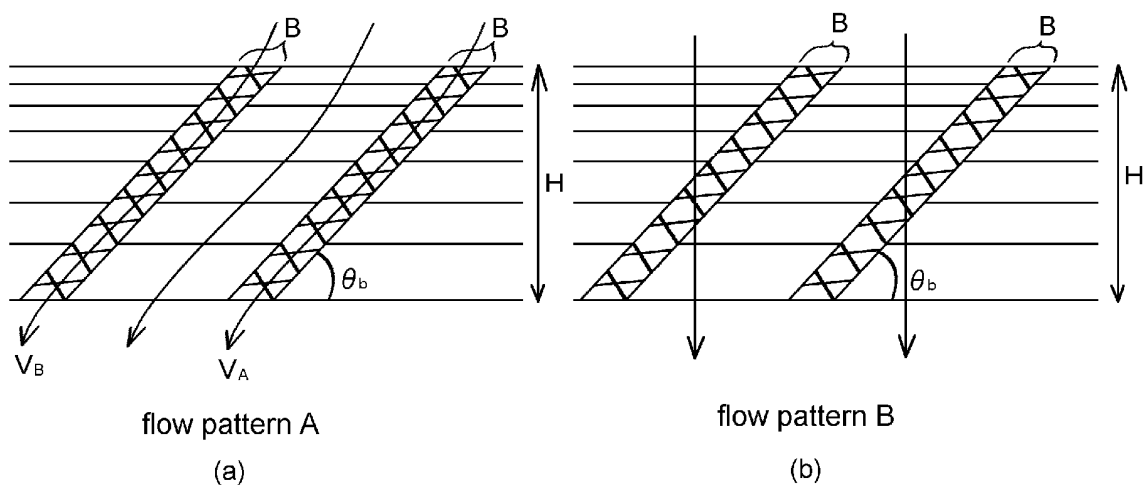


Figure 7

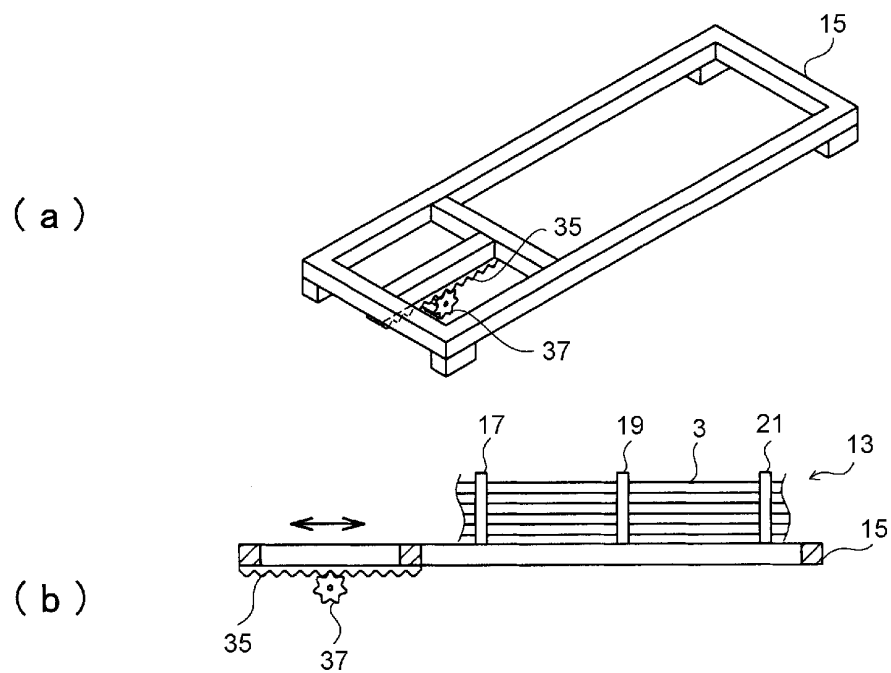


Figure 8

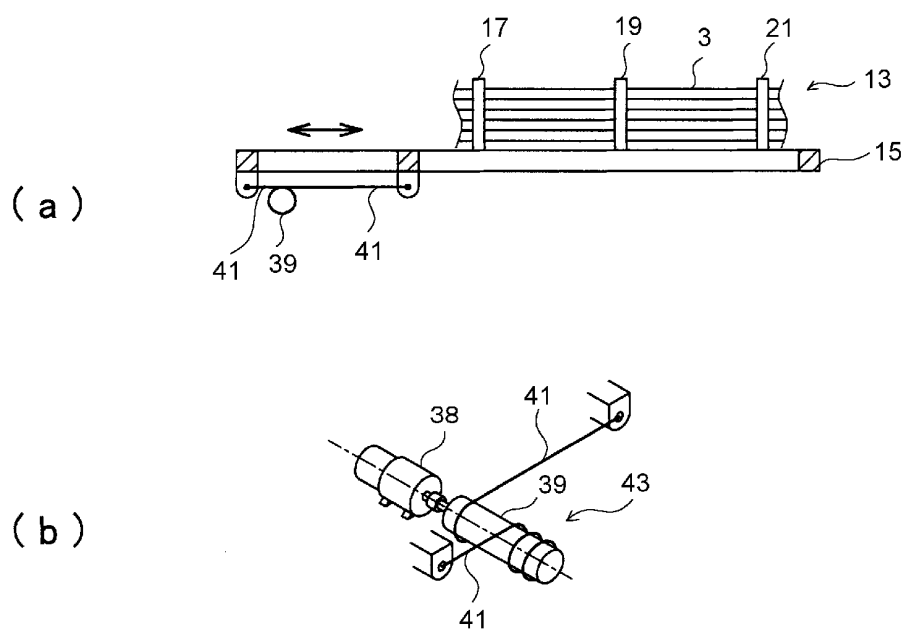


Figure 9

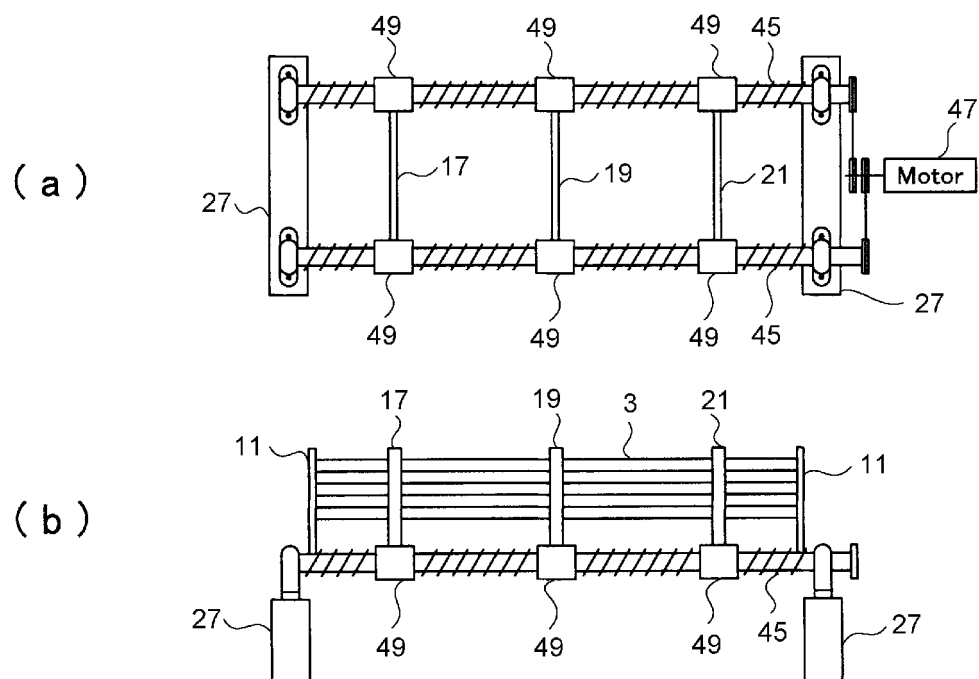


Figure 10

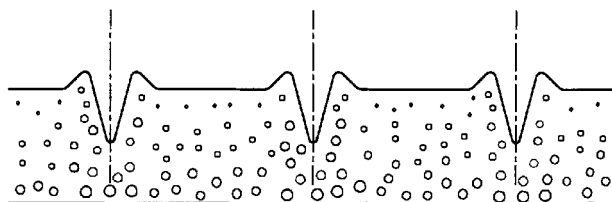


Figure 11

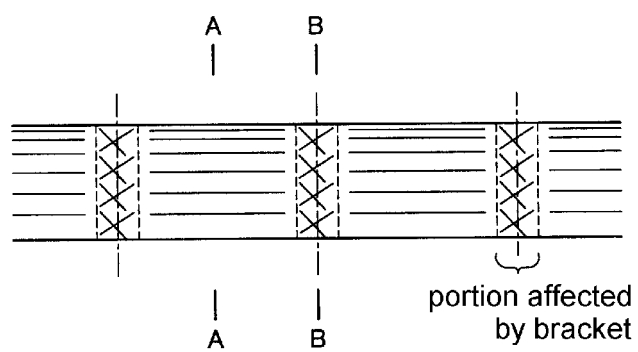


Figure 12

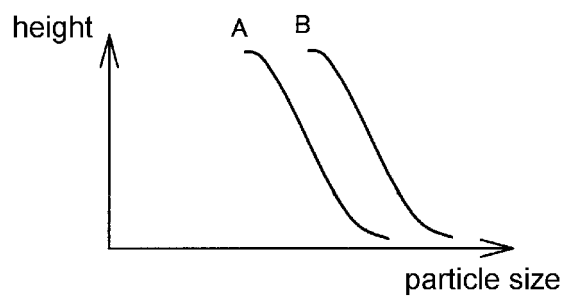


Figure 13

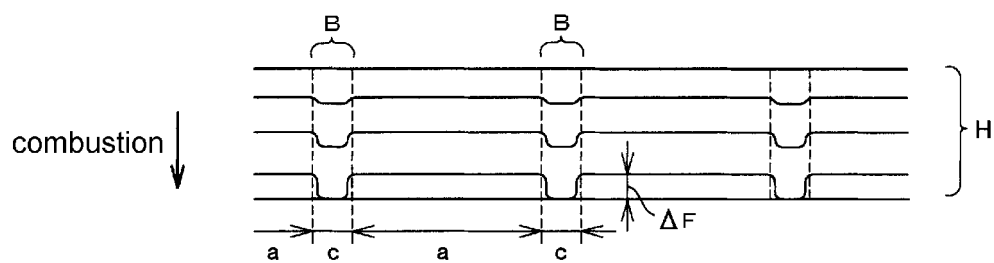


Figure 14

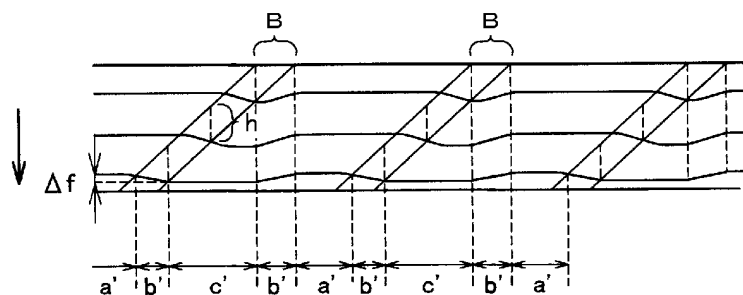


Figure 15

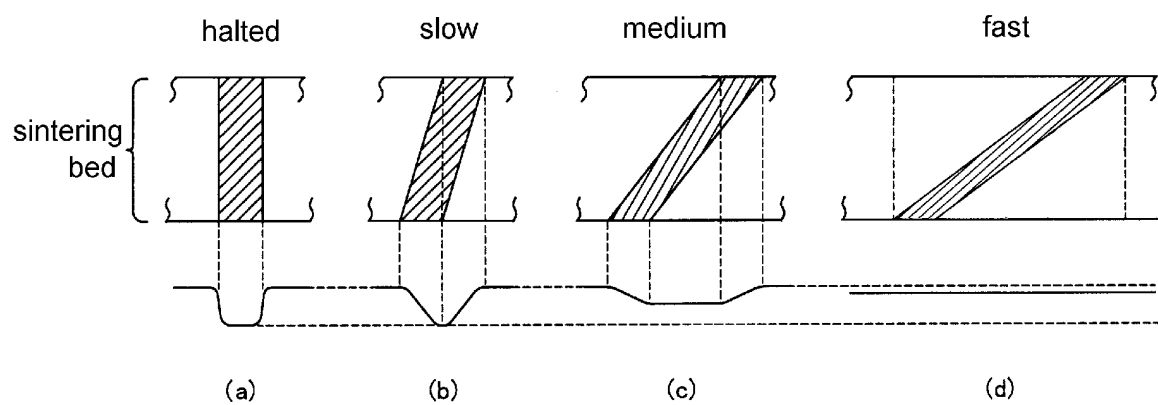


Figure 16

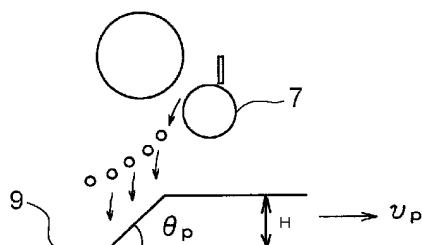


Figure 17

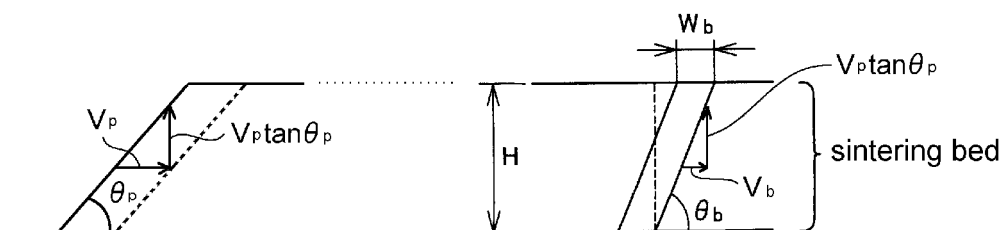


Figure 18

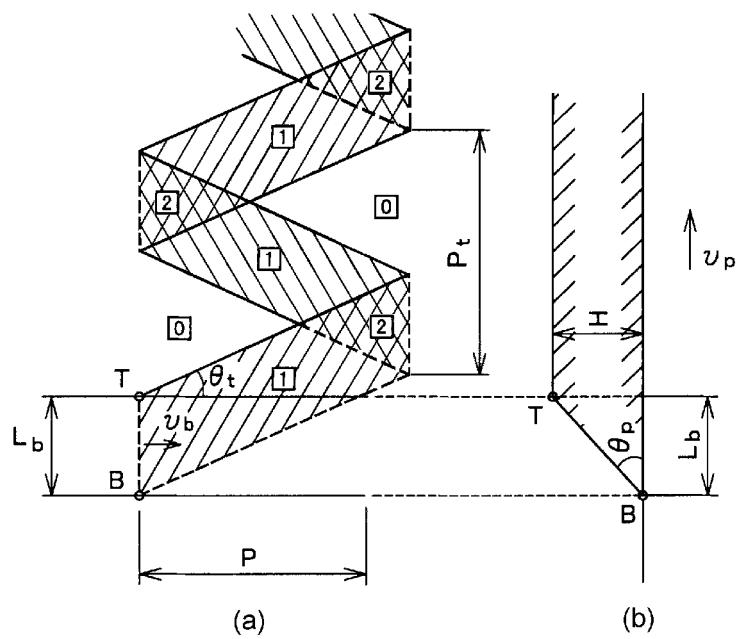


Figure 19

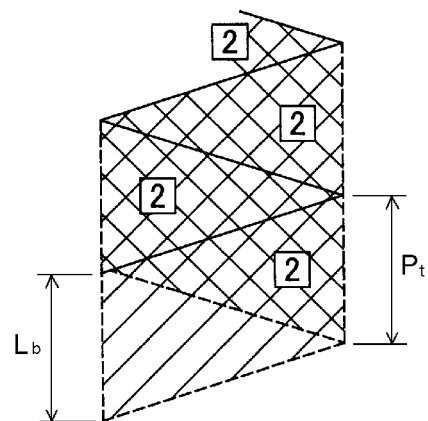
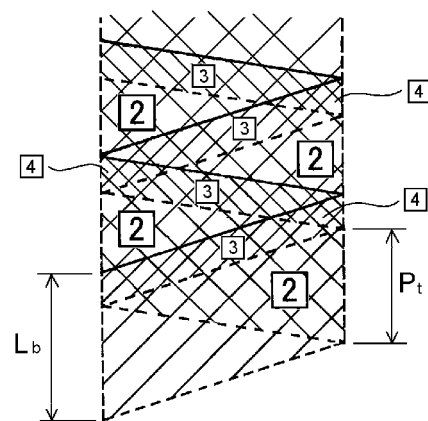


Figure 20



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/064102

A. CLASSIFICATION OF SUBJECT MATTER

C22B1/20(2006.01) i, F27B21/10(2006.01) i, F27D23/02(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)

C22B1/00-61/00, F27B21/00-21/14, F27D17/00-23/04

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009

Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 60-155894 U (Nippon Steel Corp.), 17 October 1985 (17.10.1985), claims; page 4, line 6 to page 5, line 10; page 6, line 2 to page 7, line 12; page 8, line 1 to page 9, line 4; page 9, lines 11 to 13; fig. 2, 3 (Family: none)	1-8, 12 11 9, 10
Y	JP 63-162297 U (Nippon Steel Corp.), 24 October 1988 (24.10.1988), claims; page 5, lines 11 to 17 (Family: none)	11

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
05 November, 2009 (05.11.09)Date of mailing of the international search report
17 November, 2009 (17.11.09)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/064102

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The invention of claims 1 - 8 relates to a method and an apparatus for charging a raw material to be sintered, which make no contribution over the prior art.

The invention of claims 9 - 12 relates to an apparatus for charging a raw material to be sintered comprising a drive device for inputting a pallet moving velocity to compute a bracket moving velocity on the basis of the input value, thereby moving a bracket on the basis of the computed value.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H09280741 A [0012]
- JP H11211355 A [0012]
- JP S63180079 A [0012]
- JP S6160843 A [0012]