(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 845 806 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
07.07.2021 Bulletin 2021/27

(21) Application number: **18931954.4**

(22) Date of filing: **26.10.2018**

(51) Int Cl.:
F23G 5/00 *(2006.01)* ***F23G 5/50*** *(2006.01)*
F23H 7/08 *(2006.01)*

(86) International application number:
PCT/JP2018/039867

(87) International publication number:
WO 2020/044577 (05.03.2020 Gazette 2020/10)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
KH MA MD TN

(30) Priority: **30.08.2018 JP 2018161817**

(71) Applicant: **Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.**
Yokohama-shi, Kanagawa 220-0012 (JP)

(72) Inventors:
- **SAWAMOTO Yoshimasa**
Yokohama-shi, Kanagawa 220-0012 (JP)
- **MAWATARI Masayuki**
Yokohama-shi, Kanagawa 220-0012 (JP)

(74) Representative: **Henkel & Partner mbB**
Patentanwaltskanzlei, Rechtsanwaltskanzlei
Maximiliansplatz 21
80333 München (DE)

(54) STOKER FURNACE

(57) Provided is a stoker furnace having: a burn-off-point detection device (31) that acquires a detection signal corresponding to the burn-off-point (P) of an object (B) to be incinerated; a first drive device (18a) that drives moving grates of a drying stage (11); a second drive device (18b) that drives moving grates of a combustion stage (12); a third drive device (18c) that drives moving grates of a post-combustion stage (13); and a control device (30), wherein the drying stage (11) is disposed to be inclined such that a downstream side thereof faces downward, the combustion stage (12) and the post-combustion stage (13) are disposed to be inclined such that downstream sides thereof face upward, and the control device controls the second drive device and the third drive device such that when the position of the burn-off-point (P) does not exceed a target burn-off-point, the moving grates of the combustion stage (12) and the moving grates of the post-combustion stage (13) are not changed, and when the position of the burn-off-point (P) is located downstream of the target burn-off-point, the drive speed of the moving grates of the post-combustion stage (13) is slower than the drive speed of the moving grates of the combustion stage (12).

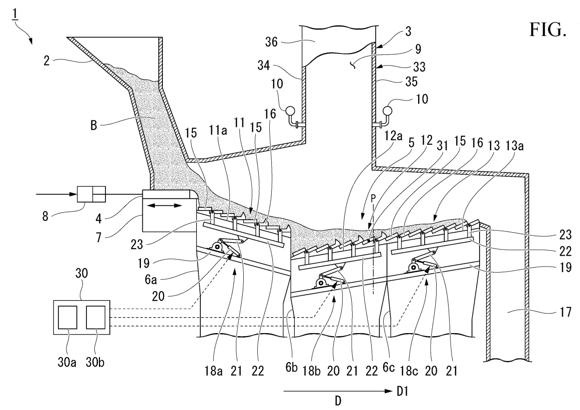


FIG. 1

EP 3 845 806 A1

Description

[Technical Field]

[0001] The present invention relates to a stoker furnace.

[0002] Priority is claimed on Japanese Patent Application No. 2018-161817, filed on August 30, 2018, the content of which is incorporated herein by reference.

[Background Art]

[0003] A stoker furnace capable of efficiently incinerating a large amount of material to be incinerated without separation is known as an incinerator for incinerating incineration object such as waste. As a stoker furnace, a stoker furnace in which the stoker is configured as a stepped type, and which is equipped with a drying stage, a combustion stage, and a post-combustion stage performing each of the functions of drying, combustion, and post-combustion is known.

[0004] In order to reliably combust the incineration object, an inclination angle of the stoker has been studied. As described in Patent Documents 1 and 2, for example, the inclination angle of the stoker may be inclined so that a downstream side in a conveying direction of an installation surface of all the stages of the drying stage, the combustion stage, and the post-combustion stage is directed downward. Hereinafter, for example, when the downstream side in the conveying direction of the installation surface of the drying stage is directed downward, the drying stage is simply referred to as being directed downward (the same also applies to the combustion stage and the post-combustion stage).

[0005] Further, as described in Patent Document 3, there is a configuration in which the drying stage is inclined downward, and the combustion stage and the post-combustion stage are disposed horizontally, as described in Patent Document 4, there is a configuration in which the drying stage and the combustion stage are inclined downward and the downstream side in the conveying direction of the installation surface of the post-combustion stage is inclined upward, and as described in Patent Document 5, there is a configuration in which all the stages are inclined upward. For example, when the downstream side in the conveying direction of the installation surface of the combustion stage is directed upward, the combustion stage is simply referred to as being directed upward (the same also applies to the case of the drying stage and the post-combustion stage).

[0006] Further, Patent Document 6 discloses, in a stoker in which all the stages are inclined upward, a technique in which movable fire grates of a drying stage, a combustion stage, and a post-combustion stage are driven with different driving devices to control the combustion completion position of the incineration object.

[Citation List]

[Patent Literature]

[0007]

[Patent Document 1] Japanese Unexamined Patent Application, First Publication No. H6-265125
[Patent Document 2] Japanese Unexamined Patent Application, First Publication No. S59-86814
[Patent Document 3] Japanese Unexamined Utility Model Application, First Publication No. H6-84140
[Patent Document 4] Japanese Examined Patent Publication, Second Publication No. S57-12053
[Patent Document 5] Japanese Unexamined Utility Model Application, First Publication No. S57-127129
[Patent Document 6] Japanese Unexamined Patent Application, First Publication No. H3-28618

[Summary of Invention]

[Subject to be Solved]

[0008] Incidentally, incineration object with various properties (materials, forms, and moisture contents) may be input to a stoker furnace, but an incineration object which is a slippery material or in a form that readily rolls such as a boll shape, or incineration object with a high moisture content (including large amount of water) may be difficult to incinerate in the same stoker furnace as that used for other incineration objects in any stoker furnace.

[0009] In addition, when an incineration object of a slippery material or a shape that is easy to roll such as a ball shape, or incineration object with a high moisture content is incinerated, in some cases, a burn out point may exceed a target burn out point which is set by the stoker furnace, and there may be a problem that a combustion residue of the incineration object easily occurs.

[0010] That is, in the stoker furnaces described in Patent Documents 1, 2, 3 and 4, since the drying stage is inclined downward and the combustion stage is inclined downward or disposed horizontally, an incineration object of a slippery material or a shape that is easy to roll is conveyed earlier to the post-combustion stage than other incineration objects. Thus, the incineration object is discharged, while still combusting without being incinerated sufficiently.

[0011] Further, in the stoker furnaces described in Patent Documents 5 and 6, since all of the drying stage, the combustion stage, and the post-combustion stage are inclined upward, an incineration object of a slippery material or a shape that is easy to roll, or incineration object with a high moisture content accumulates at the bottom of a step (a drop wall) disposed between the feeder and the drying stage and it is difficult for this to be conveyed to the combustion stage. Thus, it may be necessary to limit the charging amount or temporarily stop the charging.

[0012] An object of the present invention is to provide a stoker furnace capable of continuously charging the incineration object regardless of the properties of the incineration object and capable of eliminating combustion residue of the incineration obj ect.

[Solution to Subject]

[0013] According to the present invention, there is provided a stoker furnace which is configured to feed an incineration object from a feeder, and perform each of drying, combustion and post-combustion, while sequentially conveying the incineration object, into a drying stage, a combustion stage and a post-combustion stage, which include a plurality of fixed fire grates and a plurality of movable fire grates, the stoker furnace including: a burn out point detection device configured to obtain a detection signal corresponding to a position of a burn out point of the incineration object; a first driving device configured to drive the movable fire grate of the drying stage; a second driving device configured to drive the movable fire grate of the combustion stage; a third driving device configured to drive the movable fire grate of the post-combustion stage; and a control device configured to control the first driving device, the second driving device, and the third driving device, wherein the drying stage is disposed to be inclined so that a downstream side in the conveying direction is directed downward, the combustion stage is connected to the drying stage and is disposed to be inclined so that the downstream side in the conveying direction faces upward, and the post-combustion stage is continuously connected to the combustion stage without a step, and is disposed to be inclined so that the downstream side in the conveying direction faces upward. The control device is configured to receive the detection signal, and control the second driving device and the third driving device so that, when a position of the burn out point corresponding to the detection signal acquired by the burn out point detection device does not exceed a target burn out point, the driving speeds of the movable fire grate of the combustion stage and the movable fire grate of the post-combustion stage are not changed, and when the position of the burn out point corresponding to the detection signal is located on the downstream side of the target burn out point in the conveying direction, the driving speed of the movable fire grate of the post-combustion stage is slower than the driving speed of the movable fire grate of the combustion stage.

[0014] According to such a configuration, due to the downward slope of the drying stage, it is possible to convey the incineration object of any property to the combustion stage without any delay, and due to the upward slope of the combustion stage and the post-combustion stage, the incineration object does not easily slide down or roll down after the combustion stage and is sufficiently combusted and conveyed.

[0015] As a result, regardless of the properties of the incineration object, it is possible to continuously inject the incineration object, and it is possible to eliminate the combustion residue of the incineration object.

[0016] Further, when the burn out point is located on the downstream side of the target burn out point in the conveying direction, by slowing the driving speed of the movable fire grate of the post-combustion stage, the layer of the incineration object can be kept on the combustion stage side. As a result, the thickness of the layer of the incineration object on the combustion stage is maintained, and the fire grate of the combustion stage can be protected.

[0017] Further, since the combustion stage and the post-combustion stage are continuously connected to each other without a step, the incineration object can be incinerated continuously to a greater degree. That is, the incineration object can be incinerated without impacting other incineration objects due to the step difference.

[0018] In the stoker furnace, the fixed fire grate and the movable fire grate may be disposed to be inclined so that the downstream side in the conveying direction faces upward with respect to installation surfaces of the drying stage, the combustion stage, and the post-combustion stages.

[0019] Further, in the stoker furnace, at least some of the plurality of movable fire grates of the combustion stage may be a fire grate with a protrusion in which a protrusion is provided at a distal end.

[0020] With such a configuration, it is possible to improve the stirring effect of the incineration object when the movable fire grate reciprocates.

[0021] In the stoker furnace, the burn out point detection device may be a thermocouple installed on a fire grate surface of at least one of the combustion stage and the post-combustion stage.

[0022] According to such a configuration, by adopting a thermocouple as a burn out point detection device that acquires a detection signal corresponding to the burn out point, it is possible to set the position of the burn out point with a more inexpensive configuration.

[0023] In the stoker furnace, the burn out point detection device may be an imaging device that detects a temperature distribution of the combustion stage or the post-combustion stage.

[0024] According to such a configuration, the position of the burn out point can be more accurately set by adopting the imaging device as the burn out point detection device that acquires the detection signal corresponding to the burn out point.

[0025] The stoker furnace may further have a first wind box disposed corresponding to the drying stage; a first pressure measuring device configured to output a first pressure signal corresponding to the pressure or pressure change of the first wind box; a second wind box disposed corresponding to the combustion stage; a second pressure measuring device configured to output a second pressure signal corresponding to the pressure or pressure change of the second wind box; and a drying stage temperature measuring device installed in the drying stage to output a temperature signal corresponding to the temperature or temperature change of the drying stage, wherein the control device is configured to receive the temperature signal, the first pressure signal and the second pressure signal, and perform a control such that, when the pressure or the pressure change corresponding to the first pressure signal is equal to or greater than a first threshold value, the pressure or the pressure change corresponding to the second pressure signal is less than a second threshold value, and the temperature or the temperature change corresponding to the temperature signal is equal to or greater than a third threshold value, the driving speed of the movable fire grate of the drying stage is increased, and when the pressure or the pressure change corresponding to the first pressure signal is less than the first threshold value, the pressure or the pressure change corresponding to the second pressure signal is equal to or greater than the second threshold value, and the temperature or the temperature change corresponding to the temperature signal is less than the third threshold value, the driving speed of the movable fire grate of the drying stage is decreased.

[Advantageous Effects of Invention]

[0026] According to the present invention, it is possible to continuously charge the incineration object regardless of the properties of the incineration object, and it is possible to eliminate the combustion residue of the incineration object.

[Brief Description of Drawings]

[0027]

Fig. 1 is a schematic configuration diagram of a stoker furnace of a first embodiment of the present invention.
Fig. 2 is a view showing a stoker inclination angle of the stoker furnace of the first embodiment of the present invention.
Fig. 3 is a side view showing a fire grate shape of the stoker furnace of the first embodiment of the present invention.
Fig. 4 is a graph showing an appropriate range of the stoker inclination angle of a drying stage.
Fig. 5 is a graph showing an appropriate range of the stoker inclination angle of a combustion stage.
Fig. 6 is a graph showing an appropriate range of the stoker inclination angle of the combustion stage when considering both the drying stage and the combustion stage.
Fig. 7 is a view showing a shape of a layer of an incineration object when a driving speed of a movable fire grate of a post-combustion stage is made slow.
Fig. 8 is a schematic configuration diagram of a stoker furnace of a second embodiment of the present invention.
Fig. 9 is a schematic configuration diagram of a stoker furnace of a third embodiment of the present invention.

[Description of Embodiments]

[First Embodiment]

[0028] Hereinafter, a stoker furnace of a first embodiment of the present invention will be described in detail with reference to the drawings.

[0029] The stoker furnace of the present embodiment is a stoker furnace for combustion of incineration object such as waste, and, as shown in Fig. 1, includes a hopper 2 for temporarily storing an incineration object B, an incineration furnace 3 for combusting the incineration object B, a feeder 4 for feeding the incineration object B to the incineration furnace 3, a stoker 5 (including fire grates 15 and 16 of a drying stage 11, a combustion stage 12, and a post-combustion stage 13) provided on a bottom side of the incineration furnace 3, and wind boxes 6a, 6b and 6c provided below the stoker 5.

[0030] The feeder 4 pushes the incineration object B continuously fed onto a feed table 7 via hopper 2 into the incinerator 3. The feeder 4 is reciprocated on the feed table 7 by a feeder driving device 8 with a predetermined stroke.

[0031] The incineration furnace 3 is provided above the stoker 5 and has a combustion chamber 9 including a primary combustion chamber and a secondary combustion chamber. A blower 10 for feeding secondary air to the combustion chamber 9 is connected to the incineration furnace 3.

[0032] The stoker 5 is a combustion device in which the fire grates 15 and 16 are arranged in a stepwise manner. The incineration object B is combusted on the stoker 5.

[0033] Hereinafter, a direction in which the incineration object B is conveyed is referred to as a conveying direction D. The incineration object B is conveyed on the stoker 5 in the conveying direction D. In Figs. 1, 2 and 3, a right side is a downstream side D1 in the conveying direction. Further, a surface on which the fire grates 15 and 16 are attached is referred to as an installation surface, and an angle on the conveying direction D formed by a horizontal surface and the installation surface centered on the upstream end portions (11b, 12b and 13b) of the drying stage 11, the combustion stage 12 or the post-combustion stage 13 is referred to as a stoker inclination angle (an installation angle). When the downstream side D1 in the conveying direction of the installation surface is directed upward from the horizontal plane, the stoker inclination angle is set to a positive value, and when the downstream side D1 in the conveying direction of the installation surface is directed downward from the horizontal plane, the stoker inclination angle will be described to be set to a negative value.

[0034] The stoker 5 has, in order from the upstream side in the conveying direction of the incineration object B, a drying stage 11 for drying the incineration object B, a combustion stage 12 for incinerating the incineration object B, and a post-combustion stage 13 for completely incinerating (post-combustion) unburnt components. In the stoker 5, drying, combustion, and post-combustion are performed, while sequentially conveying the incineration object B in the drying stage 11, the combustion stage 12, and the post-combustion stage 13.

[0035] The stoker furnace 1 includes a first wind box 6a that feeds primary air sent by a blower (not shown) to the drying stage 11, a second wind box 6b that feeds the primary air to the combustion stage 12, and a third wind box 6c that feeds primary air to the post-combustion stage 13.

[0036] The drying stage 11, the combustion stage 12, and the post-combustion stage 13 have a plurality of fixed fire grates 15 and a plurality of movable fire grates 16.

[0037] The fixed fire grates 15 and the movable fire grates 16 are alternately arranged in the conveying direction D. The movable fire grate 16 reciprocates in the conveying direction D of the incineration object B. The incineration object B on the stoker 5 is conveyed and stirred by the reciprocating motion of the movable fire grate 16. That is, lower layer portions of the incineration objects B are moved and replaced with upper layer portions.

[0038] The drying stage 11 receives the incineration object B that is pushed out by the feeder 4 and fallen into the incinerator 3, evaporates the moisture in the incineration object B and partially thermally decomposes the incineration object B. The combustion stage 12 ignites the incineration object B dried in the drying stage 11, using the primary air fed from the second wind box 6b and combusts the volatile matter and the fixed carbon content. The post-combustion stage 13 combusts unburnt components such as the fixed carbon content having passed through without being sufficiently combusted in the combustion stage 12 until the unburnt components are completely ashed.

[0039] An ash outlet 17 is provided at the outlet of the post-combustion stage 13. The ash is discharged from the incineration furnace 3 through the ash outlet 17.

[0040] The stoker furnace 1 includes a first driving device 18a for driving the movable fire grate 16 of the drying stage 11, a second driving device 18b for driving the movable fire grate 16 of the combustion stage 12, and a third driving device 18c for driving the movable fire grate 16 of the post-combustion stage 13. The first driving device 18a, the second driving device 18b, and the third driving device 18c are controlled by the control device 30.

[0041] The driving devices 18a, 18b and 18c are attached to a beam 19 provided on the stoker 5. The driving devices 18a, 18b and 18c have a hydraulic cylinder 20 attached to the beam 19, an arm 21 operated by the hydraulic cylinder 20, and a beam 22 connected to a distal end of the arm 21. The beam 22 and the movable fire grates 16 are connected to each other via a bracket 23.

[0042] According to the driving devices 18a, 18b and 18c of this embodiment, the arm 21 is operated by expansion and contraction of the rod of the hydraulic cylinder 20. With the operation of the arm 21, the beam 22 configured to move along each of the installation surfaces 11a, 12a and 13a of the stoker 5 moves, and the movable fire grates 16 connected to the beam 22 are driven.

[0043] Although the hydraulic cylinder 20 may be used as the driving devices 18a, 18b and 18c, there is no limitation thereto, and for example, a hydraulic motor, an electrical cylinder, a conductive linear motor, or the like can be adopted. Further, the forms of the driving devices 18a, 18b and 18c are not limited to that of the above-described embodiment, and any form may be adopted as long as the movable fire grate 16 can be made to reciprocate. For example, instead of disposing the arm 21, the beam 22 and the hydraulic cylinder 20 may be connected directly to each other and driven.

[0044] In the stoker furnace 1 of this embodiment, the control device 30 can set the driving speed of the movable fire grates 16 in the drying stage 11, the combustion stage 12, and the post-combustion stage 13 to the same speed or to different speeds in the drying stage 11, the combustion stage 12, and the post-combustion stage 13.

[0045] As shown in Figs. 2 and 3, the fixed fire grate 15 and the movable fire grate 16 are disposed such that the downstream side D1 in the conveying direction is directed upward with respect to the installation surfaces 11a, 12a and 13a of the drying stage 11, the combustion stage 12, and the post-combustion stage 13.

[0046] Some of the movable fire grates 16 of the drying stage 11 may be fire grates with a protrusion 16P (others are normal fire grates as will be described later). As shown in Fig. 2, in the length of the drying stage 11 in the conveying direction D, the movable fire grate 16 in the range R1 of 50% to 80% from the downstream side D1 in the conveying direction is the fire grate with a protrusion 16P. By using the fire grate with a protrusion 16P, it is possible to improve the stirring power.

[0047] As shown in Fig. 3, the fire grate with protrusion 16P has a plate-like fire grate body 25, and a triangular protrusion 26 provided at the distal end of the fire grate body 25. The protrusion 26 protrudes upward from the upper surface of the fire grate body 25. The shape of the protrusion 26 is not limited thereto, and it may be, for example, a trapezoidal shape or a round shape.

[0048] Here, the fixed fire grate 15 of Fig. 3 is a fire grate with no protrusion on the upper surface of its distal end, and this shape is called a normal fire grate.

[0049] In the present embodiment, only the movable fire grate 16 is defined as the fire grate with protrusion 16P, but there is no limitation thereto, and both of the movable fire grate 16 and the fixed fire grate 15 may be a fire grate with a protrusion.

[0050] Further, the range in which the fire grate with protrusion 16P is provided is not limited to the above-mentioned range, and for example, the fire grate with protrusion 16P may be used for all the fire grates of the drying stage 11.

[0051] Furthermore, depending on the properties or types of the incineration object B, a normal fire grate may be adopted for all the fire grates (the fixed fire grate 15 and the movable fire grate 16) in the drying stage 11.

[0052] As in the drying stage 11, a part of the movable fire grates 16 of the combustion stage 12 is the fire grate with protrusion 16P. Specifically, in the length of the combustion stage 12 in the conveying direction D, the movable fire grate 16 in the range R2 of 50% to 80% from the downstream side in the conveying direction is the fire grate with protrusion 16P. The other movable fire grate 16 of the combustion stage 12 is a normal fire grate. As in the drying stage 11, both the movable fire grate 16 and the fixed fire grate 15 may be the fire grate with protrusion 16P, depending on the properties and types of the incineration object B, and all the fire grates (the fixed fire grate 15 and the movable fire grate 16) may be used as the normal fire grate.

[0053] In the fire grate of the post-combustion stage 13, both the movable fire grate 16 and the fixed fire grate 15 are shown as the normal fire grates in Fig. 2, but as with the drying stage 11 and the combustion stage 12, the fire grate with protrusion 16P may be adopted.

[0054] Next, a stoker inclination angle (an installation angle) of the drying stage 11, the combustion stage 12, and the post-combustion stage 13 will be described.

[0055] As shown in Fig. 2, the drying stage 11 of the stoker 5 of the present embodiment is disposed downward. That is, an installation surface 11a of the drying stage 11 is inclined so that the downstream side D1 in the conveying direction is lower down. Specifically, a stoker inclination angle $\theta 1$ of the drying stage 11, which is an angle between a horizontal plane centered on the end portion 11b on the upstream side of the drying stage 11 and the conveying direction side of the installation surface 11a, is an angle between -15° (minus 15°) and -25° (minus 25°).

[0056] The combustion stage 12 of the stoker 5 of the present embodiment is disposed upward. That is, the installation surface 12a of the combustion stage 12 is inclined so that the downstream side D1 in the conveying direction becomes higher. Specifically, a stoker inclination angle $\theta 2$ of the combustion stage 12, which is an angle between the horizontal plane centered on the upstream end portion 12b of the combustion stage 12 and the conveying direction side of the installation surface 12a, is an angle between +5° (plus 5°) and +15° (plus 15°), preferably an angle between +8° (plus 8°) and +12° (plus 12°).

[0057] The post-combustion stage 13 of the stoker 5 of the present embodiment is disposed upward. That is, the installation surface 13a of the post-combustion stage 13 is inclined so that the downstream side D1 in the conveying direction becomes higher.

[0058] The stoker inclination angle $\theta 3$ of the post-combustion stage 13, which is the angle between the horizontal plane centered on the upstream end portion 13b of the post-combustion stage 13 and the conveying direction side of the installation surface 13a, is the same as the stoker angle $\theta 2$ of the combustion stage 12. Specifically, the stoker inclination angle $\theta 3$ of the post-combustion stage 13, which is the angle between the horizontal plane centered on the upstream end portion 13b of the post-combustion stage 13 and the conveying direction side of the installation surface 13a, is an angle between +5° (plus 5°) and +15° (plus 15°), preferably an angle between +8° (plus 8°) and +12° (plus 12°).

[0059] As well, the stoker inclination angle $\theta 3$ of the post-combustion stage 13 may be $\theta 2 \neq \theta 3$ or may be $\theta 2 = \theta 3$.

[0060] A step (a drop wall) 27 is formed between the drying stage 11 and the combustion stage 12. The downstream end portion 11c of the drying stage 11 in the conveying direction is formed to be higher in the vertical direction than the upstream end portion 12b of the combustion stage 12 in the conveying direction.

[0061] There is no step (a drop wall) between the combustion stage 12 and the post-combustion stage 13. That is, the combustion stage 12 and the post-combustion stage 13 are continuously connected to each other. In other words, the combustion stage 12 and the post-combustion stage 13 are formed such that the downstream end portion 12c of the combustion stage 12 in the conveying direction and the upstream end portion 13b of the post-combustion stage 13 in the conveying direction are located at the same height. Therefore, the downstream end portion 13c of the post-combustion stage 13 in the conveying direction is disposed to be higher in the vertical direction than the downstream end portion 12c of the combustion stage 12 in the conveying direction.

[0062] Next, the reason why the stoker inclination angle of the drying stage 11 is set to an angle between -15° (minus 15°) and -25° (minus 25°) will be described.

[0063] The function of the drying stage 11 is to efficiently dry the moisture in the incineration object B by the radiant heat from the flame above the incineration object B of the combustion stage 12 and the sensible heat of the primary air from the lower part of the fire grate.

[0064] Here, the radiation heat from the flame has a higher contribution to the drying than the sensible heat of the primary air, and the drying of the upper layer portion of the incineration object B easily proceeds.

[0065] For this reason, the drying speed is improved by moving the lower layer portion of the incineration object B upward by a stirring operation of the fire grate and replacing the lower layer portion with the upper layer portion.

[0066] However, even if the stirring operation is performed, since the incineration object B is not basically combusted in the drying stage 11, it is necessary to secure a length enough for moisture evaporation to sufficiently proceed. As the length increases, the size of the incinerator increases, and the cost also increases. Thus, it is required to make the stoker length as short as possible.

[0067] If an absolute value of the stoker inclination angle is larger than an angle of repose of the incineration object B, since the incineration object B collapses under its own weight and a layer of the incineration object B is not formed, the stoker 5 does not work properly. On the other hand, if the absolute value of the stoker inclination angle is smaller than the angle of repose of the incineration object B, the stoker does not work properly, but the movement of the incineration object B due to gravity (movement due to its own weight) decreases. Further, when the installation surface is directed upward, that is, when the stoker inclination angle is inclined at a positive value (plus value), the gravity acts in a direction of pushing back the incineration object B from the conveying direction.

[0068] When the conveying amount of the incineration object B due to the stoker 5 is less than the charged amount of the incineration object B, the conveyance limit is reached and processing becomes impossible.

[0069] The optimum stoker inclination angle differs depending on the amount of incineration object B to be charged and the moisture content of the incineration object B. Here, the description will be provided on the assumption that a case in which the amount of the incineration object B to be charged is high and the moisture content is high (the amount of moisture is large) is a case in which the load of the charged incineration object is large. On the contrary, a case in which the amount of incineration object B to be charged is small and the moisture content is low is assumed to be a case in which the load of the charged incineration target is small.

[0070] Fig. 4 shows a graph in which a horizontal axis represents a stoker inclination angle of the drying stage 11, a vertical axis represents a required stoker length of the drying stage 11, and in order from a case (1) in which the load of the charged incineration object is the largest to a case (4) in which the load of the charged incineration object is the smallest, a relationship between the stoker inclination angle of the drying stage 11 and the required stoker length of the drying stage 11 is plotted.

[0071] Here, the required stoker length is a distance at which 95% of the moisture of the charged incineration object B is dried. "Angle of repose" on the horizontal axis represents the angle of repose of the incineration object B.

[0072] As shown in the graph of Fig. 4, the stoker inclination angle of -30° is the limit for forming the layer of the incineration object B. With respect to the stoker inclination angle of the layer formation limit, the required stoker length decreases as the stoker inclination angle gets loose. However, when the stoker inclination angle turns to a positive value, the required stoker length gradually becomes longer. This is because when the stoker inclination angle becomes a positive value, the installation surface is directed upward and the conveying speed becomes slower, and as a result, the layer of the incineration object B becomes thick and drying of the incineration object B of the lower layer becomes difficult.

[0073] It is noted that, from the four cases from the case (1) in which the load of the incineration object B to be charged is the largest to the case (4) in which the load of the incineration object B to be charged is the smallest, no matter what property or quantity of the incineration object B is, the stoker inclination angle of the optimum drying stage 11 at which the incineration object B can be properly processed and the stoker length can be set to be shortest has an appropriate range of an angle between -15° (minus 15°) and -25° (minus 25°) corresponding to the stoker length near the lowermost point of curve of (1). Further, the optimum value is -20° (minus 20°).

[0074] Next, in the case in which the stoker inclination angle of the drying stage 11 is set to be within the appropriate range as described above, the reason why it is appropriate to make the stoker inclination angle of the combustion stage 12 between +8° (plus 8°) and +12° (plus 12°) will be explained.

[0075] The function of the combustion stage 12 is to maintain the temperature of the layer of the incineration object B by radiant heat from the flame and self-combustion heat, and perform generation acceleration of the combustible gas by thermal decomposition of the volatile matter, and combustion of the fixed carbon that is left after thermal decomposition.

[0076] Here, since the time required for combustion of the fixed carbon is longer than the time required for volatilization of the volatile combustible gas, the required stoker length of the combustion stage 12 is determined by the time required for combustion of the fixed carbon.

[0077] Fig. 5 shows a graph in which, in a case in which the stoker inclination angle of the drying stage 11 is set in the appropriate range as described above, a horizontal axis represents the stoker inclination angle of the combustion stage, a vertical axis represents the required stoker length of the combustion stage, and in order from the case (1) in which load of the charged incineration object is the largest to the case (4) in which load of the charged incineration object is the smallest, a relationship between the stoker inclination angle of the combustion stage and the required stoker length of the combustion stage is plotted. Here, the required stoker length of the combustion stage is the distance at which 95% of the combustible content volatilizes or combusts.

[0078] As shown in Fig. 5, the stoker inclination angle of -30° is the limit of forming the layer of the incineration object B. For the stoker inclination angle of the layer formation limit, the required stoker length decreases as the angle becomes loose. Considering the conveyance limit, the appropriate range of the stoker inclination angle can be set to the range surrounded by the one-dot chain line shown in Fig. 5.

[0079] Even when the load of the charged incineration object is large in the drying stage 11, since the drying stage 11 has the stoker inclination angle within the appropriate range, the water content reduction and the volume reduction of the waste are accelerated. Therefore, for example, even if the load corresponds to (1) in the drying stage 11, since the load changes to those corresponding to (3) and (4) in the combustion stage 12, the larger stoker inclination angle can be adopted in the combustion stage 12. That is, since the combustion stage can be directed upward, it is possible to secure the retention time required for combustion of fixed carbon, and the stoker length can be further shortened.

[0080] Fig. 6 is a graph in which a horizontal axis represents the stoker inclination angle of the combustion stage 12, a vertical axis represents the stoker length required for both the drying stage 11 and the combustion stage 12, and in order from the case (1) in which the load of the incineration object B to be charged is the largest to the case (4) in which the load of the incineration object B to be charged is the smallest, a relationship between the stoker inclination angle of the combustion stage 12 and the stoker length required for both the drying stage 11 and the combustion stage 12 is plotted. Here, the stoker inclination angle of the drying stage 11 is set to an optimum value of -20° (minus 20°).

[0081] As shown in Fig. 6, when considering the conveyance limit, the appropriate range of the stoker inclination angle of the combustion stage 12 is an angle between +5° (plus 5°) and +15° (plus 15°), more specifically, an angle between +8° (plus 8°) and +12° (plus 12°). Further, in the case in which the stoker inclination angle of the drying stage 11 is the optimum value of -20° (minus 20°), the optimum value of the stoker inclination angle of the combustion stage 12 is +10° (plus 10°).

[0082] Since the required stoker lengths of the drying stage 11 and the combustion stage 12 can be made as short as possible by setting the respective stoker inclination angles to appropriate ranges, particularly optimum values, even if the post-combustion stage 13 is included, it is possible to provide a stoker furnace of a relatively small size and low cost.

[0083] As well, the stoker inclination angle $\theta 3$ of the post-combustion stage 13 may be $\theta 2 \neq \theta 3$ or may be $\theta 2 = \theta 3$ within the same angle range as the stoker inclination angle $\theta 2$ of the above-described combustion stage 12.

[0084] Next, the control of the driving devices 18a, 18b and 18c based on the burn out point P of the incineration object B using the control device 30 will be described. The burn out point P is a point at which the combustion accompanying the flame of the incineration object B on the stoker 5 is substantially completed.

[0085] The stoker furnace 1 of the present embodiment has the function of changing the driving speed (a moving speed) of the movable fire grate 16 of each stage (the drying stage 11, the combustion stage 12, and the post-combustion stage 13), depending on the burn out point P of the incineration object B.

[0086] As shown in Fig. 2, in the stoker furnace 1, a target burn out point Pt, which is an ideal burn out point, is set on the downstream side of the center of the combustion stage 12 as seen in the conveying direction D. Here, the target burn out point Pt is set on the combustion stage 12. If the position of the burn out point P is on the upstream side in the conveying direction with respect to the target burn out point Pt, the length of the layer of the incineration object B in the conveying direction D becomes short, and there is a possibility that combustion may not be efficient. If the position of the burn out point P is on the downstream side in the conveying direction with respect to the target burn out point Pt, the length of the layer of the incineration object B in the conveying direction D becomes long, and there is a possibility that combustion residue of the incineration object B may occur.

[0087] A thermocouple 31, which is a burn out point detection device, is installed on the surface of the fixed fire grate 15 or the movable fire grate 16 in the vicinity of the target burn out point Pt in the fire grate of the combustion stage 12. The thermocouple 31 measures the temperature of the fire grate that varies as the incineration object B on the stoker 5 combusts. The measured temperature becomes a detection signal corresponding to the position of the burn out point P of the incineration object B.

[0088] The control device 30 includes a burn out point estimation unit 30a which estimates the position of the burn out point P corresponding to the fire grate temperature T (detection signal) measured by the thermocouple 31, and a driving device control unit 30b which controls the driving devices 18a, 18b and 18c on the basis of the position of the burn out point P estimated by the burn out point estimation unit 30a.

[0089] The inventors have found that there is a correlation between the fire grate temperature T of the combustion stage 12 and the position of the burn out point P.

[0090] For example, the inventors have found that, if the target burn out point Pt as shown in Fig. 2 is set, when the fire grate temperature T is T1°C, the burn out point P coincides with the target burn out point Pt, when the fire grate temperature T is lower than T1°C, the burn out point P is located on the upstream side of the target burn-out point Pt in the conveying direction, and when the fire grate temperature T is higher than T1°C, the burn out point P can be determined to be located on the downstream side of the target burn out point Pt in the conveying direction.

[0091] In addition, the inventors have found that the layer of the incineration object B can be deposited to be closer to the combustion stage 12 side, by setting the driving speed of the movable fire grate 16 of the post-combustion stage 13 to be slower than the driving speed of the movable fire grate 16 of the combustion stage 12. That is, by slowing the driving speed of the movable fire grate 16 of the post-combustion stage 13, it was found that the layer of the incineration object B remains on the combustion stage 12 side rather than the post-combustion stage 13.

[0092] The burn out point estimation unit 30a estimates the position of the burn out point P on the basis of the fire grate temperature T of the combustion stage 12 measured by the thermocouple 31. The burn out point estimation unit 30a determines that when the fire grate temperature T is T1°C, which is a threshold value, the burn out point P coincides with the target burn out point Pt, when the fire grate temperature T is lower than T1°C, the burn out point P is located on the upstream side of the target burn out point Pt in the conveying direction, and when the fire grate temperature T is higher than T1°C, the burn out point P is located on the downstream side of the target burn out point Pt in the conveying direction.

[0093] First, the control device 30 drives the movable fire grate 16 of each of the drying stage 11, the combustion stage 12, and the post-combustion stage 13 at a predetermined driving speed (a predetermined speed). When a predetermined speed of the movable fire grate 16 of the drying stage 11 is defined as a first driving speed VI, a predetermined speed of the movable fire grate 16 of the combustion stage 12 is defined as a second driving speed V2, and a predetermined speed of the movable fire grate 16 of the post-combustion stage 13 is defined as a third driving speed V3, the values of V1, V2, and V3 are appropriately set depending on the properties of the incineration object B. Therefore, depending on the properties of the incineration object B, there are also a case in which $V1 = V2 = V3$, and there is also a case in which $V1 \neq V2 \neq V3$. In the present embodiment, in many cases, there is a case in which $V1 < V2 \fallingdotseq V3$ is set. Also, V2 is a driving speed that is about one round trip in 100 seconds. However, since the driving speed is set depending on the properties of the incineration object B as described above, this speed is merely an example, and the present invention is not limited thereto.

[0094] The driving device control unit 30b of the control device 30 controls the second driving device 18b and the third driving device 18c so as not to change the driving speed of the movable fire grate 16 of the combustions stage 12 and the movable fire grate 16 of the post-combustion stage 13 when the burn out point P is located at the same position as the target burn out point Pt or when the burn out point P is located on the upstream side of the target burn out point Pt in the conveying direction. Therefore, the movable fire grate 16 of the combustion stage 12 is driven while maintaining the second driving speed V2 which is the predetermined speed, and the movable fire grate 16 of the post-combustion stage 13 is driven while maintaining the third driving speed V3 which is the predetermined speed. That is, each movable fire grate 16 of the combustion stage 12 and the post-combustion stage 13 continues to be driven at the same driving speed as before.

[0095] The driving device control unit 30b controls the second driving device 18b and the third driving device 18c such that the driving speed of the movable fire grate 16 of the post-combustion stage 13 is driven at a driving speed slower than the driving speed of the movable fire grate 16 of the combustion stage 12 when the burn out point P is located downstream of the target burn out point Pt in the conveying direction.

[0096] In the case of $V2 > V3$, that is, when the movable fire grate 16 of the post-combustion stage 13 is originally driven at a driving speed slower than the driving speed of the movable fire grate 16 of the combustion stage 12, the driving device control unit 30b controls the third driving device 18c, for example, so that the driving speed of the movable fire grate 16 of the post-combustion stage 13 is further lower than V3. In other words, the driving device control unit 30b controls the driving speed of the movable fire grate 16 of the post-combustion stage 13 to be slower than usual.

[0097] The driving speed of the movable fire grate 16 of the post-combustion stage 13 can be set to 30% to 80% of the driving speed of the movable fire grate 16 of the combustion stage 12.

[0098] According to the prior estimation performed by the inventors, by setting the driving speed of the movable fire grate 16 of the post-combustion stage 13 to be slower than the driving speed of the movable fire grate 16 of the combustion stage 12, it was thought that a layer of incineration object B was deposited as indicated by an one-dot chain line Be in Fig. 7, but it was found by simulation that the layer of the incineration object B was deposited as indicated by a solid line Ba.

[0099] Since the layer of the incineration object B is formed as indicated by the solid line Ba, stirring is effectively performed in the combustion stage 12 by the fire grate with protrusion 16P, and consequentially, it is possible to not only gain time to hold the incineration object B on the combustion stage 12 but also combustion is effectively performed. Therefore, it is possible to reduce the incineration residue of the incineration object B discharged from the post-combustion stage 13.

[0100] According to the above embodiment, since the drying stage 11 is inclined downward, it is possible to convey the incineration object B of any property to the combustion stage 12 without any delay, and since the combustion stage 12 and the post-combustion stage 13 are inclined upward, the incineration object B is combusted and conveyed sufficiently without easily sliding down or rolling down to the downstream side of the combustion stage 12.

[0101] That is, in the case of an incineration object B of a slippery material or a shape which readily rolls, since the incineration object B is conveyed early to the combustion stage 12 by rolling over the drying stage 11 or the like, there is a possibility that the drying stage 11 cannot dry the incineration object B thoroughly. However, since the combustion stage 12 and the post-combustion stage 13 are inclined upward, the incineration object B rolling and falling down the drying stage 11 does not further roll down the combustion stage 12 and the post-combustion stage 13, but is always sufficiently dried and incinerated in the combustion stage 12. Since the incineration object B having a high water content is conveyed to the combustion stage 12 while being dried without staying in the drying stage 11, similarly, the incineration object B is always sufficiently incinerated in the combustion stage 12.

[0102] As a result, it is possible to continuously charge the incineration object B regardless of the properties of the incineration object B, and it is possible to eliminate the combustion residue of the incineration object B.

[0103] Even if the incineration object B rolling down the drying stage 11 has a strong momentum and passes through the combustion stage 12 with its momentum, the incineration object B stops at least in the post-combustion stage 13 and is not discharged from the post-combustion stage 13. Further, since the post-combustion stage 13 and the combustion stage 12 are continuously connected to each other without a step, even if the incineration object B which is not sufficiently combusted up to the post-combustion stage 13 advances by rolling or the like, the incineration object B returns to the combustion stage 12 by its own weight, and combustion can be performed. That is, it is possible to minimize the discharge of incompletely combusted incineration object B as much as possible.

[0104] Further, when the burn out point P is located on the downstream side of the target burn out point Pt in the conveying direction, by setting the driving speed of the movable fire grate 16 of the post-combustion stage 13 to be slower than the driving speed of the movable fire grate 16 of the combustion stage 12, the layer of the incineration object B can be retained on the combustion stage 12 side. As a result, the thickness of the layer of the incineration object B on the combustion stage 12 is maintained, and the fire grate of the combustion stage 12 can be protected.

[0105] Further, by maintaining the thickness of the layer of the incineration object B, even when a processed material larger than the assumed value is charged, the fire grates 15 and 16 are protected by the layer of the incineration object B, and the processed object can be conveyed in the conveying direction D.

[0106] Further, by adopting the thermocouple 31 as the burn out point detection device for acquiring the detection signal corresponding to the burn out point P, it is possible to set the position of the burn out point P with a more inexpensive configuration.

[0107] In the above embodiment, the position of the burn out point P corresponds to the fire grate temperature T measured by the thermocouple 31 disposed in the fire grate of the combustion stage 12, but the embodiment is not limited thereto. For example, a configuration in which the temperature change (change speed) of the fire grate temperature T measured by the thermocouple 31 is monitored and the position of the burn out point P is estimated on the basis of the temperature change of the fire grate temperature T may be adopted.

[0108] Further, in the above-described embodiment, the thermocouple 31 is installed in the combustion stage 12, but it is not limited thereto, and the thermocouple may be installed in at least one of the combustion stage 12 and the post-combustion stage 13. When the thermocouple 31 is installed in the combustion stage 12, the downstream side of the combustion stage 12 is desirable, and when the thermocouple 31 is installed in the post-combustion stage 13, the upstream side of the post-combustion stage 13 is desirable.

[0109] In addition, a configuration including a plurality of thermocouples as the burn out point detection device may be adopted. That is, a thermocouple may be disposed, for example, on the upstream side of the combustion stage 12, the downstream side of the combustion stage 12, the upstream side of the post-combustion stage 13, and the downstream side of the post-combustion stage 13, respectively.

[0110] In this manner, by disposing a plurality of thermocouples, the position of the burn out point P can be more accurately estimated.

[0111] The number of thermocouples is not limited to this, and can be appropriately changed according to the size and cost of the stoker 5. Further, a plurality of thermocouples may be disposed in the direction of the depth of the page of Fig. 1.

[Second Embodiment]

[0112] Hereinafter, a stoker furnace according to a second embodiment of the present invention will be described in detail with reference to the drawings. In this embodiment, differences from the above-described first embodiment will be mainly described, and description of similar portions will not be provided.

[0113] As shown in Fig. 8, the stoker furnace of the present embodiment has a drying stage temperature measuring device (the drying stage temperature measuring device includes, for example, a drying stage thermocouple 32) which measures the fire grate temperature Td of the drying stage 11 and outputs a temperature signal corresponding thereto to the control device 30B, a first pressure measuring device 33a which measures a pressure PR1 in the first wind box 6a disposed below the drying stage 11 and outputs a first pressure signal corresponding thereto to the control device 30B, and a second pressure measuring device 33b which measures a pressure PR2 in the second wind box 6b disposed below the combustion stage 12 and outputs a second pressure signal corresponding thereto to the control device 30B. The drying stage thermocouple 32 is desirably installed on the surface of the fixed fire grate 15 or the movable fire grate 16 of the drying stage 11 on the downstream side of the center of the drying stage 11 as seen in the conveying direction D.

[0114] The control device 30B of the present embodiment controls the driving speed of the movable fire grate 16 of the drying stage 11, in addition to the driving speed of the movable fire grate 16 of the combustion stage 12 and the driving speed of the movable fire grate 16 of the post-combustion stage 13, on the basis of the fire grate temperatures T and Td and the pressures PR1 and PR2.

[0115] The control device 30B of the present embodiment sets a threshold value (a first threshold value corresponding to the first wind box 6a, and a second threshold value corresponding to the second wind box 6b) with respect to the pressure in the wind box. The threshold value is set on the basis of the thickness of the incineration object B deposited on the stoker on the wind box. Further, depending on the properties of the incineration object B, in some cases, the first threshold value and the second threshold value may be set to the same value, or may be set to values different from each other. When the pressure in the wind box is equal to or higher than the threshold value, the control device 30 determines that the layer thickness of the incineration object B is excessive.

[0116] Therefore, when the pressure PR2 in the second wind box 6b is less than the threshold value (the second threshold value), it is possible to determine that the layer of the incineration object B on the combustion stage 12 is thin and the processing capacity of the combustion stage 12 has a margin. On the other hand, when the pressure PR1 of the first wind box 6a is equal to or higher than the threshold value (the first threshold value) and the fire grate temperature Td of the drying stage 11 is equal to or higher than the predetermined temperature (the third threshold value), it is possible to determine that the layer thickness of the incineration object B on the drying stage 11 is thick and combustion of the incineration object B is performed in the drying stage 11.

[0117] As in the first embodiment, the control device 30B first performs a control to drive the movable fire grate of the drying stage 11 at a predetermined speed V1.

[0118] Further, the control device 30B performs the same control as that of the stoker furnace 1 of the first embodiment, and when the pressure PR1 in the first wind box 6a is equal to or higher than a threshold value (the first threshold value), the pressure PR2 in the second wind box 6b is less than the threshold value (the second threshold value), and the fire grate temperature Td of the drying stage 11 is equal to or higher than the predetermined temperature (the third threshold value), the control device 30B performs a control to set the driving speed of the movable fire grate 16 of the drying stage 11 to be faster than the predetermined speed V1. That is, when there is a margin in the processing capacity of the combustion stage 12, the layer of the incineration object B in the drying stage 11 become thick, and the incineration object B is combusted in the drying stage 11, the incineration object B of the drying stage 11 is moved to the combustion stage 12 at an early stage.

[0119] Further, when the pressure PR1 in the first wind box 6a is less than the threshold value (the first threshold value), the pressure PR2 in the second wind box 6b is equal to or higher than the threshold value (the second threshold value), and the fire grate temperature Td of the fire grate of the drying stage 11 is less than the predetermined temperature (the third threshold value), the control device 30 performs a control to set the driving speed of the movable fire grate 16 of the drying stage 11 to be slower than the predetermined speed V1. That is, when a large amount of the incineration object B is accumulated in the combustion stage 12, and meanwhile the amount of the incineration object B in the drying stage 11 is small and there is a margin in the processing capacity, movement of the incineration object B from the drying stage 11 to the combustion stage 12 is slowed down.

[0120] According to the above embodiment, by adjusting the driving speed of the movable fire grate 16 of the drying stage 11 on the basis of the thickness of the layer of the incineration object B, it is possible to improve the processing balance of the incineration object B in the drying stage 11, the combustion stage 12, and the post-combustion stage 13.

[0121] In the above embodiment, the control device 30B performs the control, by comparing the pressures PR1 and PR2 with the threshold values corresponding thereto, respectively, but the present invention is not limited thereto. For example, the control device 30B may be configured to monitor and control the pressure change (change speed) of the pressures PR1 and PR2. Further, the control device 30B may be configured to monitor and control the temperature change (change speed) of the fire grate temperature Td of the drying stage 11. In this case, the first pressure signal is defined as a signal corresponding to the pressure change of the pressure PR1, the second pressure signal is defined as a signal corresponding to the pressure change of the pressure PR2, the temperature signal is defined as a signal corresponding to the temperature change of the fire grate temperature Td, and the first threshold value, the second threshold value, and the third threshold value may be set correspondingly.

[Third Embodiment]

[0122] Hereinafter, a stoker furnace according to a third embodiment of the present invention will be described in detail with reference to the drawings. In this embodiment, differences from the above-described first embodiment will be mainly described, and a description of similar portions will not be provided.

[0123] As shown in Fig. 9, the stoker furnace 1C according to the present embodiment is provided with, as a burn out point detection device, an imaging device 34 installed above the post-combustion stage 13, more specifically, on the ceiling of the furnace.

[0124] The imaging device 34 is a camera or a sensor capable of detecting a temperature distribution.

[0125] The temperature distribution on the downstream side of the combustion stage 12 or the upstream side of the post-combustion stage 13 detected by the imaging device 34 is a detection signal corresponding to the position of the burn out point P of the incineration object B.

[0126] The burn out point estimation unit 30a of the control device estimates the position of the burn out point P, on the basis of the temperature distribution detected by the imaging device 34.

[0127] The driving device control unit 30b controls the second driving device 18b and the third driving device 18c such that the movable fire grate 16 of the combustion stage 12 and the movable fire grate 16 of the combustion stage 13 are driven at the same driving speed, when the burn out point P is located at the same position as the target burn out point Pt or when the burn out point P is located on the upstream side of the target burn out point Pt in the conveying direction.

[0128] The driving device control unit 30b controls the second driving device 18b and the third driving device 18c such that the driving speed of the movable fire grate 16 of the post-combustion stage 13 is driven at a driving speed slower than the driving speed of the movable fire grate 16 of the combustion stage 12, as in the first embodiment, when the position of the burn out point P is located on the downstream side of the target burn out point Pt in the conveying direction.

[0129] According to the above embodiment, the position of the burn out point P can be more accurately estimated, by grasping the temperature distribution on the stoker 5.

[0130] Although the embodiments of the present invention have been described in detail with reference to the drawings, the specific configuration is not limited to this embodiment, and design changes and the like within the scope not deviating from the gist of the present invention are included.

[0131] In the above embodiment, the distal ends of the fire grate 15 and 16 are disposed to face the downstream side D1 in the conveying direction. However, the present invention is not limited thereto. For example, the distal ends of the fire grates 15 and 16 of the drying stage 11 may be disposed to face the upstream side in the conveying direction.

[0132] In addition to using one of the thermocouple and the imaging device as the burn out point detection device, the position of the burn out point P may be estimated using both the thermocouple and the imaging device. For example, a combination of the first embodiment or the second embodiment and the third embodiment may be adopted.

[Reference Signs List]

[0133]

1 Stoker furnace
2 Hopper
3 Incineration furnace
4 Feeder
5 Stoker
6a First wind box
6b Second wind box
6c Third wind box
7 Feed table
8 Feeder driving device
9 Combustion chamber
10 Secondary air supply nozzle
11 Drying stage
11a Installation surface of drying stage
12 Combustion stage
12a Installation surface of combustion stage
13 Post-combustion stage
13a Installation surface of post-combustion stage
15 Fixed fire grate
16 Movable fire grate
16P Fire grate with protrusion
17 Ash outlet
18 Driving device
18a First driving device
18b Second driving device
18c Third driving device
19 Beam
20 Hydraulic cylinder
21 Arm
22 Beam
23 Bracket
25 Fire grate body
26 Protrusion
27 Step (drop wall)
30 Control device
31 Thermocouple (burn out point detection device)
32 Drying stage thermocouple
33a First pressure measuring device
33b Second pressure measuring device
34 Imaging device (burn out point detection device)
B Incineration object
D Conveying direction
D1 Downstream side in conveying direction
P Burn out point
θ1, θ2, θ3 Stoker inclination angle

Claims

1. A stoker furnace which is configured to feed an incineration object from a feeder, and perform each of drying, combustion and post-combustion, while sequentially conveying the incineration object, in a drying stage, a combustion stage and a post-combustion stage, which include a plurality of fixed fire grates and a plurality of movable fire grates, the stoker furnace comprising:

a burn out point detection device configured to obtain a detection signal corresponding to a position of a burn out point of the incineration object;

a first driving device configured to drive the movable fire grate of the drying stage;

a second driving device configured to drive the movable fire grate of the combustion stage;

a third driving device configured to drive the movable fire grate of the post-combustion stage; and

a control device configured to control the first driving device, the second driving device, and the third driving device,

wherein the drying stage is disposed to be inclined so that a downstream side in the conveying direction is directed downward,

the combustion stage is connected to the drying stage and is disposed to be inclined so that the downstream side in the conveying direction faces upward,

the post-combustion stage is continuously connected to the combustion stage without a step and is disposed to be inclined so that the downstream side in the conveying direction faces upward, and

the control device is configured to receive the detection signal, and control the second driving device and the third driving device so that, when a position of the burn out point corresponding to the detection signal acquired by the burn out point detection device does not exceed a target burn out point, the driving speeds of the movable fire grate of the combustion stage and the movable fire grate of the post-combustion stage are not changed, and when the position of the burn out point corresponding to the detection signal is located on the downstream side of the target burn out point in the conveying direction, the driving speed of the movable fire grate of the post-combustion stage is slower than the driving speed of the movable fire grate of the combustion stage.

2. The stoker furnace according to claim 1, wherein the fixed fire grate and the movable fire grate are disposed to be inclined so that the downstream side in the conveying direction faces upward with respect to installation surfaces of the drying stage, the combustion stage, and the post-combustion stages.

3. The stoker furnace according to claim 2, wherein at least a part of the plurality of movable fire grates of the combustion stage is a fire grate with a protrusion in which a protrusion is provided at a distal end.

4. The stoker furnace according to any one of claims 1 to 3, wherein the burn out point detection device is a thermocouple installed in at least one of the combustion stage and the post-combustion stage.

5. The stoker furnace according to any one of claims 1 to 3, wherein the burn out point detection device is an imaging device which detects a temperature distribution of the combustion stage or the post-combustion stage.

6. The stoker furnace according to claim 4 or 5, further comprising:

a first wind box disposed corresponding to the drying stage;

a first pressure measuring device configured to output a first pressure signal corresponding to the pressure or pressure change of the first wind box;

a second wind box disposed corresponding to the combustion stage;

a second pressure measuring device configured to output a second pressure signal corresponding to the pressure or pressure change of the second wind box; and

a drying stage temperature measuring device installed in the drying stage to output a temperature signal corresponding to the temperature or temperature change of the drying stage,

wherein the control device is configured to receive the temperature signal, the first pressure signal and the second pressure signal, and perform a control such that, when the pressure or the pressure change corresponding to the first pressure signal is equal to or greater than a first threshold value, the pressure or the pressure change corresponding to the second pressure signal is less than a second threshold value, and the temperature or the temperature change corresponding to the temperature signal is equal to or greater than a third threshold value, the driving speed of the movable fire grate of the drying stage is increased, and when the pressure or the pressure change corresponding to the first pressure signal or is less than the first threshold value, the pressure or the pressure change corresponding to the second pressure signal is equal to or greater than the second threshold value, and the temperature or the temperature change corresponding to the temperature signal is less than the third threshold value, the driving speed of the movable fire grate of the drying stage is decreased.

FIG. 1

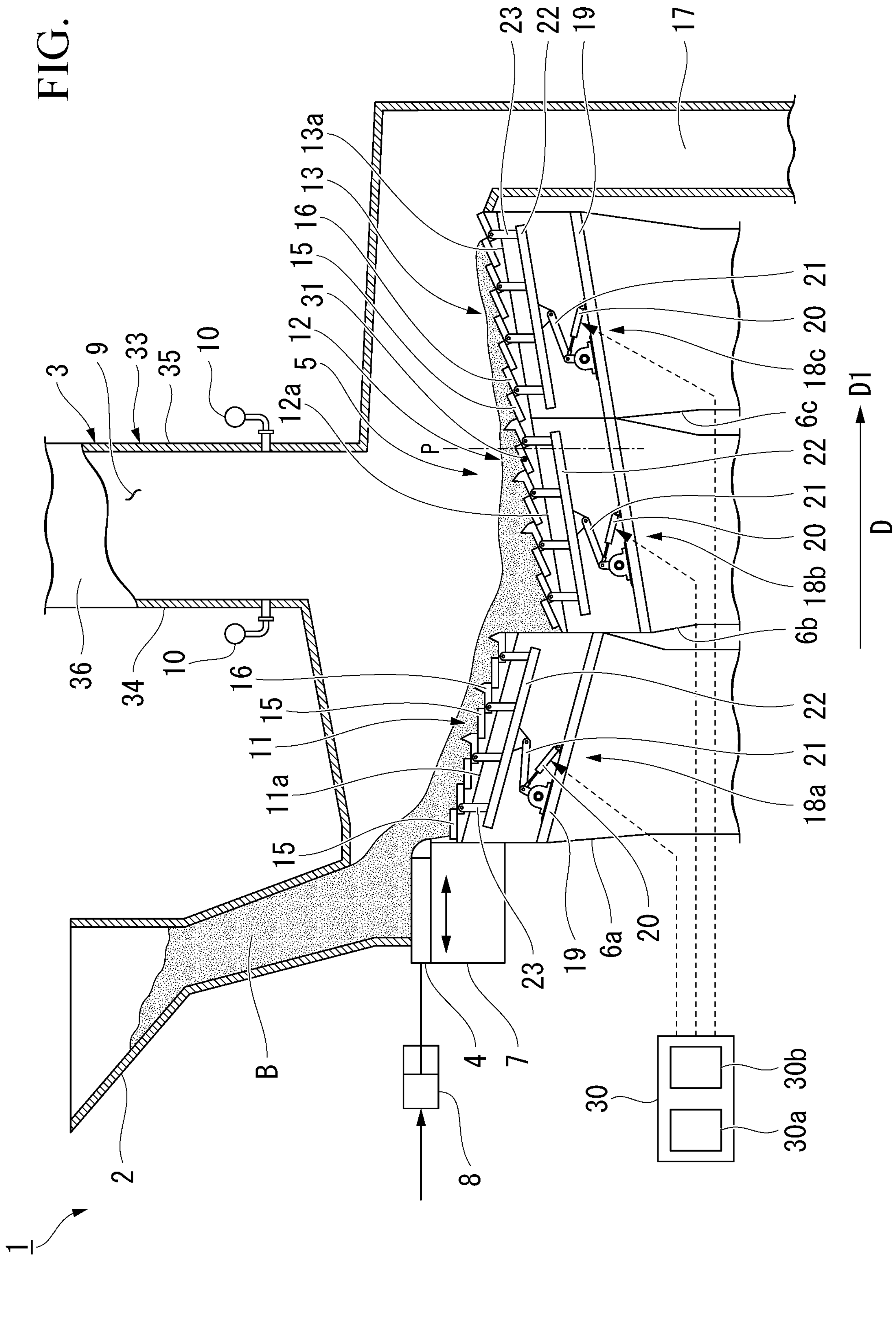
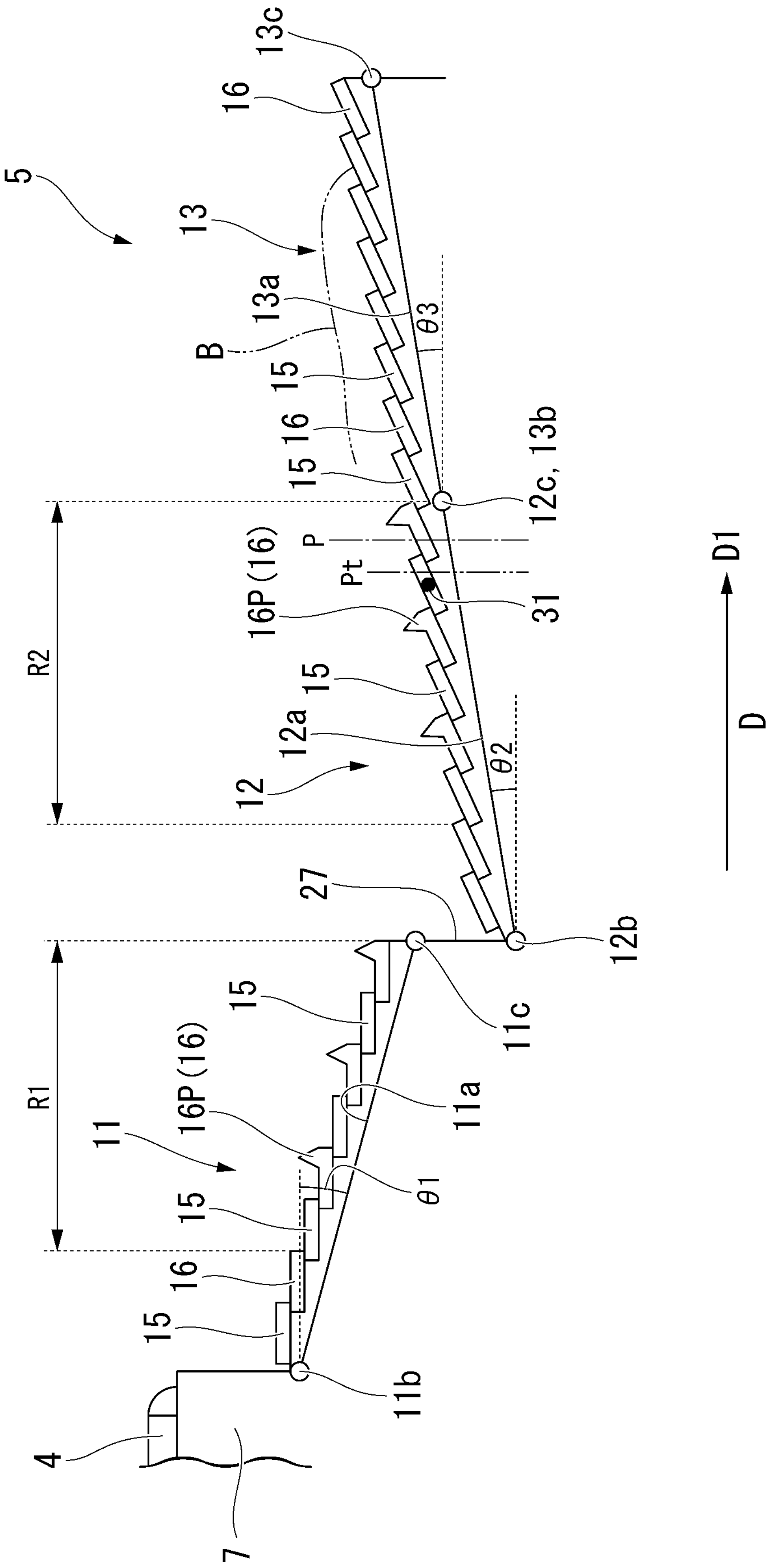

1
2
B
4
7
8
30
30a
30b
36
34
10
16
15
11
11a
15
23
19
6a
20
22
21
18a
6b
18b
20
21
22
6c
18c
20
21
D
D1
3
9
33
35
10
12a
5
12
31
15
16
13
13a
23
22
19
17
P

FIG. 2


5
13c
16
13
13a
B
15
16
15
12c, 13b
θ3
P
Pt
16P (16)
31
R2
15
12a
12
θ2
D1
D
27
12b
R1
11
16P (16)
15
11c
11a
θ1
15
16
15
11b
4
7

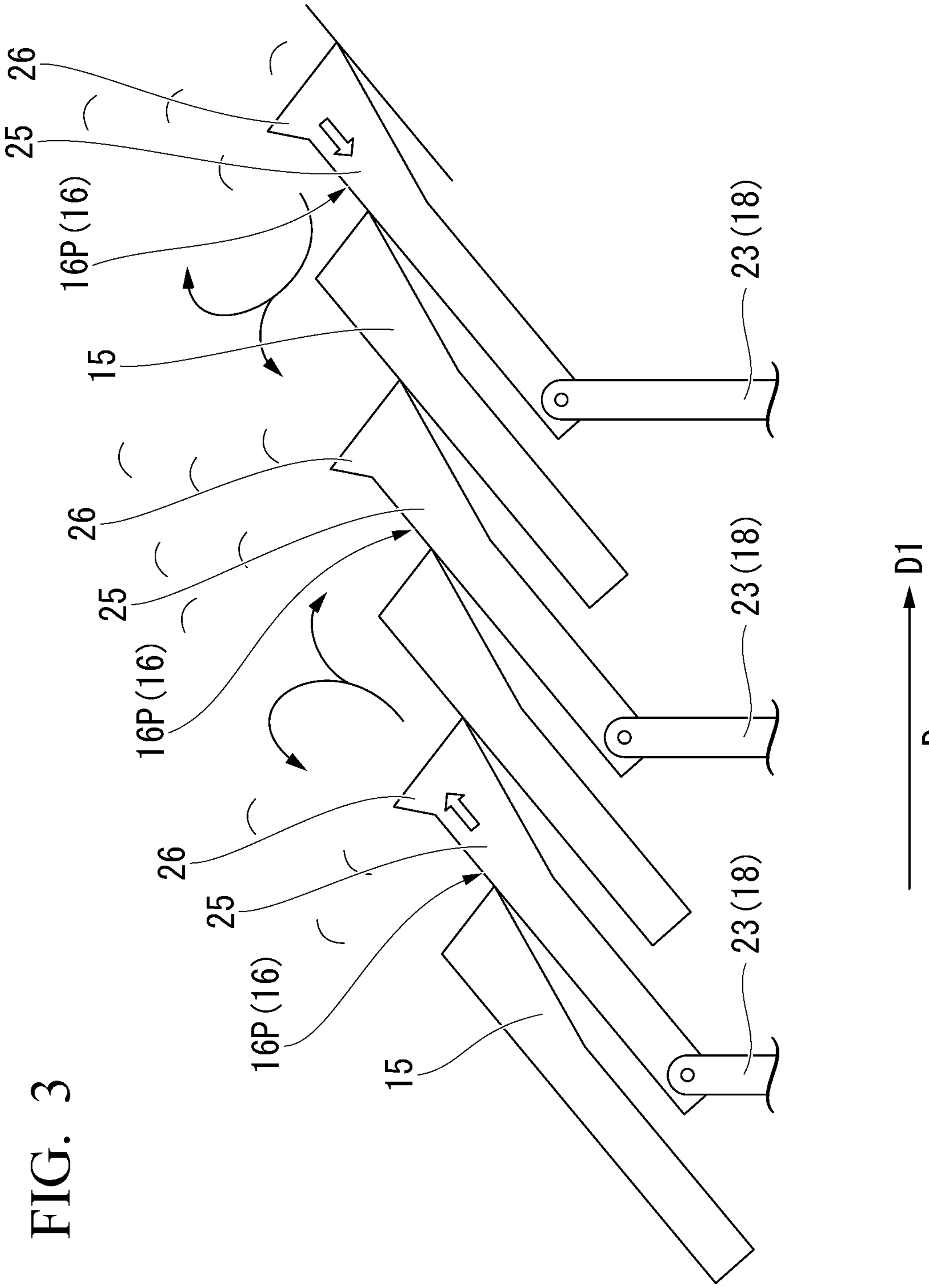


FIG. 3

FIG. 4

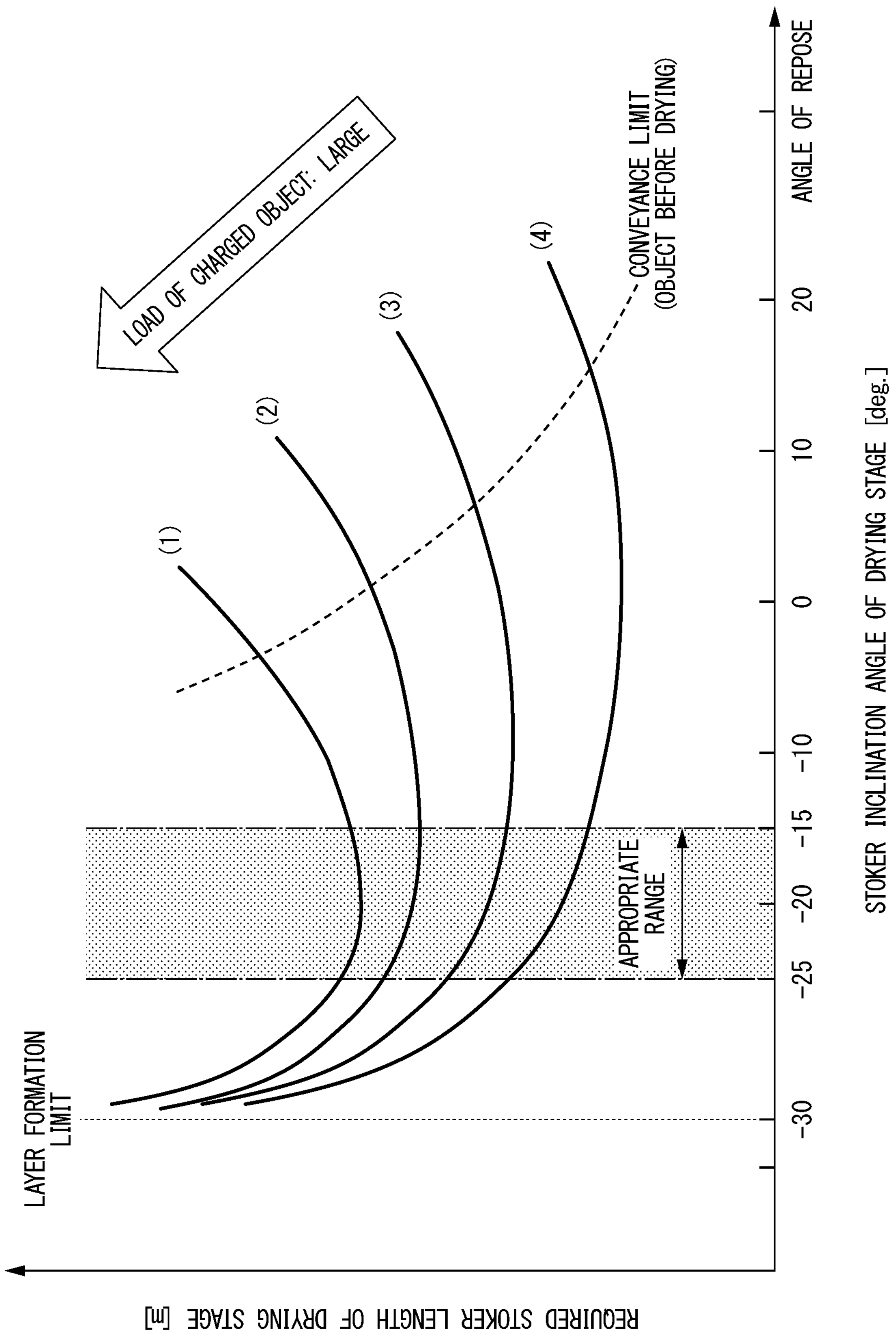

LOAD OF CHARGED OBJECT: LARGE
(1)
(2)
(3)
(4)
CONVEYANCE LIMIT
(OBJECT BEFORE DRYING)
LAYER FORMATION
LIMIT
APPROPRIATE
RANGE
ANGLE OF REPOSE
−30
−25
−20
−15
−10
0
10
20
STOKER INCLINATION ANGLE OF DRYING STAGE [deg.]
REQUIRED STOKER LENGTH OF DRYING STAGE [m]

FIG. 5

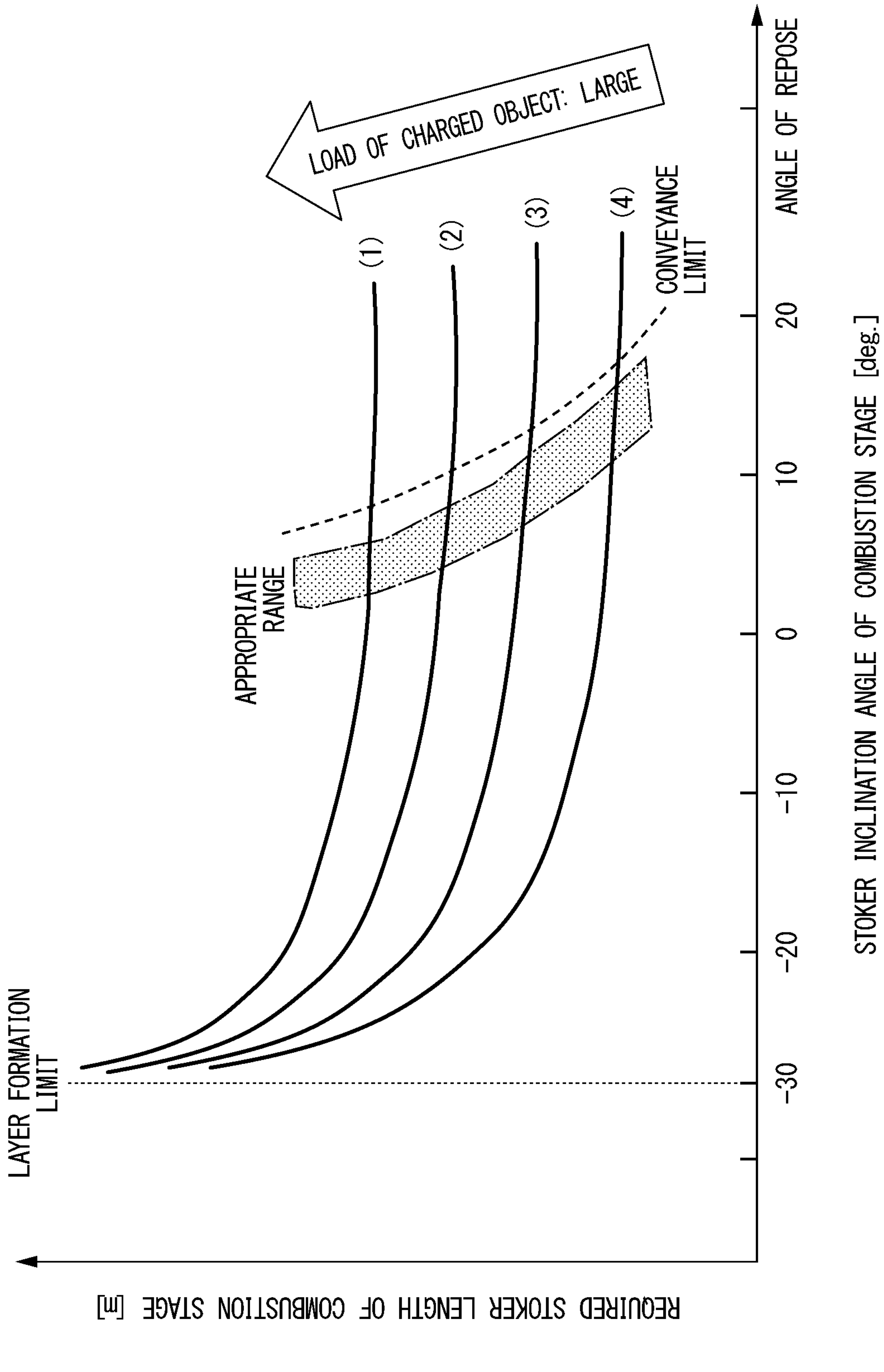
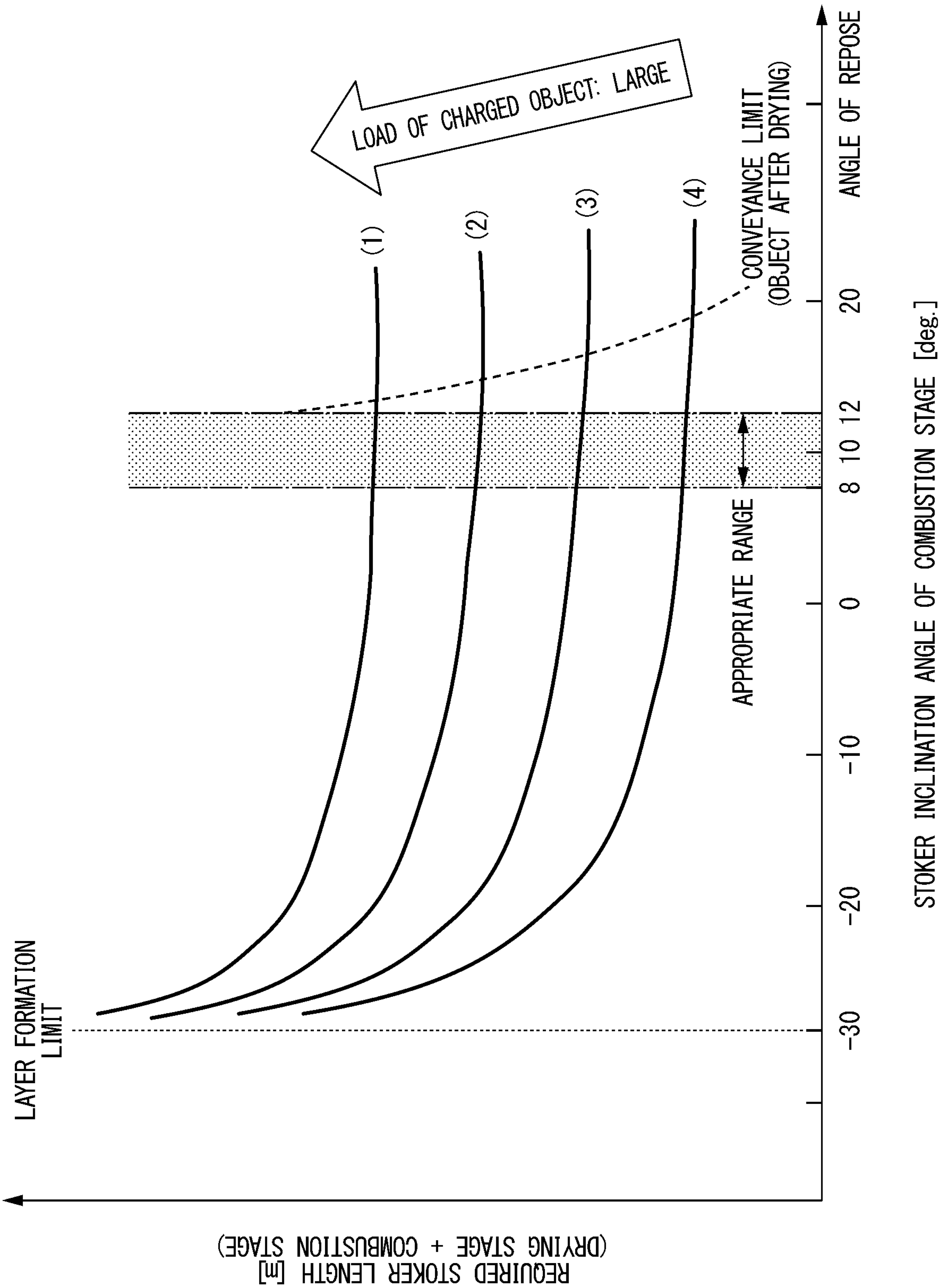

LOAD OF CHARGED OBJECT: LARGE
(1)
(2)
(3)
(4)
CONVEYANCE LIMIT
APPROPRIATE RANGE
LAYER FORMATION LIMIT
ANGLE OF REPOSE
-30
-20
-10
0
10
20
STOKER INCLINATION ANGLE OF COMBUSTION STAGE [deg.]
REQUIRED STOKER LENGTH OF COMBUSTION STAGE [m]

FIG. 6


LOAD OF CHARGED OBJECT: LARGE
(1)
(2)
(3)
(4)
CONVEYANCE LIMIT
(OBJECT AFTER DRYING)
APPROPRIATE RANGE
LAYER FORMATION
LIMIT
-30
-20
-10
0
8 10 12
20
ANGLE OF REPOSE
STOKER INCLINATION ANGLE OF COMBUSTION STAGE [deg.]
REQUIRED STOKER LENGTH [m]
(DRYING STAGE + COMBUSTION STAGE)

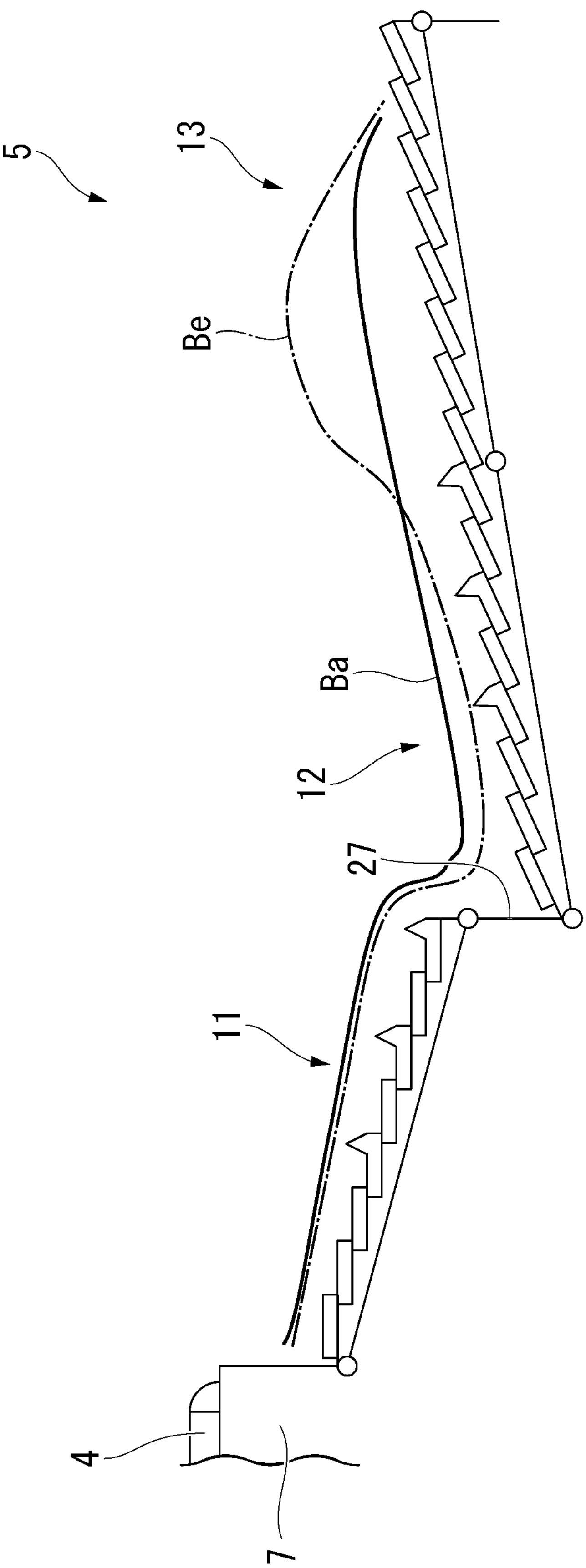


FIG. 7

FIG. 8

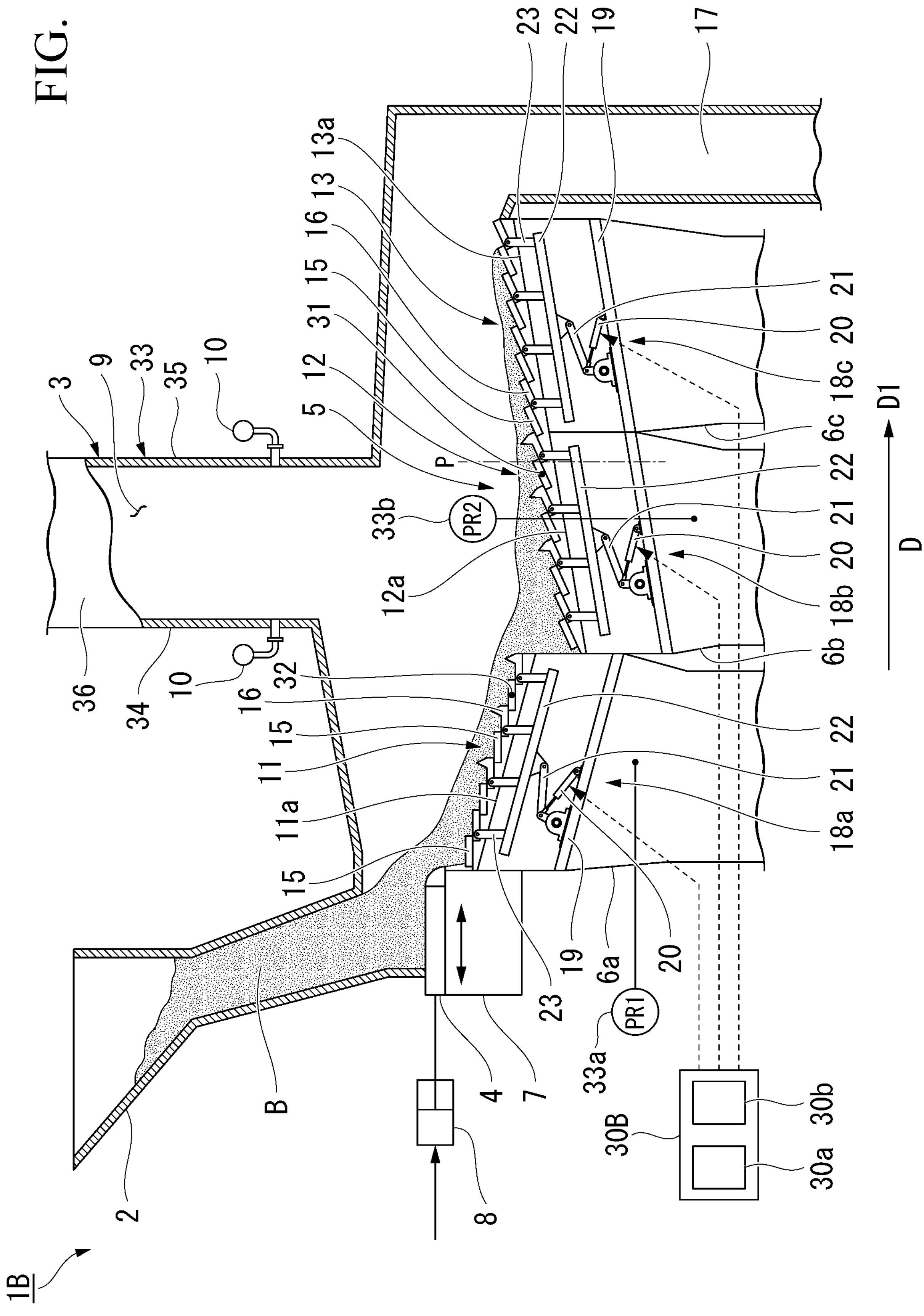
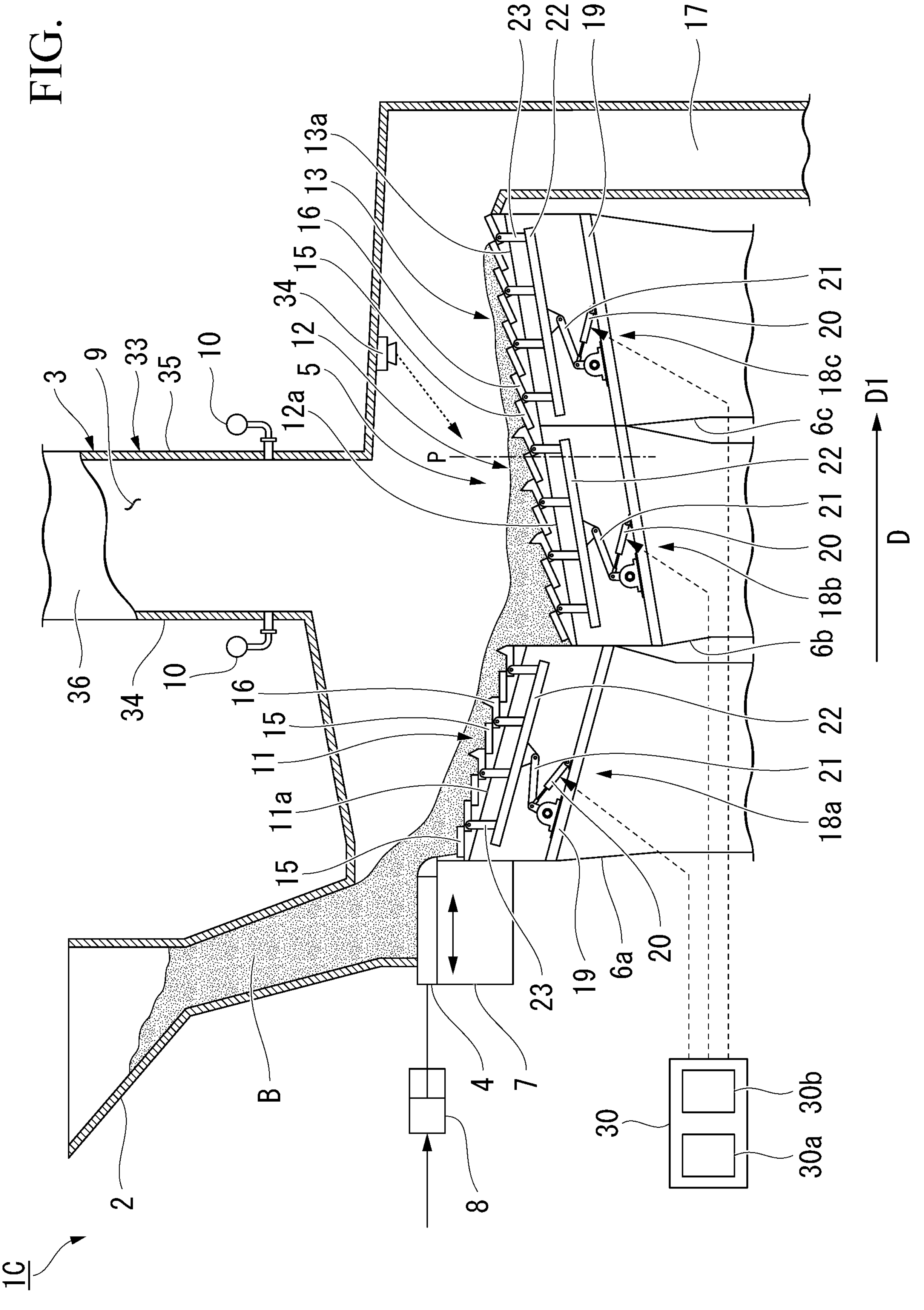

1B
2
B
8
4
7
33a
PR1
30B
30a
30b
36
34
10
32
16
15
11
11a
23
19
6a
20
22
21
18a
3
9
33
35
5
12
31
13
13a
P
33b
PR2
12a
6b
18b
6c
18c
D1
D
17

FIG. 9


1C
2
B
4
7
8
30
30a
30b
36
34
10
16
15
11
11a
23
19
6a
20
18a
21
22
6b
18b
6c
18c
D
D1
P
3
9
33
35
12a
5
12
13
13a
17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/039867

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F23G5/00(2006.01)i, F23G5/50(2006.01)i, F23H7/08(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)
Int. Cl. F23G5/00, F23G5/50, F23H7/08

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

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.
A	JP 2005-214513 A (TAKUMA KK) 11 August 2005, paragraphs [0017]-[0033], fig. 1 (Family: none)	1-6
A	JP 11-37436 A (SUMITOMO HEAVY INDUSTRIES, LTD.) 12 February 1999, paragraphs [0015]-[0040], fig. 1 (Family: none)	1-6
A	JP 6-341628 A (KUBOTA CORP.) 13 December 1994, paragraphs [0007]-[0012], fig. 1 (Family: none)	1-6
A	JP 5-141640 A (KUBOTA CORP.) 08 June 1993, paragraphs [0006]-[0010], fig. 1 (Family: none)	1-6

☒ 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	Date of mailing of the international search report
07.12.2018	18.12.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/039867

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, A	JP 6397107 B1 (MITSUBISHI HEAVY INDUSTRIES ENVIRONMENTAL & CHEMICAL ENGINEERING CO., LTD.) 26 September 2018, paragraphs [0025]-[0061], fig. 1 (Family: none)	1-6

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2018161817 A **[0002]**
- JP H6265125 A **[0007]**
- JP S5986814 A **[0007]**
- JP H684140 U **[0007]**
- JP S5712053 B **[0007]**
- JP S57127129 U **[0007]**
- JP H328618 A **[0007]**